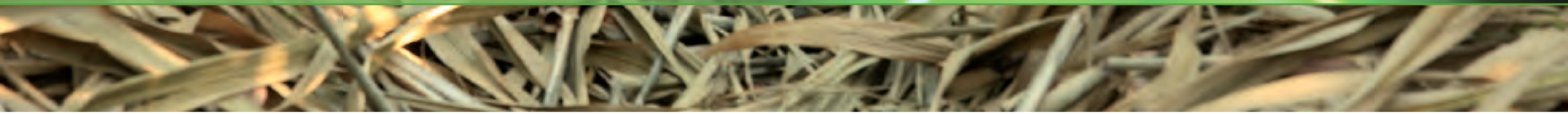
The future of the Dutch bio-based economy

Macroeconomic outlook of sustainable biorenewables innovations in the Netherlands



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content

Introduction

The transition from a fossil based economy to a bioeconomy contributes to reduce the dependency on fossil resources to meet our greenhouse gas emission reduction targets and strengthen the Dutch economy. The EC target of 20% CO_2 emission reduction must be achieved by 2020 and a 40% reduction by 2030. Based on all sectors and all pollutants emission reduction in 2013 compared to 1990 was 10%[1].

Long-term projections of the development of the bio-based economy help us to see if we are on the right track or whether additional measures are required.
In 2009 a macro-economic impact study was carried out to gain insight in the effect of the large-scale use of biomass for energy and materials in the Netherlands, and what this means in terms of jobs, national income and environmental impact up to 2030.

This economic impact assessment study conducted in 2015 is a follow-up and much extended version of the first study and has been commissioned by the Top Sector Platform for Knowledge Development and Innovation of the cross-cutting theme Bio-based Economy (TKI-BBE) in the Netherlands. The study was carried out within the BE-Basic research & development program.

The present study gives insights into the macroeconomic impact and effects on energy use and CO_2 emissions of biomass use for the production of bioenergy, bio-based heat, biofuels and bio-based chemicals in 2030 in the Netherlands. Furthermore, this second study addresses the main uncertainties and sensitivities of the impact of these applications on the Dutch economy in more detail.These insights provide starting points for policymakers and entrepreneurs to take decisions on future measures and investments.

This publication is the public version of the impact study to present the main results and key conclusions. The used methods are briefly summarized. For an in-depth review, the full scientific report of the study, performed by LEI Wageningen UR and Utrecht University can be downloaded for free at http://dx.doi.org/10.18174/370901 or at www.wageningenUR.nl/en/lei (under LEI publications).

[1] National emission registry, IPCC, 1990-2014; www.emissieregstratie.nl

[2] CPB, Toekomstverkenning Welvaart en Leefomgeving (WLO), 2015

The Dutch economy

The Netherlands is the sixth-largest economy in the Euro zone and an important transportation hub in Europe. The Dutch economy is expected to grow with up to 2% per year till 2030[2]. The low price of oil is currently still giving an additional impulse to the economic growth. The services sector, in particular, is growing and makes up three-quarters of the total Dutch economy, while the share of primary sectors and manufacturing industry is further declining.

Growth of the Dutch economy – although back on track again – is held back due to lower production at the Groningen gas field because of safety concerns. The further scaling down and eventual termination of gas production will have a large impact on the trade balance in the future.

At the Paris Climate Conference (COP21) in December 2015, 195 countries adopted the first ever universal, legally binding global climate agreement. The Paris Agreement is an extra driver for large investments in renewable energy and innovations to reach a greenhouse gas reduction of 80-95% by 2050 as aimed for by the European Union.

In this environment, a new bio-based economy is developing in the Netherlands as well as in other European countries and other parts of the world, contributing to the objectives of the Paris Agreement and other policies aimed at tackling the societal challenges of the 21st century.

1 Macroeconomic outlook
Analysing images of a bio-based future

method

The approach used for the second macro-economic outlook is similar to the first study and consists of two related parts (Figure 1):

technology
a 'bottom-up' analysis based on technological expectations, which examines in detail the markets in which biomass is expected to be used (e.g., electricity, transport fuels, chemicals). This is done using detailed information about cost structures of biomass using technologies, technology improvement rates, the energy carriers in which it will be converted, the expected prices of raw materials and the cost of conversions, the greenhouse gas emissions and the availability of biomass.[3]

macroeconomy
a 'top-down' macroeconomic analysis, that calculates the impact of increasing biomass use for energy and chemicals on the economy. The focus of the top-down part is on the growth of different economic sectors, the gross domestic product (GDP) developments and the effects on the trade balance and employment.[4]

Both methods are used in conjunction. The results and input data of the detailed bottom-up study on technology development were incorporated in the global multi-sector and multi-country, macroeconomic, top-down study.

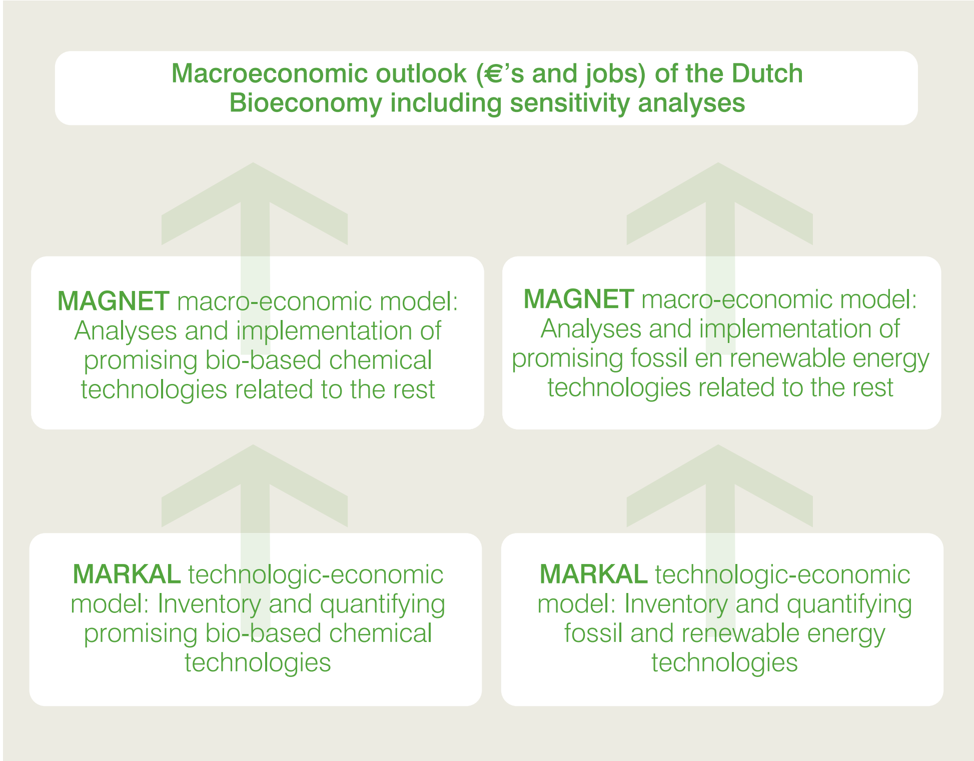


Figure 1. Methodology: bottom-up and top-down analyses

[3] This analysis was conducted by the Copernicus Institute of Utrecht University. The researchers used an advanced modelling tool (MARKAL-NL-UU) for detailed cost optimization of the energy and chemical sector of the Netherlands. It builds on the MARKAL model originally developed by ECN and is extended with non-energy use sectors and demand for aviation fuels.

