PBL Netherlands Environmental Assessment Agency

Capacity vs Energy Subsidies for Renewables: Benefits and costs for the 2030 EU Power Market?

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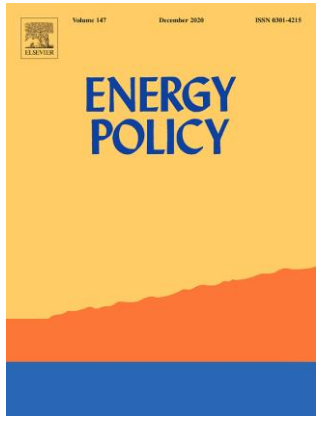
For more details

Özdemir, Ö., Hobbs B.F., van Hout, M., Koutstaal, P., 2019. Capacity vs energy subsidies for renewables: Benefits and costs for the 2030 EU power market. Cambridge Working paper in Economics 1927, Energy Policy Group, University of Cambridge, UK. https://www.eprg.group.cam.ac.uk/wp-content/uploads/2019/03/1911-Text.pdf



Özdemir Ö, Hobbs BF, van Hout M, Koutstaal PR (2020). Capacity vs energy subsidies for promoting renewable investment: Benefits and costs for the EU power market. Energy Policy. 137.

INTRODUCTION

Background

- The European Union set a binding renewable target for 2030 (Renewable energy directive, December, 2018)
  - at least 32% share of renewable energy in total energy consumption
  - the electricity sector will continue to contribute a significant share
- How will EU Member States meet the overall target?
  - Unlike 2020 targets, 2030 targets explicitly ruled out binding national RES targets
  - National energy and climate plans (NECPs) with own RES targets (Energy Governance Regulation 2018/1999)
  - European Green Deal (as of 2021) aims to encourage cooperation and enable to support projects that are most cost-efficient within Europe

Renewable support policies in the electricity sector

- Policy instruments
  - Renewable subsidies (Capacity (MW) vs. energy (MWh))
  - CO2 taxes and/or emission trading schemes (ETS)
- Policy Objectives
  - realizing specific shares of renewable energy
  - reducing CO2-emissions
  - promoting technology improvement through learning by doing
  - achieving cost-effectiveness
- It is not clearly stated which instrument is targeted at which policy objective
- Policy instruments also interact with each other
  - thereby affecting both the overall costs and effectiveness of the energy and climate policy package

