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Joint Research Centre

Energy self-consumption and regulation schemes

How to build Smart Energy Regions

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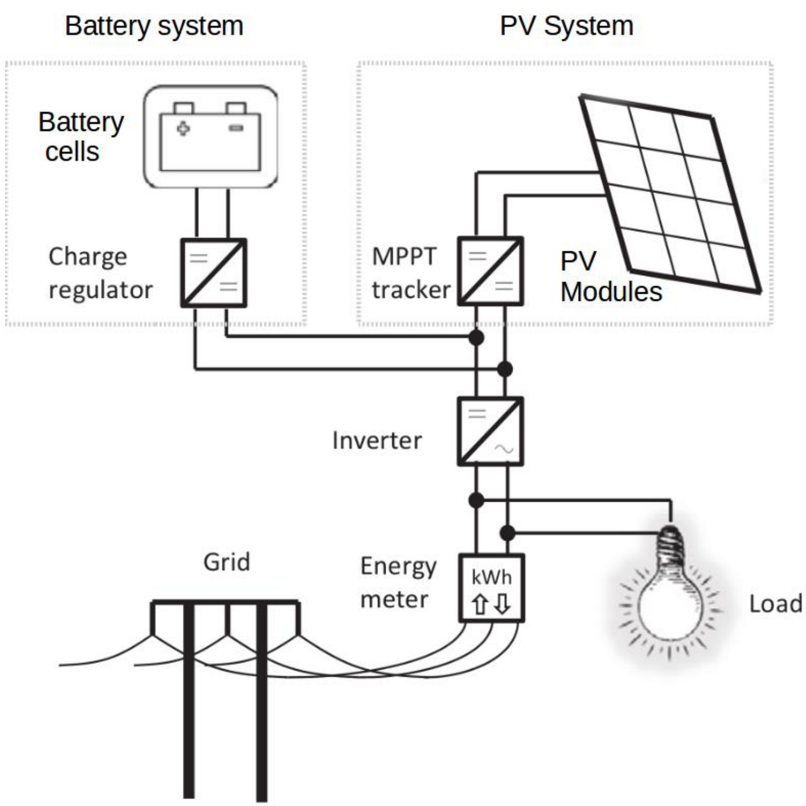
Knowledge for Energy Union, DG JRC

Content

- Concept
- Technical boundary conditions
- Economics

What could be the role of solar home battery systems?



Is it profitable for the end-users?

Is it beneficial for the system?

How much self-consumption?

Is it possible to go off-grid?

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Energy home storage systems are available on the market

Example: Tesla PowerWall

- **Gross capacity**: 7 kWh
- **Available capacity**: 6.4 kWh
- **Round-trip efficiency**: 92.5%
- **Warranty**: 10 years
- **Wholesale price** (US): $3000
  - *No taxes*
  - *No power electronics*
  - *No installation*
- **Turn-key price** (BE): 7000€[1]

1) Source: http://www.nieuwsblad.be/cnt/dmf20160317_02187821

At first sight, self-consumption plus storage is not economically viable

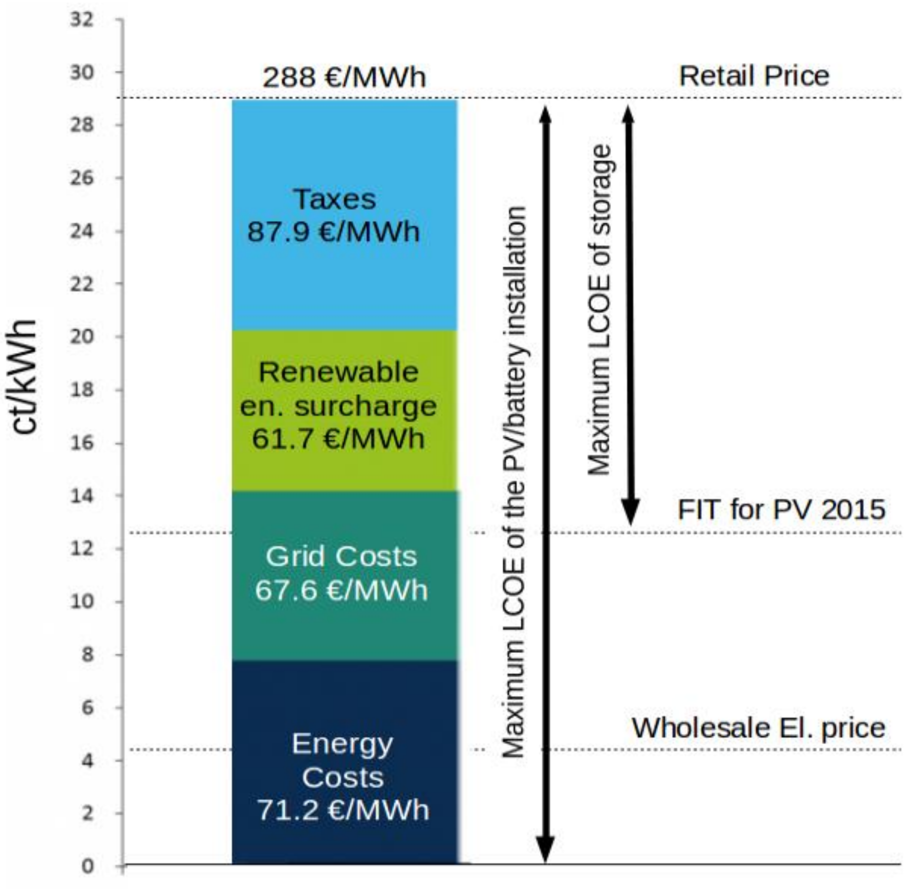
A simplistic calculation for Belgium

- *Lifetime and battery cost:*
  10 years, 7000€
- *Yearly cost for the battery:* ***700 €/an***
- *Consumption of an average household:*
  3500 kWh, 0.2 €/kWh
- *Yearly electricity bill:* ***700 €/an***

Current yearly battery costs are equal to the average electricity bill thus further cost reductions are required!

