73 NRP

Sustainable Economy
National Research Programme

Advancing Sustainability

«Sustainable Economy:
resource-friendly, future-oriented, innovative»

Policy recommendations
White Paper

Swiss National Science Foundation

2016-**2023**
Final synthesis of NRP 73

NRP 73

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The NRP 73 community

Preface

From research to action: Advancing a resource-friendly, future-oriented and innovative sustainable economy

Over a period of five years the National Research Programme “Sustainable Economy: resource-friendly, future-oriented and innovative” (NRP 73) produced valuable insights into the complex interactions between our natural environment and economy, and also provided a set of recommendations for policymakers, practitioners and stakeholders for building a more sustainable, equitable and resilient future for all.

As we confront the existential threats of climate change, resource depletion, and growing economic inequality, we are reminded of the critical importance of developing a sustainable economy, which balances economic issues with social and environmental responsibility. We believe that our research programme provides a roadmap for achieving this goal and serves as a valuable resource.

NRP 73 brings together 29 research projects from across a broad range of sectors and applies a variety of methods and disciplinary approaches. The research projects explored nine thematic areas including circular economy, finance, construction, cities and mobility, forest management, agriculture and nutrition, supply chain, sustainable behaviour and governance. For each of these areas, key opportunities and challenges were identified and strategies for promoting a sustainable economy were outlined.

Through the course of our research programme, we closely cooperated with partners from the private sector and other stakeholders and established a Sounding Board, which included representatives from administration, associations, NGOs and politics. Their collective input helped ensure that our research was shaped by a broad range of perspectives and experiences, and that our policy recommendations are both relevant and applicable.

As co-presidents, we remain committed to supporting the vision of a sustainable economy, which is both ambitious and feasible. We believe that this White Paper provides valuable insights and can serve as a shared resource that enables policymakers, practitioners and academics to work together for advancing towards a sustainable economy.

Sincerely,

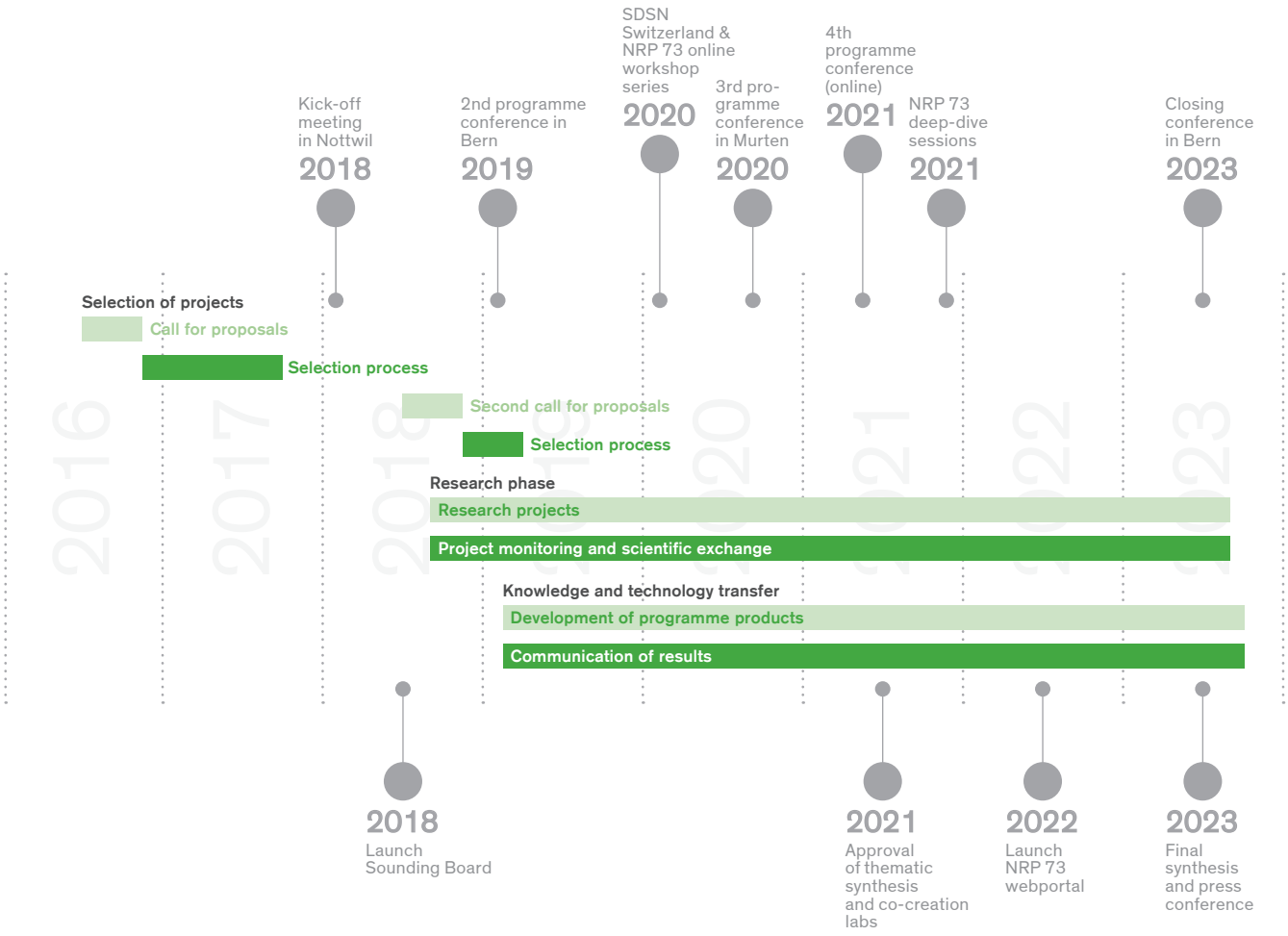
Prof. Dr. Regina Betz
Co-President of NRP 73

Prof. Dr. Gunter Stephan
Co-President of NRP 73

Highlights

Key milestones

Figure 1: Timeline



Facts and figures

Academic events:
361

Knowledge transfer events:
225

Researchers:
210

Scientific publications:
190

Podcasts, policy briefs and videos:
24

Partners:
85

1. Introduction

Severe weather events, rising sea levels, and loss of biodiversity threaten our welfare and livelihood worldwide. We need to adjust our consumption of environmental resources (see Figure 2) to nature's capabilities. This concerns consumer behaviour as well as production processes.

The necessary transition to a sustainable economy will affect both present and future generations and hence requires a long-term perspective.

This is in contrast to the challenges of the COVID-19 pandemic and the war in Ukraine which both triggered disruption of supplies. Both have made us aware of how vulnerable our welfare is, and both call for immediate interventions. Sustainability, however, requires a transition towards a society and economy that is less vulnerable and more resilient over the long term. In terms of political changes this means, that the costs and benefits of such a transition are balanced and just for both present and future generations.

In 2016, when the National Research Programme "Sustainable Economy: resource-friendly, future-oriented, innovative" (NRP 73) was initiated, the question was which policy framework and measures are well-suited and what costs and benefits the transformation to a sustainable economy would entail. Closing this knowledge gap was the main purpose of NRP 73. To that end NRP 73 adopted a systemic view taking into account the environment, the economy and society as well as all natural resources and all stages of the value chain.

More precisely, NRP 73 was designed to address the following aims:

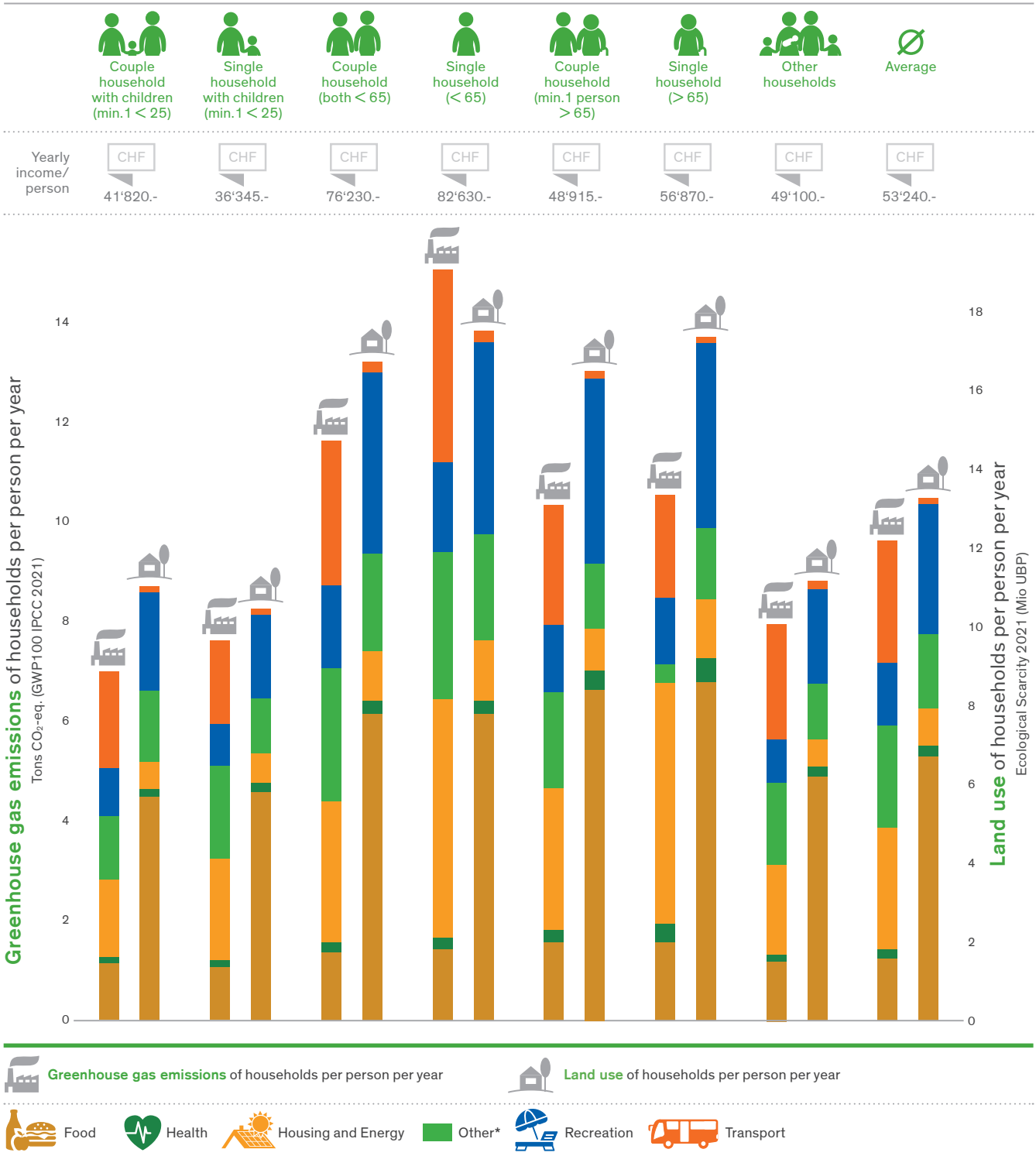
- acquire scientific knowledge to better understand and facilitate a sustainable economy;
- identify opportunities and risks against the backdrop of a globally connected Swiss economy;
- understand the dependencies and vulnerabilities resulting from specific measures and instruments, and;
- identify areas for future research and propose specific areas for implementation.

The transition of the Swiss economy towards a more sustainable one is a complex process, which needs disruptive innovations in many sectors and collaboration across disciplines as well as insights from practitioners, politicians and engagement with citizens.

NRP 73 covers 29 research projects across a broad range of sectors, applying a variety of methods (qualitative and quantitative), and disciplinary approaches (inter or transdisciplinary, e.g. combining natural and social sciences as well as co-creation of knowledge with the private sector and other stakeholders). Regular exchanges with practitioners about our research aided in the development of actionable results and revealed barriers to implementation (e.g. interdependencies between stakeholders in the value chain impede a sustainable circular economy). Consistent knowledge exchange and dialogue throughout the duration of NRP 73 ensured that Swiss industry and policy makers were involved and informed from the beginning.

Figure 2: Greenhouse gas emissions and land use of different households in 2021

The data shows that transport emissions (dominated by private passenger car travel) and housing (dominated by heating with oil and gas) have the highest potential to reduce the climate impacts, as well as animal food products dominating the land use budget of household consumption.



Co-creation lab "Data transparency"

Figure 2 shows the annual climate (left) and land use (right) impacts of household consumption **in 2021**, as well as the annual gross income for different household types. Impacts associated with regular household expenditure including the supply chain impacts, so called "grey emissions" are included. For example, this will include the production impacts of electronic devices bought, all along from the metal mine to the electronics shop. Impacts related to construction of residential properties are not included. Air travel, including international flights, are included on a consumption footprint basis, i.e., the emissions are attributed to the purchasing power. However, it must be noted that these only include flights from private expenditure and therefore any work-related travel is not included. Non-CO_2 climate impacts of aviation are not considered.

The climate change impacts take into account all greenhouse gas emissions and are given as the IPCC indicator "greenhouse gas emissions", expressed in "t CO_2-equivalents", which are converted with the 100 year IPCC global warming potential. The land use impacts are given as the ecological scarcity indicator and expressed in so called "eco-points" or UBP (Umweltbelastungspunkte). The "eco-points" method measures the total environmental impact generated in the life cycle of products. It includes greenhouse gas emissions, pollutant emissions, land use, use of other resources, etc.

*includes clothing & footwear, electronics as well as other activities

1.1 Objective and Approach of the White Paper

The aim of this White Paper is to present the key messages with a focus on policy recommendations based on the 29 research projects of NRP 73.

Given the range of research fields, sector-specific recommendations in the annexes addressing policy making options in these sectors as well as consumer behaviour and production processes supplement this synthesis.

Throughout the research phase, annual programme conferences and stakeholder workshops took place to support regular exchanges within and between science and practice. In preparation for this White Paper, project leaders and their teams provided key findings and recommendations to its authors and discussed those with them (see Figure 3). The NRP 73 Steering Committee subsequently adopted a first outline and the Editorial Board (Steering Committee and Sounding Board representatives as well as the Programme Management) accompanied, reviewed and discussed the first drafts with the authors. To validate the results and messages presented in this paper, NRP 73 research and synthesis teams provided feedback on the drafts, followed by a discussion with the Sounding Board to collect its perspective and feedback. The White Paper was adopted by the Steering Committee in March 2023.

In addition to the White Paper, synthesis products and outputs from the thematic syntheses and co-creation labs including policy briefs, podcasts, and videos highlight specific findings of NRP 73. All of which can be found on the NRP 73 webportal.

The structure of the White Paper is as follows:

Section 2 provides an overview of the diversity of policy instruments which have been considered by different NRP 73 projects.

Section 3 outlines the strategies and challenges in combining and implementing effective policy mixes in Switzerland.

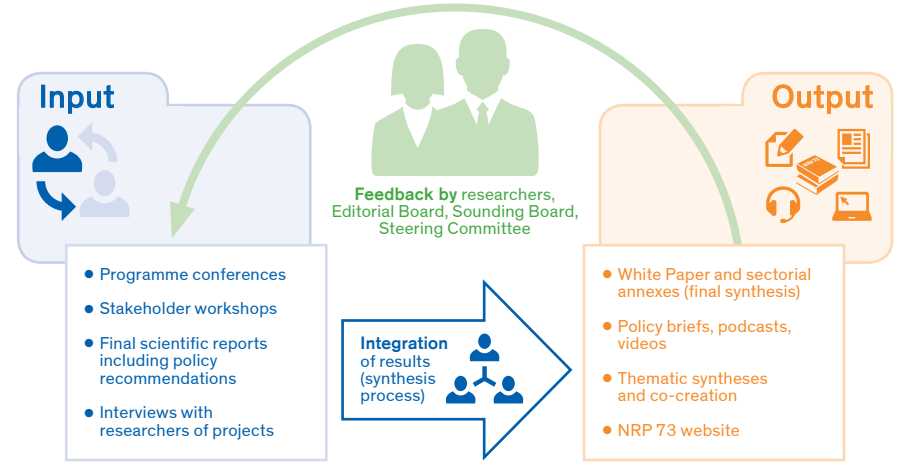
Section 4 summarises specific policy recommendations from five priority areas: “Food Production & Nutrition”, “Circular Economy”, “Building & Construction”, “Sustainable Behaviour & Consumption” and “Forest Ecosystems”.

Section 5 briefly summarises the overall policy recommendations, and highlights implementation areas and future research needs.

Section 6 includes sector specific recommendations.

