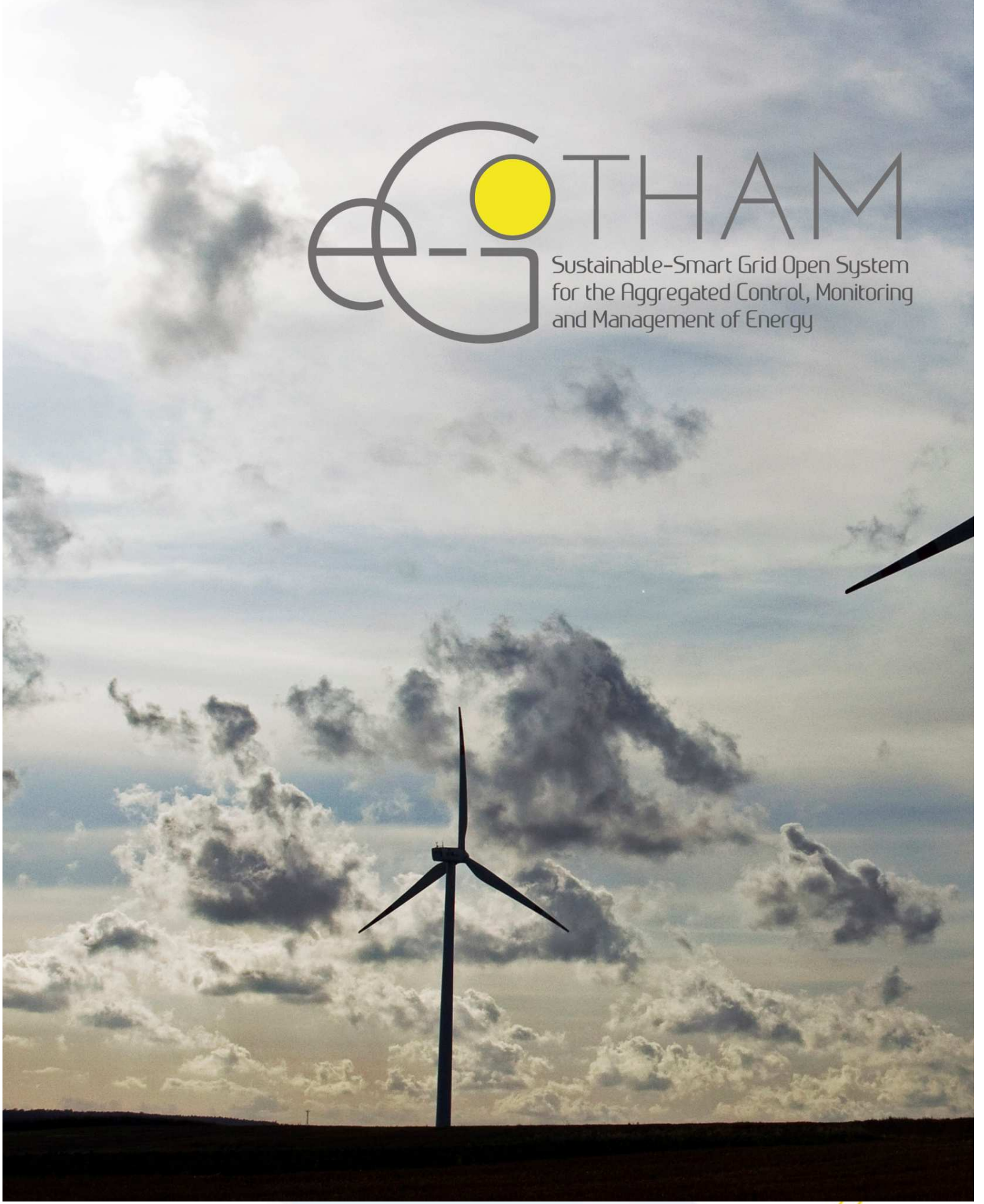


No 295378
SP1-JTI-ARTEMIS-2011-7: Embedded technology for sustainable urban life

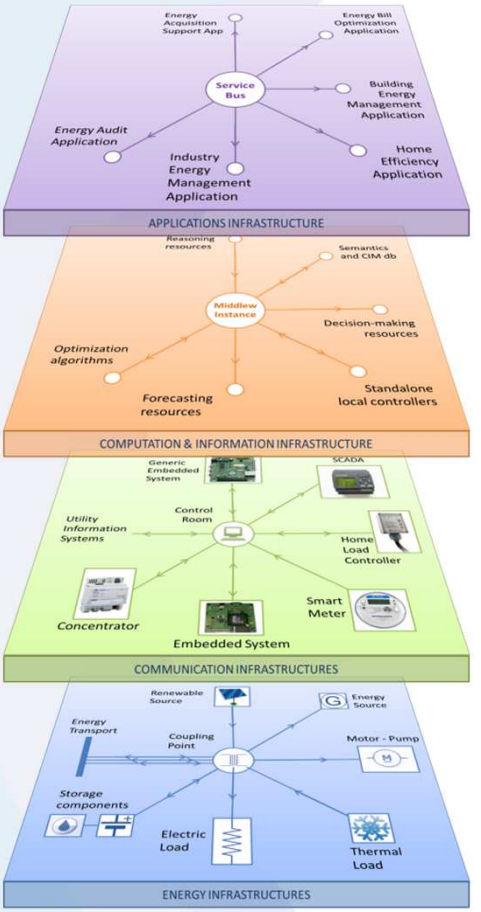
ARTEMIS Call 2011 Project
295378

e-GOTHAM

Sustainable Smart Grid Open System for the Aggregated Control, Monitoring and Management of Energy

e-Gotham aims at implementing a new aggregated energy demand model, by increasing management efficiency, raising energy consumption awareness and stimulating the development