IRED 2022 9TH INTERNATIONAL CONFERENCE INTEGRATION OF RENEWABLE & DISTRIBUTED ENERGY RESOURCES

COMILLAS ICAI — IIT INSTITUTE FOR RESEARCH IN TECHNOLOGY

Do network investment costs outweigh the benefits of integrating high shares of renewable generation into electricity networks?

1. Background

Ambitious **RES targets** require installing massive amounts of RES capacity over the next decade. **Electricity grids** are the **backbone** of the decarbonised, electrified society. Significant **investment** requirements of electricity grids are expected to integrate high RES shares.

→ Goal: evaluate the impact of high RES shares on electricity grid reinforcement costs of large-scale electricity grids.

2. Contributions

- Analysis of **electricity grid investment** requirements for the decarbonisation of the electricity sector, considering both transmission (T) and distribution (D) networks.
- Quantification of the cost of integrating high RES shares into **large-scale** electricity grids. High RES scenarios are evaluated with a baseline without additional renewable generation capacity (low RES).

3. Scenario creation

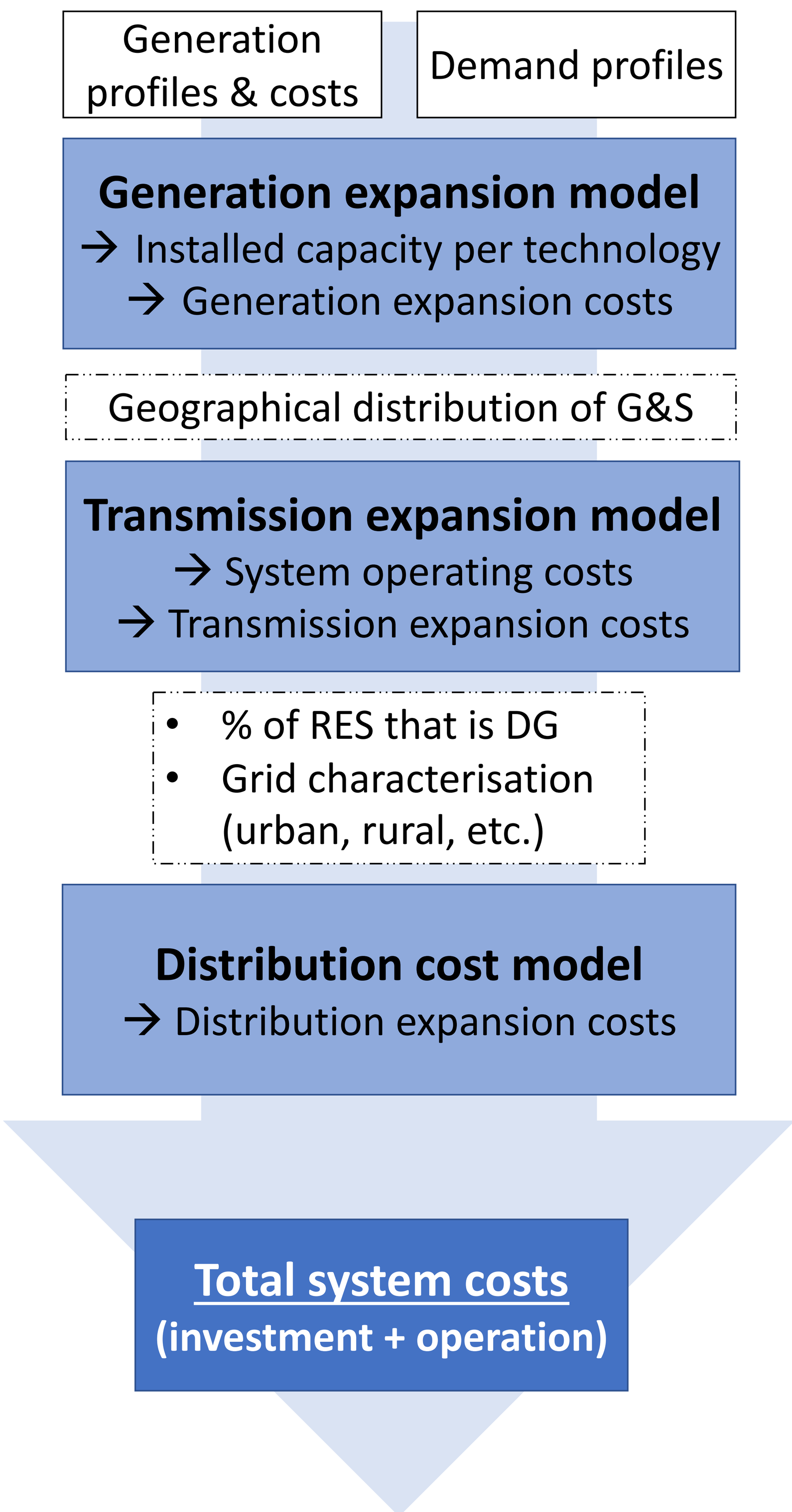
Four 2030 scenarios are created for each zone to examine the impact of high RES deployment on grid costs.