Storage could become attractive in case of high retail prices

Example: Retail tariff structure in Germany



One kWh stored:

- Is not fed to the grid
  => ~12 ct lost
- Avoids buying 1 kWh from the grid
  => ~29 ct saved
- The cost of stored kWh should be lower than the difference
  => ~17 ct

This difference heavily depends on exemption of self-consumed energy from grid fees, taxes and surcharges!

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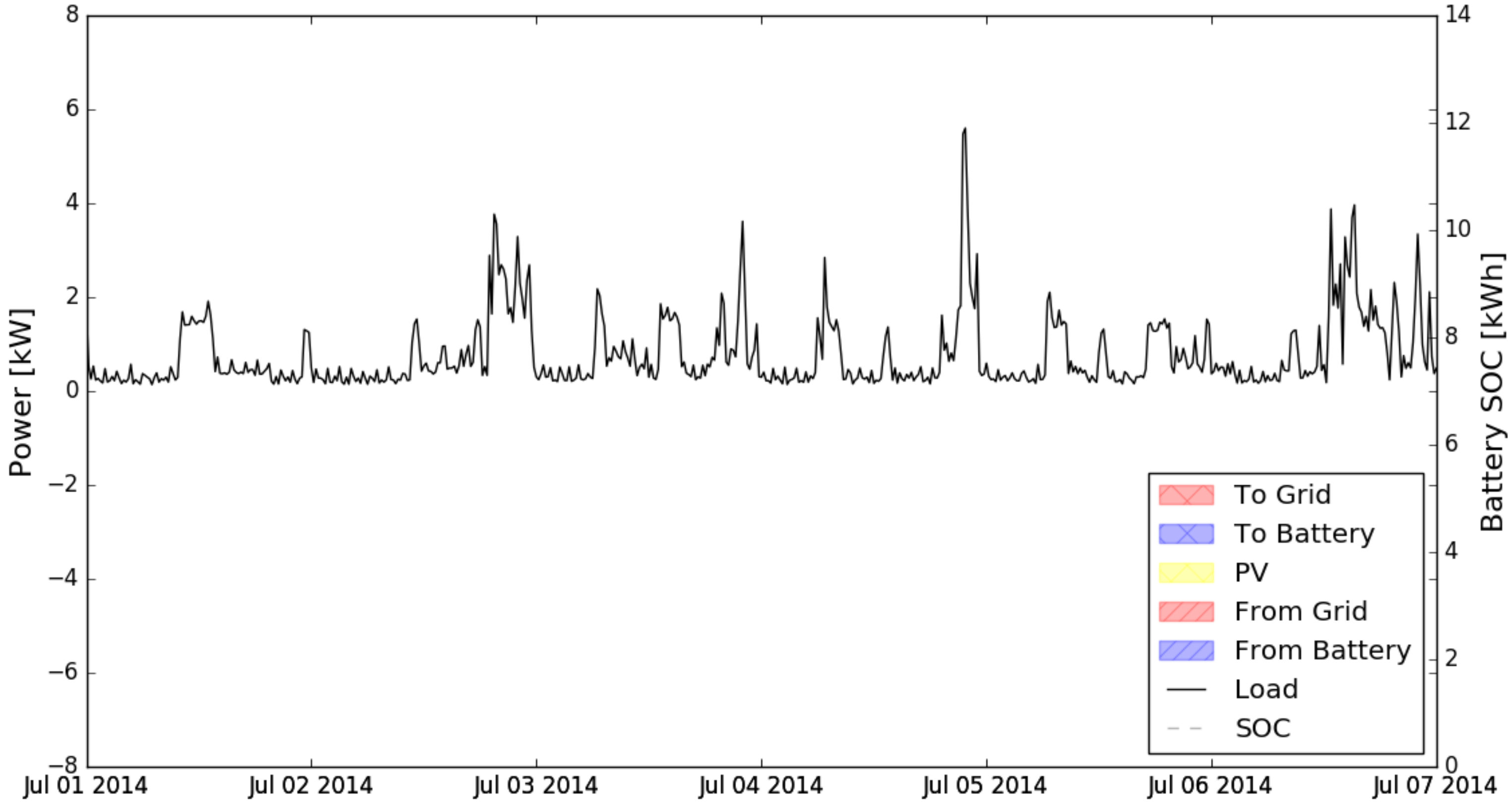
Evaluating Self-Consumption for a single household

