Demand-Side Management to the Grid Integration of Renewable Resources

Energy Saving Information Platform (ENERsip)

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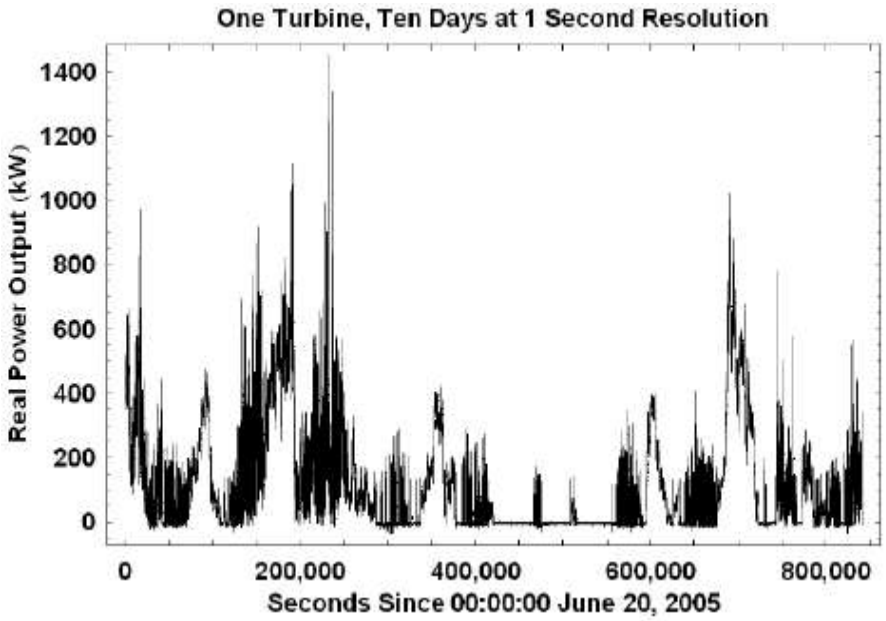
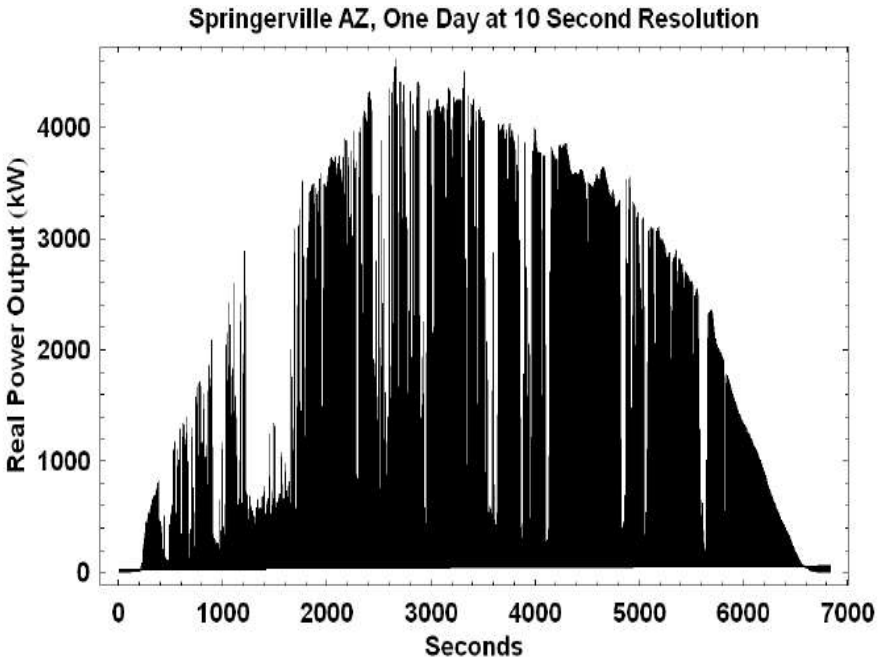
Wind Power Intermittence



Intermittence

- The output of wind power and solar is driven by environmental conditions outside the system operators and it is inherently variable.
- Supply of power from wind turbines is stochastic in nature and is more or less proportional to the third power of the wind velocity.
- Unlike conventional capacity, wind-generated electricity cannot be reliably dispatched or perfectly forecasted, and exhibits significant temporal variability.

