SEVENTH FRAMEWORK PROGRAMME: THEME 7 TRANSPORT

OPTIC

Optimal Policies for Transport in Combination

Grant Agreement No: No TREN/FP7TR/233681/"OPTIC”
Project Co-ordinator: Institute of Transport Economics (TØI)

Deliverable 2

Inventory of tools and methods for early detection of adverse effects

Authors: German Aerospace Center (DLR), Institute of Transport Research Berlin, Germany

Karlsruhe Institute of Technology (KIT), Institute of Technology Assessment and Systems Analyses

Status: Final Version

Date: 30 November 2010

Dissemination level: Public

Quality assurance checklist

Quality Assurance item	Name of responsible	Date reviewed	Date accepted
External WPL QA	Moshe Givoni		10 Sept 2010
Coordinator QA	Nils Fearnley		10 Sept 2010
WPL internal QA	Andreas Justen		15 Sept 2010

Table of Contents

Abbreviations

AHP	Analytical hierarchy process
AP	Acceptability Policy
ARTEMIS	Assessment of Road Transport Emission Models and Inventory Systems
ASTRA	Assessment of Transport Strategies
CARE	Community database on Accidents on the Roads in Europe?
CBA	Cost-Benefit Analysis
CES	Constant elasticities of substitution
CIA	Cross-impact analysis
COPERT	Computer programme to calculate emissions from road transport
CTC	Core typology categories
DEA	Data envelopment analysis
DLR	German Aerospace Center
E	Economy
EC	European Commission
EIA	Environmental Impact Assessment
EN	Environment
EP	Effectiveness Policy
ETIS	European Transport Policy Information System
FP	Feasibility Policy
GRACE	Generalisation of Research on Accounts and Cost Estimation
IRTAD	International Road Traffic and Accident Database
iTREN	Integrated transport and energy baseline until 2030
KIT	Karlsruhe Institute of Technology
LCA	Life cycle assessments
MCA	Multi-criteria analysis
MCDA	Multi-criteria decision analysis
NATA	New Approach To Appraisal
NUTS	Nomenclature of territorial units for statistics
OD	Origin Destination
OPTIC	Optimal Policies for Transport in Combination
OST	Open Space Technology
POLES	Prospective Outlook on Long-term Energy Systems
POSSUM	Policy Scenarios for Sustainable Mobility

RAND	Research and Development
REFIT	Refinement and test of sustainability indicators and tools with regard to European Transport Policies
SCENES	European Transport Scenarios
SEA	Strategic Environmental Assessment
SWOT	Strengths, Weaknesses, Opportunities, Threats
TAZ	Traffic Analysis Zones
TEN	Trans European Network
TEN-T	Trans-European Network for Transport
TRANSTOOLS	TOOLS for TRansport forecasting ANd Scenario testing
TREMOVE	Transport and Emission Model
TRIZ	Theory of Inventive Problem Solving
TS	Transport System
TT	TRANSTOOLS
VIBAT	Visioning and Backcasting for Transport Policy
VOT	Values of Time
WA	known, intentional effect
WB1	known, non intentional, counter intentional effect
WB2	known, non intentional, secondary effect
WP	Work Package
WRS	World Road Statistics
XA	unknown, intentional effect
XB1	unknown, non intentional, counter intentional effect
XB2	unknown, non intentional, secondary effect

Abstract

This Deliverable focuses on the development of an inventory of tools and methods for the early detection of unintended effects in transport policy making. Additionally, it deals with the question of when and where integrating different assessment approaches is recommendable along the policymaking process. The main distinction of the inventory is made between structurally open (mainly qualitative) and (mainly quantitative) structurally closed approaches. A methodology is developed using examples that illustrate, step by step, the consideration of either structurally open or structurally closed methods focusing on the detection and the assessment of unintended effects. On the basis of these examples, recommendations are given on how to operate the methodology and when and where the consideration of the assessment approaches is most promising regarding the initially set policy objectives.

Executive summary

The decision-making about single policies or policies in combination is ideally accompanied by high quality assessment approaches. To prepare decisions it is important for the policymaker to have a notion about expectable outcomes. At the same time exists a large variety of models and methods that provide helpful support for the evaluation of policies. This situation describes the reality of different decision-making levels from the local up to the EU level. Given the availability of tools and methods, the challenge also on the EU level remains to choose the adequate 'assessment package'.

This Deliverable deals with the issue of models and methods for the evaluation of policies and policy packages with the goal to detect unintended effects. Two major objectives are pursued: first, to provide an inventory of relevant tools and methods for the detection of unintended effects and second, to explore when and where along the policymaking process their application is most expedient. Before addressing these objectives, a categorisation of tools and methods is introduced with the purpose of differentiation. The main distinction is made between structurally open and structurally closed approaches. The former refer to approaches such as workshops, focus groups or stakeholder consultation; the latter to mainly quantitative, analytical transport and emission models as well as cost benefit analyses or multi criteria analyses. This categorisation has its limits when it comes to mixed approaches. Therefore examples for such mixed approaches are described in an individual chapter (e.g. scenarios).

Regarding the first objective, the inventory of tools and methods describes in detail the characteristics of each of the approaches. Beside the general description of functionalities and application fields, a specific focus is on the analysis to what extent they are able to detect unintended effects. With regard to the structurally closed methods, the concentration is on transport model TRANSTOOLS and emission model TREMOVE, due to their role as principal models for the assessment of policies at the EU level.

Regarding the second objective and based on the inventory, we address the questions of when and where along the policymaking process the application of tools and methods can be recommended. We develop guiding principles for the integration of tools and methods along a fictive policy example of an EU wide truck toll. The truck toll example serves to illustrate in detail at which stage what type of assessment approach is recommendable. Subsequently, some major findings are presented based on the examples and related exercises.

As main findings we identified: a) the taxonomy of structurally closed and structurally open methods is useful when it comes to decide which approach to apply, as strengths and limitations of each approach can be interpreted according to their specific characteristic of being either of mainly qualitative or mainly quantitative nature; b) uncertainty and thus, the possibility of unknown intended and unintended effects remain on the agenda and it should be recognized that quantitative models are in many cases not sufficient to anticipate unintended effects, c) the integration of structurally open methods at an early stage of the policymaking process can help anticipating and thus, reduce the number of unintended effects, d) the structurally closed methods, i.e. analytical models, need to be embedded in a broader framework for analyses, including the structural open methods, e) if methods, especially analytical models become too complex, they reduce transparency of the evaluation process, thus a balance is needed that enables non-experts in the field to follow the major causal assumptions underlying the models.

In conclusion, it is recommended to use structurally open methods in an explorative phase at the beginning of the policymaking process. Mainly qualitative elements such as a stakeholder consultation play an important role here and could be accompanied by simple pre-structured approaches (e.g. CBA) to support the exclusion of unrealistic options, or by explorative scenarios to cover different future developments. We suggest including in this phase a broader group of involved actors, such as stakeholders, experts as well as the wider public to get a clear picture of the intended and unintended effects of a policy at an early stage. It is recommended to systematically detect and transparently collect the main causal

relationships and associated unintended effects of the policies. It is after this qualitative evaluation of policy options when structural closed methods should be applied and the objective is to quantify as much as possible of the expected effects. This phase is dominated by experts and e.g. the application of models such as TRANSTOOLS and TREMOVE. Iterations can be advisable at this point. Therefore, results of the impact assessment can be returned to the multi-actor group to reflect again on the appropriateness of policies. To the end of the policymaking process, once again structurally open methods or discursive tools are recommended for the interpretation of results. This is because it can be expected that with an increased number of policies in combination assessed, the likelihood increases that non-quantifiable measures build part of the package and require for expert interpretations.

This Deliverable concentrates on the possibilities of an ex ante assessment. Recommendations are given of when and where integrating assessment approaches are likely to be most effective according to the initial policy objective. The tools and methods discussed in this inventory are instruments that also can be part of an ex post assessment where data gathering, monitoring and remedial actions come to the fore. This is where Deliverable 3 (‘Ex post identification and remedies of adverse effects’) continues the work undertaken here.

1 Main objectives and structure of the Deliverable

Within the overall project structure of OPTIC this Deliverable is part of Work Package 3 and explicitly addresses the issue of policy assessment using tools and methods. Together with the results of Work Package 2 it delivers necessary elements towards recommendations for a comprehensive policy packaging framework (see Figure 1.1). In this context it fits into the overall objective of OPTIC, which is to help identify in advance possible adverse effects of policies taken in isolation and to develop methodologies for the design and implementation of optimal policy combinations which reduce adverse effects and/or provide positive synergies. Thus, the aim of OPTIC is to develop methodologies and implementation strategies for a systematic policy packaging.

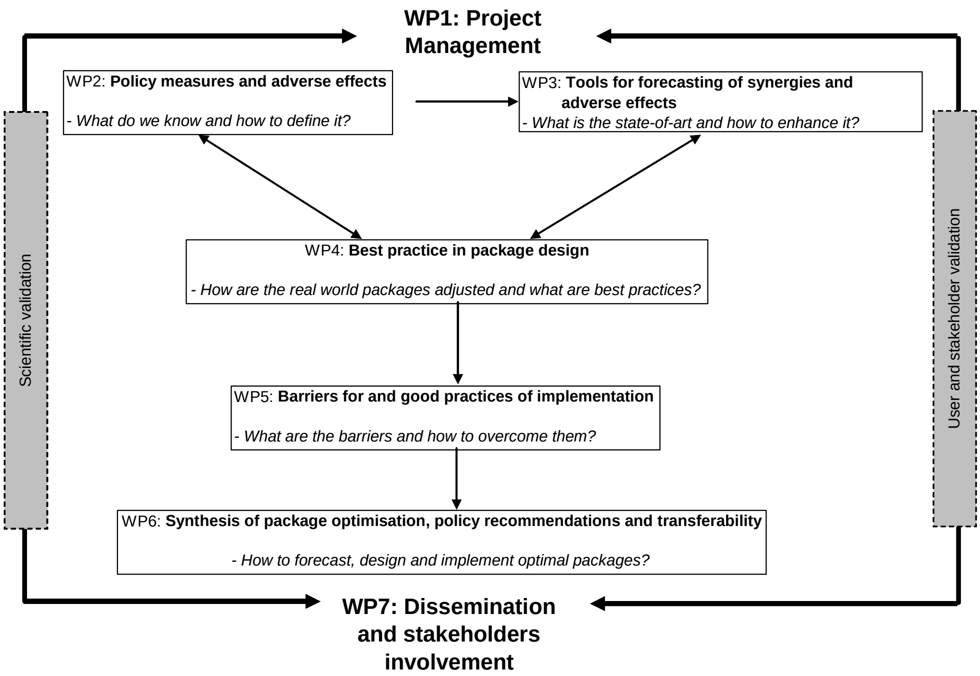

Figure 1.1: The structure of the OPTIC project

This Deliverable picks up several results provided by Deliverable 1. In Deliverable 1 a typology of intended and unintended effects and a framework for policy packaging were developed. Both aspects build the background of the work undertaken here, where the focus is on tools and methods, their ability to detect adverse effects ex-ante and their integration into the policymaking process. In continuation Deliverable 3 ('Ex-post identification and remedies of adverse effects') will deal with issues of an ex-post assessment, whereas tools and methods described here could be applied. But in Deliverable 3 the perspective is expanded by the focus on ex-post assessment and the consideration of remedial action once a policy or a package is introduced. In the final work package of OPTIC the results gained in this Deliverable will be of relevance, when it comes to recommendations regarding when and where during the policymaking process the application of assessment approaches is meaningful.

There is a constant need for adequate and high quality assessment approaches to support policy decision-making. Manifold approaches are already available, represented by a wide range of stronger qualitatively oriented approaches to mainly quantitative analytical models. The usage of such methods and models and later the interpretation of results get complex and challenging as soon as different policies are bound together in packages and inter-measure interaction appears. It is clear that the methods analyzed in this Deliverable can help to detect ex-ante unintended effects of policy interventions in the transport sector. But the questions remain, how should the approaches be integrated into the policymaking process in such way that early detection of adverse effects becomes possible? What are the strengths and limitations of methods and how to overcome these? Is it possible to generally recommend when and where the integration of methods and models is most promising and effective?

One objective of this Deliverable is to provide an inventory of relevant methods, models and methodologies available. For this purpose we introduce a taxonomy which allows us to differentiate between the approaches and investigate their pros and cons. The most relevant ones are described in more detail. This is due to the need to understand the general functionalities of the methods and models to later evaluate to what extent they may be helpful in addressing unintended effects. With regard to quantitative models a pre-selection was done by choosing transport and emission models TRANSTOOLS and TREMOVE. This is due to their central role as the models for the assessment of policies at the EU-level. It will be shown in this Deliverable that even though approaches for mitigation are available and unknown unintended effects in policy decision-making can be reduced, uncertainty remains on the agenda and adverse effects cannot be avoided entirely. Nevertheless, it is a primal objective of this Deliverable to contribute to a better understanding of the approaches optimised use in the policy processes.

This Deliverable is structured as follows: Chapter 2 gives an introduction to the variety of approaches and methods available and then derives a categorization of them which is used in the following chapters. Chapters 3 and 4 are dedicated to the description of selected methods and models. These descriptions are done along several evaluation criteria which will be introduced already in Chapter 2. Chapter 5 introduces integrative approaches where elements of both mainly quantitative and mainly qualitative characters are considered. A focus is on scenarios, ending this chapter with picking up the example of the ITS programme where integrative assessment took place. Based on the preceding chapters, in chapter 6 we develop ‘guiding principles’ for the integration of assessment methods in the policymaking process. We do that using a policy example of an EU wide Truck Toll. Chapter 6 and the example directly relate to the policy packaging process introduced in OPTIC Deliverable 1 (TSU Oxford et al., 2010). These ‘guiding principles’ are one source for the summary and the conclusive remarks given in the final chapter 7.

2 Categorising foresight tools in transport planning

2.1 Transport Policy making and the problem of unintended effects

Transport and associated decisions about modes, destinations, routes etc. are influenced by many interrelated factors such as the socio economic context of individuals and the available mobility options. At the heart of the transport system are its users, who make their travel and transport decisions. Values and norms are of importance, in many cases habits and established behavioural routines play an important role – with a similar situation in the freight sector. In general terms the behavioural outcome – person trips and goods movements – is determined by the characteristics of the transport demand (e.g. socio economics, production volumes, etc.) and the transport supply (network density and quality or public transport supply). It can be observed that consumer preferences and habits both in passenger and freight transport may be influenced, e.g. by the adoption and use of technologies. Technological and organisational innovations with effects on the quality of transport supply as well as, for instance, pricing schemes that influence modal choice have the potential to change attitudes, habits and behavioural patterns. So, technological change and socioeconomic trends co-evolve and interact. Further, it can be observed that scientists, stakeholders and policy makers have different perspectives on facts and figures based on scientific work in the transport sector and on the consequences to be taken. A simple example is the question of whether a bypass induces additional transport and increases the CO_2 emission or if it has a positive effect on the environment and human health since it relieves an agglomeration from traffic load and increases average speed. If such controversies amongst experts and stakeholder occur, it often gets difficult for policy makers to assess the motivations and quality of arguments and information.

So, governing transport is a complex task, in particular on European level where the number of influencing factors multiplies in a rather huge territory which is characterised by geographical but also economical and cultural heterogeneity. It is this complexity that makes it difficult to correctly and entirely anticipate or detect potential effects of policy making in advance. This is even more the case if not only the effects of single policy measures have to be assessed, but several measures are implemented in combination as a policy package. This issue of complexity leads to serious challenges for foresight-activities[1] in the transport sector. Policy interventions in the transport sector have to face risks and uncertainties, which become visible in the form of unintended effects after policies have been implemented.[2] It will be shown in this Deliverable that a broad range of tools and methods exist and that they are used for the purpose of assessing transport policy making by anticipating such effects. But none of the tools and methods described in this Deliverable are able to 'guarantee' that no unintended effects occur. An ex-ante assessment of effects that occur in future is always based on assumptions and simplifications. For using these methods properly and for enabling a solid interpretation of their results it is crucial to take into account that different categories of unintended effects can be distinguished.

Several approaches for a typology related to complexity and uncertainty in planning and decision making can be observed. For example, related to the application of participative methods the categories illustrated in Figure 2.1 were introduced by several authors (Hague et al., 2010; Ezrahi, 1980; Pellizzon, 2003): the horizontal axis represents the availability and uncertainty in knowledge on the issue, the vertical axis the ethical or political consensus or

[1] It should be noted that different conceptualisation on what is foresight do exist in academic literature (see for example Rader and Porter 2008; Sardar 2010). Here, we use the term foresight rather broad, for approaches that aim at supporting policy making by providing information on potential future developments in socio-technical systems such as the transport system.

[2] The relevance of risk and uncertainties for unintended effects is elaborated in more detail in Deliverable 3 (TØI et al., 2010).

controversy on the issue. For example, it might be that in spite of a high degree in knowledge on a bypass planning a controversy emerges related to the question if a loss in biodiversity caused by the new road should be ranked lower or higher than relieving an urbanisation from through-traffic. The result would be a moderately structured, political-ethical problem (see Figure 2.1).

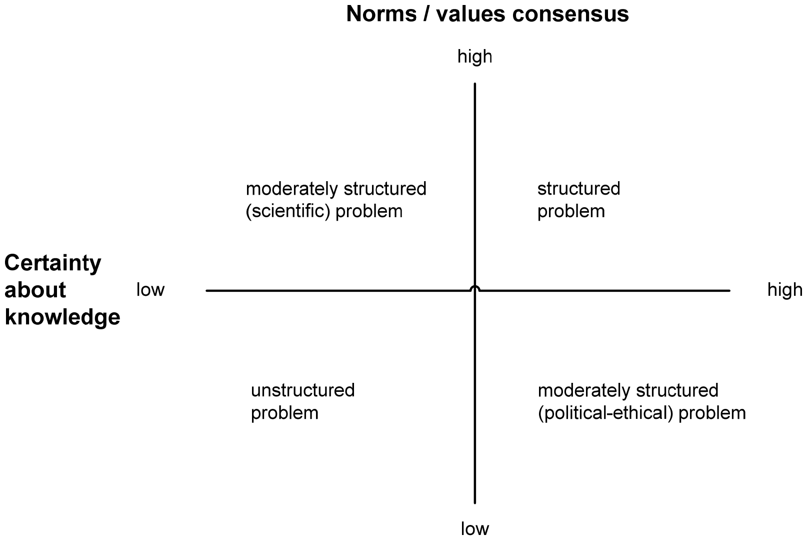

Figure 2.1: Types of policy problems. Source: Hague et al., 2010

In practice, it surely is difficult to assign a problem to exactly one of these categories; but the categories help to select a proper/suitable methodology for a certain type of problem. With regard to the exercise undertaken in this Deliverable the figure is very useful as it raises the question of when what type of assessment approach is more adequate to address a policy problem. For example, Hage et al. (2010) argue that stakeholder participation should be rather used for moderately structured and unstructured problems. In case of a low degree of certainty, rather scientist should be involved in the process. It indicates that problems, i.e. the implementation of a policy, come along with different degrees of uncertainties, which then need to be treated with the adequate mix of assessment methods. This resumes one of the principal objectives of the work presented here, to not only describe the methodologies for assessment available but also to bring them into the context of their most adequate application against the policy or policy package which is planned for implementation.

To give another example, the degree of risk and uncertainty is often used to structure types of missing knowledge (see Figure 2.2). A differentiation is made between risk, uncertainties and deep uncertainties, which can be relevant for the selection of methods to be applied. Again, the results of uncertainty as described above in decision-making are known and unknown effects.

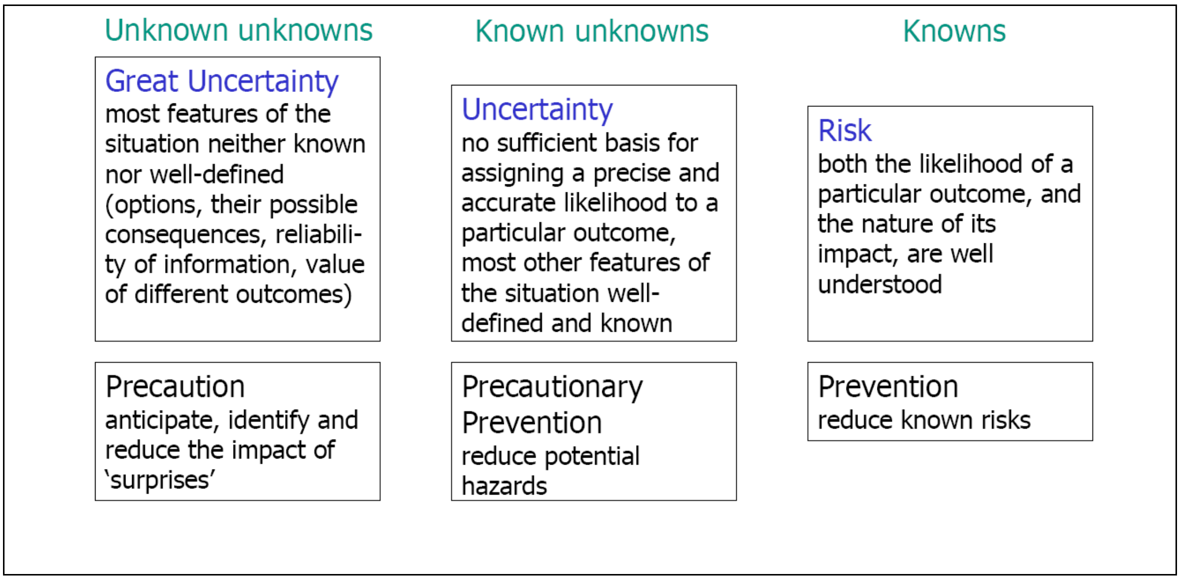

Figure 2.2: Risk and Uncertainty in decision making. Source: Fleischer 2008

In Deliverable 1 of the OPTIC project (TSU Oxford et al., 2010) a categorisation regarding the effects was developed which will be used as reference here. The categorisation is summarised once again in Table 2.1. The underlying logic is that on the one hand effects known in advance can be distinguished from unknown effects. On the other hand, unintended effects do not have to be automatically adverse. As Table 2.1 illustrates, they might be positive as well. The problematic categories are those where negative unintended effects occur. These effects might be adverse in relation to the original targets of a policy intervention (B1). Further, unintended effects could affect areas not directly related to the original target that might still be inside but could as well be outside the transport system (B2).

In this Deliverable, we use the term unintended effects for all effects, positive or negative, that are not in line with the original intention (intended effects) of policy makers who are responsible for a policy intervention; so, the term unintended effect comprises the adverse effects, counter intentional effects or secondary effects discussed in Deliverable 1. Ideally, the tools and methods analysed here support the objective to reduce the appearance of totally unknown ('unknown unknowns').

		Consequence dimension		
		A. Intentional	B. Non intentional	
			B1 Counter intentional	B2 Secondary
Knowledge dimension	W. 'Known'	The consequences that decision makers intended with the intervention ------- *Average fuel consumption of new vehicles is reduced; less fuel is consumed*	Counter-intentional effects that were anticipated at the time of decision ------- *Cars are driven longer and consume more fuel due to lower fuel cost/km (rebound effect); models may predict the effect*	Secondary effects that were anticipated at the time of the decision ------- *Longer distances driven lead to increase in congestion;* *models may predict the effect*

	X. 'Unknown'	Advantageous effects that are not known; serendipitous ------- *New cars inspire some people to 'green driving' lifestyles, saving additional energy*	Counter-intentional effects not known at the time of decision ------- *Car manufacturers economically challenged by the standard abandon plans to develop ultralite cars*	Secondary effects not known at the time of the decision ------- *Less public propensity to use alternative travel modes due to cheaper car travel, leading to line closures*

Table 2.1: Typology of unintended effects to be used for the evaluation of tools and methods. Source: TSU Oxford et al, 2010

2.2 On the categorisation of foresight tools

A wide range of tools and methods are relevant in terms of prospective analyses of the effects of policy interventions in the transport system. Since the transport system is shaped by the relationship between demand and supply, both areas have to be taken into account in such analyses. Additionally and from a holistic point of view, since transport is largely a derived demand, also impacts and interactions with neighbouring systems (e.g. land use, energy or air quality) should be considered when assessing policy impacts. At the one hand, there are computer-based efforts to quantify trends and their interrelations in order to predict the 'most likely' future. On the other hand, there are techniques based much more on dialogue and discussion, that intend to examine alternative possibilities, generate visions of desirable futures, or define 'wild cards' (unexpected, but possible, events). In practice, most foresight exercises make use of a combination of methods, and it is an important choice which methods to apply in the context of policy assessment. Further, some of the tools and methods are only usable in specific situations or in certain time slots during the policy process, e.g. due to limited financial or personal resources or the absence of adequate models for the analysis.

According to many experts, it can be observed that over the last decades prospective analyses and research on the future went through different phases, which are related to different understandings of what might be the 'future' (Kosow and Gaßner, 2006, p. 12; here Kreibich, 2006, p. 4). For example, it is argued, that in the phase of the planning euphoria of 1950s and 1960s, there was rather technocratic planning view, believing that the future is predictable in principle, if only the appropriate tools and methods were used (see Grunwald 2002; Eurofound, 2003). In the meantime, 'future research', 'future studies' or 'foresight' have moved from rather quantitative approaches to more mixed approaches, which appear to be more appropriate for dealing with complexity of future situations (see Johnston 2008). Typical for this development is the rise of scenario based approaches that can be observed over the last decades (Kosov and Gaßner, 2006). One of the main characteristics of scenarios is that they explicitly presume that different futures are possible.

Even if risk, uncertainties and, in consequence, unintended effects cannot be fully avoided there is a broad range of methods and tools to give orientation knowledge and improve the likeliness that decisions taken today do not lead to unintended effects. The fast progress in information and communication technologies enabled the application of sophisticated transport models. Research projects as well as transport planning on local, regional and national levels make use of such computational transport models for the analysis of policies, showing a great diversity of different tools in application. Regarding mainly qualitative approaches, stakeholder consultation is used on European level, focus groups are used for example to learn about the perceptions and attitudes of users. Many surveys are conducted to integrate expert views in policymaking, scenarios are developed to discuss future options for technological and organisational innovations in the transport system. Mainly on the local level, citizens participation became common and with it a huge number of academic publications on the possibilities and limits of these approaches (Feindt, 2001; Renn and Opermann, 1998, Klüver et al. 2000, Schippl and Kastenholz, 2004).

It is not always easy to identify the most promising methods for a planning process. A categorisation of tools should support the selection of the appropriate methods. In literature, many approaches can be found for a taxonomy of such tools, quite often related to foresight activities in accordance to technology development and innovation processes. An example is given in Table 2.2

Future-oriented technology analysis methods

Methods families	Sample methods
Creativity approaches	TRIZ, Future workshops, visioning
Monitoring & intelligence	Technology watch, tech mining
Descriptive	Bibliometrics, impact checklists, State of the future index, multiple perspectives assessment
Matrices	Analogies, morphological analysis, cross-impact analyses
Statistical analyses	Risk analysis, correlations
Trend analyses	Growth curve modelling, leading indicators, envelope curves, long wave models
Expert opinion	Survey, delphi, focus groups, participatory approaches
Modelling & Simulation	Innovation systems descriptions, Complex adaptive systems modelling, chaotic regimes modelling, technology diffusion or substitution analyses, input-output modelling, agent-based modelling
Logical/causal analyses	Requirements analysis, institutional analyses, stakeholder analyses, social impact assessment, mitigation strategizing, sustainability analyses, action analyses (policy assessment), relevance trees, futures wheel
Roadmapping	Backcasting, technology/product roadmapping, science mapping, multi-path mapping (Robinson and Propp 2006)
Scenarios	Scenario management, quantitatively based scenarios, different emphases, science theatres, video (Steyaert et al. 2006, Decker and Ladikas 2004)
Valuing/decision-aiding/economic analyses	Cost-benefit analysis (CBA), SWOT and scorecard analyses, analytical hierarchy process (AHP), data envelopment analysis (DEA), multicriteria decision analyses
Combinations	Scenario-simulation (gaming), trend impact analysis

Table 2.2: Future-oriented technology analysis methods, Source: Scapolo and Porter, 2008

In Table 2.2, the authors compile ‘methods families’. The chart gives a very good overview, but at the same time illustrates well that a general lack in criteria for a stringent classification must be stated. There exist many overlaps between the families and some families embrace rather different approaches, such as the family called ‘Valuing/decision-aiding/economic analyses’. A taxonomy of tools and methods has to live with these difficulties. The established methods are quite diverse and cross-cutting, which makes it impossible to find fully proper criteria for classification. Compromises are needed at this point.

