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GTZ-TERNA Wind Energy and Development Dialogue
'Grid Integration of Wind Energy', Berlin, October 11, 2007

IEA Activities for the Advancement of Wind Power Integration into Power Systems

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Berlin

- **IEA Wind Agreement Task 25**
- **Gleneagles G8 Study on Renewables**


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Task 23
Offshore Wind Energy Technology Deployment
Web Site
TASK 24
WIND/HYDRO
INTEGRATION WEB SITE
Task 25
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Strategic Plan 2003-2008
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State-of-the Art Report Task 25

Design and operation of power systems with large amounts of wind power

State-of-the-art report

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Publication planned 11/2007

Task 25
Design and Operation of Power Systems with
Large Amounts
of Wind Power

State-of-the-art of design and operation of power systems with large amounts of wind power - summary of IEA Wind collaboration

Hannele Holttinen,
Operating Agent, IEA WIND Task 25

VTT
Business from technology

IEA WIND Task 25

OBJECTIVE:

to analyse and further develop the methodology to assess the impact of wind on power systems

Started in 2006, duration 3 years. 11 countries participate.

GOALS:

- Provide an international forum for exchange of knowledge
- State-of-the-art: review and analyse the studies and results so far
  - methodologies and input data, system operation practices, planning methodologies and modifications that have been necessary with high penetration, concepts and technologies enabling enhanced penetration
- Formulate guidelines:
  - recommended methodologies and input data when estimating impacts and costs of wind power integration
- Quantify the impacts of WP on power systems
  - range of impacts/costs; rules of thumb

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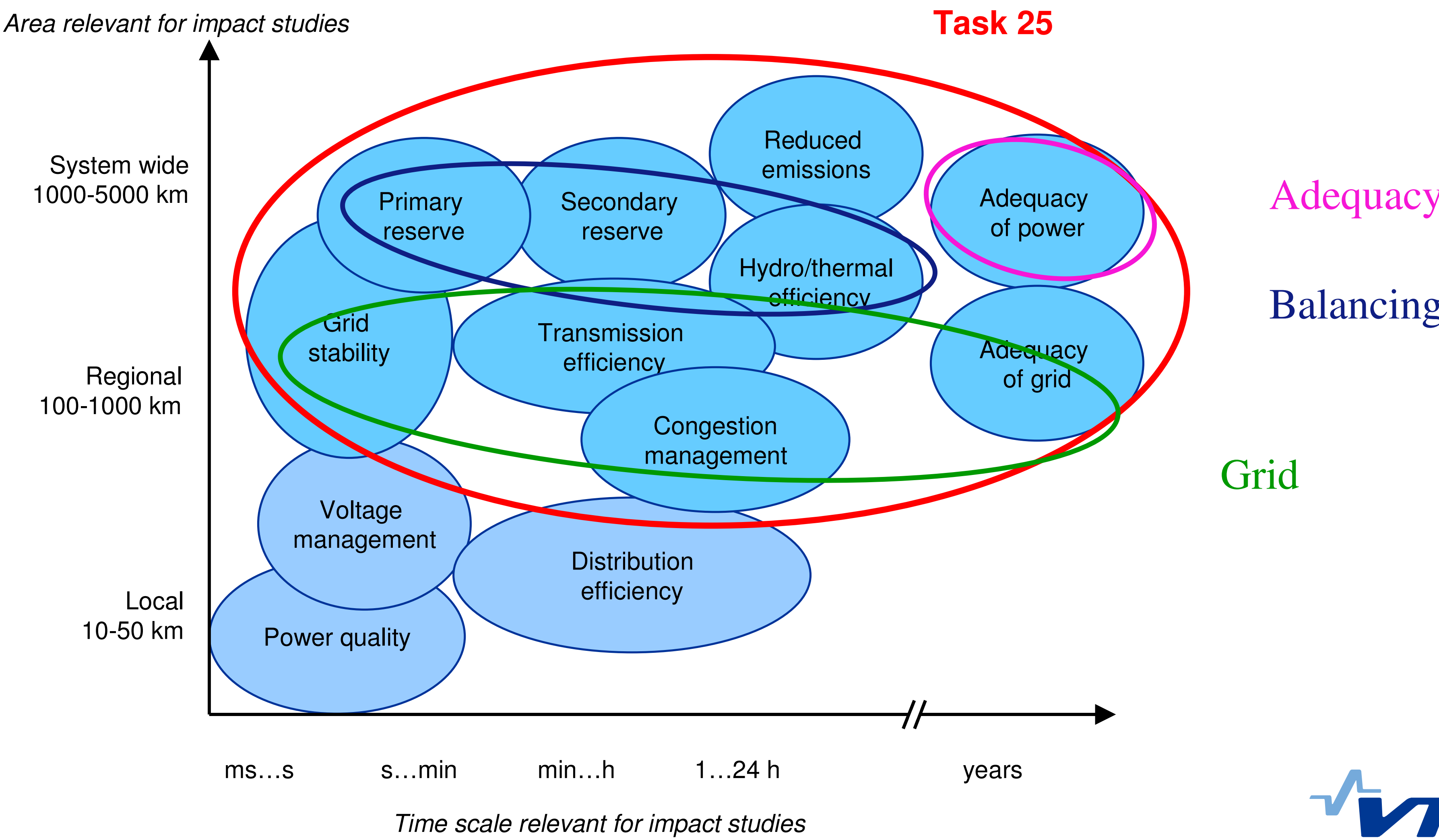
Design and Operation of Power Systems with
Large Amounts of Wind Power

