Overview of road infrastructure planning process and the use of Environmental Assessments in the Netherlands and Sweden

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# Table of Contents

Preface ...................................................................................................................... v
Summary .................................................................................................................. vi
Abbreviations......................................................................................................... viii

1 Introduction ........................................................................................................ 1
  1.1 Background .................................................................................................. 1
  1.2 Scope and objectives of the study ................................................................. 2
  1.3 Outline of the report ................................................................................... 2

2 Theoretical background ....................................................................................... 3
  2.1 Environmental Assessment in EU context ..................................................... 3
  2.2 Life Cycle Assessment .................................................................................. 5
  2.3 LCA as a tool in Environmental Assessment ............................................... 5

3 Methodology ...................................................................................................... 6
  3.1 Literature review .......................................................................................... 6
  3.2 Interviews .................................................................................................... 7
  3.3 Environmental Impact Statements ............................................................... 8
  3.4 Analysis and comparison of the results ....................................................... 8

4 Results ................................................................................................................. 11
  4.1 Road infrastructure planning process .......................................................... 11
    4.1.1 Planning process in the Netherlands ....................................................... 11
    4.1.2 Planning process in Sweden ................................................................. 14
  4.2 Results from comparison categories ............................................................. 18
    4.2.1 Comparison of road infrastructure planning processes ....................... 18
    4.2.2 Content of SEA and EIA ..................................................................... 22
    4.2.3 Life cycle perspective throughout road infrastructure planning process .............................................................................. 24

5 Discussion .......................................................................................................... 26
  5.1 Discussion of results ..................................................................................... 26
    5.1.1 Stages of road infrastructure planning process .................................... 26
    5.1.2 Use and content of Environmental Assessment ..................................... 27
    5.1.3 Use of a life cycle perspective throughout infrastructure planning process .............................................................................. 28
  5.2 Discussion of methodology ......................................................................... 29

6 Conclusion ......................................................................................................... 31

References ............................................................................................................. 32
Preface

This study is a part of the project ‘Life Cycle Considerations in EIA of Road Infrastructure’ (LICCER), which is jointly financed by Germany, Denmark, Ireland, Netherlands, Norway, Sweden and United Kingdom initiated at the ERA-NET ROAD Programme. The aim of the LICCER project is to develop a Life Cycle Assessment (LCA) model of road infrastructure for the Netherlands, Sweden, Denmark and Norway. The model is intended to be used in the early stages of the road infrastructure planning process in which the decision on localisation and route is taken. The model will focus on energy use and contribution to climate change.

We would like to thank Dr.ir. José Potting (Wageningen University), Kristina Lundberg, PhD (Ecoloop), and Susanna Toller, PhD (KTH) for their guidance and valuable comments on the structure and contents of the report. All the stakeholders interviewed are gratefully acknowledged. Special thanks to the ERA-NET ROAD Programme for funding the project.
Summary

There is a need to include life cycle energy use and greenhouse gas emissions in the early stages of the road infrastructure planning process in which the decision on road localisation and route is taken. This means that not only the direct emissions from vehicles should be assessed, but also the indirect emissions from the construction, maintenance and operation of the road infrastructure. However, in order to consider life cycle energy use and greenhouse gas emissions in the early stages of the road infrastructure planning, that process need to be better understood.

The main aim of this study is therefore to compare the road infrastructure planning process and the use of Environmental Assessments (i.e. Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA)) in the planning process in the Netherlands and Sweden. The specific objectives of this study are: (1) to identify the stages of the infrastructure planning process related to the main decisions on modality, localisation/route, construction type, and construction design; (2) to benchmark the use and content of Environmental Assessment in the road infrastructure planning process; and (3) to investigate the current and potential use of a life cycle perspective throughout the planning process.

Data was collected through literature review and interviews. The results from literature review and the interviews were verified with the information in EIA reports and during the workshop ‘Life Cycle Considerations in EIA of Road Infrastructure’. The analysis of the interviews was based on content analysis, in which the responses were grouped according to comparison categories divided in procedural aspects of the planning process and methodological aspects of road SEAs and EIAs.

The main conclusions of this study are:

- Both in the Netherlands and Sweden three levels of decision making regarding road infrastructure are identified: 1) choice of transport modality at the national level; 2) choice of localisation and construction type of a specific project; 3) choice of specific design.
- Different route alternatives and construction types, are assessed in feasibility study with EIA in Sweden and the explorative study with SEA in the Netherlands (SEA is only for large road projects).
- There is no clear definition of the impact category climate change as it includes both adaptation and mitigation measures, and a difference in the interpretation of the concept “mitigation measures” exists between stakeholders from the SEA/EIA field and the LCA field.
- No formalised way of assessing life cycle energy use and greenhouse gas emissions exists in the earlier stages of the road infrastructure planning process. Different LCA models are used
later in the planning process, in particular to assess the environmental impacts of detailed (construction) design.

- Life cycle energy use and GHG emissions can be included in the early stages of the planning process either as an output of a standardised LCA model within the SEA/EIA, separately from the SEA/EIA, or as part of a Cost Benefit Analysis.
**Abbreviations**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
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<tbody>
<tr>
<td>CBA</td>
<td>Cost Benefit Analysis</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
</tr>
<tr>
<td>EIS</td>
<td>Environmental Impact Statement</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>GHG</td>
<td>Greenhouse gas</td>
</tr>
<tr>
<td>LCA</td>
<td>Life Cycle Assessment</td>
</tr>
<tr>
<td>LCC</td>
<td>Life Cycle Costing</td>
</tr>
<tr>
<td>LICCER project</td>
<td>‘Life Cycle Considerations in EIA of Road Infrastructure’ project</td>
</tr>
<tr>
<td>MS</td>
<td>Member State</td>
</tr>
<tr>
<td>NCEA</td>
<td>Netherlands Commission for Environmental Assessment</td>
</tr>
<tr>
<td>SEA</td>
<td>Strategic Environmental Assessment</td>
</tr>
</tbody>
</table>
1 Introduction

1.1 Background

Road infrastructure planning often includes large long-term projects with possibly large impacts on the environment and society for long time periods due to a high inertia of the built environment (Åkerman and Höjer, 2006). An important prerequisite for sustainable development is to integrate both direct and indirect environmental impacts in the early stages of infrastructure planning (European Commission, 2005). Besides, it is important that decisions taken throughout the road infrastructure planning process are based on complete and robust information. The European Union requires therefore the performance of an Environmental Assessment, including Strategic Environmental Assessments (SEA) for plans and programmes and Environmental Impact Assessments (EIA) for specific projects, as set in the SEA and EIA Directive, respectively (Directive 2001/42/EC, 2001; Directive 2011/92/EU, 2011). The implementation of these European SEA and EIA Directives, however, may differ across the different Member States (Therivel, 2010).

Current practice shows that climate change aspects and energy use from the construction, maintenance and operation of the road infrastructure are often not included in Environmental Assessments (Finnveden and Åkerman, 2011; Hildén et al., 2004). This could lead to incomplete information since these impacts from the construction, maintenance and operation of transport infrastructure might be significant (Toller et al., 2011), and because the emissions from energy use are a major precursor for many other important impacts (Huijbregts et al., 2010). Regarding climate change and use of energy, there is a need for a life cycle perspective, not only including the direct emissions from vehicles, but also the indirect emissions from the construction, maintenance and operation of the road infrastructure. Road infrastructure in this study refers to plain roads, tunnels, bridges, and other supporting components such as signs, lightning installations, road furniture etcetera. Especially in the early stages of the planning process where site-dependent aspects are considered, such as the localisation of the road and the related choice between bridge, tunnel and plain road, the use of a life cycle perspective, including the road infrastructure, is important to significantly decrease greenhouse gas (GHG) emissions and energy use (Miliutenko, 2012). Life Cycle Assessment (LCA) is a method which could be used to calculate the life cycle energy use and GHG emissions of the road infrastructure. LCA quantifies the potential environmental impacts of a product system, during its whole life cycle, this means from raw material extraction through production, use and waste treatment or final disposal (ISO 14044, 2006).

In the project ‘Life Cycle Considerations in EIA of Road Infrastructure’ (LICCER) an LCA model of road infrastructure for the Netherlands, Sweden, Denmark and Norway will be developed. This model is intended to be used in the early stages of road infrastructure planning process in which the decision
on localisation and route is taken. The model will focus on energy use and contribution to climate change. However, in order to design such a model in a way so that it is useful in the early stages of the planning process, that process need to be better understood.

### 1.2 Scope and objectives of the study

This study is part of the LICCER project and therefore the scope of the study is on the consideration of energy use and contribution to climate change during the whole life cycle of the road infrastructure in the early stages of the planning process (i.e. where the decision on localisation/ route is taken).

The main aim of the study is to compare and benchmark the road infrastructure planning process and the use of Environmental Assessments (i.e. SEA and EIA) in the planning process in the Netherlands and Sweden. The specific objectives of this study are:

- To identify the stages of the infrastructure planning process related to the main decisions on modality, localisation/route and construction type, and construction design;
- To benchmark the use and content of Environmental Assessment in the road infrastructure planning process;
- To investigate the current and potential use of a life cycle perspective throughout the infrastructure planning process.

