SUSTELNET

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

Regulatory Road Map for the Netherlands

Road Map for Transition of the Regulatory Framework of the Dutch Electricity Supply System

January 2004

E.J.W. van Sambeek
M.J.J. Scheepers
A.F. Wals

Acknowledgement

Support of the European Commission

The SUSTELNET project is supported by the European Commission under the 5th RTD Framework Programme within the thematic programme 'Energy, Environment and Sustainable Development' under the contract No. ENK5-CT2001-00577.

This document or any other document produced within the SUSTELNET project does not represent the opinion of the European Commission. Neither the European Commission, nor any person acting on behalf of the Commission, is responsible for the use that might be made of the information arising from the SUSTELNET project.

SUSTELNET project partners in EU Member States:

- Energy research Centre of the Netherlands (ECN), Petten, The Netherlands (co-ordinator)
- University of Warwick, Coventry, UK
- Öko-Institut, Freiburg, Germany
- Fondazione Eni- Enerico Mattei (FEEM), Milano, Italy
- Tech-Wise A/S, Fredericia, Denmark
- Institut für ZukunftsEnergieSysteme (IZES), Saarbrücken, Germany
- ECON, Centre for Economic Analysis, Copenhagen, Denmark.

SUSTELNET project partners in Newly Associated States:

- Enviros, Prague, Czech Republic
- The Polish National Energy Conservation Agency (KAPE), Warsaw, Poland
- Hungarian Environmental Economics Centre (MAKK), Budapest, Hungary
- EGU Power Research Institute, Bratislava, Slovakia.

Other organisations contributing to the SUSTELNET project:

- Eindhoven University of Technology/Foundation for the History of Technology, Eindhoven, The Netherlands
- Eltra, Fredericia, Denmark.

For further information:

- www.sustelnet.net
- Mr. Martin J.J. Scheepers
  Energy research Centre of the Netherlands (ECN)
  Phone: +31 224 564436
  E-mail: info@sustelnet.net

Abstract

This report stipulates the regulatory actions that are necessary to reach a 'level playing field' for centralised and distributed generation in The Netherlands. This broadly means that centralised and distributed generation should be able to participate in the electricity market on equal terms. The road map contains a series of regulatory actions and developments and indicates the timing of regulatory steps. The timing of these steps depends on key developments in the Dutch electricity sector and the penetration of DG in the Dutch electricity market.

CONTENTS

PREFACE

Technological developments and EU targets for penetration of renewable energy sources (RES) and greenhouse gas (GHG) reduction are decentralising electricity infrastructure and services. Although liberalisation and internationalisation of the European electricity market has 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 10 research organisations analysed the technical, socio-economic and institutional dynamics of the European electricity supply 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 timeframe). Consequently analysis was made as to what regulatory actions are needed in 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 will bring together electricity regulators and policy makers, distribution and supply companies, as well as representatives from other relevant institutions with the final objective of enhancing implementation of DG.

Newly Associated States

The SUSTELNET project also anticipates 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 supply 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 was produced during the participatory regulatory process phase of the project and is part of the development of policy and regulatory road maps. Stakeholders and experts were invited to give comments on the draft version of this regulatory road map. Authors thank in particular Paul Raats en Jan Peter Heida (Dutch Regulator DTe), Rolf Kunneke (Delft University) and Hans van Bemmelen (EnergieNed) for their comments.

EXECUTIVE SUMMARY

This report develops a road map that stipulates the regulatory actions that are necessary to reach a ‘level playing field’ for centralised and distributed generation in The Netherlands. This broadly means that centralised and distributed generation should be able to participate in the electricity market on equal terms. The road map contains a series of regulatory actions and developments and indicates the timing of regulatory steps. The timing of these steps depends on key developments in the Dutch electricity sector and the penetration of DG in the Dutch electricity market. Consequently, a number of scenarios are developed in order to have an insight in a possible transition of the current electricity supply system to a future system with a higher share of DG and RES.

Transition of the electricity supply system in the Netherlands

The regulatory road map is developed on basis of only one scenario that assumes high incentives for DG and RES (i.e. ambitious targets and strong support schemes EU-wide) and a strong EU harmonisation policy (this scenario is named ‘DG opportunities in a fully harmonised EU market’). In particular, in this ‘DG opportunities’ scenario the development of DG capacity in the Netherlands could increase from almost 4000 MW in 2000 to 6000 MW in 2010 and to approximately 10,500 MW in 2020. Furthermore, all DG technologies are assumed to grow, except small hydro. In the DG opportunities scenario also large-scale power generation might change completely. A ‘robustness check’ is carried out to analyse the consequences in the regulatory road map of less DG intensive scenarios.

Regulatory road Map

The regulatory periods defined in the Dutch distribution network regulation establish the starting point and regulatory steps in the road map. Based on the current regulatory framework, the following are the main changes implemented through the regulatory road map:

- The current price-cap system implemented in the first regulatory period (2000-2003), that directly and indirectly determines the DNOs revenue streams - i.e. the method of calculating the use of system charges - disfavours DG as it:
  - Encourages DNOs to reduce certain cost variables. This proves to be anti-innovative, and therefore discourages DNOs to enter in activities that would raise costs not directly covered by the tariffs.
  - Encourages DNOs to maximise sales. This provides incentives not to use DG, which reduces the mount of electricity flowing through the grid, and thus revenues.

  Consequently the regulatory system is gradually changed into a *multi-driver cap*. When multi-driver cap regulation is properly applied, it can provide powerful incentives for economic efficiency on the supply-side, decrease the incentives to increase sales and therefore bias against DG and allow the inclusion of direct costs of DG programs.

- As distribution networks were not designed to accommodate high amounts of DG, they need significant development and investments to successfully operate them ‘as active networks’. The possibility for DNOs to recover ‘risky’ investments in innovative solutions and technologies is a necessary condition to fulfil this objective. Under current regulation, the fact that DNOs are encouraged to minimise operational and capital expenditures is anti-innovative. In other words, as the operational expenditures of the firms are benchmarked against other firms, firms become risk averse and therefore tend not to invest resources in new technologies or managerial systems that are uncertain. As a result, in the regulatory road map mechanisms are implemented to encourage DNOs to invest and innovate in the grid.

Two specific systems are put forward: Innovation Funding Incentive and Registered Power Zones (OFGEM, 2003). Innovation Funding Incentive is aimed at facilitating funds spent on R&D by DNOs. As operational expenditures of distribution firms come under great pressure from the incentive regulation in place, Innovation Funding Incentive would provide specific funding to demonstration phases of certain projects. Registered Power Zones are intended to offer DNOs a sufficient incentive to encourage them to pursue network projects with higher risk profiles. As a result, a financial incentive would be provided to better balance the DNO risk/reward position.

- In order to achieve ‘active networks’, DNOs have to evolve from passive organisations into more active actors. In other words, DNOs have to 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 behave concerning the network. Along the regulatory road map, it is assumed that a change in the DNO’s business practices is achieved.

- In order to provide the DNOs with instruments to gain in flexibility and allow them to actively manage the network, a system composed by shallow connection charges plus an ‘entry charge’ is implemented in the regulatory road map. The entry charge is a use of system charge for feeding into the network, and it can have a positive, zero or negative value. The entry charge charged entirely or partly during the lifetime of the DG plant, avoids prohibitively up front large connection charges. It also allows the DNOs to give locational incentives by differentiating in place and time.

1 INTRODUCTION

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[2]. 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.

This report outlines the regulatory road map for the Netherlands. Chapter 2 describes a possible transition of the Dutch electricity system when strong incentives apply to distributed generation technologies and electricity from renewables. Chapter 3 consequently outlines the regulatory steps that need to be taken in order to establish a level playing field for distributed and centralised generation against the background of the developments described in Chapter 2. In Chapter 4 these regulation strategies are tested on their robustness and effectiveness to respond to changing circumstances in the electricity sector. Chapter 5 concludes with an action plan that addresses the responsibilities and tasks of all stakeholders in implementing the regulatory road map.

---

[1] Examples are: Electricity Technology Road map, EPRI, 1999 (http://www.epri.com/corporate/discover_epri/roadmap/index.html). 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)

[2] For more information on the development of regulatory road maps, see 'Outline for Developing Regulatory Road Maps' by E.J.W. van Sambeek, M.J.J. Scheepers and A.F. Wals on www.sustelnet.net

2 TRANSITION OF THE ELECTRICITY SUPPLY SYSTEM IN THE NETHERLANDS

2.1 Introduction

Scenarios

The development of a regulatory road map requires insight in a possible transition of the current electricity supply system to a future system with a higher share of DG and RES. In the SUSTELNET project four scenarios are used to describe possible long-term development of electricity supply systems[3]. The time horizon for these scenarios is the year 2020, although the transition may continue beyond this year. The factors that are distinguishing between the scenarios are the level of incentives for RES and DG and the level of harmonisation of electricity regulation in the EU. The regulatory road maps are, however, developed on basis of only one scenario, since developing different road maps will not help to set out a clear regulatory strategy for changing the regulatory framework. Preferably, one scenario is used that complies with existing and/or desirable policies. For this purpose the scenario is chosen that assumes high incentives for DG and RES (i.e. ambitious targets and strong support schemes EU-wide) and a strong EU harmonisation policy (this scenario is named 'DG opportunities in a fully harmonised EU market'). The other scenarios are used to analyse the robustness of the regulatory road map for changes in developments and to identify alternative actions.

