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Market performance and distributional effects on renewable energy markets

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Abstract in English

A renewable obligation combined with tradable renewable energy certificates is a market-based instrument used to promote the production of electricity from renewable energy sources. A renewable obligation is an alternative for subsidies. A renewable obligation will only be an efficient instrument if certificate markets are efficient. This requires that there is no market power and no anti-competitive behaviour on the certificate market. If the current developments in Dutch renewable energy production continue, market power on a future renewable certificate market in the Netherlands will probably not be an issue, even if the RO should only rest on the retail market instead of on the whole electricity market.

A renewable obligation will raise the retail price for consumers, thereby reducing consumer surplus. Simulations show that the retail electricity price increases with € 30 per MWh to a level of € 104 per MWh in case of a 30% renewable target. Consumer surplus is reduced with 19% compared to the baseline scenario. In contrast, a subsidy such as the Dutch SDE which is financed from the state budget has the effect to (slightly) lower the retail electricity price, thereby increasing consumer surplus. It should however be realised that the costs of the subsidy will indirectly affect electricity consumers through their tax payments.

Key words: Renewable energy, renewable obligation, subsidy, market power

JEL code: Q42, Q48

Abstract in Dutch

Een verplichting voor een aandeel duurzame energie gecombineerd met een markt voor duurzame-energiecertificaten kan een efficiënt instrument zijn om de productie van duurzaam opgewekte elektriciteit te stimuleren. Een voorwaarde daarvoor is wel dat de markt voor deze certificaten niet wordt belemmerd door misbruik van marktmacht. Als de huidige trends in de ontwikkeling van de productie van duurzaam opgewekte elektriciteit in Nederland zich voortzetten, zal misbruik van marktmacht waarschijnlijk geen probleem zijn op een eventuele toekomstige Nederlandse certificatenmarkt.

Een doelstelling voor hernieuwbare energie zal tot een hogere elektriciteitsprijs voor consumenten leiden. Simulaties laten zien dat de prijs stijgt met €30 per MWh bij een doelstelling van 30% duurzame energie. Het consumentensurplus daalt dan met 19% vergeleken met het baselinescenario. Een subsidie die wordt gefinancierd vanuit het overheidsbudget, zoals momenteel de SDE, leidt niet tot hogere prijzen. Consumenten worden dan echter wel geconfronteerd met de kosten van duurzame energie via hun belastingafdrachten.

Steekwoorden: Duurzame energie, duurzame-energieverplichting

Een uitgebreide Nederlandse samenvatting is beschikbaar via www.cpb.nl.

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Preface

Both national and international the use of renewable energy is being encouraged. In 2008, the European Commission has established a renewable energy target of 20% in 2020. In 2007, the Dutch government has formulated a comparable target for renewable energy in 2020 in its energy- and climate programme ‘Schoon en Zuinig’ (Clean and efficient).

In both the Netherlands and in Europe, subsidies have been the most used instrument to promote the production of renewable energy. An alternative is a renewable obligation combined with a market for renewable energy certificates. In this document, the authors consider the working of a possible future ‘green’ certificate market for the Netherlands. They would like to thank EnerQ, the Dutch organisation which administered the Dutch renewable energy subsidy MEP, for the data it has made available on renewable energy production in the Netherlands. The effects on the electricity market of introducing a renewable obligation have been explored using the COMPETES model of ECN, a model of the North-West European electricity market.

The authors benefited from the discussions with the members of a feedback group. In particular they are grateful for the comments and reflections of Klaas-Jan Koops (Ministry of Economic Affairs). Comments from colleagues at CPB also helped to improve this study.

Summary

A renewable obligation combined with tradable renewable energy certificates is a market-based instrument used to promote the production of electricity from renewable energy sources. It has recently been introduced in a number of countries and is an alternative for subsidies, the instrument which has predominantly been used both in Europe and the Netherlands.

RO schemes are expected to be effective in developing new capacity especially in the longer run, given long term targets for the production of electricity from renewable sources. However, experience with RO schemes so far has been too short to draw definitive conclusions about the effectiveness and efficiency of RO compared with subsidies. Comparing the effectiveness and efficiency of subsidies and RO has been further complicated because other factors than instrument choice have had a significant effect on the effectiveness and efficiency of the support schemes, such as non-economic barriers and local conditions.

In principle, certificate prices in an RO should be higher than subsidies, because of the price risks producers face on the certificate market. These risks do not occur in the case of subsidies. Whether in practice subsidies will be lower depends on the ability of the government to accurately predict the costs of renewables and set the subsidy accordingly. Costs of renewables might also be higher with an RO because of regulatory risks. These will to a large extent depend on the credibility of the government in maintaining a stable policy over the years. With an RO, flexibility in target setting and design of the scheme comes at the price of higher regulatory risks for producers of RES-E and therefore higher costs.

An RO will only be an efficient instrument if certificate markets are efficient. One of the prerequisites for an efficient market is that there is no market power and no anti-competitive behaviour. If the current developments in Dutch RES-E production continue, market power on a future renewable certificate market in the Netherlands will probably not be an issue, even if the RO should only rest on the retail market instead of on the whole electricity market. The current concentration rate is moderate and there is a downward trend. Possible forms of anti-competitive behaviour such as collusion or foreclosure will probably not be an issue. Extending the obligation to all purchasers on the wholesale market instead of only the retail market would further reduce the likelihood for anti-competitive behaviour.

An RO scheme affects consumers in a different way from a subsidy such as the current Dutch SDE subsidy. An RO raises the retail price for consumers, thereby reducing consumer surplus. The decrease in consumer surplus occurs for two reasons. One reason is the higher costs of renewables, the second is a transfer to producers of renewable electricity who will make a profit on the certificate market. On this market, the price will be set by costs of the marginal producer or technology. Lower cost producers of renewable electricity will receive a rent (producer surplus). This producer surplus for renewable electricity producers will be higher the higher the renewables target is, because more expensive technologies will have to be used to meet the target. Simulations have been run with a model of the Northwest European electricity

market (COMPETES), which show that the electricity price increases with € 30 per MWh to a level of € 104 per MWh in the case of a 30% renewable target. Consumer surplus is reduced with 19% compared to the baseline scenario. With a 20% renewables target, consumer surplus will only be 6% lower.

In contrast, a subsidy such as the SDE which is financed from the state budget has the effect to (slightly) lower the retail electricity price, thereby increasing consumer surplus. It should however be realised that the costs of the subsidy will indirectly affect electricity consumers in through their tax payments.

1 Introduction

Renewable energy has received a great deal of attention in recent years. Not only will it reduce greenhouse gas emissions, it is also expected to reduce dependence on imported fossil fuels. Therefore, many countries have introduced targets for the share of renewable energy in total energy demand. In its “20 20 in 2020” climate and energy policy package (EC, 2008d), the EU has formulated a target of a 20% renewable energy share in final demand in 2020. In the Netherlands, the current government has set a target of 20% of primary energy consumption in 2020, a slightly higher target than the EU-wide target which is formulated as a share of primary energy use (VROM, 2007).

The main instruments used to stimulate electricity from renewable energy sources (RES-E) are subsidies in various forms and, more recent, renewable obligations (RO) combined with a market for tradable renewable energy certificates. In this study, we will consider whether the introduction of an RO scheme in the Netherlands is a feasible alternative for the subsidies which have been used so far. We focus on two issues. First, we examine whether anti-competitive behaviour would be a problem on the certificate market or the related electricity market if an RO scheme would be introduced in the Netherlands. Second, we compare the distributional consequences of RO and subsidies for electricity producers and consumers.

An important difference between subsidies and an RO is the creation of a market for renewable certificates in an RO scheme. Producers of RES-E receive a renewable energy certificate for each unit of RES-E they produce. They can sell these certificates to parties who have to meet a renewables obligation, such as, for example, distribution companies. An RO scheme will only be efficient if there is a well functioning certificate market which is not prone to anti-competitive behaviour. Given the possible limited number of RES-E producers obliged parties in a Dutch RO scheme, this could potentially be a problem. Starting from the RES-E producers currently active on the market, we will identify possible forms of anti-competitive behaviour such as collusion and foreclosure which might be a problem on a certificate market. Applying the policy framework developed in the CPB 2008 on foreclosure, we indicate under which conditions misuse of market power might be a problem.

On a certificate market, all certificates will be sold at the same price, regardless of the costs made to generate the RES-E and thereby acquire the certificate. Consequently, producers with lower costs will make a larger profit then those producing at the margin. In RES-E production, there can be barriers for low-cost technologies such as biomass cofiring in coal plants or wind onshore. If the RO is set at such a level that higher costs technologies are needed to fulfil the obligation, RES-E producers using biomass cofiring and wind onshore will realise an intra-marginal rent (which has been called a windfall profit in policy circles). While this is not a problem from an efficiency point of view, it does have distributional consequences. Consumers will have to pay more in an RO compared with a subsidy while producers will realise higher profits. We analyse these distributional effects on producers and consumers on both the electricity market and the certificate market. The effects are quantified with the use of the COMPETES model, a model of the North-West European electricity market which has been developed at ECN.

We conclude that, if the current developments in Dutch RES-E production continue, competitive issues on a Dutch certificate market will probably not be an issue. This holds even if the RO should only rest on the retail market instead of on the whole electricity market. The effects on electricity prices, consumers and producers differ considerably between an RO scheme and a subsidy which is financed from the state budget. Whereas an RO schemes raises the retail price, the effect of a subsidy is to lower power prices to some extent. The costs for consumers and the intra-marginal rent are considerably higher in the RO scheme compared with the subsidy, especially with a high renewables obligation which makes it necessary to use high cost RES-E technologies.

Our analysis is limited to market behaviour and distributional consequences. While these are important issues with regard to the choice between the two policy instruments investigated here, they do not provide a complete picture. There are other issues which will influence instrument choice, such as, for example, policy continuity, European and neighbouring countries policies[1]. Another question relating to the use of renewable energy which is not addressed in this study is whether governments should promote renewable energy at all. While this study does not address this question[2], it should be realised this important question should be answered before the optimal choice of instruments is considered.

In the next chapter, we introduce the most important instruments used to stimulate renewable energy and discuss briefly the main differences between RO and subsidies. In chapter 3, the current RES-E production structure in the Netherlands is described, which is used as a starting point for the analysis of possible anti-competitive behaviour on a future renewable energy certificate market. The distributional impacts of RO and subsidies are discussed in section 4. Section 5 concludes.

[1] See 2.3 for an overview of the vast literature on RES-E instrument choice.

[2] For a cost-benefit analysis of renewable energy, see CPB 2005

2 RO schemes and subsidies

The two most widely applied instruments used to promote renewable energy are price-based market instruments such as subsidies and quantity-based market instruments in the form of a renewable obligation combined with tradable renewable certificates[3]. The general properties of RO schemes are described in section 2.1, followed by an overview of subsidies. In section 2.3, an overview is given of the comparison between the two instruments in the literature.

2.1 Renewable obligations

Central in an RO scheme is the combination of an obligation to generate or provide a certain amount of power from renewable energy sources with tradable renewable energy certificates. The obligation can be met with renewable certificates, which the obliged parties can acquire on the certificate market. Assuming that the obligation is binding, the certificates will sell at a price equal to the additional costs of RES-E production, compared with the production of electricity from conventional sources.

A certificate market is an artificial market which is created by the government. Consequently, certificate prices will be influenced by choices made in the design of the scheme such as:

- Scope of the scheme
- Technologies
- Banking and price caps
- Target level

Scope

An important element in the design of a green certificate scheme is to determine which part of electricity use falls under the obligation. Total electricity consumption could fall under the obligation or it could be limited to part of the electricity market, such as, for example, the retail market. It is not efficient to put the administrative burden of acquiring and handing in certificates on all end-users of electricity, large and small. Instead, the administrative obligation can be put higher in the supply chain, depending on the coverage of the system. With a scheme limited to the retail market, the administrative obligation can be put on the retail companies. They do not have to produce the renewable electricity themselves, but can fulfil their obligation with renewable electricity certificates which they acquire from producers of green electricity.

[3] The instrument has been applied under various names. In the US, it is commonly described as a renewables portfolio standard while in the UK it is called the renewables obligation.

In such a scheme, the costs of the renewables target will be born only by those consumers that buy their electricity from retailers. Consumers who buy their electricity directly on the wholesale market will not bear the costs of the renewables obligation.

If the obligation is put on all producers and importers of electricity, the additional costs of the renewables obligation will be paid by all electricity consumers. In this case, the administrative obligation will need to rest on all generators and importers, including firms which produce or import their own electricity. This will increase the administrative and transaction costs of the scheme, compared with a scheme for the retail market only.

