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# SEERMAP

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South-East Europe Electricity Roadmap

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## RES integration issues

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## 1. System integration issues

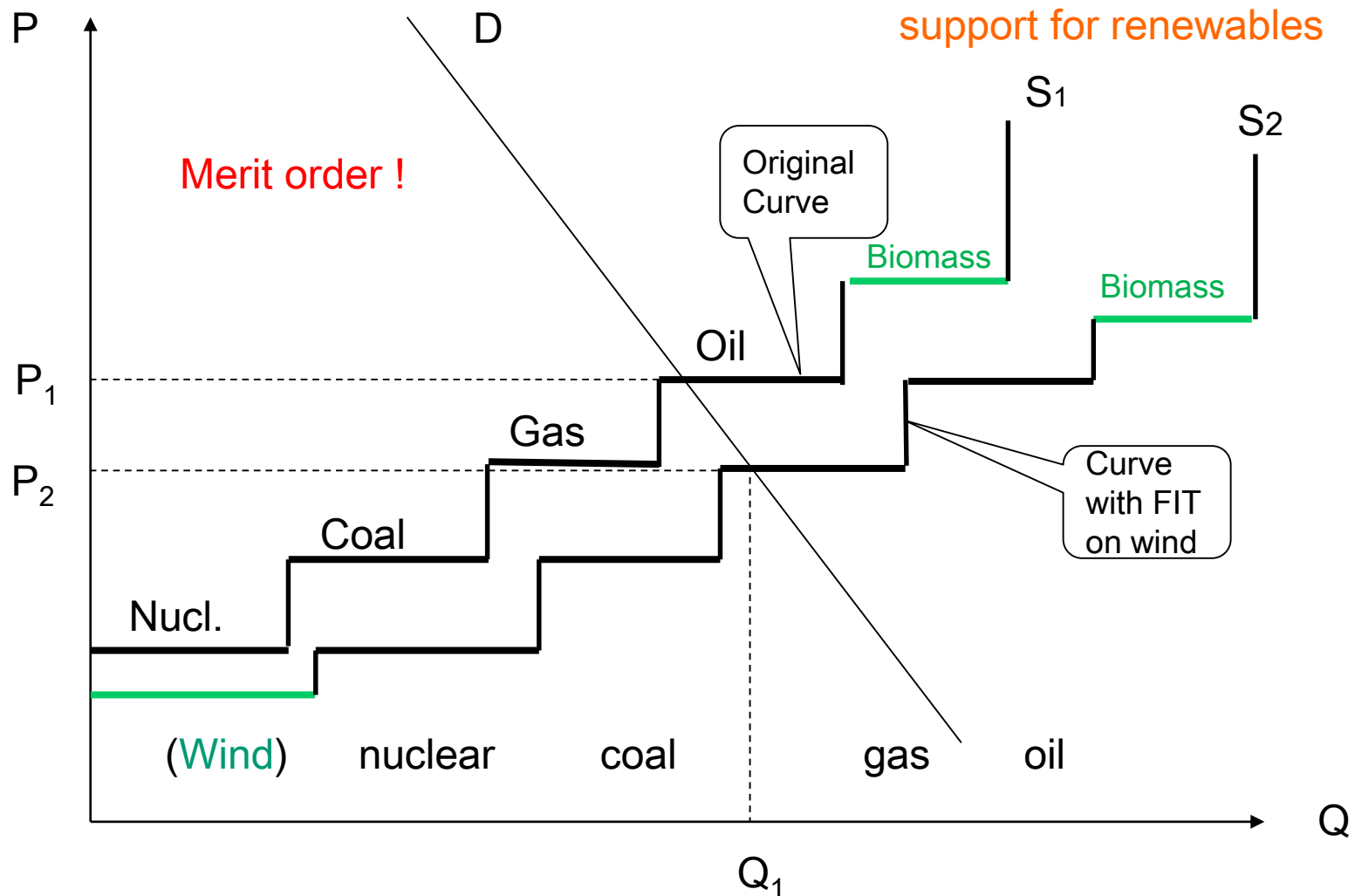
## 2. Network integration of RES-E

- Introduction
- TSO/DSO role in determining RES-E connectable intermittent capacity
- Queue management
- Connection cost charging
- Incentives to make DSOs more active in Distributed Generation (DG)

# 1. System effects of higher intermittent RES deployment

- Due to low or close to zero variable costs in competitive electricity markets wholesale electricity price will reduce
  - Positive impacts on consumers, as their price will drop
  - Conventional producers will see smaller utilisation rates and reduced margins
  - As gas plants are still required to serve as balancing entities, they still have to be kept in the market: 'missing money' problem

# Merit order effects of RES



- Wholesale price reduction reduces the revenues of traditional producers – *‘missing money problem’*
- On the long term traditional producers delay investments
- This effects reduces the burden on end users – but there is a price increasing effect by the RES surcharge (usually higher)
- Volatility of wholesale price increases (due to intermittent technologies) which can partly reduces the price reduction effect

