The guideline of this project was the company’s Waste to Energy Strategy. As the plant is very close to the Croatian capital Zagreb, many food processing industries offer a large spectrum of wastes which can be treated in a biogas plant. Also, Agrokor group, a vertically integrated agricultural and food processing, retail entity in the Republic of Croatia, has a series of strategically important locations with extremely large amount of different resources that ensured high-quality raw materials, by-products and wastes for the AD production process. It also owns companies which are consumers for part of the output of the production process (heat and organic fertilisers) on mutual benefit.

This plant was the demonstration/learning plant for a string of biogas investments (9.8 MW in 5 plants).

**Background story**

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**Main interest in the project**

This project is very interesting because many different technologies which are used in the biogas industry are implemented at one place. The hydrolysis-step of the two-phase fermentation makes sure that substrates are digested most efficiently. Additional thermomechanical equipment is installed (heat exchangers, thermal oil and storages) to allow as much heat utilisation as possible. The sterilisation and other specialised equipment makes the use of many different wastes possible. The plant generates income from sold electricity, thermal energy, waste collection and agricultural soil fertiliser which makes this project highly feasible to be applied in many different regions.
Specialties

At first, the Biogas Plant Gradec was built as a 1 MW$_{el}$ plant with a CHP but was advanced with two separate hydrolysis tanks and a 2$^{nd}$ CHP in 2015. Production with 2 MW capacity started in the 4$^{th}$ quarter of 2015.

It is built next to the pig farm and meat processing industry, within Agrokor Group. The maximum efficiency of the CHP engine can be reached by utilising most of the heat: There are two heat storages for heat from biogas CHP: two water tanks (2 x 100 m$^3$) and two thermal oil tanks (2 x 20 m$^3$). Heat from exhaust fumes at the exhaust pipe with use of additional thermo-technical equipment is stored at thermal oil tanks at up to 300 °C. The heat, combined with natural gas (as back up), is used for pressure sterilisation (133 °C at 3 bar at 20 minutes) of slaughterhouse waste. Heat is also used as process heat to support hydrolysis in pre-fermenter and AD in the main fermenter and for the digestate thickener.

Pig slurry is connected to an underground gravity piping system from the farm to the AD to avoid smell nuisance.

Maize silage is only used to balance AD process.

Financial background conditions

Total investment costs: 9.2 Mio EUR

Investors: The investor is a private company Agrokor-Energiija ltd. (est. 2010) member of Agrokor Group which is a vertically and horizontally integrated in the food & beverage company.

Investment support: One part was provided by EBRD loan

Operation support: FiT with a 14-years-guaranteed price of ~0.17 EUR per kWh incl. ‘local community’ bonus for mandated 50% energy efficiency of the CHP.

Obtained feed-in tariff: Yes, see ‘Operation support’

Incentives: -

Tax Exemption: -

Which support was provided: -

Feedstock/Substrates

The plant processes 80,000 tonnes per year mixture of 11-20 different types of substrates. The largest share in volume (55-60%) refers to pig slurry, while the other is related to animal by-products and waste from various stages of food processing industry and food retail within the Agrokor Group and third parties waste (ex-food, slaughterhouse waste, fermentation sludge, glycerine, beer yeast, various grains not intended for human consumption...). Maize silage is used for balancing the process with 11-15% volume share.

Feedstock amount ~ 220 tonnes per day

Use of products from biogas process

Use of biogas: Yes, in form of electricity and heat

CHP/electricity: Yes

Amount of generated electricity: 10,177 MWh (data is for 2015 with remark that 2$^{nd}$ CHP started with production in 4$^{th}$ quarter of 2015)

Use of electricity: Electricity sold to grid

Biomethane generation/injection: No

Amount of injected biomethane: Not applicable

Use of biomethane: Not applicable

Heat use: Heat is utilised as process heat for fermenters, post-fermenter, hydrolysis tanks, digestate thickener, management offices and pig stables. Heat from oil tanks is used for sterilisation of slaughterhouse waste.

Amount of heat produced: 6,288 MWh (used heat)

Use of digestate: Digestate is collected at lagoons and used as fertiliser within the own cropping system. One part of digestate is treated in mechanical separators to get solid phase which is also used as a fertiliser.

Way of digestate use: Different kinds of digestate applicators