### 1.3 Outline of the report

The background, overall objective and the specific aims of this study are described in Chapter 1. Chapter 2 provides a theoretical background of the study. The methodology of data collection, analysis and comparison is described in Chapter 3. Chapter 4 presents the results of the study. These results and the methodology are discussed in Chapter 5 and final conclusions are given in Chapter 6.
2 Theoretical background

This chapter presents the theoretical background of this study. The following is included: Environmental Assessment in the context of the European Union (EU) (section 2.1); Life Cycle Assessment (LCA) (section 2.2); and the use of LCA as an analytical tool in the EIA and SEA procedure (section 2.3).

2.1 Environmental Assessment in EU context

Environmental Assessments are recognized as important procedures for ensuring that environmental implications of decisions are taken into account in the decision making process before the decision is approved (European Commission, 2012a). An Environmental Assessment must be undertaken for all plans, programs and projects which are likely to have a significant effect on the environment. Two types of Environmental Assessment exists, namely Strategic Environmental Assessment (SEA) for public plans and programs and Environmental Impact Assessment (EIA) for public and private projects. The frameworks of both Environmental Assessments are set in Directives of the European Commission. The EIA framework is set in Directive 85/337/EEC, as amended by Directives 97/11/EC, 2003/35/EC and 2008/31/EC, hereafter referred to as EIA Directive. The SEA framework is set in Directive 2001/42/EC, hereafter referred to as SEA Directive.

The EIA Directive went into force in 1985. It lays down a number of steps in the EIA process (Directive 2011/92/EU, 2011). The explanation of each step is given in Figure 1. Although the steps are outlined in a linear way, the EIA process has an iterative character. The grey steps in Figure 1 are mandatory in all Member States (MS). These include a screening stage to decide whether an EIA needs to be carried out, submission of the environmental information to the competent authority, and the consultation of relevant stakeholder and the public is required in all stages. The scoping step, in which all issues to be covered in the EIA are identified, is not mandatory under the EIA Directive. However, MS need to establish a voluntary procedure by which developers can request advice from the competent authority if they wish (European Commission, 2001). Environmental Information needs to be provided to the competent authority by the developer, the requirements for what to include in the Environmental Information are laid down in article 5 and Annex IV of the EIA Directive. The issues covered in the Environmental Information depend on project characteristics and are identified in the scoping step. The other steps in Figure 1 are part of good practice in EIA and are formalised in some MS but not in all (European Commission, 2001). Therefore, and because some MS have extra mandatory steps in EIA, the use and process of EIA may vary between the MS (European Commission, 2001).
After some years of EIA practice the need for a more strategic form of EIA became apparent in order to assess all actions in a certain area in an earlier stage of the decision making process (Glasson et al., 2005). Therefore, the SEA Directive was implemented in 2001 and became operational in 2004. The environmental report is the central part of SEA (European Commission, 2003). The procedure of SEA is comparable to the EIA procedure as presented in Figure 1. However, some small differences in procedure exist, of which the main differences are that the scoping, review and post-decision monitoring stages are mandatory under the SEA Directive. Besides, all reasonable alternatives needs to be assessed in an SEA, while under the EIA the developer can choose which alternatives will be assessed (European Commission, 2012b).
2.2 Life Cycle Assessment

The main objective of LCA is to quantify the potential environmental impacts of a product system, both goods and services, throughout its whole life cycle, i.e. from raw material extraction through production, use and waste treatment or final disposal. The LCA methodology is standardised by the International Organisation of Standardisation in ISO standard 14044 (2006) and is further specified in national guidelines, and lately by the European Union in the International Reference Life Cycle Data System (ILCD) Handbook (European Union and Joint Research Centre, 2012). The LCA framework consists of four phases and has an iterative character, meaning that the outcome of one phase may lead to revisions in another phase. The first phase is goal and scope definition, in which the objective of the study is established, system boundaries and unit for comparison are defined. In the inventory phase, all data concerning material use and emissions is collected. In the impact assessment phase, this data is attributed to the different impact categories, and the relative contribution to each category is calculated. Finally, in the interpretation phase, the results of the inventory and impact assessment phases are summarised and discussed as a basis for conclusions, and decision making (Baumann and Tillman, 2004; ISO 14044, 2006). Important applications of LCA are the provision of information for decision making, identification of opportunities to improve the environmental performance of products, and marketing, for example as a basis of environmental labelling (ISO 14044, 2006).

2.3 LCA as a tool in Environmental Assessment

Although SEA, EIA and LCA are both concerned with the environmental implications of plans, projects, products and services, differences between the Environmental Assessments and LCA exist. While EIA is focused on specific local situations and takes into account time-related aspects, LCA in general is a time and location independent assessment. Furthermore, LCA is mainly a tool to help in the decision making process, while SEA and EIA are concerned with the process of decision making itself (Finnveden and Moberg, 2005; Tukker, 2000). SEA, EIA and LCA share the basic objective of providing environmental information to support decision making, and both are concerned with the consideration and comparison of alternatives (Tukker, 2000). The latter is where LCA as an analytical tool can complement and add value to procedural tools as EIA and SEA (Finnveden and Moberg, 2005; Tukker, 2000). This is argued by Tukker (2000) as follow: “For a fair comparison of alternatives, a complete set of impacts must be analyzed, and all processes causing effects that are relevant in the comparison, [...] must be taken into account. And that is just what LCA does.” This conclusion is shared by Manuilova et al. (2009) for the inclusion of LCA in EIA, and Nilsson et al. (2005) and Björklund (2012) for the inclusion of LCA in SEA. There are, however, only a few practical examples of the use of LCA in EIAs specific to infrastructure projects, for example the EIA of the design plan of Stockholm Bypass (Förbifart Stockholm) (Trafikverket, 2011a).
3 Methodology

This study comprised the following research stages (Figure 2): data collection, data analysis and comparison and the discussion and conclusions of the research. Research data was collected by means of literature review and interviews. In addition, EIA reports (so-called Environmental Impact Statements (EIS)) documenting all environmental information from the Netherlands and Sweden were used to verify the obtained data from literature review and interviews. Data validity was checked through triangulation (Kvale, 1996), which means collecting data from multiple data sources and using multiple methods.

![Figure 2: Research stages](image)

3.1 Literature review

The main objective of the literature review was to identify comparison categories between the planning processes and Environmental Assessments in the Netherlands and Sweden. In addition, literature was used for initial data collection and formulation of the interview guide for the interviews as well as the verification of results obtained from the interviews and analysis of Environmental Impact Statements.

Important sources for the literature review were among others documents from the European Commission (a.o. Directive 2001/42/EC, 2001; Directive 2011/92/EU, 2011; European Commission, 2001), national handbooks on road planning, EIA and SEA (a.o. Projectdirectie Sneller & Beter, 2010; Rijkswaterstaat, 2010a; Trafikverket, 2011b) and a book on EIA and SEA (Glasson et al., 2005).
3.2 Interviews

The objective of the interview stage was to obtain data from relevant stakeholders regarding decision making in road infrastructure planning and road Environmental Assessments, in the Netherlands and Sweden. The interview stage involved the following activities:

- Identification of relevant stakeholders through literature review and snowball sampling (Norman and Russell, 2006), where each respondent was asked for references to other individuals who could be potential stakeholders.
- Preparation of the project description and questionnaire based on the comparison categories (see section 3.4 for the comparison categories);
- Contacting the stakeholders, making an appointment and sending the questionnaire in advance of the interview;
- Interview by telephone or face-to-face;
- Providing the interviewee with the summary of the interview.

We identified relevant stakeholders in the Netherlands and Sweden on the basis of four different stakeholder groups:

1) Authorities, including National Road Administration and provincial authorities as initiator and competent authority in the EIA and SEA procedure;
2) Research on methodological and procedural aspects of EIA, SEA and LCA;
3) Independent advisor and reviewer, responsible for the review of the EIS in the Netherlands;
4) Consultancy who are responsible for making the EIS.

The list of interviewees per stakeholder group and country is included in Appendix 1.

The interviews were semi-structured using an interview guide with closed and open questions (Kvale, 1996). The interview guide was structured according to the comparison categories and was sent as a questionnaire to the interviewees in advance (see Appendix 2 and 3 for the questionnaire used for the Dutch and Swedish interviews, respectively). The questionnaires were similar except for one extra question about decisions in the planning process in the Dutch questionnaire, see question 3 in Appendix 2.

In total eight interviews were performed in the Netherlands, and seven interviews in Sweden in the period March 2012 to May 2012. Twelve interviews in total were conducted by phone, one interview was face-to-face and two people filled in the questionnaire but no interview took place. The time for the interviews varied between 15 and 90 minutes.
3.3 Environmental Impact Statements

The Environmental Impact Statements (EIS) documents all gathered information and estimations of the impacts of the alternatives assessed during the Environmental Assessment (SEA or EIA) (Glasson et al., 2005). The main objective of the use of EIS in this study was to verify the results obtained from literature review and the performed interviews. Dutch and Swedish EIS (Table 1) were selected by asking interviewees for relevant and good examples of EIS, to be able to verify the results from literature review and interviews.

