Renewable fuels for Dutch transport towards 2030

How to achieve the mobility goals of the Climate agreement?

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EXECUTIVE SUMMARY

The Dutch Climate Agreement (2019) formulates a target of 65 PJ for renewable fuels to be used in the transport sector in 2030.

The 65 PJ goal is only a small step from the current deployment of renewable fuels in the Netherlands (expected to amount 40-45 PJ in 2020). With 65 PJ of renewable fuels, the original target to limit emissions from transport in 2030 below 25 Mtonne CO_2 equivalent (Energy Agreement 2013) will not be met. It is therefore advised to set still higher targets for renewable fuels. Within the current infrastructure and vehicles up to about 152 PJ of renewable fuels can be deployed, reducing the emissions to about 23 Mtonne CO_2 equivalent.

Many types of renewable fuels exist, and even more are conceivable. They can replace fossil energy carriers without dramatic changes to the energy distribution infrastructure and vehicles. The current global and European production of such fuels is already very large, and the Netherlands can both tap into this supply and contribute to increasing the options and the volumes.

Sustainable biofuels can play a prominent role. They can be produced from a wide range of feedstocks, including crops and organic waste streams. Sustainable biofuels should adhere to strict sustainability requirements and the additional demand should not lead to indirect impacts on carbon stocks and biodiversity. With new approaches such undesired impacts can be avoided, and the legislation can specifically steer for the best performing biofuels. The largest potential for sustainable biofuels is expected from such approaches.

Furthermore, with the increasing share of renewable electricity in the grid, some can be used to produce synthetic fuels or e-fuels such as hydrogen, but also synthetic diesel or gasoline.

The 65 PJ of renewable fuels can be produced with the technologies available today and based on feedstock that can be mobilised today. To allow larger contributions of renewable fuels in the future, innovation should focus on the development of new feedstocks through improved agricultural practices and new conversion pathways.

1. TARGETS FOR RENEWABLE FUELS IN DUTCH TRANSPORT

1.1 Need for greening transport

The COP21 "Paris Agreement" of December 2015 sets out a global target to limit the increase in global temperature to well below 2 °C above pre-industrial levels, with a strong ambition to limit the increase to 1.5 °C. With current emission rates, the global carbon budget for the 2 °C target will be used up in approximately 20 years.[1] The Paris agreement therefore urges immediate swift and sharp reductions of greenhouse gas emissions.

The EU 2030 climate and energy framework has set targets for cutting greenhouse gas emissions and increasing the share of renewable energy and energy efficiency to meet the aggregate nationally determined contribution of the European Union under the Paris Agreement (the "EU NDC"). By 2030, greenhouse gas emissions should be reduced by 40% compared to 1990, and at least 32% of energy should come from renewables.[2] Efforts in all sectors will be required to accomplish this, and many concurrent solutions will be needed.

Transport is a major emitter, responsible for a quarter of the EU's greenhouse gas emissions today, and this share is rapidly increasing (see Figure 1). Within this sector, road transport is by far the biggest emitter.

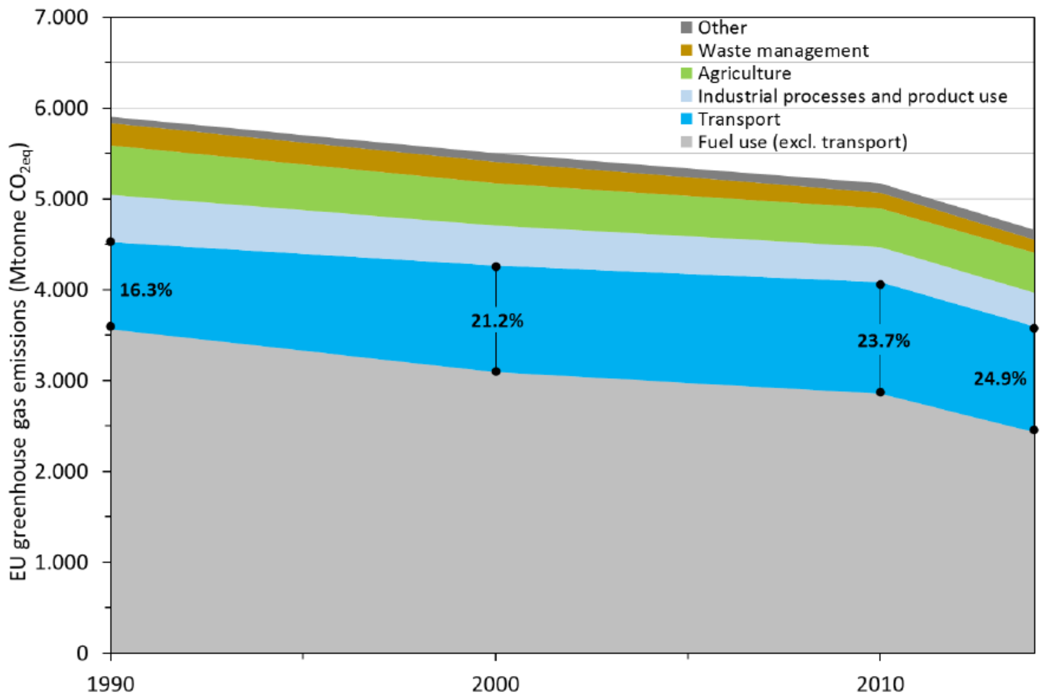

Figure 1. Greenhouse gas emissions by sector in the EU-28, with focus on share of transport.[3]

[1] The carbon budget is the estimated amount of carbon dioxide the world can emit while still having a likely chance of limiting global temperature rise to 2 °C above pre-industrial levels (Global Carbon Project, 2019).

[2] 2030 EU Climate & Energy Framework, further detailed in the recast Renewable Energy Directive [Directive EU 2018/2001].

[3] Only end-use emissions. Transport includes international bunkering for aviation and navigation (Eurostat, Greenhouse gas emissions by source sector, dataset env_air_gge).

The reduction of climate impacts from the transport sector is a challenging task given the forecasted trajectories. For instance, the International Energy Agency projects that the demand for mobility in the EU will increase by around 60% in 2050.[4]

There are three main options to reduce climate emissions from transport:

- **Reduce transport energy demand** for transport, through teleworking, modal shift, pricing, operational improvements or other demand-side measures. However, despite the adoption of teleworking and logistic solutions that temper the growth, there are too many other factors that in fact will still increase the demand. Modal shifts from individual private transport to collective public transport, from aviation to high-speed trains, from road haulage to ship haulage would all help to reduce climate emissions per tonne-km or person-km. However, the impact is negligible when compared to the demand growth in each of the modalities.

- **Efficiency improvement** through electrification, hybrid drivetrains and improved internal combustion engines, is likely one of the most important developments in all modalities. Also, our projections later in this report demonstrate that efficiency improvements strongly slow-down the growth of energy demand, despite the sharp growth in transport demand.

- **Fuel switch** to energy carriers with lower carbon intensity, like renewable electricity or sustainable biofuels.

A part of transport decarbonisation is assumed to be covered by the transition of passenger cars to electric driving. Electric engines are about 3 times more efficient than internal combustion engines on a tank to wheel basis,[5] and an increasing share of electricity is of renewable origin. The notion of increasing deployment of electric vehicles is important for the analysis in this report, as it could strongly decrease the total demand for liquid and gaseous fuels in some modalities. Electric mobility is not assessed in-depth in this report as we focus on renewable fuels.

1.2 Current application of renewable fuels in the Dutch market

The contribution of renewable energy in Dutch road transport has increased over the past two decades from virtually nothing to about 24.3 PJ in 2018 which represents 5.2% of the total energy demand in road transport.[6] This represents a saving of 1.9 Mtonne CO_2 equivalent, or 5.1%.[7]

Until now, this renewable energy mainly concerns biofuels as can be seen in Figure 2. Since 2011, residue-based biofuels are separately reported and make-up about half of the biofuels in the Dutch market. The graph shows that the consumption of biofuels strongly increased in just two years (2006 and 2007) and then stabilized for several years. This is caused by the policy support measures which

[4] The International Energy Agency assessed how carbon emission reductions can be distributed over all major sectors in the case of a 2 °C climate scenario. Known as Science Based Targets, this concept was developed by UN Global Compact, CDP, WRI and WWF, see sciencebasedtargets.org.

[5] In 2010, an electric vehicle was up to 4 times more efficient than a car with a conventional powertrain. Due to improvements in internal combustion engine technology, this will reduce to about 2.7 times by 2050 (Ricardo AEA 2012, A review of the efficiency and cost assumptions for road transport vehicles to 2050). Note that the well-to-wheel performance of an electric vehicle depends on the carbon intensity of the electricity it uses.

[6] The physical contribution of renewable energy in transport in the Netherlands was 24.3 PJ in 2018 as monitored and reported by the Dutch Emissions Authority NEa (NEa 2019, “Rapportage Energie voor Vervoer in Nederland 2018”). In the frame of the Renewable Energy Directive, this is reported as 41.6 PJ, or 8.9% due to double counting of the waste-based biofuels, five times counting of renewable electricity in road (in 2018) and 2.5 times counting of renewable electricity in rail transport.

[7] Compared to a counterfactual in which there would be no use of renewable energy. Now, 25.4 PJ fossil fuels are avoided (of which 24.3 PJ in the form of renewable energy, and an additional 1.1 PJ in the form of efficiency gains due to electric driving). With a flat-rate tank-to-wheel emission for fossil fuels of 0.75 g/MJ, this represents 1.9 Mtonne of avoided emissions (NEa reports 1.8 Mtonne) or 5.1% of the counterfactual case without renewable energy in transport.

first targeted a strong growth from 2007 onwards but were replaced with lower ceilings in 2009.[8] At the end of 2009, the double counting of waste-based biofuels was introduced and led to a strong increase of these fuels from 2010 onwards. At the same time, the overall target did not increase immediately, so that the total demand in fact decreased. In the subsequent years, the target slowly increased, but the deployment was already somewhat ahead of the official targets and did not further increase for several years. Recent years have again seen a considerable increase in the contribution of renewable fuels in the Netherlands, spurred by increasing obligations set to the fuel suppliers.

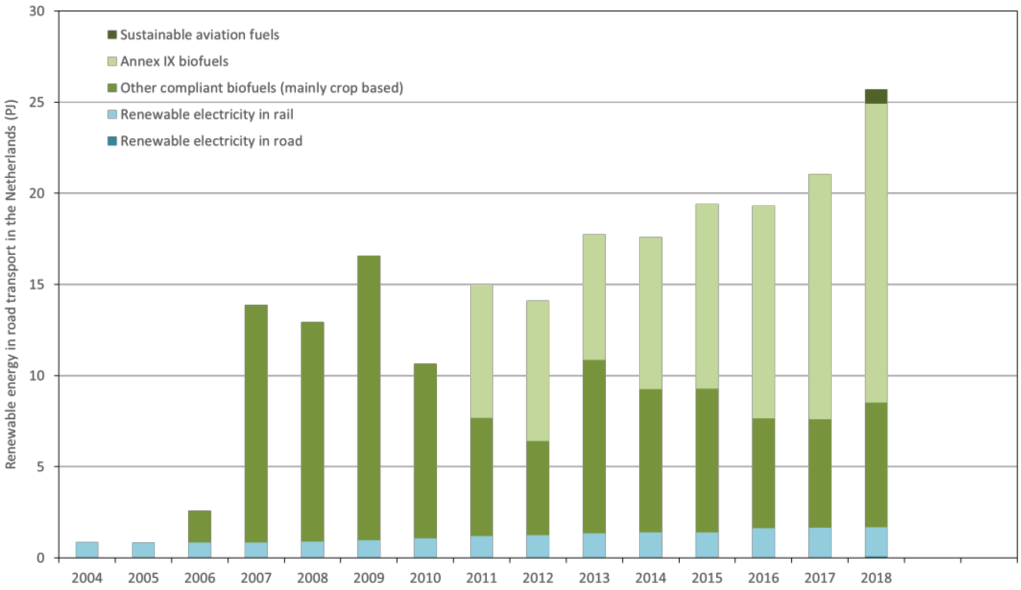

Figure 2. Development of renewable energy in transport in the Netherlands.[9] Annex IX biofuels in the Netherlands in recent years mainly concern waste-based biodiesel on basis of used cooking oil and animal fat. Renewable electricity in road transport is small (0.1 PJ in 2018) but increasing every year.

