

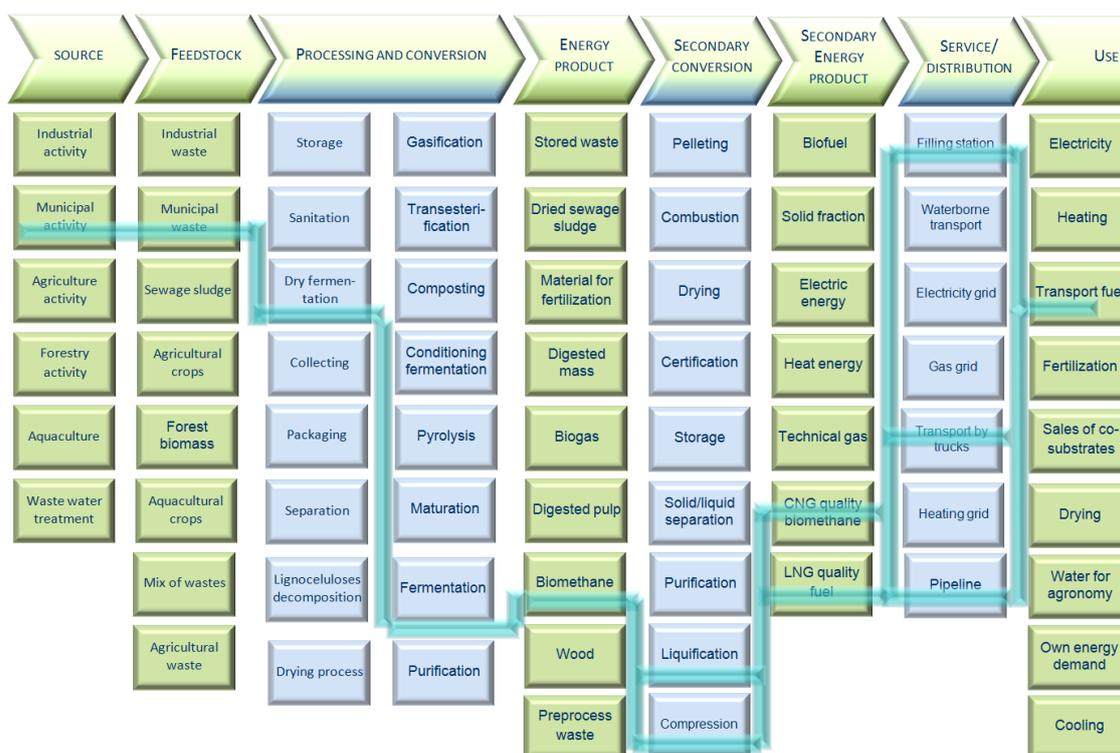
## Business Model for the case – Gdynia transportation system using biogas to transport technology

The EU policy strongly promotes the use of RES (renewable energy sources) in transport. As far as the Polish legislation is concerned, there are also regulations favoring the use of biomethane as a transport fuel. An excise tax is to be imposed on it according to the Polish Parliament's decision taken in September 2013.

Gdynia is part of the Tri-City (*Trójmiasto*) agglomeration along with Gdańsk and Sopot (~750 thous.). The city authorities are obliged to pursue the objectives set out in the Development Strategy of Gdynia which sets out a strategic goal of achieving sustainable development, taking in account social, environmental and economic aspects, helping to meet the European standards. Public transport system in Gdynia includes 15 trolleybus lines and 80 bus lines.

The entity handling 43% of bus transport in the city of Gdynia is the Municipal Transport Company, currently operating 93 buses of which 16 are MAN Lion's City G buses fueled with natural gas, what allows easy implementation of biomethane for transport.

### From municipal biological waste to transport



The City is a member of the Municipal Association of Reda and Chylonki Municipalities and together with the other members of the Association is served by the following municipal facilities producing biogas and using it as a source of energy: wastewater treatment plant in Dębogórze and waste management company Eko Dolina.

The waste management facility, Eko Dolina sp. z o.o., produces about 4.53 mln m<sup>3</sup> of landfill biogas annually. This gas is currently used by the company's own power plant with an electrical capacity of 2.5 MWe consisting of 3 gas engines (two engines of 700 kWe and one of 1.1 MWe). The plant produces approximately 6.67 GWh per year.

## Key Partners

- Who are our Key Partners?

