Transformative environmental policy:
Consistently promote and shape sustainable development

A guide for the BMU's area of responsibility

Umwelt Bundesamt

Legal notice

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1   About this guide

1.1   What is this all about?

Many environmental problems have been successfully resolved in the past decades. However, some are persistent and prove difficult to solve, and new ones have been added. Environmental problems can be particularly persistent if their causes are closely linked to the way we do business, to central aspects of our society, or to lifestyles that are perceived as attractive.

This guide can help staff in the Federal Ministry for the Environment, Nature Conservation and Nu-clear Safety (BMU) to tackle such environmental problems. For this purpose, the approaches of a "transformative environmental policy" are presented.

Transformative environmental policy considers environmental problems – larger and smaller – from a systemic perspective. It assumes that ecological burdens arise from the fulfilment of societal needs (e.g. for food, mobility, or communication) resulting from the functioning of socio-technical systems: How we eat, travel, or communicate as well as what environmental burdens this entails is influenced by the range of products on offer, existing infrastructures and technologies, market and power relations, societal norms and practices, and time constraints. Transformative environmental policy starts with the interaction of these factors. It also takes into account the dynamics of trans-formative change processes resulting from the coupling of factors.

The intention of transformative environmental policy is to either specifically initiate sustainability transformations (e.g. energy transformation) or make ongoing change processes more environ-mentally compatible (e.g. digitisation). In both cases, it serves above all to prevent further environ-mental destruction by addressing systemic causes or making use of transformation processes already taking place; in parallel, aftercare and the elimination of consequences (e.g. contaminated sites) remain necessary.

The approaches to transformative environmental policy presented in the guide can complement other forms of environmental policy design (e.g. media or substance-related). They are by no means intended to replace them. The approaches are suitable for both larger and smaller trans-for-mation processes towards sustainability and its subaspects.

What does this guide offer?

- Presentation of the concept of trans-formative environmental policy

- Notes, suggestions, practical examples and key questions on the implementation of eight approaches to transformative environmental policy

- Further reading

- Index on central terms
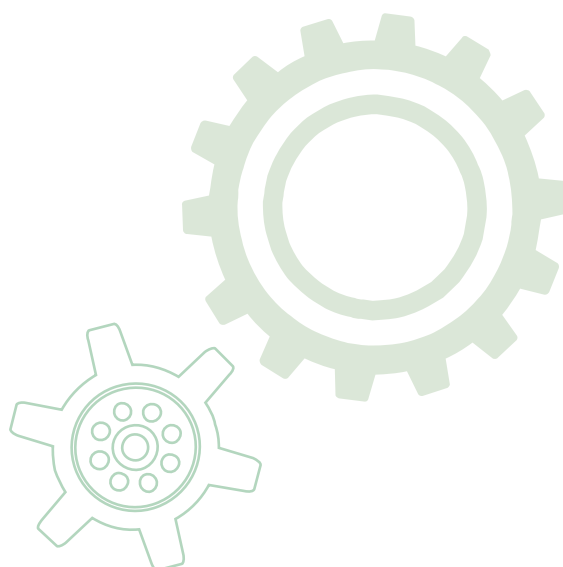
1.2 What can the guide be used for?

■ Are you developing environmental policy strategies or are you involved in their implementation?

The concept of transformative environmental policy can help to (more clearly) define the scope of strategies. This systemic approach comprehensively examines the causes of environmental degradation, identifies path dependencies and levers, and helps to address them effectively (⤳ Approach 1, 2). You will find references to the importance of future scenarios (also ⤳ Approach 1) as well as attractive societal visions and how these can be developed (⤳ Approach 4). Transformative environmental policy also entails identifying and involving actors who initiate changes in niches or bring them into the mainstream (⤳ Approach 7). You will find information on how societal and regulatory in-

novation can be promoted (⤳ Approach 5), how structural change and exnovation can be organised (⤳ Approach 6), and which role "time" can play in designing policies and processes (⤳ Approach 8).

■ Are you drafting or reforming laws or regulations?

From the perspective of transformative environmental policies, it can be useful to work with regulatory experiments. They create freedom for new actors and practices to test or facilitate alternative system configurations. As a first step, for example, simulation games or the spatially and temporally limited testing of a new regulation are suitable (⤳ Approach 5). Transformative environmental policy can also help identify and attract new supporters (⤳ Approach 7) and

develop blueprints for policy measures (⋯⟩ Approach 8). Appropriate measures can then be introduced into the process when windows of opportunity arise.

■ **Are you preparing opinions on policy proposals from other departments or levels?**

The systemic perspective of a transformative environmental policy can lead to a better understanding of the role of other responsible actors and help to develop new arguments for the integration of environmental policy. The joint development of a knowledge base (⋯⟩ Approach 1) can help in comprehensively identifying the causes of environmental degradation and thus increasing the acceptance of environmental policy proposals. Attention to the interfaces between socio-technical systems (⋯⟩ Approach 2) also sen-

sitises users to adjusting screws that lie outside the usual processing focus. Interdepartmental programmes to promote innovation or real laboratories designed jointly (also with stakeholders) can provide opportunities to reconsider deadlocked positions (⋯⟩ Approach 5). Finally, transformative environmental policy encourages the identification and promotion of "change agents" and potentially important niche innovators. You can again refer to their role (legitimising the transformation) in disputes with other departments (⋯⟩ Approach 7).

■ **Are you designing research projects?**

The concept of transformative environmental policy refers to systemic knowledge needs such as cause-and-effect relationships within transformation domains (⋯⟩ Approach 1) and environmentally relevant societal trends (⋯⟩ Approach 3). It also addresses the need for societal, technical, and regulatory innovations in order to make transformation domains more sustainable (⋯⟩ Approach 5). Calls for tenders for R&D projects can address these needs.

■ **Are you developing or implementing funding programmes?**

The concept of transformative environmental policy refers to the need to promote societal innovation (⋯⟩ Approach 5) or to support structural change (⋯⟩ Approach 6).
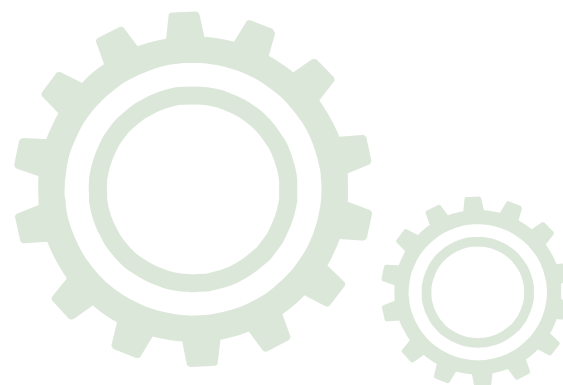
2   Core messages

■ Transformations as the object of environmental policy

Many persistent environmental problems are closely linked to the basic functioning of socio-technical systems. If the main objective of policy is to work on individual environmental media, pollutants, sectors, or causes, essential problem-solving levers can be overlooked or problem shifts and rebound effects arise. Deeper processes of change then become necessary. The aim of transformative environmental policy is to comprehensively influence certain domains and systems ("transformation domains") in such a way that their functions are fulfilled more sustainably. The following eight approaches can be used for this purpose.

■ Systemically analyse transformation domains (Approach 1)

A prerequisite for transformative environmental policy is a good understanding of how technologies, market and infrastructure, user practices, values, and policy instruments interact within concrete transformation domains and how this interaction affects environmental and resource consumption. Not only the status quo but also possible future developments and target states (scenarios) must be systemically examined. These analyses require an inter- and transdisciplinary approach that takes into account different levels of knowledge and practical experience.

■ Shape interfaces within and between systems (Approach 2)

Transformative environmental innovations (i.e. innovations that meet needs in a fundamentally different form) often arise at the interfaces between different socio-technical systems and their elements. Transformative change processes occur in particular when change processes in one system support the spread of innovations in another system (co-evolution). One example is green investments, which generate demand for environmental innovations. Their economic success, in turn, increases the attractiveness of green investments. It is therefore important to analyse the pressure for change in systems for which environmental policy is not directly responsible.

■ **Identify, evaluate, and politically address societal trends (Approach 3)**

Effective environmental policy addresses societal trends at an early stage. Some trends can be used proactively for environmental policy purposes (e.g. vegetarianism). For others, environmental and resource impacts must be improved (e.g. digitisation). Other trends must be mitigated at an early stage (e.g. low-cost flight tourism).

■ **Support the development of societal visions and objectives (Approach 4)**

A societal vision of the necessity and objectives of transformation (e.g. in the field of mobility), which is shared by many in society, gives orientation and legitimacy to innovations and policy instruments. Environmental policy can support the participatory development and concretisation of such a societal vision, even if it is not responsible for it.

■ **Promote societal and institutional innovations and experiments (Approach 5)**

It is important to strengthen the principle of "trial and error" in order to counter the complexity of transformations. Among other things, the feasibility of societal and institutional innovations that support a transformation towards sustainability can be demonstrated through simulation games or spatially and temporally limited testing of a new regulation. Path dependencies can also be broken up in this way.

■ **Exonovation: Phase out non-sustainable structures (Approach 6)**

In order for innovations to not only complement existing technologies and practices but also replace them in the long term, it is necessary to promote sustainable innovations and to abandon unsustainable production patterns, products, and practices. This transition must be planned early, be well thought-out, and have political support. Thus structural change does not become a structural break. A legally anchored phase-out timetable (possibly negotiated with industry representatives) provides planning, investment, and legal security for all sides.

■ **Connect with new actors and actors with new roles (Approach 7)**

Sustainability transformations can be promoted by actively involving new actors in policy. These can be pioneers or supporters of change as well as possible multipliers with transformative potential – even if they do not see themselves as environmental policy actors. Actors who have already been consulted or gained as allies within the framework of environmental policy will continue to be involved (in new roles if necessary).

■ **Shape policies and processes in a time-sensitive manner (Approach 8)**

Time can play a role in the emergence and management of environmental problems. For example, synchronised work rhythms encourage congestion and thus environmental burdens. The temporal disintegration of the cause and effect of an environmental problem contributes to the delay of its solution. Transformative environmental policy attempts to shape policies and processes in such a way that the negative environmental impacts of temporal structures are reduced and the positive temporal effects – such as windows of opportunity – are utilised.
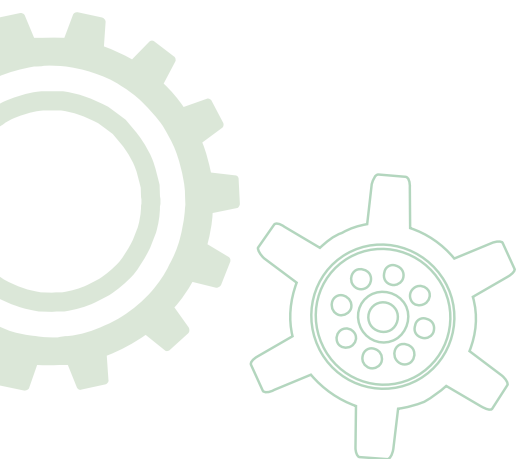
3 Background: Transformative change and environmental policy

Environmental policy has achieved impressive successes in recent decades. For example, the air and many bodies of water have become cleaner, and products and production processes have become more energy-efficient and resource-saving. Important hazardous pollutants were also reduced. These successes – supported by pressure from societal actors – can largely be traced back to the efforts of environmental policy and administration.

Nevertheless, environmental policy-makers are constantly reaching their limits. Why do problems such as climate change, the destruction of biological diversity and ecosystem services, the declining quality of soils, land consumption, and the globally increasing consumption of resources continue to exist? And why do our economies and consumption exceed the planetary boundaries?

The causes of such persistent environmental problems are often deeply rooted in culturally influenced, unsustainable societal visions and complex problem interrelations. The loss of fertile soils has to do with agricultural farming practices, housing demand, energy needs, global trade, population development, lifestyles, and eating habits. Finally, it is linked to societal visions such as "municipal planning sovereignty" and "consumer sovereignty", which make it more difficult to contain urban sprawl or to more closely regulate private consumption in ecological terms.

Partial improvements are not sufficient to solve persistent environmental problems. Technical approaches (e.g. pollutant filters and new technologies) can lead to problem shifts or rebound effects (i.e. to increased consumption of energy or raw materials) despite relief or increases in efficiency. Deeper societal changes – "transformations" – are therefore considered necessary.

In general, societies are subject to continuous change. Transformations occur when changes in culture, values, technologies, infrastructures, production, consumption, and politics intertwine and reinforce each other. These processes in-

tensify over time and lead to far-reaching, often irreversible changes in the societal fabric.

Transformations can affect the whole of society (e.g. democratisation) or individual domains (health reform). They can take place rather quickly (digitalisation) or drag on for decades (decarbonisation).

Transformations lead to societal needs (e.g. for mobility, housing, communication, nutrition, and material supply) being met differently than before. The Internet facilitates worldwide communication with many others in real time;

urbanisation enables new forms of production and coexistence.

Examples for transformations: The transition from feudal agrarian society to capitalist industrial society (Polanyi 1944: The Great Transformation); the transition of Central and Eastern European countries from socialist systems to democratically constituted market economies; at the sectoral level (e.g. the spread of the automobile or steam navigation in the transport sector); the replacement of wood by coal and later oil and gas in the energy industry; the development of the cold chain in the nutrition sector.

In history, there are many examples of transformations with different ranges. Whether industrial revolution or automobilisation: Until now, transformations have been accompanied by increasing environmental burdens in the long term. The examples also show that: Transformations are conflictual and generate resistance. Convictions, behavioural patterns, institutions, investments, and qualifications that have been valid so far are questioned. New actors emerge, and power and distribution conflicts arise. Both in society and in politics/administration, the necessity, direction, and speed of change are often assessed differently.

Examples for transformations:

The transition from feudal agrarian society to capitalist industrial society (Polanyi 1944: The Great Transformation); the transition of Central and Eastern European countries from socialist systems to democratically constituted market economies; at the sectoral level (e.g. the spread of the automobile or steam navigation in the transport sector); the replacement of wood by coal and later oil and gas in the energy industry; the development of the cold chain in the nutrition sector.

In order to utilise transformations for a more sustainable development, it is important to understand two of their central properties: they represent changes in entire systems (Section 3.1) and have a special dynamic (Section 3.2).

3.1 Transformations as changes to systems
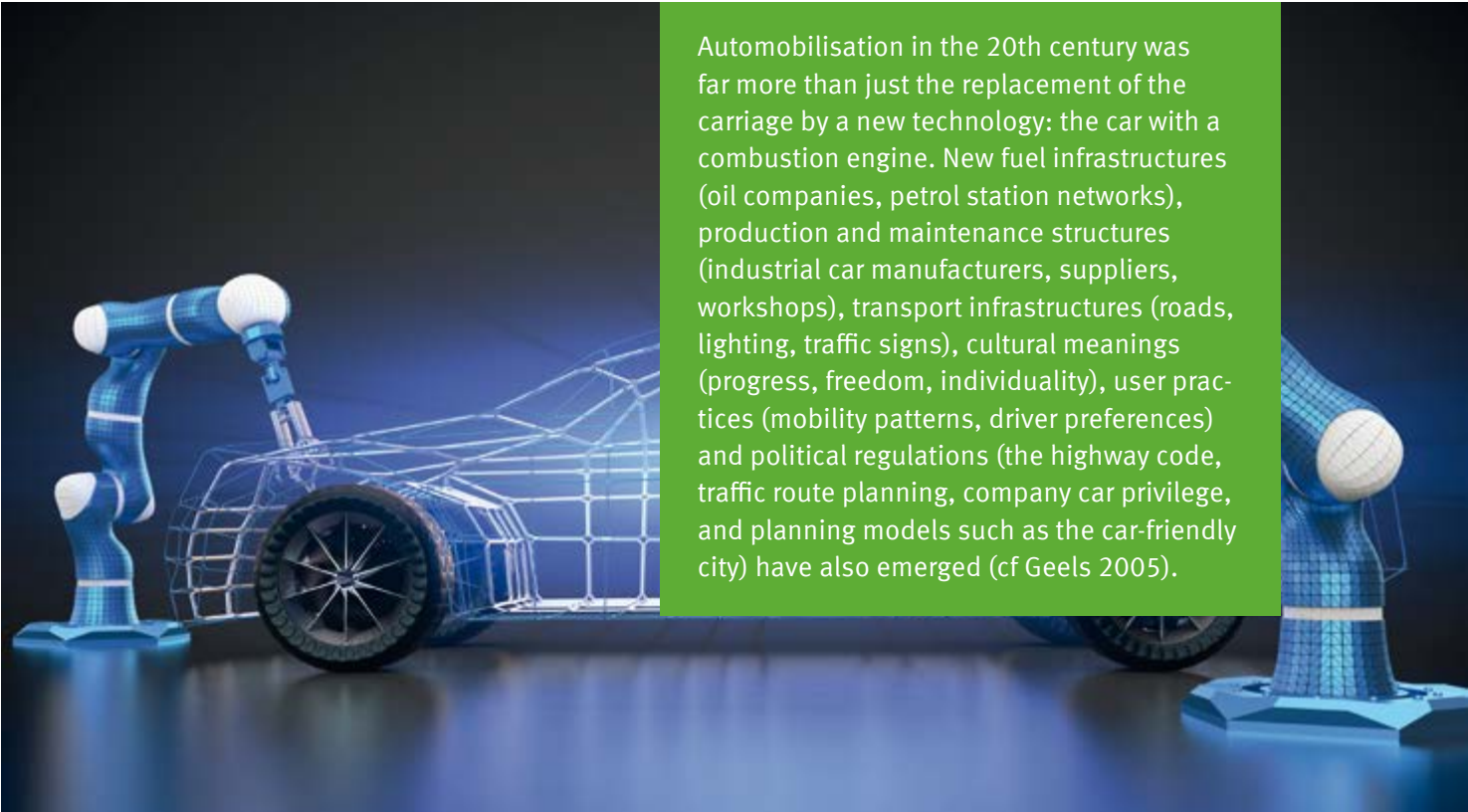
The domains in which transformations take place or are to take place – hereinafter referred to as "transformation domains" – can be understood as systems.

