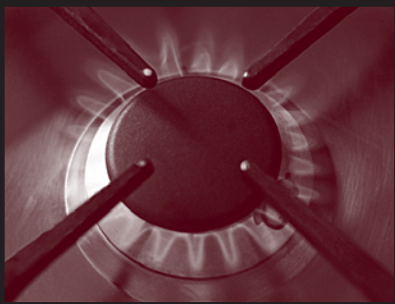
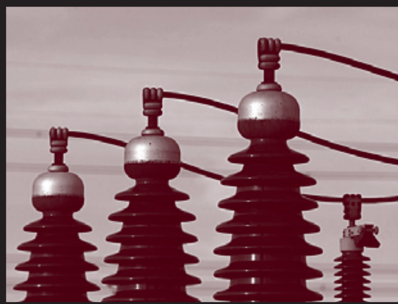
MILIEUMONITORING STADSREGIO ROTTERDAM



Energy in the greater Rotterdam region 2007

MSR - theme report
June 2007

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Energy: usage figures, policy goals and opportunities in Rijnmond

MSR – Theme Report
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Contents

Summary

Energy use in Rijnmond is substantial, amounting to approximately one seventh of the total energy use in the Netherlands. Around 70% of this is down to industry and power stations; the rest goes to housing (10%), business services and small and medium-sized enterprises (10%), and traffic and greenhouse horticulture (10%).

In compiling the report, use has principally been made of data for the year 2002. For more recent years, there are no reliable, cohesive, sufficiently-detailed figures available. There have been no major changes in energy use since 2002, so a good picture of the current situation can be obtained using this data. More recent data has of course been used whenever possible.

In 2002, the energy generated by sun, wind and biomass provided less than one percent of the total primary energy use. If all the energy from waste is counted as sustainable energy, then 2% of the energy came from sustainable sources. In Rijnmond in 2002 approximately 432 petaJoules of energy was deployed.
In the region, reuse of energy occurs. Partly within processes in a company, partly between companies, partly between sectors (industry and power stations; house-building, business services and small and medium-sized enterprises; traffic, greenhouse horticulture). The figure for energy reuse within and between companies is not known. Around 59 petaJoules of energy is transferred between sectors. Half of this is electricity, half is heat. The total energy use in Rijnmond in 2002 including recycling was approximately 491 petaJoules.
On the other hand, in 2002 around 185 petaJoules of heat was lost into the water and another 181 petaJoules into the air. Of this total of 366 petaJoules, 60 percent was from industry and power companies. It appears as if there is a lot to be gained by increasing process-efficiency and recycling the residual heat that is created.

In the region there are a large number of initiatives in the energy sector waiting to go, including the building of new power stations. It is anticipated that this will cause a sharp increase in the energy use in the region and – unless there is a change of policy CO_2 emissions will double.

At a national level, there is an ambition for sustainable energy provision, comprising policy targets of 2% energy savings per year, sustainable energy growth to reach 20% by 2020 and a 30% reduction in greenhouse gas emissions compared to the year 1990, again by 2020. Europe has set comparable targets. The province is in the process of developing a heat policy. The energy policy will certainly have consequences for the region as a major energy user although as yet no plan has been drawn up for the regional level.

On the other hand, in their *Rotterdam Energy and Climate Programme (RECP)*, the City of Rotterdam, together with the Rotterdam Port Authority, DCMR Rijnmond Environmental Agency and the trade association Deltalinqs, have formulated the ambition for Rotterdam to become the ‘capital of CO_2-free energy’. This has led to an aim to halve CO_2 emissions in port and city by 2025 compared to the year 1990. In order to achieve this, various measures are needed, including increased energy-efficiency, use of residual heat, use of biomass and CO_2 storage. Since Rijnmond’s industry and power stations are virtually all located in the Rotterdam area, Rotterdam’s CO_2 ambitions relate directly to around 80 to 90% of the regional energy use.

The goals at the various administrative levels have a lot in common, but are not effectively interlinked. Not all CO_2-free energy is sustainable (e.g. the use of coal with CO_2 storage or nuclear power). Moreover, Rotterdam’s ambitions do not automatically apply to the other municipalities in Rijnmond. Although it is of course important that things do not get stuck at the plan-making stage, it might benefit their implementation if the various goals were integrated into one regional plan.

Rijnmond has a considerable task in terms of realising the various ambitions and targets for energy use and energy provision. In realising those ambitions, however, account must be taken of external effects. After all, various measures for achieving the energy targets have a whole range of other effects. So it is important that integrated testing of the energy measures should take place. Air quality is in any case a relevant factor in this. Conversely, as regards other policy choices it is also important to make an integrated assessment and to include the energy targets in this.

Another way of achieving the energy ambitions is to go for the large-scale realising of industrial life-cycles. Financial instruments, too, such as an investment fund, may bring the measures and targets closer.

For housing, business services and small and medium-sized enterprises, the most important target is to realise heating which does not involve the conversion of primary sources or electricity into heat. Residual and ground heat in combination with insulation are highly suitable for this. Crucial factors in residual and ground heat systems comprise collective heat systems and more emphasis on renovation of the existing build. There is as yet no solution available for the increasing electricity use in the housing sector, business services and small and medium-sized enterprises.

Energy use in the traffic and transport sector can be influenced to some extent at a regional level by means of pricing measures, good infrastructure for bicycles and public transport and leading by example. Furthermore, considerable savings can be made on street lighting.

In greenhouse horticulture, there are various competing options for curbing the dependence on gas. Generally speaking, the energy price is an important factor for this sector, which means that it is possible to achieve renovation relatively quickly by means of cost advantage. The development of the provincial heat policy can help greenhouse horticulture companies which are converting to it to make energetically good choices; in this context residual heat and ground heat are preferable to combined heat and power. Supervision in particular is essential in order to realise collective systems.

Based on the insight into the sectors and their energy use, a draft for an administrative agenda has been drawn up which can support and accelerate the desired changes. This took place on the basis of a workshop with various stakeholders. A distinction was made between opportunities within the industry and electricity generation sectors ('port'), within the built-up areas ('city') and opportunities which concern 'port' and 'city' together. In elaborating the opportunities, the RECP is taken into account.

Important points are:

- *Need for dialogue.*
  The intended switch to sustainable energy provision and to a low-CO_2 city and port requires major changes in organisation, companies and residents. In order to gain support and cooperation for these changes, it is important to start a broad dialogue.
- *Making choices.*
  Achieving energy targets and CO_2 reductions requires clear choices. The important thing is to clearly reward companies and other initiative-takers which invest in energy- and CO_2-reduction measures, but on the other hand to dare to say 'No' to companies and projects which do not fit within the constraints of the projected sustainable development.
- *Clearly embed CO_2 reduction targets in policy.*
  The important thing is to fully embed the CO_2-reduction policy in regional policy. The CO_2-reduction targets must therefore also be incorporated into the main objectives of regional stakeholders and into regional policy programmes.

Finally, indicators have been identified by means of which the realisation of the energy targets can be tracked. A bibliography can be found at the back of the report.

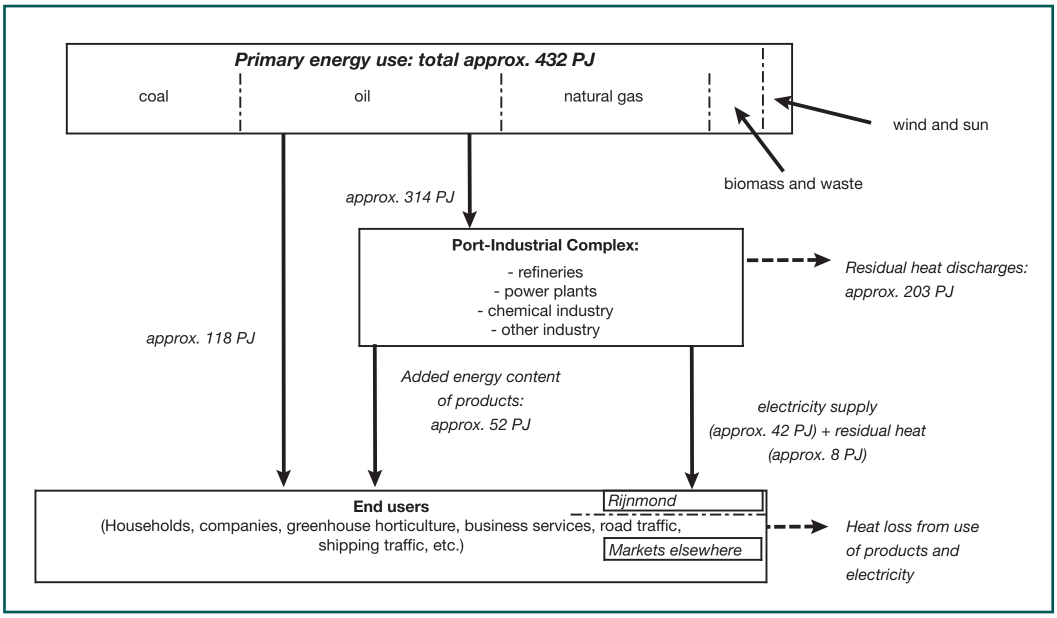
1.1 Energy is central

Energy is the central theme of this report by Environmental Monitoring in the Rotterdam Metropolitan Region. There is growing concern worldwide regarding energy use. The concern about climate change as a consequence of the use of fossil fuels is increasing. At the same time there is concern about security of supply: most fossil fuels come from unstable regions. Energy is also a very topical subject in the Rotterdam region. In the port-industrial complex large-scale initiatives for the building of new, energy-related factories and installations, such as coal- and gas-fired power stations, terminals for bringing ashore liquefied natural gas and the production of biofuels. In addition to the major developments in the port-industrial complex, 'energy' is also an important theme for other parties and target groups in Rijnmond, such as households, greenhouse horticulture and traffic.

From this perspective, energy is a very topical subject among the regional and local authorities in the Rijnmond area. The aim is a sustainable and strong economic development and taking care of the quality of the environment. In 2006, the City of Rotterdam published the Rotterdam Energy Programme. This focuses on expanding the economic position of Rotterdam as an energy port, while safeguarding security of supply and a reduction in CO_2 emissions. Then the International Advisory Board, a consultative body for the Rotterdam municipal executive led by former Dutch prime minister Ruud Lubbers, has advised the executive to aim at a low-CO_2 Rotterdam by halving CO_2 emissions. Rotterdam has joined Bill Clinton's 'Climate Initiative'. In early 2007 all this resulted in the establishing of an ambitious plan for Rotterdam: the 'Rotterdam Energy and Climate Programme' (RECP). More about this later.

The energy use by the companies in the port is related to that of 'end users outside the port'. After all, the products from the industrial complex are intended for the market and ultimately reach the consumers. A portion of these consumers is located in the Rijnmond area. This is illustrated in the following diagram (situation in 2002). As far as the companies are concerned, the diagram indicates which form of energy is used in which production processes. The energy content of the raw materials is not included, except when this forms part of the production processes (for example, as underfiring). Neither does it include the import and export of energy-containing products, such as the transfer of coal to power stations outside Rijnmond.

Figure 1 simple diagram of energy use in Rijnmond 2002



Sources: EnergieNed, 2002a; EnergieNEd, 2002b; Harmsen, 2003; Knijff, A. van der, 2006; Rooijers, 2002, www.energieweb.nl

The report is aimed both as the port-industrial complex and the house-building and utilities sectors, as well as the greenhouse horticulture and traffic sectors.

The purpose of this theme report is to give regional authorities and other stakeholders a concise overview of the energy situation in the Rotterdam region and of expected developments. It indicates where opportunities for steering lie. These steering opportunities provide tools for regional authorities and other stakeholders (companies and the environmental movement) to develop and implement policy. An important area of attention here is how opportunities can be maximised through coordination and cooperation.

In this theme report, attention is specifically devoted to:
- the position of energy use in Rijnmond in a broader context;
- the relationship between energy production and energy consumption;
- the link with air quality;
- suitable indicators for monitoring.

An additional focus relates to life cycles: a lot of opportunities are to be found in linking various companies or parties. It is precisely through cooperation between parties that these can be got off the ground.

1.2 The process

This report has been compiled in close cooperation with a theme working group, comprising DCMR Rijnmond Environmental Agency, the Province of Zuid-Holland, the City of Rotterdam, the Municipality of Lansingerland, Rotterdam Metropolitan Region, ROM-Rijnmond, Shell, ENECO Energie, SenterNovem, the Zuid-Holland Environmental Movement and CE. The input from these participants has made it possible for this report to provide a broad overview of the situation and the policy opportunities.

1.3 Chapter summary

Chapter 2 gives an overview of the development of energy use at various scale levels (global, European, the Netherlands and Rijnmond). An energy chart provides a further insight into the energy use in Rijnmond (energy streams going into Rijnmond and residual heat being released). A specific point of attention concerns the relationship between making energy use more sustainable and other policy goals.
Chapter 3 takes a closer look at industry, including the production of electricity. It gives an overview of planned economic developments and the impact of this on energy use and CO_2 emissions. The trend in emissions figures is put as far as possible into a broader national and international context. Possible measures are mapped together with an indication of any potential for a reduction in CO_2 emissions. Finally, the roles/ options of stakeholders are briefly described.
Chapter 4 discusses the situation with regard to important groups of end users: households, road traffic and greenhouse horticulture. A brief overview of possible savings options per sector is given followed by policy developments and roles/options for stakeholders.
Based on the energy know-how compiled, a brainstorming session with stakeholders was held regarding the policy opportunities for a regional energy transition. The conclusions which emerged from this brainstorming session form the final chapter.

2.1 Developments (Global – Rijnmond)

- **Global**

The growth in the world population, the attempts to raise the standard of living (particularly in developing countries) and the rapid growth in the economies of China and India are leading inevitably to an increase in energy needs.
The international energy agency (IEA) predicts that by 2030 energy use will have risen by more than 50% compared to the year 2005[1]. Emissions of CO_2 will also increase by more than 50% by 2030 and oil use worldwide will rise to 116 million barrels compared to 84 million in 2005. Stocks of fossil fuels (oil, coal and gas) are dwindling and are finite (IEA, 2006). Moreover, these stocks are mainly located in politically unstable regions such as the Middle East. The result is that oil and gas in particular have become political footballs. The developments mentioned above are being increasingly seen as a real threat.

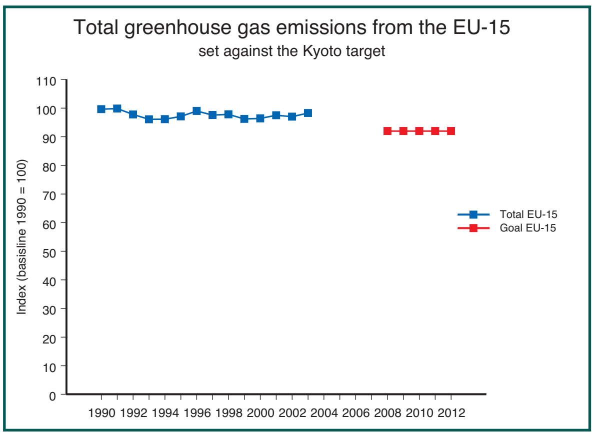
The British economist Sir Nicholas Stern in his report entitled the Stern Review concluded that measures to reduce global warming caused by greenhouse gas emissions do not need to cost more than 1% of global gross domestic product but that if nothing is done, climate change will cost the world economy as much as both the two world wars and the Great Depression in the first half of the twentieth century. Former American Vice President Al Gore published the book and released the documentary An Inconvenient Truth. In them he illustrates the seriousness of the consequences of global climate change caused by the greenhouse effect. From reports published by the IPPC, it appears that a global reduction in greenhouse gas emissions of 50 - 80% is needed to limit the global temperature increase to a maximum of 2 degrees.

