



Horizon 2020 Societal challenge 5
Climate action, environment, resource
Efficiency and raw materials

D5.6 SUMMARISING THE POLICY RECOMMENDATIONS FROM ALL CASE STUDIES

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Executive summary

This report contains a summary of the policy recommendations from the 12 cases of the Horizon2020 project [SIM4NEXUS](#), which investigated the linkages, i.e. the nexus, between the domains water, land, energy, food and climate (the 'WLEFC Nexus'). They are shown in an overview clustered in seven themes in bold, with some prominent recommendations in italics and major objectives in bold and italics.

In theme A **Energy transition** it is about achieving *climate neutrality in 2050*. A clean energy transition involves the use of bioenergy, model assessments from the Global case demonstrates, but large scale provision of bioenergy from crops, plantations and forests may have severe trade-offs to water, land and biodiversity, global food security, climate adaptation and even mitigation. We should therefore be *stimulating bioenergy without trade-offs*. A challenge is then to establish the urgency and actual motivation to monitor and evaluate the effects on food security, water, land, landscape, soil and biodiversity. This should then be supported by *better spatial regulations of energy crops*. In addition, resource efficiency in the whole agro-food chain may compensate these trade-offs to some extent. In general, the energy transition calls for efforts to *Promote energy efficiency & savings*, but by doing so the EU-case adds, a greenhouse gas tax would be needed to support the shift from carbon emissions to renewables. We should however engage in this efforts without relying too much on a technological fix, as our energy use is deeply engraved into habitual behaviour. Many interlinked tasks would increase both opportunities and reduce obstacles, with more transboundary cooperation as emphasized by the France-Germany case. There are also calls for more coordination and better economic incentives, and systems for *the use of organic waste*, but then without losing sight to reducing waste instead of just burning waste. But also popular new issues as solar power should be carefully introduced by for instance *reducing trade-offs by land-based solar power*. There are also links to a major issue as replacing animal by vegetable proteins in our diet.

Theme B Agro-Food chain transition addresses a combination of *Food security, improved public health and sustainability*. A shift towards a *Healthy diet: more plant-based and less animal proteins* is brought forward as a major impulse for this change but is a transition in itself which should be accompanied by major efforts for business and lifestyle changes, followed up by *Less livestock and more arable farming*. Additional measures proposed are also to stimulate less *nutrition loss and pesticide* and *promote organic farming*, and stimulating for instance *more sustainable cereals production* and *Stimulate less water-demanding crops*. All these represent substantial changes for agriculture but agriculture should not and cannot take all the burdens. A fair division of burdens and benefits must be pursued. All these matters are challenges for the new CAP-strategy Farm to Fork, but in combination with other plans such as the Biodiversity Strategy.

Theme C Water management under climate change to *Ensure water quality & quantity*. The water policy faces many challenges like catching up with delayed implementation, improve the quality of the EU's water bodies (also by cleaning up past pollution), enhance the limited policy enforcement and accountability and less reliance on a technological fix. But also more integration of water objectives in other policy areas such as agriculture, energy and coherence with other legislation, such as the Nitrates Directive and the Urban Waste Water Treatment Directive. This has not happened yet at the scale necessary. A recommendation concerning water works from Sardinia, is a system of *Shared vision of water management (responsibilities)*, also in relation to food/agri, energy and nature. The latter is pivotal as this is not just about agreeing on water in general but on how to share responsibilities. This proposal could be scaled up to projects and collaborative programs within the whole EU, and with a link to the EU in a workable and accountable way. Such a renewal of the water planning should come with a chapter on how to Identify regulatory ambiguity and clarify responsibilities within such a program or project. Consensus on the rules of play is important. Further

improvement could benefit from measures to *Improve the learning for better tools for water irrigation* and applying *less water consuming crops with More economic incentives to reduce water losses*.

Theme D Nature based land-use, landscape restoration, ecosystem services and biodiversity is meant to **Make biodiversity recovery beneficial**. A cornerstone for change here is to *Prioritise nature-based planning and measures*. Declaring nature-based multifunctionality as a priority for water, climate, land policies comes from the France-Germany case. It requires legal changes, such as mandatory planning requirements, but it does also goes further, as it requires new sector-crossing ways of thinking and acting, based on new values, tools and practices, including financing, research, trainings. *Land-use regulation to end conflicts* will add value to such arrangements. Additional recommendations concerns *Encourage flexible land-use in agriculture*, and new ways to *Promote biodiversity friendly food production*. Here we point to theme F and its Payments for ecosystem services.

Theme E Governance by cross-sectoral cooperation must help to **Mainstream sustainability & remedy incoherence**. In general the governance covers a field of work that require mentality change. *Stimulate cross-sectoral mind-sets against silo-thinking* is a demanding task, although *more partnership working* is not an unknown way of working, it is now seen in the light of a different and more cross-sectoral setting. The need to achieve long-standing commitment is of great importance. It is also proposed to couple this ambition to a *change in the education system* where transdisciplinary and cross sectoral work is being integrated early. It is also said that such a change should be addressed with a *Link to consumer lifestyle & business models to biodiversity*, a program to *Promote energy, water and food demand reduction*. The governance should then be accompanied by ways of discussing, assessing and evaluating competing claims for water, land, energy, food and climate. This is also a call for additional arrangements to expand and scale up the learning by good examples.

Theme F Strong instruments backed by EU frameworks is guided towards **Effective & efficient in linking issues without compromising objectives**. For an instrumental renewal it is proposed to strengthen existing instruments: *CAP implementation: Stricter conditions for public funding and lowering the administrative burden for applicants to a subsidy for voluntary measures*. This could be a strong way of stimulating more sustainable practices in agriculture. More integration, stricter conditions and lower administrative burdens of Good Agricultural and Environmental Conditions (GAEC) and Greening measures from CAP could be applied for this purpose, and direct payment could be linked to public services instead of agricultural land area. Such public services are for example restoring and keeping up the landscape, soil and vegetation for water retention and carbon sequestration. Today these instruments are difficult to apply in practice, the Greening measures have for instance only been partially implemented and did not lead to the expected results in for example the Czech Republic; Ecological Focus Areas (EFAs) had been implemented only to a little extent. Another way to improve instruments is to *Explore and innovate the practical potential of payments for ecosystem services*. It is far from easy to establish consensus on the values but its potential is substantial.

Theme G Science-policy interface for a learning society is for *Using science for impact*. In essence it is proposed to develop and apply more *Cross-sectoral and Nexus-proof evaluations of policy implementation processes*. At the core it is about clarifying the impacts of policies on other nexus sectors demands an advancement of knowledge of how sectors influence each other and also acceptance of the impact assessments used for making priorities. It does call for additional changes as well, such as; *Improve science based tools for policy formation*; and *Enhance digital data access and interoperability*. With these efforts it could be easier to bring scientific causal patterns into public debate, but also to upgrade sector-crossing knowledge frameworks. Better access to public data would ease the work and clarifying the scientific criteria for policy choices would potentially be of great value to policy and policy assessments.

Changes with respect to the DoA

No changes

Dissemination and uptake

The audience targeted/addressed here is the European Commission, MS policy makers and stakeholders from the domains water, land, energy, food and climate, within or outside the project.

Short Summary of results (<250 words)

This report contains a summary of the policy recommendations from the Horizon2020 project [SIM4NEXUS](#):

A) the energy transition: resolve trade-offs to water, land and biodiversity, global food security, climate adaptation and mitigation by improving the practice of bioenergy from crops, plantations and forests.

B) the agro-food chain transition: support a shift towards a more healthy diet, with more plant-based and less animal proteins, but also major business and lifestyle changes.

C) Water resource management: improving policy enforcement and accountability without losing sight to local conditions and needs, with more integration of water objectives in other policy areas (agriculture, energy, land) and coherence with other legislation (the Nitrate Directive).

D) For nature based land-use, landscape restoration, ecosystem services and biodiversity there is a need to prioritise nature-based planning as a priority for water, climate, land policies.

E) Governance by cross-sectoral collaboration in the nexus is needed to stimulate more cross-sectoral mind-sets against silo-thinking and also stimulate more partnership working.

F) Strong instruments backed by EU-frameworks refer to a need for strengthening the CAP implementation by stricter conditions for public funding and lowering the administrative burden of the Good Agricultural and Environmental Conditions (GAEC), Greening measures, and direct payment for public services instead of agricultural land area.

G) Science-policy interface for a learning society is about clarifying the impacts of policies on other nexus sectors. It calls for better access to public data, knowledge of how sectors influence each other and also acceptance of the impact assessments used for making priorities.

Evidence of accomplishment

The report will be public available.

Glossary / Acronyms

As the document is being written, terms and glossary will be added here as needed. Before the last version is submitted this list will be re-arranged alphabetically by the lead author.

CAP	Common Agricultural Policy
CCS	Carbon Capture and Storage
DG	Directorate General
EC	European Commission
EU ETS	European Emission Trading System
EU	European Union
FAO	Food and Agriculture Organization
GHG	Green House Gas
MS	Member State
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
RES	Renewable Energy Systems
SDG	Sustainable Development Goal
UN	United Nations
UNFCCC	United Nation Framework Convention on Climate Change
WEF	Water-Energy-Food
WFD	Water Framework Directive
WLEFC	Water-Land-Energy-Food-Climate

1 Introduction

1.1 Context

This report contains a summary of the policy recommendations of the Horizon2020 project [SIM4NEXUS](#), which investigated the linkages, i.e. the nexus, between the domains water, land, energy, food and climate (the ‘WLEFC Nexus’), see Figure 1. These domains are connected to each other in complex ways and pressure on one part of the nexus create pressure on the others, causing challenges for policies and societies (Brouwer et al 2018; Zhang et al 2018, Hoff, 2011).

The notion of a nexus is a conceptual approach to policy that emphasizes the cross-sectoral and multi-scale integration of the low carbon and resource efficient solutions needed. The nexus approach can support the transition to a Green Economy which aims at resource use efficiency and greater policy coherence (Hoff, 2011). Focus on the interconnectedness and interdependencies across scales and sectors might help reduce negative economic, social and environmental externalities by more efficient resource use, provide dynamic benefits and secure the human rights to water and food (Hoff, 2011). A nexus approach aims to identify and analyse trade-offs between conflicting policy objectives and synergies.

The current agenda for policy is to achieve the Paris Agreement on climate, the Sustainable Development Goals (SDGs) and the EU Green Deal. The policy agenda reveals an ambitious endeavour that requires effective and coherent policies within and across the domains.

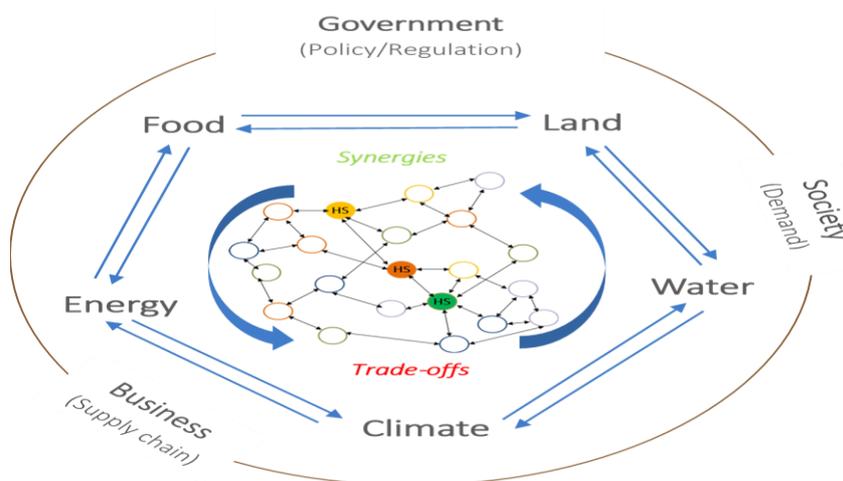


Figure 1. WLEFC nexus framework in the SIM4NEXUS project (adapted from Mohtar and Daher, 2016). HS = hotspot of nexus relations.

1.2 Goal, question and approach

The objective here is to present a summary of the recommendations of the 12 SIM4NEXUS case studies, see Figure 2. The policy recommendations for the case studies were derived from the case study descriptions in Brouwer et al (2020). The research question is *which recommendations have the case studies in SIM4NEXUS made to formulate and implement a more efficient and coherent policy for water, land, energy, agriculture and food, and climate*. The SIM4NEXUS cases delivered policy recommendations stemming from four years of analyses.

