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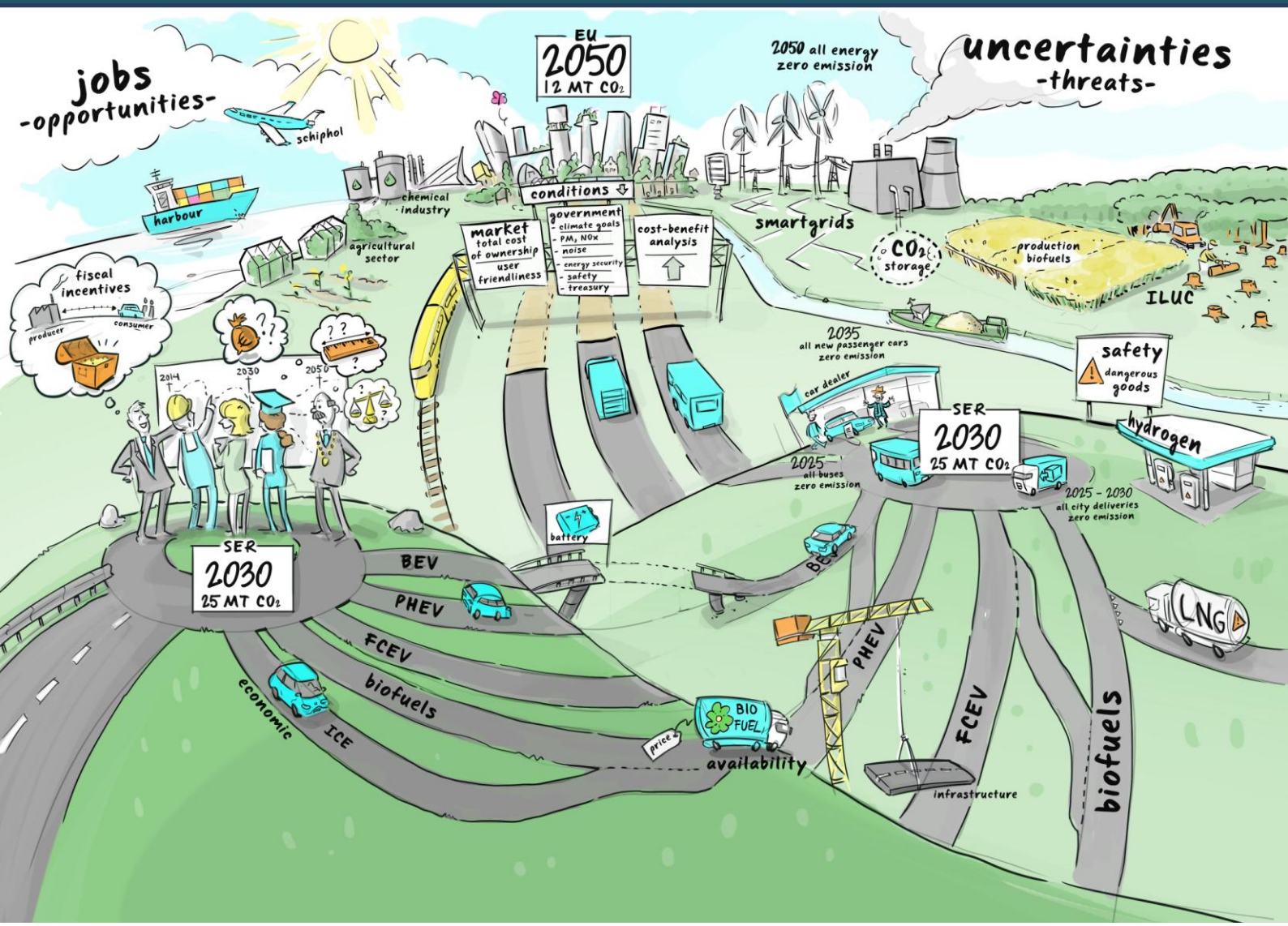
Key findings of the SER vision programme

towards a sustainable fuel mix in the Netherlands



A vision on sustainable fuels for transport

Key findings of the SER vision programme, Towards a sustainable fuel mix for transport in the Netherlands

June 2014

COLOPHON

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FOREWORD

Within the framework of the SER Energy Agreement completed in September 2013 by the Dutch Cabinet and various stakeholders, ambitious targets in the field of energy and climate were set. Our ministry was asked to lead the development of an integrated vision and action plan for a sustainable fuelmix in the transport sector, that allows the ambitious targets for the transport sector to be met in 2020, 2030 and 2050.

Demand for sustainable mobility and energy is an important topic on today's international agenda of the European Commission, International Energy Agency, UNFCCC and other relevant international organisations. At a European level a new directive has recently been adopted (Clean Power for Transport Directive) that states that alternative fuels are urgently needed to break the over-dependence of European transport on oil. Transport in Europe is currently 94 % dependent on oil, 84 % of it being imported, with an estimated bill up to EUR 1 billion per day, and increasing costs to the environment. Research and technological development have led to successful demonstrations of alternative fuel solutions for all transport modes. Market take-up, however, requires additional policy action. The Clean Power for Transport package aims to facilitate the development of a single market for alternative fuels for transport in Europe. All Member States are required under the new Directive to provide sufficient infrastructure for alternative fuels for transport and are urged to use international co funding opportunities within the EU.

This has led in the Netherlands to the development of a vision for a sustainable fuelmix for transport. A vision that inspires, connects, is realistic and provides insight in various pathways allowing the transport sector to set course for a more sustainable future. It can therefore serve as a reference framework, provides a basis for an actionplan that will be drawn up in the course of 2014 and enable a transition to a sustainable fuelmix for transport. During six sessions at the LEF Future Center, more than a hundred experts and stakeholders were challenged to look beyond their own expertise and help to clarify the anticipated development paths for road transport, rail transport, inland shipping, maritime shipping and aviation. The project team and the LEF management created an inspirational environment in which the relevant issues could be explored in depth in a number of meetings on special ' round tables on various fuels without compromising the integrity of our task: securing clean and economical transport for the future.

The vision should integrate the various transport modalities and the targets. Whilst energy and climate targets were central to development of the vision, explicit attention was also given to air quality, health, external safety and economic opportunities. The outcome is an ambitious and realistic vision, setting out how we can achieve the objectives of the Energy Agreement for Sustainable Growth and the Climate Agenda. Although we made great progress together, some issues remain to be resolved such as the availability of biomass for the transport and the extent to which gas can be used for road transport. These and other points are on the agenda for further consideration during the action plan phase.

We wish to thank all of you who contributed to the project for your invaluable input and cooperation. There is every reason to be proud of this vision that we have created together. Its publication demonstrates that all those who took part in the project realise that we must now act together and seize the opportunities in order to ensure that the Netherlands is amongst Europe's leading nations in the field of sustainable mobility. In the autumn, we will begin the task of translating the vision into an actionplan by developing a robust package of public and private measures. We look forward to setting the next step on our pathway to sustainable mobility; drawing up those plans that will allow us to put the vision into concrete action!

Els de Wit

Innovation, Fuels and Infrastructure Coordinator

Ministry of Infrastructure and the Environment

SUMMARY: A VISION ON SUSTAINABLE FUELS FOR TRANSPORT

In the Netherlands this vision of a sustainable fuel mix has been compiled in the first half of 2014 following intensive collaboration between more than 100 organisations.

Around the world, a number of major transitions are taking place with regard to energy provision (sustainability and energy conservation) and the use of fuels. This vision brings together climate-related mobility objectives and social issues relating to sustainable energy, energy conservation, green growth, living conditions (air quality and noise pollution) and safety in a global context.

The driving factor in the Netherlands is the Energy Agreement signed under the auspices of the Social and Economic Council (SER) in September 2013, in which ambitious Tank-to-Wheel (TTW) objectives[1] were agreed in order to reduce the CO_2 emissions of the mobility and transport sector. It is important that the activities conducted for this purpose also help to reduce Well-to-Wheel (WTW) carbon emissions, and closer examination must be conducted into the relationship with other measures unrelated to fuel or vehicles, such as behavioural change, logistic efficiency, and better use of infrastructure.

Achieving the Energy Agreement's objectives whilst simultaneously stimulating green growth will be a major challenge that requires courage, decisive action, co-operation, consistent strategies, and the willingness to invest. To realise this goal, there must be approximately 3 million zero-emission vehicles in the Netherlands by 2030. In order to satisfy the objectives and simultaneously reap the benefits of green growth and improvements in living conditions, these developments must be initiated immediately. The shipping sector (both inland and ocean shipping)[2] have set themselves the objective of achieving a 50% reduction in CO_2 by 2050 in comparison with 2020 levels. This objective, which was later repeated in "*Groen en Krachtig Varen*" (Eng: Powerful and Green Shipping), the environmental brochure of the KVNR[3], matches the Energy Agreement objectives for the energy sector. The aviation sector is establishing ambitious and far-reaching sustainability goals in accordance with stringent international certification criteria. A substantial proportion of the rail sector already runs on electric power.

The result of this process is an adaptive and targeted multi-track strategy that will make the Netherlands a European front-runner in sustainable mobility and a pioneer in a number of promising niches.

- The Netherlands is committed to switching to electric propulsion in transport sectors in which electricity is a promising alternative. Electric motors will be combined with sustainable biofuels and renewable gas[4] as a transitional option and a long-term solution for heavy transport. Both avenues will be supported by continual efforts to improve efficiency.
- For the shipping sector, the Netherlands is committed to implementing efficiency measures in combination with a transition to LNG and use of sustainable biofuels[5] for short-sea and inland shipping.

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[1] Maximum total emissions of 25 Mt CO_2 in 2030 compared with 1990 (-17%) for all transport in Dutch territory. These objectives apply in accordance with the IPCC definition: they include only greenhouse gas emissions within Dutch territory, and the use of biofuels, electricity and hydrogen are classified as zero emissions for the transport sector. In other words, these are Tank-to-Wheel objectives. When they apply to the entire chain, we refer to them as Well-to-Wheel objectives.

[2] In the "Energy Efficiency and CO_2 Reduction Agreement for Shipping", signed by the Minister for Infrastructure and the Environment.

[3] The members of the Royal Association of Netherlands Shipowners.

[4] This term includes biogas, bio-LPG, bio-DME, bio-LNG, power-to-gas methane and power-to-gas Synthetic Natural Gas (SNG) if produced from sustainable sources and if the CO_2 emitted during production is captured.

[5] Until 2030, biodiesel will be predominantly used, with a possible transition from LNG to bio-LNG by 2050.

- In the aviation sector, improvements in efficiency are being made by means of innovative aircraft technology, operations and infrastructure, as well as continued development and application of sustainable biokerosine sourcing, production and distribution.
- For the rail sector, the Netherlands is dedicated to expanding the use of sustainable electricity, as well as replacing diesel trains with LNG- and bio-LNG-powered trains (depending on the technical and economic feasibility).
- The periodic strategy updates that take place every three or four years create opportunities to introduce new technologies and additional instruments.

The transition to a sustainable energy mix requires:

- Made-to-measure support: Support will be tailor-made to suit specific product-market combinations and the specific development phase that the product is in. After all, products that are market mature require different support to products in the R&D stage.
- Co-operation between all relevant policy areas at all scale levels within an international context: Every policy type has a different scale level (regional, national, European, global) that varies according to the mode of transport in question. Measures for road transport are predominantly applied at the national level, inland and short-sea shipping at the European level, and aviation and deep-sea shipping at the global level.
- Swift investments to realise maximum benefits: Although 2030 and 2050 are a long way away, opportunities exist today to develop niche and early markets in order to optimally position the Netherlands for the future large-scale roll-out of technology for green vehicle transport and sustainable fuels. In a number of areas, the Netherlands can be a frontrunner.

Promising green growth projects[6] further build upon the Netherlands' strong position and its specific circumstances, such as the high degree of urbanisation. Sustainable mobility links five of the current nine innovation agendas. Promising niche markets – for both existing market players and newcomers/start-ups – in the green-growth sector with the potential for market leadership include:

- Electric transport: development and application of products and services regarding recharging infrastructure, smart grids, energy storage, and special vehicles/components.
- Hydrogen: pilots and market-introduction studies on fuel-cell cars and other vehicles (buses, refuse lorries etc.); development regarding the production and distribution of sustainable hydrogen fuel as a long-term solution. (The hydrogen economy is important for industries relating to hydrogen-fuel-cell technology, system integration, the production and distribution of hydrogen, and the supply industry.)
- Renewable gas: front-runner in R&D and pilots relating to the distribution and production of renewable gas for light vehicles and LNG/bio-LNG for heavy vehicles and shipping and certain segments of the rail sector.
- Biofuels: front-runner in the development and distribution of sustainable biofuels[7].

With an action plan made up in 2014 and a coalition of the willing, we will begin to make this vision a reality. To achieve this vision, the following points must be put on the agenda:

[6] 'Green growth' refers to the transition to a sustainable economy and the promotion of economic growth that also entails the reduction of pollution, more efficient use of raw materials, and the preservation of natural resources (source: CBS (2013), Green Growth in the Netherlands 2012).

[7] In the EU, specific criteria have been defined relating to the use of sustainable fuels. At the very least, Well-To - Wheel greenhouse gas emissions, risk of indirect land-use changes, and risks to food supplies should be taken into account.

Strategy development and action plan:

- Strive to be a front-runner in specific niche markets that offer opportunities for green growth and contribute to the pioneer projects.
- Form coalitions and examine possible synergy between the sustainable fuel mix, smart grids, energy storage and power-to-gas.
- Gear development policy towards businesses that will be willing and able to play a key role in the sustainable fuel and vehicle mix (the pioneers).
- Encourage existing sectors – such as shipbuilding or fossil fuel / biofuel production and distribution – to focus on making fuels more sustainable.
- Condense the vision and strategy into an action plan.

Source-based policy:

- Collaborate at the EU level to establish CO_2 requirements for vehicles (fleet averages of car manufacturers) that are based on the 60% CO_2 reduction objective for 2050.
- Collaborate at the EU level to reduce greenhouse gas emissions within the fuel chain – preferably within the EU Fuel Quality Directive (FQD) – and reformulate the EU Renewable Energy Directive after 2020 (following the renewable energy in transport objective), ensuring that it encompasses all fuels and that direct and indirect greenhouse gas emissions constitute the guiding factor. This will help to introduce renewable energy in all market segments of the fuel sector. It is also in line with the recommendations made by the Corbey commission.
- Focus on realising the commercial availability in the Netherlands of vehicles with zero CO_2 exhaust emissions by 2035, in addition to examining how these efforts can be realised at the EU level.
- Work towards the implementation of fuel-blending obligations in the shipping sector for sustainable biofuels or towards other renewable energy objectives, and put the standardisation of CO_2 emissions and methane slip on the agenda.

R&D and innovation:

- Develop and reinforce the market introduction of and market-development programmes for various forms of electric propulsion in passenger and freight vehicles, including loading and hydrogen-tank infrastructure and related services, as well as connection to the energy network.
- Develop programmes for sustainable fuel production by means of cascading and biorefinery.
- Work on the development of the bio-based economy. The bio-based economy can contribute to the development of advanced bio fuels with a low environmental impact.
- Facilitate a testing ground for efficiency improvements for the deep-sea shipping sector and for the bulk consumers in the short-sea and inland shipping sector.
- Support the innovation, investment and sustainability ambitions of the aviation sector to realise efficiency improvements and sustainable biofuels by means of further development of the Bioport Holland Concept.

Financial incentives (fiscal or otherwise):

- Work at both the national and EU level on a fairer CO_2-dependent incentive relating to vehicles, vessels and aircraft as well as fuel/energy carriers, with further examination in the long term of the entire chain and not just the specific attributes of the vehicles themselves. To this end, make long-term agreements in order to provide financial security.
- Create a public-private infrastructure fund for charging points for battery-powered electric cars, renewable gas and hydrogen fuel stations, and LNG bunker stations.
- Incentivise the transition from existing diesel ships to LNG ships or more sustainable technology and applications.
- Conclude a covenant regarding the financing of sustainable investments.