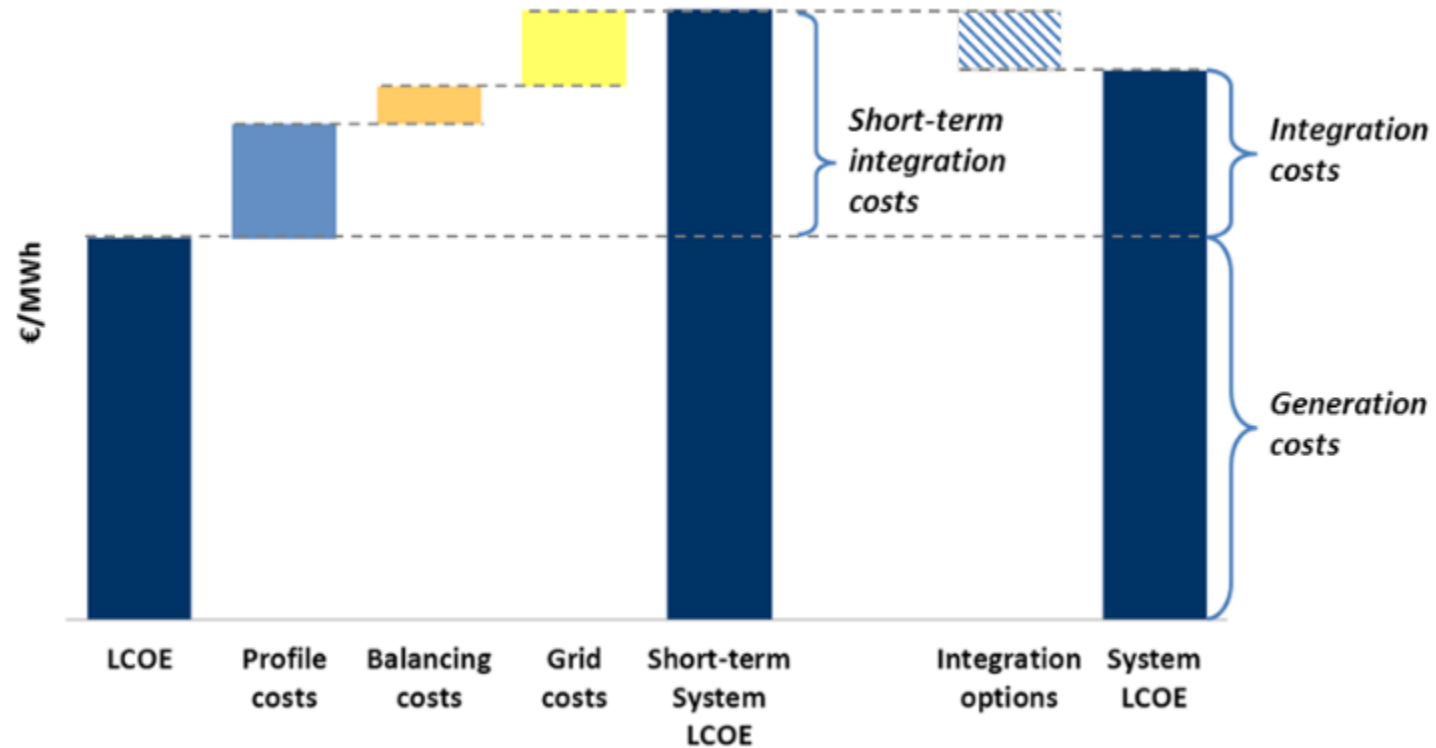
# Additional impacts of higher RES deployment

- Intermittent technologies: wind, PV

Variable production	Uncertainty in production	Production is location specific
<ul style="list-style-type: none"><li>- As electricity is not a homogeneous product – intermittent production has its 'price'</li><li>- Other, traditional producers operate at lower utilisation level</li></ul>	<ul style="list-style-type: none"><li>- Uncertainty in production forecast</li><li>- Other producers have to step in to balance the unexpected deviations</li></ul>	<ul style="list-style-type: none"><li>- Placing production in distant location has higher costs</li><li>- Due to network constraints, it does matter where the new capacities are placed</li></ul>
– 'profile costs'	- 'balancing cost'	-,grid costs'

