The International CHP/DHC Collaborative

Advancing Near-Term Low Carbon Technologies

CHP/DHC Country Scorecard: The Netherlands

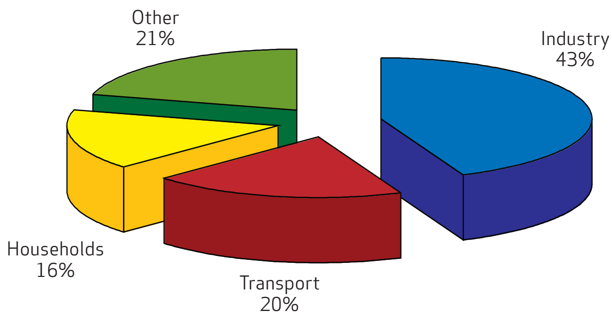
The Netherlands is a leading country in the use of combined heat and power (CHP) in energy supply. About 20% of Dutch heat demand is supplied by cogeneration. In the paper industry the share of CHP heat is 60%; in the chemical industry – in absolute terms the most important CHP sector – the share is 30%. District heating and cooling (DHC) have a smaller role in the heating and cooling markets. In 2006, 29% of the Netherlands' total electricity production came from CHP and district heating plants.[1] Rapid CHP growth in the 1990s came to an end after the liberalisation of the electricity and gas markets. Today, the only area of growth is in the agricultural sector, where CHP is widely used at greenhouses. However, further growth of industrial CHP might happen in the future with improved market conditions, a more flexible approach towards CHP operation in a liberalised market and more stringent CO_2 policies. Prospects for small-scale biomass-based DH also look promising, although competition is strong between technology options.

Energy Overview

In 2006, total primary energy consumption in the Netherlands equaled 912 terawatt hours (TWh). Natural gas (45%), oil (38%) and coal (10%) are the most important energy sources for the country.[2] The remaining 7% is covered by renewable and nuclear energy. Electricity production is largely based on natural gas and coal (including co-fired biomass), whereas wind energy is rapidly growing but smaller than nuclear energy, which contributes 3,5% of total electricity production.[1] In 2006, the final energy consumption by end-users was 711 TWh, of which almost 40% is heat demand. Figure 1 shows the shares in final energy of the different end-use sectors. Industry is the main energy consumer although about half of the energy is used for feedstock.

Figure 1: Dutch Final Energy Use by Sector in TWh (2006)

Source: Centraal Bureau voor de Statistiek (CBS, Statistics Netherlands).



1. Source; Eurostat CHP Statistics. This figure does not include the non-CHP electricity from CHP plants, which is the electricity produced in (partial) condensing mode. When not correcting for the non-CHP electricity, the share of CHP/DH in total electricity production is 56%.
2. Centraal Bureau voor de Statistiek (CBS, Statistics Netherlands) Statline database, http://statline.cbs.nl/statweb/?LA=en.

Climate Change Context

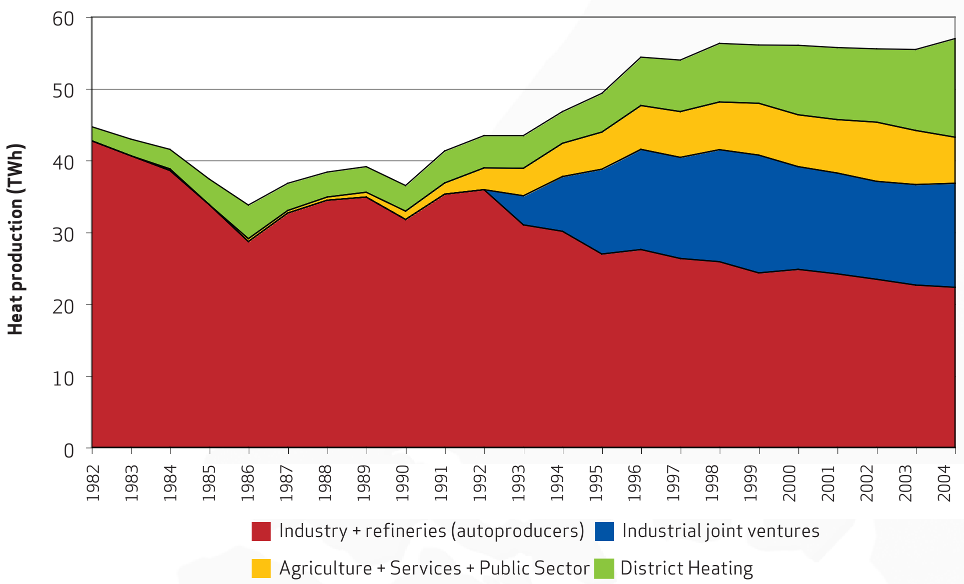
Under their Kyoto Protocol commitment, the Netherlands has committed to reducing greenhouse gas (GHG) emissions 6% by 2012 compared to 1990. In 2007, the Dutch government published an ambitious working program to realize the Kyoto commitment and to set further milestones towards 2020. The program aims at a GHG reduction of 30% in 2020 compared to 1990, an energy efficiency improvement of 2% per year and 20% supply from renewable energy in 2020. The government aims at 50 PJ of primary energy savings from newly built CHP by 2011.[3]

