



**Policy Instruments for Chinese Sustainable Future:
Environmental Policy Integration and
Strategic Environmental Assessment
for the Energy and Transport Sectors**

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Techniques for Impact and BAU Assessment in SEA

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Project outline

Policy Instruments for Chinese Sustainable Future focuses on the integration of the environment into transport and energy planning in China, both at the policy level and in terms of concrete measures for the two administrative levels of provinces and municipalities. The implementation of this project will help to build transportation and energy-use systems that are environmentally sound and capable of achieving sustainable development in China. As part of the Asia Pro Eco II Programme the project contributes to the programme's main themes for China: energy savings, improved air quality and reduced emissions of GHGs.

At the heart of this project are two closely related mechanisms that are central to the EU efforts to promote sustainability: Environmental Policy Integration (EPI) and Strategic Environmental Assessment (SEA).

The action targets the inadequate reflection on environmental policy objectives and the weakness of the environment as a cross-sectoral priority and the need for information and knowledge of technical/practical solutions that can lead to immediate improvements in the development of sectoral plans. The 30 months Action consists of four work packages and multiple activities.

For further information please look at:

http://www.epi-in-china.com/project_information/summary.html

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Abbreviations

BAU	Business-as-usual
CBA	Cost Benefit Analysis
CEA	Cost Effectiveness Analysis
EU	European Union
GIS	Geographical Information Systems
GDP	Gross domestic product
GHG	Greenhouse gasses
IA	Impact Assessment
MCDA	Multi Criteria Decision Analysis
PPP	Policy, Plan or Programme
SCBA	Social Cost Benefit Analysis
SEA	Strategic Environmental Assessment
SWOT	Strengths, Weaknesses, Opportunities and Threats

Introduction

The expected impacts (on environment, society and the economy) of a given Policy, Plan or Programme (PPP) can be assessed in a variety of manners, and with the support of a wide range of technical tools as illustrated in part B of this paper. Before impacts can be assessed, however, the baseline against which to compare the impacts of a PPP has to be analysed in the scoping phase (the business-as-usual scenario). Ideally, the scoping phase will also be used to assess alternatives to the PPP at hand.

The assessment of alternatives in energy and transport planning has been identified as one of the more challenging problems in Chinese SEA. Often, only one development option is described by energy or transport planners, so that no alternatives are assessed in the SEA either. However, identifying planning alternatives is a crucial element of the SEA scoping and early co-operation with planners is necessary. Good practice principles of alternative identification in SEA have already been discussed in detail in the SEA/EPI Paper No. 16 (Jurkeviciute and Ricci, 2008). Therefore, this paper only reviews the basic principles and added value of alternative selection and assessment in part A, but takes a more “hands-on” approach and gives a detailed description of business-as-usual (BAU) assessment.

Taking the Chinese situation into account, considering the business-as-usual (BAU) scenario is particularly important. The BAU scenario provides the baseline against which the effects of a PPP – and its alternatives – can be compared, in other words: the reference case of future environmental impacts in the absence of the PPP. It is the minimum requirement that a PPP must be assessed against this “basic” alternative. So, even in a situation, where no alternatives to the PPP are considered, the BAU scenario offers a “minimum” alternative.

In order to illustrate the principles and usefulness of alternatives and BAU assessment, the SEA of the Montenegro Energy Strategy Development is presented in detail as real-case example in the Annex of this Paper. Although the Montenegro SEA also has its limitations (such as a lack of the discussion of how the Strategy will help to fulfil national plans to reduce CO₂ emissions in general and the contribution of each option to the reduction of CO₂ emissions, which is one of the key issues in energy planning and the environment) it is one of the few examples of an energy SEA and can serve as orientation, albeit not as best practice.

Montenegro is one of the smaller countries in the Balkan region of Europe that was heavily affected by the Yugoslavian wars in the 1990s. Montenegro regained its autonomy in 2006 following the referendum and the subsequent declaration of independence by the Montenegrin Parliament and is a potential EU candidate country. The draft Energy Development Strategy (‘the Strategy’) set out the objectives of the Montenegro government for steering the future development of energy supply and demand over the period from 2005 to 2025.

Part A: General Principles on the Selection of Alternatives in (Energy) Planning

It should be stressed that selecting alternative options for SEA is not equivalent to devising alternative background scenarios (see box): the latter are meant to illustrate the uncertainty associated to future trends of exogenous factors (demography, macro economy, overall policy priorities, etc.), while the former describe alternative policy options to achieve sectoral objectives.

Why evaluations must be carried out on multiple options (alternatives)

In SEA several (i.e. at least two) plan (or programme/projects) alternatives should be evaluated. In fact, the identification of multiple options is a well-known prerequisite of all evaluation methods, including e.g. project EIA, or "traditional" Cost Benefit Analyses (CBA). An evaluation is a way of measuring the performance of a plan (or project, etc.), and whatever the criteria in focus, it mainly serves two purposes:

- assessing the viability of the option, which can in turn be interpreted as a combination of (i) its feasibility, and of (ii) its potential to achieve the initial objectives. In other terms, the viability check must allow to conclude whether the option is "generally sound", and consistent with the policy framework surrounding it. In that sense, the evaluation can be meaningful even in the presence of one, and one only option
- on the other hand, there may be several options that all fulfil the viability check, in the sense that they are all generally sound and contribute to the achievement of policy objectives. The issue then arises of which should be selected, and of how to rank them. Therefore, in order to provide conclusive input to decision makers, an evaluation must demonstrate that the option at hand is "superior" to others.

In summary, while an evaluation that examines only one option does indeed provide meaningful indications on the general soundness of that particular option, it does not allow to reach the conclusion that the option should be implemented, as other plans or programmes (which have not been considered) may prove superior.

How many alternatives?

Ideally, the widest possible range of alternatives should be identified in the scoping phase of SEA and then submitted to the comparative evaluation process within the impact assessment phase. On the other hand, SEA is a high level, strategic assessment approach, and should not be concerned with the distinction between variants that can only be differentiated in terms of e.g. technical implementation details (typically to be looked at within project EIA).

Although there is no standard rule to decide how many alternatives should be examined in any given SEA, a reasonable range spans from a minimum of 2 to a maximum of 4/5 options: less than 2 fails to provide conclusive evidence for decision making (see above), while more than 4/5 generally means that the differentiation between options is not sufficiently strong, and therefore not relevant in strategic terms. Also, comparing a large number of alternatives inevitably requires more, and more detailed, data, which is usually neither feasible (resource-wise) nor appropriate within an SEA.

Critical issues in selecting alternatives

Baseline

As a minimum requirement, a plan (or programme) must be assessed against the “basic” alternative that corresponds to the BAU option. This is often referred to as the comparison between “do nothing”¹ and “do something”. Hence the importance of carefully defining and documenting the BAU (see box), whereby this will not only serve as the reference for impact assessment, but will also establish, in line with the aim of the scoping phase, the framework for evaluation (which indicators, which level of detail, etc.) to be then consistently adopted for all the options, in order to ensure comparability.