Source: UECKERDT 2013

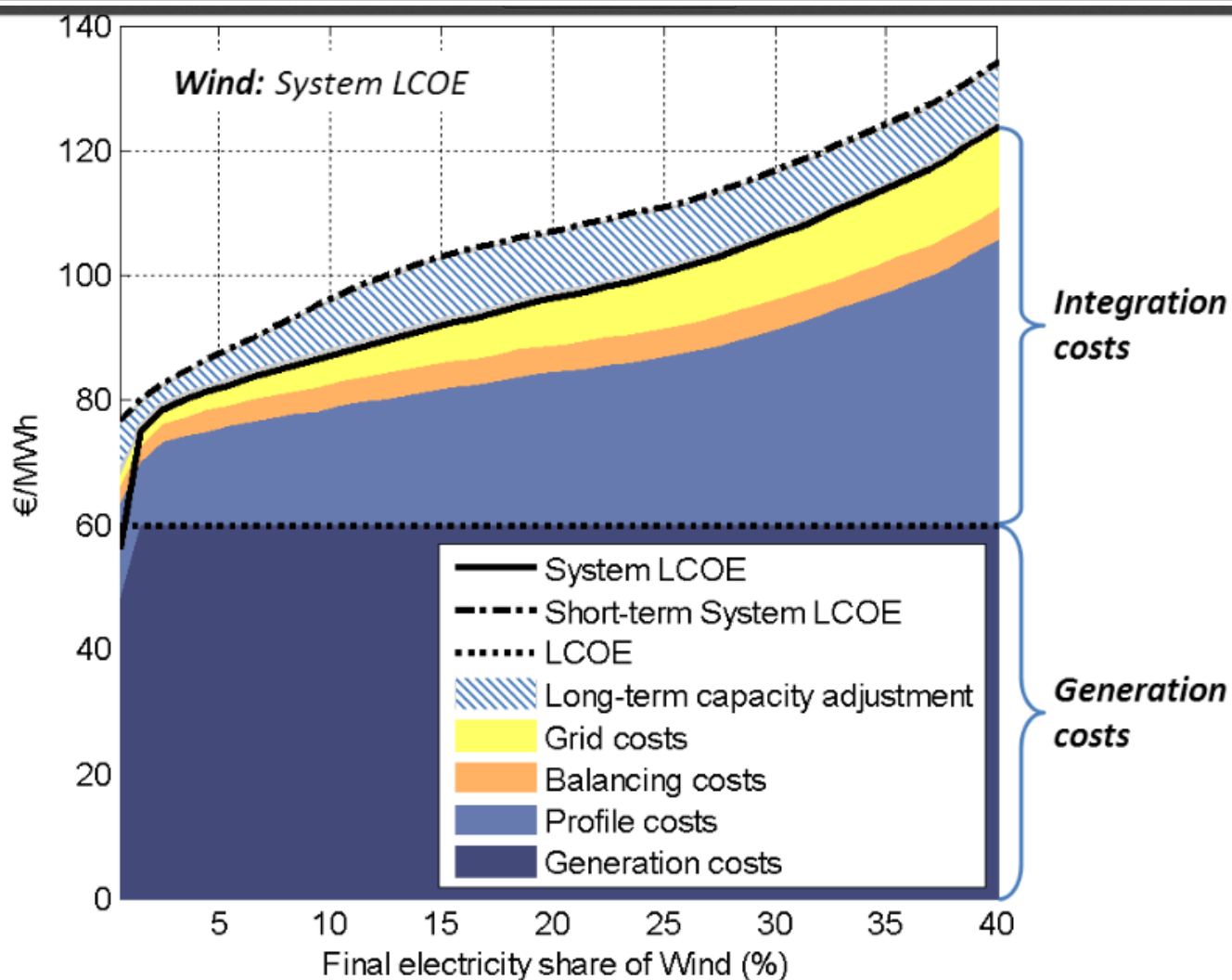
# Integration costs



Source: UECKERDT 2013



# Integration costs 2



Source: UECKERDT 2013

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# Typical problems of intermittent RES-E

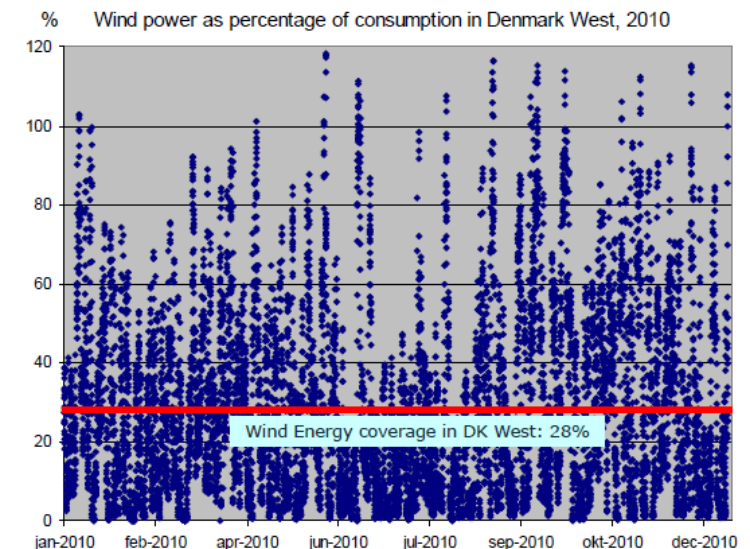
## Distance to load high transmission related cost



Source: Bloomberg NEF

Key point: Higher costs remain a key barrier to RE diffusion. BUT: RE increasingly competitive.

## Intermittency additional reserve needs, loop-flows



## Two out of three problems related to grid integration

# Asymmetric incentives for RES-E generation *versus* network to be balanced

- RES-E generation: fast; attractive; simple incentives
- Network upgrade: slow; complicated; counter-incentives
- Integrated resource and network planning
- Sufficient incentives for transmission and distribution upgrade is key



- How to judge the quality of grid connection applications for RES-E?
  - How to ensure that what is licensed is indeed built?  
Technical and financial capability?
  - How to minimize rent-seeking e.g. through auctioning /tendering: the question of allocation of development rights
  - License revoking?
- Example of Turkey's EMRA receiving 70 GW of wind applications on a single day!

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# TSO role in determining RES-E connectable intermittent capacity (1)