Integration costs

- Costs for power system for accommodating wind power
  - Not covered by wind power producers (investment costs for grid connection, …)
  - Part of the these costs may be allocated to wind power in some power systems (network charges, imbalance payments, …)
- Should be compared with the benefits of wind power
- Information needed for
  - Policymakers to ensure that the benefits of increasing wind energy will not be offset by negative impacts
  - System operators, regulators to ensure fair treatment of all producers: market design and rules, tariffs, allocation of costs

Wind power in the power system: impacts on reliability and efficiency



Recent studies: levels of wind power studied

Nordic: 69 GW peak load, up to 20 GW wind (29 %)

UK: 65 GW peak, up to 26 GW wind (40 %)

Denmark: up to 100 % penetration

Ireland: 7 GW peak, up to 3.5 GW wind (54%)

Germany: 78 GW peak, up to 36 GW wind (46 %)

Netherlands: 16 GW peak, up to 6 GW wind (39 %)

Portugal: 10-12 GW peak, up to 5 GW wind (50 %)

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Recent studies in USA

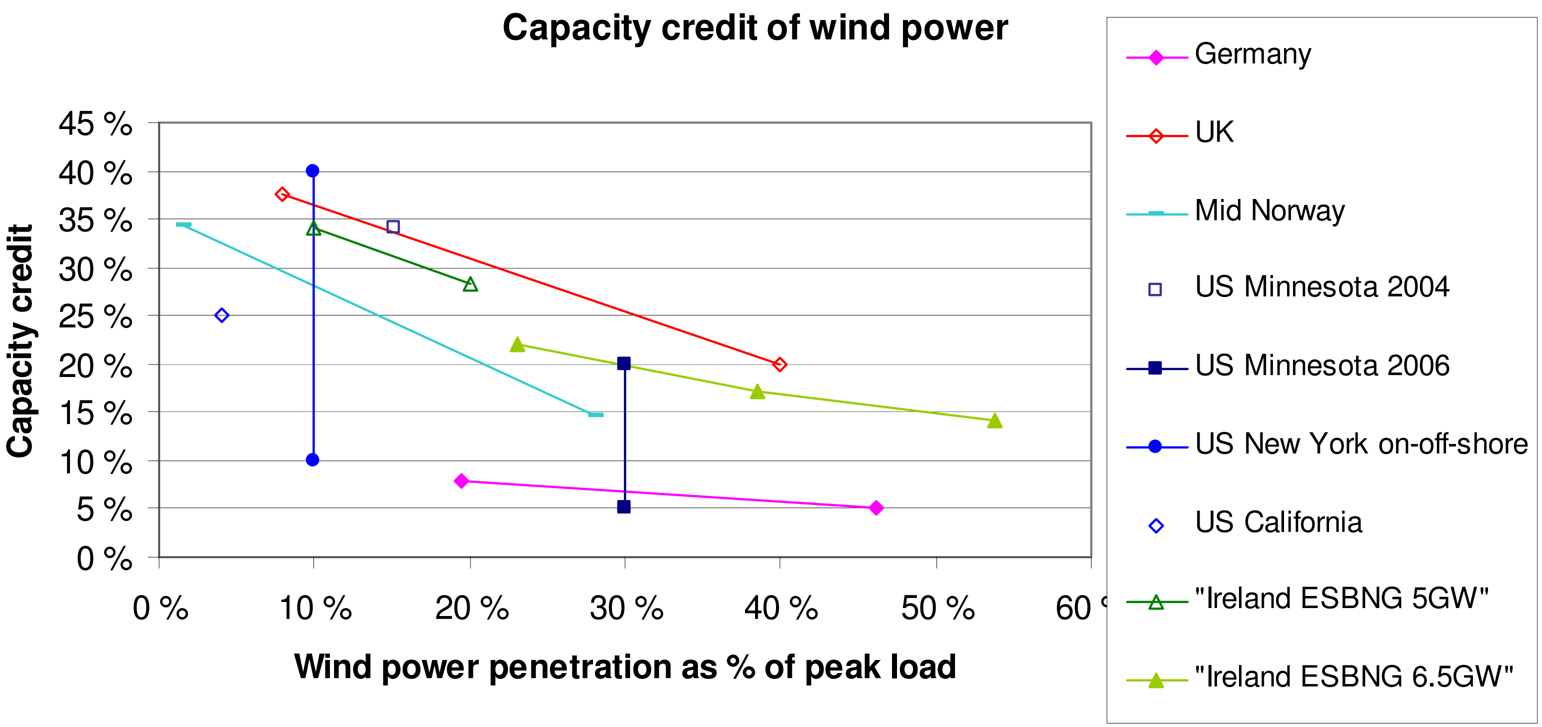
- Minnesota: 6000 MW of wind in 20 GW peak load system (=30 %)
- New York: 3300 MW of wind in 33 GW peak load system (=10 %)
- Colorado 1400 MW in 7 GW peak load system (=20 %)
- California: existing wind power, 4 % of peak load

Summary grid reinforcements

- UK : £50-100 / kW (70-140 €/kW) for 26 GW wind
- Netherlands : 60-110 €/kW for 6 GW offshore wind
- Portugal : 53 €/kW for 5.1 GW wind
- German dena study:100 €/kW for 36 GW wind