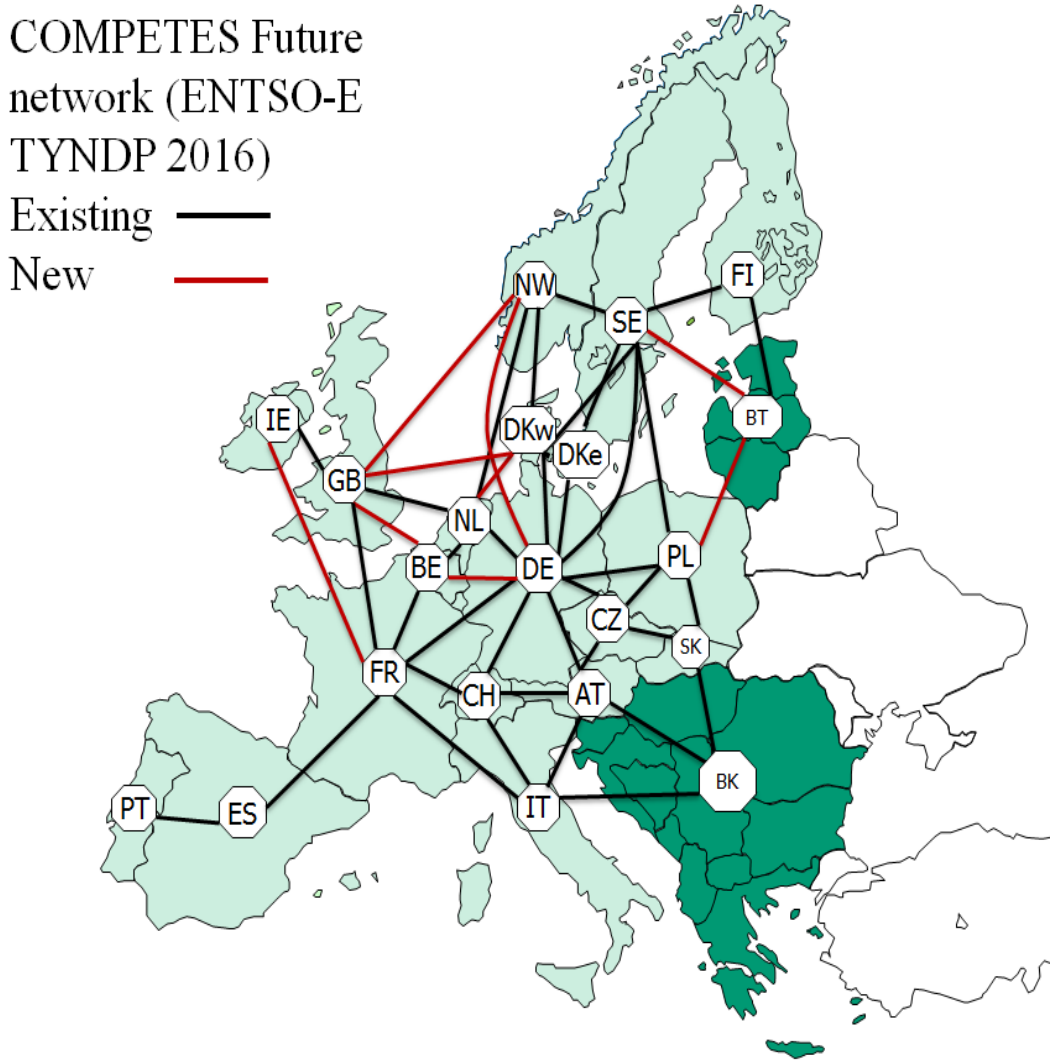
Research questions

- How do different renewable energy subsidies impact
  - type and location of renewable investments
  - renewable share
  - CO2-emissions
  - electricity generation costs and the amount spent on subsidies
- Three types of subsidy schemes
  - Energy subsidy: Renewable portfolio standards (RPS) or FIP
  - Capacity subsidy: Capacity auction
  - A mixed investment/output subsidy (Newbery et al., 2018)
- Other issues
  - Interaction with EU-ETS price
  - National vs EU-wide targets

METHODOLOGY

COMPETES

- COMPETES is a network constrained model of the European electricity market
  - 22 node pan-European network
- Transmission mimics integrated EU network limited by Net Transfer Capabilities
- Wide-range of RES and conventional generation technologies
- Hourly resolution per node
  - Hourly profiles of demand
  - Hourly profiles for wind, solar, and hydro