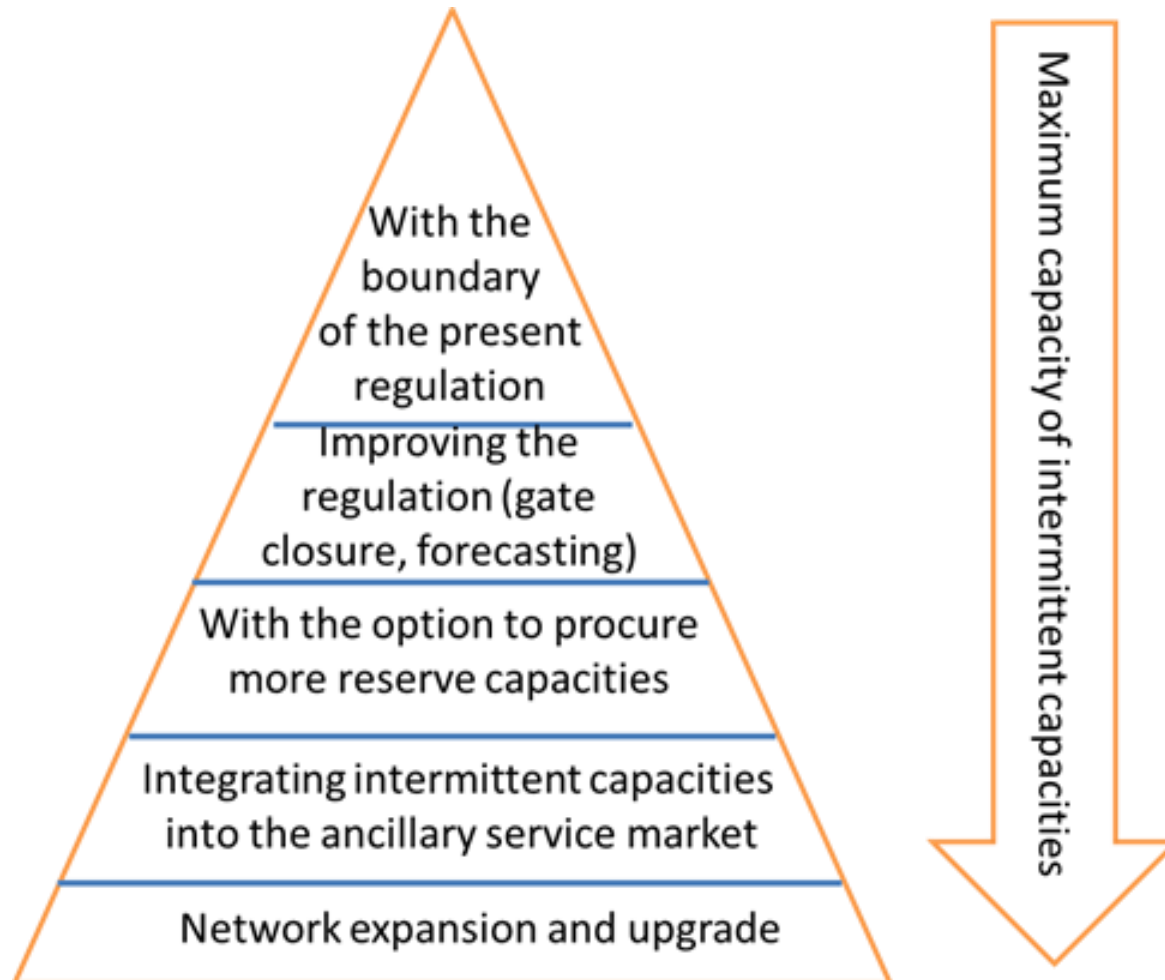
- Only few EU countries have real experience in massive RES-E penetration
- EnC members are generally characterized by less experience in handling large number of RES-E applications/developments.
- Network modelling and information gathering are the first steps to follow (example of Italy, Turkey)
  - Collection of data on new sites could be very time consuming (e.g. wind measurements last a minimum one year)
- With more experience this ‘initial’ estimate can be increased by ‘soft’ measures, before the most expensive option of grid expansion applied.

# TSO role in determining RES-E connectable intermittent capacity (2)

- Bottlenecks:
  - Network capacity
  - Available reserve capacity
- If the transmission network constrains RES-E developments, than it is the TSO's role to determine connectable capacity level:
  - In the short term capacity limits must be determined at substation level (network modelling)
  - In the long term: network development planning must incorporate RES-E needs.
- If constraints appear at the medium or low voltage level, it is the DSO who should plan its network development. (see slides later)



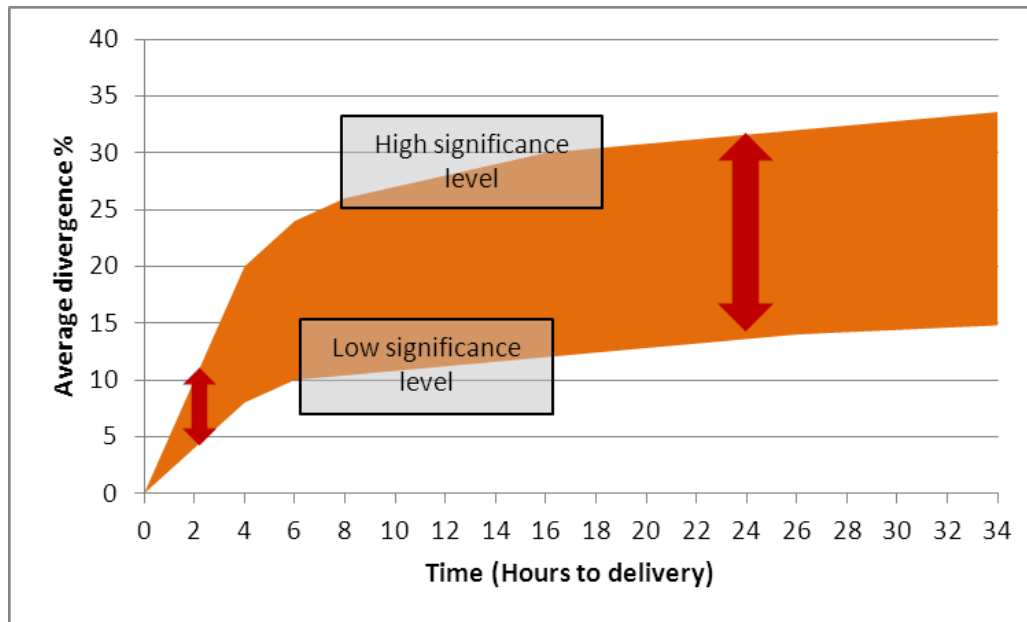
# Options to increase connectable intermittent capacity