of a leading-edge market for energy-efficient technologies with new business models.

e-Gotham's INFRASTRUCTURES



Eco-efficient

- Integration of distributed energy sources
- Energy storage management
- Creation of microgrids and their coordination with other microgrids
- Operational efficiency

Self-sufficient

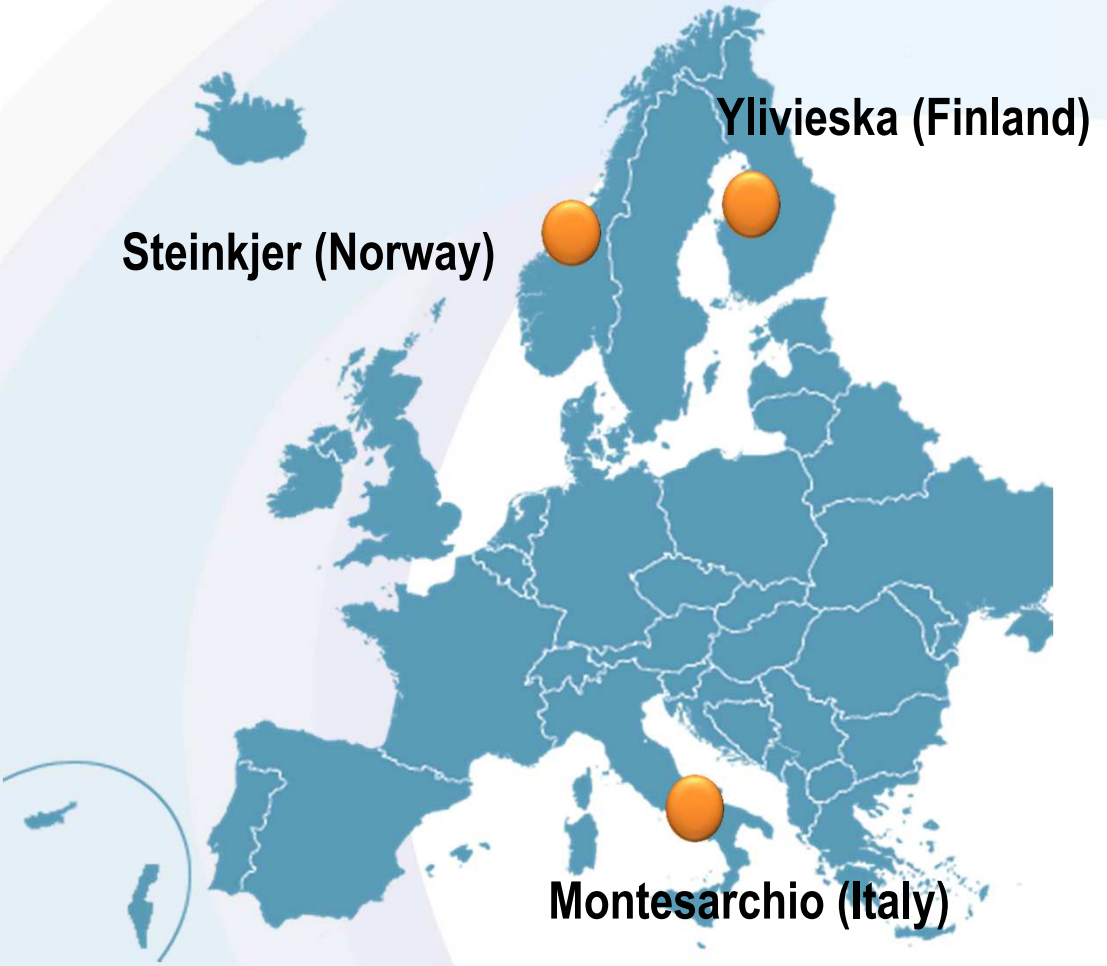
- Adaptive decision support technologies
- Motivating energy saving behaviours
- Integrating renewable energy sources