Figure 3: Approach of the White Paper

Interactions between the researchers, the authors and Editorial Board in preparation of this White Paper

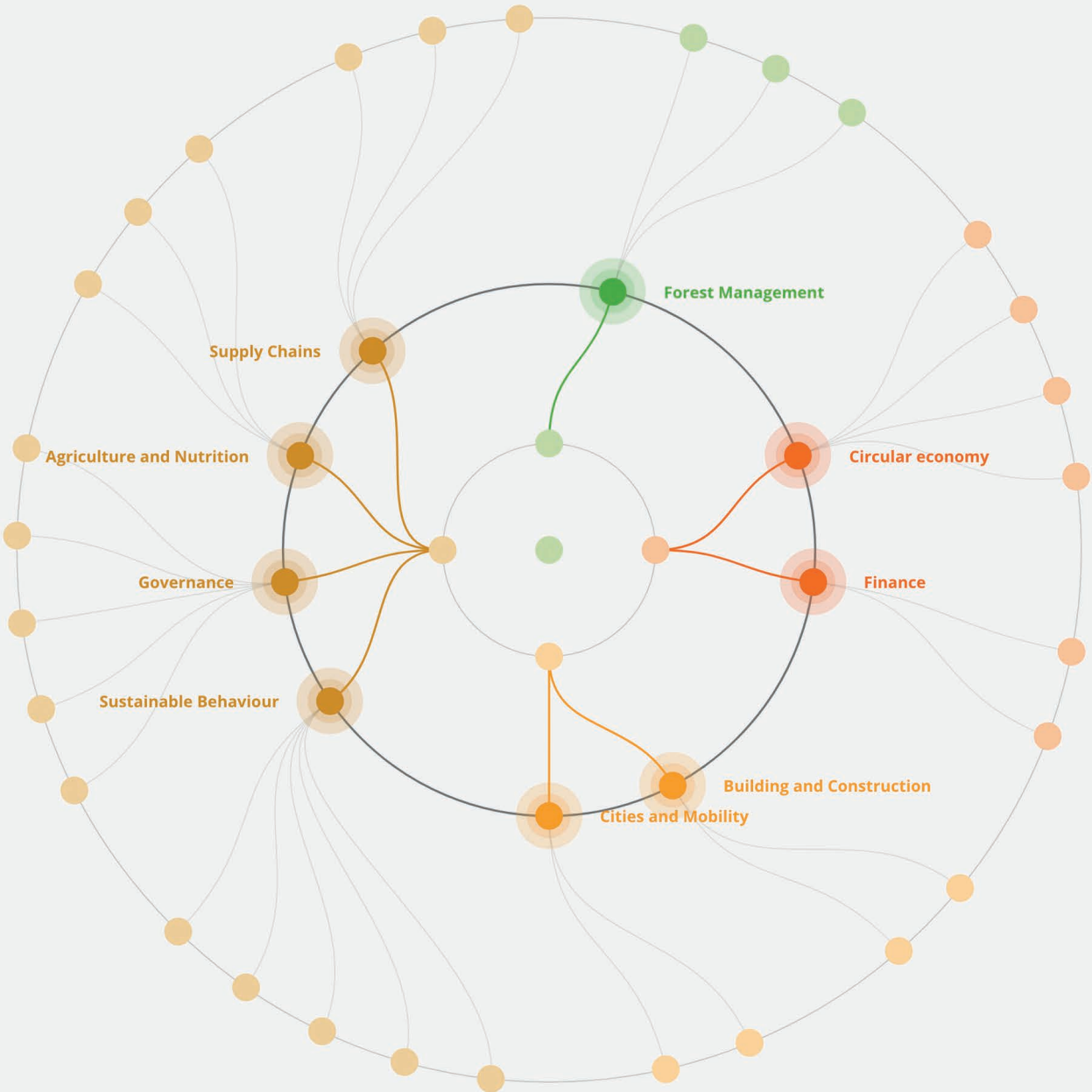


The Output reflects the policy recommendations of the scientific results and findings.

1.2 Overview of the thematic focus areas of NRP 73

The 29 projects can be clustered into nine thematic focus areas.

Thematic syntheses were conducted for the following areas: Forest management, circular economy as well as agriculture and nutrition, and co-creation labs were conducted for building and construction as well as sustainable behaviour. The results of these thematic syntheses and co-creation labs are summarised in Section 4.



Find out more
nrp73.ch/en // Topics

2. Diversity of policy instruments

NRP 73 projects consider a variety of policy instruments to be used by the different state authorities (federal, cantonal, municipal, and commissioned private individuals) to achieve a sustainable economy.

These measures include regulatory, market-based, and behavioural interventions. Policy instruments need to be considered in the context of the general legal and regulatory system, which might in some cases point in opposing directions (e.g. the implementation of competition rules). A review of such contradictions in the general regulatory system might be a necessary condition for the systematic implementation of certain regulatory instruments (Heselhaus, Bürgi).

Market-based instruments such as taxes or fees put a price tag on environmental resources, which were previously seen as a free good. This should have the effect that less environmentally damaging production processes are chosen, and higher costs are passed on to the end consumer. This makes environmentally harmful goods more expensive and thus reduces demand. At the same time, the consumer's freedom of choice is not overly restricted, and producers are free to adjust production processes according to their technological knowledge.

However, market-based instruments are only efficient if producers and consumers are equally and fully informed. Therefore, in contrast to technology standards, market based instruments do not prescribe the state of technology, and technological innovation is not impeded, but will be directed in the right direction. At the same time, market-based instruments ensure that the polluter pays for the negative impact on the environment. A typical area of application is the mobility sector and the carbon tax on petrol (Maibach), treated waste water with reuse (Truffer) as well as a recycling fee in the construction sector (Kytzia).

Both environmental taxes and fees on emissions and natural resources are economically efficient environmental policies. Of course, taxes and fees can have distributional effects, which have to be addressed for example by redistributing environmental tax income fairly to the public. Fair redistribution is important to increase acceptance of market-based instruments among the public, and hence also in politics (Stephan[1]). One proposal is a major overhaul of the tax system. This could imply the introduction of an environmental footprint tax, which would replace other taxes (Frankenberger). The basis of calculation would be the material, the carbon or environmental footprint of products and resources, calculated over their entire lifecycle.

Regulatory instruments can directly affect behaviour by restricting the consumers' freedom of choice, for example by prescribing certain technologies or prohibiting certain actions. On the other hand, regulations encouraging the development of sustainable products and services on the market also influence consumers' behaviour (Blumer). Restrictions are used to reduce environmental harmful behaviour, but do not completely prevent it. They therefore define a form and a degree of tolerated environmental degradation. Various starting points for such measures can be selected: permitted emissions, production processes or other production conditions. In any case, this requires defining standards and criteria as Maibach, Mathys and Rochet argue. Bans completely prevent certain forms of environmentally harmful behaviour and are recommended in the mobility sector to reach full decarbonisation by 2050 (Maibach). A ban on importing fossil-fueled vehicles (including hybrid cars) by 2030 has the advantage that it provides planning and investment security for the production and purchase of electric vehicles for consumers and producers.

Behavioural interventions: These include incentives (Schubert), voluntary agreements (Bernauer) and nudging (Schmitz, Schubert, Blumer). Incentives for more sustainable behaviour among households are highly effective and lead to positive spillovers (Schubert). A prerequisite for positive spillovers is that sufficient information about the environmental impact is available (Schubert). The active provision of information is also important for voluntary agreements (Bernauer). For example, companies can be encouraged to improve their sustainability voluntarily to prevent the introduction of stricter governmental regulations. The provision of information on their resource use shows that SMEs can be motivated not only with financial benefits (incentives), but also with information on their environmental impact and comparison with other companies (nudges). The integration of more sustainable products or services, such as second-hand appliances, in the offer of (online) shops is a type of nudging that even less environmentally conscious people are prompted to consume more sustainably (Blumer). Existing evidence suggests that information alone is not sufficient to achieve behavioural change. A mix of measures, including regulation, is needed, not least to ensure that information is used efficiently and thus leads to behavioural change.

[1] Stephan, G. (2022). "Circular Economy: Illusion or First Step towards a Sustainable Economy: A Physico-Economic Perspective." Sustainability 2022, 14, 4778. https://doi.org/10.3390/su14084778

3. Strategies and challenges to achieve a sustainable economy

This section outlines key strategies and challenges for a sustainable economy based on the results from NRP 73.

Environmental effectiveness and precaution

It is well known that policies should secure:

1. **Regeneration:** renewable resources should be used efficiently and their use should not exceed their long-term rates of regeneration.
2. **Substitutability:** non-renewable resources should be used efficiently, and their use is limited to levels that can be offset (i.e. substituted) by renewable resources or other forms of capital.
3. **Assimilation:** releases of hazardous or polluting substances to the environment should not exceed its assimilative capacity, and concentrations should be kept below critical levels. When assimilative capacity is reached, zero release of such substances is required to avoid their accumulation in the environment.
4. **Avoiding irreversibility:** irreversible adverse effects of human production and consumption activities on spheres like ecosystems, biogeochemical and hydrological cycles should be avoided. Tipping points in the climate system for example should not be overstepped.

The natural processes capable of maintaining or restoring the integrity of ecosystems should be safeguarded from adverse impacts of human activities. The differing levels of resilience and carrying capacity of ecosystems should be considered.

Welfare and justice

Policy for a sustainable economy must include welfare and justice. As mentioned above, such policies go beyond environmental concerns in that they enable, accelerate, shape and accompany social and economic transformation. This transformation should not be at the expense of certain groups. Policies for a sustainable economy have the task of pointing out the fundamental importance of preserving the natural basis of life for an economy that secures long-term prosperity and thus social balance and global peace. Policy for a sustainable economy should reconcile ecological concerns as guiding principles with further development of economic and social interests. NRP 73 approached the transition to a Swiss sustainable economy under these premises. However, the integration of these perspectives in sustainable policy is not just a national challenge but a global one. Addressing the broader perspective of social welfare and justice is also very important to increase public acceptance of policies that promote a sustainable economy.

Reliability, stability and predictability of policy

Policy for a sustainable economy must generate long-term planning security for investment and innovation (Noailly, Maibach). Hence, it is important to build a **stable policy framework** that is sustained over several electoral cycles and major crises. Furthermore, it should be plausible, consistent, understandable, selective, transparent and communicable. An important general conclusion is that there should be a hierarchy of actions:

- **First, avoid environmental and social degradation**
- **Second, optimise the use of natural resources,** thereby setting the right incentives to change production processes and consumer behaviour preferably by using market-based instruments.

Environmental taxes have major advantages: they are reliable, raise consumer awareness, generate revenues for the government and once implemented are difficult to remove. Despite that, regulatory measures, which define minimal standards and hence create orientation, are strongly recommended in certain contexts such as in the transportation sector (Maibach), in the food system (Mathys) and in the finance sector (Rochet). This means that **policies must create reliable, long-term binding framework conditions** for example by defining sustainability standards.

Policy mix

A **sensible combination of instruments and measures** is therefore required. If different policy measures or types of instruments are coordinated and combined in a meaningful way, the effectiveness of (environmental) policy can be increased. A “systemic” policy mix that comprehensively and consistently addresses the interplay between production, consumption, infrastructure, and markets has better prospects of promoting sustainability than one that only considers the production side of an economy (Maibach regarding the transformation of the transport sector). This means that policy measures will be built upon economic, technical or social trends to improve the set of policy instruments that will promote a sustainable economy as a whole. Policies should aim at minimising economic, social and environmental costs. Cost-effectiveness allows for the minimisation of aggregated costs and the setting of more ambitious targets in the future.

Voluntary contributions and legal sanctions

The majority of Swiss voters favour voluntary measures, provided that there exists a legal threat of sanctions in case of non-achievement or greenwashing (Bernauer). In an open society, a participatory approach is important to successfully meet the challenge of sustainable development. This requires that the process through which decisions are reached is informed by the full range of potential consequences and is accountable to the public. Voluntary agreements cannot substitute a general framework with the right policy measures despite good examples of semi-voluntary standards such as PET bottle recycling (Hoffmann).

Timing of actions with goals and timetables

It is important to establish a roadmap with clear goals and a timetable in order for the different stakeholders including investors to understand what the regulatory framework will look like in 10 or 20 years from now and to evaluate progress at regular intervals (Truffer, Kytzia, Schulz, Hoffmann, Noailly). Since there is public support for voluntary agreements, it is important to make use of such approaches, but policy must also establish transparent monitoring as well as prosecution measures, which grant enforcement if necessary. Obviously, different goals may conflict with each other (Kytzia, Schulz). For example, using forests as carbon sinks may conflict with the economic use of timber in construction or energy production. Policy makers must be aware of these trade-offs, effectively coordinate and communicate across different sectors and federal offices and aim for consistent policies by providing the right incentives (Heselhaus).

Incentives for the formation of green skills

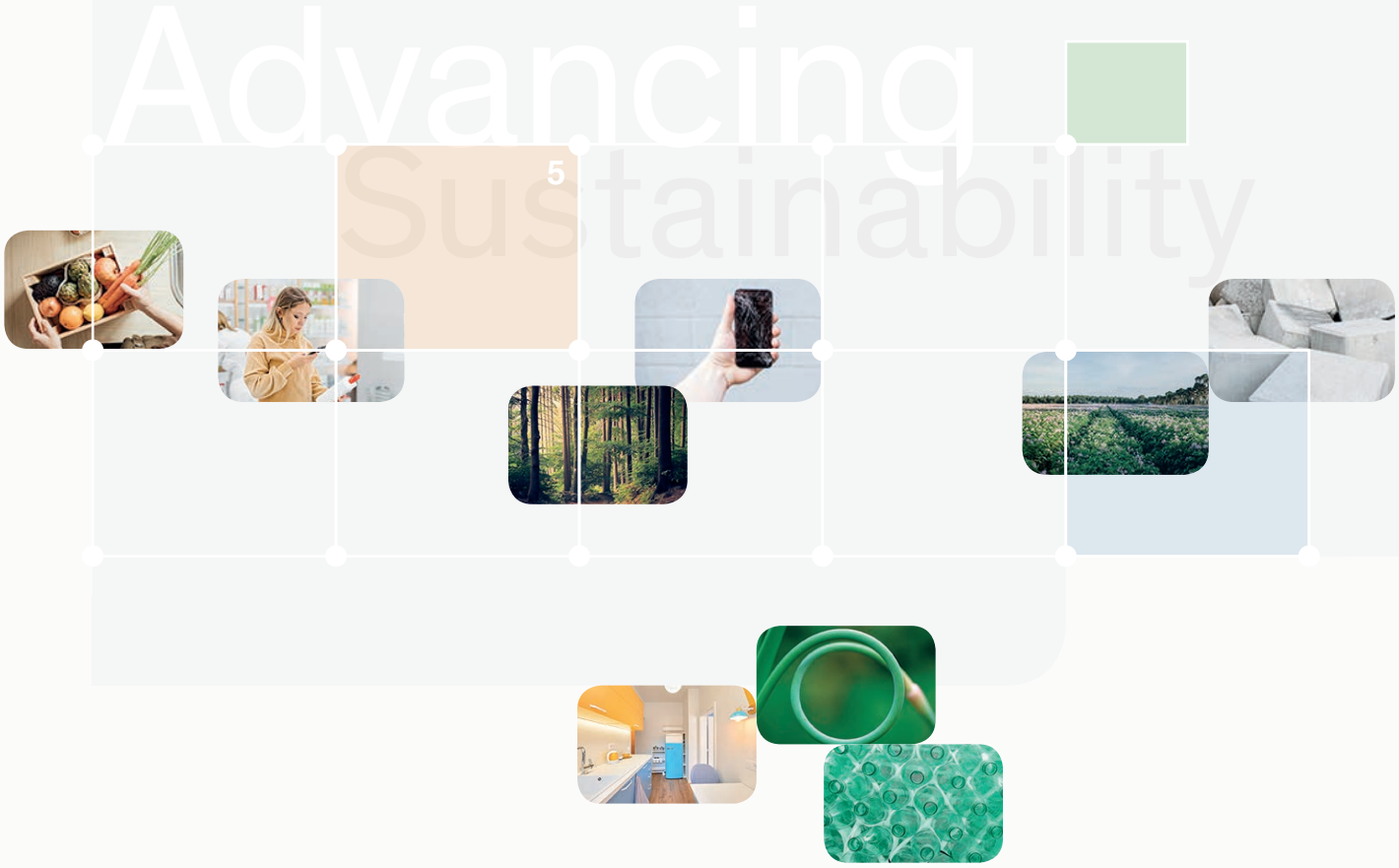
The transformation towards a more sustainable economy affects the labour market and will be successful only if sufficient "green" skills are available (Weder). Since education and training have the properties of a public good, policy should provide incentives for green skills development. This relates not only to the industrial sector but to craftsmanship as well as the agricultural sector and should cover all stages of the Swiss higher education system, i.e. technical schools as well as universities and vocational training (Weder). Training programmes should include diverse experiences with nature as this will impact the individual environmental identity which will in the long term impact voting behaviour and responsible business (Czellar).

Get the pricing right

Markets can support sustainable outcomes only if pricing encourages individuals to take the full costs of environmental degradation into account. Therefore, pricing must reflect the full costs and benefits of the goods and services being produced and consumed. This can be achieved through additional taxes and eliminates incentives to overuse natural resources and to degrade the environment (Kytzia, Hoffmann, Maibach, Finger). This could also reduce rebound effects (see Binder). Note, however, that this requires a clear public engagement strategy as trust and acceptance are vital (Noailly). This would tailor messaging to particular audiences so that it is inclusive and effective.

