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Showcases of industrial symbiosis related to anaerobic digestion at the project UBIS

Abstract
Industrial symbioses are intended to minimize greenhouse gas emissions, conserve resources and avoid waste through closed material cycles. The waste and residual materials of one actor become the resource of the other. The better use of raw materials can lead to cost and competitive advantages for the involved partners. The UBIS project investigates the realization of such industrial symbioses. Two showcases from the project region with focus on anaerobic digestion illustrate the effectiveness of industrial symbioses.

Keywords: industrial symbioses, ecosystem, greenhouse gas emissions, by-products, municipal waste.

1. Introduction to industrial symbiosis

Industrial symbioses are a relevant topic for industrial and commercial areas worldwide. The term “industrial symbiosis” was used already in the 1960s, for example by (Eyre, 1963; Spilhaus, 1968). Green (1977) has already developed an energy concept for a cement plant taking industrial symbioses into account. Frosch & Gallopoulos (1989) formed the concept of the “industrial ecosystem”, in which “the consumption of energy and materials is optimized and the effluents of one process (…) serve as the raw material for another process”. The term “industrial symbiosis” came into the focus of global public attention during the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, Brazil. Here the industrial area of Kalundborg in Denmark was presented, which at that time consisted of seven industrial companies and had established an ecologically and economically advantageous recycling system and network (Strebel, 2012).

The idea behind industrial symbioses is that by-products and waste products, such as energy in the form of heat and electricity, raw materials and materials of all kinds, water, logistics and logistical services are exchanged between companies so that they can be further utilized for the respective production processes. Thus, greenhouse gas emissions are minimized, resources are conserved and waste is avoided through closed material cycles. The waste and residual materials of one company become the resource of another. These synergy effects can lower emissions and lead to a cost and competitive advantage through more efficient use of raw materials (Gibbs, 2008).

Chertow (2000) provides an explicit definition: "Industrial symbiosis engages traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and/or by-products. The keys to industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity".

2. The UBIS Project

UBIS is an acronym for "Urban Baltic Industrial Symbiosis". Urban Baltic industrial symbiosis focuses on initiating industrial symbiosis in order to make use of energy and other resources that would otherwise go to waste.

The project contributes to reduced emission by introducing and expanding industrial symbiosis in the region. The project provides tools, implement five pilot projects and carry out activities to spread the project results and support and inspire new symbiosis projects. Since the business aspect is included in the tools, sustainable symbiosis cases are expected, and thus long-term effects on reduced pollution discharges.

Experiences, from existing symbiosis plants and planned pilot investments that are made in the project, are collected. Analyses of showcases are done, based on size of resources that could be retrieved, size of investments necessary, business model used, complexity of projects, legal agreements and other factors. Country specific conditions, such as national policies, are taken into account.

The analysis, as well as input from academic research and previous experience, develops a set of tools for identification and evaluation of industrial symbiosis prospects, including the critical success factors identified in the analysis and research. Through an iterative process, the "tool prototypes" are tested, modified and improved in the pilot symbiosis planning and implementation.

The purpose is to encourage development of tentative plans for new projects. Access to models and tools will speed up the process of attracting and engaging new companies. Actual cases, analysis tools and proven business models will help to convince new companies of the potential of industrial symbiosis.

The project includes ten partners from five countries in the South Baltic region. The ten partners are: Skåne Energy Agency (Sweden), Sustainable business Hub (Sweden), City of Malmö (Sweden), Bjuv Municipality (Sweden), Lithuanian District Heating Association (Lithuania), Silute District Municipality (Lithuania), Rostock University (Germany), Kalundborg Municipality (Denmark), Symbiosis Center Denmark (Dänemark), Kalundborg Utility (Denmark), Gdansk University of Technology (Poland).

3. Showcases for industrial symbiosis

3.1. Sugar Factory Anklam

The Suiker Unie GmbH & Co. KG operates a sugar factory in Anklam/Germany, the only one in the federal state Mecklenburg-Western Pomerania. Directly connected to the sugar factory, the subsidiary Anklam Bioethanol GmbH runs a bioethanol factory. The main products of the two companies are white sugar and bioethanol from sugar beet. A number of secondary and waste products are fabricated. These are partly used in the own company or are marketed as raw materials to other customers.

