Focus on the Dutch climate challenge

Insight into targets, certainties and uncertainties

ING Economics Department • May 2018

Contents

Major climate challenge affects everyone

The Dutch government has announced ambitious climate targets for the Netherlands. The emission of greenhouse gases needs to be reduced by 49% by 2030 compared to the base year of 1990. In 2018 this target shall be translated into a new climate agreement and imbedded in a climate law. The energy transition in the Netherlands has an important extra dimension: gas extraction in the province of Groningen will be reduced to zero and 2030 is also the target year for that.

As 'simple' as the targets sound, achieving them is a complex and vast task. It encompasses everything from basic industry to the individual consumer whose home is heated with the familiar gas-fired central heating boiler. Currently, the Dutch Environmental Assessment Agency ('Planbureau voor de Leefomgeving') estimates the additional costs of the targets set by the cabinet at between € 2 and something more than € 3 billion per year.

Insight into targets, certainties and uncertainties

In the coming decades, the climate and related energy transition shall determine the appearance of the Dutch economy: of public finances, the household purse, business investments and risks. The purpose of this publication is to use the figures to provide a better understanding of the climate challenge and the other associated challenges. What are the most important targets? What has been the trend in the emission of greenhouse gases? What is asked of the sectors to achieve the climate targets by 2030 and what are the most important certainties and uncertainties with regard to this?

In answering these questions, we are conscious that knowledge is developing rapidly and that insights are moving forward. By sharing this overview, we also hope to expand your knowledge.

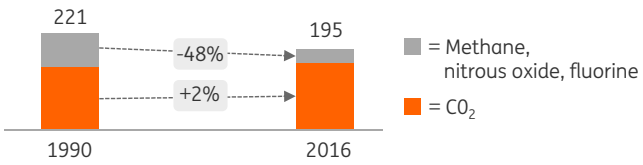
Summary

Climate Challenge Netherlands: direction clear, uncertainties great

The enormous climate challenge

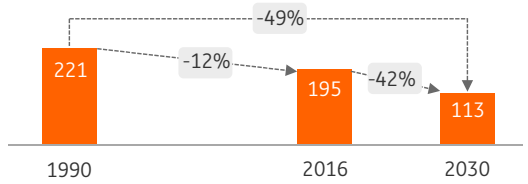
1 Total emission of greenhouse gases now lower than in 1990, but CO_2 emission has increased

Emission of greenhouse gases (CO_2 equivalents), in megatonnes



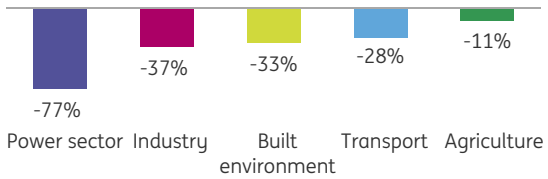
2 The 2030 climate target calls for a substantial reduction in the emission of all greenhouse gases

Emission of greenhouse gases (CO_2 equivalents), in megatonnes



3 The largest contribution to the reduction by 2030 must come from the power sector

Difference in emission of greenhouse gases 2030 vs 2016



Important certainties and uncertainties

The direction in which solutions are sought for the sectors is often clear, but there are crucial uncertainties. Below, an overview per sector. The top 3 uncertainties are:

1) Can the power sector realise its targets in a time of strong growth in demand?
2) Will the competitive position of industry remain intact?
3) How shall the costs of making homes climate-neutral be distributed?

Power sector: from 53 to 12 megatonnes

Certainties
- Wind and solar energy are crucial in meeting targets.
- For buildings, industry and transport, electrification is a large part of the solution.

Uncertainties
- Are targets achievable if electricity demand surges?
- Is the construction of offshore wind farms going well in view of the complexity and high level of ambition?
- Will large-scale electricity storage technologies be available quickly enough?

Industry: from 57 to 36 megatonnes

Certainties
- Industry operates on an international playing field.
- Combination of solutions is needed, including electrification and CO_2 capture.

Uncertainties
- Will the competitive position of industry remain intact?
- Will it be possible to make international agreements for industry?
- To what extent can industrial processes be electrified?

Built environment: from 23 to 15 megatonnes

Certainties
- Buildings must be weaned off gas.
- Electrification is an important but expensive solution.

Uncertainties
- How shall the costs of making homes climate-neutral be distributed?
- Are there enough technicians available to carry it out?
- What does electrification of homes require of the (local) electricity grid?

Transport: from 35 to 25 megatonnes

Certainties
- The demand for transport continues to grow rapidly.
- The solution going towards 2030 is electric-powered vehicles, both cars and trucks.

Uncertainties
- Will battery technology continue to develop rapidly?
- Will the emission from international aviation and maritime shipping be assigned to the countries concerned?

Agriculture: from 28 to 25 megatonnes

Certainties
- The emission of nitrous oxide has reduced, methane and CO_2 must follow.
- With regard to sustainability, much of the low-hanging fruit has already been picked.

Uncertainties
- How expensive is it to reduce the emission of methane?
- To what extent shall the potential of heat networks and the link with other sectors be exploited?

Chapter 1 | Greenhouse gas emissions in the Netherlands

<< Contents

Pillars focused on reducing emission by 49% by 2030

Different climate targets and projections

There are the necessary climate targets and projections about the emission of greenhouse gases. By 2020, the (international) Kyoto target reduction of 20% compared to 1990 applies. However, a 25% reduction may be requested from the Netherlands if the Dutch State's appeal in the Urgenda case is finally rejected*.

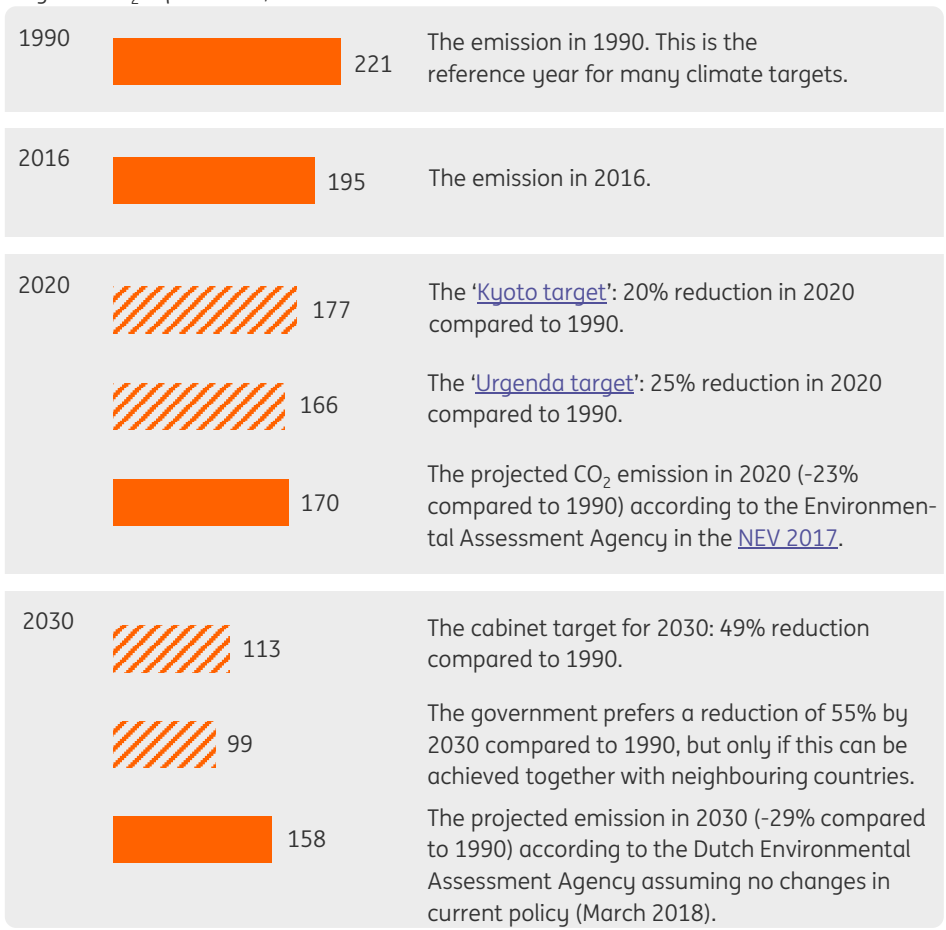
The Dutch have ratified the Paris Agreement to limit global warming to two degrees Celsius. The target from the coalition agreement is the one that gives most direction to policy: 49% reduction in emission in 2030 compared to 1990. The yearly CO_2 emissions have to fall from 221 megatonnes in 1990 to 113 in 2030 as a result.