- Two modules
  - Generation capacity expansion model (Long-term)
  - Unit Commitment model (Short-term, e.g., day ahead markets)



Model Formulation (Ozdemir et al. 2019)

- Generation capacity expansion model (LP)

  Minimize

  Generation Investment Costs + Fixed and variable O&M Costs+ Fuel Costs+ CO2 Costs +Load shedding costs

  Subject to:

  - Generation capacity constraints
  - Variable wind/solar generation
  - Feasible investments (e.g., potentials for RES)
  - Operation of storage
    - e.g., hydro pump storage, hydro availability within season
  - Cross-border transmission flow limits
  - Electricity balance by country → electricity price (€/MWh)
  - Renewable MWh or MW target (EU-wide or by country) → subsidy (€/MWh or €/MW)

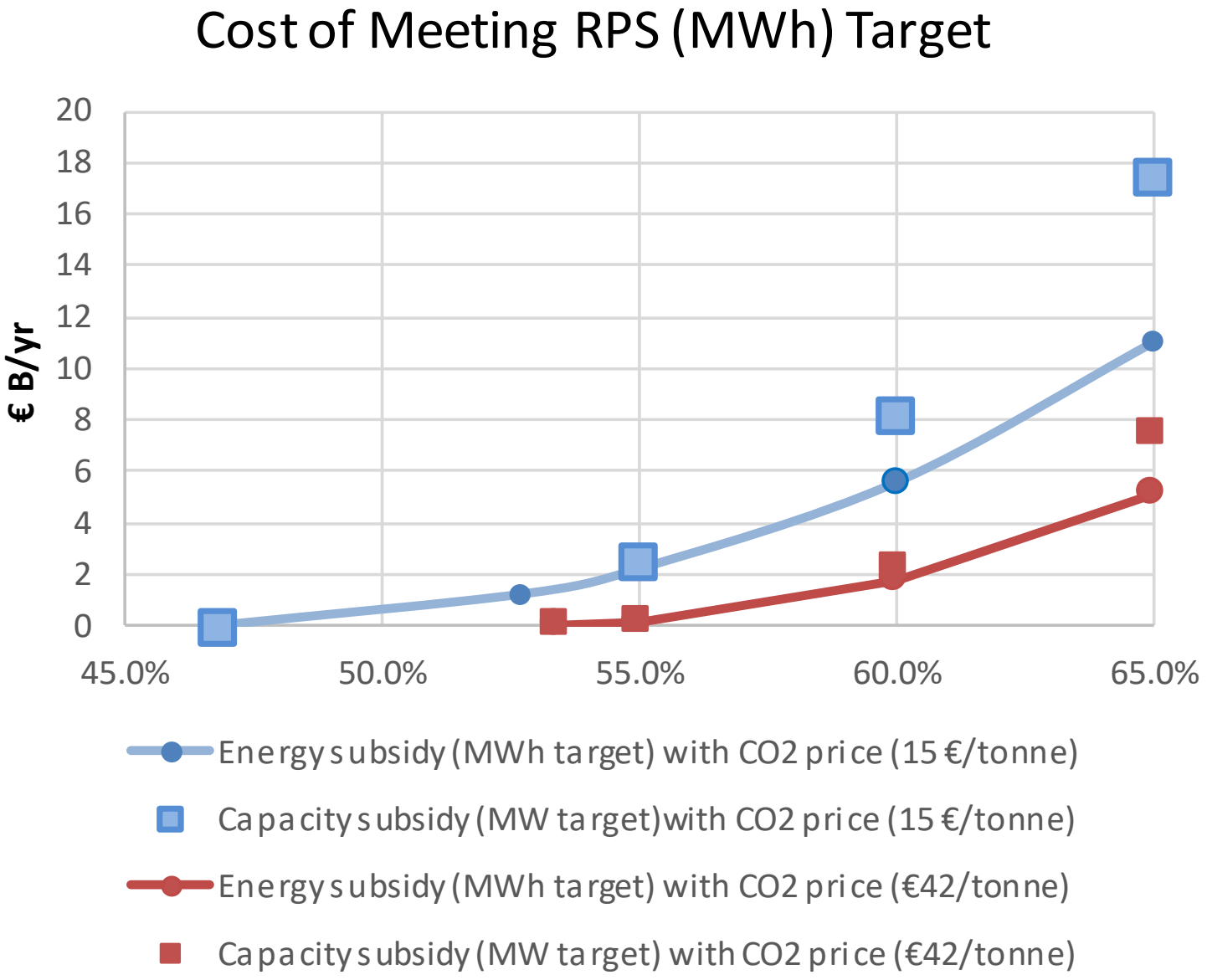
- Solution (Perfect competition equilibrium)
  - (Dis)investments, electricity dispatch, flows, electricity prices, renewable subsidies

