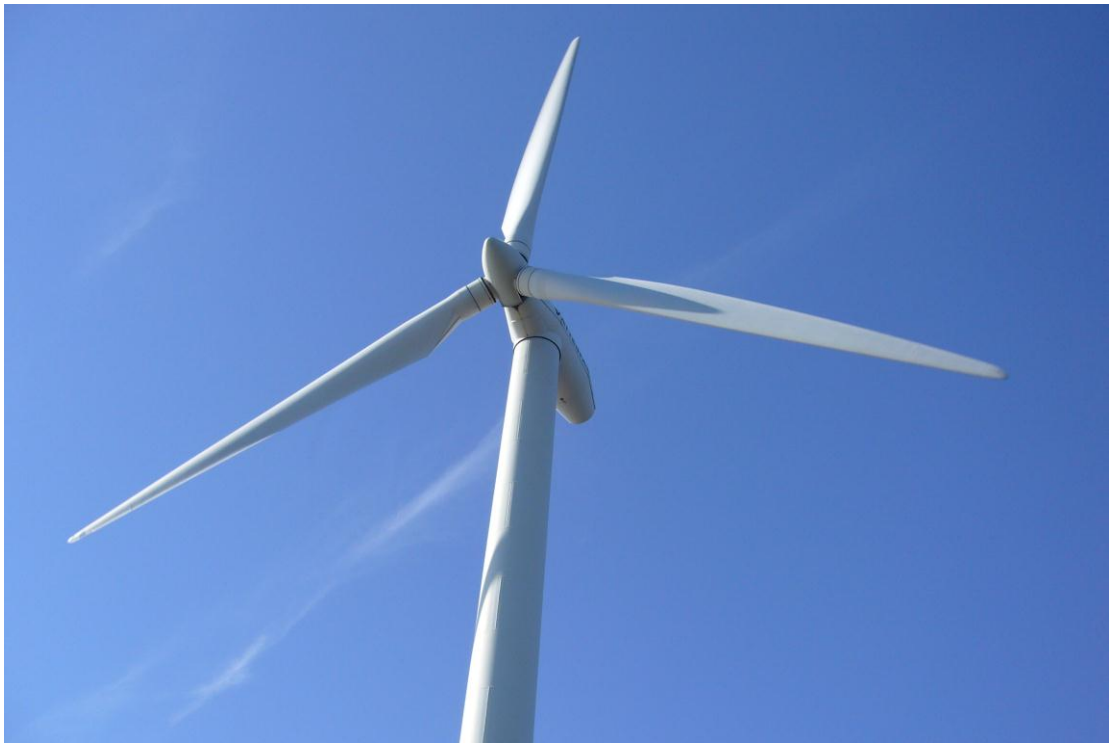

Picture: Päivi Tahvanainen/Image bank of Finland's environmental administration

IMPERIA working paper

Impact Significance Assessment and Evaluation of Alternatives - International Guidelines and Cases

The Finnish Environment Institute
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LIFE 11ENV/FI/905

Yhteenveto suomeksi raportista "Impact Significance Assessment and Evaluation of Alternatives - International Guidelines and Cases"

Raportti on osa EU/LIFE+ IMPERIA hanketta (LIFE 11 ENV/FI/905). Hankkeen tarkoitus on etsiä ja kehittää uusia hyviä YVA- ja SOVA-käytäntöjä. Tämän selvityksen tehtävänä on vertailla kansainvälisten hankerahoittajien hankevaihtoehtojen ja merkittävyyden vertailumenetelmiä YVA- ja SOVA–prosesseissa ja arvioida näiden soveltuvuutta Suomessa. Selvityksen painopiste on liikenneväylä-, energia- ja kaivossektoreissa. Selvityksen aineistoksi etsittiin internetistä YVA-ohjeistoja, yhteenvetoja YVA-menetelmistä sekä YVA- ja SOVA-raportteja.

Kansainväliset rahoituslaitokset kuten Aasian kehityspankki (ADB), Afrikan kehityspankki (AfDB) ja Euroopan jälleenrakennus- ja kehityspankki (EBRD) ovat omaksuneet yleispiirteiltään Maailmanpankin ohjeistaman käytännön YVA- ja SOVA-prosesseissa. Rahoittajat listaavat ohjeistoissaan hanketyypit, joille on tehtävä YVA.

Kaikki tutkitut hankerahoittajat vaativat vertailemaan hankkeen toteuttamisen ja toteuttamatta jättämisen vaikutukset sekä tekemään hankkeen toteutusvaihtoehtojen vertailun osana YVA-prosessia, mikäli vaihtoehtoja on tunnistettu. Useimmat kansainväliset hankerahoittajat vaativat arvioimaan vaikutusten merkittävyyden. Termi vaikutusten merkittävyys (significance) on useimmiten kuitenkin jäänyt ohjeistoissa ilman määritelmää. Lisäksi kansainväliset hankerahoittajat vaativat, että vaikutuksille johdetaan mahdollisuuksien mukaan taloudellinen arvo.

Vain Maailmanpankilta löytyi YVA-ohjeistoista esimerkkejä vaihtoehtojen vertailusta ja vaikutusten merkittävyyden arvioinnista. Esimerkeissä johdetaan kunkin hankkeen toteutusvaihtoehdon vaikutusten merkittävyydelle numeerinen arvo. Suositeltu perusmenetelmä on antaa kullekin vaikutusten kohteelle tärkeyskerroin, joka kerrotaan vaikutuksen suuruuskertoimella, josta saadaan tulona vaikutuksen "merkittävyys". Menetelmästä on erilaisia muunnelmia sisältäen mm. todennäköisyyden kunkin vaikutusten toteutumiselle tai vaikutusten suuruus on pilkottu useammaksi indikaattoriksi kuten vaikutusten kesto, laajuus ja voimakkuus.

Tutkitut Suomen YVA-ohjeistot (tiehankkeissa ja kiviaineshankkeissa) eivät tue samanlaista numeerista lähestymistapaa kuin mitä Maailamanpankki suosittelee. Suomen ohjeistot korostavat avointa arviointiprosessia, jolloin ei johdeta yhtä yksittäistä arvoa pohjaksi vaihtoehtojen vertailulle tai vaikutusten merkittävyydelle. Tällöin eri osapuolien näkemykset ja niiden arvosidonnaisuuksien katsotaan tulevan otetuksi paremmin huomioon.

Scottish Natural Heritage'n (SNH) YVA-ohjeistot tutkitiin myös, koska SNHn tiedetään olevan yksi YVA-menetelmien edelläkävijöistä. Tutkittujen suomalaisten YVA-ohjeistojen ja SNHn ohjeistojen suosittelemat menetelmät vaihtoehtojen vertailulle merkittävyyden perusteella ovat hyvin samanlaiset. SNHn suosittelemassa menetelmässä merkittävyys on selkeästi kohteen

herkkyyden ja vaikutusten suuruuden yhdistelmä. Suomalaisissa ohjeissa merkittävyyden arviointi sisältää enemmän subjektiivista arviointia.

Työssä käytiin läpi julkaisu, jossa esiteltiin laaja kirjo erilaisia vaihtoehtojen vaikutusten vertailumenetelmiä. Eräissä menetelmissä johdettiin yksi numeerinen indikaattori vaihtoehtojen vertailun tueksi. Joissakin menetelmissä oli vaikutusten suuruus jaettu useammaksi erillisiksi indikaattoriksi. Eräässä lähestymistavassa esitettiin lista toimenpiteistä, joista toteutusvaihtoehdot muodostuivat ja jokaisen toimenpiteen vaikutukset arvioitiin erikseen. Leopold Matrix on eräs tällainen menetelmä. Tätä menetelmää suositellaan mm. Environmental Law Alliance'n (ELAW) YVA-ohjeessa kaivossektorin hankkeisiin. Eräissä menetelmissä käytettiin Delphi-tekniikkaa tai "ranked pairwise comparison" –menetelmää arviointiryhmän yhteisen näkemyksen esille saamiseksi.

Kansainvälisten hankerahoittajien käyttämät menetelmät vaihtoehtojen vertailulle ja vaikutusten merkittävyyden arviointiin on pääosin kehitetty jo 1970-luvulla.

Ulkomaisissa YVA-raporteissa on suomalaisesta näkökulmasta paljon puutteita. Esimerkiksi vaihtoehtojen vertailu on usein tehty puutteellisesti tai niin myöhään, että sillä ei ole vaikutusta hankkeen suunnitteluun.

Romanialaisen Vutcani Wind Farm –hankkeen YVA:ssa on mielenkiintoinen vaihtoehtojen merkittävyyden numeerinen vertailu. Siinä lasketaan kaavan avulla vertailuarvo vaikutuksen suuruuden osatekijöiden perusteella kullekin vaikutusten kohteelle ja kullekin vaikutukselle. Tätä vertailuarvoa käytetään vaikutusluokkien valintaan kullekin vaikutuksen kohteelle. Eri vaikutusten kohteisiin kohdistuvien eri asteisten positiivisten ja negatiivisten vaikutusten jakauman perusteella tehdään päätelmiä hankkeen kokonaisvaikutuksesta.

