S U S T E L N E T

Policy and Regulatory Road maps for the Integration of Distributed Generation
and the Development of Sustainable Electricity Networks

An Outline for Developing Regulatory Road Maps

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Abstract

This document provides an outline to develop road maps for the transition of a regulatory framework for electricity markets. A regulatory road map stipulates the regulatory actions regarding electricity networks and market access that are necessary to reach a desired future state of market organisation. This desired future state is described as a level playing field for centralised and distributed generation (DG), i.e. the participation of large-scale power generation and electricity generated by combined heat and power plants (CHP) and from renewable energy sources (RES) in the electricity markets on equal terms. The road map contains a series of regulatory actions and developments (in a time frame of 10 to 15 years) and indicates the timing of these regulatory steps. The timing of these steps depends on key developments in the electricity sector and the penetration of DG in the electricity market.

PREFACE

Technological developments and EU targets for penetration of renewable energy sources (RES) and greenhouse gas (GHG) reduction are decentralising the electricity infrastructure and services. Although liberalisation and internationalisation of the European electricity market have resulted in efforts to harmonise transmission pricing and regulation, no initiative exists to consider the opening up and regulation of distribution networks to ensure effective participation of RES and distributed generation (DG) in the internal market. The SUSTELNET research project provides the analytical background and organisational foundation for a regulatory process that satisfies this need.

Within the SUSTELNET research project, a consortium of 11 research organisations analysed the technical, socio-economic and institutional dynamics of the European electricity system and markets. This has increased the understanding of the structure of the current European electricity sector and its socio-economic and institutional environment. The underlying patterns thus identified have provided the boundary conditions and levers for policy development to reach long-term RES and GHG targets (2020-2030 time frame). It was consequently analysed what regulatory actions are needed on the short-to-medium term to reach the existing medium-term goals for 2010 as well as likely scenarios for longer-term goals.

Regulatory Road Maps
The main objective of the SUSTELNET project was to develop regulatory road maps for the transition to an electricity market and network structure that creates a level playing field between centralised and decentralised generation and network development. Furthermore, the regulatory road maps will facilitate the integration of RES, within the framework of the liberalisation of the EU electricity market.

Participatory Process
To deliver a fully operational road map, a participatory regulatory process was initiated throughout this project. This process brought together electricity regulators and policy makers, distribution and supply companies, as well as representatives from other relevant institutions. This ensured a good connection with current industry, regulatory and policy practice, created involvement of the relevant actors and thereby will enhance the feasibility of implementation.

Newly Associated States
The SUSTELNET project also anticipated on the enlargement of the EU by providing support to the Newly Associated States (NAS) with the preparation of a regulatory framework and thus also with the implementation of EU Directives on energy liberalisation and renewable energy in four Accession Countries (The Czech Republic, Poland, Hungary and Slovakia).

Project Structure
The SUSTELNET project was divided into two phases. During the first phase, the analytical phase, three background studies were produced:

- long-term dynamics of electricity systems in the European Union,
- review of the current electricity policy and regulation in the European Union and in Member States,
- review of technical options and constraints for the integration of distributed generation in electricity networks.

In the second phase, the participatory regulatory process phase, two activities took place, during which there were extensive interactions with regulators, utilities, policy makers and other relevant actors:

- Development of a normative framework: criteria for, and benchmark of distribution network regulation.
- Development of policy and regulatory road maps.

This Report

This report is produced in the second phase of the project to provide in input to the development of policy and regulatory road maps.

CONTENTS

EXECUTIVE SUMMARY

In the context of SUSTELNET a road map is a guide to the development of electricity regulation. A road map stipulates the regulatory actions that are necessary to reach a desired future state of market organisation. In SUSTELNET this desired future state is described as a 'level playing field' for centralised and distributed generation. This broadly means that centralised and distributed generation should be able to participate in the electricity market on equal terms. This rather general conception of a level playing field is operationalised through criteria for electricity regulation.

This document provides a framework for developing regulatory road maps. The framework consist of two dimensions and subsequent stages of development:
- Network regulation divided into five stages: self-regulation, cost-based incentive regulation, multiple driver incentive regulation, innovative regulation and active network regulation.
- Market access divided into three stages: protected niche market, DG/RES in wholesale market and level playing field.

For the development of regulatory road maps a step-by-step approach is proposed. This approach consist of five steps:
1. *Define starting point*: the starting point of the road map is established using the stages of network regulation and market access.
2. *Scenarios and background story line*: in this step a possible future for the electricity supply system is defined on basis of a scenario. Furthermore, specific policy targets and ambitions are defined and subsequently a story line is constructed describing the path along which developments can take place.
3. *Identify final status of the regulatory framework*: the final status of the regulatory framework is identified using the two dimensions network regulation and market access and the different stages.
4. *Back cast regulatory steps and check robustness*: the route along which the regulatory framework can be developed in time is established as well as the timing of the regulatory steps. Also the corresponding criteria for network regulation and market access are described. The robustness of the road map for different future developments (other scenarios and disruptive events) is considered.
5. *Describe actions and responsibilities*: in the final step a description is made of the responsibilities of different stakeholders and their actions in the road map (what and when).

1. INTRODUCTION

1.1 Introduction

Liberalisation and internationalisation of the European electricity market has resulted in efforts to harmonise transmission pricing and regulation through the Florence Regulatory Process. Although technological developments and EU targets for renewable electricity and GHG reduction are decentralising the electricity infrastructure and services, hardly any initiative exists to consider the opening up and regulation of distribution networks to the ensure effective participation of RES and DG in the internal market. The SUSTELNET project provides the analytical background and organisational foundation for a regulatory process that satisfies this need. The objectives of SUSTELNET are to:

- analyse the long-term technical, socio-economical and institutional dynamics that underlie the changes in the architecture of the European electricity infrastructure and markets,
- develop road maps for network regulation and market transformation to facilitate the integration of RES and decentralised electricity systems,
- lay the foundations for a regulatory process on the regulation of distribution networks in the EU, involving distribution and supply companies, national regulators and national and EU policy makers.

The main objective of SUSTELNET is to develop regulatory road maps for the transition to an electricity market and network structure that creates a level playing field between centralised and decentralised generation and network development, and facilitates the integration of RES, within the framework of the liberalisation of the EU electricity market. This report outlines the process of developing the road maps.

1.2 What is a road map?

The principle of regulatory road maps can be derived from technology road maps[1]. Technology road maps describe possible routes of technology development and show the probable date of market introduction. Often technology road maps also indicate the intermediate steps and timing of technology development.

