

# Integrating Wind Power with Domestic Demand Response to Increase the Value of Wind

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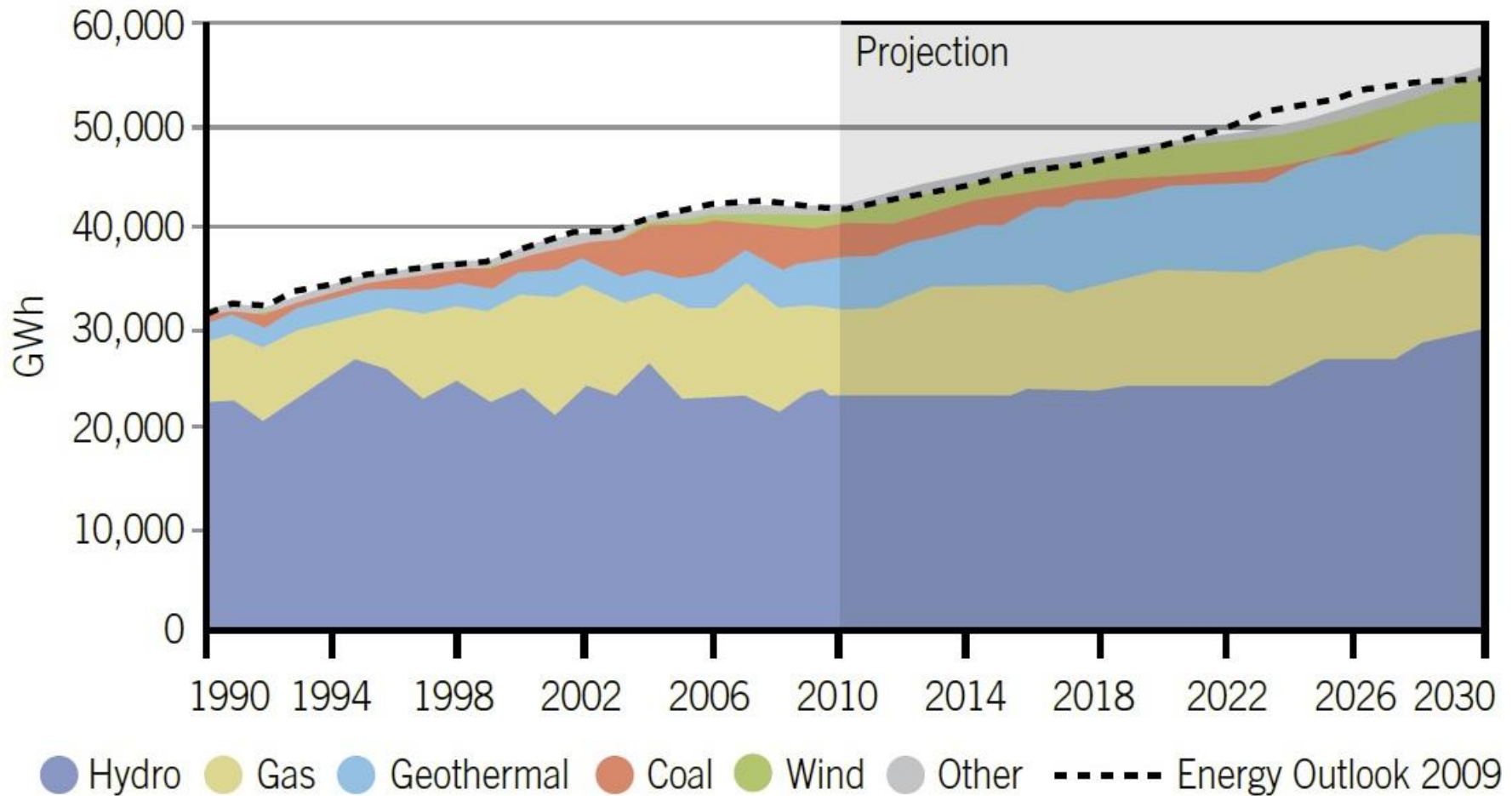
School of Engineering and Computer Science



# Today's Talk

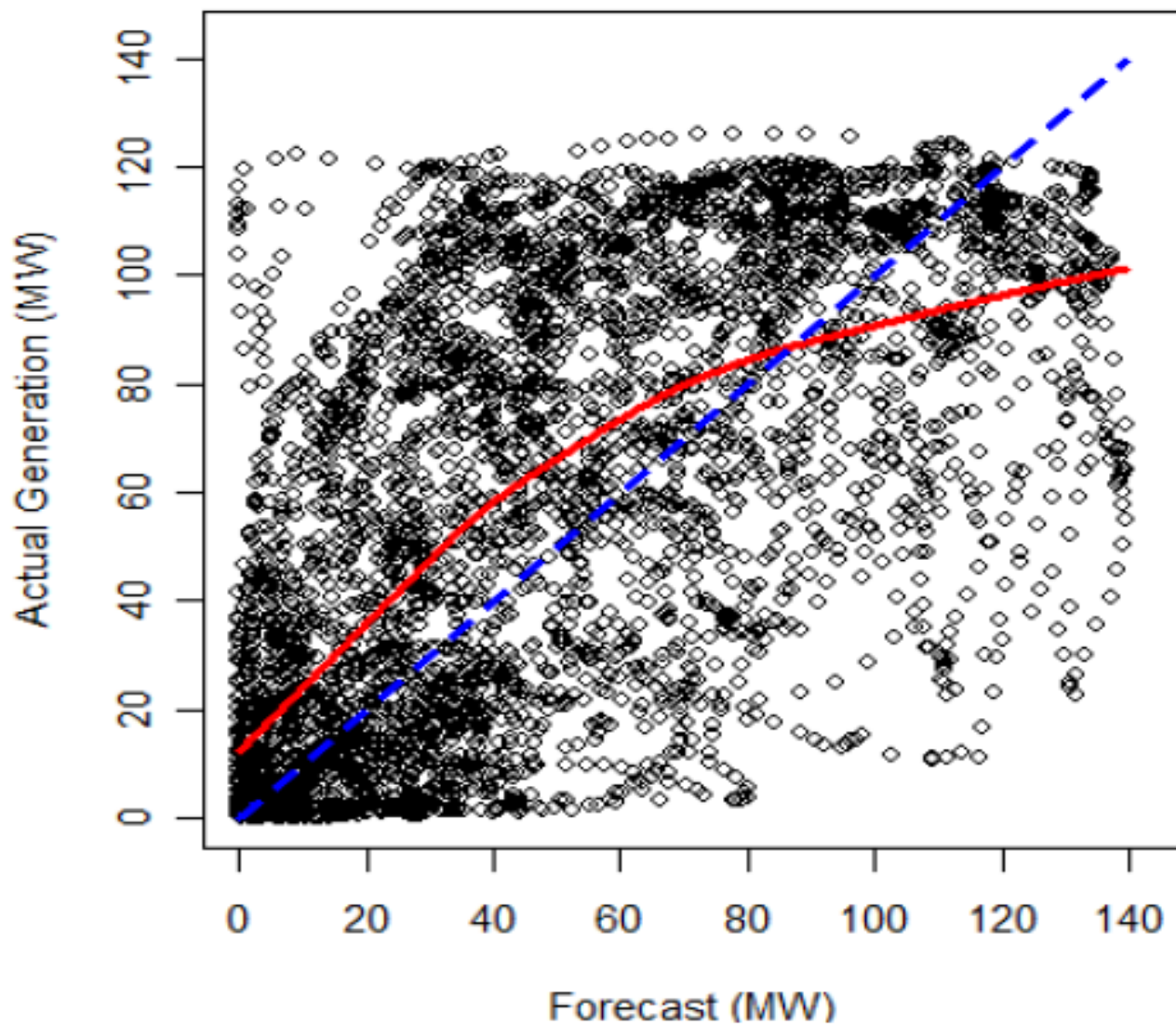
- Wind power in NZ
- Research objective
- Demand response
- Methodology
- Sample results
- Next steps & final remarks.

