**Update on implementation agendas 2014**

A review of key biofuel producing countries

**A REPORT TO IEA BIOENERGY TASK 39**

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**Executive Summary**

The Task 39 Implementation Agenda report compares-and-contrasts developments in biofuels production and market penetration for 19 different countries with an emphasis on the role of policy. These countries include the Task 39 member countries as well as important emerging economies such as China and India for completeness and comparison. The report emphasises biofuel policies and the extent to which these biofuels policies have been implemented. The report also assesses the measures taken by member countries to develop or stimulate their respective biofuels industries, including incentives and investment in research. The report also provides updates on the current status of biofuel sustainability assessments and related discussions that factor into policy development.

Total biofuels production has continued to increase worldwide from 16 billion litres in 2000 to over 100 billion in 2011, with bioethanol constituting about 80% of the market and biodiesel 20%. Bioethanol production in 2013 amounted to 88 billion litres, up from 69 billion litres in 2008. The figure below illustrates production levels for a number of countries from 2011-2013. The top bioethanol producing countries have remained the same with the USA leading the pack, followed by Brazil and China. India is emerging as a prominent bioethanol producer with available data suggesting higher production than Canada in 2013.

|  |
| --- |
| Bioethanol production (million L/a) |
|  | 2011 | 2012 | 2013 |
| USA | 52,727 | 50,035 | 50,340 |
| Brazil | 22,893 | 23,509 | 26,572 |
| EU-27 | 6,530 | 6,842 | 7048 |
| China | 2099 | 2100.7 | 2634 |
| Canada | 1,600 | 1,725 | 1979.5 |
| Germany | 1,552 | 1,463 | 1,514 |
| Australia | 440 | 440 | 453.8 |

Trends observed from the graph illustrates that US ethanol production has reached a plateau which is likely a result of the “blend wall” having been reached. Brazil, the second largest producer of bioethanol has shown a significant increase (13%) in bioethanol production from 2012-2013. The other countries that were assessed in this report showed a trend of increased bioethanol production for the period under consideration.

Biodiesel production trends for a few select countries are shown below. The EU remains the largest producer of biodiesel, while the USA is the leading country in terms of biodiesel production since 2011.

|  |
| --- |
| Biodiesel production (million L/a) |
|  | 2011 | 2012 | 2013 |
| EU-27 | 10586.9 | 10908.8 | 11287.6 |
| USA | 3,660 | 3,751 | 5,068 |
| Brazil  | 2,673 | 2,717 | 2,877 |
| Germany  | 2,522 | 2,181 | 2,022 |

Biodiesel production showed a 35% increase in the US from 2012 to 2013. Brazil also showed an increased trend over this period, while Germany showed a decreased trend and is currently producing almost half of the production volumes achieved in 2007 when it was the biggest producer of biodiesel in the world. The case of Germany is an example of the effect of a change in policy on biofuel production as the tax exemption on biofuels was reduced gradually since August 2006. For the countries assessed in this report, a general trend of increased biodiesel production was observed, except for a few countries in the EU which showed a general decline in production (Italy, Netherlands). Biodiesel producers in Brazil are currently lobbying for an increased mandate for biodiesel from B5 to B7 or B10 which would further promote biodiesel production in this country.

## Biofuel obligations

The table below lists the biofuel mandates for the countries assessed in this report. These mandates serve as an important driver for the development of biofuels. The highest mandate for ethanol blending is found in Brazil at 20-25%, followed by the USA with 10%. Although China has an E10 blending mandate, its application is limited to a few provinces and cities. Interestingly enough, a country like Zimbabwe has an E15 mandate (although temporarily reduced to E10 due to lack of supply). While some countries are increasing mandates, the EU and the USA are currently stalled on increases. This has an impact on the increased development of biofuels in these jurisdictions. The introduction of flexifuel vehicles can overcome limitations set by blending mandates, but their market penetration outside Brazil has been limited.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country**  | **Bioethanol** | **Biodiesel** | **Total biofuel** | **Comments**  |
| **Australia**  | 6% | 5% |  |  |
| **Austria**  |  |  | 5.75% | All increases postponed after 2011 |
| **Brazil**  | 20-25% | 5% |  | Lobbying for B7 or B10 |
| **Canada**  | 5% | 2% |  | These are federal mandates; provinces have higher mandates in some cases |
| **China**  | 10% | - |  | Only in select provinces, cities |
| **Denmark**  |  |  | 5.75% |  |
| **Finland**  |  |  | 6% |  |
| **Germany**  | 2.8% | 4.4% | 6.25% |  |
| **India** | 5% |  |  |  |
| **Italy** |  |  | 4.5% | 5% (2014) |
| **Japan**  | - | - | - |  |
| **Netherlands**  | >3.5% | >3.5% | 5% |  |
| **New Zealand** | - | - | - |  |
| **Norway**  |  |  | 3.5% or 5% |  |
| **South Africa** | - | - | - | E2 in 2015 |
| **South Korea** |  | 2% |  |  |
| **Sweden**  | 5% | 5% | 5.7% |  |
| **United States**  | 10% |  |  |  |

## Progress in development of advanced biofuels

Worldwide, the food versus fuel debate has seen a drive towards development of advanced biofuels over the last 7-8 years, with countries putting in place specific targets for advanced biofuels and caps on conventional biofuels. In the USA the Renewable Fuel Standard (RFS) made special provision for advanced biofuels, setting specific targets annually from 2009. However, commercialization of these technologies has been very slow with very limited volumes produced locally, with the result that these targets have not been met. At present, at least three cellulosic ethanol plants, those being developed by Poet-DSM, Abengoa and DuPont, are on track to complete construction and start commercial production in the USA in 2014, with the cellulosic RINs being recorded for January 2014. However, the inability of the industry to meet the advanced biofuel targets has led to proposed changes to the targets set in the RFS which has created policy uncertainty. The targets in the RFS act as a major driver for the development of advanced biofuels and continuity of these policy drivers is essential to maintain and increase the development and commercialization of advanced biofuels.

The changing policy landscape in the EU with respect to blending mandates and sustainability factors is creating uncertainty and negatively affecting the development of advanced biofuels. The European Commission proposed a cap of 5% on conventional biofuels in 2013. This proposal was amended by the European Parliament to 6%, although member countries favour 7%. However, the council failed to reach an agreement on capping, and discussions on iLUC criteria still remain unresolved. This policy uncertainty has affected development of and investment into biofuels. The only commercial cellulosic ethanol facility in Europe is Beta Renewables’ cellulosic ethanol plant in Crescentino, Italy which opened in October 2013, although many pilot and demonstration facilities are operating over Europe.

Many countries considered in this report have several pilot and demonstration facilities for advanced biofuels and extensive investment is being made in research and development of advanced biofuels. A brief summary is provided below:

Australia: Extensive research on algal biofuels with several pilot and demonstration facilities in operation; drop-in fuels production at pilot scale (Licella) with demonstration plant under construction

Austria: Ongoing research and development, mainly focused on production of biogas that is used in heat and power production

Brazil: Extensive investment into biofuels by companies (e.g. Petrobas); Construction of two commercial cellulosic ethanol facilities under way (Chemtex/GraalBio Investimentos and Petrobas/Raizen ); Research and development into biofuels from microalgae.

Canada: Research and development ongoing; Facilities at pilot scale and one at commercial scale (Enerkem)

China: Cellulosic ethanol encouraged by government policy and research funding. One company produces cellulosic ethanol (from corncobs) but small volumes (Longlive). Construction of further cellulosic ethanol plants has been announced.

Denmark: Cellulosic ethanol and drop-in fuels are produced from straw and other feedstocks in several pilot and demonstration facilities (Dong Energy, Steeper Energy, Biogasol, Bionic Fuel Technologies).

Finland: Research and development into advanced biofuels ongoing. Construction of various facilities using technologies such as pyrolysis and gasification, and demo plants for lignocellulosic ethanol (Chempolis, ST1)

Germany: Extensive research on cellulosic ethanol and drop-in fuels. Various plants at demonstration level (Bioliq, Clariant). A full tax exemption for advanced biofuels applies until 2015.

India: At research stage; several demonstration facilities for producing cellulosic ethanol planned (Lanzatech, Praj Industries, Chempolis)

Italy: First commercial cellulosic ethanol plant (Beta Renewables). Multiple research projects using thermochemical or biochemical production with pilot plants in operation.

Japan: Several research projects on production of advanced bioethanol (NEDO).

Netherlands: ECN operates a pilot facility which uses thermochemical technology and lignocellulosics.

New Zealand: Various research and development projects supported by government funding, although funding reduced (Scion, LanzaTech, Norske Skog/Z Energy).

Norway: National strategy for research and development and extensive research being conducted (SINTEF, PFI). Borregaard operates a biorefinery and produces bioethanol from lignocellulosic feedstocks, while Weyland operates a pilot plant for advanced bioethanol.

South Africa: Advanced biofuels only at research stage, bioethanol from biomass and algal biofuels

South Korea: Research focused on algal biofuels, bioethanol from macroalgae and biodiesel from microalgae.

Sweden: 14 million euro earmarked for commercialization of cellulosic ethanol. Three pilot and demonstration plants for advanced biofuels (SEKAB, Chemrec, IVAB). Three further projects received funding from EC (GoBiGas, Pyrogrot, SEKAB).

United States: Three commercial-scale cellulosic ethanol facilities set to commence operation in 2014 (POET-DSM, Abengoa and DuPont). Two further commercial-scale facilities that produce drop-in fuels have been experiencing difficulties in operation (KiOR, Ineos Bio). Several other pilot and demonstration facilities are operational (Gevo, Sapphire Energy, Virent). Funding for research and development mainly focused on drop-in and algal biofuels.

## Conclusions

While worldwide biofuels production has shown a general increase, in some jurisdictions such as the USA, a plateau has been reached likely due to the “blend wall”. Although the vast majority of biofuels are still produced from food-based crops, various jurisdictions have begun to restrict these biofuels, favouring advanced biofuels development. However, progress in production of advanced biofuels has been hampered by the slow rate of commercialisation and the fact that advanced biofuels, at this stage of development, do not appear to be cost-competitive with starch or sugar-based biofuels.

Government policy is one of the most important drivers for the development of biofuels worldwide. Current policy uncertainty in the EU and the USA presents an obstacle to biofuels development in these main jurisdictions, specifically for advanced biofuels. Extensive research and development into production of advanced fuels is being carried out, with a shift in focus to drop-in and algal biofuels.

**Contents**

Biofuel obligations iii

Progress in development of advanced biofuels iv

Conclusions v

1 Australia 1

1.1 Introduction 1

1.2 Biofuels policy 1

1.2.1 Biofuel targets 1

1.2.2 Excise tax reductions 2

1.2.3 Fiscal incentives and investment subsidies 2

1.2.4 Other measures used to stimulate the production and use of biofuels 3

1.2.5 Promotion of advanced biofuels 4

1.3 Market development and policy effectiveness 4

1.4 Sources: 6

2 Austria 7

2.1 Introduction 7

2.1.1 Main drivers for biofuels policy 7

2.2 Biofuels policy 7

2.2.1 Biofuel obligations 7

2.2.2 Excise duty reductions 8

2.2.3 Fiscal incentives 8

2.2.4 Investment subsidies 8

2.2.5 Other measures used to stimulate the production and use of biofuels 8

2.2.6 Promotion of advanced biofuels 9

2.3 Market development and policy effectiveness 9

2.4 Sources 10

3 Brazil 11

3.1 Introduction 11

3.1.1 Main drivers for biofuels policy 11

3.2 Biofuels policy 11

3.2.1 Biofuel obligations 11

3.2.2 Excise duty reductions 12

3.2.3 Fiscal incentives 12

3.2.4 Investment subsidies 12

3.2.5 Other measures stimulating the implementation of biofuels 12

3.2.6 Promotion of advanced biofuels 13

3.3 Market development and policy effectiveness 13

3.4 Sources 14

4 Canada 15

4.1 Introduction 15

4.1.1 Main drivers for biofuels policy 15

4.2 Biofuels policy 15

4.2.1 Biofuel obligations 15

4.2.2 Excise duty reductions 16

4.2.3 Fiscal incentives 16

4.2.4 Investment subsidies 17

4.2.5 Other measures stimulating the implementation of biofuels 17

4.2.6 Promotion of advanced biofuels 18

4.3 Market development and policy effectiveness 18

4.4 Sources 19

5 China 20

5.1 Introduction 20

5.1.1 Main drivers for biofuels policy 20

5.2 Biofuels policy 20

5.2.1 Biofuel targets and obligations 21

5.2.2 Excise duty reductions 21

5.2.3 Fiscal incentives 21

5.2.4 Investment subsidies 22

5.2.5 Other measures stimulating the implementation of biofuels 22

5.2.6 Promotion of advanced biofuels 22

5.3 Market development and policy effectiveness 22

5.4 Sources 23

6 Denmark 24

6.1 Introduction 24

6.1.1 Main drivers for biofuels policy 24

6.2 Biofuels policy 24

6.2.1 Biofuel obligations 24

6.2.2 Excise duty reductions 25

6.2.3 Fiscal incentives 25

6.2.4 Investment subsidies 25

6.2.5 Other measures stimulating the implementation of biofuels 25

6.2.6 Promotion of advanced biofuels 25

6.3 Market development and policy effectiveness 26

6.4 Sources 27

7 Finland 28

7.1 Introduction 28

7.1.1 Main drivers for biofuels policy 28

7.2 Biofuels policy 28

7.2.1 Biofuel obligations 28

7.2.2 Excise duty reductions 29

7.2.3 Fiscal incentives 29

7.2.4 Investment subsidies 29

7.2.5 Other measures stimulating the implementation of biofuels 29

7.2.6 Promotion of advanced biofuels 29

7.3 Market development and policy effectiveness 29

7.4 Sources 30

8 Germany 32

8.1 Introduction 32

8.1.1 Main drivers for biofuels policy 32

8.2 Biofuels policy 33

8.2.1 Biofuel obligations 33

8.2.2 Excise duty reductions 33

8.2.3 Fiscal incentives 34

8.2.4 Investment subsidies 34

8.2.5 Other measures stimulating the implementation of biofuels 34

8.2.6 Certification of biofuels 34

8.2.7 Promotion of advanced biofuels 35

8.3 Market development and policy effectiveness 35

8.4 Sources 36

9 India 38

9.1 Introduction 38

9.1.1 Main drivers for biofuel policy 38

9.2 Biofuels policy 38

9.2.1 Biofuel mandates 38

9.2.2 Excise duty reductions 39

9.2.3 Fiscal incentives 39

9.2.4 Investment subsidies 39

9.2.5 Other measures stimulating the implementation of biofuels 39

9.2.6 Promotion of advanced biofuels 40

9.3 Market development and policy effectiveness 41

9.4 Sources 42

10 Italy 43

10.1 Introduction 43

10.1.1 Main drivers for biofuel policy 43

10.2 Biofuels policy 43

10.2.1 Biofuel mandate 43

10.2.2 Excise duty reductions 44

10.2.3 Fiscal incentives 44

10.2.4 Investment subsidies 44

10.2.5 Other measures stimulating the implementation of biofuels 44

10.2.6 Promotion of advanced biofuels 44

10.3 Market development and policy effectiveness 45

10.4 Sources 46

11 Japan 47

11.1 Introduction 47

11.1.1 Main drivers for biofuel policy 47

11.2 Biofuels Policy 47

11.2.1 Biofuel targets 47

11.2.2 Excise duty reductions 48

11.2.3 Fiscal incentives 48

11.2.4 Investment subsidies 48

11.2.5 Other measures stimulating the implementation of biofuels 48

11.2.6 Promotion of advanced biofuels 49

11.3 Market development and policy effectiveness 49

11.4 Sources 50

12 The Netherlands 51

12.1 Introduction 51

12.1.1 Main drivers for biofuels policy 51

12.2 Biofuels policy 51

12.2.1 Biofuel targets or mandates 51

12.2.2 Excise duty reductions 53

12.2.3 Fiscal incentives 53

By the end of 2009, the Dutch government decided to reduce the excise duty on sustainably produced E85 by 27% starting 1 April 2010. This is due to the lower energy content of E85 in comparison with petrol. 53

12.2.4 Investment subsidies 53

The Energy Investment Deduction scheme (EIA) and the MIA/VAMIL scheme are schemes providing tax incentives for investment in renewable energy projects. Through these schemes various renewable energy technologies are supported, including biomass processing equipment, pyrolysis installations for recycling of residues, production facilities for algae, etc. 53

12.2.5 Other measures stimulating the implementation of biofuels 53

12.2.6 Promotion of advanced biofuels 53

12.3 Market development and policy effectiveness 53

12.4 Sources 54

13 New Zealand 56

13.1 Introduction 56

13.1.1 Main drivers for biofuels policy 56

13.2 Biofuels policy 56

13.2.1 Biofuel obligations 56

13.2.2 Excise duty reductions 57

13.2.3 Fiscal incentives 57

13.2.4 Investment subsidies 57

13.2.5 Other measures stimulating the implementation of biofuels 57

13.2.6 Promotion of advanced biofuels 57

13.3 Market development and policy effectiveness 58

13.4 Sources 58

14 Norway 59

14.1 Introduction 59

14.1.1 Main drivers for biofuels policy 59

14.2 Biofuels policy 59

14.2.1 Biofuel obligations 59

14.2.2 Excise duty reductions 60

14.2.3 Fiscal incentives 60

14.2.4 Investment subsidies 61

14.2.5 Other measures stimulating the implementation of biofuels 61

14.2.6 Promotion of advanced biofuels 61

14.3 Market development and policy effectiveness 62

14.4 Other 63

14.5 Sources 63

15 South Africa 64

15.1 Introduction 64

15.1.1 Main drivers for biofuels policy 64

15.2 Biofuels policy 64

15.2.1 Biofuel targets 64

15.2.2 Excise duty reductions 65

15.2.3 Fiscal incentives 65

15.2.4 Investment subsidies 65

15.2.5 Promotion of advanced biofuels 65

15.3 Market development and policy effectiveness 66

15.4 Sources 67

16 South Korea 69

16.1 Introduction 69

16.1.1 Main drivers for biofuels policy 69

16.2 Biofuels policy 69

16.2.1 Biofuel targets 69

16.2.2 Excise duty reductions 70

16.2.3 Fiscal Incentives 70

16.2.4 Investment subsidies 70

16.2.5 Other measures stimulating the implementation of biofuels 70

16.2.6 Promotion of advanced biofuels 70

16.3 Market development and policy effectiveness 71

16.4 Sources 71

17 Sweden 72

17.1 Introduction 72

17.1.1 Main drivers for biofuels policy 72

17.2 Biofuels policy 72

17.2.1 Biofuel obligations 72

17.2.2 Excise duty reductions 73

17.2.3 Fiscal incentives 73

17.2.4 Investment subsidies 73

17.2.5 Other measures stimulating the implementation of biofuels 73

17.2.6 Promotion of advanced biofuels 74

17.3 Market development and policy effectiveness 74

17.4 Sources 75

18 United Kingdom 76

18.1 Introduction 76

18.1.1 Main drivers for biofuels policy 76

18.2 Biofuels policy 76

18.2.1 Biofuel targets or obligations 76

18.2.2 Excise duty reductions 78

18.2.3 Other measures stimulating the implementation of biofuels 78

18.2.4 Promotion of advanced biofuels 78

18.3 Market development and policy effectiveness 78

18.4 Sources 78

19 United States 80

19.1 Introduction 80

19.1.1 Main drivers for biofuels policy 80

19.2 Biofuels policy 81

19.2.1 Biofuel targets or obligations 81

19.2.2 Excise duty reductions 82

19.2.3 Fiscal incentives and investment subsidies 82

19.2.4 Other measures stimulating the implementation of biofuels 82

19.2.5 Promotion of advanced biofuels 82

19.3 Market development and policy effectiveness 84

19.4 Sources 84

# Australia

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## Introduction

Overall energy consumption in Australia is growing moderately due to increased energy efficiency. Australia has a renewable energy target with a goal of generating 20 percent of its electricity from renewable sources by 2020. However, currently, this target is primarily being pursued through the development of solar and wind energy.

Biofuels account for approximately one percent of liquid fuel production in Australia and for less than one percent of Australian energy consumption. Over the next five years productive capacity will expand. However, even if the planned capacity is fully realised, the total consumption will still only represent a small proportion of total liquid fuel consumption.

The Australian Federal Government implemented Australia’s Renewable Energy Target (RET) in August 2009. The RET is designed to deliver the Government's commitment to ensure that 20 per cent of Australia's electricity supply will come from renewable sources by 2020. The RET expands on the previous Mandatory Renewable Energy Target (MRET), which began in 2001. In June 2010, the Federal Parliament passed legislation to separate the RET into two parts, beginning 1 January 2011; the Large scale Renewable Energy Target (LRET) and the Small scale Renewable Energy Scheme (SRES). These changes hope to provide greater certainty for households, large-scale renewable energy projects and installers of small-scale renewable energy systems.

Certain biomass projects, renewable energy power stations, solar water heaters, heat pump water heaters and small generation units such as small-scale photovoltaic panels may be entitled to small-scale technology certificates (STCs) and large-scale generation certificates (LGCs) if they fulfil accreditation and system eligibility requirements.

Australia currently has the capacity to produce up to 440 million liters (ML) of ethanol per year with an additional capacity of 173 ML expected to come on stream from 2016 onwards. The majority of ethanol fuel sold in Australia is blended at a rate of 10 percent as there are few vehicles capable of running on higher rates of ethanol blend.

In 2012 biodiesel production was approximately 350 ML. However, total capacity is estimated at 500 ML. These facilities primarily use a combination of tallow and used cooking oil as feedstock, depending on availability and cost, which varies seasonally. A new plant under construction with expected capacity of approximately 288 ML will use soybeans as a feedstock.

Although biofuels currently only account for a small portion of energy production and consumption in Australia, there is significant research and development being conducted into alternative sources of biofuels including several tree species. Australia has also been identified as an optimal location for growing algae which can be used to produce a number of products including biofuel.

## Biofuels policy

### Biofuel targets

Different states have different mechanisms by which they are introducing the use of biofuels (Table 1‑1). The New South Wales (NSW) government increased the ethanol mandate to 6% effective from 1 October 2011, while the biodiesel mandate was increased to 5% effective 1 January 2012. However, in December 2011, the NSW government suspended the scheduled increase for biodiesel due to insufficient local production to meet the mandate. The suspension will remain in place until local production is sufficient to meet any future increases.

 Table 1‑1 Biofuel targets in Australia

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Target Year**  | **New South Wales** | **Queensland** | **Victoria** | **Western Australia**  |
|  | Ethanol  | Diesel | Biofuels | Biofuels  | Biofuels |
| 2006 |  |  |  |  |  |
| 2007 |  |  |  |  |  |
| 2008 | 2% |  |  |  |  |
| 2009 |  |  |  |  |  |
| 2010 | 4% | 2% |  | 5% | 5% |
| 2011 | 6% |  | 5% |  |  |
| 2012 | 6% | 5% |  |  |  |

### Excise tax reductions

There is a post-2011 change in fuel excise arrangements for alternative fuels, which will see a reduction in the tax advantage for biofuels as the tax is introduced over a five-year period.

As of 1st July 2011, the biofuels industry in Australia was given an extension of the current taxation arrangements based on the energy content, with a 50% discount on taxation for renewable fuels (ethanol, biodiesel and renewable diesel). This will continue for the next 10 years. Ethanol, biodiesel and renewable diesel remain effectively exempt from excise, while imported ethanol remains subject to full excise equivalent customs duty. Existing arrangements continue:

* The Ethanol Production Grants Program run by RET and administered by Ausindustry;
* The Cleaner Fuels Grants Scheme run by the Australian Tax Office.

Methanol will continue to be untaxed. The Government will undertake a review of the taxation and grant arrangements for ethanol, biodiesel, renewable diesel and methanol after 30 June 2021.

To allow the “alternative fuels” industries time to adjust, the effective excise will be phased in, beginning 1 July 2011 and ending 1 July 2015. Imported ethanol will face a more gradual decline in excise equivalent customs duty over the same transition period.

As a result of the 2004-05 reforms, alternative fuels, namely ethanol and biodiesel, as well as fossil derived gaseous fuels, including liquefied petroleum gas, liquefied natural gas and compressed natural gas, will be brought fully into the tax system by being placed into one of the following three energy content bands:

* High (energy content greater than 30 MJ/L, or per cubic metre in the case of compressed natural gas) – this band includes biodiesel
* Medium (between 20 and 30 MJ/L) – this band includes ethanol; or
* Low (less than 20 MJ/L).

This excise tax will be phased in for alternative fuels from 1 July 2011, until 1 July 2015. At the end of the transition period, alternative fuels will benefit from a 50 per cent reduction of their full energy content tax rate.

The sudden loss in the relative tax advantage of domestic ethanol compared to imported ethanol that would have occurred under the policy announced by the previous Government will be addressed.

Entitlement to the Energy Grants (Cleaner Fuels) Scheme will be removed for ethanol and direct subsidies will be provided to domestic producers and phased down over the transition period. This will result in a total government revenue of $275 million over the forward estimates.

### Fiscal incentives and investment subsidies

The Australian Government’s Clean Energy Future package has been awarded $13 billion to fund R&D and innovation in clean energy, the roll out of clean energy products and services, energy efficiency initiatives and to help companies install renewable energy technologies that will help other businesses innovate and become more energy efficient.

The Clean Energy Finance Corporation (CEFC) has announced the availability of funding for Clean Energy Projects (July 2013). Projects eligible for CEFC finance include those involving the implementation of renewable energy, energy efficiency or low emissions technologies. The CEFC's preferred minimum investment size for renewable technology projects is $20 million from a pool of $10 billion.

The Renewable Energy Venture Capital Fund (REVC) will provide funding to Australian companies who plan to commercialise their renewable energy technology. The REVC is a $200 million, 13-year fund to provide candidates with venture capital and investment management support during the early stages of business development.

The Australian Renewable Energy Agency (ARENA) was established by the Australian Government to make renewable energy solutions more affordable and increase the amount of renewable energy used in Australia. It has a $3 billion budget to fund renewable energy projects, support research and development activities and support activities to capture and share knowledge. ARENA provides funds under the Emerging Renewables Program to activities that support the development, demonstration and early stage deployment of renewable energy technologies with the potential to lower the cost, and thereby increase the supply of renewable energy in Australia. From 1 July 2013 the program will also be open to activities that remove or reduce roadblocks to the delivery of ARENA’s strategic initiatives and activities to fill critical knowledge gaps within the industry. (http://www.arena.gov.au/programs/initiatives/erp/erp.html)

### Other measures used to stimulate the production and use of biofuels

The Carbon Pollution Reduction Scheme (CPRS)

The Australian government believes the CPRS is the cheapest and most effective way of tackling climate change. Its introduction has been delayed until after the end of the current Kyoto commitment period. This will allow the government to get a clearer picture of global action. In the short term the government will boost investments in clean and renewable energy (i.e. the 20% MRET and the Clean Energy Initiative).

Proposed Carbon tax

Starting July 2012, 500 of Australia’s biggest polluters will have to start paying a tax of $23 a tonne on their carbon emissions. After 3 years, a market-based emissions trading scheme will replace this fixed tax.

Australian Centre for Renewable Energy (ACRE)

The ACRE was established in 2012 as part of the Australian Government’s ‘Clean Energy Future’ Initiative. The ACRE has an independent advisory board and CEO supported by RET and it is used to advise Government on strategies and priorities in the renewable technologies area. Funding of 3.3 billion Australian Dollars (AUD) is available to improve the competitiveness of renewable energy technologies and increase the supply of renewable energy in Australia.

An initial 20 million AUD commitment was made for liquid biofuels as follows:

* + - Next Generation Biofuels Economic Study (available on ACRE web site)
		- AUD 5 million foundation grant project for James Cook University
			* Most recent investments (Licella – AUD 5.4 million; Muradel – AUD 4.4 million)

Feedstock resources for biofuels

Australia has been in the grip of drought for 7 of the last 10 years. The current grain crop is low once again, and grain prices are very high. Australia is not a large producer of oilseeds (although 450,000 tonnes of canola are exported) and tallow and waste cooking oils are generally less expensive but in limited supply for biodiesel applications. Dryland grain and oilseed production can vary by ~40% from mean values. Drought also increases the demand and price of molasses. There is a potentially large lignocellulosic resource, awaiting commercial technologies for exploitation. These include sugarcane bagasse, woody weeds, coppice eucalypt, production on marginal land and marine algae.

Research & Development

The Queensland Alliance for Agriculture and Food Innovation (QAAFI) received a $1 million government grant in October 2012 to examine the potential for using eucalypts, sugarcane bagasse and legume sources to produce commercially viable quantities of biofuels.

### Promotion of advanced biofuels

## Market development and policy effectiveness

Table 1‑2 - Biofuel production and market share, Australia – installed capacity

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol(million L/a)** | **PPO(n/a)** | **Biogas****(n/a)** | **2nd-Gen (n/a)** | **Market share (%)** |
| 2000 |  |  |  |  |  |  |
| 2001 |  |  |  |  |  |  |
| 2002 |  |  |  |  |  |  |
| 2003 |  |  |  |  |  |  |
| 2004 |  |  |  |  |  |  |
| 2005 |  | 125 |  |  |  |  |
| 2006 |  | 125 |  |  |  |  |
| 2007 |  | 125 |  |  |  |  |
| 2008 | 260 | 164 |  |  |  |  |
| 2009 | 430 | 440 |  |  |  |  |
| 2010 | 430 | 440 |  |  |  |  |
| 2011 | 250 | 440 |  |  |  |  |
| 2012 | 350 | 440 |  |  |  | *~1%* |

In 2012 total biodiesel production in Australia was 350 ML, although its production capability was 500 ML. Between 2009 and 2012 there was increased use of ethanol blended fuel (EBF). This was partly due to an increase in the number of outlets selling EBF from ~250 in 2007 to over 1,500 in 2010. There are three ethanol producers with a total production capacity of 440 ML. Ethanol is blended as E10 while biodiesel blends are available as B5 or B20.

