



Collaborating Smart Solar-Powered Micro- Grids

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

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MOTIVATION

- 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

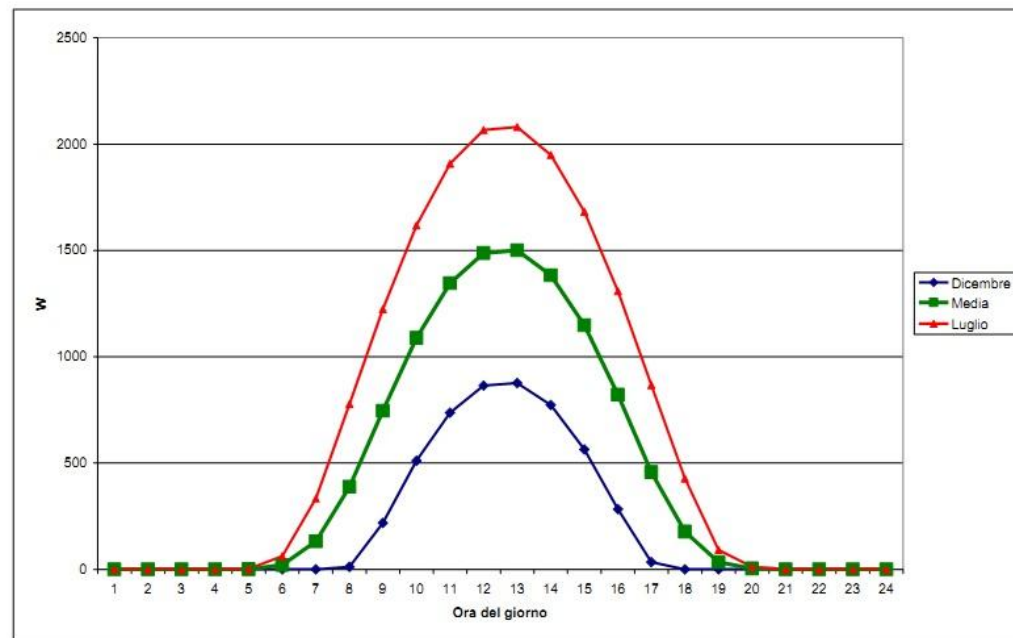
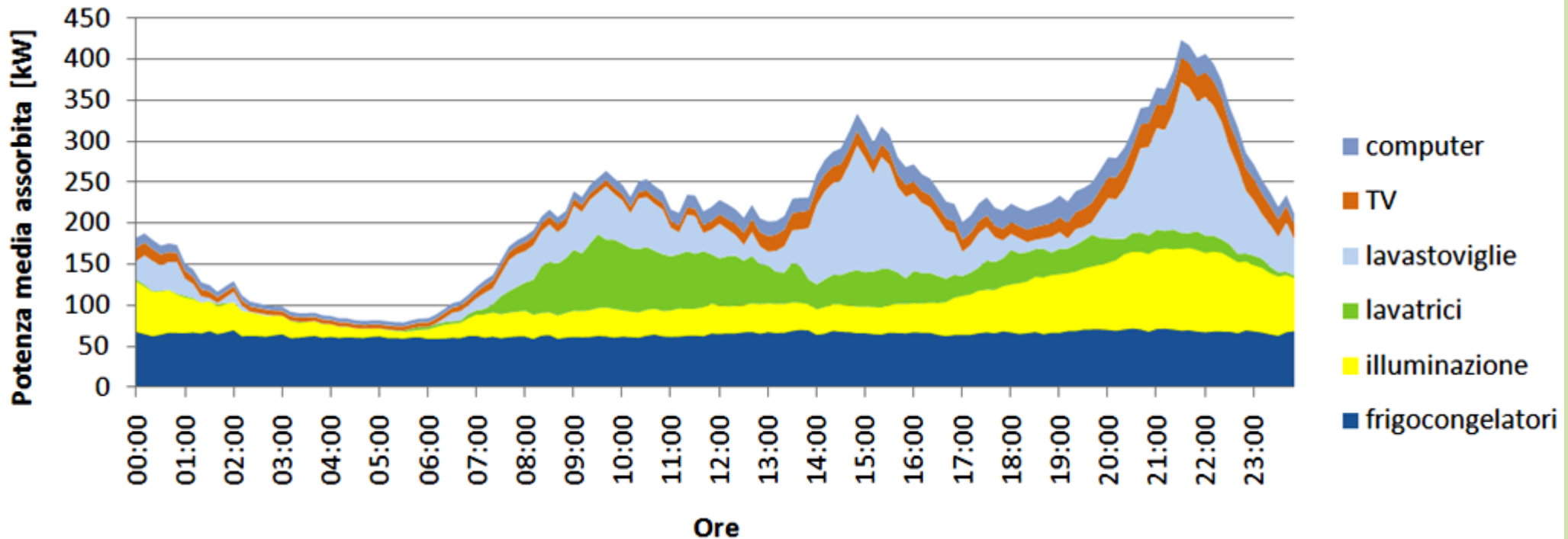