A **system** is a totality of interconnected elements that fulfil a function when concerted.

Socio-technical[1] **systems** are of particular interest for environmental policy. They contribute to the fulfilment of certain societal needs (e.g. for mobility, energy, or nutrition). Different factors interact: How we move around, supply ourselves with energy or feed ourselves is influenced by the product range, the existing infrastructures and technologies, market and power relations, societal norms, societal practices, and time constraints (Graphic 01). These "system elements" are interrelated and influence each other. Transformations can involve systems of different sizes (food system, meat sector, broiler breeding).

The environmental friendliness of a transformation domain is determined by the nature and interaction of its various system elements.

Transformations as changes to systems:

Automobilisation in the 20th century was far more than just the replacement of the carriage by a new technology: the car with a combustion engine. New fuel infrastructures (oil companies, petrol station networks), production and maintenance structures (industrial car manufacturers, suppliers, workshops), transport infrastructures (roads, lighting, traffic signs), cultural meanings (progress, freedom, individuality), user practices (mobility patterns, driver preferences) and political regulations (the highway code, traffic route planning, company car privilege, and planning models such as the car-friendly city) have also emerged (cf Geels 2005).

1   Socio-technical systems also have a socio-*economic* dimension.

Socio-technical system are embedded in ecological systems. They use their resources and ecosystem services (input), pollute them with waste and emissions (output), and are influenced by their dynamics.

Transformations represent changes not only of individual elements but also of the whole socio-technical system: A societal need is fulfilled in a fundamentally different way than before. With **sustainability transformations**, the environmental impacts of the new system state should be considerably lower than in the old state. Societal cohesion should also be preserved.
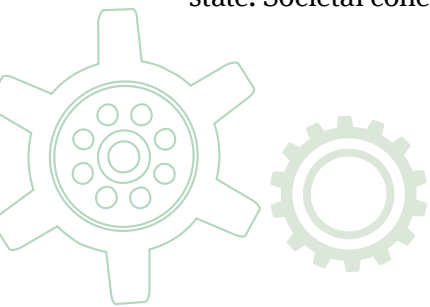
3.2 The dynamics of transformations

Transformations can be understood as the transition from one stable system state to another equilibrium. From the analysis of past transformations, it is known that this transformation process has a certain dynamic and can be divided into the following phases (Graphic 02):

▸ In the **pre-development phase**, numerous experts and innovations take place – often in niches. The density of change is high, but the direction remains unclear. The innovations still receive little support from the determining actors of the existing system (technical term: regime). These are rather dedicated to the gradual improvement of the existing situation.

Figure 01

Socio-technical system (embedded in ecological system)

Source: own illustration

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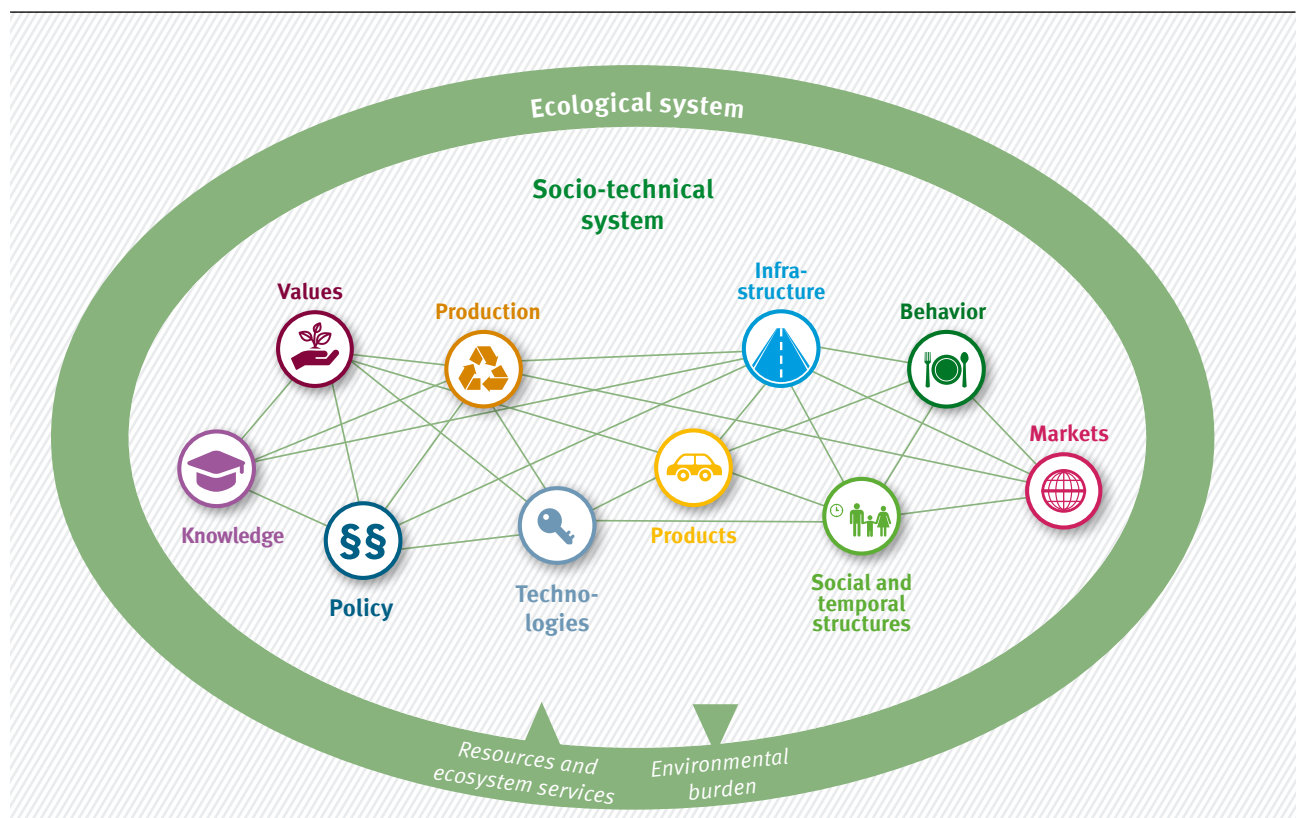
► In the **acceleration phase**, change gains momentum. Niche innovations challenge the dominant technologies, institutions and practices and are increasingly taken up by regime actors. Conflicts arise between the new and the existing as well as between different innovations. At the same time, various innovations begin to interlock and develop together (positive feedback, co-evolution). A system or system element provides services that are also important for another system or system element. Its demand for the services generates repercussions in the initial system (element). One example is smart phones (system communication), their effects in systems such as mobility or housing, and the repercussions.

► In the **stabilisation phase**, certain technical, societal, or institutional innovations prevail over alternatives; however, it is not possible to predict which ones will succeed. The old system will be replaced by a new equilibrium. This can change itself over time.

In principle, courses of development other than those of an S-curve are also conceivable. After the pre-development phase, setbacks may occur, or developments may stagnate halfway through. However, these are not (successful) transformations.

With regard to environmental objectives, in Germany, the transformation of the energy system (above all power generation) is the most advanced – compared with mobility or food, for example. However, it is not always easy to determine exactly where one is in a transformation process during the course.

Figure 02

Schematic (S-shaped) course of transformation processes

Stabilisation
New equilibrium

e.g. energy

Acceleration
Dynamic system change;
new-raditional conflicts

e.g. mobility

Pre-development
Change occuring in niches;
competing visions and innovations

e.g. nutrition and agriculture

System Change

Time
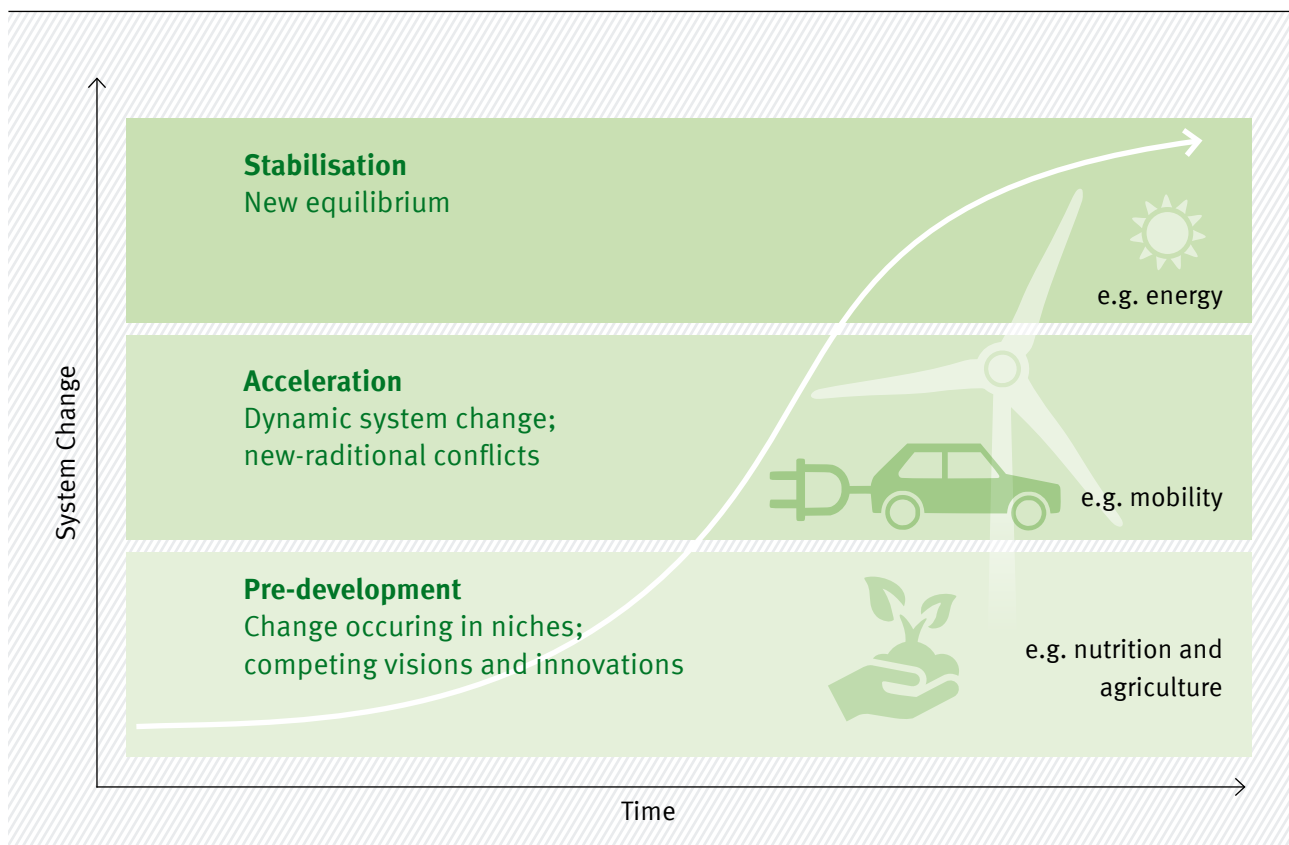
Source: based on SRU (2016)

3.3 Environmental policy challenges

Historical examples have shown that transformations cannot be planned. However, they can be perceived more consciously and influenced (environmentally) politically. Special challenges arise from the nature of transformation processes and the properties of socio-technical systems:

▸ **Complexity:** The interplay of technological, societal, economic, and ecological developments – which can often exhibit complex feedback relationships and tipping points – can make transformation a complex and uncertain process. It is difficult to predict how systems, dynamics, and innovations will develop, how and whether they will interact, what their side effects will be, and how political intervention will affect them.

▸ **Competing visions and objectives:** The path through which a transformation domain can be made more sustainable and the vision of what a sustainable system should look like are often controversial (at least initially). However, a societally accepted vision for change and the objectives derived from it are important sources for the orientation and legitimation of change processes.

▸ **Interdependencies and co-evolution within and between socio-technical systems:** The transformations of systems require changes not only in technologies but also in other system elements such as institutions, infrastructures, or cultural practices. However, these system elements are less accessible to

environmental policy control. Changes in one system (e.g. IT) can also trigger, reinforce, or inhibit changes in another system (e.g. automation of mobility or agriculture).

▶ **Capacities and resources distributed among actors to influence transformations:** Because of their systemic character, transformations cannot be controlled by a central actor. Rather, they are influenced by many actors in politics, science, business, consumers, media, and civil society. These actors have different capacities and resources and pursue sometimes conflicting interests (preservation of the status quo, optimisation of existing systems vs creation of space, and capacities for more fundamental change). In the political arena, actors are also responsible in different departments and at different levels with different responsibilities.

▶ **Role of time and path dependencies:** The design of transformations is influenced by temporal aspects – political windows of opportunity, societal adaptation speeds, and ecological reproduction times – and by the way in which they are implemented. It is further complicated by the fact that past decisions exclude or at least complicate certain options for action (e.g. technological, institutional) in the present (path dependencies).

3.4 Transformative environmental policy completes the repertoire of environmental policy

Despite these challenges, there are ways to influence transformations in order to achieve more sustainable development. Over the past few years, the BMU has carried out numerous strategic processes that explicitly refer to transformation (see box).

Examples of transformation-oriented strategies

■ Climate Action Plan 2050 ("transformative path")

■ Integrated Environmental Programme 2030 ("transformative environmental policy")

■ National Programme on Sustainable Consumption (field of needs approach)

Here, **transformative environmental policy** is understood as an environmental policy that attempts to facilitate, accelerate, shape, and support societal change. In particular, the aim is to influence transformation domains in such a way that their functions are fulfilled more sustainably. Political and societal actors can draw on a number of concrete action approaches. These are described in more detail below.

Because the aim of transformative environmental policy is to fundamentally change the status quo, it is necessarily accompanied by conflicts and power struggles. It also exploits the dynamics of societal change processes that are already taking place and opens up new opportunities

Why transformative environmental policy?

- In view of the ecological burden limits, limited changes are not sufficient to ensure a safe operating space for humanity.

- Environmental problems are largely related to the design and functioning of socio-technical systems. Environmental policy therefore reaches its limits when it addresses only individual, environmental media (water, soil, and air), pollutants, sectors, or system elements. Problem shifts and rebound effects can follow. Effectiveness also remains limited if problems are not tackled at the crucial levers.

- Experiments can demonstrate the feasibility of alternatives and thus contribute to overcoming resistance.

for action. By testing new solutions with experiments, for example, it helps to overcome resistance to environmental policy in the event of success.

Transformative environmental policy complements and develops existing environmental policy. It builds on existing and proven courses of action. These include the development of medium to long-term strategies and programmes (strategic environmental policy), the integration of environmental policy concerns into other policy domains (environmental policy integration), or the combination of different policy measures and instrument types (policy mixes) (see Chapter 6).
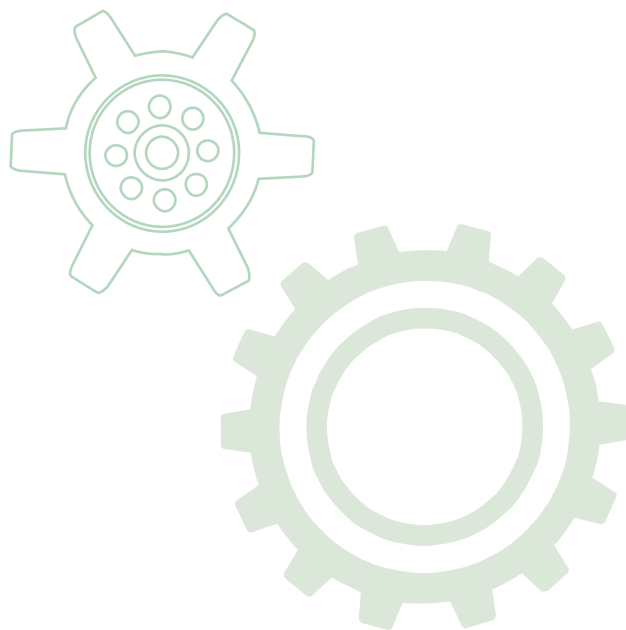
4 Specific approaches to the promotion and design of sustainability transformations

A number of action approaches can support decision-makers in environmental policy to deal with the aforementioned challenges of (sustainability) transformation. The approaches can be combined but do not build directly on each other and do not all have to be used at the same time.

