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# ICT FOR OPTIMIZING SYNERGIES AMONG ENERGY GRIDS IN SMART CITIES

Sustainable Places, Nice, France, 1<sup>st</sup> October 2014



# ORPHEUS PROJECT



- OrPHEuS: OPTimising Hybrid Energy grids for smart cities
- Aim: Development of cooperative control strategies for optimizing the synergies among hybrid energy grids in smart cities
- Project duration: September 2013 – September 2016
- Co-financed by the European Commission (FP7 – Smart Cities)
- Coordinator: WIP – Renewable Energies 



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[www.dlr.de](http://www.dlr.de)



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SWU Netze GmbH  
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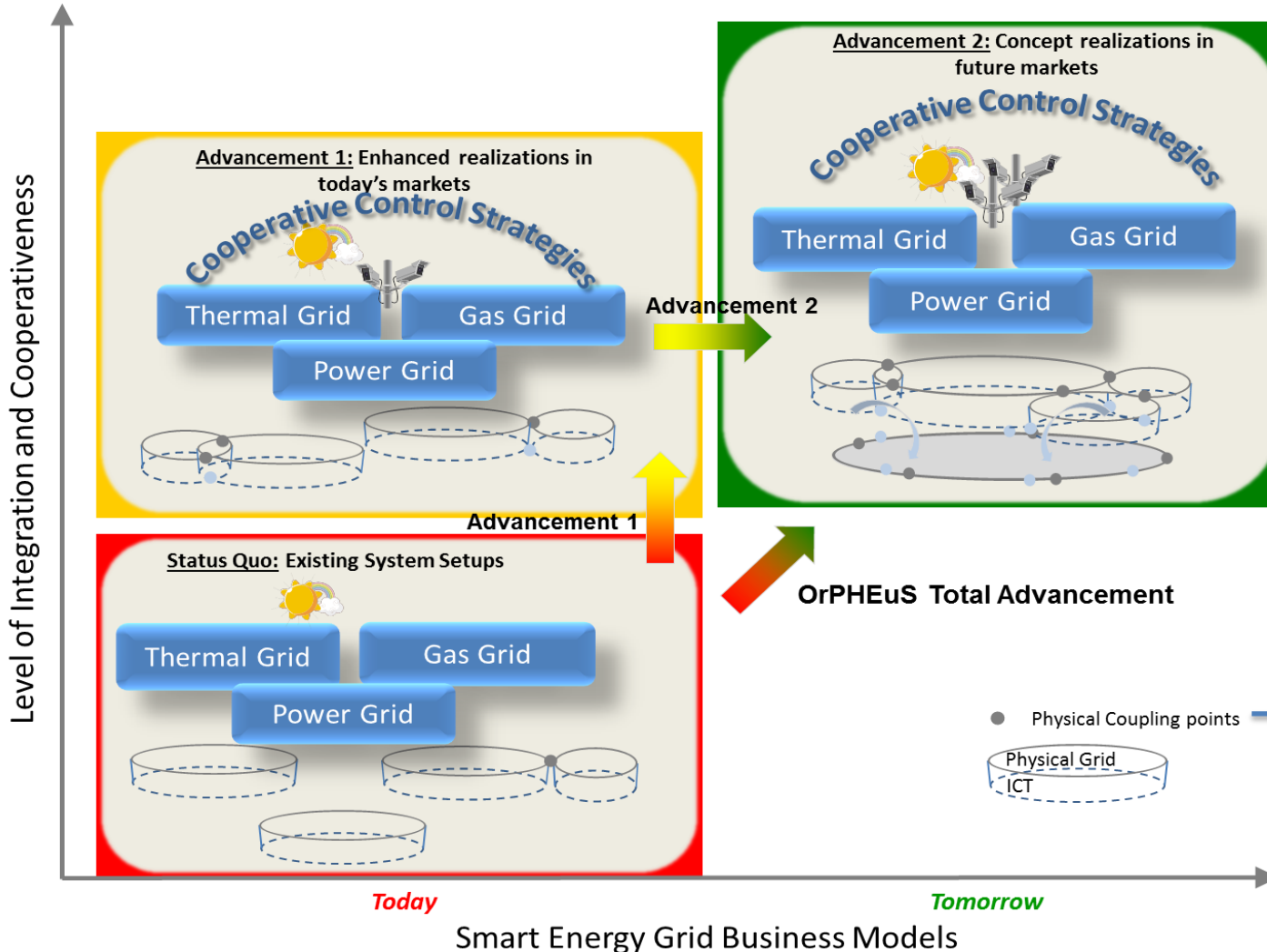
# THE IDEA BEHIND ORPHEUS



Why should we optimize the synergies among hybrid energy grids?