CHP/DH Today: Applications and Markets

Today, CHP/DH is an important energy generating resource in the Netherlands. Together CHP and DH supply about 20% of total Dutch heat demand.[4] In terms of heat production, industrial CHP is most important (see Figure 2). As a result, the Netherlands is often referred to as an industrial CHP-based country. However, Figure 2 shows that the role of district heating CHP (supplying heat to over 250 000 consumers)[5] and small-scale CHP in agriculture, services and the public sector is significant as well.

Figure 2: CHP/DH Heat Production (1982-2004)

Source: derived from statistical data from Centraal Bureau voor de Statistiek (CBS) – Netherlands Statistics.



In the electricity market, the role of CHP and DH is even more pronounced. CHP and district heating plants together accounted for 29% of total electricity production in 2006. Apart from coal-fired district heating, Dutch CHP and district heating are dominantly fired by natural gas.

3. Dutch Government, New Energy for the Climate: Working Program "Clean and Efficient" (2007).
4. Cooling based on cogenerated heat is negligible in the Netherlands.
5. Source: VNE, Energiemarktgids 2008. For comparison: natural gas is supplied to 6.8 million consumers.

Although the Netherlands has a long history in CHP/DH, rapid growth started in the 1990s. Several factors explain this. Government incentives had been streamlined and market conditions were stable. Importantly, the government recognized that the optimal design of a CHP plant should be based on the heat demand. As a result, in the Electricity Act of 1989, feed-in tariffs were adjusted accordingly. The new Act also paved the way for the development of joint ventures between energy distribution companies and industries (see Text Box).[6]

The rapid growth of CHP capacity in the early 1990s led to overcapacity in the power market. As this destabilised the market, it was decided in 1994 to reduce the use of CHP by banning the construction of new CHP capacity above 2 megawatts (MW). In 1997, favourable policies were resumed.[7]

The Dutch CHP Joint Venture

In 1981, the City of Rotterdam's electricity company attempted to build two cogeneration plants in cooperation with local industries. Neither of these projects was carried out because agreements could not be reached on steam contracts. The industrial companies did not want to enter into long-term steam contracts, and the utilities did not want to take the risk of industry cancelling their steam purchases. Moreover, utilities could not benefit from the same investment subsidies as the industry.

In 1983, a solution was found by the chemical company AKZO Nobel and the regional utility EGD (now Essent). This project (Delesto 1) was the first CHP joint venture project in the Netherlands, and would serve as example for many other projects to follow. The joint venture approach solved the problem of steam contracts, as both the industry and utility had a share in the joint venture. Joint ventures also became the basis for external financing by banks and private investors. The advantage for the industrial partner was the lower internal rate of return required compared to industry-only projects, as cheaper capital was now available. The Electricity Act of 1989 allowed distribution companies to buy their electricity from the cheapest producer or to produce the electricity themselves, e.g. through cogeneration. As the maximum allowed capacity was set at 25 MWe, a joint venture turned out to be the solution. While this type of project could not go forward today given current market policies, this showed how cogeneration projects could contribute to the public electricity market.

