MICA

Minerals Intelligence Capacity Analysis

FACTSHEET

Raw Materials Foresight Guide

This Factsheet summarises the MICA Project Deliverable 5.5 "Raw Materials Foresight Guide" (Martins & Bodo, 2017).

Scope (conceptual model & main characteristics)

What is foresight?

Foresight emerged after the Second World War as a more explicit attempt in translating this capacity of thinking about the future into a formal, systematic way. With broad goals and under a variety of landscapes it became common in such decision-making contexts as military strategic planning and (French) spatial planning. In later decades, corporations such as General Electric and Royal Dutch Shell introduced Foresight techniques in their corporate planning procedures (Popper et al. 2008). From then on, Foresight developed as a widespread practice, with different schools and approaches, addressing issues in a more integrated fashion.

The report 'A Practical Guide to Regional Foresight' by FOREN (Gavigan et al. 2001) defines that *"Foresight is a systematic, participatory, future-intelligence-gathering and medium-to-long-term vision building process"*. It can look at multiple areas, such as science, technology, economy, society, politics, and specific sectors of society. It benefits from involving a broad range of stakeholders in the process and can be used to inform policy-making, build networks, and enhance local capabilities for tackling long-term issues.

Foresight studies should be:

- **Action-oriented:** not only about analysing or contemplating future developments, but also supporting actors to actively shape the future;
- **Participatory:** it should involve numerous groups of different stakeholders; and
- **Multidisciplinary:** it should be based on the principle that the problems faced cannot be reduced to one dimension.

Kuosa (2014) suggests five classes of futures domains (Figure 1), placing Foresight in context against different types of approaches. These are defined as:

- **Foretelling and prophesy:** 'Cristal ball' level of understanding of the future – entirely deterministic;
- **Predicting:** Where the focus is on finding strong enough causality relationships that can predict events to a nearly 100% certainty (e.g. some statistical applications in natural sciences and meteorology to some extent);
- **Forecasting:** Attempts to say what is probable and plausible. Based on trend extrapolation, estimations and probabilistic statements;
- **Foresight:** Aims to create a more comprehensive understanding of change in the future, presenting a spectrum of alternative futures instead of just one forecast;
- **Future Studies:** Differ from foresight regarding their objectives. While Foresight helps decision-makers and stakeholders to explore options, Future Studies attempt to envision a better world and make a change towards it.