Figura 1 – Andamento giornaliero della potenza media prodotta da un impianto fotovoltaico di 3 kW ubicato a Firenze (dati forniti dal programma SunSim)



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 autonomous 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.

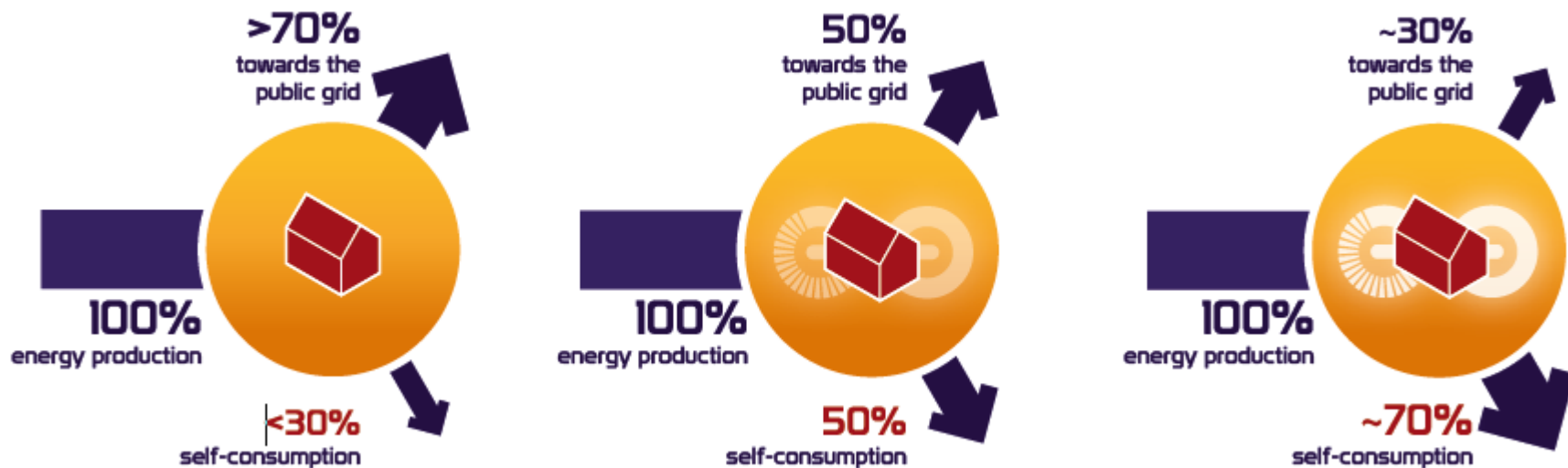


Provincia di Caserta



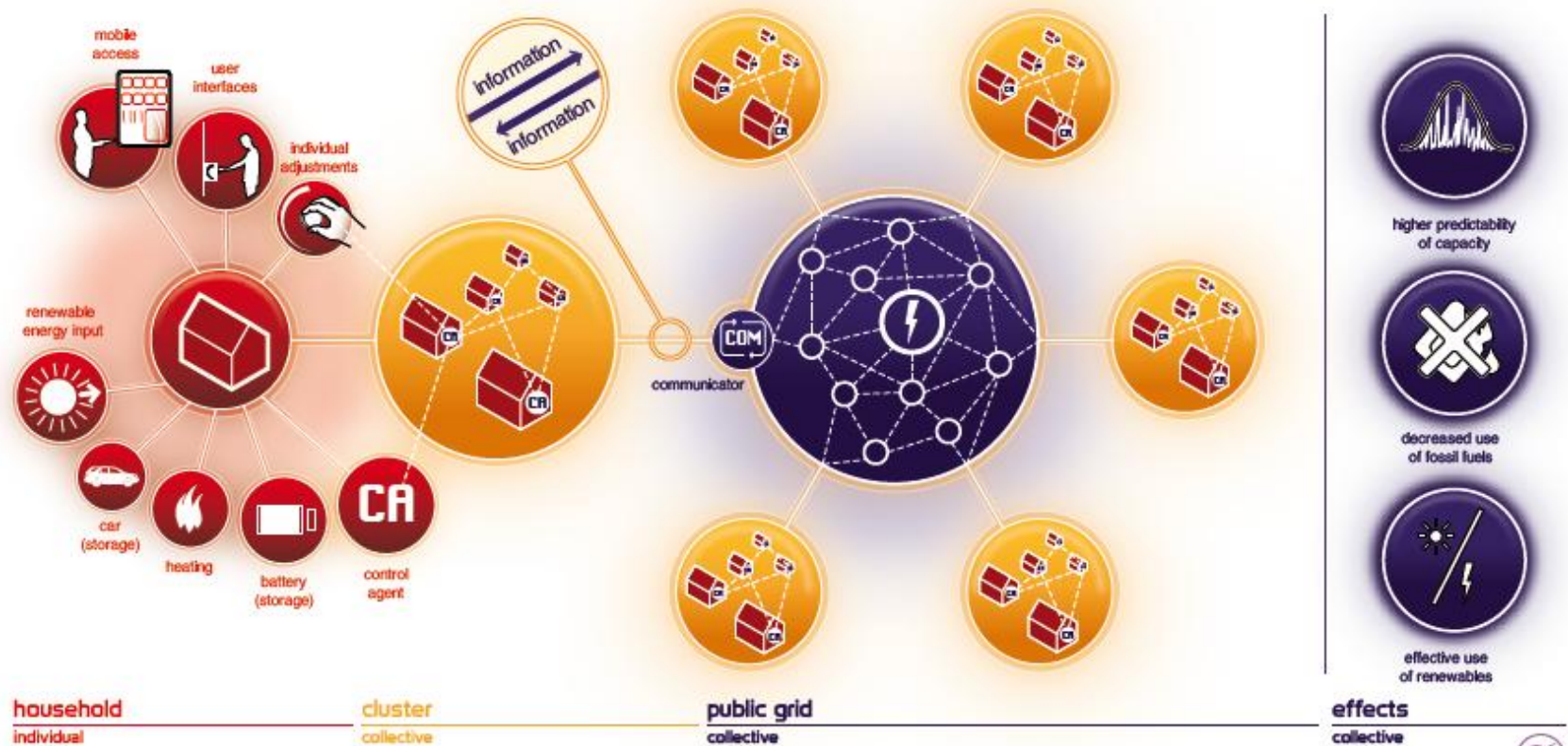
TARGET

- 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