- City Gdynia - member of the European Covenant of Mayors
- The Municipal Transport Company in Gdynia operating CNG busses.
- IFFM/BEEC - technology developer and adviser

Gdynia, after the accession to the European Covenant of Mayors, committed itself to:

- reduction in energy consumption (thermo-modernization, modernization of electricity sector),
- reduction in transport fuel consumption,
- development and implementation of RES (solar collectors, heat pumps, photovoltaic installations and wind power plants).

In 2013 the Municipal Transport Company in Gdynia operates 16 CNG busses. The company is up to buy more CNG-fuelled buses, this time non-articulated ones (i.e. "short" ones with the length of 12 meters):

- 15 vehicles in 2014,
- 10 hybrid buses (CNG/electric) in 2015.

The successful deliver of those plans will increase the number of CNG-fueled buses up to 41 of 92 operated ones. The company plans to buy 5 more CNG buses after the end of the year 2015, so that in 2020 CNG-fuelled buses will constitute 50% of the total fleet of buses. In 2020, the estimated annual demand for gas fuel used in bus public transportation will be about 2.5 million Nm<sup>3</sup>, and there is a technical possibility of replacing natural gas used in CNG buses with locally produced biomethane. Currently operated buses have tanks with the total capacity of 400 Nm<sup>3</sup>, which makes it possible to run a bus for 1.5 day. These tanks are mounted under the cover on the bus roof as a set of high pressure (20 MPa) gas cylinders, which is a standard solution for CNG buses.

- Who are our key suppliers?

eko Dolina sp. z o.o. - the waste management facility - can provide substantial amount of biomethane after some technology development (biogas installation)

Gicon GmbH - dry fermentation supplier under consideration

*Swedish Biogas International - wet fermentation supplier under consideration*

Solaris - optional CNG busprovider

MAN- optional CNG busprovider

Taking into account very significant legal changes that took place in 2012, there will be no possibility to use the most popular (until recently) technology of waste storage in the so-called energy heaps for the purpose of fermentation and subsequent acquisition of landfill gas. The regulations currently in force state that as regards the processes of biological waste treatment under anaerobic conditions, municipal waste must be subjected to anaerobic stabilization in the two-step process - in the first stage of mesophilic fermentation for at least 20 days or thermophilic fermentation for at least 12 days.

Rollout of an installation reducing the content of organic matter contained in municipal waste stream will therefore be necessary to meet the requirements set out in the regulation of the Minister of

Environment, and thus ensure compliance with the law pertaining to the activity of each Municipal Waste Disposal Plant in the perspective beyond the 2016 time horizon. Preferred technology includes, among others, dry fermentation of municipal waste. The dry fermentation technology makes it possible to use the chemical energy stored in organic fraction of municipal waste in the form of escaping bio-methane.

The size of the biogas installation is closely dependent on the mass and type of available substrates, which largely determine the quantity of produced biogas and biomethane (and the technology as well but in a smaller scale).

Obtained biogas should be purified to the value of at least 85% CH<sub>4</sub> (minimal level for a transport fuel) using different kinds of installations (scrubbers, membrane installations etc.).

The optimum method of energy waste processing and biomethane production for transport purposes is the simultaneous usage of existing installations for landfill gas combustion and construction of installations for waste fermentation producing purified methane.

Such a solution will allow for better use of the potential of cogeneration units in installation for landfill gas combustion. In case of the use of a part of biomethane produced from biogas plant (total 3.782 million m<sup>3</sup>) to cover the maximal planned urban transport demand (2.533 million m<sup>3</sup>), there still remains a surplus of 1.249 million m<sup>3</sup> per year, which can be earmarked for the production of electricity and heat in combination without additional investment - simply utilizing unused cogeneration units from installations for the combustion of landfill gas.

## Key activities

General activities to set up the supply chain includes:

- Develop and make the supply chain cost efficient
- Planning of activities on annual basis and budgeting
- Continuous evaluation and follow up
- Demonstration activities for suppliers and buyers

The key activities are to:

- develop and make the supply chain cost efficient i.e. organise meeting of Eko Dolina company and Municipal Transport Company in Gdynia in order to discuss the possible cooperation, value chain, biomethane price and volumes, revenues and risk management;
- make decision on the technology applied (i.e. dry or wet fermentation, or variants thereof) as well as on the type installation used (gas container, for continuous operation, etc.) in Eko Dolina;
- select technology provider in a tender, with particular attention paid to the specificity of the Gdynia region, the presented amounts and types of waste, their morphology (also taking into account changes occurring in a calendar year) as well as technical and organizational possibilities of digestate management;
- identify other potential biomethane provider including local chicken production chain - the technology development might be needed.