While the BAU does not, by definition, include proposals designed to address specific problems or objectives, the “do something” options - if more than one - can be defined as alternative ways to depart from the BAU in order to respond to specific problems or objectives.

Identifying and designing such options therefore requires, as a starting point, the explicit representation of the problems/objectives that must be addressed, notably by answering basic questions such as: which problem(s) should be solved? Who is affected by the problem(s)? How big is (are) the problem(s)?

Scenarios are useful tools in environmental assessment for evaluating future states of the environment and assessing how they could be affected by policy interventions. The business-as-usual scenario, by providing the baseline against which the effects of a plan or programme and its alternatives can be compared, plays an important role in decision-making, since it will highlight the environmental implications of a policy option (EC, DG TREN, 2005). In contrast to a mere assessment of the *current* state, a BAU scenario allows to compare the expected effects of a new policy, plan or programme to the *future* state of society and the environment that is likely to occur in the absence of the respective policy, plan or programme. In the Xichang case, for instance, it could be used to compare the estimated amount of SO₂ emissions or the share of renewable energy in the energy mix after implementation of the energy plan with the “do nothing” option. Without a BAU assessment, the basis for assessment of the environmental achievements or negative impacts of a plan or programme is missing.

The BAU scenario is a so-called exploratory scenario, because it starts in the present and explores trends into the future. The principal elements of a BAU scenario include (Alcamo, 2001):

1. A **description of the likely step-wise changes** in the future state of society and the environment in the absence of any new energy policies. For example, the change of SO₂ and CO₂ emissions related to energy consumption over time.
2. The **driving forces**, i.e. the main factors that influence the step-wise changes. This could be, for instance, population and economic growth in Xichang. Values for driving forces can either be assumed by the assessor or taken from existing studies. Useful information may, for instance, be found in the Xichang energy

¹ The terms “reference scenario”, BAU and “do nothing”, although not fully interchangeable, all point to the same concept, whereby what really matters is to be able to compare the plan/programme to a reference option.

plan. So that the assumptions on economic growth and demographic development etc. can simply be adopted from the plan.

3. The **base year**, which marks the beginning year of the BAU scenario. Usually it is the most recent year for which adequate data are available.
4. **Time horizon and time steps**. Whereas the time horizon describes the most distant future year covered by the scenario, the time steps mark certain years between the base year and the time horizon. In the Xichang case, to be compatible with the energy plan, the time horizon is 2020 and the time step is 2010.
5. Often, a **storyline** gives a narrative description of the scenario, highlighting its main features, as well as the relationship between the driving forces and the main features.

Although the BAU scenario can be described qualitatively as is done in the storyline, a quantitative assessment is usually required in environmental assessments, as well. It should, nevertheless, be noted that the numerical information in a scenario is not an exact prediction of the future, but describes one of many possible futures (Alcamo, 2001). In order for the BAU scenario to be effectively utilised as reference scenario, transparency of the underlying assumptions on trends etc. is essential.

Box 1: Example for a Real-world Business-as-Usual Scenario Storyline

The ‘Do-Nothing’ Option in the SEA of the Montenegro Draft Energy Development Strategy (abbreviated version)

The SEA of the draft Strategy was a pilot SEA conducted according to the terms of reference set by UNDP Montenegro, one year before the coming into force of the Montenegro SEA law in January 2008. Its aim was to assess the environmental impacts of the development measures proposed in the draft Strategy, contributing to the public discussion and decision-making processes on the final Strategy. The SEA was also designed to assess the energy needs of Montenegro in the light of privatisation of large industries and to point out alternative energy solutions and mitigation measures, making concrete recommendations on the preferred course of action. The SEA report provided relevant information to support decision-makers in finalising the Strategy and its respective action plan. It was set up to be in line with the timing and processes of the Strategy development as far as possible.

The following paragraph represents an abbreviated version of the storyline of the do-nothing option used to describe the likely future energy situation in Montenegro in the absence of the Energy Development Strategy (Land Use Consultants, 2007).

Description of possible trends

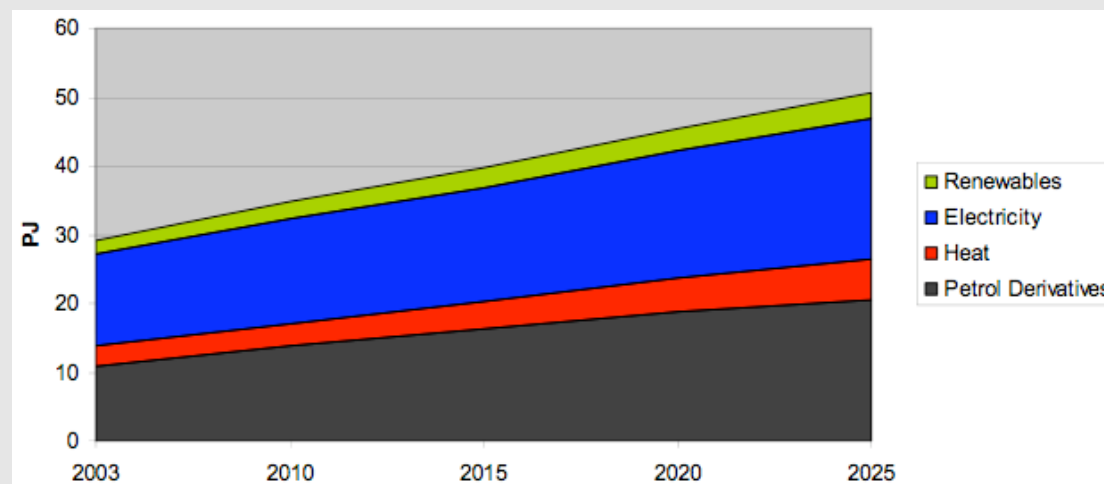
Table 1 and Figure 1 present the anticipated growth in energy consumption at five-year intervals based on the medium growth in energy demand adopted by the Energy Development Strategy.

Table 1: Energy sources meeting forecast final energy consumption

Sources	2003	2010	2015	2020	2025
Petrol Derivatives	10.9	13.75	16.36	18.81	20.38
Heat	2.84	3.29	3.88	4.81	6.06
Electricity	13.46	15.36	16.65	18.55	20.58
Renewables	1.98	2.44	2.94	3.26	3.62
Totals	29.18	34.84	39.83	45.43	50.64

