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The “Energiewende” in Germany
and how it drives research at the chair of Energy Economics

Felix Müsgens

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Research Seminar

TU Wien

Vienna, January 17th, 2019

Renewable Energy Sources Capacity in Germany, Overview

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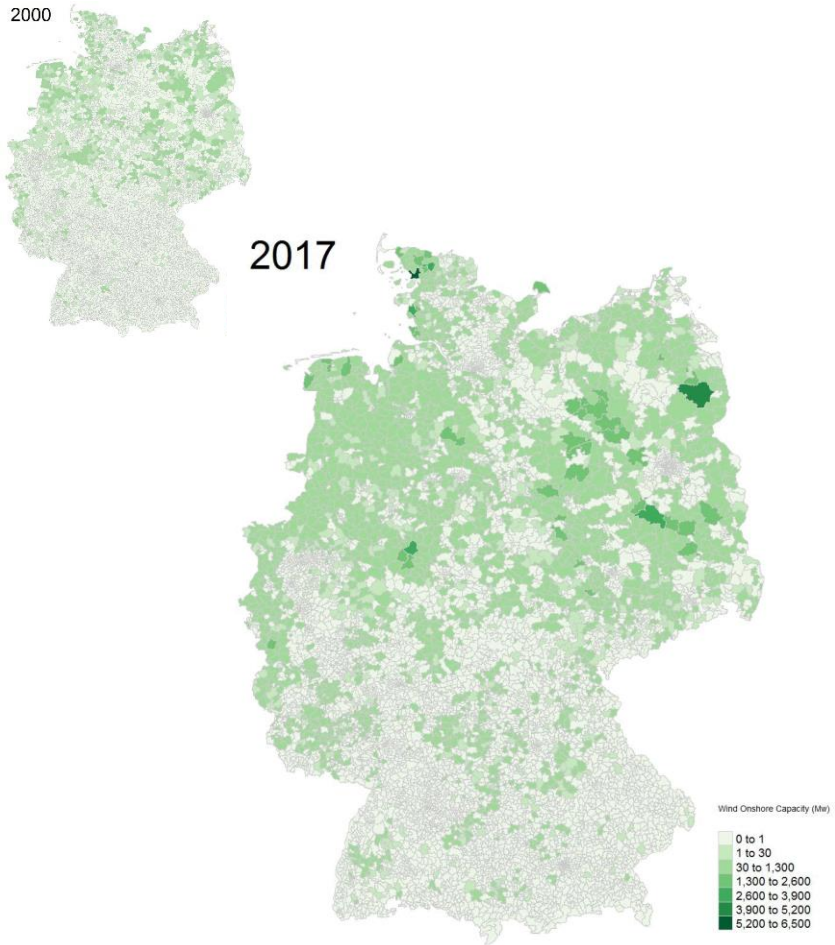
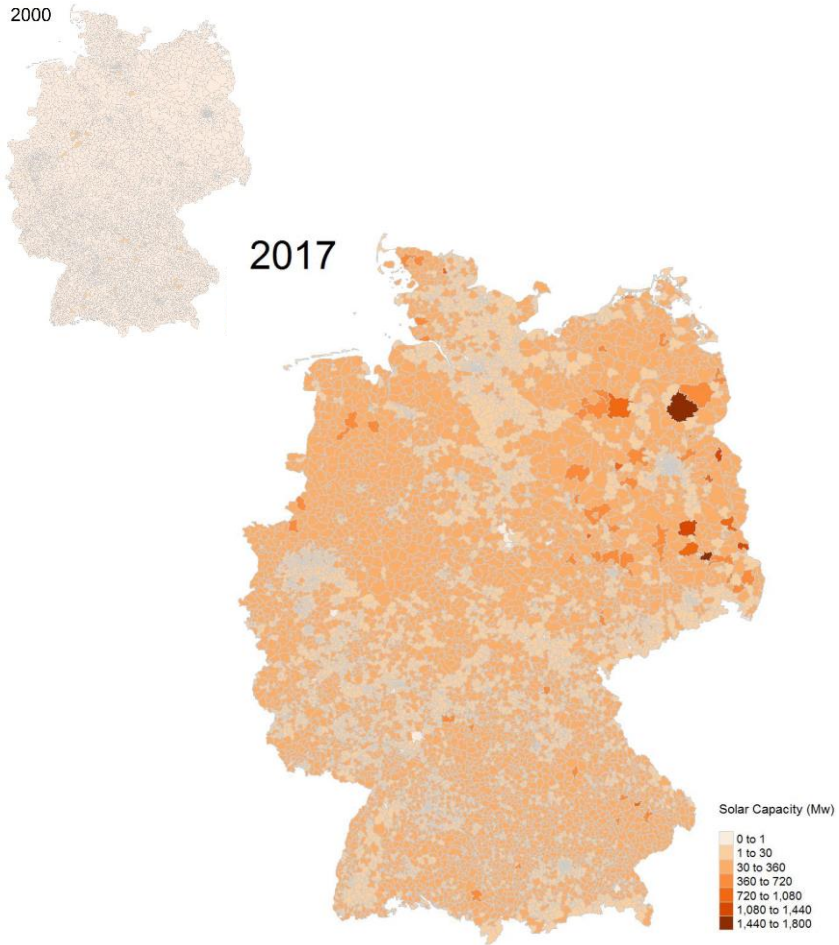
Wind



