Towards a SLA for Collaborating Smart Solar-powered Micro-grids

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When considering renewable energy sources, like solar electricity, people often do not directly see the benefit of their investment.

While the sun is shining and might be producing electricity in their homes, they are at their work and cannot use that energy directly.

Figura 1 – Andamento giornaliero della potenza media prodotta da un impianto fotovoltaico di 3 kW ubicato a Firenze (dati forniti dal programma SunSim)
**Motivation**

- While when they need the energy at night (for laundry, lighting, computers) the solar panel is no longer producing.
CoSSMic Project

- Project ID: 608806
- Duration: October 1st 2013 - September 30th 2016
- Total cost: 4,267,061 €
- Funded by European commission - Directorate General Connect
call FP7—Smart Cities –2013
- Funding scheme: Collaborative Project STREP

CoSSMic is an ICT project that aims at designing an innovative autonomic systems for management and control of power micro-grids on users’ behalf.

Different types of buildings (for instance a mix of houses, companies and schools) could be connected in such a way that this neighborhood would use more, or even most, of its renewable energy within the community.
TARGET

- Reduce peak demand to the central power grid
- Reduce the need for (carbon based) backup power generation capacity
- Reduce need for peak capacity
- With less total storage capacity
CoSSMic Concept

- Controller in each building
- Communicating in the neighbourhood using the house WiFi and the internet
- User interface on smart-phones or touch pads connected using the internet
- Peer-to-peer, no central controller for the neighbourhood
- Low-threshold technology (low cost hw, easy to install and use, deployable locally or in the cloud) AND Open source software
EVALUATION BY TRIALS AND SIMULATION

• Trial Konstanz (Germany) and Caserta (Italy)
• Between 10 and 20 buildings, (private houses, schools, office buildings, small industry building)
• Collect data over 1 year trial period with system in operation in trial neighbourhoods
• Simulation of alternative business models and dimensioning of solar panels and batteries based on collected data
Caserta Trials
PILLARS

- Real Time Monitoring
  - of PV and Devices in real Trials
- Device Profiling
- PV Production Forecasting
- Distributed Agents Based Negotiation
  - Energy exchange
  - Task scheduling
  - Load Shift

variable power output depending on meteorological conditions.
Energy Exchange: Case Study

Swimming Pool → Big Plant

Private households → Small Plants
SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

- Actually SCADA systems are used to monitor the generation, transmission and distribution of energy flows but are unable to handle coordination between components, so there is a need to have additional ICT infrastructure.
ENERGY NEGOTIATION

Agents are classified according to two categories:

- Consumers: they buy energy for passive devices.
- Producers: they can sell energy.

In the first prototype negotiation strategy is very simple:

- The cost of energy is always less than the one fixed by the power supplier (no fees).
- In this condition the only parameters that are evaluated during a negotiation are the amount of energy to buy/sell and the duration of the contract.
NEGOTIATION STRATEGY AND PROTOCOL

Control Agents will pursue complementary objectives:

- **Consumers**: try to get as much energy as it is required from the neighborhood, thus achieving significant savings.
- **Producers**: try to sell to neighborhood all the overproduction to CossMic consumers, to improve their income.

The primary goal is to obtain, by negotiation between agents the minimization of energy exchange with outside the neighborhood.
REQUIRED STEPS

A prosumer that intends to require a service will do the following steps:

- discovery of service providers,
- selection of providers that offer the required service,
- retrieval of service offers (SLA templates),
- negotiation of SLA templates,
- agreement.
SERVICE LEVEL AGREEMENTS (SLAs)

- A SLA represents an agreement between a client and a provider in the context of a particular service provision.

- SLAs allow energy producers to define the offered service and the conditions for the assessment of the service itself.

- On the other hand, energy consumers will be able to look for and book the required offer, or to express their own requirements in a negotiation scenario.
TEMPLATE FOR NEGOTIATION

- definition of a uniform model for the descriptions of offers from providers of power sources and from owner of energy storages.
- machine readable, in order to let agents understand and evaluate offers.
- additional parameters will be taken into account such as terms of services (e.g. start date, termination date, price, etc.), and provider reputation.
SLA TEMPLATE

<SLA>
  <AId> Agent 1 </AId>
  <Date> 04/15/2014 </Date>
  <Power> 3000 </Power>
  <Price> 0.2 </Price>
  <Last> 02:55 </Last>
  <ErliestStartTime> 15:05 </ErliestStartTime>
  <LatestStartTime> 16:05 </LatestStartTime>
  <Floating> 0 </Floating>
</SLATemplate>
CONCLUSION

- CoSSMic project aims at improving decentralized energy management
- Consumer and Producer Agents schedule tasks and negotiate energy exchange
- Trials sites are going to be monitored for experimental activities
- SLA enable and assure the performance and the quality of services
- Optimization model is an on-going work
Thanks!
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