RAP Energy solutions for a changing world

Demand Response

US experiences, German challenges and market barriers

Andreas Jahn
Senior Associate

Berlin, 2014

The Regulatory Assistance Project

Rosenstrasse 2
D-10178 Berlin
Germany

Phone: +49 30 2844 901-21
web: www.raponline.org

The Regulatory Assistance Project - RAP

RAP is a global NGO providing technical and policy assistance to government officials and agency staff on energy and environmental issues. RAP principals and senior staff are all former regulators, government officials, or senior policy advisors, and RAP's work is funded exclusively by foundations and government agencies. RAP has worked in more than 20 nations and 50 provinces and states. RAP's European offices are headquartered in Brussels, with a second office in Berlin.

As a senior associate in Berlin, Andreas Jahn focuses on issues relating to the German "Energiewende", or energy transition, helping develop and advance regulatory options for a carbon-neutral power sector, including demand-side resources and tariff design. He also supports RAP's work throughout Europe. Mr. Jahn has extensive experience with power markets and regulation, as well as knowledge of the German national political arena.

Prior to joining RAP, Mr. Jahn was responsible for all energy policy and regulatory matters as the director of regulatory affairs at lekker Energie, a German electricity and gas provider. Through his work as a senior expert for the Association of New Energy Suppliers, he gained valuable insight into political decision-making processes and legislative procedures. He was also a member of the Federal Ministry of Economics' task force on legislation to implement grid regulation in Germany.

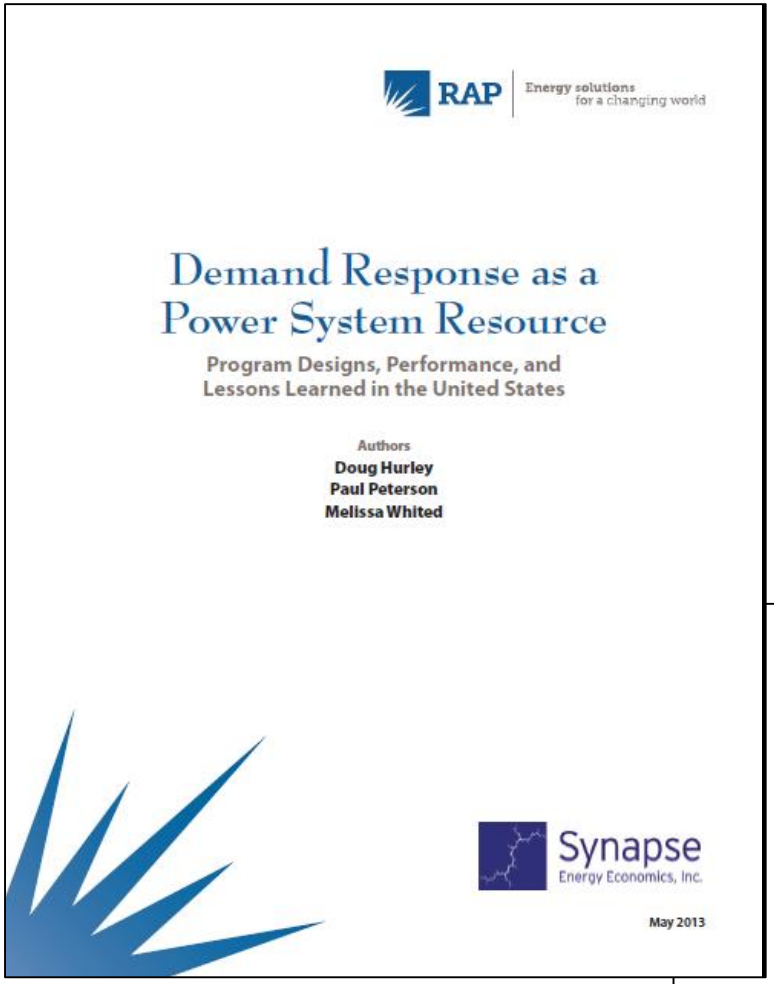
Major Points Today

1. What is Demand Response (DR)? Types of DR resources - findings from U.S.
2. New challenge - Integrating growing percentages of renewables
3. Barriers for DR in the German system

Major Points Today

1. What is Demand Response (DR)? Types of DR resources - findings from U.S.
2. **New challenge** - Integrating growing percentages of renewables
3. **Barriers** for DR in the German system

RAP Publications on Demand Response



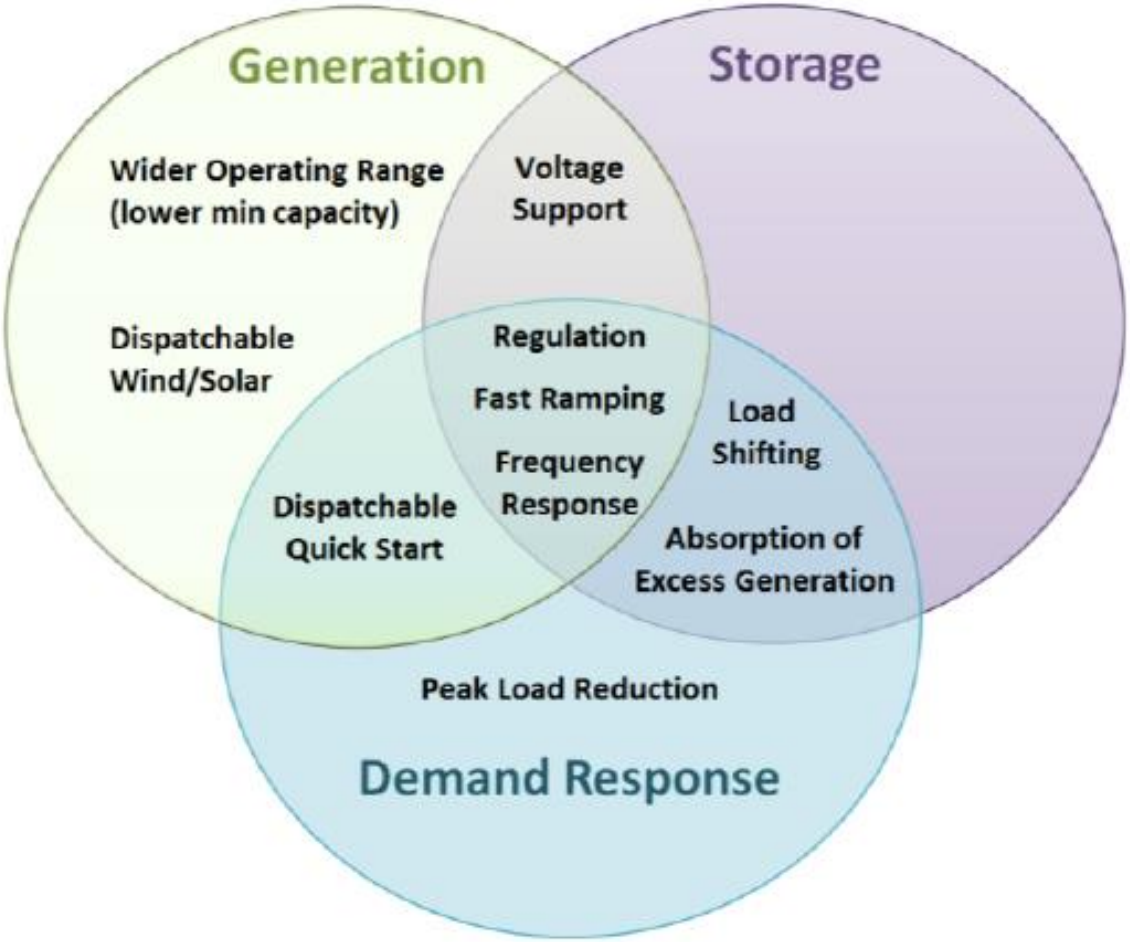
What Lies Beyond Capacity Markets
www.raponline.org/document/download/id/6041