The Electricity Act of 1998 put an end to the special treatment for cogeneration in the country. Under the Act, feed-in tariffs must be negotiated in a competitive market. Special tariffs for transmission and transport disappeared, which made back-up electricity for self-generators (also called "autoproducers") expensive. After a few years, it became clear that Dutch cogeneration was having difficulty surviving in the liberalized market. Rising natural gas prices worsened the situation. During off-peak hours, the price of electricity was set by low-cost coal and imported electricity. CHP plants were also shut down at high-cost periods, resulting in a decline of cogeneration production. In order to maintain the energy savings achieved in the 1990s, in 2001 the Dutch government developed a feed-in subsidy scheme to reinvigorate CHP and district heating.

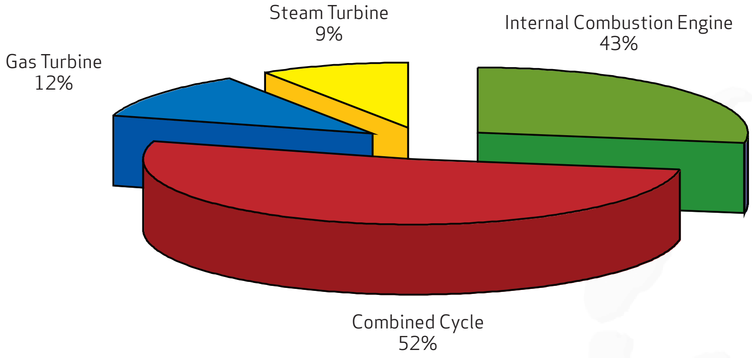
In 2006, the total installed CHP/DH electrical equivalent capacity was almost 8.6 gigawatts (GWe). As Figure 3 shows, gas-fired combined cycle engines are the dominant technology.

The majority of the steam turbine capacity includes coal-fired district heating plants, whereas internal combustion engines are mainly found in greenhouses, services and the public sector. Currently, agriculture is the only sector where CHP capacity is still rapidly growing (see Text Box).

6. Taken from: Hekkert et al. (2007), "Explaining the Rapid Diffusion of Dutch Cogeneration by Innovation System Functioning," *Energy Policy* 35, 4677-4687.
7. ECN (2002)"Effect van Energie- en Milieubeleid op Broeikasgasemissies in de Periode 1990-2000".

FIGURE 3:
SHARE OF CHP/DH TECHNOLOGIES (2006)

SOURCE: CENTRAAL BUREAU VOOR DE STATISTIEK (CBS, STATISTICS NETHERLANDS).



CHP in the Dutch Agricultural Sector

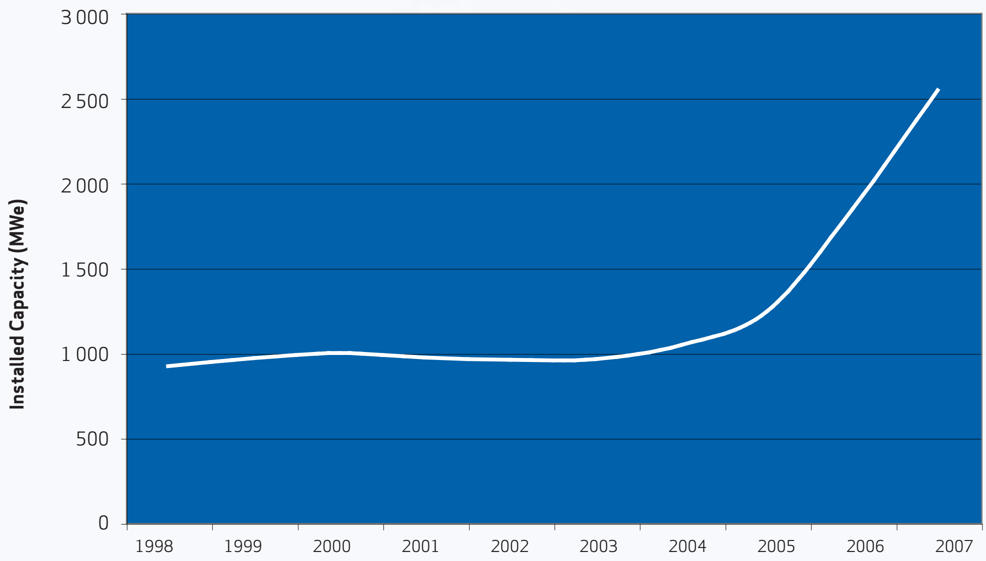
After liberalisation of the electricity and gas markets, CHP in agriculture suffered from unfavorable market conditions. However, a new wave of agricultural CHP plants is taking advantage of its flexibility to respond to changing electricity prices and profits from joint gas purchases and electricity trading services.