DG Characterisation

The majority of distributed generation technologies consist of combined heat and power (CHP or co-generation) and electricity from renewable energy sources (RES). However, not all CHP and RES applications are DG, since also large-scale CHP and RES plants exists. For the purpose of this road map DG is characterised on basis of type and size as indicated in Table 2.1.

Table 2.1 *Characterisation of Distributed Generation*

	Combined Heat and Power (CHP)	Renewable Energy Sources (RES)
Large scale generation	• Large district heating* • Large industrial CHP*.	• Large hydro** • Off-shore wind • Co-firing biomass in coal power plants • Geothermal energy.
Distributed Generation (DG)	• Medium district heating • Medium industrial CHP • Commercial CHP • Micro CHP.	• Medium and small hydro • On-shore wind • Tidal energy • Biomass and waste incineration/gasification • Solar energy (PV).

* >50 MW_e
** >10 MW_e

---

[3] For more information see 'An outlook into the future: scenarios for distributed generation in Europe' by C. Timpe and M.J.J. Scheepers on www.sustelnet.net

2.2 Electricity supply

Figure 2.1 shows the possible development of generation capacity in The Netherlands in the 'DG opportunities' scenario. It is anticipated that DG capacity will increase from almost 4000 MW in 2000 to 6000 MW in 2010 and to approximately 10,500 MW in 2020. All DG technologies will probably grow, except small hydro. In the DG opportunities scenario also large-scale power generation might change completely. Ambitious renewable targets and strong incentives for renewable energy could result in a strong increase of offshore wind. Strong GHG emission policy might result in reduction of conventional power generation. However, some coal-fired power plants could still be used for co-firing biomass, whereas gas fired power plants are required for balancing the electricity system.

The possible shares in power production for the different fuels and generation types are shown in Figure 2.2. In the DG opportunities scenario industrial CHP will become the most important type of power generation. By 2020 a similar share or even a higher share in power generation could come from offshore wind. Figure 2.3 shows the expected changes in demand and supply. The electricity demand in the Netherlands will grow between 2000-2010 with 1.8% per year and in the period 2010-2020 with 1.3% per year[4]. Electricity imports will remain relatively constant until 2010, but by 2020 the net power flow will be reversed and export will take place, due to the large offshore wind production. Wind fluctuations will be partly compensated by gas fired power plants, but the large electricity supply from wind energy will result in large import/export fluctuations on the cross border connections.

---

[4] Figures based on EU Shared Analysis 1999. In a DG opportunities scenario probably also a strong energy saving policy will be implemented. The figures for demand increase for period until 2010 (2.3%/year) and period 2010-2020 (1.8%/year) has therefore been lowered with 0.5%.

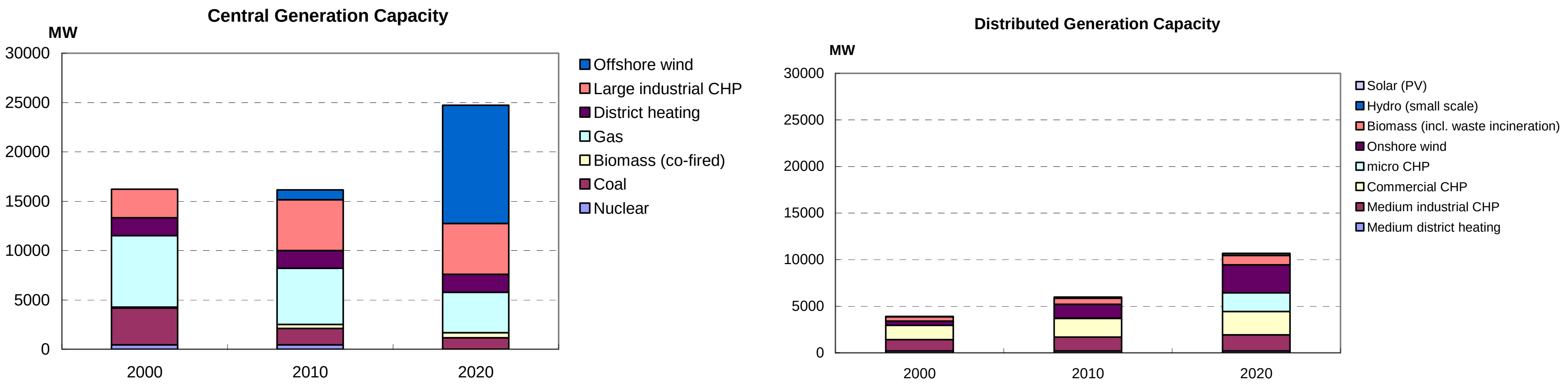

Figure 2.1 *Development of power generation capacity*

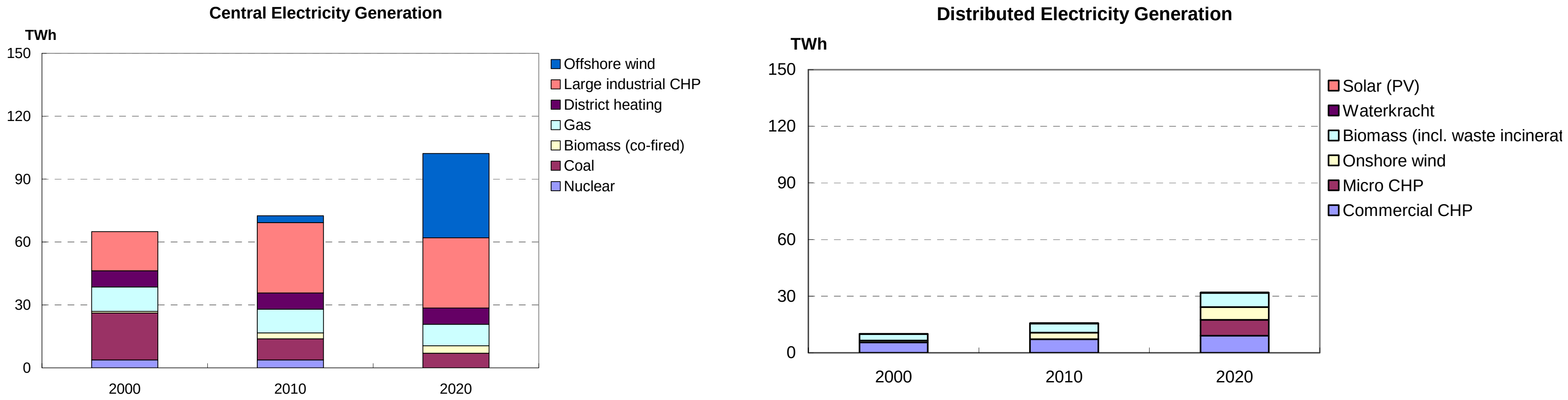

Figure 2.2 *Development of power supply from different types of generation*

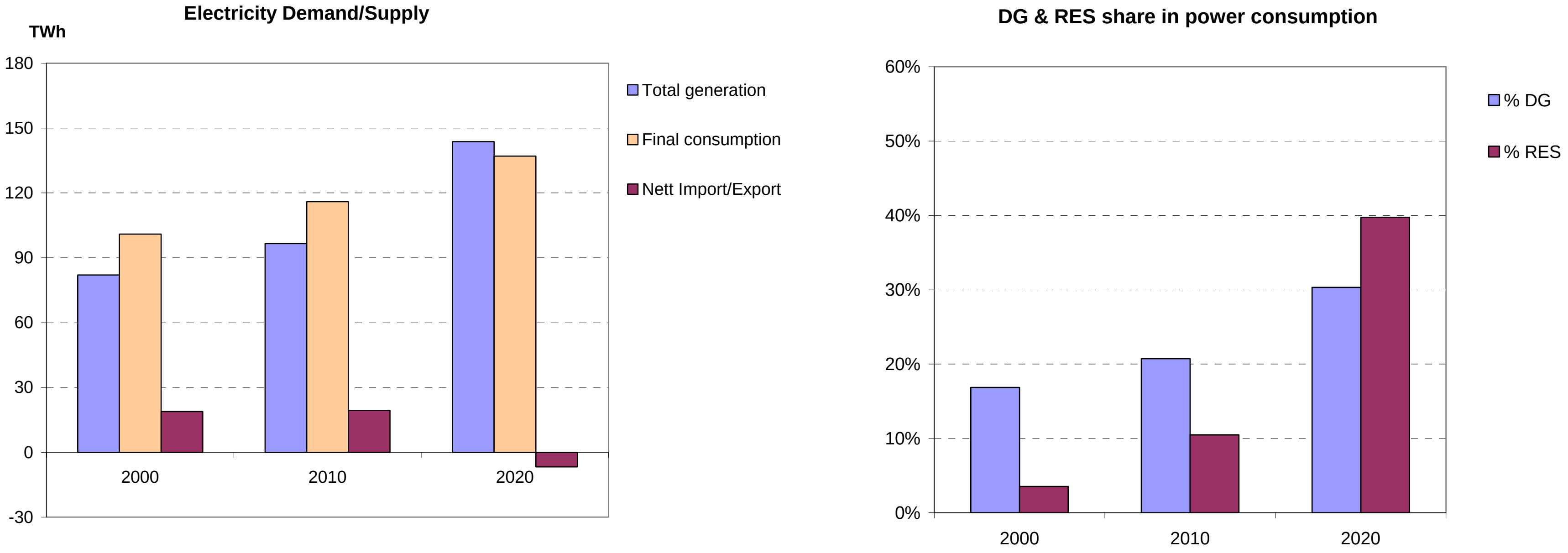

Figure 2.3 *Development of electricity supply and demand (left) and DG and RES shares in power supply relative to domestic consumption (right)*

Figure 2.3 shows also the possible development of the shares of DG and RES in the Dutch power supply relative to the domestic consumption. DG is small and medium scale CHP and small hydro, onshore wind and PV as described in Table 2.1. Electricity supplied by DG is expected to grow from 17% in 2000 to 20% in 2010 and 27% in 2020 relative to electricity consumption. Notice that the absolute growth is stronger, since also electricity demand is growing. The strong increase in electricity supply from RES, up to a level of approximately 40% in 2020, results from the strong growth of offshore wind. A more detailed description of developments in CHP, RES and conventional power supply in the DG opportunity scenario for the Netherlands is presented in Appendix A.