Evaluating Self-Consumption levels



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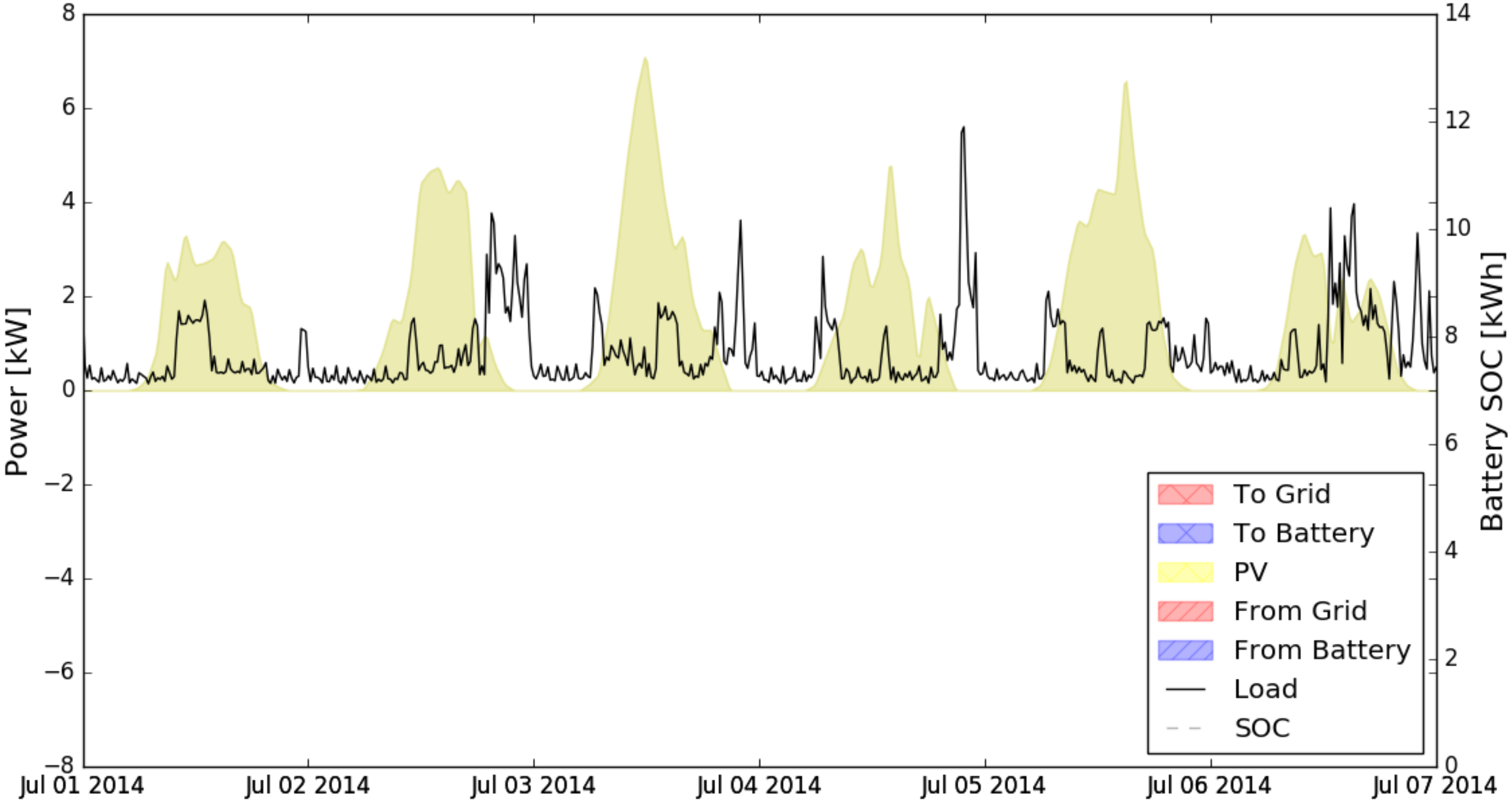
