

### 3. Scenarios: tools for coping with complexity and future uncertainty?

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#### INTRODUCTION

We cannot predict the future with certainty, but we know that it is influenced by our current actions, and that these in turn are influenced by our expectations. This is why future scenarios have existed from the dawn of civilization and have been used for developing military, political and economic strategies. Does the existence of scenarios help to accomplish the desired outcomes? It is fair to say that in most cases the answer to this question is no, simply because history is normally an open, undetermined process, where sudden and unexpected events can play a decisive, disruptive role. Could the French Revolution have been prevented if Louis XVI's counsellors had had the imagination to develop a shock-scenario, foreseeing the impact of the volcanic eruptions in Iceland and Japan, and the consequent crop failures in 1784 and 1785 and food scarcity in France – often cited as a proximate cause of the French Revolution in 1789? This is debatable to say the least.

However, scenarios have become a key tool in the policy formulation process because they help with identifying possible solutions to policy problems or exploring the various options available (Howlett 2011). As former EU Environment Commissioner Janez Potočnik has put it:

We tend not to plan well for the future and lags prevent us from reaching our goals unless we act early. We have path-dependency. For future success in almost any area, we have to incorporate future effects into our current policy-making. (EC 2010)

Regarding definitions, words such as 'futures', 'foresight', 'scenarios' and 'forecasts' are often used interchangeably in policy documents. In this chapter we use 'futures studies' as a broad term that includes different approaches for dealing with complexity and future uncertainty, that is, an interdisciplinary collection of methods, theories and

findings described as narratives, images, statistical trends, models and recommendations. ‘Foresight’ describes the process of envisioning, inventing and constructing scenarios. ‘Scenarios’ are one such method of exploring the future. They are internally consistent and coherent descriptions of hypothetical futures, often with a time horizon of more than 20 years, and are usually used in futures studies. The futures analysed can be probable, imaginable, surprising, desirable or frightening, but the likelihood of realization remains unknown. In the remainder of this chapter we also use the word ‘scenario’ to describe a surprise-free forecast or future projection. ‘Forecasts’ are more focused on an accurate quantitative prediction. They could include a sensitivity analysis to include uncertainty margins. Theoretically, forecasts are more ‘certain’ than scenarios. However in practice both approaches overlap and, as discussed more fully below, are often used in combination.

What is it that makes scenarios such an important tool in policy formulation? Four reasons can be identified:

1. They seek to *avoid risks*, preparing decision makers for what might be coming and enabling thinking about possible actions to avoid risks, for example, increasing cereal production when weather forecasts predict poor harvests in other parts of the world;
2. They have potential to *enhance policy performance*: to know whether the benefits of measures are robust; in other words, whether policy targets can still be met if circumstances change. For example, will an investment in a new airport runway still pay off if economic growth is lower than expected? Will Member States still be able to fulfil EU environmental obligations with higher than expected economic growth?
3. They attempt to *expand creativity*: they offer a catchy, ‘outside the box’ image that unites different stakeholders and sets a time path for social and technological innovations. President Kennedy’s ‘man-on-the-moon’ vision provides one example. Imagining possible futures could lead to new breakthroughs that at the time were considered unlikely;
4. They seek to *stimulate open discussion and the reaching of consensus* via processes of deliberation, thereby allowing participants to compare different perspectives on the future to see whether consensus on certain no-regret actions is possible. For example, what are sensible next steps given the different views on the causes of climate change and the different beliefs in market mechanisms or intergovernmental coordination to bring a solution?

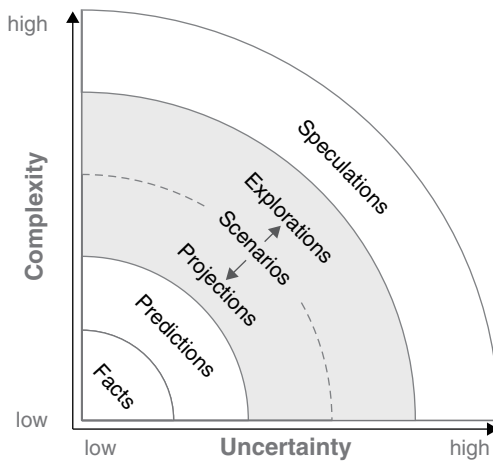
Scenarios seek to support different activities in the policy formulation process. It is particularly in problem definition where they can help answer the question of whether current trends and policies are robust. In addition, they can help to identify policy alternatives that can be an input into the functioning of other tools such as cost–benefit analysis and multi-criteria analysis.

In this chapter we discuss the role of scenarios as tools to deal with complexity and future uncertainty in the policy formulation process. The first part focuses on scenario use in theory, and the second on their use in ‘real world’ venues of policy action. The first part sets the scene by discussing the specific functions of scenarios when dealing with complexity and uncertainty in the policy formulation process, links this with scenario selection and design considering the standard stages and tasks of policy formulation, and reflects on issues of credibility, legitimacy and salience. It also describes potential links and overlaps with other policy formulation tools. It ends by briefly reviewing the historical development of scenarios. Part two summarizes a selection of cases where scenarios played a decisive role. It identifies the factors that enhanced their use in particular policy venues. It investigates why a foresight process was undertaken and in which context. It explores what knowledge sources underpinned the scenarios and how they were deployed in policy formulation activities. This chapter concludes with a reflection on the importance of acknowledging the particular needs of policymakers in policy formulation processes when dealing with complexity and uncertainty.

