Towards Scientific Foresight in the European Parliament

IN-DEPTH ANALYSIS

Science and Technology Options Assessment

EPRS | European Parliamentary Research Service

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Scientific Foresight (STOA) Unit

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"Use Foresight, and your policies will be more robust"
Luke Georghiou

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This in-depth analysis has been written by Lieve Van Woensel, PhD, and Darja Vrščaj, MSc, of the Scientific Foresight Service within the Directorate-General for Parliamentary Research Service (DG EPRS) of the General Secretariat of the European Parliament.

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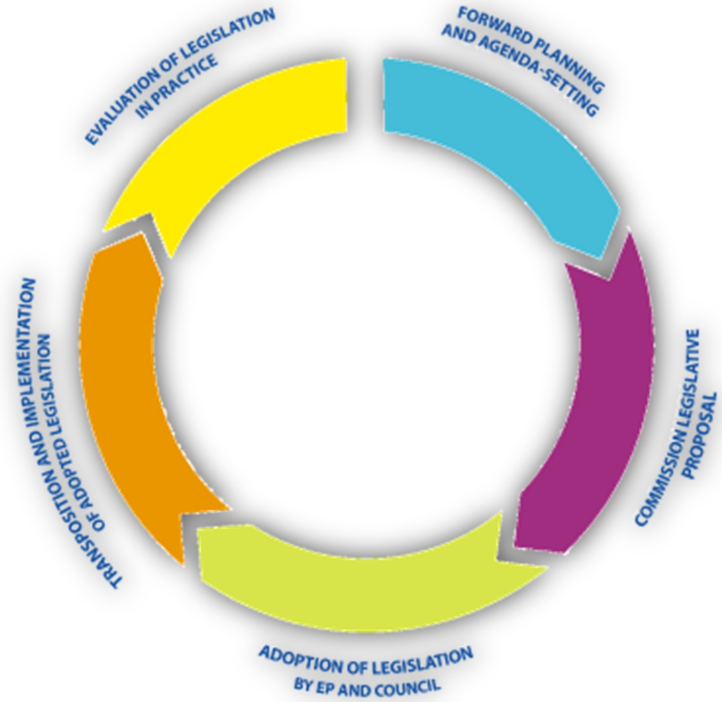

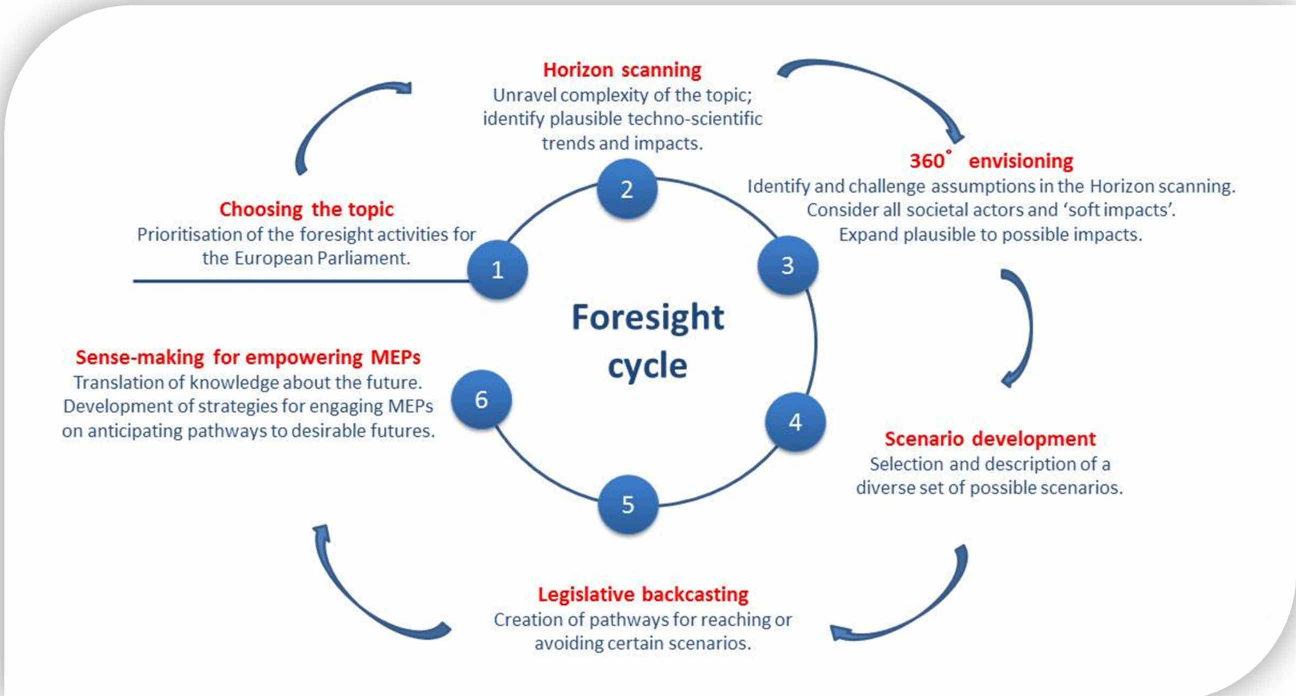

Scientific Foresight is not about predicting,
it is about creating future options.

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Context of Scientific Foresight at the European Parliament

In 1987 the European Parliament (EP) established a Science and Technology Options Assessment (STOA) Panel, an official parliamentary body with a mission to carry out studies and other activities that provide Members with impact assessments of new technologies and options for policy action. The STOA Panel decided at the end of the 7th legislature to pursue the recognition of STOA's mission as a permanent structure of the European Parliament with an explicit Foresight role in Science and Technology. This took advantage of the long-term, strategic nature of its work and put it in the context of the current political discourse, adding a Foresight dimension to STOA's work, which could thus be firmly anchored in the agenda-setting phase of the policy-cycle.

In September 2014, the STOA Unit was renamed Scientific Foresight (STOA) Unit and restructured to comprise two services: the Scientific Foresight Service and the STOA Secretariat. The newly created Scientific Foresight Service aims to strengthen the EP's capacity to carry out Scientific Foresight in order to both raise awareness of techno-scientific trends amongst Members and empower them to work through legislative actions, taken during the current legislature, towards long-term desirable futures. This will be implemented by simultaneous improvement of awareness-raising capacity relating to techno-scientific trends, and developing a robust approach to Scientific Foresight studies within the service.

This report describes an approach to undertaking Scientific Foresight activities in order to enable the individual Members and Committees of the European Parliament to make use of a reasonable time-frame (between 30 - 50 years) for conducting responsible Foresight studies. This approach goes beyond traditional Foresight studies, and incorporates an additional 'sense-making' phase for the Members. This will translate outcomes from Foresight work into an accessible description of a diverse set of possible future scenarios, and provides a range of pathways for legislative work which is more future-orientated, particularly useful in the agenda-setting phase of the policy cycle.

The European Parliament's Scientific Foresight activities should empower Members and Committees to anticipate a broad range of possible future impacts of techno-scientific trends, facilitating decision-making that will support the reaching of desirable long-term futures and avoidance of undesirable futures.

1 What is Scientific Foresight?

The future does not exist at any given moment; it is shaped by people's actions. For enhancing intelligent, informed and responsible decisions, people need to understand the consequences of their actions, of others' actions and reactions, and of forces beyond their control. Foresight, also known as 'Futures Studies', involves a broad scope and encompasses multiple dimensions with a specific interest in the social dimension. Foresight is an approach for studying possible consequences of our actions. Foresight is not about predicting long-term possible alternative futures, but about studying them in order to enhance people's reflexivity about what consequences theirs and others' actions could entail.

Over the last few decades we have been increasingly facing societal challenges. For example, climate change, resource scarcity, economic crisis, an ageing population, poverty, and so on. In the past, Foresight studies were published which raised awareness about the possibility of future challenges to society. For example, in 1972 the Club of Rome published the *Limits to Growth* report, raising awareness about the future dangers of exponential economic and population growth with finite resource supplies. However, we have not taken sufficient action to prevent such consequences. In fact, the Intergovernmental Panel on Climate Change's annual report (2014) stressed that climate change is no longer a possibility, but an existing challenge. As we have ignored the issue at hand for such a long time, nowadays we can no longer avoid climate change; if we start acting differently now we can only limit its impacts.

Many institutes use Foresight for tackling societal issues in various ways. For example, the World Bank focused recently on raising awareness about how the decisions and actions that we take in Europe are influencing developing countries. Their annual report (2015) examines how behavioural sciences can help us to make more responsible decisions, and thus take more responsible actions, on a societal and policy level, in such countries. Furthermore, Foresight is increasingly being used as a policy tool at European, national, and regional levels, enabling policy-makers to make more responsible, and more informed, decisions about the future (see annex 2 & 3).