Table 1: Environmental Impact Statements used for verification of the results during the study

<table>
<thead>
<tr>
<th>Country</th>
<th>Project name (year)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Netherlands</td>
<td>Haaglanden (A4 Passage en Poorten&amp;Inprikkers) (2012)</td>
<td>SEA during explorative study for two alternatives considering different routes, and comparison with zero-alternative.</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>Ring road Voorst (2011)</td>
<td>EIA during project study for two alternative: ring road west or east around the village Voorst, and comparison with zero-alternative.</td>
</tr>
<tr>
<td>Sweden</td>
<td>North-South connection in Stockholm Area (2005)</td>
<td>EIA during feasibility study for three alternatives: two road corridor alternatives (Förbifart Stockholm, Diagonal Ulvsunda) and combination alternative (expanding of public transportation)</td>
</tr>
<tr>
<td>Sweden</td>
<td>Stockholm Bypass (E4 Förbifart Stockholm) (2011)</td>
<td>EIA during Design Plan stage for the new road corridor construction (mainly tunnels), and comparison with zero-alternative.</td>
</tr>
<tr>
<td>Sweden</td>
<td>Umeåprojektet (E12Västra Länken) (2010)</td>
<td>EIA during Design Plan stage for the new road construction (including one bridge), and comparison with zero-alternative.</td>
</tr>
</tbody>
</table>

3.4 Analysis and comparison of the results

The analysis of the interviews was based on content analysis (Kvale, 1996), in which the responses were grouped according to comparison categories. This was supplemented with data obtained by literature review where necessary and verified with the information from EIS.

Two main comparison categories were formulated in order to be able to compare the planning processes and the use of Environmental Assessments (Table 2): (1) planning process dealing with procedural aspects such as the stages of planning, the use of SEA and/or EIA throughout the planning
process and the number and focus of road Environmental Assessments; (2) the content of Environmental Assessment dealing with methodological aspects such as the coverage of and system boundaries used in road SEA and EIA, and methods and tools used to provide the environmental information.

The workshop on ‘Life Cycle Consideration in EIA of Road Infrastructure’, held on May 9, 2012 in Stockholm (Sweden), was an important part of the analysis and comparison stage (Figure 2). The preliminary results of this study were presented during the workshop in order to verify the obtained results.
<table>
<thead>
<tr>
<th><strong>Categories</strong></th>
<th><strong>Description</strong></th>
<th><strong>Related question(s)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Planning process (procedural aspects)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road infrastructure planning process</td>
<td>• General outline of the road infrastructure planning process and involved stages.</td>
<td>- In which stages of the planning process are the main decisions on modality, location/route, construction type and construction design made?</td>
</tr>
<tr>
<td>Environmental Assessments in planning process</td>
<td>• Use of SEA and EIA in the planning process</td>
<td>- In which stage(s) of the planning process are Environmental Assessments performed?</td>
</tr>
<tr>
<td></td>
<td>• Frequency and focus of road infrastructure EAs.</td>
<td>- How often are Environmental Assessments (SEA and EIA) performed for road infrastructure projects?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Among the infrastructure projects for which an EA is required, what is the most common type of road infrastructure project?</td>
</tr>
<tr>
<td><strong>Environmental Assessment (methodological aspects)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coverage and system boundaries</td>
<td>• Consideration of alternatives and mitigation measures.</td>
<td>- Which alternatives are considered in EAs?</td>
</tr>
<tr>
<td></td>
<td>• Considered environmental effects.</td>
<td>- What mitigation measures regarding energy use and climate change are included in EAs?</td>
</tr>
<tr>
<td></td>
<td>Inclusion of energy use and GHG emissions.</td>
<td>- Which impacts are currently taken into account in the EA of road infrastructure projects?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- If energy use is included, in which stages and for which activities is this taken into account?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Is Life Cycle Assessment data used in EIA of infrastructure projects?</td>
</tr>
<tr>
<td>Methods and tools</td>
<td>• Current methods or tools to provide environmental data.</td>
<td>- Which methods and tools are currently applied to provide data on the effects of alternatives?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- What computer models are used to provide data?</td>
</tr>
</tbody>
</table>
4 Results

This chapter includes the results of the literature review and interviews. First, a description of the road infrastructure planning processes of the Netherlands (section 4.1.1) and Sweden (section 4.1.2) based on the literature review is given. The chapter continues with the results of the comparison between Sweden and the Netherlands mainly based on the interviews and the findings of the workshop, complemented with literature review where necessary. First, the road infrastructure planning process, and the use of Environmental Assessments are presented (section 4.2.1), followed by a description of the content of SEA and EIA on the basis of the comparison categories (section 4.2.2), and the use of a life cycle perspective throughout the road planning process (section 4.2.3).

4.1 Road infrastructure planning process

4.1.1 Planning process in the Netherlands

The different stages of the planning process in the Netherlands are: strategic planning, initiation stage, explorative study, project study, realisation stage and follow-up. See Table 3 for a summary of the main decisions taken and inclusion of Environmental Assessments in each stage.

<table>
<thead>
<tr>
<th>Stages of planning process</th>
<th>Decisions and considerations</th>
<th>Environmental Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic planning</td>
<td>- <strong>Modality</strong> – general: <em>what and why?</em></td>
<td>SEA</td>
</tr>
</tbody>
</table>
| Initiation stage (initiatieffase) | - **Modality** – project specific: *what mode of transportation?*  
- **Location/route** is considered but not decided |                      |
| Explorative study (verkenningsfase) | - **Location/route**: *where?*  
- **Construction type**: *road, bridge, tunnel?* | SEA (for large projects) |
| Project study (planuitwerkingsfase) | - Details of construction type are further defined: *how?*  
- Technical guidelines on construction **design** issued by Rijkswaterstaat  
- In some cases the contractor is already involved to make **design** choices | EIA                      |
| Realisation stage (realisatiefase) | - **Construction design** by contractor: *how?* |                      |
| Follow-up                  | - **How did it turn out?**       |                          |

Sources: (DHV B.V., 2010; Projectdirectie Sneller & Beter, 2010)

The infrastructure planning process starts with **strategic planning**. The purpose of strategic planning is to establish a framework of transport and infrastructure related developments on national and regional
level for a pre-determined time period (Arts, 2010). Once every 5 to 10 years a Structural Vision is published by the national government. The latest Structural Vision Infrastructure and Space (Structuurvisie Infrastructuur en Ruimte) is published in March 2012, and outlines the strategic mobility and spatial policy up to the year 2040. This is done by formulating three national goals to strengthen the structural economic perspectives of the Netherlands and which need to be achieved by 2028 (Ministry of Infrastructure and Environment, 2012a). These goals are elaborated on in national interests and described per area. The Structural Vision includes an SEA in which the environmental implications of the policy choices and the reference situation are assessed (Ministry of Infrastructure and Environment, 2011).

The national policy established in the Structural Vision is implemented through projects and programmes gathered in a programming and budgeting system, the Multi-Year Infrastructure, Spatial Planning and Transport Programme (MIRT), which runs to 2020. A MIRT project book is published every year, providing an overview of the current infrastructure projects per region established by the national and local governments, so-called regional agendas (gebiedsagenda’s) (Rijksoverheid, 2012). Four stages of decision making are defined in MIRT (Table 3): 1) the initiation stage (initiatieffase); 2) the explorative study stage (verkenningsfase); 3) the project study (planuitwerkingsfase); and 4) the actual realisation stage (realisatiefase) (Projectdirectie Sneller & Beter, 2010).

An initiative derived from the regional agendas is further defined and delimitated in the initiation stage. At the end of the initiation stage a start decision is taken whether the planning of the project should continue. This decision reflects the importance of the initiative and the explorative stage is started (Projectdirectie Sneller & Beter, 2010).

The purpose of the explorative study stage is to provide the decision makers and public with all the information needed to make a sound decision. The explorative stage act as a filter for alternatives; in the beginning of the explorative a broad range of solution opportunities are generated on the basis of for example the mobility ladder (Text box 1).
The solution opportunities are assessed by specialists and experts, and three viable alternatives for further assessment are chosen (Projectdirectie Sneller & Beter, 2010). These three viable alternatives are further developed and assessed. An SEA might be required by the Environmental Protection act (Wet milieubeheer). The SEA procedure follows all steps described in the SEA Directive (Figure 1 and section 2.1). To decide whether an SEA is required a mandatory screening is performed, in which the intended plan is checked against the activities listed in appendix C and D of Besluit m.e.r. (InfoMil, 2012). When an SEA needs to be undertaken, all issues to be covered are identified in the scoping step. This step includes consultation with different stakeholders and the public and the developer is required to request a scoping advice by the Netherlands Commission for Environmental Assessment (NCEA). NCEA is independent organisation providing among others advice in the scoping stage. A scoping document forms part of good practice but is not mandatory to issue. Stakeholder and public consultation is mandatory during different stages of the SEA procedure (Projectdirectie Sneller & Beter, 2010). The level of detail in the SEA is general, but if needed more detailed study is carried out (Projectdirectie Sneller & Beter, 2010). The SEA is reviewed by the NCEA, who checks the SEA on essential omissions, transparency and errors. The review of SEAs of complex projects is mandatory (NCEA, 2011). The SEA document is part of the structure vision or explorative report published at the end of the explorative stage. At the end of the explorative stage one preferential alternative is chosen, on the basis of the environmental information and the results from the Cost Benefit Analysis (Projectdirectie Sneller & Beter, 2010). The choice for one alternative, at the end of the explorative stage, involves a decision on location, route, the number of extra lanes, and type of construction (i.e. plain road, bridge, tunnel) (DHV B.V., 2010).

