The LIFE Programme: over 20 years improving waste-to-energy management in the EU

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Abstract

The LIFE programme, which was established in 1992, is the EU's funding instrument for the environment. The general objective of LIFE is to contribute to the implementation, updating and development of EU environmental policy and legislation by co-financing pilot or demonstration projects with added value.

With regards to waste management, LIFE has continuously co-funded innovative projects that upgrade waste recycling technologies and processes in a wide range of industrial sectors all over Europe. Out of the 4 489 initiatives supported by LIFE to date, over 700 have been exclusively on waste. In fact, waste management is the theme most widely tackled by the programme.

In particular, LIFE has focused on demonstrating innovative technologies that recycle specific materials from waste streams, such as hazardous, agricultural or municipal waste. Many projects co-funded by the programme have linked waste management to other environmental topics, such as climate change or waste-to-energy.

In this regard, the LIFE programme has supported a wide range of biogas-related projects that demonstrate innovative anaerobic digestion and gasification techniques to produce biogas from biodegradable waste - e.g. municipal solid waste, manure and slurry - to produce heat and power. Furthermore, LIFE has backed projects which develop pioneer technologies for biomethane production either for injection into a natural gas pipeline or for usage as a fuel for vehicles. Some projects have also dealt with state of the art techniques for the capture and use of methane from landfills to generate heat and electricity.

Below you can find three good examples of LIFE waste-to-energy projects developing techniques and methods that are ready for replication.

Keywords

Renewable energies, circular economy, European Union, waste-to-energy, bio-fuels

Projects

BUCEFALOS

This project developed and demonstrated innovative methodologies and tools to reduce marine eutrophication and produce clean energy in the Baltic Sea. It also showcased a holistic approach to the regional coordination of sustainable resource management of aquatic biomass.

The project established a demonstration mussel cultivation site, with vertical harvesting of mussels from submerged constructions attached to the pillars of the Öresund bridge. The project showed that it is feasible to cultivate mussels to produce biomass while also reducing the amount of nutrients in the sea. Through the use of innovative approaches such as a two-stage ditch design, the project also established 13 wetlands of 4 different types for demonstration purposes next to the river Tullstorps. The mussel cultivation site resulted in an average biomass production of 23.5 kg / m2 for the most efficient and smallest (of the three tested) mesh net size used. This equated to a total reduction of 176 kg of nitrogen and 17.6 kg of phosphorus from mussel-harvesting activities. Additionally, in the microalgae cultivation site, established in parallel, a phosphorous removal rate of more than 90% was observed along with a 60% removal rate for inorganic nitrogen from effluents. Throughout the lifespan of the project, the wetlands produced a biomass of between 1 200 and 2 100 kg dry weight per hectare, which is expected to increase as the vegetation reaches its full potential.

Moreover, the project built and demonstrated a full-scale biogas plant for the production of biogas from aquatic biomass near the Smyge wastewater treatment plant. A full production cycle was demonstrated, from algae collection, transport and analysis of biogas process to the recycling of nutrients. As the algae have a rough texture and often quite a lot of sand mixed in, the facility was designed as a two-step reactor which can handle a larger portion of sand and debris than usual biogas reactors. Several trials were undertaken within a year and the biogas unit reached a maximum production of 20-23 cubic meters of gas/day. During the project gas potential of algae used has been about 85 l CH4/kg VS (Volatile Solids).

A technical study was carried out for five aquatic substrates: mussels, beach-collected algae, wetland plants (reeds), microalgae grown in effluent at the Smyge wastewater treatment plant, and fish waste (cod) received from the coastal city of Simrishamn. The results indicated that none of the samples exceeded the SPCR 120 (Swedish voluntary certification system for digestate from biogas plants) certification values for heavy metals and pesticides

in biofertilisers. The residuals from the process were spread on agricultural land, though the project's technical report on the mineral composition of substrates provides a basis for exploring alternative applications.

If the project's innovative solutions were to be mainstreamed, it would lead to more efficient methods of reducing nutrients in aquatic environments. The project therefore contributed to achieving the "good environmental status" goal set out in the Water Framework Directive (WFD), through the utilisation of existing aquatic biomass as a way of reducing the nutrient content in the aquatic system, while producing valuable products. Moreover, the practice of producing biogas from aquatic substrates could contribute to the implementation of the Renewable Energy Directive, while reducing dependence on arable farmland for substrates.