Find out more
Policy Brief // Podcast

4. Specific policy recommendations in five priority areas



4.1 Food Production & Nutrition

Agriculture and food systems are responsible for a significant portion of the environmental footprint of humanity, and efforts to reduce their impacts are crucial for achieving sustainable development.

The value chain in food systems encompasses agricultural production including the agricultural service and product suppliers followed by processing, distribution, retailing including restaurants and other food services, consumption and disposal.

Most current agricultural practices use significant amounts of natural resources. Further aggravating factors are dietary patterns and high levels of food waste – a global average of 65 kg of food is wasted per person per year.

Sustainable food production in Switzerland

Two projects (Finger and Nemecek) analyse the issue of sustainable food production from different perspectives and have an important policy recommendation in common:

- New technologies and knowledge must be promoted, which requires training and further education and exchange in farmer networks.

In **agricultural production** the intense use of fertilizers and pesticides has severe adverse environmental and health effects. However, NH_3 and N_2O emissions from farmlands can be reduced. As Finger demonstrates, new digital technologies enable a more precise application of agricultural production factors. Satellites or drones can be used to reduce the use of fertilizers such as nitrogen, while maintaining the same yield. From an agricultural policy point of view, a holistic perspective on the possible promotion of digital innovations in agriculture is needed. This implies especially that policies:

- Establish digital infrastructure through public investments more strongly.
- Make the use of new technologies (e.g. drones) more attractive through internalising externalities (e.g. emissions or their reduction).

Reconciling food production, income generation and environmental preservation are three important objectives for ensuring the future sustainability of agricultural systems. Simultaneously fulfilling these three objectives is a challenge. But as Nemecek demonstrates with Swiss case studies, environmentally friendly production and economic viability can go hand in hand. To increase environmental efficiency as well as economic performance Nemecek recommends to:

- Shift subsidies from eco-inefficient to eco-efficient farms, this means from animal-based to plant-based production.
- Incentivise positive effects of animal husbandry on ecosystem services, rather than large scale animal production in regions with lower productivity, notably in mountain regions.
- Provide tools to farmers to measure and reduce their environmental impact.

Agricultural production outside of Switzerland

Since Switzerland is highly dependent on **food and feedstock imports,** such as cacao, soy or palm oil, the agricultural production outside of Switzerland has to be considered. To achieve this Bürgi, Schader, Bernauer and Francois suggest:

- Increased disclosure and public incentives to enable market access for products of high sustainability value and disable damaging production processes (Bernauer). This may trigger positive feedback effects on further public demand for regulation such as corporate liability clauses for damages abroad. (Bernauer, Bürgi)
- Including environmental and social provisions in international trade agreements, seems to be an effective approach as long as those provisions are binding and concrete (Bernauer). However, such regulatory approaches would need to be framed in a more comprehensive and context-based manner. (Bürgi)
- Transparency among value chain actors will allow more targeted investments, which could improve the situation on child labour and gender inequality. (Schader)
- International technology transfers related to (inter alia) cattle management and cultivation techniques in order to reduce methane emissions. (Francois)

[NH3] Ammonia is an inorganic compound of nitrogen and hydrogen with the formula NH_3.

[N2O] Agriculture accounts for approximately 75% of total Nitrous oxide (N_2O) emissions. Manure application to grassland and synthetic fertilizers are the dominant global sources of N_2O emissions.

Approaches for a sustainable agriculture and food system

Seele argues for enhancing sustainable public procurement by Swiss Federal Public Procurement Law. In addition, Schubert, Francois and Bernauer show that consumers would support better regulation of food related sustainability-labels (organic is already regulated, but sustainability not) since greenwashing concerns are substantial and there is the risk that consumers are flooded with many different labels. However, the participation of government agencies in the governance and implementation of a "sustainability label" carries the risk of WTO incompatibility as it may be seen as a protectionist practice (Francois). A response to this risk is proposed by a concrete hypothetical legal act on sustainable agricultural trade. The act illustrates how such response can be framed in a non-discriminatory and development friendly way. (Bürgi)

Dietary changes

On the **consumer side,** the major findings by Mathys show that if Swiss society would shift their diet and consume according to the "Swiss Society for Nutrition" there would be a win-win effect as this will reduce negative environmental impacts and improve health, while also being more affordable.

In terms of dietary changes, Stucki shows that hospitals can lower their environmental footprint and costs by providing incentives for the consumption of more plant-based meals with (i) more plant-based meals on offer, (ii) smaller portions of animal-based ingredients, (iii) more attractive vegetarian and vegan dishes, and (iv) vegetarian meals as the standard option.

> «The 65 kg of food wasted per person per year could provide a healthy diet for one person for 18 days.»
>
> **Prof. Dr. Alexander Mathys,** ETH Zurich

Policy recommendations

In order to reduce food waste, several projects (Heselhaus, Mathys and Stucki) recommend:

- Adopt the legal European food waste definition and measurement methodology into Swiss law, as this would provide legal certainty and a legal basis for actions and duties. (Heselhaus)
- Soften aesthetic marketing standards for fruit and vegetables (mostly private norms). (Heselhaus)
- Clarify the definition of minimum durability date and best before use and allow the sale of expired products with a minimum shelf life date, as long as safe consumption is guaranteed, and consumers are made aware of the expired date. (Heselhaus)
- Implement binding reduction targets, in case of insufficient voluntary measures, for each branch of the food industry, e.g. for food waste reduction criteria for canteens. (Heselhaus)
- Consider laws on food donation in Swiss Food Legislation Art. 7 Abs. 4 LMG: Donation of leftover food states that supermarkets are required to sign contracts with food banks or other charities. Stores can be fined for violations of the law. (Heselhaus)
- Tax benefits on facilitated distribution. (Heselhaus)
- No/reduced VAT on donated food. (Heselhaus)
- Introduce a food ordering system in hospitals that (i) automatically cancels meals when patients leave or cannot eat for medical reasons, and (ii) allows for the flexible selection of portion size and meal components. (Stucki)
- Interventions or education campaigns should focus on food waste related nutritional and environmental sustainability concerns. (Mathys)
- Well-defined regulations are more effective at combating household food waste generation than fiscal and economic incentives. (Mathys)
- The use of smart nutritional and environmental indicators at a global scale can increase the perceived value of wasted food. Presenting the true value of wasted food is a first step towards including consumers, businesses and government to take mitigation action. (Mathys)

Find out more
Video

4.2 Circular Economy

In Switzerland there is strong public support for recycling. In 2019, Switzerland achieved an overall recycling rate of 53%, which makes Switzerland one of the frontrunners in a European comparison.

A sustainable circular economy is more than recycling however. According to the widely-used definition provided by the Ellen MacArthur Foundation (2015) "a circular economy is one that is regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles. This new economic model seeks to ultimately decouple economic development from resource consumption."

This definition conveys two messages. First, it acknowledges that economies need inputs (energy and material) from nature for their operation and, therefore, generate outputs in the form of waste as well as emissions (Hoffmann, Frankenberger). Second, it embodies the promise that through technological innovation, adjusted policy frameworks and the market, a decoupling of the economy from natural resources, to the extent that the environmental impacts of a circular economy remain within planetary limits, is possible.

Overcoming the barriers

One of the most important and systemic barriers that hinders the transition to a sustainable circular economy is a dysfunctional market, which prevents an efficient allocation of resources as the pricing of energy and raw materials is too low (Kytzia).

Frankenberger argues that under current framework conditions companies must adopt new business models in order to be both sustainable and profitable. However, these new business models do not per se guarantee sustainability (e.g. leasing, which can have a rebound effect (Binder)), as keeping material in the loop is not necessarily sustainable in itself (Hoffmann). A main policy issue is therefore to redefine the framework to enable the transformation towards a sustainable circular economy; for example, by increasing transparency with regards to the environmental impact of products and services, or by changing the legal framework in such a way that activities that reduce environmental impact and increase circularity over the status quo become economically profitable and socially attractive. It is also the task of politics to establish standards for the internalisation of externalities (Hoffmann). One possibility would be a mechanism that distributes the costs along a cycle in such a way that all actors involved benefit and the cycle becomes economically viable. Another option would be to limit resource consumption through taxes or quotas (Stephan[1]).

As a sustainable circular economy is more than recycling, other **policy recommendations** from the researchers (Hoffmann, Frankenberger) addressing the 10 Rs (see Figure 4) are the following:

- Setting clear, ambitious and long-term goals for circularity of the Swiss economy and society (Hoffmann, Frankenberger).
- Expanding the scope of materials and products covered by circular economy (CE) provisions, by including sustainable CE criteria earlier in decision-making processes. Taking the construction sector as an illustration, activities leading to the extension of a building or infrastructure lifetime could be exempt from VAT, whereas primary gravel extraction could be subject to an advanced disposal/recycling fee (Kytzia).
- In public procurement, sustainable CE criteria should be included from the early phases of the procurement process (Seele).
- Broadening producer responsibility systems to new products and materials (e.g. building materials, packaging, tyres) (Kytzia).
- Increasing market transparency with regards to the environmental impact of products and services by requiring environmental assessments for products and services and providing this information to the consumers (e.g. labelling, material passports, repair ability index). (Blumer, Heselhaus)
- Pre-market responsibility instruments that impose obligations on the entry of the market (e.g. a mandatory repair ability index) should also be implemented in Switzerland, alongside their implementation in European countries. (Heselhaus)

[1] Stephan, G. (2022). "Circular Economy: Illusion or First Step towards a Sustainable Economy: A Physico-Economic Perspective." Sustainability 2022, 14, 4778. https://doi.org/10.3390/su14084778

Systemic change is needed

Since a systemic change is needed to implement a sustainable circular economy, the questions of prioritisation and coordination of the various instruments become crucial. As far as acceptance and motivation are concerned, this depends largely on the accompanying instruments that are put in place as well as the coherence of the public policies that are developed and the exemplarity by authorities.

However, **companies** do not have to wait for the legislator to pave the way for them. On the contrary (Frankenberger):

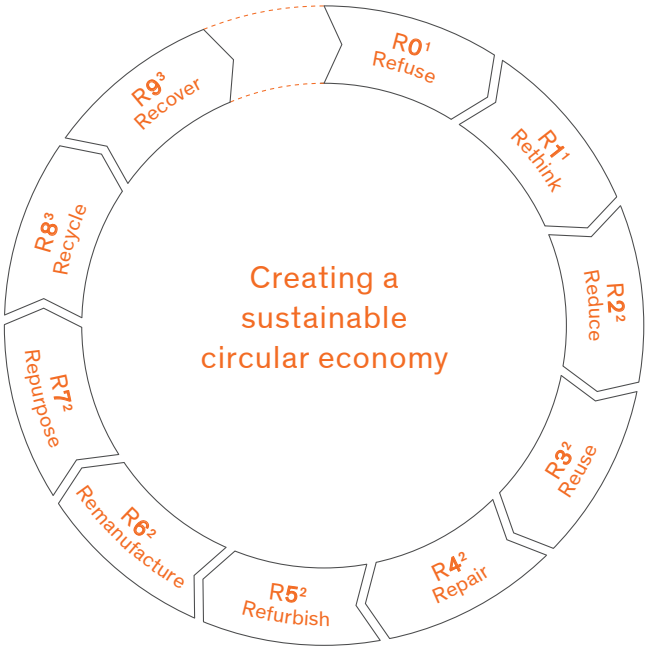
- Cycles can already be implemented profitably today. This is shown by examples such as second-hand shops, PET bottle recycling or a closed material cycle for workwear.
- A paradigm shift in companies can be implemented, as a cycle can only be developed together. Cooperation along cycles and the creation of "circular ecosystems" by several companies are required.
- In addition, new business models that fit optimally into these ecosystems must be developed at the same time as recyclable products.
- Employees must also be able to adapt to these changing requirements, and ultimately visionary management and a corporate culture that promotes such changes are needed.

«Circular economy only succeeds when all those involved work together along the entire value chain.»

Marcel Niederberger, V-Zug (Head of Sustainability)

Figure 4: Circular economy concepts

Circular economy concepts from **Refuse to Recover** must consider system boundaries



[1] Smarter use and production [2] Prolong life-time of products and parts
[3] Useful application of materials

Thematic synthesis "Creating a sustainable circular economy"

Policy recommendations

In summary, there are four major recommendations to political authorities.

- Since just keeping material in the loop is not per se sustainable, environmental and economic indicators that identify sustainable loops must be applied. (Retained Environmental Value Indicator, Hoffmann)
- Framework conditions must be adapted by introducing market-based instruments aimed at internalising externalities of all goods and services within the Swiss market and through applying border tax adjustment mechanisms for imports. (Francois)
- Incentives for entrepreneurial responsibility have to be set, as circular solutions can be tackled and successfully implemented through collaborations between companies and other stakeholders. This should be acknowledged by the general legislation through a broad review of the existing laws and regulations and a removal of the obstacles to systemic changes. (Frankenberger)
- In the construction sector, learning processes to increase the use of secondary materials in the entire value chain including building design and planning, new technologies in demolition, sorting and recycling and new concept in supply chain management shall be promoted. (Kytzia)

Find out more
CEO Brief // Policy Brief // Video

4.3 Building & Construction

Construction accounts for 71.3% of our material consumption and 28.3% of our carbon footprint.

To achieve a climate-neutral and resource-efficient construction industry in 2050, policies are needed at all levels to create incentives that will allow construction and housing to become more resource-efficient. Kytzia and Thalmann recommend a combination of demand-oriented and supply-oriented strategies.

Demand-oriented strategies

The existing stock of residential buildings in Switzerland could provide living space for around 10 million inhabitants if per-capita demand could be reduced from 51 m^2/cap (2020) to 38 m^2/cap (the standard of 1990).

In order to support the sustainability of housing, Thalmann suggests promoting **modular and adaptable housing** which offers the possibility for (i) households to adapt their dwellings to their needs and (ii) for owners to rent out more rooms. Architects, owners and tenants must be informed and trained in this regard. This requires, however, that the sharing of rooms and innovative living spaces (e.g. music rooms, storage space, guest rooms) is promoted as desirable by developers and that the desire for permanence on the side of tenants is fostered via flexible layouts that can be adapted as households evolve, reducing the burden of moving. Finally, cooperatives should be supported that prioritise households who wish to downsize, i.e. moving to a smaller dwelling, thus encouraging others to follow.

To use living spaces more effectively, the focus should be on approaches that stimulate demand for smaller apartments especially for households in the age-group over 50 years-old.

Supply-oriented strategies

The built environment must be transformed and become climate neutral and circular. The most important lever is energy supply to operate residential buildings. Renewable energies in parallel with reducing energy demand as well as new technologies to increase energy efficiency in the building material industries and construction are important strategies.

Construction processes have a significant impact on establishing a sustainable economy, as they are responsible for the most extensive material flows. Kytzia finds that public and private investors/owners of real estate and infrastructure should **increase the use of secondary materials in the entire value chain** including building design and planning, new technologies in demolition, sorting and recycling. Policy should set a signal through **taxing the use of primary material** such as gravel and subsidising reuse, and it should organise **campaigns** for supporting the necessary learning process.

Kytzia identifies a large potential for extracting gravel from excavated material in some regions in Switzerland. So far, excavated material has mostly been used to fill up empty gravel pits. However, environmental impacts could be reduced by substituting primary gravel from gravel pits with gravel gained from processed excavated materials. The success of this resource management strategy depends heavily on geological conditions in the region. Unfortunately, regions with low availability of primary gravel also have a low gravel content in excavated materials.

Kytzia further explains that a learning attitude is required when moving from local/regional optimisation towards a collaborative approach of circular economy policy implementation. Swiss Federalism appears to be a significant barrier to implementing and evaluating effective and feasible resource management policies. Experience with the limiting factors of current policy mechanisms needs to inform an adequate policy response. For example, a tax that reflects the actual resource value could imply a departure from current practices, but only works if the playing field among different regions is levelled.

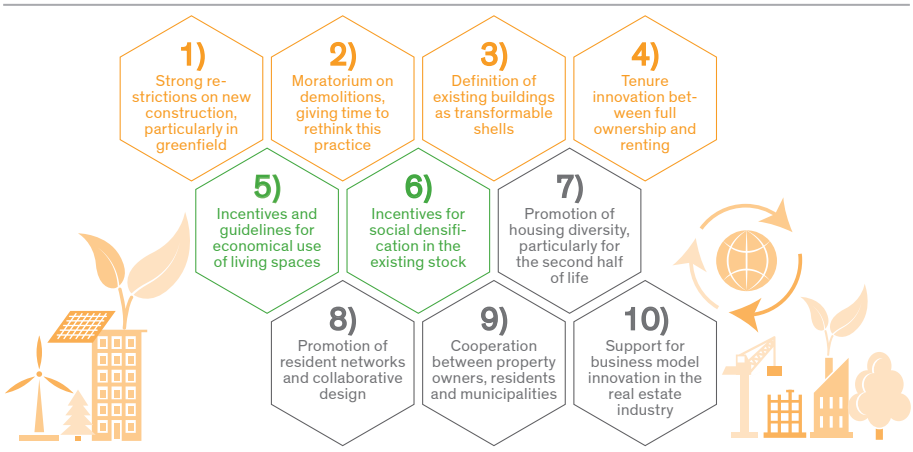
«We need to shift from building more to better using the existing stock of buildings.»