## SCENARIO USE IN THEORY

### **Uncertainty and Complexity: The Raison d’Être of Scenarios as Policy Formulation Tools**

Policymakers are faced with the complexity and uncertainty of possible future circumstances inherent in a highly dynamic, globalizing world. According to de Jouvenel (2004), policymakers often justify their decisions by claiming they had no other choice, but in truth they no longer had a choice because of a lack of foresight. In addition, politicians themselves are an important source of uncertainty by making changes in the structure of government throughout their term in office (Kelly et al. 2010). Scenarios are commonly prescribed as a tool to avoid constantly being forced to react to emergencies. They help to deal with uncertainty and complexity, and therefore enhance decision performance by supporting the definition of solutions for potential challenges.



Source: Zurek and Henrichs (2007).

*Figure 3.1 Ways to explore the future depending on its uncertainty and complexity*

Zurek and Henrichs (2007) use uncertainty and complexity as the main axes to define ways of exploring the future, specifically: (1) how uncertain we are about future developments of key drivers; and (2) how well we understand the complexity of the system and its causalities (see Figure 3.1).

Figure 3.1 helps to identify the type of futures study needed in policy formulation, depending on the degree of uncertainty and complexity of the policy question. Forecasting methods include trend extrapolations or model calculations and might be used to assess the consequences of assumed changes in policy measures, such as a rise in taxes or reduction in the number of immigrants. Speculations are often the best that can be achieved when levels of uncertainty and complexity are both relatively high. Scenarios, on the other hand, lie somewhere in between forecasts and speculations, that is, when the degree of uncertainty and complexity is of an intermediate level. The definition of scenarios used in the Millennium Ecosystem Assessment (MEA 2005) reflects this understanding of a scenario, describing them as plausible and often simplified descriptions of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces and relationships. Scenarios therefore have an exploratory character. They could assume changes in external drivers that cannot be directly influenced by policy measures (for example, higher frequency of natural hazards, higher

energy prices, and so on), as well as in internal drivers, such as certain policy changes.

We can distinguish three types of scenarios based on their degree of uncertainty and complexity:

1. Those extrapolating current trends and processes, for example, business-as-usual or reference scenarios (so-called *prospective* or *predictive* scenarios);
2. Those exploring alternative futures that are plausible, surprising or shocking, for example, scenarios that assume technological breakthroughs or events that impose a security risk (so-called *explorative* scenarios);
3. Those describing desired, not necessarily expected futures (so-called *descriptive* or *normative* scenarios). Visions are an example of normative scenarios.

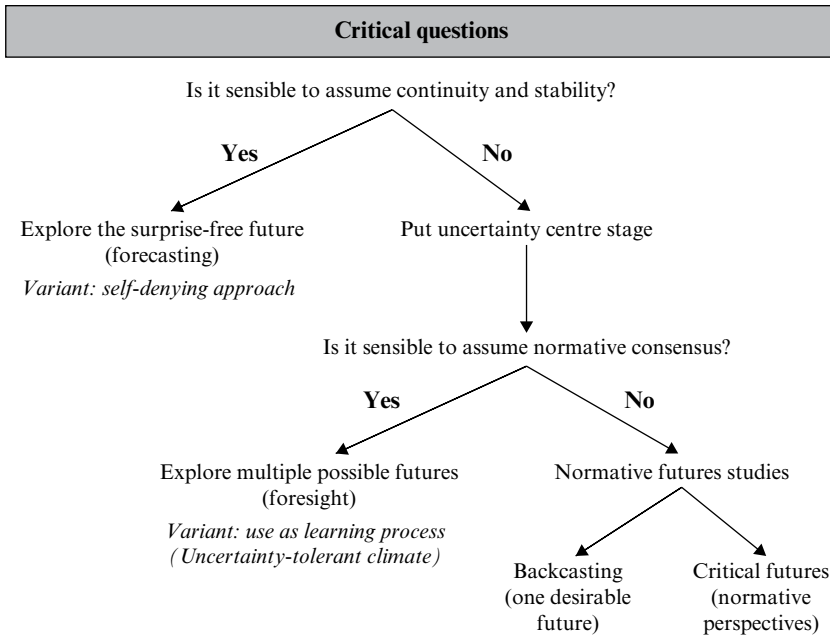
It is interesting to note that in practice, tensions can occur between forecasters (for example, modellers, economists) and visionary, creative scenario developers who focus on discontinuities and desirable futures, as described by van 't Klooster (2007) during the development of spatial planning scenarios.

### **The Selection and Design of Scenarios as a Policy Formulation Tool**

The Dutch Scientific Council for Policy (WRR) argues that since the future is fundamentally unpredictable and not every imaginable future is possible, policies should not be based on a single, surprise-free futures study (WRR 2010). Every futures study should really start with two critical questions (see Figure 3.2). Answering these two questions leads to different types of futures studies:

1. Is it wise to assume stability and continuity of the system? If not, uncertainty should be central in the study and one surprise-free forecast will be insufficient;
2. Is it sensible to assume normative consensus about what future is desirable? If the answer is yes, different scenarios should grasp the uncertainty range. If the answer is no, divergent normative perspectives on the future are needed.

According to the WRR, there is often a blind spot for developing divergent normative perspectives, which present a range of policy choices with explicit indications for whom these choices are desirable.



Source: WRR (2010).