Greenhouses require low-temperature heat and CO_2 for crop fertilization. Demand for heat and high electricity prices often do not coincide. However, many greenhouses apply heat buffers which allow them to produce electricity during peak hours and provide the heat when required. In addition, greenhouses increasingly use electricity for lighting, which improves the economics of CHP, as on-site production of electricity is usually cheaper than purchasing electricity.

At the end of 2007, total installed agricultural CHP capacity was more than 2 500 MWe, whereas in 2004 it was only 1 000 MWe. It is expected that capacity will continue to grow in the future, although in some regions with overcapacity, it might become difficult to obtain grid connection to sell the electricity.

FIGURE 4:
DEVELOPMENT OF CHP CAPACITY IN DUTCH AGRICULTURE

SOURCES: FOR 1998-2006 DATA, CENTRAAL BUREAU VOOR DE STATISTIEK (CBS, STATISTICS NETHERLANDS); FOR 2007 DATA, COGEN PROJECTS NEWS LETTER (JULY 2008).



Existing district heating plants in the Netherlands are typically large, although more recently smaller units have been installed. Industrial CHP plants vary widely in size and include installations of a few hundred kilowatts up to the largest plant, which is the 450 MWe Elsta plant serving DOW Chemical in the southwest. In terms of number of installations, district heating and industrial CHP are outnumbered by agriculture, services and the public sector where the majority of the internal combustion engines have been installed (see Figure 5).

FIGURE 5:
INSTALLED CHP/DHC CAPACITIES AND NUMBER OF INSTALLATIONS (2006)

SOURCE: CENTRAAL BUREAU VOOR DE STATISTIEK (CBS, STATISTICS NETHERLANDS).

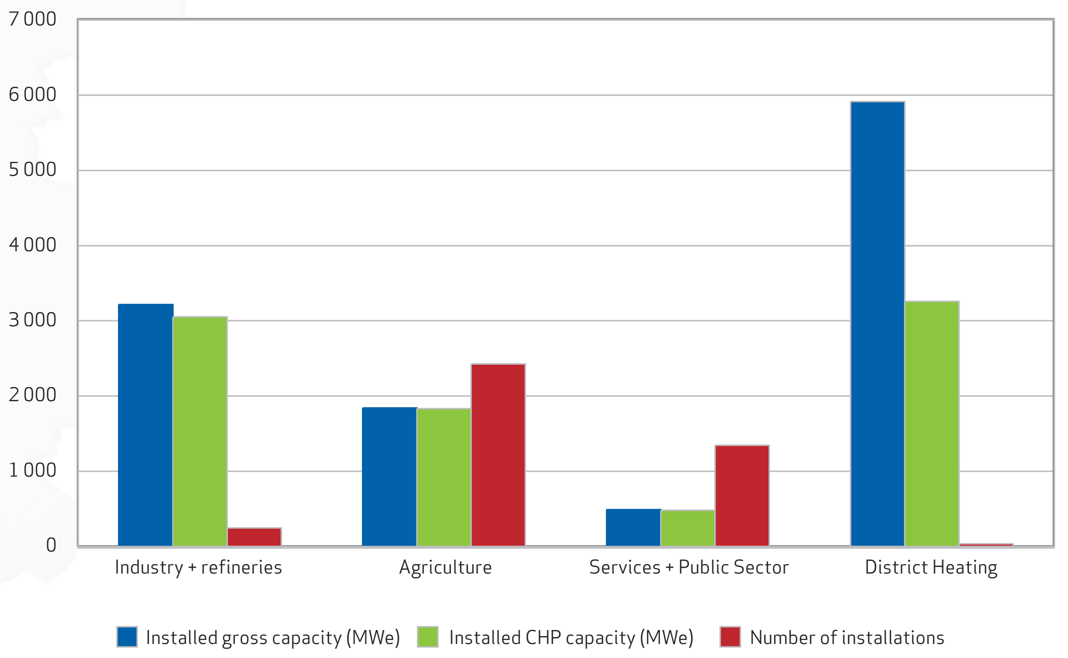
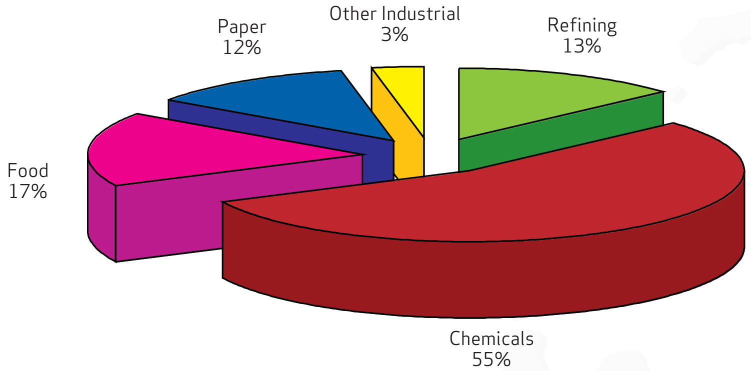