Different measuring protocols make emission figures a complex matter

Greenhouse gas emissions are measured using different definitions. The protocol of the United Nations (IPCC) is leading in international reduction targets and measures emission on *Dutch territory*. However, some emission sources are not included, the most important being (international) aviation and shipping. The exact differences between the IPCC measuring method and that of the CBS in its Environmental Accounts can be found here.

The most important emission figures for the Netherlands at a glance

Megaton CO_2 equivalents, IPCC method



Sources: ING Economics Department on the basis of Coalition agreement, Parliamentary papers, PBL, IPCC, CBS.

* The trial took place on May 28th 2018. No court decision was made public by the time of finalising this report.

<< Contents

CO_2 has by far the largest share of the total emission

Four greenhouse gases that differ in potency

Emissions and climate targets are often expressed in the form of CO_2 equivalents; a translation of the harmfulness of a greenhouse gas in terms of CO_2 emission. Each greenhouse gas has a different conversion factor. The total emission of greenhouse gases is obtained by adding together the four greenhouse gases after conversion. CO_2 with a share of 85% is by far the most important greenhouse gas.

CO_2 by volume is by far the most important greenhouse gas

Greenhouse gas	Mainly released in/at	Conversion factor to CO_2 equivalent	Share of total emission	Emission in CO_2 equivalents, in megatonnes (2016)
Carbon dioxide (CO_2)	the burning of fossil fuels, namely: • Coal, especially in the power sector and in metal production. • Oil, especially in the transport sector. • Gas, in the built environment, industry and the power sector.	1	85%	166
Methane (CH_4)	agriculture or through natural gas which 'escapes' during mining (methane leakage) or combustion (methane slip).	25	10%	19
Nitrous oxide (N_2O)	agriculture through the use of (artificial) fertilisers and the ploughing of land, in the chemical industry and during waste incineration.	298	4%	8
Fluorine (F_2)	the use of aerosols and in the production and dismantling of refrigerators and freezers.	2500	1%	3

The Netherlands runs almost entirely on fossil energy sources

91% of the current energy sources is fossil

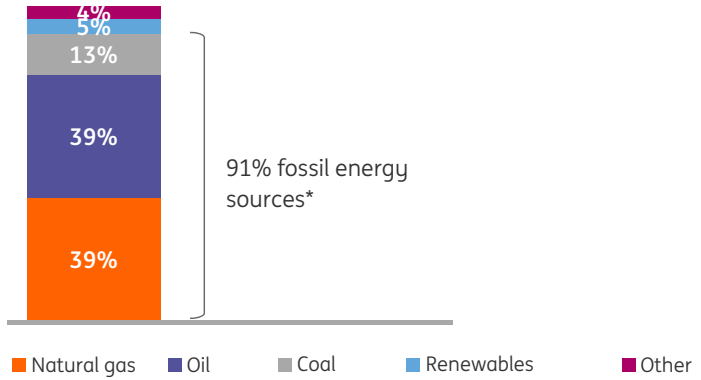
CO_2 emission is for the most part linked to the consumption of fossil energy sources. With a share of more than 90%, the energy system is dominated by the fossil sources coal, oil and gas. These energy sources have a different CO_2 footprint. Coal is most polluting, followed by oil and gas.

Oil and gas also used as raw material

About 23% of the oil and gas used is used as raw material for the chemical industry. This is also a crucial element in tackling a complete sustaining of the economy. However, the focus of this publication lies on the direct emission from the sectors. This is also the focus for the new Climate Agreement to be agreed.

Natural gas and oil dominate energy sources

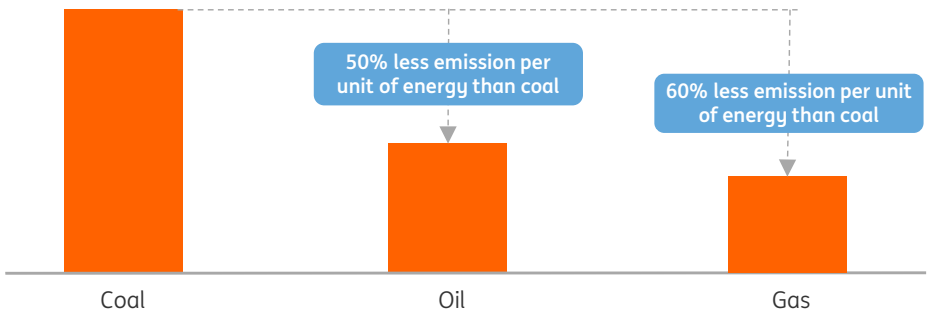
Share in Dutch energy consumption, 2016



*Figures including use of oil and gas as raw materials (feedstock).
Source: ING Economics Department on the basis of CBS, PBL and emissieregistratie.

Coal more polluting than oil and gas

CO_2 emission from oil and gas compared to coal



Source: Carbon tracker, ECN, IEA.

<< Contents

Coal for electricity, oil for transport and gas for buildings

Fossil fuels used in different ways in different sectors

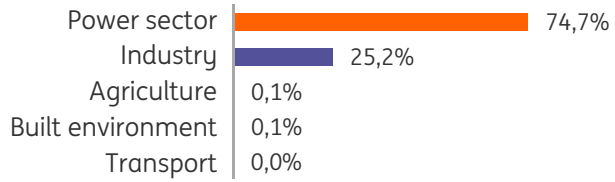
There are clearly large consumers for each type of fuel:

- **Coal** is mainly used to generate **electricity** in coal-fired power stations;
- **Oil** is the fuel for **transport**;
- **Gas** is mainly used for heating in the **built environment**;
- **Industry** is a major consumer of **all three fossil energy sources**.

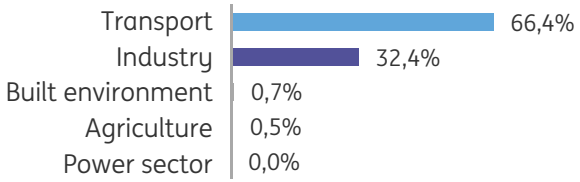
Coal, oil and gas clearly have different major consumers

Shares in total consumption by type of energy source *

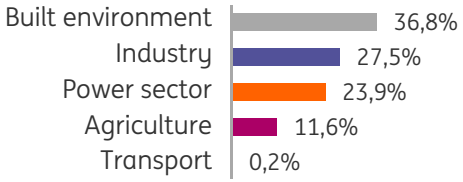
Share in coal consumption



Share in oil consumption



Share in gas consumption



Source: ING Economics Department on the basis of PBL.

* Energy consumption, figures excluding the use of oil and gas as raw materials (feedstock).