## Key resources

The key resources are the following:

1. landfill gas and potential for biogas production in Eko Dolina and Gdynia area:

The waste management facility, Eko Dolina sp. z o.o., generates about 4.533 million m<sup>3</sup> of landfill biogas annually. This gas is currently used by the company's own power plant with an electrical capacity of 2.5 MWe consisting of 3 gas engines (two engines of 700 kWe and one of 1.1 MWe). The plant produces approximately 6.67 GWh per year.

As the amount of biogas formed through the spontaneous fermentation process in this source is to decrease in the future the company is considering the possibility of increasing biogas production by supplementing the existing lines with a new biogas plant, which could be based on the so-called wet or dry fermentation technology. This would also reduce the amount of disposed waste by the estimated relative value of 15% to 20%.

It should be noted that not only waste from the area of Gdynia is utilized there, but also from other neighboring municipalities. They have similar characteristics. An additional stream of green waste fraction available in the summer time can be the algae harvested from the beaches of Gdynia and Sopot.

Besides, within Gdynia area, there are many food wholesalers as well as large stores like Makro Cash&Carry, Tesco, Real and smaller discount stores such as LIDL, NETTO, BIEDRONKA, PLUS. Furthermore, there are numerous bakeries and restaurants in the City, which guarantees a steady stream of organic waste. This increase and stabilize in time the flow of biowaste.

Local sources of biomass suitable for the biogas production at the new biogas plant would potentially amount to as much as 40 thousand ton of waste, including 6 thousand tons of urban green waste. The waste stream received in Eko Dolina plant enable generation of 3.8 mln m<sup>3</sup> of methane per year. This amount of produced methane significantly exceeds the maximum level of demand for biomethane to be used for transport purposes projected by the city of Gdynia. So it can be concluded that it provides long-term security of biogas supply, even in case of the depletion of landfill gas production from the landfill quarters of the currently operated lodging in Eko Dolina.

2. in 2013 the Municipal Transport Company in Gdynia operates 16 CNG busses, what allows easy implementation of biomethane for transport.

The company is up to buy more CNG-fuelled buses, this time non-articulated ones (i.e. "short" ones with the length of 12 meters):

- 15 vehicles in 2014,
- 10 hybrid buses (CNG/electric) in 2015.

These will increase the number of CNG-fueled buses up to 41 of 92 operated ones by 2015. The company plans to buy 5 more CNG buses after the end of the year 2015, so that in 2020 CNG-fuelled buses will constitute 50% of the total fleet of buses.

3. Gdynia, after the accession to the European Covenant of Mayors, committed itself to reduction in transport fuel consumption;
4. increased knowledge of local stakeholder (including prepared fisibility study) and good cooperation with local scientific institutions;
5. possible co-financing form European funds for regional development.

## Cost structures

The cost structure for Eko Dolina in this business model involves:

- Purchase of the biogas installation together with biogas upgrade and compression technologies;
- Fixed and variable costs of biogas production;
- Biomethane transport to customer.

The cost structure for this business model involves:

- Purchase of biomethane from Eko Dolina
- Purchase of CNG busses;
- Biomethane fuelling equipment;
- Personal cost for biomethane fuelling.

The most important and expensive of the above are related to biogas installation including upgrading. The cost of busses and fuelling is innate to any kind transportation.

The business model is cost driven and characterised by economy of scale and cost efficient operations throughout the value chain. The activities involved has little impact on end costs.

## Value proposition

- What value do we deliver to the customer?

The cost effective and ecologically superior fuel for transport is delivered. Unfortunately, given the currently unstable market and legal conditions in Poland, it is basically impossible to exactly determine the profitability of the project.

- Which one of our customer's problems are we helping to solve?

The described system of bio-waste energy processing into biofuel has many advantages: environmental, economic, social, climatic and even touristic ones.

However, it can be expected that the importance of the use of gaseous fuels in transport will increase because of the planned tightening of the standards for air quality in the EU and the reduction of the acceptable level of dust PM2.5 to 20  $\mu\text{g}/\text{m}^3$  starting from year 2020. Urban transport based on the combustion of diesel oil is one of the most significant emitters of air pollutants; hence its conversion to gaseous fuel will improve air quality the area of Gdynia.