Demand Response as a Power Resource in the US
http://www.raponline.org/document/download/id/6597

Nachfragesteuerung im deutschen Stromsystem
http://www.raponline.org/document/download/id/6658

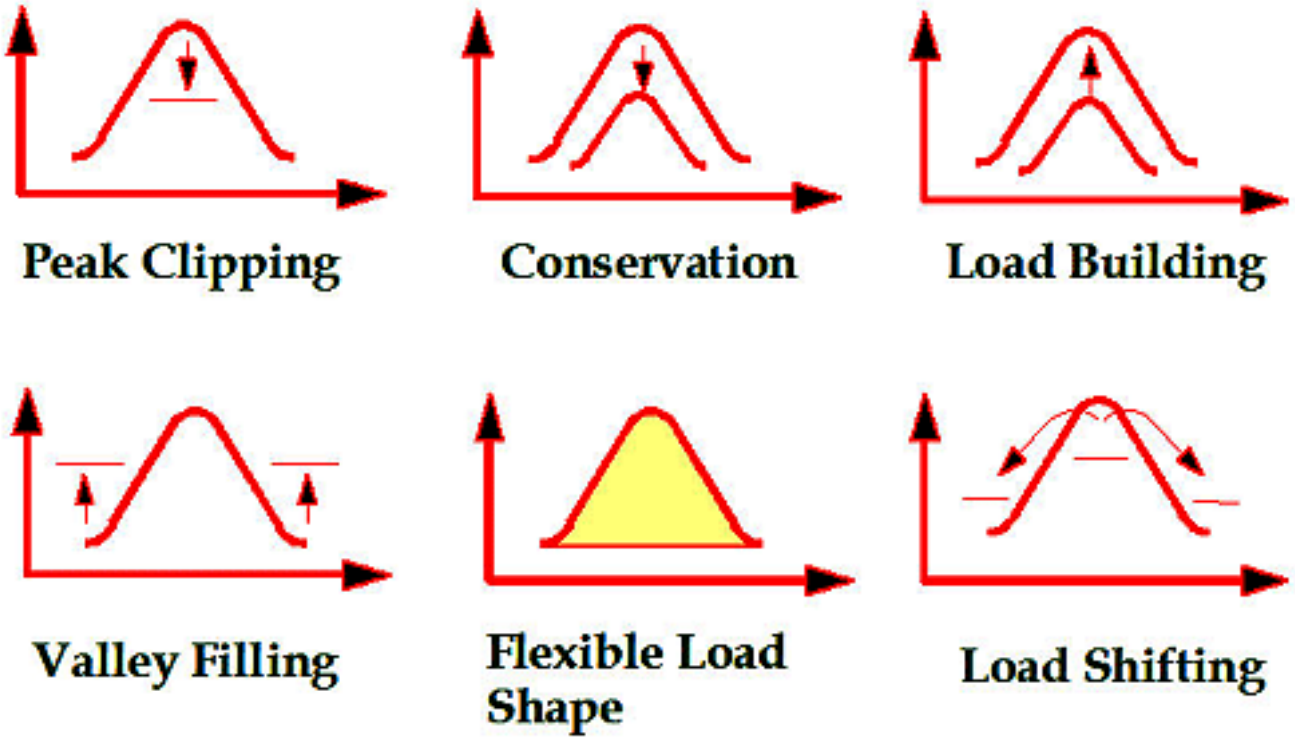
Examples of Demand Response Providers in US Forward Capacity Markets
www.raponline.org/document/download/id/4546

System Resources



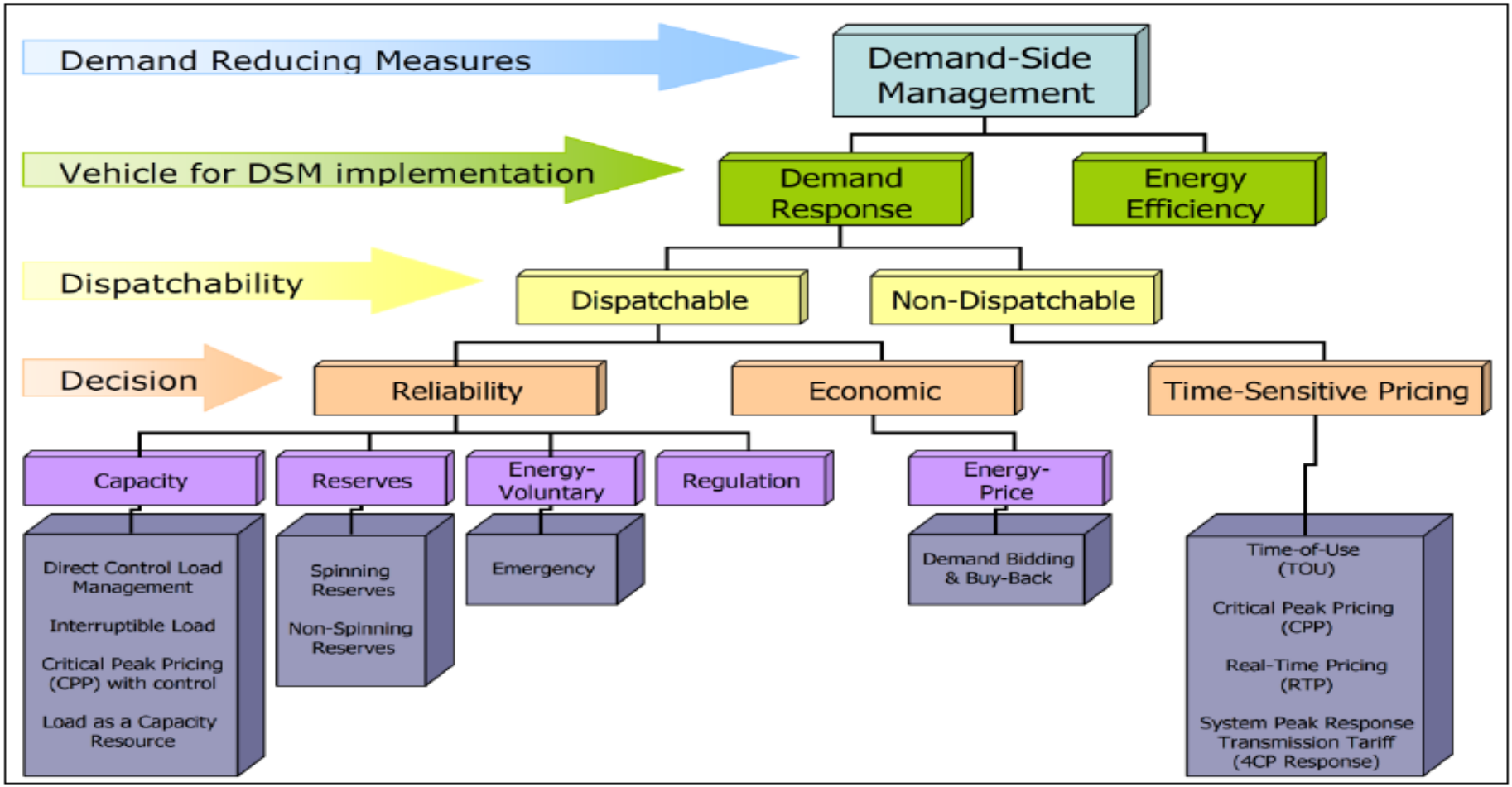
Source: Adapted from Liu (2012)