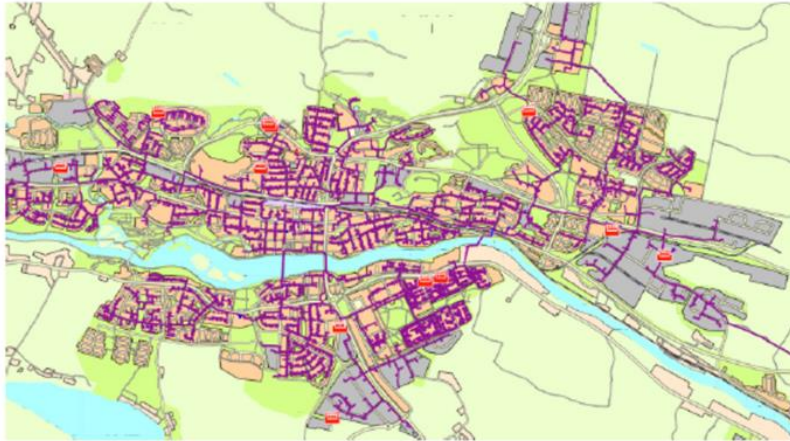
- Optimization of synergies among energy grids leads to efficient grid operation and therefore to CO<sub>2</sub> reduction
- At the present, different energy distribution grids still mainly operate independently and do not make use of synergies among them
- Although interaction and synergies are increasingly apparent, they neither have been comprehensively analyzed nor implemented in practice

# CONCEPT



**Coupling point:** Physical element which connects two different energy domains and identifies an hybrid energy grid

# IMPLEMENTATION

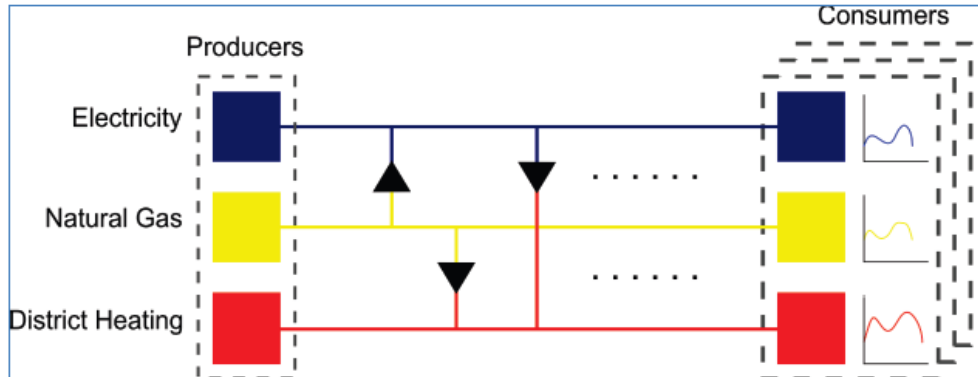


Skellefteå area in Sweden  
(Note: District area network (purple),  
CHP and pellets/oil burner plants in  
(red))