Table 1‑3 - Summary of transport fuel consumption, Australia (ML)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Gasoline** | **Diesel fuels** | **LPG** | **Biodiesel** | **Bioethanol** | **Market share (%)** |
| 2006 | 25883 | 30326 |  | 23 |  |  |
| 2007 | 25219 | 29605 |  | *61* | *84* |  |
| 2008 | 22331 | 25359 |  | *54* | *149* |  |
| 2009 | 19503 | 22040 |  | *96* | *203* |  |
| 2010 | 18198 | 21953 |  | *139* | *380* |  |
| 2011 | 17574 | 21808 |  | *275* | 440 |  |
| 2012 | 18228 | 18705 |  | *371* | 440 |  |

Sugarcane biomass has become a crucial resource for the Australian ethanol industry. In 2013, the harvest was estimated at 30.6 million tonnes of cane. However, a severe drought in Queensland may affect the harvest in 2014.

There are three bioethanol plants in Australia (Dalby Bio-Refinery, Manildra Ethanol Plant and Sarina Distillery), with a production capacity of 440 million litres. CSR (feedstock: cane molasses) produces 55 million litres per year (services the industrial solvent market). CSR has a 15 million litres per year contract with BP, and has received government assistance to install molecular sieve dehydration at their Sarina (Qld) ethanol distillery. Manildra (feedstock: waste wheat) produces 50 million litres per year from waste starch and 50 million litres per year from grains. Manildra has recently contracted with BP for 40 million litres per year of product. Dalby Biorefinery (feedstock: sorghum) started producing ethanol in January 2009 and used ~200 000 tonnes of dry grain (sorghum) per year. In June 2010 they ran into financial problems and in May 2011 the facility was sold to United Petroleum, an Australian owned independent fuel retailer and wholesaler. The plant had difficulties in overcoming a number of technical problems that had caused it to run less efficiently than expected.

Canadian biofuels developer, Lignol Energy Corporation, announced an investment in Territory Biofuels Ltd. (TBF) aimed at restarting TBF’s Darwin biodiesel plant which was mothballed in 2009 by Natural Fuels Australia after the company went into liquidation. The capacity of the plant is 150 million litres per year.

The main biofuel retailers in Australia are BP, Shell and Caltex. BP has contracts in place for 55 million litres per year of ethanol, and can produce >100 million litres per year of diesel from hydrogenated tallow. BP has >100 retail outlets for biofuels blends. Shell has about 10 outlets in each of Melbourne, Sydney and Brisbane selling E10 blends. Caltex has E10 outlets in NSW and Queensland but the number is uncertain. Caltex also sells a range of biodiesel blends to contract customers (B5 to B20).

There are seven biodiesel plants in Australia that have been built or planned, with a combined capacity of 430 M litres per year. Part of the underused capacity is related to policy changes in the mining sector, which has reduced demand for biodiesel fuels.

With respect to biofuel production from algae, three companies are involved, MDB Energy, Aurora Algae and Muradel. MBD Energy has entered into an MOU with Origin Oil to capture CO2 and produce algal oil. They hope to capture the CO2 directly from industry emissions, with a focus on coal-fired power energy generation. They announced plans to build 3 facilities of 1 ha each at three of Australia’s larger coal fired power stations. Much of the supporting research has been carried out at James Cook University and they have attracted $10.4million AUD industry and Commonwealth Government funding. In addition the research is further supported by $2.2million AUD from other industry as well as the Queensland Government to fund the Torong Display Plant, where flue gas from the Stanwell Energy coal-fired power station will be used to enhance the growth of algal biomass in a purpose designed facility for biological carbon capture and sequestration. The current facility at Torong hopes to be expand to 80 ha. It is projected that the expanded facility will produce ca. 11 million litres per year of oil. If they achieve 30 g/m2 per year of productivity, the total amount produced might actually be an order of magnitude less, emphasizing the importance of independent review of these claims. Photobioreactors are essentially bag systems and these bags will generally last about five years.

Aurora Algae, a producer of high-performance, premium algae-based products completed construction (August 2013) of their first commercial-scale facility in Geraldton, Western Australia (Aquacarotene Ltd Karratha assets). This facility will produce proprietary algae products, including high concentration eicosapentaenoic acid (EPA Omega-3 fatty acids), high-density proteins, fish meal and renewable fuels.

Muradel produced its first algae oil at a pilot scale (June 2013). The company plans to construct a demonstration scale algal biofuels plant in Whyalla, South Australia at an estimated cost of AUD 10.7 million, which will be a scale up of the pilot plant in Karratha, WA. Muradel has a joint venture with Murdoch University and the University of Adelaide, as well as SQC Pty Ltd (<http://sqcaustralia.com.au/index.php>). The projected completion date of construction is end of 2014.

A bioproducts pilot plant is currently under construction in McKay. This is a public facility that can be used by any interested party in collaboration with the Queensland University of Technology. Evaluation of the demonstration plant is ongoing with at least one patent filed. The process is based on glycerol-water with catalytic amounts of acid.

Licella, a company using a hydrothermal catalysis approach to produce “drop in” biofuels from cellulosic materials plans to construct a commercial demonstration scale plant with a capacity of ~5 million gallons per year. As of March 2013 they were in the process of selecting a site and securing the necessary permit approvals with a targeted completion date of the end of 2014. The pilot plant at Somersby has been operating since 2011. <http://licella.com.au>

North Queensland Bio-Energy Corporation Limited (NQBE) and China’s Nanning Good Fortune Heavy Industry Co. Ltd (GFHI) have entered into an agreement for construction of a $500 million State Government approved renewable power, sugar and bio products facility in Ingham, North Queensland, is on target for completion in 2016.

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# Austria

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## Introduction

Austria established a National Renewable Energy Action Plan which hopes to stabilize the country’s energy consumption at 1 100 PJ in 2020. Also by 2020, the renewable energy component will account for 388 PJ. This is an increase of 20% from 2008. The renewable energy mix in 2020 is expected to include 51% bioenergy, 41.2% hydropower, 4.5% wind and 0.5% photovoltaic. In 2011, Austria reached a renewable energy share of 26.1%; which lies under the 2020 target of 34%.

In 2012 Austria reached a biofuels share of its total transport fuels of 6.77%, clearly exceeding its European biofuels 5.75 % goal. Austria’s national biofuel production peaked in 2010.

### Main drivers for biofuels policy

The EU has established a legal framework concerning transport fuels. These include the Renewable Energy Directive (RED) 2009/28/EC on the promotion and use of energy from renewable sources and the Fuel Quality Directive (FQD) 2009/30/EC. The RED has set a goal of a 10% share of renewable energy in the transportation sector by 2020 while the FQD requires a minimum 6% reduction in GHGs per energy unit of transport fuel by 2020. Both directives include sustainability criteria for biofuels, requiring at least a 35% savings in GHG emissions as compared to fossil fuels by 2013. This requirement increases to at least 50% by 2017, and 60% by 2018 for biofuels produced by new facilities. These EU Directives are binding for all member states and need to be implemented into the respective national laws.

The Austrian goal is 34% renewable energy share by 2020, which represents a reasonable gain over current rates of growth. Biofuels share in the transport sector is about 6.77% by energy content (2012).

##  Biofuels policy

### Biofuel obligations

The EU Biofuels Directive, which requires the mandatory use of biofuels in the transport sector, was put into Austrian national law in November 2004. To reach the objective of replacing 5.75% of total transportation fuels with biofuels, up to 21.9 PJ of biofuels were used in 2011, requiring about 507,000 tonnes of biodiesel and 103,000 tonnes of bioethanol. The 2010 5.75% target was reached in 2008.

The plans for the introduction of E10 in Austria for 2012 have been stopped.

Austria’s national Renewable Action Plan hopes to stabilize energy consumption by stipulating that the energy used nationally in 2020 will be the same as in 2005,i.e. 1,100 PJ. This will mean that energy use in various economic sectors will have to be drastically reduced, including:

* -22% in the traffic sector
* -12% heating and cooling
* -6% in electricity

The country plans to increase renewable energy production from 373 PJ in 2011 to 388 PJ in 2020. In other words, 34% of energy consumed in 2020 is to be renewable. The projected renewable energy share in 2020 will be:

* 51% Bioenergy
* 41.2% Hydropower
* 4.5% Wind
* 0.5% Photovoltaic

Prior to the most recent developments, the “Fuels Ordinance” of 2012 defined technical specifications for motor fuels as well as substitution regulations for biofuels, primarily with regard to environmental aspects. As of 3 December 2012, biodiesel was specifically defined as FAME (fatty acid methyl ester). FAME can be used as a blending component up to an amount of 7% (volume) of the total diesel fuel. The Biodiesel has to be produced exclusively from vegetable oils.

Table 1‑1 Biofuel mandate as % of energy

|  |  |  |  |
| --- | --- | --- | --- |
| **Target year** | **Petrol** | **Diesel** | **Petrol + Diesel** |
| 2005 |  |  | 2.5%  |
| 2007 |  |  | 4.3% |
| 2008 |  |  | 5.75% |
| 2009 | 3.4% | 6.3% | 5.75% |
| 2020 |  |  | 8,45% |

 On 4 November 2004, the Biofuel Directive was put into Austrian national law with an amendment to the Fuel Ordinance of 1999. This amendment stipulates that all companies putting fuels on the market (e.g. OMV, Österreichische Mineralöl-Verwaltung) must, from October 2005, replace 2.5% of the total energy quantity by biofuels. From 2007, this percentage was increased to 4.3%, and in 2008 the target of 5.75%, as stipulated in the Directive, should be achieved. Table 1-1 summarizes the evolution of biofuel mandates from 2005 to 2020. Mandates from 2012 have been postponed.

Austria’s sustainability assessments are based on RED and EU frameworks. The new EU RED and FQD directives are challenging. Ongoing ILUC and overall sustainability concerns are leading to a de-emphasis of conventional and advanced biofuels.

RED and FQD biofuel sustainability criteria are being implemented into Austrian law by two separate ordinances. The cultivation of feedstock is regulated by an ordinance on agricultural feedstock for biofuels and bioliquids, while the fuel mandate that came into force in 2011 governed the certification of commercialized biofuels. The feedstock produced in Austria must of course comply with EU regulations. Imported feedstock or biofuels must be certified by another Member State or a voluntary scheme approved by the EC or Austrian control bodies. Double counting of GHG savings made by biofuels produced from wastes, residues, non-food cellulosic material and lignocellulosic material will be assessed on a case-by-case basis.

### Excise duty reductions

In 1999, an amendment of the Austrian tax law stipulated there would be no tax on biodiesel and bioethanol to a certain limit. The “Austrian Decree on Transportation Fuels” allows blending up to 7% biodiesel with fossil diesel. Blends more than 5% in gasoline are taxed in full amount. Also if the biodiesel is produced in small-scale plants and it is exclusively used in the farms themselves, it is free of mineral oil tax.

Together with the amendment to the Fuels Ordinance in 2004, the Mineral Oil Act has been revised (Mineral Oil Tax Law, BGBl. I Nr 180/2004). Accordingly, tax concessions are now be granted for fuels with a biofuel share of at least 4.4%. However, to be able to benefit from the tax concessions, the fuel must also be sulphur-free (less than 10 mg sulphur per kg of fuel). The use of pure biofuels as fuel has been exempted from mineral oil tax since 1 January 2000. The Bioethanol Blending Order that entered into force on 1 October allows refunding of the mineral oil duty for E75 blends.

### Fiscal incentives

Not available.

### Investment subsidies

Not available.

### Other measures used to stimulate the production and use of biofuels

Not available.

### Promotion of advanced biofuels

The Austrian government is funding different R&D projects on advanced biofuels. These funded R&D projects are dealing with a wide range of different topics and types of advanced biofuels, like for example biomass gasification and synthesis to FT-Diesel, mixed alcohols, conversion of algal biomass, lignocellulosic biogas and lignocellulosic ethanol.

## Market development and policy effectiveness

Table 2‑2 - Biofuel production and market share, Austria

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | Biodiesel[million L/a] | Bioethanol[million L/a] | PPO[million L/a] | Biogas[million m3] | 2nd-Gen (n/a) | Market share (%) |
| 2000 |  |  |  |  |  |  |
| 2001 |  |  |  |  |  |  |
| 2002 |  |  |  |  |  |  |
| 2003 | 106 |  |  |  |  | 0.45 |
| 2004 |  | 0 |  |  |  | 0.6 |
| 2005 |  | 0 |  |  |  |  |
| 2006 | 138 | 0 |  |  |  | 3.54 |
| 2007 | 274 | 15 |  |  |  | 4.23 |
| 2008 | 284 | 89 |  |  |  | 5.5 |
| 2009 | 367 | 174 | 8\* | 380-600 |  | 7.0 |
| 2010 | 383 | 198 | 8\* | 390-615 |  | 6.58 |
| 2011 | 352 | 216 | 8\* | 380-590 |  | 6.75 |
| 2012 | 302 | 216 | 8\* | 400-630 |  | 6.77 |
| 2020 |  |  |  |  |  | 8.45% |

Source: Federal Environment Agency reports: Biofuels in the transport sector in Austria

NB: 1 tonne Pure Plant Oil = 1,087 L = 37.0 GJ; NB: 1 tonne bioethanol = 1,262 L = 29.5 GJ;
1 tonne biodiesel = 1,136 L = 40.6 GJ; n.a. not available

\* estimated production capacity of decentralised small scale plant oil presses; no data available on how much of this production volume is used for biofuels; a large share of this production capacity is used for food, feed or technical purposes.

**Biodiesel** is the main biofuel produced in Austria. Biodiesel production capacity in Austria is ~ 650,000 t/a from 14 production facilities. The production reached its peak in 2010 with nearly 383 million L of biodiesel. The total biodiesel consumption was 627 ML in 2009, of which 461 ML was blended with fossil diesel, and 166 ML used directly. Sales of biodiesel in 2012 decreased to 567 ML with actual production also reduced at 302 ML.

The production of **bioethanol** in Austria is lower than the biodiesel production at 198 ML in 2010 E5 and E85 usage reached nearly 216 ML in 2009. Austrian E10 bioethanol demand can be achieved via the production capacity of a single plant, the AGRANA bioethanol plant in Pischelsdorf. The plant has a capacity of 240 ML of bioethanol per year, which is capable of displacing 1/3 of the Austrian soy protein imports through DDGS co-production. The plant’s emission reductions of 50% GHG have been certified by Joanneum Research. Production of bioethanol remained in 2012 at 216 ML, with sales of bioethanol also increasing to 133 ML.

In recent years pure plant oil is increasingly used as fuel, in particular by agricultural vehicles and road freight transport. While national production data isn’t readily available, plant oil for fuelling purposes is estimated to be 632 t (2012) decreasing from 2,656 t in 2009. Biogas produced in Austria is mainly used on site for heat and power production, with an estimated production ranging from 400 – 630 Mm3 of biogas per year. Efforts are being made to introduce “Bio-CNG” into the transport fuel market, but the number of CNG vehicles must still be increased.

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# Brazil

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## Introduction

Brazil remains the worldwide leading supplier of energy from renewable sources with 42.4% of their energy matrix from renewable sources in 2012.

Brazil is the oldest example of widespread biofuel development, which produces ethanol from sugar cane. In response to the first oil crisis of the 1970’s, Brazil invested heavily in fuel alcohol primarily as a means of increasing fuel security and saving foreign currency on petroleum purchases. The National Ethanol Programme, Proálcool, was launched at this time. Several policies were introduced to promote biofuel consumption, including the development of vehicles capable of utilizing hydrous (E100) fuels. In the late 1990s price regulation was removed, while Law 8.723/93 established the anhydrous ethanol blended in the gasoline ranging between 18% and 25%. From the date of this law on, all gasoline commercialized in Brazil mandatorily contains from 18% to 25% of ethanol.

### Main drivers for biofuels policy

The original policy choice was to create direct funding sources to create biofuel capacity. In 1975, the Proálcool program was created to be an alternative for the 1973 Oil Crisis. Proálcool was created with large public and private investments and supported by a World Bank loan after 1981, allowing construction of alcohol distilleries, increase of the agricultural productivity, modernization and enlargement of the existent distilleries.

The second group of policies introduced in Brazil provided a subsidy for bioethanol use. During the Proálcool period, the oil industry was totally controlled by the State and so some policies were created to stimulate the use of ethanol such as: ethanol (E100) price 25% lower than the gas price; reduction of 3% in taxes for vehicles moved by ethanol; guaranteed remuneration for producers; public loans designated for production capacity increase; obligations for gas stations to sell ethanol and maintenance of ethanol strategic storages. From 1996 on, the Brazilian Government initiated a subsidy and intervention reduction program. In 1999, the ethanol prices in the whole chain stopped being controlled by the government and a complete elimination of industry subsidies took place.

Figure 3.1 Brazilian transportation fuel composition (2010)

Lately, development of a biodiesel industry has been observed. This industry uses soybean as a feedstock in 80% of its production (as of 2009), with other oilseeds, animal fats, and waste oils providing the remainder. This industry has largely been driven by a renewable fuel obligation.

## Biofuels policy

### Biofuel obligations

Brazil has introduced mandatory blending targets for both bioethanol and biodiesel. Brazil’s domestic market still utilizes the single largest portion of fuel ethanol capacity in the country. The presence of a Renewable Fuel Standard means that all Brazilian gasoline has a legal alcohol content requirement that has ranged between 18% and 25%. From May 2010 until September 2011, the RFS was set at 25%, however since October 2011, the RFS stands at 20%. The mandate for anhydrous ethanol blend in gasoline was set to increase to E25 in May 2013.

Brazil has a B5 mandate with installed production capacity of 7.5 billion litres, and production (2012) was 2.6 billion litres. A 9% increase is projected for 2013, based on accumulated production until October. Main sources (Jan-Oct, 2013) are soybean (74%) and animal fat (19%). Brazil has a mandate for anhydrous ethanol between E18-E25 (currently E25) and flex-fuel vehicles can use E25 blended with hydrous ethanol in any ratio. Production of anhydrous ethanol is up by 22% in 2013 over 2012, while hydrated increased 15% over 2012. The overall increase in production was partly caused by good weather conditions and partly by the high rates of renewed sugarcane crops.

Table 3‑1 - Biofuel obligations (% by volume)

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Ethanol**  | **Biodiesel**  | **Petrol + Diesel** |
| 2005 | 25% | 2% (authorization) |  |
| 2006 | 25% (Jan, Feb); 20% (Mar-Nov); 23% (11/20-Dec) | 2% (authorization) |  |
| 2007 | 23% (Jan-Jun); 25% (Jul-Dec) | 2% (mandatory) |  |
| 2008 | 25% | 3% (mandatory) |  |
| 2009 | 25% | 4% (mandatory) |  |
| 2010 | 25% Jan; 20% (Feb-Apr); 25% (May-Dec) | 5% (mandatory) |  |
| 2011 | 25% (Jan-Sept); 20% (Oct-) | 5% (mandatory) |  |
| 2012 | 20% | 5% (mandatory) |  |
| 2013 | 25% (May) | 5% (mandatory) |  |

### Excise duty reductions

There are reductions in excise duty along the biodiesel chain according to the geographic region of production and according to the supplier (family farm or agribusiness).

Although the import tariff for ethanol is 20 percent, since April 2010 it is listed as an exception which sets the actual tariff at zero percent. The import tariff for biodiesel is set at 14 percent.

### Fiscal incentives

There are no tax credits or subsidies for blending anhydrous ethanol with pure gasoline, not for the final consumer or any other production and commercialization phases. Lower taxes, however, are paid on flex fuel vehicles.

### Investment subsidies

In March 2013, BNDES announced the continuity of the Prorenova, a credit line of R$4 billion (approximately US$ 1.75 billion) available until December 31, 2013, to finance the renewal and/or expansion of sugarcane fields. The interest rate dropped from 8.5-9.5 percent in 2012 to 5.5 percent in 2013. The payment is due within 72 months and an 18-month grace period.

In April 2013, the GOB, through Resolution # 4,612 from the Brazilian Central Bank (BACEN), created a R$2 billion (approximately US$ 0.87 billion) credit line with a 7.7 percent interest rate to support ethanol storage. The reference price is set at R$1.37/litre of anhydrous ethanol and R$1.21 for hydrous ethanol.

### Other measures stimulating the implementation of biofuels

Brazilian energy policy objectives include a mandate to increase the share of biofuels in the national energy mix. The main general instruments include:

* Mandatory mix: ethanol (E18-25) and biodiesel (B5)
* Tax differentiation regime at federal level
* Line of credit for ethanol strategic buffer stocks (conceived to improve off-season supply conditions)
* Public auctions for biodiesel market supply
* Research funding (CT-Petro, created in 1999 and CT-Energ, created in 2000)
* Agro-ecological zoning that orients and guarantees that raw-material production will take place only in suitable areas which was established for sugarcane (2009) and palm oil (2010).

Sales of flex fuel cars also stimulate biofuel production. About 90% of new cars sold since 2007 are flex fuel cars.

Other government initiatives include adjusting the regulatory framework for ethanol (which resulted in the approval of the Law 12.490/2011 by the National Congress) and designing future policies based on scenario analysis of projected ethanol demand (projections include the next 10 years). It is expected that the industry will also be provided with an incentives package for production expansion investments, while strengthening of future market contracts as a tool for ethanol commercialization is also underway. Government is in continuing dialogue with private sector representatives across the whole chain of production and commercialization.

In addition to government support, Brazilian companies are also stepping in to support the production and uptake of biofuels. For instance, from 2013 to 2017, Petrobras’ investments into biofuels will equal approximately US$ 2.9 billion, encompassing biodiesel, ethanol and lignocelulosic ethanol production.

### Promotion of advanced biofuels

In March 2011, the Brazilian Development Bank (BNDES) and the Research and Projects Financier (Finep) signed a Technical Cooperation Agreement to carry out the Joint Plan for Supporting Industrial Technological Innovation in the Sugar-based Energy and Chemical Sectors (PAISS). This is a Brazilian government initiative aimed at uniting the efforts of its main foment organs, so that the country may achieve the same success in advanced technologies as for conventional biofuel production.

PAISS has three main foci: second generation bioethanol; new sugarcane products, including the development from sugarcane biomass through biotechnological processes; and gasification, with an emphasis on technologies, equipment, processes and catalysts. The program has, up to 2013, 3 contracted projects (R$ 400 Million) and 22 approved projects (R$ 1.6 Billion).

Italy’s Chemtex also announced in 2011 that it would be collaborating with GraalBio Investimentos S.A., a biofuels and biochemicals company wholly-owned by the Brazilian entrepreneurial group Graal Investimentos S.A.. This plant is in construction at Alagoas state and is expected to begin operations by 2014. It would produce 82 M litres of cellulosic ethanol from bagasse and other feedstocks. Chemtex’s trademark Proesa technology will also be utilized at this plant. Chemtex and GraalBio are also working on developing a broader cooperation for development and production of Brazilian biofuels and biochemicals.

Petrobras Biofuel, together with Raízen, is expected to start production of cellulosic ethanol in 2015. Each plant will have a production capacity of 40 ML of ethanol. Another initiative is Amyris’s first purpose-designed, industrial-scale biofene plant located in Brotas, São Paulo state, in the southeastern region of Brazil, which began commercial production in early 2013.

Brazil is also exploring the potential of microalgae to contribute to the advanced ethanol market. Brazilian R&D focus is directed toward several objectives, including collecting and isolating native microalgae with potential to produce biodiesel, scale up of operations to 1000-5000 litres and evaluation of the quality of the resulting biodiesel.

## Market development and policy effectiveness

Consumption of bioethanol (anhydrous) for 2012 was about 20.8 billion litres, while imports of ethanol were 554 million litres (2012) and export levels were 3.055 billion litres. There is significant growth in ethanol production planned. Petrobras biofuels are planning to grow from 1.5 billion litres production currently to 5.6 billion litres in 2015. Raizen will process up to 80 million tonnes of sugarcane in 2015 (up from 64.5 million tonnes in 2010) and BP will process 30 million tonnes of sugarcane in 2016 (up from 7.5 million tonnes in 2010). This expansion will include new plantations as well as acquisition of existing companies.

Table 3‑2 - Biofuel production and market share, Brazil

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol(million L/a)** | **PPO(n/a)** | **Biogas****(n/a)** | **2nd-Gen (n/a)** | **Market share (%)** |
| 2000 |  | 11,000 |  |  |  |  |
| 2001 |  | 11,000 |  |  |  |  |
| 2002 |  | 12,500 |  |  |  |  |
| 2003 |  | 13,700 |  |  |  |  |
| 2004 |  | 15,600 |  |  |  |  |
| 2005 | 12 | 16,200 |  |  |  |  |
| 2006 | 70 | 17,800 |  |  |  |  |
| 2007 | 402 | 22,600 |  |  |  |  |
| 2008 | 1,167 | 27,000 |  |  |  |  |
| 2009 | 1,608 | 26,095 |  |  |  | 28.6% |
| 2010 | 2,386 | 27,965 |  |  |  | 26.8% |
| 2011 | 2,673 | 22,893 |  |  |  |  |
| 2012 | 2,717 | 23,509 |  |  |  |  |
| 2013 | 2,877 | 26,572 |  |  |  |  |
| 2015 |  |  |  |  |  |  |
| 2020 | 3,840 | 61,100 |  |  |  |  |

Source: F.O. Lichts, Biodiesel Magazine, Brazillink.org, Renewable Fuels Association, Ministry of Mines and Energy

Biodiesel production for 2012 was 2.7 billion liters. Soybeans represent about 73 percent of total biodiesel feedstock, followed by animal tallow (20 percent) and cottonseed (3 percent). As at June 2013, Brazil has 69 plants authorised to produce biodiesel. Current estimated capacity is ~8 billion litres/y. This represents about 2.8 times the biodiesel required to meet the B5 blending mandate. The biodiesel market is regulated by the government through a public auction system which gives preference to poorer farmers in disadvantaged areas through a Social Fuel Stamp.

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# Canada

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## Introduction

Canada has had a mandate of 5% renewable content for gasoline fuel since December 2010. Many provinces have equivalent or higher mandates, including 5% in Ontario, 7.5% in Saskatchewan and 8.5% in Manitoba. A biodiesel mandate of 2% has been in place since December 2011.

Ethanol production for 2013 is estimated to be about 4% higher than 2012 levels at 1,979 ML and is forecast to grow further in 2014. This won’t be sufficient to meet the federal mandate and imports will have to take place to meet requirements. Primary feedstocks for ethanol production are corn and wheat. Cellulosic ethanol is only produced in small quantities from wood waste and municipal solid waste and is being developed by Enerkem.

Biodiesel production for 2013 is estimated at 471 ML, but production is estimated to reach 646 ML in 2014. Production is based on soybean, canola, animal fat and recycled oils, with canola expected to account for nearly 40%. On July 1, 2011, a federal mandate of 2% renewable content in diesel fuel and heating oil was implemented. Eastern Canada was given an exemption for a period of time, extended until June 30, 2013. The amendment also provided a permanent national exemption for diesel heating oils.

The current federal government is predominantly focused on fossil fuels rather than renewables.

### Main drivers for biofuels policy

Canada has the world’s third largest proven oil reserves, after Venezuela and Saudi Arabia and is one of the top ten oil exporters in the world. Energy security is therefore not the driver for Canada’s renewable fuel industry. The primary drivers for renewable mandates are rural diversification and GHG emission reductions to fight climate change.

## Biofuels policy

### Biofuel obligations

The Renewable Fuel Regulations provided for the federal 5% renewable fuel mandate for the national gasoline pool, which came into effect on December 15, 2010. In June 2011, the federal government announced it was moving ahead with a July 1, 2011 implementation date for a federal mandate of two percent of renewable content in diesel fuel and heating oil. The eastern part of Canada was given an implementation exemption until December 31, 2012 (18 months) in order to get the necessary blending infrastructure in place. This exemption was further extended to July 1, 2013 and also included a permanent exemption for diesel heating oils.

Canadian provinces have a diverse set of mandates that vary by region, some provinces have implemented mandates prior to the federal mandates becoming official. A summary of federal and provincial regulations is shown in Table 4-1 below.

Table 4‑1 Biofuel mandates in Canada

|  |  |  |
| --- | --- | --- |
| Region | **Mandate** | **Implied Consumption / year 2012 (mill L)** |
| **Bioethanol regulations** |  |
| Federal | 5% from 2010  | 2145 |
| Alberta | 5% from 2010  | 290 |
| BC | 5% from 2010  | 250 |
| Manitoba | 8.5% from April 2008 | 135 |
| Ontario | 5% from 2007 | 830 |
| Quebec | 5% from 2012 (cellulosic ethanol)  | 445 |
| Saskatchewan | 7.5%  | 125 |
| **Biodiesel regulations** |  |  |
| Federal | 2% from 2012 | 585 |
| Alberta | 2% from 2010 | 145 |
| BC | 4%  | 180 |
| Manitoba | 2% from 2010 | 22 |
| Saskatchewan | 2%  | 57 |

### Excise duty reductions

In Canada, exemptions from both federal and provincial fuel excise taxes have been provided for ethanol blends. These taxes essentially act as a rebate for producers. The federal excise tax applies across the country; provincial excise tax exemptions for E10 blends are available in five jurisdictions and may be considered as additional incentives. Note that some provincial exemptions - in Quebec, Saskatchewan, and Manitoba - apply only to ethanol that is produced within that particular jurisdiction.

Table 4‑2 - Tax exemptions by province (Total fuel excise tax rate, Exemption for E10 fuel blends) (¢/litre)

|  |  |  |  |
| --- | --- | --- | --- |
| Province/Territory | **Federal** | **Provincial** | **Total** |
|  | Tax rate | Exemption | Tax rate | Exemption | Tax rate | Exemption |
| Alberta | 10.0 | 1.0 | 9.0 | 0.9 | 19.0 | 1.9 |
| British Columbia\* | 10.0 | 1.0 | 14.5 | 0.0 | 24.5 | 1.0 |
| Manitoba | 10.0 | 1.0 | 11.5 | 2.5 | 21.5 | 3.5 |
| New Brunswick | 10.0 | 1.0 | 14.5 | 0.0 | 24.5 | 1.0 |
| Newfoundland  | 10.0 | 1.0 | 16.5 | 0.0 | 26.5 | 1.0 |
| Northwest Territories  | 10.0 | 1.0 | 10.7 | 0.0 | 20.7 | 1.0 |
| Nova Scotia | 10.0 | 1.0 | 15.5 | 0.0 | 25.5 | 1.0 |
| Nunavut Territory | 10.0 | 1.0 | 6.4 | 0.0 | 16.4 | 1.0 |
| Ontario | 10.0 | 1.0 | 14.7 | 1.47 | 24.7 | 2.47 |
| Prince Edward Island | 10.0 | 1.0 | 14.0 | 0.0 | 24.0 | 1.0 |
| Quebec | 10.0 | 1.0 | 15.2 | 2.0 | 25.2 | 3.0 |
| Saskatchewan | 10.0 | 1.0 | 15.0 | 1.5 | 25.0 | 2.5 |
| Yukon Territory | 10.0 | 1.0 | 6.2 | 0.0 | 16.2 | 1.0 |

\* British Columbia offers a full rebate (14.5 ¢/litre) on E85 blends

### Fiscal incentives

Along with an announcement of the Renewable Fuels regulations, several programs were put in place to promote a domestic renewable fuels industry. However, many of these expired at the end of March 31, 2011 and the federal government has not announced future measures to replace these programs.