Scenarios for EU-power market in 2030

RES support policy scenarios		CO2 price €/tonne	Target variations
EU-wide policy and targets	Baseline (No subsidy)	• 15 vs. 42	• No target
	Energy subsidy (RPS)	• 15 vs. 42	• Energy target up to 65% • Technology neutral vs. tech specific
	Capacity subsidy (Capacity auction)	• 15 vs. 42	• Capacity target up to 550 GW • Technology neutral vs. tech specific
	The mixed investment/output subsidy	• 15 vs. 42	• MWh/MW target achieving up to 65%
National targets	Country specific targets	• 15	• Based on renewable capacities in 2030 reported by ENTSO-E's Sustainable Transition (ST) scenario (ENTSO-E, 2018).

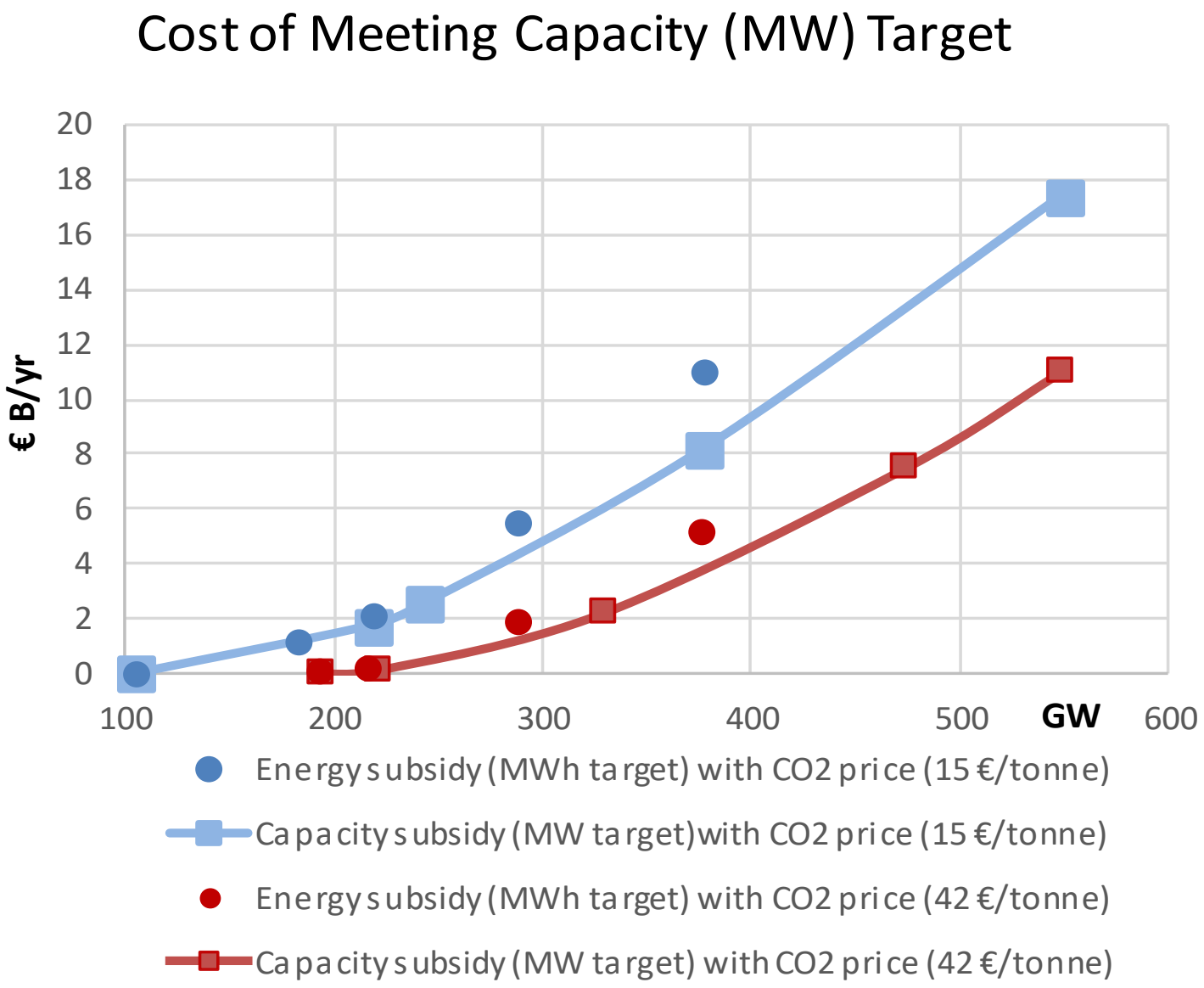
RESULTS

Incremental Costs of meeting MWh target



- Energy-based subsidy is more cost-effective
- The cost difference increases with more ambitious targets
- The mixed investment/output subsidy falls between these two cases
- The cost difference decreases with higher CO2 price
- The cost difference diminishes if the targets are technology-specific

Incremental Costs of meeting MW target



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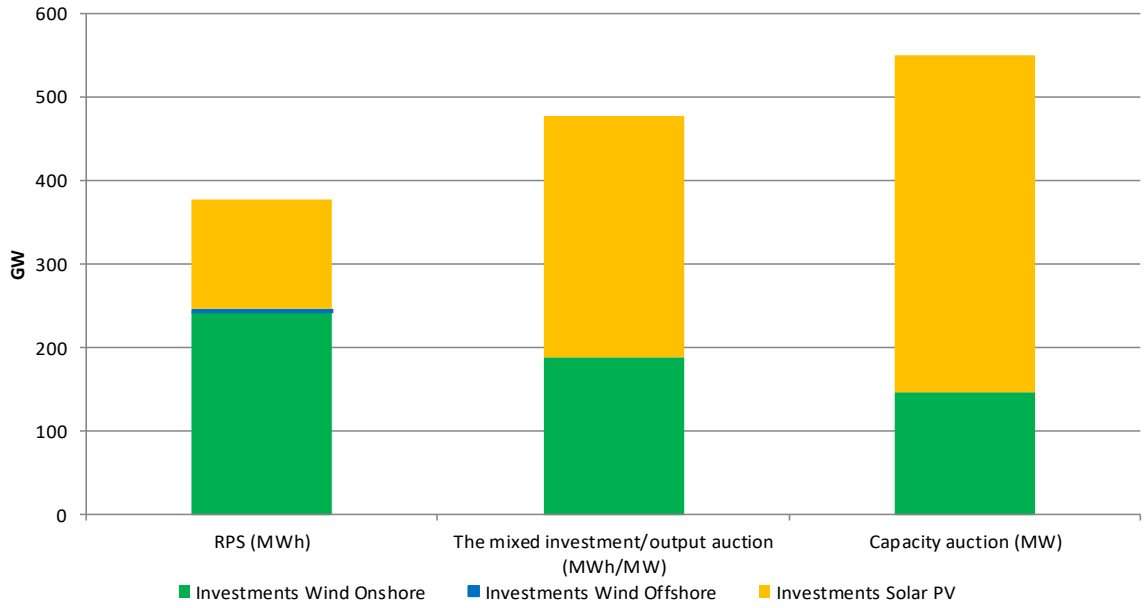
Capacity installed under energy vs capacity subsidies