[4] This part of the study was conducted by researchers from the Agricultural Economics Research Institute (LEI Wageningen UR). An advanced version of the Modular Applied GeNeral Equilibrium Tool (MAGNET) was used covering the entire global economy. It has been enhanced with the more disaggregated bioeconomy sectors, bio-based transport, electricity and chemical sectors and more disaggregated fossil-based and renewable sectors.

scenarios

Both analyses make use of the scenario approach. Scenarios are images of the future that help us understand possible future developments of complex systems such as the bioeconomy. Scenarios are therefore not predictions or forecasts. Each scenario is an alternative image of how the future might unfold and is obtained by logical thinking based on a number of related assumptions.

It is assumed that two factors are decisive for the use of biomass in the Dutch economy to 2030 and its effects: the degree of openness of biomass markets and the rate of technological development.
Starting from the existing situation in the reference year 2010 (for bottom-up study) and 2015 (for top-down study), four different developments can be outlined.

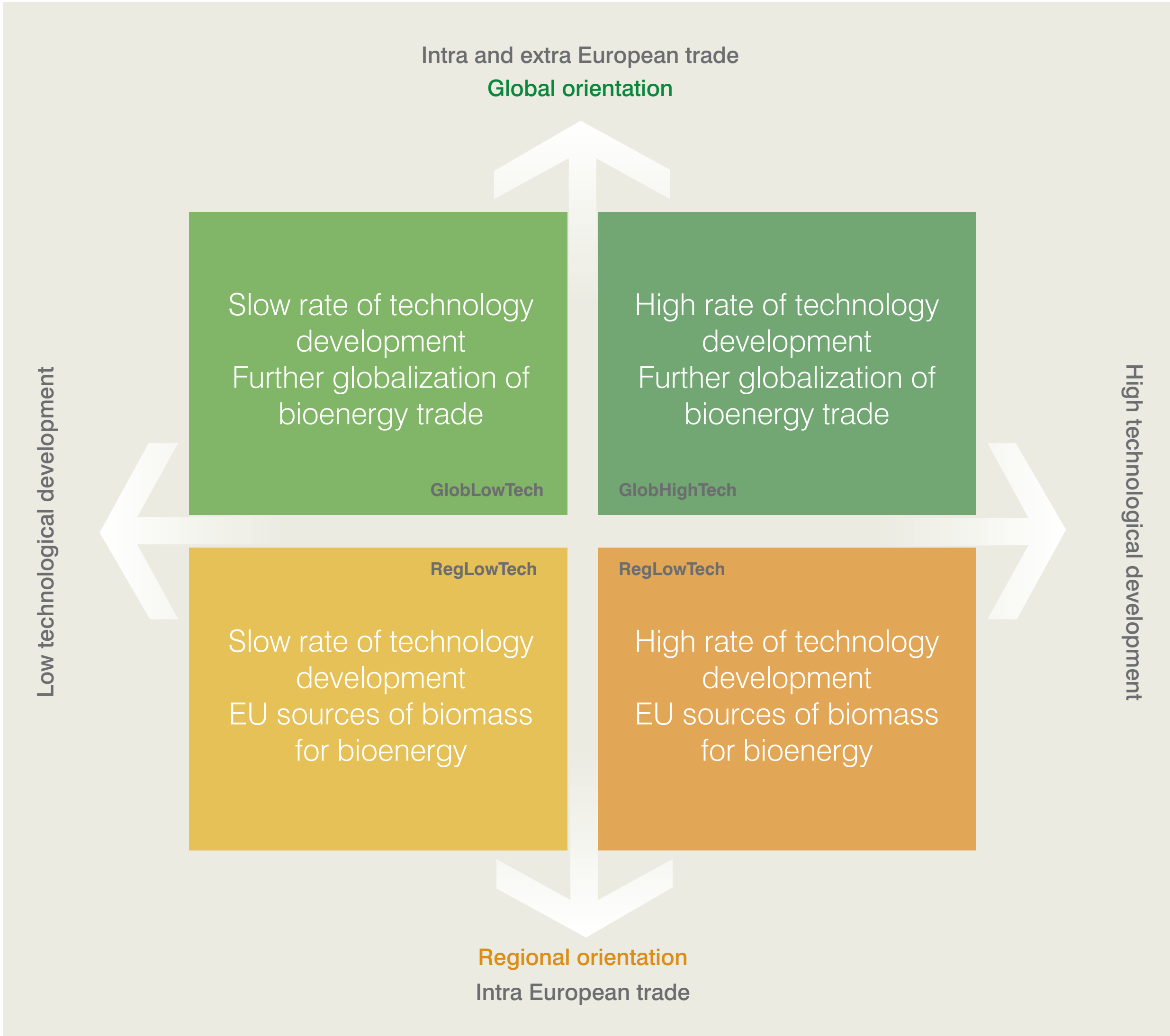


Figure 2. Overview of the four scenarios

rate of technological development: high versus low tech

Technological improvements and the upscaling of technologies can reduce production costs of bioenergy and biochemicals. This rate of technological change depends on factors such as investments in R&D and other policies. To capture these uncertainties two relatively extreme scenarios are used: high-technology development and low-technology development.

The low-technology scenarios take into account technologies that are available today and assume an increase of production based on already installed or announced capacities. The rate of improvements in yields and efficiency is conservative.

In the high-technology scenarios, more technologies as well as larger and more efficient production facilities are implemented. The rate of gradual improvements in yields and efficiency improvements is more optimistic. In the high-technology scenarios advanced biorefineries (such as lignocellulose conversion to sugar and ethanol), biomass gasification and conversion to Fischer-Tropsch (FT) fuels for transport are implemented as well as new fermentation based chemicals such as Polylactic acid (PLA) and traditional bulk chemicals such as bioethylene, while other advanced bio-based chemicals such as Polyethylene Furanoate (PEF) seem most promising by 2030.

degree of openness of biomass markets: global versus regional

The large shift from use of biomass for food and feed to new uses of biomass for additional products including energy, fuels, materials and chemicals in the last decade has resulted in rapid developments in the trade of biomass. It is expected that international biomass trade will continue to grow in the future. It is, however, uncertain how trade will develop. This uncertainty is translated in a regional scenario and a global scenario that vary with respect to the availability and price of biomass.

In the regional scenarios the EU supports renewable energy and bio-based chemicals only if produced from available EU resources. Extra-EU imports of biomass for bioenergy and bio-based chemicals are restricted.

In the global scenarios it is assumed that trade barriers for biomass will be alleviated.