In the context of SUSTELNET a road map is a guide to the development of electricity regulation. A road map stipulates the regulatory actions that are necessary to reach a desired future state of market organisation. In SUSTELNET this desired future state is described as a ‘level playing field’ for centralised and distributed generation. This broadly means that centralised and distributed generation should be able to participate in the electricity market on equal terms. This rather general conception of a level playing field is operationalised through criteria for electricity regulation.

A road map contains a series of regulatory actions and developments. Furthermore, the road map indicates the timing of regulatory steps. The timing of these steps depends on key developments in the electricity sector and the penetration of DG in the electricity market. The level of detail in the description of the regulatory actions is higher for the short-term actions than for the long-term actions. Finally, considering that regulation never takes place in isolation, a road map should address all stakeholders.

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1 For example: Electricity Technology Road map, EPRI, 1999. (http://www.epri.com/corporate/discover_epri/roadmap/index.html) or Hydrogen energy and fuel cells - a vision for our future, European Commission, June 2003 (http://europa.eu.int/comm/research/energy/nn/nn_rt_hlg2_en.html)

Within the SUSTELNET project nine national regulatory road maps will be developed:

- five EU MS: United Kingdom, Germany, Denmark, Italy and The Netherlands,
- four NAS: Czech Republic, Hungary, Poland and Slovakia.

Besides national regulatory road maps also an agenda for a European regulatory strategy will be developed.

1.3 What is a level playing field?

Market incentives and disincentives towards DG have to be treated basically in two different areas, i.e. the regulatory issues and the support mechanisms. While the former deals with the regulation of the electricity system - namely network regulation and market access - the latter are mainly introduced when the pricing system does not internalise all positive externalities created, to support technologies that are in their infant phases and to achieve a determined policy objective. Typically, regulation of current electricity systems favours centralised generation to the detriment of DG, and therefore support mechanisms are generally introduced to alter this. The SUSTELNET project departs from the basis that in a liberalised market the existence of a level playing field in the regulation of the electricity system is a precondition to achieve an efficient participation of DG. As a result, regulation issues of the electricity system are studied while support mechanisms, not specifically analysed, are assumed only to be used for the three aforementioned objectives: compensate externalities, support of infant technologies and achievement of specific policy objectives.

It is difficult to provide an exact definition of a level playing field. However, discussions in the SUSTELNET project have yielded valuable insights into what might constitute some of the ingredients of a level playing field. There is general agreement that a level playing field entails markets and regulation that provide neutral incentives to centralised versus DG. This requires that the all the values of DG are recognised, and that appropriate mechanisms are set up to put a monetary value to these values. Furthermore, incentives should be provided to network operators and generators to exploit these values in the best possible way.

It is recognised that the provision of non-discriminatory incentives and proper valuation of benefits and cost associated with distributed and centralised generation alone may not result in level playing field in the long run. Path dependencies in the electricity infrastructure are likely to create a bias towards centralised generation. It may therefore be taken for granted to temporarily tilt the playing field slightly in favour of DG in order to create a level playing field in the longer run. Thus a level playing field should balance long-term and short-term benefits and costs of the electricity infrastructure.

1.4 The future role of DNOs

Distribution Network Operators (DNOs) in the current electricity supply industry are passive organisations whose sole objective is the provision of distribution network services, mainly transport of electricity. The operation of the system and provision of ancillary services is generally done by the Transmission System Operators (TSOs). However, if the expected increase in DG wants to be successfully accommodated in the electricity system, electricity networks should reconfigure into active networks, where DNOs evolve from this passive organisation into more active actors. In other words, DNOs should become active and innovative entrepreneurs that would facilitate and profit from the connection of DG into the system. By doing so and because DNOs would receive the benefits DG creates, they would on the one hand be provided with incentives to connect DG and, on the other hand, provide the correct signals to generators and consumers in order to efficiently manage the network.

1.5 Structure of this report

Chapter 2 introduces the conceptual framework for developing regulatory road maps and in Chapter 3 the consecutive steps of developing a road map are outlined. Appendix A and B present information on the scenarios that were developed for the road maps. In Appendix C a set of general policy criteria is given that need to be taken into account when setting out regulatory strategies.

2. FRAMEWORK FOR DEVELOPING REGULATORY ROAD MAPS

Economic regulation can be defined as the protection of the public from the detrimental consequences of inadequacies of competition. As a result the regulator, via regulatory frameworks, becomes a substitute to markets forces. In the regulatory road maps, issues considered can be distinguished in issues related to network regulation and issues related to market access for DG. Various consecutive frameworks of network regulation and market development have been identified which can be used to describe the current status and development of regulation in different countries. Criteria are provided for each regulatory framework development to help determine what the current status of regulation is and to help define which regulatory steps need to be undertaken in order to establish a level playing field:

Network regulation deals with the allocation of different values DG generates. The values, which can be used as criteria of how these issues should be incorporated into regulation, were classified by the following distinctions (see also Leprich and Bauknecht, 2003):

- *Short/Long-term:* Describes the timeframe in which the benefits or costs arise to the DG or DNO.
- *Measurable/Non-measurable:* Describes whether the benefits or costs can be measured and quantified or not.
- *Individual/socialised:* Describes whether the benefits or costs can be assigned to the individual party that creates them or should be socialised as it is difficult to identify the issues. This distinction is strongly related to the distinction between measurable and non-measurable.

2.1 Network regulation

This paragraph provides of what could be considered as subsequent stages of development of network regulation. They are distinguished, on an indicative basis, for developing regulatory road maps. An overview of the characteristics, criteria and guidelines that distinguish the different stages of network regulation is provided in Table 2.1. In the sub-sections hereafter a short description is given for each stage of network regulation. Each subsection ends with one or more guidelines describing general rules or instructions.

2.1.1 Self-regulation

This regulatory framework is based on a light-handed regulation paradigm. As it relies on negotiation (nTPA) to determine contracts and tariffs, it generally develops with the absence of a central regulator[2]. It is argued that the system in practice is significantly inefficient, as companies, because no strict regulation is enforced, tend to charge higher than cost-reflective charges.

Guidelines: Implementation of negotiated Third Party Access.

[2] Not each EU MS or NAS currently has a regulator. The new EU Electricity Directive (2003/54/EC), however, requires a regulator for each member state.