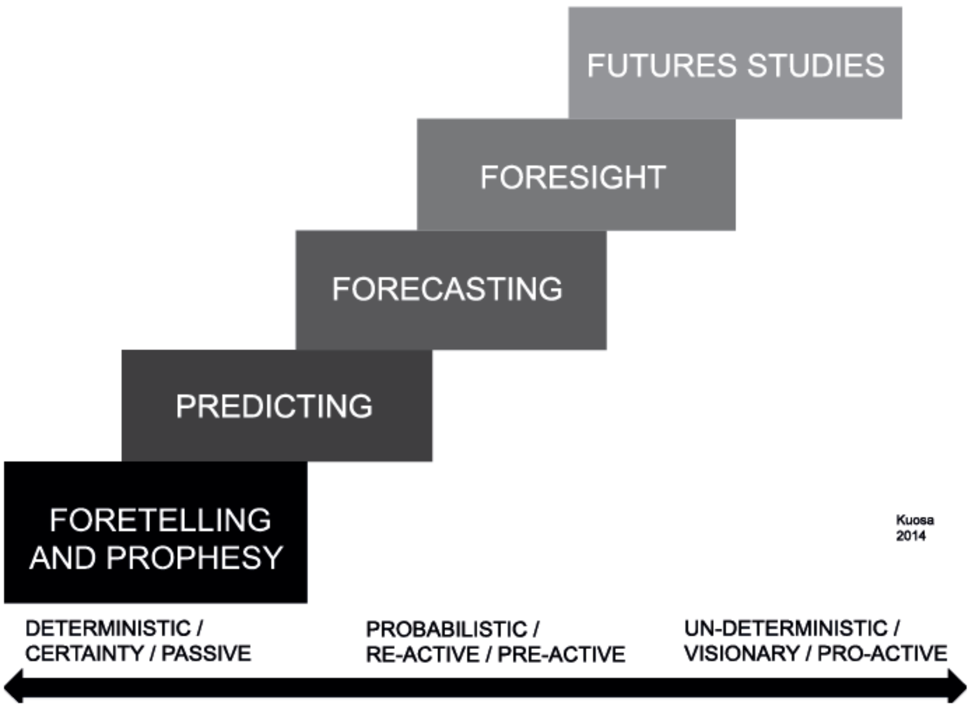

Figure 1 - Scale of different classes in futures domain (Kuosa 2014).

There are mainly two dimensions to be looked at when trying to understand whether foresight is the best approach to respond to specific needs: one is related to the comprehension of what foresight can actually deliver – and by extent matching it with the objectives – whilst the second concerns the feasibility of implementing such approach. From this starting point, one can begin to understand that there are key factors influencing the utilisation of a foresight exercise. Foresight is indicated, when considering longer time frames in the future (>10 years) and a reasonable level of access to resources.

Foresight, thus, should not be seen as a 'quick fix,' and it cannot be expected to achieve results overnight. There are situations where foresight might not be the best approach, such as when:

- Key stakeholders cannot be actively engaged in the process;
- Time-scales of interest are shorter than 10 years;
- No clear, precise, and agreed scope can be established;
- There is no possibility to act on the results.

Table 1 Raw Materials Foresight Thematic Clusters. (Martins & Bodo 2017)

Area/Thematic Cluster	Description
Geographic orientation (e.g. 'National Benefit')	**Such studies might explore the raw materials sector at a regional, national or even global scale and how to derive long-term socio-economic benefit. Primary extraction of resources affects communities at a local level but also at the level of a country's economy within a global context (e.g. resource curse). Foresight studies can aid strategic understanding of the former, informing companies seeking to better manage potential risks (e.g. Social License to Operate) and help policy makers in both cases assuring an equitable and sustainable wealth creation derived from such non-renewable resources. Some studies can explore global environments linking it to a regional/local context.**
Policy-supporting	**As mentioned in the MICA Project Deliverable 5.1 (Falck *et al.* 2017), a raw materials intelligence framework is essential for the proposition of a robust minerals policy. Foresight is an important component of such approach bringing long-term perspectives for policy-making.**
Sustainability	**At both a policy-making and corporate level, the raw materials sector historically dealt with environmental issues as well as specific socio-economic impacts. With Sustainable Development becoming a mainstream target and the emergence of paradigms, such as climate change combat, resource efficiency and circular economy, these can be objects of Foresight studies, helping to adjust policies and company strategies according to the different future perspectives.**
Research/Technology-oriented	**Primary and secondary production of raw materials are strongly impacted by technology breaks. Therefore, it is of strategic importance to understand how disruptive technologies can shape the future in a particular context as well as identifying gaps and future research needs in specific areas for tackling potential emerging issues.**
Supply/demand challenges	**Foresight studies can also focus on the futures of a single mineral commodity in the context of a company's portfolio or at a policy level considering the importance of that single product to the specific nation or region's economy.**

Foresight stages

Different sources can provide slightly different variations in terms of defining the stages of the foresight process (e.g. ForLearn, European Training Foundation). For the purpose of this report, these different stages will be described in some more detail as:

- **Scoping phase**: comprising the definition of the focus, objectives, users, outcomes, purview, approach, time horizon and timeframe. Furthermore, these factors should be feasible (feasibility assessment). The scoping phase can also produce a planning document of the foresight exercise with the methodological design (framework) of the exercise, i.e. which and how foresight methods will be used and combined;
- **Development phase:** securing sources of data and knowledge. It details the actual stakeholders and experts that will be involved, the actual schedule for the exercise in the given timeframe and systematically communicate on the developments to the targeted audience. Ultimately, it ensures the process of transforming it from a planned exercise into a running exercise producing relevant outputs and outcomes; and

Evaluation: proxies for monitoring both direct and indirect impacts and outcomes of the Foresight exercise once finalised.

