



## **Adaptation and mitigation pathways, and synergy mechanisms between them, for the case studies**

Katharina Hölscher<sup>1</sup>, Niki Frantzeskaki<sup>1</sup>, Ian Holman<sup>2</sup>, Simona Pedde<sup>3</sup>, Linda Juhasz-Horvath<sup>4</sup>, Elizabeth Clarke<sup>5</sup>, Schipper Karlijn<sup>1</sup>, Jill Jäger<sup>6</sup>

<sup>1</sup> *DRIFT, The Netherlands*

<sup>2</sup> *Cranfield University, UK*

<sup>3</sup> *Wageningen University, The Netherlands*

<sup>4</sup> *Central European University, Hungary*

<sup>5</sup> *University of Edinburgh, UK*

<sup>6</sup> *Independent, Austria*

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Strategies for Innovative Solutions ([www.impressions-project.eu](http://www.impressions-project.eu))



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## Preface

The European Commission-funded FP7 project IMPRESSIONS (Impacts and Risks from High-end Scenarios: Strategies for Innovative Solutions) is an ambitious study of the risks and consequences of high-end projections of future climate change for Europe, and the options available for averting its most adverse effects in the context of alternative development pathways. Work Package 4 aims to develop time- and scale-dependent adaptation, mitigation and transformation pathways within the IMPRESSIONS case studies that build resilience and promote sustainability in the context of combined high-end socio-economic and climate change scenarios. The development of such pathways builds on an advanced transition management approach (described in Deliverable D4.1 - Frantzeskaki et al. 2015). This provides an overarching framework to structure stakeholder engagement processes in the case studies to consider how long-term, transformative change towards a sustainable and resilient future can be enabled.

This report presents the adaptation, mitigation and transformation pathways that were developed in the four IMPRESSIONS case studies in Europe, Scotland, Hungary and Iberia. The pathways were iteratively co-developed between a broad range of stakeholders in each case study and the IMPRESSIONS team through a facilitated stakeholder engagement process. The report outlines the pathways in each case study including (1) the constituent strategies and actions to achieve a sustainability and resilience vision, (2) the conditions these create in terms of governance capacities that enable their implementation, and (3) the impacts in terms of achieving the stakeholders' vision and resulting synergies and trade-offs. The report also presents a cross-case comparison to discuss implications of pathways across scales.

The pathways that were co-developed in IMPRESSIONS provide policy-relevant knowledge on how to address climate change and support societal transformations towards sustainability and resilience in the context of different socio-economic and climate change scenarios. They identify possible courses of action for achieving desirable transformations, synergies and trade-offs between different actions and strategies, robust actions and solutions across different scenarios, as well as the institutional and agency conditions that are needed to implement them. In summary, the pathways produce concrete knowledge on strategies and actions, which were developed and agreed on by a broad range of stakeholders and provide support to decision-making.

## Summary

The emerging paradigm of climate change as a transformation challenge becomes especially relevant in view of the growing likelihood of extreme or high-end climate change. This could lead to detrimental environmental, social and economic consequences and to the emergence of critical thresholds that tip current social-ecological systems into another (probably less socially desirable) state with largely unknown consequences. Approaching climate change as a transformation challenge recognises that climate change does not act as an isolated force with detached implications for societal well-being. It opens up opportunities for focusing collective solution-finding efforts towards developing improved and just living conditions whilst keeping societies within a 'safe operating space', as foreseen as the end result of the successful implementation of the Paris Agreement.

The systemic perspective enables integrative approaches that recognise synergies and trade-offs between multiple policy domains and goals. Coping with climate change under high-end scenarios and contributing to desirable societal transformations requires new solution approaches that can deal with non-linearity and deep uncertainty, link climate resilience to broader considerations of sustainability and resilience, and foster more fundamental changes to overcome underlying path dependencies and lock-ins. Pathways thinking has been adopted within the climate adaptation community as a response to the growing realisation that efforts to adapt to climate change have not yet led to substantial implementations of systemic or transformative actions and that there is a need for decision-making oriented research. Pathways are a new tool for approaching and visualising complexity from a systemic perspective, focusing on process and learning rather than outcome and providing an explicit action perspective.

Within the IMPRESSIONS project, the aim was to develop mitigation, adaptation and transformation pathways that reduce climate change, prepare and protect societies from the impacts of climate change and support transformations towards sustainability and resilience. The development of the pathways followed an advanced transition management approach as an overarching framework to consider how long-term, transformative change towards a sustainable and (climate) resilient future can be enabled. The pathways were developed in iterative co-creation processes between IMPRESSIONS experts and stakeholders in four case studies at multiple scales across Europe (European continental scale, Scotland national scale, Iberia transboundary river basin scale and two Hungarian municipalities). The pathways are oriented towards an explicitly normative direction (i.e. a vision for sustainability and resilience in a far-away future for 2100). For each case study, we have developed pathways for achieving the vision in the context of combined high-end climate and socio-economic change scenarios.

This report presents the adaptation, mitigation and transformation pathways that were developed in the four IMPRESSIONS case studies to achieve a sustainability and resilience vision. It outlines the pathways including the constituent strategies and actions, the governance capacities that enable their implementation and their impacts in terms of achieving the stakeholders' vision and resulting synergies and trade-offs. The report also presents a cross-case comparison.

The visions that were formulated in all case studies play a key role in orienting the pathways by providing long-term and integrated directions. In all case studies the visions include a diversity of elements on social, economic and environmental sustainability as well as governance. Whilst derived through independent processes, there is a high degree of commonality in the visions developed by the stakeholders across the case studies. All visions emphasise high quality of life and well-being, including sustainable lifestyles, new health and education systems and equality. They also describe new modes of governance that are based on democratic values, transparency and multi-level and international cooperation and collaboration. The visions also include high levels of environmental

protection – planetary boundaries are respected, resilience is ensured, sustainability and natural resource protection are embedded in policy-making and economic activity, and resources such as water, energy and food are managed and consumed sustainably. In summary, from the visions a pan-European agreement within the diverse participants in the IMPRESSIONS stakeholder groups becomes apparent as to the high-level societal goals of future policy.

The case studies' bundles of pathways contain vitally important transformation pathways to move society towards more sustainable lifestyles and economies, mitigation pathways to transition Europe to a low carbon economy and adaptation pathways to reduce the impacts and vulnerabilities associated with high-end climate change in the water and agricultural sectors. The pathways include strategies and actions for technological innovation (e.g. renewable energy technology, water efficiency technologies) and nature-based solutions (e.g. nature zones, green infrastructure). Additionally, they include a suite of strong regulations and incentives to mandate and incentivise sustainable lifestyles, innovation and economic activities. In particular, the pathways to promote shifts towards sustainable lifestyles include education and awareness-raising activities to enhance consideration of the environment and social equity and cohesion, and to provide the population with the skills (practical, creative, decision-making, etc.) needed for the future.

The pathways build new governance capacities, starting from an integrated perspective on sustainability decision-making and planning. This perspective helps to engage in integrated resource and land use planning, which takes into account different context needs, opportunities and synergies, and trade-offs across Europe and its regions. For example, water management is addressed from an integrated perspective that addresses water quality and quantity protection in relation to agriculture, biodiversity, land use, energy, recreation and climate adaptation, amongst others. All case studies emphasise the need to create framework conditions that integrate environmental costs and social equity into production and consumption activities. Additionally, all pathways build on multi-level governance systems and international collaboration for a global sustainability agenda. While the European pathways (mostly) take a European-level perspective on planning, the regional and local case studies emphasise the regional and local levels and the role of local communities in decision-making, climate adaptation and promoting local economies. The Iberian pathway also includes transboundary collaboration between Portugal and Spain to manage their common water bodies. All case studies include strong notions of participation in decision-making at global, European, national and local levels.

The pathways that were developed in IMPRESSIONS provide policy-relevant knowledge on how to address climate change and support societal transformations towards sustainability and resilience in the context of different socio-economic and climate change scenarios. They contribute towards achieving a long-term sustainability vision by means of diverse strategies and actions that build social, human, natural, manufactured and financial capitals as well as the governance capacities needed to implement the pathways. By orienting diverse strategies and actions towards a long-term and integrated sustainability vision, the pathways enable society to deal with complexity and to create synergies by bridging across sectors and scales. Additionally, the pathways provide an explicit action perspective regarding who are the actors that implement the pathways and how they do so.

The analysis of the effectiveness of the pathways in achieving the vision within each case study demonstrated that many of the vision element indicators could not reach their desired value (i.e. could not meet the vision). This arises due to a combination of the significant residual impacts of high-end climate change, systemic time lags and/or recalcitrant characteristics of the socio-economic scenarios. This underscores the need for urgent and immediate action on meeting the requirements of the Paris Agreement through developing adaptation, mitigation and transformation actions which prepare Europe, its Member States and regions for an uncertain future.

## 1. Introduction

The emerging paradigm of climate change as a transformation challenge in scientific and policy discourses frames the climate debate more broadly – especially post COP21 – to consider climate change both as an amplifier and symptom of contemporary social, economic and environmental crises and problems such as resource depletion and growing social inequalities (WBGU 2011; Hermwille 2016). This view recognises that climate change does not act as an isolated force with detached implications for societal wellbeing. Rather, climate change is caused by the ways resources are produced and consumed especially in the global North. Likewise, climate impacts exacerbate existing sustainability challenges, vulnerabilities and risks (IPCC 2014). Thus, this view highlights that responses to climate change cannot be effective without understanding the larger socio-economic context of sustainability and resilience. It reframes climate mitigation and adaptation from singular and technical issues and domains such as emissions reductions and isolated climate impacts towards contributing to sustainability and resilience transformations (O'Brien and Selboe 2015; Gillard et al. 2016).

Positioning climate change as a transformation challenge opens up opportunities for focusing collective solution-finding efforts towards developing improved and just living conditions whilst keeping societies within a 'safe operating space' (Hermwille 2016; Pereira et al. 2015). Transformations are understood as radical structural changes of socio-cultural, institutional, political, economic, technological and ecological dimensions of a given system (IPCC 2014; Brand 2016). This systemic perspective enables integrative approaches that recognise synergies and trade-offs between multiple policy domains and goals associated with societal wellbeing (McHale et al. 2015; Pelling et al. 2015). For example, in this view climate adaptation connects with concerns of marginalised groups whose already heightened vulnerability will be amplified (Gillard et al. 2016).

This understanding of climate change as a transformation challenge becomes especially relevant in view of the growing likelihood of extreme climate change. Extreme climate scenarios describe climate change levels at the upper end of the range of possible futures. It is increasingly plausible that global increases in mean temperatures will surpass the 2°C threshold (IPCC 2014), despite the ambition of the Paris Agreement. This could lead to detrimental environmental, social and economic consequences and to the emergence of critical thresholds that tip current social-ecological systems into another (probably less socially desirable) state with largely unknown consequences (Rockström et al. 2009; Steffen et al. 2015; Russill 2015). To explore what such futures under extreme climate change could look like, IMPRESSIONS developed high-end scenarios, which include Representative Concentration Pathways (RCPs) beyond the 2°C threshold<sup>1</sup> and Shared Socioeconomic Pathways (SSPs). The latter are consistent with, but independent of, the RCPs (Deliverable D2.2 - Kok and Pedde 2016).

Coping with climate change under high-end scenarios and contributing to desirable societal transformations requires new approaches that can deal with non-linearity and deep uncertainty, link climate resilience to broader considerations of sustainability and resilience, and foster more fundamental changes to overcome underlying path dependencies and lock-ins (Hermwille 2017; Meadowcroft 2009; Shaw et al. 2014). Actions and responses will involve some balance of mitigation, adaptation, transformation and residual damages (Tinch et al. 2015).

Within the IMPRESSIONS project, the aim was to develop mitigation, adaptation and transformation pathways that reduce climate change, prepare and protect societies from the impacts of climate

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<sup>1</sup> Thus, in the IMPRESSIONS project, we consider RCPs beyond the EU and UNFCCC target to limit climate change to 2°C above pre-industrial levels, and the aim after Paris 2015 to make efforts to limit climate change to 1.5°C above pre-industrial levels.

change and support transformations towards sustainability and resilience in the context of high-end scenarios. These pathways would generate policy-relevant knowledge on possible courses of action for achieving desirable transformations, synergies and trade-offs between different actions and strategies, robust actions and solutions across different scenarios, as well as the institutional and agency conditions that are needed to implement them.

Across scientific disciplines and in policy discourses, the concept of pathways has received increasing attention as a way to frame the challenge of envisioning and moving towards a desirable – sustainable, low-carbon, just and resilient – future. The key contribution of the pathways concept is that it aids making sense of patterns of change and thinking of strategies and actions to respond to and proactively address complex problems like climate change from an integrated and systemic perspective (Leach et al. 2010; Turnheim et al. 2015) – including the “social and political conditions that produce vulnerability and the challenges of dealing with the complex dynamics of social and ecological processes, and the high degrees of uncertainty in planning for sustainability in the current era” (Wise et al. 2014, p.3).

Additionally, pathways thinking implies an explicit action perspective that guides (and mobilises) future action towards a long-term future by highlighting the processes by which multiple actors can mobilise, respond to and shape their contested contexts and its dynamics of change (Foxon 2013; Nevens et al. 2013). By orienting and connecting a plurality of ideas for strategies and actions across sectors and scales towards common long-term goals, pathways assist in navigating between different narratives, challenging assumptions and bridging different worldviews, especially when applied in a participatory manner (Butler et al. 2004; Luederitz et al. 2017).

For these reasons and because of the so-far persistent failures to support decisive and systemic actions to address climate change, the pathway frame has been adopted within climate change adaptation research to enable more decision-making-oriented research (Wise et al. 2014; Haasnoot et al. 2013; McPhearson et al. 2016). Pathways thinking marks a paradigmatic shift in how to address climate change as a transformation challenge. It enables the positioning of climate change within the broader social, cultural, political, economic and institutional contexts, dynamics, synergies and trade-offs and to develop an explicit agency perspective on ‘who is the solution’ (Rosenbloom 2017; Wise et al. 2014; Haasnoot et al. 2013; Nevens et al. 2013).

While having become a popular analytical frame and tool for approaching complex sustainability problems, the pathways concept is applied in many different ways (Wise et al. 2014; Rosenbloom 2017; van Vuuren et al. 2015). For example, Haasnoot et al. (2013) view pathways as an analytical approach for exploring and sequencing a set of actions based on alternative external developments over time. Constructivist approaches take into account values and social behaviour and construct desirable directions for social change towards normative goals. They often employ participatory methods (Rosenbloom, 2017). Especially within sustainability transition thinking and transition management approaches, pathways are applied as an instrument to connect the unsustainable present to the long-term sustainability vision, describing a route for reaching this vision through intermediate objectives and actions (Foxon 2013; Frantzeskaki et al. 2012).

In IMPRESSIONS, we view pathways as being oriented towards an explicitly normative direction, i.e. a vision for sustainability and resilience in a far-away future. Together, adaptation, mitigation and transformation pathways outline progressive courses of action to address climate change and related environmental, economic and social issues in a synergistic way to achieve the vision (Frantzeskaki et al. 2015). The development of the integrated adaptation, mitigation and transformation pathways in IMPRESSIONS followed an advanced transition management approach as an overarching framework to consider how long-term, transformative change towards a sustainable and (climate) resilient future



can be enabled (Deliverable D4.1 - Frantzeskaki et al. 2015). The pathways were developed in iterative co-creation processes between IMPRESSIONS experts and stakeholders in four case studies that combine multiple scales across Europe.

In addition to producing concrete knowledge on strategies and actions and supporting decision-making, this approach also generates insights into working with normative, inter- and transdisciplinary approaches for addressing sustainability and resilience problems. Pathways research is often both interdisciplinary and transdisciplinary, combining quantitative and qualitative methods such as scenario narratives, modelling and stakeholder engagement. In this way, it promises to produce more robust, context-relevant and credible insights for decision-making (Foxon 2013; Rosenbloom 2017; Robertson et al. 2017).

In summary, the pathways were developed building on the following key elements that resonate with different guiding questions addressed in IMPRESSIONS:

- **High-end scenarios** (*where might we be?*): The high-end scenarios provide through their distinct contexts different enabling and disabling conditions for building resilience and promoting sustainability.
- **Vision** (*where do we want to be?*): The vision includes normative statements that guide the development of pathways towards a desirable – sustainable and resilient – future.
- **Pathways** (*how do we get there?*): The pathways include short-, medium- and long-term actions clustered in strategies that respond to specific vision elements. Pathways include sectoral or cross-sectoral and multi-actor strategies that demonstrate how to achieve the vision (or specific vision elements) in the context of high-end scenarios.
- **Governance capacities** (*with whom do we get there?*): The governance capacities indicate the collective abilities of actors to mobilise, source and create the resources for developing and implementing adaptation, mitigation and transformation responses to climate change and socio-economic conditions and to move towards the vision. The governance capacities enable the identification of which, and how, multiple actors (government, market and civil society at multiple levels: global, European, regional, local scales) can collectively take up action for climate change and sustainability as identified by the pathways. The capacities are dependent on the initial conditions of the scenario contexts and the action conditions that are created by the pathways as they unfold.

This report presents the adaptation, mitigation and transformation pathways that were iteratively co-developed in the four IMPRESSIONS case studies in Europe, Scotland, Hungary and Iberia. In the following, we first describe the methodology used to develop stakeholder-led adaptation, mitigation and transformation pathways in the four case studies (Section 2). We then present the adaptation, mitigation and transformation pathways that have been developed in Europe (Section 3), Scotland (Section 4), Hungary (Section 5) and Iberia (Section 6). Each case study is reported by positioning the pathways within the respective scenario contexts that provide the logic for developing the pathways (as interpreted by the stakeholders) and by presenting the stakeholders' vision that has oriented the pathways development. The case study reports also include the analysis of pathways in terms of the agency conditions they build up and that enable their implementation (i.e. governance capacities) as well as their impacts (pathways' efficacy in achieving the vision, synergies and trade-offs). Section 7 includes the analysis of pathways across case studies to discuss similarities and differences and cross-scale implications and relationships. Section 8 summarises the key conclusions.

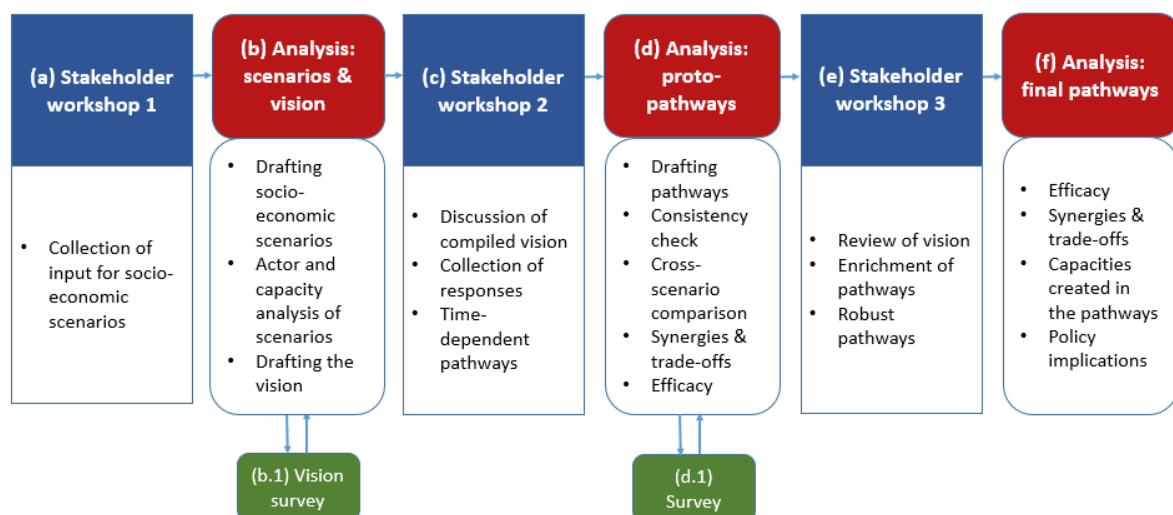
## 2. Methodology and process steps for developing the IMPRESSIONS pathways

The integrated adaptation, mitigation and transformation pathways in IMPRESSIONS were created in participatory knowledge generation processes that followed the advanced transition management approach as an overarching framework (Deliverable D4.1 - Frantzeskaki et al. 2015). The transition management methodology has been introduced as a new approach to deal with the persistent unsustainability problems that societies face today (Rotmans et al. 2001; Loorbach 2007; Loorbach et al. 2015; Frantzeskaki et al. 2012). It supports consideration of how long-term, transformative change towards a sustainable and resilient future can be enabled.

The transition management methodology has been advanced in IMPRESSIONS to consider high-end socio-economic and climate scenarios as follows (Deliverable D4.1 - Frantzeskaki et al. 2015):

- (a) Pathways are formulated using moderated backcasting to a future contextual scenario (different SSPs and matched RCPs) instead of backcasting to the current situation or projections from the current situation to the future;
- (b) Pathways include sectoral and cross-sectoral strategies that respond to achieving the same scenario-independent vision element(s);
- (c) Information inputs during the identification of actions included results from stress-testing existing EU policies for their fitness and performance in different context scenarios (Deliverable D5.3 - Carlsen et al. 2017) and simulated impacts and vulnerabilities associated with the contextual scenarios (Deliverables D3B.2 - Holman et al. 2017 and D3C.2 – Clarke et al. 2017);
- (d) Robust pathways have been identified across scenarios per case study from comparative analysis.

Following the advanced transition management methodology, we have undertaken several process steps to collect input on, verify and analyse the pathways per case study (Figure 1). The steps involved different types of activities: collecting stakeholder input via email surveys and online questionnaires (green), facilitated stakeholder workshops (blue) and expert analysis (red).



**Figure 1: The process steps to generate the pathways in IMPRESSIONS.**

In the following we outline the various steps and associated activities, as well as how they have been implemented in the different case studies. Table 1 provides an overview of the case study-specific

stakeholder participation steps. All workshops lasted two to three days, during which dialogue between stakeholders and experts from the IMPRESSIONS team was professionally facilitated. For all case studies, stakeholders were objectively identified via a stakeholder mapping exercise using categories of stakeholders (e.g. different sectors, age and gender groups), ensuring a minimum quota for each category (see Deliverables D6A.1 - Gramberger and Zellmer 2014, D6A.2 – Zellmer et al. 2016 and D6A.3 – Faradsch et al. 2017 for more detail).

**Table 1: Overview of stakeholder participation steps in all case studies.**

	Europe	Scotland	Hungary	Iberia
<b>Stakeholder workshop #1 (a)</b>	-	Mini-workshop September 2015 17 stakeholders	June 2015 27 stakeholders	June 2015 17 stakeholders
<b>Vision survey (b.1)</b>	January 2016 19 responses		Mini-workshop in February/March 2016 45 stakeholders	June 2016 16 responses (9 from Portuguese, 7 from Spanish stakeholders)
<b>Stakeholder workshop #2 (c)</b>	February 2016 23 stakeholders	April 2016 22 stakeholders	June 2016 24 stakeholders	September 2016 23 stakeholders (10 Portuguese and 13 Spanish stakeholders)
<b>Survey (d.1)</b>	January 2017 15 responses	March 2017 6 responses	Mini-workshop in December 2016 10 stakeholders; Survey March 2017, 7 responses	June 2017 13 responses (7 from Portuguese and 6 from Spanish stakeholders)
<b>Stakeholder workshop #3 (e)</b>	May 2017 17 stakeholders	June 2017 12 stakeholders	May 2017 30 stakeholders	September 2017 16 stakeholders (9 Portuguese and 7 Spanish stakeholders)

#### **Step (a): Stakeholder workshop #1**

The first step included the development of socio-economic scenarios for each case study – responding to the question “where might we be?” During the first series of workshops in 2015 in Iberia and Hungary, stakeholders developed “their own scenarios while contextualising them within a set of higher-level existing SSPs (either European or global)” (Deliverable D2.2 - Kok and Pedde 2016, p.8). For the European and Scottish case studies, pre-existing scenarios developed by stakeholders during the CLIMSAVE project (Gramberger et al. 2015; Kok et al. 2015) were used as the foundation for drafting the SSPs (Kok and Pedde 2016). For the Scottish case study, a mini-workshop was organised instead of a full workshop to increase legitimacy and buy-in of stakeholders for three scenarios (SSP1, SSP3, and SSP4) and to develop ‘from scratch’ the Scottish version of SSP5. For further information on the design and methodology of this step see Deliverable D2.2 (Kok and Pedde 2016).

#### **Step (b): Analysis: scenarios and vision**

After the workshops, IMPRESSIONS experts drafted the storylines for each SSP per case study (Deliverable D2.2 - Kok and Pedde 2016). This step was supported by a survey (in Hungary by a mini-workshop) to increase buy-in from the stakeholders. The scenarios were analysed using the agency’s capacities framework to identify the key actors and the actor-related abilities and institutional conditions in the scenarios, which reveal opportunities and challenges for developing and implementing pathways (Deliverable D4.1 - Frantzeskaki et al. 2015).

Additionally, this step included an e-mail survey (in European and Iberia) or mini-workshop (in Hungary and Scotland) to ask the stakeholders in each case study about their vision for the future. The stakeholders were asked to state important elements of the “world that they want” – responding to

the question “where do we want to be in 2100?” It was important that the stakeholders could express their ideas freely; however, they were informed about identified core vision elements (Deliverable D4.1 - Frantzeskaki et al. 2015) to provide generic guidance.

After collecting the stakeholder input on the vision (Table 1), the stakeholder contributions were sorted according to the core vision elements (e.g. planetary boundaries, health and wellbeing, see Deliverable D4.1 - Frantzeskaki et al. 2015). This helped to structure the input and to identify possible disagreements and missing elements (compared with the core elements). The contradictions and missing elements were noted so that they could be discussed with the stakeholders during workshop #2. Two main outputs were produced to present the vision to the stakeholders at workshop #2. First, a narrative was created for the vision themes by making a text version out of the bullet points from the stakeholders. Second, a shorter version of the vision was produced to be printed as a poster that could support the discussions about pathways to achieve the vision in workshop #2.

### **Step (c): Stakeholder workshop #2**

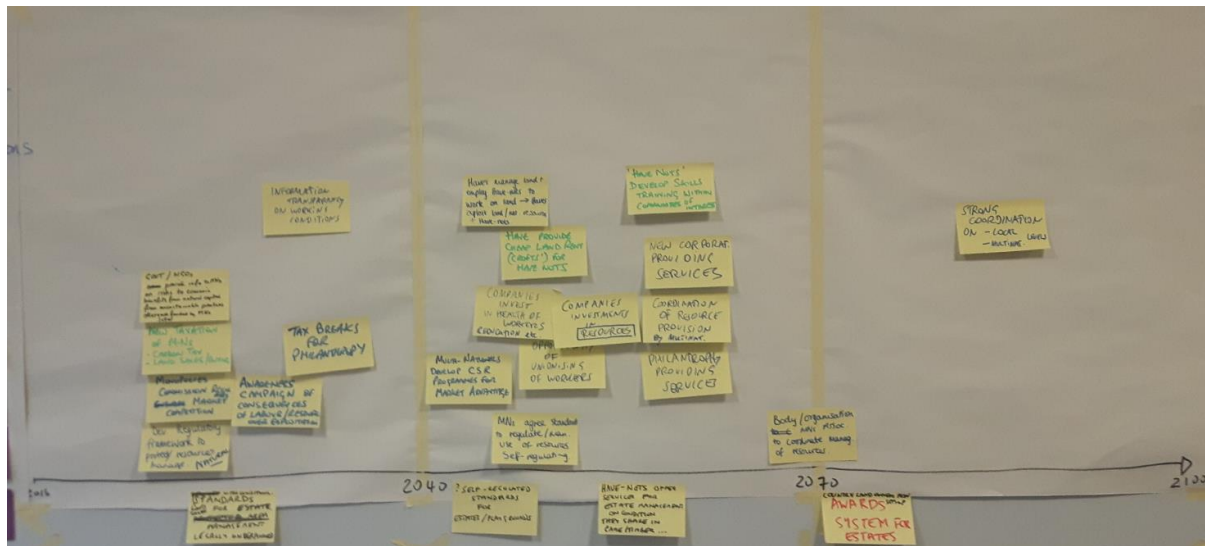
The main objective of the IMPRESSIONS workshop #2 series was to have the stakeholders identify responses per scenario that would contribute to achieving their vision, to group these responses into clusters that benefit similar vision element(s) and to put the responses on a timeline from today until 2100 to develop time-dependent strategies.

First, the vision was presented to the stakeholders and discussed. It was ensured that everyone agreed with the narrative and that requests for additional elements or changes to the text were included. Any contradictions and missing elements (compared to other visions) found during the analysis were discussed with the stakeholders and resolved. As vision development is a profoundly iterative process, further additions and comments on the vision could be made during the whole duration of the workshop.

The stakeholders identified responses per scenario to achieve the vision based on (i) the revised SSP narratives that were presented as part of the ‘integrated scenario context’ together with climate change scenarios (see Deliverables D2.3 - Sloth Madson et al. 2016; and D2.2 - Kok and Pedde 2016), (ii) the modelled climate change impacts (Deliverable D3C.2 - Clarke et al. 2017 for the results from the Scottish, Iberian and Hungarian case studies; and D3B.2 - Holman et al. 2017 and D4.3 - Tinch et al. 2017 for the European case study), and (iii) the stress-testing of current policies (Deliverable D5.3 - Carlson et al. 2017). These inputs provided the full context for identifying responses under specific high-end scenarios. The responses were collected on post-its. All responses were clustered into different stakeholder-defined categories. Some of these categories were selected for the development of strategies. The strategies were developed by taking all the responses (written on post-its) in one cluster and putting them on a time line from today until 2100, i.e. by time-stamping the responses (see Figure 2). This resulted in an initial two to three time-dependent stakeholder strategies per scenario per case study.

### **Step (d): Analysis: proto-pathways**

After workshop #2, the IMPRESSIONS team analysed the input from the stakeholders to develop the draft or proto-pathways, which would be further developed during the workshop series #3. After checking the consistency of the pathways with the scenarios, the suggested changes were cross-checked in a survey with the stakeholders. This resulted in a final draft of the proto-pathways, which were then analysed in terms of synergies and trade-offs, their efficacy in achieving the vision and dominant pathways across scenarios.



**Figure 2: An example of making time-dependent stakeholder strategies by putting all responses in a cluster on a time line from today until 2100 during the IMPRESSIONS workshops #2.**

### *d.1 Drafting the pathways*

To draft the first version of the proto-pathways, the IMPRESSIONS teams analysed the responses collected at workshop #2. The method followed for drafting the proto-pathways is the objective-driven inquiry method from operations' research (Raiffa, 1968). We applied this method in the following steps:

- I. We screened the responses and sorted out those that referred to either vision statements or additions to the scenario storylines. We included them in revising the vision and scenarios and did not consider them in formulating the pathways. The screening of the responses was performed using the narrative matching analysis method.
- II. We started with the clusters of responses that were rolled out in the three time-slices (today-2040; 2041-2070; 2071-2100) by the stakeholders (= stakeholder strategies, see Figure 2). For these stakeholder strategies we identified the vision element(s) they aim to achieve.
- III. Following the rationale developed by the stakeholders in the stakeholder strategies and as noted down in the notes from the workshops, the IMPRESSIONS team placed the other clusters of responses (that were not time-stamped by the stakeholders during workshop #2) along the three time-slices and identified which vision element(s) they aim to achieve. This resulted in a number of strategies, with each strategy including time-stamped responses and addressing one (or more) vision element(s).
- IV. Strategies that aim to achieve the same vision element(s) were clustered together as a pathway.
- V. For every strategy, we identified whether the actions are people-based, nature-based, technology-based or market-based. People-based actions seek to build or use social and human capital, nature-based actions build or use natural capital, technology-based actions build or use manufactured capital and market-based actions address financial capital.
- VI. For every pathway, we identified whether they are mitigation, adaptation and/or transformation pathways. Mitigation pathways include strategies and actions to reduce emissions and drivers of unsustainability. Adaptation pathways include strategies and actions to adapt and cope with climate change and other negative social and environmental impacts. Transformation pathways include strategies and actions to fundamentally change structures, cultures and practices of societal systems towards sustainability and resilience.

#### d.2 Consistency check of pathways with the scenarios (and survey)

For every strategy, we checked the consistency of actions with the scenario narratives and identified which actions and strategies needed to be changed (deleted/moved into different time slices). To verify the recommended changes with the stakeholders we conducted a survey that asked all participating stakeholders for their input (Table 1). The survey was distributed over email to all stakeholders participating in the workshop #2 series. In Hungary, the survey was preceded by a mini-workshop during which stakeholders discussed and revised the pathways.

Based on the survey results, we revised the pathways to improve their consistency with the scenarios. This resulted in the final proto-pathways that were subsequently presented and discussed during workshop #3.

The survey also asked the stakeholders to verify the revisions of the visions that were implemented by the IMPRESSIONS research team following the discussions during the workshop #2 series. The input collected during the workshop was first analysed by the research team. In this process, the notes from the workshop discussions were critically assessed with regard to what and how this input added to and/or changed the initial version of the vision. Based on the revisions and survey results, the vision narratives and posters were adapted for the subsequent analysis steps (e.g. analysis of efficacy of pathways) and the presentation at the workshop #3 series.

#### d.3 Cross-scenario comparison

The pathways were compared across scenarios. This was done by comparing the vision elements and sectors addressed in the pathways across scenarios. It resulted in an overview of similar pathways, themes and sectors addressed across scenarios, robust pathways across scenarios and core topics in each case study. It also revealed differences across scenarios, for example in how specific themes are addressed in different ways.

#### d.4 Analysing the efficacy of the pathways in achieving the vision

We qualitatively and quantitatively assessed the extent to which the pathways achieve the vision using a consistent methodological framework in which scenario context and capital (human, social, financial and manufactured) availability constrain the effectiveness of the actions in moving towards the vision. This has been discussed in detail within Deliverable D3B.2 (Holman et al. 2017).

Table 2 provides an overview of the different steps that were employed to analyse the pathways' efficacy in achieving the vision. A selection of vision elements and associated indicators was made for this assessment. The assessment of whether pathways achieve some vision elements can be made using models. The assessment for other elements is made qualitatively by the IMPRESSIONS team. The assessment was visualised using spider diagrams that indicate the (quantitative and qualitative) change in the value of the vision indicators in reference to the baseline and the vision for (i) the scenario storylines, and (ii) the pathways for the three time slices.

#### d.5 Identification of synergies and trade-offs

Synergies were identified based on the comparative analysis of the pathways across scenarios within each case study. The analysis revealed a pattern of interlinked pathways, of which one or two pathways in each case study represent 'conditional' pathways, i.e., these pathways put in place the key conditions for developing and implementing the other pathways.

We identified trade-offs between pathways, strategies and actions in every scenario based on experts' input during an IMPRESSIONS meeting in November 2016, the notes from the stakeholders' discussion in workshop #2 and the analysis of the pathways' efficacy in achieving the vision. Overall, the trade-

offs give indications of the need to identify additional actions to avoid or alleviate the (potential) trade-off – rather than suggesting strategies and actions that do not work by definition.

**Table 2: Steps for assessing the efficacy of pathways in achieving the vision (Adapted from: Deliverable D3B.2 - Holman et al. 2017).**

Step	Quantitative Track	Qualitative Track
1) <b>Setting vision targets</b>	The vision elements were classified according to whether they are likely to either necessitate adaptation, mitigation and/or transformation to achieve them	
	A sub-set of vision elements was identified for the analysis (related SDGs and SDG indicators were used to identify key elements within the vision)	
	For each vision element that can be related to a model indicator, expert judgement was used to derive a quantified value or threshold which would demonstrate whether the vision element has been achieved	For each vision element that <i>cannot</i> be related to a model indicator, an additional qualitative description of the vision element was added (through expert judgement) to help characterise whether it has been achieved
2) <b>Assessing each RCP-SSP scenario against vision elements</b>	Climate change impact models were run to assess whether a scenario achieves the target value of the quantitative vision element by 2100	Expert judgement, taking account of the scenario narrative, constraints and available RCPxSSP model results, were used to assess whether the desired status of the qualitative vision elements are met by 2100
3) <b>Assessing the pathways for a given RCP-SSP scenario</b>	Looking across all pathways, actions were identified within each time period that would affect, either individually or in aggregate, model inputs in a particular direction (increase/decrease). <i>For example, actions of “Invest in agricultural and water innovation to improve productivity” and “Invest in innovation in food production for food security” might lead to increases in model input values set for ‘irrigation efficiency’, ‘agricultural mechanisation’ and ‘yield improvement’ and also might decrease ‘fertiliser use’.</i>	Looking across all pathways, actions were identified within each time period that would affect, either individually or in aggregate, each qualitative vision element
	Looking across all pathways, actions within each time period were identified that would affect, either individually or in aggregate, availability of human, social, financial and manufactured capitals. Expert judgement was used to assess change in capital availability	Looking across all pathways, actions within each time period were identified that would affect, either individually or in aggregate, availability of human, social, financial and manufactured capitals. Expert judgement was used to assess change in capital availability
	Model input values were changed to represent the maximum amount of change that is credible within the scenario context, taking account of modified capital (human, social, financial and manufactured) availability and other scenario constraints	
	The model(s) were run to assess whether the target value is achieved for each modelled vision element by 2100	Expert judgement was used to assess whether the actions are likely to move the status of the vision element closer to the desired status by 2100, taking account of the availability of relevant capitals
4) <b>Analyse outcomes</b>	The ability of the pathways to achieve the vision by 2100 for a given RCPxSSP scenario was evaluated, considering: <ul style="list-style-type: none"> <li>• The quantitative and qualitative analysis of vision elements;</li> <li>• Synergies and trade-offs identified during the analysis;</li> <li>• Key vision elements that appear not to be met through the actions within the current pathways.</li> </ul>	

**Step (e): Stakeholder workshop #3**

The main objective of the IMPRESSIONS workshop #3 series was to enrich the pathways to improve their efficacy in achieving the vision, avoid trade-offs and think of concrete transformative solutions that are 'game-changing' for moving towards the vision. A particular focus was on discussing the need, and proposed actions, for transformational change and identifying robust pathway elements across scenarios.

During the workshop, the revised vision and the scenario storylines were presented to the stakeholders to familiarise them with the scenario logics. The proto-pathways were presented to the stakeholders within the different scenario groups. The stakeholders were then asked whether they agree with the proto-pathways and to identify needs for additional strategies and actions. In the following sessions, the results from the pathways' efficacy assessment and the analysis of synergies and trade-offs were presented to the stakeholders, who were then asked to think of additional actions and identify specific actors to enrich the pathways and move closer to the vision as well as to think of transformative actions. Due to time constraints, these additional actions were focussed on those vision elements that were distant from achieving the desired vision as well as those that were of most interest to the stakeholders in a given scenario. The latter was supported by input presentations on climate mitigation and agent-based modelling (see Lamperti et al. 2016) and posters that showcase 'real world' transformative solutions. Following this, the stakeholders worked across scenarios to identify key enabling conditions and robust pathway elements and specify concrete transformative actions.

**Step (f): Analysis: final pathways**

After the IMPRESSIONS workshop #3 series, the additions made to the pathways were consolidated and the analyses of pathways (steps d.3 to d.5) were updated by repeating steps 3 and 4 in Table 2. Additionally, the key actors and actor-related abilities and institutional conditions put in place in the pathways were identified following the agency capacities framework (Deliverable D4.1 - Frantzeskaki et al. 2015). This resulted in the final pathways, including the analysis of their efficacy in achieving the vision, synergies and trade-offs as well as the governance capacities that are built up and required for implementing the pathways. These results are presented per case study in Sections 3 to 6. The cross-case comparison of pathways is presented in Section 7, and the derived decision-making implications are presented in Section 8.

**3. European pathways**

Europe is a highly diverse continent, so the impacts of climate change on people, natural resources and the environment will vary. In a participatory workshop process, simulated changes in a range of urban, health, agricultural, forestry, water and biodiversity indicators over time under high-end climate and socio-economic scenarios were used to help stakeholders and decision-makers develop adaptation, mitigation and transformation pathways and strategies for coping with high-end scenarios and achieving a long-term sustainability vision. The representation of mitigation, adaptation and transformation decision-making in computer models was improved to better understand how the effectiveness of strategies and actions under high-end scenarios is influenced by timing and by socio-economic constraints. The final objective of the case study was to derive insights on decision-making options for coping with high-end scenarios and contributing to sustainability and resilience transformations in Europe.



The IMPRESSIONS European case study included the following elements to develop adaptation, mitigation and transformation pathways:

- Four linked climate and socio-economic scenarios for Europe using the RCP and SSP framework have been developed;
- A diverse range of computer models (integrated models, physically-based models, agent-based models) have been used to simulate impacts, vulnerability and adaptation of urban, health, agricultural, forestry, water and biodiversity indicators to high-end scenarios;
- A vision for Europe in 2100 was developed;
- Scenario-specific pathways were developed containing adaptation, mitigation and transformative strategies and actions that reduce the impacts and exploit the opportunities arising from high end scenarios to move towards the vision.

In the following, we present the results from the European case study with a focus on the developed pathways and their analysis. We first outline the four scenario contexts that provide the logics for developing the pathways as interpreted by the stakeholders (Section 3.1). We then present the vision that has been formulated for Europe in 2100, which provides the orientation for developing the pathways and the point of reference for assessing their efficacy, synergies and trade-offs (Section 3.2). Third, we outline the pathways that were developed; starting from the pathways that occur in all scenarios and then the pathways that occur in some or in individual scenarios (Section 3.3). Fourth, we present the governance capacities that are created through the pathways and that represent the conditions enabling their implementation (Section 3.4). Finally, we discuss the impacts of the pathways in terms of their efficacy in achieving the vision and resulting synergies and trade-offs (Section 3.5).

### 3.1. Scenario contexts and pathway logics

For the European case study, four socio-economic scenarios (SSPs) were developed and matched with either RCP4.5 or RCP8.5 (Deliverable D2.2 - Kok and Pedde 2016). Each scenario provides a distinct context, opportunities and challenges for the development of pathways, including different socio-economic enabling and disabling conditions, key actors and climate impacts. This section summarises the context provided by each scenario and describes how it was interpreted for the development of pathways to achieve the vision for Europe in 2100. Table 3 provides an overview and comparison of the key elements per scenario.

**Table 3: Key elements per European SSP (Adapted from Deliverable D2.2 - Kok and Pedde 2016).**

Key elements	SSP1: Sustainability – We Are The World	SSP3: Regional Rivalry – Icarus	SSP4: Inequality – Riders on the Storm	SSP5: Fossil-fuelled Development
RCP	4.5	8.5	4.5	8.5
Decision-making level	International/ EU leader	National/Local+ fragmentation	International/Europe leader on the global scale	International/EU not a leader on the global scale
International cooperation	Strong, EU important player	Weak	Strong, EU important player	Strong (trade)
Net migration-low in-migration	Low immigration	Outmigration	Selected immigration	High to cities and from poorer countries
Economic development	Gradual (with hiccups at the beginning)	Low	High	High
Mobility	No barriers, but movements are limited	Low	High	High
Social cohesion	High	Low EU\higher within countries	Low	High

Key elements	SSP1: Sustainability – We Are The World	SSP3: Regional Rivalry – Icarus	SSP4: Inequality – Riders on the Storm	SSP5: Fossil-fuelled Development
Technology development	High, but not pervasive	Low	High in some areas; low in labour intensive areas	Strong and crucial
Quality of Governance	High – focus on sustainability	Low and ineffective	High and effective	High – focus on businesses
Human health investments	High	Low	High for elites	High
Education investments	High	Low	High for elites	High
Environmental respect	High	Low	High in pockets	Low, but high NIMBY
Agency capacities	High ability to act – sustainability strategies and institutions, multi-level governance and participation	Low ability to act – inequality and no institutions for sustainability and collaboration, no resources	Moderate ability to act – unequally distributed and no institutional conditions on social issues	Moderate ability to act – no institutional conditions for environmentally-oriented action
Key actors	All societal actors (government, market, civil society) at multiple levels	No EU after 2040 and weak governments; rich corrupt market actors; local communities self-organise	Small political and business elite concentrates power and resources; majority of the population in local communities	Government and market actors

### 3.1.1. SSP1: Sustainability – We are the world

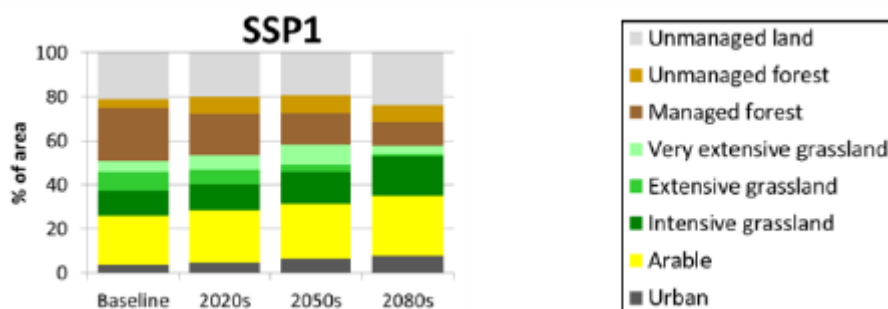
#### Scenario storyline

*There is a high commitment to achieve sustainable development goals through effective governments and global cooperation, ultimately resulting in less inequality and less resource-intensive lifestyles.*

The interplay of financial, environmental and economic crises fuels the feeling that behaviour has to change away from an unregulated market-driven economy to a sustainable development path. This puts governments under pressure to take ambitious measures, including stimulating an energy transition towards renewables and facilitating innovative research, accompanied by investments in health, education, and social support. A decrease in conflicts in Europe's southern and eastern border regions leads to higher political stability and moderate but steady economic growth in an increasingly equitable Europe. The European Union expands further and participates in new global governance initiatives. Advances in green technologies are further stimulated by international competition leading to a CO<sub>2</sub>-neutral society by 2050. By 2100, Europe is characterised by a high level of sustainability-oriented political and societal awareness, focusing on renewable energy and low material growth in a strongly regulated but effective multi-level governance structure.

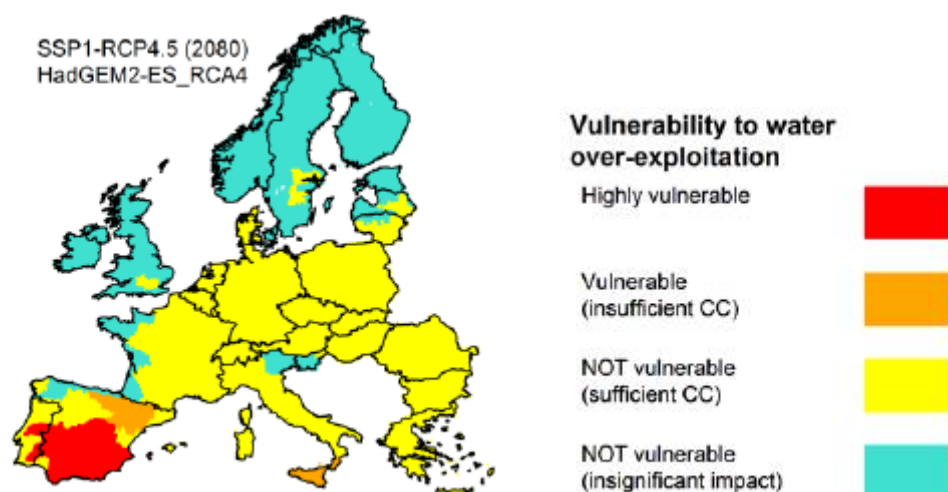
#### Selected key impacts

In the European SSP1, the agricultural area expands to meet demand leading to major losses of forest area (Figure 3). Although this scenario is associated with reduced meat demand and increased vegetarianism, an associated increased demand for dairy products increases the area of intensive grassland systems. It is notable that the model is unable to meet food demand under the European SSP1 scenario. This arises due to the decrease in imports and the de-intensification of European agriculture within the scenario.



**Figure 3: Simulated European land use proportions for SSP1×RCP4.5 using the IMPRESSIONS Integrated Assessment Platform (IAP2) (Source: Deliverable D3B.2 - Holman et al. 2017).**

Within SSP1 an increasingly environmentally aware society shifts towards more sustainable, higher density living in vibrant and attractive urban areas; a shift that mitigates substantive artificial surface expansion. Population growth is more than compensated by water savings. Total water use increases, in particular due to irrigation water demand. Figure 4 shows the vulnerability to water over-exploitation, indicating that the highly vulnerable river basins are in Iberia in SSP1.



**Figure 4: Number of river basins in Europe and European regions vulnerable to water over-exploitation in the 2080s in SSP1×RCP4.5 (Source: Deliverable D3B.2 - Holman et al. 2017).**

There is a significant decrease in species with suitable habitat and climate space. These reductions result from habitat changes that are a result of the significant agriculture-induced land-use changes, the significant increase in population, and increased European food self-sufficiency. The significant loss in forestry and expansion of agriculture considerably restricts the available habitat for species

#### **Agency capacities and key actors**

There are strong European and national governance institutions within SSP1 oriented towards sustainability and collaboration, investments in innovation and social cohesion and awareness for changing lifestyles. All actors of society play a role and contribute to sustainability through innovation, changing production and consumption patterns and protecting the environment.

There are strong EU and national governments that effectively collaborate in multi-level governance structures and ensure long-term political stability. Participatory governance structures are in place that adhere to transparency, legitimacy and accountability principles. Flexible EU and national

institutions and long-term monitoring systems facilitate learning and adaptation in the face of change. New international governance initiatives with the EU take a central position in supporting coordination and European and global collaboration (e.g. towards the SDGs).

There is common societal and political agreement at all levels on long-term sustainability goals. Shared sustainability goals in the EU foster alignment across EU nations and there is further integration of financial and fiscal policies in the EU. The EU takes responsibility for environmental impacts and puts in place new systems of national accounts that shift the EU political agenda towards well-being instead of GDP growth.

All actors in society (are able to) take responsibility for contributing towards sustainability. Strong social cohesion and high degrees of local self-organisation enable communities to respond to impacts and risks. There is a high level of societal awareness and action for changing lifestyles towards low material growth, low resource and energy intensity, resulting in a CO<sub>2</sub>-neutral society, which is especially supported by a stronger middle class, low social inequality and access to health and education.

High investments in research and innovation are available that boost innovation on sustainable technologies – including governance, technical, social and institutional innovations. There is a focus on green technologies from early on (e.g. low material growth and consumption technologies, renewable energy and energy efficiency) that are stimulated by international competition.

### **Pathways logic**

The pathways build on the high level of capacities in this scenario and especially the opportunities afforded by strong governance (both international governance and bottom-up governance), technological innovation and learning (e.g. in governance and education), as well as societal and market change.

While in this scenario there is already a strong and good governance system in place, there are still opportunities for achieving more ambitious changes by implementing more holistic planning, stronger regulatory interventions and incentives for the market and companies. A main focus is on a further depolarisation of international governance (e.g. the relationships with China and Russia) and the relationship between the public and politicians to increase trust. An overall focus of intervention in this scenario is governance technology in itself, by enabling governance experimentation and strengthening research on governance.

An additional focus is on reducing the dependence of Europe on food imports that results from the lower productivity of the (extensified) agricultural system in this scenario and which puts pressure on forests and biodiversity. This requires agricultural innovation, urban agriculture and reduction of food waste. Additionally, to reduce vulnerability to water overexploitation due to growth in demand, the pathways focus on changing water behaviours, setting up new institutions for transboundary water management and improving water technologies and infrastructures (e.g. improving water retention in urban landscapes). These measures in agriculture and water systems require compensations for more vulnerable countries.

### **3.1.2. SSP3: Regional Rivalry – Icarus**

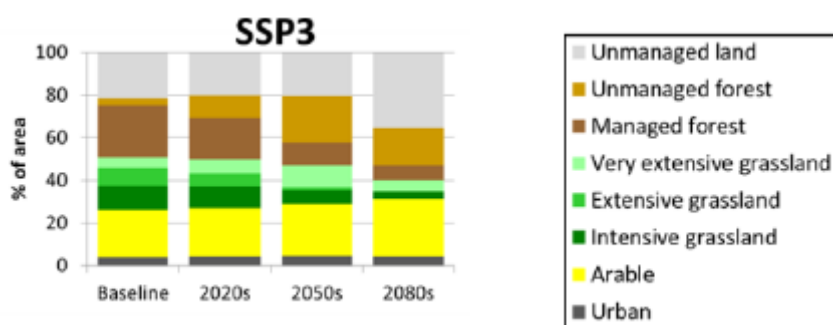
#### **Scenario storyline**

*Antagonism between and within regional blocks increases, sparked by economic woes in major economies and regional conflict, resulting in the disintegration of the social fabric and many countries struggling to maintain living standards.*

With the economy gradually picking up, the demand for resources increases, which turns out to be a tipping point for the state of the environment with severe ecosystem failures. The persistence of conflicts and decline in trade also substantially increases energy and food prices, while initiating a massive build-up of the defence sector, which is resource hungry but not resource efficient. Long-term policy planning becomes rare with little money for education, research or innovation. Eventually the EU breaks down, with new regional blocs forming in the north and in the south of Europe, while new alliances with other countries are forged to ensure sufficient energy supply. Social counter-movements temporarily appear but do not take root in a fragmented and divided Europe with strong regional rivalry and conflict. Ultimately, a high-carbon intensive Europe emerges that is not worse off than the rest of the world, but struggles not to become the world's backwater with high inequalities predominantly between, but also within, countries.

### **Key impacts**

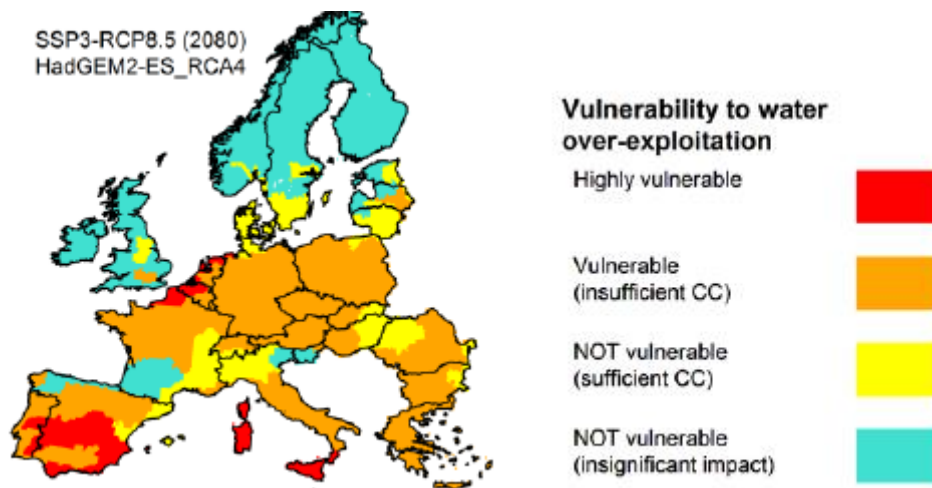
The European SSP3 leads to relatively minor changes in land use, apart from the reduction in managed forest area (Figure 5). This arises as the decreased food demand due to the continually declining European population (-38% by the 2080s) is matched by decreased imports in this fragmented world and reduced agricultural productivity. In the early time slice, autonomous adaptation within the European agricultural system to expand production is insufficient to enable European food demand to be met.



**Figure 5: Simulated European land use proportions for SSP3×RCP8.5 using the IMPRESSIONS Integrated Assessment Platform (IAP2) (Source: Deliverable D3B.2 - Holman et al. 2017).**

In selected eastern European countries (Bulgaria, Croatia, Lithuania, Latvia and Romania) the increase of artificial surfaces is substantial in SSP3. While this scenario is also characterised by an aging and declining population, a slow rate of change combined with a shift towards suburban development (associated with urban in-migration and weak planning laws) results in artificial surface expansion. Water use increases in this scenario. Figure 6 shows that the vulnerability to water exploitation is high in central and southern Europe.

The total number of European species with appropriate climate and habitat space declines in the first time-slice in SSP3 but the decline is halted after 2050 because the combination of increasing climatic pressure on resources (e.g. food, timber) and significant declines in population relative to today (-38%) mean less overall change in land use which reduces the impact on species.



**Figure 6: Number of river basins in Europe and European regions vulnerable to water over-exploitation in the 2080s in SSP3-RCP8.5 (Source: Deliverable D3B.2 - Holman et al. 2017).**

### Agency capacities and key actors

A large degree of fragmentation across and within EU member states, weak (inter)national institutions and governance structures, a high level of corruption in governments and increasing societal conflict and inequalities hinder the capacities of actors in this scenario. There is no funding for research and innovation. Civil society is disempowered, but there are local networks that can self-organise for self-sufficiency.

There is a large degree of conflict and fragmentation across and within EU Member States – by 2040, the EU dissolves and there is thus no common European governmental body. Weak (inter)national institutions and governance structures, as well as international and regional conflicts and rivalry, further hinder coordination and collaboration. New regional blocks are formed in the north and in the south of Europe as well as new alliances with other countries to ensure sufficient resource supply. Criminal organisations start to take over leadership in a corrupt, non-transparent and undemocratic governance system.

There is no societal and political awareness, or policy and institutions on social and environmental sustainability, vulnerabilities, impacts and risks. This is evidenced by the increasing demand for resources, phasing out of social securities and investments in the defence sector. With a declining economy, limited resources available and conflicted international market cooperation, there is no investment available for innovation and new technologies.

Civil society actors on a larger scale are highly fragmented and disempowered – there are riots and there is inequality and out-migration. On local scales, they can cooperate in social networks to organise low-tech social innovation for self-sufficiency.

### Pathways logic

The pathways are developed with an underlying motive of moving to local, circular economies and a decentralised and networked local community governance system in the face of weak and fragmented governmental institutions.

The pathways identify actions and unroll strategies across time according to the state of institutional and governance levels across the time slices. During the first time slice, while the EU still exists, EU policy measures can be taken to protect what is there and to pave the way for local economies. During

the second time slice, there is a move towards local community networks by supporting local economies and raising awareness. In the third time-slice, local communities that organise in regional networks become the dominant mode of operation.

### 3.1.3. SSP4: Inequality – Riders on the storm

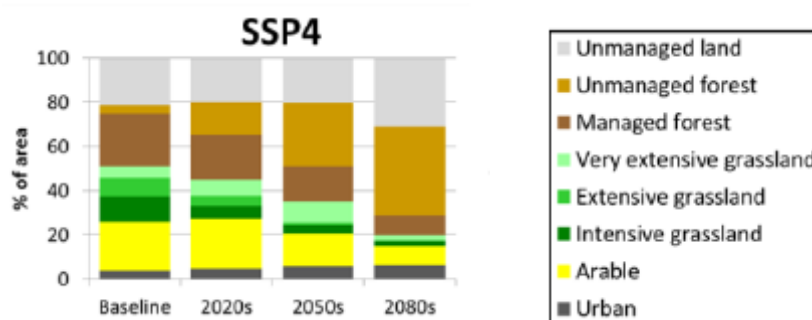
#### Scenario storyline

*Globally, power becomes more concentrated in a relatively small political and business elite, accompanied by increasing disparities in economic opportunity, leading to substantial proportions of populations having a low level of development, although Europe becomes an important player in a world full of tensions.*

Sparked by the economic crises and extreme weather events, the EU increases commitment to find innovative solutions to the depletion of natural resources and climate change. In combination with current relatively high levels of social cohesion, energy efficiency and environmental policy-making, this initiates a shift towards a high-tech green Europe. This transformation is strongly supported by large businesses that successfully seek collaboration with the increasingly powerful European government. At the same time, however, inequalities are rising because of a number of simultaneously acting factors, including highly unequal investments in education. This leads to a large and widening gap between an internationally-connected society and a more fragmented collection of lower-income societies that work in a labour-intensive, low-tech economy. Technological development has not resulted in reduced energy prices, but has instead established an oligarchy of green business developers that control energy supply. By 2100, Europe is an important player in a world full of tensions, but with growing inequalities across and within European countries.

#### Key impacts

In European SSP4, a declining population (-22% by the 2080s) combined with increased imports and agricultural productivity lead to a declining agricultural area (Figure 7), and an increasing area of land which is not managed for productive agricultural or forest purposes.

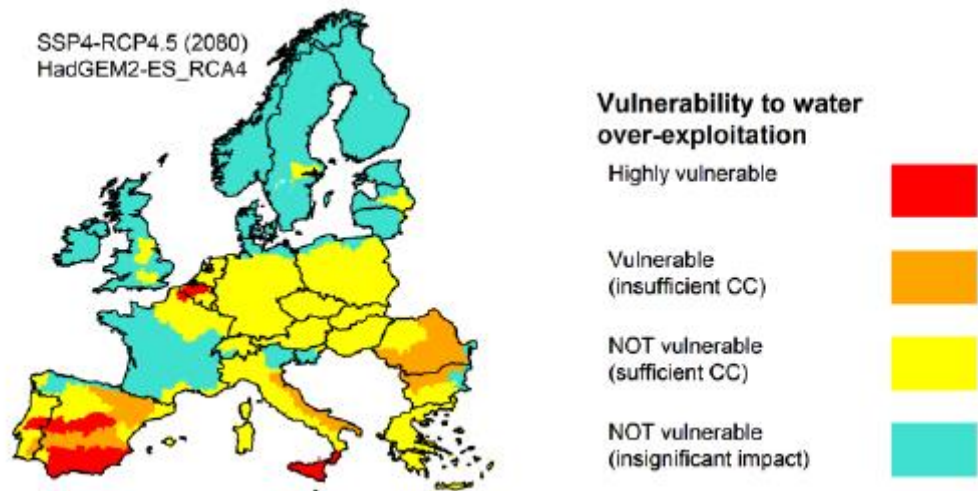


**Figure 7: Simulated European land use proportions for SSP4×RCP4.5 using the IMPRESSIONS Integrated Assessment Platform (IAP2) (Source: Deliverable D3B.2 - Holman et al. 2017).**

There are limited artificial surface increases in SSP4. Urban living is a consequence of the poorer society migrating to urban centres in search of jobs and social services. The negative population growth in SSP4 does not lead to significant changes in water savings. There is a significant increase in manufacturing water use, and irrigation water supply is reduced by increasing industrial water demand. This, in combination with lower food demand (negative population growth) and overall poor economics, leads to moderate irrigation water use. The vulnerability to over-exploitation of water (Figure 8) shows the highest vulnerability in southern Europe.