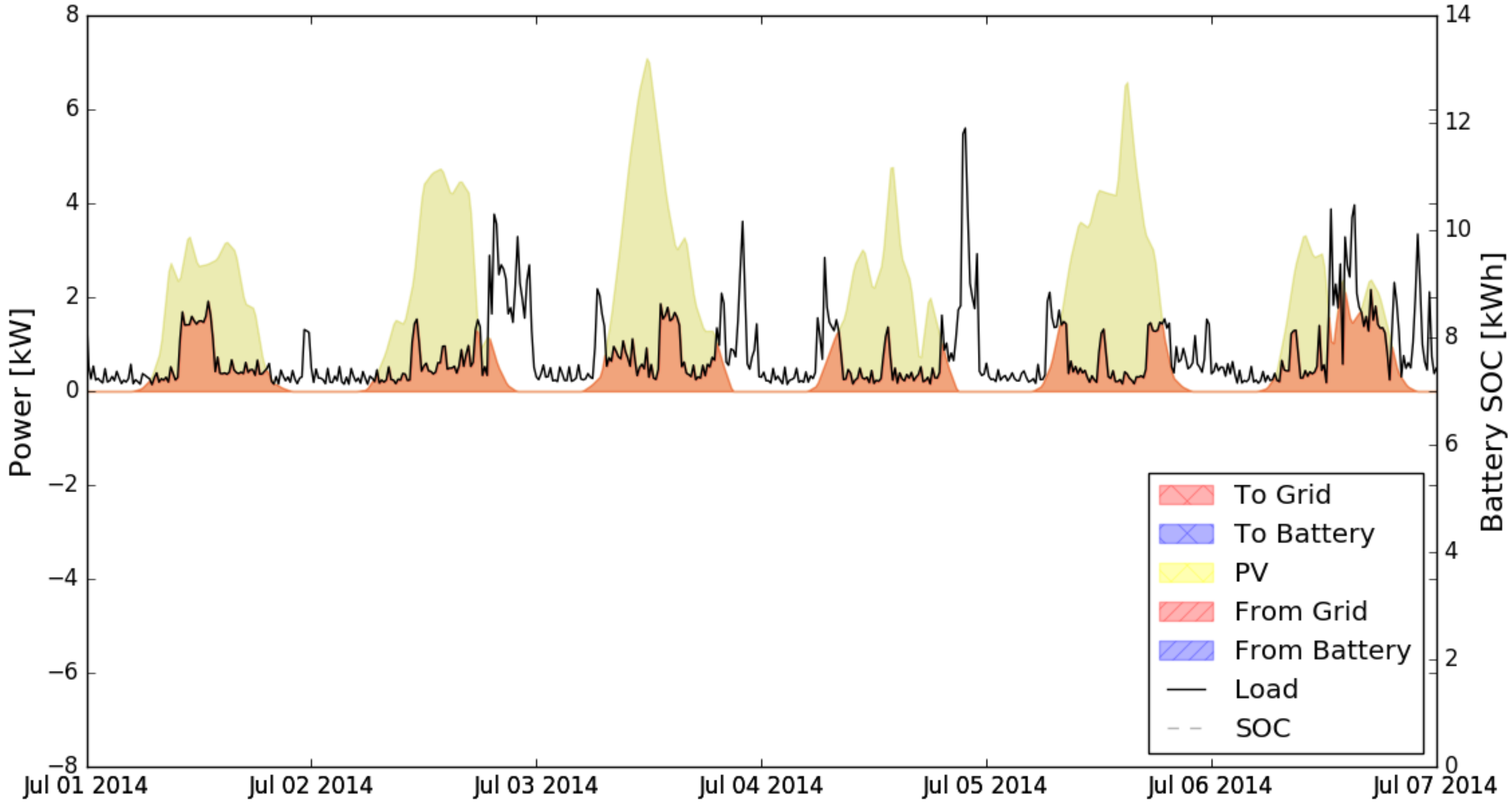
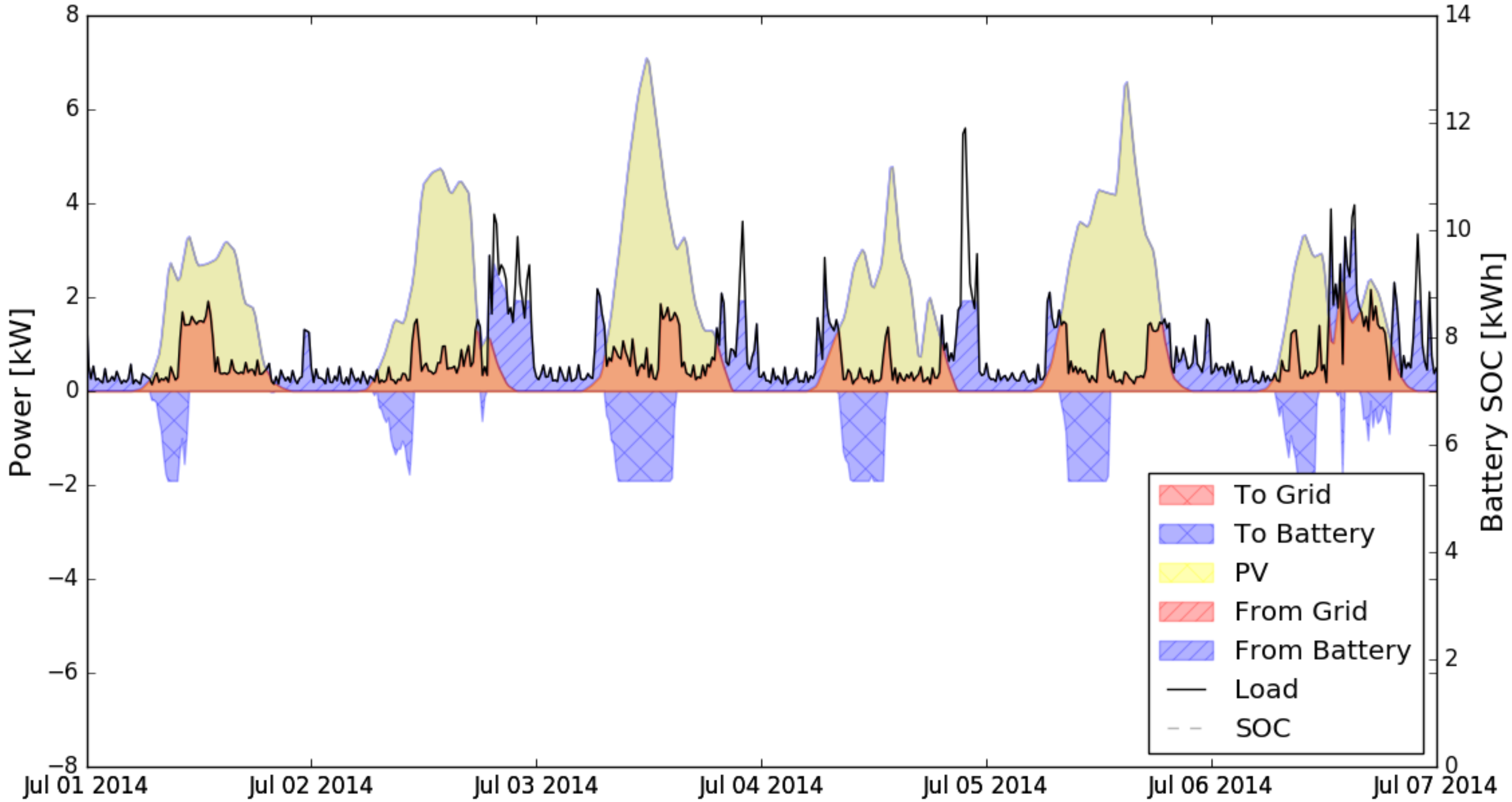
Evaluating Self-Consumption levels