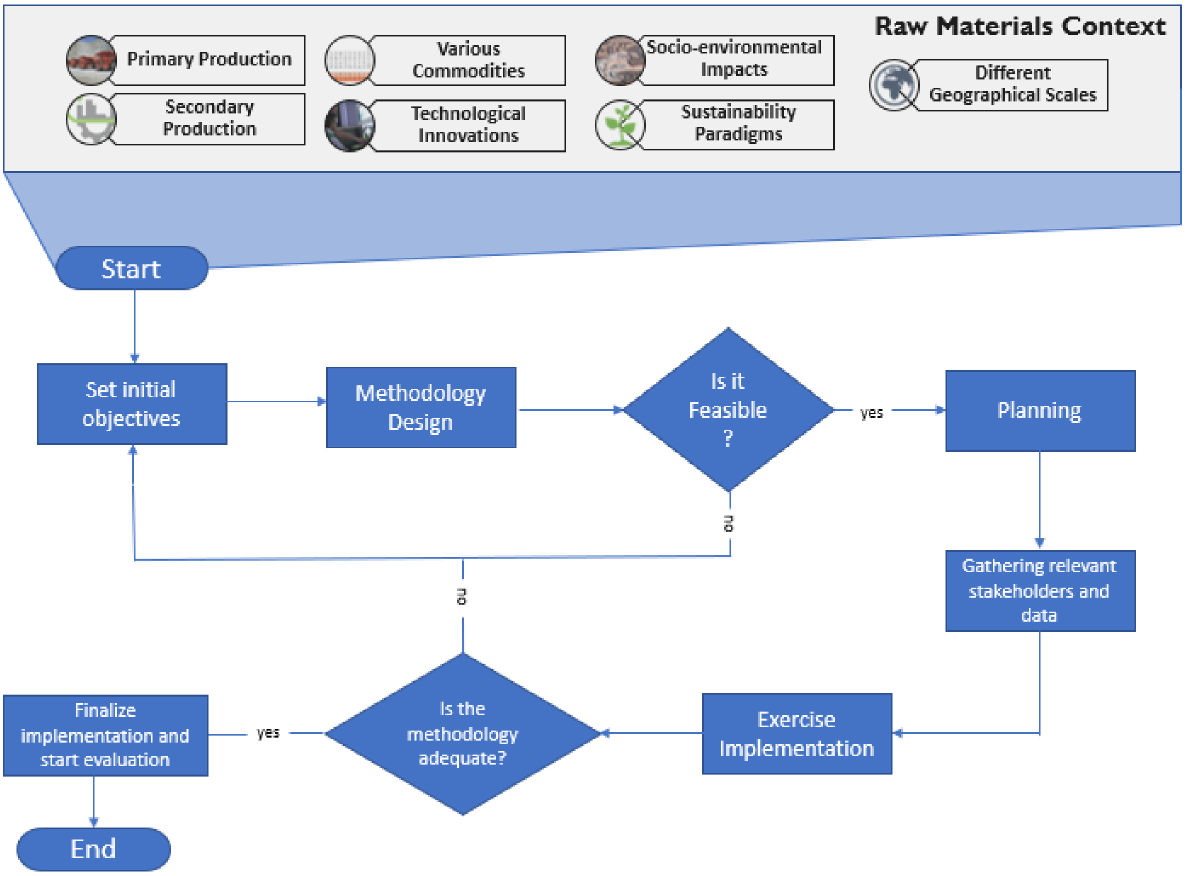

Figure 2 Foresight implementation flowchart.

Foresight scoping process

Scoping an exercise comprises the definition of the following main elements:

- Definition of general parameters:
  - Focus;
  - Objectives;
  - Users;
  - Perspective to be adopted;
  - Approach;
  - Time horizon;
  - Time-frame
  - Design of foresight methodological framework;
  - Feasibility assessment;

Methods and tools classifications

The ForLearn Portal[1] suggests distinguishing the different functions needed at different phases of the exercise:

- Diagnosis: understanding where we are;
- Prognosis: 'Foresighting' what could happen;
- Prescription: deciding what should be done.