However, such examples emphasise that as a society we lack the inherent capacity to successfully conduct internal Foresight and act in a responsible way with regards to the long-term consequences of our current actions. Therefore, we must aim to stimulate and engage all of society including decision-makers, experts, scientists, and the public, to think about alternative and desirable futures it wants to see take place. In such a way we can learn how to plan actions, both individual and collective, that will lead to a future that is desirable for everyone.

At the European Parliament's Scientific Foresight Service we have started from the assumption that we are living in a technological society where impacts of technology and science have penetrated all aspects of our common culture such as communication, mobility, and our environment. Moreover, technologies also have soft impacts which are often not possible to calculate in a way that, for example, more tangible impacts such as quantifiable health improvements would be. Their causes may also not be easily linked with effects, making it almost impossible to determine who should be held responsible for such impacts. For example, technologies shape our societal norms and values displayed through our languages, relationships, and cultural identities. Seen from this perspective, we cannot begin to understand any emerging societal challenges without first understanding their relationship to similarly emerging techno-scientific innovations.

At the European Parliament's Scientific Foresight Service we use Foresight as a tool to anticipate a broad array of possible issues that emerging techno-scientific innovations could pose for different layers of global society. The Scientific Foresight Service thus ensures that it first studies techno-scientific trends in order to raise awareness about the possible societal and legislative implications of such trends. Foresight in this context also includes a critical review of the goals of the European Parliament's activities, bearing in mind its multitude of political agendas. European Parliament Scientific Foresight studies are therefore strategic in nature, assessing multiple pathways for reaching a range of possible futures whilst analysis of scientific and technological trends provides views of how the future could be influenced by science. Scientific Foresight is key for the European Parliament to bridge the intellectual divide between society and policy-making relating to techno-scientific issues.

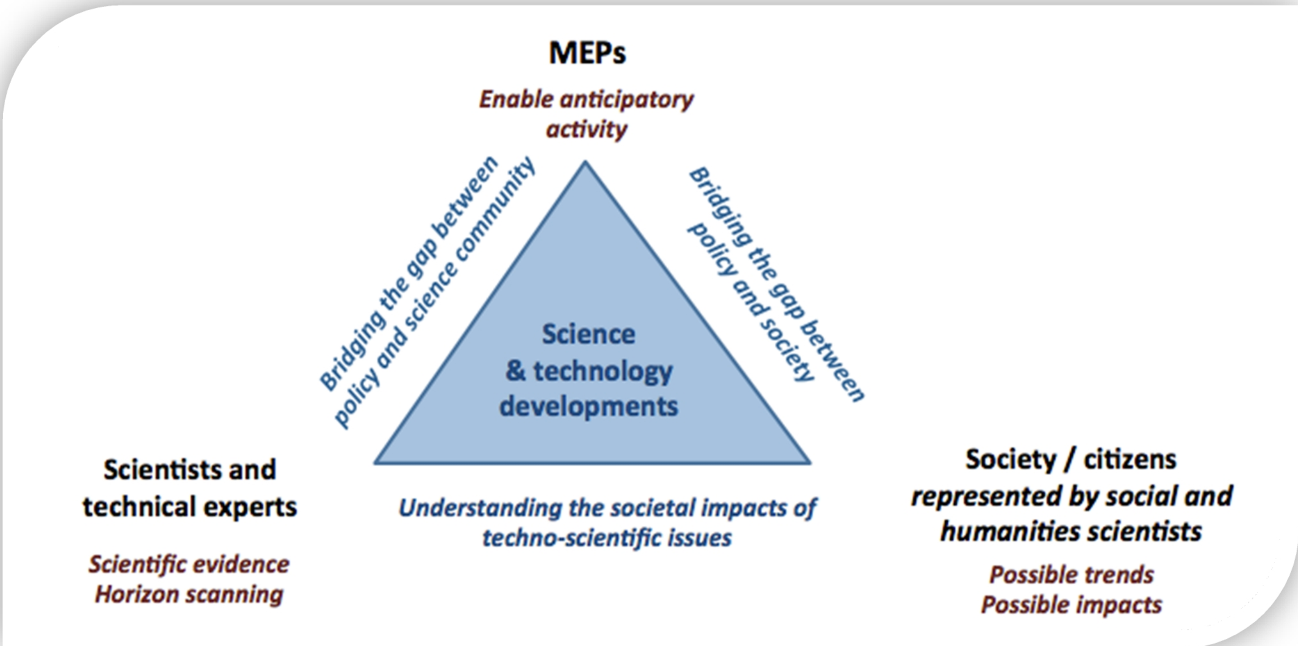
The service also aims to engage policy-makers and the society on better understanding the implications of their actions through use of innovative forms of communication. Awareness-raising activities on societal impacts of techno-scientific trends are being planned, for example by recently publishing a 'scientific trends' publication. Finally, the service aims to communicate information about various trending concerns and new perspectives to help to include Members of the European Parliament (MEPs), the public and the EP staff in its work. This will enhance the overall reflexivity of its work. For example, in regular blog posts we focus on topics that have significant potential for helping understanding, or tackling of, particular societal challenges that may at first glance fall outside the typical techno-scientific domain.

Foresight can be applied in many contexts, for example by companies, an industrial sector, an organisation, or by individuals. We have developed a Foresight approach which is tailored to the European Parliament and that aims to use an approach that is scientifically robust. Scientific Foresight studies conducted within the European Parliamentary Research Service are designed to encourage and support MEPs to:

a) consider a broad range of possible long-term outcomes from techno-scientific innovations.

b) understand the relevance of present actions to achieving desirable futures for the public.

c) align decisions with anticipation of the possible, and desirable, long-term outcomes during the agenda-setting and forward-planning phase of the legislative cycle.



Foresight studies typically make use of a time horizon ranging between 20 - 50 years. Possible topics for Foresight activities in the European Parliament could be specific technology-related questions with societal relevance (concerns, challenges, etc.), for example relating to wearable health technologies, drones, autonomous vehicles, learning and teaching technologies, or 3D-printing.

This document describes the aims and approaches of Scientific Foresight for legislative purposes. This includes an explanation of how Scientific Foresight studies could reinforce the European Parliament in playing the enhanced role that it desires in the agenda-setting phase of the policy-cycle. It will also help the Members to obtain a better understanding of their constituents' expectations of the results of their policy-making.

What comes next

To lend extra weight to the outcomes of this study, an article is under preparation for submission in a peer-reviewed journal, such as '*Science and Public Policy*' or alternatively '*Futures*'.

For capacity-building in the area of Foresight, the service has already started to grow networks within the global and European Foresight community. It is intended that this networking activity continue and be enhanced as far as possible within the areas of Foresight and science policy.

Furthermore, organisation of European Parliament training on employing Foresight methodologies, for example organising 'practitioners' workshops', is foreseen for the future for members of staff in the Scientific Foresight Service and throughout DG EPRS.

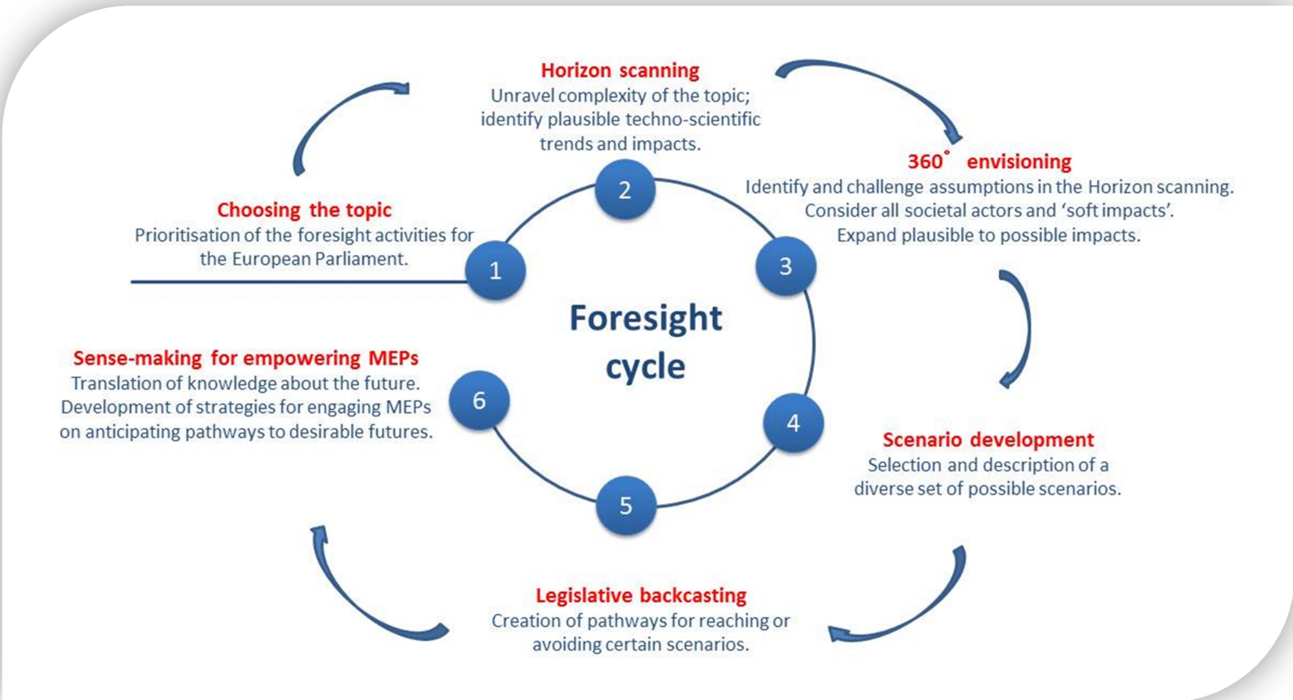
2 Methodological approach for Scientific Foresight in the European Parliament

