Summary of ORION project – first period

1 Project context and objectives

SME agro-food industries have to manage large quantities of organic waste, the industry produced 239,871,940 tonnes of organic waste in 2006. This project will provide these 280,000 European SMEs (annual turnover 862 billion) involved in this sector with a practical solution to dispose of relatively small amounts of organic waste and in turn create energy from that waste. In doing so, it will develop new knowledge and strategies that address a common technological problem for SMEs throughout Europe.

The aim of the ORION project is to develop a small automatic user-friendly digestion machine that enables the domestic on-site treatment of a wide range of organic waste from about 100 up to 5000 tons per year at low cost (€50 per ton) and with low maintenance.

To achieve this, the scientific and technical objectives of the ORION project are the following:

1. Moving from existing large scale plants (> 20'000 t/y) distant from the waste production to stand alone modular machines using standard components in order to reduce construction and assembly costs.
2. Develop a new high performance reactor to increase the process efficiency by:
    a. Increasing the conversion efficiency of the wastes from 40% to more than 90%
    b. Decreasing the retention time from about 1month to two weeks.
    c. Accelerating waste digestion by immobilisation of biomass in supported and efficient biofilms using specific coatings & surfaces
3. Develop low-costs sensors, data transmission and signal processing in order to:
    a. continuously optimise the operation of the machine
    b. anticipate possible problems in the biological activity
    c. reduce the operation costs
    d. maximize the reliability i.e. with a MTBF (Mean Time Between Failures) > 5 years.
4. Reduce problems of build-up and blockage and fouling of critical elements such as valves and sensors using specific coatings & surfaces.

Even though the results of this project will benefit a range of food producing or food service industries, the project will focus on the agro-food industry and the waste-processing industry. The problems addressed will be that of:

- Catering, canteens, large restaurants
- Open markets and supermarkets

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- Food processing companies: fish, fruit, vegetable oil processing, and transformers.

The SMEs involved in this project have to manage from 100 tons to 3000 tonnes a year. However, the only solutions currently available for these SMEs' organic waste treatment are landfill and incineration which imply a grouping of the waste before treatment and so require intermediate storage and/or waste transport (as most fish processing plants are located in remote areas); as such, **SMEs must face high costs of waste treatment**: storage costs in cool areas, specific transportation costs and finally costs for incineration or recovery. The cost of disposing of this waste varies per country but the price varies in Europe from €50 to €200 per tonne. Rising landfill costs have forced businesses to rethink their waste disposal management strategies. Moreover, such methods are associated with:

- on-site bad hygiene (nauseous odours for employees and neighbours, microorganism proliferation), which also has a negative influence on SMEs' public image.
- negative impact on the global environment quality: generation of greenhouse gases and uncontrolled emission of dioxins

Legislation on organic waste treatment and landfills tends to be harmonized at a European level. Storing industrial wastes in landfills is the most common elimination method used in the EU: in 2006, 41% of organic waste was evacuated in open fields, 19% were incinerated. However, since July 1, 2002, the storage of municipal wastes in landfills must be zero and only ultimate waste should be placed in landfills.

Therefore, there is a real need to adapt anaerobic digestion technology to SME scale and give them access to on site cost effective waste management solutions.

2 Work performed so far

The major focus for the first 15 months was on WP1 to 5 (design phase). The needs of the end users were evaluated and incorporated into the design of the ORION system. This initial part of the project was where specifications, design and modelling took place for the different modules (hydrolysis, digestion, combustion, control systems and active surfaces for bacteria) of the anaerobic digestion system.

Specifically, WP1 **"**Technological evaluation of SME needs to manage their organic waste": Defined the waste characteristics and quantities of the SME end-users through laboratory testing and questionnaires. It identified the regulations in the participating eight countries which will facilitate the introduction of the novel technologies. We assessed the cost and performance of existing solutions in the various participating countries and defined how the biogas was going to be valorised at the SMEs plants (hot

water, power) through site visits. We also defined acceptable performance criteria for the systems developed.

In WP2 “Digestion module development/test” The digestion module was designed from a technical and economical point of view according to the specifications from WP1. We investigated the kinetics of the different digestion processes in order to identify the limiting steps. Mathematical modelling tools were developed and applied to problems, in order to simulate strategies for the AD system.