Total emission has decreased, but emission of CO_2 has increased

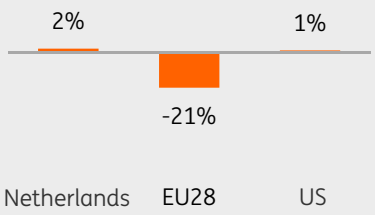
Cabinet targets also require that CO_2 emission decreases

Greenhouse gas emissions have decreased by 12% since 1990. This decrease is due entirely to the 48% decrease in methane, nitrous oxide and fluorinated gases. In that respect the Dutch are leading in international perspective. In contrast, the emission of CO_2 has increased, mainly due to increased power production from coal fired power plants as well as higher emissions in transportation. In order to achieve the 2030 reduction target, the CO_2 emission must also be substantially reduced.

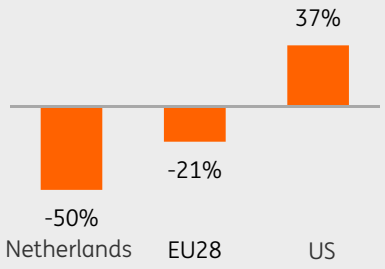
The national targets, like the Paris Agreement, do not take into account emissions from aviation and sea shipping. Related emissions are not shown in the right hand graph as a result.

International comparison

Dutch CO_2 emission increased more since 1990 compared to the US
CO_2 emission, 1990-2016



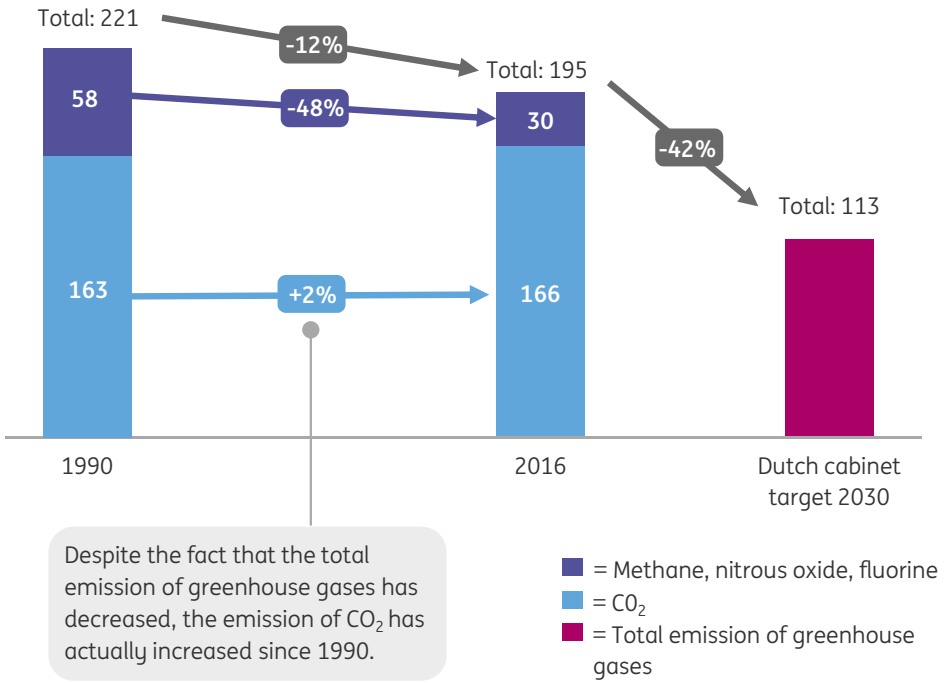
Strong Dutch performance in reduction of methane, nitrous oxide and fluorine
Non-CO_2 emission (methane, nitrous, fluorine, 1990-2016



Bron: PBL; trends in global emissions, 2017.

Total emission of greenhouses gases has decreased, emission of CO_2 has actually increased

Emission of greenhouse gases (CO_2 equivalents), in megatonnes



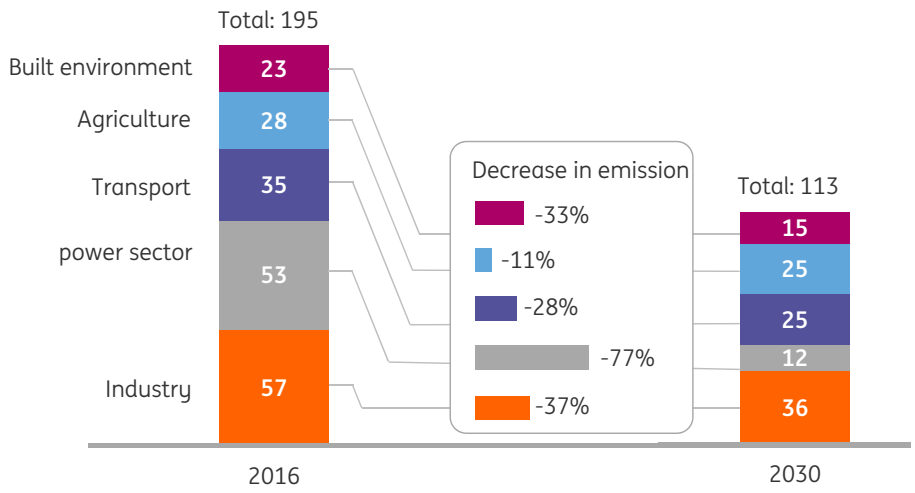
Source: ING Economics Department on the basis of CBS, PBL and Coalition Agreement.

The power sector must achieve the greatest reduction in emission

The coalition agreement contains numerous measures to achieve a substantial reduction in the emission of greenhouse gases. The power sector is the one where the largest reduction is required.

Largest reduction in emission required from the power sector

Emission of greenhouse gases (CO_2 equivalents), in megatonnes



Major reduction measures per sector

Power sector

- Close all coal-fired power plants by 2030 at the latest.
- Ending of the subsidy on biomass co-incineration in coal-fired power stations after 2024.
- More electricity from wind and sun.
- CO_2 capture and storage at waste incineration plants.

Industry

- Capture and storage of CO_2 (Carbon Capture and Storage).
- Improvement of the process coefficient.
- More raw material recycling.

Built environment

- About 1 million homes natural gas-free by 2030.
- Tightening of energy performance requirements for new buildings.
- Increase of energy tax on gas, reduction on electricity.
- Insulation of homes, more heat networks and heat pumps.

Transport

- By 2030 at the latest, all newly sold cars are to be emission-free.
- Investment in refuelling and charging infrastructure for emission-free cars and better public transport and cycling infrastructure.
- Agreements in so-called Greendeals about sustaining maritime shipping, inland navigation and ports.

Agriculture

- Reduced methane emission through improved manure processing, water level management and food mix adjustment.
- Focus on smarter land use and using the greenhouse to generate energy.

Chapter 2 | Transition in the power sector

The power sector is facing an unprecedented challenge

CO_2 emission has risen sharply...