Whilst forecasting predicts the future in absolute terms, based upon an extrapolation of past knowledge; Foresight instead explores a diverse range of future possibilities. Foresight therefore takes a wider approach to forecasting the future by placing greater emphasis on uncertainties and assumptions. Foresight, with origins in Futures Studies, has a wide scope in terms of topics and is underpinned by academic theory and methodologies and therefore Foresight is a method in itself. As was discussed during the closing session of the *Future-Oriented Technology Analysis* (FTA) Conference entitled "Engage today to shape tomorrow", organised by the Joint Research Centre of the European Commission on 27 and 28 November 2014, Foresight is described as a mental journey along different routes. It is a mechanism which enables more focused levels of decision-making to be reached.

We foresee a two-pronged approach regarding Scientific Foresight in, and for, the European Parliament. First, we will build up ***awareness-raising*** of possible impacts of techno-scientific trends through publications such as regular scientific trends overview reports and a 'What-if?' series of publications, combined with blog posts. These will be designed to trigger awareness of the need for a sound legislative underpinning of future technology-related developments. Second, we aim at ***empowering*** MEPs to work towards facilitating desirable, and to work towards avoiding undesirable, future scenarios. This will provide MEPs with legislative pathways to their desired futures therefore further informing decision-making.

The following section of the report describes a possible approach for conducting Scientific Foresight. This describes possible futures and connects these future scenarios to legislative actions that can be taken today in order to set a course towards the futures considered as most desirable by MEPs.

The proposed approach is based upon the following six phases:



"The best way to predict the future is create it"
Abraham Lincoln

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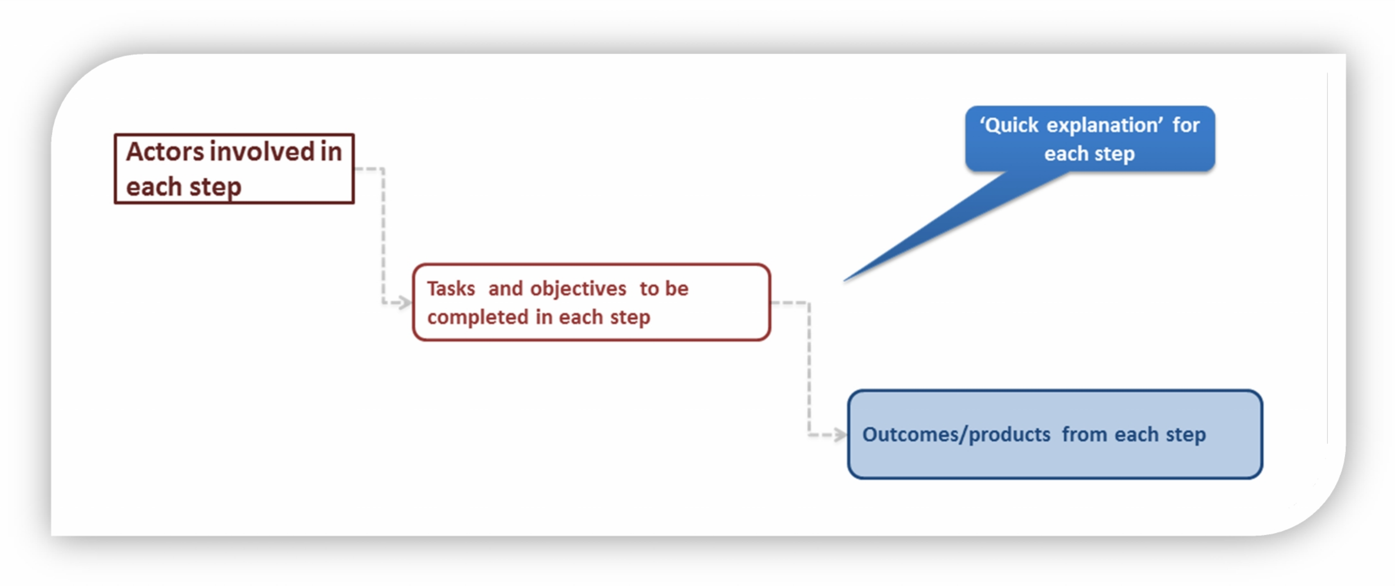
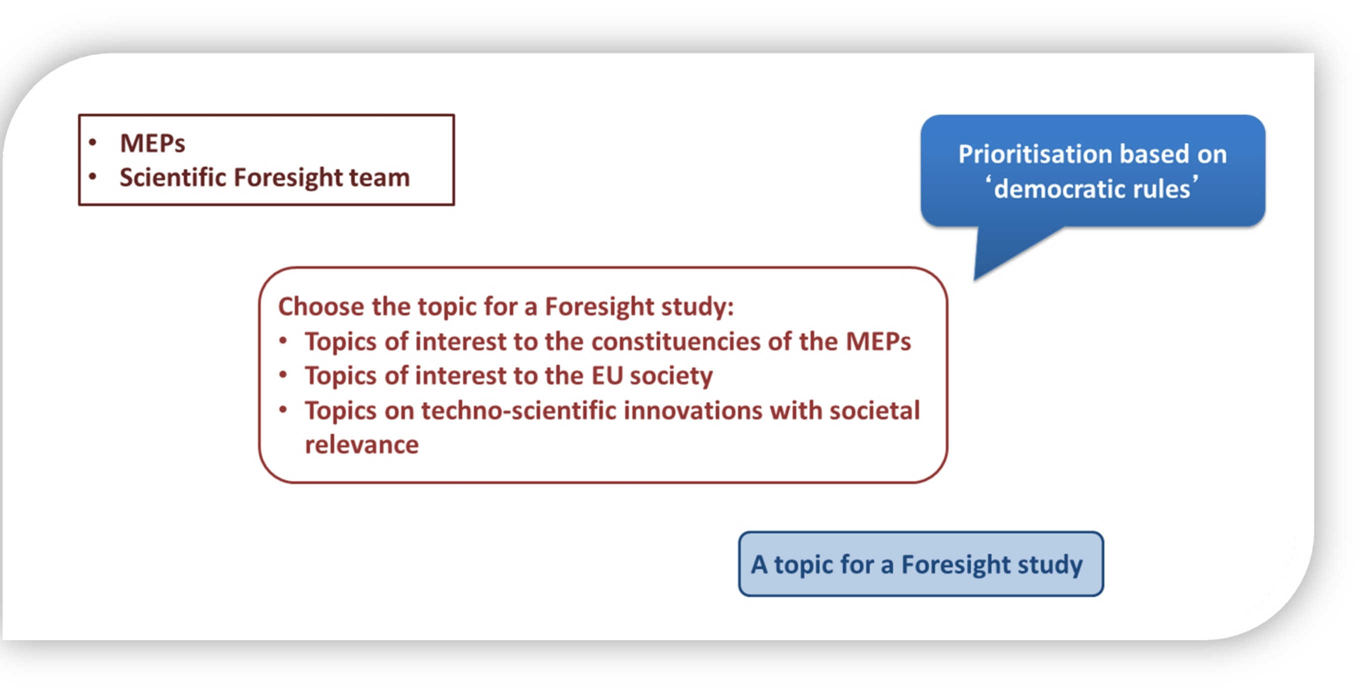


Step 1: Choosing the topic



Step 1 concerns ***Choosing the topic*** for a Foresight study, or project. This has to be chosen in an inclusive manner that is representative of the democratic wishes of MEPs. To be inclusive, the topic also needs to be relevant to the broader interests of the wider European public. As defined by the Service, the choice of Scientific Foresight topic is based upon emerging technology-scientific questions with societal relevance. The topic has to be new and innovative in the sense that a previous Foresight study has not already been carried out for the same topic. However, we can build on existing studies if there still is room for added value. The timing of the Foresight study is essential as it will focus on emerging techno-scientific trends which are still developing and not necessarily supported by legislation, such as the potential use of robots to replace and substitute for humans in the next 20 to 50 years.