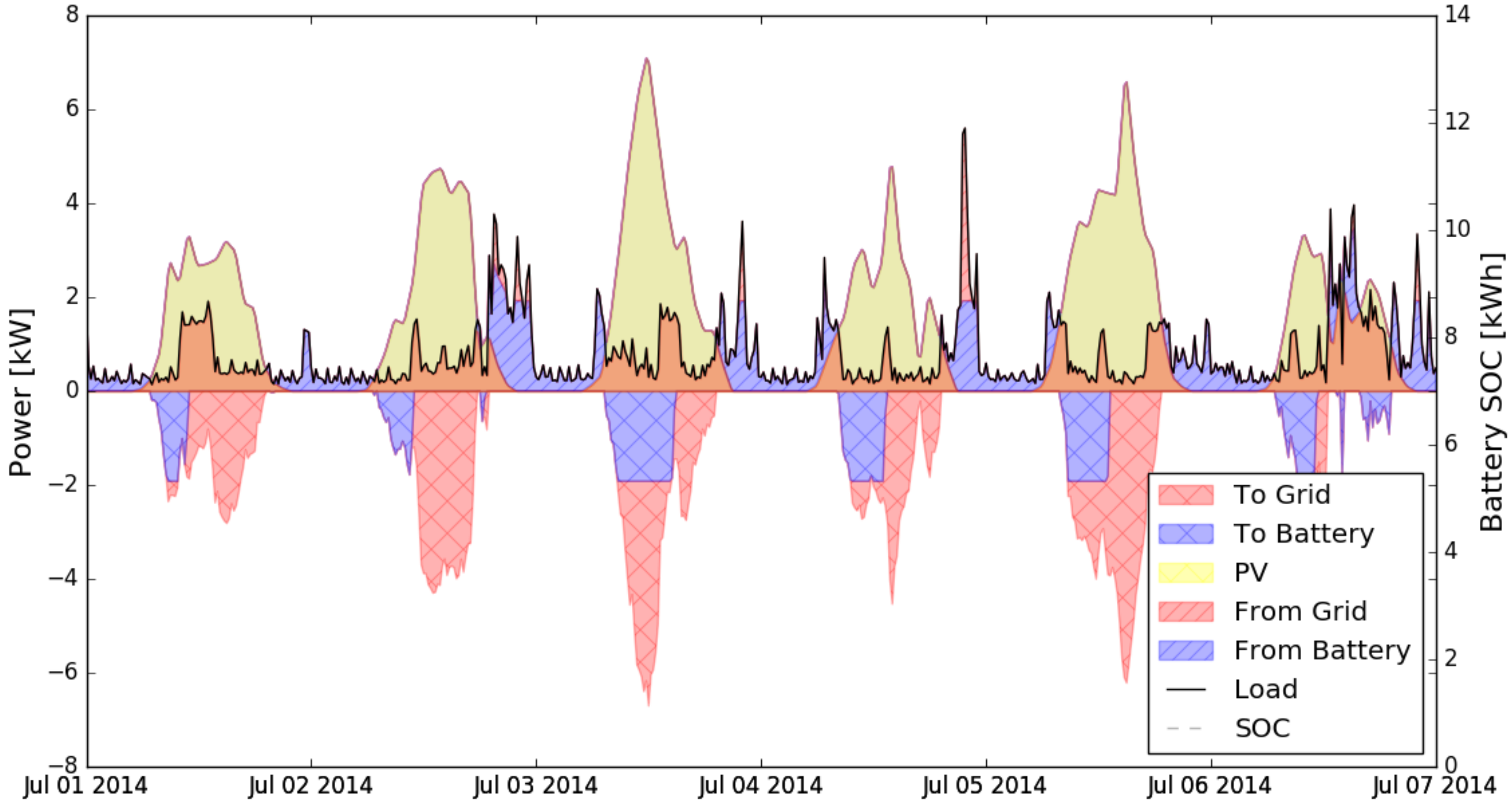
Evaluating Self-Consumption levels



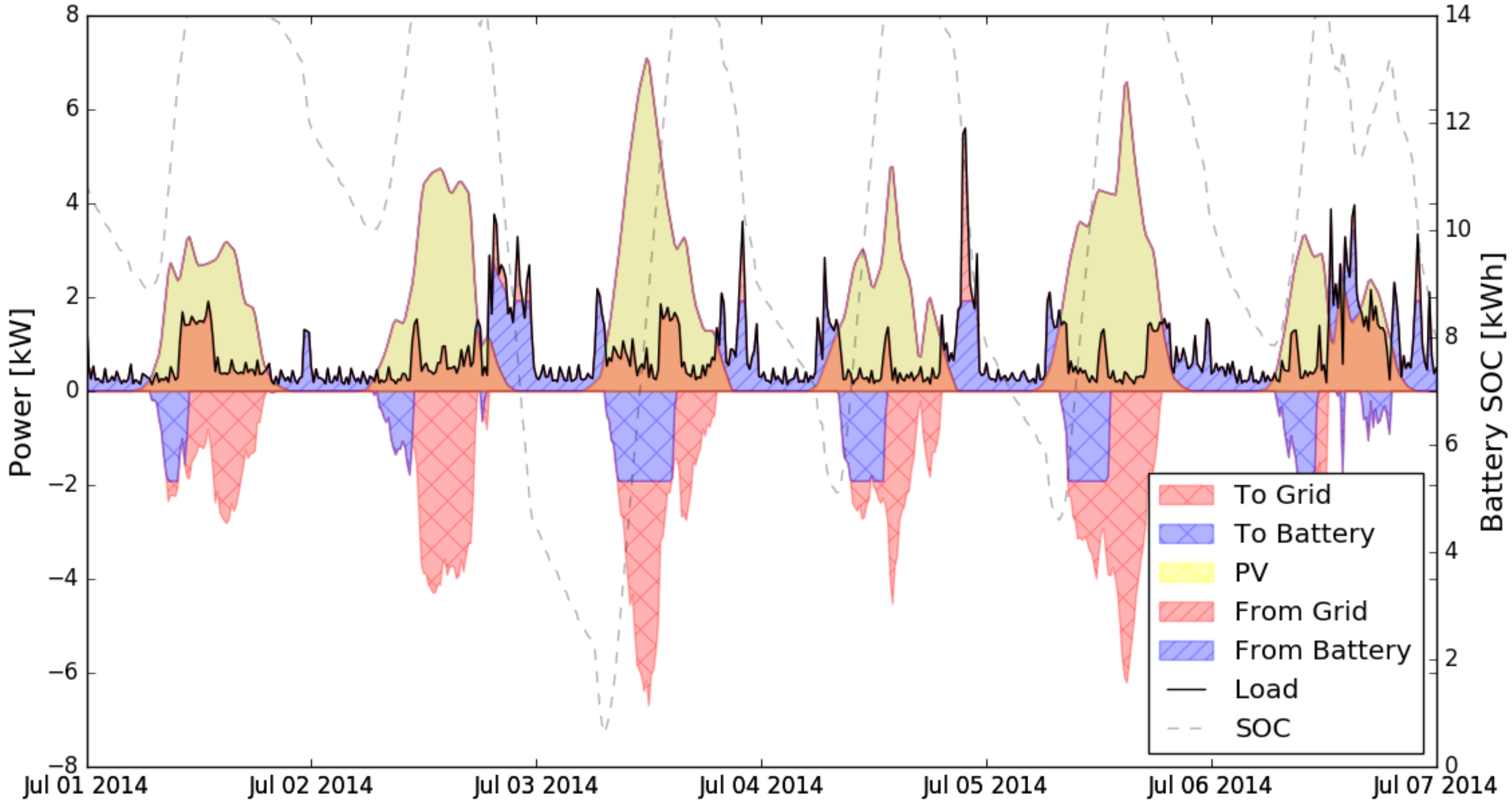
Evaluating Self-Consumption levels



Evaluating Self-Consumption levels



Evaluating Self-Consumption levels



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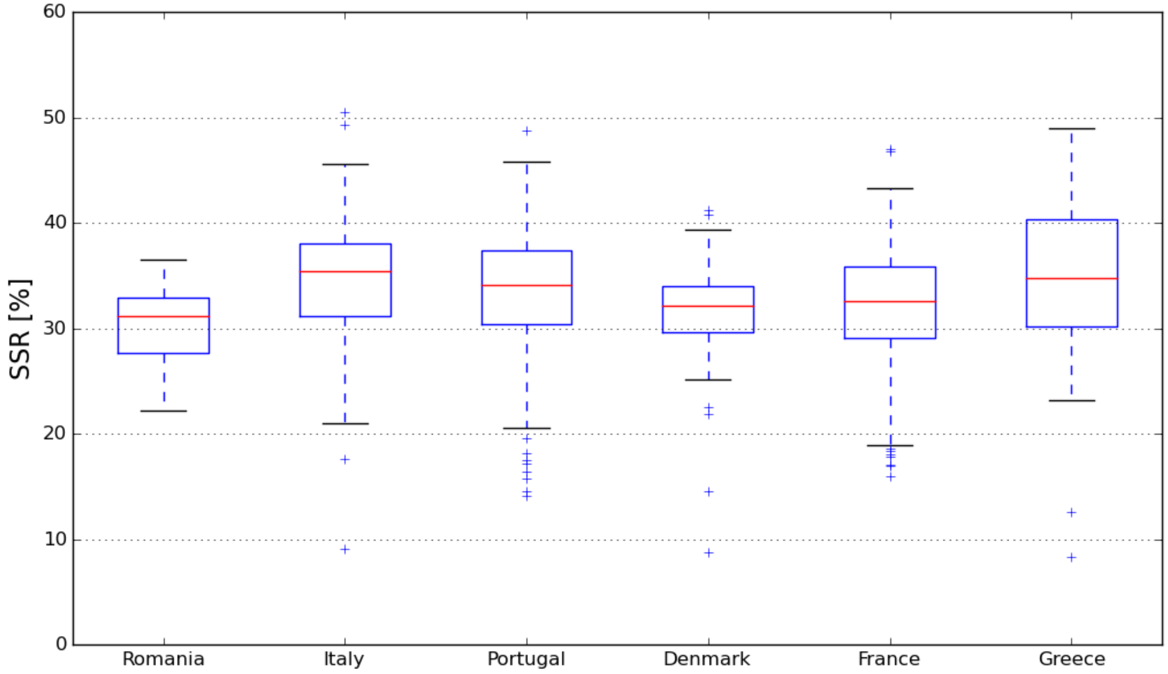
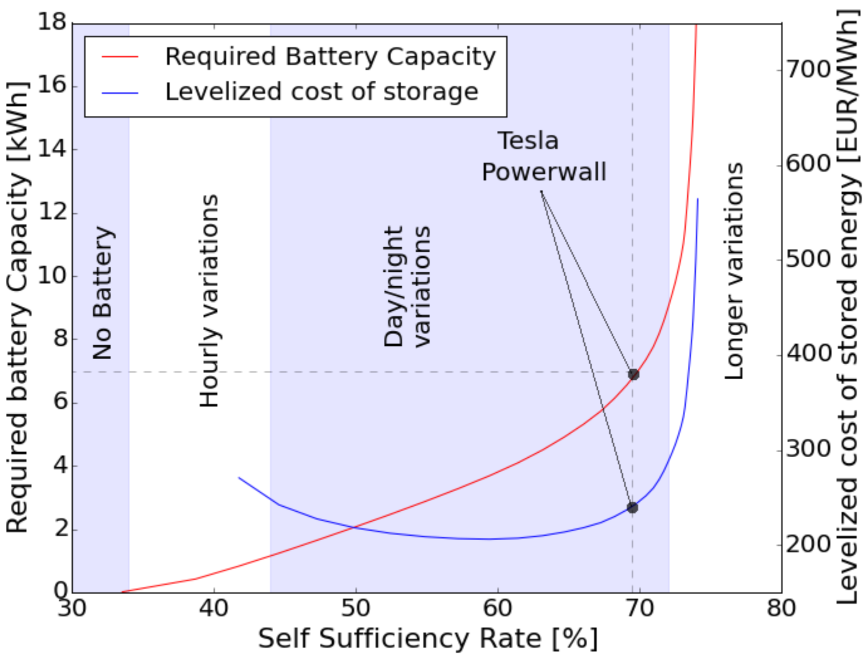
The PV self-sufficiency rate is relatively constant across Europe



- *Study performed for 987 households in 5 different EU countries*
- *High variability between households*
- *30 to 35% self-sufficiency without battery*

Deployment of batteries increases the self-sufficiency rate

Required capacity and costs as a function of self-sufficiency rate[1]



- Self-sufficiency of 30% in absence of batteries increases to 70% if 10kWh battery deployed
- Size and costs increase sharply when trying to increase self-sufficiency beyond 70%
- Costs also increase when undersizing the battery due to fixed costs (installation, cables)