In this public version only the results of the conservative Regional Low-Technology development scenario (RegLowTech) and rather ambitious Global High-Technology development scenario (GlobHighTech) are represented to show the range for the environmental and economic effects.

key input data and assumptions

Important assumptions for scenario analysis up to 2030 are the national and international policies on energy and climate change, and the anticipated demographic and macroeconomic developments.

policies on energy and climate change

- The target set by the European Union is to achieve a 20% **renewable energy** share in the final energy demand for electricity, heat and transport fuels by 2020. For the Netherlands this corresponds to 14% by 2020 and **16% by 2023** renewable energy share (RES) as stated in the Dutch Energy Agreement (SER, 2013). Deployment of wind and solar energy is supported. Biomass co-firing can be used to a maximum of 25 PJ final energy. It is assumed that all energy policies and targets are extended to 2030.
- Based on the European Renewable Energy Directive (EU RED) road transport biofuel share is 10% of the total fuel use in transport in 2020 and assumed to be extended to 2030. The use of 2nd generation biofuel from waste biomass counts double in the EU biofuel blending mandate.

macro-economic developments

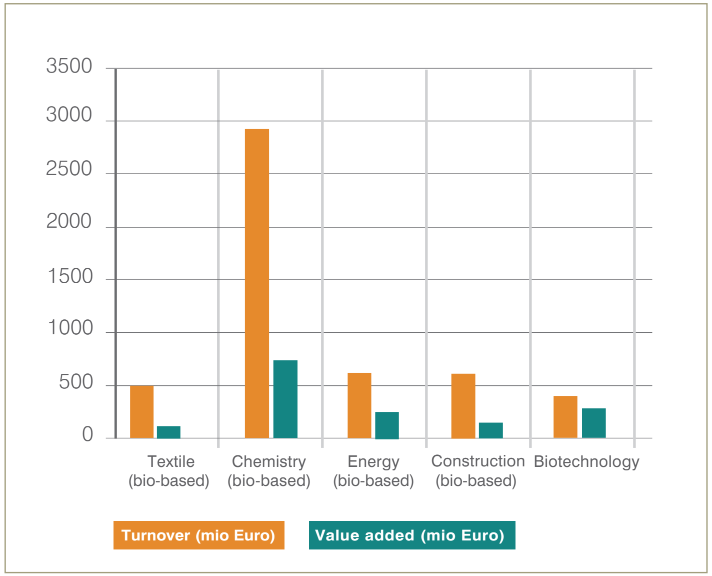
- Based on the Outlook 2014 of the International Energy Agency (IEA) the cost price of crude oil is expected to rise to **90 €/barrel** (15.1 €/GJ) by 2030.
- The primary energy consumption in the Netherlands in the year 2030 is based on moderate population and GDP growth scenarios of the IPCC (SSP2).
- In 2030 CO_2 -tax in the EU will be **26 €/tonne CO_2** according to the IEA projections (New Policies scenario). These CO_2 taxes on emission hold for all sectors in the study.

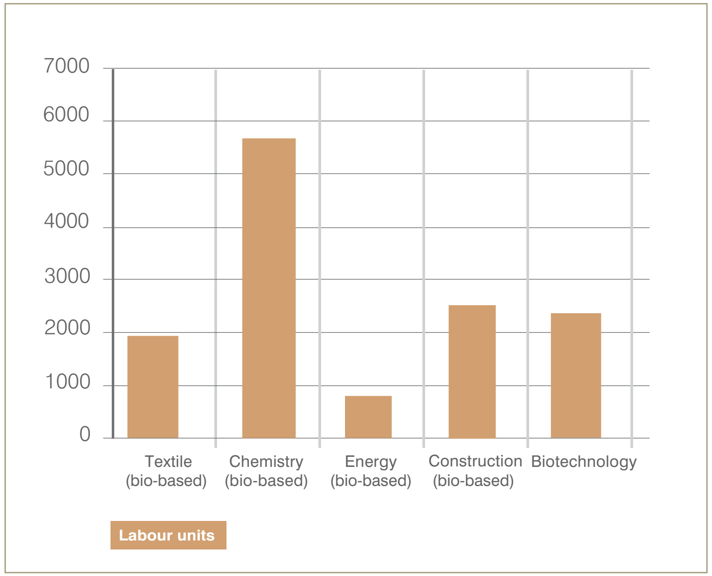
Please note: the economic impact of bio-based production systems is very much related to and dependent on the actual oil (price) dynamics.

The Dutch bio-based economy in 2013 (starting point)

In this outlook, a distinction is made between traditional (so called primary) bioeconomy sectors: agriculture, forestry and fisheries and the food and feed sector, and new bio-based economy sectors: such as bio-based chemistry, energy, biotechnology, construction and textile that use biomass from the primary bioeconomy sectors.
The primary sectors contribute 80-85% to the total bioeconomy, but this share is expected to decline significantly in the future. This outlook focuses on the potential development of the new bio-based markets, especially energy, transport and the chemical industry in the Netherlands up to 2030.

The activities in these new bio-based sectors generate extra employment and added value also in other sectors (i.e. bank services, computer services transport or distribution) (figure 3 and 4). This so-called multiplier effect for the different sectors in 2013 is above two for new bioenergy and biochemical sectors.





Direct share total bioeconomy in total economy 2013
Turnover: 7,7 %
Value added: 4,9 %
Employment: 4,9 %

Indirect share total bioeconomy in total economy in 2013
Turnover: 12,0 %
Value added: 9,5 %
Employment: 9,8 %

Figure 3 and 4. The contribution of new bio-based sectors to the total bioeconomy in 2013 in terms of turnover (euros), value added (euros) and employment (jobs)

2 Outcomes
Impact on economy and environment

Economy

By 2030 high technology development makes the use of biomass competitive in case of advanced applications like the production of biofuels and bio-based chemicals. Under these conditions a bio-based chemicals sector emerges. These developments partly compensate the decline of employment in agriculture. Opening up markets that result in low biomass prices and investing in technology development leads to a positive GDP effect of 1 billion euros a year in 2030.

supply & demand of biomass (figure 5 and 6)
The supply of sustainable biomass differs between the scenarios, because different types of products require different types of biomass as feedstock. Biomass demand in 2030 ranges from 224 PJ to 345 PJ, which demonstrates the dependence of the bio-based economy on technology development and on the availability and price of biomass.