There are currently 22+ renewable fuels plants in Canada (operating & construction) with a combined estimated 2 billion liters of production capacity. There has been an estimated C$2.3 billion totaldirect investment into renewable fuels, resulting in C$2.9 billion totalnet economic activity.

Net annual economic benefit derived from renewable fuels investment is projected to be ~ C$1.5 billion, with the following breakdown:

* C$ 14 million to municipal governments
* C$ 492 million to provincial governments
* C$ 680 million to the federal government

Some of the largest incentive programs include:

EcoEnergy for Biofuels had a C$1 billion budget which was administered by Natural Resources Canada. This program provides incentive rates of up to C$0.10/liter for renewable alternatives to gasoline and C$0.26/L for renewable alternatives to diesel for the first three years, declining in the 6 years thereafter. The program runs April, 2008 - March 31, 2017, but the final round of funding has closed.

The ecoAgriculture Biofuels Capital Initiative encourages producer equity/ownership in bio-fuel facilities and is administered by Agriculture and Agri-Food Canada. The program helped fund projects that used agricultural feedstock to produce bio-fuels and requires agricultural producer equity investments of 5% to meet the eligibility requirements. This program was extended to September 30, 2012, but is now expired.

Table 4‑3 Summary of existing programs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Program | **Start Date** | **End Date** | **Type** | **Funding** |
| Program of Energy Research and Development (PERD) |  | Ongoing | Funded by OERD |  |
| Sustainable Development Technology Canada (SDTC) | 20012007 | 20152015 | RD&DRD&D | $550 M$500 M |

### Investment subsidies

Previous governments have provided more substantial support to biofuels, including a cumulative investment of $2.7 billion CDN into the implementation of the former Climate Change Plan for Canada, which included incentives for the development and use of environmentally friendly technologies including bioethanol. The federal Canadian government provided direct funding for the industry through two rounds of the Ethanol Expansion Program (announced 2003), which in 2004 and 2005 provided a total of $118 million in direct funding for eleven projects. In 2008 the Renewable Fuel Standard required 5%+ ethanol blends, which is equal to about 3 billion litres of ethanol, in addition to a 2% biodiesel mandate.

### Other measures stimulating the implementation of biofuels

Canada has developed significant expertise in the development of technologies to convert non-food based feedstocks to ethanol. Examples of key players and current focus:

* UBC – pretreatment of softwoods
* Lignol – organosolv biorefining (wood residues), coproduction of value-added lignin-based chemicals and structural products
* Iogen – enzymatic hydrolysis (agricultural residues)
* Enerkem – gasification (municipal residues)
* Greenfield Ethanol Inc – integration of grain based and cellulosic based ethanol production
* Vaperma Inc. - Vaperma Siftek™ hollow-fiber polymeric membrane

The Agricultural Bioproducts Innovation Program is a $145 million grant that mobilizes research networks that conduct scientific research projects with a specific focus on developing effective and efficient technologies for an agricultural biomass conversion; evolve beyond bio-fuels production to a sustainable, bio-based economy. The program runs on a multi-year basis.

There are various types of government support provided in Canada for biofuels, spanning across all stages of the biorefining process. The type of support available includes:

* RD&D -Grants and low-interest loans
* Business planning - Grants for feasibility studies and market development
* Plant construction - Grants and low-interest loans, accelerated depreciation
* Production - Fuel tax exemptions, producer payments
* Price support - Mandated biofuel blending requirements and tariffs
* Distribution - Grants for storage and distribution infrastructure
* Consumption -Tax-breaks for the purchase of biofuel-consuming vehicles,

### Promotion of advanced biofuels

Lignol Innovations has a pilot plant, which uses wood as a feedstock, in Vancouver. Lignol is a Canadian company based in BC which is undertaking to construct biorefineries for the production of fuel-grade ethanol and biochemicals from Canadian forests and other biomass feedstocks. Lignol has acquired and since modified, a solvent based pre-treatment technology that was originally developed by a subsidiary of General Electric.

In March 2009, KL Energy Corporation of South Dakota and Prairie Green Renewable Energy of Alberta announced their intention to develop a cellulosic ethanol plant near Hudson Bay, Saskatchewan. The Northeast Saskatchewan Renewable Energy Facility will use KL Energy’s modern design and engineering to produce ethanol from wood waste.

Enerkem has a facility operating in Westbury, Quebec, producing 5 ML of ethanol from used electricity poles (started in 2009). The main products of this plant are syngas, biomethanol, acetates and cellulosic ethanol. Further Enerkem facilities are under construction or development: a facility in Edmonton, Alberta which will produce 38 ML ethanol/methanol (early 2013); and Varennes, Quebec which will also produce 38 ML ethanol/methanol (with Greenfield).

Programs exist which are specifically targeted at this class of fuel. They include the following:

* Next Generation Biofuels (Natural Resources Canada and Environment Canada; managed by Sustainable Development Technology Canada)
* $500 million to invest with the private sector in large-scale demonstration of next generation biofuels production
* Support of flex-fuel vehicle sales/R&D as well as engine optimization for ethanol
* One application is approved but on hold (Iogen) with other applications in the pipeline

## Market development and policy effectiveness

As at the beginning of 2013, there were 16 ethanol and 9 biodiesel plants in operation in Canada, with another 3 biodiesel plants being commissioned and another 1 under construction. Total ethanol production capacity is 1.80 billion litres, while the federal mandate (at 5%) requires about 2 billion litres. However, US imports amounted to 1.14 billion litres which is an indication of over-blending. Almost all the ethanol is produced from corn (78%, east) and wheat (21%, west). Biodiesel capacity of current plants in operation is only 158 million litres, while commissioning and construction will extend the capacity by a further 548 million litres. Based on the current federal mandate (2%), about 600 million litres of biodiesel is required. Almost all of the biodiesel is produced from canola (west) and animal fats (east). At the beginning of 2013, all Canadian biodiesel was being exported to the USA, partly due to the issues around using waste oils as a feedstock.

Table 4-4 provides an overview of biodiesel and bioethanol production levels within Canada.

Table 4‑4 Biofuel development and market share, Canada

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol(million L/a)** | **PPO(n/a)** | **Biogas****(n/a)** | **2nd-Gen (n/a)** | **Market share (%)** |
| 2000 |  | 222 |  |  | 17 |  |
| 2001 |  | 222 |  |  | 17 |  |
| 2002 |  | 222 |  |  | 17 |  |
| 2003 |  | 222 |  |  | 17 | 0.4% |
| 2004 |  | 222 |  |  | 17 | 0.4% |
| 2005 | 90 | 222 |  |  | 17 | 0.6% |
| 2006 | 90 | 389 |  |  | 17 | 0.9% |
| 2007 | 100 | 800 |  |  | 17 | 1.6% |
| 2008 | 100 | 870 |  |  | 17 | ~2% |
| 2009 | 150 | 1,400 |  |  | 17 | 3.7% |
| 2010 | 205 | 1,800 |  |  |  | 4.1% |
| 2011 | 155 | 1,600 |  |  |  | 5.0% |
| 2012 |  | 1,725 |  |  |  | 5.6% |
| 2013 |  |  |  |  |  |  |

Source: Canadian Renewable Fuels Association, Natural Resources Canada

Note: All grain based; main production is in Ontario, Quebec, Saskatchewan and Manitoba

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# China

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## Introduction

China has grown its bioethanol production sector rapidly since 2000 to become the third-largest single bioethanol producer after the United States and Brazil, although production was still low at 2 billion litres (2008 data) (Qiu et al. 2012). When all liquid biofuels are taken into account, China is the 4th largest producer after the USA, Brazil and the EU. The main challenges for development of biofuels are: food security, land scarcity, cost-efficient supply of feedstock and potential environmental problems due to large-scale cultivation of energy crops (Chang et al. 2012). While biofuel targets for 2020 seem modest, it is not clear whether these will be reached. While available information and projections are generally very positive, it is also stated that there are many barriers to be overcome, including a lack of policy support (Chang et al. 2012). Current biofuel production is still mainly based on traditional technologies using grain as a feedstock, which is threatening the food security of a growing population. Land scarcity is also a challenge, as China has limited arable land which is reducing due to industrial expansion and pollution.

### Main drivers for biofuels policy

China’s stated objectives for biofuel development are: (1) improving rural economies and the welfare of rural inhabitants; (2) energy security, specifically reducing dependence on foreign oil; (3) the mitigation of emissions noxious to the environment. Over the past two decades, China’s vehicle market has been the fastest growing in the world. In the first half of 2009, new vehicle sales in China exceed those of the United States and China became the world’s largest auto market. Increased sales in 2009 were driven by various policies such as a reduction in purchase tax and subsidies for light vehicles and light trucks. However, it should be noted that the total number of vehicles in China are still far less than the USA. Road vehicles are set to become one of the major sources of oil demand and emissions. It is estimated that passenger and freight road transportation in China have increased by 8 and 15 times, respectively (Tao et al. 2011).

The increasing dependence on imported oil and tremendous greenhouse gas (GHG) emissions is making the diversification of primary fuel such as petroleum a critical energy and environmental issue in China

## Biofuels policy

Since 2001, the use of ethanol-blended gasoline has been spreading in China, as this was when biofuels legislation was first passed and China released laws on the use of denatured fuel ethanol (GB18350-2001) and bioethanol-gasoline blends for automobiles (GB18351-2001). These laws established standards for the production of E10. A year later on March 22, 2002, the government launched a model to introduce E10 into specified areas of China. Four pilot plants were initially established based on stale corn and wheat, from the government’s grain reserves, as a feedstock. The second phase of biofuel development established a legal system for biofuel (and for the relevant raw materials required) production, transportation and sales.

In 2004, the National Scheme of Extensive Pilot Projects on Bioethanol Gasoline for Automobiles governed the expansion of mandatory bioethanol gasoline use from five cities to nine provinces. And in 2006, the Interim Measures for the Administration of Special Fund for the Development of Renewable Energy Sources ensured China would be focused on developing non-grain based fuel ethanol, and the “Flexible Loss Subsidy” was instituted for authorized ethanol producers.

According to the Medium and Long-term Development Plan for Renewable Energy (2007), targets were set for bioethanol production to reach 10 Mt by 2020, while the target for biodiesel production was set to reach 2Mt. (Qiu et al. 2012). Policy currently requires that Central Government approval must be obtained before construction of any new bioethanol plant. The plan also stated that “biofuel must not compete with grain over land, it must not compete with the food that consumers demand, it must not compete with feed for livestock, and it must not inflict harm on the environment” (Qiu et al. 2012).

Although a target has been set for biodiesel production, there is no mandatory use for biodiesel in China and the biodiesel standard is voluntary, which has made it difficult to promote biodiesel development.

### Biofuel targets and obligations

The country was set to move to a 10% biofuels mandate by 2010, while a 15% overall target was set for renewables for 2020. Nine Chinese provinces have mandated 10% ethanol blends to date, including – Heilongjian, Jilin, Liaoning, Anhui, and Henan. According to the goal set in ‘Mid-Long Term Development Plan for Renewable Energy’ (prepared by the National Development and Reform Commission), the use of bio-fuel ethanol will reach 12.7 billion liters by 2020. By that year, automotive ethanol gasoline (E10) usage will be 100%, and annual consumption of bio-diesel will reach 2 Mt.

Table 5‑1 Biofuel obligation by volume

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Ethanol**  | **Biodiesel**  | **Petrol + Diesel** |
| 2006 |  |  |  |
| 2007 |  |  |  |
| 2008 |  |  |  |
| 2009 |  |  |  |
| 2010 | 10%\* |  |  |
| 2020 |  |  |  |

\*Regional mandates in Heilongjian, Jilin, Liaoning, Anhui, and Henan

### Excise duty reductions

China Increased gasoline, diesel, and jet fuel prices in 2011, though at a slower pace than the rise in international crude prices. The government has implemented preferential taxation policies for the bioethanol industry, exempting plants from a fuel ethanol consumption tax of 5%.

### Fiscal incentives

Incentives were implemented in 2005 to support the initial plants, including exemption from Sales (consumption) Tax (5%) and refund of Value Added Tax on bioethanol production (17%) (Qiu et al. 2012). In order to support the production of fuel ethanol, the Chinese government introduced a number of preferential policies, including the investment of US$ 70.6 million in a treasury bond fund for the construction of fuel ethanol plants in Henan, Anhui, and Jilin provinces. Initially, direct, fixed subsidies were offered by the central government to ensure a minimum profit for each of the plants. That is, the plants would receive extra governmental funds which not only made up for the loss, if there was, in production and marketing of bioethanol but also led to a reasonable profit. This fixed subsidy was amended in 2006 to a “flexible subsidy for loss” which still ensured a reasonable level of profit for the industry. The Central Financial Authority allocated US$ 294 million to subsidize losses within the industry, which effectively protected the normal production and operation of fuel ethanol enterprises.

The Chinese government continues to provide subsidy support and monetary payments to the ethanol industry. To promote non-grain based bioethanol, low interest loans and direct subsidies are also offered. The government has cut subsidies for fuel ethanol production from 19 cents/liter ($241/MT) in 2009 to 6 cents/liter ($79.4/MT) in 2012.. The total subsidy level is expected to go up to US$ 616 million by 2020. To expand establishment of crops on marginal lands, the government also offered a one-off subsidy of 3000 yuan per hectare for planting of oil-bearing trees (biodiesel) and 2700 yuan for non-cereal feedstocks.

With respect to grain-based ethanol production, changes in incentives were implemented from 1 October 2011. The Sales Tax rate of 5% will be gradually reintroduced beginning on that date until the full 5% will be applicable from 1 January 2015. Where Value Added tax was refunded, this incentive was gradually reduced to zero refund from 1 January 2014.

Biodiesel derived from waste oil continues to be exempt from Sales Tax, while Value Added Tax is refunded and Income Tax reduced by 10%.

### Investment subsidies

### Other measures stimulating the implementation of biofuels

Not available.

### Promotion of advanced biofuels

The ‘Mid-Long Term Development Plan for Renewable Energy’ acknowledges that it is necessary to proactively develop cellulosic biofuels. It is estimated that, if China’s biofuel target was only met through grain-based biofuel, that about 6.6% of China’s total cereal production (2009) would be required (Qiu et al. 2012). This would have a grave impact on food security and therefore the development of advanced biofuels is very important. Non-cereal feedstocks, such as sweet sorghum, sweet potato, sugarcane and cassava are some of the main ones considered for use. There is also a drive towards 1.5 generation biofuels.

The Ministry of Finance has stated that the production of cellulosic bioethanol should be encouraged by the combination of production, study and research, and the expansion of the pilot- and demonstration-scale plants. As at December 2009, there were eight pilot and demonstration plants for cellulosic-based ethanol production (Qiu et al. 2012).

The Chinese government has ratified five fuel ethanol production plants for ethanol demand. Grain-based feedstock is used in the four plants in Jilin, Heilongjiang, Henan, and Anhui, and their production was about 1.4 MMT in 2007. The 5th plant uses cassava as a feedstock.

Recently, a two-stage dilute acid hydrolysis process has been developed by scientists in the East China University of Science and Technology, and a pilot scale plant with an annual production capacity of 600 tons from agricultural residues has been established in Fengxian, suburb of Shanghai. This was supported by Chinese government’s ‘‘863 Project”.

Novozymes has a market share of about 50 percent in China in conventional biofuel production, but more opportunities will be created as the nation's new Five-Year Plan (2011-2015) places a heavy focus on advanced biofuel production, although detailed plans are not yet available. In May 2010, Novozymes, China National Cereals, Oils and Foodstuffs Corporation, and China Petrochemical Corporation announced the construction of a 10,000 ton-capacity demonstration plant for commercial-scale production of advanced biofuels from corn stover - the leaves and stalks of maize plants - which will begin in 2011. In June 2012, China’s Shenquan Group announced an investment of $100 million to market cellulosic ethanol. Using Novozyme’s enzymes, Shenquan, who currently produces furfural from corncob xylose, will utilise the cellulose from the corncob for conversion into higher-value sugars for fermentation to ethanol. The ethanol produced, however, will be marketed as an industrial solvent.

At the end of 2012, Shandong Longlive Biotechnology (Longlive) delivered its first 300 tonnes of fuel ethanol made from corncobs. Longlive’s 51,500-tonne biofuel ethanol project is the first government-approved fuel ethanol produced in Shandong province and the fifth in the country.

## Market development and policy effectiveness

Although diesel fuels are the most widely used fuels in China today, the lack of a mandate for biodiesel use has restricted the uptake of biodiesel products. Biodiesel is produced in several small plants and mainly utilises waste oil, animal fats and wild oilseed plants for biodiesel production. China is the largest importer of vegetable oils and soybeans in the world and therefore utilisation of these for biodiesel production is not feasible. Instead, China has been looking to develop biodiesel production based on seeds of energy trees, such as *Jatropha*, *Xanthoceras sorbifolia* and *Pistacia chinensis*, with the aim of growing these trees on hilly and marginal lands. However, development of these plantations has been slow due to low yields, high risk and low return (Chang et al. 2012).

Thus, most development has focused on bioethanol. At present, China has five state certified fuel ethanol production plants. In 2012, the estimated total bioethanol production for transportation use in China was about 2,56 million litres per year. Ethanol gasoline blend (E10) is of mandatory use in nine provinces in China. According to the Middle and Long Term Development Plan of Renewable Energy formulated by the National Development and Reform Commission (NDRC), bioethanol production is expected to expand to 10 million tons per year (12,620 million litres) by 2020 and nationwide application of ethanol gasoline blend is to be realized. Most of this biofuel is sold as an E10 blend with gasoline. There are currently pilot ethanol production projects in Heilongjiang, Jilin, Liaoning, Henan, Anhui, Shandong, Jiangsu, Hebei, and Shanxi provinces.

Table 5‑2 - Biofuel development and market share, China

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol(million L/a)** | **PPO(n/a)** | **Biogas****(n/a)** | **2nd-Gen (n/a)** | **Market share (%)** |
| 2004 |  |  |  |  |  |  |
| 2005 | 59 | 1,300 |  |  |  |  |
| 2006 | 60 | 1,800 |  |  |  |  |
| 2007 | 60 | 1,840 |  |  |  |  |
| 2008 | 60 | 1,900 |  |  |  |  |
| 2009 |  | 2,050 |  |  |  |  |
| 2010 |  | 2,050 |  |  |  |  |
| 2012 |  | 2,560 |  |  |  |  |
| 2020 | 2,300 | 12,700 |  |  |  |  |

Source: F.O Lichts, RFA 2011

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# Denmark

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## Introduction

Denmark has a multi-faceted energy supply based on a variety of energy sources, a high degree of efficiency in energy consumption and a significant domestic production of oil, natural gas and renewable energy. According to the Government’s national Energy Strategy 2025, from June 2005 the goal is to improve the use of market mechanisms and to promote more cost-effective initiatives. The Danish electricity and natural gas markets have been completely liberalised. With the implementation of the CO2 allowance system in the European Union, a step has been taken towards flexibility in climate protection. It reduces energy costs and increases freedom of choice. Finally, developments in the energy system are to a large extent to be based on Danish knowledge and technology.

While the percentage of renewables reached 16% in 2010, it is expected that renewable energy in Denmark will comprise over 20% in 2011 and 30% of energy in 2025. Public funding for renewable energy includes 1 billion DKK in 2010 (133mill Euro), with 15% of the funding being directed toward biomass projects. An increased use of renewable energy, in step with market needs for new capacity, will be far more cost-effective than politically forced increased use of renewable energy by the use of, for example, quantitative targets. The Energy Legislation Package expired at the end of 2011 and a new one was negotiated and adopted. Denmark’s political climate was expected to shift in 2011 after a general election which brought a centre-left government to power. Despite positive signals towards cellulosic ethanol, no support for this was included in the Energy Legislation Package. Planned initiatives of the new government included biomass availability analysis, transportation analysis and agricultural development.

Biomass currently accounts for ~70% of renewable energy consumption in Denmark, mostly in the form of straw, wood and waste, while biogas accounts for less. Public funding for energy exceeded 1 billion DKK in 2010 (€133 mill), with 15% being directed toward biomass. Public funding for biofuels has increased to around €13 million, with the focus of the funding changing from applied and basic research (funding from DSF and HTF) towards demonstration projects (EFP/EUDP). The majority of the money from EUDP in 2008 and 2009 was divided between Inbicon and Biogasol.

### Main drivers for biofuels policy

The main driver for biofuel policies in Denmark is to contribute to the European security of energy supply and decrease the CO2 emissions from transport. Another driver is the potential for national economic growth due to a fast growing international market, particularly for bioethanol. The Danish enzyme industry is a global market leader in enzymes for the production of biofuels and farmers are looking for alternative markets for their products based on increased international competition with regards to agricultural products.

## Biofuels policy

### Biofuel obligations

Denmark is the first country to introduce nation-wide distribution of cellulosic E5. From the summer of 2010, 5.75% blending is being mandated, and E5 in gasoline is now common. Statoil has introduced cellulosic E5 in 98 petrol stations in Denmark in October 2011, but has to introduce this cellulosic E5 fuel at a premium of approx. €0.02/litre (relative to ordinary E5 => €1.5 extra to fill up a car).

If other renewable fuels/energy (e.g. electric vehicles) is used in transport, the 5.75% mandate for biofuels can be correspondingly lowered. With regard to liquid biofuels there is still a lot of debate whether the technology is the most effective way to use biomass, which creates uncertainty in funding, political direction and legislation. However, this discussion is being shaped in the context of Denmark following the EU directive on sustainability criteria.

According to the new energy plan in 2012, a focus has been placed on biomass for combined heat and power (CHP) with no support for traditional biofuels. Denmark considers that the use of biomass for CHP production is a more cost-effective way to use the biomass resources than the present technology (first generation) for the production of biofuels. However, fossil fuel consumption in transport continues to increase and this needs to be addressed.

Policies around indirect land use change (ILUC) by the EU have an impact on traditional/conventional biofuels to ensure that sustainability remains an important criterion. The European Parliament voted in September 2013 to include ILUC considerations in its biofuels targets. Implications of this are that future biofuels will focus on low-ILUC risk biofuels and that no food-based fuels will be supported after 2020. At the same meeting, the European Parliament also voted to place a cap of 6% on land-based biofuels, including energy crops. However, this policy has not been finalised, creating uncertainty. Any growth in biofuels is expected to come from advanced biofuels. It was also determined that new biofuels installations must meet a 60% GHG saving, while biofuel installations in operation before 1 July 2014 must meet GHG savings of 35% by 1 December 2017 and 50% GHG savings by 2018.

Table 6‑1 Biofuel Obligation, Denmark

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Ethanol** | **Biodiesel**  | **Petrol + Diesel** |
| 2005 |  |  |  |
| 2006 |  |  |  |
| 2007 |  |  |  |
| 2008 |  |  |  |
| 2009 |  |  |  |
| 2010 | 5% | 3.35% |  |
| 2012 |  | 5.75% | 5.75% |

From July 2010 blending of 5% ethanol is mandatory in all gasoline, while blending of biodiesel must occur at 3.35% biodiesel in 2011, and 5.75% from 2012.

In summary, the biofuel mandates are

* By 2012, the target is 5.75% renewable in the transport fuel pools.
* There is discussion around the introduction of electric vehicles, which might change this ratio.
* However, there are also questions around the best use of biomass.

### Excise duty reductions

Since January 2005, there is a minor tax-reduction according to the normal CO2-tax on fossil fuels of 0.03 €/L (0.22 – 0.24 DKK/L). The CO2 advantage for the society is considered to be the only one that can be quantified. The tax reduction is proportional to the blend; in practise, only a 5% bioethanol blend is used in Denmark.

### Fiscal incentives

Not available.

### Investment subsidies

Not available.

### Other measures stimulating the implementation of biofuels

Denmark’s total funding for energy exceeded 1billion DKK in 2010, with the majority of funding being dedicated to wind (21%), hydrogen (19%), and biomass (15%) technologies. Public funding for biofuels has increased to around €13 million, but the focus has changed from basic and applied research toward demonstration projects. Previously, the majority of the money from EUDP in 2008 and 2009 had been divided between Inbicon and Biogasol.

### Promotion of advanced biofuels

Inbicon's bioethanol plant in Kalundborg has the capacity to produce 5.4 million liters (1.4 million gallons) annually. The facility runs on about 30,000 metric tons (33,000 tons) of straw per year and employs about 30 people. The plant was inaugurated in November 2009, produced the first straw ethanol in December 2009 and has sold 5 million litres to Statoil. The plant had received €10.2 mill in public support, with a total investment around €64 mill.

Pilot and demonstration plants

The Aalborg pilot plant in Copenhagen and Bornholm produces ethanol and biogas from wheat straw and cocksfoot grass with an output of 11 t/y (in operation). The BornBiofuel demoplant in Bornholm involves the further optimisation of advanced bioethanol by the company BioGasol.

The BioGasol demo plant in Aakirkeby, Bornholm is intended to produce ethanol, biogas, lignin and hydrogen from straw, grasses and garden waste with output of 4000 t/y. This project is an extension of BornBioFuel with the objective to establish a fully integrated biomass to ethanol demo plant. The BioGasol pilot plant in Ballerup was stopped in 2010.

Inbicon (Dong Energy) operates 2 pilot plants in Frederica and a demo plant in Kalundborg. The demo plant in Kalundborg is operational and produces ethanol and C5 molasses from wheat straw with an output of 4300 t/y. The 2 pilot plants in Frederica are still operational.

BFT Bionic Fuel Technologies AG operates a demo plant in Aarhus that produces diesel and hydrocarbons from straw pellets at 200 t/y.

Renescience (Dong Energy) operates a waste-to-energy pilot plant that was inaugurated in December 2009 and is located at Amagerforbrændingen, Copenhagen. It operates at 800 kg/hr continuous treatment of unsorted household water and uses liquefaction of the organic part in gasification (+ synfuel), and/or biogas production.

In September 2013 the development of a marine biofuel plant was announced by the Denmark-based Port of Frederikshavn, Canadian biofuel company Steeper Energy and Denmark-based Aalborg University. The proposed project is expected to produce between 50,000 and 100,000 tons of sulphur-free, drop-in marine fuel per year from wood feedstock.

Incentives for advanced biofuels include “double counting” of renewables targets of member states in the EU. However, it is argued by many in the industry that this has not worked and that targets for advanced biofuels should be set.

## Market development and policy effectiveness

Prior to 2006 the use of biofuel in Denmark was marginal. In May 2006, the first and, so far, only oil company Statoil introduced a 5% bioethanol blend – Bio95 – on a voluntary basis on the Danish market at a neutral price per litre for the consumer. Other companies may follow in the near future leading to a more than marginal domestic use of biofuels.

Denmark has one RME-factory producing approximately 100,000 tons biodiesel per year, mainly for the profitable German market. One other factory exists for the production of approximately 55 million litres of biodiesel based on animal fat from slaughterhouses. A range of private and farmer initiatives (possible factories) exists for large-scale production of bio-ethanol based on wheat and sugar beet. Decisions to build some of these plants are awaiting the market response to the Statoil initiative and the investor’s judgement of other relevant market conditions.

Table 6‑2 - Biofuel development and market share, Denmark

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol(million L/a)** | **PPO(n/a)** | **Biogas****(n/a)** | **2nd-Gen (n/a)** | **Market share (%)** |
| 2000 |  |  |  |  |  |  |
| 2001 |  |  |  |  |  |  |
| 2002 | 13(A) |  |  |  |  |  |
| 2003 | 53(A) |  |  |  |  |  |
| 2004 | 94(A) |  |  |  |  |  |
| 2005 | 95(A) |  |  |  |  |  |
| 2006 | 103(B) |  |  |  |  |  |
| 2007 | 103(B) |  |  |  |  |  |
| 2008 |  |  |  |  |  |  |
| 2009 |  |  |  |  |  |  |
| 2010 | 168(B) | 5 |  |  |  | 5% |
| 2011 |  |  |  |  |  |  |
| 2012 |  |  |  |  |  |  |

NB: 1 tonne bioethanol = 1,262 L = 39.5 GJ. 1 tonne biodiesel = 1,136 L = 40.6 GJ.

(A) Statistics from the European Biodiesel Board

(B) Statistics from the Danish Energy Agency

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# Finland

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## Introduction

Bioenergy is the most important renewable energy source in Finland, with abundant domestic raw material available. In 2011 Finnish energy consumption was 1,3 TJ (~33.2 Mtoe, ~386 TWh), with wood fuels contributing approximately 23% to the overall energy demand. The most important bioenergy sources are effluents produced in the forest industry, industrial wood residues such as sawdust and bark as well as forest chips and recycled fuels. Bioenergy is used for heat and power production for industry and municipalities in general. Its use has increased by over 80% since the early 1990s. Bioenergy currently covers 20% of total energy supply, one of the highest figures among the industrialised nations.

### Main drivers for biofuels policy

The main drivers for biofuel policies in Finland are the reduction of the dependence on fossil fuel imports and reduction of greenhouse gas emissions. The National Climate and Energy Strategy of Finland, updated in March 2013, was implemented to reach EU climate and energy policy targets and objectives. By 2020, the total energy consumption will be restricted to 310 TWh (-37 TWh compared to the current trend) and electricity consumption 98 TWh (-5 TWh). The share of renewable energy is targeted to rise to 38% by 2020 and the country strives to be energy sufficient; with moderately priced electricity sourcing that supports climate objectives. The country’s objectives include having a versatile system, diversified thanks to the cogeneration of power and heat, to support the nation’s own production capacity (to provide for peak consumption and possible import disturbances), with a focus to encourage plants that do not emit GHGs. These targets are to be reached by promoting demonstration and commercialisation of advanced biofuel technologies. A further objective is to replace about 10% of natural gas with forest-based SNG by 2025.