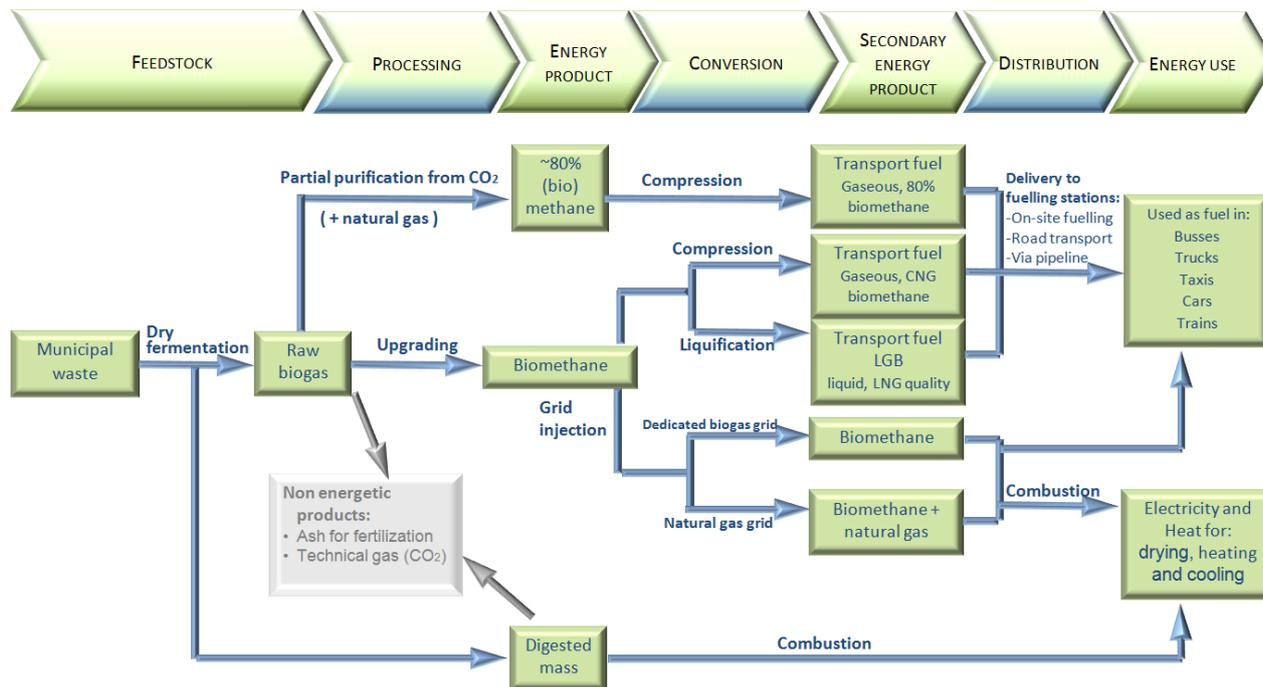
Likewise biowaste utilization in fermentation process will allow to improve air quality in the area of waste collection and storage. Presently there is a strong social protest against odor level near Eko Dolina.

## Customer relationships

The customer relationships have to built on security of supply, quality and price assurance. The fact that the Eko Dolina and Municipal Transport Company are communal companies of Gdynia may help to stabilize business model and find the revenues for all participant of the value chain. IFFM/BEEC is committed to serve as technology adviser or provider.

Transparency of the entire supply chain is crucial. Both in terms of quality assurance in fuel supply as well as sustainability and environmental concerns.

## Channels



The distributions channels and supply chain is described by scheme above.

The supply chain for initial stage (biogas from municipal and industrial biowaste) is handled by Eko Dolina. There are plans to include other biogas producer i.e. from chicken farms segment. The digestate distribution chain should be established (according to EU rules for recycling).

## Customer segments

The customer segment based on the following:

- The distance: from the Eko Dolina to Municipal Transport Company (most important customer) base is around 20 km.
- The mass market possible in the future (after technology development), when national regulations allows biomethane to be injected into a gas grid or CNG market will be more developed. Up to now there is LPG gas market developed in Poland.
- Ability to use biomethane as fuel, it may include busses, tracks, taxis, etc.

## Revenue streams

The revenue streams is based on fixed pricing for GJ. The end price includes all cost for production, transport, etc. The Municipal Transport Company is willing to pay for biomethane in the range of price what they pay today for natural gas. There is an issue of taxis for biofuel.