Supporting measures:

- Support purchasing consortia with tendering experience.
- Support regional initiatives, learn from these experiences, and roll the successful initiatives out at the national level.
- Encourage collaboration and coalition-forming between businesses in order to reinforce their growth potential and to give the Netherlands an optimal platform to present itself as a leading player in the field of sustainable mobility.

CONTENTS

BACKGROUND AND PROCESS: A MAJOR CHALLENGE REQUIRES A STRONG, SHARED VISION

Mobility and transport are important both for our welfare and for our prosperity. The Netherlands is a trading nation. A nation that likes to describe itself as an international distribution hub; a nation that lives by the transportation of raw materials, semi-finished and finished products along the chain to the consumer. Fast and reliable passenger and goods transport are essential to the quality of interpersonal and commercial relations between supplier and client and between employer and employee. In short: mobility is essential for the vitality of our society and our economic system. However, certain aspects of our mobility system have an adverse impact on people, the economy and the environment. Examples include persistent congestion, the emission of particulates, NO_x, SO_2 and CO_2, increasing noise problems and, of course, the cost of increasingly scarce fossil fuels and the resulting geopolitical tensions.

In recent years, the pressing need for solutions has focused attention on transition to sustainable mobility, and numerous initiatives have been taken with a view to promoting transport-related innovation by all community actors: businesses, governments, public bodies and other organisations. Central to all initiatives concerned with vehicles, vessels and fuels are clean energy carriers and drive train technologies, together with a focus on new mobility concepts, behavioural change, better infrastructure utilisation, intelligent transport systems and logistic innovations geared to increasing the efficiency of transport capacity utilisation. It is through the application of those levers that sustainable mobility can be realised. Furthermore, the shift towards sustainability in transport has to be aligned with major international transitions in the field of energy supply sustainability and migration to a bio-based economy, in which crude oil is increasingly replaced as a raw material by natural gas and by energy carriers from renewable sources.

Mobility is one of the main drivers of greenhouse gas emissions in the Netherlands. The sector is currently responsible for about 38 Mton of CO_2 equivalents per year. Moreover, the expectation is that mobility will continue to increase in the years ahead. Increased mobility must not be allowed to lead to higher greenhouse gas emissions, however. The latest forecasts suggest that road transport-related emissions will reach up to 33 Mton in 2030 and 35 Mton in 2050. Those figures reflect not only the anticipated impact of the existing biofuel blending policy and the European CO_2 standards, but also a substantial increase in the penetration of electric vehicles (7 per cent fully electric and 7 per cent plug-in). Limitation of emission increases to the levels indicated will only be possible with additional policies and measures, and will still be insufficient for realisation of the Netherlands' climate objectives.

Formulated under the auspices of the Social Economical Council (SER) and signed in 2013, the Energy Agreement for Sustainable Growth provides the basis for a widely supported energy and climate policy and commits the signatories to ambitious long-term targets for transport in the Netherlands: 25 Mton by for 2030 and 12.2 Mton CO_2 by 2050.

The Energy Agreement provides for practical steps to be taken in pursuit of those targets. It was agreed, for example, that the various parties would draw up a shared vision of the future energy mix for the transport sector. Such a vision is necessary because the transition from fossil fuels – mainly petrol and diesel – to new sustainable energy carriers will entail major changes, without which the objectives will not be attainable. The changes will also provide opportunities for green growth, as the Netherlands focuses on promising fields and innovations.

This document sets out a vision developed by a process in which more than a hundred organisations were intensively involved. Representatives of fuel producers, vehicle manufacturers, energy companies, transport companies and shipping companies, community umbrella groups and NGOs, knowledge centres and local, regional and national government entities all participated in the collective effort to define an integrated development path. Many of the stakeholders in question were representing a constituency of trade organisations or NGOs, so that the circle of stakeholders that had input to the vision actually included far more than the hundred or so bodies that were directly involved. The

development process enabled all stakeholders and parties with an interest in the field to have a say. Hence, the outcome of the process is a genuinely shared fuel vision. The stakeholders involved in the process believe that it is desirable to work towards a robust package of public and private measures, capable of not only bringing about realisation of the defined long-term targets, but also providing alternative means of keeping those targets within reach in the event of adverse developments.

With a view to streamlining the discussions, the process was organised on the basis of six fuel tables:

1. Road transport-renewable liquid
2. Road transport-renewable gaseous
3. Road transport-renewable hydrogen
4. Road transport-renewable electric
5. Sustainable shipping
6. Sustainable aviation

The latter two tables actually involved combinations of modalities and various fuel tracks. In addition to the six fuel tables, the process involved a Green Growth and Sustainable Energy theme group and a rail workshop. Over a period of six months, six joint meetings of all the tables took place at the LEF Future Centre in Utrecht. In addition, the individual tables held their own separate sessions. An expertise consortium made up of TNO, ECN and CE Delft provided content support for the process and worked out scenarios for the attainable CO_2 reductions.

The fuel vision was developed using the Adaptive Programming method. First used for water management in the context of the Delta Programme, Adaptive Programming is a method based on the principle that uncertainty should be explicitly incorporated into decision-making. Uncertainty is translated into striving for and valuing flexibility, working with development paths instead of fixed outcome perceptions, the linkage of short-term decisions to long-term tasks and the connection of investment agendas. The shared sustainable fuel vision of the Netherlands is characterised by those qualities.

The vision is to be followed by an action plan, whose development has to be completed by the end of 2014. The plan will set out what is to be done to bring about the vision's realisation.

Once developed, the sustainable fuel mix action plan will become one of the foundations for realisation of the Netherlands' sectoral objectives for 2030 and 2050. Nevertheless, the plan will merely be a starting point. Transition to a sustainable society will require at least three changes to be brought about through interdepartmental and international cooperation:

1. Passenger and goods transport needs to be considered in a wider context (behavioural change, improved utilisation of infrastructure, logistical efficiency, modal shift).
2. Mobility and transport need to be closely linked to the most abundantly available energy sources: the sun and the wind.
3. Biomass should preferably be processed to produce sustainable biofuels (see box 1 for definitions) in accordance with the principles of biocascading and biorefining and incorporated into a circular economy.

Box 1: Types of sustainable biofuels

This vision is based on the following definitions and views of **sustainable biofuels:**

In order to be counted in the context of Renewable Energy Directive (RED) obligations for 2020, biofuels must fulfil the following three sustainability criteria:

- Up to and including 2016, the greenhouse gas emission saving from the use of any such biofuel (relative to the use of fossil fuel) must be at least 35 per cent. From 2017, the saving must be at least 50 per cent. Moreover, from 2018, the saving associated with fuel from new installations taken into production on or after 1 January 2017 must be at least 60 per cent.
- The raw material from which biofuel is made must not come from regions with high carbon stock or high biodiversity value. A region with high biodiversity value is defined as land that in or after January 2008 acquired the status of primary forest, nature conservation area or highly biodiverse grassland. Land with high carbon stock is defined as land that in January 2008 had the status of (but no longer has the status of) wetlands, continuously forested areas or areas of woodland measuring more than one hectare. Nor may a qualifying biofuel be produced from raw materials originating from land that was peatland in January 2008. Agricultural raw materials cultivated in the Community and used for the production of biofuels must fulfil the requirements of the regulation for direct support schemes for farmers.
- It is likely that, from 2020, no more than 70 per cent of the 10 per cent may be accounted for by conventional biofuels (ILUC). It is also probable that a non-binding sub-target of 0.5 per cent will be introduced for extremely advanced biofuels (lingo cellulose).

With a view to facilitating the use of sustainable biofuels in aviation and shipping, it will be necessary to develop policies that allow the biofuels used in those sectors to be counted in the context of the RED. The biofuels under consideration are bio-kerosene for use in aviation and biodiesel blends or bio-LNG for use in shipping.

CONTEXT: THE VISION SUPPORTS TRANSITION TO A SUSTAINABLE ENERGY SUPPLY

Globally, certain transitions are essential in the field of energy supply (sustainability and energy conservation) and the use of raw materials (e.g. bio-based economy). The vision of a sustainable fuel mix reflects that global picture. The vision connects the climate targets for mobility with social agendas in the fields of sustainable energy, energy security, green growth, health (air quality and noise) and external safety. It is therefore increasingly important to also consider the (international) impact on nature, land use and land degradation, biodiversity and water availability.

- The pursuit of a sustainable mix of energy carriers for mobility and transport is necessary in relation to our mobility wishes in the long(er) term. The IEA[8] predicts that, in the period up to 2050, the global demand for energy will increase as a result of population growth, prosperity growth and urbanisation.
- As part of the international energy transition, oil is already being replaced increasingly as a raw material by natural gas (methane) and by energy carriers produced from renewable sources. Where methane is concerned, only the renewable forms of the gas constitute completely clean energy sources. Renewable gas can be used to bridge the period between the era of oil and the era of fully renewable energy sources with electricity as the energy carrier, while also achieving considerable CO_2 emission reductions in the short term. Because fossil gas is often transported over considerable distances, natural gas will in the future be brought to the Netherlands mainly in the form of LNG.
- The use of zero-emission vehicles will bring about the partial dissociation of mobility growth from the emission of CO_2, air pollutants and noise. For many consumers and local and regional governments, emissions are the central issue, due to their implications for health and quality of life. The potential impact of emission reduction is extremely great. The raw materials problem will nevertheless remain, and fuels will also need to be produced sustainably.
- The mobility and transport sector can stimulate demand for sustainable alternatives within the existing energy mix.
- Climate change, land degradation and global population growth will make the availability of fertile land and water increasingly important issues in the future. The use of biofuels whose production implies the use of agricultural land will influence developments in this field.
- The extraction of fossil fuels also has an (increasing) impact on soil, nature and water systems. As less easily recoverable sources are utilised, the negative effects and risks increase.

The energy supply system of the future (2050) will to a large extent be based on sustainable energy sources, such as the sun, the wind, water power and sustainably produced biomass. The energy supply for transport will change accordingly.

- A fully sustainable energy supply depends on the large-scale use of wind energy and solar energy. Because those energy sources are not available on demand, and are often insufficiently available when demand is greatest, one of the principal challenges will be balancing supply and demand.
- Mobility can contribute to the integration of solar and wind energy into the system and to the balancing of electricity supply and demand. Energy can be stored and distributed through the delivery of hydrogen or methane via the natural gas network (power to gas), the smart charging of electric vehicle batteries or by producing hydrogen for use in fuel cell-driven vehicles. All such measures contribute to power balance management. Electric vehicles combined with smart grids or buffering beyond the meter and sustainable local energy generation can be attractive to

[8] International Energy Agency, an independent international agency established in response to the oil crisis of the seventies, which seeks to promote international cooperation on oil and energy reserves and their distribution.

consumers. Such options need to be explored in conjunction with other possibilities outside the mobility sector. The energy-efficiency of the entire chain must ultimately be decisive in the context of identifying the best ways of balancing supply and demand.

The electrification of vehicle drive systems reduces the use of fossil fuels.

- The gradual shift towards more sustainable mobility started with the development of more energy-efficient vehicles and combustion engines, followed by the introduction of gaseous fuels and the blending of biofuels with mineral fuels.[9] Although the energy-efficiency of vehicles and combustion engines can and must be increased further and the penetration of renewable gas (for definitions, see Box 2) and sustainable biofuels can be increased, the realisation of long-term climate and energy targets depends on opening a second trend-breaking transition path, towards a fundamental change in the energy sources used for vehicular transport.

Box 2: Forms of renewable gas

Renewable gas comes from the following sources and takes the following forms:

1. Biogas: methane gas extracted from renewable sources such as manure, by means of fermentation. The quality of such gas is not sufficient for it to be used in its original form for transport, but it can be used as a raw material for the production of green gas, bio-CNG or bio-LNG.
2. Green gas: a general name applied to various types of renewable methane refined to the quality of the natural gas used in the Dutch system and fed into the natural gas network. Green gas can be used for transport in the form of renewable CNG, supported by bio-tickets.
3. Power to gas (P-t-G) methane: synthetic methane gas produced using sustainably generated electricity by the electrolysis of water and reaction with CO_2. The storage characteristics of P-t-G are similar to those of bio-CNG.
4. Bio-LNG: liquid methane (almost 100 per cent pure) made from biogas (stored at -163 degrees Celsius, max 2 bar).
5. Bio-CNG: compressed methane gas made from biogas (stored in gaseous form at ambient temperature, 200 bar, approximately 82 per cent methane).
6. Bio-LPG: liquid propane gas made from the by-products of liquid biofuel production (stored in liquid form at ambient temperature, 8 bar).
7. Bio-DME: fuel produced synthetically from the by-products of process industries, which has properties similar to LPG.
8. SNG: synthetic natural gas produced by the gasification of organic (waste) material. Storage and aggregation conditions depend on the process parameters. SNG is not yet available on any significant scale.

- Battery-electric and fuel cell-electric vehicles (for definitions, see Box 3) can run entirely on energy produced from sustainable and non-finite sources such as the sun, wind, water and biomass. Furthermore, electric motors are more energy-efficient than combustion engines. However, electric motors are not yet available to suit all transport modalities. The electrification of aviation, (maritime) shipping and long-distance road transport will be difficult to achieve.

Box 3: Types of electric vehicles

Electric vehicles come in four basic types (although numerous variations are possible):

An electric vehicle is a vehicle with a drive system powered wholly or partly by electricity. The electricity may come from a battery or from a fuel cell system.

1. Battery-electric vehicles (BEVs): fully electric vehicles whose only drive power source is an electric motor, powered by a battery charged from an external electricity source.
2. Fuel cell-electric vehicles (FCEVs): fully electric vehicles that have no combustion engine, but carry a supply of hydrogen, from which electricity is generated on board by means of a fuel cell.
3. Plug-in hybrid vehicles (PHEVs): vehicles which have a combustion engine and a battery-powered electric motor, both of which serve as drive power sources. The vehicles may run on either power source, or a combination of the two. The electric motor is powered by a battery charged from the public grid, or by the combustion engine.
4. Electric range-extended vehicles (E-REVs): vehicles that use an electric motor as their primary source of drive power,

[9] Substantial progress has already been made on air quality, e.g. through the use catalytic converters etc.

supported by a combustion engine, which extends vehicle range by driving the electric motor when the battery has insufficient power to drive the electric motor unassisted.

Electric vehicles are currently developing rapidly, meaning that new types will undoubtedly reach the market in the years ahead. Possibilities include battery-powered electric vehicles with fuel cell range-extenders, or renewable gas-powered range-extenders. In this vision, PHEVs and E-REVs are referred to collectively as plug-in vehicles.

- The adoption of electric drive systems, whether battery-powered or powered by fuel cells, implies not only migration to a different drive technology, but also migration to a different fuel and supporting infrastructure. The realisation of such profound change is complex, time-consuming and expensive, and depends partly on factors that the Netherlands cannot control independently.

At the tank-to-wheel level, the targeted use of sustainable biofuels and renewable gas would yield significant short-term emission reductions for the road transport sector as a whole, and possibly longer-term reductions for aviation, shipping and long-distance road freight and bus transport. A number of market sectors are strongly dependent on such fuels, due to the current lack of adequate alternatives. In sectors that are able to make the transition to the electric drivetrain systems, liquid and gaseous biofuels can serve a bridging function in the short term, which in the longer term serves as 'insurance' against the possibility of electrification failing to take off. Questions remain regarding the availability and attainment of well-to-wheel emission reductions, which depend very much on the type of biomass used and its origin.