## Biofuels policy

### Biofuel obligations

An obligatory biofuel law has been in place since January 2008. In 2008, 2% of the total road transportation fuels were to be comprised of biofuels, with the mandate rising to 4% in 2009. After a 2010 amendment to the law, the distribution obligation was to increase from 4% to 6% for 2011-2013; followed by a gradual increase to 20% by 2020. A key measure for the government is to achieve the target of 20% renewable energy in transportation by 2020. E10 was introduced into the fuel market in Finland in 2011. Initially the ethanol was mostly imported but increasing amounts are now being produced in Finland.

The National Renewable Energy Action Plan of 2010 provided an overall target for the share of energy from renewable sources in the gross final consumption of energy. This target is set at 38% by 2020 (28.5% in 2005). The 2020 National target for energy from renewable sources in transport is 20% (in 2005: 0%, in 2010: 6%). With regards to transport biofuels, the use will increase to 7 TWh of fuel by 2020 with a biofuel distribution obligation to be set to 20% by 2020. Tax reforms are anticipated to help achieve this mandate. Biogas use is to be increased to 0.7 TWh by 2020, with a market-based feed-in tariff scheme coming into effect in 2011 to support these efforts.

Table 7‑1 - Obligatory biofuels shares

|  |  |  |  |
| --- | --- | --- | --- |
| Year | **Petrol** | **Diesel** | **Petrol + Diesel** |
| 2005 |  |  |  |
| 2006 |  |  |  |
| 2007 |  |  |  |
| 2008 |  |  | 2% |
| 2009 |  |  | 4% |
| 2010 |  |  | 5.75% |
| 2011 |  |  | 6% |
| 2012 |  |  | 6% |
| 2013 |  |  | 6% |
| 2020 |  |  | 20% |

### Excise duty reductions

Fuel tax exemptions are in place for purposes of demonstration projects. NExBTL high concentration blending with diesel, buses in the Helsinki Metropolitan Area existed until 31 December 2010, and ST1 Biofuels RE85 were in effect until April 2011. A new fuel taxation system was introduced in Jan 2011, based on fuel quality (exhaust emissions, GHG emissions).

### Fiscal incentives

In addition to tax benefits for methane-fuelled vehicles, it is generally considered that the basis of implementation of biofuel directive should be the large-scale use of biofuels in current vehicles and fuel distribution channels. Supporting biofuel systems, which require special vehicles and new distribution channels, has not been considered sensible in the Finnish climate. Since gas-engine vehicles present a high possibility for a decrease in fine particle emissions, especially in densely populated areas, there are support actions in place for gas-engine vehicles and methane.

Taxation of personal and commercial vehicles running on methane was changed by the law on fuel taxation (1280/2003), which came into force in early 2004, so that gas consumption is no longer subject to the punitive fuel tax previously applying. In addition to methane-using vehicles being exempted from fuel tax, personal and commercial vehicles have correspondingly been granted exemption, also from the power output taxation imposed under the vehicle taxation law (1281/2003), which otherwise is charged on all motor vehicles using fuels taxed less heavily than petrol, e.g. diesel-driven vehicles.

### Investment subsidies

Not available.

### Other measures stimulating the implementation of biofuels

Not available.

### Promotion of advanced biofuels

In Finland, research and development on transport biofuels is focused on the development of production technologies for advanced biofuels. The task force suggested a special development programme for developing Finnish technologies for advanced biofuels and introducing the technologies and the biofuels to the market. The Finnish government proposed a €9 million grant over three years for this programme in its second supplementary budget for 2006. The grant was used to launch a Tekes/Ministry of Employment and the Economy development programme, including pilot and demonstration projects.

In summary the following research programmes exist:

* Tekes: BioRefine – New Biomass Products Programme 2007-2012 (completed)
* Academy of Finland: Sustainable Energy & Sustainable products and production research programmes
* Programmes of research institutes: VTT Technical Research Centre of Finland, Metla Finnish Forest Research Institute, MTT Agrifood Research Finland
* TransEco Research Programme – Energy Efficiency and Renewable Energy in Road Transport 2009-2013

## Market development and policy effectiveness

The share of biofuels has grown from 0.04% (0.076 PJ) in 2007 to 5.57% by 2010. The data below (Table 7‑2) shows the current use of biofuels in Finland.

Neste Oil is producing renewable diesel (NExBTL) with a total worldwide capacity of around 2 million tons, spread across 4 plants. The first two smaller plants are located in Finland and were originally used to demonstrate the technology. The third and fourth plants are much larger and located in Rotterdam and Singapore where they have relatively good access to large volumes of plant and animal oil feedstocks.

The ST1 biofuels company produces bioethanol (RE85) in five small-scale production plants from waste fractions, such as biowaste from food processing plants and the food industry by-products. Several small-scale units are spread around the country using one distillation unit with a capacity of 22,000 toe/yr. In February 2013, ST1 announced that it was planning to construct a bioethanol plant in Kajaani using sawdust as a feedstock. The company is also a retailer and owns 20 service stations in Finland.

New biofuel production technologies:

Finnish company UPM is currently constructing a hydrogenation biorefinery in Lappeenranta, Finland. The biorefinery will produce 100,000 tonnes (120 million litres) of renewable diesel for transport. An investment of EUR 150 million formed the basis of this project.

Three industrial consortia have been developing gasification-based BTL processes. Only two BTL advanced biofuel projects will be supported under the first NER300 call. Investment decisions were pending as at March 2013.

Fortum’s pyrolysis plant is under construction in Joensuu, Eastern Finland, with a capacity of 50,000 tonnes bio-oil. The pyrolytic oils are intended for use in the heating sector.

Chempolis has been operating a demo plant in Oulu, Finland, which produces 5000 t/y ethanol and various other chemicals from lignocellulosics such as straw, reed, bagasse, corn stalks and wood residues.

Table 7‑2 - Biofuel development and market share, Finland

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol(million L/a)** | **PPO(n/a)** | **Biogas****(TWh)** | **2nd-Gen (n/a)** | **Market share (%)** |
| 2000 |  |  |  |  |  |  |
| 2001 |  |  |  |  |  |  |
| 2002 |  | 1.4 |  |  |  | 0.02% |
| 2003 |  | 7.5 |  |  |  | 0.1% |
| 2004 |  | 8.0 |  |  |  | 0.1% |
| 2005 |  | n/a |  |  |  | n/a, <0.1% |
| 2006 |  | 1.5 |  |  |  | 0.02% |
| 2007 | 0.14(A) | 3.0 |  |  |  | 0.04% |
| 2008 (B) | 97 | 50 |  |  |  | 2.11% |
| 2009 | 250 (C) | 4 |  |  |  | 4% |
| 2010 | 327 (C) | 4 |  |  |  | 5.75% |
| 2011 |  |  |  |  |  | 6.5% |
| 2012 |  |  |  |  |  |  |
| 2020 |  |  |  | 0.7 |  | 20% |

NB: 1 tonne bioethanol = 1,262 L = 39.5 GJ. 1 tonne biodiesel = 1,136 L = 40.6 GJ.

1. Consists of NExBTL biodiesel
2. Biofuel obligation applies
3. Includes hydro-diesel production

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# Germany

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## Introduction

Renewables form 12.7% (2011: 11.6%) of primary energy consumption in Germany (2012), while biofuels form 11% of renewable energy (which means 1.4% of total energy consumption). While production of nuclear power has decreased, power from coal has increased. In 2013 the public filling stations sold about 1.2 million tons of bioethanol as blend component E5/E10. But the national production was only 0.672 million tons. In 2013 about 2.2 million tons of biodiesel had been sold. This figure includes also the share of Hydrotreated Vegetable Oil (HVO), of estimated 0.45 million tons. The biodiesel production is estimated to about 2.8 million tons – thereof about 1.1 million tons were exported. B7 is still the current standard diesel fuel (only premium diesel does not contain biodiesel). Bioethanol is sold as E5 or E10 blend. But three years after the so called E10 disaster, the market share rose to merely 20 %, so there is still reluctance from customers to embrace the E10. Current information is available: http://www.ufop.de/medien/downloads/english/market-information/

The policy situation is the same as in most EU nations, with a set of targets and mandates set by the European Commission. It should be noted that the aim is for renewable energy, not only biofuels, which means that the amount of biofuels required to meet various targets may not be as great as originally thought. The current activities concerning introduction of electric vehicles and plug-in hybrids have also changed the situation. The GHG impact of different biofuels has been estimated. It has been acknowledged that the default values for biodiesel from soybeans and from rapeseed meet actual GHG reduction targets, but likely not the future targets in 2017. The definition of waste oil for double-counting and the different certification requirements are currently being questioned across the European Union. Starting in 2015, the blending quota obligation, based on the Renewable Energy Directive (RED), will be superseded by the Greenhouse Gas Quota, which is imposed by the Fuel Quality Directive (FQD). The latter does not contain the double counting for used cooking oil.

### Main drivers for biofuels policy

GHG savings are the primary driver for implementing German biofuel policies, and for that reason, Germany will be subject to Article 17 of the European Renewable Energy Directive (RED) 2009/28/EC “Promotion of the Use of Energy from Renewable Sources” that states that GHG savings from biofuels, compared to fossil fuels, must exceed 35% as of 2009, 50% as of 2017, and 60% as of 2018 (if the production line started in or after 2017).

Policy Drivers

* In 2006, the former tax exemption for biodiesel was ceased. Yearly rising taxes were introduced. It was intended to maintain the former biofuels’ market share by introduction of biofuels blending quotas (where the quota biofuel is fully taxed).
* In 2009, the quotas were reduced and from 2015 GHG savings are being prescribed in accordance with the European Fuel Quality Directive (FQD).
* The reduced total quota is 6.25% by 2014. The change in policy (i.e. the taxation) has had a huge impact with respect to the selling of B100. Most of the 1,900 public stations discontinued sales of biodiesel and only small amounts are still sold to commercial vehicles owners.
* The highest consumption was in 2007 (3.24 million tons, and 0.7 million tons of vegetable oil). The quota commitment has not been able to maintain production and consumption levels that were seen before the tax was introduced. Biodiesel plants had to be decommissioned or went bankrupt – the current biodiesel capacity is about 4 million tons (2009: 5.2 million tons)
* German production of ethanol has risen over recent years, but it is still by far lower than biodiesel production. Ethanol consumption is rising due to the impact of the quota and is nowadays first of all depending on the market share of E10.
* Recently, the acknowledgement of certification schemes has gained a lot of attention. ISCC is, like REDcert, fully acknowledged in Germany and also by the European Commission. But due to the acknowledgement of 13 certification systems by the EU Commission the international availability of sustainable certified biodiesel/bioethanol and consequently the competition increased.

## Biofuels policy

### Biofuel obligations

In January 2007, a quota for admixture of biodiesel into diesel fuel and ethanol into petrol was introduced. These biofuels are fully taxed. A summary of biofuel obligations is shown in Table 1‑1. in 2006 the German parliament’s lower house gave its final approval to the government proposals to cut the 2009 blending target to 5.25% biofuel content in fossil fuel in 2009 from the 6.25% originally intended. The blending obligations for the subsequent years were reduced, too. The obligation can be fulfilled by blending 7% v/v biodiesel in diesel fuel (EN 590). The so called co-refining of vegetable oils in mineral oil refineries is not yet allowed.

In case the quota is not reached then a fine of 0.62 €/L for biodiesel and 0.90 €/L for bioethanol, respectively, will apply.

Table 8‑1 Biofuel obligation, percentage by energy

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Petrol** | **Diesel** | **Petrol + Diesel** |
| 2006 |  |  |  |
| 2007 | 1.2 | 4.4 |  |
| 2008 | 2.0 | 4.4 |  |
| 2009 | 2.8 | 4.4 | 5.25% [previously 6.25%] |
| 2010 | 2.8% [previously 3.6%] | 4.4 | 6.25% [previously 6.75%] |
| 2011 | 2.8% [previously 3.6%] | 4.4 | 6.25% [previously 7%] |
| 2012 | 2.8% [previously 3.6%] | 4.4 | 6.25% [previously 7.25%] |
| 2013 | 2.8% [previously 3.6%] | 4.4 | 6.25% [previously 7.5%] |
| 2014 | 2.8% [previously 3.6%] | 4.4 | 6.25% [previously 7.75%] |
|  |  |  |  |
| Greenhouse Gas Quota |
| 2015 - 2016 | Reduction of the GHG emissions by 3.0% is required |
| 2017 - 2019 | Reduction of the GHG emissions by 4.5% is required |
| 2020 | Reduction of the GHG emissions by 7.0% is required |

### Excise duty reductions

Since 2006, there have been rising taxes on biofuels (the agricultural use is still energy tax free) and, at the same time, specific quotas for biofuel blends have been implemented. This follows a former complete tax exemption on biofuels. Biofuel blending targets were introduced, which are subject to full taxation. It is noteworthy that advanced biofuels and E85 are exempt until 2015.

There is no taxation until 2015 for synthetic biofuels (biomass to liquid – BTL), bioethanol based on hemicellulose, and E85. The reductions are subject to an annual revision. From 1 January 2013, the full tax has to be paid for all fuels. As a result, B100 (neat biodiesel) and pure plant oil have disappeared from the German market.

Table 8‑2 - Tax exemptions in Euro per liter (€/L) biofuel

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | **Ethanol** |  ETBE |  **Biodiesel** | **Vegetable Oil** | **BTL(C)** | **EtOH** |
|  | E85(A) | Blend | blend | B100 | blend | pure | blend |  | 2nd gen(C) |
| **2003** |  |  |  |  |  |  |  |  |  |
| **2004** | 0.65 | 0.65 | 0.65 | 0.47 | 0.47 | 0.47 | 0.47 |  |  |
| **2005** | 0.65 | 0.65 | 0.65 | 0.47 | 0.47 | 0.47 | 0.47 |  |  |
| **2006** | 0.65 | 0.00(B) | 0.00(B) | 0.38(B) | 0.32(B) | 0.47 | 0.47 |  |  |
| **2007** | 0.65 | 0.00 | 0.00 | 0.38 | 0.00 | 0.47 | 0.47 |  | 0.65 |
| **2008** | 0.65 | 0.00 | 0.00 | 0.34 | 0.00 | 0.39 | 0.47 |  | 0.65 |
| **2009** | 0.65 | 0.00 | 0.00 | 0.30 | 0.00 | 0.30 | 0.47 |  | 0.65 |
| **2010** | 0.65 | 0.00 | 0.00 | 0.30 | 0.00 | 0.30 | 0.47 |  | 0.65 |
| **2011** | 0.65 | 0.00 | 0.00 | 0.30 | 0.00 | 0.30 | 0.47 |  | 0.65 |
| **2012** | 0.65 | 0.00 | 0.00 | 0.30 | 0.00 | 0.30 | 0.47 |  | 0.65 |
| **2013** | 0.65 | 0.00 | 0.00 | 0.02 | 0.00 | 0.02 | 0.47 |  | 0.65 |
| **2014** | 0.65 | 0.00 | 0.00 | 0.02 | 0.00 | 0.02 | 0.47 |  | 0.65 |
| **2015** | 0.65 | 0.00 | 0.00 | 0.02 | 0.00 | 0.02 | 0.47 |  | 0.65 |

(A) Ethanol (E85) remains fully tax exempt until 2015

(B) Since Aug 1, 2006, tax on use of pure biodiesel was € 0.09 per liter, and tax exemptions for 1st generation biofuels in blends were withdrawn (besides ethanol as E85)

(C) 2nd generation biofuels will be examined annually by overcompensation calculations

### Fiscal incentives

The agriculture and forestry remains fully tax exempted.

### Investment subsidies

In the Eastern part of Germany the regions that suffer from high unemployment rates had been subsidized by funds of the European Structure Fonds (Europäischer Struktur-Fonds). These subsidies could also be used for installation of biofuels plants and infrastructure and expired in 2013. Hence especially in Eastern Germany biofuel plants had been raised, although it was well known that due to the annual overcompensation calculation by the ministry of finance a correction of the tax relief was to be considered. In some cases, the distribution of the biofuel and the supply with raw materials (cereals, rape seed, vegetable oil) was suboptimal. Consequently the most biofuel plants were shut down in Eastern Germany.

### Other measures stimulating the implementation of biofuels

Biogas and the use of renewable electricity for cars can be counted towards the quota commitment. In 2009, Germany implemented the ordinance for sustainable biomass production for biofuels and electricity production. On June 30, 2011, the German Parliament (Bundestag) voted for a complete nuclear power phase-out until the year 2022. This will change the situation for all renewables in the near future.

### Certification of biofuels

The sustainability criteria for biofuels agreed at European level under the Renewable Energy Directive and the Fuel Quality Directive were transposed into national law in 2010. The sustainability criteria had to become applicable as of 2011. With the Biofuel Sustainability Ordinance (Biokraftstoff-Nachhaltigkeits-Verordnung), Germany transposed the requirements of the Renewable Energy Directive (RED) into national law. The Federal Government authorized the “Bundesanstalt für Landwirtschaft und Ernährung” (BLE - Federal Institute of Agriculture and Nutrition) to guide and supervise the implementations. The BLE is responsible for the acknowledgment and control of certification systems, certification bodies and the web-based documentation system, called “Nabisy”. Two certification systems have been fully acknowledged: The International Sustainability and Carbon Certification System (ISCC) and REDcert. Tentatively acknowledged is the certification system “Round Table on Sustainable Biofuels” (RSB).

The certification systems have to reflect the requirements of the RED/ Biofuel Sustainability Ordinance: the detailed documentation and the implementation of a mass balance system in the entire supply chain. This includes: the farm, the first collector, the oilmill (1st processor), and finally the biofuel producer. This documentation chain is the precondition that the biofuel producer is enabled to generate a so-called sustainability certificate from the Nabisy web-system. This certificate is the precondition for the corresponding amount of biofuel to be counted towards the quota commitment or to apply for the tax reduction. In 2013 almost the entire harvest of rapeseed in Germany was certified, but due to the acknowledgement of 13 certification systems by the EU Commission the competition in the EU market is determined by sustainable certified biofuels or biomass from third countries (Asia, South America) and the generally reduced demand for biofuels due to the introduction of double-counting of biofuels (HVO/biodiesel) from waste oil and animal fats.

The certification process: The required documentation starts at the grower’s end. The grower sells the rapeseed to the agricultural trader and by issuing a so called producer declaration provides written confirmation that the rapeseed was grown in compliance with the sustainability requirements of the EU directive. The agricultural trader, in turn, documents the quantity of rapeseed received before he puts it in store. He also decides which producers will later be checked for the truth of the information supplied by them because at least 3% of the farms submitting a producer declaration must be checked.

The agricultural trader, upon selling the rapeseed to the oil mill, confirms whether the quantity sold was grown in line with sustainability requirements. The oil mill acts in the same way vis-à-vis the biodiesel producer. Then, the latter is entitled to issue the actual sustainability certificate. For this purpose, all data is entered in the "Nabisy" database of the BLE. The sustainability certificate will only be issued if the data relating to the origin of the input material is in order and a greenhouse gas reduction of at least 35% is obtained. This means that, considering the entire production pathway, the combustion of the biofuel must release 35% less greenhouse gases than conventional fuel. This ensures that only biofuels are sold that make a real contribution to climate protection.

### Promotion of advanced biofuels

A full tax exemption for advanced biofuels applies until 2015 and charging on the quota commitment. A pre-condition is an annual check of over-compensation.

The Bioliq demonstration plant at the Karlsruhe Institute of Technology is based on fast pyrolysis for production of biocrude, which will be converted to dimethyl ether (DME) and finally gasoline.

CHOREN went bankrupt in July, 2011 and was acquired by Linde Engineering, who has licensed its technology to Forest BtL Oy, which is pursuing production of 130 kt biofuel from 1.5 Mt of wood in Finland.

The Sunliquid demonstration plant of Clariant (formerly Süd-Chemie) started operations in 2012, producing 1000 t of cellulosic ethanol per year. Feedstocks are wheat straw and corn stover and enzyme production is integrated, with ethanol separation by adsorption carried out. In 2013, the EU-Commission agreed on the request of the company VERBIO to produce biogas from straw. This project is funded with EUR 22.3 million in the framework of the NR-3000 initiative of the European Union.

Attempts to commercialize butanol production are also under way, including approaches based on classical ABE fermentation using Clostridial strains. Süd-Zucker is currently doing R&D on catalytic production of butanol from ethanol.

Twenty institutes of RWTH Aachen University as well as two external research facilities from the fields of biology, chemistry, chemical and combustion engineering have joined in the newly founded “Fuel Design Center” to explore the production and combustion of novel fuels from biomass. The public funding of this so-called cluster of excellence, named “Tailor-made Fuels from Biomass (TMFB)” amounts to about 6.5 Mill € per year. One of the fuels that were in the focus of the group was 2-methyltetrahydrofurane (2-MTHF); it exhibited a good soot reduction potential.

In a large fleet test with more than 280 vehicles (cars, trucks and buses) a new fuel is road-tested. Diesel fuel R33 is a biodiesel fuel that is composed of 33 % of biogenic fuel and a premium-quality diesel fuel (67 %). The biogenic part consists of 7 % biodiesel that is derived from used cooking oil and 26 % of HVO (Hydrotreated Vegetable Oil from rapeseed oil and palm oil). The fuel meets the requirements of the European diesel fuel standard DIN EN 590. The scientific guidance of the project is performed by the Coburg University of Applied Sciences and Arts and the Thünen Institute in Braunschweig. A reduced emission of harmful engine exhaust gases – which would suggest an application of R33 particularly in inner-city traffic – and, through an extended oil change interval, some savings of engine lubricating oil are expected.

## Market development and policy effectiveness

The evolution of the German biofuel market is relatively unique in that it shows the dramatic impact of removal of policy incentives, which is identified in the peak production in 2007 and the decline thereafter (Table 8-3).

The effects of German biofuel policy have resulted in the following consequences:

* B100 is almost non-existent.
* Many of the smaller producers stopped production or went bankrupt.
* The quota biodiesel is partly produced from imported seeds or imported oils and esters (SME, PME), in particular during summer time. (see: UFOP filling station study)
* The Growth Acceleration Act (December 2009) stipulates that, until 2015, the tax is frozen to the level of the year 2009 (i.e. 0.18 €/L). As of January 1, 2011, E10 gasoline blend has been offered at the German filling stations, alongside the “old” blend (E5) --- for those cars that cannot comply with the higher alcohol content. This policy has been one of the more controversial efforts with substantial protests from the public who rejected E10 fuel in preference for conventional gasoline.

Table 8‑3 Biofuel consumption development and market share, Germany

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol+ETBE(million L/a)** | **PPO(million L/a)** | **Biogas****(n/a)** | **2nd-Gen (n/a)** | **Market share (% energetically)** |
| 2000 | 375 |  |  |  |  | 0.5% |
| 2001 | 510 |  |  |  |  | 0.7% |
| 2002 | 625 |  |  |  |  | 0.8% |
| 2003 | 910 |  |  |  |  | 1.2% |
| 2004 | 1,330 | 25 |  |  |  | 1.7% |
| 2005 | 2,100 | 165 | 270 | 0(A) | 0(B) | 3.3% |
| 2006 | 2,725 | 431 | 650 |  |  | 5.5% |
| 2007 | 3,685 | 580 | 761 |  |  | Diesel: 12.0%Gasoline: 1.3% |
| 2008 | 3,062 | 789 | 435 |  |  | Diesel: 9.1%Gasoline: 1.9% |
| 2009 | 2,859 | 1,139 | 108 |  |  | Diesel: 7.4%Gasoline: 2.8%  |
| 2010 | 2,933 | 1,461 | 75 |  |  | Diesel: 7.2%Gasoline: 3.7% |
| 2011 | 2,522 | 1,552 | 20 |  | 270(B) | Diesel: 6.4%Gasoline: 4.0% |
| 2012 | 2,181 | 1,463 | 24 |  | 540(B) | Diesel: 6.3%Gasoline: 4.4% |
| 2013 | 2,022 | 1,514 | 1 |  | 540(B) | Diesel: 5.9%Gasoline: 4.2% |

NB: 1 tonne bioethanol = 1,262 L. 1 tonne biodiesel = 1,136 L. 1 tonne Pure Plant Oil = 1,087 L.
 1 tonne HVO = 1,282 L

(A) Biogas is used in stationary applications. Utilization in the transport sector began in 2009.

(B) Hydrotreated Vegetable Oil (HVO)

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# India

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## Introduction

India imports nearly 70% of its annual crude petroleum requirement, about 220 billion litres in 2012. As vehicle sales continue to grow at 8-10% annually, demand for transportation fuels will continue to increase. Biofuel policies are in place for both bioethanol and biodiesel. For 2013, a target of 2.9% was set for blending ethanol with gasoline. The demand for diesel is five times higher than for gasoline (73% of transportation fuel demand) and an ambitious target of 20% blending was set for 2011/2012. Currently, bioethanol is produced from sugar molasses, a waste product from the sugar industry, while biodiesel is produced from *Jatropha curcas*. However, a lack of high yielding drought tolerant jatropha cultivars resulted in an undersupply of seeds for biodiesel production and the target of 20% was not met. Due to India’s large and expanding population, the food vs fuel debate is very important and no biofuels may be produced from any edible feedstocks. A downswing in sugar production for 2012 and 2013 will therefore affect ethanol production in 2014 due to a shortage of feedstock.

### Main drivers for biofuel policy

The main driver for biofuel policy is India’s energy security as continued expansion of the vehicle fleet increases the country’s reliance on imported oil. There is also an emphasis on development of biofuels in India that utilizes waste, while biodiesel production focusses on the cultivation of shrubs and trees bearing non-edible oil seeds. Due to India’s rapidly growing vehicle fleet, emissions from transport have also increased significantly (IEA, Biofuels roadmap). Rural development is also a main objective of bioenergy policy (IEA, Bioenergy report).

Land availability is a problem. India is densely populated with 51% of total land already under agricultural cultivation (at 2010). 13.5% of total land area is classified as cultivable waste land, but some of it is already used by rural farmers. Any available land will be used for crop cultivation, rather than cultivation of feedstock for advanced biofuels (IEA 2nd generation biofuels report). Water shortages are a growing concern which could have an impact on feedstock cultivation, as well as biofuel production.

## Biofuels policy

### Biofuel mandates

The National Policy on Biofuels was approved by the Indian government in December 2009. This policy proposed a target of 20 percent biofuel blending for both bioethanol and biodiesel by 2017. The National Biodiesel Mission (NBM) was launched which identified Jatropha curcas as the most suitable source of oilseeds for biodiesel production. The Planning Commission of India had set ambitious targets for Jatropha cultivation to cover 11.2-13.4 million hectares. Fiscal incentives were put in place to achieve these goals. As at 2013, Jatropha only occupied about 0.5 million hectares, of which 65-70 percent are new plantations of less than three years. A major stumbling block has been sufficient research on Jatropha and the development of drought-tolerant, high-yielding plants. Various other problems have hampered the growth of biodiesel production, including limited commercial production and virtually non-existent distribution. Jatropha takes 3-5 years to produce crops, which creates a problem for the farmer who doesn’t see a return on investment. India was unable to meet its mandate of 5% biodiesel blend in 2012 due to a shortage of jatropha fruits.

The target of 5% blending of ethanol in gasoline has been partially successful in years of surplus sugar production, but when sugar production declines, ethanol production falls short and the government has to rely on imports of ethanol. As sugar production is seasonal, ethanol production varies accordingly, causing a fluctuating supply. Lower availability of the molasses feedstock affects pricing and therefore cost of ethanol production, which also affects supply of ethanol.

Table 9‑1 Biofuel obligation, in percent

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Ethanol** | **Biodiesel**  | **Petrol + Diesel** |
| **2005** |  |  |  |
| **2006** | 5% |  |  |
| **2007** | 5% |  |  |
| **2008** | 5% |  |  |
| **2009** | 5% |  |  |
| **2010** | 5% |  |  |
| **2012** | 5% |  |  |
| **2017** | 20% | 20% | 20% |

In 2012, the Indian government unveiled a road map for the biotechnology sector “The Bioenergy Road Map Vision 2020”. It sets out the innovative technologies and policies for biofuels development, with a particular focus on the algal route for production of second generation biofuels.

### Excise duty reductions

India plans to eliminate cooking gas and kerosene subsidies in a phased manner starting April 2012, replacing it with direct cash support to the poor. In 2011, India has held down gasoline, diesel, LPG and kerosene prices from state-owned marketers amid escalating international prices.

Except for a concessional excise duty of 16 percent on bio-ethanol, no other central taxes and duties are proposed on bio-diesel and bio-ethanol. Higher taxes and levies in different states have impacted the Ethanol Blending Program. Rules and regulations (high excise duty, interstate charges, etc.) applicable to the control of alcohol for potable industry use are equally applicable for ethanol blending with petrol, thereby constraining its availability and utilization for the Ethanol Blending Program.

### Fiscal incentives

Not available.

### Investment subsidies

The Indian government does not provide direct financial assistance or tax incentives for the production or marketing of ethanol. However, several subsidized loan programs exist (via sugarcane development funds) to sugar mills for the building of ethanol production facilities. The loans cover a max of 40% of project costs to sugar mills [3].

The National Biofuels policy states: In view of the current direct and indirect subsidies to fossil fuels and distortions in energy pricing, a level playing field is necessary for accelerated development and utilization of biofuels to serve the Policy objectives. Appropriate financial and fiscal measures will be considered from time to time to support the development and promotion of biofuels and their utilization in different sectors.

### Other measures stimulating the implementation of biofuels

The government has expressed that planting of non-edible oil bearing plants, the setting up of oil expelling/extraction and processing units for production of bio-diesel and creation of any new infrastructure for storage and distribution would be declared as a priority sector for the purposes of lending by financial institutions and banks. National Bank of Agriculture and Rural Development (NABARD) provides re-financing towards loans to farmers for plantations. The Indian Renewable Energy Development Agency (IREDA), Small Industries Development Bank of India (SIDBI) and other financing agencies as well as commercial banks would be actively involved in providing finance for various activities under the entire biofuel value chain, at different levels.

The Government of India is offering subsidized loans through sugarcane development funds to sugar mills for setting up of ethanol production units. The loan would cover a maximum of 40% of the project cost.