*Figure 3.2 A decision tree that considers the degree of future uncertainty and normative consensus*

In developing scenarios, we can distinguish different phases in any policy formulation process (Schwartz and Ogilvy 1998; de Jouvenel 2004; Metzger et al. 2010):

1. *Problem characterization*

A specific scenario exercise will have to start with the definition of the policy issue at stake, for example, energy security, climate change, and so on, and, related to that, the system boundaries, that is, what is the spatial scale of the subject and the relevant time horizon? For example, when developing scenarios for city planning, global scenarios for the next 100 years will not be necessary, although they can give input to the process in defining relevant exogenous factors.

2. *Problem conceptualization*

This phase identifies the drivers that impact the system under analysis. The drivers can be exogenous/external (for example, technological

developments or oil prices), exogenous/internal (for example, policy choices) or endogenous factors (drivers that are dependent on other drivers, for example, energy demand as the result of traffic development or energy saving). Literature surveys, analyses of statistical trends, surveys with Delphi methods, and stakeholder workshops can all produce inputs for a scenario development. A morphological analysis of relevant factors and relationships, a scheme with causes and effects, such as the Drivers–Pressures–State–Impacts–Responses (DPSIR) scheme (EEA 1999) is one means to frame the problem. Workshops and (qualitative) modelling or systems analysis techniques can help to create a common understanding or find out where views on how the world works differ. The result of this phase is the identification of key drivers that affect the subject directly or indirectly.

### 3. *Scenario framing*

In this phase, the logic of the scenarios is defined. The certainty of future development of the key drivers is identified. Can continuity be assumed and trends extrapolated (for example, on energy use)? Alternatively, for which exogenous drivers are contrasting scenarios needed because the uncertainty range is large or discontinuities cannot be excluded (for example, the oil-price development, or new European regulation on electric vehicles)? If so, what are the main drivers and do these need contrasting scenarios? If there are many uncertain drivers, the number of possible scenarios can become quite large and this would lead to a set of scenarios that becomes incomprehensible to users. In such cases, a *tree structure* can be used to create some order. For example, a high versus low economic growth scenario can be assumed, each split into a fossil fuel and renewable energy scenario. All four scenarios can be further split into a high or low oil price variant, and so on.

In order to limit the total number of scenarios to a manageable number, the main drivers have to be selected, or assumptions made about different drivers with a high mutual dependency can be merged into a set of contrasting coherent scenarios (for example, combining high oil prices with fast technological developments). The latter approach requires the development of a credible storyline or narrative.

Triangles, scenario-axes or pentagons can be used to explain the contrasts in such coherent scenarios. *Triangles* and *pentagons* can be used to illustrate that scenarios have been designed from a certain perspective (economy, society or environment; or from a citizen, public or private company perspective). This can assist in identifying trade-offs and looking for compromises. *Axes* can be used when two

dominant drivers (or groups of drivers) have been identified that are independent of each other. Use of the deregulation–regulation axis versus the globalization–regionalization axis is quite common. In this phase, it is also good to consider the inertia in the system and to check if the chosen time horizon is still valid.

#### 4. *Scenario description*

Here, each scenario comes to life, that is, it is described in a credible and salient way, for example, using figures, images, narratives and metaphors. According to van der Heijden (2005), a scenario that will actually be used in policy formulation is internally consistent, links historic events with hypothetical ones in the future, carries storylines that can be expressed in simple diagrams, is as plausible as other scenarios, reflects elements that are already determined, and identifies indicators or ‘signposts’ that show that the scenario is already occurring. The narrative should not only be written in scientific or economic terms; it should also be based on different ‘ways of knowing’ (Lejano et al. 2013) and include memorable metaphors (Wack 1985). Participatory approaches can help to enrich the plausibility of the scenarios, and increase the acceptance for use in the policy process.

#### 5. *Scenario assessments*

In this final phase, potential policy options are identified and assessed. Many questions typically emerge in this phase. What, for example, is the impact of policy options in each scenario? What trade-offs do policymakers have to face? Can no-regrets options (in other words, measures that are right in all scenarios) be defined? How can the cost-effectiveness of policies be optimized? Numerical models can be an important tool to use, but in the last few years (serious) gaming has often been used as an option to better understand the attitudes of key players in a scenario and to define robust policy recommendations.

### **Surprising Futures**

The crucial question in each scenario exercise is whether all uncertainties have been taken into account, or whether something vital has been overlooked. What would cause surprises or abrupt changes? And do we need (additional) ‘what-if’ scenarios to address such surprises?

There are many examples in futures analysis where factors have interacted in complex ways, due to non-linear feedback loops, and produced sometimes surprising futures. The combination of systems analysis and qualitative storylines enables the inclusion of factors that are difficult to



formalize – such as technological breakthroughs or shifts in values – and demonstrates their impacts.

Brooks (1986) identifies methods to spot surprises that might subsequently be explored via systems analysis:

- assume non-linearities;
- amplify responses to small random changes/events;
- change the (perceived) scarcity or thresholds;
- assume delayed effects;
- assume human ingenuity and transitions towards another carrier for economic development.

Saritas and Nugroho (2012) distinguish discontinuities, but also wild cards and weak signals as sources for surprise, which can be identified (and prioritized) in surveys. Wild cards are trend-breaking assumptions, fault lines or external shocks, for example on social or political stability. Weak signals are less prominent trends that might eventually become important game changers, for example the sudden availability and exploitation of ‘big data’, the sudden uptake and use of a new technology such as electric bicycles, or an increased focus on new behaviours such as consuming healthy food.