2.3 Consequences for the electricity system

The transition in electricity supply as described in the previous section requires adaptations of the electricity system, i.e. the transmission network, the distribution network, the balancing of the electricity system and management of import/export flows.

Distribution Network

Today the electricity supply from DG in some Dutch distribution networks is already relatively high. A change of the management of distribution networks towards so-called active networks is desired when DG supply increases. Due to the substantial growth of micro CHP and PV the electricity supplied to the low voltage networks might become significant after 2010, in particular in new residential areas. By that date distribution network operators (DNOs) should know which type of technologies should be applied. Therefore, the technological systems to accommodate such an increase of small-dispersed sources feeding electricity into the grid should be developed and tested before 2010.

The introduction of new concepts for management of distribution networks also requires a clear co-ordination between DNOs and the TSO. This is a technological as well as an institutional challenge. DNOs might outsource certain operation and control functions to the TSO if this is more efficient.

Transmission Network

The connection of the first offshore wind farms to the transmission network on the mainland will not be too difficult. In the ‘Green’ scenario[5] the Dutch TSO, TenneT, indicates possible options for connection of 3000 MW offshore wind to high voltage grid. A further increase of offshore wind capacity might require further reinforcements, also on the cross border connections with Germany and Belgium.

It is likely that in due course offshore wind farms on the North Sea will be interconnected with each other. Because Dutch offshore wind farms will not develop completely isolated from similar developments in other North Sea countries (UK, Denmark, Germany, Norway), these interconnections might also be cross border connections to these countries. Currently existing plans to connect the Dutch transmission network with the UK and Norway could become part of this ‘Trans North Sea Network’. With such a network the risk of fluctuating supply will decrease since this is mainly a local risk and can be partly compensated with wind energy supply from other regions of the North Sea. It will also be possible to use excess of wind energy for pump storage and to balance electricity supply and demand in the Netherlands with hydropower from Scandinavia. It should be noted that the dispatch ability of offshore wind is expected to increase as implementation experience grows.

It is interesting to note that the anticipated growth of DG and offshore wind pose different demands on the development of the electricity network. While DG puts the focus on the manage-

---

[5] Capacity Plan 2003-2009.

ment of the distribution network, offshore wind could require reinforcement of the transmission network and innovations of its management.

Balancing

Although strong interconnections between offshore wind farms may reduce the problem of intermittent electricity supply from wind, the supply from onshore wind could also increase significantly. Furthermore, a large part of power from CHP will be supplied as a function of heat demand. Balancing the electricity system will become more difficult. A further improvement of supply predictions from wind power and CHP will be necessary (on basis of ambient temperature and wind forecasts). Gas fired plants could be used to match the difference between demand and electricity supplied by RES and CHP. Specific peaking plants are required to make corrections for unbalances, while by 2020 also storage of electricity may start to play a role in balancing the supply and demand for electricity.

Distribution networks that are managed as active networks will probably use new ICT technologies. This may create opportunities for demand response options to play a role in balancing the electricity system.

Management of import/export flows

Figure 2.3 suggests a reduction of net imports. By 2020 the Netherlands might become a net exporter of electricity. The power flows will, however, be less constant. Periods with high export flows (e.g. cold period with strong wind) will alternate with periods with imports (e.g. summer, less wind). This requires a relatively large cross border capacity. Fortunately the Dutch power sector is already highly interconnected with neighbouring countries and currently connections are being expanded.

2.4 Socio-economic and political factors

Current structure of the production sector

Four large power producers dominate currently the Dutch power market. Two of these power producers are vertically integrated with retail companies[6]. Foreign companies own the other two large power producers[7]. Three large energy distribution companies (one without large power production capacity) dominate the retail sector. All these publicly owned companies have a distribution network, which is legally unbundled, i.e. the network is operated independently of the retail activities. The energy supply companies operate DG plants (CHP plants, wind turbines, waste incineration, biomass, hydro). Some industrial CHP plants are operated in a joint venture with industrial parties. Currently two large industrial CHP plants (both 800 MW) are under construction or planned. A new entrant builds one of these plants.

In 2004 the electricity market will be opened completely. The market for green electricity has already opened in 2002.

Future developments

The Dutch competition authority will probably not allow a further concentration of power generation and retail. However, a takeover of one or more Dutch retail companies (also those who are vertically integrated) by foreign energy companies is plausible, i.e. a further concentration on the EU level. Also privatisation of the current publicly owned energy companies, under certain conditions, is likely to happen in the coming years.

---

[6] The public owned energy distribution companies Essent and Nuon are vertically integrated with the former power production companies EPZ and UNA, respectively.

[7] E.ON Benelux and Electrabel Netherlands, both private owned companies.

In the DG opportunities scenario there is hardly any need for conventional power capacity. Large power producers may become interested in other types of large power generation, e.g. offshore wind energy. However, the retail companies have gained more experience and could become a strong competitor in new renewable capacity. At the same time there is a trend of vertical integration between generation and retail companies. Whereas incumbents can create entry barriers in the conventional power market, new types of electricity generation may create opportunities for new entrants.

In a competitive retail market energy companies will extend their services to the consumers. Micro CHP, PV and also demand response options, will create new business opportunities for these companies. However, other companies with strong consumer relations may move into the energy market as well.

Environmental policy

When developments follow the DG Opportunities scenario the renewable targets for 2010 (9% of Dutch electricity consumption should be covered by renewables) can be met with indigenous RES production. As a result of the large share of renewable electricity production it will not be too difficult to meet the Dutch renewable target for 2020 as well (10% of total energy demand, i.e. including heat demand, should come from renewables).

The increase of CHP and RES will also help to realise GHG-emission reductions in the budget period 2008-2012 (-6%) as agreed in the Kyoto burden sharing agreement. A further emission reduction may be expected from the strong increase of renewable electricity production after 2010. However, ambitious targets can only be achieved with a strong incentive program for CHP and RES. These programs will be market based and EU harmonised, e.g. a system of tradable green certificates and CO_2 emission trading. In the DG Opportunities scenario the prices for green certificates and CO_2 credits are relatively high, due to large quota obligations and/or strong fiscal incentives for renewables and restrictive CO_2 emission caps.

Energy/fuel prices

Electricity prices in the Netherlands show a strong sensitivity for gas price fluctuations. This is a result of the relative large share of gas in electricity production both in large gas fired power plants as in DG (CHP plants). In a high gas price scenario electricity prices will also be relatively high. This could stimulate alternatives, such as electricity from RES (i.e. less support will be necessary). However, high gas prices are harmful for CHP developments. CHP will profit from low gas prices, for instance as a result of a competitive gas market. On the other hand, high efficient CHP (e.g. fuel cells) will be less sensitive to high gas prices. High gas prices might therefore even incentify the transition to fuel cell based CHP.

Electricity prices are also influenced by the market circumstances, i.e. demand and supply developments. The current prices are set by the short run marginal costs of electricity generation (i.e. dominated by fuel costs). With the current market mechanism the Dutch electricity market will tend towards a tight supply with, on average, higher electricity prices than current price levels. Prices will presumably become quite volatile (high price peaks). It is likely that a capacity market or another type of market mechanism will be introduced to ensure investment in generation capacity to avoid the risk of power disruptions. Such a mechanism may also result in more stable electricity prices. With or without such a change of the market mechanism the average price level increases to a level of long run marginal costs of power generation. Incumbent power producers may try to keep price levels just below this level for some time in order to protect their market position. However, this will not hinder the development of DG and RES, since these technologies will receive extra support.

2.5 Path dependencies and critical points

In the previous sections a possible development of the Dutch electricity supply system is described, which results in high penetration of DG and RES. Structural aspects of the Dutch electricity system, however, may be of influence to the transition of the Dutch electricity system. The Netherlands has, for example, a well-developed electricity infrastructure, both of the transmission and the distribution grid, with strong connections with neighbouring countries. Although, CHP has been connected to the distribution grid for many years, the system is still managed centrally, i.e. one balancing region and ancillary services provided by the TSO. Another path dependency is the relative large industrial sector using medium sized CHP-plants. A tendency towards larger industrial CHP-plants (400 to 800 MW), presumably stimulated by market liberalisation, can be observed. Also the well-developed natural gas infrastructure is a path dependency with potentially positive effects towards the development of DG.