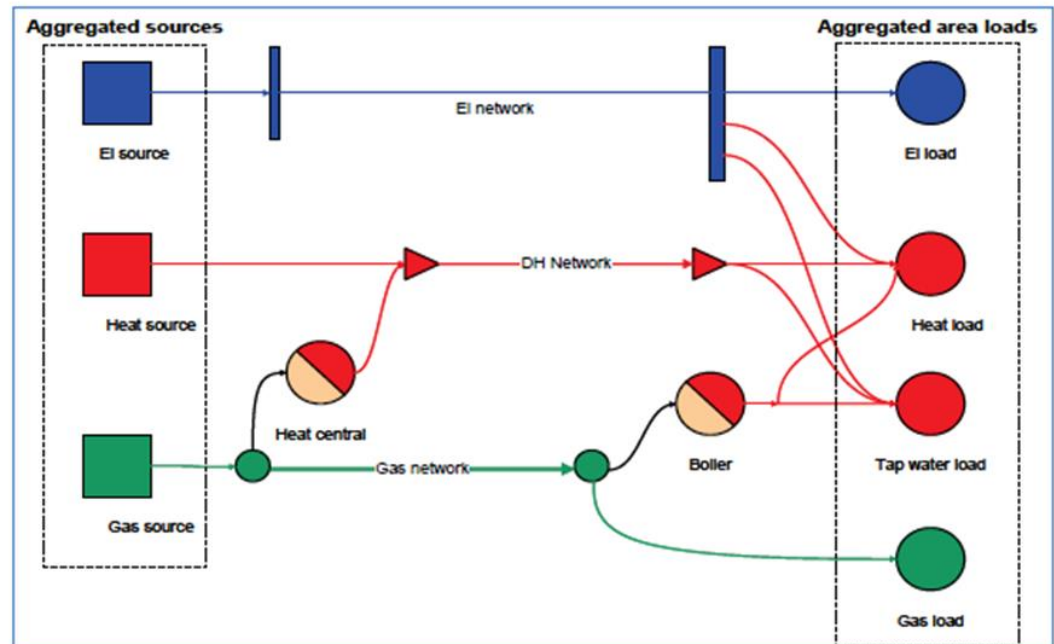
Test Area in Ulm, Germany  
(Overlaid of the roof solar  
potential analysis and the  
position of the PV systems  
and transformer station)

# COUPLING POINTS



## Coupling point:

Physical element which connects two different energy domains and identifies an hybrid energy grid





# CONTROL STRATEGIES



<b>Cooperative green supplier</b>	<p>Target: General energy supplier, which provides electricity and heat to its costumers</p> <p>Aim: optimize the operation of the hybrid power heating grids</p>
<b>Carbon free heating</b>	<p>Target: the energy supplier Skelleftea Kraft, which owns CHP plant, electric boiler, oil boiler and thermal storage</p> <p>Aim: Avoid the use of oil consumption for heating occurring during the period of peak demand</p>
<b>Green Community</b>	<p>Target: <b>consumers in Ulm</b>, owners of PV system (prosumers), heating devise(s) and both thermal and electricity storage</p> <p>Aim: minimize the total amount of energy (gas and electricity) bought from the energy providers and <b>balance the local energy load and energy generation</b></p>