### **What Policy Formulation Tasks do Scenarios Aim to Perform?**

Scenarios may, in principle, perform several tasks at the same time in the policy formulation process, as defined in the first chapter of this book:

1. Characterization of the current situation: this is a usual starting phase in foresight analysis, as a reference to the current state is needed to measure the impact of the policy option and assess its policy relevance;
2. Problem conceptualization: this is the core business of any foresight exercise. There are two contrasting conceptual approaches in scenario development: the ‘exploratory’ (how the future *could* be) and the ‘normative’ (how the future *should* be). As part of the exploratory scenarios, frightening scenarios may enable precautionary policy, security policy and improved crisis management (preparedness). Pessimistic assumptions about the environment (for example, scarcity, natural disasters, major accidents), economic system (economic cycles, growing inequality, financial bubbles) or the behaviour of actors (crime, lack of enforcement of laws, conflicts) may make it possible to assess worst-case developments;

3. The identification of policy options: scenario techniques include the identification of options or alternatives for the future: ‘exploratory’ methods begin from the present, and see where events and trends might take us; ‘normative’ methods begin from the future, asking what trends and events would take us there (EC et al. 2005). Scenarios can focus on the short term (close to the 4–8 years regional and national policy cycle) or on the longer term (usually more than 20 years, used in global policy formulation processes);
4. The assessment of potential policy options: this is the last phase in scenario development (see previous section).

In addition, the scenario building process offers opportunities to open up debate and involve government policymakers and stakeholders outside the official state machinery, seek consensus on a policy strategy and increase the legitimacy of policy measures.

### **What Expertise/Knowledge is Needed in Scenario Development?**

A broad awareness of what is happening in the world is a basic requirement for any scenario developer. Useful information can come from the existing literature, statistics, news programmes, experience or conversations with experts and non-professionals. Scenario developers are often interdisciplinary generalists, interested in history, as well as economic, physical and social processes. They should be able to work directly with real world decision takers or with scenario consultants/trainers, and translate scenario findings into practical and robust policy recommendations. In addition, awareness is needed about the way in which individuals select and discard information without being aware of doing so. As far as possible, scenario developers should be aware of their own biases and be as reflexive and open-minded as possible. Scenario developers are trained in finding key trends and imagining attitudes of key players. They analyse flows and what factors may disrupt them. Where knowledge is lacking or inconclusive, value-laden opinions become an inevitable part of a scenario exercise. Ideological questions regularly arise in scenario-based policy formulation processes. For example, is market liberalization or more government regulation the best way forward?

Surveys, workshops and Delphi methods are techniques that can help generate future expectations shared by a larger group. According to Swart et al. (2004), a successful scenario study requires a sufficiently large group of participants and adequate time for problem definition, knowledge-based development, iterative scenario analysis, and for review and outreach. The development of coherent, engaging stories about the future, including potential surprise events or seeds of change, has to place

the focal problem in a broader context. Last but not least, it is vital to be clear for whom scenarios are made and for which purpose. Normative judgements and political worldviews have to be made explicit in scenario development (Metzger et al. 2010).

Successful scenario development meets three fundamental characteristics (Alcamo and Henrichs 2008). *Credibility* refers to the scientific rigour and internal coherence of the scenario. *Legitimacy* is linked to the scenario development process. Finally, *saliency* refers to the appropriateness of scenarios in responding to information needs. These criteria can be further specified as follows (Rounsevell and Henrichs 2008):

Credibility:

- addressing the subjectivity of scenario developers and stakeholders involved (biases, prejudices, expectations, ideology);
- quantifying uncertainty in scenario assumptions (differences in drivers' uncertainty or in interpretation of stakeholders' inputs);
- quantifying uncertainty within models (data, calibration).

Legitimacy:

- including stakeholder participatory approaches can help to facilitate societal acceptance;
- ensuring transparency and traceability of the scenario development process and its political context (aim, who built it/funded it).

Saliency:

- designing scenario processes that ensure relevance to the policy question and stakeholder perspectives (for example, stakeholder participation, focal questions, and so on);
- stimulating and capturing creativity, by allowing the exploration of 'surprises';
- presenting and communicating scenarios in an accessible manner.

These criteria are not, however, necessarily followed in practice (see below) (Rounsevell and Henrichs 2008).

### **Links with Other Policy Formulation Tools**

In principle, scenarios have close links with other policy formulation tools, especially those to assess potential impacts of policy options, like modelling, cost–benefit analysis (CBA) (see Chapter 7, this volume),

cost-effectiveness analysis (CEA) and trade-off analysis. In fact, these tools arguably become more policy relevant when based on futures studies, as their outcomes greatly depend on underlying assumptions about present and future circumstances.

Exploratory scenarios are largely based on multivariate systems analysis and cause–effect models. Normative forecasting relies more on Bayesian statistics, linear and dynamic programming. For both exploratory and normative approaches, dynamic modelling is very relevant to identify the feedback mechanisms. Modelling (see Chapter 5, this volume) is intrinsically linked to the use of scenarios because models provide artificial experiments to explore system behaviour in the future where facts are not freely available (Matthews et al. 2007). Models help assess the complex interactions between system components and therefore support the development of quantitative pathways. This is the reason why model-based scenarios are often prescribed in *ex ante* assessments of policies (see Chapter 5, this volume; Bennett et al. 2003; Rounsevell et al. 2006; Helming and Pérez-Soba 2011). ‘Story-And-Simulation’ is the state-of-the-art of linking scenario narratives and models, thus enabling interaction between scientists and a range of other stakeholders (see Chapter 2, this volume). The framework is on the one hand flexible enough to use in conjunction with additional tools, and on the other sufficiently strict to separate clearly the roles of stakeholders and scientists and allow for co-production of knowledge (Kok et al. 2011). Most studies use a traditional ‘Story-And-Simulation’ approach coupling qualitative stories with (spatially explicit) mathematical models. More recently, the addition of other tools such as conceptual models and Fuzzy-Sets has shown their potential in facilitating the quantification of stakeholder input, for example directly obtaining estimates for model parameters. The potential for using these (and other related tools) has barely been touched upon in the literature.

