Control the Grid or be Controlled

Role of Storage Management, Integration of Renewables and Prediction on the Demand Side

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1. **Integration of Renewables**

2. **Smart Grid**

3. **Role of Storage Management**

4. **Prediction of Demand Side Management**

5. **Summary**

Integration of renewables

Smart grid

Role of storage management

Prediction of demand side

Summary

- Integration of bioenergy, geothermal, hydro power, ocean, solar, wind.... enables 1) sustainable development, 2) energy access, 3) energy security and 4) low carbon economic growth.

- **Storage management, demand side prediction and integration of multiple renewables would eventually lead to more independence from the Grid**
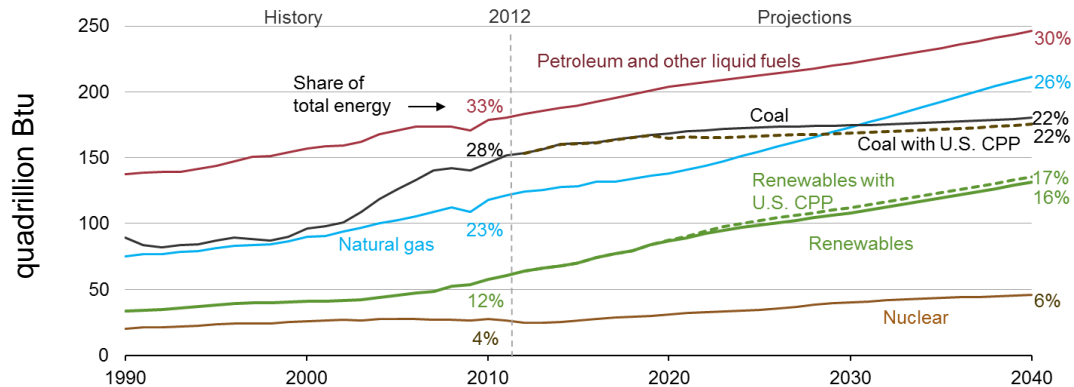

Figure 1 : World energy consumption

Source: EIA, International Energy Outlook 2016 and EIA, Analysis of the Impacts of the Clean Power Plan (May 2015)
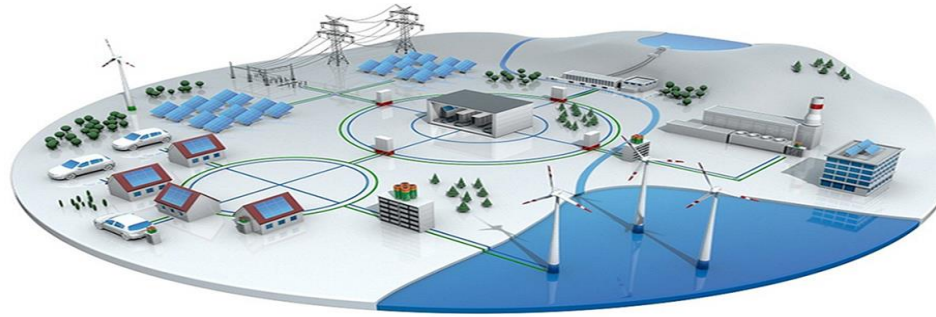
Source: http://solutions.3m.com/wps/portal/3M/en_EU/SmartGrid/EU-Smart-Grid/

Smart Grid and Mini Grid

- Smart Grid should integrate technologies and innovative services to manage complex electricity supply in a sustainable, efficient, economically viable and secure manner.

- The basic framework of a smart grid can be categorized in to **Integration, control and communication.**

- **Micro grid is a localized stand alone energy grid that can operate independently from the main grid.**
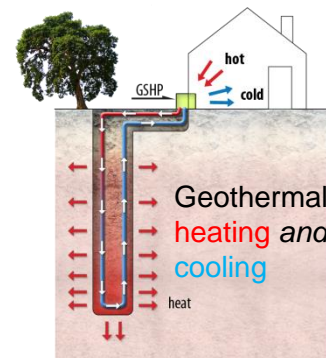
Integration of renewables
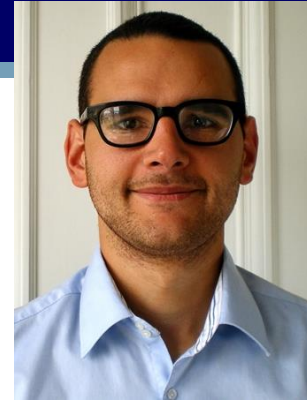
Smart grid