In WP3 “Combustion module development/test”. The burner and the heat exchanger were designed according to the specifications from WP1. The combustion module will provide a continuous biogas disposal and re-use with no additional gas storage with maximum safety and hygiene. Two main routes of investigation were followed: the selection of a standard combustion module that can be adapted for ORION purposes and the setting-up of a porous and/or FLOX® burner and associated combustion module.

In WP4 “Supervision and control module development / test”. An integrated multi-functional control system for organic waste digestion and biogas energy recovery to achieve maximum reliability of the complete digestion machine was designed. The aim of the control system was to ensure a daily supervision of the operational conditions of the digester and to prevent breakdowns of the machine by early detection and diagnostic of breakdown causes.

In WP5 “Active surfaces for bacterial control” work has started on sourcing a solution for local anti-bacterial surfaces to reduce fouling of critical elements such as sensors and valves. Also work continues in the development and test of structured and chemically functionalized surfaces that promote the growth and stability of biofilms of methanogenic bacteria in order to: (i) improve their retention in the digester, thereby reducing the residence time and increasing the organic waste throughput of the digester, and (ii) increase the exchange surface between substrate and biomass, optimizing metabolite transfer between individual cells, and improving the overall performance of the microbial syntrophic association.

Other important WPs from this period were WP8- Validation and pre-normalisation activities, economic and environmental risk assessment and WP9 – Dissemination, training and exploitation. This has involved evaluating the economic feasibility of the system even at this early stage. Also promoting the project through public awareness; creation of a website, brochures and a press release, attendance at relevant conferences and publications in relevant trade magazines and scientific journals.

3 Potential impact

SMEs within the project will gain potentially new patentable AD systems and new management tools. Both end-users and technology providers SMEs and SME-AGs are represented in the project, both will directly benefit from the technology development and transfer of knowledge within the lifetime of the project. This project will offer them with a practical solution to dispose of relatively small amounts of organic waste and in turn create energy from that waste. In doing so it will develop new knowledge and strategies that address a common technological problem for SMEs throughout the Europe. The results will provide benefits to the SMEs by improving their productivity and efficiency and hence their competitiveness.

Food processing plants must face to high costs of waste treatment: storage, transport for incineration or recovery. The results of the ORION project will be able to reduce the SMEs' treatment costs and to improve their profitability. The project aims at developing a system enabling the reduction of treatment cost to €25 per tonne (including waste valorisation as energy source). The cost of the digester will be about €50 000 for the SME (including control tools and boiler part of the system). The use of the digester can be shared by a number of SMEs. This makes this solution profitable in 1 to 2 years. Moreover, it will involve an energy saving thanks to the biogas production: it is estimated that 10 % of the current energy costs could be recovered by the biogas utilization (electricity or hot water production). Similar benefits can be foreseen in other agro-food sectors.

The **SME-AGs** will own the new IP emanating from the project which will be patented directly following the project end and will license the new technology to their members. They SME technology providers expect to sell initially 100 AD systems in the year immediately following the project end (€5 million turnover) and increase this to 500 systems per year after 3 years (€25 million turnover).

In addition the ORION project will participate to the implementation of several EU policies and regulations related to:

- Treatment of organic wastes
- Valorisation as renewable energy sources or organic waste
- Improvement of environmental performance of European SMEs from traditional European industries
- Contribution of SMEs to sustainable development

ORION is in accordance with EU and National regulations related to waste management.

Landfills: **Council Directive** 99/31/EC **of 26 April 1999 on the landfill of waste** which includes the objective that all waste be treated before landfilling. The target for 2010 has been set that only 25% of biodegradable waste is allowed into landfill.

Incineration: The main objective of the Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste is to prevent or reduce, as far as possible, air, water and soil pollution caused by the incineration or co-incineration of waste, as well as the resulting risk to human health.

ORION participates to the implementation of this directive through reduction of amount of waste to be treated by incinerators or in landfills that will be replaced by in situ valorization in SME facilities.

The development of renewable energy - particularly energy from **biomass** - is a central aim of the EC's energy policy. Renewable energy has an important role to play in reducing CO2 emissions (a major Community objective). ORION objectives are fully in compliance within these EU policies insofar as, ORION will have impacts on energy use since the system proposes a cost effective and reliable alternative to storage in cool areas, transport or incineration. Moreover, the biogas produced will be directly used to heat the digester or to produce hot water, i.e for dish-washers: organic waste can become somehow a non-pollutant source of bio-energy.

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