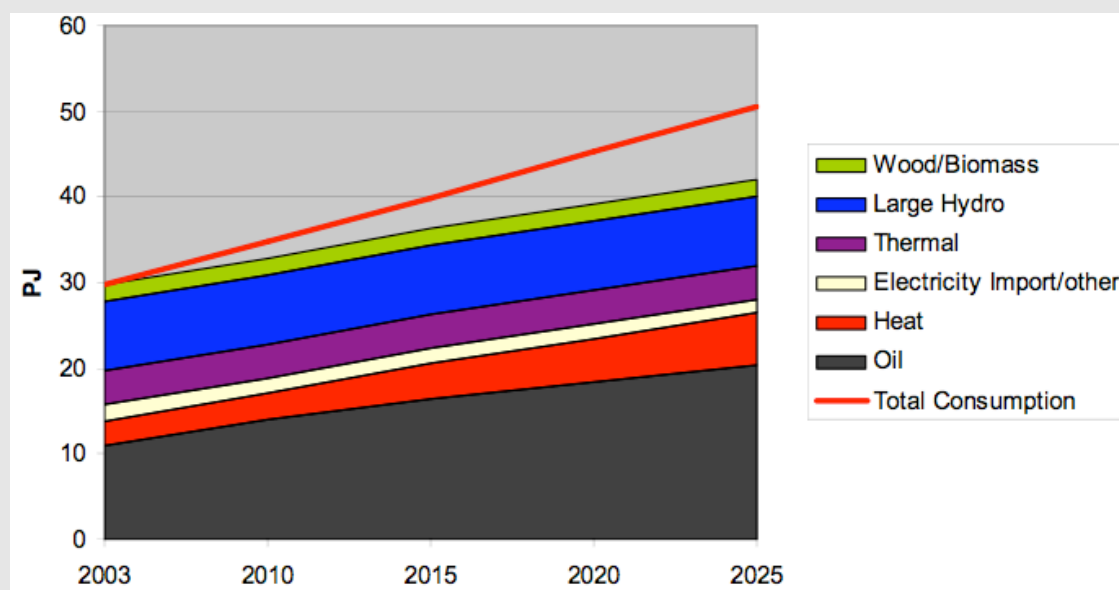
Figure 1 shows the contribution provided from different energy sources in the event that no development were to take place in terms of thermal or hydro electric energy and no government interventions were made in the markets. It is, however, assumed that the supply of oil, gas and heat energy would continue to expand to meet demand.

Figure 1: Growth in energy consumption (demand to 2025 based on the medium growth forecast of 6% per year)



The net consequence of doing nothing to support Montenegro's rising demand for energy would be a deficit increasing from its current level of 1500 GWh electricity to around 2788 GWh in 2025. This increased deficit would cost the national economy 56 million Euros² per year (i.e. 3.7% of GDP) at 2005 prices. Figure 2 illustrates the shortfall in energy supply projected in the Do-Nothing option.

Figure 2: Shortfall in energy supply in do-nothing option



Balance of Supply and Demand

In the event that the energy development strategy was not adopted and ad-hoc policies were imposed instead, it is likely that oil imports would play an increasingly important role in energy

supply to make up for any shortfall in electricity supply. The extent to which this substitution can be made is, however, limited and additional electricity would have to be imported at increased cost. Under these circumstances, energy prices would be strongly influenced by prevailing world costs for oil. The absence of a strategy would also make it less likely that coordinated programmes would be developed for urban transmission networks for liquefied petroleum gas (LPG). Nevertheless the main impact of having no energy strategy would be felt in the electricity sector, especially if measures to upgrade the transmission grid and links with neighbouring countries were not promoted.

Demand for oil derivatives cannot be satisfied from local sources in the foreseeable future (i.e. the next 10-15 years) although in the longer term there is the possibility of extracting oil and gas from Montenegrin waters if the presence of hydrocarbons, which has already been confirmed, leads to the discovery of commercially exploitable reserves. Montenegro therefore has no choice but to continue importing oil derivatives. As Montenegro's economy continues to grow, the demand for energy will also increase, even though energy efficiency and conservation measures are brought into effect. This reflects the fact that the country's economy was badly affected by the war and subsequent sanctions and is still in the recovery phase. All models of economic growth show that the current rate of growth (at around 6% per annum) will slow down to around 4% towards the end of the planning period.

If the forecast growth rates for energy demand (used in developing the Moderate Construction Scenario) are considered, demand for electrical energy is expected to increase from 4,765 GWh in 2005 to 5,791 GWh in 2025, an increase of 1,026 GWh representing 21.5%. In theory, this would give rise to a total annual deficit of around 2,542 GWh by 2025.

Energy Efficiency and Conservation

In the absence of any increase in electricity supply within Montenegro the country would have to rely increasingly on the import of electricity (or alternatively import larger quantities of lignite or oil derivatives from which to produce electricity). This would be likely to increase the costs in both the domestic and industrial market sectors.

Increasing electricity prices would have a range of negative effects, but increasing cost would also have positive benefits in terms of encouraging some fundamental changes in attitudes to energy use. Most consumers have become accustomed to buying electricity at heavily subsidised prices, and are only just beginning to adjust to increased costs. Greater concern over electricity prices would result in reduced electricity consumption, which would slow down or even reverse the trends of rising demand. Household consumers would be likely to reduce their dependence on electricity for space and water heating, turning back to wood fuel as a primary source. Higher costs would also make alternative heating solutions including use of solar energy much more attractive and in the process help stimulate new and innovative technologies.

Constraints on Development

An electricity shortage would also force industry to take the issue of energy efficiency more seriously. Nevertheless, such changes would take time and a shortage of supply at affordable prices could put a significant halt on economic growth in the short term.

Higher electricity costs would also affect all other sectors of the economy, including tourism, which is one of the primary growth areas. Fluctuating power supplies and increased overloading of the existing distribution system could further lead to more frequent failures in power supply.

Economic Effects

The economic consequences of increasing reliance on imported power and increased costs of electricity could be severe and would be both direct and indirect. In terms of direct effects, reduced profit margins, increased redundancies and more business closures could be anticipated. Indirect effects would include a loss of business and investor confidence and a decreased rate of GDP growth.

Social Effects

Rapid increases in domestic electricity prices could have a disproportionate effect on the most vulnerable sectors of society, who would have little or no opportunity of switching energy sources. Here, it needs to be acknowledged that the transition to a free market cost for energy is, however, already underway.

Any downturn in industrial activity could exacerbate the already high level of unemployment in Montenegro, which exceeds 21%³ in some areas. The most critically affected areas would be the main industrial towns in the central region, which currently provide more than 50% of overall employment.

Environmental Effects

While the absence of new energy infrastructure construction would avoid direct environmental impacts, there would undoubtedly be a range of indirect effects. Demand for fuel wood to meet short-term domestic needs could put pressure on forest resources by stimulating illegal logging or excessive felling rates in sensitive areas.

Review

In this case, the BAU scenario was explicitly used to describe a 'worst case' scenario, outlining the adverse social, economic and environmental consequences that would follow from not addressing future energy needs in Montenegro. It highlights the importance to reduce energy import dependency and identifies the speed of economic transition as a key-determining factor for the success of Montenegro's changing economy. By describing the adverse effects of the do-nothing option, the BAU scenario was used to highlight that socio-economic development has to be coordinated with the development of the energy sector to avoid energy scarcity, the importance of promoting energy efficiency, but also of avoiding a cheap supply of electricity from unsustainable sources

In the framework of sectorial development plans (e.g. energy, transport), and particularly so in regions characterised by high/fast growth expectations, the typical problem that drives the design of alternatives is that of satisfying increased demand volumes. This calls for a number of important considerations:

- How accurate, and detailed, are the available demand forecasts?
- Is infrastructure development the only possible answer?
- If infrastructure capacity increase is inevitable, should this happen through the construction of new infrastructure or/and through the expansion of existing infrastructure?