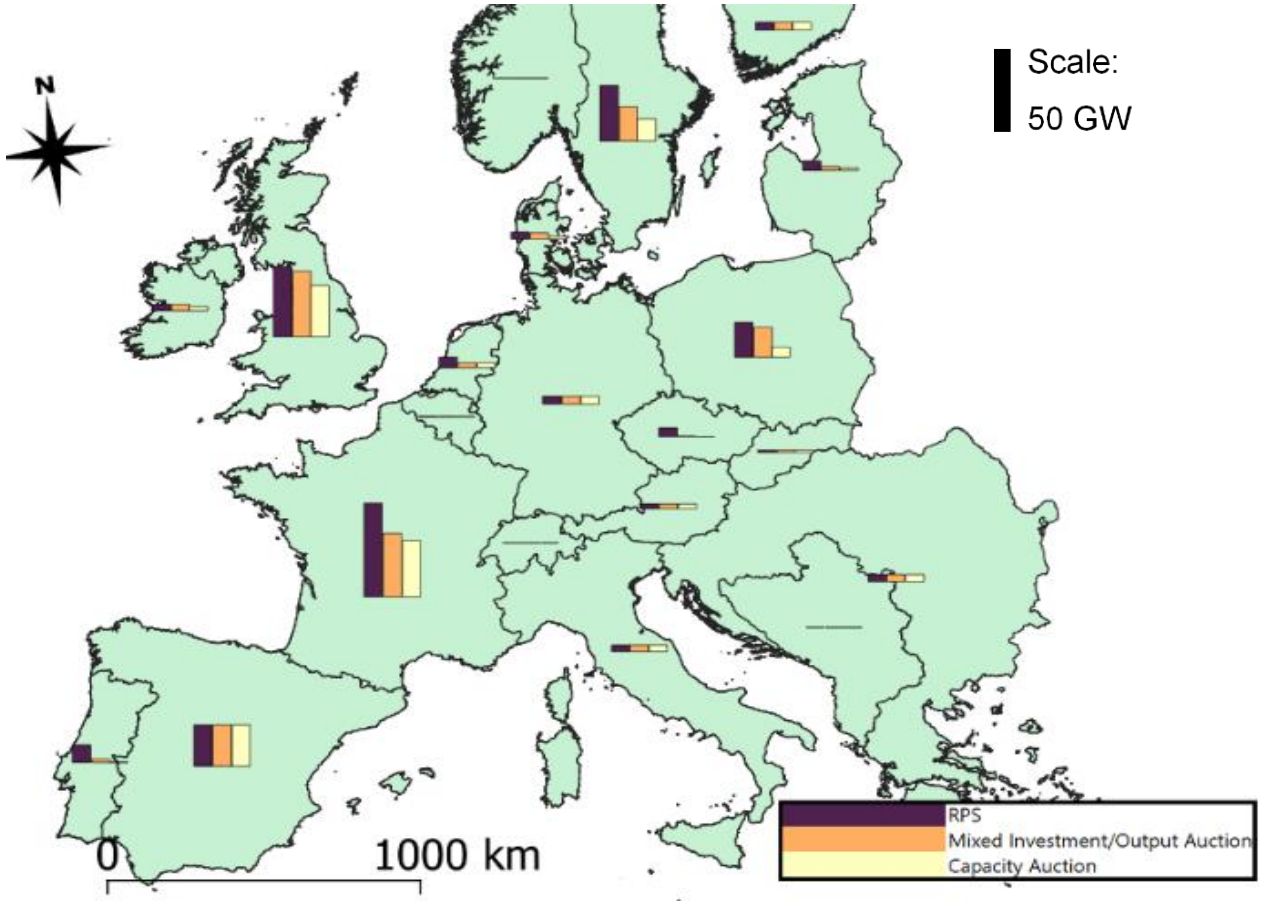
- *An energy-based subs*idy boosts technologies with higher capacity factors (e.g., wind)
- *A capacity-based subsidy* boosts technologies with lower investment costs (e.g., solar PV)
- *The mixed investment/output subsidy* falls in between
- Trade-off:
  - A capacity-based subsidy is a more expensive way to achieve an implicit energy goal
  - But in exchange for that added expense, much more capacity might be built and more learning achieved
  - ***Ex for 65% renewable share:*** 46% more total renewable investments with capacity subsidy while increasing the cost by 50%.

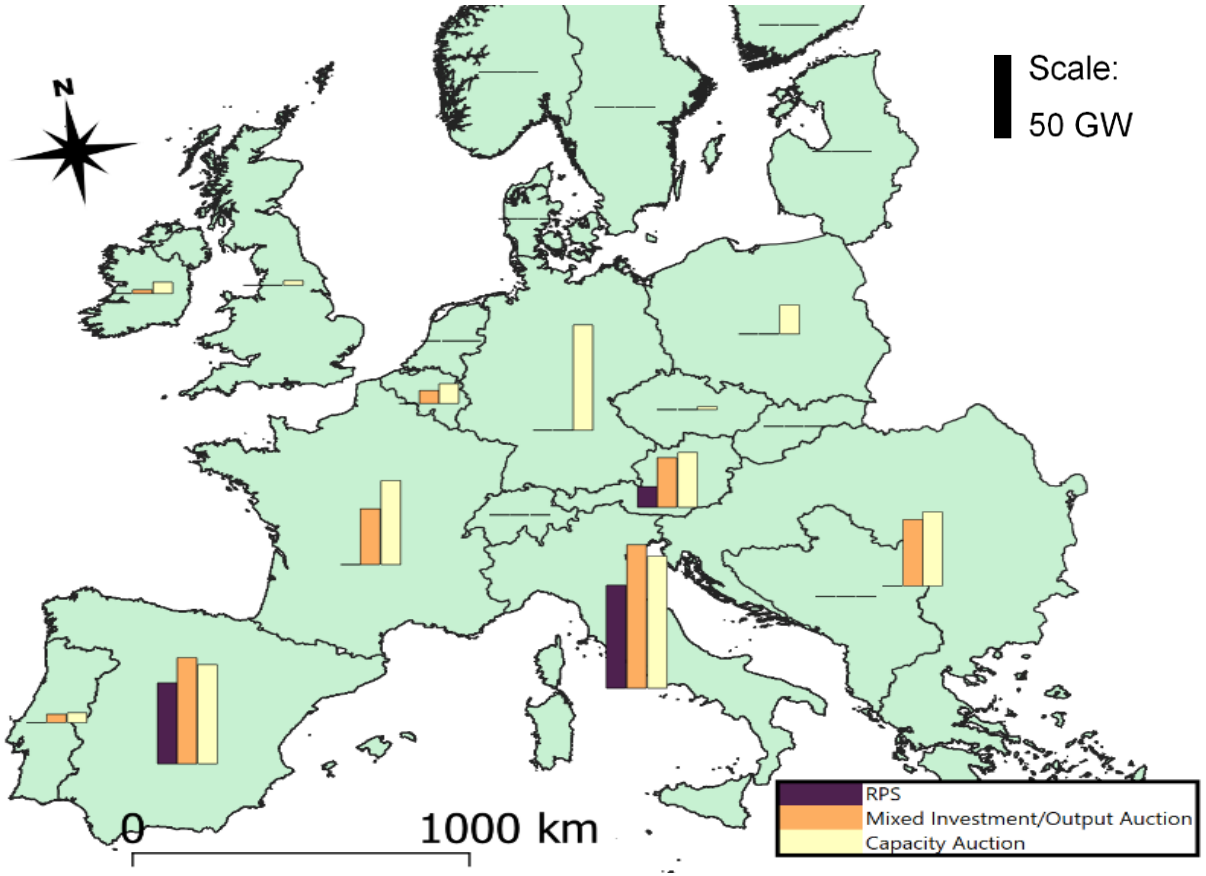
Incremental investments compared to base case: wind and solar under energy and capacity-focused subsidies achieving 65% renewable share: Technology neutral case