Topics could also be chosen in answer to specific technology-related questions with societal relevance (concerns, needs, challenges, etc.) relating to the main priorities areas for the STOA Panel, namely to anticipate a world in 2050 that contains 10 billion people, with an emphasis on:

(i) Mobility;
(ii) Resource availability e.g. food, feed, energy, water and raw materials;
(iii) Information and communication technology;
(iv) A 'perfect life': to keep and make people healthy.

Possible Scientific Foresight topics, with particular societal consequences stemming from their use, that the European Parliament could focus on are:

- Wearable technologies for health
- Drones
- Autonomous vehicles
- The future of learning and teaching technologies
- 3D printing
- Going 'off-grid'

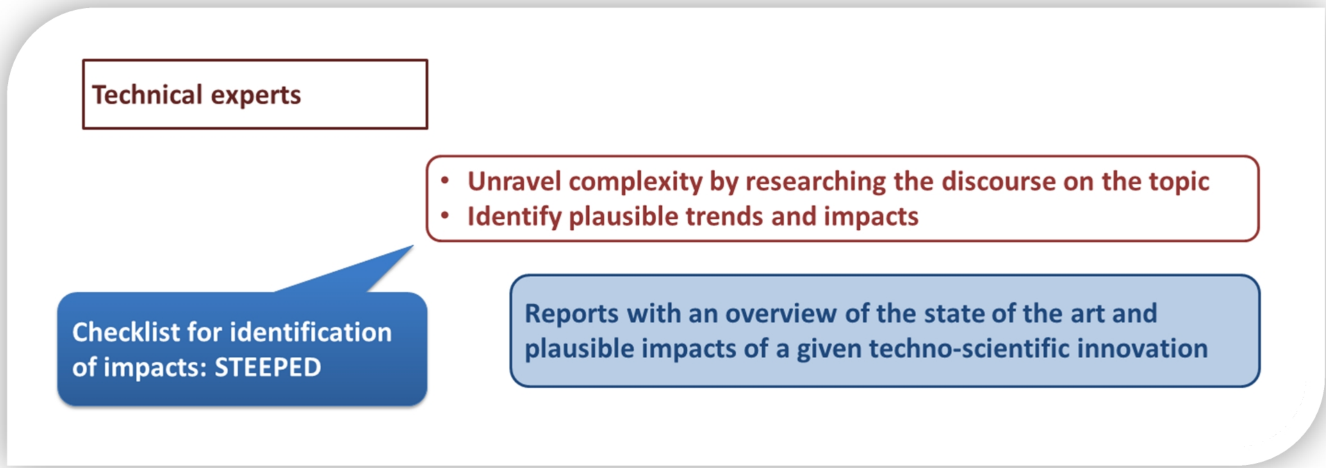
A topic could address a wider societal challenge in a more holistic sense, such as a 'circular economy'.

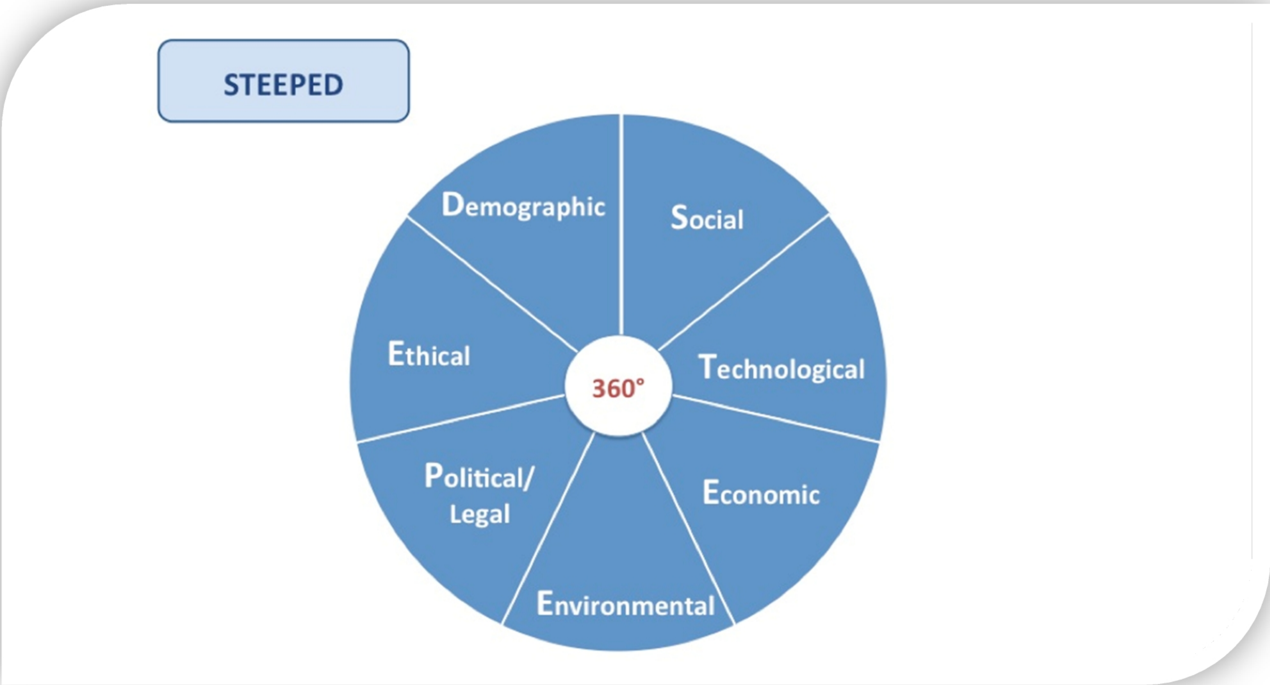
Step 2: Horizon scanning

The second step includes ***Horizon scanning***, where the plausible impacts of a given techno-scientific trend are investigated by experts or stakeholders from the aspects of STEEPED. This first step of technical Horizon scanning is necessary in Foresight studies because the techno-scientific topics in question are complex and are rarely understood without expert knowledge.

In this step a 360° view is produced by employing a guiding framework which we call STEEPED (Social – Technological – Economic – Environmental – Political/legal– Ethical – Demographic) ensuring that the impacts of future trends are investigated with an interdisciplinary perspective in mind. This is an extension of the STEEP acronym which is often used by 'Futures Scientists' as a checklist for analysing trends.

This step is about analysing the existing discourse about a given topic. Horizon scanning based on an existing knowledge-base of available, or ongoing, technology assessments and Foresight exercises in the techno-scientific area being investigated and provides an assessment of emerging trends and their impacts.





Social aspects cover changes in social and cultural values and lifestyles.

Technological aspects include how, and in which directions, technology is developing and the diversification of the use of techno-scientific devices.

Economic aspects cover issues related to conjuncture, production systems, different distribution and trade systems, and consumption of goods and services.

Environmental aspects embrace interactions with our natural habitat and our biophysical environment which is our planet. This category also includes the availability of natural resources.

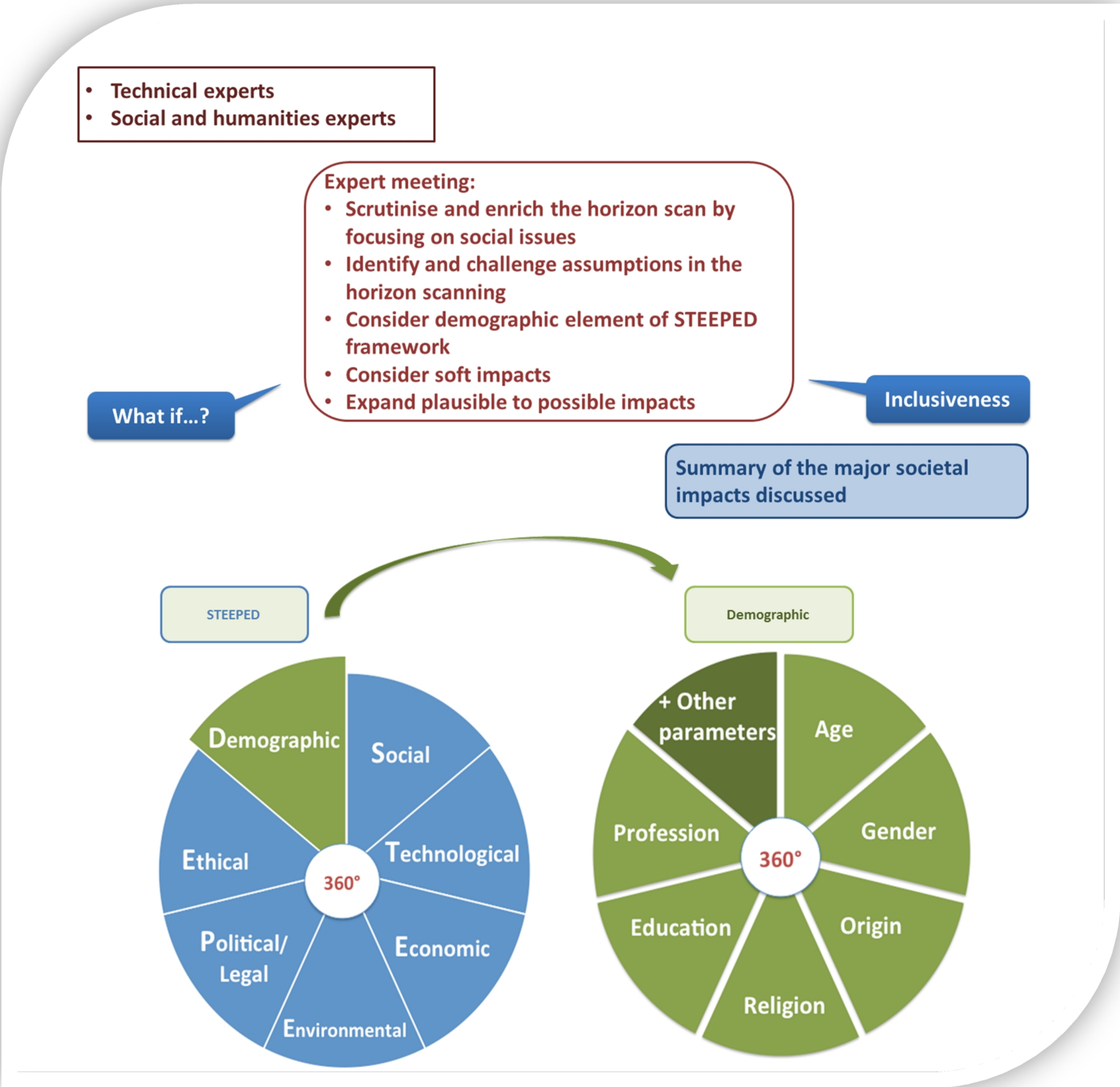
Political/legal aspects describe developments or changes in various policy-making and legislative systems or forms of governance.