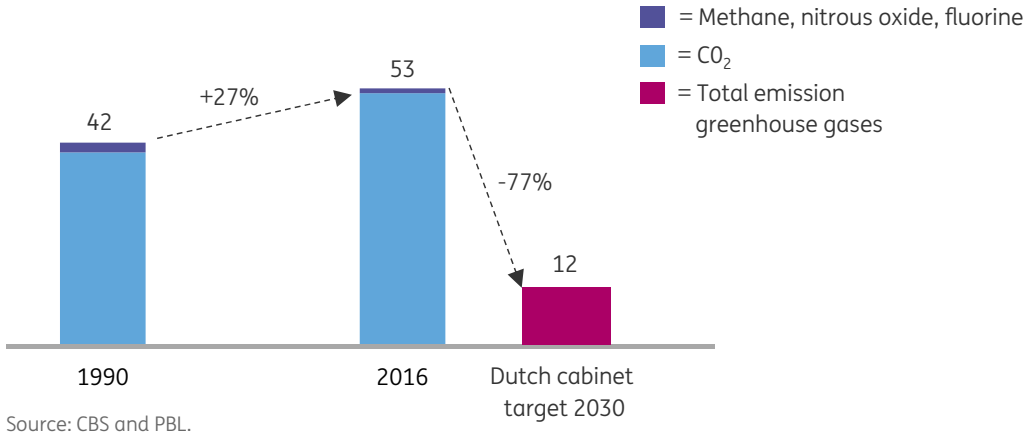
The power sector accounts for three quarters of Dutch coal consumption and a quarter of gas consumption. Because electricity production with coal and gas leads to much CO_2, the sector is responsible for 27% of the total emission of greenhouse gases in the Netherlands. Almost all the emission (98%) consists of CO_2.

Emission has risen sharply since 1990 because of:

- an increase in electricity production;
- an increase in the use of coal which has been cheaper than gas in recent years;
- the construction and commissioning of 3 new large coal-fired power stations.

CO2 emission in power sector increased considerably

Emission of greenhouse gases (CO_2 equivalents), in megatonnes



Source: CBS and PBL.

...but needs to decrease dramatically as we move towards 2030

Nowhere else does the turnaround in the CO_2 emission need to be as strong as in the power sector. While the emission rose by 27% between 1990 and 2016 to 53 megatonnes (+0.9% per year), in the coming years it needs to fall by no less than 77% to 12 megatonnes (-9.9% per year).

<< Contents

Power stations especially in the Randstad

Energy requirement

Most of the power stations are in the Randstad. The energy requirement is high here because of the high population density and the presence of ports and energy-intensive industries.

Coal most polluting

A coal-fired power station generates two to three times more CO_2 per unit of electricity generated than a gas-fired power station. The closure of the coal-fired power stations is expected to result in a net reduction of 11 megatonnes of CO_2 (i.e. more than 20% of the emission of the power sector in 2016). The loss of capacity of the coal-fired power stations can be offset by currently unused capacity at the existing gas-fired power stations and the expected growth in the wind energy capacity.

	Location of power stations	Capacity (megawatt)
1	Rotterdam (7 power stations)	2954
2	Eemshaven (2 power stations)	2370
3	Maasbracht	1900
4	Lelystad	880
5	Vlissingen	870
6	Moerdijk	765
7	Diemen	701
8	Bergum	664
9	Utrecht (2 power stations)	576
10	Amsterdam	435
11	Terneuzen	369
12	Chemelot	231
13	The Hague	97
14	Leiden	81
15	Velsen (3 power stations)	869
16	Rotterdam – Maasvlakte (2 power stations, closure before 2030)	1870
17	Eemshaven (closure before 2030)	1560
18	Amsterdam (closure by end of 2024)	630
19	Geertruidenberg (closure by end of 2024)	600

Source: ING Economics Department on the basis of CBS, PBL and Wikipedia.

Electricity now mainly from gas and coal, later from the wind and the sun

Certainty: wind and solar energy must enable reductions to be made

The two oldest coal-fired power stations shall be closed by the end of 2024, the other three by the end of 2030 latest. In the mid term the loss of capacity can be offset by a higher utilisation of gas fired power plants. In the longer term (offshore) wind and solar energy must enable the transition.

Uncertainty: can targets be met with increasing electricity demand?

Electrification is a solution for industry, built environment and transportation to meet the reduction targets. Scenario analyses for the built environment and transport alone indicate that the power demand can roughly double towards 2050. Electrification in industry only adds to this figure. It is an open question to what extend the increase in power demand will be a limitation in meeting the emission target of the power sector.

Uncertainty: will offshore wind farms be build as scheduled?

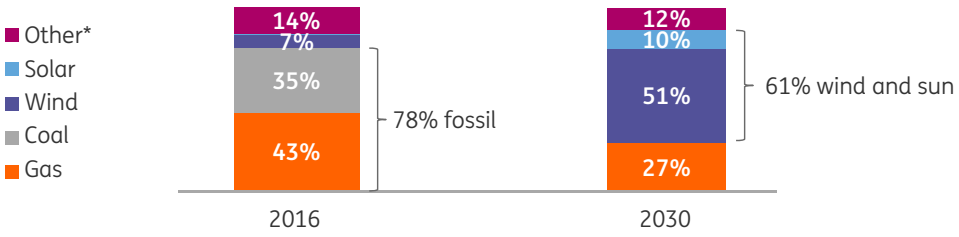
Especially offshore wind energy is the solution to the transition of the power sector. Installed capacity has to grow by one gigawatt yearly. That is quite an ambitious target given the complexity of building offshore and the fact that contractors might choose to delay construction if market conditions deteriorate.

Uncertainty: are storage techniques available in time and will they be affordable?

The Dutch power sector will increasingly depend on wind and solar energy, but the sun does not always shine and the wind not always blow. Gas fired power stations can serve as back up but in the future electricity needs to be stored. There are various storage techniques which differ in terms of storage time and capacity. Hydrogen and hydropower are particularly promising, although cost-effectiveness is still a major challenge.

Electricity now mainly generated from fossil fuels, later with wind and sun....

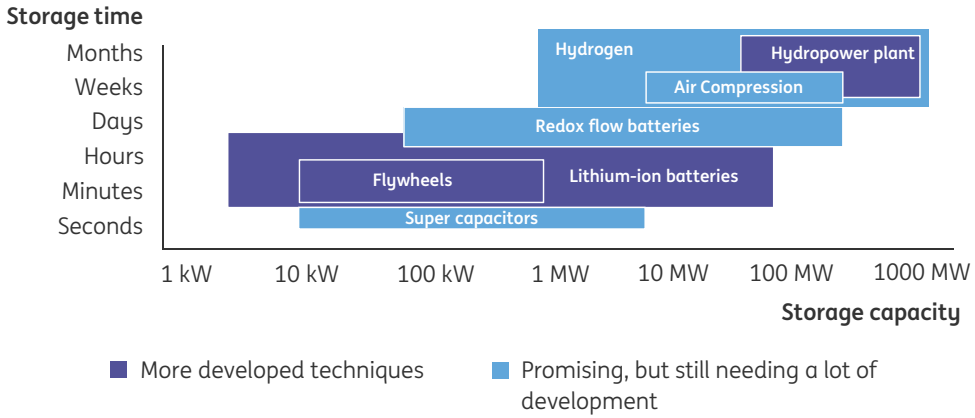
Share in energy production



Source: ING Economics Department calculations on the basis of CBS, PBL and Coalition Agreement.
* Especially hydropower, nuclear and biomass.

...which will require us to store electricity

Storage techniques, storage time vs. storage capacity



Source: ING Economics Department on the basis of BNEF and Wikipedia.

Chapter 3 | Transition in industry

Emission in industry has fallen sharply, but needs to be reduced even more

Industry already heavily engaged in reduction

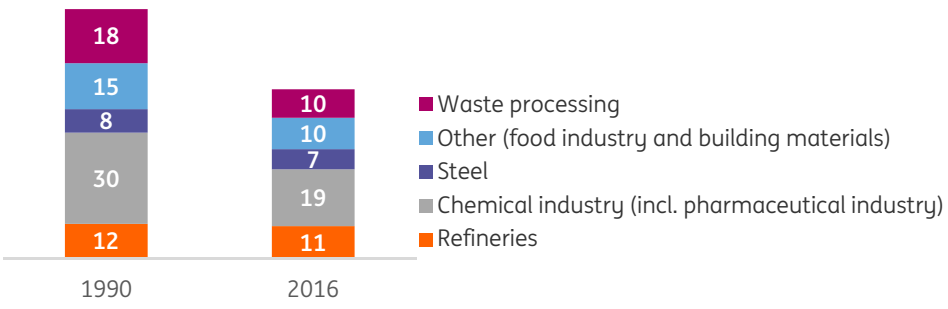
With important elements for the emission such as chemicals, steel and refining, the industrial sector plays a central role in achieving the climate targets. The sector has been able to reduce its emission across the board since 1990. Not only methane (-54%) and nitrous oxide (-81%), but also CO_2 (-17%).