The SSP4 scenario leads to a significant decrease of around 14% compared to the baseline in species with suitable habitat and climate space.



**Figure 8: Number of river basins in Europe and European regions vulnerable to water over-exploitation in the 2080s in SSP4×RCP4.5 (Source: Deliverable D3B.2 - Holman et al. 2017).**

#### **Agency capacities and key actors**

Society is marked by a large divide between a small political and business elite that is strongly connected and concentrates power, decision-making authority and resources on the one hand and the majority of the population that does not have access to neither power nor resources on the other. While the European elite is a key player in the global economy and can push for its (green growth) agenda globally, the majority are fragmented and disempowered.

The EU remains a strong governing body and important economic player, but it becomes increasingly influenced by large businesses; decision-making is marked by strong alliances between a small political and business elite. The political system becomes non-transparent and less affluent groups lose any political power. The European political and business elite is strongly connected to other global elites and players and can take a central position to push for its (economic) interests globally.

The EU's strategic agenda is committed to innovation and environmental sustainability. Economic incentives facilitate technological development and a shift towards low-carbon energy sources, whilst large businesses drive the shift towards a high-tech green Europe. The international connection of the European elite contributes to knowledge sharing and export. However, there is no focus on social issues – this is evidenced by decreasing public funding for education and health services. The majority of the population becomes increasingly poor and socially fragmented across and within countries; the middle class ceases to exist and there is a high level of migration and low social capital and access to credit and resources.

#### **Pathways logic**

The pathways start from different needs and abilities in the two-layered society in this scenario. On the one hand, the elite realises that to maintain their power and stability they need to provide basic quality of life and services to the majority of the population. The elite are also assumed to have an interest in the sustainable management of resources for their own benefit. On the other hand, the majority of the population can organise alternative economies and survival mechanisms in local networks.



Because of its strong political and financial power, the European elite can implement top-down strategic planning approaches. This results in a very planned and regulated society; a ‘master plan’ is developed in the first time slice and subsequently built on as the elite gets stronger. The plan takes a birds-eye perspective on context-specific conditions, opportunities and needs in European regions, building on the notion of a ‘small ecosystems’ approach. In this way it can connect different opportunities, find synergies for resource access and land management across regions and avoid trade-offs. The planning approach builds on a new type of process-based governance system that builds on continuous monitoring and learning.

The pathways also build on the opportunities arising from Europe being a market leader in green technologies to shift towards zero emissions technologies.

### 3.1.4. SSP5: Fossil-fuelled development

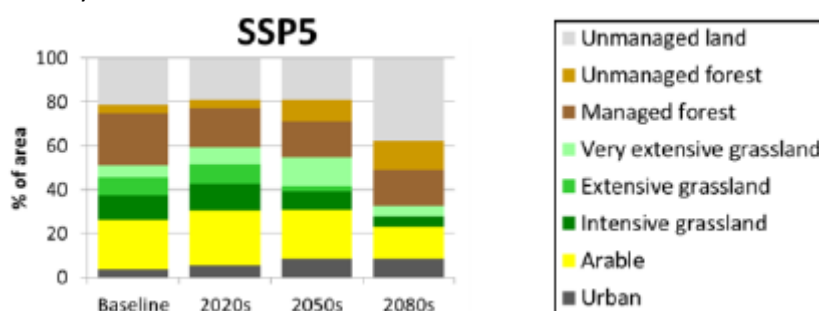
#### Scenario storyline

*People in this world place increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development. A lack of environmental concern leads to the exploitation of abundant fossil fuel resources.*

Global markets are increasingly integrated, with interventions focused on removing institutional barriers. There are also strong investments in health, education, and institutions to enhance human and social capital. The push for economic and social development is coupled with the exploitation of abundant fossil fuel resources, including large-scale extraction of shale gas. This further stimulates economic wealth, part of which is used to stimulate the development of (green) technologies. Europe regains its leading position in the global economy. Faith is strong in the ability to effectively manage social and ecological systems, including by geo-engineering. Population across all societal classes adopts a very energy intensive lifestyle. The environment degrades, but the majority of the population is unaware of this because of successful technological innovation. Towards 2100, the environment is locally seriously degraded, which eventually results in a slow re-emergence of investments in renewables.

#### Key impacts

The European SSP5 is associated with effective innovation (that increases agricultural productivity) and an increased reliance on global free markets and associated food imports. As a consequence, these gradually offset food demand increases (due to increases in population and wealth) so that agricultural land uses peak in the 2020s and then decrease to the 2080s (Figure 9). Unmanaged forest increases significantly until 2100.

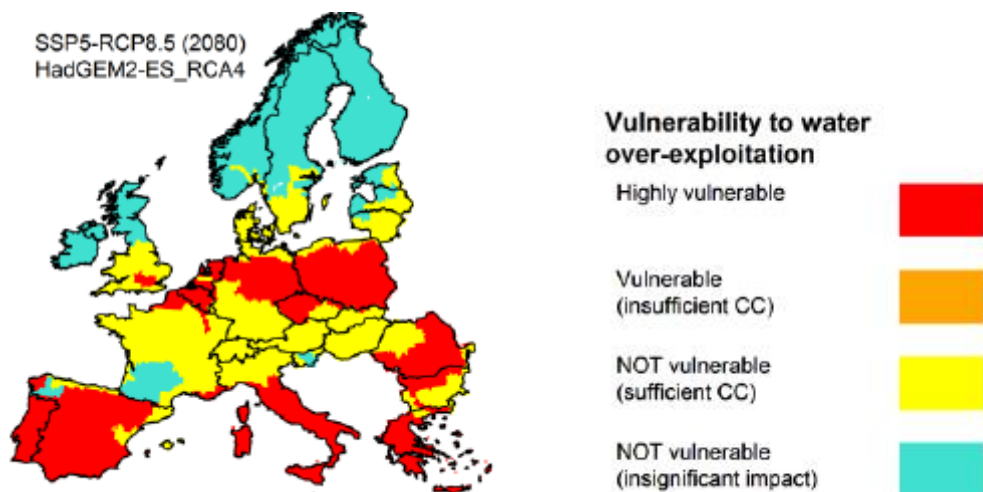


**Figure 9: Simulated European land use proportions for SSP5×RCP8.5 using the IMPRESSIONS Integrated Assessment Platform (IAP2) (Source: Deliverable D3B.2 - Holman et al. 2017).**

At a European scale, SSP5 is characterised by urban sprawl; artificial areas expand from ~4% to over 9% of the European land area by 2100. This sprawl parallels the scenario storyline in which a growing, individualistic and wealthy society seeks larger properties in suburban and rural areas. Urban sprawl of this magnitude (i) increases the competition for land (for example, for food production or nature protection), and (ii) detrimentally impacts ecosystem services and biodiversity. At a sub-European scale, eastern European countries are, within SSP5, characterised by an aging, but overall decreasing population, which is in distinct contrast to the population increases associated with SSP5 in the remainder of Europe.

SSP5 leads to a strong increase in water use, mainly because the manufacturing and thermal electricity generation sectors grow considerably. Figure 10 shows the vulnerability to over-exploitation of water, which is high in central and southern Europe.

The total number of European species with appropriate climate and habitat space declines until 2050 and then stabilises at a level of about 11% below the baseline.



**Figure 10: Number of river basins in Europe and European regions vulnerable to water over-exploitation in the 2080s in SSP5×RCP8.5 (Source: Deliverable D3B.2 - Holman et al. 2017).**

#### **Agency capacities and key actors**

There is a high level of cohesion across EU members and populations and a shared focus on economic growth and societal wellbeing, which orientates and facilitates common action. The free and competitive markets support technological innovation, but leave no room for considerations of the environment.

There is strong cohesion across EU Member States building on a transparent and participatory decision-making system that has removed all institutional barriers to the participation of disadvantaged population groups and strongly invests in social services. The EU has a lead position in the global economy and the ability to push for its interests. National governments have less political power.

Overall, the focus is on fostering economic growth and export markets and investing in human and social capital. There is no policy and societal attention to environmental protection – environmental problems can only be tackled *ad hoc*, locally and reactively with technological solutions. Market deregulation erodes further institutional opportunities for environmental protection and exacerbates resource overexploitation. Integrated global markets work to exploit fossil fuel resources. However,

the economic wealth in the EU facilitates technological innovation to decrease dependency on ecosystem services (e.g. innovations in food and water production, vaccination availability).

There is a high level of social cohesion and a strong middle class, but societal cultures are characterised by individualism and energy-intensive lifestyles.

### **Pathways logic**

The underlying logic of the pathways is to use the dominant market-based orientation of the scenario to protect ecosystems and to integrate environmental protection into business practice. While the invisible hand of the market is the dominant driving force, the private sector realises the need for protecting the resources upon which the economy depends in the long-term and pushes for change. Pathways thus employ a market logic to develop institutions and incentives for environmental protection while remaining economically efficient.

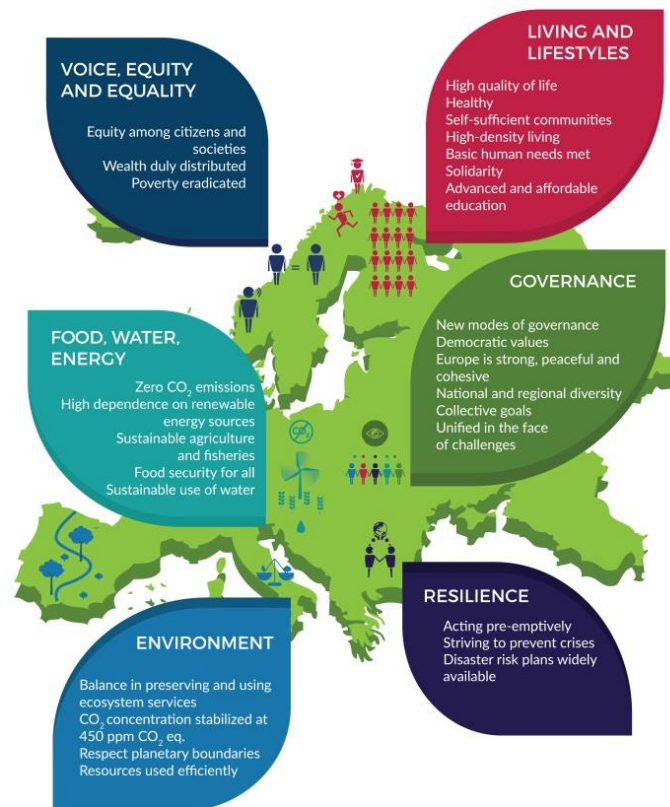
Market mechanisms are also used to boost innovation on green (energy) technologies, which is enabled by the strong economy. Research, innovation and decision-making shift from sectoral-based to problem-based and monitoring approaches and this underpins the ability of new institutions to integrate environmental concerns into long-term cost-benefit calculations.

## **3.2. A Vision for Europe in 2100**

The vision for Europe in 2100 presents a strong and cohesive continent that achieved social equity, shared prosperity and collaboration and builds on participatory democracy and democratic values, evidence-based policy-making, and multi-sectoral collaborations. Environmental pollution is alleviated and Europe is a world leader in sustainable energy technologies. Figure 11 shows the poster of the vision after workshop #3. The full vision narrative can be found in Appendix 11.1.1.

The European vision presents Europe as a strong, peaceful and cohesive continent allowing for national and regional diversity, positioning Europe as an exemplar to the rest of the world. The vision centres on the values of social equity, and equal wealth distribution, shared prosperity and collaboration. Aspirations for future European societies include a high-quality of life, meeting basic human needs and having achieved human rights and well-being. Europeans have access to services including health and advanced affordable education and live in high-density, medium-sized cities with maximum liveability. Additionally, new ideals of participatory democracy and democratic values, inclusive technological and social innovations, evidence-based policy-making, and multi-sectoral collaborations are presented in the vision.

Europe also ensures sustainable systems for provision of food, energy and water from a healthy environment where environmental pollution is alleviated and the CO<sub>2</sub> concentration in the atmosphere is stabilised at 450 ppm CO<sub>2</sub> eq. Energy systems are self-sufficient, sustainable agriculture ensures food security for all and Europe is a world leader in sustainable energy technologies. The vision further presents orientations for new paradigms of circular systems where resources are used efficiently, and sustainability is embedded as the main investment criterion in all economic activities. In view of shocks and disasters, Europe is envisioned to act pre-emptively and strives to prevent crises; it stays unified in the face of internal and external challenges.



**Figure 11: The Vision for Europe in 2100.**

### 3.3. The European pathways

This section builds upon the scenario-specific pathway logics described above, to introduce the European pathways starting from the pathways that occur in all scenarios and moving towards the pathways that occur in less or individual scenarios (Table 4). The full overview of pathways per scenario can be found in Appendix 11.1.2.

**Table 4: The European pathways per SSP.**

Pathway	SSP1	SSP3	SSP4	SSP5
Promote shifts towards sustainable lifestyles (e.g. through education, regulation and incentives)	✓	✓	✓	✓
Promote good governance systems for sustainability	✓	✓	✓	✓
Promote sustainable agriculture	✓	✓		✓
Promote strong environmental policy	✓		✓	✓
Promote integrated water management		✓		✓
Promote Europe as a global leader for sustainability	✓			
Establish a circular economy with green energy technologies			✓	

### 3.3.1. Promote shift towards sustainable lifestyles

All scenarios include a pathway to promote a shift towards sustainable lifestyles, which involves changing towards sustainable production and consumption patterns and behaviours in all sectors (e.g. food, water, health, energy and mobility) as well as ensuring social security and equity. This is a transformation pathway that involves fundamental shifts in values, behaviours and practices of civil society, markets and governmental actors towards a reflexive society for sustainability and resilience. The pathway addresses vision elements on ‘health, well-being and sustainable lifestyles’, ‘jobs, income and education’, and ‘voice, social equity and gender equality’ (see Appendix 11.1.1).

This pathway includes actions for **awareness-raising** to induce and trigger behavioural changes towards sustainable lifestyles that align to environmental conditions and needs. Across scenarios, awareness-raising actions include storytelling, clear communication on product labels and awareness campaigns on efficient resource use and waste reduction. In SSP5, a strategy employs agriculture as a lever for environmental awareness by fostering awareness about agricultural products and practices. There is also awareness-raising on social solidarity and cohesion, intercultural understanding and philanthropy – this is especially relevant in SSP3 and SSP4, which are marked by high levels of societal fragmentation and inequality.

A key pillar for achieving a shift towards sustainable lifestyles includes strengthening and setting up **education systems** that are accessible for everybody and promote environmental and social values. For example, the pathway in SSP3 includes actions such as investing in (reorganisation and improvements of) education that is accessible to all, developing bottom-up education (e.g. village schools) and setting up education platforms. This type of action is particularly relevant in the context of this scenario, which builds on the capacity of local communities that organise themselves in a bottom-up way. In SSP5, the pathway includes actions such as investing in education for nature, including highlighting the monetary value of ecosystem services, to create a mind-set for nature protection and investing in bio-based economy research and other technologies. The SSP1 pathway includes actions to foster an engaged and educated civil society by adding sustainability and social values in school education (e.g. education on farming, mosaic curriculums, project-based and community-embedded learning) and investing in exchange programmes such as an Erasmus programme for elderly.

Another element of this pathway is the creation of **institutional conditions** that incentivise sustainable lifestyles and production and consumption. This is achieved through similar actions across scenarios, such as providing incentives to people and companies and implementing regulation to reduce energy and resource consumption. In SSP4, there is also a strong notion of top-down regulation to control people’s diets and health, which is implemented by the elite. SSP1 includes actions to control supply by connecting actors along the supply chain and setting up IT platforms.

Especially in SSP3 and SSP4, this pathway also builds (institutional, cultural) conditions for **social equity and social security** to ensure that Europe that does not leave the poor behind. A strategy in SSP3 serves to foster social cohesion and support among the overall impoverished local communities. This is achieved through actions such as providing social measures to support unemployed people (e.g. revenue, training), NGOs pressuring local governments, building a strong social support system and strengthening local initiatives. In SSP4, the focus is on fostering elite philanthropy for wealth redistribution to meet the basic needs of the masses. This is implemented through actions such as tax incentives for charity, investing excess profits in societal profits, creating jobs (e.g. from producing solar panels), minimum wage and ensuring insurance for financial and social protection. In SSP1, one strategy seeks to support a well-being focus for equity and social capital development. This is achieved through actions such as developing indicators and investing in human well-being and safety, restricting

the financial system to get more money in public hands and investments in cultural development and leisure. One action suggests the provision of unconditional basic income.

Actions in SSP1 and SSP3 pathways emphasise a shift to **self-sufficient local communities**. In SSP1, this is connected to actions that promote (public and private investments in) new infrastructure and technology to, for example, reduce car dependency by supporting intermodal mobility and promote sustainable housing and decentralised renewable energy production. SSP3 supports sustainable local communities through supporting innovative entrepreneurship, diversifying economic activities, developing alternative economies (e.g. bartering) and establishing regional economic co-dependence and cooperatives.

### 3.3.2. Promote good governance systems for sustainability

All scenarios include a pathway to set up good governance systems for sustainability. The governance system fosters transparent, participatory and accountable governance institutions and builds on multi-level, open and learning-based approaches oriented towards ensuring social, environmental and economic sustainability and resilience in the long-term. This is a transformation pathway that involves fundamental shifts in the ways governance systems are set up to facilitate decision-making towards long-term and integrated goals. This pathway addresses vision elements on 'governance' and 'regional and global interrelationships' and 'voice, social equity and gender equality' (see Appendix 11.1.1).

This pathway creates **transparent, accountable and sustainability-oriented governance systems** that provide the institutional conditions for developing, implementing and monitoring policies in a fair way. The governance systems are oriented towards environmental protection, guaranteeing the satisfaction of basic human needs and reaffirming personal privacy. The SSP1 and SSP5 pathways develop new indicators for human well-being and safety to guarantee that sustainability values are not sacrificed for economic growth and that decision-making is based on human needs and development. Actions ensure strong and fair legal systems and pluriform media landscapes.

The governance systems created through this pathway build on strong **international and multi-level governance institutions** for coordination and collaboration across scales and societal spheres (government, market, civil society). On the international level, Europe takes a key role in promoting a sustainability agenda globally and in mediating collaboration and support, which also supports its market leadership. In the SSP5 pathway, Europe creates economically driven cross-border alliances with the USA, Russia and China. In the context of SSP3, which is marked by international conflict, the pathway enhances and increases diplomatic channels for international conflict resolution and conflict resolution between EU members. On the EU level, a common EU identity is promoted. European, national and regional decision-making and rule systems are clearly defined and integrated while paying respect to national, regional and local diversities and needs. Transboundary platforms and agreements are developed on the management of resources, such as transboundary water boards. The SSP4 pathway establishes a single energy market in Europe including the distribution of energy infrastructure. In SSP3, because of the fragmentation on European and national levels, decision-making and economic activities are moved to local communities that are regionally connected in networks.

This pathway sets up an **inclusive and participatory governance system** that engages all societal actors in sustainability decision-making. This is achieved by actions to strengthen access to decision-making as well as building the capacities of actors to enable participation in decision-making. This is achieved by strengthening societal involvement in research and knowledge processes as well as the development and implementation of social, environmental and economic programmes (e.g. for climate adaptation). At the EU level, the SSP1 pathway includes actions to strengthen EU-citizen

connections and hold European elections to reinforce EU democracy. There is also attention to ensuring an open communication infrastructure for citizens that enables effective participation and collaboration. Capacity-building activities focus on both policy-makers and citizens to create awareness about their roles and the potentials of their actions in decision-making and governance. In the pathways of SSP3 and SSP4, the degree to which a participatory governance system is set up is constrained by the scenario contexts. In the SSP3 pathway, there is a shift towards local communities that organise outside of the 'corrupt' governance system. In SSP4, the European political and business elite maintains its powerful position and only gives minor decision-making authority to the majority of the population. The elite sets up a committee for governance that develops and oversees a 'master plan', which takes a European birds-eye perspective on infrastructure planning and sustainability policies in relation to context-specific conditions, opportunities and needs in European regions.

This pathway establishes **open and learning-based governance approaches** that enable both governance experimentation for the innovation of governance technologies and continuous monitoring, learning and adaptation of approaches and actions in line with social, economic and environmental realities. To encourage learning, the pathway includes knowledge exchange on best practices and setting up of monitoring systems. Particularly the pathways in SSP1 and SSP3 emphasise the need for governance experiments through research and application of new governance technologies and pilot projects in 'small labs'. This learning-based approach to governance includes all societal actors: experts, citizens, entrepreneurs and policy-makers. The pathway in SSP4 highlights the setting up of data- and evidence-based governance and monitoring systems to oversee and adapt the European-level master plan.

### 3.3.3. Promote sustainable agriculture

SSP1, SSP3 and SSP5 include a pathway to develop and mainstream sustainable agriculture across Europe. This pathway combines adaptation and mitigation strategies and actions to promote integrated and flexible land management, reduce negative consequences of agriculture on sustainability and climate, ensure food security, resilience and self-sufficiency in Europe and create co-benefits with recreation opportunities and health. It creates the institutional conditions and policy frameworks, establishes new types of infrastructures, fosters technological innovation and changes production and consumption practices for a sustainable agriculture system. The pathway addresses vision elements on 'food, water and energy', 'environment' and 'resilience' (see Appendix 11.1.1).

The pathway develops **integrated agriculture standards and policy frameworks** to provide a systemic perspective on agricultural practices along the whole food chain, regional/local needs and opportunities, and synergies and trade-offs with other sectors (e.g. water, biodiversity). The EU-level framework and programmes inform national and regional integrated land planning. It also supports sustainable agricultural production outside of the EU to help maintain sustainability standards and support domestic production systems. In particular, this pathway includes strategies for scaling and strengthening the EU Common Agricultural Policy (CAP) to internalise environmental and other costs in both agricultural production and consumption, promote urban agriculture and multifunctional land management and make CAP implementation more obligatory. The framework and standards are implemented in the form of a combination of regulations, taxes and incentives.

The pathway includes taxes and incentives that **internalise environmental costs into food practices** along the whole food chain and to reduce food waste. In the SSP3 pathway, taxes are implemented to force the rich population groups to invest in the environment. The SSP5 pathway additionally introduces carbon taxes to agricultural production. The incentives build on the internalisation of environmental costs, e.g. of environmental and land degradation resulting from agriculture, and support organic and sustainable agriculture practices and local market development (e.g. providing

farm income support). For example, the SSP1 pathway introduces a CAP pillar that incentivises and rewards environmental and socio-economic services from agriculture. The implementation builds on administrative and institutional systems that facilitate communication and collaboration across sectors.

Regulations focus on shifting towards **integrated and multifunctional agriculture** with flexible use of space to preserve the cultural landscape and ecosystems. Multi-functional agriculture means that food and other services are provided from the same land parcel and monoculture is reduced. Land uses are designed to meet different needs besides agriculture. Building on the CAP, integrated farming is enforced to produce different types of food and other services from a small space of land. The CAP is also expanded to promote urban agriculture and make it part of urban planning policies and practices. The SSP3 pathway identifies ecological corridors and increases nature protection areas and develops guidelines for designing integrated landscape planning with eco-tourism. Land is set aside for forestry and nature-based solutions for flood management. The SSP1 pathway includes regulation to support agro-forestry, bio-economy and reforestation, which counters the loss of forest in this scenario caused by extensive agriculture and related agricultural expansion. One action promotes a land use system in southern Europe that moves away from intensive agriculture and enhances extensive forestry.

This pathway shifts the agriculture market organisation towards **local community- and family-based agricultural systems**. Support is provided to small-medium enterprises that enables family-based agriculture and the organisation of agriculture in local community cooperatives. For example, the SSP1 pathway suggests that civil society organisations lend land ('terre de lien') and that financial resources are sourced through crowd-funding. In the SSP3 pathway local networks are developed for a circular economy.

The pathway introduces and facilitates **organic and climate-friendly farming practices**. Such farming practices include permaculture, legume-crop rotation and no-tillage. To adapt agriculture to climate change, locally adapted crop varieties are used. The SSP3 pathway suggests to use brownfield sites for local food production and to increase greenhouse farming. The SSP5 pathway proposes actions to shift agriculture to rain-fed compatible areas.

The shift towards sustainable agriculture is underpinned by **innovations in agriculture technologies and infrastructure**. In SSP1 and SSP5, investments in research and technological innovation on models and options for agro-ecological and agro-economy approaches are provided. Technological innovation focuses on new industrial production, food production to ensure food security (e.g. artificial food, replacements for meat) and energy and water efficiency improvements. The technological development also enables the transfer and selling of innovative technologies. In the SSP3 pathway, infrastructure is put in place that enables local agricultural economies.

In SSP3 and SSP5, this pathway also includes actions to **build skills and knowledge and promote knowledge transfer** for local organic agriculture. For example, in SSP3 agriculture and farming practices are integrated in local education and skills networks are created. Awareness is raised about management practices on extensive land use to protect biodiversity. The SSP5 pathway similarly includes agricultural sector awareness raising on land degradation and resulting losses in profits. It also identifies the role of citizens' knowledge for participating in local agriculture and environmental restoration.



### 3.3.4. Promote strong environmental protection and regeneration

In SSP1, SSP4 and SSP5, a pathway was developed that strengthens environmental protection and restoration. This is an adaptation pathway that includes strategies to promote integrated and water sensitive land use and biodiversity protection by mainstreaming nature-based solutions and integrated sustainable resource management. The pathway addresses vision elements on 'environment', 'resilience' and 'food, water and energy' (see Appendix 11.1.1).

The pathway develops an **integrated nature protection framework and policies** that ensure resources and land use in Europe are in harmony with nature and context-specific needs. The framework and policies ensure context-specific measures and natural networks to protect and restore biodiversity and water resources. In SSP1, the pathway builds on existing governance frameworks and approaches on the EU level. In SSP4, the master plan that is developed and implemented by the elite includes a stratified top-down strategy on land use and flood management that takes different characteristics and needs of regions across Europe into account.

In SSP5, this pathway includes a strategy to **internalise the value of the environment and ecosystem services into economic and planning activities**. This is achieved by determining higher costs of resources, ecosystem services and environmental degradation and highlighting the value of ecosystem services for quality of life. To create awareness about, and support for, valuing the environment, market failures to address negative externalities in a proactive way are highlighted and publicly communicated. Market prices and taxes are adapted to reflect the cost of resources and nature. Funds are provided to deal with climate change impacts. Research, innovation and decision-making shift from sectoral-based to problem-based and monitoring approaches, and this underpins the new institutions for integrating environmental concerns into long-term cost-benefit calculations.

The pathway shifts towards **ecosystem-based land use planning** that assigns flexible nature zones for biodiversity protection while promoting connectivity across territories. The SSP1 pathway builds on the EU Habitat Directive to expand Natura 2000 areas. Particularly in light of climate change impacts, these areas need to be re-defined and expanded outside of existing Natura 2000 areas. Traditional land use classifications are modified to integrate ecosystem services, geographical contexts and climate change impacts into planning. Land uses are re-assigned to establish and maintain protected areas that are good surroundings for species and provide space for leisure (e.g. natural parks). Re-zoning measures protect species with special habitats, while decreasing physical barriers for species to flexibly move and adapt in larger corridors. To implement land use changes and protect biodiversity, forest protection and reforestation policies are implemented as well as international policies on invasive species. In the pathway of SSP1, alternative forms of carbon sequestration are developed as part of integrated land use planning, e.g., permanent grassland is maintained to have more biodiversity and soil carbon sequestration. Additionally, cities are planned in a way to reduce urban sprawl and to not interfere with ecosystems and biodiversity. The SSP4 pathway sets up integrated local sustainable food production that produces context-specific food commodities for the European network and creates jobs. The SSP1 pathway also highlights the need for developing ocean resource planning to protect services and resources provided by oceans. In the SSP5 pathway, the integration of ecosystem service values into economic decisions guides land use decisions. Unmanaged land is used for habitats as much as possible, for example, safe havens for endangered species are created, which could also serve the establishment of a new market. High value nature parks are created that could also have a high market value for attracting tourism.

The pathway promotes and mainstreams **nature-based solutions for water management and climate adaptation**. Blue-green infrastructure is made obligatory for planning and investors in cities and flood plains to improve water retention. This is enforced by taxes and codes for green spaces, and

communities are involved in the management of green spaces. Other measures to enhance infiltration and flood protection include river re-naturalisation and improving soil infiltration. The pathway in SSP4 includes actions to assign large zones for flooding (e.g. forests and wetlands). The SSP1 pathway includes a strategy on holistic water management that enlarges water re-use and recycling, improves water transfer infrastructures and enhances water use efficiency in the built environment.

In the SSP5 pathway, the pathway facilitates **innovation in green technologies** in order to tap into nature's capitals and create new markets while protecting the environment, reducing emissions and building resilience. Research and development focuses on technologies to reduce high carbon dependency (e.g. by investing in alternative energy technologies and developing a bio-based economy), achieve higher energy and water efficiency and create robust service provisions through technologies.

Resource management is implemented by **polycentric and knowledge-based management approaches**. Resource management builds on knowledge about how to use land in the best way and on mapping and assessment of ecosystem services. The polycentric organisation enables local resource management that is integrated in the wider region. In the SSP4 pathway, the forests are used for self-subsistence food production (e.g. mushrooms, berries) by the high amount of relatively poor populations.

### 3.3.5. Promote an integrated water management system

In SSP3 and SSP5, a pathway was developed that shifts towards an integrated water management system to manage water in a way that resonates with the natural and climate change-related water availabilities, water needs and river flows. This pathway is an adaptation pathway to ensure availability of good water quality and resilience against flooding across Europe. It addresses vision elements on 'food, water and energy', 'environment', and 'resilience' (see Appendix 11.1.1).

The pathway in SSP5 builds on the EU Water Framework Directive (WFD) to set up an **integrated water management framework** that manages the water cycle EU-wide. This framework takes an integrated perspective on water, energy, agriculture and climate change to develop context-specific policies and plans. It also includes control measures to ensure water quality and reduce water pollution.

**Water infrastructures** ensure high quality water availability across Europe and support climate adaptation. The pathway develops water transportation networks (e.g. from northern to southern Europe) and local water harvesting to ensure widespread access to water. It also builds and reinforces the dyke system, sewer systems and physical structures for rain absorption to build resilience against flooding. The pathway in SSP3 includes actions for low-key water harvesting from floods in the south and household rain harvesting.

The pathway implements **nature-based solutions for water availability and flood protection**. The latter establish flood protection zones in synergy with living areas, recreation and land use planning and use flood protection to increase habitats for biodiversity (e.g. wetlands). A specific focus is on increasing water storage in river beds and floodplains through river re-naturalisation.

The sustainable water management system is supported by **changing uses of water and living patterns**. The SSP5 pathway includes awareness campaigns about water savings. The SSP3 pathway discourages living in areas with high flood risk and high vulnerability. Additionally, the SSP5 pathway includes investments in **innovative water technologies** to use wastewater for crops and make electric power less freshwater intensive.

### 3.3.6. Promote Europe as a global leader for sustainability

SSP1 includes a pathway to position Europe as a global leader for sustainability that makes headway with transformative commitments for sustainability and develops effective international and European partnerships and institutions for realising climate and sustainability goals. This is a transformation pathway that builds up 'world governance' for common global goals and action towards sustainability and resilience. A particular focus of this pathway is on international and European climate adaptation and resilience building. The pathways address the vision elements on 'regional and global interrelationships', 'governance' and 'resilience' (see Appendix 11.1.1).

The pathway includes actions to define **supra-national sustainability goals** for coordinating global and European action towards a common, long-term and integrated agenda. The United Nations Sustainable Development Goals (SDGs) are taken as the main orientation for coordinating global sustainability action. The pathway mentions the possibility of using global crises as well as public movements and NGOs as triggers for shifting towards more ambitious goals and determined action for global sustainability and resilience. An important element for ensuring shared ownership over these goals among all nation states and societal actors is effective communication.

Building on the global sustainability orientation, the pathway includes actions to strengthen **European and international governance institutions and mechanisms** for collaboration and coordination towards the common agenda. An important element of these institutions and mechanisms is that they build trust internationally for a global collaborative system. Collaboration mechanisms and partnerships build on stronger EU solidarity mechanisms that ensure concerted action and equality across Member States. On the international level, the capacities and authority of global institutions like the UN and the World Bank are strengthened in line with the global sustainability orientation. Additional institutions are put in place to rigorously monitor the negative effects of global action on the environment and other sectors (e.g. energy, water, food, health).

There is also attention to **building governance capacities worldwide** and supporting countries outside of Europe to ensure that all countries have the capacities in place for effectively implementing strategies and actions towards sustainability, resilience and coping with climate change. This includes support for the formulation of climate strategies and action plans. In view of expected climate change impacts, actions support the creation of know-how and preparedness for coping with weather extremes.

An important element for ensuring that the implementation of the global sustainability and resilience agenda is effective and that trade-offs and negative side-effects are accounted for and avoided is **knowledge generation**. To facilitate the implementation of the global and European sustainability agenda, the EU makes research funds available for monitoring.

### 3.3.7. Promote a circular economy with green energy technologies

In SSP4, a pathway was developed to establish a circular economy to increase resource efficiency and green energy, to achieve a self-sufficient Europe and to strengthen Europe's market position in green technologies. This pathway combines mitigation and adaptation actions that massively invest in green technologies to reduce resource demand, ensure resource quality and security and produce zero waste. This pathway addresses vision elements on 'food, water and energy', 'environment' and 'resilience' (see Appendix 11.1.1).

The pathway builds on the 'master plan' that is developed and implemented by the elite in this scenario. Building on the notion of a 'small ecosystems' approach, the circular economy is designed

to **close resource loops at multiple scales** from the European scale down to regional and local scales by connecting context-specific conditions, opportunities and needs in European communities and regions. With regard to water, this is achieved by connecting areas with low water availability and areas with high water availabilities. For example, water from northern Spain (Pyrenees) can be transported to the south. With regard to energy, a European energy grid with cross-border connections and regional energy provision and generation is established. Available land is strategically used for renewable energy production. For example, unmanaged forests (which are abundantly available in the SSP4 scenario) are used for biomass production, while there is attention to avoiding conflict between biomass and food production. Massive energy production is implemented in southern Spain to make use of the region's solar potential. Additionally, nuclear and fossil energy sources are strategically phased-out by, for example, replacing conventional power stations that have reached the end of their life cycle with renewable power stations.

To achieve resource efficiency (especially energy, water and food), improve resource quality and promote renewable energies, the pathway invests in **innovation in green technologies**. A central focus is on the expansion of renewable energies while ensuring effective energy distribution and energy security. This is achieved by, on the one hand, expanding renewable energy and energy efficiency technologies in all societal sectors, including the electrification of transport, energy efficiency in building and shifting towards energy systems that require low cooling – and making them mass products. Also waste and (second, third and fourth generation) biomass are used to produce energy. On the other hand, to achieve effective energy distribution and energy security, virtual energy grids for green energy distribution at regional levels and intelligent systems for storage capacity (e.g. huge pumped hydro plants) are developed. While fossil energy is still used, carbon capture and storage is implemented. Additionally, technologies are implemented to improve water efficiency and decrease water use, including technologies for de-salination and using recycled water (e.g. treating water and waste water from post-production processes). To improve food quality and food security, investments for research and development on sustainable food technologies are provided.

The pathway also includes actions to ensure the **knowledge conditions for resource efficiency and resource security** (through technologies) and build resilience. For example, the pathway includes actions to implement early warning systems for extreme weather events. Additionally, it includes actions to change behaviours in line with the implemented technologies. For example, water consumption is regulated through water quotas.

### 3.4. Governance capacities in the pathways

Across scenarios, **different types of actors** are identified as carriers of the actions. *Governmental actors* in all scenarios provide regulation, coordination, incentives and financing, although they play a considerably smaller role in SSP3. Except for SSP3, the pathways in the scenarios build (on) a strong EU that has good international relations and works within a multi-level governance structure. Especially in SSP4, the pathways build on centralised governmental structures that strategically plans and implements actions top-down. *Civil society actors* play critical roles in the pathways of all scenarios, being actively involved in decision-making and in the development and implementation of action (e.g. sustainable consumption, local renewable production, education). Especially in SSP3, most actions are developed and implemented by civil society actors and entrepreneurs on local community levels given the lack of governmental capacity in this scenario. *Market actors* (industry and business actors) and *knowledge institutes* (e.g. actors from universities, research institutes) have an implied role in the pathways of all scenarios. For example, the pathways to promote sustainable agriculture address the production patterns and require innovations of farmers and other actors along the food chain. In SSP4, market actors are actively involved in governmental decision-making. The involvement of actors from knowledge institutions (e.g. universities, research institutes) is implied in actions to

implement better monitoring and research on environmental and social problems and solutions and to set-up process-based governance approaches.

All pathways across scenarios share a **strategic orientation towards sustainability** that orientates political, social and economic behaviours. This strategic orientation is guided by the vision for Europe in 2100 and shared by all actors in Europe across the scenarios – underpinning, for example, the shifts towards sustainable lifestyles. It is manifest in the long-term, synergistic and integrated thinking behind the pathways, which provide interrelated and long-term strategies and actions towards a diverse set of goals. While in SSP1 this orientation was already in the scenario storyline, the pathways strengthen international, EU and national sustainability goals. In SSP4, this strategic orientation is defined from the top-down in form of a ‘master plan’. The plan takes a birds-eye perspective on context-specific conditions, opportunities and needs in European regions, building on the notion of a ‘small ecosystems’ approach. In this way it can connect different opportunities, find synergies for resource access and land management across regions and avoid trade-offs. In the SSP3 pathways, this strategic orientation is more implicit than in the other scenarios, because there is no overarching institutional body for carrying this orientation. However, it implicitly appears in the way local and networked communities self-organise.

The strategic orientation guides the **formulation of integrated framework conditions** such as regulations, incentives, taxes and (self-regulated) financing mechanisms that enable long-term decisions and investments to create synergies across sectors. For example, the systemic perspectives on the implications of agricultural practices along the whole food chain, on regional and local needs and opportunities enables multifunctional agriculture and integrated land use planning that accounts for synergies and trade-offs with other sectors (e.g. water, biodiversity). The framework conditions also support the implementation of nature-based solutions that provide benefits for climate adaptation, health, biodiversity and leisure, amongst others. Additionally, the framework conditions dis-incentivise unsustainable practices. For example, in SSP5, the costs of environmental degradation and the intrinsic value of nature are internalised into economic activity, which serves to adapt prices and promote investments in green technologies.

Building on the conditions in the respective scenarios, the pathways set up **participatory coordination and collaboration networks, structures and mechanisms**, which enable the mediation of interests, knowledge and resources across scales and sectors in Europe and globally. Especially the pathways in SSP1 build on a multi-level governance structure and international collaboration; the latter also serves to achieve Europe’s sustainability agenda globally and to build capacities in other countries. Multi-level governance structures help to manage resources on local and regional levels in relation to context-specific needs and opportunities, while connecting them to the overarching European sustainability agenda. This is especially visible in the SSP4 pathways, in which the European elite strategically coordinates the implementation of the master plan, but regions and communities are interconnected to build on each other’s assets and support each other. Inclusive and participatory governance systems enable civil society actors to actively participate in political discourses and decision-making at international, European, national, regional and local levels.

To ensure that the actions are in line with social and environmental conditions and to prepare for risks, the pathways put in place comprehensive **knowledge and monitoring systems**. For example, the planning approach in SSP4 builds on a new type of data- and evidence-based governance system that builds on continuous monitoring and learning to oversee and adapt the European-level master plan. In SSP5, research, innovation and decision-making shift from sectoral-based to problem-based and monitoring approaches, which underpin the new institutions for integrating environmental concerns into long-term cost-benefit calculations. In SSP1, resource management builds on knowledge about how to use land in the best way and on mapping and assessment of ecosystem services.

Finally, the pathways build on and create **conditions for innovation** by investing in innovative technologies, research and education and providing flexible regulation. Innovation can be both high-tech and low-tech and include social, technological and governance innovations. While in SSP3 innovations include mostly low-tech and social innovations for self-sufficiency on local levels, in SSP4, SSP1 and SSP5 there are also high-tech innovations. Governance technology itself is constantly innovated, by enabling governance experimentation and strengthening research on governance.

### 3.5. The pathways' impact: efficacy, synergies and trade-offs

This section presents the impacts of the pathways in terms of their efficacy in reaching the vision as well as the synergies and trade-offs created across pathways, strategies, actions and sectors.

#### 3.5.1. Efficacy of pathways in reaching the vision

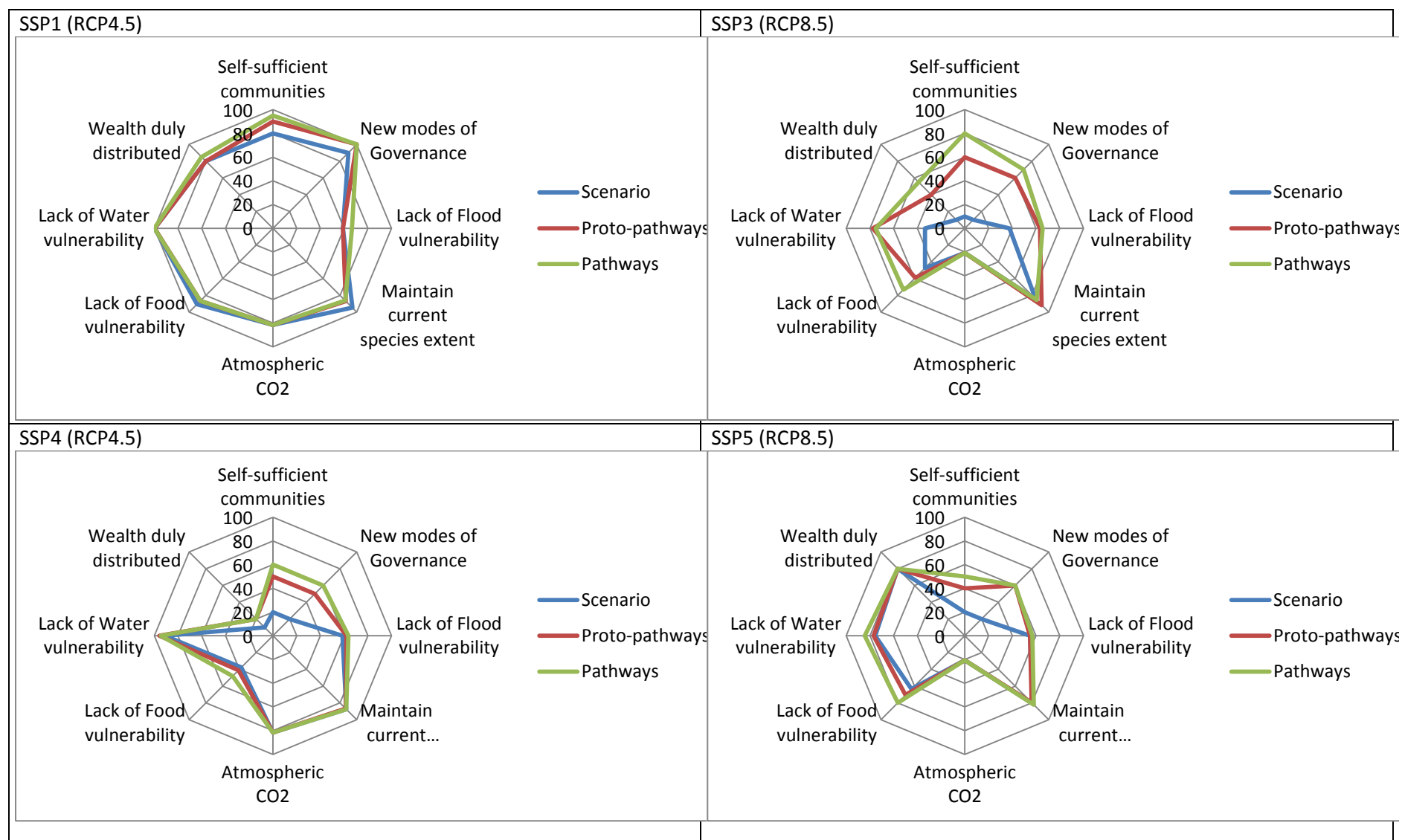
The results of the qualitative and quantitative assessments of the effectiveness of the actions within the proto- and final pathways in moving the status of the vision element indicators towards the target, compared to the SSPs, are shown in the spider diagrams in Figure 12. The analysis shows that the adaptation, mitigation and transformation actions within the pathways are generally effective in moving Europe in a positive direction towards the vision, although the effectiveness of identified actions differs between the scenarios and the vision element indicators.

Particularly the pathways in SSP3 (the most dysfunctional scenario) are effective in improving multiple vision indicators, due to the major improvements in human and social capital that both improve the ability of society to implement effective adaptation actions but also increases their capacity to cope with residual impacts. For example, the spider diagram shows the improvements in moving towards self-sufficient local communities that also organise within new modes of governance in participatory, informal and networked ways. This results in the visible major improvements in the vulnerability to flooding, water availability and food availability.

The analysis also shows that it is difficult to achieve some of the vision element indicators, despite high availability of capitals (for example, in SSP5) and/or lower degrees of climate change (RCP4.5 compared to RCP8.5). This arises due to unavoidable impacts of climate change (for example, reducing suitable climate space for European species, as shown by the target of maintaining current species extent despite an assumption of effective species dispersal over the century) or system lags (the significant number of people that will continue to live in floodplains due to existing housing stock).

The analysis has also demonstrated the challenges of implementing effective transformational change within scenarios in which there are considerable 'lock-ins'. For example, the strong 'elites' within SSP4 prevent a more equitable distribution of wealth; whilst the unsustainable free market-based behaviours of European society within SSP5 hinder the transition to more locally self-sufficient and circular economy-based communities and the establishment of new modes of governance based on embedding sustainability principals within multi-level governance structures.

Whilst there are many actions within the pathways which contribute towards mitigation, it has not been possible to assess the effectiveness of these in reducing atmospheric CO<sub>2</sub> levels due to the dominant effect of other countries' contributions to global emissions. As such, the CO<sub>2</sub> levels in SSP3 and SSP5 (the RCP8.5 scenarios) remain high. Nevertheless, this should not underplay the importance of the mitigative actions within the pathways in reducing Europe's contribution to climate change.



**Figure 12: Results of assessment of whether the vision is achieved for a selection of indicators. Achieving 100 (the outside line of the spider diagrams) means that the vision has been achieved.**

### **3.5.2. Synergies between pathways**

All pathways in all scenarios are highly interdependent and support each other in contributing towards the vision. Two pathways have been identified as conditional for the other pathways across all four contextual scenarios: the pathway that promotes shifts to sustainable lifestyles and the pathway that promotes good governance systems for sustainability.

The pathway that promotes shifts towards sustainable lifestyles underpins changing resource use and demands for sustainable products and technologies. For example, it pushes for mainstreaming of sustainable agriculture practices that respect the environment, as there will be higher demand, incentives and obligations for sustainable products and production approaches. Likewise, it supports integrated water management in SSP3 and SSP5, because there will be less water use and more water re-use.

The pathway that establishes participatory and transparent governance approaches conditions the ways in which services are organised, used and delivered in the other pathways. For example, it supports setting up integrated water management systems in SSP3 and SSP5, by providing institutions and frameworks for developing policies and land use management systems. In SSP1, it strengthens the positioning of Europe as a global leader for sustainable development by defining ambitious goals and showcasing how to achieve them in participatory and transparent ways. In SSP4, it generates a framework in the form of a master plan and identifies the conditions for its top-down implementation. This enables the setting up of a European circular economy that closes loops at multiple and interconnected scales according to environmental conditions, resources and needs.

### **3.5.3. Trade-offs between pathways**

While trade-offs with regard to land use (especially agriculture) occur in all scenarios, most of the other trade-offs are scenario-specific.

Across scenarios, the modelling results indicate trade-offs with regard to different types of land uses. Especially in SSP1, because of the assumed extensification of agriculture due to a shift towards organic agriculture in the scenario storyline, there is a potential trade-off between decreasing food imports and exports and promoting nature protection and biodiversity due to agricultural expansion (to make up for reduced net imports). Modelling suggests a need to ensure effective sustainable intensification through, for example, favouring the expansion of arable agriculture across the middle of Europe. Likewise, in SSP1 the action to promote a land use system in southern Europe that moves away from intensive agriculture toward extensive forestry might lead to a trade-off with agricultural expansion implied in this scenario because it leads to a reduction in agricultural areas. Similarly, in SSP3 there is a trade-off between setting land aside and incentivising forestry and nature-based solutions for flood management and increasing extensive grazing, because only limited land will be available.

In SSP3 and SSP4, trade-offs were identified between actions in the pathway that promotes a shift towards sustainable lifestyles. In SSP3, the action to establish higher taxes on water use in drier areas might reduce the access to water for a large part of the population. Thus, it requires attention to potential financial inequalities. In SSP4, the top-down approach to control food and health for all might be at odds with the more education-based approach in the other actions that seeks to enable people to make conscious lifestyle choices. This indicates a general tension in this scenario, i.e. the extent to which there can be strong top-down controls while ensuring a high level of support, ownership and empowerment.



In SSP1, one trade-off was identified between actions across pathways in relation to biodiversity. The action to modify crops and use varieties that are more resistant to drought might cause a trade-off with actions to maintain biodiversity. This demands attention to whether modified crops can be considered as a threat to biodiversity.

In SSP5, there is a potential trade-off between the pathway to shift towards integrated water management and the increased irrigation usage arising from improved efficiency and profitability. This requires that full cost pricing of degradation in agriculture provides the additional financial mechanism to limit abstraction.

## 4. Scottish pathways

Scotland has a population of over 5.3 million and comprises 32 local authority areas. Scotland has a highly ambitious climate change adaptation policy, implemented through the Climate Change Act of 2009 and the associated Climate Change Adaptation Programme and Climate Change Adaptation Framework.

The rural economy of Scotland is vulnerable to the impacts of climate change. This case study is exploring the risks posed by high-end climate change scenarios for land and water resource sectors, including forestry, agriculture, tourism, health and river flows. It focuses on the potential implications for Scotland's reforestation targets; changing growth patterns for commercial tree species; potential changes to tourism activity; changing hydrological patterns and their implications for aquatic ecosystems; and the implications of future land use/climate on the risk of Lyme's disease. The outcomes of the project provide new evidence to support the Scottish Adaptation Strategy and Land Use Strategy; as well as to support decision-makers in incorporating high-end scenarios into their risk management strategies.

The IMPRESSIONS Scottish case study included the following elements to develop adaptation, mitigation and transformation pathways:

- Four climate and socio-economic scenarios for Scotland using the RCP and SSP framework have been developed;
- A diverse range of modelling approaches (including integrated models, physically-based models) have been used to simulate impacts, vulnerability and adaptation of forestry, agriculture, tourism, health and river flows to high-end scenarios;
- A vision for Scotland in 2100 was developed;
- Scenario-specific pathways were developed containing adaptation, mitigation and transformative strategies and actions that reduce the impacts and exploit the opportunities arising from high-end scenarios to move towards the vision.

In the following, we present the results from the Scottish case study with a focus on the developed pathways and their analysis. We first outline the four scenario contexts that provide the logics for developing the pathways as interpreted by the stakeholders (Section 4.1). We then present the vision that has been formulated for Scotland in 2100, which provides the orientation for developing the pathways and the point of reference for assessing their efficacy, synergies and trade-offs (Section 4.2). Third, we outline the pathways that were developed starting from the pathways that occur in all scenarios and then the pathways that occur in some or in individual scenarios (Section 4.3). Fourth, we present the governance capacities that are created through the pathways and that represent the conditions enabling their implementation (Section 4.4). Finally, we discuss the impacts of the

pathways in terms of their efficacy in achieving the vision and resulting synergies and trade-offs (Section 4.5).

#### 4.1. Scenario contexts and pathway logics

Four socio-economic scenarios (SSPs) were developed and matched with either RCP4.5 or RCP8.5 (Deliverable D2.2 - Kok and Pedde 2016). Each scenario provides distinct contexts, opportunities and challenges for the development of pathways, including different socio-economic enabling and disabling conditions, key actors and climate impacts. This section summarises the context provided by each scenario and describes how it was interpreted for the development of pathways to achieve the vision for Scotland in 2100. Table 5 provides an overview and comparison of the key elements per scenario.

**Table 5: Key elements per Scottish SSP (Adapted from: Deliverable D2.2 - Kok and Pedde 2016).**

Key elements	SSP1: MacTopia	SSP3: Mad Max	SSP4: Tartan Spring	SSP5: Techadonia
RCP	4.5	8.5	4.5	8.5
Decision-making level	Multilevel and communitarianism	Corporate and clan level	National/Multinationals	International/national and “clantons”
International cooperation	Strong with like-minded countries and BRICS	Weak	Strong, EU important player	Strong (trade)
Net migration-low in-migration	High immigration	High immigration at the beginning	High migration	High to cities and from non-EU countries
Economic development	Steady but somewhat slow	Low	High	High
Mobility	No barriers,	Very low	Low	High
Social cohesion	High	Low between strata, higher within strata	Low	High
Technology development	High	Low	High	Strong and crucial
Quality of Governance	High – focus on trade-offs and social inclusiveness	Low and ineffective at national level (short-term)	Ineffective	High – focus on profitable investments
Human health investments	High	Low	High and then private (exclusive)	High
Education investments	High	Low	High and then private (exclusive)	High (focus on sciences, engineering and technology)
Environmental respect	High	Low	Low	Low, but high NIMBY
Agency capacities	High ability to act – sustainability frameworks, multi-level governance, participation	Low ability to act – high inequality, no institutional sustainability frameworks, no resources	Moderate ability to act – unequally distributed and no institutional conditions on social issues	Moderate ability to act – no institutional conditions for environmentally-oriented action
Key actors	All societal actors (government, market, civil society) at multiple levels	Multinationals control government and resources; weak governments; local communities organise for self-sufficiency	Small elite and multinationals concentrate power and resources; majority of the population in local communities	Government and market actors, public-private partnerships

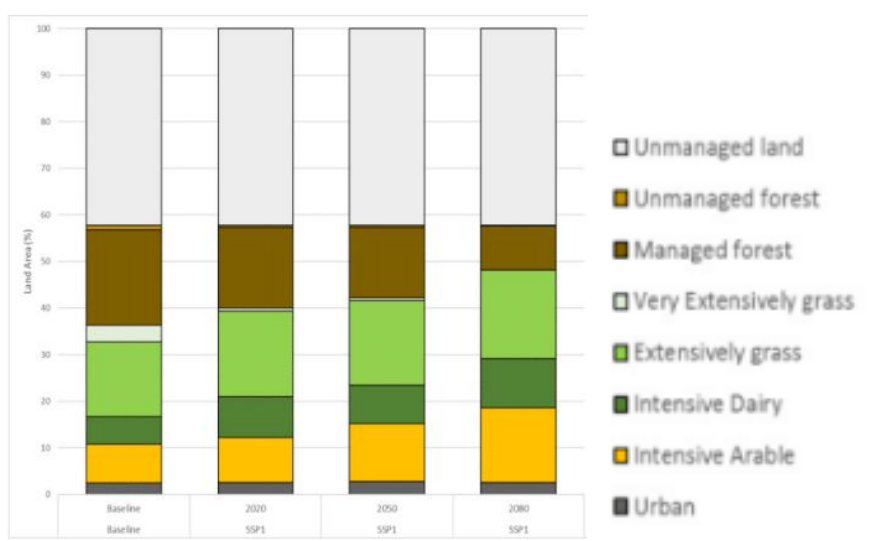
### 4.1.1. SSP1: MacTopia

#### Scenario storyline

Through increased societal involvement, policy and effective governance, Scotland achieves the transition towards a sustainable and equitable society by 2040. This transition comes within the context of positive economic development and a further devolution from the UK. Scotland has stronger ties with other like-minded countries both within and outside the EU. More income is also generated from the export of surplus water and is invested in social and environmental policies. The shift towards a green (but highly taxed) economy increases tax evasion and resource smuggling. In addition, some social unrest develops as a result of the increase in both unskilled and highly skilled migrants, especially from the rest of the UK. These problems are, however, limited due to high government presence (e.g. with social assimilation programs). By 2070–2100, Scotland has become more aware of national security issues, but the core values of social and environmental sustainability and equity are dominant. Thus the country remains open to trade by consolidating healthy trade relationships with rich countries, as well as helping with the (economic) development of poor countries. The country has grown a bit less than business-as-usual, but unemployment and homeless people are now things of the past.

#### Selected key impacts

The need to produce more food because of reduced food imports leads to an increase of agricultural intensity (Figure 13). The largest increases in intensive agriculture are in the northeast and southeast of the country. The extent of extensive agricultural areas decreases with a shift to intensive agriculture, or urban. There are very small levels of change in unmanaged land.



**Figure 13: Land use in the baseline and three time slices for SSP1xRCP4.5 scenario (MacTopia) simulated by the IMPRESSIONS Integrated Assessment Platform (IAP2) for Scotland (Source: Deliverable D3C.2 - Clarke et al. 2017).**

Mild to moderate decreases in forest area are seen across all three time periods (Figure 13); the strongest decreases are seen in the northeast of Scotland. There is increased productivity of the remaining forest areas. Changes in aboveground biomass are mixed, depending on the area. Land use for agricultural and urban areas continues to put significant pressure on biodiversity. The upland areas are more favourable for biodiversity and the warmer climate can lead to more biodiversity, but also to losses and pests. There is serious habitat loss for iconic species (Osprey -52%, wild cat -57%, capercaillie -67% and scots pine -40%).

**Agency capacities and key actors**

All actors collectively contribute to promoting sustainability in Scotland. Governmental actors from national to local scales implement regulations to ensure environmental protection and social justice and they coordinate sustainability actions in Scotland. Both large business actors and small and medium-sized enterprises push for economic development in line with the political sustainability goals. Civil society in Scotland is well organised and participates in decision-making at national to local levels.

Scotland's policy agenda is oriented towards long-term sustainability and equity goals. These goals build on the Inverness Conversations; these take place early in the scenario, involve representatives from all layers of society and set the overarching societal framework. The Scottish government has a central coordinating role to implement the common sustainability and equity goals. The governance structure is highly polycentric with strong governmental bodies at all scales and local community involvement. There is a high level of participation and transparency in decision-making processes. Trade-offs between different goals are openly dealt with, although some conflicts persist, for example between the increased need for timber as an eco-building material and sustainable forest management (including reforestation targets).

Scotland acts within cohesive EU frameworks and legal systems on sustainability. For example, it adopts the EU Environmental Framework Directive to ensure an integrated regulatory system for land and water management. Scotland also collaborates with and shares resources with other like-minded countries both within and outside of the EU. Trade partnerships and agreements, also between Scotland and BRIC countries, facilitate innovation for example on information technology. There is a distinct Scottish identity and Scotland politically separates from the UK.

Governments at all levels regulate and provide incentives for efficient use of resources, circular economy, resilience and equity. For example, regulations do not allow building in flood risk areas, require new buildings to be energy neutral and implement penalties to companies and people with unsustainable behaviour. This also supports the creation of an environmentally aware and diversified economy that disconnects economic growth from natural resources. The Sovereign Scotland Fund provides resources for sustainable investments and ensures the well-being of the population regardless of social status. Investments include a reforestation programme and extensive railway network.

A high level of financial resources are available for investments in research and innovation on sustainable technologies (including governance, technical, social and institutional innovations). This is supported by the government (e.g. through the Sovereign Scotland Fund) and industry that focuses on innovation and technology. Research programmes boost innovation in the field of renewable energy and IT. Scotland becomes a frontrunner in IT, life sciences, green technology and finance. It exchanges best practices with other countries with similar economies and philosophies.

There are high degrees of local self-organisation to respond to impacts and risks based on a high level of societal awareness on sustainability and of social cohesion. Scottish people strongly identify with local communities, which are so strong that a new type of governance is adopted: Communitarianism.

**Pathways logic**

The pathways strengthen the potential that is already in the scenario, i.e. the focus on green energy technologies, sustainable lifestyles, international collaboration, participatory governance and local community empowerment. Focal areas for the pathways are the creation of strong international and multi-level governance collaboration, civic engagement and community empowerment, as well as lifelong education and learning.

Multi-level cooperation and collaboration is facilitated to ensure a balance between vision and strategies and their local and regional implementation. Multi-level governance is regarded as a prerequisite to ensure community engagement and empowerment. Civic engagement is enhanced through citizen science and citizen juries to see what choices fit within measures and policies. Knowledge and learning is expanded to enable individuals to operate under the policies, e.g. agricultural ecologists work to change the philosophy of land managers. Lifelong learning of society as a whole is important to ensure wider awareness. This is set up as a cycle through time to have moments for society to reflect both through top-down consultations and bottom-up social media and local consultations.