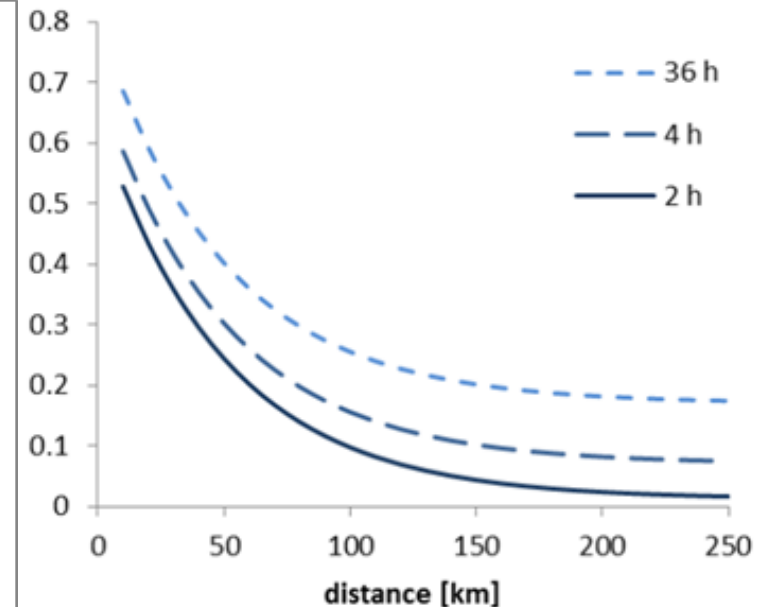
# TSO role in determining RES-E connectable intermittent capacity (3)

- In case reserve capacity is the bottleneck the first solution is to prescribe the participation of intermittent producers in the reserve market and locational diversification of wind generation in order to reduce their overall volatility.
  - In Hungary, the original TSO forecast for admissible wind capacity was 330 MW. 3 years later this capacity level was increased by more than 400 MW without any major investment in the transmission network. Due to:
    - Experience gained
    - Better forecasting method
    - New provisions in new tender (geographical diversification, regulability)