Uncertainty management is another tool that is intrinsically linked to the credibility of scenarios. If continuity in trends can be assumed, uncertainties for investment decisions can be assessed in a quantitative way by attaching probabilities to different quantitative forecasts in order to calculate pay-off periods under different assumptions. Decisions can be optimized and project risks can be included in the required discount rate for an investment. For government policy, robustness can be increased by assessing whether a measure is still effective in meeting a policy target when scenario assumptions are changed. Policymakers could choose to limit the policy to no-regret measures (saving money and accepting the risks of non-compliance with the policy targets) or extend the policy strategy with additional measures to ensure that targets will be met under different scenario assumptions (the precautionary approach).

## SCENARIOS: THEIR USE IN PRACTICE

### The Historical Evolution of Scenarios as a Policy Influencing Tool

In this overview we briefly describe the evolution of scenarios in decision making, highlighting the particular role they played in certain policy formulation venues. *Utopia* by Thomas More (1516) offers a very early example of a visionary scenario, aimed at stimulating social change in Renaissance society (More 2012). By contrast, Malthus' *Essay on the Principle of Population* (1798) was based on a statistical analysis of trends and warned that limitations in agricultural productivity would halt population growth. Other types of 'frightening' scenarios have been published in more recent decades (for example, on climate change or resource scarcity), and were intended to provoke action to address risks.

Are futures studies, we might ask, science, fiction, or science-fiction? The future cannot be tested empirically because there are no data. In his article *The Discovery of the Future*, H.G. Wells was the first to discuss the possibilities of exploring the future as a scientific activity (Wells 1913). Later on, techniques and methods were developed that systematically included the future in policy strategies and planning. Although science-fiction literature, futuristic 'megatrends' or mystical prophecies can be a source of inspiration for policymakers, in this chapter we have focused on scenarios developed by scientists.

Futures studies nowadays closely relate to 'strategic planning', which aims at meeting a certain goal and choosing the required means, depending on the (possible) circumstances and reactions from other parties. Originally, strategic planning had a military meaning, inspired by 2400-year old lessons on the 'art-of-war' (Sun Tzu 400BC), but later on was also used by private companies. In the private sector, Royal Dutch Shell first developed scenarios in the 1970s to prepare for the impact of sudden changes in oil prices. Pierre Wack acknowledged that uncertainties and potential discontinuities made traditional surprise-free forecasts less useful and introduced the development of alternative scenarios (Wack 1985).

The US military think tank RAND first used scenarios in the 1940s for strategic planning. After the Second World War, the RAND corporation became a leading institute for technologically oriented futures studies. RAND's Herman Kahn was one of the lead authors of *The Year 2000* (Haydon 1967), an optimistic study about the possibility of political control and technological and societal progress. In sharp contrast, the *Limits to Growth* report to the Club of Rome, produced by the System Dynamics Group of the Massachusetts Institute of Technology (MIT) (Meadows et al. 1972), presented (in Malthusian style) political

challenges including resource scarcity and pollution of the atmosphere that remain important. Several countries started to develop economic forecasts after the Second World War to optimize economic policies and to assess the need for infrastructural investments. Some, including the Netherlands and Belgium, institutionalized this activity in Central Planning Bureaus.

In the more recent past, the range of topics covered by futures studies has widened, from national security and technology development, to social and environmental policies. In some European countries, futures studies are common practice in government institutes, with the UK's Foresight Horizon Scanning Centre (and formerly the Central Policy Review Staff), and the Netherlands' economic, social and environmental planning offices providing prominent examples. In international policy venues, futures studies have become especially indispensable. The celebrated Brundtland report, for example, set out an influential vision in *Our Common Future* (WCED 1987). Since the 1980s, the Convention on Long-Range Transboundary Air Pollution has used cost-minimized policy scenarios as a starting point for policy negotiations, and the UN Framework Convention on Climate Change derived political greenhouse gas reduction targets from the scenarios of the Intergovernmental Panel on Climate Change (Swart et al. 2004; Robinson et al. 1996). The OECD has been involved in futures studies since the 1970s. In 1979 it published the 'Interfutures' report *Facing the Future: Mastering the Probable and Managing the Unpredictable*. More recently, the OECD (2013) started a web-based knowledge bank for futures studies.

The relevance of future studies for European policy formulation is shown by the institutionalization of foresight activities. For example, in 1989 European Commission president Jacques Delors established a Forward Studies Unit as a think tank to evaluate European integration on the basis of long-term prospects and structural tendencies. This interdisciplinary unit is now known as the Bureau of European Policy Advisers (BEPA). A Forward-Looking Information and Scenarios (FLIS) working group was created in 2010 by the European Environment Agency Strategic Futures group as part of EIONET (European Environment Information and Observation Network) to share the latest developments between their members (for example, tools for visions building, environmental goal setting).