Secure and convenience

- Adaptable energy automation of supply and consumption
- Anticipate and response to system disturbances

E-Gotham will design an open reference architecture and develop middleware with seamless connectivity that enables the needed communication to manage and optimize microgrids.

E-Gotham will define a complete solution for a microgrid in the industrial, residential and tertiary sector that include different configuration of loads, distributed generators and energy storage components.



E-Gotham Approach

Optimization
Algorithms

Business models
Semantics

Open
Smart grid
Platform

3rd party applications
Communication

HW reference designs
Infrastructure

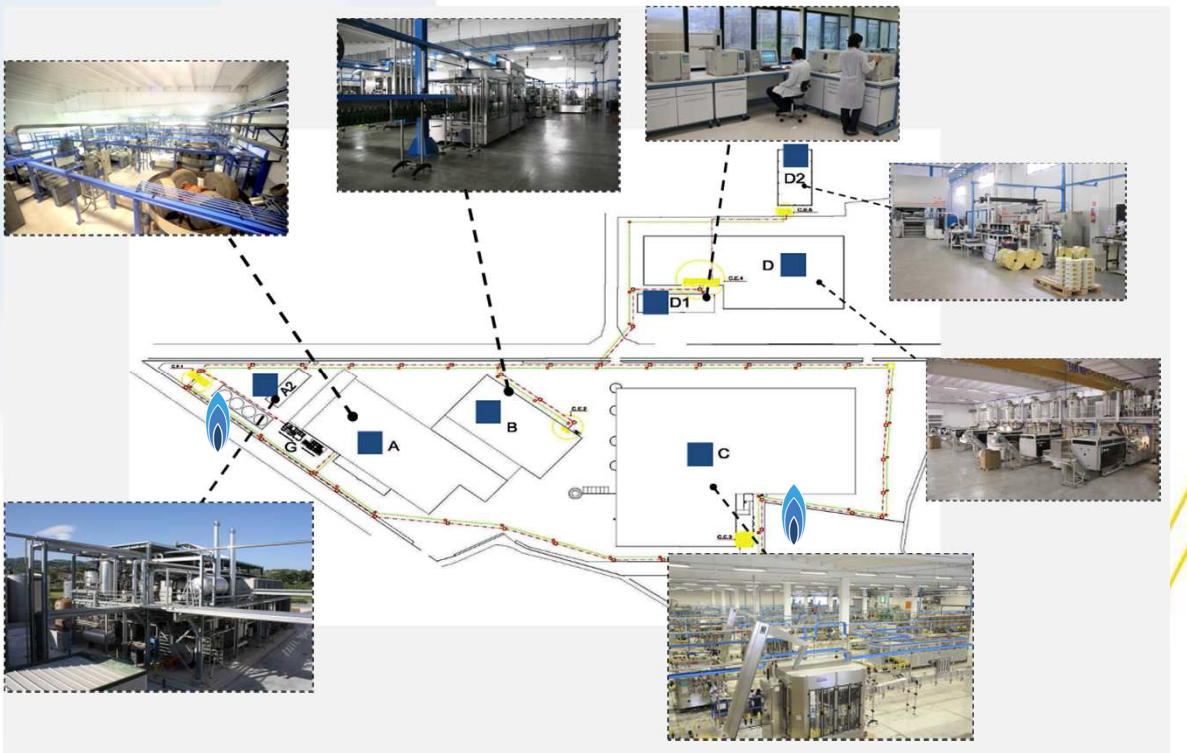
Industrial Pilot

Enemont is a consortium company which produces and supplies energy to its associated companies. The associated companies of Enemont consortium carry out several different production processes in the same industrial complex: olive oil mill, vegetable oil refining, vegetable oil filtration and blending, vegetable oil bottling and packaging, production of plastic bottles and caps, and printing of labels and boxes.