Using Demand Response to Shape Load



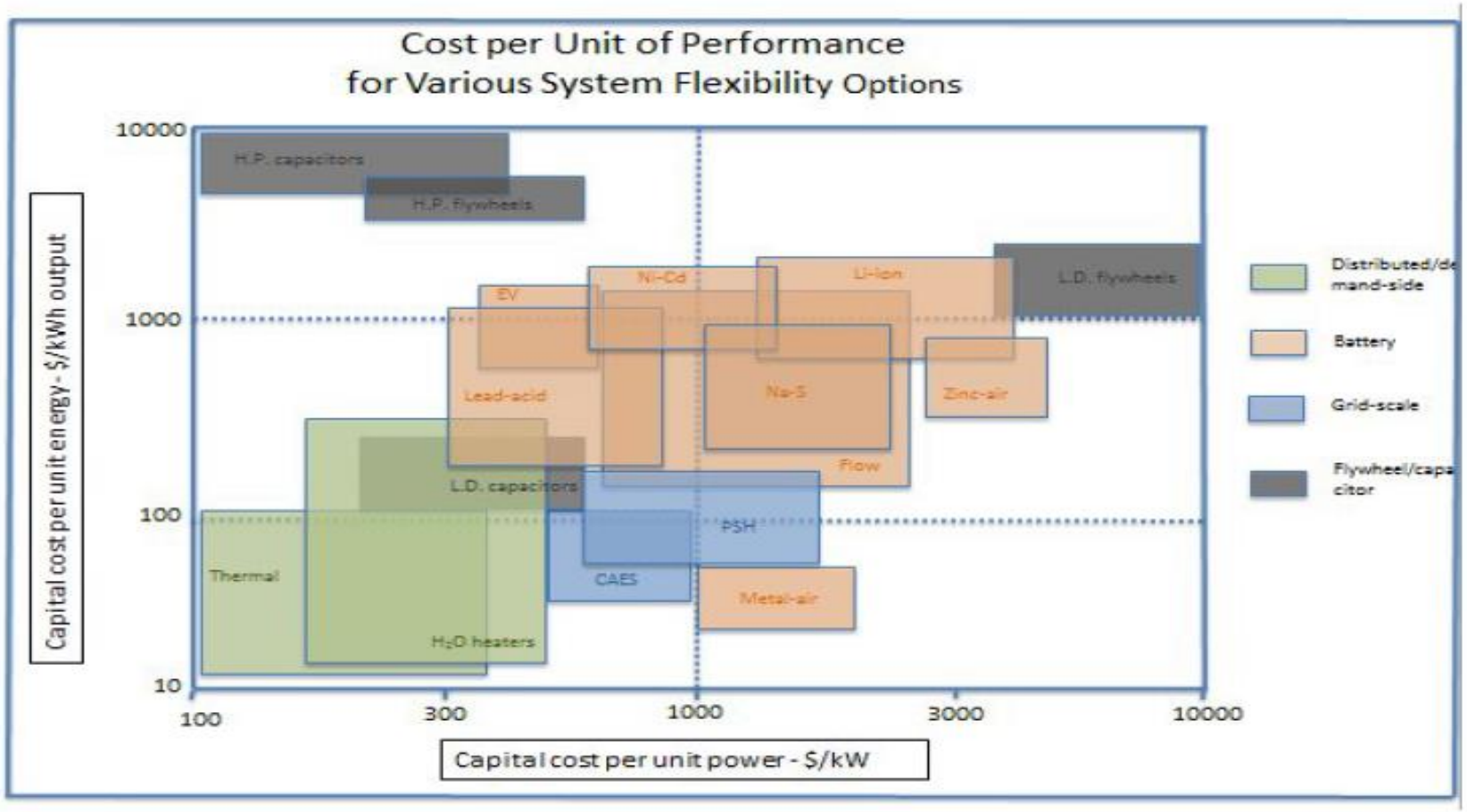
Source: http://www.cp.tatapower.com

Demand-Side Management Categories

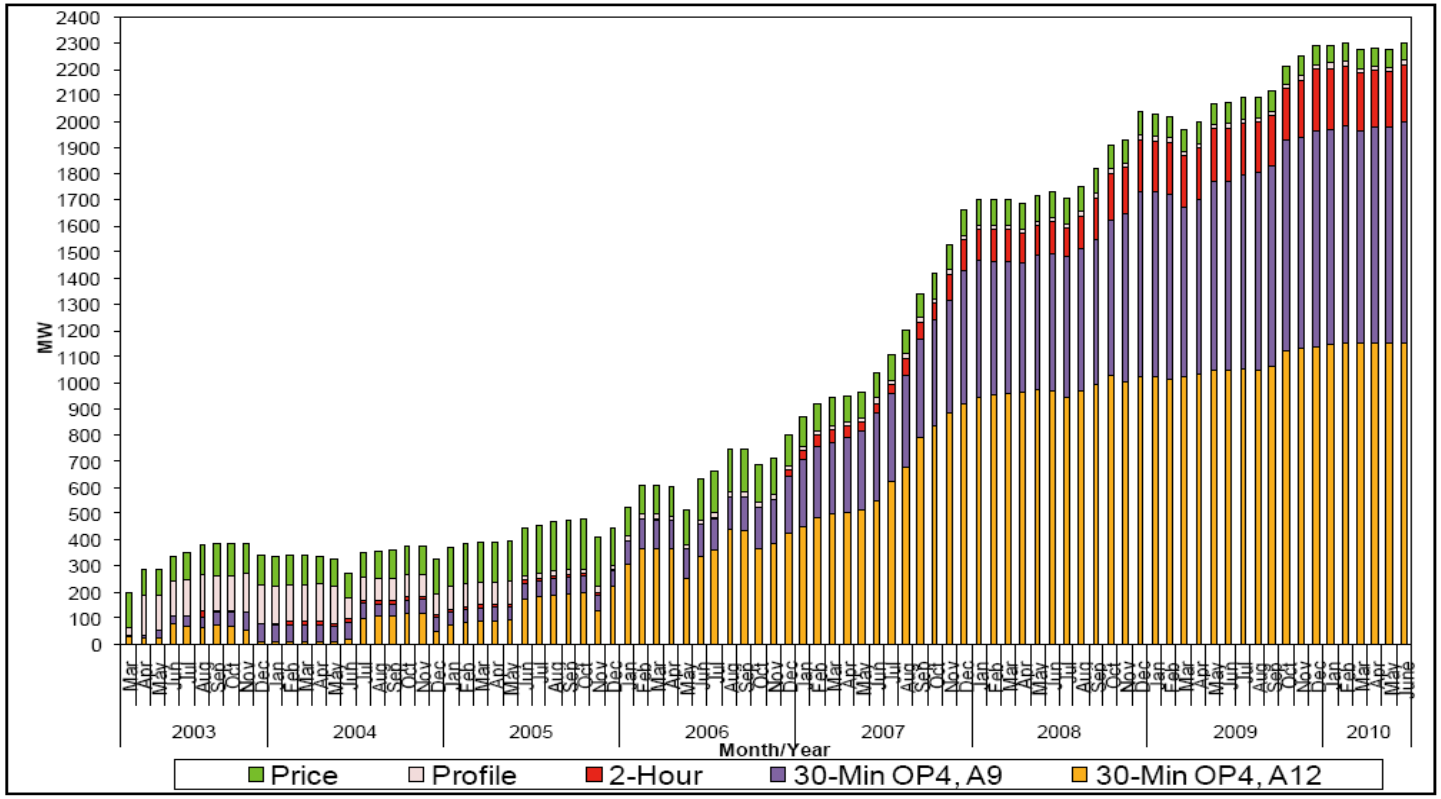


Source: NERC (2011)

