System integration costs - a useful concept that is complicated to quantify?

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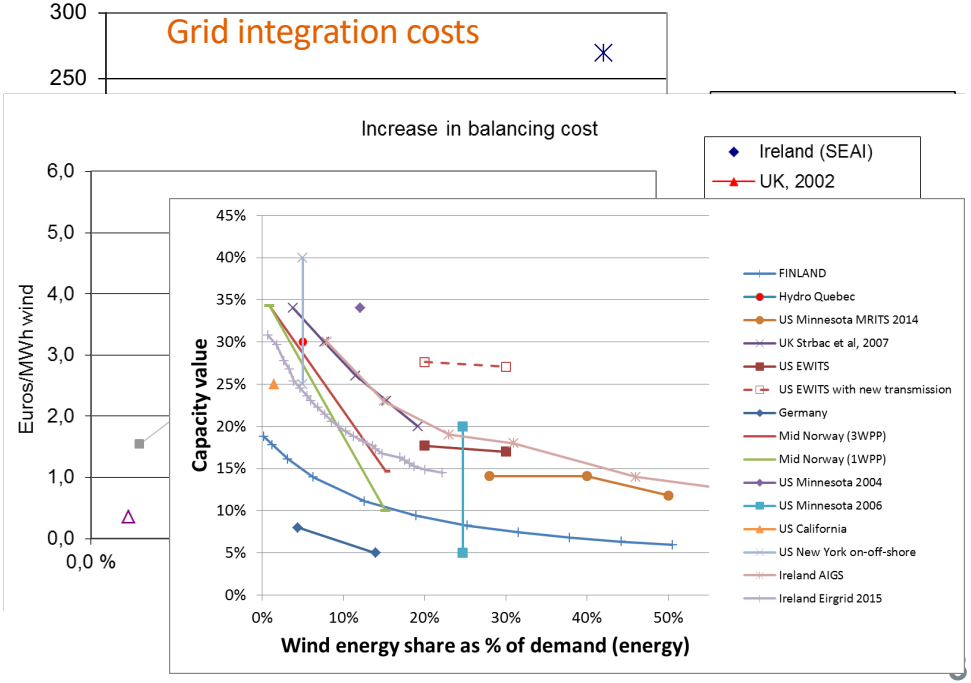
Contents

- Integration costs: relevance; discussion on methods and challenges

- Approaches for assessing system integration costs
- Recommendations

Recommending methods for integration costs – work of IEA WIND Task 25

- Comparing studies for Balancing costs, Grid infra costs, and Capacity value of wind;
  - Depend on share of VRE and flexibility available in the system
- Recommended practices on methods: **Outcome cannot find a proper way to draw estimates of integration costs**



Relevance of the question

- Decline of cost of energy of wind and PV– becoming mainstream
- Confidence of system operators, focus more on total system integration of more renewables

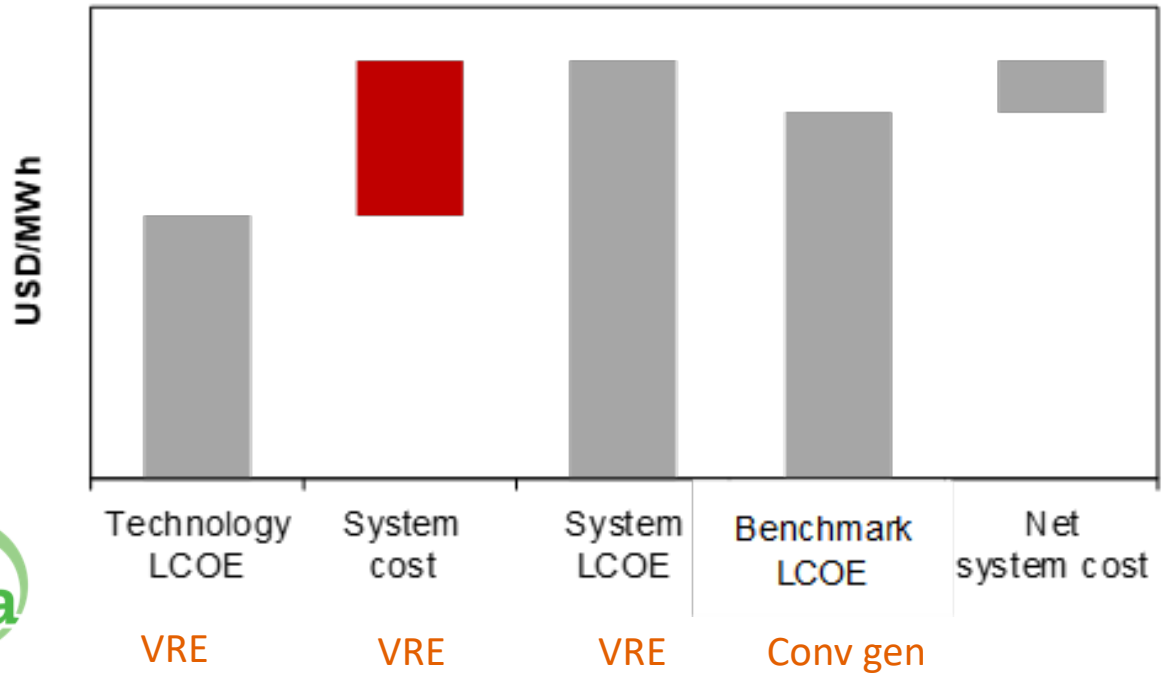
Interest in balancing costs decline in the US and many EU countries