e-Gotham will help Enemont to plan and manage upcoming changes that increase the complexity in their microgrid.

To accomplish these activities and others, Enemont needs electric and thermal energy. Enemont plant buys and produces energy from the following sources:

- public electric energy company,
- photovoltaic plant
- CHP plant
- natural gas network (Salerno Energia)



Optimisation Problem in Enemont

In the industrial pilot the optimization problem relays on the selection of the most economically convenient combination of energy sources. There are three possible energy sources in the industrial microgrid: PV plant, CHP plant, external provider of electric energy. For each day, the central controller shall decide which is the most economically convenient combination of these sources.

The objectives related to industrial microgrids that are interesting are:

- Optimal energy mix (Grid, solar, CHP).
- Guaranting the constraint on production planning.
- Managing the electric and thermal energy production from the CHP.

Prototype 1

- Monitoring hourly production, consumption & energy purchase.
- View & Export history data.

Prototype 2

- Decision making of power combination against production plans & forecasts.

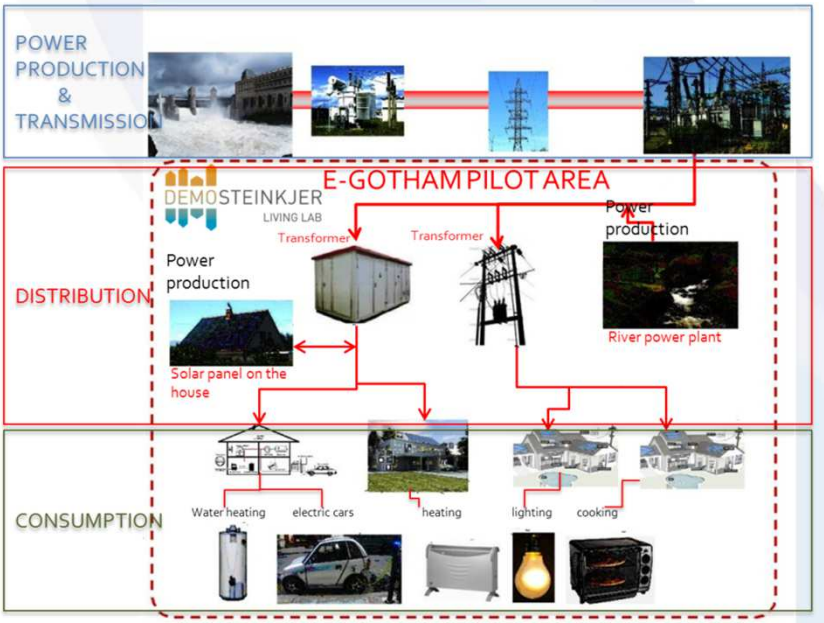
Residential Pilot

Demo Steinkjer
Steinkjer
Norway

The Norwegian pilot project in e-Gotham will be a part of **Demo Steinkjer**, which is a large scale living lab for Smart Grid activities. The area for this pilot will be in the community of Steinkjer, located about 120 km north of Trondheim. The e-Gotham's residential microgrid pilot will cover 771 consumers and one hydropower plant.

In addition, this pilot will consider solar energy by virtually connecting solar power panel production to the Steinkjer community. This means that the solar panels are not physically within the pilot, but located in Trondheim, which has similar weather conditions as the Steinkjer community.

e-Gotham will contribute to 20-20-20 objective through the reduction of power failures 20-50%, and save controlling power loss up to 7%



Demo Steinkjer data

- 772 customers
  - 700 residential
  - 66 commercial
  - 1 farm
  - 1 water power plant
- Energy demand
  21 350 kWh / year
- Distribution of energy is provided by **NTE** from the electrical distribution network through 9 feeders of 22 kV.