In 1997 the Kyoto Protocol was established in order to combat the greenhouse effect. In the Kyoto Protocol, industrialised nations agreed to cut their greenhouse gas emissions during the period 2008 to 2012 by, on average, 5% from 1990 emission levels.
The Protocol has now been ratified by 164 countries, including the member states of the European Union, Japan, New Zealand, India, China and Russia. The Protocol entered into force in February 2005.
The United States have not ratified the treaty. President George W. Bush is concerned it could cause serious harm to the American economy. A number of individual US states, however, are trying to do something about reducing emissions. An example is California. In September 2006, California Governor Arnold Schwarzenegger signed an Act which would make California a world leader in the field of reducing emissions of CO_2 and other harmful gases (The Volkskrant newspaper, 2006).
The Kyoto Protocol will terminate in 2012. Negotiations in Nairobi regarding a Post-Kyoto policy have made little progress and the Post-Kyoto policy is having trouble getting off the ground.

- **The European Union**

Greenhouse gas emissions in the EU member states have more or less stabilised since 1990: CO_2 emissions have risen, but this rise is offset by a decrease in emissions of the other greenhouse gases.

Figure 2 Total greenhouse gas emissions from the EU-15 set against the Kyoto target (source: EEA, 2006)



Source: EEA, 2006

[1] The rapidly growing economies in China and India are responsible for two-thirds of this increase.

The European Union, which at that time consisted of 15 countries (EU-15), ratified the Kyoto treaty in early 2002. In the Kyoto Protocol, the European Union agreed to reduce greenhouse gas emissions across all EU countries by an average of 8% in the period between 2008 and 2012 compared to the year 1990. One of the measures for realising this is the carbon emissions trading system.

The carbon emissions trading system went into operation in Europe in 2005. Energy-intensive industries, the electricity sector and companies with an incineration plant with a capacity of more than 20 MWt have had an emissions cap imposed on them. If companies emit more CO_2 than their quota, they can purchase credits via the emissions trading system from companies with excess allowances (VROM, 2007).

In January 2007, the European Commission tightened the targets for energy and climate change. Core points are shown in Table 1. The targets are binding on the 27 EU countries. The allocation across the member states has not yet been specified.

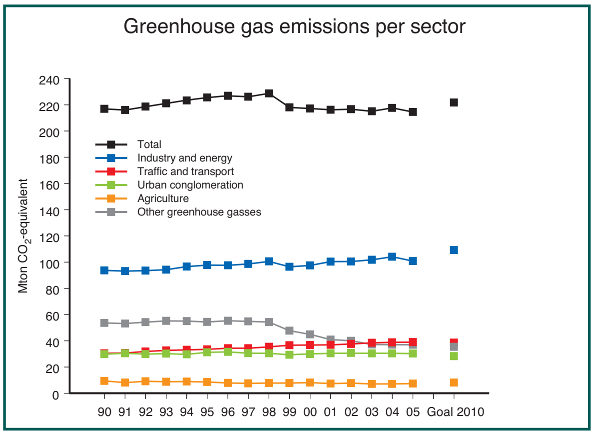
Table 1
EU objectives with regard to energy and climate change. All objectives relate to the target year 2020 compared to the 1990 baseline

Subject	*Target*	*Comment*
Greenhouse gas emissions	Reduce by 30%	As long as international agreement is reached
	Reduce by 20%	If no international agreement is reached
Energy saving	20%	
Renewable energy sources	Minimum share 20%	
Bio fuels	10% share	

- **The Netherlands**

In recent years, greenhouse gas emissions in the Netherlands have more or less stabilised: the increase in CO_2 emissions is offset by a decrease in emissions of other greenhouse gases. The target for the Netherlands under the Kyoto Protocol is a reduction in greenhouse gas emissions by 6% in the period between 2008 and 2012 compared to the year 1990. It is expected that the Netherlands will just meet this target. Around 50% of this reduction will be achieved through the financing of measures abroad (via the Joint Implementation Mechanism and the Clean Development Mechanism).

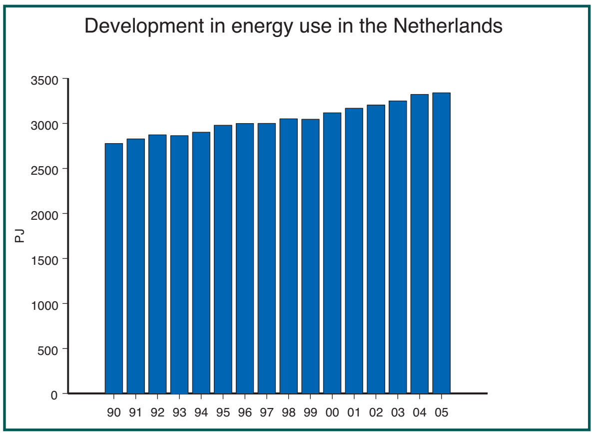
Figure 3 Greenhouse gas emissions per sector 1990-2005 (source: MNP/MNC/sept06/0168; ER2006)



Source: MNP, 2006

Although it is expected that the emissions reduction target will be met, energy use is showing a sharp increase. This is shown in Figure 4.

Figure 4 Development in energy use in the Netherlands 1990-2005 (source: www.energie.nl; CBS)



Source: Energy in figures, 2007a

The slight increase in energy use in the Netherlands is linked with economic growth and population growth, which contribute to a growth in mobility and electricity use.
CO_2 emissions have risen less sharply than energy use because more sustainable energy sources have been deployed in electricity production in the Netherlands, notably biomass and wind power. In addition, more electricity is being imported from abroad.

In its coalition agreement, Prime Minister Balkenende's fourth government has set out its ambition that over the next government period, the Netherlands should make great strides in its transition to become one of the most sustainable and energy-efficient suppliers in Europe 2020. From this perspective, the following objectives have been formulated (Coalition agreement Balkenende IV, 2007):

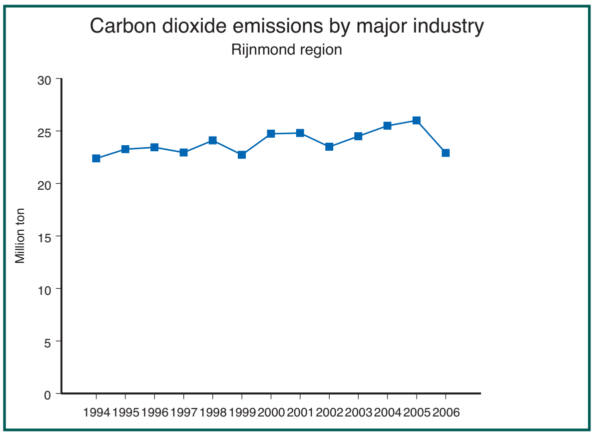
1. Energy savings of 2% per year.
2. An increase in sustainably-generated energy to 20% in 2020.
3. A reduction in emissions of greenhouse gases, preferably at European level, by 30% in 2020 compared to the year 1990.

In 2006 the *Energy Transition Task Force*, a national cooperation initiative between the business community and provincial and local authorities, concluded that a 50% reduction in CO_2 emissions by 2050 is feasible for the Netherlands. Important elements in this are improving efficiency, use of sustainable energy and carbon storage. Large-scale innovations will be crucial in order to realise the necessary transition (TFE, 2006). Finally, it is worth mentioning an initiative developed by a consortium of non-governmental organisations (nature and environment organisations and unions). Using the name Green4Sure, this consortium is working on a plan aimed at 50% energy savings by 2030.

- **Rijnmond**

Economically speaking, Rijnmond is a very important region. Together with its ambition to create a strong economy, the region has the ambition to improve the quality of the living environment. These objectives are confirmed in the framework of the ROM-Rijnmond covenant.
The figure below shows the current CO_2 emissions from major industry in Rijnmond. Emissions of other greenhouse gases from industry in Rijnmond are negligible.

Figure 5 Carbon dioxide emissions from major industry in the Rijnmond region (source: MSR 2007)



Source: MSR, 2007

- **Rotterdam**

The energy policy in Rotterdam is being given a lot of attention. In December 2006 the Rotterdam municipal executive presented the *Rotterdam Energy Programme*. Central goals of the Rotterdam Energy Programme are to strengthen the economic position of the port of Rotterdam, to safeguard the delivery of affordable energy, and to save and reuse energy (utilisation of residual heat). The key theme in this is the concept of a *factor of 4*. This aims to halve pollution while doubling economic activity (City of Rotterdam, 2006).

The Rotterdam Port Authority (HbR) in its '*Long Term Vision for Rotterdam Energy Port*' has elaborated how the position of the port of Rotterdam with regard to energy can be further strengthened in the long term. An important emphasis focuses on the realisation of an infrastructure for CO_2 (HbR, 2006). The Port Authority is further developing this vision at present, including in the field of biomass and options for realising Rotterdam's CO_2 ambitions.

In November 2006 Rotterdam's consultative body, the International Advisory Board, came together under the leadership of former Netherlands Prime Minister Ruud Lubbers. They formulated a tough ambition with regard to CO_2 emissions in Rotterdam: a reduction of 50% by no later than 2025 (in less than half the time than the objective specified by the Energy Transition Task Force).

In March 2007, these initiatives finally resulted in the *Rotterdam Energy and Climate Programme*.

In the coming years, Rotterdam has the ambition to further develop itself into a low-CO_2 city and major energy port. In order to achieve this, there must be a transition to sustainable and efficient energy use and energy provision.

Through its Rotterdam Energy and Climate Programme (RECP), Rotterdam wants to have achieved a 50% reduction in CO_2 emissions by 2025 compared to emissions in the year 1990. This is despite the prognosis that emissions will double. Table 2 shows the targets.

The RECP is a cooperation initiative by the City of Rotterdam, the Rotterdam Port Authority, DCMR Rijnmond Environmental Agency and the trade association Deltalinqs, chaired by the mayor of Rotterdam. Through the RECP, Rotterdam expressly wants to support the far-reaching ambitions of the government and the EU in the field of climate and energy.

Central ambition and spearheads of the Rotterdam Energy and Climate Programme (RECP) (March 2007)

To have reached a 50 percent reduction in CO_2 emissions in the port and in the city by 2025 compared to emissions in 1990.

Spearheads:

a. the transition to an energy-neutral built environment;
b. behavioural change and exemplary function for residents, companies and the municipality itself;
c. a mobility transition: changed vehicles, different choice of vehicles, spatial fit;
d. the concentration and bundling of energy know-how and sustainable energy developments;
e. an energy-efficient port of global dimensions oriented towards the future.

Table 2 RECP CO_2 reduction targets

CO_2 emissions in Rijnmond [Mton/year]	*Emissions of CO_2 in 1990*	*Emissions of CO_2 in 2005*	*Predicted CO_2 emissions in 2025*	*Technical Reduction potential*	*RECP in 2025*
Industry and electricity production	21,7	24,8	40	-/- 30	
Built-up areas and traffic (road and water)	5,8	7,9	10	-/- 6	
Total	27,5	32,7	50	-36	14

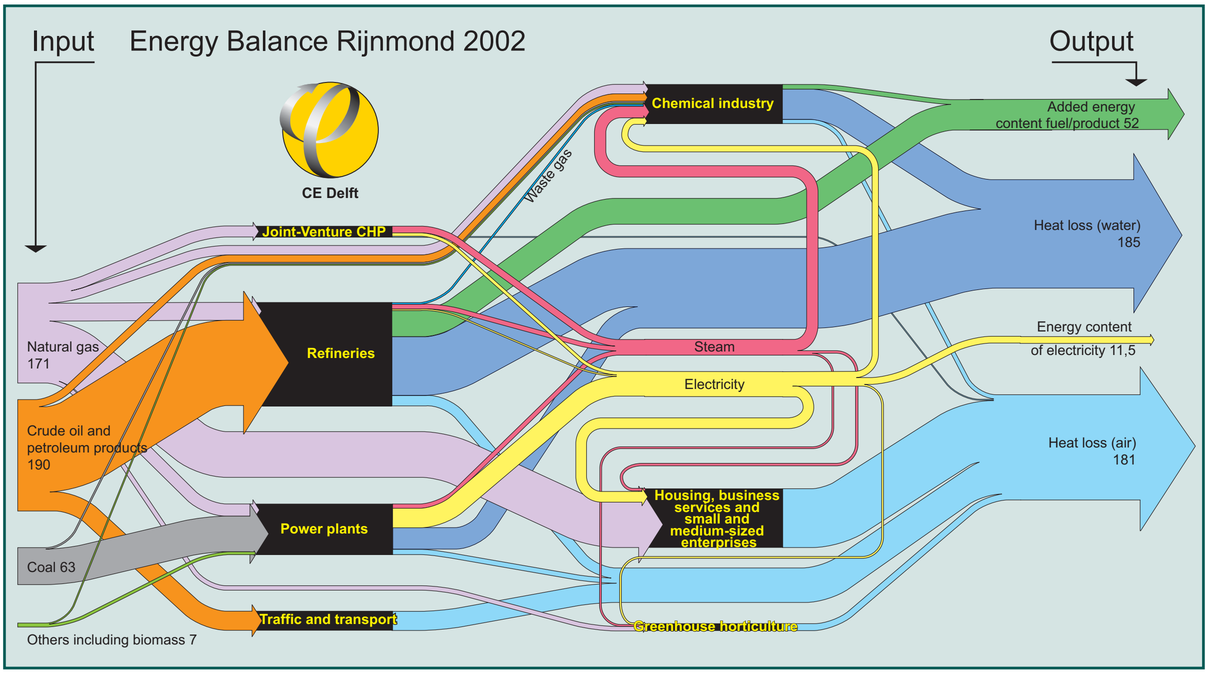
Source: draft RECP, March 2007.

The target of a 36 kton reduction in CO_2 emissions is widely seen as extremely ambitious. Most targets are complex to realise and require a great deal from a number of parties. This means there is a risk of setbacks. In view of the ambition, the measures provide very little opportunity to offset the setback elsewhere. With regard to underground CO_2 storage, the capture and storage of CO_2 are still under development. Furthermore, CO_2 storage results in a substantial additional use of energy.