Table 2.1 *Stages of network access and regulation*

Network Access		Description	Criteria DG values	Regulatory issues	Guidelines*
I	Self regulation	Passive, nTPA, no real unbundling required.	-	(Negotiated) connection charges (Access possible)	Negotiated TPA.
II	Cost-based incentive regulation	Passive, cost-driven, efficiency improvements, accounting/legal unbundling.	-	(Standardised) connection charges (Access mandatory)	Shallow connection charges, e.g. large scale power generation charged with UoS charges of the transmission network.
III	Multiple-drivers incentive regulation	Passive, cost-driven, short-term benefits and costs of all DG incorporated, multiple-drivers (quality, etc), DG integrated part of the regulation model, legal unbundling.	Short-term; measurable/non-measurable; socialised.	*Short-term* *Socialised*: network losses, avoided investments, (extra) DNOs OPEX	Shallow connection charges, e.g. dummy compensation for DG connected to low/medium voltage for network losses; DNOs contract system services with DG.
IV	Innovative regulation	Innovative network predominantly passive, multiple drivers, long-term/short-term, benefits/costs of DG, some individual allocation, incentives for innovation, legal unbundling.	Some short-term/long-term; measurable/non-measurable; socialised/individual.	*Short-term* *Individual*: metering, connection costs. *Socialised*: network losses, (extra) DNOs OPEX *Long-term* *Individual*: avoided investments *Socialised*: improved security of supply by DG, DNOs innovation incentive	Shallow connection charges plus entry/exit charges, e.g. surcharge UoS charge in order to cover for innovation experiments costs.
V	Active Networks	Holistic approach, active, innovation, DG integrated part of regulatory model, legal (ownership?) unbundling. Isn't ownership unbundling more appropriate here?	Short-term/Long-term; measurable/non-measurable; socialised/individual.	*Short-term* *Individual*: network losses, metering, connection costs, system services (reactive power, voltage support, etc). *Socialised*: (extra) DNOs OPEX, *Long-term* *Individual*: avoided investments *Socialised*: improved security of supply by DG, DNOs innovation incentive	Actively managed networks. Shallow connection charges plus entry/exit charges, e.g. higher allowable rate of return for innovation investments (consequence of higher risk).

* This column includes both guidelines that are universally agreed upon and therefore should be considered when building the road map and examples of guidelines. The latter, which are preceded by an example, are included only for clarification purposes and therefore it is up to the users to make use of it or not in the development of the national road maps. Although the examples can repeat themselves in the different regulatory stages, they are only included once in the table.

2.1.2 Cost-based incentive regulation

Cost-based incentive regulation aims at reducing the problem of asymmetric information between the regulator and the DNOs, while providing incentives for efficiency improvements. Firms under this regulatory framework are encouraged to reduce the costs of the benchmarked variables, i.e. improve the firm's cost performance on the components that are compared against some predefined or benchmark performance. The system can be implemented either through a price or revenue cap. The latter system favours the development of DG by not encouraging DNOs to maximise flows in the grid - as a price-cap does. It is important to note that this type of regulation while encouraging DNOs to reduce costs does not provide, by itself, enough incentives to improve or even maintain the technical performance of the network.

> *Guidelines*: Price or revenue caps; benchmarks; x-factors; shallow connection costs, compensation mechanism to treat unequal division of costs between DG and centralised generation (e.g. large scale power generation charged with UoS charges of the transmission network).

2.1.3 Multiple drivers incentive regulation

Under a multiple drivers incentive regulation framework, short-term benefits and costs of DG are allocated through the regulatory framework. The main difference between a simple cost based incentive regulation, and a multiple driver incentive regulation lies on the issues considered for benchmarking between firms. In other words, the incentive regulation does not only focus on costs, but also on other issues such as quality, number of connections or network losses, which are also benchmarked between DNOs. This regulatory framework provides incentives maintain or improve technical performance of distribution networks.

> *Guidelines*: performance based incentive regulation; price or revenue cap; benchmarking of issues such as quality; x-factor; shallow connection charges, compensation to treat unequal division of costs between DG and centralised generation (e.g. large scale power generation charged with UoS charges of the transmission network), network losses (dummy[3] compensation for DG connected to low/medium voltage for network losses).

2.1.4 Innovative regulation

Active (or innovative?) networks are the consequence of innovative regulation. In other words, innovative regulation sets the playing rules and provides incentives for DNOs to develop the network through innovation and the implementation of new technologies. The innovative regulatory framework emphasises therefore on providing DNOs with incentives to innovate. Although some short and long-term benefits and costs of DG are allocated, some of them are not as, for example, network losses still cannot be individually measured.

Connection charging in this regulation stage remains shallow, however the compensation to treat unequal division of costs between DG and centralised generation is replaced by the introduction of entry and exit charges (see also Mitchell, 2002). Entry charges are a single or annual payment for generation connecting into the distribution grid which can be positive, zero or negative, depending of the incentives that want to be given. The entry charge does not reflect the reinforcement costs to the network of the connection - i.e. the difference between deep and

[3] Dummy approach refers to e.g. a method of averaging costs and/or benefits of DG and spreading them equally across connected DG.

shallow, but could be based on capacity and would provide the DNOs with the ability to incentivise generation to particularly areas of value to the network.

Exit charges should encompass all other costs raised by the distribution of electricity generated by generators. These include: the payment for the difference between deep and shallow connection, the payment for transport of kWh across network, the payment for operation and maintenance of the network and the payment to ensure capacity to meet peak demand. Moreover, different demand customer sets could pay for different elements of the costs. For example, all demand customers might pay an average charge for the difference between shallow and deep connection while demand customers in a DNO region might pay for Operation and Maintenance (O&M) of their region.

> *Guidelines*: Shallow connection charges plus entry/exit charges, innovation incentive (e.g. surcharge UoS charge in order to cover for innovation experiment costs).

2.1.5 Active Networks

Active network regulation is the final stage of the series of subsequent regulatory frameworks. The process to achieve active networks can differ in time, depending on the different variables that influence the development of the networks. Some systems can react slower to the exogenous (tools regulators and policy makers have) and endogenous (intrinsic to the system) incentives given than other systems. Therefore uncertainty levels on when active networks will develop are high.

Active networks are considered as facilitators of DG, i.e. they consider DG as an integrated part of regulatory models. Active Networks work under the premise that passive distribution networks evolve into actively managed networks. Consequently, active networks (or Active Networks?) do not supply power but connectivity, in other words, the network should not be considered as a power supply system but as a highway system that provides connectivity between points of supply and consumption. DNOs become entrepreneurs; business oriented firms that should gain from connections and be incentivised to keep costs down, meet performance outputs and do things differently or in an innovative way.

DG is considered as an integral part of the regulatory framework. Consequently, all costs and benefits of DG are, when possible, effectively allocated. As an example, network losses can be measured individually under active networks.

> *Guidelines*: actively managed networks, shallow connection charges plus entry/exit charges, innovation incentive (e.g. higher allowable rate off return for innovation investments as a consequence of higher risk).