Prosumers will likely not abandon the power grid, but they will underutilize it

1) Analysis, based on real household consumption and PV production profiles for Belgium

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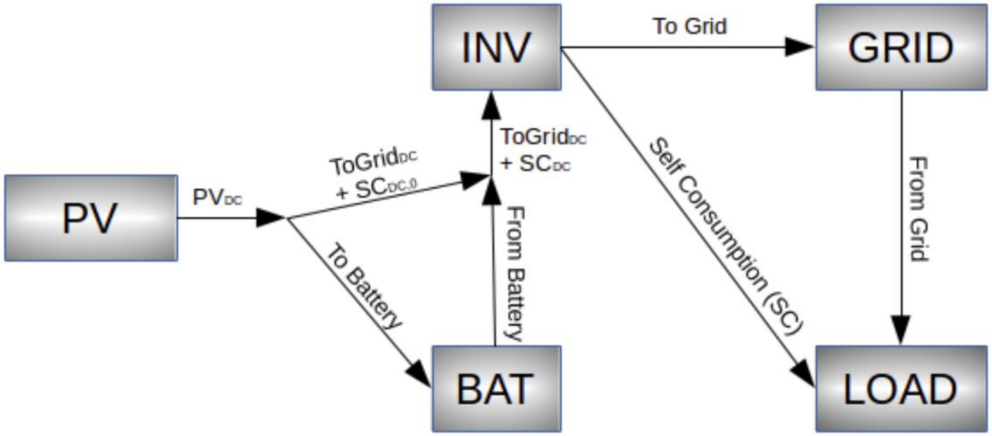
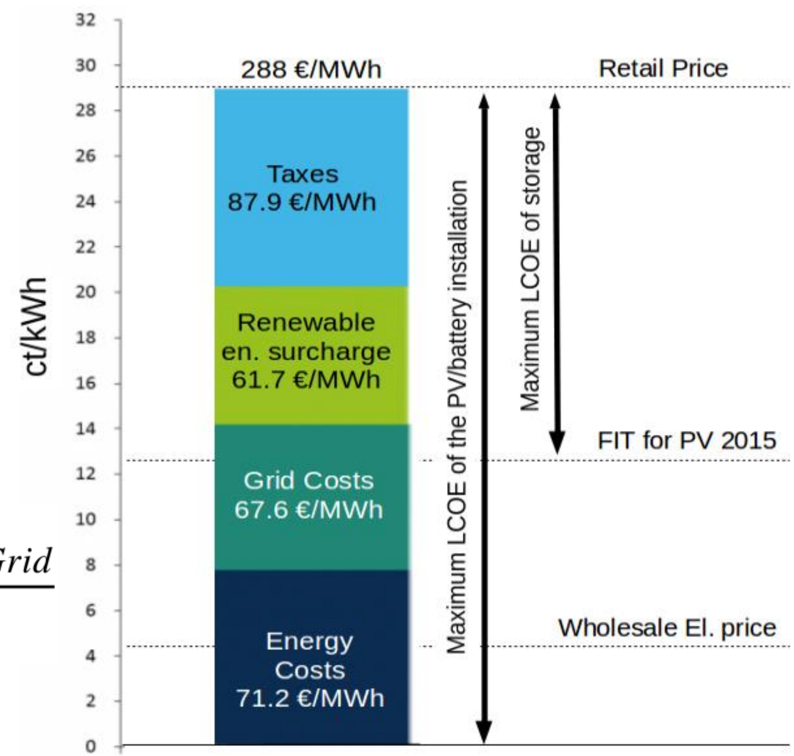
Economic evaluation of PV/battery systems

Economic indicators

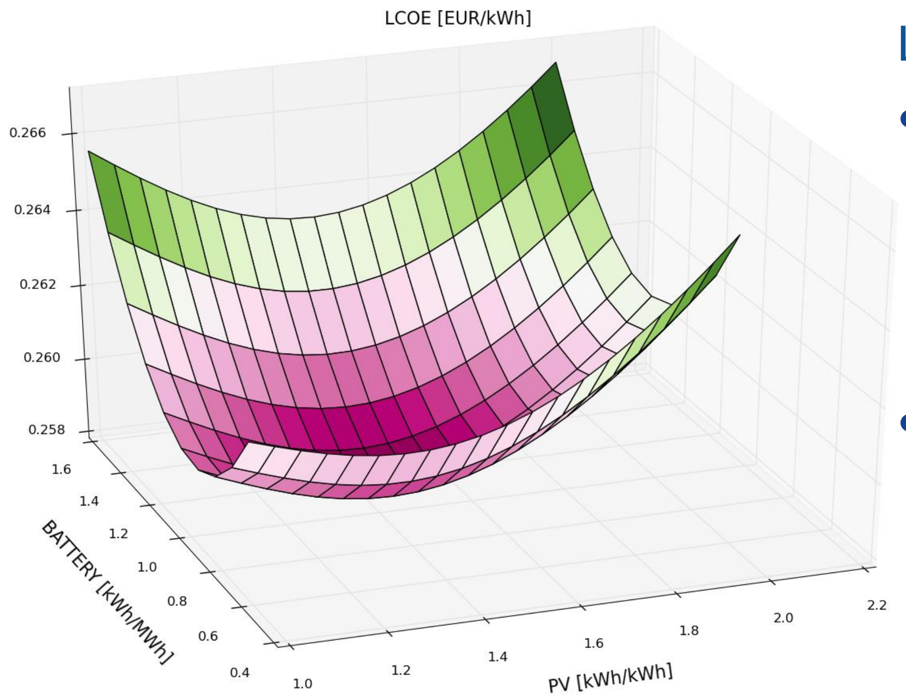


$$LCOE = \frac{A + E_{FromGrid} \cdot P_{Retail} - E_{ToGrid} \cdot P_{ToGrid}}{E_{load}}$$

$$LCOS = \frac{A_{bat}}{E_{FromBat} \cdot \eta_{inv}}$$



PV and battery systems can be optimised for costs of electricity (LCOE)