In addition, many of the methods in the table have derivates, are used in combination or merged to a certain extent. We will not be able to deal with all the approaches in this

Deliverable – which will not be conducive with respect to the objectives – thus, we focus on methods which can be understood as being ‘prototypes’ for their category, and of relevance for the detection of unintended effects.[3] Since models play an important role in transport planning (and beyond) a particular focus will lie on strongly quantitative transport models. For this purpose transport model TRANSTOOLS as well as emission model TREMOVE are selected as representatives and studied in more detail.

Since the focus is on reduction and assessment of remaining unintended effects a problem oriented categorisation will be the first priority in this Deliverable. Key criteria for the categorisation of tools and methods should be their ability in detecting different types of unintended effects. It is clear that some of the effects are inside the transport system or its subsystems whereas others are beyond the boundaries of the transport system as illustrated in Table 2.1.

Figure 2.3: ‘web of nodes’: a practical example that inspired the abstract model

All tools and methods have their limits in detecting effects. The limitations of different approaches can be made clear by using the following abstract model: The transport system can be understood as a web with nodes and with linkages between these nodes (as a good approximation, one might think of climbing nets that can be found on children’s playgrounds, see Figure 2.3). This web-model of the transport system illustrates well that when tackling one of the nodes, this is not an isolated phenomenon but other nodes are affected as well, via the linkages between these nodes. At the more or less blurred borderlines other systems (energy system, land-use patterns and economic system) are attached and interact. Some of these nodes are known by planners and researchers, some nodes are anticipated but not exactly known, other nodes are completely unknown. When remaining in this abstract image, a policy intervention in the transport sector directly affects at least one, maybe several of these nodes. At the same time, a number of nodes are affected indirectly, via the linkages. The directly and the indirectly affected ones start swinging and produce rebound effects. The model illustrates that a policy intervention might lead to wide ranging effects, and some of them might only become visible after the measure has been implemented. This fact calls potentially for remedial actions and flexibility in planning, issues dealt with in Deliverable 3 of this project (TØI et al., 2010).

---

[3] This is also the most appropriate approach since this Deliverable aims at being relevant and usable for practitioners and not only academically stimulating.

Foresight tools are never able to systematically reproduce the full picture; neither in scope nor in depth are they able (or even designed) to fully reproduce this web. They either cut out a certain area of the web (transport models) or, at the other extreme they provide only punctual knowledge from different areas (brainstorming, open space). Typical transport and emission models such as TREMOVE or TRANSTOOLS only show a certain slice or cut-out of the web, with some selected nodes and the linkages between them. It is even not sure that the interaction between the nodes is fully understood. On the one hand, working with such a cut-out enables the detailed study of a certain area of the web. It should be noted that the original epistemic function of a model is to reduce complexity in order to get a better understanding of selected factors and linkages between these factors.[4] On the other hand, this abstract conceptualisation illustrates that wide parts of the 'world' can not be included in transport models. So, it is not possible to detect any effects in excluded areas by applying the model. Other tools with a different and/or broader focus are needed (could be another model or a different type of tool).

On this basis, we make a general distinction between two groups of tools along the following criteria: Does the structure of the method allow for a high degree in openness concerning the inclusion of parameters and linkages between parameters or is the method rather characterised by a pre-defined set of nodes and linkages between these nodes?

Accordingly, we introduce one category that is called 'structurally open methods' and one category called 'structurally closed methods'. In reality, there is rather a continuum than a clear border line between these two categories. But Table 2.3 illustrates that it is possible to define clear characteristics for both of them.

Structurally open methods	**Structurally closed (pre-defined) methods**
• no fixed setting • mainly explorative • never purely quantitative, strongly shaped by qualitative elements • in principle open to detect effects beyond the system boundaries	• pre-defined setting • mainly for analyses of specific situations • more or less clear understanding of the relevant parameters and causal relationships represented by the linkages between these parameters • mainly quantitative • focus on effects inside the pre-defined system • effects outside the system can not be detected
Examples: brainstorming, open space, expert workshops, explorative scenarios	Examples: quantitative models, cost-benefit analyses, multi-criteria analyses

Table 2.3: Categorisation of tools and methods

This categorisation has considerable overlaps with the distinction between qualitative and quantitative approaches. One of the main criteria to distinguish between tools and methods is whether they use and/or produce qualitative or quantitative data. The range of quantitative approaches may vary between simple trend extrapolations up to analytic behavioural models that predict transport demand based on the explicit and data intense reproduction of variables that determine (travel) behaviour.

[4] Please note: The fact that models don't recognise all possible effects is not a critique of models, but a matter of fact. Models are developed for their purposes and not for all purposes. One of the aims of this Deliverable is to identify what effects the different models and tools can identify and what is beyond their scope.

In this Deliverable, we prefer to use 'structurally closed' and 'structurally open' as main categories, since this openness or closeness seems to be highly important for the type of unintended effects that can be detected (see Chapter 6). We use quantitative and qualitative as sub-criteria inside these categories. However, this categorisation has its limits when it comes to mixed approaches. Therefore, we will describe typical examples for such mixed approaches in an individual chapter (see Chapter 5).

2.3 OPTIC criteria for the description and assessment of tools

The description and analyses of the tools and methods has to be in line with the overall objectives of the project. Optic's main subjects are the design of policy packages and the reduction of unintended effects applying assessment approaches. The basis for analysis is given by the developed policy packaging framework in Deliverable 1 and the proposed typology of intended and unintended effects. These are the main criteria for the reflection on tools and methods. Tools will be discussed in relation to the two poles introduced before 'structurally open' and 'structurally closed'. This classification brings in transparency, since the purpose and limits of the tools are becoming clearer. In general, structural open methods are strongly shaped by qualitative elements whereas structural closed tools are mainly of quantitative character.

As it was described in Deliverable 1, a policy making process consists of different phases. Some tools might be mainly usable in specific phases of the policy process. Furthermore it is important to look at the practicability and usability of these tools. This is done on the one hand in relation to practical issues such as resources needed (time and man power) for conducting analyses. On the other hand it is done in relation to restrictions such as the time horizons or geographical scopes the methods can be used for.

According to these reflections, in this Deliverable we will describe and assess structural open and structural closed methods along the following list of criteria:

- Overall objectives and target groups
- Structure of the model
- Data requirements and output
- Practical aspects (Resources, Time Horizon, Geographical area of application)
- Strengths and limitations

As mentioned above, the main focus is on the ability of the models and methods to deal with unintended effects. Of specific interest is to identify when and where along the policy packaging process the application of assessment approaches is recommended and to what extent 'critical paths' appear. Based on the in-depth study of the methods and models and the discussion about their integration into the policy packaging framework we formulate guiding principles for the integration of methods and tools in the policy packaging process.

3 Structurally closed methods: simple approaches and complex models

As it was explained in the introduction to this Deliverable, we introduce two main categories: structured closed and structured open approaches. In this chapter we deal with structured closed approaches. These are methods dealing with quantitative assessments of the effects of policy interventions.

3.1 Simple pre-structured methods

In this section tools are subsumed which are characterized by highly formalised and pre-structured approaches. Some of them are strongly based on quantitative elements (for example CBA), but the approaches described here are structured much simpler than the models described in section 3.2. These tools can be applied as stand-alone approaches, but are also often used in combination with other tools.

3.1.1 Cost benefit analysis

Cost benefit analysis (CBA) is a widely used and mandatory step in many projects, in particular when it comes to large infrastructure investments. CBA is about comparing the gains and losses of undertaking a new project or a policy. All gains and losses thought to be relevant are measured in the same units to be able to aggregate them. The unit of measurement is money (Hanley, Barbier 2009). So, in CBA, cost and benefit elements of a given policy measure are monetised and summarised in order to assess whether its benefits exceed costs (the compensation test) and by how much. Many textbooks introductions to CBA are available, and the reader is referred to one of them (e.g. Mishan and Quah 2007; Layard and Glaister 1994; or similar) for further reference. The method can be used ex-ante but also for an ex-post evaluation of projects.

It is the striking advantage of the method, that it makes effects of different nature comparable by using money as a common denominator. So, it allows for integrating a wide range of effects into an evaluation procedure. On the other hand, the process of monetising can be challenging; it can be a controversial task to express effects of an action or a policy in monetary values. For example, a bus connection to a hinterland might help to avoid social exclusion of people living there, but is it difficult to translate this in monetary metrics. Another typical example is the destruction of ecosystems and the related reduction in biodiversity that might be caused by a new street but can hardly be captured in monetary terms, in particular when it comes to long-term effects on the eco-system. Benefits arising from the functions of ecosystems generally are not “marketed” (see Hanley, Barbier 2009, 208). Still, it is crucial to include their “value” in the assessment of the consequences of policy making. Further, the questions of the system delimitations, e.g. which consequences are included in the monetisation and which are not, can be issue of controversial discussions. A good example is the discussion on the internalisation of external costs caused by transport, e.g. the questions to what extent costs of health effects should be included in the assessment of a road planning project.

The overall intention of CBA is the assessment of projects, plannings or programmes. But not only can the results of a CBA be useful for assessing potential effects. Also the process of conducting a CBA can be understood as a means for increasing transparency and rising awareness, for example, when unintended effects are made visible by high costs for specific consequences. Not only the results but also the process of monetising, provided that is done in careful and transparent way, can improve the understanding of the consequences of a project. There is a need to understand relevant causal relations to apply the method properly. So, even if it is not the main intension of the methods, it can support the detection of unintended effects by providing a systematic framework for the integration and aggregation of information. The strengths of CBA includes that it provides a rather easy understandable and commonly used framework for reducing complexity. It can help to get a clearer picture on WA and WB effects. Indirectly, by rising awareness for causal relations, it might also help to give hints on potential XA and XB effects (see Table 2.1). Resources needed for applying the method strongly depend on the issues at stake.

3.1.2 Multi Criteria Analyses

Multicriteria analysis (MCA), also termed multicriteria decision analysis (MCDA) or multiobjective decision making, is a type of decision analysis tool that is particularly applicable to cases where a single-criterion approach (such as cost-benefit analysis) falls short, especially where significant environmental and social impacts cannot be assigned monetary values. MCA is a structured decision-making tool developed and used in complex and conflicting situations where multiple criteria are involved (Mendoza et al., 1999). It is often considered as an alternative or an extension to pure CBA in cases where important effects can not be monetised or CBA is not seen sufficient enough to cope with the ambiguous or controversial understanding of a plan or policy. MCA is increasingly required as a part of a policy making process (Tuominen and Ahlqvist, 2010).

By explicitly including non monetary criteria MCA goes beyond the framework set by the CBA methodology. CBA surely needs a higher description of detail (DEFRA, 2003): The strength of an MCA is the integration of very different criteria in a systematic and transparent ways (similarity to scenario approaches). This might include a CBA but includes also criteria of different character. However, the number and type of objectives need to be carefully selected. Compared to CBA, MCA has fewer tendencies to oversimplify complex casualties, but on the other hand MCA does not result in such an acuminated and easily manageable result as CBA does with the purely monetary values. Still, MCA can result in criteria for decision making by offering an approach for the ranking of options, from the most preferred to the least preferred. The options are usually faced with trade offs, they may differ in the extent to which they achieve several objectives, and no one option will be obviously best in achieving all objectives (Communities and Local Government, 2009). MCA can be used in combination with scenario building as an appraisal method, which assesses options or scenarios on the basis of a multi-dimensional criteria framework (Kowalski et al., 2009).

MCA is in particular interesting in multidisciplinary teams, where different rankings of criteria - according to the disciplinary backgrounds - can be expected. Each member of a team enters own judgements, and makes a distinct, identifiable contribution to a jointly reached conclusion. That way, it is possible to highlight conflicts. Unlike methods that assume the availability of measurements, measurements in MCA are derived or interpreted subjectively as indicators of the strength of various preferences. Preferences differ between decision makers, so the outcome depends on who is making the decision and what their goals and preferences are. Since MCDA involves a certain element of subjectiveness, the morals and ethics of the researcher implementing MCDA play a significant part in the accuracy and fairness of MCDA's conclusions (see: http://www.cifor.cgiar.org/acm/methods/mca.html). MCA allows decision makers to include a full range of social, environmental, technical, economic, and financial criteria. Similar to CBA, a rough understanding of the causal relation relevant for a policy intervention are needed to apply MCA. Therefore, the method can help to raise awareness for unintended effects of different categories by providing a systemic framework for the assessment. However the evaluation of the W-effects (see Table 2.1) is the main purpose of MCA; it helps to clarify which W-effects are less and which are more relevant.

In the UK, the Department of Transport has implemented the so-called NATA framework which actually is an MCA methodology that integrates CBA and also environmental impact analyses approaches (see http://www.dft.gov.uk/webtag/).

3.1.3 Cross-Impact Matrix

Most events and trends are interdependent in some ways. Cross-Impact Analysis (CIA) is a foresight method that was initially developed by Helmer and by Gordon (see Gordon and Hayward 1968; Helmer 1981) to determine and analyse interdependencies between events. Many other foresight methods, such as Delphi methodology, generally do not provide any direct information whether events are interrelated. CIA intends to fill this gap by providing probabilities of occurrence of an event, adjusted in view of the occurrence of related items with potential interactions on its occurrence. CIA is unlikely to be able to provide decision makers with exact solutions, but it is able to illustrate complex causality of dynamic socio-economic systems and to provide a better understanding on how a system works (Scapolo and Miles, 2006).

Choi et al. (2007) identify five major steps in performing a general cross-impact analysis:

(1) First step is to define the events (could be a policy measure or its effect) to be included in the analysis. The number of events handled is limited, adding many events has an exponential effect, since the number of interactions increases rapidly when the number of events increases. Generally a maximum of six events is recommended, defined most widely by subjective estimation of experts (Scapolo and Miles, 2006; Enzer, 1972). So, working with policy is in principle possible, but the number or measure of related effects should not be too high.

(2) Second step is the estimation of simple probability of occurrence of each event. Experts are asked to estimate the likelihood that each event will occur at some future time. Meaning that in this stage occurrence of each event will be estimated in isolation, without considering possible impacts of other events.

(3) Third step is the estimation of the conditional probabilities for each event pair. In order to apply this, the estimate refers to the probability of the occurrence of one event as a function of the probability of another event. To increase objectivity, estimates should be carried out by groups of experts from various disciplines, since they reflect the experts' views on future situations.

If this event were to occur...	**Having had this probability of occurrence by year *x***	**...then the probability of this event also occurring would become**			
	Probability of occurrence	**A**	**B**	**C**	**D**
A Average fuel consumption of new vehicles is reduced	0,70	X	0,90	0,50	0,85
B More people aspire to "green driving"	0,20	0.35	X	0,20	0,30
C Less people use alternative travel modes	0,35	0,10	0,40	X	0,05
D Longer distances are being driven	0,90	0,15	0,50	0,60	x

Table 3.1: Basic form of a cross-impact matrix. Numbers are only exemplary, Source: Modified based on Enzer, 1972

(4) Fourth step is the creation of an analytic model, the cross-impact matrix. The matrix serves to assess the impact of alternative actions and of the occurrence of exogenous events. The matrix consists of a list of possible future events, their likelihood of occurrence and the new probability of occurrence that each event would have if some other event were to occur. An example of how such a matrix could look like is provided in Table 3.1.

(5) Fifth step is the evaluation of results. A computer programme is used to perform a calibration run of the matrix. Therefore events are randomly selected to assess occurrence of events and to calculate information about possible impacts on all events. For the matrix shown above, that would imply that more people aspire to “green driving” (event B) has a probability of 0,20. But if the average fuel consumption of new vehicles is reduced by the same time (event A), the probability that event A occurs increases by 0,90.

A critical reflection of the approach shows some weaknesses. It is still difficult to ensure consistency of estimated forecasts, since probabilities are adjusted according to the subjective judgement of experts. Further, collection and evaluation of data is very complex and time consuming. Yet, when having the aim to focus on interrelationships among events, cross-impact analysis is seen as a useful tool when forecasting well defined topics (Scapolo and Miles, 2006). Since its initial notion in 1968 by Gordon and Hayward many modifications and improvements have been made. More recently many efforts have been made to improve CIA, such as integrating it to other methods (Choi et al., 2007).

In terms of unintended effects (see Table 2.1), the method is usable to get a better understanding of W category effects in a pre-defined system. It is not an appropriate method to focus on X category effects.

3.1.4 Life Cycle Assessment

Life cycle assessments (LCA) are compilations and interpretations of

- inputs and outputs between the technosphere and the environment and
- potential environmental impacts of a product or product system
- along the total product life cycle.

Therefore, life cycle assessments provide comprehensive information about many different environmental impacts of products and services “from cradle to grave,” not just about individual production steps or environmental problems. Life cycle assessments form the basis for environmentally compatible product design and for fundamental decisions related to energy, environmental, and technology policies and to corporate strategies. Most of the procedure for conducting life cycle assessments is defined by ISO standards 14040/44. According to it, a life cycle assessment involves four phases:

(1) Goal and scope definition (target groups, system function and boundaries, timely and geographic reference, etc.)

(2) Life cycle inventory analysis (graphically: material flow model; inventory of energy, resources, and emissions)

(3) Life cycle impact assessment (graphically: “transformation of emissions to environmental impacts")

(4) Life cycle interpretation (quality of results, evaluation, recommendations)

In the meantime certain simplifications of the quite complex processes are being considered. As for most methods in this chapter 3, it is a crucial question to what extent effects are taken into consideration; which effects are inside and which are outside the boundaries of the analytical system. For practical reasons, certain limitations to the environmental impacts that are analyzed are common and mostly unavoidable for methodological and practical reasons. Such limitations do not question the LCA-claim of being comprehensive as long as they are well documented and reasonable, if its effects on the results are evaluated, and if it is done in accordance with the knowledge being sought in the study concerned. LCA offers an ex-ante assessment of the environmental impacts of a product, a plant or a facility. It is not focussed on policy programmes or policy interventions but its results can be useful for the reflections about any unintended effects in a planning process. So, it needs to be combined with other tools and methods.

3.2 Complex Models: TRANSTOOLS and TREMOVE

In this chapter we briefly describe EU models TRANSTOOLS and TREMOVE, to discuss later – based on the understanding of their main functionalities – their abilities to detect unintended effects in transport policy making. The assessment of both models takes into account a number of criteria: giving an overview of the overall structure and functionalities of the models (sections 'Overall Objectives and target groups', 'Structure of the model') and the evaluation regarding data requirements, outputs and practical issues such as time and resources needed for application (sections 'Data requirements'; 'Practical aspects'). Concluding remarks discuss 'Strengths and limitations' of both models which at the same time can be understood as hints for future developments.

Based on the general understanding of how the models work and for what purposes they are applied, in chapter 6 we focus on their abilities to address unintended effects of single policies and policy packages according to the typology of unintended effects provided in Deliverable 1 (TSU Oxford, 2001, pp. 40-43). In combination with qualitative approaches presented in more detail in chapter 4, we define where and how the consideration and application of quantitative and qualitative assessment methods along the policy making process is recommendable.

3.2.1 TRANSTOOLS: Overall objectives and target groups

The overall objective pursued with the development of TRANSTOOLS (TOOLS for TRansport forecasting ANd Scenario testing, in the following denominated TT) was "to produce a European transport network model covering both freight, as well as intermodal transport, which overcomes the shortcomings of current European transport network models" (Burgess et al., 2005, p. 1). The objective coming along with the development of TT essentially was to enhance the assessment of strategic transport policies at EU level. With TT several existing models were brought together to provide an integrated policy support tool for the EU.

Right from the beginning, the development of TT was also influenced by a policy-making perspective. This means, beside the revision of existent models and state-of-the art techniques in transport modelling, TT was supposed to meet the "demand requirements of policy makers" (Burgess et al., 2005, p. 2). Already at this stage the policy perspective was implicit, which means that specific transport policies as defined in the White Paper from 2001 were analysed regarding the possibilities of being tested and evaluated by TT (Burgess et al., 2005, pp. 7-18). "The objective is to develop a European freight and passenger model for the assessment of large-scale policy questions raised by the challenging environment of an enlarged Europe" (Cheng and Meijeren, 2008, p. 15). An example for the EU perspective in transport policy assessment are the Trans European Network (TEN) projects, such as e.g. updating the interoperability in rail transport or common speed limits on highways among others. Naturally, not all measures indicated in the White Paper can be analysed with TT, nevertheless the ability for quantifying some of them using TT indicates the type and scope of measures the model is designed for. In principal TT is designed as a supporting tool for policy makers at the level of the EU Commission. Ideally, it quantifies expected impacts of large scale EU policies.

With the following sections, the focus is less on the detailed reconstruction of the model and its development over time, than on providing a summary of its main functionalities. In recent years several projects were conducted in which either the model was applied for scenario testing or further developed regarding its conceptual and theoretical backgrounds. The emphasis in OPTIC is different, thus for a detailed revision of TT including detailed functionalities and mathematics, reference is made to other sources that treated these issues in previous projects (Rich et al., 2009; Newton et al., 2009). But, in the context of OPTIC it is perceived as indispensable to provide at least an introduction to general functionalities, applications, required data, strengths and limitations of TT. This background knowledge is of crucial importance to later understand whether or not the model is able to detect (un-)intended effects.

Until today several projects have been carried out for the development and application of TT. In the following a short summary is given about some key reference projects in which the most important development steps and applications of TT were undertaken.

- **2004-2006: TRANSTOOLS: TOOLS for Transport forecasting ANd Scenario testing:** Starting in 2004 the project aimed at bringing together the experience of existing transport models and to provide improvements that lead to an integrated policy support tool, the first version of TT (Burgess et al., 2005).
- **2006-2008: REFIT: Refinement and test of sustainability indicators and tools with regard to European Transport Policies:** The REFIT project aimed at the combination of existing modelling instruments (including TREMOVE and TRANSTOOLS) to improve the analysis of sustainability indicators in the transport sector. The main task was to provide a comprehensive methodology for the impact assessment of transport policies. Already in REFIT the issue was raised that assessment is often done for measures in isolation, rather than for policy packages (Martino et al., 2008).
- **2005-2009: iTREN 2030: Integrated transport and energy baseline until 2030:** The project focused on the application of the existing modelling suite in the EU. Based on the use of TT on an updated data base, a specific effort was to link environmental assessment by using TREMOVE and to extend the forecasting time horizon to 2030 (Newton et al., 2009).
- **2008-2009: TENCONNECT: Traffic Flow: Scenario, traffic forecast and analysis of traffic on the TEN-T:** Within the project substantial improvements to the model itself and data bases were made. For instance the networks were updated (from the year 2000 to 2005) and extended and the zoning system disaggregated primarily towards new member states. Additionally, the passenger and assignments model were replaced and the matrices for all modes updated or re-estimated (Petersen et al., 2009).

The current state of the model is denominated as a second version of TT, result of the improvements made in the TENCONNECT project. This version builds the background for the following description of its structure and functionalities and later the analysis regarding its abilities for the detection of (un-)intended effects. Although the model is constantly under development – a new project is underway to further develop conceptual and theoretical foundations – we can assume that general functionalities remain as they are observed today.

3.2.2 Structure of the model[5]

It is important to introduce at least the main characteristics and functionalities of each sub-model of TT. As mentioned above, without going into a very detailed analysis, this overview is meaningful to identify which elements of TT should be further developed to better address (un-)intended effects. In the following Figure 3.1 the TT main model flow from demand generation in freight and passenger transport, to the network assignment and the feedback of impedance values to the demand and economic models is shown. To keep the explanations about the general structure and functionalities of TT short, reference is made in this chapter only to the passenger and freight model; further descriptions about the network, economic and air travel model can be found in Chapter 9.

[5] The following sections and the respective summary on the structure and functionalities of TRANSTOOLS is in principal a result of the documentation of a four-day workshop at the Technical University of Denmark, Department of Transport and Rapidis (both Copenhagen), during 8.-11.03.2010. In addition, previous reports about the development of TT were revised, essentially those associated to the projects mentioned above.

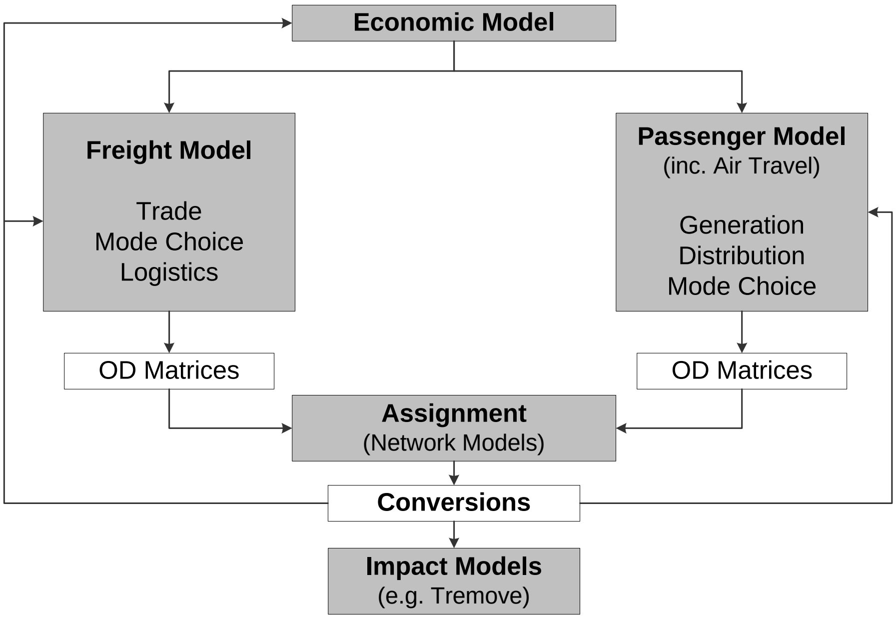

Figure 3.1: TT model flow (adapted from Cheng and Meijeren, 2008, p. 4)

The passenger demand model

The most distinctive characteristic of the passenger demand model is its differentiation into short and long trips. Short trips are those realized in a distance of up to 100km, long trips those above 100km distance. The major differences regarding trip purposes and transport modes of the short and long distance models are as presented in Table 3.2.

	Short Distance	Long Distance
Trip Purposes	Holiday	Holiday
	Private/Leisure/Shopping	Private
	Commuting	Business/Commuting
	Business	
Transport Modes	Car Driver	Car Driver
	Car Passenger	Car Passenger
	Bus	Bus
	Train	Train
		Airplane
Destinations	1.441 Traffic Analysis Zones (NUTS3)	

Table 3.2: Main Characteristics of TT (long and short distance passenger model)

Especially with regard to the long distance trips it is important to mention that trips are modelled as return trips. This means a trip crossing a border is supposed to be going back to the origin zone considering for the associated choices the income level and Values of Time (VOT) of the origin zone. The estimation of Origin Destination (OD) matrices follows the classical and sequential 4 step approach in transport modelling, starting with a trip generation step, in TT denominated as frequency model that indicates the number of trips by Origin taking into account e.g. the number of people living in a zone, the GDP and car ownership rates. The attractiveness of zones is described by the number of jobs (for travel purposes business, commuting and private) and hotel capacity (for travel purposes leisure and holiday). The second and third step of trip distribution and mode partition are modelled jointly applying a combined destination and mode choice logit model. Theoretically and given the 1.441 Traffic Analysis Zones (TAZ) of TT, 4 transport modes and 4 trip purposes, 23.056 mode destination combinations are feasible. For such a huge amount of options the estimation of behavioural parameters for mode and destination choice is not reasonable due to data and computational limitations, thus a set of mode destination combinations is sampled. The same applies for the passenger model in TT where a sample set of spatial alternatives according to distance categories was determined for both the short and long distance passenger module (0-200km, 200-400km, 400-600km, 600-1200km, 1200-1800km, > 1800km).

Any of the mode destination alternatives is associated with specific impedance values by mode, normally measured in time units, whereas the perception of impedance depends – at least – on the travel purpose realized and on the type of person that realizes the trip. Essential to any transport model during the step of evaluation of alternatives (here for the combination of mode and destination) is the availability of reliable VOT. VOTs describe by e.g. person type, trip purpose and mode the monetary value of saving one unit of time. To consider realistic VOTs is of crucial importance, especially when the main drivers for the modelling of behavioural decisions are different types of costs. Thus, good approximations for VOTs are needed to quantify policy impacts, especially as a lot of policies that can be analyzed with TT do have an impact on time aspects (new infrastructure, different costs). Ideally VOTs would be available specific to each EU member country, differentiated by trip purpose and transport mode. As this information is not available on an EU wide level, within TT VOTs of Denmark differentiated by mode and purpose were used (Danish Transport Panel Survey Data) and extended to the European level by observed income differences between the countries.