# NZ going 90% renewable

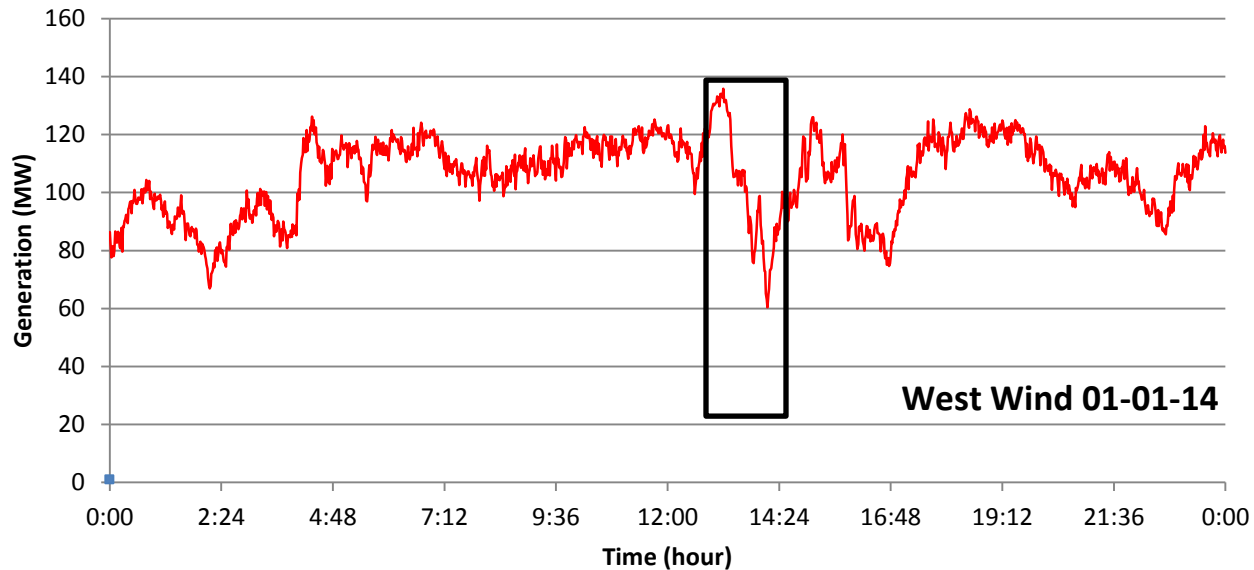
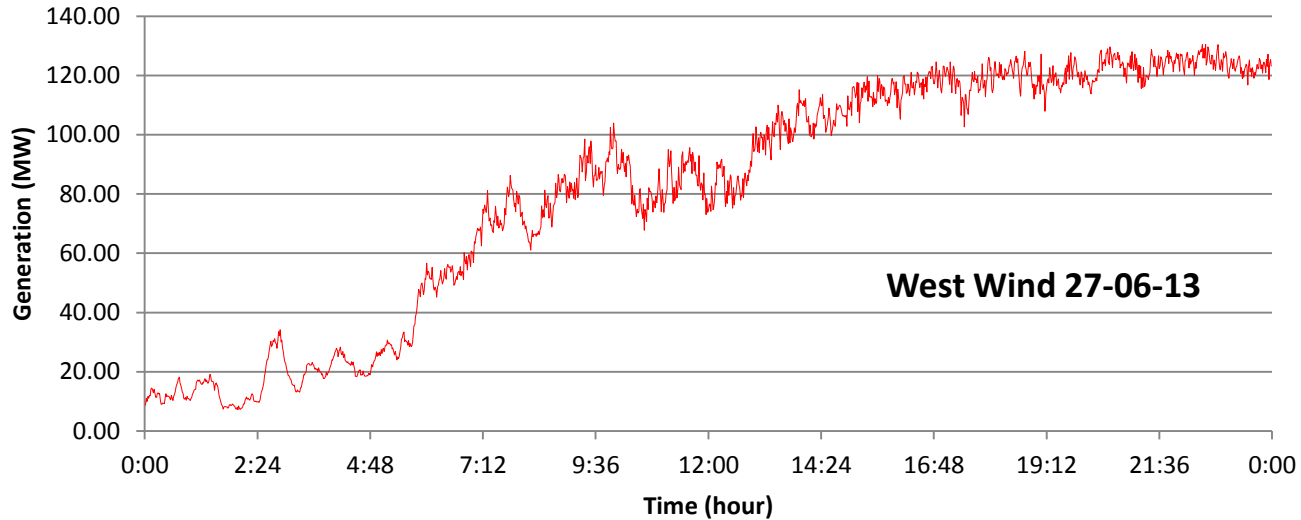