Locational Impact of energy vs capacity subsidies

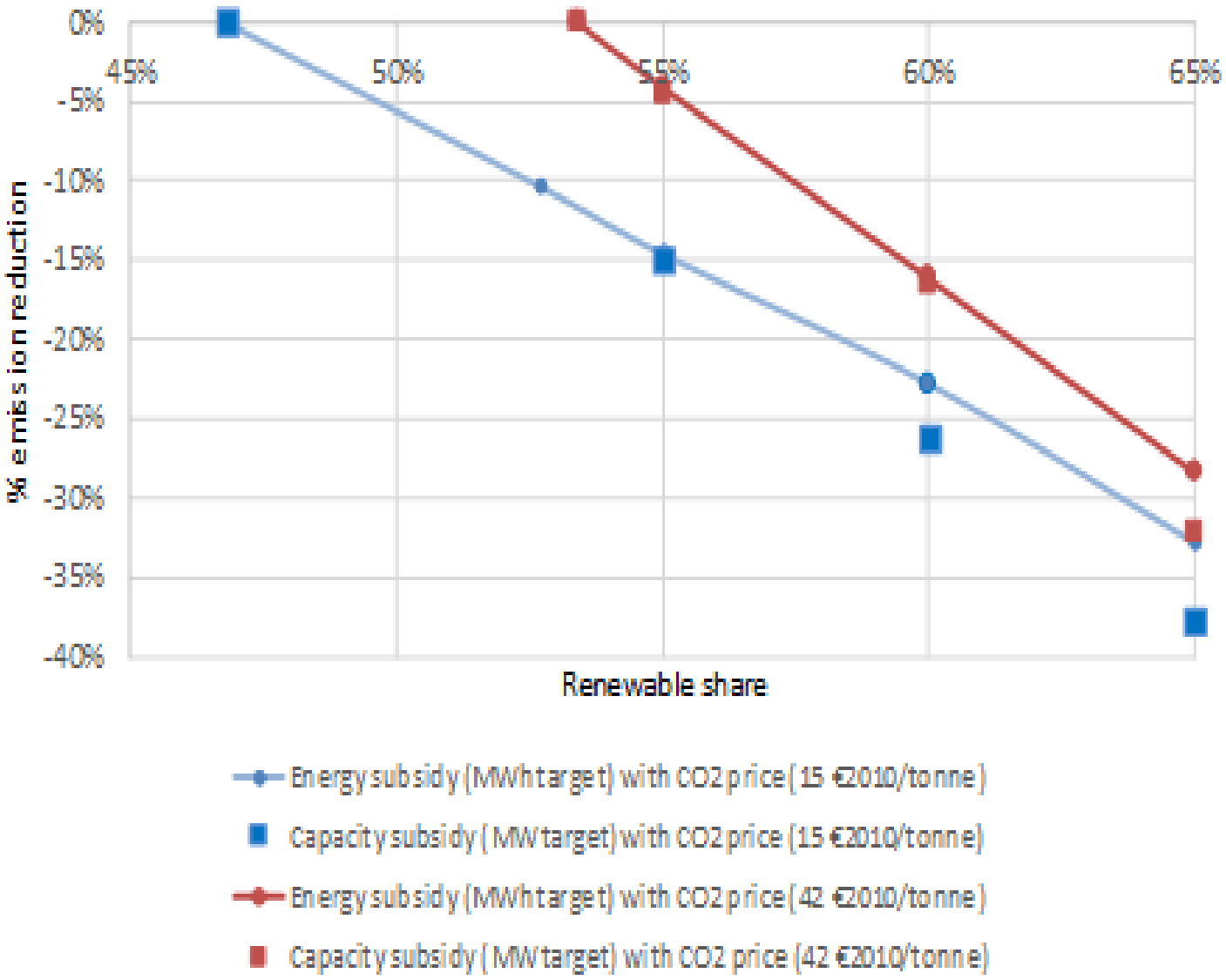
The locational distribution of wind (left) and solar (right) investments achieving 65% renewable share