Generation and storage (G&S) investment requirements are determined by combining technology restrictions for additional G&S capacity and demand growth.

Scenario names combine G&S restrictions and demand growth.

	Do not invest in new RES → Low RES	*Invest cost-optimal* → High RES
0% demand growth	0% & Low RES	0% & High RES
2.3% annual demand growth	2.3% & Low RES	2.3% & High RES

4. Methodology



5. Case studies

Consideration of three large-scale electricity grids representing different power systems selected based on their differences in:

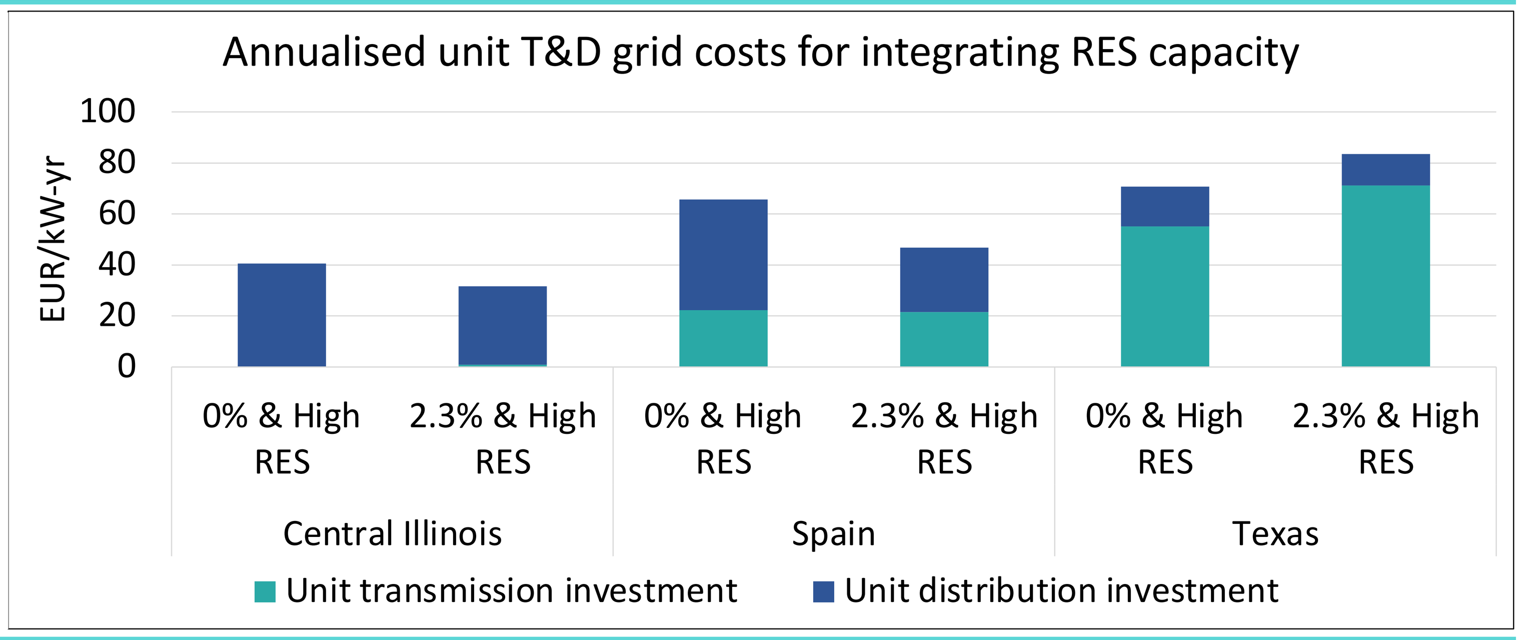
- Availability of natural resources, load density, initial generation capacity mix and electricity grid (T&D) characteristics.