Useat tässä selvityksessä tutkitut vaihtoehtojen ja merkittävyyden arviointimenetelmät ovat sellaisia, että niiden soveltamismahdollisuuksia Suomen YVA-prosesseissa voi harkita ja tutkia.

List of Contents

List of Abbreviations

ADB	Asian Development Bank
AfDB	African Development Bank
BP	Bank Policy
EA	Environmental Assessment
EBRD	European Bank for Reconstruction and Development
EHSIA	Environmental, Human and Social Impact Assessment
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EMP	Environmental Management Plan
EC/LIFE+	The Financial Instrument for the Environment of the EC
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
FAO	Food and Agriculture Organization
IFI	International Financing Institution
IMPERIA	Project "Improving environmental assessment by adopting good practices and tools of multi-criteria decision analysis"
OP	Operational Policy
OVOS	EIA according to the Russian legislation
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
SEA	Social and Environmental Assessment
SESA	Strategic Environmental and Social Assessment
SNH	Scottish Natural Heritage
WB	The World Bank

1. Introduction

1.1. General

This report has been prepared as a part of the project "**Improving environmental assessment by adopting good practices and tools of multi-criteria decision analysis, IMPERIA**", which is called IMPERIA in this report. IMPERIA is a EU/LIFE+ project (LIFE 11 ENV/FI/905) aiming to recognize and develop new tools and practices for Environmental Impact Assessment (EIA) and Strategic Environment Assessment (SEA).

Based on the original plan for the assignment, the purpose of this assignment is to summarize different approaches and methods used and recommended in EIA guidelines and manuals of international financing institutions (IFI) (e.g. WB, EIB, ABRD, AfDB, ADB, UNEP, UNDP) in comparing alternatives and assessing significance of impacts of projects. The study was originally planned to focus in energy, mining and traffic corridor or traffic route projects. In addition the study should assess the usability of the approaches and methods in the Finnish EIA/SEA practices.

The study was made in May - June 2013. The guidelines, manuals and other material were searched and found on Internet. The results of the analysis of this material are presented in this report.

The studied IFI guideline and manual material contains only a limited number of good examples or instructions for comparing impacts of project alternatives and assessing significance of impacts. The examples presented in this report may cover also other sectors than the original above mentioned three sectors, because guidelines and manuals include only a limited number of examples.

The expression "significance of impacts" is use in the studied documents in a limited extent. For this reason the examples presented do not necessarily analyze significance of impacts in the meaning "magnitude of impact * sensitivity of the resources impacted = significance of impact". The end result of the process of comparing impacts may be called with other expressions like "weighted scores", "aggregate total", "grand index".

In general it was noted that the guidelines and manuals of IFIs' are old and many of them from 90s'.

1.2. International Financiers studied

Environmental assessment guidelines and/or manuals of the World Bank (WB), International Financing Corporation (IFC), Asian Development Bank (ADB), African Development Bank (AfDB), the European Bank for Reconstruction and Development (EBRD), the Food and Agriculture Organization of the United Nations (FAO) and Scottish Natural Heritage (SNH) were reviewed and good

examples analyzed and reported for this study. The time did not allow to study closer EIB, UNDP and UNEP documents. EIB follows most likely EBRD/the World Bank procedures. UNDP and UNEP are not expected to have any major investment projects in energy, mining and transportation corridor sectors.

SNH, even if it is not IFI, was taken to the analysis, because it is known to be a frontrunner in EIA methodologies.

Because there are only a limited number of examples in the IFI and SNH documents, some methodologies presented in EIA literature were also included into the analysis.

Many good practice examples can be found in various EIA reports for international projects. Even if review of them was out of scope of this study, some references were included in the text and more references to EIA reports are listed in the Annex I of this report.

2. Environmental Assessments of the World Bank and the other IFIs

This chapter presented the results of the review of the different Environmental Assessment types of the World Bank including EIA and the requirements to include analysis of alternatives in the assessment. The Environmental Assessment, especially EIA system of all the other IFIs is very similar, because they have copied the World Bank system.

The Bank's Environmental Assessment policy and procedures are described in Operational Policy 4.01 (OP 4.01) and Bank Procedures 4.01 (BP 4.01) [1]. Other IFIs commonly refer to these documents in their EA instructions.

Environmental Assessment (EA) is one of the ten Safeguard Policies used in the World Bank. The purpose of the Safeguard Policies are to prevent and mitigate undue harm to people and their environment of the development process. The purpose of the EA is to examine the potential environmental and social risks and benefits associated with investment operations.

1

http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTENVASS/0,,menuPK:407994~pagePK:149018~piPK:149093~theSitePK:407988,00.html

http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTSAFEPOL/0,,contentMDK:20543912~menuPK:1286357~pagePK:64168445~piPK:64168309~theSitePK:584435,00.html

http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTOPMANUAL/0,,contentMDK:20064724~menuPK:64701637~pagePK:64709096~piPK:64709108~theSitePK:502184,00.html

http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTOPMANUAL/0,,contentMDK:20066691~menuPK:64701637~pagePK:64709096~piPK:64709108~theSitePK:502184,00.html

EIA is not the only environmental assessment type of the World Bank. Depending on the project, a range of instruments are used to satisfy the Bank's EA requirement: environmental impact assessment (EIA), regional or sectorial EA, strategic environmental and social assessment (SESA), environmental audit, hazard or risk assessment, environmental management plan (EMP) and environmental and social management framework (ESMF).

The Bank classifies the projects into four categories A, B, C and FI depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts.

A Category A project is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. EA for a Category A project examines the project's potential negative and positive environmental impacts, compares them with those of **feasible alternatives (including the "without project" situation)**, and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. For a Category A project, the borrower is responsible for preparing a report, normally an EIA.

Category B and C projects are likely to have less adverse impacts than those of Category A projects. The scope of EA for a Category B project may vary from project to project, but it is narrower than that of Category A EA. For category C projects no EA is required. A project is classified as Category FI, if it involves investment of Bank funds through a financial intermediary, in subprojects that may result in adverse environmental impacts.

Environmental impact assessment (EIA) can be defined as an instrument to identify and assess the potential environmental impacts of a proposed project, **evaluate alternatives** and design appropriate mitigation, management, and monitoring measures and to ensure that potentially affected people have been properly consulted.

Summary/Conclusions

As a summary it can be concluded that requirements for both EA and EIA state that analysis of alternatives should be carried out.

3. Environmental Impact Assessment Guidelines

3.1 The World Bank and IFC

Details of the process and contents of the EA and EIA of the World Bank are described in Environmental Assessment Sourcebook (and its Updates)[2]. The Sourcebook is designed to assist all those involved in (EA). The Sourcebook provides practical guidance for designing sustainable Bank-assisted projects.

The Sourcebook focuses on those operations with major potential for negative environmental impact, such as new infrastructure, dams, and highways.

Content of an Environmental Assessment Report for a Category A Project is given in Annex B of OP 4.01[3]. The report should focus on the significant environmental issues of the project.

The EA report should include the following items (not necessarily in the order shown):

(a) Executive summary.
(b) Policy, legal, and administrative framework.
(c) Project description.
(d) Baseline data.
(e) Environmental impacts.
(f) **Analysis of alternatives**, the requirements for analysis of alternatives are described in the document in the following way:
"Systematically compares feasible alternatives to the proposed project site, technology, design, and operation--including the "without project" situation--in terms of their potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. **For each of the alternatives, quantifies the environmental impacts to the extent possible, and attaches economic values where feasible. States the basis for selecting the particular project design proposed and justifies recommended emission levels and approaches to pollution prevention and abatement**."
(g) Environmental management plan (EMP).
(h) Appendixes

2

http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTSAFEPOL/0,,contentMDK:20509076~hlPK:1287595~menuPK:1286567~pagePK:64168445~piPK:64168309~theSitePK:584435,00.html

http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTENVASS/0,,contentMDK:20482325~pagePK:210058~piPK:210062~theSitePK:407988,00.html

3

http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTOPMANUAL/0,,contentMDK:20065951~menuPK:64701637~pagePK:64709096~piPK:64709108~theSitePK:502184,00.html

Other Word Bank Group organizations like International Financing Corporation (IFC), which finances private sector projects, uses the World Bank standards in its environmental review processes.

Summary/conclusions

The analysis of alternatives of the World Bank EIA should quantify and attach economic value to the extent possible to the impacts of each of the alternatives. Requirement of analyzing of significance of the impacts is not mentioned in the suggested "Content of the Environmental Assessment Report".

3.2 European Bank for Reconstruction and Development (EBRD)

The need and requirements for conducting EIA (or ESIA or EHSIA) is defined in a document: "Supporting tools, Environmental and Social Impact Assessment (ESIA)"[4] in EBRD Internet home pages.

Environmental Impact Assessment (or an environmental assessment under some other name e.g. ESIAs or OVOS) is generally required for Category A projects of EBRD, involving a new "greenfield" development or a significant expansion or modification of an existing facility, before the proposed development may be authorized. The definition of the project categories of EBRD is in practice the same as the definition of the World Bank and the IFC.