2.2 Market Access

This paragraph describes the subsequent stages of market access for DG that are distinguished for developing regulatory road maps. An overview of the characteristics, criteria and guidelines that distinguish the different stages of market access is provided in Table 2.2. In the subsections hereafter a short description is given for each stage of market access.

2.2.1 Protected niche market

With low to moderate penetration levels of DG and possible underdeveloped energy and ancillary services markets, support mechanisms such as priority dispatch or obligatory purchase regimes are in place. If this is the case, DG does not have to deal with the access to energy and ancillary services markets. In other words, DG works outside the market. All external energy costs and benefits are born by other actors in the electricity market. With low penetration levels, priority access and obligatory purchase schemes, such as feed-in tariffs may be the most efficient way to incorporate DG in the electricity infrastructure. However, as the penetration of DG rises, the efficiency of such schemes is likely to diminish and participation of DG in energy and ancillary services markets may be warranted. In some countries wholesale energy and ancillary services markets have not yet developed to the extent that DG could be integrated in them. In these cases creating a protected niche market for DG may also be justified.

2.2.2 Settlement in energy and ancillary services markets

Moderate penetration levels of DG together with developed energy and ancillary services markets are a characteristic in this energy system. DG is supported through market conform pricing mechanisms such as green certificates or premium tariffs based on the environmental attributes of the power. DG has to sell its energy on the wholesale market, just like any other generator. It also has to purchase ancillary services from the TSO, distribution system operator (DSO) or from the ancillary services market. DG can only enter on the demand side of the ancillary services market. DG cannot participate in the supply side of ancillary services markets. For example, in the Netherlands DG operators can sell their electricity on the wholesale electricity market. DG induces demand for ancillary services from the TSO. However, DG is not allowed to offer balancing capacity in the balancing market and it cannot be compensated for providing ancillary services to the grid operator.

2.2.3 Active participation in energy and ancillary services markets

In systems with a high level of DG/RES supply dispatch problems can occur, for example if large amounts of wind power are supplied to the market. DG/RES supply should respond to changes in the power demand, i.e. DG/RES supply start playing a role in balancing the electricity system. In this stage of development of energy and ancillary services markets DG can also participate in the supply side of markets. For example, DG is allowed to bid its supply into the balancing market, or a DG can have contract with a DNO to provide voltage support and reactive power. A supply contract for ancillary services with a DNO requires that the DNO has a free choice in deciding where to source its ancillary services. This also has to be taken into account in network regulation. DG/RES generators can be controlled in so-called active networks. For this a data acquisition and control system should be in place (i.e. an active distribution network). See also stage V of the network regulation.

Table 2.2 *Stages of market access*

Market access	Description	Rationale	Criteria		Guidelines
			Type of market access issues	Market access issues	
A. Protected niche market	DG outside the markets; good market mechanisms in place?	Low (Moderate) penetration level of DG. Protection of incipient (???) DG.	Energy.	DG supplies: - Energy.	- Priority dispatch, obligatory purchase regimes, - Regulated feed-in tariff possibly also compensating for system benefits.
B. Settlement in energy and ancillary services markets	Assuming markets for energy and ancillary services in place, DG anticipates in the demand side of this market. Demand side is regulatory/mandatory. DG has no or indirect effect on prices.	(Low) moderate penetration level of DG.	Supply of energy and demand of services.	DG supplies: - Energy. DG demands: - Reactive power - Balancing power - Back up power - Voltage support.	- Separate commodity price, - Market support mechanisms to stimulate technologies and account for externalities, - DG in competition with large-scale generation.
C. Active participation in energy and ancillary services markets	DG participates in demand and supply side of markets. DG has direct effect on prices through markets.	High penetration level of DG.	Supply and demand of energy and services.	DG supplies: - Energy - Balancing power - Reserve power - Voltage support - Reactive power. DG demands: - Balancing power - Back-up power, - Voltage support - Reactive power.	- Separate commodity price, - Market support mechanisms account only for externalities, - DG in competition with large-scale generation.

2.3 Regulatory road map scheme

The scheme for defining the starting point and regulatory steps for the road maps can be established through a combination of the stages of network regulation and the stages of market access. Table 2.3 gives an overview.

The arrows indicate the possible routes for improvement of the regulatory framework. Network regulation can be improved separately from market access (vertical arrows), but if market access of DG improves this will probably also require changes in network regulation (diagonal arrows).

If market access of DG/RES remains low or moderate, this will not require innovative networks (grey area in Table 2.3). Therefore, the development of network regulation could be limited to Stage III for a low and Stage IV for a moderate DG/RES supply level.

Table 2.3 *Regulatory road maps scheme*

			Market Access of DG/RES		
Market access			Protected niche market	DG/RES in wholesale market	Level playing field
	I	No regulation/ self-regulation	I-A	I-B	I-C
Network regulation	II	Cost driven incentive regulation	II-A	II-B	II-C
Network regulation	III	Refinement of cost driven incentive regulation	III-A	III-B	III-C
Network regulation	IV	Innovative regulation, predominant passive network		IV-B	IV-C
Network regulation	V	Innovative active network	No innovative networks required		V-C

3. A STEP PLAN FOR DEVELOPING REGULATORY ROAD MAPS

3.1 Introduction

The development of the regulatory road maps can be divided into five steps:
1. define starting point,
2. scenarios and background story line,
3. identify final status of the regulatory framework,
4. backcast regulatory steps and check robustness,
5. describe actions and responsibilities.

3.2 Step 1: Define starting point

The first step is to define a starting point for the road map, i.e. the starting point of scenarios for possible futures. This starting point can be described with use of descriptors that were used in the scenario development. Within the SUSTELNET project more than 120 possible descriptors have been identified. To keep the scenarios operational, a limited number of these have been selected for the basic scenario layout (see also: Timpe and Scheepers, 2003). Table 3.1 provides an overview of selected scenario descriptors.

Table 3.1 *Scenario descriptors*

Category	Descriptors
Technical	• share of DG in the electricity supply system, • share of natural gas and renewables in power supply, • interconnection with other countries/ imports, • reliability of the electricity network, • ICT development, • investment plans for power plants, • network innovation, experiments, • new DG technologies.
Socio-economic/political	• market concentration in electricity supply, • national/EU policy on energy markets (harmonisation), • environmental policy, • energy/fuel prices, • support schemes for CHP and RES, • cross-border trade, • market opening.
Institutional	• ownership of networks, • vertical/horizontal integration/ unbundling, • regulator, • power markets.
Regulatory	• network regulation considering DG, • type of network access (nTPA/rTPA).