Demand forecasts

Decision making with respect to sectorial policies and plans, including large infrastructure projects, is largely based on ex ante evaluations of costs and impacts. The quality of these evaluations is in turn highly dependent on the reliability of the

demand forecasts. Notably, most environmental impacts (emissions of pollutants and GHG, noise nuisances, etc.) are directly (often linearly) related to the volume of demand: an *underestimation* of demand therefore leads to underestimate the negative environmental effects, and the social costs these represent. Furthermore, such underestimation will lead to the insufficient provision of mitigation measures, and the subsequent omission/underestimation of the corresponding costs and benefits. On the other hand, *overestimating* future demand may lead to the approval of a plan for expanding infrastructure capacity to an extent that is not required, with an unnecessary increase in environmental effects both at the infrastructure construction site(s) and across the network to which the new infrastructure is connected.

Basic recommendations to ensure the reliability of demand forecasts include:

- The use of modelling tools: as and when available, sectorial and intersectorial models provide precious inputs into demand estimation, notably by combining the effect of exogenous factors (demography, overall socio-economic trends, national economic policies, etc.) with that of sectorial policy decisions (infrastructure development, technological choices etc.). Models also allow carrying out sensitivity analyses, which are very useful in high uncertainty contexts such as those corresponding to long-term forecasts and fast growth. In the absence of modelling capabilities, demand forecasts will inevitably be affected by a high degree of uncertainty, which can only partly be addressed by recurring to background studies carried out in other regions with similar development prospects
- Rebound effects: expected growth in demand stimulates investment for the provision of additional capacity. It is however well known that in turn, the availability of additional capacity (supply) further stimulates demand growth. In other terms when supply is (over)abundant, additional demand is generated. Such “rebound effects” should be considered in projecting future demand.

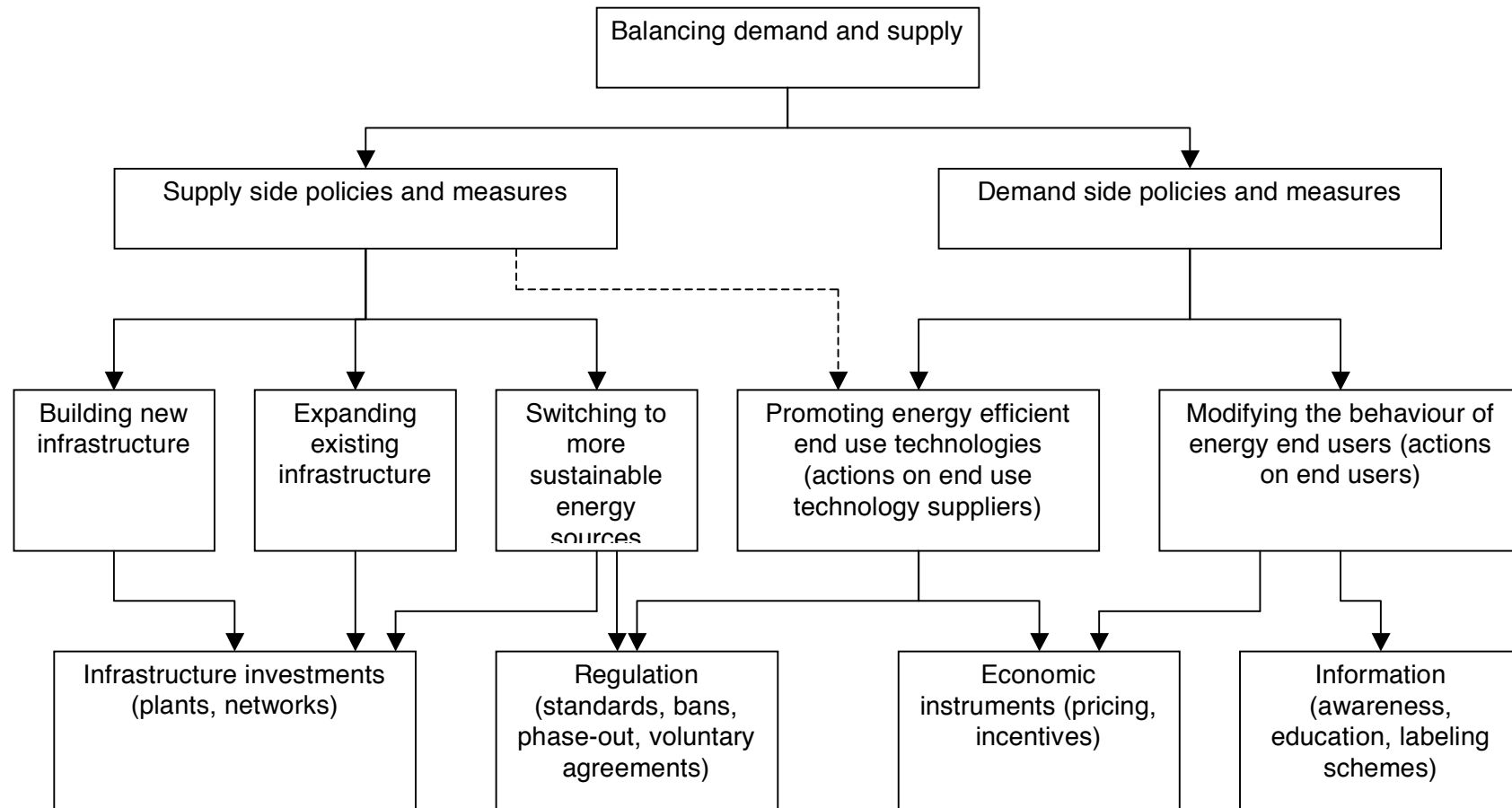
Infrastructure development vs. alternative options

Matching supply with expected demand is in most cases addressed through the provision of additional infrastructure capacity. Particularly in the framework of SEA, it is however essential that non-infrastructure solutions are also considered, as the negative effects on the environment are mostly associated with infrastructural developments and their subsequent operation. A typical example in the energy sector is the management of demand peaks: it is well known (and to some extent inevitable) that energy demand varies, even significantly, over time (daily peak hours, seasonal variations according to climate conditions, etc.). While infrastructure provision may appear to be justified by the need to ensure that peak demand is satisfied, there are alternative ways of matching supply with demand, for instance through pricing (or other instruments such as fiscal incentives, information campaigns etc.), which can considerably reduce the need for capacity expansion.

In most cases, balancing supply and demand can be achieved through a mix of infrastructure and non-infrastructure measures, and this must directly be reflected in the selection of SEA alternatives.

The diagram overleaf illustrates the range of options from which such a mix can be designed.

Figure 3: Summary of policy instruments to ensure the balance between energy demand and supply



New infrastructure vs. expansion/modernisation of existing infrastructure

Meeting an increase in demand can be achieved by the provision of new infrastructure or by enhancing the existing facilities to increase their supply capacity. While traditional CBA allows comparing these two options from the economic and financial viewpoint, the wide-ranging environmental impacts are often underestimated. The SEA approach often turns out to shed new light on the relative merits of the two options. The table below summarises the critical factors affecting the comparison, which should therefore be fully incorporated in the selection of alternatives.