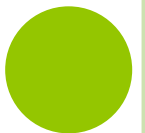
CoSSMIC CONCEPT

- 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

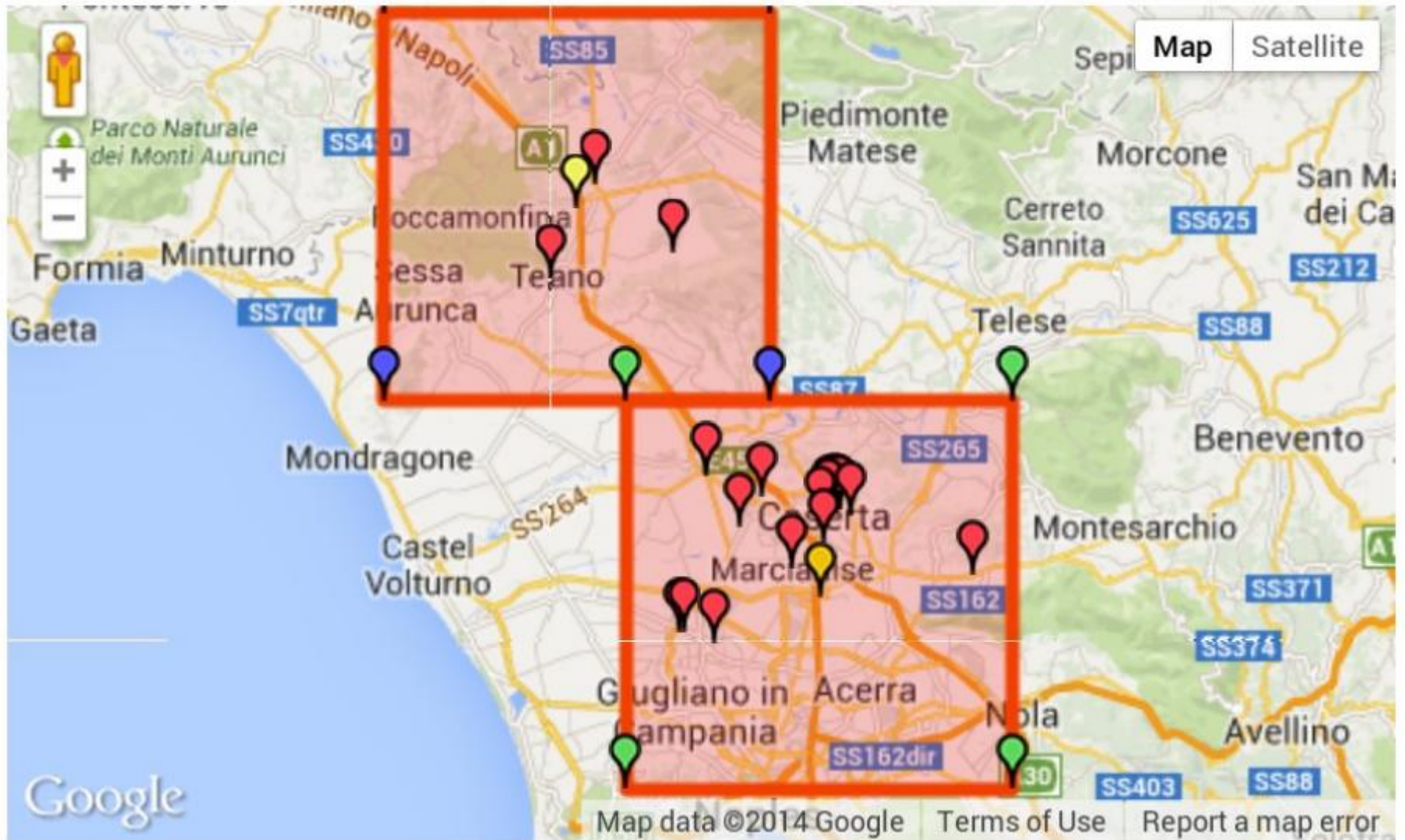


EVALUATION BY TRIALS AND SIMULATION

- 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