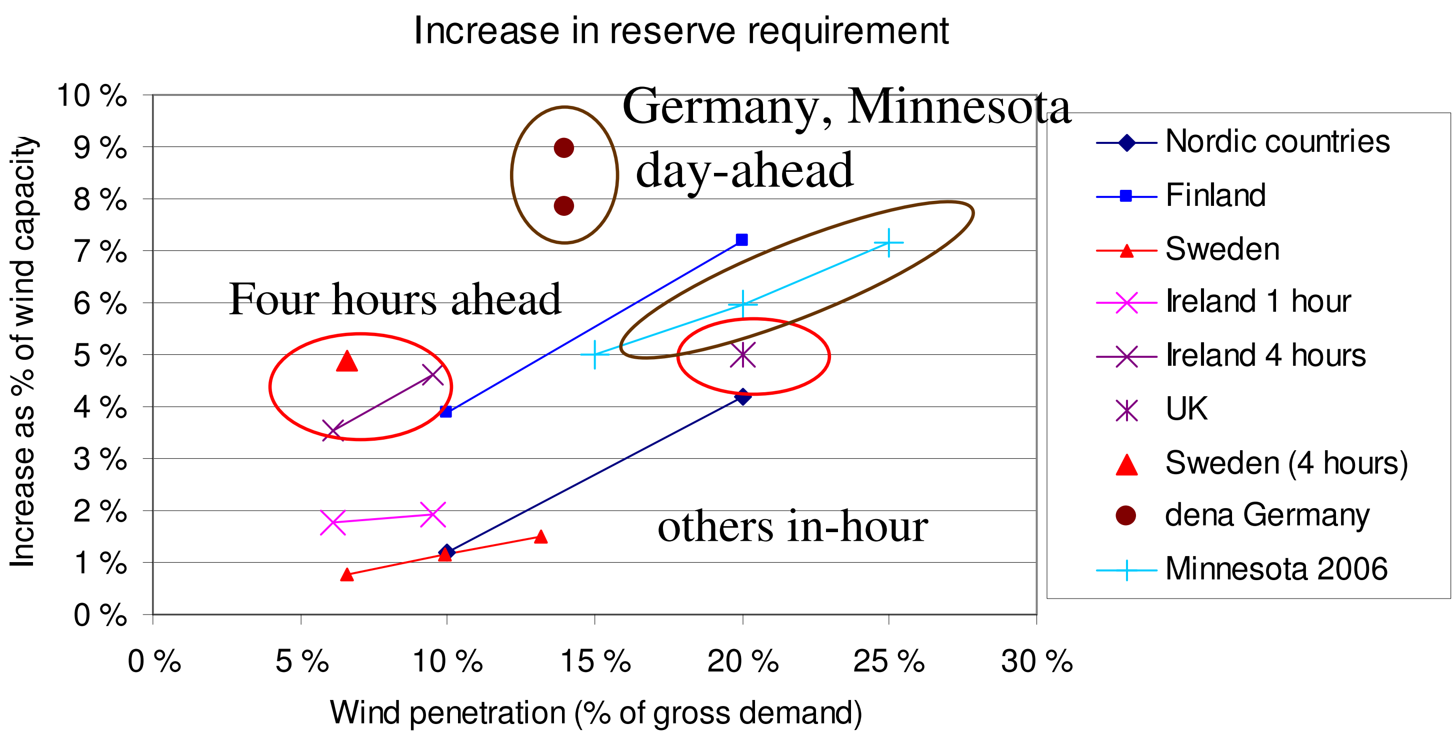
- Not comparable:
  - Depends on wind resource location versus load centres
  - Grid reinforcement costs are not continuous, there can be single very high cost reinforcements
  - The way that grid costs are allocated to wind power can differ:
    - Shallow/deep costs
    - Wind farm and power system interface

Summary capacity credit



- Even if mainly energy resource, wind has a capacity value to power systems. However, at larger penetrations the value decreases. Value decreases faster for smaller areas.

Summary balancing requirements



- different time scales for estimating the reserve requirement
- different methodology used