Solar



Status-Quo: Renewable Energy Shares and Net-Subsidies in Germany

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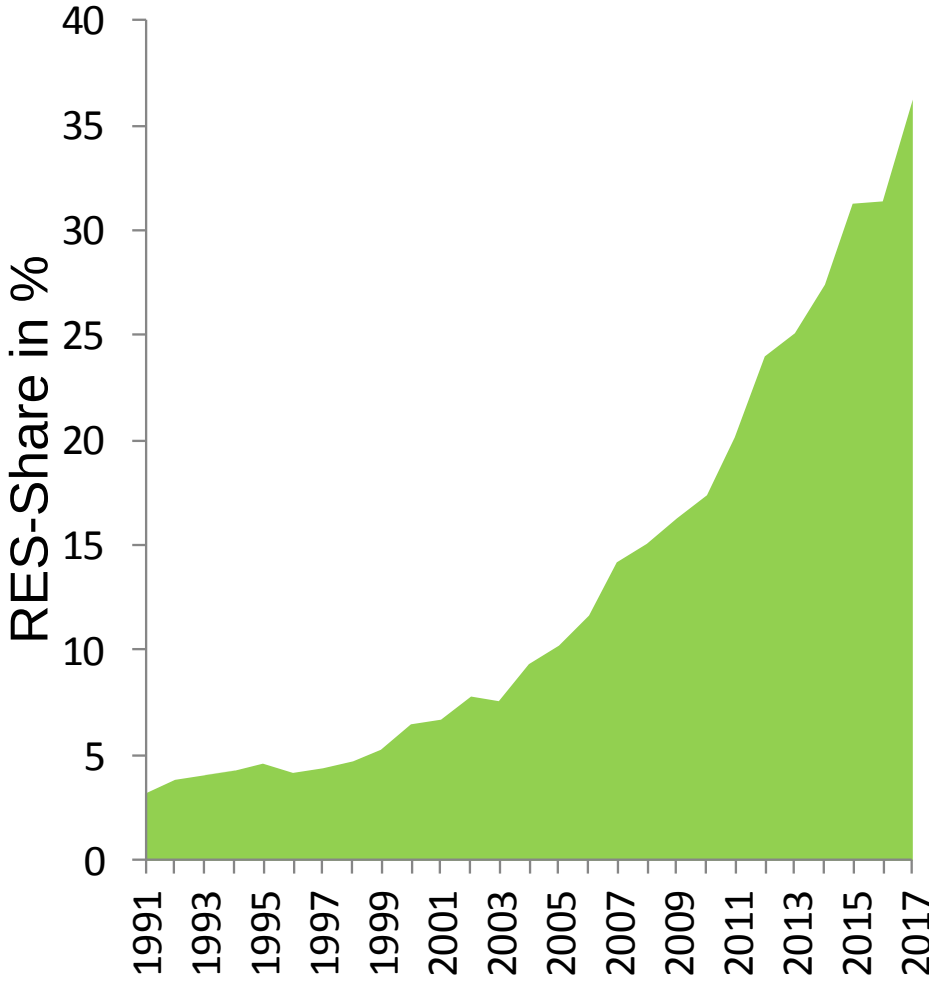
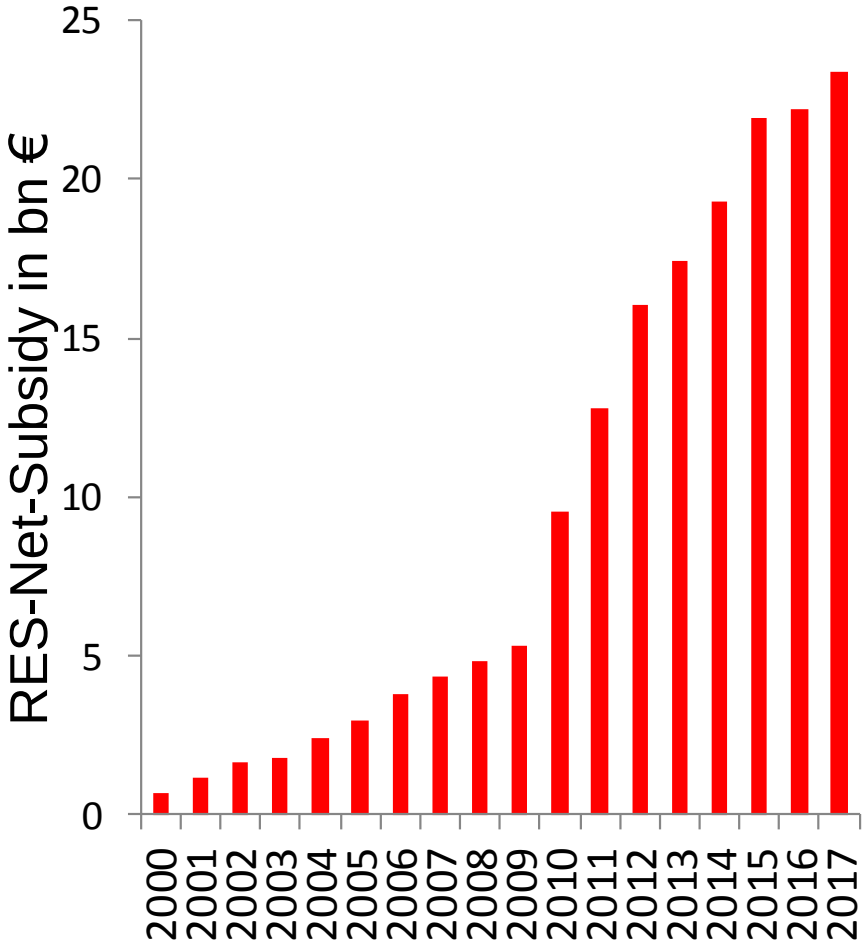