2.2 Rijnmond energy chart

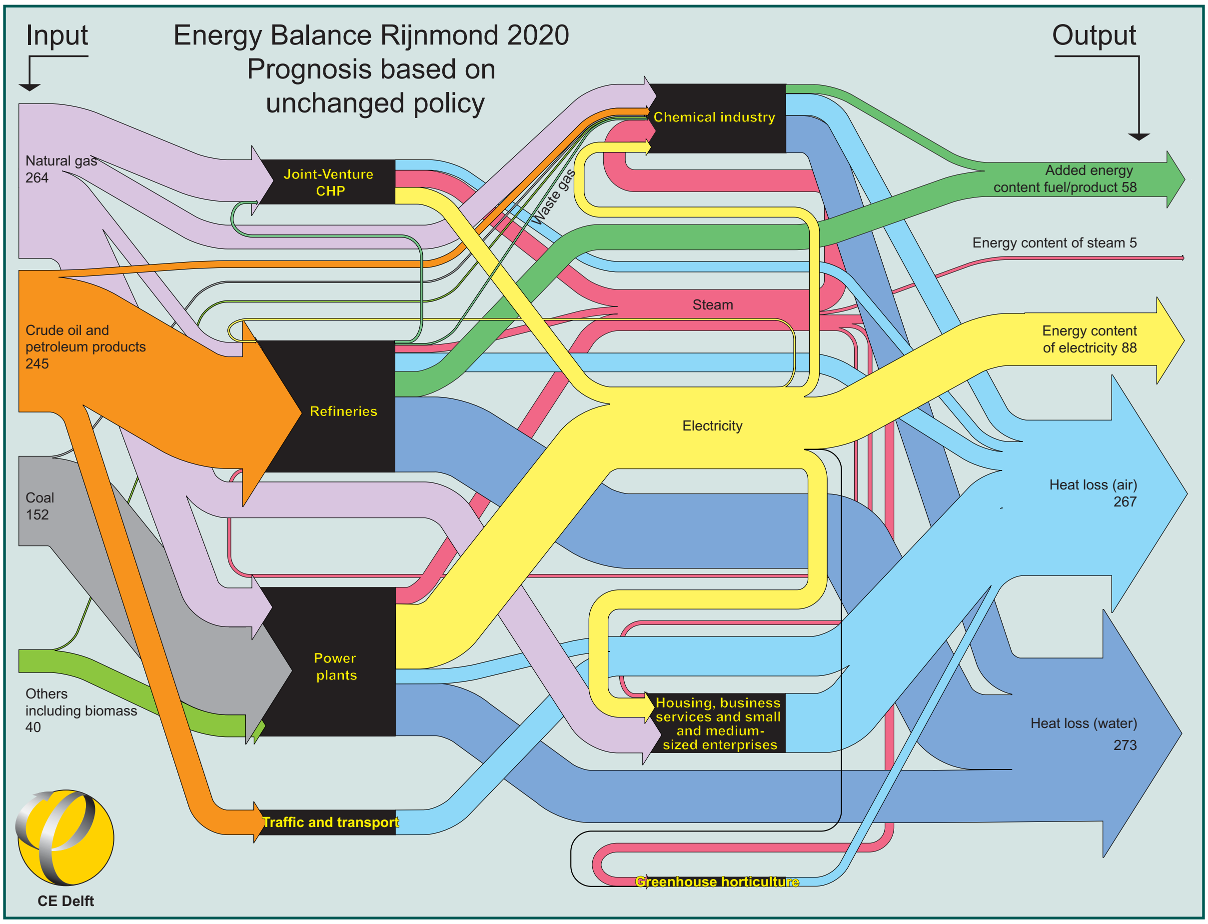
In the Rijnmond region, a large amount of energy is used: in 2002 this comprised approx. 432 petaJoules[2] (PJ) out of a Netherlands total of approx. 3,200 PJ (CBS, 2005). A major part of the energy used in Rijnmond is used by the industries and electricity producers in the port area of Rotterdam. The products generated by these companies are then used by end users on a national and international scale. In addition to the delivery of energy to the 'Port-industrial Complex', energy is also delivered directly to end users, such as households, the utilities sector, traffic and transport, and greenhouse horticulture in Rijnmond.
Within Rijnmond, a total of 60 PJ is delivered from one sector to another. Half of this is electricity use, the other half is heat, for example steam from combined heat and power stations and residual heat from power stations to houses.
This is shown in figure 6 in a Sankey diagram.

Figure 6a Energy streams in Rijnmond in 2002



[2] A joule is a unit of energy which is approximately equal to 0.24 calories. Since the joule is an extremely small unit, calculations are made using the multiples kilo-, mega-, giga-, tera- and petaJoule. A petaJoule is 1 000 000 000 000 000 joules (a 1 with 15 zeroes) (source: CBS, 2007).

Figure 6b Energy streams in Rijnmond in prognosis for 2020 if policy remains unchanged



Explanation of the figures:

The energy streams are given in petaJoules. The size of the arrow corresponds to the size of the energy stream. The arrows on the left-hand side of the figure symbolise the influx of energy carriers into the Rijnmond area. The arrows on the right-hand side show the added energy content of products and electricity which leave the Rijnmond area. The heat losses to air and water are also shown on the right-hand side.

The figure only shows the energy streams which are used for heating and conversion processes, both in industrial processes as well as in households and in traffic. Not included are the energy streams from raw materials or half-products which go into the processes. For example, a refinery turns crude oil into fuels (petrol, diesel, kerosene, etc.). This is a process which requires a lot of energy. The figure shows the energy which is needed to for this process and not the energy-content of the crude oil which is converted to products.

The data which is used for the Joint-Venture CHP, Refineries, Power stations and the Chemical Sectors is taken from the ECN (Harmsen, 2003). The recently published update of this report has also been used (ECN, 2006). For the Traffic & Transport, House-building and Greenhouse Horticulture sectors, data came from a number of sources including the BEK[3] and BAK[4] of EnergieNed, a report by the LEI (2006) and a report by CE (2002). For those areas where data was not immediately available, expert guesses were used.

Table 3 shows a specification of the use of primary and renewable energy sources in Rijnmond.

Table 3 Use of primary energy in Rijnmond: fossil versus renewable energy sources

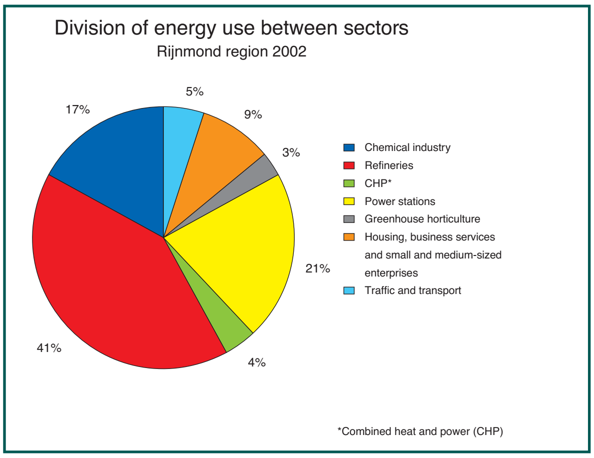
Fossil energy sources				Sustainable energy sources		
Natural gas	Coal	Oil	Waste[5]	Wind	Biomass	Sun[6]
171	63	190	3,8	0,9	3,4	0,0011

Sources: EnergieNed, 2002a; EnergieNed, 2002b; Harmsen, 2003; Knijff, A. van der, 2006; Rooijers, 2002, www.energieweb.nl

[3] Basic research on Electricity use among Small-scale users
[4] Basic research on Natural gas use among Small-scale users
[5] Figures from AVR Rijnmond (Rozenburg), electricity generated is 497 GWh, heat is 2.043 TJ source: waste processing in the Netherlands data 2005. Energy from waste partly counts as sustainable energy. According to international agreements, the portion of waste coming from a biogenic source counts as sustainable energy.
[6] Figures from Diergaarde Blijdorp project only, 325.000 kWh.

Figure 7 shows the energy use of the most important sectors in Rijnmond.

Figure 7 distribution of energy use across the sectors in Rijnmond 2002



Sources: EnergieNed, 2002a; EnergieNed, 2002b; Harmsen, 2003; Knijff, A. van der, 2006; Rooijers, 2002, www.energieweb.nl

Later in this report this figure is repeated with the share of the sector concerned highlighted. This makes it easy to see what contribution would be made by a saving in that sector to the total energy use in Rijnmond.

2.3 Energy use in relation to impact on air and water

Curbing the use of fossil fuels and switching to other sources for energy provision has a number of side effects. Some of these effects are desirable, others undesirable. This is why it is important to look at the measures aimed at reducing energy use, making energy provision more sustainable and reducing CO_2 emissions from an integrated perspective.

2.3.1 Emissions of NO_x, fine particulates and SO_2: impact on air quality

During the combustion of fuels, nitrogen oxides (NO_x), sulphur dioxide (SO_2) and fine particulates may be released. The size of the emissions depends to a large extent on the type of fuel. Broadly speaking, gas is by far the cleanest type of fuel (no emissions of SO_2 or fine particulates).

These emissions are important with a view to the air quality in Rijnmond. In spite of substantial improvements over the last decades, Rijnmond has considerable problems primarily with fine particulates and nitrogen dioxide. In many places, these two substances exceed the guide values. For nitrogen dioxide (NO_2) this is chiefly alongside major arterial roads, for fine particulates (PM_{10}) chiefly in the urban area.

Every measure which causes energy use to decrease thus has a favourable side effect on air quality. But not every measure has an equal impact. The realisation of the heat network, with 500,000 households connected to residual heat, has caused a drop in the NO_2 content of the ambient air of 1 µg/m^3. It has also caused a drop in the fine particulate content in the air. The impact of the heating network on air quality is relatively large because a large number of NO_x sources at ambient level are disappearing.
Shifts in energy use are not by definition positive for air quality. Burning coal – without additional measures – is worse for air quality than burning gas. CO_2 emissions per kWh of electricity generated, incidentally, are also higher than from burning gas. Depending on the type, biofuels can have a positive, neutral or negative impact on air pollution.

Road traffic, shipping and industry are the most important sources of emissions in Rijnmond. Industry, however, makes a comparatively limited contribution to ambient concentrations in Rijnmond because emissions from companies frequently take place via high chimneys. This means the impact of emissions from industry therefore generally occurs further away. Both locally and regionally, road traffic is the largest contributor to air pollution in Rijnmond. Measures which lead to less traffic have a positive side effect on air pollution. Measures which cause shifts in transport can have various effects on air quality. For example, shipping traffic is not by definition less polluting than road traffic because emissions standards for ship's engines are less stringent. Moreover, energy measures per vessel type with regard to shipping can have a variety of effects on air quality. For example, shore-side electricity for ships in the port may have a positive impact on air quality, but not necessarily on energy use. The impact on the latter is partly determined by the efficiency of a ship's on-board generator.

It is anticipated that the expected growth in power plants will lead to an increase in emissions of NO_x. As a result of high chimneys and the application of additional emission-reducing techniques (SCR), the contribution to concentrations at ambient level will be reduced. However, at locations in the industrial zone where concentrations are already approaching the guideline value, such as near the Botlek and Pernis industrial areas, an increase in emissions can lead to new air quality bottlenecks.

In December 2005, the authorities in the Rijnmond region established the Rijnmond Regional Air Quality Action Programme. This programme comprises 34 measures in various sectors aimed at bringing about a substantial improvement in air quality. A side effect of a number of the measures is that they may also contribute to a reduction in energy use. This applies particularly to the measures shown in Table 4.

Table 4 Rijnmond Regional Air Quality Action Programme measures with possible side effects on energy use

Sector	*Nr.*	*Measure*	*Lead*
Traffic	2a	'Clean' municipal vehicle fleets	City of Rotterdam, municipalities
	2b	Low emission zones	City of Rotterdam
	3	'Clean' Public Transport (requirement for granting a permit)	City of Rotterdam, Province of Zuid-Holland
	6	P&R Transferia	City of Rotterdam
	8	Requirements with regard to 'clean' transport in contracting out local government work	City of Rotterdam, regional municipalities
	5	Dynamic speed regulation along whole Rotterdam diamond	Min. of Transport, Public Works and Water Management
Industry	12	Additional measures at 'low NO_x sources' (particularly combined heat and power)	DCMR Rijnmond Environmental Agency
	13	Stimulate clean/ efficient AGVs at container terminals	DCMR Rijnmond Environmental Agency
Shipping	29	Financial instruments in port	HbR
	14	Promote modal shift at container terminals	HbR
	19/21	Lobby to tighten up EU emission standards for rail and shipping traffic	Min. of Transport, Public Works and Water Management
	22	Research into extending subsidies for emission-reducing measures for inland shipping	Min. of Housing, Spatial Planning and the Environment
	24	Certification of inland shipping	Min. of Transport, Public Works and Water Management
	25/30	Shore-side electricity for inland shipping	HbR
Innovation	34	Experimental area for new technologies	City of Rotterdam

It is not known how much impact these measures will have on energy use. Some measures have a larger energy component than others. In view of the fact that it partly concerns measures in the field of performing an exemplary function and that most of the measures do not have energy use as their primary aim, it is expected that the impact will be moderate.

2.3.2 Heat discharges: impact on water quality

Industry's large-scale use of energy is accompanied by large-scale heat discharges to water. It is the cheap option for getting rid of excess heat which forms one of the most favourable factors for a site located next to a large body of water. These heat discharges have reached their limit, though, and during hot summers are no longer standard procedure. During hot weather, companies may be forced to restrict their heat discharges which will mean a loss of production. Reducing the heat losses obviously has a positive impact on the scale of the heat discharges to water. In addition to an improvement in air quality, water quality also benefits from improving energy efficiency.
Combating climate change has various other positive effects on water management. Climate change is not only causing a rise in sea level but is also affecting precipitation, particularly in terms of intensity. Heavy rainfall is leading in turn to a decrease in water quality due to a greater number of sewage overflows. The salt tongue is also moving inland, which in turn has consequences for the drinking water supply.

2.4 Order of preference and cascading; using biomass

It seems that it is not always easy to choose between various energy supply options. Consider, for instance, all the commotion about burning palm oil (BIOX), about the sustainability of burning chicken manure (Fibroned) or the choice between insulating pre-war housing or connecting them to the residual heat network. Considerations with regard to 'energy' do not stand alone: for example, burning biomass also impacts on air quality and biomass production also impacts on food supply and biodiversity.

2.4.1 Order of preference

Making good choices requires an understanding of what is involved: an order of preference for energy cannot be set in stone. Generally, however, the order of preference for taking energy measures shown in Table 5 applies.

Table 5 Order of preference for taking energy measures

1: REDUCE / PREVENT ENERGY USE.
This is nearly always the best choice. Reducing scores well in every area: less CO_2 emissions, positive effects on air quality and improvements in security of supply. When sustainable energy sources are used, saving is still worthwhile because other things can then be done with the energy saved, or other choices again become possible in the long run (smaller or more efficient electricity generation, for example, or further reductions in the creation of residual heat).

2: UTILISING /USING SUSTAINABLE ENERGY SOURCES.
In the second place there is the use of sustainable energy sources, such as wind or sun energy and biomass. Renewable energy sources do have their disadvantages, such as disturbance from wind turbines and life-cycle effects caused by the use of biomass.

3: EFFICIENT USE OF FOSSIL ENERGY (LIFE-CYCLE AND MATERIAL USE EFFICIENCY).
In the third place there is the efficient use of fossil energy sources. This includes not only process efficiency, but also materials efficiency. This means deferring the waste stage of fossil materials as long as possible (cascading).

2.4.2 Cascading

Cascading is an efficient word for the stepped use of materials, working gradually downwards from high-grade to low-grade functions, thus keeping materials in a life-cycle for as long as possible before they are definitively written off. Cascading is not a new concept, it is already happening. But it can be managed and strengthened.

Examples of cascades:

1: from tree to energy.
Things seem to be heading in this direction: cultivate fast-growing wood (e.g. willow) to be burnt for energy.
An alternative is: grow trees which can first of all be used in a wood function (outdoor and indoor building, etc.). Recycle beams and planks as wood, for example for finger jointed lumber or for furniture, use remaining wood from other processes for wood chip and subsequently woodfibre products (e.g. paper), and turn contaminated, preserved wood and other residual streams which can no longer be used as material into such things as biodiesel or synthetic gas (if it is unsuitable for such purposes, burn it in a power plant with appropriate flue gas cleansing).

2: from gas to heat.
This is how things have been for years: burn gas to heat water that is pumped through pipes and radiators in order to achieve a pleasant indoor climate.
An alternative is: (this is a working model; in reality, gas would not be the logical raw material here): Use gas for high-grade applications (e.g. monomer production for plastics), use a portion of these plastics to make insulating materials for insulating buildings and instead of burning gas residual material from cascades (e.g. household waste) combined with electricity and heat generation, to use residual heat directly and use the electricity to drive heat pumps which abstract heat and cold from the ground to use in winter and summer to achieve an even more pleasant indoor climate.