As an example the following project types are listed to require generally EIA (the whole list is long including 28 different project categories:
- Thermal power stations and other combustion installations with a heat output of 300 megawatts1 or more;
- Construction of motorways, express roads and lines for long-distance railway traffic;
- Large-scale peat extraction, quarries and opencast mining, and processing of metal ores or coal;
- Projects implemented in sensitive locations and projects, which may result in significant adverse social impacts to local communities or other project affected parties and projects, which may involve significant involuntary resettlement or economic displacement.

Indicative EIA (ESIA or EHSIA) structure for EBRD Category 'A' Projects is:
- Non-Technical Summary
- Operational Framework
- Project Description
- Description of the Existing Environment
- Potential Impacts

    Identify the potential environmental and social impacts that could be associated with the proposed project and its **feasible alternatives** including those of an indirect and cumulative nature. Through a process

[4] http://www.ebrd.com/environment/e-manual/r16eia.html

of reasoned argumentation, impacts, which are unlikely to arise or be insignificant, should be discounted.
Local impacts
National impacts
Transboundary and Global impacts

- **Analysis of Alternatives**
  A systematic comparison of feasible alternatives to the project in terms of location, project technology or design in terms of potential environmental impact. This should include the 'do-nothing' option.
- Characterisation of Impacts and Issues
  This section should identify and characterize positive and negative environmental impacts in terms of **magnitude, significance, reversibility, extent and duration**.
- Mitigation and Management of Impacts and Issues
- Residual Impacts and Risks
- Environmental and Social Opportunities for Project Enhancement
- Action Plans and Management Systems
- Appendices

By large EBRD uses the same standards in environmental assessments as the World Bank and IFC.

Summary/conclusions

The major projects financed by EBRD in energy, mining and traffic corridor projects (and many other kind of major projects) need an EIA before implementation. Based on the suggested structure of the report the analysis should include formulation of alternatives and their comparison and assessment of significance of impacts. Expression of significance is not defined in the document.

3.3 Asian Development Bank (ADB)

In a document of ADB "Environmental Assessment Guidelines, Asian Development Bank (2003)"[5] it is described the need for an environmental assessment. The document categorizes the projects into three categories; A, B, C and FI. The categories are basically the same as the categories of the World Bank.

Based on the document the Category A projects typically require an EIA, because potentially significant environmental impacts of these projects may lead to changes in land use, as well as changes to the social, physical, and biological environment. However, the project type, scale, and location determine this designation.

At a minimum, an EIA report should have the following contents:

A. Introduction
B Description of the Project
C. Description of the Environment

[5] http://www.adb.org/sites/default/files/pub/2003/Environmental_Assessment_Guidelines.pdf

D. **Alternatives**
E. Anticipated Environmental Impacts and Mitigation Measures
F. Economic Assessment
G. Environmental Management Plan
H. Public Involvement and Disclosure
I. Conclusions

Alternatives should be compared in terms of their potential environmental impacts, capital and recurrent costs, suitability under local conditions, and institutional, training and monitoring requirements. For each alternative, the environmental costs and benefits should be quantified to the extent possible, economic values should be attached where feasible, and the basis for the selected alternative should be stated. One alternative that should receive special attention is the "no go" alternative. In some cases, this may be the only alternative to the project that can be realistically considered.

In EIA it should be estimated the magnitudes of environmental impacts and **assessed the significance of the impacts**. The assessment of the significance should include consideration of whether the impacts are (i) acceptable, (ii) acceptable after mitigation measures are applied, or (iii) are unacceptable – because of significant adverse impacts to people and their livelihoods, or because there will be an irreversible impact on the ecosystem.

The documentation of ADB does not provide any examples of analysis of alternatives or significance.

Summary/conclusions
The ADB requires that in the EIAs alternatives should be analyzed and the analysis includes an assessment of significance. The meaning of significance is left open in the document.

3.4 African Development Bank (AfDB)

African Development Bank (AfDB) has adopted the same EIA methodologies as the other regional development banks and the EIA instructions can be found in the World Bank documents. This issue is referred e.g. in Environmental Assessment Course Module, which states “The World Bank and the regional development banks, such as the African Development Bank have well-established EIA procedures, which apply to their lending activities and projects undertaken by borrowing countries. More specialized guidance on appropriate EIA methodology, and applications to particular types of projects and areas can be found in the World Bankâ€™s Environmental Assessment Sourcebook.”[6]

African Development Bank (AfDB) has a document Integrated Environmental and Social Impact Assessment, 2003[7]. The document does not mention

[6] http://eia.unu.edu/course/?page_id=111

[7] http://www.afdb.org/fileadmin/uploads/afdb/Documents/Policy-Documents/Integrated%20Environmental%20and%20Social%20Impact%20Assesment%20Guidelines.pdf

alternatives or significance. The document has sectorial annexes – e.g. Annex 7 Roads and Railways. However, the annexes were not found via Internet.

Summary/conclusions
AfDB follows the same standards as the World Bank in EIA. One specific guidelines document AfDB was found in Internet, but not the sectorial annexes to the document.

3.5 Food and Agriculture Organization (FAO)

According to Environmental impact assessment Guidelines for FAO Field Projects from 2012[8] EIA is a tool for decision-makers to identify potential environmental impacts of proposed projects, to **evaluate alternative approaches**, and to design and incorporate appropriate prevention, mitigation, management and monitoring measures.

Most FAO projects may not require a fully-fledged EIA and may be reviewed with limited analytical effort. Still, they will need to undergo the screening procedures described under the guidelines.

FAO has like the World Bank and many other IFIs project categories A, B and C. The categories are defined shortly in the following way:

1. Category A projects have significant, or irreversible adverse impacts and it is mandatory to make an environmental impact assessment.
2. Category B projects have less significant adverse impacts that may be easily prevented or mitigated and it is needed an environmental analysis to identify more precisely potential negative impacts.
3. Category C projects have minimal or no adverse impacts and no further environmental and/or social analysis or assessment is required.

The profile of FAO is in agriculture, forestry, fishery, livestock, water service, bioenergy, watershed management and land use type of projects, which are listed to be A Category projects, if the project is sizable enough. List of FAO projects does not include mining, traffic corridor or large energy projects.

The EIA according to FAO Guidelines should assess feasible alternatives (including a "without project" scenario). Analysis of alternatives includes assessment of recurrent costs, suitability, training and monitoring requirements. Significance of impacts should be assessed and classified high, medium and low **significance categories**. The expression significance is not defined in the documents.

Summary/conclusions

[8] http://www.fao.org/docrep/016/i2802e/i2802e.pdf

In significant FAO projects the alternatives and significance should be studied. The meaning of significance is left open in the document.

3.6 Scottish Natural Heritage

Scottish Natural Heritage (SNH) is an organization, which purpose is to promote care for and improvement of the natural heritage of Scotland, help people enjoy it responsibly, enable greater understanding and awareness of it and promote its sustainable use, now and for future generations. SNH is funded by the Scottish Government.

Environmental Impact Assessment (EIA) of SNH is defined in "A handbook on environmental impact assessment, Guidance for Competent Authorities, Consultees and others involved in the Environmental Impact Assessment Process in Scotland"[9] and "SNH Environmental Assessment Handbook
Guidance on the Environmental Impact Assessment Process"[10] . EIA is a means of drawing together, in a systematic way, an assessment of a project's likely significant environmental effects.

Whether a project must be subject to the EIA process in Scotland depends entirely on whether it is of a kind described in the Regulations issued by the Scottish Government to ensure compliance with the EC Directives on EIA.

A proposer **does not have to consider alternatives**, but if they do they must provide an outline of the main alternatives studied and the **reasons of choice of the alternatives** explaining the environmental effects. However, it is obligatory to compare the planned project to the "do-nothing" case.

Impact significance should be considered already in the scoping stage in the Environmental Statement of the project. Impact **significance is defined to be the product of the receptor and the magnitude and nature of the change**.

Summary/conclusions
In Scotland formulating alternatives is not obligatory. However, if there are alternatives the reasons for choice must be given. Significance is defined and it should be considered already in the scoping stage of the project.

4. Formulation of Alternatives

In many EIAs financed by IFIs the analysis of alternatives has been done in an unsatisfactory way. There are several reasons for this. Projects come to the institutions in a too late stage, when it is not possible to formulate proper alternatives any more, because several decisions have been already made and planning has advanced too long.