#### **4.1.2. SSP3: Mad Max**

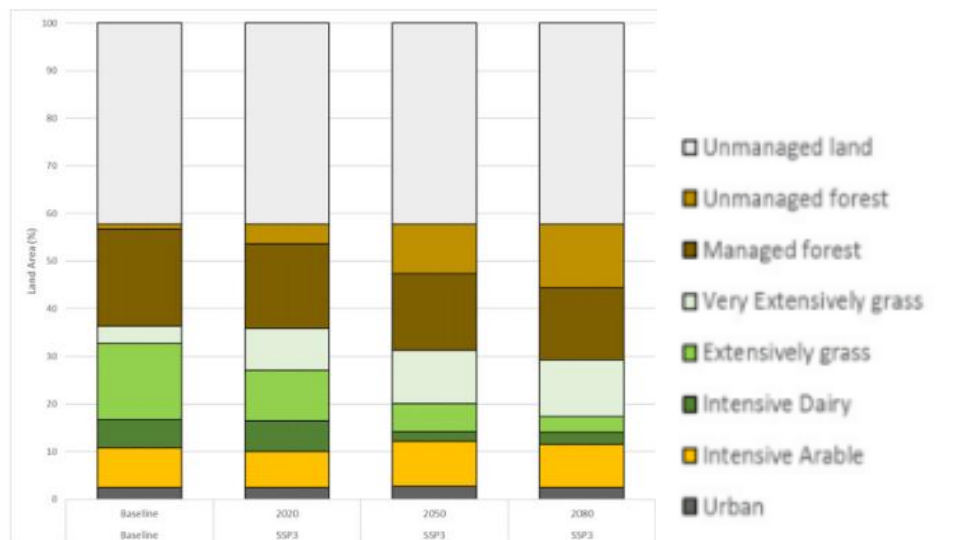
##### **Scenario storyline**

On-going conflicts, political instability and demographic issues in other countries are drivers for increased resource problems and migration to Scotland. Because of increased pressure on resource exploitation, investors buy up land and access to water leading to volatile markets. More and more people have problems buying land but also food and water. This leads to a society with less solidarity. Energy becomes increasingly valuable and the government sells energy to the highest bidders. These are multinationals who also own large portions of land, control the scarce water and food supplies and determine the consistently high pricing of essential goods and commodities. Fragmentation of society leads to more sectarianism. Conflicts between Catholics and Protestants are rampant, especially in the small mining communities in the Highlands. By 2040 the EU breaks down and suffers from social unrest and an economic and energy crisis. In Scotland, a survival from day-to-day, “getting the sandbags out” type of mentality prevails over a long-term structural approach, especially for the ‘have-nots’. The ‘haves’ on the other hand are preoccupied with securing their fortunes and the few remaining resources. By 2070–2100, a balance is reached, where both the ‘haves’ and ‘have-nots’ realise they have to organise themselves: the ‘haves’ to protect themselves and their property, the ‘have-nots’ to survive. These unions originate out of necessity. However, conflict within these groups is also common. There is no, or very limited, contact between the different strata. The poorer Scots work for the richer Scots, but that is the only interaction between them. The whole society has learned to live with less.

##### **Selected key impacts**

The intensity of agriculture increases (Figure 14), with some smaller increases also in extent. The largest increases in intensive agriculture are in the east and the central belt. There are very small levels of change in unmanaged land. Managed forest area decreases in all time slices and the decrease is strongest in the northeast. The strongest and most extensive decreases of forest area are in the last time slice. The areas of decrease match the areas where agricultural intensity has increased. There are extensive decreases in aboveground biomass in the late century; this is linked to areas where forest areas have decreased.

There are strong increases of biodiversity in some areas and strong decreases in others. The latter is associated with areas of increased agricultural intensification. The change in the number of species present shows mixed increases and decreases in the early- and mid-century. There are widespread increases in the number of species present in the late century, apart from small areas of the coastline. There are increasingly large losses of potential suitable habitat and climatic areas for Capercaillie as the century progresses, showing that despite overall gains in biodiversity in the late century there could still be losers.



**Figure 14: Land use in the baseline and three time slices for SSP3xRCP8.5 (Mad Max) simulated by the IMPRESSIONS Integrated Assessment Platform (IAP2) for Scotland (Source: Deliverable D3C.2 - Clarke et al. 2017).**

#### **Agency capacities and key actors**

In this scenario, the Scottish population is divided into a small group of ‘haves’ that has access to resources and the majority of ‘have-nots’. Governments have an increasingly weak position and they are not able to intervene and respond to crises; rather they serve the short-term interests of multinational companies. There is a decreasing number of multinationals that control all resources and land in Scotland and largely act following short-term economic interests. Civil society becomes highly fragmented at larger scales, with large degrees of stratification and conflicts between groups, but communities organise basic services and subsistence locally.

In this highly fragmented scenario, there are no shared goals for Scotland and no long-term planning is in place. Short-term economic thinking in a profit-driven system prevails, as Scotland has no stable regulatory force and multinationals and clans control and exploit Scotland’s resources. Later on, the governance approach changes towards a ‘Victorian approach’ to serve the economic interests more long-term and eliminate social unrest. There is no fair and participatory governance system and low international, multi-level and regional collaboration. Overall, the governance system is marked by a high degree of conflict, which mirrors the disintegration of the EU.

Without an institutional sustainability framework, multinationals act through high pricing of goods and commodities, which creates an increasing pressure on resource exploitation and a volatile market together with an erosion of labour laws and trade unions. There is no regulation of prices and for the majority of the population it becomes increasingly difficult to buy food and water. There are no investments in technological innovations and in service provisions.

Civil society actors organise themselves locally for self-sufficiency, but with large degrees of stratification and conflict between groups. There is local level innovation for subsistence and day-to-day survival.

#### **Pathways logic**

The pathways move from governmental regulation to self-regulation across time as corporations grow stronger and governments weaken. There are two tiers of society, the ‘haves’ and the ‘have-nots’ that act within separate but interacting corporate and community levels.

The 'haves', i.e. especially corporations, develop an interest in long-term investments and maintenance of nature and environmental services as well as a healthy workforce. In the early time slices of the pathways there is also education to encourage a philanthropic approach for corporate social responsibility (CSR). There is a need for diversity amongst companies so that there is competition and to support CSR. The corporations own land and protected areas, but allow the 'have-nots' to live on the land for subsistence and to work on the land, e.g., they get paid for hunting game for food and estate management.

#### **4.1.1. SSP4: Tartan Spring**

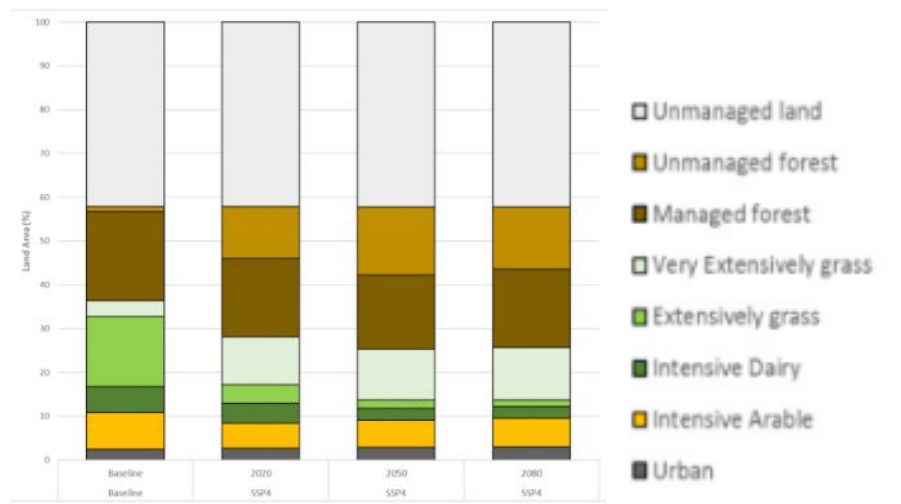
##### **Scenario storyline**

The strong middle class and present prosperity pave the way for technological innovation which leads to more efficient use of resources. A whole new generation of highly educated young people takes the lead. To capture the full potential of all these technological developments, the Scottish government decides to open resource access to the private sector and to establish liberal market structures. As a result, by 2040 the influence of the private sector in Scotland has become very strong. Economic growth becomes the fundament of Scottish nationalism and political independence is achieved in 2040. The middle class favours further deregulation and cuts in public spending, spearheaded by the economic growth. An unwanted consequence is the disappearance of welfare measures and more public GDP spent on overseas conflicts to secure ownership of access to resources. With more income from resources going to multinationals and little welfare, the disparity between the poor and the wealthy in Scotland becomes more pronounced. This disparity further increases because technological innovation makes it possible to eliminate jobs and manpower. Those that have a job still benefit from privately organised health care schemes, but a large part of the workforce services the super-rich and has only limited social security, barely enough for a decent life. By 2070 people realise that is not enough to live in a rich country which lacks sustainability and accountability of governance. Strikes and uprising become more frequent and violent. Scotland enters turbulent times.

##### **Selected key impacts**

There are major changes in the rural landscape especially in the latter parts of the century. There are decreases in both intensity and extent of agricultural areas in the later time slices (Figure 15). The decreases of extent are more widespread than the decreases of agricultural intensity. Winter barley yield increases in the earlier part of the century then decreases in the latter parts of the century. The forest area shows an increase of unmanaged forest compared to the baseline and a small decrease of managed forest.

The index of biodiversity has a mixture of increases and decreases in the early century, with decreases particularly in the northeast and southeast of Scotland. This changes progressively towards primarily (and stronger) increases in the mid and late century. The change in total species in 2100 shows mixed increases and decreases in different parts of the country.



**Figure 15: Land use in the baseline case and three time slices for SSP4xRCP4.5 (Tartan Spring) simulated by the IMPRESSIONS Integrated Assessment Platform (IAP2) for Scotland (Source: Deliverable D3C.2 - Clarke et al. 2017).**

### Agency capacities and key actors

There is a centralised and strong state apparatus with political and economic power converged in the hands of a relatively small political and business elite. The private sector has a strong influence on decision-making and there is a high level of investment in science and (green technological) innovation. There is a privatised approach to manage public resources and the majority of the population does not have access to services, resources and decision-making. The social fabric erodes.

Multinational market actors strongly invest in Scotland, which is beneficial for the Scottish economy but results in multinationals obtaining control over the government as they control Scotland's resources. There is a low level of accountability of the government and no participation of the majority of the population in decision-making. Rather, the political and business elite act to safeguard their wealth without overarching societal goals. The Scottish elite secure a large majority of resources following market liberalisation, while the majority does not have access to basic services.

Scotland obtains independence from the UK and establishes trade partnerships with other resource rich countries such as Canada, Norway, Iceland, China and Russia. This strengthens the power of the rich in Scotland. The Scottish elite is also well-connected with the elite in the EU to secure ownership of, and access to, resources.

The governance system is marked by a poorly regulated privatisation process to manage public resources. While there is a high level of investments in technological innovation and science for efficient and sustainable resource use through market liberalisation, there are no safeguards in place to ensure that everybody benefits from the strong economy. There are decisive cuts in public expenditure, resulting in the full retreat of the welfare state and lack of societal safety nets.

### Pathways logic

The pathways start from the societal division between the elite and the masses, building on the assumption that the elite has an interest and need to take care of environmental and social sustainability; to keep stability by ensuring resource availability in the long-term; and providing people with basic services. There is interaction between both societal levels and interdependence. For example, communities rely on support from the elite, while the elite rely on people's health and happiness. In this context, the 'branding' of Scotland is a key element to create a common identity,



pride and cohesion as well as economic opportunity and environmental and social responsibility, which is also an important source of wealth for the elite.

There are dual but interlinked pathways that involve actions by the elite and by the masses, respectively. On the one hand, there are top-down interventions from the political and business elite, which can draw on the high level of technology development and energy surplus and facilitate the efficient use of (especially renewable) resources. The elite employs a mix of measures regarding 'the masses', including providing education for solidarity and services for easing of pain. On the other hand, there are bottom-up actions from communities (the 'have-nots'), which increasingly have to take care of themselves and which are based in both rural and urban communities. Communities develop in self-sufficiency and self-reliance, and organise local, sharing and informal economies. As it is a high-tech society, communities are able to share knowledge and information and build community networks.

#### **4.1.2. SSP5: Techadonia**

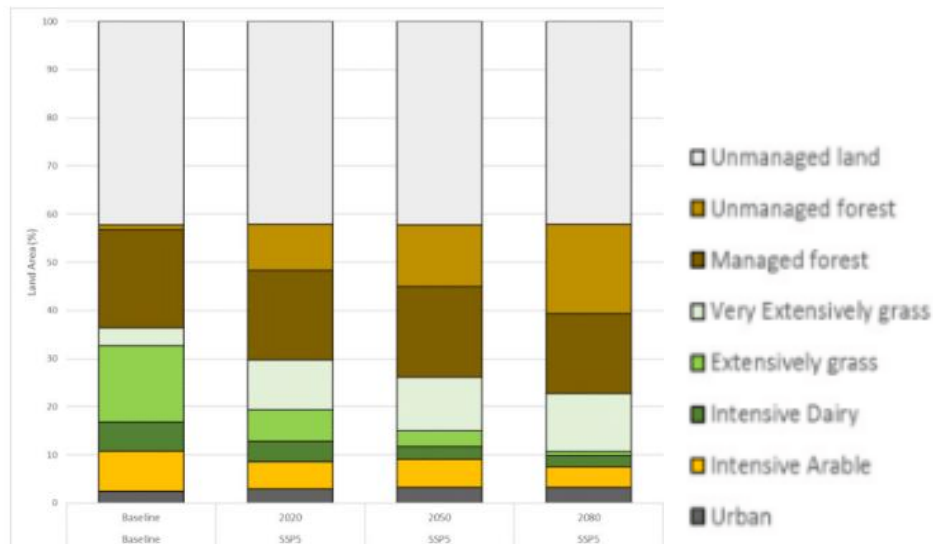
##### **Scenario storyline**

A stabilisation of the fossil fuel price has allowed for an increased tax on fossil fuels. Because of a concomitant increase of immigrants from outside the EU, the Scottish government invests extra income in health services, social housing and education. The government also invests in the establishment of for-profit publicly owned energy companies, such as the Scotland Energy Corporation (SEC). At the central level, the SEC investment fund has a large stake in fossil fuels and can invest in public services. This means profits stay in Scotland, with SEC paying dividends to each Scottish resident. By 2040, Scottish policy is increasingly driven by technology in many sectors: finance, education (e.g. a technology university) and labour force. Strong devolution has also resulted in 'clantons'. These become more and more powerful alongside public participation through, for example, innovative internet referenda. The lack of focus on environmental problems, however, starts to take its toll. Some discontent starts to rise among pockets of the population, driven by issues such as 'the last bumblebee in Scotland'. This is initially partly overshadowed by steady economic growth. By 2070 energy and food demands are met and surpassed. On the other hand, environmental degradation reaches a tipping point. Larger shares of the population realise the high costs of geo-engineering, and the increasing economic inefficiency of fossil fuels. As a result, unhappiness about environmental degradation spreads. After a major clean-up undertaken by SEC, a shift towards renewables triggers a change towards a whole new energy system. SEC investments in renewables slowly increase, matching those in fossil fuels by the end of the century.

##### **Selected key impacts**

There is a mix of increase and decrease in the extent of agriculture (Figure 16) in the early part of the century with some strong decreases in the middle of the century as imports and agricultural productivity increase. The increases in the extent of agriculture in the first time slice are particularly in the northeast and southeast of Scotland. While the areas of extensive grassland and intensive arable decrease throughout the century, the use of very extensively farmed grassland increases. The area of unmanaged forest increases throughout the century and is larger than the area of managed forest in the last time slice.

Increases in biodiversity in the mid and late century are linked to the increase in unmanaged forest and the decreases in extent of intensive arable land use. A decrease in biodiversity in some parts of the country (location changes with the time periods) are linked to the: decreases in forest area in certain parts, more extensive agriculture in parts, increases in unmanaged land, and increased urbanisation (particularly in the central belt).



**Figure 16: Land use in the baseline case and three time slices for SSP5xRCP8.5 (Techadonia) simulated by the IMPRESSIONS Integrated Assessment Platform (IAP2) for Scotland (Source: Deliverable D3C.2 - Clarke et al. 2017).**

### **Agency capacities and key actors**

There is a common societal and political focus on economic growth and social wellbeing, which is implemented by strong governments and market actors. However, there is a low level of awareness about (long-term) environmental degradation and environmental and social impacts and risks. While free and competitive markets ensure affordability of commodities and overall wealth, market deregulation exacerbates resource exploitation.

There is a high level of cohesion in the Scottish society with a transparent and participatory governance system that ensures overall wellbeing and economic growth. The government invests in the establishment of for-profit publically owned energy companies, and in regulation being devolved to regional, local and community entities.

Locally, 'Clantons' have developed from the devolution policies and market deregulation. There is a high level of civil participation both at national and 'Clanton' levels, which is facilitated by technological advances (e.g. internet referenda). Later in the scenario, public satisfaction decreases because of environmental degradation – this also results in less possibility for referenda. International trade agreements inside and outside of the EU foster collaboration (including with the BRICS) and contribute to keeping commodities affordable.

The economic wealth facilitates technological innovation and investments in science as well as social services such as health, social housing and education. This is also facilitated by ensuring that energy companies pay high dividends. However, the approach to environmental problems is reactive and purely technological. As environmental degradation reaches a tipping point, there is an increased need for a more centralised political approach.

### **Pathways logic**

The pathways build on the perception of the natural environment as an opportunity for creating monetary value, profit and employment, as well as the need for long-term environmental planning and management to maintain economic opportunity, cost efficiency and wellbeing. In this line, the value of nature is internalised into economic activities, for example, by valorising water as a resource to create new markets and new export opportunities. The high level of education and R&D enable Scotland to set up monitoring mechanisms for early warning systems to increase the sense of urgency,

understand environmental deterioration and recognise tipping points. This also enables the collection of data and later on identification of areas of opportunities for resource exploitation and marketisation. Thus, investments in 'big data' and long-term thinking are promoted and supported from an economic perspective.

#### 4.2. A Vision for Scotland in 2100

The vision for Scotland in 2100 focuses on equality of opportunity for an engaged and educated society that is underpinned by a fair and democratic governance system. Resource use is responsible and knowledge and technology support a sustainable economy. Scotland has a strong international position in the global economy and in facilitating sustainability globally. Figure 17 shows the poster of the vision after workshop #3. The full vision narrative can be found in Appendix 11.2.1.

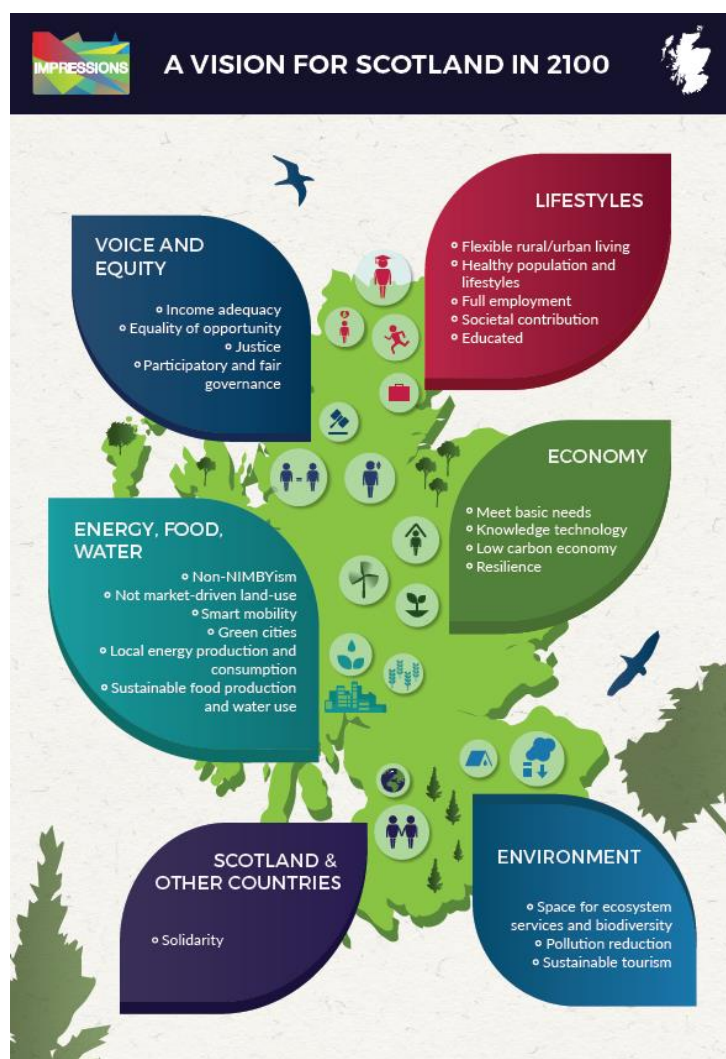


Figure 17: A Vision for Scotland in 2100.

Scotland in 2100 is a country of equality in relation to opportunity, access to services and decision-making. There is equality of opportunity to access the economy and future generations are treated equally in all decisions made that affect the future. All people have an income adequate to satisfy their basic needs and enjoy personal safety and freedom. There is full employment, basic human rights are respected and access to education and health services is free, allowing all people to develop their talents and make fully informed decisions. With an enhanced process of participatory government, fair democratic governance is characterised by proportional representation and the opportunity to

make frequent input to decisions. The population is maintained at a sustainable level with communities living in low density areas.

The economy has a global focus and businesses trade globally. Scotland is active in helping other countries to achieve their positive visions. The focus of the economy is on producing and consuming what is important in life in a low-carbon and climate-resilient way. Food is produced sustainably with a low-carbon footprint. Water use for agriculture is responsible and less energy intensive. Energy is produced locally and owned by communities. Knowledge technology contributes to the low-carbon economy. There is space for essential environmental services in every catchment. With equitable land ownership, land use is driven by public choices and priorities. A better spread of public services allows people to choose between rural and urban living. Nature is well integrated into all cities, providing better living spaces.

### 4.3. The Scottish pathways

This section builds upon the scenario-specific pathway logics described above, to introduce the Scottish pathways starting from the pathways that occur in all scenarios and moving towards the pathways that occur in less or individual scenarios (Table 6). The full overview of pathways per scenarios can be found in Appendix 11.2.2.

**Table 6: The Scottish pathways per SSP.**

Pathway	SSP1	SSP3	SSP4	SSP5
Promote integrated environmental planning and resource management	✓	✓	✓	✓
Promote local and low-carbon economies	✓	✓	✓	✓
Promote local community empowerment and sustainable lifestyles	✓	✓	✓	✓
Promote, showcase and market a sustainable Scotland brand nationally and internationally	✓		✓	✓
Promote strong environmental policy and create natural resource markets	✓			✓
Promote the market potential of water				✓

#### 4.3.1. Promote integrated environmental planning and resource management

All scenarios include a pathway to develop and implement integrated environmental and land use planning and resource management for climate adaptation, environmental protection and sustainable resource use. This is a transformation pathway that involves fundamental shifts in the ways resources and land are managed and planned in integrated, collaborative and coordinated ways. It takes a long-term perspective on the value of ecosystem services and nature, including innovations for integrated infrastructure systems and nature-based solutions. This pathway addresses vision elements on 'resources and the environment' and 'food, water and energy' (see Appendix 11.2.1).

Many strategies in this pathway focus on developing new types of **integrated infrastructure systems** to promote resilient, low-carbon and resource-light infrastructure from macro to micro scales. The SSP4 pathway puts in place coordinated infrastructure planning to connect infrastructures and their functions across scales. For example, regional frameworks are put in place that take a "people and place" approach to planning to provide location-specific infrastructure solutions. This enables the creation of synergies across scales and sectors, for example through a canal network that also links to low carbon transport and through building connectivity in remote regions. In SSP1, this pathway

includes strategies to shift towards low-carbon and resilient water, energy and mobility systems. It promotes local and water-sensitive infrastructure systems that reduce water waste, increase sustainable urban drainage and enable community hydropower. With regard to mobility, the SSP1 pathway invests in low-carbon mobility infrastructure to connect urban and rural areas, low-carbon public transport and free integrated transport systems that facilitate intermodal mobility. It also supports regional energy supply based on local energy generation through connecting local power generation and networks to national smart grids. The energy system makes use of local and regional energy generation to ensure energy security.

The pathway includes strategies to promote and develop **technological innovations** for environmental protection and societal wellbeing. In the SSP1 pathway, technological solutions are promoted to ensure food security and to limit impacts on biodiversity. For example, research and development is supported for indoor agriculture within underused buildings, food security and drought. The SSP5 pathway includes investments in technological innovation to eco-modernise urban and rural areas by advancing transport links for high levels of mobility, renewable energy, CCS schemes on unmanaged land and smart mobility. Smart mobility also improves connectivity of rural and island communities.

There are also many strategies in this pathway to develop and implement **nature-based solutions** for climate adaptation and to protect nature and its services. The SSP3 pathway designates and protects natural areas and biosphere reserves to maintain environmental quality as well as ensure water and food provision through, for example, aquaculture and peatland restoration for carbon storage and water management. The SSP1 pathway promotes a shift towards intensive and sustainable agriculture that reduces pollution, protects and increases biodiversity and reduces resource waste. This is achieved through permaculture, using varieties of crops and land uses, using worms for compost from food waste to reduce nitrate pollution and increasing water storage in winter for use in the summer. Urban agriculture is promoted by assigning allotments within urban environments. Also the capacities of farmers are built to enable effective intensive agriculture implementation. In SSP5, the pathway seeks to take advantage of carbon sequestration from tree planting and to develop green cities and wildlife corridors for climate adaptation and for improving people's health while creating environmental concern and awareness.

To make investments in integrated infrastructure systems, nature-based solutions and technological innovations for environmental protection attractive, the pathway includes strategies to **create sustainable markets** that integrate the value of ecosystem services and social benefits and provide long-term perspectives on financing. Carbon markets are set up for forestry to make it more viable and innovative financing programmes, such as crowd-funding for tree planting. In SSP3 and SSP5, strategies focus on sustainable tourism to boost the tourist market by showing the value of Scotland's natural environment. For example, unmanaged land is used for wildlife tours and grants and incentives are created to invest in transport on the islands. This helps to protect biodiversity, increase environmental awareness and connection of the Scottish population and also direct strategic infrastructure investments. It also provides employment opportunities; people can, for example, work as foresters and estate wardens on unmanaged lands. The SSP1 pathway provides governmental funding for local energy generation and retrofit, as well as strong governmental regulations to cap landfills to capture methane and other GHGs and use them for energy generation.

The pathway shifts towards **integrated land management and land use planning** that appreciates the existence and cultural value of nature and protects it in the long-term and that facilitates climate adaptation. Land use planning is coordinated and planned on small, medium and large scales following a needs-based approach that ensures nature protection and service delivery. For example, the SSP1 pathway develops a national plan for land use to maximise effective food production in the longer term and to coordinate land use for climate adaptation by moving all households from the flood plains

and reinstating natural flood defences. The SSP4 pathway moves towards ecosystem-based land management that identifies designated areas for biosphere reserves, natural flood defence, energy generation, nature, recreation, forestry and tourism. Strategic land sparing is also included as a way to improve land management. A key question is land ownership – the pathway suggests to nationalise private estates and land and to increase community ownership of land and other assets.

To enable integrated planning the pathway includes actions to enable **coordination across scales and sectors**. For example, policy for maintenance and management of major infrastructure such as hydro schemes and reservoirs needs to be coordinated at national levels to ensure demand and export of water is in line with availability. The SSP3 pathway sets up coordination mechanisms between corporations such as on invasive species and pollination. A Scottish business council for sustainable natural capital management is established. The SSP1 pathway ensures that the government has the oversight of a national energy grid that enables local control of the energy mix. Cities form alliances with regions to ensure the security of the energy supply.

The pathway includes strategies for **monitoring, assessments and resource mapping** to account for the value of ecosystem services and ensure that actions protect the environment in the long-term. For example, ecosystem service assessment tools and volunteer monitoring on the use of natural resources is developed, especially in scenarios that rely on self-regulation of companies such as SSP3 and SSP5. The SSP4 pathway implements coordinated and networked monitoring stations to inform adaptation to climate change and the protection of the environment, for example by overseeing fertiliser use. Especially the SSP5 pathway includes a strategy for monitoring and resource mapping that provides funding for solution-oriented research and research on ecosystem service values and impacts, develops GIS tools to account for resources and utilises more localised maps. The SSP1 pathway implements regular infrastructure updates.

#### 4.3.2. Promote local and low-carbon economies

All scenarios include a pathway to promote local and low-carbon economies. This is a transformation pathway that involves fundamental shifts in the ways that the economic system is set up, by integrating the value of natural and social capital into market activities, promoting community-based economic activities and employing low-carbon and circular economy technologies. This pathway addresses vision elements on ‘sustainable economy’, ‘resources and the environment’ and ‘food, water and energy’ (see Appendix 11.2.1).

The pathway includes a shift towards **local and community-based economies** that make use of alternative economic activities and feedback into community development. This is particularly central in the SSP3 pathway to promote local food production and consumption. Communities organise in smallholdings to grow food themselves in rural and urban areas. There is also the opportunity to make use of alternative food sources, including seaweed, algae, mushrooms and mussels. Agroforestry, vertical farming and aquaponics reduce the land demand for food that is grown locally. The economy builds on sharing of goods, local trading systems and services and alternative currencies. Capital is provided for community low-carbon energy schemes.

The pathway invests in **technological innovation for a low-carbon and circular economy** that closes loops as locally as possible, minimises waste, builds resilience and creates job opportunities. For example, the SSP4 pathway develops community schemes based on bio-based materials for urban centres and positions Scotland as a technological test area and showcases technical solutions. Technological innovations focus on smart solutions to reduce flood risks. The SSP5 pathway invests in low-carbon high-tech solutions (e.g. smart meters, fusion technology) while ensuring corresponding skills development through training and education and achieving full employment. To promote

technological innovation for a low-carbon economy, the SSP1 pathway similarly promotes research and development on circular economy principles and the efficient use of waste, as well as action research for equality between communities in view of low-carbon developments.

Especially in SSP4, the pathway includes **regulations and financial incentives** to incentivise philanthropy and market self-regulation by integrating natural and social capital accounting into economic activities. For example, fiscal levers encourage private industry trade tariffs, taxation and interest rates. Tax incentives support philanthropy and environmental and social sustainability and justice. The SSP3 pathway includes carbon taxes and monopolies commissions to regulate the market. In the SSP5 pathway, the Scottish government puts forth carrot-and-stick legislation on corporations to tackle environmental damage.

In SSP3, the pathway also includes the promotion of **local and regional networks for coordination and knowledge exchange**. For example, local advice networks for sustainable agricultural solutions enable peer-to-peer advice. Similarly, local networks for new crops and farming techniques enable knowledge exchange and promote climate adaptation. International seed sharing networks facilitate new varieties of crops that are climate-adapted from, for example, Scandinavia.

#### 4.3.3. Promote local community empowerment and sustainable lifestyles

All scenarios include a pathway to promote local community empowerment and shifts towards sustainable lifestyles. This is a transformation pathway that involves fundamental shifts in the ways communities are able to self-organise on local levels within multi-level governance structures. It also involves shifts in values, behaviours and practices towards a reflexive society for sustainability and resilience. The pathway addresses vision elements on 'jobs, equality and lifestyles', 'health and education' and 'governance' (see Appendix 11.2.1).

The pathway includes strategies to **strengthen local democracies**. Local democracies are developed by establishing community councils, citizen juries and by giving responsibility to local communities for local place-making and securing environmental quality. The SSP4 pathway includes an action to set up democratic organisations according to the 'John Lewis' model, which fosters the roles of cooperatives. Local identities and community cohesion are strengthened to enable communities to commonly respond to risks and extreme events. There is also a strong emphasis on professional dialogue and the creation of communication spaces. The SSP4 pathway builds IT infrastructure to integrate social media into local democracy and increase participation opportunities and share best practices. NGOs and civil society play a key role in this strategy by self-organising, lobbying and awareness-raising.

Communities are **regionally and internationally connected** to exchange knowledge and resources. For example, the SSP1 pathway sustains multi-level partnerships for flood risk management and community planning. This also enables the up-scaling and replication of place-based, bottom-up initiatives. Regions and local governments connect with other examples in the EU to share best practices and obtain financial support. Community connectors are identified to work with and connect different communities. The government provides resources to community planning partnerships and to create professional dialogues with the communities using trained facilitators.

The pathway shifts towards **localised systems of infrastructure and service provisions**. Communities invest in community-owned resources to manage services and goods locally and create local jobs. In the SSP3 pathway, low-tech tools enable communities to manage their resources themselves off the grid and sustainably (e.g. rainwater harvesting, natural insulation). The SSP4 pathway creates urban green spaces and vertical farms and promotes shared roof gardens to enable local community food growing. Alternative working systems are established. For example, the SSP1 pathway implements

universal income and time banking. The SSP3 and SSP4 pathways set up job leasing, skill sharing and a four-day working week.

The provision of localised services and infrastructures is facilitated by **governmental regulation and incentives and business investments**. In the SSP3 pathway, firms provide health and education benefits to the workforce, which is facilitated by taxes and incentives such as a CO<sub>2</sub> tax. A Green Investment Bank is established to invest in low-carbon communities. Incentives are provided for microfinancing low-tech solutions on a community level. The SSP4 pathway supports sustainable rural and urban communities by, for example, obligating corporate community reinvestments, fostering business philanthropy and setting up community improvement schemes. Funds are provided for community-owned energy, which also provides income to rural and urban communities. Community carbon credits are set up that support investments in local energy infrastructure. The SSP1 pathway increases governmental regulation to support community businesses and limit the influence of multinational corporations.

To support local decision-making and service provision, the pathway includes strategies for **building capacities of communities and individuals** by promoting life-long learning and environmental and social awareness. Learning outcomes of education are geared towards practical, social and creative competences. Education and capacity-building initiatives address the provision of practical skills and knowledge for local self-sufficiency, social enterprise, healthy and sustainable lifestyles and participating in decision-making. For example, education on civil engagement, advocacy and negotiation skills targets young people to empower them for participating in decision-making for their future. Children are given responsibilities in schools so they learn the consequences of their decisions and environmental education (e.g. on cooking and avoiding food waste, traditional ways of preserving food) is mainstreamed in schools so that people make informed lifestyle choices. To build practical capacities for land management, the SSP4 pathway includes education projects for sustainable local agriculture and technology use. It also implements social media and MOOCs (Massive Open Online Courses) to promote new forms of, and accessibility to, learning. The SSP1 pathway fosters life-long societal learning, self-determination and creative mind-sets through integrating art, creativity and imagination into education. There is also awareness-raising to build social cohesion and community and environmental conscience. This also includes education on food 'barriers', e.g. eating insects. Another emphasis is given to exchange of knowledge and skills. For example, the SSP3 pathway includes actions to foster exchange on subsistence farming skills across EU communities and by connecting to migrants.

The pathway also includes strategies for **awareness-raising for corporate social responsibility** to promote self-regulation in line with nature and people. This includes awareness-raising about resource efficiency and the benefits, opportunities and threats relating to the use of natural and social capital. Companies thus invest in the health and education of workers and agree on standards to manage the use of resources.

#### 4.3.4. Promote, showcase and market a sustainable Scotland brand nationally and internationally

SSP1, SSP4 and SSP5 include a pathway to position Scotland as a global sustainability leader, which builds on its natural capital assets and creates opportunities for the country's economic development. This is a transformation pathway that involves fundamental shifts in the ways Scotland manages and frames its assets and presents itself internationally. The pathway addresses the vision elements on 'governance' (see Appendix 11.2.1).

The development of a **brand for a sustainable and resilient Scotland** underpins the country's societal sustainability agenda and identity. Internally, the 'Sustainable Scotland' brand manifests in the



appreciation and protection of Scotland's resources and a shared identity. Through the international showcasing of this brand and solution approaches to promote sustainability, Scotland attains international recognition as a sustainability leader and creates new economic opportunities and attracts investments. For example, Scotland starts to invest in its natural capital (e.g. whisky, salmon) and in eco-tourism and sells green technologies worldwide.

Scotland sets up **international partnerships, cross-boundary agreements and trade deals** for global climate protection, knowledge sharing and creating business opportunities. Scotland strengthens diplomatic ties with other nations and increases international collaboration. For example, the SSP1 pathway develops global collaboration on biodiversity protection to plan for at-risk species in the long-term and on cyber security and other threats. Good relationships between Scotland and other UK countries are created. The SSP4 pathway sets up different types of think tanks (internationally, regionally etc.) that involve diverse actors from civil society and government, and which market and research across scales and sectors to promote knowledge sharing and alignment of interests and goals. The SSP5 pathway includes the development of new trade agreements and deals with other countries to ensure resource supply and expand its economy. Scotland promotes the trading of biodiversity, technology and unmanaged land as global resources for carbon storage. International collaboration and cooperation is in the SSP1 pathway, additionally supported by digital connectivity.

#### 4.3.5. Promote strong environmental policies and create natural resource markets

SSP1 and SSP5 include a pathway to introduce strong environmental policies and natural resource markets that integrate environmental costs in economic activities and incentivise innovative solutions, initiatives and practices for long-term environmental protection. This is a transformation pathway that involves fundamental shifts in the ways market value is created, and planning and investments are directed, e.g., building on long-term and integrated sustainability and resilience goals. The pathway addresses vision elements on 'governance' and 'resources and the environment' (see Appendix 11.2.1).

Scotland develops **integrated environmental protection frameworks and policies** that integrate environmental costs into market and planning activities. The SSP1 pathways include actions to ensure the continuous review, monitoring and updating of these frameworks and policies. Environmental frameworks and policies are formulated on national, regional and local levels in an integrated way. For example, a national land use planning framework supports effective local energy systems and grids and prevents NIMBYism of local planning while capitalising on context-specific resources and needs. Integrated and flexible land use is promoted to, for example, account for species change to improve adaptability to inevitable habitat change.

Scotland implements **taxation, incentives, standards and regulation** to integrate environmental costs into economic activities; reinvest in community energy and repair environmental damages; and to incentivise innovative solutions, initiatives and practices for environmental protection. Effective environmental and carbon taxes and penalties are implemented against harmful activities and to promote environmental protection. Existing regulation is relaxed, if needed; for example, building restrictions on historic buildings are relaxed to favour environmental performance. New building regulations cover ground and air source heat pumps, active and passive solar, passive cooling, insulation etc. There is divestment from fossil fuels, while subsidies for green energy are provided. The SSP5 pathway also adapts planning laws to reduce settlements in flood plains and protect urban populations. Other examples are waste management regulations and polluter pays taxation. Additionally, incentives and tax credits are provided for positive environmental contributions for businesses and consumers. For example, an incentive scheme for consumers and social marketing of products and services are introduced to promote good environmental practice.

#### 4.3.6. Promote the market potential of water

SSP5 includes a pathway to position water as a valuable resource and support the development of technological innovations and infrastructures for sustainable water management and climate change adaptation. This is an adaptation pathway that saves water use, protects from flooding and builds resilience. The pathway addresses the vision elements on ‘food, water and energy’ (see Appendix 11.2.1).

Firstly, the pathway develops **integrated multi-level planning frameworks** that position water as a valuable resource and combine different views on water as a commodity, for example for renewable energy use and drinking water. Knowledge is developed to show the context-specific potentials and needs with regard to water.

The pathway puts in place **interconnected national, regional and local water systems** with high-tech interconnectivity to ensure continuity of water supply for human use and climate adaptation. A national water grid is developed to ensure water for consumers and energy. Soft engineering solutions are developed to decrease the risks of flooding and water pollution. For example, rain water harvesting reduces carbon emissions from irrigation and supports responsible water use. Technology reduces the cost of water treatment and makes homes water efficient.

#### 4.4. Governance capacities in the pathways

Across scenarios, **different types of actors** are identified as responsible for implementing the actions. Especially the SSP1 pathways build on the high level of capacities of all actors in society and a strong multi-level governance system. *Governmental actors* in all scenarios provide regulation, incentives and financing, although they play a considerably smaller role in SSP3. This resonates with the disintegrated EU and the lack of strong governmental capacities to regulate markets and invest in expensive technologies. In contrast, especially in SSP4 the pathways build on centralised governmental structures that strategically plan and implement actions in a top-down way, while also addressing local communities to self-organise. *Civil society actors* play critical roles in the pathways of all scenarios, being actively involved in decision-making and in the development and implementation of action (e.g. sustainable consumption, local renewable energy production, education). Especially in SSP3, most actions are developed and implemented by civil society actors and entrepreneurs at local community levels given the lack of governmental capacity in this scenario. *Market actors* (business and industry actors and entrepreneurs) have important roles in the pathways of all scenarios. Especially in SSP4 and SSP5, where multinationals have strong power, they engage in public-private partnerships and self-regulate to internalise environmental costs and philanthropy into market activities. The involvement of actors from *knowledge institutions* is implied in actions to implement better monitoring and research on environmental and social problems and solutions, and to set-up process-based governance approaches.

All pathways across scenarios share a **strategic orientation towards sustainability** that orientates political, social and economic behaviours and enables synergies to be identified. This strategic orientation is guided by the vision for Scotland in 2100. It is manifested in the long-term, synergistic and integrated thinking behind the pathways, which provide interrelated and long-term strategies and actions towards a diverse set of goals. For example, the pathway that occurs in all scenarios on environmental planning and resource management takes an integrated perspective on infrastructure systems to promote resilient, low-carbon and resource-light infrastructure from macro to micro scales. For land use planning, regional frameworks are put in place that take a people- and place-based approach to planning to provide location-specific infrastructure solutions. This enables synergies

between different infrastructure and planning considerations to be identified. Except for SSP3, this long-term sustainability orientation is also marketed internationally to 'brand' Scotland, create an export base, participate in international governance for sustainability and to strengthen internal support.

The strategic orientation guides the **formulation of integrated framework conditions** such as regulations, incentives, taxes and (self-regulated) financing mechanisms that enable long-term decisions and investments to create synergies across sectors. For example, there is a strong emphasis across scenarios about the need to create sustainable markets that integrate the value of ecosystem services and social benefits and provide long-term perspectives on financing to make sustainable investments attractive. In the long-term, environmental frameworks and policies are formulated on national, regional and local levels in an integrated way. For example, a national land use planning framework supports effective local energy systems and grids and prevents NIMBYism of local planning while capitalising on context-specific resources and needs. Especially in SSP4, the pathways include regulations and financial incentives to incentivise philanthropy and market self-regulation by integrating natural and social capital accounting into economic activities. For example, fiscal levers encourage private industry trade tariffs, taxation and interest rates. In the SSP5 pathway, the Scottish government puts forth carrot-and-stick legislation on corporations to tackle environmental damage.

The pathways set up **multi-level governance structures and mechanisms**, which enable the mediation of interests, knowledge and resources across scales and sectors in Scotland, Europe and globally. Except for SSP3, the pathways position Scotland within a strong multi-level governance structure and within EU and international collaboration and cooperation. Multi-level governance structures help to manage resources at local and regional levels in relation to context-specific needs and opportunities, while connecting them to an overarching European sustainability agenda. For example, the maintenance and management of major infrastructure and energy supply are coordinated on national levels to ensure demand is in line with availability.

Especially in the pathway to promote local community, empowerment strengthens **local democracies and self-organisation** to promote local self-sufficiency. These local networks are regionally and internationally connected to exchange knowledge and resources. Inclusive and participatory governance systems educate and enable civil society actors to actively participate in political discourses and decision-making at regional and local levels.

Internationally, Scotland sets up **international partnerships, cross-boundary agreements and trade deals** for global climate protection, knowledge sharing and creating business opportunities. For example, the SSP1 pathway develops global collaboration on biodiversity protection to plan for at-risk species in the long-term and on cyber security and other threats. The SSP4 pathway sets up different types of think tanks (internationally, regionally, etc.) that involve diverse actors from civil society and government, that market and research across scales and sectors to promote knowledge sharing and alignment of interests and goals.

To ensure that the actions are in line with social and environmental conditions, to account for the values of ecosystem services and to prepare for long-term risks, the pathways put in place comprehensive **knowledge and monitoring systems**. Especially the SSP5 pathway includes a strategy for monitoring and resource mapping that provides funding for solution-oriented research and research on ecosystem service values and impacts, develops GIS tools to account for resources and utilises more localised maps. The SSP4 pathway implements coordinated and networked monitoring stations to adapt to climate change and protect the environment, for example by overseeing fertiliser use. Ecosystem service assessment tools and volunteer monitoring on the use of natural resources is developed.

Finally, the pathways build on and create diverse **conditions for innovation** by investing in innovative technologies, research and education and providing flexible regulation. For example, research and development is supported for indoor agriculture within underused buildings, food security, low-carbon mobility and renewable energy. The pathway to promote a local and low-carbon economy also provides investments in technological innovations. For example, the SSP4 pathway develops community schemes based on bio-based materials for urban centres and positions Scotland as a technological test area and showcases technical solutions.

#### 4.5. The pathways' impact: efficacy, synergies and trade-offs

This section presents the impacts of the pathways in terms of their efficacy in reaching the vision as well as the synergies and trade-offs created across pathways, strategies, actions and sectors.

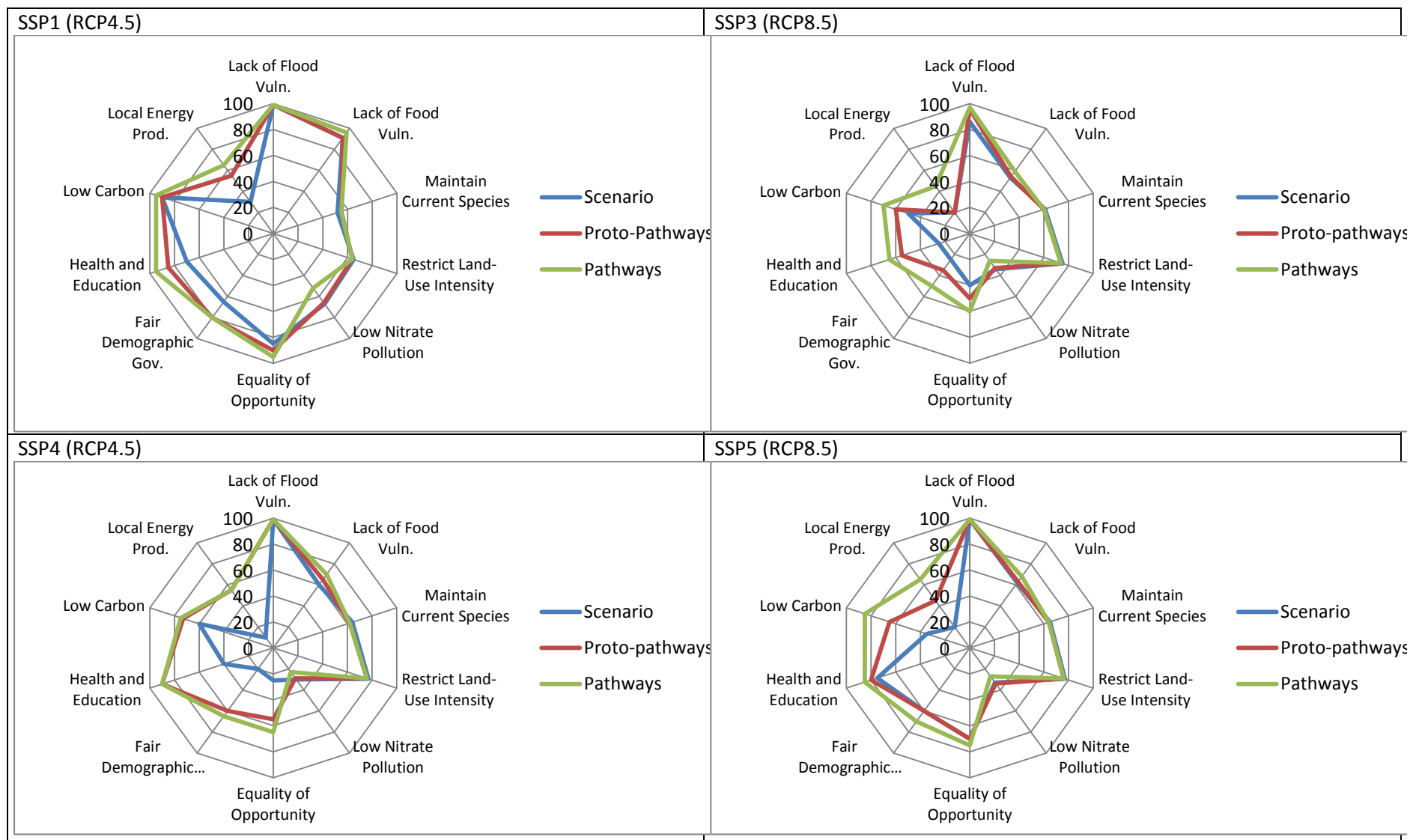
##### 4.5.1. Efficacy of pathways in reaching the vision

The results of the qualitative and quantitative assessments of the effectiveness of the actions within the proto- and final pathways in moving the status of the vision element indicators towards the target, compared to the SSPs, are shown in the spider diagrams in Figure 18. The analysis shows that the adaptation, mitigation and transformation actions within the pathways are generally effective in moving Scotland in a positive direction towards the vision, although the effectiveness of identified actions differs between the scenarios and the vision element indicators.

While all pathways move closer to the vision, the assessment shows that there is still room for improvement. Overall, the assessment shows that in Scotland there is a relatively low level of flood vulnerability. In contrast, the pathways particularly fall short in reducing nitrate pollution in all scenarios. Actions linked to participatory, multi-level and transparent governance as well as (education for) healthy and sustainable lifestyles are key features of the pathways in each socio-economic scenario. As such, the vision assessments demonstrate that the pathways contribute to achieving vision elements such as fair and democratic governance, equality, health and sustainable production and consumption. Additionally, the pathways include regulation, incentives and (technological) innovation to boost low carbon economies.

Integrated assessment modelling has demonstrated that each of the socio-economic scenarios (when combined with a RCP) has the potential to change land use patterns within Scotland (see "impact and vulnerability results section"). Pathway actions have been demonstrated to further influence these patterns of change. Pathway actions which (i) promote increased agricultural production (i.e. increased yields, increased mechanisation), and/or (ii) result in changed demand (i.e. reduced meat consumption) have the potential to reduce the area of land required for food production. Such patterns of change are projected, for example, to reduce the extent of extensive grazing and create space for forests within SSP1.

The maintenance of species' habitats (biodiversity) is central to multiple pathways. Actions to increase protected area coverage, forest and/or agricultural set-aside each influence the way in which land is used. Increasing the permeability of agricultural landscapes for biodiversity, by the inclusion of set-aside removes agricultural land from production and could, for example, result in small increases in the spatial extent of agricultural land (to ensure food demand is met).



**Figure 18: Results of assessment of whether the vision is achieved for a selection of indicators. Achieving 100 (the outside line of the spider diagrams) means that the vision has been achieved.**

Shortcomings partially relate to the socio-economic scenario conditions and resulting path dependencies. SSP1 is typically closer to the vision both with and without pathway actions. The low target scores of SSP3 offer more scope for pathway actions to make larger relative improvements toward the vision, especially regarding health and education. Like in SSP4, the SSP3 pathways fall short on the vision indicator on equality of opportunity and fair democratic governance, which is due to the constraints of the respective scenarios. Interestingly, while SSP4 has a high level of opportunity for investing in low carbon technologies, also the SSP3 and SSP5 pathways make considerable progress in moving towards low-carbon energy systems because of the actions on local and renewable energy generation.

#### **4.5.2. Synergies between pathways**

All pathways in all scenarios are highly interdependent and support each other in contributing towards the vision. Two pathways have been identified as conditional for the other pathways across all four scenarios: the pathway that promotes integrated environmental planning and resource management and the pathway that promotes local community empowerment and sustainable lifestyles.

The pathway that promotes integrated environmental planning and resource management supports the other pathways by setting up integrated and holistic framework conditions for infrastructure development, investments and land use. For example, in the context of SSP3, ensuring sustainable management of natural resources and ecosystems supports the shift towards community-based and local economies and reinforces solidarity and appreciation of nature. It also underpins the branding of Scotland in the SSP1, SSP4 and SSP5 pathways as a global sustainability leader. Integrated infrastructure planning is highly interdependent with enabling local and low-carbon economies that are self-sufficient at regional and local levels. In the context of SSP5, establishing a new planning and land use management programme creates new job opportunities with nature and low-carbon technologies.

The pathway that promotes local community empowerment and sustainable lifestyles underpins the changing societal behaviours for a local and low-carbon economy and enables local communities to implement environmental planning at local levels.

#### **4.5.3. Trade-offs between pathways**

Across scenarios, most trade-offs relate to agriculture and land use. To meet food demand, the pathways are likely to expand or intensify agricultural production. For example, within the SSP4 pathways, actions to localise food systems and support community farming imply a decreasing role for food imports. As food imports decrease, a greater proportion of food demand must be met within Scotland – implying increased production. No pathway actions support agricultural intensification, consequently the areal extent of agricultural production increases (to produce more food). This expansion has potential implications for environment-based actions. For example, land competition in terms of the “establishment of designated nature areas” or “development of natural flood defence mechanisms”. In contrast, in SSP5, actions that intensify agricultural production – such as facilitating a step-change to mechanised and intensive farming – have the potential to reduce the area of land required for food production. Land no longer required for agricultural production can support actions to “introduce a mass tree planting programme” or set up a “wild land trust for donations of unwanted land”.

However, regions of increased intensity production (if not managed/governed) may be less permeable for biodiversity and/or impair ecosystem service provision. Within SSP5, intensified production could produce a trade-off with actions to “engage with nature”, “tackle environmental damage” and so on.

In the SSP1 pathways, one effect identified within the modelling is a potential increase in nitrate pollution. Similarly, actions targeting biodiversity, such as an increase in set-aside, could have implications for food security. Increasing set-aside, as a means of increasing the permeability of agricultural landscapes for biodiversity, removes agricultural land from production. This could result in agricultural expansion and/or intensification (to meet food demand) or result in food demand not being met. In the SSP5 pathways, the action to “introduce a mass tree planting programme” has the potential to trade-off against actions to promote eco-tourism/engagement with nature/see a recovery in species numbers (as a function of species selected etc.). The introduction of mass tree planting programmes may also see increased land use competition with, for example, actions to set up “long-term wild land reserves”.

## 5. Hungarian pathways

Veszprém and Szekszárd are two county capitals in Hungary’s Transdanubian region, close to Lake Balaton, the largest lake in Central Europe. Hungary is in the Carpathian basin, where the number and intensity of extreme climate events have increased over recent decades – especially droughts, floods, heavy rainfalls and heat waves. There is a clear increasing trend in annual average surface temperatures.

This case study explores the risks posed by high-end climate change scenarios for Veszprém and Szekszárd. It focuses on the potential implications for water management, soil conservation, human health, and food supply chains. Participatory methods were combined with quantitative analysis to explore robust locally relevant adaptation options that are in line with shared visions of a sustainable future.

The IMPRESSIONS Hungarian case study included the following elements to develop adaptation, mitigation and transformation pathways:

- Four climate and socio-economic scenarios for Hungary using the RCP and SSP framework have been developed;
- A diverse range of modelling approaches (physically-based models, agent-based models) have been used to simulate impacts, vulnerability and adaptation related to human health and land use indicators in the context of high-end climate change;
- A vision for Hungary in 2100 was developed;
- Scenario-specific pathways were developed containing adaptation, mitigation and transformative strategies and actions that reduce the impacts and exploit the opportunities arising from high-end scenarios to move towards the vision.

In the following, we present the results from the Hungarian case study with a focus on the developed pathways and their analysis. We first outline the four scenario contexts that provide the logics for developing the pathways as interpreted by the stakeholders (Section 5.1). We then present the vision that has been formulated for Hungary in 2100, which provides the orientation for developing the pathways and the point of reference for assessing their efficacy, synergies and trade-offs (Section 5.2). Third, we outline the pathways that were developed starting from the pathways that occur in all scenarios and then the pathways that occur in some or in individual scenarios (Section 5.3). Fourth, we present the governance capacities that are created through the pathways and that represent the conditions enabling their implementation (Section 5.4). Finally, we discuss the impacts of the pathways in terms of their efficacy in achieving the vision and resulting synergies and trade-offs (Section 5.5).

### 5.1. Scenario contexts and pathway logics

For the Hungarian case study, four socio-economic scenarios (SSPs) were developed and matched with either RCP4.5 or RCP8.5 (Deliverable D2.2 - Kok and Pedde 2016). Each scenario provides distinct contexts, opportunities and challenges for the development of pathways, including different socio-economic enabling and disabling conditions, key actors and climate impacts. This section summarises the context provided by each scenario and describes how it was interpreted for the development of pathways to achieve the vision for Hungary in 2100. Table 7 provides an overview and comparison of the key elements per scenario.

**Table 7: Key elements per Hungarian SSP (adapted from Deliverable D2.2 - Kok and Pedde 2016).**

Key elements	SSP1: Pink dream – Rózsaszín álom	SSP3: Regional Rivalry – Regionális rivalizálás	SSP4: Inequality – Egyenlőtlenség	SSP5: Procrastinator – Pató Pál úr
RCP	4.5	8.5	4.5	8.5
Decision-making level	Multilevel – development model upscaled from local to national	National	State - Europe	International/national
International cooperation	Strong, EU important player	Weak - conflict	Strong for elites	Strong (trade)
Net migration-low in-migration	Moderate immigration – reverted brain drain	Brain drain – increased immigration	First high immigration, then controlled	High
Economic development	Gradual	Low	Medium-high	High, until collapse
Mobility	No barriers, but movements are limited	Low – people move to ghettos	High for elite	High
Social cohesion	High	Low	Low – high for have-nots	Low, then higher
Technology development	High – focus on renewable and re-use	Low	High in some areas; low in labour intensive areas	Strong and crucial
Quality of Governance	High – focus on sustainability	Low and ineffective	Effective (stability)	High – focus on national level and industries
Human health investments	High	Low	Low	High – welfare system
Education investments	High	Low	Low	High – welfare system
Environmental respect	High	Low	High in pockets	Low
Agency capacities	High ability to act – sustainability frameworks, multi-level governance, participation	Low ability to act – high inequality, no institutional sustainability frameworks, no resources	Moderate ability to act – unequally distributed and no institutional conditions on social issues	Moderate ability to act – no institutional conditions for environmentally-oriented action
Key actors	All societal actors (government, market, civil society) at multiple levels	Multinationals control government and resources; weak governments; local communities organise for self-sufficiency	Small political and elite concentrates power and resources; majority of the population in local communities	Governments and industry actors; individualism erodes communities but later re-emergence



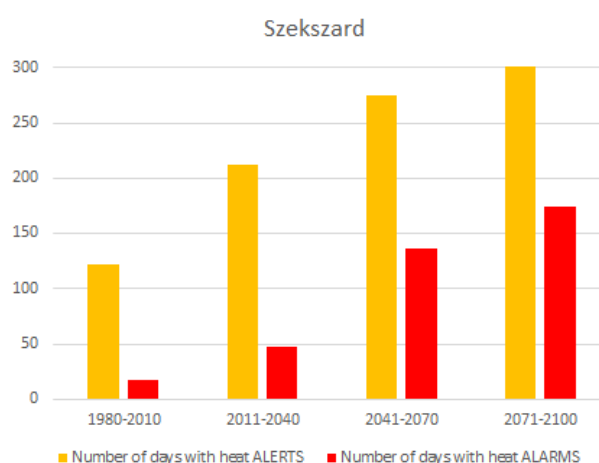
### 5.1.1. SSP1: Pink dream – Rózsaszín álom

#### Scenario storyline

Triggered by changing public opinion on current economic and demographic problems, local governments take the initiative to invest in services. This results in the local increase of skills and good practices: Veszprém becomes a knowledge centre and Szekszárd turns to sustainable agricultural practices. A new generation of policy-makers comes from local communes and represents the will of the people. Because of more transparency and accountability of politicians, corruption decreases. This also leads to an economic shift in many sectors, whereby technology development and high-value exports become the new backbone of the Hungarian economy. International cooperation is strong also thanks to stable neighbouring countries and a decrease in migration. Emigration and birth rates stabilise. Hungary in 2100 is a fully sustainable, financially healthy and safe country.

#### Selected key impacts

There is an increasing frequency of heat alarms per decade (health warnings for heatwaves) as temperatures increase (Figure 19). The average annual number of heat-related deaths increases in Veszprém from 151 to 187 and Szekszárd from 171 to 208. Furthermore, the risk of Lyme disease increases with increasing temperature and decreasing forest area.



**Figure 19: The number of days per decade with heat alerts and heat alarms in Szekszárd, Hungary in SSP1 (RCP4.5) (Source: Deliverable 3C.2 - Clarke et al. 2017).**

The yearly runoff of the Zala river is projected to increase by between 10% and 29% in the first time slice. However in the second and third time slices, the Zala river region is projected to experience a decrease in runoff of up to -10%, with decreases in autumn and spring and increases in summer and winter. For the Tolna and Veszprém regions, the runoff is projected to increase up to 30% by mid-century and by the end of the century by 16% to 20% with respect to the reference period.

The area of agricultural land declines, with a decrease in the number of business-oriented farmers and an increase in the number of traditional, non-diversified farmers. Major cereals (i.e. maize and wheat) and industrial plants (i.e. sunflower and rape) remain popular.