## Wind forecast precision

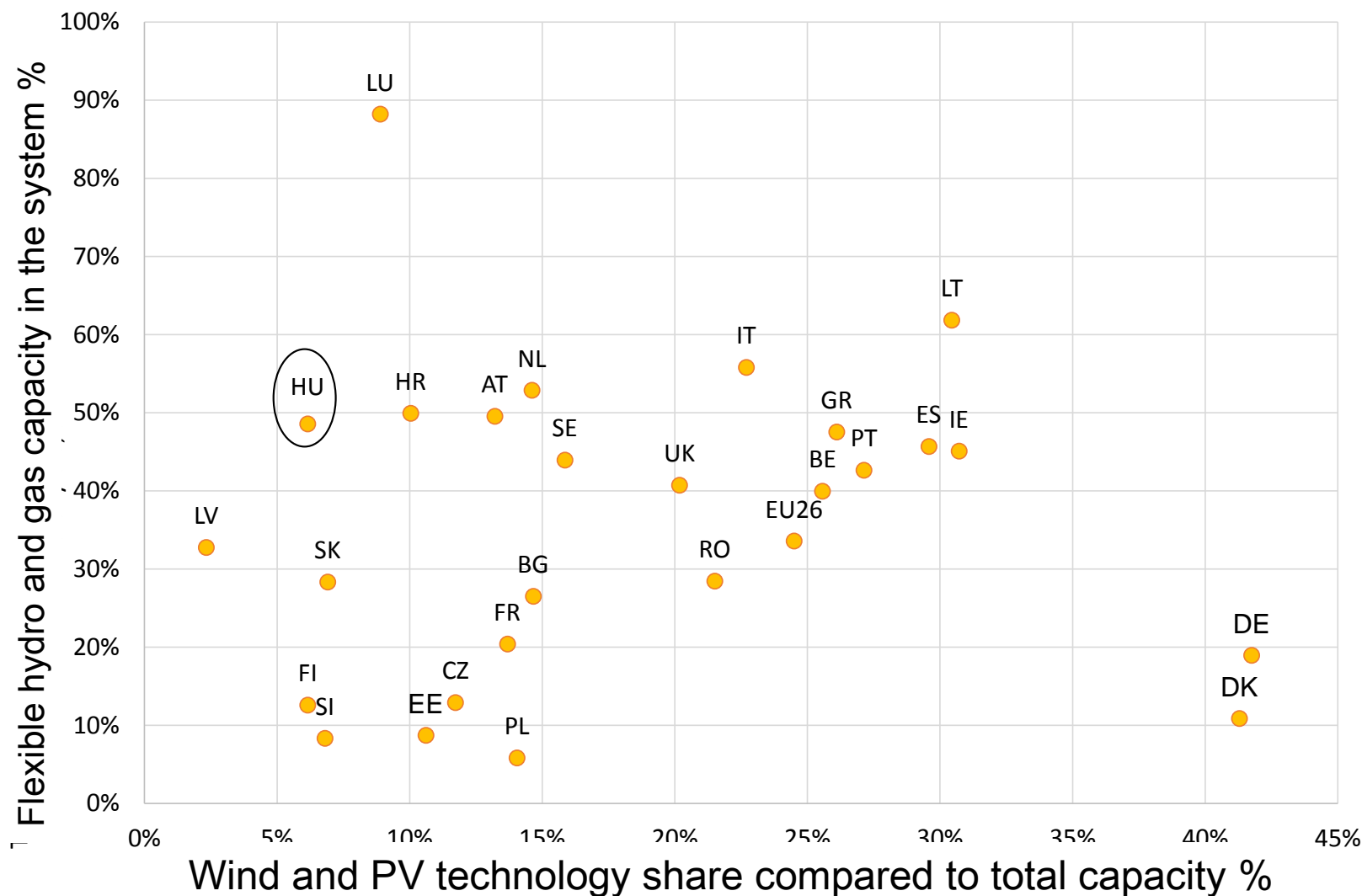


## Correlation of two wind farms depending on distance and time of forecast

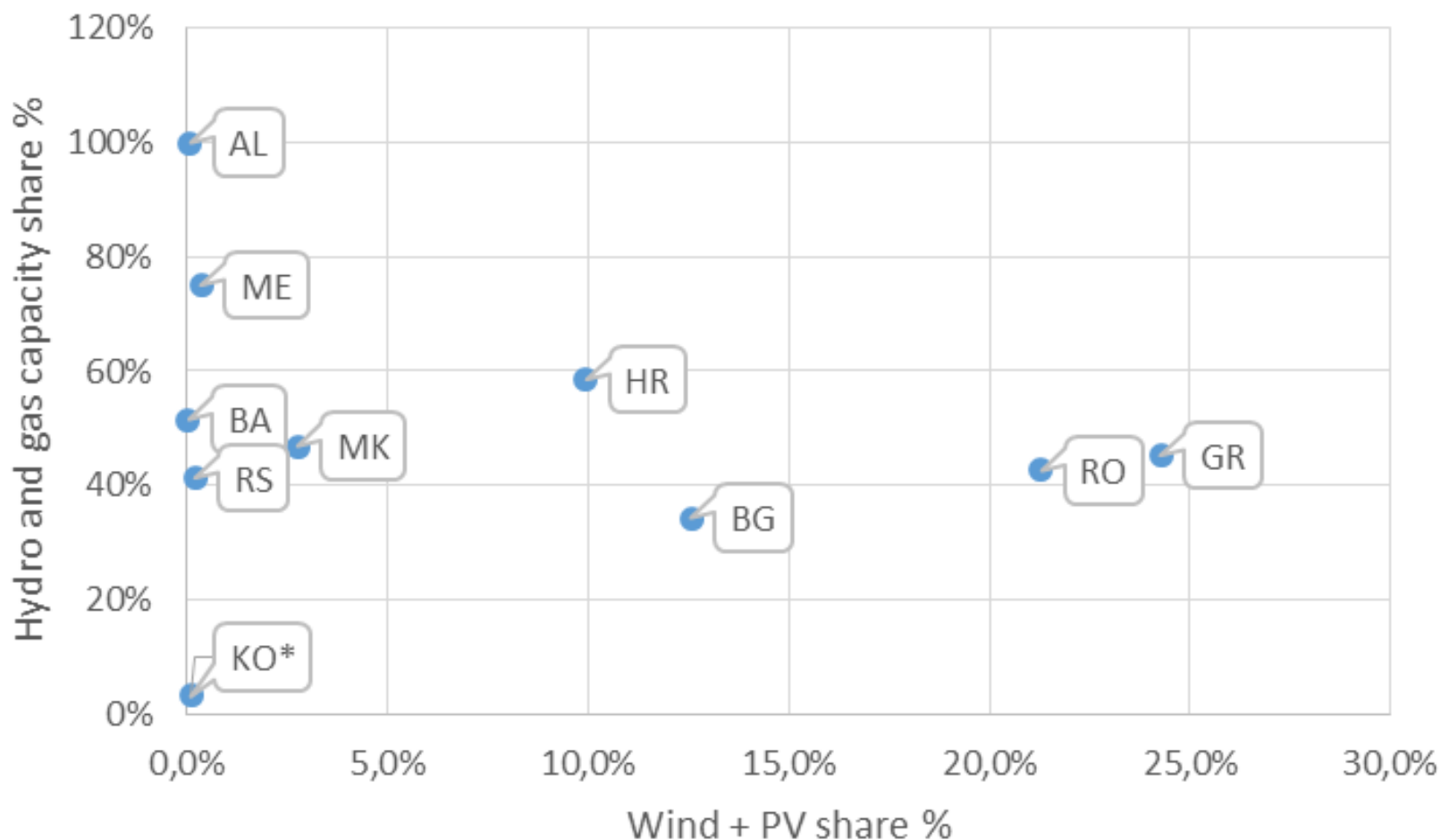


Source: DIW 2011

# Flexible capacities in the system (EU)



# Flexible capacities in the SEE region



# Lessons learned –TSO role

- A staged approach of TSOs is a prudent solution when there is limited knowledge about the impacts of sizeable RES-E penetration.
- The first steps should include the collection of information on network capabilities, the RES-E production potential and network development costs.
- As a next step ‘soft’ measures, such as improved regulation on scheduling RES-E should be used before the more expensive network upgrade is undertaken.
- The upgrade due to RES-E developments should be synchronized with the long term network development plans.