It is not possible to realise the optimal cascade in all cases. The extremes are often clear. Felling old growth forests for energy production does not exactly appear to be a desirable choice. Using solar energy or growing biomass on poor soils which are not suitable for agriculture may well be a very good idea, as is growing algae.
It is advisable that when assessing options for energy supply, the impact on the whole life-cycle must be looked at. Policy should be aimed at stimulating options which are comprehensively favourable. Other options, which have inefficient life-cycles and/or cause harmful effects elsewhere, should be discouraged.

2.4.3 Biomass

Biomass can be used as a fuel for power plants, as a raw material for biofuels (bioethanol, bio-diesel) and as a raw material for chemical processes.
Particularly when using biomass, it is essential to look at the whole life-cycle. The thing is, using biomass can have major other side effects, especially on food supply and on biodiversity (felling tropical rainforest). Examples of the discussion which has arisen about this include the increased price of maize in Mexico (competition between food production and production of bioethanol) and the use of palm oil in Dutch power plants (see box).
In addition, the energy content of biofuels is often less than that of the fossil source it is replacing. This means that when they are burnt, the CO_2 emissions are actually greater than from fossil fuels. This is why biofuels are not simply 'climate neutral'. The impact a biofuel has on the CO_2 levels in the air depends on the method of cultivation, of transport, and the use of biofuels in comparison with what would otherwise be grown and burnt.

Biomass under attack: the case of palm oil

In late 2006 there was a lot of commotion about the use of palm oil as a source of biomass. Both the environmental movement and the business community criticised the subsidies provided for burning palm oil. State Secretary van Geel announced that he deplored the fact that the government had provided considerable subsidies for this.

The palm oil is cultivated on huge plantations in Indonesia and Malaysia. The market is growing rapidly. Creating new plantations is an important cause of felling tropical rain forests. Most of the crop is intended for the production of food, but due to the high yield per m^2 of land used, it is also attractive as biomass.

In the Netherlands, palm oil is used as a biofuel in the Essent power station in Geertruidenberg. In addition, the BIOX company has developed an initiative to build three small 50 MW power stations which will burn biomass. The use of palm oil was made attractive by a government subsidy (the MEP). The amount involved is € 750 million for the three power plants.

The followiing discussion points have emerged:

- clearing land for the creation of new palm oil plantations causes the destruction of tropical rainforest, a valuable ecosystem, or takes up agricultural land thus reducing local food supply;
- once tropical rainforest has been felled, the peat soil is exposed to sunlight resulting in decomposition which leads to large quantities of greenhouse gases being released;
- in the production, processing and transport of palm oil, significant emissions of CO_2 are also produced, directly or indirectly (use of fertiliser, agricultural machinery, ships);
- utilisation in the Netherlands creates emissions of fine particulates and NO_x.

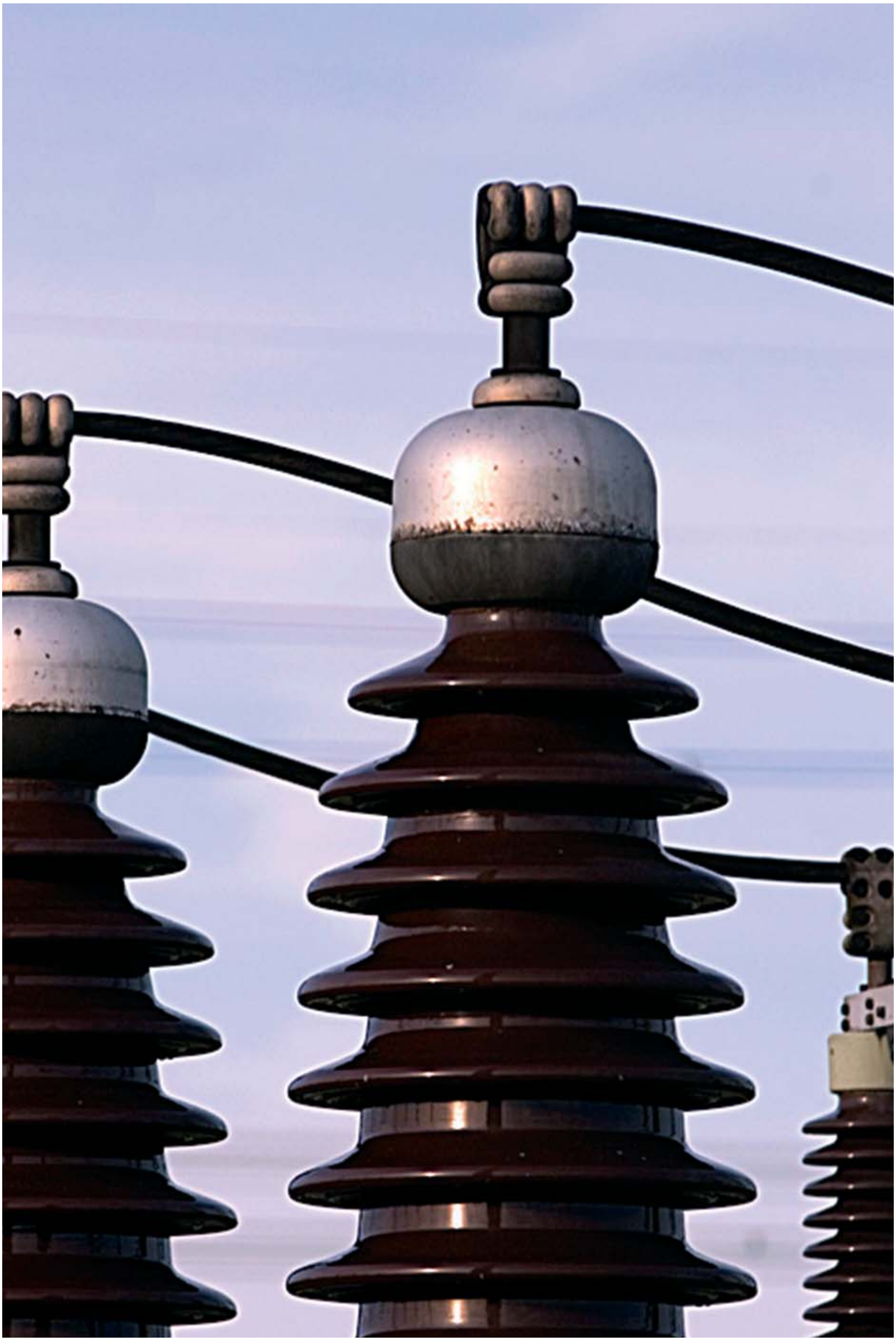
In early 2007, Essent decided to abandon the continued burning of palm oil for the time being. The use of palm oil in the BIOX power plants appears to be going ahead.

Palm oil plantation →	Processing →	Transport →	Electricity generation
Greenhouse gas emissions from:			
- Creating plantations - Production of fertilisers and pesticides - Use of machines	- Use of machines	- Shipping	- Burning

Source: VNO-NCW, 2006

Biofuels tend to be defined in terms of first and second generation fuels. The first generation comprises biofuels from food crops such as sugar beet, maize and rapeseed and is already on the market. The second generation biofuels are made from ligneous crops or non-consumable parts of food crops or on land which is unsuitable for food production. The second generation biofuels are expected in the second decade of this century. The second generation biofuels provide a greater CO_2 reduction (50 to 90%) than the first generation (30 to 50% CO_2 reduction compared to a standardised fossil alternative).

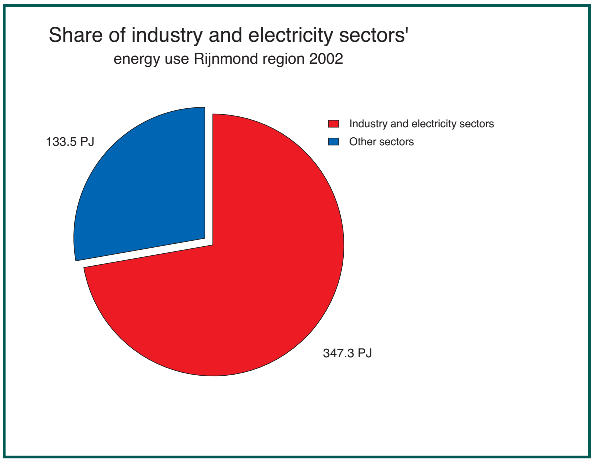
The Cramer Commission has drawn up sustainability criteria for biofuels in order to prevent unintended negative effects as far as possible.



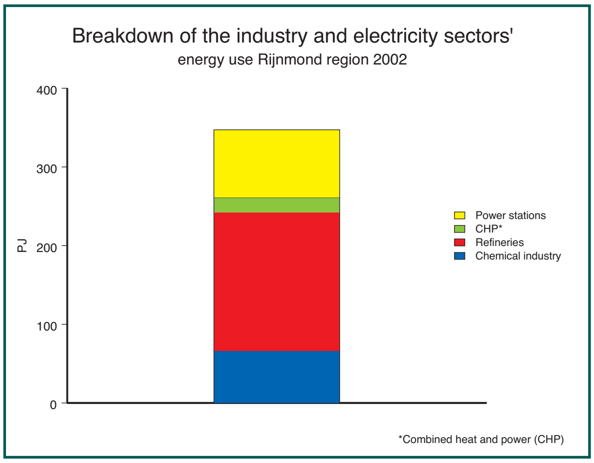
3.1 Industry and electricity sectors' share of energy use

Rotterdam's industrial port complex has a huge share of the total use of energy in the Rijnmond region. The complex accounts for 70% of the total energy use in Rijnmond. Changes within the industrial complex are crucial to making the energy supply more sustainable and reducing CO_2 emissions. Within industry, most energy is used at the refineries, followed by the electricity producers, the chemical industry and 'joint venture' Heat-Power installations[7].

Figure 8a Industry and electricity sectors' share of energy use in Rijnmond 2002



Figuur 8b Breakdown of the industry and electricity sectors' share of energy use in Rijnmond 2002



Sources: EnergieNed, 2002a; EnergieNed, 2002b; Harmsen, 2003; Knijff, A. van der, 2006; Rooijers, 2002, www.energieweb.nl

Processing industry
Over the years, the processing industry has been characterised as a relatively innovative sector. A lot of energy-reducing measures with cost recovery times of 2 to 3 years have been encountered. In the period between 1990 and 2005, energy use in Netherlands industry has shown a slight increase and CO_2 emissions have stabilised across the board[8]. During the same period production, expressed in Gross Value Added, increased by around 40%. Reductions in the period between 1990 and 2000 were occurring at a considerably higher rate than in the period after 2000: approx. 1.9% and 1.0% per year respectively (van Dril, 2005). It is highly likely that these national developments also apply to industry in Rijnmond.

Electricity production
Nationally, CO_2 emissions from electricity production have risen steadily. At many power plants there has been a net increase in energy use per unit product since 1999. This is attributed to the liberalisation of the energy market. However, there has been a clear increase in the use of biomass.

3.2 Industry and electricity production in a national and international context

The port-industrial complex in Rijnmond is anything but an isolated system. Products from all over the world come into the port of Rotterdam which are then transferred to numerous countries in Europe. Industry in Rijnmond produces products for the European and world markets. The electricity which is generated is primarily sold on the national market.

[7] The 'joint venture' combined heat and power plants comprise those companies which produce electricity and heat, where the electricity is supplied to the national grid and the heat to a chemical process. These plants are usually a joint venture between a petrochemical production company and an energy company.
[8] For the trend in emissions from the industry sector, various figures are used. A crucial factor is whether the allocation of the emissions from the 'joint venture combined heat and power plant' are ascribed to industry or the electricity companies. In the most recent estimates by ECN and MNP (MNP, Milieucompendium, 2007) the emissions from these plants are ascribed entirely to the electricity companies, and there has been a decrease in emissions from industry (decrease of between 50 and 44 Mton in the period between 1990 and 2005) and a considerable increase from the electricity production companies over the same period (increase from 42 to 56 Mton).

In recent years in a national and international context, Rijnmond appears predominantly to be a highly attractive location for the production of electricity. A number of companies have taken concrete steps to establish a coal-fired power plant there. Various factors may be distinguished:

- According to the prognoses, the demand for electricity continues to grow; up to 2020 an increase of approx. 20% is expected in the Netherlands. Prognoses range from between 1.3 to 2% growth per year until 2020[9]. The ECN expects that the demand for electricity will grow from approx. 111 TWh in 2003 to between 139 and 157 TWh in 2020 (van Dril, 2005).
- Due to security of supply (gas stocks are running out; coal is still plentiful), coal is once more becoming an attractive energy source. A lot of inland power plants (the Netherlands, Germany) are increasingly running up against the problem that during hot summers there is insufficient cooling-water available to absorb the heat. Rijnmond appears to be an attractive place to locate these companies, however, because its position by the sea means that there is an adequate supply of cooling water.
- Various power plants are coming to the end of their lives and will be closed down over the coming years. Two of the five Netherlands coal-fired power stations, in Nijmegen and Geertruidenberg, are very old. There is a chance that they will be closed down by 2020. This also applies to various gas-fired power stations.
- Rotterdam has a good infrastructure for supplying raw materials, transfer of products and clustering with other industrial activities (combined heat and power).

Both developments – the increase in the demand for electricity and the replacing of obsolete old plant – will result in the expected growth in electricity production in Rijnmond. This may be accompanied by a decrease or reduced growth elsewhere.

3.3 Economic developments

In recent years, there has been a large influx of companies that want to realise new locations for the production or supply of energy in Rotterdam. This represents a total investment of around 5 billion Euros. These initiatives tie in with the port of Rotterdam developing into an 'energy port'.

Table 6 Plans for power plants

Type	*Investor*	*Location*	*MW_e*	*Status as of April 2007*	*Planning*
Gas	Air Liquide	Pernis	300	Under construction	2007
	ENECO/IP	Europoort	800	Licence granted	2009
	Intergen	Rijnmond	400	Licence granted	2009
Coal	Electrabel	Maasvlakte	750	EIS + application submitted	2011-2012
	E.ON	Maasvlakte	1100	EIS + application submitted	2010

Table 7 Plans for bringing ashore liquefied natural gas (LNG)

Initiator	*Location*	*Capacity (m^3 gas)*	*Status as of April 2007*	*Planning*
LionGas (Petroplus)	Europoort	18 billion	Licence granted	2009
GATE (Vopak/Gasunie)	Maasvlakte	12 billion	Licence granted	2010

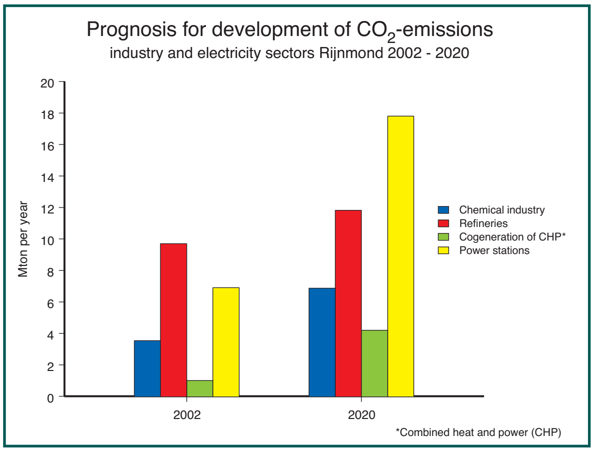
[9] In the SE (strong Europe) and the GE (global economy) scenario respectively (ECN/MNP, reference estimates energy and emissions 2005 - 2020).

