The EU-funded IMPROGRES Project: Quantifying and Addressing Cost Impacts of High Penetration of DG

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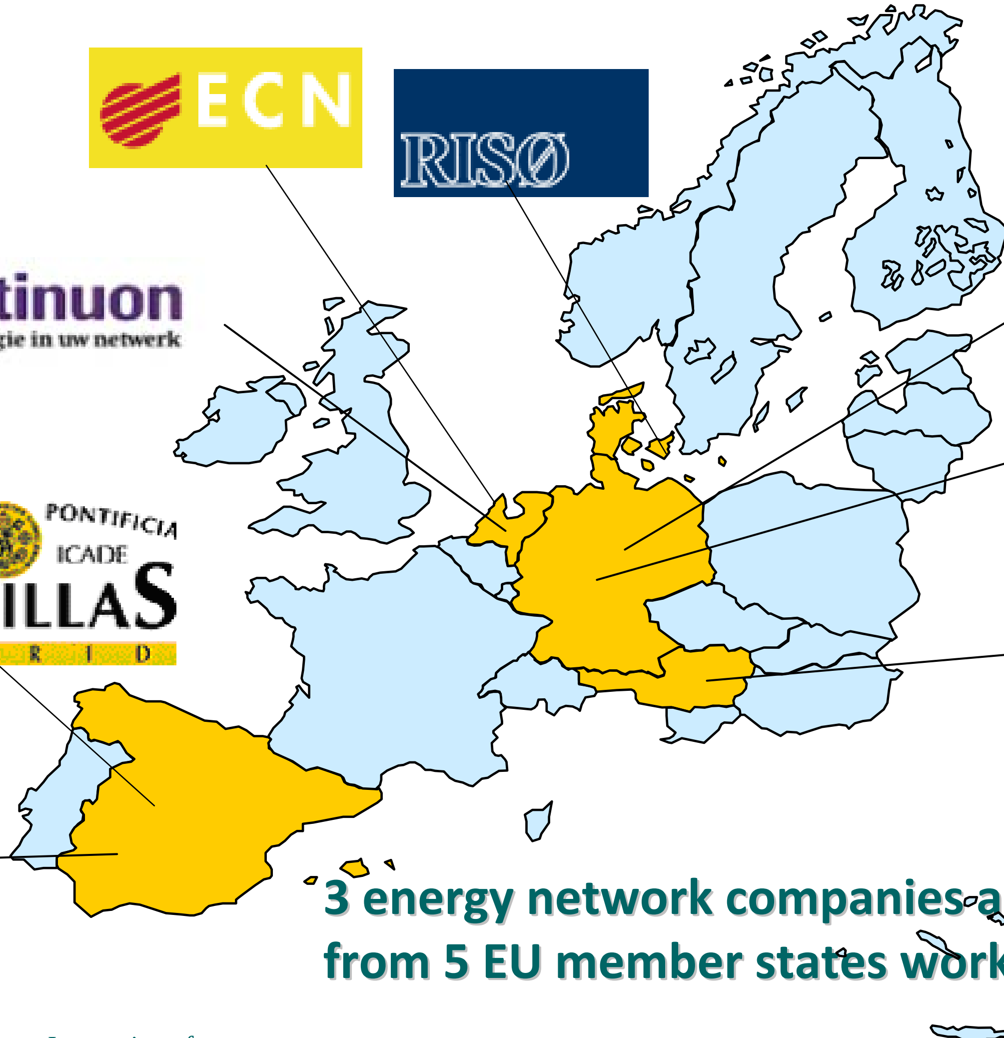


3 energy network companies and 5 research institutes from 5 EU member states worked together…..

… in the IMPROGRES project

- to improve the social optimal outcome of market integration of distributed generation (DG) and electricity from renewable energy sources (RES-E) in European electricity markets
- during 2.5 years (September 2007-March 2010)
- Funded by the EU Altener programme in Intelligent Energy Europe

What is the problem?