The DG opportunity scenario will only be realised under specific circumstances and when the order of specific developments is right. From the description in the previous sections the following critical points can be identified:

- Governments (EU and The Netherlands) should have a high ambition in achieving a sustainable electricity supply system during the whole period until 2020. Market players should also share this ambition.
- A strong incentive program is necessary to promote DG technologies and electricity for renewables. The environmental benefits of DG and RES may be internalised in electricity prices (e.g. CO_2 emission trading system). The introduction of new technologies may require extra support during the testing and market introduction, particularly for offshore wind energy in the period until 2010 and for fuel cell based CHP after 2010.
- Technological developments that are critical for the scenario are:
  - a successful introduction of offshore wind technology in the period until 2010,
  - further increase of the share of biomass in co-fired power plants,
  - a breakthrough of fuel cell technology and the application of this technology in CHP/micro CHP. In the scenario this break through is expected by 2010,
  - innovation in management of electricity networks, in particular distribution networks, with use of ICT technology. New concepts for managing electricity distribution networks should be introduced after 2010. This implies that pilot and demonstration projects should be completed before 2010.
- A clear coordination of management functions between DNOs and the TSO should be implemented by 2010.
- The strong increase of intermittent power supply requires improvements of the system balancing. Since the programme responsible parties remain responsible for their contracts, they have to compensate expected increase or decrease of wind energy supply by alternative power supply or demand response options.

3 REGULATORY ROAD MAP

This chapter describes the successive steps that can carry the Dutch electricity system from its current situation, a cost-driven incentive regulatory framework with moderate market access of DG (II-B in Table 3.1), to an active network system with high market access of DG (V-C in Table 2.2). The steps are descriptions of snapshots in the different regulatory periods. They describe the regulatory framework and market access of DG in general and specific issues affecting DG in particular.

3.1 Regulatory steps

The scheme for defining the starting point and regulatory steps for the road map can be established through a combination of the stages of network regulation and the stages of market access (Van Sambeek, et.al., 2003). Table 3.1 gives an overview.

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

If DG/RES will remain on a low or moderate level this will not require innovative networks (grey area in Table 2.1). 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 3.1 *Regulatory road maps scheme*

			Level of DG/RES supply		
			Low A	Moderate B	High C
Market access			Protected niche market	DG/RES in wholesale market	Level playing field
Network regulation	I	No regulation/ self-regulation	I-A	I-B	I-C
	II	Cost driven incentive regulation	II-A	II-B ● (2003)	II-C
	III	Refinement of cost driven incentive regulation	III-A	III-B	III-C
	IV	Innovative predominant passive network		IV-B ● (2007)	IV-C
	V	Innovative active network	No innovative networks required		V-C ● (after 2013)

Based on a review of the current regulatory framework and market condition (Wals et. al, 2003), it is considered that the starting point of the Dutch power sector is Section II-B of Table 3.1. The road map describes the path the sector should take in order to reach Section V-C, where a level playing field exists for DG, through an innovative active network and high amounts of DG actively participating in both energy and ancillary services markets. The path is linked with the scenario and the story line presented in the previous chapter.

3.2 Regulatory framework in its final stage

As explained in the introduction section, the regulatory road map stipulates the regulatory actions that are necessary to reach a desired future state of market organisation, which 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.

It is difficult to provide an exact definition of a level playing field. There is general agreement that a level playing field entails markets and regulation that provide neutral incentives to centralised power generation versus DG. This requires that 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 (Leprich and Bauknecht, 2003).

To describe the desired future state, a close look is taken at the regulatory framework in general, and the market access of DG and incentives for DG operators and distribution network operators (DNOs) in particular. The latter is usually closely connected with their revenue streams, i.e. the method of charging the connection costs, and the method of calculating the use of system charges.

Regulatory framework

In the last years, regulation of distribution networks evolved from a rate-of-return to an incentive based regulation system. In the Netherlands, the price-cap system implemented in the first regulatory period (2000-2003), which promotes efficiency by benchmarking different DNOs and reducing tariffs through an efficiency (X) factor, disfavours DG by:

- Encouraging DNOs to reduce certain cost variables. This proves to be anti-innovative, and therefore discourages DNOs to enter in activities that would raise costs not directly covered by the tariffs.
- Encouraging DNOs to maximise sales. This provides incentives not to use DG, which reduces the amount of electricity flowing through the grid, and thus revenues.

A regulatory system should correctly consider all DG values and, furthermore, solve the constraints mentioned above. In the SUSTELNET project, two systems are put forward (Leprich and Bauknecht, 2003):

- *Revenue-cap regulation:* In its simplest form, revenue-cap regulation limits the amount of revenue per year that a firm can collect from its customer base to a predetermined level. In particular, a revenue-per-customer-cap is argued to be the best system that does not bias against DG. A utility under this regulatory framework has a clear incentive to encourage minimising total demand, and thus minimising demand per customer. One way to do this is to encourage the efficient use of power. In other words, with proper adjustment, and in the right circumstances, a revenue cap might motivate both supply-side cost minimisation and demand-side efficiency maximisation without imposing too much risk or inducing perverse behaviour on the part of the utility (Comnes, et. al., 1995).
- *Multi-driver cap regulation:* When multi-driver cap regulation is properly applied, it can provide powerful incentives for economic efficiency on the supply-side, decrease the incentives to increase sales and therefore bias against DG and allow the inclusion of direct costs of DG programs.

Moreover, two issues of importance are considered in the road map. First, 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 a level playing field in the long run. Path dependencies in the electricity infrastructure are likely to create a bias towards centralised generation. The existing transmission network, for example, is considered as sunk costs, which favours large-scale power generation. It may therefore be granted to temporarily tilt the playing field slightly in favour of DG in order to create a level playing field in the longer run.

Secondly, in order to reach a desired state where active networks (see below) manage the distribution of electricity, innovation should be promoted. The current regulation system discourages investment in projects considered risky. As a result, in this paper it is argued that transition measures that promote innovation should be implemented. Two possible measures are power zones and innovation funds (see Section 3.4.1).

Connection costs

It is generally agreed that *shallow* connection charges (connection only) do not create a level playing field. When only a part of the full costs of connecting DG is charged to the DG investor, it may lead to economically inefficient investments in DG. In addition, it does not give DG operators the right signal where to locate a new plant, and it might discourage DNOs from connecting DG.

With *deep* connection charges every new entrant is treated individually and will face actual marginal cost of connection. In theory this will give correct signals for investment. However there are some problems (Leprich and Bauknecht, 2003).

- *Economies of scale and first mover disadvantage:* The initial investment in grid reinforcement may be large, while any later DG entrants will not induce any further investment costs. Therefore, the first mover must not be charged for the entire investment.
- *Meshed grids:* Any grid reinforcement in meshed grids induced by DG may also benefit other customers. It may be argued, therefore, that such reinforcement costs should not be included in deep connection charges. However, if they are left out, DG investment will induce more of such reinforcements than is economically optimal.
- *Prohibitively large connection charges:* In some cases the deep connection charges may be so large that any DG investment is discouraged. This, however, is a policy argument and not an economic argument.

A proposed system is to use shallow connection charges plus an ‘entry charge’. The entry charge is a ‘use of system charge’ for feeding into the network, and it can have a positive, zero or negative value. The entry charge charged entirely or partly during the lifetime of the DG plant, avoids prohibitively up front large connection charges. It also allows the DNOs to give locational incentives by differentiating in place and time.

There is a whole range of options for connection charges between shallow and deep connection charges. Deep charges are economically correct, but may only be used when the deep costs are measurable. An entry charge may be an alternative to deep connection charging. It should be kept in mind that the difference between deep and shallow connection costs would be socialised and paid through the use of system charges by the customers (Mitchell, 2002).

Active networks and the role of DNOs

Literature argues that the actively managed distribution networks can accommodate DG in a more efficient way than electricity systems that are managed centrally through the transmission network, and are the best way to provide a level playing field between centralised and decentralised generation. It is argued that passive electricity distribution networks will have to evolve, both technically and economically, into actively managed networks. Such networks, with a new range of paid-for system services, should prove to be the best tool to facilitate distributed generation in a deregulated electricity market (Overbeeke, Roberts, 2002). This road map puts forward the regulation that can make current passive grids evolve into active networks.

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. As previously said, if the expected increase in DG is to be successfully accommodated in the electricity system, electricity networks should reconfigure into active networks. To achieve this, DNOs will have to evolve from passive organisations into more active actors. In other words, DNOs will become active and innovative entrepreneurs that facilitate and profit from the connection of DG to the system. By doing so, and because DNOs receive the benefits DG creates, they are on the one hand, provided with incentives to connect DG and, on the other hand, provide the correct signals to generators and consumers in order to efficiently behave concerning the network.

Market access

To create a level playing field between centralised production and DG (no bias towards or against DG), DG must be given market access. In this context, market access for DG plants means:

- network access for selling electricity in the wholesale and retail market,
- access to markets for reserve power, reactive power and balancing markets (ancillary service markets).

The DNOs must provide the technological opportunities for such access. In case the DG plant operators are not prepared to participate in the markets, an ‘active’ DNO might be an intermediary between DG operators and the markets. Such participation should be an opportunity for the DNO - and not an obligation.