Solar Power Intermittence



Intermittence

- The output of solar power is driven by environmental conditions outside the system operators and it is inherently variable (very large dP/dt).
- Supply of power from solar is stochastic in nature and is more or less proportional to solar radiation.
- Unlike conventional capacity, solar-generated electricity cannot be reliably dispatched or perfectly forecasted, and exhibits significant temporal variability.

Options for Managing Intermittency

Intermittency Reduction

- Grid integration
- Technical distribution of the generators
- Geographic distribution of the generators
- Improved forecasting techniques

Flexible Capacity Reserve

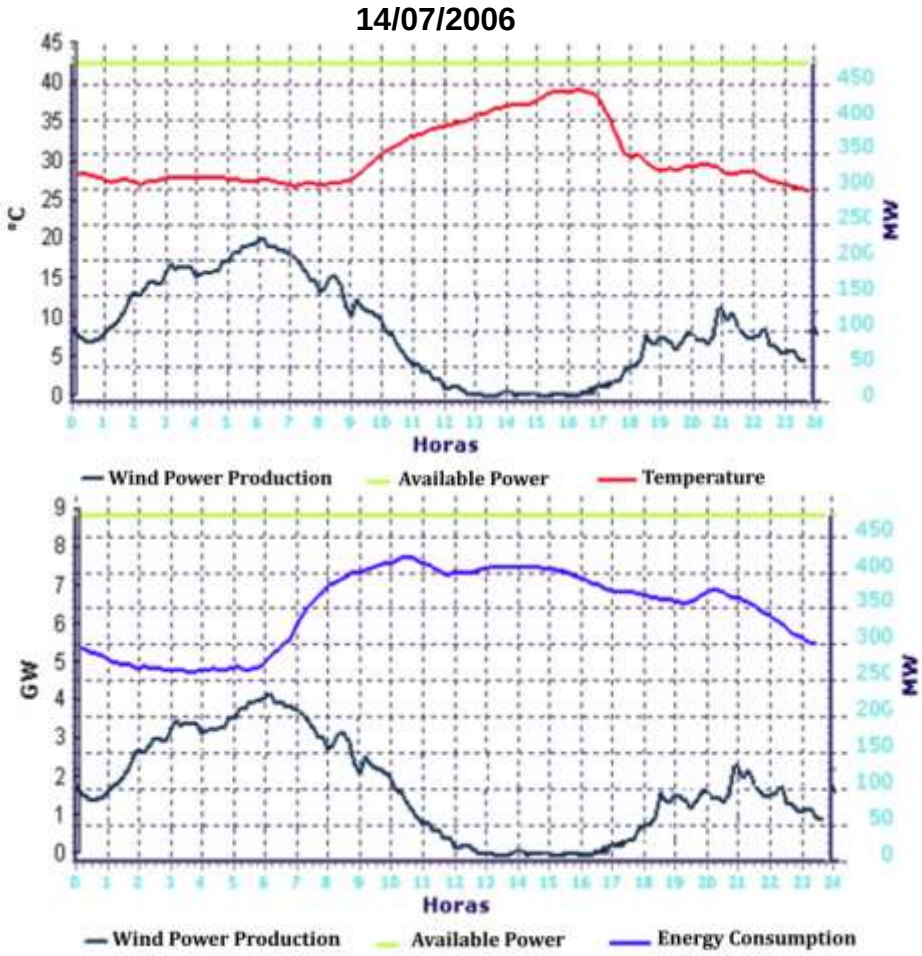
- Power plants providing operational and capacity reserve
- Interconnection with other grids
- Curtailment of intermittent technology
- Dispatchable distributed generation
- Energy storage
- Complementarily between renewable sources
- ***Demand-side management***
- ***Demand response***

Demand-Side Management

DSM

- Rather than attempting to match power generation to consumer demand, the philosophy of load management takes action to vary the load to match the power available.
- As far as security of supply is concerned, the most severe problems due to the wind-solar power intermittence occur in the peak load hours.
- The simultaneous occurrence of a higher consumption and a low renewable power production will lead to reliability problems and higher operating costs.