Largest emitter the chemical industry farthest along the road

The chemical industry is the largest emitter in the industry sector with a 40% share, but with a 40% reduction it has already taken the biggest step. This is due to the reduction of nitrous oxide, which has been reduced by 85% and which accounted for a fifth of the total emission in the industry in 1990.

Reduction of emission across the board in industry

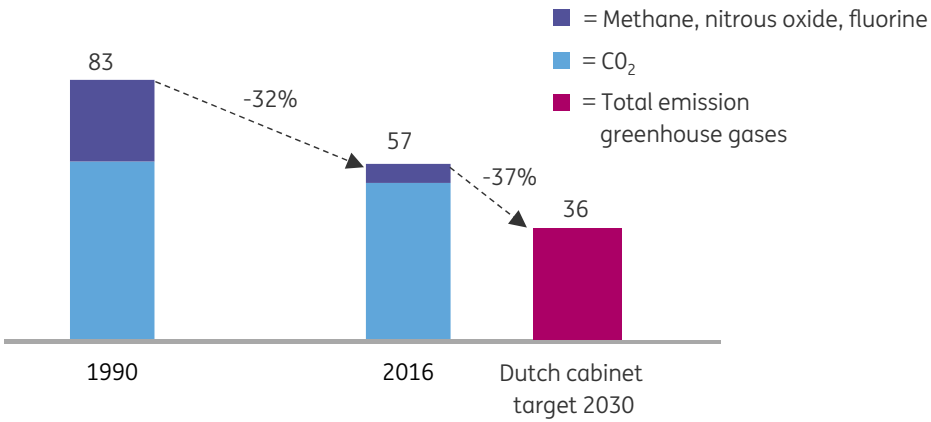
Emission of greenhouse gases (CO_2 equivalents), in megatonnes



Source: ING Economics Department on the basis of CBS

Industry emits a quarter less, but still needs to reduce by more than a third

Emission of greenhouse gases (CO_2 equivalents), in megatonnes



Source: ING Economics Department on the basis of CBS, PBL. Industry including waste processing

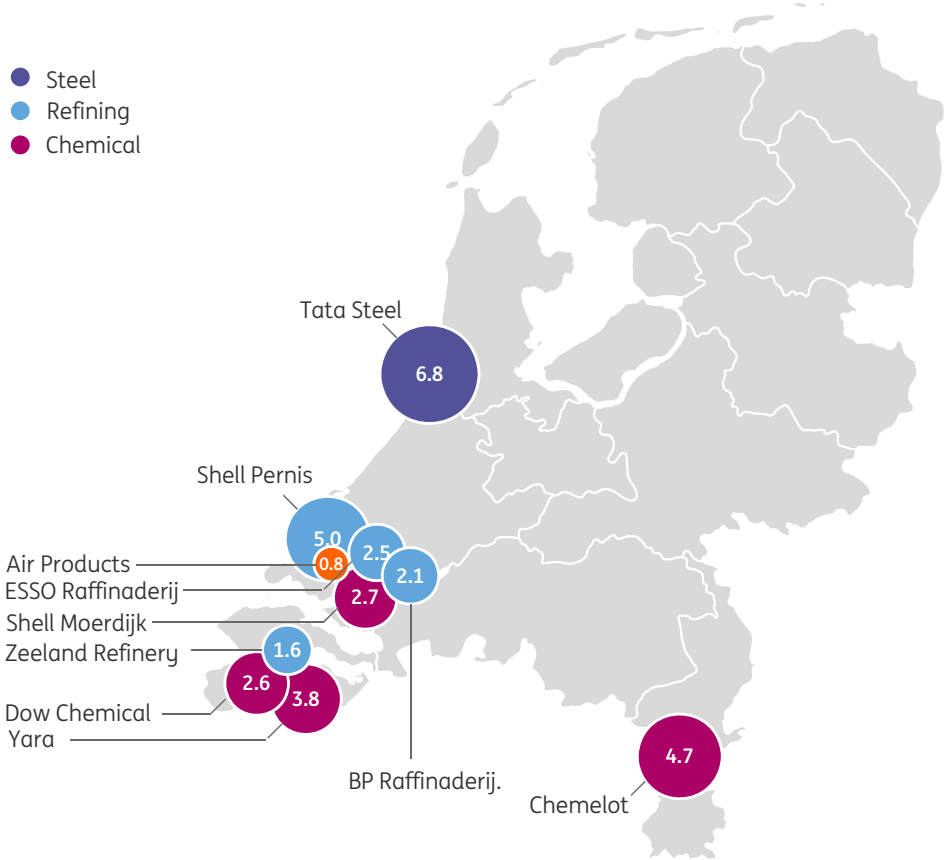
<< Contents

Many large emitters in the southwest of the Netherlands

Large companies dominate the emission of greenhouse gasses
The emission of greenhouse gases by industry is highly concentrated. The top 10 accounts for more than 70% of the total emission of CO_2 in the industry sector.

Concentration is an advantage, foreign ownership can influence tempo
The advantage of a limited number of large emitters is that the problem is clear, although it does not diminish in size. The Netherlands wants to be one of the leading countries in terms of reducing greenhouse gases and industrial complexes are an important factor in this. A difficult issue may be that most of the large industrial companies are part of a foreign parent organisation. Major investment decisions are taken at the foreign head office, which may affect the speed of the transition.

10 largest industrial emitters of CO_2 in the industry by location in 2017
CO_2 emission in megatonnes*



Source: Emissions authority, editing ING Economics Department. *Reuse of greenhouse gases not corrected for in this. Yara used, for example, 1.4 megatonnes in its own production and supply to agriculture.

Multiple solutions needed in industry, capture and reuse promising

Certainty: multiple techniques needed

Industry can make itself more sustainable in a number of ways, all of which are needed to achieve the reduction target:

1. Increased efficiency of production processes;
2. Capture and storage of CO_2 (CCS: carbon capture and storage). This ambition has been scaled down from 18 to 7 megatonnes of CO_2 in 2030, of which 2 to 5 is feasible in the Port of Rotterdam.
3. Reuse of residual gasses is an opportunity. Not in the least part, because (industrial) companies in the Netherlands are relatively close to each other (see visual).

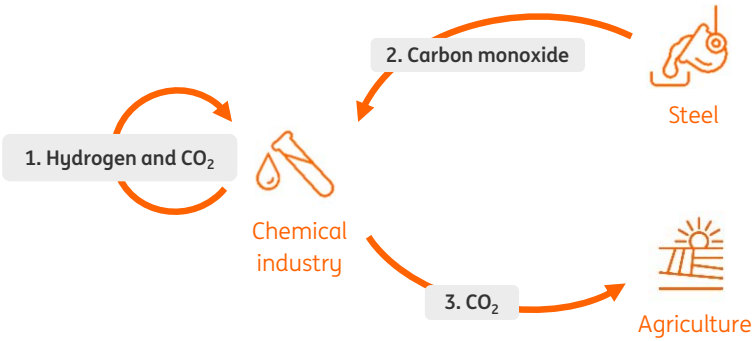
Uncertainty: Will the competitive position of industry remain intact?