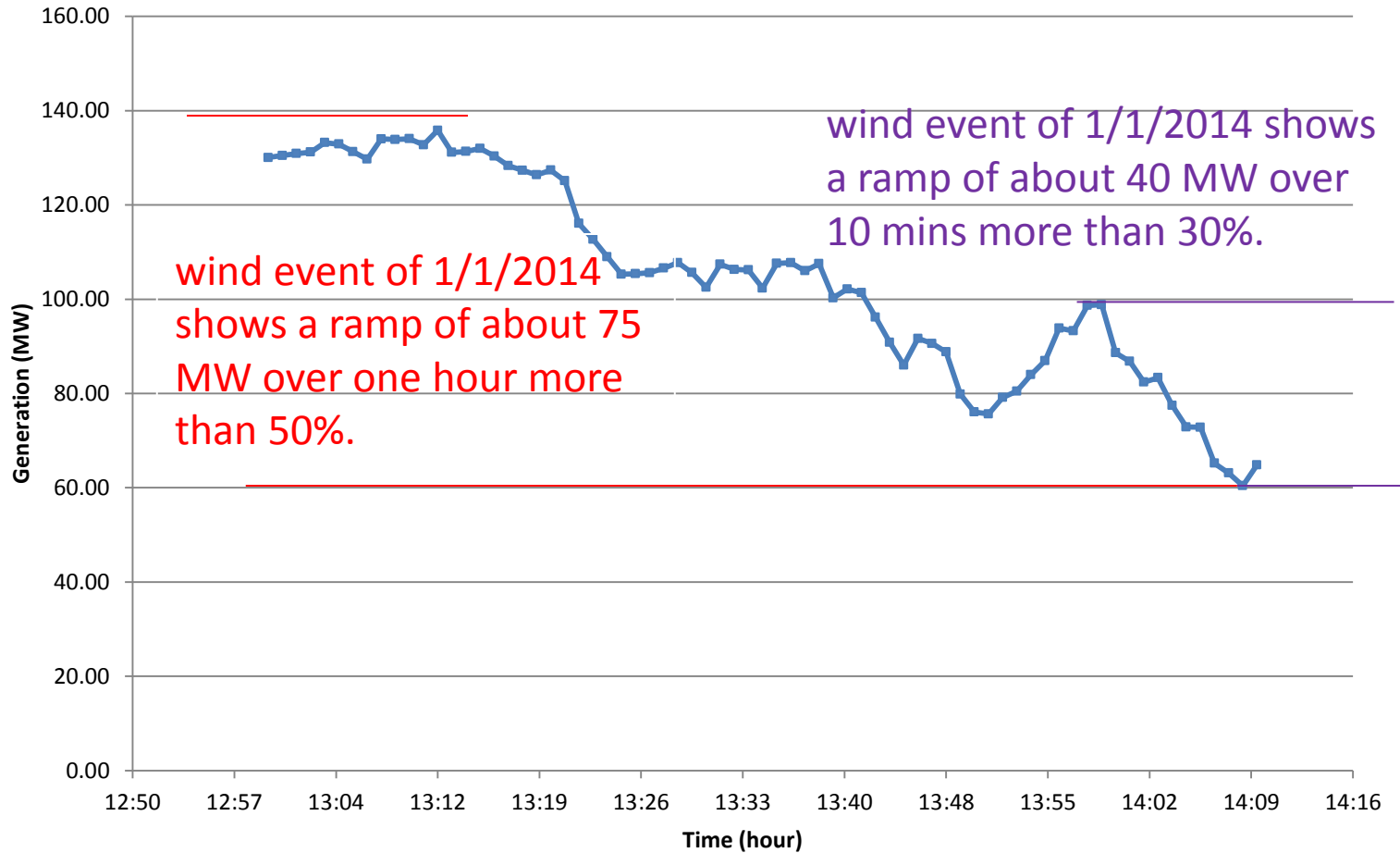
Source: Ministry of Economic Development, 2011

# Wind generation – uncertain



# Wind generation – variable





Source: Transpower, 2014

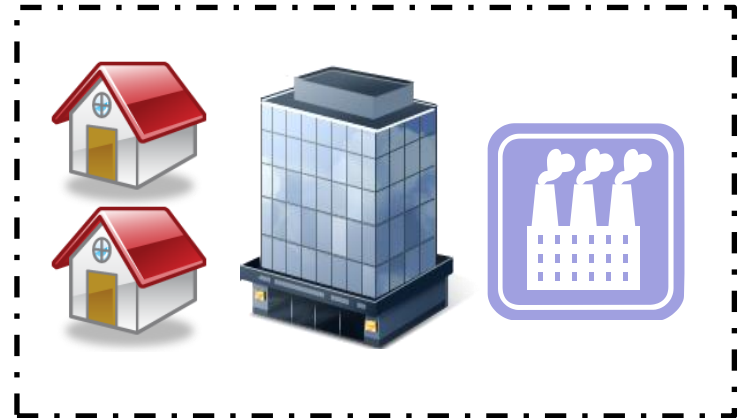
# How are these challenges managed?

Flexibility Additional reserve for large un-forecasted wind ramps.

## Supply



## Demand



# Research objective

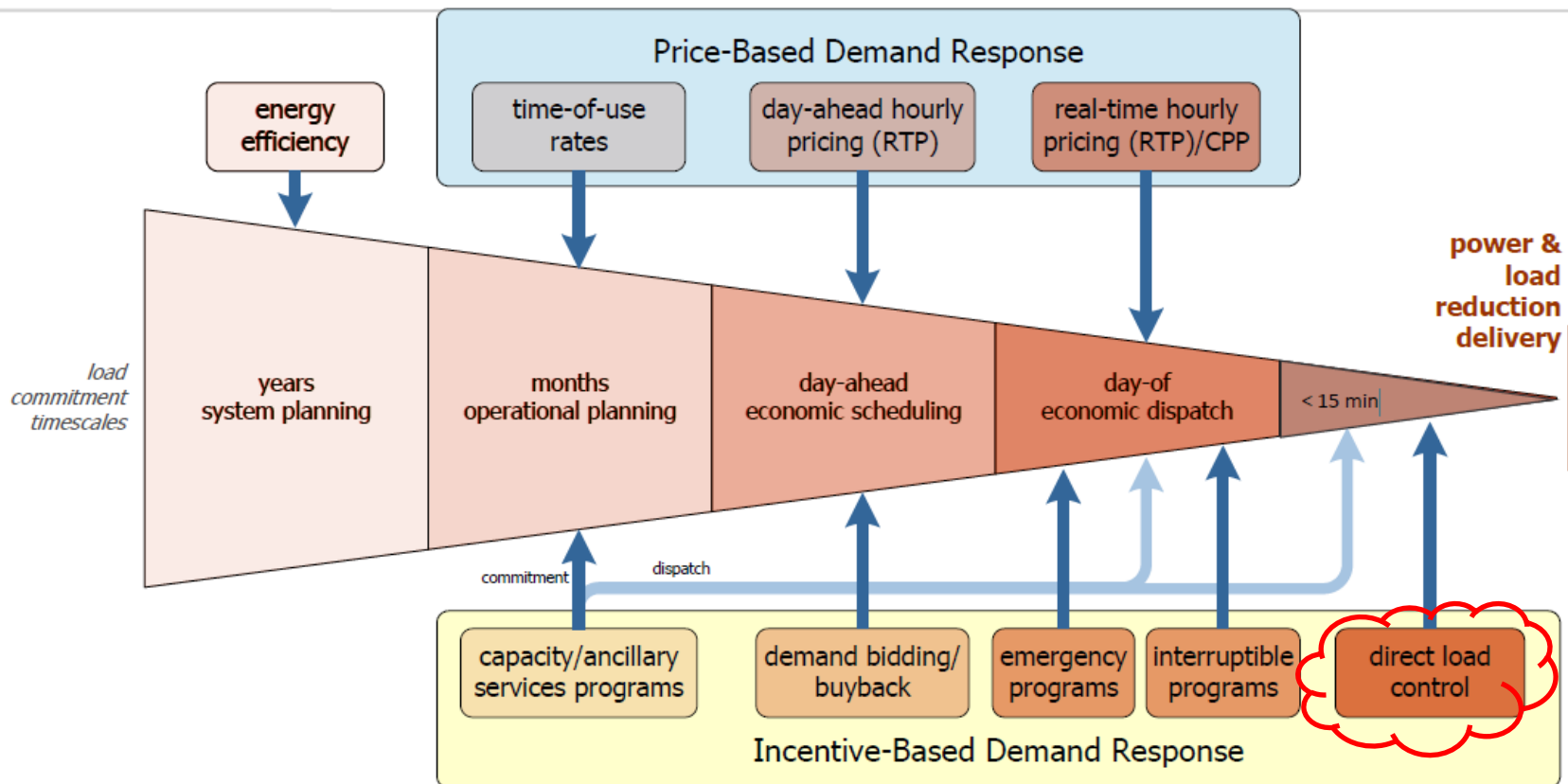
- Assess the potential of residential demand response in providing flexibility services to mitigate the variability of generation due to the unpredictable nature of wind.