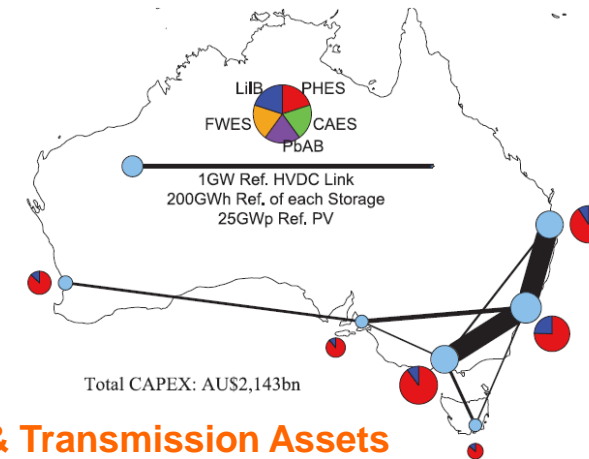**Role of storage management**

Prediction of demand side

Summary

- Energy storage management plays an essential role in the smart grid and contributes to grid stability from generation to consumer end.

- Energy storage (electrical and (geo)thermal) on customer's side enables controlling of power flow, mitigating congestion and maintains voltage in appropriate range.

- It supports integrating equipment into smart grid such as electrical vehicle which enables load shifting function.

Geothermal heating *and* cooling

- **Integration of non-dispatchable renewable energy sources, in particular the interaction between forecasting and operational optimisation under uncertainty.**

- "Optimal Operation of Energy Storage Systems Considering Forecasts and Battery Degradation," *IEEE Transactions on Smart Grids*, (submitted)

- Energy demand prediction is an essential function for energy system planning strategies due to growing complexity of smart grid environment.

1GW Ref. HVDC Link
200GWh Ref. of each Storage
25GWp Ref. PV

LiIB PHES
FWES CAES
PbAB

Total CAPEX: AU$2,143bn

Least Cost Storage & Transmission Assets

- It allows optimal operation and balance of the power supply system.