Technologies

In order to be eligible for a certificate, the technology used has to be included in the RO scheme. The choice of technologies will have consequences for both the costs and the distributional effects of the obligation. For example, including renewable energy technologies which are profitable, given electricity prices on the market, will lower the price of the certificates compared with a scheme which excludes those technologies. These profitable technologies will acquire a rent from being included if the marginal unit on the market has positive costs.

A related issue is whether existing capacity is to be included. This also depends on current and past incentive schemes which apply to existing capacity. Existing capacity might have been written off or might still receive subsidies from an earlier support scheme such as for example a subsidy. Allowing such capacity to sell certificates would grant them the value of certificates which would not be required to cover their costs. Keeping existing capacity out of the market however would reduce the size of the market and result in a higher price.

The choice of technologies will not be a one time concern. Costs of many renewable technologies such as, for example, wind offshore and solar, are expected to fall over time. This will lower the price of renewables certificates. Moreover, certain technologies might become profitable and would at that stage not require support for deployment.

Banking and price caps

In the certificate schemes which have been implemented so far, the price of certificates has been limited by a maximum price or penalty which can be paid instead of acquiring certificates. The main argument for this maximum price is the stochastic character of renewable resources such as wind, hydro and sun. Given the yearly variations in wind, rainfall and sunshine, the production of RES-E will show considerable variations over years. Consequently, prices of certificates will be volatile with substantial price peaks in years with low production and low prices in high production years. This volatility can be addressed in two ways. One is to allow banking of certificates from one compliance period to the next. The other option is to introduce a maximum price (in addition, a minimum price could also be introduced). As shown by Amundsen (2005), both instruments will reduce price volatility. However, whereas banking will increase welfare (because the constraint on intertemporal trade is relaxed), minimum or maximum price bounds can reduce welfare because it restricts the market in green certificates. In the Dutch context, biomass in coal- or gas-powered plants could provide up to 18% of electricity demand within the Netherlands in 2007 (see section 3.1). In contrast with wind, the use of biomass does not depend on the weather and the production level can be varied at short notice by the generator. Biomass therefore provides flexibility which will limit the price volatility. In a windy year, the high volume of wind turbines will put a downward pressure on the certificate price, which will induce biomass generators to reduce their volume until price equals their marginal costs. In a year with less than average wind, the high certificate price will bring on more biomass, driving down the price. Therefore, price volatility will be less of an issue in a Dutch certificate market compared with RO which include more stochastic renewable sources.

Another reason given for a price cap is to limit the costs of meeting the target in case investments in new capacity are not enough to produce sufficient RES-E to meet the obligation. Without a price cap, the price of certificates could rise considerably, given the lack of certificates. Adjustment could then only take place through a reduction of electricity consumption.

Target setting

A determining factor in an RO is the target which has to be met. Not only the target level itself will determine the certificate price, the period for which the target is set and the duration for which technologies receive certificates will also have consequences. Investments in renewable energy projects have a long life span. Therefore the renewables target over the life span of a project should be known in order for market parties to form expectations about future prices of green certificates. This is also influenced by the period for which certificates are granted. If this period is limited to less than the life span of a project, targets will have to be known for this period only. Limiting the duration for which certificates are granted will increase their price, as the additional investment costs will have to be recovered over a shorter period.

2.2 Subsidies

Subsidies have been applied in various forms. Basically, two main types of subsidy can be distinguished, feed-in tariffs (FIT) and premiums. A feed-in tariff offers a technology-specific subsidy for RES-E, consisting of both a payment for the electricity delivered and a compensation for the additional costs of producing RES-E, compared with the competitive costs of electricity production. An example of such a feed-in tariff is the German EEG (Erneuerbare-Energien-Gesetz).

Premiums subsidize only the additional costs of RES-E, leaving it to the producers of RES-E to sell their electricity separately. Both the Milieu Energie Premie (MEP) and the current Stimulering Duurzame Energieproductie (SDE) are examples of such premium schemes.
FIT and premiums can differ in the period over which subsidies are given, whether the premiums or tariffs are fixed over time or flexible, how access to the grid is arranged and whether the subsidy scheme is limited by a maximum budget or open ended.

The length of the period will have an effect on the level of subsidy, with investment projects requiring a higher yearly subsidy to break even the shorter the period is. The subsidies need not be set at one fixed rate for the duration of the subsidy. It can be specified in advance that subsidies will be lowered stepwise, reflecting expectations about declining costs. This is the case in the German EEG since the revision in 2004. Moreover, subsidies can be adjusted to changing circumstances such as, for example, the electricity price. In the Dutch MEP, there was only limited flexibility for the government to adjust the subsidy levels which had large consequences for the profitability of RES-E project. The return on projects increased significantly with the increase in wholesale electricity prices in the years after 2001. In the SDE, the premium is adjusted at the end of the year on the basis of the realised wholesale electricity price.

In order to determine the subsidy level for the individual technologies, the government has to have accurate knowledge about the costs of producing RES-E. In addition, if the subsidy is fixed in advance, assumptions have to be made about future electricity prices for the duration of the subsidy. Given uncertainty and asymmetric information, the government will not be able to set the subsidy such that it precisely covers the additional costs. In case costs will on average be higher than expected, less RES-E will be produced[4]. With lower than expected costs, for example because costs decline faster over time than assumed a priori, projects will be more profitable.

2.3 Comparing renewable obligations and subsidies

Assuming perfect information, zero transaction costs and an efficient certificate market, RO schemes and subsidies can be equally effective. A subsidy p can be introduced which results in quantity q, or the obligation can be set at q, which will result in a certificate price of p (Finon and Menanteau, 2006). However, in case of incomplete information and uncertainty, the instruments will not be equivalent. With uncertainty about the costs of producing renewables and about energy prices, the quantity of RES-E produced under a subsidy is uncertain. If costs are higher or energy prices lower than anticipated, less will be produced than expected ex ante.

[4] Assuming that there is a range of costs for projects using the same technology. For example, because of differing local wind speeds or differences in the efficiency of a project.

With an RO scheme, the quantity is fixed, regardless of costs and prices. Instead, total costs will be higher if the costs of RES-E production are higher than predicted.

Uncertainty will also create risks for other parties such as developers of RES-E projects and consumers. These risks are affected by the choice of instrument, which can introduce additional risks or distribute risks differently over producers, consumers and government. We will first consider the risks faced by producers of RES-E. The risks considered are regulatory risk, risks on both the certificate market and the power market and balancing risks. Subsequently, the consequences for governments and consumers will be discussed.

2.3.1 Regulatory risks

Flexibility in policy targets and policy design allows governments to adjust to changing circumstances or to new information. However, this flexibility comes at a price. Frequent policy changes increase the risks for market parties. This regulatory risk applies to both instruments. An example of regulatory risks associated with an RO is a change in the level of the obligation. In the case of a subsidy, the tariff or premium level can be changed, technologies can be excluded from the scheme or the whole support scheme can be terminated.

From a macro, industry point of view, the regulatory risks do not differ fundamentally between the two instruments. In either case, there is the risk of policy changes which will change the market conditions for the industry. From the point of view of an individual project, however, there is a considerable difference between the instruments. Under a feed-in tariff such as formerly the MEP or the SDE in the Netherlands, investors will receive a guaranteed subsidy for a given number of years. This is regardless of possible changes or abolishment of the scheme in later years, because the conditions for and the level of the subsidy are set when the investment decision is taken. With an RO, the revenue they will earn depends on the market price for renewables. Changes in the obligation level or of the specifics of the obligation will have an effect on the certificate market and therefore on the price paid for the certificates. In contrast to a feed-in tariff, grandfathering of the support scheme with an RO is not possible because the level of support is determined on the market. Regulatory risk under an obligation scheme therefore introduces additional uncertainty about future revenues from renewable investment projects. This will increase the risk premium investors will demand and therefore the costs of renewable energy, compared with feed-in tariffs. The size of this risk premium will depend on how investors assess the credibility of the government in committing itself to maintain the support scheme over a longer period without change.

2.3.2 Market risks

In an RO scheme, producers of RES-E do not receive a guaranteed price for their renewable energy, as is the case with a feed-in tariff. Furthermore, they have no guarantee that they can sell the certificates produced, as is the case with a subsidy. There are several reasons why prices and volumes might vary. New producers might enter the market that can produce at lower costs (due for example to newer, less costly technology). This will reduce the certificate price and therefore revenue for the established firms. It can also affect the volume which the established producers will be able to sell, because they might lose market share to new entrants.[5]

Furthermore, in an RO scheme in which wind has a large market share, varying wind conditions can lead to large volume and price fluctuations between years. With a subsidy, producers are shielded from these price fluctuations. However, these price fluctuations can be reduced by allowing for banking (see section 2.1). Banking provides producers the opportunity to put aside part of the certificates in a year with a high (wind) production and sell them in a year with a low level of production, which will dampen price fluctuations. Furthermore, in a calm year the lower production volume will be compensated by an increase in the price (and vice versa), thereby diminishing the effect of wind fluctuations on revenue (Lemming 2003). Producers of RES-E not only have to sell their renewable certificates, they will also have to sell their electricity on the power market and therefore face price and volume risks on the electricity market. The electricity market is influenced by factors such as macro-economic development, changes in fossil fuel prices and changes in CO_2 prices. The electricity prices are based on the marginal production unit in the merit order. In the Netherlands, these are gas fired generation plants or coal plants. Changes in gas or coal prices are therefore reflected in the electricity price, therefore RES-E producers will be exposed to the price volatility of fossil fuels. In addition, changes in CO_2 prices in the ETS will also affect the price of electricity, introducing further risks (including the regulatory uncertainty regarding the future developments of the ETS) for RES-E producers. It should be noted that long-run price fluctuations on the electricity market will to some extent be mitigated by changes in the certificate prices. A decrease in the electricity price will increase the additional costs of RES-E production, driving up the price on the certificate market.

With a subsidy, there is neither a price risk nor a volume risk for RES-E producers. The tariff is known in advance and purchase of the produced green electricity is assured. With a premium such as the SDE, producers receive a subsidy for the additional costs of RES-E production and have to sell the electricity on the power market. In principle this would expose them to price risks on the electricity market. However, the SDE subsidy is adjusted for the electricity price, which mitigates the electricity price risk[6].

[5] However, entry of new firms will be limited because of the sunk costs incurred with investments in renewable energy projects, such as wind or solar where total costs are to a large extent determined by the sunken investment costs. Given these sunk costs, incumbent firms have an advantage vis-à-vis potential entrants who will be reluctant to enter the market because they are not sure that they will be able to sell certificates at a price which allows them to recoup their investment costs (Agnolucci 2007, Gersoki, P. A. (1991): Market Dynamics and Entry. Blackwell, Oxford).

[6] In the SDE, there is a maximum set for the subsidy. This does create some risk for investors, because below certain electricity prices the revenue from the subsidy will not cover the full additional.

2.3.3 Balancing risks

On electricity grids, supply and demand need to be balanced in real time. Electricity cannot be stored, therefore electricity has to be produced when it is consumed. This makes flexible power supply, such as power produced by gas-fired plants, more attractive than power from wind energy which is difficult to predict and has only limited options to be reduced (except switching off). Depending on market regulation, the costs of the balancing risk can be put on the producers of RES-E or they can be guaranteed access to the grid regardless of time and demand. In the UK RO scheme, RES-E producers bear the whole balancing risk. In the Spanish subsidy scheme, the balancing risk born by RES-E producers depends on the tariff scheme chosen, a fixed feed in tariff or a premium on top of the electricity price. Under the fixed feed-in tariff, RES-E producers will pay a balancing price if they deviate from a production schedule which they have to provide in advance by certain margins. In the case of the premium tariff, they get a subsidy in addition to the price they can make for their electricity on the power market, which includes the balancing risk. In the German EEG, the balancing risk is born by the grid operators. This was also the case with the Dutch MEP subsidy. In the current SDE subsidy, producers have to bear the balancing risk.

Whoever bears the balancing risk is not determined by the support system as such, it is determined by the specific rules which apply to access to the grid for RES-E producers. Under an RO scheme, grid operators could bear the balancing risk, just as under a tariff scheme such as in Germany.