The definition of utility for each mode of the short distance model is primarily based on time related indicators.[6] This is comprehensible as the associated network models provide this information. Respectively, level of service components such as public access/egress times, car free flow time, ferry sailing time, in-vehicle times (rail, bus) are considered. To better estimate the differences in attractiveness between transport modes, even more variables might be included into the utility function. This definitely would expand the abilities of the model to quantify policy effects. But, again an example can explain the associated difficulties to increase the number of variables towards those which are less time oriented, respectively network based: from a user's point of view, the perceived comfort associated with a trip realized by rail might influence mode choice. But the perception of what is comfort varies not only among users but maybe among countries. Beside that, data for this type of variable is generally impossible to get, its conversion into time units is even more complicated and not without methodological limitations.

The long distance passenger module is reduced in the number of trip purposes considered but integrates the additional mode airplane. The trip generation is based on simple trip chains, referring to that a trip to a long distance destination necessarily induces a trip back to the original departure location. This means, return trips are coupled with the outbound trip. There is no explicit modelling of secondary trips once arriving at a long distance destination as it is assumed that subsequent trips are realized within the same zone of arrival. An advantage over the short distance model is a comprehensive travel behaviour data base for long distance travel (trips over 100km) covering EU25 is available (the DATELINE Survey). This data base was used to calibrate the mode and destination choice logit models for long distance travel. Like the short distance model, also VOTs for long distance trips were needed. Based on four long distance VOT studies realized in Denmark, Sweden, UK and the Netherlands, VOTs were expanded to the remaining countries where no information was available by using the purchasing power parity index.

Due to the structure of TT with rather rough zones covering the whole EU27, a separate procedure is needed to preload network links with short distance travel demand occurring within zone boundaries. The reason to that is that intrazonal trips are not loaded to the network, as no OD relation can be defined. As the number of trips that remain within the

[6] The estimation and use of logit models, setting up utility functions builds the background for several model parts in TT. In general terms, the functions serve to describe the attractiveness of one option (e.g. mode) in comparison to all other. The variables treated in the models are of crucial importance as they allow reproducing policy effects, e.g. when different types of costs are elements of the function.

zone (by mode and purpose) is known for each zone, a method was developed to further distribute these trips within the zones and loading them to the existent network. In general terms, average trip lengths and travel times by zone are estimated and the trips loaded to the network according to the traffic counts available (calibration of intrazonal flows to observed totals). The process which is only briefly described here cannot replace a separate model for the estimation of intrazonal transport flows but is an approximation considering reasonable assumptions. The advantage of the approach is that intrazonal traffic is at least considered and thus, overall congestion levels are expected to be more accurate. Still, this indicates that intended and unintended effects can only be assessed on the level which is actually modelled. Policies with impacts on short distance travel, say a regional focus, cannot be reproduced adequately with TT. If the attempt is to assess policies with local impacts, the use of a regional transport model should be the preferred option.

This allows for the conclusion that much more flexibility regarding the analysis of policy impacts is given for long distance travel, as these trips are modelled explicitly taking into account the demand, attractiveness of zones and the level of service between zones. The distribution of intrazonal trips is in comparison to that rather static. With an increase in the overall demand (e.g. due to demographic development, changes in income levels or car ownership), the overall number of trips that needs to be distributed within the zone is changed, but alterations in the land use within the zone will not affect directly traffic flows – issue which is of specific interest in more disaggregated models.

The Freight and Logistics Models

In general terms, the estimation of freight flows follows strictly a top down approach, where based on global economic trends and country specific GDP, trade volumes between regions are calculated. These are later translated into distributed freight flows applying the freight and logistics models described below. The integration of an economic model is reasonable from the point of view that the magnitude of freight transport flows as well as passenger flows are determined by regional economic activity. In a first step, a trade prediction model is applied using a double constrained gravity model which means that the trade totals (by commodity group) are fixed for every origin and destination zone. The gravity model then adjusts the flows between zones according to the impedance measured (elements are described below) and the row totals given by the production step. To calculate the origin and destination totals in tons, money flows are converted into tons. As reference for the conversion between monetary units and tons serves the ETIS 2000 base year matrix representing tons transported between all regions covered by TT applying a pivot point procedure to estimate the relation value to weight for the respective year that is modelled. With regard to future developments of the ratio of (monetary) values to weights (in tons), past data was analyzed to estimate a trend development that is used for future forecast. The attractiveness between zones for the distribution is then described by a function of trade impediments (distance, membership in trade associations, common language, common border, cultural dissimilarity). The so achieved distributional structure of Origin Destination relations for goods is adjusted to future years according to the expected regional GDP growth.

A general characteristic of the freight demand model is that in difference to the passenger model it is working currently on a much more aggregated spatial level (NUTS 2). It considers four modes (road, rail, inland waterway, sea) and 10 commodity groups. After the distribution of goods, a main mode for the good flow is determined. Therefore, the productive amount (tons per good) is further segmented by commodity group, distance, countries and available transport modes. For each segment an individual logit model is estimated. These models provide the necessary parameters which indicate the probabilities of how a good is transported according to the level of service considered. For the estimation of modal split in freight, the explanatory variables are cost, time, existence of service (yes/no variable), distance (as the crow flies), total transport tons and dummy variables to incorporate extra time due to borders (e.g. because of technical delays in rail due to missing interoperability) or in port regions (e.g. because of waiting times for shipping). This is important, as the variability of the explanatory variables because of changes in infrastructure or other policy measures, directly influences mode choice and thus, the transport flows on either the road, rail or water networks. In almost the same manner as in the passenger model, the number and type of variables considered, determine the ability for policy impact assessment. Theoretically, the more variables included the more effects that can be assessed. In practice, main obstacles are data lacks and an increased complexity (coming along with a decrease of transparency) of the parameter estimation with every new variable entering the statistical analysis.

Until this point the trade flows are assigned to the main freight modes as described above. But, for the calculation of transport units (number of trucks, wagons or ships), the transport flows by mode need to be assigned using loading factors. These factors are crucial as they have a direct impact on the number of vehicles required for transport. In TT, these loading factors depend on the good transported and the vehicle type used. Although, the process of assigning the amount of goods to concrete vehicles is from a modelling point of view rather simple, the influence of these factors is enormous. Thus, it is worth to spend resources on their investigation, as they may vary by vehicle type and country.

Additional to the freight model that distributes in general terms the overall amount of goods by mode, a logistics module is implemented within TT which primarily aims at the determination of the location and usage of distribution centers. The logistics module is applied for 5 commodity groups, excluding those that most likely will not be shifted between modes (such as solid mineral, fuels or crude oil). The further disaggregation of the main transport flows by mode as described above is meaningful, as a large amount of goods is transported by several modes. To describe the attractiveness of and thus the decision for a complex logistics chain (e.g. from a starting point to a national distribution centre, further on to an European distribution centre, to the final destination by different modes), a sequential approach is applied. For every zone a combined score is defined based on the activity share, the centrality and the flexibility denominated by the availability by modes. Based on this score a ranking is made that determines the 5 most likely locations for distribution centers (highest combined scores). For the estimation of probabilities for the logistic chains, a nested logit model is applied with the decision for the combination of zones at the first nest, followed by the second nest about available mode options. Once again, the main components of the logit models are costs, distances, time, border resistance dummies and tolls.

3.2.3 Data requirements and output

As TT covers passenger and freight transport (including the pre-applied economic trade model and the post-applied impact assessment models), manifold input data are required. In the context of the OPTIC project it is meaningful to highlight the point of data requirements and outputs by the model(s) as these aspects give an indication to what extent intended and unintended effects can be evaluated.

Table 3.3 gives an overview of processed data and information in the different models that compose TT.

	DATA/INFORMATION REQUIREMENTS
PASSENGER MODEL	
Short-Distance	Value of Time by mode and purpose
	Level of Service attributes
	Car Ownership per zone
	Jobs per zone
	Population per zone
	Trip frequency rates
	Occupancy rates by trip purpose
	Traffic Counts (road, rail)
	Networks (road, rail)
Long-Distance	DATELINE Survey (Trip Diary)
	Trip frequency rates
	Occupancy rates by trip purpose
	Population by zone
	Hotel Capacity by zone
	Number of Jobs by zone
	GDP
	Value of Time by mode and purpose
	Level of Service attributes
	Traffic Counts (road, rail)
	Border resistance dummies
	Networks (road, rail)
FREIGHT MODEL	Level of Service attributes
	Total tons by commodity group (Output of the Trade Predicion Model)
	Reference for the conversion of monetary units into tons
LOGISTIC MODEL	Level of Service attributes
	Share of Activity by zone
	Share of Centrality by zone
	Border resistance dummies

Table 3.3: Data/Information requirements of TRANSTOOLS

Without going into detail, the table shows that e.g. level of service attributes, thus density and quality of the used networks, are crucial in every model of TT. Additionally the data used for the estimation of VOTs is very important to adequately translate policies into respective changes in the model. Other rather inconspicuous data such as occupancy rates in passenger transport or the conversion factors used to translate monetary units of economic activities into goods, have an enormous influence on the results. This is where good empirical proofed values are needed. This does not yet alter or improve the underlying causal assumptions of the model and its algorithms, but truly increases confidence in results, also by external stakeholders, when assumptions about these type of data inputs are up to date and transparently collected.

Again, the relationship between data quality, level of disaggregation and the ability of the model to deal with unintended effects are manifold and should be exemplified. Currently, TT considers the number of households in each TAZ and 'assigns' them a travel behaviour which results in trips by mode between origins and destination. Attraction of trips is characterized by job locations and density as well as hotel capacity in the case of leisure oriented trips. This is a common procedure for transport models to create production-attraction relationships resulting in OD matrices. With regard to policies, the level of detail of the data (and associated models and matrices to calibrate) is important. As long as socio economic differentiation of the population or household behavioural interaction is not considered in the model, policies with effects on these aspects are not reproduced adequately; hence assessment of these policies is difficult or even impossible.

As it is known, the model is aggregated in zoning and socio economic differentiation as well as regarding trip purposes. Respectively, it aims at delivering aggregated indicators that quantify results of primarily large-scale policies with regional, national or even EU wide impact. The main policy relevant output parameters delivered by a TT run are either related to the transport system (TS), the economy (E) or the environment (EN):

- TS: Traffic volumes in vehicle, passenger and ton km
- TS: Modal Share
- TS: Identification of congested areas and corridors (number of links in the network)
- TS: Accessibility indicators based on the level of service by mode
- TS: Travel times, travel distances (by mode)
- TS, E: Travel costs
- E: Impact on GDP and employment
- E: Impact on governmental budget and welfare
- EN: fuel consumption
- EN: emissions (air, noise, accidents)

Relevant changes of these indicators are due to major interventions, i.e. large projects or fundamental changes in prices or demographics. In other words, micro oriented measures in terms of spatial scope or financial magnitude hardly change the overall system performance. Nevertheless, several leverages are given, for instance to test the effectiveness of pricing schemes or technological innovation of vehicles (applying the impact model). When later in this Deliverable the integration of TT into the policy packaging process and its ability to detect unintended effects is discussed, it is important to have in mind the initial purpose the model was designed for as well as its main functionalities as described in this chapter.

3.2.4 TREMOVE: Overall objectives and target groups

The transport and emission model TREMOVE is used to assess the impact of single environmental policies and policy packages on European level. Currently the model includes the EU27 region, Switzerland, Norway, Croatia and Turkey (EC 2007b). TREMOVE calculates transport demand and its partition into different modes (TRE-part), both for passenger and freight transport. Comprehensive data bases of vehicle stock turnover and emission factors of air pollutants (MOVE-part) build part of TREMOVE and allow the calculation of transport related emissions. Each country is modelled separately, hence the same iterative simulation process is used. In the past TREMOVE was used to simulate different European policies and their effect on transport demand and emissions. Among the most relevant policies assessed using TREMOVE were e.g. the impact assessment of EURO 5 and 6 emission standards for cars and heavy duty vehicles, the installation of catalytic converters in older cars, fuel efficiency improvements, taxation of certain car types and infrastructural charging schemes.

In context of the AUTO-OIL II-project a first version of TREMOVE was used to support the project's cost effectiveness analysis. The analysis aimed at:

- collecting input data on national level on costs and effects of potential measures to reduce emissions.
- carrying out a cost-effectiveness assessment as a basis for a future air quality strategy.

For this purpose TREMOVE provided the possibility to compare different scenarios such as tighter emission standards for motorcycles or promotion of enhanced environmental friendly passenger cars. A new model version was developed under the Clean Air for Europe Programme, the Mid-Term Assessment of the White Paper on Transport Policy and a number of 6th Framework Programme research projects (Van Herbruggen, 2007). The most significant model changes and developments were undertaken during the following projects:

- **1998-2007 AUTO-OIL II Project and DG ENV Contract:** A first model version was developed to simulate country specific vehicle stock changes and emissions. Later a welfare cost module and lifecycle emissions module were added.
- **2005-2007: GRACE: Generalisation of Research on Accounts and Cost Estimation:** One of the main objectives in this project was to close gaps in knowledge about marginal costs in road and rail transport. During the project TREMOVE was used to simulate scenarios on the internalisation of external costs.
- **2006-2008: REFIT: Refinement and test of sustainability indicators and tools with regard to European Transport Policies:** During the REFIT project the ability of different models (TREMOVE, TT) to exchange data was investigated. A first version of a conversion tool was developed which links output data from other models such as TT with the input database of TREMOVE.
- **2005-2009: iTREN 2030: Integrated transport and energy baseline until 2030:** Similar to REFIT the focus of this project was to enable data exchange between TREMOVE and other models. The model was developed further in order to have a coherent baseline with the other tools. In this project transport demand values are supposed to be derived from TT; yet further database synchronization is needed.

3.2.5 Structure of the model

TREMOVE has a broad scope covering 31 countries and all modes of transport. The model simulates changes in volume of transport, mode choice and vehicle choice relative to a transport and emissions baseline. Information on initial/baseline transport demand and supply quality is derived from network models such as SCENES or TT. TREMOVE consists of three inter-linked core modules: a transport demand module, a vehicle stock turnover module and a fuel consumption and emissions module. The welfare cost and well-to-tank modules were added and are explained later on in this chapter. For each year the model simulates transport and vehicle volumes, emissions and welfare changes.

It is important to recognize that TREMOVE may work as a stand-alone model, calculating both transport demand and associated impacts of emissions. But, changes in transport demand are estimated based on elasticities that are used to alter aggregate numbers about person- and vehicle-km per mode. Transport demand is not modelled bottom-up including the steps of trip distribution and partition. This is why attempts are underway to make TT and TREMOVE compatible in such way that the TREMOVE transport demand model can be replaced by TT.

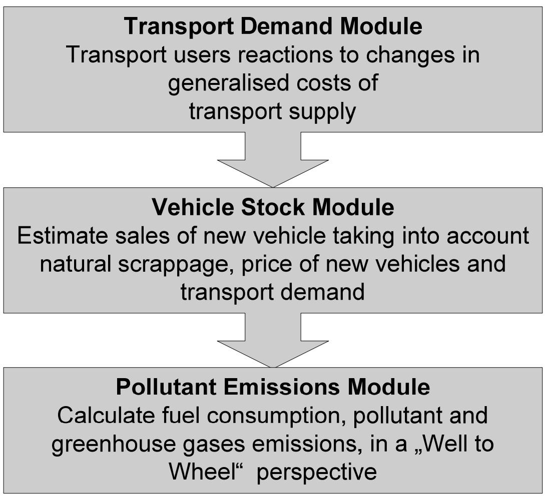

Figure 3.2: TREMOVE core modules

The transport demand and the changing vehicle stock are key determinants to evaluate transport emissions. Changing transport demand affects the existing vehicle stock in size and usage and thus also the emissions. TREMOVE, being an aggregate elasticity model, processes transport volumes without explicitly estimating OD matrices. As described in Figure 3.2 changes in transport demand are due to user reactions to changes in generalised costs of transport. Given transport demand, the vehicle stock module estimates the sales of new vehicles additionally taking into account natural scrappage and prices of new vehicles. Finally, the pollutant emission module calculates fuel consumption and most important the emissions caused by the transport sector.

The simulation process is the same for each country covered in TREMOVE. Each country is described using three distinctive regions: one metropolitan area, an aggregate of all other urban areas and an aggregate of all non-urban areas.

Based on forecasts made with the SCENES model a baseline for 1995 was defined for TREMOVE and future developments calculated assuming a scenario for 2030. To do so, the following main input data were required both for the baseline and the scenario:

- transport volumes per year in passenger-km, vehicle-km and ton-km
- transportation prices (e.g. resource costs, taxes, fuel costs, travel time costs)
- vehicle stock composition and emission factors

The transport volumes for the baseline and the scenario were derived from forecasts made with the transport model SCENES during the mid-term assessment of the White Paper on transport. In future applications transport volumes will be provided by TT.

TRE-part: Transport Demand Module

The key assumption in this module is that transport users make their choices based on the prices and travel time for each mode. Generalized costs per person-km or ton-km consist (from the transport user point of view) of the transport provider's price (e.g. public transport fees), taxes (e.g. fuel tax, annual vehicle tax), subsidies which transport users receive (e.g. for the purchase of environmental friendly cars) and time costs (VOT). In TREMOVE users are divided according to their vehicle usage in private transport (including non-working and commuting passenger trips) and business transport (including freight transport and business trips). Here it is important to highlight that the terminology of TREMOVE differs from that used in TT. In TT business trips are part of the passenger demand model and estimated there, in TREMOVE the business trips category comprises both freight and business trips. Private and business transports are modelled separately in TREMOVE. For each model region in each country, the transport demand is expressed in disaggregated passenger-kilometres and ton-kilometres per year. The following Table 3.4 summarizes the transport modes considered in TREMOVE and the respective vehicle categories.

Road Transport	**Rail Transport**
car	metro
moped	passenger train
motorcycle	freight train
van	**Inland waterways transport**
light truck	inland ship
heavy duty truck < 7.5 ton	**Air transport**
heavy duty truck < 7.5-16 ton	plane
heavy duty truck < 16-32 ton	
heavy duty truck < 32 ton	
bus	

Table 3.4: TREMOVE vehicle categories

To calculate the mode choice of private and business transport users the economic concept of utility maximization is applied. Private transport, denoted in the following as 'households', and business transport users decide upon the utility and costs on different types of transport options. The decision making process is described for households more in detail with the following steps:

(1) Households decide – based on relative transport prices – how much time they spend for e.g. commuting or leisure oriented activities. Transport costs are part of a larger set of consumption goods. Higher car taxes for example cut car owners' possibilities to consume other goods.

(2) Households make a trade-off between peak and off-peak trips. This allows to model time-of-day choices, congestion and emissions depending on speeds in peak and off-peak hours.

(3) Having defined the travel purpose, region and peak/off-peak period the household decides between modes of private and public transport. These include car, motorcycle, walking and biking, train (also metro) and bus. The mode choices depend on the region and road type. For non-urban trips a differentiation is made for vehicles (cars, buses) driving on highways or rural roads.

Utility and production functions represent the decision making process of private and business transport users in TREMOVE. These functions are assumed to have constant elasticities of substitution (CES). Substitution elasticities are used in utility functions to describe to what extent a consumer is willing to substitute one good if he or she receives more of another good as compensation. Assuming for example that costs for private car usage increase due to higher fuel taxes. The price for car usage increases compared to other alternative transport modes (e.g. public transport). The substitution effect describes the behavioural change which makes transport users consume more from the cheaper good (here: public transport). The substitution elasticities indicate the magnitude in behavioural change. This mechanism is crucial, as by the use of price elasticities the impact of policies on the cost structure and the effect on transport demand is considered in TREMOVE.

In TREMOVE it is possible to simulate the change in consumed quantities by knowing the substitution elasticities between the different types of transport possibilities. The CES functions in TREMOVE are disaggregated into a 10-level decision tree. The upper part of the decision tree includes trip purpose, trip environment (urban, non-urban) and distance categories. In the lower part for each distance category a distinction is made between private vehicle usage and network transport usage (the term 'network' refers here to public transport usage). The last three decision levels represent different vehicle types for private and public transport as shown in Figure 3.3. In private transport the combination of options results in 160, for business trips in 228 transport possibilities. All nodes in the lower part of the decision making tree must be fed with transport quantities and prices.

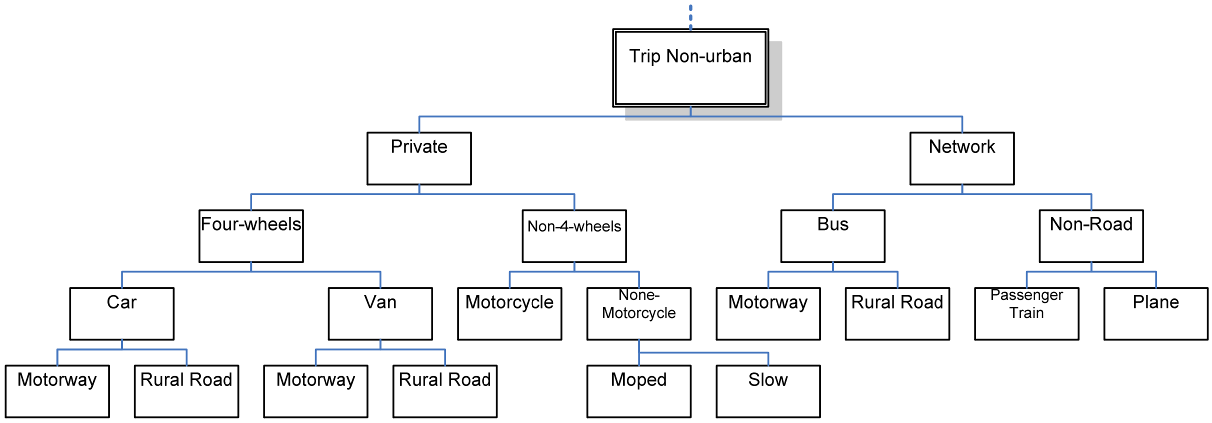

Figure 3.3: Extract of TREMOVE decision tree

For business transport production functions are represented using CES functions. The decision making process in its structure is similar to the one of private transport. In the first four levels, decisions upon freight transport and other purposes are treated and information on the trip region and trip distance are included. In the lower part the tree is divided into bulk or non-bulk transport, cargo or unitised non-bulk transport categories, truck or other modes. Trucks are further split according to the vehicle type.

For modelling demand for maritime transport (freight vessels and ferries) the CES approach has been considered unsuitable since the substitution possibility between maritime transport and other modes is very limited. The assumption which is made here is that maritime transport does not affect land transport and vice versa (Van Herbruggen and Bart, 2007).

Recent Improvements of TREMOVE include a clear definition of nodes in the CES function (decision tree) and the harmonization of the aggregation levels with other models. This allows TREMOVE to interact with other transport models and use their databases. This is important as it means a gain in flexibility and adaptability to other transport models.

TRE-part: Welfare Module

An important extension to the TRE-part is the welfare module. It was developed complementarily to TREMOVE's 'core' modules in order to assess welfare effects of transport and environmental policies. The assessment of such effects is an important step when comparing costs and benefits in policy-making. The impact of fuel prices, congestion charges or improvements in car technology can be assessed for different stakeholders in the transport market such as car drivers, public transportation users or the government. The idea is to calculate changes in social welfare between a baseline scenario (the same as in the demand module) and the simulated policies. The overall modification of social welfare is calculated as the sum of four factors:

- changes in utility of households (consumer utility)
- changes in production costs of firms
- changes in external effects (congestion costs, environmental costs, accidents)
- distortion effects of changes in taxes and subsidies.

For the welfare model the change in utility is calculated according to welfare concepts of consumer surplus and producer surplus. The general assumption is that any policy affects both the demand and the supply side of the transport market. The demand side represented by transport users is affected by changes to their utility and private budget which further influence their mode choice. The adaptability of these factors was explained earlier in this chapter. The effects to freight transport are represented respectively by changes of production and transport costs.

The external costs of pollution and congestion are also considered in the welfare cost calculation. The costs for air pollutants are expressed in Euro per ton and are included as external costs in social welfare calculations. Therefore, changes in the composition of pollutants in the emissions module influence the calculation of external costs in the welfare module.

MOVE-part: Vehicle Stock Module

The transport demand module delivers aggregated passenger-km and ton-km per year. This data is disaggregated in the vehicle stock module into detailed vehicle-km by vehicle type, vehicle technology and age. The detailed vehicle-km data is later passed on to the emissions module which calculates vehicle emissions and fuel consumption.

TREMOVE covers the fleet structure of road transport, rail transport and water transport. It considers five vehicle types. The assumption is made that vehicles of a certain age can be classified according to their compliance of EU emission standards (EURO emission tiers). This represents their vehicle technology level. Classification of waterway vessels is done according to pre-defined size and freight categories. Airplane stocks are not simulated. They are categorized by external specifications which consider plane cruising ranges.

The calculation of vehicle stock for road vehicles follows a four step approach. Here we take the car stock as an example to explain the procedure.

(1) First, it is of interest what has changed in vehicle stock compared to the year before. As described above, TREMOVE runs a simulation for each year iteratively. The amount of cars

taken out of the stock due to scrappage or export to other countries is subtracted from total stock. The vehicle stock module considers external information on vehicle specific scrappage functions to calculate the share of cars leaving the stock due to their age. The result of this first step is the surviving vehicle stock.

(2) The surviving vehicle stock is then connected with transport demand. The demand module delivers information on the demanded passenger-km and applying occupancy rates also the vehicle-km. The amount of cars missing to meet the transport demand is the expected additional vehicle stock. It is calculated by dividing the demanded vehicle-km by the average yearly km-mileage of a car. The average mileage is taken from statistics and is considered to be constant over the years. Knowing the gap-filling stock and the surviving stock the amount of total cars of each simulated year can be calculated.

(3) The amount of new cars is subdivided into different car types according to fuel type, engine size and vehicle technology (based on the age of the car):

(4) The shares of new cars are estimated using a logit discrete purchase choice model. The total vehicle sale is divided into vehicle category. The logit model relates consumers' and firms' purchase decision to prices and characteristics of the vehicle types on the market. Similar logit models exist for other vehicle types such as motorcycles, vans or buses. For each vehicle type a complete description of the forecasted age structure is obtained.

(5) The last step in the vehicle stock module is to determinate the detailed vehicle-km per year by vehicle type. This data depends on three factors: the vehicle category average, the type under consideration and the vehicle's age. For each vehicle type and emission category the vehicle-km driven can be estimated combining the previously mentioned factors and the fleet age. This data serves to calculate emissions and fuel consumption in the emissions module.

MOVE-part: Pollutant Emissions Module

The fuel consumption and emissions for different transport modes are calculated in the emissions module. The calculation of single pollutants from exhaust emissions takes into account the fuel consumption of a vehicle category, the fuel type used by the vehicle and a fuel consumption-specific emission factor.

Road transport emission factors are exogenous to the model and obtained from COPERT software calculations. TREMOVE uses COPERT data to calculate emissions for the vehicle-km driven. Emission factors have been derived consistently from EU sources and thus might deviate slightly from national estimates. COPERT estimates emissions of all major air pollutants (CO, CO_2 NO_x, VOC, $PM_{2.5}$, NH_3, SO_2, heavy metals) produced by the different vehicle categories. The TREMOVE emissions module uses the same methodology to calculate emissions for all the disaggregated vehicle kilometres derived from the vehicle stock module.

COPERT considers the following sources for emissions: evaporative emissions, exhaustive emissions, vehicle tyre and brake wear and road wear caused by vehicle motion (Ntziachristos, and Samaras, 2009). For the emissions calculation vehicle categories are further sub-divided to match the categorization of TREMOVE's vehicle stock module. For certain pollutant types the emission factors for these vehicle categories can be further sub-divided according to three types of driving: highway, rural or urban. Table 3.5 is the classification of a vehicle type (exemplary for passenger cars) which is consistent with TREMOVE datasets. Several additions had to be made to the COPERT calculation methodology in order to use it in the TREMOVE model.

Vehicle type	Fuel type	Vehicle technology	Emission factors (CH4 in mg/km)		
			Urban	Rural	Highway
Passenger car	Gasoline	Euro4	59	2	2

Table 3.5: TREMOVE vehicle type classification

Fuel consumption and emission factors for rail transport and aircrafts are derived from TREND database. For electric driven rail transport only the total energy consumption is considered in this module. Emissions from waterway transport are calculated following an approach developed in the ARTEMIS project.

Additionally to vehicle emissions TREMOVE has a small module which calculates well to tank emissions. The idea is to not only estimate direct emissions (from vehicles) but also have information on the share of pre-processor emissions from fuel production. The fuel production process needs energy and produces emissions. Including the fuel life cycle emissions allows for a broader assessment of policies.