Optimisation Problem in Steinkjer

Microgrids in residential areas will become a necessity as soon as prosumers with local generation and storage become dominant, but until this situation occurs, microgrids will be a tool for the grid company to cluster local grids and information in order to try to optimize parts separately and in turn enforce a global optimization strategy from the overall system.

The demo area in Steinkjer has a mix of residential, light industrial and tertiary customers, but with the residential being dominant.

The **peak shaving and energy distribution grid optimization** is the most interesting objective to be realized in e-Gotham, utilizing measurements and DER at different grid levels at the same time:

- Smart house systems supporting DR and storage
- AMR/Smart meter readings
- Grid measurements both in LV and MV level

Prototype 1

- Contracted capacity tariff with local display.
- Mobile UI's for instant consumption monitoring and simple remote control.
- Comparison to baseline customers at the same network.

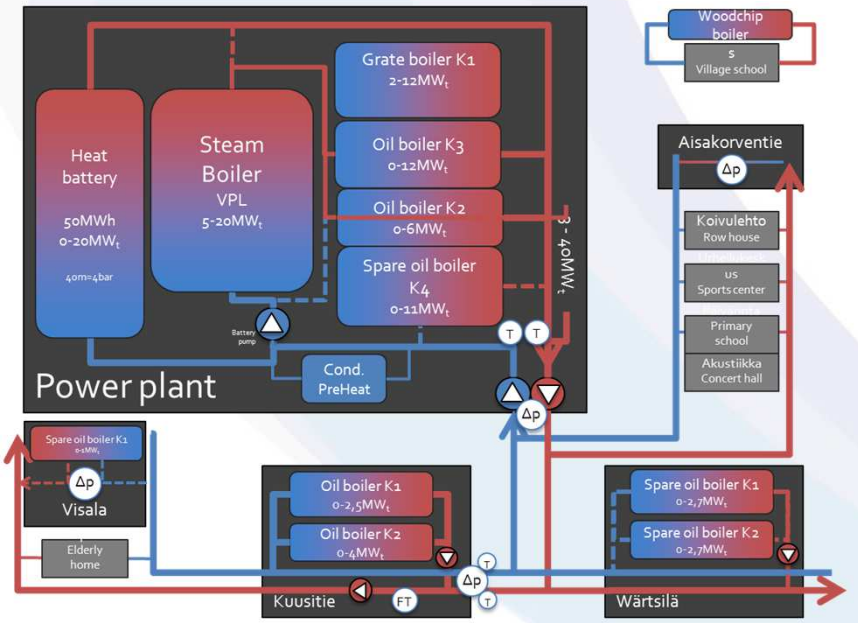
Prototype 2

- Automatic Demand Response.
- Integrating tariff and price information.
- Grid measurements in secondary substation.
- API for integration of AMR data to e-Gotham database.

Tertiary Pilot

The **Ylivieska City Building Management** team (YCBM) is managing tertiary buildings for the city of Ylivieska with a total area of 73000 m^2. The district heating network is a water pipe construction which is used for centralized heating of houses in cities in Finland and other Northern areas. Also tertiary buildings owned by Ylivieska City Building Management team are located in this same microgrid area and they are consuming both electricity and district heating energy produced by **Herrfors**.

e-Gotham will reduce energy costs of the tertiary buildings by better optimized control with help of forecasting and better real time measurement possibilities.



Tertiary pilot contains the following elements:

- thermal power station
- district heating network
- tertiary buildings and

Optimisation Problem in Ylivieska

The optimization problem for the tertiary pilot has two sides, which need some interaction with each other to be effective:

- On the one side, **Herrfors** has an individual challenge of setting up the production of the power plant in intelligent way, which both fulfils the need of customers and provides energy savings for the company at the same time.

- On the other side, **YCBM** has a challenge of adjusting heating and ventilation of its buildings so, that, they keep building users happy while making savings for energy usage.

e-Gotham middleware should be able to help this process by providing an optimized forecast of district heating consumption for next 8 hours. This estimation shall be based on the intelligent algorithms, which will have all statistical data, current production parameters and the weather forecast as their input.

Prototype 1

- Storing real-time data from AMRs, weather station, power plant, room temperatures from WSNs.
- District heating consumption forecast for power plant control room.