The marked fields indicate which challenges of transformations are addressed by each approach. How this is done is described in the following chapter.
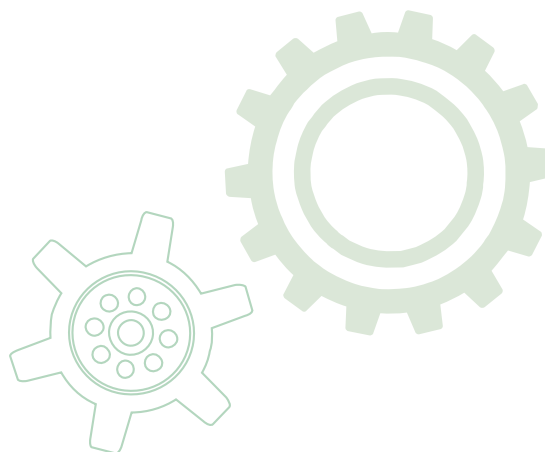
Table 01

Characteristics and challenges of transformations and action approaches

Action approaches to transformative environmental policy	Complexity	Competing visions and controversial objectives	Interdependencies and co-evolution within and between socio-technical systems	Distribution of capacities and resources between many actors	Role of time and path dependencies
1. Systemically analyse transformation domains	■		■		■
2. Shape interfaces			■	■	
3. Identify, evaluate, and address societal trends	■				■
4. Support the development of societal visions and objectives		■		■	
5. Promote (societal and institutional) innovation and experiments					■
6. Phase out non-sustainable structures (exnovation)		■		■	
7. Connect with new actors and actors with new roles				■	
8. Shape policies and processes in a time-sensitive manner			■		■

Source: own illustration

4.1 Approach 1: Systemically analyse transformation domains

Transformation domains such as mobility are characterised by the interplay of technological, political, economic, and societal factors that jointly shape resource consumption and environmental impacts (see Section 3.1). System elements such as infrastructures, production patterns, and behaviour patterns influence each other – they often co-stabilise the status quo. In order to contribute to the sustainable transformation of such socio-technical systems, a good understanding of the system and its interrelationships is required.

An **integrative, systemic knowledge base** provides answers to questions like these: Which starting points in the current form and current developments of the various system elements represent a hurdle or an opportunity for sustainability? How do the system elements interact, and how will they behave in the future? How is the transformation domain related to other systems? (⤑ Approach 2)? How do certain policies affect the system configuration?

Environmental policy issues and problems that are transverse to socio-technical systems (e.g. certain resources, substances, emissions, or environmental media) can also be analysed as transformation domains in such a systemic perspective. In this case, several socio-technical systems have to be considered, in particular those that contribute most to the emergence of the environmental problem. In the case of nitrogen, for example, these would be agriculture, industry, and transport.

Systemic analysis is not only important with regard to the status quo. It is also relevant with regard to possible future developments and target states of the transformation domain. In view of the dynamics and long periods of transformations, uncertainties about future developments and their effects as well as continuous monitor-

ing of the system and its changes are necessary. The analyses must be updated regularly. This may, in turn, lead to a need for political adjustment. Policy measures should also be regularly evaluated.

The analyses should be as inter- and transdisciplinary as possible in order to take into account different knowledge and practical experience. This chapter refers only briefly to more in-depth methods. The focus is on an understandable introduction to thinking in socio-technical systems and future scenarios.
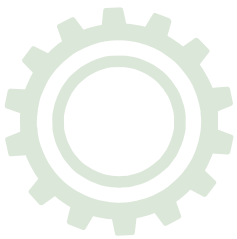
Procedure

Systematically consider the status quo

▸ At the beginning, it is important to define the transformation domain under consideration – i.e. the focus and the width of the system layout. For example, one can look at the entire field of nutrition and agriculture or focus on the production and consumption of meat.

▸ It is then necessary to develop a systemic basic understanding of the transformation domain. This means that the existing characteristics of the various system elements (Table 02) are analysed with regard to their sustainability barriers and opportunities as well as their interrelationships and their interactions with the ecological system (resource flows, emissions, and ecosystem services, including sinks). The concept of "path dependency" can play an important role in analysing factors and interactions that inhibit change.

■ **Path dependencies** lead to an event or development being shaped and limited by past events and developments. This stabilises or even "cements" the status quo. Different types of path dependencies can be distinguished; these can also reinforce each other (Clausen & Fichter 2016):

■ Technological and infrastructural path dependencies arise from the development advantage of existing technologies and their compatibility with existing products and infrastructures (e.g. sewage systems, filling stations, and operating systems).

■ Economic path dependencies are caused by investments already made and corresponding capital commitment (e.g. in fossil power plants) as well as by economies of scale, i.e. lower unit costs for large production and sales volumes (e.g. fossil-fuelled passenger cars compared with electric cars).

■ User and organisational path dependencies arise from behavioural and process routines that shape human behaviour (e.g. habit of driving to work by car) as well as from network effects (i.e. the more people use something – such as an exchange or sales platform on the Internet – the more attractive it is).

■ Institutional and legal path dependencies arise when laws, technical testing and approval regulations and other societal norms strengthen the status quo (e.g. non-technological specification of treatment processes for pollutants).

▶ If a topic has so far been dealt with from a more technical perspective, greater attention should be paid to the role of societal system elements (values, behaviours, and societal and temporal structures). And vice versa.

▶ If a transformation is more advanced in relation to some system elements than in relation to others, barriers to the latter should be increasingly considered.

▶ A system analysis also includes (different) actors (cf box for actor analysis in ⋯⟩ Approach 4):

· actors promoting and inhibiting sustainability

· niche actors (⋯⟩ Approach 7) as well as established actors

· actors from the various sectors of society (politics and administration, business, civil society, research and education)

· Actors at different levels from local to international (depending on the topic) and in different spatial contexts (city – country).

▶ From the system and actor analysis, possible conflicts in the course of a transformation can usually already be identified. These are to be expected in particular with established actors who have an interest in maintaining the status quo (⋯⟩ Approach 6).

▶ The considerations can be carried out systematically (e.g. in tabular overviews along the system elements). They can also be recorded either in cross tables (in which each system element is crossed with each other) or in graphics (in which essential correlations are clarified by means of arrows).

▶ The aim is to put one's own systemic understanding on an inter- and transdisciplinary basis. Exchange with colleagues from other disciplines/departments, external research actors, or societal stakeholders is useful for this purpose. An uncomplicated approach to this is to conduct workshops. Research projects can be commissioned for more in-depth analyses (see third section of the procedure).

Development, analysis, and evaluation of possible futures

▶ Working with scenarios is an obvious option for exploring possible **future** developments and states of a socio-technical system as well as potential interactions with other systems.

■ **Scenarios** are coherent, consistent, and conceivable images of the future as well as the corresponding paths of development. Scenarios are developed in a creative process. They are also suitable for long-term periods; uncertainties and surprises can be explicitly taken into account. Scenarios help to identify knowledge gaps and limitations, to make future developments tangible (knowledge function), to form normative ideals (objectives) (objective formation function), to evaluate options for action, and to make strategic decisions about future paths (strategy-building function). They can also promote the emergence of a shared understanding of a problem and the external communication of a topic (communication function).

Table 02

Characteristics and effects of system elements using the example of mo-bility (passenger traffic)

System element		Important characteristics and effects on other system elements
Values (including societal norms and societal vision)		Declining attractiveness of car ownership among younger people but, at the same time, continued popularity of powerful passenger vehicles such as SUVs Societal visions such as "Free travel for free citizens" and "Car-friendly city" de-legitimised the restriction of car traffic – this is partly changing (e.g. "city worth living in").
Knowledge		Research funding has so far focused predominantly on technologies
Behaviour		Routines ("always commute to work by car") and rebound behaviour (more efficient vehicle or electric car driven) Increasing bicycle traffic in cities is putting pressure on politicians
Products and technologies		Limited battery capacities and thus the range of electric cars have so far had a dampening effect on willingness to buy – however, both are improving Limited, partly decreasing public transport offer in rural areas Digitisation and automation bring advantages and new offers for different forms of mobility (e.g. cars, sharing offers, and public transport).
Production and technologies		Advantages in development and expertise as well as economies of scale in existing drive technologies and the associated production structures and supply chains
Markets		Not factoring in negative externalities (CO_2, air pollutants, noise) as well as low oil prices ensure that driving a car is (too) affordable. Electric cars have higher, albeit decreasing, acquisition costs
Infrastructures		Current traffic infrastructure (space, traffic lights) favours cars and is reaching spatial capacity limits (competition for space in cities) Lack of charging infrastructure hampers the purchase and use of electric cars
Societal and temporal structures		In many cases, larger distances must be travelled from the place of residence to the place of work In recent years, there has been a reurbanisation trend
Policy		Environmentally harmful subsidies (e.g. company car privilege, tax advantage for diesel, tax exemption for kerosene) make car and air travel more affordable Generous speed regulations affect practices and standards

Source: own illustration

► There are different scenario types and techniques for fulfilling the different functions of scenarios.

► Within scenario processes, a range of other methods (e.g. modelling, trend analysis, actor analysis, cross-impact analysis, intuitive and narrative approaches, expert Delphi, and road mapping) can be used and pragmatically combined.

► For the systemic analysis of transformation domains, the knowledge function is in the foreground (see box). It is best achieved with *explorative* scenarios. Various scenarios are created that depict alternative development possibilities descriptively – regardless of their desirability – and ask "What if?". Qualitative and quantitative knowledge can be integrated here. Within the explorative scenario type, environment scenarios can help to anticipate changes in the policy environment (e.g. in technologies, economic sectors, societal spaces, and international contexts) that may affect the implementation of transformation strategies. (*Normative* scenarios that describe the aspirations of the future – "Where do we want to go?" – and strategy scenarios – "How do we get there?" – are suitable for ⋯⟩ Approach 4).

► Scenario processes usually run through five phases: **1.** The topic or problem to be dealt with is determined (scenario field determination). **2.** Key factors or drivers that affect the problem or topic are identified. **3.** The key factors are analysed. For each key factor, it is examined individually which characteristics or developments are conceivable. **4.** Consistent scenarios are developed from different combinations of key factors (scenario generation); these often involve a reference scenario (without intervention) and several politically different alternatives. In some cases, random events and discontinuities are deliberately taken into account. 5. Finally, the scenarios are evaluated (e.g. with regard to conclusions for political action).

► **Quality criteria:** Good scenarios should be plausible, consistent, comprehensible, selective, transparent, and communicable. They should take into account interactions between developments in different systems and system elements at different levels.

► **Process criteria:** Depending on the objective, different groups of actors can be involved. Participative scenario development, which also involves scientists from various disci-

plines and societal stakeholders (potentially affected individuals; citizens as "everyday experts") in the moderated process, mobilises the experience and practical knowledge of a diverse group of actors. This makes the visions of the future more robust. The ownership and effectiveness of scenarios is increased if groups work together on a binding basis over several dates; process organisation and moderation are adapted to the size of the group; the distribution of responsibilities and the organisational procedure have been clarified; there are possibilities to leave alternative opinions standing in order to prevent "trench warfare"; it is communicated that it is about "thinking in options" – not about the best solution but rather about robust solutions in certain contexts.

▸ If the scenario results are to be used for monitoring, the data must be updated regularly. Here it must be clarified who can take over data maintenance and evaluation and at what level it is necessary.

Inter- and transdisciplinary deepening through research projects

▸ If a system or certain contexts are to be examined in depth or a larger scenario process is to be carried out, it is advisable to invite tenders for R&D projects. System-based approaches and modelling, integrated assessment approaches, and foresight methods can be used (see literature in Section 8.2). In any case, the terms of reference should require an inter- and transdisciplinary approach.

▸ In addition to being anchored in the departmental research plan of the BMU, attempts can also be made to influence the departmental research of other ministries (e.g. BMWi, BMVI, and BMELV). The BMBF also offers the possibility of starting larger research programmes. Topics such as the sustainable transformation of a societal subsystem or sector can be placed, inter alia, within the framework of research for sustainable development (FONA; Forschung für Nachhaltige Entwicklung) and societal-ecological research (SÖF; Sozial-Ökologischen Forschung).

■ **Example of energy transformation scenarios:** Since 2016, various paths of energy transformation have been reflected in Germany in a scientifically supported scenario process with broad participation of stakeholder groups ("Copernicus Projects for the energy transformation" of the BMBF). The scenarios gained here should serve to formulate concrete implementation steps. The central group includes representatives from trade unions, municipalities, churches, environmental associations, consumer protection, and business.

■ **Example of BMBF programme "Environmentally and Societally Compatible Transformation of the Energy System":** Under this programme, the BMBF funded 33 inter- and transdisciplinary research projects from 2013 to 2017. These dealt with both technical and economic issues as well as socio-cultural and political aspects. A specially established "scientific coordination" was concerned with synthesis and transfer.

To date, there is no corresponding programme for the transformation of mobility.

Summarising key questions

▸ Where are the sustainability opportunities and hurdles (including problematic path dependencies) for the various system elements?

▸ How do the system elements interact?

▸ For which of these system elements has the transformation already progressed, and where is there a need to catch up?

▸ Are there important differences between different societal milieus and different geographical areas (e.g. urban and rural areas)?

▸ Do previous strategies and policy instruments neglect certain system elements or concrete obstacles associated with them?

▸ What are *possible* developments and futures in the transformation domain? Which developments and futures would be *desirable* (according to societal and environmental policy objectives)? How are the futures and paths to it to be assessed in terms of sustainability? (⋯▸ Approach 4)

▸ Which research results are available? Is there a need for a new research project?

4.2 Approach 2: Shape interfaces within and between systems

(Environmental) policy cannot deal holistically with a socio-technical system or transformation domain in the necessary degree of detail. In many cases, this would overburden capacities and exceed departmental responsibilities. It is therefore advisable to concentrate on those aspects – specifically system elements – from which a leverage effect for the entire system can be expected.

Thinking in **border areas** of the systems and the **interfaces** is helpful. The question is: Which other systems or system elements can initiate further developments in their interaction – positive feedback or co-evolutions (see Section 3.2)? An answer to this question influences which actors are to be addressed (⋯▸ Approach 7). It also concerns the communicative framing of the topic.

■ An **example** are interfaces between the system elements "infrastructures" and "financing" (the latter as part of "markets"): Many green technologies require infrastructures to prevail over fossil technologies. How can the funds for this be raised? It may be possible to exploit innovations and trends in the financial sector (e.g. investment products that encourage investment in green infrastructures).

The aim of the approach is to think about the interfaces between the systems or system elements and to bring together actors who have so far had little exchange. This is intended to strengthen transformation dynamics. What potential unfolds for a traffic transformation if changes in work forms or demographic change are taken into account? For example, can niches for sustainable mobility in rural areas that ensure access for older people be conceived and financed? What dynamics are conceivable when "food and agriculture" are considered together with other systems? The link between agriculture and tourism is seen as an opportunity for a transformation in land use. A link with the financial sector could, for example, strengthen sustainable agriculture through crowd funding. There are many interfaces, not least with innovations and trends in the domain of digitisation.

The examples show that **levers** for the promotion of transformations can be found in the boundary areas between systems and system elements. Levers refer to adjusting screws outside the responsibilities of environmental policy; rearranging these will noticeably change the framework conditions for environmental policy (specifically: improve). Experiments can and should be carried out here.

At the same time, the well-known repertoire of **environmental policy integration** can be used: The (vertical and horizontal) integration of environmental aspects into other policy domains and levels is a proven policy approach that is also important for transformative environmental policy. Because environmental problems arise largely from the design and functioning of socio-technical systems (Section 3.1), it is not sufficient to address them within a sector or on an environmental medium. Many relevant factors ("system elements") are outside the sphere of influence of the environmental department: They are dealt with by other departments and actors at different political levels (i.e. local, regional,

and international). Contrary to the tendency to defend responsibilities, environmental policy integration strives towards cooperation on a problem or system across administrative borders and levels ("positive coordination"). Because transformative environmental policy works with experiments, new scope for action can open up for stalled positions that arise in the conflict between departments.

Procedure

Analyse interfaces between system elements and to other systems

▸ Based on the thorough system analysis (⋯⋗ Approach 1), which system elements in the respective transformation domain or which other systems are currently under pressure to change? Some examples: Against the backdrop of new capital market regulations and weak investment, financial markets are facing pressure to change; towns and cities must deal with demographic change and migration; all socio-technical systems are changing through digitisation; societal security systems must adapt to changes in the working environment. Within the framework of an interface analysis, it is asked whether this pressure has any significance for the transformation domain under consideration. Which functions are provided by the respective transformation domain for the other system (and vice versa)? Which actors are associated with this and could have an interest in driving change forward in order to cushion their own pressure for change? Which framework conditions do these actors need, and what can environmental policy contribute to their improvement? (⋯⋗ Approach 7).

▸ Results of such initial considerations (e.g. in the form of a thesis) can be used in the form of a workshop to bring actors from the different systems into dialogue with each other.

▶ A further step can be the in-depth analysis of the functionalities and interactions of relevant transformation domains. It can take place within the framework of departmental research (if necessary, together with other departments, BMBF programmes, and other research funding agencies).

Use findings from the interface analysis for political action

▶ The findings from the interface analysis can find their way into the (further) development of environmental policy strategies and expand their scope of action.