Table 2: Building vs. expanding: pros and cons

	Building new infrastructure (i.e. new energy conversion/electricity generation plants)	Expanding the capacity of existing plants
Flexibility in the choice of technologies (and therefore possibility of selecting technologies that are less harmful to the environment)	+	?
Optimal siting of energy plants (and therefore possibility of selecting sites that minimise environmental impacts)	+	-
Minimising the number of production sites (and therefore the corresponding environmental impacts)	-	+
Minimising construction works (and the corresponding environmental impacts)	-	?
Limiting the needs of network expansion (e.g. distribution) and therefore reducing the associated environmental effects	-	+
Optimising the size of energy plants (and therefore reducing the associated environmental effects)	+	?

Summary recommendations on the selection of alternatives

Ultimately, the criteria to be taken into account for the selection of alternatives to be submitted to the SEA are primarily the following:

- Priority technological options (mostly derived from high level policy inputs such as e.g. phasing out of coal, promoting solar etc.)
- Infrastructure intensity

Clearly, budget constraints and potential access to the financial resources required to carry out the plan is also fundamental: even an alternative for which the full CBA is favourable may prove concretely unfeasible in case of insufficient short-term access to the required finance.

Part B: Tools for Impact Assessment

The expected impacts (on environment, society and the economy) of a given Policy, Plan or Programme (PPP) can be assessed in a variety of manners, and with the support of a wide range of technical tools. The choice of the most appropriate method (or combination of methods) mainly depends on:

- (i) the scope and scale of the assessment (spatial, temporal, sectorial)
- (ii) the required level of detail (which in turn depends on the strategic/operational nature of the decisions at stake)
- (iii) the availability of resources (data, tools, skills, finance, time).

In the context of SEA, the most relevant methods and tools from which to select are summarised in the table below.

Table 3: the SEA toolbox (simplified)

		Check lists	SWOT	Causal chains	GIS	Models	Indicators	CBA	CEA	MCDA
Screening										
Scoping	Definition of goals									
	Baseline analysis									
	Identification of alternatives									
	Evaluation framework									
Impact assessment										
Review										
Monitoring										

In this section we briefly present the main methods and tools for Impact Assessment, highlighting their strengths and weaknesses and their conditions of use.

Geographical Information Systems (GIS)

Main use for impact assessment

GIS are mainly used in the scoping and impact assessments steps, whereby the overlay of thematic maps allows to immediately visualise the critical phenomena (air quality, noise, sensitive natural resources, etc.) and the potential impact of the PPP development on such phenomena. A typical output is the identification of hot spots, corresponding e.g. to areas where the values of critical indicators (concentrations, number of people affected by noise, number of species endangered by the PPP) exceed the acceptable thresholds.

In addition to their power of representation, GIS can be used for simulation purposes, e.g. to carry out sensitivity analyses on drivers such as traffic flows, output level of energy conversion plants, etc. Simulations can also be carried out with GIS for what concerns e.g. the width of buffer zones around infrastructure, the sustainable level of critical indicators etc.

Strengths

GIS allow incorporating in a unique system a variety of tools designed to handle spatial data, including statistical analysis of territorial indicators. They do not require particular technical skills (e.g. programming knowledge). They allow for immediate visual inspection of complex phenomena, and are therefore also very useful for communication purposes (e.g. dialogue between technical experts and policy stakeholders, but also with the public at large in the framework of consultation and participation initiatives).

Weaknesses

GIS require large and detailed datasets, and often rely on vector data whose generation can be very expensive and time consuming.

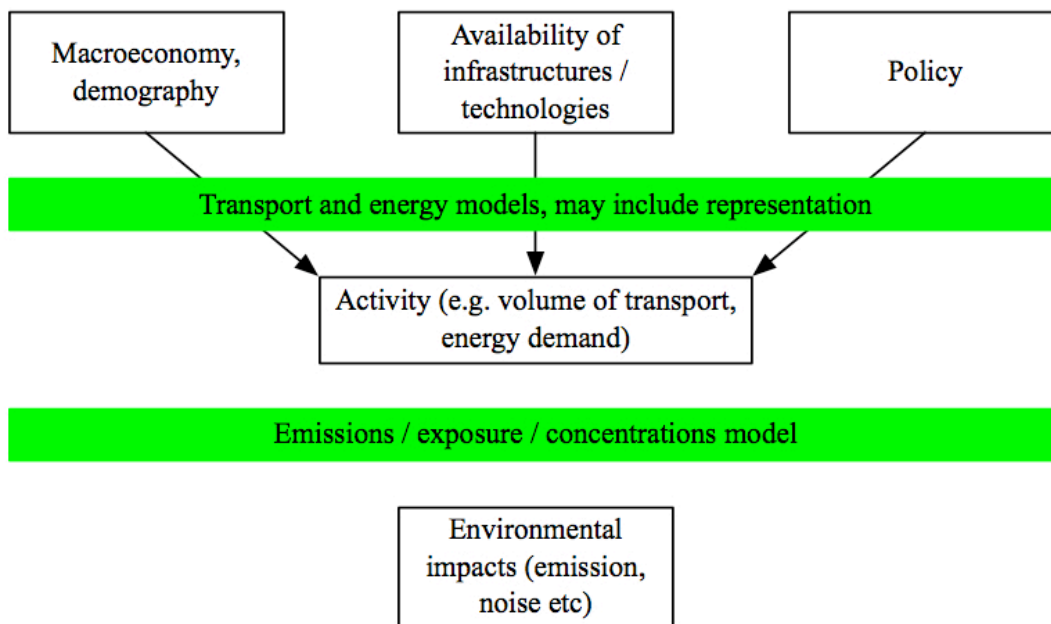
Models

Main use for impact assessment

Mathematical models, and the software developed to implement them, have the primary purpose of allowing for the analytical representation of current and future realities. In the framework of SEA, one should distinguish two main classes of modelling tools (see figure below):

- (i) Demand models, whose purpose is to simulate/predict the future evolution of demand (energy consumption, traffic flows) as the result of the implementation of the PPP at hand, and to compare these projections with the BAU forecasts. As explained in the previous sections on BAU and alternatives, a credible appraisal of the future dynamics of demand is a fundamental input to any impact assessment exercise, and models are by far the preferred option to achieve this. Demand models may or may not incorporate the interaction with land-use, by representing the influences of the PPP development on different groups of users, and relating the behaviour of residents and firms to physical changes in land-use.
- (ii) Emissions/exposure/concentration models, whose purpose is to simulate/predict the environmental consequences of a given level (and structure) of future demand on the quality of environment. The main outputs are changes in the concentration of pollutants in the ambient air and changes in the level of noise for affected population. These models may or may not be extended to the monetary valuation of the impacts, following the Impact Pathway Approach (IPA). Monetary valuation of environmental impacts is essential to carry out full-fledged Cost Benefit Analyses (see below) but may not be necessary in the framework of high-level assessments such as in SEA.