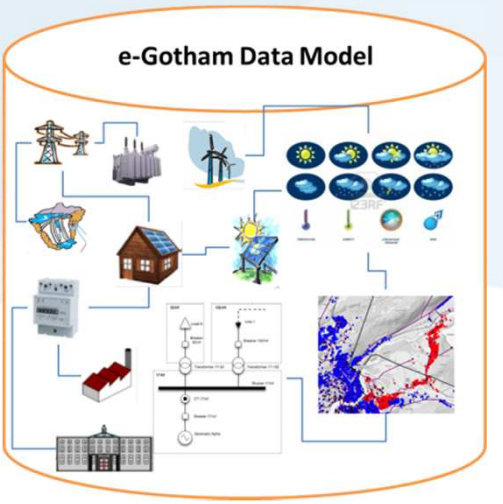
Prototype 2

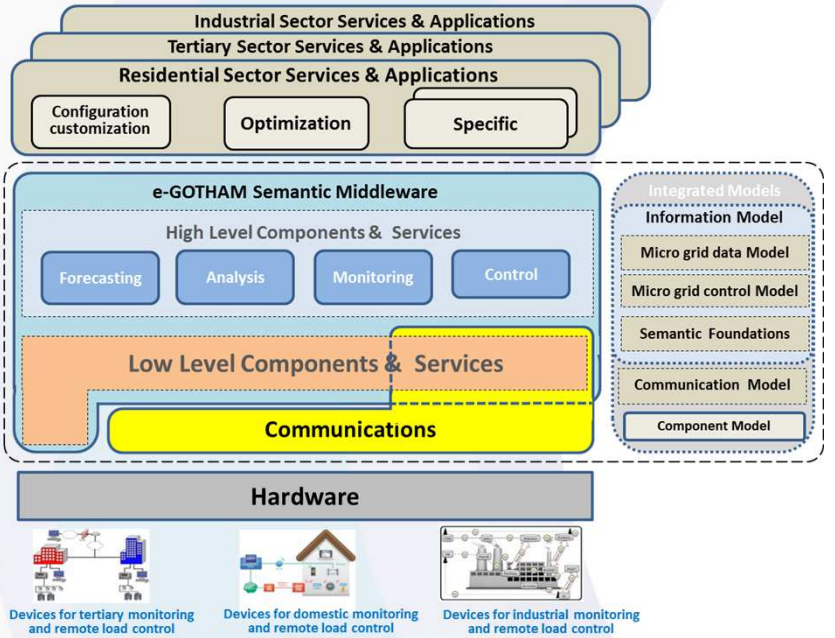
- Storing real-time data from AMRs, weather station, power plant, room temperatures from WSNs.
- Decision on energy production and dispatch.

Semantic middleware and data model

The semantic Middleware is the core of the e-Gotham approach and it will be based on Service and Information Oriented Architecture.

It integrates and provides seamless connectivity among the micro-grid data information model, the decision making mechanism and smart grid services and applications needs, including control, monitoring and management.

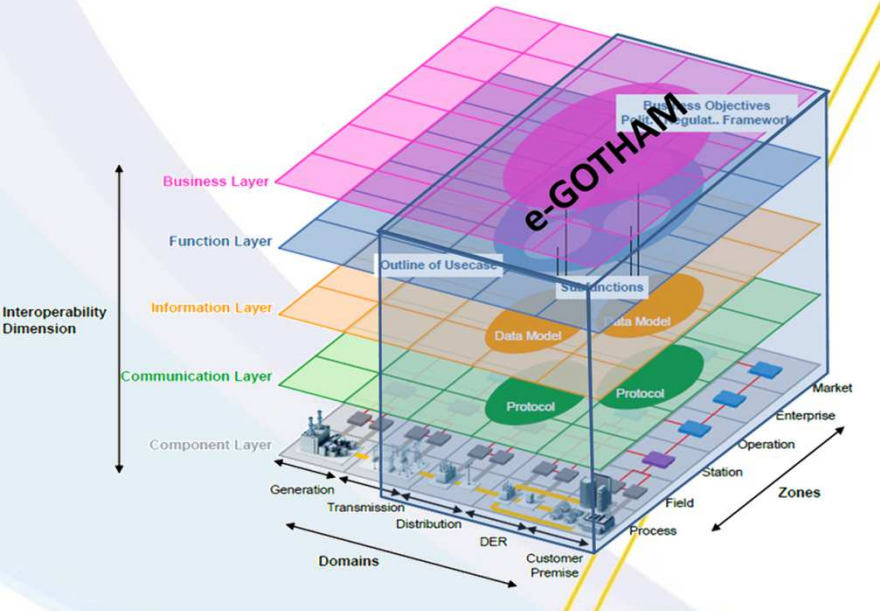




e-Gotham data model contains a formalized representation of all the entities, elements, systems, properties and relationships that exist in the e-Gotham domain.

