Environmental policy in a liberalised electricity market: The case of The Netherlands

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1. Introduction

In the first GRENELEM meeting, the state of the liberalisation process of the electricity market in the Netherlands was discussed including the impact on the environment (see Oosterhuis, 2001). During the second meeting, methods and tools for environmental impact assessments were reviewed. This paper for the third GRENELEM meeting focuses attention on how environmental impacts are or can be incorporated in the Dutch electricity system. A review of policy instruments teaches us that the environmental aspects do already play a role in the electricity market. However, there is still little known about environmental impacts of the liberalised electricity market. The Institute for Environmental Studies participates in an EU commissioned project called EMELIE.[1] The aim of the project is to model the liberalised European electricity market and to investigate what the economic and environmental impacts of such an electricity market are.

The outline of the paper is as follows. Section 2 describes the state of the art of the liberalisation process in the Netherlands. In addition, we summarize some developments due to the liberalisation process of the electricity market. In section 3, we review the environmental policy instruments that are relevant for the electricity market in the Netherlands. We also discuss the effectiveness of policy instruments in a liberalised electricity market. Section 4 presents the EMELIE project and the EMELIE model. The EMELIE model is a game theoretic model with which the economic and environmental impacts of a liberalised European electricity market can be estimated. We present preliminary results of the EMELIE model for the Netherlands. Finally, section 5 concludes.

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1 EMELIE is the acronym of Electricity Market Liberalisation in Europe.

2. The liberalisation process in The Netherlands

2.1 Liberalisation process: state of the art

As Oosterhuis (2001) has mentioned, liberalisation of the electricity market in The Netherlands started in 1995 with the publication of the Third White Paper on Energy Policy. This policy document contained proposals for a radical change in the structure of electricity supply, aiming at a rapid transition towards competition and free trade. With a new Electricity Act entering into force in 1998 (which was adjusted later on to accelerate the liberalization process) the electricity market will be opened up in three stages as table 1 shows.

Table 1 Stages of the electricity market liberalisation process in the Netherlands

Date	**Consumers or users**	**Description of consumers**
January 1999	extremely large-scale industrial users	> 2 MW, accounting for about one third of electricity demand
January 2001	large business and SME users (>100 MWh)	using less than 2 MW but having a connection of more than 3x80 Ampère
January 2004	SME users (<100 MWh) and households	The rest of the consumers
In addition		
July 2001	All	'Green' electricity (i.e. renewables based)

Large users (>100 MWh electricity consumption per year), which account for two third of the total annual electricity consumption, can already freely choose their electricity supplier. They account for two-third of the total electricity consumption. As of January 1st, 2004, the liberalisation process will be completed, because then all consumers including SME users (<100 MWh per year) and households can freely choose their electricity supplier. Note that since July 1st, 2001 all consumers can already choose their own 'green' electricity supplier.

In order to establish a liberalized electricity market three agents were introduced. Firstly, electricity grid management and electricity transport are unbundled from production and distribution. TenneT is the national Transmission System Operator (TSO) and is a state owned company. TenneT operates the high-voltage transmission grid and is responsible for the 'system services'. Next to TenneT, there are 14 regional and local network operators that operate the low voltage transmission grid. Secondly, DTe (Office of Energy Regulation) is responsible for grid supervision, determination of grid utilization tariffs, and rules of competition. DTe is a part of NMA (Netherlands Competition Authority). Thirdly, Amsterdam Power Exchange (APX) is the electricity spot market. In 2001, approximately 8% of the electricity was traded on the APX.

2.2 Electricity market

The liberalization process has induced developments in the electricity market. Before the liberalization process started, there were four large Dutch power producers in the Netherlands. However, these producers were considered to be too small to be able to compete on the European market. The government's suggestion to create one Large Electricity Generation Company failed. As a result, foreign firms took over three Dutch large power producers, see Table 2. The experimental 253 MW coal gasification plant was sold to NUON. NUON was already one of the largest electricity suppliers in the Netherlands but will become one of the major electricity producers, as they recently, announced that they will take over Reliant's power plants in the Netherlands.