# TEST AREA IN ULM, GERMANY



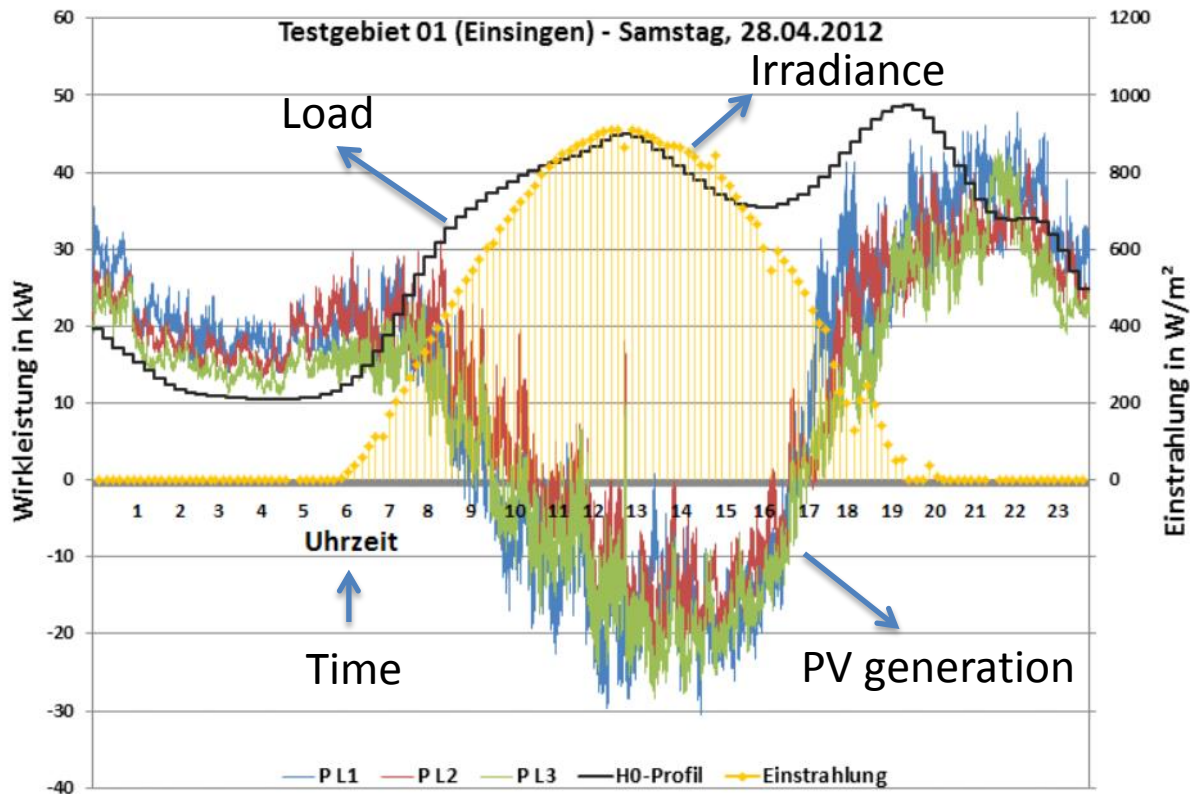


# NEED FOR ENERGY BALANCING



Reverse flow at the test area in Ulm, Germany

## ■ Power flow at the LV transformer



Messung an 8  
Transformator-Abgängen  
im Sekundentakt

# THE STATE OF THE ART

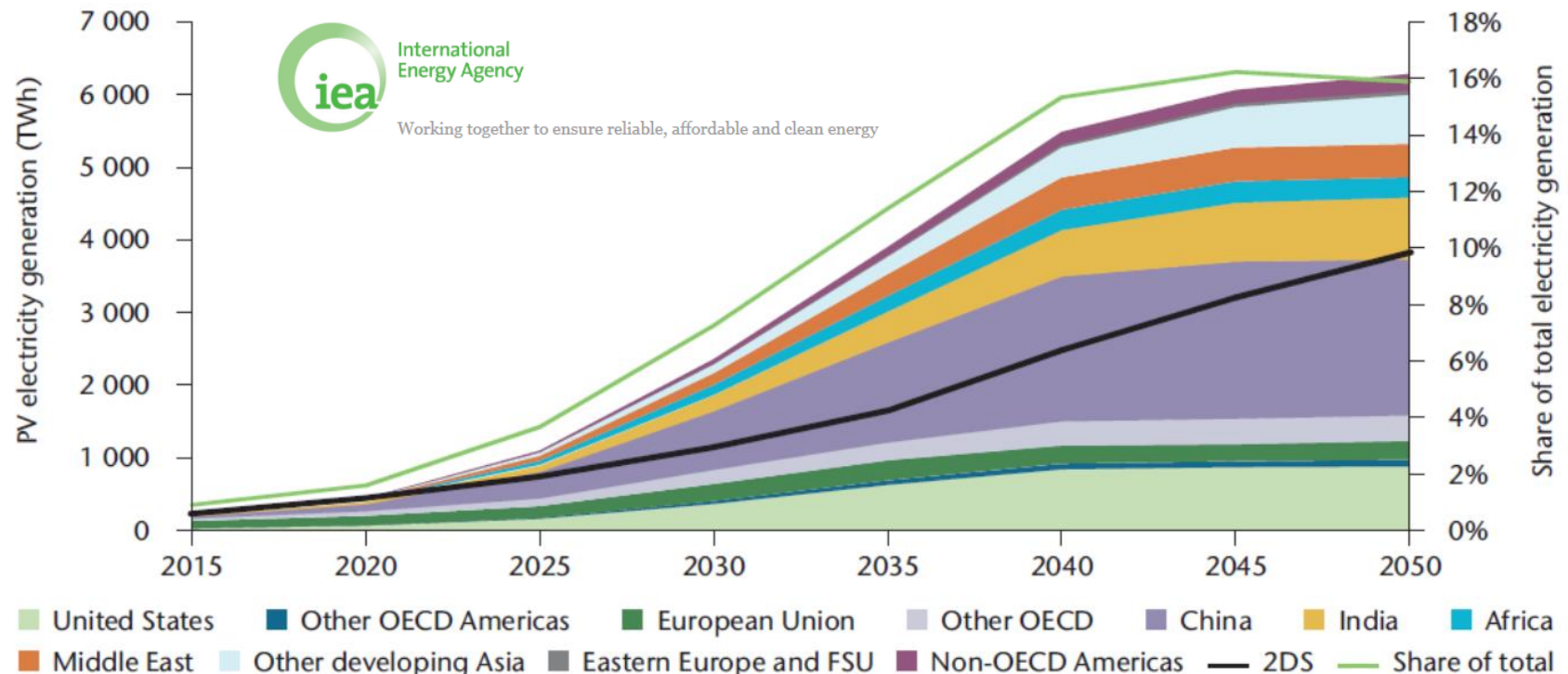


Curtailment of PV systems is now the „solution“, but ... until when?