The preferential alternative is further defined and assessed in the project study. Although the preferential alternative is spatially bounded, different variations (f.e. shape and size of noise barriers, 

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**Text box 1: The use of the mobility ladder in the explorative study**

Different tools exist to generate a broad range of solution opportunities for mobility problems in the beginning of the explorative study. For example, the mobility ladder (zevensprong van Verdaas) in which seven aspects, influencing the traffic and mobility system, are defined:

- Spatial planning
- Pricing policy
- Public transport
- Mobility management
- Better utilisation of existing infrastructure
- Adaptation of existing infrastructure
- New infrastructure

All aspects need to be considered, however not in a specific hierarchical order.

*Source:* (Projectdirectie Sneller & Beter, 2010)
type of pavement, and number and location of wildlife crossings) of the alternative may be analysed in
the project study (DHV B.V., 2010; Projectdirectie Sneller & Beter, 2010). An EIA is carried out
during the project study in which the environmental implications of the preferential alternative, with
possible variations, are assessed in detail and in most cases compared with the zero-alternative. The
zero-alternative describes the situation with autonomous development in which the proposed activity
is not taking place (DHV B.V., 2010). An extensive EIA is obligatory for all road projects (NCEA,
2010), and is fully integrated with plan preparation. The EIA procedure is similar to the SEA
procedure (InfoMil, 2012). The level of detail in assessing the impacts of the alternative is, however,
more detailed than in the SEA. Besides, some extra requirements on the content of the EIA report
(EIS) exist. A description on the approach to perform the intended project needs to be included in the
EIS as well as a list of all decisions made related to the intended project and alternatives. The EIS is
reviewed by the NCEA (NCEA, 2011). A final project decision (or route decision) is taken at the end
of the project and technical design conditions are set in guidelines and issued by the Dutch National
Road Administration, Rijkswaterstaat, at the end of the project study (DHV B.V., 2010).

The last phase of the MIRT programme is the **realisation phase**, which starts with the procurement. In
to the technical conditions issued by Rijkswaterstaat at the end of the project study. However, there is a
trend towards early market involvement in which the project study and the procurement stage take
place in parallel. In this case, design choices are already earlier made alongside the project study
(Projectdirectie Sneller & Beter, 2010). After the bidding, the actual construction of the road takes
place. After the construction is finished, an EIA **follow-up**, including monitoring and evaluation, is
mandatory under Dutch EIA regulations (Arts, 2010).

### 4.1.2 Planning process in Sweden

Table 4 provides an overview of the different stages of the current planning process in Sweden, the
main decisions taken, and the inclusion of an Environmental Assessment in each stage. However, the
infrastructure planning process will change in January 2013. A short explanation of these changes, as
far as they are known now, is given at the end of this section.

**Strategic planning** is the first stage in the planning process and covers large geographical areas to
enable intermodal studies and the analysis of global, national and regional consequences. Strategic
planning results in different types of plans, for example national and regional transportation and
mobility plans, and the analysis of the existing mobility problems (Trafikverket, 2011b). Strategies to
solve the identified problems are selected according to the so-called four-stage principle (Text box 2).
The choice for mode of transport on a general level is made in the strategic planning stage and an SEA of the different strategies is carried out (Trafikverket, 2011b).

Table 4: Stages of the current planning process and related decisions in Sweden (before January 2013)

<table>
<thead>
<tr>
<th>Stages of planning process</th>
<th>Decisions and considerations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic planning (strategisk planering)</td>
<td>- <strong>Modality</strong> – general: what and why?</td>
<td>SEA</td>
</tr>
<tr>
<td>Initial study (förstudie)</td>
<td>- <strong>Modality</strong> – project specific: what are alternative solutions?</td>
<td></td>
</tr>
<tr>
<td>Feasibility study (utredning)</td>
<td>- <strong>Location/route</strong>: where?</td>
<td>EIA</td>
</tr>
<tr>
<td>Design plan (plan)</td>
<td>- Details of construction type are further defined: how?</td>
<td>EIA</td>
</tr>
<tr>
<td>Construction Documents (bygghandling)</td>
<td>- Detailed construction <strong>design</strong>: how?</td>
<td></td>
</tr>
<tr>
<td>Follow-up during construction and operation stage (Bygg- och driftskede)</td>
<td>- <strong>How did it turn out?</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: based on Trafikverket (2011)

The second stage of the planning process in Sweden is the *initial study*. The purpose of this stage is to establish the objective of the road project and to roughly study the environmental prerequisites and trends on the basis of existing information. In addition, the initial study should carry out a broad analysis of the environmental implications of alternative measures based on the four-stage principle that is initiated in strategic planning (Trafikverket, 2011b). Initial study and strategic planning play an important role in the analysis of measures according to stages 1 and 2 of the four-stage principle (Trafikverket, 2011b). It is decided at this stage whether the planning of the project should continue. The environmental analysis during initial study serves as a basis for the selection of actions in the next stage, the feasibility study.
Text box 2: The four-stage principle in the planning process in Sweden

The four-stage principle (Fyrstegsprincipen) is applied in the strategic planning and initial study in Sweden. It includes four stages of measures which must be examined in this order to solve mobility problems:

1) Measures which can affect the demand for transport and choice of transport mode, for example: planning, management, and information campaigns to reduce the demand for transport.
2) Measures which can result in a more efficient utilisation of the existing road network, for example: traffic control and other intelligent transport systems; ridesharing.
3) Limited realignment measures on existing roads, for example: rebuilding of existing segments of road, speed reductions signs, load-bearing capacity measures
4) Measures in the form of new roads and major refurbishment, for example: new segments of road that demand new land.

Source: (SKL, 2007; Trafikverket, 2011b; Vägverket, 2002)

The purpose of the feasibility study is to define and assess alternatives for localisation of a road corridor and its technical standard (i.e. plain road, bridge or tunnel). Feasibility study is the first stage in the planning process that demands EIA, which assesses the environmental implications of the various road corridor alternatives and zero-alternative. The EIA should contribute to the development of the most environmentally friendly alternative for road location and technical design. It should also identify impacts that are highly related to the site selection (Trafikverket, 2011b). The formal requirements for EIA of road projects are established under two systems: the Road Act (Väglagen) and the Environmental Code (Miljöbalken). Similar EIA requirements apply for the planning of roads as for environmentally hazardous activities (Trafikverket, 2011b). The Swedish Road Administration regulations on EIA (VVFS 2007:223) describe additional requirements for the contents of an EIA for various planning stages and projects that have either significant or insignificant environmental effects. If the project is assumed to have significant environmental effects, clear requirements on the content of EIA and public participation are specified (Trafikverket, 2011b).

The Swedish EIA process follows a number of steps that are described in the EU Directive (Figure 1). As described in Trafikverket (2011b), the main legal requirements for EIA in both feasibility study and design plan include: public participation and consultation, preparation of the EIA document (EIS), approval of the EIS by the County Administrative Board (Länsstyrelse), and the announcement and public display (in case of significant environmental impact). It was observed that even though screening is a mandatory step in EIA process under EU Directive, it is not always performed for EIAs of road infrastructure projects in Sweden. As a result, EIA is carried out for different types of projects with either significant or insignificant environmental impacts. However, it will be changed in 2013, when a screening stage will be introduced into the planning process as described later in this section.
The road location within the chosen road corridor and design are defined in detail in the design plan. There is also a requirement for EIA at this stage. Environmental issues identified in EIA should be considered during decisions on detailed localisation, design and technical solutions of the road. Besides, EIA should consider the project's environmental impact, the need for ecological and environmental measures during the construction and operation stage and the need for environmental monitoring. The design plan is legally binding, meaning that only minor deviations could be made during implementation.

After publication of the design plan the construction documents are established, containing a detailed construction and technical design, and the actual realisation of the road could start. A follow-up, comprising monitoring and evaluation takes place during and after the construction phase (Trafikverket, 2011b). Even though according to EIA Directive post-decision monitoring should be included as one of the steps of the EIA process, it is poorly performed in practice for infrastructure projects in Sweden. As discussed in Lundberg (2009) there is “a variety of little coordinated monitoring activities, poor utilization of the monitoring results, as well as limited internal feedback on monitoring results”.

New planning process in Sweden
The infrastructure planning process in Sweden is going to change from January 2013 onwards. Some of the main changes, as presented by Faith-Ell (2012, pers.comm.) at the LICCER workshop, are expected to be as following (Figure 3):

• Introduction of a screening stage to decide whether an EIA should be carried out for the project, meaning that EIA will be carried out only for projects with significant environmental impacts and projects without significant environmental impact will have a more simple assessment process.
• Exclusion of the initial study (the four-stage principle that concludes whether the road project is needed will be performed at the strategic planning level).
• The feasibility study and design plan will be integrated in a combined planning process (meaning that only one type of EIA will be performed).
4.2 Results from comparison categories

4.2.1 Comparison of road infrastructure planning processes

Decisions and the use of Environmental Assessments in the planning process

The following decisions taken during the road infrastructure planning processes in the Netherlands and Sweden are compared (Figure 4): mode of transport, localisation of the road, construction type (i.e. plain road, bridge and tunnel) and construction design.