- By making targeted use of renewable gas and sustainable biofuels (to power combustion engines), some mobility can be rendered sustainable in the short-term at a relatively low transition cost. While such fuels are more expensive than conventional fuels, vehicles designed to run on them are often barely any more expensive, and the infrastructure is largely available and can be scaled up. A relatively rapid transition can be achieved, provided that certain conditions are met, such as manufacturers being able to develop suitable vehicles and make them available in sufficient numbers, and sustainable biomass being readily available.
- For the transport sector, the use of biofuels is very significant, especially in aviation, where bio-kerosene currently appears the most promising option for increasing fuel sustainability. In the shipping industry and probably the heavy road transport sector as well, liquid and gaseous biofuels are expected to play an important role on the road to increased sustainability, also in the longer term.
- Biofuel tracks (gaseous and liquid) can serve as 'insurance' against the possibility that the market introduction of electric vehicles proceeds more slowly than anticipated. In that scenario, the use of biofuels can assure a certain level of climate and green growth benefit.
- Sustainable biofuels (liquid and gaseous) should in principle be used only in sectors where there is no alternative to the combustion engine. As the penetration of battery-powered and hydrogen-powered electric mobility increases, the use of renewable gas and sustainable biofuels should be concentrated within the heavier transport modes, such as long-distance road freight, aviation and shipping. In the meantime, the use of biofuels can support the upscaling and development of biorefining expertise and technologies.
- The targeted use of renewable gas, bio-kerosene, and biodiesel can expedite the transition to a low-carbon fuel mix, while also contributing to CO_2 emission reduction targets and green growth. Battery-electric and hydrogen-based mobility will consequently have the time needed to mature and, where possible, take over from biofuels. However, it is important to ensure that the renewable gas and biofuel tracks do not unnecessarily delay or impede the transition to electrification (particularly gas and hybrid). Any potential for such undesirable lock-in effects need to be identified and addressed in the context of periodic updating of the vision.

Optimal use of biomass in the mobility and transport sector.

- Any biofuels that are used have to meet the European sustainability criteria. Because of concerns as to whether biofuels are produced in a sufficiently sustainable manner, the criteria are likely to

require periodic revision. The key requirements for use of both gaseous and liquid biofuels are: low WTW greenhouse gas emissions, a low risk of indirect land use changes and a low food supply risk. In Europe, it is recognised that the existing policy of compulsory biofuel blending (at a concentration of 10 per cent by 2020) has adverse consequences. The Energy Council therefore recently decided to introduce a 7 per cent ceiling on biofuels whose production can compete with food production or animal feed production. The realisation period for the current targets of a 10 per cent renewable energy share in transport (European Renewable Energy Directive) and a 6 per cent reduction in greenhouse gas emissions from the fuel supply chain (European Fuel Quality Directive) expires in 2020. Both targets will be secured largely through the use of biofuels. The Netherlands is arguing for the retention of a reduction target for greenhouse gas emissions in the fuel supply chain in the period after 2020. The expectation is that European sustainability criteria for biofuels will remain in existence, because biofuels may well be needed to secure the European renewable energy target for 2030. That will open the way for the targeted use of biofuels in certain sectors and market segments.

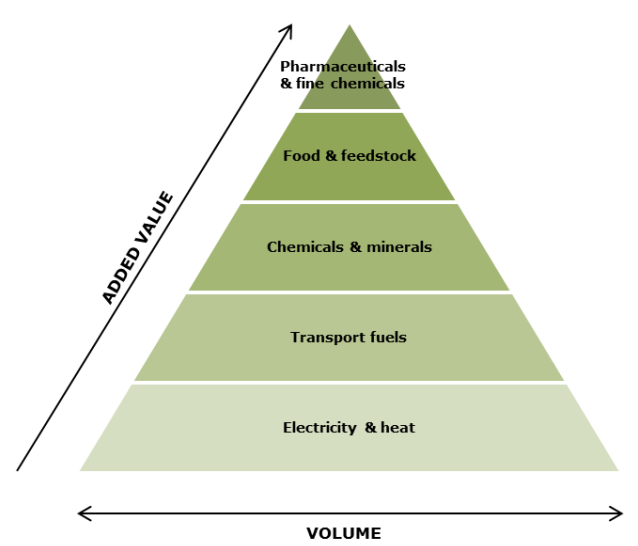
- Efforts were made to arrive at a shared view on the potential of energy from sustainable biomass for transport. However, views on that topic and the available scientific data were found to vary considerably. The potential will ultimately depend on developments in the bio-based economy and the circumstances in which they take place. It is a highly dynamic field, characterised by some very promising developments. It is consequently difficult to estimate the ultimate potential of energy from sustainable biomass. The intention is to return to this question during the action planning phase and when this vision is updated.
- The availability and distribution of biomass are pertinent issues for the whole bio-based economy, within which transport use is a relatively small field. The production and use of sustainable advanced biofuels and renewable gas require a cross-sectoral approach. Where possible, policy should promote high-grade applications, in accordance with the cascade principle (see Box 4). Cascading involves withdrawing as much high-grade material as possible and making the best possible use of the remainder. Transport is one of the lowest-grade applications. Because the availability of biomass is uncertain and inherently finite, the optimisation of biomass use may lead to it being used primarily for other applications. However, smart stimuli are required within the mobility market as well. Market imperfections due to differences tax laws, policy, etc. mean that the business case for the application of renewable gas and bio-kerosene now appears less compelling than is desirable.

Box 4: bio-based economy with cascading and biorefinery

Within a bio-based economy, the aim should be to use biomass for the highest-grade applications possible. In addition, all components of the biomass should be utilised as effectively as possible. That results in 'cascading'.

The pyramid diagram shows how the added value of biomass is determined by its application. In an efficient market, the greater the added value of the biomass, the higher its economic value.

In much the same way that crude mineral oil is refined, biomass can also be refined into valuable products, by means of 'biorefinery'. In some cases, biorefinery can be undertaken using the existing industrial infrastructure. However, new processes need to be developed as well. By means of biorefinery, various components of the biomass can be released with very little waste. After the refining, the various fractions are each used for their own application and each have their own economic value. Hence, biomass can acquire a higher economic value than it would have if it were not broken down into its constituent components (based on www.biobasedeconomy.nl).



The use of sustainable energy sources makes the Netherlands less dependent on oil and gas and the nations that produce them, thereby directly contributing to our targets for energy security and security of supply.

- Investing in a sustainable fuel mix can create opportunities for transforming the expected decline in the importance of oil as a raw material into 'green growth' for the Netherlands, based on the production, knowledge and development of services associated with biofuels (gas and liquid), sustainable electricity and hydrogen, and linkage with the added value chain for biomass in the food, chemicals and agricultural sectors.
- The oil and gas sector is currently one of the mainstays of the Dutch economy. The transition to sustainability constitutes an opportunity, as long as the Netherlands takes a lead role. Conservatism on the question of the sustainability of the oil and gas sector represents a risk to the Dutch economy, government finances and pensions.
- The market players are seeking ways of realising the transition to a sustainable future on a cost-effective basis. Furthermore, fossil, hybrid and/or biofuel tracks will remain relevant for a considerable time to come. Decision-making will be closely linked to the tax implications, CO_2 pricing and the offsetting of costs and benefits. Long-term policy stability is essential in this context.

ON THE VISION AGENDA

- Policies that incentivise businesses that are willing and able to play a role in the future sustainable fuel and vehicle mix (leaders).
- Incentivisation of existing sectors, including shipbuilding and the production and distribution of fossil fuels and biofuels to focus on the sustainability of fuels.
- Research into and the development of synergy between the sustainable fuel mix and developments such as sustainable (local and regional) electricity generation, power-to-gas and smart grids.
- Development of the bio-based economy and the conditions for its creation. The bio-based economy can contribute to the development and affordability of advanced sustainable biofuels with a low environmental impact.

THE TASK: THE NETHERLANDS SETS AMBITIOUS TARGETS ON THE ROAD TO SUSTAINABLE MOBILITY

The SER Energy Agreement of September 2013 includes provisions for the mobility and transport sector, with a view to increasing the efficiency of travel and transport and realising mobility on a sustainable basis (see Box **5** for the Energy Agreement's mobility provisions). The following CO_2 emission reduction targets[10] were agreed:

- A 60 per cent reduction in CO_2 emissions by 2050 relative to 1990 (= max. 12 Mton in 2050, in accordance with the EU white paper).
- By 2035, all new passenger vehicles sold to be zero-emission capable.
- By 2030, a reduction of at least 25 Mton relative to 1990 (-17 per cent), en route to the objective for 2050.
- Mobility sector to contribute 15-20 PJ towards the overall energy efficiency target of 100 PJ by 2020.

In addition, a green growth agenda was drawn up, setting out perspectives for the long term and measures for the short-term.

Box 5: SER Energy Agreement mobility targets

The seventh basic component of the Energy Agreement consists of mobility and transport measures intended to make traffic and transport more efficient and mobility more sustainable. The parties have agreed on ambitious targets, namely a 60% reduction in CO 2 emissions by 2050 (compared to 1990), with a reduction of 25 Mton (- 17%) in 2030 en route to attaining that target. In order to achieve this, the parties have drawn up a green agenda for growth setting out long - term prospects and short - term measures. Steps will be taken in twelve key areas. The parties will shortly produce a shared overall strategy concerning the future fuel mix, public - private partnership in preparing the market, source - specific policy and Dutch leadership, and arrangements regarding the public infrastructure for charging electric vehicles. Other important topics will also be dealt with, including the use by the transport sector of a uniform measuring method for reducing CO2. These matters will be worked out in the near future, with central government taking the lead as regards the policy measures and cooperating with the organisations involved. In the context of the targeted energy saving of at least 100 PJ energy (final) for the economy as a whole, the parties have agreed that the transport and mobility sector will contribute by saving an expected 15 to 20 PJ by 2020 compared to the reference estimates produced by the Energy Research Centre of the Netherlands (ECN) in 2012, assuming that this corresponds to a reduction of 1.3 to 1.7 Mton compared to the trend - based forecasts for 2020.

For emissions purposes, the rail sector is included in the SER targets. However, the sector is responsible for little CO_2 emission in IPCC terms, since most rail transport is electrified. Non-electrified rail transport must also be placed on a sustainable footing and Dutch Railways (NS) has the ambition of operating entirely on green power in due course.

The international shipping sector has not formulated any explicit CO_2 emission reduction target. Nevertheless, in 2011 the International Maritime Organization (IMO) did introduce an Energy Efficiency Design Index (EEDI) for new vessels. The Dutch shipping sector has accepted its responsibility and is aiming to achieve carbon-neutral growth in maritime shipping from 2020 and a CO_2 emission reduction of 50 per cent between 2020 and 2050.[11]

The aviation sector is also excluded from the SER targets, but is pursuing the ambitious aim of 5 per cent biofuel penetration by 2020. The ICAO[12] has stated the ambition of achieving carbon-neutral growth after 2020, by which it means that all growth in the global aviation sector should be achieved without any additional CO_2 emissions (ICAO 2013). Assuming that the trend in the sector's energy

[10] The cited targets conform to the IPCC definition: they relate only to greenhouse gas emissions on Dutch territory, biofuels, electricity and hydrogen used for transport count as zero-emission fuels. In other words, they are tank-to-wheel (TTW) targets. Targets relating to the whole chain are referred to as well-to-wheel (WTW) targets.
[11] Source 'Groen en krachtig varen' ('Green and powerful shipping'), the environmental statement of the KVNR, January 2013.
[12] International Civil Aviation Organization.

consumption growth continues (3-4 per cent growth per year in association with volume growth of 4-5 per cent) a substantial level of biofuel use will be necessary by 2030.

The focus of the sustainable fuel mix is road transport. Passenger vehicles, light goods vehicles and heavy goods vehicles together account for more than 80 per cent of all CO_2 emissions attributable to the mobility sector (excluding international aviation and maritime shipping). Hence, major changes need to be realised in these subsectors.

The SER vision of a sustainable fuel mix for transport follows upon earlier agreements:

- The current approach to sustainable mobility draws on the Energy Innovation Agenda, the Sustainable Mobility Platform and the Sustainable Mobility Sector Agreement ("Clean & Economical").
- Important levers for realising sustainable mobility are clean fuels and clean and energy-efficient drivetrain technologies, together with new mobility concepts, better infrastructure utilisation, intelligent transport systems and logistic innovations.

The vision has to be aligned with the existing European Directives that have implications for the mobility sector, such as:

- The European Renewable Energy Directive (RED): by 2020, at least 10 per cent of the energy used for transport must come from renewable sources.
- The European Fuel Quality Directive (FQD): by 2020, the lifecycle greenhouse gas emissions associated with all motor fuels supplied (fossil and non-fossil) must be 6 per cent lower than in 2010.
- The European Directive on Clean Power for Transport (CPT): this directive is intended to make Europe less dependent on oil imports, to reduce CO_2 emissions and to improve air quality by encouraging the use of alternative fuels, establishing a network for all alternative transport fuels, defining communal technical specifications for charging and fuel delivery points and informing consumers properly about the use of such fuels.
- The EU Sustainable Urban Mobility Package (2013): the package builds on the 2009 Action Plan on Urban Mobility and its aims include the promotion of sustainable urban mobility action planning by local governments and the acquisition and exchange of relevant expertise.
- EU regulations on CO_2 emissions: from 2015, the average CO_2 emissions of all new passenger vehicles sold must not exceed 130 g/km. By 2021, the figure is to be further reduced to 95 g/km and a ceiling of roughly 70 g/km is under discussion for about 2030. For light goods vehicles, the corresponding figures are 175 g/km by 2017 and 147 g/km by 2020.

The task of developing an SER vision of a sustainable fuel mix was defined as follows:

- During the development of this SER vision of a sustainable fuel mix, the stakeholders focused primarily on the scope for improving vehicles and fuels. Although general CO_2 policies (e.g. ETS[13]) and measures aimed at behavioural change (e.g. volume reduction) could also contribute significantly to the reduction of carbon emissions associated with the mobility sector, they are outside the scope of this SER task. Measures intended to bring about behavioural changes that would increase fuel efficiency (e.g. slow steaming by maritime shipping) are, however, within the explicit scope of the vision development process.
- The SER transport sector targets are 'tank-to-wheel' (TTW) targets. Well-to-tank (WTT) emissions, as associated with the extraction of oil and gas, refining, biofuel production, grey power generation and the production of hydrogen, may mean that, over the whole energy chain, greater CO_2 reductions may be achievable than TTW accounting reveals.

Most of the parties involved in development of the vision would like more ambitious targets to be adopted and would prefer the CO_2 implications of each option for the whole chain (well-to-wheel,

[13] Emission Trading System, which applies to manufacturers and others.

WTW) to be considered and the scope of the exercise to include measures concerned with behavioural change, efficiency, volume and modal shift.

- WTW accounting would provide insight into the true practical performance of the sector, uncompromised by historically devised methods for calculating CO_2 emission reductions. Therefore both TTW and WTW projections were made for all the proposed options.
- The large-scale use of sustainably generated electricity and hydrogen in road transport that is sought implies a major undertaking, insofar entire production chains will need to be placed on a sustainable footing. If all passenger vehicles are electric powered by 2050, that will necessitate the supply of 15 to 20 per cent more (sustainable) power than if all existing power generation were made sustainable. That emphasises the importance of using this fuel vision and other initiatives to coordinate developments and harmonise the mobility system with the energy system.

What matters is not only the formal targets, but also in particular a clear ambition to achieve a sustainable and renewable fuel mix.

THE STRATEGY: ADAPTIVE, TARGETED AND MULTI-TRACK WITH A POSITION IN THE EUROPEAN VANGUARD

Realisation of the defined SER targets will require the pursuit of several fuel tracks, for particular markets and modalities.