Table 2. Centralized power producers in the Netherlands

Forner companies (number of power plants)	**New owners**	**Latest developments:new owner**
EPZ[1] (without Borssele, 5)	Essent (Netherlands)	
EDON (6)	Electrabel (Belgium)	
EZH (6)	E-On (Germany)	
UNA (6)	Reliant (United States)	NUON (Netherlands)
experimental 253 MW coal gasification plant	NUON (Netherlands)	
EPZ[1] (Borssele)	Essent (Netherlands) 50% Delta Nutsbedrijven (Netherlands) 50%	

[1] EPZ owned the Borssele power plant, which consists of a nuclear power plant and a coal power plant. The ownership of the Borssele power plant is now equally divided between Essent and Delta Nutsbedrijven.

Due to the liberalisation, electricity consumers can freely choose their electricity supplier. In the Netherlands, EnergieNed (2002) reports on the actual switching behaviour of large electricity users. Since the opening of the market, approximately 40% of the large-scale industrial users have switched from their initial supplier to another. In addition, 20% has plans to switch. A similar pattern has been found for large business and SME users (>100 MWh).

Table 3. Number of 'green' electricity customers in the period 1996-2002 in the Netherlands

Date	**Number of customers (x 1,000)**	**Business customers**
July1st, 1996	16	395
July 1st, 1999	83	
July 1st, 2001	250	1,000
July 1st, 2002	1,000	

Source: ECN (2002)

Also, the market for green electricity has been opened up since July 2001. Next to this liberalization of the market, electricity suppliers have actively campaigned to sell 'green' electricity. Table 3 shows that the number of customers has grown from 250 thousand in 2001 to one million in 2002.

3. Review of environmental policy relating to the Dutch electricity sector

The objectives in Dutch environmental and energy policy with respect to the electricity industry, as reported in Oosterhuis (2001), remain unchanged:

- In 2020, renewables should account for 10% of primary energy supply (with an intermediate objective of 5% in 2010; currently it is just above 1%);
- The overall energy efficiency should improve by 2% per year;
- Greenhouse gas emissions have to be reduced by 6% in 2008-2012, compared to the 1990 level (the Dutch 'Kyoto' target);
- Total emissions of NO_x (presently about 400 kt) should be reduced to 260 kt in 2010 and those of SO_2 (presently about 100 kt) to 50 kt, according to the new EU Directive on national emission ceilings. Power plants currently account for some 10% of these emissions.

According to the Fourth National Environmental Policy Plan, the national directives of emission reductions for the Netherlands are even somewhat more stringent than the NEC directive of the EU. For instance, total NO_x emission should be reduced to 231 kt in 2010, and SO_2 should be reduced to 46 kt.

Several types of policy instruments are being used to pursue these objectives. They will be shortly discussed in the following subsections.

3.1 Regulations

3.1.1 Emission limits

As an EU member, The Netherlands has to comply with the emission standards as specified in EU legislation. For the electricity industry, the main relevant EU law is the Large Combustion Plant Directive (LCPD). The first LCPD (88/609) has recently been largely replaced by a new one (2001/80). The LCPD requirements have been transposed into Dutch law by means of the Decree on emission standards for combustion plants A ('Bees A'). The authorities issuing environmental permits to power producers (normally the provinces) are not allowed to require less stringent standards than those of the Bees A or the LCPD. However, they can (and sometimes must) impose more stringent requirements under certain conditions, for instance if this would be necessary to comply with local air quality standards.

3.1.2 Environmental Impact Assessments (EIA)

As Lise & Oosterhuis (2002) mention, Environmental Impact Assessments have to be made for activities with potentially significant adverse environmental impacts. This applies to energy producers as well. For the exact description and the use of assessment methods in EIA, we refer to Lise & Oosterhuis (2002). The regulations for EIA remain unchanged. Note that the Dutch legislation is stricter than EU directives on EIA.