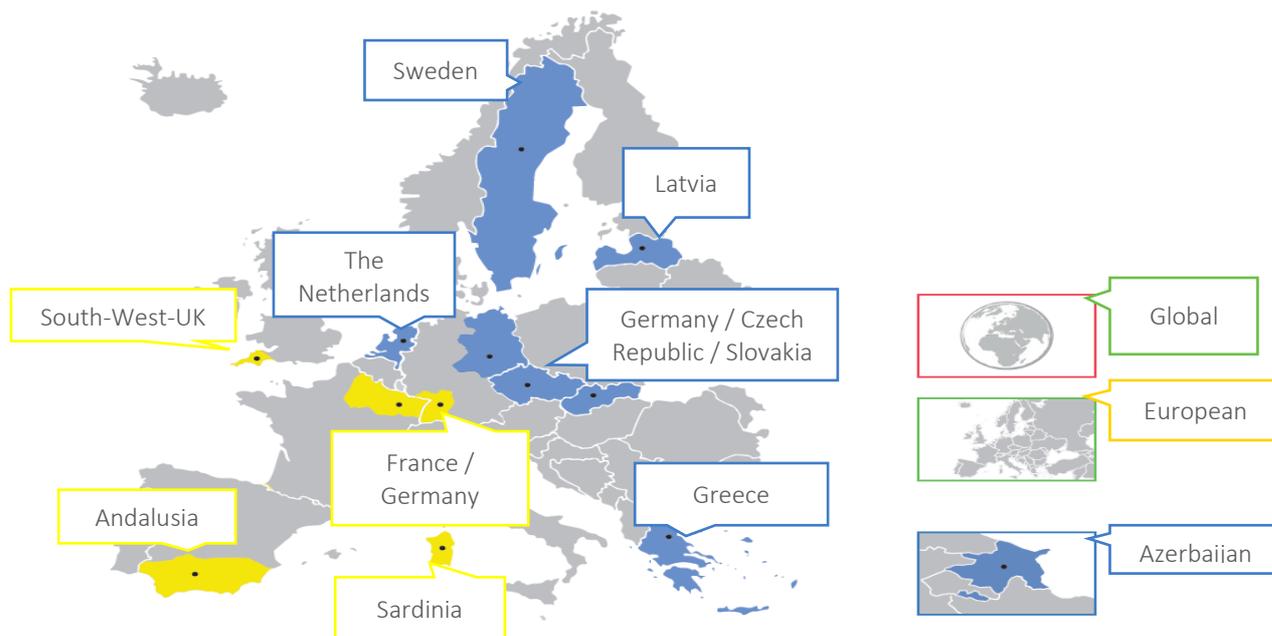


Figure 2. The twelve SIM4NEXUS case studies

The case work has been published throughout the project period (in for instance Munaretto and Witmer, 2017; Munaretto et al, 2018; Witmer, et al 2018; Robbmond et al, 2018; Brouwer and Fournier, 2019; Selnes et al, 2019). All of the policy recommendations we refer to were tailor-made for the specific cases. Every case made its own recommendations based on their specific issue at stake and analyses of policy coherence from document research and gathered data, with workshops and interviews of stakeholders. The Global and European cases based for instance their recommendations on modelling, using thematic models. The Southwest-UK case on water used the System Dynamics model for some of their recommendations. The Netherlands focused on biomass and used a literature study and interaction in workshops to identify barriers and opportunities and from that formulate the recommendations.

1.3 Structure of the document

The report is structured in four chapters. This chapter 1 contains the structure of the document, the aim pursued and an overview of the cases built up in the project SIM4NEXUS. Chapter 2 offers the summary of the recommendations. Chapter 3 connects the recommendations to the recent EU Green Deal, the policy agenda for which the recommendations are related to.

2 Summary of policy recommendations from the SIM4NEXUS cases

2.1 Introduction

This chapter contains the summary of the recommendations from the SIM4NEXUS cases. First we present the main formal policy goals involved and then a table with the recommendations of the SIM4NEXUS cases.

We also note that the cases are still in different stages of development and some will complete the recommendations after further model simulations or when the Serious Game has been played. But what we have might contribute to more general policy recommendations that concern more cases and therefore will be relevant for a higher level of policy making: regions and EU MS (member states) might share common characteristics or issues, with commonalities that might call for similar changes at the EU level, or even the global level.

We present the results by using categories; a brief description with the main targets; the challenges involved; the targeted institutions; and the targeted policy processes; and which source case it comes from. The scale the recommendations are referred to as: regional, national, European, global. For the EU the Green Deal is the central arena and agenda, as this is now in the stage of being worked out into detailed plans and programmes.

For this summary, the recommendations of the SIM4NEXUS cases are clustered in the following themes:

- Energy transition in the nexus between water, land, energy, food and climate (A);
- Agro-food chain transition (B);
- Water resource management under climate change (C);
- Nature based land-use, landscape restoration, ecosystem services and biodiversity (D);
- Governance by cross-sectoral collaboration in the nexus (E);
- Strong instruments backed by EU-frameworks (F);
- Science-policy interface for a learning society (G)

2.2 Energy transition

The main global policy for energy is the Paris Agreement from 2015 and the 2015 United Nations SDG goal 7. In the EU there are goals from the Renewable Energy Directive (2018) and the Directive on Energy Efficiency from 2018. At the end of 2019 the European Green Deal is introduced and a binding European Climate Act will come later. The Regulation on the governance of the energy union and climate action (EU)2018/1999 entered into force on 24 December 2018 and is part of the Clean energy for all Europeans package (European Commission, 2015). The EU Member States now must make a 10-year integrated national energy and climate plan (NECP) for the period from 2021 to 2030. The EU Energy Union, as it is called, is built on five dimensions and renewables are central to all: energy security; market integration; energy efficiency; decarbonisation and innovation. Cooperation is here a core value for progress and the different countries can contribute to the energy union in different ways.

2.2.1 Policy goals

Limiting global mean temperature increase below 2 degrees compared to pre-industrial situation.	UNFCCC Paris Agreement (UNFCCC, 2015).
Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all. 7.1 By 2030, ensure universal access to affordable, reliable and modern energy services 7.2 By 2030, increase substantially the share of renewable energy in the global energy mix 7.3 By 2030, double the global rate of improvement in energy efficiency By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology	United Nations (2015)
No net emissions of greenhouse gases in 2050 by Europe. 50-55% reduction in 2030 of greenhouse gas emissions compared to 1990	The European Green Deal (EC, 2019)
Reach at least a 32% share of renewable energy in the EU by 2030 with a clause for an upward revision of the share by 2023. Limit on share of high ILUC-risky bioenergy from food and feed crops with expansion into land with high-carbon stock. A freeze at 2019 levels for the period 2021-2023 (may be used but not accounted for target achievement), then decrease from the end of 2023 to 0% in 2030. Currently only palm oil defined as risky (EC, 2019).	EU Renewable Energy Directive (EC, 2018a).
Increase energy efficiency in EU at least 32,5% in 2030 compared to reference projection, leading to annual cumulative energy saving of at least 0.8 % of final energy consumption in MSs from 2021 to 2030, with a clause for upwards revision of the % by 2023.	Directive on Energy Efficiency (EU, 2018b)

2.2.2 Recommendations

If we look at the recommendations we see that many of these goals have been addressed in the cases, see Figure 3. Addressing the trade-offs and risks of bioenergy is a recommendation from the global case but is also part of the France-Germany case. France-Germany also call for better regulations of land, more cooperation and promotion of energy efficiency and savings, and the latter is also emphasized in the EU case. From the Sardinia case we learn that there is also a need for improving the energy infrastructure by for instance Smart Grids, in order to enhance the access of renewables into the energy market, see Table 1.

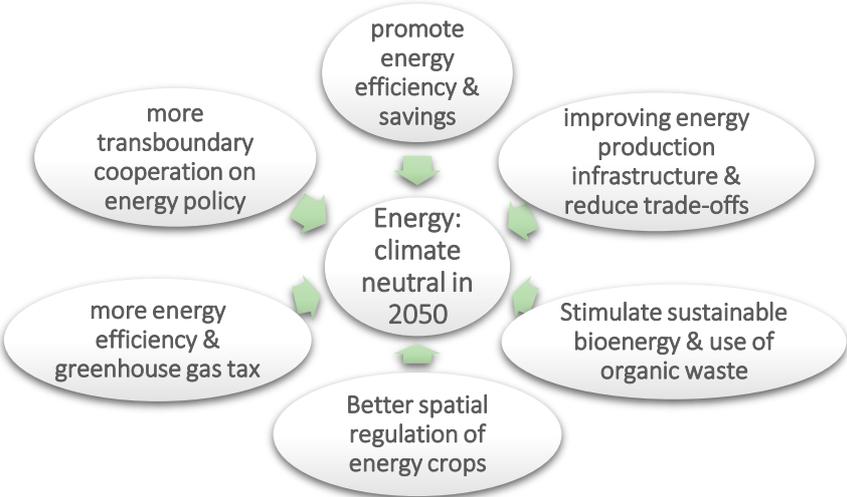


Figure 3: brief overview of recommendations for the energy transition

Table 1: Summary of recommendations for the energy transition

No	Source case	Recommendation	Challenge	Target Institutions	Target policy processes
A1	Global	Stimulating bioenergy without trade-offs	Monitoring and evaluation of bioenergy related to food and land	UNFCCC and EU DG CLIMA, DG AGRI, DG ENER a.o.	Global and EU climate policy making
A2 (E5)	France-Germany (SW-UK)	More energy efficiency and energy saving	Change focus to energy efficiency and energy saving.	National and regional policy makers in Grand-Est and Baden-Württemberg.	Energy and climate policy formation.
A3	France-Germany	Reduce trade-off of land-based solar power	Stricter laws and law enforcement	National and regional policy makers	Law and law enforcement and policy funding
A4	Greece	Further promotion and use of RES for electricity generation.	Increase RES share to lower prices of RES (remove economic barriers)	Ministry of Environment and Energy.	Greece national energy policy
A5	France-Germany	Separate collection of households' organic waste for energy.	Requires a stricter law and social acceptance	Ministry of Ecology, Sustainable Development and Energy)	Law for energy transition and green growth (2015). EU Circular Economy
A6	France-Germany	Strengthen transboundary cooperation on energy policy.	More cooperation, division of costs and benefits.	Public and private energy stakeholders	Upper Rhine conference.
A7	France-Germany	Set a maximum of cultivated area with spatial rules for energy crops	Minimizing the pressure on water resources	Policy makers France and Germany	Legal changes and funding
A8 (A2)	EU	More focus on energy efficiency in combination with a GHG tax.	Reducing GHG emissions while limiting trade-offs to food, land, water.	EU DG Climate Action, DG Agri. Economic sectors	EU Climate plan EU-Green Deal
A9	Sardinia	Energy distribution by Smart Grids to enhance the RES share.	Moving forward from research to practice	Regional government and Ministry of Economic Development (energy)	Funds for R&I and pilot sites

A1: Stimulating bioenergy without trade-offs. Stimulating bioenergy should only be put in place if both food security and climate-neutrality are guaranteed and effects on water, land, landscape, soil and biodiversity are monitored and avoided or mitigated. A clean energy transition involves the use of bioenergy, according to model assessments by the Global case. However, large scale provision of bioenergy from crops, plantations and forests may have severe trade-offs to water, land and biodiversity, global food security, climate adaptation and even mitigation. Replacing animal by vegetable proteins in our diet and increasing resource efficiency in the agro-food chain may compensate these trade-offs to some extent, as these measures are synergistic with goals for energy, climate and natural resources. It is emphasized that many institutions should be involved, such as the UN institutions (UNFCCC, IPCC, UNEP, General Ass. SDGs, etc.) and EU institutions (EC DGs CLIMA, AGRI, ENER, DEVCO, ENV; Council; Parliament). In addition also national governments must be involved. The main policy process targeted is the UNFCCC Paris agreement implementation at all levels: UN, EU, national, regional, local; the EU Energy & Climate policymaking and implementation; and technology investments and subsidies, supporting low-carbon solutions at the level of both EU and MS.

A2: More energy efficiency and saving is pointed out by stakeholders in the France-Germany case as important. The stakeholders emphasize that the energy transition focuses too much on its technology (composition of the energy mix, innovation for energy/electricity storage, etc.) and too little on energy efficiency and decrease in energy consumption. A change in focus is needed, among national policy makers and the regional institutions in the Grand-Est and Baden-Württemberg. The policy process at hand in the Grand Est is the French strategy for energy and climate – multi-annual energy plans and its regional adjustment (Schéma Régional D'aménagement, De Développement Durable Et D'égalité Des Territoires) and in Baden-Württemberg: Erneuerbare-Energien-Gesetz with regional adjustment.

A3: Reduce trade-off of land-based solar power: PV on land installations may impact biodiversity through direct and indirect effects such as fragmentation, soil and habitat disturbance. Requires a stricter law and law enforcement to avoid negative impacts on soil and habitats. National policy makers should engage in dialogue with regional institutions in the Grand-Est and Baden-Württemberg. In Baden-Württemberg on the implementation of the *Freiflächenöffnungsverordnung*; and in Grand-Est: Legislation for environmental impact assessment, the agricultural modernization law and the Climaxion program and funding in Grand Est.

A4: Further promotion and use of RES for electricity generation aims at the further exploitation of RES for electricity generation. Achieving a RES share of 32% of the gross energy consumption in 2030 demands more electricity generation from PVs, wind parks, hydro-power plants and biomass power plants. This reinforces also the reduction of GHG emissions. It is then also important to improve coordination, remove economic barriers and make effort to reduce electricity prices of RES. The Ministry of Environment and Energy is important for the support and funding of the development of wind parks, photovoltaic parks and roofs, hydro-power plants and biomass power plants. Cost-effectivity is expected to be high as costs for confronting possible hazards caused by climate change will be mitigated.

A5: Separate collection of households' organic waste for energy. Using organic waste for energy generation is sustainable if organic waste is minimized. This could be a contradiction or dilemma for policy: burning waste instead reducing waste in the first place. Using organic waste from households and companies for energy production would however be resource efficient compared to not using this

waste. It would require the separate collection of organic waste, which in turn requires legal change and social acceptance. Feasible in urban areas where collection costs are low and not in rural areas.

A6: Strengthen transboundary cooperation on energy policy. This requires changes in the policy process to push territorial/local formal arrangements for collaboration further, and by that widening up their mandate to act. Using the already existing physical energy networks and facilities in the upper Rhine would be needed as well, but then with a commitment to cooperation by all the involved. It also calls for attention to the sharing of costs. Both public and private stakeholders from the energy and climate sector will be needed for this, and it should be useful for the Upper Rhine conference.