The national transport and mobility policies for a certain time period, including decisions on investments in different transport modalities, are outlined in the strategic planning stage in both Sweden and the Netherlands. In both countries an SEA is performed to assess the environmental implications of the strategic policy documents (Figure 4).
The objective of the road project is formulated and the main choice for the project-specific mode of transport is taken in the initiation stage in the Netherlands and the initial study in Sweden. Existing environmental information about a broad range of solution opportunities is collected at the end of the initial study in Sweden, whereas this is done in the beginning of the explorative study in the Netherlands (Figure 4). The collection and assessment of this environmental information lead to a choice in route alternatives at the end of the initial study in Sweden (Figure 5) and after filter 1 of the explorative study in the Netherlands (Figure 6).

**Figure 4:** Comparison of planning process and moment of decisions in the Netherlands and Sweden (current and future system). *The heights of the rows do not relate to the time spent in each stage.*
The different route alternatives are further defined and assessed in the feasibility study in Sweden and the next stage of the explorative study in the Netherlands. An EIA is carried out in the feasibility study in Sweden and an SEA in the explorative study in the Netherlands to assess the environmental implications of the different route alternatives and to compare with the zero-alternative (Figure 5 and Figure 6). From the interviews it did not become clear why an SEA is carried out in the Netherlands and an EIA in Sweden. Dutch interviewees indicated that an SEA during the explorative study is only required in case of large and complex road projects, while in Sweden an EIA in the feasibility study is always required according to the Road Act (Vägverket, 2008). At the end of the feasibility study in Sweden and the explorative study in the Netherlands a choice is made for one route alternative and certain construction type (i.e. plain road, tunnel and bridge).

The construction type is further defined in the design plan in Sweden and the project study in the Netherlands. Different variations of the route alternative and the zero-alternative are assessed in detail.
in an EIA in both Sweden and the Netherlands (Figure 5 and Figure 6). The difference between the design plan in Sweden and the project study in the Netherlands is the level of detail in which the construction design is assessed. Technical guidelines on the construction design including material choice are issued in the Netherlands, while in Sweden a more detailed design plan is issued. At the end of the design plan stage in Sweden and the project study in the Netherlands a legally binding final decision is taken, including the location/route and construction type, and in Sweden also the construction design (Figure 4). This means that in both countries only minor deviations may be made during construction of the road.

Decisions on the detailed design of the road are already partly made in the design plan and further worked out in the construction documents in Sweden and in the procurement stage of the realisation in the Netherlands. A follow-up, including EIA related monitoring during and after the construction of the road, is legally required in both Sweden and the Netherlands. However, as indicated earlier, the follow-up is not always well performed in practice in Sweden.

Based on the current knowledge about the new transport planning system, which will be introduced in the beginning of 2013 in Sweden, several similarities and differences with the Netherlands are likely to occur. The introduction of the screening stage in Sweden and the performance of Environmental Assessments only for projects with significant environmental impacts will be one of the main similarities. A main difference is likely to be that decisions on localisation/route and construction design will be included in an EIA for the combined planning process in Sweden, while they are included in a separate SEA for localisation alternatives and EIA for design alternatives in the Netherlands.

**Focus and number of road SEAs and EIAs**

All Dutch interviewees indicated that almost all national road projects in the Netherlands concerns the realignment, widening and/or a more intensive use of existing roads. Only a few new roads were built in the last decennia. On provincial and municipal level in the Netherlands, most of the road projects concerns the construction of new ring roads to diverse traffic through the municipality. According to the Swedish interviewees, the type of road projects in Sweden is more diverse; road projects concern the construction of new roads, on average 5,000 km every year (Miliutenko, 2012), as well as the realignment and widening of already existing roads.

The number of Environmental Assessments for road projects carried out per year is higher in Sweden than in the Netherlands. The number of EIAs in the design plan for national road projects is on average 60 per year in Sweden. Further, it can be estimated that about 5 EIAs in the feasibility study for state road projects are performed in Sweden each year. While in the Netherlands, around 1 or 2
SEAs including a road alternative are performed per year and on average 20 EIAs of road projects are reviewed by the NCEA every year (in the period 2007-2011). However, the number of EIAs for road projects is higher since the EIAs of projects falling under the Priority Road Works system (Spoedaanpak) are exempted from review by the NCEA. Road projects under the Priority Roads Works require a less extensive EIA procedure to speed up the decision making process. In total there are 30 road projects falling under the Priority Road Works (Rijkswaterstaat, 2012).

### 4.2.2 Content of SEA and EIA

**Considered impacts**

The interviewees indicated to what extent the impacts in Table 5 are included in SEA and EIA. The primary goal of the question was to assess to what extent energy use, resource use and climate change are considered and the difference between the Netherlands and Sweden. Energy use and resource use are sometimes included in EIAs in Sweden, and never included in EIAs in the Netherlands (Table 5). However, it was stated by two interviewees that energy use is sometimes considered in SEAs in the explorative study in a qualitative manner in the Netherlands.

Dutch interviewees indicate that climate change is sometimes included in SEA and EIA in the Netherlands, for example in the SEA of Rotterdam Vooruit (Ministry of Infrastructure and Environment, 2012b) and the SEA of Haaglanden (Ministry of Infrastructure and Environment, 2012c). However, if included, the focus is on adaptation measures to climate change, such as a road which can act as a dike in the same time to protect the land against flooding, rather than the reduction of carbon dioxide (CO₂) emissions (i.e. climate change mitigation measures). Swedish interviewees indicate that climate change is sometimes considered in EIAs. For example adaptation and mitigation measures are considered in the EIA in the design plan of Stockholm Bypass.

We also asked the interviewees to indicate whether other impacts are included in the SEA and EIA, in order to assess further similarities and differences regarding impacts in Environmental Assessments between the Netherlands and Sweden. Impacts always considered in SEA/EIA in both the Netherlands and EIA in Sweden are air quality (nitrogen oxides and particulate matter), nature, landscape and noise (Table 5). Besides, water and cultural heritage are always included in Sweden. In addition to the impacts listed in Table 5, external safety, traffic intensity, traffic safety and archaeology are always mentioned by the interviewees in the Netherlands and risk analysis is mentioned by the interviewees in Sweden.
### Table 5: Included impacts in EAs in Sweden and the Netherlands

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Sweden</th>
<th>Netherlands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of other resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate change (CO₂-eq.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodiversity</td>
<td></td>
<td></td>
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<tr>
<td>Soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landscape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cultural heritage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Odour nuisance</td>
<td></td>
<td></td>
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<tr>
<td>Light pollution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acidification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eutrophication</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean of respondents indicating the inclusion of the impact, on a scale from 0 to 3:
- 0.00 – 0.25 (*never included*)
- 0.25 – 2.50 (*sometimes included*)
- 2.50 – 3.00 (*always or almost always included*)

Another difference is the inclusion of acidification and eutrophication in almost all SEAs and EIAs in the Netherlands, while these impacts are only sometimes included in EIAs in Sweden. According to several of the Dutch interviewees, acidification and eutrophication are important impacts to consider in EIAs of both roads and intensive farming systems in the Netherlands, in particular in relation to Natura 2000 areas and other protected nature areas, due to the existing high background values. Therefore, acidification and eutrophication are almost always included under nature.

**Methods and tools used**

Different methods and tools are used to provide the environmental data of the alternatives assessed in SEA and EIA. Most of the impacts are calculated with standardised calculation models and tools. Impacts in both the EIAs for the feasibility study and the design plan in Sweden are based on model calculations. While in the Netherlands, sometimes rules of thumbs are used in SEAs, and all impact data presented in EIA in projects studies are based on model calculations, as stated by a Dutch interviewee.
Interviewees indicated that in both Sweden and the Netherlands professional standards exist for most environmental impacts; in both countries for noise, air quality, nature and biodiversity, landscape, risk analysis and water models. In addition, in the Netherlands also standard deposition models for acidification and eutrophication are used. Professional standards for archaeology exist in Sweden but not in the Netherlands and unlike in the Netherlands, there is no standardised model for health impact in Sweden. Some of the models are integrated, for example the output of the traffic intensity model (*Nieuw Regionaal model*) in the Netherlands is an input to calculate noise, air quality and other impacts.

In addition to the computer models, the interviewees from Sweden confirmed that interviews, literature surveys and expert estimates are an important part of EIA process. Checklists, scorecards, matrices and overlay maps are used primarily for the EIA report (i.e. Environmental Impact Statement) in both Sweden and the Netherlands.

The interviewees stated that a Cost Benefit Analysis (CBA) is made in the feasibility study in Sweden and the explorative study in the Netherlands. In both countries the CBA is published in parallel with the EIS. A computer programme that is known by its Swedish acronym EVA is used for CBA of road infrastructure projects in Sweden (Fridtjof, 2007). This programme includes a model for calculation of CO₂ emissions caused by future traffic on the road.

### 4.2.3 Life cycle perspective throughout road infrastructure planning process

In the Netherlands, no life cycle perspective is used to calculate energy use and greenhouse gas (GHG) emissions in the explorative study and project study as stated by Dutch interviewees. According to Swedish interviewees, a life cycle perspective in EIAs in Sweden is not commonly used, except in the EIA for the design plan of Stockholm Bypass. LCA is used in this EIA to calculate the energy use and CO₂ emissions during the construction, maintenance and operation stages of the road infrastructure, which mainly consists of tunnels (Stripple, 2009). The life cycle inventory data was extracted from an LCA study on roads performed by Stripple (2001). A separate chapter in the EIS of Stockholm Bypass of the design plan presented the results of the LCA study (Trafikverket, 2011a). Many of the Swedish interviewees indicated that the EIA for the design plan of Stockholm Bypass has set the example for inclusion of life cycle energy use and carbon dioxide.