The use of ontologies facilitates the development of the intelligent applications and the interoperability between applications outside e-Gotham.

To guarantee the interoperability of future e-Gotham smart microgrids with other European Smart Grids, e-Gotham architectural model will follow the European Smart Grid Architecture Model that is being defined as a consequence of the European M/490 mandate.

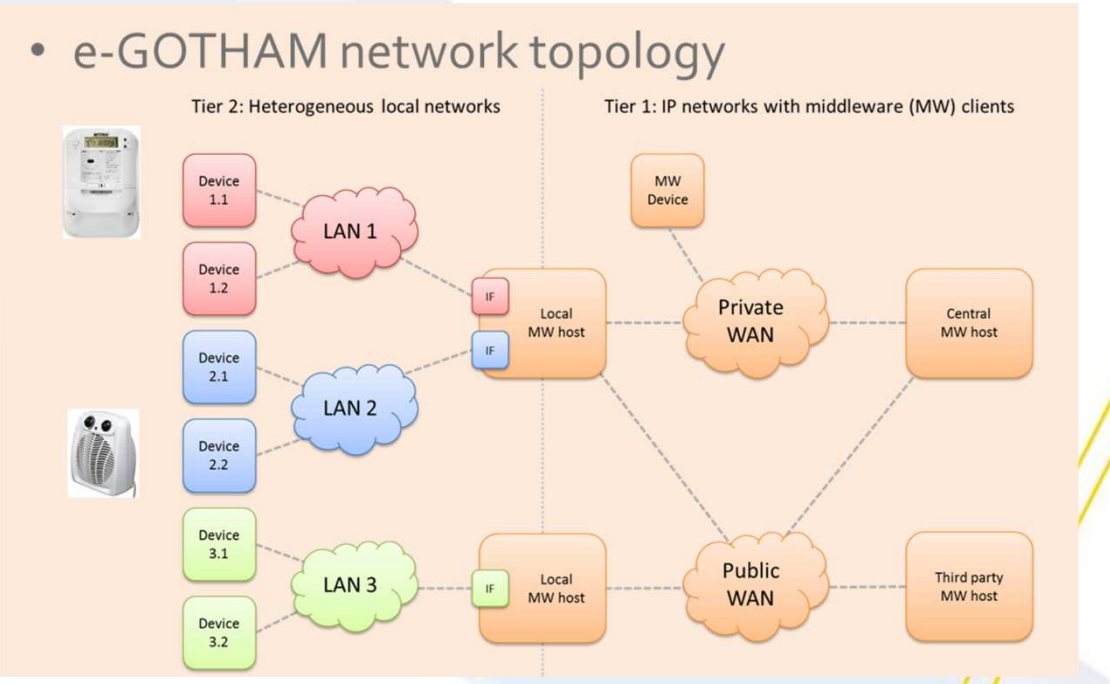


The communication model

The Communications layer is the overlay level in charge of ensuring the network interoperability (protocols) among the different e-Gotham components, services and applications, and other existing elements different to the context of e-Gotham. This layer is closely related with the Middleware Services in order to offer to the upper layers (Service and Applications) application oriented communications services.