[9] http://www.snh.org.uk/publications/on-line/heritagemanagement/eia/d.8.shtml#fig6

[10] http://www.snh.org.uk/publications/on-line/heritagemanagement/eia/c.3.shtml

Formulating of alternatives is done in a too late stage of planning processes. Several sources emphasize a need to formulate the alternatives already either in the development planning or project identification phases or in an earlier stage. Strategic Environmental Assessment (SEA), which is made in an earlier stage than EIA, may have a proper impact on the project alternatives. (Source: The World Bank, Environmental Assessment Sourcebook, UPDATE, Number 17, December 1996, Analysis of Alternatives in Environmental Assessment, p 1)

Formulation of alternatives is also difficult in the cases when the project is in a fixed location like mining projects. In these cases there are no alternatives for the project location. (Source: World Bank OP 4.01, Environmental Assessment Sourcebook, UPDATE March 1998 Number 22, page 9)[11]

5. Guidelines for Comparing Alternatives and Assessing Significance

5.1 The World Bank

Evaluating of the impacts based on significance is described in "The World Bank, Environment Assessment Sourcebook, Update 17, Analysis of Alternatives in Environmental Assessment"[12] in the following way:
"Ranking entails ordering alternatives from best to worst in terms of potential impacts on decision criteria. Rating refers to the use of a predefined rating scheme to rate the significance of decision criteria for each option. Scaling involves the assignment of numeric or algebraic scales to the impact of each alternative on each decision criterion (see Table 5.1.1.). Importance weighting involves assigning a weighting factor to each decision criterion relative to the other decision criteria."[13]

The World Bank EIA Sourcebooks provides two examples of scoring the impacts of projects. The first example is from "Environmental Assessment Sourcebook, UPDATE Number 17, December 1996, Analysis of Alternatives in Environmental Assessment".

The first example is from Java where it was planned a new four-lane dual-carriageway toll read. There are three road alignments 1, 2 and 3. The comparative assessment was made based on environmental, traffic, planning and engineering related criteria.

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11 http://siteresources.worldbank.org/INTSAFEPOL/1142947-1116495102237/20507370/Update22EnvironmentalAssessmentOfMiningProjectsMarch1998.pdf

12 http://siteresources.worldbank.org/INTSAFEPOL/1142947-1116495579739/20507390/Update17AnalysisOfAlternativesInEADecember1996.pdf

13 http://siteresources.worldbank.org/INTSAFEPOL/1142947-1116495579739/20507386/Update16ChallengesOfManagingTheEAProcessDecember1996.pdf

Table 5.1.1. An example of Assessing of Significance of Impacts, Four-lane Dual Carriage Toll Road in Java.

Java, Impact Significance of a New Four-lane Dual Carriage Toll Road

Environmental Impacts	Weight = Relative Importance, Scale 0,5 - 4,0	Scaling score = Impact Criterion, Scale 1,2 or 3			Signicicance of Impacts = Impact Criterion Scores		
		1	2	3	1	2	3
Negative							
1. Disturbance to nature	3,0	2	2	3	6,0	6,0	9,0
2. Landscape changes	1,5	1	3	2	1,5	4,5	3,0
3. People directly impacted	3,5	3	3	3	10,5	10,5	10,5
4. People indirectly impacted	2,5	1	2	2	2,5	3,8	5,0
...	...	...	...	...	...	...	...
21. XXXX		...	...	...	...	...	...
Positive							
1. XXXX	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
6. XXXX	...	...	...	...	...	...	...
				Sum	-42,0	-49,0	-67,5

Traffic Impacts	Weight = Relative importance, Scale 0,5 - 4,0	Scaling score = Impact Criterion, Scale 1,2 or 3			Signicicance of Impacts = Impact Criterion Scores		
		1	2	3	1	2	3
Negative							
...	...	...	...	...	...	...	...
Positive							
...	...	...	...	...	...	...	...
				Sum	30	73	47

Planning Impacts	Weight = Relative importance, Scale 0,5 - 4,0	Scaling score = Impact Criterion, Scale 1,2 or 3			Signicicance of Impacts = Impact Criterion Scores		
		1	2	3	1	2	3
Negative							
...	...	...	...	...	...	...	...
Positive							
...	...	...	...	...	...	...	...
				Sum	49,5	71,5	34

Engineering Impacts	Weight – Relative importance, Scale 0,5 - 4,0	Scaling score = Impact Criterion, Scale 1,2 or 3			Signicicance of Impacts = Impact Criterion Scores		
		1	2	3	1	2	3
Negative							
...	...	...	...	...	...	...	...
Positive							
...	...	...	...	...	...	...	...
				Sum	31	48	71

TOTAL SCORE	68,5	143,5	84,5
PRIORITY RATING	3	1	2

Weight of Relative Importance is multiplied by Scaling Score of Impact Criterion, which results Impact Criterion Scores indicating Significance of each Impact. Impacts are summed up, which results Total Score of Significance. Rating of alternatives 1, 2 and 3 is done based on the magnitude of Total Score. The

alternative 2 was rated to be the most favorable alternative based on impact significance. The economic and financial assessment was made separately. The final decision was made based on the impact and economic/financing criteria. The example did not indicate how these criteria were used.

The second example is from "The World Bank, Environmental Assessment Sourcebook, UPDATE Number 16 December 1996, Challenges of Managing the EA Process"[14].

The example is a comparative assessment of three water supply options Option 1, Option 2 and Option 3 (Tables 5.1.2. and 5.1.3.). The impacts in the example are impacts on water quality and erosion. However, in the real project case there would be more different types of impacts. In the first stage of the analysis the different classes of magnitude, extent and duration of impacts in general were given relative scores "Scale of Scores". The expected impacts on water quality and erosion were assumed to be similar in each of the water supply options (see in the Table 5.1.2. "Scores Assigned for Impacts"). This can be interpreted so that the "magnitude", in a broad meaning, is broken down into components "magnitude", "extent" and "duration". The water quality impacts were assumed to be of minor magnitude, local extent and the long-term duration The erosion impacts were assumed to be of major magnitude, local extent and long-term duration. The total score for water quality impacts was 50 and for erosion 100.

Table 5.1.2. Scoring of magnitude for different types of impacts

Water Supply Options in Kathmandu Valley

Scale for scores and scores assigned for impacts

		Score Assigned for Impacts	
Magnitude	**Scale for scores**	**Water quality**	**Erosion**
Major	60		60
Moderate	20		
Minor	10	10	
Extent			
Regional	60		
Local	20	20	20
Site only	10		
Duration			
Long-term	20	20	20
Medium-term	10		
Short-term	5		
Total score sum		50	100

[14] http://siteresources.worldbank.org/INTSAFEPOL/1142947-1116495579739/20507386/Update16ChallengesOfManagingTheEAProcessDecember1996.pdf

Table 5.1.3. Likelihoods of impacts multiplied by scores assigned for the impacts of three different water supply options in Kathmandu valley, Nepal

Water Supply Options in Kathmandu Valley

Likelihood of Impacts Multiplied by Scores Assigned

		Water quality	Erosion	Total Rate
Option 1	Impact score	50	100	
	Likelihood	0,1	0,4	
	Total	5	**40**	45
Option 2	Impact score	50	100	
	Likelihood	0,1	0,4	
	Total	5	**40**	45
Option 3	Impact score	50	100	
	Likelihood	0,2	0,2	
	Total	**10**	**20**	30

The likelihoods that the impacts will get realized were assumed to be different for different water supply options (Table 5.1.3.). The likelihood of water quality impacts to be realized in Option 1 was 0,1 and the erosion impacts to be realized were 0,4. Resulting the total rate 45. The Option 2 received also total rate 45 and Option 3 received rate 30. The option with the lowest rate was the preferred option.

The sourcebook "The World Bank, Environmental Assessment Sourcebook, UPDATE Number 16 December 1996, Challenges of Managing the EA Process" provides a more schematic presentation of the same method used in the Kathmandu example above. (See Table 5.1.4.)

In the method project alternatives are compared by assigning first relative importance grades from 0 to 10 for each element of environment. Magnitude of each impact is estimated for each project alternative (A, B and C) and environment element combination. Relative importance of each element multiplied by magnitude of impact of each alternative are multiplied which results Grand index indicating importance of impacts on each element of environment. Summing up Grand indexes of each project alternative results the importance of all impacts of each project alternative.

Table 5.1.4. The World Bank schematic example of analysis of alternatives using scaling-weighting

Comparative analysis of alternatives using scaling-weighting shecklists

Environmental factors	Relative importance
Floora	7
Fauna	6
Water Quality	9
...	...
XXXXX	5

Magnitude of impact on		
A	B	C
7	10	5
6	6	2
5	5	4
...	...	...
9	9	7

Grand index		
A	B	C
49	70	35
36	36	12
45	45	36
...	...	...
45	45	35
TOTAL 175	196	118

5.2 International Financing Corporation (IFC) and EBRD

No guidelines or manuals of IFC or EBRD, giving examples for carrying our analysis of alternatives or analysis of significance, were found. The reason being the fact that both IFC[15] and EBRD[16] are using the procedures of the World Bank Group, which are explained in the World Bank documents e.g. Operational Policy OP 4.01.

5.3. Scottish Natural Heritage (SNH)

Scottish Natural Heritage presents in its document "Environmental Assessment Handbook, Guidance on the Environmental Impact Assessment Process"[17] an example of matrix of impact significance in landscape receptors.

Significance of impact is a result of combination of magnitude of the impact and sensitivity of landscape resource. (Table 5.3.1.)

The scale of magnitude of changes to the landscape resource is defined in the following way:

High magnitude	Significant changes, over a significant area, to key characteristics or features or to the landscape's character or distinctiveness for more than 2 years
Medium magnitude	Noticeable but not significant changes for more than 2 years or significant changes for more than 6 months but less than 2 years, over a significant area, to key characteristics or features or to the landscape's character or distinctiveness.
Low magnitude	Noticeable changes for less than 2 years, significant changes for less than 6 months, or barely discernible changes for any length of time.
No change	No predicted changes.