Increase in DG/RES-E electricity production leads to:

- ***Increase in power generation costs***
  - electricity from RES is relatively more expensive than conventional power production
- ***Increase in network integration costs***
  - e.g. reinforcement costs
- ***Increase in system integration costs***
  - e.g. increasing reserve power and balancing costs due to intermittent power production

What was done in IMPROGRES?

- Analysed and compared incentive schemes for DG-RES in different European countries
- Developed scenarios for future increases of DG-RES in distribution grids
- Assessed regulatory issues and network cost recovery
- **Quantified total integration cost of DG-RES in distribution grids in 3 case studies**
- **Analysed SmartGrids/Active Network Management (ANM) solutions to reduce network costs**

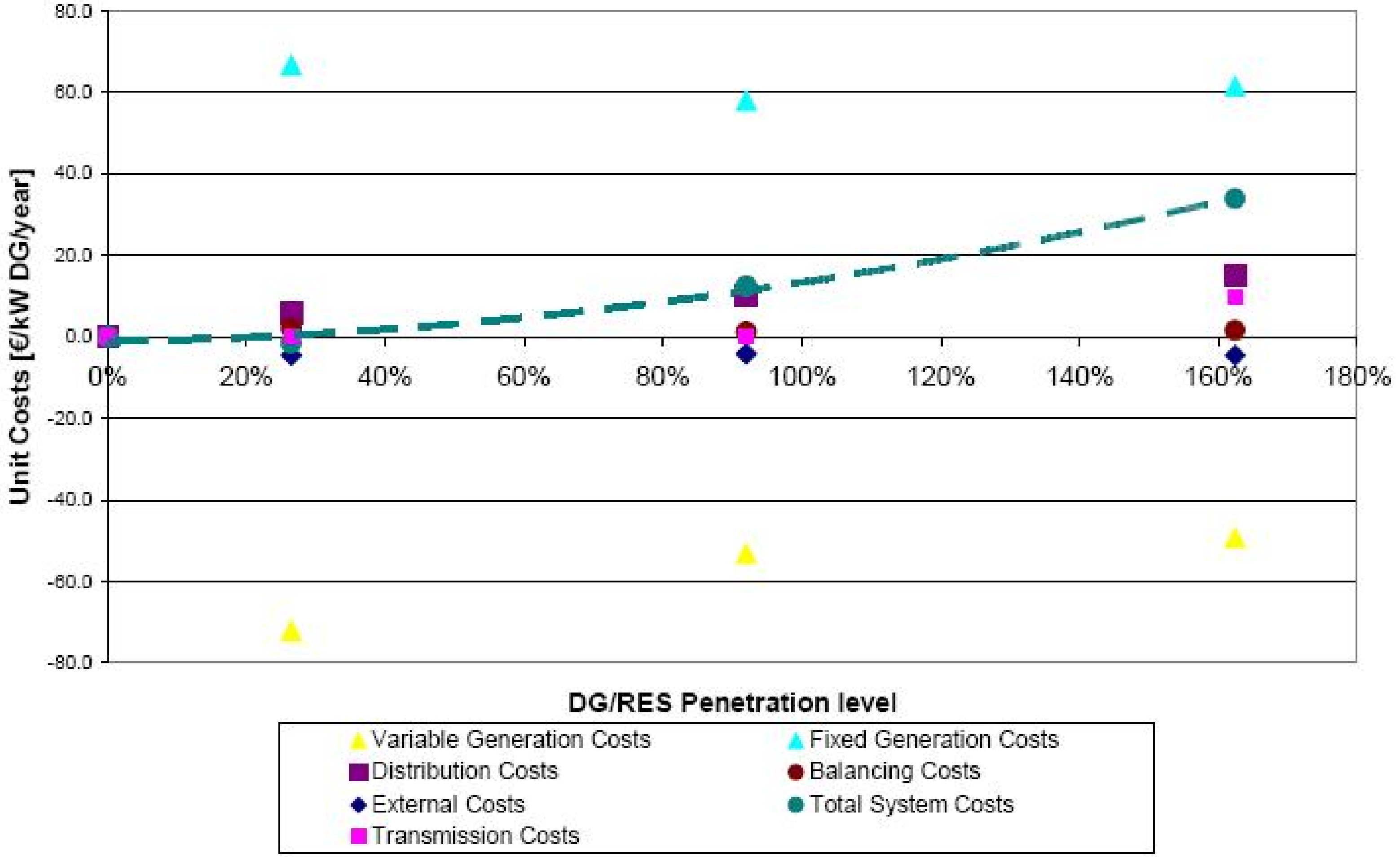
Approach: network cost savings due to ANM