Economic instruments

3.2.1 Taxes

Electricity use is subject to the standard 19% VAT rate, as well as to the 'Regulatory Energy Tax'. This tax was introduced in 1996 and is intended to reduce energy consumption and consequently CO_2 emissions. In subsequent years, the rates of this tax have been increased considerably (with simultaneous small decrease in the income tax rates). The rate structure is degressive (cf. Table 4). Electricity use above 10,000 MWh per year remains untaxed, so as to protect energy intensive industry against foreign competition. The Netherlands is in favour of a harmonised European energy tax, but proposals for such an EU wide tax have been vetoed by Spain. Annually, all users receive a fixed energy tax reimbursement of € 142 on their electricity invoice. Note that the regulatory energy tax is also paid for natural gas consumption.

Table 4. Current tax rates of the 'Regulatory Energy Tax' for electricity (excluding 19% VAT tax)

Electricity use (kWh)	**Tax rate (Euros per MWh)**			
Grey electricity	**2001**	**2002**	**2003**	**2003 with EQEP***
up to 10,000	58.31	60.10	63.90	63.90
10,000 – 50,000	19.38	20.00	20.70	20.70
50,000 – 10,000,000	5.94	6.10	6.30	6.30
> 10,000,000	0	0	0	0
Green electricity	0	0	17.50	34.90
Reimbursement	142	142	142	176

* See Subsection 3.2.2.

Up until January 2002, electricity from renewables was exempted from the tax. Since January 1, 2003, a reduced regulatory energy tax of € 0.0175 per kWh is levied on 'green' electricity. When the EQEP is implemented, which we will discuss below, is implemented (June or July, 2003) the regulatory energy tax for 'green' electricity will increase to € 0.0349 per kWh for electricity consumption up to 10 MWh per year. The reimbursement (intended to leave a certain amount of basic, 'inevitable' electricity consumption untaxed) will increase to € 176 per year.

3.2.2 Subsidies

Environmental Quality Electricity Production (EQEP) is a subsidy with the aim to stimulate the renewable electricity production in the Netherlands.[2] Renewable electricity does not only include wind power, bio power, hydropower, and photovoltaic power but also include climate neutral power and cogeneration power. The subsidy per kWh differs across the type of power generation. More expensive power generation will receive a higher subsidy per kWh. The total amount of subsidy depends on the subsidy per kWh

[2] More information can be found on www.pde.nl including the proposed subsidy amounts per kWh per power generation technology.

and the number of green certificates of the electricity producer. The subsidy will be implemented later on this year (June or July, 2003). This EQEP subsidy partly replaces the former reductions and refunds of the Regulatory Energy Tax for renewable electricity production, which were based on the demand for renewable electricity rather than the production of renewable electricity (see Van Damme & Zwart, 2002). The benefit of these fiscal facilities went to a large extent to foreign suppliers of renewable electricity (often existing large hydropower plants), which was obviously not the intended outcome. The EQEP scheme is meant to avoid such 'leaking' of subsidy funds.

3.3 Emissions trading

Emissions trading schemes have two main advantages. Firstly, the total amount of emissions is limited by the number of allowances provided, and secondly, participants can choose to reduce emissions or purchase allowances on the market. Since all actors are expected to reduce emissions, emission trading is a cost-effective instrument. In the Netherlands, two systems of emission trading are under construction, a national system for NO_x emissions and an EU system for CO_2 emissions.

3.3.1 NO_x emission trading

In the United States, the implementation of the NO_x emissions trading schemes such as the NO_x budget program of the Ozone Transport Commission (OTC) has been successful.[3] Based upon these promising results, the Netherlands has a national NO_x emissions trading scheme under construction in order to achieve the 260 kt NO_x emission ceiling in 2010. Initially, the introduction of this scheme was planned for 2003 but its start off is delayed until the end of 2004. The main reason for the delay is that some issues are unresolved yet. In the case that the NO_x objectives are not met in 2010, for instance, it is still unclear what the consequences will be for the participating plants.