Figure 6 (see next page) shows that industrial CHP is dominated by the chemical industry, with 55% of the installed capacity. Almost 30% of the heat demand in the chemical industry is covered by CHP. In relative terms, CHP is more widely utilised in the paper industry, where 60% of the heat demand is covered by CHP. For the food industry the share is 30%; for refineries it is 20%.

FIGURE 6: INDUSTRIAL CHP CAPACITY BY SECTOR (2006)

SOURCE: CENTRAAL BUREAU VOOR DE STATISTIEK (CBS, STATISTICS NETHERLANDS).



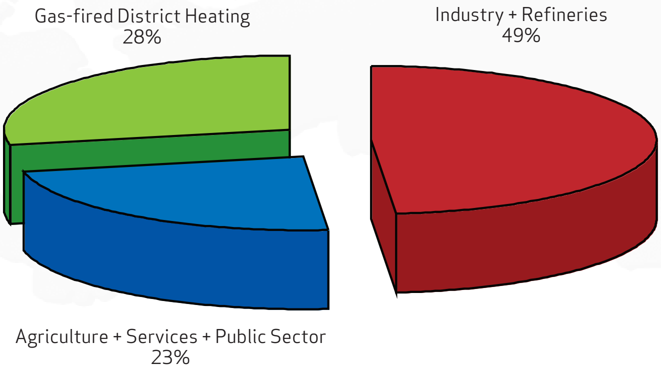
Small-scale biomass CHP is not well-developed in the Netherlands. At the end of 2006, over 50 installations were operational; the majority of these projects involve fermentation plants at farms.[9]

Environmental Benefits of CHP/DH

CHP/DH has been a major contributor to Dutch energy savings achieved in the 1990s under the energy companies' Environmental Action Plan and the Long-Term Agreements negotiated with several industry, service and agricultural sectors. After the liberalisation of the electricity and gas markets, CHP/DH energy savings slightly decreased. Most of today's 22 TWh savings can be attributed to the CHP policies of the 1990s. Almost half of these savings come from industrial CHP (see Figure 7).

FIGURE 7: CHP/DH ENERGY SAVINGS (2006)[10]

GOVERNMENT CHP/DH PROMOTION POLICIES



9. SenterNovem, Statusdocument Bio-energie (2006).
10. Derived from CBS data. The savings are based on 50% reference efficiency for separate power production and 85% reference efficiency for separate heat production. Coal-fired district heating is taken out of the calculation as – with the applied reference values – the energy savings are negative.