#### Agency capacities and key actors

The Hungarian policy agenda focuses on long-term economic and environmental measures with the overarching common good as a priority. There are strong local governments that invest in social services and initiate participation. Community participation is intrinsic to policy-making at all levels;

all levels are interconnected (“hálózatosodás”) and there is a high level of transparency and accountability such that corruption decreases. There is thus a high level of trust in decision-making and tax morale improves. Hungary is integrated in the EU, implementing its sustainability goals and frameworks, and has increased trade relations within and outside the EU which creates social and economic opportunities.

Policy focuses on health, sustainability and responsible finance. The national Hungarian government implements strong measures to increase green economic growth through prudent fiscal policy and anti-corruption measures and to promote clean energy, energy efficiency, education and public health. Local governments develop ambitious climate adaptation plans, reform social services, and invest (EU) subsidies in local and sustainable agriculture (e.g. local food processing), green industry and renewable energy. Szekszárd and Veszprém become role models for good practices, which are replicated throughout the country. Prevention is the preferred form of environmental management. There are investments for green technological, social and institutional innovations as well as skills development.

There are strong community organisations and people focus on health and sustainable lifestyles. People are able to respond dynamically to new challenges and opportunities and they actively participate in decision-making.

#### **Pathways logic**

The pathways build on the capacities for multi-level cooperation, an engaged civil society and changing lifestyles towards sustainability. The pathways start working early towards local decision-making and regional community cooperation. A system of local decision-making is set up that does not only include the towns and cities but also the regions around them. There is a high level of cooperation between communities, which builds on the extension of the IT system and virtual worlds. Communities cooperate, for example, in virtual worlds that facilitate equal access to decision-making and knowledge. Local governments and mayors take up leading positions in this governance system, but there is also civil control (e.g. vote committees). To avoid corruption and institutional path dependencies, the governance system is expert- and monitoring-based.

Water is managed in a decentralised way based on subsidiarity and within regional frameworks. Fiscal prudence is an important element in the pathways: for example, local governments need to be able to set money aside to make sure it is available for maintenance and intervention. Though it is fully publicly managed, individual responsibility to save water is emphasised.

### **5.1.2. SSP3: Regional Rivalry – Regionális rivalizálás**

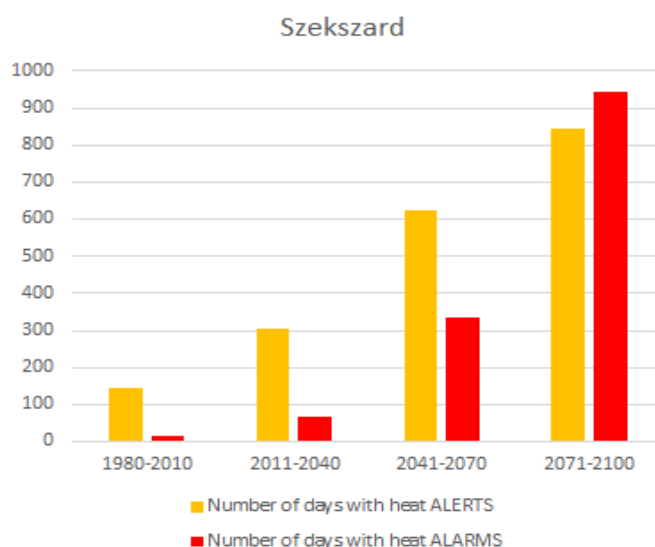
#### **Scenario storyline**

In the context of increased geopolitical instability and higher energy prices, the Hungarian government shifts its budget away from environmental and social services towards industrial development and defence. However, stalling wages, low resources and unemployment trigger social tensions and brain drain. The government responds with authoritarian measures, further decreasing social services and implementing fossil-fuel subsidy schemes to keep prices artificially low. Poverty increases and people move out of cities: urban and rural ghettos develop. People try to become self-sufficient by re-learning old practices. By 2100, Hungary is affected by energy shortages: large-scale agriculture and urbanisation are halted. Because of increased in-migration, a new multicultural society emerges.

#### **Selected key impacts**

There is an increasing frequency of heat alarms per decade (health warnings for heatwaves) as temperatures increase (Figure 20). The average annual number of heat-related deaths increases in

Veszprém from 151 to 362 and Szekszárd from 171 to 392. In addition, the risk of Lyme disease increases with increasing temperature and increasing forest area.



**Figure 20: The number of days per decade with heat alerts and heat alarms in Szekszárd, Hungary in SSP3 (RCP8.5) (Source: Deliverable D3C.2 – Clarke et al. 2017).**

There is an increase in the discharge of the Zala River in winter and summer and a possible decrease in spring. The yearly runoff is projected to increase in the Tolna, as well as Veszprem regions. The projected increase in the runoff for the first time slice varies between 3.5% and 20% with respect to the reference period. For the mid-century the increase persists with an increase of runoff between 4 to 46%. At the end of the century the increase is between 4% and 59%. The area of agricultural land increases strongly. The number of business-oriented farmers increases, while the number of traditional, non-diversified farmers decreases. Major cereals (i.e. maize and wheat) and industrial plants (i.e. sunflower and rape) remain popular.

#### **Agency capacities and key actors**

The political system is highly authoritarian without overarching sustainability goals and the decision-making focus is on meeting day-to-day needs. The Hungarian government takes authoritarian measures that lead to increasing social inequity and structural poverty. There is a high level of corruption and low social cohesion.

Hungary has a weak bargaining power within the EU, which becomes increasingly fragmented due to a lack of political consensus. After the EU disintegrates by 2040, Hungary is caught in a war zone between regional powers of the East and West.

With deteriorating economic conditions, the Hungarian government reallocates budget from social services, infrastructures and climate adaptation to industry and (fossil) energy subsidy schemes. Only the rich have access to higher quality healthcare and education, and those who can, particularly the educated, leave in large numbers. There is no regulation on environmental protection and no investment in innovation.

The majority of people live in quasi-autonomous, self-sufficient local communities in urban and rural ghettos. While social participation and environmental responsibility of people decrease as they

struggle to meet their daily needs, people are trying to become self-sufficient in food by re-learning forgotten gardening and livestock-keeping practices.

### **Pathways logic**

Because of the lack of a strong Hungarian state government and the dissolution of the EU, the focus of the pathways is on the empowerment of civil society (organisations) on local levels through education and communication to foster self-sufficiency. Regional collaboration networks between local communities and across (former) EU countries help to provide services and resources. The pathways also focus on conflict management to address the huge social unrest in the scenario. Civil society organisations play a key role in mediating interests, resources and knowledge.

As there are less and less resources available in the scenario, the pathways focus on local solutions to enable resource availability. This is underpinned by changing lifestyles and consumption behaviours through, for example, awareness-raising and low-tech solutions to reduce resource use.

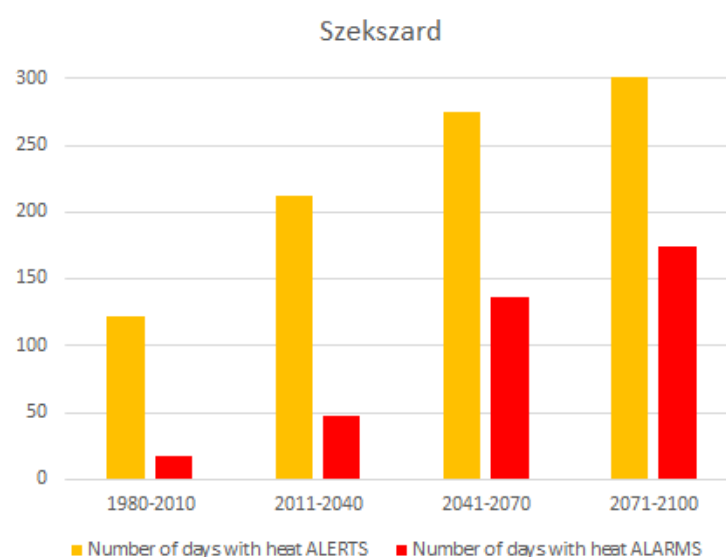
### **5.1.3. SSP4: Inequality – Egyenlőtlenség**

#### **Scenario storyline**

There is a concentration of power and land ownership in the hands of few. With corruption and tensions on the rise, new elections promise change but fail: new leadership brings stability but strengthens the power of elites. The EU is complacent. A centralised Hungary stabilises borders and supplies a cheap (but poorly educated) labour force. Health and education services are minimal and the state prefers to manage crises rather than prevent them. The poor (“have-nots”) self-organise even if the life of the majority is still a struggle, with a controlled media and education system. With growing hunger riots, the elites show flexibility to avoid revolts (thawing of dictatorship) with a new charismatic leader. People live in a very unequal world but they are happy with what they have.

#### **Selected key impacts**

There is an increasing frequency of heat alarms per decade (health warnings for heatwaves) as temperatures increase (Figure 21). The average annual number of heat-related deaths increases in Veszprém from 151 to 198 and Szekszárd from 171 to 221. In addition, the risk of Lyme disease increases with increasing temperature and increasing forest area.



**Figure 21: The number of days per decade with heat alerts and heat alarms in Szekszárd, Hungary in SSP4 (RCP4.5) (Source: Deliverable D3C.2 - Clarke et al. 2017).**

The Zala river region is projected to experience a decrease in runoff of up to -10%, by the end of the century, with a decrease in autumn and spring, and increase in summer and winter. In the first time slice, however, the yearly runoff is projected to increase from 10 to 29%. In the Tolna and Veszprém regions the runoff is projected to increase up to 30% by mid-century and by the end of the century by 16% to 20% with respect to the reference period. Agricultural land use increases till 2040 then declines rapidly towards the end of the century. The number of business-oriented farmers and traditional, non-diversified farmers stabilise. Major cereals (i.e. maize and wheat) and industrial plants (i.e. sunflower and rape) remain popular, while there is a shift from maize to wheat.

#### **Agency capacities and key actors**

The Hungarian government is strong and centralised with political and economic power concentrated in the political and business elite that seek to maintain stability. Decision-making is very authoritarian; the majority of the population does not participate in decision-making.

The Hungarian elite collaborates with the EU and international elite and sets up trade partnerships. Hungary relies on EU subsidies and financial support, but while some enterprises, individuals and communities have privileged access to subsidies and financial support, most SMEs and other actors outside of this circle have no access to capital. Multinationals have access to Hungary's markets and a persistently cheap, even if poorly educated, labour force.

The elite invest in technological innovations for green energy and provide subsidy funds for modernisation and efficiency improvements. For example, agricultural production becomes more industrialised and intensive on the large estates of the elite. Public services (e.g. education) decrease for the majority of the population, leading to riots and growing discontent.

The masses organise new forms of collaboration (e.g. the old educate the young) and live in quasi-independent and autonomous communities. New forms of survival mechanisms emerge; people make use of a mix of low-tech local and off-the-grid innovations (e.g. reuse of wastewater as fertiliser) and cheap, mass-produced technologies in daily life and subsistence living. The poor develop their own 'green methods' based on a mix of traditional knowledge and new citizen science-based inventions.

#### **Pathways logic**

The starting point of the pathways is that the Hungarian elite has good relations with the EU, which enables Hungary to mobilise subsidies for more sustainable resource management. However, as the political and economic elites are moving further away from the majority of the, increasingly poor, population, they realise this might cause social problems and conflict. This is why the political powers make 'soft adjustments' and provide basic services to the masses. For example, state education and health care is provided, but also changed towards more traditional and self-organised service provisions (e.g. traditional health care, community schools, local economies). Civil society organisations regain importance and receive support, for example by a restructured taxation system that redistributes elite profits to the poor. This also enables improved self-sufficiency by the masses in local communities, to decrease social tensions and create a more diverse society.

The rich elite implement regulation and more transparent governmental structures to protect its natural, social and human capitals in the long-term. Climate adaptation is tackled locally and with low-tech solutions that can be implemented by the masses, including for example heat resistant plants, cultivating local herbs and seeds, and greening urban and rural environments.

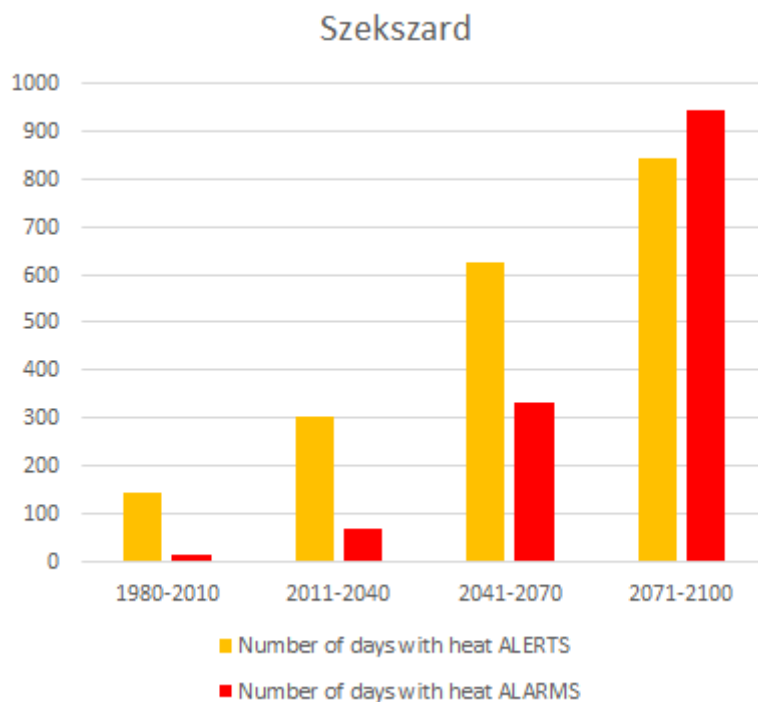
#### 5.1.4. SSP5: Procrastinator – Pató Pál úr

##### Scenario storyline

Lifestyles in Hungary are increasingly coupled with increased consumption, less social interactions and pervasive technology. Higher energy demand is met with readily available fossil fuels and limited investments in new energy or infrastructure. An exclusive development model is established, with rising corruption. However, popularity is high because of effective crisis management and welfare spending. Even if education is stratified, with high mobility for the rich, all layers of society have a decent energy-hungry lifestyle. Technology can temporarily fix the widespread environmental and health degradation until the system collapses by the end of the century. The increasing awareness of the need for change leads to a rebirth of communities. Hungary returns on the bumpy path towards a post fossil fuel era that was abandoned decades before.

##### Selected key impacts

There is an increasing frequency of heat alarms per decade (health warnings for heatwaves) as temperatures increase (Figure 22). The average annual number of heat-related deaths increases in Veszprém from 151 to 366 and Szekszárd from 171 to 396. In addition, the risk of Lyme disease increases with increasing temperature and increasing forest area.



**Figure 22: The number of days per decade with heat alerts and heat alarms in Szekszárd, Hungary in SSP5 (RCP8.5) (Source: Deliverable D3C.2 - Clarke et al. 2017).**

There is an increase in the discharge of the Zala River in winter, summer and a possible decrease in spring. Yearly runoff is projected to increase in the Tolna, as well as the Veszprém regions. The projected increase in the runoff for the first time slice varies between 3.5% and 20% with respect to the reference period. In the mid-century this trend persists with an increase in runoff from 4 to 46%. In the last time slice the increase in runoff is from 4% to 59%. Agricultural land use declines throughout the century. The numbers of business-oriented and traditional, non-diversified farmer stabilise. Major cereals (i.e. maize and wheat) and industrial plants (i.e. sunflower and rape) remain popular, while there is a shift from maize to wheat.

### **Agency capacities and key actors**

There is a common societal and political focus on economic growth and technological innovation, but without a long-term view on sustainability, climate change impacts and equality. Corruption increases through unbalanced repartition of energy supply. This also results in increasing inequality, but the political elite manage to maintain high levels of popularity and a degree of stability. Hungary is dependent on resource imports; international cooperation is based on free markets and globalisation.

Both the ‘technically educated’ elite and the majority lack awareness of environmental problems and long-term sustainability concerns. Lifestyles and economic activity are energy demanding and met with fossil fuels. Economic and professional growth is built on a weak foundation of resource exploitation and import; reliance on foreign energy supplies creates supply chain risk and makes the system vulnerable to disruption such as from social unrest and terrorism. As resources start to diminish, governments react with effective crisis communication and focus on technological fixes but redirect investments away from social welfare. Investments are made especially in industries and technological development.

Typical community characteristics erode because of increasing societal individualisation and stratification. Only in the 2070s do communities re-emerge to develop joint survival mechanisms and social innovations (e.g. transforming education to focus on knowledge) and to engage in more sustainable lifestyles.

### **Pathways logic**

Education and awareness raising play pivotal roles in the pathways to shift towards sustainable lifestyles and economic production and consumption that uses less resources and conveys the value of the environment. In this regard, community and social aspects are especially important to achieve this change in mind-sets. The role of the government overarches all pathways: It works towards holistic approaches to achieve societal wellbeing and protect the environment in the long-term.

While there is no agreement on emissions reductions in this scenario and Hungary will have to deal with extreme climate change impacts, a strength is the development of IT technology. This supports climate adaptation and shifts towards sustainable agriculture and water management by innovating resource-efficient, green energy and health technologies.

## **5.2. A Vision for Hungary in 2100**

The vision for Hungary in 2100 addresses a community-based, equal and engaged society with a participatory and multi-level governance system that prioritises sustainability and protection of the environment and the climate. Lifestyles and economic activities are sustainable. Figure 23 shows the poster of the vision after workshop #3. The full vision narrative can be found in Appendix 11.3.1.

The legal foundations of governance and institutions are stable, secure, multi-level and participatory. With participatory local governance, there are many local civil initiatives. Community and local cultural life are strong, also in urban areas, and supported by direct communication between people, as well as by the free dissemination of community knowledge and best practices. Living in safe communities, families and nature are connected and there is an awareness of the importance of values and morals. Active and healthy lifestyles and the virtues of a sustainable level of population are promoted through all levels of education. Positive, long-term, systems thinking is embedded in formal and informal education.



**Figure 23: A Vision for Hungary in 2100.**

Protection of the environment and climate is a priority in political agendas, lifestyles and economic activity. The level of corporate social responsibility is high. Using modern and highly eco-efficient technologies, the economy is sustainable and also provides meaningful local and almost full employment. Part-time work, telecommuting, job sharing is available everywhere. The value of manual work is respected. There is a balanced urban fabric with a lot of green areas and sustainable urban services. Rural lifestyles are attractive, so many move to the countryside and engage in family farming. Material consumption has been reduced through use of technologies that produce little or no waste and through changes towards sustainable lifestyles.

The energy supply is environmentally friendly and sustainable, relying at least 60% on renewables. Energy supply is decentralised. Energy efficiency has been increased in all walks of life. Transport is environmentally friendly and energy efficient. Sustainable food production includes large-scale organic farming and self-sufficiency based on kitchen gardens. Health-centred water management involves the use of micro-reservoirs, new irrigation systems, extensive use of rainwater, effective drainage of excess surface water and protection of natural water bodies. There is an ample supply of clean healthy drinking water. Soil quality is excellent due to enhanced soil protection measures and appropriate crop production.



### 5.3. Overview of Hungarian pathways

This section builds upon the scenario-specific pathway logics described above, to introduce the Hungarian pathways starting from the pathways that occur in all scenarios and moving towards the pathways that occur in fewer or individual scenarios (Table 8). The full overview of pathways per scenarios can be found in Appendix 11.3.2.

**Table 8: The Hungarian pathways per SSP.**

Pathway	SSP1	SSP3	SSP4	SSP5
Promote sustainable and resilient water management	✓	✓	✓	✓
Promote inclusive and multi-level government and governance for sustainability	✓	✓	✓	✓
Promote shifts to healthy lifestyles and new education systems	✓	✓	✓	✓
Promote shifts to green and comfortable cities	✓		✓	
Promote shift to green energy		✓		✓
Promote rural development and local economies			✓	

#### 5.3.1. Promote sustainable and resilient water management

All scenarios include a pathway to promote sustainable and resilient water management. This is an adaptation pathway that protects water quantity and quality for all and builds resilience. The pathway addresses the vision elements on 'food and water', 'environment' and 'governance and institutions' (see Appendix 11.3.1).

The pathway establishes **integrated and holistic water resource management strategies and approaches** that appreciate and utilise all water sources, protect water quality, promote water savings and reuse, is adaptive to climate change and inclusive to community needs. Water use is considered broadly, also in terms of health, recreation and employment in recreation-related uses of water. It is also connected to climate adaptation and the use of water for energy and agriculture. For example, in the SSP3 pathway, water management builds on comprehensive climate change adaptation and resource management plans that also include agriculture-related issues for water management. The water management plans and approaches are regularly updated and translated into 3–5 year action plans on specific themes (e.g. storing winter precipitation, developing irrigation). The SSP1 pathway emphasises that strategies are based on scientific knowledge. The SSP4 pathway emphasises integrated planning across scales. For example, regional planning identifies locations for water reservoirs and context-specific water needs.

The pathway develops **multi-functional and water sensitive infrastructure systems** that are adapted to drought and flooding and provide equal access to save water. The infrastructure systems provide retention systems, enable water reuse, preserve water quality and promote water efficiency. Actions create rainwater storage, build water reservoirs and increase the capacity of surface water reservoirs (e.g. cisterns, water canals) and improve drainage systems and greywater separation. For example, the SSP4 pathway includes an action to make a 1 ha water reservoir per 100 ha of arable land. The SSP5 pathway includes an action to collect, use and reuse run-off water. A focus is on local and household-level infrastructure systems. The SSP4 pathways includes actions to create micro-reservoirs for local rainwater collection, to promote local water supply systems, to create wells to supply toilets and washing in households and to set up toilets with zero water use and that destroy all by-products.

There is also an emphasis on equity considerations and water access. For example, the SSP3 pathway includes an action to install public water taps. Water infrastructure is set up to be multifunctional and provide synergies with other sectors, for example by using rainwater storage for fisheries or recreational use. It also enables synergies with mobility and energy, for example, water canals can be used for low-carbon transport and hydropower can be expanded by using dams, rivers and water circulated in channel systems and linking water reservoirs to energy production.

The pathway includes **technological innovations** to enable water savings and water reuse and protect water quality. Technologies include water treatment technologies, water savings technologies in households and greywater recycling. A focus is also on developing technologies for improving water use in agriculture through innovations in water irrigation technologies and in remediating water pollution sources.

The SSP3 and SSP5 pathways include a strategy to change **towards ecological agricultural practices** to improve natural retention capacity and soil and water drainage and quality, and reduce water use in agriculture. The SSP3 and SSP5 pathways include a strategy to make agriculture more water-efficient, multi-functional and resilient by switching to new cultivation methods and land use practices and reducing large-scale farming. For example, soil is used in a conscious way to protect water surfaces, drought-resistant plants are used, and water drainage is implemented on agriculture land for erosion control. The water retention capacity of the soil is increased (e.g. deep cultivation, manure use, permanent cover, terracing) and the organic matter content in the soil is increased (e.g. application of manure, compost). Multi-functional and adaptive land use is implemented for pasture in drought periods and water retention and drainage areas during floods. Land use is switched: from arable land to forest and pasture. Floodplain farming can be introduced in some areas. The SSP4 pathway includes actions to promote home gardening, climate-proof cultivation and growing edible plants wherever possible.

The pathway puts in place **governmental incentives and regulations** to promote sustainable water use and quality. The price for water is adapted to integrate environmental costs to motivate water savings. Budgeting also includes long-term maintenance activities and prioritises irrigation systems and reservoir maintenance. Construction regulations are reformed to require rainwater collection and water reuse for all new house constructions and renovations. There are penalties on the illegal use of drinking water in the Carpathian basin and on household chemical use to enable greywater use for irrigation. Local public authorities are responsible for supervising the protection of water resources. The SSP1 pathway stops underground mining to protect groundwater.

The pathway builds on new types of **collaboration and cooperation** between different actors across scales and sectors. Collaboration and coordination span local, regional, national and international levels and involve actors from government, market and civil society. For example, on local and basin levels, activities include the establishment of watershed management and the coordination of dams and sluices and of a surface canal system. On regional levels, a regional utility government is established and cooperation on water among micro-regions supported. International cooperation related to water is developed and international water conflicts are mediated. New types of organisations are set up and strengthened, for example on flood control, infrastructure protection and water quality control. Also the collaboration of local governments with civil society organisations on water is strengthened.

The pathway also includes **awareness-raising activities** to motivate water savings. Citizens are informed of their ecological footprints, revealing water and energy use. Guides on good practices are formulated. The SSP3 pathway implements a “water is life” communication programme. In the SSP5

pathway, the local government gives Best Home Garden Award to promote home gardening. Applications of water saving technologies in households are communicated.

The pathway sets up a **full-cycle water monitoring system** to monitor and control water use, water quality and water quantity. Monitoring systems go hand-in-hand with strict civic controls of water use and education programmes to train water management professionals.

### 5.3.2. Promote inclusive and multi-level government and governance for sustainability

All scenarios include a strategy to set up inclusive and multi-level government and governance systems for sustainability. This is a transformation pathway that involves fundamental shifts in the governance system to strengthen strong governmental intervention, transparency, democracy and multi-level cooperation in line with overarching sustainability goals. The pathway addresses vision elements on 'governance and institutions' (see Appendix 11.3.1).

The pathway **strengthens the role of the government** at multiple levels that sets new policies for a national sustainable welfare system. The government develops new climate strategies and action plans and puts in place strong environmental regulation for climate mitigation and adaptation through strict environmental standards and taxes. For example, it implements building regulations and regulates multinational companies to prevent profits from leaving the country. It is also responsible for law enforcement, monitoring and controlling environmental quality; it mandates reporting, controls farmers and strengthens penalties against corruption and illegal water use. The government is responsible for ensuring equity by, for example, allocating a large share of the GDP to disadvantaged regions and providing energy loans, developing new social contracts, ensuring access to basic goods and providing better public services.

This pathway creates a **transparent, accountable and democratic governance system**. Transparency and accountability are improved by ensuring insights into the concrete tasks of the government and administration, eliminating corruption, simplifying decision-making processes and making reporting mandatory, objective and transparent. Results need to be tangible and effectively communicated. Independent communication channels and freedom of the press are strengthened. Broad and equal participation in decision-making is ensured by expanding direct democracy, enabling online voting and setting up a virtual General Assembly that integrates disadvantaged people. Scientific knowledge supports informed decision-making and the younger generation is explicitly included in decision-making.

The pathway strengthens a **multi-level governance system** that enables participation and collaboration across scales and sectors. Multi-level governance is set up based on the subsidiarity principle and gives authority to local levels. Local decision-making is enhanced through the redistribution of power and resources to local governments and local civil society organisations.

The pathway also strengthens **international collaboration**. Hungary establishes good international relationships and develops common strategies with neighbouring countries. International collaborations also support the exchange of good practices.

The pathway includes actions to support the **capacities of communities and individuals** to participate in decision-making. Social networks and communities are strengthened by integrating social tolerance in education and improving communication processes, for example intergenerational communication and migrants' integration. The role of the media is changed to contribute to environmental and social awareness-raising. Local treasures and beauties are rediscovered and communicated in relation to sustainability. Rewards are provided for social responsibility. It is ensured that everybody has access

to the internet and international and local information systems. Incentives are provided for voting. Civil initiatives are strengthened.

### 5.3.3. Promote shifts to healthy lifestyles

All scenarios include a pathway to promote shifts towards healthy and sustainable lifestyles. This is a transformation pathway that involves fundamental shifts in values, behaviours and practices as well as the underlying education, health and working systems. The pathway addresses vision elements on 'health, education and well-being' and 'community life, social relations and values' (see Appendix 11.3.1).

The pathway includes **awareness-raising activities** to promote changing lifestyle practices with regard to reduced resource consumption and health choices. Individual responsibility and social solidarity are highlighted, for example to enable community support mechanisms and intergenerational relationships. Traditional lifestyles are examined for their contributions to sustainable lifestyles (e.g. air drying of fruits and vegetables, composting). Awareness campaigns on good practices provide concrete examples on healthy lifestyles (e.g. healthy eating) and communicate the values of nature, physical health, culture, diversity and cooperation. A meat-conscious diet is spread to decrease the consumption of meat and animal products and support eco-conscious nutrition. The citizens' conscious protection against heat stress is promoted, for example by communicating on heat alerts. Consumers are made aware of concrete solutions, for example, for energy efficiency.

The pathway sets up a new **education system** to which everyone has access and that integrates education about health, climate adaptation, spirituality, traditional knowledge and sustainability and new education approaches including arts, e-learning and project-based education. The education system is implemented in public schools and self-provided education in communities. Education is diversely oriented towards fostering individual responsibility, building up practical skills and promoting community values and acceptance of diversity. It is tailored to region-specific needs and knowledge. Personal development and an awareness of life-long learning, reflexivity and morality is integrated in education. For example, sustainability lectures are made compulsory in primary and high schools. Practical education for a skilled workforce includes training on sustainable and eco-conscious farming, IT, self-sufficient food production and skills for green technological development and research. Education about UV radiation protection enables individual climate adaptation. The education system is set up to provide for future-oriented skills, competences and professions.

The pathway shifts towards a new **health system** that is accessible to everybody and includes new approaches for care provision and organisation, new medicines and technologies. Health plans are developed that give priority to prevention and address healthy lifestyles, climate adaptation (e.g. risks from ticks, heat stress), mental health, emergency and contingency planning. Health care is provided equally and especially attends to the most vulnerable. Traditional treatment methods in healthcare are re-discovered (e.g. herbs, natural healing methods) and strengthened in relation to medications. A society-wide nutrition reform reduces meat and sugar consumption and people are incentivised to take up healthy nutrition. Investments in healthcare R&D supports new medications and technologies for health, including new sunscreen cosmetics, health screening programmes for prevention and increasing the use of natural and less synthetic ingredients. Health care is provided at the family-level. Community facilities for healthy lifestyles are expanded, e.g. community gyms and swimming pools. Monitoring systems are set up to prepare for (new) infectious diseases and epidemics. General practitioners are trained to recognise new diseases.

There is a strong focus on protecting people's health through **heat management measures**. Heat management is promoted by implementing cooling and shading systems and by supporting new heat

protection creams and technologies. For example, the shading and insulation of buildings is improved and availability of climate controlled public facilities on hot days is ensured. Infrastructure is planned to provide natural shading and cooling; for example, green roofs, parks and wind tunnels are installed. The pathway promotes **green mobility** that also supports intermodal mobility and creates healthy environments by reducing air and noise pollution. A modern public transport system is created and community transport is set up. Bicycle parks are expanded. Electric vehicles are supported.

The pathway also changes the **working system** to ensure good working conditions for everybody, improved wages and to maintain a skilled workforce. The SSP5 pathway includes actions to reduce working hours, widen social employment and to regulate automation and multinationals in the interest of meaningful job opportunities and controlling unemployment. The SSP3 pathway includes an action to expand home working.

#### 5.3.4. Promote green and comfortable cities

SSP1 and SSP4 include a pathway to make cities green and thermally comfortable. This is an adaptation and mitigation pathway that contributes to adaptation to heat and water stress and to renewable energy production in cities. The pathway addresses vision elements on 'energy, built environment and transport' and 'health, education and well-being' (see Appendix 11.3.1).

The pathway installs new **infrastructure** to make cities green and thermally comfortable for dealing with heat waves and collecting water. New urban infrastructures include cooling and ventilation systems such as ventilation corridors in cities and new shading technologies. Green infrastructures are installed including green roofs, parks, roof gardens and green walls. Paved surfaces are reduced to reduce heat and water stress. Urban planning is adapted to create more green space, for example by putting electric cables underground and making streets smaller to set up green boulevards. Urban green is connected to agriculture by planting fruit trees in the city. The planted vegetation is resistant to extreme weather conditions and can be used for animal and human consumption.

The pathway develops **green energy and smart systems** to increase the use of renewable energy that is locally produced and reduce energy demand. Natural and air-conditioned cooling areas make use of renewable energy. Residential buildings are refurbished to become energy efficient. This is underpinned by regulation that only gives permissions to building that produce green energy and to passive buildings.

#### 5.3.5. Promote shift to green energy

SSP3 and SSP5 include a pathway to promote a shift to green energy production and consumption systems. This is a mitigation pathway that includes technological innovation for renewable energy production at local and regional levels and for energy and resource efficiency. The pathway addresses vision elements on 'energy, built environment and transport' and 'environment' (see Appendix 11.3.1).

The pathway promotes **innovations in green technologies** that support local and renewable energy production, green transport, waste reduction and reuse and energy efficiency. A specific focus is on developing new renewable energy sources and promoting local biomass energy production. The ability of households to generate and use energy efficiently is improved by installing solar panels, energy efficiency technology and smart grids. There are public investments in new technologies and solar energy production. Nuclear and fossil energy is phased out and the electrification of transport is supported.

The pathway includes **policy, regulation and incentives** to promote energy savings, energy and resource efficiency and renewable energy. Especially residential and community-based renewable and efficient energy systems are supported. A new energy price is introduced that makes renewable energy and energy savings more attractive. The use of technologies with lower energy requirement is supported. Investment of profit in the production of renewables is made mandatory.

### 5.3.6. Promote rural development and local economies

SSP4 includes a pathway to promote rural and local economies by strengthening local markets, and resource and land management. This is a transformation pathway that fundamentally shifts the ways products and services are provided and consumed by strengthening local communities and self-sufficiency, and installing local infrastructures for energy generation. The pathway addresses vision elements on 'economy and employment', 'food and water' and 'energy, built environment and transport' (see Appendix 11.3.1).

The pathway develops **local markets** for products and services in self-sufficient communities that provide for their own needs. Products and services are produced and consumed locally. For example, locally produced food is also locally processed. Exchange of local goods is facilitated by local and regional trade. The local markets are enabled by equal land distribution that enables communities to produce for their needs. Production cooperatives are supported.

The pathway promotes **local energy and resource management**. Subsidies are provided for solar panels on houses. Infrastructures and management practices are put in place to collect waste and re-use waste in construction materials.

The pathway includes a strategy to shift towards **sustainable agriculture and forestry** in local communities. This contributes to local food self-sufficiency with regional exchange and increases employment in agriculture and forestry. Agriculture is diversified and made organic through the cultivation of herbs, the introduction of new species and crops that are climate change-resistant and the use of biomass for soil quality improvement. The fertility of the soil is increased by using biodegradables and providing nutrients. Community- and family-based agriculture is promoted instead of industrial agriculture.

## 5.4. Governance capacities in the pathways

Across the scenarios, **different types of actors** are identified as both carriers and targets of the actions, which relates to the respective scenario contexts. *Governmental actors* in all scenarios provide regulation, incentives, coordination and financing. The pathways emphasise the strong role of governments across different scales. *Civil society actors* play critical roles in the pathways of all scenarios, being actively involved in decision-making and in the development and implementation of action (e.g. sustainable consumption, local renewable production, education). Especially in SSP3, most actions are developed and implemented by civil society actors and entrepreneurs on local community levels given the lack of governmental capacity in this scenario. *Market actors* and actors from *knowledge institutes* have an implied role in the pathways of all scenarios. Especially in SSP5, market actors self-regulate to internalise environmental costs into market activities. The involvement of actors from knowledge institutions is implied in actions to implement better monitoring and research on environmental and social problems and solutions, and to set-up process-based governance approaches.

All pathways across scenarios share a **strategic orientation towards sustainability** that is derived from the vision for Hungary in 2100 and that orients political, social and economic behaviours. The long-

term strategic orientation is particularly manifested in the pathway to establish integrated and holistic water management. Water is approached systemically, for example also in terms of health, recreation, employment, climate adaptation, energy and agriculture. This enables the creation of synergies and avoidance of trade-offs between different types of water uses and sectors. Especially the SSP4 pathway emphasises integrated planning for water resource management across scales to connect regional and local opportunities and needs. The common sustainability orientation also underpins the pathway that promotes shifts to healthy lifestyles. For example, health and education are thought broadly to promote well-being, environmental sustainability, individual and collective climate adaptation, community values and equity, amongst others. Transparency and accountability are improved by ensuring insights into the concrete tasks of the government and administration, eliminating corruption, simplifying decision-making processes and making reporting mandatory, objective and transparent.

The strategic orientation guides the **formulation of integrated framework conditions** such as regulations, incentives, taxes and financing mechanisms that enable long-term decisions and investments to create synergies across sectors. In the Hungarian pathways these are primarily implemented by strong governments at multiple levels that set new policies for a national sustainable welfare system. The government develops new climate strategies and action plans and puts in place strong environmental regulation for climate mitigation and adaptation through strict environmental standards and taxes. For example, the government ensures equity by allocating a large share of the GDP to disadvantaged regions and providing energy loans and developing new social contracts. The pathway to promote sustainable and resilient water management integrates environmental costs and long-term maintenance into the price for water to establish a more realistic water price and to motivate water savings. Similarly, the pathway to promote shifts towards green energy introduces a new energy price that makes renewable energy and energy savings more attractive and makes investments in renewable energy mandatory.

The pathways set up **multi-level governance structures and mechanisms** to mediate interests, knowledge and resources across scales and sectors. These build on a strengthened role of the government at multiple levels. Especially regarding sustainable and resilient water management, collaboration and coordination span local, regional, national and international levels and involve actors from government, business and industry actors and civil society. For example, at local and basin levels, activities include the establishment of watershed management and the coordination of dams and sluices and a surface canal system. On regional levels, a regional utility government is established and cooperation on water among micro-regions supported.

The multi-level governance is set up based on the subsidiarity principle and gives authority to **local decision-making and community self-organisation**. Local decision-making is enhanced through the redistribution of power and resources to local governments and local civil society organisations. On all governance levels, broad and equal participation in decision-making is ensured. Also the capacities of communities and individuals to participate in decision-making and social networks are strengthened. It is ensured that everybody has access to the internet and international and local information systems.

On international levels, **international cooperation** related to water is developed and international water conflicts are mediated. Except for SSP3, Hungary establishes good international relationships and develops common strategies with neighbouring countries.

The pathway to promote sustainable and resilient water management puts in place **knowledge and monitoring systems** that address the full water cycle and monitor and control water use, water quality

and water quantity. Overall, scientific knowledge contributes to informed decision-making and controls are put in place to supervise the protection of water resources.

Finally, the pathways build on and create diverse **conditions for innovation** by investing in innovative technologies, research and education and providing flexible regulation and incentives for innovation. For example, residential and community-based renewable and efficient energy systems are provided with subsidies and financial support. Lifestyles are innovated by widely communicating the sustainability orientation, environmental problems and climate adaptation.

## 5.5. The pathways' impact: efficacy, synergies and trade-offs

This section presents the impacts of the pathways in terms of their efficacy in reaching the vision as well as the synergies and trade-offs created across pathways, strategies, actions and sectors.

### 5.5.1. Efficacy of pathways in reaching the vision

The results of the qualitative and quantitative assessments of the effectiveness of the actions within the proto- and final pathways in moving the status of the vision element indicators towards the target, compared to the SSPs, are shown in the spider diagrams in Figure 24. The analysis shows that the adaptation, mitigation and transformation actions within the pathways are generally effective in moving Hungary in a positive direction towards the vision.

In all SSPs but SSP1, the final pathways show a great improvement compared to the original scenarios. All pathways promote sustainable water management, which leads to improved water storage capacity in reservoirs in all SSPs. Notably, in SSP3, the most dysfunctional scenario, the shift towards local community democracies in the face of a disintegrated EU and weak Hungarian nation state, radically improves on the vision indicator voter participation in local elections. The pathways in all scenarios do not contribute to a decisive reduction of GHG emissions (compared to the scenario). Interestingly, however, the SSP3 pathways slightly decrease GHG emissions compared to the original scenario.

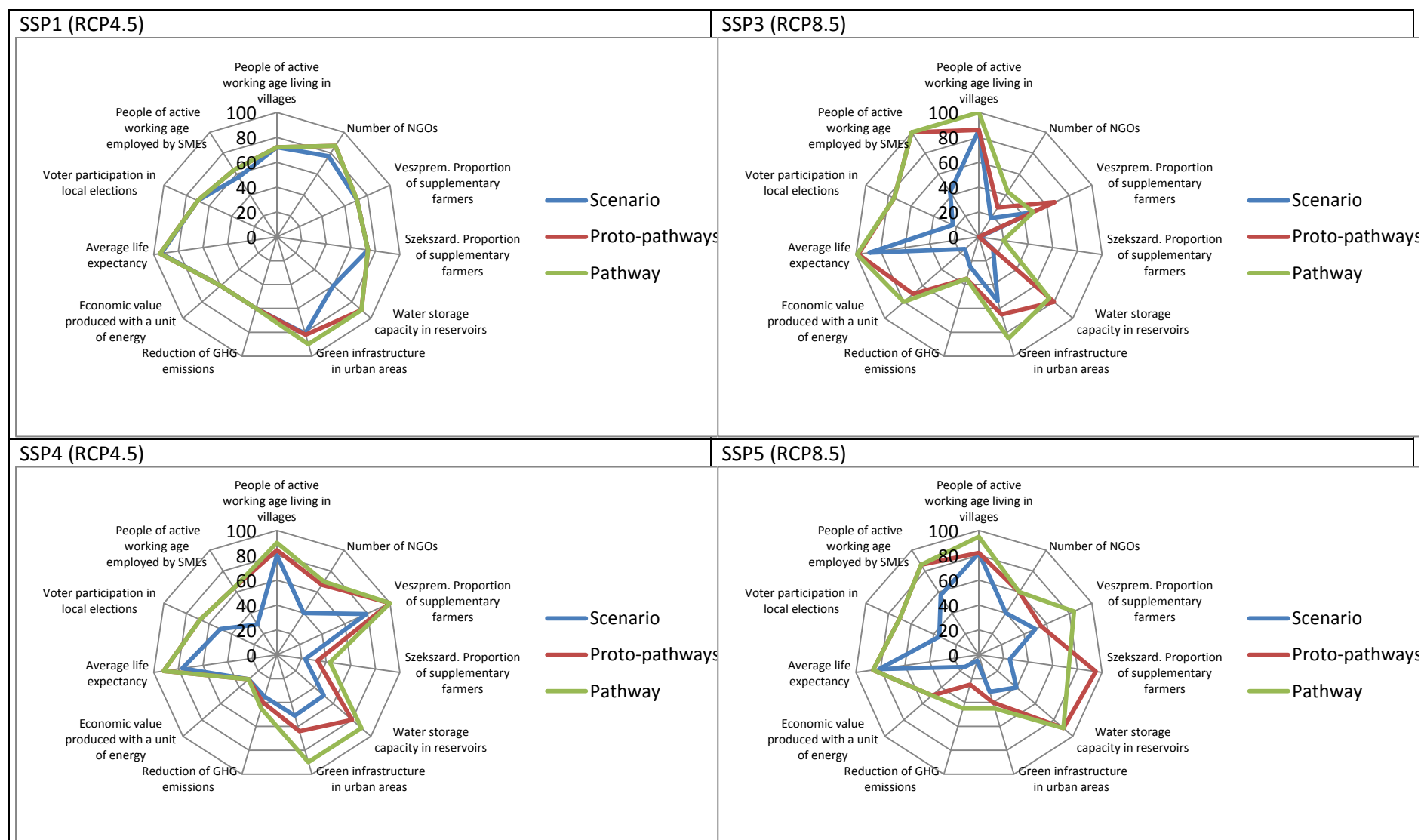
### 5.5.2. Synergies between pathways

All pathways in all scenarios are highly interdependent and support each other in contributing towards the vision. Three pathways have been identified as conditional for the other pathways across all four contextual scenarios: the pathway that promotes sustainable and resilient water management; the pathway that promotes inclusive and multi-level government and governance for sustainability; and the pathway that promotes shifts to healthy lifestyles.

The pathway that promotes sustainable and resilient water management underlies all pathways by developing integrated resource management frameworks and technologies. As such, it conditions the way that resources are managed and addressed in the other pathways, i.e. on local levels and in a holistic way to promote synergies between for example water management, agriculture and energy.

The pathway that promotes inclusive and multi-level government and governance for sustainability supports the implementation of all pathways by setting up the framework conditions for actors to move towards sustainability and resilience. For example, it supports setting up integrated and collaborative water management systems by enabling strong governmental regulations and incentives that incorporate the real price of water and other resources into economic activities and by enabling collaboration across scales and sectors. It also underpins local and rural development by strengthening local democracies and local investments in infrastructure and technologies.





**Figure 24: Results of assessment of whether the vision is achieved for a selection of indicators. Achieving 100 (the outside line of the spider diagrams) means that the vision has been achieved.**

The pathway that promotes shifts to healthy lifestyles underpins changing resource use and demands for sustainable products by prompting societal changes towards health and sustainability. For example, it supports rural and local market development in the SSP4 pathways by educating people about lifestyle choices and opportunities. It also supports local democracies by building the capacities of people to participate in decision-making and fostering political cultures.

### **5.5.3. Trade-offs between pathways**

Most trade-offs between pathways relate to potential trade-offs between climate adaptation and lifestyle choices on the one hand and climate mitigation on the other hand. For example, in the SSP1, SSP3 and SSP4 pathways there are actions to create public cooling centres and air-conditioned resting areas to protect people's health given the projected increased heat stress. These cooling spaces would increase emissions, unless they use renewable energy. Additionally, the SSP3 pathway includes actions to promote rural infrastructure development, which might increase emissions unless people have jobs in the countryside or travel to the city via sustainable transport means.

The SSP3 and SSP4 pathways might induce trade-offs between strong governmental regulation on the one hand and democratic participation and equity on the other hand. For example, there might be a trade-off between strong leadership and environmental laws and societal self-determination. It is important to clarify who are the strong leaders that have control, and to what extent they have control and enforce regulations. Additionally, in light of the high levels of inequality in both scenarios, the internalisation of environmental costs into economic activities and products (e.g. energy, water) might require additional actions to ensure the affordability of such products to the majority of the population while not compromising the sustainability contribution.

## **6. Iberian pathways**

Iberia is likely to be one of the areas in Europe to be affected mostly negatively by high-end climate change in sectors that directly depend on precipitation and temperature, such as agriculture and water supply. This case study focuses on the impacts of climate change on water management and forestry and has developed strategies and solutions to address high-end climate change in Iberia using the examples of the transboundary Tagus river basin, the Guadiana river basin, and other related issues such as the management of the Montado-Dehesa ecosystem.

The IMPRESSIONS Iberian case study included the following elements to develop adaptation, mitigation and transformation pathways:

- Four climate and socio-economic scenarios for Iberia using the RCP and SSP framework have been developed;
- Physically-based models have been used in the context of high-end scenarios to simulate impacts and adaptation in relation to forestry and water indicators;
- A vision for Iberia in 2100 was developed;
- Scenario-specific pathways were developed containing adaptation, mitigation and transformative strategies and actions that reduce the impacts and exploit the opportunities arising from high-end scenarios to move towards the vision.

In the following, we present the results from the Iberian case study with a focus on the developed pathways and their analysis. We first outline the four scenario contexts that provide the logic for developing the pathways as interpreted by the stakeholders (Section 6.1). We then present the vision that has been formulated for Iberia in 2100, which provides the orientation for developing the

pathways and the point of reference for assessing their efficacy, synergies and trade-offs (Section 6.2). Third, we outline the pathways that were developed starting from the pathways that occur in all scenarios and then the pathways that occur in some or in individual scenarios (Section 6.3). Fourth, we present the governance capacities that are created through the pathways and that represent the conditions enabling their implementation (Section 6.4). Finally, we discuss the impacts of the pathways in terms of their efficacy in achieving the vision and resulting synergies and trade-offs (Section 6.5).

### 6.1. Scenario contexts and pathway logics

For the Iberian case study, four socio-economic scenarios (SSPs) were developed and matched with either RCP4.5 or RCP8.5 (Deliverable D2.2 - Kok and Pedde 2016). Each scenario provides distinct contexts, opportunities and challenges for the development of pathways, including different socio-economic enabling and disabling conditions, key actors and climate impacts. This section summarises the context provided by each scenario and describes how it was interpreted for the development of pathways to achieve the vision for Iberia in 2100. Table 9 provides an overview and comparison of the key elements per scenario.

**Table 9: Key elements per Iberian SSP (adapted from Deliverable D2.2 - Kok and Pedde 2016).**

Key elements	SSP1: Sustainability	SSP3: Regional Rivalry	SSP4: Inequality	SSP5: Fossil-fuelled Development
<b>RCP</b>	4.5	8.5	4.5	8.5
<b>Decision-making level</b>	International – both bottom-up and top-down	National/Local+ fragmentation	International / Europe	International/EU not a leader on the global scale
<b>International cooperation</b>	Strong, EU important player	Weak	Strong , Iberia strong player in EU	Strong (trade)
<b>Net migration-low in-migration</b>	Moderate immigration	Outmigration	First high immigration, then controlled	High to cities and from poorer countries
<b>Economic development</b>	Gradual	Low	High	High, until collapse
<b>Mobility</b>	No barriers, but movements are limited	Low	High	High
<b>Social cohesion</b>	High	Low within and across Iberia	Low	Medium
<b>Technology development</b>	High – focus on renewable and re-use	Low	High in some areas; low in labour intensive areas	Strong and crucial
<b>Quality of Governance</b>	High – focus on sustainability	Low and ineffective	High and effective	Focus on businesses
<b>Human health investments</b>	High	Low	High for elites	High (private), then low
<b>Education investments</b>	High	Low	High for elites	High (private), then low
<b>Environmental respect</b>	High	Low	High in pockets	Low
<b>Agency capacities</b>	High ability to act – sustainability frameworks and institutions, regulations, markets and lifestyles	Low ability to act – institutional fragmentation and corruption; inequality and conflict	Moderate ability to act – unequally distributed and no institutional conditions on social issues	Moderate ability to act – no institutional conditions for environmentally-oriented action
<b>Key actors</b>	All societal actors (government, market, civil society) at multiple levels	4 governments in Iberia with weak and corrupt power; corrupt market actors; no participation	Small political and business elite concentrates power/ resources; diverse and conflicted communities	Government and market actors

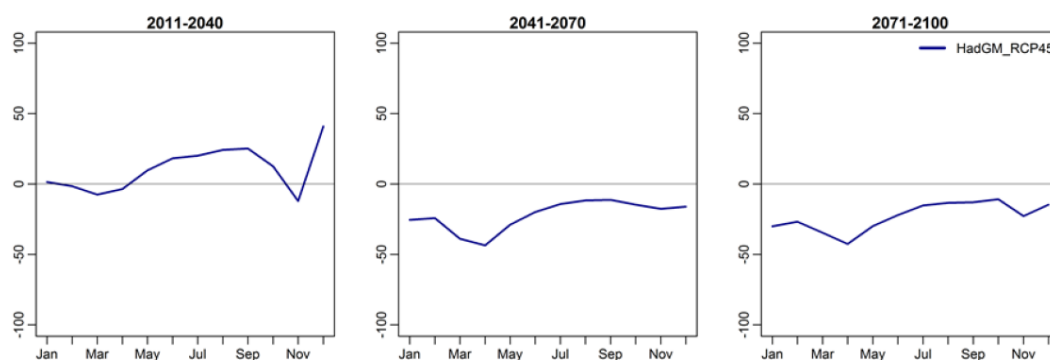
### 6.1.1. SSP1: Sustainability

#### Scenario storyline

Triggered by continuing and growing social participation in environmental, social, and economic issues and fuelled by a European social-oriented political framework, Iberia embraces a path towards a new development model. Initially at a slow pace, but rapidly increasing and supported by socially and environmentally sustainable policy-making, a fundamental change is achieved towards boosting education, innovation, job opportunities in the green sectors (renewables and reuse of materials), and eventually green technologies. Because of the strengthening of the democratic governance structures, globalisation is no longer opposed to local sustainability, but on the contrary, positive sustainable development synergies are being created. This leads to an economic shift in many sectors, whereby technology development and high-value exports become the new backbone of the Iberian economy. By 2100, the new decision-making culture and practice culminates in the new development model for the Iberian countries. This model encourages broad public participation, institutional collaboration and includes a harmonious integration of health, social, economic, political and environmental sectors.

#### Selected key impacts

In the first time slice there is an increase in water availability in the Tagus river basin during the summer months of up to 20%. In the second and third time slices there is a decrease in water availability of up to 50% in winter and the early spring months and 10 - 18% during the summer and autumn (Figure 25). The amount of water transferred to the Segura river decreases drastically. The water supplied to society also decreases because of water transfers and increases in infrastructure. There is a decrease in the inflows into Alcantara Dam in winter and an increase in summer, due to decreased withdrawals. While there is a slight increase in the stored volumes in Alcantara dam for 2011-2040, this is followed by a slight decrease up to the end of the century. Hydropower production decreases generally in the whole catchment due to decreasing water availability. Hydropower decreases are as high as 45% by the end of the century. The volumes of the Buendia and Entrepenyas reservoirs are preserved better when a “sustainable” way of operation is introduced.



**Figure 25: Changes in the water availability for the entire Tagus river basin simulated for SSP1 (RCP4.5) using the SWIM model (Source: Deliverable D3C.2 - Clarke et al. 2017).**

In the Montado-Dehesa ecosystem, climate change increases tree mortality in the larger size classes (i.e., the cork-producing trees). However, lower grazing pressure results in stable regeneration. There is a decrease in cork production starting in the second half of the century. By the end of the century, cork production has decreased by 68%. Grass biomass decreases, and there is an increasing number of years where extreme droughts prevent grass from growing at all. A reduction in grazing pressure in SSP1 compensates for the reduction in grass production. In pine forests, climate change induced drought limits pine tree establishment and this becomes a limiting factor for growth.

**Agency capacities and key actors**

Iberia's policy and societal framework commonly focuses on ensuring social well-being and environmental sustainability. The Iberian framework is positioned within the European Social Framework. Networks of institutions manifest in a Union of Iberian Countries, which supports cooperation in an integrated and participatory way for planning, environmental protection and management of resources. For example, a joint Portuguese-Spanish Agency on environmental protection and natural resource uses is established, which is responsible, among others, for transboundary sustainable water planning. This 'Union of Iberian Countries' becomes very effective in supporting cooperation and in dealing in an integrated and participatory way with the planning and management of shared natural resources.

European, national and local levels collaborate and work more in synergy. Flexible, polycentric, participatory and cross-sectoral resource management and governance institutions are place-based and collaborate on learning cycles and long-term planning and monitoring. Local identities are respected and embraced. This fosters learning and multiple forms of experimentation, also in governance approaches. Public participation spans over multiple sectors and also across governance levels.

National and European policy programmes and regulations promote shifts towards renewable energies, a green economy, resource efficiency, green buildings and sustainable tourism. New types of financial and technological innovations (e.g., including crowd-funding for green products and investments) support the emerging green economy and reduced water and energy demand. Natural resources are managed from a more local and environmentally friendly perspective in synergy with higher level regulations. In addition, water resources are managed at the river basin level, hence also taking into account long-term land use planning. For each international river basin, a single and participative joint authority is created which deals not only with water issues, but also with other sectoral and cross-cutting issues such as land use, agriculture, energy or public awareness.

Communities are strong, embracing local identities and complexity, and with high societal awareness about sustainability. Social movements and NGOs support a shift towards sustainability and broad public participation.

**Pathways logic**

The pathways provide the capacity to plan ahead and implement measures and it starts already on a route towards sustainability, but there are still issues relating to climate change impacts. For example, in the later time slices, as precipitation decreases and droughts increase, there is more need for sustainable water management and efficient irrigation systems.

The pathways start by putting in place plans and programmes and establish monitoring programmes during the first time slice. The later time slices put in place corrective measures. The pathways build on the capacities of all societal actors and on strong multi-level, transboundary and participatory governance systems. A green economy is achieved by implementing a polluter pays principle. Research and technological innovation are integrated in the pathways to ensure that knowledge and the best technology is available.

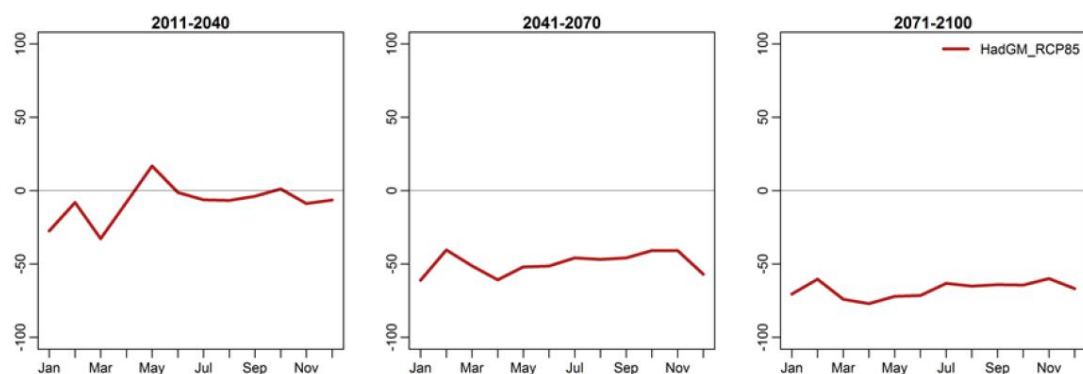
**6.1.2. SSP3: Regional Rivalry****Scenario storyline**

Short-lived governments lead to a fragmentation of the social and economic fabric in Iberia. In 2030 Catalonia gains independence, which is later followed by other regions both in Iberia and in other Mediterranean countries. To counteract economic crises, the Southern countries unite in a separate

Union, the 'Club Med'. Continued environmental and economic problems increase social tensions and social inequalities, which in turn negatively affect tourism. By the 2060s, four countries have come to exist in Iberia: Portugal, Spain, Catalonia and the Basque Country, with strong borders between them. Over time, conflicts escalate although war over water and other scarce resources is prevented. By 2100, a deserted and desertified inland rural Iberia remains and this produces a larger divide with the rest of Europe. Continuous conflicts across multiple countries, which experience similar disintegration processes, occur and this limits cooperation within Club Med and with other international power blocs.

### **Selected key impacts**

In the first time slice there is a decrease in the water availability in the Tagus river of up to 35% in winter and late autumn, and a slight increase in May of up to 15%. In the second and third time slices there is a decrease in water availability throughout the year: up to -58% for 2041-2070 and up to -75% until the end of the century (Figure 26). The amount of water transferred to the Segura river decreases due to water resources availability. The Buendia and Entrepénas reservoirs are in danger of running dry. The discharge in the headwaters of the Tagus river is not able to satisfy irrigation needs after 2070. The volume in the Alcantara dam cannot be sustained in order to provide the required transfers to Portugal after 2040. Hydropower production decreases generally in the whole catchment due to decreasing water availability. The decrease is as high as 50% by the end of the century.



**Figure 26: Changes in the water availability for the entire Tagus river basin simulated for SSP3 (RCP8.5) using the SWIM model (Source: Deliverable D3C.2 - Clarke et al. 2017).**

In the Montado-Dehesa ecosystem, climate change results in a strong increase in tree mortality and a reduction in regeneration. No cork oaks in any size class persist by the end of the century. The decrease in cork production occurs in the second half of the century. Grass biomass decreases, and there is an increasing number of years where extreme droughts prevent grass from growing at all. Reductions in grass production mean that not enough forage is being produced for livestock. Thus there is an increasing number of years where extreme drought causes critical thresholds (for both cork oak and livestock) to be crossed. In pine forests, drought is a limiting factor for growth.

### **Agency capacities and key actors**

Iberia is marked by a large degree of fragmentation; there are no shared goals for Iberia and Iberia has no stable regulatory force. Rivalries between Iberian countries and regions increase. In Spain, Catalonia gains independence in 2030 and spearheads autonomist movements. The regions remaining within Spain and Portugal are in conflict with each other due to resource scarcity, especially water. The dissolution of the EU and the growing divide between northern and southern European countries fosters the creation of a 'Club Med' which includes Italy, Spain, Portugal and Northern African countries. The 'Club Med' brings some social and political stability. However, continuous conflicts and

social unrest across multiple countries (with a similar disintegration process occurring in other countries) limit its potential for international cooperation.

No fair and participatory governance system is in place in Iberia and citizens become detached from politicians. There is no long-term planning as environmental and social issues are no longer on the agenda and only end-of-pipe symptoms are tackled. Because of limited resources, there are no investments in innovation. The Iberian society is marked by social disorder and conflict with increasing inequality and social exclusion.

### **Pathways logic**

This scenario is a storyline of disintegration – the EU dissolves, there are four countries in Iberia and lots of tensions within society. The pathways focus on coping with, or decreasing, the climate and socio-economic change impacts associated with the scenario, and especially on minimising the problem of fragmentation between Iberian countries. A platform is established that enables actors from the different regions to meet and decide on joint directions for Iberia. Investments can only be undertaken in the first period because afterwards there is not much money. A lot of investments are undertaken in the first period on water saving, efficiency, and also investment in technology. A focus is especially on decreasing water use.

The pathways also involve ‘giving up’ things and accepting trade-offs, because some measures are unfeasible. One of the major problems is a lack of water in this scenario, a focus is on water availability in balance with water demand. As there might be a trade-off between water quality and water availability for use, some measures are included that assume that water quality in e.g. lakes, reservoirs and rivers cannot be as good as is now demanded, which enables more use of water (by lowering quality standards).

Another focus in the pathways is on creating local economies and local jobs to foster communities and regional self-sufficiency. Education and information is very important to decrease stress in the population.