▶ If necessary, the findings can be used to advance the corresponding concerns in departmental negotiations vis-à-vis other departments.

▶ A network that brings together the various actors and their innovation activities (e.g. within the framework of a series of events) can be developed.

▶ Finally, consideration may be given to the development of instruments aimed at linking the innovation processes of different socio-technical systems. One example is the sector coupling in the context of the energy transformation (⋯▸ Approach 2).

▶ The well-known instruments of environmental policy integration also support the management of interfaces and are essential for transformative change. This includes involvement in potentially environmentally relevant processes in other departments as well as joint working groups, strategies, reports, and evaluations.

Summarising key questions

▶ Which system elements are subject to particularly high pressure to change? Which other societal systems or system elements could contribute to the solution?

▶ What are the functional logics and what pressure for change exists for these other systems?

▶ Which actors need to be addressed in the result of the interface analysis, and which actor configurations result from a possible linkage of the systems? Which networks can be used and connected?

▶ Which (technical, societal, and institutional) innovations can be developed and tested at the interfaces?

▶ How can the findings be used in strategies and political instruments? What do the findings mean for the integration of environmental concerns in other departments?
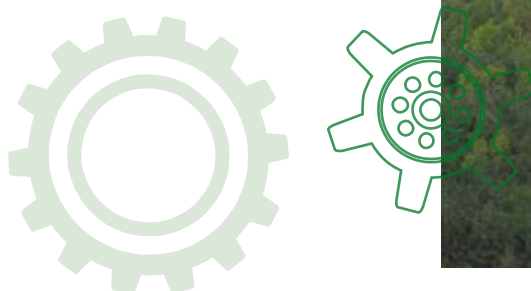
4.3 Approach 3: Identify, evaluate, and address societal trends

Societies are constantly changing. This is often largely independent of policy or at least not directly influenced by it. Short-lived trends, new societal practices, and culture are constantly changing. So far, environmental policy has usually involved "follow-up care" when it comes to limiting harmful effects.

This action approach sets out to observe the **dynamics of societal change that are taking place in any case** and to assess their ecological impacts at an earlier stage than before. A transformative environmental policy identifies political starting points and develops blueprints in order to mitigate environmentally harmful trends or promote environment improving trends. In addition to major trends ("mega trends") such as digitisation, urbanisation, demographic change, and climate change, environmental policy should identify, evaluate, use, or mitigate smaller trends and emerging issues (for a clarification of terms, see Behrendt et al. 2015). Because some important

trends emerge at the interfaces within and between systems ⋯⟩ Approaches 1 and 2 can be built on.

Societal trends have so far received little recognition as a topic and object of environmental policy. One reason for this is that the environmental impacts of new developments are not (yet) known. On the other hand, according to the prevailing understanding, policy does not interfere with societal diversity and innovation as long as these are within the scope of what is legally permissible. Nevertheless, trends should be observed, identified as early as possible, and evaluated ecologically.

The task of environmental policy is then to develop political starting points (initially blueprints if necessary) such as unsustainable trends associated with high environmental burdens or sustainable trends that can improve, promote, and utilise the state of the environment. Above all, it is a question of using the processes of change for environmental policy already taking place in society (i.e. supporting if positive from an environmental point of view and weakening if negative).

In the process, societal change processes not directly connected with environmental protection should also be addressed. They too can open up options for environmental policy. Examples are changing attitudes towards work-life balance, urbanisation, the increasing emphasis on quality in education, and new production processes (e.g. the production of artificial meat). Such processes can be used indirectly to conserve resources, reduce emissions, or necessitate political regulation.

Societal trend:

describes a change and dynamic in society that can be observed, lead to new forms of behaviour, and often only be influenced to a limited extent by policy.

- There are already some **examples** of environmental policies that have successfully used, supported and strengthened societal trends:

- the growing awareness of healthy eating, which is linked to the issue of animal welfare and industrial agriculture from an environmental policy perspective

- the development of bicycle express ways or the promotion of model projects for companies that promote environmentally friendly commuting (both factors reinforce the trend and the need for environmentally- and health-friendly mobility)

- the "citizen's energy transformation" in which individual citizens, cooperatives, or municipalities invest in renewable energies supported by the Renewable Energies Act.

Procedure

Identify societal trends at an early stage

The aim is to obtain an overview of possible trends – including those not directly related to environmental policy. For example, so called Horizon Scanning is suitable for this. This methodology is used for the strategic early recognition of societal changes. In the case of limited financial, personnel, and temporal resources, a separate literature or web search can be carried out based on the Horizon Scanning method (for existing studies on trends, see further literature in Section 8.4). Another possibility is to conduct expert surveys or to commission external experts to

carry out a Horizon Scanning process. It is also advisable to consult colleagues with methodological experience.

- **Development of a Horizon Scanning System for the environmental department:** In a UFOPLAN project (FKZ 371211104), a Horizon Scanning System will be established for the environmental department (status: middle of 2018). This should help to identify new developments that have a significant effect on the state of the environment but are not (yet) on the political agenda. In trend analyses, these newly identified developments are systematically analysed with respect to their positive and negative effects on the environment (see Behrend et al. 2015).

Evaluate societal trends

► The trends identified can then be evaluated to determine which negative and/or positive effects are to be expected in each case (see examples on trend reports in Section 8.4). Therefore not only direct effects but also indirect effects should be considered.

► For the evaluation, it can be helpful to refer to existing objectives (from strategies, laws) in the respective topic area. Does the trend contribute to the achievement of objectives? Or does it stand in the way of them? A useful method for this is the formation of causal chains: First of all, actors who are affected by the trend and are likely to change their behaviour are named. The effects that can be produced by the altered behaviour are then explored. Such analyses can be carried out in a participatory workshop format or using software designed for the qualitative modelling of causal chains.

■ **Example – causal chains for the evaluation of the trend:** In an R&D project of the Federal Environment Ministry, a trend report for 3D printing was prepared. The method of causal chains or derivation of effects was applied here (Keppner et al. 2018).

■ **Example – using trend analyses to develop and justify environmental policy:** In the National Programme for Sustainable Consumption, several trends from the literature were analysed within the framework of an R&D project and with respect to their significance for sustainable consumption.

► Variants: Qualitative and quantitative or hybrid scenario techniques (⋯⋗ Approach 1) are particularly suitable if the effects of several trends are to be recorded and evaluated. The participants in a scenario process exchange arguments about what possible effects the trends can have, what interactions could arise, and what a future (or different futures) with these trends could look like. These scenarios could then be used to illustrate futures with these trends or to develop strategies for dealing with them politically.

► Analyses of interactions between societal trends and transformation domains can also be advertised as R&D projects (see box).

■ **Example of research projects on trends and their environmental impacts:** The R&D project "Digitisation in transport – potentials and risks for the environment and climate" (2017–2020) aims to identify the positive and negative ecological impacts of possible development paths of digitisation in transport. Based on this, recommendations for action for a sustainable design of digitisation in transport will be developed.
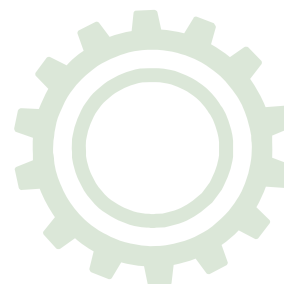
Politically address transformation trends and design blueprints

▸ Trends cannot be influenced directly. However, they can be strengthened or weakened by incentives and framework conditions.

▸ For example, the environmental impact of a trend is often not immediately foreseeable or only when economies of scale arise. Blueprints can be designed to enable early reaction: They show the possibilities for reducing the environmental impact of a trend or strengthening positive effects. R&D projects can also be put out to tender for this purpose.

▸ Publications or campaigns can address how trends promoting environmental protection and sustainability can be exploited. An example would be a campaign on cycling ("Good for health and for the environment"). Prizes and awards for activities and innovations that illustrate the ecological use of the trend are also conceivable.

Examples for the use of trends:

■ **Shareable City Seoul:** In Seoul, two societal trends were used to improve the quality of life and reduce the consumption of resources. Because many people in the mega metropolis are becoming lonely (trend towards individualisation/loneliness), the city has turned "sharing instead of owning" into a strategy (trend towards "sharing"). This should enable a communal, neighbourly life in the urban space. At the same time, the consumption of resources is reduced. Part of the strategy is promoting sharing companies, start-ups, and other organisations that promote sharing.

■ **Cycling in Berlin:** In Berlin, the proportion of bicycle traffic has been increasing for years (by some measurements, even by 170 % since 2001). Bicycle demonstrations ("Critical Mass" rides) are held regularly, and a referendum for a bicycle-friendly city was initiated in 2016. In the meantime, one can speak of a societal trend. This trend was embraced by the Senate and taken as an occasion for a new, integrated mobility law ("Initiating a turnaround in mobility").

▸ Within the framework of unsustainable trends, niche innovations that contribute to reducing adverse impacts can be sought and promoted. Examples include green IT technologies (e.g. fair phones, data centres powered by green electricity), eco-tourism (e.g. low-emission cruise ships), or innovative eco-food (e.g. from urban organic farming). Such examples can also be reinforced by prizes and awards as well as by public procurement.

Summarising key questions

▸ Which trends exist in society and which are emerging "on the horizon"?

▸ How can these best be identified (e.g. Horizon Scanning, existing literature studies, expert workshop)?

▸ Which trends are particularly relevant for the transformation domain to be worked on, and how do they affect it (opportunities and risks)?

▸ How can the impact of trends be assessed most efficiently (e.g. workshop, scenario process, or R&D project)?

▸ Which measures (e.g. incentives, promotion of innovation, or procurement) could be taken to promote opportunities in a timely manner or to reduce risks?

4.4 Approach 4: Support the development of societal visions and objectives

Transformative environmental policy supports the development of shared societal visions for specific transformation domains together with societal actors. Long-term objectives and transformation paths – also participatory – are derived from the societal visions. Over the course of time, these are repeatedly reviewed and adapted (e.g. to new ideas and insights, technological or socio-political developments, and unforeseen dynamics).

The aim of this approach is to provide directional certainty for the transformation process. At the same time, positive societal visions represent a "promise" that helps to overcome societal fears of change. Last but not least, their joint development increases the acceptance of societal visions. This also makes it possible to use knowledge resources and implementation capacities that are distributed among many actors.

■ **Societal visions** bundle visions (positive visions of the future) and overarching objectives that are shared in a society. The future anticipated in the societal visions is regarded as both desirable and attainable. As orientation patterns, societal visions structure future-oriented thinking and acting and motivate change.

Individual **objectives** can mark verifiable steps (milestones) on the path to change. They help to determine the status (success) of the transformation.

On the one hand, **transformation paths** are understood as patterns of transformations that actually take place; on the other hand, they are understood as paths of change suitable for achieving a societal vision. In the latter case, the determination of such paths should help to steer investment decisions in the desired direction.

Societal visions can refer to the entire society (e.g. the societal visions "knowledge society" or "sustainable development"), to societal sub-sectors (e.g. "women in management" or "activating state"), or to socio-technical systems (e.g. "nuclear phase-out", "energy transformation").

In particular, societal visions with a high mobilising power can also legitimise more drastic measures. Societal visions also make objectives easier to communicate and negotiate. Last but not least, they offer starting points for evaluating innovations in funding decisions (i.e. whether they contribute to the desired transformation).

For **implementation**, objectives and transformation paths can be derived from societal visions within the framework of participatory strategy processes (long-term and medium-term; quantitative and qualitative). Ideally, the individual targets can be verified. Their chances of success increase if they are linked to indicators that enable a target–actual comparison. Because framework conditions and requirements change over the course of transformation processes, societal visions and objectives should be continually adapted.

However, societal visions are often controversial. Even if transformations are considered necessary or unavoidable, there is not necessarily a societal consensus about their objectives or forms. Should an agricultural transformation be geared towards objectives such as farming, organic farming, and regionality – or towards an area- and input-efficient "precision agriculture" (as measured by agricultural industry practice) by internationally operating agricultural groups? Societal visions include long-term decisions on direction and (de-)legitimise certain visions of the future vis-à-vis others: The desired transformation can "devalue" investments, knowledge, and norms and redistribute power and resources between actors and institutions.

Experience has shown that the participatory development of effective societal visions is not trivial: Different societal visions often compete with each other; interest groups discredit the competing societal visions as unrealistic or undesirable. A part of developing societal visions entails different societal actors – including new actors – exchanging information (⋯⋗ Approach 7). It also helps to demonstrate the feasibility of a societal vision – be it through new knowledge (⋯⋗ Approach 1) or innovation and experiments (⋯⋗ Approach 5).

If it is not possible to develop a shared societal vision, transformation processes can – and should – also be promoted without one; the other approaches are available for this purpose.

Procedure

Support participatory societal vision processes

▸ The BMU has only limited responsibility for many transformation domains. Moderating the development of a societal vision for sustainable agriculture, for example, requires close cooperation with the leading agricultural department.

▸ It can be easier to complain about responsibilities via the interdepartmental German Sustainability Strategy, via interface topics (biodiversity, climate impact of agriculture) or via topics with unclear or distributed responsibilities (in the past: area, climate adaptation, resource efficiency). In particular, external (e.g. international, EU) processes offer windows of opportunity for this.
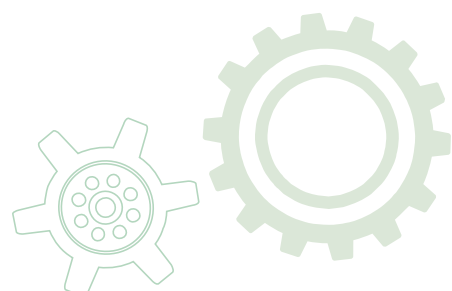
Define and limit the topic

▸ First, it must be clarified how the chosen transformation domain can be defined and delimited or where there are interfaces to other domains (⋯▹ Approach 2); these must be included in the societal vision. Is there sufficient information (system knowledge) to be able to provide the actors with a development framework for their objectives (⋯▹ Approach 1)?

▸ Is the topic already on the agenda or is it societally new? Other groups of actors must then be taken into account than in the case of a topic that has already been the subject of controversy. In order to be able to assess this better, an actor analysis can be helpful.

■ **Actor analysis:** Which persons, groups, and organisations are important for the transformation domain? How do the actors differ – what interests do they pursue (change or perseverance), and what resources and veto potentials do they have? What are the relationships and conflicts between the actors? The analysis can build on administrative experience, additional expert knowledge (semi-structured interviews), focus groups, or media evaluation.

Determine methods for developing a societal vision

▸ Developing a societal vision requires a structured discussion process. Different methods can be used for this purpose. An essential approach is the development of normative scenarios: As a rule, several alternative scenarios are developed in discussion forums asking the question "How do we envision the future?" These can be evaluated with regard to the achievement of ecological objectives or in comparison with environmental scenarios (⋯▹ Approach 1). The desired scenario is condensed into a societal vision. Using strategy scenarios, concrete options for action ("How do we get there?") can then be identified. For example, different measures can be developed (backwards) from the societal vision (back casting) or derived from a multi-optional strategy development process.
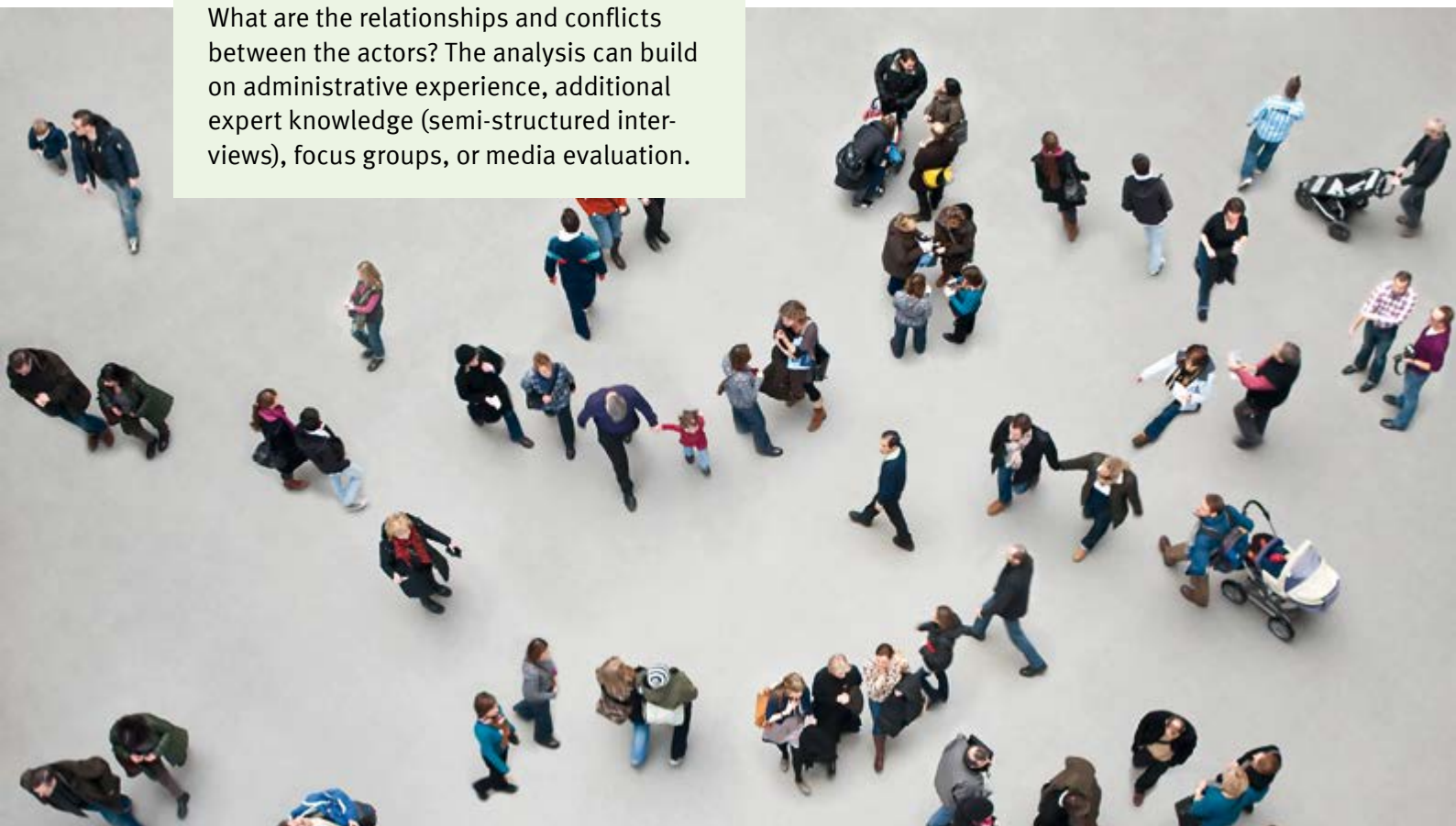
► In the concrete design of the procedure, care must be taken to ensure that fewer loud voices are heard – for example, by controlling the selection of participants (see below) or by control mechanisms that make processes more representative (e.g. large group formats, votes, and representative surveys).