# Demand Response (DR)

## Demand response – engaging the end-use consumer

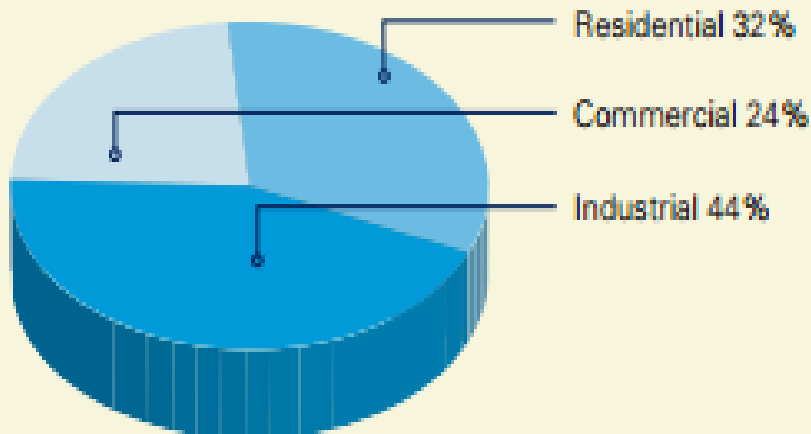


# Sectors of Demand Response

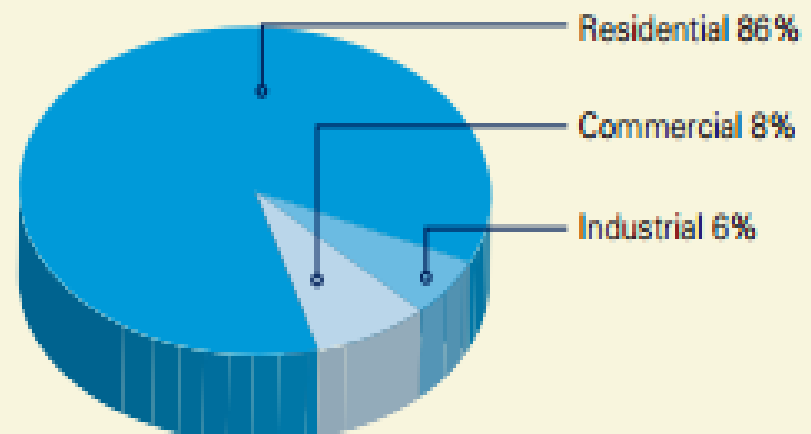
Traditionally, Industrial & commercial loads are best candidates for DR programs:

- Large consumption of electricity
- A substantial amount of power available in case of a DR event
- Simplicity of interacting with a small number of large customers

**ESTIMATED ENERGY CONSUMPTION BY SECTOR (GWh)**  
 (38,545 GWh total in year ended Dec 2008)



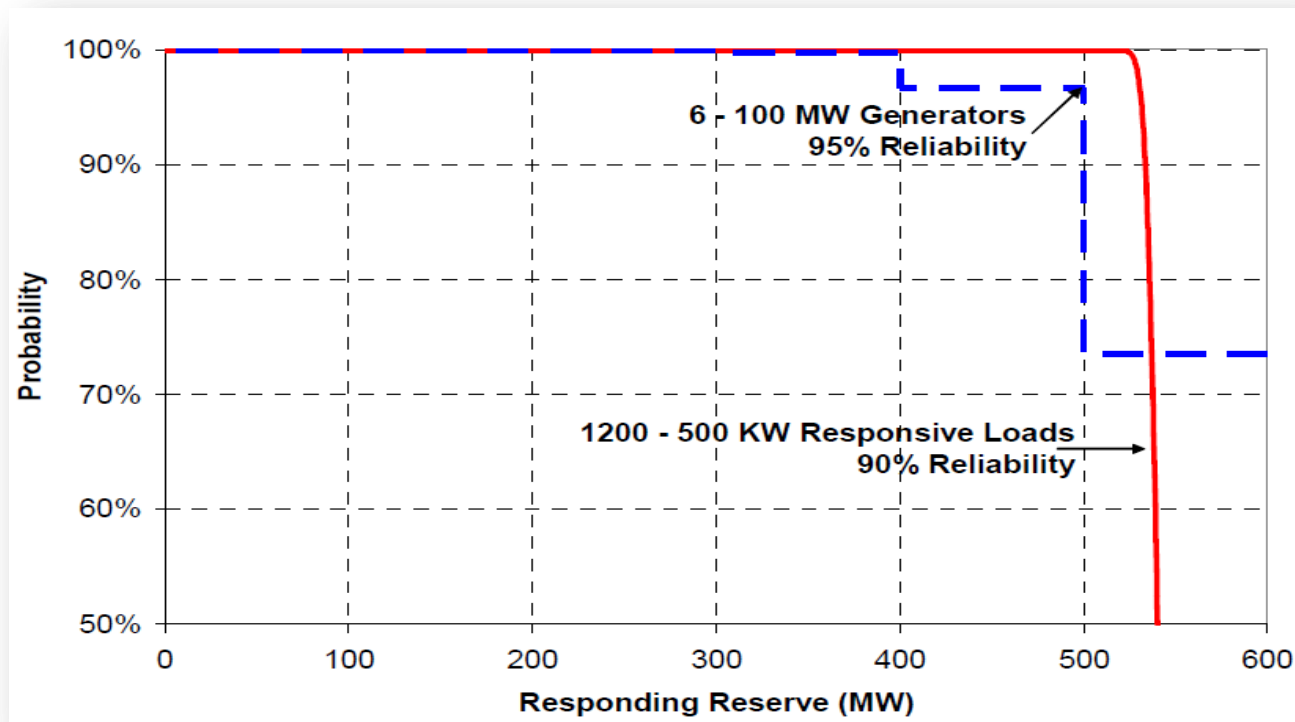
**CUSTOMERS BY SECTOR**  
 (total of 1,930,814 customers in the year ended Dec 2008)