Government CHP/DH Promotion Policies

Feed-in subsidy

Exploitation support for CHP/DH was introduced in 2001 with a feed-in subsidy for grid-delivered CHP electricity. From 2003, the subsidy was based on the plant's CO_2 performance, providing a premium for every CO_2-free kilowatt hour (kWh) of electricity produced. The CO_2 impacts of a CHP plant are determined by calculating the energy savings compared to separate production of heat and electricity. The subsidy is determined yearly and varies for different CHP/DH technologies. For 2008, the subsidy was set at zero for fossil-fired CHP/DH, as the Ministry of Economic Affairs concluded that improved market conditions took away the need for operational support.[11] For biomass-fired cogeneration, the 2008 feed-in premium is 5.3 cents/kWh. This premium is corrected downwards when actual electricity price turns out to be higher and upwards (to a maximum of 7.5 cents/kWh) when the electricity price is lower. The subsidy is guaranteed for a 12-year period.[12] The subsidy is linked to the electricity production and does not have incentives for optimal use of the heat.

CO_2 emissions trading scheme (ETS)

Directive 2003/87/EC, commonly known as the ETS Directive, introduces a mandatory cap-and-trade system for greenhouse gas (GHG) emissions for the energy sector and the energy-intensive industry. The system is operational since January 2005. The emissions trading scheme provides a general incentive for measures that reduce CO_2 emissions such as CHP. In the first phase (2005-07) of the ETS, Dutch CHP/DHC operators received surplus CO_2 allowances to reward the energy savings which they had already achieved. In the second phase, most existing CHP plants will need to reduce their emissions as well, and also new CHP plants will not receive surplus allowances.

Energy tax exemption

In the Netherlands the energy tax was introduced in 1996-97. Installations that produce electricity do not have to pay energy tax on their fuel consumption if the power efficiency is higher than 30% and the power capacity is higher than 60 kilowatts (kW). This tax exemption also applies to CHP installations (heat-only boilers are liable to pay the tax). Electricity produced in a CHP plant for its own consumption is also exempt from the tax.

Energy investment deduction scheme

The 1997 energy investment deduction scheme is a general investment incentive for renewable energy and energy saving technologies. It allows investors to subtract 44% of the total investment costs from the company's profit. With current tax rates, this fiscal arrangement is equivalent to an investment subsidy of about 11%.

Micro-CHP investment subsidy

In September 2008, a subsidy for micro-CHP[13] will be introduced as part of the Dutch "Clean and Efficient" policy to support the introduction of micro-CHP in the market. The subsidy is set at €1 000 per unit. For the period 2008-11, €10 million has been reserved.[14]

Stakeholders

Government

- The Ministry of Economic Affairs is the responsible ministry for CHP policies.
- SenterNovem is the Dutch Energy Agency and executing agency for the Energy investment deduction scheme, feed-in subsidy and the investment subsidy for micro-CHP.
- CertiQ is the issuing body for CHP Guarantees of Origin (GoO). The feed-in subsidy scheme is linked to the GoO.

Non-governmental organisations

- Cogen Nederland is the Dutch association for the promotion of CHP.
- VEMW, the Association for Energy, Environment and Water, focuses on the interest of industrial users of gas, electricity and water, and has an interest in CHP and DH.

11. ECN, Onrendabele top Berekeningen voor Nieuw WKK-vermogen 2008 (June 2008a) & ECN, Onrendabele top Berekeningen voor Bestaande WKK 2008 (June 2008b).
12. For more information, see http://www.senternovem.nl/sde/publicaties/leaflet_sde_biomassa.asp.
13. The subsidy is meant for existing residential buildings. Typically, micro-CHPs with about 1 kW power capacity are targeted with the subsidy.
14. For more information, see http://www.senternovem.nl/duurzamewarmte/nieuws/nieuwe_subsidieregeling_duurzame_warmte_bekendgemaakt.asp

CHP/DH Potential

The European Union's CHP Directive obliges EU Member States to establish an analysis of the national potential for application of high-efficiency CHP, including micro-CHP. The Dutch potential study has been carried out by the Energy Research Centre of the Netherlands (ECN).[15] All estimates are based on a high economic growth.