[15] http://www1.ifc.org/wps/wcm/connect/190d25804886582fb47ef66a6515bb18/ESRP+Manual.pdf?MOD=AJPERES

[16] http://www.ebrd.com/environment/e-manual/r16eia.html and http://www.ebrd.com/pages/project/eia/43006.pdf

[17] http://www.snh.org.uk/publications/on-line/heritagemanagement/eia/d.8.shtml#fig6

The scale of sensitivity of landscape resource is defined in the following way:

High Sensitivity	Key characteristics and features, identified by systematic landscape character assessment, which contribute significantly to the distinctiveness and character of the landscape character type. Designated landscapes eg. National Parks, NSAs and AGLVs and landscapes identified as having low capacity to accommodate proposed form of change.
Medium Sensitivity	Other characteristics or features of the landscape that contribute to the character of the landscape locally. Locally valued landscapes which are not designated. Landscapes identified as having some tolerance of the proposed change subject to design and mitigation etc.
Low Sensitivity	Landscape characteristics and features that do not make a significant contribution to landscape character or distinctiveness locally, or which are untypical or uncharacteristic of the landscape type. Landscapes identified as being generally tolerant of the proposed change subject to design and mitigation etc.

Table 5.3.1. Significance of impact in landscape receptor is a result of magnitude of the impact and sensitivity of the landscape resource.

Scottish Natural Heritage Example of a Significance Matrix

Sensitivity of Environmental Receptor	Magnitude of Change			
	Substantial	Moderate	Slight	Neglible/None
High	Major	Major	Moderate	Neglible/None
Medium	Major	Moderate	Minor	Neglible/None
Low	Moderate	Minor	Minor	Neglible/None

5.4. Alternatives and Significance Comparison Methods in Literature

An article of Mark A. Thompson "Determining Impact Significance in EIA: a review of 24 Methodologies" [18] presents 6 different approaches for determining impact significance. Below it is presented the basic idea of each of the 6 approaches.

Approach 1, Water Resource Assessment Methodology (WRAM).
This method was originally developed for water resource assessment projects by Solomon, R.C. et. al. ,1977[19]. Interdisciplinary team weights the environmental, social and economic components, which may be impacted by the project, by using ranked **pairwise comparison techniques**. There are several ways to do the scaling. The values obtained from scaling for each of the components are called "Alternative Choice Coefficients", which expresses the magnitude of the

[18] Mark A. Thompson "Determining Impact Significance in EIA: a review of 24 Methodologies", Journal of Environmental Management (1990) 30, 235 -250

[19] Solomon, R.C., Colbert, B.K., Hansen, W. J., Richardson, S. E.,Canter, L. And Valachos, E. C. (1977) Water Resource Assessment Methodology (WRAM) Impact Assessment and Alternative Evaluation. Technical Report No. Y-77-1 Vicksburg, Mississippi, U.S. Armu Corps of Engineers.

impact. Weights multiplied by Scales result Aggregate Score and Aggregate Scores summed up result Final Aggregate Scores for each of the alternatives. (Table 5.4.1.)

In principle this is the same method as the method presented in the World Bank section of this report "schematic example of analysis of alternatives using scaling-weighting checklist".

Table 5.4.1. Approach 1, Water Resource Assessment Methodology (WRAM)

Environmental, Social and Economic Component	Weight	Scale, Alternative Choice Coefficient			Aggregate Scores		
		Alterna-tive 1	Alterna-tive 2	Alterna-tive 3	Alterna-tive 1	Alterna-tive 2	Alterna-tive 3
Environmenal							
Env. Component 1							
…	…	…	…	…	…	…	…
Env. Component N							
Social							
Sos. Component 1							
…	…	…	…	…	…	…	…
Sos. Component N							
Economic							
Econ. Component 1							
…	…	…	…	…	…	…	…
Econ. Component N							
		Final Aggregate Score					

Approach 2, Crawford Methodology
This method was originally developed for highway route planning purposes by Crawford, et. al., 1973[20]. This method uses extensively a **Delphi techniques**, which is a method where expert panels make their estimates in several rounds. After each round the results are presented for other panels. On this way the estimates are expected to become closer to each other in each new round and finally reach the "correct" estimates. (Table 5.4.2.)

The presentation of this method in the publication is not detailed enough. Most likely the weighting and scaling of the impacts is otherwise similar in this method than in the Approach 1 exempt the weight multiplied by magnitude of impact is further multiplied by **probability**. The end result of the analysis is magnitude, which is certain percentage of the maximum impact.

Table 5.4.2. Approach 2, Crawford Methodology

[20] Crawford, A. B., (1973). Impact Analysis Using Differential Weighted Eveluation Criteria, in Multiple Criteria Decision Making. Cochrane, J. L. and Zeleny, M. (eds). Columbia, SC: University of South Carolina Press.

Components or Impacts	Relative Weights	Consequence			Propability			Magnitude of Impact			% of Maximum		
		Alternative 1	Alternative 2	Alternative 3	Alternative 1	Alternative 2	Alternative 3	Alternative 1	Alternative 2	Alternative 3	Alternative 1	Alternative 2	Alternative 3
Component/ Impact X													
componen/Impact Y													
etc.	...	...	...	...	...	...	...	...	...	...	...	...	...

Approach 3, Project Appraisal for Development Control (PADC) methodology
This method (Clark et. al., 1983[21]) makes a choice between five polarities (adverse/beneficial, ...) for each of the impacts. The significance of the impacts could be determined based on the sum the numbers in each polarity. This would give a same weight for each polarity. However, in the document it is not explained how the polarities are suggested to be used to analyze significance. (Table 5.4.3.)

Table 5.4.3. Approach 3, Project Appraisal for Development Control (PADC) methodology

Alternative 1

Impacts	Adverse/Beneficial	Short-term/long-term	Reversible/Irreversible	Direct/Indirect	Local/Strategic	Significance
Impact X						
Impact Y						
Impact Z						
etc						

Alternative 2

Impacts	Adverse/Beneficial	Short-term/long-term	Reversible/Irreversible	Direct/Indirect	Local/Strategic	Significance
Impact X						
Impact Y						
Impact Z						
etc.						

Alternative 3

...

Approach 4, The Leopold Matrix

[21] Clark, B. D., Chapman, K., Bisset, R., Wathern, P. and Barrett, M. (1983). A Manual for the Assessment of Major Development Proposals. PADC Aberdeen University. London: HMSO.

This methodology is base on the Leopold Matrix (Leopold et al., 1971)[22], which has existing environmental conditions, which might be affected by actions, as rows and actions, which cause environmental impacts, as columns. (See Table 5.4.4.)

In the matrix the number of actions listed in columns is 100. The number of environmental factors listed in rows is 88. This provides a total of 8,800 interactions. In practice, however, only a few of the interactions would be likely to involve impacts of such magnitude and importance to warrant detailed treatment. The number of interactions for a typical project is between 25 and 50 of which about dozen actions are usually significant according to Leopold et. al.

Each shell in the matrix is divided into two parts. In the upper part it is presented relative magnitude (scale 1 – 10) of the impact and in the lower part the relative importance of the impacts (scale 1 – 10).

The analysis concentrates in the shells where significant magnitudes and importance are marked (high numbers in both). The significant impacts must be well reasoned in the text. The method does not give any numerical figure for significance and leaves room for judgment of the analyst. Separate matrixes are prepared for each of the project implementation alternatives.

Table 5.4.4. Approach 4, The Leopold Matrix

Environmental parameter	Activity			
	1	2	...	100
1	**9** / **8**		**9** / **6**	2 / 1
2	6 / 4	**10** / **7**		5 / 3
3		1 / 3	1 / 3	2 / 1
...		2 / 1	8 / 2	
88	4 / 4	**9** / **9**		

magnitude / importance

Leopold Matrix approach was used in Guidebook for Evaluating Mining Project EIAs of Environmental Law Alliance Worldwide (ELAW). [23]

Approach 5, The Fischer and Davis methodology
In this methodology (Fischer and Davis, 1973)[24] the impacts of each project alternative are assigned + or – sign indicating positive or negative impact,

[22] Leopold, L. R., Clark, F. A., Henshaw, B. R. And Balsey, J. R. (1971). A Procedure for Evaluating Environmental Impact. U.S. Geological Survey Circular 645 and http://eps.berkeley.edu/people/lunaleopold/(118)%20A%20Procedure%20for%20Evaluating%20Environmental%20Impact.pdf and http://ponce.sdsu.edu/the_leopold_matrix.html

[23] http://www.elaw.org/files/mining-eia-guidebook/Full-Guidebook.pdf

[24] Fischer, D. W., and Davis, G. S. (1973). An approach to assessing environmental impacts. Journal of Environmental Management 1, 207 – 227 and

degree of impact indicating the magnitude of the impact and if the impact is short term or long-term impact. For further analysis are taken only the impacts, which have highest impact scores. (See Table 5.4.5.)

The analysis is not taken further in numerical level. This leaves room for judgment of the analyst.