- By 2030 the CO_2 emissions have to be reduced by 8 Mton relative to what would be expected given the continuation of existing policies and the currently forecast transport growth (*the reference estimate*). By 2050, a reduction of 23 Mton on the reference estimate is required.
- The targets can be achieved through a combination of various sustainable fuels and technologies. Calculations by the expertise consortium on the basis of the highest realistic estimates from the various round tables on fuels, indicate that neither the target for 2030 nor that for 2050 can be achieved by the adoption of any single fuel or technology. Some fuels are not expected to be available in sufficient quantities to support the target, while some fuel-technology combinations are unsuitable for all market sectors.
- Moreover, the consortium's calculations are based on a reference estimate that itself assumes a considerable baseline reduction in CO_2 emissions. It is assumed that existing policies and autonomous developments involving the use of biofuels, electric vehicles and efficiency improvements will bring about a 12 Mton reduction in emissions by 2030 and a 15 Mton reduction by 2050.
- For road transport, various solutions are possible, but the most promising solution differs from one market segment to the next. Fully battery-electric vehicles are appropriate for personal mobility in urban areas, but do not yet appear promising for long-range bus or freight transport or for heavy goods transport. In the latter segments, hydrogen, renewable gas and biofuels, including (bio-)LNG are likely to prove better solutions. The various options are shown in Figure 1.
- Relatively few sustainable fuel options are available for aviation or maritime transport.. For inland shipping and short sea shipping and ferries, there is more scope for adopting sustainable alternatives, including a wide variety of biofuels.

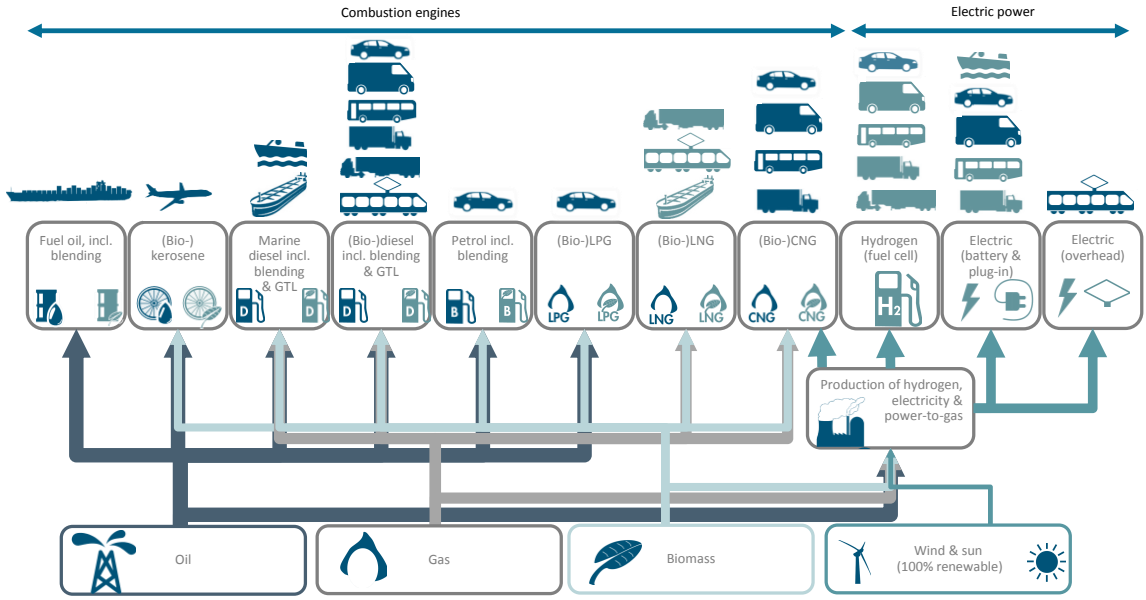


Figure 1: Interrelationships between raw materials, energy carriers (light green = low-carbon variant) and market sectors (light green = not yet developed)

- The prospects for realisation of the targets and security-of-supply objectives are improved by having a back-up alternative for each market sector.

- Because of technological and market uncertainties, most automotive manufacturers are pursuing a portfolio strategy, under which they do not assume a future dominated by any one fuel or technology, but are developing vehicles that can use various energy carriers.

It is desirable to take an adaptive approach in order to secure the Energy Agreement targets, partly because no single fuel or technology provides the so-called silver bullet in any given sector and partly because the course of many of the developments will be determined outside the Netherlands.

- Achievement of the SER targets for 2030 and 2050 will inevitably depend to a considerable extent on zero-emission vehicles. The development of such vehicles has some way to go before they are available at a competitive price or in sufficient numbers to enable realisation of the target for 2030.
- The scope for scaling up the biomass chain to support the mobility sector is closely linked to the penetration of biomass into the energy, chemicals and agricultural sectors (for which it has significant added value), and to the scope for creating a biofuels supply chain in the Netherlands.
- In the period up to 2050, new alternatives will appear and radical innovations will emerge as serious alternatives, such as the use of wind power for shipping and the use of induction or overhead power systems for freight transport. Such alternatives have not yet been taken into account in the development paths. To prevent the neglect of technologies that emerge after the development of this vision, the vision will be updated every three to four years.
- Adaptive programming will be directed towards the identified destination point on the horizon: the maximum possible electrification of mobility. At the same time, the approach will provide sufficient flexibility to cope with the uncertain nature of developments between now and 2050 and beyond.

A position in the European vanguard of countries actively pursuing sustainable mobility is in keeping with the Netherlands' ambitions and is expected to create opportunities for green growth.

- Within the vanguard, coalitions may be formed to facilitate the realisation of EU policies and international standards.
- Having a larger base volume makes it easier to cover the uneconomic element of the cost of new technologies. Also, the research, design and development phases of new technologies can be completed more quickly than when working in isolation.
- In certain niche fields (relatively small fields where it is possible to build on existing strengths), the Netherlands can take the lead, giving us influence at an affordable cost.

Both alternative positioning strategies, either a responsive or a leading role in all sectors, are not realistic.

Moreover, a responsive strategy would be inconsistent with our aims and would not support green growth.

- If the Netherlands adopted a strategy of merely following developments within Europe, it is unrealistic to suppose that the targets could be met. Despite our relatively strong position within Europe in fields such as electric vehicle use and the obligation to blend sustainable fuels, realisation of the defined targets depends on rapid further progress towards sustainability and concerted effort by all EU countries. The Netherlands cannot achieve its aims alone.
- If all developments and innovations originate elsewhere, the Netherlands will lose its leading position in the field of freight transport, fuel production and electric vehicle use. That will have a negative impact on Dutch business and consequently on the Dutch economy and the Netherlands' green growth opportunities.
- If the Netherlands does not take the initiative in certain fields, the country will cease to have an influential voice within Europe and within international forums.

A leading role in all market sectors is not technically feasible or financially viable.

- The Netherlands is too small to drive developments in automotive technology and fuel supply.

- The Netherlands' domestic automotive industry is relatively small.
- Stakeholders expect the adoption of a leading role to require the Netherlands to bear a disproportionate amount of the R&D costs, development costs and uneconomic cost elements associated with scaling up. That would impose a serious burden on the treasury, with adverse economic implications in other fields.

ON THE VISION AGENDA

- Embracing the adaptive and targeted multi-track strategy.
- A position in the vanguard, taking up a lead role in particular niche fields that offer green growth opportunities and innovation.
- Systematic promotion of the electrification of mobility in all market sectors, where possible.
- Support for the most promising alternatives in sectors where electrification is not possible or offers little promise in the short or long term.
- Monitoring developments and updating the strategy every three to four years.
- An integrated Dutch approach based on a wide range of measures.

ROAD TRANSPORT: A SMART MIX OF ELECTRIC VEHICLE USE, RENEWABLE GAS AND SUSTAINABLE BIOFUELS

The Netherlands will pursue a transition to electrification in all transport sectors where the prospects for electric vehicle use appear good, where this use is not feasible the use of sustainable biofuels and renewable gas is applicable.

- A 60 per cent reduction in CO_2 emissions by 2050 is not possible without the use of electric vehicles. Battery-powered electric drive technology is the most energy-efficient solution. The TTW CO_2 emissions associated with the technology are by definition zero, and the WTW CO2 emissions are potentially very low as well, if the batteries are charged using electricity produced from wind or solar energy. Drive systems based on hydrogen fuel cells are also associated with zero TTW emissions and, although such systems are less energy efficient than battery-powered systems, hydrogen fuel cells represent a valuable supplementary power source, since they increase vehicle range with a shorter refill-time.
- The current generation of electric vehicles are viewed positively, but further improvements are needed with regard to aspects such as range, charging duration, charging infrastructure, and total cost of ownership (TCO). Realising such improvements will take time. A gradual transition from plug-in hybrid vehicles to fully electric (battery and/or fuel cell-powered) vehicles appears the most viable development path, because the use of plug-in hybrids will drive the development of a charging infrastructure, reductions in the cost of electric drive chains and public acceptance of electric vehicles. Nevertheless, an intermediate phase characterised by the use of plug-in hybrids will not be necessary if battery and fuel cell technologies develop more rapidly than currently foreseen. The adoption of affordable electric vehicles in urban areas can be expedited by the introduction of light electric vehicles.

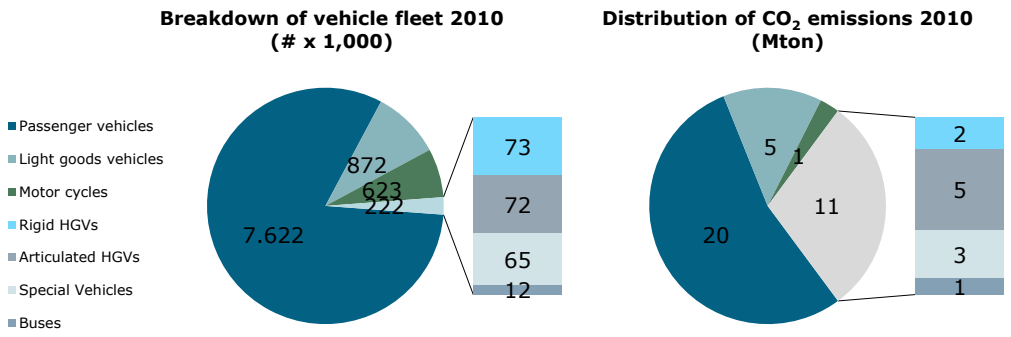


Figure 2: Vehicle numbers and CO_2 emissions in 2010

Electric vehicles will form part of a smart mix with sustainable biofuels and renewable gas.

- If electric technology does not develop sufficiently rapidly to underpin achievement of the targets, progress on the reduction of CO_2 emissions from the various sectors may nevertheless be made by the transitional use of biofuels, renewable gas and hybrids. Inadequate or delayed attainment of climate benefits through the electrification of passenger vehicles, light goods vehicles and lighter heavy goods vehicles will jeopardise realisation of the SER targets, because such vehicles currently account for a high proportion of CO_2 emissions. Realisation of the SER targets for 2030 requires roughly three million zero-emission passenger vehicles and light goods vehicles to be in use by that date.
- Renewable gas and sustainable biofuels can be valuable for long-range transport and heavy freight transport.

- Figure 2 shows that, in the road transport sector, roughly 70 per cent of fuel consumption can be attributed to light vehicles (passenger vehicles, light goods vehicles and two-wheeled vehicles) and 30 per cent to heavy vehicles (heavy goods vehicles, buses, mobile machinery and special vehicles). However, the trend is towards greater heavy transport volumes. In this market, there is a demand for high energy densities and high refuelling speeds, similar to those associated with the conventional liquid or gaseous fuels used for combustion engines. The necessary energy density and refuelling speed is not currently attainable using battery-electric or fuel cell-electric drive systems. Full transition to battery-electric or (hydrogen) fuel cell vehicles is not therefore expected in the long-distance and/or heavy freight transport segments. In the longer term, however, fuel cell-powered electric vehicles may enter use for domestic and urban freight transport.
- The use of gas and biofuels in passenger and light goods vehicles would be relatively straightforward and would yield short-term climate benefits. In the longer term, gas can feature in a sustainable fuel mix only insofar as largely renewable gas may be used for long-distance road transport and shipping.
- Developments may occur, which are not currently foreseen. Other energy carriers may emerge as viable options, for example. Any promising developments should be taken into account when this vision is reviewed every three to four years.

The sustainable fuel mix is supported by maximum use of efficiency improvements.

- Improving efficiency in all sectors (short and long-distance passenger transport, urban light goods transport, regional transport and international transport) can also yield significant additional CO_2 emission reductions in the coming decades. Efficiency improvement is important where all energy carriers are concerned. Enhanced aerodynamics, lightweight construction materials, regenerative braking and low-friction components can all reduce the energy required by a vehicle and thus promote the development of low-energy drive technologies. The scope for improving efficiency by use of the measures outlined above appears to be considerable: up to 65 per cent in the passenger transport sector and 30 to 40 per cent in freight transport. Almost all that efficiency potential could be realised before 2020, at a cost that is expected to be recovered in the first five years of a vehicle's life by reduced fuel expenditure. Experience has shown that targeted policy measures are needed to secure such 'quick wins'. The suggestion is not that technological development should be enforced – the Netherlands is too small to do that – but that the use of more economical models in the transport sector should be promoted.
- In the field of vehicle economy, European standards play an important role. In Brussels, the Netherlands will actively strive for the setting of CO_2 standards and other European policies that facilitate realisation of the potential for increasing the efficiency of passenger vehicles, light goods vehicles, heavy goods vehicles and buses.

Thus, a targeted and robust development path for road transport has been formulated.

- Large-scale introduction of battery-electric and fuel cell-electric vehicles is assumed in the period up to 2050. That will require the targeted use of government policy in the short term. The levels of market penetration that battery-electric and fuel cell vehicles must achieve in order to secure the targets set for 2030 and 2050 depend on the dynamic continued rollout of battery-electric vehicles and charging infrastructure, together with initiation of the rollout of fuel cell vehicles and hydrogen refuelling infrastructure in the period 2017 to 2025.
- Transition to sustainability will be more robust if an alternative solution is identified, which is capable of deployment in all segments if electric vehicles do not come on the market to the required extent. In the meantime the use of more renewable gas and biofuels contribute to some extent to the targets. As the development of battery and/or fuel cell technology proves to be slower than currently hoped, biofuels are a good alternative for lighter vehicles and shorter distances.

- Safety issues associated with new refuelling infrastructure and the distribution of alternative fuels can be taken up directly at the start of the development paths.

Figure 3 shows the CO_2 emission reduction currently foreseen and the contributions of the various techniques. Technical breakthroughs in the coming years may result in a revised picture, both in terms of the overall reduction forecast and in terms of the various contributions. That in turn may necessitate revision of action plan investment programmes, that are linked to the vision.

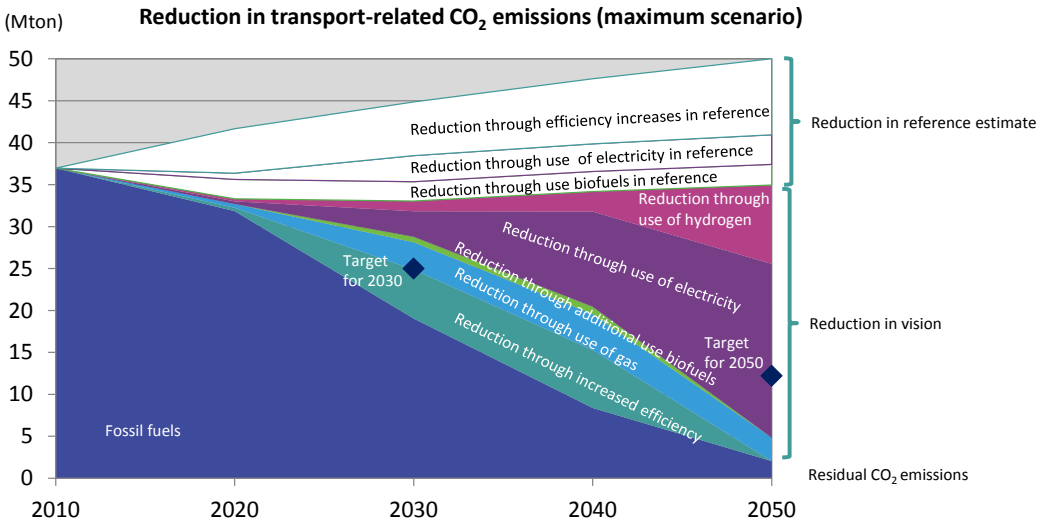


Figure 3: Estimated reduction in CO_2 emissions from road transport (maximum scenario)

Before 2030, the transition will principally involve amplification of the current trend. The course of transition between 2030 and 2050 is less certain. The extent to which developments continue will depend on numerous factors. The most important are (first) the speed of technological development in the electric vehicle sector (batteries, fuel cells), in terms of both performance and cost, and (second) the availability and affordability of renewable fuels. If progress is disappointing, alternatives are available.