**Demonstration Projects**

Demonstration Projects are planned for bio-diesel and bio-ethanol production, conversion and applications via Public Private Partnership (PPP). For R&D and demonstration projects, grants will be provided to academic institutions, research organizations, specialized centers and industry; however the mechanisms for these remain somewhat unclear. Strengthening of existing R&D centers and setting up of specialized centers in high technology areas will also be considered. Linkages would be established between the organizations / agencies undertaking technology development and the user organizations.

In regard to Research and Development in the area of biofuels, a Sub-committee under the Biofuel Steering Committee proposed in this Policy comprising Department of Bio-Technology, Ministry of Agriculture, Ministry of New and Renewable Energy and Ministry of Rural Development would be constituted, led by Department of Bio-Technology and coordinated by the Ministry of New and Renewable Energy.

### Promotion of advanced biofuels

Advanced biofuels in India are still at the research stage and it will take time before commercial production becomes economically viable. The government has expressed an intention to ensure that advanced of technologies are based on non-food feedstocks, as fuel vs. food security is very relevant in the Indian context.

“Intensive R&D work” is planned in the following areas:

* Biofuel feed-stock production based on sustainable biomass with active involvement of local communities through non-edible oilseed bearing plantations on wastelands to include production and development of quality planting materials and high sugar containing varieties of sugarcane, sweet sorghum, sugar beet, cassava, etc.
* Advanced conversion technologies for conventional biofuels and emerging technologies for advanced biofuels including conversion of lignocellulosic materials to ethanol such as crop residues, forest wastes and algae, biomass-to-liquid (BTL) fuels, bio-refineries, etc.
* Technologies for end-use applications, including modification and development of engines for the transportation sector based on a large-scale centralized approach, and for stationary applications for motive power and electricity production based on a decentralized approach.
* Utilisation of by-products of bio-diesel and bio-ethanol production processes such as oil cake, glycerine, bagasse, etc.

Lanza Tech Concord Enviro Systems is planning a demonstration plant in Aurangabad, India that will use carbon monoxide and dioxide to produce ethanol (300 t/y) and electricity.

Praj Industries announced the development of a biofuel demonstration facility that will process 100 tonnes of biowaste per day to produce cellulosic ethanol. The plant is under construction in the Sangli District of Maharashtra, India. Biowastes will include corn stover, corn cobs and bagasse.

Finland based biorefining technology Chempolis has signed a memorandum of understanding (MoU) with ONGC for the production of cellulosic ethanol and biochemicals from non-food biomass in India. The MoU will act as a road map for the first bio-refinery project in India and will also see both companies cooperating on constructing bio-refineries across the country preferably in areas of Uttar Pradesh, Punjab, Haryana, Maharashtra, Karnataka and Gujarat. Chempolis said that its third generation bio-refining technology will produce biofuels as well as sugars and lignin, which can be used as a platform into different products, in a sustainable way

To try and meet a 20% blending target by 2020, the Indian Government is also focusing on utilising algae for production of biofuels.

## Market development and policy effectiveness

Domestic ethanol production for 2014 is projected to be about 1.9 billion litres. India has 330 distilleries (of which 143 can produce fuel ethanol) with the capacity to produce about 2 billion litres of fuel ethanol.

Commercial production of biodiesel in India is fairly small. There are about 5-6 large capacity biodiesel plants in India with capacity to produce biodiesel from alternative feedstocks such as edible oil waste, animal fats and inedible vegetable oils. The government’s plan of producing sufficient bio-diesel to meet its mandate of 20% diesel blending will be unrealized due to a lack of sufficient jatropha seeds to produce bio-diesel. Jathropa yields have been significantly lower than was expected, which has caused farmers to organize and reject the feedstock, as it was not able to live up to the previously overly optimistic yield projections.

Biomass is frequently used in sugar mills, textiles, paper mills, and small and medium enterprises (SME) for heat and power generation. This purpose will be in direct competition for use of biomass for advanced biofuel production.

Due to scarcity of agricultural land and the need for vast amount of land for cultivation of biofuel feedstock, biofuels crops are considered a threat to both food production and forests. Hence the focus of the Indian Government on planting vast areas with *Jatropha curcas*, which was chosen as ithas the potential to grow in diverse agro­climatic conditions, withstand drought and pest attacks. However, the failure of Jatropha is highlighted by some authors due to low and inconsistent yields and inefficient return on investment. Due to the lack of research on Jatropha, many aspects of its growth and characteristics remain unknown and lead to variation in important parameters like seed yield, oil content, nutrient requirements etc. which are critical to economic viability of plantations.

Table 9‑2 Biofuel consumption development and market share

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol+ETBE(million L/a)** | **PPO(million L/a)** | **Biogas****(n/a)** | **2nd-Gen (n/a)** | **Market share (%)** |
| 2004 |  |  |  |  |  |  |
| 2005 |  |  |  |  |  |  |
| 2006 |  | 200 |  |  |  | 1.5 |
| 2007 |  | 200 |  |  |  | 1.4 |
| 2008 |  | 280 |  |  |  | 1.8 |
| 2009 | 30 | 100 |  |  |  | 0.0 / 0.6 |
| 2010 | 52 | 50 |  |  |  | 0.1 / 0.3 |
| 2011 | 60 | 365 |  |  |  | 0.1 / 1.7 |
| 2012 | 70 | 305 |  |  |  | 0.1 / 1.4 |
| 2013 | 75 | 650 |  |  |  | 0.1 / 2.9 |

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USDA Gain Report

# Italy

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## Introduction

Italy has a national energy demand of 79.2 million tonnes of oil equivalent, of which about 17 Mtoe is sourced from renewables (9%). Around 69.5 Mtoe (36%) is derived from natural gas, and 16.7 Mtoe (9%) is sourced from coal. The remaining 5% is imported as electricity from neighbouring nations. In summary, Italy’s energy supply still relies on fossil fuels and on foreign imports. Renewable energy availability is modest relative to overall energy consumption.

According to the last agricultural census, the total surface area of Italy is 30 Mha. The area used for agriculture is 40% (SAU), while the total agricultural farm area (SAT) is 60%. On the whole, up to 6 Mha would in principle be available for energy crops. However this is an upper potential that include forests (15%), meadows (13.7%) and marginal lands (7.5%) widespread over the entire Italian territory[[1]](#footnote-1).

Based on the European mandate that provides for Italian energy production from renewables of 17% by 2020, an overall renewable energy production of 22.3 Mtoe is anticipated. Bioenergy will contribute 45% (9.8 Mtoe) to this target. This estimate is congruent with Italian bioenergy potential, which is presently estimated to be around 15-18 Mtoe, excluding energy from microalgae (ENEA’s national atlas of biomass).

### Main drivers for biofuel policy

The primary drivers for the development of Italian biofuels policy are increasing energy demands coupled with a drive to reduce GHG emissions.

## Biofuels policy

The “Italian Action Plan for Renewable Energy – Biomass” lays out the following bioenergy and renewable energy goals by 2020. The total renewables substitution is expected to reach 17% at 6.94 Mtoe and transport fuels are to increase from 0.2 Mtoe in 2005 to 2.5 Mtoe by 2020, a more than ten-fold increase in transport biofuel utilization in 15 years.

Table 10‑1 - Targeted mandate for renewable energy

|  |  |  |
| --- | --- | --- |
| **Biomass** | **2005****(Mtoe)** | **2020** **(Mtoe)** |
| Electricity | 0.4 | 1.8 |
| Thermal Energy | 1.65 | 5.5 |
| Transport fuels | 0.2 | 2.5 |
| Total Biomass | 2.25 | 9.8 |
| Total Renewables | 6.94 | 22.3 |

The Italian approach to biofuel policy changed over the years. During the period from 2006 to 2009, the Italian Government adopted a policy based on fiscal incentives. Afterwards the strategy changed into a mix of fiscal incentives and a compulsory quota and since January 2010 is only based on a compulsory quota. The existing policy consists of a fixed obligation quota per year as seen in Table 10‑2 below.

### Biofuel mandate

Italy implemented a mandatory target for 2% biofuels in 2008, which increased to 3.5% of biofuel sales in 2010, 4% in 2011 and 4.5% in 2012 (Table 10‑2).

Table 10‑2 – Biofuel targets in Italy

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Biodiesel (%)** | **Bioethanol (%)** | **Biofuel** |
| **2007** |  |  |  |
| **2008** |  |  | 2% |
| **2009** |  |  | 3% |
| **2010** |  |  | 3.5% |
| **2011** |  |  | 4% |
| **2012** |  |  | 4,5% |
| **2014** |  |  | 5% |

### Excise duty reductions

The Finance Act of 2007 introduced a program of incentives from January 1, 2007 to December 31, 2010, providing a quota of 250,000 tonnes of biodiesel (2007 to 2009), which are eligible for a 20% excise duty reduction. The measure was approved by the European Commission, via a decision made on 20 August 2008 - C (2008) 4589.

The same 2007 Finance Act provided a three-year EUR 73 million program of fiscal facilitation (January 1, 2008 - Dec 31 2010) for certain products, including bioethanol and ETBE of agricultural origin. In 2010, the biodiesel quota eligible for a 20% excise duty reduction was fixed by the Finance Act 2010 to 18 000 tonnes and the budget for the facilitation for bioethanol was reduced from EUR 73 million to EUR 3.8 million. The introduction of lignocellulosic fuels could bring further changes in the coming years.

Table 10‑3 - Tax reductions in Euro

|  |  |  |
| --- | --- | --- |
| **Year** | **Biodiesel** | **Bioethanol** |
| 2007 | 20% excise duty reduction  | ~50% excise duty reduction |
| 2008 | 20% excise duty reduction | ~50% excise duty reduction |
| 2009 | 20% excise duty reduction | ~50% excise duty reduction |
| 2010 | 20% excise duty reduction | ~50% excise duty reduction |
| 2011 |  |  |

### Fiscal incentives

Fuels are subject to obligations (it is a different case from bioelectricity, which is subsidized in various ways).

### Investment subsidies

Special European funds are made available through the member state, for example, to investments located in 4 southern regions. However, this is not strictly limited to biofuels, but it is rather a general instrument to stimulate investment in sustainable technologies to promote developments of these regions. Thus biofuels are also eligible, but the measure is not dedicated strictly to biofuel technologies.

### Other measures stimulating the implementation of biofuels

Measures stimulating the implementation of biofuels are based on the *obligation quota.*

### Promotion of advanced biofuels

Mossi & Ghisolfi is a family company headquartered in Italy, is the country’s second largest company, and a leader in PET production and PET technology with plants in Italy, USA, Mexico, Brazil and China. The M&G Group have invested significant resources in renewables and have dedicated years of effort in developing an innovative technology, PROESA® for advanced bioethanol production from non-food biomass.

Chemtex and its parent M&G Group have engineered and constructed a pilot facility in Rivalta Scrivia, Italy, where they have developed a unique biomass pretreatment and hydrolysis process, for which 11 patent applications have been filed, for transforming cellulosic feedstock into sugars, for conversion into ethanol and bio-based chemicals.

Key features of M&G technology:

* Feedstock flexibility with the ability to utilize a wide variety of biomass species that are suitable for cultivation on low productivity/marginal land
* Proprietary pre-treatment and viscosity reduction processes that produce high quality low cost fermentable cellulosic sugars for ethanol or sustainable chemical production
* Simultaneous fermentation of C5 and C6 sugars
* Production of cost-competitive ethanol all over the world even with oil at USD 60-70/bbl.
* Creation of field-to-plant supply chain

Beta Renewables, part of the Mossi & Ghisolfi Group, and Novozymes announced the official opening of the cellulosic ethanol plant in Crescentino, Italy in October 2013. Beta Renewables’ PROESATM engineering and production technology is used alongside Novozymes’ Cellic® enzymes to produce this advanced biofuels platform. The plant uses wheat straw, rice straw and arundo donax, a high-yielding energy crop grown on marginal land. More than $200 million has been invested in research and development of the technology since 2011. The lignin extracted from the biomass is used in an attached power plant to produce power and excess electricity is sold to the local grid. In full production, the plant is expected to deliver 75 million litres of ethanol.

The Italian no-profit Research Consortium RE-CORD, in participation with the University of Florence, has multiple projects across the bioenergy area - including thermochemical and biochemical production as well as feedstock production.

Sites of the Consortium:

* Experimental Area (1 ha, fenced) at the Villa Montepaldi University farm, with a building and a greenhouse hosting various pilot plants.
* Chemical lab in the Mugello area (via Pianvallico SpA), dedicated to renewable energies and in particular biomass and biofuels.
* Via CREAR, the research center on renewables at the university of Florence, operates various Renewable (Biomass) Energy plants (such as a small scale gasifier, a lab pyrolyser/torrefier, several MGT fed with BD, VO, PO, an external solid biomass combustion plant, as well as innovative algae cultivation raceway-ponds, and other technologies).
* Via Spike Renewables Srl performs first engineering and installation of plants.
* Location at CREAR premises downtown Florence (“S.Stecco” Energetics Dept).

ENEA, the National Agency for the new technology, Energy and Sustainable Economic Development has a specific mission to advance applied research activities, technology transfer and dissemination of innovation. In particular, the Research Centre “La Trisaia” (in the south of Italy) ENEA has constructed complete platforms for the conversion of biomass/wastes, comprising a number of bench scale, pilot scale and demonstrative scale. In the last 10 years, ENEA CR Trisaia has been involved in several R&D projects on advanced/lignocellulosic ethanol from residues including poplar chips, residual straws, corn stover, waste paper, crops from phytodepuration. Thanks to the centre’s competencies and infrastructure, ENEA is one of most suitable Italian stakeholders for implementing biorefinery systems.

## Market development and policy effectiveness

Biodiesel production has been severely affected by the increase in imports since 2008. Imports are from countries where there are several fiscal production incentives, such as Argentina and Canada. Imports of biodiesel provided 35% of total consumed volume in 2009, 51% in 2010 and 70% in 2011.

Table 10‑4 - Biofuel development and market share, Italy

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol(million L/a)** | **PPO(n/a)** | **Biogas****(n/a)** | **2nd-Gen (n/a)** | **Market share (%)** |
| 2000 |  |  |  |  |  |  |
| 2001 |  |  |  |  |  |  |
| 2002 | 239 |  |  |  |  |  |
| 2003 | 310 |  |  |  |  |  |
| 2004 | 364 |  |  |  |  |  |
| 2005 | 450 | 8 |  |  |  |  |
| 2006 | 508 | 128 |  |  |  | 5% |
| 2007 | 412 | 60 |  |  |  |  |
| 2008 | 761 | 58 |  |  |  |  |
| 2009 | 903 | 128 |  |  |  |  |
| 2010 | 830 | 45 |  |  |  |  |
| 2011 |  | 60 |  |  |  |  |
| 2012 |  | 150 |  |  |  |  |

NB: 1 tonne bioethanol = 1,262 L = 39.5 GJ. 1 tonne biodiesel = 1,136 L = 40.6 GJ.

Source: Re-Cord and NBB 2011, epure

The experience of the advanced biofuels plant at Crescentino has highlighted the problems/challenges associated with EU directives’ application. The practical issues in certifying supply and production chains according to EU requirements are complex and difficult to overcome. Certification requirements seem poorly suited to cellulosic ethanol, where certification of supply chains could involve thousands of farmers supplying straw to such a plant. Several European biofuels stakeholders are working to reduce these practical obstacles.

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# Japan

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## Introduction

The Basic Energy Plan established by the Japanese government in October 2003 was revised in 2007 and 2010 in consideration of changes in the situation associated with energy, and established as the Strategic Energy Plan of Japan (1) in which gasoline blended with 3% or more of bioethanol equivalent will be introduced in Japan by 2020.

Under the Strategic Energy Plan of Japan (1), the Ministry of Economy, Trade and Industry (METI) has proposed an action plan in which more than 50% of such biofuel is targeted to be produced in Japan or produced abroad by the technology developed in Japan for cellulosic bioethanol and imported to Japan for its utilization. In addition, developments of BTL (Biomass to Liquid) technologies, as well as microalgae, are taking place and targeted for commercial production of biofuels by 2030.

As shown in Table 11-1, biodiesel production in Japan gradually increased from 4.5 ML in 2006 to 8.6-8.7 ML in 2009-2011 as fatty acid methyl esters (2), while PPO (pure plant oil) has not been used at all. Production of conventional (1st generation) bioethanol was 22.7ML in 2010 and 25.2 ML in 2012. In order to meet the government target of 360 ML bioethanol in 2010, equivalent to 840 ML ETBE (Ethyl Tertiary Butyl Ether), sales of 370ML as bioethanol was recorded (which is equivalent to 870ML ETBE and 220ML crude oil), of which 350ML of bioethanol was imported from the US and Brazil in the form of ETBE (3).

There are two reasons put forward by the Petroleum Association of Japan for the use of ETBE instead of bioethanol for blending with gasoline. The addition of bioethanol to gasoline causes a rise in the vapor pressure by azeotropy so that hydrocarbon gas emissions would be increased. In addition, absorbance of moisture from the atmosphere results in phase separation which decreases gasoline quality. For 2011 and 2012, a similar quantity was also imported.

### Main drivers for biofuel policy

One of the key drivers for biofuel policy in Japan is environmental, focusing on the reduction of CO2 emissions as a countermeasure against global warming. The government has targeted reductions in oil dependency as a means of increasing national energy security, and biofuels support this goal. A major reason for focusing research efforts on cellulosic ethanol is the fact that it does not compete with food. As food prices have increased over the years, debate has increased on the use of food crops to produce biofuels.

## Biofuels Policy

### Biofuel targets

In the Basic Energy Plan, the fundamental principles of energy policy are essential for “securing of a stable supply,” “environmental suitability against global warming,” and “decrease of dependence in fossil fuels” (1). However, the present situation in Japan is deplorable and alarming from a viewpoint of energy security, because 96% of energy is dependent on imports. Thus, utilization of biofuels is of great importance. In “Japan’s New National Energy Strategy“, announced in 2006 (4), therefore, 98% dependence in the transport sector on petroleum in 2000 is going to be reduced to 80% by 2030 through shifting the use of liquid fossil fuels into biofuels. Improving energy efficiency by 30% was also set as a target.

The Next-generation Vehicle and Fuel Initiative (announced by METI in 2007), emphasized the importance of development of cellulosic bioethanol. In 2008, the Biofuel Technology Innovation Plan was launched by METI and MAFF (Ministry of Agriculture, Forestry and Fisheries), and set targets for cellulosic ethanol production cost at 40 yen per litre. In 2010, the Basic Energy Plan set a target for 3% of gasoline to be blended with biofuel by 2020. The focus was on the reduction of GHG emissions. To meet this target, gasoline was to be blended with 3% or more of bioethanol in form of ETBE, 7% of which is equivalent to 3% bioethanol, by 2020. By 2030, higher blend levels of bioethanol are expected through the establishment of technology to produce biofuels from lignocellulosics. Similarly, microalgae are also expected as raw materials for biodiesel production.

The Act on the Sophistication of Energy Supply Structures (2009) imposed an obligation on oil refiners to use a certain amount of biofuel. Next-generation biofuel technologies, whose GHG emission reduction effects are higher than 50% is also being promoted. For these lines of future prospects in Japan, “Sophisticated Methods of Energy Supply Structures”, was established in 2009 (5) for promoting the utilization of renewable energy and the biofuel targets are as described in Table 11-1 for gasoline and diesel. However, a target was only set for gasoline to be blended with bioethanol, but not for diesel with BTL and FAME (Fatty Acid Methyl Esters) from plant oils and oils from microalgae.

After the accident at Fukushima, a revision of the Basic Energy Plan is under discussion.

Japan has established biofuel targets for gasoline and diesel blended fuels spanning 2010 to 2030. The emphasis on ethanol is for production of ETBE to be used as a gasoline extender, with the 360 ML target for ethanol in 2010 met through imports. The 2017 target is 870 ML, 1210 ML by 2020 and “maximum” by 2030. Japan projects some reduction in future demand for transportation fuels due to higher efficiency vehicles (hybrids) and a decrease in vehicle sales.

Table 11‑1 Biofuel targets in Japan

|  |  |  |  |
| --- | --- | --- | --- |
| Year | Petrol | Diesel | Petrol + Diesel |
| 2010 | 360 ML bioethanol \* | - | >360 ML |
| 2017 | 870 ML bioethanol \*\* | - | >870 ML |
| 2020 | 1,210 ML bioethanol) or3% \*\*\* | - | >1,210 ML |
| **2030** | Maximum | Maximum | Maximum |

\* Target by Petroleum Association of Japan

\*\* Mandatory for oil refiners to consume 870 ML

\*\*\* Policy target based on the Basic Energy Plan

### Excise duty reductions

Diesel oil delivery tax is not charged for B100 (100% biodiesel). Therefore, in many local governments, the use of B100 as fuel is investigated for official vehicles such as garbage trucks. For bioethanol, on the other hand, the Japanese government introduced temporary special tax incentives for promoting its use. In case of E3 gasoline, gasoline tax ￥1.6/L (= 1.2¢/L, under a currency exchange rate of US$1 = ￥77), as of November, 2011 is reduced, effective until March 2013. To maintain the quality of E3 gasoline, the government demands the blender to be registered.

### Fiscal incentives

Not available

### Investment subsidies

Not available.

### Other measures stimulating the implementation of biofuels

Under the “Basic Law for Promoting Biomass Utilization” enacted in 2009 (6), MAFF (Ministry of Agriculture, Forestry and Fisheries) has a target to establish biofuel manufacturing technology by 2020, with energy plants developed in Japan (0.4 Mt) based on carbon conversion such as corn, sugarcane, rapeseed, willow, etc., while in the ME (Ministry of Environment), projects for the technology development of biofuels and their commercial utilization are also deployed under the Strategic Energy Plan of Japan. However, the different proposals among these ministries in the Japanese government are not unified as the single straight targets of the government biofuels strategy, thus the different ministries are now trying to set unified targets for the Japanese government.

### Promotion of advanced biofuels

For production of advanced (2nd generation) bioethanol around 2020, technology development from lignocellulosics has been making progress. NEDO (New Energy and Industrial Technology Development Organization) projected to meet the target of ￥40/L (under US$1 = ￥102) as of 2008 on the scale of 100-200ML/yr for the commercial plants. This target was set in “The Bio-fuel Technology Innovation Plan” announced in 2008 by METI (7), considering the commercial cost of bioethanol in the US. However, this goal has not yet been met at pilot plant scale. NEDO coordinates cooperative research and development between universities and companies for the purpose of developing practical applications and commercializing innovative technologies. With respect to bioethanol production, a specific focus is placed on development of cellulosic bioethanol from non-edible plants. R&D of technologies is carried out in Japan, but demonstration projects are often established overseas, mainly in Asia. However, production of advanced (2nd-Gen) bioethanol is not yet at commercial stage.

NEDO is currently running two projects for the development of advanced biofuels. NEDO Project 1 investigates the development of an integrated system for low-cost cellulosic bioethanol production from energy crops such as *Erianthus* and Napier grass. Collaborators include JX Nippon Oil & Energy Corp, Mitsubishi Heavy Ind Mechatronics Sys, Ltd., Toyota Motor Corp, Kajima Corp, Sapporo Eng Ltd., Toray Ind Inc., and The University of Tokyo. Research is focused on ammonia pretreatment and Separate Hydrolysis and Fermentation, while raw materials are imported. Enzymes are produced on site and both C6 and C5 sugars are targeted for fermentation. NEDO Project 2 operates a pilot plant in Hiroshima, Japan for bioethanol production from fast growing trees (*Eucalyptus*). Collaborators include Oji Holdings Corp, Nippon Steel & Sumiking Eng Co Ltd, and the National Institute of Advanced Industrial Science & Technology. The plant produces 250 L bioethanol per day, using mechanochemical pretreatment and Simultaneous Saccharification and Fermentation. The process includes integrated enzyme recovery and low pressure (vacuum) distillation.

Research and development is set to continue on both projects until 2014, after which scale- up will take place to fulfill a target for 100-200 ML per year in the future.

## Market development and policy effectiveness

The gross amount of biofuels production in Japan is extremely low. As already mentioned, 370ML of bioethanol based on bioETBE was sold in 2010. However, 350ML was imported from abroad in the form of bioethanol. Biofuel production figures of conventional (1st generation) bioethanol and biodiesel for the last several years in Japan are shown in Table 11-2.

Table 11‑2 - Biofuel development and market share, Japan

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol(million L/a)** | **PPO(n/a)** | **Biogas****(n/a)** | **2nd-Gen (n/a)** | **Market share (%)** |
| 2006 | 4.5 | 0.03 |  |  |  |  |
| 2007 | 6.7 | 0.09 |  |  |  |  |
| 2008 | 7.0 | 0.2 |  |  |  |  |
| 2009 | 8.6 | 14.7 |  |  |  |  |
| 2010 | 8.7 | 22.7 |  |  |  |  |
| 2011 | 8.6 | 22.8 |  |  |  |  |
| 2012 | - | 25.2 |  |  |  |  |
| 2013 |  |  |  |  |  |  |

Plants that produce conventional bioethanol are shown in Table 11-3. The JA plant in Niigata Prefecture was established in 2008 and has a production capacity of 1.0ML for conventional (1st generation) bioethanol, while the Oenon Holdings Inc. plant in Hokkaido, established in 2009, has a capacity to produce 15ML. Hokkaido Bioethanol Co., Ltd, Hokkaido has a production capacity of 15ML. Production of bioethanol in these companies for 2012 were 0.75, 12.6 and 11.1ML and has remained more or less constant for the last few years from 2010 through 2012. The raw materials used by these plants are rice grain and beet. The two companies in Hokkaido and JA in Niigata have already been contracted to supply all their bioethanol for bioETBE production. On the other hand, Ryuseki Co. is producing bioethanol (0.6ML/yr) from molasses from sugarcane under the “Bioethanol Island” project in Miyakojima Island, Okinawa Prefecture. This project has proceeded under cooperation among Cabinet Office, METI, MAFF, MOE, MLIT (Ministry of Land, Infrastructure, Transport and Tourism) and FDMA (Fire and Disaster Management Agency) from 2008, and the produced bioethanol is directly used with gasoline as E3 without converting bioethanol into ETBE.

Table 11‑3 Commercial production of conventional bioethanol

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Company | City in Japan | Production (ML/yr) | Production Capacity (ML/yr) | Raw Materials | Ref. |
| 2010 | 2011 | 2012 |
| JA | Niigata | 0.72 | 0.71 | 0.75 | 1.0 | Rice grain | 8),9) |
| Oenon Holdings, Inc. | Tomakomai, Hokkaido | 9.2 | 12.0 | 12.6 | 15.0 | Rice grain | 9),10) |
| Hokkaido Bioethanol Co., Ltd | Tokachi,Hokkaido | 12.2 | 9.6 | 11.1 | 15.0 | Beet | 9),11) |
| Ryuseki Co. | Miyakojima,Okinawa | 0.54 | - | - | 0.75 | Sugarcane | 9),12) |
| Brazil-Japan Ethanol Co. | Demizu,Kagoshima | - | 0.46 | 0.80 | - | Sugarcane | 9),13) |
| Total | - | 22.7 | 22.8 | 25.3 | - | - |  |

For biodiesel from waste cooking oil, production has been low (8.6ML for 2009) due to the fact that the users of this biodiesel, local governments and industrial waste disposal operators, are small in scale. In addition, the tax exemption for biodiesel is only on B100 biodiesel, but not for the biodiesel blends.

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# The Netherlands

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## Introduction

In comparison with other European countries, natural gas plays a very important role in the Dutch energy supply system. Both on-land and in the North Sea, large natural gas reserves are exploited. As a result, natural gas is the major fossil fuel for production of electricity and heat. The share of renewables in the total primary energy consumption has been continually increasing from 2.4% in 2005 to 3.5% in 2008 and 4.4% in 2012.

The national energy policy aims to secure energy supply for the future and reduce emissions from the energy sector. Mandatory targets set by the Directive on the Promotion of the use of energy from renewable sources (RED, 2009/28/EC) are as follows:

* 14% share of renewable energy sources in final consumption of energy in 2020.
* 10% share of renewable energy in final consumption of energy in transport by 2020.

As part of a national energy agreement in September 2013, a target was set for 2023 for a 16% share of renewable energy sources in final consumption of energy in 2023.

### Main drivers for biofuels policy

The main driver for biofuel policies in the Netherlands is to decrease GHG emissions from transport. For all sectors except transport, GHG emissions have decreased over the last years. Other drivers like security of supply and an opportunity for people in rural areas have been mentioned but are of less importance in the Netherlands. For the Dutch government, guaranteeing the sustainability of biofuels for transport and biomass for electricity and heat production is an important condition of promoting the use of bioenergy in the Netherlands.

## Biofuels policy

### Biofuel targets or mandates

Table 12‑1 presents the actual biofuels targets adopted by the Netherlands. In 2012 and 2013, the State Secretary of Environment discussed the introduction of more ambitious targets with the Dutch parliament, leading to a 10% biofuel obligation in 2017, including a cap of 5% for conventional biofuels. This increase in the targets was postponed (letter of State Secretary to parliament in 2013).

Table 12‑1 - Biofuel obligations (percentage by energy)

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Petrol** | **Diesel** | **Petrol + Diesel** |
| **2007** | 2% | 2% | 2% |
| **2008** | 2.5% | 2.5% | 3.25% |
| **2009** | 3% | 3% | 3.75% |
| **2010** | 3.5% | 3.5% | 4% |
| **2011** | ≥3.5% | ≥3.5% | 4.25% |
| **2012** | ≥3.5% | ≥3.5% | 4.5% |
| **2013** | ≥3.5% | ≥3.5% | 5% |
| **2014** | ≥3.5% | ≥3.5% | 5.5% |
| **2015** |  |  | 6.25% (announced) |
| **2016-2017** |  |  | Not yet determined |
| **2020** |  |  | 10% |

As of January 2007, a biofuel obligation has been in place in the Netherlands with the obligation on the oil companies that bring petrol and diesel from excise warehouses onto the Dutch fuel market. In 2007 the obliged parties had to show administratively that 2% (by energy) of their total amounts of petrol and diesel sold consisted of biofuel. Back then it was the intention that in 2008, 2009 and 2010 this percentage would gradually increase to 3.25%, 4.5% and 5.75% respectively. In October 2008, it was decided to lower the obligation to 3.75% and 4% in 2009 and 2010 respectively. This was motivated by the ‘food vs. fuel’ discussion plus the fact the certification of biofuels (by which sustainability of biofuels can be shown) had only been introduced slowly, with the result that in 2009 and 2010 the sustainability of biofuels could not be guaranteed. The obligation refers to an overall market share and is not a blending obligation. The obligation must be met for petrol and diesel separately to ensure that biofuels will be developed in both markets. Suppliers must maintain records, which show they are complying with their obligations.