3.3 Current system and the proposed new system

3.3.1 Current system: Incentive Regulation and Market Access

The regulation of the distribution system in the Netherlands is currently being challenged by the DNOs in the Dutch court. [8][9] This section illustrates the intended regulatory framework, with theoretical introduction date 2000 and applicable until December 2003. The market access of DG is also described. Both systems fit best in the Section II-B in Table 3.1, and are considered as the starting point of the regulatory road map.

Price-cap system

The Dutch government intended to implement, as from the year 2000, an incentive regulation system based on a price cap to regulate the distribution network activity. The system aimed at providing DNOs with a competitive atmosphere that encourages them to minimise certain operational and capital expenditures. While individual tariffs were determined by efficiency factors - x-factors - and the inflation index, they aimed at shifting all DNOs to an efficiency frontier where all firms would be equally efficient. The benchmarking[10] of a number of operational and capital expenditures, based on the Data Envelopment Analysis (DEA) model, determined the x-factors. The system established the maximum tariffs firms were, in theory, allowed to charge for their services during the regulatory period. The x-factor was applied to all of the regulated tariffs (a tariff basket), and while DNOs calculated them, the tariffs had to be approved by DTe. The tariffs included the use of the system charges, the connection charges and the system tariff.

---

[8] An in-depth description of the current regulatory system and market access of DG can be found in ‘Review of Current Electricity Policy and Regulation: Dutch Study Case’, Wals et. al., 2003.

[9] The regulatory system, which sets distribution tariffs, is currently being reviewed because the Trade and Industry Appeals Tribunal declared it null in November 2002. The court ruled that the x-factor could not be different for each company.

[10] Benchmarking can be broadly defined as the comparison of a firm’s actual performance against some pre-defined reference or benchmark performance (Jamasb, Nillsen, Pollitt, 2003).

Connection charges

Connection charges in the Netherlands depend on the type of connection. Connections until 10 MVA are shallow, regulated and averaged.[11] Under this system, additional costs raised inside the grid - e.g. by reinforcements - are passed down to consumers through the use of the system tariff or absorbed by DNOs. Furthermore, connection charges are set by the regulator and are not individually calculated but cover a different number of connection profiles. Connections bigger than 10 MVA are negotiated and deep.[12] Charges, in this system, are determined through negotiation processes between users and the DNOs.

The current connection policy favours small and medium sized DG in the sense that it provides reduced connection costs compared to deep charges (small and medium sized DG normally have connections up to 10 MVA). Furthermore, as charges are regulated, the regulator removes the risk of uncertainty that negotiated charges would create. On the other hand, DG cannot get the connection benefits associated with its connection, which, when positive, could be an extra income source.

Use of system charges

For the use of system (UoS) charges the cascade principle applies. According to the cascade principle, the costs of higher voltage grids are allocated to the users at lower voltage grids in proportion to their use of this higher voltage grid. Producers that have connections at EHV (380/220 kV) and HV (150/110 kV) grid levels have to pay the National Uniform Producer Tariff (LUP), which accounts for the 25 percent of the sum of the total transport related UoS tariffs of these grids. Consumers have to pay for the rest of the charges in the EHV and HV grid levels (75%) plus the total of the costs in the lower voltage levels. The LUP tilts the level playing field in favour of DG when it comes to UoS charges. As DG is connected to middle and lower voltage levels grid, it profits from this system. In other words, while large-scale production units have to pay for UoS charges, DG does not.

Costs raised by *network losses* are considered as non-controllable and therefore socialised. The costs generated by network losses are all recovered through the UoS tariff. DG profits from a temporary provision, which indicates that DG connected to the medium voltage (MV) and low voltage (LV) systems, receives compensation for reducing net losses that amounts 0.1 € ct for every kWh dispatched into the LV and MV grids. [13]

Connection of DG to the network may *engender investments in the grid*. In case of DG connections with shallow connection charges, the grid investments might exceed these connection charges. The extra costs could either be passed on to the consumers through the UoS tariff or absorbed by the DNOs. As tariffs are fixed under a price-cap, DNOs can request for an ad-hoc increase of the UoS tariff. This mechanism is stated in the Electricity Act (Article 40.2), yet is normally turned down by the regulator. If the request is rejected, extra investment costs must be born by the DNOs, which discouraged them to let new producers connect to the grid, even though the law obliges them to do so.

DG can also *avoid investments in the grid*. When considering fixed distribution tariffs, DNOs will carry out the necessary investments as efficient as possible. DG can be an efficient option to avoid, for example, the upgrading of the particular grid area. However, in the current system, DNOs will not implement that option, because DNOs cannot own generation and no economic

---

[11] Shallow is referred to connection charges that only comprise capital and maintenance costs of the connection itself but are not charged directly for other costs incurred by the network operators, e.g. reinforcement costs.

[12] Deep is referred to connection charges that cover all costs raised by connecting to the grid. They included the direct costs of connecting to the grid and all indirect costs raised inside the grid.

[13] The low voltage (LV) net allows plants smaller than approx. 0.1 MW; the LV and medium voltage (MV) net between 0.1 MW and approx. 1 MW; the MV net between 1MW and approx. 5 MW; the MV and high voltage (HV) between 5 MW and approx. 75 MW; and the HV net higher than approx. 75 MW.

incentives (e.g. entry charges) are available for them to encourage the installation of DG in relevant areas. Moreover, congestion costs are completely paid by consumers through the system tariff. However, if a DG connects at a favourable site to the DNO, the benefits of avoided grid investments accrue to the DNO.

Reactive power is treated as a 'non-controllable' (not benchmarked) cost as all costs incurred by DNOs are passed down to consumers through he UoS tariff. Consequently, DNOs have no incentives to sort out reactive power problems in the most efficient way, either by optimising their reactive demand on the transmission system or by paying distributed generators to produce or absorb reactive power. In other words, there are no correct signals to value the services that DG can provide.

Quality and innovation

Under current performance standards, quality of supply of DNOs is not effectively addressed as only indicative performance standards are in place. In other words, DNOs are not penalised when the standards are not achieved. If penalties are in place - the Network Code stipulates that a network company is required to pay its customers a fixed compensation if an interruption of supply lasts for longer than four hours - they are minimum standards, which will not result in an optimal level of quality.

Two other important issues are also worth mentioning. The first one is that, due to the unbundling of the sectors, a long-term cost minimisation policy through integrated resource planning cannot be achieved anymore. As decisions about building new generation capacity are detached from the grid managers, DNOs face constraints in determining how and where infrastructure developments should take place in the most efficient way.

The second one is the fact that DNOs are encouraged to minimise operational expenditures, which has an anti-innovative effect. In other words, as the operational expenditures of the firms are benchmarked against other firms, firms become risk averse and therefore will tend not to invest resources in new technologies or managerial systems that are uncertain. This can negatively influence the development of DG.

Market access of DG

Until 2003 RES were supported through a mix of tax exemptions to their consumption and subsidies to the production. Both RES and CHP have to sell its energy on the wholesale market, just like any other generator and, furthermore, has to purchase ancillary services from the TSO (e.g. to balancing power). Under current conditions, DG does not participate in the supply of ancillary services and cannot be compensated for providing ancillary services to the grid operator. DG that is independently owned and managed, mainly sells the produced electricity through long-term bilateral contracts with retailers.

3.3.2 2004: Multi-Drivers Incentive Regulation and Market Access of DG

In the year 2004 a (second) regulatory period begins in which a system approaching the definition of a new multi-drivers incentive regulation system will most probably be implemented. This will shift the Dutch power sector from Section II-B to Section III-B in Table 3.1. The outline of this new regulatory framework, though still in consultation, is highly certain and based on the regulators (DTe) literature.[14]

The two basic modifications, compared to the previous regulatory system, are the establishment of new x-factors for firms and the internalisation of quality in the regulatory framework. For the x-factors it is expected that the price-cap system, that individually assigned efficiency reduc-

---

[14] Yardstick Competition: Regional Electricity Network Companies, Second Regulatory period, November 2002.

tions (x-factors) to DNOs, will be replace by a yardstick competition regulatory system. For the quality regulation it is expected that, on the one hand, a number of performance based incentives will be introduced and, on the other hand, certain quality variables will be internalised in the benchmarking method.

Yardstick system

DTe considers a yardstick system as the best approach to minimise transaction costs and asymmetries in information in the regulation of the distribution networks. As a result, DTe intends to implement this regulation system for the second regulatory period that starts in January 2004. Individual price caps implemented in the first regulatory period were aimed at moving all DNOs to an efficiency frontier. Once there, the tariffs will be determined based on the average productivity changes of the sector. In other words, the performance of the DNOs will be benchmarked against the performance of the sector as a whole. Companies that do better than the sector average will receive extra benefits. Conversely, DNOs that do worse than the sector average will see their benefits reduced. It is important to note that the x-factor will be estimated before the regulatory period starts (ex-ante), and any differences between the estimated and ex-post x-factor will be included in the tariffs of the subsequent regulatory period.

Connection

Connection charges will remain the same as in the first regulatory period. In other words, connection costs will remain shallow, regulated and averaged for connections up to 10 MVA and deep and negotiated for connections higher than 10 MVA.

Use of System tariffs

UoS tariffs will, on the basis, remain the same as in the first regulatory period. The cascade principle will still apply including the incentive to DG by which producers - normally large-scale generators - having a connection at EHV and HV grid levels have to pay the LUP, which accounts for 25 percent of the sum of the total transport related UoS tariffs of these grids. The differences will come on the variables that will be internalised in the decision making process of the DNOs, i.e. network losses, network investment and reactive power.