The Dutch manufacturing sector is active in global markets. Therefore it's competitiveness is crucial for success. On the one hand a fast transition might facilitate a leading position in terms of innovation, on the other hand it might worsen cost competitiveness. Question remains to what extend international targets and agreements can solve these dilemmas.

Start now with future electrification

Electrification is still being researched, but must ultimately also bring about radical greening in the industry. In order to reap the benefits between 2030 and 2050, the sowing must start now. For example, with investments in research and pilot plants. Due to the low CO_2 price, many solutions still require financial support. There is therefore a great deal of uncertainty about who is going to pay for this and whether it will affect competitiveness too much. At the same time, there is an opportunity to switch to more sustainable production techniques with the replacement of old plants.

Solutions for reuse of residual gases



1. Reuse of hydrogen

Hydrogen which, for example, is released during the cracking of naphtha can be reused as a raw material in the chemical industry for the production of ammonia or other products. Similarly, residual product from Dow Chemical can be reused by Yara and ICL, for example.

2. Reuse of CO (carbon monoxide) from the steel industry in the chemical industry

The production of steel releases carbon monoxide. At Tata Steel, this is delivered to the nearby power station for power generation, but this is paired with twice as much CO_2 emission as for energy from coal. In the chemical industry, carbon monoxide can be used as a raw material. This solution requires investments, but offers great opportunities.

3. From waste to chemistry 'waste2chemistry'

CO_2 from industrial processes can be used in agriculture to stimulate the growth of crops (see chapter on agriculture).

Chapter 4 | Transition in the built environment

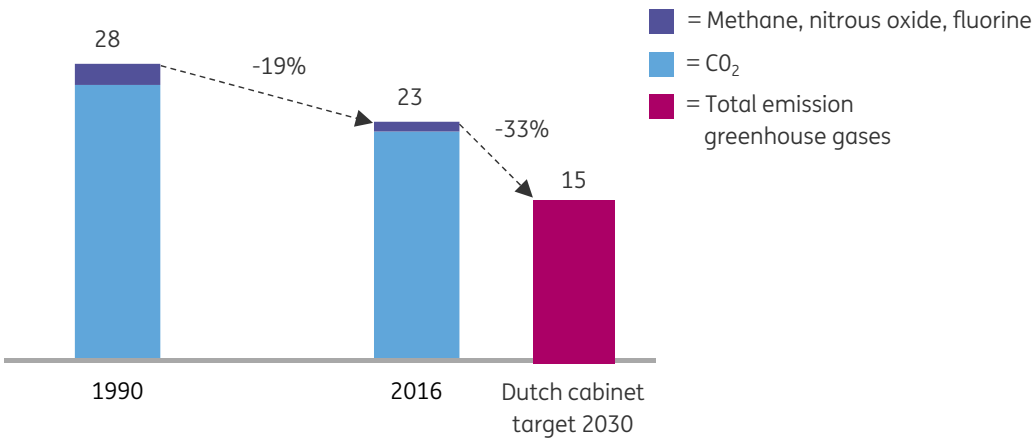
Emission through buildings should reduce by 3% per year

Gas consumption leads to emissions

The energy consumption of the built environment (residential and commercial properties) consists mainly of the consumption of natural gas and electricity. Only natural gas leads to emissions in the built environment itself. In 2016, more than 23 megatonnes of greenhouse gases were emitted, the majority of which was CO_2 (96%). Thus buildings are responsible for 12% of the Dutch emission. The built environment needs to reduce the emission to 15.3 megatonnes by 2030. The emission reduction rate until 2030 therefore needs to accelerate by more than three times to 2.8% per year. Gas use in the built environment needs to be reduced as a result. This is a major challenge in which the emphasis in the public debate is currently on the housing stock. Eventually, offices, shops and business premises must also stop with gas.

Emission reduction rate change from -0.8% to -2.8% per year

Emission of greenhouse gases (CO_2 equivalents), built environment in megatonnes

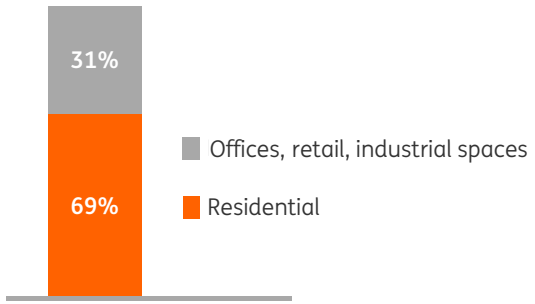


A long-term process

The emission of greenhouse gases has decreased slowly by 0.8% per year since 1990. On the one hand, property is becoming increasingly better insulated, which means that average gas consumption and the emission are falling. But on the other hand, it takes a long time to insulate the stock properly and the stock is still increasing due to the growth in the number of households and business activities. The coalition agreement aims to make about 1 million homes natural gas-free by 2030. As yet there are no concrete targets for commercial real estate.

Two thirds of gas used in houses, one third in commercial real estate.

Share of gas use in built environment



Bron: ING Economisch Bureau o.b.v. CBS en PBL

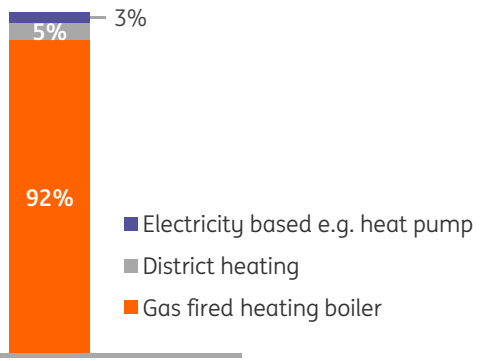
Phasing out of gas: technically feasible, but difficult to realise

Technically feasible, but difficult to realise

One certainty is that there are many technical possibilities for reducing CO_2, but it is not easy in practice. The costs of the savings options are relatively expensive compared to other sectors and it is difficult to create economies of scale. In the existing housing stock, it is not easy to phase out the popular and cost-efficient central heating boiler very quickly.

Gas fired heating boiler dominates Dutch houses

Share energy source in housing heating provision



Bron: ING Economisch Bureau op basis van CBS, PBL, CE Delft, Berenschot, Ecorys en RIVM, Milieudefensie.

Getting homes off gas is a topical issue, technically possible, but not easy.

There are various alternatives to the central heating boiler, such as heat pumps, better insulation of homes, use of geothermal energy or heat networks with residual heat (district heating).

The disadvantages of the alternatives are important barriers to a rapid phasing out of the central heating boiler:

More expensive
Many alternatives are even more expensive. Although the costs shall decrease in the future, the central heating boiler shall continue to be the most efficient choice for certain types of households in the future. This is so, for example, for people with a low income and an energy-efficient home.

Requires more space
Alternatives for the central heating boiler require more space and are therefore generally not an option for very small homes (families in city centres with high m2 prices).

Heat pumps contain greenhouse gases
Heat pumps contain greenhouse gases such as HFKs that are also harmful to the environment. More heat pumps would go against EU regulations to phase out these greenhouse gases.

Electrification requires grid reinforcements
Electrification of the heat requirement requires grid reinforcements, especially in neighbourhoods where this is difficult, for example in historic city centres with relatively old networks.

Many uncertainties

The transition to a gas-free built environment still has many uncertainties. Important questions are:

- To what extent can local electricity networks cope with an electrification of the heat supply?
- Who will pay for the still high costs of taking existing homes off gas, and will lower incomes be compensated?
- Are there enough technical personnel available to carry out a rapid transition?