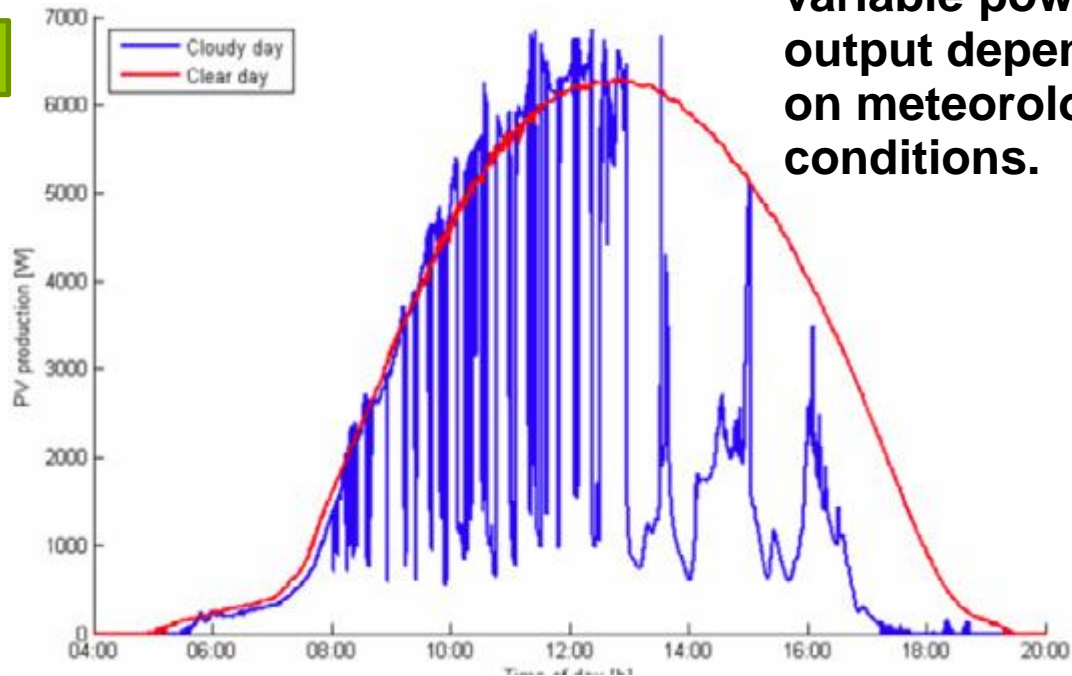
CASERTA TRIALS



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.

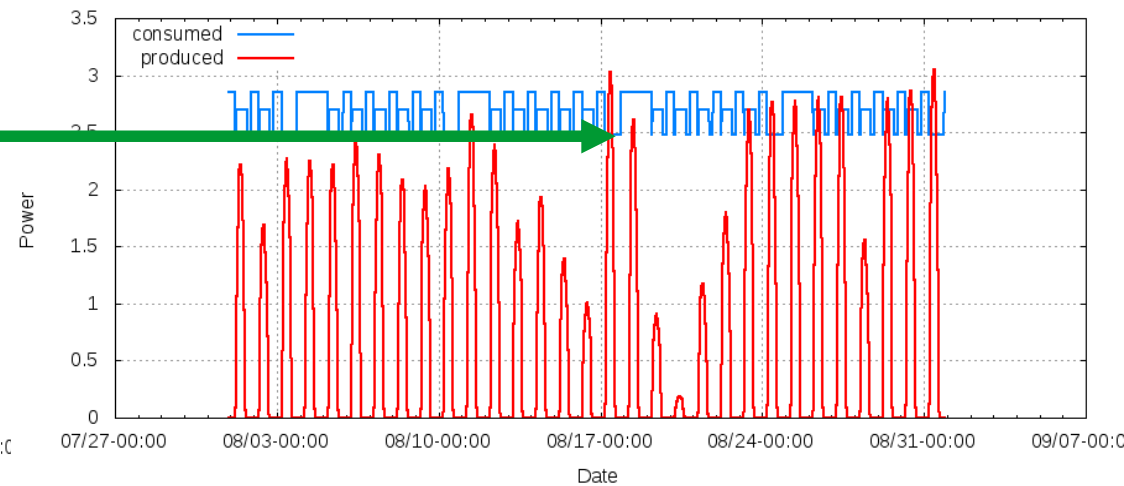
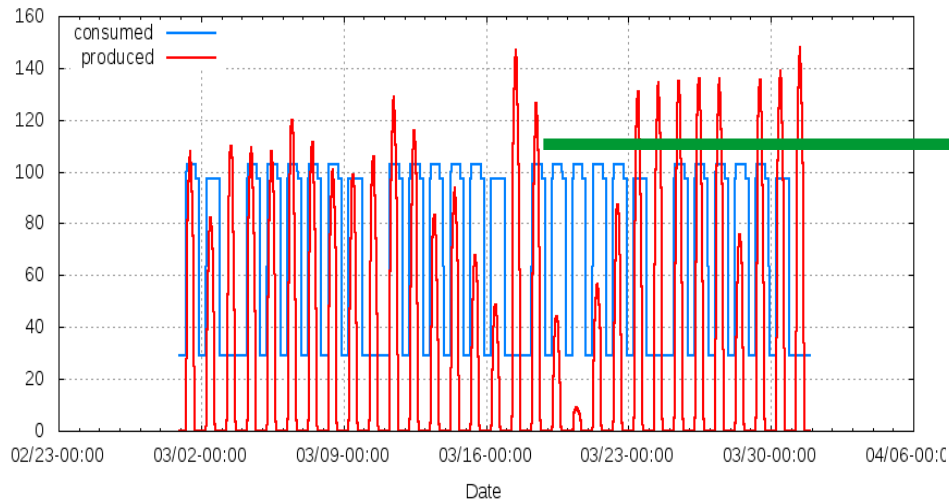