Carbon emissions in electricity sector

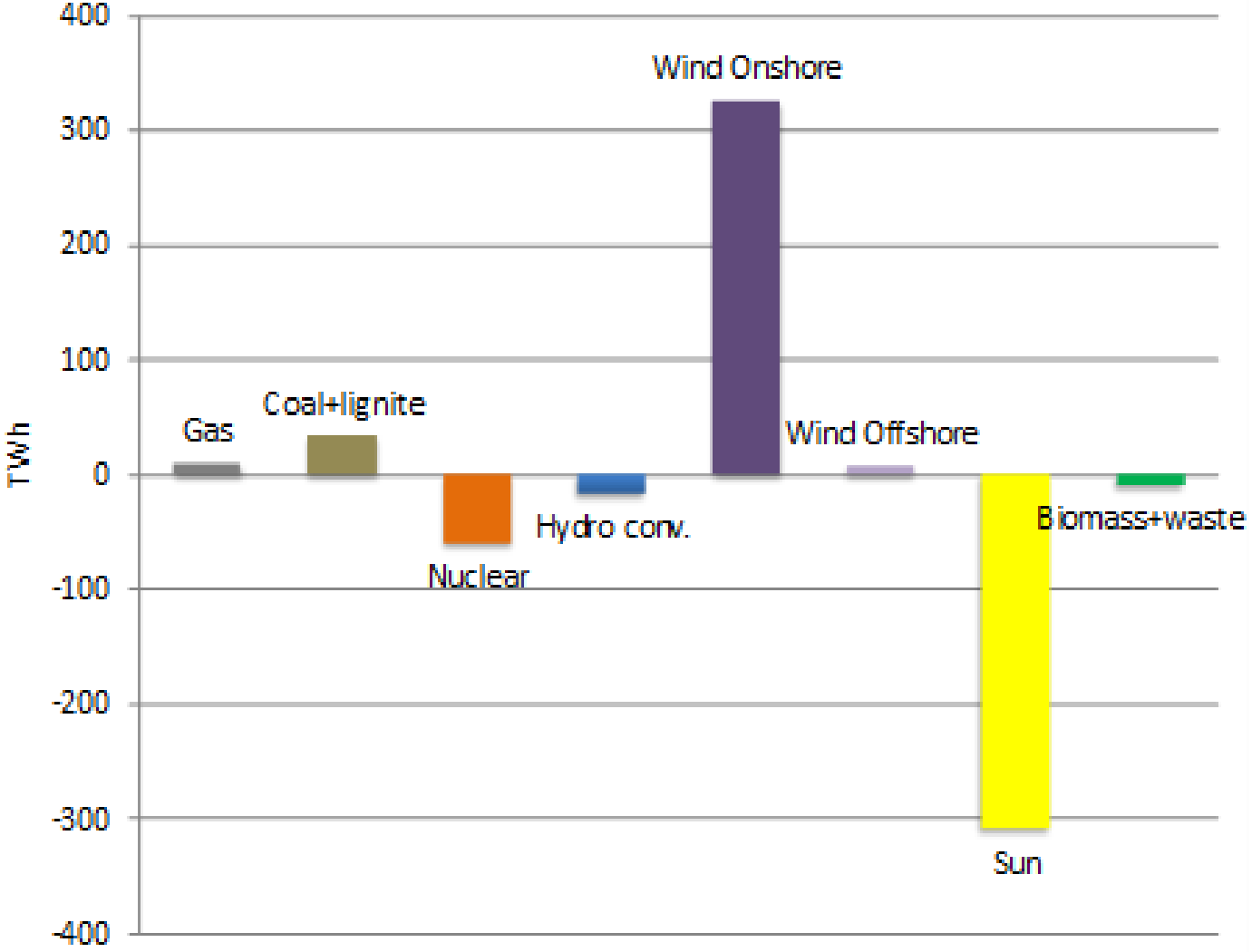
Fig. Percentage emission reductions (relative to Baseline)



- Smaller emission reduction under energy subsidy
- The difference increase at higher penetration levels
- Depends on the existing generation-mix in locations where renewables increase

Differences in EU-28 generation-mix

Fig. Differences in EU-28 generation-mix from RPS mechanism compared to capacity mechanism at 15 €/tonne CO_2 price, both achieving 65% renewable share



Energy subsidy

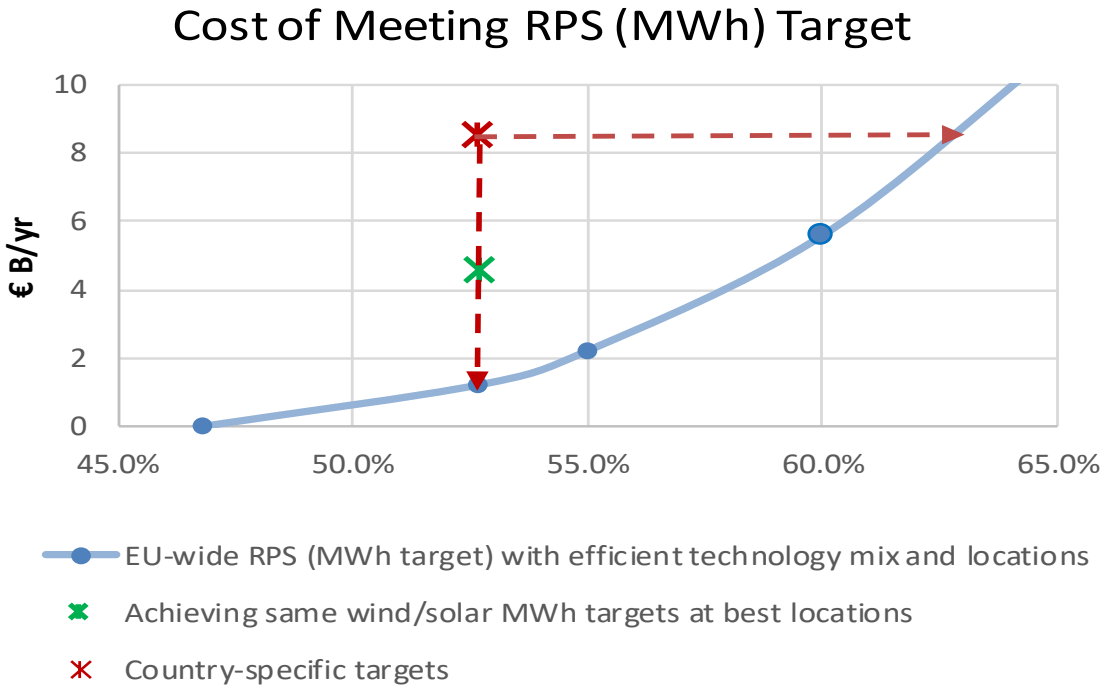
- higher wind generation in countries with relatively low-carbon technologies (e.g., Sweden)
- less solar-PV production in countries with significant coal-fired power generation (e.g., Germany)