Table 8 Plans for factories processing biomass (as of April 2007)

Initiator	*Raw material/product*	*Capacity*
Biopetrol	Biodiesel	400,000 ton/j
Dutch Biodiesel	Biodiesel	250,000 ton/j
Abengoa	Bioethanol	400,000 ton/j
Biox	Electricity from palm oil	50 MW_e
AVR BEC power plant	Electricity and heat from biomass (chiefly wood)	22 MW_e
Bioethanol Rotterdam	Bioethanol	125,000 ton/j
Wheb Biofuels	Biodiesel	400,000 ton/j
European Biofuels	Biodiesel	500,000 ton/j

It is expected that the large number of initiatives in the energy sector will result in an increase in energy use by the companies of around 340 to around 580 PJ. Following naturally from the growth in energy use, a considerable increase in CO_2 emissions is also anticipated. Moreover, the increase in emissions will be concentrated in the power plant sector. He reason for this is that with the arrival of new power stations, a lot more coal in particular will be burnt. Coal has a higher CO_2 emission per unit energy content than gas which is the dominant energy source in the other sectors.
The phrase 'clean coal-fired power stations' is sometimes used. This refers to power stations which do not release CO_2 into the air but capture it instead.

Figure 9 Prognosis for development of CO_2 emissions from industry and the electricity sector



Source: ECN, 2006

From the figure shown above it appears that the growth plans for electricity production from coal if policy remains unchanged (without additional measures) will lead to a considerable increase in CO_2 emissions in the Rijnmond region. It is anticipated that the intended sharp drop in CO_2 emissions in the Rijnmond region will only be attainable if these CO_2 emissions are stored (section 3.4).

3.4 Possible measures

There are various technical and organisational options for curbing CO_2 emissions from industrial companies and power plants. The most important are:

- *Increasing energy efficiency*

In recent years, the rate of energy saving in the major industries has been around 1% per year. Using available technology and technology that is still under development, there are possibilities for making further energy savings[10]. In addition, more extensive reductions can be realised using innovative technologies which are still

[10] Many energy efficient appliances and technologies available at the present time have a great deal of potential but occupy only a small fraction of their possible market share.

under development. These offer opportunities during overhauls or construction of new processes. An example is the HIDC (Heat Integrated Distillation Column), a type of distillation column that uses approx. 20% less energy than a conventional column. In the present situation, however, it appears difficult to achieve the scaling up of these technologies to applications on a practical scale. In other situations, too, it appears difficult to allow potential innovations to break through (De Wilde, Stienstra, 2006). Organisational and financial measures can also make an important contribution to the creation of a climate in which the available new technologies can obtain a market share more quickly, with a resultant positive impact on energy saving.

- *Utilising residual heat*

The concentration of energy producers and consumers in Rijnmond offers major opportunities for clustering: between companies themselves, and between companies and those needing energy in the surrounding area. Residual heat steams can be used in other industrial companies or for heating offices, dwellings or greenhouse horticulture enterprises. Important initiatives taken in this field are based on the ROM-Rijnmond R3 programme. This programme has taken an important step in setting up the Rotterdam Heat Company. Another important initiative is the ‘Botlek loop’: an annular conduit between industrial enterprises, aimed at utilising residual heat streams.

Rotterdam Heat Company

At the end of 2005, the Rotterdam Heat Company was set up by the City of Rotterdam, Rotterdam Port Authority N.V., the Province of Zuid-Holland and the Woonbron housing corporation, with a subsidy from the Ministers of Economic Affairs and Housing, Spatial Planning and the Environment. The Heat Company is aimed at connecting 50,000 households to a supply of industrial residual heat from the AVR Brielselaan and Shell-Pernis. The households to be connected are located mainly in Hoogvliet and Rotterdam-Zuid. A total of 85 MW of residual heat is available for this use.

In the longer term, between 350 and 500 MW of residual heat will become available in the Botlek area. On the basis of this, ROM-Rijnmond’s ‘R3 residual heat project’ is aimed at connecting 500,000 households. By means of this ‘Grand Design’, a net reduction of around 1 Mton in CO_2 emissions can be achieved. An added advantage of the application of residual heat is an improvement in air quality: in residential areas where residual heat is used instead of a gas-fired central heating system, concentrations of nitrogen dioxide decrease by around 1 µg/m^3.

Generally speaking, the application of residual heat requires susbstantial investments. These are especially cost-effective if large amounts of heat are needed and if transport distances are short. From this perspective, large new-build complexes and greenhouse horticulture offer most potential.

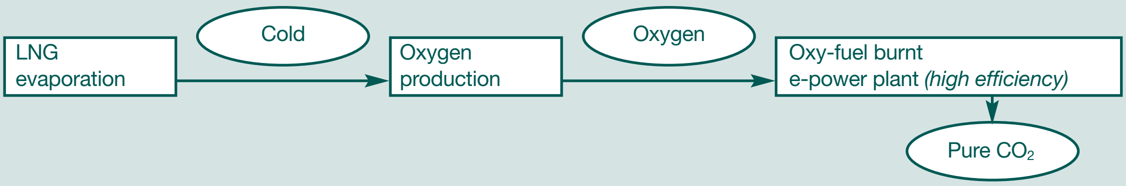
In the framework of the R3 residual heat project, municipalities in Rijnmond are being asked to cooperate on connecting dwellings to a residual heat supply. Concrete plans are in place for Spijkenisse and Delft. Schiedam, Vlaardingen and Maassluis have conducted feasibility studies. Effectiveness and feasibility are determined to a considerable extent by the demand for heat and the distance from the heat source. In addition, major opportunities for use exist particularly in greenhouse horticulture.

Source: ROM-Rijnmond, 2006a and ROM-Rijnmond, 2006b

- *Smart integration between companies*

Integration between industrial processes also offers important opportunities for improving energy efficiency. There are major opportunities here, particularly in newly-locating companies. An example is the possible integration between liquefied natural gas terminals, oxygen production and coal-fired electricity generation.

Example: Life-cycle options for supply of liquefied natural gas and oxyfuel coal plant



Using the cold from liquefied natural gas (LNG) (-160°C) cryogenically pure oxygen can be efficiently produced. This can be used for burning coal in an oxyfuel process. Oxyfuel burning is more efficient than burning with air. As a result of the absence of nitrogen gas during the burning process, virtually no NO_x is produced The pure CO_2 waste gas stream can be used at relatively low cost for CO_2 supply or storage: there is no need for a separate [energy-intensive] CO_2 separation installation.

Source: CML

Getting a smart option such as this onto the drawing board in time is a job in itself. The next big question is how the life-cycle can be transferred from paper to reality. The two LNG terminals have abandoned the energetically least favourable form of heating – natural gas. They are going to evaporate LNG using residual heat. Energetically speaking, there is still a big gap between residual heat use and the above life-cycle. The gap can only get smaller if we invest in doing so. The major challenge facing the region is to find methods, modes, and instruments to ensure on the one hand that 'drawing board brainwaves' such as this keep on being produced and on the other hand that the plans also get put into practice.
Various parties in Rijnmond are already putting a lot of effort into realising these types of opportunities. However, it has not always been in the interest of individual parties to achieve optimal energy performance and there is no duty to cooperate. Better instruments are certainly possible, for example in a balanced division of costs and yields, reducing interdependence, risk covering and winning parties over. Attention also needs to be devoted to reducing legal obstacles.

- *Expansion of Combined Heat and Power (CHP)*

CHP involves the combined generation of electricity and heat. The electricity is supplied to the electricity grid or to other electricity users, the heat is used for industrial processes. CHP is already being used on a large scale in the Rijnmond area. Examples include the Eurogen C.V. power plant, a joint venture between Air Liquide, Lyondell, Huntsman and ENECO in Europoort, and the InterGen installation in Pernis. An Air Liquide installation is under construction, PerGen, which will supply electricity (approx. 300 MW) to ENECO from 2010 and electricity and steam to the Shell Pernis refinery. In addition to the opportunities which are already being utilised there are many more opportunities for the further use of CHP. For example, one option in refineries is to integrate CHP into the furnace that heats the crude oil prior to distillation. Use of this at all refineries would represent a CO_2 reduction of approx. 2 Mton. During complete overhaul or new build of factories, even more substantial additional opportunities for CO_2 reduction through the use of CHP are available. In the current context (free energy market), CHP has to compete with other methods of producing electricity (such as coal-fired power stations). CHP does not always appear to be the cheapest method of generating electricity, so that potential opportunities are not utilised (Daniëls, 2006).

- *CO_2 storage*

CO_2 emissions can also be considerably reduced by capturing CO_2 and storing it in empty natural gas or oil fields. The North Sea can potentially store 100 Gigatons, more than 15 times the Netherlands' overall annual emissions.
Practical experience with CO_2 capture and storage is still limited which means there is uncertainty regarding practicability, risks and costs. In addition, an all-out effort is needed if CO_2 storage is to be installed on a large scale by 2020.
A disadvantage of CO_2 storage is that the capture of CO_2, its transport and its compression require a lot of energy. Compression and pumping for the purposes of storage entail 5% additional energy use (GdF, 2007). Then there are the capture and pumping for the purposes of transport on top of this. An increase of between 5 and 20% in the use of fossil fuels is required in order to realise capture and storage.
One problem is that at the moment CO_2 capture and storage has not yet produced credits under the emissions trading system.
An important advantage of CO_2 storage is that it offers opportunities to extract additional oil and gas from the North Sea fields. If a number of companies can use infrastructure at the same time, costs could go down. In this respect, Rotterdam has major opportunities for efficiency gains.

- *Broadening financial instruments*

Industry consists almost entirely of internationally competing companies in which decisions are determined to a large extent by the potential to make a profit. An important point in realising energy targets, therefore, is to maintain their competitive position.

Financial instruments can create the frameworks in which technological measures become cost-effective. Possibilities might include trade within a system of emission capping (such as the existing EU trade system for CO_2), levies, subsidies, and government investment, e.g. in infrastructure or in a 'revolving fund'.

3.5 Roles/options for regional stakeholders

In Rijnmond various parties are involved in the elaboration and implementation of the energy policy in the industrial complex. The most important parties and tasks are shown in Table 9.

Table 9 Parties and roles in implementation of energy policy in the industrial complex

Stakeholder	*Task/role*	*Frameworks*
Regional municipalities[11]	Municipal energy policy (e.g. using industrial residual heat in house building)	
City of Rotterdam	Municipal energy policy	Rotterdam Energy Programme
DCMR Rijnmond Environmental Agency	Licensing under Environmental Protection Act: - 'capture-ready' is compulsory for new power plants	Assessment framework for licensing for power plants
Province of Zuid-Holland	Energy policy Province of Z-H - Heat policy Province of Zuid-Holland (under development) - Assessment framework for licensing for power plant - Establishing 'Climate innovation' industry cluster	National energy policy
ROM-Rijnmond R3	Facilitator energy transitions	Programme R3 2007 – 2010 'sustainable enterprise in Rotterdam Energy Port'
Rotterdam Port Authority	Developer and manager of port area (developing port infrastructure, attracting companies; granting sites, etc.) Research into CO_2 storage and transport	Energy Vision (under development)
Deltalinqs	Exchange of knowledge, promoting coooperation between companies	
Industry	Energy saving, innovation, integration, utitisation of residual heat	
Energy producers	Realising energy-efficient processes, integration, utilising residual heat, locating new companies	
Scientific research (TUD/ HRO/ EUR etc.)	Innovation, supply frameworks for assessments	
Non-governmental parties (nature and environment organisations, etc.)	Social pressure and support in concrete measures and innovative developments	

Additional options are included in the conclusions and recommendations (chapter 5).

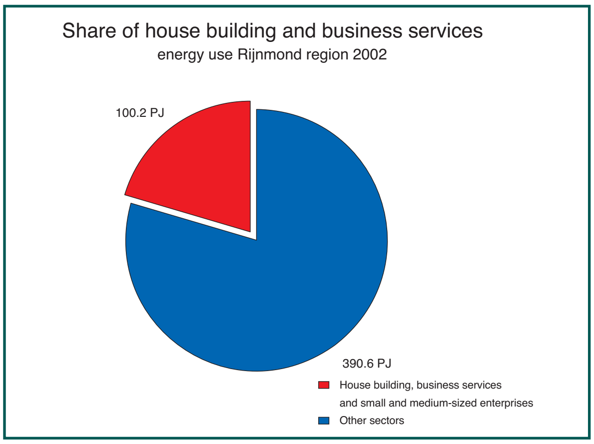
[11] The regional municipalities cooperate within the framework of the Rotterdam Metropolitan Region.

4.1 House-building, business services and small and medium-sized enterprises

House-building, business services and small and medium-sized enterprises in Rijnmond account for around 20% of energy use in the region (see figure 10). Households account for just under half of the energy use in this sector while a little over half is utilised by business services and small and medium-sized enterprises.

As regards energy use and saving options, the situation and possibilities of households, business services and small enterprises tend to correspond. Where necessary, a distinction has been made.

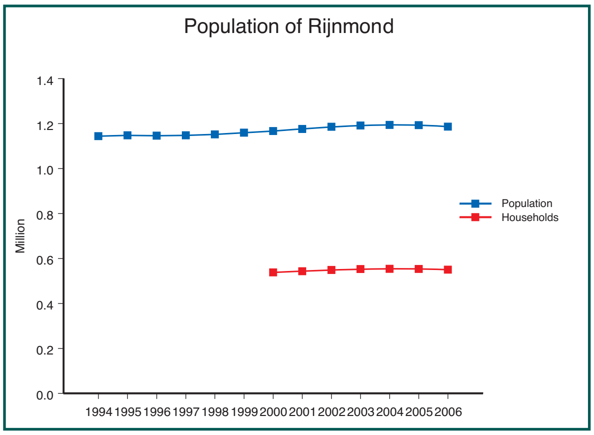
Figure 10 House building, business services and small and medium-sized enterprises share of energy use in Rijnmond in 2002



4.1.1 Households

In recent years, there has been a steady increase in the population and the number of households in Rijnmond, but this now appears to have stabilised (figure 11). In 2006, Rijmond had 0.55 million households with a total of 1.2 million residents.

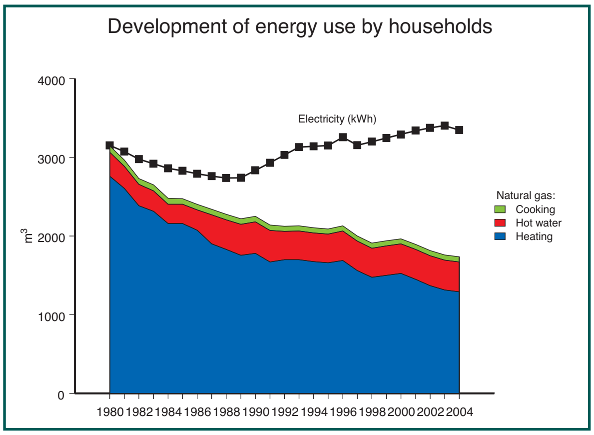
Figure 11 Population of Rijnmond



Source: MSR, 2007

Households use energy for heating (space heating and hot water) and electricity. Since houses are increasingly well-insulated (especially new houses) the demand for heat per household has fallen and the demand for home cooling is on the increase. Electricity demand is rising because an increasing number of electrical appliances are being used (computers, tumble driers, etc.). The increasing demand for home cooling, too, leads to more electricity use. All in all, energy use in households in the Netherlands showed a sharp drop up until 1990 but over the last 10 years has shown a slight rise (figure 12). In the coming years, it is expected that if policy remains unchanged, the upward trend in use will continue.