Curtailments due to security reasons for RES in Germany:

6 days in 2010 and 142 days in 2013

... but electricity generated by RES should have the “feed-in priority”!

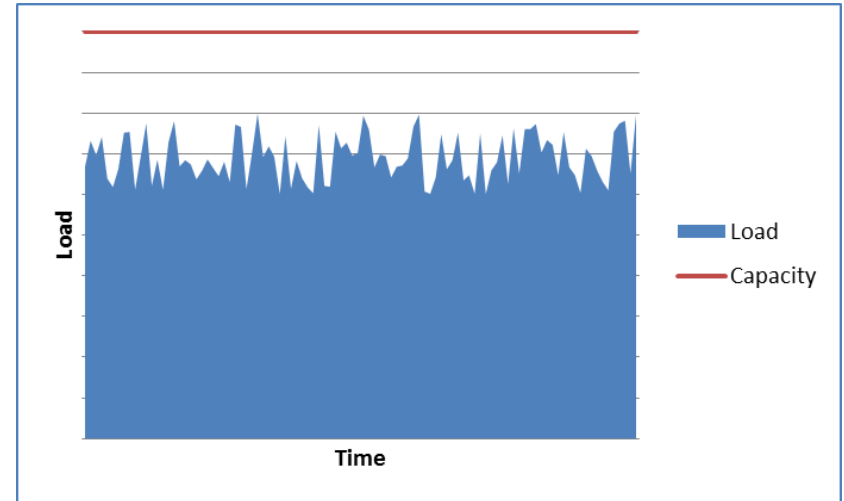
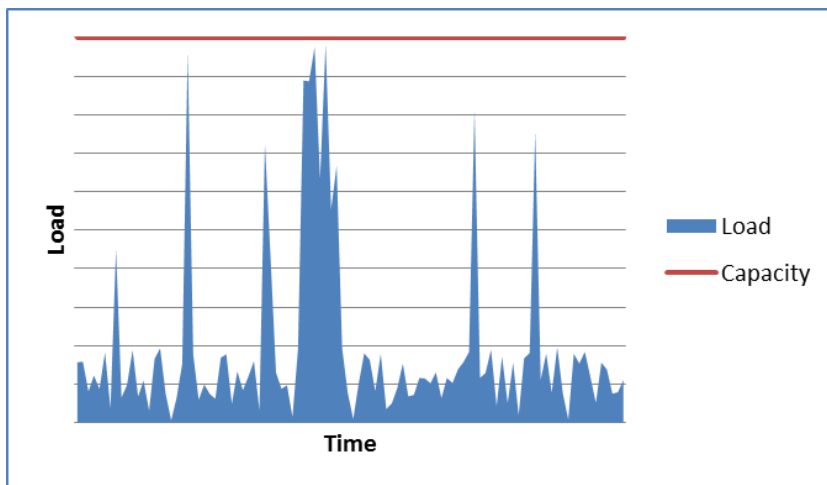