Table 5.4.5. Approach 5, The Fischer and Davis methodology

Alternative 1

Impacts	Environment Compatibility Matrix: Benefit +/Cost -	Degree of Impat, 1-5	Short/long term
Impact X	+	4	l
Impact Y	-	2	s
Impact Z	-	5	s
Impact A	+	3	l
Impact B	-	1	s
etc.	...	...	...

Impacts	Decision Matrix: Benefit +/Cost -	Degree of Impat, 1-5	Short/long term
Impact X	+	4	l
Impact Y			
Impact Z	-	5	s
Impact A			
Impact B			
etc.	...	...	...

Alternative 2

Impacts	Environment Compatibility Matrix: Benefit +/Cost -	Degree of Impat, 1-5	Short/long term
Impact X	+	3	l
Impact Y	-	4	s
Impact Z	-	5	s
Impact A	+	4	l
Impact B	-	2	s
etc.	...	...	...

Impacts	Decision Matrix: Benefit +/Cost -	Degree of Impat, 1-5	Short/long term
Impact X			
Impact Y	-	4	s
Impact Z	-	5	s
Impact A	+	4	l
Impact B			
etc.	...	...	...

Alternative 3

...

Approach 6, Loran methodology

This methodology presented by Loran 1975[25] uses a matrix with 234 project activities and 27 environmental features. Each combination of activity and environmental feature are scaled according to forecasted severity of impact from 0 to 5 by interdisciplinary team. The result is recorded using a computer algorithm and a primitive aggregation of impacts is achieved by "clustering" of highly rated impacts. The method serves in identifying the critical environmental areas. Further processing of numbers is not done and the method leaves room for the own judgment of the analyst. (See Table 5.4.6.)

Table 5.4.6. Approach 6, Loran methodology

http://books.google.fi/books?id=7MYOAAAAQAAJ&pg=PA332&lpg=PA332&dq=Fischer+Davis+environmental+impacts+Journal&source=bl&ots=4j25GYajYo&sig=XX10WKlfHmVCoSFnmcELgpkwCsU&hl=fi&sa=X&ei=pWuoUfjOBoOz4ASo2ICYBw&redir_esc=y#v=onepage&q=Fischer%20Davis%20environmental%20impacts%20Journal&f=false

[25] Loran, B. (1975). Quantitative assessment of environmental impact. Journal of Environmental Systems 5, 247 – 256.

Environmental Feature	Project Activity					
	1	2	3	...	233	234
1	1	0	2	1		
2	0	5	0	0	0	2
3	1	0	5	1	5	0
4	4	1	1	4		
...	...	...	...	...	...	...
26	0	2	1	0	2	0
27	3	0	0	5	0	5

Environmental Feature	Project Activity					
	10	44	65	3	230	78
3	1	0	2	1		
12	4	4	0	0	0	2
4	4	5	5	5	4	0
22	3	4	1	3	4	
26	...	...	...	1	...	...
5	0	2	1	0	2	0
27	3	0	0	5	0	5

7. Assessment of Examples from EIA Reports

7.1. Parc Eolian Vutcani (Vutcani Wind Farm)

Vutcani Wind Farm EIA[26] is in list of EBRD supported projects[27]. It serves as an example of one way of scoring significance. The EIA report (2008) was found only in Romanian language and the presentation may include some translation mistakes. The translations were made by using Google translator.

The wind farm at Vutcani in Romania comprises 12 wind turbines, providing a total power of 24MW. The turbines each have a total height of 150 m. The total area occupied by the wind farm is 400 ha, of which approximately 18 ha will be dedicated to the wind turbines. The remaining land will be used for agricultural use. Within the Site there are no forested areas or rare/sensitive plant species. There are three protected areas within 20 km of the Vutcani Wind farm.

There are no alternatives presented or analyzed in the EIA report.

In the first step the criteria for impacts were assigned (Table 7.1.1.). A scoring system for importance of resources impacted was assigned a scale from 0 to 4. The impact was broken down into four variables: magnitude, permanence, reversibility and cumulative. Each of them were assigned scales from -3 to +3 or from 0 to 3.

[26] http://www.edpr.com/sustainability/documents-library-and-publications/?search=Vutcani&langue=

[27] http://www.ebrd.com/english/pages/project/eia/43647.shtml

The used formula to estimate the impact (Average Score) of each resource impacted is "Avg.Score = (A1*A2)*(B1+B2+B3)". The rule to assign an Impact Category for each resource impacted is given in the Table 7.1.2. E.g. if Avg.Score is +20 the Impact Category is +C. The Average Score is calculated by using the formula above based on the estimated resource and impact criteria in the Table 7.1.3. Impact on birds due to habitat destruction receives Average Score 0 based on the calculation (1*0)*(2+2+2) = 0. In this example the birds have local importance (1) and the impact magnitude score is (0) "no change". The Average Score is 0 and the Impact Category is N.

The Summary Scores are presented in the Table 7.1.4. Based on the Summary Scores table, can be concluded that most of the impacts studied received "no change"/"not applicable" category. –A category (slight negative impact) received one impact component of biodiversity, 4 impact components of water and one impact component of soil. However, base on the Summary Scores table Total row the Vucani Wind Park project has more positive impacts than negative impacts.

Table 7.1.1. Vutcani Wind Park, Evaluation Criteria for Impacts

A1, Importance of resource impacted		A2, Magnitude of impact		B1, Permanence		B2, Reversibility		B3, Cumulativity	
4	national	3	major benefit	1	no change	1	no cahange	1	no cahnge
3	regional	2	...	2	temporal	2	reversible	2	cumulative
2	local and close to local	1	...	3	permanent	3	non reversible	3	cumulat. & synergistic
1	local	0	...						
0	no imprtance	-1	...						
		-2	...						
		-3	major disadvantage						

Table 7.1.2. Vutcani Wind Park, Conversion of Scores into Impact Categories

Average Score	Category	Description
+72 - +108	+E	Major positive impact
+36 - +71	+D	...
+19 - +35	+C	...
+10 - +18	+B	...
+1 - +9	+A	...
0	N	No change/not applicable
-1 - -9	-A	...
-10 - -18	-B	...
-19 - -35	-C	...
-36 - -71	-D	...
-72 - -108	-E	Major negative impact

Table 7.1.3. Scoring of Impacts by Resource Impacted

Resource Impacted	Impact	Significance of Impact					Measures to reduce	Comment	Category	
		A1	A2	B1	B2	B3			Avg.Score*	Category
Biodiversity										
Birds										
	Collision	1	0	1	1	1	not applicable	...	0	N
	Electrocution	1	0	1	1	1	not applicable	...	0	N
	Habitat destruction	1	0	2	2	2	not applicable	...	0	N
	Habitat fragmentation	1	0	1	1	1	not applicable	...	0	N
	Strămutare (in Romanian)	0	0	1	1	1	-	...	0	N
	Expanding habitats by changing landuse	1	1	3	3	3	-	...	9	+A
Other animals										
	...								0	N
	...								0	N
	...								0	N
	...								9	+A
Vegetation	Loss of vegetation	1	-1	2	2	2	-		-6	-A
	...									
Water										
Surface water										
Ground water										
Landscape										
...										
...										
TOTAL										

* Avg.Score = (A1*A2)*(B1+B2+B3)

Table 7.1.4. Summary Scores

Category	-E	-D	-C	-B	-A	N	+A	+B	+C	+D	+E
Biodiversity	0	0	0	0	1	7	2	0	0	0	0
Water	0	0	0	0	4	2	0	0	0	0	0
Landscape	0	0	0	0	0	0	0	1	0	0	0
Shading	0	0	0	0	0	1	0	0	0	0	0
Noise	0	0	0	0	0	1	0	0	0	0	0
Socio-economic	0	0	0	0	0	0	1	1	0	0	0
Public health/safety	0	0	0	0	0	5	0	0	0	0	0
Communication	0	0	0	0	0	4	0	0	0	0	0
Transport/traffic	0	0	0	0	0	1	0	0	0	0	0
Waste	0	0	0	0	0	0	0	0	0	0	0
Air	0	0	0	0	0	0	0	0	0	0	1
Soil	0	0	0	0	1	1	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**5**	**22**	**3**	**2**	**0**	**0**	**1**

Summary/evaluation

The method finds values for significance by multiplying importance of resource impacted by magnitude of impact. The end result is dependent on:

- the scales of criteria variables (importance of resources impacted, magnitude of impact, permanence, reversibility and cumulative),
- rules to convert scores into impact categories,
- the formula to calculate Average Score and
- the subjective judgment to assign values for significance of impact scores.

With good judgment and by having right balance between different parts of the variables, scales and formula, you may gain understanding of how the significance is dependent on the different variables. However, the long process may also result loosing understanding of dependence between variables.

7.2. S.C. Rosia Montana Gold Mine EIA

Environmental Impact Assessment Study[28] for The Roşia Montană Mining Project of S.C. Rosia Montana Gold Corporation S.A. (RMGC) in Romania is made, according to the report, to satisfy the World Bank standards for EIA. The purpose of the project is to mine gold and silver ore.