In the Netherlands, the legislation that implemented the EU Renewable Energy Directive (RED) came into force on January 1st 2011. The administration, inspection and enforcement of this legislation is the responsibility of the Dutch Emissions Authority (NEa). NEa publishes a yearly report on the amount, type and origin of biofuels supplied to the Dutch market (first report for 2011 (reports are in Dutch).

The new legislation, which builds upon the biofuels obligation in place as of 2007, obliges companies that supply transportation (bio)fuels to supply a certain share of renewable energy. Biofuels must be in compliance with the sustainability criteria set by the EU RED in order to count towards the obligatory percentages. In achieving the obligatory targets (see Table 12.1) both the petrol and diesel markets must include a minimum percentage of 3.5% biofuels.

The new legislation, just as the Regulation on double counting of better biofuels that entered into force in 2009, provides that biofuels produced from wastes, residues, non-food cellulosic material and cellulosic material under certain conditions may be double-counted in meeting the obligation. During an update of the legislation in June 2013, a list of wastes/residues and (co-)products was added to the legislation. From this list it is clear which materials lead to double counting biofuels. For these biofuels a verification statement needs to be provided to the company with the obligation. The regulation contains requirements for the statement and for the verifier; without meeting these requirements a verification statement for double counting will not be accepted.

In addition to liquid biofuels, from 2011 onwards, biogas (provided it is sustainable) and renewable electricity may also be counted towards the targets if they have been supplied to road vehicles and/or mobile machines. Biogas and electricity suppliers may choose to be included in the system ("opt-in") and sell their ‘over-performance’ to companies that must comply with the obligation. Renewable electricity that is supplied to electric road vehicles shall count 2.5 times towards the obligation.

Companies with an obligation shall electronically submit to the NEa completed biofuels balance sheets (spreadsheets) within two months after the end of each half year. The reports on the greenhouse gas of fuels, following the requirements from the EU Fuel Quality Directive (FQD) and of which the first will be in 2012, must be submitted electronically to the NEa before March 1 of the subsequent year. From January 2015, the temporary administration for both Decrees will be replaced by an automated digital register that is managed by the NEa. Companies that do not comply with their obligation are subject to a financial penalty.

Biofuel quantities can be traded administratively among companies (biotickets). Registration-obliged companies can meet the obligation for renewable energy in transport by purchasing biotickets. In addition, reporting-obliged companies can comply with the mandatory reduction in greenhouse gas intensity by purchasing biotickets. The legislation sets a maximum to the administrative transfer of biofuels supplied in a previous year with the objective of selling them to others with the purpose of using them for meeting their obligation in a subsequent year ("carry-over"). This restriction does not apply to physical biofuel stocks. Physical and administrative biofuel stocks, which are transferred to a subsequent year, must still comply with sustainability requirements in force in that year. To demonstrate the sustainability of biofuels, companies must use the voluntary schemes that have been recognised by the European Commission.

### Excise duty reductions

In 2006 a start was made on biofuel policy by providing tax incentives, in the form of a reduction in excise duty, to encourage the blending of a 2% biofuel component (bio-ethanol, bio-ETBE or biodiesel). In the case of the displaced quantity of unleaded light oil (petrol) to which at least 2% of ethyl alcohol had been added, the reduction in excise duty amounted to €10.10 per 1000 litres. If less ethyl alcohol was added the reduction would be lowered proportionately. In the case of the displaced quantity of gas oil (diesel) to which at least 2% of biodiesel had been added, the reduction in excise duty amounted to €6.10 per 1000 litres. If less biodiesel was added the reduction would be lowered proportionately.

In 2006, a general tax reduction was given for maximum of 2 vol% of biodiesel and ethanol, blended in diesel and petrol, respectively. This tax reduction ended at the end of 2006, and as of 2007 it was replaced by mandatory blending rates.

### Fiscal incentives

### By the end of 2009, the Dutch government decided to reduce the excise duty on sustainably produced E85 by 27% starting 1 April 2010. This is due to the lower energy content of E85 in comparison with petrol.

### Investment subsidies

### The Energy Investment Deduction scheme (EIA) and the MIA/VAMIL scheme are schemes providing tax incentives for investment in renewable energy projects. Through these schemes various renewable energy technologies are supported, including biomass processing equipment, pyrolysis installations for recycling of residues, production facilities for algae, etc.

### Other measures stimulating the implementation of biofuels

Through the programme Refuelling pumps for alternative fuels (Tankstations Alternatieve Brandstoffen, TAB) the Dutch government as well as other governmental bodies have invested together in the expansion of the refuelling pump infrastructure for alternative fuels including biofuels. In the first tender in 2008 a total subsidy of € 1.8 milion was granted to 68 ethanol fuel pumps and 31 natural gas refuelling pumps, of which 24 and 11 fuel pumps, respectively, were realised. The second tender started at the end of 2009 and in 2010 a total subsidy of € 3.6 milion was granted to 53 refuelling pumps for natural gas, and 3 for E85 and 4 for B30 that are currently being built.

In 2010, there was also a tender of the subsidy programme “Effective and efficient digestion chains”, which also included pilot and demonstration projects for renewable gas production, infrastructure and supply. A total amount of €7 million of subsidy was granted. In 2011 a subsidy programme started aiming to promote the purchase and the use of vehicles using biogas and high biofuel blends.

### Promotion of advanced biofuels

Obligation

The Dutch government included a double counting provision in its national legislation implementing the EU RED (Biofuel policy) thus promoting the use of biofuels with a better performance in terms of sustainability. However, this leads to debates on whether this measure provides an incentive for biofuels produced from lignocellulosic feedstocks such as straw and wood.

Subsidy

Starting end of 2006, a subsidy was available for projects aimed at production of advanced biofuels, including biofuels that are not themselves advanced but represent developments from conventional fuels (IBB). This subsidy was not continued after the first round in 2006.

## Market development and policy effectiveness

As a consequence of the introduction of biofuels policy the share of biofuels in the Dutch market for transport fuels increased substantially in the past years from 2005 to 2008. Since 2008 the increase has been more gradual. In 2005 the share of biofuels was only 0.02%. As a result of the partial excise duty exemption in 2006 the share increased to 0.3%. In 2007 the obligation target of 2% was achieved. In 2008, the share of biofuels amounted to 3.26%, in this way achieving the target of 3.25% in 2008. In October 2008, as a consequence of the discussion on the sustainability of biofuels the objective for 2009 was reduced from 4.5 to 3.75%. The target for 2010 was reduced from 5.75 to 4%. The targets from 2009 and 2012 were achieved according to the National reports on the implementation of the EU Biofuels Directive (2003/30/EC) and the yearly NEa reports[[2]](#footnote-2).

Current production capacity is 1660 kton per year of biodiesel, 800 kton per year of HVO, 425 kton of ethanol and 200 kton of methanol. This production capacity has been steady for some years (2012 and 2013) after relatively fast growth in the years before, and after bankruptcy and restarts of some smaller plants.

In the last five years some large plants have started up:

* BioMCN commercial plant in Farmsum (200 kton per year of methanol from glycerine), Abengoa (480 ML ethanol per year, mainly from wheat),
* Neste Oil commercial plant in Rotterdam (800 kton per year of HVO, produced from palm oil, rape, UCO and animal fat).
* ECN (Energy Research Center) pilot plant in Petten which uses thermochemical technology to produce syngas from lignocellulosics (wood). Output of 346 t per y. A demo plant is planned in Alkmaar by ECN and Consortium Groen Gas using the same technology but at a larger scale with an output of 6500 t per year.

In the Netherlands there are about 30 biofuel production plants (status January 2014) with a production capacity ranging from very small to very large. The total production capacity for biodiesel is the largest, i.e. 1.45 million tonnes. For ETBE and bio-ethanol the production capacity amounts to 755,000 and 385,000 tonnes, respectively. One plant is producing biomethanol with a capacity of 200,000 tonnes per year. The production of biogas is increasing.

Table 13‑2 - Biofuel development and market share, the Netherlands

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol(million L/a)** | **Bio-ETBE****(million l/a)** | **Bio-MTBE + biomethanol****(million l/a)** | **PPO(million l/a)** | **Biogas****(m M3 /a)** | **Market share (%)** |
| **2000** |  |  |  |  |  |  |  |
| **2001** |  |  |  |  |  |  |  |
| **2002** |  |  |  |  |  |  |  |
| **2003** |  |  |  |  |  |  |  |
| **2004** |  | 14 |  |  |  |  |  |
| **2005** |  | 8 |  |  | 2.7 |  | 0.02% |
| **2006** | 18.5 | 30.1 |  |  | 2.3 |  | 0.3% |
| **2007** | 187.2 | 80.9 | 187.8 |  | 6.5 |  | 2.0% |
| **2008** | 269.2 | 154.7 | 129.0 |  | 6.5 |  | 3.26% |
| **2009** | 222.1 | 22.8 | 389.3 |  |  |  | 3.75% |
| **2010** | 229.0 | 277.8 | 59.3 | 35.1 |  | 1.1 | 4.01% |
| **2011** | 326.5 | 250.1 | 0 | 26.2 |  | 9.7 | 4.31% |
| **2012** | 294.5 | 250.5 | 1.6 | 26.8 |  | 9.7 | 4.54% |

## Sources

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* Policy letter on biofuels of Government to parliament - March 2006.
* www.biofuel-cities.eu
* Besluit van 20 oktober 2006, houdende regels met betrekking tot het gebruik van biobrandstoffen in het wegverkeer (Besluit biobrandstoffen wegverkeer 2007)
* Policy letter on biofuel obligation to the government – October 2008
* National Renewable Energy Action Plan – The Netherlands: <http://ec.europa.eu/energy/renewables/transparency_platform/doc/national_renewable_energy_action_plan_netherlands_en.zip>
* GAVE website (English):
	+ <http://www.agentschapnl.nl/en/programmas-regelingen/dutch-biofuels-policy-2006-2010-uk>
	+ <http://www.agentschapnl.nl/en/programmas-regelingen/dutch-biofuels-policy-uk>
* <http://www.erec.org/fileadmin/erec_docs/Projcet_Documents/RES2020/NETHERLANDS_RES_Policy_Review__09_Final.pdf>
* https://www.emissieautoriteit.nl/biobrandstoffen/(website of the Dutch Emissions Authority (NEa))
* English versions of the Dutch biofuels legislation (in force as of 1 January 2011):
* Fuels and Air Pollution Decree: Stb. 2011, 192
* Fuels and Air Pollution Regulations: Stcrt. 2011, 7532
* Decree on Renewable Energy in Transport: Stb. 2011, 197
* Regulations on Renewable Energy in Transport: Stcrt. 2011, 8235

(https://www.emissieautoriteit.nl/mediatheek/biobrandstoffen/nieuwsberichten/07-09-2011-07-09-2011-engelse-vertaling-regelgeving-biobrandstoffen-beschikbaar-english-translation-available-regulations-and-decrees-of-biofuels )

* National reports on the implementation of the EU Biofuels Directive (2003/30/EC), <http://ec.europa.eu/energy/renewables/biofuels/ms_reports_dir_2003_30_en.htm>
* NEa reports on biofuel implementation in the Netherlands for
	+ 2011: <https://www.emissieautoriteit.nl/mediatheek/biobrandstoffen/publicaties/20120606-rapport-DEFINITIEF>
	+ 2012: <https://www.emissieautoriteit.nl/mediatheek/biobrandstoffen/publicaties/20130807%20Biobrandstoffen%20verplichtingen%202012.pdf>

# New Zealand

***Ian Suckling and Michael Jack***

## Introduction

New Zealand is a geographically-isolated country with a small population (4.5 M) and a relatively low population density. As a result, transportation fuel requirements per person are comparatively high. Most of New Zealand’s transportation fuel needs (200 PJ, 37.6% of total consumer energy in 2012) are met by fossil fuel imports. There are also significant exports of unrefined crude oil (31% of total oil consumption) as these are not processed at New Zealand’s only oil refinery.

An estimated 7.2 million litres of liquid biofuels were produced in 2012, mainly as ethanol from whey, and biodiesel from canola, tallow and used cooking oils. Figures on biofuel consumption are not available, as almost all liquid biofuel production, plus additional imports of bioethanol, are blended with fossil fuel oil, and specific data on the biofuel component is not collected.

Bioenergy use has remained relatively constant at between 11 and 13% of consumer energy since 2000. In 2012 bioenergy usage was 11.5% of total consumer energy, made up of 55 PJs of woody biomass and 0.3 PJ of biogas. Woody biomass is used mainly in the wood processing sector as a source of process heat, but a portion (7.3 PJ) is burnt to heat private homes (7.3 PJ).

A total of 73% of New Zealand’s electricity was generated from renewable resources in 2012 (falling from 77% in 2011), mainly from hydro (53%), geothermal (14%), wind (5%) and bioenergy (1%). New Zealand has a target of 90% of electricity generation from renewables by 2025.

### Main drivers for biofuels policy

The New Zealand Energy Strategy 2011-2021 sets the strategic direction for the energy sector and the role energy will play in the New Zealand economy. In this strategy, developing renewable energy resources, and developing petroleum and mineral fuel resources are two key focus areas. Biomass is recognised as a resource that has considerable potential, and the Government has indicated it will encourage biomass-to-energy development, including working with industry to support its bioenergy strategy. The companion New Zealand Energy Efficiency and Conservation Strategy 2011-2016 also indicates Government support for the actions of industry, including the aviation industry’s efforts to develop sustainable alternative fuels.

The New Zealand Bioenergy Strategy, developed jointly by the New Zealand forestry and bioenergy sectors and launched in 2010, is designed to achieve: “Economic growth and employment built on New Zealand’s capability and expertise in growing and processing wood-crops and converting organic by-products to energy, leading to new business opportunities which by 2040 supply more than 25% of the country’s energy needs, including 30% of the country’s transport fuels.” This builds on the realisation that in New Zealand only wood can be grown in sufficient quantities to enable biofuels to make a significant impact as a transportation fuel (biofuels from agricultural sourced materials, algae and municipal and industrial process residues are also important). A preliminary analysis of the economic impact of this Bioenergy Strategy has provided evidence of a prima facie case that expansion of the bioenergy sector envisaged by the Strategy has the potential to yield significant positive benefits to “New Zealand Inc” and that the benefits are significantly greater if co-products can be produced.

## Biofuels policy

### Biofuel obligations

A [Biofuel Bill](http://www.bioenergy.org.nz/documents/publications/Liquid%20Biofuels/About/Biofuels%20Legislation-Regulation/Biofuel%20Bill%5B1%5D.pdf), enacted in September 2008, introduced a mandated Biofuel Sales Obligation from October 1st 2008. This required all oil companies to include liquid biofuels as a fixed percentage of their total sales. Under the Obligation liquid biofuels were to have made up 0.5% of oil companies' sales in 2008, with obligation levels rising by 0.5% increments to 2.5% in 2012. However, as a result of a change in Government, the Biofuel Sales Obligation and associated regulations were [repealed](http://www.beehive.govt.nz/release/biofuel%2Bobligation%2Blaw%2Brepealed) in December 2008, and since then there have been no biofuel blending target or mandates.

Table 13‑1 - Biofuel obligations (percentage by energy)

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Petrol** | **Diesel** | **Petrol + Diesel** |
| **2005** |  |  | - |
| **2006** |  |  | - |
| **2007** |  |  | - |
| **2008** |  |  | 0.5% |
| **2009** |  |  | - |

### Excise duty reductions

Fuel ethanol, including imported ethanol, is exempt from excise duty (50.5 c/L), with excise duty only paid on the petrol portion of blended fuels. This provides a significant incentive for its use in transportation fuels.

### Fiscal incentives

Not available.

### Investment subsidies

A biodiesel grants scheme ran from 1 July 2009 to 30 June 2012. This was designed to support the growth of a biodiesel manufacturing industry within New Zealand by providing a grant of up to 42.5 cents per litre for biodiesel production, subject to certain conditions. This did lead to a steady increase in biodiesel production in New Zealand, but since the scheme ended production of biodiesel has plummeted.

### Other measures stimulating the implementation of biofuels

New Zealand has an emissions trading scheme (NZETS) in place, which is based on tradable units. Most sectors, including the transport sector, are now included in the scheme. Agriculture, responsible for 47% of New Zealand’s GHG emissions, remains outside the scheme. The NZETS could have a significant impact on energy prices and therefore provide an incentive for biofuel production if the carbon prices are sufficiently high. However, the direct impact of the NZETS on consumers to date has been comparatively modest, up to about 3.1 cents per litre for gas and 3.3 cents per litre for diesel, and within the normal range of variation in fuel prices seen at the pump as a result of fluctuations in the oil price and exchange rates. Furthermore, carbon prices are currently low, meaning that the NZETS provides little incentive for biofuel production.

A number of potential end-users remain interested in using biofuels. These include Air New Zealand, the national airline, and New Zealand Rail, the operator of the main ferry service between the two islands. While not a policy measure, such end-user interest may well stimulate biofuel production within New Zealand.

### Promotion of advanced biofuels

The Government, via the Ministry of Business, Innovation and Employment, supports a number of Research and Development projects aimed at the production of advanced biofuels. This includes projects aimed at: converting woody biomass into liquid fuels; the isolation of novel cellulolytic and thermophylic bacteria for the degradation of cellulose to sugars; the in planta production of cellullases as an enzyme source for biofuel production; bio-oil production from algae; algal biofuel energy from wastewaters; second-generation feedstocks for biodiesel production; and biomass to syngas and liquid fuels. Work on the conversion of woody biomass to liquid fuels at Scion was moved in 2011 to Scion Core funding, and as of September 2013 the remaining contestable funding for advanced biofuels, which supported many of the above projects, will be reduced from ca. $2 M pa to $1 M pa and is no longer targeted specifically at the production of advanced biofuels.

LanzaTech, a NZ startup company, has developed a proprietary process to ferment CO-rich industrial waste gases into ethanol and other products. They have previously received over $10 M in government grants to fund process development and scale-up and were able to prove their process at pilot scale at the BlueScope steel mill in Glenbrook, New Zealand. Their process has subsequently been demonstrated at a 100,000 gal/yr demonstration facility with Baosteel in China and in the USA an integrated biorefinery is being developed using forestry waste. Although LanzaTech is now US-based, it still retains R&D facilities in NZ.

Newsprint manufacturer Norske Skog and fuel distributor Z Energy have been awarded Primary Growth Partnership (PGP) funding of $6.75M in 2013 to study the feasibility, including the cost-effectiveness, of making biofuel from forestry waste. This will be used to determine the commercial viability of establishing a modular test plant to process New Zealand forest waste into a sustainable transport fuel.

## Market development and policy effectiveness

There has been a rapid rise in liquid biofuel production within New Zealand since 2007, with approximately 7 million litres of liquid biofuel being produced in 2011 and 2012. However, biofuels (0.19 PJ) still make up only a small proportion, less than 0.1%, of total transportation energy (200.2 PJ). While bioethanol production has continued to rise, the production of biodiesel has dropped dramatically as a result of the end of the Biodiesel Grants Scheme in June 2012. This drop in biodiesel production has yet to be fully reflected in official statistics. As mentioned above, figures on consumption of biofuels are not available, as almost all liquid biofuel production is blended with fossil fuel oil, and so is included under oil in the statistics.

Table 13‑2 - Biofuel development and market share, New Zealand

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol(million L/a)** | **PPO(n/a)** | **Biogas****(n/a)** | **2nd-Gen (n/a)** | **Market share (%)** |
| **2003** |  |  |  |  |  |  |
| **2004** |  |  |  |  |  |  |
| **2005** |  |  |  |  |  |  |
| **2006** |  |  |  |  |  |  |
| **2007** | 1.2 | 0.3 |  |  |  |  |
| **2008** | 1.2 | 2.0 |  |  |  |  |
| **2009** | 1.1 | 3.7 |  |  |  |  |
| **2010** | 1.6 | 4.21 |  |  |  |  |
| **2011** | 2.35 | 4.81 |  |  |  |  |
| **2012** | 1.54 | 5.67 |  |  |  |  |

## Sources

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* NZ Energy Strategy 2011-2021 and NZ Energy Efficiency and Conservation Strategy 2011-2016 [www.med.govt.nz/upload/77402/NZ%20Energy%20Strategy%20LR.pdf](http://www.med.govt.nz/upload/77402/NZ%20Energy%20Strategy%20LR.pdf)
* NZ Bioenergy Strategy [www.bioenergy.org.nz/NZBioenergyStrategy2010.pdf](http://www.bioenergy.org.nz/NZBioenergyStrategy2010.pdf)
* Bioenergy Association of New Zealand <http://www.bioenergy.org.nz/index.asp>
* Energy Efficiency and Conservation Authority [www.eeca.govt.nz/](http://www.eeca.govt.nz/)

# Norway

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## Introduction

Although Norway is not a full member of the EU, it has committed to the Renewable Energy Directive (Directive 2009/28/EC) by setting a target of 10% renewable fuel to be used in road transport by 2020. A part of this mandate is expected to be reached by the use of electric cars, and the fleet is currently growing fast as a result of favorable taxes, tariffs and other incentives. The main part of the goal is, however, expected to be reached by the increased use of biofuels; biodiesel, bioethanol and biogas. The use of biofuels increased fairly rapidly due to mandatory blending and fuel tax reductions, but has now leveled out due to the lack of new incentives. The use of fossil fuels for road transport has had a rather flat development to just above 4.000 million liters per year, but the relative share of diesel vs. gasoline has increased from below 45 % in 2004 to above 65 % in 2012, mainly due to a tax and tariff system favoring diesel-powered passenger cars. This has, to some degree, resulted in an over-proportional focus on biodiesel over the last few years.

### Main drivers for biofuels policy

The Norwegian energy consumption has increased by 40% during the last 30 years. This has led to an increased focus on renewable energy sources that can increase energy supply without increased emissions of greenhouse gases. In addition, by applying biofuels the energy portfolio will be diversified and rural development can be supported. Finally, the Norwegian government wants to retain the position as a major energy nation.

## Biofuels policy

### Biofuel obligations

Norway has required mandatory blending of 3.5 % as an average of the entire road transport fuel pool since 2009, and has further incentivized this with reduced tax for some biofuels and blends. The future target is 5%, but it is not clear when it will be increased to this level. The main biofuel in Norway is currently FAME (Fatty acid methyl esters), derived from rapeseed oil (RME, rapeseed methyl esters ~160 mill. liters in 2012), followed by bioethanol (~20 mill. liters) and biogas (equivalent to 8-10 mill. liters of diesel). The current mandate is overachieved, as the total average biofuel blend is currently around 4.3 %. Norway will adopt sustainability criteria for biofuels based on the current EU policy from 01.01.2014, and will also allow double counting of fuels produced from waste and lignocellulosic materials from the same date. New data on ILUC (especially for RME) has caused concern, and there will not be an increased mandate until the sustainability criteria are further revised to adopt expected updates of the EU regulations. Blends available at the pump are B7, B30 and B100 (biodiesel), E5, E85 and ED95 (bioethanol) and biogas/LNG. Further increases are pending based on revised sustainability criteria.

Table 15‑1 Biofuels obligations (by volume)

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Petrol** | **Diesel** | **Petrol + Diesel** |
| **2007** | -- | -- | -- |
| **2008** | -- | -- | -- |
| **2009** | -- | -- | 2.5 % |
| **2010** | -- | -- | 3.5 % |
|  |  |  | 5.0% |

There is no conventional biofuel production in Norway based on Norwegian raw materials, as the current agricultural policy and cost level strongly discourage the use of domestic feedstock which has a use for food or feed.

Biodiesel

All of the RME consumed in Norway is imported. Uniol (<http://www.uniol.no>) operated a conventional biodiesel plant with a capacity of around 100,000 tons since 2009, but the feedstock was imported, and the FAME is sold outside Norway. Operation of this plant was stopped in November 2012.

Bioethanol

There is no production of conventional bioethanol for fuels in Norway, but Borregaard (<http://www.borregaard.com>) is operating an advanced bioethanol plant based on lignocellulosic feedstock (Norway Spruce). The current output is between 20 – 25 million liters, of which only around 2 million liters are used domestically as advanced biofuel. The majority of the 20 million liters (0.5 % of total road transport fuel consumption) of bioethanol used for fuel is imported and sold as an E5 blend, mainly through the fuel retailer Statoil in select regions. The number of cars using E85 is small and stable, but the use of mid-sized transport vehicles and buses, with modified diesel engines using ED95, is growing. Growth in this sector has been hampered by a lack of distribution infrastructure, but pumping stations are now being established in several of the large Norwegian cities. Further growth in E5 is subject to an increase in the mandatory blending target.

Biogas

The interest for biogas use in transport in Norway is growing. Currently, the total production of biogas is around 0.5 TWh, but most of this is used for heat and power. There are over 400 buses operating on gas, but so far only 70 – 80 are running on biogas due to the lack of availability of upgraded gas. In addition, around 200 heavy transport vehicles are running on biogas. There are few statistics available, but currently the estimated consumption of biogas for transport in 2014 will be equivalent to 7-10 million liters of diesel (0.2 -0.3 % of total road transport fuel consumption). A recent study carried out by KLIF (The Norwegian Environmental Protection Agency) claims that production may be increased to 2,3 TWh by 2020, and that the remaining volumes of renewable fuels to meet the 10% target in 2020 may be achieved with some of these volumes (0,7 TWh). Primary production is very fragmented, but upgrading and distribution is handled by two players; AGA and Lyse Neo.

### Excise duty reductions

There are varying taxes levied on biofuels, ranging from 100% to 0%, with no apparent logic. Excise duty regulations make E85 and ED95 attractive to use from a tax perspective as it becomes profitable for blenders to use biodiesel.

Table 15‑2 Biofuel taxes.

|  |  |  |
| --- | --- | --- |
|  | **Petrol Tax** | **Diesel Tax** |
| E5 | 100% NOK 4.50/l | -- |
| E85, ED95 | 0% | - |
| B7 | - | 50%NOK 1,90/l |
| B30, B100 | - | 50%NOK 1,90/l |
| **Biogas** | 0% | 0% |

The biodiesel share in auto diesel (7 % and 30 % blends, B7 and B30, respectively) have full exemption from CO2-tax and 50% reduction of road-use tax. The auto diesel share in the mixture has full taxes. Pure biodiesel (B100) is subject to half road-use tax.

Ethanol in gasoline (E5 and E10) is given exemption from CO2-tax, but not from road-use tax. Use of more than 50% ethanol (E85), gives full exemption from road-use tax. Imported E85 is given full exemption from road-use tax, also on the gasoline part. This is, however, not the case for E85 produced in Norway.

### Fiscal incentives

The duty on vehicles able to utilize E85-E100 is reduced by 10 000 NOK as a once-off .

### Investment subsidies

A once-off amount of financial support for advanced biofuel pilot and demo projects of about 100 mill NOK was provided by the government in 2010. This money was mainly awarded to Borregaard and Weyland in December 2010.

### Other measures stimulating the implementation of biofuels

Agencies active in the area include Transnova, established in 2009, which is funded to about 50 mill NOK per year in 2009, 2010 and 2011; the program is designed to accelerate voluntary use of renewable fuels. This scheme will be continued.

R&D activities in the biofuels area supported by the Research Council of Norway amounts to a total of 80 mill NOK for 2011. The funds are distributed among activities focusing on

1. Resources, environment and climate (16 mill NOK)
2. Harvesting and production (20 mill NOK)
3. Biofuels and biorefineries (27 mill NOK)
4. Biogas (13 mill NOK) and
5. Politics, policy instruments and consumer behaviour (4 mill NOK).

### Promotion of advanced biofuels

There is a National strategy for increased R&D on advanced biofuels and support for selected demonstration projects. There are no first-generation biofuel producers in Norway. Two companies (Borregaard and Weyland) are active in advanced bioethanol.

Xynergo was based on producing advanced biodiesel by the CHOREN process and reached only a desktop study phase. It stopped operation in November 2010 with a reported 60 mill NOK loss.

Borregaard produces 20 million litres of advanced bioethanol from Norway spruce, of which only 1.5 million litres is sold in Norway as ED95 (hydrous 95% ethanol plus ignition improver). Borregaard built a biorefinery pilot in Sarpsborg that has been fully operational since the start of 2013. The total investment was 130 mill NOK, of which 58 mill NOK is support from the Norwegian government,

Weyland has an advanced bioethanol process based on concentrated acid hydrolysis, with acid recovery. The annual production capacity of their pilot plant is 200,000 litres per year of bioethanol. The goal is to build a demo plant with production around 25-30 million litres. The preliminary cost of a demo plant is about 800 mill NOK.

There is currently no production of biodiesel for transport use in Norway.

Research projects

The SINTEF group, the largest independent research organization in Scandinavia, started a project in 2013 which involves the use of marine biomass for production of 3rd generation bioenergy. Three research institutes (SINTEF Fisheries and Aquaculture, SINTEF Energy Research and SINTEF Materials and Chemistry) will be involved. Research will include cost-effective production of seaweed biomass. SINTEF Energy Research has several research projects in the area of biomass gasification for liquid biofuel applications. Within catalytic conversion, SINTEF Materials and Chemistry is focusing their research on material needs (catalysts, adsorbents) and the chemistry of key processing steps along the major thermo-chemical and bio-chemical value chains with potential to produce different types of fuels from lignocellulosic feedstock.

The bio-energy research at the Department of Energy and Process Engineering at NTNU is focusing on stationary units for energy and fuel production and combustion units for transportation.