3.2.6 Data requirements and output

The TREMOVE baseline data requirements are necessary to calculate a current state of transport demand, vehicle stock and emissions (in which no policy is introduced). Data for the baseline is differentiated for countries and model regions. The exogenous baseline input data on transport demand was previously derived from the SCENES network model and during the iTREN project replaced by TT. Other Input data regarding vehicle stocks and emission factors is collected into a separate database.

Figure 3.4 summarizes the data exchange between TREMOVE and external sources. The right column named ‘Knowledge required’ shows external information needed to calibrate the model. Sources to this knowledge can be manifold, e.g. the important information on demand elasticities is obtained from different literature sources. Parameters that reproduce vehicle stock renewal are based on observed trends in the past. These data are crucial as they represent the ‘dynamic’ part of TREMOVE as according to this values vehicle stock is renewed or changes in mode choice modelled. Other data needed shown in the left column are demand volumes (explained above), vehicle stocks by technology (given e.g. by national statistics) and emission inventories.

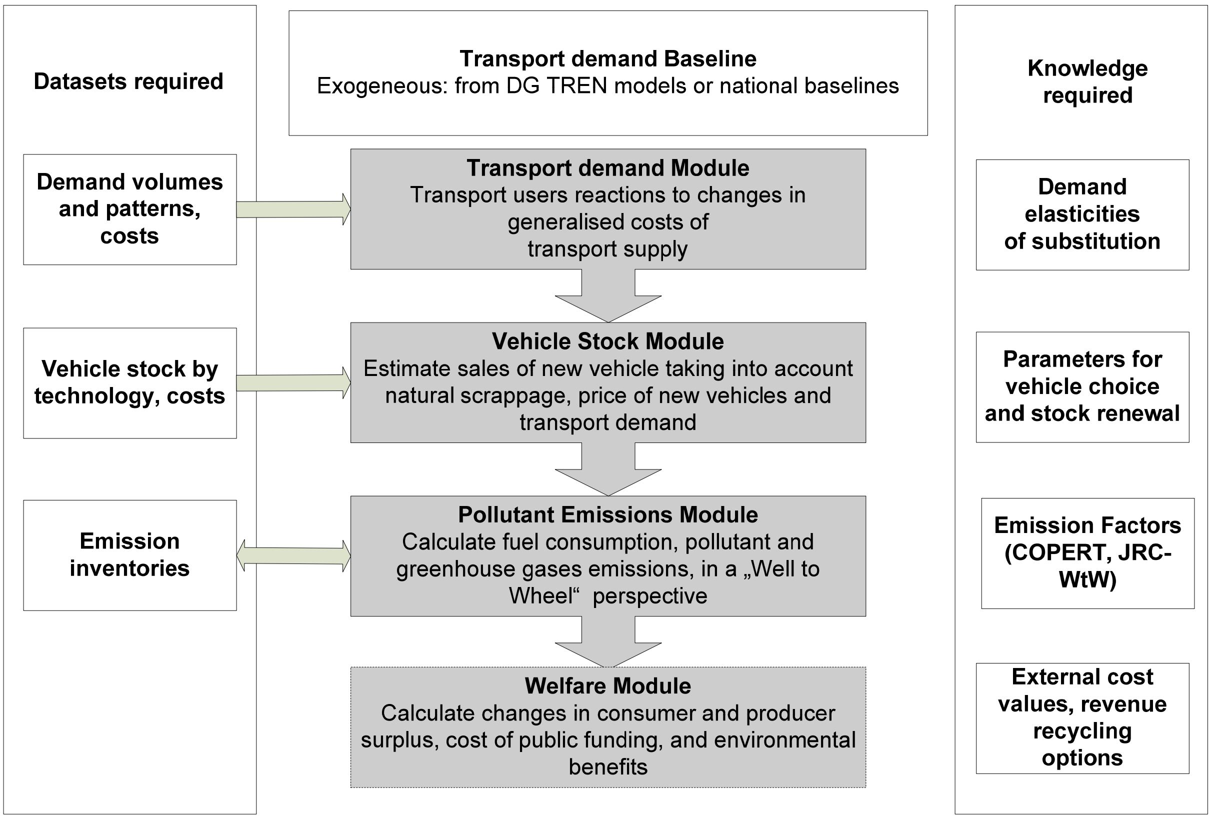

Figure 3.4: TREMOVE input data. Source: EC, 2007b

The main policy relevant output parameters delivered by TREMOVE are the following:

- Detailed information about vehicle emissions (by type) and life cycle emissions

- Fuel and Energy consumption
- Vehicle Stock (road, rail, vessels, planes)
- Impact on Welfare (consumer surplus, producer surplus, governmental budget, external costs)
- Prices, taxes and subsidies

Especially vehicle stock and prices, also taxes and subsidies need to be pre-defined, respectively collected for the data baseline. This means they are at the same time input data as due to e.g. a change in the cost structure leads to a different vehicle stock in response to alterations in transport volumes. The same applies for fuel and energy consumption. For the baseline averaged fuel consumption by each vehicle type must be defined, to then later obtain the aggregated consumption of fuel over all vehicle types considered and in accordance to the scenario assumptions made.

TREMOVE is not a network model like TT and the transport data derived from such models is aggregated to national level and later disaggregated according to the model's purposes (e.g. vehicle types). The question of a higher level of detail in TREMOVE is not about geography, rather than if country-specific, detailed data is available for vehicle fleets or emission factors.

3.3 TRANSTOOLS & TREMOVE: Strengths and limitations

TRANSTOOLS

In the following two sections, some general remarks are given according to the strengths and limitations as well as to practical aspects concerning the work with TT and TREMOVE. These are primarily based on the previous analysis, but also on the experience of the authors in the work and application of models of transport demand and emissions.

Due to the comprehensiveness of TT and the respective modelling details, strengths and limitations can vary broadly, between criticism of unreliable VOTs up to aspects of handling and application of the model. In the following some selected aspects are discussed which are perceived as most relevant with regard to the quality of the model and the results it produces.First of all it should be noticed that TT helps to discover complexities with regard to transport world interactions. It is likely that even basic causal relationships are not completely foreseen rather than understood by the policymaker. Although by nature the capacities of TT are limited to correctly reproduce these relationships, it provides insights into causalities most experts probably would not be able to name in advance to the analysis.

As already said TT is a comprehensive approach that comprises passenger and freight, as well as short and long distance travel. This aspect for itself is an important strength of the model, when it comes to assignment and to the calculation of system performance indicators, all modes are considered, thus the effects of congestion interaction, e.g. between trucks and cars can adequately be reproduced. Another positive aspect is that the model works in iterations between supply and demand are considered. This is nothing new and should rather be the standard when applying transport models; nevertheless it is sometimes done making only few iterations – if at all. The aim to assign all transport flows and feed back changes in the level of service into the models again is standard, but of crucial importance to achieve stable results.

The air travel model seems to be one of the major strengths of the different models that compound TT. Very detailed information about flight connections is available and integrated into the model. Also the explicit consideration of access and egress trips and related mode choices make it a proper reproduction of long distance trips.

Another strength of the model is that the whole EU is covered and the assessment of EU wide policies became possible. This strength at the same time causes one the major limitations: the zoning is rather rough and differs in number among countries. For instance, Germany alone is distributed into 439 zones, responsible for about 30% of the overall number of zones considered. It is not very clear how this disequilibrium in spatial zoning affects the results.

The rough zoning also causes that large parts of the demand – at least in passenger transport where the far majority of trips is done in short distance – are actually not modelled. A compensatory process is applied to distribute local trips within the zones, so they are considered when estimating congestion effects. The authors are aware of the fact that spatial zoning has also to do with the availability of data and network density. Nevertheless, a more detailed model structure (network, zones, purposes, population) should be a continuous objective which also broadens the ability of the model for policy analysis. As said above, further detail in population and/or household types leads to a sounder behavioural framework. For instance, social equity aspects which can be of interest to the policymaker when it comes to the evaluation of pricing schemes can hardly be assessed as long as socio economic characteristics of users remain aggregated.

All these alleged 'weak' aspects of TT are primarily due to missing data. To fulfil requirements of more detail, comprehensive survey data is required that still allow e.g. to quantify parameters of mode choice when more population types or travel purposes are considered. The same applies for the availability of reliable information of VOTs. This is not a specific problem of TT, but a common lack of data in transport modelling. The collection of respective data that allows for the estimation of VOTs considering different countries, travel purposes and income levels (given different transport supply qualities) seems urgent as the VOTs often work as mechanisms to 'translate' transport policies in the model application. Beside VOTs and behavioural data in general, there is also a lack of information about e.g. loading factors by vehicle types in freight transport or about capacity restrictions of passenger trains.

For some of the upcoming policies in the future TT seems to be only partly prepared. Especially, transport technology systems, such as vehicle-to-vehicle or vehicle-to-infrastructure communication cannot be assessed with TT. Again, translations of expected policies and changes have to be found. For instance, the electronic communication between trucks which might increase capacity due to better distance management between them needs to be translated in an adjusted capacity restraint function. This means, effects of the policy have to be estimated externally to be then integrated into the model.

The detected limitations and data lacks can be vice versa interpreted as recommendations with regard to model improvements. Especially the aspect of providing more detail in the reproduction of behaviour – both in passenger and freight transport – seems promising to capture more policy effects and thus, detect unintended effects of policymaking.

TREMOVE

The principal strength of TREMOVE can be denominated as being an instrument that allows a relatively simple economic assessment of transport-environment questions for the EU member states using a minimum amount of data. Another strength lies in its compatibility with other models, as mentioned earlier, TREMOVE can be supplied with databases and inventories from other transport models. For the demand module the transport volumes – which are country specific – can be derived from other demand and network modules such as TT. Respectively, in the iTREN project one major objective was to develop a converting tool for data exchange between TT and TREMOVE. This essentially means to replace the demand module of TREMOVE by TT demand output. Therefore TREMOVE's demand input database is modified in order to process transport demand data from TT. The conversion of demand input data is a great challenge since TT transport volumes have to be disaggregated to meet the number of entries at the lowest level of the TREMOVEs demand CES functions. Further modifications to the TREMOVE model allow it to use data of new vehicle types and technology from the ASTRA (economic) and POLES (energy) models. This work on enhancing integration between different models does not yet improve them in their theoretical foundations, but broadens the possibilities for policy analysis and most likely allows for a better reproduction of feedback effects. For instance, changes in transport volumes due to a pricing scheme (modelled in TT or TREMOVE) may have an impact on the economy regarding the localization of firms or types of transport they choose for shipping (ASTRA).

TREMOVE reproduces behavioural changes regarding mode decisions considering a huge number of elasticities. As variations between transport volumes are result of the consideration of these elasticities, transport demand need not be modelled bottom-up, but is rather a derived number of different sources such as other transport models, national statistics or as a result of an economic function. This makes it impossible to assess geographically local impacts of policies. Clearly, from a transport modelling perspective this is perceived as a limitation, hence the attempt to combine TT and TREMOVE is comprehensible. Nevertheless, for countries and/or entities that do not dispose over a respective bottom-up transport model, TREMOVE represents an interesting alternative, as the assessment of transport policies is possible.

Since TREMOVE simulates countries separately, transport demand from one country to another is not included. Especially for freight transport this is inconvenient because of the high amount of trips made across national borders. Thus, the assessment of international transport demand is not part of TREMOVE simulations. Therefore TREMOVE is supposed to be used conjointly with other models to reproduce transport demand and supply in a better way.

Analogous to TT the issue of data availability and quality is crucial and can be perceived as a limitation in TREMOVE. As a European model it attempts to assess measures with impacts in very different countries. In this context, especially information about emission factors plays an important role. The inspection of emission factors is done in differing intervals in each country and is not equally up-to-date. The same applies for the inventories of country-specific vehicle-stocks. Again and to some extent similar to the discussion about VOTs in TT, efforts are necessary to provide European wide databases. Even though, the required level of detail by the models is not anytime and everywhere possible to provide, the possibility of comprehensive data collected applying a single method would imply a great development concerning the model quality.

3.4 Practical aspects of model application

The aspects of *resources* (in time and money), *time horizon* (for what timeframe modelling runs reasonably can be made) and *geography* (spatial solution of the model) are not the most decisive ones regarding the assessment of the general quality of the model. But they are of crucial importance when thinking of its practical use and application within the policy-making process. In many cases quantitative policy analysis is not considered simply because of short timing and missing budgets. As it was said before, the purpose in OPTIC is also to detect where along the policymaking process the application of quantifying models is recommendable. It can be expected that during the definition of policies (or policy packages) the need for several model runs arises, e.g. when policymakers want to explore the impacts of different toll schemes on transport demand or new vehicle technologies on emissions. In addition to the criteria named above, we shortly discuss the general ability of the models to deal with the *combination of effects* as a result of the assessment of policies in combination. We expect this issue to be of practical relevance if the decision is about which method or model to apply.

The practical issues discussed here are defined as ‘critical elements’ in the policy making process, which – not or insufficiently recognized – may lead to ‘critical paths’ which in the worst case delay, jeopardize or even disrupt the policy process.

Resources

Naturally, the number of necessary person months correlates with the amount and complexity of the policies modelled. It is highly recommendable to determine right from the beginning of an analysis with TT or TREMOVE the amount of model runs (thus policy options) expected. Time necessary for model validation and calibration is generally underestimated. Decision makers should be aware that a model run itself might not need as much time as the interpretation and evaluation of the results afterwards. Policies which are modelled should be analyzed in beforehand if they require structural modifications of the model which can end up very time consuming. The development and testing of new model functionalities will take by far longer than any additional run within the given modelling framework. To estimate adequately the need of resources, knowledge about the expected model modifications is required. For instance, the actualization of parameters that determine mode choice is much more time consuming and complex than the codification of a new rail or road link. The relationship between number and type of policies and resources required for their evaluation is also discussed in Chapter 5.

Even though the resources needed for modelling depend very much on the specific project, some principal recommendations can be given:

a) first of all, the issue whether or not analytical models are applied for policy assessment need to be decided right from the beginning of the project

b) it needs to be clarified whether or not model modifications, i.e. parameter estimation, methodological improvements, etc. are necessary to fulfil the project requirements; if respective modifications are necessary, prediction of resources becomes nearly unmanageable as in this case investigation issues are mixed up with the urgency of model applications aiming at the rapid provision of tangible results

c) there is a need to clarify if the model(s) depend on further, supportive sub-models; often resources are underestimated or even not taken into account for substantial pre-processing of data or the application of sub-models; for instance, transport models require for detailed population data sets which require for a reasonable amount of time spent on processing and statistical analysis

d) finally, the number of scenarios where model applications are involved should be determined and fixed in the beginning of the project; policymakers tend to understand the tools as quick ‘question-answer’ machines, lacking awareness of the resources required to set up and run the model

Notice that the general recommendations given here assume that an established and calibrated tool or model such as TT or TREMOVE is available that already had been applied for policy analysis. As soon as model development, thus research, becomes a prerequisite to fulfil project requirements, the estimation of resources needs becomes much more difficult and unsecure.

Time Horizon

The aspect of time horizons can be interpreted as less critical for TT, TREMOVE or any other (transport) model. One may say that as long as the required input data is available, theoretically any time horizon can be modelled. Nevertheless, practical applications show that most scenario oriented work in transport does not consider futures beyond a 20 to 30 years time horizon. Beyond this timeframe uncertainties regarding changes in framework conditions of economic and demographic change become very high. Even though assumptions for demographic and economic developments are often made in scenarios in this time horizon, shifts in mobility behaviour or trend breaks (social, economical, technological) are rarely treated. This is where the degree of uncertainty determines the time horizon considered. This means a first uncertainty is related to the unknown – but assumed – development of framework conditions, i.e. data for demographic and economic growth, a second uncertainty, also unknown – and generally not assumed for the future – is about behavioural changes. If we assume a model with a correct reproduction of underlying causal interactions, the points of data availability and reliability determine the level of uncertainty.

The same applies for TREMOVE. Estimations in vehicle stock and emission standards strongly depend on technological development. This again is influenced by economic growth conditions, competiveness or the application of governmental programmes to promote technological progress. In this context predictions regarding technological development become uncertain as well, this leads to the comparable situation of not extending the time horizon for policy analysis beyond 20 to 30 years.

Regarding TT we can detect a positive correlation between the time horizon and the level of aggregation of the model. The aggregated level of TT– which naturally has to do with its large geographical coverage –is also reproduced by its aggregated input data, e.g. using overall population numbers and few travel purposes rather than numerous socioeconomic population clusters and disaggregated purposes. If predictions are done for model runs in 20, 30 or more years from today, the bias impact of a poor prediction on the results might be less according to the overall population numbers than for highly disaggregated population sub-groups (e.g. differentiated by age, income, etc.).

Geography

It is important to recognize the impact of geographical zoning on the results in TT. An example for that was given in chapter 3.2.2. In TT the zoning is much more aggregated than for example for an urban or regional forecasting transport model. The impact of the geography on the results can be exemplified as follows: very large zones cause that the majority of the demand remains within the same zone; these intrazonal trips cannot be assigned to the route network and need to be considered by pre-loading the intrazonal network (see chapter 3.3). The pre-loading should only be an auxiliary process, as the associated methods are generally based on rough assumptions and provide less flexibility as no real decision-making is modelled. The attempt should be to continuously increase the number of zones within TT. Clearly, this has to be done in accordance with data availability. But, from a computational point of view, a more detailed zoning seems possible, as some national models already work with much more than 1.500 zones.

Combination of effects

Both TT and TREMOVE are designed to estimate effects of policies in combination. In a simple case the combination could mean to quantify the effects of two new road infrastructures at the same time. Or, in the case of TREMOVE, to change travel costs and vehicle fleet composition at once. Thinking one step further, even more complex policy packages considering more than two policies can be assessed. But, this is has to be seen against the background of an increasingly difficult interpretation of the results. For instance, if an improved rail network is assessed together with decreased km-costs in freight and the results indicate a mode shift towards rail, is this due to the new cost-structure or the better infrastructure or both and to what extent? A similar example was given in Table 2.1, where the new technology leads to less fuel consumption and emissions, but cheapens km-cost and thus, induces new traffic. Generally, the models will reproduce reasonable the opposed effects. But, in the example, the policymaker might question the result that the emission levels remain the same although a major policy was introduced. The emissions saved by technological improvement, are nullified because people drive more. Further analysis would now be needed to clarify to what extent the effects do abolish each other. Coming back to the example of the improved rail network and decreased km-costs: It is recommended to first analyse the policies separately – at least those denominated here as primary measures – to check if the model reproduces the effects within reasonable ranges. Once this is done, two or more policies are analyzed at once. This step-wise approach creates awareness for the effects of single measures and allows interpreting better results of policies in combination. We pick up the issue of modelling policies in combination again in Chapter 6 and discuss the related assessment requirements along a policy example.

4 Structurally open methods: mainly qualitative approaches

In this chapter we focus on structurally open approaches. In general these are strongly shaped by qualitative data. Quantitative data might well play a role, but the main characteristics of these approaches is the way in which they seek to integrate knowledge of expert stakeholders and lay people in the process of policy making. As such, they can be seen as complements to quantitative approaches, which by definition are limited in scope.

According to De Smedt (2006, p. 91) the involvement of members of the public and/or stakeholders improves decisions in two respects

- The decisions will receive more respects form the stakeholders;
- The decisions benefit from the knowledge provided by the stakeholders.

Expert knowledge is needed to inform policy making, to give insights into fields where decision makers lack sufficient knowledge. However, in many cases there is a huge amount of information available which could be difficult to handle. It might become challenging to differentiate between crucial or important issues and unimportant or even wrong or erroneous arguments. Qualitative approaches can help to filter and structure information or arguments. In particular in relation to issues that are discussed controversial amongst stakeholders or experts, structurally open methods can help to separate facts form values (see 4.2.4) and, thus, help that unintended effects are not overseen.

So, in this section, tools that are used for consulting the experts, stakeholders and/or the wider public are discussed with focus on their ability to detect unintended effects. A basic distinction is made between tools that are mainly characterised by a one-way communication on the one hand and, on the other hand, tools that are use for the framing of a discursive exchange of arguments.

4.1 Tools strongly based on one-way communications

There are many different forms of one-way communication approaches that can be used to get information on unintended effects. Typical is an expert hearing, where prepared statements are presented to a group of decision makers. The format in general does not give too much room for discussions; it is rather a questioning and answering process that follows on the presentations. Most of these approaches are well known; therefore they are only briefly described and discussed here.

Expert hearings

In its pure form, an expert hearing is a series of expert presentation in relation to a specific issue or questions. It is often used in the parliamentary realm, where experts are invited to express their opinion in a committee. The presentation usually is followed by questions but in many cases this does not change the character of a one way communication since the information flow from expert to the politicians is at the heart of the activity. Of course, a longer discussion between experts and politicians might follow and give the situation a discursive character.

The advantage is the high flexibility and that there is a chance to detect all kinds of unintended effects. The methodology can be applied quite easily. Disadvantage is that because of time constraints only a few experts can be heard. Further, already the balanced selection of adequate experts might be a challenge.

Surveys

A survey with closed questions is not able to detect new effects, so it can rather be used to specify WA and WB effects (see Table 2.1). A survey with open questions could be used to detect unintended effects of XA and XB categories. It strongly depends on the background of the panel that is included in the survey. It has the advantage, that a high number of participants can be included.

Interviews

There is a huge variety in the way interviews are conducted. The interviewed person can be a stakeholder, an expert or a lay person. The questionnaire can be rather open or pre-structured. So, in principle interviews are an appropriate means to get a hint on all kinds of unintended effects. As for survey, it depends on the sampling method and design of the questionnaire if X-effects can be detected or not. In general, interviews are not an expensive means of integrating knowledge.

Delphi

A Delphi survey is a standard anonymous questionnaire survey with two rounds of iteration; is used to test prepared assessments or hypothesis with the questionnaire (see Scapolo, Miles, 2006); Delphi is characterised by a highly formalised interaction between experts. But it does not allow for a direct exchange in opinions. Not much focus is put on the interdependences between events, actors etc.

A Delphi could be usable to specify WA and WB types of effects. It is not usable to detect unknown effects (XA and XB) for similar reasons as a survey with closed questions. A Delphi can help to get a better understanding of the relationships and the character of impacts in a known system.

Written stakeholder consultation on EU level

Written expert consultations are often used in transport policy making on European level. It is mainly applied for policies of programmatic character, e.g. white papers or actions plans, but also for more specific policy interventions.

Written consultations offer the chance to get hints on all kind of unintended effects. However, different stakeholder might have different opinions and there is normally no room for a direct exchange of arguments provided by this method.

Example: The Commission services public consultation concerning the review of the 2001 Transport White Paper took place via the Internet from 28 October to 31 December 2005. It was based on a presentation of recent transport developments and a questionnaire related to the 2001 White Paper measures and their impacts. This consultation has been a success in terms of the number of contributions received and the quality of the comments. 187 contributions have been received, totalling more than 1650 pages. These contributions come from various associations (at international, European and national level) representing all transport sectors (air, maritime, inland waterways, road, rail, urban transport, logistics and intermodality), from employees and users' associations, from business and industry, from environmental associations, from local, regional and national authorities, from local associations, from research organisations, universities and consultants, and from citizens. They provided the European Commission services with very valuable information on transport issues and sectors. (CEC 2006)

Public consultation on regional level

On European level public consultation means that mainly the organised stakeholders take part in the procedure. In local and regional planning procedure, it happens frequently that affected citizens that are not organised in established associations play a significant role in the process. Public hearings are mandatory elements of planning processes in many European countries (for example in the so-called "planning approval procedure" in Germany). It can also be used as an informal procedure at an early stage to test acceptance and to get information about perceptions, attitudes and concerns (in relation to unintended effects or effects not accepted by those who are affected by the measure). It can help to get hints concerning areas that need further research activities. Public hearings can be both a one way-communication or of discursive character.

The public needs to be informed about the projects. The quality of data strongly depends on the character of the projects. For larger projects, a transport model might have been used.

Further, Cost Benefit Analyses and Strategic Environmental Assessment (SEA) and/or Environmental Impact Assessment (EIA) usually are part of the data (see chapter 5.2 for SEA and EIA). System boundaries depend on the selections of experts and on the agenda, boundaries are flexible in principle.

As a formal procedure public consultation is in general applied rather late in the planning process. As an informal procedure, a public hearing could be an early stage to test acceptance and to get information about perceptions, attitudes and concerns (in relation to unintended effects or effects not accepted by those who are affected by the measure).

It is a basic intention of such procedures to not only gain acceptance but to give the chance to raise concerns that have been overseen in the planning process. So, it is surely a measure to detect not “only” W but also X effects in and beyond the transport sector. In practice, in most cases these effects might have already been anticipated by the planers and decision makers.

Example: Formal hearing in the German planning law - Planning approval procedures

Before a planning is approved by the planning authority, it has to be published in order to give directly affected citizens the possibility to submit objections against the planning. These objections have to be considered by the planning authority in a public hearing. Public consultation in the hearing occurs late in the planning process and is basically a mechanism for the exchange of information between the public and the administration (Renn, Oppermann, 1998, 355). The administrations and experts inform the public about their plans. Citizens have the right to ask questions and the administration can learn then about the public’s constraints and fears. In general, organised interest groups dominate the audience. Consequences for the design of the planning are possible, but in most cases, this obligatory involvement of citizens is initiated by the administration because of formal reasons in order to legalise the planning and not in a sense of participation of citizens in the planning process.

According to § 73 *VwVfG* the procedure begins with an application by the developer of the project which, in the case of Federal Roads, may well be the Federal Government itself. The authority responsible to administer the application (*Anhoerungsbehoerde)* will then solicit the opinions of other government authorities whose competences is affected by the project. The plan is to be made available for inspection by the public for a period of one month, during which time anyone whose interests are affected by the project is entitled to raise objections to the plan within the specified time limits. After this stage a public hearing is scheduled where the objections raised are discussed with the developer, the authorities, those affected and those who originally raised the objections. The authority responsible for administering the application will adopt a position and will forward this to the Plan Approval Authority. The Plan Approval Authority will consider the application and decide on whether to accept the plan.

4.2 Discursive approaches

The approaches summarised in this section are based on the exchange of arguments in predefined situation. These approaches can be widely unstructured or stronger formalised. Many variations of these approaches exist, which are related to stakeholder or public participation in decision making processes. Over the last decades a wide range of rather innovative or experimental approaches were applied. Even if this phase has been followed by a phase of criticism and disillusion, for the moment it seems as if many approaches are established in the routines of policy making (Hage et al., 2010). Examples include the round tables, future workshops, planning workshops with citizens etc. They are not all described here in detail with all their variations and derivates. Instead, we focus on some examples to illustrate and discuss the principle ability of discursive and/or participative approaches for the early detection of unintended effects. As it will be shown, these methods in general have a structure, but are quite flexible in integrating new arguments and views. In principle, they are able to give hints on all types of unintended effects. Some of them need considerable amounts of resources if applied properly. In some cases, the recruitment of suitable citizens could be a problem, in particular if citizens are not paid for participation.

4.2.1 Workshops

Workshops are daily business in science and in policy making. At first glance, it might seem somewhat trivial to consider them as sort of foresight tool. But workshops, in general, allow the exchange of information and the generation of new knowledge by bringing expertise form different fields together in a discursive way. The can be organised in a stronger formalised and structured way, with a strict agenda and prepared key-questions, focussed on concrete results or on testing of concepts. Quantitative data might play key role in the discussion. On the other hand workshops could be kept rather open with a sort of brainstorming character and a loosely structured agenda. Their strength and weakness has to be discussed in relation to the purpose. From a general viewpoint, strengths surely are the highly flexibility and comparatively low costs for application. Typical weakness is that the open format often makes it difficult to produce concrete results and that participants vary enormously in the way they behave and argue. A strong facilitator might be needed to avoid that a few participants dominate a workshop (maybe motivated by lobby interest).

Their ability to detect unintended effects as well as their strength and weakness strongly depends on the tasks to be discussed and on the background of the participants. In principle, an interdisciplinary panel should be able to roughly indicate potential unintended effects of secondary character (XB2). In contrast, highly specialised participants from one scientific community or stakeholder groups might be able to get detailed insights in WA and WB1 effects.

A very open form of a workshop or a conference is the so-called “open space” approach (Open Space Technology, OST). The key characteristic is that the theme is only roughly specified and the agenda is developed with a specific methodology by the participants themselves. The highly scalable and adaptable methods can be used for meeting with a few people or with one or two thousand people.