In the first step of the production of sugar or bioethanol, the sugar beet is cleaned and then comminuted. As a result, raw juice is obtained and the leached sugar beet chips are used as a by-product.

The sugar beet chips are mixed with process water and then used energetically in the company's own biogas plant, in addition to other waste materials such as sludge or similar. Biogas is also produced at the anaerobic step of the waste water treatment facility of the company. The biogas is mainly upgraded to biomethane (not owned by the factory) and fed in the natural gas grid.

As another by-product, the chips are dried and pressed into pellets under the addition of molasses and then marketed as animal feed.

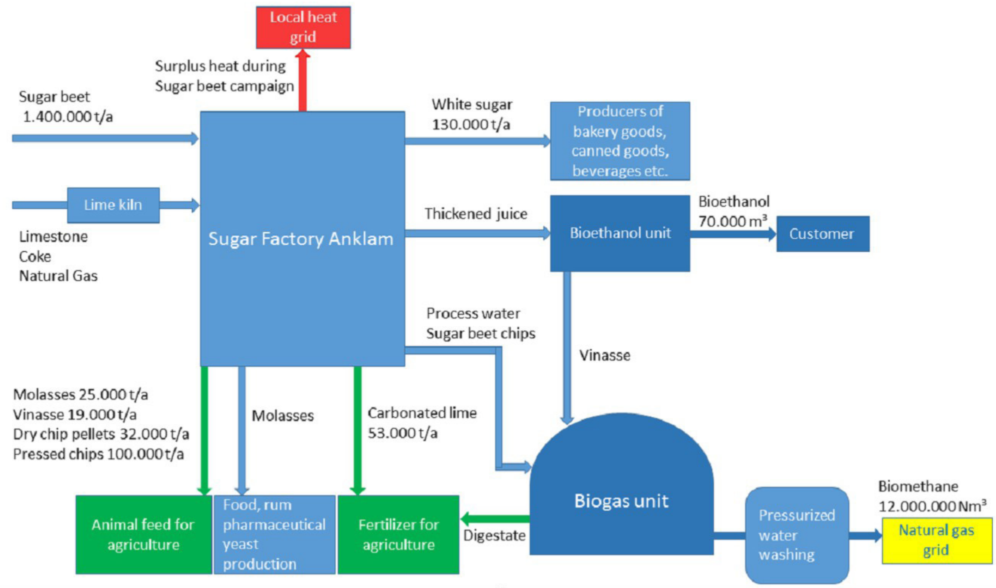

Fig. 1. Flow chart of the products of the sugar factory

The cleaning of the raw juice is carried out with milk of lime. After cleaning, the lime is separated and used as fertilizer. The purified raw juice is thickened for crystallization at the sugar production and bioethanol production in the connected bioethanol factory. The by-product molasses is generated during the crystallization. The sugar content in molasses is still about 50%. Molasses is used, e.g. to pellet the dry sugar beet chips or directly as a feed additive. Furthermore, molasses is taken from the food, pharmaceutical and yeast-production industry. The produced bioethanol is used in petroleum refineries as an additive or mixed with petroleum to reach the biofuel rate. Vinasse arises as residue after the distillation process of the ethanol production and is used either as an animal feed additive or biogas substrate. A number of industrial symbioses have been developed around the sugar factory in Anklam. The main partner is agriculture. However, other industries can also profit from the waste products of sugar production (Zuckerfabrik, 2018). Figure 1 shows the material flows within the company.

3.2. MBT Rostock

The Mechanical-biological Treatment plant (MBT) and Refuse Derived Fuels-Combined Heat and Power plant (RDF-CHP) at the industrial site Port Rostock, Germany is an example for the use of municipal solid waste (MSW). Figure 2 shows the industrial symbiosis between the two companies by material exchanges.