This national scheme allows stationary sources with minimum 20 MW power capacity or more than 50 tonnes NO_x emissions to participate in the system. The emission ceiling for each plant is not an absolute figure, but is based on a 'performance standard' related to its energy use, the 'performance standard' is set to 50 grammes of NO_x per GJ based on the reduction target of 55 kt in 2010.[4] Plants emitting less than this standard can sell emission credits, and plants with higher emissions will have to buy them. In the case of unforeseen developments in economic growth (and the associated growth in energy use), leading to overall emissions exceeding the target, the 'performance standard' can be adjusted with a maximum of 20% (i.e. 10 g/GJ). According to simulations commissioned by two Dutch banks (ING and Rabobank), the market price for NO_x credits will be in the range from €1.50 to €4.50 per kg (PT Industrie, August 8, 2002).

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3 See for instance http://www.epa.gov/airmarkets/otc.

4 This target is much lower than the national emission ceiling of 260 kt, because important NO_x sources are not included in the emissions trading scheme (e.g. transport).

3.3.2 CO_2 emission trading

In the case of a trading system for CO_2 emissions, the Dutch Committee on CO_2-trading concludes that CO_2 emission trading is an achievable and effective instrument to reach the CO_2 targets. The Committee CO_2-trading and the Dutch Social Economic Council (SER) recommend that joining the EU initiatives in this context would yield maximum cost effectiveness. The EU scheme for CO_2 emissions trading will start in 2005, according to the agreement on the Commission proposal that has been reached in December 2002. Preparations for the implementation of the scheme in the Netherlands are well on their way. A study on the allocation of emission allowances has been presented to the Ministry of Economic Affairs in October 2002.[5] Recently, a preliminary draft law on emissions trading has been presented, covering both CO_2 and NO_x trade.

3.4 Other instruments

An important type of instruments in Dutch environmental policy relies are the agreements or ‘covenants’ signed between the government and the business sector. Here we mention three of them.

In 1990, the electricity producers and the government signed an agreement on the reduction of SO_2 and NO_x emissions. In 2000, these emissions should have been reduced to 18 and 30 kt, respectively, implying emission reductions of more than 90 and 60 percent, respectively, compared to 1980. According to a recent evaluation study of EnergieNed, the electricity producers have exceeded these objectives. At present, there is no new agreement between the government and the electricity producers because the government has not formulated a new objective yet. Note that there is a national ceiling for SO_2 and NO_x emissions in 2010 according to the EU NEC directive (see section 2.1). Table 5 shows the levels of emissions from electricity production in the Netherlands.

Table 5. Emissions from electricity production in The Netherlands, 1980-2000

	1980	1990	1995	2000
SO_2 (kt)	194	45	16	12
NO_x (kt)	83	79	58	46
CO_2 (Mt)		41	46	45

Source: ECN (2001)

In April 1999, a ‘Benchmarking Covenant’ was agreed upon between the state, provinces, energy intensive industries (including electricity production) and the employers’ federation. In it, the industries commit themselves to belong to the world leaders in energy efficiency by 2012. In exchange, the government has promised not to impose new regulations on energy or CO_2 reductions for these industries. The result of this agreement is a CO_2 emission reduction ranging from 5 to 9 Mt per year in the period 2008-2012.

In April 2002, the government and the owners of coal power plants agreed on additional use of biomass in the coal power plants. This so-called Coal Agreement will contribute to the objectives of renewable electricity and CO_2 reductions. In the period 2008-2012,

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5 KPMG/Ecofys, 2002.

the use of biomass has to represent a power capacity of 500 MW_e in the total of existing 4100 MW_e coal power capacity (including coal gasification), resulting in emission reductions amounting to 3.2 Mt CO_2. The industry advocates that the EU CO_2 emission trading system, which is scheduled for implementation in 2005, should be in line with the Coal Agreement.

3.5 Liberalised electricity market

As can be concluded from the review of policy instruments, the environmental aspects are already widely incorporated in the Dutch electricity system. The question is whether or not the impacts of particular policy instruments remain unchanged in the liberalised electricity market. As the processes of liberalisation of electricity markets are recently started and still in progress, there are hardly any environmental assessments available yet.