- Decline of cost of energy of wind and PV – more interest to invest in new countries
- Comparison to other investment options relevant

A new interest in integration costs in some countries

Shift of interest from original integration costs as a tariff charged for more complex system operation towards more integrated assessments

A nice to have: LCOE + system integration cost to compare VG with others



System cost defined relative to scenario with less VRE and using benchmark technology.
Valid for specific system and VRE share only.

(Benchmark technology can also include system cost)

LCOE levelised cost of energy

Challenge 1: isolating system costs

- How much cheaper would it be for the power system to use VRE, if VRE was *non-variable*?
- To answer, need to strip away the impact of variability from *all other* impacts VRE bring to the power system
  - generating electricity at very low short-run marginal cost and displacing other generation

    → **Cannot find a suitable benchmark**

    → **Extracting the cost** from system cost: Impacts of VRE are a result of an interaction – system specific and time specific
    - Flexibility and operational practices matter
    - Allocation difficult: flexibility build out will have benefits for all

Related challenge: system boundary

- Neighbouring areas: Result from previous comparisons: assumptions of the interconnector use to neighboring systems has a large impact on results
- System boundary in future: decarbonizing challenge leading to electrification: energy sector coupling, flexibility from heat and transport and industry sectors

Challenge 2: categorising effects to grid, balancing and long term capacity

- Grid costs can be separated, but
  - How to allocate a cost of an asset that is used by all users to one single cause to build that asset? Especially when multiple reasons to build – and reliability benefits of all lines.
- Balancing: costs for short term variability and uncertainty in balancing and operating reserves, but
  - How to choose the non VRE case
  - Quantifying impact of VRE, as main impact is reduction of use of fuel and operational costs
  - Allocating costs to VRE

Challenge 2: categorising effects to long term capacity

- Simplified assessment, only peak load contribution of VRE – converted to a cost of peakers added to system to cover for lower capacity value of VRE
- Full profile costs: Lower cost to meet demand from non-VRE sources, but higher specific cost /MWh
  - The short term reduction of utilisation rate is a ”private cost” not to be covered by VRE
  - Long run costs for the new generation mix – from a generation mix optimised for VRE: a system cost of VRE in comparison to an alternative way of covering the load
    - Extracting this cost: double counting with balancing impacts

Approaches for integration costs

- Avoiding the challenges linked to system integration cost calculations by changing the question:

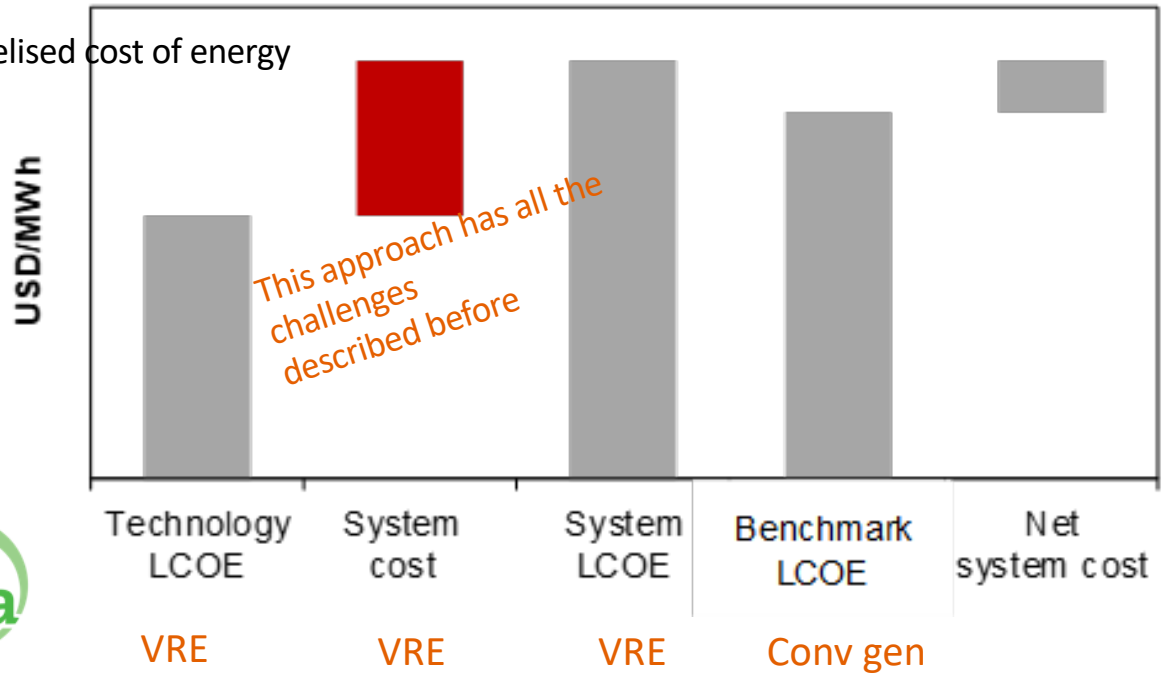
  How much cheaper or more expensive will it be for the power system to rely on a certain amount of VRE generation compared to an alternative scenario?

- Calculate total system costs for different scenarios

  Assessing costs and benefits between scenarios or comparing the total cost

Approaches for integration costs: LCOE + system integration cost comparison

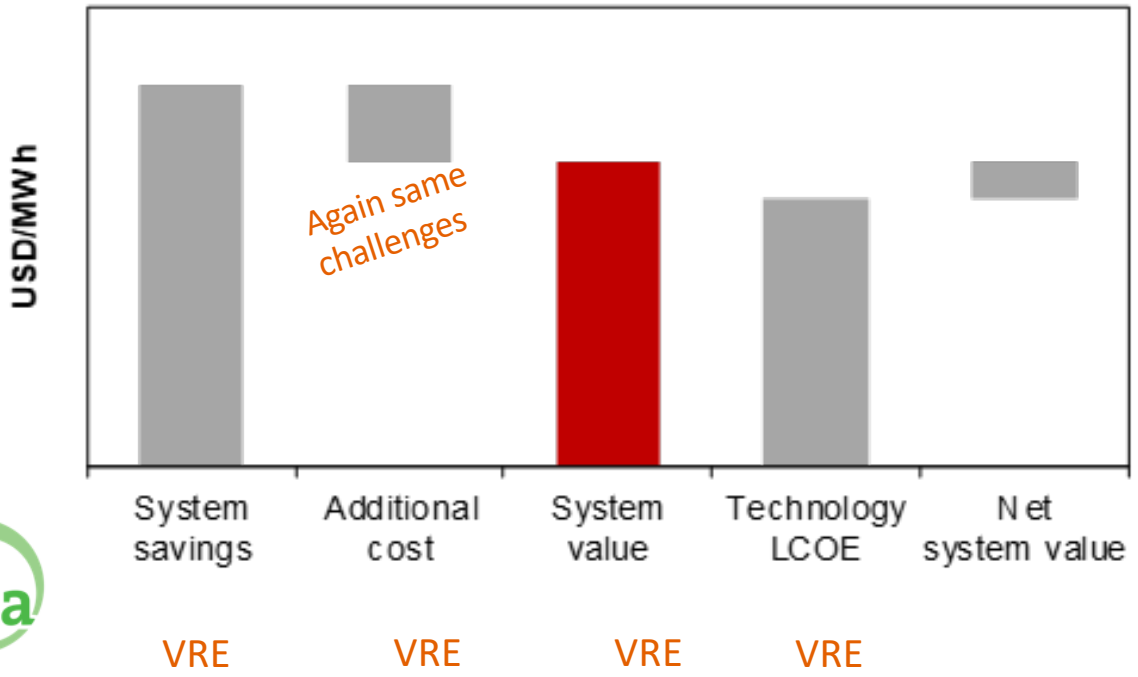
LCOE levelised cost of energy



System cost defined relative to scenario with less VRE and benchmark.
Valid for specific system and VRE share only.

