

Biorefinery in The Netherlands

(based on text from draft IEA 42 brochure)

Food & Biobased Research, 26 August 2014

Introduction

In the Netherlands (NL) the Bio(based) Economy has been widely adopted in the last years. The most important motives behind this adoption were: the economic opportunities offered to Dutch business through the use of renewable biological resources and residues, striving for more sustainability (reduction of CO₂-emissions, circular economy), and the awareness of the finite nature of fossil fuels. The NL possesses an agri-food and chemical sector that is on par with global industry leaders. The Netherlands also has a well-developed energy sector. Add to that a large number of innovative small and medium enterprises, an international ports linked to a close-knit logistics network, a sizable hinterland, and the availability of high-quality education and knowledge institutes, it is clear that the Netherlands is in a strong position to make the Bio(based) Economy a success. Consequently, the government as well as the business world have made the Bio(based) Economy a main priority.

Different market sectors

The NL is the second largest exporter of **agricultural and food products** worldwide. It has 2 million ha of agricultural land. The added-value of the overall agri-complex is about 50 billion Euros (2010) being about 9% of the of the added-value of the Dutch economy. The Dutch production efficiency per ha is still the highest in Europe. Further, the NL is a global player in the breeding of new plant varieties with 8000-10000 employees, and about 300 companies (Rijk Zwaan, Nunhems, Enza, KeyGene, Syngenta, Novartis, ...). The processing and upgrading of primary (agricultural) residues is increasingly improving. Part of these residues are currently sold as livestock feed; however, several consortia are currently analysing the opportunities to process protein-rich residues to protein ingredients for human food (Avebe, Grassa, HarvestaGG, ...). They also explore if enzymes can be extracted that can be used in the chemical industry; whereas also initiatives are analysing the extraction of specific fibre fractions (NewFoss, Solidpack, ...). In Roosendaal, Cosun has built a pilot-plant for upgrading beet pulp to high quality fibres and bio-based intermediates for polymers, cosmetics, coatings and human food.

The **horticulture sector** is also actively involved in upgrading of their residues (a.o. tomato box from tomato stalks). In addition this sector is a producer of high-quality and complex extractives for applications in pharmaceuticals and cosmetics; whereas they are also involved in the production of aquatic biomass (microalgae, duckweed) for proteins, fatty acids, antioxidants, and colouring agents. Digestion – for the conversion of manure, food industry residues, water treatment residues, and to a lesser extent energy crops (co-substrates) – for the production of biogas, to be upgraded to SNG (natural gas grid) or CNG/LNG (transport fuel), is another important theme in these sectors.

Over the past 10 years, the Dutch **chemical sector** has expanded its turnover by 30% by introducing new products in the market, increasing labour productivity by more than 30%, and reducing energy consumption per tonne of product by 25%. The chemical industry has set a target of consuming 50% less fossil fuels within the next 25 years. The substitution of fossil resources with biomass is an important development in the chemical sector. Huge global players, like Shell, DSM and AkzoNobel are based in the NL, and are actively involved in the development and production of bio-based chemicals. Examples of other stakeholders involved are: BioMCN, Suikerunie, Cosun, Croda, Nuplex Resins, Purac, Avantium, Synbra, Parengo, Rodenburg Biopolymers.

Biomass is currently already being used on a large scale in the **energy sector**. This development is being driven by the European objective of 14% renewable energy (final gross end-use) in 2020. Biomass is anticipated to contribute significantly (about 50%) to this 2020 objective, the rest is from solar, wind and heat pumps. In 2012 about 97 PJ renewable energy was produced in the NL, corresponding to about 4.5% of the national gross end-use. The bioenergy sector is one of the major biomass consumers in the NL. Over 52% (49.8 PJ) of the renewable energy produced in the NL in 2012 was biomass based by combustion of organic materials in domestic waste combustion facilities, direct and indirect co-firing in existing coal-fired power plants, and the use of wood stoves. Mono and co-digestion for the production of power, heat and raw biogas to be upgraded to SNG or CNG/LNG give an additional contribution of about

8% (8.8 PJ). The use of biomass resources for the production of secondary energy carriers (power, heat, biogas) is currently financially supported by the Dutch government (SDE+: 1.7 billion € in 2012, 3 billion € in 2013, 3.5 billion € in 2014), and probably will also remain being subsidised for the mid and longer term to meet the Dutch part of the European renewable energy policy goal of 14% in 2020 [RED; Directive 2009/28/EG [EU 2009a]]. For the period after 2020, the self-support issue concerning energy will become an even more important issue at European level. Within that framework the production and use of bioenergy will remain an important issue.

Positive aspects of the large-scale use of biomass for bioenergy are that a significant biomass potential has been made available in the recent years, certification systems have been developed that guarantee the sustainability over the full production and valorisation chains, and that full chain covering stakeholder consortia are formed that are successful in the market deployment of the full value chains.

A promising near future way to use the available biomass also for higher value Biobased applications (chemicals, materials) is to co-operate with the stakeholders from the energy sector to make use of their expertise and already available infrastructure for biomass sourcing. Options for synergetic co-operation are: i) upstream fractionation of raw biomass resources to separate added-value bio-based products (proteins, carbohydrates, oils) before energy production from the lignin-rich residue stream, and ii) downstream valorisation of produced secondary (process) residue streams (ash fractions, heat, CO₂, ...). The up-/downstream integration of the energy sector with the agro-food and/or chemical sector creates a win-win situation for both the Dutch government and all the stakeholders involved because biomass valorisation chains are developed and deployed that are technically mature, socio-ecologically acceptable and economically profitable.