Flexibility Options and Costs

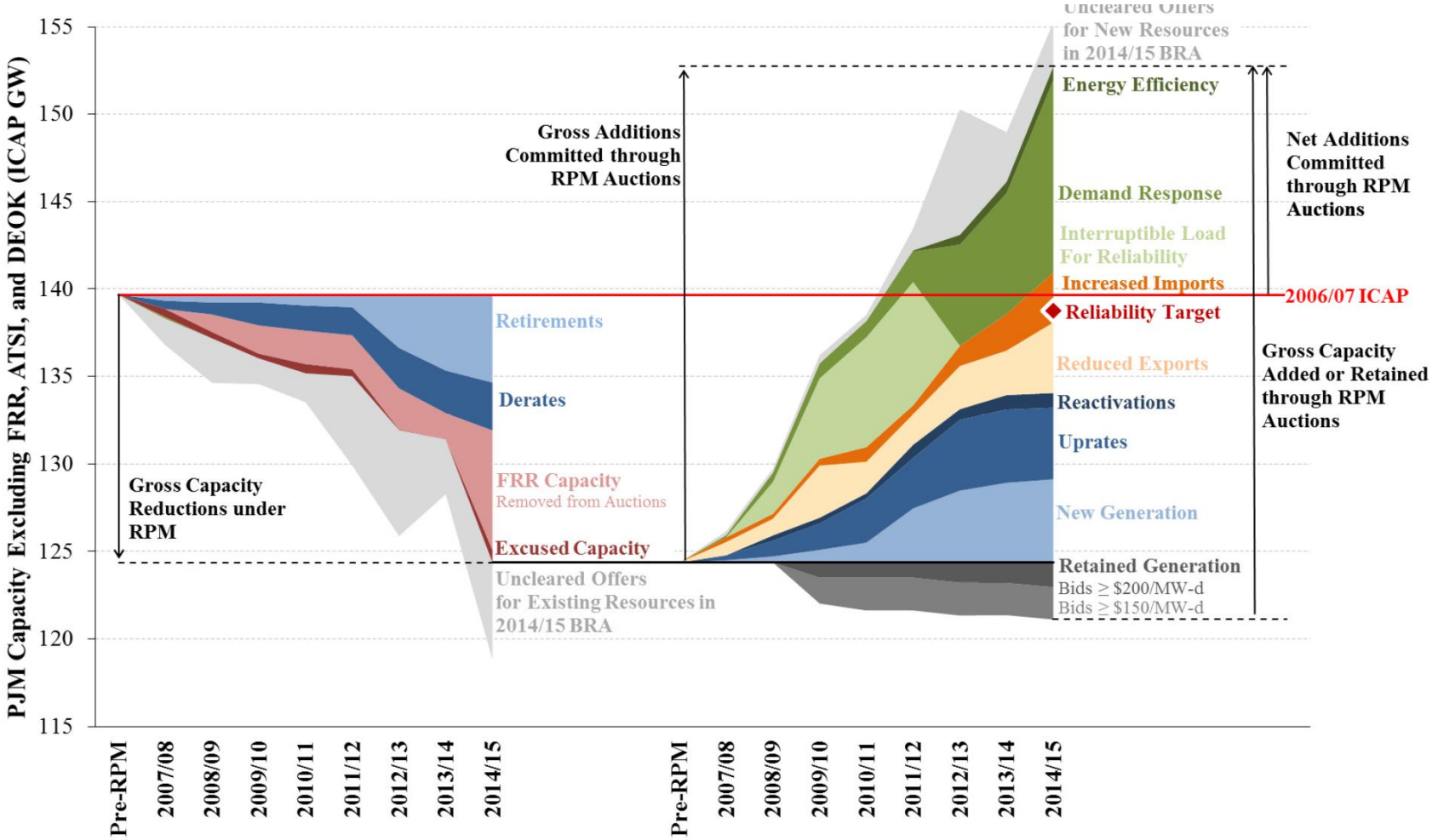


Growth of Demand Response Resources in New England

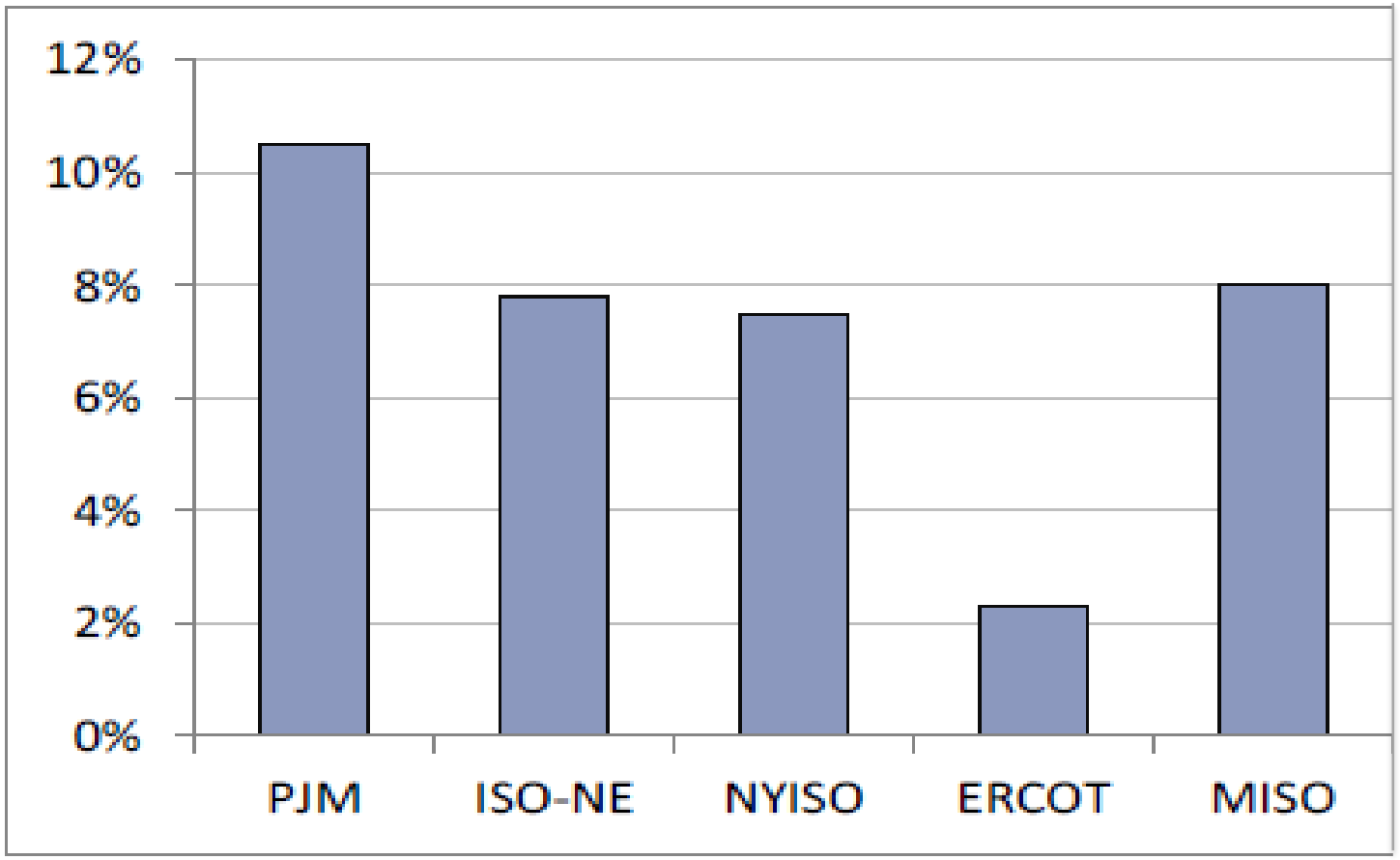


Hurley, *et al*. (2013). *Demand Response as a Power System Resource: Program Designs, Performance, and Lessons Learned in the United States*. Montpelier, VT: RAP.