Chapter 5 | Transition in the transport sector

<< Contents

Rising emission must be reversed

CO_2 emission in the transport sector is not yet falling

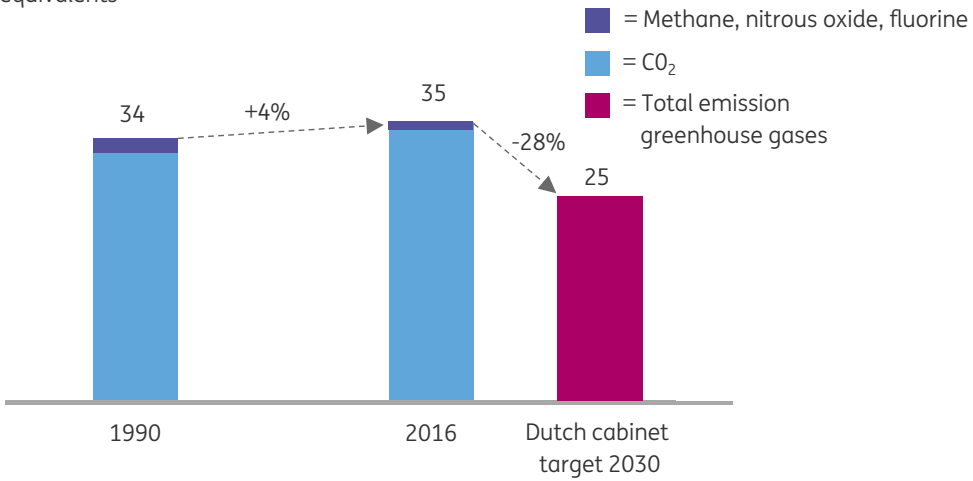
The transport sector, next to the electricity generation sector, is the only sector in which the CO_2 emission has grown since 1990. For the official climate targets, only road traffic is generally taken into account, which is by far the largest emitter. In 2016, the emission was 4% higher than in 1990. This while the intention is to reduce the emission by 28% by 2030. It is highly likely that the demand for transport will continue to grow in the near future.

Aviation and maritime transport outside the target, but emission is rising

The emission of these sectors has increased by 145% and 42% respectively since 1990. Both sectors are pre-eminently active internationally, but are not part of the Paris Agreement and are also largely outside the scope of the Dutch climate agreement. At the same time, both sectors, and in particular aviation, continue to grow. The global allocation of the emissions to countries is complex, but in view of the growing emission it is important that attention is given to this. It is still very uncertain if and when this will be reflected in the national reduction targets.

The emission by the transport sector has increased by 4%

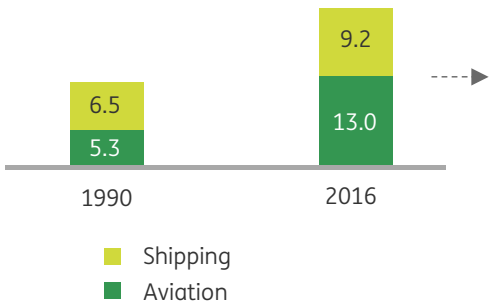
Transport sector emission (including tractors and road traffic), in megatonnes CO_2 equivalents



Source: CBS, IPCC, emission of nitrous oxide and methane very limited

Emission from shipping and aviation significantly higher than in 1990

Emission from shipping and aviation, in megatonnes CO_2 equivalents*



Sector targets for 2050

- Maritime shipping: 26% reduction compared to 1990
- Inland navigation: 100% reduction compared to 1990
- Aviation: (still) no CO_2 reduction target, but the sector aims to grow with zero emissions from 2020 onwards

Source: CBS, national accounts, emission of nitrous oxide and methane very limited

*Emissions from aviation and shipping are exclusively from foreign companies that refuel (bunker) in the Netherlands. Schiphol Airport and especially the Port of Rotterdam are important ports for fuel supply, amounting to **52 megatonnes of CO_2** in 2015. This remains largely outside the climate targets, but is important since it is increasing and the allocation may change.

<< Contents

Opportunities for a substantial reduction in CO_2 emission in road transport

Road transport is an important source of emission. Approximately two-thirds of the emission come from passenger cars and one-third from vans and trucks.

Despite a growing car fleet, emission from passenger cars can be reduced significantly as we go towards 2030

Cars in the Netherlands are relatively old and polluting. Although the vehicle fleet will increase in size in the coming years, the total emission can be reduced considerably. The large reduction impulse comes from electric vehicles. Whether battery technology will continue to show rapid technological and cost improvements is a big uncertainty. If so, electric vehicles will be cost competitive with internal combustion engines (petrol and diesel cars) in 2024 on a total cost of ownership bases.

Electric vehicles need to be charged. Currently around 35% of electricity in the Netherlands is generated by coal fired power plants. The greening of power generation will reduce the total emission from electric vehicles (see visual).

Energy transition in road transport

About one third of the emission in road transport coms from vans and trucks of which the vast majority runs on diesel. Emission can be reduced by:

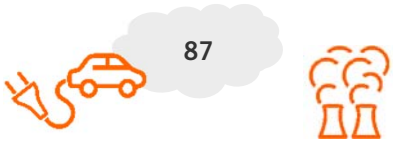
1. **Fuel saving** delivers an immediate gain and is therefore most important in the short term. This includes, for example, an optimum driving style, speed limits and replacement by the cleanest new Euro VI vehicles or by long heavy vehicles.
2. For trucks, too, **electrification** can lead to substantial progress. After light trucks and vans, after 2020 the heavy electric truck will be widely available on the market. Emission-free city centres and urban transport should make a significant contribution to reducing emissions especially between 2025 and 2030.

Electric car in combination with greening of the power sector leads to enormous reductions in the emission

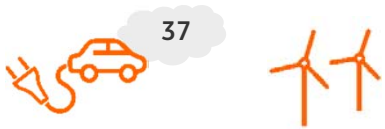
CO_2 emission in grammes per kilometre

The current average emission per car

The emission of an electric car with the current Dutch electricity mix (including 35% coal)*



The emission of an electric car when the electricity from coal is replaced by wind and sun. The remaining indirect emission then comes from power generation in gas-fired power stations.



* The electric car has no direct emission, but power generation does (indirect emission)
Source: ING Economics Department calculations on the basis of CBS

Aviation and shipping are both not yet on the climate course

Aviation and maritime shipping currently not included in emission targets, but might be in the future

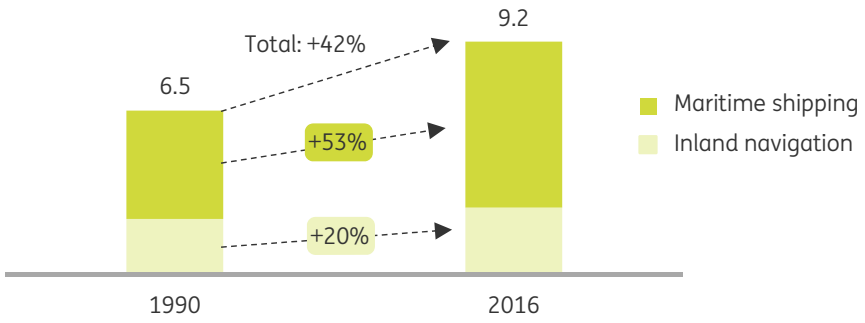
Both air and sea transport remain outside the climate targets*. However, they are sectors (in particular aviation) that are growing rapidly and are therefore increasing the burden on the climate. Inland navigation, however, is covered by the climate agreement.