The same approach is applicable for digestion processes, however, on a smaller and more regional scale. Without financial governmental support these systems are economically not feasible. Therefore, they require a biorefining approach for creating sustainable business concepts.

In the **transport sector** the use of renewable energy is achieved by requiring fuel suppliers to blend fuels with biofuels. The mandatory share of renewable energy in transport amounted 4.5% in 2012, 5% in 2013, 5.5% in 2014, and probably will be set on 6.25% for 2015. This share will continue to expand in the next years. In the NL in 2012 about 15% (14.3 PJ) of the renewable energy used in the NL was for transport purposes (bio-based gasoline and diesel substitutes).

To meet the European policy goal of 10% renewable energy in the transport sector in 2020 also in the coming years the use of biomass in this sector is expected to increase. Like the bioenergy sector, also the biofuel sector offers the running train concerning expertise, logistics, certification, and infrastructure that can be used to further realise the Bio(based) Economy. By development and deployment of Biofuel-driven Biorefineries, using existing infrastructure, multi-product facilities can be realised to valorise biomass in the most efficient and sustainable way.

Knowledge infrastructure

The NL counts a number of public-private joint ventures that conduct targeted research programmes in the **knowledge infrastructure** of the Bio(based) Economy, viz.:

- Regional Clusters with cross-sector cooperation, including provinces, development companies, industry, SMEs, research institutes, universities (BioEconomy Innovation Cluster Eastern Netherlands (BIC ON), Biobased Delta, BioDelta South Wing, Port of Amsterdam, Biobased Limburg, Bio-based Economy North Netherlands, ...)
- Knowledge-based Clusters: Application Centre for Renewable RESources (ACCRES), AlgaeParc, Bioprocess Pilot Facility (BPF), Fresh Biomass Refinery Parc, BioSolar Cells, Green Genetics Centre of Excellence (TGG), Knowledge Centre on Vegetable Substances, Chemelot Institute for Science and Technology (tbe), Shared Research Centre Biobased Aromatics (tbe), ...
- Research Programmes: Catchbio (biocatalysis), BE-Basic (biotechnology), DPI (polymers), BPM (bio-based performance materials), CCC (carbohydrates), BIOcab (agricultural residues valorisation), ISPT (sustainable process technology), AMIMB (bio-based materials, tbe), ...

The Dutch government has been closely involved in **policy** development for promoting the Bio(based) Economy for approximately 10 years by:

- Set-up of a specific Bio-based Economy Programme Management within the Ministry of Economic Affairs (setting the agenda, establishing relationships and coordinating the bio-based policy at various Dutch ministries).
- Co-operation with France and Germany on a EU-wide approach to the Bio-based Economy which contributed to the EU Vision Document "Strategy for a Sustainable BioEconomy in Europe".
- Initiation of 9 Top Sectors for encouraging knowledge development and innovation; Bio-based Economy has been designated as the common theme with its own programme and Knowledge and Innovation Top Consortium (TKI).
- Promotion of the cooperation within the golden triangle business world, knowledge institutes and government, by facilitating two platforms: Biorenewables Business Platform and Agri-paper-Chemical Platform.
- Support of the deployment of the Bio-based Economy by the removal of technical (joint pilots and demos) non-technical bottlenecks (laws and regulations) by initiating Green Deals between government and the business world.
- Encourage the implementation of bioenergy through subsidies and tax instruments

Overall, the NL has a strong initial position for a Bio(based) Economy, as far agriculture and industry as well as the knowledge infrastructure is concerned. Moreover, the Bio(based) Economy is a focal point of the policy on innovation.

The **Top Consortium for Knowledge and Innovation (TKI) Biobased Economy (BBE)** is one of the seven TKIs within the Top Sector (TS) Chemical Industry. This TS is one of the nine defined TSs in which the NL holds a strong global position. The TKI BBE is directed at the production of biobased innovation across the entire biomass value chain, from field to end-product, including the closing of loops. The TKI BBE is organised around six programme lines: high quality energy carriers (focus on pre-treatment/fractionation of biomass), high percentages of additional and auxiliary co-firing, biorefining, chemical and biotechnological conversion technology, aquatic biomass and Economy, Policy and Sustainability (EBD). The TKI BBE has a network of about 100 companies, research institutes, and non-governmental organisations. The available governmental innovation budget in 2012 was 42 million Euro, supplemented with about 150 million Euro individual contributions; for 2013 and 2014 governmental budgets of the same magnitude were/are available.

The information presented in this paragraph on country specific challenges in the Netherlands is mainly taken from a) "The Bio-based Economy in the Netherlands", NL Agency – NL EVD International, The Hague, the Netherlands (www.ianetwerk.nl), May 2013, b) "TKI Biobased Economy" (www.tki-bbe.nl), Top Sector Energy, NL Agency, March 2013, c) "Status Document Bioenergie 2012", NL Agency, Utrecht, the Netherlands, 2013. It is slightly processed by the Dutch representative within IEA Bioenergy Task42 for this specific report. Further, at <http://www.rvo.nl/onderwerpen/duurzaam-ondernemen/groene-economie/biobased-economy> you will find the Protocol Monitoring Biobased Economy and the 2013 Report BBE in NL.