Demand-Side Management



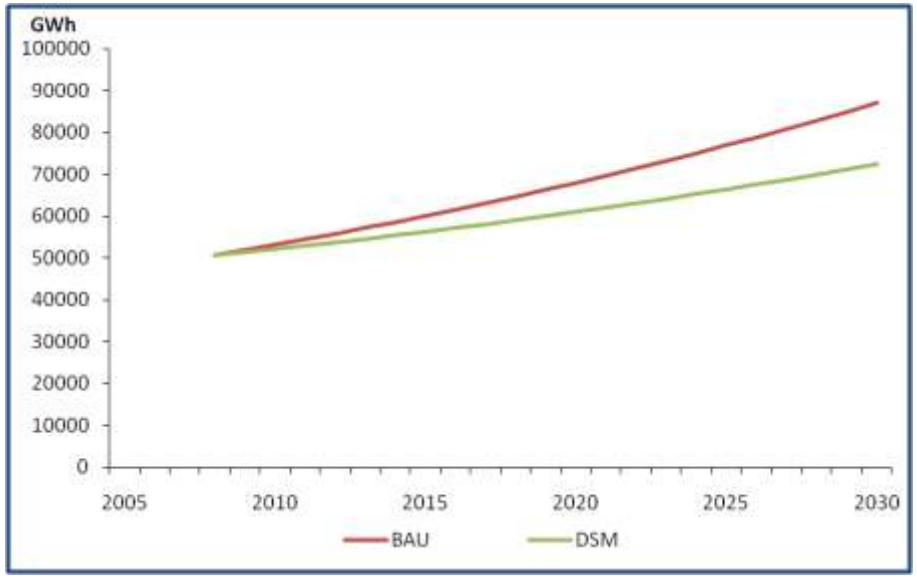
Consumption and Temperature

- Due to the higher peak load and wind availability, the sudden reductions of the wind power production can be more severe in winter days.
- On hot days the wind power production varies almost inversely relatively to the average temperature, whereas the energy consumption varies almost directly with the temperature.
- Instead of acting in the supply side, to avoid the most severe intermittent situations, the demand-side must be influenced in the direction of achieve consumption reductions.

Demand-Side Management

- Generically, any consumption reduction will contribute to mitigate the intermittence. With lower energy consumption, the installed power in renewable intermittent resources needed to meet the minimum renewable targets, will be lower.
- The most severe intermittence problems occurs during the peak load hours and thus the DSM measures with greater impact in such hours are of large importance.
- In cases of high renewable power penetration, the energy consumption reduction may not be enough. In such situations it will be very important to have Demand Response technologies to “force” consumption reductions at near real time.