A7: Set a maximum of cultivated area with spatial establishment rules for energy crops. This is especially meant for maize in the Upper Rhine to minimize the quantitative and qualitative pressure on water resources. CAPRI and IMAGE results suggest an increase in cultivated area dedicated to energy crops. This would lead to an increased pressure on water resources both in qualitative and quantitative terms, as underlined by stakeholders. A challenge here is to achieve support for legal changes in the policies for energy, land and water. In the Grand-Est a 15% cap on crops for biogas is suggested and in Baden-W a feeding tariffs/premium for biogas is recommended. Policy makers in both France and Germany should be engaged. In the Grand-Est change should be made in the Environmental law (Decree n°2016-92, 7th July 2016; in French: Code de l'Énergie and related decrees and orders). In Baden-Württemberg it is suggested to change the support mechanisms for biogas, including the finance of biogas.

A8: More focus on energy efficiency in combination with a GHG tax. A GHG tax on energy use will increase energy prices. Energy efficiency (in combination with a GHG tax) is an important component in reducing greenhouse gas emissions in Europe while limiting the trade-offs with other elements of the Nexus (Energy, Food, Land, Water). Increasing the energy efficiency with no GHG tax could however lower prices for energy with a possible rebound effect is more energy use. Support for the climate policy could however be increased if the energy costs are lowered, but a tax will increase the energy prices.

A9: Energy distribution by Smart Grid to enhance the RES share: to increase the RES share in the gross final energy consumption by 32% until 2030 there is a need to increase the electricity generation from PVs, wind parks, hydro-power plants and biomass power plants. Energy efficiency and carbon neutrality could be brought closer to realisation by increasing the efficiency of energy distribution systems and accumulation capacity through smart grids and accumulators including reservoir recharge. The region has access to experts in energy issues that have already in part assessed the potential and the requirements needed. Now it is time to make a step forward from research to practice, according to the case study. This would have important effects on climate as well as water (hydropower).

2.3 Agro-Food chain transition

For the agro-food chain the leading policies are the SDG goals and in the EU the new European Green Deal. Within the EU Green Deal the agriculture and food strategy Farm to Fork (Farm2Fork) and the upcoming Biodiversity Strategy are at the heart of the transition towards a sustainable and efficient use of water, land and energy. Farm2Fork is very much focusing on public health; on reducing the environmental and climate footprint of the EU food system, ensure food security in the face of climate change and biodiversity loss and being in the lead of a global transition towards competitive sustainability. The Biodiversity Strategy (European Commission, 2020) also emphasizes the links to the agro-food chain. Biodiversity loss threatens our food systems, putting our food security and nutrition at risk, it underpins healthy and nutritious diets and improves rural livelihoods and agricultural productivity. Certain agricultural practices, it is reported, are a key driver of biodiversity decline. The EU wants to work with farmers to support and incentivise the transition to fully sustainable practices by improving condition and diversity of agroecosystems; reduce environmental risks and socioeconomic shocks, while creating new jobs, for example in organic farming, rural tourism or recreation. The Biodiversity Strategy will work in tandem with the new Farm to Fork Strategy and the new Common Agricultural Policy (CAP), including by promoting eco-schemes and result-based payment schemes. These plans should lead to sustainable practices such as precision agriculture, organic farming, agro-ecology, agro-forestry, low-intensive permanent grassland, and stricter animal welfare standards.

2.3.1 Policy Goals

<p>SDG Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture</p> <p>By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.</p> <p>By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.</p>	<p>United Nations (2015)</p>
<ul style="list-style-type: none"> -Increase competitiveness and agricultural productivity in a sustainable way to meet the challenges of higher demand in a resource-constrained and climate uncertain world. -Contribute to climate change mitigation and adaptation, as well as sustainable energy. -Foster sustainable development and efficient management of natural resources such as water, soil and air. -Contribute to the protection of biodiversity, enhance ecosystem services and preserve habitats and landscapes. -Promote employment, growth, social inclusion and local development in rural areas, including bio economy and sustainable forestry. -Improve the response of EU agriculture to societal demands on food and health, including safe, nutritious and sustainable food, reducing food waste, as well as animal welfare 	<p>The European Green Deal (EC, 2019)</p>
<p>-ensuring that the food chain, covering food production, transport, distribution, marketing and consumption, has a neutral or positive environmental impact, preserving and restoring the land, freshwater and sea-based resources on which the food system depends; helping to mitigate climate change and adapting to its impacts; protecting land, soil, water, air, plant and animal health and welfare;</p>	<p>Farm2Fork</p>

<p>and reversing the loss of biodiversity;</p> <ul style="list-style-type: none"> -ensuring food security, nutrition and public health – making sure that everyone has access to sufficient, nutritious, sustainable food that upholds high standards of safety and quality, plant health, and animal health and welfare, while meeting dietary needs and food preferences; and -preserving the affordability of food, while generating fairer economic returns in the supply chain, so that ultimately the most sustainable food also becomes the most affordable, fostering the competitiveness of the EU supply sector, promoting fair trade, creating new business opportunities, while ensuring integrity of the single market and occupational health and safety. 	
<p>Bringing nature back to agricultural land:</p> <ul style="list-style-type: none"> -work with farmers to support and incentivise the transition to fully sustainable practices: improving the condition and diversity of agroecosystems. - assess the CAP Strategic plans against robust climate and environmental criteria (MS set explicit national values for the targets). -reduce by 50% the overall use of – and risk from – chemical pesticides by 2030 and reduce by 50% the use of more hazardous pesticides by 2030. - bring back at least 10% of agricultural area under high-diversity landscape features. MS must translate the 10% EU target to a lower geographical scale to ensure connectivity among habitats (through the CAP instruments/plans, in line with the Farm2Fork and the Habitats Directive 	<p>Biodiversity Strategy</p>
<p>Protect and improve public health Promoting informed choices Delivering strategic solutions for healthy and safe foods and diets for all</p>	<p>EU DG Sante Horizon Europe</p>

2.3.2 Recommendations

From the recommendations in the cases we see the link to and need for more focus on public health, SEE Figure 4 with a pledge for more plant-based food instead of animal-based food, see . By that lifestyle change is emphasized as a part of the transition. But such a change affects land use as well, as we see in a recommendation of less livestock and more arable farming. We also see the need for a stimulation of less nutrition loss and less pesticides. In addition there are calls for more sustainability in the production of crops.

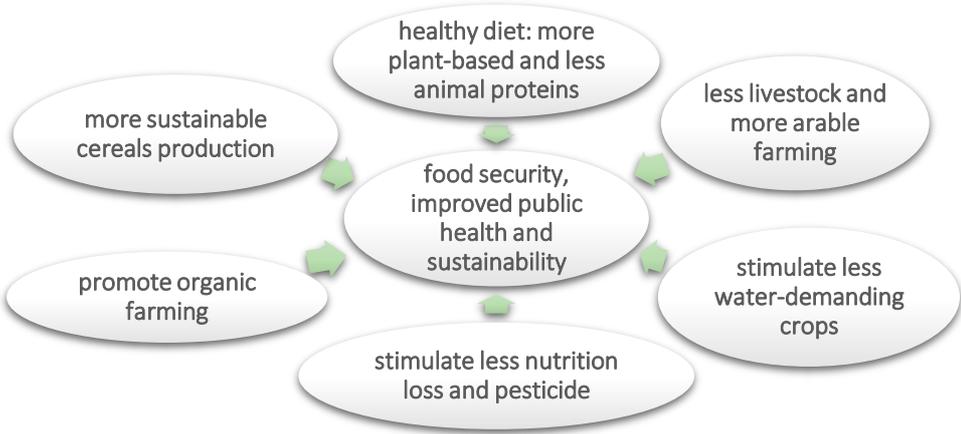


Figure 4: brief overview of the agro-food recommendations



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Table 2: Summary of recommendations for the agro-food transition

No	Source case	Recommendation	Challenge	Target Institutions	Target policy processes
B1	Global European	Encourage a healthy diet with more plant-based instead of animal proteins.	Life-style change	EU DG Climate Action, DG Agri, economic sectors	EU Green Deal UN-SDG
B2	EU	Shift from livestock to arable farming and horticulture	Change focus and involve the whole food-chain	EU DG Agri	EU Green Deal, CAP
B3	EU	Reduce GHG emissions agriculture	Involve whole food-chain	EU DG Agri and DG Climate Action	EU Green Deal
B4 (C6)	EU	Encourage less water-demanding crops	Encourage farmers to save water and energy	EU DG Agri, MS, and the agricultural sector.	From farm to fork, CAP revision
B5	EU	Stimulate techniques to reduce emissions of nutrients and pesticides	Encourage farmers	EU DG Agri, MS, and the agricultural sector.	From farm to fork, CAP revision
B6	Latvia	Promote organic farming	Change rural support programs	Ministries and subordinated institutions	Implementation of farming practices: country & EU
B7	Latvia	Sustainable cereals production	Performance-based regulation (rural support programs)	Ministries and subordinated institutions	Implementation of farming practices: country

B1: Encourage a healthy diet with more plant-based instead of animal proteins. Encouraging healthy diets with less meat consumption and food waste combined with further demands for a reduction of greenhouse gas emissions in agriculture, such as the carbon tax, is in line with climate goals and will lead to more resource-efficient agriculture in Europe. National and global coalitions will increase the impact of these policies, see Table 2.

B2: A shift from livestock to arable farming and horticulture parallel to changing diets of Europeans there is a need to stimulate change of focus for farming, away from livestock farming. It calls for major changes in the focus for farming, and support in the Common Agricultural Policy would be needed. It can be addressed in the European CAP strategy 'From Farm to Fork'.

B3: Reduce GHG emissions agriculture: could be achieved for example via a carbon tax or stimulating measures in the CAP. Together with a diet transition this will lead to a significant contribution to GHG reduction in Europe. It can be addressed in the European CAP strategy 'From Farm to Fork'.

B4: Encourage less water-demanding crops: To save water as well as energy, farmers could be encouraged to grow less water-demanding or non-irrigated crops, by using for instance precision irrigation technology. The EU can support the transition to a more resource efficient agriculture in From farm to fork (CAP revision).

B5: stimulate techniques to reduce emissions of nutrients and pesticides. To avoid environmental problems from farming the EU case propose technological stimulation, which could be done through a program as From farm to fork (CAP revision).

B6: promote organic farming. Organic farming is on EU political agenda. Biological products are getting an increasing attention by consumers. Organic farming has a positive impact on water, land and climate Nexus health. Setting more ambitious target for organic farming is a future development.

B7: Sustainable cereals production includes balanced use of fertilisers, growing of more productive cultivars. Model predictions for Latvia indicate increased growing of cereals along with expansion of cereals export. In order to balance economic (farm welfare) and sustainability considerations, policy content shall ensure sustainable production of cereals. This would imply good land use practice (avoiding large areas of monocultures), keeping balance of agricultural and other land use types (e.g. maintaining areas for pastures and meadows).

2.4 Water management under climate change

Since 2000 the water policy in the EU has been covered by the Water Framework Directive, in relation to the Environmental Quality Standards Directive; the Groundwater Directive and the Floods Directive (European Union, 2000). The fitness check in 2019 concluded from the evidence and the stakeholder feedback that the Directives are largely fit for purpose. The EU has been successful in setting up a governance framework for integrated water management for the more than 110,000 water bodies in the EU; the level of protection is higher; the deterioration of the water status has slowed down; and the chemical pollution is lowered. But the implementation has been delayed, less than half of the EU's water bodies are in good status; it has proved hard to take into account the specific conditions in each Member State; policy enforcement and accountability are limited, the reliance on a technological fix is high; the restoration of past pressures (pollution) is incomplete and implementation of other pieces of EU legislation, such as the Nitrates Directive and the Urban Waste Water Treatment Directive, as well as better integration of water objectives in other policy areas such as agriculture, energy or transport. This has not happened yet at the scale necessary.

2.4.1 Policy goals

<p>SDG Goal 6: Ensure availability and sustainable management of water and sanitation for all</p> <p>6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.</p> <p>6.4 By 2030, substantially increase water use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.</p> <p>6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.</p> <p>6.6 By 2020, protect and restore water related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.</p>	<p>United Nations (2015)</p>
<p>A sufficient quantity of good quality water is available for people's needs, the economy and the environment throughout the EU. This objective, mentioned on the Blueprint website (EC, 2012a), combines water quality (EC, 2000) and quantity targets. The Blueprint (EC, 2012b) fills in the gaps in water quantity policy.</p> <p>Improve efficiency of water use, leading to reduced water use. The Blueprint (EC, 2012b) is the water milestone of the EU Resource efficiency Roadmap (EC, 2011).</p>	<p>European Union (2000): EU Water Framework Directive</p>

2.4.2 Recommendations

The recommendations mirror the objectives in their call for more integrated solutions, see Figure 5. This focus involves a need for more clarity in who is responsible for what. Clarifying responsibilities, more economic incentives and improving the learning and the tools for water irrigation and water-loss reductions seem to be key to water management.

