

Sonja Kind, Ernst A. Hartmann, Marc Bovenschulte

The Method of Visual Roadmapping for Trend Analysis, Roadmapping and Visualisation of Expert Knowledge

An instrument of the iit (Institute for Innovation and Technology) for use in politics and the economy for the management of innovation and technology

Summary

The Visual Roadmapping method developed by the iit (Institute for Innovation and Technology) is particularly well-suited for the performance of trend analyses and the creation of roadmaps in the context of foresight activities or ex-ante evaluations.

The Visual Roadmapping method has already been deployed by the iit in diverse projects related to research and innovation policy in order to forecast technological developments. Using this method, not only the central milestones of technological development are reflected in a chronological order, but also socio-economic influences and impacts on the economy and on society are correlated to one another. The Visual Roadmapping approach allows a uniform manner of proceeding and is thus applicable to a wide variety of different topics. The results are

visual roadmaps or structure plans providing an at-a-glance understanding of the complexity, the critical development paths and the chronological sequence of the respective topic.

The method presented here is a modified, further developed variant of the Structure Formation Technique (SFT) according to Scheele and Groeben (1984), originally applied in psychology. This is a so-called dialogue consensus method used to visualise the knowledge and insights of experts in a moderated dialogue process and to find a consensus with regard to the process presented and the factors depicted. The visual roadmap compiled in the workshops serves as the starting point for further in-depth analyses and discussions as well as the formulation of recommendations for action. Innovation and technology policy can thus be given decisive impulses.

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1. Introduction to the Visual Roadmapping Method

The Visual Roadmapping method is an instrument developed by the iit that is particularly suitable for the forecast and identification of milestones on the road from 'here and now' to the future.

In research and innovation policy, the Visual Roadmapping method may be used equally for the analysis of trends or the compilation of roadmaps. Both, future scenarios and missions may be described. Thus, the Visual Roadmapping method is an ideal instrument that may be used for ex-ante evaluations in innovation and technology policy, as strategic potentials may be identified and requirements for action derived.

With the aid of the Visual Roadmapping method, the complex interplay of the object under investigation may be visualised

with regard to its future development, depending on essential influencing factors. This is particularly useful when investigating developments in innovation policy or society, as these are integral part of a complex framework of mutually dependent and inter-related factors.

This method is usually applied in discussions with one or two experts, but may also be implemented in small groups of about four to eight people. The result of such a process is the visual roadmap (structure plan) that reveals at a glance an impression of the complexity, the critical development path and the chronological sequence. Four relevant aspects are categorised in a visual roadmap, the progress of which is monitored over a period of time:

- ▶ Socio-economic determinants (legal, economic, social framework conditions, phenomena and prerequisites)
- ▶ Enabling technologies (scientific-technical prerequisites for the respective topic)
- ▶ Development of the topic to be investigated (central aspects and milestones that are of importance when developing the topic)
- ▶ Impact (economic and social effects but also offers of new products and services, etc.)

Figure 1 shows an 'empty' coordinate system that is 'filled' with relevant aspects in the course of a moderated two-hour discussion with experts. Based on our current views, the question will be raised as to how the selected target may be reached in about 15 years' time¹, and which determinants will hereby be of major relevance. The moderators keep records of the main focal points of the discussion. The result is a 'filled' coordinate system of headwords visualised on presentation cards that are set into relation with one another using arrows. At the end of the discussion process the experts agree as to which aspects are of the greatest significance for the progress of the topic. Whilst there is no ideal type of visual road map, the white arrow is intended to indicate that the 'typical' direction of development is from bottom left (starting point, influenced by socio-economic factors) to top right (target point with its impact on economy and society).

Taking as example the topic 'Energy Self-sufficient Districts' it is demonstrated how, with the aid of the Visual Roadmapping method, the central technical developments but also the socio-economic determinants and effects may be illustrated in chronological sequence. Figure 2 below shows an example of a final result of a workshop with experts implemented using the Visual Roadmapping method. The superordinated question that