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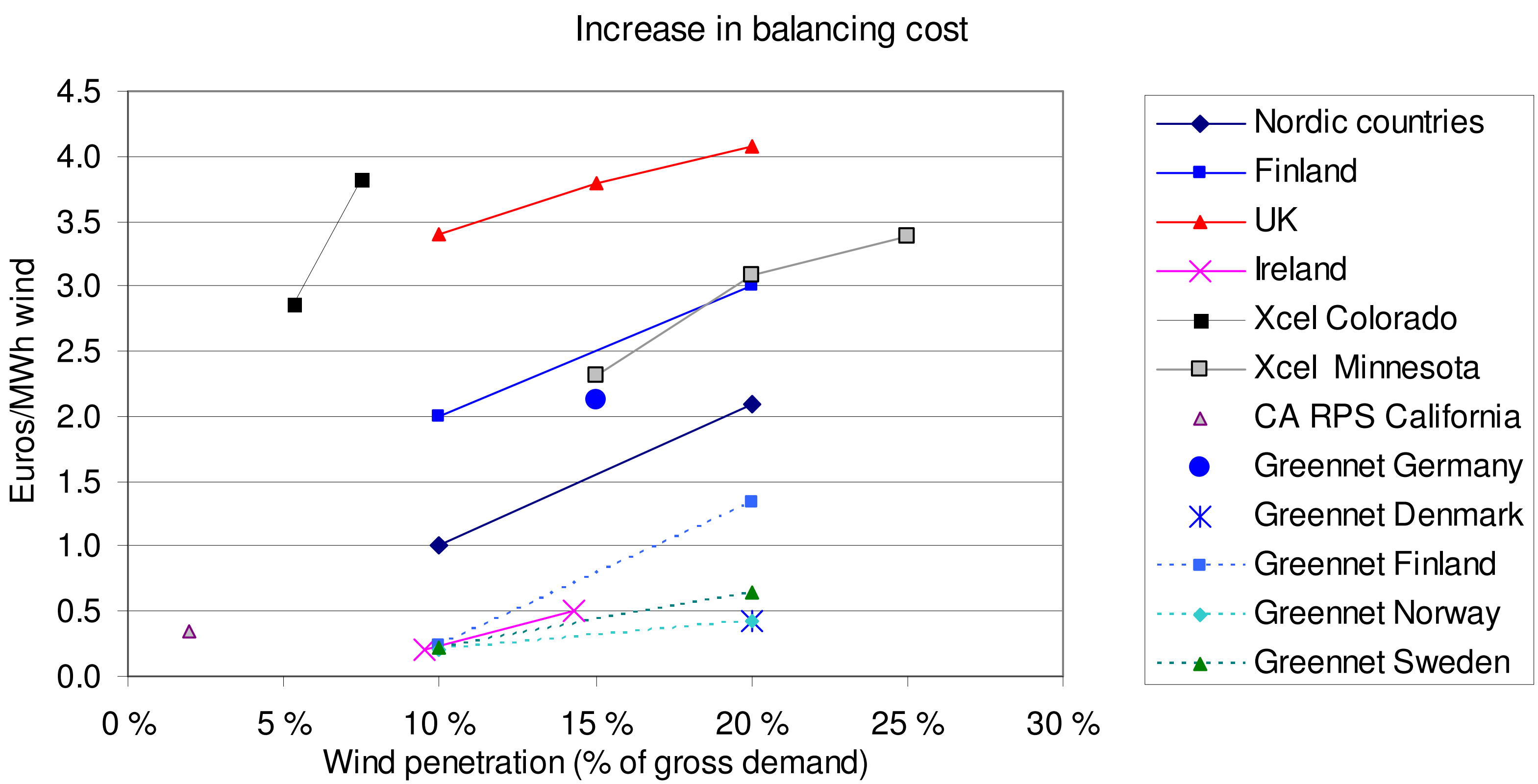
Summary balancing costs



- Not directly comparable due to: different time scales; allocating investment for new reserve or only use of reserves; possibilities for power exchange to neighbouring countries; method for calculating costs based on assumptions on thermal power

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Design and Operation of Power Systems with Large Amounts of Wind Power

State-of-the-art report – main messages

- The case studies summarized not easy to compare
  - Different methodology, data, assumptions on interconnection
  - Integration costs to be compared to f.ex. production costs or market value of wind power, or integration cost of other production forms
  - **Cost-benefit analysis** : benefit reducing total operating costs and emissions
- Issues impacting on the amount of wind that can be integrated:
  - Large balancing areas: aggregation benefits help reducing variability and forecast errors of wind power as well as help pooling more cost effective balancing resources.
  - System operation/electricity markets at less than day-ahead time scales help reduce forecast errors of wind power.
  - **Transmission is the key** to aggregation benefits, electricity markets and larger balancing areas.