Ethical aspects cover individual preferences about the diverse values embedded in the broader society.

Demographic aspects entail various aspects of society, looking at the society as a collection of a varied set of social groups based upon parameters such as age, gender, religion, origin, profession, education, income level, etc.

Step 3: 360° Envisioning

The third step is called ***360° Envisioning***, which involves holding envisioning meetings with the aim of identifying the possible impacts of a particular innovation in a holistic and inclusive way. Knowledge about the future is based on assumptions because the future cannot be predicted. Furthermore, technologies are normally designed to solve some societal issues. However, technologies often end up being used for different purposes than they were originally designed. Once embedded in society, technologies end up having different impacts than were assumed originally. Therefore, another aim of the envisioning exercise is to challenge the assumptions about the future that were identified in the Horizon scanning step.



During the envisioning meetings, experts on technical issues such as engineers and natural scientists, will debate possible futures with experts on societal issues. In this phase, social and humanities experts play a key role in scrutinising the Horizon scanning phase together with technical experts through debating the results of this phase. The two groups of experts will identify and challenge the implicit assumptions taken in the previous step and thereby extend knowledge about plausible impacts (expected to happen) to possible impacts (including those impacts not yet supposed to happen).

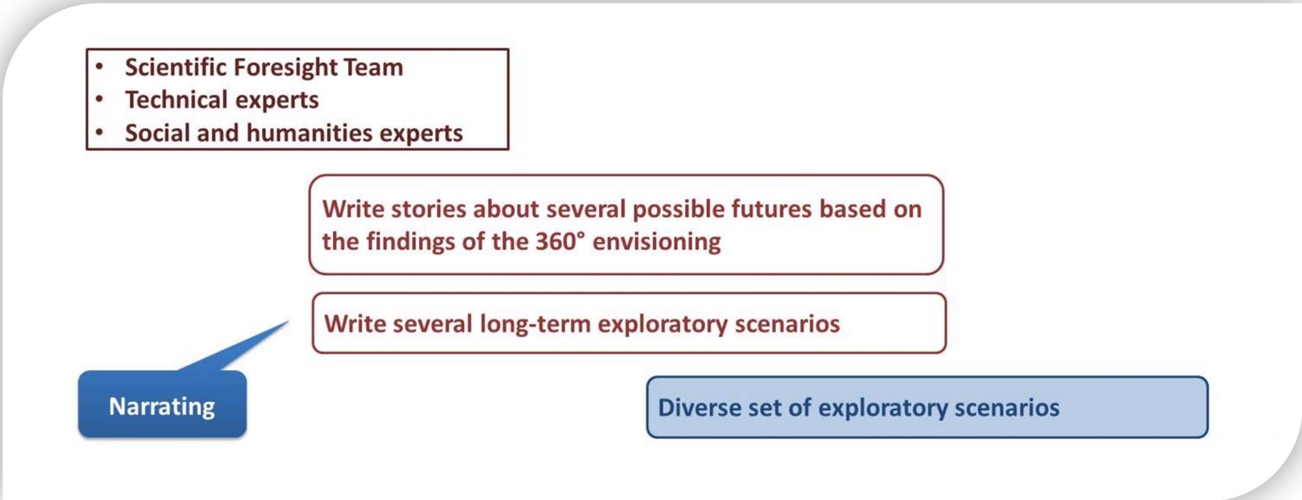
Inclusion of humanities and social experts is also crucial because technologies shape societal morals and create new social and cultural needs. For example, women can plan to have children later in life, after first prioritising the establishment of their career, because they can have their eggs stored safely outside of their body. Technologies also give us new responsibilities, for example being able to make more informed ethical choices, in difficult situations such as choosing whether or not to continue to bear a child which will be born with Down's Syndrome. In this step we aim to take account of such impacts that raise perhaps more philosophical questions but are nonetheless highly relevant for our future decision-making.

Furthermore inclusion of social and humanities experts would also ensure that the identification of impacts takes into account the concerns of all societal actors and includes soft impacts. It is important to note that the 'D' (*Demographic)* of STEEPED, refers to multiple attributes including age, gender, origin, education, profession, etc.

To encourage invited experts to think about a vast array of possible long-term impacts and challenge the assumptions taken in the Horizon scanning, we will develop some 'what if?' questions focusing on the demographic dimension and soft impacts. The 'what if?' questions will enable us to facilitate the discussion at the envisioning meeting to meet the above mentioned objectives.

Step 4: Scenario development

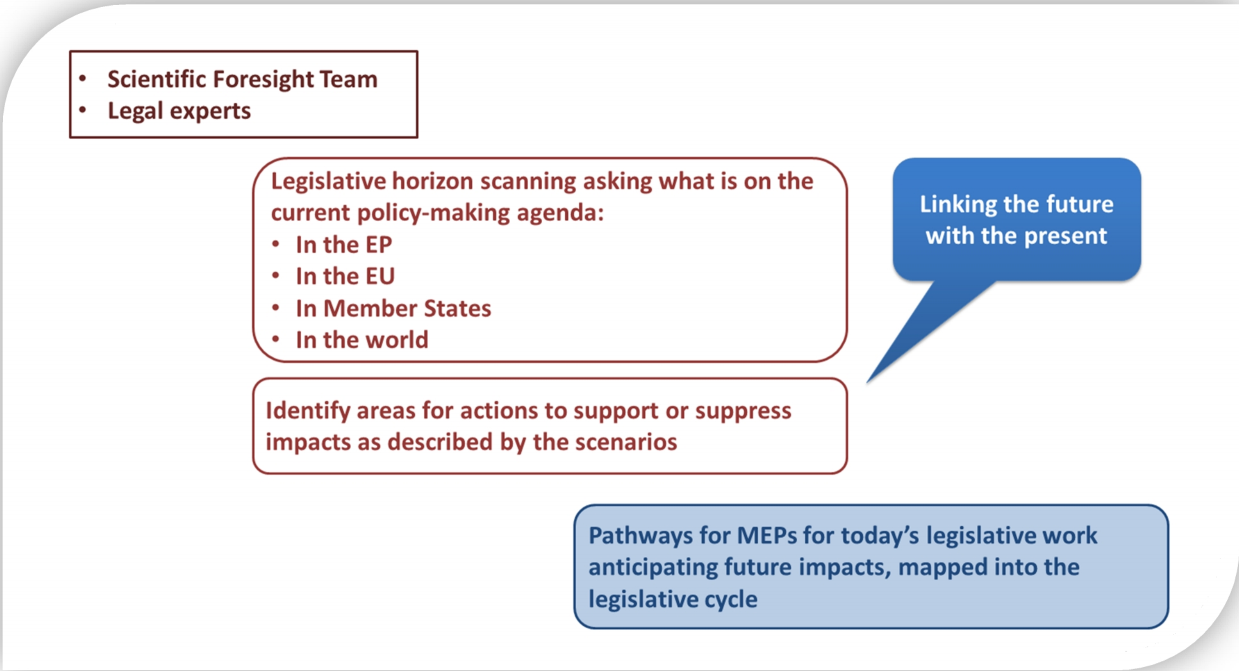
The fourth step mainly concerns S***cenario development***, where the results of the envisioning meeting are used to describe events and trends as they could evolve based on alternative assumptions on how these events and trends may influence the future. Scenarios are stories about alternative futures. The aim is to develop several exploratory scenarios, which provide a plurality of plausible alternative futures. Using exploratory scenarios, we ensure that we are not predicting the future but are instead exploring a wide range of possible futures.
This phase should lead to the construction of a diverse set of exploratory scenarios. These scenarios will be written in the form of 'storytelling' narratives describing possible impacts along the STEEPED dimensions.