An exception is Bigano and Proost (2002). They study the impact of the degree of competition for the implementation of environmental policies in the European electricity market. The environmental policy consists of a SO_2 target and a CO_2 tax. Their results on environmental targets are mixed. Under imperfect competition, SO_2 targets are more difficult to meet, because the stringency of these targets declines. In the case of CO_2, emission reductions are higher in the case of imperfect competition.

For the Netherlands, few studies have addressed the effectiveness of policy instruments in a liberalised electricity market. Van Damme & Zwart (2002) consider the new EQEP subsidies to renewable electricity production as a second best instrument, because this instrument is only focused on the national electricity production. An EU wide subsidy regime on the production of ‘green’ electricity would be favourable, so that the benefits of trading ‘green’ electricity are fully captured.

Berkhout et al. (2001) show that the Regulatory Energy Tax has a downward impact on electricity use by households, despite the fact that other factors (such as growing incomes) lead to a net increase in electricity use. Lijesen et al. (2001) conclude on the basis of scenario studies that the energy tax scheme in the Netherlands is an effective instrument to contribute to the emission reductions.

The main issue for policy instruments to be effective in a liberalised European electricity market is the fact that the policy and the use of policy instruments should be harmonized across countries, see Van Damme & Zwart (2002). Moreover, additional policy instruments such as the agreements in the Netherlands should not interfere with the European policy instruments.

4. EMELIE model

4.1 EMELIE project

In 1996, the EU Council of Ministers adopted Directive 96/92/EC on the internal market in electricity, providing for a phased opening up of electricity markets to competition. The provisions of the Directive came into force in February 1999, with Member States required to open up about 25.37% of national market share to competition. This directive must be implemented in the member states before 2005. EU policy was therefore one of the factors triggering changes in national policy, a wave of privatisation, restructuring, unbundling and more open competition. The market for electricity in the EU amounts to 181 billion euros and is growing at a rate of 2.5% per annum (Eurostat, energy yearly statistics, data 1998).

The motivation for liberalisation is to reduce the cost of energy to the consumer and to give the consumer a greater choice of service provider. The liberalisation of the energy markets is generating new problems and opportunities for energy suppliers and energy users. These problems include technical problems for distribution and monitoring and also economic problems (and opportunities) such as market share, competitiveness, and scarcity of energy (as in California). The policy makers who make decisions on energy liberalisation should understand the implications of their decisions on consumer costs, the environment and the market. Energy models exist for regions of Germany, but there is still a lack of adapted models. In particular, a generic model is needed which can be adapted to any region of the EU. Therefore, the EU commissioned the EMELIE project.

The objective of the EMELIE project[6] is to study the impact of energy market liberalization in Europe starting from a computable game theoretic model that has already been applied to German energy markets. The outcome of the project will be a decision support tool for assessing the impact of various scenarios on energy market liberalization regarding the European economy and environment.

The EMELIE project is an international project in which researchers and business men collaborate. The EMELIE project is co-ordinated by SPEED (University of Oldenburg, Germany), and the participants have different backgrounds. On the one hand, research centers participate, such as SGC (Hamburg), Institute for Environmental Studies (IVM, Amsterdam), RISO (Copenhagen) and Stockholm School of Economics (SSE, Stockholm) and on the other hand power utilities and consulting companies participate, such as SKM (Norway), Sydkraft (Sweden), Linz Strom (Austria), EnergieDienst (Switzerland) and Electrabel (Belgium).

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6 EMELIE is the acronym of Electricity Market Liberalisation in Europe (EMELIE), Market Imperfections and their Impact on the European Economic and Environmental Situation" (EC contract No NNE5-2001-00519).

4.2 EMELIE model

The basic idea of the EMELIE model is that electricity producers can act strategically in a liberalised electricity market. The EMELIE model is computable partial General Equilibrium model of the electricity market. Eventually, it will represent the liberalised European electricity market including imports and exports. In the first phase of the project, as we are now, we collect data for the single countries in order to run the (static one-year period) EMELIE model for each country separately. Lise et al. (2003), for instance, have calibrated the EMELIE model for Germany. They also discuss the EMELIE model in more detail.