Impact of DR on Peak Demand in PJM



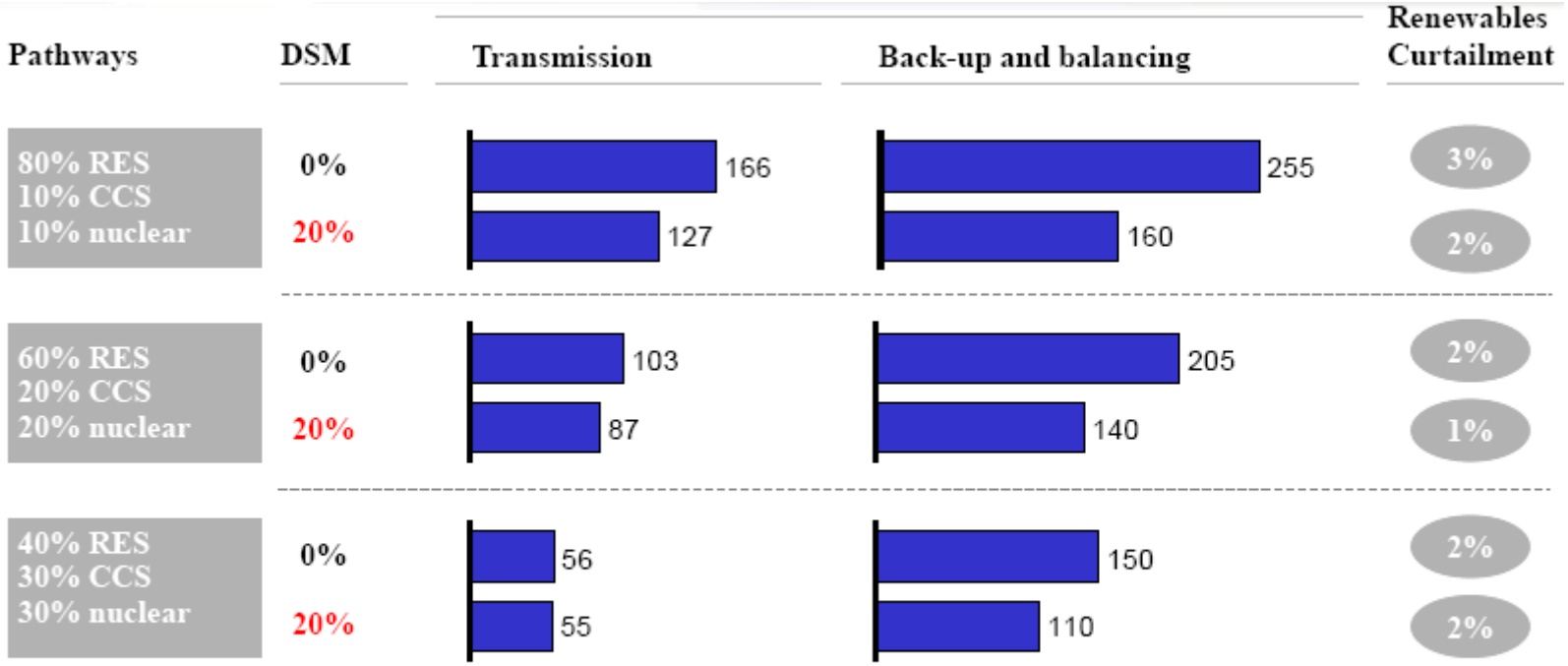
Percent of Peak Demand Covered by DR in 2010



Source: FERC (2011)

Benefits of Demand Response

Demand Response Can Reduce Grid Investments and Minimize Curtailment of Low-Carbon Resources



EU transmission and additional generation requirements by 2050 (GW) to reduce greenhouse gas emissions to 80% below 1990 levels

Source: European Climate Foundation, *Roadmap 2050*

Demand-side Participation Reduces Cost of Reliability

- **Calculation for PJM for the latest auction** :
  - Total consumer savings $1.2 billion due to demand-side resources
  - Savings 10% to 20% region-wide, 30% in the constrained power zone

- **Calculation for New England (single auction):**
  - Demand-side resources reduced costs by ~$290 million
  - Savings >15% of total cost

Demand-Response Proven Reliable—Better than Generation Resources?

- **Demand-response** (in aggregate) to ISO-NE orders to reduce load:
  - 653 out of 669 MW (**98%**) responded, June 2010
  - 855 out of 939 MW (**91%**) responded, July 2011
- Response of **Generators** to ISO-NE dispatch orders in Sept, 2010 *far from reliable*
  - 393 out of 986 MW (**40%**) of 90 online units
  - 673 out of 936 MW (**72%**) of the 56 start-ups
  - ***851 MW deficiency***

“Level Playing Field” for DR Changed Markets

FERC Directives (2007 -2011):

- System operators must give equal consideration to bids from DR and traditional generators
- DR aggregators may bid the collective demand of residential customers as a single market “resource” into all markets
- If DR is helping to balance supply and demand in the same way as traditional generators, they must be compensated equally
- System operators must pay for resources based on their operational capabilities (speed, precision)

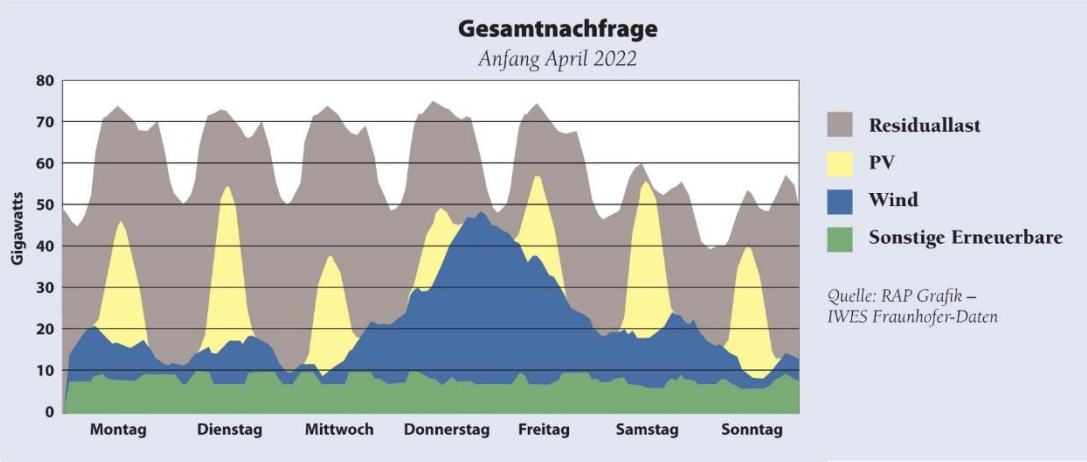
DR Lessons to be learned from US

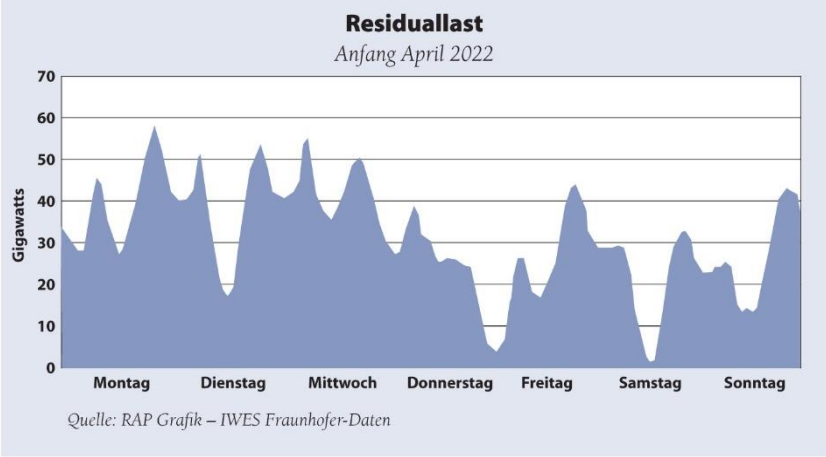
- DR is a reliable and low-cost resource i.e. to cover peak demand
- System services payments should be related to their system quality i.e. speed, load following.
- DR need to bid successfully into markets on a competitive level with other resources
- DR success dependent on predictable payments
- Defined regulatory guidelines has been key objective for fair competition between all resources