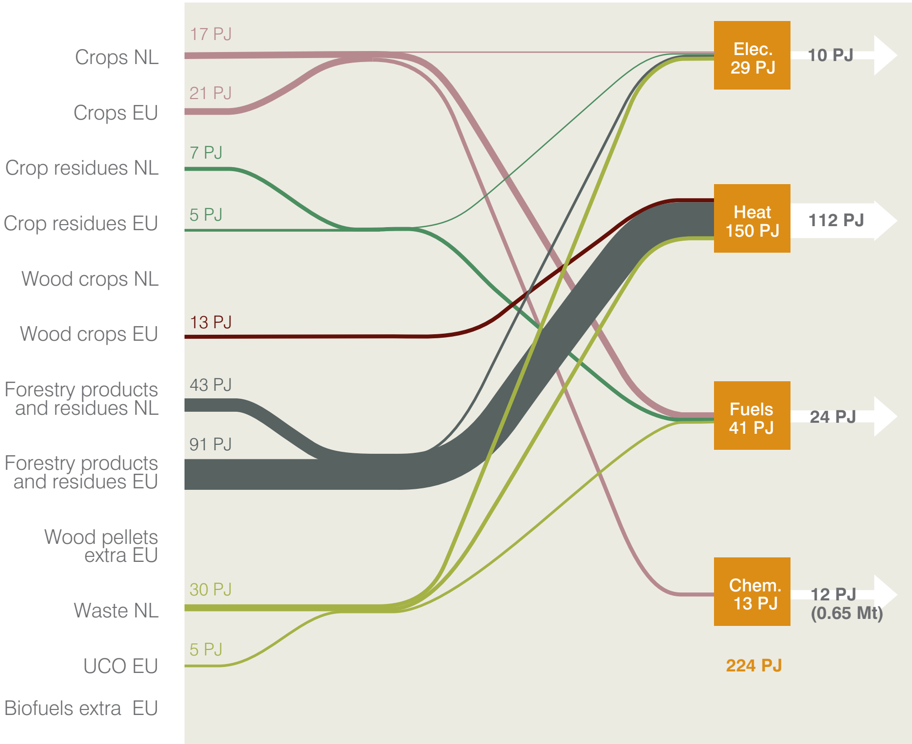


Figure 5. RegLowTech - 2030

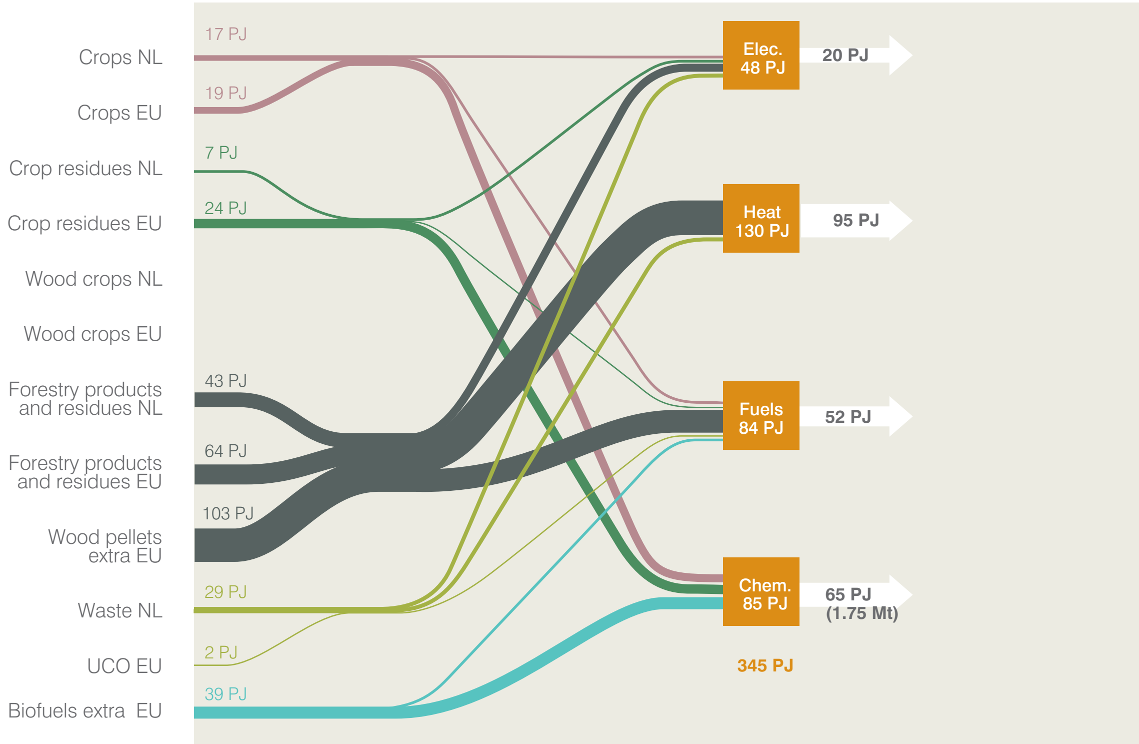


Figure 6. GlobHighTech - 2030

Forestry products and residues and wood from short rotation forestry are the most consumed feedstock across all scenarios, accounting for approximately 50-55% of total biomass consumption.
In the GlobHighTech scenario the import of bio-based commodities such as wood pellets and bioethanol grows rapidly. In low-technology development scenarios these In low-technology development scenarios these resources are primarily used for heat (75%) and a small part is used for the production of liquid biofuels. In the high-technology development scenario both the production of biochemicals and liquid biofuels becomes competitive. In the high-technology development scenario the fuels share in biomass consumption increases to 24% and chemicals (with higher added value) grow significantly to roughly a share of 24% as well (compared to 5,6% in RegLowTech for chemicals and ≈ 18% for fuels).
Biomass consumed for electricity generation is relatively stable across both scenarios (12-18%).

biomass consumption in biorefineries
Lignocellulose consumption in advanced biorefineries (biochemical refineries) in 2030 is large varying between 0.4 and 4 Mt in wood pellet equivalents per year for all four scenarios[5], with ethanol biorefineries consuming the lion's share of lignocellulose. Consumption by thermochemical refineries (gasification and conversion to FT fuels) is approximately 5 Mt annually. Similar to biochemical refineries, sensitivity analysis and additional scenarios indicate a wide range of solid biomass input (1,2 Mt – 14,5 Mt per year).

[5] This outcome is very sensitive to the assumptions made such as fossil fuel prices, which can lead to significant increase or collapse.

production of bio-based chemicals (figure 7)
The production of bio-based chemicals and especially bulk bio-based polymers such as poly ethylene (PE) from second generation ethanol and PLA from lignocellulosic sugar and from conventional sugar, emerges in all scenarios in 2030. In the high-technology scenarios, 2 billion euros turnover is realised by producing PE and PLA. For the LowTech scenarios this is 700 million.
The production of bulk bio-based polymers in the GlobHighTech scenario reduces the projected decline of the chemical sector in the Netherlands from 11,4% to 10% compared to 2015. The RegLowTech scenario has no impact on this decline.

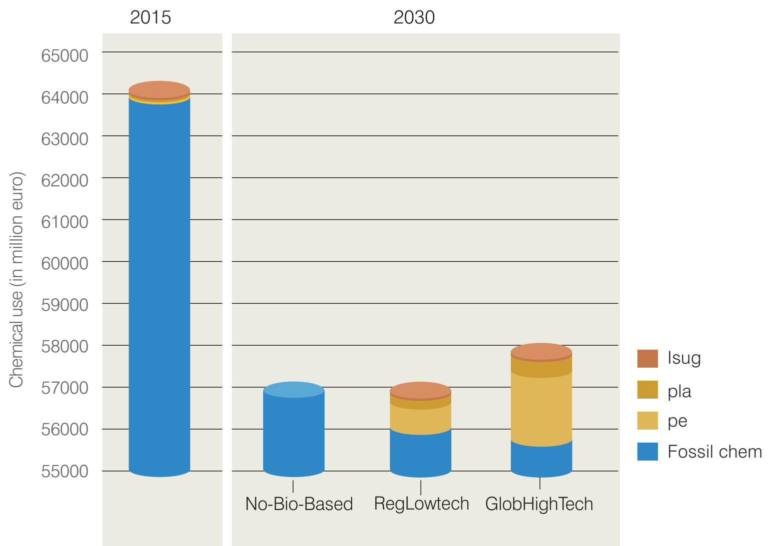


Figure 7. Production of chemicals in million euro compared with no-bio-based scenario in 2030

effect on GDP (figure 8)
Figure 8 shows that on the short term compliance with the 14% renewable energy targets creates a negative GDP effect in all scenarios in 2020 compared to a no-bio-based scenario. The renewable energy policies (RED) require substitution of fossil technologies with more costly bio-based technologies . The effect is especially negative (800 million euros) in the regional scenarios in which import of (relatively cheap) biofuels from South and North America is restricted. The positive effect of new technology advances becomes only visible after 2020; only the RegLowTech has a negative GDP effect in 2030 (195 million euros). Opening up markets and investing in technology development lead to a positive GDP effect in 2030. This effect is highest in the GlobHighTech scenario which combines high technical development and open markets. The GDP difference between the RegLowTech and the GlobHighTech bio-based scenarios is about 1.0 billion euro or 0.12% of Dutch GDP.

effect on trade balance (figure 9)
The total trade balance in the Netherlands in 2030 deteriorates in all bioeconomy scenarios compared to the no-bio-based scenario. This is mainly due to deterioration of the trade balance of other industries and services. In the high technology scenario the negative impact is smallest since chemicals and second generation biofuel exports are increasing.