Source: AGEB



Source: Bundesregierung

Total Net Costs for German Renewable Energy Sources installed before 31/12/2011

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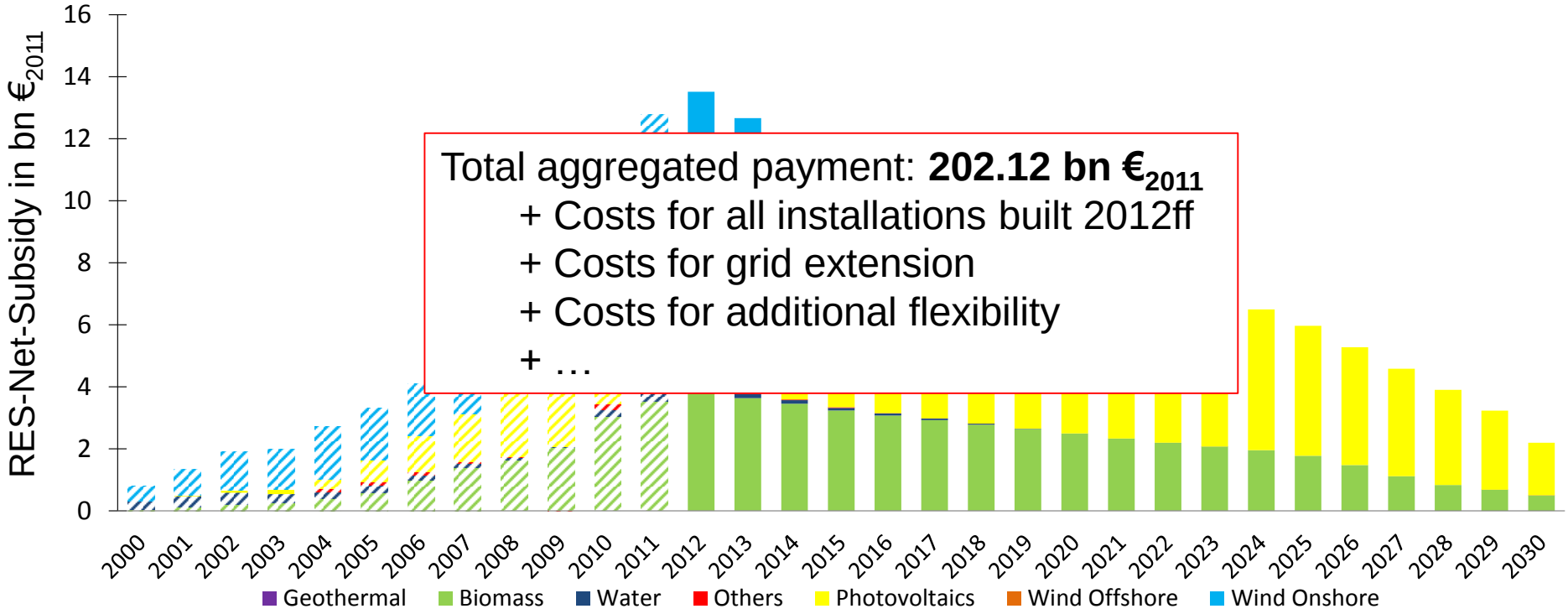
- The German “EEG” (RES-Act) specified that all RES installations receive feed-in tariffs for 20 years (plus year of installation).
- Below are estimates for the future cost burden for all RES plants built before the end of 2011 (again, only net costs are shown, market value for electricity has been subtracted):