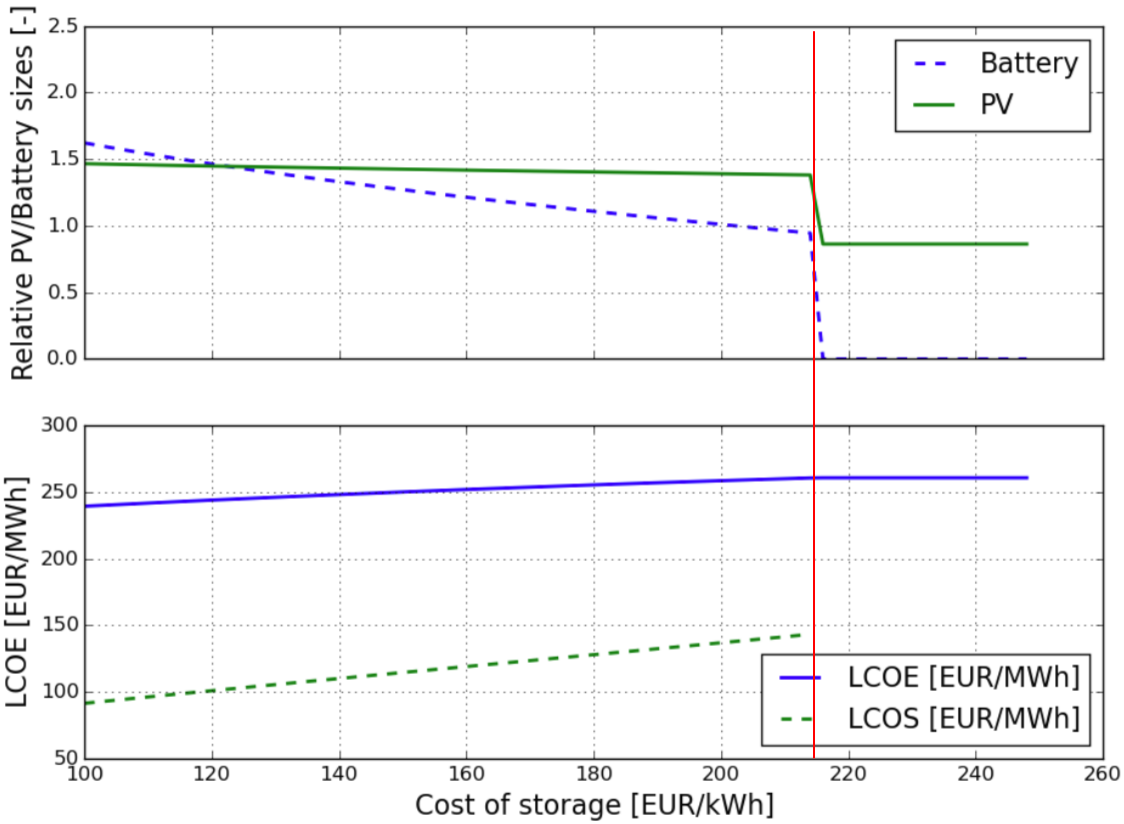


LCEO increase if

- Battery underutilised:
  Less than optimum PV for a given battery size leads higher costs of storage per energy produced.
- PV 'under-remunerated'
  more than optimum PV leads to more revenues from sales which are lower than buying prices.

There is a break-even price below which batteries lower energy costs

Relative size of battery, PV and LCOE as function of storage costs



- Break-even cost of the battery: 214 €/kWh for a fixed installation cost of 300€
- Optimum battery sizes increases (+60%) if prices fall further to 100 EUR/kWh
- 50% more PV panels in case with batteries
- Effect on electricity costs very small

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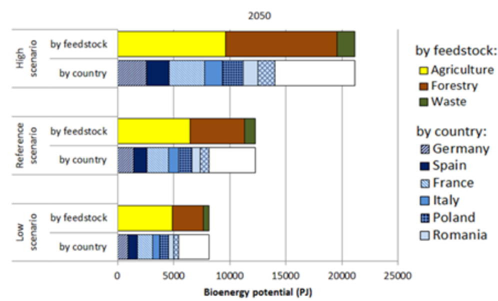
Conclusions

- Home batteries do not necessarily allow to go off-grid
- The profitability of self-consumption strongly depends on the retail tariff structure
- Taxes, levies and surcharges are key
- Home batteries are not profitable yet (but they might be bought anyway)
- Electricity prices (retail) could keep increasing, and battery costs decreasing

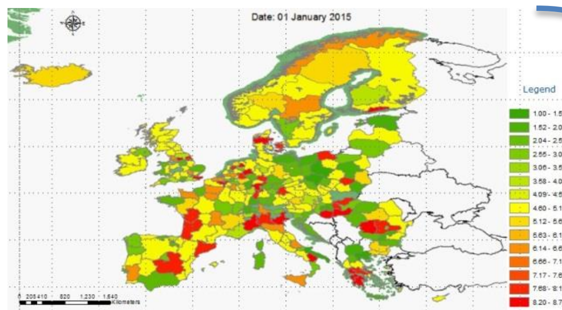
The JRC develops open datasets allowing transparent assessments

JRC datasets

RES-E potentials
Potentials and cost curves for biomass, solar and wind energy at NUTS 2 level



JRC EMHIRES
30 yrs of wind and PV hourly generation time series at NUTS 2 level



JRC EPPD
Full set of technical power plant data (MW, efficiencies, ramps...)

Typical applications

- Long term energy system studies
- Energy system transitions

- RES-E integration
- Generation adequacy
- Power system flexibility and storage needs
- Power market design
- Network expansion
- …

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