# DSOs role in network planning (1)

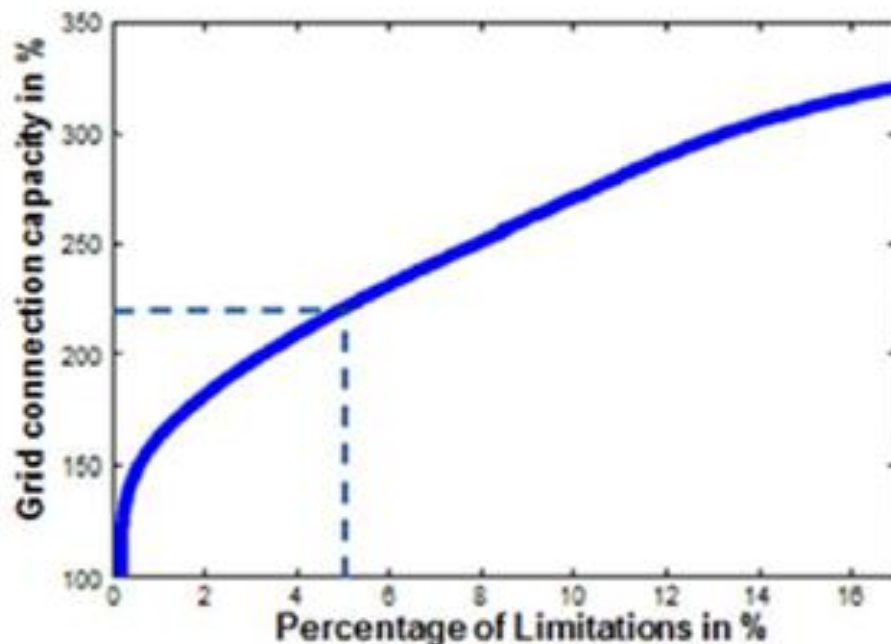
- Most RES-E connects to the medium or low voltage level. In this case the DSO, who should plan RES-E connections.
- The conventional '*Fit and Forget*' approach of DSOs:
- DSOs plan their network capacity to the theoretical maximum load that can appear in the given network node.
- Results in maximum system security
- But at a very high investment cost: socially might not be the optimal

- *Reactive network integration* or ‘*only operation*’ approach:
- DSOs admit all RES-E capacities that apply for grid connection
- All arising problems will be solved later during the operational phase:
  - if the network cannot handle the electricity to be injected, certain operators, including RES-E units, can be curtailed on the basis of pre-negotiated conditions
  - as RES-E producers generally have priority dispatch rights in these countries, they are compensated for the lost production



- The third approach is the *Active distribution system management*, where various phases of the grid connection process: planning, connection and operation takes place in an integrated manner
  - sophisticated supporting IT infrastructure is needed
  - network planning is not exclusively carried out by the DSO, but the other affected parties - the TSO and RES-E developers are also involved in the process
  - RES-E plants and also consumers take part in the ancillary service market as well, providing higher flexibility to the system – ‘flexibility platforms’
  - Network reinforcements and loads are optimised, which means that it can be a more economical option of increasing the connection capacity of the grid, without too much investment in the physical infrastructure

- If regulation allows TSO/DSOs can apply the ,*variable access contracts*':
  - Pre-defined mechanisms to curtail RES-E output.
  - Results in increased connection capacity.



Source:Eurelectric 2013. EWE Netz

## Recommendations – DSO role

- The active distribution management method has several advantages, it can reduce/optimize the need for physical infrastructure developments
- As a first step, EnC members might apply first other tools, such as the coordinated application processing, and variable access contracts
- Access regulation needs to be adjusted to accommodate these flexible options

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# Queue Management methods

**Queue management: evaluation and selection method to grant scarce development and connection rights.**

- Administrative methods:
  - ‚First come first serve’
  - ‚Pro rata’ allocation
- Competitive tendering process
  - Efficient allocation method: resulting prices will reflect the economic value of the connection right
  - Resulting income could be used to either reduce consumer prices or increase the network capacity at the critical points
- Other tools:
  - Deposits: to filter out ‚junk’ project proposals
  - Connection scheduling: to prevent blocking of the connection point

- Competitive tendering is the most efficient way to allocate available connection capacities among a large number of applications.
- Tendering requires more preparation from the TSO/Regulator side than the 'first come first served' or 'pro rata' allocation methods (see example of first Hungarian wind tender)
- Tendering is a feasible solution in EnC member states as well (see e.g. the example of Turkey).