Selection of participants

► The selection of groups of actors to be included in the societal vision discourse must be well prepared in technical, methodological, and strategic terms. An actor analysis (see box) helps to find out where conflicts between potential participants are to be expected.

► Political decision-makers should be closely involved in the process or at least support it. Only in this way can a transfer into policy be guaranteed.

► Involving pioneers of change and supporters ("Change interests" ⸱⸱⸱⸱⸱⸱⸱ Approach 7) strengthens the process of defining ambitious sustainability visions and objectives. Involving established actors with "persistent interests"

at an early stage can slow down the process. But it can also lead to a convergence of problem views and joint approaches to solutions. A balance in favour of changing interests makes strategic sense – at least in the initial phase. Later, the changes often have enough momentum of their own to captivate even the initial opponents.

► As a rule, the actors invited at the beginning support the process until the end. Additional experts can be involved in certain phases (e.g. when defining key factors in scenarios). In the case of "major" topics such as energy transformation or the sustainable development of cities, regional stakeholder groups are often also involved.

► Selecting the "right" contact person is important: Is the person creative and open to the process? Does he/she have the necessary power of assertiveness in his/her organisation to communicate agreements and positions formed in the process? Are individuals invited on a level playing field?

Moderation, professional support, and institutionalisation

► Whether a professional moderation makes sense depends, inter alia, on the objective, the strength of possible lines of conflict between the actors involved, and their (presumed) ability to communicate.

► The technical support structures the process of developing the societal vision taking into consideration the process criteria mentioned in ⸱⸱⸱⸱⸱⸱⸱ Approach 1.

► Institutionalisation supports the longer-term effect of societal visions. For example, by monitoring (environmental) indicators and by regular update and organisational attachment to an (administrative) actor with visibility and ownership. This checks milestones and measures the achievement of objectives. In particular, the strategic planning of the implementation of milestones must be anchored in day-to-day business.

Develop and communicate mobilising societal visions

▸ Societal visions are effective to varying degrees. They are considered to be mobilising if they are tangible and conceivable, based on empirically credible cause-and-effect chains, compatible with everyday experience, point out feasible and desirable developments, contain a concept for action, and appeal to "strong" motives for action. In environmental communication, it has proven successful to emphasise the positive side effects of environmental policy measures (e.g. on health or safety). Positive emotions, attractive pictures, and the ability to connect to common cultural interpretations also have a supporting effect. The societal visions of sustainable development and the Green Economy only fulfil part of these success factors and are considered to be rather weakly mobilising.

■ **Sustainability 2.0 – modernisation approaches to the societal vision of sustainable development**

In this UFOPLAN project, strengths and weaknesses of the current societal vision of sustainable development were analysed, approaches for updating it were developed, its ability to connect to more recent discourses (e.g. "vulnerability and resilience"; "good living") was examined, and recommendations for conceptual extension and institutional embedding were developed (Weiss et al. 2017).

▸ Elements of an (evolving) societal vision for a transformation domain must be communicated intensively. Only in this way can corresponding interpretative framework ("Frames") be activated in people's minds and become established in the discourse.

▸ Societal visions are easier to communicate if they are translated into appealing and, if necessary, target-group-specific "narratives". For the transformation of socio-technical systems, for example, it is essential that narratives are not technology-oriented but rather motivate people to take part in the "transformation".

■ **Narratives** an be understood as meaningful motifs that convey orientation within societal groups. They contain arguments and convey values and emotions. In political processes, narratives help, among other things, to create acceptance for problem interpretations and solutions, forge alliances, and facilitate joint action. Narratives can sometimes be expressed in "plots" – with actors ("heroes"), places and times, and (turning) points in the plot (e.g. "For some years now, repair cafés have been springing up. In these cafés, hobbyists and helpers have been turning supposed scrap metal into functional equipment")
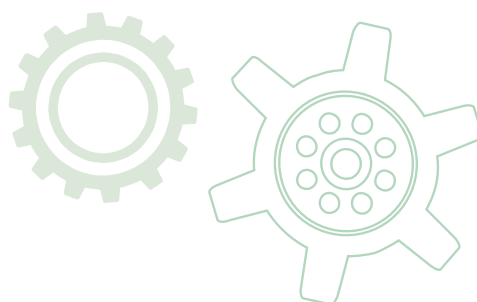
▶ Developing narratives is time-consuming, especially if they are to be differentiated according to target groups. Close cooperation between specialist departments and the press office is recommended. It is less time-consuming for the experts if they give the communication experts simplifying argumentation chains instead of narratives.

▶ Transformative environmental policy attempts to network actors who are considered a medium of discourse for the societal vision (i.e. promoters) with one another because their values or interests can be strongly linked to it.

■ **"Sustainable City 2030":** In the UBA (Umweltbundesamt; German Environment Agency) project, normative scenarios were developed on the topics of "Closed-loop city" and "Sustainable economy in the city" based on creative workshops with specialist actors from administration, business, and local authorities. The participants identified visionary ideas and desirable future perspectives and derived options for action, strategy elements, and networking approaches.

■ **Transition management in the Netherlands:** In the Netherlands, the transition management approach was made the basis of policy in various ministries in 2001 (4th National Environmental Plan 2001; transport, agriculture, energy, and biodiversity). Transition management starts with the change of socio-technical systems. In each case, processes were initiated in which visions were developed with the participation of various actors. Experiments were also conducted in order to try out ways in which these visions could be achieved (e.g. Roadmap "Transition Sustainable Agriculture 2003–2006"). However, the visions developed there were not accepted by political actors as guiding action. However, embedding them in political processes is central to the effectiveness of visions.

■ **Civil dialogue "Living well in Germany":** On the initiative of the Federal Chancellery, more than 200 citizen dialogues with professional moderation were conducted nationwide in 2015. Oral and written feedback was evaluated with scientific support and compiled into a report. In the future, a system of indicators will assess the development of quality of life in Germany.

■ **"Climate Action Plan 2050":** The climate protection plan defines societal visions for the fields of energy, buildings, mobility, industry and commerce, agriculture, land use, and forestry for the year 2050. It describes transformative paths (e.g. "It will only be possible to meet the climate targets if coal-fired electricity production is gradually reduced.") and outlines path dependencies. Interim objectives up to 2030 are underpinned by concrete milestones and measures. The plan should be updated regularly.
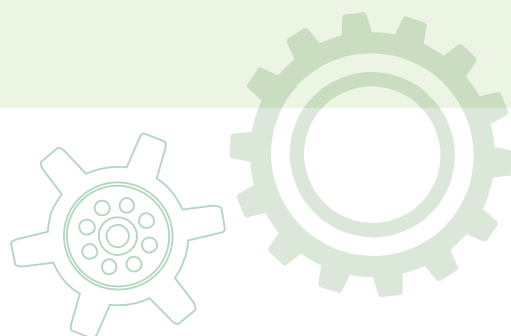
Summarising key questions

▸ Which groups of actors are potential supporters of the targeted transformation? Which representatives are suitable, and at which level are they to be addressed?

▸ Which interests do the actors pursue, and which of these can support the transformation?

▸ Is the composition of the group of actors appropriate for the development of a shared vision?

▸ Would an external moderation be helpful (especially if diverging visions and objectives are to be expected from various stakeholder groups)?

▸ Can the societal visions and objectives be institutionalised and regularly reviewed? By whom? What are suitable indicators?

▸ How can strategically planning the implementation of milestones be anchored in day-to-day business?

▸ Which narratives can be used to support the communication of the societal visions?

4.5 Approach 5: Promote societal and institutional innovations and experiments

Innovations and experiments are central to transformations: They create new, more sustainable opportunities for action. Trial and error are indispensable when it comes to searching for transformation paths in the face of complex socio-technical contexts and uncertain future developments.

The aim of this approach is to use experiments and innovations to identify more sustainable paths and demonstrate their feasibility. This can also legitimise corresponding societal visions and break up path dependencies (···> Approach 4 and 8).

Transformations towards sustainability require technical, societal, and institutional innovations. Because it is generally not foreseeable from the outset which new technology, societal practice, or institutional innovation will best contribute to the change towards sustainability, how innovations will develop, and which will ultimately prevail, a large number of innovations and experiments should be promoted.

With regard to institutional innovations, one sub-domain, regulatory innovations, will be discussed in more detail below. The basic assumption is that the state itself (with its organisations, processes, and instruments) is – and must be – the object of transformation in order to be able to respond to the challenges of transformation.

■ **Societal innovations** are defined as novel and alternative practices that differ substantially from established practices and which may lead to perceptible and far-reaching structural changes (see Rückert-John 2013). Examples include car sharing, community-supported agriculture, urban gardening, clothes exchange parties, and repair and sewing cafés. They are partly based on old, rediscovered practices (e.g. repair and manual work). Societal innovation as part of cultural change cannot be imposed "from above". However, it can be promoted.

■ **Regulatory innovations** re those that affect **government action**. These can be policy instruments of any kind (i.e. legislation, expenditure programmes, plans, and information-based instruments). It can also include rules that affect the state itself (e.g. the rules of procedure of ministries).

Societal and regulatory innovations are an expression of societal and political learning: Because transformations can be designed in a target- and direction-oriented way but cannot be planned different types of innovation serve to search for alternatives and to learn from experiences.

> ■ **Learning** can refer to i) better problem solving to achieve set objectives (single loop learning), mostly through trial and error ii) rethinking objectives (double loop learning), and iii) questioning one's own assumptions, mental models, or values (third loop learning).

Societal and regulatory innovations can – and should – be tested in an open-ended manner, especially in the early phases of transformations. As with technical innovations, funding is justified: In the case of societally desired innovations, the research and development phase is often associated with risks for microeconomic actors, while the benefits of (successful) innovations often benefit society as a whole ("spillover" effect). If there were no support, the level of innovation would remain below the societally desirable level. While this argument for technical innovation is recognised, a policy for promoting societal and regulatory innovation has yet to be established.

Procedure for societal innovations

Incorporate the promotion of societal innovations into political strategies and provide funds for them

▸ This approach implies that the importance of societal innovation is emphasised during the development of environmental policies and programmes. Specialist units are also planning to use subsidies for this purpose.

▸ A funding programme for societal innovations does not have to be financed from BMU funds. It can also be developed by the BMBF or other research funders. For this, funding justifications (What is the need for innovation? Why are innovations not developed by the market?) must be provided. Funding addressees and criteria for the evaluation of proposals must also be formulated. Consideration should be given to whether and to what extent own funds can be expected.

> ■ **Use the flexible innovation fund in the "Integrated Environmental Programme 2030" for societal innovations, among other things**
>
> The "Integrated Environmental Programme 2030" announces the creation of a flexible innovation fund with which BMU funding can be used as free resources for innovative measures. Societal innovations are central to this.

▸ A more long-term starting point for promoting societal innovations is the creation of framework conditions (e.g. shorter working hours) to facilitate commitment to and the institutionalisation of societal innovations (Kny et al. 2015).
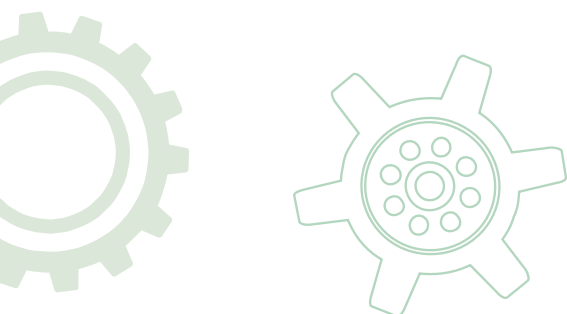
Develop objectives and criteria for evaluating proposals

▶ Various technical, societal, and regulatory innovations must be promoted. It must be ensured that these innovations contribute to sustainable development. Evaluation criteria should be defined for this purpose. Possible economies of scale should also be taken into account: For example, car sharing on a small scale (e.g. when neighbours share a car) can contribute to fewer cars being used. If car sharing is offered on a large scale and commercially, this could lead to growth in motorised private transport (⤑ Approach 3).

■ **Argumentation aids and criteria for societal innovations and the promotion thereof**

"From the niche to the mainstream" project (concept study + follow-up project): In the UFOPLAN project "Niche I (concept study), it was examined how good examples of sustainable action can be anchored in a broad societal context. What are "good" examples of sustainable action? What might an order structure look like to cover the whole range of sustainable behaviours and practices? How do certain behaviours and practices spread in society? What motives and personal preconditions must be present in order to start and maintain sustainable action? (Kny et al. 2015) The follow-up project "From the niche to the mainstream" provides argumentation aids for employees of the BMU area of responsibility; these can be used to emphasise the importance of societal innovations. Criteria will also be developed to measure the added value of societal innovation for a sustainable society (Wunder et al. 2017).

UBA guide "Societal innovations on the upswing" This guide evaluates criteria for defining societal practices (e.g. degree of diffusion, and formality) in terms of what they mean for their initiation, development, and promotion (Rückert-John et al. 2014).
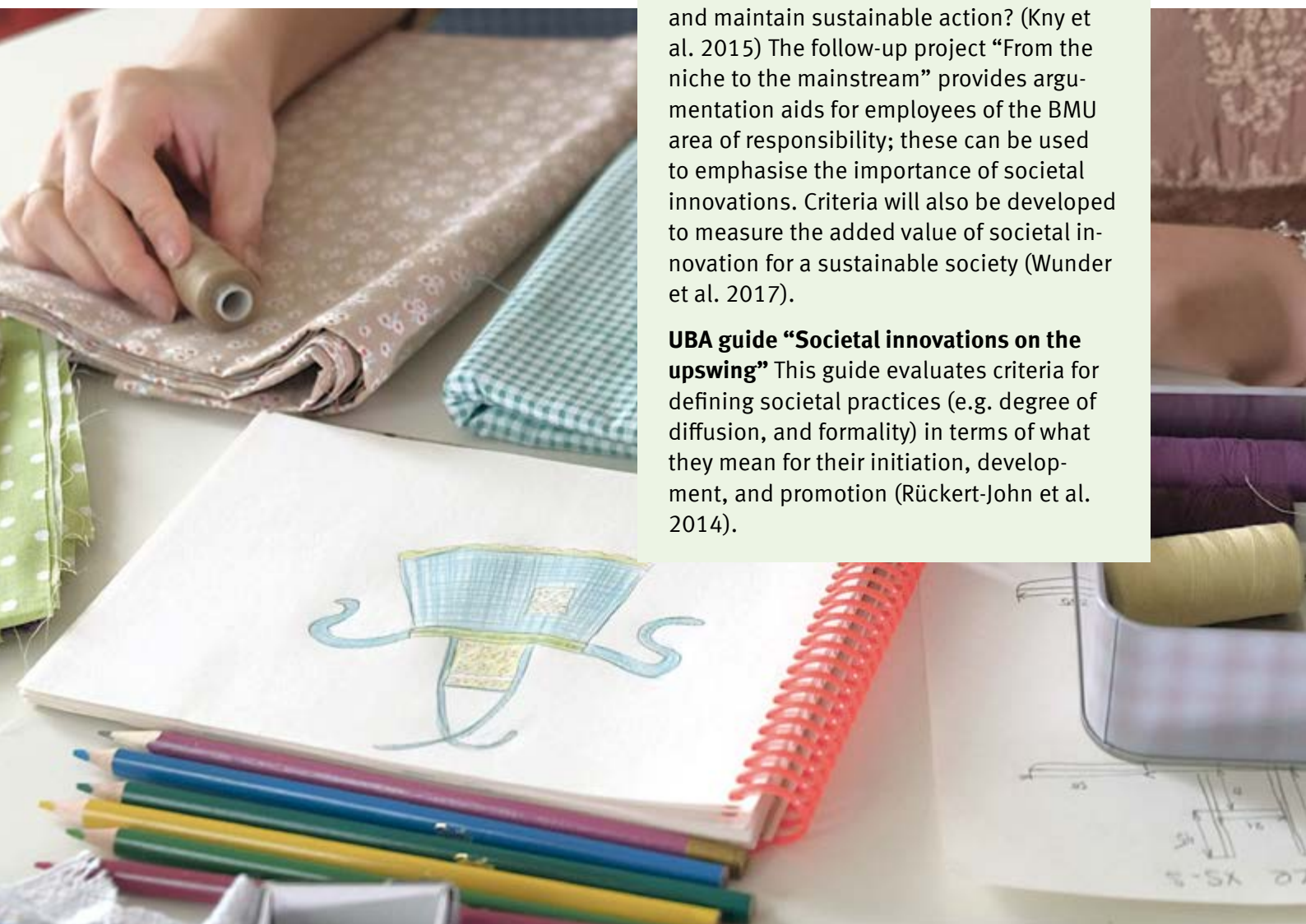
▶ Furthermore, it should be considered which objectives are pursued with the promotion of innovations. With funding, actors develop new interests and networks – or even new actors who, in turn, have an interest in longer-term funding – emerge. In order to move from the niche to the mainstream, innovations must become independent of funding in the long term.