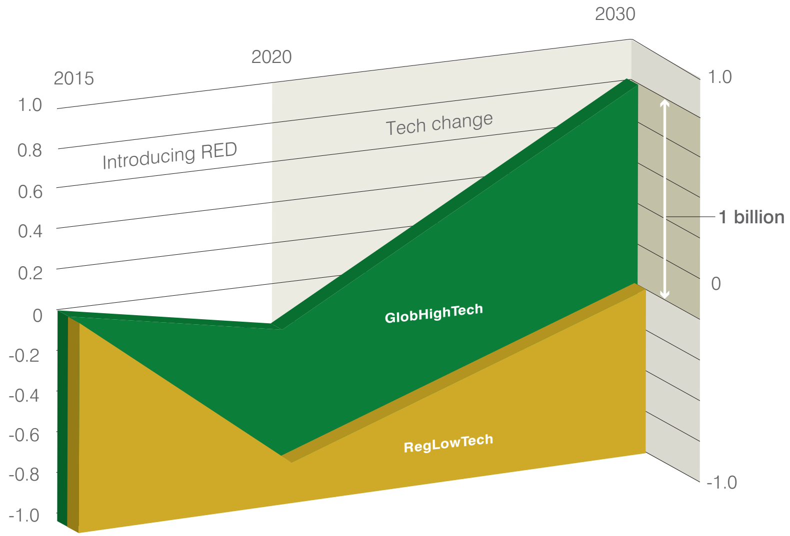


Figure 8. Annual effect of implementation of a bio-based economy on GDP for RegLowTech and GlobHighTech scenarios compared with a no-bio-based scenario

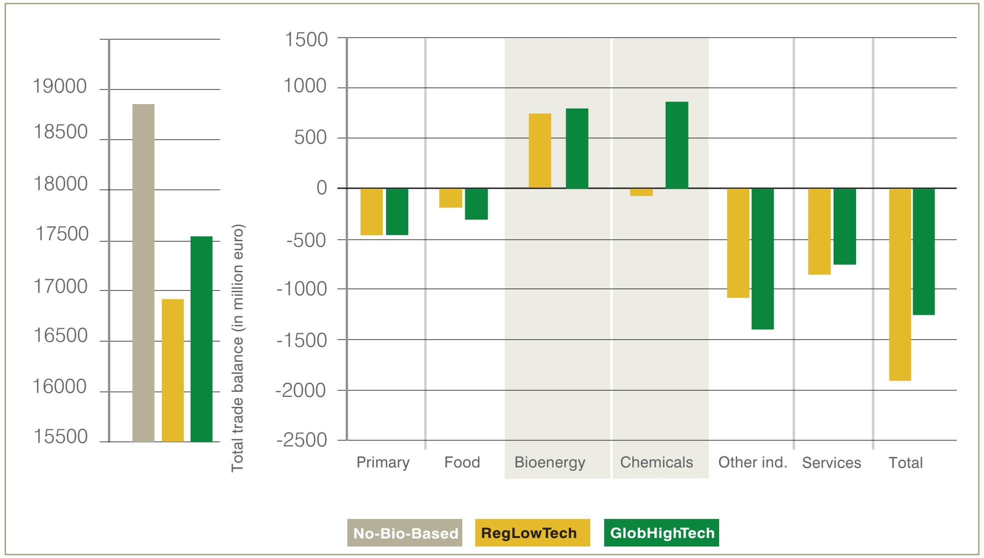


Figure 9. Total trade balance in millions of euros in 2030 (left handside) and relative to no-bio-based scenario (right handside)

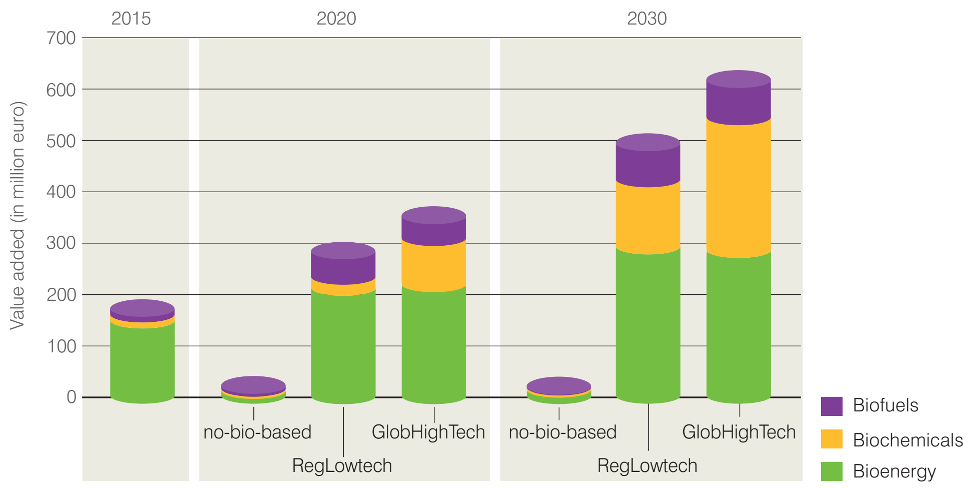


Figure 10. Value added of modern bio-based sectors in million euro in 2015 and in 2030 compared with no-bio-based scenario

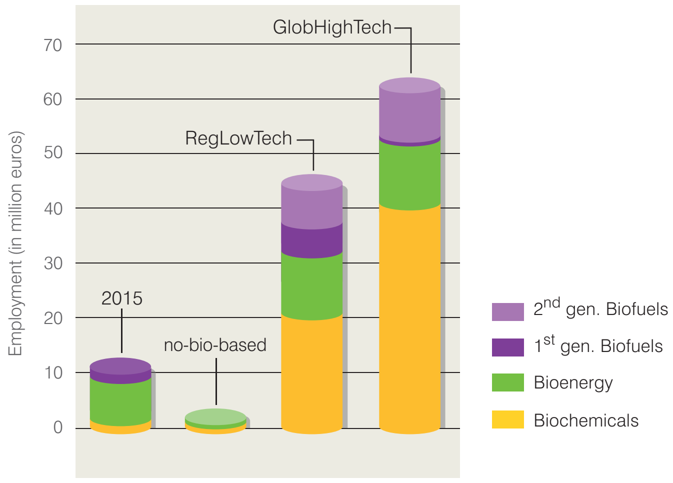


Figure 11. Employment of bioeconomy sectors in million euro in 2015 and in 2030 compared with a no-bio-based scenario

Technological change in bio-based technologies has a positive impact on the total trade balance as Dutch competitiveness improves.
Compared to a no-bio-based scenario, the total energy balance of the Netherlands becomes positive as fossil imports are replaced with imported and partly domestically produced bio-based substitutes. In the LowTech scenarios fossil energy imports are replaced with first generation biofuels. In the HighTech scenario, first generation biofuels are fully substituted by domestically produced second generation biofuels that are also exported.
The additional value of export of chemicals in the GlobHighTech scenario is 0.8 billion euros compared with a negative contribution in case of the RegLowTech scenario of -0.1 billion euros.