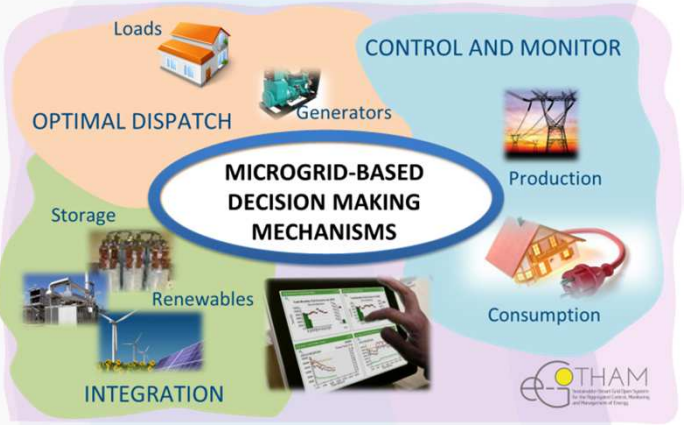
The Communication model is based on open building blocks with the following characteristics:

- Open source OS platforms preferred
- AMQP message queue protocol
- Broker–based secure message interchange
- Apache QPID selected
- ESB for application interconnectivity
- Service oriented architecture (SOA) backbone
- Fuse ESB selected



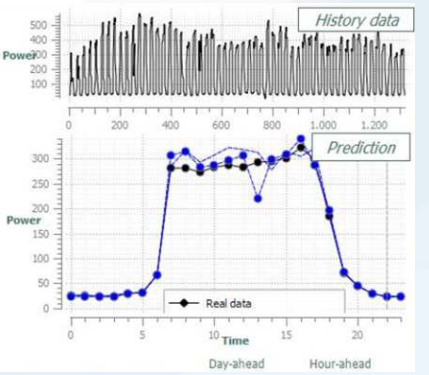
e-Gotham optimisation

The dispatch of energy supply is designed through an optimal control strategy able to balance energy demand (from loads in the field) and energy supply minimising costs. The control strategy is designed taking into account the integration of different energy generators (including renewables) and storages systems placed in the microgrid.



This control strategy employs:

- a central controller, computing the optimal reference energy signals based on estimated energy demand
- local controllers, implementing reference signals computed by central controller

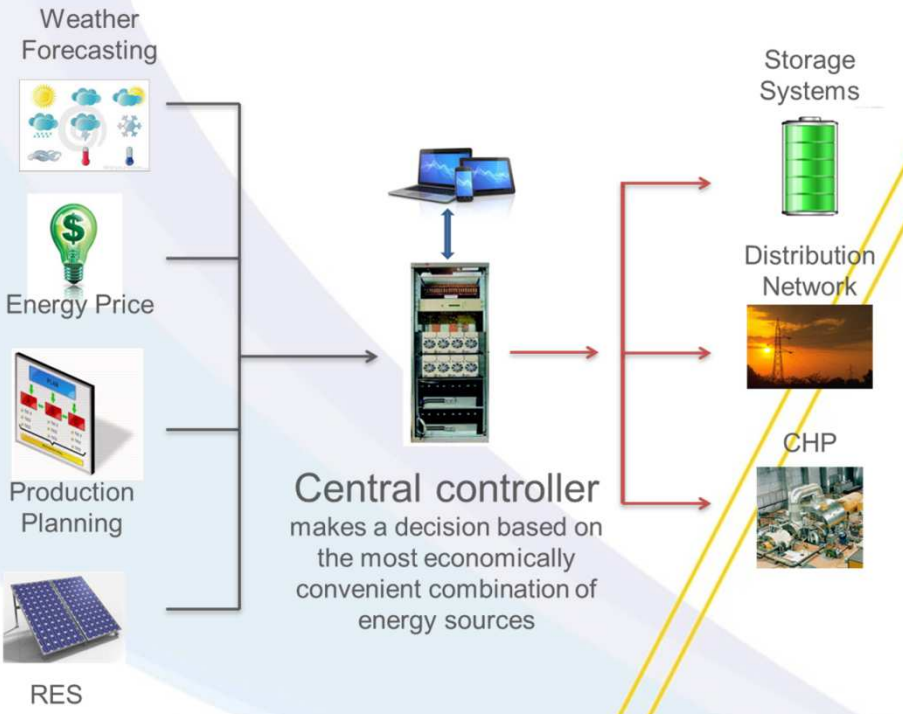


Forecasting

Forecasting module is responsible to estimate the future aggregate energy demand taking into consideration:

- weather forecast
- the estimated contribution of renewable sources
- the estimated production plan (for industrial case)
- the consumer contracts (for the residential case)
- the historical data

Decision-making mechanisms will efficiently manage microgrid operations.



e-Gotham Consortium

17 partners from 5 countries
Overall budget 7 M€
Duration 3 years
ARTEMIS JU sub-programme 7

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