Shipping starts to set own targets

Due to the fact that shipping is not included in the Paris Agreement and the need to reduce emissions becomes more evident, shipping is imposing targets on itself. The International Maritime Organisation aims to reduce emission by 50% in 2050 in reference to 2008. For the Netherlands, this implies a 26% reduction from 1990 levels. There are several ways to reduce emission. Large players in inland navigation aim to sail emission free in 2050. Aviation, in contrast, does not have clear reduction targets yet. As of 2020 it wants to offset emission, but that does not imply an actual reduction in emission.

Emission especially from shipping increased

CO_2 emission from shipping in megatonnes



Source: CBS Environmental Accounts, emission Dutch companies

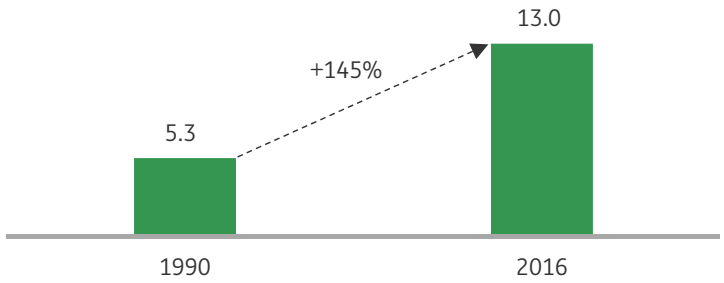
*with the exception of inland waterway transport seagoing vessels and take-off and landing of aircrafts

Demand in aviation continues to grow faster than efficiency gains

Aviation is growing rapidly as a result of increasing prosperity and more tourism. This is partly stimulated by the fact that flying is relatively cheap due to the lack of excise duty and VAT. Future growth in the Netherlands is determined by political decisions to what extend Schiphol and Lelystad Airports are allowed to grow. Nevertheless, aviation is expected to grow 4.5% per annum globally until 2030. This exceeds fuel savings made through efficiency and aircraft replacement.

Aviation outlier with 145% higher emission

CO_2 emission from aviation in megatonnes



Chapter 6 | Transition in the agricultural sector

<< Contents

Emission reduced, in particular from nitrous oxide

Methane accounts for half of agriculture emission

In contrast to other sectors, CO_2 is not dominant in the total emission of greenhouse gases by the agricultural sector. Only a quarter of the emission is CO_2 which is caused mainly by the heating of greenhouses and the use of tractors and agricultural machinery. Methane accounts for half of the emission and therefore attracts attention. The emission is mainly caused by livestock farming.

Significant decrease in nitrous oxide and fluorinated gases

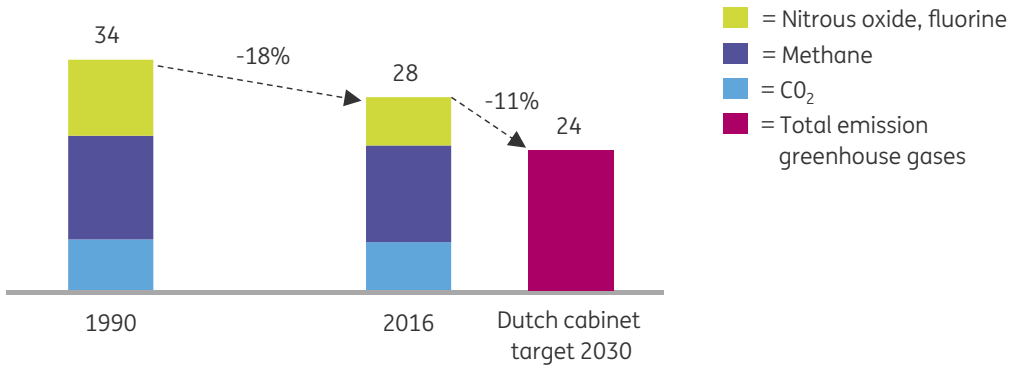
Between 1990 and 2016, the emission of greenhouse gases in the agricultural sector fell by 18%. Just as in the chemical industry, the largest decrease so far has been achieved in nitrous oxide and fluorinated gases due to low-emission manure application techniques. At the same time, the methane emission has only slightly decreased, although milk production is considerably higher due to efficiency gains.

Climate challenge in agriculture relatively limited

In comparison with other sectors, the agricultural sector faces the smallest challenge within the Dutch targets. By 2030 the sector will still have to reduce by 11%, which is considerably less than for the other clusters. Apart from greenhouse gas emission the reduction of particulate matter to improve air quality is a top priority.

Total CO_2 emission agriculture decreased by 18%

Emission of greenhouse gases (CO_2 equivalents) in agriculture in megatonnes



Source: CBS, ING Economics Department

<< Contents

More use can be made of CO_2 from industry

Collaboration in recycling and own green energy solutions for agriculture

The agricultural sector has a reduction target of 3 megatonnes by 2030. Reduction measures include:

1. The use of high quality fodder and shortening the duration of manure storage.
2. The agricultural sector is working on utilising solutions for renewable energy for the replacement of natural gas with sustainable sources and for the generation of green energy. Examples include the fermentation of biomass, the use of geothermal energy, solar panels and wind turbines.
3. Use of residual heat and CO_2 from other sectors through heat and CO_2 networks (see box).

Vine tomatoes thanks to industrial residual heat and residual CO_2

An excellent application of reuse is the supply of residual heat and CO_2 to the greenhouse horticulture sector neighbouring **Yara in Sluiskil** (Zeeuws Vlaanderen). This is where vine tomatoes, aubergines and peppers are grown. Because of less gas consumption, CO_2 is reduced by 0.14 megatonnes. The greenhouse complex has expanded quickly, increasing its potential.

From port to greenhouse

A similar combination will be created with the expansion of the heat network between the Port of Rotterdam and the Westland. Links between, for example, waste processing plants and greenhouses are also possible in other locations. The potential for this is great. The disconnection of Groningen gas in greenhouse horticulture has increased the urgency.

Certainties/uncertainties

The transition to a sustainable agricultural sector still faces many certainties/uncertainties. The following is quite certain.

- Methane and CO_2 emissions need to be reduced as well to meet the target. Reducing the dairy herd does not provide a solution as production will be replaced abroad at often higher greenhouse gas emissions.
- With regard to sustainability, a lot of the low-hanging fruit has already been picked.

But there are also many uncertainties. The main questions are:

- How expensive is it to reduce the emission of methane?
- To what extent shall the link with other sectors be exploited for example by the use of heat networks and CO_2 infrastructure?

<< Contents

This can also interest you

Regional emission of greenhouse gases
Utrecht the cleanest province, Zeeland the most polluting (in Dutch)

Ascent of the electric car
Breakthrough of electric vehicle threatens European car industry

Alternative fuels in road transport
Truck and trailer market getting ready for CO_2 reduction (in Dutch)

Innovative companies are at the forefront of sustainability
Earning money from sustainability (in Dutch)

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Most consulted sources in Dutch

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PBL; Analyse regeerakkoord: effecten op klimaat- en energie, 2017
PBL; Kosten energie- en klimaattransitie in 2030, update 2018
PBL; Trends in global CO_2 and total greenhouse gas emissions, 2017
Rijksoverheid; Regeerakkoord 2017-2021, 2017

Want to know more?

Authors

Gerben Hieminga
Economist
+31 (0)6 83 64 00 72

Rico Luman
Economist
+31 (0)6 83 64 89 54

Jurjen Witteveen
Economist
+31 (0)6 83 63 57 86

With the assistance of

Anna Dijkman — ING Economics Department
Lex Hoekstra — ING Economics Department
Dirk Jan van Swaay — ING Sector Banking

Take a look at ing.nl/kennis and follow us on Twitter

Analisten:
Gerben Hieminga gerben.hieminga@ing.com
Rico Luman rico.luman@ing.com
Jurjen Witteveen jurjen.witteveen@ing.com