- Quantified the costs of connecting DG:
  - BAU: Passive behaviour of demand and DG
  - ANM: Demand response and generation control
- Three actual distribution areas in Germany, the Netherlands and Spain
  - Several scenarios of demand (2) and DG penetration (4)
  - Two snapshots per scenario: maximum net demand and maximum net generation
- Reference Network Models:
  - Large-scale distribution planning models (regulatory use)
  - Results independent from actual network conditions

Distribution areas studied

- **Kop van Noord Holland (Netherlands):** Sub-urban, rural area. 80,000 customers, 675km^2. Large penetration levels of wind and CHP (DG production can surpass peak demand).
  - Response options considered comprise shifting lighting demand of greenhouses, limited wind curtailment and controlling CHP production.
- **Mannheim (Germany):** Urban area. 6,100 customers, 20km^2. Connection of roof PV and micro-CHP. PV production may surpass the maximum instantaneous consumption at LV level.
  - Response options considered: LV demand response was unattractive. Hence, DG maximum production reduced by 20%.
- **Aranjuez (Spain):** Sub-urban, industrial area. 61,600 customers, 3400km^2. Some wind and CHP units (HV) and PV farms (MV).
  - Response options: LV demand response and changes in CHP and PV production patterns by active control and a shift in peak demand time

Total supply cost in the Netherlands case study



4 DG penetration levels as % of contracted load

Blue: investment costs in CHP and onshore wind

Yellow: Fuel + CO_2 savings

One of the options to reduce integration costs: Active Network Management

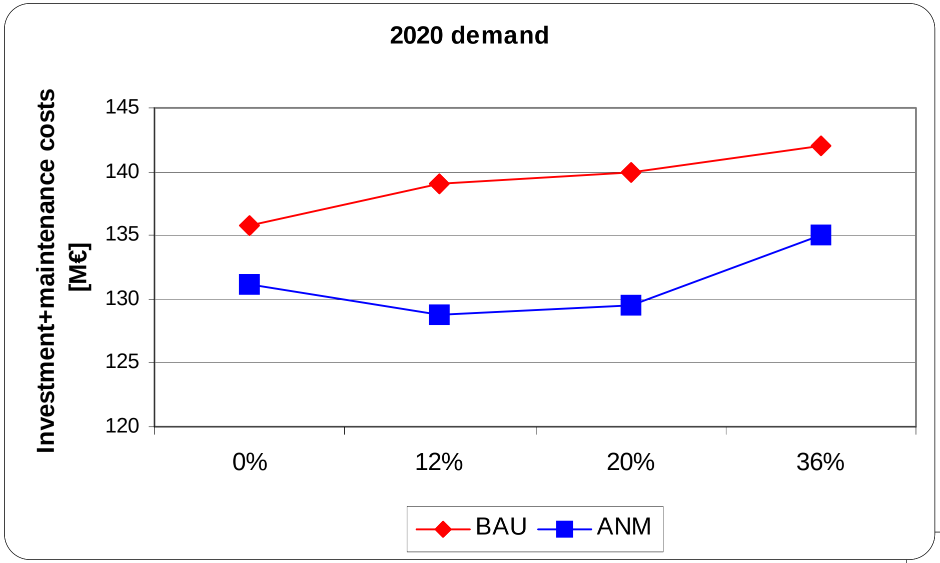
- Definition: DG integrated into network control, with greater coordination of power system operation, rather than connection only. ‘DG’ includes demand response

- Fundamental differences with existing congestion management to deal with insufficient network capacity:
  a) ANM is a permanent and not a temporary solution
  b) DSO no longer has obligation to relieve congestion as soon as possible