[6] Value added is the difference between the total sales revenue of an industry and the total cost of components, materials, and services purchased from other firms within a reporting period.

effect on value added (figure 10)
The value added[6] of bio-based sectors increases the value added of the total bio-economy compared with the negative trend of the no-bio-based scenario. Value added in bioenergy is fairly constant across all scenarios since that is mainly driven by policies. With high-technological change the bioeconomy sector contributes almost 600 million euros of which the biochemical sector accounts for 260 million euro and the bioenergy sector over 280 million euros in 2030. Technology implementation takes time; between 2020 and 2030 a tipping point to further increase is expected.

effect on employment (figure 11)
The highest impact on employment comes from bio-based bulk chemicals production in the HighTech scenarios. Jobs created in the biofuel sector in the LowTech scenario are linked to first generation biofuels and in the HighTech scenarios to 2nd generation biofuels.

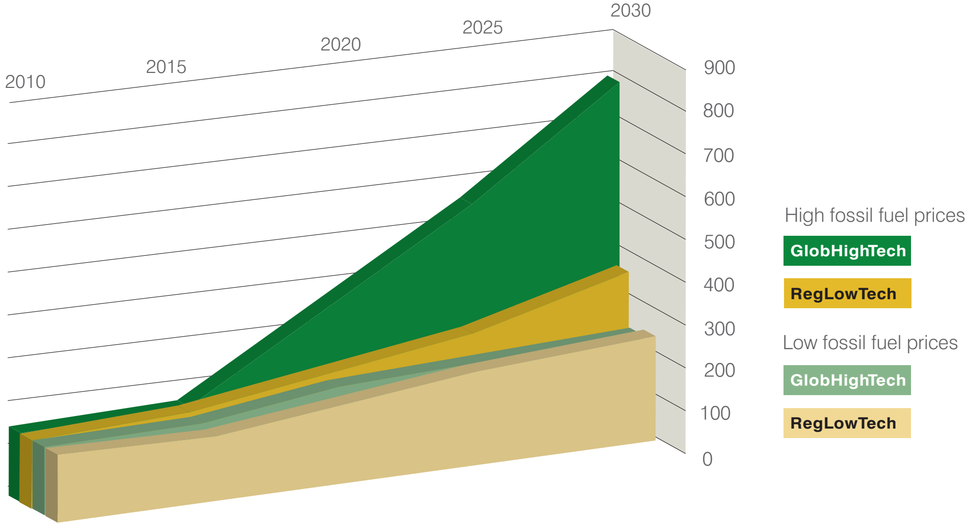


Figure 12. Biomass consumption expressed as primary energy in fossil fuel price variation scenarios (±50% of reference fossil fuel price of 90 €/barrel)

In all scenarios employment in the total bioeconomy is lower in 2030 than in 2015, due to the strong decline of employment in the traditional sector of agriculture. This is a continuation of an existing trend, which is mainly driven by relatively high increase in labour productivity and low growth in food demand. The emerging bioeconomy partly compensates this decline of employment in agriculture.

effect of high or low fuel price (figure 12)
The fossil fuel price is a key determinant of the use of biomass and other renewable energy technologies and resulting effect on the economy and environment.

In case of low fossil fuel prices the policy targets for renewable energy and biofuel use lead to a small emission reduction (around 2%) compared to 1990. Low fossil fuel price scenarios limit biomass consumption to 219-205 PJ.

Under high fossil fuel prices biomass consumption increases by a factor 1,6 – 3,8 (356–770 PJ). In this situation strong emission reduction is reached and renewable energy share are almost doubled (30%) compared to the target (16%) with 58% of this coming from biomass. Wind energy, the other key contributor of renewable energy in the Netherlands, increases by 60-75%.

If the energy equivalent for non-energy use (chemicals and materials) is included, the share of renewable energy increases to 32% and the biomass contribution increases to 70%.

Environment

To reach the 40% CO_2 emission reduction target a mix of carbon capture and storage (CCS), wind energy, biomass use and 2nd generation biofuels from the global high-technology scenario are needed.
The renewable energy share targets are met for all reference scenarios and even exceeded in the global high technology scenario: open trade and high-technology development stimulate the cost-competitive diffusion of renewable energy in the Dutch energy system beyond policy targets.

effect on renewable energy share (figure 13)
The target of 14% renewable energy share in 2020, as mandated by the EU directive, and 16% in 2023 for the Netherlands according to the Dutch Energy Agreement is met in all scenarios and exceeded by 1%-point in the GlobHighTech scenario. The renewable energy targets can only be reached by the combined deployment of bioenergy and wind energy. Biomass contributes 50% to the renewable energy share in 2030 and in the GlobHighTech scenario this share rises to 55%.
These results show that open trade and high technology development stimulate the cost-competitive diffusion of renewable energy to the Dutch energy system beyond policy targets. In all other scenarios renewable energy remains driven by policy mandates. The 10% biofuel blending mandate determines the biofuel share in fossil fuels. In high-technology scenarios second generation biofuels are mainly used; in the low-technology scenarios mainly first generation biofuels are used.
When energy and non-energy (for production of bio-based chemicals) uses are taken into account the share of renewable energy slightly drops to 10–12% in 2020 and 12-16% in 2030. This is due to the high share of fossil feedstocks used for chemicals in the energy mix. By 2030, in open trade scenarios coupled with rapid technology development the biomass contribution in renewable energy, including non-energy use (biochemicals production), is higher than biomass contribution for energy purposes only. This points to the importance of the emerging sector of bio-based chemicals.

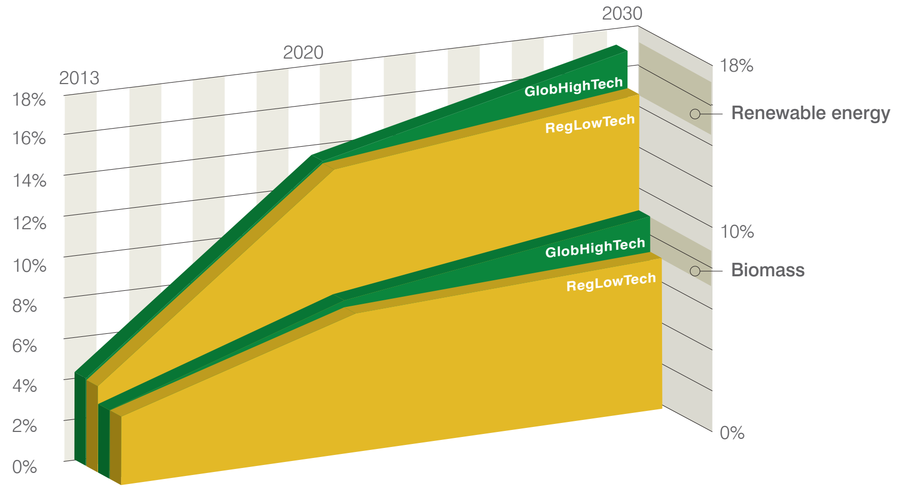


Figure 13. Renewable energy and biomass share on final energy consumption (excluding chemicals)

effect on CO_2 emission reduction (figure 14)
The present renewable energy policies for heat, fuels and electricity and the moderate tax on CO_2 emissions reduce the total emissions in the Netherlands with only a moderate 9-13% (CO_2-eq) compared to 2010. Even though some reduction is achieved due to the use of biomass (10-12 Mt CO_2) the overall reduction target of 40% is not met in any scenario: much more is needed for the target to be met.