Describing the starting points with the use of descriptors provide a very broad picture of the current status of the electricity sector in a country. In order to be able to develop a regulatory road map more details on the status of electricity regulation are needed. Therefore, the regulatory starting point should be established. This is done by using stages of network regulation and market access in the conceptual framework of the regulatory road map scheme. For a country the current stage of network regulation and market access is determined. The criteria that are provided for each stage will help to determine at which stage a country currently is.

3.3 Step 2: Scenarios and background story line

3.3.1 Scenarios

The next step is to define the possible future for the electricity supply system. By using two independent factors (harmonisation of EU regulation and the incentives for RES and DG) in the SUSTELNET project four different possible futures have been identified (Christof and Scheepers, 2003). These four scenarios are characterised in Table 3.2 (see also Appendix A).

In principle regulatory road maps can be developed for each of the four scenarios. However, a better approach is probably to develop one road map as a reference and to investigate the robustness for other scenarios and to identify possible alternative actions. Since road maps should map out a regulatory strategy that allows a strong increase of DG and RES, the road maps should be developed for a scenario complying with such a development. Furthermore, the road map should take into account certain external conditions, e.g. EU requirements. Therefore, scenario A (DG opportunities in a fully harmonised EU market) is the preferred scenario for developing the regulatory road maps.

Table 3.2 *DG Scenarios*

	High RES & DG incentives	Moderate RES & DG incentives
Stronger EU harmonisation policy	<u>Scenario A</u> DG opportunities in a fully harmonised EU market • Efficient regulation (EU Regulator), • Market concentration, • Non discriminating grid access rules, • Ambitious EU-wide targets for RES & DG, • Strong EU-wide support schemes (tradable certificates).	<u>Scenario B</u> Difficult times for DG in a fully harmonised EU market • Efficient regulation (EU Regulator), • Market concentration, • Grid access rules disfavour small units, • Harmonisation of RES & DG support at a low level, • EU wide certification schemes (tradable certificates).
Reduced EU harmonisation policy	<u>Scenario C</u> DG opportunities in national markets • No harmonised regulation (national focus), • Some MS implement fair grid access, • Ambitious EU-wide targets for RES & DG, • Diversity of national support schemes, • Strong RES & DG support compensates for regulatory deficits.	<u>Scenario D</u> Difficult times for DG in national markets • No harmonised regulation (national focus), • No improvements in grid access, • National support schemes partially reduced, • No compensations for regulatory deficits.

The scenarios are meant to cover a time frame until at least 2020. Because of the relative slow changes of the electricity networks, this year is used as a ‘snapshot’ in a long-term development that will continue beyond this year. The situation of electricity supply system in a country in 2020 should be described by using the scenario descriptors (Table 3.1). As an example scenario descriptors are presented in the multi-level matrix for Scenario A in Appendix B.

3.3.2 Set targets and ambition

Specific policy targets and ambitions should be defined. The most important target for the development of road maps is the level of DG and RES.

To be able to determine the DG supply level existing CHP and RES scenarios and forecast approaches can be used. Unfortunately, quantified DG scenarios are not available. In principle the level of DG can be derived from more specified scenarios and forecasts. For example district heating and large-scale industrial CHP subtracted from total CHP will result in DG-CHP and large hydro, offshore wind and biomass co-firing subtracted from the total RES supply will result in DG-RES.

For the possible development of CHP the quantitative information from scenarios developed in the SAVE project Future COGEN[4] can be used. This study provides quantitative forecasts for individual countries, EU MS as well as NAS. For possible development of RES in EU MS results of the ALTENER project Admire REBUS[5] can be used. Based on renewable electricity cost potential curves for each EU MS, the REBUS model quantifies the development of renewable electricity production in EU MS if a market of tradable green certificates is introduced and by creating demand for green electricity, either by setting a quota obligation, or by sustaining the voluntary green electricity market through fiscal incentives. NAS are not included yet in this model.

Other targets and ambitions, which are relevant for future energy and environmental policy, are:

- security of electricity supply (including system reliability),
- securing the basic infrastructure of member states' economies,
- economic efficiency and cost-effectiveness of electricity supply (this shall be facilitated by liberalised markets with fair competition),
- harmonisation of electricity policy and creation of a European Internal Market (including integration of the NAS countries),
- environmental targets, these include:
    - greenhouse gas emission reduction
    - expansion of renewable energy and co-generation market shares
    - targets for the development of bio-fuels and hydrogen,
- protection of other interests (e.g. creation and conservation of jobs, etc.).

3.3.3 Construct background story line

Subsequently, a story line should be constructed, i.e. a description of the path along which developments could take place. For constructing the story line the scenario descriptors should be used by which already the starting point and the future state (2020) was described.

Existing policy targets should be taken into account (e.g. complete market opening in 2007, GHG-emission reduction targets for 2008-2012, RES target for 2010, etc.). Also the possible effects of existing policies should be considered, as well as new policy that will be implemented soon (e.g. renewable energy policy, CO_2 emission trading, changes in electricity regulation).

Although, in reality disruptive events may change developments drastically, these events cannot be foreseen and should not be included in the story line. The story line should assume a gradual development. The story line should be consistent and realistic.

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[4] (*The Future of CHP in the European Market - The European Cogeneration Study*, 2001). Http://tecs.energyprojects.net.

[5] Http://www.admire-rebus.net.

3.3.4 Identifying critical points

From the background story line critical points and path dependencies in achieving medium and long-term targets should be identified. It may be impossible to achieve the targets and ambitions set in 3.3.3 or these targets can only be met under specific conditions. These conditions should be identified and described. If targets cannot be met, the targets should be adjusted.

3.4 Step 3: Identify final status of the regulatory framework

With the scenario and the background storyline the future is described. Now the final status of the regulatory framework in the road map scheme should be identified (see Table 2.3). The following approach should be used:

- establish stage of market access on basis of the level of DG (low, medium, high),
- establish the stage of network regulation:
  - in case the market access level is becoming A (low), the network regulation develops to level III (Refinement of cost driven incentive regulation).
  - in case the market access level is becoming B (moderate), the network regulation develops to level IV (Innovative predominant passive network).
  - in case the market access level is becoming C (high), the network regulation develops to level V (Innovative active network).

3.5 Step 4: Backcast regulatory steps and check robustness

3.5.1 Establishing the route

There are more routes along which the regulatory framework can be developed. These routes are marked in Table 2.3 with arrows. Network regulation can be improved independent from improvement of market access, but if the market access of DG/RES is changed this may require an improvement of the network regulation (diagonal arrow). The route along which the regulatory framework could be improved should be established.