The Paper and Fiber Research Institute (PFI) is a centre of expertise for fiber, pulp and paper, wood fiber composites and sustainable biofuel/biorefinery processes. Several projects in the biofuels area are conducted at PFI, focusing both on thermochemical and biochemical conversion processes. Several projects are underway:

* *Cost-effective production of 2nd generation liquid biofuel*; to develop an industrial process for efficient conversion of Scandinavian wood-based raw materials into fuel components. Dates back to 2005.
* *New, innovative pretreatment of Nordic wood for cost-effective fuel-ethanol production*. This project aimed at developing production techniques that would reduce the overall production costs for fuel-ethanol from Nordic lignocellulosic biomass. A second objective was to quantify the possibilities to reduce investment and operating costs by co-locating and integrating the ethanol plant with existing industry infrastructure (e.g. pulp mill, oil refinery).
* *Innovations in Bioethanol Production Technologies (SusBioFuel)* - aims to carry out break-through science leading to innovations in central production technologies in conversion of lignocellulose into bioethanol. These central processes include pretreatment, hydrolysis and fermentation.
* *LignoRef* - cost-effective conversion of lignocellulosic materials into advanced biofuels and value-added products.
* *The Bio-oil Refinery Project* - developing technology for producing and fractionating bio-oil components as a basis for a biorefinery producing green chemicals, transportation fuels and energy.
* *PROFIT project* - to develop technical solutions for profitable bioenergy (synthetic biodiesel, bio-oil, pellets) and paper production by integrating a synthetic biodiesel plant and/or a pellet plant with a paper mill.

The Norwegian University of Life Sciences (UMB) in Ås, Norway, formerly The Agricultural University of Norway, has a long tradition in bioproduction (forestry, plant science, resource economics). Its bioprocessing activities towards bioenergy are mainly focused on anaerobic digestion (AD) and enzyme technology for saccharification.

Pilot and demonstration projects

Borregaard AS has been operating a continuous biorefinery demonstration plant at its site in Sarpsborg since 2012. In the first step, wood, energy crops or agricultural waste undergoes a chemical pretreatment, yielding lignin specialty chemicals and fiber. In the second step, the fiber is converted to fermentable sugars by enzymatic hydrolysis. The sugars are then converted to advanced bioethanol by conventional fermentation and distillation. The demonstration plant is partly funded by Innovation Norway (<http://demoplants.bioenergy2020.eu/projects/info/469>).

Weyland AS ([http://weyland.no](http://weyland.no/)) is operating a concentrated acid hydrolysis process, combined with conventional fermentation and distillation to produce advanced bioethanol in their pilot plant outside Bergen (http://demonstrationplants.bioenergy2020.eu/projects/info/268). The plant has been in operation since 2010.

## Market development and policy effectiveness

The ambition of introducing biofuels in Norway is low, as the Government keeps delaying the increase in mandatory blending targets. Sales of B30 and B100 have dropped to almost zero after a 50% diesel tax was introduced for these biofuels in January 2010. The voluntary use of biogas in the fleet market (buses and heavy vehicles) is growing.

Table 15‑3 – Biofuel development and market share, Norway

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Biodiesel****(million L/a)** | **Bioethanol(million L/a)** | **PPO(n/a)** | **Biogas****(n/a)** | **2nd-Gen**  | **Market share (%)** |
| **2003** | n/a | n/a |  |  |  |  |
| **2004** | n/a | n/a |  |  |  |  |
| **2005** | 4 | 0 |  |  |  |  |
| **2006** | 7.1 | 0 |  |  |  |  |
| **2007** | 39 | 0 |  | Gas for 23 vehicles |  | Gasoline: 0 %Diesel: 1.6% |
| **2008** | 105 | 0 |  |  |  |  |
| **2009** | 128 | 1 |  |  |  | Gasoline: 0.1 %Diesel: 5.2 %Average: 3.1% |
| **2010** | 144 | 10 (starch/sugar) |  |  | 1.1 (lignocellulosic) | Gasoline: 0.6 %Diesel: 5.7 %Average: 3.7 % |
| **2011** | 138 | Approx. 16 |  |  |  | Gasoline: 1.7 %Diesel: 5.3 %Average: 3.8 % |
| **2012** | 160 | Approx. 18 |  | 8-10 ML diesel eq |  | Average 4.3% |

## Other

It seems that in general, Norway’s approach to biofuel policy is currently more hesitant than a few years ago. Norway is an oil producer and is very focused on this. Recent major oil discoveries have contributed to this.

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# South Africa

***Bernard A. Prior*** *and* ***Willem H van Zyl****, Department of Microbiology, University of Stellenbosch*

## Introduction

South Africa is ever more under pressure to reduce its carbon footprint, most notably in the production of electricity from primarily coal by the national utility company, ESKOM. South Africa has a high level of Renewable Energy potential and presently has in place a target of 10 000 GWh of Renewable Energy. The Minister has determined that 3 725 megawatts (MW) to be generated from Renewable Energy sources is required to ensure the continued uninterrupted supply of electricity. To extend the electricity capacity, ESKOM planned to raise electricity prices by 20% per year through 2015 according to the Integrated Resource Plan, approved in March 2011. However these increases have been substantially limited in 2012 and 2013. It is not clear whether any tariff increases will be approved in 2014. NERSA, (National Energy Regulator of South Africa) strives to diversify energy sources in South Africa. The Department of Energy thus announced an Independent Power Producers Procurement Programme where bidders will bid on tariffs and the identified socio-economic development objectives of the Department before or on 19 Dec 2011. However, 7 Dec 2011 during the COP17 conference in Durban, the Minister of Energy announced that wind and solar projects for 1 415 MW were awarded in the first round of applications. This constitutes a definite move towards commitment for green energy in South Africa.

### Main drivers for biofuels policy

South Africa consumed approximately 11.3 billion litres of petrol and 9.1 billion litres of diesel during 2009, showing a 2.2% increase in petrol and a 6.6% decrease in diesel from the previous year. In terms of primary energy supply, nearly 80% is from imported oil – crude oil represents the single largest import item in South Africa's import account.

Biofuels are a priority sector under the accelerated and shared growth initiative of South Africa, as biofuels have the potential to stimulate development in under-developed areas. The South African Industrial Biofuels Strategy had a lackluster start since its announcement in December 2007, but will continue to evolve in light of international prices for crops and for oil, technology development, food security and food price inflation, water limitation in the country, poverty alleviation and job creation, and the need for state financial incentives. The Department of Science and Technology has developed a 10-year R&D plan for biofuels and this plan focuses on advanced biofuel technologies, developing energy crops, the science around biofuels, and sustainability (including life cycle analysis and policy). The first step towards such a plan is the sponsoring of the Senior Chair of Energy Research: Biofuels at Stellenbosch University and the Associated Chair at the University of the North-West. The primary drivers behind biofuels policy in South Africa includes attracting investment into rural areas, promoting agricultural development, reducing imports of foreign oil and improving the current account, and overcoming agricultural trade distortion of South Africa with the developed countries.

## Biofuels policy

### Biofuel targets

In December 2006, a draft Strategy Document proposed a target of 4.5% biofuels penetration by 2013 (energy basis). This initiative was estimated to lead to 55 000 jobs in rural farming, adding $ 250 million per annum to GDP; it would contribute 75% of the country’s renewable energy target. The South African Biofuel Strategy was launched in December 2007 after extensive consultation but the biofuels penetration target was reduced to 2% with non-mandatory blending. This translates into approximately 400 million litres per annum, and could contribute 35% of the country’s renewable energy target. Maize (corn) was excluded as a feedstock due to food security concerns and Jatropha was also excluded as it is an invasive plant. The approved crops for bioethanol included sugar cane, sorghum and sugar beet; crops for biodiesel included sunflower, canola, and soya beans. However, by not allowing farmers to channel excess maize to biofuels, without mandatory blending (thus no guaranteed take-off) and the financial difficulties over the past three years, the biofuels industry in South African has yet to develop.

However, the SA government acknowledged that new interventions are needed to accelerate development in the biofuels sector. In the latest Industrial Policy Action Planfor 2010/11 – 2012/13 (IPAP2) [adopted by Parliament in March 2011] they proposed that high-level co-ordination with relevant government departments, investors and development finance institutions should take place to ensure that a coherent and co-ordinated approach to the development of the sector is to follow. Specific key milestones identified for 2011/12 were:

1. Create a permit-base rebate facility for the importation of bio-ethanol in the event of local bio-ethanol supply disruption.
2. Amend fuel specifications to allow for requisite waivers.
3. Conclude and sanction price support/incentive mechanism for biofuel producers.
4. Mandate 2% of biofuel, increasing to 10% over next 10 years.
5. Develop water tariff policy for biofuel feedstock producers.
6. The Industrial Development Corporation to provide industrial financing options to investors, thereby leading to the commissioning of biofuel processing facilities.

Towards this end, the Department of Energy published, in Aug 2011, draft mandatory blending targets (5% for biodiesel and 2% for ethanol) in the Government Gazette for comments and reviewed comments received by 16 Nov before announcing the mandatory blending targets.

In 2012, the dates of implementation of milestones were moved a year forward in a revised Industrial Policy Action Plan. Only milestone 4 has been achieved by the announcement of mandatory blending in 2012 which will become effective from October 2015. In The Budget Speech of February 2013, the Minister of Finance announced a ZAR 3.5–4.0c levy on all fuels to create an approximate ZAR 1 billion fund to support construction of the first commercial ethanol plants, addressing milestone 3. This levy has been increased to ZAR 4.5-6.0c per litre.

### Excise duty reductions

Currently, biodiesel enjoys a 50% fuel tax exemption ($80/barrel crude oil equivalent), while bioethanol receives a 100% fuel tax exemption ($65/barrel crude oil equivalent). The South African Biofuels Association and other role players have requested further incentives to stimulate the industry and rapid implementation of biofuels policy. Lack of such incentives hampers further development of the biofuels industry in South Africa.

### Fiscal incentives

Accelerated Depreciation Allowance for Biofuels Production:

An incentive to encourage the production of biofuels in South Africa was introduced in 2004. Plant and machinery used to produce biofuels qualifies for a 50:30:20 percent write-off over a 3-year period. In the 2009 budget, it was proposed that investments by companies in energy-efficient equipment should qualify for an additional allowance of up to 15% on condition that there is documentary proof of the resulting energy efficiencies (after a two- or three-year period), certified by the Energy Efficiency Agency. However, without mandatory blending and other necessary incentives, no major industrial company has entered the biofuels arena since the IBS in 2007.

### Investment subsidies

Not available.

### Promotion of advanced biofuels

RD&D Programs

Research projects are underway at a number of South African universities on the production of biofuels including biodiesel from algae (University of the Western Cape, Durban University of Technology) and bioethanol from biomass (Stellenbosch, Rhodes, Free State Universities). Significant progress has been made within the Senior Chair of Energy Research (SCoER): Biofuels at Stellenbosch University. Under the leadership of Prof. Emile van Zyl, the SCoER has focused on the development of both biochemical and thermochemical processes for the conversion of cellulosic feedstocks, such as agricultural residues, to biofuels. The laboratory of Prof. Emile van Zyl participated in a joint project with VTT, Finland and Mascoma Corporation to develop consolidated bioprocessing yeasts capable of converting pretreated hardwood to ethanol with significantly reduced requirement for enzyme addition. Mascoma is in the process of commercializing a Consolidated BioProcessing (CBP) type process utilizing proprietary strains developed in this joint project. The group of Prof. Johann Görgens developed the capability to carry out pilot-scale pretreatment using a 15-L capacity steam gun reactor. Pretreatment of different agricultural residues has been evaluated with South African sponsored research funding in anticipation of an emerging cellulosic ethanol industry. The laboratory of Prof. JH (Hansie) Knoetze has developed the capability to generate pyrolysis and gasification products using different cellulosic feedstocks to substitute fossil fuels such as coal, coking coal and reductants. This research also supports developments toward a future green economy. Apart from the development of both biochemical and thermochemical technologies, the SCoER has also developed expertise in process modelling, energy efficiency optimisation, economic viability assessment and life cycle analysis. Such assessment tools are critical to guide technology selection and technology integration into future biofuels/bioenergy/biorefinery industries.

Fast pyrolysis is one thermochemical avenue being explored; this involves the heating of biomass for a few seconds to about 500°C in the absence of O2, followed by rapid cooling. The result is the formation of biogas, bio-oil from condensation of vapours during rapid cooling, and solids called char. Unfermentable products from bioethanol plants can also be converted by fast pyrolysis.

A research goal is to develop fast pyrolysis units that can handle 100,000 tons of biomass per year. After woody material has been converted to bio-oils, it can be readily transported to larger refineries such as PetroSA’s Mossgas plant in the Southern Cape.

The alternative is gasification at higher temperatures for longer periods in the presence of O2, which yields syngas for Fischer-Tropsch synthesis (SASOL has experience in this area). A research goal is to adapt FT-technology by SASOL to accommodate biomass in addition to coal as fossil fuel for synthetic fuel production.

Bio-oils or biogas may be used directly to generate electricity of replace usage of crude oil or electricity in large industrial boilers.

Algal RD&D Programmes

New interest has begun to focus on algal biofuels especially at the Durban University of Technology under the leadership of Prof Faizal Bux. Research has been applied to the isolation and identification of indigenous microalgae capable of producing oil. The process has been scaled up to lab scale open raceway ponds and closed photo bioreactor processes (5 to 15 L volume). Municipal domestic wastewater streams are being considered as a readily available substrate for cost-effective and sustainable microalgal cultivation for biodiesel production. It has been further scaled up to a pilot scale 3,000 litre raceway pond for growing and harvesting bulk quantities of biomass. This technology is being tested in a 300,000 litre volume raceway process for the next two years. Results have demonstrated lipid yields of up to 35% oil/dry mass and cell concentrations of 1.5 g/l in an open pond system, but challenges in scale-up, contamination, harvesting and extraction remain. The initial study had challenges such as contamination by bacteria, insects, over flooding caused by heavy rains, salt deposition caused by high water evaporation in summer and slow growth rate because of cold nights in winters.

Algal processes may help solve other environmental problems. The final sewage from wastewater treatment plants will be fed to the raceway process to grow algal biomass for biodiesel production. The residual biomass will produce organic fertilizer. Glycerol, the by-product of biodiesel production, will be used to produce methane for power generation and for running the process. Products with a value higher than oil are also being considered.

## Market development and policy effectiveness

* In 2006, Sasol Oil began evaluating a 112 million litre per annum biodiesel plant based on soya for completion in 2007. This facility was not built.
* In 2006 it was also announced that South Africa's first maize-to-ethanol plant would be built in the Free State province by the end of 2007. Seven similar size plants in the maize-growing area of South Africa would follow, each of which would produce ~470,000 litres of ethanol per day and 320 tons of Distillers Grain for livestock feed, and each of which would consume ~400,000 tons of maize per year grown on ~150,000 hectares within a 80 kilometre radius. However, maize-to-ethanol plants have been put on hold for several reasons, including:
	+ Severe drought in the maize growing area
	+ Lack of government support
	+ Increase in maize price
	+ Food security issues

Recently it was announced that a ZAR2.4 billion (~$ 240 million) sorghum-to-bioethanol plant would be built in Bothaville in the Free State province. The project will be funded by various local investment sources. Approximately 380 000 tonnes of grain sorghum will be used to produce ~ 160 million litres of bioethanol annually.

* In 2008, Sasol Oil linked with the Central Energy Fund and Siyanda Biodiesel to build a soya-based biodiesel plant but required government incentives for viability. The company still awaits a decision on this.
* J & J Bioenergy is evaluating the production of 100 million litres of ethanol per annum from sugar cane.
* Other South African sugar producers are reluctant to invest in ethanol plants without government support.

South Africa has recently issued and granted licences for the production of at least 500 million litres per annum of bioethanol and biodiesel from sorghum, soybean and waste vegetable oils (Table 16.1).

**Table 16.1 Planned bioethanol and biodiesel plants in South Africa**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Company | Product and feedstock | Capacity ML/y | Location | License status |
| Arengo 316 (Pty) Lyd | Bioethanol (sorghum) | 90 | Cradock | Granted |
| Mabele Fuels | Bioethanol (sorghum) |  | Bothaville | Issued |
| Ubuhle Renewable Energy | Bioethanol (sugarcane) |  | Jozini | Granted |
| Rainbow National Renewable Fuels Ltd | Biodiesel (soybean) |  | Port Elizabeth | Issued |
| Exol Oil Refinery | Biodiesel (waste oil) |  | Krugersdorp | Granted |
| Phyto Energy | Biodiesel (canola) |  | Port Elizabeth | Initial stage of application |
| Basfour 3528 (Pty) Ltd | Biodiesel (waste oil) |  | Berlin | Granted |
| E10 Petroleum Africa OC | bioethanol |  | Germiston | Granted |

The biofuel plant to be built in Cradock in the Eastern Cape Province, to be funded by the Industrial Development Corporation of South Africa (IDC), has received the most attention as it will provide a case study for the nascent biofuels industry. In the first phase, 225,000 tonnes of grain sorghum will be imported from around the country, and in the second phase the produce of local farms, purchased by the Department of Rural Development and Land Reform, will be used. This will mainly take the form of sugar beet and sorghum, which will be turned into 90 million litres of bioethanol per year. The development of these biofuels facilities appears to be delayed by financing, availability of suitable land and policy decisions.

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* Business Day Friday January 17, 2014

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# South Korea

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## Introduction

The share of renewable energy in South Korea was about 2% in 2011. South Korea’s energy use per capita has increased substantially from 1970 to 2010 and is indicative of economic growth in the country. In 2009, the country’s per capita consumption was at 4,693 kg oil equiv, approximately five times the energy intensity in the 1970s; however, still significantly lower than US consumption at 7,075 kg oil equiv in (2009).

Biomass supplies would largely need to be sourced from other countries based on current biomass supplies. In response, research and development efforts have focused on options including algae, which are being focused on both bioethanol and biodiesel production.

### Main drivers for biofuels policy

In 2008 the Government’s Energy Policy emphasized Low Carbon Green Growth and identified green technology development as the new growth engine with the intent to improve the quality of life and to contribute to the global community. Core Green Technologies of the Green New Deal include Photovoltaics, wind, fuel cells, IGCC and nuclear, while “clean fossil fuels” of interest are clean fuel cells and CCS. Energy Efficiency, Smart Grid, LED, Energy Storage, CHP, Heat pumps were also identified as important technologies.

South Korea is the 5th largest petroleum importer in the world (and the 10th biggest CO2 emitter in the world, with 550 million tons in 2007. The National GHG Reduction Target (2009) was set to reduce emissions by 30% from the BAU levels by 2020 (813 MTon down to 560 MTon). In 2010 the government announced an introduction of an emission trading scheme starting in 2013.

The new government’s energy policy includes increasing renewable energy to 11% of primary energy consumption by 2035, and the policy includes an RFS introduction in 2013, effective from 2015.

## Biofuels policy

Approximately 19% of energy consumption is dedicated to transportation. The share of renewables in primary energy is expected to increase five-fold by 2030, while total bioenergy share will increase by a factor of 30 over the same period.

In terms of biomass feedstock, over 50% of the feedstock needs to be sourced domestically. As the strategy for securing a stable biomass supply, the South Korean government is investigating the following three options

* Utilization of Available Biomass (Organic wastes, agricultural residues, forest residues),
* Identification of New Biomass (Aquatic biomass, energy crops),
* Utilization of Foreign Biomass (Plantation residues).

### Biofuel targets

Supportive biofuel policies in South Korea have relied on a tax exemption scheme. However, the government encountered tax deficits of $200 million due to biodiesel supply, therefore as of April 2011 South Korea is changing the supporting policies from tax exemption schemes to blending mandates.

Biodiesel is currently applied as B2 (0.4 M kL/y). It is expected that biodiesel blends will reach B5 blends by 2020. Bioethanol blending is being evaluated for at E3 and E5 levels for compatibility with current Korean infrastructure (at 4 gas stations over 1 year). Biomethane is also under evaluation. A public hearing on the RFS will take place during 2013, with nominal implementation set for 2014. Two scenarios, one conservative and the other more ambitious are under review. The main challenges are with respect to bioethanol. An option under consideration is whether local residues can be used as feedstock or whether feedstocks will be imported. Another option is whether bioethanol will be directly blended or as ETBE.

Table 17‑1 – Targets and mandates for biofuels

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Biodiesel (%)** | **Bioethanol (%)** | **Biofuels**  |
| **2005** |  |  |  |
| **2006** |  |  |  |
| **2007** | 0.5% (target) |  |  |
| **2008** | 1.0% (target) |  |  |
| **2009** | 1.5% (target) |  |  |
| **2010** | 2.0% (target) |  |  |
| **2012** | Mandate effective for biodiesel |  |  |
| **2013** | Mandate for other biofuels under review |  |  |
| **2020** | 5.0% (target) | 5.0% (target) |  |

### Excise duty reductions

Biodiesel is currently exempt from taxation in South Korea, but this was revisited in 2011 and it is anticipated that biodiesel blending mandates will replace tax exemptions.

### Fiscal Incentives

R&D funding for bioethanol from algae is at $16 million, whereas funding for biodiesel from algae is at $0.2 billion.

### Investment subsidies

Not available.

### Other measures stimulating the implementation of biofuels

Not available.

### Promotion of advanced biofuels

South Korea is dedicating significant efforts toward algal biofuel commercialization. Due to limited availability of land, the algal biofuels are regarded as a promising option to meet the implementation target of transport biofuels in Korea. Uncertainty about the availability of the algal biomass is the major barrier for commercialization of the biofuels. To improve economics of algal biofuels, a biorefinery-based approach based on multi-disciplinary collaboration may be required. Active R&D (~2020) is now being performed to elucidate some of the R&D uncertainties.

South Korea has two major projects involving algae. The bioethanol from macroalgae (*Gelidium amansii*) project runs over from 2010 to the end of 2012 with a budget of $16 million. The R&D target for this project is to establish a pilot ethanol plant with production levels of 400L/day, and to evaluate the ethanol cost from macroalgae. To date the project has developed a continuous saccharification process by dilute acid with ethanol yields of 0.2 (w/w biomass) or 3.5% ethanol. The next steps include development of a pilot process (capacity: 0.4kL/day).

The long-term biodiesel production from microalgae project has been underway from 2010 and is expected to conclude in 2019. The $150 million project has set out to identify suitable algal strains (freshwater and marine), investigates the feasibility of low cost photobioreactors (PBR) for mass cultivation and on the demonstration of a pilot-scale production system. Sea-floating photobioreactor systems for marine microalgal culture were developed and a pilot system is under construction and various unit processes (open pond, vinyl bag, harvesting, dewatering, extraction, biodiesel/green diesel conversion, utilization of residual biomass) were proposed and are under optimization. Oil yields are currently at ~ 3 L/m2 /yr (for land-based systems).

## Market development and policy effectiveness

Currently, there are 15 biodiesel producers which have a combined production capacity of 1,044,000 kL/y, with primary feedstocks being palm oil (48%), used cooking oil (28%), soybean oil (23%), and rapeseed oil (1%).

Table 17‑2 - Biofuel development and market share

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol(million L/a)** | **PPO(n/a)** | **Biogas****(n/a)** | **2nd-Gen (n/a)** | **Market share (%)** |
| **2003** |  |  |  |  |  |  |
| **2004** |  |  |  |  |  |  |
| **2005** |  |  |  |  |  |  |
| **2006** | 46 | - |  |  |  | 0.5% |
| **2007** | 108 | - |  |  |  | 0.5% |
| **2008** | 195 | - |  |  |  | 1% |
| **2009** | 288 |  |  |  |  | 1.5% |
| **2010** | 396 |  |  |  |  | 2.0% |

Korea’s limited biomass resources and the high cost of biofuels are the major barriers to achieving 2030 implementation targets. To solve this dilemma, a systematic approach for identification and mass production of novel biomass residues such as algae and plantation residues is now being undertaken. Research activities are also targeting the commercialization of advanced biofuels. With all these efforts, biofuels are expected to be cost competitive by 2020 and as a result, South Korea may achieve the 2030 bioenergy implementation target.

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# Sweden

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## Introduction

The proportion of renewable energy in Sweden in relation to the final energy use has increased steadily since the beginning of the 1990s, and amounted to 48% in 2012. In total, wood fuel including liquors is the renewable energy that is used most in Sweden, followed by hydropower, heat extracted by heat pumps, renewable waste, motor biofuels and wind power.

Total energy use for transport in 2010 amounted to about 128 TWh. Of this, domestic transport used about 96 TWh, and foreign transport (including bunkering for foreign maritime traffic and air transport) used about 31 TWh. In 2010, renewable motor fuels (ethanol, FAME (Fatty Acid Methyl Esters)and biogas) supplied about 5.7% of the energy use for road traffic. Sweden’s goal is to achieve independence of fossil fuels for vehicle stock by 2030. The interim goal is to have 10% renewable fuels in the fuel mix by 2010 (RED).

Biofuels presently used for vehicles are mainly ethanol, biogas and FAME. Natural gas and biogas are known as motor fuel gas and are used mainly as a fuel for buses and private cars. Low amounts of ethanol can be blended with gasoline, but is also the main constituent in fuels such as E85 and ED95. FAME can be used in either an undiluted (100% FAME) form as well as being blended with regular diesel fuel. Motor fuel gas consists either of pure biogas, pure natural gas or a mixture of the two. The ratio of natural gas in motor fuel gas varies with location, with the proportion of gaseous fuel vehicles tending to be higher in the parts of Sweden that are more extensively covered by the natural gas grid. In 2010, the proportion of biogas in gaseous motor fuels reached almost 65%.

### Main drivers for biofuels policy

Sweden consumes the highest proportion of renewable energy in relation to final energy use of any country in the entire EU. This is not only due to the fact that Sweden has significant renewable energy resources, but also because it has actively pursued progressive energy policies.

The new policy includes targets for the transport sector, requiring at least 10% of its energy use to be sourced from renewable sources by 2020. The long-term strategy outlines that vehicles in Sweden should not be reliant on fossil fuels by 2030. Parliament has also approved a target for improving the efficiency of energy use, with an overall reduction of 20% in energy intensity between 2008 and 2020.

The main drivers for biofuels policy in Sweden include decreased dependence on oil products and to decrease the emissions of CO2 of the transport sector. Another aim, not directly related to biofuels, is to increase the overall energy efficiency in the transport system. In June 2010, the EC announced a scheme for certifying Biofuels. The Swedish Energy Agency is the national agency responsible for implementing these sustainability criteria.

## Biofuels policy

### Biofuel obligations

Low blending limits have increased for ethanol (from 5 to 10%) and for biodiesel (from 5 to 7%). However, there is no obligation to blend biofuels into petrol and diesel. Also, the actual low blending depends on the excise duty, see below.

Table 17‑1Actual low blending levels 2007-2010 (number in parenthesis shows allowed level of low blending according to regulation)

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Biodiesel (%)** | **Bioethanol (%)** | **Biofuels**  |
| 2007 | 4% in 67% of all diesel (5%) | 5% in 93% of all petrol (5%) | 4,2% |
| 2008 | 4,5% in 76% of all diesel (5%) | 5% in 94% of all petrol (5%) | 4,9% |
| 2009 | 5% in 81% of all diesel (5%) | 5% in 95% of all petrol (5%) | 5,4% |
| 2010 | 5% in 80% of all diesel (7%) | 5% in 96% of all petrol (10%) | 5,7% (target 5,75%) |
| 2012 | (7%) | (10%) | No specific target for 2012 |
| 2013 | (7%) | (10%) | No specific target for 2013 |

### Excise duty reductions

The current limits of the tax exemption are 6.5% for ethanol, and 5% for biodiesel. Low blends above these levels are subject to the same tax as petrol or diesel. High blends, for example E85, ED95 and biodiesel (100% RME) are subject to full tax exemption. Biogas as a transport fuel is also tax exempt.

The gasoline/diesel ratio in Sweden is closer to the North American average than the European average, largely due to tax differences. However, diesel is increasing its share rapidly due to fiscal incentives for new cars and an increasing demand for transportation of goods.

### Fiscal incentives

In 2006 a carbon dioxide differentiated vehicle tax was introduced. This mainly provides guidance towards increased energy efficiency but has an element of tax relief for cars that can be run on alternative motor fuels.

As of 1st July 2009, new clean vehicles are exempt from vehicle tax for five years. A clean vehicle is a vehicle equipped with technology for operating entirely or partially on electricity, alcohol or gas, or a fuel-efficient petrol or diesel car with carbon emissions below 120 g/km. As of 1st January 2012, a super-green car rebate (cars with emissions below 50 g/km) is scheduled to be introduced. The size of the premium is € 4000 for individuals and 35 per cent of the additional cost of producing a super-green car or a maximum of € 4000 for legal entities.

On 1 January 2011, the carbon dioxide differentiation of vehicle tax was increased from € 1,5 to € 2 per gram of carbon dioxide per kilometre, making vehicles with low carbon emissions a more advantageous choice. From 2011, the vehicle tax for newly registered light goods vehicles, buses and motor caravans are also subject to carbon dioxide differentiation. The vehicle tax for heavy goods vehicles does not include carbon dioxide differentiation, but is levied by weight and exhaust class.

The “benefit value” of a company car is subject to income tax, and the tax for this is also levied through the social insurance contributions paid by employers. Free motor fuel may also be part of a company car package. How these benefits are taxed, affects which cars are selected and how they are used. The present structure of “benefit value” tends to even out the effect of price differences between cars, with the result that company cars emit more carbon dioxide per kilometre than the average for new cars. Benefit taxation is also reduced for clean vehicles.

### Investment subsidies

In 2009, the Swedish Energy Agency was authorized to award grants of about € 80 million in support of three demonstration facilities; two of them will produce advanced motor fuels, € 49 million for a black-liquor gasification project, and € 22 million for a gasification project to synthetic gas. The largest project aims to extract biofuels from black liquor at a facility in Domsjö, Örnsköldsvik, with gasification technology provided by Chemrec AB (€53 million). Göteborg Energi AB got €23 million for a project that aims to build and run a facility for the transformation of low-quality forestry materials to produce high-quality biofuels – biomethane. Sweden has earmarked a 14 M euro budget (9 million euro funded so far) for a cellulosic ethanol process program aimed at developing technology that can be commercialized (including demonstration through pilot or larger pre-commercial demonstration scale).

### Other measures stimulating the implementation of biofuels

On 1 April 2006 a law on the obligation to make renewable fuels available came into place. According to the law, filling stations with a certain sales volume must offer a renewable motor fuel in addition to petrol and diesel. Many local incentives for environmental cars exist, such as free parking and relief from congestion charges. Procurement rules for state authorities also include the demand for a certain proportion of environmental cars. From 1 July 2011, a new Act requires that the procurement or leasing of cars and public transport services take into account a vehicle's energy consumption and emissions during the vehicle’s life.

Two major research projects were completed in 2010. BEST was an EU-wide project in which the City of Stockholm and the Biofuel Region were participants, while many Swedish research groups were linked to the NILE project.