ENERGY EXCHANGE: CASE STUDY



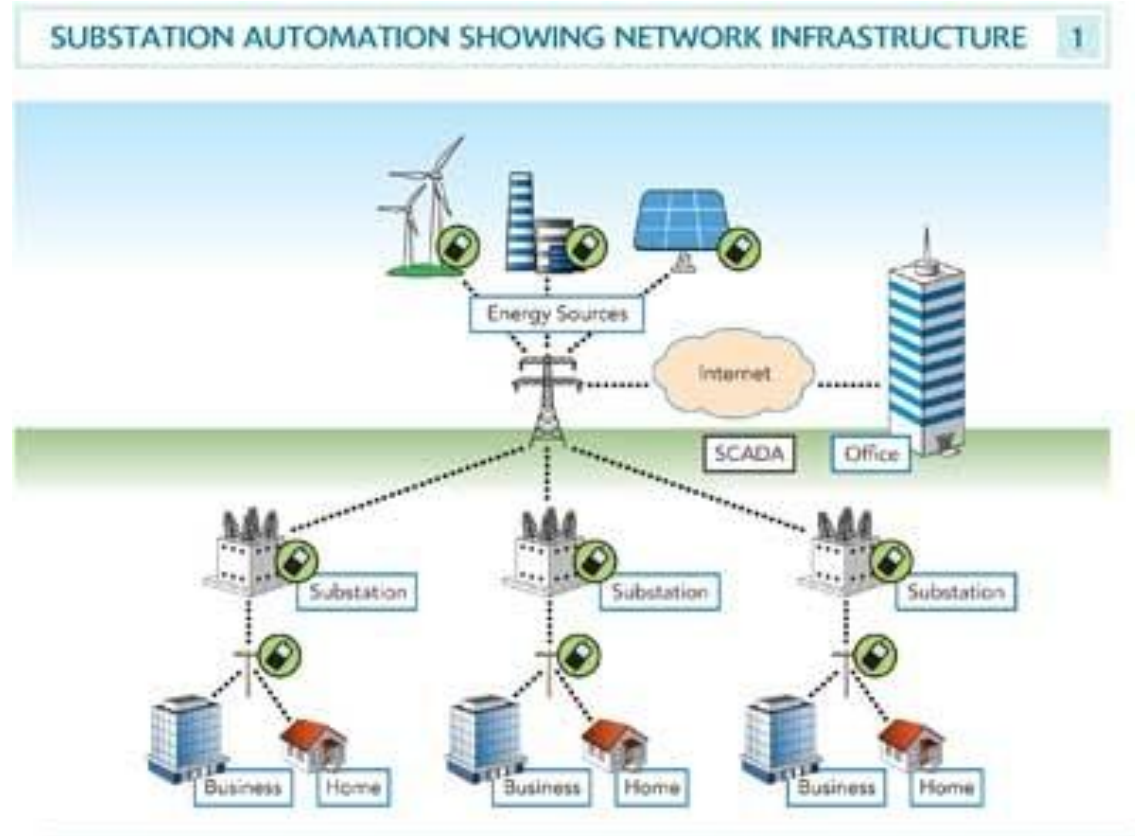
Swimming Pool → Big Plant

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.