Figure 4: Models for Impact Assessment in SEA



Strengths

Demand models provide quantitative estimates of future flows and consumptions that are more reliable than simple extrapolations. They allow for easy sensitivity tests and can usually cope with both discrete and continuous variables (which can prove useful in planning the development of indivisible infrastructure, such as a new power plant or a new transport link).

Environmental models allow estimating the actual impacts (concentrations) and do not have to solely rely on inputs (emissions), therefore providing a more realistic and reliable assessment of the consequences of the PPP development. Depending on their level of detail, they allow for meaningful distinctions between different types of emissions and for the space-dependent assessment of impacts.

Weaknesses

The accuracy of demand models is highly dependent on the level of representation of the context (demand and supply segmentation, territorial/network segmentation). High levels of detail require large amounts of data that can be difficult to obtain. Environmental models can be highly demanding in terms of input data: accurate predictions require complex atmospheric modelling, which in turn requires a detailed knowledge of e.g. wind and temperature patterns (to simulate the fate of airborne pollutants), and of the topography of the affected territory (canyon effects, etc.).

Indicators

Main use for impact assessment

Indicators are quali-quantitative variables that are selected for their high meaningfulness in representing the critical behaviour of the system under observation. In the framework of environmental assessments, typical indicators are

e.g. the concentration of pollutants in the atmosphere, the number of people exposed to unacceptable levels of noise, etc. Their use in impact assessment exercises is dependent on the capability to measure the evolution of the variables they represent, which in turn normally requires specific provisions of infrastructure or equipment such as air quality measurement stations or the implementation of ad hoc surveys (e.g. to appraise the level of exposure of humans, fauna, flora, etc.). The main output of an indicator-based assessment is the estimate of the differential between the indicator values before and after the PPP development.

Strengths

Indicators are a highly synthetic form of representation of critical information. They therefore allow concentrating on the most important phenomena, and to communicate/discuss the expected impacts in an easy (although rough) manner. In the absence of modelling or other analytical tools, they provide meaningful indications of expected impacts. They can (and, as much as possible, should) be directly coupled with the use of GIS (see above).

Weaknesses

Indicators fail to provide the level of accuracy and reliability that can be expected from more analytical methods. Interactions (synergies, redundancies) between the phenomena that are measured by each of the individual indicators are usually not considered, which may lead to significant errors in quantitative estimations. Indicators should usually be complemented by other methods (e.g. MCDA, see below).

Cost Benefit Analysis (CBA)

Main use for impact assessment

CBA is a well-known method to assess the economic and financial performance of a PPP. It compares all costs and all benefits expected from the development of the PPP, and draws a balance (preferably a benefit/cost ratio). From the environmental perspective, traditional CBA is not appropriate in that it is limited to the costs and benefits for which there is a market (direct investments, operational costs, profits and losses of the economic agents involved, indirect economic benefits for society at large, etc.). The modern form of CBA, however, extends the list of costs and benefits to a variety of goods and services that, although they are not directly tradable on the marketplace, are recognised to have a value for society. SCBA (Social CBA) thus allows to account for costs and benefits that were formerly ignored, typically in the area of environmental and social performances and, in general, of the changes in well being and quality of life of society at large. In the context of impact assessment, the SCBA of a PPP is a very ambitious approach in that it requires the monetary valuation of all cost and benefit items. When feasible, however, it provides a solid and objective basis for decision, and is particularly helpful in ensuring the comparability of alternatives.

Strengths

SCBA is possibly the most objective method to compare the future performances of PPP alternatives. It overcomes the well-known problem of estimating the combined effect of phenomena that are not measurable in the same physical units (e.g. air concentration in PPM, noise in db(A), etc.), which in SEA terms correspond to the calculation of cumulative impacts.

It is based on a highly structured accounting framework, which usually helps reducing the risk of divergent interpretations of specific effects that are not immediately tangible.

Weaknesses

Although significant progress has been made over the past decades in the monetary valuation of environmental effects (and, to a much more limited extent, of social effects), the current body of knowledge and of practice does not allow for a comparable level of accuracy and reliability of the results. A typical example is the monetary value to be assigned to GHG emissions that contribute to climate change: the current uncertainties are still very high (values typically range between less than 10 EURO to several hundreds EURO for 1 ton of CO₂ emitted to the atmosphere), and the reliability of a CBA incorporating such estimates is clearly limited. On the other hand, when used for the purpose of comparing alternatives, SCBA can prove meaningful even in the presence of such uncertainties, as what ultimately matters is the differential between the various options.

Cost Effectiveness Analysis (CEA)

Main use for impact assessment

CEA is a limited form of CBA, whereby all costs are still accounted for, but only one benefit is considered. Typically, in the framework of environmental assessments this can be a targeted reduction in pollutant emissions or a targeted reduction in the number of species endangered etc. The final outcome of CEA is normally expressed as the cost required to achieve the target.

Strengths

CEA overcomes the problem of assigning a monetary value to goods and services that are difficult to value in economic terms. On the other hand, it still provides the means to compare the relative performance of alternative options.

Weaknesses

CEA requires that one - and only one - impact is considered. In some specific situations, where policy priorities are extremely clear-cut, this can be accommodated (e.g. in the case of policies where the reduction of CO₂ emissions is driving the whole strategy of the PPP). In most cases, however, policies identify more than one strategic target (e.g. energy savings + security of supply), which makes it difficult to adopt a CEA perspective.

Multi Criteria Decision Analysis (MCDA)

Main use for impact assessment

MCDA is another reduced form of CBA, whereby a wide range of costs and impacts are indeed considered, but are not systematically quantified in economic terms. MCDA identifies a set of criteria (reflecting policy priorities) and compares alternative options through the appraisal of their relative performances for each of the selected criteria. The output of MCDA is typically in the form of a matrix that maps the alternatives against the evaluation criteria, which can in fact be selected on the basis of the SEA objectives (see example below).

Table 4: Impact matrix with CEA (simplified version)

Criteria (= SEA objectives)	Alternatives			
	A	B	C	D
Conserve and enhance biodiversity	-	-	0	++
Improve air quality	-	-	+	0
Minimise land use	++	+	-	-
Minimise impact on protected areas	++	-	-	+
Reduce noise impacts	+	+	?	0

Weighting systems and/or numerical marks can allow to refine the analysis, and to add up results.

Strengths

MCDA can be carried out even with very limited input data. The MCDA process is easy to understand even to non-experts and can be adopted as a practical discussion framework.

MCDA can be carried out with limited time and financial resources, and entails the direct involvement of decision makers with different perspectives, which inherently facilitates the consultation and participation process.

Weaknesses

Although MCDA can be purely qualitative, it only achieves some robustness when the assignment of weights and marks is rooted in objective, technical knowledge. For instance (re. the above example), the extent to which a given option will actually allow to improve air quality can only be appraised with a reasonable degree of confidence if simulations are carried out to this end etc.