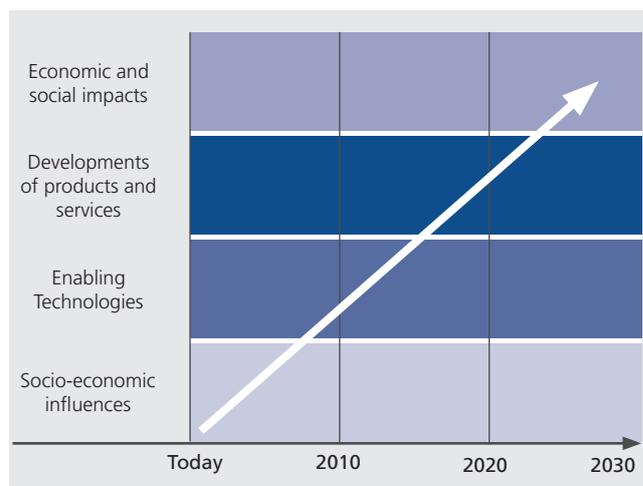


Figure 1: A still 'empty' coordinates system of a visual road map
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had been posed in this workshop was: What are the decisive steps that are necessary to achieve the goal of energy self-sufficient districts? The topic of 'energy self-sufficient districts – the generation of energy always at the point where it is needed' has created the basic idea of neighbourhood energy districts that come together and, establish self-governed, with the aid of new technologies and infrastructures, energy self-sufficient units. The general idea is the networking of both the households among each other to form intelligently managed energy districts and of the energy suppliers and consumers as well as of different technologies. The target expressed here was the result of a brainstorming session that preceded the Visual Roadmapping workshop. Individual aspects were entered in the respective categories of the visual roadmap and connected partly with each other using arrows. The connecting arrows describe, within each of the categories, an evolutionary-temporal development, whilst the arrows between aspects across the category boundaries illustrate influences and dependencies. At first sight this example shows a complex picture. But at the same time it is made clear that an, on the whole, complex process is illustrated in a strongly simplified way and with a few aspects relevant for the topic.

By means of the visual roadmap one is able, at one glance, to recognise trends and to identify those steps that are of particular importance for the development of the topic under observation and/or of sub-topics. Such critical paths and milestones may be identified by colour-coding in order to highlight them optically. The Visual Roadmapping method is, as a general rule, implemented in discussions with at least one and up to a maximum of 10 experts. If the experts involved come from different disciplines or represent different stakeholder

¹ The time range of the forecast depends on the respective job and scope of investigation. The 15 years referred to represent a 'typical' value.