Three research programs in the energy sector in Sweden include Bio4Energy, a consortium headed by Umeå University, the Chalmers Energy Initiative, a centre for research on energy technology at Chalmers University, and STandUP for Energy, a consortium headed by Uppsala University focused on sustainable energy and electrical vehicles.

### Promotion of advanced biofuels

There are three pilot and demonstration plants in Sweden for so-called advanced motor biofuels:

* Ethanol production from cellulose; SEKAB (Örnsköldsvik). In 2012, SEKAB ended the operation of its pilot plant and SP (Technical Research Institute of Sweden) is exploring taking over the plant operation.
* Synthesis gas production from black liquor; Chemrec, (Piteå).
* Synthesis gas production from biomass; IVAB (Piteå).

Sweden has earmarked 14 M euro for cellulosic ethanol aimed at developing technology that can be commercialized.

Three new projects have been awarded funding from the EC:

GoBiGas Phase 2: The plant will produce 100 MW gas, using low quality forest feedstock. It is scheduled to be in service in 2016. (Phase 1 is a 20 MW plant and is planned to be operational by the end of 2013). Pyrogrot is planning a 160,000 tons/yr plant using pyrolysis oils from forest residues to produce 750 GWh of energy. A third project is planned in Poland using the SEKAB cellulosic ethanol technology. This plant will produce 60 ML/y ethanol from wheat straw and corn stover, with lignin and power as coproducts.

The Swedish Energy Agency believes that ILUC concerns may be counterproductive. Its value as an element of policy is uncertain, as inclusion of ILUC won’t provide enough incentives for advanced ethanol (cellulosic) and is likely rather to result in higher use of fossil fuels.

## Market development and policy effectiveness

The ambition of introducing biofuels in Sweden is high. A large share of biofuels in Sweden is used as low blending in petrol and diesel. Currently almost all petrol has a 5% blend of ethanol, while about 80% of the diesel contains a 5% blend of biodiesel. Sweden also has a very high use of alternative fuels such as E85 and biogas due to the fact that the number of cars that can run on alternative fuels has a large market share.

Only about 30% of the ethanol and 50% of biodiesel used in Sweden was produced within the country in 2010. All of the biogas was domestically produced. Bioethanol production capacity is about 200 million litres per year and biodiesel capacity is about 160 million tonnes per year.

The amount of bioethanol being used in Sweden is about 400 million litres per year, with ethanol stabilizing at the low blend limit. Biodiesel consumption is now at about 225 million litres per year. Finally, biogas has increased rapidly during the last couple of years.

Table 17‑2 - Biofuel development and market share, Sweden

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | Biodiesel(million L/a) | Bioethanol(million L/a) | PPO(n/a) | Biogas(million m3/a) | 2nd-Gen (n/a) | Market share (%) |
| 2004 | 9 | 261 |  | 13 |  | 2.1% |
| 2005 | 11 | 285 |  | 16 |  | 2.3% |
| 2006 | 65 | 321 |  | 24 |  | 3.2% |
| 2007 | 130 | 359 |  | 28 |  | 4.2% |
| 2008 | 165 | 422 |  | 34 |  | 4.9% |
| 2009 | 205 | 389 |  | 43 |  | 5.4% |
| 2010 | 225 | 400 |  | 59 |  | 5.7% |
| 2011 | 26 | 220 |  |  |  |  |
| 2012 | 42 | 219 |  |  |  |  |

Source: Swedish Energy Agency

In recent years, the proportion of biofuels used by road vehicles has increased substantially in Sweden. In 2010, the proportion of biofuels amounted to 5.7%, while the corresponding proportion for 2009 was 5,4%.

With respect to the distribution of renewable fuels in Sweden (beginning 2013), 60% of all filling stations sell E85 (1600 stations), more than 130 sell methane, 4 sell LBG, 4 DME and 1 sells ED95. All 95 octane petrol is blended with 5% ethanol, while 4% of car sales are E85 vehicles and 3% methane.

Sweden projects only a small market for cellulosic ethanol by 2020 and sees the need for longer-term policy instruments (10-20 years) to attract investors for new production.

## Sources

* Energy in Sweden 2011, The Swedish Energy Agency, November 2011.
* Transportsektorns Energianvändning 2010, Swedish Energy Agency, April 2011.

# United Kingdom

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## Introduction

Renewable energy is an integral part of the UK Government's longer-term aim of reducing CO2 emissions by 60% by 2050. In 2000 the Government set a target of 10% of electricity supply from renewable energy by 2010 introducing the Renewable Obligation, and in 2006 they announced their aspiration to double that level by 2020. In 2011 the Government published a renewable energy roadmap. This document sets out a comprehensive action plan to accelerate the UK’s deployment and use of renewable energy, and put the UK on the path to achieve their 2020 target, while driving down the cost of renewable energy over time. This includes a renewable target of 15% of all the UK energy consumption by 2020. Road transport biofuels already make up over 3% by volume of all road transport fuels and are proposed to increase to 5% by 2014. Subject to the results of current consultations, Government will come forward with options in spring 2012 for the period after 2014.

### Main drivers for biofuels policy

The main driver for biofuels policy in the United Kingdom is carbon reduction. In the UK the transport sector has seen a steady increase in carbon emissions whilst other sectors have been reducing their emissions.

## Biofuels policy

### Biofuel targets or obligations

|  |  |
| --- | --- |
| **Year** | **Petrol + Diesel** |
| **2005** |  |
| **2006** |  |
| **2007** |  |
| **2008** | 2.5% |
| **2009** | 3.25% |
| **2010** | 3.5% |
| **2011** | 4% |
| **2012** | 4.5% |
| **2013/2014 onwards** | 4.75% |

The current Renewable Transport Fuels Obligation (RTFO) was introduced in 2008 and places an obligation on owners of liquid fossil fuel intended for road transport use to ensure that either a certain amount of biofuel is supplied or that a substitute amount of money is paid. This obligation is assessed according to who owns the fuel when it crosses the duty point (the point when a fuel becomes chargeable for duty). Only those organisations that supply more than 450,000 litres of fossil fuel in a given year are obligated by the Order. The amount of biofuel that must be supplied increases annually until April 2013 when it will reach 4.75% of total road transport fuel supplied by volume. There are currently no plans to increase this level.

Owners of biofuel at the duty point are awarded one Renewable Transport Fuel Certificate (RTFC) per litre of biofuel, or kilogram of bio-methane, supplied. Fuels produced from certain feedstocks are eligible for double counting. These include fuels derived from wastes and residues as well as those from lignocellulosic and non-edible cellulosic material.

RTFCs may be earned irrespective of the volume of biofuel owned, providing a potential revenue stream for even the smallest suppliers. RTFCs may be traded between participants in the scheme.

At the end of the year, suppliers of fossil road transport fuel demonstrate compliance with the RTFO by redeeming the appropriate number of RTFCs to demonstrate the required volume of biofuel was supplied. Alternatively, obligated fossil fuel suppliers can pay a buy-out price per litre of obligation, the buy-out price being set in the RTFO. Suppliers are allowed to carry over RTFCs from one year to the next, provided that no more than 25% of the supplier’s obligation to supply biofuel for the later year is met by carrying over RTFCs. This enables suppliers to ‘bank’ certificates against unforeseen circumstances. Under the current scheme, biofuel suppliers must provide information on the GHG savings, and environmental and social impacts of their fuels in order to earn a certificate. The content of the information does not affect whether an RTFC is issued.

In December 2011, the RTFO was amended to implement the sustainability criteria of the European Renewable Energy Directive (RED). This introduced mandatory sustainability criteria which biofuels must meet for those fuels to be eligible for renewable transport fuel certificates. Biofuels that do not meet these criteria are considered fossil fuels for the purposes of the order and accrue an obligation to supply sustainable biofuels in the same manner. The mandatory sustainability criteria include a minimum greenhouse gas saving and those relating to land use, which require fuel suppliers to demonstrate that the cultivation of feedstocks for their fuels did not damage areas of high carbon stocks or high biodiversity. The 2011 amendment also introduced double rewards for some fuel types, including those made from waste materials such as used cooking oil, and a requirement to have data on the carbon and sustainability performance of fuels to be independently verified before Renewable Transport Fuel Certificates (RTFCs) are awarded.

Targets have not currently been set beyond 2013 however the UK Government intends to meet the European target of 10% renewable transport fuels by 2020, although the use of electric vehicles can count towards targets.

In Year 4 (14 April 2011 to 15 April 2012) of the RTFO:

* 1.6 billion litres of renewable fuel have been supplied, which is 3.6% of total road transport fuel reported to the RTFO Administrator against an annual obligation of 4.0%.
* More biodiesel (57%) has been supplied than bioethanol (43%). There were also small volumes of biogas, biomethanol and pure vegetable oil.
* 1.7 billion RTFCs have been issued of which 464 million were for double counting feedstocks.

From 15 Dec 2011 to 14 Apr 2012:

* 43% of the Year 4 RTFCs were issued to biofuel supplied in this period.
* The largest proportion of renewable fuel was derived from used cooking oil (229 million litres, 45% of total biofuel supplied). The most widely reported source (by feedstock and country of origin) for biodiesel was used cooking oil from the Netherlands (48 million litres, 18% of biodiesel supplied). The most widely sourced bioethanol was corn from the United States of America (163 million litres, 69% of bioethanol supplied).
* 12% of renewable fuel was sourced from UK feedstocks.
* An aggregate greenhouse gas saving of 63% compared to fossil fuels was achieved. This figure excludes emissions from indirect land-use change.

This report covers the supply of renewable fuels under the Renewable Transport Fuel Obligation from 15 April 2012 to 14 April 2013 based on data currently available1. The headline figures are:

* 1,337 million litres of renewable fuel have been supplied, of which 1,031 million litres (77%) has so far been demonstrated to meet the sustainability requirements2.
* 1,465 million RTFCs have been issued to fuel meeting the sustainability requirements, of which 868 million were issued to double counting feedstocks.
* Of the 1,031 million litres meeting the sustainability requirements, bioethanol comprised 56% of supply, biodiesel (FAME) 39% and biomethanol and methyl tertiary butyl ether (MTBE) 5%. There were also small volumes of biogas, and pure vegetable oil.

C&S characteristics of the biofuels to which RTFCs have been issued:

* The most widely reported source for biodiesel (by feedstock and country of origin) was used cooking oil from the UK (128 million litres, 12% of total fuel, 32% of biodiesel).
* The most widely reported source for bioethanol (by feedstock and country of origin) was corn from the United States of America (203 million litres, 20% of total fuel, 35% of bioethanol).
* 42% of fuel was made from a waste/non-agricultural residue (double counting) feedstock.
* 22% of the fuel was sourced from UK feedstocks.
* An aggregate greenhouse gas saving of 67% compared to fossil fuels was achieved. This figure excludes emissions from indirect land-use change.
* 77% of the fuel was sourced from a voluntary scheme.
* The most commonly used voluntary scheme was ISCC (60% of fuel) followed by Abengoa RED Bioenergy Sustainability Assurance (11%).

### Excise duty reductions

Tax reductions for biofuels were first introduced in 2004 with a reduction for biodiesel. On the first of January 2005 a similar tax reduction was introduced for bioethanol. With the introduction of the RTFO these tax reductions were phased out. From 1 April 2010 bioethanol and biodiesel were taxed at the same rate as their fossil equivalents. The only exception being biodiesel produced from used cooking oil, which was taxed at £0.20 per litre less than fossil diesel until March 2012.

### Other measures stimulating the implementation of biofuels

On 27 January 2009, the Biotechnology and Biological Sciences Research Council (BBSRC) announce a significant public investment in bioenergy research has been announced by the main funding agency for the biosciences – The £27M BBSRC Sustainable Bioenergy Centre has been launched to provide the science to underpin and develop the important and emerging UK sustainable bioenergy sector – and to replace the petrol in our cars with fuels derived from plants.

The BBSRC Sustainable Bioenergy Centre is focused on six research hubs of academic and industrial partners, based at each of the Universities of Cambridge, Dundee and York and Rothamsted Research and two at the University of Nottingham. Another 7 universities and institutes are involved and 15 industrial partners across the hubs are contributing around £7M of the funding. The Centre’s research activities will encompass many different stages of bioenergy production, from widening the range of materials that can be the starting point for bioenergy to improving the crops used by making them grow more efficiently to changing plant cell walls. The Centre will also analyse the complete economic and environmental life cycle of potential sources of bioenergy.

### Promotion of advanced biofuels

In the longer term, the Renewable Transport Fuel Obligation (RTFO) should be able to encourage and reward the development and use of those biofuels (including cellulosic ethanol) which deliver the maximum carbon savings with the minimum environmental impact. The amendment in 2011 includes provision for advanced biofuels to count double towards the transport fuel targets. It is hoped that this will raise the value of these fuels and encourage investment in their production.

## Market development and policy effectiveness

Table 18‑1 - Biofuel development and market share, UK

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol(million L/a)** | **PPO(n/a)** | **Biogas****(n/a)** | **2nd-Gen (n/a)** | **Market share (%)** |
| **2007** | 347 | 153 |  |  |  | 1.01 |
| **2008** | 886 | 206 |  |  |  | 2.26 |
| **2009** | 1044 | 320 |  |  |  | 2.90 |
| **2010** | 1045 | 631 |  |  |  | 3.61 |
| **2011** | 932 | 698 |  | 1 |  | 4 |
| **2012** | 493 | 780 |  | 1 |  | 3 |
| **2013** |  |  |  |  |  |  |

\*2012 –Further contributions by biomethanol (35 ML) and MTBE (renewable) (28 ML)

## Sources

* [*http://www.decc.gov.uk/en/content/cms/meeting\_energy/renewable\_ener/re\_roadmap/re\_roadmap.aspxl*](http://www.dti.gov.uk/energy/sources/renewables/index.html)
* <http://www.uktradeinfo.com/index.cfm?task=bulloil>
* <http://www.dft.gov.uk/topics/sustainable/biofuels/>
* <https://www.gov.uk/renewable-transport-fuels-obligation>
* Renewable Transport Fuel Obligation statistics: Year 4 2011/2012, Year 5 2012/13,

# United States

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## Introduction

US imports of crude oil and petroleum products have shown a decline in recent years. In 2012, imports amounted to 11 MMbd of crude oil, while 3.2 MMbd was exported, so net imports equaled 7.4 MMbd (EIA). Net imports accounted for 40% of the oil supply in the US. The top sources of imports are Canada (28%), Saudi Arabia (13%), Mexico (10%), Venezuela (9%) and Russia (5%).

U.S. dependence on imported oil has declined since peaking in 2005. This trend is the result of a variety of factors including a decline in consumption and shifts in supply patterns. The economic downturn after the financial crisis of 2008, improvements in efficiency, changes in consumer behavior, and patterns of economic growth all contributed to the decline in petroleum consumption. At the same time, increased use of domestic biofuels (ethanol and biodiesel), and strong gains in domestic production of crude oil and natural gas plant liquids expanded domestic supplies and reduced the need for imports.

The primary biofuel used in the United States is ethanol from starch (mostly corn). Ethanol production remained at similar levels from 2010-2012 (50,00 ML/y) while biodiesel production increased to 3,751 ML/y after reaching a low level of 1,194 ML/y in 2010. In 2012, U.S. ethanol production decreased from roughly 900,000 barrels per day (≅ 13.4 B gal/yr ≅ 51 B L/yr) due to higher corn prices coupled with weaker gasoline demand (corn supplies decreased due to severe drought). Bioethanol production for 2013 was projected to reach approximately 14 billion gallons (53 billion litres) while biodiesel production was estimated to reach 1 billion gallons (4 billion litres)

### Main drivers for biofuels policy

In the United States, the primary political drivers that support research programs and development of biofuel capacity are related to the economy and to energy security. Biofuel regulations are in flux but government support remains strong for biofuels development and deployment. The biggest issue right now is the “blend wall” for ethanol, as the government moves to raise the maximum permissible blend level in non-FFV light duty vehicles from 10 to 15% (which has been approved by the EPA, but only for vehicles manufactured in 2001 or more recently). With the recent changes in the US Congress, the importance of environmental security and climate change mitigation as bi-partisan drivers for biofuels has diminished relative to energy security and economic development. Uncertainty remains around carbon regulation, GHG emissions reduction initiatives, and the ethanol blend wall. The 2010 funding for R&D included $80 million for advanced hydrocarbon (‘drop-in’) biofuels, including $44 million for algae-based and $34 million for cellulosic-based biofuels.

Two agencies remain the primary implementing bodies for U.S. development biofuels. The Department of Agriculture (USDA) has a mandate to increase rural employment, diversify agricultural economies and stimulate rural development by harnessing crops and crop residues and identifying new uses for these materials. The Department of Energy (DOE) has a mandate to diversify the energy supply, expand the availability of renewable energy sources, and develop new technologies to exploit renewables in all forms. The US Environmental Protection Agency develops and implements regulatory policies for biofuels use.

The initial drivers for the US biofuels industry were in part the oil shocks and associated rising prices of fuel in the 1970s, but today are dominated by a strong agricultural lobby that is interested in creating additional revenue streams for farmers. A number of different policy options have been employed to help build the industry. Both federal and state governments have offered the industry direct funding in the form of public-private partnerships and research funds, as well as tax incentives and state-level renewable fuel mandates. With the US bioethanol industry primarily using corn, these incentives substantially influence agriculture in the States.

## Biofuels policy

### Biofuel targets or obligations

|  |  |  |
| --- | --- | --- |
| **Year** | **Advanced Biofuel (B gallons)** | **Total Renewable Fuel (Including starch ethanol)** |
| **Biomass-Based Diesel** | **Cellulosic Biofuel** | **Total Advanced Biofuel** |
| **2006** |  | 0 |  | 4.0 |
| **2007** |  | 0 |  | 4.7 |
| **2008** |  | 0 |  | 9.0 |
| **2009** | 0.5 |  | 0.6 | 11.1 |
| **2010** | 0.65 | 0.1 | 0.95 | 12.95 |
| **2011** | 0.80 | 0.25 | 1.35 | 13.95 |
| **2012** | 1.0 | 0.5 | 2.0 | 15.2 |
| **2013** | >1.0 (tbd) | 1.0 | 2.75 | 16.55 |
| **2014** | >1.0 | 1.75 | 3.75 | 18.15 |
| **2015** | >1.0 | 3.0 | 5.5 | 20.5 |
| **2016** | >1.0 | 4.25 | 7.25 | 22.25 |
| **2017** | >1.0 | 5.5 | 9.0 | 24.0 |
| **2018** | >1.0 | 7.0 | 11.0 | 26.0 |
| **2019** | >1.0 | 8.5 | 13.0 | 28.0 |
| **2020** | >1.0 | 10.5 | 15.0 | 30.0 |
| **2021** | >1.0 | 13.5 | 18.0 | 33.0 |
| **2022** | >1.0 | 16.0 | 21.0 | 36.0 |

The Renewable Fuels Standard (RFS) program was created under the Energy Policy Act (EPAct) of 2005, and established the first renewable fuel volume mandate in the United States. Under EPAct, the original RFS program (RFS1) required 7.5 billion gallons of renewable- fuel to be blended into gasoline by 2012. Under the Energy Independence and Security Act (EISA) of 2007, the RFS program was expanded (RSF2) in several key ways. The Renewable Fuels program of the EPA states:

* RFS2 included diesel, in addition to gasoline;
* RFS2 increased the volume of renewable fuel required to be blended into transportation fuel from 9 billion gallons in 2008 to 36 billion gallons by 2022;
* EISA established new categories of renewable fuels, and set separate volume requirements for each one.
* EISA required EPA to apply lifecycle greenhouse gas performance threshold standards to ensure that each category of renewable fuel emits fewer greenhouse gases than the petroleum fuel it replaces.

RFS2 lays the foundation for achieving significant reductions of greenhouse gas emissions from the use of renewable fuels as well as for reducing imported petroleum. RFS2 requires LCA assessments to determine which fuels meet mandated GHG performance thresholds relative to the petroleum fuels they displace. New facilities need to demonstrate reductions of at least 20% relative to petroleum-derived gasoline, advanced biofuels need to demonstrate 50% reductions, and cellulosic biofuels are required to meet a 60% reductions target.

Table 19-1

The EPA set a total renewable fuel standard of 16.55 billion gallons for 2013. This total volume, presented as a fraction of a refiner's or importer's gasoline and diesel volume must be renewable fuel. The final 2013 standards are shown in below in Table 20-2. The target for cellulosic biofuels was set at 6 million gallons, which is far below the 1 billion gallon target specified by the EISA. The required volume of total renewable fuels remained at 16.55 billion gallons as specified in the EISA 2007. However, the EPA anticipates the need to adjust these targets for the 2014 RFS program year, for which EISA 2007 specifies a total renewable fuels target of 18.15 billion gallons.

Table 19‑2 EISA fuel production obligations (million L/year)

|  |
| --- |
| **(Revised) Standards for 2013** |
| **Fuel Category** | Percentage of Fuel Required to be Renewable | Volume of Renewable Fuel (in billion gal) |
| **Cellulosic biofuel** | 0.004% | 0.006 |
| **Biomass-based diesel** | \*1.13% | \*1.92 |
| **Total Advanced biofuel** | 1.62% | 2.75 |
| **Renewable fuel** | 9.74% | 16.55 |

Apart from delays in the increased production of cellulosic biofuels, RFS implementation has also been challenged by the decline in recent and projected gasoline consumption since enactment of EISA 2007. This is due to higher vehicle fuel economy standard, slower economic growth, higher gasoline prices and possible changes in consumer behaviour. The level of gasoline consumption limits the amount of ethanol that may be used as the blending mandate is fixed at 10%, referred to as the E10 blend wall. The gasoline market in the US has a limited ability to consume higher ethanol blends as a result of infrastructure and market-related factors. There is also difficulty in producing significant volumes of non-ethanol advanced biofuels such as biodiesel, renewable diesel and biogas.

### Excise duty reductions

The Volumetric Ethanol Excise Tax Credit (“VEETC”), also known as the “blender’s credit”, was the primary federal tax incentive for the use of ethanol. As such, VEETC has been a major factor behind the spectacular increase in ethanol use, production and continued innovation in the industry. This tax credit expired on December 31, 2011. The biodiesel income tax credit for unblended biodiesel (B100) ($1 per gallon) comes to an end on 31 December 2013. The cellulosic ethanol producers' credit was extended by The American Taxpayer Relief Act of 2012 (Pub. L. 112-240; AKA "Fiscal Cliff deal"), and now is scheduled to expire December, 2013.

### Fiscal incentives and investment subsidies

The rate of increase in conventional ethanol production will slow going forward as the 15 B gal/yr cap on grain ethanol called for under RFS2 is reached; above this cap there is no subsidy and concerns exacerbate about the ability to maintain reasonable corn grain supplies at reasonable prices for food and feed markets.

A second generation biofuel production plant placed into service between December 20, 2006, and December 31, 2013, may be eligible for an additional depreciation tax deduction allowance equal to 50% of the adjusted basis of the property. The plant must be solely used to produce second generation biofuel and is only eligible for the depreciation allowance for the first year in operation.

### Other measures stimulating the implementation of biofuels

Several new Funding Opportunity Announcements (FOAs) were issued by USDOE and USDA for thermochemical and/or biochemical biofuels R&D and demonstrations. The DOE and RFA estimate over 3 dozen cellulosic biofuels pilot plants being built or operating in USA. A few larger scale cellulosic ethanol demonstrations are occurring, some stimulated by government loan guarantees, albeit the rate of biofuels deployment is slower than previously projected and total US production levels remain well below RSF2 targets. Government funding for R&D continues to transition from oxygenated biofuels (e.g., ethanol, FAME biodiesel) to “drop in” hydrocarbons (no oxygen content, infrastructure compatible).

### Promotion of advanced biofuels

US Congress passed an augmented Renewable Fuel Standard (RFS2) as part of the Energy Independence and Security Act (EISA) of 2007. The RFS2 mandates 136.3 billion litres of biofuels in the US transportation fuel mix by 2022, and includes specific provisions for advanced biofuels, including cellulosic ethanol and biomass-based diesel.

Classifications for biofuels include conventional (previously called 1st-generation) biofuels, as well as advanced biofuels (including cellulosic ethanol and ‘green gasoline, green diesel, and other synthetic fuels all of which can be classified as 2nd-generation biofuels). However, to date, the ability of the industry to meet the RFS for advanced biofuels is limited, with only one or two projects under construction for biofuel production. Commercialization of advanced cellulosic biofuels continues but at a slower pace than previously forecast.

The INEOS Bio plant in Florida began production of cellulosic ethanol in July 2013 using INEOS Bio’s breakthrough gasification and fermentation technology for conversion of biomass waste into bioethanol and renewable power.

Construction of Poet-DSM Advanced Biofuels’ first commercial cellulosic ethanol plant is on schedule to start up in early 2014. Poet-DSM’s Project Liberty will use bales of corn cobs, leaves, husks and some stalk to produce 20 million gallons of cellulosic bio-ethanol annually, later ramping up to 25 million gallons. The plant is under construction in Emmetsburg, Iowa. Other commercial cellulosic plants

Gevo Inc. has begun supplying the U.S. Coast Guard Research & Development Center with initial quantities of finished 16.1 percent renewable isobutanol-blended gasoline for engine testing.

Sapphire Energy’**s** project continues on track towards producing 100 barrels of crude oil per day in 2015, and at commercial-scale production in 2018. A fully integrated, algae-to-crude oil commercial demonstration facility in Columbus, New Mexico, is operational as of August 2013. When completed, the facility will produce 1.5 million gallons per year of crude oil and consist of approximately 300 acres of algae cultivation ponds and processing facilities.

In May 2013, the US Department of Energy (DOE) announced $16m investments in 3 drop-in biofuel projects (Emerald, Natures BioReserve and Fulcrum). Under the grants, the companies will develop plans for up to 150 million gallon biorefineries that are expected to supply aviation and marine diesel fuel.

In July 2013, the US DOE announced a further $13m investment in 4 advanced biofuel projects (3 pyrolysis projects and 1 Virent project).

 In August 2013, the US DOE announced an additional $22m for algae biofuel technologies to four projects in California, Hawaii and New Mexico aimed at breaking down technical barriers and accelerating the development of sustainable, affordable algae biofuels. Awardees were Sapphire, Hawaii Bioenergy and New Mexico State University.

Another $14m has been awarded by the US Dept. of Agriculture (USDA) to advanced biofuel producers (162 producers in 38 states). Sorghum growers represent the majority of these USDA awardees and this is likely an effect of the recent approval of sorghum as an advanced biofuel feedstock by the US EPA.

Virent delivered 100 gallons of bio-based jet fuel to the US Air Force Research Laboratory for testing purposes in May 2013.

Table 19‑3 Cellulosic Ethanol Plants in the U.S. (operational or under construction)

|  |  |  |
| --- | --- | --- |
| Company | Location | Feedstock |
| Abengoa Bioenergy | Hugoton, KS | Wheat straw |
| BlueFire Ethanol | Irvine, CA | Multiple sources |
| Colusa Biomass Energy Corp | Sacramento, CA | Waste rice straw |
| Fulcrum BioEnergy | Reno, NV | Municipal solid waste |
| Gulf Coast Energy | Mossy Head, FL | Wood waste |
| KL Energy Corp. | Upton, WY | Wood |
| Mascoma |  Kinross, MI | Wood |
| POET LLC | Emmetsburg, IA | Corn cobs |
| SunOpta | Little Falls, MN | Wood chips |
| US Envirofuels | Highlands County, FL | Sweet sorghum |

As at January 2013, fuel ethanol plant production capacity included 193 plants with a capacity to produce 51,966 ML/y, which was slightly lower than the 2011 figure of 52,435 ML/y.

## Market development and policy effectiveness

Production levels of bioethanol in the USA remained at similar levels to 2010 13.2 billion gallons (50 B liters) of ethanol. Production is still dominated by conventional corn grain (starch)-based ethanol. Ethanol production slowed down as the RFS2 16.55 B gal/yr cap for renewable fuels are reached.

In the United States, most bioethanol production capacity is concentrated in the Midwest, in the so-called corn belt, where state and federal government incentives have combined to make an attractive environment for investment in the infrastructure required for bioethanol production. There are 160 facilities (planned, under construction or complete – 138 complete) for producing advanced biofuel for the US market, with 13 demonstration facilities in existence.

Biodiesel capacity is primarily found along the Northeastern seaboard, in the Mideast and Southern states, and on the West Coast. Biodiesel production continues to increase after dropping to its lowest levels in 2010 (1,194 ML/y).

Table 19‑4 - Biofuel development and market share, USA

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Biodiesel****(million L/a)** | **Bioethanol(million L/a)** | **PPO(n/a)** | **Biogas****(n/a)** | **2nd-Gen (n/a)** | **Market share (%)** |
| **2000** | 8 | 6,169 |  |  |  |  |
| **2001** | 19 | 6,699 |  |  |  |  |
| **2002** | 57 | 8,062 |  |  |  |  |
| **2003** | 76 | 10,598 |  |  |  |  |
| **2004** | 95 | 12,869 |  |  |  |  |
| **2005** | 285 | 14,777 |  |  |  |  |
| **2006** | 945 | 18,378 |  |  |  |  |
| **2007** | 1,893 | 24,605 |  |  |  |  |
| **2008** | 2,613 | 34,069 |  |  |  |  |
| **2009** | 2,064 | 40,125 |  |  |  |  |
| **2010** | 1,194 | 50,081 |  |  |  |  |
| **2011** | 3,660 | 52,727 |  |  |  |  |
| **2012** | 3,751 | 50,035 |  |  |  |  |
| **2013** | 5,068 | 50,340 |  |  |  |  |

Source: NBB (2009), RFA (2011), EIA (2013)

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1. G. Venturi in International Forum – Second Edition BIOENERGY in EU countries – Current Status and Future Trends, Cluj-Napoca, Romania, 26 May 2011 [↑](#footnote-ref-1)
2. The volumes mentioned in these reports may differ from the national statistics determined by the Dutch Central Bureau for Statistics (CBS). The reason for this is that CBS reports only physical volumes supplied to the market in a certain year whereas the national reports (both the formal reports to the EU as well as the yearly NEa reports since 2011) include both physical and administrative (i.e. carry-over of volumes from the preceding year) volumes reported by the companies to meet their obligation in a certain year. The national reports include double counting of biofuels that meet the requirements for this (as of 2009), whereas the numbers of CBS do not. [↑](#footnote-ref-2)