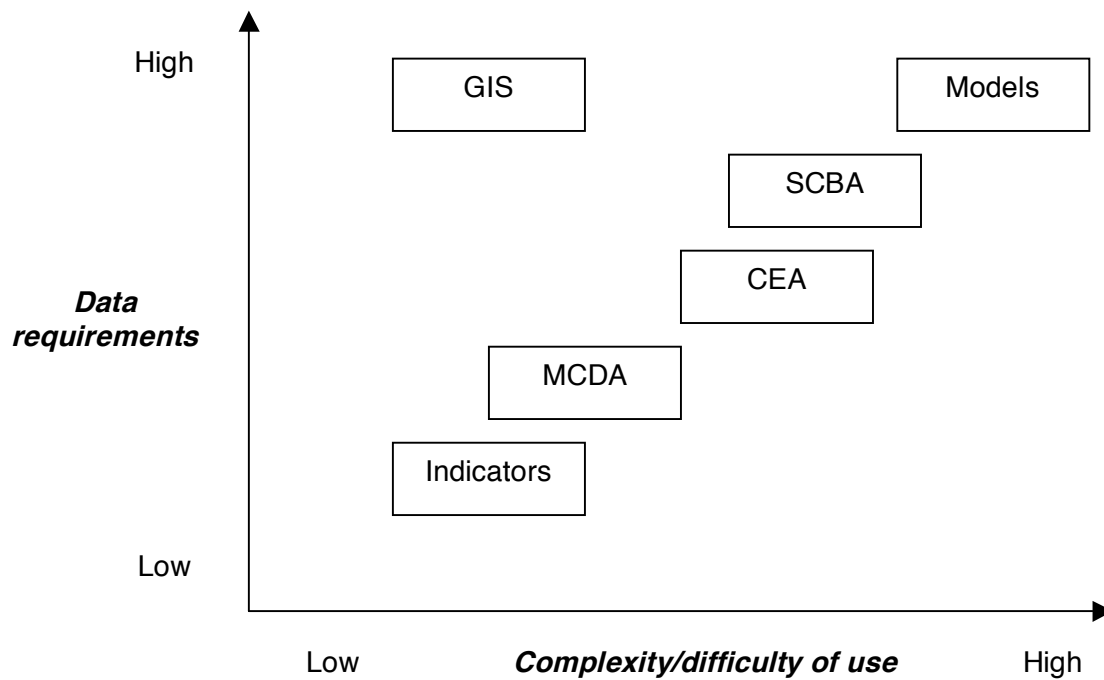
In the absence of a robust set of background inputs (possibly quantified), the risk is therefore that the subjectivity of the players prevails, and that the ultimate result of MCDA is meaningless.

Summary of Impact Assessment Tools

The choice of the most appropriate methods to carry out Impact Assessments in an SEA context depends on a variety of factors, and no preferred practice can therefore be recommended. Clearly, the functional performances of the main tools (as outlined above) play a fundamental role in this choice. Ultimately, however, constraints associated to the practical adoption and use of the tools often determines the final selection.

The figure below provides a simplified representation of the relative performance of the main IA tools with respect to the two most typical constraints: data requirements and complexity of use.

Figure 5: selecting IA tools and methods



Box 2: Access to the UNECE Resource Manual

For a more detailed overview of impact assessment methods please see the UNECE Resource Manual, created to support the application of the SEA Protocol. The Manual can be found online at:

http://www.unece.org/env/eia/sea_manual/welcome.html

In particular please see the following annexes to the UNECE Resource Manual:

[Annex A5.1](#): Description of selected analytical tools

[Annex A5.2](#): Description of selected public participation tools

[Annex B1.1](#): Example of a detailed capacity assessment for the implementation of the Protocol used in selected countries in the Eastern Europe, Caucasus and Central Asia region

[Annex B1.2](#): Example of simple terms of reference used for national capacity-development strategies for implementation of the Protocol in selected countries in the Eastern Europe, Caucasus and Central Asia region

Annex: The Montenegro Energy Development Strategy: an example of alternatives selection

This section summarises the process of selection of alternatives for the SEA of the Energy Development Strategy of the Republic of Montenegro, and briefly illustrates how such process matches with the general principles described in the box above.

Problems and objectives

An SEA was carried out for the Energy Development Strategy (EDS) of the Republic of Montenegro (RoM). The EDS is a high level strategic document that specifies plans, programmes and projects in view of the attainment of series of policy objectives laid out at the outset of the EDS:

1. Securing high quality, reliable and diversified power supply
2. Maintenance, rehabilitation and modernisation of existing, and construction of new infrastructure
3. Reduction of import dependence
4. Design of relevant legislative, institutional, financial and regulatory framework to encourage private sector involvement and investments
5. Creating conditions for higher utilization of renewable energy resources, combined power and heat and clean fossil fuel
6. Establishing of a competitive energy market
7. Provision of institutional and financial incentives to improve energy efficiency and reduce energy intensity in all sectors, from generation to consumption of energy
8. Sustainable energy production in relation to environmental protection and international cooperation especially with respect to reducing GHG emissions
9. Supporting research, development and promotion of new clean and efficient energy technologies and implementation of energy policy

These objectives have driven the design of the ESD itself and must be constantly referred to in the assessment of the proposed strategy. Their attainment is expected to provide a response to the basic “problem” faced by RoM in the energy sector, which can be summarised as “ensuring that energy supply from all sources and technologies potentially available allows to meet the needs of the fast growing RoM economy in the most sustainable way”.

In that sense, the 9 objectives must be distinguished between:

- Primary objectives, which are the direct “translation” of the basic problem and the conditions attached thereto: these are objectives (1) Securing high quality supply, (3) Reducing import dependence, and (8) Limiting the negative environmental effects of the development of the energy sector.
- All other objectives, which are in fact already expressed in terms of strategic lines of action: these can therefore be considered as the *high level means* to achieve the primary objectives. It is interesting to note that such proposed lines of action represent a good example of how to combine *supply side* options (provision of new infrastructure, enhancement/expansion/modernisation of existing infrastructure, development of renewable energy sources and technologies) with

demand management options (increasing energy efficiency, reducing energy intensity, regulatory and institutional interventions, market transformation), as illustrated in the diagram presented in the previous section.

Demand forecasts

Not surprisingly, the starting point for the EDS, and indeed for the identification of meaningful alternatives, is the assessment of future (up to 2025) energy demand. This is consistent with the nature of the “basic problem” addressed by EDS.

Energy demand forecasts have been elaborated for the BAU (“do nothing”) alternative, and summarised in the BAU chapter of this document. In the process of identifying other alternative options, it is however particularly important to gauge to *reliability* of the available forecasts. As previously noted, this is often the most critical input to the entire planning exercise: different levels of expected consumption will call for strategies and actions that differ both quantitatively (e.g. how much additional supply must be provided?) and qualitatively (e.g. can we live with a limited share of renewable energy sources while efficiency improvements are being implemented in traditional plants?)

Demand forecasts are affected by uncertainty in the EDS case, mainly due to:

- Uncertainties in the long term forecast of the basic macroeconomic indicators (i.e. GDP, trade, welfare, etc.)
- Uncertainties in the assessment of long term overall performances of the energy sector at both the national and the international level (technological performance, market trends, shortages, prices, etc.) that will strongly contribute to determining the dynamics of energy intensity (i.e. the extent of the possible decoupling of energy demand from economic growth)

Uncertainties in the energy demand forecasts ultimately result from the combination of these two basic factors. While the former (macro economy) must be considered as largely exogenous with respect to EDS, the latter (overall performance of the energy sector) is at least partially dependent on the soundness of future energy policies.