DSM Impact

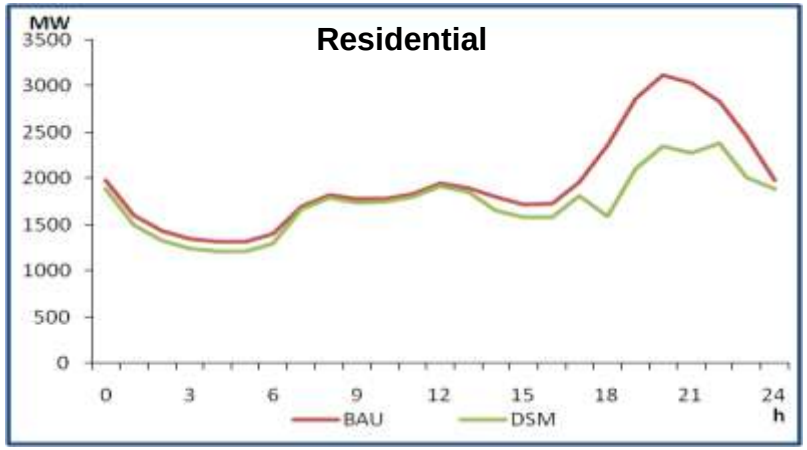


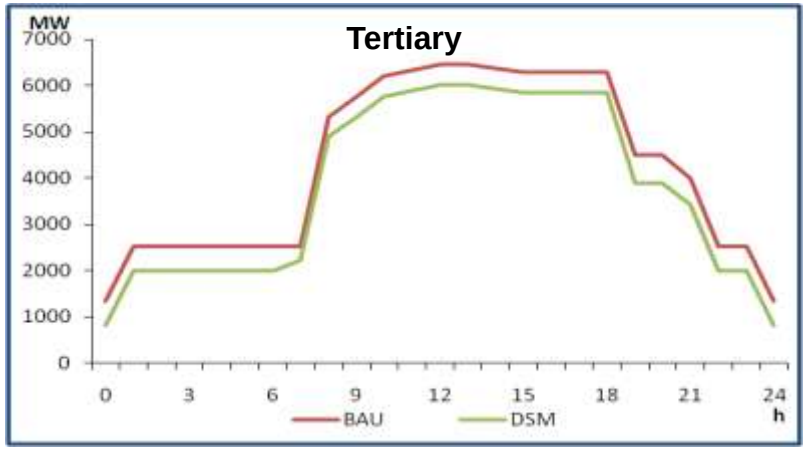
Measures Selection

- Taking as reference the electric energy consumption in Portugal, an evaluation of the consumption evolution was made, considering a BAU scenario (increase of 3%/year) and a scenario with DSM measures application (consumption reduction of 1%).
- The consumption reduction was divided between several measures for each sector, having as selection criterions: the cost-effectiveness, the application potential and the consumption reduction during the peak hours.

- The application of DSM measures can represent, in 2020, a consumption reduction of 10.3% relatively to the BAU scenario.
- For a renewable share, for instance of 50% of the generated energy, the DSM can reduce the needs of renewable power in 8.8%.