A life cycle perspective on energy use and GHG emissions is more often used in later stages of the planning process, as indicated by interviewees in both Sweden and the Netherlands. In the procurement stage of the Dutch planning process contractors are required to use the LCA model DuboCalc since April 2012. DuboCalc is developed by Rijkswatersaat and calculates the
environmental impacts of different construction designs including the construction, operation, maintenance and end-of-life stages of the road (Rijkswaterstaat, 2010b). The main aim of DuboCalc is to stimulate contractors, and Rijkswaterstaat, to design more sustainable constructions. The LCA results are presented in one indicator reflecting the environmental costs. LCA models, for example Anavitor and LCcalc (Erlandsson, 2012, pers.comm.), for roads are also developed in Sweden, however they are not mandatory to use by contractors.

Besides the use of Life Cycle Assessment in some stages of the transport planning process, the tool Life Cycle Costing (LCC) is used in the road infrastructure planning process in the Netherlands and Sweden. According to a Dutch interviewee, an LCC is made at the end of every planning in the Netherlands, with an increased level of detail for every stage. LCC includes the net present value of future benefits and costs of the operation and maintenance of the road in the coming 100 year. In Sweden, several LCC models are developed as a part of cost calculation that is included in the planning process. Some of the most used LCC models are as following: MNV, “Olofsson”, 2Ö, and EVA (Holmvik and Wallin, 2007). However, as in the case of LCA, there is no clear established process for their implementation. The Swedish Transport Administration aims at improving the use of LCC during the planning process (Trafikverket, 2012).
5 Discussion

This chapter discusses the results in relation to the specific objectives set in the introduction (Section 1.2). Subsequently, the methodological choices, related limitations and the influence on the results are discussed.

5.1 Discussion of results

5.1.1 Stages of road infrastructure planning process

The order in which the main decisions are made during the road infrastructure planning processes is similar in the Netherlands and Sweden. However, different names are used for the planning stages and the stages are not one to one comparable to each other as shown in Figure 4. Three main levels of decisions can be distinguished during the transport planning process in the Netherlands and Sweden:

1) Choice of transport modality at the national level: SEA in the Netherlands and Sweden is performed in order to assess alternative modes of transport (i.e. railway, road, sea, public transport etcetera).

2) Choice of localisation and construction type of a specific project: SEA in the explorative study in the Netherlands and EIA in the feasibility study in Sweden are performed in order to assess alternative road corridors including choice of alternative road elements (i.e. tunnel, bridge, plain road etcetera). An SEA is only required for large road projects in the Netherlands.

3) Choice of specific design: EIA for project study in the Netherlands and EIA for design plan in Sweden are performed in order to assess design alternatives. However, as far as the Netherlands is concerned, main decisions within this level are taken after EIA is performed – during the realisation stage. Choice of detail design is also further elaborated outside of EIA – in construction documents in Sweden. It was observed that most of the LCA models are developed for this latest stage.

Stripple and Erlandsson (2004) made a similar subdivision into three levels of assessment: 1) network level (i.e. yearly transportation consumed per capita), 2) corridor level (i.e. per person and km) and 3) project level (i.e. per km of road).

As far as the new infrastructure planning system in Sweden is concerned, the division into three levels of decisions is likely to prevail. The only change that is likely to happen will be that the second level of decision (choice of localisation and construction type) and the third level (choice of specific design) will be assessed during one EIA process.
5.1.2 Use and content of Environmental Assessment

Although different names are used for the Environmental Assessment in which different route alternatives are assessed (i.e. EIA in the feasibility study in Sweden and SEA in the explorative study in the Netherlands), the EAs have the same goal. The main goal of the EIA/SEA for route alternatives in both the Netherlands and Sweden is to provide objective environmental information about the different road corridor alternatives in order to ensure that all relevant environmental issues are considered in the decision making process (Projectdirectie Sneller & Beter, 2010; Trafikverket, 2011b). In the Netherlands, an SEA in the explorative study is only undertaken for large complex projects, while in Sweden an EIA in the feasibility study is always required. The reason for the difference in the use of SEA and EIA to assess route alternatives is not clarified in this study. We recommend to do further research to clarify the difference.

The results present a higher number of Environmental Assessments carried out in Sweden compared to the Netherlands. Possible causes for this are a lower threshold for which an EIA is required in Sweden, the absence of a screening stage in Sweden, and more new road constructions in Sweden. However, the specific reason for the difference in number of SEA/EIA is not assessed in this study since it is out of the scope.

It could be derived from the interviews that life cycle energy use and climate change are not (often) included in SEA/EIA in the Netherlands and Sweden. However, it was observed that there is no clear definition of the impact category “climate change”. Climate change can mean both mitigation measures (i.e. strategies for reduction of GHG emissions, such as asphalt with lower rolling resistance to decrease fuel use) and adaptation measures (i.e. strategies for adjustment of road infrastructure to consequences of climate change, such as protection of the road against flooding). Even though both of those aspects should be considered, it happens often that only one of them, mostly adaptation measures, is included in the impact category of climate change.

Besides, we noticed a difference in the interpretation and calculation of mitigation measures between stakeholders in the LCA field and in the SEA/EIA field. Whereas stakeholders in the LCA field consider the effects of mitigation measures in a quantitative manner in full life cycle perspective (i.e. all GHG emissions of future vehicle use and the GHG emissions during construction, operation, maintenance and demolition of the road should be quantified), SEA/EIA stakeholders think of mitigation measures in a more qualitative manner or consider the direct CO₂ emissions of future traffic only. The latter is illustrated in the EIA in the feasibility study of Stockholm Bypass in Sweden, and the SEAs in the explorative study of Rotterdam Vooruit and the SEA of Haaglanden in the Netherlands. In these EIA/SEAs, the impact category climate change was considered, however only
estimations on direct emissions of CO₂ by future traffic on the road were quantified, and no mitigation measures were identified.

5.1.3 Use of a life cycle perspective throughout infrastructure planning process

From the interviews it became apparent that no life cycle perspective on energy use and GHG emissions is used in the earlier stages of the planning process. The above mentioned EIA in the feasibility study of Stockholm Bypass and SEAs of Rotterdam Vooruit and Haaglanden illustrate this. Energy use and GHG emissions in a life cycle perspective are only considered late in the planning stage, during the stage in which a (detailed) construction design is developed. The interviewees and participants of the LICCER workshop indicated a need for the inclusion of life cycle energy use and GHG emissions in all stages of the planning process (i.e. from the strategic planning stage onwards till the actual construction of the road and follow-up), with an increasing level of detail throughout the planning process.

It was suggested during the LICCER workshop to include a simplified LCA, for example only focusing on energy and global warming potential, on the checklist for scoping in the early stage of the planning process, and to decide if it is important to carry out a more extensive LCA during the planning of the road infrastructure. The interviewees and workshop participants expressed a doubt if LCA should be included in the EIA process or whether it should be performed separately during the planning process. It should also be kept in mind that there is a difference between the process of EIA and the EIA document (EIS). Thus even if LCA is performed separately, the results can still be included in the EIS. The respondents indicated the following ways of including an LCA-model in the early stages of the road infrastructure planning process:

- The model could be used as a standardised model in the SEA and/or EIA, such as already existing standard models for air quality, noise, water in Sweden and the Netherlands.
- The LCA could be performed separately from the EIA process but the LCA results could be published in the EIS.
- The LCA could be performed separately from the EIA process and the LCA results could be published in parallel with the EIS, for example in Sweden in the Collected Assessment (Samlad Konsekvensbeskrivning), in which other consequences assessed during feasibility study (for instance, economic consequences, traffic safety and others) are integrated (Trafikverket, 2011b).
- Life cycle energy use and GHG emissions could be included in the CBA, as is done in the EFFEKT model developed by the Norwegian Public Road Administration (Sandvik and Hammervold, -). The EFFEKT methodology is based on LCA and incorporates the indirect GHG emissions during the construction and maintenance stages throughout the whole life
cycle of the road infrastructure with the direct emission from traffic, in the CBA. The model includes data to calculate the GHG emissions from plain roads, steel and concrete bridges, ferries and tunnels.

Respondents also expressed their willing to have a simple and transparent LCA model to be developed within the LICCER project, in order to be able to easily explain the reasoning behind calculations. In addition, the model should be easy to change when one assumption turns out to be wrong. Moreover, interviewees expressed the need for a good way of communication of energy and GHG emissions. For example the results from the LCA model should not be presented in a quantitative way only, for example as ton of CO$_2$ or MJ, but could be related to for example the total Swedish or Dutch energy use and GHG emissions per year to set the results in a broader context.

5.2 Discussion of methodology

The comparison in this study focused on the Netherlands and Sweden only. The study is part of the LICCER project in which four countries take part: Sweden, the Netherlands, Denmark and Norway. We assumed the road infrastructure in Sweden and Norway and in the Netherlands and Denmark are comparable, mainly because the dense road network and focus on extension of existing roads in both the Netherlands and Denmark and the less dense network and a higher amount of construction of new roads in Sweden and Norway.