The EIA of the project is an example of a project where a large number of alternatives have been analyzed. Each different component of the project has been assigned several alternatives and they have been compared to the selected alternative. The following comparisons were made:

- No-action option compared to the selected option;
- Alternative industry option compared to the selected option;
- Production rate options compared to the selected option;
- Plant location options compared to the selected option;
- Tailings Management Facility (TMF) site options compared to the selected option;
- Inert Waste Landfill location options compared to the selected options;
- Waste rock disposal options compared to the selected option;
- Site access options compared to selected option;
- Options for Plant Access compared to the selected option;
- Worker housing options compared to selected options;
- Power supply options compared to selected option;
- Quarry rock supply options compared to selected options;
- Pit closure options compared to selected option.

The impacts analyzed are:

- Water flow and quality,
- Air quality,
- Noise and vibration,
- Soil,
- Biodiversity,
- Landscape,
- Socio-economic issues,
- Cultural heritage,
- Transportation issues,
- Transboundary impacts.

The comparison of alternatives is done in a table format verbally. Verbal description summaries in the tables are short including normally one sentence. The analysis in the table is based on the wider discussion in the text part of the EIA report.

<u>Summary/evaluation</u>

[28] http://en.rmgc.ro/Content/uploads/eia-en/alternatives.pdf
http://www.gabrielresources.com/documents/EIA/Chapter%201/C1.pdf

This EIA is a good example of a bad practice EIA, which is made too late and does not impact on the project implementation. The selection of all the options has been made already before the EIA analysis. The comparison of alternatives for each component of the project separately is not a credible because selection of one option has an impact on other components of the investment. Also cumulative and co-impacts of the components cannot be evaluated. A good part of the analysis is having different assessment of significance for each physical component to the project.

8. Assessment of Best Practices in Comparison of Alternatives and Significance

8.1 The Finnish EIA Guidelines and EIAs

Examples of the best practices recommended in the Finnish EIA guidelines were taken from two recent guideline booklets: "EIA in designing of road projects" (Ympäristövaikutusten arviointi tiehankkeiden suunnittelussa[29]) and "EIA in stone material extraction projects" (Kiviaineshankkeiden ympäristövaikutusten arviointi[30]).

According to the guidelines in the stone material extraction EIA processes, **one of the essential methods in reducing impacts of projects is formulation of alternatives**. Impacts must be described and compared to each other for all of the alternatives including "no-project" alternative. Comparison of alternatives should concentrate in the activities, which have significant impacts on the environment.

Assessment of significance is always a subjective issue and depends on values of people. For this reason **assessment of significance** should consider opinions of different stakeholders. In comparing alternatives the recommended method is to characterize the impacts with descriptive variables and not to combine impacts into one single number.

According to the guidelines of EIA in designing road projects, **an essential method in reducing impacts is to design alternatives and to assess their impacts**. Because the impacts are not directly comparable to each other, they should be **described well and weight should be put on the significance**. Unambiguous conclusions about the best alternative are not meaningful, because the features of the impacts vary a lot. It is adequate to compare the prefrability of the alternatives verbally by using various sets of criteria and to condense the presentation into table form, describing shortly the main points of the impacts (see Table 7.1). Based on the guidelines a summary of the alternatives should be

[29] Ympäristövaikutusten arviointi tiehankkeiden suunnittelussa, Tiehallinto, Edita Prima Oy 2009. http://alk.tiehallinto.fi/thohje/pdf/2000027-v-09-yva-ohje.pdf

[30] Kiviaineshankkeiden ympäristövaikutusten arviointi, Suomen Ympäristökeskus. Jorma Jantunen, Suomen ympäristökesks 27/2012. http://www.infrary.fi/files/4249_SY_27_2012_Kiviaineshankkeiden_ymparistovaikutusten_arviointi.pdf

made in a matrix or in some other format. It is recommended to use a +/- type of presentation and to make comparison by impact groups or by resources impacted (e.g. impacts on soil and bedrock, ground and surface water, nature, life of humans, etc). (see Table 7.2)

Table 7.1. Table of impacts based the Finnish EIA Guidebook "EIA in designing of road projects"

Description of Significance of Impact

Resource impacted	**Alternative 1**	**Alternative 2**	**Alternative 3**	**…**
Nature				
Biodiversity	Description of impact…	Description of impact…	Description of impact…	Description of impact…
Nature protection areas	Description of impact…	Description of impact…	Description of impact…	Description of impact…
…				
Traffic				
Treffic safety	Description of impact…	Description of impact…	Description of impact…	Description of impact…
Traffic volumes	Description of impact…	Description of impact…	Description of impact…	Description of impact…
…				
Resource X				
…	Description of impact…	Description of impact…	Description of impact…	Description of impact…
…	…	…	…	…

Table 7.2. Summary matrix of impacts based the Finnish EIA Guidebook "EIA in designing of road projects"

Summary Marrix for Significance of Impacts

Resource impacted	Alternative 1	Alternative 2	Alternative 3	…
Social impacts	--	0	+++	++
Nature	-	+	0	-
Traffic	++	++	---	--
Noice	---	--	+++	---
Emissions	0	---	--	0
…	-	0	+++	+

---	--	-	0	+	++	+++
Very significant negative impact	Significant negetive impact	Moderate negative impact	Only negligible impacts	Moderate positive impact	Significant positive impact	Very significant positive impact

The method described above was used in the EIA report for the project "Upgrading of Highway 7 between Hamina and Vaalima" (Valtatien 7

paranaminen moottoritieksi välillä Hamina – Vaalimaa, ympäristövaikutusten arviointiselostus[31]).

In two other recent EIA reports (Luumäki-Imatrankoski- kaksoisraiteenalustava yleissuunnittelu ja ympäristövaikutusten arviointi (YVA), Ympäristövaikututen arviointiselostus, 2008) and (Ventusneva, Kokkola – Pyhäselkä, Muhos ympäristövaikutsten arviointiselostus 400 kV voimajohtohankkeessa, 2010) the same method was employed exempt the summary matrix was not prepared.

In mining and windmill project EIAs the methods seem to be very similar to the methods described above. This kind of projects are e.g. Mustasaari mining project (Mustasaaren kaivoshanke) [32] , Mielmukkavaara windmill park (Mielmukkavaaran tuulipuisto) [33] and Maalahti Sidlandet windmill park (Maalahden Sidlandetin tuulivoimapuisto) [34]. However, some differences exist.

8.2 Comparison of IFI/SNH and the Finnish EIA Guidelines

8.2.1 Finnish v.s. IFI system

The guidelines of IFIs instruct to quantify and set economic value for impacts as far as possible. The methods recommended instruct to find one single number or figure to indicate "significance", which is the final indicator to compare alternatives. Expression significance is not well defined and can be a result of different variables in different cases.

The methods for comparing impacts of alternatives, presented in the World Bank documents, which methods are basically followed by the other IFIs, are based on giving importance score for each resource impacted and then multiplying it by impact magnitude score, which results the total significance score for the resource. By summing up all the significance scores of different resources results the total significance score of the project alternative. The preferred alternative is the alternative, which receives the most favorable significance score.

In another example of the World Bank the method is closely related to the first example. The difference being that in the first step the size of impact (or impact score) is a combination of impact magnitude, extent and duration. The size of impact is then multiplied by probability of the expected impact happening. This is estimated separately for each of the alternatives. The final result is one single number or figure for each alternative.

The examples in the World Bank guidelines can be interpreted so that based on the case the derivation of the single indicator figure for "significance" of impacts

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31 Valtetien 7 parantaminen moottoritieksi välillä Hamina – Vaalimaa, Ympäristövaikutusten arviointiselostus, Tiehallinto, Kouvola 2008. http://www.ymparisto.fi/download.asp?contentid=81832&lan=fi

32 http://www.ymparisto.fi/download.asp?contentid=110153&lan=fi and http://www.ymparisto.fi/download.asp?contentid=110124&lan=fi

33 http://www.wpd-finland.com/fileadmin/pdfs/Mielmukkavaaran%20tuulipuiston%20ymparistovaikutusten%20arviointis.pdf

34 http://www.epvtuulivoima.fi/Dokumentit/Yhtiöt/EPVT%20Aineisto/maalahti-selostus-suomi.pdf

for alternatives can be derived in a different way by combining importance of resources impacted, magnitude of impacts, extent of impacts, probability of impacts happening, etc.

A difference in the typical IFI projects and the Finnish projects falling under EIA procedure is that IFI projects are usually larger in size than the Finnish ones. Another difference is that the World Bank guidelines state that there should be at least two consultations, one in the scoping phase and another in the impact identification phase. The Finnish EIA typically includes more extensive hearing and participation process.

In the Finnish environment it is possible to organize an extensive hearing and participation process and the findings can be discussed extensively with different stakeholders. The preferred alternative can be selected based on verbal presentation of impacts in this kind of environment. Deriving one numerical indicator for each alternative might lead the decision making to predetermined direction. Also the Finnish guidelines emphasize that different stakeholders experience impacts in a different ways.

However, in the case it is seen justified also in the Finnish EIA to derive numerical indicators for the set of methods recommended for IFI projects could be used also in Finland.

8.2.2 Finnish v.s. SNH system

For comparison of alternatives, the SNH recommends to derive a significance matrix for each environmental receptor (or resource), where the significance is a combination of magnitude of change and sensitivity of environmental receptor. Both variables are recommended to have three categories.