Major Points Today

1. **What** is Demand Response (DR)? Types of DR resources - findings from U.S .
2. New challenge - Integrating growing percentages of renewables
3. **Barriers** for DR in the German system

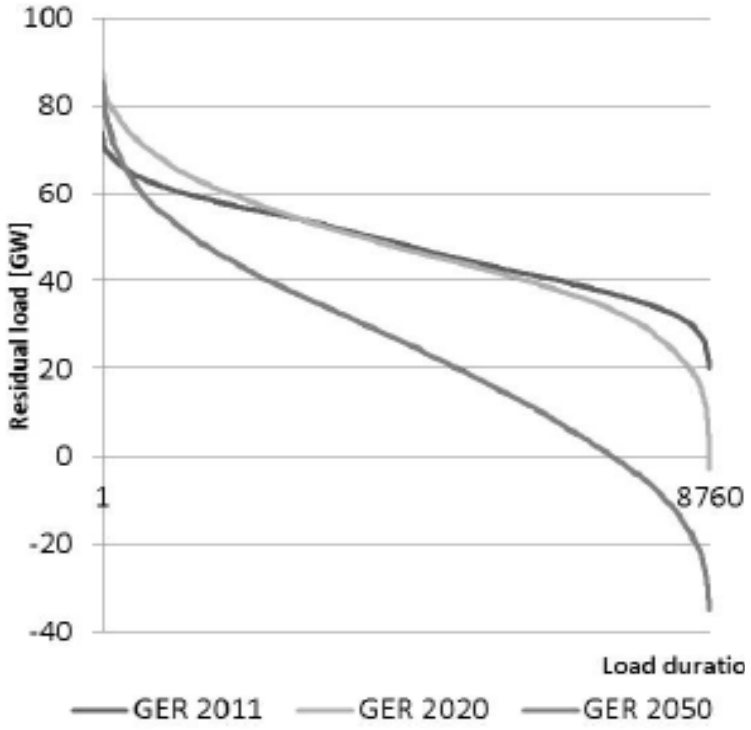
Net Demand in Germany

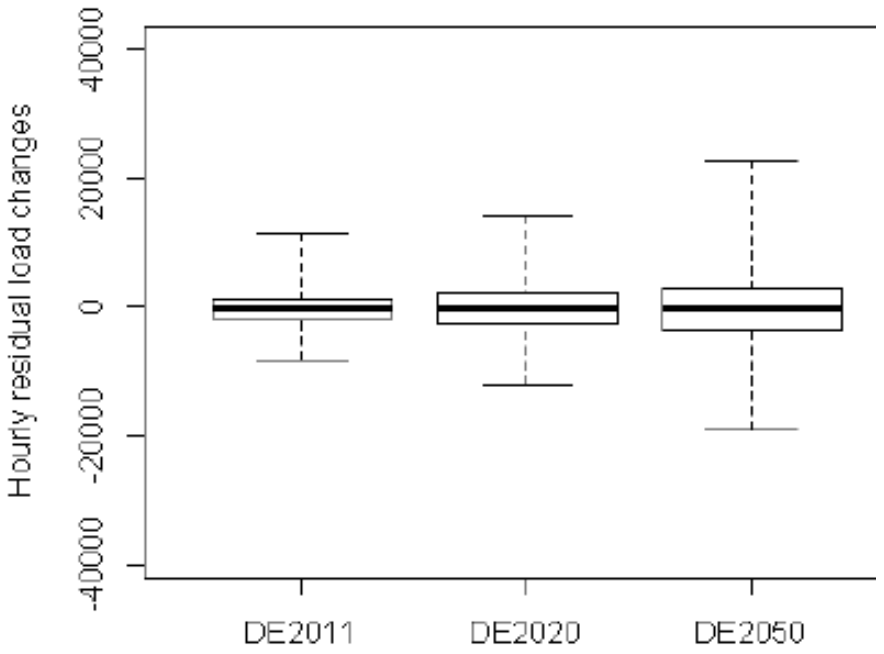




Total demand (above), compared to net demand in Germany by 2020

Flexibility Requirements in Germany



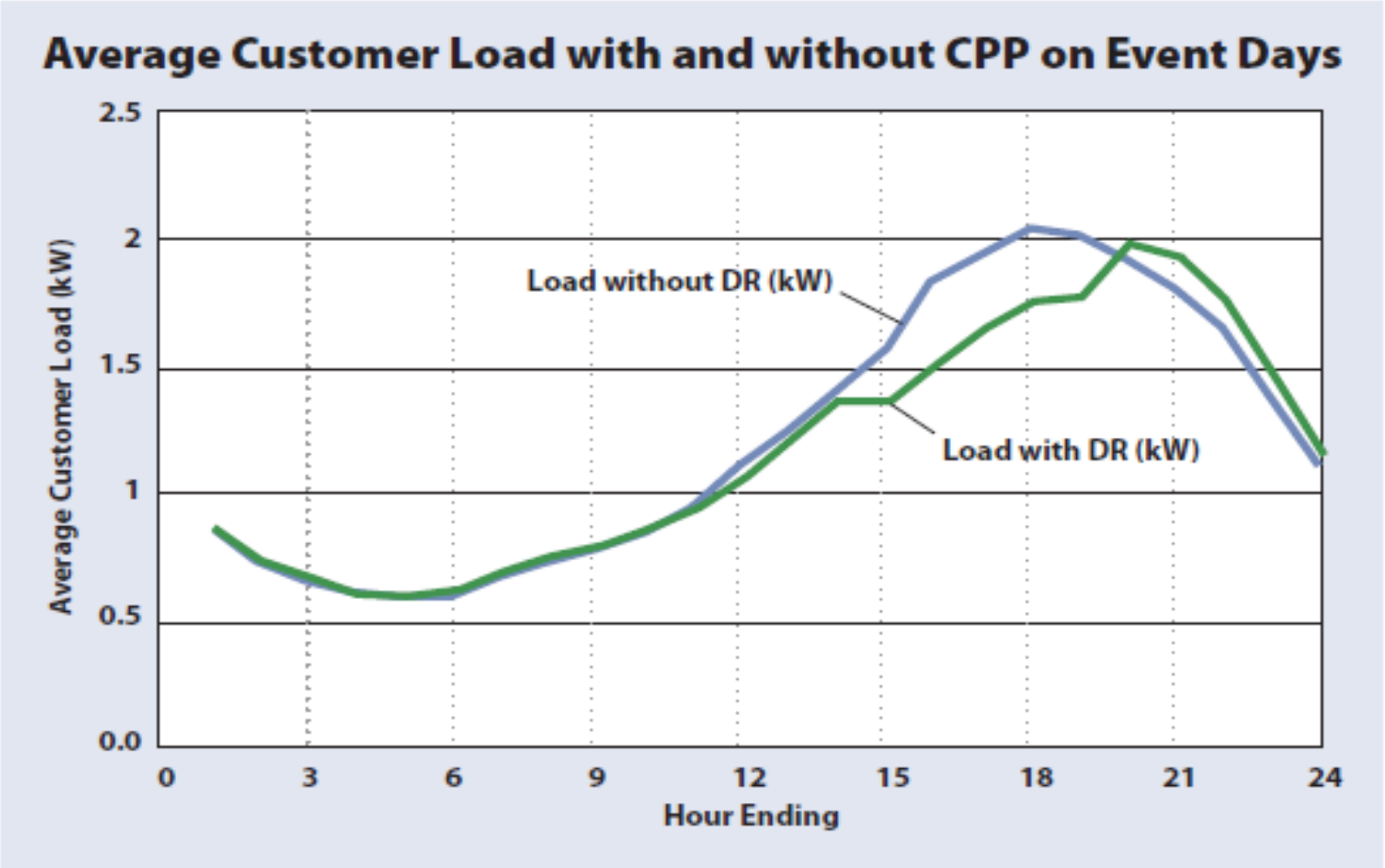


Net demand: a. Annual load duration curve

b. Boxes plot hourly change

Source EWI 2013, Flexibility in Europe‘s power sector

Demand in California is Similar



Source: Faruqui, *et al.* (2012). *Time-Varying and Dynamic Rate Design*. Montpelier, VT: RAP.