With the EMELIE model, we can investigate firms' strategic behaviour in a market with imperfect competition (oligopoly). The EMELIE model is a game theoretic model of the electricity market. The basic assumptions of the model are the following. In a liberalised electricity market, electricity producers maximize profits based on the electricity price and the production costs. Producers have different technologies to produce renewable and non-renewable electricity. Power capacity and production costs differ across technologies. In addition to these assumptions, the electricity grid can restrict the transportation of electricity across regions. In particular, transportation capacity constraints are relevant in the case of the European model in which imports and exports are included. Note that electricity grid utilization costs and electricity transportation costs do not affect the behaviour of producers, because consumers pay for these costs.

Basically, we consider two types of producers' behaviour in a liberalized market. Firstly, we assume that the electricity market is a competitive market, and the electricity prices are given for the producers (COMP case). Secondly, we assume that producers act strategically and they will affect the price of electricity (STRA case). In the latter case, the maximum market share of the largest producer determines the electricity price on the market. Note that the strategic action STRA solution of the model refers to the Nash equilibrium.

Since we apply a partial GE model, we consider the demand side of the electricity market as well. We assume that the electricity demand reacts on price changes by a constant electricity price elasticity. Equilibrium of the electricity market is assured by market clearing conditions i.e. market price adjustments. Based on the results of the model we investigate the environmental effectiveness of applied technologies.

4.3 EMELIE model results for the Netherlands

4.3.1 Data

For the calibration of the EMELIE model for the Netherlands we use the year 2000 as our reference case. For the electricity production, we consider centralised and decentralised electricity production. The centralised power plants only produce electricity to put on the national electricity grid. Other types of electricity production are referred to as decentralised electricity production. Large part of the decentralised electricity production exists of the cogeneration power plants of the manufacturing industry. Renewables electricity production is also captured in the decentralised electricity production.

Table 6 shows the preliminary results of the calibrated EMELIE model for the Netherlands. In the STRA case the electricity price is significantly higher than in the COMP case. From an environmental point of view, this is a positive result as the demand for electricity is significantly lower in the STRA case in comparison with the COMP case. Note that the electricity demand in the STRA case is higher than in the reference case (REF) representing the electricity market in the Netherlands in 2000. However, one of the reasons to introduce a liberalised electricity market was the production cost reduction through efficient production. Consequently, market prices will be lower.

Table 6 shows the centralized production capacity of the major electricity producers in MW. The net electricity production of Delta Nutsbedrijven is included in the net electricity production of Essent. The net electricity production is gross electricity production minus the own electricity use, which is approximately 4% of gross electricity production.

Table 6. Production capacity and main technology in the Netherlands

Region	**Electricity producer**	**Main technology**	**Power capacity in MW**
North	Electrabel (Belgium)	Gas & coal	4,649
South	Essent[1]	Coal & gas	3,903
North-West	Reliant Energy (US) [2]	Gas & CHP gas	3,472
West	E-On (Germany)	Coal & gas	1,770
South	Delta[1]	CHP gas & nuclear	717
South	NUON	Coal gasification	390
	Fringe (decentralised production)	CHP-gas	5,934
Total national capacity			20,834
	Import via Germany	Hydropower	2,520
	Import via Belgium	Nuclear	616

1 Both Delta Nutbedrijven and Essent own 50% of the EPZ utility in Borssele, and therefore, the capacity of the Borssele power plant is equally divided.

2 In 2003, NUON (Netherlands) announced that they will take over the centralised power plants of Reliant Energy. With this take-over, NUON will be the third large electricity producer in the Netherlands.

The total net electricity production was 85.8 TWh. Next to this production, the Netherlands imported 18 TWh mainly from Germany and France (via Belgium). The net losses of transmission were approximately 4%. In 2000, the electricity consumption was 100.6 TWh. The average wholesale price of electricity was set to € 25 per MWh. Table 7 shows the operating costs per technology.