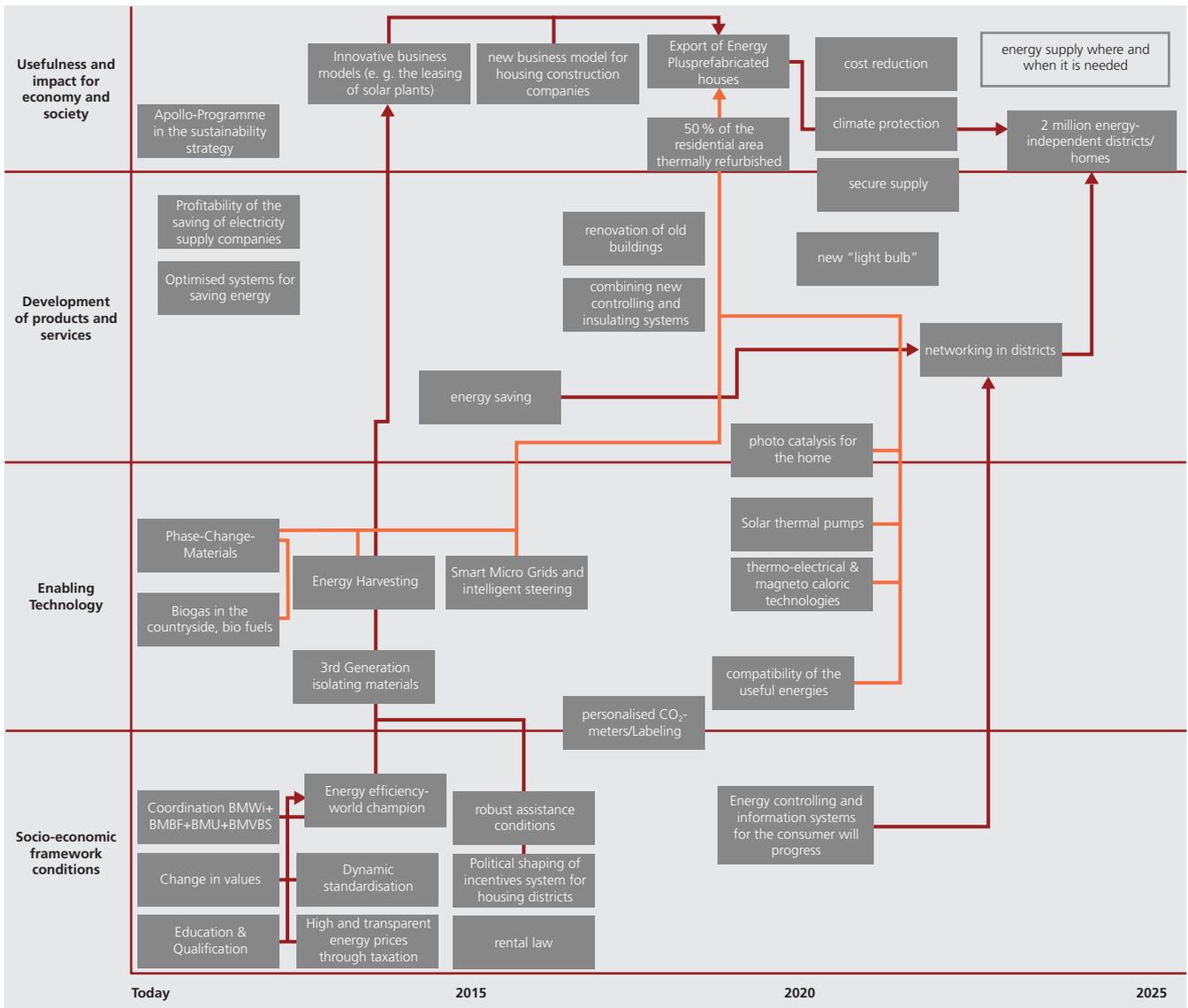


Figure 2: The visual road map depicted here is the result of a moderated workshop with a group of experts from the realm of Climate/Environment/Energy (Apollo-Workshop of the Federal Ministry for Education and Research held on October 5th 2009).²

groups, it is possible, with the aid of the visual roadmap, to bundle the interdisciplinary and thus, usually quite different viewpoints. The result of the Visual Roadmapping method, the visual roadmap, represents a consensus between the experts involved, as these are required to agree at the end of the discussion process on one picture, a visual roadmap. Thus, the Visual Roadmapping method also supports, in the course of the process of working out a visual roadmap, the formation of a consensus between the representatives of different interest

groups on a single topic. The visual roadmaps offer a reliable starting point for the next stage of the analysis. First of all the visual roadmaps are commented in writing and the essential statements are summarised. After that, recommendations for action are derived that in this way form the basis for the orientation, adjustment and development of measures in innovation and technology policy.

² This diagram illustrates an intermediate status and does not reflect the results that continue to be used by the BMBF. Reference is made in this context to the future-related project 'The CO₂-neutral, energy efficient and climate-adjusted city'. This is one of ten future related projects in the context of the high-tech-strategy of the Federal Government which, inter alia, has been derived from preliminary work performed with the aid of the Visual Roadmapping method, cf. also <http://www.bmbf.de/pubRD/morgenstadt.pdf>

Usefulness of the Visual Roadmapping Method at a Glance:

- ▶ Visualisation of complex processes
- ▶ Substantiation of statements and determination of events, dimensions and relationships
- ▶ Reduction of complex correlations and dependencies to their central aspects
- ▶ Trend statements / Identification of necessary milestones
- ▶ Interdisciplinary due to the incorporation of different groups of experts
- ▶ Formation a common view of a topic and finding a consensus
- ▶ Derivation of recommendations for action

2. About the Visual Roadmapping Method

The method presented here is a modified, further developed variant of the Heidelberg Structure Formation Technique according to Scheele und Groeben (1984) originally applied in psychology for the extraction of expert knowledge. The method has been used for the illustration of working biographies (influences of one's private and working life on stages in one's employment history; cf. Hartmann, 2000). This is a so-called dialogue-consensus method. The aim is to visualise the knowledge and insights of experts in a dialogue process directed by moderators and to reach a consensus based on the process depicted and the factors reflected. The 'structure plan' or visual roadmap developed in the workshops serves as the starting point for further-reaching analyses and discussions as well as the derivation of recommendations for action.