When a high CO_2 tax scenario of 70 €/tonne CO_2 (instead of 26 €/tonne) is applied the CO_2 emissions decrease 15-35% by 2030. Only in a GlobHighTech scenario does a high CO_2 tax enable a large amount of CO_2 capture and storage (CCS) so that the target is almost reached. These results show that the 40% target can be achieved domestically, by using a mix of wind energy and CCS, combined with higher fuel use

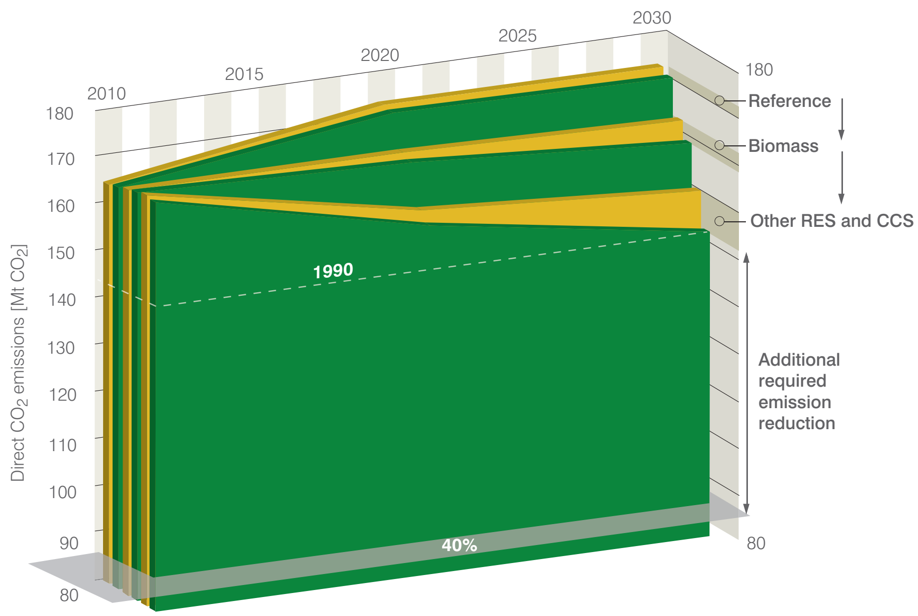


Figure 14. Direct and avoided CO_2 emissions in the Netherlands in million ton CO_2 compared with reduction target of 40% to level in 1990.

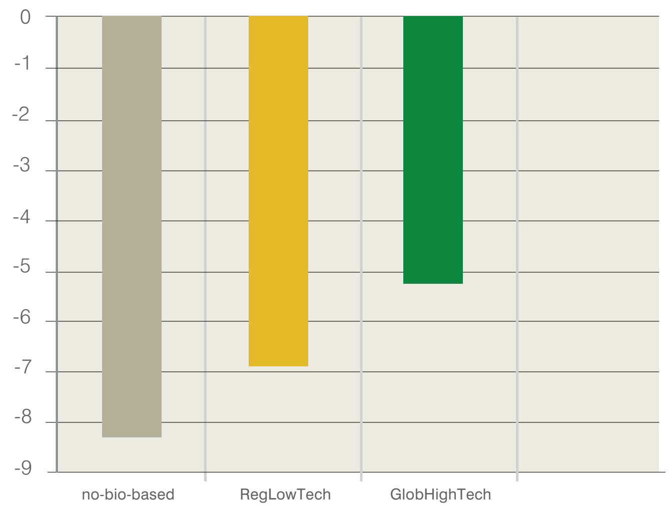


Figure 15. CO_2 emissions mitigation costs to reach the 40% target

efficiency in transport and a higher use of biofuels. Note: the 40% reduction target applies to all greenhouse gas emissions and all sectors.
In addition higher CO_2 tax drives the renewable energy share in 2030 to 17-28%, which is beyond policy targets (16%).

CO_2 mitigation costs (figure 15)
The costs of realising a 40% greenhouse gas reduction target are highest for no- bio-based scenarios, beyond 8 billion euro's and higher for low technology scenarios (beyond 6 billion euros (0,8% of GDP)) in 2030.
The costs decline to 0,6% of GDP in case of fast technological change in the bio-based technologies and global trade of biomass.

The mitigation costs are 55 €/tonne CO_2 in GlobHighTech compared to 105 €/tonne CO_2 in RegLowTech scenario.

impact on aviation sector
The impact of the use of biofuels in the aviation sector is assessed as an additional scenario, since this sector has no alternatives then biofuels to achieve required emission reductions in addition to improved aviation operations, technology and infrastructure[7]. In the-low technology development scenarios jet fuel demand is met exclusively by fossil resources. Without incentives no biofuels are used for aviation. Only in the GlobHighTech scenario will biojet fuels be competitive in 2030.

[7] Deelrapport Brandstofvisie Duurzame Luchtvaart, 2014.

Conclusions 3

Targets Renewable Energy Share reached; 40% reduction emissions not reached				
	RegLowTech	RegHighTech	GlobLowTech	GlobHighTech
Effect on GDP million €/year	-195	+483	+562	+848
Additional employment million €/year	44	43	59	62
CO_2 avoided compared to 2010	9%	12%	9%	13%
Biomass share RES	51%	52%	51%	55%
Biomass consumption High fossil prices PJ	356	449	520	770
Biomass consumption Low fossil prices PJ	219	233	205	205
Added value chemistry sector million €/year	130	135	250	260
RES reached; 40% reduction emissions reached with high CO_2 tax (70 €/t), CCS, wind and biomass				
Costs avoided in comparison to no-biobased million €/year	1.400	1.930	3.004	3.850
Costs per ton CO_2 reduction required to reach the target[1]	105	82	73	55

[1] In addition to a low CO_2 tax of 25 €/tonne

Results in 2030 for the RegLowTech and GlobHighTech scenario (fossil prices 90 €/barrel)

This study reconfirms the main conclusions of the first macroeconomic outlook in 2009: the use of biomass for energy and chemicals reduces greenhouse gas emissions, contributes to energy security and generates economic activities in the Dutch agriculture, chemical and energy sectors.

In all scenarios the mandatory 16% renewable energy share is reached in 2030. 45–55% of the renewable energy comes from electricity; mainly from wind and partially from biomass and solar. Heat from biomass is the second largest contributor to renewable energy production (25–45%), The remaining contribution comes from biofuels (5–20%). The total contribution of biomass to the renewables energy share in 2020-2030 is 50–60%. The biofuel blending target of 10% is in the low technology scenarios mainly fulfilled by first generation biofuel, but in high tech scenarios second generation biofuels become competitive (~13% of fuel mix). For the same reason biojet fuel is supplied without blend mandate in the GlobHighTech scenario.
The 40% CO_2 reduction target is not reached in any of the scenarios. The emission reduction target is nearly realized in case of the GlobHighTech scenario, in which the use of biomass is the highest of the four scenarios (630 PJ) in combination with CCS deployment and a high CO_2 tax of 70 €/ton.
Renewable energy and climate change policies are key drivers behind the production and use of biomass for all scenarios.

The macroeconomic effects of biomass use differ less between the four scenarios compared to the first macro-economic outlook analysis of five years ago. The impact is less because technology development is slower than previously assumed. Despite the relative small effect on GDP a complex and large-scale transition from fossil resources based technologies to biomass based (and other renewables) resources takes place.
The bio-based economy will compensate partly for a decline in value added by the traditional bioeconomy (especially agriculture). The bioenergy sector and the biochemical sector contribute almost equally and biofuels contribute to a lesser part.