# THE „ORPHEUS“ SOLUTION



## Today

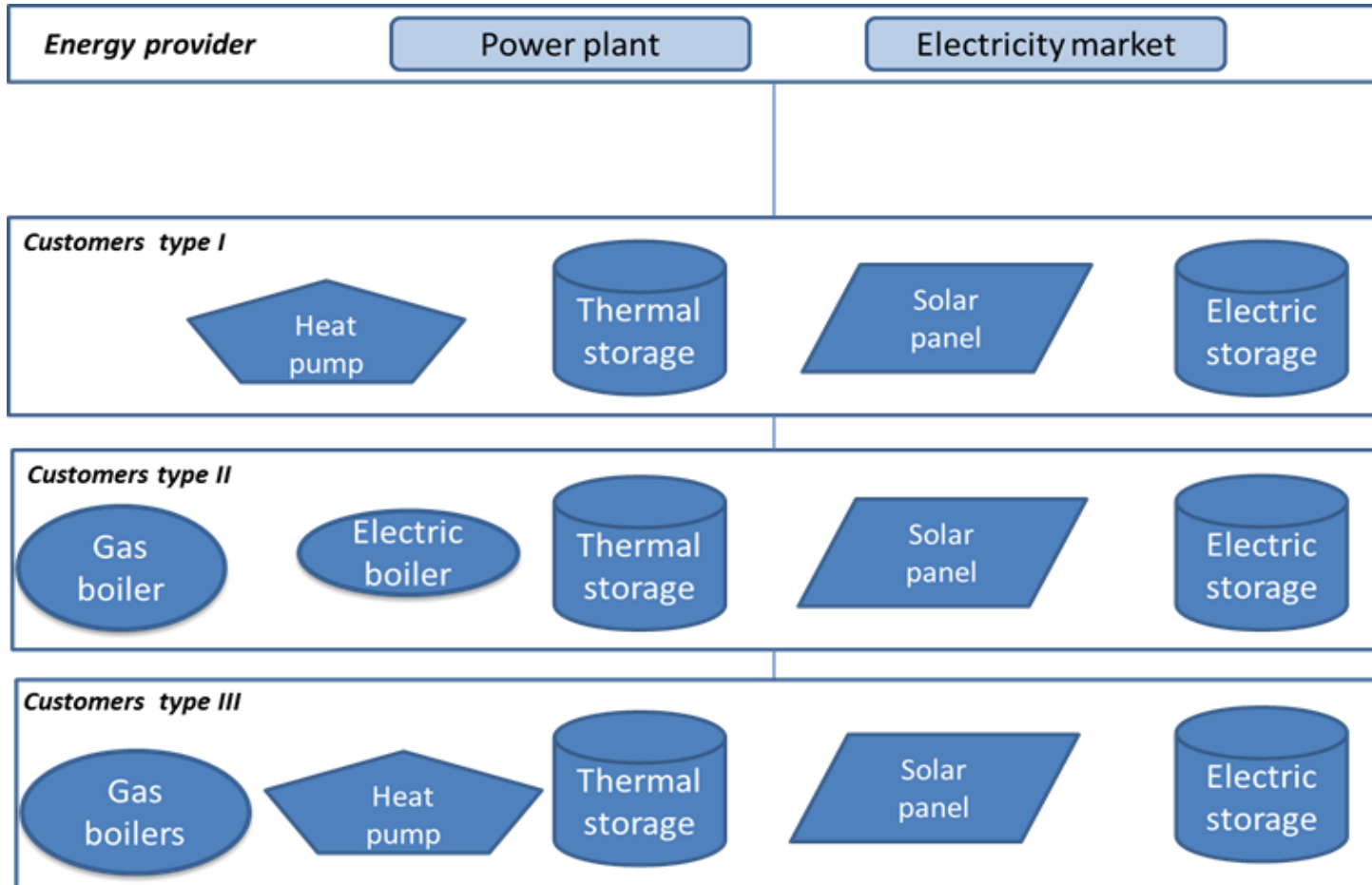
Challenging/undesirable load factor of an energy distribution network



