Competition between different flexibility alternatives in electricity markets with a high share of intermittent renewable energy sources

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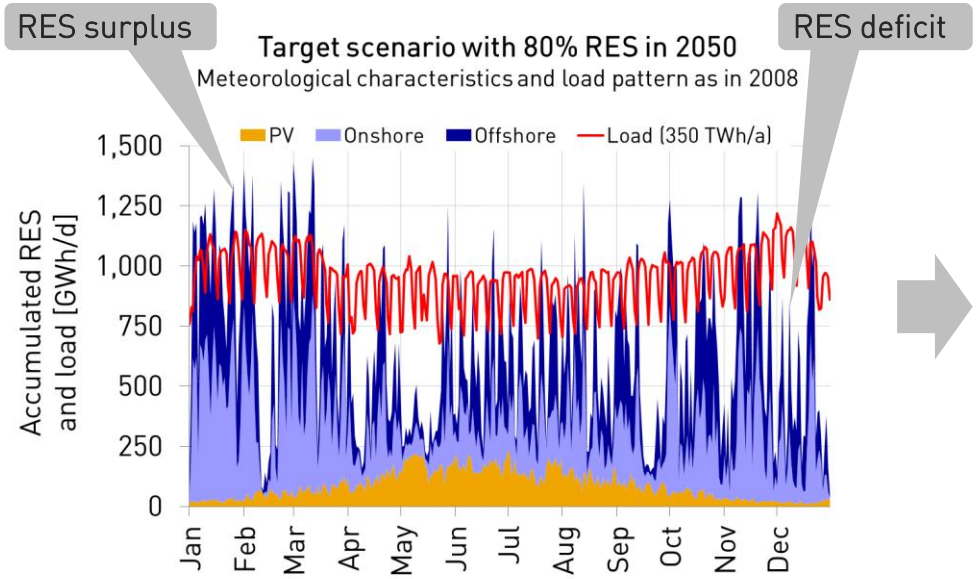
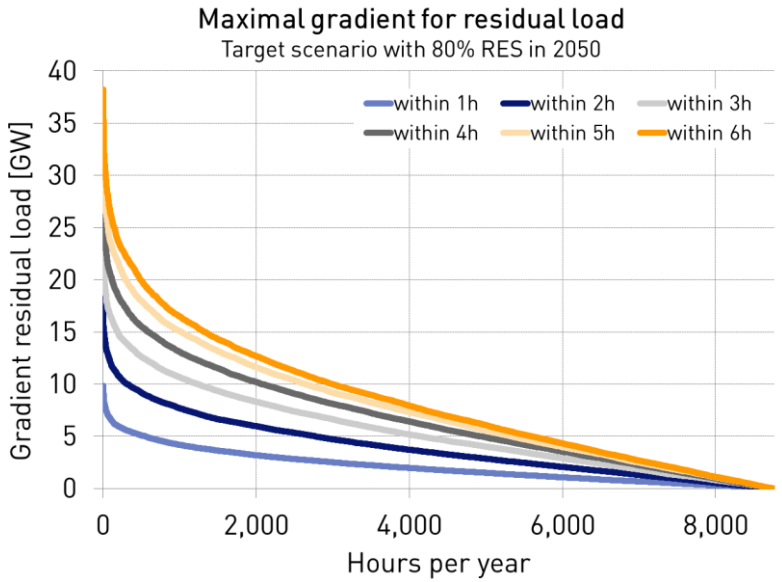
Structure

1. Need for higher system flexibility
2. Measures to increase system flexibility
3. Competition between different flexibility alternatives
4. Conclusion

1. Need for higher system flexibility

- The present generation structure needs to become more flexible to integrate the increasing share of intermittent renewable energy sources (RES) that causes higher load gradients
- To balance RES deficits and surpluses, flexibility measures on the generation and demand side are required





Source: Own calculations based on reference scenario with 54% RES and target scenario (II_B) with 80% RES for the energy concept of the German government

2. Measures to increase system flexibility

Overview

Generation	Demand	Grid	Storage
› Flexible thermal power plants › RES curtailment	› Demand shift (changes in user behavior) › Increase (substitution)	› Reconstruction › Expansion	› Generation shift › Demand shift using inherent storage