The next section explores issues of use by investigating a selection of environmental, economic and spatial planning scenarios that were used by policy formulators. We describe why particular scenarios were developed, how they were applied in combination with other policy formulation tools, and what the impact was on policy decisions. We focus on one

international experience (the abatement of air pollution), and a national one in the Netherlands. The chosen cases offer examples of policy formulation venues where 'official' (government sanctioned) scenarios were developed 'externally' by experts (and not 'internally' by policymakers). We conclude with lessons learned and recommendations for forthcoming scenario development as a policy formulation tool.

### **The Use of Scenarios in International Policy Venues**

Scenarios are used across various policy venues. In general, quantitative scenarios are widely adopted in economic policymaking, for example the European Commission and the International Monetary Fund apply model based scenarios for tracking expected budget deficits. They are also commonly used for several aspects of physical planning, for example demographic trends, traffic projections, expected sea level rise, or the land use requirements for biofuels. In environmental policy planning, scenarios for national emissions of greenhouse gasses and air pollutants must be reported to the United Nations periodically. All the above-mentioned scenarios are typically developed by (external) experts, where needed with some input from policymakers (for example, on envisaged policy measures), and are relatively undisputed. The time horizon and the indicators used are generally well defined.

Scenarios are also indispensable for the impact assessment of (large) investment projects. At least a reference scenario (in other words, future without the project) and a scenario including the project are needed. The time horizon and the set of relevant indicators are less well defined, may vary from project to project, and are often subject to public debate (for example, for a shale gas project, an extension of an airport, or a plan to prevent flooding). Meaningful scenarios and indicators are often co-produced by experts and stakeholders.

### **International Environmental Negotiations: Transboundary Air Pollution**

Since 1979, international negotiations to reduce air pollution have resulted in agreements (protocols) with emission reduction obligations for European countries. The scientific community has played a key role in providing measurements, modelling and information on air pollution impacts and the cost-effectiveness of available abatement measures. From the beginning of the 1990s, flat rate reduction targets were replaced by protocols aiming at a cost-effective, effect-oriented approach, meaning that measures should be taken that offer the best protection for health and ecosystems at the lowest costs. This approach causes emission reduction obligation percentages to

vary widely among countries. For example, in a less densely populated area, in principle, fewer measures are needed.

Scenario calculations by the International Institute for Applied Systems Analysis (IIASA) using the GAINS model are the basis for political negotiations. GAINS delivers optimization results: given (politically chosen) ambition levels to protect health and ecosystems, the model gives the minimum cost solution for a target year (with a 10–20 year time horizon). Scenario results give insights to policymakers (in other words, negotiators) on the relationship between environmental protection ambitions and the costs for their country. This is effectively a backcasting scenario and addresses the following question: ‘what do we need to do today to reach that desired level of protection?’

The scenarios describe the most likely future of emissions and their impacts, and are based on model extrapolations of drivers (for example, population, GDP, energy use, transport, agriculture), emission factors (influenced by abatement measures), dispersion models, dose–response relationships for health and ecosystems, and costs of (additional) abatement measures. Scenario selections are made by the policymakers, namely the leaders of the various national delegations. Differences between scenarios are the result of differences in policy measures (policy variants). In order to increase trust in the GAINS model, much effort has been spent on the review of the quality of all the input data. Country experts check and improve data on emissions, base-year activity and existing policies, the assumptions made for the development of drivers and ecosystem data. Countries are stimulated to deliver their own national projection. The GAINS team at IIASA checks the consistency of the data officially delivered by the countries. Conflicts can be managed by a Task Force on Integrated Assessment Modelling, which oversees the process (Reis et al. 2012).

The use of scenario-derived knowledge in the last thirty years has been highly significant. However, uncertainty management is likely to become steadily more important in the future, as most of the low-cost measures have already been taken and the complexity increases as air pollution and climate change interactions become more important. Uncertainty analysis will also be needed to deal with systematic biases in the scenario approach: potentially optimistic assumptions about the (full) implementation of additional policies, and pessimistic assumptions about (the absence of) emerging new technologies and behavioural change.

### **The Use of Scenarios in National Policy Venues**

Scenario planning in the Netherlands has a long history. After the Second World War, Nobel Prize Winner Jan Tinbergen became the first director of



the Central Planning Bureau (CPB) which was legally mandated to provide economic forecasts for *economic policy*. The need to optimize public investments in rebuilding the post-war economy and a strong belief in the possibility of influencing economic development were the main drivers behind this mandate. In addition, trade unions and employers agreed to use the CPB forecasts as the basis for wage agreements. Forecasts have used econometric models based on the latest macroeconomic knowledge and historical data, and assumptions on external factors (such as the development of world trade, oil prices and the population projection) and on existing or new policy measures (taxes, expenditures, social security, and so on). The CPB has the legal mandate to define the baseline scenario that includes existing policy measures. In an iterative process involving the Ministry of Finance, additional policy measures have been formulated that would be needed to meet policy targets, for example on employment, income distribution or government debt. Ultimately the cabinet of ministers have decided on policy changes. The organization's role in policy formulation grew in the 1980s, due to an agreement by political parties to subject their election manifestos to assessment by the CPB.

Due to the Netherlands' high population density, *spatial planning* is important to make the most efficient use of available land. It became the mandate of the Spatial Planning Bureau (currently entitled the Netherlands Environmental Assessment Agency) to define the scenarios that are to be used as the basis for the political spatial planning process. Long-term economic forecasts of the CPB form a quantitative input for scenario development on land use, transport, energy and environment. However, contrasting normative scenarios have proved to be more important in stimulating public debate.