DTe intends, in this regulatory period, to regard *network losses* as a controllable cost, i.e. benchmark network losses with the whole sector. By doing do, DNOs will receive incentives to act efficiently. Either investing in network grids or promoting DG can reduce grid losses.

Congestion in transmission and distribution lines was, in the former regulatory period, considered as an uncontrollable cost and managed through the balancing market. By increasing and decreasing the production in the deficit and surplus areas respectively (redispatching) the congestion was eliminated. The costs raised in this process were socialised among consumers through the UoS tariff. In this regulatory period, by considering congestion costs as controllable, DNOs are encouraged to manage congestion in a more efficient manner. Options to eliminate congestion include upgrading the grid, redispatching, or contracting DG in certain locations.

As network companies can purchase *reactive power* from power producers - DG is an option - or can obtain it from capacitor installations, DNOs have alternative sources to obtain this power. DTe intends to regard reactive power as a controllable cost and therefore benchmark it with the whole sector. This will provide DNOs with incentives to opt for the most efficient solution with regard to the procurement of reactive power.

Quality and innovation

To solve the lack of incentives DNOs had to maintain quality levels of service during the first regulatory period, DTe is implementing a number of performance-based incentives. Since the yardstick regulation system also provides DNOs with strong incentives to reduce costs, by internalising quality into the regulatory framework, DTe aims at achieving an optimal relationship between price and quality. Under the new system, tariffs will be also determined based on a reliability/quality standard set by DTe. An individual network company may achieve a profit if it outperforms the standard, but a loss if it underperforms relative to the standard. Initially the standard will be determined for each network company separately and thereafter will be adjusted annually by the same factor that applies to all companies.

Concerning innovation, DNOs will receive no extra incentives to undertake innovation. As a result, even though stability of the system will be encouraged through a number of performance based incentives, innovation is expected to remain low, too low for risk averse DNOs to perform projects to that would aim at enabling DG to be integrated more effectively and efficiently.

Market access of DG

RES and CHP generators (DG) are, as from 2003, supported through a feed in tariff under the MEP programme based on the environmental attributes of the electricity generated.[15] These generators have to sell their electricity on the wholesale market, just like any other generator and, furthermore, purchase ancillary services from the TSO. In this regulatory period, DG will not be able to participate in the supply of ancillary services and will not be compensated for providing ancillary services to the grid operator. DG that is independently owned and managed will, considering the risks, sell the produced electricity through long-term bilateral contracts with retailers.

3.4 Future Regulatory Steps

From the above, it can be concluded that the current regulatory framework differs from a regulatory framework proposed in Section 3.2 that creates a level playing field between centralised generation and DG. The next sections describe the transition of the current regulatory framework into the proposed new regulatory system (i.e. innovative active network regulation) in two successive steps. The power system will be characterised by a high penetration level of DG (around 30% of the total electricity consumed in 2020 based on the DG opportunities scenario) and active distribution networks.

3.4.1 2007: Introducing Innovative Regulation

By 2007 the third regulatory period will be in place, which in this regulatory road map will lead the Dutch power sector from Section III-B to Section IV-B in Table 3.1. Tariffs in the network sectors will still be determined through a yardstick system, yet including a number of changes from the system implemented in the previous regulatory system. In order to provide appropriate incentives to manage and operate their networks in an efficient and co-ordinated manner while absorbing a steady increase of DG (see Section 2.2), DNOs will be provided with instruments such as entry and exit charges that will enable them to actively manage the network. Depending on the DG growth and the success of innovations in network management, the innovative regulation may be continued in the forth regulation period (2010-2012)

Yardstick system

Tariffs in this regulatory period will be set by a performance based yardstick system, consistent with the DTe's belief that light-handed regulation is the best approach to minimise transaction costs and asymmetries in information. Operational and capital expenditures, together with an increasing number of performance indicators, will be benchmarked. It is expected that the portion of the revenue resulted from quality will increase compared to the previous regulatory period.

---

[15] See: http://www.renewable-energy-policy.info/relec/netherlands/policy.html.

Connection charges

All connection charges in this regulatory period will be shallow. That is to say, connections higher than 10 MVA will move from covering deep costs to covering shallow costs.

Use of System charges

Network losses, congestion costs and reactive power are all issues considered as ‘controllable costs’ in this regulatory period. In order for DNOs to actively manage the network and therefore be able to implement optimal decisions, correct instruments should be provided. As a result, in this regulatory period UoS charges will be composed by entry and exit charges, together with performance based incentives (Mitchell, 2002).

DNOs in previous regulatory periods had no instruments to give locational incentives to generators to make optimal grid connections. Entry charges would solve this flaw by providing DNOs with the possibility to set single or annual payments to generation entering the distribution system. Positive or negative charges would signal the best place in the grid to connect in order to reduce network losses, solve congestion or reactive power issues.

Exit charges (UoS charges paid by consumers) would cover other costs faced by DNOs, i.e. transportation costs, operation and maintenance costs, investment costs, and the difference between shallow and deep costs. The charges will move away from a kWh based charging, as the increase of reverse power flows caused by an increase in DG, may mean that a kWh-based charging system would no longer suffice adequately to recover the DNOs costs (DGCG, 2003).

Entry charges reward DG that connects in certain locations for certain reasons. In this regulatory period, DG as a whole will also be rewarded by its contribution to reduction in network losses and improvement in security of supply. That is to say, a socialised payment to DG will occur based on global calculation of the benefits it generates. DG that can provide reactive power efficiently will be able to contract with DNOs, and be compensated for this service.

Quality and innovation

Based on the assumption that active networks can manage DG in a more efficient way, DNOs should be provided with incentives to implement innovative grid management technologies. To achieve this, innovation has to occur in both business practices and networks.

As DNO networks were not designed to accommodate high amounts of DG, they will need significant development and investments to operate them successfully as ‘active networks’. The possibility for DNOs to recover ‘risky’ investments in innovative solutions and technologies is a necessary condition to fulfil this objective. Investment in innovation is characterised by a high degree of uncertainty, because, among other things, it can take a relatively long time to receive a return on such projects. In the third and fourth regulatory period, DNOs will receive incentives to invest and innovate in the grid.

Two different systems that could promote innovation in this regulatory period are put forward here: Innovation Funding Incentive and Registered Power Zones (OFGEM, 2003). Innovation Funding Incentive is aimed at facilitating funds spent on R&D by DNOs. As operational expenditures of distribution firms come under great pressure from the incentive regulation in place, Innovation Funding Incentive would provide specific funding to demonstration phases of certain projects. Registered Power Zones are intended to offer DNOs a sufficient incentive to encourage them to pursue network projects with higher risk profiles. As a result, a financial incentive would be provided to better balance the DNO risk/reward position.

Market access

RES and CHP generators (DG), in this regulatory period, will continue to be supported through a feed in tariff under the MEP programme. These generators will still have to sell their energy from this generation sources on the wholesale market, just like any other generator and, furthermore, purchase ancillary services from the TSO through the balancing market. In this regulatory period, DG will continue not to be able, in general, to participate in the supply of ancillary services. Reactive power will be the only exemption.

3.4.2 Active Network Regulation

As from 2013 it is expected that the Dutch power sector will move to Section V - C in Table 3.1, in which an active network regulatory framework is in place and a high penetration level of DG exists. As a consequence of the innovative regulation, it is expected that innovative forces and investments in new technologies will take the sector to more active networks. Active networks here comprise both the physical networks and the business orientation of DNOs. Technically active networks will be considered as facilitators, which do not distribute power but connectivity. Moreover, DNOs will become entrepreneurs, which, instead of having a reliable transportation system as 'main product', will profit from a range of products related to the technical performance of the network (DGCG, 2003).

Yardstick system

Tariffs in the active regulation periods will be set by a performance based yardstick system. Operational and capital expenditures will be benchmarked, together with an increasing number of quality indicators. The portion of the revenue resulted from quality will be significantly high.

Connection charges

Connection charges in this regulatory period will be shallow. Furthermore, DNOs will be able to provide connection incentives with entry charges.

Use of system charges

UoS charges under an active network regulation system will be composed by entry and exit charges together with a performance based system. Exit charges will find an equilibrium between a kWh charge and fixed charges that would allow DNOs to recover all costs, including investment in the grid and innovation expenditures.

Active network regulation will be able to provide DG with the correct rewards for the benefits they generate. While DG will be individually rewarded by their contribution to reduction in network losses and network reliability, the contribution to the improvement in security of supply will still be socialised through the sector. DG will also be able to sell ancillary services, including reactive power, in corresponding markets.

Quality and innovation

Performance based tariffs together with extra incentives to innovate will keep on providing the network to innovate and remain dynamic. DNOs will be business-oriented firms that are incentivised to keep costs down, while pursuing quality and innovation in an efficient way.

Market access

Under an active network regulation, a high level of DG/RES penetration exists. On top of DG/RES supplying electricity in the wholesale energy market, these sources will start playing a role in balancing the electricity system. In other words, in this stage of development DG/RES will be able to provide ancillary services and receive compensation for this service. For example, DG is allowed to bid its supply into the balancing market, or DG can have contracts with a DNO to provide voltage support and reactive power. New ICT solutions will facilitate market access and will keep transaction costs low.