The development of the past decade demonstrates that the deployment of renewable fuels in transport very much depends on the policy support framework. In the final chapter of this report we will explore the measures to support higher volumes of renewable fuels in the coming decade.

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[8] Implementing the EU Biofuels Directive (2003/30/EC), the Dutch government (Staatsblad 2006-542: "Besluit Biobrandstoffen Wegverkeer 2007") mandated the sales of biofuels in road transport fuels, starting with 2% in 2007 and increasing to 3.25 % in 2008, 4.5% in 2009 and 5.75% in 2010. In 2009, in reaction to raising sustainability concerns, the targets for 2009 and 2010 were replaced with 3.75% and 4.00%, thus abruptly stopping the growth path (Staatsblad 2009-211).

[9] Data as reported by Eurostat SHARES for 2004-2012, Data for 2013-2018 from NEa except for renewable energy in rail transport. The dip in 2010 is caused by the changing requirements which rendered some biofuels not to be administrated.

1.3 Goals for renewable transport fuels in the Netherlands by 2030

Early Summer 2019, the Dutch government presented the Climate Agreement, with the key aspiration to reduce greenhouse gas emissions by 49% by 2030 (compared to 1990 emission levels). The measures presented will enable the Netherlands to fulfil its commitments under the Paris Agreement and the National Climate Act.

The Climate Agreement contains a chapter on Mobility,[10] with amongst others targets on electricity, hydrogen, biofuels and other renewable fuels to be used in transport. Initially, the assignment of the Mobility subgroup was to identify additional measures which would achieve an additional emission reduction of 7.3 Mtonne CO_2, to bring the estimated emissions from transport in 2030 below 25 Mtonne target of the earlier Energy Agreement.[11] This 25 Mtonne ceiling was still the target of the *Design* Climate Agreement presented in December 2018, but in the June 2019 published final Climate Agreement the 7.3 Mtonne additional emission reduction target has disappeared. This study focuses on the following goals as formulated in the final version of the Climate agreement:

- A **maximum** of 27 PJ **renewable** fuels in **road transport**. This 27 PJ is additional to the separate targets for hydrogen and electric mobility, and it is on top of the fuels projected by the 2030 scenario of the National Energy Outlook (next bullet). The 27 PJ equals 2 Mtonne of CO_2 emission reduction.

- The National Energy Outlook (NEV 2017) **projects** a contribution of 33 PJ of **biofuels in (all) transport** on basis of existing and intended policy measures.[12],[13]

- A **minimum** of 5 PJ of **sustainable** fuels in **inland shipping**.

Note that these three targets have different scopes in terms of extent (maximum, minimum, projected) types of fuels (renewable fuels, biofuels, sustainable fuels), and in terms of modalities (road transport, all transport, inland shipping).

The biofuels are automatically renewable, and we assume they should also be sustainable in line with RED II requirements.

For the purpose of this study, we assume the three sub-targets can be translated to an overall goal of **65 PJ of *renewable* fuels** to be deployed in all forms of transport, and that the following two clarifications apply:

- Where this concerns *biofuels* indicates that the fuels must comply with sustainability requirements as set out in the RED II.

- *At least* 5 PJ of the 65 PJ should be in inland shipping. The remainder can be in all other forms of transport.

Within the context of international climate concerns, the Dutch Climate Agreement, the European Renewable Energy Directive and the Effort Sharing Regulation, the Dutch government will have to stimulate the deployment of renewable and sustainable fuels in the Dutch market.

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[10] The Mobility chapter of the Dutch Climate Agreement can be found here: https://www.klimaatakkoord.nl/mobiliteit/documenten/publicaties/2019/06/28/klimaatakkoord-hoofdstuk-mobiliteit

[11] The 2013 Energy Agreement formulated the target to strongly reduce emissions from the transport sector by 60% in 2050 compared to 1990, and with an interim target of 25 Mtonne (-17%) in 2030.

[12] The scenario variant “intended policy measures” in the National Energy Outlook assumes that existing measures continue beyond 2020 and lead to a 7% share of biofuels in transport fuels in 2030 (PBL 2017, Nationale Energieverkenning). Table 10 in the Outlook does not specify the nature of the biofuels while Table 7 reports the same values for all years 33 PJ in the category liquid biofuels (next to 20 PJ of biogas, which partially could be used in transport). We assume both liquid and gaseous biofuels are in principle included in the 33 PJ.

[13] In the course of this study, PBL published the KEV Climate and Energy Outlook, in which the 33 PJ is increased to 35 PJ.

1.4 How can these goals be achieved?

This study explores how the 65 PJ target for renewable fuels in transport in 2030 can be achieved.

This will depend on various factors as addressed in the following chapter:

- **How to make enough fuels available?** As we will discuss in the following chapter, the Dutch target is modest when compared to the current global availability of sustainable biofuels and the expected availability by 2030 of advanced biofuels and other renewable fuels.

- **How can the supply of renewable fuels to the Netherlands be significantly increased?** The 65 PJ target is less than triple the 24 PJ contribution of renewable fuels in 2018. The steeply increased deployment of renewable fuels in recent years was entirely caused by increasing obligations set to fuel sales in the Dutch market. In this light, the required increase is modest.

- **How can these renewable fuels be deployed in the Dutch transport sector?** In the following chapter, it will be discussed how (1) various types of fuels can be deployed in higher fractions than today in the mainstream (regulated) gasoline and diesel in large parts of the Dutch vehicle fleet and (2) how other types of fuels with limited adaptations can be deployed in dedicated vehicles. We will discuss the available infrastructure and necessary adaptations to cater for larger volumes and different types of biofuels.

- **How to secure feedstock to produce these renewable fuels?** Part of the fuels discussed in this study concerns biofuels. We will show how the feedstock supply for biofuels can be increased with limited direct and indirect sustainability risks. Other fuels can be produced from renewable electricity or from fossil waste streams.

- **What measures (policy, R&D, innovation, etc.) are needed to achieve the 65 PJ?** In Chapter 3, we discuss options for policy support to the development and deployment of scalable renewable fuels in the Netherlands.

2. OPPORTUNITIES FOR RENEWABLE FUELS

2.1 Main current and near future renewable fuel options

Many types of renewable fuels exist, and even more are conceivable. They can be produced from a wide range of feedstocks and can replace fossil energy carriers without dramatic changes to the energy distribution infrastructure and vehicles. Figure 3 below gives an impression of the wide range of production pathways and deployment options available to replace amongst others fossil gasoline and diesel.

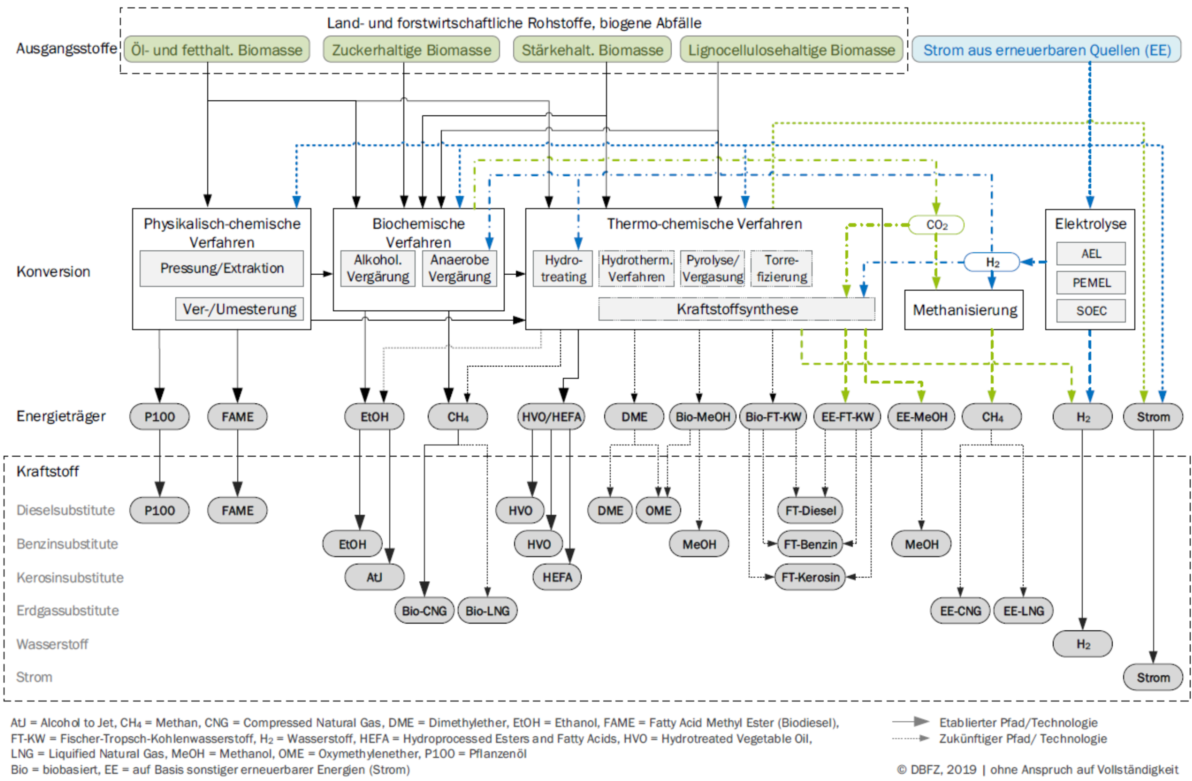

Figure 3. Conversion pathways for biofuels and other renewable fuels, such as produced from renewable electricity, and various synergy options (Included with permission from Deutsches Biomasseforschungszentrum DBFZ 2019, Monitoring Biokraftstoffsektor 4. Auflage).

Renewable fuels are categorised along several dimensions. For the purpose of this study (to evaluate if the 65 PJ renewable fuels target is achievable), it is relevant to understand how renewable fuels are categorised in the current policy framework:

- **Sustainable biofuels**, which shall meet the EU sustainability criteria. The main categories are:
  - **Crop-based biofuels**. The RED II sets a 7% maximum cap to the fraction of crop-based biofuels that can be reported or 1% above the 2020 level (whichever is lower), while the application of these fuels is not per se limited.[14] Within and above this cap, crop-based biofuels could make a significant contribution to the Dutch 65 PJ target. However, the Netherlands has capped the contribution of crop-based biofuels to 4% in 2019 and 5% in 2020, and the cap currently set for subsequent years is equal to the real contribution of these fuels in 2020.
  - **Waste-based biofuels** in line with RED II Annex IX B. This concerns biofuels produced from used cooking oil or animal fat. The RED II caps their contribution to 1.7%, which can be double counted for the achievement of the target on renewable energy in transport.
  - **"Advanced" biofuels** in line with RED II Annex IX A. This concerns biofuels produced from a wide range of waste materials, as well as from woody and grassy energy crops. Their contribution counts double for the achievement of the target on renewable energy in transport. The RED II sets a subtarget for these fuels of 3.5% in 2030, which can be achived by double counting 1.75%.
- **Renewable Fuels of Non-Biological Origin** (RFNBOs) are introduced by the RED II. These are liquid and gaseous fuels "the energy content of which is derived from renewable sources other than biomass". The Directive suggests these are likely produced from renewable electricity.[15] Hence these are also called **Power-to-X** or **e-fuels**. The share of renewable energy in these fuels depends on the share of renewable electricity in the country where these fuels are produced.
- **Recycled Carbon Fuels** (RCFs) are also introduced by the RED II. These concern fuels produced from waste streams of non-renewable origin, such as the non-recoverable fossil carbon present in municipal solid waste, or carbon monoxide in steel waste gases. These fuels are not renewable (and may thus not comply with the formulation of 60 PJ of the 65 PJ in the Climate Agreement[16]) and are not further considered in this study. The RED II nevertheless allows application of these RCFs for the achievement of the renewable energy in national transport targets, although these fuels do not count towards the overall Union target for renewable energy. The rules for evaluating eligibility of RCFs are not yet clear.[17]

In this section, we briefly present opportunities with fuels in each of these categories, and discuss their potential availability in 2030. We focus on the key production technologies that are commercially available and operational now or that are expected to be available within the next 5-10 years, with an indicative Technology Readiness Level (TRL) of 8 or 9.