Data validity in this study is secured by collecting data through literature review and interviews, and through the verification of the results with published EIS and the LICCER workshop in which participants were able to comment on the preliminary results. However, some comments on data collection could be made. The identification of the stages of the planning process and the main decision taken in each stage was based on literature review for both Sweden and the Netherlands. Besides, Dutch interviewees were asked to indicate where in the planning process which decision is taken, the results from the interviews confirmed the results from literature review. The different terminology used for the stages of the planning processes complicated the comparison of the planning processes in the Netherlands and Sweden. However, participants of the LICCER workshop, including representatives of the Swedish and Dutch National Road Administrations, confirmed the comparison.

We chose literature review and snowball sampling to select stakeholders for interviews in order to find experts in the studied field. A disadvantage of snowball sampling is that we do not know if we excluded other relevant stakeholders. However, we judge the group of interviewees as representative since it covers the different stakeholder groups. We consider the amount of interviews performed as appropriate for the purpose of this interview study (i.e. information gathering). However, we are aware
that a margin of error is included in the results presented in Table 5 in Section 4.2.2 on the inclusion of impacts in EAs, due to the limited number of respondents. In addition, we observed possible misunderstanding of the impacts listed in the question on the included impacts in EIA (see question 6 in Appendix 2 and question 5 in Appendix 3). The impacts were not defined precisely enough to be interpreted in only one way, as described for climate change in Section 5.1.3. However, the ambiguity of the listed impacts does not alter the results for the inclusion of energy use, resource use and climate change, as presented in Table 5, since we used triangulation of data methods. The other impacts are not verified since they fall out of the scope of the study. However, we consider the presentation of these results as valuable in order to create a context of EAs in Sweden and the Netherlands.

The Dutch questionnaire consisted of one extra question compared to the Swedish questionnaire, as mentioned in section 3.2. This was done to provide a basic overview of the Dutch planning process in addition to the overview obtained by literature review. We considered the question on decisions in the planning process as unnecessary to include in the Swedish questionnaire as we already had a well-illustrated handbook about the Swedish planning process. This led, however, to a less detailed overview of the Swedish planning system since the Dutch interviewees were elaborating on the Dutch planning system beyond what could be found in literature.

To summarise, despite some methodological limitations, we consider the comparison made in this study as relevant and valuable, as triangulation was used for validation of data. Moreover, no major differences between the responses of the interviewees were observed. This study is a valuable input to the LICCER project, since the outcomes of this study contribute to better understanding of current road infrastructure planning processes in the Netherlands and Sweden.
Conclusion

The main aim of this study was to compare and benchmark the road infrastructure planning processes and the use of Environmental Assessments (i.e. SEA and EIA) in the planning process in the Netherlands and Sweden. The main conclusions are:

- In both the Netherlands and Sweden three levels of decision making regarding road infrastructure are identified: 1) choice of transport modality at the national level; 2) choice of localisation and construction type of a specific project; 3) choice of specific design.

- Different route alternatives and construction types, are assessed in the feasibility study with EIA in Sweden and the explorative study with SEA in the Netherlands (SEA is only required for large road projects). Different design variations within one route alternative are assessed in an EIA for the project study in the Netherlands and EIA for the design plan in Sweden.

- There is no clear definition of the impact category climate change as it includes both adaptation and mitigation measures. For this latter concept, there is a difference in definition between stakeholders from the SEA/EIA field and the LCA field.

- No formalised way of using a life cycle perspective regarding energy use and GHG emissions exists in the earlier stages of the road infrastructure planning process. Later in the planning process a life cycle perspective might be used, in particular in assessing the environmental impacts of (detailed) construction designs. In this stage different LCA models are used, such as DuboCalc, Anavitor and LCcalc.

- Life cycle energy use and GHG emissions can be included in the early stages of the planning process in different ways: (1) as an output of a standardised LCA model within the SEA/EIA; (2) separately from the SEA/EIA, the results could be published in the SEA/EIA report or published in parallel with the report; or (3) included in a Cost Benefit Analysis.
References


## Appendix 1: List of interviewees

Table 6: Interviewees in the Netherlands

<table>
<thead>
<tr>
<th>Name</th>
<th>Function</th>
<th>Organisation</th>
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<tbody>
<tr>
<td><strong>Authority</strong></td>
<td></td>
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</tbody>
</table>
| Jos Arts           | Strategic Advisor Infrastructure and Environment                        | Centre for Transport and Navigation, Rijkswaterstaat, Ministry of Infrastructure and Environment  
                      | Professor Environmental and Infrastructure Planning  | Faculty of Spatial Sciences, University of Groningen                                                                                      |
| Bart Stolte        | Advisor Programmabureau Verkenningen en Planstudies                      | Centre for Transport and Navigation, Rijkswaterstaat, Ministry of Infrastructure and Environment                                           |
| Jeroen Weertman    | Senior Advisor Tracé/MER                                                 | Centre for Transport and Navigation, Rijkswaterstaat, Ministry of Infrastructure and Environment                                           |
| Evert Schut        | Senior Advisor in Raw Materials and Building Materials  
                      | Network Manager Sustainable Concrete                                       | Centre for Water Management, Rijkswaterstaat, Ministry of Infrastructure and Environment  
                      |                                                                                     | CSR Netherlands (*MVO Nederland*)                                                     |
| **Research**       |                                                                          |                                                                                                                                            |
| Arnold Tukker      | Program Manager Sustainable Innovation  
                      | Extraordinary Professor Sustainable Innovation                             | TNO  
<pre><code>                  |                                                                                     | Department of Product Design, NTNU                                                   |
</code></pre>
<p>| <strong>Independent advisor and reviewer</strong> |                                                                          |                                                                                                                                            |
| Roel Meeuwsen      | Technical Secretary                                                      | Netherlands Commission Environmental Assessments (<em>Commissie m.e.r.</em>)                                                                        |
| <strong>Consultancy</strong>    |                                                                          |                                                                                                                                            |
| Henk Otten         | Senior Consultant                                                        | Consultancy and Engineering firm Oranjewoud, member of Antea Group                                                                          |
| Jan van Belle       | Senior Consultant                                                        | Consultancy and Engineering firm Oranjewoud, member of Antea Group                                                                          |
| Paul Eijssen        | Strategic Advisor Environmental Assessment                                | Consultancy and Engineering firm DHV                                                                                                       |</p>
<table>
<thead>
<tr>
<th>Name</th>
<th>Function/Department</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irene Lingestål</td>
<td><em>Environmental specialist in the Department on Investment, Technology and Environment</em></td>
<td>Swedish Transport Administration</td>
</tr>
<tr>
<td>Ebbe Adolfsson</td>
<td><em>Unit for policy instruments on climate and air</em></td>
<td>Swedish Environmental Protection Agency</td>
</tr>
<tr>
<td>Susann Sass-Jonsson</td>
<td><em>Transport infrastructure, detail local plans</em></td>
<td>County Administrative Board in Stockholm</td>
</tr>
<tr>
<td>Yvonne Andersson-Sköld</td>
<td><em>Department of Land Use Planning and Climate Adaptation</em></td>
<td>Swedish Geotechnical Institute</td>
</tr>
<tr>
<td>Mari Kågström</td>
<td><em>Environmental Researcher, PhD Candidate</em></td>
<td>SLU/Swedish EIA Centre and Tyrens</td>
</tr>
<tr>
<td>Charlotte Faith-Ell</td>
<td><em>Technical Director of EIA and SEA and Researcher</em></td>
<td>WSP and KTH</td>
</tr>
<tr>
<td>Ulf Wiklund</td>
<td><em>Business Development, Marketing and Development Manager, Environment</em></td>
<td>Tyrens</td>
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</table>
Appendix 2: Questionnaire the Netherlands

Questionnaire

Introduction to the project

Transport planning often includes large long-term projects with possibly high impacts on the environment and society. Therefore, it is required to perform an Environmental Impact Assessment (EIA) in the early stages of transport planning. Current practices show however, that there is a lack of life cycle considerations of energy use in the EIA process of road infrastructure. A joint research programme is established under ERA-NET ROAD. The overall aim of this project, called LICCER, is to develop a model for Life Cycle Assessment (LCA) of energy use in road infrastructure which can be used within the EIA process in the early stage of transport planning (see Figure 1). By early stage of transport planning, we mean the stage in which decisions on where the new road infrastructure should be localized takes place.

Figure 1: Schematic structure of the LICCER project

The model includes a framework and guidelines on the application within the EIA process, and is intended to be used in different countries. Therefore, at the start of the project, the important requirements of EIA processes and how energy issues are incorporated in different countries will be identified.

The main objective of the first part of the research is to compare and benchmark the incorporation of energy use and life cycle perspective in EIA in the Netherlands, Sweden, Norway and Denmark. This part of the project is carried out by the Division of Environmental Strategic Research at the Royal Institute for Technology in Stockholm.

Interview

By conducting interviews with stakeholders and experts in the field of EIA and/or LCA, it is aimed to identify important requirements of EIA and similarities and differences between the EIA processes in the different countries. The results from the interviews are complemented with literature review and analysis of performed EIAs in the different countries.