Example of ANM options in North Holland

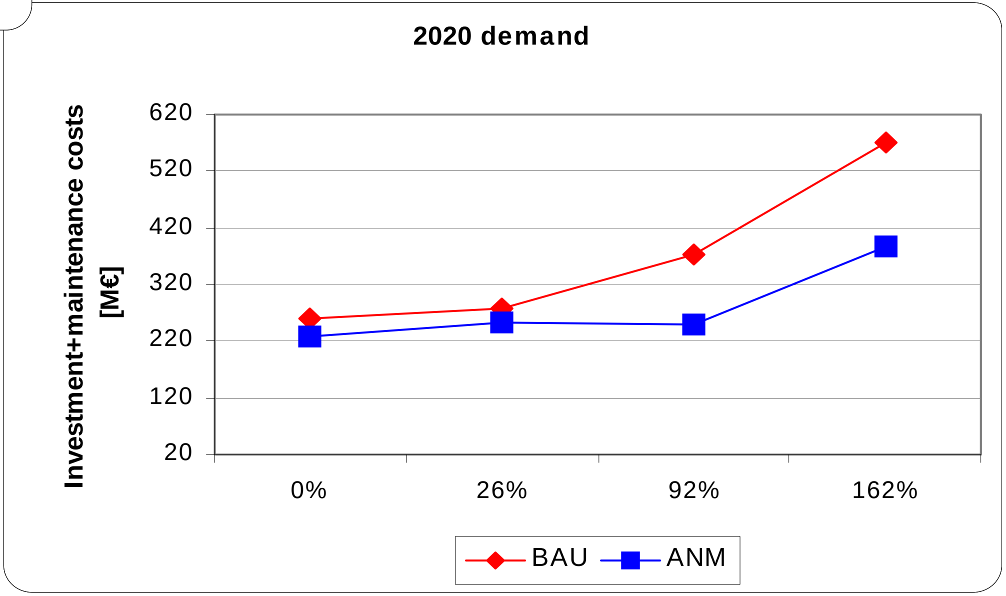
1. Wind curtailment (temporarily reduce output of wind turbines)
2. Shifting combined heat and power (CHP) generation (reduce during peak generation; increase during peak load)
3. Demand response (shifting greenhouse lighting load to different hours)

Network cost with ANM and business as usual (BAU)