2.3.4 Risks and costs

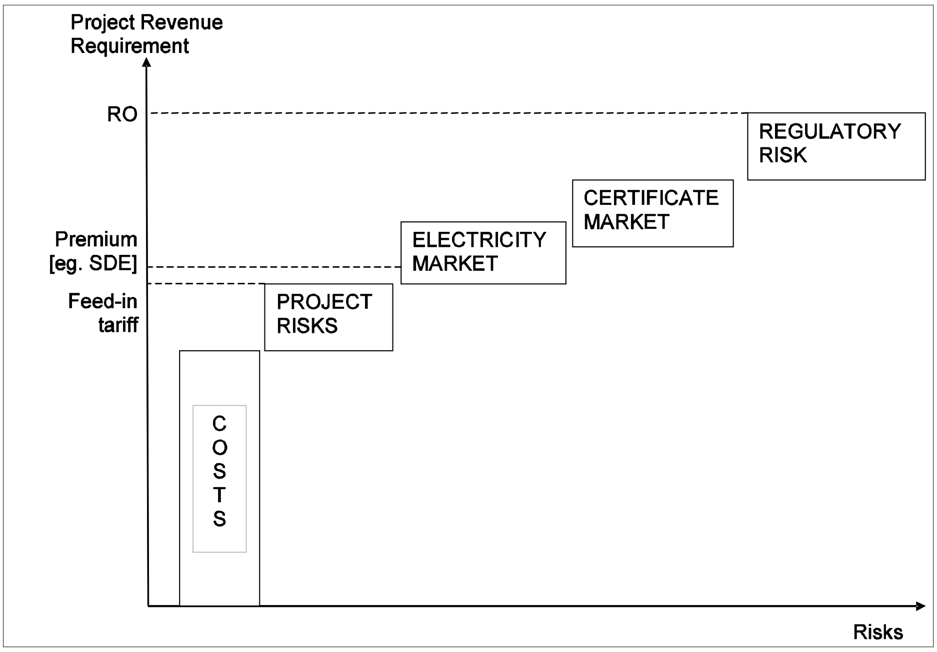
As a consequence of the higher risks which investors face under an RO, the risk premium for RES-E projects as compared with a feed-in tariff will be higher. However, the lower risks associated with feed-in tariffs are not necessarily reflected in the level of subsidies given under feed-in tariffs. On the contrary, feed-in tariffs appear to have generated high return on investments, on average in the order of 10-15%, according to Menanteau (2003), who report a relatively high return on investment with feed-in tariffs which is on average in the order of 10-15%. Similar results have been found in an evaluation of the Dutch MEP subsidy, which finds profits which are considerably higher than the 15% return on equity on which the subsidy tariffs had been based (CE 2007, see also IEA 2008).

Long-term contracts can cover the risks, such as the uncertainty over electricity prices, but the risk will then be born by the buying party, which will be reflected in the lower price which RES-E producers will receive for long-term contracts as compared with short term contracts. In the UK, long-term contracting appears to be limited, according to Johnston (2007). Although contract terms are confidential, prices in long-term contracts appear to be significantly lower than those in short-term contracts. In the US, some states include the obligation to use long-term contracts for certain forms of RES-E. The available evidence indicates that prices paid for

RES-E are lower in states where long-term contracts dominate as compared with states where long-term contracts are hardly used (Wiser 2008).

Figure 2.1 illustrates how the costs associated with the various risks identified above affect individual RES-E projects under different support schemes. Additional risks increase the revenue requirement for producers of RES-E in order to cover the costs associated with extra risks.

Figure 2.1 Costs and Risks of renewable energy projects



With a feed-in tariff, producers will only face project-related risks such as technology failing or unexpectedly high maintenance costs. The SDE-scheme adds some price- and volume-risks on the electricity market, although these will be mitigated by the ex-post adjustment of the subsidy to the electricity prices. However, some risks remain such as the risk of not being able to find a buyer for the electricity produced. With a renewables obligation, price- and volume-risks on the certificate market (including risks from volatility of wind resources) will increase the revenue requirement to make a project profitable. To some extent, these risks will be mitigated by price changes on the electricity market because electricity prices and certificate prices will be negatively correlated. Last, regulatory risks concerning future RO design will increase the returns required.

2.3.5 Risks for governments and consumers

While producers of RES-E face less risks with feed-in tariffs and premiums as opposed to an RO, this does not mean that this represents an absolute decrease in variability of volume and costs from a societal point of view. Risks do not necessarily disappear, they will instead be born by other parties than the investor, such as the government or electricity retailer. Furthermore, cost fluctuations will, depending on market conditions, be passed on to either customers or taxpayers. The price and volume risks on the certificate market and the electricity market which are born by producers of RES-E in an RO scheme will ultimately rest on the electricity consumers.

With a subsidy, there are no certificate market price and volume risks for RES-E producers and electricity market risks are limited. Instead, the government budget or consumer expenditure on electricity will fluctuate . This is illustrated by the experience with the Dutch MEP, which showed a large increase in expenditure in 2002 and 2003. The increase in electricity prices from 2002 onward increased the profitability of RES-E, given the premium. As a result, production of RES-E increased substantially, especially from (liquid) biomass co-firing, which did not require large investments with long start-up times. Expenditure on the MEP- subsidy therefore increased as well, from € 76 million in 2003 to 594 in 2005 (www.minez.nl, 2009-04-21).

2.3.6 Empirical evidence on the effectiveness and efficiency of support schemes

There are various reasons why it is difficult to assess the effectiveness of the different support schemes based on empirical evidence. First of all, while price instruments have been used for long periods in various countries, the experience with RO is more limited and only from recent years. Data on the performance of RO schemes are therefore limited.

Another complication is that other factors than the choice between instruments have had a significant effect on the effectiveness of support schemes. Non-economic barriers such as, for example, planning delays and restrictions, grid access and electricity market design have considerably affected the success of support schemes[7]. Furthermore, local situations differ in for example the availability of natural resources such as average wind speeds and solar radiation. Another complicating factor is that the subsidies and RO schemes implemented so far differ significantly in their actual implementation which makes it difficult to draw overall conclusions on the effectiveness and efficiency of generic support instruments.

The relative success of a policy should not only be judged on its effectiveness, but also on the costs of achieving its target. While a large number of studies provide information on the price support given by both feed-in tariffs and ROs in various countries, these studies rarely take into account the specific details of support schemes such as the ambition level and local conditions. An exception is the study by Butler and Neuhoff (2004) who take into account differences in average wind speed between Germany and UK. They estimate that, from 2012 onwards, the price for renewable obligation certificates (ROCs) in the UK will be below the tariff paid for wind in the German EEG. It should however be noted that this estimate is a projection, it has to be seen whether this will be realised in practice.

[7] See IEA study 2008 for a recent overview and analysis of renewable policy instruments.

Given the available evidence, it should be concluded that the experience to date does not provide clear, definitive conclusions on the effectiveness and efficiency of price versus quantity support schemes.

2.3.7 Conclusions

Experience to date does not allow to draw clear conclusions on the effectiveness of either subsidies or an RO, because other factors than instrument choice have had a significant effect on the effectiveness and efficiency of the support schemes, such as non-economic barriers and local conditions.

The major differences between RO and subsidies concern the risks which RE-E producers face under the different support schemes. Certificate prices in an RO would in principle be higher than subsidies, because market risks which are reflected in the certificate price are not faced by RES-E producers under a subsidy. Instead, government (and therefore taxpayers) is faced with fluctuating costs and an uncertain volume of RES-E produced. Whether in practice subsidies will be efficient and therefore lower depends on the ability of the government to accurately predict the costs of renewables and set the tariffs or premiums accordingly.

Costs of renewables might be higher with an RO because of regulatory risks. These will to a large extent depend on the credibility of the government in maintaining a stable policy over the years. With an RO, flexibility in target setting and design of the scheme comes at the price of higher regulatory risks for producers of RES-E and therefore higher costs.

The efficiency of an RO depends on the design of the scheme and on whether there will be a well functioning certificate market. In the next chapter, design options for an RO scheme in the Netherlands will be discussed. Subsequently, in chapter 3 it will be analysed whether there will be a competitive certificate market in the Netherlands.

3 Market analysis

3.1 Renewable energy certificate markets

3.1.1 General characteristics of renewable energy certificate markets

An important characteristic of renewable energy certificate markets is that the government creates demand by obliging parties to participate in the market. Without this government intervention, the market for renewable energy certificates would be limited to voluntary purchase of renewable electricity. Government policy creates the demand for certificates through the obligation that is put on parties to supply or consume a certain (relative or absolute) amount of green electricity, an obligation that must be met with green certificates. A change in government policies such as an increase of the target or obliging more parties to buy certificates will influence demand. The parties with the obligation are the buyers in the market. Their number will depend on where in the vertical chain the obligation is placed. In most RO schemes, the obligation is put on retail suppliers. Another option is to include all parties who buy electricity on the wholesale market (as in the Australian MRET scheme), which can significantly increase the number of buyers on the market.

On the supply side of renewable energy certificate markets, are the generators of renewable electricity, who produce both certificates and electricity. Government policy has a direct influence on the supply side of the market as well, because the government determines which technologies are eligible for certificates.

In addition to the suppliers and end-users, brokers and (financial) traders might be active on the market, providing services such as searching for counterparts for a trade, risk reduction etc. The extent to which these types of market participants will enter the market will among other things depend on the development of the market. In an immature, shallow market with a limited number of participants, brokers can play an important role.

In most markets for renewable electricity certificates, long-term contracts are an important feature. Most renewables production is characterised by high up-front capital costs and low operating and maintenance costs. If uncertainty about pay-offs is high, banks may not be willing to provide loans. Long-term contracts reduce uncertainty. Especially small scale, independent producers therefore favour, and often need, long-term contracts in order to acquire the necessary loans for the investment.

3.1.2 Market structure in existing RO schemes

Experience with RO schemes is limited and mostly confined to the last three or four years. Moreover, information on market structure is scarce. Only for the UK and for Australia there is some limited information on the structure of the ROC market.

Mitchell et. al. (2006) report that trading of ROCs in the UK ROC scheme is limited because of the vertical integration between the larger generating companies and their in-house suppliers on whom rests the renewables obligation. As a consequence, the market for ROCs tends to be illiquid. However, concentration levels appear to be low, as is the case on the wholesale power market on which the same firms tend to be active as on the renewable electricity market. Market power therefore is probably not an issue on the ROC market.

On the demand side, the Australian RO differs from most other schemes in that all parties who purchase electricity on the wholesale market (above a certain level) are required to purchase renewable energy certificates (RECs). Therefore, in addition to retail companies, large electricity users who buy directly from generators also participate in the market. In 2007, a total of 65 parties were required to surrender RECs (ORER 2007 administrative report). On the supply side, in December 2007 there were 444 registered individuals and companies who could create RECs, ranging from agents who represent owners of solar water heaters to large energy generators who own several renewable energy power stations such as hydro and wind. On the basis of the information available, there appear to be no cases of anti-competitive behaviour on the Australian REC market.

3.2 Potential for anti-competitive behaviour on a Dutch renewable certificate market

3.2.1 Introduction

In markets with only a small number of producers and entry barriers to new production, anticompetitive behaviour is a potential problem. As argued above, renewable certificate markets are characterised by physical constraints due to the limited availability of production capacity of renewable electricity. Moreover, investments in renewable energy projects such as wind energy have large up-front investment costs, which are to a large extent sunk costs, which can also raise entry barriers. And in some renewable certificate markets the number of producers is limited.

In this section, we will consider to what extent a renewable certificate market in the Netherlands would be susceptible to anticompetitive behaviour, and how such a market might be designed to minimize the risk of this behaviour. Initially, we will consider a market in which the RO is placed on retail companies. In section 3.3, other options will be considered such as an RO on all electricity purchasers on the wholesale market.

We first focus on potential market power in the market for production of green certificates itself. Then we analyse to what extent market power in this (upstream) market may affect market structure in related markets: is there a risk of foreclosure, which would also affect competition in related markets of production and retail of electricity. Finally, we consider whether collusion may be a problem in such a market.

3.2.2 Market structure and upstream market power

Any concerns for anticompetitive behaviour will depend on whether individual producers have market power. To analyse this we first take a closer look at the current players in this market, as well as the potential for new players to enter and the demand side.

Analysing the market structure of a green certificate market that does not exist poses quite a challenge. A possible future certificate market would need time to develop. An analysis of the market structure of such a future market therefore has to be based on *expected* future market developments. Currently, renewable electricity is being produced in the Netherlands by a number of market parties. This production is subsidized through the MEP-subsidy scheme, which lasted from 2003 - 2006. Under this scheme, producers receive a fixed amount of subsidy for a period of 10 years, the amount of the subsidy depending on the type of RES-E produced. Current RES-E production in the Netherlands is still financed to a large extent by these MEP subsidies. MEP subsidies will continue until 2018 for the last installations which were granted a license for MEP subsidy in 2006 (and which had start-up times of two years before they started operating).

An important difference between an RO and the MEP is that the MEP-subsidy covered the additional costs of most types of RES-E production. Therefore there was no incentive to develop the least cost technologies first, as there would have been on a certificate market (although within a category, the projects with the lowest cost would have been developed first). The structure of current RES-E production might therefore differ from what it would have been in the case of an RO with a market for certificates. Nonetheless, information on current RES-E production can still provide valuable information on what a green certificate market might look like and it can provide a starting point for an assessment of future developments of a market for green certificates.