Note that the interview covers Environmental Impact Assessment ('Miljökonsekvensbeskrivning (MKB)' in Swedish and 'milieueffectrapportage' in Dutch) of road infrastructure projects only, unless stated otherwise.

A summary will be sent to you after the interview. Moreover, your permission will be asked before publishing any type information provided by you. If you want, you have the right to remain anonymous.

You may answer only the questions relevant to your field.
Questions about the interviewee

1. *Please indicate to which stakeholder group(s) you belong:*

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<thead>
<tr>
<th>Stakeholder group</th>
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<td>Competent authority</td>
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<td>Property owner</td>
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<td>Research &amp; Development</td>
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<td>Reviewer</td>
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<td>Consultancy</td>
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<tr>
<td>Contractor</td>
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<tr>
<td>Other, namely __________</td>
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</table>

2. *How much experience do you have regarding road infrastructure EIAs on a scale from 1 to 5, in which 1 is lowest and 5 highest?*  
   1  2  3  4  5

General questions regarding the process of infrastructure EIAs

3. a. *Where in the planning process are the following questions answered according to your experience? Please indicate this with the number of the question in Figure 2.*

   1) **Should the** new road or other type of infrastructure be built?
   2) **Where** should the road be built? (location/route)
   3) **What** type of construction (i.e. road, bridge, tunnel) should be built?
   4) **How** should the construction be designed (i.e. choice of material, stabilisation ways, etc.)?

![Figure 2: Schematic overview of the transport planning process](image)

b. *Where does EIA take place in the planning process? Please indicate this in Figure 2.*
4. a. How often are EIAs performed for road infrastructure projects in the Netherlands?
   On average ______ each year

   b. Which EIA procedure is mostly followed for road infrastructure projects in the Netherlands?

   □ Limited (‘beperkte’) procedure  □ Extensive (‘uitgebreide’) procedure

5. Among the infrastructure projects for which an EIA is required, what is the most common type of road infrastructure project in the Netherlands?

   □ Construction of motorways and express roads
   □ Construction of new roads of four or more lanes
   □ Realignment and/or widening of existing roads of two lanes or less so as to provide four or more lanes
   □ Other, namely ________________________________

Specific questions regarding road infrastructure EIAs

6. Which impacts are currently taken into account in the EIA of infrastructure projects, according to your experience? If possible, please indicate to what extent (on scale from 0 to 3)

   □ Use of energy
   □ Use of other resources
   □ Air quality
   □ Human health
   □ Nature
   □ Biodiversity
   □ Soil
   □ Water
   □ Landscape
   □ Cultural heritage
   □ Noise
   □ Dust
   □ Odour nuisance
   □ Light pollution
   □ Climate change (CO₂-equ. emissions)
   □ Acidification
   □ Eutrophication
   □ Emission of toxic substances
   □ Other, namely __________________

7. a. If energy use is included, in which stages and for which activities is this taken into account according to your experience? If possible, please indicate to what extent (on scale from 0 to 3)

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<thead>
<tr>
<th>Activity</th>
<th>Stage</th>
<th>Construction</th>
<th>Operation (f.e. lightning, cleaning, salting)</th>
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<td>Waste management</td>
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   b. Do you consider the above inclusion of energy use in the various stages as sufficient? If not, what should be included in future EIAs?
8. Do you have experience with mitigation measures regarding energy use and climate change included in EIA? If yes, could you give examples of those mitigation measures?

9. a. Which methods and tools are currently applied to provide data on the effects of alternatives, according to your experience?

- Checklists
- Scorecards
- Matrices
- Networks
- Overlay maps
- Life Cycle Assessment
- Cost Benefit Analysis
- Other, namely ___________________________

b. What computer models are used to provide data with the above mentioned methods/tools?

Open questions

10. Regarding EIA in the Netherlands what do you consider as the most important goal of EIA:

11. Is there any typical feature of EIA process in the Netherlands? If yes, which one(s):

12. Could you recommend us to contact other persons regarding this subject?

13. Do you have any further comments?
Thank you for your time and expertise. If you have any questions or comments do not hesitate to contact us.

Best regards,

Ingeborg Kluts  
*MSc student*  
Tel: +46 8 790 8676  
Email: kluts@abe.kth.se

Sofiia Miliutenko  
*PhD student*  
Tel: +46 8 790 7395  
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KTH Royal Institute of Technology  
Division of Environmental Strategies Research – fms  
SE 100 44 Stockholm, Sweden
Appendix 3: Questionnaire Sweden

Questionnaire

Introduction to the project

Transport planning often includes large long-term projects with possibly high impacts on the environment and society. Therefore, it is required to perform an Environmental Impact Assessment (EIA) in the early stages of transport planning. Current practices show however, that there is a lack of life cycle considerations of energy use in the EIA process of road infrastructure. A joint research programme is established under ERA-NET ROAD. The overall aim of this project, called LICCER, is to develop a model for Life Cycle Assessment (LCA) of energy use in road infrastructure which can be used within the EIA process in the early stage of transport planning (see Figure 1). By early stage of transport planning, we mean the stage of “Feasibility study” (i.e. decisions on where the new road infrastructure should be localized).

Figure 3: Schematic structure of the LICCER project

The model includes a framework and guidelines on the application within the EIA process, and is intended to be used in different countries. Therefore, at the start of the project, the important requirements of EIA processes and how energy issues are incorporated in different countries will be identified.

The main objective of the first part of the research is to compare and benchmark the incorporation of energy use and life cycle perspective in EIA in the Netherlands, Sweden, Norway and Denmark. This part of the project is carried out by the Division of Environmental Strategic Research at the Royal Institute for Technology in Stockholm.

Interview

By conducting interviews with stakeholders and experts in the field of EIA and/or LCA, it is aimed to identify important requirements of EIA and similarities and differences between the EIA processes in the different countries. The results from the interviews are complemented with literature review and analysis of performed EIAs in the different countries.

Note that the interview covers Environmental Impact Assessment (‘Miljökonsekvensbeskrivning (MKB)’ in Swedish and ‘besluit -m.e.r.’ in Dutch) of road infrastructure projects only, unless stated otherwise.

A summary will be sent to you after the interview. Moreover, your permission will be asked before publishing any type information provided by you. If you want, you have the right to remain anonymous.
Questions about the interviewee

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2. How much experience do you have regarding road infrastructure EIAs on a scale from 1 to 5, in which 1 is lowest and 5 highest? 1 2 3 4 5

General questions regarding the process of infrastructure EIAs

3. a. How often are EIAs performed for road infrastructure projects in Sweden?
   On average ______ each year

4. Among the infrastructure projects for which an EIA is required, what is the most common type of road infrastructure project in Sweden?

- Construction of motorways and express roads
- Construction of new roads of four or more lanes
- Realignment and/or widening of existing roads of two lanes or less so as to provide four or more lanes
- Other, namely _____________________________________________________________

Specific questions regarding road infrastructure EIAs

5. Which impacts are currently taken into account in the EIA of infrastructure projects, according to your experience? If possible, please indicate to what extent (on scale from 0 to 3)

- Use of energy
- Use of other resources
- Air quality
- Human health
- Nature
- Biodiversity
- Soil
- Water
- Landscape
- Cultural heritage
- Noise
- Dust
- Odour nuisance
- Light pollution
- Climate change (CO₂-equivalent emissions)
- Acidification
- Eutrophication
- Emission of toxic substances
- Other, namely __________________
- Other, namely __________________
- Other, namely __________________
6. a. If energy use is included, in which stages and for which activities is this taken into account according to your experience? If possible, please indicate to what extent (on scale from 0 to 3)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Stage</th>
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<td>Demolition and final disposal</td>
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b. Do you consider the above inclusion of energy use in the various stages as sufficient? If not, what should be included in future EIAs?

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

7. Do you have experience with mitigation measures regarding energy use and climate change included in EIA? If yes, could you give examples of those mitigation measures?

__________________________________________________________________________

__________________________________________________________________________

8. a. Which methods and tools are currently applied to provide data on the effects of alternatives, according to your experience?

- [ ] Checklists
- [ ] Scorecards
- [ ] Matrices
- [ ] Networks
- [ ] Overlay maps
- [ ] Life Cycle Assessment
- [ ] Cost Benefit Analysis
- [ ] Other, namely ____________________________

b. What computer models are used to provide data with the above mentioned methods/tools?

__________________________________________________________________________

__________________________________________________________________________
Open questions

9. Regarding EIA in Sweden, what do you consider as, the most important goal of EIA:
_____________________________________________________________________________
_____________________________________________________________________________

10. Is there any typical feature of EIA process in Sweden? If yes, which one(s):
_____________________________________________________________________________
_____________________________________________________________________________

11. Could you recommend us to contact other persons regarding this subject?
_____________________________________________________________________________
_____________________________________________________________________________

12. Do you have any further comments?
_____________________________________________________________________________
_____________________________________________________________________________

Thank you for your time and expertise. If you have any questions or comments do not hesitate to contact us.

Best regards,

Sofiia Miliutenko                  Ingeborg Kluts
PhD student                       MSc student
Tel: +46 8 790 7395               Tel: +46 70 489 6350
Email: sofia.miliutenko@abe.kth.se Email: kluts@abe.kth.se

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SE 100 44 Stockholm, Sweden