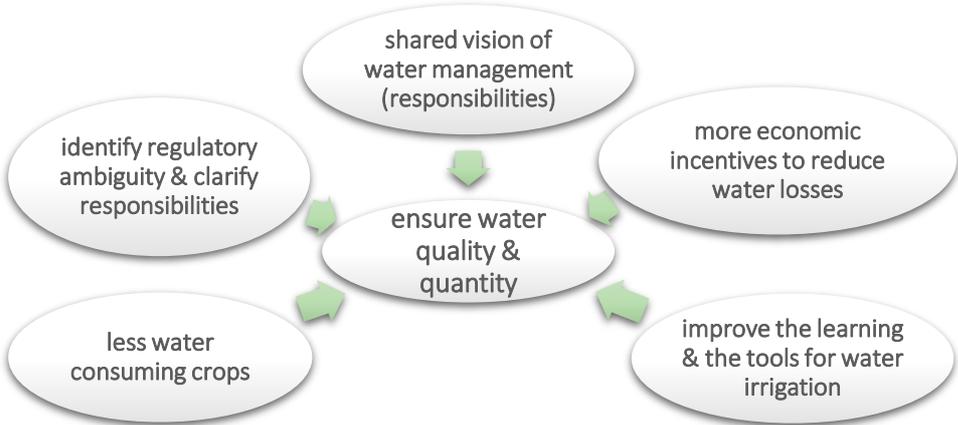


Figure 5: Brief overview of the water management recommendations



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Table 3: Summary of recommendations for water resource management

No	Source case	Recommendation	Challenge	Target Institutions	Target policy processes
C1	France-Germany	Improve efficiency of irrigation systems in the Upper Rhine	Efficient resources use by engaging agricultural sectors	Chambers of Agriculture, farmers/agriculture and research	CAP, European Agricultural Fund for Rural Development
C2	Sardinia	Clarify the responsibilities of the water management	Establish a new division of formal responsibilities	Ministry of Environment and Regional Water Authority ENAS	Regulatory powers and policy formation
C3	Sardinia	Enhance irrigation efficiency	Agreement of technology and farmer business incentives	Ministry of Agriculture and Regional Water Authority ENAS	National policy making water and agriculture
C4	Sardinia	Shared vision of sustainable water resource management regulations	Achieve a coherent sector-crossing binding agreement	Regional government with broad participation. Scaling up to EU.	Policy formation sustainable water management
C5	Greece	Minimisation of water losses in agriculture	Improve irrigation and reduce economic barriers.	Ministry of Rural Development and Food, Local Organisations of Reclamation Services	National policy making
C6 (B4)	Greece	Decrease water-consuming crops and cultivation of less water-demanding crops	Water saving in agriculture calls for diversification of crops	Ministry of Rural Development and Food, Local Organisations of Reclamation Services	National policy making

C1 Improve efficiency of irrigation systems in the Upper Rhine is meant for an efficient use of resources, see Table 3. It is argued that other optimization measures have to be implemented in parallel (varietal selection, etc.). CAPRI results show an increase in irrigated areas in Baden-Württemberg (stability in Grand Est) as well as a net increase in water use for irrigation in the two case study regions, despite an overall decrease in gross irrigation requirements in m³/ha.

C2 Clarify the responsibilities of the water management. The Sardinia case emphasises that policies goals are clear for most nexus components, but regulations and standards are not as clear, leaving administrative gaps that hamper effective actions by ambiguous responsibilities for water resources. The ministry for the environment and the regional water authority both have a role in the protection and management of water resources, but the geographical boundaries of the resource are different for the two institutions. Furthermore, the definition and computation of the Minimum Environmental Flows (MEF) are not clear. Solving this incoherency with clear regulations would have effects on land and food components of the nexus, it could reduce the trade-offs and strengthen the Minimum Environmental Flows (MEF). This recommendation should be a joint effort by many to learn how to think and act. A system of Shared vision of water management (responsibilities) must be seen in relation to food/agri, energy and nature. The latter is pivotal as this is not just about agreeing on water in general but on how to share responsibilities. This proposal could be scaled up to projects and collaborative programs within the whole EU, and with a link to the EU in a workable and accountable way. Such a renewal of the water planning should come with a chapter on how to identify regulatory ambiguity and clarify responsibilities within such a program or project. Consensus on the rules of play is important.

C3 Enhance irrigation efficiency. Sustainable water management in Sardinia depends on improving irrigation efficiency in agriculture. Technology is considered important for this task. Sensor based services at farm level and farmer business incentives belongs to the tools that could improve the water usage and irrigation scheduling. In addition to farmer incentives and more promotion of sensor based services, the irrigation requirements need to be improved. All this means that enhancing the irrigation efficiency should be a joint effort of both the national government and the region.

C4 Shared vision of sustainable water resource management regulations. This is related to C2 and C3 and would offer more coherency between water needs, environmental quality, food and energy production and climate adaptation. The challenge is to achieve a coherent sector-crossing agreement. For achieving such a shared vision many stakeholders must be engaged, ranging from the regional government to the multiple actors involved, as the water authority, agriculture/farmers, fisheries, irrigation consortia, environmental associations. A broad and early engagement from all stakeholders is beneficial to achieve such a mission.

C5 Minimisation of water losses in agriculture. Water saving in the agricultural sector calls for attention to alternative irrigation methods, to demand reduction and to removing economic barriers. The change proposed is for the national policy making in Greece.

C6 Decrease water-consuming crops and cultivation of less water-demanding crops. Also this recommendation is for the national policy making in Greece. It covers water saving in agriculture by a diversification of crops as in a shift to less water-consuming production.

2.5 Nature based land-use, landscape restoration, ecosystem services and biodiversity

In close relation with the other themes of energy, water and agri-food chain, this theme is about the interlinkages between nature and humans. The Biodiversity Strategy stresses that biodiversity is the extraordinary variety of life on Earth which we humans are part of and fully dependent on. It is the web of life that gives us the food we eat, filters the water we drink, and supplies the air we breathe. Nature gives us mental and physical wellbeing and provide our society's ability to cope with global change, health threats and disasters. The credo is 'we need nature in our lives'. The recent COVID-19 pandemic, it is said, makes the need to protect and restore nature all the more urgent. The pandemic is raising awareness of the links between our own health and the health of ecosystems.

Thus, just as the agriculture policy is increasingly moving towards public health, so does the nature policy. The Biodiversity Strategy states firmly that investing in nature protection and restoration will also be critical for Europe's economic recovery from the COVID-19 crisis. An integrated coherent policy is for this endeavour essential.

2.5.1 Policy goals

<p>Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society</p> <p>Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use</p> <p>Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity</p> <p>Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services</p> <p>Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building</p>	CBD (2018)
<p>SDG Goal 15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss</p>	United Nations (2015)
<p>To put Europe's biodiversity on a path to recovery by 2030 with benefits for people, the climate and the planet in the post-COVID context, the Biodiversity Strategy aims to build our societies' resilience to future threats such as climate change impacts, forest fires, food insecurity or disease outbreaks, including by protecting wildlife and fighting illegal wildlife trade:</p> <ul style="list-style-type: none"> -Legally protect a minimum of 30% of the EU's land area and 30% of the EU's sea area and integrate ecological corridors, as part of a true Trans-European Nature Network. -Strictly protect at least a third of the EU's protected areas, including all remaining EU primary and old-growth forests. -Effectively manage all protected areas, defining clear conservation objectives and measures, and monitoring them appropriately 	EU (2020). EU Biodiversity Strategy for 2030

2.5.2 Recommendations

The recommendations concerning nature-based landscape restoration, ecosystem services and biodiversity show a great interest in a more nature-based planning based on mandatory sector-crossing solutions within, land-use, agriculture and nature, see Figure 6. It is also a call for more focus on how to end land-use conflicts by better regulation.

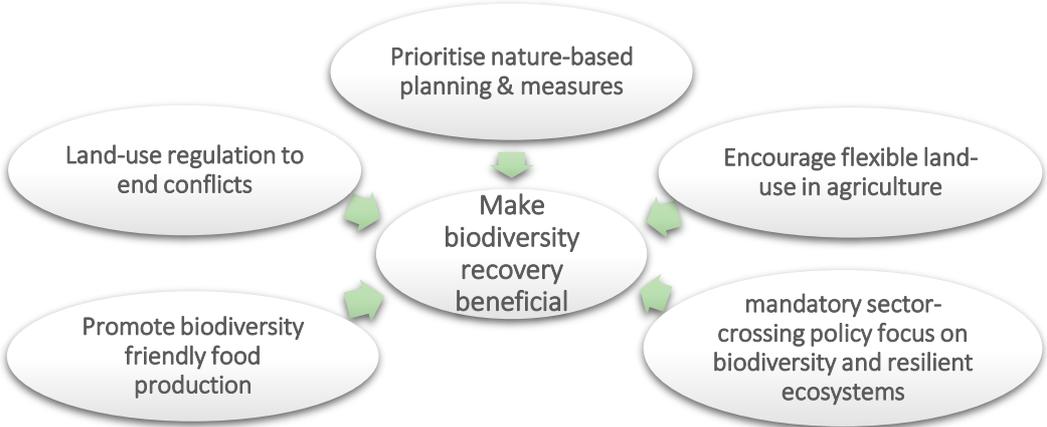


Figure 6: Brief overview of the nature-based recommendations



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Table 4: Summary of recommendations for nature-based land use, landscape restoration, ecosystem services and biodiversity

No	Source case	Recommendation	Challenge	Target Institutions	Target policy processes
D1	France-Germany	Prioritise nature-based multifunctional measures	Develop new sector-crossing ways of thinking and acting	Public policy-/decision-makers national and regional.	Agenda setting and policy formation for the Grand-Est
D2	EU	Encourage flexible land-use in agriculture	Division of burdens and benefits	EU DG CLIMA & DG AGRI; sectors, MS	CAP Farm to Fork-strategy EU Green Deal
D3	Greece	Land-use regulation to end conflicts	Regulatory protection of land ownership: completion of the Greek Cadastre	Ministries of Environment & Energy; and Rural Development & Food	National policy making
D4	Sweden	Strengthen policy for more focus on biodiversity and resilient ecosystems	Support multifunctional agriculture	National government initiates support for agriculture	National policy making, EU-CAP Farm to Fork strategy; EU Green Deal
D5	Sweden	Promote environmentally friendly food production	Use market competitiveness on it better alignment with energy, environment, climate	National government initiates support for agriculture	National policy making, EU-CAP Farm to Fork strategy; EU Green Deal
D6	Germany, Czech republic, Slovakia	Programme of landscape restoration	Make implementation work	Governments, regions, stakeholders	Transboundary, national, regional

D1 Prioritise nature-based multifunctional solutions. Declaring nature-based multifunctionality as a priority for water, climate, land policies comes from the France-Germany case, see Table 4. It requires legal changes, but it does also go further, it is argued, as it requires new sector-crossing ways of thinking and acting, based on new values, tools and practices, including financing, research, trainings. It is agenda setting for the Grand-Est: Schéma Régional D'aménagement, De Développement Durable Et D'égalité Des Territoires.

D2 Encourage flexible land-use in agriculture. Placing of burdens to mitigate greenhouse gas emissions on the agricultural sectors (such as a tax on GHG emissions) result in higher food prices. Encouraging flexible land use within agriculture can result in favourable circumstances for crop production even with increased burden of mitigation as crop farmers can take advantage of land and other resources that are not being utilized in a diminished livestock sector. This will lower food prices that would otherwise have been higher.

D3 Land-use regulation to end conflicts. This recommendation aims at the explicit regulation of land uses and the elimination of land use conflicts, with protection of agricultural land. The Ministry of Environment and Energy and the Ministry of Rural Development and Food should make spatial plans regulating land uses, and also the completion of the Greek Cadastre. Social implications are expected to be positive through the protection of land uses serving food production and contributing to CO₂ sequestration (e.g. cropland and grassland).

D4 Strengthen policy for more focus on biodiversity and resilient ecosystems. Policies and policy instruments should be strengthened for the purpose of achieving more focus on biodiversity and strengthening resilience of ecosystems, as tool to improve climate adaptation and food security. In addition, support from the state is needed for the multifunctional agriculture that at the same time produces food and energy, supports biodiversity and is good for the climate resilience.

D5 Promote environmentally friendly food production. To promote and utilize the image of "environmentally friendly" food production comes from Sweden. The idea is to build the effort on the already existing market competitiveness and ensure that this leads to better alignment of the agricultural objectives with other ones, particularly environmental objectives. This could be coupled to the need for investment in food crops that are more resilient to effects of climate change.

D6 Programme of landscape restoration. The increase of the average temperatures in the Czech Republic and Slovakia has been higher than the global average and in some regions it increased 3.5 degree C between 2000 and 2020. The climate change has been more serious than the change of the average temperature indicates. Mismanagement of the landscape has caused overheating, water losses and carbon emissions from degraded soils. The landscape has been drying out. In the last decade, production of feed crops decreased, fishponds repeatedly did not fill up and deeper wells were drilled both legally and illegally. Shortage of water has become a serious problem in agriculture, forestry, inland fishery and rural areas. Big cities were supplied with water from large water reservoirs. There was a shortage of water in rivers, minimal flow rates could not be kept, the water consumption by the industry was limited during the summer in some regions and shipping on the river Elbe between Germany and the Czech Republic practically stopped. Focus on how ecosystems help regulate the climate and it promotes nature-based solutions. These two policy intentions in the Green Deal may become reality in landscape restoration as proposed by

the transboundary SIM4NEXUS case study Germany-Czech Republic-Slovakia. This case has been focusing on the impact of large drained agricultural fields and large sealed urban areas on the water regime and on the air temperature, looking at the distribution of solar energy. This resulted in a passionate plea for paying attention to the role of land cover changes in the local and regional climate change and in carbon sequestration. Water retention and support of permanent vegetation may cool down the land relatively soon, with higher primary production and carbon accumulation in the recovering soil. It has already been elaborated and approved in Eastern Slovakia and a similar one is being prepared for Southern Bohemia in the Czech Republic. Ideas and approaches were presented at several conferences and dealt with local communities and politicians about landscape restoration with representatives from regional governments, municipalities, research institutes and stakeholders - environmental NGOs, farmers and land owners- participated from the Czech Republic, Slovakia and Germany. A programme was discussed to support pilot studies that aim at water retention in the landscape for climate change mitigation and adaptation.