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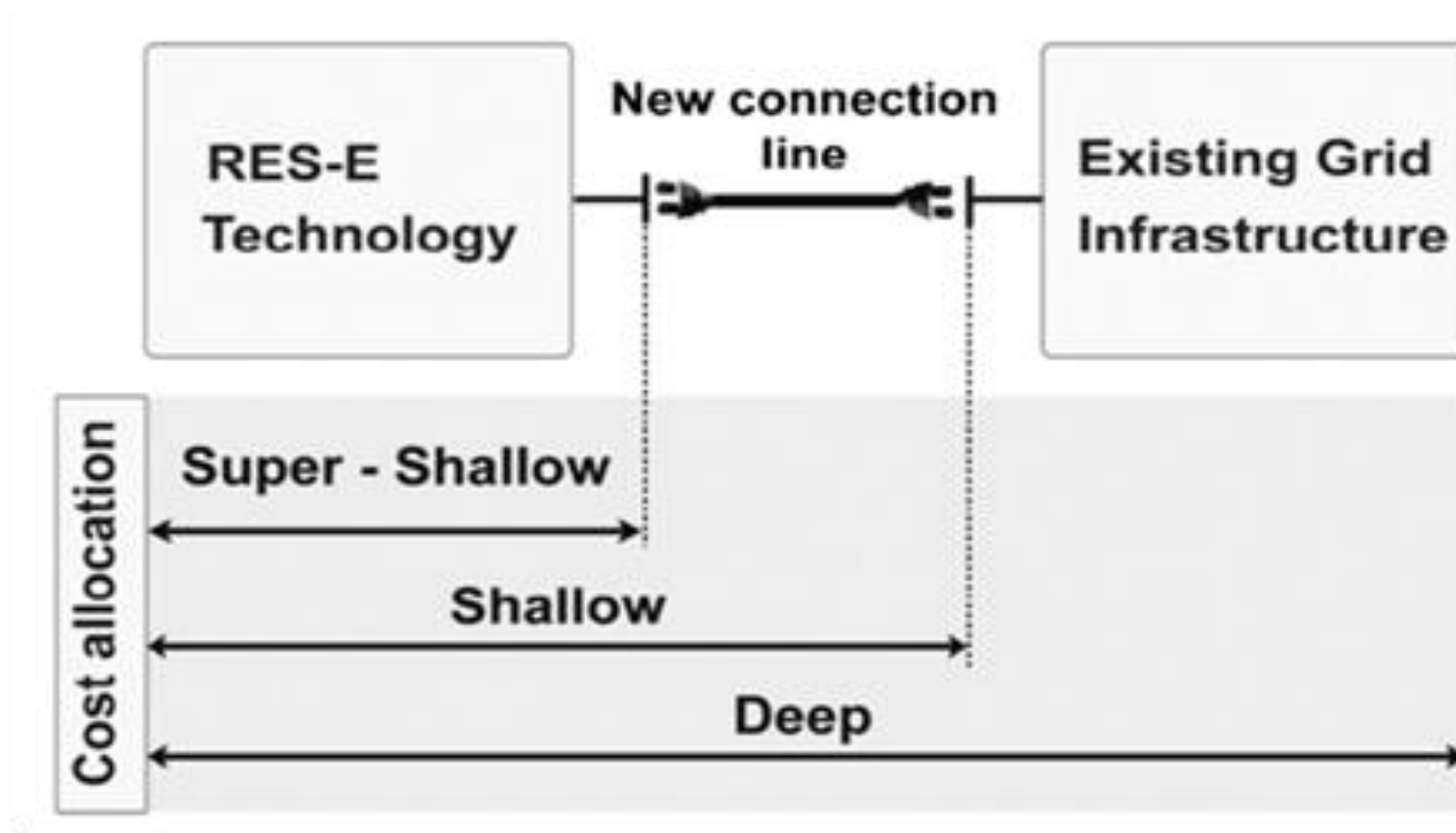
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- Connection cost is a significant burden on RES-E developers, could amount to 5-15% of the total project cost due to the spatial distribution characteristics and smaller unit size of RES-E technologies.
- Cost advantages are generally applied tools, but with many drawbacks:
  - Distorting locational signals
  - Placing the financing burden on end-consumers (through 'cost socialisation')



# Connection cost charging approaches



Source: Swinder (2008)

- Shallow approach
- Deep approach:
  - Strongest locational signal
  - But, creates ,first mover disadvantage'
  - Full financial burden on RES-E developer
- Hybrid approach:
  - Paying the direct cost plus part of the system upgrade  
– problem in determining the adequate level
- Shallow, hybrid: need for ,cost socialisation'
  - strict cost control from the regulatory side is needed in order to avoid an unnecessary cost increase for the consumers

- It is advisable to follow a stepwise approach related to the connection charging regime in the ERRA countries.
- The shallow cost approach should be used only for a limited period in the beginning of RES-E deployment and then substituted with the deep cost charging approach before more sizeable RES-E developments take place.
- This choice is supported by the lower purchasing power in the ERRA countries, as this places the cost burden on the producer, thus limiting the price impact on the final consumers.
- If DSOs have a discretionary role in this process (e.g. due to the lack of detailed regulation of certain elements) the shallow cost approach might deteriorate their incentives to actively participate in this process. (Hungary case study)

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- Main issue: DSOs are negatively impacted by large scale distributed generation in incentive regulation:
  - System is designed to power demand (MW) but revenue is based on electricity consumed (MWh).
  - Time lag in receiving their costs in the revenue cap (CAPEX time shift problem)
  - Pricing problem as well: ‚prosumers‘ do not pay network tariff and flat rate volumetric tariffs do not reflect the marginal cost of network use (peak versus off-peak)
- In rate of return regulation DSOs have higher incentives to participate in RES developments:
  - The regulator must safeguard that no overinvestment takes place in this situation to prevent cost increase to consumers.

- Network tariff schemes can be redesigned by moving towards deep connection charges or by expanding the network tariffs to generation as well
- Time-of-use (ToU) network tariffs paid by both consumers and producers would provide signals for all network users towards minimizing the overall cost of maintaining an adequate electricity grid
- Reduction in the CAPEX time lag: e.g. through the application of 'investment budget' for cases of network restructuring (Germany).
- Application of public funds to cover expenses of DG developments of DSOs.

## Lessons learned

- Reduce the time lag for DSOs in receiving the reimbursement for their grid infrastructure developments that are aimed at the improved deployment of DG solutions.
- Presently applied solutions, such as radio controlled meters should be kept, as these are economic options to reach a shift in consumption (Serbia, Hungary)
- For low income countries, the public funding solution and separate budgeting (Germany) is less adequate.

- Many open issues in grid integration and in system integration of intermittent RES-E
- Many solutions exist (technical, regulatory), but they depend on the country electricity network and system characteristics
- Right incentives for TSOs and DSOs are key!
- More solutions on system flexibility and regionalisation - come in tomorrow presentation!



Thank you for your attention!

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