(Benchmark technology can also include system cost)

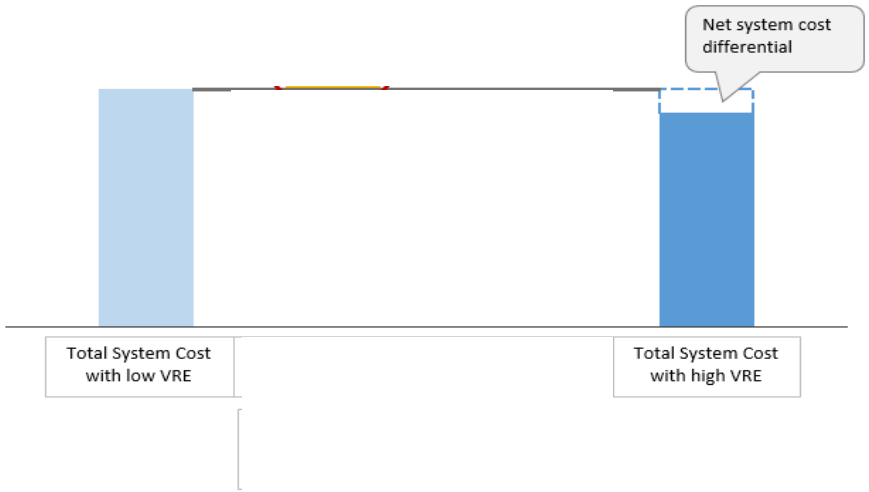
Approaches for integration costs: system value larger than for alternative



System value defined relative to scenario with less VRE (plus environmental). Valid for specific system and VRE share only.

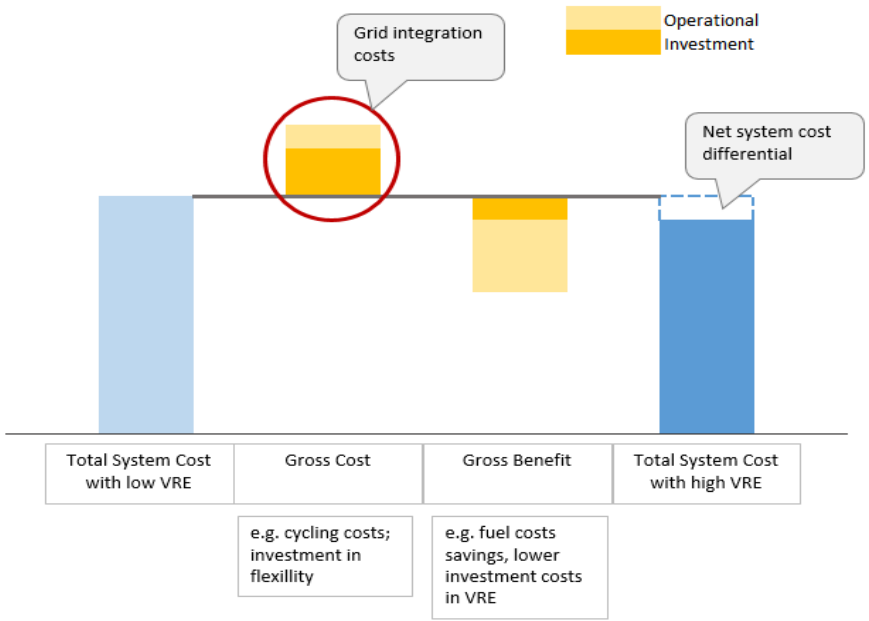
Check if value larger than LCOE of VG

Recommended approach – total system cost comparison



- Compare the all-in system costs of different scenarios
  - avoid the pitfalls of introducing a *non-variable* VRE benchmark technology.
- Results still depend strongly on what is chosen as reference scenarios for the comparison.

Recommended approach – total system cost comparison



- does not provide a direct quantification of different VRE related effects – although some of them can be extracted from simulation results
- compare the all-in system costs of different scenarios – CAPEX & OPEX
  - avoid the pitfalls of introducing a *non-variable* VRE benchmark technology.
- Results still depend strongly on what is chosen as reference scenarios for the comparison.

Summary – from integration costs to total cost comparisons

- Capturing “system integration cost” component is a challenge
  - Isolating/extracting integration from other costs, no good benchmark exists
  - Defining system boundaries – energy sector coupling
  - Dividing costs to variability, uncertainty, location
- Recommended to calculate total system costs – including operational and investment costs.
  - comparing different future scenarios for the system

Summary – from cost of integration to cost of inflexibility

- Even for total cost approach, results are system/share of VRE specific
  - Assumptions about future systems – and system boundaries crucial: Flexibility of generation fleet (including VRE) and demand; storages and operational practices
- Marginal effects may be interesting in addition to average impacts
- Allocation of balancing costs in a cost reflective, transparent imbalance settlement for wind generation. Grid costs in connection fees and tariffs
  - Allocation of benefits, after subsidies?

Thank you!

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