2.6 Governance by cross-sectoral cooperation

The governance recommendations covers the policy process with the matter of how to conduct policy. For the EU Green Deal all efforts now are pointed towards keeping our planet and people healthy, the defining task of our times according to the European Commission (2020). The European Green Deal is the framework for the governance, set up as a roadmap with policies and measures to deliver the transformative change we need, and the European Commission stresses that this must take place across all sectors (European Commission, 2020). There will be actions across our economy and this sector-crossing work will be supported by a number of plans: a first and binding European Climate Law; a new Circular Economy Action Plan will help transform our production and consumption system, the way we use, produce and consume things; a new EU Biodiversity Strategy for 2030 will preserve and protect the natural environment; a 'Farm to Fork' Strategy for the whole food chain; a European Green Deal Investment Plan will unlock at least €1 trillion of sustainable investments over the next decade. Sustainable investments are to be mainstreamed across our financial system, a Renewed Sustainable Finance Strategy will aim at redirecting private capital flows to green investments. Embedding a culture of sustainable corporate governance in private sector firms will be equally important. This transition to a climate neutral continent will only happen if it is fair and just for all and no one can be left behind (European Commission, 2020). The SIM4NEXUS cases have been formulated with this as a foreground, as these plans did not exist earlier in the project.

2.6.1 Policy goals

<p>SDG Goal 17 on systemic issues: 17.14: Enhance policy coherence for sustainable development</p> <p>Multi stakeholder partnerships: 17.16: Enhance the Global Partnership for Sustainable Development complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources.</p> <p>17.17: Encourage and promote effective public-public, private and civil society partnerships, building on the experience and resourcing strategies of partnerships.</p>	<p>United Nations (2015)</p>
<p>Mainstream sustainability in all EU policies: Stakeholders to identify and remedy incoherent legislation that reduces the effectiveness in delivering the European Green.</p>	<p>EU Green Deal check F2F + Bio Strat</p>

2.6.2 Recommendations

The governance recommendations are stressing the need for cross-sectoral ways of thinking and making solutions, see Figure 7. Collaboration is at the heart of the recommendations, as are the need for more consistency and coherence. An explicit need for more focus on competing claims is a core feature of the work towards more collaboration. And again we see a need for more clarity in the division of tasks, which might reflect the underlying need to connect the various domains involved. Broad participation and actual engagement are important for the governance of the nexus.

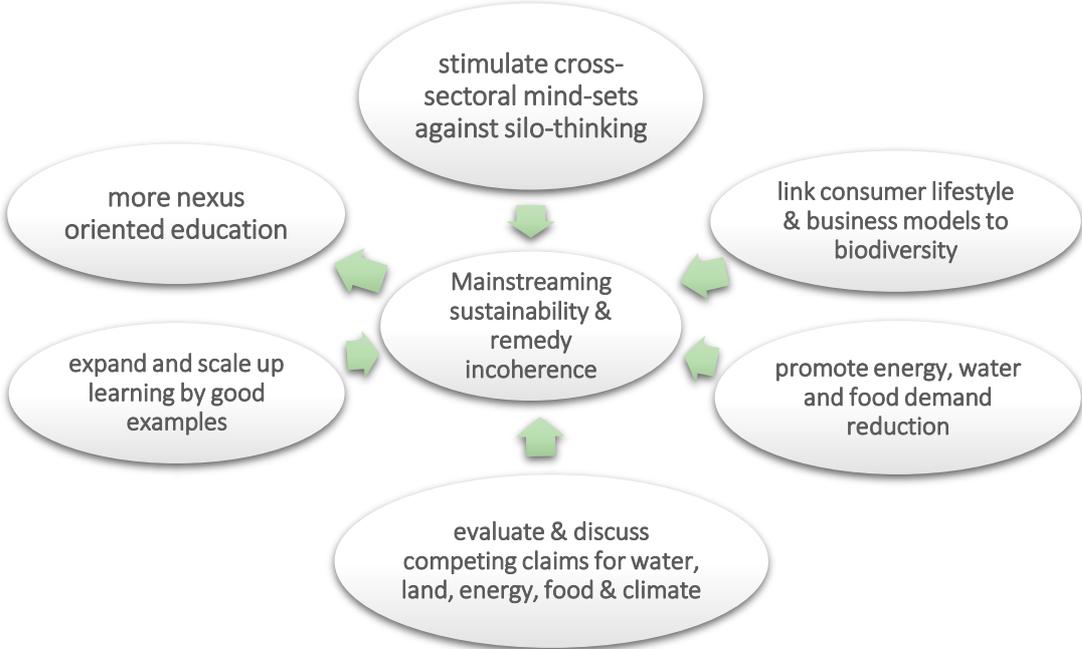


Figure 7: Brief overview of the governance recommendations

Table 5: Summary of recommendations for governance by cross-sectoral cooperation

No	Source case	Recommendation	Challenge	Target Institutions	Target policy processes
E1	France-Germany	Change education system to enable transdisciplinary and cross-sectoral mind-sets against silo-thinking.	Requires a shift within the education system	Education system (politician/decision-makers, Universities, etc.)	Agenda setting and policy formation of the French and German education
E2	France-Germany	Change governance at all levels of policy making to enable transdisciplinary and cross-sectoral cooperation and “eliminate” silo-thinking.	Requires a shift from a sector-based to multi-level cooperation.	Ministries, research, local State services, etc.	French and German policy strategies, from research to implementation.
E3	South West UK	Partnership working	To increase the collaboration within nexus sectors and policies.	National government Defra, with South-West Water; local stakeholders	Task force for partnerships formation.
E4	South West UK	Interconnecting governance	Scale and sector-crossing structures for decision making	National government (Defra) with South-West Water and local stakeholders	Creation of working groups to spread policy making both vertically and horizontally
E5	Azerbaijan	Procedure for cross-sectoral policy consistency	To achieve coherence by changing the policy planning	All nexus-relevant Ministries	National policy formation: Cross-sectoral committee
E6	Netherlands	More focus on competing claims for land for feed, fiber and bio-energy purposes	Deal with disputed issues; agree on cost/benefit assessments.	Ministries with relevant economic sectors	Climate Agreement (2019) + action plan 2030 (Roadmap), link to the new CAP.

No	Source case	Recommendation	Challenge	Target Institutions	Target policy processes
E7	Netherlands	Bring more clarity and transparency in the various uses of different types of biomass and link the usage to business models	Agree on cost/benefit assessments	Business, NGOs, science;; the national government should facilitate.	Climate Agreement (2019) and the planned Roadmap for implementation 2030.
E8	Netherlands	Continuation of the support for innovations through public-private partnerships	Enable the parties by removing barriers.	Government and private parties	Use existing research programmes such as the Topsector Policy.
E9	Netherlands	A broad participative process for the policy road map to 2030 for a low-carbon and resource efficient economy	Tailor made stakeholder engagement for reliable and acceptable solutions	Ministries initiate the engagement: business, citizens, and NGOs central	Policy agenda and formation
E10	Sweden	Develop policy processes by more collaboration by learning from good practices and success stories	developing practises and routines for learning and collaboration.	National government in collaboration with economic sectors	Policy formation for agriculture, forestry, environment, water.

E1 Change education system to enable transdisciplinary and cross-sectoral mind-sets against silo-thinking is about increasing policy coherence by a shift that starts in the education system with emphasize of cross-sectoral & integrated understandings of problems and solutions, see Table 5.

E2 Change governance at all levels of policy making to enable transdisciplinary and cross-sectoral cooperation and “eliminate” silo-thinking. E2 is similar to E1 but is guided towards policy, with increasing coherence by a shift from a compartmentalized (sector-based) policy-making and implementation to multi-level cooperation, with cross-cutting missions for those involved. Both come from the France-Germany case, pointing to a need for less -trade-offs and more synergy based on joint understandings of problems and solutions.

E3 Partnership working is an argument for more collaboration in the governance of the nexus domains. The case characterise the Catchment Sensitive Farming programme (CSF) as the most successful example of sector-crossing public-private collaboration in the South West, including governments, businesses and NGO. CSF is a project run by Natural England in partnership with the Environment Agency and the Department for Environment, Food and Rural Affairs DEFRA. It is described as an approach to farming in which subsidies / incentives and advice are given to farmers at the top of a river catchment to promote sustainable farming practices (e.g. decreased use of pesticides in sensitive areas; habitat restoration, etc) leading to improvements in water quality downstream. Upstream Thinking is a programme operating in Devon and Cornwall in 2006 using a CSF approach. The partnership is aimed at prioritizing catchments where agricultural practices are having the most significant impact on rivers, lakes and estuaries in the South West river basin. It has two aims (to save farms money while delivering environmental benefits) and provides practical solutions, targeted advice and capital grants. The partnership format is crucial and this brings together a central public bodies (Defra and Natural England) with a range of others (e.g. the Environment Agency, the RSPB, the Rivers Trusts, the Wildlife Trusts, local industry and local farmers). Important factors are **i)** keeping the interests of all relevant stakeholders in mind; **ii)** awareness raising; **iii)** the use of robust evidence; **iv)** flexibility; **v)** emphasising local contexts in determining solutions; **vi)** establishing stable funding mechanisms; **vii)** a supportive policy, political and organisational environment. To transfer the success of CSF to other areas, it is argued, there needs to be on-going engagement with stakeholders and assurance of longstanding and committed support, both financial and administrative. Task forces could be established to identify where such partnerships could be effective in all nexus sectors. CSF has evaluation as a core part, it is added, essential for assessing delivery of objectives and benefits. The case holders see evidence that this form of ‘tailor made’ approach can be rolled out nationally.

E4 Interconnecting governance. The UK case adds an governance recommendation based on support from the highest levels of policy decision making, e.g. government departments, to avoid fragmentation of the decision making process and misinterpretation of policies by practitioners. Conditions emphasized **a)** acknowledge the complexity; **b)** accept the inevitability of unintended outcomes and **c)** set out clear principles for effective nexus governance. Strategic energy and food government white papers could then add to the new framing of policies, complemented with a cross-sectoral body to help understand, communicate and manage trade-offs and deal with the interactions of policies between nexus components to foresee future challenges and risks between sectors and implement policies that allow for optimal outcomes for the nexus rather than maximum outcomes for a single sector alone. Engagement is seen as a foundation for such a nexus-sensitive framing and principles. Stakeholders emphasised that engagement was necessary at multiple levels to avoid the

feeling that decisions were taken behind the scenes. Learning around nexus-sensitive framings and responses within local contexts is important in informing more generalised national-level framings and responses to key issues. Working across scales helps coordinate local visions and plans with national strategy, ensuring a more coherent nexus approach.

E5 Procedure for cross-sectoral policy consistency in of the Azerbaijan case is quite similar to the first two recommendations as it goes further than just a procedure. The proposal contains a change in the way the policy planning is organized and coordinated with a committee asses policies against other policies and the different ministries involved could then provide feedback. Important here is to create a process that encourages cooperation, prevent barriers and speed up decision making among the involved ministries.

E6 More focus on competing claims for land for feed, fiber and bioenergy. Ensuring better coherence of the governance also calls for attention to rival claims on land. Biomass production for energy is such an issue where sectors are competing for land use in the Netherlands. Renewable energy (solar and wind) is competing with biomass for land. Land use for wind energy is limited. Solar panel fields are for some an attractive form of land use but scarce land results in competition with for instance agriculture and biomass.

E7 Bring more clarity and transparency in the various uses of biomass and link the usage to business models is a necessary condition for improving the use of biomass and also for reducing rival claims on land. In general the potential of biomass from national production in the Netherlands is limited. Biomass use for other purposes like maintaining biodiversity in forests or as input for industry is of such importance that when the Netherlands wants to increase the share of biomass for energy production it needs to import. The lack of clarity and transparency leads to public unease. The SDM shows that biomass is an heterogenous resource originating from 8 different sources that are strongly connected to economic development (GDP per capita, number of animals, agricultural production, etc.). The implementation of policies directed at increasing the share of biomass for energy needs to consider the impact on other prioritized policies areas like Natura 2000, Water framework directive, policies oriented on droughts, and polices to promote circularity. The need for more clarity is seen in many ways: Phasing out coal could for instance be compensated by biomass production or to increase natural gas. For biomass to contribute in a significant way, a huge restructuring of the energy is needed where the (now disputed) imports of biomass will play an important role. Off-shore wind energy and/or solar panel fields could be alternatives, certainly in the short run, but must also be compared to oil and gas, which are important to produce electricity and oil-based products (petrol for instance) in the Netherlands.

E8 Continuation of the support for innovation through public-private partnerships and E9 on a broad participative process for the policy road map to 2030 are then supportive for bringing more clarity and improving the alternative uses of in this case biomass. In general, the Dutch government has been engaged in a lengthy multi-stakeholder approach to tackle many of the Nexus-issues we cover here including on stimulating innovations. For the Netherlands this is also about making use of favourable conditions for bio-based investments such as the big harbours, a good infrastructure, high quality knowledge institutions, a well-educated population and strong agricultural, chemical and energy sectors. Innovation is seen as a key factor to deal with biomass in the Netherlands. Both public and private parties aim to invest both at the national and international level. The Dutch government stimulates investments through public programmes for research, investments and business development for the short and long term. Arrangements such as the Program Department Biobased Economy, a Green Deal program and the investment and exploitation subsidy SDE+ support the industry and agriculture by removing obstacles and offering opportunities. The central idea is that the government facilitates and accelerates initiatives by removing barriers. Barriers may be formed by legislation, or by a lack of market incentives, innovation and networking.

E10 Develop policy processes by more collaboration by learning from good practices and success stories

is a way to trigger more and better use of what actually works in practice. Policy decision makers like science and hard numbers to inform decision. However, for a coherent nexus thinking there can be a danger in using numbers, as it usually implies many simplifications, where the number lose the deeper sense and context information. Also, many potential solutions are not about “hard” innovations, but about “softer” changes in the system. For example, during the SIM4NEXUS case study work in Sweden, stakeholders provided many good suggestions for the changes in the nexus system that were not possible to translate into hard data that could be used in modelling. These were for example about improving water planning through information, collaboration and capacity building, or introduction of elements of green infrastructure in agriculture and forestry that would improve biodiversity and as a result landscape resilience. This is where learning of good practices and from success stories through communication between sectors can be very useful. The authorities of particular sectors should strive for developing routines for such learning and collaboration, at least as an addition to their established, very sectoral routines of work. This is necessary to create a better culture of communication between sectors and increase country’s capacity to deal with nexus challenges. The stakeholders in the case study highlighted very much the importance of communication and coming together to discuss with people from other sectors. Because the nexus system is very complex and incorporating this complexity in a model has its limits, it is crucial to still apply sectoral approaches to modelling, but such sectoral modelling should be conducted by people with in-depth insights into connections with other sectors.