Increased flexibility of the entire energy systems

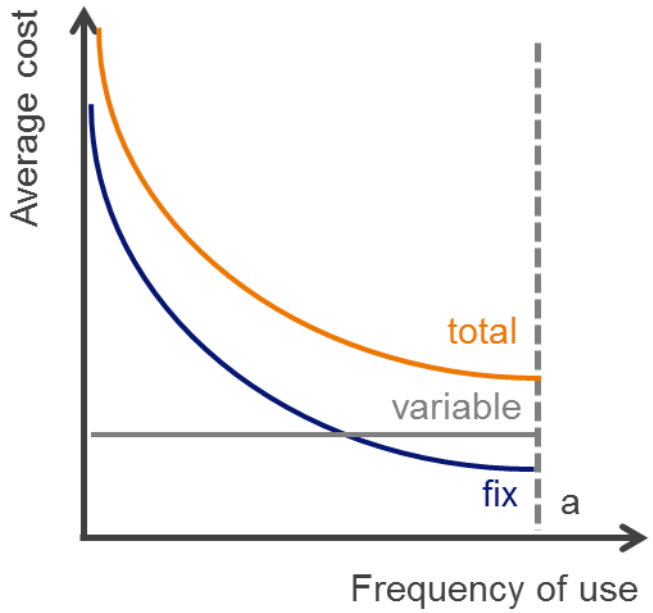
- The suitability of each measure depends on the specific RES surplus or deficit situation
- *NO* single solution, a mix of different measures is required
- An appropriate market design that enables competition between all balancing alternatives is essential to meet the required level of flexibility at lowest costs

2. Measures to increase system flexibility

Supply side measures

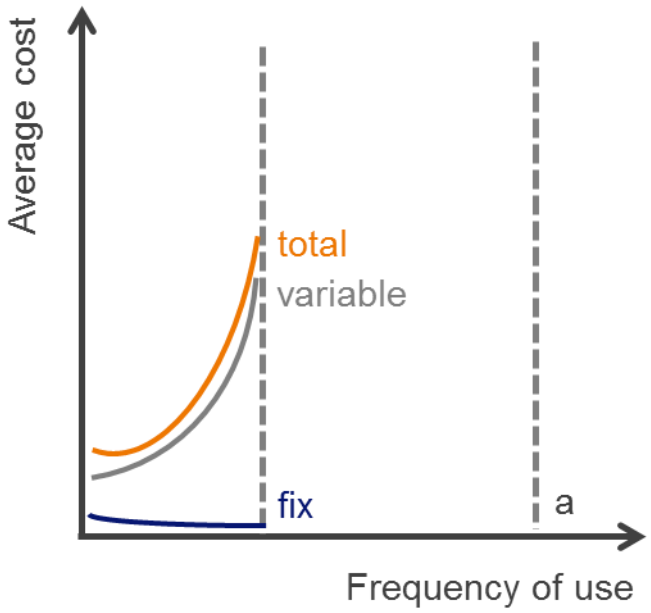
Flexible thermal power plants

- Balancing of RES deficits
- High availability and load change ability, e.g. OCGT, enables usage of inherent storage feature of fossil and/or bio fuels



RES curtailment

- Balancing of RES surpluses
- Only suitable for a few hours per year, for frequent utilization reduces cost effectiveness of RES units
- Last measure since generation cost of weather-dependent RES are low