4.2.2 Focus groups / interview meetings

A Focus Group is a method of qualitative social science research. Qualitative data is gained in form of a group discussion. It is characteristic for a focus group that participants are talking mostly amongst themselves rather than interacting too much with the researcher or facilitator (Barbour, 2007, p. 2). Another characteristic point is that the group is provided beforehand with information on the issue to be discussed (topic guide, stimulus material). Participants should be on a comparable stage of knowledge on the selected topic. At least, they should have a common basis to have an informed discussion. On the other hand, there should be variety in viewpoints and perspectives; thus, the homogeneity or heterogeneity of the group needs careful design. Selection of participants depends on the purpose. Typically, citizens, experts or potential users of a service or a technology are selected, often in form of a random selection. In general, focus groups do not claim to be representative.

In principle, focus groups or at least similar methods have been applied for decades. The sociologist Merton played an important role in promoting group interviews, already in 1946 Metron and Kendall published a paper titled “The focused interview”. In the following decades focus groups were mainly used in marketing research (Morgan, 1997; Rogers, 1994). In the 1980s and in particular in the 1990s focus groups became a widely used methodology in social science. According to Morgan (1997, p. 2) focus groups are used as a self-contained method in studies in which they serve as the primary means of collecting qualitative data. Further, they are used as supplementary source of data in studies that rely on some other primary method such as a survey; quite often group discussions serve as a source of preliminary data in a mainly quantitative study; they can be used to generate survey questionnaires or to develop the content of applied programs and interventions. Focus groups might also be used to further analyse the output of a primary methods; they could be used to get a better understanding or verification of specific results of a survey or also of model calculations; they might be used to evaluate the outcome of a programme or an intervention. In multi-method studies that combine two or more means of gathering data in which no one primary method determines the use of others. Here, focus a groups are just an additional tools that enables gathering data from another perspective.

In marketing applications focus groups are often used for setting up a phase of quantitative research. In this context focus groups are used as first test of a new product, a service or a marketing strategy (Morgan, 1997, p. 3). Focus groups allow, for instance, learning on perceptions and attitudes of a group, to test reaction on a stimulus; to include knowledge form a specific group in decision making process or to get insides on where lines of conflicts might be located. Concerning the detection of unintended effects focus groups could be used

- In a quite explorative sense to see if any effects are mentioned and discussed in the group (secondary effects). It is well possible to discuss the effects of a policy package in qualitative ways. Results could serve as an input for further research tools (modelling, survey, scenarios)
- To test reactions on unintended effects that are known (could be done in form of scenarios; might be the results of a model)

Linking focus groups and experiments could be an appropriate means to support the early (and ex-post) detection of unintended effects. Referring to Merton et al. (1990) Morgan (1997, p. 28) argues that in an experimental context this would mean using preliminary focus groups to define “manipulations” of independent variables. So, focus groups might be used in designing programs or policy interventions as an early test of the effectiveness of these programs or interventions. In this context Morgan (1997, p. 28) stipulates: “The larger goal is to increase the chance of designing a successful intervention. Focus groups can provide information on the behaviour of the people affected by a policy intervention. In a similar way it is imaginable to use focus groups for the evaluation of a policy after is was implemented. They can help in “interpreting discrepancies between anticipated and actual effects, interpreting the ways that effects on subgroups may differ from the effects in the larger population, and interpreting the process involved in the actual production of interventions effects” (Morgan, 1997, p. 29).

A slightly different approach is the group interviews. In contrast to focus groups, in group interviews the facilitator is playing a more dominant role. There is less direct dialogue between the participants. But in practice there often is no clear distinction between focus groups and group interviews and the frontiers between these two methods are rather blurred. The interaction within the group is also the main difference to individual interviews, which could also be a means to get information on unintended effects.

4.2.3 Particular focus on integrating citizens perceptions and knowledge

In the following, several methods are briefly described that are aiming in particular on the integration of lay people’s opinions and perceptions. All these methods are not explicitly related to the detection of unintended effects, but implicitly they support anticipation and avoidance of such effects; also because usually they are used as a supplementary tool in addition to the formal planning processes. This enables the inclusion of citizens’ perspectives and knowledge in a structured way. However, quite a lot of resources are needed to carry out these approaches: In particular the planning panel and the consensus conference, with the extensive information of the citizens, can take quite along time and consume many resources.

Planning panel: This approach is in general related to a concrete local planning of a concept or an infrastructure measure. It aims at including citizens in the decision making and evaluation process. A planning panel (Planungszelle Dienel, 2002) consists of 15-25 randomly selected citizens. In general, several planning panels are working on the same topic in parallel, which enables the participation of a relatively lager number of citizens. The panels meet several times, or, alternatively, work for several days. Experts provide the citizens with extensive information about the issue at stake. This could be done by presentations, hearings, location visits etc. The information is reviewed and discussed by citizens in smaller groups of 3-5 people, in general supported by a facilitator. The idea is that the discussion lead to a careful evaluation of different options on basis of the information provided. The experience is that planning cells enable an intensive discussion and produce qualitative valuable results (Dienel, 2002).

Future Workshop: A future workshop aims a enabling an open and creative work of about 15 people. They design different images of the future, similar to scenarios. The work is structured in three phases. First, the discussion is on identification of deficits and critics related to the present situation. Second, in a “utopian phase” an ideal situation is designed. This can be rather creative and coined by fantasy like ideas. In a third step, critics and deficits are discussed together with the utopian ideas in a “realisation phase”. The aim is to formulate realistic objectives or concrete projects. This approach resembles the backcasting approach in scenario building (see Chapter 5)

Consensus Conference: The approach was developed in Denmark; in the meantime it is also applied in other European countries (Klüver et al. 2000; Joss 1998). Consensus conferences should enable a dialogue between sciences and society, the issue at stake should be of nation wide importance. In general, it is focused on technological developments and their potential impacts on society, economy and the environment. Typical examples are the debates on genetically modified food. For a consensus conference up to 30 citizens are selected and invited. They should be more or less representative for the society in a country and come together to meet for 4 days. The preparation phase takes several weeks where the citizens are informed by the organisations or by specific experts. During this period, the citizens prepare key questions to be discussed at the meeting and have the option to select an expert which they would like to invite for the meeting. During the first days of the meeting, there are experts’ presentations and debates between experts and the citizens. The discussions are open to the wider public. On the third day, the citizens formulate their statement, which is presented to the public on the fourth day. In the Danish model, the final consensus document is presented to the Danish Parliament. Consensus conferences in Denmark have resulted in public debates, in particular related to technologies and their impacts, and have led to politicians being made aware of the attitudes, hopes and concerns of the public (Rauschmeyer and Risse, 2005). The consensus conference is not particularly aimed at the identification of unintended effects in planning process. The approach rather aims at embedding expert knowledge in the context of wider social expectations and needs (Klüver et al., 2000). However, in doing so, it could well contribute to the identification of unintended effects. The method needs considerable amount of time and resources and is rather applied for broader socio-technology issues.

4.2.4 Cooperative Discourse

Several analysts of participatory processes claimed that single models of participation such as referendums or citizen panels are insufficient to become a major change agent for enhanced participation and effective policy-making (see Webler and Renn, 1995). As a means to ensure effectiveness, transparency, efficiency and public acceptability, a sequential model combining different instruments has been suggested (ibid.). This sequential model (called the cooperative discourse model) attempts to integrate scientific and technical expertise, stakeholder representation and citizen participation in three phases (Renn and Webler, 1998; Renn, 1999). At first, in an epistemological discourse scientific experts generate the cognitive basics regarding available facts, information and knowledge on which the participants must relate their arguments and proposals. The second phase deals with the normative and value-oriented interpretation of options of action and their consequences. In this reflective discourse representatives of interest groups (stakeholders) have the opportunity to mediate and exchange their desires, perceptions and preferences. In the last phase affected citizens shall stipulate the political decision in a designing discourse, i.e. citizens evaluate options of action and form a collective preference with respect to a concrete problem solving. The sequential model was applied to search for a disposal site in the Swiss canton Aargau and to design a waste management plan on the county level in the Northern Black Forest in Germany. A modified form of the sequential model was also applied in town planning. Furthermore, the three-step model was also used to measure public preferences with respect to the use of genetically modified organism in food (see Klinke, Renn 2002).

The method seeks to integrate and evaluate all the available knowledge in a structured way. It uses the special abilities of each of the participating groups: stakeholders, scientific experts and citizens. It keeps facts and scientific knowledge separated from values and norms. The co-operative discourse is a structural open approach that is able to use of all the quantitative and qualitative data available. It systematically works on uncertainties in expert knowledge (Rauschmeyer and Risse, 2005), that can support the detection of all kinds of unintended effects. The disadvantage of the methodology is that it is time consuming and expensive.

5 Integrative Approaches

In this chapter, foresight approaches that are usually based on a combination of several tools and methods are discussed. These tools are able to integrate data of different character and sources. Quite often they combine qualitative and quantitative data. For example, the results of modelling might be assessed with the help of expert workshops or stakeholder consultation.

There is a huge variety of possible combinations in this field and the related terminologies are not always clear and fully developed. Therefore, this field is illustrated with the help of two methodological examples and one practical example from transport policy packaging. One methodological example is scenario building, surely one of the most prominent foresight methodologies, the other one is strategic environmental assessment which is interesting since it explicitly aims at reducing negative effects on the environment. The third example, taken from policy practice, is the development of the European ITS action plan.

5.1 Scenarios and roadmapping

Scenarios can be seen as an adequate means to support the process of policy packaging and for assessing the effects of policy packages. Typically, they are not only focusing on one isolated measure or on one variable, they are able to take different measures or variables into account and explore or analyse the mutual interrelations between these variables.

Ten years ago, Greeuw et al. (2000, p. 6) stipulated: “Scenarios are becoming increasingly important as tools for policy makers. Also models and the links between models and scenarios are seen as useful means to support policy decisions.” This quote indicates that the term “scenario” subsumes a broad range of tools and methodological approaches. In general several tools are combined in a scenario process (workshops, CBA, trend analyses, models such as TRANSTOOLS and TREMOVE, Delphi, roadmaps and others). Even if huge amounts of data of different sources can be integrated in the process of scenario building, scenarios are not predicting the future. The term “scenario” always implies that other futures are possible, but predictions can be part of scenarios.

In principle, scenario-technique is a methodology that is used to design future situations in relation to a certain topic or context. Scenarios are defined by many authors as a coherent illustration of possible future situations together with pathways that might lead to these situations (Kosov and Gaßner, 2008, p. 9; Grunwald, 2002). Originally, the methodology was developed by the US based RAND cooperation in military context. Kahn and Wiener (1967), pioneers in this field, explained scenarios as hypothetical sequences of events constructed for the purpose of focusing attention on causal processes and decision points (Kahn and Wiener 1967, p. 6). Scenarios help to reflect on the consequences of decision making, to make effects visible and to give hints or even detect unintended effects. Scenarios can serve as playfields, where certain policy interventions are “tested” to get a better understanding of the related casual relations and of the anticipated effects – intended and unintended ones.

Scenarios are fulfilling different functions (Kosov and Gaßner, 2006). Most relevant in the OPTIC context is that scenarios are having a knowledge function. They help to systemise and deepen knowledge in a certain field. They can illustrate possible consequences of specific activities. Furthermore, they help identifying uncertainties, blind spots, contradictions or dilemmas. So, they allow the identifications of unknowns and help to turn such unknowns into known. They are an appropriate tool to get a rough understanding of where unintended effects might be “hidden”. Furthermore, they are an ideal platform for the integration of knowledge of different character and sources, e.g. empirical grounded data, trend extrapolations, assumptions etc. In principle, they give the possibility to integrate normative settings in a transparent way.

There are more functions that overlap to a certain extent. Scenarios support communication between different actors (communication function), and they can serve as discursive platform for the integration of different opinions or perceptions. On a strategic level, scenarios help to define targets (goal-defining function). They allow to integrate questions such as “where do we want to go?” or “what should be reached?” Further, they can give orientation in planning processes (strategy-building function). They allow for testing the efficiency or robustness of policy strategies.

An important reason for the variety in approaches is that scenarios are used in very different contexts. They can have rather different functions in a policy or research process. They could be the starting point of a larger project or the end point of an activity. They can be the central integrative element of a planning process or rather used to support discussions at certain points in an illustrative way. Even if there is a huge variety in approaches, a range of criteria exists that should be fulfilled by “good” scenarios. “Ideally, scenarios should be internally consistent, plausible and recognisable stories exploring paths into the future” (Anastasi, 1997; in Greeuw et al., 2000, p. 7). Further, assumptions and arguments should be made transparent and understandable. In addition, practical restrictions have to be taken into account. The degree in complexity, scope and number of drivers considered in a scenario is at least limited by the cognitive abilities of its developers and/or users (IZT, 2008).

Typical distinctions between types of scenarios are related to the dichotomies explorative versus normative and quantitative versus qualitative (Kosov and Gaßner, 2008). Some approaches are mainly based on qualitative data whereas others are strongly based on quantitative input and sophisticated modelling tools. For example economic aspects as well as developments in transport growth or modal split are usually done on a quantitative basis. Cultural, institutional or political dimensions are rather integrated in a qualitative way. Narrative scenarios in general are purely qualitative (Kosov and Gaßner, 2008).

The two types of scenarios have different abilities concerning the detection of unintended effects. Quantitative scenarios have the advantage of producing more precise results. Similar to models (or by using models), they define a certain set of variables that is considered with their interrelation and, thus, have rather fixed system delimitation. Such scenarios are able to produce quantified information on effects in relation to variables included, they allow for a detection of unintended effects inside the system. Qualitative scenarios are more open regarding the variables and the factors included, the system delimitations are less fixed. A detection of secondary effects is easier possible; a quantification of such effects might need additional quantitative tools.

Another distinction is the one between baseline scenarios and policy scenarios. Baseline scenarios are extrapolating recent trends in to the future. They assume that no significant changes take place regarding key factors; accordingly they are also called “Business as Usual” scenarios. They are used as a point of reference for the comparison with alternative scenarios. Such alternative scenarios, or policy scenarios, do explicitly include political interventions or specific measures. They are used to analyse the effects of different options of action. They are able to demonstrate the robustness of a policy by illustrating that a certain measure or strategy is beneficial under different future conditions.

A typical categorisation of scenarios distinguishes between forecasts, explorative approaches and backcasting.

A **forecast** is often based on or developed in relation to an extrapolation of trends, for example when the growth rates in freight transport of the last 10 years are used to assess the growth of the next 10 years. Forecasts are able to illustrate unintended effects at least in relation to one factor that could be related to a second factor (for example the relation between transport growth and different developments of the GDP). Forecasts might be used to illustrate known intentional and known counter-intentional effects (WA, WB; see Table 2.1) They are a rather simple and transparent methodology, but they involve a high degree of uncertainty since secondary effects are outside the system boundaries and additional criteria would be needed to assess the accuracy or likeliness of the extrapolation. Forecasts should be used rather early in the policy process since they are easy to conduct and give a rough overview on the potential development of specific items. Typically, forecasts are used as reference case in explorative and backcasting scenarios, often called a baseline scenario or a Business as Usual scenario (BAU).

Explorative scenarios elaborate on possible futures, in the ideal case it does not matter if these futures are desirable or not. They are also called descriptive scenarios, which underlines that their main objective is to describe how the future could look like. Desirability or undesirability of these futures are not key issues in the process. The central question is "what happens if". In practice, however, explorative scenarios are not fully free of normative settings. At least implicitly, the selection of key drivers and variables is always having a normative basis.

Explorative scenarios appear to be the most interesting ones in the OPTIC context; the underlying "what-happens-if-approach" explicitly tries turning unknowns into knowns; the approach is able to support detecting and highlighting potential unintended effects of all categories (X and W). This can be done in a quantitative way, support by sophisticated transport models or also by more simple calculations. The disadvantage of applying the method in a meaningful way is that it requires a lot of resources; a wide range of interdisciplinary expertise and stakeholder should be included; quantitative data might be produced and included in the process. Explorative scenarios should be used at early stages in a planning process where most options are still open. The methodology is mainly used for mid to long term approaches between 10 and 40 years. Explorative scenarios are used on all levels from local (city planning) to global predictions. From a theoretical point of view, a two step approach with an exploration phase and an evaluation phase is appropriate in terms of anticipating unintended effects:

Step 1: Pure exploration of a measure or a policy, designing possible future no matter if they are desirable or not, thus, leaving out values and norms as far as possible

Sep 2: Evaluation of results, discussion which effects are desirable for whom and which are not. Now, norms and values come in explicitly.

Normative scenarios, in contrast, take norms and values explicitly into account form the very beginning. They ask questions such as "what is a desirable future" and "how can we get there" (Kosov and Gaßner, 2000; Schippl and Leisner, 2009). A typical form is the backcasting approach, where targets are defined that should be fulfilled at a certain point in the future (for example an 80% reduction in CO_2 emissions in 2050). Backcasting means designing 'images' of the future that seem to allow the achievement of targets and then describing options or pathways to get there. Several future transport studies aiming at sustainability or specifically on reducing CO_2 emissions have used the Backcasting method, e.g. the POSSUM EU-project and the UK VIBAT project (Banister, 1998; Hickman and Banister, 2005). The method allows designing policy packages together with a corresponding socio-economical environment that is supposed to enable the fulfilling of the specific targets. It is a rather integrative or holistic approach. Detecting unintended effects is not an explicit aim of the backcasting approach. However, designing images of the future might help to get hints on unintended effects. Similar to an explorative scenario, conducting a backcasting process requires a considerable amount of resources.

In principle, scenario building is able to highlight all kinds of unintended effects. In particular when knowledge from different sources is combined, scenarios offer a chance to anticipate secondary effects inside the transport system and also beyond. However, the ability to detect specific unintended effects depends on the scenario methodology applied and, thus, has to be discussed in relation to the different methodologies. Greeuw et al. (2000, p. 9) summarise: "Scenarios are perhaps most effective when seen as a powerful tool to broaden perspectives, raise questions and challenge conventional thinking. Scenarios are in principal powerful frameworks for using both data and model-produced output in combination with qualitative knowledge elements".

A different approach is a **technology roadmap** (Kostoff and Schaller, 2001; Fleischer et al., 2005; Schippl et al., 2009). It is mentioned here because of its overlaps with the backcasting approach. The term technology roadmap is rather widespread, but can be defined and used in different ways. In general, a technology roadmap is a concept or a plan that brings together short-term and long-term goals with specific technology solutions to meet those goals. It makes use of knowledge of different sources and is able to integrate qualitative and quantitative data. As such, it could be used in the context of a backcasting scenario. Roadmapping is not explicitly designed for detecting unintended effects; still tools used during the process (e.g. expert workshops, surveys or a Delphi) might help to get a notion of unintended effects. Such effects could become relevant for the roadmapping process; unintended effects on the environment, for example, could be seen as a potential barrier in an innovation process in the transport sector. Tuominen and Ahlqvist (2010) give an illustrative example on socio-technical roadmapping in the transport sector.

5.2 Environmental impact assessment and strategic environmental assessment

Both instruments of environmental impact assessment (EIA) as well as strategic environmental assessment (SEA) are related to the assessment of the environmental consequences of an activity. They both aim at reducing negative environmental effects of a policy. These tools illustrate well that different phases of policy making need their specifically designed tools. They clearly indicate that foresight activities related to concrete project need different approaches than activities to broader programmes or plans, or at least variation in methodology (see Figure 5.1).

SEA and EIA use combinations of different tools rather than only one tool. Scenario processes and modelling approaches quite often play an important role. But also participatory and consultative methods are used frequently. Rauschmayer and Risse (2005) provide an overview on participatory approaches for SEA that cover work with stakeholder groups (mediation, mediated modelling), the general public (consensus conference, citizens' jury), and with members of both groups (cooperative discourse).

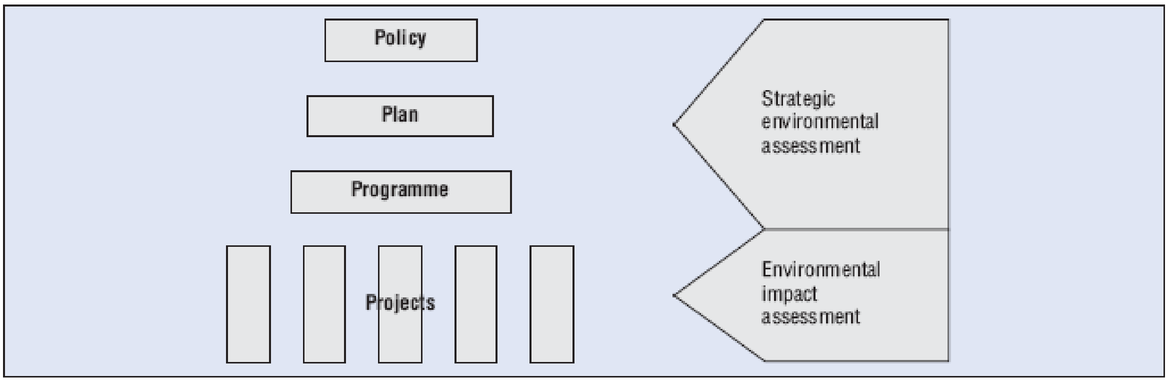

Figure 5.1: Up-streaming environmental considerations into the decision-making hierarchy, Source: OECD, 2006

The two approaches are designed for different levels in planning processes and they are of different legal status (see Table 5.1). EIA is a mandatory tool which is applied in individual projects. The instrument is used for several decades. In relation to transport, experiences illustrated that because of its focus on single projects the instrument has shortcomings in dealing with cumulative effects such as a progressive degradation of natural habitats or the cumulative air and noise pollution caused by multiple transport projects (Thérivel, 1998, p. 509). As further mentioned by Thérivel, there are also shortcomings in dealing with induced traffic, with modal alternatives, with global level impacts and a range of other strategic level issues (B2 effects). These issues can only be effectively addressed at decision making stages which precedes the planning of individual projects, thus, at a level of more holistic or programmatic character. To overcome some of these limitations of EIA the instrument SEA was developed and applied for transport policies, plans and programmes. It is also used for assessing the environmental consequences of Public Private Partnership schemes. The main differences between these two approaches are summarised in Table 5.1.

Environmental Impact Assessment (EIA)	Strategic Environmental Assessment (SEA)
Applied to specific and relatively short-term (life-cycle) projects and their specifications.	Applied to policies, plans and programmes with a broad and long-term strategic perspective.
Takes place at early stage of project planning once parameters are set	Ideally, takes place at an early stage in strategic planning.
Considers limited range of project alternatives.	Considers a broad range of alternative scenarios.
Usually prepared and/or funded by the project proponents.	Conducted independently of any specific project proponent.
Focus on obtaining project permission, and rarely with feedback to policy, plan or programme consideration.	Focus on decision on policy, plan and programme implications for future lower-level decisions.
Well-defined, linear process with clear beginning and end (e.g. from feasibility to project approval).	Multi-stage, iterative process with feedback loops.
Preparation of an EIA document with prescribed format and contents is usually mandatory. This document provides a baseline reference for monitoring.	May not be formally documented.
Emphasis on mitigating environmental and social impacts of a specific project, but with identification of some project opportunities, off-sets, etc.	Emphasis on meeting balanced environmental, social and economic objectives in policies, plans and programmes. Includes identifying macro-level development outcomes.
Emphasis on meeting balanced environmental, social and economic objectives in policies, laws and programmes. Includes identifying macro-level development outcomes.	Inherently incorporates consideration of cumulative impacts.

Table 5.1: A comparison between SEA and EIA, Source: OECD, 2006

There is still not a commonly accepted definition for SEA available (Rauschmayer and Risse, 2005). The following definitions can be found:

- Strategic environmental assessment can be defined as the process of identifying, assessing and mitigating the environmental effects of a policy, plan or programme and its alternatives. Findings are compiled in a report and are discussed on a broader basis in a public consultation process. (Thérivel, 1998, p. 51)
- SEA is a continuous, iterative and adaptive process focussed on strengthening institutions and governance. It is not a separate system, nor a simple linear, technical approach. Instead, it adds value to existing country systems and reinforces their effectiveness by assessing and building capacity for institutions and environmental management systems. (OECD, 2006, p. 18)

The methods have a strong focus on environmental issues. They are using a variety of available information including quantitative and qualitative data. Quantifications are important for assessing the impacts but not always possible. EIA is strong in detecting primary effects. SEA clearly is of explorative character as it offers the broader focus and, thus, is able to detect secondary effects illustrated in Table 2.1 (see Thérivel 1998).

The methods can be used for short- to mid and long term analyses depending on the issues at stake. In practice, the geographical scope is mainly regional, but it could also be national or European. SEA is applied in several European countries as well as on European level (Thérivel, 1998, p. 509).

Both methods require considerable resources when applied properly. EIA is closer to the category of structural closed approaches. Ideally, it is applied in the policy process at a stage when there is already a pre-selection of options. It hardly makes sense to apply these resource intensive methods too early in the planning process.

SEA is used at an earlier stage of the planning process, at a point where various options are still feasible. The methodology considers a much broader range of possible options than EIA. In fact, EIA in general only describes a “no or without” option. SEA seeks to influence policy making in its formative stage (OECD, 2006, p. 31); it aims at anticipating unintended effects on the environment at an earlier stage and pays more attention on strategic alternatives. Therefore, SEA is the more explorative and open approach belonging clearly to the category of structural open methods.

It should be noted that similar approaches focused on impacts in other fields such as “social impact assessment” or “cumulative impact assessment” (OECD, 2006, p. 31). In principle both approaches, but in particular SEA, can support the anticipation of all kinds of unintended effects in transport policy making.

5.3 Example: the development of the ITS action plan

The case of the ITS action plan is interesting because an ex-ante impact assessment was conducted on basis of different tools and methods, including stakeholder consultations, interviews, workshops, modelling and others. Therefore the example is briefly introduced and discussed here. Figure 5.2 illustrates the ITS problem tree (CEC, 2008a and 2008b).

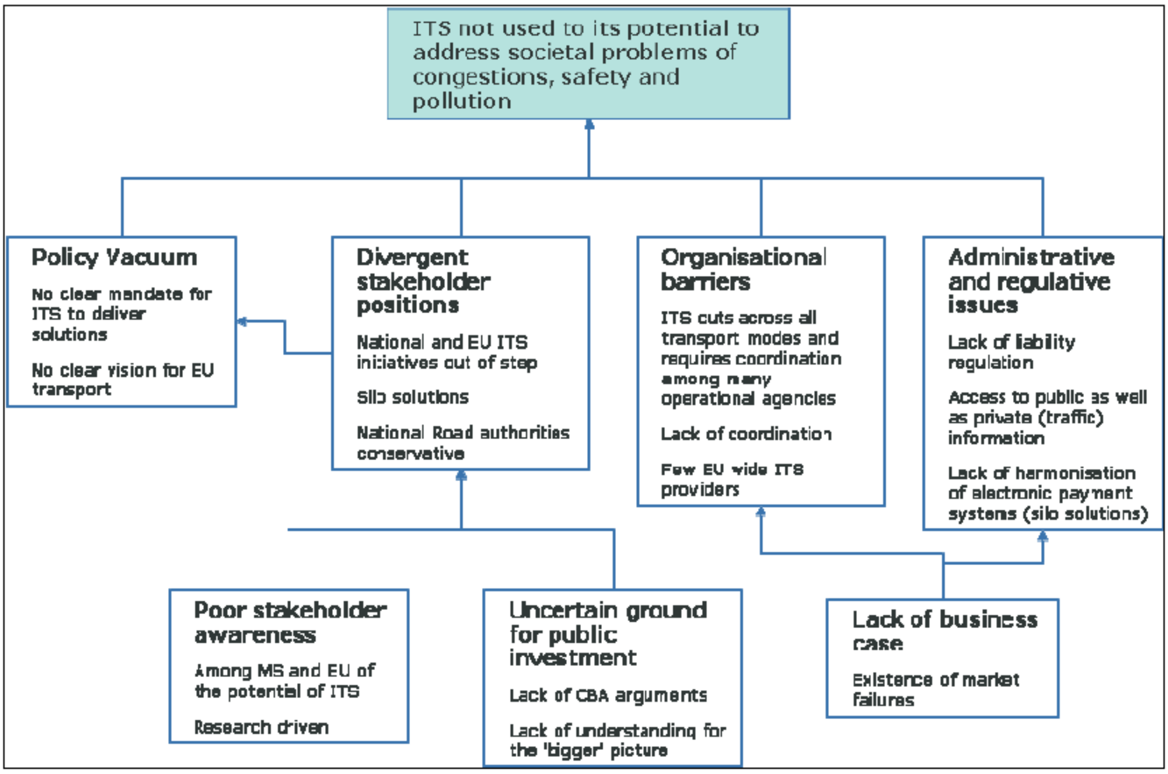

Figure 5.2: ITS Problem Tree, Source: CEC, 2008b

ITS solutions in road transport are being taken up slower than expected. Furthermore, services are deployed in a fragmented basis in Europe. Against this background a need for action on a European level was identified. Some issues need to be addressed from a European perspective to avoid the emergence of a patchwork of ITS applications and services: geographical continuity, interoperability of services and systems and standardisation. They should facilitate pan-European applications, secure, accurate and reliable real-time data and an adequate coverage of all travelling modes. The action plan senses the need to create adequate framework conditions to accelerate and coordinate the deployment of ITS.