### **6.1.3. SSP4: Inequality**

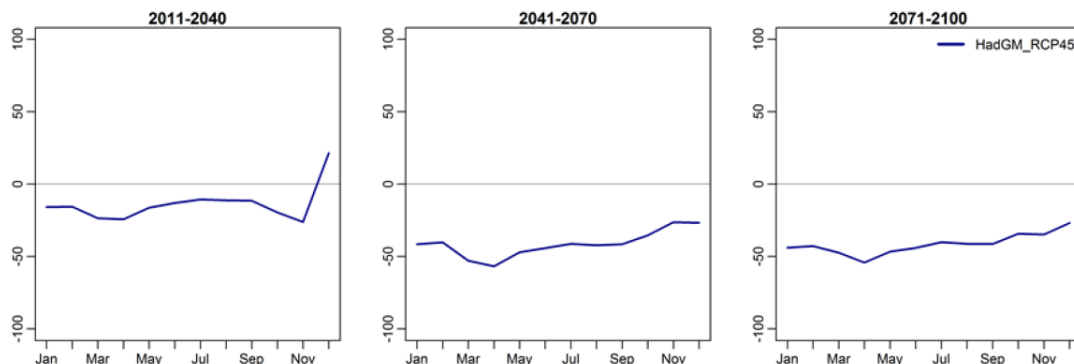
#### **Scenario storyline**

Economic challenges and environmental accidents are exacerbated by new European and global crises, which leads to increased migration from northern Africa and the Middle East. In Iberia, unemployment rises to record levels, which eventually results in social unrest and massive protests. Social stratification intensifies with strong high-income elites and a divided large lower class, bringing about strong tensions within and between social classes. This unstable social situation escalates in the 2040s, and leads to a shift in the political system. New governments establish an oligarchical system with power and money gradually centralised and controlled by an elite of a few companies and central governments. The political and industrial elite successfully implement a strategy of “subtle” enforcement of inequality through education and keeping people busy on low-skilled tasks, with low future expectations. To their benefit, the elite invests in solar and wind energy, eventually becoming a market leader.

#### **Selected key impacts**

In the first time slice there is a decrease in the water availability in the Tagus river basin during the summer months of up to 20% (Figure 27). In the second and third time slices there is a decrease in water availability of up to 55% in winter to early spring and 20–30% during the summer and autumn. The amount of water transferred to the Segura river decreases. The environmental flows are not established in the headwaters of the Tagus river, but the amount of water in the reach is enough to

sustain local agricultural production. The volumes in the Buendia and Entrepénys reservoirs remain just above the critical level. The volume in the Alcantara dam decreases significantly. Hydropower production decreases generally in the whole catchment due to decreasing water availability.



**Figure 27: Changes in the water availability for the entire Tagus river basin simulated for SSP4 (RCP4.5) using the SWIM model (Source: Deliverable D3C.2 – Clarke et al. 2017).**

In the Montado-Dehesa ecosystem, climate change increases tree mortality and reduces regeneration. The total population of cork oak trees is reduced by 60% by the end of the century as a result of climate change and grazing pressure. Grass biomass decreases, and there is an increasing number of years where extreme droughts prevent grass from growing at all. Reduction in grass production means that not enough forage is being produced for livestock. In pine forests, drought limits pine tree establishment and is the limiting factor for growth under climate change.

#### **Agency capacities and key actors**

There is a centralised and oligarchic governance system that monopolises markets and access to goods through powerful public-private partnerships. There is no transparency and participation, resulting in multinationals having more power and high levels of inequality and tensions between the elite and poor masses. The media is controlled to maintain public order. The motto ‘divide et impera’ is back in Iberian politics: rivalry between social and ethnic groups are maintained and increased by the elite to maintain its power.

In line with EU priorities to diversify the energy portfolio and become self-sufficient and because of rising worldwide energy demand, Iberia starts to invest in wind and solar technology through taxes and EU funding. To increase their benefit, the elite monopolises natural heritage, health, education and culture, while privatising the energy resource market. To ensure a continued approval and support from the public, the rulers provide for basic needs but ensure relatively low levels of education and health conditions for the masses, restricting access to high-level privatised education and health services to themselves.

There is low social cohesion between the lower levels of income due to diverse ethnicities, religions, etc. Within the top classes (“club”), social cohesion is increasingly strong. This leads to strong tensions both between lower and higher social classes and within the lower social classes, also resulting in social unrest.

#### **Pathways logic**

The basic feature of this scenario is the strong division between the elite and the rest of the population. The main focus for governance is integrated planning throughout the entire basin and land, so e.g. there are trade agreements and protocols between Portugal and Spain. There are also a lot of opportunities for technological innovation to achieve self-sufficiency and protect the environment.



In the first period, it is important to put in place good planning and collaboration/coordination between Portugal and Spain. Policies and regulations are implemented to protect natural resources and achieve sustainable land use planning. In the second period, the centralised government is able to implement a lot of measures. The strong elite recognises the need to keep the population happy. Public-private partnerships and the government ensure that the majority of the population has its basic needs covered.

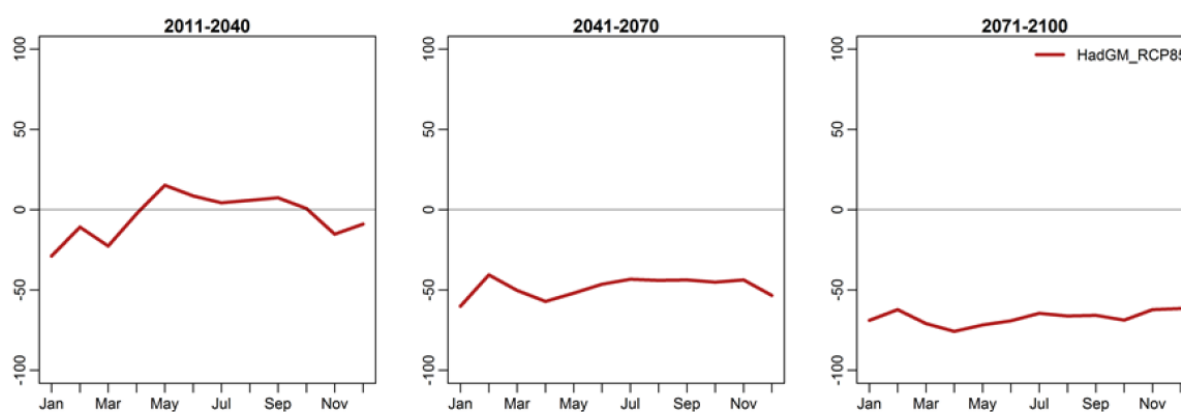
#### 6.1.4. SSP5: Fossil-fuelled development

##### Scenario storyline

The burst of the financial bubble increases the need for social aid and subsidies for Iberia, which is facilitated by an increasing economic surplus in the north of Europe. Crucial is the establishment of a connection of electricity networks that increase access to external (fossil) resources. Iberia is part of this network and located strategically in the energy nexus. Iberia also starts exploiting its own resources, while intensifying agriculture and forestry. In the 2040s, environmental problems occur that are combatted with successful technological solutions. The accompanying environmental destruction goes by unnoticed as most people live in the cities, where water, food, and energy supply are secured. By 2060, Iberia totally depends on technology, fossil fuels, and investments of large companies. Ultimately, a number of environmental disasters lead to an increased awareness across Iberia that technology can no longer sustain agricultural production. The outlook is uncertain as the fossil-fuel based development model collapses and business opportunities decrease.

##### Selected key impacts

In the first time slice there is a decrease in water availability in the Tagus river basin of up to 25% in winter and late autumn and a slight increase in the summer of up to 15% (Figure 28). In the second and third time slices water availability decreases throughout the year: up to -55% for 2041–2070 and up to 65% for 2071–2100. The amount of water transferred to the Segura river decreases. The minimum flow required for the environment and agriculture cannot be sustained after 2070.



**Figure 28: Changes in the water availability for the entire Tagus River basin simulated for SSP5 (RCP8.5) using the SWIM model (Source: Deliverable D3C.2 - Clarke et al. 2017).**

The overall Tagus discharge decreases drastically – the high flows in winter are stored by the reservoirs to increase the water flows during summer to satisfy growing agricultural and urban water demands. As a result of technological advances, high demands can be met in the first time slice but not thereafter. The Alcantara dam volume can be maintained until the year 2040. Later the volume decreases by as much as -75%, leading to frequent failures in fulfilment of the Albufeira agreement. The Buendia and Entrepnyas reservoirs reach critical volume levels during the second time slice.

Hydropower production decreases generally in the whole catchment due to decreasing water availability. Decreases in hydropower are as high as 50% by the end of the century.

In the Montado-Dehesa ecosystem, climate change results in a strong increase in tree mortality and reduction in regeneration. No cork oaks in any size class persist by the end of the century. The decrease in cork production occurs in the second half of the century, with production ceasing by 2080. Grass biomass decreases and there is an increasing number of years where extreme droughts prevent grass from growing at all. Reductions in grass production mean that not enough forage is being produced for livestock. Thus, there is an increasing number of years where extreme drought causes critical thresholds (for both cork oak and livestock) to be crossed. In pine forests, drought limits the establishment and growth of pine trees.

### **Agency capacities and key actors**

There is a common societal and political focus on economic and social well-being, while there are low levels of awareness about environmental degradation. Corporations increase their influence on national decision-making; free and competitive markets ensure affordability of commodities but market deregulation exacerbates resource exploitation. Towards the end of the scenario the societal and political fabric breaks down as environmental impacts intensify.

Policies in Iberia focus on economic growth through the exploitation of fossil fuels and technological development. In order to increase its economic output and further exploit its natural resources, Iberian countries invest in large-scale intensively managed and mechanised agriculture and commercial forestry. This is supported by EU subsidies and the widespread access to cheap fossil fuel-based energy. By 2060, Iberia totally depends on technology, also for climate adaptation, fossil fuels, subsidies from the EU and gas from northern Africa, and investments of large corporations. Towards 2070, the peak of the fossil fuel crisis triggers a strong economic crisis leaving many in debt. The majority of people, however, are unaware of the effects of a lack of investment in environmental protection because of technological solutions that ensure resource availability for a long time.

### **Pathways logic**

The pathways start in a period where there is a lot of money and technological innovation. Monitoring programmes are put in place and subsidies and incentives are provided to promote sustainable market activities, lifestyles and resource management. The environment is integrated in all policies as it has become a priority. The pathways build on a new education system and awareness programmes that improve environmental communication and achieve change towards sustainable lifestyles. Science and knowledge-sharing mechanisms become important in decision-making.

Environmental problems increase in later periods and efficiency solutions cannot be improved any more. This leads to more aggressive measures – sometimes the only ones that are still available (e.g. reduced irrigated surface, rationing resources, conservation agriculture).

## **6.2. A Vision for Iberia in 2100**

The vision for Iberia in 2100 envisions new and sustainable lifestyles, coordinated Iberian governmental institutions that ensure access to food, education and health for all and sustainable natural resource management and economy. Figure 29 shows the poster of the vision after workshop #3. The full vision narrative can be found in Appendix 11.4.1.



**Figure 29: A Vision for Iberia in 2100.**

In 2100, people in Iberia engage in new lifestyles that fit in more sustainable ways with the special characteristics of the territory. There is access to safe food, water, education and health for all. Natural resources are managed sustainably and strictly protected. Rural and close-to-nature lifestyles co-exist with those relying on cutting-edge technologies. Abandonment and the deterioration of rural areas have been reduced. Cities are smaller than in 2016, reducing emissions and making them less dependent on transport. Furthermore they are energy self-sufficient, based on the development of circular economy models, eliminating waste production and improving air quality. Land use management and planning promote the socio-economic sustainability of the region and equal opportunities between different areas.

The sustainable economy is based on a balanced use of Iberian natural resources with minimum impact on natural ecosystems and maximum reuse, recycling and recirculation of materials. With full employment and a fair income distribution, a new welfare model focused on well-being and social welfare decouples development from economic growth. The consumption of local, seasonal and organic products is prioritised. Public policies support more sustainable agriculture. With 100% renewable energy, a distributed network of energy production and consumption and no more investment in fossil fuels, Iberia has a low-carbon economy. Integrated Iberian water management ensures a balanced use of water for urban supply, agriculture, forestry and energy production. Improved water management helps to mitigate extreme events, such as droughts and floods.

Portugal and Spain are united with coordinated Iberian governmental institutions. Iberia also has a highly politically engaged society. Different cultural and regional identities are respected and

accommodated. Iberia supports greater global cooperation and fosters solidarity, with respect for human rights and social development of peoples.

### 6.3. Overview of Iberian pathways

This section builds upon the scenario-specific pathway logics described above, to introduce the Iberian pathways starting from the pathways that occur in all scenarios and moving towards the pathways that occur in fewer or individual scenarios (Table 10). The full overview of pathways per scenarios can be found in Appendix 11.4.2.

**Table 10: The Iberian pathways per SSP.**

Pathway	SSP1	SSP3	SSP4	SSP5
Promote integrated and collaborative water management and sustainable water use	✓	✓	✓	✓
Promote shifts to sustainable lifestyles	✓	✓	✓	✓
Promote ecological agriculture	✓	✓	✓	✓
Promote democratic and multi-level governance for sustainability and social equity	✓		✓	✓
Promote shift to low-carbon and local energy systems and markets	✓	✓	✓	

#### 6.3.1. Promote integrated and collaborative water management and sustainable water use

All scenarios include a pathway to promote integrated and collaborative water management and sustainable water use. This is an adaptation pathway that ensures water quality and water quantity and climate adaptation. The pathway addresses the vision elements on ‘food, water and energy’, ‘resilience’ and ‘governance’ (see Appendix 11.4.1).

The pathway establishes **integrated and holistic water management strategies and approaches for Iberia** that protect water quality and quantity, adapt to climate change and ensure equal access to water. The strategies integrate different goals on water quality and quantity (e.g. 100% water reutilisation) and agriculture, biodiversity, land use, energy, recreation, equality and resilience. The SSP4 pathway builds on reviews and revisions of the existing Albufeira Agreement and emphasises its rigorous implementation. The objective is to develop an agreement for the transboundary collaboration of water in Iberia and integrated water management at the river basin level. The protocol is to be regularly updated and revised. The agreement regulates and allocates water in relation to different uses, for example urban, industrial and agriculture.

The pathway installs **innovative water infrastructures and technologies** to improve water efficiency, protect water quality and adapt to climate change. Infrastructure is developed to promote closed water cycles, reduce water loss and increase water retention capacity by installing rainwater harvesting, improving aquifer recharge. Water is also combined with energy – for example, water is pumped back to reservoirs when there is an excess of energy. Water efficiency is increased through technologies for water metering, recirculating water and irrigation. Water reuse is enabled by water purification, wastewater treatment and desalination. For example, the SSP5 pathway suggests cost-effective desalination in the Atlantic with renewable energy.

The pathway sets up **participatory, multi-level and transboundary water governance systems** to manage and control water use, quality and quantity. On the Iberian level, a common body for shared water bodies and international river basins is established. Joint agencies for the implementation and

monitoring of the agreement and actions are set up. Iberia collaborates with the EU to transfer water from northern Europe to Iberia. Water bodies are managed at the regional level. For example, the SSP4 pathway proposes to partially regionalise the management of the Tagus river basin using the model of the Great Lakes in North America. These regions could be transboundary. Additionally, transboundary and transregional water bodies are set up at the river basin level and address the multiple uses of water (e.g. recreation, energy, agriculture). There is also better public participation in water and land planning.

The pathway puts in place **strong regulations, standards and incentives** to promote sustainable water use and water efficiency innovations. The 'real' price of water, water taxes and tariffs for water use and amounts are enforced. Progressive water pricing includes, for example, the costs of wastewater cleaning. Strong regulatory measures include the establishment of water quotas, closing the Tagus-Segura water transfer and eliminating illegal water use. Water metering is made compulsory for farmers. Norms for urban water harvesting and water saving appliances in households are implemented. The regulations are enforced with regular inspections. Subsidies are provided for water efficiency measures. For example, taxes for firms who save water are reduced and payments for ecosystem services are incentivised. An eco-label for water efficiency is introduced. Firms are required to provide water saving plans.

The pathway promotes **water use changes** to save and protect water. People and companies are educated and incentivised to use less water. A more conscious approach to using water is promoted with water and climate change awareness campaigns.

The pathway establishes **water monitoring systems** to control and monitor water quality and ensure that water use is in line with ecological flows. Real-time monitoring of water flows in rivers in summer and winter is introduced using e-monitoring technologies. The state controls and evaluates underground water. Remote monitoring systems are developed to control irrigation and illegal water use. Operating rules for managing water resources and water demands are continuously adapted and reviewed.

### 6.3.2. Promote shifts to sustainable lifestyles

All scenarios include a pathway to promote a shift towards sustainable lifestyles, which involves changing towards sustainable production and consumption patterns and behaviours, and changing the education system. This is a transformation pathway that involves fundamental shifts in values, behaviours and practices. The pathway addresses vision elements on 'health, well-being and sustainable lifestyles' and 'income, education and jobs' (see Appendix 11.4.1).

The pathway sets up a new **education system** to which everyone has access and that integrates education about sustainability, solidarity, traditional knowledge, skills and entrepreneurship. Education is provided and targeted for all age groups and to intergenerational groups for solidarity. Environmental and social education is integrated in schools, e.g. on water savings, healthy food behaviours, intercultural communication and long-term thinking. Practical job and skills training and immigrant education are provided to achieve zero unemployment. Also the awareness and capacities of teachers regarding the new type of education is enhanced.

The pathway invests in **environmental and social research** that provides a basis to communicate environmental and social problems and underpins the education system. Applied research is supported.

The pathway includes **awareness-raising activities** to promote awareness on self-sufficient lifestyles, energy efficiency, food waste reduction, intermodal mobility, climate change, water savings and reuse, and different diets (e.g. sheep, fish and insects). The SSP1 and SSP5 pathways focus lifestyle changes on changing food practices to reduce food waste and meat consumption and to ensure food security. Transnational agreements revolutionise the food system, making fair trade obligatory. Consumers' awareness is enhanced by providing comprehensive information on products' origins and their environmental and social impacts. There are lifestyle role models that support reduced water consumption and energy use and self-sufficiency. NGOs show best practices for local production and consumption. The media and virtual reality are used to augment environmental and social communication.

The SSP3 and SSP4 pathways facilitate **social cohesion and protect social and human rights**. Everybody in Iberia is provided with basic services. The elderly, migrants and diverse religious groups are integrated into society. Social volunteering supports a non-formal education system. A culture of mutual dialogue and political tolerance is promoted. Access to basic services is guaranteed and equality policies are implemented. Social universal income for all is provided.

The SSP1 and SSP5 pathway creates **alternative community-based markets**. New markets are set up at the local level with job sharing. Alternative trading systems are put in place such as local currencies and time banks. Local renewable energy is promoted for self-sufficiency.

### 6.3.3. Promote ecological agriculture

All scenarios include a pathway to develop and mainstream sustainable ecological agriculture in Iberia. This pathway combines adaptation and mitigation strategies and actions to promote integrated and flexible land management, reduce negative consequences of agriculture on sustainability and climate, ensure food security, resilience and self-sufficiency in Iberia and create synergies with water. The pathway addresses vision elements on 'food, water and energy', 'protecting the environment' and 'resilience' (see Appendix 11.4.1).

The pathway develops **integrated policy frameworks for ecological agriculture** that are adapted to ecological and context-specific needs and conditions and to climate change. Agriculture is approached from a systemic perspective to derive integrated sectoral policies in relation to other issues such as energy, rural development, biodiversity, water and health. Agriculture is adapted to water resources. The SSP1 pathway derives the regulations and incentives from a revised CAP by the EU that creates better integrated policies, focuses on innovation and adaptation measures to climate change, and implements strategic planning from a European perspective to take context conditions and needs into account. For example, it is suggested to change the CAP to shift water intensive crops to northern Europe and to import water and food into southern Europe and export energy to northern Europe. A green indicator variable becomes more important than the GDP.

The pathway shifts towards **ecological agricultural practices** to adapt agriculture to climate change impacts and land and water availability. Conservation agriculture is implemented with cycles during which the land is not worked (left fallow). New species and crops are introduced that fit the climate conditions (less precipitation and higher temperatures). For example, there is a shift to permanent crops that are less water-intensive and summer crops are replaced with winter crops that require less irrigation. Foreign invasive species are reduced, while traditional and local crop species are recovered. Crop rotations are improved. Biogas is produced with effluents from cattle grazing. Burning old grass is stopped and the grass is used instead as biomass (e.g. creating compost). There is a shift to natural fertilisers.

The pathway includes a shift towards **agro-forestry and sustainable forestry**. Areas in Iberia are reforested with native species. Forest fires are reduced. After a forest fire the soil is managed to prevent erosion and pollution.

The pathway supports **technological innovation** to facilitate ecological agriculture and protect water quality and quantity. Innovations include technologies in irrigation, desalination, hydroponics and combinations of irrigation and renewable energy. Soil sensing technology is developed for efficient irrigation scheduling. Fossil fuels are substituted by renewables in agricultural practices.

The pathway puts in place **regulations, standards and incentives** to promote ecological agriculture. These build on studies that accurately valorise ecosystem services to determine new pricing, for example by integrating environmental externalities into food and clothing prices, and to only produce according to the capacity of ecosystems. The for-profit sector is regulated to account for sustainability and to prevent huge mergers in the agroindustry, which might be detrimental to biodiversity. Regulations focus on efficient use of fertilisers and ban chemical fertilisers, requiring retrofitting and implementing penalties. For example, penalties for burning waste from agriculture are provided to support a reuse of waste. Food distribution and the production of the agricultural stock are managed at the Iberian level to reduce food waste. Incentives are provided to consumers to consume organic agriculture products and renewable energy. Funding (subsidies from national governments and the EU) is provided to farmers to adapt crop species and implement ecological agriculture. Payment schemes for ecosystem services (e.g. vegetation and water quality) are created that enable the compensation of farmers who shift towards ecological agriculture. A market of biodiversity and seed banks is created.

The pathway shifts towards **integrated land use management** that takes account of different land uses from an Iberian perspective, plans at the farm scale and protects the soil. For example, irrigated agriculture is relocated to north-western Iberia. Land use is changed to bush in the uplands and to cultivate where there is rainfall. Ecosystem corridors are restored to protect biodiversity and improve water quality by filtering pollutants. Soil conservation is improved, carbon sinks are created and permeable surfaces are expanded. The pressure and density of livestock intensity in Iberia is limited and adequate to the soil and context to avoid soil degradation and erosion.

The pathway includes the **education of farmers** in ecological agricultural practices, which also contributes to rural development and social cohesion. For example, the techniques of how to work the land are shown, as well as how to deal with new equipment and irrigation techniques. Key actors for agro-environmental policy governance are included in decision-making and planning.

#### **6.3.4. Promote democratic and multi-level governance for sustainability and social equity**

SSP1, SSP4 and SSP5 include a pathway to promote policy and governance for sustainability and social equity. This is a transformation pathway that involves fundamental shifts in the ways the governance system is set up to enable multi-level cooperation, transparency and participation in line with long-term and integrated sustainability and resilience goals. The pathway addresses vision elements on 'governance' and 'cooperation and identity' (see Appendix 11.4.1).

Iberia develops **integrated environmental protection frameworks and policies** that integrate nature into market and planning activities and fit policies to specific regional conditions to harmonise social and economic development in line with environmental conditions and climate change. A particular emphasis is placed on redistributing income to promote social equity and preserving Iberian biodiversity. Environment is integrated in all policies and environmental protection is made a priority.

Planned obsolescence is forbidden. Progressive taxation is introduced for equal distribution of welfare.

The pathway ensures a **democratic, fair and transparent governance system**. Public participation is increased and political power is decentralised. NGOs are supported to take an active role in decision-making and engaging people. Bureaucracy is simplified. The legislative system is strengthened to ensure justice. Women in decision-making positions are promoted.

The pathway sets up **collaborative and multi-level governance** across scales and sectors. Participation forums are established from schools to the parliament. Social networks and enterprises and political activism is fostered to ensure broad participation and social collaboration. International collaboration is strengthened and Iberia engages in global integrated environmental decision-making and international knowledge sharing.

The SSP5 pathway puts in place **monitoring systems** to ensure that decision-making is supported by science and to measure individual consumption in agriculture. This also supports stricter follow-up of investments (e.g. performance of wastewater projects) and the stopping of subsidies where groundwater is exploited. The monitoring and accounting builds on an integration of environmental costs and new sustainability accounting indicators.

### 6.3.5. Promote shifts to low-carbon and local energy systems and markets

SSP1, SSP3 and SSP4 include a pathway to promote shifts to low-carbon and local energy systems and markets to support urban and rural development. This is a mitigation pathway that includes technological innovation for renewable energy production on local and regional levels and for energy and resource efficiency. The pathway addresses vision elements on 'food, water and energy' and 'sustainable and local economy' (see Appendix 11.4.1).

The pathway invests in a **diversified local economy** that is adapted to context conditions, promotes production and consumption based on local resources and creates local jobs. Local markets are created based on local resources for production, waste, water, energy and services. The pathway works towards a circular economy. For example, the SSP4 pathway promotes local industries in wood products and biofuel production in forests. Inclusive market development and a balance between rural and urban areas are ensured. Cooperatives are supported.

The pathway develops **green technological innovations** to increase energy efficiency and achieve self-sufficient renewable energy production. Technological alternatives to clean energy include a shift from hydro power. The safety of the electricity system is ensured by innovating smart grids. A focus is on making cities energetically self-sufficient, for example by putting PV on all buildings in cities. The SSP4 pathway establishes energy networks between Europe and north Africa.

The implementation of renewables and decreasing energy consumption is incentivised and enforced through **subsidies and regulations**. Iberia divests from fossil and nuclear energy and the implementation of green energy is made compulsory. An annual carbon budget is established and carbon taxes based on real carbon costs are introduced. For example, carbon taxing on tourism is established. Low carbon production processes and the use of renewable energies in agriculture (e.g. machinery, irrigation, transport, processing) are incentivised. Renewable energy is also supported in transport and the need for daily commuting to work is reduced.



## 6.4. Governance capacities in the pathways

Across scenarios, **different types of actors** are identified as responsible for implementing the actions. Especially the SSP1 pathways build on the high level of capacities of all actors in society and a strong multi-level governance system. *Governmental actors* in all scenarios provide regulation, incentives and financing, though they play a considerably smaller role in SSP3. Resonating with the weak role of national governments in the scenario, more emphasis is given in SSP3 to local self-organisation and local democracies. *Civil society actors* play critical roles in the pathways of all scenarios, being actively involved in decision-making and in the development and implementation of action (e.g. sustainable consumption, local renewable production, education). *Market actors* have important roles in the pathways of all scenarios. Especially in SSP4 and SSP5, where multinationals have strong power, they engage in public-private partnerships and self-regulate to internalise environmental costs and philanthropy into market activities. The involvement of actors from *knowledge institutions* is implied in actions to implement better monitoring and research on environmental and social problems and solutions, and to set-up process-based governance approaches.

All pathways across scenarios share a **strategic orientation towards sustainability** that orientates political, social and economic behaviours. Building on the vision for Iberia in 2100, Iberia develops integrated environmental and social protection frameworks and policies. In this way, the environment and equity are integrated in all policies and made a priority. This is manifested in synergistic and integrated thinking in the pathways, for example on water management. For instance, integrated and holistic water management strategies and approaches focus on protecting water quality and quantity for everybody and integrate considerations of climate adaptation, agriculture, biodiversity, land use, energy, recreation and resilience. Similarly, agriculture is approached from a systemic perspective that also addresses energy, water, biodiversity, rural development and health.

Iberia develops **integrated frameworks and policies** such as regulations, incentives, taxes and (self-regulated) financing mechanisms that enable long-term decisions and investments to create synergies across sectors. These frameworks integrate nature into market and planning activities and fit policies to specific regional conditions to harmonise social and economic development in line with environmental conditions and climate change. The environment is integrated in all policies and environmental protection is made a priority. Progressive taxation is introduced for equal distribution of welfare. For example, the real price of water is defined and water taxes and tariffs for water use and amounts are enforced. Similarly, ecosystem services are valorised to determine new pricing, for example by integrating environmental externalities into food and clothing prices, and to only produce according to the capacity of ecosystems. An annual carbon budget is established and carbon taxes based on real carbon costs are introduced. With regard to agriculture, ecological and context-specific needs and conditions are integrated into land use planning and policy frameworks to manage food distribution and the production of the agricultural stock from the Iberian level and reduce food waste. This is integrated into wider European frameworks. For example, it is suggested to shift water intensive crops to northern Europe and to import water and food into Iberia, whilst exporting energy to northern Europe.

Iberia sets up **multi-level and transboundary governance structures and mechanisms**, which enable the mediation of interests, knowledge and resources across scales and sectors in Iberia. Public participation is increased, for example by establishing participation forums and fostering social networks and political activism. International collaboration is strengthened and Iberia engages in global integrated environmental decision-making and international knowledge sharing.

A particular focus is on collaborative and transboundary water management. On the Iberian level, a joint body for common water bodies and international river basins is established. Additionally,

transboundary and transregional water bodies are set up at the river basin level and address the multiple uses of water (e.g. recreation, energy, agriculture). There is also better public participation in water and land planning. Joint agencies for the implementation and monitoring of the agreement and actions are set up. Iberia collaborates with the EU to transfer water from northern Europe to Iberia.

The pathways put in place comprehensive **knowledge and monitoring systems** to control and monitor the use and quality of resources, especially of water. The pathway to promote integrated and collaborative water management sets up water monitoring systems to ensure that water use is in line with ecological flows. Especially the SSP5 pathway puts in place monitoring systems to ensure that decision-making is supported by science and to measure individual consumption in agriculture. This also supports stricter follow-up of investments (e.g. performance of wastewater projects) and the stopping of subsidies where groundwater is exploited.

Finally, the pathways build on and create diverse **conditions for innovation** by investing in innovative technologies, research and education, and providing regulation and subsidies that prompt innovation. For example, subsidies are provided for water efficiency measures and the implementation of green energy is made compulsory. Similarly, low carbon production processes and the use of renewable energies in agriculture (e.g. machinery, irrigation, transport, processing) are incentivised.

## 6.5. The pathways' impact: efficacy, synergies and trade-offs

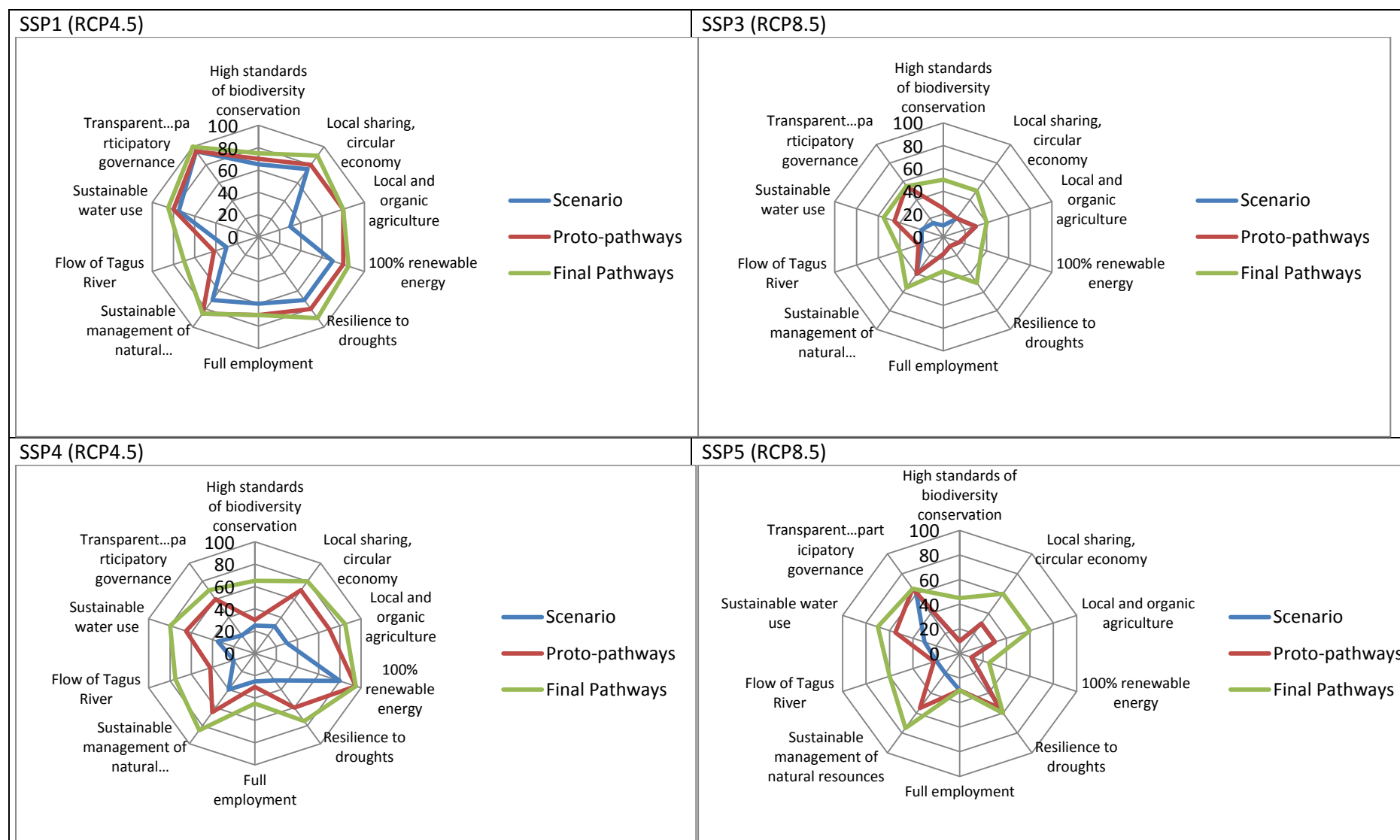
This section presents the impacts of the pathways in terms of their efficacy in reaching the vision as well as the synergies and trade-offs created across pathways, strategies, actions and sectors.

### 6.5.1. Efficacy of pathways in reaching the vision

The results of the qualitative and quantitative assessments of the effectiveness of the actions within the proto- and final pathways in moving the status of the vision element indicators towards the target, compared to the SSPs, are shown in the spider diagrams in Figure 30. The analysis shows that the adaptation, mitigation and transformation actions within the pathways are generally effective in moving Iberia in a positive direction towards the vision, although the effectiveness of identified actions differs between the scenarios and the vision element indicators.

The analysis also shows that it is difficult to achieve some vision indicators, which relates to path dependent scenario conditions and climate change. For all scenarios, it is difficult to maintain the flow of the Tagus river and to achieve resilience to droughts. This is due to extreme climate change and overexploitation. Nonetheless, the pathways in all scenarios shift towards more sustainable water use and the river basins become more resilient to droughts. For example, there are policies on water recycling and reuse, crops are adapted to climate conditions and there is transboundary water management at the river basin level.

Regarding SSP3 and SSP4 it is particularly challenging to achieve full employment and democratic governance, which is due to the high levels of inequality in the scenarios and the centralisation of power. In SSP3 and SSP5 there are major shortcomings with respect to the renewable energy target, which also relates to high intensity of fossil fuel use in the scenarios. In contrast, the SSP4 scenario already scores well on renewable energy production in the scenario, so the pathways are able to expand on this potential.



**Figure 30: Results of assessment of whether the vision is achieved for a selection of indicators. Achieving 100 (the outside line of the spider diagrams) means that the vision has been achieved.**

### **6.5.2. Synergies between pathways**

All pathways in all scenarios are highly interdependent and support each other in contributing towards the vision. Two pathways have been identified as conditional for the other pathways across all four contextual scenarios: the pathway that promotes integrated and collaborative water management and sustainable water use, and the pathway that promotes shifts to sustainable lifestyles. In SSP1, SSP4 and SSP5 the pathway to promote democratic and multi-level governance for sustainability and social equity also represents a conditional pathway.

The pathway to promote integrated and collaborative water management underlies all pathways by developing an integrated framework for the management of water in relation to other sectors, such as energy and agriculture. For example, shifts towards ecological agriculture and low-carbon and local markets build on the integrated water management frameworks.

The pathway that shifts to sustainable lifestyles underpins changing resource use and demands for sustainable products by prompting changes of social behaviours and preferences. For example, it sets up a new education system that enables the population to actively participate in decision-making and provides skills for local market development. The integration of environmental and social education supports individual water savings, healthy food behaviours, intercultural communication and long-term thinking.

The SSP1, SSP4 and SSP5 pathway to establish democratic and multi-level governance for sustainability and social equity supports the implementation of all pathways by setting up the framework conditions for actors to move towards sustainability and resilience. For example, it supports setting up integrated and collaborative water management systems by enabling strong governmental regulations and incentives that incorporate the real price of water and other resources into economic activities and by enabling collaboration across scales and sectors.

### **6.5.3. Trade-offs between pathways**

Most trade-offs between pathways relate to trade-offs between different types of water uses (especially in relation to agriculture). For example, there might be trade-offs between increasing efficient irrigation and improving water availability. Efficiency increases do not necessarily lead to more water availability unless they are accompanied by additional actions (that e.g. limit water use for irrigation overall). Thus, there is a need for abstraction management or environmental protection rules. Similarly, in the SSP5 pathway “reducing irrigation surface”, if referring to reduced irrigated areal extent, would lead to reduced agricultural productivity and potentially to a shift to less intensive agricultural systems. The relocation of irrigated agriculture to north-western Iberia could lead to trade-offs with other land uses, depending on whether this is anticipating land use conversion to agriculture or intensification of existing agricultural areas. It might also lead to an extreme divide between the north and south of Iberia.

There are also trade-offs between water quality and quantity and access to water. For example, if the real price for water is included, this might require some social security standards to ensure equal access to water. However, the provision of “water rights” needs to be specified to balance rights and responsibilities for the protection of water. The SSP3 pathways include an action to reduce environmental standards for water quality for maximum water quantity, in light of the severe water stress in this scenario. There is a need to specify whether there could be other measures instead, who would benefit from still good water quality and what would happen with biodiversity protection.

There might also be trade-offs across pathways in relation to forestry, biodiversity and local economies. Especially in the higher-end climate scenarios (RCP8.5), model results suggest a strong reduction of growth in pine forests and increased tree mortality of cork oak. Thus, there is a need to specify actions relating to reforestation, for example, which types of trees should be planted (e.g. oak instead of pine that are less water intensive). The modelling also shows that cattle raising and livestock production might not work under the scenarios, given that forage production will decrease. This requires new types of strategies for promoting local agriculture.

## 7. Cross-case analysis of pathways

The IMPRESSIONS case studies were developed to represent the different scales (European, national, transboundary river basin, municipalities), geographical regions (northwest Europe, Mediterranean, central Europe) and key environmental challenges (land use change, habitat loss, water stress and heat stress) in Europe. Through a series of professionally facilitated workshops and in-between engagement activities, a diverse range of stakeholders stratified by gender, age, interests, organisation etc. were identified and co-produced the outputs described in the preceding sections.

In this Section, we look across these case studies to assess the degree of similarity in societal desires for the future (i.e. visions in Section 7.1), identified adaptation, mitigation and transformation responses to high-end impacts and vulnerabilities (i.e. pathways and strategies in Section 7.2) and the identified actors who will implement these responses as well as the institutional and governance conditions enabling them to do so (i.e. governance capacities in Section 7.3). This cross-scale analysis aims to identify the generalisable and transferable insights that can inform European policy-making to reduce the impacts and vulnerabilities, and take advantage of any opportunities, arising from high-end climate change.

### 7.1. Visions

The visions that were formulated in all case studies play a key role in orienting the pathways by providing long-term and integrated directions. In all case studies the visions include a diversity of elements on social, economic and environmental sustainability as well as governance. Across case studies, there are some differences in what specific elements were emphasised by the stakeholders. However, whilst derived through independent processes, it is apparent that there is a high degree of commonality in the visions developed by the stakeholders in each of the four IMPRESSIONS case studies. There is therefore an apparent pan-European agreement within the diverse participants in the IMPRESSIONS stakeholder groups as to the high-level societal goals of future policy.

All case studies identify vision elements on **lifestyles and well-being**. Overall, all (European, Scottish, Hungarian, Iberian) citizens should enjoy a high quality of life; welfare and access to services for all should be ensured; and sustainable and healthy living patterns and engagements with arts and culture are common. All visions describe living patterns based on networked, local and self-sufficient communities. The visions for Hungary and Iberia in particular emphasise community values and lifestyles, which build on strong social ties and provide social protection and support for children, disabled and the elderly.

All case study visions include elements on new types of **health care and education**. Everybody has access to health services and education regardless of their income. Health and education are approached from comprehensive perspectives: health care focuses on prevention and health, rather than on just the treatment of illness. Education focuses on long-term and holistic thinking that enables people to develop their talents and to make fully informed decisions, increases creativity, tolerance

and collective responsibility. The Hungarian vision emphasises that active and healthy lifestyles, which are fostered through education, as well as sport and community facilities underpin a healthy society. It also highlights widespread access to natural, traditional medicine. The Iberian vision states that the education system supports the development of carbon-neutral technology.

All visions emphasise **equality** in terms of access to services, resources and decision-making – relating to age, gender, race, ethnicity, religion etc. The European and Scottish visions specify equality of opportunity to access the economy. The European vision states that the gap between the wealthy and the less-well-to-do groups in each country is lower than in 2016. Wealth is duly distributed, globally and regionally. The Scottish vision also includes future generations as being treated equally in all decisions made that affect the future.

The case study visions also include statements on **employment**. Many jobs are generated within communities. The Scottish, Hungarian and Iberian visions describe full employment and the availability of meaningful employment opportunities that allow people to fulfil their (social) potential. The European, Scottish and Hungarian visions indicate a reduction of working hours and an increase of volunteering, job sharing and other contributions to society.

All visions include **new modes of governance** that are based on democratic values and transparency and enable multi-level and international cooperation and collaboration. There is a high level of political awareness and engagement in society and a high level of participation at different levels of decision-making. The European vision emphasises the role of science in policy-making (e.g. scientific and finance data, integrated risk assessments). On the European scale, the European vision describes Europe as a strong, peaceful and cohesive continent allowing for national and regional diversity, while countries and regions prioritise collective goals. The Hungarian vision states that national participation and representation of interests is present with equal weight in the work of the EU. Regions are strongly interconnected and integrated to respond to economic, environmental and social challenges. The Scottish, Hungarian and Iberian visions emphasise European and global cooperation based on solidarity, respect for human rights and tolerance for distinct identities. The Iberian vision highlights transboundary collaboration with coordinated Iberian governmental institutions, while cultural and regional identities are respected and accommodated. The visions for Scotland and Hungary advocate the principle of subsidiarity and strong local governments that also collaborate within the international community. The Hungarian vision additionally highlights the role of local civil initiatives within participatory local governance and accountability of elected municipal leaders.

All vision case studies include statements on **environmental protection**. The integrity and capacity of environmental systems is maintained through a balance of preserving and using ecosystem services, whilst respecting planetary boundaries. Sustainability and natural resource protection are embedded as fundamental criteria in policy-making and economic activity. The Hungarian vision includes a high level of corporate social responsibility; the value of production is not measured in GDP; and full lifecycle costs are used. The Iberian vision includes a sharing economy based on a balanced exploitation of Iberian natural resources, which fosters a new welfare model that decouples development from economic growth and emissions. Resources are used efficiently based on a closed loop perspective, producing little or no waste and are carbon neutral. According to the European vision, the CO<sub>2</sub> concentration in the atmosphere is stabilised at 450 ppm CO<sub>2</sub> eq. The European vision also specifies that biodiversity is not declining and that pollution is almost non-existent.

All visions also include statements on **urban and rural land use**. Land use promotes the socio-economic sustainability of regions and equal opportunities. Nature is well integrated into cities, which are clean, healthy and climate-adapted. The Hungarian and Iberian visions emphasise that urbanisation is kept under control, there is a harmonious relationship between urban and rural

communities and rural abandonment has been reduced. The vision for Europe specifies high-density living patterns in medium-sized cities that use a minimum of space and ensure a maximum of liveability and access to culture, green space, jobs, education and transport.

All visions include statements on **sustainable energy production and consumption** with zero emissions. According to the European vision, Europe is energy self-sufficient, with a high dependence on renewable energy sources. The Scottish vision states that less than 1% of energy is derived from fossil fuels, the Hungarian vision states that there are at least 60% renewables (solar, geothermal, wind, wood), and the Iberian vision states that Iberia has 100% renewables. The Scottish, Hungarian and Iberian visions emphasise local and decentralised energy production that is owned by communities. All visions also emphasise that buildings are retrofitted and energy efficient (if not self-sufficient) and that there is low-carbon and smart mobility. The Hungarian vision includes intermodal mobility (walking, cycling, water transport and electric vehicles, dense public transport system).

All visions include statements on **sustainable agriculture** that provides food security for all. Food is produced sustainably, focusing on quality rather than quantity, with a low-carbon footprint and with responsible water use. The European and Hungarian visions emphasise local community-based food growing and urban agriculture. According to the Iberian vision, the production and consumption of meat has been reduced substantially and the consumption of local, seasonal and organic products is prioritised.

The European, Hungarian and Iberian visions include statements on **sustainable water management** that protects water quality and quantity and enables climate adaptation. Improved methods and technology for water use and irrigation support the harmonisation of economic development with water availability and limit exploitation.

Finally, the European and Iberian visions include statements on **resilience** to adapt to climate change and other risks in a flexible and quick manner. According to the European vision, Europe acts pre-emptively and strives to prevent crises; disaster risk systems and plans are widely available and an appropriate level of protection is ensured in cities and in coastal areas and river banks. People are able to react and self-organise rapidly in the case of disruptions. Europeans impacted by climate change (be it financially, physically or mentally) are provided with assistance. The Iberian vision emphasises improved water management to respond to droughts and floods.

## 7.2. Pathways and strategies

Overall, the pathways, elements and actions are similar across case studies (Tables 11 and 12). All case studies include pathways to shift towards sustainable lifestyles by setting up new types of education and strengthening local communities and local democracy. There is also a pathway in all case studies to establish governance systems that are oriented towards long-term and integrated sustainability goals, ensure transparency, participation and accountability and on-going learning and knowledge integration, and establish multiple coordination and cooperation mechanisms across international, national and local scales. All case studies also include pathways on sustainable water management and moving towards local and low-carbon economies.

**Table 11: Overview of adaptation, mitigation and transformation pathways across case studies.**

Pathway	Europe				Scotland				Hungary				Iberia			
	SSP1	SSP3	SSP4	SSP5	SSP1	SSP3	SSP4	SSP5	SSP1	SSP3	SSP4	SSP5	SSP1	SSP3	SSP4	SSP5
Sustainable lifestyles	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sustainability governance	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓
Integrated and sustainable water management		✓		✓				✓	✓	✓	✓	✓	✓	✓	✓	✓
Sustainable agriculture	✓	✓		✓									✓	✓	✓	✓
Circular and local economies			✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
Integrated environmental planning	✓		✓	✓	✓	✓	✓	✓								
Sustainability leadership	✓				✓		✓	✓								
Green and comfortable cities									✓		✓					

Adaptation
Mitigation
Adaptation / Mitigation
Transformation



**Table 12: Pathways and key actions across case studies.**

Pathway	Case study	Scenarios	Key actions
<b>Sustainable lifestyles</b>	Europe	All	<p>Education (e.g. environmental and social values, practice-based and bottom-up education)</p> <p>Awareness raising (e.g. storytelling, product labelling, campaigning)</p> <p>Self-sufficient communities (e.g. intermodal mobility, decentralised energy, alternative economies, economic diversification)</p> <p>Regulations and incentives (e.g. control diets, subsidies for energy and resource efficiency)</p> <p>Social security (e.g. minimum wage/unconditional income, insurance for financial and social protection, well-being indicators)</p>
	Scotland	All	<p>Education (e.g. practical, social and creative competences for self-sufficiency, healthy lifestyles, decision-making)</p> <p>Awareness raising (e.g. corporate social responsibility, social cohesion)</p> <p>Local democracies (e.g. community cohesion, community councils, local place-making, cooperatives)</p> <p>Connected communities (e.g. regional/international partnerships for flood risk management, community connectors)</p> <p>Localised infrastructure and service provisions (e.g. community-owned resources, universal income, time banking, skill sharing)</p> <p>Regulation and incentives (e.g. health and education benefits by firms, microfinancing low-tech solutions, community carbon credits)</p>
	Hungary	All	<p>Education (e.g. health, traditional knowledge and sustainability, new education approaches including arts, e-learning, skill-based)</p> <p>Awareness raising (e.g. campaigns on good practices, values of nature and physical health, heat stress protection)</p> <p>Health system (e.g. integrated approaches for care provision focused on prevention, traditional medicines, nutrition reform)</p> <p>Heat management (e.g. cooling and shading systems, heat protection creams and technologies, green infrastructure)</p> <p>Working system (e.g. meaningful employment, regulation of automation and multinationals, reduced working hours)</p>
	Iberia	All	<p>Education (e.g. all age-group education, sustainability, solidarity, traditional knowledge, practical job and skill training)</p> <p>Awareness raising (e.g. self-sufficiency, resource efficiency, diets, intermodal mobility, climate change, reuse, product labelling)</p> <p>Social and human rights (e.g. basic service provision, social volunteering, mutual dialogue and tolerance, universal income)</p> <p>Community-based markets (e.g. job sharing, local currencies, time banks, local energy)</p>
<b>Sustainability governance</b>	Europe	All	<p>Transparent, accountable and sustainability-oriented governance (e.g. pluriform media, human well-being indicators)</p> <p>International cooperation (e.g. promoting global sustainability agenda, mediating, transboundary platforms and agreements)</p> <p>Multi-level governance (e.g. single European energy market, subsidiary European to local community governance)</p> <p>Inclusive participatory governance (e.g. capacity building for participation, EU-citizen connection, open communication)</p> <p>Open and learning-based governance (e.g. governance experimentation, learning, knowledge exchange)</p>
	Scotland	SSP1; SSP5	<p>Integrated environmental protection frameworks (e.g. nature integration in market and planning activities, multi-level and context-specific planning)</p>

Pathway	Case study	Scenarios	Key actions
			Taxation, incentives and regulation (e.g. incentivising innovative solutions, penalties, building codes)
	Hungary	All	<p>Strong governments (e.g. environmental standards and taxes, new social contract)</p> <p>Transparent, accountable and democratic governance (e.g. no corruption, direct democracy, knowledge integration)</p> <p>Multi-level governance (e.g. strengthening local governments and civil society organisations)</p> <p>International collaboration (e.g. common strategies with neighbouring countries, exchange of good practices)</p> <p>Decision-making capacities of communities and individual (e.g. social networks, rewards for social responsibility and voting)</p>
	Iberia	SSP1; SSP4; SSP5	<p>Integrated environmental protection frameworks (e.g. nature integration in market and planning, fit policies to contexts)</p> <p>Democratic, fair, transparent governance (e.g. decentralise political power, enhance public participation and NGOs)</p> <p>Multi-level governance (e.g. participation forums across scales and sectors, social networks, political activism)</p> <p>Monitoring systems (e.g. performance of waste water projects)</p>
<b>Integrated and sustainable water management</b>	Europe	SSP3; SSP5	<p>Integrated water management framework (e.g. water cycle EU-wide, integrated view on water, energy, agriculture and climate change)</p> <p>Integrated water infrastructure (e.g. water transportation networks, dyke and sewer systems, low-key water harvesting)</p> <p>Nature-based solutions for water availability and flood protection (e.g. multi-functional flood protection zones, river re-naturalisation)</p> <p>Changing uses of water and living patterns (e.g. awareness campaigns about water saving and living in flood risk areas)</p> <p>Innovative water technologies (e.g. to use wastewater for crops)</p>
	Scotland	SSP5	<p>Integrated multi-level water planning (e.g. integrating different water uses)</p> <p>Interconnected and multi-level water systems (e.g. national water grid, local rain water harvesting)</p>
	Hungary	All	<p>Integrated and holistic management (e.g. cross-sectoral view on water including health, recreation, agriculture, energy, cross-scale planning)</p> <p>Multifunctional water-sensitive infrastructure systems (e.g. retention systems, rainwater storage, water reservoirs).</p> <p>Innovative water technologies (e.g. water treatment, greywater recycling, irrigation technologies, remediating water pollution)</p> <p>Ecological agriculture for water protection (e.g. natural retention capacity, new cultivation methods, multi-functional land-use)</p> <p>Regulations and incentives (e.g. integrate environmental costs in water price and budgeting, require rainwater collection and water reuse)</p> <p>Collaboration and cooperation (e.g. local watershed management, regional utility government, international water conflict mediation)</p> <p>Awareness raising (e.g. motivating water savings, guides of good practices)</p> <p>Full-cycle water monitoring system</p>
	Iberia	All	<p>Integrated and holistic management (e.g. cross-sectoral view on water including agriculture, biodiversity, energy, cross-scale planning)</p> <p>Innovative water infrastructures technologies (e.g. closed water cycles, rainwater harvesting, water purification, desalination)</p>

Pathway	Case study	Scenarios	Key actions
			<p>Participatory, multi-level and transboundary water governance (e.g. Iberian body for international water bodies, transregional water bodies at river basin levels)</p> <p>Regulations and incentives (e.g. real price of water, water taxes and tariffs, water quotas, closing Tagus-Segura transfer)</p> <p>Water use change (e.g. awareness raising on water use and climate change)</p> <p>Water monitoring (e.g. real-time e-monitoring, state controls)</p>
<b>Sustainable agriculture</b>	Europe	SSP1; SSP3; SSP5	<p>Integrated agriculture standards and frameworks (e.g. cross-sectoral view on agriculture along food chain, regional and local needs, scaling and strengthening CAP)</p> <p>Internalisation of environmental costs into food practices (e.g. carbon taxes to agricultural production)</p> <p>Integrated and multifunctional agriculture and land-use (e.g. integrated farming, urban agriculture)</p> <p>Local community- and family-based agriculture (e.g. community cooperatives, lending land)</p> <p>Organic and climate-friendly farming practices (e.g. permaculture, tillage, locally adapted crops, greenhouse farming)</p> <p>Innovations in agriculture technologies (e.g. agro-ecological and agro-economy approaches, energy and water efficiency, meat replacement)</p> <p>Building skills and knowledge (e.g. local education on farming, skills networks)</p>
	Iberia	All	<p>Integrated ecological agriculture frameworks (e.g. context-specific needs and conditions, cross-sectoral perspective)</p> <p>Ecological agricultural practices (e.g. conservation agriculture, local species and crops, crop rotation, natural fertilisers, agro-forestry)</p> <p>Technological innovation for ecological agriculture (e.g. irrigation, desalination, hydroponics, soil sensor technology)</p> <p>Regulation and incentives (e.g. integrate environmental externalities into food prices, ban chemical fertilisers, incentives for organic products)</p> <p>Integrated land use management (e.g. relocate irrigated agriculture, ecosystem corridors)</p> <p>Education of farmers (e.g. techniques of how to work the land and deal with new equipment)</p>
<b>Circular and local economies</b>	Europe	SSP4	<p>Close resource loops at multiple scales (e.g. connecting areas with low and high water availability, European energy grid with cross-border connections and regional energy provision)</p> <p>Green technologies innovation (e.g. renewable energies, energy distribution, resource efficiency, desalination, food technologies)</p> <p>Knowledge for resource efficiency and security (e.g. early warning systems, water quotas)</p>
	Scotland	All	<p>Local and community-based economies (e.g. local food production and consumption, alternative currencies, community energy schemes)</p> <p>Technological innovation (e.g. community schemes for bio-based materials, smart solutions to reduce flood risks, smart meters)</p> <p>Regulation and incentives (e.g. trade tariffs, carbon taxes, monopolies commissions)</p> <p>Local and regional coordination networks and knowledge exchange (e.g. local advice networks, international seed sharing networks)</p>
	Hungary	SSP3; SSP4; SSP5	<p>Green technologies innovation (e.g. local renewable energy, green transport, waste reduction and reuse, resource efficiency)</p> <p>Regulation and incentives (e.g. community-based energy, new energy price, mandatory investment in renewables)</p>

Pathway	Case study	Scenarios	Key actions
			Local markets (e.g. local food production and processing, local and regional trades, production cooperatives) Local sustainable agriculture and forestry (e.g. agricultural diversification, climate change resistant crops, biomass use, regional exchange)
	Iberia	SSP1; SSP3; SSP4	Diversified local economy (e.g. context adaptation, local job creation, local wood and biofuel production) Green technological innovation (e.g. energy efficiency, renewable energy, smart grids) Regulation and subsidies (e.g. divestment from fossil energy, mandatory green energy, carbon taxes, real carbon costs)
Integrated environmental planning	Europe	SSP1; SSP4; SSP5	Integrated nature protection frameworks (e.g. ensuring land use in harmony with nature and contexts, biodiversity restoration) Ecosystem-based land-use planning (e.g. flexible nature zones, rezoning, expand Natura 2000 areas, carbon sequestration) Nature-based solutions for water management and climate adaptation (e.g. green infrastructure, large zones for flooding) Polycentric and knowledge-based management (e.g. mapping of ecosystem services, local resource management) Internalise value of environment and ecosystem services (e.g. costs of resources, ecosystem services, environmental degradation) Innovation in green technologies (e.g. green energy, bio-based economy)
	Scotland	All	Integrated and multifunctional infrastructure systems from macro to micro scales (e.g. canal networks linking to low-carbon transport, intermodal mobility, local energy generation and regional distribution) Technological innovation (e.g. indoor agriculture, advancing transport links, smart mobility) Nature-based solutions (e.g. biosphere reserves, intensive agriculture, urban agriculture, carbon sequestration) Sustainable markets (e.g. integrate value of ecosystem services, crowd funding for tree planting, sustainable tourism) Integrated land use management and planning (e.g. national plan for land use, land sparing) Coordination across scales and sectors (e.g. Scottish business council for natural capital management) Monitoring (e.g. resource and ecosystems mapping, monitoring fertiliser use)
Sustainability leadership	Europe	SSP1	Supra-national sustainability goals European and international governance institutions and mechanisms (e.g. EU solidary mechanisms, global institutions) Building governance capacities worldwide (e.g. support for climate strategies and action plans, knowledge exchange) Knowledge generation (e.g. funding for monitoring)
	Scotland	SSP1; SSP3; SSP5	Brand for sustainable and resilient Scotland (e.g. international showcasing, invest in natural capital) International partnerships (e.g. cross-boundary agreements, trade deals, think tanks)
Green and comfortable cities	Hungary	SSP1; SSP4	Infrastructure (e.g. green infrastructure, cooling and ventilation systems, permeable surfaces) Green energy and smart systems (e.g. local renewable energy, refurbishing buildings)

Overall, there is a strong emphasis across case studies on integrated planning that provides multi-functional solutions and takes synergies and trade-offs between different sectors and policy goals, as well as context-specific needs, into considerations. For example, water management is addressed from an integrated perspective that addresses water quality and quantity protection in relation to agriculture, biodiversity, land use, energy, recreation and climate adaptation, amongst others. This perspective is manifest in the types of solutions suggested, such as holistic and water sensitive infrastructure systems that set up regional and international water transportation networks. Across case studies, the strategies to implement the pathways include technological innovations (e.g. renewable energy technology, water efficiency technologies) and nature-based solutions (e.g. nature zones, green infrastructure). Additionally, they include a suite of strong regulations and incentives to mandate and incentivise sustainable lifestyles, innovation and economic activities. Especially the pathways to promote shifts towards sustainable lifestyles include education and awareness-raising activities to enhance consideration of the environment and social equity and cohesion, and to provide the population with the skills (practical, creative, decision-making, etc.) needed for the future.

While some case studies (Europe, Iberia), in most scenarios, include a pathway on sustainable agriculture, the other case studies integrate considerations of agriculture into other pathways. For example, the Hungarian water management pathway addresses organic agriculture for water protection (e.g. increasing water efficiency in agriculture). The Iberian pathway on organic agriculture is particularly based on connecting agriculture to climate adaptation and shifting towards a circular and bio-based economy. It also includes a strong emphasis on forestry and dealing with forest fires. While the Hungarian and Iberian pathways highlight the need to eradicate corruption from the decision-making system, the European and Scottish case studies include a pathway on global sustainability leadership to support the sustainability agenda globally and expand economic opportunities for exporting green technologies and solutions.

### 7.3. Governance capacities

Across case studies, each scenario inspires specific entry points for strategies and actions based on the actors and their abilities to act in the respective scenario and the derived pathways logic. Overall, the SSP1 pathways across the case studies identify strategies and actions that build on the high level of capacities of all actors in society and a strong multi-level governance system. The strategies and actions in SSP3 particularly address civil society actors who self-organise in networked local communities. This resonates with the lack of opportunities to regulate markets and invest in expensive technologies. SSP4 pathways take a two-fold approach, focusing on strategies and actions that are strategically planned and implemented top-down by the elite, but also building on the capacities and needs of the majority of the population living in local communities. The pathways in SSP5 generally follow a free-market logic; there is market self-regulation to internalise the value of nature into economic activities as well as governmental incentives for environmental protection.

The **types of actors** that are identified across scenarios in each case study can be considered as complementary to each other. *Governmental actors* in all scenarios provide regulation, incentives and financing, though they play a considerably smaller role in SSP3. This resonates with the disintegrated EU and the lack of strong (national) governmental capacities to regulate markets and invest in expensive technologies. In contrast, especially in SSP4 the pathways build on centralised governmental structures that strategically plan and implement actions in a top-down way, while also addressing local communities to self-organise. *Civil society actors* play critical roles in the pathways of all scenarios, being actively involved in decision-making and in the development and implementation of action (e.g. sustainable consumption, local renewable production, education). Especially in SSP3, most actions are developed and implemented by civil society actors and entrepreneurs on local community levels given the lack of governmental capacity in this scenario. *Market actors* (e.g. industry

and business actors) have important roles in the pathways of all scenarios. Especially in SSP4 and SSP5, where multinationals have strong power, they engage in public-private partnerships and self-regulate to internalise environmental costs and philanthropy into market activities. The involvement of actors from *knowledge institutions* such as universities, think tanks and research institutes is implied in actions to implement better monitoring and research on environmental and social problems and solutions, and to set-up process-based governance approaches.