Convenient/desirable load factor of an energy distribution network

## Tomorrow

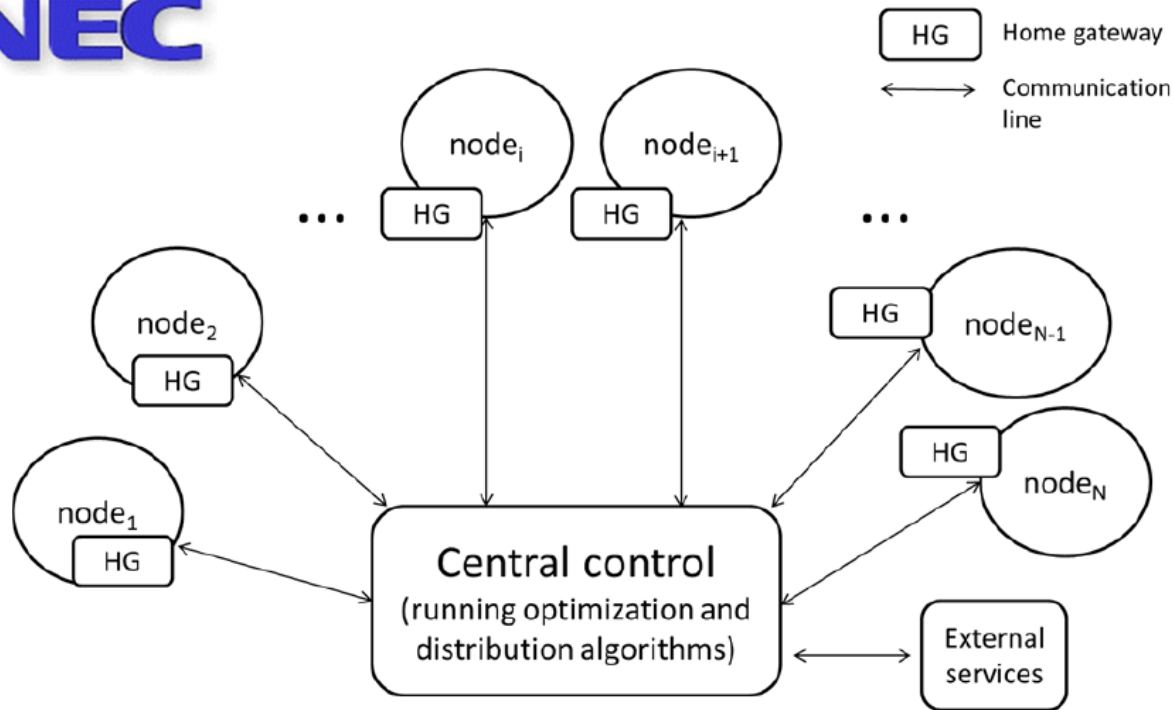
# GREEN COMMUNITY SET UP



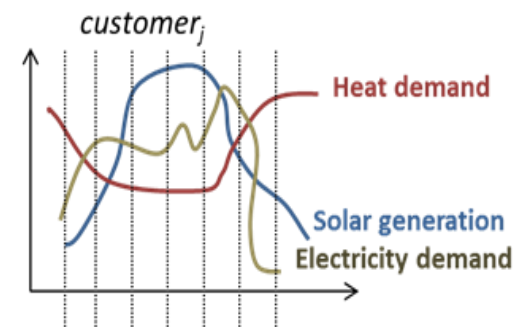
# GREEN COMMUNITY ALGORITHM



NEC



The central control (server) performs the optimization and distributes storage operation instructions to the nodes via communication infrastructure.





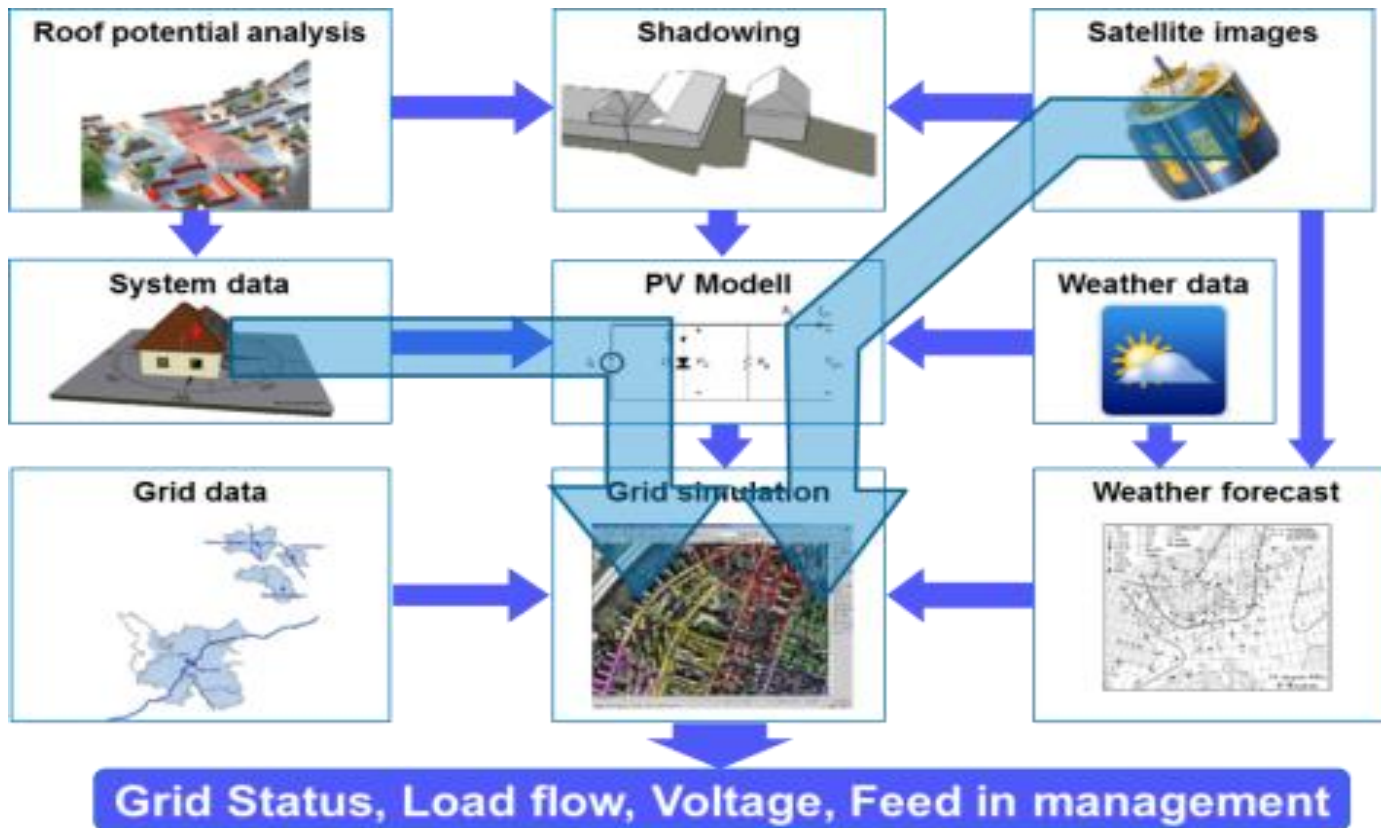
# HOW DOES “GREEN COMMUNITY” WORK?