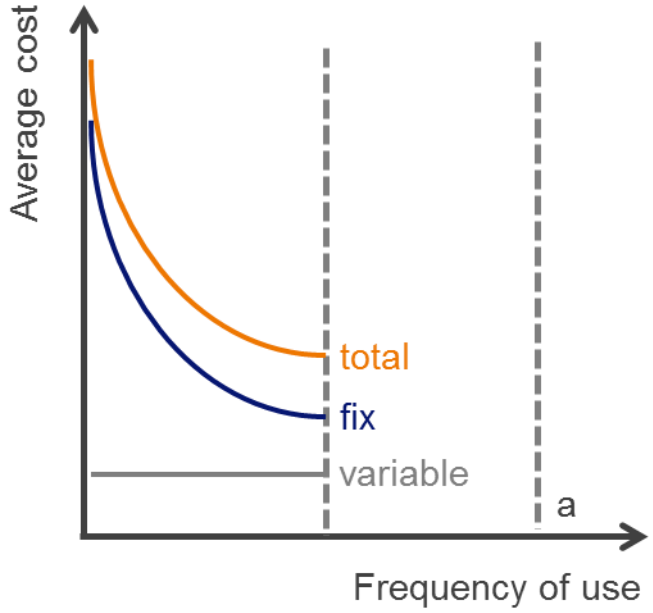


2. Measures to increase system flexibility

Demand side measures

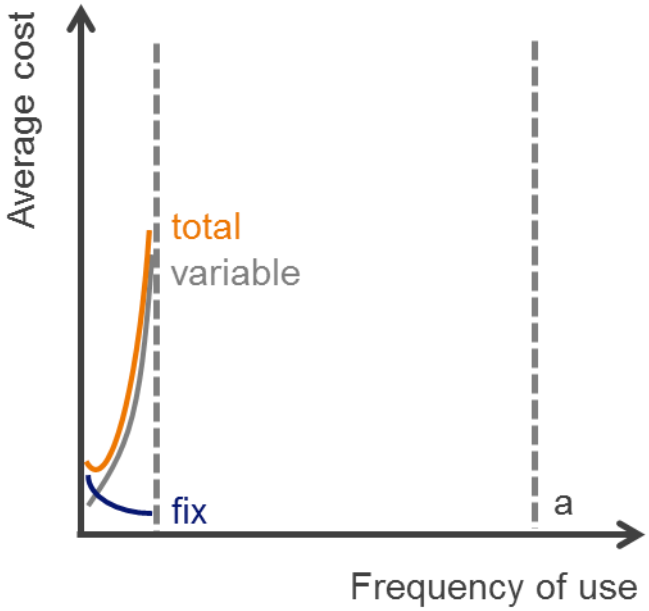
Increase (substitution)

- Balancing of RES surpluses
- Direct or indirect replacement of fuel-driven energy applications
- Variable costs are supposed to reflect willingness to pay to substitute other energy sources by electricity



Demand shift (changes in user behavior)

- Balancing of RES surpluses and deficits
- Changes in electricity usage of consumers due to changes of electricity prices over time
- Requires enhanced IT to provide short-term signals for consumers

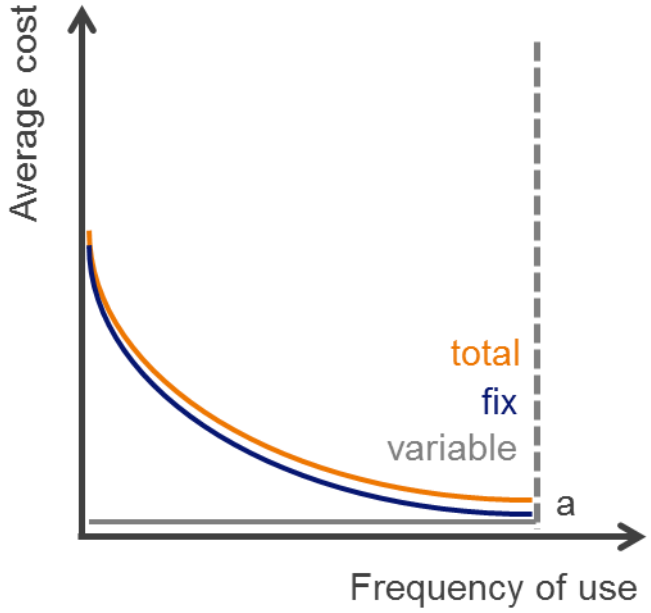


2. Measures to increase system flexibility

Supply and demand side measures

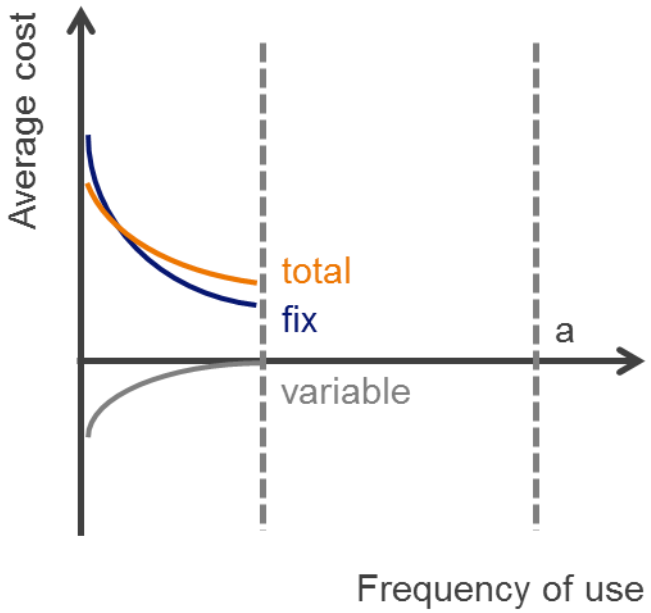
Grid

- Balancing of RES surpluses and deficits
- Indirect increase of system flexibility due to grid reconstruction and expansion
- Equalization of widely spread, weather-dependent RES generation reduces load gradients