Source: Kreuz, S., Müsgens, F. (2018): Measuring the cost of renewable energy in Germany, *The Electricity Journal* 31, May 2018, 29-33

Benefits of RES-Promotion

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- Low carbon technology
- Correction of R&D externalities (i.e. market participants invest too little in renewables for fear of other companies copying advances)
- Correction of externalities related to fossil fuels
  - Particulate matters (respirable dust)
  - NO_x, SO_2, …
- „Green Growth“
  - Jobs in economically weak regions (North and East Germany)
  - Know-How for Exports
- Reduction of fossil fuel imports
- Making green technologies available for world wide expansion

These advantages have often been discussed…

… but rarely quantified.

An extended qualitative discussion can also be found in:
Kreuz, S., Müsgens, F. (2017): ‘The German Energiewende and its roll-out of renewable energies: An economic perspective’, Frontiers in Energy 11(2): 126 – 134, 10.1007/s11708-017-0467-5

RES as low carbon technologies

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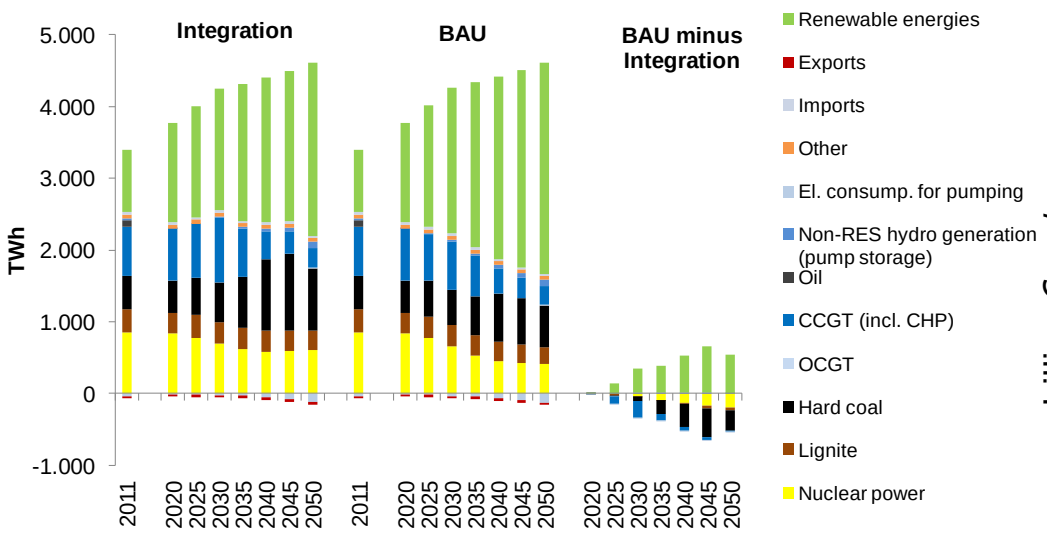
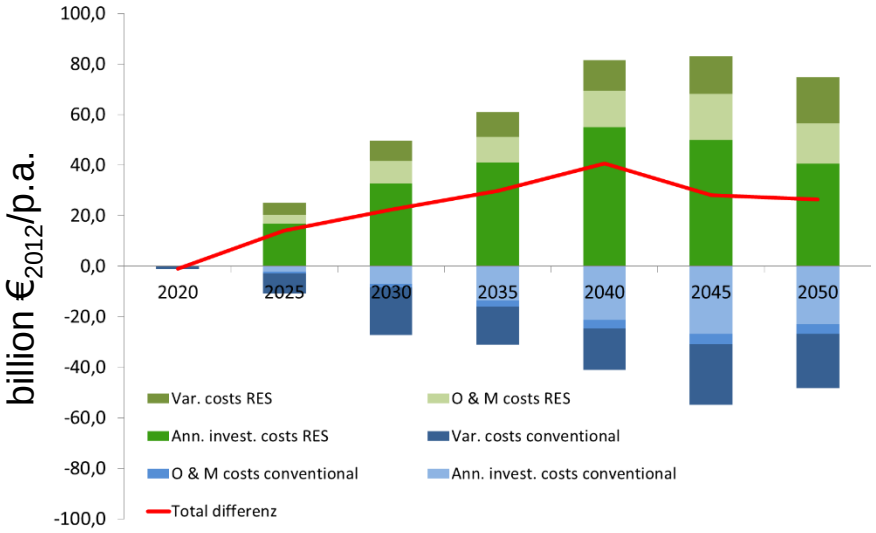
- RES are crucial to reach long-term decarbonisation goals…
- … but several studies show that decarbonisation could be significantly more efficient:





Source: Müsgens, F. (2018): Equilibrium Prices and Investment in Electricity Systems with CO2-Emission Trading and High Shares of Renewable Energies', *Energy Economics*, 10.1016/j.eneco.2018.07.028.