In order to perform the optimisation, the central control:

- is in charge of obtaining the weather forecast needed to predict both types of load and renewable energy generation for the community
- obtains energy pricing information
- is aware of the electric energy flows between each nodes and the rest of the grid and between the community and the rest of the grid

# WHAT DOES “GREEN COMMUNITY” NEED?



„We are driving a car with black windows“.

This is what we are doing at the low voltage level today, since until now only few data from the low voltage level have been collected.

# CONCLUSIONS



Three cooperative control strategies for hybrid energy grids have been developed (cooperative green supplier, carbon free heating and green community).

Focusing on the “green community” control strategy, this is done by:

- Simultaneous control of multiple energy systems through ICT
- High resolution predictions of demand of multiple energy carriers and production of uncontrollable energy sources
- Interconnection of previously unlinked systems such as **heat demand with electricity overproduction** in order to use locally renewable energy and **balance the local energy load with renewable energy generation avoiding curtailment of RES!**

# CONTACT



## Project coordinator

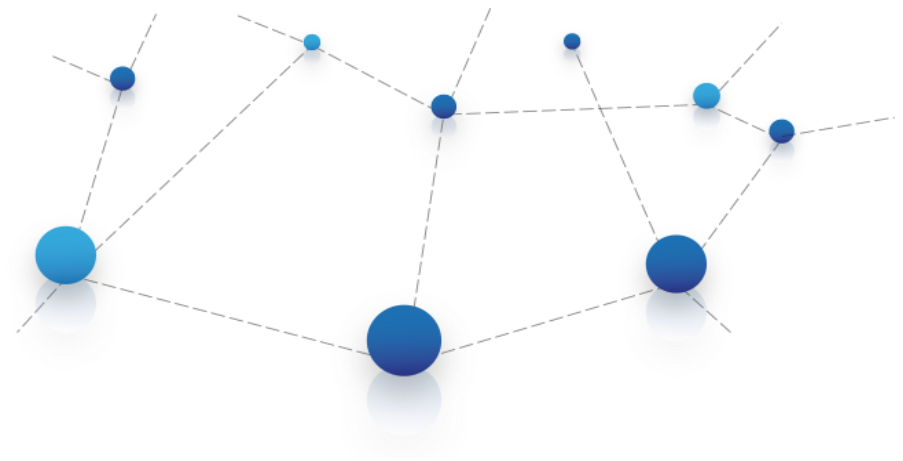
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# Thank you.



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