3. Possible Areas of Application for the Visual Roadmapping Method

The object that is investigated by the Visual Roadmapping method can be variable. An entire field of technology can, for example, be extensively analysed. Questions that may guide the investigations are described in the following, using the example 'Information and communication technologies':

- ▶ How will the information and communication technologies develop by the year 2030?
- ▶ Which socio-economic factors, i. e. social, economic, legal etc. framework conditions will play a role in this context?
- ▶ Which decisive technologies are of significance for the development of this topic?

- ▶ How will the topic develop, i. e. which products and/or services will come into being?
- ▶ Which positive or indeed negative impacts upon economy and society are to be expected?
- ▶ How do the individually cited aspects correlate to each other chronologically and causally?

It is also possible to analyse technological sub-topics and their development. For example: "How will the biologically-based micro system technology develop until 2030?" or more complex questions may be analysed: "How could one succeed in realising electromobility by the year 2030?" The method may, in principle, be applied to all relevant questions to technology and innovations that are subject to change in the course of time and the changes that are dependent on different factors. Thus, the method is equally suitable for analyses in politics and the economy.

4. Visual Roadmapping as a Method of Forecasting for Politics and Management

Forecasting activities are not only demand in the context of innovation and technology politics but also in innovation and technology management of business enterprises. Methods of forecasting are intended to help find the answer to the fundamental questions as to what the world of tomorrow will look like and which needs for action can be derived for politics and economy. In the case of politics, it is a matter of setting the points, adjusting and shaping framework conditions and intervening if there are signs of market failure. Against the background of limited R&D budgets it is necessary to recognise and set priorities for innovation and technology policy. Companies are required to recognise market potentials and critical developments of the future as early as possible in order to maintain their competitive ability in the long term and to increase it as much as possible. Typical questions that have to be answered in the context of forecasting processes aim at recognising the future fields of activity for innovation and technology policy. This encompasses on the one hand the technology and innovation fields themselves and on the other hand the identification of cross-cutting issues and essential determinants. Among the aspects to be mentioned here are framework conditions such as human capital, financing, legal questions or general infrastructure matters. In the case of technical questions the attitudes and positions within society towards new technological developments and their social consequences play a very important role. Research and innovation policy regards the innovation system as a whole with its actors, processes and structures. In this context those points must be identified at what point the actors have to interact with one another.

The analysis of the possible (strategic) potentials of technologies and innovation is of immense significance for the question of the setting of priorities. Depending on that, one should decide where to set priorities. Like other forecasting methods, the Visual Roadmapping method is also used within a strategic process in which scientists, experts and representatives of different interest groups participate. The results of forecasting processes such as may be implemented with the aid of the Visual Roadmapping method are recommendations for action that are directed at the various stakeholders involved in the processes – politics, economy and society.

5. Possible Results of the Visual Roadmapping Method

In addition to an insight into the future with the identification and determination of milestones one may also conversely ‘think backwards’ from the future beginning with a desired target. The visual roadmap may, thus, also be developed ‘in reverse’ by determining a desired result for the future and, at a next stage, by thinking about which decisive steps are necessary or which factors can support or disturb the development. If the visual roadmap is rather intended to look from ‘today’ into the future, trends may be identified in the context of the factors involved. This may be a question of both technological and socio-economic trends.

It often happens that so-called ‘chicken and egg problems’ are often only made visible in the visual roadmap. A typical example is that technological developments do not make progress as the economy expects that politics will set decisive points. Reversely, politics is waiting for the business enterprises to show clear-cut commitment before undertaking any further actions. It is only when such mutual dependences are recognised that steps can be worked out for the resolving.

A further crucial result that may be achieved by means of the Visual Roadmapping method is the discovering of critical paths.

Result of Visual Roadmapping:

- ▶ An insight into the future, starting from ‘today’ versus a look back from the future to the present
- ▶ Identification/definition of milestones: roadmapping
- ▶ Identification of future developments: trend analysis
- ▶ Identification of ‘chicken and egg problems’
- ▶ Identification of critical path dependencies
- ▶ Identification of positive and negative impacts
- ▶ Identification of important influences
- ▶ Derivation of recommendations for action

In the visual roadmap one may quickly identify which stages build on one another, which aspects are important for a desired or undesired development. The visual roadmap discovers the positive and negative determinants and shows what impacts are to be expected. The recognising of the critical path and its influential factors simplifies the derivation of recommendations for action and prioritisation of subsequent activities.