3.5.2 Define timing of regulatory steps

Changing the regulatory framework will often take more than one step. The consecutive steps should be timed. Network regulation is often valid for a certain period (the regulatory period) and should not be changed within this period. The start of a new regulatory period is the optimal timing for implementing new regulation.

3.5.3 Describing criteria and guidelines

After the route and timing of the regulatory road maps is established, criteria and guidelines for each regulation step should be described. Criteria and guidelines are presented in Table 2.1 and Table 2.2 (see also Leprich and Bauknecht, 2003). Since electricity network regulation is complex the descriptions should be limited to criteria and guidelines. However, to make the road map more concrete guidelines could be more detailed for the regulatory improvements on the short-term. Furthermore, planned changes in the current regulatory framework that will be implemented soon, should be included. Appendix C presents some general policy criteria for regulation that should be considered.

3.5.4 Check robustness

In the road map different future developments should be considered. If for example the development of DG will be constrained and the level of DG in 2020 will be lower than assumed for

Scenario A, the regulatory framework in place should still be appropriate. Therefore the regulatory action in the road maps should be checked for different developments. Two approaches should be used:

1. check for a gradual development in another direction (in the direction of Scenarios B, C, D)
2. check for disruptive events.

In case of a different scenario outcome than Scenario A we can use the descriptions of the other three scenarios (see Appendix A). For each of the scenarios (B, C, and D) it should be indicated in the road map at what point the regulatory framework should changed if the outcome will be different from Scenario A.

Disruptive events can have a major impact on the development of electricity networks. There are several types of disruptive events. First of all, we can make a distinction between 'man-made' and 'natural' events. Examples of 'man-made' events are accidents, e.g. in a nuclear power plant or a terrorist attack on power plants or on the network infrastructure. Examples of 'natural events' are severe droughts, influencing the availability of hydropower, floods or earthquakes, destroying the infrastructure. One can also make a distinction between events inside the electricity supply system (e.g. a crisis in supply like the California crisis) or outside the system (e.g. terrorist attacks, but also an economic or political crisis).

The essential character of disruptive events is that they disrupt the 'normal' course of development, or in other words they *can* change the direction or pattern of development decisively. The impact of disruptive events on a system depends on the timing (when does the event happen?). If such events happen in a situation of great stability, the impact usually will be limited. Stable systems normally are able to absorb or cope with external or internal disruptions. The impact of disruptive events on systems in a phase of transition - like the current electricity systems - can be much larger. Summarized: not only the specific nature of the event but also the state of the 'recipient' is relevant. Moreover, a combination of events (relatively close in time) or a chain of events can have a much larger impact than a single event.

Although disruptive events are unpredictable by nature, also the timing of disruptive events matters in another way: for the situation in 2020 disruptive events in 2015 will affect the state of the electricity system less than events that take place in 2005. In order to deal with this we have to make a few simplifications. Although, disruptive events that result in scenarios, which are not yet covered by the range of the four scenarios used here, only the impact of a disruptive event on the two main scenario dimensions (the degree of harmonization in the EU and the degree of support for Distributed Generation in the EU) will be evaluated. It should be indicated how the regulatory framework should respond to a sudden change on the short-term (2005) as for the long-term (2015).

3.6 Step 5: describe actions and responsibilities

In the final step a description should be made of the responsibilities of different stakeholders and their actions in the road map (what and when). This could be structured in three parts:

1. Network regulation
    - role of the regulator, TSO, DNOs, etc.,
    - actions by these stakeholders in the different regulatory periods.
2. Market access DG
    - role of the actors: generators, energy traders/suppliers, power exchange, etc.,
    - actions by these stakeholders.
3. Governance
    - role of the actors: policy makers, Ministry of Energy, regulator, etc.,
    - necessary changes in legislation,
    - other actions by these stakeholders.

REFERENCES

Leprich, U., and D. Bauknecht (2003): *Development of criteria, guidelines and rationales for distribution network functionality and regulation*. IZES/Öko Institut, November 2003 (can be downloaded from http://www.sustelnet.net).

Mitchell, C. (2002): *Response to OFGEM's Update on Structure of Electricity Charges*. Warwick Business School, December 2002 (can be downloaded from: http://users.wbs.warwick.ac.uk/cmur/publications/other_publications.htm).

Timpe, C. and M.J.J. Scheepers (2003): *A look into the future: scenarios for distributed generation in Europe.* Öko institut/ECN, November 2003 (can be downloaded from http://www.sustelnet.net).

APPENDIX A SCENARIOS

To understand the position of DG in electricity systems on the longer term and to be able to develop appropriate regulatory strategies, the possible future developments for DG have been investigated. A large number of factors can influence the development of DG. These factors have a different nature (technical, socio-economic, institutional) and can be part of the electricity system (part of the 'regime') or be external (part of the 'landscape'). For instance, harmonization in the EU is an important external factor that cannot be influenced directly by the actors in the electricity sector but can have a significant impact on the electricity regulation. The use of information and communication technologies for operation and control of electricity networks is an example of a technology development on the regime level. A third level that can be distinguished is the 'niche level'[6]. Niches are protected spaces, created for enabling the development of promising innovations (or radical innovations) that could not survive the direct competition with the dominant technologies and practices. There are several promising technological options, that could substantially contribute to a more sustainable energy supply system, e.g. fuel cells or solar cells, but at this moment electricity generated by these technologies cannot compete at all with electricity from traditional power plants. Therefore, some kind of support is for technological development is essential.

The SUSTELNET project must reflect the diversity of the electricity systems and framework conditions for DG in EU member states and accession countries. In order to reduce the complexity of the scenarios, the countries cannot be included individually in the analysis. Moreover, the project has identified a total of four "generic" types, which describe the range of starting points in the different countries in a suitable way.

Table A.1 *Generic starting points for the scenarios*

Type (typical example)	*Explanation*
Type 1 ("France")	Countries with some decentralised production, a large, dominant market player, regulation and liberalisation under development, public ownership of networks
Type 2 ("Italy")	Countries with some decentralised production, a large, dominant market player, moderate pace of regulation and liberalisation, mixed ownership of networks
Type 3 ("Netherlands")	Countries with much decentralised production, medium-concentrated markets, much liberalisation, regulation under development, public ownership of networks
Type 4 ("Finland")	Countries with much decentralised production, no dominant player, liberalised and well-regulated market, private ownership of networks

These generic types of countries can in general also be applied to the NAS countries.

[6] This 'multi-level framework for socio-technical change' has been developed for the analysis of long-term, structural changes - or system innovations - in technology and society. The model tries to explain the development of technology from the interplay and interaction between developments at different 'levels'.

