Orchestration of Renewable Integrated Generation in Neighbourhoods

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D4.4 Energy Saving Calculation Method

WP4 – Modeling of the energy networks and development of the prediction, optimization and control algorithm

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ORIGIN	WP4 – Modeling of the energy networks and development of the prediction, optimization and control algorithm
Deliverable	D4.4 Energy Saving Calculation Method

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Energy Saving Calculation Method - ORIGIN Energy & Emissions Accounting Procedure

ORIGIN is predominantly concerned with the orchestration of community energy demand to better match locally generated renewable energy. Demand and generation involves both thermal and electrical energy flows and protocols will therefore have to be included to account for both. Within this overarching aim, each participating building will have their electrical and thermal demand modified to the benefit of community goals. It is imperative therefore that any accounting procedure followed is able to reflect individual building and community performance.

At an individual building level, standardised approaches will be taken to compute energy flows (e.g. BS ISO 50002; Building Audits). At a community level, standardisation is at a more evolutionary stage and it is likely that existing approaches will be modified to suit the specific community conditions and goals encapsulated by the ORIGIN project. For instance, BS ISO 50015 (Measurement and verification of organisational energy performance – general principles and guidance) may provide the basis for a template. Similarly, a range of alternative community scale audit schemes have been published and it is possible that from these an agreed standardised approach can be developed (see for example Crawley and Aho, 1999; AlQahtany et al., 2013, Bugel et al., 2012; BREEAM, 2013; LEED, 2013; CASBEE, 2013; the DomEARM audit procedure described in HCA, 2013).

Issues may abound with the direct adoption of these existing standards. ORIGIN aims cannot be simplified to enhancement of efficiency or promotion of conservation; the primary aims of these standards is to quantify urban form energy flows from these perspectives. There may therefore be a requirement to modify these existing platforms. The ORIGIN project team see a key role for the FP7 cluster ICT for energy-positive neighbourhoods[1] in developing these energy and emission accounting protocols.

In the first instance, the ORIGIN team propose to develop a simple, bottom up accounting procedure that addresses explicitly the requirements of the ORIGIN project. Community energy flows will be discretised to allow accounting and boundary protocols specific to each energy flow to be applied.

It is envisaged that a live sankey diagram would be useful in displaying performance to the community, where each energy flow is displayed indicating *fuel in: service out* analysis in conjunction with losses.

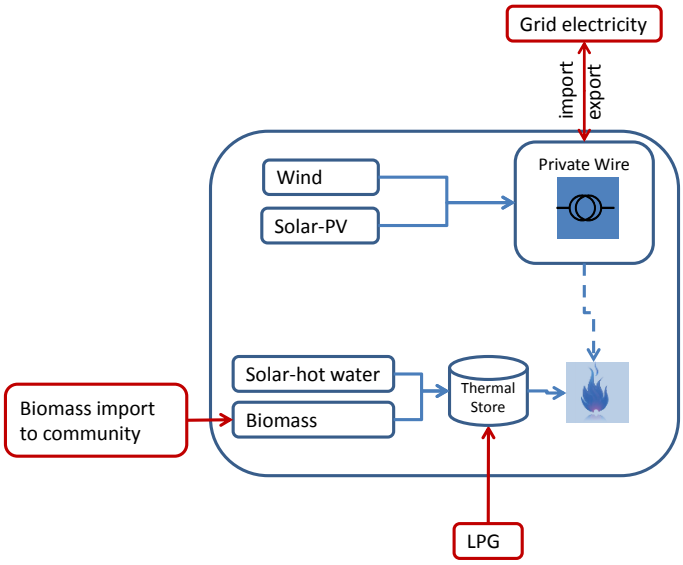
An example of the energy flows that will be affected (and therefore will be measured and quantified) by the ORIGIN project is shown below. The overarching aim in each community will be to minimise the energy flows from outside the community (marked in red in each diagram) by maximising the local consumption of renewable generation.

[1] Projects included in this cluster are URB-Grade, EPIC-HUB, EEPOS, ODYSSEUS, ORIGIN, SMARTKYE, E+, COOPERATE and NRG4Cast

Findhorn Community Energy Flows

Biomass Usage (district heating systems)

The total biomass used, energy consumed and energy lost via boiler efficiency, storage and distribution will be measured. System boundaries will be defined as an output of data analysis but could for instance incorporate transport fuel for biomass delivery as a loss to the overall system.



Solar Water Heating Usage

A utilisation factor for Solar water heating usage will be computed – local weather data from the dedicated station will be used to predict for each SWH system on the site a forecasted, idealised output. The amount actually collected, stored and used will be monitored. In this manner a sankey diagram for SWH will be constructed to highlight deviation from the idealised output together with loss diagnosis.

LPG Usage

The project does not monitor this but New Findhorn Directions do provide the occupants with use details. It may therefore be possible to include the data in the overall Community energy balance.