Figure 12 Development of energy use by households (Netherlands) 1980 – 2004 (Source: Energie in Cijfers)



Source: Energie in Cijfers, 2007b

In older houses, substantial energy savings can often be made. Renovation can drive down energy use by more than 50%.
In the Rijnmond region there is great potential in this regard for renovating old residential neighbourhoods in the urban area.
For new dwellings, insulation already has to meet the strict requirements of the Energy Performance Standard (EPS). This standard has been tightened since its introduction in 1995 from 1.4 then to 0.8 in 2006.
All in all, on a national scale it is calculated that energy savings in the household sector can reduce energy use by between 20 and 25% (Benner, 2006).
The 'Regional Advisory Body on Sustainable Building' gives municipalities in the region advice regarding opportunities for energy-efficient and sustainable building. According to their 2006 annual report, various municipalities have improved their Sustainable Building scores, but on average the region is still lagging behind national developments (RDC Rijnmond, 2007). This is chiefly because a regional policy still does not yet exist.

4.1.2 Business services and small and medium-sized enterprises

A large number of companies and organisations fall under the umbrella term 'business services'. These include offices, schools, sports and recreational facilties, and hospitals and nursing homes. The term small and medium-sized enterprises also includes a large number of companies. These are principally small and medium-sized production companies, wholesale and retail businesses, totalling tens of thousands of companies in Rijnmond.

The economic significance of the business services is rising sharply. In the Rijnmond region too. Nationwide, there is a considerable rise in energy use in this sector. This applies both to the use of gas (for space heating) and to the demand for electricity.
The use of gas rose between 1990 and 2003 from 150 PJ to around 203 PJ. This is due to the fact that the number of m^2 of space is rising more sharply than the savings which are being made through better insulation and more efficient central heating boilers. This provides a clear contrast to households, where gas use is gradually decreasing. Electricity use is rising year on year, from 69 PJ to 108 PJ. (van Dril, 2005). This is caused by the growth in the sector and the increasing use of electronic equipment (computers, air conditioning).
The ECN has made prognoses of development trends in the period up until 2020. It is expected that gas use will stabilise and that electricity use will continue to steadily rise.
The same pattern is likely in the Rijnmond region.

4.1.3 Possible measures

As we have indicated, older buildings generally use considerably more energy than new buildings. This applies both to dwellings and to other buildings. This means that during renovation/ urban renewal substantial savings in energy used can often also be realised.

- *energy performance of new-build housing*

Energy use in new build must be substantially lower to meet the Energy Performance Standard. There are various measures for reducing the energy demand of new houses and buildings even further.
Curbing the demand for heat through insulation, design and orientation are the most important of these measures.

An example of a new housing development with additional energy saving is Wilderszijde in the Municipality of Lansingerland. In this locality, a total of 2,400 dwellings are being built. The feasibility of realising a collective system of cold/heat storage is being looked into. Part of the plan is a project with 60 single-family dwellings with an extra-pleasant indoor climate and an EPC of 0.6 (the standard for the rest of the neighbourhood is 0.8).

Wilderszijde pilot project (60 new build houses with an EPC of 0.6)

60 single-family dwellings in the WIlderszijde master plan will be developed with an EPC of 0.6. These dwellings form a clearly-defined section of the de Tuinen subplan and are therefore well suited to such a pilot project.
A standard energy performance coefficient (EPC) of 0.8 already applies to the realisation of Wilderszijde. This represents a saving of around 20% compared to the previous energy standard of 1.0. In principle, a dwelling with an EPC of 0.6 is 24% more energy-efficient than a dwelling with an EPC of 0.8.

The table below shows the indicative energy costs per single-family dwelling in 2010 with different EPCs.

Energy prices in Euros per single-family dwelling in 2010	EPC 0.8	EPC 0.6
Gas costs	€ 614.22	€ 466.81
Electricity costs	€ 273.92	€ 208.18
Saving		€ 213.00

Realisation of this standard is based on low-temperature heating combined with heat retrieval. In addition, there are various options available to the developer for meeting the energy performance standard (e.g. solar power, additional insulation of roof and walls).

The expected additional costs of the measures, their impact on the EPC and the savings involved are shown in the table below.

Measure	Costs	Impact on EPC
Low temperature heating (ltv)	€ 1,350	-0.03
Hear recapture with balanced ventilation	€ 730	-0.01
Additional insulation ($R_c = 4$)	€ 900	-0.04
Total	€ 2,440	-0.08

The measures imposed are thus not sufficient to achieve a reduction to an EPC of 0.2. A rough calculation to reduce the EPC from 0.8 to 0.6 gives an indication of additional costs of between € 6,400 and € 7,200. This includes a solar boiler system. Profits for the developer may, depending on the energy system selected, go up to € 2100 per dwelliing.

In addition to the 60 dwellings with an EPC of 0.6, the options for cold-heat storage for the whole Wilderszijde master plan (approx. 2400 dwellings) are being considered. Using an energy supply such as cold-heat storage, a lower EPC can be achieved with less additional investment to the shell of the house. A soil survey has already been conducted which showed that the soil is suitable for cold/heat storage. A definitive decision to use cold/heat storage in the 2,400 dwellings has not yet been taken.
High-density build and a tight schedule are critical factors in realising cold/heat storage given that all kinds of surveys (including a soil survey and drawing up an EIA) are necessary. At the same time, the higher costs must not be allowed to lead to negative consequences for the land development.

Source: Wilderszijde pilot projects, Municipality of Lansingerland

- *energy performance of existing build*

In existing build, energy saving takes more effort, but a lot of saving can nevertheless still be made and the cost of more stringent measures will be recovered in a few years. Insulation programmes in combination with district improvement, for example, are easy to implement. With an eye to the heat network, it is certainly necessary for municipalities to develop renovation programmes for their entire housing stock, including plans for each district regarding the switch to collective heat supply.

- *savings by residents/users*

Just as with street lighting, households can also save energy by using energy saving light bulbs. In addition, many savings are achievable through energy saving behaviour. In this area, there are government initiatives to set up information campaigns. At a regional level, a contribution can be made, for example though environmental education in schools, neighbourhoods and clubs; i.e. geared to specific target groups. Box-packs of energy saving materials or coupons for buying energy-efficient products can be organised locally. It should not be forgotten that a considerable part of energy use by 'households' can be attributed to transport. There are lots of local measures that can be taken to curb this.

- *Residual heat*

Dwellings are usually heated using gas. However, a substantial number of dwellings in the region are connected to the regional heating network. These are located chiefly in the city centre, the Kop van Zuid, Rotterdam Alexander and Capelle aan den IJssel. On an annual basis in the region a total of 4.3 PJ of heat is supplied via the regional heating network (as against 25.9 PJ energy use via gas).
ROM-Rijnmond is making efforts via the R3 residual heat project to usefully employ the residual heat in the area. The objective is that by the target year (2015) 500,000 household equivalents will have been connected up to residual heat (see box in § 3.4). The cooperation of a lot of parties both inside and outside Rijnmond will be necessary to realise this 'Grand Design'.
One point worth mentioning is that the Energy Performance Standard score (the EPC value of the dwelling) does not improve if residual heat is used. This needs to be looked at separately as part of the requirements regarding building plans. The Energy Performance on Location (EPL) does take residual heat into account.

For both residual heat and cold/heat storage, it is essential to realise a collective heat supply network. Converting buildings from individual heating to a collective system leads to substantial disinvestments. A collective system, on the other hand, can simply be run temporarily on auxiliary boilers until it can be hooked up to a residual heat or geothermal heat supply.

4.1.4 Roles/options of regional stakeholders

The roles of provincial and local authorities and market parties offer various options for realising energy savings in the built environment. Table 10 shows an indicative overview of this.

Table 10 Indicative overview of stakeholders' roles/ powers (not exhaustive)

Stakeholder	*Tasks/powers*	*Frameworks*
Municipalities	- Development of house building and restructuring - establishing land use plans - granting building licences	
City of Rotterdam	- structure plan	RR2020
Province of Zuid-Holland	- regional plan - assessment of land use plans - granting licences under the Groundwater Act[12]	RR2020 Policy document on Plan Assessment
Project developers	- developing house building and restructuring plans	
Housing corporations	- restructuring/ new build social sector housing	
Non-governmental parties (nature and environment organisations, residents organisations, etc.)	- Social pressure and support in concrete measures and innovative developments, e.g. Green4Sure	

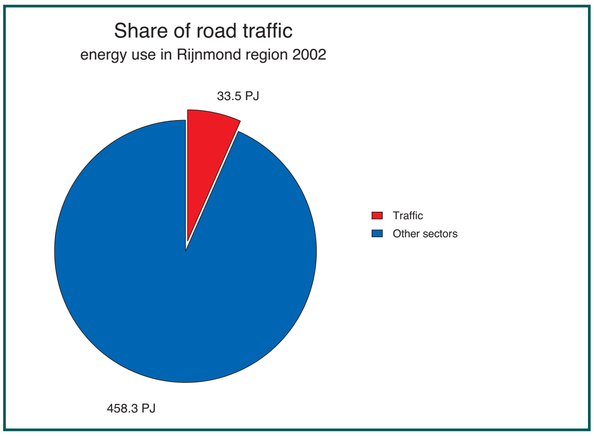
Additional options are included in the conclusions and recommendations (chapter 5).

[12] In the context of constructing cold/heat storage in the ground

4.2 Road traffic

Road traffic in Rijnmond accounts for more than 5% of the energy use in the region[13]. This relates to both passenger and goods vehicles.

Figure 13 Road traffic's share of energy use in Rijnmond in 2002



Nationwide, a stabilisation in emissions from passenger vehicles is foreseen (approx. 18 Mton CO_2). A considerable growth is expected in goods vehicle emissions: from approx. 8 Mton in 2006 to approx. 13 Mton in 2020. Passenger vehicles account for the largest share of the emissions but the share from goods vehicles is increasing. In Rijnmond the share from goods vehicles is higher due to the transport to and from the port. There will also be substantial growth in this sector, particularly in view of the expected growth in container transhipment in the port and the future construction of the Second Maasvlakte.

In addition to road traffic, shipping traffic is also responsible for a share of energy use and CO_2 emissions. It is estimated that these amount to 1 Mton CO_2 in the region and are from both inland and seagoing shipping traffic. Inland shipping is an important alternative to the transportation of goods by road. Inland shipping is considerably more energy-efficient per ton of product than road transport; CO_2 emissions are considered to be around 50% lower. Further improvements are possible, e.g. the development of the 'new sailing' initiative for fuel savings in inland shipping. However, shipping traffic does emit relatively high levels of pollutants because the emissions standards for ship's engines are less stringent than those for goods vehicles on the roads.

4.2.1 Possible measures

As a general guideline, CO_2 emissions from the road traffic sector can be reduced by:

- reducing road traffic (less kilometres driven);
- making cars more energy-efficient (including energy-efficient driving behaviour and good vehicle maintenance);
- biofuels.

The first approach was a key policy theme in the Netherlands in the 1990s. In recent years this has no longer been the case; emphasis has shifted to allowing the consumer the freedom to choose the mode of transport he or she wishes. At a regional level, too, there has been a shift: in the Regional Traffic and Transport Plan 2003 – 2020 (Rotterdam Metropolitan Region, 2003) there are no quantitative targets for reducing car traffic. However, alternative forms of transport (bicycle, public transport) are being promoted, by constructing park-and-ride sites on the outskirts of the city among other things.

As regards goods transport, national and regional policy is to realise a 'modal shift' in transport: a shift from transport by road to transport by water and rail. The main motivation for this is to increase accessibility and reduce traffic congestion. A side effect is a reduction in energy use. The objectives with regard to shifting the

[13] Shipping traffic for around another 3%.

modal split are given concrete form in the location policy for storage and transhipment companies: in the location conditions for new container terminals, the Rotterdam Port Authority stipulates that a certain part of the transport must occur via inland shipping or rail (Volkskrant, 2007).

As regards energy-efficient cars, the policy is primarily pursued at EU level. The EU aims at reducing the average CO_2 emissions from brand new cars. Among the measures taken in order to achieve this, a covenant has been entered into with the automobile industry (to reduce average CO_2 emissions between 1995 and 2008/9 from 186 g/km to 130 g/km). From an interim evaluation in December 2006, however, it appears that the majority of car manufacturers are not going to meet this target. In Februari 2007, the European Commission recommended a target of 120 g CO_2 emissions per kilometre, partly to be achieved through a compulsory proportion of biomass in car fuels.
Modified driving behaviour has proved to have a positive effect on energy use in all types of motor vehicle. The saving to be made depends on the type of vehicle and the former style of driving. Savings can be as much as 10%. The national 'New Driving' campaign is aimed at this. Government subsidies are available towards driving behaviour training courses offered by driving schools, the Dutch Automobile Association (ANWB) and other providers.

Good vehicle maintenance forms part of the 'New Driving' campaign because this is another way to save fuel. Correct engine tuning and tyre pressures are important.
Both these behavioural measures are broadly applicable and will quickly pay for themselves.

As regards biofuels, the European Biofuels Directive (Directive 2003/30/EC) obliges EU member states to make every effort to promote the introduction of biofuels. Targets include 2% replacement of conventional fuels by 2005 and 5.75% by 2010 (EC, 2003). These targets have led to a good number of initiatives for the production of biofuels (bioethanol, biodiesel, etc.), many of which are in the Port of Rotterdam. These mainly concern first generation biofuels.

4.2.2 Roles/options for regional stakeholders

Energy-efficient traffic and transport
Although the opportunities for local and regional authorities to reduce energy use by road traffic are relatively limited, they are sometimes underestimated. There are opportunities in the field of spatial planning, the design of public spaces and the use of financial and communication instruments. Physical measures include, for example, constructing cycle paths and park-and-ride sites, cycle parking racks and cycle parking areas, introducing 'reduced car access areas', traffic flow schemes and road design. An example of a financial instrument is the introduction of levies (such as the 'congestion charge' in London). Communication can also be a useful tool for influencing transport choice and thus energy use.
One way to stimulate the use of cleaner, energy-efficient cars – including hybrids – is for the authorities to purchase energy-efficient vehicles *(green municipal vehicle fleets*) and to enter into agreements with lease companies. The Environmental Management Act offers limited opportunities in the framework of the so-called Expanded Scope principle. Initiatives in this area can to a great extent run paralle with initiatives in the framework of air quality. For example, companies can be required to provide courses in energy-efficient driving (New Driving) and good vehicle fleet maintenance under the Expanded Scope of the Environmental Management Act. Companies with sizeable transport streams can either carry out a transport scan or may have to set up a transport plan. This is used to examine whether and how the company can realise a modal shift.
Regional authorities can make a contribution to reducing car use for short journeys, energy-efficient driving and vehicle maintenance. Opportunities: setting a good example, using publicity to reinforce the good example set and to make it more attractive to follow training courses and start regular vehicle maintenance. The Rotterdam Metropolitan Region is now doing the latter, for example. It is financing the implementation of the New Driving course for all drivers of government-run vehicle fleets in Rijnmond. Financial support is not the only method of encouragement, however. Targeted information campaigns, reducing red tape or a competition are all ways to make it easier for people to change their behaviour. The Rijnmond regional Traffic and Transport Centre (VCC Rijnmond) can be helpful here.

ROM-Rijnmond's R3 programme has a project aimed at cleaner transport by 2020. Within this R3DM project, plans of approach have been developed to help both companies and local authorities to convert to more sustainable vehicle fleets. This involves switching over from diesel and petrol to less polluting fuels based on bioethanol blends. Furthermore in the region, the Transumo research project under the supervision of Erasmus University Rotterdam is progressing. A broad group of interested parties in the region are cooperating on this. The project aims at identifying major changes in logistics and transport that can be realised in the longer term.