Each of these functions might suggest a specific set of methods that can be more suitable. Diagnosis is frequently covered by Environmental Scanning approaches, identifying relevant trends and drivers of the system under study and structural analyses to better understand causal relationships. Prognosis might use Scenarios Development to explore what could happen or a mix of methods, balancing between qualitative and quantitative approaches. The prescription function can be covered with tools supporting the development of recommendations.

When choosing methods for a specific exercise, it is important to understand key classificatory differences between the vast amounts of methods used in foresight exercises.

The foresight methods and tools are commonly classified:

- By their nature: Qualitative, quantitative or semi-quantitative;
- By their knowledge source: Interactive, creative, evidence, expertise-based; and
- By following either normative or exploratory approach.

The first aspect when looking at the various methods is the objective of the exercise previously defined. Framing the issue at stake with single questions can aid the translation of such issues into possible approaches. For instance, when asking "how will something develop in the future?" exploratory approaches tend to be more compatible with open-end questions, whereas asking "how can something become more sustainable?" introduces a more normative element. The principle of triangulation suggests a combination of different methods and approaches to improve the robustness of the foresight methodological framework and increase its reliability.

In terms of nature of foresight methods can be:

- **Qualitative:** methods providing meaning to events and perceptions. Creativity or subjectivity play a significant role as the focus is on interpretations, judgements, opinions etc. Qualitative methods are often employed where the key trends or developments are hard to capture using simplified indicators. Various tools used in qualitative foresight approaches have a 'facilitating' background (for meetings and workshops), such as 'Mind Mapping'. In general, qualitative methods evolved into capturing and analysing quantitative data and displaying the analyses in a well-digested form.
- **Quantitative:** methods generally focus on variables, applying statistical analyses, using or generating reliable data. Quantitative methods rely on representing developments numerically. Numerical data are useful in thinking about future developments and can be useful to express Foresight results. A common property of quantitative methods in foresight is that they are variable-oriented. Advantages of using quantitative methods can be summarised as:
    - Works with a greater level of precision as it allows to compare data, examine rates of change, identify increase/decrease of relevant variables;
    - It can be used systematically to produce trend extrapolation/analysis;
    - Support the scale perspective of problems, underlining and validating comparisons with confidence for decision-making;

[1] Website: http://forlearn.jrc.ec.europa.eu/guide/4_methodology/meth_framework_functions.htm

- Results can be represented in charts, graphs and tables, which is often appealing in communication strategies.

Disadvantages can be summarised as follows:

- Some factors are hard to present numerically – and the more important they are the less likely quantitative approaches can be indicated. Avoid assuming that because something can be measured it is central to the exercise.
- Skills required for working with quantitative data are unevenly developed. Apart from requiring considerable expertise to apply quantitative methods, it can be difficult to examine statistical information if they are in an upper level of complexity for general users/participants;

- **Semi-quantitative:** methods are basically applying mathematical principles to quantify qualitative subjectivity, judgements and opinions e.g. weighting opinions and probabilities.

Figure 3 The Foresight Diamond (Popper & Teichler 2011).

As foresight usually draws on both quantitative and qualitative approaches, quantitative data are often given a great deal of weight, but they should not be allowed to dominate. There is a high dependence on the access to expertise and nature of the problems being studied with finding the right mix of methods. However, mixing qualitative and quantitative methods underpins most of foresight studies as a rather desirable goal. The classification of 'semi-quantitative' methods underlines the demand for combining qualitative and quantitative techniques.

In terms of capabilities, foresight methods and tools can be described as:

- **Creativity-based:** Methods rely heavily on the inventiveness and ingenuity of very skilled individuals.
- **Expertise-based:** Skill and knowledge of individuals in a particular area or subject is used to support top-down decisions, provide advice and make recommendations.
- **Interaction-based:** focus on the gains generated by expertise brought together, challenged with other stakeholder's perspectives. Especially important when the object of the study requires a more 'democratic' element in the process, with a more inclusive and participatory appeal.
- **Evidence-based:** providing the support for understanding the current state and possible developments.