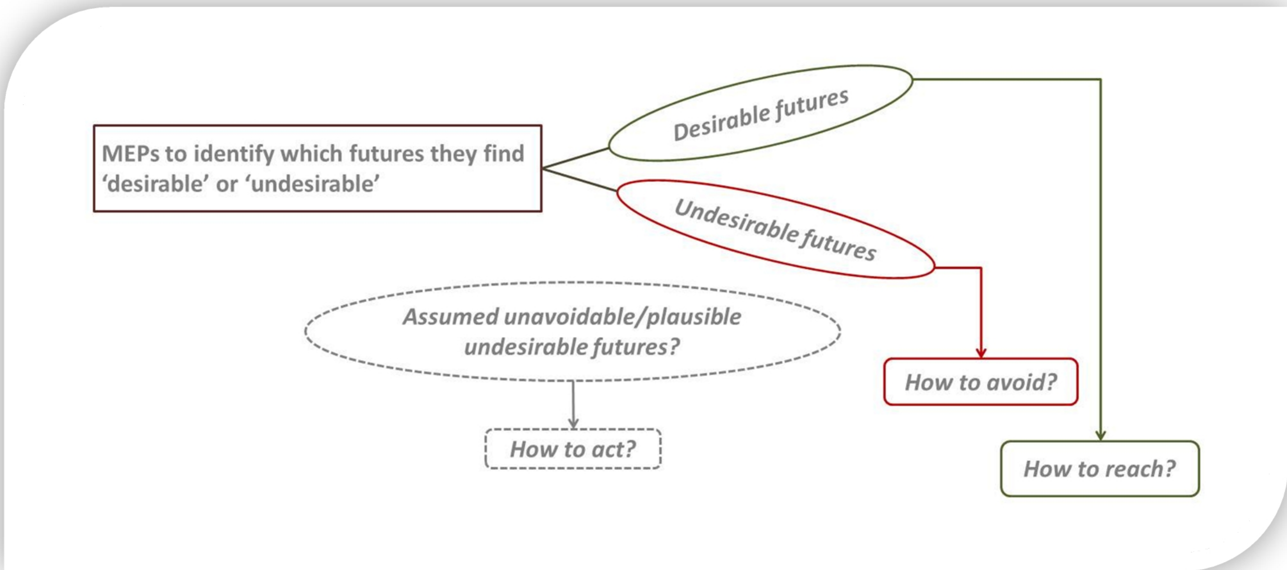
Narrative descriptions of a selection of long-term exploratory future scenarios provide the input for the next step which is the backcasting of future scenarios to today's legislative agenda.

Step 5: Legislative backcasting

We use Foresight exercises as an empowering tool for the Members and Committees of the European Parliament to make informed decisions in the present in anticipation of desirable futures. This will be underpinned by a process of ***Legislative backcasting*** which concerns the connection of exploratory scenarios with current societal and legislative issues. To achieve this, we have to relate the future scenarios to present policy-making agendas. This means that we will analyse the agendas and priorities of the different policy-making and legislative bodies within the European Union, Member States and globally. This can be seen as political horizon scanning. In short, the legislative backcasting makes the Foresight exercise useful for the target users, the MEPs.



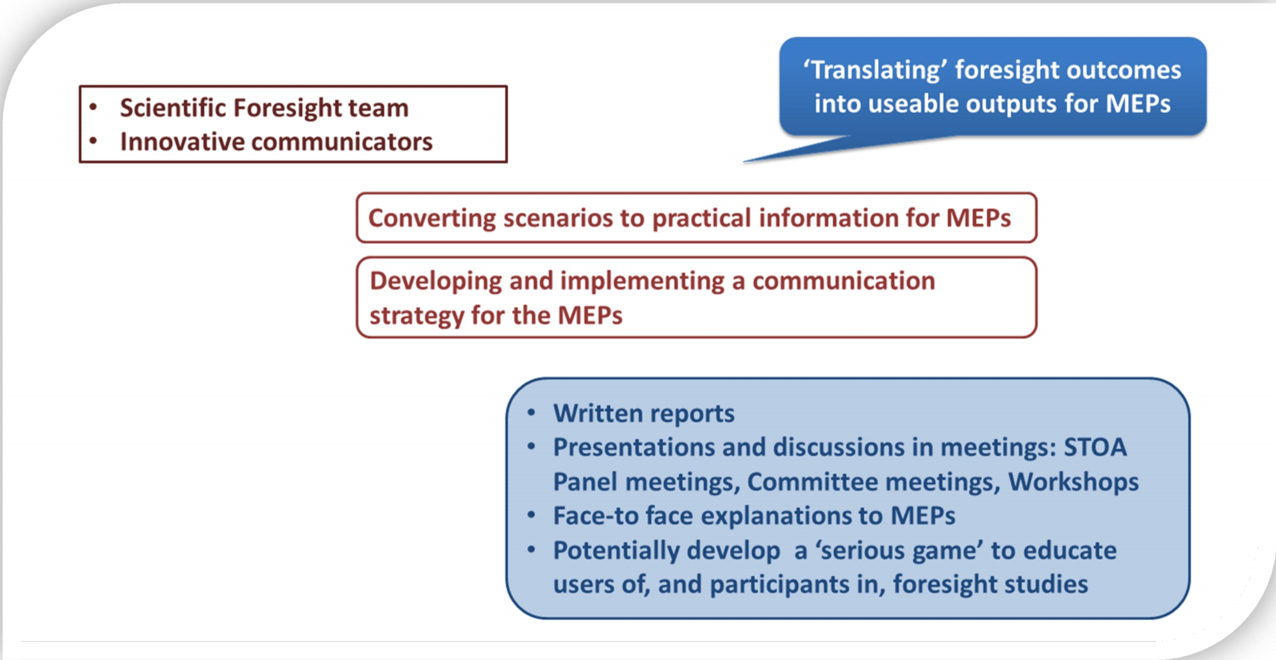
This phase adds concrete guidelines on how scenarios could be reached or avoided. The aim of legislative backcasting is to identify areas of action to support certain scenarios or to suppress unwanted consequences. Through using such reverse thinking, working backwards from possible future scenarios, policy areas could be identified which connect the future to the present. Legislative backcasting enables us to draw several pathways for reaching desirable scenarios or avoiding undesirable scenarios and provide transparent evidence for responsible decision-making to MEPs. The term 'transparent evidence' means that we provide evidence to explain clearly which assumptions were used to identify the impacts described in the scenarios. MEPs could, for example, use the legislative pathways for initiating legislative actions in the agenda-setting phase of the policy-making cycle, thus anticipating possible futures. MEPs are provided with legislative pathways, from which they are able to decide how to reach their desirable futures or suppress undesirable futures.



Step 6: 'Sense-making' for empowering MEPs

"Foresight is a lever to reach higher levels of decision making"
Jennifer Cassingena Harper

A crucial phase of the Scientific Foresight process in the European Parliament is Sense-making, where the results of a Foresight study are converted into an instrument by which MEPs can make informed decisions on policy and legislation. To elicit a response from MEPs to our Foresight studies we will focus on scenarios with the highest impact and where legislative initiatives, including in the agenda-setting phase, could result in futures occurring following their considerations of what are desirable and undesirable futures.



The presentation of legislative pathways produced will be further promoted by a programme of engagement events, for example breakfast workshops or face-to-face meetings with Members, to discuss outcomes, possibly using an interactive tool. This would present identified scenarios, together with possible legislative pathways to realise these, to Members who have expressed a special interest in the Foresight topics in question.

The development of an interactive tool (a 'serious game') to present the outcomes of Foresight studies could be a viable option for effective communication.

Follow-up

After the Scientific Foresight Service has completed at least one Foresight study we propose certain follow-up measures be taken, including activities to promote successes of the Scientific Foresight approach. For example, an impact assessment would enable the Service to identify and better understand the usefulness of Foresight studies at the European Parliament. Depending on the results of the impact assessments, the Scientific Foresight approach could be adjusted to more effectively address the needs of the MEPs.

What is specific in the Scientific Foresight approach

Novelties in our method

This six-phase approach covers some aspects that are not generally used in Foresight studies. The Scientific Foresight Service adopted these novelties in order to focus the approach on the end-users who are the MEPs. Overall, this Scientific Foresight is highly innovative in combining various foresight methodologies in an approach that will produce outputs suitable for legislative bodies, particularly the European Parliament.