A distinct development path will be followed in each segment of the road transport sector. On the following pages, consideration is given to four segments:

- Passenger vehicles (Figure 4)
- Light goods vehicles (Figure 5)
- Heavy goods vehicles (Figure 6)
- Buses (Figure 7)

PASSENGER VEHICLES

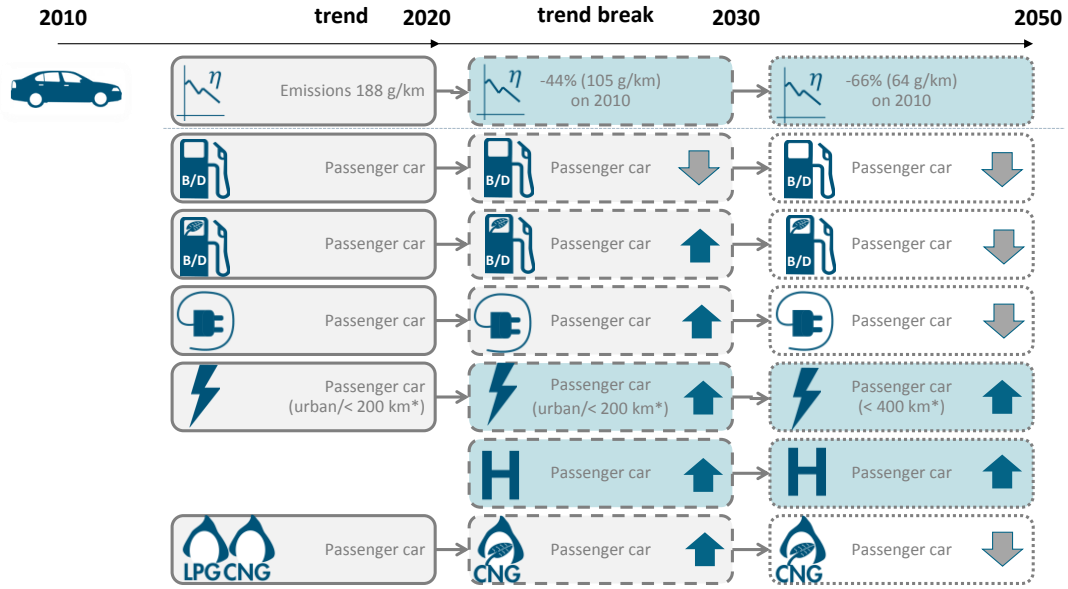


Figure 4: Development path for passenger vehicles (pilots not included, * daily distances)

Long-term picture: introduction of electric vehicles and promotion of efficiency gains.

Why?

- CO_2 target is difficult to attain with other energy carriers.
- Electric drive technology is more energy-efficient than the known alternatives.
- Energy carriers (electricity and hydrogen) can be produced sustainably from solar and wind energy and CO_2 released in the production of grey power can be captured.
- Electric drive technology has major advantages for quality of life and health in urban areas.
- The availability of biomass for the production of biofuels and renewable gas is limited and dependent on levels of demand from other sectors.

Short-term development path aims:

- Increasing the energy-efficiency of vehicles and engines.
- Maintaining current levels of sustainable biofuel blending with diesel and petrol.
- Introducing renewable gases and vehicles to the market.
- Scaling up use of plug-in hybrids with increasing electric range.
- Continuing the market introduction of battery-electric vehicles (with focus on urban markets and light electric vehicles).
- Running pilots with hydrogen-powered vehicles and first hydrogen refuelling stations.
- Creating basic hydrogen refuelling infrastructure, with integration of public and fleet refuelling stations where possible.

Development path aims 2020 – 2030:

- Pursuing further increases in energy-efficiency of vehicles and engines.
- Blending: on the basis of sustainable biofuels (see definition, page 3).
- Scaling up use of battery-electric vehicles for more market segments.
- Scaling up use of renewable gases and vehicles.
- Introducing fuel cell-electric vehicles to the market.

Why this development path for passenger transport? (Reasons why long-term picture is not immediately realisable)

- Fully electric (hydrogen and battery-powered) vehicles are currently too expensive and achieving full energy

carrier sustainability is time-consuming.

- Plug-in hybrids, renewable gas and biofuel blending can serve as transitional and fall-back options.
- It is not yet certain that the range of fully electric battery-powered vehicles can be doubled.

LIGHT GOODS VEHICLES

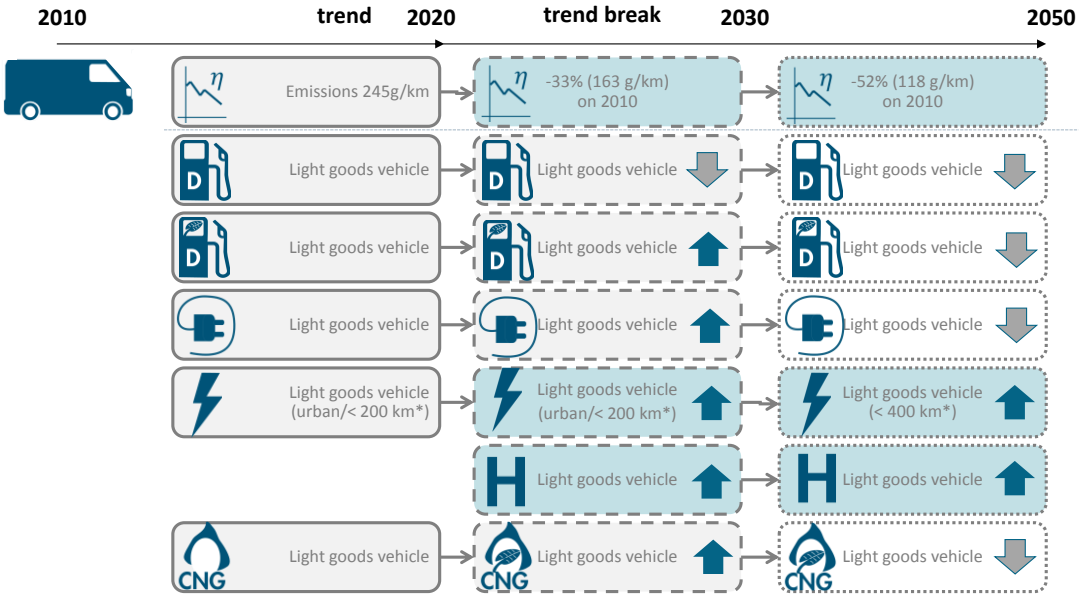


Figure 5: Development path for light goods vehicles (pilots not included, * daily distances)

Long-term picture: introduction of electric vehicles and promotion of efficiency gains.

Why?

- Rationale similar to development path for passenger vehicles.
- Quality-of-life and health benefits of using electric light goods vehicles in urban areas are greater; also, light goods vehicle users are more cost-conscious than passenger vehicle users.

Short-term development path aims:

- Increasing energy-efficiency of vehicles and engines.
- Maintaining current levels of sustainable biofuel blending with diesel.
- Introducing plug-in hybrids and urban battery-electric vehicles to the market.
- Introducing renewable gas and vehicles and urban battery-electric vehicles to the market.
- Pilots with hydrogen-powered light goods vehicles and first hydrogen refuelling stations.

Development path aims 2020 – 2030:

- Pursuing further increases in energy-efficiency of vehicles and engines.
- Blending: on the basis of sustainable biofuels (see definition, page 3).
- Scaling up use of renewable gas and battery electric vehicles for more market segments.
- Introducing hydrogen-powered light goods vehicles to the market.

Why this development path for light goods vehicles? (Reasons why long-term picture is not immediately realisable)

- Fully electric (hydrogen and battery-powered) vehicles are currently too expensive and achieving full energy carrier sustainability is time-consuming.
- Plug-in hybrids, renewable gas and biofuel blending can serve as transitional and fall-back options.
- It is not yet certain that the range of fully electric battery-powered vehicles can be doubled.

HEAVY GOODS VEHICLES (RIGID AND ARTICULATED)

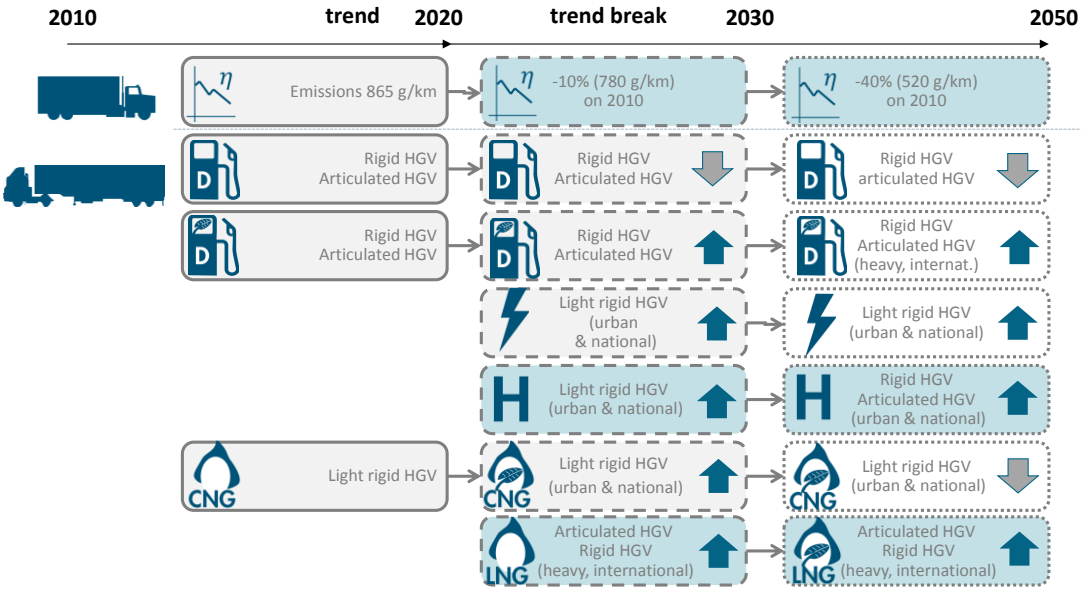


Figure 6: Development path for rigid and articulated HGVs (pilots not included)

Long-term picture: it is expected that conventional diesel will remain the predominant fuel for HGVs for the long term. The emphasis is therefore on efficiency. The use of (renewable) LNG is expected to enter into the market for long-distance transport and heavy goods transport. For light goods transport and short-range transport both forms of renewable gas (CNG and LNG) are viable alternatives. Electrification will occur in some market segments (e.g. rigid goods vehicles) and for 'last mile' urban goods transport. Fuel cell technology may become viable for longer-range and heavy goods transport in the longer term.

Why?

- When making a transition to sustainable fuels, it is important to take international competitiveness and a level playing field into account.
- The use of LNG is increasing in the heavy, long-distance transport, partly due to an expected price reduction.
- Requirements for air quality and noise pollution in urban areas are drivers for the development of clean and quiet freight transport.

Short-term development path aims:

- Increasing energy-efficiency of new vehicles and engines.
- Maintaining current levels of sustainable biofuel blending.
- Introducing renewable gas to the market for rigid goods vehicles.
- Piloting renewable LNG HGVs and tractor-trailer combinations.
- Piloting battery-electric rigid goods vehicles in urban areas.
- Piloting prototype hydrogen-powered HGVs and special (freight) vehicles.

Development path aims 2020 – 2030:

- Pursuing further increases in energy-efficiency in fleet average (vehicle efficiency already maximised).
- Blending on the basis of sustainable biofuels (see definition, page 3).
- Scaling up use of renewable gas vehicles (CNG and LNG), and introducing battery electric vehicles in urban areas.
- Introducing hydrogen-powered vehicles to the market.

Why this development path for freight? (Reasons why long-term picture is not immediately achievable)

- Currently there is little prospect of fully electric (battery or fuel cell-powered) vehicles coming into the market for this segment this sector.
- The availability of biomass (for blending and renewable gas) is limited and dependent on developments

elsewhere in the value chain (agriculture, chemicals, food).

- Renewable (compressed) gas and biofuel blending can serve as transitional and fall-back options for electrification in the urban and short-range light goods transport segment. The liquid biofuels may be a long-term option for long-range and heavy goods transport, if the electrification of that segment on the basis of fuel cells does not prove possible.

BUSES

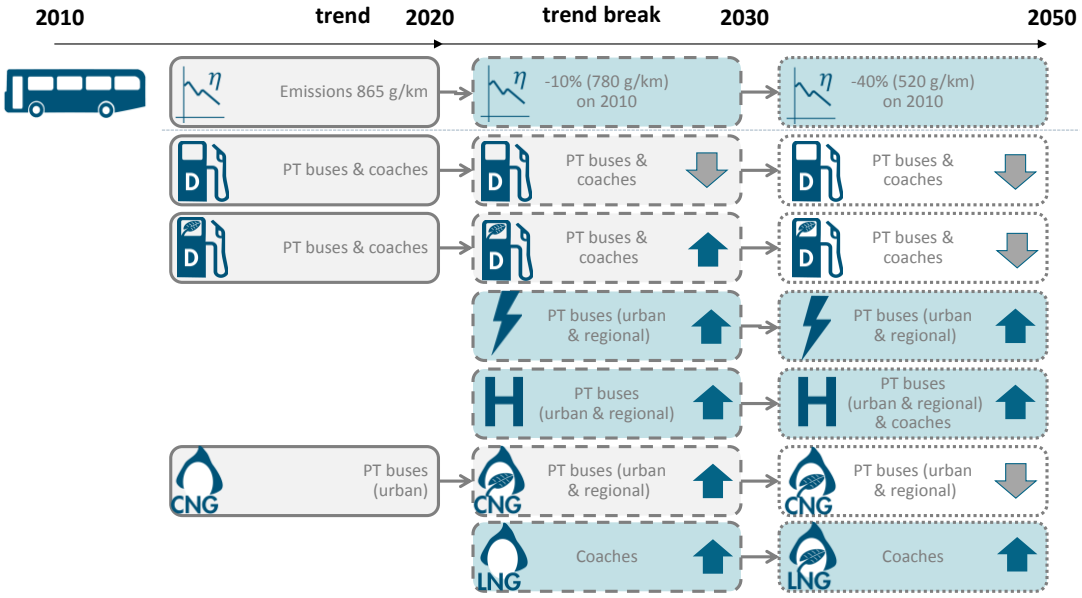


Figure 7: Development path for buses (pilots not included)

Long-term picture: full electrification of buses used for both intra-urban and inter-urban public transport is expected. Developments in the coach segment are expected to be similar to those in long-range freight transport.

Why?

- Intra-urban and inter-urban public bus transport is a small market, which lends itself to government policy control (green deal zero-emission bus transport).
- Air quality and noise control are important issues in public urban bus transport.
- Drivetrains for coaches are expected to develop in a similar way to those for HGVs.

Short-term development path aims:

- Increasing energy-efficiency of new vehicles and engines (including hybrid, using regenerative braking).
- Introducing renewable gases to the market for existing intra-urban and inter-urban public transport buses, which already run on natural gas and possibly for new buses, together with the required infrastructure.
- Introducing battery-electric and fuel cell-electric drive systems to the market for public transport buses (intra-urban and inter-urban), together with the associated refuelling infrastructure for buses.
- Maintaining current levels of sustainable biofuel blending and possibly additional blending of new sustainable biofuels with diesel.
- Piloting coaches that run on renewable gas (LNG).

Development path aims 2020 – 2030:

- Pursuing further increases in the energy-efficiency of new vehicles (including hybrid, using regenerative braking).
- Scaling up use of battery-electric and fuel cell-electric drivetrain systems for public transport buses (intra-urban and inter-urban).
- Introducing renewable LNG to the market for coaches.
- Pursuing further scaling up of renewable gas use by public transport buses.