DSM Impact

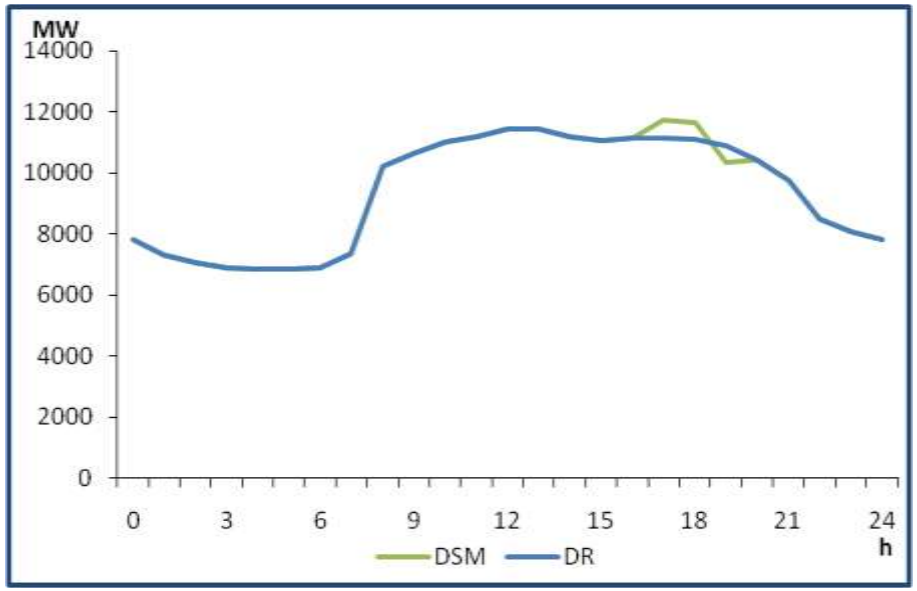




Sector Impact

- The load diagrams supplied by the transmission operator were used and updated for each year, by the relation between the consumptions to each sector.
- Taking into account the load diagrams of the sector disaggregated by loads, the variation for each load was transformed in a percentage variation and used to distribute the consumption reductions due to DSM measures along the load diagrams.
- The diagram of the DSM measures was subtracted, obtaining the BAU and DSM scenarios.

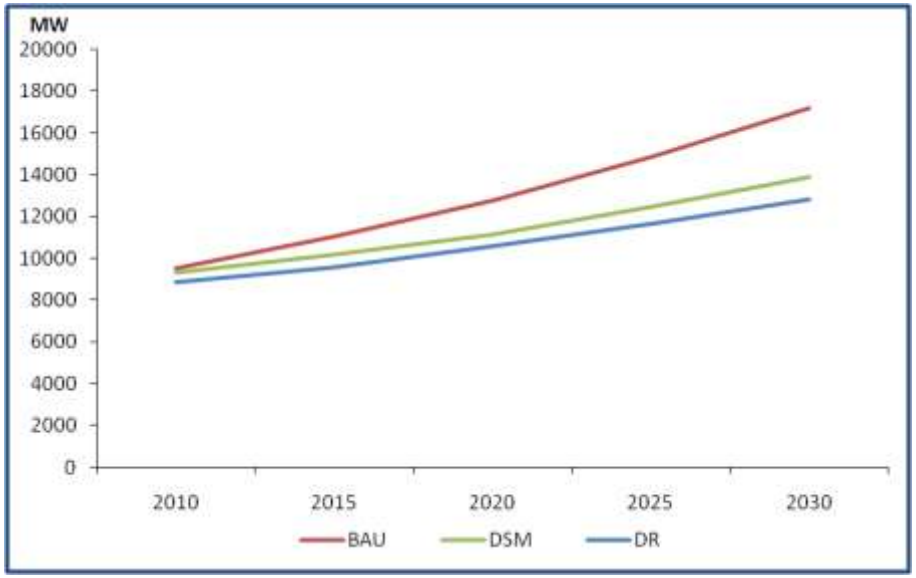
DSM Impact



Global Impact

- The global impact of the DSM measures in the Portuguese load diagram was evaluated, adding the impact of the three sectors.
- Additionally, controlling 5% of the peak load (nearly 490 MW) with DR technologies it is possible to smooth the loads diagram.
- With the aggregated action of the measures it will be possible to achieve a peak load reduction, in 2020 of 17.4%.