[14] The RED II effectively does not stimulate nor forbids the application of crop-based biofuels. Member States can set a target for these fuels between 0% and 7% in the frame of the RED II renewable energy in transport target, and can stimulate any fraction of these fuels for the purpose of meeting the RED II overall renewable energy target, Paris climate goals, and the targets from the Effort Sharing Decision.

[15] It is also possible to produce these fuels from other sources, such as directly from sunlight, but only few initiatives are known. For instance, Joule Unlimited developed a cyano-bacteria based process to generate hydrocarbon-based fuel directly from sunlight – although this process involves biological activity, the feedstock is not biomass.

[16] See discussion on the formulation of the target for renewable energy in transport in the Climate Agreement in Section 0.

[17] The EC will evaluate the greenhouse gas savings from RCFs and establish minimum thresholds by 2021. The Directive notes that the feedstock should "not [be] suitable for material recovery in accordance with Article 4 of Directive 2008/98/EC". However, that Directive does not provide a clear rule on how to decide a material is not suitable for recovery.

2.2 Considerations

The Dutch goal is realistic in a current global and European perspective

Renewable (and sustainable) fuels today mainly concern biofuels. The current global production of biofuels is about 3,700 PJ,[18] which is more than 50 times larger than what the Netherlands would need to achieve the 2030 goal of 65 PJ. Of course, not all of this will meet the EU biofuels sustainability criteria. The current EU consumption of *sustainable* biofuels is about 641 PJ,[19,20] which is about ten times the Dutch 2030 goal of 65 PJ.

In the EU, the current production of biofuels amounts to 9.3 Mtonne FAME biodiesel, 3.1 Mtonne HVO biodiesel (increasing to about 3.6 Mtonne in 2020) and 6.1 Mtonne bioethanol.[21] Only a small part of the biofuels consumed in the EU market are imported from third countries (about 6% of biodiesel and 11% of ethanol in 2016, though fluctuating between the years as a consequence of changing trade policies). Vice versa, only a small part of EU produced biofuels is exported outside the bloc. The international trade follows the value of biofuels which mainly follows from policy support measures and is limited by trade barriers. Part of the EU produced biofuels are produced from imported biomass. Eventually, about 64% of all feedstock for EU consumed biofuels stems from the EU.[22]

For the feasibility of the Dutch 2030 goal this implies that the Netherlands can obtain renewable fuels from anywhere in the world. And in principle, all the fuels needed for 2030, are already available.

Dutch share in the global biomass potential

An unrestrained import of renewable fuels or their feedstocks to the Netherlands could lead to a larger footprint than what would be a fair share. This could limit other countries to achieve their climate goals by similar means and such competition for limited resources would not solve the global climate challenge.

It is difficult to establish exactly what would constitute a “fair share”. In a study for Dutch environmental NGOs we estimated on basis of the population share, that the Dutch fair share in the global primary bioenergy potential would be about 200 PJ in 2030.[23] This was based on a global primary bioenergy potential of about 100 EJ (an EJ is 1000 PJ) as assumed by IPCC.[24] The 200 PJ primary biomass can be translated to a fair share of about 100 PJ sustainable biofuels for transport.

This fair share approach assumes that the global bioenergy potential is largely exogenic and cannot be influenced by the Netherlands.

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[18] FO Licht 2018, World Ethanol & Biofuels Report.

[19] Eurostat SHARES, EU consumption of compliant biofuels in 2017.

[20] All biofuels supported in the frame of the EU Renewable Energy Directive meet the EU sustainability requirements.

[21] Different Eurostat datasets reports on the EU production or consumption of sustainable biofuels. Dataset nrg_107a enables to split the production and consumption to biodiesel (presumably FAME and HVO) and biogasoline (presumably ethanol), while Dataset SHARES gives insight in the volumes of Annex IX type biofuels and other compliant biofuels (presumably all from crops). SHARES unfortunately does not indicate the physical type of biofuel – nevertheless it is generally assumed that the majority of Annex IX type biofuels concerns Annex IX B waste-based biodiesel (Used Cooking Oil and animal fat).

[22] See detailed assessment by Navigant (Navigant, 2019, Technical assistance in realisation of the 2018 report on biofuels sustainability, for European Commission DG ENER).

[23] Study for a group of Dutch environmental NGOs: *Natuur en Milieu*, Greenpeace, Friends of the Earth Netherlands (*Milieu Defensie*), IUCN and WWF (*Natuur en Milieu* 2014, *Een heldergroene visie op duurzame brandstoffen*). Note that the Dutch economy plays a relatively large role in global economy, international transport and agricultural production, which could justify a larger share in the global bioenergy potential.

[24] The IPCC observed a reported range of <50 to >1000 EJ biomass potential in literature, and concluded that most researchers agreed on a sustainable biomass potential of 100 EJ (IPCC 2014, Working group III – Mitigation of climate change - Chapter 11 Agriculture Forestry and Other Land Use – Appendix Bioenergy). In reality, this conclusion cannot be drawn. The lower range of 50 EJ follows from the assumption that only waste material from other sectors can be used, while the higher range of 1000+ EJ results from significant improvements in the global agro-food system. In other words, while sustainability requirements can limit the bioenergy potential, sustainable development actually increases the bioenergy potential.

Increasing the global and European bioenergy feedstock supply

However, much larger volumes of sustainable bioenergy feedstock, and thus of biofuels, can be mobilized through improvements in the global agriculture and food system. By bridging agricultural yield gaps and reducing losses in food supply chains, more food can be produced on less land, and more land can be used for bioenergy production. This could increase the global bioenergy potential to above 1,000 EJ (= 1,000,000 PJ).[25]

The underlying principles can be used to develop additional and sustainable biomass on a project basis or at national or European level, without competing with other demand sectors or further encroaching on nature.

Such improvements will not take place automatically, but they could be spurred by investments in biofuels feedstock. There are broadly two options to achieve this:

- A narrow interpretation is **Low ILUC risk feedstock production**. We expect that, initially, Low ILUC risk methodologies will be applied to feedstock otherwise identified as high ILUC risk. The RED II introduces this option to produce additional biofuels feedstock through (a) yield improvements above the trendline or (b) targeted expansion into low carbon land.

  The European Commission is currently developing strict and detailed guidelines for the certification of such feedstock, expected to be published by 2021. Also, the European Commission will support a range of pilot projects with the most common crop biofuels feedstocks in Europe, Asia and South America, in 2020-2022.[26] Both Commission activities involve stakeholder consultation. We expect that a credible regulated approach to Low ILUC risk feedstock production and certification will therefore be available from 2021 or 2022 onwards. With the certificate, it can then be proven that a feedstock is produced without the unwanted indirect risks for carbon stocks and biodiversity.

  - One of the options considered for Low ILUC is the introduction of **sequential crops** after the production of (current) annual crops. In the current European agricultural practice, the land is left barren for some time between two crops. This time can be used to grow an energy crop, perhaps not to full fruition but still with an appreciable energy yield. Additional advantages are less soil erosion and increased soil biodiversity.[27]

- The Low ILUC approach still targets biofuel crops in isolation. The large bioenergy potential discussed above, would require a **food-fuel synergy approach**: A biofuels feedstock investment can be used to increase crop yields in a region, for example through access to know-how and education, machinery, improved logistics and cooperative market approaches. FAO, for instance promotes Bio Energy Food Systems (BEFS), and provides practical guidelines to implement this synergetic approach.

[25] Studies by Hoogwijk (2003, Exploration of the ranges of the global potential of biomass for energy) and Smeets (2007, A bottom-up assessment and review of global bio-energy potentials to 2050) explored the higher ranges of the global biomass potential if yield gaps could be bridged, if supply chain losses would be reduced, and if land would be used in a more intelligent manner.

[26] European Commission, Call for Tenders ENER/C2/2018-462, Support for the implementation of the provisions on ILUC set out in the Renewable Energy Directive. This work will be carried out by Navigant in close cooperation with stakeholders in the three research regions, with voluntary schemes, auditors and NGOs.

[27] See work by the Consorzio Italiano Biogas on sequential cropping. The 2019 Gas for Climate report estimates that following this approach 41 billion cubic meter (431 TWh or 1550 PJ) of biomethane can be produced. Instead of biomethane, the crops can (obviously) be used for the production of a range of other biofuels.

Improved waste mobilisation

The RED II expects a large contribution of renewable fuels from waste-based feedstock and promotes these by setting a subtarget for advanced biofuels, including biofuels based on some types of waste (such as the biomass fraction of mixed municipal waste, and residues from forestry and related industries) and allowing the double counting of biofuels based on used cooking oil and animal fat.

- While the contribution of biodiesel from **used cooking oil** in the Netherlands is considerable (79.4% of all biodiesel in the Netherlands in 2018), a large part of the European potential for used cooking oil is still untapped. Used cooking oil is typically collected from gastronomy sector and households. Both sectors have similar potentials, but very limited volumes are currently collected from households, while most of the used cooking oils from households ends up in sewage systems and causes blocking problems. The collection from households can be further improved.

  In Asia, Africa and South America, cooking oil is currently re-used too often which leads to food safety issues. It is expected that the global potential for waste oils will significantly increase, due to a growing population and increasing attention for hygiene and health safety.

- The growing world population and increasing attention for health and the environment also support the increasing collection and treatment of **municipal solid waste**. Several large-scale initiatives have been announced for biofuels production from municipal solid waste which will tap into this increasing potential, such as methanol (Enerkem in Rotterdam) or sustainable aviation fuels (British Airways and Velocys in the UK). Note that only the biogenic fraction counts as renewable fuel (and counts double in the frame of the RED II renewable energy targets for transport), while the remainder may be seen as a recycled carbon fuel.

- With a growing forest acreage in the EU and North America, and an increase in the use of wood in the building sector, the volume of **residues from forestry and forest industry** is increasing strongly.[28] It is technically and commercially possible to produce a wide range of biofuels from these feedstocks, and several initiatives are ready to be developed when the demand market improves.

- Biomethane is produced by anaerobic digestion from wet organic waste material such as **sewage sludge** and **manure** (and distributed by for instance OrangeGas in the Netherlands). It is can also be produced from the wet organic fraction in **municipal solid waste**, and **waste streams from food and beverage industries**. Although anaerobic digestion is increasingly developed in the Netherlands, the potential is still largely untapped.

Dutch renewable fuels production for the European market

The Netherlands has a significant current production of almost 2 Mtonne biofuels, which is below the production capacity of almost 2.7 Mtonne. On top of this, about 0.3 Mtonne of new production capacity is foreseen in the short term (see Table 1).

[28] All countries under UNFCCC are required to report on the on GHG emissions and removals from forests and soils, following strict accounting rules, and are committed to manage and maintain carbon stored in these sinks.

Table 1. Current and projected renewable fuels production capacity in the Netherlands.

Site	Location	Production capacity (ktonne)		(PJ)
Ethanol				
Alco Energy	Rotterdam	380		
Biorefinery Development	Rotterdam	75	(expected 2022)	
Cargill	Bergen op Zoom	32		
Biondoil	Rotterdam	80	(expected 2023)	
Methanol				
BioMCN	Delfzijl	440		
Enerkem	Rotterdam	220	(expected 2021)	
FAME biodiesel				
Sunoil Biodiesel	Emmen	88		
Biodiesel Kampen	Kampen	120		
Argent Energy Group	Amsterdam	110		
Biopetrol	Rotterdam	400		
Eco-Fuels	Eemshaven	50		
Ecoson	Son	5		
Pure plant oil				
Ecopark	Harlingen	32		
HVO biodiesel				
Neste	Rotterdam	1,000		
Green gas / biomethane				
Attero	Wijster	15 million	Nm3/year	
Attero	Tilburg	7 million	Nm3/year	
Carbiogas		6 million	Nm3/year	
HEFA Sustainable Aviation Fuel				
DSL-01	Delfzijl	75	(expected 2022)	

With a growing share of variable renewable energy in the European electricity grid in the coming decade, the need to balance the grid will become more urgent. The intermittency in power can be captured and stored in e-fuels such as hydrogen. The Mobility Chapter in the Climate Agreement includes a vision on hydrogen, with 300,000 fuel cell vehicles in 2030 consuming about 140 ktonne of hydrogen (18 PJ), produced from renewable electricity. Other e-fuels (methanol, methane and synthetic diesel) can be used in the current fleet and do not require adaptation of infrastructure or engines. The options for deploying methanol (low blend fraction) and methane (CNG/LNG vehicles only) are currently limited but still larger than the expected near-term e-fuel production. Methanol can be further converted into DME (dimethyl ether) which can be applied in LPG vehicles.