Figure 3.1 shows quarterly RES-E production for biomass (combustion and cofiring), wind onshore and a rest category including water and solar power in the Netherlands in the last 3 years. Wind shows an increasing trend (corrected for seasonal wind variations), reflecting the growth of installed capacity. The steep decline in biomass cofiring can be explained by the adjustment of the cofiring tariffs by the Ministry of Economic Affairs on July 1st 2006, an option included within the contracts signed for co-firing subsidies. EZ chose a relatively low level, which made cofiring less attractive The subsequent increase of biomass was caused by increasing fossil fuel prices and the start of the ETS, which put a price on CO_2-emissions from fossil fuels.

Figure 3.1 Certified RES-E production Netherlands

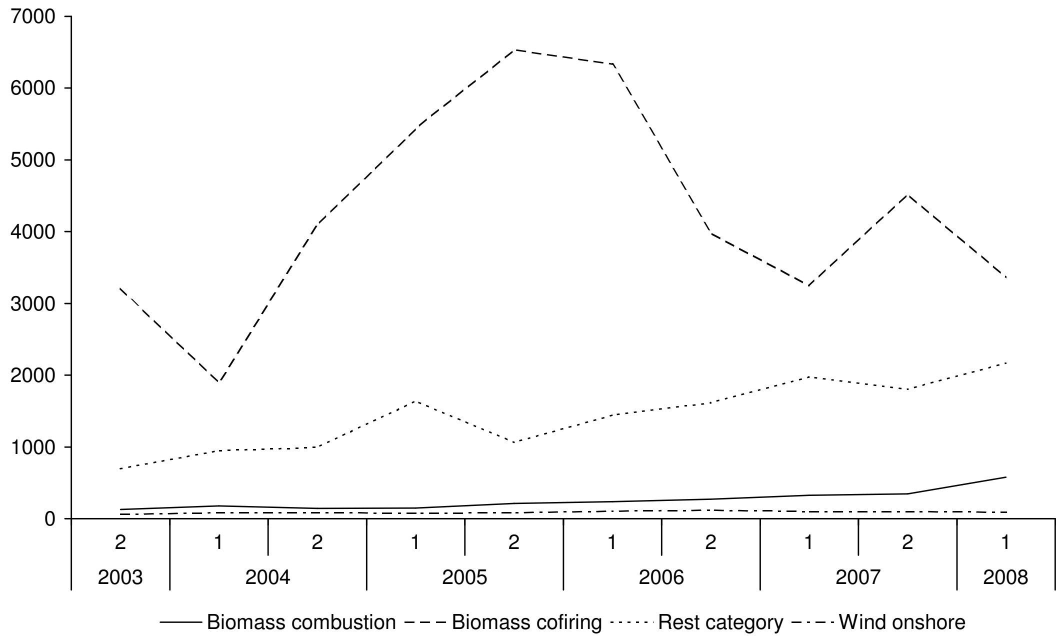


Table 3.1 provides a breakdown of total RES-E production in 2007 (excluding AVI production) on the basis of production which was granted MEP-subsidies[8]. Biomass co-firing is both the largest and, with the exception of power production in waste incinerators (AVIs)[9], the most cost-effective option for RES-E generation. Note that the data shown is production data, this does not represent total available capacity for cofiring. Wind on shore is the next largest RES-E technology, followed by biomass combustion. At the end of 2006, the first off shore wind park was completed in the Netherlands (OWEZ / Noordzeewind). In 2008, Q7 (Prinses Amaliawindpark) came online, which is expected to produce ca. 435 GWh per year.

Table 3.1 RES-E production Netherlands 2007

	TWh			
	2004	2005	2006	2007
Biomass combustion	0.3	0.4	0.5	0.7
Biomass cofiring	6.0	12.0	10.3	7.8
Wind onshore	1.9	2.7	3.1	3.8
Rest (DG/HR/SOL)	0.2	0.2	0.2	0.2
Wind offshore	0	0	0	0.3
Total	8.4	15.2	14.1	12.8

[8] Except for the data on WOS, which are based on personal communication from ECN.

[9] In 2005, AVI RES-E production was ca. 1 TWh. It is the least expensive form of RES-E. At current electricity prices of ca. [NB currently much lower] € 100 / MWh, AVI RES-E production is profitable and does not need support. RES-E from AVI's is therefore not included in the RO.

In 2007, up to 1400 installations in the Netherlands received MEP subsidy for RES-E. This included both small installations, such as solar-PV which produced less than 1 GWh per year and wind turbines with an average 2007 production of 4 GWh, and large co-firing power stations with an average 2007 production of 366 GWh.

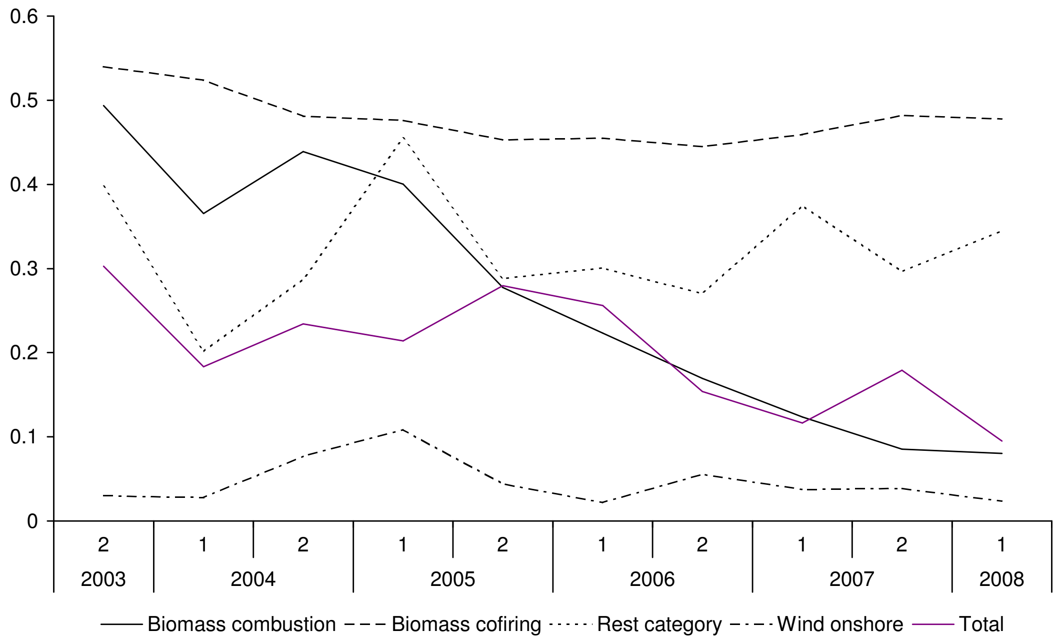
Figure 3.2 shows the development of the Herfindahl index (HHI), a measure for the level of concentration in the market, over time for both total RES-E production and for the individual categories, based on the MEP subsidies conferred. Co-firing is highly concentrated, with the four largest firms producing around 90% of co-firing renewables production over the years. The high concentration level for co-firing has considerable influence on the concentration level for the total production of RES-E, given the large share of co-firing in total RES-E production (63% in 2007). The high concentration level in the rest category is caused by 2 hydropower installations that produce most of the output in this category (which further includes solar-PV). With a HHI for total RES-E production between 0.1 and 0.2, the RES-E market in the Netherlands is moderately concentrated, while the trend shows a decreasing level of concentration.

These concentration ratios are based on the subsidies received under the MEP. This does not include all RES-E produced in the Netherlands, a very small amount is not included (excluding AVIs). Furthermore, wind off shore is excluded. Given the limited contribution of offshore wind to renewables supply in the Netherlands (less than 10%) and the shared ownership of the two offshore wind farms in the Netherlands, in which both established large RES-E producers and other firms participate, it is not expected that this will significantly affect the concentration ratio for RES-production.

Another characteristic of current RES-E production in the Netherlands is the high level of vertical integration between RES-producers and electricity retail companies. Figure ... shows the share in RES-E production which is owned by retail companies in the Netherlands. With an overall share of more than 50% and a share of co-firing, the largest and least expensive renewable energy source, of around 90%, vertical integration is high. Furthermore, the small producers in the competitive fringe often have long-term contracts with the retail companies, which further increases vertical integration on the market.

The concentration ratios presented above do not take into account these long-term contracts between small RES-E producers and the vertically integrated retail companies. Therefore, these concentration ratios might underestimate the market power of the vertically integrated companies if long-term contracts make up an important part of the sale of RES-E. Information on the use of current long-term contracts in Dutch RES-E production is limited.

Figure 3.2 Development of Herfindahl-index RES-E production Netherlands



Whether the current market structure will change as the market develops and new production capacity is constructed, depends on the barriers to entry for new firms. For some technologies entry barriers are significant because capacity is physically limited. For biofuel co-firing capacity in the short run is limited by the capacity of coal-fired power plants and suitable gas fired power plants. New investment in coal-fired generation, which is expected to occur in the coming years, may bring new players to the market. Production of onshore wind is limited by the availability of suitable sites for wind turbines. Other techniques such as wind at sea, biomass combustion or photovoltaic (PV, solar energy) have less restrictive physical constraints, but at the moment have considerably higher production costs compared with onshore wind or co-firing biomass. However, these costs are expected to fall over time, with wind having expected lower costs in 2020 than co-firing. Biomass combustion can be considered a backstop technology. Given the availability of (imported) biomass, there is no hard constraint on the expansion of biomass combustion. Moreover, new biomass combustion plants can be built at short notice, in contrast with wind off shore which may take a long time to realise (from planning to production, time spans of 2-7 years are not uncommon). However, compared with the other renewables technologies (with the exception of solar PV), biomass combustion is the most expensive form of RES-E production.

Figure 3.3 Share of RES-E production owned by retail companies in the Netherlands, 2003 - 2008

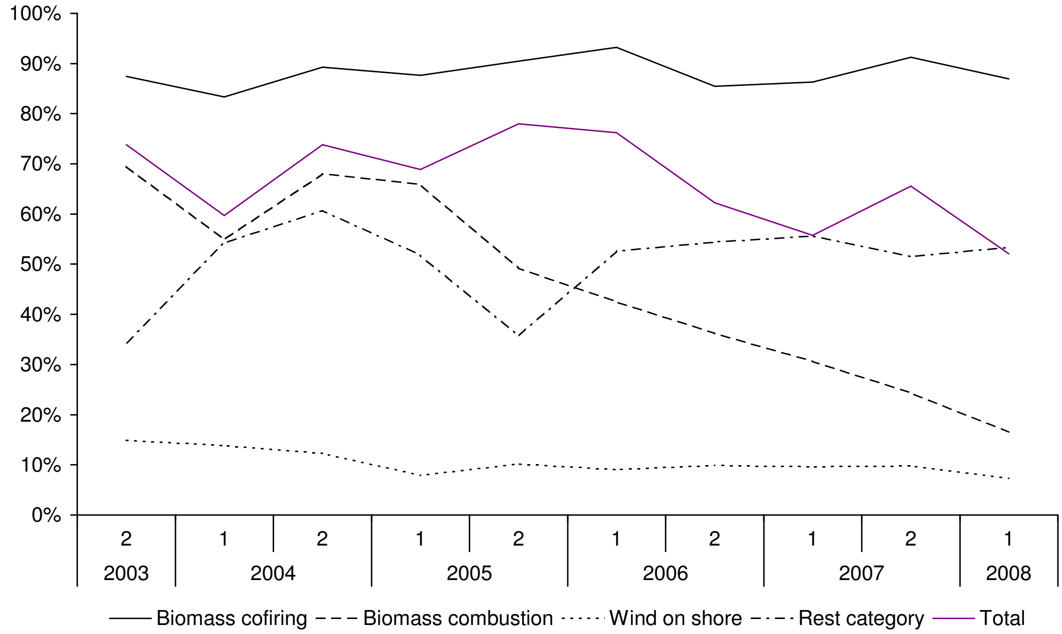


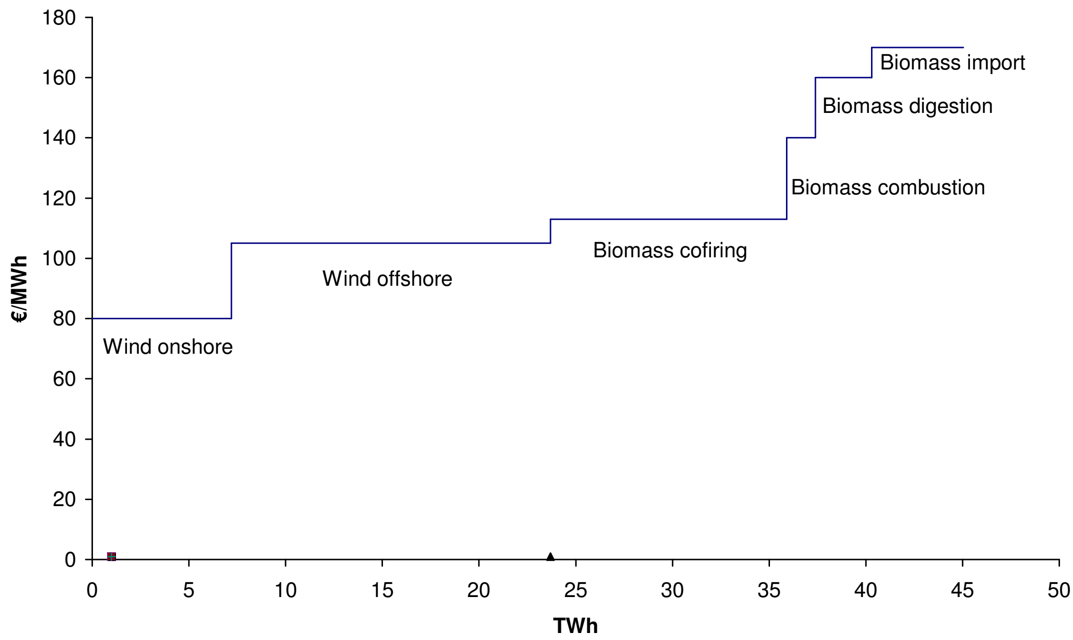
Figure 3.4 gives the supply curve for renewable in the Netherlands in 2020, showing expected costs and expected capacity of the various renewable technologies available in 2020.

