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Subject: Comments on draft
EcoGrid EU-D2.1-Report on DER models and control algorithms developed_v1.2.doc

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1.1 General Comments

The document is a combination of mathematical description of a set of physical device models which are supposed to offer flexibility in the power consumption over time.

The mixture of MATLAB code and formal descriptions is peculiar, a clear separation between modeling and implementation would have been welcome.

The distinction between devices which can accept variable power levels, including off-times, at intermittent times versus devices which run to completion once started is not clearly elaborated.

The energy buffering class of devices include freezing/refrigeration, water-heating, and compressed air model. Room heating, pumping, air-conditioning, batteries (stationary or on-wheels) are not addressed. There is no distinction made on the relevance of these devices in terms of their energy volumes (A typical domestic fridge uses 250 kWh/year and thus only offers limited balancing capabilities).

The modeling focuses on individual devices. There is no possibility to simulate an ensemble of different devices each with different parameters settings, external factors, etc. To study large systems such as the power grid, the one device at a time MATLAB approach falls short. The inclusion of model parameters into the code (as constants) limits flexible configurations: parameters should come from a configuration file or the alike.

1.2 Price sensitive set-points for thermal devices

The basic idea here is to relate a set-point to a deviation of the current price to some average price. This has been described in the literature (e.g. GridWise) and is now seemingly becoming the mantra of price sensitive load adaptation.

However, the following issues remain with this approach:

- Momentary shifts in power do not reflect energy demands: if the price remains high, the energy demand is not satisfied at all?
- Price sensitivity over time is correlated: the colder/hotter it gets, the higher the acceptable price becomes and price sensitivity drops.
- As there is no time-horizon in the real-time clearing price, no forecast can be made with regards to energy (versus power). The user needs are mainly in terms of energy, not power. In most geographies, pricing is also currently based on energy, not on power.
- If a large load population has similar price sensitivity (cheapest is best), demand will surge at moments of cheap price. There only is local optimization per load, not across all loads.
- Thermostat driven devices have some hysteresis around their set-point. I.e. there is a range around the actual set-point which controls the power on/off. This does not seem to be reflected in the models here. A set point without hysteresis would lead to continuous on/off switching (instability).
- Heating systems are often controlled via heat-curves in which the set-point is a function of the external ambient temperature.
- The models seem to assume that power settings are binary: on/off. What about a set of different power levels (boilers have more than two power settings, batteries accept variable power levels)?

- How do dead-times affect the modeling? It is common practice in some geographies to disallow certain loads to operate during morning and evening peak demand times (boilers, heat-pumps). Since thermostat settings are limited at T_{min} even a very high "real-time" price would not completely shut off the load.

1.3 Combined Heat-Power (CHP)

The model includes variable power levels for J. It also includes a minimum on-time.

The "forecast" for thermal demand only covers the subsequent time-slot. No longer planning horizon thus seems possible.

The decision on running the CHP appears to be based solely on the price of electricity in relationship to the thermal energy stored in the heat tank. This assumes the monetary value of thermal energy to be constant over time? Similarly, what about the cost of generation which is assumed to be (relatively) constant, but would need to be taken into account against the price of electrical energy fed back into the grid? [1]

What is the relationship between electrical power and thermal power? Is it constant or can it be varied?

What about combinations of micro-CHP and PV generation in which case local optimization between (local) thermal and electrical demand, PV generation, CHP generation, and cost of external electricity supply needs to be performed.

1.4 Time-shiftable loads

For these loads, the flexibility is not based on variable power levels, but on deadlines with regards to the completion of their cycles.

The suggested solution is to have a (linear) relationship between acceptable price levels to *start* a device's cycle in relationship to the time remaining until its deadline. This evidently can lead to a situation where one cheap price signal will trigger the cycle to start although subsequent prices over the remaining cycle can be astronomical. How is market rigging prevented?

Furthermore, if all devices have a same price sensitivity curve, all devices would start simultaneously. Not good for grid congestion and power supply.

If price sensitivity would differ, i.e. some sub-population willing to pay more for power[2], one could imagine staggering prices such that earlier in time high-prices would trigger only the loads willing to tolerate higher prices; further loads will then be "scheduled" via lower prices later in time. Such pricing could be related to forecast stochastic power supply. However, the bid prices and power demand of the loads would have to be communicated to the market maker; not a one-way price signal dear to the EcoGrid consortium! (People can change their price sensitivity over time depending on the size of their wardrobe, for example.)

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[1] For CHP, high feed-in prices trigger operation of the electrical generation or thermal demand.

[2] Although this is hard to imagine for real people: avarice is cool!