These renewable fuels produced in the Netherlands can flow to other markets. Production in the Netherlands is not a guarantee for use in the Netherlands. Nevertheless, many stakeholders indicate that a strong Dutch renewable fuels policy would help investment decisions in the Netherlands, especially where these individual investments concern a relatively small volume compared to a large Dutch goal, and when similar support policies are seen in neighbouring markets. We will come back to this in the policy recommendations in Chapter 3.

Harmonisation of fuel types, blends and technical specifications

Most sustainable fuels in the Dutch market will be applied in vehicles (cars, trucks, inland ships) that also cross international borders. Mainstream fuels, sold to the general public, must meet European quality specifications. Nevertheless, within these specifications there is much room to introduce higher levels of renewable fuels.

An overview of the main options to blend (higher fractions of) biodiesel and ethanol in fossil diesel and gasoline is given in Figure 4. Further, green gas (renewable methane) can be 100% blended in CNG and LNG engines. Options for the introduction of higher blends are further explained in Section 2.4.

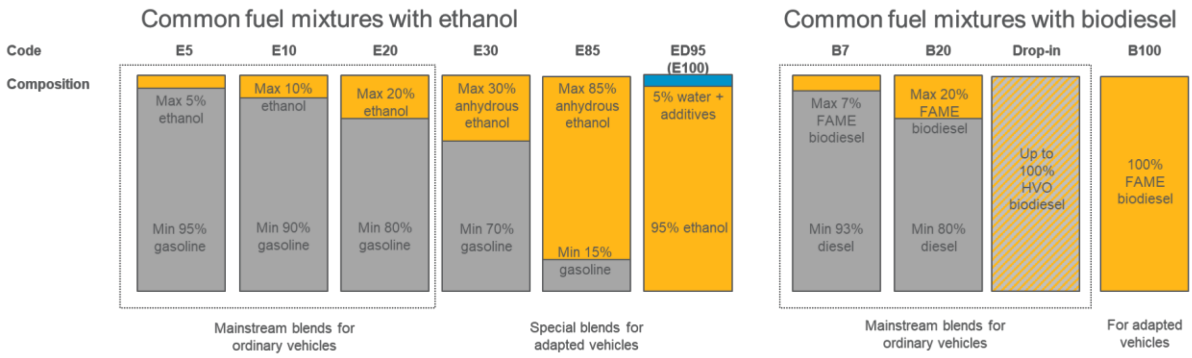

Figure 4. Common mixtures of ethanol and biodiesel.

2.3 Current Dutch legislation will not be sufficient to achieve 65 PJ in transport in 2030

Dutch legislation for renewable energy in transport is formulated in response to targets set by the European Renewable Energy Directive. At first glance, RED II seems to ask for 14% renewable energy in transport. However, the RED II can easily be met by a small volume of renewable fuels, because the target can be decreased by limiting the contribution of crop-based biofuels, and because of several double counting mechanisms. Figure 5 shows the projected deployment of renewable energy in Dutch transport in 2030.

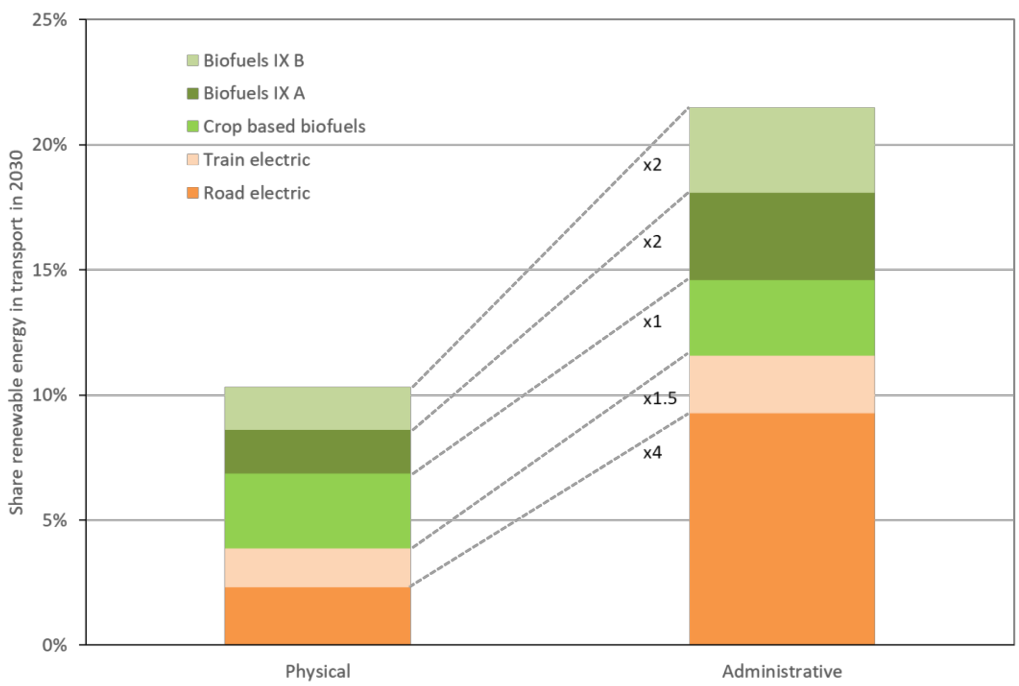

Figure 5. Projected deployment of renewable energy in transport in the Netherlands in 2030 in line with RED II. Administrative share includes multipliers as indicated.

This projection is based on the following observations and assumptions:

- RED II (Appendix C) allows to report a maximum of 7% contribution for crop-based biofuels to the overall 14% target. However, RED II also allows to set a target of 0% to these biofuels and at the same time lower the overall target accordingly, i.e. to 7%. This means that crop-based biofuels do not matter to achieve RED II target for renewable energy in transport. RED II de facto does not stimulate the application of crop-based biofuels. Also note that RED II does not forbid the application of crop-based biofuels above 7% – the cap only implies that more crop-based biofuels do not contribute to meeting the target. In short, Member States are free to set their own targets.

  In the Dutch Climate agreement, it was agreed to freeze the contribution of crop-based biofuels in the 2021-2030 period at the level of 2020, which is expected to amount 2 - 3%.[29] In the graph we have assumed 3%.

- RED II allows to report a maximum of 1.7% of Annex B type biofuels produced from UCO and animal fat. Their contribution can be double counted, so that this contributes to 3.4% renewable energy in transport.

  In the Netherlands, this type of fuels currently has a share of 3.7% (before double counting). In 2030, we assume that the contribution of this fuels is at the maximum of 1.7% set by RED II.

- RED II asks for a minimum of 3.5% of Annex A type biofuels, commonly known as “advanced biofuels”. The administrative 3.5% can be achieved by double counting a real contribution of 1.75%.

  In 2030, we assume the Netherlands will indeed see this minimum 1.75% physical contribution. The contribution will not be higher than the minimum, because the overall target is already easily met as will be seen below.

- The contribution of renewable electricity in rail transport follows from assuming 50% more rail transport than today combined with a 70% renewable share in Dutch electricity.[30]

- The contribution of renewable electricity in road transport is based on 2 million electric vehicles (20 - 25% of the total fleet), as further explained in Section 0.

The total administrative share of renewable energy in transport in 2030 is projected to be 21%. The total real contribution of renewable energy is 49 PJ, which implies that 423 PJ of fossil fuels remain in the Dutch transport sector.[31] This equals a tank-to-wheel greenhouse gas emission of 31.7 Mtonne CO2eq,[32] which is well above the 25 Mtonne ceiling formulated at the start of the Climate Agreement (see discussion and footnotes in Section 0.

[29] The Dutch RES-T target for 2020 will be 16.4% (administrative). If we assume the current ratio of 70% double counting and 30% single counting is maintained, then this 16.4% would be achieved by 2.9% single counting + 2 x 6.8% (physical) = 13.6% (administrative) double counting. Note that economic operators can achieve the 16.4% target with a maximum of 5% crop-based biofuels.

[30] According to the Climate Agreement, the share of renewable energy in the Dutch electricity mix should be 75% by 2030. RED II states that “for the calculation of the share of renewable electricity in the electricity supplied to road and rail vehicles […] Member States shall refer to the two-year period before […]”. We therefore apply a slightly lower share: 70%.

[31] The total energy demand in the transport sector in 2030 amounts to 472 PJ, under assumptions explained in Section 0. Note the scope of this “Dutch transport sector” consists all “mobility in the Dutch territory” as defined by SER in the 2013 Energy Agreement. This is understood as all road and rail transport plus a part of aviation and inland shipping.

[32] Emissions from the mobility sector in the Climate Agreement are measured on a tank-to-wheel basis. Emissions from renewable electricity and renewable fuels are therefore set to zero. The tank-to-wheel emissions from fossil fuels are 70 g/MJ on average. Note that the well-to-wheel emissions for fossil fuels are in fact 94 g/MJ on average (and increasing), while the well-to-wheel emissions from renewable fuels are limited by the RED II and should be at least 50 - 70% less than the fossil emissions. In 2015, the PBL Netherlands Environmental Assessment Agency projected an emission of 32.7 Mtonne from the transport sector (same scope) in 2030 based on the current and intended policies.

In other words: while the Dutch interpretation of the Renewable Energy Directive will well achieve the targets of that Directive, it will not achieve the greenhouse gas emission savings target of the Climate Agreement and the earlier Energy Agreement.

Vice-versa in case the targets of the Climate Agreement are achieved, the RED II targets are automatically far exceeded. Thus, the Dutch Climate Agreement should be leading to formulate the policy framework.

2.4 Palette of options

However, all types of renewable fuels could be deployed in higher volumes in the Netherlands.

In Annex B we present a palette of options to introduce higher fractions of renewable fuels in the Dutch transport sector. We explore how various existing and new types of renewable fuels can be produced in the Netherlands, how they can be further developed and scaled up, considering their technology status and feedstock needs. Also, the overview includes options to sustainably increase the production of feedstocks (without ILUC), or to increase the collection of waste and residues.

The main opportunities are:

- **HVO and synthetic biodiesel can be used at very high fractions in the diesel sector**. A density requirement in the mainstream diesel EN590 quality standard currently limits the share of HVO to about 30%. However, all major truck manufacturers allow the use of these fuels up to 100% in Euro V and VI trucks, provided that the EN 15940 specification for paraffinic fuels is met.
    - HVO is hydrotreated vegetable oil, as produced by amongst others Neste and UPM, from fresh or waste vegetable oil, or from tall oil (a waste from the paper and pulp industry)
    - Synthetic diesel is produced either from biomass via gasification to syngas and subsequent Fischer-Tropsch synthesis (as researched and developed by amongst others Shell, BP and Total), or as an e-fuel from renewable electricity (Audi).
- **FAME biodiesel can be used at higher fractions than today**. The blend limit for FAME type biodiesel in mainstream diesel, currently at 7%, could be increased to 10% like elsewhere in the EU and US. For application in dedicated fleets of trucks and buses, blends with 30% FAME and above are possible. The use of B30 results in higher end-use carbon emissions,[33] while the well-to-wheel carbon emissions still decrease. Also, maintenance and some local emissions increase.
    - FAME can be produced from waste vegetable oils such as UCO, the potential of which is still increasing globally. Half of the potential resides with households and is largely untapped, and collection can be improved.
    - FAME can also be produced from low ILUC risk crop vegetable oil feedstocks (Section 2.2). Low ILUC risk biofuels can be used outside the cap set for crop-based biofuels
- Co-processing of vegetable oil or pyrolysis oil can **introduce a 5 - 10% renewable fraction in gasoline and diesel in existing fossil oil-based refineries**. This likely does not hinder additional blending of other renewable fuels in the supply chain.

[33] The efficiency of engines on B30 is somewhat lower than on paraffinic fuels (HVO, FT diesel), and therefore the end-use emissions increase with about 10%. If the FAME itself would achieve 80% emission reduction compared to the fossil comparator, this would achieve still 78% emission reduction on a well-to-wheel basis.