Industry

In the baseline scenario, industrial heat demand increases towards 83 TWh for steam/hot water and 100 TWh for direct heat. The technical potential for CHP in 2020 is estimated at 61 TWh for steam/hot water and 28 TWh for direct heat. However, the CHP steam/hot water production in the baseline (the economic potential) is only 36 TWh (slightly lower than today), whereas the direct heat production is negligible. The uptake of industrial CHP is highly dependent on natural gas prices, coal and electricity prices, further demand side efficiency improvements, better use of residual heat from processes and developments in the CO_2 Emission Trading Scheme (e.g. auctioning of allowances instead of grandfathering).

Agriculture

In the baseline scenario, heat demand in greenhouses decreases from 33 TWh to 29 TWh. The technical potential for CHP in 2020 is about 21 TWh, whereas the heat production (the economic potential) is about 8 TWh. Combined demand for heat (applying heat buffers), CO_2 (for crop fertilization) and electricity (for assimilation lighting) makes CHP attractive. However, actual profitability differs by crop and by company size. The economic potential is mainly concentrated in large-scale companies with energy intensive crops. The further uptake of CHP in agriculture strongly depends on the development of alternative heat sources. Seasonal storage of excess summer heat in aquifers for use during the winter period is currently seen as one of the most promising options to reduce energy demand from fossil sources. In addition, geothermal heat and residual heat from nearby industries also offer means to further reduce CO_2 emissions.[16]

Services and public sector

The technical potential for CHP in the services and public sector is estimated at 8-17 TWh in 2010. This potential is likely to decrease towards 2020 due to improved building concepts and application of seasonal heat/cold storage technologies. Cooling demand is expected to grow. Estimates for CHP potentials to cover this demand are not given.

Micro-CHP

The economic potential of micro-CHP is mainly found in existing dwellings with a large heat demand. The Dutch policy program "Clean and Efficient" aims at a decrease of the heat demand of existing buildings. It is expected that the economic potential of micro-CHP in the residential sector will decrease over time. The uptake of micro-CHP will therefore be dependent on the success of "Clean and Efficient." In addition, micro-CHP competes with solar thermal collectors and condensing boilers with integrated heat pumps. The ECN potential study found that at the most 1 million micro-CHP units will be on the market in 2020. For comparison, another recent study on micro-CHP estimates the 2020 potential on 0.9 – 1.4 million units.[17]

District heating & cooling

The ECN study concludes that new district heating networks become increasingly expensive as new houses have a low heat demand due to improved insulation. Potentials for district cooling were not addressed in the potential study.

15. ECN, High-Efficiency Cogeneration in the Netherlands: Analysis of the Potential for High-Efficiency Cogeneration and Overview of Barriers and Recent Developments (November 2007).
16. See also Ecofys, *Duurzame Warmte en Koude 2008-2020; Potentiëlen Barrières en Beleid (Renewable Heat and Cooling 2008-2020: Potentials, Barriers and Policies)*, (July 2007).
17. Cogen Projects et al., *Energie- en CO2-besparingspotentieel van micro-wkk in Nederland*, (May 2008).

Key Barriers to CHP/DH

Market price fluctuations

Dutch CHP/DH is generally natural gas-fired. Gas-fired facilities have relatively low capital costs and relatively high fuel costs. As both gas and electricity prices are determined by the market, the spark spread between gas and electricity prices fluctuates more widely (especially between peak and off-peak hours). During off-peak hours, the price of electricity is set by coal-fired production capacity. This affects both the competitiveness of existing CHP/DH units with a must-run character (forced by the heat demand) and new units that are more flexible but face increased capital costs per unit of production (less full load hours) and more uncertainty with respect to future revenues. To address this market uncertainty, the government could consider maintaining the feed-in subsidy for CHP plants.

Policy uncertainty

In the period 2001-08, the feed-in subsidy scheme changed several times. This created uncertainty among investors. To ensure further growth of CHP, government policies should be aimed at providing stable support.

Difficulties in recognising the benefits of CHP in emissions trading schemes

The current approach to inclusion of CHP in emission trading schemes does not incorporate CHP in a double benchmarking or other scheme.[18]

Micro-CHP in an infant stage

Micro-CHP is currently new to the market and is not cost-competitive. Cost reductions can only be realised if the initial market introduction is sufficiently subsidised by the government; the government will need to decide whether it can offer this support.