A.1 Scenario A: DG opportunities in a fully liberalised EU market

Landscape: The European electricity market is driven by strong EU-wide policy harmonisation and continuation of market liberalisation philosophy. This is supplemented by efficient operation of national departments of an EU energy regulator and general EU competition and Internal Market rules. An international CO_2 trading system has been established, which generates incentives for DG plants.

Regime: Electricity industry has been unbundled at all levels. European TSOs have harmonised their operation. There is a single postage-stamp system tariff all over Europe. 75% of the power generation is concentrated in six large European companies. 20% of the market volume is traded at power exchanges. The indicative targets from the renewable electricity Directive have been transformed into national legislation and are facilitated by EU-wide support mechanisms based on tradable certificates. A similar support system exists for cogeneration.

The share of renewable generation rises to 40% as an average. The share of DG also reaches 40% (excluding large hydro and offshore wind farms).

Niche: The strong demand for DG stimulates the development of new DG technologies, including ICT for optimised integration of DG into load management. DG lobby groups gain more influence on energy politics.

Developments from starting points: As this is a harmonised European scenario, electricity markets in EU member states will converge to a nearly uniform system. For the generic Types 1-3 this scenario means considerable progress in market liberalisation and development of (harmonised) regulation. Types 1 and 2 will see a sharp increase of DG production, replacing older centralised power plants.

Scenario evaluation: This is a quite favourable scenario for the development for DG. The setting of clear targets will lead to a continuous growth of the market shares of DG technologies. The general attitude towards regulation in the sense of facilitating fair market conditions is positive.

A.2 Scenario B: Difficult times for DG in a fully liberalised EU market

Landscape: Similar to Scenario A, the European electricity market experiences strong harmonisation and liberalisation, which is enforced by harmonised regulation co-ordinated at the EU level. Security of supply is a much stronger driver for energy policy than environmental issues. There is no CO_2 trading system.

Regime: The general set-up of the market is similar to scenario A: The electricity industry has been unbundled, TSO operation is harmonised and a single postage-stamp system tariff is applicable all over Europe. 75% of power generation is concentrated in six large European companies. 20% of the market volume is traded at power exchanges. Although there are EU-wide systems of tradable certificates for renewables and cogeneration, the member states have not set binding targets and support for these technologies is not increased. Demand for new capacity is covered by central plants based on nuclear and coal. The shares of renewable and DG do not grow much above the 2002 levels.

Niche: The development of new DG technologies is slow because of small market volumes.
Developments from starting points: Scenario B also is a strongly harmonised European scenario. The generic types 1-3 will make considerable progress in market liberalisation and development of (harmonised) regulation. The production from DG and also large renewables will not increase much from current levels, in some Type 3 and 4 countries even a reduction of these market shares might occur.

Scenario evaluation: This scenario would lead to a generally functioning electricity market including regulation. But regulation would be concentrated on balancing the interests of an oligopoly of large generators and utilities, and it would neglect the potentials and needs of DG.

A.3 Scenario C: DG opportunities in national markets with different degrees of liberalisation

Landscape: The European electricity markets are not harmonised. Some countries continue with market liberalisation philosophy, others stay with the current (minimum) market opening. Regulation is not harmonised and implementation of EU competition and Internal Market rules differs between member states. A high environmental awareness stimulates strong support for DG technologies, although member states choose individual support policies. An international CO_2 trading system has been established, which generates additional incentives for DG plants.

Regime: Electricity industry unbundling, the operation of TSOs and system tariffs differ widely between member states. Some countries have established regulators, others lack regulation. The indicative targets from the renewable electricity Directive have been transformed more or less directly into national legislation, but the design of support mechanisms for renewables and cogeneration is left to member states. New plants are built in part as centralised condensing plants, with a variety of fuels used.

The shares of renewable electricity and DG are rising to levels between 25% on average, only in some countries these shares are somewhat above 35%.

Niche: The strong demand for DG stimulates the development of new DG technologies, including ICT for optimised integration of DG into network management.

Developments from starting points: The four generic types develop into four sub-scenarios (C1 … C4). Type 1, 2 and 3 countries do not make much progress in the establishment of regulation, whereas Type 4 countries maintain their level of liberalisation and regulation. The development of DG technologies depends from the starting points and is based on support instruments defined on a national basis.

Scenario evaluation: This scenario would create quite favourable incentives for DG, although the framework conditions would differ strongly between member states. European countries would continue and intensify their current schemes for DG support. Not all countries regard regulation as being positive for establishing fair market conditions. Moreover, strong support schemes might be used to counterbalance continuous deficits in regulatory regimes. Some countries (Type 1 and 3) might think that regulation is not a relevant issue at all.

A.4 Scenario D: Difficult times for DG in national markets with different degrees of liberalisation

Landscape: The European electricity markets are not harmonised. Some countries continue with market liberalisation philosophy, others stay with the current (minimum) market opening. Regulation is not harmonised and implementation of EU competition and Internal Market rules differs between member states. Security of supply is a much stronger driver for energy policy than environmental issues. There is no CO_2 trading system.

Regime: Electricity industry unbundling, the operation of TSOs and system tariffs differ widely between member states. Some countries have established regulators, others lack regulation. Member states have not set binding targets for renewables or cogeneration and support for these technologies is not increased. Demand for new capacity is covered by central plants based on nuclear and coal.

The shares of renewable electricity and DG do not grow much above the 2002 levels, in some countries they might even drop.

Niche: The development of new DG technologies is slow because of small market volumes.

Developments from starting points: The four generic types develop into four sub-scenarios (D1 … D4). Type 1, 2 and 3 countries do not make much progress in the establishment of regulation, whereas Type 4 countries maintain their level of liberalisation and regulation. DG technologies are generally not gaining more ground than they currently have.

Scenario evaluation: Scenario D is leading to an adverse environment for DG. Although framework conditions would differ strongly between member states, existing positive incentives will even be reduced in most countries. Those member states with rather favourable conditions for DG (mostly Type 3 and 4) will experience a reduction of the DG market share. Effective regulation is only seen as being beneficial to the market in Type 4 countries (and partly in Type 2 countries.