The action plan was prepared on the basis of input provided by the consultation of stakeholders on the one hand and on existing expertise from various work carried out over the past years on the other hand (see CEC 2008b).

Expertise:

- The eSafety initiative has developed a roadmap covering in-vehicle applications implementation. They in turn gathered information from appropriate literature research and from accident causation data of member states.
- An eSafety forum was dedicated to the initiative with some 35 participants debating supplementary actions.
- Being basically a qualitative assessment, criteria have been rated on a five-point Likert scale, ranging from positive to negative.
- Use was also made of TT to simulate the effects of various policy options; the model has been applied at a rather early phase of the assessment.

Stakeholders' consultation:

- Thirteen high-level stakeholders' interviews were conducted with persons from: national ministries of transport, government-owned development and deployment agencies for ITS, a city authority, a membership-based international organisation bringing partners together to develop ITS-based services, a toll motorway operator, an ITS-based information service provider, a membership-based organization representing the heavy road transport industry, representatives of the Directors of the National Road Authorities, a mobile telecommunications operator, an electronic components supplier to the automotive industry and an automobile and truck manufacturer
- Two public Stakeholders' workshops were organised to discuss, group and fine-tune problem areas, objectives and potential actions.
- Member states delegates discussed the rationale behind specific actions at a meeting in Brussels.
- A questionnaire based internet-survey was launched and generated 34 replies. The results can be downloaded on the European Commission's homepage, making the process transparent.
- An inter-service group composed of representatives of the Directorates-General concerned (SG, ECFIN, ENTR, EMPL, ENV, INFSO, RTD, TAXUD and JRC) was created. The group met four times.
- An ITS Steering Group was set up with Directors from five different Directorates-General (INFSO, RTD, ENTR, ENV and TREN). This Group provided guidance on the preparation of the ITS Action Plan.

This impact assessment addresses the items listed in Art. 21(1) of the Implementing Rules and can therefore be regarded as an, basically qualitative ex-ante evaluation. Options for action have been examined in favour of ITS for road transport using a multi-criteria analysis. Further, a general cost assessment has been used, keeping in mind the impact on the EC budget and the consistency of the impacts.

The Action Plan outlines six priority areas of action. For each area a set of specific actions and a clear timetable is identified. As an important additional criterion the time perspective has been considered, ranging from short to medium-term (up to 2020). This has been developed for each option and indicator.

The Action plan emphasises clearly, that the results of the analysis on expected impacts must be approached with a certain degree of uncertainty. Further, it points out that expected benefits of ITS can in turn enhance the attractiveness of driving resulting in higher road transport demand both for passenger and freight and would therefore offset the benefits of ITS. At last it has to be noted, that the assessment has not been accomplished to guarantee a better take-up of any specific ITS application, but to show the impact of possible EU measures to influence the coordinated delivery mechanism for ITS deployment.

6 Policy analysis in the EU and the role of unintended effects

In the following sections the attempt is to stepwise approach and precise the role of assessment methods for the detection of unintended effects. Focus is on an assessment of the abilities of transport and emission models to detect unintended effects along concrete examples for policy making. This is done by going through several examples which mainly refer to the European level. In addition, it is discussed which other methods could be used for policy assessment. It will be illustrated how models are or could be linked with mainly qualitative approaches.

In 6.1 we briefly resume the key areas of EU transport policies named in the White Paper 2001 and the Mid-term Review from 2006 and relate them to the modelling abilities of TT and TREMOVE. In 6.2 we exemplify the role of models along three policy examples, 6.3 is about how to relate assessment approaches to the OPTIC typology of unintended effects and the policy packaging process as introduced in Deliverable 1. In section 6.4 'guiding principles' are developed of when and where along the policy packaging the application of assessment approaches is recommendable.

6.1 Key areas of EU transport policies

Of major priority to EU transport policy is the further construction of the Trans-European Networks for Transport (TEN-T). The associated projects are seen as a key element to guarantee the transport of persons and goods, thus improving connectivity and interoperability of (inter-)national networks. For this purpose, TT and TREMOVE serve as analytical instruments to enable the assessment of respective policies and infrastructural projects in such way that (Burgess et al., 2005, p. 6):

- an evaluation of TEN-T projects is possible (ex-ante, ex-post, socio economic and environmental impacts),
- main indicators of the level of service can be quantified (congestion levels, accessibility, modal split) and
- measures to improve the TEN-T network (regarding missing links, new technologies) can be assessed.

To define priority areas for EU policy analysis with models, main references at the time of writing are the White Paper of 2001 (EU Commission, 2001) and the Mid-term review of the White Paper from 2006 (EU Commission, 2006). In 2001, 76 specific transport measures were identified. Already in the first version of TT (Burgess et al., 2005), explicit reference was made to the question of which measures can be analyzed with TT. Without going into detail regarding specific policies, the White Paper of 2001 still serves to indicate the major fields for policy action. In the following we resume briefly the major policy action fields and relate them to functional abilities of TT and TREMOVE[7]:

- **Economic sustainability:** the free movement of people and goods is understood as principle for the development of European markets; the transport networks that enable these movements are in continuous change, thus models such as TT support monitoring the state of the infrastructure system and estimate levels of connectivity.

[7] For all the examples in this section, structurally open, qualitative methods may be helpful to prepare the modelling and for drawing conclusions from the quantitative results. Integrating a broader range of expert, stakeholders or citizens by using, for example, workshops, focus groups or a scenario process can help to guarantee that the relevant questions are tackled with the models, and that unintended effects outside the scope of the model are not overseen.

TREMOVE complements this assessment with its view on vehicle stocks, emission standards and respective externalities (noise and emissions).

- **Internalisation of externalities:** in order to achieve a more equitable transport system the internalisation of costs by mode is a referred objective; models like TT enable and support (at least partly) the quantification of such effects like congestion and related emissions and noise levels (via related impact models such as TREMOVE); TT allows for example to quantify the number of people affected and their spatial proximity to infrastructure on which externalities are produced.
- **Modal Split:** the share between transport modes is crucial for the description of the transport system, both in passenger and freight transport; it is a main domain of transport models to predict modal shifts due to interventions (be it by infrastructure or regulatory policies) or changes in main driving factors (demographic and economic development). Again via the use of impact model such as TREMOVE environmental impacts can be quantified.
- **Congestion:** levels of congestion can be explicitly addressed with transport models (and with TT), nevertheless it is important to consider the degree of spatial solution of the system modelled; models such as TT are used to predict congestion levels along a route or link on a very aggregated level (for the highest level of urban roads or rail networks); naturally local congestion effects in urban agglomerations are not addressed adequately and should not be analyzed with TT.
- **Accessibility:** there are numerous definitions of accessibility, in TT accessibility can be described by the travel time (by mode) needed to reach any other destination by zone in the area; the development of this indicator over time is important due to its ability to tackle aspects of equity when accessibility is analyzed against the background of different socioeconomic groups.
- **Efficiency:** the question if aspects of efficiency can be addressed by TT or TREMOVE depends strongly on the definition given for efficiency; e.g. TREMOVE can support analysis in this direction and quantify impacts if efficiency is associated with resource consumption and emission production;; additionally, efficiency in terms of a cost-benefit analysis may be addressed also with TREMOVEs welfare module (see 3.2.5)
- **Effects of system boundaries:** as TT and TREMOVE are European models, a huge advantage is the availability of a model system that covers various countries, not limiting the spatial extension of the model to administrative boundaries; nonetheless, covering different countries at the same time opens up the possibility of relevant bias in the analysis, e.g. due to only aggregated information regarding delay times at borders or sparse information about country specific mode choice behaviour.
- **Safety and Security:** the answers that can be given by TT regarding safety and security aspects are rather weak; accidents in passenger or rail transport cannot be modelled; indirectly the traffic flows by mode indicate spatially where main transport activities are located and thus, where a great number of people (and/or goods) would be affected by an unpredictable event; based on international safety data (IRTAD, CARE, WRS) the risks of accidents are covered in TREMOVE; for road, rail and air transport accident costs are expressed in EURO per vehicle-kilometre and included in external costs calculation.

The mid-term review of 2006 emphasized the need to re-adjust policy measures, as “measures envisaged by the Commission in 2001 will not be sufficient on their own to continue achieving the fundamental objectives of EU policy” (EU Commission, 2006, p. 6). With regard to a potential assessment of policies using TT and/or TREMOVE, amongst others, the following areas for measures were named:

- **Technologies:** referring to the optimisation of engines, the introduction of intelligent vehicle energy management systems or alternative fuels and propulsions

- **Infrastructure:** the construction of new infrastructure and the reduction of bottlenecks remained on the agenda, thus the extension of the main trans-european network axes and improved accessibility are key concerns
- **Intelligent mobility systems:** technologies for an intelligent transport system (vehicle-to-vehicle and vehicle-to-infrastructure communication, navigation systems and real-time management of traffic, tracing and tracking of transport flows)
- **Freight and Logistics:** improving load factors and stimulation of transhipment, intelligent logistics enhancing co-modality of different modes along the transport chain
- **Charging:** charging the use of infrastructure to finance extension and maintenance and to optimise traffic, i.e. manage flows in accordance to road capacities

This list does not reflect the complete agenda of possible policy interventions named in the review of 2006, but serves to briefly summarize the main actual and future requirements to the models. In other words, policymakers would expect from the modelling suite available (TT and TREMOVE) that it is capable to quantify effects of these measures. Each of the named policies most probably is not implemented individually, but introduced as part of a policy package. In the following section we pick up some of the policy areas introduced here and use them as examples to discuss if the available models are able to quantify associated intended and unintended effects.

6.2 The detection of unintended effects: policy examples

The following examples are helpful as it is impossible to answer in general terms whether or not the models are able to cope with unintended effects. The policies named above are much too heterogeneous in their expected outcomes and models too specific to give a definite answer. These exercises serve as an attempt to exemplify the ability of the models to detect unintended effects. The intention is that based on the examples a better understanding can be developed regarding the models' abilities to quantify adverse effects.

Example 1: Charging for the use of infrastructure

The policy itself can be reproduced quite reasonably with TT, as it has an direct effect on transport costs, which are considered in the modelling of decisions (whether or not to drive, which mode to choose, etc.). Thus, first order impacts of changes in transport flows and modal shift are adequately addressed by the model. So, the first question raised about general ability may be answered positively. More problematic is the second question about unintended effects. What are unintended effects in the context of a pricing scheme? Additionally, we might ask how the generated revenues are used once the charging system is introduced.

If revenues are used to finance further and/or maintain existent roads the generated benefit feeds back to the road system and its users. This means those less affected by the increased price will experience a benefit from their monetary contribution as roads are better maintained and connectivity improved. Nevertheless, an unintended effect can be that lower income groups are not able to afford car travel any more and are forced to switch to different modes or not to travel at all. This scenario would create a conflict to the objective of providing a high level of mobility to all people in the EU. And given the fact that revenues are once again invested in road, these users cannot expect improvement in alternative modes due to cross-financing.

In this context, the policymaker would 'desire' a very detailed model that predicts who would be affected by the pricing scheme, where do affected people live and to what extent they are affected, e.g. how is their mobility budget reduced and/or are alternative modes available in their living surrounding. A model such as TT in its current version is not designed for answering these very specific questions, as such population subgroups are not considered and spatial zoning too aggregate. Then there is still the option to run a different model, maybe one with a regional focus but at the cost at loosing the impact analysis for the entire EU. But, structurally open methods can point at issues that might become problematic because of unintended effects. Methods such as interviews, focus groups or surveys would be needed to better anticipate the reactions to pricing schemes. Still, there remains the need to collect this information systematically – which itself can be challenging both in the sense of designing the adequate methodological approaches or survey instrument as in funding such an activity – trying to anticipate peoples reaction to changes in mobility costs.

Example 2: Subsidies for the purchase of electric vehicles

The appearance of more vehicles with electric propulsions would not be reflected directly in TT. We may assume a higher share of electric vehicles externally and as a result of a subsidy policy, but during the estimation of transport demand and later the assignment step no differentiation between vehicle types is made within TT. The policy would imply different transport costs for different vehicle types if less fuel costs for electric vehicles are assumed. Whereas the consideration of electric vehicles in TT is not foreseen, the impact of the policy could be assessed ex-post by applying the impact model TREMOVE. Here, the associated reduction in emissions (anticipated, known and intended effect) due to a significant share of electric vehicles (with less or no local emissions) would be estimated adequately. Additionally TREMOVE estimates the emissions that appear due to higher electricity demand in its fuel life cycle module. Nevertheless, the consideration of differentiated cost structures by vehicle type in the demand model of TT – with the effect that e.g. more trips are realized by a specific vehicle type due to reduced fuel costs – would require modifications of the model structure. Additionally, known but further unintended effects most probably appear. For instance, the demand for electric energy increases and new power plants are necessary which produce additional emissions. The unintended effect would be out of the scope of TT because the effect occurs in the energy sector, thus, beyond the system delimitations. This example shows that unintended effects often are likely to happen in a variety of systems, thus requiring for a more complex modelling environment to be able to cope with all effects. Again, the extension of the modelling environment is limited (due to restrictions of time, resources, knowledge, complexity) and either additional models would be required (rather a model of the energy system would be needed to get more insights here) or the assessment needs to be combined with structurally open methods (for example a workshops with experts form the energy sector).

Example 3: Vehicle Scrappage Scheme

In 2009 the German government introduced the so called ‘Umweltprämie’, a 2.500 Euro bonus when a new car was purchased and an old car handed in for scrappage (certain conditions applied here though). The measure intended a) to stimulate Germany’s car manufacturing in the time of the economic crisis and b) to lower the stock of high emission cars. Regulations failed to avoid that old cars not being scrapped were sold to foreign markets. The intended effect of an increased number of newer cars with fewer emissions can be reproduced with TREMOVE, also the respective shift within the vehicle stock. Thus, as an outcome of a model run fewer emissions (given a stable demand) are calculated. From the policymaker perspective the policy may be perceived as a success as the primary objective was achieved. But the unintended effect of scrappaged cars exported to other countries would not be covered by the model due to a limited scope (covers only EU member states, has fixed scrappage rates).

The conclusion about the model capabilities is ambiguous: on the one side, TREMOVE would predict reasonably improved emission levels and a drop in of revenues of car repair services due renewed fleet. But still, it remains outside the system boundaries and thus unclear how many vehicles are sold to EU external markets and how this affects the purchase behaviour of new vehicles there, the associated emission levels, etc. Again, it gets evident that although main effects are covered by the model (here TREMOVE) not all uncertainties and probably unintended effects can be covered by one model. Although it is very difficult (we might say impossible) to quantify these secondary effects in advance, a broader – early and systematic – involvement of experts and stakeholder might help to better anticipate such kind of unintended effects (even if it is not clear if such anticipation would have changed the decision in this specific case).

The examples make clear that, a) both transport and emission model TT and TREMOVE have only a restricted capability to quantify policies, b) some impacts cannot be quantified internally by the model itself but by exporting model results to other impact assessment approaches such as e.g. a cost-benefit analysis, c) sometimes no quantitative method at all is applicable and assessment alternatives need to be found.

From a modelling perspective it is clear that TT is designed to estimate effects on macro scales. These macro scales refer to a spatially aggregated level (large zones), an activity related level (few travel purposes, rough economic activity categories) and user related level (no socioeconomic differentiation of population). Having this in mind, an additional requirement comes up when using quantitative methods: the necessity to translate policies in such way that they can be modelled using TT, TREMOVE or similar types of models.

Measures which can be integrated directly into the model have to be separated from those that need some type of translation, similar to the issue of using VOT when transferring time into money or vice versa. For example: if we assume a technically perfect interoperability between different European rail systems, a translation of that policy needs to be made for incorporation in TT. In this case, e.g. any extra time (or cost) currently considered in the model at borders can be removed from the system, leading to an increased attractiveness of the mode, thus leading probably to mode choices in favour of rail options. This is a rather technical (model) translation of an at least partially bureaucratic decision of enhancing interoperability in the EU. The options for model application increase substantially if we agree on the allowance for this type of ‘policy translations’ into the model.

This stage of ‘policy translation’ is where the consideration of experts (stakeholder) is recommendable. The required translation of a policy in such way that the model ‘may understand the leverage’ is due to experts and people that adequately traduce effects. Staying with the example of an improved interoperability in rail: the relevant question would be who, where and to what extent a better interoperability can be expected? Are there experiences with improvement measure that may indicate how much travel time (cost) can be saved at frontiers? Once stakeholders (or even surveys) have given an indicative response to that question, only now the model application starts.

The examples used in this chapter point out the necessity of a careful usage of modelling instruments as their field of application is restricted. In very few cases they will deliver an entirely comprehensive answer to the policymaker; they should be perceived as one part of a more complex and multi-methodological assessment. This becomes more obvious bringing to mind the numerous expected and unexpected (un-)intended effects related with a policy package. The examples in this chapter reduced this discussion to only one dimension of unintended effects, but even though the exercise already indicated the necessity for alternative assessment approaches. In the following sections we address this issue suggesting a (sequential) methodology of how to integrate both qualitative and quantitative assessment methods in the policy packaging process to a) allow for a reliable assessment and b) to avoid the appearance of ‘critical paths[8]’.

6.3 The role of assessment approaches in policy packaging

Quantitative models like TT or TREMOVE are developed to explicitly quantify intended and – as far as they are measurable – unintended effects. But as we stated already, the question if unintended effects can be identified in general cannot be answered unambiguously. A definition of what do we understand by unintended effects in transport policymaking was required and the stakeholder perspective needs to be considered as the perspective on what is intended and unintended may differ substantially according to the type of stakeholder included. Deliverable 1 set the outline for the definition and categorization of intended and unintended effects. In the following when talking about intentional (intended) and/or non intentional (unintended) effects, we refer to this typology introduced in chapter 3.3.1 of Deliverable 1 about ‘Knowledge, attention and anticipation’. To improve traceability of the following sections, with the subsequent Table 6.1 the respective typology of unintended effects shown in Table 2.1 is repeated here.

[8] We define ‚critical paths’ as a non-desired, non-planned development of the policymaking process. A critical path leads to a deviation from the original target, objectives are not longer achieved or results only suboptimal. It is likely that a critical path leads to the appearance of (new) unintended effects.

<table>
<tr><td colspan="2" rowspan="3"></td><td colspan="3">Consequence dimension</td></tr>
<tr><td rowspan="2">A. Intentional</td><td colspan="2">B. Non intentional</td></tr>
<tr><td>B1 Counter intentional</td><td>B2 Secondary</td></tr>
<tr><td rowspan="2">Knowledge dimension</td><td>W. ‘Known’</td><td>The consequences that decision makers intended with the intervention
----
Average fuel consumption of new vehicles is reduced; less fuel is consumed</td><td>Counter-intentional effects that were anticipated at the time of decision
----
Cars are driven longer and consume more fuel due to lower fuel cost/km (rebound effect); models may predict the effect</td><td>Secondary effects that were anticipated at the time of the decision
----
Longer distances driven lead to increase in congestion;
models may predict the effect</td></tr>
<tr><td>X. ‘Unknown’</td><td>Advantageous effects that are not known; serendipitous
----
New cars inspire some people to ‘green driving’ lifestyles, saving additional energy</td><td>Counter-intentional effects not known at the time of decision
----
Car manufacturers economically challenged by the standard abandon plans to develop ultralite cars</td><td>Secondary effects not known at the time of the decision
----
Less public propensity to use alternative travel modes due to cheaper car travel, leading to line closures</td></tr>
</table>

Table 6.1: Typology of unintended effects to be used for the evaluation of tools and methods. Source: TSU Oxford et al, 2010

To answer the question to what extent models are able to detect unintended effects, it is meaningful to work with policy examples. This is due to several reasons: it is most likely that models will be able to quantify only a part of all associated effects of a measure. Thus, to what extent a quantification of both intended and unintended effects is possible depends on the measure and the type of model, thus the specific situation. Nevertheless, the exercise of examples including the application of models can proof the general practicability of the policy packaging process introduced in Deliverable 1 and finally, allows us to exemplify the use of the methodology for applications (other policy packages) which are beyond the specific policy context of OPTIC. Intentionally we refer in this chapter to the more aggregated typology of unintended effects provided by the table introduced in Deliverable 1 and do not consider the more disaggregated typology of chapter 3.3.2 (TSU Oxford, 2010). This is because of the very practical reason to provide traceability along the developed processes, although the consideration of the categories ‘AZ1’ to ‘B2X’ makes sense from a theoretical point of view. In practical policymaking it is less likely that unintended effects – if detected at all – are further assigned to sub-categories in accordance for example to the degree of intended ignorance of decision-makers at the time of taking the decision.

As another important assumption we state that quantitative approaches, such as TT and TREMOVE, are not able to detect ‘X’ (unknown) consequences of policies. In other words: we assume that the person(s) that apply the model have complete knowledge about its causal functionalities as well as input and output data. Given this condition, this leads us to the assumption that no unknown effect may be predicted by the model. As long as there is complete knowledge about the model’s underlying causal relationships, no ‘surprises’ in the sense of counter-intentional or secondary effects can be an outcome of the model. [9] Note, that this does not mean that no unknown unintended effects may appear – they most likely will. But, in these cases there will be no model available to quantify them; otherwise these effects would have been unintended, but known in the first place. Known unintended effects (categories WB1 and WB2) may be predicted by the models.

This is the situation where structural open, qualitative approaches come into play. Most probably even a single policy measure will have effects that cannot be quantified with a model because they are outside the scope of the model or not quantifiable in an adequate manner, thus these effects need to be evaluated by other types of assessment. Or measures will have effects that – intended or unintended – cannot be quantified at all and need qualitative assessment. It is this multi-measures, multi-effects environment of combined policies where the answer has to be a multi-assessment, applying both quantitative and qualitative approaches. It is difficult to provide a generalized scheme of when and where to apply the assessment approaches available as every policymaking decision is unique. But the stepwise methodology suggested here indicates when and where one of the techniques discussed in Chapter 3 and 4 seem appropriate to reduce unknown effects and to describe (or quantify) intended and unintended effects.

Another emphasis is on the detection of what we denominated before as ‘critical paths’. For instance, the general intended or unintended effect of a policy is estimated correctly by the model, nevertheless due to different reasons the effect can be under- or overestimated. The reasons for this ‘critical path’ can be technically or politically motivated (see types ‘Off the Mark’ and ‘Blind Spot’). In reference to the core typology of Deliverable 1 this can be due to e.g. failed assumptions regarding price elasticity of users which would be a technical error (in the sense of an error when measuring user’s behaviour towards changes in the price system). The political dimension may also be responsible for the bias if the policymaker modifies the causal model in such way that results appear more convenient. It can be confirmed that this example already resumes one of the most critical situations as stated in Deliverable 1 because it makes results difficult to interpret. If such manipulation of the causal foundations of the model is done it might be even better to fully avoid the application of the model.

Generally, the consideration of quantitative and qualitative approaches within the policy decision making process as it is understood in OPTIC is challenging as we focus not only on the analysis of a single measure but broaden the perspective by addressing policy packages. This is done stepwise, first we ‘localize’ where the application of assessment approaches in the policy packaging framework of OPTIC is recommendable and second exemplify and discuss their ‘role’, referring to whether they are applied for detection, estimation or (model based) quantification of effects.

In reference to the process of policy packaging initially described in Deliverable 1 (Chapter 4.3, ‘The process of policy packaging’) and shown here in a further developed version, we extend the phases in the packaging process by the explicit consideration of assessment approaches in phase 3, the evaluation part (‘Building the package’)[10].

---

[9] This rather strong statement of ‘full knowledge’ will be issue of discussion later on. In the example which is developed in the following sections this assumption eases differing between known and unknown effects and the respective role models have in their assessment.

[10] Note that the policy packaging process as described here is a stylized interpretation of what we would expect to be the process in real life. Even though, the process helps to illustrate the most important aspects of policymaking and indicates interdependencies between decision-making steps.

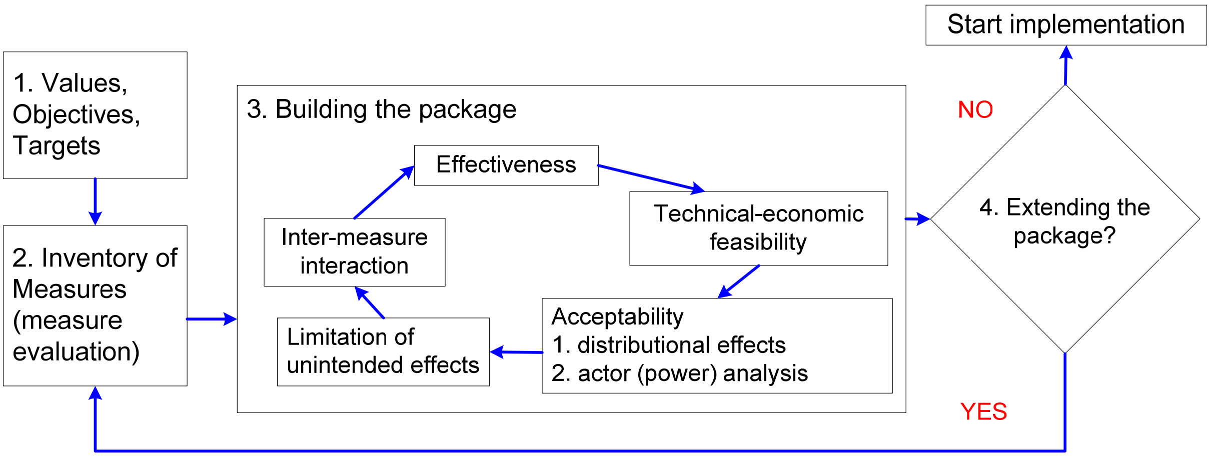

Figure 6.1: General phases in the policy packaging process – with detailed 'Building the package part'

Starting point in Figure 6.1 is the definition of an objective or target (1., upper left box) that motivates the search for and definition of policy action. In a second step a measure is defined (we assume only one primary measure is defined at the beginning, 2., lower left box). It is clear that already in the steps of the definition of objectives and the selection of a measure can be very contradictory in discussion and iterative when considering different opinions from stakeholders or interest groups. The output of these steps, the definition of a measure which then needs to be assessed, is assumed as given here, thus we concentrate on the order of the following assessment steps.

As a very first step within the packaging circle (3., greater box in the middle) the issues of effectiveness, technical-economic feasibility and expected acceptability can be evaluated in general terms without the use of modelling tools. This refers to an e.g. qualitative step where using a structural open methodology such as explorative scenarios or transdisciplinary brainstorming workshops helps to identify assumed intended and unintended effects. Note that at this point quantifications may only be used in a simplistic form. One example for a methodology is the causal mapping used to illustrate major impacts and adverse effects of the measure. Although resource intensive modelling has not yet taken place, this first evaluation step is of importance as a measure might be rejected already at this stage, when the causal mapping shows that by far more unintended and/or counter-intentional effects appear.

After the evaluation of measures (or their combination) in general terms, for instance using methods of causal mapping as described above possibly combined with an explorative scenario process, the quantification of effects (both intended and unintended) is of interest. This is where the circle 'Building the package' starts to move: Is the measure (or the policy package) effective, feasible and acceptable? Does the package limit the number of unintended effects? How do the measures interact, do their interaction affect effectiveness, feasibility and acceptability? The application of this iterative proceeding is exposed to different constraints, for instance certain measures are politically not welcome (although they might be effective) and resources for assessment are limited. Regarding the latter aspect it is very important to estimate the expected resource consumption analyzing policies (see 3.4). The 'exit' of the circle is achieved once a satisfactory policy (package) was put together. Otherwise additional measures are considered that require for a new turn of multi-assessment.

One objective of the exercise to check for effectiveness/feasibility/acceptability is to limit the appearance of unintended effects. For example, a congestion charging scheme is in the best case accompanied by measures that improve public transport services in such way that user recognize where revenues are used for. This can help to increase acceptability among people affected and most probably reduces the unintended effect of having strong opponent groups against the measure. If additional measures are added to the primary measure, the issue of inter-measure interaction comes into play. This could well be the most challenging aspect during the assessment, as now different options appear: a) the package is assessable only by applying qualitative approaches, b) the primary measure can be quantified using a model, the secondary measure need qualitative assessment and c) both measures are quantifiable using models. In practice it is most likely that a combination of assessment methods is required due to the heterogeneity of policy packages.