Spatial plans are formulated at different government levels, where the national plan describes the long-term vision (the desirable future, but consistent with CPB forecasts) in the form of a land-use map for the Netherlands 25 years ahead, and a list of government investment projects. The national plan contains political choices, for example on suburbanization or concentration of housing, on the protection of valuable nature areas and landscapes, or on the direction of investments (to harbours and airports or to the development of rural areas). Provinces have the task of translating the national plan into regional plans, which in turn are the basis for detailed land designation maps by the local governments. The latter are decisive for acquiring a building permit. At each government level a participatory approach in the development of spatial plans has been successfully applied. Participatory spatial planning has proved to be a good vehicle to discuss desirable developments in neighbourhoods, regions or the country as a whole.

Development of environmental forecasts for the coming 25 years started in the Netherlands in the 1980s. The first *environmental scenarios* were developed to support the national energy debate: should the country use coal, gas or nuclear energy for power production or should it focus more on energy saving and renewables? While the public debate focused on the safety risks of nuclear energy and the health and ecosystem risks of coal, the long-term environmental scenarios (based on the economic forecasts of the CPB) were important to assess the costs and impacts of different options.

In the study by RIVM (National Institute for Public Health and Environment) *Concern for Tomorrow* (RIVM 1988), the focus of the scenarios was broadened to other issues, such as pollution of air and water, toxic chemicals, manure, waste treatment and climate change. The scenario method was rather simple: extrapolations based on trends in population growth, activity levels and available technologies. However, the comprehensive approach gave new insights into the urgency and common drivers of environmental problems, the limitations of end-of-pipe technologies and the need for structural changes, for example in waste treatment, energy, transport and agriculture. After *Concern for Tomorrow*, RIVM was given a legal mandate to develop environmental forecasts on a regular basis and to make *ex ante* environmental impact assessments of policy proposals. RIVM (now renamed the Netherlands Environmental Assessment Agency) received a legal mandate to develop both a baseline scenario and a maximum feasible scenario that includes technical and non-technical measures (and their additional costs). This frames the policy formulation envelope. It remains the responsibility of policymakers to decide on the measures that will be included in the National Environmental Policy Plan.

In order to maintain credibility, broad consensus among experts on data, methods and results proved to be important. Therefore, RIVM organized close cooperation with expert institutes in the field of agriculture, transport, energy and nature conservation. Participatory methods with representatives from government, industry and NGOs were limited to the definition of ambition levels for environmental protection and the identification of new measures. Although uncertainties in economic developments were grasped using high, medium and low economic growth forecasts produced by the CPB, in practice policymakers were often unable to use the uncertainty ranges and simply adopted the medium projection as the basis for policymaking.

The 'surprise-free' approach was quite effective as long as the need for environmental protection was relatively undisputed and the authority of experts was accepted. This changed in the beginning of the twenty-first century when scepticism about environmental problems grew and the

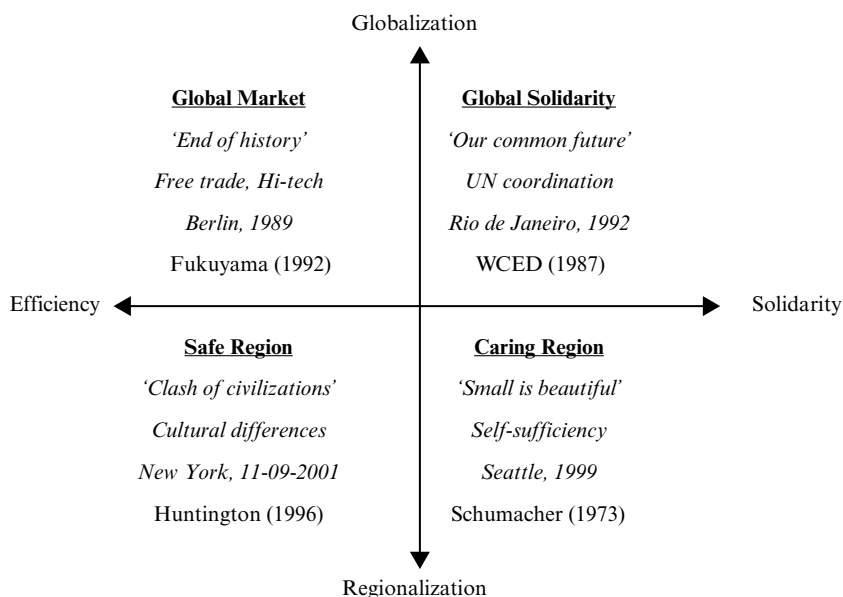


Figure 3.3 Four normative futures developed in the RIVM Sustainability Outlook, symbolized by four emblematic books

monopoly enjoyed by experts over knowledge declined, due in part to the expansion of the Internet. Many environmental issues (not only climate change, but also air pollution, nitrate in groundwater, electromagnetic fields or pesticides) were perceived as 'wicked' problems, with a high degree of scientific controversy and of conflicting interests or values.