Exploratory vs. Normative Approaches

As the European Foresight Platform defines, exploratory methods are 'outward bound'[2]. They begin in the present and move forward to the future, either extrapolating trends or causal dynamics, or else asking "what-if?" type of questions on the possible implications, developments and events that may lie ahead in the future. Trend (extrapolation) analyses, cross-impact analyses, Delphi surveys, some modelling techniques and scenarios can belong to the pool of methods used in an exploratory fashion.

Normative methods, by contrast, usually start from a point in the future with a view of a possible – often a desirable – future. They then work backwards to see how these futures might be reached from the present state, identifying constraints, resources and technologies enabling or disrupting the path to that desirable future state. Tools used in this case can be morphological analyses, relevance tree, aspirational scenarios and back-casting. Typically, studies with such approach would include the creation of a 'vision' through participatory workshops, integrating different – but converging – perspectives.

Most importantly, the practice shows us a mixture of both approaches. As sometimes an exploratory approach can serve as a starting point to identify a possible desirable approach or an undesirable one that should be avoided. Normative approaches are powerful in priority-setting studies, as well as creating the conditions for monitoring progress towards the desired future. Where consensus is hard to achieve and there is no clear vision of shared goals, explorative approaches are largely expected – at least as a starting point.

Methodological frameworks

Designing the methodological framework of a foresight exercise requires a good comprehension of the foresight methods and tools available, their classification and possible approaches. Many factors impact the definition of methods and tools to be used and how the framework should be constructed (how the methods can be combined). These are largely related to the factors described in the previous sections, although there can be some additional issues affecting this stage of the process. For instance, many methods and tools can be used with the same objective and the actual selection can be related to the foresight practitioners' skills. As some methods are relatively easy to implement, they can become more appealing for newcomers to foresight, while **methods requiring**

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[2] Source: www.foresight-platform.eu/community/forlearn/how-to-do-foresight/process/methodology/

more specific skills (e.g. computer literacy and modelling) might require additional efforts, if the project members involved are not used to such approaches. This issue, however, can be curbed by either hiring foresight practitioners according to the expertise required, or by training project members accordingly – the latter being more time-consuming.

Overall, the methodological framework definition is an evolutionary process. It is about finding the appropriate sequence and combination of methods in function of all the above-mentioned factors and constraints. Monitoring the alignment of the methodological framework with the development of the exercise is important to adjust the utilisation of the methods throughout the exercise so as to improve the exercise in line with its evolution.

Raw Materials Foresight framework

Figure 4 sums up a framework of foresight components against different foresight (exercise implementation) stages, and its implications for potential methods to be used. For comparison, the 'generalised layered methodology' from Voros (2003) is also featured.