New co-firing capacity will belong to power generators who build power stations capable of co-firing, predominantly coal fired power stations. When new co-firing capacity is built by the incumbent power producers, this will not have a decreasing effect on the concentration ratio on the market for RES-E. If instead new power stations with biomass co-firing capacity are built by new firms entering the electricity production market, concentration ratios will be lower. New off shore wind parks and biomass combustion plants can be built and operated by other firms than the current vertically integrated power companies, which would further diminish concentration on the supply side of the certificate market.

Given the current trend towards less concentration in the market and the importance of technologies such as wind onshore and offshore which do not necessarily have to be operated by the current power producers and the relative absence of barriers to entry for these technologies, it might be expected that the concentration in the market will further diminish in the years to come. New cofiring capacity is more likely to belong to incumbent producers, it is however expected that cofiring will constitute at most one third of new RES-E capacity.

Another determinant of market power in the green certificate production market is the elasticity of supply and demand: how does the supply of certificates vary in response to rising prices, and how does demand adapt? If the response to higher prices on the demand or the supply side of the market is weak, producers are not restricted in raising prices significantly above costs. The long-run elasticity of supply is related to the barriers of entry. If prices remain higher for long periods, suppliers with lower average cost will only enter the market insofar as

Figure 3.4 New renewables potential Netherlands 2020



there are no physical capacity constraints. In the short run, the elasticity of supply given the available installed capacity will be determined by the marginal costs of production: do short-run higher prices provoke higher production of green electricity? For intermittent resources such as wind energy, the marginal costs are typically very low: these technologies will always produce when available, and therefore will not exhibit significant price response. The situation is different for in particular biomass co-firing, where both the costs of the fuel itself, and the opportunity costs of reduced output when replacing coal with biomass, create responsiveness to certificate prices, as long as there is still capacity available for co-firing.

Supply elasticity might be substantially higher if imports of green certificates would be allowed. International markets for green certificates are the subject of chapter 6.

On the demand side, price responsiveness will depend on the mechanism that determines the requirement for green certificates. As long as demand for certificates is fixed in absolute terms by the government, demand will obviously be unresponsive. If on the other hand the requirement for certificates is a fixed fraction of the demand for electricity, a higher price for certificates will result in a higher price for electricity. This derived effect on electricity prices, will result in some price responsiveness . Price elasticity for electricity is generally assumed to be low, but not negligible in particular in the longer term. Moreover, elasticity is largest for industrial users. When the RO applies only to retail companies, demand elasticity for certificates will be lower, which may aggravate any problems with market power.

Elasticity both on supply and demand side will also depend on the timing of the markets. Longer time frames for meeting certificate requirements enable both producers and consumers to respond more elastically to price changes. In most green certificate systems implemented so far, the commitment period is one year. The possibility to bank certificates for use in another commitment period will increase supply elasticity because RES-E producers will have more flexibility.

Concluding, the current concentration rate in the production of RES in the Netherlands is moderate and there is a downward trend. If this trend continues, market power on a future renewable certificate market in the Netherlands will not be an issue. The technologies which are expected to play an important role in the years to come such as wind on shore and offshore do not necessarily have to be owned by the established RES-E producers.

However, there is the possibility that market power might be an issue in a number of cases. The downward trend might be reversed, for example if wind off shore would primarily be owned by incumbent producers. Another reason is the occurrence of exclusive contracts between producers and retail companies. In the next sections we will discuss two forms of anti-competitive behaviour that might occur if market power would occur for one of these reasons.

3.3 Collusion

Wholesale producers of renewable energy may form a cartel, either on the market for green certificates, or on the retail market between vertically integrated suppliers of electricity. A relevant question, therefore, is whether the new market increases the probability of cartel formation?

Factors facilitating collusion are: the number of firms in the market, asymmetry in market share, entry barriers, frequent interaction, market transparency, (predictable) demand growth and multi-market contracts. Unpredictable fluctuations in demand, innovative markets, cost asymmetries and buyer power hinder collusion.

A number of factors favouring collusion occur on the certificate market. Although the market concentration on the current RES-E market is moderate, as described above, the possibility of long-term contracts between independent RES-E producers and the distribution companies might be conducive to collusion. Moreover, the entry barriers for the least cost technologies such as co-firing because of the physical limitations might also contribute to collusion.

Producers of green electricity are highly integrated with the distribution companies which sell electricity on the retail market (see above ...). This increases interaction, which again facilitates collusion. Moreover, it provides the opportunity to collude both in the green certificate market and the electricity retail market, which increases the likelihood of collusion. Last, demand for green certificates will be highly predictable, because future renewables obligations, which are set by the government, drive the demand for certificates.

Some arguments also relate the high level of vertical integration in the industry to increased potential for collusion (Riordan, 2005). Defection in the upstream certificates market can be more swiftly punished by easy renegotiation of downstream contracts. Through the downstream business’s contacts with other producers, agreements may be more easily reached and monitored. Against collusion speaks the argument that integration secures part of the downstream sales, making punishment after defection less effective.

Introduction of an RO might increase the likelihood of collusion on the electricity market, provided that there is market power on the certificate market. However, conclusions on the possible occurrence of collusion on a future market remain highly speculative and should be treated with due reservation. Moreover, collusion is not allowed under the competition law and therefore would be prohibited and penalised if discovered.

3.4 Foreclosure

Wholesale producers may try to foreclose upstream or downstream competitors. To analyse this aspect note that in the base case where it is the retailers that are required to buy certificates, we have, on the upstream side, two complementary markets: green certificates and electricity. In order to be active downstream, retailers have to purchase upstream input. Some certificate producers will also produce electricity, but other electricity producers will not produce certificates. Certificates are an essential input in selling to retail consumers. This may give rise to concerns that dominant producers in the certificate market may extend their market power to the related retail market, or the market for non-renewable energy.

There are two types of foreclosure we consider. First, on the upstream level there may be the potential for horizontal foreclosure (tying or bundling), where certificate producers put their grey rivals at a disadvantage by only selling their certificates together with the electricity, or more generally to reduce competitiveness of other electricity providers.

Second, there may be vertical foreclosure on the downstream market. Vertical foreclosure comes in two forms. On the one hand, input foreclosure exists where the certificate producers deny certificates to some retailers, forcing them to be inactive or less competitive. On the other hand customer foreclosure might occur where a particular certificate producer enters into exclusive contracts with downstream retail producers, foreclosing other producers from access to these potential customers. Certificate producers are often active on the downstream retail market, and hence are vertically integrated. Renewable energy producers have a preference for long-term contracts in order to minimise risks and to have access to external finance. Vertical foreclosure is therefore a potential concern in these markets.

Theory shows that the anticompetitive goals of the two types of foreclosure are distinct (Bijlsma et al. 2008). Horizontal foreclosure may be profitable if it achieves making the market for grey electricity less competitive. The goals of vertical foreclosure may either be to prevent the erosion of market power in the certificate market, or to prevent or hinder entry by other green certificate producers, or to alter the market structure in supply in adjacent markets (e.g. supply to large customers).

3.4.1 Vertical foreclosure

To identify whether vertical foreclosure is indeed a risk, we apply the policy framework developed in Bijlsma et al (2008), which consists of three steps. First, determine whether vertical foreclosure might occur. Second, identify the theory of anticompetitive foreclosure. Third, Identify possible welfare enhancing efficiencies that arise from vertical integration

Market power

As regards the first step, we start from the presumption that market power exists in the production of renewable energy. If there is no market power in a potential market for green certificates, there will be no reason to worry about foreclosure or about other anticompetitive effects.

Theory of anticompetitive foreclosure

From the description above, we conclude that a market for renewable energy certificates will probably have the following characteristics:

- The good in question (renewable certificates) is tradable and homogeneous. This implies that if trade occurs or is allowed, there will be little scope for price discrimination (firms will pay similar unit prices). Non linear contracts (for example quantity discounts) will allow market participants to engage in profitable arbitrage by reselling certificates to other market players.
- Scale effects will not be an issue for some specific technologies such as onshore wind, solar PV and solar water heating. However, for co-firing of biomass and wind offshore, scale effects probably will be important.
- There are production constraints for both green certificates and electricity.
  For green certificates there are constraints on the production of specific technologies such as wind on land, biomass co-firing, which limits the production of especially the lowest-cost technologies. For high cost production technologies, such as wind on land, solar PV and solar water heating, production constraints play a less important role.
- The upstream market for production of grey electricity is oligopolistic. The upstream market for certificates is more competitive, but long-term contracts with downstream retailers could reduce competition in the upstream certificate market.
- The downstream market for electricity is potentially competitive.
- Upstream producers and downstream retailers are to a large extent vertically integrated, which might be increased by long-term contracts between independent RES-E producers and downstream retailers.

Based on this list of characteristics, we can identify three potentially relevant theories of foreclosure in this market. First, foreclosure of (downstream) retailers may arise if downstream competition leads to erosion of the oligopoly profits on the upstream green certificate production: supplying many retailers might expose the producer to risk of overselling the market (see Hart and Tirole, 1990) The fact that contracts, if offered to multiple retailers, are restricted to consist only of a (volume independent) price (since the retailers can arbitrage any lump sum prices by trading among each other) suggests that exclusive contracts or no supply at all to non-affiliated retailers(and thus foreclosure) may constitute an equilibrium (see Mathewson and Winters, 1990).

Second, if scale effects make a minimum scale of operation in the (green) production market necessary, a firm can enter into exclusive contracts with a critical number of downstream firms ('buyers'), depriving a potential entrant of the minimum scale necessary to enter the upstream market, see Rasmussen et al. (1991) and Segal and Whinston (2000). Entry can be deterred profitably, because not all the buyers have to be bribed into signing a contract.

Third, if scale effects exist in the retail market, green producers might try to limit operations of rival retailers in the residential market (where green certificates are required) so as to make them less competitive in the related market of supply to large users (where certificates do not play a role). In the mirror image of the previous scenario, downstream firms enter into exclusive contracts with a critical number of upstream firms.

The potential foreclosure effect of exclusive contracts suggests that these should be treated with caution in a market for renewable energy certificates. If on the other hand the certificate market develops into a competitive market, there should be no concerns for foreclosure. Exclusive contracts may also increase efficiency. In the next section, we therefore investigate the efficiency increasing potential of these contracts.

Possible welfare enhancing efficiencies that arise from vertical integration

In theory, several welfare enhancing effects exist that may arise as a consequence of vertical integration or exclusive contracts.

First, welfare reducing double mark-ups may exist, which can be resolved by vertically integrating or other vertical restraints. In principle, we might expect double mark-ups to exist if there is market power in both markets. However, we expect that the retail market is fairly competitive. This implies that double-mark-up problems will be limited if the retailers are required to buy such contracts.

Second, in general, exclusive contracts or vertical integration can stimulate relation specific investments, which may enhance efficiency. For such investments, firms could behave opportunistically ex post, i.e., once an investment has been made. Exclusive contracts and vertical integration can mitigate such opportunistic behaviour. However, investments in production capacity for renewable energy is not relation specific. The energy generated can be sold to anybody.

In conclusion, it is unlikely that exclusive contracts have large efficiency effects in a market for renewable energy certificates.