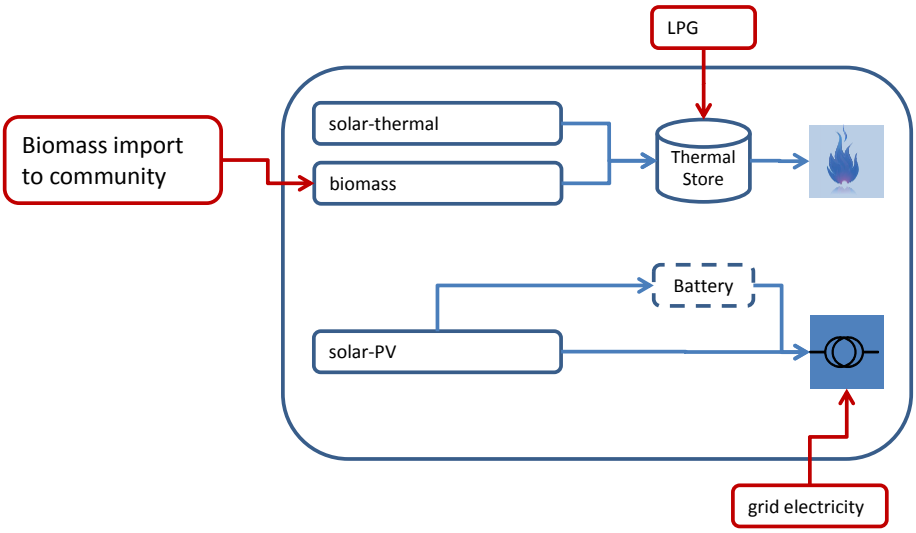
Electricity: Solar-PV, Wind Park, Grid Electricity

In terms of electricity, a simple approach of monitoring generation from PV and Wind Park, total demand and import and export flows will be followed. In this manner the overarching theme of the project can simply be computed. Additional assessment could be provided by

converting the grid electricity generation (import) into an emission. This can be reasonably temporally precise, e.g. hourly or daily using Balanced Mechanism report data for the Scottish grid or can be assigned using annual (or monthly) emission factors. This would permit the energy flows detailing electricity to be viewed as emission flows. Alternatively the primary energy flows of the Scottish grid could be estimated allowing a Sankey diagram to be produced.

Damanhur Community Energy Flows

The Damanhur pilot site consists of a series of grid connected individual buildings, both domestic and commercial in nature. These buildings are all heated using hydronic heating systems with either biomass or Natural Gas boilers augmented with solar hot water systems. Electrical demand is met by a combination of solar-PV and grid electricity. One of the residential buildings has battery storage.



Heat

All heat flows will be measured using heat meters and thermal comfort will be measured using temperature and occupancy sensors (CO_2 and humidity). It will therefore be possible to provide an input:output analysis of heating system efficiency. The capacity of the system to expand system boundaries and consider conversion efficiency of biomass calorific value and biomass delivery distance will be explored as an output of the data analysis.

Electricity

Electricity generation from solar-PV, imports from the grid and usage in each building will be measured. As with Findhorn, the possibility of computing temporal emission factors for grid electricity will be explored in conjunction with the communities.

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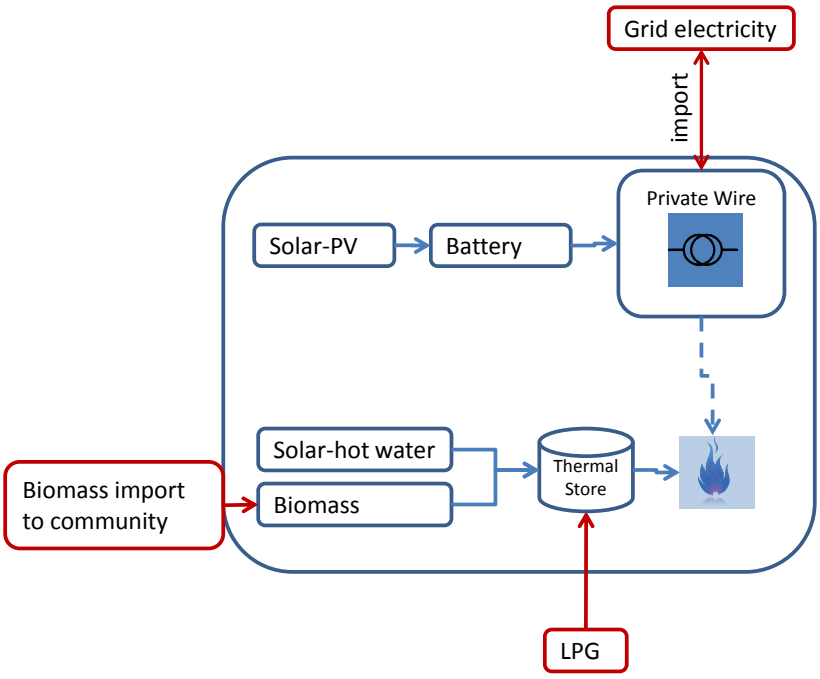
Tamera Community Energy Flows

The Tamera pilot site consist of a series of buildings, both domestic and commercial in nature that are connected to a private wire electricity grid that is fed by a Solar-PV system via battery storage. The small heating requirement for the buildings is provided by a mixture of biomass and LPG. LPG is also used for hot water and cooking. There is no arrangement for export of electricity to the grid but electricity is imported when the batteries are exhausted.



Heat

All heat flows will be measured using heat meters and thermal comfort will be measured using temperature and occupancy sensors (CO_2 and humidity).

Electricity

Electricity generation from solar-PV, imports from the grid and usage in each building will be measured. As with the other sites, the possibility of computing temporal emission factors for grid electricity will be explored in conjunction with the communities.

Reference List

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