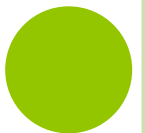


ENERGY NEGOTIATION

- 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:

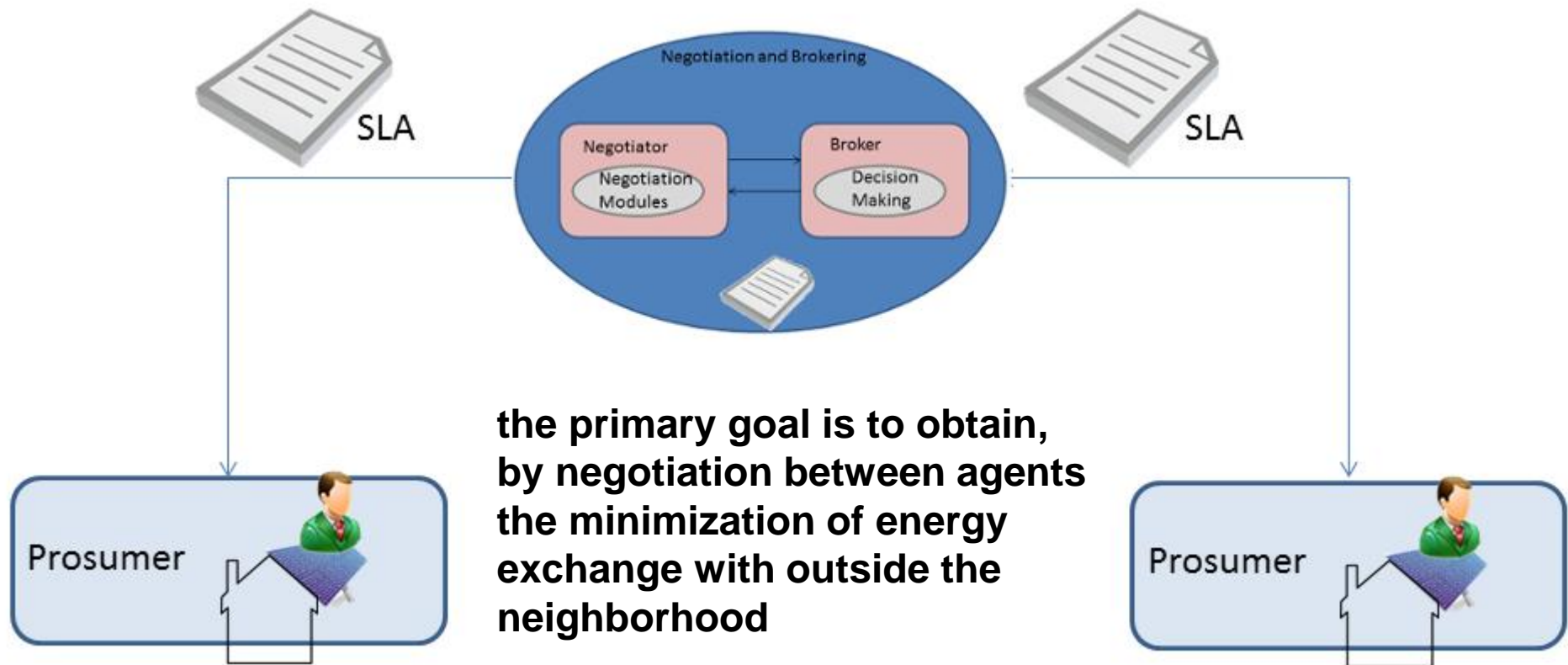
- The cost of energy is always less than the one fixed by the power supplier (*no fees*).
- In this condition the only parameters that are evaluated during a negotiation are the *amount of energy* to buy/sell and *the duration of the contract*.



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.



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.



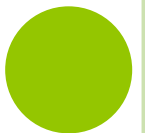
SERVICE LEVEL AGREEMENTS (SLAs)

- 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.



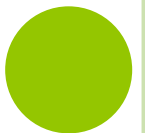
TEMPLATE FOR NEGOTIATION

- 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 </ A g e n t I d>  
  <D a t e> 0 4 / 1 5 / 2 0 1 4 </ D a t e>  
  <Power> 3000 </ Power>  
  <P r i c e> 0 . 2 </ P r i c e>  
  <L a s t> 02 : 5 5 </ L a s t>  
  <InteractionProtocol>C o n t r a c t N e t </InteractionProtocol>  
  <ErliestStartTime> 15 : 0 5 </ErliestStartTime>  
  <LatestStartTime> 16 : 0 5 </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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