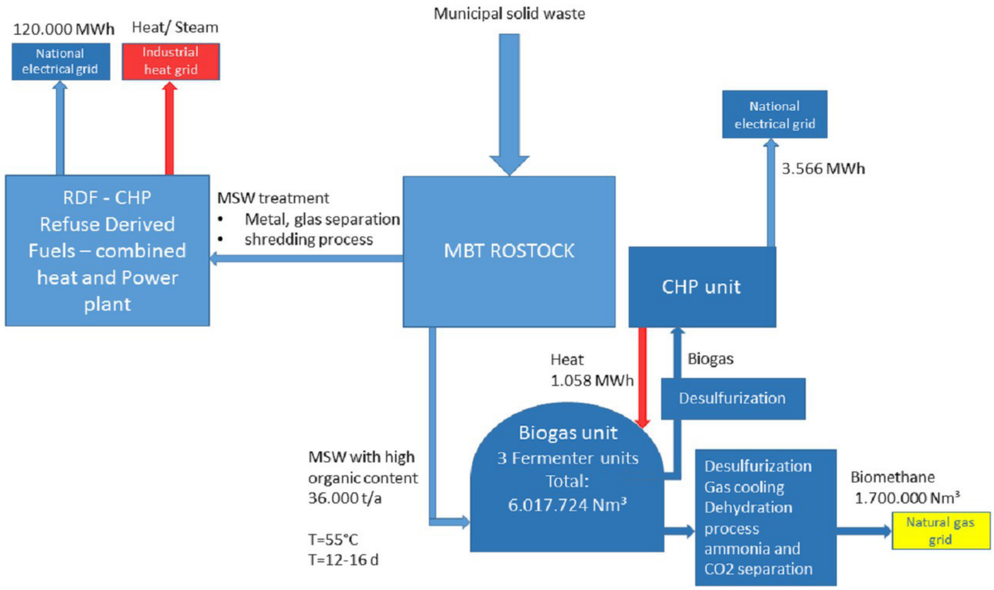

Fig. 2. Flow chart of the Mechanical-biological Treatment plant and Refuse Derived Fuels-Combined Heat and Power plant

The mechanical part of the MBT (Veolia) generates different material flows from municipal waste for recycling at another place (e.g. metal, glass) and for a valuable energetic use (RDF). The mechanically at the plant separated biological part produces biogas in three plug-flow fermenters. The biogas is upgraded to biomethane and fed in the national natural gas grid. A small part of biogas is used by a biogas-CHP unit, which provides heat for the fermenters. The co-located RDF-CHP plant (Vattenfall) uses the RDF in co-generation and feed per year more than 120,000 MWh electricity into the national electrical grid. Due to low prices for the electricity the plant is driven by heat demand. The heat is used as steam at the industrial site Port Rostock as well as at the MBT for technical drying of the remaining organic fraction after the anaerobic digestion to produce an additional RDF fraction with high organic content. For the incineration at the RDF-CHP plant a secondary air flow is needed. Therefore the ventilation air of the MBT plant is used, which saves there an exhaust air cleaning by bio-filters or air washer (Vattenfall, 2018; Veolia, 2018).

4. Conclusion

Anaerobic digestion offers excellent opportunities to connect symbiosis partners. A broad variety of organic wastes and residues are suitable for this technology and the produced biogas can be used flexible in different ways — also to supply processes run at high temperature or for cold production in trigeneration.

Every industry has material cycles and flows. Even service companies need energy in the form of heat and electricity and produce secondary material streams such as waste paper and householdlike waste. It is important to reach and involve the different industries. This increases the possibility of industrial symbioses being realized.

In addition to private companies, another approach is to involve political actors in the formation of industrial symbioses. An incentive could be public procurement. For example in the food sector, the public meals are a significant actor. Industrial symbioses can be achieved through laws, legal framework conditions and specifications. Many symbiotic partnerships are closely related to policy incentives (Mirata, 2004). In addition to possible political incentives (such as tax reductions or other advantages), the main focus must be on networking (Gibbs, 2008). These networks are of particular importance because the common goal, the exchange of interests and information, sets the framework for a successful industrial symbiosis in the future.

Aside from ecological issues and economic incentives, the social aspects also play a decisive role. Entrepreneurs often lack access to information from neighbouring companies (Chertow, 2007). This makes cooperation to complete possible material cycles more difficult and the potentials are not fully utilized. Cooperation and communication between the individual actors is therefore of crucial importance. Industrial symbiosis must be understood as a concept for collective optimization of resources (Jacobsen, 2006). The creation of networks to promote exchange and communication is elementary for industrial symbioses.