'Sustainable development' is perhaps the most 'wicked problem' of all, with many different opinions on what it means and what should be done. In order to facilitate the development of a sustainable development strategy, in 2004 RIVM was asked by the Dutch Cabinet to develop a Sustainability Outlook with four normative futures (see Figure 3.3; RIVM 2004). From a survey among 40,000 people, four major worldviews were selected. For each of these, the main trends, worries and desired policy measures were identified via additional surveys among 2500 people. In four focus groups of about 20 selected people each (representatives of a certain worldview), narratives, cause-effect diagrams and images for the scenarios were developed. The scenarios were thus the result of a broad participatory approach. Quantitative figures were not crucial, but only used for illustration (and derived from CPB forecasts). Each normative

scenario contained a consistent storyline: trends, external developments and chosen policy strategies would lead to the desired future (a so-called 'utopia').

What each group thought of the scenarios developed by the others was also analysed. It soon became clear what the main weaknesses were in each of the four scenarios, for example risk of excessive bureaucracy, overly optimistic assumptions about the ability of markets to produce timely technological solutions, too much emphasis on voluntary contributions without a solution for free-rider problems. The analysis of weaknesses made it possible for policymakers to make their policy strategy more robust. Moreover, it was possible to identify which policy measures would be no-regret in all scenarios (for example, efficiency improvements) and which measures would face strong opposition (for example, stricter regulation). During simulated negotiation sessions with experts and policymakers, possibilities for consensus were identified. For example, emissions trading was identified as a compromise between the taxation and regulation of CO<sub>2</sub>.

## CONCLUSIONS

In theory, scenarios are tools that aim to deal with the increasing complexity and future uncertainty of modern life. The real world examples presented in this chapter indicate that they have become indispensable tools in policy formulation processes and are used in very different policy venues. Scenarios are fundamentally linked to the initial, problem conceptualization stage of the policy formulation process. However, a full foresight process is closely interwoven with the other phases and important tasks. Scenarios can, for example, be used to acquire and consolidate ideas on the long-term effects of possible policy decisions, and can facilitate evaluation of the trade-offs that would result from adopting different policy options.

The two examples described above highlight the three 'golden rules' that make futures studies more successful in informing the policy formulation process: credibility, legitimacy and saliency. Credibility is perhaps the critical factor: trust in the sources (in other words, who gave information, the data quality), in the foresight process (addressing the developers' and stakeholders' subjectivities), in the models used (data, calibration), the framing (narrative, metaphor) as well as the dissemination of the results (who communicates and in what context) (Selin 2006). Explorative scenarios *seem* to be more credible in the eyes of policymakers because they are based on the knowledge of experts in the fields at stake that understand the current state and possible future trends. Normative scenarios tend to

have lower credibility because their development relies upon 'crystal-ball gazing' and leaping inferentially to what will occur in a (usually probabilistic) future. However, little objective evidence exists to defend these assertions. The inputs to explorative scenarios could be biased as well, consciously or unconsciously, and not in a systematic manner.

As regards saliency, scenario processes that ensure relevance to the policy context combine different scenario development methods (mainly explorative and normative) to expand the range of possible alternative futures. In this way, they increase the number of possible pathways to the future and enhance flexibility in the policy formulation process. The lack of diversity in scenario types is often the main limitation in scenario-based policy formulation activities. Focusing on one 'most probable' or 'most wishful' scenario makes policy formulation easier, but may constrain innovation, limit strategic thinking, and distract policymakers from the more creative solutions that are widely perceived to be needed in the environmental sector. Rosy futures with optimistic assumptions about policy effectiveness increase the risk of problem mis-diagnosis and eventually policy failure (Neugarten 2006). In addition, the integration of normative and explorative methods will enhance legitimacy (as different methods allow a broader participation of society in the development of narratives). However this has proved to be challenging because it requires dynamic system modelling techniques including feedback relationships that are not yet fully developed.

As nobody has a monopoly on knowledge of the future, broad participation and communication with relevant stakeholders is a critical factor to ensure greater legitimacy. However, involving more stakeholders often leads in practice to new problems (Tonn 2003): a high turnover among process participants and a lack of credibility because some participants miss expert authority. If some are unwilling to reveal their values and stakes, tensions between participants (for example, from different departments and government levels) could prevent creative thinking.

In practice, the belief in a scenario is limited to the people involved in their construction (Schoonenboom 2003). The theoretical solution would be to involve 'internal' policymakers in the scenario development process. However, involvement of policymakers could block the development of alternative futures, as many policymakers are not willing to have the existing policy criticized. In practice, many policymakers have difficulties in dealing with uncertain futures (especially when scenarios are also value-laden). They may expect experts to deliver certainty, as shown by the examples in this chapter which were developed by experts 'external' to the government.

Theoretically, scenarios need to be credible, legitimate and salient to be

successfully used in policy formulation. Understanding the characteristics of the relevant policy venue at the start of scenario development activities, considering who will use the scenarios, for what purpose and in what political context (in other words, the values and stakes of those involved), is more likely to make the scenario a more successful tool in informing policy formulation. For example, in relation to really complex issues such as the 'sustainable development' of a country or the development of a 'smart city', legitimacy and credibility are crucial and therefore participatory approaches are a 'must' for successful scenarios.

Finally, as an additional way to reduce uncertainty and understand complexity, policymakers are starting to request periodic *ex post* evaluations of the actual realization of scenarios and policy plans (for example, mid-term assessment of Europe 2020, mid-term review of EU Common Agricultural Policy) in order to draw lessons for future forecasts and plans. Optimism on the actual implementation of envisaged policy measures (for example, on energy saving or clean vehicles) often causes a structural bias in scenarios (Maas 2000). The challenge is to either accept the risks of non-compliance with the policy targets, or to develop robust scenarios that include reserve measures in the policy package that can substitute for those that do not survive the implementation phase.

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