Philippe Thalmann, EPFL

The installation practice for example of insulation makes clean separate dismantling difficult (Hoffmann). Requirements with regards to installation and disassembly (alternative installation practice) would foster clean separate collection, but at significantly higher cost (Hoffmann). This implies in particular that the installation practice of insulation needs to be changed (e.g. bolting, screwing) as it would facilitate clean separate disassembly and would enable separate collection. Hazardous substances should be forbidden in building material products altogether, as it makes their reuse impossible.

Figure 5: Activities for successful transition experiments

10 activities for the public sector, with the help of all stakeholders, to make the housing sector more resource efficient



Co-creation lab “Sustainable living and building”

Policy recommendations

The major recommendations of the co-creation lab “Sustainable living and building” are:

- Design for disassembly and recycling of buildings, components and building materials.
- Replacement of fossil fuels in operational energy demand for buildings and the production of building materials, encouraged through economic incentives.
- Larger share of biomass-based materials (e.g. timber) as well as reused/recycled material in construction to change the material mix in housing construction. This involves better use of local forests.
- More efficient use of built living areas. The focus should be on approaches stimulating the demand for smaller apartments especially for households in the age-group over 50 years-old.
- Increase residential mobility of households.
- Stronger collaboration, mutual learning and innovation between actors in the planning phase, with greater involvement of experts in sustainable construction and building management.
- Consideration of a ban on building demolition until a sufficient circular economy is established.

Find out more
Policy brief // Podcasts

4.4 Sustainable Behaviour & Consumption

Public policies and both technological and organisational innovations, as well as the promotion of a sharing culture are important factors in the process of transforming the existing economy towards a more sustainable one.

Their success, however, depends on corporate and individual behaviour.
Sometimes environmentally friendly products or technologies are not consumed or adopted, even if financially worthwhile (Blumer). In other cases, the benefits of the efficient use of natural resources are drastically lower than expected due to rebound effects, as the saved money from a sharing action is used to finance another one, such as a holiday (Binder). Occasionally, environmental policies are ineffective or cause unintended negative impacts due to not anticipated behavioural patterns.

Determinants of corporate and individual behaviour
Generally, there are two sources of motivation for individual behaviour: intrinsic motivation means doing something because it is personally rewarding; extrinsic motivation means doing something because the person wants to earn a reward or avoid punishment. Policy measures such as environmental taxes or regulations are examples of extrinsic motivation.

Blumer, Czellar, Schmitz and Schubert analysed the determinants of corporate and individual behaviour to understand how it can be applied towards a sustainable economy. People's environmental identity influences their behaviour, and sustainable decisions in one domain do not negatively spillover to others (Czellar, Schubert). Therefore, it is important to analyse what constitutes an environmental identity and how this identity can be activated to promote sustainable behaviour.

Research results indicate that, at least in the short term, messages highlighting the environmental consequences of personal decisions have a greater impact on sustainable behaviour than on personal values. In other words, irrespective of a person's environmental stance, reminding them of their connection to nature is likely to have an effect on their sustainable behaviour (Czellar).

Policy recommendations:

All projects strongly recommend that policy makers and federal authorities:

- Strengthen the environmental identity of citizens with long-term, nature-immersive educational programmes, starting from the earliest possible age, to develop a strong bond with the natural environment. (Czellar)
- Repeat as frequently and as close to the consumers' decision-making point as possible, pro-environmental messages that are meant to induce specific citizen action. (Czellar)
- Support platform providers through the promotion of a sharing culture and the clear communication of environmental benefits. (Blumer)
- Encourage consumers to think about their (unconscious) moral licensing behaviour, which means that a person who frequently uses public transportation may feel less uncomfortable when deciding long distance flights. (Binder)
- Peer to peer sharing platform providers should modify their services to attract more customers and reduce rebound behaviour. (Binder)

«The Hot Water Challenge led to substantial savings in energy and water for the participants, with relatively little effort.»

Miriam Kittinger, Swiss Life Asset Manager

Inducing behavioural change at individual level

Simulation games like postfossilCities (see box) provide a powerful framework to test climate protection measures in an experimental setting by making stakeholders aware of the urgency and value of protection measures and can be used as a "nudging tool" to help encourage change across interest groups (Wäger).

In postfossilCities – the simulation game for a climate-neutral Switzerland, people from administration, politics, business, education and civil society explore paths to a post-fossil future.

The clock is ticking, the model shows whether one is on course or not. The goal is to transfer the findings to one's own field of action.

Inducing behavioural change at corporate level

If companies want to adopt sustainability within their businesses, they should keep in mind that customer behaviour change may be as effective as other measures, such as technological investments, depending on the sector. Inducing behavioural change might be more efficient for the company and also for society. Furthermore, deploying digital forms that monitor customers' use of natural resources can increase their motivation (Schmitz, Blumer).

Incentives to foster environmental identity do not only work at the individual level. Nudges are also a viable tool to induce behavioural change within SMEs (Schmitz). They could be used more systematically. Finally, managers/business owners should be (made) aware of their positive influence on employees. Corporate behaviour can have positive spillovers on employees (Schmitz).

Policy recommendations:

Policy makers must make sure not to counteract peoples' intrinsic motivation with false external incentives such as pricing and regulation. Schubert therefore recommends:

- Targeting the use of natural resources by private households with interventions that ensure that sustainable goods and services are no more expensive than non-sustainable ones, as well as providing information on which goods and services are sustainable and what the effects of behavioural changes and interventions are.
- Ensuring that interventions are effective in the targeted area of behaviour and that social and environmental identities of consumers are activated. Hence, careful ex-ante analyses of the most appropriate behaviour change pathways in the targeted area as well as secondary areas would be useful. Interventions should be designed in such a way that several areas which are perceived as similar are addressed, that the efforts required for pro-environmental behaviour are perceived as low, and that relevant information about the environmental effects of behavioural changes is available.

Find out more
Policy Brief // Podcasts

4.5 Forest Ecosystems

Forests provide multiple ecosystem services, among them the provision of timber, climate regulation, protection against natural hazards, biodiversity protection as well as the provision of recreational spaces.

Forests, therefore provide ecological, economic and social benefits. However, current global challenges, such as climate change, the loss of biodiversity, the energy crisis, as well as the transformation towards a sustainable economy, are increasing the demand for forest ecosystem services (FES). Suitable policy instruments are needed to ensure the sustainable provision of multiple FES.

Three research projects considered the following aspects:

- **Decision support systems** (Thürig)**:**
  Today's decisions on forest management entail consequences for the next 50 to 100 years. They will determine how forest ecosystem services will develop and which synergies and trade-offs will arise. Forest development models allow us to simulate the ecological and economic impacts of different forest management systems on FES over long periods of time and at different spatial scales. By combining forest development scenarios with a set of FES indicators and a flexible multi-criteria decision analysis, a decision support system (DSS) was developed. The DSS can help forest managers to **define sustainable forest management strategies** for different forest types.

- **Off-setting forest clearances** (Schulz)**:**
  The Swiss forest area is strongly protected by law, and any forest clearance must be compensated by afforestation. However, the competition for land and the growing demand for forest resources intensify the pressure on the forest. The researchers thus recommend increasing the transparency regarding the causes and scope of forest clearances. Compensating forest clearances by encouraging afforestation on non-agricultural land, such as urban wasteland, could reduce the pressure on surrounding agricultural land. In principle, it is also possible to implement nature conservation projects (also within the forest) as a substitute for such afforestation requirements. However, respective guidelines need to be further developed. Particularly, permanence and equivalence have to be addressed, in case forest nature conservation projects are to be realised by the more popular so-called **"production integrated measures"** (e.g. habitat trees or small biotopes). Finally, a market-based coordination of projects compensating or substituting forest clearances neither seems to offer many advantages nor does it currently appear to be politically feasible. Rather, the current momentum in promoting an **"ecological infrastructure"** should be capitalised to identify advantageous areas for compensation projects based on inclusive planning.

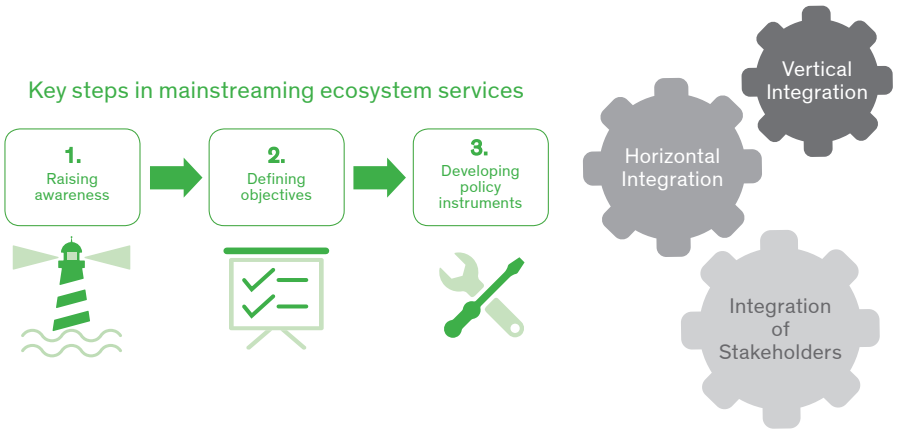
- **Forests as protection from natural hazards** (Olschewski)**:**
  Forests can protect people and infrastructure from gravitational hazards, such as avalanches or rockfall. In Switzerland, managing such hazards is organised as a joint task of the federation, cantons and municipalities, combining strict regulations, monetary incentives, and market-based elements in a historically evolved system. However, the respondents of surveys in the mountain area show a high willingness to pay for improved, additional management of the protected forests. As a consequence, forest and house owners could develop a **payment scheme to finance additional forest management measures** aiming to enhance the insurance service of forests against natural hazards beyond legal requirements. However, for such a scheme to become feasible, a substantial number of participating forest and house owners is required, and liability aspects have to be clarified. Further, forests grow slowly, and investments to improve the resilience of forests often pay off only after decades. Thus, the opportunities of a market-based approach are challenged by uncertainties with respect to climate change and the long time spans that have to be taken into account. As a consequence, complementing the current mix of policy instruments with a market-based private business model is **deemed challenging.**

«With the question of CO_2 storage in the forest, the research addresses a current conflict of objectives and provides a methodologically sound basis for decision-making.»

Bruno Röösli, Agriculture and Forest Service, Canton Lucerne

Figure 6: Mainstreaming Forest Ecosystem Services

The mainstreaming of forest ecosystem services (FES) **aims at their wider consideration in strategies, policies, programmes and practices of public and private actors** across all those sectors that either benefit from or influence FES. It requires a proactive, integrative approach.



Inspired by IPBES 2018

Sustainable environmental policy should consider forests' limited capacity to meet all demands and **avoid using FES to compensate for policy failures in other sectors.** This is especially relevant in view of the global climate and biodiversity crises: only healthy and resilient forests are able to sustainably provide FES in the long run. This requires a proactive and precautionary policy and management approach.

Policy recommendations

To mainstream forest ecosystem services, Olschewski, Schulz and Thürig recommend the following steps:

- Awareness of FES and their complex interactions needs to be raised among the general public, policy makers as well as forest owners and managers. This requires making the **benefits of FES and their trade-offs more visible,** e.g. by increasing cost transparency, clarifying property rights and promoting the user-pays principle.
- Forest policy should define **ambitious targets** for all major FES and provide guidance for prioritisation to actively address trade-offs and harness synergies. This requires the goals to be **coordinated across sectors.**
- Forest policy instruments should be based on a policy mix and need to be coordinated with other sectors. A regulatory framework should set clear rules for **certification of carbon sequestration projects and market-based coordination** could be promoted, although within limits and to different degrees depending on the FES.

Find out more
Policy Brief // Podcast // Video

5. Conclusion and outlook

5.1 Eight Policy Recommendations

The transition to a sustainable economy in Switzerland will require the decoupling of economic activities from environmental degradation and ensuring that humanity operates within planetary boundaries. The eight recommendations for the Swiss government to make progress in this direction are the following:

1) **Support sustainable technologies and innovations through sustainable finance instruments** such as green bonds, which NRP 73 research has shown are effective (Rochet). This could contribute to Switzerland's positioning as one of the world's leading knowledge and infrastructure hubs for sustainable finance.

2) **Innovation also requires long-term investments, policy incentives as well as commitment from and trust in public authorities** (Noailly). If those innovations increase resource efficiency and lead to higher disposable incomes, this can, in turn, stimulate additional demand for resources, generating the risk of **rebound effects.** This would offset the environmental benefits achieved from increasing efficiency (e.g. energy saving in building renovation). Rebound effects were identified by many NRP 73 projects (e.g. Binder, Blumer, Hoffmann, Schubert, Thalmann) and the government needs to be both aware of and try to counteract them.

3) **It must pay off to develop and use environmentally friendly technologies.** Market pricing is often too low, and doesn't tell the ecological truth: neither the advantages we derive from ecosystem services (Thürig); nor the environmental damage is reflected (Maibach, Truffer, Finger, Kytzia, Bürgi). First of all, subsidies which provide wrong incentives should be abolished. Second, new taxes on resources or on environmental impacts should be introduced and the revenue should either be returned or other existing taxes may be reduced (Frankenberger).

4) **Making trade-offs transparent and establishing integrated evaluation approaches** (e.g. mixes of regulatory, socio-political, and fiscal policies) is recommended to deal with conflicting goals and trade-offs between social, ecological and economic aims (Schulz, Kytzia, Mathys, Finger). The situation becomes more complex if the responsibility is distributed between the different levels of government, which may result in gaps and contradictions in regulations (Heselhaus, Kytzia, Schulz, Truffer).

5) **Policy coordination** between different sectors such as housing, energy, waste and resources, land use and transportation, or heritage and historic preservation is necessary. To enhance coordination, **"roadmaps",** which set intermediary targets, and the involvement of all relevant stakeholders would be a suitable approach (Truffer, Schulz). In any case, the consequences of not reaching agreed targets need to be made clear from the outset.

6) **Government should lead by example,** as several NRP 73 projects (e.g. Frankenberger, Kytzia) point out. Sustainable public procurement (Seele, Heselhaus) plays an important role in this regard. As such, targets need to be set, measurement methods need to be tested and standards need to be continuously reviewed and improved. In addition, the government should strengthen the labour market (Weder) to ensure that the development of necessary skills and the adaptation of academic and professional training is supported.

7) **Government needs to define minimum standards** to stop the race to low environmental standards. As many NRP 73 projects demonstrate (Heselhaus, Hoffmann, Rochet, Seele), compulsory **definitions** and **regulation** of sustainable products and sustainable investments are seemingly absent in Switzerland. Marketing and the pressure of product differentiation have led to a wide range of labels, which in turn has increased greenwashing. Other countries and institutions like the EU have introduced their own label schemes to reduce consumer confusion. Switzerland has done this privately in the context of organic food labels (Bio Suisse) but for ICT and sustainable finance there is still no regulation (Blumer).

8) **"Hybrid governance" approaches should be used** for the sustainable transformation as they go beyond the jurisdiction of the legislating body. Several NRP 73 research projects (Bernauer, Bürgi, Schader, Schulz) advise to implement multi-pronged sustainable economy strategies, which would enable accounting for environmental impacts along entire supply chains. Voluntary corporate action will not be sufficient and needs to be supported by binding measures (Bernauer). This is particularly important in the case of global supply chains, for example through binding national policies combined with voluntary cooperative commitments (such as trade agreements) and voluntary private action plans as well as voluntary agreements, which should be backed by legal sanctions in case of non-compliance.

5.2 Implementation Areas & Future Research

One of the aims of NRP 73 was to propose specific areas for implementation and to identify areas for future research.

Implementation areas

Given the inter- and transdisciplinary nature of NRP 73, the programme needed to establish a common language among a diverse group of partners. Upholding these partnerships and strengthening the collaboration between them was an important step in ensuring that the research provides long-term impact. The implementation networks introduced by SNSF, which are currently in their pilot phase, provide an opportunity to keep well established inter- and transdisciplinary consortia in place.

Some of the models developed in various NRP 73 projects (e.g. Thalmann, Hoffmann, Frankenberger) were based on a limited amount of case studies set up with project partners and may therefore not be representative of Switzerland as a whole. Therefore an important next step is to validate the results and make them more representative or transferable. For the upscaling of such models testing in diverse situations with increased numbers of participants is necessary.

Data privacy issues must be solved. So far, data privacy issues not only blocked some of the studies, but also prevented the collection of relevant data within NRP 73 (Schubert).