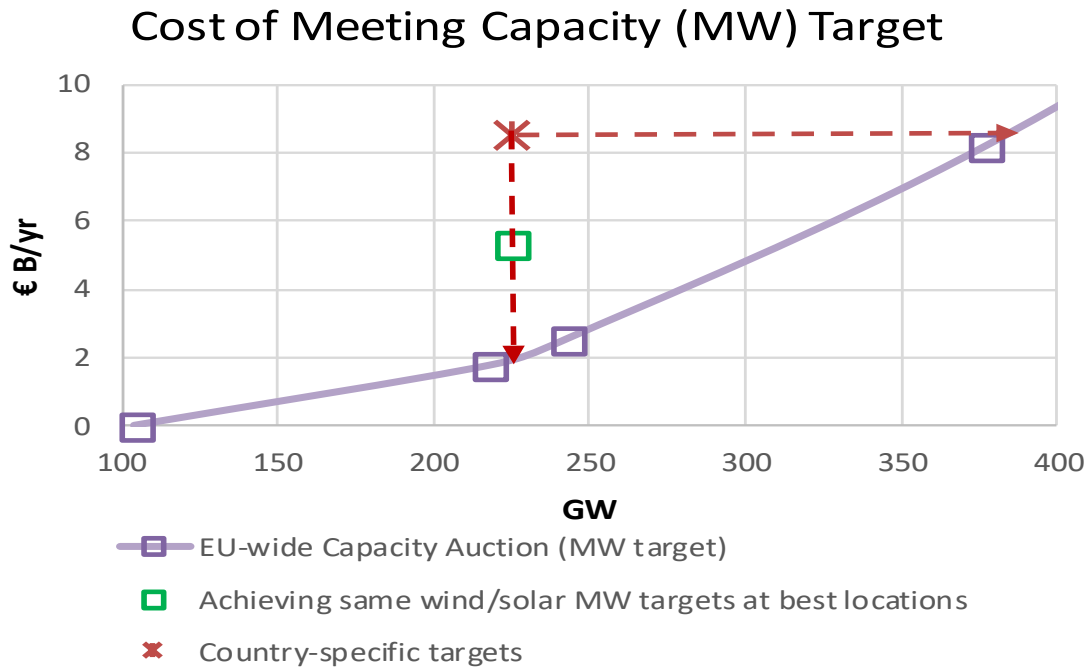
National vs EU-wide targets

- Country targets: ENTSO-E's 2030 "Sustainable Transition"
  - 52.7% renewable share
  - 225 GW of new renewable capacity investments

- The incremental cost of country specific targets is 8.5B€/yr
  - *seven* times higher than the cost of EU-wide RPS
  - *four* times higher than the cost of EU-wide capacity auction

- Half of the inefficiency is due to the wrong mix of technologies, and half is due to the wrong locations





Conclusions (1)

- Cost-effectiveness of a policy depends on the goal
  - An energy subsidy scheme is more cost-effective in realizing renewable energy target
  - If learning by doing is the main policy objective, a capacity subsidy may be more cost-effective
  - A mixed investment/output subsidy falls in between these cases as it has characteristics of both capacity and energy policies

- The inefficiency resulting from choosing one type of policy to meet a different type of goal
  - Increases with more ambitious targets
  - Decreases with higher CO2 price

Conclusions (2)

- Impact on type and location of renewable investments
  - Energy subsidy results in higher wind capacity investments in northwest Europe and less solar investments in eastern and southern Europe

- Impact on emissions in Europe
  - An energy subsidy scheme results in smaller emission reductions than a capacity subsidy scheme achieving the same level of renewable share
  - The differences are more pronounced at higher penetration levels of renewables

- National targets without renewable energy credit trading
  - greatly increase the cost of renewable policies
  - less efficient choice of technologies and locations
  - The efficiency gain of setting a EU-wide target with cooperation/trade between member states (e.g., EU Green Deal) is much higher than the choice between subsidy schemes

Any questions?

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