# Residential Demand Response

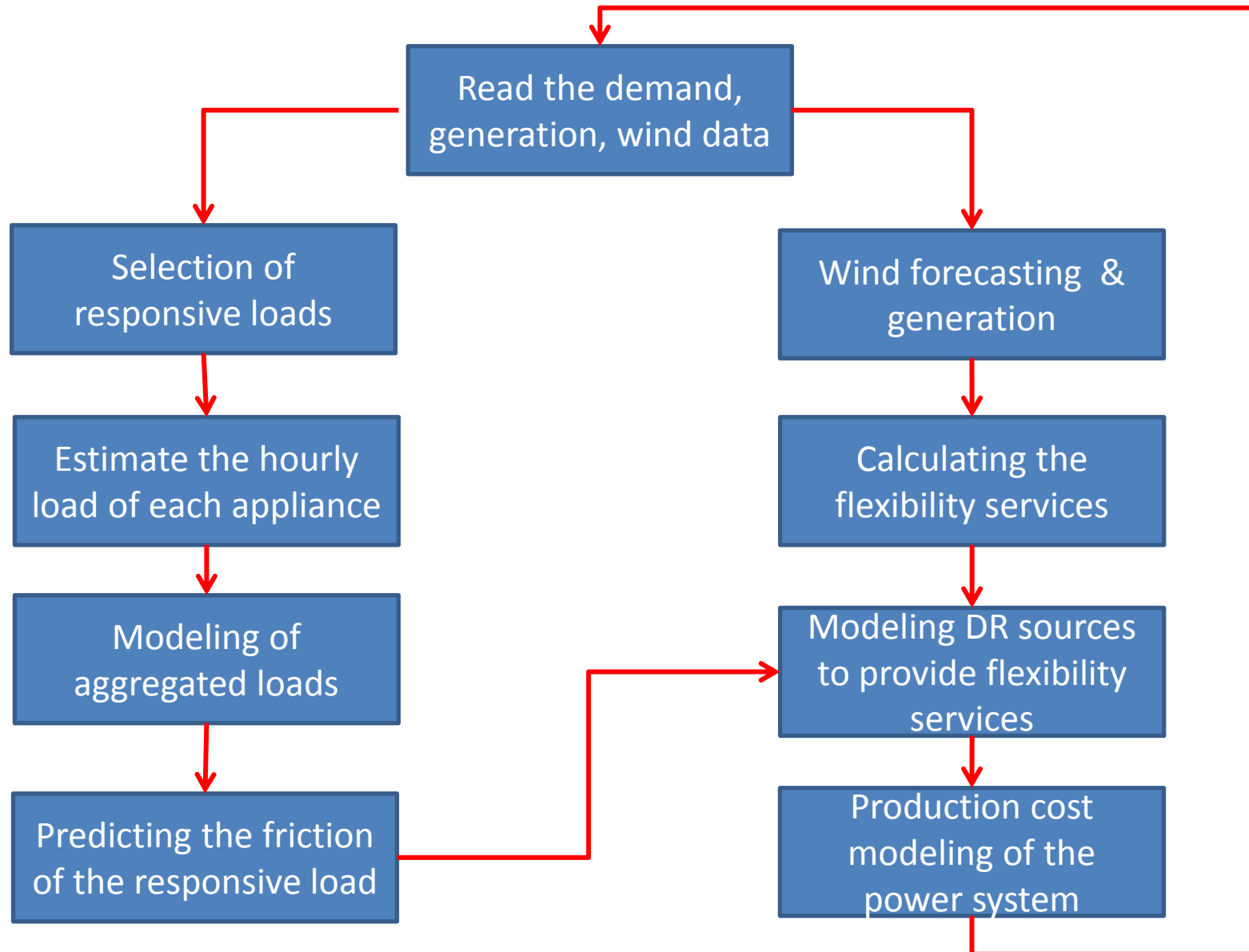
Benefits to using aggregations of small residential loads:

1. Reliability in aggregate
2. Spatially distributed
3. Huge resource potential



Source: Kirby 2003

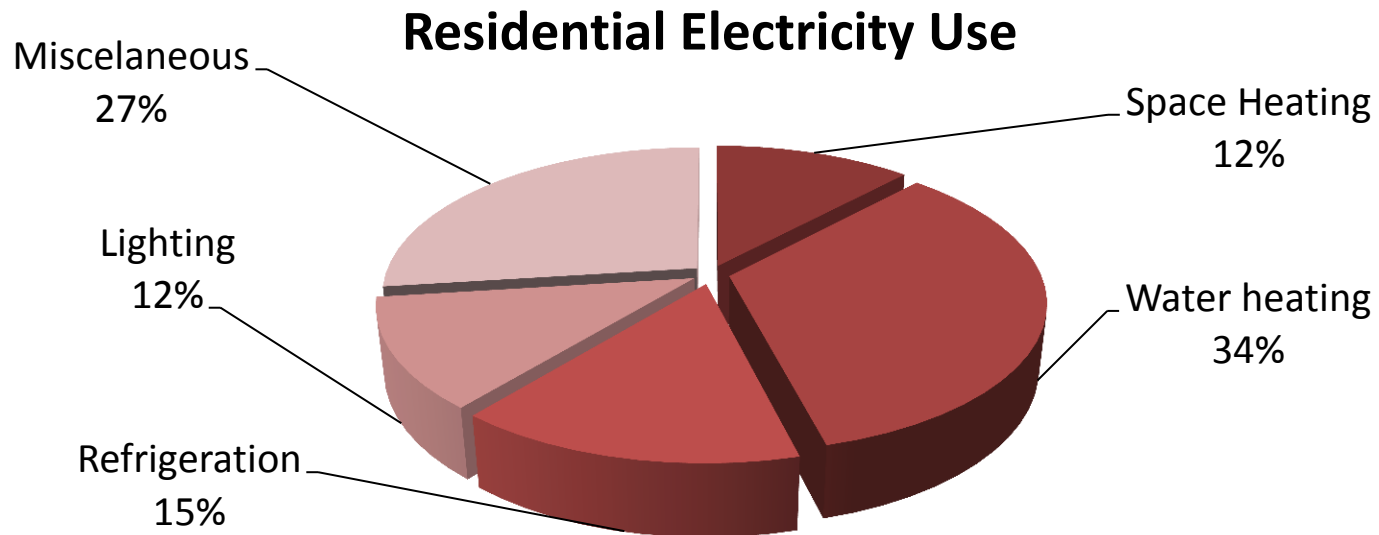
# Methodology



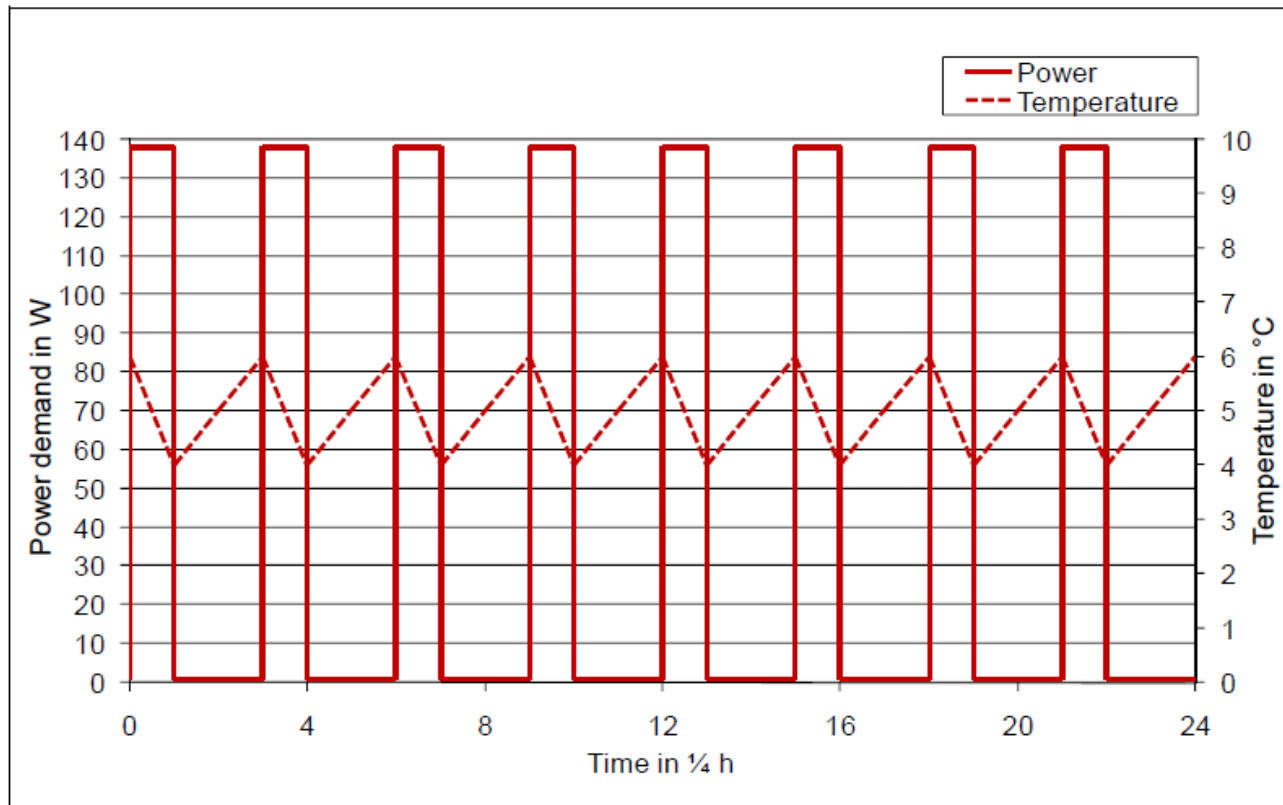
- **For sure, lighting is not meant here.**
- **Neither entertainment is suitable for that purpose....**
- **But many other appliances in the household are ...**
- **Without impacting the comfort level of the end user.**

# Examples of Responsive load

- Thermostatically controlled loads TCL such as electric water heaters, Space heaters, and refrigerators.
- Thermal loads are like storage
- Suitable for brief interruptions in power supply.