Table 7 Variable operating costs per technology

Fuel/technology	Variable operating costs in € per MWh
Nuclear	10
Coal	15
Gas	20
CHP gas	10
Hydropower	12
Oil	27
Biomass	9
Wind	9
Import from Germany	5
Import from France/Belgium	10

Table 8 shows the preliminary results of the calibrated EMELIE model for the Netherlands. In the STRA case, the electricity price is significantly higher than in the COMP case. From an environmental point of view, this is a positive result as the demand for electricity is significantly lower in the STRA case in comparison with the COMP case. Note that the electricity price in the STRA case is lower than in the REF case representing the electricity market in the Netherlands in 2000. This lower electricity price results in a higher electricity demand. Note also that one of the main reasons to liberalise the electricity market is the expected production cost reduction through more efficient production. Consequently, market prices will be lower. As a result, the electricity demand in the STRA case is higher than in the REF case.

Table 8. Preliminary results of EMELIE model for the Netherlands

	Reference case	**Strategic action**	**Full competition**
Electricity price (€/MWh)	25.0	21.91	18.36
Demand (TWh)	100.6	106.2	114.0

Next to the lower electricity demand in the STRA case with respect to the COMP case, producers use less coal power and gas power production in the STRA case. Note that these results are preliminary as the EMELIE model calibrations for the Netherlands are still in progress.

For each producer, the payoffs are higher in the STRA case than in the COMP case, as Table 9 shows. The payoffs in the COMP case are positive because the marginal costs of production increase with the level of production.

Table 9 Payoff and marginal costs per firm

	Payoff (€ million)			Marginal cost (€ per MWh)	
Firm	**Reference**	**Strategic action**	**Full competition**	**Strategic action**	**Full competition**
Electrabel	64.7	45.7	23.9	18.74	18.36
Reliant	140.3	105.1	64.8	16.05	18.36
EON	10.1	63.3	30.5	17.14	18.36
Essent	205.7	134.5	109.5	15.00	18.36
NUON	38.8	28.5	16.7	20.20	18.36
Delta	80.2	61.6	40.2	18.81	18.36
ImportG	425.0	358.8	282.7	10.86	18.36
ImportB	76.9	60.7	42.2	19.21	18.36
Fringe	447.8	354.7	247.9	21.91	18.36

4.4 Extensions of the EMELIE model

The EMELIE project is still in the early phase of developing the EMELIE model. However, the researchers of the EMELIE project aim at developing an EMELIE model that is a more accurate and realistic representation of a liberalised European electricity market. Step-by-step, the EMELIE model will be extended. So far three extensions are agreed on. Firstly, the EMELIE model will be made European wide including imports and exports between countries. This means also that the cross-border transportation capacities are activated in the model. Secondly, the EMELIE model will be a dynamic game theoretic model that incorporates investment decisions over time as well. Finally, the environment will enter the model. So far we already distinguished different technologies for electricity production. In addition, specific emissions ceilings could enter the model.

With these extensions, the EMELIE model is used to simulate (policy) scenarios for the European electricity market. Economic and environmental impacts are considered and investigated. The dynamic EMELIE model will have a time horizon ranging from 10 to 50 years.

5. Conclusions

In this paper we have taken a brief look at the relationship between electricity market liberalisation and environmental policy in The Netherlands. In general, it can be concluded that a substantial set of policy instruments (regulatory, economic and voluntary) has been developed to ensure that the Dutch electricity industry will meet the ambitious environmental objectives that have been formulated, even in a liberalised market. Emission standards, taxes and voluntary agreements have already proven to be effective; NO_x and CO_2 trading schemes will soon get the opportunity to show their added value.

So, if the environmental targets for the Dutch electricity industry will turn out not to be achieved, it will not be due to a lack of policy instruments. It is obvious, however, that the relevance of national policies is becoming smaller as both the electricity market and the nature of the main environmental problems are increasingly 'Europeanised' or even globalised. This also implies that analyses and assessments of policy instruments for the electricity industry should preferably be carried out at an international level. Tools like the EMELIE model may provide valuable assistance in such exercises.

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