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G8 Renewable Electricity Integration Project
Trading and Transmission: a Roundtable - 10th October 2007, Berlin

Benefits of Recent Technology Developments to the Integration of Renewables

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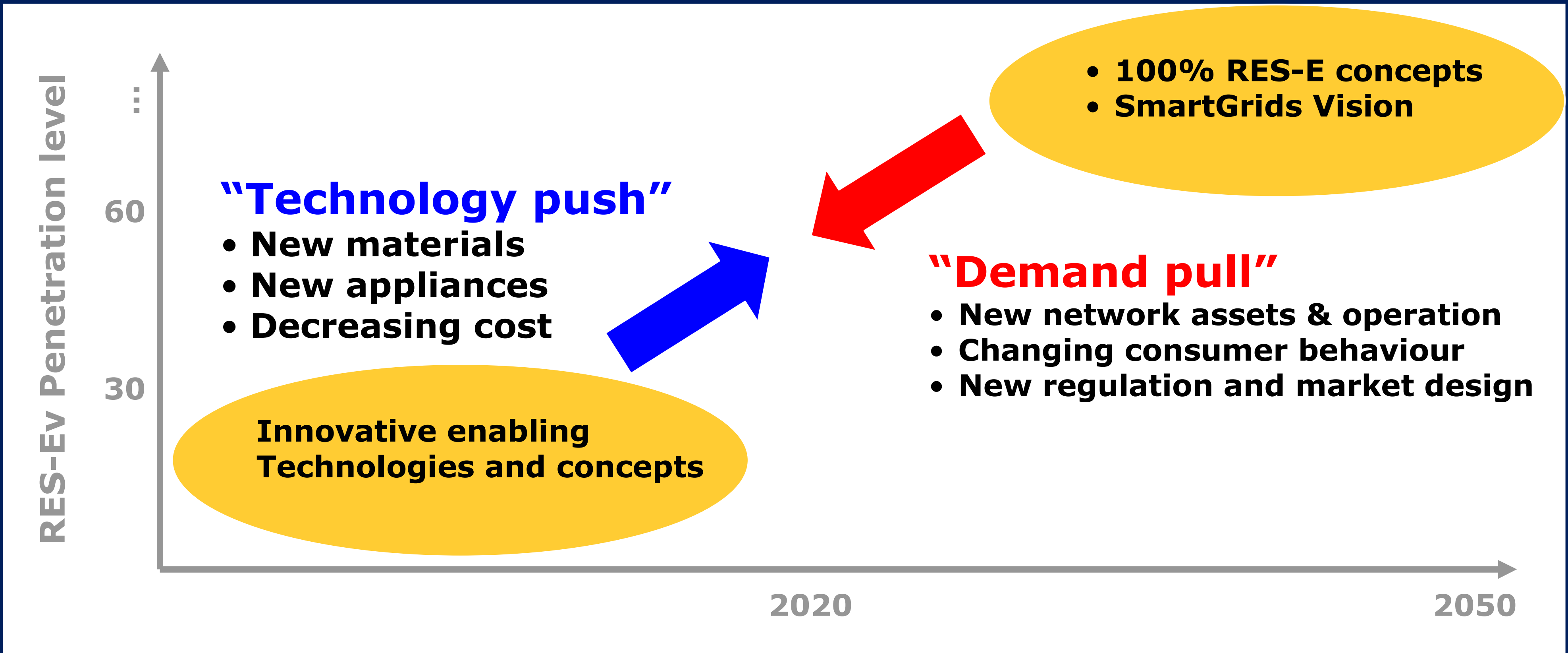
Motivation for introducing new technologies

(1) RES-E bring more variability and uncertainty to power systems.
(2) New power system demands, new enabling technologies:



Thank you for your attention!

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