Sludge2Energy

The Sludge2Energy project demonstrated an integrated system which enables the decentralised reuse of sewage sludge in an efficient small-scale heat and power generation plant directly on the premises of a wastewater treatment plant (WWTP). The reuse of sludge at the point of origin is significant. Using the self-sufficient plant, the project reduced the initial volume of sludge for disposal by over 87%, allowing the WWTP operators to be more independent of the disposal market and avoid potentially significant fines.

The main system consists of a belt dryer, a micro gas turbine and a grate stoker furnace for dried sludge. The sewage sludge is dried through the process of air streaming and subsequently the dried sludge is incinerated – via a mono incineration process that also provides the option of phosphorus recovery - to produce electricity while the thermal energy is sufficient to heat the air for the drying process as well as to pre-heat the air for the incineration process. Importantly, the micro-gas turbine produces enough energy to operate the sewage sludge drying plant as well as the incineration plant.

This self-sufficient and economically viable decentralised solution showed that the concept is suitable for WWTPs throughout Europe with a size of greater than 150 000 PE (population equivalent). The prototype plant was designed for an annual processing capacity of up to 3000 tonnes of dry substance and a maximum electrical capacity of 100 kWe. Consequently, the project team analysed the validated technology and estimated that the theoretical capacity of such a prototype is about 170 plants for Germany alone.

Importantly, the project results are highly replicable and can be used to manufacture modular units for implementing the concept in other European WWTPs without any additional development costs. The validated concept could be transferred to other application areas, such as small-scale biomass-fired combined heat and power plants and further foster the exploitation of renewable energy sources and strategically contribute to the implementation of EU climate and energy policy.

DEMONSTRATION OF KDV TECH

This Spanish project developed the first pilot plant to adapt and validate the catalytic depolymerisation technology for the production of high-quality and market ready diesel fuel. The demonstration plant was built in the waste treatment centre of Constanti, which treats municipal solid waste produced in the Catalonian district of 177 000 inhabitants.

The project designed the necessary modifications to the existing pilot plant. The first stage involved the fitting out of the existing plant to operate in continuous conditions, with a treatment capacity of 200 l/h. Subsequent to additional technological modifications, the treatment capacity increased to 900 l/h. Through the final phase a second catalytic treatment unit was added to reach the maximum performance of 1800 l/h. Within the modification stages, the project team optimised the process by identifying the most suitable fluidisation liquids to be used along with the adequate proportion of crushed solid waste. A mixture of crushed solid waste with 25-40% of Solid Recovered Fuel (SRF) enriched with low density polyethylene is mixed with used industrial mineral oil to form a fluid, and passing through the catalyser the long carbon chains (polymers) within the fluid are broken down into shorter carbon chains and a gas is formed. This gas is then condensed to produce high quality synthetic diesel, branded as DieselR.

The pilot plant could treat 40 000 tonnes of waste/year and produce 15 000 tonnes/year of high-quality diesel fuel, which is a clean fuel, without carbon emissions, smoke, toxic gases or dioxins. Importantly, the plant achieved a maximum recovery of waste up to 80% whilst 20% of the diesel fuel produced provides enough energy to run the entire plant.

The pilot plant demonstrated notable environmental benefits as the plant successfully saved some 44 000 tonnes of CO2 emissions annually, thus significantly contributing to climate change mitigation goals. Moreover, the project beneficiary and owner of the plant plans to use the synthetic diesel from the residual valorisation, i.e. the rejected biodegradable fraction from the recovery/sorting process of organic matter, packaging, glass and paper transformed into high quality synthetic diesel - in order to fuel its own fleet of vehicles.

The process represents a climate friendly, quick, profitable and highly replicable treatment for biodegradable non-recyclable urban waste fractions, being in accordance with biofuel production sustainability criteria as stated by 2009/28/EC Renewable Energy Directive, specifying that raw material cannot be taken from

i) primary forest and other wooded land, ii) areas designated for nature protection purposes, iii) land with high carbon stocks, such as wetland or peatland.

References: All the information in this abstract has been extracted from the LIFE programme project database: http://ec.europa.eu/environment/life/project/Projects/index.cfm