In addition, we ensure that we cover a broad spectrum of credible and scientific evidence. This is complemented by the use of an inclusive '360° scanning' process, using 'STEEPED', which includes an element of reflexive anticipation and responsive decision-making. STEEPED covers Social, Technological, Economic, Environmental, Political/legal, Ethical and Demographic aspects. This enables us to adopt a holistic perspective of possible impacts throughout our methodology.

Involving MEPs

Before being finalised, the approach to Scientific Foresight was discussed in a STOA Panel meeting. The aim is that the Foresight studies should be tailored to the needs of the MEPs.

In addition to the 360° approach of the Foresight studies, we include sense-making of the outcomes for the Members by describing varied sets of future scenarios and offering – for reaching desirable scenarios or avoiding undesirable ones - possible pathways for their future-oriented legislative work particularly in the agenda-setting phase.

The Scientific Foresight Service will investigate ways to assess the impact of the Foresight cycles (monitoring policy action triggered by the published results). It will also evaluate the approach after the first of the Foresight studies has been carried out and reflect on the methodologies used where necessary.

As Scientific Foresight is conducted for the MEPs, and as the Service aims to provide the MEPs with an in-depth description of the possible consequences of their preferred legislative actions, we have considered organising face-to-face meetings with MEPs. In this way MEPs will be able to get a deeper insight into possible societal, political and technical consequences than those that were already described in the diverse future scenarios.

Scientific credibility

To ensure that the Scientific Foresight approach detailed above is recognised as being carried out to a high standard with sufficient standards of integrity and credibility, articles on this approach are being prepared for submission to the appropriate, peer-reviewed journals[1]. Codes of conduct for Foresight practice in a legislative environment will also be developed.

[1] (i) A paper on Legislative Scientific Foresight: The case of the European Parliament. For submission to '*Science and Public Policy*', Lieve Van Woensel, Darja Vrščaj, Yonghyup Oh *(Researcher; Full Member of The Club of Rome - EU Chapter).*
(ii) A paper on Responsible Foresight. Darja Vrščaj and Lukas Dorer - In preparation for submission to *Futures*.

3 How will Scientific Foresight support the MEPs? A taster

This chapter gives a taster of what Scientific Foresight in practice can bring to the MEPs. The example used covers a set of emerging techno-scientific trends related to the Internet of Things (IoT). We choose this topic because it could potentially change our entire social environment and thereby influence various actors.

What does the Internet of Things entail?

Thanks to on-going advances in material engineering and the dramatic reduction of the costs of producing very low power electronic chips equipped with advanced bio sensors and wireless networking capabilities, it will become possible to embed advanced computer chips in all the objects that we use in our daily lives. This includes in our clothes, tiny probes inside our bodies, our vehicles, our homes and of course every corner of our cities and living areas. F

The IoT is about the dramatic increase of the volume of data generated and shared quasi-automatically and instantaneously by these connected devices. The IoT is about the ubiquity of the Internet in all aspects of our lives and the exploitation of our digital traces (for intended or unintended purpose, with or without user consent). The volume of data generated over the Internet is increasing drastically. For example, in 2050 we could be 9 or 10 billion of people on earth, but there could be 1 trillion IoT devices.

What impacts could we expect according to the STEEPED framework?

The impacts of the IoT are increasingly obvious, affecting all spheres of EU citizenship. We have learned that technologies are not neutral artefacts, but that their implementation causes diverse impacts, and are sometimes used for different purposes than originally intended. Technologies also have unintended impacts. The first question to address here is what impacts could the IoT have on social, technological, economic, environmental, political/legal, ethical and demographic domains in 20 - 50 years?

If we imagine analysing possible impacts of the IoT using the STEEPED framework, this could bring us to possible consequences described below.

Social – The basic assumption is that new technologies will save us time, for example, because we do not have to think about planning our days, and what we need to buy, where we will buy it, how we will get from point A to point B: the vehicle of the future could drive us to work, drive our kids to school, and automatically suggest making a turn to our favourite brasserie for breakfast. However, this can have two very different kinds of impacts. (i) We could use that extra free time for doing work-related things. Gradually, our work days are expanding. With smart phones, and omnipresent Wifi connection, we are often expected to answer our work mails till right before we go to bed. (ii) We could use the gained free time for concentrating on personal relationships and personal growth and development.

Technological – One of the technological implications of the IoT is that, for it to realise itself, the technology has to continue developing exponentially, especially in terms of nano sensors that can be integrated in mundane devices. Furthermore, IoT devices require IP addresses, however currently we are using IPv4 which has a limited address space, so we will need to move to, for example, IPv6, IPv10... For the IoT to succeed, or start to reach its promised potential, a global adoption of IPv6 is crucial.

Economic - The data generated by IoT devices will be used for commercial purposes, opening the way to new forms of “commercial sales". The IoT will also enable the production of new forms of “customised sales" since the use of IoT devices in combination with 3D printing will also allow us to manufacture fully customized objects fitting perfectly our personal needs. As such, 3D printing could disrupt the existing economic model by decentralising the production of goods.

Environmental - A big promise of several technologies is that we could become more responsible in taking care of the environment. Smart houses will offer a greater flexibility in managing our daily energy and water consumption. More broadly, the IoT offers applications to monitor and control environmental conditions.

However, will we use the emerging IoT tools precisely for purposes of environmental sustainability? It maybe is naive to expect that, out of all the possibilities offered by the IoT, we will use them to save energy, particularly since our society has not necessarily been 'environmentally conscious' in past decades.

Furthermore, the production of IoT devices can be hazardous to environment and humans. Such devices consist of complex combinations of heavy metals and rare-earth metals, as well as highly toxic synthetic chemicals, which make it impossible to sustainably recycle them. Not to mention that in Europe especially, we are running out of many precious metals needed to produce devices.

Political/legal - Legislation on the uses of Big Data is scarce, and needs to catch up with the fast evolving technological possibilities. If we want to support the development of the IoT, we have to take care of the big-data security, privacy, and ownership issues starting now. Will health care systems provide the use of expensive new IoT-based health monitoring systems for everyone, regardless of their income?

Ethical - Given the multitude of devices involved in the IoT; data protection and the privacy of 'smart home users' is a pressing issue. Particularly, ICT technologies are constantly recording users' data about personal things, such as eating habits, weights, health issues, financial transactions, personal relationships. Applications of wearable technologies, such as outlined for healthcare, will require a huge amount of data collection and assimilation. This includes both privacy of the public (what if a Google Glass-wearing user took unauthorised pictures of you?), and of individual wearers for whom data may be automatically uploaded into 'the cloud' in a non-transparent way. There are serious ethical implications of the 'Big Data', which is being used without users' consent or control, and remains stored on the cloud, somewhere where the user cannot delete it. Users normally do not have the control of their personal data. Furthermore, many users do not know what they are agreeing to when they waive their rights to Apple or Facebook, or give their cookies to random pages.

Whose responsibility is it to prevent abuse of private data? Should governments be responsible for enhancing the public's literacy about their privacy concerns and possible consequences? Is it the users' responsibility to inform themselves properly and, based upon that, to take decisions on using or not certain devices and services?

Demographic - The development of wearable technologies offers huge potential for both the type of medical care that patients receive and the way in which such care is delivered. For example, we could become aware of possible health risks much earlier than nowadays, before the disease actually evolves. People for whom travelling to a medical centre is difficult, such as the elderly, would potentially benefit. However, some members of society may feel particularly uncomfortable in wearing clothing or technology that contravenes personal religious or cultural views or beliefs. What could be the disadvantaging or advantaging effects for them of wearable technologies in this regard? Given that recent research has suggested that women are potentially less likely to actively engage with wearable technology, would a predominantly male consumer-base be inadvertently developed for such technology? Will certain IoT-based health-related services only be available for people with a high income?

Which legislative pathways could be related to the Internet of Things?

The Internet of Things (IoT) has taken a rapid path of development and this is a challenge for the European Parliament (EP), in its role as a co-legislator. If properly regulated, the IoT could potentially yield gains and a very positive outcome for European citizens, while avoiding negative ones. With this in mind, the primary objective of the EP could be to legislate in a way that is beneficial for its constituents. Scientific Foresight would provide an ideal situation where quality would prevail over quantity. In short, it is not a matter of more regulation, but more anticipating regulation.

The legal framework has yet to be written however. Traditionally, it has been thought that law cannot advance as fast as new technologies. This can potentially bring about scenarios in which a lack of regulation, or ineffective regulation, leads to undesirable outcomes. Through making use of Scientific Foresight, the EP should now be ready to meet this regulatory challenge. It should be able to better anticipate possible outcomes and identify the pathways needed to set EU society in desirable directions.

The EP could focus on two separate procedure tracks, being (a) the ordinary legislative procedure, stemming from a Commission initiative, to ensure that the text respects the principles described below, and (b) legislative initiative reports i.e. to encourage the Commission and Member States - to take regulation for the IoT seriously and to express their opinion on how such subjects should be regulated.