„Green Growth“ - Know how for exports?
Global top 10 of solar module production companies 2017

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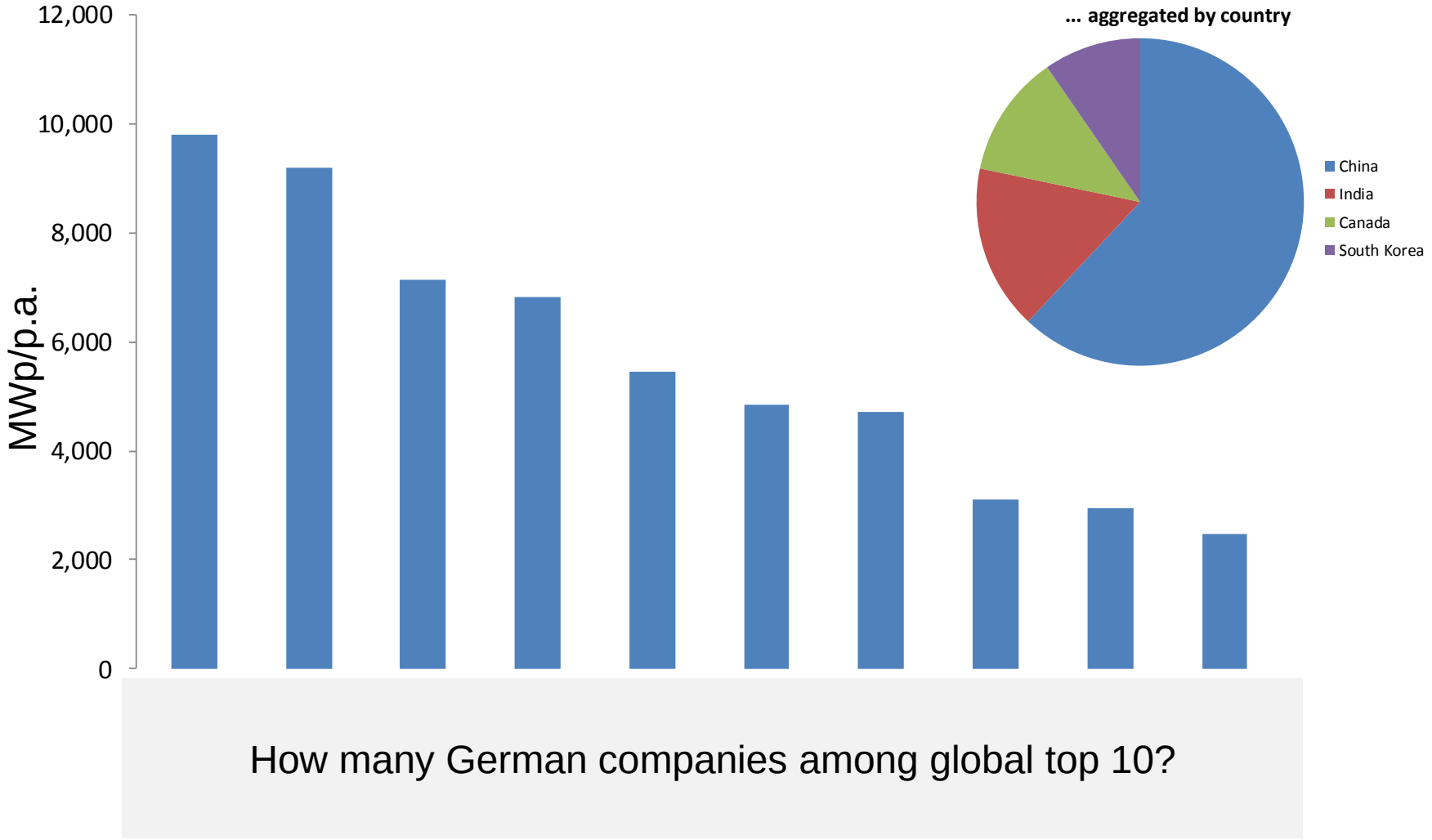

How many German companies among global top 10?