To reiterate: taking into consideration the fact that any measure (primary and/or secondary ones) may be modelable or not increases the exigencies for the following assessment step. For instance, a primary measure might be perfectly modelable (e.g. a toll on highways), but additional measures (e.g. exceptions for selected vehicle types or the use of revenues for subsidizing public health care) can be out of the scope of the models, but most probably influence strongly its acceptance and feasibility. In this case the combination of both quantitative and qualitative approaches is indispensable. Consequently, the application of different assessment approaches increases the requirements for interpretation for the policymaker.

The so far description of the schematic policy packaging process leads to a summary of conclusions regarding the application of assessment approaches (quantitative and qualitative):

- Any (primary) measure that enters the evaluation circle ('Building the package') needs to be evaluated regarding the type of assessment required, thus if a quantitative model can be applied or not.
- We assume the assessment by a quantitative instrument prior to the application of a qualitative approach. In other words: if the measure is modelable, the assessment is done with a quantitative tool. To check if it is modelable or not and to prepare the modelling, a precedent qualitative method might be needed.
- We assume complete knowledge by modelers about functionalities of the applied quantitative models, which means that every modelable effect (intended, unintended) necessarily belongs to the dimension of 'known' effects ('W').[11]
- With the application of qualitative assessment in the very first step of the circle (detect and name unintended effects), it is intended to reduce the number of unknown ('X') effects taking into account that the consequence dimension of 'X' and related effects can never be entirely avoided.
- If the secondary measures are also modelable, both the single primary measure as well as the policy package (primary + secondary measures) is analyzed using quantitative models to evaluate the whole range of effects. This means that a) the single effect of the primary measure and b) the effect of the combined package are quantified, thus the additional effect that is achieved by the secondary measure.
- If the measures are not modelable, qualitative assessment is realized.

Based on these statements, a detailed play through of the policy packaging process as described in Figure 6.1 follows. Independent if the package comprises several measures and if these are all quantifiable or not, there is a need for flexibility in adjusting the package to the specific needs. The probability is low that a technically 'clean' designed policy package is automatically the most effective and efficient one. In practice, the packaging process suggested here has to be understood as a framework providing guiding principles that structures processes and ensures that intended and unintended effects are not forgotten already at the beginning of forming the policy package. Even if the primary measure is

[11] It is likely that in practice even an experienced modeller can be surprised by the results his/her model provides. This means, although knowledge about functionalities of the model is given, there seems to be still a chance of that the model indicates relationships and effects that were not foreseen. For the sake of the following example, we assume for the moment that the modeller applying the tool is aware of its functionalities and thus, in complete knowledge about potential effects and impacts it predicts.

politically ‘fixed’ and not for discussion, the range of complementary (secondary) measures requires a flexible interpretation of the packaging process. However, flexibility is also constrained to practical issues inherent to the assessment approaches applied. Time resources for the application of numerous model runs are limited as are personal resources regarding the participation of experts in stakeholder or focus group events.

6.4 Framework for the integration of assessment approaches: guiding principles

The framework for policy packaging introduced before serves as the background to illustrate its application along a concrete policy example. It must be clear that even a concrete policy example remains a schematic reproduction of what would be the process of policymaking in the real world. This is because the process evolves over time, decision-makers may change during the process, stakeholder groups appear/disappear or the package itself is altered due to unforeseen changes of political conditions. Nonetheless, the following exercise is meaningful as it ensures that causal assumptions are thought trough, intended and unintended effects are identified and eventually addressed by additional measures with mitigation impact. And even more important, the availability and usability of a set of assessment approaches is considered, that help to reduce the space of unknown (‘X’) effects and thus increase certainty about potential impacts of transport policies.

In the following we illustrate the integration of assessment approaches along a fictive, but conceivable policy, an EU wide ‘Truck Toll’ that is iteratively expanded selecting additional (secondary measures). Again, to follow the guiding principles and assessment steps, note that every step that follows is related to the general phases (1 to 4) of the policy packaging framework (see Figure 6.1). To assure that traceability of the methodology is possible, the following Figure 6.2 provides an overview of all following steps which are then described individually in more detail. Step numbers also refer to the numeration used in Figure 6.1.

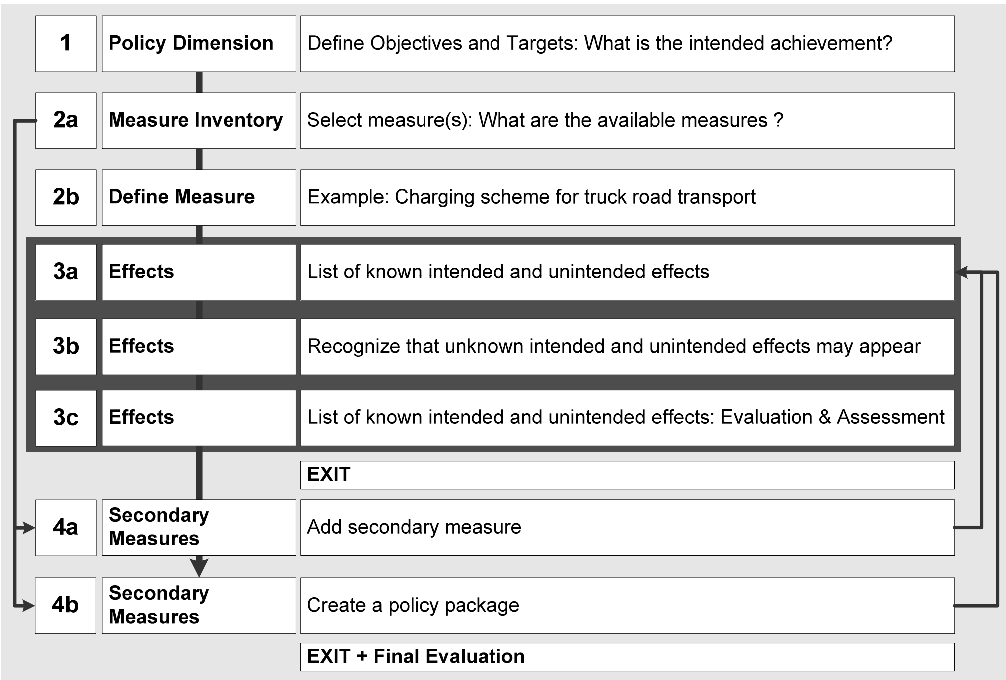

Figure 6.2: Integration of assessment approaches in policy making - overview

As a starting point major objectives and targets are defined. In our example these would be the intention to reduce negative externalities of truck road transport (congestion, emissions) and at the same time increase the use and loading of rail freight transport. This step refers to point 1 of the policy packaging framework.

1. Policy Dimension	**Define Objectives and Targets:** What is the intended achievement?
reduce negative externalities of truck road transport // increase use and loading of rail freight transport	

Figure 6.3: Integration of assessment approaches - step 1

Generally, several potential policy measures are available that support the achievement of the objectives introduced above. In the context of OPTIC this background of policy experiences was denominated as 'Measure Inventory' where manifold measures were listed. To start the policy packaging process one specific primary measure is defined out of the options available. In our example the measure 'charging scheme for truck road transport', denominated as 'Truck Toll' is chosen. This step refers to point 2 of the policy packaging framework.

2a. Measure Inventory	**Select measure(s):** What are the available measures ?
charging scheme for truck road transport // improve connectivity of rail freight transport // ...	

Figure 6.4: Integration of assessment approaches - step 2a

This measure now represents the starting point for a comprehensive analysis on intended and unintended effects and what type of assessment approaches are adequately applied to detect and quantify them. Nevertheless, it is worth to mention that the measure needs exact specification so misleading interpretations regarding associated intended and unintended effects are avoided right from the beginning. In our example, the Truck Toll would be a distance and vehicle emission standard based charging scheme for Trucks with a total weight above 12 tons and applied on national highways. For each EU member, country-specific values are assumed, charged by a commonly developed and EU wide introduced technology. This step is still part of point 2 of the policy packaging framework. We assume that before starting the evaluation and package building the primary measure has to be clearly defined.

2b. Define Measure	Charging scheme for truck road transport
distance based, emission standard based toll for heavy trucks (> 12t) on highways (country-specific values, EU wide toll system (uniform technology))	
CRITICAL PATHS	
- an ambigous definition of the measure can lead to misleading interpretations of potential intended and unintended effects; an exact definition of the measure is crucial for the ongoing evaluation steps	

Figure 6.5: Integration of assessment approaches - step 2b

The next step 3a includes first aspects of policy assessment. This means we now enter point 3 of the policy packaging framework and the iterative process of 'Building the package'. For the detection of intended and unintended effects that come along with the proposed measure a mainly qualitative, structural open method is required (workshop, survey, focus group) to determine as many as possible of the expectable causal relationships (see Chapter 2.2). In the example the presented effects do not cover all effects, but rather give an indication about the variety regarding positively and negatively perceived intended and unintended effects. We select for instance the effect 'increase in the demand for regional products': the idea behind this effect is that with rising transport costs some products get economically advantageous in a nearer geographical distance to the consumer. To simply detect this potential effect most probably a discussion of different stakeholders is necessary. Hence, the point is that if we do not apply this exercise on detecting intended and unintended effects, it is expectable that the effect 'increase in demand for regional products' would have remained a previously unknown, intentional effect (XA).

Here, several more aspects come into play and need to be considered: the list provided here differs between intended and unintended effects, assuming an EU policy maker perspective. It can be expected that the qualitative evaluation done here will have a different outcome when assuming a different stakeholder perspective. This can lead to bias in the outcome of detected intended and unintended effects, if interests of one stakeholder are given priority over others. Therefore, it is recommended to additionally group the intended and unintended effects by the group/stakeholder concerned with the policy impacts, thus repeat the exercise according to number and type of stakeholders included. This can actually mean to separate conflictive stakeholder groups from each other during a first collection of effects. The outcomes of the exercise can be helpful to identify the need for additional policies with the objective to increase e.g. the acceptability of a policy (see step 4a and 4b, further below).

The list of potential effects is left open, more and other effects might be of relevance and identified according to the methodology applied for their detection. Evidently, the critical paths associated with this step are that important effects (intended, unintended) might be overseen and not considered in the further assessment steps. Therefore, it is of importance to well define the structural open methodology applied for the detection of intended and unintended effects. The outcome of this exercise is crucial to reduce significantly adverse effects belonging to the category of 'X' (unknown intentional and non-intentional effects). Note that so far we are still evaluating a single primary measure.

3a. Effects	List of known intended and unintended effects

Remark: tendencies for intended and/or unintended effects depend on the stakeholder perspective – we assume an EU policy maker perspective

	INTENDED	**UNINTENDED**	**CRITICAL PATHS**
Less Truck Congestion	X		- intended and/or unintended effects are overseen and remain unknown - the methodology for the detection of intended and/or unintended effects must be chosen carefully, to assure that most likely effects are identified
Increase in Freight Rail Transport	X		
Less Truck Emissions	X		
Increase in Rail Noise		X	
Increase in Truck Flows on Secondary Roads		X	
Toll Revenues	X		
General Decrease in Demand for Trucks		X	
Higher Demand for new Trucks	X		
Increased export of old Trucks in Non-Member-States		X	
Increase in Private Car Flows		X	
Increase in Demand for local Products	X		
More Air Transport within the EU		X	
High Costs for Charging Technology		X	
Export of Charging Technology	X		
Improved Congestion Management	X		
...	...	...	

Figure 6.6: Integration of assessment approaches - step 3a[12]

[12] A table as presented here can increase transparency and enhance discussions. If respective stakeholders cannot agree on what should be in or left out of the list, several more tables can be created and used to develop different scenarios.

Although step 3a is expedient to reduce unknown effects, convert them into known effects, and make these 'visible' for the ongoing assessment, unknown intended and unintended effects remain on the agenda (see step 3b). As stated above, the objective is to identify most of the expectable effects ex-ante, in reverse, unknown ex-post effects cannot be assessed by any approach considered here as they are unknown at the time of evaluation and decision-making. In this sense step 3b does not contribute to the analysis of unintended effects, but we highlight this point as we believe that the existence of these unknown 'background issue' should at least be recognized.

3b. Effects	Recognize that unknown intended and unintended effects may appear
? ? ...	The risk remains that totally unknown effects appear. Even though different assessment approaches are applied this cannot be completely avoided. By the exercise made in 3a, it is intended to reduce unknown effects to a maximum.

Figure 6.7: Integration of assessment approaches - step 3b

For the assessment of intended and unintended effects we make use of the consequence versus knowledge dimensions provided in OPTIC Deliverable 1 and illustrated in Table 6.1 (WA, WB1, WB2), in such way that every effect is assigned to one of the evaluation categories. Note that only known effects are considered, as we assume we already minimized the unknown effects by the exercise conducted in step 3a. We now expand this step by the consideration of the different assessment approaches available. Note that in the example we assume TT and TREMOVE as representatives for structural closed, mainly quantitative methods as well as the set of structural open approaches denominated with 'SO'. This proceeding leads to a classification of intended and unintended effects regarding their ability of being assessed by the types of assessment approaches considered. For example, we identified 'less truck emissions' as an intended effect which can be evaluated using TREMOVE. But, the increase in demand for local products is also an intended effect, but it will not be able to quantify this effect using the models assumed here.

This exercise is meaningful as it gives an indication whether or not primary effects can be modelled and to what extent further structural open methods are necessary. Additionally and with special concern to the unintended effects, the exercise allows getting a notion of what further, secondary measures are required to mitigate non-desired side effects of the policy. This step is crucial as important aspects are addressed here: (a) the definition of the type of intended and unintended effect (Core Typology Categories, CTC; see Table 6.1); (b) the assignment of an assessment method (Assessment); (c) the assessment itself (which is not explained in detail) and thus, the evaluation regarding effectiveness, feasibility and acceptability; (d) the deduction of which unintended effects most probably need to be mitigated by secondary measures. In addition, the application of models in this step can provide valuable information that should be feed backed to step 3a: the analysis of effects predicted by the model should be reflected against the list of effects derived from any qualitative approach applied in 3a. For instance, we may assume that the effect 'Increase in private car use' was not found, i.e. named, during the consultation of experts, nevertheless the model predicted this effect as less truck flows eased (attracted) car travel.

So far one primary measure is analyzed along the suggested framework, hence we did not yet consider secondary, additional measures. Naturally, the evaluation process will get more ambitious if we assume that various policies are introduced at the same time. Regarding the policy packaging framework this refers to the loop implied by step 4 'Extending the package'. In practice this means the consideration of further policies that increase the effectiveness of the primary measure, the social and/or political acceptability or the technical-economic feasibility. The motivation for the consideration of secondary measures is also a result of step 3c. Looking at the list of intended and unintended effects, in the example, 7 unintended effects are expected, for those mitigation actions are required. For instance, an increase in rail noise or high investment costs for the charging technology can be named here. The exercise also allows detecting effects which are somehow in-between the categories. The expected ‘General Decrease in Demand for Trucks’ seems an understandable result when reducing truck-based transport. In this sense, it could be denominated as an intentional effect. But at the same time production for new trucks declines, respectively do the job capacities necessary. This effect might be unintended and eventually influences the policy setting. The important point here is, that the explicit naming and categorization of effects allows identifying these effects with potential for conflicts in their interpretation.

3c. Effects	List of known intended and unintended effects: Evaluation & Assessment			
	INTENDED	**UNINTENDED**	**CTC***	**Assessment****
Less Truck Congestion	X		WA	TT
Increase in Freight Rail Transport	X		WA	TT
Less Truck Emissions	X		WA	TM
Increase in Rail Noise		X	WB2	TM
Increase in Truck Flows on Secondary Roads		X	WB1	TT
Toll Revenues	X		WA	TT
General Decrease in Demand for Trucks		X	WB2	SO
Higher Demand for new Trucks	X		WA	SO
Increased export of old Trucks to Non-Member-States		X	WB1	SO
Increase in Private Car Flows		X	WB1	TT
Increase in Demand for Regional Products	X		WA	SO
More Air Transport within the EU		X	WB2	TT
High Costs for Charging Technology		X	WB2	SO
Export of Charging Technology	X		WA	SO
Improved Congestion Management	X		WA	SO
...	...	...	...	...

CTC* = Core Typology Categories (Optic D1, page 41)
Assessment**: TT = TransTools, TM = Tremove, SO = mainly structural open methods

WA = known, intentional
WB1 = known, unintended, counter-intentional
WB2 = known, unintended, secondary

CRITICAL PATHS

- assignment to one of the assessment categories can be wrong due to missing knowledge about model functionalities or ambiguity of the measure is not given

Output	knowledge about principal (un-)intended effects (type and magnitude) // proritization of mitigation action (secondary measures)

Figure 6.8: Integration of assessment approaches - step 3c

In step 4a, and in response to the need identified in step 3c, additional, secondary measures are added to the primary measure. These can be categorized according to their main objective of increasing effectiveness, feasibility or acceptability. Again, a classification is suggested in accordance to what type of assessment approach should be applied. First, we assign each secondary measure to one of the categories (Secondary Measure Type, SMType: EP, AP, and FP). Second, we check for the type of assessment approach required to evaluate both measures (Assessment). The example indicates that the outcome of this exercise results in a more heterogeneous picture of required assessment methods. For instance, only the secondary measures of expanding the truck toll to secondary roads or increasing tolls for private cars represent packages that can be analyzed by applying TT. Any other combination requires for a mixed-methods assessment.

Complexity becomes transparent at this point, although interaction between effects of the two measures may occur. As we now assess a policy combination, we start dealing with the aspect of ‘inter-measure interaction’. It is recommended to analyze the measures first separately, to get later an indication of the inter-measure interaction when analyzing both of them together. As long as quantitative assessment is possible (TT or TREMOVE in this case), it is recommended to first analyze the effect of the single primary measure and then based on these results, conduct the combined assessment, once again, to get a clear picture of inter-measure interaction. When adding one or more secondary measures, second order intended and unintended effects can appear. If significant impacts are expected only from the implementation of the secondary measure itself, the analysis for the detection of intended and unintended effects introduced in step 3a should be repeated.

4a. Secondary Measures	Add secondary measure

Remark: Secondary Measures are denominated as a) EP: Effectiveness Policy, b) FP: Feasibility Policy, c) AP: Acceptability Policy

Primary Measure (1)	***Secondary Measure (2)***	**SMType***	**Assessment**
Truck Toll on EU Highways	Truck Toll on Secondary Roads	EP	TT(1), TT(2)
	Rail Noise Mitigation	AP	TT(1), SO(2)
	Truck Scrappage Scheme	AP	TT(1), TM(2)
	Increase Toll for Private Cars on Highways	EP	TT(1), TT(2)
	Investment in Highways Infrastructure (e.g. truck parking facilities)	AP	TT(1), SO(2)
	Technology: Funding of Research Projects	FP	TT(1), SO(2)
	...	...	...

SMType* = Secondary Measure Type

CRITICAL PATHS

- mixed assessment methods may increase the uncertainty about potential combined measure impacts
- if measures are not analyzed separately in the first place, inter-measure interaction remains unclear
- secondary measures may create further known and unknown unintended effects

Recommendation: apply exercise for the identification of intended and unintended effects for the secondary measure

Recommendation: analyze first the effect of the single primary measure using the respective approach (here models), then conduct the combined assessment to quantify (or at least estimate) the inter-measure interaction

Figure 6.9: Integration of assessment approaches - step 4a

Continuing the proceeding by adding another measure leads to even more possible policy packages combinations. The example of step 4b indicates some of these combinations. Once again we conduct the exercise of assigning the secondary measures to SMTypes and assessment methods. It is most likely that the policy combinations require for an assessment using different approaches. We may even say that the likelihood that the package cannot be entirely modelled using TT and/or TREMOVE increases with adding further measures. In the examples indicated below, the third package (Truck Toll + Investment in Highways + Technology Funding) implies two structural open assessment steps added to the quantitative assessment of the Toll using TT.

Considering more measures, it gets likely that qualitative assessment approaches assume a more important role. This phenomenon can be explained as follows: analytical models generally are developed to quantify principal causal relationships, for instance the modal shift due to higher prices. The same applies for the Truck Toll example, where reproductions of transport interactions – which build the core of TT – are counted for. It is likely that additional secondary measures tend to be not directly related to the core functions of the transport model. In the example this would be measures to mitigate noise, improve parking facilities or increase funding for technology oriented research. Some of these effects might still be measureable with an additional model (e.g. TREMOVE), but still, the extension of the policy package most likely requires further approaches, among them structural open methods. This has the side-effect that the assessment of inter-measure interaction becomes more challenging when the effects are not evaluated by one single assessment approach. And, additional measures create further known and unknown effects which – in the case they are perceived of having major impacts – should be identified repeating step 3a (Figure 6.6).

4b. Secondary Measures	Create a policy package				
Primary Measure (1)	***Secondary Measure (2) + Secondary Measure (3)***			**SMTypes**	**Assessment**
Truck Toll on EU Highways	Truck Toll on Secondary Roads	+	Rail Noise Mitigation	EP(2), AP(3)	TT(1), TT(2), SO(3)
	Truck Toll on Secondary Roads	+	Truck Scrappage Scheme	EP(2), AP(3)	TT(1), TT(2), TM(3)
	Investment in Highways Infrastructure (e.g. truck parking facilities)	+	Technology: Funding of Research Projects	EP(2), FP(3)	TT(1), SO(2), SO(3)
	...		...	...	...
CRITICAL PATHS					
- the more measures considered, the more likely that mixed assessment methods are necessary which may increase the uncertainty about potential combined measure impacts - the estimation of inter-measure action gets uncertain with more measures combined, especially when more structural-open measures are applied - secondary measures may create further known and unknown unintended effects					
Recommendation: apply exercise for the identification of intended and unintended effects for the secondary measures					
Recommendation: the final evaluation of the policy package necessarily becomes a qualitative character, when impact evaluation is based on both strongly quantitative (TT, TM) and mainly structural open methods					

Figure 6.10: Integration of assessment approaches - step 8

This stepwise approach can be extended considering more policies in combination. In practice it is likewise that even more than one primary measure is applied, accompanied by several additional measures to mitigate negative, unintended effects. Even for complex policy packages, the guiding principles provided here can be used. Following the example, there is a natural limit where the illustrations become hard to interpret because of the number of relations involved. But, the question is if all policies need to be assessed in the way described here or if there is a chance to select and/or prioritize measures. To deal with complexity, we suggest prioritizing between measures. It makes sense to apply the methodology for those measures that are expected to have a major contribution in achieving the policy goal. Small, additional measures with only a very minor impact might be left out of the analysis. But, and this is where the process shows interdependencies, the decision which measure is of relevance depends on the results of the impact assessment. This force us to understand the principles suggested as an iterative approach, where the assessment enables the prioritization between measures.

In general terms, it is recommended to especially apply step 3a (identification of intended and unintended effects) and step 3c (evaluation and assessment) to additional measures of relevance. Even if a model-based ex-ante assessment is not possible in every case, step 3a will help to identify unintended effects of the policy, both negative and positive ones. The results of step 4a and 4b will support the understanding of where along the continuum from mainly quantitative to mainly qualitative assessment methods, the final package is situated. This creates awareness for the assessment methods needed. It was stated before, that it is expectable that a mix of assessment methods is required with more policies assessed in one package. In case of complex policy packages it will hardly be possible to cover all effects in one model. In this case, a sort of screening for unintended effects with the help of qualitative approaches is getting more important.

6.5 Summary

The proceeding indicates that a policy package set up by different measure types most likely will require a multi-assessment approach. The issue of inter-measure interaction and second order intended and unintended effects (that may counteract the effects identified for the primary measure) practically impede the application of a single assessment approach. This problem remains a challenge during the assessment, but the methodology introduced before creates awareness for unintended effects and offers a structure for the identification of which assessment methods are needed. In sum, several lessons can be learned from the methodology conducted so far:

(1) Resources should be dedicated to identify intended and unintended effects using a qualitative approach; this exercise is decisive to reduce the unknown effects and to recognize the need for different types of assessment methods. For example, it is argued that in particular simpler pre-structured methods (CBA, MCA) as well as structurally open approaches are suitable to anticipate and, thus, avoid what we called ‘critical paths’.

(2) It is recommended to get back to the identification of intended and unintended effects after the application of models and adding additional measures; possible overlaps in effects and/or counteracting impacts can be detected (at least qualitatively); the detailed analysis of modelling results can help identify unintended effects that were not discovered by the qualitative approach applied in the first place

(3) It needs to be clearly defined which measure is analyzed by either a structurally open or structurally closed method; this should be done after having identified intended and unintended effects.

(4) It is recommended to assess primary measures in isolation (with a structural closed method if available) and afterwards conduct the combined assessment considering structural open approaches; until the policy package becomes not too complex (in the sense of illustrating all processes and interdependencies as done in the example), a notion for inter-measure interaction can be achieved.

(5) If several policies in combination are assessed it is recommended to test policy packages that can be assessed by e.g. only applying one method/model; this creates confidence regarding the inter-measure interaction, as uncertainties that are due to the application of a mixed assessment approach can be avoided.

(6) The application of the proposed proceeding enhances transparency in the evaluation of policy making; applied assessment approaches are denominated explicitly for each measure; it gets clear what is modelled and what assessed by SO approaches.

(7) The process helps to indicate the expected resources needed for policy evaluation; according to the number of measures that – after going through the process – are either evaluated by a model or a SO approach, required resources (model runs, stakeholder or expert consultations, etc.) can be estimated. Naturally, this requires certain experience with the resources needed for the application of each assessment type.

Additionally, some remarks regarding how to operate the methodology can be given (in accordance to Figure 6.2):

We can assume that the definition of objectives and targets and the selection and definition of primary measures is done initially by the policymaker or policymaker group (step 1 to 2b). It is important that the suggested methodology assumes that after step 3 the policy package is not yet fixed, even though several primary measures were defined. With step 3a a stakeholder consultation using a structurally open approach is recommended. Primary measures are discussed and the intended and unintended effects detected, considering heterogeneous perspectives on the expected effects. This step can already lead to a reformulation of the primary measure(s), if e.g. a large amount of unintended effects is detected during the stakeholder exercise. Step 3c is about the assessment of impacts, which means the application of models and/or other methods enters the proceeding. The outputs of the models are then evaluated once again either by the policymaker group (if no more stakeholder integration is desired) or in combination of policymakers and stakeholders. It is important to recognize the need for a specific analysis (and comparison) of the intended and unintended effects identified by the qualitative approach suggested in step 3a and further ones identified applying the models in step 3c, which can be feed backed to the list of effects identified in 3a. According to the results (effectiveness, acceptability, feasibility of the policies) and taking into account the number and type of unintended effects detected in the first place, secondary measures are defined (steps 4a, 4b). Again, these might be analysed using a structurally open approach regarding intended and unintended effects by the policymakers and/or the stakeholder group. After the definition of additional measures once again the models/methods are applied for their quantification and evaluation. These steps can be repeated and after several iterations even the comparison between different policy packages becomes possible.

As a variation to the isolated assessment of a primary measure (point 4 above), it is also imaginable to ‘cluster’ a small and clearly arranged number of measures in explorative scenarios. The scenarios could be built and played through with different stakeholder groups in a rather simple and qualitative process, by developing descriptions or images of how the future might look like if different measures are introduced. In addition, external factors could be varied (oil price, development in GDP, demographic changes) to assess the robustness of the planned measure in the light of different situations.

These ‘storylines’ could integrate some quantitative elements like rough estimations of expected transport flows and an overview of the costs (for example a simple CBA). If the situation is getting too tricky, a multi-criteria analysis could be used. It can be an explicit part of the scenario methods to separate a purely explorative or epistemic step from a quantifying evaluative step: so, in a first step the desirability of the developments are not considered; only in a second step norms and values come into play. However, such an approach is getting more resource intensive. Once such ‘starting scenarios’ are built, they can be used as a framework for the modelling phase. Results of the modelling would than be included in the scenarios and could again be discussed with stakeholder or citizens. This example illustrates that it makes sense to explicitly embed models in a broader methodological framework.

7 Summary and concluding remarks

This Deliverable is dedicated to the development of an inventory of tools and methods for the identification and mitigation of unintended effects and to provide examples and guiding principals for the integration of them in the policy packaging process. As basic distinction between different assessment approaches we introduced the categories of 'structurally open' (mainly qualitative approaches) and 'structurally closed' methods (mainly quantitative approaches; models). For both categories a comprehensive overview was given with emphasis on those methods that are usable for the assessment of unintended effects. With regard to the modelling tools, several criteria were applied for the assessment such as the overall structure of the models, data requirements and outputs and their general strengths and limitations. As examples for complex models European transport and emissions models TRANSTOOLS and TREMOVE were selected and assessed in more detail due to their important role in the context of EU policy evaluation.