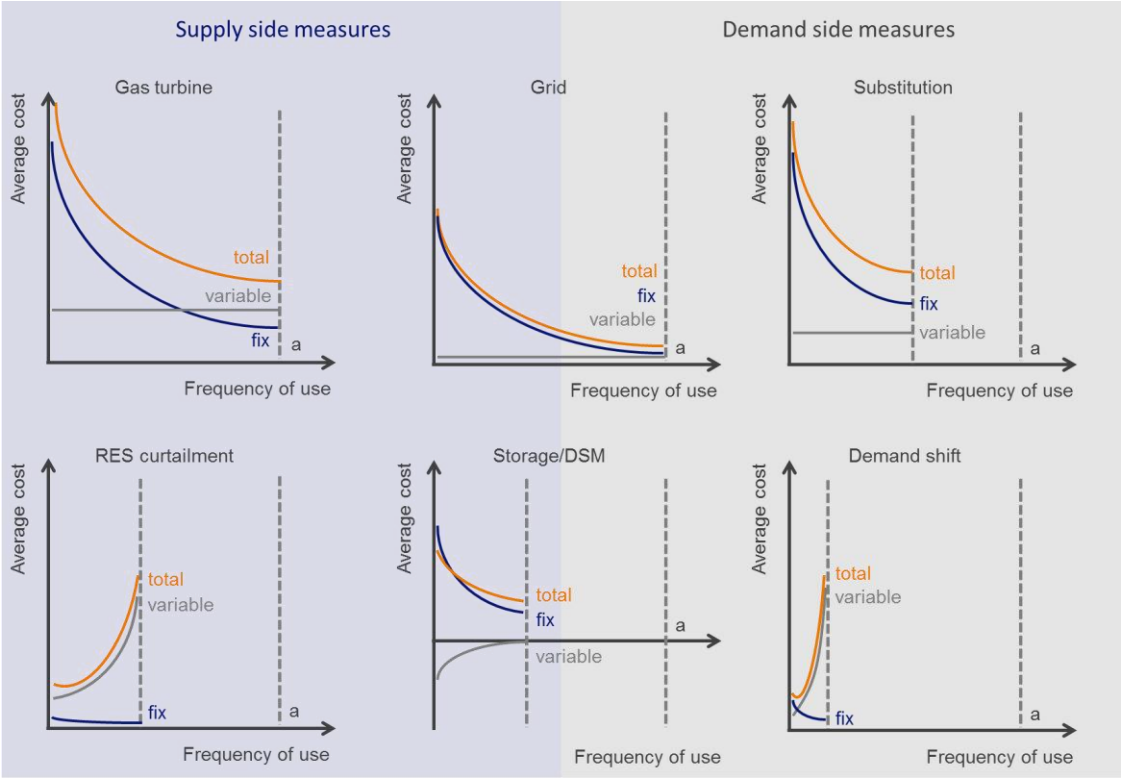
Storage/demand side management (DSM)

- Balancing of RES surpluses and deficits
- Inter-temporal link between balancing of supply and demand mismatches offers arbitrage possibilities, i.e. variable costs are ≤ zero



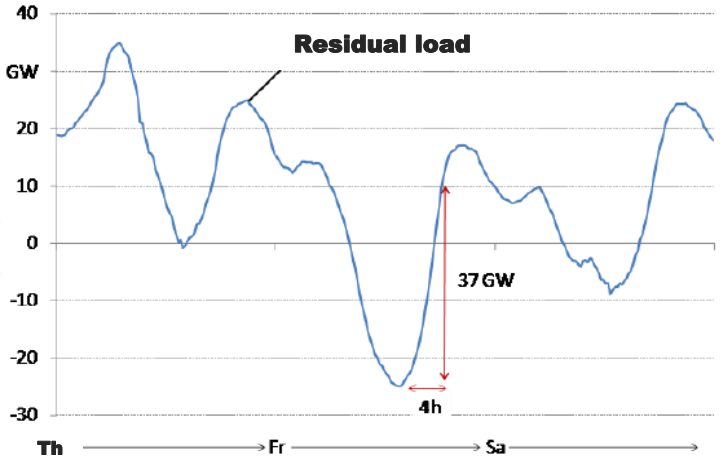
3. Competition between different flexibility alternatives

- The total costs to utilize a certain flexibility measure are dependent on the frequency of use
- To meet the required system flexibility at lowest costs, a mix of different measures is needed
- To achieve competition between different flexibility alternatives, future energy markets are supposed to reflect the time-dependent value of flexibility



4. Conclusion

- To balance RES deficits and surpluses, a **mix of flexibility measures** on the generation and demand side are required **to integrate** the increasing share of intermittent **RES that causes higher load gradients**
- Since the individual flexibility alternatives affect different parts of the energy systems, the **suitability** of each measure **depends on the specific RES** surplus or deficit **situation**
- An appropriate market design that enables **competition between all balancing alternatives** is essential to meet the required level of flexibility at lowest costs
- **Future energy markets are supposed to reflect** the time-dependent value of flexibility, i.e. the **ability to balance different load gradients**



Source: cf. IAEW and consentec, 2011, p. 17.

Thank you for your attention!

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