Uncertainty about the merits of district heating

There has been an ongoing political debate on district heating in the Netherlands. Due to a lack of transparency in real costs for district heating and the calculation of the heat prices for consumers, it is presumed that consumers pay too much for district heat. This barrier could be addressed by the implementation of a heat law (this is currently being discussed in the Dutch Parliament) and by the creation of an independent body for regulation of the heat tariffs.

Achieving the Potential

The environment for CHP/DH in the Netherlands is changing. Increased awareness of the climate change problem has caused a movement towards more renewable and energy efficient technologies. Further uptake of CHP, especially in industry, is possible. To realise this, the government needs to ensure a level playing field for all low-carbon technologies, including CHP/DH.

18. IEA (2008), *Combined Heat & Power and Emissions Trading: Options for Policy Makers.*

Main Policy Recommendations

- A CO_2 allocation based on a generic and strict benchmark would improve the effectiveness of the ETS and lead to low-carbon options such as CHP. Instead of grandfathering emission rights, the system could provide a preset amount of CO_2 emission rights for each kilowatt hour electricity produced (the benchmark). In this system, gas-fired CHP plants could sell surplus emission rights to coal-fired power plants that need to buy additional rights to cover their emissions. As the CO_2 allocation is a European issue, the Dutch government cannot act by itself. However, as a member of the EU, the Netherlands can use its influence to promote an ETS that more effectively leads to low-carbon solutions.
- The feed-in subsidy for CHP plants should be maintained as a safety net in case market conditions worsen for a longer period (e.g., allowing good years to compensate for bad years).
- For biomass CHP, to maximize energy savings, the feed-in subsidy, which today is linked to power production only, should also reward useful use of heat. This could be accomplished by providing an additional premium on top of the regular subsidy for those plants that provide energy savings based on useful heat output.
- Government policies should be stable to ensure a stable climate for investors.
- For district heating, the government should explore implementation of a heat law that ensures consumer protection and promotes the use of waste heat from industry and power plants.

CHP/DHC Scorecard

To aid in comparing amongst countries, the IEA has developed a scorecard of national CHP/DHC policy efforts that takes into account three criteria:

- The effectiveness of past policies in developing the CHP/DHC market over the last 5 years;
- Statements and commitments of intent in respect of future CHP/DHC policy, for example through the creation of national growth targets; and
- The existence today of meaningful policy incentives that are already causing significant market growth or that are likely to do so in the near future.

Each country is given a scorecard rating as follows:

No material policy effort or intent to promote CHP/DHC. The market is not expected to grow for the foreseeable future.	★☆☆☆☆
Some minor recognition of the role of CHP/DHC, but policies are not fully effective or are otherwise insufficient to influence market development.	★★☆☆☆
There is a clear recognition of the role of CHP/DHC, accompanied by the introduction of some measures to accelerate the market, but CHP/DHC are not high priorities compared to other energy solutions. In addition, the country lacks an integrated CHP/DHC strategy. As a result, market growth is likely to be modest.	★★★☆☆
CHP/DHC is at or close to the top of the list of energy policy priorities and a series of effective policies are being implemented as part of a coherent strategy. Important growth is expected in CHP/DHC markets.	★★★★☆
A world leader in prioritising CHP/DHC, with a clear and proven strategy for bringing about significant market development and the implementation of at least one global best-practice policy measure.	★★★★★

Netherlands Rating: ★★★☆☆

The International CHP/DHC Collaborative

The **International CHP/DHC Collaborative** was launched in March 2007 to help evaluate global lessons learned and guide the G8 leaders and other policy makers as they attempt to assess the potential of CHP as an energy technology solution.

The Collaborative includes the following activities:
• collecting global data on current CHP installations
• assessing growth potentials for key markets
• developing country profiles with data and relevant policies
• documenting best practice policies for CHP and DHC
• convening an international CHP/DHC network, to share experiences and ideas

Participants in the Collaborative include the Partners, mentioned in the acknowledgments, as well as the Collaborators, a group of over 40 government, industry and non-governmental organizations that provide expertise and support. The Collaborative Network, the larger group that is informed about meetings, publications and outreach, has almost 300 participants.

If you are interested in participating in the Collaborative or want more information, please visit www.iea.org/G8/CHP/chp.asp.

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