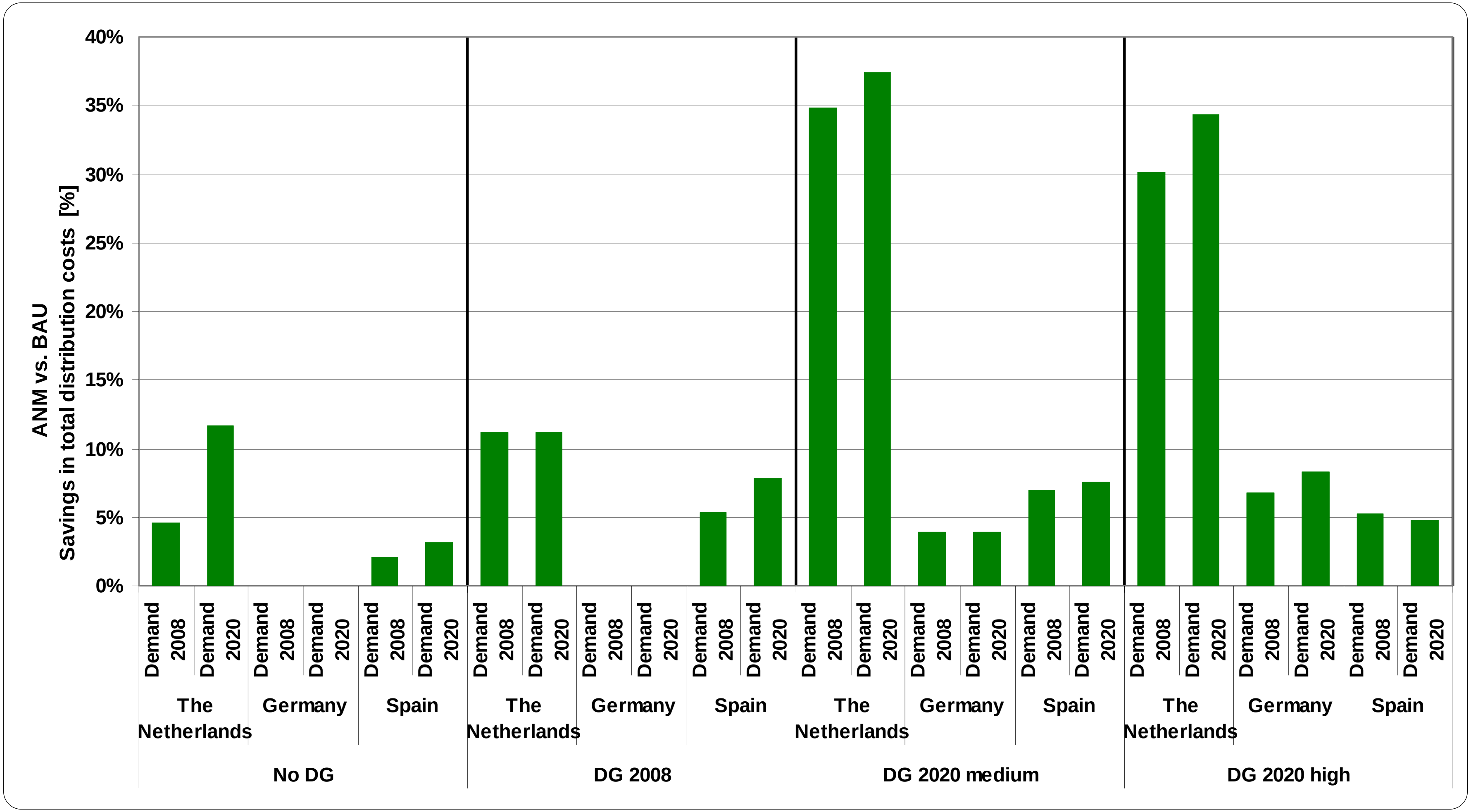


Spanish case study (left): a reduction in network costs is obtained with moderate DG penetration levels. This is due to the lower capacity needs caused by DG production at peak load periods

Dutch case study (right): network costs increase with DG, albeit much less than under a BAU. Main savings correspond to transformer capacity due to a reduction in maximum DG production



ANM savings as % of distribution costs



Conclusion: savings differ widely from 2-37%, depending on scenarios en local circumstances

Annualised costs and benefits of Active Network Management in 3 case studies

	Network cost savings €/kW_{DG}/year	Technology cost (ICT) €/kW_{DG}/year	Net benefits €/kW_{DG}/year
Spain	3.3	7.9	-4.6
Germany	10.5	2.5	8.0
Netherlands	8.6	0.1	8.5

- ICT costs differ, depending on kW-scale household applications (ES, DE) or only MW-scale (NL)
- High uncertainty on costs and net benefits => more pilot projects needed such as e.g. the German E-Energy programme

Extrapolating to EU-25 level in 2020
Cost for DG, networks and ANM benefits

- DG will increase from 201 GW to 317 GW in 2020 (investments of more than €200 bn)
- Requiring additional network cost of about €25 bn
- ANM will reduce network costs by €1-3 bn (about 5-10% savings in additional network costs)

- Putting ANM in perspective: Network benefits of flexible integration of DG are only about 1% of the investment cost in DG

Conclusions

- Demand response and active generation control of DG can contribute to market integration of wind (and solar): Less investments in back-up generators are needed to compensate for fluctuations in generation
- These benefits for the **electricity system** are likely to be more important than the **network benefits**
- When an infrastructure for demand response and active generation control is established to provide reserve power and balancing services, this can **also** be made beneficial for ANM
- Electricity retailers and ESCOs may become important players in smart grids projects
- Challenge for regulators: a substantial share of costs of smart grids is in the regulated domain, while most of the benefits of controlling DG and DR accrue to market parties (producers, suppliers/retailers)

For more information and project results:

www.improgres.org