▶ Accordingly, the question of which criteria should be used to terminate funding is important. It is advisable to define criteria on the basis of which the transitions from research funding to demonstration projects and broad-based funding are decided. The evaluation criteria should include environmental impacts. Possible economies of scale (see above) must also be taken into account.

Promote networking and the formation of innovation clusters

▶ Just like technical innovations, societal and institutional innovations are generally not developed by individual actors but are rather the result of interaction between actors: developers and users, different disciplines, policy and business. Promoting innovation clusters serves to consciously bring together the innovation activities of the various actors.

Support the scaling of (successful) societal innovations

▶ In order to prevent target-oriented societal innovations from not being further disseminated after initial successes, they should be supported (in the development of demonstration projects, in large-scale promotion) (up-scaling). Here, too, the justifications of innovation policy can be used: In the case of technical innovations, the term "Valley of Death" is used to refer to a gap between the promotion of research and innovation and market maturity. There is a risk that government funding will be in vain if it is terminated too early.

■ **Systematic promotion of societal innovation in the US – the Office of Societal Innovation and Civic Participation:** Under US President Obama, the Office of Societal Innovation promoted societal innovation. In the interest of the community "new ways for old problems" should be found. The programme was developed in 2009 with the consideration that fundamental change cannot be decreed from above. Rather, societal actors should participate and be given responsibility for shaping society. Funding was provided for experiments and pilot projects. However, societal innovation was not primarily about change towards sustainability but rather about economic recovery and the strengthening of societal cohesion.

■ **Funding of real laboratories in Baden-Württemberg:** The Baden-Württemberg Ministry of Science supports real laboratories (2012: €3 million; 2014: €15 million). The aim is to bring science and civil society together so that they can learn from each other in an experimental environment. In the real laboratories, actual change processes are supported. One example is the introduction of a sustainable mobility culture ("Future City-Lab Stuttgart"). The participants reflect their own mobility behaviour in various formats. Civil society is involved as a "co-researcher" in the development of pilot projects.

Procedure for regulatory innovations

With regard to regulatory innovations, there are so far only a few, mostly municipal, funding programmes. The following steps can be taken to increase their promotion:

Analysis of the promoting and inhibiting regulations in the transformation domain

▶ In the respective transformation domain, state (regulatory and incentive-oriented) policies must first be analysed: Which regulations are relevant in the corresponding transformation domain? Do they promote or inhibit the transformation towards sustainability? How can the effectiveness of promotional regulations be improved, and how can sustainability-inhibiting regulations be reduced? The main focus is on specifications for production processes, products, and access to infrastructures and markets. Which regulations hinder and which promote new practices? Which regulations may provide relative benefits for unsustainable technologies and practices?

Systematic monitoring and evaluation of regulatory changes abroad:

▶ Systematically observing and evaluating what happens abroad can provide suggestions for promoting regulatory innovations domestically. In the medium term, a "reserve of innovation" can be created; this can then be used at the right time (⋯⟩ Approach 8). In many policy areas, networks in the EU or OECD can be used for this purpose. Where appropriate, a systematic stocktaking process of innovative policies can be initiated at the OECD level. This, in turn, could provide input for the national level.

▶ When analysing foreign policy innovations, it should also be examined which framework conditions are important for the functioning of policies. Based on this, it can be examined whether these prerequisites also exist (or could be created) in Germany.

Testing of regulatory innovations: Simulation games, "regulatory innovation zones", and innovation labs

▶ A first step in the development of regulatory innovations is simulation games. They are used to simulate complex processes or systems. (Future) addressees of the regulation as well as enforcement bodies can be involved.

■ **Example of testing a regulatory innovation: "Area trading" simulation game**

Within the framework of the UFOPLAN project "Area trading simulation game", a simulation game that involved trading land with 87 model municipalities was conducted under the direction of the Cologne Institute for the German Economy (duration 2012–2017). The pilot project realistically examined whether tradable land certificates could be an instrument to help cities and municipalities reduce new land consumption and improve inner city development.

The development of the "Framework regulation"[2] was also based on simulation games.

2 Ordinance laying down requirements for the introduction or discharge of substances into groundwater, for the use of alternative building materials, and for the revision of the Federal Soil Protection and Contaminated Sites Ordinance.

▶ For regulations with inhibitory or promoting potential within the transformation domain, spatially and temporally limited regulatory experiments can be developed ("regulatory innovation zones"). Such experiments could, for example, be carried out through calls for tenders between municipalities, which could be granted funding for their participation. The programme itself can be supported scientifically. This may require flexibility clauses in federal legislation that allow municipalities to try out new approaches (limited in time and place).

▶ Policy and administration can also initiate or participate in "Public" or "Societal Innovation Labs". These are intermediary platforms for regulatory or societal innovations. Stakeholders from business, science, NGOs, and foundations work together here – often on a long-term basis and just a project-by-project basis – to develop practical solutions to problems. With the help of design and system thinking as well as anthropological and ethnographic methods, solution ideas ("prototypes") are developed, tested, adapted, and (if necessary) up-scaled.

■ **Example for testing control mechanisms: Roadmap and regulatory innovation zones for smart grids (Baden-Württemberg)**

As part of the roadmap for smart grids, various technologies and control mechanisms for implementing the energy transformation in the sense of a regulatory innovation zone are to be tested. Participation is voluntary and limited in time. It should be possible to integrate the basic principles of the Energy Industry Act and the EU internal market. The Federal Network Agency and the state regulatory authority should also be involved in the development.

■ **MindLab (Denmark)**

Three Danish ministries and the city of Odense operate a "Public and Societal Innovation Lab". An interdisciplinary team of almost 20 employees conducts stakeholder processes and experiments under the strategic leadership of a board of several state secretaries. Their objective: to develop solutions for societal challenges together with citizens, local authorities, and the business community.

Summarising key questions

▸ Which **societal** innovations are there in the transformation domain?

▸ How is their current and future potential for sustainability and for dynamising the transformation process to be assessed?

▸ What are the support structures for societal innovations (e.g. framework conditions, funding landscape)?

▸ How could the support base be improved?

▸ Which **regulatory** innovations are there in the transformation domain?

▸ Which regulatory innovations are being tested in other countries?

▸ Could studies be commissioned or suggested within the framework of the EU or OECD?

▸ For which innovations could regulatory innovation zones be tendered?

4.6 Approach 6: Phase out non-sustainable structures (exnovation)

Transformations for sustainability require more than just innovation (⋯▸ Approach 5). Also needed is a phase-out from unsustainable old structures – exnovation. Otherwise, the old structures are often only supplemented and not replaced by the new.

For example, the Renewable Energies Act has significantly increased the share of renewable energy sources in the electricity mix in Germany (from around 3 % in 1990 to over 30 % in 2016). However, the production volumes of lignite and hard coal have remained relatively constant so far (2016).

■ As a **counterpart** to innovation, exnovation describes the process in which something existing is (almost) completely removed from one system. Exnovation can refer to various things: to individual products (e.g. incandescent lamps) and behaviours (e.g. waste incineration), infrastructures, or entire industries (e.g. coal mining). It can also refer to technologies that are so central to an industry that their abolition entails or requires a fundamental change (e.g. the combustion engine for the automotive industry).
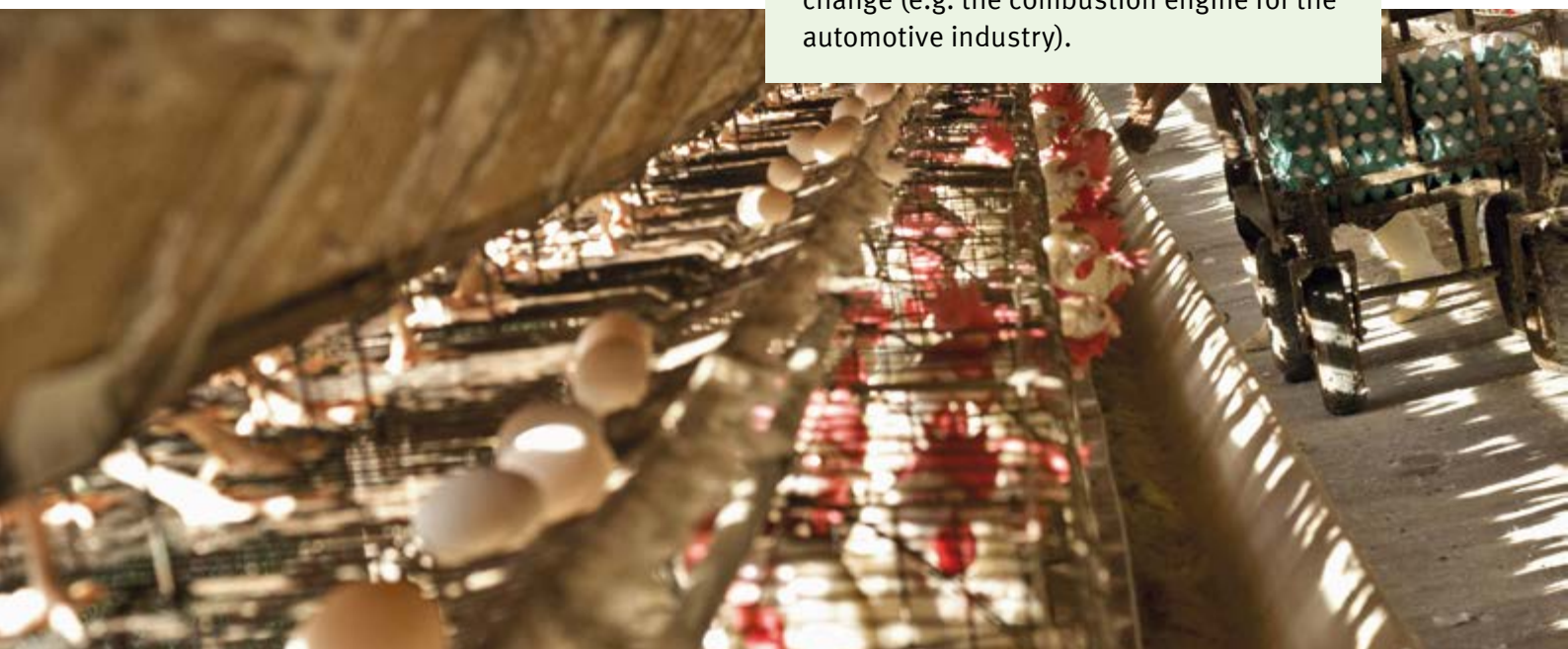
Existing socio-technical structures are usually strengthened by various path dependencies (┈┈⟫ Approach 1) and thus have an advantage over something new. Therefore, in addition to promoting innovation, additional political measures are often needed to promote exnovation as part of transformation processes. However, because they destabilise the status quo, such measures are subject to a higher claim to legitimacy and design. In addition to the promotion of exnovations, attractive alternatives are required (┈┈⟫ Approach 4 and 5). Equally important is the societally acceptable design of structural change i.e. the transition from old to new structures (see below).

Procedure

Finding allies – even outside the environmental domain

As in politics in general, it is also important to forge alliances in exnovation projects because different actors bring different resources and address different target groups. The first allies to be considered for exnovation projects are the innovators behind more sustainable alternatives and environmental associations.

■ **Example:** Greenpeace was involved in campaigns for the exnovation of ozone-depleting chlorofluorocarbons (as refrigerants in refrigerators) and paper bleaching with chlorine as well as for the development of environmentally friendly alternatives.

▶ It is advantageous if actors with motives beyond environmental protection can also be acquired (see ┈┈⟫ Approach 7). To this end, further problems of the status quo (in addition to the environment) must be taken into account.

■ **Examples:** The end of decades of subsidising the coal industry in Germany was decisively driven forward by budget politicians and finance ministers. The water industry could again be won over more strongly as a supporter for phasing out open pit lignite mining because waterworks suffer from the burdens associated with open pit mining.

▶ Communication should not only emphasise the costs and ecological disadvantages of existing structures (e.g. nuclear power). Rather, the advantages of more sustainable alternatives, including economic opportunities (e.g. from renewable energies), should also be presented. In general, we should not only talk about phasing out the old but also about the new and its advantages.

▶ Not only should one's own line of argumentation be considered. It is also necessary to hear the arguments of the other side. Because there is a threat of unrealistic costs and job losses in some cases (e.g. in debates on coal phase-out), independent studies can be commissioned in advance.

Dialogue and consensus building with stakeholders

▶ The upcoming exnovation and structural change processes must be discussed with those affected early on. It may be possible to convince them of the benefits of change. If this is not the case, a joint agreement could nevertheless be reached on the design of the process – as with the first nuclear phase-out and the phasing-out of the coal industry. The possibility of unilateral action by politicians ("shadow of the hierarchy") and the prospect of planning security increased the willingness of those concerned to compromise.

■ **Examples:** In the year 2000, the federal government reached an agreement with the energy suppliers regarding a compromise on limiting the operating lives of nuclear power plants. In contrast to the nuclear phase-out in Sweden, legal disputes and compensation payments were (initially) avoided. At the beginning of 2007, the Grand Coalition at the federal level and two state governments reached an agreement with representatives of the coal industry to cut back subsidies – and thus the domestic coal mining industry as a whole – by the end of 2018. Unlike in the case of the mine closures in Great Britain under Margaret Thatcher, riots and societal upheavals were avoided

▶ As the two cases in the box show, the most important advantage of cooperation for policy is avoiding resistance and costly political or legal disputes. For this, compromises (among other things, with regard to the time horizon of the process) were neccessary. Negotiated compromises are not necessary or ecologically justifiable in all exnovation cases. In the event of legal barriers or impending economic structural breaks, a consensual approach is recommended.

▶ "Consensus negotiations" can take place within the framework of a commission set up for this purpose and could be moderated externally. A Bundestag mandate with important cornerstones should serve as a basis for the negotiations. If no agreement is reached, the legislator may have to act unilaterally – and announce this beforehand. The result of the negotiations should be legally codified and passed by the Bundestag. A pluralistic negotiating circle, including the opposition parties, reduces the risk of decisions being reversed by new political majorities (as in the meantime with the nuclear phase-out).
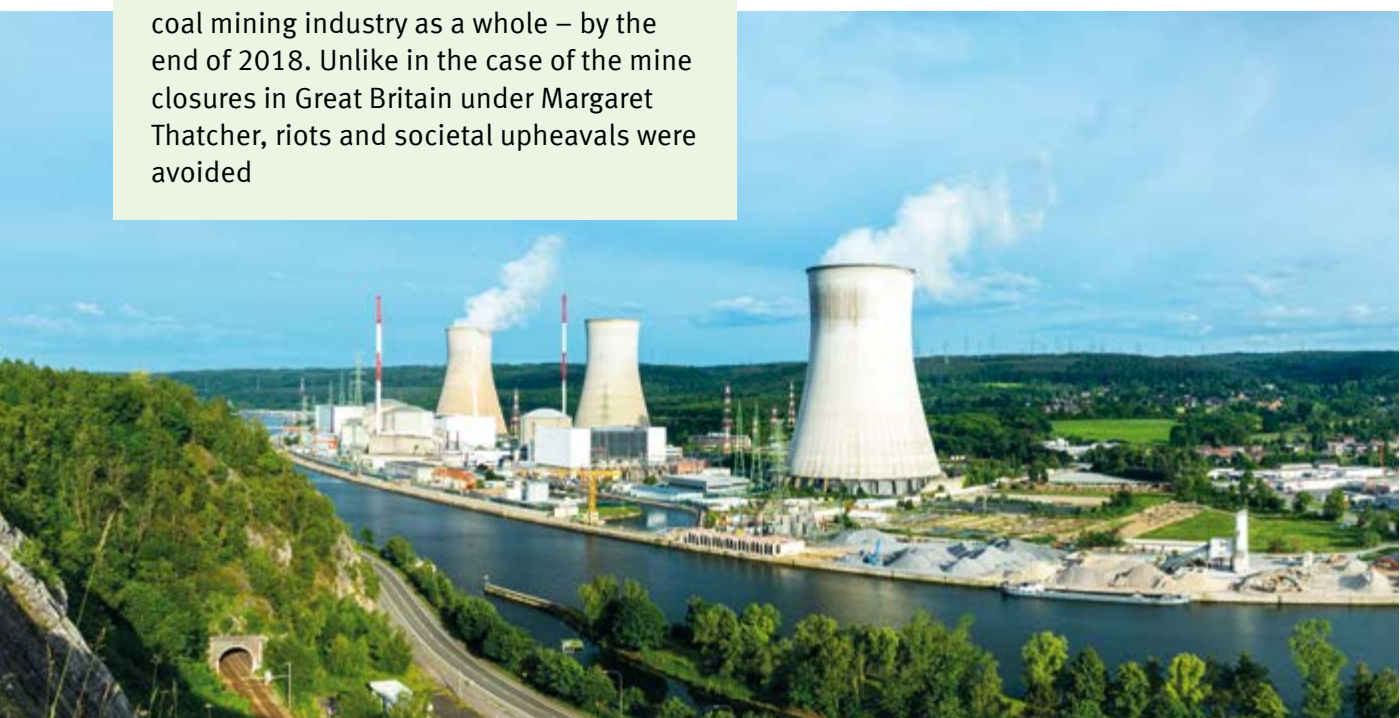
Force exnovation – through classical policy instruments

▸ A first political step towards exnovation and structural change is the cutback of environmentally harmful subsidies and the divestment of public funds from non-sustainable (e.g. fossil-based) facilities. In the German coal industry, the expiry of state subsidies was sufficient to achieve the exnovation of the sector. However, this is an exception because the domestic coal industry has not been able to survive without these subsidies.