2.7 Strong instruments backed by EU frameworks

Policy instruments in the EU must meet a number of criteria before being applied in a specific EU law, policy or funding programme, as shown in the table. Instruments are also checked according to the REFIT. The European Commission's regulatory fitness and performance (REFIT) programme aims to ensure that EU legislation delivers results for citizens and businesses effectively, efficiently and at minimum cost. REFIT aims to keep EU law simple, remove unnecessary burdens and adapt existing legislation without compromising on policy objectives. The fitness check is an evaluation that assesses multiple interlinked actions, guided towards identifying how different laws, policies and programmes interact, any inconsistencies or synergies, and their collective impact. The REFIT Platform is meant for national authorities, citizens and other stakeholders for involvement in improving EU legislation by making suggestions on how to reduce the regulatory and administrative burdens of EU laws, which are then analysed by the REFIT Platform and the Commission. Recommendations concerning instruments from SIM4NEXUS will eventually have to meet these criteria if they are brought to further development.

2.7.1 Policy goals

We commit to engaging in systematic follow-up and review of the implementation of this Agenda over the next 15 years. A robust, voluntary, effective, participatory, transparent and integrated follow-up and review framework will make a vital contribution to implementation and will help countries to maximize and track progress in implementing this Agenda in order to ensure that no one is left behind.	United Nations (2015) SDG, UNFCCC
sustainability in all EU policies	EU Green Deal
-decision-making is open and transparent -citizens and stakeholders can contribute throughout the policy and - law-making process -EU actions are based on evidence and understanding of the impacts -regulatory burdens on businesses, citizens or public administrations are kept to a minimum	EU REFIT
-effectiveness (whether the EU action reached its objectives) -efficiency (what are the costs and benefits) -relevance (whether it responds to stakeholders' needs) -coherence (how well it works with other actions) the EU added value (what are the benefits of acting at EU level)	

2.7.2 Recommendations

The recommendations for the instruments varies from improved communication, with for example public campaigns for changing the framing of problems and solutions, to more mandatory instruments, see Figure 8. Better evaluations is part of the need for renewal in the 'tool-box' for change. Also the stimulation of business opportunities is here considered important, including a system of payments for ecosystem services.

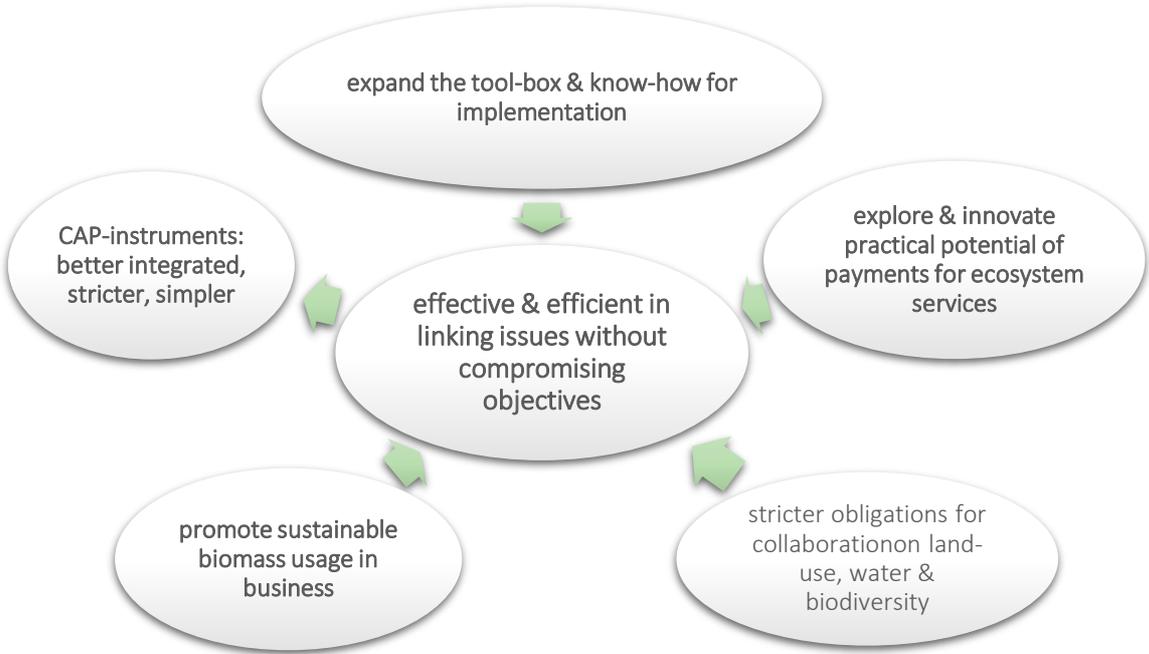


Figure 8: Brief overview of the recommendations for instruments

Table 6: Summary of recommendations for strong instruments back by EU frameworks

No	Source case	Recommendation	Challenge	Target Institutions	Target policy processes
F1	Azerbaijan	Catalogue for local measures to increase climate change resilience in the agricultural sector	Providing farmers a tool box to improve know-how and local infrastructure	Ministries involved with agriculture; farmers and research institutions.	Support for the implementation
F2	Sardinia	Payments for ecosystem services to increase environmental quality	The valuation of payments and scale of the services	Ministries of Agriculture and Environment	Should be scaled up from region to country and the EU
F3	Latvia	Promotion of competitive local use of biomass	More market based instruments, less bureaucracy	Ministries	Policy implementation country, EU-CAP
F4	Sweden	Stricter instruments for obligatory protection of land and biodiversity	Coordination, monitoring and enforcement	Ministries. EU DG AGRI	National policy making, the EU-CAP From Farm2Fork
F5	France-Germany	Make evaluation of policy implementation processes cross-sectoral and Nexus-proof	Agreement on a robust monitoring and how to conduct impact studies.	Public stakeholders involved in national policy	Evaluation of policy
F6	EU	Strategic policy dialogue on the links between climate and resource efficiency and social effects.	Engage policy makers, and then initiate a broader debate	EU DG AGRI and DG ENER	EU Circular Economy Action Plan and the CAP Farm2Fork. EU Green Deal
F7 (A2,A)	SW UK (EU and global case)	Demand reduction of energy, water and food usage	Public campaign in the UK on awareness, lifestyle changes	Broad engagement; national to local governments, communities, individuals.	White papers; citizen assemblies UK, policy makers, general public.
F8	SW UK	Clarify the hierarchy of policies: behaviour>efficiency>capacity.	Achieve agreement on a cost-efficient hierarchy of policies	Government, science, sectors	White papers; citizen assemblies UK, policy makers, general public

No	Source case	Recommendation	Challenge	Target Institutions	Target policy processes
F9 (D6)	Germany, Czech Republic, Slovakia/Sweden	CAP implementation: Stricter conditions for public funding and lowering the administrative burden for applicants to a subsidy for voluntary measures.	Stronger integration of the CAP-instruments (GAEC, greening, EFA's)	EU DG Agri	CAP Farm2Fork

F1 Catalogue for local measures to increase climate change resilience in the agricultural sector.

This proposal for Azerbaijan aims to create a set of measures that could increase the resilience of the Azeri agriculture to climate change, see Table 6. The measures should start from building an understanding at the local level of the potential implications. One aim is to secure the productivity of the Azeri agriculture to avoid increasing import dependencies. Another aim is to prevent an abrupt reduction in jobs in the sector, due to for example draughts. It is meant to be a bottom-up approach where the first step is to use or create local knowledge concerning the potential implications. The concrete mitigation and adaptation measures are then locally agreed on and implemented with support from the central government. The bottom-up approach has several advantages in comparison to centrally driven policy. Firstly, the creation of local awareness will increase the acceptance and willingness to implement measures, especially if the measures are affecting habits and routines. Secondly, the local needs might vary quite strongly but they will address those local needs a lot better if the measures have been agreed on locally. The catalogue provides a sufficiently large variety of measures to allow the local stakeholders to develop a tailor-made mix of measures for which they can get support, either financially or in know-how. The recommendation is naturally challenging for a country used to a centralised organisation. But local tailor-made solutions are more prone to fit the needs than a centralised plan.

F2 Payments for ecosystem services to increase environmental quality. The Sardinia case calls for policy instruments with a stronger focus on the environmental benefits provided by forests, agriculture and water. This could offer synergies, for example between water (improvement of water quality and productivity of wetlands) and land (reduced land abandonment). It would however demand a process of valuation of the services, and those involved must agree on the valuation method and outcome. This work could start at the two Ministries of Agriculture and Environment, together with the regions and sectors involved. But it should be scaled up from region to country and the EU.

F3 Promotion of competitive local use of biomass. Latvia proposes to apply more market based instruments combined with less bureaucracy for the forest sector, a cornerstone in the economy with a high export capacity. The industry still operates in the frame of long developed economic conditions with low added value generated. Stimulation of more wood processing in Latvia would help both the sector and the ecology. Currently forestry leads to wood export for renewable energy production abroad. This generates income to the forestry sector and helps to reach RES targets in the countries importing the wood by burning the wood to fuel. But, it has a negative impact on meeting the GHG emission reduction and CO₂ sequestration targets in Latvia. Export of wood biomass is thus in conflict with the climate objectives. Promotion of more competitiveness and high added value forestry (wood processing, furniture production etc) could help both the economy and the climate. By the opinion of Latvian Wood Industry Federation there are key preconditions to the success: i) availability of raw material; ii) research and development (R&D) support; iii) access to a qualified work force; iv) a sufficient local market for products; v) infrastructure; and vi) competitiveness in the market. Despite the availability of financial instruments in support of innovations and business in Latvia, the response from SMEs is reserved due to rather high load of bureaucratic procedures and high effort to prepare for use of support instruments.

F4 Stricter instruments for obligatory protection of land and biodiversity. Stakeholders in Sweden pointed out the large number of voluntary instruments (e.g., recommendations provided by the Forestry Agency to the private forest owners in the forestry sector or possibility to create voluntary

local water councils in the water sector), but highlighted the need for stronger legal instruments, for the use of resources; the protection of agricultural land against development; for making forest management more biodiversity friendly and not only production-oriented. Strengthened legal requirements were also suggested in relation to water management. Currently, there is no legal demand for stakeholders from different sectors (e.g. municipalities, forestry managers) to collaborate on water issues, collaboration depends mostly on engaged and interested individuals. Legal requirements as well as legal frameworks for such (obligatory) collaborations could be introduced to facilitate more integrated water planning that considers multiple sectors. To enable stronger national regulations, there is a need for support from the EU legal framework. Particularly, the environmental aspects, such as biodiversity conservation or development of green infrastructure for increased resilience need to be strengthened. This could be incorporated in the new revised CAP, for a stronger integration of agricultural food production, bioenergy production, biodiversity conservation, adaptation to climate change and improving climate resilience, as well as water management.

F5 Make evaluation of policy implementation processes cross-sectoral and Nexus-proof. Changing how we conduct evaluations is recommended from the France-Germany case and it fits well in a picture of efforts to trigger a shift towards a more collaborative governance. It does require an agreement on how to set-up a robust monitoring and how to conduct and assess impact studies.

F6 Strategic policy dialogue on the links between climate, resource efficiency and social effects from the EU case might be seen as a special case of such a shift towards a more cross-sectoral and social oriented approach, as the dialogue intends to change how people think and organizations act, with more collaboration as a possible result. It will be necessary to engage the involved policy makers in a close look at what this means for who is carrying the costs and benefits, as a stepping stone to go out to the broader society and develop a problem understanding and related solutions with a high enough level of social acceptance for the longer term.

F7 Demand reduction of energy, water and food is about how we frame problems. The UK case sees an ongoing creation of citizen assemblies in the UK as a central element in ensuring that policy framing and implementation is aligned with values and interests of the general public. Resource efficiency in the UK is often framed in terms of meeting environmental objectives while satisfying rising demand for resources, whether it is about water, energy or food. The recommendation is to challenge assumptions around ever-increasing per-capita demand in all three domains and move away from just trade-offs to making net reductions, it is argued. But it will be a quite radical change which necessitates reduction in demand in the water, energy and food sectors. In energy, this may relate to guiding energy infrastructure pathways (particularly for heat and transport) away from those locking us into fossil-fuel dependency and towards electric and other low carbon and flexible pathways for the electricity system. For food and food waste, policy should promote plant based diets across our school, hospitals and public offices, as well as the reduction, separation and sustainable processing of food waste. The water sector should be focusing on utilising rainwater for domestic water systems and leading by example in state owned buildings. All this calls for lifestyle changes in society.

F8 Clarify the hierarchy of policies: behaviour>efficiency>capacity. From the SW UK case a recommendation that is highly related to F6 demand reduction. It is about making a very clear hierarchy of policies regarding the policies to be implemented in the nexus to achieve a specific goal in a cost-efficient manner. First, behavioural changes should be optimised. This is the essence of F6 demand reduction, 'tackle at the source'. Secondly, efficiency increase options should be explored. We can say that it is guided by 'if you use it, use it wisely'. Thirdly, capacity-building (awareness, know-how) is needed and infrastructure (such as technical solutions for reuse or smart usage of water, waste or energy). Several runs of the UK SDM have shown that environmental sustainability and resource management objectives can easily be reached if no attention is paid to cost. And the least total cost solutions can be found if interventions are maximised in hierarchical order of

behaviour>efficiency>capacity. Debates through up-coming white papers could be a way to launch debates around how responses to net zero will necessitate action around lifestyle thinking and changes.