4 ROBUSTNESS OF THE REGULATORY ROAD MAP

4.1 Introduction

In the previous chapter a regulatory road map is developed against a background of ambitious policy targets and strong support for distributed generation and electricity from RES in combination with a strong EU harmonisation policy. However, developments may take another course than intended or expected. In this chapter the regulatory road map will be analysed for its robustness, i.e. are the regulatory actions in the road map still appropriate, should the timing be changed or are alternative actions necessary. Section 4.2 discusses the impact of two types of developments: other scenarios and disruptive events. The consequences for the regulatory road map are discussed in Section 4.3.

4.2 Other developments

4.2.1 Other scenarios

Figure 4.1 shows schematically the four scenarios developed in the SUSTELNET project (Timpe and Scheepers, 2003). Scenario A (DG Opportunities scenario) has been used as background for developing the regulatory road map (see Chapter 2). The three other scenarios assume lesser ambitious targets and limited support for DG and RES and/or more national oriented policies.

Table 4.1 *DG Scenarios*

	High RES & DG incentives	Moderate RES & DG incentives
Stronger EU harmonisation policy	*Scenario A* 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)	*Scenario B* 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	*Scenario C* 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	*Scenario D* 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

Scenario B: Difficult times for DG in a fully harmonized EU market
In this scenario the growth of DG & RES will be lower than in the DG opportunities scenario. Introduction of new technologies will become more difficult. Onshore wind energy will grow to the same levels as in scenario A, but the more expensive offshore wind technology will stay in its infant stage (less than 1000 MW realized in 2020). Also the fuel cell CHP will develop slower. This technology will be introduced in commercial and industrial applications, but not in dwellings (micro CHP). In general, electricity supply from renewables will grow, but slower than in scenario A. The electricity supplied from DG will still increase in this scenario, however, the DG-share relative to consumption in 2010 and 2020 will not differ substantially from today's share.

The moderate development of DG will probably not require active management of the distribution network. However, DG will profit from improvements of operation and control systems that are introduced in course of time. Since the amounts of electricity supplied from wind energy will be less than in the DG Opportunities scenario, the impact for the transmission grid, management of import/export flows and system balancing will be limited.

Scenario C: DG opportunities in national markets
In this scenario the policies are more national oriented. This means that, although renewable targets in EU will be ambitious, export of renewable electricity might be more difficult compared to the DG Opportunities scenario. This puts a constraint on the development of offshore wind, as foreseen in the DG Opportunities scenario. The development of DG might not be affected, i.e. the development of onshore wind energy, fuel cell CHP, etc. will be similar as in the DG Opportunities scenario. The management of the distribution network will be changed as described in Section 2.3. However, for the development of the transmission network, the import/export flows and system balancing, this scenario has similar consequences as Scenario B.

Scenario D: Difficult times for DG in national markets
Regarding the development of DG and RES this scenario is comparable with scenario B. DG and RES will develop slower and the introduction of new technology will be more complicated, i.e. restricted to a niche market level. Since energy policy is more national oriented, policy makers and regulators might be less motivated to change the regulatory framework.

4.2.2 Disruptive events

Disruptive events can have a major impact on the development of electricity networks. There are several types of disruptive events. A distinction can be made between 'man-made' and 'natural' events. 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 impacts of disruptive events on systems in a phase of transition -electricity systems currently undergo an institutional transition - can be much larger. Also, the timing of disruptive events matters in another way: disruptive events in 2015 could affect the state of the electricity system less than events that take place in 2005. A limited number of events will be discussed here. Since discussion of critical points (Section 2.5) indicates that the period around 2010 might become a crucial period for the transition of the electricity system, we assume disruptive events to happen in this period.

Four events will be discussed to illustrate what the impact of disruptive events on the transition of electricity supply systems could be.

Three events will have an impact on European scale, one on a national scale:

- European events
    - a fuel cell technology breakthrough,
    - gas price crisis,
    - collapse of the Kyoto process.
- National events
    - national power crises.

Fuel cell technology breakthrough

A breakthrough of fuel cell technology is already expected for many years. Such a breakthrough is mainly related to the unit specific costs that could make this technology competitive with conventional power generation. When car manufacturers start to produce fuel cell motorcars on a large scale, substantial decrease of costs may be expected. Manufactures of (micro) CHP plants may profit from this development and may put competitive CHP units on the market. As fuel cell stacks uses hydrogen, a breakthrough may also originate from a breakthrough in the low-cost production of hydrogen, e.g. a cheap fuel processor converting natural gas into hydrogen.

Although the DG Opportunities scenario for the Netherlands (see Appendix A) was already quite optimistic regarding fuel cell technology development, a breakthrough will further enhance the market introduction of micro CHP. After 2010 the share of small CHP units in power supply could become larger and, therefore, the level of DG as well.

Gas price crisis

Section 2.4 already discussed the impact of energy prices on the DG Opportunities scenario. Because power is generated in the Netherlands for a large part on basis of natural gas, high gas prices will presumably result in high electricity prices, in particular during peak hours. This could make electricity imports more attractive, which could make CHP plants less profitable. However, it is also possible that gas prices result in higher prices for CO_2 emission allowances, if natural gas based power generation is the marginal option. This would be a positive effect for CHP in comparison to conventional power generation.

In the DG opportunity scenario a gas price crisis might help the transition of the electricity supply system towards DG, because it could make fuel cell based CHP plants become attractive in comparison to conventional CHP plants. CHP power plants based on fuel cell technology have higher efficiencies and will therefore be less sensitive to high gas prices and profit more from high prices of CO_2 allowances. In the DG Opportunities scenario the capacity growth of CHP plants after 2010 will be higher, in particular in the commercial and domestic sector.

Collapse of the Kyoto process

If in the Kyoto process no agreement is reached on new greenhouse gas reduction targets, an important driver for DG and RES disappears. Moreover, an increase of RES (new indigenous energy sources) and CHP (energy savings) in the electricity supply will still contribute the supply security. Depending on the political importance of this issue, the support for DG and RES might become less strong. After 2010 the increase of CHP and RES might become much smaller than in the DG Opportunities scenario.

National power crisis

A structural shortage in power generation capacity relative to peak demand could very likely result in a power crises. Such a power crisis may materialise into supply interruptions (black outs) when supply shortages cannot be covered by imports, because other countries also suffer a power crisis or import capacity is (temporally) insufficient. In principle there are two effects: (1) very high electricity prices for some time and (2) (high risks for) supply interruptions. High prices will stimulate electricity savings, but consumers may also look for options to generate power themselves since electricity prices could be at a level higher than the integral costs of power generation. An extra incentive for DG will come from the risk of unexpected supply interruptions, since in particular commercial and industrial consumers will also bear the indirect costs of interruptions.

As a result of a national power crisis around 2010, the amount of DG capacity will probably boost, i.e. increase faster than in the DG Opportunities scenario. Due to the availability of the fuel cell technology new (micro) CHP plants will be realised. However, also large-scale power generation capacity will be built and might even receive support from the government (e.g. tenders with guaranteed prices and simplified licence procedures). It is likely that a power crisis will be followed by a period of over-capacity with relatively low electricity prices, which might temporarily slow down the growth in DG and RES. Nevertheless, a power crisis could enhance the transition of the electricity supply system.

4.3 Consequences for the regulatory road map

The regulatory road map is based on Scenario A, which describes a scenario friendly to DG and RES. However, the probability of other scenarios and a number of disruptive events - described in the previous section - makes it relevant to investigate their influence on the development of DG and on electricity networks. Analogous to a sensitivity analysis, it is important to illustrate the possible impact the scenarios and disruptive events can have on the development of regulation on the one side, and on the development of the distribution network on the other side. Of course, the development of the regulatory framework and of the network is highly, though not perfectly, related.

The different regulation instruments implemented throughout the regulatory road map aim at creating a level playing field between centralised and decentralised generation in general, and promoting active networks in particular. In this Dutch regulatory road map, the regulatory system aims at increasing economic efficiency in the electricity system and is mainly independent of the development of exogenous factors like the disruptive events aforementioned. Consequently, it can be concluded that the other scenarios or the disruptive events have no significant impact on the regulation proposed.

Nonetheless, the level of DG - determined by the scenarios and disruptive events - which develops in the system, can have an impact in the development of the distribution network. It is assumed that active networks are the most efficient way of managing a distribution network with high penetration of DG. If DG does not fulfil the targets assumed in Scenario A, i.e. less DG capacity is invested, the cost-effectiveness of developing the distribution networks into active networks can be questioned. For example, in the case of a collapse in the Kyoto process, the fact that less DG develops can make the development of active networks not cost-efficient and therefore the road map would stop in the Section IV-B in Table 3.1. Due to the qualitative characteristics of this study, it is not possible to determine strictly the inflexion point of the developments, i.e. under which precise conditions - disruptive events - the regulatory road map develops to Section IV-B and under which ones to Section V-C. It is important to stress that if the distribution system does not develop into active networks, no level playing field would arise between DG and centralised generation. As a result, DG might need to be compensated for its enduring disadvantage.