Across case studies, similar governance capacities are built up to develop and implement the pathways (Table 13). Overall, these build on the integrated perspective on sustainability decision-making and planning, which suggest integration of diverse goals and considerations of synergies and trade-offs across sectors and scales moving along from global, European, national to local levels. This perspective helps to engage in integrated resource and land use planning, which takes into account different context needs and opportunities across Europe and its regions. All case studies emphasise the need to integrate environmental costs into production and consumption activities and formulate strong regulations and incentives to stimulate sustainable behaviours and to incentivise innovation. Especially the Hungarian case study highlights the need for a strong government. There are also considerations for ensuring social equity and the need to redistribute wealth as well as re-assigning responsibilities for environmental and social protection (e.g. requiring (multinational) companies to take an active role).

Across case studies, the pathways identify the need for different types of collaboration and coordination. These include international collaboration for a global sustainability agenda as well as subsidiary multi-level governance structures for European/national oversight and planning, regional resource sufficiency, low-tech and social innovation, and local decision-making and production and consumption. While the European pathways (mostly) provide a European-level perspective on planning, the regional and local case studies emphasise the regional and local levels and the role of local communities in decision-making, climate adaptation and promoting local economies. The Iberian pathway also includes transboundary collaboration between Portugal and Spain to manage their common water bodies. All case studies include strong notions of participation in decision-making at global, European, national and local levels.

All case studies emphasise monitoring and knowledge integration into governance and decision-making processes. Especially the European case study includes considerations of governance experimentation, i.e. to experiment with different types of ‘governance technologies’ and engage in open, learning- and process-based decision-making processes.

**Table 13: Governance capacities across case studies.**

Capacity element	Case study	Key elements
<b>Strategic sustainability orientation</b>	Europe	Long-term synergistic and integrated perspective on a diverse set of international, EU and national sustainability goals
	Scotland	Long-term synergistic and integrated perspective on a diverse set of goals (e.g. integrated and cross-sectoral infrastructure planning from macro to micro scales, integrated land use planning)
	Hungary	Long-term synergistic and integrated perspective on a diverse set of goals (e.g. new policies for sustainable welfare system, climate strategies and action plans, integrated and holistic water management, integrated planning for resource management, connecting regional and local opportunities and needs) Transparency and accountability of governance
	Iberia	Long-term synergistic and integrated perspective on a diverse set of goals (e.g. mainstreaming environment and equity into all policies, fitting policies to regional conditions, integrated cross-sectoral water management)
	Europe	Regulations, incentives, taxes and (self-regulated) financing mechanisms for long-term and integrated decisions and investments (e.g. agricultural practices along the

Capacity element	Case study	Key elements
<b>Integrated framework conditions</b>		whole food chain, internalisation of environmental degradation and value of nature into economic activity)
	Scotland	Regulations, incentives, taxes and (self-regulated) financing mechanisms for long-term and integrated decisions and investments (e.g. integrating value of ecosystem services and social benefits, national land use planning for local energy systems and grids, natural and social capital accounting, market self-regulation, taxation and trade tariffs)
	Hungary	Strong role of the government – regulations, incentives, taxes and (self-regulated) financing mechanisms for long-term and integrated decisions and investments (e.g. environmental standards and taxes, new social contracts, integrate environmental costs and long-term maintenance into water price, new energy price)
	Iberia	Regulations, incentives and taxation for long-term and integrated decisions and investments (e.g. real price of water, water taxes and tariffs, valorisation of ecosystem services)
<b>Multi-level and international collaboration and coordination</b>	Europe	Multi-level governance (strong integration of European, national, regional and local decision-making levels) International collaboration
	Scotland	Multi-level governance (to manage resources on local and regional levels with context-specific needs and opportunities) International collaboration (partnerships, cross-boundary agreements and trade deals, think tanks)
	Hungary	Multi-level governance (e.g. local and basin level watershed management, regional utility government, cooperation among micro-regions) International collaboration (conflict mediation to address international water conflicts, partnerships with neighbouring countries)
	Iberia	Multi-level and transboundary governance structures (e.g. common Iberian bodies for international river basins and monitoring, transregional water bodies at river basins) International collaboration (e.g. participate in global environmental decision-making, international knowledge sharing, collaboration with EU on water transfer)
<b>Community self-organisation</b>	Europe	Participation of civil society at international, European, national, regional and local levels Local self-sufficiency and local markets
	Scotland	Inclusive and participatory governance systems, capacity building for participation in decision-making Local democracies and self-organisation for local self-sufficiency, strong NGOs Regional and international connection of local communities
	Hungary	Local decision-making (e.g. redistributing power and resources to local governments and civil society organisations, strengthen capacities of communities and individuals to participate in decision-making)
	Iberia	Public participation (e.g. participation forums, social networks and political activism)
<b>Knowledge and monitoring mechanisms</b>	Europe	Data- and evidence-based governance system (e.g. continuous monitoring and learning, shift from sectoral-based to problem-based and monitoring approaches, mapping of ecosystem services)
	Scotland	Monitoring (e.g. resource mapping, localised maps, coordinated monitoring stations) Solution-oriented research
	Hungary	Monitoring (e.g. full water cycle, controlling water use, quality and quantity, including scientific knowledge in decision-making)
	Iberia	Monitoring (e.g. control use and quality of resources, e-flow monitoring of water, strict follow-up of investments)



Capacity element	Case study	Key elements
Conditions for innovation	Europe	Investments, regulations and subsidies for high-tech and low-tech social, technological and governance innovations (e.g. local self-sufficiency, governance experimentation) Awareness raising and education for sustainable lifestyles
	Scotland	Investments, regulations and subsidies, research and education for innovative technologies (e.g. nature-based solutions, low-carbon and local economy, renewable energy) Showcasing Scotland Awareness raising and education for sustainable lifestyles
	Hungary	Investments, regulations and subsidies, research for technological innovation (e.g. subsidies for community-based renewable energy systems) Awareness raising and education for sustainable lifestyles
	Iberia	Investments, regulations, subsidies and research for innovation (e.g. mandating green energy, incentives for renewable energy in agriculture) Awareness raising and education for sustainable lifestyles

## 8. Conclusions

The adoption of pathways thinking within the climate adaptation community was a response to the growing realisation that efforts to adapt to climate change had not yet led to substantial implementation of systemic or transformative actions and that there was a need for decision-making oriented research. Pathways became a new tool for visualising, focusing on process and learning rather than outcome. By applying the advanced transition management methodology in IMPRESSIONS, we have co-created with stakeholders in four case studies adaptation, mitigation and transformation pathways that build resilience and promote sustainability in the context of combined high-end climate and socio-economic change scenarios.

The developed pathways contribute towards achieving a long-term sustainability vision by means of diverse strategies and actions that build and/or use social, human, natural, manufactured and financial capitals as well as the governance capacities needed to implement the pathways. By orienting diverse strategies and actions towards a long-term and integrated sustainability vision, the pathways enable society to deal with complexity and to create synergies by bridging across sectors and scales. Additionally, the pathways provide an explicit action perspective on who are the actors that implement the pathways and how they do so. As such, the pathways enable the derivation of policy recommendations on how to address climate change and support societal transformations towards sustainability and resilience in the context of different climate and socio-economic change scenarios.

By developing pathways in the context of different scenarios, different issues find emphasis, yet from an integrated perspective. These issues are all critical for a sustainability transformation. For example, different actors are highlighted as playing fundamental roles in the sustainability transformation – including governmental actors at different scales, civil society and business and industry actors. Different needs are highlighted, such as the need to ensure that nobody is left behind in the context of highly unequal scenarios. As such, while the scenarios provide barriers, they also open up specific opportunity spaces for thinking about specific strategies and actions and further boost transformative thinking. Additionally, thinking in terms of scenarios stimulates thinking about uncertain futures and long-term impacts. The cross-scenario comparison can be used to check the robustness of strategies and actions and to explore interlinkages across scales (e.g. taking into account context specific needs and opportunities such as the solar potential in Iberia for an energy self-sufficient Europe).



In summary, we can show how pathways can act as a means to open up policy processes and make them more participatory. Importantly, the pathways produce concrete knowledge on strategies and actions, which were developed and agreed on by a broad range of stakeholders and provide support to decision-making. The advanced transition management approach provided an overarching framework to structure the stakeholder engagement processes to consider how long-term, transformative change towards a sustainable and resilient future can be enabled. However, there is still a need to pay more attention to ensure continuous reflexivity on the pathways created, to interrogate choices at critical junctures as well as to assess the “evolving character of society, lifestyle patterns and social practices” (Rosenbloom 2017 p. 46).

The case studies’ bundles of pathways contain vitally important transformation pathways to move society towards more sustainable lifestyles and economies, mitigation pathways to transition Europe to a low carbon economy and adaptation pathways to reduce the impacts and vulnerabilities associated with high-end climate change. However, the IMPRESSIONS analysis of the effectiveness of the pathways in achieving the vision within each case study demonstrated that many of the vision element indicators could not reach their desired value. This arises due to a combination of the significant residual impacts of high-end climate change, systemic time lags and/or recalcitrant characteristics of the socio-economic scenarios. This consequently demonstrates the need for urgent and immediate action on meeting the requirements of the Paris Agreement, through implementing adaptation, mitigation and transformation actions to prepare Europe, its Member States and regions for an uncertain future.

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## 11. Appendices

### 11.1. Appendix 1: Supplementary materials for European pathways

#### 11.1.1. European vision narrative

##### **Health, Well-being and Sustainable Lifestyles**

All European citizens enjoy a high quality of life that does not compromise the future of generations to come. They are healthy and live long. Money is spent on prevention of illness and diseases rather than on hospitals. Everybody has access to advanced health services regardless of their income. Sustainable and healthy living patterns, which are common, include high-energy-efficiency housing, low waste generation, use of sustainable (public) means of transportation, sustainable energy consumption and the practice of urban agriculture.

Many Europeans live in high-density, medium-sized cities that use a minimum of space with a maximum of liveability and access to cultural highlights, near to open space and green, but also near to jobs, education and public transport. Outside these dense areas are large spaces for agriculture, nature, water buffering, productive open space and recreation. People live in strongly networked, small-scale, self-sufficient communities based on social equity and cooperation. Producing food and energy is an important part of their activities.

##### **Jobs, Income and Education**

Europeans work fewer hours than they did in 2015 and they volunteer and share jobs more. Many jobs are generated within the community and linked with achieving self-sufficiency. Basic human needs (e.g. clean water, healthy nutritious food, decent shelter, free basic education) are met and all communities have access to the goods and assets that facilitate the pursuit and achievement of human rights and well-being. A solidarity system transfers resources between younger and older generations.

Citizens have advanced and affordable education (on all levels). Research aims to advocate, communicate and practice a more holistic approach towards solving major scientific and societal challenges.

##### **Voice, social equity and gender equality**

There is true equity among citizens and societies, and the gaps between the wealthy and the less-well-to-do groups in each country are lower than in 2016. Wealth is duly distributed, globally and regionally. Poverty is eradicated. Global (economic) equity and fair chances for previously lesser developed countries mean that the desire of people to leave their own country to seek asylum and shelter in Europe is low.

##### **Governance**

Given the networked community-based living, new modes of governance and European integration deal with the increasing interconnectedness of the problems across the globe. There are active mechanisms to counteract the concentration of wealth and power that come from automation and technological advancement in a free market. Society is based on democratic values that include all people. All levels of civil society participate in decisions on technical and social innovations. Policy-making in any field is based on scientific evidence (e.g. scientific and finance data), integrated risk assessments and is the result of collaborations between scientists, engineers, governments, policy-makers, and other stakeholders.

**Regional and global relationships**

Europe is a strong, peaceful and cohesive continent allowing for national and regional diversity. There is strong awareness and recognition among citizens and societies of the advantages that this strength and cohesiveness offers. Countries and regions (within Europe and beyond) have strong functional incentives to prioritise collective goals over individual ones. This includes binding bilateral and multilateral agreements and strong political accountability that avoid externalising negative consequences from unsustainable practices. Europe is unified in the face of internal and external challenges (e.g. climate change, migration). The regions are strongly interconnected, each with its own identity. Neighbouring regions are integrated to respond to economic, environmental and social challenges (i.e. aging, migration, economic development, cross-border pollution). Thus Europe exerts a positive and stabilizing impact on its neighbouring regions. The citizens are positive about Europe, which is an exemplar to the rest of the world.

**Environment**

All environmental systems providing support to human societies and other forms of life maintain their integrity and capacity to regulate basic matter, energy and ecological cycles, through a balance in preserving and using ecosystem services. Biodiversity is not declining and chemical, biological and other (e.g. solid waste) pollution is almost non-existent in water, air and soil. Atmospheric pollution has been cut by 95% compared to the level of 2010. The CO<sub>2</sub> concentration in the atmosphere is stabilized at 450 ppm CO<sub>2</sub> eq.

The population and economy respect the planetary boundaries. Resources are used efficiently based on a closed loop perspective. Political, financial and individual motives are guided by the protection of Europe's (and the world's) natural resources and environment, as well as cultural heritage. Sustainability is embedded as a fundamental investment criterion in all economic planning, including agriculture, manufacturing, finance, and energy. Europeans have an open society, in which the major strength is the normative power exercised through standard setting, protection of environment and human health, and inclusive innovation.

**Food, water and energy**

Energy is produced and consumed in the most intelligent, sustainable, non-polluting ways with no environmental impact and with zero CO<sub>2</sub> emissions. Europe is energy self-sufficient, with a high dependence on renewable energy sources, free from any dependence on fossil fuels. As a world leader in the field, Europe exports renewable energy technologies to other countries. *Historical buildings are retrofitted and new buildings are built according to minimum energy performance requirements.* Terrestrial transport systems are powered primarily by electricity and hydrogen.

Sustainable agriculture and fisheries provide food security for all. Europeans are more attentive to the quality of their food rather than the quantity. Innovative technologies are used to produce food and recover and reuse water at reasonable prices, while respecting the environment and human health. Quality agricultural clusters satisfy the needs of communities at local and global level.

Deep aquifers and fossil water are no longer exploited. Potable water is provided through closed-loop systems. Storm water management, bio-remediation, biologically driven desalination and rainwater harvesting support the sustainable use of water.

**Resilience**

Society is well prepared to adapt to the consequences of climate change in a flexible manner: it ensures the appropriate level of protection / resilience of our coasts and river banks with respect to flooding. It uses the forces of nature in harmony with both nature and stakeholder and societal interests.

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Europe acts pre-emptively and strives to prevent crises; it stays unified in the face of internal and external challenges. Technological advances help people react and reorganize rapidly in the case of major disruptions. Economies can rebuild swiftly and extreme losses are not carried by individuals but collectively. People are rarely permanently displaced. Europeans impacted by climate change (be it financially, physically or mentally) are provided with assistance. Systems and plans for disaster risks are widely available and also applied for cultural heritage. There is a highly advanced dataset for environmental risk assessment, constructed through knowledge sharing and emergent data that is available to policy makers and the public. This influences zoning, city planning and policy decisions to maximise the number of risks that can be avoided or reduced. Resilient cities and resilient communities' behaviours are widespread.

### 11.1.2. European pathways tables

#### European pathways in SSP1:

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway A.1 Shift to sustainable lifestyles</b>	<p>Strategy A.1.1: Induce and trigger behavioural changes to sustainable lifestyles</p> <p>People-based</p>	<ul style="list-style-type: none"> <li>*Reduce water and food waste – capacity building, change behaviours along the food chain</li> <li>*Control demand &gt; supply-based &gt; link local farmers to companies with catering and IT platform</li> <li>*Use less! Save energy, recycle</li> <li>*Enhance societal awareness on benefits of a sustainable lifestyle</li> <li>*Reduce biofuel consumption</li> <li>*Reduce energy consumption</li> <li>*Promote energy savings by increasing energy efficiency</li> <li>* Reduce car dependency by increasing public transport, biking, car sharing options</li> <li>* E-mobility</li> <li>* Democratisation and liberalisation of energy sector</li> <li>* Efficient energy storage and smart-grids</li> <li>* Local energy production and consumptions with solar roofs</li> <li>* Energy producing cars</li> <li>* Battery management</li> <li>* Shift to diets with less animal protein &gt; replace with vegetal proteins</li> <li>*Sustainable housing</li> <li>*Sustainable biogas production from farm residues and catch crops</li> </ul>	<ul style="list-style-type: none"> <li>*Incentivise people at the local level as well as implement top-down regulation. Establish strong democratised system</li> <li>*Develop local communities which are happy with self-sufficient lifestyles</li> <li>*Promote ownership of lifestyle choice at local level</li> <li>*Incentivise greater willingness to compromise from all levels by social and economic change</li> </ul>		<i>'health, well-being and sustainable lifestyles', 'jobs, income and education', 'voice, social equity and gender equality'</i>



Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	Strategy A.1.2: Support well-being focus for equity and social capital development  People-based	<ul style="list-style-type: none"> <li>*Focus on wellbeing - develop wider indicators of well-being</li> <li>*Invest in human wellbeing</li> <li>* Increase safety</li> <li>* Cleaning actions</li> <li>* New Deal 2.0 with public works and cleaning parks and help older people</li> </ul>	<ul style="list-style-type: none"> <li>*Restructure financial system to get more money in public hands / Redistribution of fiscal policies to increase equity &gt; who creates the money? &gt; fourth pillar of the power – monetary</li> <li>*Invest in cultural development and leisure</li> <li>*Implement mechanisms to cope with population growth link birth control or enhanced level of general education</li> <li>*Provide unconditional basic income / voluntary wage supported</li> </ul>	<ul style="list-style-type: none"> <li>* Introduce incentives for families to live in village by investing in infrastructures and green jobs</li> </ul>	
	Strategy A.1.3: Establish new education models  People-based	<ul style="list-style-type: none"> <li>*Invest in education – strategic education and continuous education</li> <li>*Good stories, good practices – media</li> <li>*Encourage reflexive society to include new governance vision</li> <li>*Educate in order to reduce pollution</li> <li>*Undertake capacity building actions to raise awareness of the potentials and effects of action</li> <li>*Add sustainability to civil classes &gt; exemplary schools, administration etc.</li> <li>*Green/ eco-social public procurement at local level</li> <li>*Education in farming and agronomy in primary school and communities</li> <li>*Invest more in exchanges (e.g. Erasmus for older, and Erasmus for younger)</li> <li>*Change agronomy training to support new mentality towards less machinery, more labour, more sustainable production</li> </ul>	<ul style="list-style-type: none"> <li>*Invest in psycho-social education, trauma reduction, emotional and social health to improve human and social well-being</li> <li>*Undertake capacity building for policy-makers to raise awareness of their role and the potential of their actions</li> <li>*Work more with young people; actions to get them prepared and maintain momentum</li> <li>*Implement new work scheme: people for 5 years in public sector / 5 years in private sector</li> <li>*Foster engaged and educated civil society</li> <li>*Sabbatical for all and education experiences</li> <li>*A shift from institutional to more personal financing in education</li> </ul>	<ul style="list-style-type: none"> <li>* Make available human enhancement technology for all</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		*Mosaic curriculums, project based learning, community embedded learning processes			
<b>Pathway B.1 Establish open governance for sustainability</b>	<p>Strategy B.1.1: Set up and experiment with open governance models</p> <p>People-based</p>	<p>*Strengthen EU-citizen connection, reinforce EU democracy</p> <p>*Enhance subsidiary principle – define different levels of governance</p> <p>*Enforce civil society outside EU through trade and customs agreements that are beneficial</p> <p>*Strengthen participation civil society in decision-making</p> <p>*Establish more participative processes for sharing decisions across levels (bottom-up)</p> <p>*Set up governance experiments</p> <p>*Develop new governance technology: massive research and application</p> <p>*Set up participatory Budget</p>	<p>*Change decision-making system - more transparency</p> <p>*Incentivise communities and research activities</p> <p>*Implement civil society engagement activities</p> <p>*Enhanced civil society actions in context of massive changes in production sector (industry 4.0, Artificial Intelligence)</p> <p>*Involve society more in decisions taken by government</p> <p>*Build European identity and governance</p> <p>*Reduce pollution (multi-level agreements)</p> <p>*Hold European elections</p>		<i>'governance', 'regional and global interrelationships', 'voice, social equity and gender equality'</i>
<b>Pathway C.1 Mainstream sustainable agriculture</b>	<p>Strategy C.1.1: Strengthen and scale over time CAP in Europe</p> <p>Nature-based</p>	<p>*Support agricultural practices of food exporters to maintain environmental standards</p> <p>*Significantly expand CAP with food price support and significant environmental conditionality</p> <p>*Support climate friendly farming - leg-crop action recycling, agroforestry and tillage</p> <p>*Research on models and options for agro-ecological and agroecology approaches</p> <p>*Tax for unused land</p>	<p>*Set urban agriculture target in CAP - Urban agriculture - measures to promote it. Production targets from urban agriculture. Part of urban planning policy</p> <p>*Promote organic farming</p> <p>*Make implementation of greening CAP measures more systematic, less voluntary, obligatory</p> <p>*Promote land use system in Southern Europe that moves away from intensive agriculture and focuses on more extensive forestry</p> <p>*New legislation to promote bioeconomy forests</p>	*Use of improved and locally adapted crop varieties	<i>'food, water and energy', 'environment', 'resilience'</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>*A CAP pillar that incentivises and rewards environmental and socio-economic services to be 100% EU financed</li> <li>*Community supported agriculture with cooperatives, crowd funding and platforms</li> <li>*Develop permaculture (the farm as a system)</li> <li>*Land reform EU wide</li> <li>*Civil society organisation lending land (terre de Lien)</li> </ul>	<ul style="list-style-type: none"> <li>*Forests as integral part of bioeconomy with federal cooperation of bioeconomy forests</li> </ul>		
	Strategy C.1.2: Support market introduction and diffusion of sustainable agriculture technologies and products  Market-based	<ul style="list-style-type: none"> <li>*Support agricultural practices of food exporters to maintain environmental standards &gt; local markets and standards</li> <li>*Provide incentives for market development in agriculture &gt; local markets and standards</li> <li>*Farm income support and agricultural protection. Common market organisation</li> </ul>	<ul style="list-style-type: none"> <li>*Increased food imports/exports – free market</li> <li>*Support agricultural products in other countries to help maintain the qualities we look for and help build up domestic production systems</li> <li>*Avoid monopolistic market solutions --&gt; see to that there are several available options</li> </ul>	<ul style="list-style-type: none"> <li>*Set up cooperative type of companies</li> </ul>	
	Strategy C.1.3: Invest in sustainable agriculture technology and technology transfers  Technology-based	<ul style="list-style-type: none"> <li>*Transfer innovative technologies (selective)</li> <li>*Sell innovative technologies</li> <li>*Invest in agriculture innovation also for water to improve productivity</li> <li>*Government's support for technology and innovation - incentives</li> <li>*Invest in innovation in food production for food security. Could be compatible with artificial food</li> <li>* Bio-economy – regional production – forestry and new products, new industrial production</li> </ul>	<ul style="list-style-type: none"> <li>*Support innovation transfer to third countries</li> <li>*Innovate in irrigation</li> <li>*Invest in technologies to help improve energy efficiency also in developing countries</li> </ul>	<ul style="list-style-type: none"> <li>*Innovate in technologies to address potable water scarcity (bio remediation)</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>*Enlarge other renewables</li> <li>*Promote energy efficiency</li> <li>*Implement laws to improve energy use</li> <li>*Regulate for more energy efficient products, housing, etc.</li> </ul>			
<b>Pathway D.1 Strengthen environmental policy</b>	Strategy D.1.1: Promote nature protection with stronger environmental policy  Nature-based	<ul style="list-style-type: none"> <li>*Implement forest protection policy and laws to plant new ones</li> <li>*Implement policy on invasive species in an international political environment with Treaties and political agreements</li> <li>*Rezone and protect species with special habitats</li> <li>* Taxes based on environmental impact to fund bonuses for green activities and products</li> </ul>	<ul style="list-style-type: none"> <li>*Increase protection of species that require specialised habitats</li> <li>*Integrate ocean resource planning (hand-in-hand with integrated land use planning)</li> </ul>	<ul style="list-style-type: none"> <li>*Promote connectivity and manage full territory to host natural assets</li> <li>*Control migration to promote diversity &gt; not clear how to realise this</li> </ul>	<i>'environment', 'resilience', 'food, water, and energy'</i>
	Strategy D.1.2: Promote nature protection and restoration with mainstreaming nature-based solutions  Nature-based	<ul style="list-style-type: none"> <li>*Assist species that have special needs and habitats, e.g. wetlands species, that are not related to agricultural</li> <li>*Expand and protect Natura 2000 network</li> <li>*Expand biodiversity outside Natura 2000 areas</li> <li>*Enhance appreciation of non-material ecosystem services</li> <li>*Invest in nature protection</li> <li>* Introduce different models of agroforestry all over Europe</li> </ul>	<ul style="list-style-type: none"> <li>*Invest in conservation networks (biodiversity, ecosystem services)</li> <li>*Reforestation</li> <li>*Further implement ecosystem restoration (including ferrets?)</li> <li>*Strong steps to maintain biodiversity</li> <li>* New financial standards on agreed indicators integrate in business account</li> </ul>	<ul style="list-style-type: none"> <li>*Adapt protected areas if climate change modifies habitat types</li> </ul>	
	Strategy D.1.3: Advance integrated land use planning with ecosystem services framework Nature-based	<ul style="list-style-type: none"> <li>*Modify the traditional land use planning classification</li> <li>* Increase number of check dams to enhance infiltration and reduce water level (to 'reduce' flood risks)</li> </ul>	<ul style="list-style-type: none"> <li>*Integrate land-use rules (covering nature and agriculture)</li> <li>*Implement land-use planning reform to utilise ecosystem services sustainably</li> <li>*Base land-use (e.g. conversion to arable land) on mapping and assessment of ecosystem services</li> </ul>		

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
			<ul style="list-style-type: none"> <li>*Reduce urban sprawl</li> <li>*Develop alternative forms of carbon sequestration included as part of integrated land use planning</li> <li>*Maintain permanent grassland (not rotational grassland, usually less intensive/productive for sheep, tend to have more biodiversity and soil C). Pressures are that you would plough it and convert to rotational grassland or arable</li> <li>* Extensive farming for grazing areas to have better meat and sustainable meat</li> </ul>		
	Strategy D.1.4: Adopt a holistic approach to water management  Nature-based	<ul style="list-style-type: none"> <li>*Enhance storm water management and water retention – specific focus in urban areas</li> <li>* Renature rivers and reconnect with flood plain</li> <li>* Reduce artificial land (e.g. agro-ecological agriculture)</li> <li>* Mainstream green and blue technologies and infrastructures in cities and in flood plains</li> <li>* Create incentives and enhance awareness of resource use of treated waste water in e.g. householders, for cleaning and washing</li> </ul>	<ul style="list-style-type: none"> <li>*Establish Water Union</li> <li>*Improve water transfer infrastructures, networks and interconnections</li> <li>*Enlarge water re-use and recycling</li> <li>*Improve wastewater treatment</li> <li>*Improve soil infiltration</li> <li>*Enhance water use efficiency in built environment</li> <li>* Introduce code for green spaces and infrastructure managed by communities</li> <li>* Try to enhance holistic approaches to enable sustainable build environment</li> </ul>	<ul style="list-style-type: none"> <li>*Move water</li> <li>* Green infrastructure measures obligatory for planning and investors with a tax if delay</li> </ul>	
<b>Pathway E.1 Position Europe as a global leader for sustainability</b>	Strategy E.1.1: Strengthen and implement EU's global vision and will  People-based	<ul style="list-style-type: none"> <li>*Build governance capacities worldwide</li> <li>*Implement stronger EU solidary mechanisms</li> <li>*Use crises with visionary leaders that help trigger new way of thinking including agreement of global leaders to move to sustainable pathway</li> </ul>	<ul style="list-style-type: none"> <li>*Return to UN, World Bank etc.</li> <li>*Focus on SDGs</li> <li>*Develop supra-national goals</li> <li>*Advance European cooperation to make sustainability available for all</li> <li>*Develop clear EU-wide sustainability vision and more effective communication</li> </ul>	<ul style="list-style-type: none"> <li>*World governance</li> <li>*Establish truly global cooperation to achieve sustainability</li> <li>*Support other countries outside Europe to help them cope with growing EU autarky in agriculture</li> <li>*Implement climate action plans in all countries that financial support</li> </ul>	<i>'regional and global interrelationships', 'governance', 'resilience'</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>* Worldwide public movements and NGOs (as mechanisms to trigger actions)</li> <li>* Monitor negative effects on environment and on other sectors (energy, water)</li> </ul>	<ul style="list-style-type: none"> <li>* Make more funds available through EU research policy</li> <li>* Inspire electorate through visionary leaders</li> <li>* Build trust internationally (after crises period) to create global collaborative system</li> <li>* Global superpowers collectively agree to move in this direction</li> </ul>	<ul style="list-style-type: none"> <li>has been provide already for climate strategy formulation</li> <li>* Achieve SDGs globally</li> </ul>	
	Strategy E.1.2: Build resilience and prepare for extreme unexpected events  Nature-based	<ul style="list-style-type: none"> <li>* Increase know-how and preparedness to deal with weather extremes</li> <li>* Build capacity to be prepared to unexpected events</li> <li>* Avoid further growth in coastal and river settlements</li> <li>* Create incentives to avoid people to settle in flood-prone areas (e.g. subsidies, move away)</li> <li>* Compulsory building codes for flood resilient houses</li> <li>* Invest in preventing damages due to climate change (desertification, biodiversity loss, etc.)</li> <li>* Introduce preventive measures</li> </ul>	<ul style="list-style-type: none"> <li>* Be open to adapt and react to unexpected and resilience</li> <li>* Prepare for black swell events; preparedness, increase know-how to deal with extremes</li> </ul>		

**European pathways in SSP3:**

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
Pathway A.3 Shift to sustainable lifestyles	Strategy A.3.1: Foster social cohesion and support  People-based	Pro-active action needed already in this time slice  Social measures to support unemployed people (revenue and training)  NGO activities (TI and Greenpeace) pressuring local governments	Use migration for solidarity and cultural diversity  Turn around fragmentation by enhancing sense of solidarity  Build a strong social support system  Strengthen local initiatives – to live with less  Create transparency for social cohesion	Visionary leaders collaborate  Encourage more social responsibility on resilience and climate change issues  Engage the rich bubble in social programs to provide opportunities to address problems i.e. poverty	<i>'health, well-being and sustainable lifestyles', 'jobs, income and education', 'voice, social equity and gender equality'</i>
	Strategy A.3.2: Integrate awareness raising on solidarity and sustainability in education  People-based	Further the awareness of risks for all that loss of social cohesion implies.  Raise awareness on ethical issues related to growing inequality  Strongly invest in education and social services  Reorganize and improve education  Provide education for all levels to all groups  Develop awareness and communication tools (zoos and reserves) for education and visibility  Provide for strong media to offer examples of the effects of pollution  Give everyone access to high quality education  Raise awareness of positive actions /successes  Invest in international (educational) exchanges and languages	Invest in capacity building and education at all levels  Develop bottom-up education (missionaries, village schools)  Run "alternative schools" through social movements to enhance lifestyles  Use social counter-movement, engage poor people – educate, networking, support entrepreneurship  Enhance education for all groups of society to counter fragmentation  Provide info campaigns for basic knowledge		

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		Education, publicity, policy coordination on solidarity, values, rule of law, respect Invest in science and sustainability education platforms – agro-science – communicate sharing			
	Strategy A.3.3: Incentivise sustainable and equitable lifestyles  Market-based	Provide tax incentives for healthy lifestyles Pursue unilateral trade liberalisation and antitrust policy to restore growth Put in place strong economic and environmental regulation Establish higher taxes on water use in drier areas Basic need – free ration Build equitable tax structure across Europe for big business Invest in communication technologies to enable collaborations Tax on biggest users Affordability mechanisms or social tariffs locally organized Support sharing economy (using ICT, social media – Communication) Improve self-sufficient communities – build social capital through virtual communities around topics Increase ambition of climate change mitigation Now to avoid worst case	Re-establish economic co-dependence and co-operations in regions Increase social protection; cover food, water, healthcare, housing Diversify economic activities Pursue market efficient measures to tackle inequality – payments to increase equality and opportunity		
Pathway B.3 Establish local and	Strategy B.3.1: Establish decentralised,	Strengthen democratic inclusiveness and transparency Reaffirm personal privacy	Strengthen civil society and community building Establish multilateral defence agreements	Strengthen and open communication infrastructure for citizens	'governance', 'regional and global'



Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
community-based governance for sustainability	community-based governance (Stakeholder strategy)	<p>Protect role of experts in decision-making processes</p> <p>Stimulate strong, fair legal system to counter clustering of power</p> <p>Protect fundamental human rights</p>	<p>Develop circular economies and strong social networks</p> <p>Maintain strong national states and conflict resolution</p> <p>Stimulate regional communication and trade</p>	<p>Develop successful, semi-autonomous local communities</p> <p>Network-based society (economy + culture)</p>	<i>interrelationships', 'voice, social equity and gender equality'</i>
	People-based	<p>Ensure pluriform media landscape</p> <p>Enhance number of diplomatic channels for international conflict resolution and regional conflict resolution between EU members</p> <p>Reinforce market-supporting institutions to ensure economic prosperity</p> <p>Utilize migration to advance new ideas and strengthen governance</p> <p>Create rules for integrating European policies with national / regional/ local development and urban plans</p> <p>Increase resilience of institutions and adaptability after EU</p> <p>Ensure cooperation survives the collapse of EU, so technological development and investments continue</p> <p>Encourage more private R&amp;D</p> <p>Encourage volunteering especially of the +60s (Potential trade off -Taking away € and influence of younger generation)</p> <p>Knowledge exchange on best practice</p> <p>Devolve – Implementation of policy innovation</p> <p>Experiment and pilot actions /policies</p>	<p>Establish small “labs” approach to governance</p> <p>Exchanging best practice for regional governance (knowledge sharing)</p> <p>Create awareness that economic fragmentation means living with less</p> <p>Enable alternative economies and barter</p> <p>Increase integration of migrants – proactive de-escalation of violence</p> <p>Stimulate innovative start-ups and entrepreneurship</p> <p>Experiment with non-fuel-intensive solutions</p> <p>Local community continue to fund R&amp;I and its application</p>		

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		Strengthen local institutions already here Facilitate ownership of issue at local level			
	Strategy B.3.2: Develop infrastructure for a local network economy  Technology-based	Maintain cultural heritage through creative and proactive approaches (e.g. privatize) Invest in urban planning in water retention systems Invest in water management technology and knowledge sharing Increase innovation partnerships for water, resources Transboundary water boards for governing and exchange, also among students Invest in telecommunication infrastructure and development by EU Start-ups for meat alternatives Invest in R&D for resource efficiency Fund/incentivise innovation e.g. subsidy, tax (governments)	Collectivise energy Encourage start-ups and entrepreneurship Ensure there is minimum accessibility of commercial level land for SMEs to maintain diversity Adapt local building codes Ensure infrastructure exists to allow network economy to exist: Trade – ports, rail airports Build water harvesting infrastructure Adapt waste water infrastructure -> more expensive	Rich groups expand investments in clean tech and innovation and aim to become the driving force vs corrupted organisations	
Pathway C.3 Mainstream sustainable agriculture	Strategy C.3.1: Strengthen policies and build skills for local organic agriculture  Nature-based	Integrate different policies (agriculture, water, environment, biodiversity) Share knowledge on agriculture and land-use Provide local education and skills network Provide incentives for environmentally friendly local agriculture Research into vegetarian or non-dairy diets	Encourage local entrepreneurship Take agricultural decisions locally - Restart from local, rural and organic agriculture Increase greenhouse farming Set land aside and incentivise forestry and nature-based solutions for flood management Put in place integrated farm management Take unmanaged forests into account	Here more organic?	<i>'food, water and energy', 'environment', 'resilience'</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		Push for sustainable agriculture rather than organic (only) Identify and protect ecological corridors and increase natural protected areas Investment support to sustainable intensification Establish an EU framework to use EU Bioenergy potential in temperate zones Meat substitutes (soya etc.) as cheaper alternatives Promote bio-refineries to mitigate climate change – provide jobs, foster agriculture, stimulate local economies Bio-economy focus locally – biomass use (what about pollutants?) Cities – combined with open space “Hinterland” to take care of Use brownfield sites for local food production			
	Strategy C.3.2: Regenerate ecosystem services in cities and rural areas to build resilience  Nature-based	Create more green areas in cities and coastal areas Invest in nature-based solutions against extreme weather (set example) Position nature as cultural heritage Increase nature reserves-> eco-tourism Put in place nature reserves (Create safe havens for endogenous species (animals)) Improve waste management Capitalise on habitat preservation (tourism, medicinal)	Develop local networks for circular economy Increase extensive grazing Inform about management practice on extensive land-use to increase biodiversity Establish a recreation and biodiversity link Reuse resources, swapping /exchange of goods	Force the rich to invest in environment	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		Implement resource management and regulation Invest large-scale in R&D to reduce resource dependency Develop guidelines for designing integrated landscape plan with eco-tourism Make set-aside “profitable”(e.g. by identifying monetary value of ecosystem services)			
Pathway D.3 Set up an integrated water management system	Strategy D.3.1: Strengthen physical and social resilience to protect from flooding  Nature-based	Incentivise against self-fuelling investment risks and ratchet effects in flood areas Include flood initiatives as a quantified externality in infrastructure investment Discourage living in areas with high flooding risk and high vulnerability - >urban planning Stimulate migration to less flood prone areas Combine river-flow interventions with clearance of rivers to make more effective actions Build / reinforce dyke system Build + invest in sewer systems and absorption of rain Contain urban sprawl – Compacting cities Water canals Infrastructure protection Avoid socializing “unnecessary” private costs e.g. flooding	Use flood protection to increase habitats/ biodiversity e.g. wetlands Organise recreational activities so rivers are preserved and taken care of Set land aside for flood management Incentivise forestry and natural solutions to flood management	Promote living in house boats	<i>‘Resilience’, ‘food, water and energy’</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	Strategy D.3.2: Implement water saving measures to ensure universal access to high quality water  Nature-based	Position universal access to clean drinking water as a precondition for social stability and avoiding unrest  Develop water transportation system from north to south Europe  Incentivise tech and innovation solution to reduce water demand  Link CAP with WFD objectives: less water-intensive crops have financial incentives  Reduce demand through R&D incl. wastewater for crops  Policy to induce water tech savings  Use waste water	Low-key water-harvesting (from floods) in South  Household rain harvesting for specific uses		

#### European pathways in SSP4:

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
Pathway A.4 Shift to sustainable lifestyles	Strategy A.4.1: Develop value-based education and incentives for sustainable lifestyles  People-based	*Strengthen education for all people (invest)  *Promote efficient use of resources  *Set-up process-oriented society based on learning and monitoring	*Implement education and awareness campaigns for waste reduction (e.g. packaging, food)  *Promote intercultural understanding to allow people to live together with a mind-set for a peaceful existence  *Promote low consumption (of resources, food etc.)  *Raise awareness for responsible water consumption	*Control food and health for all: Planned society lifestyle – you control food, what you eat, you need to exercise	<i>‘health, well-being and sustainable lifestyles’, ‘jobs, income and education’, ‘voice, social equity and gender equality’</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
			<ul style="list-style-type: none"> <li>*Educate the elite to foster philanthropy and spending for the societal good (e.g. health, education, charity)</li> <li>*Educate about the master plan results</li> <li>*Provide training to communities to execute the masterplan</li> </ul>		
	Strategy A.4.2: Re-distribute resources to meet basic needs  People-based		<ul style="list-style-type: none"> <li>*Tend to the basic needs of the masses</li> <li>*Provide tax incentives for charity</li> <li>*Invest excess profits in societal profits (foundations)</li> <li>*Provide jobs from producing solar panels</li> <li>*Subsidised social services</li> <li>*Lower tax for poorer people</li> <li>*Invest in public health</li> <li>*Ensure supply chains for re-distribution of food between regions</li> </ul>	<ul style="list-style-type: none"> <li>*Provide minimum wage for everybody</li> <li>*Ensure insurance for financial/social protection</li> </ul>	
Pathway B.4 Establish multi-level process-based governance for sustainability and European self-sufficiency	Strategy B.4.1: Strengthen and stabilise cross-sectoral and cross-scale governance institutions  People-based	<ul style="list-style-type: none"> <li>*Strengthen federalism</li> <li>*Strengthen institutions to deal with shocks</li> <li>*Create elite university (with international exchange) to include young people in the elite</li> <li>*Create cross-EU network for elite to spread the same idea across Europe</li> <li>*Set up data-based and evidence-based governance</li> <li>*Plan for a combination of European mass basic food production and local sustainable production</li> </ul>	<ul style="list-style-type: none"> <li>*Create a committee of elite for governance</li> <li>*Develop a master plan of small 'ecosystems' for land and people with centralised control of infrastructure</li> <li>*Increase institutional checks and balances</li> <li>*Set up monitoring system of the evidence from the implementation of the masterplan</li> </ul>	*Implement strong regulation of everything	<i>'governance', 'regional and global interrelationships', 'voice, social equity and gender equality'</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	Strategy B.4.2: Establish international collaboration and markets  Market-based	*Prevent import of food to the EU to promote autonomy of the EU	*Establish partnerships with developing countries within and outside EU to use for resources; investment in infrastructure and aid  *Formulate regulation to establish a single energy market in Europe including distribution of energy infrastructure  *Invest in international property as major source of wealth and political stability  *Export massively (technology)  *Invest in external countries to keep a flow of resources from abroad (e.g. water, energy)	*Expand market leadership globally to enhance sustainability globally  *Advance economic growth in less developed countries and enlarge markets	
Pathway D.4 Strengthen environmental policy for 'small ecosystems'	Strategy D.4.1: Strengthen biodiversity protection  Nature-based	*Invest in biodiversity protection and protection of wildlife	*Maintain and establish new zones/protected areas that are good surrounding for animals and provide space for leisure (e.g. natural parks)  *Decrease physical barriers and larger corridors to create zones where species can flexibly move and adapt  *Increase local food production to provide good quality food to elite and masses	*Set up biodiversity banks (like seed banks)	'environment', 'food, water and energy', 'resilience'
	Strategy D.4.2: Implement land-use and planning in harmony with nature  Nature-based	*Create more green and less hard structures/surfaces  *Promote efficient use of land by encouraging low consumption and consciousness – how to use the land in the best way  *Reforestation in Southern Spain  *Set up local sustainable food production with parks to also create	*Develop a stratified top-down land-use strategy in alignment with masterplan  *Develop central strategic plans for the continent based on knowledge about areas that are prone to flooding  *Move cities to not interfere with ecosystems and biodiversity  *Assign zones for flooding	*Geographical and climate-based specialism – in areas of drought avoid a lot of cities, in others efficient agriculture etc.  *Establish massive zones for water production and recycling  *Decrease infrastructure that is strategically positioned: ports, airports, in-between cities – in relation to efficient food production	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		new jobs at the European level also considering regional and local contexts  *Produce food commodities for the European governance network	*Use forests flexibly *Use forests for defence from flooding and recreate wetlands *Produce food in forests: mushrooms, berries	*Privately owned land is managed and cleaned by the people living on the land	
Pathway E.4 Establish a circular economy with green energy technologies	Strategy E.4.1: Improve water efficiency and decrease water use  Nature-based		*Develop de-salination to create more fresh water sources *Use recycled water – not necessarily for human consumption (e.g. treating water and waste water from post-production processes) *Look for water rich areas outside of Europe	*Transport water e.g. from Northern Spain (Pyrenees) to the South *Regulate water consumption through water quotas	'food, water and energy', 'environment', 'resilience'
	Strategy E.4.2: Strengthen Europe's market position in developing and applying green energy technologies (stakeholder strategy)  Technology-based	*Replace conventional power stations that have reached the end of their life cycle with renewable power stations *Implement early warning systems for extreme weather events that protect technology, energy provision *Move from local to regional energy provision and generation *Invest in R&D for improving quality of food and food technologies *Protect European energy markets to avoid/decrease fracking and import of fuels *Promote development of virtual energy grids for green energy distribution at regional levels	*Establish EU as leader in technologies *Electrify transport to make transport systems more energy efficient *Make all public buildings energy efficient (e.g. government buildings, schools, universities) *Expand renewable energy and energy efficiency (wind, solar, hydro) *Move towards global European energy grids – implementation of cross-border connections *Use of nuclear energy, fossil fuels and coal with carbon capture and storage to ensure reliable energy supply *Use waste to create energy *Improve access to green energy for all – make it a mass product	*Massive investment in green energy and technology *Develop intelligent systems for storage capacity (e.g. huge pumped hydro plants) *Massive energy production in Southern Spain	



Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
			<ul style="list-style-type: none"> <li>*Use unmanaged forests land for biomass production but avoid conflict between biomass and food production</li> <li>*Invest in second, third, fourth generation biomass</li> <li>*Build wind farms on newly available land</li> <li>*Shift towards energy systems that require low cooling</li> <li>*Invest in technologies to increase production of sustainable food</li> </ul>		

#### European pathways in SSP5:

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
Pathway A.5 Shift to sustainable lifestyles	Strategy A.5.1: Foster consumer awareness for agriculture products and practices  People-based	<ul style="list-style-type: none"> <li>*Employ agriculture as lever for environmental awareness</li> <li>*Create demand for sustainable healthy products and good communication marketing of them</li> <li>* Introduce circular economy principles</li> <li>* Communication on labels by producers and shops</li> <li>* Labelling reflections – good practices for sustainability</li> <li>* Food import and textile</li> </ul>		*Source public and private investments for innovation	<i>'health, well-being and sustainable lifestyles', 'jobs, income and education', 'voice, social equity and gender equality'</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	Strategy A.5.2: Invest in environmental education & research  People-based	*Invest in education for nature to create a mind-set for nature *Educate young people to achieve higher sustainability *Educate people about ecosystem services including monetary values of ES *Strengthen the education on value of nature and biodiversity	*Promote that schools run environmental awareness programs for kids * Geo-engineering to mitigate CC impacts on hotspots in agricultural production *Invest in bio-based economy research and other technologies (who: private investments)	* Link education to technology-based solutions	
Pathway B.5 Establish participatory governance for sustainability	Strategy B.5.1: Invest in human development to meet basic needs  People-based	*Guarantee that satisfaction of basic human needs are not subject to the market (food, water, housing) * Labelling standards * Introduce circular economy principles (manufactured capital)	*Change the indicators of prosperity to include human development		<i>'governance',            'regional and global interrelationships',            'voice, social equity and gender equality'</i>
	Strategy B.5.2: Build capacity for participatory governance  People-based	*Increase government participation and society involvement in economic, social and environmental programs *Support of full cost concept and pricing of ecosystem services *Develop capacity building actions to raise awareness and fully understand the power of decisions to connect and concretely achieve results (knowledge brokerage) *Increase participation of decision-making to research and knowledge processes * Temporary lift regulation to promote innovation in agriculture production			

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	Strategy B.5.3: Foster Political Alliances (geopolitical alliances)  People-based	*Create economically driven cross-border alliances with USA, Russia, Eastern EU, and China			
Pathway C.5 Mainstream sustainable agriculture	Strategy C.5.1: Design an integrated and organic agricultural system  People-based	*Increase agriculture sector awareness on land degradation e.g. profit losses *Increase share of organic farming	*Design a new integrated EU agriculture directive * Design an EU programme and informed national integrated land planning *Restructure administrative and institutional system for managing the process to facilitate communication and collaboration across sectors *Introduce enabling policies for citizens' actions for environmental restoration *Create consistent integrated European policies to counter environmental degradation * Put price on degradation (2050-2060)		'food, water and energy', 'environment', 'resilience'
	Strategy C.5.2: Increase food security and rural agriculture  Market-based	* Employ SME-instrument for family-owned agriculture (who: EU) * Subsidy program to support family-owned agriculture (who: EU)	* Introduce irrigation water management technologies * Achieve a transition of agriculture sector to a family-based free market sector	*	
	Strategy C.5.3: Incorporate ecosystems' services in	*Incorporate cost of degradation of land in agriculture products *Introduce carbon taxes	*Introduce full cost pricing of degradation in agriculture	*Incorporate payment for ecosystem services of agriculture	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	agriculture life cycle	*Regulate to create an environmental market (eco-market)	*Identify relevant policies for disaster management		
	Market-based				
	Strategy C.5.4: Scale the CAP policy	<ul style="list-style-type: none"> <li>*Removal of CAP subsidies</li> <li>*Revise of CAP measures</li> <li>*Redevelop extensive agriculture to support land management</li> <li>*Shift agriculture to rain-fed compatible areas</li> <li>*Continue integrated farm management and organic agriculture (scale over time CAP measure)</li> <li>*Preserve cultural landscape for business and market exploitation/use (scale over time CAP measure and adapt it to the SSP5 scenario context conditions)</li> <li>*Introduce incentives for good practices in agriculture</li> </ul>	<ul style="list-style-type: none"> <li>*Incorporate food measures in the CAP</li> <li>*Reduce extent of monocultures</li> </ul>	<ul style="list-style-type: none"> <li>*Achieve a multifunctional environmental friendly agriculture sector</li> <li>*Position Europe as a global leader in environmental friendly agriculture</li> <li>*Introduce assessment of global footprint of agriculture</li> </ul>	
Pathway D.5 Establish European integrated water management system	Strategy D.5.1: Implement integrated adaptive management of water resources across Europe	<ul style="list-style-type: none"> <li>*Make electric power less freshwater intensive</li> <li>*Adapt and reinforce control measures for water quality and water pollution</li> <li>*Invest in effective and efficient water technologies</li> <li>*Strong awareness campaign about water</li> </ul>	*Buy-in of business sector of adaptive water management approaches	<ul style="list-style-type: none"> <li>*Manage availability of good quality of drinking water across Europe in view of climate change</li> <li>*Manage availability of agriculture products</li> <li>*Manage navigation on rivers</li> </ul>	<i>'food, water and energy', 'environment', 'resilience'</i>
	Technology-based				

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		*Manage the water cycle EU-wide >> (Revised EU Water Framework Directive)			
	Strategy D.5.2: Work with nature to build resilience  Nature-based	*Incorporate flood risk reduction into catchment management  *Implement land management to reduce risks of extreme events > not only on extreme events  * Give space to the rivers programs in Europe  * Land-use change in support of water storage in river beds		*Work with nature in flood protection	
Pathway E.5 Create markets of ecosystem services	Strategy E.5.1: Move from habitats to ecosystem services and create nature-based markets that account for  Nature-based	*Invest heavily in restoring ecosystems and their services  *Use unmanaged land for habitats as far as possible  *Include/integrate value of ecosystem services in economic decisions to select what can work in management for land  *Revisit the Natura 2000 cases  * Change fiscal system  *Introduce higher taxes for fossil fuels	*Develop safe havens for endangered species (that have also a market creation result)  *Capitalise on ecosystem services to improve quality of life  *Create nature parks with high value to attract tourism  *Stress failure of markets to address (L-T) externalities in a proactive way  *Set up funds to deal with climate impacts	*Think of new ways to preserve high value wetlands and mountains  *Introduce higher values of ecosystem services	'environment', 'resilience', 'food, water and energy'
	Strategy E.5.2: Invest in technology-based solutions for	*Employ technology to reduce HC dependency	*Develop mixed system to protect environment		

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	improving environmental quality and creating new markets  Technology-based	*Drive technologies to achieve higher energy and water efficiency *Invest in robust function of utilities	*Use economic power to invest in alternative energy technologies * Develop biobased economy (around 2050)		

## **11.2. Appendix 2: Supplementary materials for Scottish pathways**

### **11.2.1. Scottish vision narrative**

#### **Jobs, equality and lifestyles**

Scotland in 2100 is a country of equality: Equality of gender, race, sexuality, age, (dis)ability and faith. Gender equality applies to the family, the workforce, aspirations, overcoming unconscious biases, state spending and political prioritisation. There is equality of opportunity to access the economy and future generations are also treated equally in all decisions made that affect the future.

The population of Scotland is maintained at a sustainable level with communities living in low density areas with diversity and local equality. There is full employment in Scotland in 2100 and everyone wants to work. Work allows people to fulfil their (social) potential. The working week has been reduced to 4 days, allowing people more time to make other contributions to society and connect better with nature. Individuals and communities engage with arts and culture and are creative.

In an inclusive society where everyone thrives, basic human rights are respected and people fulfil their potential. Access to justice is ensured and people enjoy personal and environmental security.

#### **Sustainable economy**

All people have an income adequate to satisfy their basic needs and enjoy personal safety and freedom. The focus of the economy is on producing and consuming what is important in life. In many areas in Scotland, local currencies contribute to a sustainable economy.

#### **Health and education**

There is free access to education and health services, allowing all people to develop their talents and make fully informed, democratic decisions. Health expenditure focusses on health not illness. Interdisciplinary education, research and innovation are valued by society. As a result the population understands and can make decisions on conflicts and trade-offs and has the capacity to think ahead.

#### **Governance**

With an enhanced process of participatory government, all people are empowered to take part in all levels of decision-making. All are properly and fully informed about issues they are taking a decision on. Communication within and between communities is adaptive to the needs of the people. Fair democratic governance is characterised by proportional representation and the opportunity to make frequent input to decisions.

In Scotland we appreciate the influx of immigration and understand that we are part of a global community. Local governments are responsible for building productive relationships with the international community. Our economy has a global focus and businesses trade globally. Scotland is active in promoting and helping other countries to achieve their positive visions.

#### **Resources and the environment**

Scotland has a low-carbon and climate-resilient economy with less than 1% of energy derived from fossil fuels. Everybody can enjoy a green environment. The low-carbon economy is supported by smarter physical mobility and better virtual “mobility”. Energy is produced locally and owned by communities. Knowledge technology contributes to the low-carbon economy of Scotland.

There is space for essential environmental services (flood control /pollution reduction/ biodiversity) in every catchment. People appreciate the environment and live a valuable life in balance with nature. With equitable land ownership, land use is driven by public choices and priorities and not by NIMBYism

or the market. A better spread of public services allows people to choose between rural and urban living. People are able to explore the countryside and tourism is maintained in geographically isolated areas. Nature is well integrated into all cities providing better living spaces. New species have become emblems of Scotland.

**Food, water and energy**

Scotland has food security while being a low-carbon economy. Food is produced sustainably with a low-carbon footprint. Water use for agriculture is responsible and less energy intensive.