Integration of renewables

Smart grid
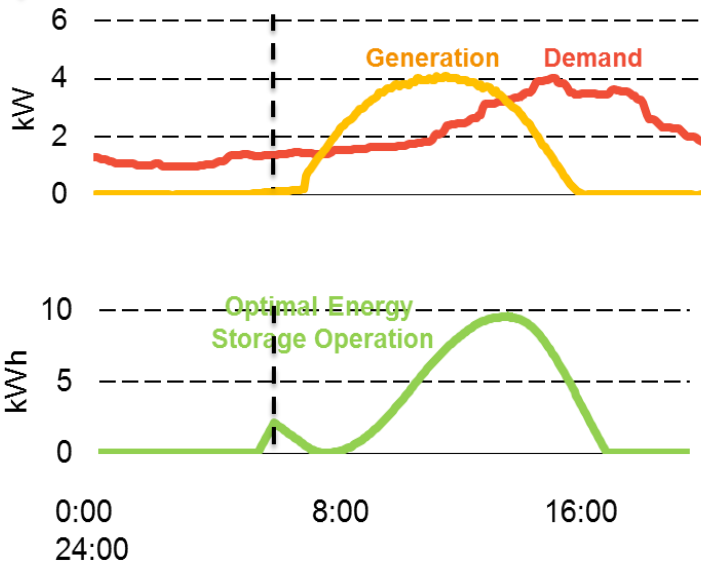
Role of storage management

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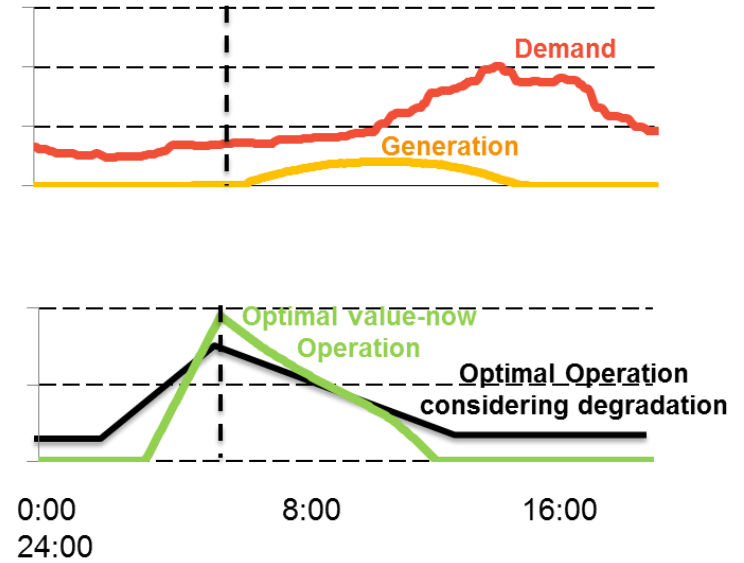Role of storage management

Prediction of demand side

Summary

Sunny Day

Cloudy Day

In the morning, battery must be empty
(to use full capacity for solar self-consumption)

In the morning, battery must be full
(to have taken advantage of overnight prices)

➢ Without forecasting, you cannot maximise value from an energy storage system

➢ Without considering degradation, you cannot maximise asset lifetime value

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- Utilizing renewable energy resources as solar, wind, geothermal, hydro power, tidal, bio fuel in a controlled manner with clever storage management would overcome the draw backs of a single system.

- It would lead to a hybrid renewable energy system which can be an approach to off the grid electrification system which enables a reliable power supply and Increases the overall percentage of renewable energy generation capacity.

Can we predict the peak demand and reduce its dominance?

Source-http://energy.gov/eere/femp/renewable-energy-technologies-federal-projects

- B.Sc.(Hons) in Mechanical Engineering at the University of Peradeniya (2014)

- Shallow geothermal opportunities for heating and cooling buildings and issues associated with integration

- Electricity consumption data – Taken from Smart grid-Smart city pilot project jointly funded by the Australian Government and an industry consortia, led by Ausgrid.

- Heating and cooling demand is assumed to be 30% of the total electricity consumption.
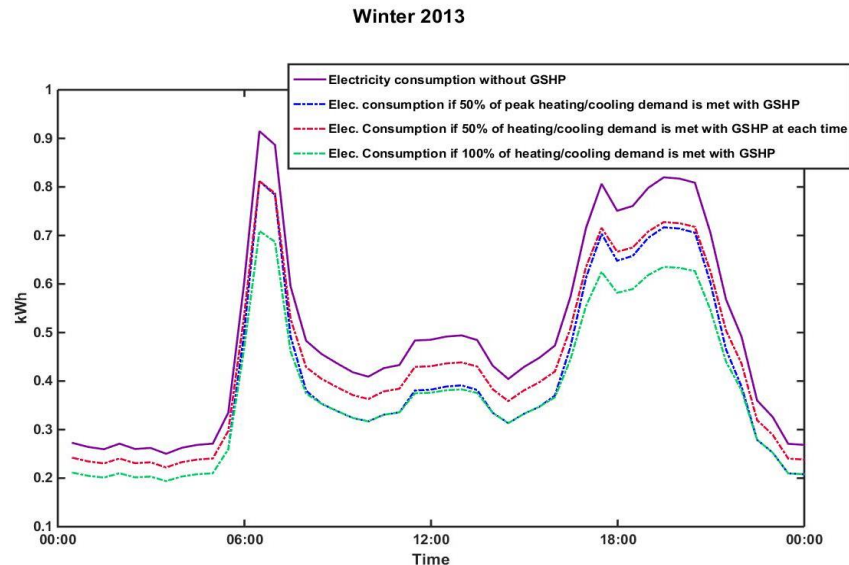

Fig.: Average electricity usage of a house

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- The smart grid should create a better energy infrastructure which enables integration of renewable and distributed generation with a better demand response.

- Due to intermittent and variable nature of renewable energy sources, energy storage is essential in stabilization of the grid.

- As the applications of grid become more complex, prediction of demand is more important in energy system planning.

- **Combining many renewable energy sources with clever storage management and demand side prediction may lead to stand alone off grid solutions, which may be the answer for remote communities and big islands without existing grid infrastructure.**