- Additional blending of sustainable biofuels with diesel.

Why this development path for buses? (Reasons why long-term picture is not immediately achievable)

- Zero-emission buses can pave the way for zero-emission heavy goods vehicles (particularly for last-mile use), which have a similar deployment profile.
- Renewable gas and biofuel blending can serve as transitional and fall-back options – and as long-term alternatives – for the international coach sector, if the electrification of (international) coaches on the basis of fuel cells does not develop.
- Contrary to HGVs and coaches, public transport buses with electric or gas-powered drivetrain systems are already available on the market.

ON THE VISION AGENDA

- Development of programmes for various electric drive systems and associated services and infrastructure.
- Incentivisation of sustainable biofuel production based on cascading and biorefinery.
- Public-private infrastructure fund for electric charging infrastructure, hydrogen stations, renewable gas refuelling stations.
- Support for market introduction, rollout and production of various sustainable biofuels and energy carriers.
- Promotion of vehicles that run on the above fuels and energy carriers.
- Work at EU level for CO_2 requirements for vehicles (fleet averages for automotive manufacturers), based on the 60 per cent CO_2 reduction target for 2050.
- Work at EU level for tougher requirements regarding the reduction of the greenhouse gas emissions associated with the fuel supply chain (preferably in the European Fuel Quality Directive (FQD)) and reform of the European Renewable Energy Directive (RED post 2020-target renewable energy for transport) so that all fuels are taken into account (also gases, electricity, hydrogen), and allowing for direct and indirect WTW greenhouse gas emissions to be taken into account. This approach will allow the introduction of renewable energy into all segments of the fuel market, in line with the recommendations of the Corbey Committee.
- Work at national and EU level to promote the use of CO_2-dependent methods for incentivising the use of vehicles and fuels/energy carriers that are more fair, so that in the longer term the whole chain is taken into consideration, rather than merely the characteristics of the vehicle. Systems should be established that are suitable for long-term retention, in order to provide financial certainty.
- Work at national and EU level to allow for all new vehicles sold in the Netherlands from 2035 to be zero-emission capable.

SHIPPING: SUPPORT FOR EARLY LNG-ADOPTERS, ENERGY-EFFICIENCY AND BIOFUELS

In the Covenant on Energy Efficiency and CO_2 Reduction in Maritime Shipping – which was signed in 2011 by the Minister of Infrastructure and Environment, ship owners, shipping companies, shipbuilders and hydraulic engineers – the Dutch maritime shipping industry adopted the target of reducing CO_2 emissions by 50 per cent relative to 2020. This target, which was restated in 'Groen en krachtig varen' ('Green and powerful shipping'), the environmental statement of the KVNR, is consistent with the SER energy sector targets.

- For (intercontinental) deep sea shipping, the most promising option is the promotion of efficiency measures with a view to reducing fuel consumption.
- Where short sea shipping and inland shipping are concerned, LNG is regarded as the most promising option in the longer term. LNG is not yet 100 per cent renewable and sustainable, but a development path from LNG to renewable LNG is possible.
- Because the track outlined above is the most sustainable and promising in the long term, it should be made the focus of policy in this field. Such a focus will align Dutch policy with the European Clean Power Directive[14], which requires all larger sea ports and TEN-T core inland ports to have LNG-bunker facilities by 2025.
- In the inland shipping sector, the Netherlands can probably adopt LNG as an alternative fuel more quickly. However, accelerated adoption will require investment in bunker facilities. In view of the long depreciation periods of vessels and engines (thirty to forty years) and the limited scope for investment by inland shipping operators, retrofit incentive schemes will (probably) be necessary.
- For the inland shipping sector, the electrification of propulsion systems (use of diesel-electric power units) is a no-regret-option[15]. In the short-term, electrification brings efficiency gains; in the long term, the diesel and possibly LNG used for the generators can be replaced by hydrogen and fuel cells.
- Because adoption of the SER energy targets implies the reduction of CO_2 emissions not only in the long term but also in the medium term, migration to LNG will not be sufficient on its own. The interim targets are to be pursued through biofuel blending. Battery-electric power units are an option for certain niche segments (ferries and recreational vessels).
- In the maritime shipping sector, opportunities are seen for simple (but sustainable) biofuels. Such fuels will need to be introduced on the basis of international standards (IMO).
- Figure 8 shows the development paths for the various shipping sectors.

[14] Member states must ensure the siting of a sufficient number of LNG bunker stations in maritime ports no later than 31 December 2025, so that LNG-powered inland and maritime vessels can circulate on the TEN-T core network. Member states should work with their neighbours where that is necessary to ensure adequate network coverage.

[15] Not to be confused with shore power, i.e. electricity that vessels use when in port for 'hotel' purposes (lighting, heating, cooling, etc.), and not for charging the batteries of electric navigation power units.

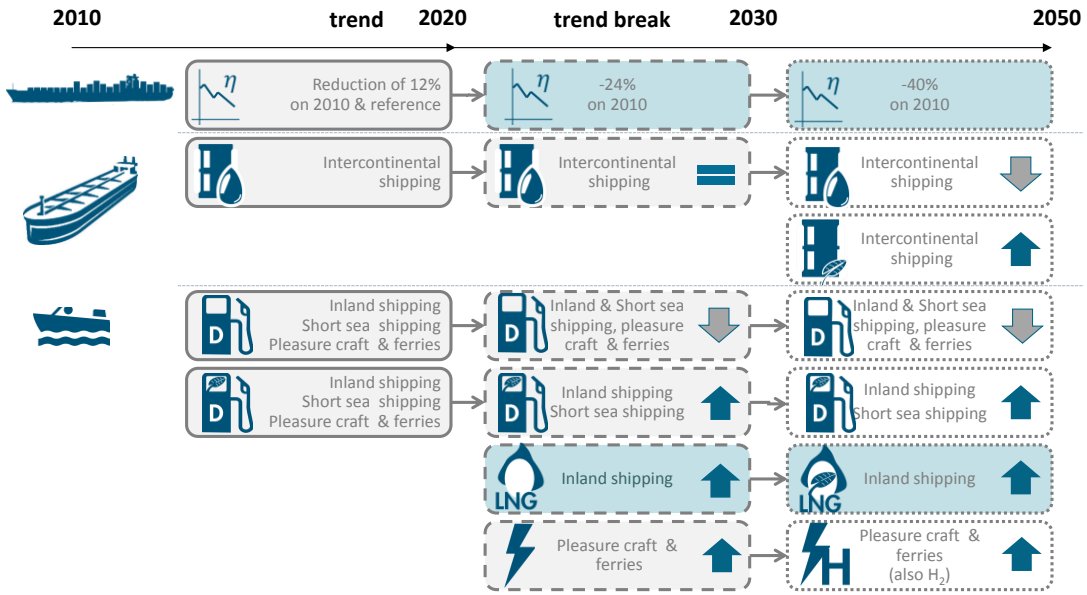


Figure 8: Shipping development paths

Long-term picture: efficiency measures designed to reduce energy consumption, promotion of (renewable) LNG and blending with biofuels.

Why?

- Maritime shipping sector has set itself CO_2 reduction targets, in line with road transport targets (>50 per cent).
- Autonomous reduction in use of conventional fuels expected. Drivers: higher crude oil prices and lower gas prices, technological developments and environmental regulations for maritime shipping.
- The general expectations for biofuels are not very high, due to lack of supply and competition with other sectors (chemicals, agriculture, food) and other modalities (mainly road transport and aviation). Nevertheless, there may be opportunities, e.g. for maritime shipping to use simple (but sustainable) biofuels such as pure plant oil (PPO) and pyrolysis oil.
- In addition to the introduction of alternative fuels, there is considerable potential for efficiency improvements and for making heavy fuel oil cleaner (up to 40 per cent CO_2 reduction).
- (Renewable) LNG not only reduces CO_2 emissions, but also contributes to improved local air quality targets.

Short-term development path aims:

- Efficiency measures and biofuel blending on the basis of international standards. Also develop EEDI (Energy Efficiency Design Index) for inland shipping.
- Introduction of methane emission standards for engines
- Conventional fuels (fuel oil, diesel), LNG for commercial shipping, electric drive for niche segments and for pleasure craft <1 per cent.
- Behavioural change (slow steaming).

Development path aims 2020 – 2030:

- Continued use of conventional fuels, plus LNG and biofuels (biodiesel and renewable LNG).
- Stricter EEDI requirements for maritime and inland shipping, plus operational efficiency measures and monitoring.
- Improvement of standards in maritime shipping closer to those of inland shipping and to bring standards in inland shipping closer to European standards for heavy road transport.
- Promotion of biodiesel and renewable LNG.
- Gas-to-liquid can play an important role in shipping, particularly in relation to local air quality requirements.
- For international shipping, there are options such as gas-to-liquid, wind, hydrogen and electric, but expectations very limited (1-2 per cent).
- For recreational craft, there are opportunities for the use of electric power units. Incentivises for the use of electric power on recreational vessels and in niche segments (e.g. ferries).

Why this development path for shipping? (Reasons why long-term picture is not immediately achievable)

- Efficiency measures have the greatest potential for delivering CO_2 emission reductions.
- Liquid fuels (conventional, biofuels and LNG) are necessary and required due to market requirements.
- HFO will remain available as a (residual) product for a long time.
- CO_2 emission reduction potential of LNG depends on the extent to which problems with methane emissions are resolved.
- Biodiesel is currently too expensive and not generally used; users and engine manufacturers therefore hesitate to adopt it.
- Promotion of LNG and biofuels is attractive because of compatibility with current infrastructure and technologies.
- Promotion of LNG dovetails with European Clean Power Directive.
- A development path from LNG to renewable LNG is possible for vessels involved in the transportation of biomass. Widespread use of renewable LNG not currently expected in the period up to 2050.

Primary principle is that measures must be introduced to encourage early adopters.

- Transition to LNG is important in relation to green growth and energy security. Promotion of the transition to LNG will initially have a positive effect mainly on local air quality. Real benefit in terms of CO_2 emissions will not come until later (after 2030), when transition to renewable LNG becomes possible.
- In the long term, it is very important that standards are developed to control the methane slip associated with LNG. The regulation of CO_2 and methane emissions needs to be placed on the international agenda.
- Maritime vessels that spend more than 70 per cent of their time in Emission Control Areas (ECAs) and are no more than five years old are more likely than others to invest in LNG equipment. A programme to promote the transition to LNG is desirable to complement other measures, such as the use of gas scrubbers in combination with fuel oil (<1 per cent sulphur). The cost of switching to LNG is between two and three million euros per ship. It is estimated that roughly a hundred Dutch short sea vessels would fall into the category described. If methane emissions can be prevented, switching to LNG will cut CO_2 emissions by 8 to 20 per cent per vessel.
- Roughly nine hundred inland vessels could consider switching over to LNG in the period up to 2030. That corresponds to a fleet penetration level of 19 per cent for both LNG and renewable LNG by 2030. The figure could rise up to 26 per cent by 2050. This represents an opportunity. In order to realize this potential concrete policy measures and programmes are required that support a switch to LNG. For new vessels, the business case is often positive, but this is not the case for existing vessels. The cost of conversion would typically be about € 1.3 million. Conversion would yield a CO_2 reduction per ship of 20 per cent until 2030, potentially rising to 44 per cent by 2050, when it may be possible to use renewable LNG.
- Other niche markets such as gas-to-liquid, battery-electric, H2 and methanol should be monitored to establish what bespoke policies are needed.

In addition to encouraging early adopters, the promotion of efficiency and biofuels can be advantageous:

- More progress can be achieved by promoting more efficient energy use by shipping. Up to about 40 per cent of the sector's CO_2 emissions could be prevented by efficiency improvements. Of that potential saving, about half can be realised fairly easy, since it may be expected to flow from autonomous developments and existing policies, such as larger vessels, sailing more slowly and meeting the Energy Efficiency Design Index (EEDI) requirements for maritime shipping. In order to achieve further improvements, additional policy will be required.
- Identify major consumers in the inland and short sea shipping sectors and establish a pilot with the aim of reducing energy consumption by 20 per cent compared to current levels.

Agreed measures could be set out in the form of an energy performance contract or based on a Lean & Green award[16] supported by an appropriate funding mechanism.

- The promotion of biofuels by requiring a certain percentage to be blended into fossil fuels is necessary in the shipping sector for realisation of the CO_2 emission reduction ultimately required. Steps should be taken to ensure that shipping can also use locally and nationally produced biofuels.

Figure 39 shows the currently estimated maximum CO_2 reduction attainable by implementation of the measures described above in the maritime shipping sector.

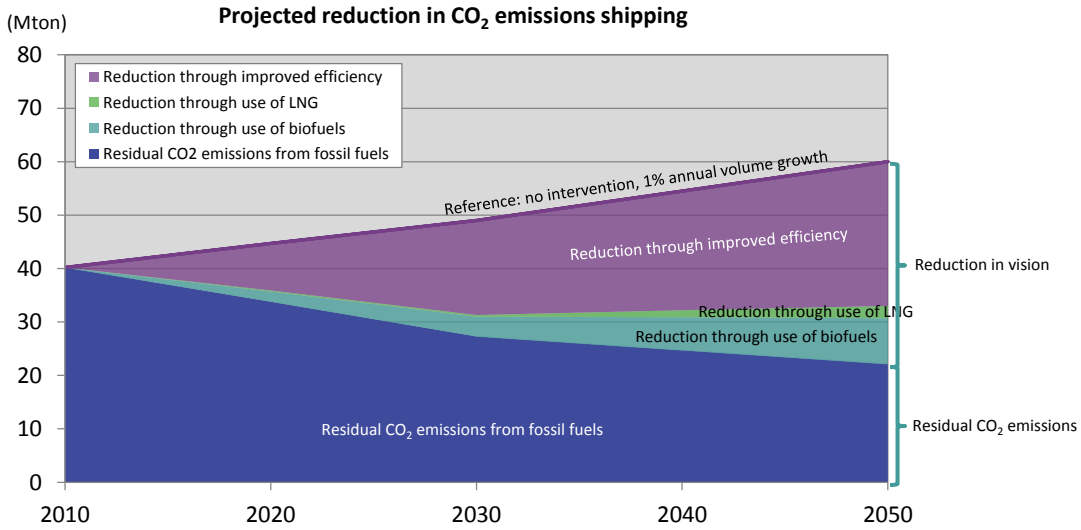


Figure 9: Forecast development of CO_2 emissions from maritime shipping

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- Pursue obligation to blend sustainable biofuels or an alternative obligation for shipping to use renewable energy.
- Work at national and EU level for CO_2-dependent methods for incentivising the use of vessels and fuels/energy carriers that are more fair, so that in the longer term the whole chain is taken into consideration, rather than merely the characteristics of the vessel. Systems should be established that are suitable for long-term retention, in order to provide financial certainty
- Develop policy measures that promote the conversion to LNG for inland and short sea vessels.
- Work at the international and EU level on the control of CO_2 emissions and methane slip.
- Innovation pilots for efficiency improvement.
- Formulate an action plan covering the focus points and measures referred to above.

[16] If an organisation presents an approach plan demonstrating that it can achieve a 20 per cent CO_2 emission reduction within five years, it qualifies for a Lean and Green Award. Organisations that succeed in hitting their 20 per cent target are able to use the Lean and Green Star symbol to show that they have attained their Lean and Green ambition.

AVIATION: PIONEERING ROLE IN SUSTAINABLE BIO-KEROSENE WITH THE NETHERLANDS AS BIOFUEL CAROUSEL

The aviation sector is pursuing an ambitious course that entails:

1. Further efficiency improvements through innovation of aircraft technology, operations and infrastructure
2. Development and implementation programme of actual sustainable bio-kerosene sourcing, production and distribution based on the BioPort Holland concept (see Sustainable Aviation Fuel Vision)
3. Detailed sustainability ambitions based on stringent, international certification criteria.

In contrast to the situation in other transport modalities, aviation has no technical alternatives other than the use of biofuels for reducing CO_2 emissions from fossil fuels (see figure 10).