The SEA of EDS explicitly recognises this:

- first, the existence of uncertainties in energy demand forecasts is not ignored: setting long-term targets (e.g. in terms of energy intensity or total value of final demand etc.) is one thing, prescriptively adopting such targets as deterministic forecasts is far more dangerous
- second, alternatives are selected as appropriate (realistic) combinations of (i) a given macroeconomic scenario with (ii) a given energy policy option, where the latter reflects the implications of the former (e.g. a slow-down of the economy clearly accommodates reduced growth in additional power provision)

Selection of alternatives

At the outset, the EDS identifies a series of development scenarios and options. Although it explicitly recognises environmental and sustainability concerns as important policy drivers, it ultimately selects a “preferred option” (the so-called “moderate construction scenario”), retains a limited number of variants and discards other possible options, primarily based on the need to meet the targeted balance between supply and demand.

While it is not the duty of SEA to identify “new” scenarios, and even less to question the priority awarded to “solving the problem” (i.e. balancing supply and demand), SEA must somehow revisit the various alternatives in the light of environmental priorities. This results, in the case of the SEA of EDS, in widening the range of possible alternatives, as summarised below (simplified representation).

I. Moderate construction scenario

- Alternative I is set out to ensure that energy supply will be able to meet a medium-high growth in demand.
- Accordingly, it entails minimum risks of shortage and reduced need of electricity imports.
- While tapping a variety of both new and traditional energy sources, its emphasis is clearly on the construction of new, major HPP (Hydro Power Plants), while other “clean” sources (Wind, Solar, Biomass and to some extent LPG) are only expected to play a major role in the medium to long term.

II. Limited construction scenario (basic option)

- Alternative II mainly differs from Alternative I in that no major new HPP is foreseen.
- Consistently, it is unlikely to meet high energy demand growth, and therefore is mainly credible to the extent that demand forecasts are assumed to be lower than in the mainstream forecasts.
- Furthermore, electricity imports may increase in the short term

III. Limited construction scenario (first variant)

- Alternative III differs for Alternative II in that it strives to achieve a higher supply capacity (therefore also reducing the risk of higher electricity imports) without, however, recurring to the construction of new HPP.
- Accordingly, it focuses on:
 - the upgrade of existing power plants
 - the development of cogeneration (CHP)
- In addition, it aims at progressively replacing coal fired thermal plants with LPG.

IV. Limited construction scenario (second variant)

- Alternative IV is in fact an augmented version of Alternative III, in that it features, in addition, a major expansion work at one of the primary HPP plants, with the construction of an additional generator.
- It thus further reduces the risks associated to insufficient supply capacity.

V. Limited Construction scenario (third variant)

- Alternative V can also be considered as a variant to Alternative II, but as opposed to Alternatives III and IV, it gives clear priority to the development of renewable energy sources.
- This is expected, on the one hand, to provide increased flexibility in responding to future demand increases and the associated uncertainties. On the other hand, it is likely to entail higher risks of undercapacity in the short/medium term.

The Table overleaf provides a comparative view of the main characteristics of the Alternatives: as previously highlighted, from the SEA perspective, the two most important criteria correspond to (i) the technology choice(s), and (ii) the amount of new infrastructure to be built. On the other hand, the performance of each Alternative (in terms of its potential capability of ensuring the targeted supply/demand balance) plays a major role and must in any instance be explicitly considered in the decision process.

Table 5: Summary comparison of alternatives

Alternative	Main technology focus/priorities	Infrastructure intensity	Capability to meet demand targets (risk)
I. Moderate construction	Hydro Moderate increase in renewables (medium/long term)	Medium-high: construction of new major Hydro Power Plants (HPP)	Low risk if medium/high growth Reduced energy imports
II. Limited construction (basic option)	All sources (as Alternative I, with however no major new Hydro)	Medium-low: no major new construction	Assumes lower demand growth Risks of increased imports
III. Limited construction (first variant to II)	Replacement of coal with LPG Growth of CHP	Medium-low: focus on the upgrading of existing plants (including HPP)	Limited risk even with medium/high growth of demand
IV. Limited construction (second, augmented variant to II.)	Same as Alternative III + additional HPP generator at existing plant	Medium: major expansion at existing HPP	Low risk even with medium/high demand growth
V. Renewables (third variant to II.)	Major growth of renewables (wind, solar, biomass) All other sources as in Alternative II	Medium: high expected cost of effective policies for a decisive promotion of renewables	Very good prospects in the medium/long term Some risks in the short/medium term

Some lessons learned

- Ultimately, three main Alternatives seem to be sufficient from the SEA perspective:
 - BAU
 - Moderate construction
 - Limited construction (however with several significant variants)
- Alternatives are clearly differentiated in terms of the main criteria that are central to the SEA purpose: technology options and infrastructure intensity and therefore allow to provide “real” alternatives.
- The uncertainty inherently associated to long-term energy demand forecasts is fully recognised and this is in fact what appears to have prompted the design of the three variants to the basic Alternative II.
- Options that had been envisaged but somehow discarded in the formulation of EDS are brought back to attention, particularly for what concerns the credibility of alternatives that are based on a reduced growth in energy demand.

- The detailed analysis of alternatives carried out in the SEA has clearly shown that, despite the explicit recognition that is made - at the outset of the EDS - of the importance of energy efficiency programmes, the scenarios and options then formulated in the EDS do not then come forward with concrete suggestions in this regard. This reflects the (fairly common) habit of analysing with more care those decisions that entail investments (and the associated high costs/constraints), while assuming that all interventions that can be implemented at limited or no cost must somehow be taken for granted and therefore don't deserve particular attention in the decision making process. While this is understandable in the context of "traditional" planning (where budget constraints dominate), it is not acceptable from an SEA perspective: for instance, the contribution of a forceful energy efficiency programme may be decisive in attaining the targeted balance between supply and demand, so much so that it may in turn lead to significantly reduce the need for new construction.

References

- Alcamo, Joseph (2001) Environmental Issue Report No. 24: Scenarios as tools for International Environmental Assessments. Copenhagen: European Environment Agency. Available online at: http://reports.eea.europa.eu/environmental_issue_report_2001_24/en (accessed 18.08.2008).
- EC, DG TREN, ed. (2005) The SEA Manual. A Sourcebook on Strategic Environmental Assessment of Transport Infrastructure Plans and Programmes. Brussels: European Commission.
- Jurkeviciute, Ausra and Ricci, Andrea (2008) Good Practice principles for identification and assessment of alternatives in SEA. China-EPI-SEA Paper No. 16_EN. Wuppertal: Wuppertal Institute.
- Land Use Consultants, ed. (2007) Draft Environmental Report: SEA of the Montenegro Draft Energy Strategy. Bristol: Prepared for UNDP Montenegro and the Government of Montenegro.