- **Ethanol can be used at significantly higher fractions than today**. The blend limit for ethanol in mainstream gasoline, currently at 10% by volume, could be increased to 15% for cars produced after 2001, as is allowed in the US. A further increase to 20% blends could be possible (See Opportunity A in the Appendices). Use of 85% ethanol is possible in flexi-fuel cars (produced by all major car brands). It is also possible to use nearly neat ethanol in slightly adapted diesel engines (ED95) for instance in bus fleets.
    - Ethanol can be produced from low ILUC risk sugar or starch feedstocks and then used outside the cap for crop-based biofuels.
    - Ethanol can also be produced from lignocellulose feedstocks, such as agricultural residues, forestry residues, or dedicated energy crops.
- Options exist to produce synthetic gasoline, which could be used as **drop-in in fossil gasoline.**
- **100% renewable methane can be used to replace CNG or LNG**. Driving on CNG or LNG requires a small conversion of the fuel system in existing gasoline cars. Besides this, all main car brands produce dedicated CNG and LNG vehicles.
    - Gas TSOs in the EU have presented a vision to significantly scale up the production of renewable gas within the EU, including biomethane (via anaerobic digestion of gasification) synthetic methane from renewable electricity.[34]
- **All the LPG used in Dutch transport could entirely consist of bioLPG**.
    - Propane is a co-product (8-10% side stream) from HVO production. Biopropane from the Neste facility in Rotterdam is currently sold as bioLPG in France. The global current potential for biopropane is estimated to be amount 200 ktonne, and increasing.

Some options are not included as they are considered out of scope, although their contribution would certainly be useful. For instance, hydrogen is not included because it is outside the 65 PJ target of the Climate Agreement. The Agreement provides separate attention to the production and deployment of hydrogen in transport. Still, hydrogen is relevant as a precursor to other Renewable Fuels of Non-Biological Origin.

[34] See publications by the “Gas for Climate” consortium, a group of seven leading European gas transport companies (Enagás, Fluxys, Gasunie, GRTgaz, Open Grid Europe, Snam and Teréga) and two renewable gas industry associations (EBA and CIB), www.gasforclimate2050.eu.

2.5 Vision on energy in transport in 2030

Considering all the options that have been presented above, we find the potential contribution of renewable fuels in transport in 2030 can be similar to what has been presented by the Platform Sustainable Biofuels on previous occasions, and as presented in Figure 6.

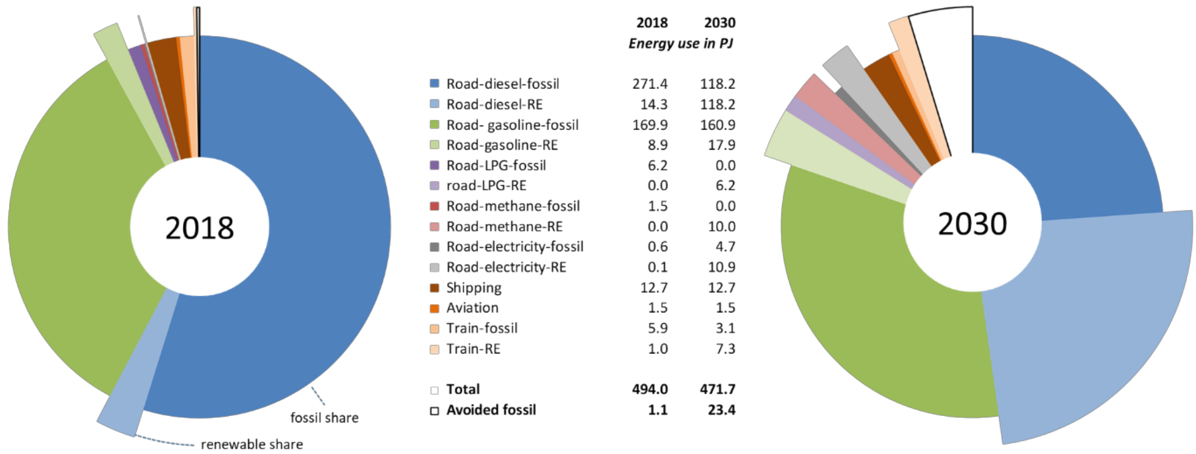

Figure 6. Contribution of fossil and renewable fuels in 2018 and 2030. RE indicates renewable, shown as expanded parts of the diagram.

The estimation for 2030 is based on basic assumptions:

- **The total demand for transport stays roughly the same**. While it is generally projected that the demand for transport increases, climate action requires that the demand is curbed.
- **Electric vehicles are massively introduced**. We assume that 2 million electric vehicles in 2030 in the Dutch market (passenger vehicles, vans and busses) and replace mainly diesel cars.[35] These vehicles consume about 15.6 PJ of electricity, of which 11 PJ (70%) is renewable.[36]

  The **efficiency of electric vehicles is 2.5 times that of vehicles with internal combustion engines**. This means that on top of the 16 PJ of fossil fuels that is replaced with electricity, another 23.4 PJ of (fossil) energy demand is completely avoided.
- The **deployment of methane is 10 PJ in 2030** compared to 1.5 PJ today. This methane, in the form of CNG (in passenger cars and vans) or LNG (in trucks) again replaces mainly diesel.

  In 2030, this methane will all be renewable (either biogas or e-fuel).
- The consumption of LPG in vehicles remains at the 2018 level. **In 2030, LPG will entirely be from renewable source.** This amounts to 6 PJ.
- **Freight transport by train increases with 50%** compared to 2018 and again replaces diesel consumption. The electricity consumption in trains will be about 10 PJ, of which about 7 PJ is renewable.

[35] From 2030 onwards, only zero-emission passenger vehicles will be sold in the Dutch market. This would first concern electric vehicles, and later also include fuel cell vehicles. The SparkCity model of the TU Eindhoven predicts 2 to 3 million electric vehicles in the Dutch fleet in 2030. Other research by Leiden University concludes it is unrealistic to expect 2 million electric vehicles by 2030, since the batteries involved would require 2-4% of the global production of rare earth metals (Leiden University 2019, Critical Metals Demand for Electric Vehicles, in Dutch *Metaalvraag van elektrisch Vervoer*).

[36] With an average mileage of 13,000 km/year and an efficiency of 6 km/kWh, this fleet consumes 4.3 TWh or 15.6 PJ/year.

- **Half of the remaining energy use in diesel engines is renewable**. This can consist largely of drop-in fuels such as HVO and synthetic diesel. This amounts to 118 PJ of renewable diesel alternatives (FAME and HVO biodiesel, synthetic and e-diesel, and ethanol as ED95). With FAME and HVO being largely produced from vegetable oils, this requires an increasing mobilisation of waste vegetable oils, and development of oil crops with low ILUC risks. Synthetic and e-diesel require further technology innovation, demonstration and commercialisation.

- **About 10% of the remaining energy use in gasoline engines is renewable.** This amounts to 18 PJ of renewable gasoline alternatives (ethanol and methanol mainly as E10, plus a fraction of co-processing).

The total energy consumption in the transport sector under this scenario amounts to 471 PJ, with a share of 36% renewable energy, or 170 PJ, consisting of **18 PJ renewable electricity** and **152 PJ of renewable fuels**. This is considerably more than the goal of the Climate Agreement.

This scenario would limit the tank-to-wheel emissions from the Dutch transport sector to **23 Mtonne CO_{2eq}**, which is in line with the 25 Mtonne goal.

Note that the 65 PJ specified in the Climate Agreement and underlying the current report, will not be enough to meet the 25 Mtonne goal, as it still would lead to 29 Mtonne CO_{2eq} emissions from the Dutch transport sector.

3. POLICY RECOMMENDATIONS

To achieve the scenario sketched in the previous chapter, the production and deployment of renewable fuels in the Netherlands should be further supported. This can involve economic or market support to spur the sales of renewable fuels, support to the development of infrastructure and fleets to spur deployment of renewable fuels, support the production of existing renewable fuels as well as the R&D for future renewable fuels, support to the mobilisation of sustainable feedstock, and encouraging the communication between all stakeholders.

3.1 Stimulate the sales of renewable fuels

To achieve 65 PJ or more renewable fuels in the Dutch transport sector, it is required to set higher targets than what the RED II suggests. Expecting that crop-based biofuels under the cap contribute 3% or 14 PJ maximally, the remainder (51 PJ or 11%) should consist of the following options.

- A high target on Annex IX A type biofuels
- A high target on Annex IX B type biofuels
- A high target on low ILUC risk biofuels outside of the 7% cap.
- A high target on Renewable Fuels from Non-Biological Origin

Note that this 65 PJ specified in the Climate Agreement and underlying the current report, will not be enough to meet the 25 Mtonne goal, as it still would lead to 29 Mtonne CO_{2eq} emissions from the Dutch transport sector.

To arrive at the 25 Mtonne CO_{2eq} original goal of both the Energy Agreement and the Climate Agreement, much more renewable fuels will be required, about 120 PJ or 26% of renewable fuels would be needed, or 106 PJ in the above categories, which would translate to a target of 23% (for these four categories together, and before applying multipliers) and 3% of crop based biofuels. Note this is still below the 152 PJ vision explored in Section 0.

In Figure 7, a proposed pathway is shown to arrive at 65 PJ or 14% renewable fuels in 2030, with contributions from the options discussed in this report.

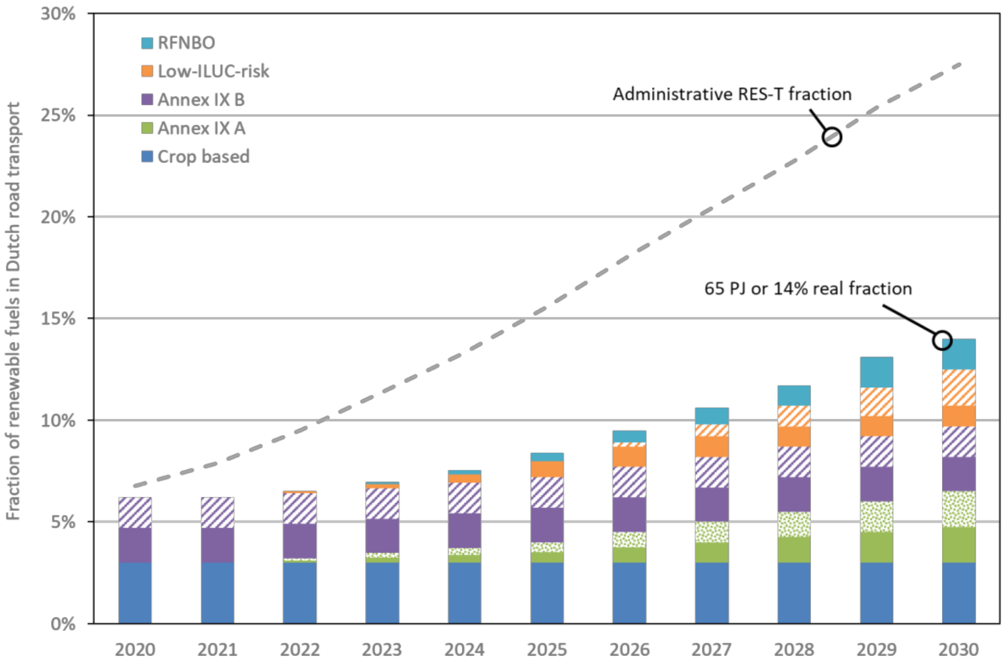

Figure 7. Proposed targets for renewable fuels in Dutch transport to achieve 65 PJ in 2030. Solid areas show fuel shares for RED II reporting. Striped areas show additional fuels on top of RED II or outside reporting caps.[37] The 2030 contribution in this proposed roadmap consists of 3% crop based biofuels (presumed maximum set by Netherlands), 3.5% Annex IX A type biofuels (double the RED II target indicated by dotted green area), 3.2% Annex IX B type biofuels (of which 1.7% reported for RED II), 2.8% low ILUC risk biofuels and 1.5% renewable fuels of non-biological origin. Dotted line indicates fraction of renewable fuels to be reported in the frame of RED II, far overachieving its 14% target.

We expect the amounts of these fuels will be available if clear and reliable targets are set in advance. The necessary feedstocks can be mobilised as explained in the previous chapter.

The main options to spur the sales of these renewable fuels are:

- An **obligation to economic operators**. This is a straightforward measure to ensure that the above explained 14% (for the 65 PJ goal) or 26% (for the 25 Mtonne CO_{2eq} limit) of renewable fuels is being achieved. Advantages of an obligation are (1) cost neutrality for the government and (2) a level playing for most economic operators.