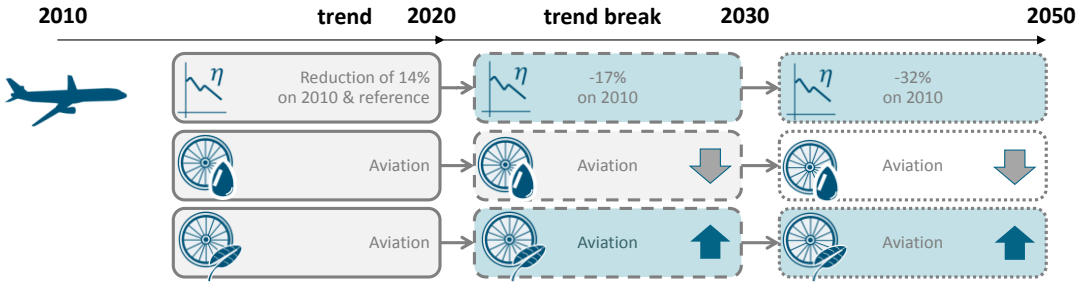


Figure 10: Aviation development paths

Long-term picture: promotion of sustainable bio-kerosene as a drop-in fuel and further efficiency improvements.

Why?

- The aviation sector has set itself the target of achieving carbon-neutral growth, meaning that by 2050 the sector's CO_2 emissions must be reduced by 50% compared to the 2015 level.
- The blending of bio-kerosene is currently the most realistic possibility for the aviation sector.
- At the moment, there is still no business case for bio-kerosene, which costs three to six times more than conventional fuel.
- There remains considerable potential for efficiency improvement.

Short-term development path aims:

- Promotion of efficiency.
- Innovation of pilot and demonstration projects to promote conversion technologies.
- Liquid fuels dominate.

Development path aims 2020 – 2030:

- Promotion of further efficiency improvements.
- Systematic biofuel blending.

The Netherlands has a unique combination of proactive production and distribution businesses, product developers and product users (including airlines), leading knowledge centres and public-private partnerships and supportive government entities committed to green growth. The country is therefore well placed to successfully develop and implement sustainable bio-based-products, including bio-kerosene.

The ports of Rotterdam and Amsterdam are amongst Europe's major logistic hubs for kerosene trading and already have an extensive bio-based infrastructure. They benefit from a leading position in the field of bio-kerosene.

The Dutch players, including the financial sector through international co-investments, are in an excellent international position to gain maximum benefit from sustainable bio-kerosene development (technology and production). Hence, the Netherlands can also maintain its leading international position in setting sustainability standards for bio-kerosene.

The proposed development path is outlined in the following CO_2 emission reduction scenario,[17] which is aligned with the international objective of carbon-neutral growth from 2020 and a 50 per cent emission reduction by 2050, compared to 2005:

1. Direct market preparation with bio-kerosene based on hydrogenated sustainable plant oil and fats, and the further development of sustainability standards.
2. Until 2020 development of and after 2020 large-scale use of bio-kerosene technology based on biomass (residue) flows.

That results in the emission reduction pattern illustrated below, involving reductions relative to 2014 (and the no-change reference scenario): ~ 0 per cent (-12 per cent) by 2020, 6 per cent (-42 per cent) by 2030, 24 per cent (-65 per cent) by 2040, 50 per cent (-82 per cent) by 2050 (also shown in Figure 1). The CO_2 emissions illustrated are for the entire chain (*'well to wing'*).

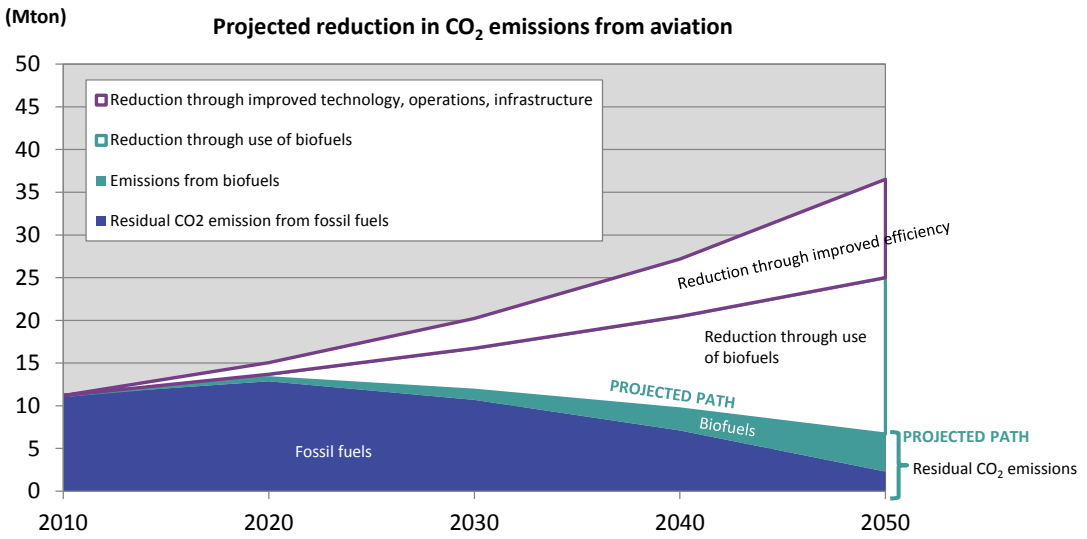


Figure 11: Forecast development of CO_2 emissions from aviation, based on the fuel vision sustainable aviation, TU Delft, BE Basic, well-to-wing.

ON THE VISION AGENDA

- Support for the innovation, investment and sustainability ambitions of the aviation sector in the field of efficiency improvement and sustainable biofuels, to be realised by further development of the Holland BioPort concept.
- Specific measures for the realisation of Holland BioPort:
    1. An integrated approach including the production of stationary energy (electricity and heat) and the production of chemicals and materials in an integrated biorefinery process.

[17] For details, see the Sustainable Aviation Fuel Vision.

2. Investment in public-private R&D and (international) pilot projects for both raw materials and production and distribution technologies for bio-kerosene.
3. Development of instruments that can promote the demand for bio-kerosene on a large scale.
4. Development of detailed sustainability ambitions based on stringent international certification criteria.

RAIL: FURTHER PROGRESS TOWARDS SUSTAINABILITY

For the rail sector a separate workshop was organized within the vision process. The results are therefore indicative and require deeper analysis. Although the rail sector is already largely electrified, the sector is nevertheless seeking to move towards greater energy carrier sustainability (see Figure 2).

Diesel is still used extensively for shunting, regional transport and freight transport. Also, if almost all of a route is electrified, but a small section is not, a diesel engine is often used for the whole route for logistic reasons. Since freight transport is an international issue, change must be instigated at an international and European level. In the regional rail transport sector, regional and national initiatives involving (bio-)LNG may be appropriate.

Progress could be made by cooperation with shipping and road transport on the use of (bio-)LNG. LNG is quieter than diesel and therefore preferable not only in air quality terms but also in terms of noise. Gas-to-liquid can also serve as a solution with minor CO_2 emission benefits.

The sustainability of the chain as a whole could also be increased by considering how the electricity is generated. In that context, Dutch Railways (NS) is aiming to ultimately use only green power, without trading certificates.

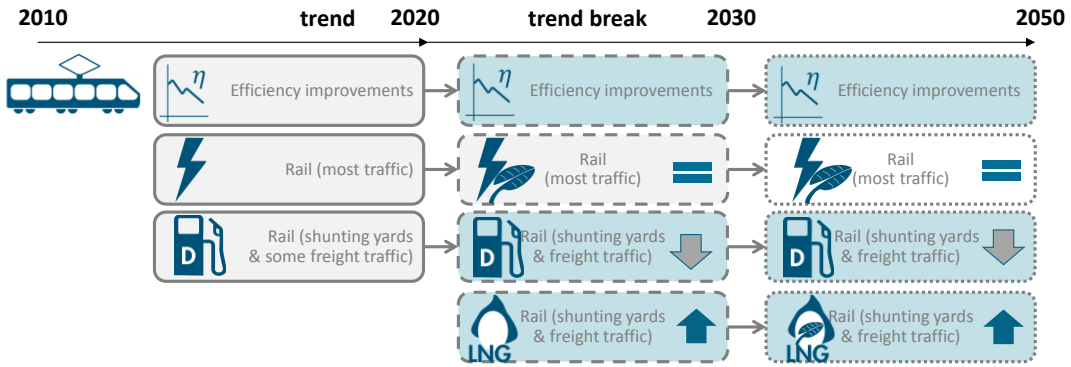


Figure 12: Rail development paths

TAILOR-MADE SUPPORT DURING THE TRANSITION TO SUSTAINABLE FUELS IN TRANSPORT

The support provided by government must take the particular market phase of the product development in question into account: a product that is ready for market requires a different form of support than a product that is still in the R&D phase. A product is defined by the market sector for which it is intended (passenger transport, light goods transport, freight transport, etc.) and the type of fuel. In the stakeholder process, the phrase 'product-market combination' (PMC) is therefore used.

- Where the business case for a product is already strong, investment will come from the market. In other situations, the government can provide temporary support.
- Such support may be provided through various types of policy (see also 'Action plan'). Options include:
    1. Standardisation and regulations
    2. Subsidisation of R&D and innovation
    3. Additional measures, such as privileges that promote sustainable transport
    4. Fiscal incentives
- Support should be geared to the product's market phase (R&D, pilot, market introduction, scaling up and mass marketing).
- In order to maintain a level playing field, policy geared for standardisation and regulation) is formulated more generically, while R&D and innovation policy is often more specific.
- For a successful transition to sustainable fuels, policy must address products in various fields: infrastructure, vehicles and the fuels itself.

Basic policy principles:

- Policy that is initially expensive to implement for a given PMC (i.e. for immature PMCs) is applied to relatively small numbers of vehicles, provided that there is reason to believe that learning and upscaling effects can ultimately make the product competitive and viable.
- Policy whose unit cost is relatively low (mature PMCs), can be applied to larger numbers of vehicles and remain affordable. Of course, regulatory or standard-setting policy can also be affordable for larger numbers of vehicles even in 'expensive' PMCs.

For each policy type, numerous measures are possible. A number of examples are given below.

- A covenant providing funding of sustainability projects from capital providers (banks, pension funds, EIB), and EU co-financing instruments aligning with pillar 10 of the SER Energy Agreement:
    1. The creation of specialist investment funds for higher-risk investments.
    2. The creation of guarantee funds to counteract the currently unfavourable lending market.
    3. A covenant providing for the stricter definition of risk profiles used in the funding of new technologies.
    4. The creation of funds, supported by an emissions tax, such as a tax on CO_2 and NO_x emissions (to promote air quality). The funds' resources could be used to invest in more sustainable applications. A good example is Norway's NOx Fund, from which the whole fleet has been converted to LNG at a little cost to the state.
- Support for public and private purchasing consortia, on the basis of:

1. Practical support for public contracting procedures and, if necessary, amendment of the applicable legislation and regulations.
2. Utilisation of a national contracting bureau for legal, financial, organisational and technical/content support (e.g. PIANOO).

- Support must take account of the total cost of ownership (TCO): there must be a prospect of a product ultimately being available at a competitive price. Electric vehicles must ultimately be available at a price similar to that of combustion engine vehicles if they are to win over consumers.
- In view of the points outlined above, it is important that the value and development of various PMC indicators are closely monitored. If the indictor values for a given PMC change, it may be necessary to adjust the policy for that PMC.
- Where a product is already in use, support should be focused on their practical application and user acceptance. Example 1: in the heavy road transport sector, there is need for a new innovation programme. Support is required not only for market-ready technologies, but also for technologies still under development, which need to be prepared for market and piloted. Support for the latter category may take the form of R&D and innovation policies and incentives, preferably in the form of public-private partnerships. Example 2: in the bus sector, there is need for a programme that encourages the purchase and sustainable use of buses that run on renewable gas or fuel cell-electric or battery-electric motors.
- Environmental costs need to be incorporated into TCO calculations and steps taken to prevent the development of a non-level playing field or perverse stimuli that can work against the transition to sustainability.
- Within the European Emission Trading System (ETS), the price of CO_2 emissions is currently too low to encourage businesses to invest in (more expensive) clean technologies.
- Certain sectors, vehicle types and fuels are exempt from taxation, or are taxed at a lower rate. Examples include aviation, shipping, mopeds and scooters, mobile machinery, CNG, LNG and LPG. The relevant users pay much less tax than, for example, users of conventionally fuelled passenger vehicles. It is consequently difficult to influence behaviour with fiscal policy, making other policy tools more appropriate.
- Hydrogen is not currently taxed and the tax on electricity is low, because the tax system does not regard it as a transport fuel. In due course, it will probably be necessary to harmonise the tax on hydrogen and electricity with that on other fuels. However, that will be possible only when the relevant fuel tracks reach the upscaling phase or mass marketing phase.
- Tension exists between the need for vehicle and fuel tax regimes that are sustainable in terms of revenue generation and the need to support sustainable fuel tracks by providing long-term certainty about the tax benefit of a particular option for the user. A system of differential taxation, in which the polluter pays for progress towards sustainability can ease that tension in a PMC's early market development phases. However, as the PMC's market share increases, there are fewer polluters left to pay, and revenue declines unsustainably.
- The stakeholder process emphasised the need for a long-term fiscal policy framework that promotes sustainable options, without creating inequality between options that are unrelated to their (long-term) contribution to sustainability. The question is, can we in the longer term place sustainable options on a fiscal 'footing' that is more proportional to their (ultimate WTW) contribution to CO_2 reduction? The possibility of using a TCO calculation, which takes account of social cost and benefits (including long-term potential) should therefore be investigated.
- In view of the long-term agenda and green growth ambitions, it will probably also be necessary to focus on supporting radical innovations.

ON THE VISION AGENDA

- A covenant for funding sustainable investments via the various mechanisms identified.
- Support for purchasing consortiums with contracting expertise.
- Monitoring market phase progression of PMCs, reducing total cost of ownership, technical developments that facilitate wider use, greater WTW sustainability, etc.
- Support for the practical application of market-ready PMCs and the development of high-potential technologies and PMCs that are not yet market-ready.
- Research into fiscal policy for supporting sustainable options.
- Incorporation of other recommendations and principles set out above into the action plan.

COOPERATION REQUIRED AT ALL LEVELS

Developments in the Netherlands are to a significant extent determined by decisions made in other countries, by international and indeed local and regional policy-makers, by vehicle producers and fuel producers and by consumers' purchasing behaviour. Within this complex field, the government can provide direction by helping to shape international and European policies (e.g. strict requirements for vehicles regarding CO_2 and other emissions) and through innovation programmes and projects. Additionally measures can be used such as targeted investment, incentivisation schemes and targeted network management.

The policy and instruments needed to support the desired transition therefore require international, local and regional measures and alignment.

Each type of policy is associated with a particular level or combination of levels, which can vary from one modality to the next.

- Stricter standards and source oriented policies need to be formulated within the EU.
- Maritime transport and aviation may be influenced at the European and global levels. Revision of standards and policy initiatives requires action through the IMO or ICAO and through the industries that serve global markets.
- Inland shipping is a West-European matter. Standards are defined in Strasbourg (CCR) and policy in Brussels (EU).
- Additional measures, such as parking privileges and emission-free zones are defined mainly at municipal level.
- Fiscal incentives are a national government matter.
- Innovation policy is formulated at various levels: provincial green deals, municipal focuses, national top-sector policy and in international and European framework programmes.

Effective support is needed for the development paths, market segments, and industries and depends on proper coordination between the various levels, with simultaneous policy deployment and joint investment.