Future research

Sustainable finance is of particular importance in establishing a sustainable economy. This requires international cooperation and coordination as a sustainable economy cannot be implemented on the national level alone. Further research is required to analyse the interplay between sustainable finance and its international dimension.

Last but not least it must be remembered that any and all policy interventions and changes will affect the distribution of income and that as such there will be both winners and losers. A well-known insight from behavioural economics is that individuals resist solutions if they perceive them as unfair. Therefore, a better understanding and more research on how actors are impacted by different interventions and what distribution impacts are perceived as acceptable by Swiss society is a central requirement for sustainability.

Efficiency, is a central requirement for the sustainable management of natural and environmental resources. But markets are bad at granting equity. Therefore, analysing the distributional effects of policy interventions and means of how to compensate potential losers should be the subject of further research activities.

Annexes

6. Sector specific recommendations

Disclaimer:
Please note that the sector specific recommendations do not provide a comprehensive analysis of the sectors discussed and therefore the policy recommendations mentioned are very specific and related to the results of the research projects of NRP 73.

6.1 Agriculture

Relevant NRP 73 Projects:
[1] **Bürgi:** Sustainable Trade Relations for Diversified Food Systems
[2] **Finger:** Digital Innovations for a Sustainable Agriculture (InnoFarm)
[3] **Nemecek:** Interaction of economy and ecology in Swiss farms
[4] **Francois:** Switzerland's sustainability footprint

Contributing to the following SDG

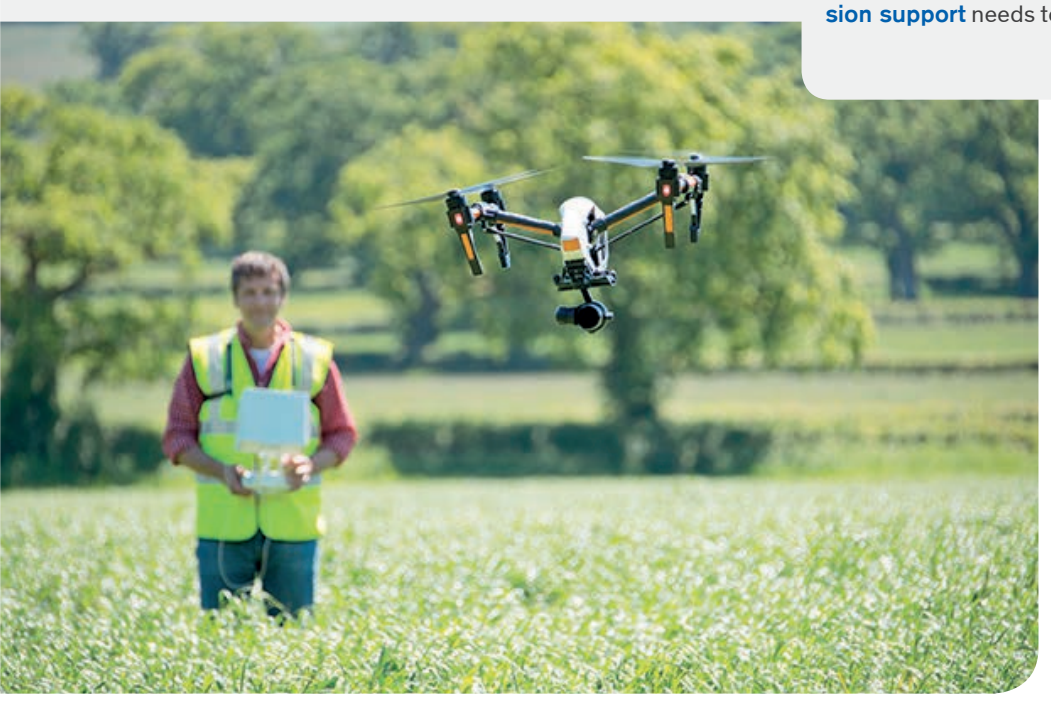
Policy recommendations

General:
Assessment of the **consistency of domestic agricultural policy** regarding enabling and disabling measures, in order to develop a long-term vision of a **consistent policy framework.**[1]

Regulation:
- **Bare soil periods** need to be **avoided.**[2]
- **Regulation is needed on** how **drone and satellite data** may be used by different actors.[2]
- **Crop diversification** should be encouraged.[1]

Market-based instruments:
- **Shift subsidies** from eco-inefficient to eco-efficient farms and from animal-based to plant-based production.[3]
- **Taxes** to internalise the **negative externalities of harmful inputs** such as **imported feed, mineral fertilisers, and pesticides.**[1]
- **Invest in digital infrastructure** so farmers can utilise precision agriculture technologies.[2]
- Incentivise reduction of agricultural footprint e.g. via results-based payments and/or taxes.[2]
- Provide **subsidies** for technology improvement and **international technology transfers,** e.g. in cattle management and cultivation techniques to reduce methane emissions.[4]

Information and Training:
- Support the promotion of knowledge and green skills for new precision farming technologies which require **training and further education** e.g. via **farmer networks.**[2]
- Enable **agricultural producers** to improve their environmental efficiency to reduce the overall impact of agriculture without a reduction in output.[3]
- For **nitrogen fertilisation,** state-of-the art **imaging decision support** needs to be implemented in practice.[2]

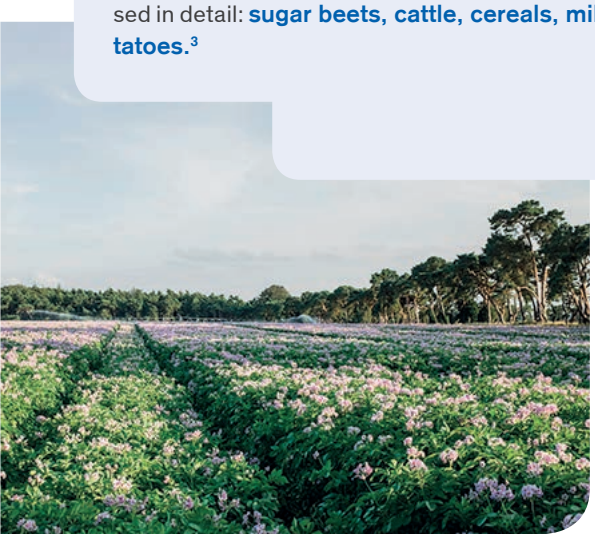


Environmental impact

Agriculture has large impacts on:

1. **Soil quality.**
2. **Water quality** due to nutrients and pollutants released by agriculture and water use.
3. **Greenhouse gas emissions** due to fertiliser use (N_2O) and methane (CH_4) emissions from cattle.
4. **Biodiversity and land use change.**

The footprint of the following products has been analysed in detail: **sugar beets, cattle, cereals, milk, and potatoes.**[3]



Barriers and Solutions

Barriers for sustainable agriculture:

- High investment costs
- Existing policy mix
- Missing information about their added value
- Knowledge intensive technology
- Lack of technology sharing infrastructure between farmers
- Lack of binding rules, e.g. for sustainable public procurement
- Unclear and insufficient definitions of sustainability in agriculture
- Trend to monopolisation

Information from **satellites or drones used for precision farming** can help to reduce the use of fertilizers, leading to lower nitrogen and N_2O emissions while maintaining the same yield.[2]

Fields in Switzerland are often small and irregular in shape. As such a **technology with high spatial resolution** such as drone imagery is needed. Satellite imagery may not provide sufficient spatial resolution.[2]

However, the drone equipment is currently **too expensive** and the digital infrastructure is not suitable for single and/or small-scale farmers.[2]

Solutions:

A holistic approach that understands our food system as a global one.

The government needs to invest in the **necessary digital infrastructure as a public good,** to support farmers in applying precision farming technologies.[2]

Industry:

Given the high investment costs for drone equipment, approaches such as renting from **contractors** will be necessary.[3]

Find out more
Policy Brief // Video // Podcasts

6.2 Housing and Construction

Relevant NRP 73 Projects:
[1] **Co-creation lab "Housing and Construction"**
[2] **Hoffman:** Combining material flow, business and policy perspective (TACLE)
[3] **Kytzia:** Co-evolution of business strategies and resource policies in the building industry
[4] **Thalmann:** Ecological footprint of the housing sector
[5] **Wäger:** Post-Fossil Cities

Contributing to the following SDG

Policy recommendations

Demand and supply side recommendations:[1]
- Reversing the trend of an increasing per-capita demand for living space (demand side) and
- Increasing energy and material efficiency in building construction and operation (supply side)

Target setting:
A clearly formulated net-zero target for housing needs to be politically agreed on and broken down to the different levels of action (e.g. city, neighbourhood, site and building) and actors (e.g. city administration, housing owners, developers). All construction activities (new building, maintenance, transformation, renovation, and deconstruction) need to be included under the target.[1]

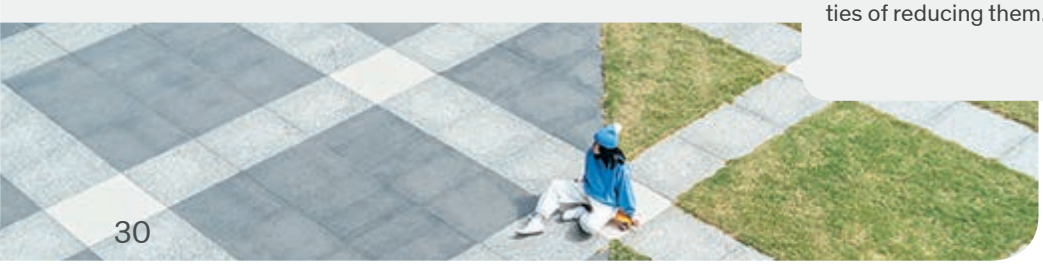
Government leading by example:
Starting 2025, public buildings, building operations and further development of the existing building stock are net-zero according to regulation. From 2030, this obligation is extended to the entire building stock.[1]

Market-based instruments:
- Subsidies for construction activities should only be provided if they meet the net-zero target, to foster the evolution of building materials and new technologies.[1]
- The creation of **housing cooperatives should be promoted** and enabled to facilitate behavioural change such as sharing rooms or innovative living spaces.[4]
- **Tax on living space** should be introduced starting at a maximum level (revenue should be used to support social housing) to reduce floor area from 47 m^2 to 41 m^2/cap.[4,5]
- **Tax on primary gravel extraction and imports should be used** to support markets for recycled construction material.[3]

Regulation:
- **Target values for embodied greenhouse gas emissions** should be included in standards (SIA 390) and laws (e.g. cantonal environmental and energy laws) similar to target values for operational energy demand (SIA 180 thermal insulation).[1]
- There should be a **phase-out of fossil fuels** in the residential building sector by 2050 at the latest.[5]
- Allow for **heated surface areas** only inside apartments.[5]
- **Rental law** should be adapted to ensure that small apartments are not more expensive just because they have a higher turn-over.[4]
- **Hazardous substances** should be **forbidden** in building material products to improve material circularity.[2]
- The concept of self-sufficiency for gravel supply and landfill volume on a regional scale should be abandoned and regional planning for gravel extraction and landfilling between different regions / cantons should be better coordinated.[3]

Behaviour change:
- **Sharing of rooms and innovative living spaces** (e.g. music rooms, storage space, guest rooms) are promoted by marketing them as **new status symbols by developers and** preserving the desire for permanence via flexible layouts that can adapt to the evolution of households while reducing the burden of moving.[4]
- **Lower average indoor temperatures in office buildings and private dwellings,** i.e. from 22°C to 20°C.[4]
- Address the large **rebound effects** of rent savings in the market segment of non-profit housing, which are mainly used for larger housing, by restricting dwelling size and by promoting low-impact consumption options.[4]
- The **installation practice of insulation** needs to be changed (e.g. bolting, screwing) to make clean dismantling easier and to foster clean separate collection.[2]

Information:
- Ensure that there is **transparency for property owners to know who really lives in their apartments,** with a view to using their housing stock more efficiently.[4]
- Raise awareness **about potential rebound effects** from e.g. renovations in energy-efficient buildings and the possibilities of reducing them.[4]



Environmental impact

Buildings are becoming more energy efficient, but the **continued growth in living space** (total and per capita) has **largely offset the efficiency gains.** However, downsizing is undesirable for three quarters of surveyed tenants, due to factors that span from the attachment to a dwelling to higher rents.[4]

The construction sector uses a lot of **mineral raw materials** and there exist **land-use conflicts** associated with construction material management.[3] Construction activity still generates the largest share of waste produced in Switzerland (84 %). As such there is room to reintroduce materials into the economic cycle as secondary raw materials.[3]

The **thermal insulation industry** has the **highest potential for circularity** from a cost and resource perspective. The Economic Impact of Circular Strategy indicator revealed that recycling the **non-contaminated extruded polystyrene** is the most cost-effective compared to contaminated extruded polystyrene.[2]

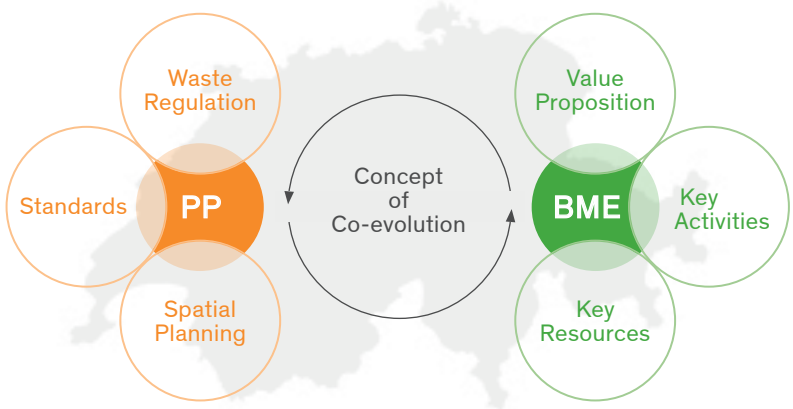
The strategy of **redensification through replacement of buildings is problematic,** as cumulative greenhouse gas emissions are higher due to emissions intensity in the production of building materials .[1]

Barriers and Solutions

Scarce deposit volumes and regional trade lowers the price for gravel and reduces the incentive for recycling. The coordination of regional planning for gravel extraction and landfilling between different regions / cantons needs to be promoted. Especially cantons with high gravel, cement and concrete production should take the lead by accelerating the circular economy for building material. Co-evolution processes of public policies and business models (see Figure 7) are important for the socio-technical transition of the construction industry.[3]

Demand management e.g., regulation of living space is perceived as a restriction of individual and market freedom. Government should incentivise both landlords and tenants to downsize and, in parallel, support households that decide to do so. Involving tenants needs to go further and empower them to make collective decisions on e.g. heating system, energy source.[4]

Figure 7: The concept of Co-evolution



PP = Public Policies BME = Business Model Ecosystem

Ohmura and Creutzburg 2021

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6.3 Food Sector

Relevant NRP 73 Projects:

[1] **Synthesis "Towards a sustainable food system"**
[2] **Bernauer:** Voluntary Corporate Initiatives
[3] **Bürgi:** Sustainable trade relations for diversified food systems
[4] **Francois:** Switzerland's sustainability footprint
[5] **Heselhaus:** Legal framework for a resource-efficient circular economy
[6] **Mathys:** Impacts of Swiss food consumption and trade
[7] **Nemecek:** Interaction of economy and ecology in Swiss farms
[8] **Schader:** Enhancing Supply Chain Sustainability
[9] **Schubert:** Sustainable Consumer Behaviour
[10] **Stucki:** Resource efficiency in Swiss hospitals

Contributing to the following SDG

Policy recommendations

Target setting:

- Implement binding **reduction targets for food waste,** in case of insufficient voluntary measures, for each branch of the food industry, e.g. targets for food waste reduction for canteens with indicators.[5]
- Create incentives for more sustainable production and consumption.[1]

Market-based instruments:

- **Reduce the import tax** for sustainable food products, while disincentivising unsustainable products.[3]

Regulation:

- Improve the regulation of food-related **sustainability labels,** taking into account the risk of adopting protectionist practices which are possibly regarded as discriminatory by the World Trade Organisation (WTO).[2,3,7,8]
- Adopt a **minimum durability date** and allow the sale of expired products with a minimum shelf life date, as long as safe consumption is guaranteed and consumers are made aware of the expiry date.[5]

Behavioural change:

- Provide **incentives for the consumption of more plant-based meals,** with (i) more plant-based meals on offer, (ii) smaller portions of animal-based ingredients, (iii) more attractive vegetarian and vegan dishes, (iv) vegetarian meals as standard option.[10]
- Be alert that food related incentives work only in the food-related area, not spilling over to other environmental areas.[9]

Information:

- Highlight our food system as a global one relying on **diversity rather than uniformity,** to ensure food security.[1]
- Introduce a **food ordering system in hospitals** that (a) automatically cancels meals when patients leave or cannot eat for medical reasons and (b) allows for the flexible selection of portion size and meal components.[10]

Environmental impact

The food sector has significant **direct and indirect environmental impacts** on:

- land use (change) and biodiversity,
- water use and water quality,
- greenhouse gas emissions (fertiliser/N_2O, methane/CH_4),
- waste.