→ Central Illinois, Spain and Texas

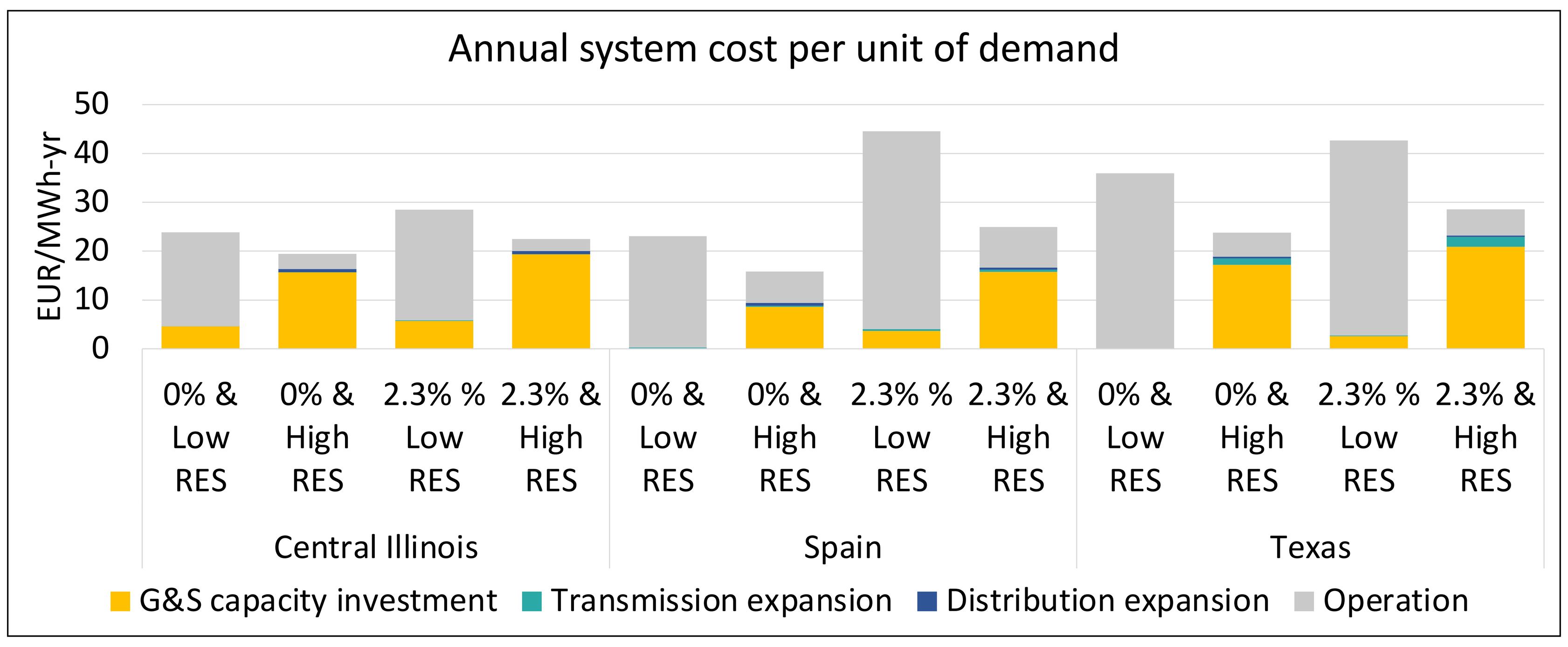
Key parameters of the three selected electricity grids

	Central Illinois	Spain	Texas
RES participation in the initial energy mix			
	13.5%	44.7%	12.3%
Transmission (T) grid characteristics			
Number of nodes	200	479	2,000
Length of lines (km)	2,585	36,273	48,580
Peak demand (GW)	2.2	41	59
Distribution (D) grid characterisation: share of RES to connect to D			
PV	60%	43%	25%
Wind	0%	6%	0%