- *Street lighting*

Substantial savings in municipal energy use are possible in the area of street lighting. This uses a considerable amount of energy: for municipalities and road maintenance authorities, street lighting forms a sizeable debit item on their energy bill. Appreciable savings can be realised by using more energy-efficient lighting. A recently-found option is to utilise lamp posts with LEDs. In addition, it appears that it is possible to reduce street lighting without this compromising traffic safety. In this area there are clear opportunities for municipalities and the Province. A recent example in the region is the decision by the Municipality of Krimpen aan den IJssel to employ energy-efficient street lighting alongside the river Lek.

Street Lighting in Krimpen aan den IJssel

In Krimpen aan den IJssel a project is being realised in which a section of the street lighting is being replaced by dimmable street lighting. First, Philips calculated how much CO_2 could be saved if dimmable street lighting was used. Over a period of three years, a total of 200 masts over a 6 kilometre stretch will be replaced (around 60 per year). This will produce the following overview:

		6 kilometres (200 masts)	
		Reference	*New project*
Energy costs:	- 20 years	240,240	97,020
	- 1 year	12,012	4,851
Maintenance costs (20 years)		54,300	54,300
Break-even point			2 yrs 3 mths
Energy use (20 years)		1,601,600 kWh	646,800 kWh
CO_2 consumption (20 years)		673 ton	272 ton

Over a period of 20 years, 6 kilometres of dimmable street lighting can thus represent a saving of 401 tons of CO_2 .

Energy used in the street lighting in Krimpen aan den IJssel amounts to approx. 50% of the total municipal energy use. Philips reports that energy use in street lighting in the Netherlands accounts on average for 35% of the total energy use by municipalities and that savings of between 50% and 60% can be achieved in this area. Krimpen aan den IJssel's streetlamps thus use a relatively high amount of energy and this was their motive for doing something about their street lighting.

Krimpen aan den IJssel also has the advantage that the street lighting is under municipal management and has not been contracted out which is the case with many other Dutch municipalties (In Rotterdam it is contracted out to ENECO Energie and City Tec). The decision making regarding dimmable street lighting is thus in the municipality's own hands.

It should be noted with regard to the above calculation that the reduction depends on the type of installation which is already in place, the type of light bulbs and a number of other factors. This may thus vary from one municipality to another and from one stretch of road to another. In this context, a calculation can be requested from Philips regarding the most ideal situation, an interim situation and continuing in the currrent situation.

Source: CO_2 Tool; Cost of Ownership Tool, Philips

Table 11 gives an indicative overview of roles and possibilities for regional stakeholders.

Table 11 Indicative overview of roles/ options for regional stakeholders with regard to road traffic energy reductions

Stakeholder	*Tasks/ powers*	*Frameworks*
Regional municipalities	Municipal traffic and transport policy (incl. street lighting)	
City of Rotterdam	Regional traffic and transport policy Granting concessions for public transport Rijnmond Regional Air Quality Action Programme (in cooperation with ROM-partners)	Regional traffic and transport plan
Province of Zuid-Holland	Provincial traffic and transport policy (incl. provincial roads) Granting concessions for public transport	
Department of Public Works and Water Management, Zuid-Holland Directorate[14]	Construction and managment of national roads	
Rotterdam Port Authority	Stimulate modal shift in goods transport	Location conditions for container storage and transhipment companies
Transporters	Choosing modality (largely determined by principal) Choosing energy-efficient vehicles	
Lease companies	Choosing type of vehicle (energy-efficient)	
VCC Rijnmond	Stimulating efficient use of transport	
Non-governmental parties (nature and environment organisations, etc.)	Social pressure and support in concrete measures and innovative developments	

Additional Possibilities have been included in the conclusions and recommendations (chapter 5).

4.3 Greenhouse horticulture

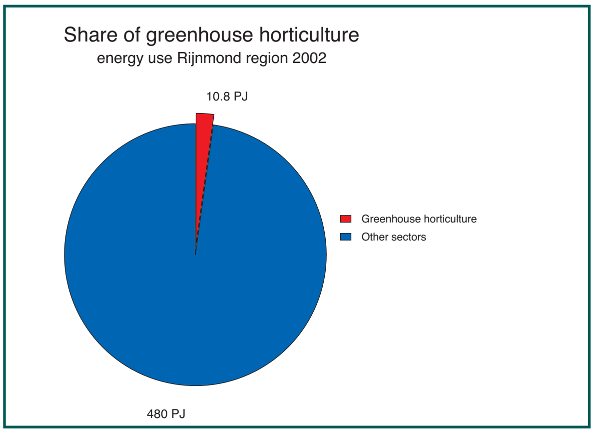
In Rijnmond there is a high concentration of greenhouse horticulture enterprises in Lansingerland (amalgamated municipality comprising Berkel en Rodenrijs, Bleiswijk and Bergschenhoek). In addition, there are greenhouse horticulture clusters in Hoek van Holland and on Voorne-Putten at Tinte-Vierpolders. Lansingerland is a relatively new greenhouse horticulture area. In Tinte/Vierpolders as well a lot of modern greenhouses have recently been added.

Greenhouse horticulture in Rijnmond accounts for approx. 2% of the regional energy use.

Just outside Rijnmond lies the old, large-scale greenhouse area of Westland. Work is being done on restructuring this area: renovation of the greenhouse complex, including shifting of companies within it. This restructuring offers opportunities to bring in sustainable options at the same time. Although it is outside the Rijnmond area, the restructuring of the Westland area is important because of its potential take-up of residual heat and CO_2 from the Rijnmond area.

[14] Regional implementation agency under the Ministry of Traffic and Transport.

Figure 14 Greenhouse horticultures' share of energy use in Rijnmond in 2002



In recent years, the sector has realised considerable savings in energy use through innovations. As a result, production has doubled since 1980 while emissions of CO_2 have remained constant: per unit product emissions have therefore halved. The lion's share of the efficiency improvement was realised in the period prior to 1986. That year oil and gas prices halved. In recent years, the consumption of electricity has shown a rise due to the fact that assimilation lights are being increasingly employed[15].

Nationwide, agreements regarding the measures to be taken have been incorporated into the Greenhouse Horticulture and the Environment covenant (GLAMI). Following on from this covenant, the Greenhouse Horticulture Decree also sets out requirements for energy use. The requirements in both covenant and Decree, however, are the same for new build as for existing enterprises. Unlike the case in the housing sector, this means that both GLAMI and the Decree do not lead to to optimal energy efficiency in new greenhouses. The covenant will terminate in 2010.
The greenhouse horticulture sector must prepare itself for the impact of the CO_2 emissions trade. Under this system, CO_2 reduction acquires economic value and this can have an effect on both new and existing greenhouses. The expected price development for fuels, however, is the most important motor for energy saving in the greenhouse horticulture sector.

Supply of residual heat and CO_2 from industry
In recent years, the supply of residual heat has got underway. Residual heat is supplied from the E.ON RoCa-III plant to 140 greenhouse growers in the Municipality of Lansingerland. In addition, in the framework of the R3 residual heat project efforts are being made to supply residual heat to greenhouse growers in Tinte/Vierpolders and Lansingerland (zie ook § 3.4).
Since 2005, via the OCAP-project[16] Shell has been supplying CO_2 to around 500 greenhouse growers with a total acreage under glass of approx. 1.300 hectares between Rotterdam and The Hague. This prevents the greenhouse growers themselves having to generate CO_2. OCAP supplies approx. 160 tons of CO_2 per hour (www.ocap.nl).

4.3.1 Possible measures

Within the greenhouse horticulture sector, there are opportunities to curb energy use even more. The most important options for change are:
- further development of CHP;
- residual heat and CO_2 supply;
- utilising cold/heat storage;
- 'closed greenhouse', zero energy greenhouse and heat producing greenhouse;
- more efficient lighting.

[15] Assimilation lighting: artificial lighting to accelerate the growth of crops.
[16] OCAP stands for 'Organic CO_2 for Assimilation in Plants'.

The greenhouse horticulture sector is in the middle of a switchover from conventional gas-fired heating to combined heat and power (CHP). CHP has become interesting now chiefly because greenhouse growers are reasonably free to choose when to fire up the heating unit which enables them to realise top rates for the prodution of electricity at peak times. It is expected that in approx. 5 years these top rates (up to € 2000 per MW) will collapse once international transport cables for electricity are realised.

A second strategy switch is the use of external heat, such as residual heat and CO_2 from industry. Using residual heat is an excellent option if sufficient take-up within a limited distance can be realised. Collectivity is a precondition of this system. A collective CO_2 supply forms part of the system in order to prevent greenhouse growers from burning fuels in summer to meet their need for CO_2.
Another form of 'external' heat supply is geothermal heating, the abstaction of warmth stored in the earth at a depth of between 1½ and 3 km. Opportunities for this in Zuid-Holland are relatively favourable. A grower in Bleiswijk has started a pilot project. Like residual heat, geothermal heat requires a considerable initial financial outlay which will have to be recovered in the long run. There is a risk that an aquifer suitable for geothermal heating will not be found. This is a financial risk that cannot be borne by a single company.

A third strategy switch concerns the closed greenhouse, the zero-energy greenhouse and the heat producing greenhouse. These are all relatively new greenhouse concepts. Central to them all is abandoning the burning of fuels as a source of heat in combination with a closed ventilation system – i.e. air is circulated inside the greenhouse. A closed greenhouse requires a different style of growing than an open greenhouse. By means of these concepts, heat/cold buffering on a seasonal basis is realised via cold/heat storage in the ground ($2^{nd}/3^{rd}$ aquifer layer, at a depth of around 100m). The applicability of cold/heat storage partly depends the balance between demand for heating and cooling and the requirements of a particular crop. Moreover, it is not yet clear whether the 'buffering capacity' of the soil is high enough to support large-scale cold/heat storage, for example for a greenhouse horticulture area of 100 ha. or more. It is particularly important that thermal pollution of the subsoil should be prevented.
With regard to cold/heat storage, a collective approach clearly delivers more added value than an individual approach because the limited capacity of the soil can be more efficiently utilised. As with the use of external heat, cold/heat storage requires a considerable financial outlay which must be recovered in the long run.

The first energy-producing greenhouse has arrived!

In 2006, the first energy-producing greenhouse came into use in the municipality of Bemmel. In the Province of Gelderland. This experimental greenhouse offsets its own energy use and is expected to produce an energy surplus. The greenhouse in Bemmel was made possible due to a number of technological innovations:

- high-grade and energy-efficient heat exchangers;
- cold/heat storage in the water-containing sand layers in the soil;
- installing an insulating greenhouse deck;
- greenhouse closure system.

The principle of the energy-producing greenhouse is that the surplus heat in the summer can be stored in the groundwater and can then be used during colder periods. This releases more heat than can be used for the purpose of running the greenhouse.

Source: www.energiek2020.nu

The above three strategies compete with each other both as regards environmental and economic performance. Although from an environmental viewpoint, CHP scores higher than the conventional gas and oil-fired heating methods, it still loses out to the other options. Further development of gas-fired CHP will lead, in the long term, to insufficient reductions in CO_2 emissions. A CHP unit which runs on biofuel scores mugh higher on CO_2 emissions, but local air pollution caused by emissions of such things as heavy metals and the permanent availability of sustainably-grown biofuels mean that questions still remain. How the performance of the closed greenhouse concept compares with that of the residual heat greenhouse is more difficult to answer. As regards CO_2 emissions, using industrial heat, as long as it is 'freely' available, is the most favourable option: on an annual basis, closed greenhouses can in principle be heat-neutral, but the heat pumps that form part of the system do use more electricity than residual or geotherma heating. For crops that do not require supplemental lighting, residual heat in combination with CO_2 supply is generally the best option. An advantage of residual heat supply is that it reduces heat releases to surface waters. If crops require supplemental lighting then this depends on the situation. Important factors to consider include the size and frequency of the demand for electricity, for cooling and for heating.

The fourth strategy is to switch to energy-efficient lighting, for example using LEDs. This strategy is unrelated to the previous three. In the long run, LED lighting will change the whole picture again for all crops needing supplemental lighting, because it will reduce the demand for electricity and cooling. The heat production from the light sources will then decrease.

4.3.2 Roles/options for regional stakeholders

The Province of Zuid-Holland has set itself the target of realising a reduction in the Zuid-Holland greenhouse horticulture sector of 0.25 Mton by 2010 and 1.2 Mton by 2020. Using heat from external sources is an essential part of this. To this end, a framework has been worked out for using external heat, unless this proves not to be feasible[17] (Province of Zuid-Holland, 2006).

Roles of the authorities involved may be summarised in a table as follows:

Table 12 Roles and instruments of regional stakeholders in energy policy in greenhouse horticulture

Stakeholder	*Task/role*	*Framework*
Municipalities	- land use plansbestemmingsplannen - municipal energy policy - using 'heat-unless' policy in assessment of building plans *(future)*	Spatial Planning Act
Municipalities/ DCMR Rijnmond Environmental Agency	- implementation AMvB Greenhouse horticulture/ GLAMI-covenant - promoting construction & use of collective heat systems - including energy performance of greenhouse in integrated assessment	
City of Rotterdam	- regional spatial policy	RR2020
Province of Zuid-Holland	- policy on restructuring Westland region - supervising application of heat-unless policy *(future)* - issuing licences under the Groundwater Act - deciding on land use plans	- policy framework 'heat-unless' policy *(under development)* - Province of Zuid-Holland greenhouse horticulture implementation programme
ROM-Rijnmond R3-residual heat project	- facilitator for realisation of residual heat utlisation in greenhouse horticulture areas	R3 2007 – 2010 'sustainable enterprise in Rotterdam Energy Port' Programme, 'Grand Design' for residual heat
LTO – West	- promoting exchange of know-how and cooperation	administrative Agreements Framework Restructuring Greenhouse Horticulture
Greenhouse horticulture enterprises	- renovation of greenhouses (energy saving measures/ innovation/ use of sustainable energy) - cooperating on realising collective systems	Economic perspective for the sector and for the individual company
Non-governmental parties (nature and environment organisations, etc.)	- Social pressure and support in concrete measures and innovative developments	

Additional options are included in the conclusions and recommendations (chapter 5).

[17] This policy framework:
- Determines that the heat supply for buildings must be dealt with according to the order of prefe-rence for residual heat, if this is not possible, cold-heat storage and only if this proves not to be possible either, the production of heat by a burning process;
- realises an optimal use of the subsoil by assessing licenses under the Groundwater Act in the light of a 'master plan' for priority areas;
- includes future developments in the licensing process;
- has a preference for collective systems rather than individual systems.

Conclusions and recommendations 5

'The significant problems we face cannot be solved at the same level of thinking we were at when we created them'. Albert Einstein'

Introduction

In the preceding chapters a broad outline of the energy situation in Rijnmond has been described and a number of solution options have been indicated. In this final chapter, the focus is on the questsion of which opportunities the stakeholders in the Rijnmond region actually have to realise the targets with regard to making energy use more sustainable and curbing CO_2 emissions. In view of the existence of the Rotterdam Energy and Climate Programme (RECP), the realisation opportunities involved play a major role and the question is, what meaning will this programme will be given in a regional context.

In view of the question regarding the opportunities which the administrative parties in the region can utilise, a group brainstorming session was organised with stakeholders from the region, including the authorities, companies and research institutes. The participants listed and prioritised policy opportunities. In this chapter we present the results, supplemented here and there by opportunities which emerged from the earlier chapters.

These policy opportunities, together with the RECP, provide a picture of policy developments which are crucial to the realisation of the goals which MSR monitoring must aim at in the near future. Following on from the workshop, indicators were drawn up for this. The policy opportunities and indicators have been bundled into three clusters: the port, the built environment and subjects relating to both of these. We will start with providing a general impression.