- Without adequate supply or sufficient improvement potential, fiscal policy is ineffective.
- International arrangements are necessary to ensure level playing fields; strong local and national initiatives and policies will help to ascertain a vanguard position.
- National involvement is desirable for creation of the uniform conditions needed for regional initiatives. At present, local rules (e.g. regarding permit and environmental requirements for hydrogen refuelling stations and environmental zones) vary so much that businesses find it difficult to introduce innovative solutions throughout the country.
- For the national rollout of alternative fuels, it is advisable to start with regional initiatives, so that lessons can be learned before scaling up to the national and international level. The charging infrastructure for electric vehicles forms an exception, however. In that field, smart nationwide upscaling and cost management are required.
- Experience in other countries indicates that joint investment by national, local and regional governments and private-sector actors can accelerate breakthroughs.

ON THE VISION AGENDA

- Implementation of the vision and translating it into action at various levels: international, European, and local, regional and national governmental.

- Support for regional initiatives, learning from experience and national rollout of successful initiatives.

GREEN GROWTH THROUGH LEADERSHIP IN PROMISING NICHES

Green growth is necessary for our long-term prosperity and welfare.

- A transition to a more sustainable economy and energy supply is inevitable and essential; to remain competitive one must 'go green', not only for the sake of the environment but also for the economy for competitiveness and energy security.
- Green growth entails a transition to a sustainable economy and the promotion of economic growth, accompanied by the reduction of pollution, more efficient use of raw materials and the continued availability of natural resources.[18.] The cabinet wishes to increase the competitiveness of the Netherlands while also reducing environmental impact and dependency on fossil energy.
- The capital invested in existing industry can serve as a point of departure for new developments. Current assets, infrastructure and knowledge act as a platform for new products, thus accumulating a cost-effective competitive advantage.
- Much of our prosperity (15 per cent of pension funds) is linked to fossil industries – a situation that does not provide a sound basis for future prosperity.
- The Netherlands is vulnerable in this context, because our exports depend heavily on sectors that consume large amounts of fossil energy and scarce raw materials. The Dutch mobility sector is similarly dependent.

Mobility and fuels are elements of the green growth challenge.

- Mobility and economic growth go hand in hand; more mobility currently places even more pressure on the environment and greater dependency on scarce raw materials.
- The Netherlands has a prominent position as a bunkering and transit port for aviation, maritime shipping and road transport.
- In the future, a bio-based economy can create opportunities for the development of bioports, advanced biofuels with a low environmental impact.
- Switching to hydrogen fuel cells, batteries or renewable gas can make an important contribution to breaking the link between mobility development and environmental impact (CO_2, air quality, noise). Once the fuel used for mobility is 100 per cent sustainably produced, we are well on the way to breaking that link. The environment then ceases to be a limiting parameter for mobility growth and the associated economic growth. The potential economic impact of transition is therefore very great.

A sustainable mobility sector is not only a cost item, but also a source of earnings. Promising projects build on the Netherlands's current strengths or distinguishing characteristics, including the country's urbanisation level, and provide opportunities for newcomers and start-ups. Furthermore, the pursuit of sustainable mobility is to a significant extent a condition of membership of the European vanguard nations.

[18] Source: CBS (2013) Green Growth in the Netherlands 2012.

Box 6: Developments and options in the European vanguard.

Leaders in Europe

In the field of sustainable fuels, Europe's vanguard countries are Denmark, Germany, UK, France, Norway and Sweden.

- Denmark and Sweden are aiming for completely climate-neutral transport by 2050.
- Where alternative refuelling infrastructures are concerned, the emphasis is currently on electric vehicles. In Norway, the number of charging points is expected to increase rapidly, because of the current tax incentives.
- Germany is the first country to formulate a definite hydrogen refuelling infrastructure ambition: four hundred H2 refuelling stations by 2023 and nine hundred by 2030.
- Sweden has high ambitions in the field of biofuels: by 2040, all demand for liquid fuel in the country is to be covered by biofuels.
- Tax incentives are currently targeted mainly on fully battery-electric vehicles (and to a lesser extent plug-in vehicles) and on the differentiated taxation of conventional vehicles on the basis of their CO_2 emissions. In most countries, (future) fuel cell-electric vehicles are covered by the same incentive schemes.
- Vehicles that run on biofuels (high blends) and natural gas have a distinct fiscal status in only a small number of countries.
- Many automotive manufacturers are currently bringing out new fully electric or hybrid electric vehicles. Various brands have announced plans to introduce the first mass-produced fuel cell vehicles between 2015 and 2017. Because of the uncertainties surrounding the technologies and markets, most brands are pursuing a portfolio strategy, rather than backing one particular option.

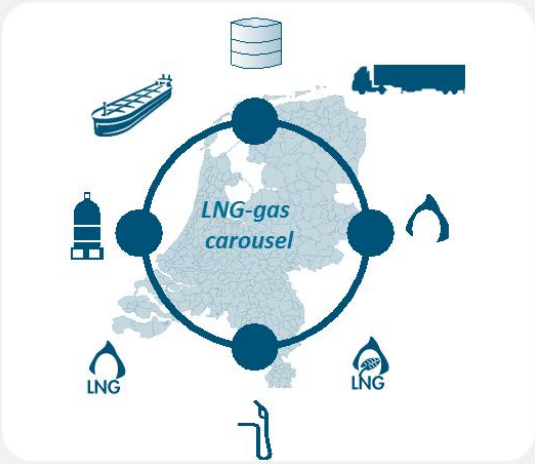
- The Netherlands has a strong position in the fields of system knowledge, materials, 'auxiliaries' and components, fuel services and logistics, charging infrastructure, special vehicles and transport, gas, agriculture and chemicals. That position, coupled with the country's mainports, increases the opportunities for biofuels and the use of gas in transport. For example, opportunities exist for the Netherlands in the production and transfer of non-fossil fuels (sustainable biodiesel, bio-ethanol, renewable gas, power-to-gas, and hydrogen).
- The Netherlands is a relatively wealthy and highly industrialised and urbanised country, where a lot of importance is attached to quality of life, but with few natural reserves of raw materials. As such, the Netherlands is ideally placed to take a leading role in the development and implementation of innovative solutions suitable for a short-range travel environment and adapted to the quality-of-life challenges of densely populated urban areas. Solutions for problems that require urgent attention here serve as examples to other countries when they subsequently encounter similar issues.
- Solutions for which the Netherlands could play a pioneering role include innovative vehicle technologies, such as battery-electric and fuel cell-electric drive systems capable of contributing to the quality of life in urban areas, charging and refuelling infrastructures for new fuels (electricity, hydrogen and renewable gas) and energy transition and buffering. Services relating to such solutions are globally applicable.
- Sustainable mobility connects five of the nine top sectors and innovation agendas (agriculture, chemicals, sustainable energy, high tech and logistics).
- Long term fuel cost savings are advantageous to the general economy.
- Increasing emphasis will be placed on the new technologies at universities and other higher education centres. That will have spin-off benefits for the labour market and the economy.

Niches with high green growth potential have been identified for all fuels and modalities. Smart coalitions with other vanguard countries can increase the success prospects and market potential of the four identified leaders.

GAS

Leader on R&D and pilots in the fields of distribution, regulation, production of renewable gas for light vehicles and (bio-)LNG for heavy road transport and shipping. This niche builds on:

- The strong position that the Netherlands has because of mainports Rotterdam and Amsterdam as hubs for transfer between maritime shipping, inland shipping and road transport and as bunkering locations.
- Renewable gas (bio-LNG) is the most promising sustainable fuel for articulated HGVs and shipping.
- Expertise in the fields of distribution, regulation, production of renewable gas from sustainable biomass and power-to-gas as a possible sustainable energy buffer.



BIOFUELS

Leader on the development of sustainable biofuels for all modalities. The niche dovetails with:

- Ambitions and position of aviation sector.
- Ambitions of Amsterdam and Rotterdam.
- The strong position of the Netherlands in chemicals and agriculture.
- Position and capacity of refineries.

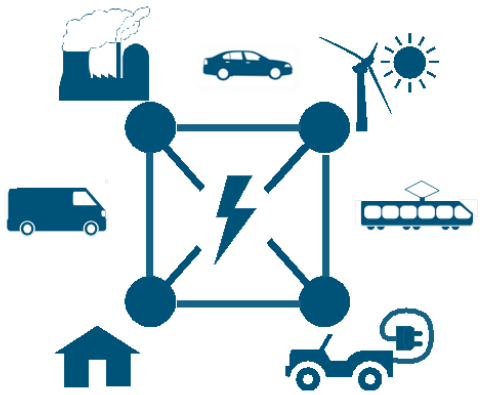
The size of the latter opportunity depends on the extent to which co-production and biorefinery are realised on the basis of the current position and on the extent to which existing capital investments act as impediments to change.

ELECTRICITY

Products and services linked to the charging infrastructure, transport concepts, smart grids, production of vehicles for particular applications, the bus sector, electric pleasure boats and ferries, components, parts and materials. Ties in with:

- Leading role on electric transport due to e.g. urbanisation.
- Battery-electric vehicles can play a role in energy transition and energy buffering. Buffering-related services are globally applicable.
- Expertise and the Dutch service economy.
- Opportunity for linkage with the development of (local and regional) sustainable generating capacity.

Smart-grids, charging infrastructure, services

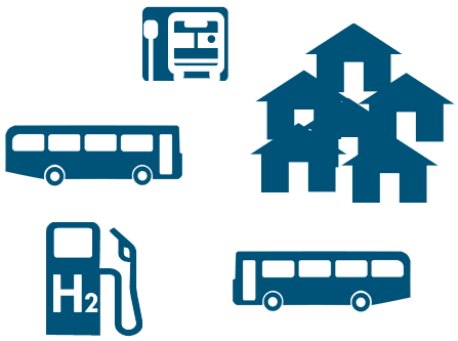


HYDROGEN

Development, pilots and market introduction projects with fuel cell-electric buses and passenger vehicles and the simultaneous realisation of a basic hydrogen refuelling infrastructure, capable of supporting daily bulk users and incoming minor users.

- Buses are one of the first markets to which hydrogen could be rolled out.
- The Netherlands has its own bus manufacturing industry.
- The government is the biggest customer and can facilitate rollout.
- The Netherlands has a refuelling infrastructure industry with several niche players.
- Sustainably produced hydrogen from established production processes is available for the pilots and market introduction of hydrogen-powered vehicles.

Hydrogen-powered PT buses



- The energy requirement of the public transport bus fleet is relatively small, so the absolute reduction in CO_2 emissions will be relatively small, but the bus sector can serve as a good test environment for the use of new technologies in heavy vehicles.
- Public transport buses are very visible to the general public and public transport buses make a significant contribution to local air and noise pollution.

Other important niche markets include urban light goods transport, the vehicle fleets of governments and businesses (where influence can be exerted through sustainable purchasing and contracting), and vehicles for special applications.

ON THE VISION AGENDA

- 'Greening' the Netherlands' competitive position and employment by seizing the opportunities created by the vision on sustainable fuels.
- Aligning the sustainable fuel mix with policy on top sectors and innovation.
- Supporting the identified promising niches.

ACTION PLAN 2014: A 'COALITION OF THE WILLING'

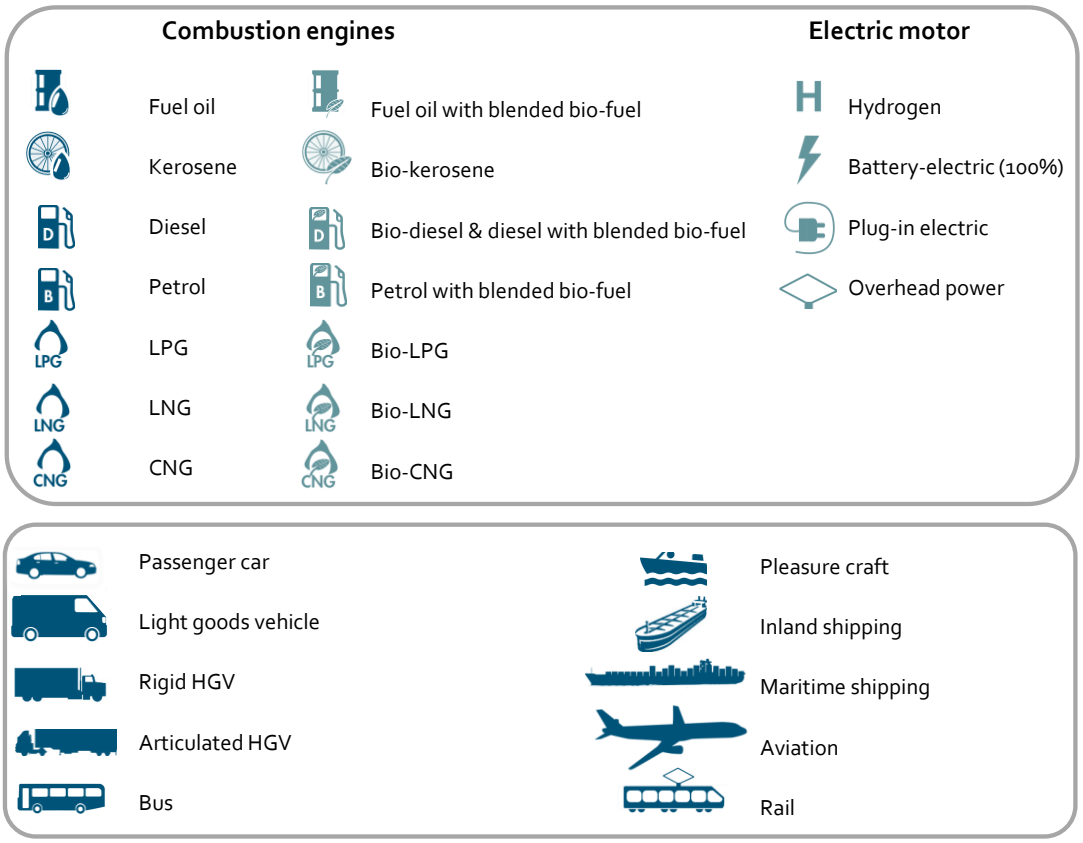
- An action plan sets out the steps necessary for realisation of the vision and the CO_2 reduction provisions of the SER Energy Agreement.
- An action plan implies the formation of coalitions of willing stakeholders, tailored to the particular cooperation needs of the market sectors in question. Intensive cooperation will be required between private and public parties, both on market-ready products and particularly on the development of pre-competitive technologies. Platforms already in existence or under development, such as the FET team for electric vehicle use, the H2MobilityNL group and the Green Gas Platform can play important roles in that regard.
- The coalitions define the specific targets and the associated sets of measures.
- Targets and ambitions and associated policy measures will also be tailored to the market phase that the product is in: R&D, pilot, market introduction, upscaling or mass market.
- The types of policy measures required (regulatory, innovative, additional, fiscal) depend on the phase that the product is in and on the targets that have been set. The policy measures cover four various policy levels: global, European, national, and local/regional.
- The action plan must lead to further commitment by the stakeholders to make the necessary investments and by the various tiers of government to take the necessary policy measures. For that to happen, there must be sufficient confidence that the benefits will justify the cost. The costs and benefits to be considered are, however, not only conventional economic costs and benefits, but also benefits in the form of CO_2 reduction, improved air quality, increased employment, energy security and increased economic activity.

ON THE VISION AGENDA

- Agreement on the approach described above.

APPENDICES

Box 7: Key to figures



The following reports used for this vision of a sustainable fuel mix in the Netherlands. The documents are available from the SER website:
http://www.energieakkoordser.nl/nieuws/brandstofvisie.aspx

- Scenarios for energy carriers in the transport sector. January 2014, TNO, ECN, CE Delft (final report on phase 1 of the process of developing an SER vision of a sustainable fuel mix).
- Sub-report from renewable liquid road transport fuel table, June 2014.
- Sub-report from renewable gaseous road transport fuel table, June 2014.
- Sub-report from renewable electric road transport fuel table, June 2014.
- Sub-report from renewable hydrogen road transport fuel table, June 2014.
- Sub-report from sustainable shipping fuel table, June 2014.
- Sub-report from sustainable aviation fuel table, June 2014.
- Process of developing an energy carrier vision: summary of the knowledge questions and answers during development of the energy carrier vision. June 2014, TNO, ECN, CE Delft.