  If it is desired that several renewable fuel options develop alongside, then it is advised to set sub-targets for each option to avoid that the cheapest option always prevails over other desired options.

  For instance, RED II requires a minimum of Annex IX A type biofuels (0.1 % in 2022, 0.5 % in 2025 and 1.75% in 2030[38]) which should at least be met. Furthermore, Low ILUC risk biofuels (certifiable from 2022 onwards) and renewable fuels from non-biological origin (available from 2025 onwards) may initially be more expensive to produce, while their development is desired to allow a high contribution towards 2030.

[37] Assuming 3% of crop-based biofuels in 2020, a maximum of 4% can be reported in the frame of the RED II targets for renewable energy in transportation. The Netherlands will presumably cap the contribution of conventional crop-based biofuels to the 2020 3% achievement. The remaining 1% could be used to report part of the low ILUC risk fuels (solid orange area). A maximum of 1.7% of Annex IX B biofuels can be reported.

[38] The 1.75% of Annex IX A type biofuels may be double counted to arrive at the administrative minimum target of 3.5%.

If sub-targets are formulated, multiple counting should be avoided where possible in the Dutch legislation. (some of fuels can obviously still be double counted in the frame of reporting to Europe).

The current obligation in the Netherlands is formulated in terms of renewable fuel units (HBEs) and this will be changed towards greenhouse gas units (BKEs). This does not impact the achievability of 65 PJ, and should not fundamentally change the dynamics of an obligation scheme.

- **Taxation measures** to bridge the gap between delivery costs and market prices. Either an additional excise (carbon tax) can be introduced for non-renewable fuels, or the excise duty on renewable fuels can be reduced, or both can be connected via a revolving fund. Additional income from a carbon taxation can also be used to finance research, development or fuel infrastructure.

- It is also possible to **tender or auction** fuels that are early in their development stage, in analogy with the auctioning of offshore wind energy allotments. For example, the government could ask for an increasing volume of low ILUC risk fuels to be delivered to the Dutch market in 2023-2027 to stimulate the development of this option. An additional advantage of auctioning would be the visibility of the selected projects, inspiring wider deployment.

  The advantage of a tender/auction is that the supplier is guaranteed a market volume and a premium price, which facilitates to secure the necessary investments.

3.2 Stimulate the deployment of renewable fuels

The 65 PJ (climate agreement) or 120 PJ (25 Mtonne CO2eq limit) scenarios can be achieved within the current E10 and B7 blend walls in diesel and gasoline, and without adaptations to the fuel infrastructure. Nevertheless, it is advised to prepare infrastructure, fleets and fuel quality standards to allow for higher blends of renewable fuels and so a wider set of practical solutions.

On the fuel side the Netherlands could drive European fuel standardization efforts to allow for higher fractions of ethanol in gasoline (going from the current E10 towards E15 or E20 in mainstream gasoline), and of FAME biodiesel in diesel (from the current B7 towards B10 in mainstream diesel).

High blends for fleets can be made available at dedicated gas stations, at logistical centers or sites of logistical service providers, and along fuel corridors throughout the EU (bilateral agreements with Germany, Belgium and France would help to spur uptake of such high blend fuels). High blends of HVO could be made available via flexible fuel stations which would then sell any blend of 0% - 100% HVO depending on customer wishes.

Similarly, high blends or pure renewable fuels can be sold to the inland shipping, and fuel corridors could be organised along the main rivers.

3.3 Stimulate the production and availability of renewable fuels

While the production of renewable fuels in the Netherlands is not a guarantee for deployment, and vice versa, production and consumption can still enforce each other.

Investments will follow once clear and reliable future targets are set for renewable fuels. Already, after years of limited investments, the publication of the RED II has spurred a new wave of investments in renewable fuels throughout the EU.

The production of advanced biofuels and e-fuels (from surplus renewable electricity) can be interesting propositions for the Netherlands, both in terms of direct economic activity in a growing EU market, as well as to drive related research, to become an international trade platform of the most sustainable biomass feedstocks and to earn a pole position in the biobased economy.

There are many ways to stimulate investments. It is advised to consider the European Innovation Fund for co-funding options.

3.4 Stimulate innovation

The future 14% (for the 65 PJ goal) or 26% (for the 25 Mtonne CO_{2eq} limit) scenarios can be achieved with feedstocks that can be mobilised and fuels that can be produced. However, innovation is still needed in all areas to further increase the global feedstock basis, decrease fuel costs, increase the number of fuel options, increase competition and eventually decrease fuel prices and costs to consumers and the government:

- Sustainable production or collection of Annex IX A feedstock, and improved mobilisation of both Annex IX A and B feedstocks towards the Netherlands.
- Experience with low ILUC feedstock production. The European Commission will support pilot projects in the period 2020 - 2022. The Dutch government should try to be closely involved with this development, communicate the results (practices, guidelines) to interested investors, and stimulate additional pilots aimed at direct delivery of volumes to the Dutch market.
- Connect to international technical innovation networks and facilitate network meetings between industry and (academic) research institutes.

The development of cost-effective advanced renewable fuel pathways eventually depends on the prospect of an attractive market in a reasonable timeframe. An attractive *future* market stimulates R&D. In the commercialization phase an attractive *existing* market allows for scale-up and further learning through development of second and third plants. Both scale-up and learning are needed for decreasing production costs. In absence of an attractive market, many developments do not cross the “valley of death” between pilot or lab-scale (TRL 5 or lower) and commercialization (TRL 8-9). The existence and prospect of an attractive market are therefore *condiciones sine quibus non* for innovation.

3.5 Stimulate feedstock mobilisation

The 152 PJ renewable fuels scenario explored in this report requires the sustainable mobilisation of additional feedstock. This will only happen in time if clear targets for the various fuel categories are set in advance.

New agricultural approaches should be assessed for their potential to sustainably increase the feedstock potential (without conflicting with food or feed provisions, and without increasing the pressure on nature). The yields of many crops around the world are unnecessary low because of a lack of know-how, machines and means. Dutch agricultural expertise can be employed to increase yields of crops above the trendlines, and so to produce low ILUC risk crops, or to increase the productivity of food and feed crops thereby creating room for biofuel feedstock crops.

Also, Dutch stakeholders can invest in sustainable feedstock projects around the EU and beyond.

The Netherlands is furthermore active in waste collection and the Dutch waste sector can assist or drive increased waste feedstock collection.

For some waste feedstock, such as used cooking oil, safe collection levels should be understood, the transparency of the chain of custody should be improved through expanding into how the waste was generated and collected.

3.6 Improve communication

A positive and constructive view on alternative fuels is needed. It should be recognised that besides electric mobility, that other solutions are needed to decarbonise transport, that multiple solutions can co-exist, and that for a long time they will not hinder each other's development.

The contribution of renewable fuels should increase and where sustainability is a restricting concern today, it should be turned into a strong prerequisite and enabler in the coming years. This requires a strong understanding of perceived concerns and true risks, transparent reporting on supply chains and their sustainability performance, and investments to improve certification systems and governance. This is a task both for the government and for the producing sectors.

The government may not be able to set all desired sustainability requirements, but they can request the industry to provide transparency.

It is also advised to renewable fuel producers and economic operators to develop a vision on how the role of various renewable fuels for transport can be sustainably increased.

APPENDIX A. STAKEHOLDERS CONSULTED

Person	Company (A-Z)	Stakeholder category
Mrs. Mariël Rouschop	Argent Energy	Biodiesel producer
Mr. Dick-Jan Marees	Avia Marees	Fuel distributor, operating fuel stations
Mr. Hennie Zirkzee	Biondoil	Project developer ethanol production facility
Mr. Anton Robek	BioRefinery Development BV	Project developer new cellulose ethanol production facility
Mr. Henk Groeneveld	CCT Criss Cross Technologies	Project developer of new biofuel production facilities
Mr. Niek Roesink	Den Hartog BV	Fuel distributor to logistic service providers and groundworks
Mrs. Rianne de Vries Mr. Bart Hellings	GoodFuels	Sustainable fuel reseller, mainly to shipping sector
Mr. Eelco Dekker	Methanol Institute	Renewable fuel expert
Mr. Jeroen van Mil	Nefco & Association Liquid Gas	Reseller of automotive LPG
Mr. Jeroen Meiberg	OrangeGas	Sales of green gas and other alternative fuels
Mr. Martijn de Man	PitPoint	Develops fuel stations for green gas, LNG, electric and hydrogen
Mrs. Loes Knotter Mr. Eric van den Heuvel	Platform Sustainable Biofuels	Renewable fuel experts and stakeholders
Mr. Michael Fiedler Panajotopoulos	REG (Renewable Energy Group)	Producer of waste-based FAME biodiesel
Mr. Paul Sinnige	RVO Netherlands Enterprice Agency	Agency under the Ministry of Economic Affairs and Climate Policy
Mrs. Mina Porthun Mrs. Carlijne Mouthaan	Shell	Oil company
Mr. Danny de Bruin	Tamoil	Fuel distributor, operating fuel stations
Mr. Jaap Kiel	TNO / Biomass ECN Petten	Research in the field of biomass and bioenergy
Mrs. Ayla Uslu	TNO / Energy Transition Studies	Research in the field of energy transition
Mr. Bart Somers	TUe Eindhoven University of Technology	Development of engines and renewable fuel options
Mr. Henk Wolthaus	VARO Energy Supply Trading	Fuel distributor, mainly to inland shipping
Mrs. Lorena Paz	Viride Holding BV	
Mr. Marnix Koopmans	VNPI Dutch Petroleum Industry Association	Represents downstream petroleum industry companies in the Netherlands

APPENDIX B. OPPORTUNITIES

Opportunity A — Ethanol high blend in mainstream gasoline

Description

- At present in the Netherlands, ethanol is marketed as E5 and E10 (respectively 5% and 10% volume blends in gasoline).
- E10 can be used in the internal combustion engines of most modern automobiles and light-duty vehicles without need for any modification on the engine or fuel system.
- In principle, the blend level could be increased to E15. For instance, the US EPA allows the use of E15 in passenger cars with a model year of 2001 or later. This would require clear labelling at the pump.
- Possibly, blends up to E20/25 can be used in current gasoline vehicles.[39]
- Ethanol can also be used at higher fractions, up to 85% (E85) in dedicated flex fuel vehicles.

Brazil has mandatory blends fluctuating from E18-E25 depending on the sugar and ethanol market prices. All automakers selling to Brazil have adapted their gasoline engines to run smoothly with this range of mixtures.

Almost 5% of all vehicles in Sweden are flex fuel vehicles that drive on E85. All larger fuel stations are required to sell at least one renewable fuel. One third of the fuel stations sell E85.

Key characteristics

- Ethanol sold in the EU has a good greenhouse gas performance (at least 50% emission reduction over gasoline is required – the reported saving in the Netherlands was 68% in 2018) and low indirect impacts.
- Ethanol in higher blends represents a relatively cheap way to introduce low carbon fuels and to achieve cost effective emission reduction.

Availability and development

- Large production capacity exists in EU (4.4 Mtonne) and globally (96 Mtonne)
- Current production is mainly from sugar or starch crops, such as sugar beet, sugar cane, corn and wheat. These have low ILUC impacts.
- Can also be produced from residues, wood or grass (Opportunity C) or waste steel gas (LanzaTech process).

Major players in the Netherlands

- Between 2006 and 2015 Tamoil supplied E85 at several dozen fuel stations.
- E85 in the Netherlands is currently sold at (at least) 1 fuel station (Green Planet nearby Hoogeveen), while Den Hartog delivers to any address provided it has the correct tank storage/equipment.
- Most car makers produce flex fuel vehicles capable of driving on E85 and most of these are type approved in the EU and therefore could be sold/imported to the Netherlands

Opportunities in the Netherlands

- There is still room to increase the volume of ethanol until the current blend wall of 10% by volume
- There are options to raise the blend wall to 15% or even 20% by volume
- It is also possible to cross the blend wall by stimulating the use of E85 introducing Offer E15 at larger fuel stations.

Policy recommendations

- Demand certification of higher ethanol blends.
- Ensure the room until the blend wall is fully utilised and introduce options to cross the blend wall.
- The taxation of ethanol should be same (or lower) than that of gasoline, on energy basis.
- Stimulate supply (oil companies), availability (fuel stations) and application (vehicles).

