If and when will Sweden have a need for demand flexibility?







What value can demand flexibility provide?

What value can demand flexibility provide FOR THE SOCIATY?



Policymaking

Research



What value can demand flexibility provide FOR THE SOCIATY?

Comparing energy systems in California and Sweden:

A pilot-study to further develop a methodology for prediction of overall demand response potential in Northern Europe

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LBNL demand response potential methodology

- Forecast demand response potential for for year 2025
- Estimates the potential size and cost for future DR resources for California's three investor-owned utilities
- Funded by California Public Utilities Commission (CPUC) to support rulemaking R.13-09-011



- Data:
 - load data from ~ 11 million customers -> grouped into clusters
 - hourly load data ~220 000 customers -> define characteristic load profiles for the clusters
- The analysis employs:
 - a bottom-up, customer end-use load forecasting model with tight integration between weather, loads and renewable generation patterns.
 - combined with a detailed DR cost database to express DR supply curves for each grid service, showing how much DR is expected to be available across a range of costs.
- Model is published as open source





Objectives

My new project:

A Swedish Demand Response (Flexibility) Potential Study

Objective of paper:

- overview of available methods
- compare the electricity generation and energy markets between California and Sweden and discuss demand response needs and barriers
- provide an understanding on how existing methodologies can be implemented in Sweden and elsewhere



Comparison between California and Sweden

- Motives for demand response
- Energy markets
- Electricity generation and supply





Motives for demand response programs in California Net load - March 31



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Motives for demand response programs in Sweden

But when and to what extent?

Situation: Future challenges (Swedish Energy Markets Inspectorate, 2016):

- Frequency control
- Power shortage situations
- Ineffective use of resources
- Local congestion problems

Solution: Demand response, but how?

- Customers needs a signal e.g. price or signal
- Business models that enables customer flexibility

No demand response programs exists today!



| Electricity value chain Production Transmission | System operation Distribution | Retail | | |
|---|-------------------------------|--------------------|----|---------------------|
| A: Vertical integrated model | | | וו | |
| Utility | | | | |
| B: Single buyer model | | | | |
| Multiple Producers | Utility | | | |
| | | | | |
| C: Wholesale competition model 3/4 electricity supply from 3 Investor-Owned Utilities | | r-Owned Utilities | | * ASA DA |
| Multiple producers Multiple buyers | Utility | | | CALIFORNIA REPUBLIC |
| | | | 1 | |
| D: Retail and wholesale competiton model 134 retailers, > 8000 electricity contracts | | | | |
| Multiple producers Multiple buyers | Independent operators | Multiple retailers | | |
| | | | | |
| | | | _ | SE |

Electricity market in California



CAISO is the balancing authority with the responsibility for

- 1) operating the wholesale market and
- 2) for managing the reliability of the transmission grid

Utilities purchase power primarily from the wholesale market (auction process administered by CAISO)

CAISOs markets include

- day-ahead market
- real-time market
- ancillary services
- congestion revenue rights
- Energy Imbalance Market (EIM)



Electricity market in Sweden

- Svenska Kraftnät (Svk) is the transmission system operator
 - responsible for maintaining the balance between electricity generation and use of electricity
 - partial owner of the electricity market Nord Pool
- The electricity market is divided between four segments;
 - 1) future contracts (Nasdaq)
 - 2) the day-ahead market (Nord Pool, Elspot)
 - 3) the intraday market (Nord Pool, Elbas)
 - 4) the regulating power market
- A total of 380 companies from 20 countries trade on Nord Pool





Electricity generation in California and Sweden







Hourly generation profiles in year 2015

California



Sweden



Daily profiles per month based on average hourly values

California





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Duration load curve comparison



Sweden load duration [MW]

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Differences and challenges in applying the LBNL method

California

- Data acquisition from 3 investor-owned utilities
- Available demand response programs
- Most renewables from solar

Sweden

- 134 retailers
- No demand response programs
 - No incentives for customers
 - Lack of business models
- Most renewables from wind
- Possible flexibility
 - Spot prices better reflected to customers
 - Aggregated flexibility sold to Nord Pool



Discussion

- One of the upcoming challenges for Sweden is the integration of more wind to the system
- Four challenges are identified:
 - Frequency control
 - Power shortage situations
 - Ineffective use of resources
 - Local congestion problems
- Currently hydro is still a sufficient source to create load following to absorb the fluctuations in wind resources. (But for how long?)
- When hydro no longer is enough, there will be a need for <u>Fast</u> Demand Response Services due to fluctuations in wind
- Can the current market structure on it's own sufficiently handle future need for flexibility?



If and when will Sweden have a need for demand flexibility?