▸ Regulatory law is also an option. The construction of new installations may be prohibited, or operating licences for existing installations may be withdrawn Further options are regulations that increase the sustainability requirements for products or make the production or use of non-sustainable goods increasingly difficult. Phase-out periods can be used depending on the harmfulness, age, and degree of amortisation of a plant or its substitutability. This was the case for incandescent and halogen lamps, asbestos, and CFC applications as well as the phase-out of nuclear energy (residual lifetimes).

▸ Taxes are also conceivable. However, the federal government cannot introduce (environmental) taxes at will but rather must strictly orient itself to the types of taxes for which it is expressly empowered by basic law (e.g. excise duties). Like to the fuel tax (2011–2016), this was not the case according to the Federal Constitutional Court. It was therefore declared unconstitutional, and the federal government had to repay the revenues. Taxes are also legally contestable if they make activities economically unprofitable ("throttling effect") without a clear and well-founded intention for exnovation on the part of the legislator. By comparison, well-founded regulatory measures may be less problematic.

■ **Constitutional issues in exnovation through regulatory law:** A production and purchase ban directed towards the future is usually unproblematic under constitutional law. On the other hand, the constitutional protection of personal property and freedom to choose an occupation, together with the principles of proportionality and protection of legitimate expectations, can act as barriers against the imposition of environmental conditions on existing installations or other property. Proportionately designed (and possibly with the help of transitional regulations) subsequent regulations can be constitutionally permissible and free of compensation. In December 2016, following complaints by energy suppliers, the BVerfG ruled that the accelerated nuclear phase-out after Fukushima (with fixed shut-down periods) was not expropriation. Rather, it constitutes a definition of content and limits that is, in principle, permissible and reasonable. Compensation, which does not necessarily have to be monetary compensation, is only necessary in two specific cases.
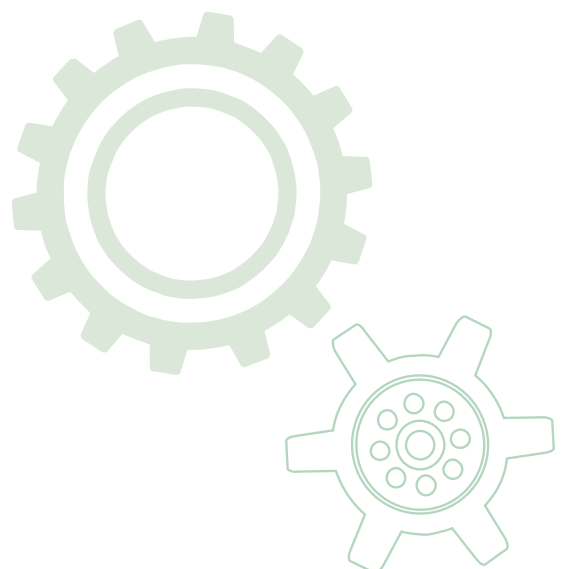
Shape structural change in a societally acceptable way – support regions

▶ Possible economic and societal risks for companies, their employees, and sometimes entire regions must be taken seriously and cushioned. First, it is up to the companies themselves to establish new business models in good time. The policy can support this.

▶ Thus, the transition to new business models and workplaces can be facilitated by a transparent timetable and a temporal extension of the process. This gives companies planning and investment security, especially in industries with long investment cycles. Employees can more easily adapt their career choices. In order to ensure that the temporal extension does not burden the environment too much, phase-out processes should be initiated at an early stage.

▶ In cases in which exnovation hit companies or entire industries particularly hard economically, compensation schemes for companies are conceivable. In doing so, it must be ensured that it is compatible with EU state aid law, which requires appropriate reasons and compensatory measures for favours. For reasons of sustainability, compensation should be linked as far as possible to investment in new business models. Additional state support for (former) employees (e.g. special early retirement, further training offers, or new models of basic security) can also reduce societal hardship.

▶ If an industry shapes an entire region economically and emotionally (e.g. mining) and if a structural change endangers its economic power and public budgets, the region should be supported. In addition to general infrastructure funding, future-oriented industries are also an ideal focus for funding. Region-specific potentials and location factors must be taken into account. It may be possible to build on skills and identities associated with the old industry structure (e.g. "Energy region"). Bottom up processes for developing ideas and societal visions anchored in the region (⋯▸ Approach 4) with participation of local business (including start-ups), research, and civil society help to mobilise ideas and promote the acceptance of change. This has been implemented to some extent since 2014 in the "Rhine Revier Innovation Region".

▶ Existing economic development programmes may also be used to finance the aforementioned support. In particular, the "Joint Task for Improving the Regional Economic Structure" of the federal government and the federal states as well as the European Structural Fund are particularly suitable. Special funding programmes can be established for major structural change processes.

Summarising key questions

▸ Which actors beyond environmental protection have similar interests and objectives with regard to exnovation and structural change processes?

▸ Which advantages and opportunities of the change can be communicated?

▸ Are those affected willing to discuss the shaping of change?

▸ From which actors can headwinds be expected? Which counter-arguments must the environmental side be prepared for? How can they be debilitated?

▸ Are there suitable studies on possible socio-economic effects of a change? If not, should such a study be commissioned?

▸ Are there regions that might be particularly affected? Which regional actors should therefore be involved in the process?

▸ Who would qualify as a moderator of a dialogue process? (negotiation experience, recognised by the various parties involved)

▸ How can the change of a region and its familiar living environments be accompanied and supported? How can new living environments that provide a positive experience of meaning and identity be created together?

▸ What could an implementation timetable that achieves ecological objectives whilst preventing constitutional and/or socio-economic risks look like?

4.7 Approach 7: Connect with new actors and actors with new roles

Beyond those actors who have long been consulted as affected parties or gained as allies within the framework of environmental policy, the perspective on transformations opens up a view of "new" actors and new roles of "older" actors. The aim of stronger integration, support, and networking of new actors is to incorporate additional perspectives. In this way, a counterweight can be built up against established and grandfathering actors, and the pressure for change can be increased. Notwithstanding, established actors should continue to be consulted in order to gain their knowledge and acceptance of change.

Especially at the beginning of transformation processes, **"pioneers of change"** are central. These individuals or organisations develop ideas for change, realise technical or societal innovations, and demonstrate their feasibility. A well-known example are the "Schönau electricity rebels". Innovation research has shown that large, established companies tend to bring about gradual improvements and thus remain within the given systems. On the other hand, disruptive innovations that call the current system into question and which are associated with a vision for alternative designs often come from either niche actors or major actors who have been

active in another domain and are playing a new role there (e.g. like Google).

In addition to the pioneers, **"change agents"** (also referred to as "promoters" in the innovation literature) play a special role in transformations. They are the actors who disseminate or enforce change. This requires different competencies that can be distributed among actors (see box).

Pioneers and change agents are often not classic environmental policy actors. They do not necessarily even have to perceive themselves as actors in the transformation domain under consideration (e.g. mobility).

To promote sustainability transformations, actors who may not have any ex officio power in the transformation domain but who nevertheless exert influence in certain sub-domains or at interfaces must also be included (⋯⟩ Approach 2). An example: When it comes to making public procurement more environmentally friendly, pro-

curement officers in public administrations are such potential change agents – not necessarily the top management or the users. Other change agents for sustainability transformations could be:

▸ Educational actors

▸ Market intermediaries, in particular trading and financial market players

▸ Health insurance funds and welfare associations

▸ Religious communities

▸ Individuals with "interpretive power": Celebrities, columnists, bloggers

The "promoter model"

is frequently used in the literature on innovations and organisational change processes (change management). It is assumed that change is best driven by different types of actors with different expertise pulling together. A distinction is made between specialist promoters for knowledge transfer, power promoters for overcoming resistance, and process and relationship promoters for communication and interaction. Actors with creativity, willingness to innovate, and persuasiveness are also necessary.
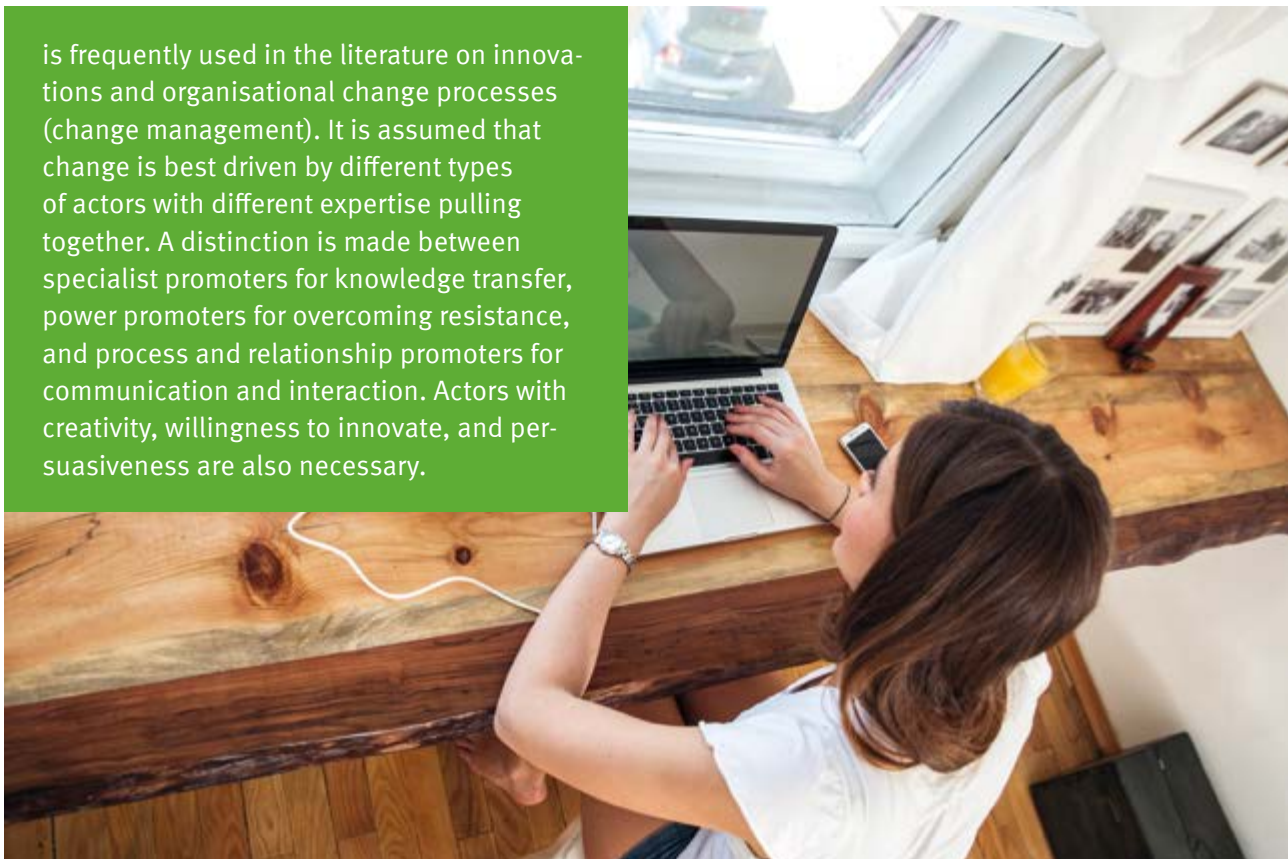
Procedure

Identify, connect with, and promote pioneers of change

- In order to identify pioneers of change, it is necessary to look at societal niches. When (prematurely) observing societal trends (⋯⟩ Approach 3), it is also important to look at the actors behind them.

- The actors behind sustainable innovations and trends should be (even) more closely involved than before by the BMU and its authorities when it comes to networking, agenda, policy formulation, strategy, and societal vision processes (⋯⟩ Approach 4). The promotion of innovation should be extended to societal innovation and thus to societal innovators and entrepreneurs, for example in the context of real laboratories (⋯⟩ Approach 5).

- It should be taken into consideration that not all niche initiatives are interested in funding but rather fear political appropriation. Planned funding and communication steps are to be coordinated with such initiatives.

Attract change agents outside environmental policy as well

- For each transformation domain, further allies that go beyond traditional allies (environmental associations, industry players) can be sought (e.g. the aforementioned intermediaries). The respective perspectives and logic of action must be understood, and common interests must be identified.

- It makes sense to conduct a continuous dialogue with important change agents and to agree on joint steps and announcements. Depending on the topic and the alliance partners, the office management or department management should be involved.

- For a detailed actor analysis (⋯⟩ Approach 4) as well as for model cooperation projects at the local or regional level, a research and consulting project can also be helpful – cf the ReFoPlan project "Identification of new socio-political alliance partners and cooperation strategies for environmental policy" (FKZ 3717 11 104 0, since 2017) with a focus on trade unions and societal and welfare associations as potential alliance partners.

- It should be checked whether contacts to different change agents for different target groups and/or in different regions are needed. For example, consider the varying importance of trade unions or the Christian church in different societal areas and regions.

Summarising key questions

- Which pioneers of change are there in the transformation domain?

- How can these be better integrated and promoted?

- Which change agents – beyond classic alliance partners – can support the transformation or individual aspects of it?

- With which arguments (narratives) and common interests can the change agents be acquired for a dialogue and common steps?
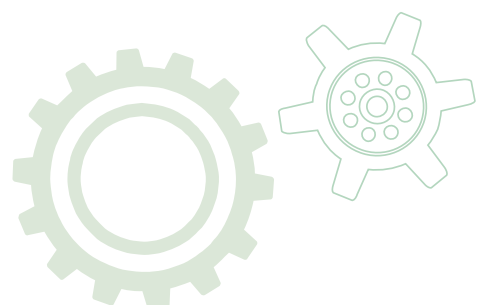
4.8 Approach 8: Shape policies and processes in a time-sensitive manner

Time aspects play an important role in politics, in the everyday life of citizens, in consumption, and in production processes. They also influence environmental and resource consumption. Example of working rhythms: If everyone works at the same time, peak times, traffic jams, and environmental burdens increase. In most cases, such aspects are given little attention because they are transverse to classical approaches or indicators (e.g. environmental impacts and monetary costs).

■ **Time dimensions:** For sustainability transformations, phases and duration of (transformation) processes can be relevant as can the time situation, which includes the "right" point in time (timing), speed, inherent and system times, permanence, and the time sovereignty and prosperity of people.

Transformative environmental policy takes into account time – both in the design of material policies and political processes as well as in the context of path dependencies. On one hand, the aim is to reduce the environmental and resource consumption resulting from the influence of temporal aspects on everyday actions, consumption, and production. On the other hand, the chances of transformation are to be increased by using their temporal framework conditions.

One example of the role of time in **shaping material policies** is electricity production in the context of energy transformation: The long-standing power supply system was essentially based on base load power plants (nuclear power plants, coal-fired power plants) and an oversupply of electricity, especially at night. Night electricity was therefore offered cheaply. As far as possible, industrial processes were geared to night-time electricity, and electric heating systems were

promoted. A power supply system is currently establishing itself with a high supply to oversupply of solar power in the middle of the day and in summer – a paradigm shift is necessary.