Chapter 3 to 5 accomplish two requirements: One the one hand the chapters provide a review of state-of-the-art methodologies and models that are today used in the process of policy evaluation. This overview serves as an inventory or 'toolbox' describing the ability of the methods to detect intended and unintended effects. On the other hand we developed and discussed, based on the list of methods and models, their integration into the policy packaging process. The application of methods is challenging especially when heterogeneous (i.e. consisting of policies that cannot be evaluated by the same type of assessment method) policy packages need to be assessed. Therefore, their role within policymaking was of specific interest in this Deliverable and explicitly addressed in Chapter 6. We exemplify their integration along a policy packaging example and recommend where and when the approaches should be considered and also if "critical paths" – understood as developments that may deviate the policy from achieving its initial objective – are expected to appear.

In this concluding chapter we summarize and interpret the main findings. We do that along principal conclusions that are the result of the work done in the precedent chapters.

A clear taxonomy helps to structure the assessment of the approaches itself and is also useful when it comes to decide which approach to apply during the policy packaging process.

The distinction between 'structurally open' (mainly qualitative) and 'structurally closed' methods (mainly quantitative) allows distinguishing between approaches of very different nature. It helps to make the strengths and weaknesses of the approaches more transparent. This is relevant when they are used in the assessment of policies. Required resources, both financial and intellectual, are quite different and these differences need to be considered. Otherwise probably a non-adequate assessment is done or time running short so that no profound analysis and interpretation of results is possible..

There are no tools or methods that are able to detect ex-ante all unintended effects. Uncertainty and the possibility of unknown intended and unintended effects remain. Quantitative assessments must be understood as a necessary but in many cases not sufficient approach to reduce number and magnitude of unintended effects.

It would be negligent to assume that with the application of a model, all intended and unintended effects can be detected. If policymakers concentrate only on these aspects that are within the scope of the model or method applied, important effects (positive and negative) will be overseen. This sounds like a palpable finding but awareness must be created from the moment on when policy evaluation is started, that methods and tools are helpful but not foreseeing all types of possible developments. Many authors emphasize that it is highly important to make risks and uncertainties transparent and to address them in an appropriate manner. Quantitative approaches generally reproduce only a part of the 'web' of interactions, in our case of the transport system. For this part of the reality they are powerful tools and often able to quantify effects. Structurally open, qualitative approaches are, in principle, able to integrate a variety of different knowledge and thus, to anticipate previously unknown interrelations and effects. But the results are not that clear and homogenous as those produced by models.

The appropriate design and integration of structurally open methods in the policymaking process can help anticipating and thus, reducing the number of potential (unknown) unintended effects.

It is recommended by many authors and supported by this Deliverable that structurally open, qualitative approaches should be integrated more systematically in the process of policymaking. After the definition of a policy and before starting the step of quantitative/qualitative assessment an effort on the identification of unintended effects is indispensable. Within OPTIC the workshop exercise of 'causal mapping' (TSU Oxford, 2010) is one example for a structurally open method to identify policy effects. The most adequate methodology to apply may depend on the specific situation (policy type, available time and resources, number and type of stakeholder), but independently of the method applied as an outcome a transparent list of expected intended and unintended effects must be available. All participants of this exercise then would have to agree that this outcome reflects from their point of view all expectable outcomes. In case of serious controversies, further discussions and/or working with scenarios might be a solution. This reduces the number of unknown effects and the degree of associated uncertainty. One benefit of this is to get a more complete and transparent picture of policy impacts, another benefit is that the overview of effects serves as indication of what type of assessment approaches is now required for evaluation and/or quantification and what would be the necessary resources required. The latter point makes the question of resources explicit. A positive externality of the detection of unintended effects in advance is that resources needed for ongoing planning steps can be better estimated. A clearer picture of required resources (time, money, personal capacities) can be drawn from the number and type of unintended effects discovered.

Models can well support an ex-ante identification of unintended effects, but they need to be embedded systematically in a broader framework for analyses, including structurally open methods. Mixed approaches for the assessment of complex policy packages are recommended. Although the evaluation gets more challenging with different approaches, this seems unavoidable.

Following the policy packaging framework provided in Deliverable 1 and adding additional measures to a primary measure, complexity increases and most likely a mix of assessment approaches is required. This is not per se negative, but increases personal exigencies for a meaningful interpretation of the results. There will often be no other choice than combining methods, as models – as mentioned above – focus on a part of the 'web' of interactions. We do not vary from this position but recommend, e.g. referring to the guiding principles provided in Chapter 6, to analyze carefully which of the measures can be modelled, which not and what are the associated unintended effects. This most likely leads to a sort of iteration within the assessment when additional measures force us to get back to an earlier step where the qualitative detection of unintended effects is necessary. We also recommend that the analysis of unintended effects and the impact of a policy package should not start with the final package. Even though several measures are bound together to a package, a separate assessment of the primary measure – ideally using a structurally open method – is recommended. If then successively further measures are added, still a notion of inter-measure interaction can be achieved. In the guiding principles we demonstrate that the evaluation of inter-measure interaction is difficult and becomes challenging if 3 or more measures interact at the same time. Again, it is important to at least separate the impact expected by the primary from those of additional measures. Otherwise, if inter-measure interaction is not addressed explicitly, the interpretation of the impact of a policy package becomes a somehow random exercise where every stakeholder interprets and explains the outcomes according to his/her interests.

If methods become too complex they reduce transparency of the decision-making process. A balance is needed between complexities of the methods to adequately reproduce parts of the 'web' and at the same time maintaining them understandable for non-experts in the field.

We assume that there is an interest of the decision-maker to at least conceptually understand the methods and models applied for the assessment of proposed policies or policy packages. The impression that a ‘black box’ was used for the assessment most likely will decrease the acceptance by the decision-makers as well as by those affected by the policy and thus, the likelihood that results are considered when decision are taken. The issue of transparency is also highly relevant for the interpretation of results. Very often underlying assumptions and used data sources are not published. Additionally, analysts that support the decision-making with their methods and tools should create the awareness that predicted developments are most likely expectable tendencies and not fixed, exact results due to the uncertainties associated with causal relationships and data.

In summary there is no unambiguous ‘blueprint’ for successful policy packaging considering tools and methods for the early identification of unintended effects. Nevertheless, important principles could be detected that should be considered when it comes to the assessment of policies and policy packages. It is evident that the systematic application of structurally open methods in an early stage of the policy process is recommendable. The detection and categorization of unintended effects regarding their ability of being assessed by either a structurally open or structurally closed method in the beginning is crucial for the ongoing steps and thus, the quality of the overall assessment. As far as possible structurally closed methods follow this initial step aiming at a quantification of impacts. We intensively discussed the potentials and limitations of models; as long as their reproduction of the ‘web’ – the interactions in the transport system – allows for the assessment of a respective policy, their application is given priority. Using the example in Chapters 5 and 6, we illustrated that most likely a single quantitative assessment is not sufficient and additional methods of mainly qualitative character come into play. The uncertainties and difficulties associated with the mix of approaches were discussed earlier in this Deliverable. The final step, the interpretation of results and their translation into policy action, again should make use of more open, qualitative methods since the figures and numbers produced by models or other tools might lead to controversial interpretations by experts and stakeholders. This is also due to the ultimate complexity given the models applied, their assumptions and used data. So, it seems as if an ideal approach for tackling complex policy problems makes use of tools and methods by being open in the beginning of the policymaking process, closing up in the middle and being open in the end again:

(1) Use of structurally open methods in an explorative phase at the beginning. If several options are to be discussed, explorative scenarios could be an appropriate mean. Qualitative elements are important in this starting phase, but need to be accompanied by simple pre-structured approaches (e.g. CBA) to support the exclusion of obviously unrealistic options. In this phase, stakeholders, experts as well as the wider public should be involved actively.

(2) Using structurally closed approaches in the middle of the planning process in an analytical phase where quantifications are the main task. In this phase, work is dominated by experts.

(3) Using structurally open, discursive methods for an interpretation of results. Potentially affected groups should be included.

With this Deliverable we concentrated on tools and methods, especially their role in ex-ante assessment. Naturally, the policy process is not static with a defined policy that effectively heads towards the objective during its entire time of implementation. Framework conditions evolve and most likely, the effectiveness of the measure alters over time in such way that corrective action, adjustments up to a complete policy reformulation is necessary. This is where the following OPTIC Deliverable continues this work by looking at possibilities for an ex-post identification of unintended effects and evaluating the potentials for remedial action.

8 References

Banister, D. (1998, ed.). Transport Policy and the Environment. London and New York.

Barbour, R. (2007). Doing Focus Groups. London.

Burgess, A., et al. (2005). TRANS-TOOLS (TOOLS for Transport forecasting ANd Scenario testing) Deliverable 1. Funded by 6th Framework RTD Programme. TNO Inro, Delft, Netherlands.

Cagnin, C., Keenan, M., Johnston, R., Scapolo, F., Barré, R. (Eds. 2008). Future-oriented Technology Analyses. Strategic Intelligence for an Innovative Economy. Berlin, Heidelberg.

CEC (2008a). Action Plan for the Deployment of Intelligent Transport Systems in Europe. Communication for the Commission of the European Communities. Brussels, 16.12. 2008. COM(2008) 886 final.

CEC (2008b). Accompanying document to the Action Plan for the Deployment of Intelligent Transport Systems in Europe. Impact Assessment. Commission staff working document. Commission of the European Countries.

CEC (2006): Impact Assessment of the Communication “Keep Europe Moving” Sustainable mobility for our continent. Mid-term review of the European Commission’s 2001 Transport White Paper. Commission of the European countries. http://ec.europa.eu/transport/strategies/doc/2006_keep_europe_moving.doc/2006_transport_policy_review_impact_assessment.pdf (access: 7.7.2010)

Choi, C., Kim, S., Park, Y. (2007). A patent-based cross impact analysis for quantitative estimation of technological impact: The case of information and communication technology. Technological Forecasting and Social Change, 74(8), 1296-1314.

Communities and Local Government (2009). Multi-criteria analyses: a manual. Department for Communities and Local Government, London. http://eprints.lse.ac.uk/12761/1/Multi-criteria_Analysis.pdf (Access: 5.7.2010)

DEFRA (2003). Use of multi-criteria analysis in air quality policy: A Report.

Dienel, P.C. (2002). Die Planungszelle. Der Bürger als Chance. 5. Auflage mit Statusreport. Wiesbaden.

EC (2006). TREMOVE 2: Service contract for the further development and application of the TREMOVE transport model - Lot 3. Service Contract PART 3: Policy runs, K.U. LEUVEN, Belgium.

EC (2007). TREMOVE: past, present and future. Project presentation at final TREMOVE Contact Group Meeting, Leuven (BE), 5-6 March 2007. http://www.tremove.org/meetings/20070305_01%20Delsalle_2.pdf

EC (2007). TREMOVE Final EC Report / Service Contract. http://tremove.org/documentation/Final_Report_TREMOVE_9July2007c.pdf

Enzer, S. (1972). Cross-Impact Techniques in Technology Assessment. Futures, 4(1), 30-51.

Feindt, Peter Hennig (2001). Regieren durch Diskussion? Diskurs- und Verhandlungsverfahren im Kontext von Demokratietheorie und Steuerungsdiskussion. Frankfurt a. M.

Finnveden, G., M. Nilsson, J. Johansson, A. Persson, A. Moberg and T. Carlsson (2005). Strategic Environmental Assessment methodologies – Applications within the Energy Sector. Environmental Impact Assessment Review, 23(1), 91-123.

Fleischer, T. (2008). Nanotechnologies - Political and societal aspects of their regulation. Presentation at the Conference "Nanotechnologies: The Present State of Regulation". Vienna, Fleischer, T., Decker, M., Fiedler, U. (2005). Assessing emerging technologies - Methodical challenges and the case of nanotechnologies. Technological Forecasting & Social Change, 52, 1112-1121.

Flyvbjerg, B.; Bruzelius, N.; Rothengatter, W. (2003): Megaprojects and Risk: An Anatomy of Ambition. Cambridge University Press.

Greeuw, S., van Asselt, M., Grosskurth, J., Storms, C., Rijkens-Klomp, N., Rothman, D.S., Rotmans, J. (2000). Cloudy crystal balls. An assessment of recent European and global scenario studies and models. Experts' corner report. Prospects and scenarios No 4. Report prepared by: International Centre for Integrative Studies (ICIS). European Environmental Agency.

Gordon, T.J., Glenn, J.C., Jakil, A. (2005). Frontiers of Future Research: What's next? Technological Forecasting and Social Change, 72, 1064-1069

Gordon, T.J.; Hayward, H. (1968): Initial experiments with the cross impact matrix method of forecasting. In: Futures 1 (2), Page 100-116.

Grunwald, A. (2009). Technology Assessment: Concepts and Methods. Handbook of the Philosophy of Science. Volume 9: Philosophy of Technology and Engineering Sciences, 1103-1145.

Grunwald, A. (2002): Technikfolgenabschätzung – Eine Einführung. Berlin.

Hage, M., Leroy, P., Petersen, A.C. (2010). Stakeholder participation in environmental knowledge production. Futures, 42, 254-264.

Hanley, N.; Barbier, E.B. (2009): Pricing Nature. Cost-Benefit Analysis and Environmental Policy. Cheltenham, Northampton

Helmer, H. (1981): Reassessment of cross-impact analyses. In: Futures 13, (5), Page 389-400

Hisschemöller, M., Hoppe, R. (1996). Coping with Intractable Controversies: The Case for Problem Structuring in Policy Design and Analysis. Knowledge and Policy, 40-60.

ISO 14040 (2006). Environmental management – Life cycle assessment – Principles and Framework.

ISO 14044 (2006). Environmental management – Life cycle assessment – Requirements and Guidelines.

iTREN (2009). iTREN - Integrated transport and energy baseline until 2030. Deliverable2, Project co-funded by the European Commission

Johnston, R. (2008): Historical review of the development of Future-Oriented Technology Analyses. In: Cagnin et al. (2008): Future-Oriented Technology Analyses. Strategic Intelligence for an Innovative Economy. Berlin, Heidelberg. S. 17-24.

Joss, S (1998). Danish consensus conferences as a model in participatory technology assessment: an impact study of consensus conferences on Danish Parliament and Danish public debate, Science and Public Policy, 25(1), 2–22.

Kahn, W., Wiener, A.J. (1967). The Year 2000 – A Framework for Speculation on the Next Thirty-Three Years, Macmillian, New York.

Kleindorfer, P.R. (2008). Reflections on the Decision Making under Uncertainties. Faculty and Research Working Paper. INSEAD The Business School for the World. http://ssrn.com/abstract=1310239

Klinke, A.; Renn, O. (2002): A New Approach to Risk Evaluation and Management: Risk-Based, Precaution-Based, and Discourse-Based Strategies. In: Risk Analysis, Vol. 22, No.6, Page 1071-1094

Klüver, L., Nentwich, M., Peissl, W., Torgersen, H., Gloede, F., Hennen, L., van Eijndhoven, J., van Est, R., Joss, S., Bellucci, S., Bütschi, D. (2000). EUROPTA. Report published on www.tekno.dk/europta. Publisher: The Danish Board of Technology, Denmark.

Knockaert, J. (2010). Economic and technical analysis of road transport emissions, PhD thesis, University of Leuven

Kosow, H., Gaßner, R. (2008). Methoden der Zukunfts- und Szenarioanalyse. Überblick, Bewertung und Auswahlkriterien. WerkstattBericht Nr. 103. Berlin IZT - Institut für Zukunftsstudien und Technologiebewertung.

Kostoff, R.N., Schaller, R.R. (2001). Science and Technology Roadmaps. IEEE Transactions on Engineering Management, 48(2), 132-143.

Kowalski, K., Stagl, S., Madlener, R., Omann, I. (2009). Sustainable Energy Futures: Methodological challenges in combining scenarios and participatory multi-criteria analyses.

Layard, R. and Glaister, S., (1994). Cost-Benefit Analysis Second Edition. Cambridge University Press.

Lundvall, B. A., Borrás, S. (1998). The Globalising Learning Economy: Implications for Innovation Policy. Commission of the European Countries. http://cordis.europa.eu/tser/src/globec.htm

Martino, A., Fiorello, D., Casamassima, G., Ivanova, O., Tavasszy, L., de Kievit, M., Korzhenevych, A., Bickel, P. (2008). The REFIT framework for Strategic Sustainability Assessment of European Transport Policies. Project co-funded by European Commission DG-TREN, 6th Framework Programme.

Mendoza, G.A., Macoun, P. with Prabhu, R., Sukadri, D., Purnomo, H. and Hartanto, H. (1999). Guidelines for Applying Multi-Criteria Analysis to the Assessment of Criteria and Indicators. Published by Center for International Forestry Research (CIFOR). Jakarta.

Merton, R.K., Kendall, P.L. (1946). The focussed interview. American Journal of Sociology, 51, 541-557.

Mishan, E. J. and Quah, E. (2007): Cost Benefit Analysis, Fifth edition. Routledge.

Morgan, D.L. (1997). Focus Groups as qualitative research. Qualitative Research Methods Series. A Sage University Paper. London.

Newton S., Szimba E., van Meijeren J., Kraft M., Schröder S., Krail M., van Herbruggen B., Purwanto J., Maurer H., et al. (2009): Preparing TRANSTOOLS and TREMOVE for linkage with long-term energy and economic models. Deliverable D2 of iTREN-2030 (Integrated transport and energy baseline until 2030).. Zoetermeer, Netherlands.

Ntziachristos L., Samaras Z. (2000). Copert III computer programme to calculate emission factors from road transport. Modelling and emission factors (version 2.1.). Report to EEA.

Ntziachristos L., Samaras Z. (2009). EMEP/EEA emission inventory guidebook. http://lat.eng.auth.gr/copert/

OECD (2006). Applying Strategic Environmental Assessment. Good Practice Guidance for Development Co-operations. DAC Guidelines and Reference Series. Organisation for Economic Co-operation and development.

Petersen M.S., Bröcker J., Enei R., Gohkale R., Granberg T., Hansen C.O., Hansen H.K., Jovanovic R., Korchenevych A., Larrea E., Leder P., Merten T., Pearman A., Rich J., Shires J., Ulied A. (2009): Report on Scenario, Traffic Forecast and Analysis of Traffic on the TEN-T, taking into Consideration the External Dimension of the Union – Final Report, Funded by DG TREN, Copenhagen, Denmark.

Renn, O. and Oppermann, B. (1998). Politische Kommunikation als Partizipation; Jarren, O., Sarcinelli, U., Saxer, U. (eds.) (1998). Politische Kommunikation in der demokratischen Gesellschaft, Wiesbaden. 352-361.

Rogers, E.M. (1994). A history of communication study: A biographical approach. New York: Free Press.

Rader, M.; Porter, A.L. (2008): Fitting Future-Oriented Technology Analyses Methods to Study Types. In: Cagnin et al. (2008): Future-Oriented Technology Analyses. Strategic Intelligence for an Innovative Economy. Berlin, Heidelberg. S. 25-40.

Rauschmayer, F., Risse, N. (2005). A Framework for the Selection of Participatory Approaches for SEA. Environmental Impact Assessment Review, 25(6), 650-666.

Sardar, Z. (2010): The namesake: Futures; futures studies; futurology; futuristic; foresight What's in a name? In: Futures 42, Page 177-184

Scapolo, F., Porter, A. L. (2008). New Methodological Developments in FTA. In: Cagnin, C., Keenan, M., Johnston, R., Scapolo, F., Barré, R. (Eds. 2006)

Scapolo, F., Miles, I. (2006). Eliciting experts' knowledge: A comparison of two methods. Technology Forecasting and Social Change, 73, 679-704.

Schippl, J., Leisner, I. (2009). Backcasting in Transport. Scenarios for the Future of European Long-distance Transport. Technikfolgenabschätzung – Theorie und Praxis Nr. 2, 18. Jg., September 2009. http://www.itas.fzk.de/eng/tatup/inhalt.htm

Schippl, J., Grunwald, A., Hartlieb, N., Jörissen, J., Mielicke, M., Parodi, O., Stelzer, V., Weinberger, N., Dieckhoff, Chr. (2009). Roadmap Umwelttechnologien 2020 - Endbericht. Karlsruhe: Forschungszentrum Karlsruhe . (Wissenschaftliche Berichte, FZKA 7519).

Schippl, J., Kastenholz, H. (2004). Public Accountability. Ein Beitrag zu mehr Transparenz und Bürgernähe bei der Technikgestaltung? Soziale Technik, 4, 3-5.

Thérivel, R. (1998). Strategic Environmental Assessment in the Transport Sector. In: Banister, D. (1998, ed.): Transport Policy and the Environment. London and New York,

Therivel, R. (2004). Strategic Environmental Assessment in Action, Earthscan: London,

TSU Oxford et al. (2010). OPTIC Deliverable 1: Inventory of measures, typology of non-intentional effects and a framework for policy packaging.

TØI et al. (2010). OPTIC Deliverable 3: Ex post identification and remedies of adverse effects.

Van der Heijden, K. (2005). Scenarios. The Art of Strategic Conversation. 2nd Edition. West Sussex

Van Herbruggen, B. and Logghe, S. (2005). TREMOVE Version 2.3 Simulation model for European Environmental Transport Policy Analysis, Transport & Mobility Leuven, Leuven, Belgium

Van Herbruggen, B. (2007). TREMOVE model description, Transport & Mobility Leuven, available at: http://tremove.org/documentation/TREMOVE_Short_Description.pdf

Tuominen, A; Ahlqvist, T. (2010). Is the transport system becoming ubiquitous? Socio-technical roadmapping as a tool for integrating the development of transport policies and intelligent transport systems and services in Finland. Technology Forecasting and Social Change, 77, 120-134.

Warnke, P.; Heimeriks, G. (2006). Technology Foresight as Innovation Policy Instrument: Learning from Science and Technology Studies. Cagnin, C. et al: Future-oriented Technology Analyses. Strategic Intelligence for an Innovative Economy. Berlin, Heidelberg.

Venables (2007). Evaluating urban transport improvements. Journal of Transport Economics and Policy, 41(2), 173-188.

Viegas, J.M. (2003). Transport policy development in Europe 1950–2020. Fifty Years of Transport Policy. European Conference of Ministers of Transport. OECD Publication Services, Paris, 105–115.

Vieira, J., Moura, F., Viegas, J.M. (2007). Transport policy and environmental impacts: The importance of multi-instrumentality in policy integration.

9 Appendices

9.1 Further TT model components

The Air Travel Model

The realization of a trip by plane is composed by 3 decisions and respective models: a) the air access mode choice, b) the air choice (airport and flight connection) and c) the air egress mode choice. Once again, the quality of the level of service of air travel is given by travel time and travel cost with VOTs differentiated by trip purpose (business, vacation, other). In this context low cost carriers are not modelled as a singular or specific mode but described by their specific parameters of time and cost respectively. As only time and cost are considered, other aspects are left out. For instance, safety, punctuality or service can play an important role in the selection of a specific carrier. But as long as these characteristics are not included, respective policy effects – intended, unintended – cannot be quantified. Again, this weakness is rather due to a lack of data then to a missing methodological capability of the model to integrate these variables.

To define catchment areas for major hub airport, again assumptions were indispensable. In the air travel model, it is assumed that passengers are willing to travel quite far to major transport hubs or that a major hub within the same country from where the passenger starts his long distance trip appears more attractive than another one in a neighbouring country in shorter distance. This is an interesting approach, as in fact non-quantifiable aspects of e.g. language or culture play a role in the decision for or against an airport. Although it is difficult to integrate and quantify these aspects, they expand the abilities of the model to deal with policies. The connectivity of zones to airport hubs is applied in such a way that all zones are connected to an airport in 2 hour travel time distance (road, rail), all major hubs in 3 hour distance and all national hubs in 4 hour distance. As relevant modes for the access and egress mode choice, public transport (bus, rail) and car travel are the considered options. The choice between car and public transport for access and egress to and from the airport is modelled applying a binary logit model including travel time, cost and a border crossing penalty in the utility function. For several possible paths to/from the airport a weighted travel time (and cost) is calculated and considered in the decision model. Note, that the attractiveness of access/egress legs do not differ only by mode but by trip purpose as different parameters in the utility function are considered. Thus, as stated initially the decision for a long distance trip by plane is composed by several sub-decisions which together reproduce the air travel decision and its outcome: access/egress trips on the network (rail, road) and point to point airport connections. This process can be described in a sequential manner where a) the mode choice for the long distance trip is determined (road, rail, plane), b) if the plane option is chosen, the decision for an airport for departure and arrival is determined, c) the specific connection between both airports according to the characteristics is selected (based on travel time, travel costs) and d) the mode choice for access and egress to and from the airport is defined.

The Network Models

The current networks within TT (road, rail, waterways and air) were updated during the TENCONNECT project and have the state of 2005. The road transport assignment is realized in TT applying stochastic user equilibrium (SUE). This assignment procedure is based on the individual traveller's perception of utility for a specific route, thus traveller class utility functions, his/her preferences and the type of vehicle (passenger cars, trucks) are considered. The respective coefficients of the utility function were fitted in order to reproduce behaviour and counts in a best way. It is of major importance to recognize, that in road assignment a high degree of flexibility is given due to the consideration of parameter settings by traveller/vehicle classes. This flexibility plays a role when thinking about the abilities of TT to react to policy interventions. The utility function itself and thus, the possibilities to influence factors are: cost of each road link (depending on e.g. fuel prices and fuel taxes), tolls, a VOT factor (depending on the zone where the traveller/trip starts), the product of VOT and free flow time, the product of VOT and congested flow time or the product of VOT and ferry sailing and/or waiting times. As argued before, the integration of further variables describing route choice quality (e.g. reliability of the expected travel time, safety) expands the possibility to quantify intended and unintended effects. Again, given increased data requirements and complexity.

The congestion within a network is influenced by all road related transports. Therefore, although OD matrices are estimated by different models and purposes (e.g. passenger and freight, long and short distance), the assignment has to be done simultaneously. In TT this is realized using a multi-purpose assignment procedure which summarizes the calculated demand by different modes and assigns it entirely to the network. In this step, long and short distance passenger trips are assigned together with trucks resulting from the freight demand model.

For the evaluation of individuals belonging to traveller classes as mentioned above it is worth to repeat that for long distance trips that cross national borders, the VOTs are applied of the respective country in which the traveller lives (starts his/her trip). Doing so, bias is avoided that would influence travel related decisions (modes, destinations, routes) due to higher/lower economic evaluation of time in different countries of the EU. As the VOTs directly affect practically any relevant travel decision within the model, it is of crucial importance to have available country specific or even population cluster specific estimations for the VOTs. The evaluation of time by users is of general relevance for scenario building or attempts of transport demand forecasting. In reference to the utility function components mentioned above, an externally given scenario can be e.g. on altered VOTs by country (due to GDP growth) or country specific changes in fuel cost and taxes. In contrast to the road assignment, rail assignment is done considering only link time and cost. No time table information or real data about frequencies is introduced at the moment. Nevertheless, high speed rail is coded differently as respective link types show higher speeds and different costs. If then different (country specific) VOTs are considered, the distinctions between high speed rail and traditional rail options can be reproduced.

The Impact Models

In the context of transport models, associated impact models generally follow the step of network assignment. The main impact models related to TT are the economic impact model CGEurope and the environmental impact models (e.g. being TREMOVE a representative for that). CGEurope captures the economic impacts resulting from a model run with TT (for instance because of new infrastructure or a pricing scheme) primarily on the regional GDP and the sectoral structure. Within the framework of TT the CGEurope component is used to quantify regional welfare effects of policies, changes in income and the development of the unemployment rates. Income levels and unemployment, respectively the number of jobs can then be used once again for a (new) model run of TT where the alterations in income and number of jobs are considered (remember that income levels have an effect on the VOTs and the number of jobs on the attractiveness of a zone).

Once all estimated transport flows are routed on the network, the calculation of e.g. energy consumption or emissions can be done. The same applies for TT where the traffic volumes on network links (rail, road, waterways) can be translated via an environmental model to emissions, energy consumption or expected external costs. The validity and reliability of the impact assessment is highly dependent on the data available to describe e.g. the vehicle technology or the related emission factors (see chapter on TREMOVE, 3.2.5). This is where a direct connection to the appearance of intended and unintended effects occurs which is rather self-explaining: only those effects can be explained (and quantified) which build part of the impact model; e.g. effects of emissions which do not build part of the assessment tool cannot be analyzed regarding their impacts on the transport system or related subsystems such as the public health sector. This example justifies a closer look on the data requirements associated with TT and impact models.