[39] Kolbeck and Costenoble, 2019, Engine tests with new types of biofuels and development of biofuel standards (results on Grant Agreement SA/CEN/RESEARCH/EFTA/000/2014-13), presentation to EC Workshop Future fuels and engine concepts.

Opportunity B — E95 in the heavy transport sector

Description

- Near pure ethanol can be used in adapted diesel engines in buses, trucks and mobile machinery.
- This is generally called ED95 consisting of 95% ethanol (by volume) with ignition improver.
- ED95 technology is mature and fuel standard exists.
- Currently, diesel engines suitable for ED95 are only manufactured by Scania.
- Compared to a normal diesel engine, the compression ratio is adjusted from 18:1 to 28:1, fuel injection nozzles are larger, and the injection timing is changed.
- ED95 engines have a high efficiency similar to diesel, and NOx and PM (near zero) emissions comply with Euro VI.

> Over 300 ED95 buses are operational in Stockholm since the early 1990s. Recent years have seen the introduction of ED95 garbage and distribution trucks.

> The EU BEST project (BioEthanol for Sustainable Transport) during 2006-2009 demonstrated ED95 fuelling and use with 138 buses and 12 fuel stations in five major cities (3 in Europe, 1 in China, 1 in Brazil).

Advantages

- Ethanol in higher blends represents a relatively cheap way to introduce low carbon fuels and to achieve cost effective emission reduction.
- Low local NOx and PM emissions

Availability and development

- ED95 can be made available with small changes to the current fuel infrastructure
- Outside Sweden, also cities in France, Norway and Finland have recently introduced ED95 buses and trucks
- VTT (Finish research institute) researches methanol with ignition improver (MD95).
- ED95 trucks and buses are available (Scania).

Major players in the Netherlands

- ED95 has not been demonstrated in the Netherlands. ED95 is currently not sold in the Netherlands.

Opportunities in the Netherlands

- Introduce regional ED95 buses, garbage distribution trucks.

Policy recommendations

- Include ED95 as an option in local and regional bus concessions.

Opportunity C — Production of cellulose ethanol

Description

- Ethanol serves as a transport fuel (see opportunities A & B).
- Cellulose ethanol is based on conversion of the cellulose and hemicellulose in agricultural residues, wood or grass, or the organic fraction of e.g. municipal solid waste.
- Cellulose ethanol usually (depending on the exact feedstock) falls in Annex IX A of the Renewable Energy Directive and thus helps to achieve the subtarget of 3.5% advanced biofuels in 2030.
- Several production pathways are possible to first hydrolyse the (ligno)cellulose into C5 and C6 sugars, and then ferment these sugars to ethanol. The technology is proven, and some commercial demonstration has taken place (Denmark, Italy, US).

Several European companies have demonstrated (commercial) cellulose ethanol production:

Inbicon (Dong)
Kalundborg Denmark
4 ktonne/year since 2010

Beta Renewables
Crescentino Italy
40 ktonne/year since 2013

Borregaard
Sarpsborg Norway:
16 ktonne/year since 1938.

Advantages

- Cellulose ethanol counts for the 3.5% RED II Annex IX A subtarget.
- Cellulose ethanol also serves as a major building block in the biobased economy. And several biobased pathways need related conversion technologies.
- Ethanol is a precursor to Alcohol-to-Jet Sustainable Aviation Fuels.

Availability and development

- The availability of cellulose ethanol in the EU is currently limited.
- Many initiatives are waiting for improving demand market.

Major players in the Netherlands

- At least three commercial scale production initiatives in the Netherlands wait for investment decision.
- The expected Dutch production capacity is >75 ktonne by 2023.

Opportunities in the Netherlands

- High demand market for cellulose ethanol in the Netherlands and surrounding markets would support investments.
- EU Innovation fund is likely attractive for investments in cellulose ethanol

Policy recommendations

- Set considerable target for the application of advanced fuels.
- Support initiatives to deploy higher blends of ethanol.
- Consider the combination of national support measures with EU Innovation Fund.

Opportunity D — Higher blends of FAME biodiesel

Description

- FAME (Fatty acid methyl ester) is derived by treating vegetable oil or fats with methanol.
- In EU, rapeseed oil is the common feedstock for this process, and fuel made from it is called RME.
- In the current Dutch market, most FAME stems from Used Cooking Oil and called UCOME.
- At present in the Netherlands, FAME biodiesel is marketed as B7 (7% volume blend in diesel).
- Blend level could be raised to B10. This is done in France. The fuel can be used in most of today's diesel vehicles.
- CEN published standard EN16709 for use of B20 and B30, depending on the engine type and manufacturer warranty, in closed vehicle fleets. Other countries are already increasing to B20 (several US states, Malaysia, Indonesia and Thailand).

Advantages

- FAME biodiesel is the dominant biofuel in the EU and has a large existing production capacity.
- The fuel is relatively cheap, the most attractive biodiesel option within blend limits.

Availability and development	Major players in the Netherlands
• The availability of the fuel is large • Feedstock basis should and can be increased.	• There are about 6 FAME biodiesel production facilities in the Netherlands with a combined capacity of over 700 ktonne.
Opportunities in the Netherlands	**Policy recommendations**
• The feedstock demand for FAME and HVO (typically the same feedstock) is expected to increase. Netherlands could play a role in mobilising Low ILUC risk crop feedstock (opportunity K) and improving the collection of used cooking oil (Opportunity L).	• Raise the blend wall to B10 (mainstream) and support B20 (fleets).

Opportunity E — HVO biodiesel in various blends

Description

- HVO (Hydrotreated Vegetable Oil) is produced from vegetable oil and fats, via catalytic hydrogenation.
- The feedstocks are in principle the same as for FAME Biodiesel (opportunity D), with some additions (tall oil).
- HVO is a "drop-in" fuel and could be used (in principle) in very high fractions.
- Blending is limited within diesel standard EN590 to about 35% due to the lower density.
- Nevertheless, truck OEMs approve the use of 100% HVO in Euro V/VI engines. Manufacturer PSA allows 100% HVO in their passenger vehicles.
- HVO can be produced in stand-alone facilities, or through co-processing in existing refineries. In the latter case, the product consists of a biomass and a fossil fraction.

Several traditional oil companies have adapted their refineries to now (co)process vegetable oil to (in part or fully) replace fossil oil, and so produce HVO (ENI, Total, Repsol, Cepsa, Galp, Preem).

Advantages

- While HVO is more expensive than FAME, it can more easily be applied in higher blends.
- HVO production can be converted to HEFA (a Sustainable Aviation Fuel).

Availability and development

- The production and availability of HVO in the EU is steeply increasing.

Major players in the Netherlands

- Major producer Neste is strengthening its position; has new HQ in Hoofddorp.
- Economic operators (blenders) already put Renewable Diesel at 20/30% in the market.

Opportunities in the Netherlands

- This fuel can play a major role above the FAME blend limits.
- Smart fuel stations can deliver specialty blends between zero and 100% depending on the vehicle warranty or customer choice. This could be interesting for fuelling LSP fleets (Logistical Service Providers)

Policy recommendations

- Set high targets to stimulate the demand for higher blends above the blend limits.

Opportunity F — Co-processing of pyrolysis oil

Description

- Fast pyrolysis converts solid biomass into liquid oil. This oil can be stored and transported, used for energy generation or as a feedstock in the biobased economy.
- Pyrolysis oil can be co-processed in existing oil refineries to a level of 5-10%, which then automatically introduces a level of renewable energy in the fuel leaving the refinery.

> TechnipFMC and BTG-BTL recently announced they will design and build a production facility in Sweden where sawdust will be converted into bio-oil. The oil will be processed in Preem's refinery in Lysekil, on the Swedish west coast.

Advantages

- One of the few options to achieve fuel decarbonisation at the refinery. The resulting product can still be used for the blending of ethanol or diesel (Opportunities A, B, D and E).

Availability and development	**Major players in the Netherlands**
• Empyro (JV of BTG-BTL and TechnipFMC) operates a commercial demonstration of pyrolysis in Hengelo the Netherlands (~18 ktonne/yr). • TechnipFMC deliver turnkey Fast Pyrolysis Bio-Oil (FPBO) units, based on modular design allowing for quick installation.	• BTG-BTL has developed fast pyrolysis technology, as well as technology for the co-processing of the pyrolysis oil in refineries. • TechnipFMC developed technology for the co-feeding and fluid catalytic cracking of pyrolysis oil in traditional oil refineries.
Opportunities in the Netherlands	**Policy recommendations**
• The Netherlands has a large refining capacity that could use this technology to decarbonise a share of their product.	• Stimulate the co-processing of (pyrolysis) oil in existing refineries. • Allow for accounting of co-processed biofuels in legislation.

Opportunity G — Biomethane

Description

- Biomethane can replace fossil CNG and LNG in vehicles.
- Biomethane today is mainly derived from biogas.
- Biogas is produced by anaerobic digestion of organic matter such as animal manure, plant residues, sewage waste, the organic fraction of municipal solid waste, etc.
- This biogas can be upgraded to methane quality, injected in the gas grid and used as transport fuel.
- It is also possible to produce biomethane via gasification of solid biomass (see Opportunity J).
- Note a synthetic methane can be produced from renewable electricity (chemically almost identical, see opportunity M).
- Several brands sell CNG vans and LNG trucks.
- With a small adaptation, existing gasoline-powered vehicles can be converted to run on CNG or LNG.

> The *Gas for Climate* consortium was established by a group of EU gas grid operators to explore the role of renewable gas (from biomass or renewable electricity) in decarbonising the EU gas supply.

Advantages

- Driving on bioCNG is a cost attractive option to decarbonize transport.
- Renewable methane for industry, households and transport can be supplied via multiple pathways (from residues, from solid biomass, from renewable electricity), and replace current natural gas.
- Good CNG / LNG fuel infrastructure throughout most of the EU.

Availability and development

- Anaerobic digestion technology is widely available, and biogas is produced at scale in many EU Member States.
- The current use of biogas in the EU is roughly equal to the use of liquid biofuels.

Major players in the Netherlands

- Over 150 green gas fuel stations exist in the Netherlands.
- The most prominent players are Orange Gas and Pitpoint.

Opportunities in the Netherlands

- The production of green gas in the Netherlands can further increase, from residues and other low ILUC feedstock.
- Also, the production in the rest of EU is increasing and becomes more attractive for the Dutch market because transborder trade is now possible.

Policy recommendations

- Stimulate the replacement of CNG and LNG by biomethane and synthetic methane.
- Appreciate the low well-to-wheel emissions similar to electric driving.
-

Opportunity H — BioLPG

<table>
<tr><td colspan="2">Description
• Propane and butane are the main components of LPG.
• Propane is a co-product from HVO and HEFA production (Opportunity E).
• Current global hydrotreating of bio-oils is already producing 200 kilotonnes of biopropane, with some additions planned.[40]
• Many other technical pathways to produce bioLPG are conceivable.[40]
• BioLPG is already sold by SHV Energy companies Primagaz and Calor in Great Britain, France, Denmark, Sweden, Germany, Ireland, Netherlands and Belgium, but not as transport fuel</td></tr>
<tr><td colspan="2">Advantages
• Requires only limited adaptations to HVO and HEFA production facilities.</td></tr>
<tr><td>Availability and development
• Neste in Rotterdam produces 40 ktonne propane per year, which can be used as a drop-in fuel in LPG vehicles.</td><td>Major players in the Netherlands
• Neste (Rotterdam, now) and the planned sustainable aviation fuel plant in Delfzijl (2022) both produce bioLPG.
• SHV markets bioLPG, but not yet to Dutch transport.</td></tr>
<tr><td>Opportunities in the Netherlands
• Replace LPG with biopropane</td><td>Policy recommendations
• Explore how biopropane produced in the EU can flow to the Dutch transport market.</td></tr>
</table>

[40] See amongst others Johnson 2019, Process Technologies and Projects for BioLPG, Energies 12:250.

Opportunity I — BioHFO

Description

- Several types of biofuels could be used as renewable Heavy Fuel Oil, or HFO, for the shipping sector.
- Fresh vegetable oil and FAME (Opportunity D) can be used in the current engines up to high fractions. Some adaptations in the fuel system and good housekeeping are needed.
- HVO may be used up to 100% without adaptations, and is better positioned for large scale application.
- The use of methanol and DME (see opportunities O) is tested in the shipping sector.
- Internationally, there is some interest to fuel ships with LNG, this could be bioLNG (opportunity G).