… Led California ISO to Requirements on Flexible Capacity:

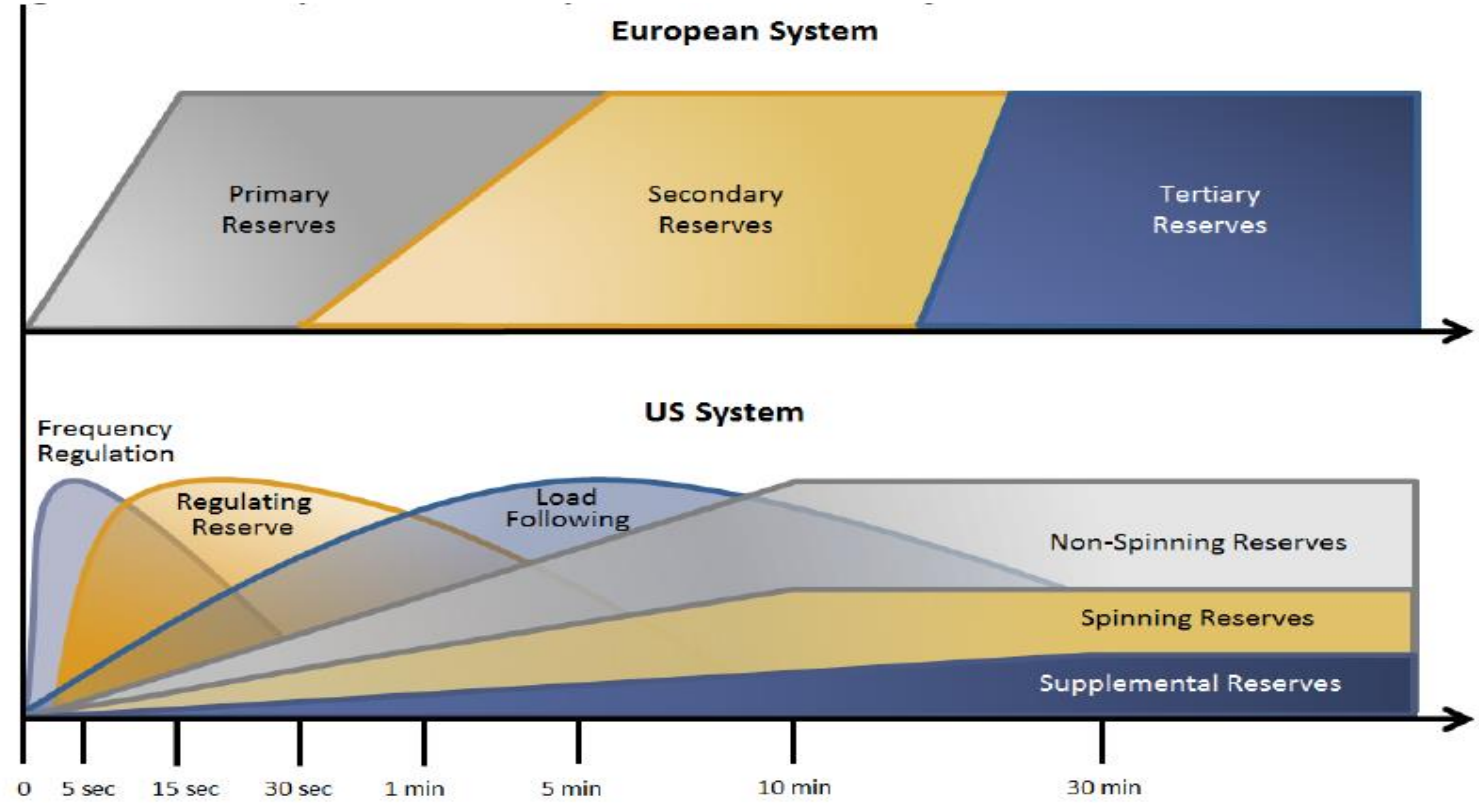
- How fast can the resource ramp up or down?
- How long can the resource sustain an upward or downward ramp?
- How quickly can the resource change its ramp direction?
- How far can the resource reduce output and not encounter emission limitations?
- How quickly can the resource start?
- How frequently can the resource be cycled on and off?

"Resource" includes supply, demand, and storage

CAISO Defined Three Types of Capability

Maximum Continuous Ramping	Load Following	Regulation
Definition The MW amount the net load[1] is expected to change in either an upward or a downward direction continuously in a given month.	**Definition** The maximum MW the net load is expected to change in either an upward or a downward direction in a given hour of a month	**Definition** The amount of regulation service needed to maintain standard frequency in accordance with established reliability criteria
Benefit Ensures that there is sufficient ramping capacity to meet the ISO's largest continuous net load ramp for a particular month. Maximum continuous ramping capacity is expressed in megawatts	**Benefit** Ensures that there is enough unloaded capacity with a defined ramping capability is available to be dispatched on a five-minute basis through the ISO real-time dispatch market application	**Benefit** Ensures the ability to balance net loads and maintain system frequency within the 5-minute real-time market dispatch interval

Balancing Services in US and EU are Defined Differently, but Serve Similar Needs



Sources: Adapted from Ruggero Schleicher-Tappeser diagram based on NERC (2011) and Amprion (2013).

Major Points Today

1. **What** is Demand Response (DR)? Types of DR resources - findings from U.S .
2. **New challenge** - Integrating growing fractions of renewables
3. Barriers for DR in the German system

Challenges for Supply Security

Supply security has 4 dimensions, traditionally served by generation:

1. Resource adequacy (to cover peak demand)
2. Ancillary services
3. Balancing on daily basis (load following)
4. Emergency reserves

and all can be served by DR resources in Germany, too!

Electric Heat Pumps etc. as DR

Demand response with thermal storage is an untapped resource for flexible response