Even now, policy (as well as business) is intervening strongly in societal and individual time arrangements – for example in the high taxation of working hours as well as through holidays, daylight savings time, speed limits, shop opening hours, parking times, prescribed rest periods, warranty periods, or time-dependent tariffs. Citizens are usually under considerable time pressure in their everyday lives. This includes having "too little time", struggling with "slivered time" (repeatedly interrupted activities) or receiving requests "at the wrong time". Time aspects can play a similarly important role as prices in consumer decisions. For many people, it is not only a matter of lack of time or duration but also of time sovereignty and temporal fit (synchronicity).

In order to promote sustainable lifestyles and implement transformation, it is important to understand the needs of consumers with regard to time. In the debate about prosperity, well-being, and happiness, strong reference is made to the use and distribution of time. In the federal government's future dialogue "Living well in Germany", time issues – such as the compatibility and appreciation of family, care, and working hours – were also of great interest.

Example of time-shifted effects: In many environmental and health problems, causes and effects occur with a time delay – often years or decades. Impacts (e.g. the CO_2 content in the atmosphere) can also aggregate over time. Because of the temporal dissociation of cause and effect, environmental problems are often underestimated and politically repressed until later. In sustainability policy, the prevention of adverse effects on future generations is an important principle.

When designing policy processes, transformative environmental policy takes into account the fact that time aspects can significantly influence the enforceability of transformation efforts. Windows of opportunity thus give policy proposals related to the occasion better chances in competing for scarce financial and political attention. When an event has highlighted the need for action, less resistance is to be expected.

At the same time, innovation dynamics can overtax society's "speed of adaptation". If a majority does not yet feel ready for a transformation, it reacts with fears and resistance. Such time aspects must be included when developing a strategy.

Windows of opportunity arise regularly (e.g. in new elections and coalition negotiations) and through singular events (catastrophes as well as regional events such as dramatic traffic accidents and sharp price increases). Under certain circumstances, time windows can be created (e.g. organisation of conferences or commissioning of studies).

Example: The best-known example of the use of windows of opportunity in environmental policy is the reactor disaster at Fukushima in 2011, which marked the start of Germany's second nuclear phase-out. In the 1980s, the high public interest in "forest dieback" was used to enforce some previously blocked environmental protection measures. In contrast, the global economic and financial crisis of 2007 was hardly used as a window of opportunity by environmental policy: The economic and support programmes developed and implemented as a result were not particularly environmentally oriented. There were hardly any proposals ("blueprints") for this.

Transformative environmental policy takes time into account in the context of **path dependencies** (⋯⋗ Approach 1). This is the shaping of current and future developments by earlier decisions. When things happen influences how they happen. Windows of opportunity are useful or even necessary to bring about change, especially in constellations of strong path dependencies. For example, it is easier to transform the energy system, which is heavily influenced by technological and economic path dependencies, after an event such as Fukushima. This also applies when the life cycle of many power plants is drawing to an end.
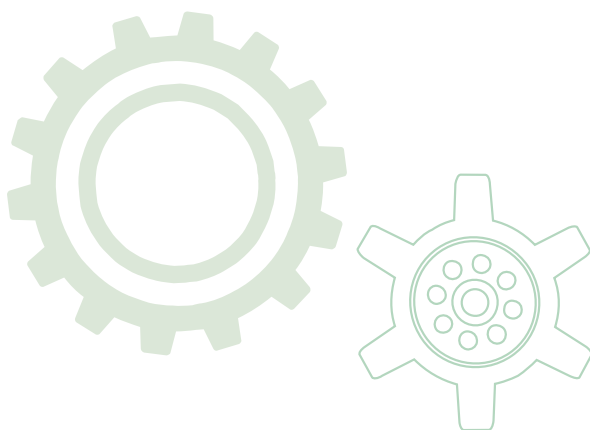
When designing transformation-oriented policies, it should be taken into consideration that new path dependencies can never be avoided. Some of these are even desired for ecological reasons..

■ The cutback of (environmentally harmful) agricultural subsidies in New Zealand in the 1980s was a reaction to a budget crisis (window of opportunity) and led to a fundamental restructuring of New Zealand's agriculture. On the other hand, the much slower restructuring of EU agricultural policy has preserved path dependencies.

Procedure

Shape policies and processes in a time-sensitive manner

▸ When developing transformation strategies and measures, the significance of time aspects is analysed. When planning measures, an attempt is made to take time dimensions into account in such a way that the environmental consumption of the addressees is reduced.

▸ R&D projects can be awarded to have focus groups check whether a planned measure is compatible with the time preferences and structures of different target groups, for example.

▸ The promotion of innovation takes into account an "error-friendly innovation speed" and enables phases of slow development. They make it possible to understand undesired effects as well as successes.

▸ Another option is to encourage time autonomy for niche actors so that innovations can be developed and tested.

■ **Promotion of cycling:** A major obstacle to the use of bicycles is the amount of time required. According to a survey, the accepted average path length is 3 km on weekdays and around 4.5 km on weekends. Behind the accepted path length is, among other things, the expenditure of time. Because the average speed increases considerably through the use of e-bikes, longer journeys can also be made. In addition to the promotion of e-bikes, there are other ways to reduce the time required. These include the construction of bicycle express ways (without detours and traffic lights and with few intersections).

■ **Inclusion of usage time and operating costs:** Consumers perceive the purchase of household electrical appliances as a singular event: They decide once (at the point of sale) and pay a one-off price. However, in reality, operating costs are incurred annually. These can be significantly higher than the purchase price over the entire service life of the appliances (e.g. tumble dryer). Lifetime and total cost of ownership can be indicated by additional information on the price tag or at the point of sale, thereby encouraging the purchase of energy-efficient appliances.

Plan and use windows of opportunity in the political process

▸ The use of windows of opportunity plays an important role in the implementation of transformative measures. They offer opportunities for a political proposal related to the particular occasion to be met with less resistance or to compete less strongly than usual with other issues in the political process.

▶ Windows of opportunity can be the only chance to break strong existing path dependencies. Here it is important to be particularly sensitive and well prepared.

▶ Regular and/or upcoming political or economic windows of opportunity (e.g. elections, investment cycles, and industrial upheavals already taking place) can be systematically planned in. Suggestions should be made on such occasions.

▶ Proposals and associated communication concepts should be set aside for windows of opportunity (e.g. crisis events) that cannot be planned in advance but can be expected.

▶ Time windows can be organised. For example, scientific studies can be commissioned in such a way that they can be used within political cycles and investment cycles.

Summarising key questions

▶ Which role do time aspects play in the respective transformation domain?

▶ How can time aspects be integrated into policy measures?

▶ Which recurring windows of opportunity are there, and how can they be used?

▶ Which unplannable, yet expectable windows of opportunity are conceivable?

▶ How can you prepare for windows of opportunity? (commissioning studies, deriving measures, having a blueprint in the drawer, planning public relations)?

5 Use the approaches in a differentiated way in different transformation phases
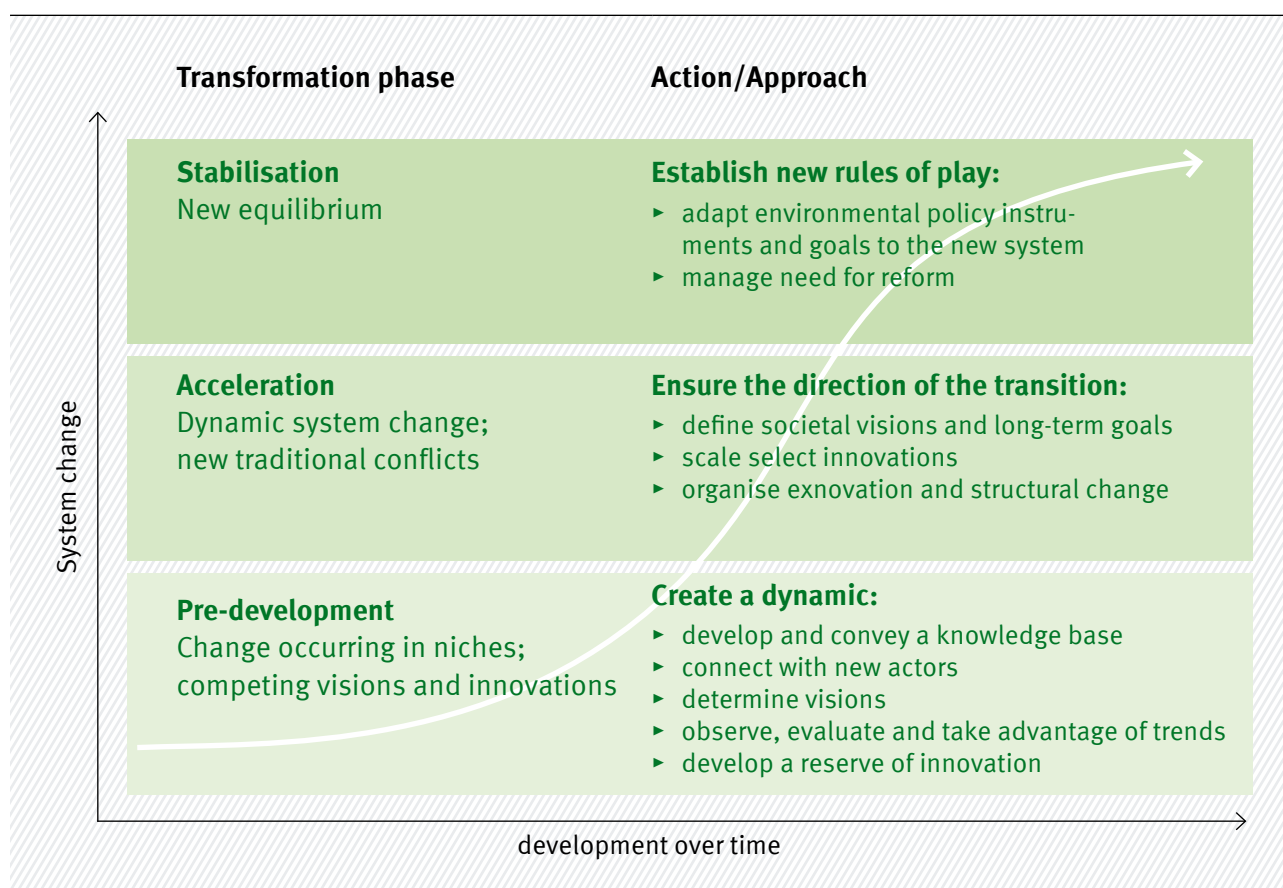
The eight approaches to transformative environmental policy play different roles in different transformation phases (for a schematic S-curve, see Chapter 3.2):

In the pre-development phase, dynamics are to be generated by integrating new actors, moderating visions, using societal trends, and promoting various (technical, societal, and regulatory) innovations. In the acceleration phase, there should be directional certainty; selected innovations are scaled and pre-developed exnovations are organised. The stabilisation phase entails setting out new environmental rules for the emerging system.

Figure 03

Approaches to transformative environmental policy during the transformation

Transformation phase	Action/Approach
Stabilisation New equilibrium	**Establish new rules of play:** ▸ adapt environmental policy instruments and goals to the new system ▸ manage need for reform
Acceleration Dynamic system change; new traditional conflicts	**Ensure the direction of the transition:** ▸ define societal visions and long-term goals ▸ scale select innovations ▸ organise exnovation and structural change
Pre-development Change occurring in niches; competing visions and innovations	**Create a dynamic:** ▸ develop and convey a knowledge base ▸ connect with new actors ▸ determine visions ▸ observe, evaluate and take advantage of trends ▸ develop a reserve of innovation

System change

development over time

Source: based on SRU (2016)

6 Use proven environmental policy approaches for sustainability transformations

Transformative environmental policy is by no means intended to replace existing environmental policy. On the contrary: Sustainability transformations can only be (co-)shaped by using transformative environmental policy approaches from previous environmental policy approaches – and vice versa.

Transformative environmental policy cannot be conceived without **strategic environmental policy.** This is understood as an environmental policy that gradually achieves long-term objectives by coordinating the activities of independent actors. Strategic environmental policy has been implemented in the BMU's area of responsibility for many years. It refers to problems such as combating climate change, preserving biological diversity, and reducing material use or nitrogen inputs that cannot be solved by unilateral and short-term action. In addition to substantive and strategic definitions, strategic environmental policy includes the creation of strategic capa-

bility, winner-loser analyses, the establishment of a support group, the institutionalisation of implementation, and the review and adaptation of objectives and measures. It can also aim to consciously strengthen change interests or weaken blockade interests.

Strategic environmental policy can make use of the perspective of transformative environmental policy. This means, for example, focusing on the interfaces between transformation domains and identifying starting points from these that do not come into view when looking exclusively at individual systems. At the same time, the focus is on promoting change agents and taking into account the dynamics of transformation.

■ **Integrated Environmental Programme 2030 and transformative environmental policy:** The IUP 2030 is a departmental strategy that takes up key aspects of transformative environmental policy. Entire transformation domains are considered, a vision is developed, reference is made to exnovation, and a broad understanding of innovation is used as a basis (e.g. innovation fund for societal and institutional innovations).

The following environmental policy (non-transformation-specific) approaches appear to be particularly useful for the design of transformations:

1. **Adaptive strategy and policy development (monitoring, evaluation):** In order to deal with long-term dynamics, adaptive strategies and institutions as well as political learning are necessary. Rules and instruments should be easily adaptable in order to be able to respond to societal or environmental developments or undesirable side effects without creating undesirable path dependencies. Among other things, this requires regular review and evaluation in order to respond to unforeseen developments and to adapt policy approaches.

2. **Participation:** The BMU is increasingly involving citizens in policy development. Participation processes open up the practical knowledge of citizens and can help to additionally legitimise a planned policy. This is also important for transformative environmental policy. Participation also plays an important role in experiments (⋯⟩ Approach 5).

3. **Environmental integration:** The (vertical and horizontal) integration of environmental aspects into other policy domains and levels is a proven policy approach that is also important for transformative environmental policy (⋯⟩ Approach 2).

4. **Policy coherence:** Environmental policy is differentiated into many sub-areas. Accordingly, the addressees of environmental policy are confronted with different demands, which can conflict with each other (e.g. climate and nature conservation). Comprehensive, systemic change requires close cooperation between those responsible for different environmental issues.

5. **Policy mixes:** If different policy measures or instrument types are coordinated and combined, the effectiveness of (environmental) policy can be increased. A "systemic" policy mix that comprehensively and consistently addresses the network of production, consumption, infrastructures, markets, and values within a transformation domain has better prospects of promoting a transformation than, for example, a policy that only addresses aspects of production. Levers are to be addressed within the different domain ("system elements"). This means that instruments use economic, technical, or societal trends to improve the framework conditions for environmental policy instruments. For example, innovation funding can pave the way for regulatory measures. Such levers are not always obvious. A transformative policy mix could thus encompass different policy instruments in order to first test their respective suitability for competitively dealing with systemic challenges (e.g. in "regulatory innovation zones"⋯⟩ Approach 5).

7 Outlook

The approaches proposed here for a transformative environmental policy are intended to supplement and support existing environmental policy. For some of the activities described, it might be useful to provide appropriate capacities and training opportunities for the various specialist units. This includes:

▸ Methodological knowledge, data, scenarios, and models for **integrated system analyses** (integrated assessments)

▸ Knowledge for **the analysis and evaluation of societal trends and societal innovations**

▸ Methodological knowledge and experienced **moderators** who can support the participatory development of common societal visions and strategies (by means of a framework agreement, where appropriate)

▸ Methodological knowledge and capacities in order to effectively communicate **societal visions** for sustainability transformations in appealing **narratives**

▸ Methodological knowledge and budgets to **promote societal and regulatory innovations** as well as advice on legal framework conditions (e.g. state aid law)

▸ Skills for **stakeholders and conflict management** in transformation domains

▸ Formats for **cross-departmental and cross-divisional project groups** that can be set up temporarily for the joint processing of systemic problems

Such capacities and further training do not only impart specific skills. They increase employees' awareness of the need for transformation and of their own role in transformative processes.

As part of the RefoPlan project "Venturing transformations – preparation and further development of transformation research with regard to its application in political-administrative organisations" (FKZ 3717 11 01 2), a learning programme is being developed to impart the appropriate skills.

Finally, it is important to consider whether complexity, indeterminacy, instability, and suddenness as characteristics of complex systems and their transformations require a **new societal vision for administrative action** – one that recognises uncertainties and the need for experiments and takes into account that experiments can fail and that "failure" is a question of perspective and a chance to learn something about the behaviour of the system. Finally, problem-solving techniques can be learned individually, and organisational cultures can be structurally more error-friendly.
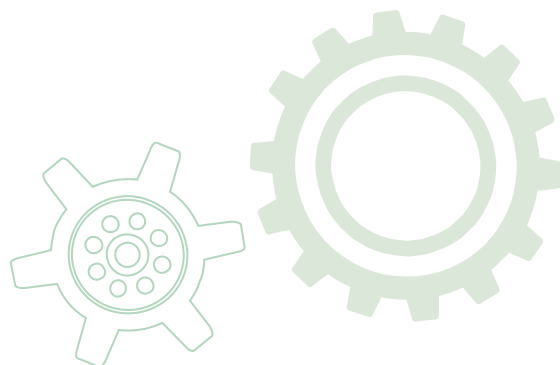
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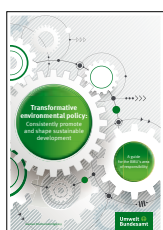
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