> International container ship operator Maersk operates a ship on 20% UCOME, sponsored by amongst others Dutch multinationals FrieslandCampina, Heineken, Philips, DSM, Shell and Unilever.

Advantages

- The shipping sector requires renewable fuels to decarbonise.
- IMO, the UN International Maritime Organisation is developing a pathway to decarbonisation.

Availability and development

- The fuels suitable as bioHFO for shipping are widely available.

Major players in the Netherlands

- Amongst others Good Fuels and VARO already have a strong position in selling renewable fuels to the shipping sector.

Opportunities in the Netherlands

- Netherlands is home to some of world's largest harbours.
- Several Dutch stakeholders are developing initiatives to decarbonise the shipping sector.

Policy recommendations

- Connect Dutch stakeholders with IMO developments.
- Increase demand for renewable fuels in shipping sector, with goal to decarbonise inland and international bunkering.

Opportunity J — Production of wood and grassy feedstocks

Description

- Woody and grassy biomass generally has a good sustainability performance. Biofuels produced from these feedstocks are advanced by RED II Annex IX A.
- Such biomass consists mainly of cellulose, hemicellulose and lignin, and the fraction of functional material (sugar, starch, oil) is generally low.
- The yield per hectare is generally very high.
- Biofuels can be produced from these feedstocks via the gasification platform (Opportunity N) or via biological pathways (Opportunity C).

> The higher end estimations for the global biomass potential all include dedicated woody or grassy energy crops. EU is currently researching the potential for these feedstocks on abandoned agricultural land, degraded land and other land that would not compete with nature or current agricultural provisions.

Advantages

- There are a few platform technologies that allow conversion from many types of cellulose, into many types of biofuels.
- Cellulose biomass is also used for heat and power production, and global supply chains are being developed.

Availability and development	Major players in the Netherlands
• The potential global availability is very high. • Local availability in the Netherlands is seasonally large.	• Water boards and forest owners.
Opportunities in the Netherlands	**Policy recommendations**
• Increase the sustainable harvesting of biomass from Dutch forests, and initiate dedicated bioenergy plantations.	• Start projects for the dedicated supply of solid biomass for fuels, heat, power and materials.

Opportunity K — Low ILUC risk feedstocks for crop based biofuels

Description

> RED II and a Commission Delegated Act have further defined the boundary conditions for low ILUC feedstock certification. Commission is currently developing guidance for certification. The Commission will support the piloting of Low ILUC certification for multiple crops and in several regions during 2020-2023.

- It is possible to produce much more crops within the current agricultural boundaries, without compromising food production and without further encroaching upon nature.
- One main option is to increase agricultural yields and supply chain efficiencies. In many regions in the world, the yields are low and much produce is lost. By increasing yields for food crops, and by reducing losses, space is created for new services, such as biomass.
- The other main option is to use abandoned agricultural land (in the EU 1 million hectare of land is abandoned per year because farming loses economic attractiveness) or degraded and unused land.

Advantages

- With low ILUC certification, the main concerns associated with crop based biofuels (indirect land use change, food security impacts) disappear. It will then be possible to increase the contribution of certified biofuels above the current caps.

Availability and development

- The guidance for low ILUC certification is under development. The Commission is expected to publish the guidance early 2021.

Major players in the Netherlands

- Dutch agricultural sector.

Opportunities in the Netherlands

- Netherlands has much know-how on agriculture, which can be deployed to initiate or accelerate low ILUC feedstock projects, also outside the Netherlands.

Policy recommendations

- Demand that an increasing fraction of renewable fuels is produced from low ILUC feedstock.

Opportunity L — Improved UCO collection

Description

> McDonalds recycles the used cooking oil from their kitchens into biodiesel which is then used to fuel around 42% of their delivery fleet.

- Waste-based biofuels in line with RED II Annex IX B only concern biodiesel (FAME and HVO) produced from Used Cooking Oil or animal fat.
- The production processes are very similar to those of crop-based FAME and HVO; are well-known and take place at a considerable scale.
- Professional UCO collection from restaurants and hotels in the EU is already quite mature.
- Household collection of used cooking oil might be an opportunity for increasing the UCO supply.
- Collection of UCO from individual households is challenging but can be further improved.
- The import of UCO from other regions is interesting in the short term, until these regions develop UCOME facilities.
- Other waste feedstock suitable for FAME/HVO production are tallow (animal fat) and POME (palm oil mill effluent).

Advantages

- Used Cooking Oil is an abundant and cheap waste feedstock.
- Improved UCO collection from households and restaurants also avoids fat blockages in the sewage system.

Availability and development

- The potential for UCO collection from households in the EU is over 800 ktonne, and largely untapped.
- Global supply of UCO is increasing due to increasing world population and increasing attention for hygiene and health safety.

Major players in the Netherlands

- Rotie collects used cooking oils in the Netherlands, Belgium and parts of Germany at more than 35,000 addresses. Biodiesel Amsterdam converts the UCO into UCOME.
- SunOil in Emmen and Biodiesel Kampen both produce UCOME.

Opportunities in the Netherlands

- The amount of UCO collected from households in the Netherlands is about 0.21 kg of recycled oil per capita which is still low compared to other Member States (Austria 1 kg/capita, Belgium 0.73 kg/capita).

Policy recommendations

- Set target for Annex IX B type biofuels up to the 1.7% cap. Possibly allow higher fractions if

Opportunity M — Renewable fuels of non-biological origin

Description

- Renewable Fuels of Non-Biological Origin, or RFNBOs, are mainly based on the conversion of renewable electricity to hydrogen (via electrolysis), and subsequent further processing into methane (identical to biomethane, Opportunity G), methanol (see opportunity N & O), or synthetic diesel (see Opportunity N).
- These fuels are also known as e-fuels, or Power-to-X.
- Other types of RFNBOs, not based on electricity, are also conceivable, but hardly developed.

> International development of e-fuels is still in the research phase. For instance, in the MefCO2 (Methanol fuel from CO_2) project, RWE and others aim to demonstrate the economic feasibility of valorising captured CO2 by turning it into methanol using hydrogen produced from renewable energy.

Advantages

- E-fuels allow for peak shaving a surplus renewable electricity supply.

Availability and development	Major players in the Netherlands
• Note that hydrogen is separately supported in the Climate act (outside of the 65 PJ of renewable fuels). • The availability of other e-fuels at significant scale in 2030 is uncertain.	• Multiple stakeholders are forming ideas on hydrogen and other e-fuels.
Opportunities in the Netherlands	**Policy recommendations**
• With the massive offshore wind development, hydrogen production becomes interesting.	• Stimulate innovation and development of e-fuels.

Opportunity N — Fuels via the gasification platform

Description

- Many types of fuels can be produced from solid biomass via gasification and subsequent synthesis.
- By gasification, biomass is converted to mainly carbon monoxide and hydrogen.
- Through different synthesis reactions, amongst others hydrogen, methanol, dimethylether and synthetic diesel can be produced.
- Investments in gasification & synthesis require a large scale, and therefore a large market.

> Enerkem is developing a facility in Rotterdam to produce methanol from the organic (and non-organic) carbon of municipal solid waste (MSW). The technology is proven and demonstration plants exist, but commercial scale operation is new.

Advantages

- At very large scale, gasification of solid biomass becomes economically more attractive than conversion of crop biomass.

Availability and development	Major players in the Netherlands
• Both gasification and synthesis technologies are well developed. The gas cleaning before synthesis still has some bottlenecks.	• Shell researched biomass gasification and subsequent synthetic diesel production, in the frame of the CHOREN pilot plant.
Opportunities in the Netherlands	**Policy recommendations**
• Enerkem is developing a plant in Rotterdam, to produce methanol via gasification from municipal waste.	• Set a high target on Annex IX A type biofuels.

APPENDIX C. TARGETS FOR RENEWABLE TRANSPORT FUELS IN THE EU TOWARDS 2030

Since the Dutch legislation on renewable transport fuels is partly informed by the European legislative framework, and also because the Dutch market is strongly connected to the EU market, the EU legislative framework must be understood.

- **The transport sector provisions in RED II oblige each EU Member State to achieve an *administrative* 7 to 14% share of renewable energy in transport by 2030.** The exact fraction is to be determined through complex formulae and multiple counting such that the actual renewable energy obligation for each Member State in transport by 2030 is between 2.6% and 10.5%.[41] The RED II includes sub-targets for certain biofuels and other forms of renewable energy as further detailed in Table. Some stakeholders see this part of the RED II as the most important of the three pillars, since it applies specifically to transport, but that may not be the actual case.
- **RED II also sets an EU wide target of 32% renewables across the combined power, heating, cooling and transport sectors.** Contrary to the transport specific target, this overall target must be achieved without any options of double counting. This could require a significant role for renewable energy in transport, because without a strong contribution from the transport sector – responsible for more than a quarter of the energy use and increasing – even more action would be required in other sectors.
- **The Effort Sharing Regulation (ESR) sets binding national emission reduction targets for the period between 2021 to 2030 for sectors that fall outside of the EU Emission Trading System ETS.**[42] Like the RED II overall target, the ESR does not specify the exact emission reduction in each of these sectors. However, the overall ESR target is large, 30% emission reduction at an EU level, and even 36% for the Netherlands, and transport represents an ever-increasing proportion of the EU's emissions. This implies again that transport cannot easily be ignored, since any shortcomings in one sector will have to be made up for in the other sectors.

The cap on crop-based biofuels is informed by concerns over Indirect Land Use Change.[43] Two notions are important here:

- Many stakeholders seem to understand the cap on the target for crop-based biofuels as a cap on the deployment of these fuels. That is not correct and higher deployment is allowed, but any volume above the cap would simply not contribute to achieving the RED II targets. These types of fuels could still be supported, if they comply with the RED II sustainability criteria.

- Low ILUC risk biofuels have the potential to sustainably increase the role of biofuels in greening the transport sector. Biofuels can be produced in a sustainable manner, and can carry low ILUC risk, even when being crop-based.

[41] The target for crop-based biofuels in the RED II is between 0 and 7% depending on Member State preferences. The contribution of biofuels produced from Annex IX A type feedstock shall be 1.75% (counting double to arrive at 3.5% administratively). The contribution from other renewable energy should be 3.5% administratively. However, this can be achieved in a minimum case by 0.875% electricity in road transport (counting four times), or in a maximum case by 1.7% biofuels from Annex IX B type feedstock (counting twice to arrive at 3.4% administratively) plus 0.1% other renewable energy. The latter could be 0.066% electricity in rail counting 1.5 times. The minimum case adds up to 0% crop + 1.75% Annex IX A + 0.875% renewable electricity in road = 2.6%. The maximum case adds up to 7% crop + 1.75% Annex IX A + 1.7% Annex IX B + 0.066% electricity in rail = 10.5%.

[42] EU Regulation 2018/842.

[43] Recital 62 BIS new, in version 18 of the final compromise text.

Table C-1. RED II targets and caps, as specified in Article 25.

Overall target
• 14% renewable energy in transport, can be achieved by a range of options.
Crop-based biofuels
• Capped at 1% above the 2020 fraction per Member State, or 7% (whichever is lower).
• If the 2020 fraction is below 1%, the crop cap may be set at 2% maximally.
• If a Member State caps crop-based biofuels at a level lower than 7%, then it can reduce the overall 14% target.
High ILUC risk biofuels
• Definition will be given by European Commission in delegated act.
• High ILUC risk biofuels will be phased out towards 2030.
• Unless they are certified as being low ILUC risk.
Biofuels from Annex IX A type feedstock
• 0.2% required in 2022.
• 1.0% required in 2025.
• 3.5% required in 2030.
• Note that fuels may be double-counted to achieve this target, which de facto implies that the targets are only 0.1%, 0.5% and 1.75%.
Biofuels from Annex IX B type feedstock
• Capped at 1.7%, which may be double counted to arrive at a contribution of 3.4%.
Other forms of renewable energy in transport
• Renewable electricity. When used in road vehicles, renewable electricity counts 4 times. When used in rail, renewable electricity counts 1.5 times.
• Renewable liquid and gaseous transport fuels of non-biological origin. (can be produced from renewable electricity).
• No sub-targets are specified, but they contribute to achieve the overall 14% (or lower) target.