Environmental and social impacts outside of Switzerland also have to be considered.

Barriers and Solutions

Consumers

A win-win-win situation can be achieved, if Swiss society would shift their diet and consume according to the "Swiss Society for Nutrition", as this will **reduce negative environmental impacts, improve health and at the same time be cheaper,** thus also affordable for lower income groups.[6] However, to change diets is challenging especially for lower income groups and less educated consumers.

Policy Makers

When **framing trade measures,** the government should choose an **enabling and a disabling approach** to foster market access of products of high sustainability value and preclude products with damaging production practices, as well as non-negotiables such as child labor, land grabbing and highly hazardous pesticides. This should be done in a non-discriminatory, inclusive and context-based manner, in order to comply with WTO requirements. The approach chosen in the Swiss-Indonesian Agreement can be used as a starting point, but must be elaborated further to overcome sustainability deficits.[3]

A **federal law on sustainable trade relations which allows for the distinction between more and less sustainably produced food** (see Figure 8) helps to reduce environmental and social impacts outside of Switzerland. A draft law has been developed which can be used as a starting point.[3]

To reduce food waste, it is recommended to adopt the **legal European food waste definition and measurement methodology** into Swiss law as this would provide for legal certainty and a legal basis for action and duty. It also suggested adding **laws on food donation** in Swiss Food Legislation.[5]

Figure 8: Proposal for a Federal Act on Sustainable Trade in Agriculture

Combining enabling and disabling measures

Synthese SNF-NFP 73 Projekt «Diversifizierte Ernährungssysteme dank nachhaltiger Handelsbeziehungen»: hypothetischer Gesetzesentwurf

Bundesgesetz über nachhaltigen Agrarhandel (Agrarhandelsgesetz, AhG)

vom dd.mm.2024

Die Bundesversammlung der Schweizerischen Eidgenossenschaft,
gestützt auf die Zuständigkeit des Bundes in auswärtigen Angelegenheiten sowie gestützt auf die Artikel 2, 54, 73, 80, 104 und 104a der Bundesverfassung[2]
und insbesondere auf Artikel 104a Buchstabe d der Bundesverfassung, wonach der Bund Voraussetzungen schafft für grenzüberschreitende Handelsbeziehungen, die zur nachhaltigen Entwicklung der Land- und Ernährungswirtschaft beitragen,
in Ergänzung zu Artikel 18 Landwirtschaftsgesetz[3] und Artikel 35e Absatz 3 Umweltschutzgesetz[4],
mit Blick auf die Globalen Nachhaltigkeitsziele SDGs sowie gestützt auf die Ziele verschiedener internationaler Abkommen, welche die Schweiz ratifiziert hat und auf die sich die SDGs beziehen,
nach Einsicht in die Botschaft des Bundesrates vom xx.dd.jj,
beschliesst:[5]

Vorschlag

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Relevant NRP 73 Projects:
[1] **Olschewski:** Insurance Value of Forest Ecosystems
[2] **Schulz:** Trade-offs in Forests
[3] **Thürig:** Ecosystem Services in Forests

Contributing to the following SDG

6.4 Forest

Policy recommendations

Target setting:

Forest policy is closely intertwined with other sectors' policies associated with a sustainable economy. Better coordination of respective **policy targets** and instruments could not only prevent adverse effects on forests but also improve the provision of **forest ecosystem services (FES)** for other sectors.[2]

Regulatory framework:

- Swiss forests are protected by law, with preservation and multifunctionality as the guiding principles. This legal and regulatory framework is the **backbone of forest policy.** It is necessary to promote and safeguard biodiversity and FES, and generally to defend forests against external development pressure. Nonetheless, the provision of specific FES could be incentivised through more flexible information and market-based instruments.[1,2,3]

Market-based instruments:

(i) **Certification schemes** are particularly promising to incentivise forest owners to store more carbon either as standing wood in their forests or as harvested timber in products. While carbon storage efforts beyond standard forest management seem feasible, securing the additionality and permanence of such climate mitigation services requires regulation.[2]

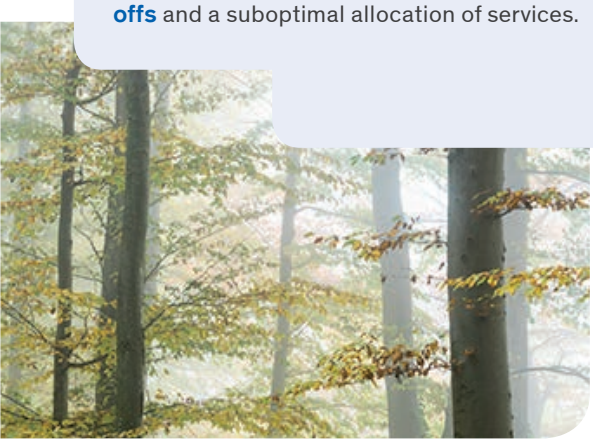
(ii) **Hazard insurance schemes** adapted to the demand of the local population could take advantage of existing willingness to pay for improved protection services beyond legal requirements, and thus help increase the efficiency of protective forest management.[1]

Information:

- Forest **Scenario Analysis** and **Decision Support Systems** (see Figure 9) can help decision makers and forest managers to anticipate and cope with the increasing demand of FES from both within and outside the forest sector. Such information can be applied at the national, the regional and the enterprise level.[3]
- **Transparency** concerning **forest clearances** and their causes could allow for a more far-sighted planning process of forest replacement measures.[2]
- **Integrating climate, forest and wood policies** is key to pursue a sustainable economy.
- **Awareness raising** and **capacity building** among actors is crucial to recognise and manage FES in an efficient and sustainable way.

Environmental impact

Forest management impacts the provision of **Forest Ecosystem Services (FES),** such as timber production, carbon storage, natural hazard protection, local climate regulation, biodiversity and recreation. The challenge is to decide which FES to provide, where, and in which quantity.[3] Promoting some FES over others can cause **trade-offs** and a suboptimal allocation of services.



Barriers and Solutions

The main barriers in forest policy root in the particularities of forest management:

(i) **long-term horizons** and **uncertainties,**
(ii) **complex interactions** between FES,
(iii) **limited acceptance** of non-traditional management approaches.

These challenges are compounded by the **small-scale ownership structure** of Swiss forests, hindering the uptake of novel instruments, such as carbon certification schemes, decision support systems or insurance products.[1,2,3]

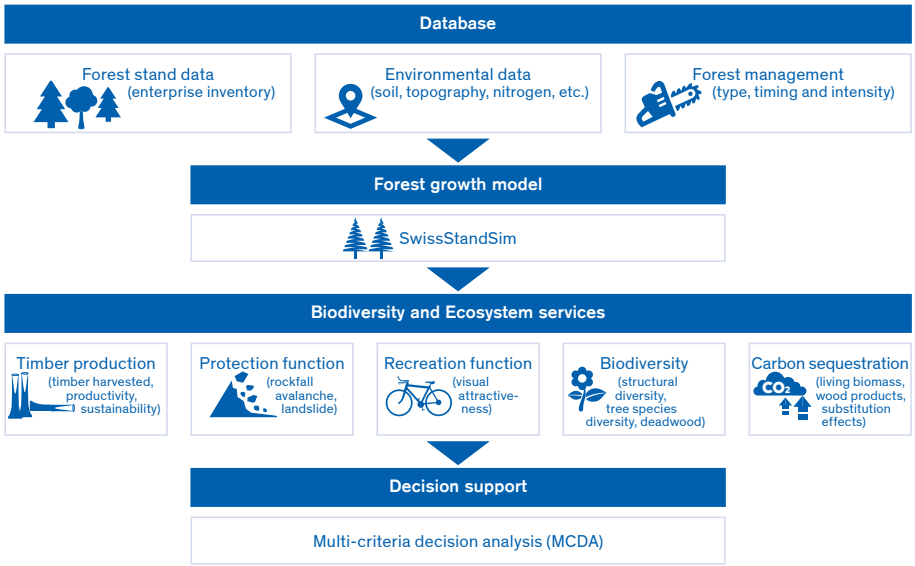
As is the case of forest management, the **instruments** applied to support the sustainable use of FES require **long-term** financial and personnel **commitments,** especially if these are still in the development phase.[1,2,3]

Further solutions can include **raising awareness** as well as **organisational approaches,** such as capacity building for regional forests owner associations or fostering the participation of local residents to promote the uptake of voluntary instruments.

Lastly, policy targets making FES beyond timber more explicit would facilitate the promotion of such services and address possible interactions between them.[1,2,3]

Figure 9: Decision Support System (DSS) for Forest Enterprises

Schematic representation of the DSS elements: from data inputs over forest growth simulation to effects on FES and the output in the form of a multi-criteria decision analysis



A multi-criteria decision support system for strategic planning at the Swiss forest enterprise level: coping with climate change and shifting demands in ecosystem service provisioning. Frontiers in Forests and Global Change.

Thrippleton, T., C. Blattert, L. G. Bont, R. Mey, J. Zell, E. Thürig und J. Schweier. 2021

Find out more
Policy Brief // Video // Podcasts

6.5 Green Finance

Relevant NRP 73 Projects:
[1] **Noailly:** Financing clean tech
[2] **Rochet:** Sustainable finance

Contributing to the following SDG

Policy recommendations

Regulation:
Binding and stable framework conditions: Policies must create long-term binding framework conditions to create a reliable basis for investments, e.g. by defining sustainability standards.[2]

Market-based instruments:
- **Green finance instruments, such as green bonds, are effective and should be promoted:** Their development and growth should be encouraged by Swiss policy makers and regulators to contribute to Switzerland's positioning as one of the world's leading knowledge and infrastructure hubs for sustainable finance.[2]
- **Environmental policy must create a market for green innovations:** Policy makers should create robust conditions to increase demand for sustainable products and services, thus supporting start-ups in their formative stages.[1]
- **Policy should include innovative instruments such as venture competition and crowdfunding:** However, these instruments (due to the specificities of cleantech) are not always suitable for financing clean technologies and need to be complemented by standards such as the EU taxonomy that create demand for cleantech and green products.[1]
- When considering the sustainability of an investment, **financial actors** should look beyond labels, as disagreements in ESG ratings represent a hidden source of risk for investors requiring a risk premium.[2]
- **Investors** should therefore pay even more attention to the quality and heterogeneity of ESG data in portfolio allocation.[2]
- **Policy makers** must promote and provide appropriate tools such as standards like the EU taxonomy.[1,2]

Barriers and Solutions

Innovation requires long-term investment. At the same time, **investors** need to know what to expect in terms of regulatory frameworks.

Policy commitments are crucial. The successful issuance of green bonds in Switzerland shows that this requirement can be met.

Cleantech investments differ from other sectors in that[1]:

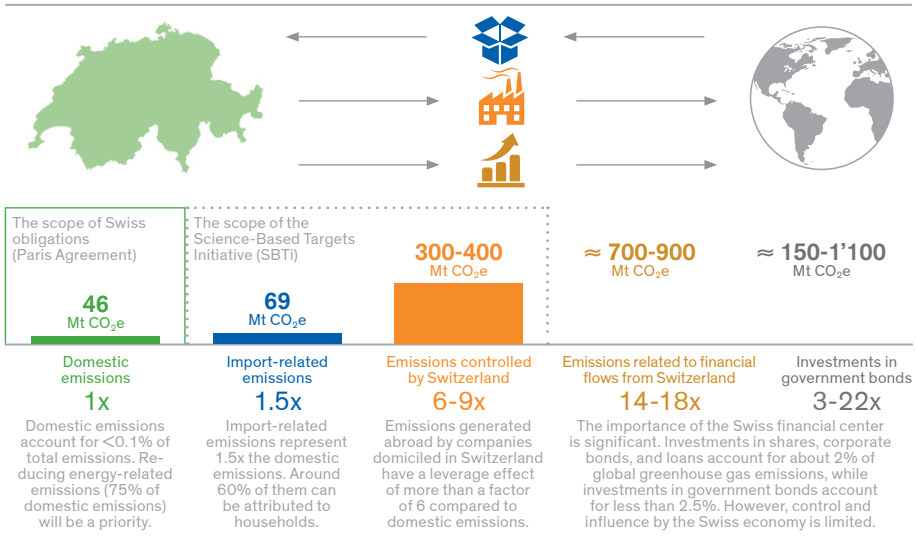
(i) they are usually more capital intensive,
(ii) there is little product differentiation,
(iii) established companies (especially in the energy sector) are reluctant to buy cleantech start-ups for fear of cannibalising their own business,
(iv) the Swiss market is too small to support cleantech to the extent needed.

However, research and development should nevertheless be promoted as it facilitates international technology transfer. This requires coordination and support from **policy makers** at the European level.

What are Green Bonds?

Green Bonds are a type of fixed-income instrument that is specifically earmarked to raise money for climate and environmental projects. As such they can be used to finance cost-intensive investment projects. Investors are attracted to green bonds since they allow a closer connection to positive environmental impacts. **The Swiss Government successfully issued the first green bond in October 2022 (766 Mio. CHF).** The emission volume of green bonds is planned to be several hundred million CHF every year.

Figure 10: Switzerland's climate lever



klimastandort-schweiz.pdf (McKinsey&Company 2022)

Small but with a big lever! Switzerland's contribution to climate protection should also include the emissions of large corporations controlled from Switzerland and the financial sector.

Find out more
Podcast

6.6 Health & Healthcare

Relevant NRP 73 Projects:
[1] **Stucki:** Resource efficiency in Swiss hospitals
[2] **Mathys:** Impacts of Swiss food consumption and trade

Contributing to the following SDG

Policy recommendations

Regulatory Conditions:
- Provide **regulatory conditions** that encourage hospitals to include sustainability criteria in decision making.[1]
- Provide **external financial support** for sustainability measures.[1]

Optimisation Potential:
There is significant potential to improve the hospital footprint by using **100% renewable energy** for heating, cooling, electricity and mobility.[1]

Another significant potential lies in improving **building infrastructure.**[1]

Procurement should **favour environmentally friendly products and materials.**[1]

Processes should be optimised to reduce food waste (e.g. enabling choice of meal size and introducing an ordering system) and improve medicine management (e.g. automated ordering system). Similarly, **standards** for the use of disposable products (e.g. acute care) **should be revised** to reduce resource consumption.[1]

Information:
- Create **life cycle-based** sustainability **labels** for hospital services and infrastructure.[1]
- Hospital decision makers need a **joint platform** for an active exchange about successes and failures on the pathway to sustainable hospitals.[1]

Nudging:
- Provide attractive **vegetarian meal options** in hospitals and use them as a **standard** option.[1]
- Provide a **minimum share of plant-based meal** options in hospitals and serve **smaller portions** of animal products.[1]
- Raise **awareness** for the recommendations of the **Swiss Society for Nutrition (SSN).**[2]

For further information see **www.greenhospital.ch**

Environmental impact

- **Half of Swiss hospitals** could **reduce their impact by 50%** while providing the same healthcare services.[1]
- A **diet based** on the recommendations of the **Swiss Society for Nutrition (SSN)** can **reduce** our **ecological footprint by 36%,** save 33% in costs and reduce negative health impacts by 2.7%.[2]

Barriers and Solutions

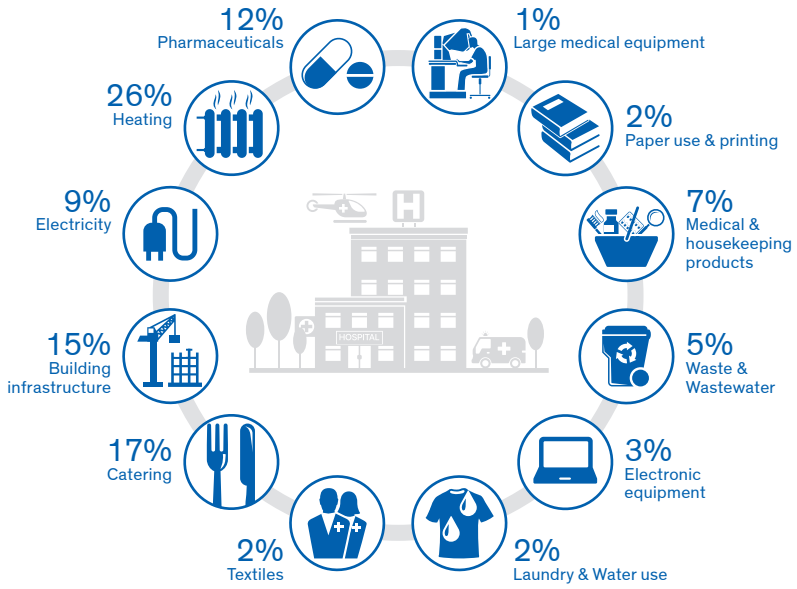
Management of hospitals: Only a few hospitals have set sustainability targets, as the **necessary expertise and resources are lacking. Management commitment** is indispensable to advance targets.

Cost pressure in the health care sector is **high,** sustainability often neglected, e.g. choice of cheapest electricity tariff (imported fossil-based electricity). Support and **awareness raising for management** is needed.