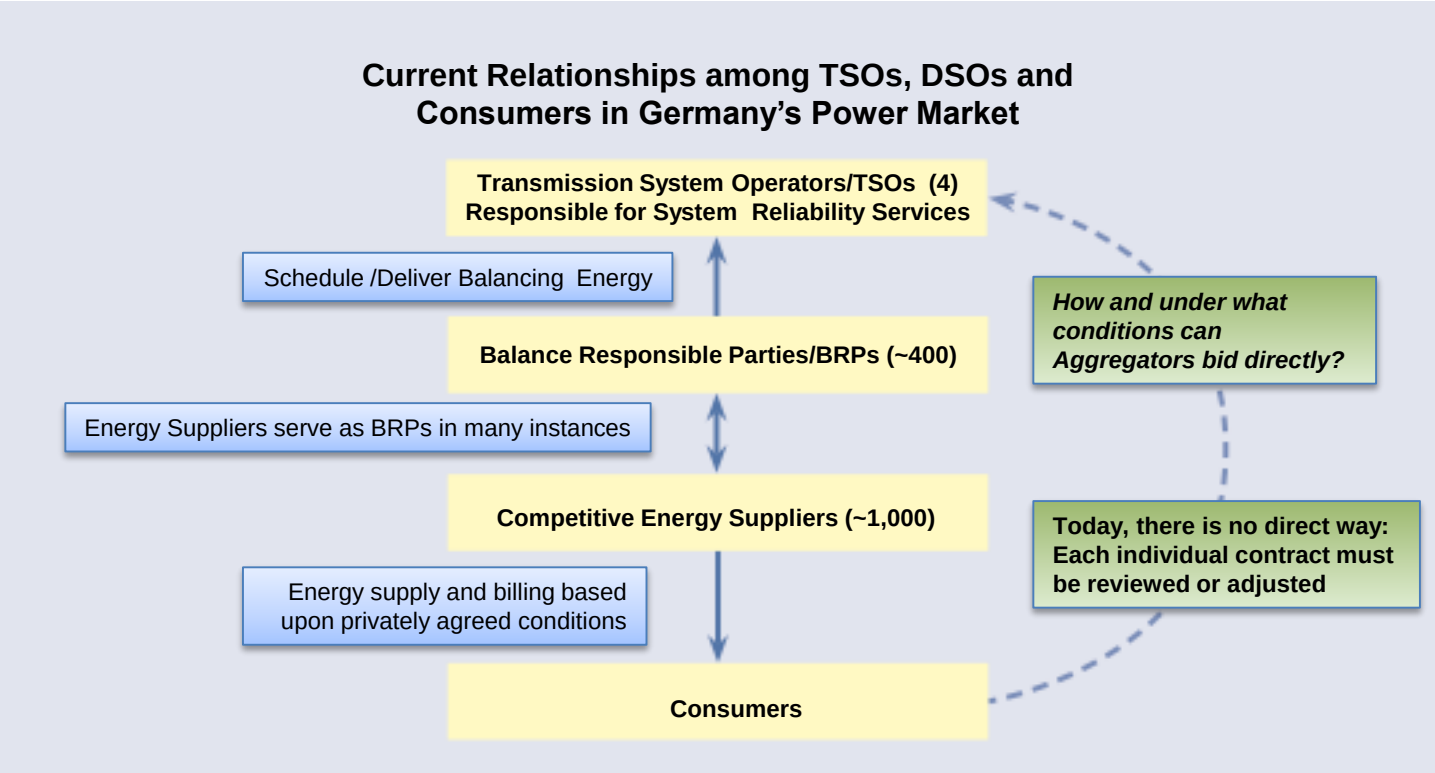
- Can quickly absorb unexpected changes in load and renewable energy generation
- Commercially available technologies exist that add communication and control capability to enable and disable electric water and space heaters for fast response
- Requires high-speed, two-way communication infrastructure

Regulatory Barriers to DR in Germany I

More than 1.5 million residential heat-pumps and thermal storage space-heating systems already have the capability to be enabled and disabled for fast response. By regulation, it may only be used to “balance” local network operation with predictable, ex-ante announcements. It doesn’t affect the supply security requirements of the system.

⇒ Regulated operators should be allowed to interrupt heating systems for system requirements

Regulatory Barriers to DR in Germany II

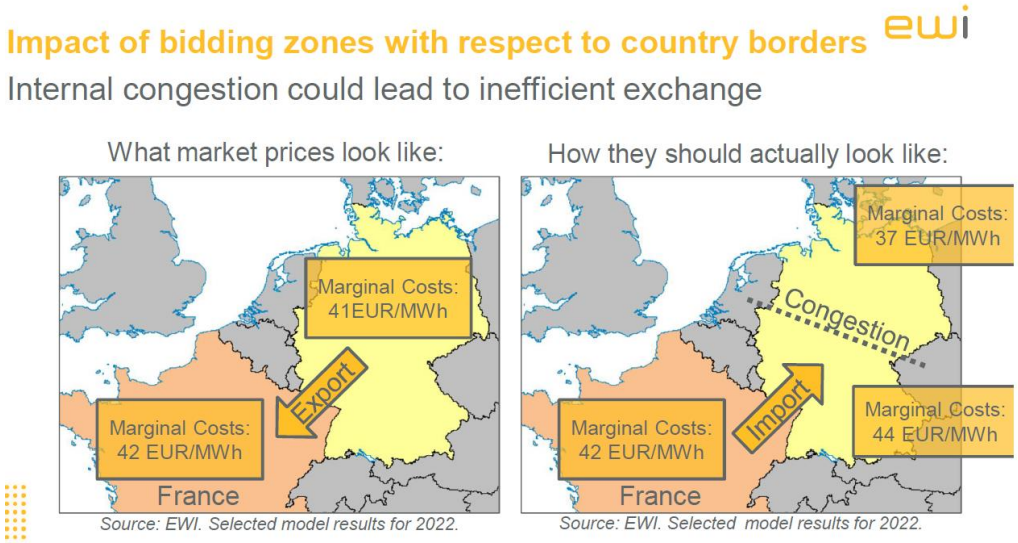


Balancing authorities and suppliers "own" the flexibility of their customers.
This means that aggregators or distribution network operators can't provide flexibility to the system operator without entering into (many!) supply contracts.

Regulatory Barriers to DR in Germany III

Today's bidding zones fail to address grid congestion cost-effectively

System operators have to reshuffle supply to ease congestion, so-called re-dispatch (165 Million Euro in 2012). Demand response is not taken into account.



Over the long-term, bidding zones should be created to reflect congestion realities. In the meantime, re-dispatch should be organized by bids including DR.

Regulatory Barriers to DR in Germany IV

Grid tariffs are not in line with flexibility needs:

- **High demand charges** push customers to limit peak demand and limit flexibility in shifting load
- **Grid fee exemptions/reductions** for industry are related to high load factor and foster inflexibility as well
  - Grid fee reductions on the above mentioned (inflexible) heat pumps are high (up to 80%), no business case for competitive offers for heat pumps serving flexibility

Regulatory Barriers to DR in Germany V

Today the **market revenue to DR is very limited**:

A large amount of **older base-load generation** (with high emissions) feed into the grid at low energy prices, but **are not flexible enough to fill net demand requirements.**

- This results in an oversupply of capacity, lack of market value for flexibility, and also uneconomic curtailment of renewables.

Producing real market prices for flexibility while lowering overall costs *of the Energiewende would be served by:*

- Required disinvestments of inflexible, high-emitting power plants,
- Tapping the full potential of energy efficiency
- Plus other improvements in market design/operations

Markets That Value What is Meeded

Recognize and tap the value of flexibility

- Upgrade scheduling, dispatch, and weather forecasting processes
- Consolidate/integrate balancing areas
- Update system operations to unlock flexibility in the short term:
  - Currently these resources are selected based on bids for capacity costs (standby/availability) and marginal costs (when called)
  - Why not select based on additional flexibility criteria?
- Value and access dispatchability of renewable energy assets
- Employ day-ahead markets for current ancillary services
  - Currently ancillary services auctions run on a weekly (sometimes bi-weekly) basis, but renewables and some demand can't bid on that basis due to forecast uncertainties
  - Why not reduce that auction timeframe to at least day-ahead?

Markets That Value What is Needed

Create investment incentives to ensure flexibility in the long term

- Develop tools to **better forecast net demand** and **forward value of critical capabilities**
- Adapt **forward mechanisms to send investment signals** that will capture the value of flexible resources (demand and supply)
- **Encourage DR aggregators**, flexible generation providers, **and similar new entrants** wherever possible consistent with overall market structure

Markets That Value What is Needed

Recognize the value of efficiency, e.g. System Benefits Study "German Layer Cake"

- Total consumer savings $1.2 billion due to demand-side resources
- Calculates the value of end-use efficiency to the German power system in the range of € 0.11-0.15 per kilowatt-hour (in levelized avoided costs)
- International experience shows that efficiency investments run in the range of one-third to one-half of these values
  - Net economic benefits to Germany are potentially huge

Effectively tap that value by:

- Investing in end-use efficiency up to its full system benefits
- Consider location-specific energy efficiency as a competitive alternative to transmission.
- If a separate capacity/capabilities market is created, allow energy efficiency to compete.

About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power and sector. RAP has deep expertise in regulatory and market policies that:

- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

Learn more about RAP at www.raponline.org

Andreas Jahn, senior associate; ajahn@raponline.org

The Regulatory Assistance Project™
Beijing, China • **Berlin, Germany** • Brussels, Belgium • Montpelier, Vermont USA • New Delhi, India
Rosenstrasse 2 • D – 10178 Berlin • *phone:* +49 30 2844 901-21
www.raponline.org