APPENDIX B

Table B.1 *Generic Scenario A: DG opportunities in a fully liberalised EU market (strong harmonisation/strong liberalisation/high DG incentives)*

	Technical	Socio-economical/ Political	Institutional/organisational	Regulatory
Landscape	• Higher share of CHP in heat supply (industrial/small domestic).	• Strong EU policy harmonisation. • Continuation of market liberalisation philosophy. • Political agenda dominated by EU level. • No changes in environmental awareness (differences in MS). • Well-working international CO_2-trading system in place.		• General EU competition/Internal Market rules.
Regime Overall		• Energy laws revised to support liberalisation and harmonisation. • RE targets from directive taken over into national legislation. • RE and CHP support facilitated by EU-wide mechanisms (targets plus certificates).	• Strong electricity industry unbundling at all levels. • Harmonised operation of European TSOs. • National departments of EU-wide regulator.	• Regulation well established and EU-wide harmonised.
Production/ Dispatch	• Only few new condensing plants, rush for gas! • DG share rises to approx. 40% in 2020 as an average. • Renewables share rises to 40% as an average. • ICT development supports integration of DG into network management.	• Low electricity and fossil fuel prices.	• Considerable concentration of large generators (5-6 for the whole of the EU) • Power exchanges handle 20% of physical electricity volume	
Transmission/ Distribution	• One large improved and integrated European Transmission Network. • Regional networks with integrated DG.	• Cross-border trade is as common as inter-border trade in EU-wide market (electricity and certificates).	• Public or private ownership of networks.	• rTPA • One postage stamp tariff for the whole of the EU.

	Technical	Socio-economical/ Political	Institutional/organisational	Regulatory
Demand	• Reliability somewhat lower than before.	• Full market opening since 2008.	• Energy Service Companies function as interface between small consumer/producer and electricity market.	
Niche	• Strong DG market stimulates new DG technologies.		• Influence of DG lobby groups.	

APPENDIX C GENERAL POLICY CRITERIA FOR REGULATION

In addition to the criteria above to distinguish the different stages of network regulation and market access, there are several more general policy criteria that need to be taken into account when developing regulatory road maps. Below these general policy criteria are shortly explained. This section draws from the REMAC report ‘Renewable energy policies and market developments’ (ECN-C--03-029).

C.1 Efficiency

In economic terms efficiency is defined as Pareto optimality: the optimum allocation at which it is impossible to reallocate resources to make one person in the economy better off without making someone else worse off. In principle well defined markets should lead to an efficient allocation of resources in this sense.

Static efficiency
Static efficiency refers to the situation where in the short run efficiency is attained. The short run here refers to a period during which capital goods are assumed to be fixed. In the regulatory road maps static efficiency refers to the efficiency of operation of existing generating capacity and the way the costs and benefits of operating these plants is allocated to society.

Dynamic efficiency
The economic term dynamic efficiency considers the efficiency in the longer run, when capital is variable. The degree of dynamic efficiency reflects how in the long run the proper economic incentives are created to stimulate the most optimal investment in capital goods. Optimal here is understood as fulfilling the Pareto criterion. In the context of regulatory road maps dynamic efficiency refers to the efficiency of investment and exploitation of generating capacity, the effects on technology development, and the way the costs and benefits of investment and technology developments are allocated to society in the long run.

C.2 Effectiveness

The most straightforward measure for success of any policy instrument is whether it has had the required effect. Effectiveness is normally defined as the degree to which a measure contributes to attaining a specified goal or target. It should be noted that effectiveness does not imply anything about the way in which a target is achieved, it merely relates to the impact. For instance, certain very costly measures may be very effective to attain certain policy goals, but make the overall policy process rather expensive.

C.3 Equity

From a government point of view and for the long-term sustainability regulation, a ‘fair’ distribution of both costs and benefits from the implementation of regulation is important. Regulatory instruments can be designed to steer on the distribution of costs and/or benefits, for example over various stakeholder categories, or geographically. Good insight and foresight into the market and its developments is necessary to achieve such equity. Equity aspects of policy instruments are not inherent to the policy instrument itself, but depend very much on its design.

C.4 Transparency

Transparency means that the functioning of policies and regulation is clear, controllable and simple. It should be clear for all stakeholders involved what their role is or what their benefit from a regulation can be. Simplicity of regulation helps in this regard. Furthermore, the actions of individual stakeholders should be transparent, i.e. controllable, particularly with regard to the flows of money. Transparency also requires the free availability of information on all data that are relevant for the functioning or the development of markets and regulation.

C.5 Market conformity

Market conformity is a success factor for the contribution of a policy to a *sustainable* development of the supported technology or sector. Because direct policy support (in the form of subsidies, feed-in tariffs etc.) is transitional to the development of a fully demand driven mature market, it is important that the sector learns to cope with market conditions. The danger of policies which do not stimulate market conformity is that developments of the sector and of technology focus too much on these policies, making the transition to functioning in a competitive market much more abrupt. In a liberalising energy market, the international dimensions of market conformity are becoming ever more important. Especially the possibility to harmonise a policy scheme for international trade will be essential for long-term applicability.

C.6 Certainty

Policies and regulation should provide certainty to their target groups. Investors must be able to rely on relatively stable market conditions.

C.7 Flexibility

From a policy and regulatory point of view the regulator may want to maintain a certain level of flexibility in developing new policy and regulation and changing the existing policies and regulations in order to respond to new developments. This criterion may sometimes be opposed to the certainty criterion.

C.8 Minimisation of transaction cost

Transaction costs are defined as the costs that arise from initiating and carrying out transactions. Examples of transactions are: finding partners, negotiating, consulting with lawyers and other experts, monitoring agreements, or opportunity costs, like lost time and resources. The most obvious impact of transaction costs is that they raise the costs for the participants of the transaction and discourage transactions from occurring. Furthermore, high transaction cost places high demands on administrative capacity to implement a policy instrument. Transaction costs can be divided into *market transaction costs*, which accrue to the investors and traders, and *institutional transaction costs*, which are incurred by the government.

Market transaction cost, in turn can be subdivided into:
- Search costs: costs of finding interested partners to the transaction as well as the costs of identifying one's own position and optimal strategy.
- Negotiation costs: the costs for coming to an agreement. Negotiating terms may for example take time, visits to the site of a project, and hiring lawyers to draft contracts.
- Approval costs arise when the negotiated exchange must be approved by a government agency. Modifications could be imposed on the deal.

- Monitoring costs are the efforts the participants must make to observe the transaction as it occurs, and to verify adherence to the terms of the transaction.
- Enforcement costs: the expenses to insist on compliance once discrepancies are discovered.
- Adjustment costs: costs of changing strategies, due to a change in regulations or new scientific discoveries.

Institutional transaction costs include:
- developing the instrument in question,
- enacting it by legislature,
- establishing of an administrative infrastructure,
- implementing, monitoring and enforcing the policy by administrative agencies and the courts,
- fighting political opposition against the instrument; campaigning for social acceptance.

Note that the market transaction costs concern the individual investor while the institutional transaction costs concerns society at large. Institutional transaction cost have direct implications for the required administrative capacity on the part of the government, and have to be carefully weighted before selecting a policy instrument.