Hospital administration: Too little experience with new **sustainability options in public procurement,** in particular in terms of catering, energy and workwear. A joint platform for exchange and specific sustainability targets could support this.

Figure 11: From bandages to buildings

Proportion of the **global warming potential** of an average Swiss Hospital



Keller, R., Muir, K., Roth, F., Jattke, M., & Stucki, M. (2021). From bandages to buildings: Identifying the environmental hotspots of hospitals. Journal of Cleaner Production, 319, 128479. https://doi.org/10.1016/j.jclepro.2021.128479

Find out more
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6.7 Households & Consumers

Relevant NRP 73 Projects:
[1] **Blumer:** Extending the lifespan of mobile devices
[2] **Binder:** Rebound effects of the Sharing Economy
[3] **Czellar:** The influence of environmental identities
[4] **Schubert:** Sustainable consumer behaviour

Contributing to the following SDG

Policy recommendations

Market-based instruments:

- **Special tax/ license** for private consumers on idle (i.e. that mostly stand around), specialised and resource-intensive products (e.g., specialised machinery) to disincentivise private ownership.[2]
- **Emission taxes** on emission-intensive service products (e.g., long-distance flights) in order to reduce the environmental rebound effect due to re-spending (targeting consumers who feel morally entitled after they engage in environmentally responsible behaviour).[2]

Information:

- **Improve transparency through apps and meters** for consumers on e.g. CO_2 impacts of water usage, emissions in production process/ services including estimates about rebound consumption behaviour.[2]
- **Labelling:** A smart form of labelling, which is rather simple (e.g., animal well-being and climate neutrality) according to a 5-star rating which can be easily understood, would help private households make more sustainable choices in regard to their natural resource use.[4]
- **Labels** (e.g., what is a sustainable ICT product) and descriptions of sustainable products.[1]

Nudging:

- **Support programmes** which allow people to learn more about connecting with nature will improve their environmental identity, which, in the long run, will increase sustainable consumption choices (i.e., buying products with longer lifespans,[3] and avoiding rebound effects).[2]
- **Appeal to citizens' environmental identity** in decision situations as this will influence their choices.[3, 4]
- **Sustainability Challenges,** like for instance a hot water challenge, drive people to behave more sustainably in the respective area and may also yield positive spillovers in other seemingly unrelated environmental areas.[4]

Environmental impact

Citizens have an impact on the quality of the natural environment through their use of water, electricity and other commodities (e.g. ICT devices) that are produced using natural resources or lead to waste related behaviour.

As Switzerland imports a significant amount of products, **the global impact of Swiss consumption needs to be considered.**

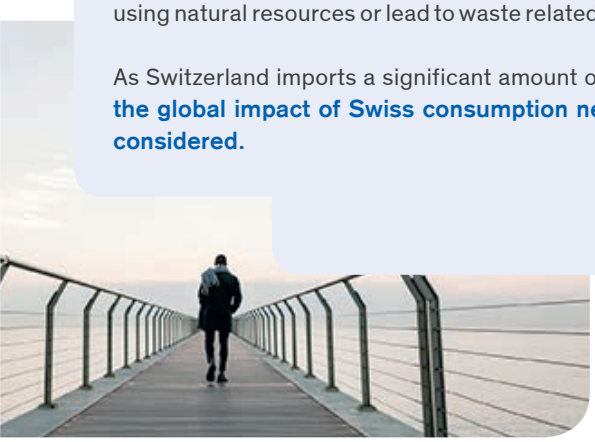
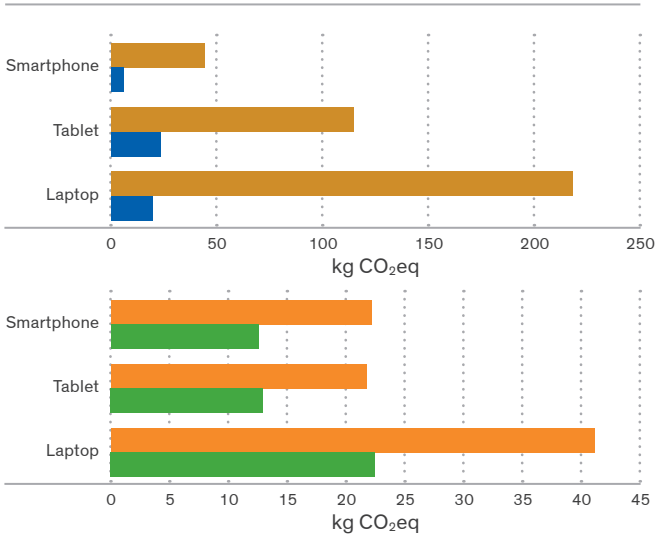


Figure 12: Environmental impacts of extending the service life of mobile devices

Assuming the service life of the smartphone is extended from 2 to 4 years and the display as well as the battery are replaced after 2 years, **more than 80% of the GHG emissions of a new device can be saved** compared to buying a new device every two years



- Production of new device
- Repair of display and battery (incl. transport Eastern Europe)
- New device per year of usage
- Repaired device per year of usage (assumed lifetime in years)

Figure 12 shows greenhouse gas emissions according to IPCC GWP 2013 of a new device in comparison to the repair scenario above and per year of use with and without lifetime extension below.

Jattke et al. (2023): Jattke, M., Bieser, J.C.T., Stucki, M. & Itten, R. (2023) LIFESAVING: Life Cycle Assessment of mobile internet-enabled devices, ZHAW IUNR, Switzerland (unpublished)

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Barriers and Solutions

Consumers:
Alerting or incentivising citizens to treat the natural environment carefully and use natural resources consciously contributes to achieving environmental sustainability goals. Consumer behaviour can be influenced with nudges and incentives. Certain conditions can lead to **positive spillovers** to other environmental areas; in that way interventions in one target area positively influence sustainable citizen behaviour in seemingly unrelated environmental areas. For instance, incentives to reduce warm water usage may encourage people to reduce their heating as well.[4]

Too many idle products are bought. A **sharing economy and sharing platforms** should therefore be promoted.[3] **Rebound effects** have different reasons and are very hard to tackle. They are also not very well understood yet, both in science and among the public,[2] so information campaigns and further research are important. **Moral licensing** plays an important role in post-sharing consumption, thus, there is a need for **sustainable consumption options after sharing.**[2]

Private sector:
Sharing platforms to advertise less resource-intensive services/products to nudge consumers into not spending their savings and reduce rebound of re-spending.[2]

Changes in the choice architecture of an (online) shop (i.e. how easily available sustainable options are) can have significant impacts on consumers' sustainable choices.[1]

Labelling and banners can increase the likelihood of buying a refurbished smartphone. Experiments have shown that the odds were considerably higher if such interventions were present on the website than if no additional information on the environmental impact of refurbished smartphones was available.[1]

Researchers:
Access to information from retailers to evaluate impacts from labelling or nudges is limited and causes for positive spillovers should be explored further.[4]

Policy Makers:
Include diversified experience with nature in educational programmes and implement informational campaigns as this shapes individual environmental identity and improves sustainable behavior in voting,[3] consumption decisions, and can lead to positive spillovers.[4]

6.8 Industry

Relevant NRP 73 Projects:
[1] **Bernauer:** Voluntary Corporate Environmental Initiatives
[2] **Binder:** Rebound Effects of the Sharing Economy
[3] **Mutel:** Open Assessment of Swiss Economy and Society
[4] **Schmitz:** Nudging Small and Medium-Sized Companies
[5] **Schader:** Enhancing Supply Chain Sustainability

Contributing to the following SDG

Policy recommendations

Smart Mixes/Hybrid Governance:
Combining national policy with voluntary cooperative commitments and voluntary private action plans can be an effective mix in addressing entire supply chains. **The private sector** should be encouraged to define, advance and develop best practices for supply chain sustainability.[1,5]

Online sharing platforms promoting a sharing culture and clearly communicating environmental benefits should be supported.[2]

Trade Agreements:
When negotiating **trade agreements,** sustainability must be included and systematically analysed in terms of potential WTO conflicts which can be avoided.[1,5]

Market-based instruments:
VAT should be (temporarily) lowered or **abolished** for sharing services to lower cost for consumers (or increase earnings for sharing platforms).[2]

Prescriptions:
Minimum standards as well as monitoring/transparency requirements for companies regarding environmental impacts throughout the supply chain are needed. Once developed, best practices for supply chain sustainability should be binding.[5]

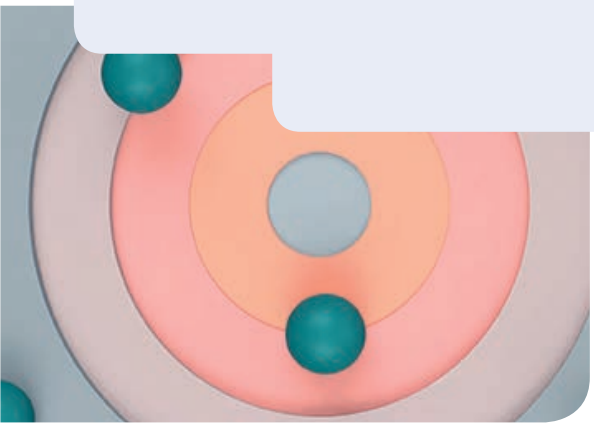
Information:
- **Labelling:** Prescriptions/regulations are needed for terms such as "Sustainability" when used on labels.[5]
- Consumers need to be made aware of their **(unconscious) moral licencing behavior.**[2]

Nudging and Spillovers:
- **Sharing platforms** could be used to promote less resource-intensive services/products and to nudge consumers into not spending their savings and reduce rebound of re-spending.[2]
- Increased environmentally friendly behaviour on the part of companies that have been "nudged" **is positively transmitted** to the individual company and its employees. The **effect** of **nudging** is therefore **underestimated.**[4]

Environmental impact

Around one third of the greenhouse gas footprint of a Swiss average household comes from consumer products such as clothing, electronics or furniture.[3]

The Swiss population is concerned about equity abroad, greenwashing in reporting and lack of accountability.[1]



Barriers and Solutions

Low hurdles are already a deterrent to sustainable behavior of SMEs, therefore designing support policies with an **extremely low-entry threshold** is crucial.[4]

There is no legal competence to regulate global supply chains. Therefore, smart mixes or hybrid governance approaches are necessary which will require **transparency and reporting for companies in addition to voluntary cooperative commitments.** Co-regulatory framework/oversight seems essential in terms of public support as greenwashing concerns are substantial.[1,5]

Capacity building via development aid:
Support for local governments in major exporting countries to create robust environmental governance as this is a key factor to improve environmental impacts.[5]

Figure 13: Components and conditions of a Smart Mix

1.	**Binding public measure**	+ **Voluntary cooperative measure**	+ **Voluntary private measure**
	Government	Government/industry/ civil society/organisation	Industry
	e.g. national legislation, EU regulation or directive, trade agreement, standard, taxes, public procurement policies	e.g. guideline, label, standard, certification scheme, roundtable, knowledge platform, financial support	e.g. best practice principles, industry standard, label, guideline, corporate policy/action plan
2.	**Interaction**		
	The mix of measures must interact		
3.	**Performance**		
	The interaction must improve the achievement of the objectives of at least one of the measures		

Smart Mixes in International Supply Chains, Home et al. 2021

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6.9 Mobility Sector

Relevant NRP 73 Projects:
[1] **Maibach:** Decarbonisation of the Transport Sector
[2] **Wäger:** Post-Fossil Cities
[3] **Schubert:** Sustainable Consumer Behaviour

Contributing to the following SDG

Policy recommendations

Regulation:
- **Phase out sales of fossil-fuel cars by 2025 and hybrid cars by 2030** as it provides planning and investment security for the production and purchase of battery-electric vehicles.[1,2]
- **Incentives,** such as road pricing, **to increase car occupancy rates** are necessary.[2]

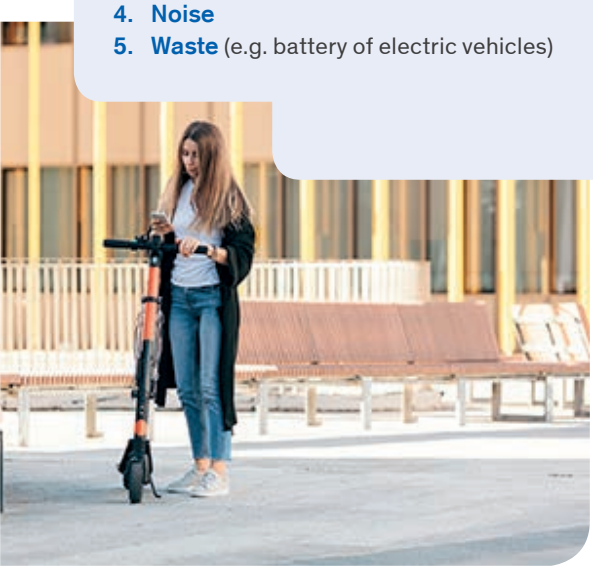
Market-based instruments:
- **A CO_2 tax** on fuels should be introduced.[1]
- **Initial subsidies** for battery-electric vehicles (BEV) – **infrastructure** financed by CO_2 tax revenue.[1]

Information and Training:
Simulation games like postfossilCities provide a powerful tool to interact with stakeholdesrs, e.g. for raising awareness, experimental learning, or changing existing mental models and may be used as "nudging tools".[2]

Environmental impact

Mobility has large impacts on:

1. **Fossil resources** (outside Switzerland)
2. **Greenhouse gas emissions** (CO_2)
3. **Air quality** (e.g. NO_X, particulate matter)
4. **Noise**
5. **Waste** (e.g. battery of electric vehicles)



Barriers and Solutions

Decarbonisation of the transport sector is possible with positive economic impacts (GDP, welfare) but requires **a combination of measures** for smart timing (as technology-driven measures can be severely delayed by the time it takes to replace the existing vehicle fleet):[1]

1. Fleet electrification (full electric not hybrid)
2. Increasing occupancy rate
3. Modal shift towards less emission intensive options (e.g. railways, cycling)

Shared mobility, such as ride-sharing, with increased **occupancy rates,** has a great potential to reduce direct energy consumption, GHG emissions but also noise and air quality.[2] The trend towards **autonomous cars** (ACs) may be combined with ride-sharing to further increase the potential for climate change mitigation. But ACs without shared mobility could increase direct energy consumption and emissions, and trigger urban sprawl.[2] **Changing mobility behaviour is challenging** as it seems unrelated to other environment-related behaviour. Positive spillovers that were observed in other areas like energy and water do not apply to mobility.[3]

Mobility tracking apps with feedback features such as information, moral appeal, social comparison, goal setting etc., raise awareness for environmental impacts of transportation, but hardly lead to changes in mobility behaviour.[3] This emphasises the need for fuel taxes to effectively induce environmentally and climate friendly mobility behaviour.[3]

Figure 14: Main results of the model analyses of the decarbonisation of private transport until 2050

Indicator / Value 2050	Reference "BAU"	Scenario 1 "CAPU"	Scenario 2 "SHIFT"	Scenario 3 "TECH"	OPT1: "all Scenarios"	OPT2: "OPT 1 plus ban"
Number of private cars	5.2 Mio.	3.7 Mio.	3.8 Mio.	5.2 Mio.	2.7 Mio.	2.7 Mio.
Share E (BEV*) of total cars	35 %	35 %	35 %	65 %	65 %	96 %
Energy needs BEV* (TWh)	5.1	3.6	4.5	9.7	5.2	6.6
Net import of electricity (TWh)	7.0	5.0	5.6	9.9	5.6	6.7
Transport performance, motorised individual transport (pkm)	110 Bn.	110 Bn.	86 Bn.	106 Bn.	76 Bn.	74 Bn.
Transport performance, public transport (pkm)	37 Bn.	38 Bn.	60 Bn.	38 Bn.	63 Bn.	74 Bn.
CO_2 emissions in private transport Mio. t (in % to reference)	**5.4**	**3.9 (-28 %)**	**4.0 (-25 %)**	**2.7 (-50 %)**	**1.1 (-79 %)**	**0 (-100 %)**
Share of work traffic (business and commuter), compared to BAU		-0.4 %	-0.1 %	-0.4 %	-0.5 %	-0.2 %
Share of leisure traffic, compared to BAU		**+0.5 %**	**+0.1 %**	**+0.4 %**	**+0.7 %**	**+1.0 %**
Actual per capita consumption, compared to BAU		-0.3 %	-0.5 %	-0.6 %	-1.1 %	0 %
Actual net import, compared to BAU		-0.3 %	-0.2 %	0 %	-0.5 %	-1.3 %
Savings compared to BAU		+0.7 %	+0.2 %	+0.4 %	+1.0 %	+1.3 %
Actual GDP compared to BAU		**0 %**	**-0.2 %**	**-0.2 %**	**-0.3 %**	**+0.2 %**
Actual social welfare comp. to BAU		**+0.7 %**	**+0.3 %**	**+0.4 %**	**+1.0 %**	**+1.4 %**

BAU: business-as-usual, CAPU: increase of capacity use, SHIFT: modal shift towards public transport, TECH: improved fuel/engine technology and fostered diffusion of battery electric vehicle, OPT1/OPT2: optimal scenario. OPT1 combines the specific approaches of the scenarios; OPT2 includes a ban of fossil fuels in order to reach the CO_2 target. pkm: passenger kilometers, TWH: terawatt hours.
*BEV: Battery electric vehicles

INFRAS/ETHZ

The decarbonisation of private transport requires a combination of all three scenarios including a ban on fossil fuels.