General impression

The ambition to strive for a healthy economy with drastically reduced CO_2 emissions is broadly endorsed. The participants in the workshop underline the fact that Rotterdam has set itself an extremely ambitious aim which can only be realised through taking radical steps. Clear choices will have to be made which in the short term will lead to higher costs for the various sectors. An example is the financial outlay needed for residual heat or storage of CO_2 or the renovation of dwellings in accordance with stringent energy standards. The participants have no doubts about the wisdom of choosing an offensive energy policy. They anticipate that sooner or later the costs will be recovered on investments made in this regard. However, they do not anticipate that the administrators will automatically share their confidence. Moreover, existing doubts will increase if painful consequences turn up. This is why they think it is important to compare these investments with the risks of continuing on the present course. More work will need to be done in this area over the coming period.

In addition to the broad support, there are a lot of questions relating to the risks of continuing on the present course and the consequences of changing the course towards a low-CO_2 economy. What are the risks, how big are they, what are the consequences for employment, and the residential and living climate in the region? How does the future look? The participants feel it is essential to set up a dialogue in which these questions can be addressed. The dialogue will make a major contribution to the creation of support and commitment and fostering confidence for the new path. The various elements of the climate plan also need dialogue in order to test the support for them and their interrelationship and to ensure that these are long-lasting. In addition to initiating very concrete steps, the setting up of a dialogue with all the parties involved forms the most important challenge for 'Turning words into deeds'.

There is still uncertainty regarding the question of who the problem owner is. The problem is collective and this is at once both an opportunity and a threat. Each tier of government has equal responsibility, the owners of many companies have their head office abroad. The challenge for the regional governments in Rijnmond is to give shape to collective ownership.
Rotterdam has taken up the challenge with its Rotterdam Energy and Climate Programme (RECP) and has the backing of DCMR Rijnmond Environmental Agency, The Rotterdam Port Authority (HbR) and Deltalinqs. This does not alter the fact that major efforts and leadership will be required from other parties (local authorities, companies) too. For Rotterdam no less than for the regional municipalities the question applies of to what extent the RECP will remain a plan solely for Rotterdam or whether it will be given a regional scope. Although this last appears to be in everyone's interest it will require a joint regional ambition.

What it ultimately comes down to is the courage to make real choices. And at times those choices will lead to certain activities being banned from the region if they do not make a sufficient contribution to the objective of economic growth combined with a drastic reduction in CO_2 emissions. Such choices require a robust vision, great courage and solid support.

Policy opportunities and indicators:

During the workshop, a list of policy opportunities was made. Mostly following on from the RECP. It is anticipated that these policy opportunities will turn out to be crucial developments in the realisation of the regional goals. Based on the policy opportunities, the following indicators have been formulated. Although the indicators do not yet provide a complete picture, they do give the initial impetus to the issues which will have to be addressed in the coming years.

Port

Policy opportunities:

1 Use public participation in private enterprises not only for financial returns but also for societal benefits. For example, set CO_2 reduction targets for the Rotterdam Port Authority or the AVR.
2 Draw up a regional assessment framework for the location of companies. This assessment framework can provide tools for the local climate ambition and incorporate it with other policy such as the provincial assessment framework for power stations and the Province of Zuid-Holland's proposed 'heat-unless' policy. The assessment framework covers public law and private law legislation, such as land granting agreements. Sustainability and energy use will play a role in this which is equal to the added economic value of the companies.
3 More clearly reward companies which invest in clean technology and CO_2 reductions. For example, by making land available to these companies at a lower rate. Another option is to create an experimental area where certain hampering rules do not apply.
4 Give preference to infrastructure for residual heat transport and for capture and storage of CO_2.
5 Utilising the large-scale cold and heat streams in the port by facilitating and providing tools for smart solutions such as integrating the bringing ashore of LNG with an oxygen factory and power station.
6 Give companies clear information about the long term (15-20 year) requirements with regard to CO_2 emissions so that they can plan accordingly.
7 Press for credits for residual heat or CO_2 supply within the CO_2 trading system.
8 Take account of the impact of measures within the life-cycle (such as when using biomass).
9 Create preconditions for realising cascading and optimal life-cycle solutions. Invest more (including in terms of time on the part of government officials) in finding and realising life-cycles.

Indicators:

Effects:

- CO_2 emissions from industrial sectors
  (can be broken down into power stations, chemical industry, refineries, joint venture CHPs and others)

Achievements:

- Realised energy saving
  (can be broken down into savings within companies, CHP, residual heat supply, etc.)
- Amount of sustainable energy produced
  (can be broken down into wind power, biomass and other forms)
- Use of biomass
  (can be broken down into sustainably-grown biomass and other)
- Supply and storage of CO_2.

Efforts:

- Degree to which CO_2 energy targets are incorporated into the main objectives of the major regional stakeholders (including the HbR)
- Degree to which financial incentives are realised for clean/ energy-efficient companies (e.g. in the form of lower land prices).

Built environment

Policy opportunities:

1 Become the leader in the field of energy-efficient building. In order to gain this position, ambitious agreements are needed between municipalities, housing corporations, energy companies and project developers.
2 Devote attention to education and training of authorities, project developers, building companies at all levels, aimed at implementing energy saving measures and adopting sustainable energy.
3 Make the land price in the region dependent on sustainability performance. For clean, energy-efficient companies and energy-efficient housing the land price would be lower. This would provide an incentive to build and produce in an energy-efficient way.
4 In the field of mobility, additional measures are advisable in order to realise cleaner transport and thus less local air pollution and CO_2 emissions.

Indicators:

Effects:

- CO_2 emissions in the urban area
  (can be broken down into house building, commerce/ services/ authorities, greenhouse horticulture and traffic).

Achievements:

- Energy saving in new build and renovation
  (number of dwellings with EPN per class, e.g. 0.8 and 0.6)
- Realised energy saving in existing build
- Number of existing dwellings renovated to energy perfomance standards
- Amount of residual heat supplied (can be broken down into existing supply (regional heating network), new build, greenhouse horticulture and other sectors)
- Realised energy saving through traffic measures
- Realised sustainable energy generation in the built environment (solar boilers, solar photovoltaic panels (PV), wind).

Efforts:

- Degree to which financial incentives have been realised for clean/ energy-efficient dwellings (e.g. in the form of lower land price)
- Number of dwellings about which agreements have been made with regard to energy-efficient renovation
- Number of people who have attended an energy training course.

Between the port and its environs

Policy opportunities:

1 Create facilities, such as e.g. a general and technical services agency, to advise and assist all parties in the region on taking energy saving measures.
2 Incorporate energy and CO_2 targets in policy documents and implementation programmes for all policy fields. And to make visible the energy consequences of important policy measures.
3 Designate places in the region as experimental areas where pioneering initiatives can be tested. For example, Rozenburg could be the first Western European hydrogen municipality.
4 Direct the purchasing policy of all stakeholders towards energy saving and CO_2 emissions reduction.
5 Take investment decisions based on product lifespan rather than purchasing cost.
6 Utilising residual heat by pursuing a ‘heat-unless’ policy. Giving preference to heat use and only deviating from this if it is really found not to be feasible, a far larger proportion of the residual heat can be usefully utiltised.
7 Develop integrated spatial-economic visions based on the key points of the proposed energy policy.
8 As a region, formulate a joint regional ambition in which the RECP can be incorporated.

Indicators:

Efforts:

- Degree to which CO_2 energy targets are incorporated into policy documents and implementation programmes.
- Degree to which infrastructuur is designed for CO_2 storage and residual heat supply (can be broken down into investments for CO_2 storage, supply of residual heat and other infrastructural facilities, such as the Botlek loop)
- The number of stakeholders who have incorporated energy saving and CO_2 reduction targets in their purchasing policy.
- Develop an integrated spatial-economic vision based on the key points of the proposed energy policy.

Benner, 2006
J.H.B. Benner, M.I. Groot, M.C.M. Koot, F.J. Rooijers, B.L. Schepers
Dossier Energiebesparing
Delft : CE, 2006

CBS, 2005
Centraal Bureau voor de Statistiek
Revisie Nederlandse energiehuishouding 1995-2003
Heerlen : CBS, 2005

Coalitieakkoord Balkenende IV, 2007
CDA, PvdA en ChristenUnie
Coalitieakkoord tussen de Tweede Kamerfracties van CDA, PvdA en ChristenUnie.
Den Haag : 07-02-2007 (www.kabinetsformatie20062007.nl)

Daniëls, 2006
B.W. Daniels, J.C.M. Farla
Optiedocument energie en emissies 2010/2020
ECN / MNP, 2006

DCMR, 2006
A. Snijder, P. Kummu, W. Schiphorst, J. v.d. Laan, D. van Tuinen, J. Gijsbers
Lucht in cijfers 2005, luchtkwaliteit in het Rijnmondgebied
Schiedam : DCMR, 2006

DCMR en ROM-Rijnmond, 2005
Projectorganisatie Regionaal Actieprogramma Luchtkwaliteit Rijnmond
Regionaal Actieprogramma, Luchtkwaliteit Rijnmond
Schiedam : DCMR, 2005

Dril, 2005
A.W.N. van Dril, H.E. Elzenga
Referentieramingen energie en emissies 2005-2020
ECN / MNP, 2005

EC, 2003
Europese Commissie
Richtlijn 2003/30/EC
Brussel : Europese Commissie: publicatieblad voor de European Union persbericht 17-05-2003

EC, 2007
Europese Commissie
De Commissie stelt een geïntegreerd pakket maatregelen inzake energie en klimaatverandering voor om voor de 21e eeuw de emissies te doen dalen
Brussel : Europese Commissie persbericht 10-01-2007 (www.europa.eu)

ECN, 2006
Energy research Centre of the Netherlands
Presentatie: Energiegebruik HIC Rotterdam tot 2020, actualisatie van de raming uit 2003
Petten : ECN, 2006

EEA, 2006
European Environment Agency
Annual European Community greenhouse gas inventory 1990-2004 an inventory report 2006
Copenhagen : EEA, 2006

EFN, 2006
Energie Forum Nederland
Nederland Energieland - Energiebeleid in C-majeur
Amsterdam : EFN, 2006

EnergieNed, 2002a
EnergieNed
Basisonderzoek Elektriciteitsverbruik Kleinverbruikers BEK 2000
Arnhem : EnergieNed, 2002

EnergieNed, 2002b
EnergieNed
Basisonderzoek Aardgasverbruik Kleinverbruikers BAK 2000
Arnhem : EnergieNed, 2002

Financieel dagblad, 2007
K. Beckman, T. Olde Monnikhof
Energiepoort Rotterdam aast op vloeibaar goud
Financieel dagblad, persbericht 12-02-2007

City of Rotterdam, 2006
City of Rotterdam, programmabureau Energie
Rotterdams Energie Programma
Rotterdam : City of Rotterdam, 2006

Harmsen, 2003
R. Harmsen, A.W.N. van Dril, B.W. Daniels, P. Kroon, A.J. Seebregts
Ontwikkeling energiegebruik HIC Rotterdam 2002-2020 bij lopend beleid
Petten : ECN, 2003

HbR, 2006
Rotterdam Port Authority
Managementsamenvatting LTV Rotterdam Energy Port
Rotterdam : HbR, 2006

IEA, 2006
International Energy Agency
World Energy Outlook, 2006
International Energy Agency , 2006

Keulenaar, 2004
H. de Keulenaar, R. Belmans, E. Blaustein, D. Chapman, B. de Almeida, B. de Wachter, P. Ragden
Energy Efficient motor driver systems.
Brussel : European Copper Institute, 2004

Knijff, A. van der, 2006
Knijff, A. van der, Benninga, J., Reijnders, C.E., Nienhuis, J.K.
Energie in de glastuinbouw van Nederland. Ontwikkelingen in de sector en op bedrijven tot en met 2004
Den Haag : LEI, 2006

MNP, 2006
Milieu Nationaal Planbureau
Broeikasgasemissies in Nederland per sector, 1990-2005
Milieu Nationaal Planbureau, referentie MNP/MNC/sep06/0168, 2006

MSR, 2007
Milieumonitoring Stadsregio Rotterdam
Het milieu in de regio Rotterdam 2007
Schiedam : DCMR Milieudienst Rotterdam, 2007

Nieuw Rotterdams Tij, 2006
S. van der Most
Ruud Lubbers: ‘Kiezen voor een sterke economie door investeren in ecologie’
Rotterdam : Nieuw Rotterdams Tij, editie 8, 2006

Philips, 2007
CO_2 Tool, Cost of Ownership (Krimpen aan de IJssel)
Philips, 2007

Provincie Zuid-Holland 2006
Ontwerpbeleidsplan groen, milieu en water
Den Haag : Provincie Zuid-Holland, 2006

RDC Rijnmond, 2007
Regionaal DuBo consulentschap regio Rijnmond, jaarverslag 2006
Rotterdam : 2007

Rooijers, 2002
Rooijers, F.J., Haan, F.de, Groot, M., Blaauw, K., Slingerland, S., Singels, K., Keizer, I. de
Van restwarmte naar nuttige warmte in de Rijnmond.
Delft : CE, 2002

ROM-Rijnmond R3, 2006a
ROM-Rijnmond R3
Programma R3 2007-2010; duurzaam ondernemen in Rotterdam Energy Port
Rotterdam : ROM-Rijnmond R3, 2006

ROM-Rijnmond R3, 2006b
ROM-Rijnmond R3
Grand Design, warmte voor zuidvleugel Randstad
Rotterdam : ROM-Rijnmond R3, 2006

SenterNovem, 2006
Werkgroep Afvalregistratie
Afvalverwerking in Nederland, gegevens 2005
Utrecht : SenterNovem, 2006

Stadsregio Rotterdam, 2003
dS+V (stedenbouw, wonen en verkeer) afdeling verkeer en vervoer
Stadsregio Rotterdam Verkeers- en Vervoersplan Deel 2 Uitvoeringsprogramma
Rotterdam : Stadsregio Rotterdam, 2003

TFE, 2006
Task Force Energietransitie
Meer met Energie! Kansen voor Nederland
Utrecht : SenterNovem, 2006

VNO-NVW, 2006
Wie wordt er beter van palmolie?
VNO-NCW bericht 16-11-2006 (www.vno-ncwmidden.nl)

Volkskrant, 2006
Californië voert strenge milieuwetgeving in
Volkskrant, 2006

Volkskrant, 2007
Tweede Maasvlakte maakt lucht schoner
Volkskrant, persbericht 07-03-2007

Wilde, 2006
H.P.J. Wilde, G.J. Stienstra
Meer energiebesparing voor de chemie in Rijnmond
Petten : ECN, 2006

Website References

CBS, 2007
www.cbs.nl (29-03-2007)

Enecogen, 2007
www.enecogen.nl (08-03-2007)

Energie in cijfers, 2007a
http://www.energie.nl/index2.html?stat/trends133.html (08-03-2007)

Energie in cijfers, 2007b
http://www.energie.nl/index2.html?stat/trends024.html (08-03-2007)

Energieweb
http://www.energieweb.nl/ency/tabel/ency-co2.html

Energiek2020
www.energiek2020.nu

OCAP, 2006
www.ocap.nl (08-03-2007)

VROM, 2007
http://www.vrom.nl/pagina.html?id=22819 (08-03-2007)

Referenties

ENECO Energie, 2007
Afrekentabel 2006 sunport
C. Oskam

GdF, 2007
ORC CO_2 Injectie Project
R. Romijn

Gemeente Lansingerland (formerly Bergschenhoek)
Voorbeeldprojecten Wilderszijde

Philips, 2007
R. Koster (account manager)

WSH, 2007
Wind Service Holland, data Rijnmond
J. Langenbach

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MILIEUMONITORING STADSREGIO ROTTERDAM

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