3.4.2 Horizontal foreclosure

Horizontal foreclosure may arise when a monopolist producer in the one market (market A) can leverage its market power to another market (market B, which is competitive and where the monopolist has an affiliate) by tying or bundling its product in market A to its product in market B. The famous Microsoft case is a well-known example of (alleged) horizontal; see e.g. Whinston (2001). In the context of a market for renewable energy certificates, horizontal foreclosure would amount to a producer of such certificates to tie or bundle certificates to the sales of electricity.

As in many cases of alleged abuse of monopoly power, a Chicago critique applies, which states that, absent efficiencies, a monopolist will not benefit from tying the products in the two markets.[10] In response, economists have identified circumstances under which tying may be profitable for anticompetitive reasons, see e.g. Rey and Tirole (2005). As argued by Whinston (2001), there are "two features that are central to all of these models: 1) the monopolized product is not essential for all uses of the complementary good; and 2) scale economies (or network effects) are present in the complementary good." This leads to three requirements for tying to be (potentially) anticompetitive:

1. A commitment to tying must be possible;
2. There should exist economies of scale;
3. The goods in the different markets should not be full complements, but must be independent to some extent.

Whether these conditions hold in a potential market for renewable energy certificates is questionable. On the one hand, since only supply to retailers requires certificates, the complementary good (electricity) can well be sold without the certificate, in the related large user market, making the last conditions easier to satisfy. On the other hand, it seems fairly difficult for the green producers to commit to not selling to the (wholesale) market for electricity, in particular if the production capacity of green producers is larger than the small and medium sized users' market supplied by retailers. In addition, the presence of scale effects in generation is likely to become of decreasing importance as viable scale of generation facilities goes down (in particular for distributed generation). Therefore, the first and second conditions seem not to be met if current developments proceed as projected. Horizontal foreclosure seems to be less likely, therefore.

[10] Assume production costs in market A(B) are CA(B). The price for the tied product can never exceed the total value consumers V attach to the two products separately. Monopoly profit therefore equals V-CA-CB. If the products are not tied, the maximum price the monopolist can charge equals this total value minus the competitive price CB in the B-market. The monopolist's profits again are V-CA-CB.

3.5 Other scenarios

Other scenarios change our characterization of the market and its potential for vertical and horizontal foreclosure. If the renewable obligation is put elsewhere, e.g. on all purchasers on the wholesale market instead of on retail companies, the market structure will change and one might regard all electricity purchasers as the downstream market while production of certificates is the upstream market. The downstream market will be less concentrated, moreover vertical integration will be considerably reduced. Therefore, the likelihood of anticompetitive behaviour will be reduced and foreclosure less likely.

The focus in this study is on a potential market for renewable certificates in the Netherlands. An RO however could also extend over more than one country. This would add both producers of RES-E and buyers of certificates to the market. In the standard RO case, extending the scheme to include parties from other countries in addition to the Netherlands would further reduce the likelihood of anticompetitive behaviour and of foreclosure.

3.6 Conclusions

If the current developments on the Dutch RES-E market continue, market power on a future renewable certificate market in the Netherlands will probably not be an issue. The current concentration rate is moderate and there is a downward trend. Moreover, the technologies which are expected to play an important role in the years to come such as wind off shore and on shore, do not necessarily have to be owned by the established RES-E producers. New cofiring capacity is more likely to be developed by incumbent producers, however the expected share of new cofiring capacity is expected to be less than one third of total new capacity.

Market power on the RES-E market might be a problem if extensive use will be made of long-term exclusive contracts for the sale of certificates. It is difficult to predict the extent to which these long-terms contracts would be employed on a future certificate market in the Netherlands. If this would be the case, anti-competitive behaviour such as collusion or foreclosure might in theory be a problem.

As regards vertical foreclosure it is unlikely that exclusive long-term contracts have large efficiency effects in a market for renewable energy certificates. Horizontal foreclosure is not likely to occur on the market, given the increasing potential for decentralised generation and therefore reduced economies of scale in electricity production and the possibility of selling electricity on the wholesale market to other electricity purchasers than the retail companies. Extending the obligation to all purchasers on the wholesale market would reduce the likelihood for anti-competitive behaviour.

4 Distributional consequences of RO and subsidies

Implementing a renewables obligation or a subsidy will have consequences for producers of both renewable and grey electricity and for consumers. When a renewable obligation is introduced, consumers will face higher costs because of the renewable certificates[11]. This will have an effect on the price and demand for electricity. Equilibrium on the electricity market will be affected, which has consequences for both consumers and producers. The consequences for consumers can be measured by the consumer surplus, which is the amount that consumers benefit by being able to purchase a product for a price that is less than they would be willing to pay. Producer surplus is the equivalent measure for producer benefit[12]. Introducing a renewables obligation will also have an effect on producers of RES-E, who can sell both electricity and their renewables certificates and realise a producer surplus on both markets. Comparing the effects on producer and consumer surplus of introducing a support scheme will show the distributional impact on producers of both green and grey electricity and consumers. In the next section, the effects on the electricity market and on producer and consumer surplus of introducing a renewables obligation or a subsidy are outlined. Subsequently, an estimate is given of the quantitative impact of a renewables obligation on the Dutch electricity market and on producer and consumer surplus. This will be compared with the impact of a feed-in tariff such as the SDE.

4.1 Price and volume effects of renewable certificates and subsidies

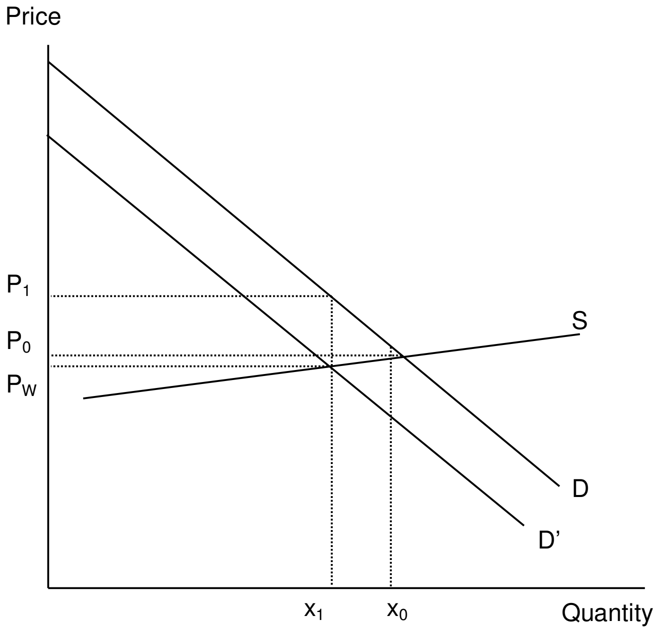
Renewable obligation

Introduction of a renewables obligation and the appearance of a renewable certificate market will have consequences for the electricity market. This is illustrated in Figure 4.1. With a renewable obligation, electricity retailers will have to acquire renewable certificates, which will raise their costs. Passing on these costs to their customers will drive a wedge between the wholesale price of electricity and the price which consumers have to pay. This can be shown as a downward shift of the demand curve, equal to the price of the green certificates, from curve D to D' (which is equivalent to an upward shift of the supply curve). As a result of this higher price, demand for electricity will fall from X_0 to X_1, which will lower the wholesale price of electricity from P_0 to P_W. Consumers will pay retail price P_1, with the difference between the wholesale price P_W and the retail price P_1 being determined by the certificate price and the share of the RO in final electricity demand. In addition, because of the RO, electricity generated from fossil fuel will be replaced by RES-E. This will further reduce supply of grey electricity and

[11] For small consumers, retailers will have to acquire renewable certificates to fulfil their obligation. They will pass on these costs to their consumers.

[12] Producer surplus will be passed on to, for example, the owners of inputs such as labour and capital.

Figure 4.1 Price and volume effects RO on the electricity market



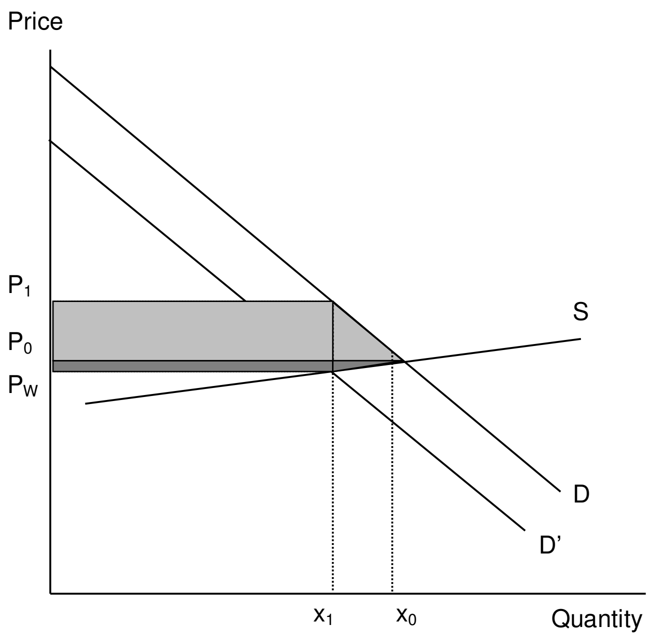
therefore further lower the wholesale price (for the sake of simplicity, this has been omitted in Figure 4.1).

Figure 4.2 shows the consequences for producer and consumer surplus. The loss in CS equals the surface under the demand curve between p_1 and p_0, the light grey shaded area. The dark grey shaded area is the loss of producer surplus. Only part of the loss in consumer and producer surplus represents a loss to society as a whole, a loss which will ideally be less than the benefits of using more renewables such a, for example, reduced CO_2 emissions. For the other part the loss in consumer and producer surplus is a transfer to the producers of green electricity, covering both their costs and the producer surplus they acquire on the certificate market.

Introduction of an RO raises the retail electricity price (including the costs of the RO) paid by consumers. The extent to which the retail price will increase depends on the elasticity of the supply curves of both RES-E and fossil fuel generated electricity. The increase will be lower the more elastic is the supply of RES-E and the more inelastic is the supply of non-renewable electricity. With an elastic supply of RES-E, the costs of an increase in the RO are relatively small, therefore the effect on the retail electricity price will also be limited. With an inelastic supply of non-renewable electricity, a decrease in the consumption of non-renewable electricity will cause a larger drop in the wholesale price of electricity.

In the longer run, the effects of introducing an RO will be less pronounced because supply (RES-E as well as non-renewable electricity) can adjust to the new situation. In the short run, the introduction of an RO will create excess electricity generating capacity, which will lower the wholesale price of electricity. In the longer run, when the necessary RO capacity has been installed and grey electricity capacity has been adjusted to the new situation, the wholesale

Figure 4.2 Producer and consumer surplus on the electricity market



price might increase (Amundson and Mortensen 2001). Loss of PS for fossil fuel based electricity production will therefore be smaller in the long-run.

So far, the effects of introducing an RO on prices and volumes have been addressed without taking into account the possibility of import and export of electricity. However, the Dutch electricity market is linked to markets in neighbouring countries. This will have consequences for the effects which the introduction of an RO will have on the electricity market. The effect on the wholesale price in a Northwest European electricity market of introducing an RO in the Netherlands will be more limited, compared with the effects on an electricity market which is not linked to other countries. There will be changes in import and export, with less import or more export of non-renewable electricity. Given the more limited effect on wholesale prices with a wider electricity market, producer surplus of fossil fuel based electricity generators will be less affected compared with a national electricity market which is not connected to other electricity markets in neighbouring countries.

Subsidy

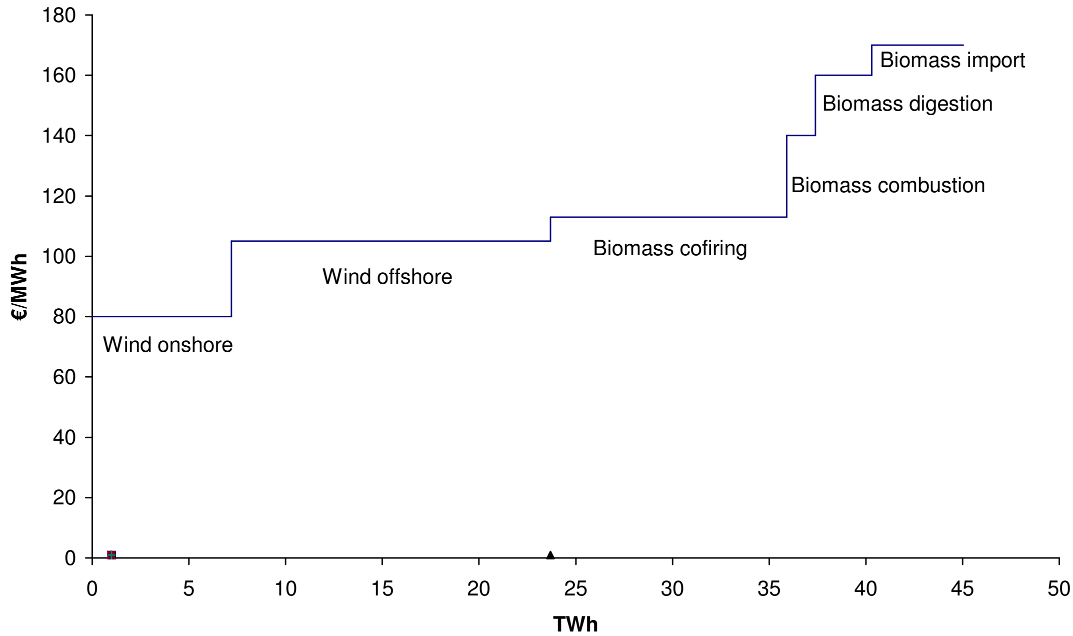
The effect of a subsidy for green electricity on the electricity market will depend on the way in which the subsidy is funded. If the subsidy is funded through a surcharge on the electricity price, the effects will be similar to those of an RO scheme. The electricity price for consumers will increase, which reduces demand. This reduces the wholesale price, which will further decline because of the additional supply of RES-E with low marginal costs, which shifts the supply curve of fossil fuel generated electricity to the right. The size of the effects will be smaller compared with an RO scheme, because an RO scheme entails larger transfers to RES-E producers, see the next section on producers surplus for RES-E producers.