Auction Results for RES in Germany

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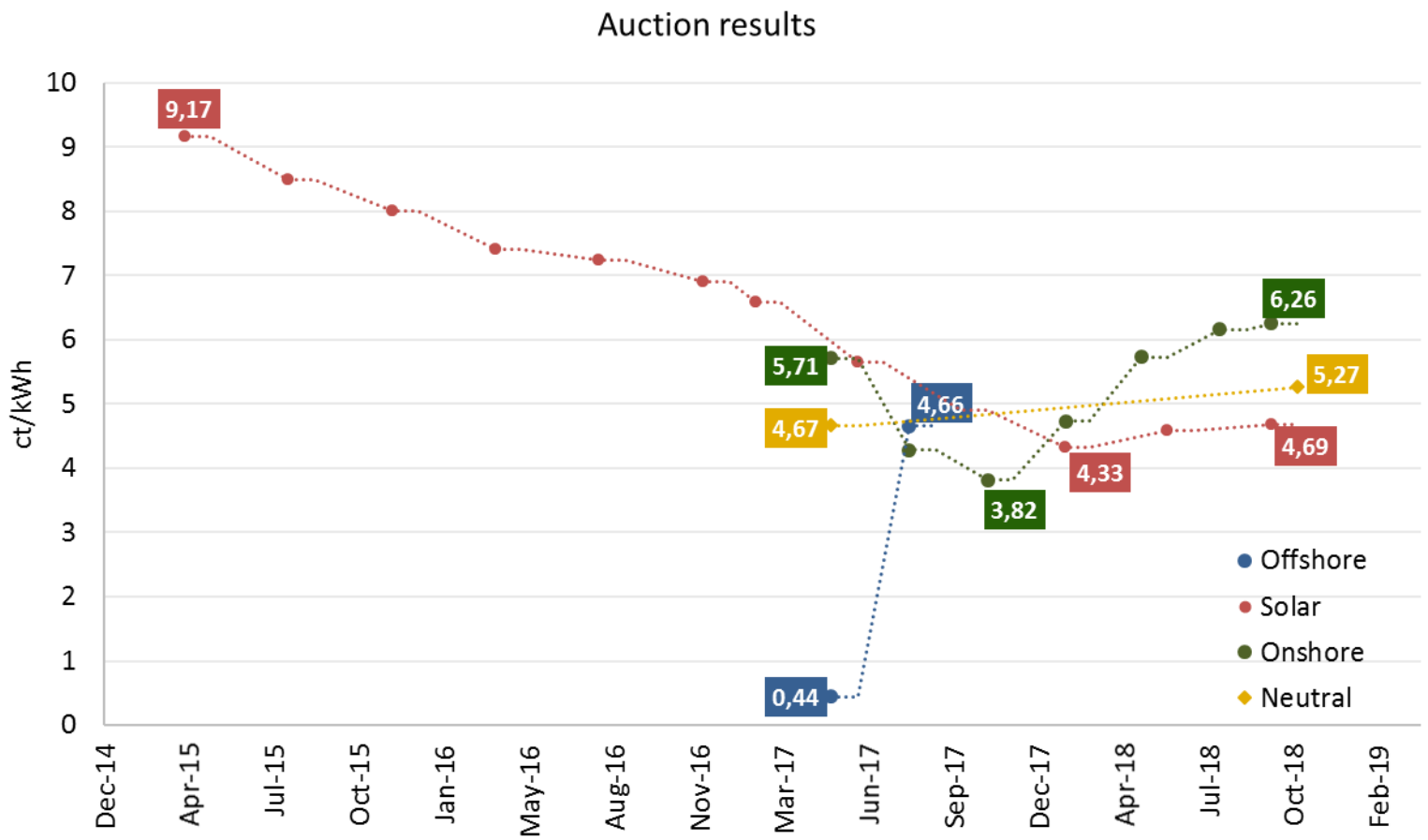

Competitiveness and Cost Reductions
Off-shore Wind

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- Offshore wind saw subsidy free bids in two German auctions. Müsgens and Riepin (2018) provide four (complementary) explanations:
  - Wholesale prices are (expected to be) cost covering, i.e. wind is competitive
  - Bids can be perceived as “options to build”
  - Bids are adjusted to secure grid access to specific clusters;
  - Other reasons
- Follow-up paper on other European offshore auctions is work in progress.

Competitiveness and Cost Reductions
Market Values for Onshore Wind

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- Market values are becoming increasingly important.
- Engelhorn and Müsgens analyse the example of wind onshore with data from more than 25,000 individual turbines in Germany:

Market Values

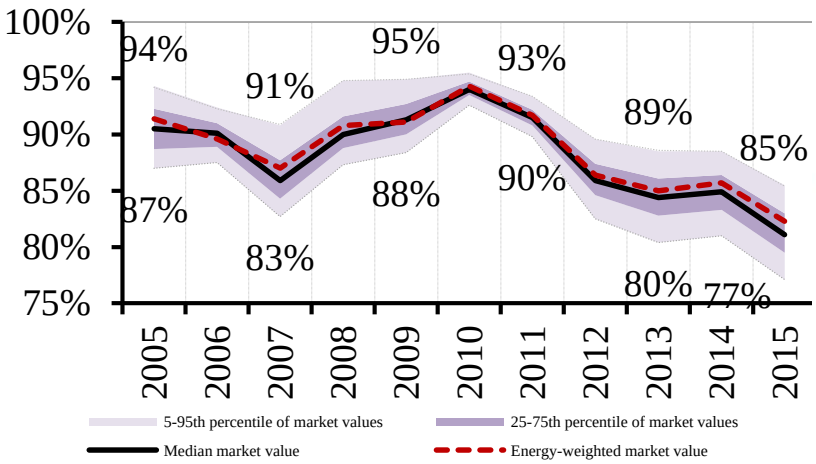
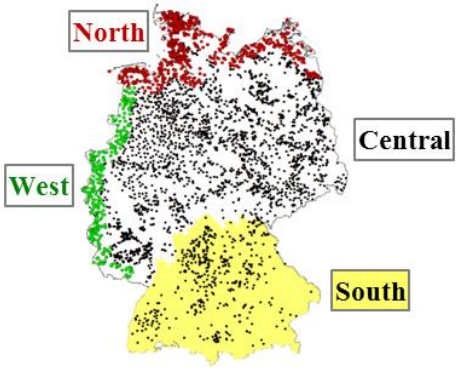
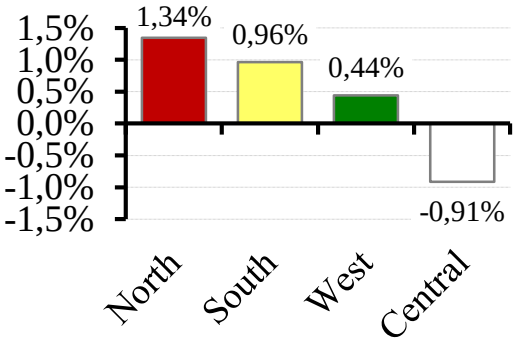


