ELECTRICAL ENERGY
Distributed (renewable) energy sources (part 1)
Within the scope of the EPOS project, extensive literature and market research reviews were performed in order to identify different technological, organisational, service and management solutions that could be applied to different industrial sites and clusters. The collected information will aid in establishing on-site and/or cross-sectorial industrial symbiosis opportunities; additionally, to enhance overall sustainability, performance and resource efficiency of different process industry sectors. Through the cooperation of project partners, a longlist of different technological options was created. Resource material for this list included: scientific articles, project reports, manufacturer’s documentation and datasheets.

About the EPOS Technology Focus

ELECTRICAL ENERGY

Almost all of modern human activity is either directly or indirectly dependent upon a reliable and quality supply of electricity; this electricity is also a cornerstone of each energy intensive industrial sector. There are both constant incentives and demands for more sustainable and green electricity generation and its efficient use in households and energy intensive industrial sectors (e.g. steel industry). There have been rapid developments in the areas of renewable energy sources, storage systems, and advanced monitoring and control systems that can contribute to the more effective use of electrical energy. These technological developments should be integrated into the industrial environment.

From an industrial perspective, a top priority is a reliable and quality supply of electrical energy. Any kind of (longer) interruption can lead to the outage of the production lines. This results in significant costs for the industry, not only from the decreased productivity but also due to increased amounts of waste, “stand-by” of the workforce and re-establishment of the production process.

If the electricity supply is not of adequate quality (harmonic distortion, voltage mitigation, voltage sags/swells, flicker, etc.), there will also be an impact on industry; this may cause malfunctions. Additionally, accelerated ageing of equipment can occur. In order to avoid such issues, industries must take care of proper power quality conditioning. This is not only to protect their own assets, but also to minimise the effects of industrial activities (e.g. operation of arc furnaces) on the quality of electricity supply of other customers that also connect to the electrical network.

DISTRIBUTED (RENEWABLE) ENERGY SOURCES

The following technologies relate to distributed (renewable) energy sources.

- Dish Stirling
- Combined heat and power plant – cogeneration
- Combined cooling, heat and power – trigeneration
- Small/micro hydro power plant
- Micro-turbine
- Wind turbine
- Electrical vehicle charging infrastructure
DISTRIBUTED (RENEWABLE) ENERGY SOURCES
Using a large, reflective, parabolic dish, sunlight that strikes the dish is focused up onto a single point above the dish, where a receiver captures heat and transforms it into a useful form. Typically, the dish is coupled with a Stirling engine, but sometimes a steam engine is used. The engines create a rotational kinetic energy that can be converted into electricity using an electric generator.

**Technology 1: Dish Stirling**

**Applicability**
For the generation of electricity by the utilisation of solar thermal energy.

**Maturity**
Commercial.

United sun systems' solution.
Technology 2: Combined heat and power plant - cogeneration

The simultaneous generation of thermal energy and electrical and/or mechanical energy in one process.

**Applicability**
For the simultaneous generation of heat and electricity. It is especially suitable for plants with a significant heat demand at temperatures within the range of medium or low-pressure steam.

**Maturity**
Commercial.

**Project/product reference**
CHP in chemical industry: Millennium Chemicals.
Technology 3: Combined cooling, heat and power - trigeneration

The simultaneous conversion of a fuel into three useful energy products: electricity, hot water or steam and chilled water. A trigeneration system is a cogeneration system with an absorption chiller that uses some of the heat to produce chilled water.

Applicability
Used in building air conditioning, heating during winter and cooling during summer or for heating in one area and cooling in another area.

Maturity
Commercial.

Project/product reference
Cisco data centre trigeneration.
Technology 4: Small/micro hydro power plant

A hydraulic turbine converts the potential energy of water into kinetic energy/mechanical work. The mechanical work is further transformed into electrical energy, using an electric generator.

Applicability
Generation of electricity by the exploitation of water’s hydro potential. It is usually implemented near small creeks or rivers.

Maturity
Commercial.

Project/product reference
Smart Hydro Power’s turbines.
Technology 5: Micro-turbine

A combustion turbine that produces both heat and electricity on a relatively small scale. Typical outputs are from 25 kW to 1000 kW. Most micro-turbines are comprised of a compressor, combustor, turbine, alternator, recuperator, and generator. Different types of fuel can be used such as natural gas, hydrogen, propane or diesel.

Applicability
Generates electricity through the utilisation of different fuels (e.g. gas obtained from a landfill). It usually provides services such as stand-by power, power quality improvement, reduction of the peak demand, etc.

Maturity
Commercial.

Project/product reference
Landfill gas-fired micro-turbines installed at the Jamacha Landfill in Spring Valley.
Technology 6: Wind turbine

Converts the kinetic energy of the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this mechanical energy into electricity. The wind turns the blades, which spin a shaft, which connects to a generator and generates electricity.

Applicability
Generates electricity through the utilisation of wind energy. It is suitable for windy areas with a constant wind speed.

Maturity
Commercial.

Project/product reference
Integration of small wind turbines into the urban areas.
Electricity generation based on a semipermeable membrane, which separates two fluids with different salt concentrations. Salt ions travel through a membrane, until there is the same salt concentration in both fluids. Ions are simply atoms with electrical charges; the movement of the salt ions can be exploited to generate electricity.

**Figure 7 Osmotic power plant**

**Applicability**
Osmotic power plants can be used to generate clean electricity.

**Maturity**
Research stage, demonstration cases.

**Project/product reference**
Statkraft prototype osmotic power plant, Norway.
Technology 8: Electrical vehicle charging infrastructure

For charging electric vehicles. The rapid growth of electric vehicles offers new opportunities for stable operation of the electric power system. The expected growth of electric vehicles will result in a significant impact on the future development of electrical networks.

Applicability
Can be used as a support for the electrical networks via balancing the variability of other energy resources.

Maturity
Commercial.

Project/product reference
Flemish living lab: electrical vehicles.
REFERENCES


8. “Electricity generated with water, salt and a 3 atoms thick membrane,” [Online].


11. “Portland Airport Gets Record Number Of EV Charging Stations,” [Online].
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 679386. This work was supported by the Swiss State Secretariat for Education, Research and Innovation (SERI) under contract number 15.0217. The opinions expressed and arguments employed herein do not necessarily reflect the official views of the Swiss Government.