Find out more
Policy Briefs // Podcasts

6.10 Waste and Packaging

Relevant NRP 73 Projects:
[1] **Blumer:** Extending the lifespan of mobile devices
[2] **Frankenberger:** Applied Circular Economy (LACE)
[3] **Hoffman:** Towards a sustainable circular economy (TACLE)
[4] **Heselhaus:** Legal framework for a resource-efficient circular economy
[5] **Kytzia:** Co-evolution of business strategies and resource policies in the building industry

Contributing to the following SDG

Policy recommendations

Target setting:
Introduction of a **roadmap** with clear **environmental targets** (e.g. rate of recycling of plastics) coordinating between municipal, cantonal and federal actors. This will lead to improvements in collection, sorting and disassembly.[3]

Market-based instruments:
- **Reduced prices for recycled or repaired products** (e.g. reduction of VAT, tariffs) and provision of incentives to return old ICT products when a new one is bought.[1]
- Increase of resources prices **(tax).**[2]
- **Upfront disposal fee** in the construction sector (similar to ICT products) using the revenue for the recycling of demolition waste.[5]

Regulation:
- **Technical standards** to ensure the quality, durability and reparability of goods (e.g. see Repair-Index of France) will reduce waste and improve circularity.[4]
- **Prohibit** the use of **substances** or organisms that can **endanger health** as well as the environment, as they make their circulation impossible.[2]

Information:
Transparency with regards to environmental impact and recyclability of products, e.g. **information on the availability of spare parts, repair costs, warranty.**[4]

Environmental impact

- **In Switzerland the waste** volume is 698 kg/person and in 2021 the **recycling rate was 52%** (according to waste statistics).
- The **PET** recycling rate is >82%.[3]
- There are high volumes of waste in the **construction sector** of which a large part **ends in landfills.**[5]
- Extending the service life from two to four years in the **ICT sector** would save 72% of the GHG emissions compared to buying a new device every two years.[1]

Barriers and Solutions

Along the value chain, Switzerland should introduce the concept of resource conservation and **efficiency** into legislation, thereby protecting the environment and the use of natural resources as well as **reducing waste from the outset.**[4]

In order to **reduce waste and promote circularity, waste legislation needs to be changed** starting with the **definition of waste.**[3]

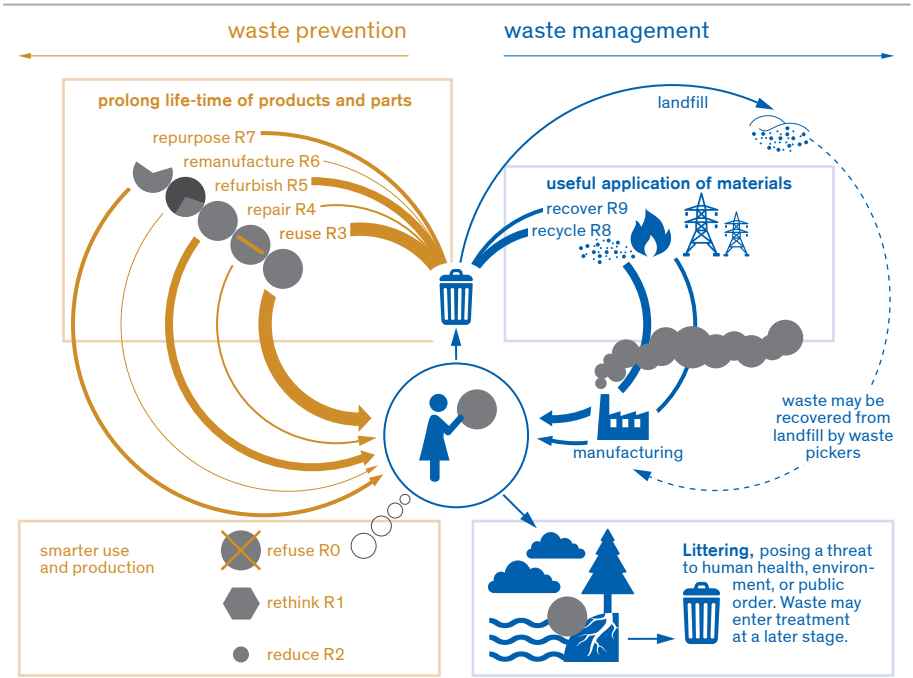
"Refuse" and "reduce" (sufficiency) approaches must be included, because reduced consumption is the most sustainable approach to reducing waste.[3]

The greatest potential for increasing circularity lies in the **innovation of new products, processes and services** which prolong the lifetime of products e.g. utilising modular designs or mono materials. The EU Eco Design Directive should therefore be adopted.[2]

The right to repair may lead to **monopolistic structures or stand in conflict with intellectual property rights.** Warranty rights (conversion, reduction & replacement) may need to be adapted.[4]

Figure 15: Waste management and prevention activities

Explaining the ambiguities around waste management and prevention activities



Wiprächtiger, M., Haupt, M., Rapp, M. & Hellweg, S. (2021). Waste not, want not – ambiguities around waste and waste prevention. Resources, Conservation and Recycling, 173, 105742. https://doi.org/10.1016/j.resconrec.2021.105742

Find out more
CEO Brief // Policy Brief // Video

6.11 (Waste) Water

Relevant NRP 73 Projects:
[1] **Truffer:** Challenges of Modular Water Infrastructure Systems
[2] **Schubert:** Sustainable Consumer Behaviour

Contributing to the following SDG

Policy recommendations

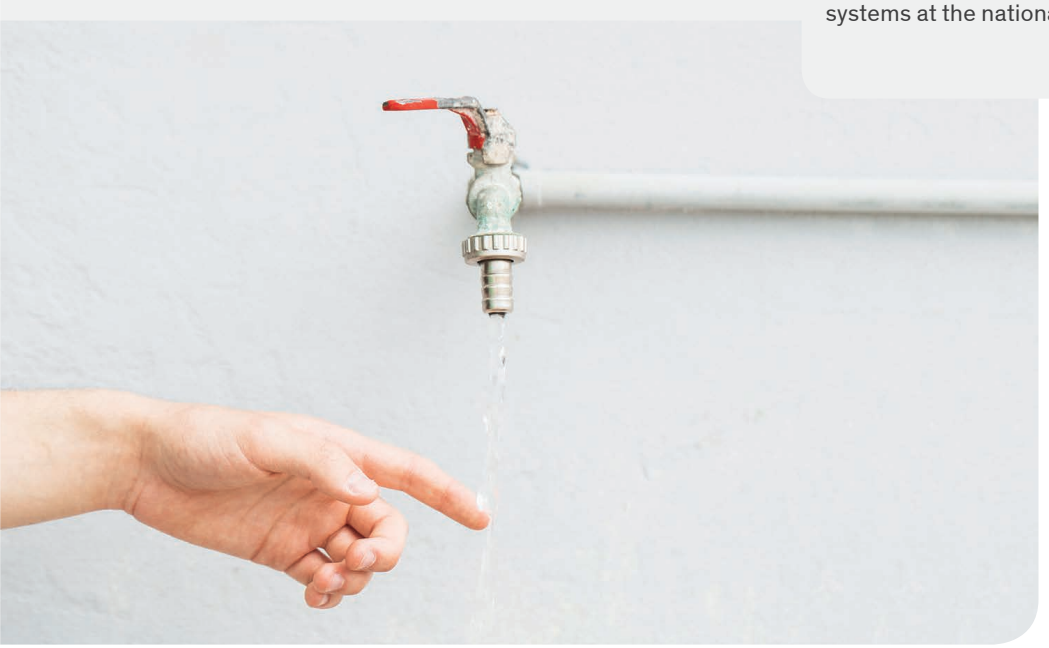
Regulation:
- **Certification** of modular water infrastructure is important for legitimacy and acceptance.[1]
- Existing **discharge requirements for treated wastewater need to be adapted,** in order to remove barriers for the diffusion of modular technologies, which would support sustainable urban water management.[1]

Market-based instruments:
- Positive incentives (i.e. **subsidies)** to drive the uptake of modular water technology, especially in contexts where the implementation of the new technology entails extra costs.[1]
- **New wastewater tariff** models identifying a compromise between polluter-pays and solidarity principles, while providing an incentive for innovation.[1]

Information:
- Improve transparency through **apps and meters for consumers** on e.g. water usage.[2]
- Support **further education** in the wastewater sector in relation to modular technology.[1]
- Disseminating **information** towards end-users and raising awareness for modular water technologies and their relevance for Swiss urban water management.[1]

Spillovers:
Sustainability challenges, for instance a hot water challenge that incentivises citizens to reduce their hot water usage may increase sustainable behaviour in citizens (e.g. positive spillovers) in other related environmental areas.[2]

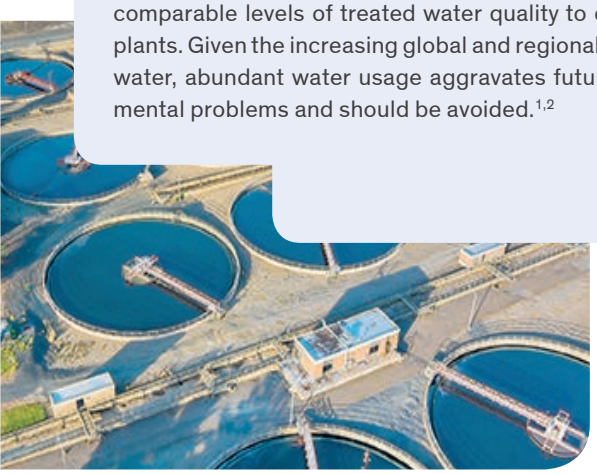
Guidelines & Plans:
- **Wastewater plans** identify future target areas for modular water infrastructure implementation.[1]
- **Guidelines for General Drainage Plans (GDP)** for hybrid systems at the national level.[1]



Environmental impact

Current water provision is confronted with challenges such as **climate change, new pollutants and ageing infrastructures.**

Furthermore, water quality is under scrutiny in Switzerland due to the **high nutrient and pollutant release** of the agricultural sector. A hybrid system including modular water technologies can help address some of these challenges. Modular wastewater technologies can achieve comparable levels of treated water quality to centralised plants. Given the increasing global and regional scarcity of water, abundant water usage aggravates future environmental problems and should be avoided.[1,2]



Barriers and Solutions

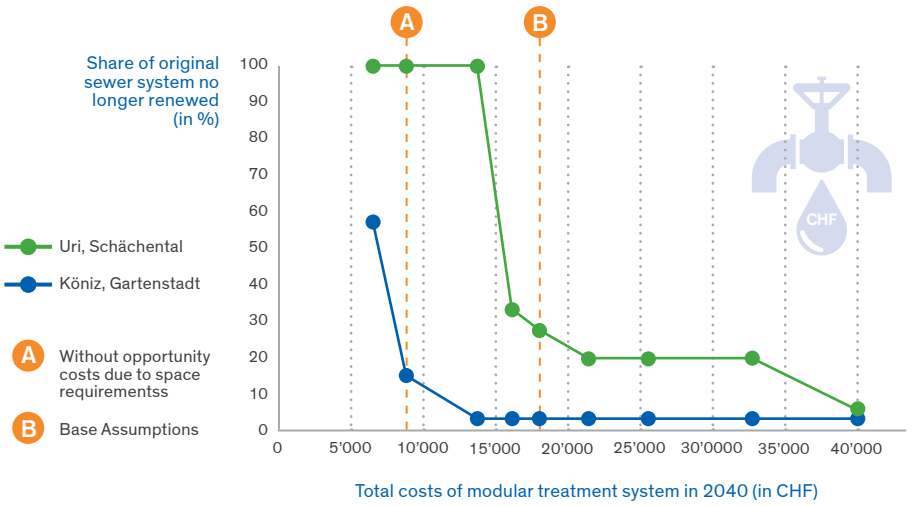
Federal policy makers:
Water is governed within a relatively decentralised system in Switzerland. Competences are located at the cantonal and municipal level. The Federal Office for the Environment has little legislative leverage. Since no procedures exist for modular water technologies on those levels, **administrators are reluctant to approve** them. Federal agencies should **coordinate** the **process** by bringing together relevant actors; creating guidelines, and highlighting best practices.[1]

Researchers:
More thorough assessments of total social benefits are needed. Funding for research should be provided at the federal level (e.g. for living labs) which would allow for an estimation in regard to system synergies (e.g. integrating water, energy and resource recovery).[1]

Water suppliers:
Water suppliers should provide **water meters** to private households to incentivise the reduction of water usage.[2]

Figure 16: Share of original sewer system

Share of original sewer system that is no longer renewed given cost-eficient system in Köniz, Gartenstadt and Uri, Schächental



"Cost-benefit analysis of modular wastewater treatment plants", Ecoplan, 2021

Find out more
Policy Brief // Podcasts

7. Project list, thematic syntheses and co-creation labs

The statements in this report are based on the outcomes of the research projects, the thematic syntheses and the co-creation labs. All research publications can be found on the NRP 73 web portal (nrp73.ch)

Governance

Project Bernauer, Th.
Voluntary corporate environmental initiatives

Project Bürgi Bonanomi, E., Mann, S., Belser, E. M.
Sustainable trade relations for diversified food systems

Project Francois, J.
Switzerland's sustainability footprint

Project Heselhaus, S.
Legal framework for a resource-efficient circular economy

Project Weder, R., Kägi, W.
Green labour market effects

Finance

Project Noailly, J., de Rassenfosse, G.
Financing clean tech

Project Rochet, J.-C., Balkenhol, B., Gibson Brandon, R.
Sustainable finance

Cities and Mobility

Project Maibach, M.
Decarbonisation of the transport sector

Project Wäger, P., Müller, B. D., Hilty, L.
Post-fossil cities

Circular Economy

Project Frankenberger, K., Nahrath, S., Favre, A.-C., Hischier, R.
Laboratory for circular economy

Project Hoffmann, V., Hellweg, S.
Towards a sustainable circular economy

Project Truffer, B., Maurer, M., Müller, A., Lieberherr, E.
Challenges of modular water infrastructure systems

Project Stucki, M., Meyer, S., Wibbeling, S.
Resource efficiency in Swiss hospitals

Thematic Synthesis:
Blum, N., Desing, H., Haupt, M.
Creating a sustainable circular economy

Buildings and Construction

Project Kytzia, S., Opitz, C., Hügel, K., Bunge, R., Scheidegger, A.
Co-evolution of business strategies and resource policies in the building industry

Project Thalmann, P., Hellweg, S., Binder, C.
Ecological footprint in the housing sector

Co-Creation Lab:
Kytzia, S., Thalmann, P.
Sustainable living and building

Supply Chains

Project Mutel, C., Wäger, P., Pauliuk, S.
Open assessment of the Swiss economy and society

Project Schader, C.
Enhancing supply chain sustainability

Project Seele, P., Stürmer, M., De Rossa, F.
Sustainable public procurement

Co-Creation Lab:
Mutel, C.
Data transparency for sustainability

Sustainable Behaviour

Project Binder, R. C., Gutner, S., Ritzén, S.
Rebound effects of the sharing economy

Project Blumer, B. Y., Hilty, L., Stucki, M.
Extending the lifespan of mobile devices

Project Czellar, S.
The influence of environmental identities

Project Schmitz, J.
Nudging small- and medium-sized companies

Project Schubert, R.
Sustainable consumer behaviour

Co-Creation Lab:
Blumer, Y., Czellar S., Schubert, R.
Sustainable behaviour and consumption

Agriculture and Nutrition

Project Finger, R., Huber, R., Buchmann, N., Walter, A.
Digital innovations for sustainable agriculture

Project Mathys, A.
Impacts of Swiss food consumption and trade

Project Nemecek, T., El Benni, N.
Interaction of economy and ecology in Swiss farms

Thematic Synthesis:
Bürgi, E., Jacobi, J., Mann, S., Schader, C.
Towards a sustainable food system

Forest Management

Project Olschewski, R., Hanewinkel, M., Bartelt, P., Yousefpour, R.
Insurance value of forest ecosystems

Project Schulz, T., Zabel von Felten, A., Lieberherr, E.
Trade-offs in forests

Project Thürig, E., Rohner, B.
Ecosystem services in forests

Thematic Synthesis:
Olschewski, R., Schulz, T., Thürig, E.
Mainstreaming forest ecosystem services

8. Organisation

Various actors from research and the administration are responsible for conducting the National Research Programme “Sustainable Economy” (NRP 73).

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