In case the subsidy is not funded through a surcharge on the electricity price, there is no direct effect on electricity prices. What remains is an increased supply of RES-E, which will lower the wholesale price and therefore induce an increase in electricity use.

Producer surplus for RES-E producers

On a certificate market, all RES-E producers will get the same price for the certificates produced. This is regardless of the technology they use. Consequently, low-cost producers of renewable energy, such as cofiring, will receive a high producer surplus if the RO level is such that the costs of the marginal producer of certificates and therefore the price is high. This is illustrated in Figure 4.3. If the RO is set at such a level that the most expensive technology will have to be used, the certificate price will be based upon the marginal costs of biomass import, ca. € 170 per MWh. The least expensive option to produce RES-E, wind-on-shore, will make a profit of ca. € 90 per MWh produced. Total producer surplus on the certificate market equals the area above the marginal cost curve under the € 170.

Figure 4.3 **Long-run marginal costs of RES-E production in the Netherlands, 2020.**



In an ideal subsidy scheme, the tariffs are set in such a way that producers will only make a reasonable profit on their investments. This realised through a technology-specific subsidy based on the additional costs for each technology. Consequently, there is no producer surplus, assuming that the subsidy is set at the right level.[13]

RO can have considerable distributional consequences, depending on the stringency of the renewables target and renewable technologies available. The transfer from consumers and

[13] Note that producers which can produce at lower costs than assumed in setting the subsidy for a specific technology will realise a higher profit.

producers of grey electricity to producers of RES-E will be larger the more stringent the target is and the large cost differences are. This transfer, and the potential large profuts for intra-marginal producers of RES-E has encouraged policymakers to look for options to minimise these transfers within an RO scheme. An example of such an option is the banding approach in the UK RO which was introduced as of 1st April 2009. In this banding scheme, technologies are given a number of certificates which varies between 1 and 2 per MWh, depending on the costs of production (Department of Energy and Climate Change 2008).

In such an approach, the regulator has to specify the number of certificates for each technology (or group of technologies). This should be based on the cost difference with the least cost RES-E technology. For example, a technology with additional costs which are twice the additional costs of the least cost technology should receive two certificates per MWh if the least cost technology receives 1 certificate per MWh. This ratio is based on the *additional* costs of RES-E compared with grey power production. These additional costs however are not fixed. Changing fuel costs will affect the production costs of grey power and therefore the additional costs of RES-E. And with changes in the additional costs, the ratio between the additional costs will change as well. Therefore, a ratio set in advance will not reflect cost differences if fuel prices change. This will affect the profitability of different technologies and therefore the certificate price. Total costs of realising the RES-E target therefore will increase.

Comparable options are to combine an RO with subsidies for the more expensive technologies or to set specific obligations for each technology, thereby creating separate markets for certificates from each technology. These options have in common with banding that they reduce the certificate price, the loss of consumer surplus and the producer surplus for RES-E producers

A major drawback of these options is that the authorities have to acquire detailed information about the costs of specific technologies, as is the case with a subsidy. One of the major advantages of a certificate market is that the market generates this information, which will be reflected in the market price. This advantage is nullified with these variants. They combine the drawbacks of a certificate market, such as higher transaction costs, with the higher administrative costs of a subsidy scheme.

Moreover, there is no incentive for RES-E developers to prefer the least cost technologies, because the additional costs of all technologies, regardless of their cost level, will be covered by the scheme. Consequently, the actual investments will not necessary reflect the merit order of renewable technology options and therefore the costs of meeting the RO will probably be higher.

Given the major drawbacks of these options, we will not further consider them in this study.

4.2 Quantitative assessment

In this section, the effects of introducing an RO and a premium subsidy in the Netherlands on electricity prices, consumers and producers which have been outlined in the former section are analysed by performing a number of model simulations. The model used for these simulations is the COMPETES electricity market simulation model from ECN. The COMPETES model has been developed by ECN to simulate competition on the Northwest European electricity market. Using COMPETES therefore includes the effects on price changes from import and export of electricity, as has been described in section 4.1.

Various market structures can be simulated with COMPETES, ranging from perfect competition to oligopolistic market structures. In this study, it is assumed that there is a liberalised, competitive electricity market in Northwest Europe in the target year 2020 (see Ozdemir et. al. 2008). Demand in COMPETES is distinguished for three seasons (winter, summer and autumn) and four time periods (super peak, peak, shoulder and off-peak), yielding 12 different levels of demand. For a detailed description of COMPETES, see the COMPETES page on the ECN website (ECN, 2009).

In addition to the baseline scenario, both the introduction of an RO and a premium subsidy such as the SDE are simulated. Two renewable targets are analysed, 20% and 30% of final electricity demand. These targets are rough approximations of the amount of RES-E needed to meet the renewable energy targets as a share of total energy demand as formulated by the EU and the Dutch government in its climate and energy action plan. The 20% RES-E target reflects the EU target for renewable energy (14% of final demand), the 30% target reflects the Dutch target of 20% of primary energy use.

4.2.1 Baseline scenario

In order to determine the effects of introducing an RO, a baseline scenario has to be chosen against which the effects can be measured. The baseline scenario used here is derived from the so-called High Demand Growth-High investments (Coal dominating) scenario from the Future Electricity Prices study (ECN 2008). For the Netherlands, this scenario is based on the Global Economy High Oil Price (GEHP) scenario. This scenario is defined in the 'Welvaart en leefomgeving' study by CPB, MNP, ECN and RPB (WLO) and has been used as the background scenario for recent energy and climate policies such as the 'Schoon en Zuinig' programme of the Dutch government.

For other countries in the Northwest European market (i.e. Germany, Belgium, France and the United Kingdom) comparable country specific scenarios are used in combination with PRIMES scenarios that were developed as reference projections for the European Commission (EC, 2006).

The 'high oil' price in GEHP was assumed to be ca. $40 per barrel in 2040 (in $2000). The price for natural gas in 2020 in line with this oil price assumption is €6.82/GJ (€2000), the price for coal is €2.5/GJ. Prices in the other countries are comparable, the only difference are higher gas prices in Belgium and the UK and higher coal prices in Germany. The price for CO_2 allowances is set at €20/ton.

Electricity demand growth in the Netherlands in the baseline scenario is high, 2.1% per year, resulting in a final demand in 2020 of 155 TWh (as compared to 116 TWh in 2006). Demand growth in the other countries is based on the background scenarios for these countries. The price elasticity of demand, which determines the change in demand resulting from price changes in the policy scenarios relative to the price in the baseline is set at -0.2.
Investments in new capacity is based on the current plans for new plants and on the growth in peak demand. In the baseline used here, new capacity installed consists of coal and gas-fired plants.

In addition to new investments, there will also be plants decommissioned in the period considered here. Decommissioning of existing capacity is based on IEA data, for the Netherlands it is expected that 2.3 GW of old coal capacity will be decommissioned in 2020. Interconnection capacity is expected to increase according to current plans. For the Netherlands, these include a connection with Norway (Norned), the U.K. (BritNed) and an extension of the interconnection capacity with Germany.

The High Demand Growth-High investments scenario from the future electricity price study includes significant increases in renewable capacity in the period 2006-2020, implicitly assuming there is a policy to stimulate the development of renewable energy. In order to be able to assess the impact of introducing an RO, it has been assumed in the baseline used here that no new renewable energy capacity will be installed. Consequently, in 2020 RES-E is only produced by plants already operating in 2006 (mainly wind and biomass), which adds up to 2.2 percent of total electricity consumption.

4.2.2 Renewable obligation scenarios

Two different RO are examined, one in which the RO is set at 20% of electricity consumption in 2020 and another with a renewable target of 30%. Table 4.1 lists the options available in 2020 and the long run marginal costs of these options. It is assumed that the RO has to be met from renewable energy sources within the Netherlands, import of green certificates is not allowed. The certificate price will be determined by the marginal technology which is needed to meet the level of the RO.
Wind is expected to be the most inexpensive option in 2020. Biomass cofiring in coal fired power plants is slightly more expensive, given the assumptions made about the costs of biomass. Biomass import for use in stand-alone biomass plants is the most expensive option and is regarded as backstop technology which has sufficient potential to meet the renewable targets. It should be noted that solar PV is not included. Given the still high costs of solar which are expected for 2020, solar-PV will not be an attractive option in a renewables market.

It is assumed that renewable technologies bid low in the wholesale market, reflecting the low or zero short run marginal costs of renewable technologies, and therefore operate as base load units.

Table 4.1 Renewable technologies potential Netherlands 2020

	Long-run marginal cost €/MWh	Potential new capacity TWh
Wind onshore	80	7.2
Wind offshore	105	16.5
Biomass cofiring	113	12.2
Biomass combustion	140	1.5
Biomass digestion	160	2.9
Biomass import	170	

In the simulations, it is assumed that the costs of the renewable obligation are born by all electricity consumers. In terms of the design options of an RO, this is equivalent to assuming that the RO applies to all electricity demand, both small-scale power users and large industrial consumers. The cost increase is equal to the certificate price times the share of the obligation.

In Table 4.2, the effects on the electricity market in the Netherlands of the introduction of an RO (both 20% and 30% share of electricity use) are shown. The base load price will fall slightly in the 20% RO scenario, reflecting the effect of a shift in the merit order because of the increase in production of RES-E. However, the effect is small because the electricity markets of Northwest Europe are integrated to a large extent. The simulations show that the introduction of an RO in the Netherlands also leads to a small decrease in the base load wholesale price in Germany.

Table 4.2 RO scenario results 2020

	Baseline scenario	20% RO	30% RO
Base load wholesale price Netherlands (€/MWh)	56	54	54
Certificate price (€/MWh)	–	56	104
Retail price (€/MWh)	56	65	84
Electricity consumption (TWh)	155	150	140
Increase in renewables production[a] (TWh)	–	26.5	38.4
Decrease in grey production[a] (TWh)	–	29.2	45.6
Reduced import (TWh)		3	6

[a]Compared to baseline

Source: COMPETES

In the 20% RO scenario, the increase in renewable production consists mainly of wind (both on shore and off shore) and, at the margin, a limited amount of cofiring, which sets the certificate price[14]. Production of grey electricity is reduced with 29.2 TWh, a reduction of 22% compared to baseline grey power production. Import is also reduced, by 3 TWh.[15]

In the 30% RO scenario significantly more expensive renewables capacity need to be installed in order to meet the higher obligation. The effect on the base load wholesale price is still limited, about 1 euro per MWh less, as is to be expected on an integrated Northwest European market.

The price for certificates is almost double the price in the 20% RO scenario, at € 104 per MWh. In addition to wind, biomass cofiring is used on a large scale and the full potential of biomass combustion capacity is installed. At the margin, 1.5 TWh of biomass digestion is being produced.

With the higher certificate price and the higher obligation, the retail price in the Netherlands increases to 84 € / MWh, an increase of 50%. In response, electricity demand falls to 140 TWh, a decrease of 10%. With the lower demand and the increase in renewables, grey production falls with 45,6 TWh.