### 11.2.2. Scottish pathways tables

#### Scottish pathways in SSP1:

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway A.1.:</b> <b>Invest in sustainable low-carbon systems of service and commodities provision</b>	Strategy A.1.1: Water - Shift to water sensitive infrastructure *Technology-based	<ul style="list-style-type: none"> <li>- Reduce water wastage by improving water infrastructure and responsible water use</li> <li>- Reduce leakage, increase SUDs (sustainable urban drainage), individual action</li> <li>- Harvest water without impacting the environment</li> </ul>	<ul style="list-style-type: none"> <li>- Ensure water trade remains congruent with responsible water use</li> <li>- Use increased precipitation for community hydropower including micro hydropower schemes</li> <li>- Move all households from floodplains to reinstate natural flood defences</li> </ul>		<i>Resources and the environment</i>  <i>Food, water and energy</i>
	Strategy A.1.2: Food - Deal with food security with new technological innovations * Technology-based	<ul style="list-style-type: none"> <li>- Promote technological solutions to fix food security gap</li> <li>- Increase demand for food where is a technological innovation to limit impacts on biodiversity</li> </ul> <p>Foster R&amp;D into agriculture within disused/underused buildings (e.g. indoor agriculture, use carparks)</p>	<ul style="list-style-type: none"> <li>- Enforce technology policy to focus on adaptation to climate impacts (flooding, droughts, food security)</li> </ul>		
	Strategy A.1.3: Agriculture - Shift to sustainable agriculture * Nature-based	<ul style="list-style-type: none"> <li>- Develop climate friendly intensive agriculture (e.g. forest, farming, gardening, agriculture (farming forest multi-buyer cropping – permaculture)</li> <li>- Shift to sustainable agriculture with varieties of crops and land-uses within intensification - Introduce ecosystem based approach for agriculture</li> <li>- Increase water storage in winter and in the west for using it in the summer for intense agriculture - Increase productivity</li> </ul>	<ul style="list-style-type: none"> <li>- Wet woodland, alder und willow riparian vegetation to reduce pollution and increase biodiversity around intensive agriculture</li> <li>- widespread use of sewage sludge as fertiliser to reduce nitrate pollution</li> <li>- Reduce production of red meat and dairy, pricing regulation to discourage consumption, and to reduce non CO<sub>2</sub> gases</li> <li>- Worms for compost from food waste to reduce nitrate pollution</li> </ul>	- Change the perception of farmers	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>- Develop national plan for land use to maximise effective food production in longer term</li> <li>- Foster urban agriculture to help preserve natural landscape (including brownfields, roofs, walls)</li> <li>- Establish allotments within urban environments (reconsider values of parks, public golf courses)</li> </ul>			
	Strategy A.1.4: Mobility - Invest in shifting to low-carbon infrastructures for mobility * Market-based	<ul style="list-style-type: none"> <li>- Invest in low-carbon mobility infrastructure to connect urban and rural areas</li> <li>- Support infrastructure updates and development in local communities to reverse migration to cities</li> <li>- Free integrated transport system (people can have their own car but pay – high carbon tax, or you can use communal car, other transport); balance time + mode</li> </ul>	<ul style="list-style-type: none"> <li>- Invest in smart mobility to ensure connectedness of place</li> <li>- Develop low-carbon and low-cost public transport around the country that is government funded</li> </ul>		
	Strategy A.1.5: Energy - Support a regional energy supply and local energy generation * Technology-based	<ul style="list-style-type: none"> <li>- Local power generation and local networks connected to adequate national smart grid</li> <li>- Create a government programme to support a regional energy supply and local energy generation</li> <li>- Put in place a government program that finds representative who could control local energy and local energy groups</li> <li>- Create the conditions to ensure that government has the oversight of a national grid that enables local control of energy mix</li> </ul>	<ul style="list-style-type: none"> <li>- Cities form alliances with regions to ensure security of energy supply</li> </ul>		

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>- Support for community-owned energy generation through loans, grants and incentives</li> <li>- Invest in/capture power regeneration from breaking trains</li> <li>- Cap all landfill to capture methane and other GHGs and use for productive energy</li> <li>- Expansion of local heat from e.g. sewers, landfill (networks)</li> <li>- Retrofit grants for ground and air source heat pumps (active and passive solar, insulation etc.)</li> <li>- Use all waste for heat and power production (including agricultural and forestry waste)</li> <li>- Local biogas generation for local heat and/or injection into grid</li> </ul>			
<b>Pathway B.1: Invest in low-carbon technologies and economies</b>	Strategy B.1.1: Invest in research and innovation for low-carbon technologies * Technology-based	<ul style="list-style-type: none"> <li>- Invest in technology and innovation for low-carbon economy and future</li> <li>- Invest in action research for equality between communities in view of low-carbon developments</li> <li>- R&amp;D – Circular economy principles and effective use of waste (energy?)</li> <li>- R&amp;D for CSS – Scotland takes forward UK's abandoned CCS project</li> <li>- Energy efficiency measures implemented in homes, businesses, industry</li> <li>- R&amp;D to remove pollutants from sewage to enable widespread use of sewage sludge as fertiliser to reduce N fertiliser</li> </ul>	-Develop CCS for tree-based biofuels as carbon sink and energy source		<i>Sustainable economy</i> <i>Resources and the environment</i> <i>Food, water and energy</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		and use metals for batteries, electronics, etc. – circular economy - R&D research around soil nitrates and alternative circular economy ideas			
<b>Pathway C.1</b> <b>Foster communities' resilience</b>	Strategy C.1.1: Put in place a new multi-level governance approach for social equity and shared responsibility * People-based	- Identify where it would add value to have multi-level governance and partnership approach - Strengthen local democracy with a learning by doing approach in schools and with citizen juries - Support education to empower young people to expect a say and make decisions now and in future - Support local community action with buy outs - Empower community connectors (people who work with and connect communities) - Establishment of place-based initiatives with communities and decision makers - Reinforce community councils - Introduce localised certification schemes	- Up-scale place-based bottom up initiatives - Fund subsidiary devolution adequately - Provide resources to community planning partnerships to engage with all stakeholders - Harness peoples' skills to enable civic participation - Support and sustain multi-level partnership arrangements (NHS, flood risk management, community planning)	- Sustain a functioning multi-level governance system that is effective in reduction of poverty and homelessness - Encourage people who immigrate to Scotland to participate in local decision making	<i>Jobs, equality and lifestyles</i> <i>Health and education</i> <i>Governance</i>
	Strategy C.1.2: Support community engagement and empowerment * People-based	- Promote and consider societal values and faith - Create a professional dialogue with trained facilitators with the communities - Put in place national conversations and invernness conversations - Support community waste reduction through group projects – food and objects	- Increase governmental regulation in limiting big multinational corporations to allow community businesses to be successful - Support community businesses and community enterprises to generate local employment	- Strengthen existing links with developing world/other countries - Support a shift in giving children responsibilities in schools and learning the consequences of decisions	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<p>passed on, recycled etc., grants, repair workshops</p> <ul style="list-style-type: none"> <li>- Increase accessibility of local seasonal food through local government support of farmers markets/allotment owners</li> <li>- Implement universal income</li> </ul>	<ul style="list-style-type: none"> <li>- Move to time banking instead of money earning – all time valued equally with universal time income</li> </ul>		
	<p>Strategy C.1.3: Sustain lifelong learning *People-based</p>	<ul style="list-style-type: none"> <li>- Introduce crowd-sources research and information</li> <li>- Put artists to play an active role to help society imagine the future and be creative</li> <li>- Support education on civil engagement</li> <li>- Make environmental education key part of schools so that people make informed choices on lifestyle and elected representatives in government – include diet and agricultural impacts and waste (food)</li> <li>- Introduce a value-based learning to change education system and its priorities</li> <li>- Reskilling on cooking and avoiding food waste (local courses, schools, at all levels of education)</li> <li>- Educated population reduces food waste from consumers</li> <li>- Fund a scholarship for championing native plants (and animals) to replace imported equivalents</li> </ul>	<ul style="list-style-type: none"> <li>- Mainstream environmental education by crosscutting across silos as a norm by stakeholders</li> <li>- Foster a creative, brave mind-set away from reliance and steady income, to reimagine the future</li> </ul>	<ul style="list-style-type: none"> <li>- Support that learning outcomes of education are geared towards social and creative competences</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway D.1: Scotland open to the world</b>	Strategy D.1.1: Promote Scotland as a regional and global connected leader  * People-based	<ul style="list-style-type: none"> <li>- Consider Scotland's place in a global biodiversity system – reintroduction and planning for at risk species in the long-term</li> </ul>	<ul style="list-style-type: none"> <li>- Strengthen international collaborations</li> <li>- Set the example to other countries in the world on global collaboration</li> <li>- Create better relationships between Scotland and England – other parts of UK</li> <li>- Support cross boundary agreements of what the priorities are like climate ready Clyde and Climate Agreement at global level</li> <li>- Increase collaboration with other countries earlier through sharing expertise</li> </ul>	<ul style="list-style-type: none"> <li>- Invest equally in rural and urban communities in the region</li> <li>- Support digital connectivity across communities to drive local economy and global collaborations</li> <li>- Ensure that Scotland is strong enough to respond to terrorist attacks, piracy and theft</li> </ul>	<i>Governance</i>
<b>Pathway E.1: Introduce policy for strong environmental protection</b>	Strategy E.1.4: Introduce taxation, standards and regulation for environmental protection  * People-based	<ul style="list-style-type: none"> <li>- Put in place natural capital accounting for co-operations/ business</li> <li>- Enhance environmental tax for impactful activities - Introduce tax credits for positive environmental contributions</li> <li>- Review and realign all policies on 5 yearly basis ongoing throughout</li> <li>- Relaxation of building restrictions on historic buildings to favour environmental performance</li> <li>- New build regulations covering ground and air source heat pumps, active and passive solar, passive cooling, insulation etc.</li> <li>- Increase carbon tax to effective level</li> <li>- Switch subsidies from fossil fuels to green energy</li> <li>- Introduce regulations</li> </ul>	<ul style="list-style-type: none"> <li>- Strengthen environmental protection legislative framework in Scotland</li> <li>- Introduce scheme of incentives for consumers towards good environmental practice</li> <li>- Introduce social marketing of products and services</li> <li>- Adopt a flexible approach to land-use planning for species change to improve adaptability to inevitable habitat change</li> <li>- Develop new building standards to FORCE improved environmental standards</li> <li>- Local government works to ensure all Scots have open or wooded recreational space within 10 min walk</li> <li>- Every Scot lives within 5 min walk of a tree big enough to hug</li> <li>- Implement fully flexible and agile working policies</li> </ul>		<i>Governance</i>  <i>Resources and the environment</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>- Develop national plan for land use and regulation to support effective local energy systems and grid</li> <li>- Growing trees for furniture construction as long-term carbon storage</li> <li>- Encourage more household-level solar PV and solar heat</li> <li>- Develop new building standards to encourage improved environmental standards</li> <li>- Combine recreational land with biodiversity habitat through local authority policy change</li> <li>- Implement penalties and taxes to encourage biodiversity and sustainable forestry</li> </ul>			

### Scottish pathways in SSP3:

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway A.3: Ensure sustainable management of natural resources and ecosystems</b>	Strategy A.3.1: Set up natural protection areas  * Nature-based	<ul style="list-style-type: none"> <li>- Establish natural playgrounds for the rich – in remote areas (repopulation of the glens and islands also marine for sport-fishing, swimming with dolphins etc)</li> <li>- Sell off protected areas to multinationals</li> </ul>	<ul style="list-style-type: none"> <li>- Offer employment to have-nots as foresters and estate wardens</li> <li>- Allow have-nots to shoot but the food is for the haves</li> <li>- Offer deer forests as services</li> </ul>	- Create awards (competition=) for protected areas owned by the multinationals	<i>Resources and the environment</i>  <i>Food, water and energy</i>
	Strategy A.3.2: Foster ecosystem		- Develop aquaculture – biomass of fish for food		

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	services for resource provision  * Nature-based		<ul style="list-style-type: none"> <li>- Multinationals invest in cheap labour to ensure water for themselves</li> <li>- Identify and use water export opportunities for multinationals</li> </ul> Develop eco-tourism to provide income /employment for have-nots  Establish peatland restoration (low tech) paid by rich for carbon storage and water management		
	Strategy A.3.3: Coordinate resources among multinationals to protect natural capital  * Nature-based			<ul style="list-style-type: none"> <li>- Establish 'resource government'</li> <li>- Long-term view to benefit multinationals + Have nots</li> <li>- Set up Scottish business council for sustainable natural capital</li> <li>- Set up coordination mechanism between corporations on issues such as invasive species pollination</li> <li>- Develop ecosystem service assessments tools for multinationals (skewed) economically motivated</li> <li>- Coordinate land use strategies within a group of multinationals</li> <li>- Multinationals spend cash on infrastructure</li> <li>Afforestation for carbon storage (philanthropy CSR)</li> <li>Volunteer monitoring of multinationals use of natural resources</li> </ul>	



Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
				Use ag waste and whisky waste for bioenergy (multinationals)  Multinational champions for iconic species invest in actions for osprey, wildcat, golden eagle	
<b>Pathway B.3:</b> <b>Promote a shift towards community-based and local economies</b>	Strategy B.3.1: Move towards community-based food growing  * People-based	<ul style="list-style-type: none"> <li>- Local community grabs land</li> <li>- Community food growing – urban</li> <li>- Community kitchen prepares climate friendly meals</li> <li>- Local advice networks for sustainable agriculture solutions in peer to peer advice and smallholdings</li> <li>- More venison diet</li> <li>- Poultry / rabbit production locally replacing beef</li> </ul>	<ul style="list-style-type: none"> <li>- Have-nots band together for community owned agriculture - communities of interest for growing, building etc.</li> <li>- Grow own food to tackle food shortages.</li> <li>- Development of non-financial goods and services skills/schemes.</li> <li>- Encourage have-nots to farm the land – smallholdings, dachas</li> <li>- Community land buy-out</li> </ul> Alternative food sources: seaweed, algae, mushrooms, quinoa, mussels  Agroforestry, vertical farming, aquaponics, ->reduce land demand for food  Plant trees to give shade for salmon  Afforestation : food, energy and carbon storage  Utilise abandoned land for community growing to reduce food vulnerability  Use sustainable agriculture to improve biodiversity	<ul style="list-style-type: none"> <li>- Community acts to demand community benefit, shared equity, % share of profits</li> <li>- Seed sharing networks to promote new varieties of crops adaptable to new climates e.g. from Scandinavia</li> </ul> Local advice networks for new crops/farming techniques to take advantage of climate change opportunities	<i>Sustainable economy</i>  <i>Resources and the environment</i>  <i>Food, water and energy</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	Strategy B.3.2: Promote a local and sharing economy  * Market-based	Set up local credit union	<ul style="list-style-type: none"> <li>- Promote sharing economy, goods and services</li> <li>- Establish local trading systems</li> </ul> Set up machinery rings and tool banks/libraries  Provide capital for community low carbon energy schemes (philanthropy from estates to improve workforce resilience + self-financing)	<ul style="list-style-type: none"> <li>- Develop bartering on local scale to include alternative currencies (for skills development E3.1)</li> <li>- Secure funding through philanthropy for food banks + schools</li> </ul>	
	Strategy B.3.3: Develop self-regulation to protect nature and people  * Market-based	<ul style="list-style-type: none"> <li>- Provide information to multinationals on risks to economic benefits from natural capital from unsustainable practices</li> <li>- New taxation of multinationals – carbon tax; land sales/building</li> <li>- Monopolies commission regulates market commission</li> <li>- Develop regulatory framework to protect natural resources management</li> <li>- Standards for estate area management – legally underpinned</li> <li>- Conduct awareness campaign on consequences of labour / resource overexploitation</li> <li>- Provide tax breaks for philanthropy</li> <li>- Information transparency on working conditions</li> </ul> Ban trawling within 3 m of coast (food for have-nots)  Apply natural capital accounting protocol (multinationals)	<ul style="list-style-type: none"> <li>- Have-nots provide cheap land rent (crofts) for have-nots</li> <li>- Companies invest in health of workers &amp; education etc</li> <li>- Companies invest in resources</li> <li>- New corporations provide services</li> <li>- Coordinate resource provision by multinationals</li> <li>- Multi-nationals develop CSR programmes for market advantage</li> <li>- Multinationals agree standard to regulate /manage use of resources (self-regulating)</li> <li>- Implement self-regulated standards for estates /playgrounds</li> <li>- Have-nots offer services for estate management on condition they share in game / timber</li> </ul>	<ul style="list-style-type: none"> <li>- Establish multinationals association to coordinate management of resources</li> <li>- Awards system for estates</li> <li>- Strong coordination on local and multinational levels</li> </ul> Organize work force into unions	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		Set up peer to peer advice network for sustainable agriculture solutions Make land management plans to prevent use of flood plains for housing			
<b>Pathway C.3: Provide education, tools and social services to local communities</b>	Strategy C.3.1: Skills development for the have-nots  *People-based	Support social enterprise and self-sufficiency education from early on	<ul style="list-style-type: none"> <li>- Educate in skills useful for world ahead – skills and sufficiency</li> <li>- Foster immigration/exchange to enable communities of poor people to learn subsistence farming skills from people in other EU countries and from other immigrants</li> <li>- Have-nots organize with similar in other countries</li> <li>- Share skills among the have-nots</li> <li>- Implement education programmes to build community conscience</li> <li>- Have-nots develop skills training within communities of interest</li> <li>- Provide education on food “barriers” e.g. persuade people to like insects</li> <li>- Educate in advocacy and negotiation skills to build political capital – more equality</li> <li>- Persuade Haves to move to remote (expensive to keep) locations (new skills for the have-nots)</li> <li>- Use time credits (see B 3.2) for childcare and education</li> <li>- Provide education on traditional ways of preserving</li> <li>- Provide education on food from the sea</li> </ul>	<ul style="list-style-type: none"> <li>- Empower the have-nots – localized democracies</li> </ul>	<i>Jobs, equality and lifestyles</i>  <i>Health and education</i>  <i>Sustainable economy</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	Strategy C.3.2: Provide social and health services  * Market-based		<ul style="list-style-type: none"> <li>- Firms provide benefits to workforce (health, education)</li> <li>- Implement land sales tax as a percentage of price to support social fund</li> <li>- Offer tax incentives for firms to improve employee health and education</li> </ul>	<ul style="list-style-type: none"> <li>- Incentivise philanthropy for social services</li> <li>- Use 4 day week encourage haves to provide services for have-nots on 5th day</li> <li>- Use corporation tax (CO2 tax) to provide for health in society</li> <li>- Conduct deals with the corporations to fund staff family health and education</li> </ul>	
	Strategy C.3.3: Invest in the development of practical and low-tech skills and tools  * Technology-based	Establish Green Investment Bank for companies to invest in low carbon communities to access finance for local energy (and/or Credit Union)  Support micro-hydro, small-scale solar and wind	<ul style="list-style-type: none"> <li>- Develop low tech water quality assessment techniques/tools</li> <li>- Work with the have nots to innovate low carbon solutions</li> <li>- Use natural insulation (sheep, wool etc.)</li> <li>- Support transition to low carbon economy – incentives and competitive advantage</li> </ul>	<ul style="list-style-type: none"> <li>- Rainwater harvesting for have-nots</li> <li>- Encourage off grid water management and tools</li> <li>- Manage seasonal and locational water</li> <li>- Provide incentives/ low tech solutions/microfinance for measures to reduce nitrate runoff i.e. hedges, soil testing, anaerobic digesters for waste</li> </ul>	
	Strategy C.3.4: Foster philanthropy for nature and people  * People-based			<ul style="list-style-type: none"> <li>- Educate multinationals and haves to be benign dictators in the interest of succession/longevity</li> <li>- Raise awareness about resource efficiency (water/energy) --&gt; benefits of efficiency (economic/environment)</li> <li>- Show links, opportunities, threats of use of natural capital</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
				<ul style="list-style-type: none"> <li>- Develop a vision and plan for a future world (with buy-in!)</li> <li>- Foster philanthropy for biodiversity.</li> </ul> <p>Buy up estates and restore ecosystems. (wild and remote therefore no conflict with food (trade-off with playgrounds)</p> <p>Bring in bison?</p>	

#### Scottish pathways in SSP4:

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway A.4: The elite creates space for ecosystems through integrated infrastructure solutions and land management</b>	<p>Strategy A.4.1: Develop integrated infrastructure solutions on macro and micro scales</p> <p>* Technology-based</p>	<ul style="list-style-type: none"> <li>- Promote canal network (flood management measures): development for low carbon transport solutions for heavy goods transport</li> <li>- Land conservations and visualisation events: Independent individuals organise via social media, internet, academics, interested parties – to create awareness for land</li> <li>- Set up informed dialogue on strategic options for land use and mitigation with land</li> </ul>	<ul style="list-style-type: none"> <li>- Private companies develop infrastructure for their own needs (without government) – build regional framework but location-specific to provide infrastructure</li> <li>- Support the development of infrastructure based on commoditised resources (e.g. water) and build connectivity in remote regions</li> <li>- Ensure equal water quality across Scotland for good public health -&gt; responsible water use</li> </ul>	<ul style="list-style-type: none"> <li>- Take a ‘people- and place’ approach to planning in rural areas to allow infrastructure in rural areas to cope with immigration</li> <li>- Coordinate policy for maintenance and management of major infrastructure (hydro schemes and reservoirs for water export)</li> <li>- Invest in hydro-schemes – make infrastructure (hydro schemes and reservoirs) for water export requires national coordinated policy for maintenance and management</li> </ul>	<p><i>Resources and the environment</i></p> <p><i>Food, water and energy</i></p>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	Strategy A.4.2: Implement ecosystem-based land management that builds climate change resilience  * Nature-based	<ul style="list-style-type: none"> <li>- Local government creates designated areas, e.g. biosphere reserve, nature, in hope of attracting investment</li> <li>- Implement coordinated, networked monitoring stations to mitigate the climate change impacts (e.g. increased fertiliser use)</li> <li>- Scotland's rich acquire land as status symbol or investment</li> <li>- Assign land also for urban food growing</li> </ul>	<ul style="list-style-type: none"> <li>- Develop recreation and tourism on unmanaged land</li> <li>- Set up solar farms on unmanaged land</li> <li>- Set up carbon credit scheme for forestry to make it more viable</li> <li>- Protect from flooding: put in hard infrastructure</li> <li>- Develop natural flood defence mechanisms</li> <li>- Conduct on-going official land management data set</li> <li>- Monitor around mining areas / controls on industries</li> </ul>	<ul style="list-style-type: none"> <li>- Large landowners (the rich) implement ecosystems approach</li> </ul>	
<b>Pathway B.4: Shift towards a resilient, low-carbon economy</b>	Strategy B.4.1: Boost technology development and use  * Technology-based	<ul style="list-style-type: none"> <li>- Include natural resources in circular economy – technological solutions</li> <li>- Develop bio tech opportunities to protect nature resource from pests and diseases, invasive species - smart water metering</li> <li>- Development of community schemes based on bio-based materials for urban centres</li> <li>- New food sources, e.g. micro-proteins and insects</li> </ul>	<ul style="list-style-type: none"> <li>- Promote Scotland as a technical test area for flooding solutions – maximise high rain benefit</li> <li>- Develop SUDs and technology to alleviate flood risk</li> <li>- Showcase technical solutions</li> <li>- High-tech approach to agriculture and nutrient application and low waste</li> <li>- Soil stabilisation (and reduction of nitrate loss)</li> <li>- Strengthen mechanisms to re-invest in Scotland</li> </ul>	<ul style="list-style-type: none"> <li>- Develop technology to allow flexible urban-rural living</li> <li>- Logic of progress towards self-interest of companies to provide basic infrastructure for employees and citizens by returning profit into community</li> </ul>	<i>Sustainable economy</i>  <i>Resources and the environment</i>  <i>Food, water and energy</i>
	Strategy B.4.2: Promote low-carbon exclusivity  * Market-based	<ul style="list-style-type: none"> <li>- Implement fiscal levers to encourage private industry trade tariffs, taxation, interest rates</li> <li>- Develop Scottish low carbon brand and metrics</li> </ul>	<ul style="list-style-type: none"> <li>- Invest in energy and water etc. as commodity reservoirs</li> <li>- Investment in infrastructure facilitates commodity delivery</li> </ul>	<ul style="list-style-type: none"> <li>- EU enforces philanthropy</li> <li>- Legislate tax incentives to support on-going philanthropy</li> <li>- Benign companies provide decent conditions to look after</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>- Build/invest in natural capital, e.g. whisky, salmon</li> <li>- Start water commoditisation (part of branding of natural capital)</li> <li>- Invest in energy infrastructure (about 2025)</li> <li>- Support R&amp;D for low-carbon energy</li> <li>- Account natural capital to assess how well natural capital is being managed</li> <li>- Reduce taxes to incentivise private R&amp;D (after Scottish independence) /Devo max</li> <li>- Implement land reform bill 2100</li> </ul>	<ul style="list-style-type: none"> <li>- Set up the financial system to support private philanthropy – the rich have some association with the national vision, proud to be a rich Scot, moral responsibility, and recognise they need a healthy workforce</li> <li>- Compartmentalise land pockets, one company owning an entire/massive flood catchment area – to get responsible management in a piecemeal manner</li> <li>- On-going commodification of data: Develop data gathering and analysis (to account for commercial value) – from private companies as academia and public declines (e.g. Google climate analysis data and selling scenarios)</li> <li>- Private companies invest in their business assets and communities to improve conditions</li> <li>- Implement social capital accounting</li> <li>- Corporate self-regulation to continue to protect the environment</li> <li>- Invest funds from ‘exports’ into funds for population plus ‘energy’ profits to develop local communities</li> <li>- Supplier of last resort</li> </ul>	<ul style="list-style-type: none"> <li>poor people, promote environmental and social sustainability and justice (e.g. Whisky and salmon) – because natural capital and brand reliance</li> <li>- Develop national infrastructure projects to employ people funded through EU and private enterprises, using tax incentives – big loans – to support employment</li> <li>- Improve conditions of workforce – health care and pay</li> <li>- Co-operative fair trade whisky</li> </ul>	
<b>Pathway C.4: Promote flexible urban-rural living that builds on cohesion and local, sustainable economies</b>	Strategy C.4.1: Strengthen community-based land management and community cohesion	<ul style="list-style-type: none"> <li>- Communities invest in community-owned resources</li> <li>- Communities commonly respond to storms and extreme events, this leads to social cohesion and communities</li> </ul>	<ul style="list-style-type: none"> <li>- Promote local economy</li> <li>- Private companies sponsor local communities (philanthropy) – ‘pseudo-laird’</li> <li>- Set up community improvement schemes</li> </ul>	<ul style="list-style-type: none"> <li>- Establish social-democratic networks at community level to utilise social media, technology, data, non-violent way</li> <li>- Develop (virtual, social) ‘clan network’/social movement at community level that lobby the</li> </ul>	<i>Jobs, equality and lifestyles</i> <i>Health and education</i> <i>Sustainable economies</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	*People-based	<ul style="list-style-type: none"> <li>- Facilitate local pride – i.e. also sense you get from independence and devolution, national and local (equity, social cohesion) – enables greater interventions at community level – also links to good education, economic growth</li> <li>- Increase the role of civic society</li> <li>- NGO/civil society highlight the dangers of decreasing welfare spending</li> </ul>	<ul style="list-style-type: none"> <li>- Establish macro areas of regional influence</li> <li>- Regions reach out to EU: regional partnerships at rural or urban levels for sharing of best practices (RURAL) and financial support (URBAN), e.g. Edinburgh and Berlin pact</li> <li>- Local governments looks to wider regional EU examples when splits happen and there is no support (2060s-2070s)</li> <li>- Unofficial economy /bartering, black market (when networks start to form) – sharing economy also (dark economy: unlicensed, untaxed, unofficial)</li> <li>- Promote community-owned energy - use land for new low carbon solutions, e.g. solar farms = income for rural communities</li> <li>- Local communities get income from looking after habitats and forests, to conserve carbon stocks</li> <li>- Increase local democracy and participation by giving responsibility to local communities for local place-making and environmental quality</li> <li>- Localise systems, e.g. food, governance, economy, services</li> </ul>	<ul style="list-style-type: none"> <li>EU to intervene/provide support - people with like-minded outlooks, not necessarily in the same geographical area, also through communication technology/social media etc.; virtual protest</li> <li>- Organise dissent, disruption, direct action, occupation, hacking</li> <li>- Build physical infrastructure for social media (e.g. internet)</li> <li>- Conduct a social cohesion monitor</li> <li>- Build links with other regions across the EU to inform development opportunities in their regions</li> <li>- Increase of ad hoc community councils, micro democracies</li> <li>- Develop alternatives to welfare spending, e.g. care in community using 4-day work week</li> <li>- Establish inter-community voluntary mechanisms</li> <li>- Set up some social democratic organisations according to John Lewis model, foster roles of cooperatives</li> <li>- Corporate community reinvestment obligation via non-tax channels</li> </ul>	
	Strategy C.4.2: Promote rural	- State sponsors community buy-outs – state encourages communities to buy	- Support community farming	- Share best practice in sustainable farming through	



Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	community development  * People-based	land from land owners – focus on unmanaged land  - Set up community carbon credits - EU-led (late 2020s) – that helps the infrastructure investment at local level and energy infrastructure (e.g. local energy schemes, local land management) and supports self-sufficiency of communities also in terms of energy (community creates capital)  - Communities sell carbon credits to companies to offset the companies' footprint – synergies with local brand development  - Invest in land-based policies to give people access to land, new crofting commission  - Community entrepreneurs develop local energy solutions	- Implement community specific education projects: for land management, e.g. to support sustainable energy production, agriculture, provision of technology  - Take up multiple jobs – I am a farmer, plumber, taxi driver, etc.  - Train farmers to enable them best to manage soil and waste /water resource, e.g. knowledge on water flows  - Set up job leasing for unskilled jobs: multiple skilled individuals might share jobs – or one person who is contractually employed to do something and then leases out the job	social media in other global communities  - Rural communities build tourism business and increase prosperity	
	Strategy C.4.3: Promote urban community development  * Nature-based	- Create urban green spaces for food resilience (state sponsored)  - Vertical farms  - Local community food growing  - Part of a global approach to bottom-up energy solutions	- Promote shared roof gardens  - Provision of high tech manufacturing, getting investments to build a factory, communication systems, IT  - Develop green cities, urban gardening, roof gardens	- Focus on green cities, more of a relationship with environment to increase life expectancy --> community gardens in ghettos, vegetable growing	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	Strategy C.4.4: Establish new education models for self-organisation and new skill development  * People-based	<ul style="list-style-type: none"> <li>- Educate for social values and in social conscience (by 2030), skill-based education and knowledge</li> <li>- Increase spend in education</li> <li>- New skill development programmes</li> <li>- Promote social innovation research and development, e.g. in community volunteer mechanisms – how do we get people to support themselves, self-reliance</li> <li>- Encourage alternatives use arts and culture and faith-based systems</li> <li>- Use social media and MOOCs for new forms of communication to influence learning, skills sharing, manufacturing</li> <li>- Promote sharing economy</li> <li>- Implement value-driven approach to sharing – based on intrinsic motivation</li> </ul>	<ul style="list-style-type: none"> <li>- Provide education free for all</li> <li>- Focus education on self-sufficiency and social enterprise</li> <li>- Get successful businesses to invest (incentivise) invest in education to get enough qualified people /workforce</li> <li>- Improve knowledge and skills about healthy eating through schools and community education</li> <li>- Skills given to population = feeding into energy solutions</li> <li>- Next generation of 3D-printing and new production and manufacturing (e.g. hole in the wall technology)</li> </ul>	<ul style="list-style-type: none"> <li>- NGOs fill void of ineffective governments to help communicate the importance of the environment</li> </ul>	
<b>Pathway D.4: Strengthen Scotland's 'brand' nationally and internationally</b>	Strategy D.4.1: Foster international cooperation  * People-based	<ul style="list-style-type: none"> <li>- Set up different types of think tanks (international, regional, elite, local etc.) supported by rich individuals</li> </ul>	<ul style="list-style-type: none"> <li>- Maintain diplomatic ties with other nations by using multi-millionaires as advocates for the nation</li> <li>- Increase international collaboration (driven by individuals)</li> </ul>	<ul style="list-style-type: none"> <li>- Report to the EU which has a greater power to act</li> </ul>	<i>Governance</i>
	Strategy D.4.2: Brand Scotland internationally  * Market-based	<ul style="list-style-type: none"> <li>- Brand Scotland – continue to promote natural capital – attract global markets</li> </ul>	<ul style="list-style-type: none"> <li>- Foster eco-tourism to incentivise management of the natural environment and encourage appreciation of nature</li> <li>- Showcase Scotland – knowledge export – EU and globally</li> <li>- Foster whisky philanthropy for industry PR reasons</li> </ul>		

**Scottish pathways in SSP5:**

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway A.5: Establish new planning and land use management program</b>	Strategy A.5.1: Planning and land use management with nature-based solutions * Nature-based	<ul style="list-style-type: none"> <li>- Introduce a mass tree planting programme</li> <li>- Non-traditional fish species for consumption</li> <li>- Invest in urban green space and sustainable urban development solutions</li> <li>- Use wealth to replant forests and improve resilience of environment</li> </ul>	<ul style="list-style-type: none"> <li>- Develop green cities to address pockets of concern like environment and detract from destruction and exploitation of rural areas</li> <li>- Biodiversity – improving land management strategies (land sparing)</li> <li>- Take advantage of carbon sequestration potential of tree planting program</li> <li>- Carbon market develops</li> <li>- Crowd funding for tree planting</li> </ul>	<ul style="list-style-type: none"> <li>- Support more investment on resilience of environment</li> <li>- Create wildlife corridors going through intensive farming land</li> <li>- Pursue integrated land use (could lead to greater appreciation and existence and cultural value of nature)</li> </ul>	<i>Resources and the environment</i>  <i>Food, water and energy</i>
	Strategy A.5.2: Change land ownership * Market-based	<ul style="list-style-type: none"> <li>- Nationalise private estates and land early</li> <li>- Increase community ownership of land and other assets</li> </ul>	<ul style="list-style-type: none"> <li>- Wild land trust for donations of unwanted land</li> </ul>		
	Strategy A.5.3: Invest in technological innovation to eco-modernise urban and rural areas * Technology-based	<ul style="list-style-type: none"> <li>- Technology advance to avoid nitrogen runoff (nitrogen inhibitors etc)</li> <li>- Technological solutions and innovation focus on transport links to allow high levels of mobility</li> </ul>	<ul style="list-style-type: none"> <li>- NGOs and private research funding ensures renewable tech is ready and affordable when wanted</li> <li>- Innovation and R&amp;D policy on SEC to develop biomass to CCS schemes using non-managed land</li> <li>- Invest in GENE and Seed banks early to allow recovery</li> </ul>	<ul style="list-style-type: none"> <li>- Invest in green cities and smart mobility to deal with environmental problems</li> <li>- mealworm farms in every town</li> </ul>	
	Strategy A.5.4: Invest in tourism and recreation market/industry * Market-based	<ul style="list-style-type: none"> <li>- Build inland water recreation parks to replace coasts</li> <li>- Make accessible heritage sites with high speed transport options</li> <li>- Promote and support tourism in heritage sites</li> </ul>	<ul style="list-style-type: none"> <li>- Population is encouraged or chooses to use unmanaged land for recreation</li> <li>- Use unmanaged land for wilderness tours to appreciate and connect with nature</li> <li>- Invest and promote Scottish safaris for hunting and putting a price on the environment</li> </ul>	<ul style="list-style-type: none"> <li>- 2080s when species numbers increase, unmanaged land can be used for wildlife tours, appreciate and connect with nature</li> <li>- Boost of tourism market by the availability of biodiversity, variation, increasing interest in Scottish population</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		- Develop of water sports interest and facilities (due to warming oceans)	- Policy support for making Scotland an eco-tourism destination - Encourage participation and interest in water sports (results in concern of the environment )	- Increase in leisure and recreation activities that creates a return to intrinsic value of nature - Create wild life parks that become a station opportunity with camping	
	Strategy A.5.5: Deploy market-based solutions for peripheral connectivity * Market-based	- Grants and incentives to increase population in island communities	- Invest in transport from islands		
	Strategy A.5.6: Resource mapping and data collection * Technology-based	- Support/Fund academic research for exploitation - Using the models/develop GIS tools to enable maximum exploitation of resources rather than assessment of resources - Utilise more localised map based ecosystems assessments to inform funding decisions - Improve our monitoring of raw water to understand quality impacts - Invest in further monitoring of wastewater catchments to understand climate impacts	- Use new technology - Establish a mechanism for early warning of resource exploitation (from data collection to use/exploitation to assessment) - Introduce governmental zoning for planning exploitation of resources - Assessment of costs of impacts from technologies and exploitation - Valuation of more non-monetary resources and ecosystem services - Support/Fund academic research for environmental reasons	- Put emphasis of mapping of resources exploitation shifts to include environmental concerns - Data mapping highlights environmental problems - Reassessment of datasets to inform policy to address environmental concerns - Fund solution-focused research (research is seen as an investment) - Shift from sole exploitation of fossil fuels to also exploit wind as a resource - Introduce/implement policy to clean up environment - Data collection and mapping to ensure that 2010= baseline situation does not happen again	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway B.5: Create new job opportunities and lifestyles with nature and low-carbon technologies</b>	Strategy B.5.1: Invest in technological innovation to ensure full employment *Technology-based	<ul style="list-style-type: none"> <li>- Invest in new technologies to achieve full employment</li> <li>- Encourage full employment by investing in re-training</li> <li>- Technology policy to invest in bio-materials and high value income generation</li> <li>- Facilitate a step-change to mechanized and intense farming (measure adapted from land use strategy that is suggested to be included in strategy)</li> <li>-SEC funding for fusion development</li> <li>-Profit-driven (food) waste management</li> </ul>	<ul style="list-style-type: none"> <li>- Ensure free knowledge transfer of new technology including energy efficiency technology</li> <li>- Develop education and innovation in biotech, based in urban universities to achieve an educated population and full employment</li> </ul>	<ul style="list-style-type: none"> <li>- Invest in water innovation education to encourage development of high-tech solutions to water treatment challenges in degraded environment</li> <li>-Technology solutions (e.g. insulating smart meters to reduce energy consumptions)</li> <li>-Scotland develops fusion technology (incl. small scale plants)</li> <li>- Tax natural beef - &gt; cultured meat</li> </ul>	<i>Sustainable economy</i>  <i>Resources and the environment</i>  <i>Food, water and energy</i>
<b>Pathway C.5: Support local community empowerment for sustainability</b>	Strategy C.5.1: Support local empowerment * People-based	<ul style="list-style-type: none"> <li>- Local rural communities raise concerns in order to make government responsive</li> <li>- Clantons are given responsibility power for sustainable place-making framework for government</li> <li>- Government framework to require energy, water and food trading</li> <li>- Clantons are given opportunities to develop local energy renewable schemes</li> <li>- Educate on critical thinking to make Clantons work</li> </ul>	<ul style="list-style-type: none"> <li>- Reopen of power station to focus on growth of local economy. Burning fossil fuels etc</li> <li>- Available land for new areas of urban development built around shared resources (recreation shops)</li> <li>-SEC decentralizes energy production to Clantons and manages trading</li> </ul>	<ul style="list-style-type: none"> <li>- Invest in community enterprises for low-carbon low-food miles and low carbon technology</li> <li>- Clantons start to find the environment of interest because of champions</li> </ul>	<i>Jobs, equality and lifestyles</i>  <i>Health and education</i>
	Strategy C.5.2: Invest in environmental education * People-based	<ul style="list-style-type: none"> <li>- Put in place environmental education programs by government</li> <li>- Ensure education includes knowledge about environmental impacts</li> </ul>	<ul style="list-style-type: none"> <li>- ESD promotes the necessity for resource efficiency and a long term governance of resources</li> <li>- Make David Attenborough's documentaries compulsory TV viewing</li> </ul>	<ul style="list-style-type: none"> <li>- Invest in environmental education in schools to ensure that all citizens have a basic understanding of environmental issues (this action continues from "- Put in place environmental</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
			<ul style="list-style-type: none"> <li>- Connect and communicate with people who live in rural areas about vulnerabilities</li> </ul>	<ul style="list-style-type: none"> <li>education programs by government" )</li> <li>- Improve connection and communication of Scotland's environment and its importance</li> </ul>	
	Strategy C.5.3: Raise awareness about environmental issues and appreciation of nature  * People-based	<ul style="list-style-type: none"> <li>- NGOs use biodiversity changes to engage populations</li> <li>- Local community knowledge (to increase social capital and technology) environmental issues prevail environment especially the children</li> <li>- NGOs and community groups encourage environmental engagement at a local scale</li> <li>- NGO community pushes for awareness when an environmental tipping point happens</li> <li>- Incentivize charity giving to environmental causes</li> <li>- Exploit emergence of Clantons to encourage community energy</li> </ul>	<ul style="list-style-type: none"> <li>- NGOs raise general interest in biodiversity by harnessing the experience of new species within cities</li> <li>- (international) NGOs need to push for environment to become focus earlier than the tipping point (of the scenario)</li> <li>- Direct action and lobbying by grassroots eco-centric organisations</li> <li>- Clantons pick-up community decarbonisation. Focus of Clantons (compared to government) is on implementation</li> <li>- Encourage communities to engage with nature, environmental education</li> <li>- Encourage investment to renewables</li> <li>- Increase energy regulation earlier</li> </ul>	<ul style="list-style-type: none"> <li>-Government pick-up community/clanton decarbonisations</li> <li>-Health-driven changes in food habits</li> </ul>	
<b>Pathway D.5: Foster strong regional economy and global presence of Scotland</b>	Strategy D.5.1: Strengthen global relations  * People-based	<ul style="list-style-type: none"> <li>- Enhanced devolution: UK becomes federal</li> <li>Set up agreements with countries and conglomerates we import from to ensure supplies are resilient</li> </ul>	<ul style="list-style-type: none"> <li>-Selling technology to the world</li> <li>- Scottish government takes active part in global organizations related to low-carbon technology transfer</li> <li>- Scottish government puts forth a carrot-and-stick legislations on corporations to tackle environmental damage</li> </ul>	<ul style="list-style-type: none"> <li>-Scotland sells fusion technology to the world for profit</li> </ul>	<i>Governance</i>
	Strategy D.5.2: Regulate imports	<ul style="list-style-type: none"> <li>- Remain in EU as part of connecting with global community</li> </ul>	<ul style="list-style-type: none"> <li>- Promote trading of biodiversity and non-managed land as a global resource for carbon storage</li> </ul>		

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	and support global trade relations * Market-based	- Investment in health, housing, education and society is done on global scale to connect with global community	- Make trade deals and technology exports as recompense for failure to meet climate agreements		
<b>Pathway E.5:</b> <b>Valorise the market potential of water</b>	Strategy E.5.1: Capitalise on water as a marketable resource * Nature-based	- Development of upland water sources to feed growing populations in Inverness and Aberdeen - Consider to exploit water to increase income further with water exports - Study how to maximize potential for water as a commodity to renewable energy and shared to other parts of the world	- National and local water systems ensure continuity of supply for human use including maintenance of green space in urban areas		<i>Food, water and energy</i>
	Strategy E.5.2: Employ technology-based solutions to exploit natural resources as commodities * Technology-based	- Invest in and develop national water grid to ensure services to consumers and energy for pumping is abundant	- Technology to store (and transport) renewable energy more efficiently - Support rain water harvesting in order to reduce carbon emissions for water irrigation and responsible water use - Develop soft engineering solutions to water problems driven by low cost of upland land and high cost of urban property - Development of high-tech, low-input treatment to increase profit/reduce cost of water treatment	- Hi-tech interconnectivity of water sources to ensure adequate supply to populations (especially urban)	
	Strategy E.5.3: Invest in technological innovation to ensure flood protection * Technology-based	- Adaptation investment to address increased flooding and pollution - Technology policy on water efficient homes	- Develop technology to allow marginal land on islands to be maximized	- High-tech solutions prevent flooding and keeps population at risk low	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway F.5: Environmental policy as a positive return-of-investment action</b>	Strategy F.5.1: Planning and land use management with new governance approaches * People-based	<ul style="list-style-type: none"> <li>- Government institutes and funds independent environmental advices to advise on long term environmental challenges</li> <li>- National planning framework to prevent NIMBYism of local planning</li> <li>- Develop regional land use frameworks for rural areas</li> <li>- Promote increasingly integrated land use</li> </ul>	<ul style="list-style-type: none"> <li>- Availability of land for energy tech</li> <li>- Planning laws to protect urban population reduce development on flood plains and keep effects of flooding low</li> </ul>		<i>Governance Resources and the environment</i>
	Strategy F.5.2: Introduce environmental regulation * People-based	<ul style="list-style-type: none"> <li>- Regulation of companies' activities in the natural resources because of conflicts between them (litigation – impacts on bottom lines)</li> </ul>	<ul style="list-style-type: none"> <li>- Biodiversity policy focus on long-term wild land reserves</li> <li>- Implement waste management regulations</li> <li>- Increase the power of the environmental regulation</li> </ul>		
	Strategy F.5.3: Introduce taxation and funding schemes for environmental benefiting investments * Market-based	<ul style="list-style-type: none"> <li>- Invest in bigger reserves for restoration on contingency fund (Cash In = Cash out principle in practice)</li> <li>-Sovereign wealth fund like Norway to Community</li> <li>- Environmental taxation locally by Clantons</li> </ul>	<ul style="list-style-type: none"> <li>- Polluter pays taxation</li> <li>- Referendum allows dividend cut from SEC to address environmental degradation</li> <li>- Take into account the environmental performance of technology so as to incorporate the costs of teach-solutions to investment decisions</li> <li>- Use the state profit to invest in community energy</li> </ul>	<ul style="list-style-type: none"> <li>-Incentive specifically targeting low-carbon</li> <li>- Scottish government invests in SEC finance in repairing environmental damage</li> <li>- Guaranteed income for everyone as in Finland</li> </ul>	



## **11.3. Appendix 3: Supplementary materials for Hungarian pathways**

### **11.3.1. Hungarian vision narrative**

#### **Governance and institutions**

The legal foundation of governance and institutions is stable and secure. Decision-making is based on broad social consensus. The management of energy, water and healthcare is not profit-oriented, sustainability-oriented systems have been developed.

With strong and participatory local governance, there are many local civil initiatives. Indeed, the Szekszárd Climate Circle (Szekszárdi Klímakör – a local green NGO) is now celebrating its 100th anniversary. Representatives of NGOs are present in local governments and ensure balanced participatory decision-making. There is direct communication between communities and local government.

Elected municipal leaders are accountable and can be called back based on a referendum called at the request of 10% of the population and decision-making on major developments requires strong civil society participation. Citizens and communities, including young generations are responsible. The level of individual responsibility is high, and majority instead of minority interests are prioritized. Political leaders can be held to account. There is an extensive twinning program with other municipalities abroad. Hungary is member of an EU alliance, which advocates the principle of subsidiarity (decisions on local issues made locally). The EU has been reformed and responds more directly to European community's needs and challenges. National participation and representation of interests is present with equal weight in the work of the EU.

#### **Community life, social relations and values**

Community and local cultural life are strong, also in urban areas, and supported by direct communication between people, as well as by the free dissemination of community knowledge and best practices. Those in the younger generations who move away temporarily to work or study find it both attractive and possible to return. As a result, cities and rural communities retain their population. Due to strong family ties and dedicated civil society organizations, support for youth and the elderly is strong and public safety is maintained. Living in safe communities, families and nature are connected and there is an awareness of the importance of values and morals. Morals and the ethics of sustainability play an important role within communities and interest in low quality, manipulative, mass consumption promoting media is minimal. Money is not considered to be the exclusive and only measure of value and success. Society successfully handles differences and diversity.

#### **Health, education and well-being**

Active and healthy lifestyles and the virtues of a sustainable level of population are promoted through all levels of education from kindergarten to adult education. There is widespread availability of sports facilities and child-friendly programmes. Every settlement has a swimming pool, sports and community hall. The population has access to a sustainable healthcare system, social services and widespread mental health programmes. Hungary has top hospitals that are modern, together with health centres that concentrate on sustaining health and prevention. There is a comprehensive basic healthcare system readily available for everyone through family physicians.

Positive, long-term and systems thinking are embedded in formal and informal education and characterizes the mentality of the people. Education also strengthens holistic thinking for children/pupils to recognise early on that everything is interrelated at local, regional, European and global levels as well as between people and ecosystems. There is widespread access to natural, traditional medicine that limits the need for hospital treatment. Excellent schools and informal

institutions provide environmental and health education, as well as education based on traditions, personal and collective responsibility, increasing creativity and problem-solving ability. Children have good examples to follow. Education creates capacity in people and strengthens their ability to be creative and to use their own brain. Vocational, practice-oriented training provides skills necessary for both traditional and modern (but sustainable) aspects of life and older people pass on knowledge to the younger generation. Society appreciates different – modern as well as traditional - forms of knowledge and concentrates on acquiring skills that contribute to society and sustain the vision for sustainable communities. As a result, each of our actions has a meaningful impact.

### **Economy and Employment**

Using modern and highly eco-efficient technologies, the economy is sustainable and preserves values in both urban and rural areas, and also provides meaningful local employment. In this society, meaningful employment opportunities will be available for all, including those with limited skills and lower education. An advanced social security system ensures that social inequity is at an acceptable level. The level of corporate social responsibility is high. There is an increase in higher value added products.

Sustainable tourism (mostly domestic, nature-oriented) industry is booming. In line with the principle of subsidiarity, very significant taxation authority and policy-making powers are vested with local government. Corruption is minimal.

The total number of employed almost equals the total working age population. Part time work, telecommuting, job sharing is available everywhere. The value of working in the physical trades is respected. Most people are employed in local food production, family farms and SMEs. The value of production is not measured in GDP, with a representation of full lifecycle costs.

### **Environment**

Protection of the environment and climate is a priority under the conditions of a changing climate and dynamic ecological challenges. Industrial emissions of air pollutants are near zero. Trees are planted wherever possible both in urban and rural areas and species resistant to climate change are used. The urban environment is clean, healthy and continuously improving and cities are climate-adapted. There is a balanced urban fabric with a lot of green areas and sustainable urban services where people live in harmony with the environment.

Urbanization is kept under control and there is a harmonious relation between urban and rural communities. The distribution of the population is based on the carrying capacity of the areas where people live. People in cities are in direct contact with their surrounding ecosystems and support conservation.

Rural lifestyles are attractive to people, many move to the countryside and engage in family farming. There are subsidies and support for sustainable environmental management.

Material consumption has been reduced through use of technologies that produce little or no waste and through changes towards sustainable lifestyles. There is no overconsumption and travel with high ecological footprint is limited to what's essential as people are aware it is counterproductive to personal comfort and well-being. There is no promotion of overconsumption through advertising. All of the little waste that is generated is collected and recycled. Wood and paper are used for packaging in minimal amounts and the use of wood composite materials is prevalent, as well as the use of wood in construction.

Nature conservation is active and based on awareness, not restrictions.

**Energy, built environment and transport**

The energy supply is environmentally friendly and sustainable, relying at least 60% on renewables (solar, geothermal, wind, wood). Biomass is composted and the energy produced is used at the local level for supporting local production. Municipal energy consumption is lower than it was in 2016, with attention paid to energy efficiency of public lighting, buildings, appliances and transportation. Energy supply is decentralized, where feasible, local power plants provide heat where necessary to communities. Energy efficiency has been increased in all walks of life. Old houses have been renovated, rather than demolished, and have been retrofitted with modern insulation and heating systems. Due to energy efficiency measures, less energy is required and this can be to a large extent covered by renewables. Some new buildings can produce rather than consume energy but all modern buildings are at least self-sufficient with respect to energy supply. Institutional awareness of the issues surrounding energy consumption, production and security is high. As a result, Hungary has total energy independence.

Industry invests in renewable energy as a matter of routine. Energy storage is highly efficient, which further increases the feasibility of solar and wind energy production. Small-scale and community based energy systems are constructed and energy is sold on the open market.

Transport is environmentally friendly and energy efficient. This is achieved through an emphasis on walking, cycling, water transport and electric vehicles, as well as through technological developments. There is a dense and well-used network of sidewalks, pedestrian only areas and bike lanes in both urban and rural areas. Freight transport is also environmental friendly and energy efficient and rationalized due to higher demand for local products that come with shorter supply chains. Former parking lots now serve as community gardens. Everybody pays attention to green space and natural cooling. There is also a dense public transport system, entirely run on renewables and widely used. Transport-related CO<sub>2</sub> emissions are much lower than in 2016.

**Food and Water**

Sustainable food production includes large scale organic farming and self-sufficiency based on kitchen gardens. Consumption of locally produced organic food is a priority and urban inhabitants are able to produce a large part of what they need. The way food is produced does not have negative effects on people. With diverse land ownership that effectively prevents the establishment of large private holdings, decisions on land use and land conversion for agriculture are taken carefully. Given favourable climatic conditions for viticulture, the quality of wine is excellent and Szekszárd is the primary wine producing region in Hungary.

Health-centred water management involves the use of micro-reservoirs, new irrigation systems, full use of rainwater, and effective drainage of excess surface water and protection of natural water bodies. Floodplains regain their ecosystem functions and traditional management systems have been re-established in a modern form.

There are water reservoirs and irrigation canals by the Sió and the Danube rivers. Water management is responsible and focused on water retention. The value of rainwater collection and storage is obvious for people and communities. Soil quality is excellent, soil is rich in organic matter and minerals due to enhanced soil protection measures and appropriate crop production. There is an ample supply of clean healthy drinking water. Sewage is managed in a closed cycle and cannot enter surface water flows.

### 11.3.2. Hungarian pathways tables

#### Hungarian pathways in SSP1:

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway A.1: Advance to a water sensitive infrastructure system</b>	Strategy A.1.1: Introduce water sensitive management * People-based	<ul style="list-style-type: none"> <li>- Introduce incentives to people to use grey water</li> <li>- Introduce economic incentives to decrease the use of water resources</li> <li>- Put in place a full-cycle water monitoring system</li> <li>- Reform construction regulations: Rainwater collection and grey water reuse are required for all new house construction or renovation</li> <li>- Inform every citizen of his/her ecological footprint, including water and energy footprint</li> <li>- Regulate protection of water resources</li> <li>- Strengthen local regulations</li> <li>- Provide incentives for green economy</li> <li>- Install an information system with electronic signature to monitor the water use</li> <li>- Authorities supervise the protection of water resources</li> <li>- Ensure that local health services are coupled with the recreational use of water</li> <li>- Formulate guide of good practices</li> </ul>	<ul style="list-style-type: none"> <li>- Use grey water in households</li> <li>- Support cooperation on water among micro-regions</li> <li>- Put in place a hydrology IT system</li> <li>- Amend local regulations on water</li> <li>- Support regional self-governance</li> </ul>	<ul style="list-style-type: none"> <li>- Devolve regulatory power to local government (local government, local regulation)</li> <li>- Establish utility government at regional level</li> <li>- Represent environmental objectives in the budget, payment for environmental damage</li> <li>- Support water economy that is built on local resources</li> </ul>	<i>Food and water</i> <i>Environment</i> <i>Governance and institutions</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>- Introduce new construction principles and new construction materials and technologies</li> <li>- Raise the price of irrigation water to motivate people to water savings</li> <li>- Strengthen collaboration of local governments with civil society organisations</li> <li>- Increase the water retention capacity of the soil</li> </ul>			
	Strategy A.1.2: Set up a water monitoring system * People-based	<ul style="list-style-type: none"> <li>- Monitor quality and quantity of water system</li> <li>- Ensure local social services of the water system</li> </ul>	<ul style="list-style-type: none"> <li>- Ensure a civic control of the water use system</li> <li>- Put in place civil control in implementation of water infrastructures</li> </ul>	<ul style="list-style-type: none"> <li>- Ensure adequate budget for infrastructure maintenance that is part of the city structure and budget</li> </ul>	
	Strategy A.1.3: Extend to an integrated water management system * Technology-based	<ul style="list-style-type: none"> <li>- Create employment in recreation related uses of water</li> <li>- Develop strategies for the new water management system based on professional foundations</li> <li>- Stop underground mining to protect groundwater</li> <li>- Remediate water pollution sources</li> <li>- Switch to technologies with lower water demand</li> <li>- Install infrastructure to separate grey water</li> <li>- Install infrastructure for local water collection</li> <li>- Install public water taps</li> </ul>	<ul style="list-style-type: none"> <li>- Reuse sewage water</li> <li>- Use hydropower to support water system</li> <li>- Rainwater to be managed by residents</li> <li>- Implement energy storage technology</li> </ul>	<ul style="list-style-type: none"> <li>- Decrease drinking water consumption</li> <li>- Maintain utility system of water</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>- Increase water retention in urban surfaces</li> <li>- Use plants that resist drought</li> <li>- Use soil in a conscious way to protect surface waters</li> <li>- Motivate waste reduction</li> </ul>			
<b>Pathway B.1: Strengthen the role of government and participatory democracy</b>	Strategy B.1.1: Strengthen the role of government and national policy including a strong welfare system * People-based	<ul style="list-style-type: none"> <li>- Introduce birth control</li> <li>- Encourage state leadership</li> <li>- Introduce rules on all fields of life (strong policy)</li> <li>- Secure the sovereignty of the country</li> <li>- Allocate large share of GDP to disadvantaged regions</li> <li>- Mandate reporting on the actions done for the community</li> <li>- Ensure better insight into the concrete tasks of the government (transparency)</li> <li>- Enable online voting</li> <li>- Make reporting mandatory and transparent</li> <li>- Incentivise the community to vote by providing a holiday for the voting day</li> <li>- Put in place policies to increase populations</li> <li>- Provide tax exemptions when saving energy</li> <li>- Modify framework curricula</li> <li>- Enhance local decision-making</li> </ul>	<ul style="list-style-type: none"> <li>- Develop and present municipal and regional strategies</li> <li>- Motivate state subventions</li> <li>- Establish good international relationships while maintaining national positions</li> <li>- Strengthen international relations</li> <li>- Develop common strategies with neighbouring countries</li> <li>- provide energy loan among countries</li> </ul>	<ul style="list-style-type: none"> <li>- Set up a virtual general assembly that supports participatory democracy, transparency and integrates disadvantaged people</li> </ul>	<i>Governance and institutions</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway C.1:</b> <b>Shift to healthy lifestyles</b>	Strategy C.1.1: Support education and communication about sustainable lifestyles * People-based	<ul style="list-style-type: none"> <li>- Set examples on healthy lifestyles for young generation</li> <li>- Sustain a continuous communication and awareness campaign of good practices</li> <li>- Put a higher value on homeland studies</li> <li>- Communicate today's values and past mistakes in education and media</li> <li>- Increase awareness about healthy choices (health conscious life)</li> <li>- Provide information and education on lifestyle change</li> <li>- Introduce natural healing methods and less medications</li> <li>- Improve communication</li> <li>- Form local interest groups</li> <li>- Educate about sustainable, eco-conscious farming</li> </ul>	<ul style="list-style-type: none"> <li>- Stimulate professional consultations about sustainable lifestyles</li> <li>- Include health issues in basic education</li> <li>- Support arts to have a bigger role</li> <li>- Support culture and development of arts as part of education for healthy lifestyles</li> </ul>		<i>Health, education and well-being</i>  <i>Community life, social relations and values</i>
	Strategy C.1.2: Support health technologies * Technology-based	<ul style="list-style-type: none"> <li>- Introduce health screening programs</li> <li>- Introduce new medications and new technologies for health</li> <li>- Support community facilities for healthy lifestyles – e.g. community gym, swimming pool</li> <li>- Create modern public transport system</li> <li>- Set up community transport</li> <li>- Support electrical vehicles</li> </ul>	<ul style="list-style-type: none"> <li>- Increase natural and less synthetic ingredients</li> </ul>		

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway D.1: Make cities green and thermally comfortable</b>	Strategy D.1.1: Improve urban environment  * Technology-based	<ul style="list-style-type: none"> <li>- Change pavements in cities</li> <li>- Increase green areas in cities with more parks and urban greening</li> <li>- Create ventilation corridors in cities</li> <li>- Introduce shading technologies</li> <li>- Design/install natural shading in cities</li> <li>- Promote eco-thermal energy</li> <li>- Implement new building technology</li> <li>- Increase localised energy production that is decentralised (e.g. local heat plants)</li> <li>- Construct wild farms</li> </ul>	<ul style="list-style-type: none"> <li>- Support brownfield investments</li> <li>- Create public cooling centres</li> <li>- Implement carbon capture technologies</li> <li>- Increase the use of timber/wood as a raw material</li> <li>- Use renewable energy in natural cooling centres</li> <li>- Provide urban cooling spaces based on nature-based solutions</li> <li>- Only permit passive houses</li> <li>- Move towards smart city development</li> <li>- Implement plants that are resistant to extreme weather conditions, for animal and human consumption</li> <li>- Refurbish residential buildings to become energy efficient</li> </ul>	<ul style="list-style-type: none"> <li>- Online give permission to buildings which produce green energy</li> </ul>	<i>Energy, built environment and transport</i>  <i>Health, education and well-being</i>

### Hungarian pathways in SSP3:

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway A.3 Adapt resource management to climate change</b>	Strategy A.3.1: Implement holistic water management to save water  * Technology-based	<ul style="list-style-type: none"> <li>- Adopt a comprehensive water management plan</li> <li>- Implement 3-5 year action plan: store winter precipitation, build reservoirs, develop irrigation</li> <li>- Implement 3-5 year action plan on improving soil quality (manure, green fertilizer)</li> </ul>	<ul style="list-style-type: none"> <li>- Develop drainage systems</li> <li>- Regulate local water extraction</li> <li>- Cultivation link to water approach</li> <li>- Build water reservoirs, canals</li> <li>- Increase the capacity of reservoirs</li> <li>- Store precipitation in winter</li> </ul>	<ul style="list-style-type: none"> <li>- Initiatives at the local government level</li> <li>- Apply water saving technologies (in households, agriculture, awareness raising)</li> <li>- Implement "water is life" communication program</li> </ul>	<i>Food and water</i>  <i>Environment</i>  <i>Governance and institutions</i>



Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>- Utilize fallow lands</li> <li>- Secure water resources protection</li> <li>- Establish Lake Balaton as an interest of national economy, state priority for increased protection</li> <li>- Create rainwater storage</li> <li>- Manage irrigation</li> </ul> <p>Pet Bottles- Use of resources, environmental tax</p> <p>Grey water systems for households (high costs of maintenance?)</p> <p>Compost toilets</p>	<ul style="list-style-type: none"> <li>- Improve water retention capacity of the soil</li> <li>- Water drainage on agricultural lands (erosion control)</li> <li>- Retention and storage of runoff in settlements, irrigation of parks</li> </ul>		
	<p>Strategy A.3.2: Adapt agriculture to climate change</p> <p>* Nature-based</p>	<ul style="list-style-type: none"> <li>- Cultivation perpendicular to slopes, build drainage ditches</li> <li>- Reduce large-scale, industrial farming</li> <li>- Increase the use of crop residues as green manure</li> <li>- Protect the soil for agricultural production</li> <li>- Increase organic matter content in the soil (manure, compost)</li> </ul> <p>Recycling, reuse, avoid waste</p>	<ul style="list-style-type: none"> <li>- Switch to drought-resistant crops and livestock</li> <li>- Make crops more resistant through plant breeding</li> <li>- Switch land use: move from arable land to forest, meadow and pasture</li> <li>- Switch to new cultivation methods</li> <li>- Increase forest cover</li> <li>- Promoting production without chemicals</li> <li>- Shift to plant-based diet</li> <li>- Change land use patterns by increasing afforestation</li> <li>- Promote planting of fruit trees</li> <li>- Afforestation of steep slopes</li> </ul>	<ul style="list-style-type: none"> <li>- Change land use practices on arable land</li> <li>- Grow drought resistant crops</li> <li>- Develop self-sufficient farms</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway B.3 Strengthen the role of the government to facilitate environmental protection and collaboration</b>	Strategy B.3.1: Make strong environmental regulation and policy  * People-based	<ul style="list-style-type: none"> <li>- Implement building regulations</li> <li>- Ensure equality between leaders and those who really have control</li> <li>- Adopt climate strategy and yearly action plan for municipalities</li> <li>- Define and monitor sustainability rules – for countries, corporations, individuals</li> <li>- Use state control actions e.g. on farmers</li> <li>- Strengthen penalties against corruption</li> <li>- Simplify decision-making processes</li> <li>- Stabilize democracy, transparency of decision-making</li> <li>- Masses of educated people as counter-balance</li> <li>- Stop urbanization</li> </ul>	<ul style="list-style-type: none"> <li>- Promote cooperation instead of segregation</li> <li>- Decrease corruption</li> <li>- Increase redistribution of goods by the state</li> <li>- Provide better public services</li> <li>- Ensure transparency in decision-making</li> <li>- Involve professionals into decision-making</li> <li>- Ensure strong environmental protection with strict standards</li> </ul>	<ul style="list-style-type: none"> <li>- Introduce tighter control</li> <li>- Introduce environmental taxes</li> </ul>	<i>Governance and institutions</i>
	Strategy B3.2: Foster international cooperation  * People-based	<ul style="list-style-type: none"> <li>- Promote cooperation of the Visegrad countries</li> <li>- Strengthen international cooperation through contracts</li> <li>- Build relationships between countries on new foundations</li> </ul>	<ul style="list-style-type: none"> <li>- Set up bilateral agreements with neighbouring countries</li> <li>- Watch and adopt global good practices at the regional level</li> </ul>		
	Strategy B.3.3: Strengthen civil society organizations and solidarity  * People-based	<ul style="list-style-type: none"> <li>- Pressure for science education and local innovation</li> <li>- High quality education</li> <li>- Balanced media</li> <li>- Education supporting local participation</li> </ul>	<ul style="list-style-type: none"> <li>- Strengthen civil society organisations</li> <li>- Support civil society organisations</li> <li>- Strengthen local communities</li> <li>- Restore trust between people</li> </ul>	<ul style="list-style-type: none"> <li>- Get rid of urban ghettos</li> <li>- Implement conflict management</li> <li>- Integrate migrants</li> <li>- Increase social solidarity</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>- Civil initiatives</li> <li>- Encourage people to build own communities e.g. streets, common interests</li> <li>Improve security (people, food)</li> <li>Local systems (water, energy)</li> <li>Motivate to be part of group. Motivate to stay “Handball team”</li> <li>Eco-Tourism – civil groups develop local projects</li> <li>Obligation to vote: introduce locally</li> <li>Charities in rural areas</li> <li>- Promote rural infrastructure development</li> <li>- Provide subsidies for people to buy rural properties</li> </ul>	<ul style="list-style-type: none"> <li>- Strengthen local sustainability/self-sufficiency</li> <li>- Promote human relations, cooperation, relation between communities</li> <li>- Support local products and services</li> </ul>	<ul style="list-style-type: none"> <li>- Create equality</li> <li>- Strengthen equal relationships</li> <li>- Control out-migration</li> <li>- Strengthen local patriotism</li> <li>- Take care of generational roots</li> </ul>	
<b>Pathway C.3:</b> <b>Shift to healthy lifestyles</b>	Strategy C.3.1.: Protect people’s health  *People-based	<ul style="list-style-type: none"> <li>- Improve protection against UV radiation and shading technologies</li> <li>- Provide family-level healthcare</li> <li>- Develop a health plan for this time slice (including mental health)</li> <li>- Improve health awareness raising plan – protection against heat stress</li> <li>- Keep the living environment clean, infection control</li> <li>- Make clothes of natural materials</li> <li>- Integrate health screening, prevention in the framework of basic healthcare</li> </ul>	<ul style="list-style-type: none"> <li>- Provide a healthy environment (humidity, irrigation, families, municipal governments)</li> <li>- Health development plan for 2040-2070, with implementation plan</li> <li>- Provide incentives to people for healthy nutrition (media, more favourable prices)</li> <li>- Support movement of people from cities to the countryside</li> <li>- Provide a health network to deal with heat stress, developing special care</li> <li>- Promote of healthy eating</li> </ul>	<ul style="list-style-type: none"> <li>- Realize the program of the health plan</li> <li>- Strengthen the population’s conscious protection against heat stress</li> <li>- Gradually prepare the health care system to deal with heat stress</li> <li>- Develop emergency management and contingency planning</li> </ul>	<i>Health, education and well-being</i>  <i>Community life, social relations and values</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>- Provide effective communication for heat alerts</li> <li>- Bicycle paths and remote working (home office); public transport</li> <li>- Gradually increase urban green areas</li> </ul>	<ul style="list-style-type: none"> <li>- Improve the shading technologies of buildings</li> <li>- Develop green roof buildings</li> <li>- Reduce tick-borne threats through pest control</li> </ul>		
	Strategy C.3.2: Provide environmentally and socially conscious education and awareness-raising  * People-based	<ul style="list-style-type: none"> <li>- Create a knowledge base (publicity)</li> <li>- Provide environmentally conscious education (education system)</li> <li>- Raise awareness and information about migration</li> <li>- Foster dialogue between civil organizations and government</li> <li>- Maintain a skilled workforce – Improve wages, benefits, and conditions</li> <li>- Decrease consumption</li> <li>- Increase water retention capacity (education, awareness raising)</li> <li>- Make sustainability lectures compulsory in primary and high schools</li> </ul> Role models – being cool and taking responsibility  Make all consumers aware of energy efficiency	<ul style="list-style-type: none"> <li>- Institutions for special needs, develop education</li> <li>- Maintain environmentally conscious education</li> <li>- Learn self-sufficiency</li> <li>- Educate about individual responsibility</li> <li>- Promote acceptance of diversity between people by being more aware of the differences</li> </ul>	<ul style="list-style-type: none"> <li>- Promote energy savings through media</li> </ul>	
<b>Pathway D.3 Shift to green energy</b>	Strategy D3.1: Develop green energy alternatives  * Technology-based	Focus on biggest household energy use: Transport  Households to buy energy—efficient equipment  Introduction of new energy sources	Public investment in technology: solar panels	<ul style="list-style-type: none"> <li>- Support local solar energy production</li> <li>- Promote development of local biomass energy production</li> <li>- Implement low waste/reuse policy</li> </ul>	<i>Energy, built environment and transport Environment</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		New technologies (development and implementation)  Regulate for long-life machines with low consumption		- Promote the use technologies with lower energy requirement - Make use of climate change benefits through tourism - Support renewables - Promote solar and green energy - Replace nuclear energy - Look for new energy sources - Measures to improve energy efficiency	
	Strategy D.3.2: Provide incentives to shift towards sustainable technologies  * Market-based	- Energy price – savings - Implement tender system to support climate adaptation		- Create incentives through the price of construction materials to use green construction technologies	