6. How the Visual Roadmapping-method works in practice

The Visual Roadmapping method is implemented in the context of workshops with a duration of about two hours and involving a circle of persons numbering between a minimum of one and a maximum of ten. The process will be moderated by at least two persons who lead the way through the workshop and document the ideas of the participants in the discussions successively.

At first the moderators present the method and explain the procedure for the following workshop. It is intended that the experts should discuss the topic along the lines of the named categories in the coordinates system of the visual roadmap in chronological sequence. The moderators record the thoughts and ideas of the experts. These are noted, for example, on metaplan cards and laid out into the coordinates system of the visual roadmap. Thereby, the moderators make sure that the card e.g. aspect has been correctly named, been laid down in the correct category and is to be found at its desired position in the chronological sequence. The experts themselves are also allowed to move the cards around until they are in what they regard to be the correct place in the coordinates system.

In order to facilitate the start it has been shown to be helpful if one or two example cards are placed in the empty coordinates system. These cards serve as anchor points or may directly lead to a controversial discussion that helps the process to move on. Depending on the size of the group the size of the coordinates system should also be adjusted so that the keywords written down are visible to all participants. From a group size of five persons it is recommended that the individual aspects should be laid down on metaplan-cards in a coordinates system of the dimension DIN A0.

After a finding and initiating phase lasting ca. 30-minutes the discussion within the group begins to flow and continues as a general rule for about one hour quite intensively. During this time the moderators make notes of the most important aspects, lay the cards down in the coordinates system or move cards already placed around. They keep the discussion flowing by purposefully throwing in targeted questions to possible links and



towards the end of the discussion point to aspects or categories that have not yet been illuminated in quite such detail. In this way obvious and less obvious 'gaps' may be closed.

After this intensive discussion phase, a phase of consolidation and consensus building follows in the mostly remaining 30 minutes of the workshop. At the very end, the moderators ask whether any essential points still need to be supplemented or placed elsewhere within the coordinates system. Only when agreement thereupon has been reached between the participants do the moderators, as a final step, purposefully ask about dependencies between the various aspects and connecting arrows are drawn in. In order that the visual roadmap should not become too confusing it is generally sufficient that connecting lines should only be drawn between those aspects that have been identified by the experts as being the most important ones.



As an option, in a very last working stage, those aspects or determinants that appear particularly critical for the topic may be identified and optically highlighted. If the strategic process plans that visual roadmaps can be compiled by different working groups, for example in parallel sessions, a presentation of the results in front of all participants in the workshop would be a good idea. Here, the results may be evaluated for the first time by 'externals' and reviewed for its validity.

After the Visual Roadmapping workshop the visual road maps are briefly documented in writing by describing the obvious development threads and dependencies. The visualisation of the visual roadmap will also be brought into an easily manageable form (e.g. in PowerPoint). The result obtained from a Visual Roadmapping workshop, the visual roadmap with written documentation of about one until two pages, forms the starting point for further discussions. From this roadmap it can be derived which technological preconditions need to be fulfilled and which necessary political, economic or social framework conditions have to be created – that means, what is necessary for the success of the topic. The visual roadmap provides orientation for the derivation of recommendations for action and the next work steps.

7. Challenges connected with the Visual Roadmapping method

The implementation of a Visual Roadmapping workshop and the results achieved have, in the projects we have realised on various thematic topics and with very different interest groups, shown to be extremely useful. Nevertheless the instrument may also be connected with challenges or even with disadvantages; these will be discussed in the following. The visual roadmap mostly represents a very complex process in a very simplified manner. This may lead to topics or processes that are possibly too strongly simplified and thus, to superficial performances. In such a case, it makes sense to pluck certain areas from the visual roadmap and to analyse them separately.

And while on the one hand there is a strong simplification, the result may on the other hand still be too complex. The meaning of the image or visual roadmap is, as a general rule, not immediately apparent to the person studying it and one is required to spend a longer period of time taking a good look at it in order to be able to comprehend the correlations. Owing to the need for explanations the visual roadmap is not a suitable vehicle for the transportation of simple measures. It is, however, possible by way of a follow up to isolate the central aspects and connections as 'paths' and thus, to visualise the core statements of the development as a roadmap. In this way, different visual roadmaps which have been drawn up in different sessions on the same topic/subject matter may also be brought together.

