# Demand-side Management in the Smart Grid

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## INTRODUCTION

At every second in power grid, energy generated is equal to energy consumed. This process is dynamic and should be controlled. If the load fails to be balanced, frequency and/or voltage in power grid will change, resulting in damage to equipment.

Traditionally, we manage and control generation side to follow the demand and keep the load balance.

## BACKGROUND

In future, to 1)utilize renewable energy source (wind, solar, etc. ) which has limited dispatchibility and intermittent nature, 2)support electric vehicles, control strategies for load balance and architecture of power grid have to be upgraded.

## NEW DSM METHODS

**Real time pricing (RTP):**

RTP is a price-based strategy which allows utilities to post real-time electricity price based on demanding requirement.

Advantages: add feedback of customers reaction to demand dynamic price

Challenge: market and customers' behavior modeling is needed

**Demand bidding program:**

market participants managing a certain DLC customer base, a large industrial load or even single residential customers directly make an offer to the wholesale market to use less electricity during peak hours on the next day.

Advantage: market driven
less cost of operation

Challenge: operation standards are needed

**Digital direct load scheduling (DDLS):**

We unbundle individual requests for energy and digitize them so that they can be automatically scheduled.

Advantage: balance RTP and direct load control strategies

Challenge: Smart appliances with control unit are needed

Figure 1 shows how the DDLS technology will smooth the load demand curve.

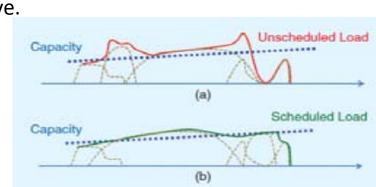


Figure 1:Load scheduling by DDLS

## ARCHITECTURE OF FUTURE GRID

**Information domain for future smart grid**

Demand side control strategies are practical only when digital processing and network communication technologies are applied. We can roughly summarize the information that needs to be gathered locally for effective planning and design as well as efficient operation and management as follows:

- Equipment should be capable of communicating
- Accurate sensor data, with context information on time, location, type of measurement
- Pricing-incentive descriptions should be easily accessible

Figure 2 is an abstraction of the network architecture and highlights the different information domains. Contrary to the traditional model for the grid, to ensure scalability in intelligently dispatching the resources, it is critical to perform a number of decisions at the edge of the network.

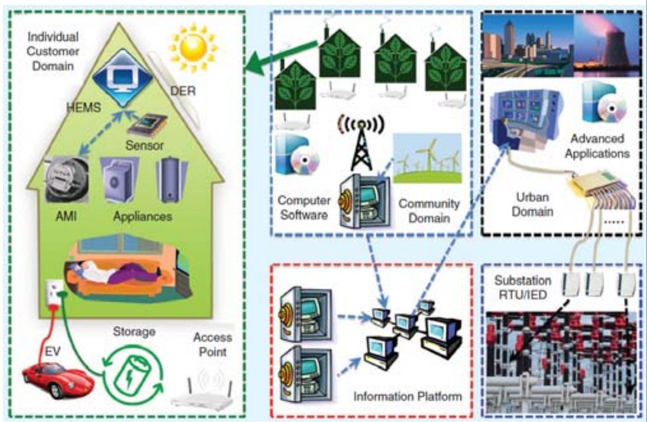


Figure 2:Communications and information processing in smart distribution networks

**Micro-grid architecture:**

A microgrid is a coordinated cluster of DER units, loads and storage with appropriately designed intelligence for management and control.

Micro-grid can be connected to the main power grid or be cut off and run as isolation mode. The architecture of microgrid reduces uncertainty of load and DER in ISO mode and reduce power loss due to short transmission lines.

## SIMULATION RESULTS

**Simulation of direct load scheduling for EV charging**

In a numerical example, data of power consumption in 5 houses during the night is recorded. All 5 houses have to finishing charging EVs before 6am.

Without load scheduling, EVs start and keep being charged until the battery is full. However, in DDLS, the charging process can be divided into 30-min interval.

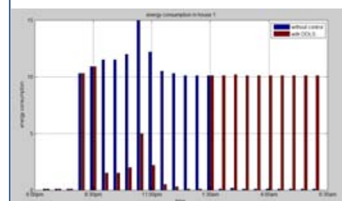

Figure 3: scheduling for house 1

EV charging, compared to other appliance, consumes significant higher energy.

Figure 1 shows that the scheduler postpone EV charging time from evening to late night in house 1.

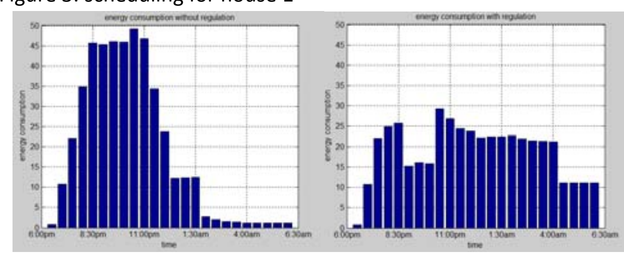

Figure 4: DDLS for EV charging

Figure 4 shows the total energy consumption of 5 houses from 6pm to 6am with and without DDLS. After balancing and modifying the time of EV charging, the total demand curve is smoother.

## CONCLUSIONS

To integrating large scale of renewable energy source and supporting electric vehicles in future, feasible demand side control methods as well as micro-grid architecture are essential.

## REFERENCES

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