5 ACTION PLAN

This chapter develops an action plan, which materialises the regulation issues put forward in the regulatory road map. Specifically, it allocates the tasks that should be completed by the different stakeholders in order to achieve an active distribution network. As seen in Table 5.1 and consistent with the different regulatory phases that structure the road map, the action plan illustrates the allocation of the different tasks in the different periods.

Ministry of Economic Affairs

The Ministry of Economic Affairs lays down in published policy rules the general instructions on the performance of the tasks assigned to the director of DTe under the Electricity and Gas Acts. In case any regulation in this regulatory road map would need changes in the law to be implemented, the Ministry should be responsible for this action.

Regulator - DTe

As the regulator, DTe, is in charge of implementing most of the proposals put forward in this regulatory road map. In accordance with the Electricity Act 1998, which assigns DTe the power to set network charges, its rate structure and conditions, they are in charge of implementing all proposed new regulations. In order to be consistent with the law - Article 42 of the Act states that the pricing system that regulates distribution tariffs shall be a price-cap - the proposal of a multi-driver price regulation is considered.

Table 5.1 *Action Plan*

	2004	2007	After 2013
Ministry of Economic Affairs	• The Ministry has to provide changes to the law, if necessary.		
Regulator	• yardstick system, • quality measures, • benchmark of: - Network losses - Network investment - Reactive power.	• entry, exit charges, • performance based incentives, • innovation incentives.	• improvement of incentives based on the active networks.
DNOs		• increase innovation and technology testing to develop active networks • evolve into active business oriented firms, • actively manage the network, providing location signals to generation, • improve coordination with TSO.	• allocation of benefits and costs to DG.
DG Operators		• Actively participate in energy and ancillary markets	

Distribution Network Operators

Typically DNOs are passive organisations whose business is to transport electricity. With the increase of DG, a change of the management of distribution networks is desired. As a result, as from the year 2007, they should evolve into more active business oriented firms. In order to provide connectivity and actively manage the grid, DNOs should know which type of technologies should be applied. Therefore, the technological systems to accommodate such an increase of small-dispersed sources feeding electricity into the grid should be developed and tested before 2012. Moreover the co-ordination between DNOs and the TSO should be improved.

DG Operators

As the network develops from passive to active, DG operators will gain market access, especially to ancillary markets. DG operators will have to participate in the market as any other power producer, and, furthermore, as the technologies develop, will receive less and less the benefit of support mechanisms. Profits will rise from the selling of electricity as a commodity, but also from the benefits they accrue in other areas, such as management of the grid and ancillary services.

REFERENCES

Distributed Generation Co-ordinating Group (OFGEM): *First Annual Report of the Distributed Generation Co-ordinating Group (2001/2002)*. March 2003.

Dte: *Yardstick Competition: Regional Electricity Network Companies, Second Regulatory Period.* Information and consultation document, Office for Energy Regulation (DTe), 20 November 2002.

Dutch Electricity Act, 1998.

G. A. Comnes, S. Stoft, N. Greene and L. J. Hill: *Performance-Based Ratemaking for Electric Utilities: Review of Plans and Analysis of Economic and Resource-Planning Issues.* Energy & Environment Division, Lawrence Berkeley National Laboratory, University of California. November 1995.

Jamasb, T., M. Pollitt: *Benchmarking and Regulation of Electricity Transmission and Distribution Utilities: Lessons from International Experience*. Cambridge University, December 2000.

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

Mitchell, C.: *Response to OFGEM's Update on Structure of Electricity Charges*. Warwick Business School, December 2002.

OFGEM: *Innovation and Registered Power Zones*. Discussion Paper, 2003.

Overveeke, F. van, V. Roberts: *Active Networks as Facilitators for Embedded Generation. Co-Generation and Online Power Production.* March-April 2002 (can be downloaded from: http://www.jxj.com/magsandj/cospp/2002_02/active.html).

Sambeek, van, E.J.W., M.J.J. Scheepers, A. Wals: *An Outline for Developing Regulatory Road Maps*. ECN-C--03-101, July 2003 (can be downloaded from http://www.sustelnet.net).

Timpe, C. and M.J.J. Scheepers: *A look into the future: scenarios for distributed generation in Europe*. Öko institut/ECN, ECN-C--04-xxx (to be published), January 2004 (will be available at http://www.sustelnet.net).

Wals, A.F., E. Cross, E.D. van Sambeek: *Review of Current Electricity Policy and Regulation: Dutch Study Case*. ECN-I--03-005, February 2003 (can be downloaded from http://www.sustelnet.net).

APPENDIX A POWER GENERATION IN THE DG OPPORTUNITIES SCENARIO FOR THE NETHERLANDS

CHP

For possible developments of CHP, the quantitative information from the Post-Kyoto scenario developed in the SAVE project Future COGEN[16] is used. This scenario assumes a strong GHG emission reduction policy, enhanced liberalization and full legal unbundling, a strong renewables policy and fast technological developments. In this scenario micro CHP and fuel cells are quickly introduced. Micro CHP will reach a significant market penetration.

In the Netherlands four groups of CHP can be distinguished:

1. District heating plants (mainly large power plants with heat supply to residential areas): district heating schemes will not grow substantially, but the operation of existing schemes will continue. This also counts for medium scale district heating schemes, which are DG.
2. Industrial CHP: new large gas fired power generation capacity will be built as CHP-plants before 2010 (growth of total capacity with approximately 50%) but capacity will remain constant after 2010. The growth in medium sized industrial CHP (DG) will be moderate.
3. Commercial CHP: current small scale CHP is used in the commercial sector (incl. horticulture greenhouses). CHP based on gas engines will be replaced by fuel cell CHP after 2010. A moderate growth is expected for commercial CHP.
4. Micro CHP (<5 kWe): a significant penetration of small scale CHP will start after 2010 when the fuel cell technology become available at reasonable cost levels. A penetration level of 20 to 30% is expected in the residential sector by 2020 resulting in 2000 MW. The 6000 MW forecasted for 2020 in the Post-Kyoto scenario of the Future COGEN project is unrealistically high.

RES

For possible development of RES the Admire REBUS[17] model is used. This model is based on renewable electricity cost potential curves for each EU MS. The REBUS model quantifies the development of renewable electricity production and consumption in EU MS as a function of policies, such as quota obligations, feed-in tariffs, or fiscal incentives.

1. Small scale hydro: the capacity will remain at the current level (38 MW)
2. Biomass: biomass is a renewable fuel type with diverse fuel and environmental qualities. Part of the waste currently burned in incineration plants is considered as biomass (50%). Other biomass waste is used as fuel in coal power plants (co-firing). Because a strong growth in biofuels may be expected, the high quality biomass will not be used for power generation on the longer term. Restricted availability of biomass waste and low cost biomass fuel will determine growth of biomass in power production.
    - Co-firing in coal power plants: the biomass share in coal-fired power plants will increase. However, since some coal-fired power plants will be decommissioned and no new coal fired power plants will be built, the growth of co-fired biomass will slow down after 2010. Alternatively, a gas-fired power plant in combination with a gasification plant may also be used for co-firing biomass.
    - Biomass in incineration plants: currently 50% of the waste in incineration plants is considered as renewables. This will not grow substantially, because some biomass waste will be separated and go to coal plants or specific biomass plants.

---

[16] The Future of CHP in the European Market - The European Cogeneration Study, 2001, http://tecs.energyprojects.net.

[17] http://www.admire-rebus.net.

    - biomass in DG plants: the number of these type of plants will increase. Some of these plants will also be CHP-plants. The total capacity of DG biomass, including waste incineration will be 1000 MW by 2020.
3. Wind: electricity from wind is currently only produced by onshore wind turbines. However, a first offshore wind farm of 100 MW will be in operation before 2005.
    - Onshore wind: partly by development of new sites and partly by replacements of existing wind turbines the current capacity will be tripled by 2010 (1.500 MW) and grow to 3.000 MW by 2020.
    - Offshore wind: By 2010 the offshore wind capacity could be 1000 MW. After 2010 this type of wind energy will really boost. Both by new sites and the significant increase of the size of wind turbines. By 2020 the total capacity might go up to 12.000 MW, because of its large potential and the competitiveness in the renewable energy market.
4. Solar (PV): in a social-political climate that strongly supports renewable energy, consumers may become vulnerable for the idea of producing renewable energy themselves instead of buying green electricity, even if costs of PV will remain rather high. The total capacity for PV will be 100 MW in 2010 and 200 MW in 2020.

Conventional power generation

Three types of conventional power generators are used in the Netherlands: nuclear, coal, and gas. In 2000 an overcapacity in power generation capacity existed, partly due to increasing imports of lower priced electricity from neighbouring countries. The electricity demand growth can be covered by this extra capacity for some time. However, in the DG opportunity scenario new renewable and DG power generation capacity will become available. The result will be that part of the existing power capacity is not longer needed or could be used for other purposes:

- Nuclear: it has already been decided that the only nuclear power plant in the Netherlands will be decommissioned in 2013.
- Coal: internalising of CO_2 emission costs (i.e. implementation of a CO_2 emission trading system) will make power generation in coal power plants less attractive. The oldest plants will be decommissioned, whereas newer plants will be used for co-firing of biomass. The biomass/coal ratio will increase: on average up to 20% in 2010 and up to 30% in 2020. This requires innovations and extra investments.
- Gas: increase of CHP and RES plants will result in less conventional gas power plants. However, a relatively large capacity of flexible gas power plants remains necessary to balance the electricity system.