The application of the Visual Roadmapping method presupposes that the experts involved willingly share their knowledge and permit it to become visible to others. This may, in individual cases, lead to difficulties in acceptance of the instrument on the part of those experts who are unwilling to share knowledge. Attention should be paid to this point when selecting the experts for a Visual Roadmapping workshop.

The implementation of a Visual Roadmapping workshop is comparatively time and resources consuming. For the moderators, it requires an intense analysis of the topic; rooms and working materials must be arranged, the experts coordinated and prepared. A considerable amount of work may additionally arise subsequent to the workshop: for the compiling of records and the formulating of recommendations for action and the coordination thereof with the experts involved and the client.

Should the Visual Roadmapping method be used on the other hand as a kind of 'interactive protocol' of a discussion amongst experts – i.e. with just one or two contributors – the amount of time and effort may be kept down considerably owing to the lack of group dynamism; the process may be implemented without a huge amount of preparation to a normal interview context.

8. The visual roadmaps have been compiled? What may be done next? – A look ahead

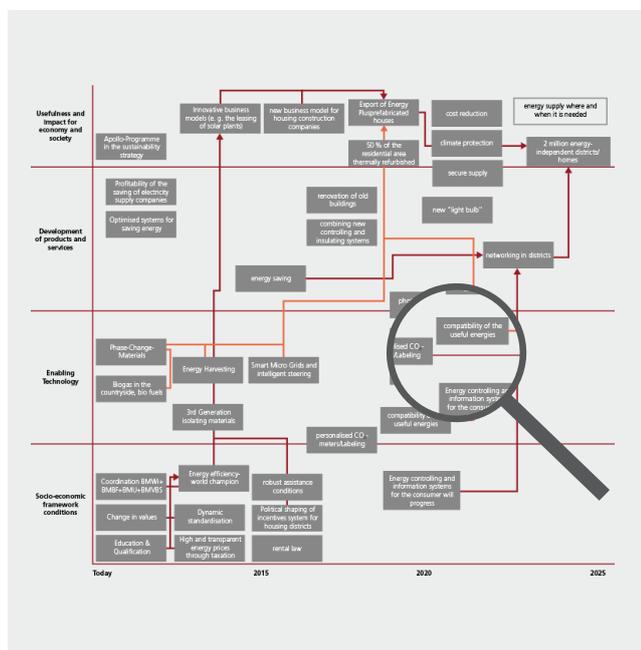
The result of a visual roadmap within a strategic process is not the end point thereof but may be the starting point for further analytical steps.

1) Define sub-topics pursuant to complex questions
 In the case of very complex topics such as technologically oriented missions, it is appropriate to define individual areas of action and to draw up separate visual road maps for each respective one. These areas may, for example, be identified in the course of a preceding strategy process (possibly by means of the Visual Roadmapping method).

The visual roadmaps of the areas of actions are individual roadmaps which, in their entirety, may be joined together as components to an overall roadmap. It may also be that connecting elements between these individual roadmaps may be discovered that are decisive for the realisation of several areas of action.

2) A detailed analysis of individual aspects
 In addition to the definition of sub-topics, which are regarded in their chronological order, it is also possible to analyse individual aspects in detail. It would therefore be possible, in a second stage, to 'zoom in' on the visual roadmaps, to pick out a certain area and to depict chosen aspects 'in enlargement', i.e. partial areas are regarded in isolation and investigated in more detail, which drivers or obstacles for the chosen aspect are of significance.

The instrument that could possibly be deployed here is the set up-analysis (modified constellation analysis). This analysis is conducive to the purpose of focussing different viewpoints of a certain topic and combining interdisciplinary perspectives. For example it is possible, by building onto the example illustrated above, to implement a further workshop with experts from various disciplines, the result of which will once again be the visualisation of a complex subject matter. But this time not in the shape of a roadmap in chronological sequence but as the time-independent 'macro-incorporation' of a situation (visual set up), i.e. the depiction of the interplay between determinants and the aspect considered.



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Contact:

Institute for Innovation and Technology (iit)
 Steinplatz 1, 10623 Berlin
 Germany

Dr. Sonja Kind

Tel.: +49 30 31 00 78-283
 Email: kind@iit-berlin.de

PD Dr. Ernst A. Hartmann

Tel.: +49 30 31 00 78-231
 Email: hartmann@iit-berlin.de

Dr. Marc Bovenschulte

Tel.: +49 30 31 00 78-108
 Email: bovenschulte@iit-berlin.de

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