Possible legislative pathways related to the IoT could cover

- Transparency in the market;
- Equilibrium between providers and consumers;
- Respect towards privacy and ownership of personal data;
- Protection of Intellectual Property (IP) and 'systematic intelligence' for platform providers and designers/intermediate users;
- Setting quality standards (however this typically remains within the realm of 'private law').

The creation of a legislative framework on the IoT would potentially affect policy areas (according to current organisational structure of the EP) such as the Internal Market and Consumer protection, Industry, Research and Energy, International Trade, Employment and Social Affairs, Environment and Legal Affairs.

Annex I: Overview of relevant literature for further reading

This list gives an overview of the main references for those interested in learning more about Foresight and Futures Studies.

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Annex II: Historical timeline of future-oriented approaches

The interest in the future has been present for centuries. For example, various cultures have been concerned with divination or discovering the unknown, such as, anticipation of the weather, or of gods' will. Several historical legends tell us stories about people who had the capacity to provide prophetic predictions about the future, for example, the Delphi Oracle or Nostradamus. However, the first reference to the possibility of the study of the future as scientific activity can be traced to 1902 when H. G. Wells proposed to establish a Foresight profession, which would study the future outcomes of technological innovations, as opposed to history, which studies what happened in the past. Various streams and Foresight approaches exist. Bellow we describe how such approaches emerged and how various strands of futures studies co-evolved.

- 1930s- 40s:
  - During World War II, the American military establishment developed analytical capacities to anticipate possible events. They studied not only military events, but anything that could affect military affairs, such as technological, demographic and political trends. The focus was on how to win the war.
  - After World War II, Foresight activities were shaped by the tensions of the Cold War and the threat of nuclear annihilation. Foresight activities were highly focused on 'strategic' issues related to national survival.
  - New aims to explore and control the future through national planning emerged after World War II. European nations engaged in rebuilding of Europe based on national economic planning processes. The focus was on long-term planning for achieving social goals.
- 1950s:
  - In Western Europe, Foresight was developed in a network of academics form France, Italy, the United Kingdom (UK) and Germany. With the support of the US Ford Foundation and the Congress for Cultural Freedom, intellectuals and founders of the Futuribles association and journal could finance some of their activities. The motivation of many of these individuals was not related to security and defence. However, Foresight in military affairs also became a normal government activity, especially in France and the UK.
- 1960s:
  - Technological forecasting and other approaches that are predecessors to Technology Assessment emerged. These strands focused on studying the impacts and opportunities emerging from various technological innovations.
  - Futures Studies gained acceptance as an academic field that aimed to study alternative futures. The first attempt of a scholarly futures study looked into 'images of the future' to analyse the rise and fall of civilisations. The World Future Society was established.
- 1970s:
  - Growth of operations research and think-tanks gave more visibility and diversity to Foresight approaches. RAND Corporation developed several Foresight tools, such as scenario-writing, computer simulations, and the Delphi technique.
  - With growing modernisation various natural and man-made disasters such as oil spills, and nuclear risks related to the Cold War increased. This led to a more broadly accepted awareness that it is not possible to predict how the future will play out as there are several influential forces that make the future highly uncertain. For example, in 1973 Royal Dutch Shell developed two sets of scenarios for strategic planning, with an increasing appreciation of uncertainty.

- From the 1980s:
    - Technology Assessment (TA) approaches, defined as an "interdisciplinary research field aiming at providing knowledge for better-informed and well reflected decisions concerning new technologies", started to gain relevance (Grunwald, 2011). For example, Science and Technology Options Assessment (STOA) became a body set up for TA activities at the European Parliament.
- From the 1990s onward:
    - With growing globalisation and international exchanges of world views, ideas, and values, the socio-cultural aspects of development gained even more relevance in the sense that the social context technology is embedded in became relevant. New concepts, such as risk society and technological culture, were popularized, which emphasised the tangible consequences of modernity observed in a wider society and caused preoccupation with the future safety and environmental issues.
    - There has been growing interest in policy-oriented Foresight in many countries, particularly in relation to security issues. This interest in security-related Foresight may be seen as related to changing perceptions about potential threats to which governments must respond. The rapid rise of China, for example, is focusing on the geopolitical power balance again and leading to a revival of military-centred long-term strategic studies.
    - Scientific research and technological innovations (hereafter abbreviated as techno-scientific) became the principal area of foresight in which governments have invested around the world. It is the most common area of focus for Foresight activities in Europe. It is also at the heart of EU Foresight activities. It includes, for example, the work of the Directorate-General for Research & Innovation (DG RTD).
    - Techno-scientific Foresight has evolved in recent years to focusing on the social context. This is seen in the UK's Foresight programme, which has broadened before narrow focus on techno-scientific topics to also understanding the social context in which the techno-scientific changes take place. The goal is to help clarify how the social and economic setting will impact on the use and relevance of the predicted changes in techno-scientific innovations. Ultimately the goal is to create an evidence base to lead strategic planning.
    - Other countries are developing new technology oriented Foresight efforts with the goal of applying science and technology to 'grand challenges'. South Africa, for example, has an increasing interest in using Foresight to deal with 'grand challenges' such as climate change. In Australia, technology Foresight is being applied in sectors such as energy, sport and tourism by the new futures unit in the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Annex III: Inventory of Foresight initiatives

While Foresight is still an emerging and evolving field, a **few universities offer the possibility to study Foresight** or Futures Studies in official academic programs in several universities around the world. For example, the largest Futures Studies program in the world is at Tamkang University, Taiwan. Furthermore, the University of Hawaii at Manoa and the University of Houston are also prominent. In Finland Futures Research Centre offers a Masters Degree in Futures Studies, while Manchester University offers degrees in Strategic Foresight.

Other relevant **European Foresight research centres and organizations** are: Copenhagen Institute for Futures Studies; The Foresight Programme, London, Department for Business, Innovation and Skills; The Futures Academy, Dublin Institute of Technology, Ireland; Kairos Future, Sweden; World Future Society (global); World Futures Studies Federation (global); Italian Institute for the Future, Naples, Italy; Club of Rome; The Millennium Project (global).

Furthermore, several **governmental institutions** are actively involved with Foresight. In the European Union: European Strategy and Policy Analysis System – ESPAS; The Unit for Science Policy, Foresight and Data, Directorate-General for Research & Innovation (DG RTD); European Commission, coordinating networks such as the European forum on forward looking activities – EFFLA, which has nowadays been integrated in the RISE project; The “Foresight and Behavioural Insights” Unit and the Seville-based Institute for Prospective Technological Studies (IPTS) of the Joint Research Centre of the European Commission; Futurium, “the Digital Agenda for Europe”, a participatory web platform created by DG Communications Networks, Content and Technology (DG CNECT). UK: Government Foresight in the UK is dominated by the UK Foresight Office, a central agency of government that reports directly to cabinet, and is headed by the Chief Scientific Advisor. It was originally dedicated to technology and industry but now has a broader thematic mandate to look at challenges for the future, pursuing major Foresight projects, horizon scanning, and training activities across government. Separately, the Development, Concepts and Doctrine Centre (DCDC) and the UK Defence Science and Technology Laboratory (DSTL) do Foresight and horizon scanning for the Ministry of Defence.

Organizations and institutes involved with Foresight **outside of Europe**: AUSTRALIA: The Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia's national science agency, has a dedicated team (CSIRO Futures) working on Foresight in energy, transport and other fields. CANADA: Policy Horizons Canada (PHC), a centralised agency for doing Foresight work and building Foresight capacity in government. PHC is directed by a high-level steering committee of deputy ministers and reports to the Privy Council. Parts of the Department of National Defence, including the Directorate of Future Security Analysis, use Foresight for capabilities and personnel planning, primarily for internal audiences. KOREA: Korean Institute for Science and Technology Evaluation and Planning (KISTEP), very focused on developing techno-scientific capabilities. RUSSIA: The Institute for World Economy and International Relations (IMEMO) is a think tank that does influential economic and geostrategic Foresight studies. The Kremlin-sponsored Council on Foreign and Defence Policy (SVOP) is a group of experts contributing to developing long-term visions (rather than Foresight) on military and strategic issues. USA: Many agencies (State, FEMA, Defence, Treasury, Energy, OMB and especially GAO) have strategic planning capacities that use Foresight to varying degrees. The National Intelligence Council produces major Global Trends reports every 4 years. As the world's foremost producer and user of Foresight work in the last half century, the US military has an array of strategic planning and intelligence organisations, in which Foresight work is well entrenched to inform planning.

We are living in a technological culture in which technologies penetrate every domain of our society. Techno-scientific innovations are often designed to make our lives easier, or to solve some societal issues. However, technologies pose unwanted and unintended impacts. This document describes a methodology for Scientific Foresight which offers the Members of the European Parliament legislative pathways to anticipate possible impacts of techno-scientific innovations.

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