# Basic idea of Thermostatic loads

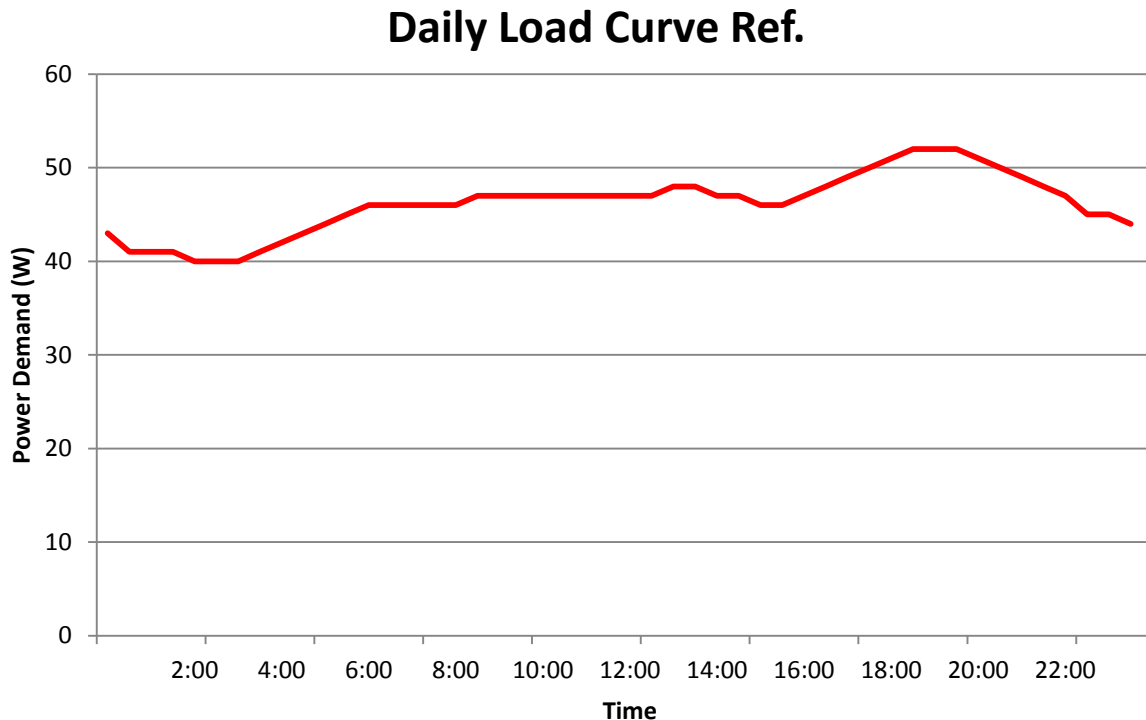


*General pattern of a power demand curve of a refrigerator in 1/4 hour steps*

Source: Synergy , 2008

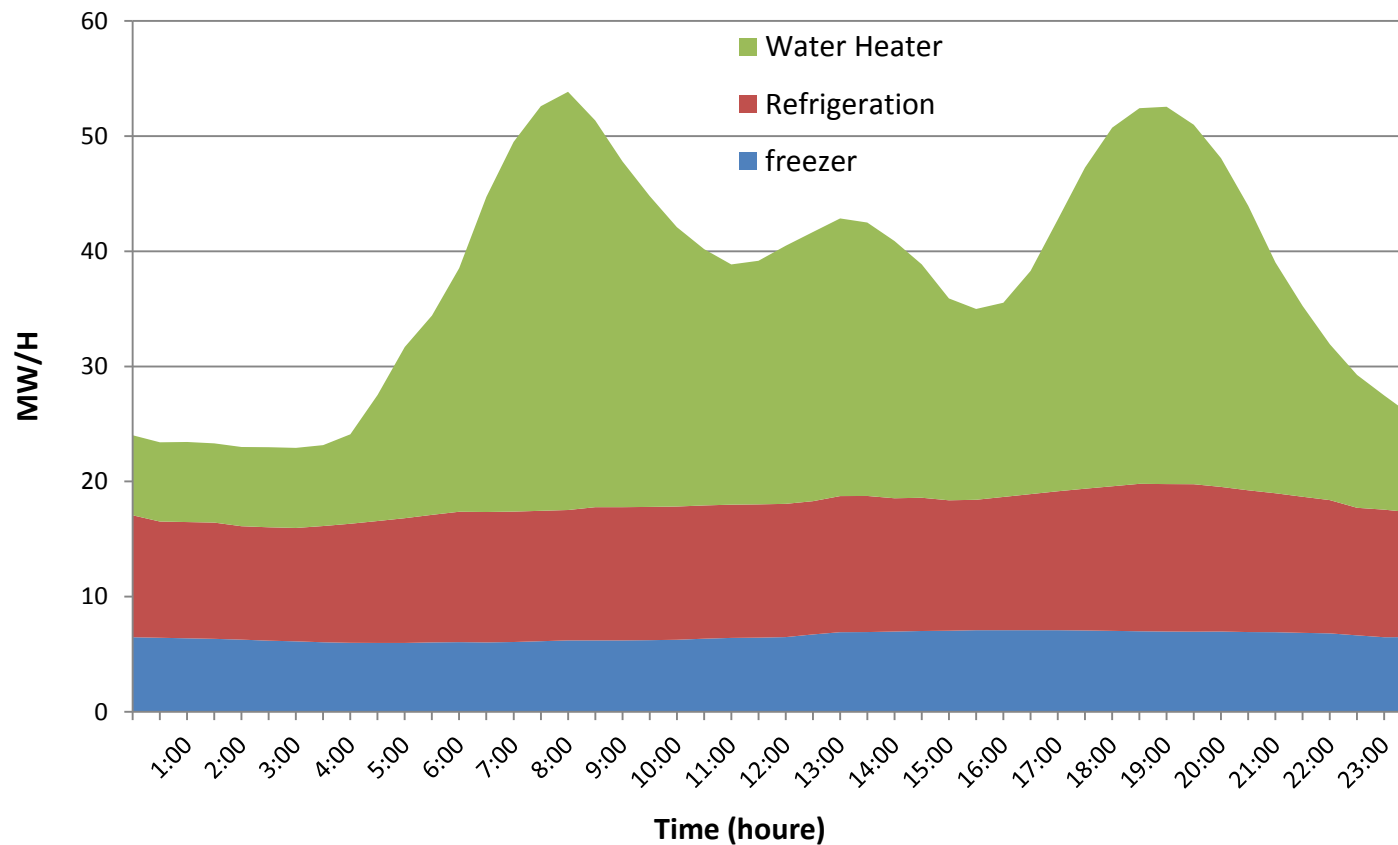
# Example: Potential of Refrigeration

- Substantial aggregate potential due to high penetration (1.8 per household) (Branz, 2010).
- Stable aggregate load profile.
- Short interruptions in power supply should not impact on the service.

