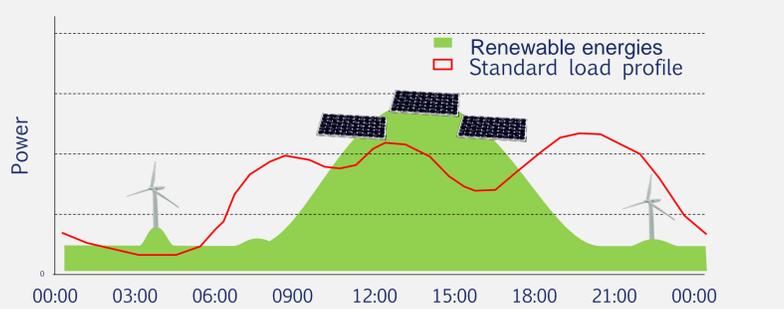


Real-time, decentralized automation Smart grid for islands and isolated grids

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The Challenge

The **variable** sun and wind energy depend on weather, causing a mismatch between generation and consumption.



As volatile generation grows, integration becomes difficult. To avoid its curtailing (switching it off), two alternatives exist:

- Energy storage
- Demand side management DSM/Load shifting (economical solution)

The Approach

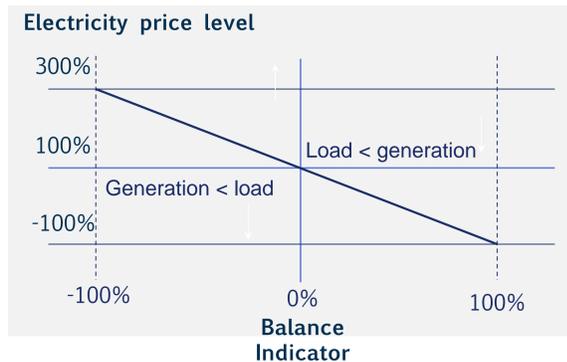


The basis of our solution is an innovative technology to keep **grid balance** under control by creating a market environment based on grid state variables.

- System reacts immediately (real-time)
- Energy infrastructure provides communication platform (no need for dedicated communication infrastructure)
- High resilience, easy to maintain

Balance indicator shows mismatch between generation and load

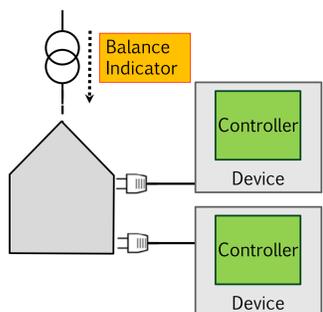
- Use customers flexibility
- **Dynamic prices** enable and incentivize customers to use electricity efficiently.
- Customer flexibility supports grid with "virtual batteries".



Our Solution

A combination of different components:

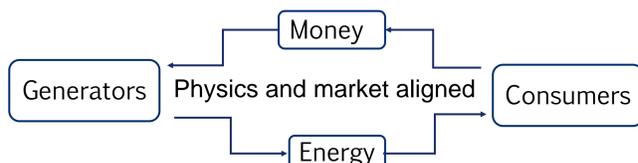
1 Smart controller



Algorithms are integrated into control hardware. Electricity price is interpreted by the algorithm, along with other variables such as the minimum operating time, to decide if energy is best used now, or **consumption is shifted**.

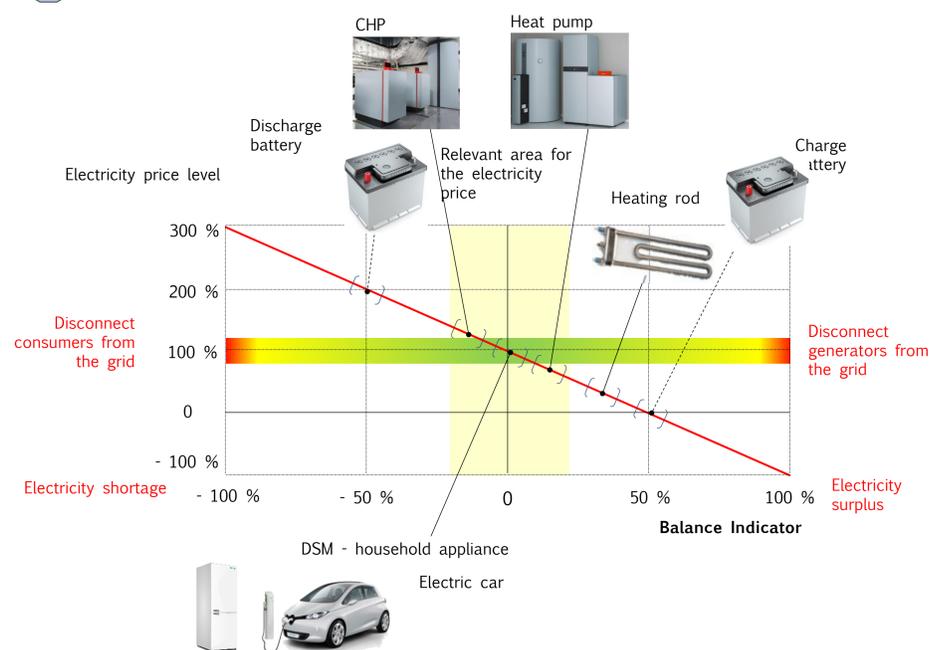
Smart controllers actively compensate generation variability. They can also be used to help avoid grid congestion.

3 Extension of physical network to financial market



- Manage energy system with a **real time market**. Real time means gate closure times and trading slices in the seconds range.
- **Simplification** by integration of several market segments into one (day ahead, intra day, control power) to abolish market entry barriers.
- **Cost Reduction** for smartness/trading from 10-500 kW electric to 100 Watts, (even fridges can economically be integrated).

2 Automatic merit order



All devices shown participate in the market governed by the balance indicator. Each of them tries to operate in the range **most profitable** for its owner, by adapting its price preferences to achieve the service at lowest cost (or highest income). Fair pricing is thus ensured, and a "merit order" that integrates cheapest flexibility first.

The Potential

Flexibility is available broadly with great potential for savings as "virtual batteries".



- Pumping (water desalination, processing, supply) in combination with reservoirs and tanks

- Cooling (buildings, food, ice making for fishery)



- Heating (building, industry), both with heat pumps and CHP in combination with thermal storage

- Electric cars (just charging, or even V2G)



- Household goods (washing, cooling, freezing)

The Environment

Favorable framework conditions.

- 15 Mill. Citizens on 2,700 European islands,
- 740 Mill. Citizens on 85,000 islands w/w

High subsidies needed for fossil energy on islands

Spain	13 Bill €/a
France	1,7 Bill €/a
Greece	1,3 Bill €/a



- Support packages (EU: H2020, cleaner & cheaper energy for islands)
- Successful island solutions can help transform large grids (mini/cellular grids)