Table 4.3 RO scenarios and surplus in 2020

	20%			30%		
	Absolute level (million €)	Compared to baseline (million €)	% Change relative to baseline	Absolute level (million €)	Compared to baseline (million €)	% Change relative to baseline
Producer surplus grey electricity		– 470	– 31		– 562	– 37
Producers surplus renewables	681	502		2515	2335	
Consumer surplus		– 1379	– 6		– 4127	– 19

Source: COMPETES

Table 4.3 presents the results of the RO scenarios for both producer and consumer surplus in 2020 (excluding investment costs for grey production). Producers of grey energy will see demand for their product decline for two reasons. First, the production of the obligatory share of RES-E replaces grey electricity. Second, the reduction in demand due to the increase in the retail price reduces electricity use. In the 20% RO scenario, grey producers lose 31% of their producer surplus, compared with the baseline scenario, a decrease of € 470 million. In contrast, renewable producers will see their surplus increase with € 516 million to € 681 million. This surplus is made up of the producer surplus on the certificate market and a surplus realised on

[14] The certificate price and wholesale price do not add up exactly to the costs of the marginal renewable technology.

[15] In the baseline scenario, the Netherlands import electricity. This is a result of the baseline assumptions, in which there is no new renewable capacity installed in addition to installed capacity in 2006.

the electricity market by the renewable capacity already installed in 2006, which is assumed to have been paid off. Combined, grey and renewable power producers will see a slight increase in producer surplus.

Consumer surplus falls with 6% relative to the baseline scenario, a loss of € 1.4 billion. The loss in consumer surplus consists of a transfer to RES-E producers in order to pay for the total additional costs of renewables (producer surplus and the additional costs of renewables compared to grey power production) and of a deadweight loss because of reduced demand. The total value of the green certificate market is € 1.7 billion, which is made up of a producer surplus on the certificate market of € 0.5 billion (including the surplus realised by selling certificates from the renewable capacity installed already in the baseline scenario) and the costs of producing the certificates (the additional costs given the revenue earned on the electricity produced) of € 1.2 billion.

In the 30% RO, the effects are considerably more pronounced, due to the high costs of producing the additional 10% of RES-E compared with the 20% RO. Producers of grey electricity will see their surplus reduced by 37%, an increase with almost € 92 million compared with the 20% RO. RES-E producer surplus rises with a factor of more than 4 in comparison with the 20% obligation, reaching € 2515 million in 2020. This is due to the high price caused by the high-cost marginal technology, biomass digestion, which substantially increases the intramarginal rents of the less expensive options such as wind and biomass cofiring. Consumers lose 19% of their consumer surplus, relative to the baseline, or € 4.1 billion.

The total value of the green certificate market is € 4.3 billion, which consists of a producer surplus on the certificate market of € 2.3 billion (including the surplus realised by selling certificates from renewable capacity installed in the baseline scenario) and the costs of producing the certificates (the additional costs given the revenue earned on the electricity produced) of € 2 billion.

The increase in the RO from 20% to 30% has a profound effect on the distributional consequences of introducing an RO. Given the barriers which limit the more cost-effective options, the high cost of the marginal technology drives up the certificates price, which generates a large producer surplus for the less expensive, intramarginal technologies.

4.2.3 Premium subsidy

Instead of RO, a feed-in tariff or premium subsidy such as the SDE could be used to realise the 20% or 30% renewables target. Here, a premium subsidy comparable to the SDE is simulated with the same baseline scenario as the RO simulations. The SDE is funded from the government budget and therefore the subsidy is not reflected in the electricity price. Consequently, power consumption will only be affected by the inclusion of RES-E in electricity production in so far as it affects the merit order. This will have an impact (although limited, given the integrated Northwest European power market) on electricity prices.

Table 4.4 gives the results for the premium subsidy. The electricity price falls slightly, reflecting the higher share of renewables with very low marginal costs in the energy mix for power generation. The retail price does not include a component for the funding of renewables and therefore equals the wholesale price. Power consumption therefore shows a small increase because of the lower electricity price. This is in contrast with the RO simulations, where electricity consumption has declined because of the higher retail price. In the 30% renewables simulations, electricity consumption is 17 TWh higher under the premium subsidy, compared with the RO. Consequently, RES-E production will be higher, given the percentage target, 1.2 TWh more in the 20% RES-E share simulations for the premium subsidy compared with the RO and 5 TWh more in the 30% RES-E share simulations. In the 30% RES-E share scenario, the increase in green production necessitates the import of biomass for combustion in stand alone biomass-fired power plants, the most expensive form of renewables.

Table 4.4 Premium subsidy scenario results 2020

	Baseline scenario	20% RES-E share	30% RES-E share
Base load wholesale price Netherlands (€/MWh)	55.9	54.1	53.2
Retail price (€/MWh)	idem wholesale price		
Electricity consumption (TWh)	155	156	157
Increase in renewables production[a] (TWh)	–	27.7	43.4
Decrease in grey production[a] (TWh)	–	24.8	38.1

[a]Compared to baseline

Source: COMPETES

It has been assumed that the level of subsidy provided exactly reflects the additional costs of each renewable technology. In reality, these costs are not known with certainty by the regulators. Therefore, costs might be higher than in the optimal case presented here.

Table 4.5 premium subsidy scenarios surplus and subsidy in 2020

	20%			30%		
	Absolute level (million €)	Compared to baseline (million €)	% Change relative to baseline	Absolute level (million €)	Compared to baseline (million €)	% Change relative to baseline
Producer surplus grey electricity		– 444	-29		– 524	– 35
Subsidy to RES-E producers	1257	–	–	2587		
Consumer surplus		286	1%		422	2%

Source: COMPETES

The losses in grey producer surplus under the premium subsidy are comparable to those in the RO simulations, see Table 4.5. Producer surplus loss is somewhat lower, due to the higher demand for grey power. The subsidy to new production of RES-E is slightly higher than the costs of producing renewables in the RO simulations, due to the higher production of RES-E. As consumers do not pay directly for the RES-E production, they do not suffer a loss in consumer surplus. Instead, consumer surplus shows a small increase because of the lower electricity prices. It should however be realised that the costs of the subsidy will indirectly affect electricity consumers in their role as tax payers. The premium subsidy for RES-E is funded from the government budget, which is financed by taxation. Either taxes will have to be raised to pay for the subsidy or other government spending will have to be limited.

4.3 Comparing support schemes

The effects on retail electricity prices and the distributional consequences of RO schemes and of premium subsidies vary considerably. **Error! Reference source not found.** summarize the main results.

Table 4.6 Price and distributional effects of RO schemes and subsidies 2020, 20% renewable target

	Standard RO scheme	Premium subsidies
Certificate price (€/MWh)	56	0
Retail power price (€/MWh)	65	54
Producer surplus certificate market (mln €)	502	0
Change in consumer surplus (mln €)	– 1379	286
Subsidy (mln €)	–	1257

Table 4.7 Price and distributional effects of RO schemes and subsidies 2020, 30% renewable target

	RO scheme	Premium subsidies
Certificate price (€/MWh)	104	0
Retail power price (€/MWh)	84	53
Producer surplus certificate market (mln €)	2335	0
Change in consumer surplus (mln €)	– 4127	422
Subsidy (mln €)	–	2587

In the RO case, consumers suffer a loss in surplus, which consists of both a transfer to RES-E producers and a loss because of reduced electricity consumption. With a 20% renewable target, the transfer to producers of RES-E is limited, the loss in consumer surplus is mainly due to the reduced electricity consumption. With a 30% renewable target, the effect is more pronounced, with a 19% reduction in consumer surplus. In order to meet the higher renewable target, more expensive technologies are required. The resulting higher certificate price substantially increases the transfer to RES-E producers, as is illustrated by the producer surplus on the certificate market in the RO case.

Under a premium subsidy, there is no direct transfer to RES-E producers. Consumer surplus shows a small increase because of the lower retail prices. RES-E has low marginal costs, therefore retail prices show a slight decrease. It should however be realised that the costs of the subsidy will indirectly affect electricity consumers in their role as tax payers. The premium subsidy for RES-E is funded from the government budget, which is financed by taxation. Either taxes will have to be raised to pay for the subsidy or other government spending will have to be limited.

An alternative is to fund a subsidy through a surcharge on the electricity price, as is the case with the German feed-in tariff. In that case, electricity use will decline and consumer surplus will decrease because of the higher electricity price.

5 Conclusions

The major part of renewable energy is expected to come from electricity produced from renewable sources such as hydro, wind, biomass and solar energy. Over the years and in different countries, various policy instruments have been applied to stimulate RES-E production. The main instruments used in the earlier years have been tenders and subsidies, either in the form of feed-in tariffs or as premiums which provide a surcharge on the electricity price to compensate for the additional costs of renewables compared with conventional power production. More recent, renewable obligation schemes (or renewable portfolio standards, as they are called in the US) have been implemented.

The major difference between subsidies and RO schemes is that the former is a price instrument while the latter is a quantity instrument which creates a new market for renewable energy certificates. So far, experience with RO schemes is too limited for definitive conclusions about the effectiveness and efficiency of RO as compared with subsidies. This is the more important because RO schemes are expected to be effective in developing new capacity especially in the longer run, given long term targets for RES-E production. In contrast, subsidies create a direct incentive to develop new capacity when the policy instrument is introduced. Moreover, other factors than instrument choice have had a significant effect on the effectiveness and efficiency of the support schemes, such as non-economic barriers and local conditions.

Another important difference between RO and subsidies concerns the risks which RE-E producers face under the different support schemes. Certificate prices in an RO should in principle be higher than subsidies, because producers of RES-E face price risks on the certificate market, risks which do not occur in the case of subsidies. Whether in practice subsidies will be efficient and therefore lower depends on the ability of the government to accurately predict the costs of renewables and set the tariffs or premiums accordingly. Moreover, costs of renewables might be higher with an RO because of regulatory risks. These will to a large extent depend on the credibility of the government in maintaining a stable policy over the years. With an RO, flexibility in target setting and design of the scheme comes at the price of higher regulatory risks for producers of RES-E and therefore higher costs.

The cost-effectiveness of certificate markets will only be achieved if markets are efficient. One of the prerequisites for efficient markets is that there is no market power and no anti-competitive behaviour. If the current developments in Dutch RES-E production continue, market power on a future renewable certificate market in the Netherlands will probably not be an issue, even if the RO should only rest on the retail market instead of on the whole electricity market. The current concentration rate is moderate and there is a downward trend. Moreover, the technologies which are expected to play an important role in the years to come such as wind off shore and biomass combustion, do not necessarily have to be owned by the established RES-E producers. New co-firing capacity will be realised to a large extent through new coal fired plants. This might lower concentration ratios if this additional capacity is owned by entrants instead of incumbent power producers.

Market power on a certificate market might be a problem if extensive use will be made of long-term exclusive contracts for the sale of certificates. It is difficult to predict the extent to which these long-terms contracts would be employed on a future certificate market in the Netherlands. If this would be the case, anti-competitive behaviour such as collusion or vertical foreclosure might in theory be a problem. Horizontal foreclosure is not likely to occur on the market, given the increasing potential for decentralised generation and therefore reduced economies of scale in electricity production and the possibility of selling electricity on the wholesale market to other electricity purchasers than retail companies.

Extending the obligation to all purchasers on the wholesale market instead of only the retail market would reduce the likelihood for anti-competitive behaviour. Moreover, extending the scheme to include parties from other countries would further reduce the likelihood of anticompetitive behaviour and of foreclosure in an RO scheme.

The effect on electricity prices and consumption differs considerably between RO and subsidies. Whereas RO schemes raise the retail price by up to € 30 per MWh to a level of € 104 per MWh in the RO case for the 30% renewable target, the effect of the premium subsidy is to lower power prices to some extent. Electricity consumption ranges from 140 TWh at its lowest in the RO case with a 30% renewables to 157 TWh with a subsidy and a 30% renewable target. The largest loss in consumer surplus occurs with an RO of 30%. This is due to the high costs of the marginal technology needed to meet the 30% renewables target (stand alone biomass combustion). With the 20% renewable target, the marginal technology is cofiring, which is only slightly more expensive than wind on shore and off shore. For the same reasons, producer surplus on the certificate market is limited with the 20% renewable target and increases significantly in the 30% case.

Under a premium subsidy, there is no direct transfer to RES-E producers. Consumer surplus shows a small increase because of the lower retail prices. RES-E has low marginal costs, therefore retail prices show a slight decrease. However, this effect is limited because of the integrated Northwest European electricity market. It should however be realised that the costs of the subsidy will indirectly affect electricity consumers in their role as tax payers. The premium subsidy for RES-E is funded from the government budget, which is financed by taxation. Either taxes will have to be raised to pay for the subsidy or other government spending will have to be limited. An alternative is to fund a subsidy through a surcharge on the electricity price. In that case, electricity use will decline and consumer surplus will decrease because of the higher electricity price.

Producers of grey electricity will see a small decrease in producer surplus in all cases. However, the effect is limited because the electricity markets of Northwest Europe are integrated to a large extent.

The distributional consequences of an RO will be different if the scheme would be extended to include parties from other countries. The effect on electricity prices will be larger if electricity markets of those countries involved are integrated. Moreover, different potentials for RES-E production from different technologies will affect the cost distribution between countries. An analysis of these effects falls outside the scope of this study.

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