Obstacles to industrial symbiosis are often economically justified. For example, the return of investment or the granting of credit for companies can be problematic. Another stakeholder is the political level. Regulations, bureaucratic processes and missing standards have an influence on the expansion of industrial symbiosis (Mirata, 2017). But even if the framework conditions are ideal, it is ultimately an individual decision to establish industrial symbioses.

Industrial symbioses, especially by using anaerobic digestion, have great potential to reduce emissions and conserve resources. Besides the commitment of the industrial-symbiosis participants, the support must be established at political, economic and social level (Hewes, 2008; Mirata, 2005).

References

Chertow, M.R. (2000). Industrial Symbiosis: Literature and Taxonomy. *Annu. Rev. Energy. Environ., 25*(1), 313–337.

Chertow, M.R. (2007). “Uncovering” Industrial Symbiosis. *Journal of Industrial Ecology, 11*(1), 11–30.

Eyre, J.D. (1963). Industrial Growth in the Suwa Basin, Japan. *Geographical Review, 53*(4), 487.

Frosch, R.A., Gallopoulos, N.E. (1989). Strategies for Manufacturing. *Scientific American*, *261*(3), 144–153.

Gibbs, D. (2008). Industrial Symbiosis and Eco-Industrial Development: An Introduction. *Geography Compass, 2*(4), 1138–1154.

Green, L. (1977). Gas-Turbine Total Energy System for a Cement Plant. In *ASME 1977 International Gas Turbine Conference and Products Show*. Philadelphia (Pennsylvania, USA): ASME. V001T01A021.

Hewes, A.K., Lyons, D.I. (2008). The Humanistic Side of Eco-Industrial Parks: Champions and the Role of Trust. *Regional Studies, 42*(10), 1329–1342.

Jacobsen, N.B. (2006). Industrial Symbiosis in Kalundborg, Denmark: A Quantitative Assessment of Economic and Environmental Aspects. *Journal of Industrial Ecology, 10*(1–2), 239–255.

Mirata, M. (2004). Experiences from early stages of a national industrial symbiosis programme in the UK: Determinants and coordination challenges. *Journal of Cleaner Production, 12*(8–10), 967–983.

Mirata, M., Emtairah, T. (2005). Industrial symbiosis networks and the contribution to environmental innovation: The case of the Landskrona industrial symbiosis programme. *Journal of Cleaner Production, 13*(10–11), 993–1002.

Mirata, M., Eklund, M., Gundberg, A. (2017). *Industrial symbiosis and biofuels industry: Business value and organisational factors within cases of ethanol and biogas production*. Report No. 2017:11, f3 The Swedish Knowledge Centre for Renewable Transportation Fuels. Retrieved from: www.f3centre.se.

Spilhaus, A. (1968). The Experimental City: With components designed as an experimental system, new cities in open land will open up land in old cities. *Science* (New York, N.Y.), *159*(3816), 710–715.

Strebel, H. (2012). Zwischenbetriebliches Stoffstrommanagement. In M. Tschandl, A. Posch (eds.), *Integriertes Umweltcontrolling: Von der Stoffstromanalyse zum Bewertungs- und Informationssystem* (2nd ed., pp. 85–98). Wiesbaden: Gabler Verlag/Springer Fachmedien Wiesbaden GmbH.

Vattenfall Europe. (2018). *New Energy Ecopower GmbH, Abfallentsorgung mit Kraft-Wärme-Kopplung: EBS-HKW*. Rostock. Retrieved from: https://blog.vattenfall.de/va-content/uploads/2016/08/Abfall-Entsorgung-EBS-HKW-Rostock.pdf.

Veolia. (2018). *Teilstromvergärungsanlage Rostock*. Retrieved from: https://www.veolia.de/teilstromvergaerungsanlage-rostock.

Zuckerfabrik. (2018). *Anklam Suiker Unie GmbH & Co. KG*. Retrieved from: https://zuckerfabrik-anklam.de/.