F9 CAP implementation: Stricter conditions for public funding and lowering the administrative burden for applicants to a subsidy for voluntary measures. Improving the CAP instruments is proposed to stimulate more sustainable practices in agriculture. More integration, stricter conditions and lower administrative burdens of Good Agricultural and Environmental Conditions (GAEC) and Greening measures from CAP could be applied for this purpose, and direct payment could be linked to public services instead of agricultural land area. Such public services are for example restoring and keeping up the landscape, soil and vegetation for water retention and carbon sequestration. Obligatory instruments would mean higher costs, as implementation would need coordination, monitoring and enforcement. But, as reported in the policy brief of Witmer (2020) there is great potential for the CAP to contribute to sustainable use of water, land and energy, climate mitigation and adaptation. It has however proved difficult to apply these instruments in practice. The Greening measures have for instance only been partially implemented and did not lead to the expected results in for example the Czech Republic. According to data from 2015, Ecological Focus Areas (EFAs) had been implemented only to a little extent. There had been no increase in the share of permanent grassland, as greening obligations had been met by mowing existing grassland. Crop diversification had also been applied so as to only meet the minimum requirements. The reason for keeping the implementation of greening and environmental measures to a minimum appeared to be those non-productive elements in the landscape interfered with farm practices, lowering their efficiency. Agro-environmental and climate measures are voluntary and set by the Second Pillar of the CAP as part of the Rural Development Programme. The objective of the measures is to promote sustainable agricultural land use. Because these measures are voluntary, the success of their implementation depends on access to the related subsidy—the administrative burden of the application and accountability process is often too great for applicants to obtain the subsidies, as reported by the Czech case. Only a few farmers have chosen to adopt these measures.

2.8 Science-policy interface for a learning society

2.8.1 Policy goals

EU Horizon Europe will be the main EU plan covering the science-policy interface. The new European Union Framework Programme for Research and Innovation, Horizon Europe, will run from 2021 to 2027 (European Commission 2020). A political agreement on large parts of the draft legislation in spring 2019, the Commission reported that it, together with Member States and concerned stakeholders, launched a co-design process for the work programmes.

The SDG is also very much focusing on the matter, for instance with its SDG Knowledge Platform. Horizon Europe support European partnerships with EU countries, the private sector, foundations and other stakeholders, with an aim is to deliver on global challenges and industrial modernisation through concerted research and innovation efforts. Achieving synergies between themes is a key priority.

The SDG Knowledge Platform: Helping governments and stakeholders make the SDGs a reality	United Nations (2015)
A main objective is to generate knowledge, strengthen the impact of research and innovation in developing, supporting and implementing Union policies and support the access to and uptake of innovative solutions in European industry, notably in SMEs, and society to address global challenges, including climate change and the Sustainable Development Goals Cluster 5, 'Climate, Energy and Mobility', emphasizes the need to "establishing a better understanding of the causes, evolution, risks, impacts and opportunities of climate change" Cluster 6, Food, Bioeconomy, Natural Resources, Agriculture and Environment "will advance knowledge, expand capacities and deliver innovative solutions to accelerate the transition towards the sustainable management of natural resources (such as biodiversity, water and soils)"	EU Horizon Europe (2019)

2.8.2 Recommendations

The science-policy recommendations here are very diverse and also aligned with many of the Horizon Europe targets, see Figure 9. Improving impact is essential, and better tools, also digital tools and access to data, are seen as pivotal to this effort. One of the ways to expand impact is the recommendation to bring science closer to people in the broader society.

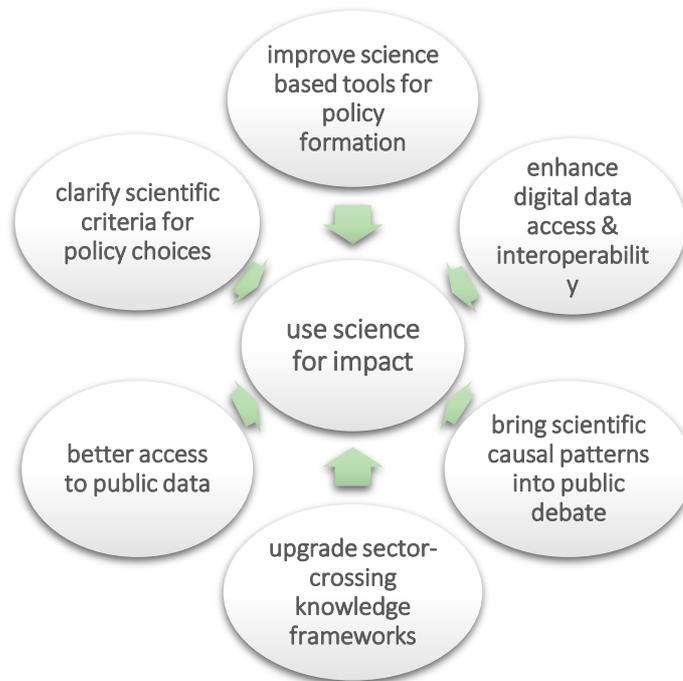


Figure 9: Brief overview of the science-policy recommendations for a learning society



Horizon 2020 Societal challenge 5
Climate action, environment, resource
Efficiency and raw materials

Table 7: Summary of recommendations for science-policy interface for a learning society

No	Source case	Recommendation	Challenge	Target Institutions	Target policy processes
G1 (E3)	France-Germany	Cross-sectoral and Nexus-proof evaluations of policy implementation	Acceptance of nexus impact knowledge for priorities	Government, science, sectors	Evaluation of policy. Link to EU policy
G2	EU	Stakeholder engagement with fully formed maps of nexus interactions	Provide understandable input for non-scientists and support their efforts	EU-DG Agri (initiative). Broad participation	EU Farm to Fork; Biodiversity Strategy; EU Green Deal
G3	EU	'Move the Cursor' Serious Game as a feeder for discussions	Clarify causal pathways for easy explorations	Science, education, policy makers	Green Deal, CAP Farm to Fork strategy.
G4	Sardinia	Increase trust in science based options for society and public administration	Resolve disputes on sustainability issues	Government, agencies, science	Communication processes for agenda setting and policy
G5	Sardinia	Improve digital data access rights and interoperability	Make clear and workable tools for digital data	National and regional governments, agencies	Policy on digital information
G6	SW UK	Better data tools and facilities for the nexus	Increase data availability and improve nexus coordination	Government, science, companies	Policy on digital information
G7	Netherlands	Clarify criteria for sustainable biomass use	Reach agreement on the criteria	Ministries, sectors, NGOs	Climate Agreement
G8	Latvia	Integration of a Nexus approach in stakeholder dialog	Acceptance of a nexus approach input	Researchers, policy makers, sectors	Communication policy formation phase
G9	Sweden	Collaboration between researchers, stakeholders and decision makers on an	Bridge the gaps between needs, evidence and advice	Ministries, stakeholders and researchers	For the whole policy process

No	Source case	Recommendation	Challenge	Target Institutions	Target policy processes
		integrated system of governance			
G10	Sweden	Streamlining data for policy relevant coherent nexus analysis.	Knowledge framework for sector-crossing analysis	Science, government and stakeholders	Policy formation
G11	Sweden	Nexus oriented education .	Trustworthy cross-sectoral information	Education, government	Education policy
G12	Latvia	New technologies for biomass energy	Resource efficiency	Energy companies	Implementation

G1 Cross-sectoral and Nexus-proof evaluations of policy implementation processes. Clarifying the impacts of policies on other nexus sectors demands an advancement of knowledge of how sectors influence each other and also acceptance of the impact assessments used for making priorities, see Table 7. The background is a workshop in France-Germany where stakeholders were quite critical about the modelling tools, related assumptions and their results. On the other hand, researchers underlined that the dissemination of research results can be very heterogeneous; sometimes stakeholders and decision makers have high expectations regarding model results and the potential policy recommendations that could be derived from these models. A close dialogue between decision-makers, stakeholders and researchers is needed to manage expectations and by that improve the dissemination and the usage of research results in policy evaluations and policymaking. A broad involvement in the development of assumptions and for instance scenarios underlying models would enhance the trust and acceptance of the results.

G2 Stakeholder engagement with fully formed maps of nexus interactions. In order to strengthen the engagement of stakeholders in policy processes the EU-case propose that stakeholders are approached with the support of fully formed maps of the nexus interactions in their area or for their issue before asking for the stakeholder reaction and detailed opinion as opposed to coming to the stakeholders as a first step in the process, with little premade input. This will speed up and enhance the process and could be valuable for the EU Farm to Fork strategy, the Biodiversity Strategy and the EU Green Deal effort to mainstreaming sustainability in EU policies as the sub-process 'Stakeholders to identify and remedy incoherent legislation that reduces the effectiveness in delivering the European Green Deal'.

G3 'Move the Cursor' Serious Game as a feeder for discussions. Establish an understandable, easy to use and robust way to show people clear causal pathways they can explore by 'moving the cursor'; i.e. the players actually can move the cursor over the different options to reach the different objectives in the nexus (SDGs, EU objectives) and see how the nexus components interact and counteract. Useful for stakeholder and policy maker interactions around policies as the Green Deal or the CAP Farm to Fork strategy. This can support decision making, or be a tool for education, maybe even as a part of the training of new EU-employees.

G4 Increase trust in science based options for society and public administration. To enable discussions on disputes concerning sustainability issues like forestry and RES production plants people in Sardinia must meet to discuss issues as for instance Not In My Backyard. Environmentalists for instance have been met with the criticism that they are not guided by science based information. Among the issues at stake are disputes around wood cutting, with discussions of the legality and authorisation of permits, and how to understand sustainability of forests, increasing yields (carbon sequestration) and biodiversity in relation to tree cutting. Not In My Backyard phenomena also play a role, such as in RES production plants. There is a need to increase the knowledge and trust the science behind decision making processes. Dialogue between science, society and policy with awareness campaigns and dedicated courses at all educational levels could help this issue further.

G5 Improve digital data access rights and interoperability. A main challenge in developing the SDM and SG for Sardinia was access to data both because of lack of digital information and access rights issues. Some authorities provided data rapidly, others could not find the data or data were not available in digital form. Some data-bases could not be downloaded or explored, with no meta-databases or no

access authorization. This did not only limit research but also the coordination between sectors. A policy that regulates data access and interoperability would be beneficial to coordination between sectors both horizontally and vertically. Even data transmission from subordinated authorities to higher authorities is weak and often results in slow responses to planning or emergency moments. Improved data usage would have effect on all nexus components.

G6 Better data tools and facilities for the nexus. A great deal of the academic insight into the nexus challenge has focused on where the nexus challenges lie and the potential conflicts and synergies that are likely to arise from increasing disciplinary linkages. The UK case shows a similar pattern and increasing knowledge around the nexus is allowing for an expanded and more diverse understanding of how nexus thinking can facilitate a sustainable and fair future. To operationalise the solutions found however, there needs to be an adequate approach from government using tools that can elicit the desired response from different stakeholders. The government needs to ensure that the time and space exists for actors to come together for the exchange of problems, ideas and data. Setting up active, monitored and inclusive working groups, across scales, that can manage the coordination of actors and stakeholders is therefore a must to facilitate clear communication of goals, practices and data monitoring. Actors within sectors need to be held to account for their decision making regarding the nexus and this can only be done with greater transparency and communication.

G7 Clarify criteria for sustainable biomass use. During the stakeholder process many pointed out the need to clarify the criteria for a sustainable biomass usage. In particular there is low public trust in using (imported) biomass and also in the pollution from biomass plants, which have been documented by media attention, the work of the Social and Economic Council (SER) on a sustainability framework, and the questions within the parliament. All this illustrate the need for more clarity and better criteria, which is vital to improve the image of and trust in biomass, which was also pointed out in the workshops. The effect could be more expensive import and higher costs of biomass, but also possibly new domestic business-models. All relevant ministries should be engaged (Economic Affairs & Climate Policy; Infrastructure & Water Management; Agriculture, Nature & Food Quality, together with others).

G8 Integration of a Nexus approach in stakeholder dialog. Biomass is an important resource in Latvia. Local biomass production is also heavily debated e.g., criteria for forest cutting and cultivation of monocultures. These discussions are silos-based presenting strong opinion of sector specific stakeholders (industry representatives, forest owners, farmers, nature experts) rather than sound arguments based on research results. Integration of science-based results from a nexus perspective into the debate will help fill the gaps of missing knowledge to develop cross-sectoral compliant policy. Integration aspects shall be adequately communicated to wide range of stakeholders.

G9 Collaboration between researchers, stakeholders and decision makers on an integrated system of governance. Swedish stakeholders did not express high interest in the SG. They have questioned the use of the SG for decision-making and suggested the SG rather for educational purposes and awareness raising. The key rationale for that was that the SDM and SG can only be a very simple version of reality that does not reflect the real complexity of the nexus. While this is enough for educational purposes, in form of showing basic links and interdependencies between sectors, it is not sufficient for real-life decision making. This emphasizes the need for discussing with decision makers a priori how to reach policy recommendations. In SIM4NEXUS it was decided already at the time of the proposal to use an SDM and to develop a SG for decisions making. However, while this approach worked well in some of the case studies, it did not fit the needs of Swedish stakeholders. From this case the recommendation is that decision makers should work in close collaboration with researchers and clearly communicate their expectations, beliefs and needs to guarantee a successful policy-making process that leads to an integrated system of governance. Collaboration between researchers and stakeholders/decision makers from start to end of the policy process has been proven to be beneficial to bridge the gap between the evidence produced by researchers and the advice received

by the decision makers. Stakeholders noted the role of a small number of influential research groups and individuals in promoting political change. Encouraging actively the crossing of boundaries between academia, policy making and practice would remedy this. A better link between academic and national and local decisions on what to choose, fund and implement is needed.