Illustration of regional clusters

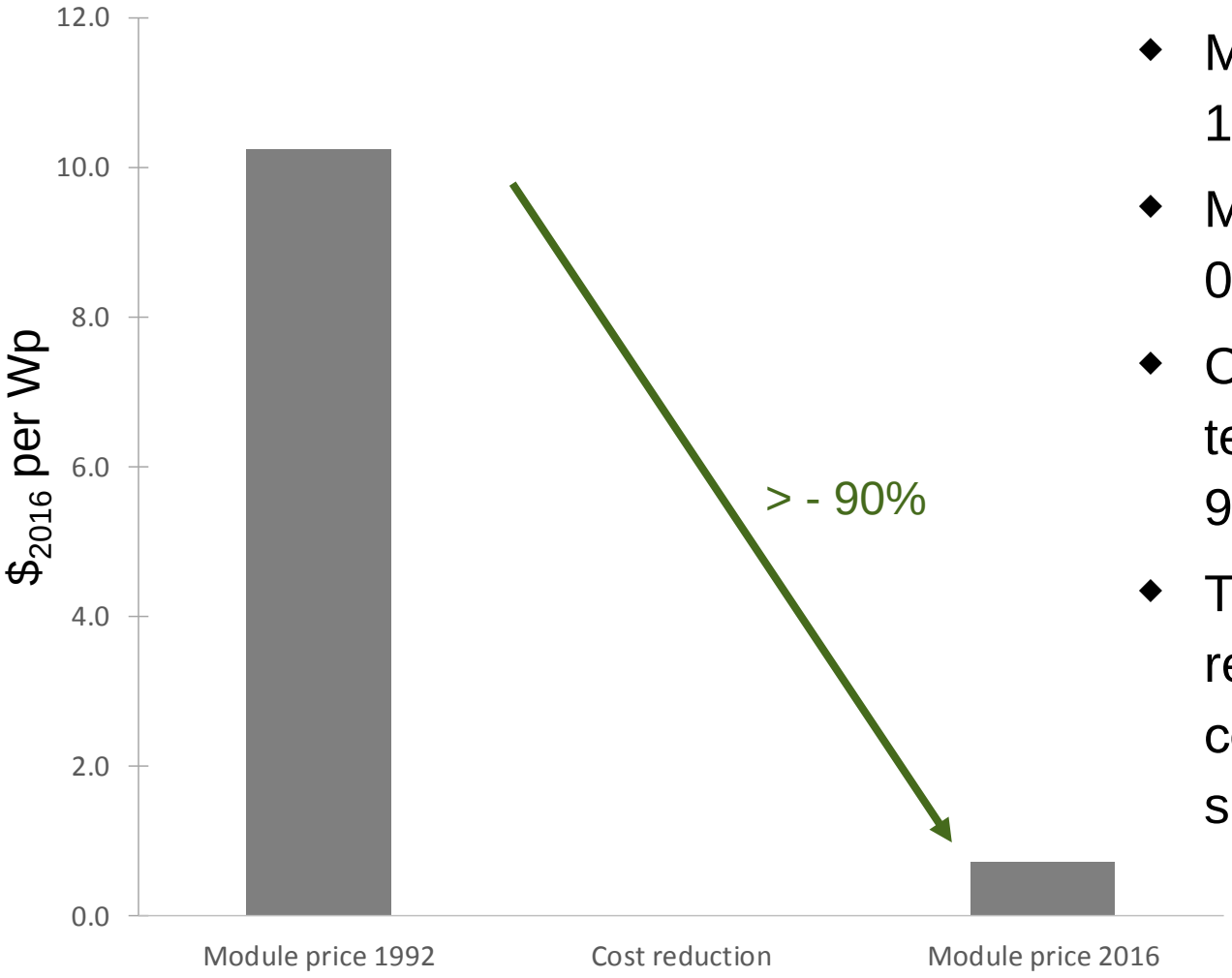


Average relative performance



Extensive online appendix (with turbine specific data) publicly available:
Engelhorn, T., Müsgens, F. (2018): 'How to estimate wind-turbine infeed with incomplete stock data: A general framework with an application to turbine-specific market values in Germany', *Energy Economics*, 10.1016/j.eneco.2018.04.022

Module prices decreased >90% between 1992 and 2016 (Results from model 2)



- Module price 1992: 10,25 $\$_{2016}$ per Wp
- Module price 2016: 0,72 $\$_{2016}$ per Wp
- Cost reduction in real terms: 9,53 $\$_{2016}$ per Wp
- To what extent is this resulting from individual countries‘ renewable support schemes?

Laufende Projekte (Auswahl)

FOCCSI

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- **F**orecast **O**ptimisation by **C**orrection and **C**ombination methods for System **I**ntegration
- Praktische Anwendung:
  - Vielzahl von Anbietern für Windprognosen
  - Welche ist „die beste“?
  - Sollten Prognosen kombiniert werden? Wie?
  - Welchen Wert liefert welche Prognose? (Wie viele soll ich kaufen?)
- Kooperationspartner: TSO

AG Marktdesign im Akademienprojekt „ESYS“

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- Das Projekt ESYS bündelt Expertise aus der Energieforschung in Deutschland unter dem Dach der Wissenschaftsakademien (Leopoldina, acatech, Union).
- Dabei werden in Arbeitsgruppen (AGs) Handlungsoptionen und Politikempfehlungen erarbeitet.
- Die **AG Marktdesign**
  - „Marktdesign ist die Kunst, Institutionen so auszugestalten, dass die Verhaltensanreize für individuelle Marktteilnehmer mit den übergeordneten Zielen des Marktarchitekten im Einklang stehen.” (Ockenfels in Gabler Wirtschaftslexikon)
  - zwei Schwerpunkte
    - **Sektorenkopplung**
    - **Flexibilität/Netzengpässe**

ProKoMo

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- **Pro**gnose**ko**mbination und **Mo**delloptimierung
- Praktische Anwendung
  - Verbesserte (Kurzfrist-)Preisprognose
  - Fundamentale Energiesysteme und stochastische Modelle existieren nebeneinander. Beide werden zur Preisprognose eingesetzt und haben individuelle Vor- und Nachteile.
  - Forschungsfragen:
    - Welche Ansätze sind wann (und warum) besonders gut?
    - Können Ergebnisse verbessert werden, wenn beispielsweise einer fundamentalen day-ahead Prognose ein Zeitreihenmodell „nachgeschaltet“ wird?
- Kooperationspartner: Karlsruhe Institute of Technology (KIT)
- Organisation einer Summer School im Jahr 2020

Decarb-Lau

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- Decarb-Lau: Mobilisierung endogener Entwicklungspotentiale für den Strukturwandel – Dekarbonisierung einer Braunkohlenregion
- Motivation:
  - Wie kann in einer strukturschwachen Region ein Braunkohlenausstieg proaktiv begleitet werden?
  - Teilziele des Lehrstuhls:
    - Quantifizierung der zukünftigen Beschäftigungsentwicklung in der Lausitzer Braunkohlenindustrie (direkte und indirekte Effekte)
    - Direkte Effekte: Verwendung eines Kraftwerkseinsatz- und Investitionsmodells zur Bestimmung der Entwicklung der betriebsbereiten Kraftwerksleistung und der Stromproduktion in den Lausitzer Braunkohlenkraftwerken
    - Indirekte Effekte: Input-Output-Analysen

Papers

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- Engelhorn, T., Müsgens, F. (2018): How to estimate wind-turbine infeed with incomplete stock data: A general framework with an application to turbine-specific market values in Germany, *Energy Economics*, 10.1016/j.eneco.2018.04.022
- Kreuz, S., Müsgens, F. (2018): Measuring the cost of renewable energy in Germany, *The Electricity Journal* 31, May 2018, 29-33
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- Müsgens, F., Riepin, I. (2018): 'Is Offshore Already Competitive? Analyzing German Offshore Wind Auctions', *EEM Conference Proceedings*, 10.1109/EEM.2018.8469851.

Thank you for your attention!

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https://www.b-tu.de/en/fg-energiewirtschaft