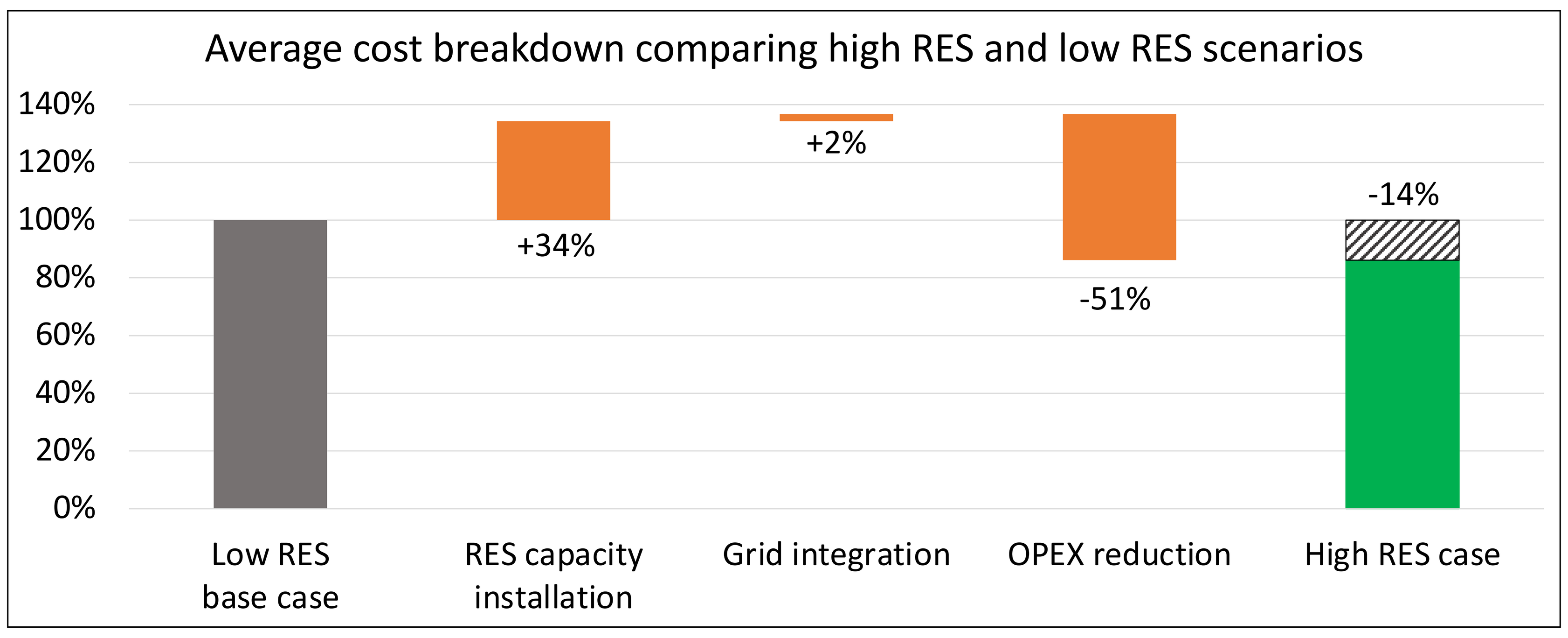
The annual unit grid investment composition (T&D) reflects the share of RES connecting to distribution as well as distribution grid configuration (urban, rural).



6. Results



Despite increasing both G&S capacity and grid (T&D) investments, high RES scenarios reduce total annual system costs in all zones.



High RES scenarios allow for an average OPEX reduction of 51%, reducing total system costs (investment + operation) by 14%.

7. Conclusions

Unit T&D grid investment costs represent 3 to 10% of the total investment costs in the high RES scenarios and 2 to 9% in the low RES scenario.

Required added G&S capacity increases significantly when moving from low to high RES scenarios. However, injecting additional energy from RES leads to **0.94 to 2.97 €/MWh** incremental grid (T&D) investment.

→The saving potential of RES generation is in the operating cost reduction. **Despite the increasing network investment costs, annualised system costs are reduced** by around 6 to 18% compared to the corresponding low RES scenario.

→The power system has a low impact on the finding that investing in RES allows for a **decrease in system costs** via the reduction of OPEX.

IRED 2022 Poster Session

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Methodology

Case study