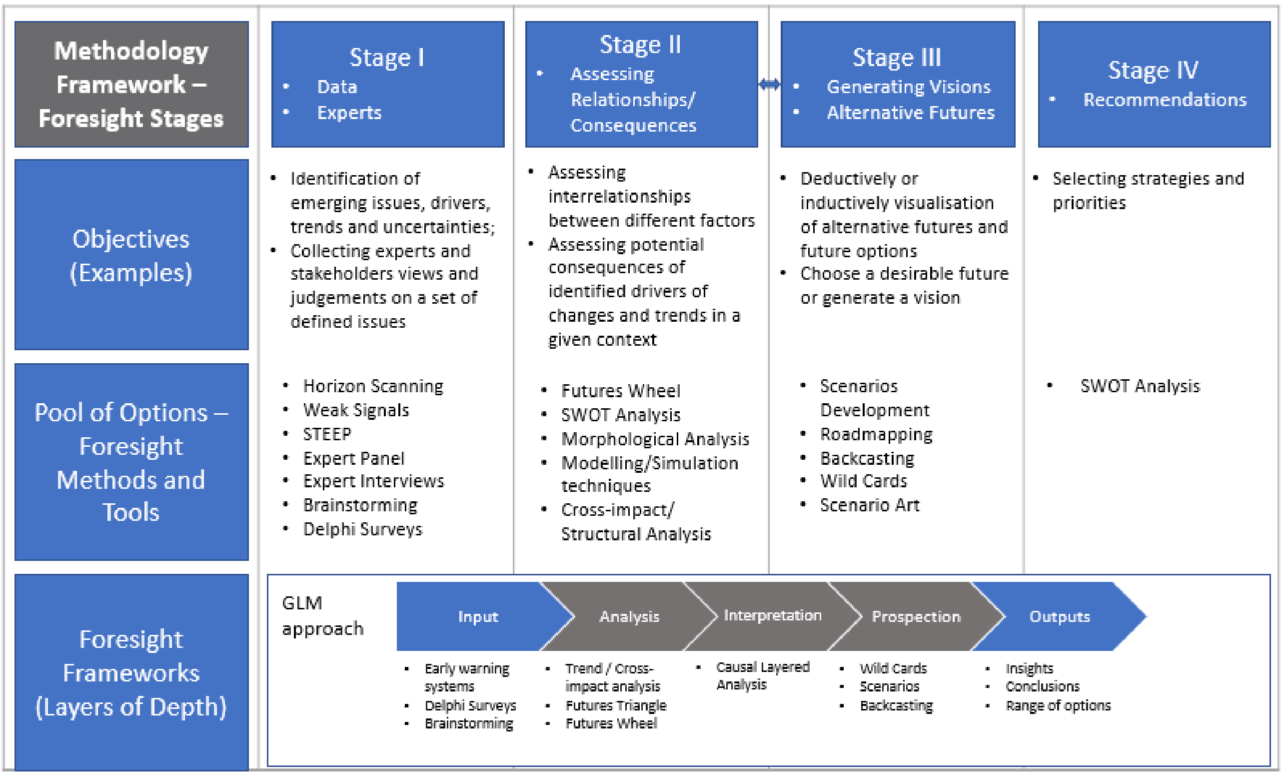

Figure 4 Methodology Framework schema – Foresight Stages. (Martins & Bodo, 2017)

Although the Foresight process can be somewhat fixed, there can be often feedback loops of inquiry to the methodological framework, as well as 'modular' approaches, which in turn make the process less 'linear'. The stages are defined as:

- Stage 1: Focus on people and data gathering. Methods at this stage might rely more directly on data and/or qualitative inputs from experts. They will support the identification of initial relevant factors according to the scope and objectives of the project;
- Stage II: As the relevant factors are brought to light, the second stage can analyse their interrelationships and consequences, setting an important view on potential future

developments. This stage can require more interaction-based, multi-disciplinary approaches.

- Stage III: This stage is the generation of alternative futures. It may frequently feature workshops with a broad involvement of stakeholders and creativity-based approaches. Furthermore, it is also a point to define – or refine – a preferred future, and different pathways to get there. This can provide more robust insights to be assessed in the last stage.
- Stage IV: The last stage is focused on the outputs of the foresight process. It should focus on delivering the message clearly to the client. Typically, recommendations will be provided, shedding a light on both, the foresight process insights and outputs and also the objectives initially defined. Translating this into clear, timely and robust strategic recommendations is the main goal of the step.

Stages I and II might require feedback loops to refine the 'picture' of the issues at stake, whereas Stages III and IV might be undertaken interchangeably as consequences. Insights and potential recommendations can emerge also across the different stages.