G10 Streamlining data for policy relevant coherent nexus analysis. In the case of Sweden, a huge amount of data from different sectors are freely available in national open data portals, which is potentially very beneficial for the decision making with regards to the nexus and for research that can support such decision making. For example, the Swedish Forest Agency, the Swedish Board of Agriculture and Swedish Energy Agency, all have large comprehensive databases covering many dimensions of their particular sectors. Much of these data has been used in the Swedish case study. However, a problem arises when data are to be used in analysis that should inform decisions that may have implications across sectors. Not all data are compatible for use in-between sectors, e.g. different categories can be included in different classifications of resources, energy use; or data can be grouped in different categories (e.g. sectors of energy use). In addition, it is difficult to find information on how changes in one sector may impact other sectors. For example, in the Swedish SDM we planned to use an intervention of increasing forest biomass use (applying tax reliefs), but we were not able to connect that in the model to the energy sector – what would increasing biomass mean for the use of fossil fuels. While there was general information of how much of different categories of biomass is being used in the energy sector, it was not clear what type of biomass it is, where it comes from (forest, agriculture) and in which societal areas it is being used (transport, heating, households, services), etc. Thus, it was difficult to understand how changes in the forest sector's production of biomass can impact use of fossil fuels in Sweden and, as a result, this policy intervention was disregarded in the SDM and the SG.

This points to the need of streamlining the data produced and gathered and of trying, at national scale, to collect a more coherent data that can work with each other. In Sweden, much progress has been made to collect/synthesize such regional and national data by Statistics Sweden, a government agency that produces official statistics, and the National Archives in Sweden. However, such an open data portal is not available in many other countries. Thus, to collect such data, a new framework must be created that represents the key connections in the nexus and highlights key priorities linked to the intersectoral relations. The conceptual model developed in SIM4NEXUS could be a starting point for such discussion among Swedish authorities responsible for data gathering in different sectors.

G11 Nexus oriented education. Stakeholders argued that it is very important to introduce nexus related environmental aspects early on in education systems to create a society that is aware of and can deal with environmental problems. Increasing capacity of the general society with regard to nexus challenges can then lead to social innovations that will improve our chances for dealing with these challenges. Most of all, including nexus thinking from the early stages of education will support development of the new generation of experts for whom the nexus interaction will be an obvious thing and who will only be able to work in integrated manner. On top, the stakeholders in the case study highlighted very much the importance of communication and coming together to discuss with people from other sectors. If the sectors improve their cross-sectoral communication, policies with synergetic effects can be introduced and negative effects from potentially conflicting policies can be avoided. This could, in long term, lead to governance innovations where the silo-approach of sectoral thinking could change to a more integrated system of governance.

G12 New technologies for biomass energy. Biomass resource is projected to be widely used for energy production. However, substantial amount of energy production installations are old and out-dated with low energy production efficiency. Considering the goal on resource efficiency, application of new and more efficient technologies is needed for the coming decades. New technologies for electricity production from biomass e.g., gasification, pyrolysis are known, but have to be introduced in the

energy sector. Replacement of old technologies for use of biomass in combustion plants installed in district heating and local heating is required as well.

3 Connecting recommendations to the EU Green Deal

The recommendations from the 12 SIM4NEXUS cases needs a place to land in the policy makers' agenda. In essence this is currently the European Green Deal, which is now being set-up to achieve climate ambitions of no net emissions of greenhouse gases in 2050 and realise an economic growth that is decoupled from resource use (European Commission 2019b). The Green Deal is shown in Figure 10.

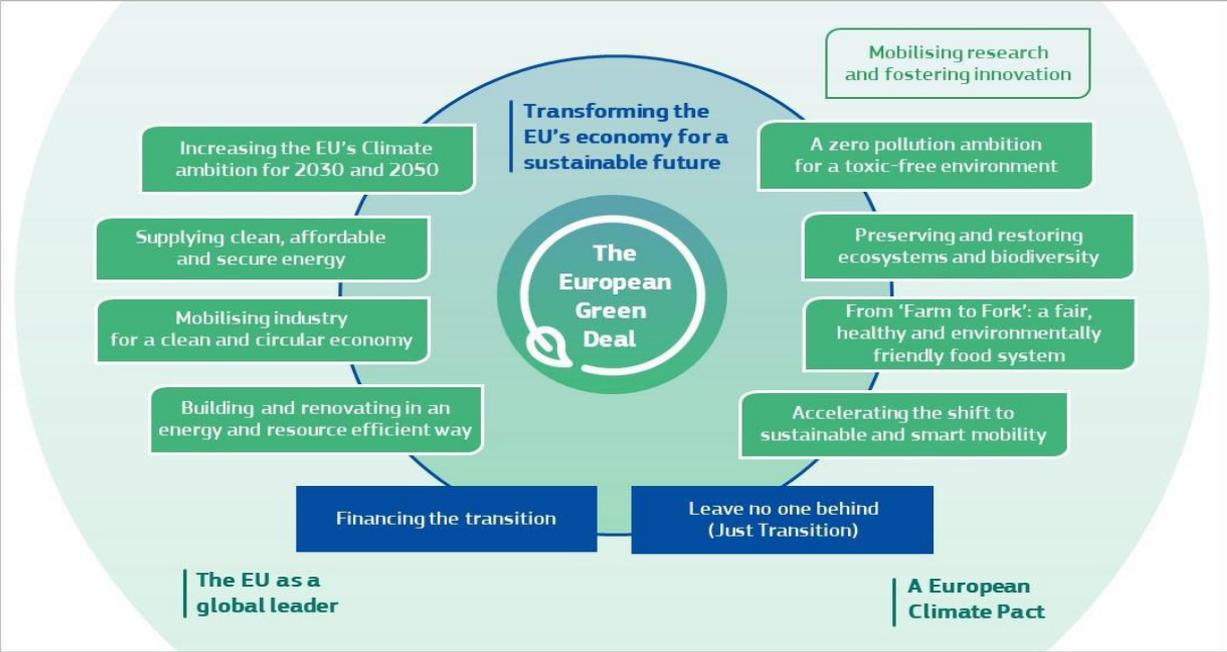


Figure 10: the European Green Deal – an overview (European Commission, 2019b).

For the implementation of the European Green Deal a timetable has been made for making the EU's economy sustainable. Climate and environmental challenges are now to be turned into opportunities across all policy domains. The original timeline was to start in 2020 or 2021, depending on the matter at hand, but the agenda has now become uncertain, due to the Corona crisis. Here we present the roadmap actions with a link to the recommendations from SIM4NEXUS. We like to point out that the recommendations represent the needs felt in the cases and that these are made before the Green Deal was made. Yet we do see a great overlap in focus and direction of the proposed actions.

If we look closer at the findings in the table we note that the focus has been oriented towards land-use and water issues and related matters concerning energy, agriculture, biodiversity, environment and less attention has been paid to financial mechanisms or general industrial or mobility matters. This is a logical consequence of the project focus on interlinkages between and coherence of the domains water, energy, land, climate and food. We do note that the rather strong call for action for more collaboration and competing claims have a rather general importance. Finance is in that respect of crucial value, which together with an including and just transition is at core of the EU Green Deal.

When developing and assessing the Biodiversity Strategy and the Farm2Fork strategy further we emphasize the link to the science-policy interface for a learning society. The SIM4NEXUS development of complexity models like SDM and a Serious Game, represents ways of making causal relationships more clear and establish foundations for further discussion of both problems and solutions.

In Table 8, the policy recommendations of the SIM4NEXUS project are linked to the key actions of the roadmap of the European Green Deal.

Table 8: European Commission 2019c, linked to the SIM4NEXUS recommendations

Roadmap - Key actions	SIM4NEXUS Recommendations (main connections to the EU)
Climate ambition	
Proposal on a European 'Climate Law' enshrining the 2050 climate neutrality objective	A1-9; F1 catalogue for local measures to increase climate change resilience in the agricultural sector
Comprehensive plan to increase the EU 2030 climate target to at least 50% and towards 55% in a responsible way	A1 Stimulate bioenergy without trade-offs
Proposals for revisions of relevant legislative measures to deliver on the increased climate ambition, following the review of Emissions Trading System Directive; Effort Sharing Regulation; land use change and forestry; Energy Efficiency Directive; Renewable Energy Directive.	All (in general) A2 More energy efficiency and saving A3 Reduce trade-offs of land-based solar power A4 Promotion and use of RES for electricity generation A7 set a maximum of cultivated land with spatial rules for energy crops B3 reduce GHG emissions agriculture B4 encourage less water-demanding crops E2 Change governance at all levels of policy making to enable transdisciplinary and cross-sectoral cooperation and 'eliminate' silo-thinking F4 stricter instruments for obligatory protection of land and biodiversity E6 More focus on competing claims for land for feed, fiber and bio-energy purposes E7 Bring more clarity and transparency in the various uses of different types of biomass and link the usage to business models
Proposal for a revision of the Energy Taxation Directive	A8 More focus on energy efficiency in combination to a GHG tax
New EU Strategy on Adaptation to Climate Change	F6 Strategic policy dialogue on the links between climate and resource efficiency and social effects. F7 Demand reduction of energy, water and food usage F8 Clarify the hierarchy of policies: behaviour>efficiency>capacity.
Clean, affordable and secure energy	
Assessment of the final National Energy and Climate Plans	A1-9; G2 Stakeholder engagement with fully formed maps of nexus interactions; G6 Better data tools and facilities for the nexus
Strategy for smart sector integration	A9 energy distribution by Smart Grids to enhance RES share
Evaluation and review of the Trans-European Network – Energy Regulation	A6 strengthen transboundary cooperation on energy policy
Industrial strategy for a clean and circular economy	
Circular Economy Action Plan, including a sustainable products initiative and particular focus on resource intense sectors such as textiles, construction, electronics and plastics	E6, E7 on better usage of biomass, not only for energy but also high-end usage
Initiatives to stimulate lead markets for climate neutral and circular products in energy intensive industrial sectors	E6, E7 on better usage of biomass, not only for energy but also high-end usage
Propose legislative waste reforms	A5 separate collection of households organic waste for energy
Greening the Common Agricultural Policy / 'Farm to Fork' Strategy	
Examination of the draft national strategic plans, with reference to the ambitions of the European Green Deal and the Farm to Fork Strategy	B1 encourage a healthy diet with more plant-based instead of animal-based proteins B2 shift from livestock to arable farming and horticulture C2 clarifying responsibilities water management C3 on enhancing irrigation efficiency C4 shared vision of sustainable water resource management regulations C5 minimisation of water losses in agriculture

	<p>C6 decrease water-consuming crops and cultivation of less water-demanding crops D1-6 E on governance in general; E3 partnership working; E4 on an interconnecting governance, to promote support and avoid fragmentation; E6 on competing claims E10 Develop policy processes by more collaboration by learning from good practices and success stories G4 Increase trust in science based options for society and public administration; in combination with for example G2 and G6; and G3 'Move the Cursor' Serious Game as a feeder for discussions,</p>
'Farm to Fork' Strategy: Measures, including legislative, to significantly reduce the use and risk of chemical pesticides, as well as the use of fertilizers and antibiotics	<p>B5 stimulate techniques to reduce emissions of nutrition and pesticides B6 promote organic farming B7 sustainable cereals production D5 Promote environmentally friendly food production. F9 CAP implementation: Stricter conditions for public funding and lowering the administrative burden for applicants to a subsidy for voluntary measures</p>
Preserving and protecting biodiversity	
EU Biodiversity Strategy for 2030	<p>D1-6; F4; E2 due to its focus on transdisciplinary and cross-sectoral cooperation F2 Payments for ecosystem services to increase environmental quality; G3 on Serious Game; with G2, G6</p>
Measures to address the main drivers of biodiversity loss	B5, B6, B7 on less pesticides; D1-6; F2; F4
New EU Forest Strategy	D6 programme of landscape restoration, for instance soil recovery
Measures to support deforestation-free value chains	<p>D4 strengthen policy for more focus on biodiversity and resilient ecosystems D5 promote environmental friendly food production</p>
Towards a zero-pollution ambition for a toxic free environment	
Chemicals strategy for sustainability	B5, B6, B7
Zero pollution action plan for water, air and soil	B5, B6, B7
Mainstreaming sustainability in all EU policies	
Proposal for a Just Transition Mechanism, including a Just Transition Fund, and a Sustainable Europe Investment Plan	A4; A8 More focus on energy efficiency in combination with a GHG tax; A9
Renewed sustainable finance strategy	E3 and E8 continuation of the support for innovation through public-private partnerships, both focuses on cooperation on finance
Review of the Non-Financial Reporting Directive	F5 Make evaluation of policy implementation processes cross-sectoral and Nexus-proof
Initiatives to screen and benchmark green budgeting practices (MS and of the EU)	F5
Align all new Commission initiatives with the Green Deal objectives and promote innovation	<p>D5, D6 F7 Demand reduction of energy, water and food usage</p>
Stakeholders to identify and remedy incoherent legislation that reduces the effectiveness in delivering the European Green Deal	D3 land-use regulation to end conflicts; D6
Integration of the Sustainable Development Goals in the European Semester	All (in principle)
The EU as a global leader	
EU to continue to lead the international climate and biodiversity negotiations, further strengthening the international policy framework	A1
Strengthen the EU's Green Deal Diplomacy in cooperation with Member States	A1 but also F7 on Payments for ecosystem services
Bilateral efforts to induce partners to act and to ensure comparability of action and policies	F7
Working together – a European Climate Pact	F5
Proposal for an 8th Environmental Action Programme	D5

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