DSM Impact

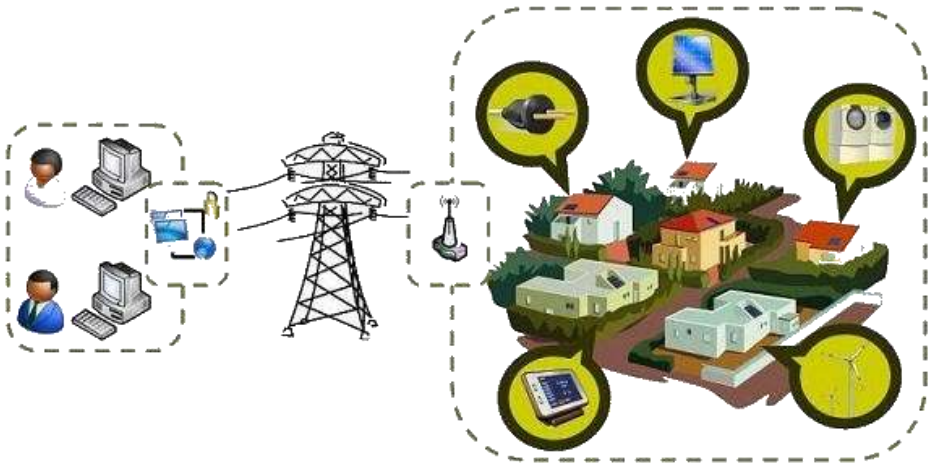


Peak Load

- The evolution of the peak load was estimated, for the scenarios BAU, DSM and DR and can be noted the increasing reduction of the peak load.
- Such situation will represent obvious benefits in the attenuation of the intermittence problems.
- It must be noted that such impact, caused by the DSM measures, is obtained with an average cost of 0.023 €/kWh, that is much less than the production cost of any renewable energy.

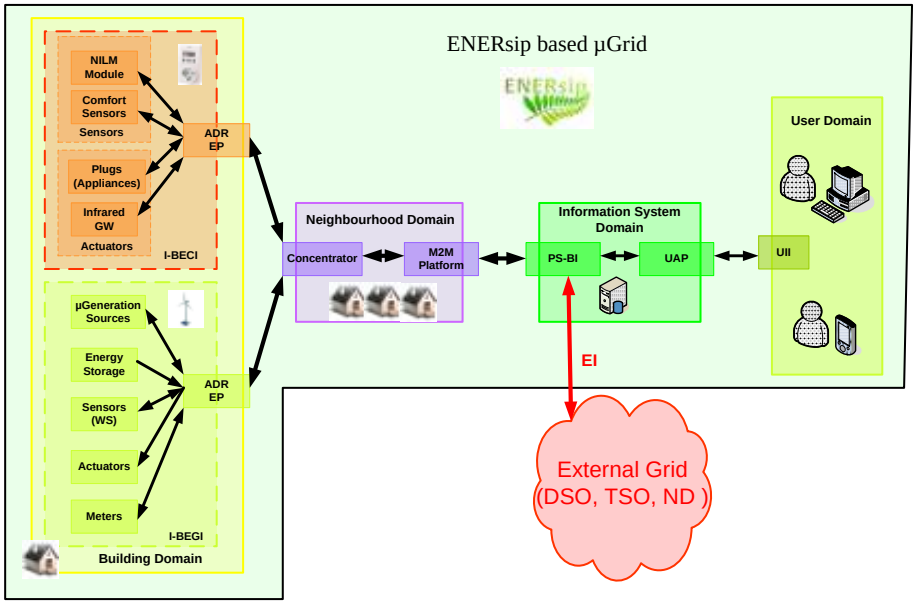
ENERsip Project

http://www.enersip-project.eu/



- The main goal of the ENERsip project is to design, develop and validate an adaptive, customizable, and service-oriented energy monitoring and control system for energy grids and decision makers, allowing energy usage reduction by coordinating the actual users' needs with the in-buildings and neighborhoods positive-energy generation facilities.
- ENERsip was conceived on the idea that mixing energy, communications, control, computing and implementation of the consumption and generation elements, must be active and proactively coordinated.

ENERsip Project



- The ENERsip platform will support the DSM measures providing real-time consumption information. The information will influence most consumers to change their attitudes toward conservation, shifting and reduce overall consumption.
- The communication and control capabilities will allow the implementation of DR programs, by the utility.
- The real-time optimization of generation and consumption matching in buildings and neighbourhoods will allow the integration of building generation with a lower impact on the grid.

Conclusions

- Generically, any consumption reduction will contribute to reduce the intermittence as far as security of supply is concerned.
- The DSM measures with greater impact in the peak load hours will also mitigate the problems caused by the variations and reduced wind power productions in the peak hours.
- When abrupt variations of the wind power production occur, DR technologies can in near real time adjust the demand to avoid the most unbalanced situations.
- Enabling the implementation of DR programs, supporting the DSM measures and ensuring the real-time optimization of generation and consumption matching in buildings and neighbourhoods, the ENERsip system will be an important tool to the integration of intermittent renewable resources.

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