By 2030 the biochemical sector becomes increasingly important and the production value increases to 2 billion euro annually in the GlobHighTech scenario. Most jobs will be created in this sector.

The results are sensitive to the price of fossil fuels. Given an oil price of 90 €/barrel and assuming rapid technological change the GDP increases 1 billion euros per year. A prerequisite is also open trade of biomass to ensure the availability of relatively cheap biomass. Fossil fuel prices and CO_2 tax levels have been shown to be more influential than the rate of technical change and trade of biomass considered in the four main scenarios.

The horizon of this study is limited to 2030 and does not provide insights in the potential role of the bioeconomy in the longer term. Technologies will become more competitive as they benefit from economies of scale and technological learning. In addition, the technologies relevant for the period beyond 2030 include options that are currently in the early stages of development, such as lignin valuation, but which could become commercial beyond 2030.


Recommendations
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Investments in (development of) bio-based production systems will be needed to reduce greenhouse gas emissions and reach the targets of renewable energy share. Economic benefits depend on fossil fuel prices but given the increasing need to reduce greenhouse gas emissions towards 80-95% in 2050 the contribution of a bio-based economy is crucial. In addition, developing a bio-based economy will decrease the influence of fluctuating oil prices resulting in increasing energy security as well as providing more stable business investment opportunities.

The macro-economic outlook presented here shows that serious additional effort is needed to realise the CO_2 emission targets of 40% reduction in 2030 (as compared to 1990). Greenhouse gas emission targets will not be met in any of the future scenarios even with the present policy measures in place. Biomass makes a substantial contribution to the renewable energy mix; the biomass share is 50% or higher in the renewable energy mix for the Dutch targets of 2023 (16%).

With these conclusions the macro-economic outlook confirms the Dutch Urgenda concern and consequent court ruling: the government has to put more effort into reaching its sustainability targets and all available mitigation options are needed. The latter include large-scale deployment of renewable energy (wind, solar energy and biomass) as well as novel materials from biomass and capture and storage of CO_2 (CCS). In addition, to deploy all options for renewable energy efforts are needed from various sectors including banking, industry, logistics and governmental measures to reach the overall ambitions.

Strong incentives and ambitious policies are necessary to ensure compliance with the climate targets. Such targets will be very complex and costly (1% of GDP), as is demonstrated by the Paris' call for a 100 billion US $ climate fund and the even larger projections of The Worldbank Group (World Energy Outlook). If biomass markets are global and especially if technological change is higher in bio-based technologies, as assumed in the GlobHighTech scenario, these cost to GDP can be reduced to 0,6% of GDP.

Our gas resources are diminishing, and the Netherlands is expected to become a net natural gas importer around 2030 (NEV 2015). The effect of declining gas revenues is already visible on the trade balance, since gas production was reduced in 2015 by court order to reduce earthquake risks. The increasing dependence on fossil fuels from abroad underlines the importance of an ambitious renewable energy policy for the period from 2023 to 2050 for the Netherlands and the European Union.

Fluctuating fossil fuel prices create a turbulent environment in which to build a sustainable bio-based technology business. In the case of low fossil fuel prices the implementation of renewable alternatives will be more difficult. Introducing a bio-based economy in a context of low fossil fuel prices is costly resulting in 2 billion euro GDP loss in the RegLowTech schenario versus the no-bio-based scenario. Open markets and high-technological change in bio-based technologies reduces this negative impact on GDP to -400 million euros.

In the case of high oil prices the use of alternative feedstocks is more interesting from a business perspective. In this situation, the bio-based options become competitive and the Dutch economy can benefit more easily in the long term. The role of the government can be less rigorous but it will still need to focus on sustainability in its policies, prioritise areas of key regional interest and steer towards cascading and the establishment of biorefineries. This seems to be a no-regret scenario for both the environment and the economy in both low and high fossil prices. Increasing the amount of biomass used lowers the costs for emission reductions and increases the added value for industry and the economy.

Investments in bio-based production systems will be needed to reduce greenhouse gas emissions and reach the targets for renewable energy share. Economic benefits depend on fossil fuel prices but given the increasing need to reduce greenhouse gas emissions towards 80-95% in 2050 the contribution of a bio-based economy is crucial. In addition, developing a bio-based economy will decrease the influence of fluctuating oil prices. This will increase energy security and provide more stable business investment opportunities.

The scenario with global trade for sustainable biomass and a fast technology development and deployment track turns out to be the most promising: it reduces the costs to meet emission reduction ambitions, and has the highest potential to add value to the economy. Moreover, the technology model indicates a tipping point in 2030, after which benefits may even further increase.
Accelerating the development of efficient production systems, in particular large scale multi-output biorefineries that produce chemicals and energy, is a prerequisite for further growth.

In effect, the results of this study confirm the need for long-term effective policy incentives, starting now, for strategic investment to stimulate technology development in bioenergy and novel materials, especially large-scale multioutput biorefineries for biomass conversion, sustainable energy plants as well as other mitigation options, as this will:

- ensure lowest cost for highest emission reduction and renewable energy share;
- improve the competitiveness of the chemical sector;
- also help to meet the ambitions of the aviation and other heavy transport sector (which are not supported yet by energy policies);
- provide an expected growth in GDP of 1 billion euros per year in 2030 (with an expected rapid increase in annual growth depending on fossil fuel price developments).

Such investments will need adequate amounts of sustainable resources, which according to the vision of the Commission Corbey and the latest report from the Ministry of Economic Affairs “Biomass 2030, Strategische visie voor de inzet van biomassa op weg naar 2030” should not be a problem, as long as due attention is given to biomass production and sustainability schemes within and beyond The Netherlands.
Taking all of these factors into account, the report provides the basic evidence for joint cross-sectoral actions, governmental leadership and active participation and investments from industry.

The political measures needed to achieve the desired greenhouse gas reductions and consequent implementation of sustainable renewable technologies will require a broad societal support. The present debates on the use of wind- and bioenergy and CCS show that this will not be easy. Efforts should be made to improve the communication about the use of different technologies and their environmental and economic impacts. This report aims to help to provide evidence to this debate, but it requires substantial attention to engage the public in a further understanding and reach the necessary societal support.

TKI - BBE

The Top Sector Platform for Knowledge Development and Innovation of the cross-cutting theme bio-based economy (TKI-BBE) in the Netherlands has presented the research agenda for the Bio-based Economy ‘B4B: bio-based voor bedrijven, burgers en beleid’ for the period of 2015 – 2027.
The agenda describes how Top Sectors Chemistry, Energy and AgroFood will realise the bio-based economy in the Netherlands for the next 8 to 12 years. A key aspect is the efficient use of biomass via cascading and prioritization for sectors without alternatives such as heavy duty aviation, marine transport). Via cascading valuable compounds are extracted as much as possible from the biomass before the organic residues are used for energy production. TKI BBE is committed in the short term to a more efficient use of biomass for energy and materials. In the longer term the TKI-BBE sees significant opportunities for capturing solar energy for the direct conversion into chemical building blocks.

BE-Basic

BE-Basic Foundation is a leading international public-private partnership that develops industrial bio-based solutions to build a sustainable society. To switch from fossil fuels to biomass, we require new technologies and insights for all industries that provide us with food, chemicals, materials and energy. BE-Basic stimulates collaborations between academia and industry, between scientists and entrepreneurs and between the Netherlands and abroad to build a bio-based economy together.

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