Contexts of use, application fields

Foresight can be used in long term, forward-looking multiple issues and when there is capacity to act in the present day. The table below shows where foresight can be applied in the raw materials domain (first column) and introduces relevant related references (second column):

Contexts of use/application fields	**Related published references**
Provide a platform for sectoral futures thinking in a global or national level, stimulating dialogue and generating tools for decision-making and collaborative actions.	(WEF, 2009; 2015); (Schimpf et al, 2016)
Support the transition to a – desirable – future state, such as a 'sustainable world' or to derive long-term sustainable benefits from national mineral endowment.	(WEF, 2015); (Mason et al, 2011); (Sheraz, 2014); (Jäger & Schanes, 2012)
Support policy definition and/or implementation for the sector or for a specific area.	
Set research & technology priorities and strategy in private or public sectors.	(Bodo et al, 2013)
Platform for evaluating future raw materials supply and demand issues and challenges.	
Identify main challenges related to the competition for accessing (mineral) resources.	(Polinares, 2012)

Better understand the complex interplay of geological, economic, environmental, socio-political and techno-scientific issues for the future of mineral exploration.	(Sykes, 2015).
Setting future visions for the raw materials sector, organisations or institutions and/or supporting 'paradigm-shifts' e.g. sustainability-related, "digital mine". This can be directed at strategic/operational aspects and also issues such as the 'Social License to Operate'.	
Support the evaluation of mineral projects, capturing externalities and uncertainties to improve decision-making.	(Vann et al, 2012; Jackson et al, 2014)
Explore the long-term future outlook for a specific commodity and relevant factors such as supply and demand and potential discontinuities.	(Almeida & Moraes, 2014)

Input parameters

Foresight studies usually draw on evidence, experts inputs, creativity and interaction. Input parameters in the raw materials context can be overall related, but not limited to:

- Focus;
  - A geographical coverage;
  - Productin (Sourcing);
  - Framing aspects:
- Objectives;
  - Context-dependant
- Users;
  - Governments, Industry, Academia, NPOs (Non-for-profit organisations), Service providers.
- Perspective to be adopted;
  - Confined:
  - Techno-economic:
  - Holistic:
- Approach;
  - Top-down:
  - Bottom-up:
- Time horizon
  - 10 to 40 years, typically.
- Time-frame

    - Few months (1 to 2) to years (1 to 3), or ongoing processes.
- Design of foresight methodological framework;
    - Function of all listed parameters plus resources and skills available.
- Feasibility assessment;
    - Iterative evaluation of the planned foresight process against the available resources and related costs.

Type(s) of related input data or knowledge needed and their possible source(s)

N/A

Model used (if any, geological mathematical, heuristic…)

Foresight can use a variety of different modelling approaches, namely:

Scenario modelling

System Dynamics

Agent-based modelling

Cobweb Modelling

Utility maximisation and choice modelling

System and/or parameters considered

Foresight time horizon usually lay between 10 and 40 years in the future.

Time / Space / Resolution /Accuracy / Plausibility…

Temporal domain concerns necessarily the longer-term future and the spatial resolution is determined by the context of foresight application.

Indicators / Outputs / Units

Typical foresight outputs are:

- Scenarios
- Survey results
- Sectoral analyses
- Critical technology lists
- Technology priority lists
- Technology roadmaps

- Policy recommendations

Treatment of uncertainty, verification, validation

N/A

Main publications / references

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Voros, J. (2003). A generic foresight process framework. Foresight vol. 5, no.3: pp. 10-21. DOI: 10.1108/14636680310698379

Related methods

Back-casting

Bibliometrics

Brainstorming

Causal Layered Analysis

Citizens' Panel or Focus Groups

Cross-impact Analysis

Delphi Survey

DPSIR Frameworks

Expert Panels

Futures Triangle

Futures Wheel

Idea Networking

Genius Forecasting

Global Value Chain (GVC) Analysis

Horizon Scanning

Mindmapping

Morphological Analysis

Relevance Tree

Roadmapping

Scenario Art

Scenario Development

Serious Gaming

STEEP Analysis

Stakeholder Analysis

Structural Analysis

SWOT Analysis

System Dynamics modelling

Trend Extrapolation

Trend impact analysis

Utility maximization and choice modelling

Wild Cards and Weak Signals

Some examples of operational tools (CAUTION, this list is not exhaustive)	

N/A

Key relevant contacts	

N/A

Glossary of acronyms /abbreviations used	