The method is basically the same as recommended in the Finnish guidelines for "EIA in designing of road projects" when the results are presented in a + and – type summary matrix. Only the way of naming the different impacts classes is different. In SNH example it is used verbal expression e.g. "major negative impact" when in the Finnish guidelines it is used "---" notation.

In the method recommended by SNH the significance is well defined and the process in deriving it is clear (significance = magnitude of impact * sensitivity of the environmental resource). In a typical Finnish EIA system and the system recommended by the studied EIA guidelines the derivation of significance is a subjective process and it is derived from verbal description of impacts. However, in some EIA processes a more structured method may have been used.

8.2.2 Finnish v.s. examples from literature

The six approaches presented in the publication of Mark A. Thomas are compared in this chapter to the Finnish system presented in this article.

The method to derive the "aggregate scores" in the Approach 1 is the same as the derivation of the "Impact Significance" and the "Grand Index" in the World Bank examples. However, the definitions of the variables, which are used to derive "aggregate scores" are not necessarily the same as in the World Bank example.
The method derives one single numerical indicator for significance. This is a method, which is not recommended in the Finnish EIA guidelines. However, in the case a numerical derivation of indicator for significance is employed an interesting feature in this method is the ranked pairwise comparison technique in defining weights for environmental components. It was not possible to study closer the different methods to derive scaling in this study. However, the methods may prove to be interesting.

The Approach 2 is also a method to derive one numerical indicator for significance. In practice this method only adds probability to the analysis presented above in Approach 1. An interesting feature in this method is using Delphi techniques in assigning values for variables. This could be used in the present Finnish EIA method e.g. for assigning plusses and minuses for alternatives and resources impacted in the Summary Matrix for Significance of Impacts.

The Approach 3 derives the significance of each impact by summing up assigned values of 5 different parameters or polarities of impacts adverse/beneficial, short term/long term, reversible/irreversible, direct/indirect and local/strategic. Separate tables are derived for each alternative. One single numerical indicator is not derived for each alternative. This kind of method could be well used in the Finnish EIAs even if the recent EIA guidelines studied do not recommend this kind of approach. The method leaves also room for judgment of the analyst. Similar types of indicators have been used in Finnish EIAs, e.g. Mielukkavaara windmill park (Mielukkavaaran tuulipuisto) [35].

The Approach 4 is the Leopold matrix case where each environmental parameter (in practice the same as the resource impacted in some other examples) and activity combination is assigned two indicators, magnitude and importance of impact. The conclusions are made based on environmental parameter and activity combinations, which receive high scores for both parameters. The alternatives are compared to each other by making separate matrixes for each of the alternatives. In the analyzed Finnish EIA method guidelines the alternatives are not broken down into activities in tabular presentation. The Leopold matrix type of approach could give more understanding for differences between alternatives. Also the verbal description of impacts could be processed forward into two parameters magnitude and importance (or some other well justified variables). This could be a step before the Finnish Summary matrix for Significance of Impacts (where the + and – notations are used) is prepared.

[35] http://www.wpd-finland.com/fileadmin/pdfs/Mielmukkavaaran%20tuulipuiston%20ymparistovaikutusten%20arviointis.pdf

The Approach 5 gives for each impact a sign + or -, degree of impact and short/long term indicator. Only impacts with highest scores are taken to further analysis, were alternatives are compared to each other. The method simplifies the analysis into two indicators. However, it leaves room for judgment of the analyst. The method is quire simplistic. In some cases it, or some variation of it, could be used as a step of a more comprehensive analysis.

Approach 6, where each cell of an environmental resource impacted and activity matrix are given impact severity score. The matrix, by using an algorithm, is rearranged so that the combinations that receive high scores are grouped together and this reveals critical environmental interconnected impacts and activities. The method could be tested, if it improves understanding of the relationships between impacts and activities.

9. Summary and Conclusions

The IFIs studied have adopted the World Bans approach for EIA. The only documents, describing and recommending approaches for comparing alternatives and assessing significance, found were documents of the World Bank.

The methods, which are recommended by the World Bank, instruct to derive one single numerical indicator for each alternative. The indicator, which is in some examples called with name “significance”, is derived in different ways and from different variables in the examples presented.

The premier method presented is to multiply an “importance” of a resource impacted indicator with the magnitude of the impact, which results a “significance” indicator of the impact. However, there may be different variations of the method involving e.g. probabilities of impact taking place or impact can be described with several indicators like magnitude, extent and duration. However, all of them involve multiplying of indicators with each others resulting the final “significance” indicator of alternatives.

The similar methods used by the World Bank are not recommended in the Finnish guidelines for EIA. The guidelines emphasize open ended approaches, which leave room for judgment and does not make the decision for the analyst by giving a single numerical indicators for each alternative.

SNH method, which derives significance indicator for each resource impacted as a combination of sensitivity of the resource impacted and magnitude of impact, is very close to the method used in practice and recommended to be used in Finland. However, in the Finnish EIA guidelines the significance is not clearly a combination of sensitivity of the resource impacted and magnitude of impact. The significance could be defined and the process could be more structured.

In the EIA literature there are a wide range of methods for comparing alternatives presented. One document was reviewed in this study, because it

contained a wide range of methods. The first two methods, Approaches 1 (WRAM) and 2 (Crawford Method), develop a single numerical indicator for each alternative. This approach is not recommended to be used in Finland. An interesting aspect in the methods was the use of "ranked pairwise comparison" techniques in assigning values for indicators. Another interesting method is Delphi techniques, which helps in reaching consensus about significance of impacts. The both techniques can be used in Finland in suitable cases.

In one example Approach 3 (PADC Methodology) the magnitude of impact is broken down into several variables like reversible/irreversible, local/strategic, etc., this kind of break down has been used in EIA works in Finland as well, however, not very commonly.

Two other methods presented, Approaches 4 (the Leopold Matrix) and 6 (Loran Methodology) breaks the alternatives down into activities and assign indicators for each activity and environmental feature (or parameter) combination separately. This approach may help in gaining further understanding about impacts. This approach was not recommended in any of the EIA guidelines reviewed or used in any of the reviewed Finnish EIA reports. However, the method could be useful in right type of projects. The Leopold matrix (Approach 4) is recommended to be used in some foreign EIA guidelines.

There exists also more studies comparing EIA methods, including comparison of alternatives and assessment of significance. One such document is listed in the Annex 1 of this report.

In general foreign (non Finnish) EIA reports are not well done. The comparison of alternatives is in many EIA reports done after project planning phase, which means that the EIA process cannot have an impact on the project implementation. One example of this kind of EIA is reviewed in this report - EIA of the Roşia Montană Mining Project.

Comparison of alternatives is in most foreign EIA reports only descriptive without any proper structure or method. Significance is not defined properly. References to several this kind of EIA reports are listed in the Annex 1 of this report. However, one interesting example of a well structured way to derive significance is reviewed in this document - Vutcani Wind Farm EIA. Structured numerical process needs a good judgment and experience in order to be useful. Otherwise it may lead loosing understanding of dependencies between variables and the process defines the end result of the analysis - not the analyst.

Multiple criteria analysis methods have been also used in EIA reports, however only in rare cases. They are not recommended to be used in any of the reviewed EIA guidelines.

One limiting factor for making a systematic comparison for alternatives and assessment of significance is limited resources allocated for EIA processes. Also the further you go in deriving numerical indicators the more you need data to

derive unambiguous indicators. Open-ended descriptive approach is less resource intensive.

Annex I

EIA reports:

1. Phase 2 Expansion: Port of Saldanha: http://www.transnet.net/BUSINESSWITHUS/EnvPubDoc/Saldanha/Final_Scoping/Chapter%207%20-%20Alternative%20Analysis.pdf

2. Proposed Wind Farms, Restera and Carnavoda, Dobrogea Region, Romania, Non-Technical Summary of Environmental Impact Assessment, EDP Renewals, April 2010: http://www.edpr.com/sustainability/documents-library-and-publications/?search=Pestera&langue=EN

3. Black Sea Transmission Network Project, ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR CONSTRUCTIO OF 500/220 KV SUBSTATION AT Jvari & TRANSMISSION LINES: KAVKASIONI OHLTO JVARI SUBSTATION AND JVARI TO KHORGA SUBSTATION; http://www.minenergy.gov.ge/en/4446

4. 400 kV Overhead Line Lastva Grbaljska – Pljevlja: http://www.ebrd.com/english/pages/project/eia/42768c.pdf

5. Komi Aluminium Komi Aluminium Programme, Environmental and Social Impact Assessment (ESIA): http://www1.ifc.org/wps/wcm/connect/190d25804886582fb47ef66a6515bb18/ESRP+Manual.pdf?MOD=AJPERES

6. Yang_et_al: Quantitative analysis in large scale water transfer projects: http://www.hydrol-earth-syst-sci.net/16/2685/2012/hess-16-2685-2012.pdf

Studies comparing alternatives:

1. Impact Significance5, Integrated Environmental Management Information Services, Department of Environmental Management and Tourism, South Africa: https://www.environment.gov.za/sites/default/files/docs/series5_impact_significance.pdf