#### Hungarian pathways in SSP4:

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>A.4 Advance to a water sensitive infrastructure system</b>	Strategy A.4.1: Protect water and use water for hydropower	*Support effective water governance *Increase the capacity of surface water reservoirs/cisterns *Coordinate the operation of dams and sluices (Sió canal – Danube)	*Introduce realistic prices for products (e.g. energy, water, integrate environmental costs) *Develop surface canal system *Develop surfaces that absorb water	*Set up water guard service to protect infrastructure, water quantity and quality	<i>Food and water</i> <i>Environment</i> <i>Governance and institutions</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	*Technology-based	<ul style="list-style-type: none"> <li>*Recycle grey water</li> <li>*Rainwater collection and storage (micro-reservoirs, urban water management)</li> <li>*Set up toilets with zero water usage to be used by households (toilets that destroy all by-products – not even compost)</li> <li>*Create wells for toilets and washing on household level</li> <li>*Exploit existing opportunities for hydropower by using dams and rivers</li> <li>*Use water circulating in channel system to produce energy</li> </ul>	<ul style="list-style-type: none"> <li>*Link water reservoirs and energy production</li> <li>*Improve irrigation systems and irrigation water storage</li> <li>*Make 1ha water reservoir per 100 ha arable land</li> <li>*Preserve the quality of recreational surface waters</li> <li>*Do not put too many water reservoirs (plan on regional level)</li> <li>*Bring water to the right spot (plan on regional level)</li> <li>*Put in place legislation on detention of drinking water in the Carpathian basin</li> </ul>		
	Strategy A.4.2: Promote gardening and climate-proof cultivation	<ul style="list-style-type: none"> <li>*Establish parks</li> <li>*Introduce heat-tolerant plants that are easily maintained</li> <li>*Support home gardens</li> </ul>	<ul style="list-style-type: none"> <li>*Grow edible plants wherever possible</li> <li>*Introduce chemical tick control</li> </ul>		
	*Nature-based				
<b>B.4 Strengthen accountable decision-making and participatory regional to local planning</b>	Strategy B.4.1: Support democracy and social capital  *People-based	<ul style="list-style-type: none"> <li>*Elite formulates strategies for climate and socio-economic impacts, in the interest of accessing EU subsidies</li> <li>*Adopt EU laws and regulation</li> <li>*Support religious communities</li> <li>- Guarantees for sustainability</li> <li>- Strong rules and 'carved in stone' implementation of sustainability processes</li> </ul>	<ul style="list-style-type: none"> <li>*Regulate multinational companies and prevent profits from leaving the country</li> <li>* Definition and enforcement of responsibilities</li> <li>*Stop, control and punish corruption</li> <li>*Modify voting law in order to strengthen democracy</li> <li>*Change the tax law, restructuring of the tax system, progressive taxes</li> </ul>	<ul style="list-style-type: none"> <li>*Effective communication of tangible results</li> <li>*Strengthen independent communication channels and freedom of the press</li> <li>*Strong measures to reduce corruption</li> <li>*Set up support system so the rich help the poor</li> </ul>	<i>Governance and institutions</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>*Strengthen law enforcement</li> <li>*Renew social and community relationships</li> <li>*Strengthen local governments and local decisions</li> <li>*Strengthen and support civil society</li> <li>*Ensure transparent public administration</li> </ul>	<ul style="list-style-type: none"> <li>*Develop new social contract – access to basic goods (e.g. land redistribution)</li> <li>*Implement stricter environmental rules and strong monitoring systems</li> <li>*Re-distribute power and money to local organisations, strengthen local governance</li> <li>*Undertake objective review processes</li> <li>*Improve direct accountability and legitimacy – ruling not dominating</li> <li>*Strengthen self-organisation</li> <li>*Provide subsidies for renewables and recycling</li> <li>*Make participation measurable</li> </ul>		
<b>C.4 Shift to healthy lifestyles &amp; access to education</b>	<p>Strategy C.4.1: Provide education and training that nurture social values</p> <p>*People-based</p>	<ul style="list-style-type: none"> <li>*Restart public schools</li> <li>*Spread meat-conscious diet (decreasing consumption of meat and animal products) and eco-conscious nutrition</li> <li>*Nurture human and community values, emphasize morals in education</li> <li>* Provide education resulting in a skilled workforce</li> <li>*Restructure education – need for useful knowledge</li> <li>*Improve burial practices, ability to mourn</li> <li>*Revive traditional lifestyles in a modern form (e.g., air drying of fruits and vegetables, hoeing, composting)</li> </ul>	<ul style="list-style-type: none"> <li>*Society-wide nutrition reform: Reducing meat and sugar consumption, vegetable based diets</li> <li>*Consumption that helps meet vital needs – no over-consumption, improve existing rather than invent new products</li> <li>*Promote education and information on health hazards, e.g. to prevent heat impacts</li> <li>*Improve physical fitness and heat tolerance</li> <li>*Acknowledge traditions and values in communities</li> <li>*Use biological tick control and treatment</li> <li>*Teach self-sufficient food production</li> </ul>	<ul style="list-style-type: none"> <li>*Promote social solidarity</li> <li>*Promote social cooperation</li> <li>*Support NGOs</li> </ul>	<p><i>Health, education and well-being</i></p> <p><i>Community life, social relations and values</i></p>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>*Improve social responsibility and motivation of the elite to help the poor</li> <li>*Strengthen church institutions</li> <li>*Establish an alternative education system that is independent and free</li> <li>*Promote voluntary engagements (e.g. of youth)</li> <li>- Spread of traditional treatment methods (e.g. in health care, herbs, methods)</li> <li>- Teaching of traditional healthcare</li> <li>- Bottom-up and self-provided education in communities</li> </ul>	<ul style="list-style-type: none"> <li>*Promote energy savings on individual levels</li> <li>*Develop skills for new technological development and research – e.g. on green energy, cold fusion</li> <li>*Create partnerships between local communities</li> <li>*Tailor education to include region-specific needs and knowledge</li> <li>*Change mindsets for local sustainable energy production</li> <li>*Promote energy savings through law (individual, companies etc.)</li> </ul>		
<b>D.4 Promote rural development and local economies</b>	<p>Strategy D.4.1: Promote local community development</p> <p>*People-based</p>	<ul style="list-style-type: none"> <li>*Regulate restoration after sudden storms</li> <li>*Consume local products</li> <li>*Produce local products</li> <li>*Local trade</li> <li>*Set up new waste management to collect waste</li> <li>*Provide subsidies for solar panels on houses</li> <li>*Re-use waste in construction materials</li> <li>*Change the attitude of service providers: solar energy feeds back into the electric grid</li> </ul>	<ul style="list-style-type: none"> <li>*Promote gardening instead of industrial agriculture</li> <li>*Support local community development</li> <li>*Support local agriculture</li> <li>*Food self-provision</li> <li>*Shelterbelts between fields to reduce dust</li> <li>*Foster local markets</li> <li>*Land Distribution in support of self-sufficiency of the poor</li> <li>*Support bottom-up movements so locals take part in decision-making and local community-planning</li> <li>*Promote food self-sufficiency on local levels but with regional exchange</li> </ul>		<p><i>Economy and employment</i></p> <p><i>Food and water</i></p> <p><i>Energy, built environment and transport</i></p>



Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	Strategy D.4.2: Shift to sustainable and community-based agriculture and forestry  *Nature-based	*Increase the fertility of soil, use biodegradables and provide nutrients for the soil – do not use biodegradables for energy  *Process locally produced food locally  *Local food production is organised at the country level	*Plant heat-resistant plants *Seed production *Increase employment in agriculture *Introduce afforestation *Use of biomass for soil quality improvement *Make use of the biomass on arable lands *Make a forest registry for forest maintenance *Support the creation of production cooperatives and community supported agriculture *Include reforestation in forest management – extra forestation in surfaces not covered today	*Make forest management more effective (owner) *Cultivate of herbs *Introduce new species in agriculture, change species *Invest in effective agricultural technologies (avoid overexploitation of arable land) *Produce different crops *Prevent the abuse or theft of cropland	
<b>Pathway E.4: Move towards green cities</b>	Strategy E.4.1: Move towards green urban development  *Technology-based	*Promote green roofs, roof gardens, green walls *Reduce paved surfaces *Reduce urban development on the southern shore of Lake Balaton *Separate handling of rain water and sewage *Decrease urban population and promote rural development *Put electrical cables underground to create more space for green *Promote high buildings to safe space and use the space for green *Modify building regulation to promote high-rise buildings and green buildings	*Urban reforestation - plant fruit trees in the city *Develop water retention systems *Communicate best practices *Reduce motorisation – promote walking and cycling *Increase urban cross-ventilation *Store runoff from paved urban surfaces *Make compulsory rain water cisterns in residential buildings proportionate to their size *Innovate cooling technologies *Provide air-conditioned resting areas – using renewables!	*Use natural cooling systems to counteract microclimates (vaporization, greening the surfaces, open urban water surfaces)	<i>Energy, built environment and transport</i>  <i>Health, education and well-being</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		*Make streets smaller and set up green boulevards			

### Hungarian pathways in SSP5:

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway A.5: Advance water and energy infrastructure systems</b>	Strategy A.5.1: Water – Development water management  * Technology-based	<ul style="list-style-type: none"> <li>- Train water management professionals</li> <li>- Strengthen flood control organizations</li> <li>- Develop international cooperation related to water</li> <li>- Develop monitoring systems</li> <li>- Develop irrigation systems and technologies</li> <li>- Government support for development plans and technologies</li> </ul>	<ul style="list-style-type: none"> <li>- Start programs to retain water management professionals</li> <li>- Invest in technological solutions for water management such as sewage and grey water treatment</li> <li>- Increase irrigated areas and more efficient water use</li> <li>- Sustain watershed management</li> <li>- Manage international water conflicts</li> <li>- Ensure continuous development of reservoir capacity</li> <li>- Increase water holding capacity of the soil</li> <li>Support the development of early warning systems</li> <li>Construct reservoir systems to deal with flash floods</li> <li>Manage flood crests – development of flood protection technologies</li> <li>- Monitor the state of the environment (for pollution and damage prevention)</li> <li>Using rivers and waterways for transport</li> </ul>	<ul style="list-style-type: none"> <li>Willow cultivation in flood areas (Mitigation)</li> <li>- Promote community water supply systems</li> <li>- Introduce local irrigation systems</li> <li>- Develop individual and community rainwater storage</li> </ul>	<i>Food and water</i> <i>Environment</i> <i>Governance and institutions</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	Strategy A.5.2: Introduce water sensitive solutions for integrated water management * Technology-based	<ul style="list-style-type: none"> <li>- Tech development according to the needs of soil and plant types (Mitigation)</li> <li>- Build water reservoirs</li> <li>- Support water saving solutions</li> <li>- Develop water treatment technologies</li> <li>- Start reservoir reconstructions</li> <li>- Collection, use and reuse of run-off</li> <li>- Utilise canals and old channels of mill races</li> <li>- Reconstructions old drainage channels</li> </ul>	<ul style="list-style-type: none"> <li>- Flood area cultivation, decrease in river control, forestation</li> <li>- Introduce floodplain farming in some areas</li> <li>- Reuse greywater</li> <li>- Create multifunctional rainwater storage (e.g. fisheries, recreational use)</li> <li>- Develop water saving technologies and irrigation systems</li> <li>- Collect rainwater in settlements</li> <li>- Set programs to reduce household chemical use to enable greywater use for irrigation</li> </ul>	<ul style="list-style-type: none"> <li>- Irrigation system and reservoirs maintenance is given priority in budgeting</li> <li>- Value every drop of water (water protection even with the use of the police if needed)</li> </ul>	
	Strategy A.5.3: Support agrarian environmental management *Nature-based	<ul style="list-style-type: none"> <li>- Selection and breeding of drought resistant plants</li> <li>- Support afforestation of areas unsuitable for farming</li> <li>-Loosening the soil for carbon absorption</li> <li>- Promote the production of diverse plant, fruit and vegetables products</li> <li>- Support the use of native plant species in increasing green cover</li> <li>- Loosening EU regulation on disposing sewage water and paddle</li> <li>-Cultivation of industrial areas, covering mining waste with paddle</li> <li>-Supporting home gardens with seeds and seedlings (Resp: citizens, civil society and local authority)</li> </ul>	<ul style="list-style-type: none"> <li>- Support and develop the breeding of heat tolerant plant species</li> <li>- Promote climate adaptive and multifunctional agriculture</li> <li>- Increase financing for the melioration of arable land</li> <li>- Development of shading and UV protection technologies in horticulture</li> <li>- Support multifunctional (adaptive) landuse and agriculture (e.g., pasture in drought, water retention and drainage area during floods)</li> <li>- Agricultural use of sewage (Resp: authority, gov. local authority, agricultural businesses)</li> <li>-Forestation in the Bakoni region (Resp: gov, local authority, forestry)</li> </ul>	<ul style="list-style-type: none"> <li>- Breed plant species that are fit for the climate in this time period</li> <li>- Wide dissemination of drought-resistant plant species</li> <li>- Strengthen local production and self-sufficiency</li> <li>- Establish small scale production communities</li> <li>- Spread manual and animal power labour</li> <li>- Strengthen barter trading</li> <li>- Green soil protection measures</li> <li>- Spread of backyard livestock farming</li> <li>-Local food production/processing (Responsible: civic society, local communities, chambers)</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		- Measures to increase the soil's water retention capacity (e.g. deep cultivation, manure use, permanent cover, contour farming, terracing)	-Home composting	- Best Home Garden Award (Local Authority) -Recultivated land as agricultural areas (Resp: agr businesses, gov authority)	
<b>Pathway B.5: Strengthening governance and social solidarity</b>	Strategy B.5.1: Strengthen democracy and communication * People-based	- Direct democracy (controlling the gov) - Introduce social communication - Support access to the internet, international and local information systems - Strengthen intergenerational communication - Involve the younger generation and women in decision making	- Ensure means for direct democracy are available - Travelling together (Tolerance) - Strong NGOs , more transparency - Teach social tolerance towards people of special needs - E-voting - Change the role of media in (environmental and social) awareness raising - Change the media	- Create new social icons and examples - Eliminate social inequalities - Sustain direct democracy	<i>Governance and institutions</i>
	Strategy B.5.2: Empower communities and foster multi-sector partnerships * People based	- Rediscover local treasures and beauties - Strengthen a social network as a social base for stronger communities	- Ensure that more organizations participating in heat management - Reward social responsibility - Telecar schedule	- Support voluntary forms of cooperation and partnerships - Strengthen local communities and production of local products - Rediscover community as a value through sport and culture	
<b>Pathway C.5 Create new education and health systems</b>	Strategy C.5.1: Revolutionise education to prepare future generations for new markets and professions * People-based	- Reform the education system to be inclusive and accessible across all social classes - Introduce new approaches to education - Introduce project-based education - New public transport vehicle) (mitigation)	- Using own bioenergy (sport) - Provide education that pays special attention to talented children - Education for people with special needs so that they can be integrated into the economy - Broaden of education towards new skills, competencies and professions	- Strengthen local education (village and city schools) - Cut back the training of overeducated but unemployable people when there is an acute shortage of qualified tradesmen	<i>Health, education and well-being</i>  <i>Community life, social relations and values</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>- Emphasize environmental consciousness and health in education</li> <li>- Integrate migrants into training programs</li> </ul>	<ul style="list-style-type: none"> <li>- Support creativity in education and practice with and through lifelong learning</li> <li>- Educate of farmers about new methods and approaches</li> <li>- Support lifelong learning</li> <li>- Engage civil society in education for sustainability</li> </ul>		
	Strategy C.5.2: Support new education system * People-based	<ul style="list-style-type: none"> <li>- Prestige of teachers and more men in education</li> <li>- e-learning, remote education (universities, chamber)</li> <li>- Trainings for the unemployed</li> <li>- Agricultural training, practical (responsible: chamber, universities)</li> <li>- Rethink pedagogical programs, reformulating values</li> <li>- Teach deeper interlinkages between health and the environment</li> <li>- Boost environmental protection education</li> <li>- Provide professional challenges for education, full career pathways</li> </ul>	<ul style="list-style-type: none"> <li>- School bus</li> <li>- Support the development of education</li> <li>- Integrate migrants into the education system</li> <li>- Primacy of health-conscious approach in education</li> <li>- Knowledge and acceptance of nature's rules</li> <li>- Strengthen IT education</li> <li>- Introduce health care and healthy lifestyles education</li> <li>- Train environmental educators</li> <li>- Lobbying – wealthy, PR (social relations), support for civil society</li> </ul>	<ul style="list-style-type: none"> <li>- Develop community survival mechanisms</li> <li>- Balanced intergenerational relationships, mentally mature society</li> <li>- Support a holistic approach</li> <li>- Promote conscious environmental protection</li> <li>- Reduce overconsumption</li> <li>- Introduce education for self-sufficiency</li> <li>- Integrate natural healthcare into education programs</li> <li>- Increase awareness of community values</li> <li>- Document and integrate traditional knowledge and traditional trades into the education system</li> </ul>	
	Strategy C.5.3: Put in place a heat management system	<ul style="list-style-type: none"> <li>- Support the cooling of public facilities</li> <li>- Establish heat alarm system and strengthened communication</li> <li>- Teach UV radiation protection</li> </ul>	<ul style="list-style-type: none"> <li>- Create even more climate controlled facilities</li> <li>- Afforestation and natural shading</li> </ul>	Disseminate individual and small community-scale climate protection technologies	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	* Technology-based	<ul style="list-style-type: none"> <li>- Develop sunscreen cosmetics</li> <li>- Support greening programs in cities to create cooling zones</li> <li>- Ensure availability of climate controlled public facilities on hot days</li> </ul>	<ul style="list-style-type: none"> <li>- Ensure natural ventilation of cities to maintain natural cooling (review city planning, open up wind tunnels)</li> <li>- Incentivise climate friendly construction</li> <li>- passive/active houses</li> <li>-green wall roof</li> <li>- Make use of architectural options and regulations in climate protection</li> <li>-Shading/insulation of buildings</li> </ul>	<ul style="list-style-type: none"> <li>- Establish heated / cooled public spaces using renewable energy</li> </ul>	
	Strategy C.5.4: Invest in health research and healthcare technology * People-based	<ul style="list-style-type: none"> <li>- Invest in healthcare R&amp;D</li> <li>- Invest in improving and developing health care</li> <li>- Invest in gene technology R&amp;D</li> <li>- Improve health care for the most vulnerable</li> <li>- Prepare for infectious diseases and epidemics</li> </ul>	<ul style="list-style-type: none"> <li>- Build up monitoring systems for new diseases, create database</li> <li>- Train general practitioners to recognize new diseases</li> </ul>	<ul style="list-style-type: none"> <li>- Strengthen the use of traditional medicine</li> <li>- Widespread cultivation of herbs</li> <li>- Give priority to prevention</li> </ul>	
	Strategy C.5.5: Change employment laws and practices * People-based	<ul style="list-style-type: none"> <li>- Incentivise meaningful jobs and occupations for everyone</li> <li>- Change of working hours due to robotization, spread of part time work</li> <li>- Reduce of working hours</li> <li>- Increase school time</li> <li>- company bus (mitigation)</li> </ul>	<ul style="list-style-type: none"> <li>- Widen social employment</li> <li>- Invest in public services and ICT education</li> <li>- Regulate internet technologies in the interest of meaningful job opportunities</li> <li>- Regulate automation in the interest of controlling unemployment</li> <li>- Regulate of multinational companies to promote employment</li> </ul>	<ul style="list-style-type: none"> <li>- Strengthen community self-determination (subsidiarity)</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway D.5: Support green energy transition</b>	Strategy A.5.1: Energy – Support green energy with policy and regulation  * Technology-based	<ul style="list-style-type: none"> <li>-Support increasing the efficiency of fossil energy use</li> <li>-Support residential energy efficiency programs</li> <li>-Reconsider international conventions aimed at the reduction of GHG emissions</li> <li>-Strengthen the regulatory activity of the state (via short- and long-term plans)</li> </ul> <p>Tech Development to decrease fuel consumption</p> <ul style="list-style-type: none"> <li>- Support renewable energy pilot programs of university research institutions</li> </ul>	<ul style="list-style-type: none"> <li>- Support electrification of transport</li> <li>- Introduce government support for increasing the efficiency of fossil energy use</li> <li>- Make mandatory investment of profit in the production of renewables</li> <li>- Continue residential energy efficiency programs</li> <li>-Self-fund residential renewable energy</li> </ul> <p>Water efficient industry</p>	<ul style="list-style-type: none"> <li>- Distribute energy to various sectors (as per their need)</li> <li>- Explosive, self-funded growth of residential and community-based renewable energy systems</li> <li>- Make short supply chains, promotion of local products</li> <li>- Develop of small-scale supply systems</li> <li>- Support community farming, continuous strengthening of self-sufficiency</li> </ul>	<i>Energy, built environment and transport Environment</i>

## **11.4. Appendix 4: Supplementary materials for Iberian pathways**

### **11.4.1. Iberian vision narrative**

#### **Health, wellbeing and sustainable lifestyles**

In 2100 people in Iberia engage in new lifestyles that fit in more sustainable ways with the special characteristics of the territory. There is access to safe food, education and health for all. In general, people care more about health and also make sure that the elderly, the children and the disabled are supported and have suitable living conditions and social protection. Abandonment and the deterioration of rural areas has been reduced. Rural and close-to-nature lifestyles co-exist with those relying on cutting-edge technologies. Welfare and access to public services of all inhabitants are ensured. Community activities are valued.

#### **Protecting the environment**

Natural resources, such as water, soil, biodiversity and air, are managed sustainably and strictly protected. Their protection and management are incorporated into all policies. Environmental violations are punished severely in economic, criminal and political terms. Only companies that act with strict environmental and social responsibility standards have a place in the economy, since those who do not comply with standards pay a great price in terms of their reputation and are rejected by consumers, most of whom are very concerned about environmental and social issues.

All economic activity is carbon neutral. There is a focus on mitigation strategies in the industrial, agricultural and productive economy and support for environmental recovery. Production is decoupled from emissions, waste and discharges. The use of suitable technologies supports environmental protection and decreases resource use.

#### **Sustainable urban planning and land use**

Cities are smaller than in 2016, reducing emissions and making them less dependent on transport. Furthermore they are energy self-sufficient, based on the development of circular economy models, eliminating waste production and improving air quality. Urban planning applies sustainability criteria. Land use management and planning promote the socio-economic sustainability of the region and equal opportunities between different areas (including urban and rural areas as well as coastal and inland areas). The urban and non-urban areas dedicated to private transportation are smaller than they were, providing more space for social activities. Humans live in harmony with nature and millennia-old sustainable land-uses such as agroforestry systems (e.g. montado, dehesa) are respected, maintained, and improved.

#### **A sustainable and local economy**

The sustainable economy is based on a balanced use of Iberian natural resources with minimum impact on natural ecosystems and waste production as well as maximum reuse, recycling and recirculation of materials. With more green industries and less dependence on tourism, business models are adapted to the specific conditions of Iberia. Integrated technological innovations and income are used to solve problems like water shortages, forest loss and food insecurity.

#### **Food, water and energy**

Everybody enjoys safe food and Iberia has food security. The production and consumption of meat has been reduced substantially, leading to a sharp decline in livestock and crops dedicated to animal feed. The consumption of local, seasonal and organic products is prioritised. Public policies support more sustainable and natural agriculture, which is less dependent on fertilizers, pesticides and pharmaceuticals, to ensure a healthy diet for the population and provide greater protection of forests,



taking advantage of the carbon sink function that agriculture and forests provide. This creates environmentally positive synergistic effects.

With 100% renewable energy, a distributed network of energy production and consumption and no more investment in fossil fuels, Iberia has a low-carbon economy. Housing construction fulfils standards that make it possible to achieve practically zero energy consumption. Transport is 100% electrical. With no dependence on external energy supply, Iberia is the major (solar) energy producer for Northern European countries.

With clean rivers, lakes and reservoirs, re-naturalised water bodies and reinstatement of water canals in urban areas, all citizens have full access to clean and safe water. Integrated Iberian water management ensures a balanced use of water for urban supply, agriculture, forestry and energy production and has reduced conflicts between different water users. Improved methods and technology for water use and irrigation support the harmonisation of economic development with the environment.

### **Income, education and jobs**

The flexible education system supports the development of carbon-neutral technology and professional activities which are also resilient from a climate point of view. Rich cultural activities promoting diversity and tolerance are included in all schools and at all levels. With guaranteed access to education, more people can benefit from it and therefore education becomes a pillar of social welfare. This economy also supports the generation of large revenues and many jobs. Technological development creates meaningful jobs. There is full employment, a fair income distribution including reasonable salary differences leading to a smaller difference between rich and poor than existed in 2016. Men and women are paid and treated equally. Integrated investment in education and research supports the finding of innovative, sustainable solutions for a sharing economy based on a balanced exploitation of Iberian natural resources. This further fosters a new welfare model that is centred on wellbeing and social welfare and decouples development from economic growth. This investment also supports technological advances that foster solutions for essential sectors such as agriculture, industry and tourism, thus creating profits that are fairly distributed and new jobs.

### **Resilience**

All cities have adaptation plans and have implemented strategies to combat climate change. Improved water management helps to mitigate extreme events, such as droughts and floods. Integrated adaptive management deals with environmental challenges in an assertive sustainable way, with multiple mechanisms able to respond quickly to changing weather and extreme events (droughts, floods, heat waves, etc.).

### **Governance**

Portugal and Spain are united with coordinated Iberian governmental institutions. Iberia also has a highly politically engaged society, which understands the global societal challenges and is able to give their opinions, which are heard and taken into account. Iberia is a coherent, diverse, developed and peaceful territory, where different cultural and regional identities are respected and accommodated. Human rights, human well-being and opportunities are universal. Society and economy advance together and are based on strategically defined sectors, good leadership and adaptive management. Migration flows within Iberia are common and do not create conflict but are integrated in society. Public participation and involvement are mandatory at all levels of decision-making, where thinking about sustainable long-term as well as short-term sustained options is the rule. Laws are just and everyone is subjected to them, rich or poor, powerful or not. The government is strong and enforces environmental and social laws. The government promotes the open participation of multiple agents to ensure good governance without being subject to the will of any particular vested interest groups.

Public and private planning and management are transparent and democratic, but also flexible. Policies developed using a participatory approach include those related to the sustainable management of Iberian river basins and inclusive immigration policies to balance the endogenous population decline. The role and authority of environmental policy is balanced with the fair involvement and authority of the other sectoral policies.

**Cooperation and Identity**

Iberia supports greater global cooperation and fosters solidarity, with respect for human rights and social development of peoples. Communities maintain distinct identities based on the interaction with their own and neighbouring environments. People are tolerant and broad-minded, sharing knowledge and information and exchanging experiences. Support is provided to those in need and refugees are welcomed.

#### 11.4.2. Iberian pathways tables

##### Iberian pathways in SSP1:

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway A.1</b> <b>Support integrated water management</b>	Strategy A.1.1 Implement new water regulations and governance to ensure good water for everyone * People-based	<ul style="list-style-type: none"> <li>- Eliminate illegal water use</li> <li>- Control of the ecological flows</li> <li>- Adapt every treatment system to reduce river pollution</li> <li>- Control and evaluate underground water (by the state)</li> <li>- Close Transvase Tajo-Segura</li> <li>- Develop a remote monitoring system for irrigation and illegal water use</li> <li>- Close and sustainable water transfers between Iberian rivers</li> <li>- Better public participation to irrigation land planning</li> <li>- Iberian body for international river basins</li> <li>- Require a water saving plan by firms by 2030</li> <li>- Establish water controls in all irrigated lands</li> <li>- Program for establishing complete regimes of environmental water flows</li> <li>- Program of efficient management of water purification</li> <li>- Integral management of water in every basin</li> </ul>	<ul style="list-style-type: none"> <li>- Implement (MTD) better technologies to purify water</li> <li>- Promote closed cycle of water</li> <li>- Introduce programs for monitoring and adapting environmental water flow regimes</li> <li>- Improve and promote aquifer recharge. Less evaporation</li> <li>- assure ecological flow</li> <li>- Integrated water management between the two countries</li> <li>- Efficient irrigation water management</li> <li>- Rainwater harvesting for non-potable uses</li> </ul>	<ul style="list-style-type: none"> <li>- Open transfer North Europe-Iberia</li> <li>- Mandatory laws on per capita water consumption</li> <li>- Increase of water availability (administered)</li> </ul>	<i>Food, water and energy</i>  <i>Governance</i>  <i>Resilience</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		- Renovate urban supply system			
	Strategy A.1.2 Introduce water taxes and fiscal measures for water  * Market-based	<ul style="list-style-type: none"> <li>- Introduce measures to direct and control rivers funded by TRH (water resources tax)</li> <li>- Reduce taxes for firms who save water</li> <li>- Introduce fiscal incentives for all water resources</li> <li>- Introduce tax and fiscal exemption</li> <li>- Introduce efficient norms for "Urban water harvesting"</li> <li>- World trade changes for a fair trade. Combat inequities</li> </ul>	<ul style="list-style-type: none"> <li>- Foster self-production at family level (water and energy)</li> <li>- Optimise water taxes</li> <li>- Significant increase of water taxes</li> </ul>		
<b>Pathway B.1</b> <b>Shift to sustainable lifestyles</b>	Strategy B.1.1 Change food systems and diets  * People-based	<ul style="list-style-type: none"> <li>- Do not waste of ugly fruit</li> <li>- Reduce consumption of meat and other animal products</li> <li>- Guarantee the overall food security and sovereignty</li> <li>- School has to educate children to secure and healthy food</li> </ul>	- Mainstream vegetarian diet		<i>Health, well-being and sustainable lifestyles</i>  <i>Income, education and jobs</i>
	Strategy B.1.2 Establish sustainability education  * People based	<ul style="list-style-type: none"> <li>- Improve technology and human skills</li> <li>- Foster people to education and entrepreneurship</li> <li>- Invest in research</li> <li>- Promote more education on social issues</li> <li>- Change the entire education system (corrected from "integrate")</li> <li>- Introduce adult education</li> <li>- Educate people to save water</li> </ul>	<ul style="list-style-type: none"> <li>- Sustain access to education</li> <li>- Refocus education on sustainability and not competition</li> <li>- Social revolution on environmental concerns relates to political change</li> <li>- Refocus education on sustainability and not on competition</li> <li>- Sustain access to education</li> </ul>	<ul style="list-style-type: none"> <li>- Ensure a stable education system</li> <li>- Support more training, more information to achieve zero unemployment</li> <li>- Support more training, more information to achieve zero unemployment</li> <li>- Ensure a stable education system</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>- Introduce changes in intellectual property</li> <li>- Promote more education on social issues</li> <li>- Change the integrate education system</li> <li>- Improve technology and human skills</li> <li>- Foster people to education and Entrepreneurship</li> <li>- Introduce adult education</li> <li>- Invest in research</li> <li>- Provide more information for consumers on products' origin and their impacts</li> <li>- Adjust the production to the demand</li> </ul>			
	Strategy B.1.3. Shift to local and sustainable markets * Market-based	Local currency and time banks New models of market at the local level - Promote job sharing			
<b>Pathway C.1</b> <b>Move to more sustainable agriculture</b>	Strategy C.1.1 Support ecosystem-responsive agriculture * Nature-based	<ul style="list-style-type: none"> <li>- Shift to ecological agriculture and cattle raising</li> <li>- Adapt the crops to new conditions</li> <li>- Introduce improved, appropriate crop rotations</li> <li>- Introduce new species (crops and animal) for new climate conditions</li> <li>- Change to natural, organic fertilizers</li> <li>- Cultivate bush upland (arbustivos secano)</li> <li>- Recover of autochthonous woods</li> </ul>	<ul style="list-style-type: none"> <li>- Improve efficiency of the extensive systems</li> <li>- Change in cultivations</li> <li>- Create gene-banks to preserve biodiversity</li> <li>- Exploit regimes adapted to natural resources</li> <li>- Change land-use</li> <li>- Implement technology to make crops less climate affected: vertical rural cultures, hydroponic, energy and water sufficiency</li> </ul>		<i>Food, water and energy</i> <i>Protecting the environment</i> <i>Resilience</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>- Abolish GMO products</li> <li>- Mainstream drip system agriculture</li> </ul>			
	Strategy C.1.2 Market measures for efficient agriculture management * Market-based	<ul style="list-style-type: none"> <li>- Incentivise ecological agriculture</li> <li>- Change CAP at European Level</li> <li>- Improve the quality of grazing</li> <li>- Incentivize the population to consume organic agricultural productions and renewable energy</li> <li>- Enforce sustainability principles in pillar I (more action, less talking)</li> </ul>	<ul style="list-style-type: none"> <li>- Give more importance to the II pillar of CAP</li> <li>- Improve the measures for an efficient use of fertilizers</li> <li>- Support studies to establish with the highest accuracy possible the value of each ecosystem service (valorize ecosystem services)</li> <li>- Soil sensing technology for an efficient irrigation</li> <li>- Create a market of biodiversity banks</li> </ul>	<ul style="list-style-type: none"> <li>- Integrate environmental externalities into food and clothing prices</li> <li>- Produce only according to the capacity of the ecosystem</li> <li>- Support consumption of ecological agricultural products</li> <li>- Change the CAP to shift water intensive crops to Northern Europe</li> <li>- Import water and food and export energy to North of Europe.</li> </ul>	
	Strategy C.1.3 Change management system of agriculture * People-based	<ul style="list-style-type: none"> <li>- Fix population to territory</li> </ul>	<ul style="list-style-type: none"> <li>- Effective management of the territory (e.g. restricted areas)</li> <li>- Regulate the for-profit sector</li> <li>- Educate farmers to rural development</li> <li>- Achieve/Maintain social cohesion and agricultural activity through CAP</li> </ul>	<ul style="list-style-type: none"> <li>- Improve water management between the two countries</li> <li>- Create integrated and environmental CAP policies</li> <li>- Guarantee efficient mechanisms of perms management</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
			- Engage with key actors for agro-environmental policy governance		
<b>Pathway D.1</b> <b>Shift to a low carbon economy</b>	Strategy D.1.1 Divest from environmental harmful energy and shift to clean energy * Technology-based	<ul style="list-style-type: none"> <li>- Shut down nuclear central</li> <li>- Turn carbon energy into a zero-emissions energy</li> <li>- Find other technological alternatives to the production of hydric energy</li> <li>- Enforce renewables implementation</li> <li>- Make cities energetically self-sufficient</li> <li>- Put PV on buildings in cities</li> </ul>	<ul style="list-style-type: none"> <li>- Decrease environmental footprint</li> <li>- Decrease energy consumption through better technologies</li> <li>- Ensure that technology is adapted to the existing resources</li> </ul>	- Create and develop cheap renewable energy solutions for agriculture water (desalinisation)	<i>Food, water and energy</i> <i>Sustainable and local economies</i>
	Strategy D.1.2 Shift to low-carbon practices for energy * People-based	<ul style="list-style-type: none"> <li>- Incentivise renewables</li> <li>- Enforce renewables implementation</li> <li>- Reduce need for daily commute. – New forms of work</li> </ul>	<ul style="list-style-type: none"> <li>- Introduce life-cycle assessment (LCA) =&gt; products, services</li> <li>- Unleash the green indicator variables (move from GDP)</li> </ul>		
	Strategy D.1.3 Introduce market incentives for the shift to low-carbon energy * Market-based	<ul style="list-style-type: none"> <li>- Establish an annual carbon budget</li> <li>- Introduce carbon tax based on real carbon costs</li> <li>- Introduce market incentives to green energy (ex. Transport)</li> <li>- Introduce carbon taxing on tourism (e.g. Balearics islands)</li> <li>- Better prices and tax reduction to encourage efficiency</li> </ul>	<ul style="list-style-type: none"> <li>- Provide market or tax incentives to change practices</li> <li>- Market incentives for green practices</li> <li>- Provide economic incentives directed to applied technologies</li> <li>- Differentiate sustainable business</li> </ul>		
<b>Pathway E</b> <b>Strengthen sustainability practice, policy</b>	Strategy E.1.1 Advance policy and governance	<ul style="list-style-type: none"> <li>- Adapt policies to the specific condition of the region</li> <li>- Simplify bureaucracy</li> </ul>	<ul style="list-style-type: none"> <li>- Participate to Forum at any level of decision making, from schools to Parliament</li> <li>- Ensure full transparency</li> </ul>		<i>Governance</i> <i>Cooperation and identity</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>and governance in everyday life</b>	processes for sustainability * People-based	<ul style="list-style-type: none"> <li>- Increase the public participation in the planning</li> <li>- Decentralize political power, structures, cities</li> <li>- Forbid planned obsolescence</li> <li>- Support public budget participation</li> <li>- Put in place more programs on adaptation</li> <li>- Harmonise social and economic development</li> </ul>			
	Strategy E.1.2 Inclusive and just economic development * Market-based	<ul style="list-style-type: none"> <li>- Support redistribution of income</li> <li>- Introduce progressive taxation and more welfare</li> </ul>	<ul style="list-style-type: none"> <li>- Strengthen collaboration with developing countries</li> <li>- Change development metrics</li> <li>- Nurture start-ups with business friendly attitudes</li> </ul>		
	Strategy E.1.3 Conserve Iberian biodiversity	<ul style="list-style-type: none"> <li>- Preserve Iberian Biodiversity</li> <li>- Increase biodiversity integration in sectorial policies</li> </ul>	<ul style="list-style-type: none"> <li>- Prevent huge mergers in agroindustry (less biodiversity then)</li> </ul>		

### Iberian pathways in SSP3:

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway A</b> <b>Move towards integrated and sustainable</b>	Strategy A.3.1 Implement regulation for ecological protection and	<ul style="list-style-type: none"> <li>-Establish minimum water quality protection scheme</li> <li>-Improve water quality</li> </ul>	<ul style="list-style-type: none"> <li>- Conduct continuous review of operation rules considering resources and demands</li> <li>-Boost water reuse – even for drinking (direct potable reuse)</li> </ul>		<i>Food, water and energy</i> <i>Governance</i>



Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>ecosystem management</b>	water quality improvements  *People-based	<ul style="list-style-type: none"> <li>-Introduce eco-label for water use efficiency</li> <li>- Introduce corrective measures for restoration</li> <li>-Improve biodiversity protection</li> <li>-Enforce existing policies on water availability increase</li> <li>-Programme for water storage + water efficiency + reuse (Include addressing social acceptance and funding; Include role of local level)</li> <li>-Reduce environmental standards for water quality (i.e. lake, river) for maximum water quantity</li> <li>-Provide incentives for payments for ecosystem Services e.g. forests</li> <li>-Provide incentives for improving houses, transport etc (energy efficiency)</li> </ul>	-Change water uses, change reservoir operations		<i>Resilience</i>
	Strategy A.3.2 Develop green technologies for ecosystem conservation  *Technology-based	<ul style="list-style-type: none"> <li>-Invest in energy technology: Solar, Wind and bioenergy</li> <li>-Develop technological solutions for water reuse and desalination</li> <li>-Technology development (greening) for adaptation</li> <li>-Invest in renewable energies</li> <li>-Invest in water-saving technology</li> </ul>			
<b>Pathway B Shift to sustainable lifestyles</b>	Strategy B.3.1 Promote education and information for	- Subdivide into social educations; environmental education and Lifestyle adaptation	<ul style="list-style-type: none"> <li>-Promote regional self-sufficiency</li> <li>-Promote different diet (sheep, fish, insects)</li> <li>-Reduce food waste</li> </ul>		<i>Health, well-being and sustainable lifestyles</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	sustainable lifestyles  *People-based	<ul style="list-style-type: none"> <li>-Educate for local solidarity with respect to population and cultures</li> <li>-Implement intercultural education/peace education</li> <li>-Implement education through technology</li> <li>-Promote social education</li> <li>-Implement strict energy measures</li> <li>-Adapt to the availability of resources</li> <li>-Promote self-sufficiency (energy, food, mobility)</li> <li>- Role models for lifestyle, reduced water consumption</li> <li>-Peer recognition</li> <li>-Cultivate influencers (civil society)</li> <li>-NGOs showing best practices re local markets</li> <li>-Skills training</li> <li>-Increase awareness of teachers</li> <li>-Virtual realities/augmented reality to raise awareness</li> <li>-Improve thermal insulation – renovate houses (leads to more jobs)</li> <li>-Provide incentives for mobility solutions away from the private car –(leads to more jobs)</li> <li>-Introduce alternative non-animal proteins (water and land saving)</li> </ul>	<ul style="list-style-type: none"> <li>-Raise awareness for more efficient water reuse</li> <li>-Promote social development and cohesion through education</li> <li>-Show to people that a regional fragmentation is detrimental to solve global change problems</li> <li>-Boost green education programmes</li> </ul>		<i>Income, education and jobs</i>
	Strategy B.3.2 Ensure protection	-Starting in families and local shops			

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	of social and human rights  *People-based	<ul style="list-style-type: none"> <li>-Integration of older people</li> <li>-Social volunteering (non-formal education system)</li> <li>-Implement social policy</li> <li>-Improve solidarity (social and economic)</li> <li>-Strengthen democracy and participation</li> <li>-Eradicate political corruption</li> <li>-Boosting the culture of dialogue and political tolerance</li> <li>-Promote social and religious integration</li> <li>-Raise social awareness towards integration through social networks</li> </ul>			
<b>Pathway C Move towards water efficient agriculture</b>	Strategy C.3.1 Increase water efficiency and quality in agriculture  *Nature-based	<ul style="list-style-type: none"> <li>-Adapt crops and high value/dryland agriculture</li> <li>-Combine irrigation and renewable energy for more efficient use of water</li> <li>-Implement ecological restoration programmes               <ul style="list-style-type: none"> <li>- Improve soil conservation</li> </ul> </li> <li>-Set up energy-driven water allocation</li> <li>-Increase water storage</li> <li>-Avoid increasing impermeability</li> <li>-Reforestation of degraded areas</li> <li>-Drought-resistant species</li> <li>-Promote agro-forestry</li> </ul>	<ul style="list-style-type: none"> <li>-Increase efficient irrigation (but at the same time restrict area used for irrigated agriculture)</li> <li>-Increase desalination</li> <li>-Build dams</li> <li>-Change criteria on land uses and forestry</li> <li>-Implement land use management by farm scale</li> </ul>		<i>Food, water and energy</i>  <i>Protecting the environment</i>  <i>Resilience</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway D</b> <b>Develop rural and urban areas and boost local economies</b>	Strategy D.3.1 Foster local and circular economies  *Market-based	<ul style="list-style-type: none"> <li>- Promote a balance between rural and urban areas</li> <li>-Promote regional rural development</li> <li>-Inclusive local market development</li> <li>-Local markets production, waste, water, energy and services</li> <li>-Rural development linked to circular economy and biodiversity economy and bio-economy, e.g. cork sector</li> </ul>	<ul style="list-style-type: none"> <li>-Promote local economy and local job creation</li> </ul>		<i>Food, water and energy</i>  <i>Sustainable and local economies</i>

#### Iberian pathways in SSP4:

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway A.4</b> <b>Protect water resources through trans-regional collaboration</b>	Strategy A.4.1 Implement infrastructure and technologies to maintain and improve the integrity of all water bodies  * Technology-based	<ul style="list-style-type: none"> <li>- To guarantee wastewater treatment (urban and industrial uses)</li> <li>- Pump back water to reservoirs when there is excess of energy</li> <li>- Increase recirculated water</li> </ul>	<ul style="list-style-type: none"> <li>- Adapt to effects of climate change (sea level rise)</li> <li>- Improve water policies</li> <li>- Develop river restoration strategy</li> <li>- Increase desalination</li> <li>- Assure water desalinated for most population near coast</li> <li>- Improve water infrastructure to reduce water loss</li> <li>- Improve technologies for recirculated water</li> </ul>	<ul style="list-style-type: none"> <li>- Improve water management in irrigation projects</li> <li>- Restore river areas at start of river basin</li> </ul>	<i>Food, water and energy</i>  <i>Governance</i>  <i>Resilience</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	Strategy A.4.2 Set up and maintain trans-regional and integrated governance systems on water  * People-based	<ul style="list-style-type: none"> <li>- Sign the Toledo Protocol between Spain and Portugal to have water</li> <li>- Include an objective for the use of the soil – land use directive</li> <li>- We advance in updating cycles to renew the protocol in 2030 – second review: to impose new tariffs/taxation on water – water taxation</li> <li>- Regionalise partially the management of the Tagus river basin using the model of the Great Lakes in North America (transboundary, e.g. in Iberia Extremadura, Andalusia, etc.)</li> <li>- Review the Albufeira protocol: has it been amended by the government of Portugal and Spain in 2017 but not implemented – model the Toledo Protocol on the Albufeira and implement it rigorously</li> <li>- Close the Tagus-Segura water transfer</li> </ul>	<ul style="list-style-type: none"> <li>- Periodic review of whether water tariffs are according with development</li> <li>- Set up common agencies for water (Portugal and Spain)</li> <li>- Public administration makes river basin plans to regulate uses (urban; industrial; agriculture)</li> </ul>	<ul style="list-style-type: none"> <li>- Implement measures to ensure good relationships between both countries</li> </ul>	
	Strategy A.4.3 Implement regulation and monitoring to protect water quality and quantity	<ul style="list-style-type: none"> <li>- Monitor water flows in rivers to ensure sustainable flow</li> <li>- E-flow monitoring by real-time summer and winter</li> <li>- Progressive water pricing (water pricing includes costs of wastewater cleaning; real price of water) (who: public administration, owners, users / how: public agencies)</li> <li>- Measure ecological flows in each moment, instantaneous flows</li> <li>- Implement conservation policies for natural areas to protect water resources</li> </ul>	<ul style="list-style-type: none"> <li>- Ear-mark water quotas (prices) for use in basin, rivers, water</li> <li>- Implement plans for efficient water use</li> <li>- Implement sanction for illegal wells</li> <li>- Conduct inspection</li> <li>- Regulate the rich to reduce loss of water in system (e.g. agriculture)</li> <li>- Progressive tariffs for water uses and amounts</li> <li>- Improve management of infrastructure to keep in good condition</li> <li>- Enforce the real price of water</li> </ul>	<ul style="list-style-type: none"> <li>- Strengthen sustainable water policies</li> </ul>	

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>B.4 Promote sustainable lifestyles and values</b>	Strategy B.4.1 Educate on sustainability values and behaviour * People-based	<ul style="list-style-type: none"> <li>- Transmit traditional knowledge in education system</li> <li>- Inform people about environmental problems and develop environmental consciousness</li> <li>- Implement strategy for immigration education</li> </ul>	<ul style="list-style-type: none"> <li>- Educate people on intergenerational solidarity and to think more about the medium and long-term</li> <li>- Educate on health food behaviours</li> <li>- Increase education for emission reduction</li> <li>- Implement taxation for hyper-caloric food</li> </ul>		<i>Health, well-being and sustainable lifestyles</i>  <i>Income, education and jobs</i>
	Strategy B.4.2 Ensure social equity * People-based	<ul style="list-style-type: none"> <li>- Guarantee access to basic services</li> </ul>	<ul style="list-style-type: none"> <li>- Implement equality policies</li> </ul>	<ul style="list-style-type: none"> <li>- Improve salaries</li> <li>- Implement social universal income for all</li> </ul>	
<b>Pathway C.4 Foster organic agriculture that ensures food quality and quantity for all</b>	Strategy C.4.1 Promote sustainable and organic agriculture in synergy with rural development * Nature-based	<ul style="list-style-type: none"> <li>- Use of the crops adapted to the climate</li> <li>- to less precipitation and high temperatures</li> <li>- Produce biogas with effluents from cattle grazing</li> <li>- Implement sustainable forestry (including livestock)</li> <li>- Ensure that agricultural sequences go over 6 years so they do not coincide with the hydrologic sequences</li> <li>- Keep livestock in the mountains to avoid forest fires and regulate the vegetation</li> <li>- Limit the pressure/density of livestock intensity in Iberia</li> <li>- Stop burning old grass etc., to incorporate biomass, e.g. creating compost (incorporation on the soil)</li> <li>- Protection natural space</li> </ul>	<ul style="list-style-type: none"> <li>- Increase carbon sinks/absorption – carbon fixing</li> <li>- Produce high good quality food</li> <li>- Improve grazing</li> <li>- Promote rural areas through agriculture and tourism</li> <li>- Ensure that livestock pressure is adequate to the soil / context</li> <li>- Form/use organic materials in the soil/ground of forests</li> <li>- Reduce the areas of forest for evapotranspiration and forest consumption during drought</li> <li>- Avoid soil degradation and erosion by conservation agriculture and forestry</li> <li>- Create terraces to avoid soil erosion and fix soil</li> </ul>		<i>Food, water and energy</i>  <i>Protecting the environment</i>  <i>Resilience</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
		<ul style="list-style-type: none"> <li>- Increase compost of the rest of farm materials</li> <li>- Adaptation of agriculture to water resources</li> <li>- Adapt forestry techniques</li> <li>- Fight against foreign invasive alien species (e.g. plants, fish)</li> <li>- Promote sustainable farming activities (e.g. crops, livestock)</li> <li>- Shift to/recover local/traditional crop species</li> <li>- Shift to less water demanding crops</li> <li>- Shift soil uses to conserve soil (e.g. agricultural practices promote good soil conservation)</li> <li>- Reduce carbon footprint of agriculture</li> <li>- Reduce forest fires</li> <li>- Reforestation</li> <li>- Restore ecosystems/corridors to improve water quality by filtering pollutants</li> <li>- Manage the soil after a forest fire to prevent erosion and pollution</li> <li>- Implement conservation agriculture – you do not work the land, no labour</li> </ul>			
	Strategy C.4.2 Promote sustainable agriculture regulations	<ul style="list-style-type: none"> <li>- Provide funding to farmers to adapt crop species (public administration, funding, subsidies from national governments and EU)</li> <li>- Implement forestry politics</li> <li>- Ban fertilisers</li> </ul>	<ul style="list-style-type: none"> <li>- Manage food distribution – also how to manage excessive stocks of food (to reduce food waste)</li> <li>- Manage the production of the agricultural stock to avoid having</li> </ul>		

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	*People-based	<ul style="list-style-type: none"> <li>- Penalties for burning waste from agriculture</li> <li>- Payment schemes for ecosystem services (e.g. vegetation and water quality, compensate farmers)</li> </ul>	<ul style="list-style-type: none"> <li>excessive stocks of food that are unsellable</li> <li>- Implement programme of rural development</li> <li>- Provide education and training in the rural environment – in the techniques of how to work the land, links to modernisation and new equipment, irrigation techniques – new technological solutions</li> <li>- Provide subsidies for ecological agriculture</li> </ul>		
	Strategy C.4.3 Innovate technologies for sustainable agriculture *Technology-based	<ul style="list-style-type: none"> <li>- Increase water efficiency in agriculture</li> <li>- Innovate technologies for agriculture</li> </ul>	<ul style="list-style-type: none"> <li>- Eliminate/substitute fossil fuels by renewables in agricultural practices</li> </ul>		
<b>Pathway D.4</b> <b>Establish a low-carbon economy powered by 100% renewables</b>	Strategy D.4.1 Invest in green technologies * Technology-based	<ul style="list-style-type: none"> <li>- Improve self-sufficient energy (solar)</li> <li>- Produce and use renewable energies</li> <li>- Increase safety/security of electricity system (interconnecting goes up)</li> <li>- Improve renewable energies, maintain or decrease nuclear</li> <li>- Support low carbon production processes</li> <li>- Support for green technologies</li> <li>- Foster renewable energies in agriculture (e.g. machinery, irrigation, transport, processing)</li> </ul>	<ul style="list-style-type: none"> <li>- Implement low carbon production</li> <li>- Establish interconnection of energy Europe and North Africa</li> <li>- Make implementation of green energy compulsory</li> <li>- Phase out nuclear (zero nuclear)</li> </ul>	<ul style="list-style-type: none"> <li>- Implement self-sufficient green energy</li> </ul>	<i>Food, water and energy</i> <i>Sustainable and local economies</i>



Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	Strategy D.4.2 Foster a diversified local economy  * Market-based	<ul style="list-style-type: none"> <li>- Diversify economic activities of rural world</li> <li>- Establish local markets</li> <li>- Promote local production and consumption</li> <li>- Promote local economic activity based on local resources, e.g. food production and traditional activities</li> <li>- Promote sustainable tourism in Iberia as one way to reduce unemployment</li> <li>- Promote local industry in wood products</li> <li>- Incentives for biofuels from forests</li> </ul>	<ul style="list-style-type: none"> <li>- Unlink development from consumption from natural goods</li> <li>- Increase VAT (e.g. food imports)</li> <li>- Form cooperatives</li> </ul>	<ul style="list-style-type: none"> <li>- Implement circular economy</li> </ul>	
<b>Pathway E.4</b> <b>Promote a sustainable and democratic governance system</b>	Strategy E.4.1 Ensure basic service provisions through accountable and fair governance  * People-based	<ul style="list-style-type: none"> <li>- Promote women in decision-making positions</li> <li>- Put in place more participatory governance</li> </ul>	<ul style="list-style-type: none"> <li>- Implement legislation for responsible consumption – controlling e.g. eating big steaks, buying too many clothes, doing this through raising prices of the products</li> <li>- Help NGOs</li> <li>- Promote social collaboration and cooperation</li> <li>- Foster networking of people</li> <li>- Integrate cultural heritage</li> <li>- Foster social enterprises (worker owned companies)</li> <li>- Engage in political activism</li> <li>- Cooperate outside the system – get out of the grid (informally)</li> </ul>	<ul style="list-style-type: none"> <li>- Put justice to work (the courts of law)</li> <li>- Establish participative democracy – from elite to citizens</li> <li>- Demand changes through local population movements, NGOs</li> <li>- Support rural women</li> <li>- Change the tax system to re-distribute profits to have-nots</li> </ul>	<i>Governance</i>  <i>Cooperation and identity</i>

## Iberian pathways in SSP5:

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
<b>Pathway A.5</b> <b>Support integrated water management</b>	Strategy A.5.1: Improve water management infrastructure and technology * Technology-based	<ul style="list-style-type: none"> <li>- Improve wastewater treatment</li> <li>- Introduce subsidies to water efficiency measures</li> <li>- Investment on water efficiency technologies</li> <li>- Risk analysis for whole industry chain + life cycle</li> <li>- Reutilization of water (100%)</li> <li>- Cost-effective desalinization in the Atlantic with renewable energy</li> <li>- Real-time water resources monitoring &amp; measures (WFD)</li> <li>- Real (actual) monitoring of water quality</li> </ul>	- Introduce efficiency solutions		<i>Food, water and energy</i>  <i>Governance</i>  <i>Resilience</i>
	Strategy A.5.2: Develop regulation to protect water quality and quantity * People-based	<ul style="list-style-type: none"> <li>- Make water metering compulsory for farmers</li> <li>- Suspend Tagus-Segura transfer</li> <li>- Regulations for housing to save water (appliances)</li> <li>- Give water authorities real power for a given watershed (in WFD)</li> <li>- Integrated River Basin Management addressing uses (energy / food), environment, climate with rules for minimum approach</li> </ul>	- Draw regulation on water use and sealing soil		
<b>Pathway B.5</b> <b>Promote sustainable lifestyles</b>	Strategy B.5.1 Introduce environmental education	<ul style="list-style-type: none"> <li>Societal change of perception</li> <li>Revolutionize way of working</li> <li>Food change in consumption and production</li> </ul>	<ul style="list-style-type: none"> <li>- Invest in social sciences – tools for change</li> <li>- Work with media to improve environment communication</li> <li>- Make water awareness campaigns</li> </ul>	<ul style="list-style-type: none"> <li>- Build capacity for water efficiency</li> <li>- Support cultural change towards sustainable lifestyles</li> </ul>	<i>Health, well-being and sustainable lifestyles</i>  <i>Income, education and jobs</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
	* People-based	Change distribution of working hours Transnational food revolution – fair trade obligatory environmental evaluation - Change energy policy	- Set up climate change awareness campaigns - Support applied research - Reform the education system - Make lifestyle change campaigns - Make campaigns to reduce meat consumption	-Mandatory food sufficiency (controversial) - Learn to live well with “less” (because less resources) - Promote local renewable energies (auto-sufficiency)	
<b>Pathway C.5 Move towards water efficient agriculture</b>	Strategy C.5.1: Adapt agriculture to water availability *Nature-based	- Foster permanent crops (less water intense) - Change summer crops to winter crops (less irrigation) - reforestation with native species - biodiversity + forest management - ecosystem based adaptation	- Reduce irrigation surface - Relocate irrigated agriculture in North-western Iberia? - Adapt water use to resources - transformation of agriculture - cultivate where there is rainfall - Focus CAP on innovation and adaptation measures to climate change - agroecology in small fields - Manage recovery of land: agro-forestry system “montado/dehesa”, humid areas - Improve network of protected areas (ecological connectivity)		<i>Food, water and energy</i> <i>Protecting the environment</i> <i>Resilience</i>
<b>Pathway D.5: Promote strong environmental governance</b>	Strategy D.5.1: Strengthen environmental policies and governance * People-based	- Introduce rules and practical guidelines for CAP implementation - Reinforce the EBA with incentives, sanctions and guidelines - Collaboration + co-creation of strategies for territorial organization	- Create programs that cities are not the only development sites - Introduce regulation on marine use for oil exploitation - Integrate environment in all policies and make environmental protection a priority - Resources rationing policies	- Transfer competences to EU or UN - Engage in global integrated environmental decision-making	<i>Governance</i> <i>Cooperation and identity</i>

Pathway	Strategies	Actions			Vision elements addressed
		2015-2040	2040-2070	2070-2100	
			<ul style="list-style-type: none"> <li>- effectiveness of organization of use of territory</li> <li>- Improve efficiency in transport, energy, housing</li> </ul>		
	Strategy D.5.2: Put in place an environmental monitoring system * Technology-based	<ul style="list-style-type: none"> <li>- Establish a CAP governance scheme with close monitoring</li> <li>- Use mid-term climate forecasts to support Spain-Portugal agreements (WFD)</li> <li>- Stricter follow-up of investments (e.g. performance of waste water projects)</li> </ul>	<ul style="list-style-type: none"> <li>- Create a culture of measuring (e.g. measuring individual consumption in agriculture)</li> <li>- Ensure that decision making is supported by science</li> <li>- Support international knowledge sharing mechanisms</li> <li>- knowledge transfer (policy-science business)</li> </ul>		
	Strategy D.5.3: Implement environmental taxes * Market-based	<ul style="list-style-type: none"> <li>- Stop subsidies where groundwater is exploited</li> <li>- Internalization of externalities and environmental costs in financial accounting</li> <li>- Promote small companies</li> <li>- Enable tax buying, tax trashing, promote re-use (2nd hand sale)</li> <li>- Promote communities with residue recycle</li> <li>- Change economic indicators</li> </ul>			