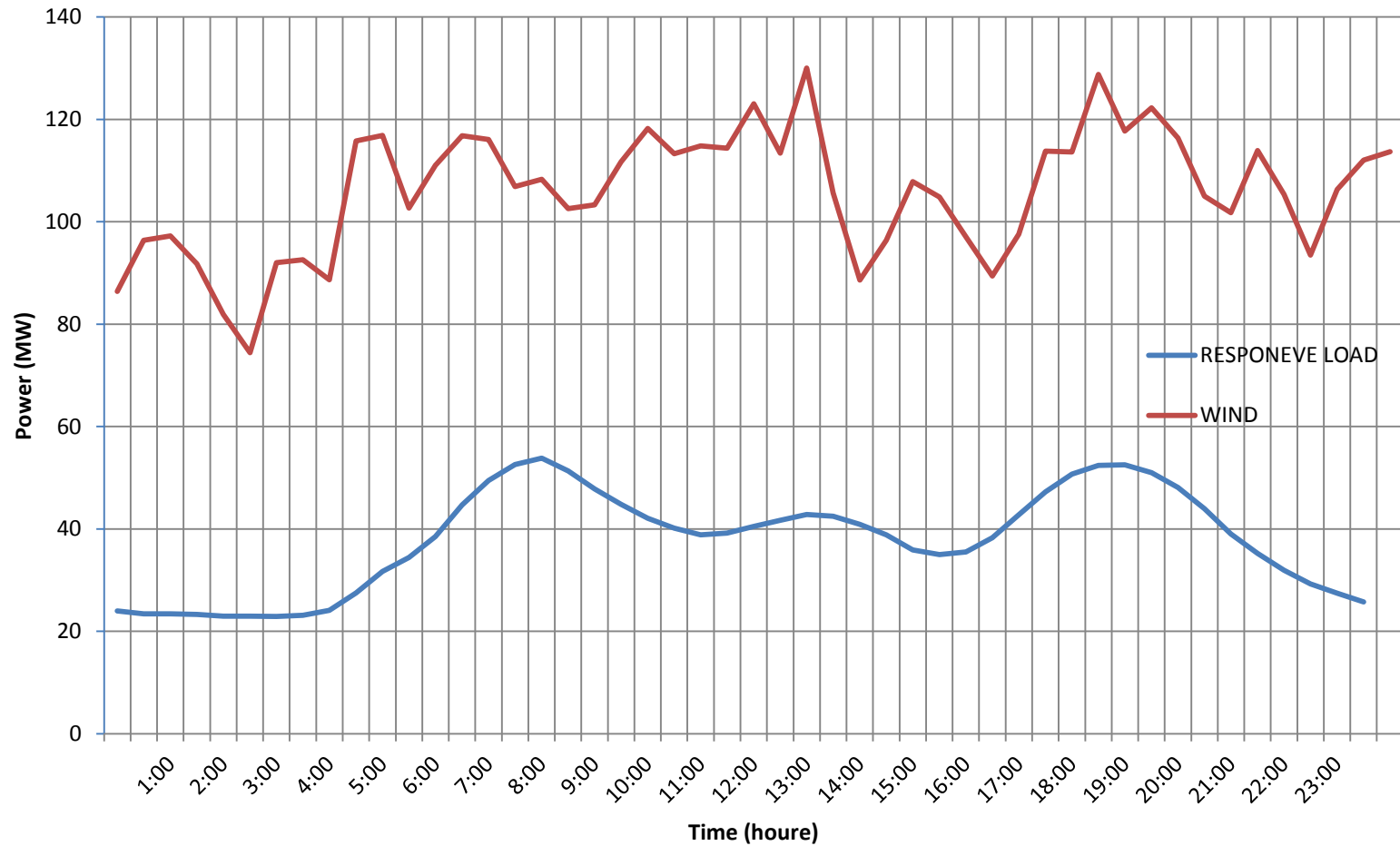




# Direct Load Control Potential

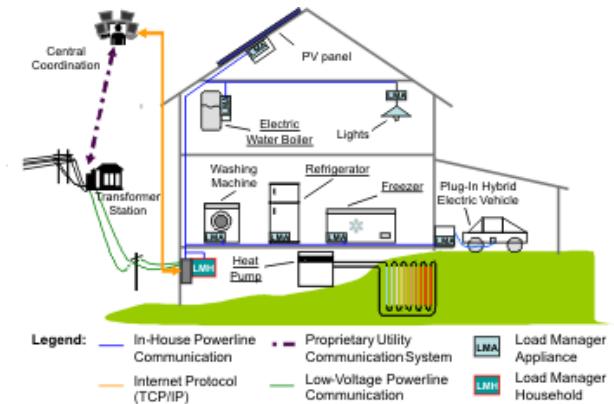


# Responsive load with wind

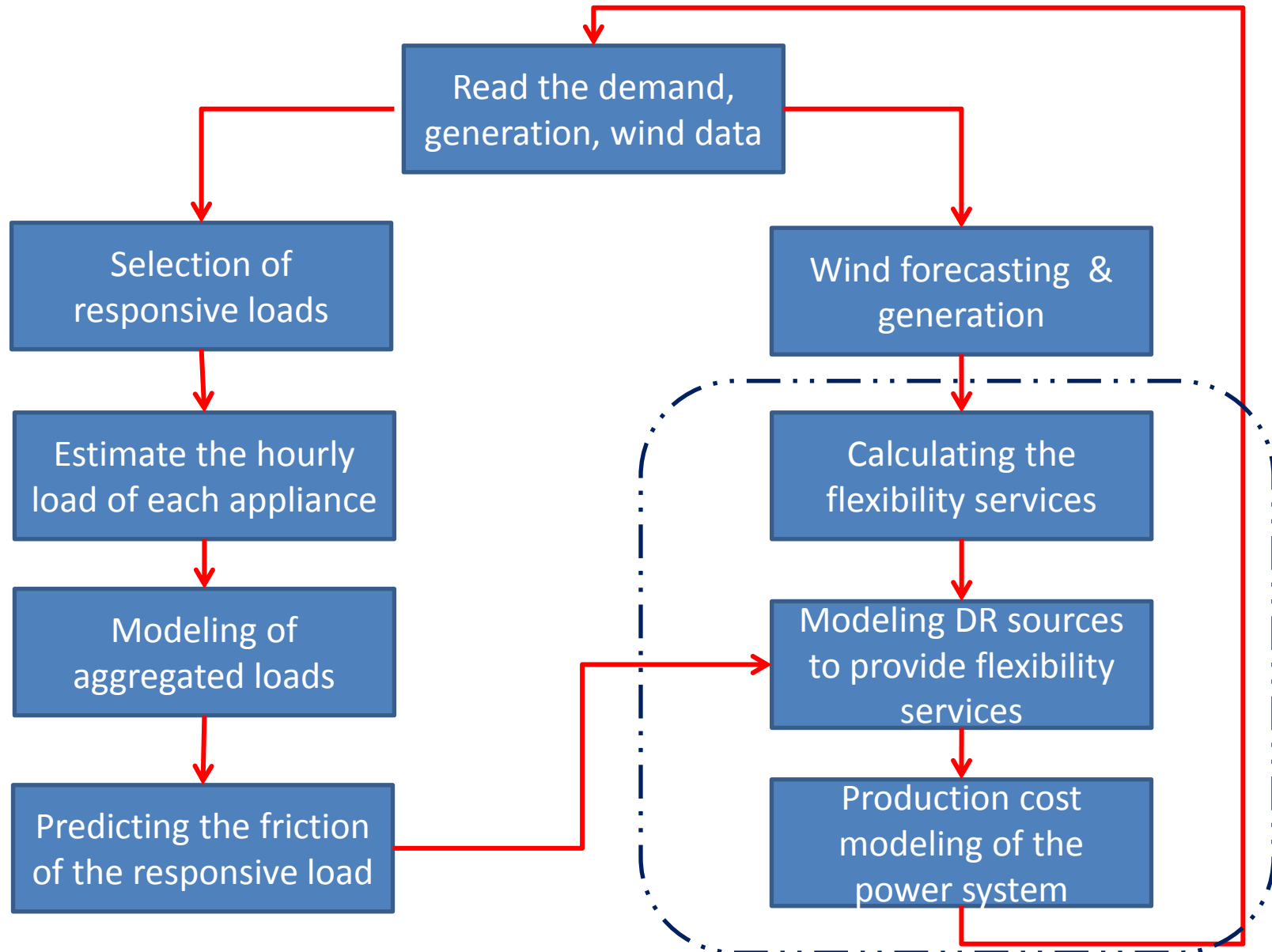


# Is this technology possible??

- Load Control Switches
- Smart Appliances
- Home Automation

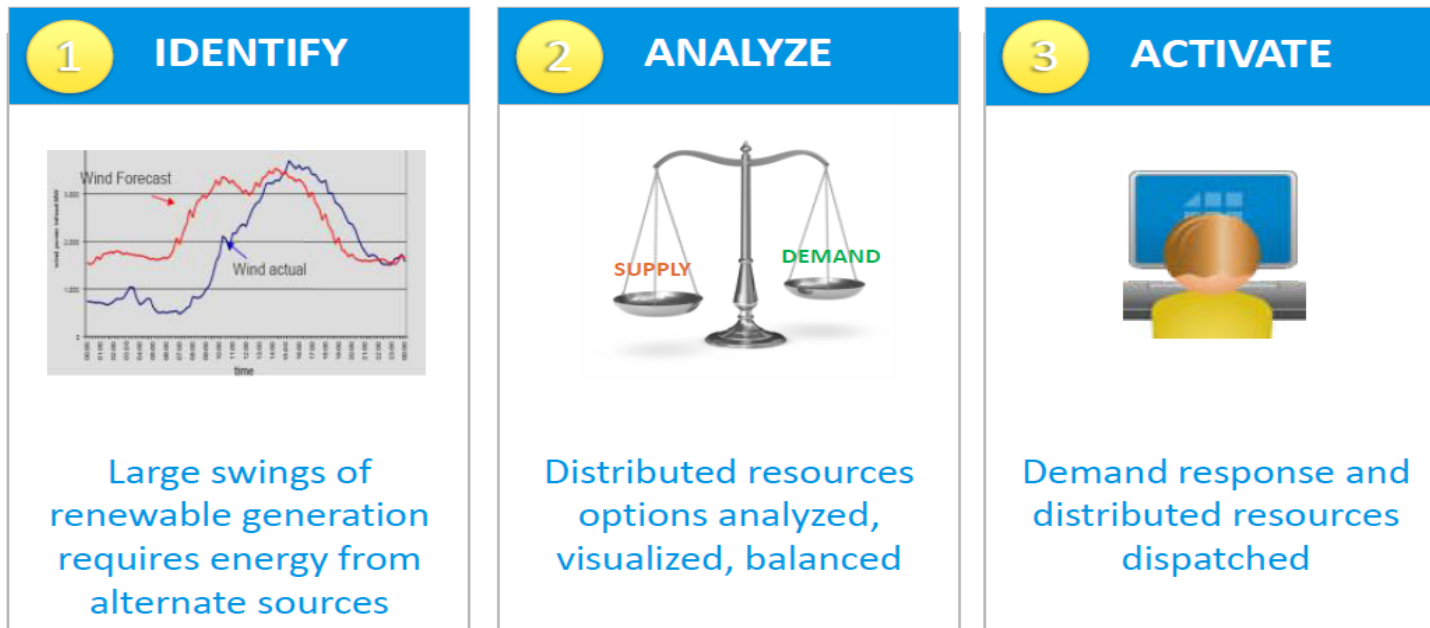


# Next Step



# Final Remarks

- Residential Responsive loads can have significant potential.
- Actual potential will depend on marketing effort, consumer education and the incentives offered.



Source: ABB