



# Cross-Border Cost Reductions from PV Capacity in Germany

Felix Müsgens

Presentation at the

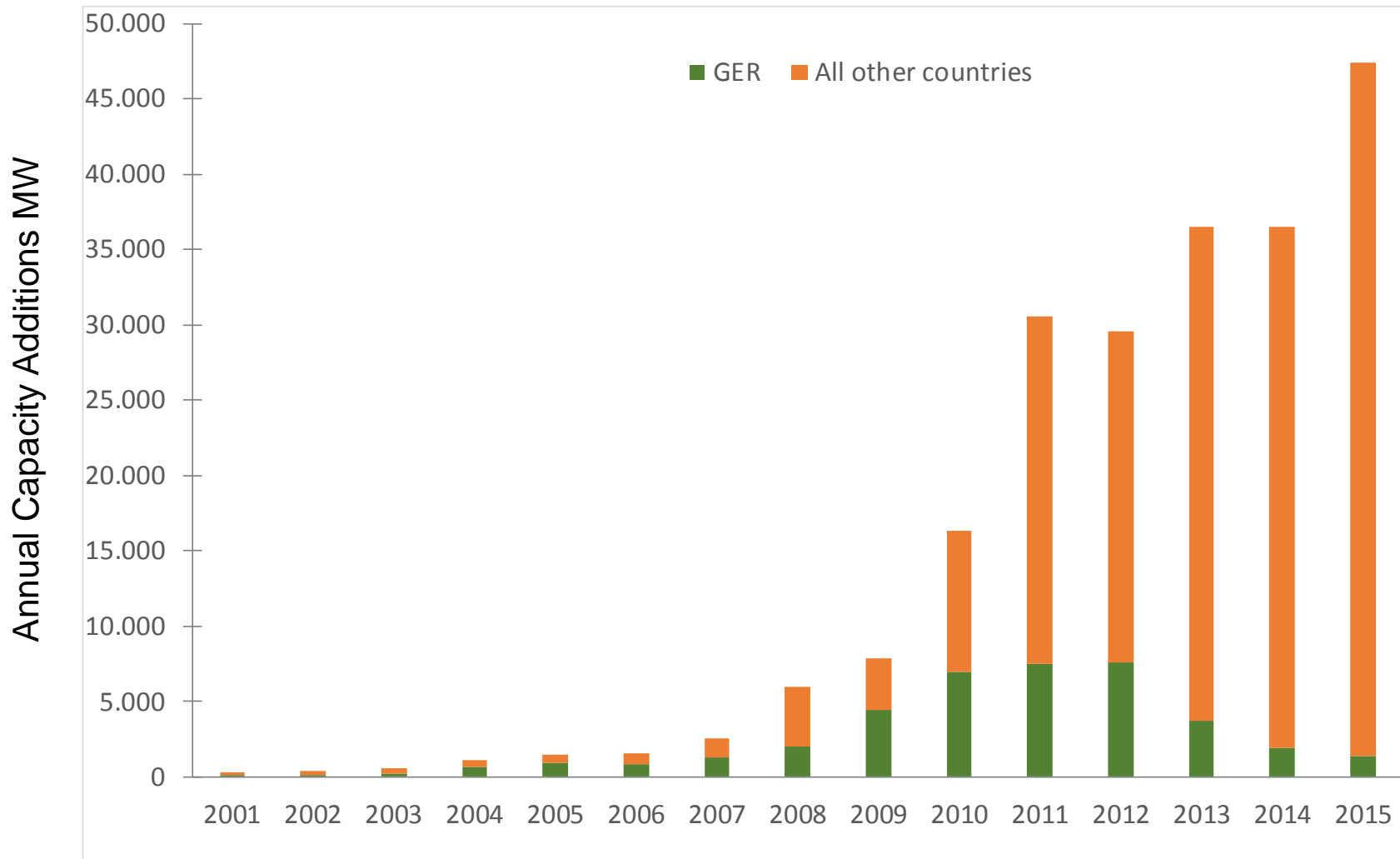
35<sup>th</sup> USAEE/IAEE NORTH AMERICAN CONFERENCE

Houston, November 14<sup>th</sup>, 2017

# German Energy Transition

- ◆ Similar to many other countries worldwide, Germany wants to decarbonize its economy.
- ◆ Within this context, there exist specific targets for the share of renewable energies of gross electricity consumption, e.g. 40 to 45% in 2025.
- ◆ Germany
  - Started the promotion of renewable energy relatively early
  - Set relatively ambitious targets
  - E.g. in 2000 the first version of the RES-promotion act was enacted, RES-Share was 3.4%.
  - Now (at the end of 2016) around 30%.

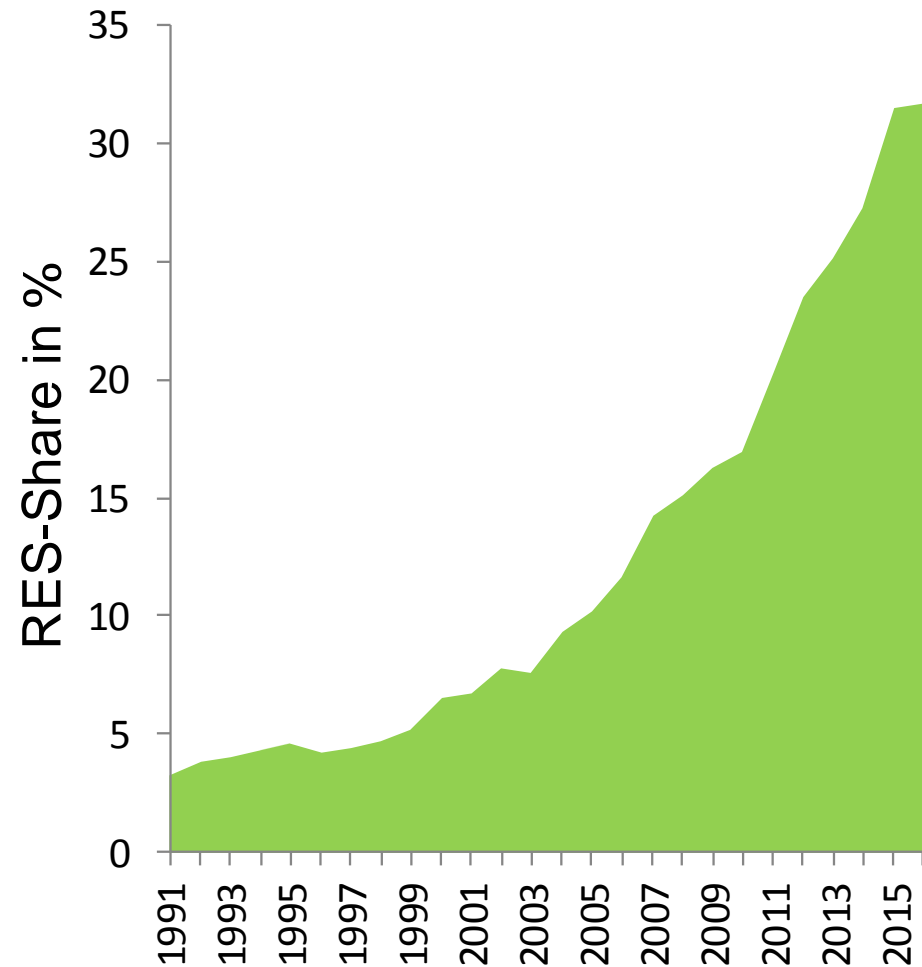
# Annual Photovoltaics Capacity Additions 2001 - 2015



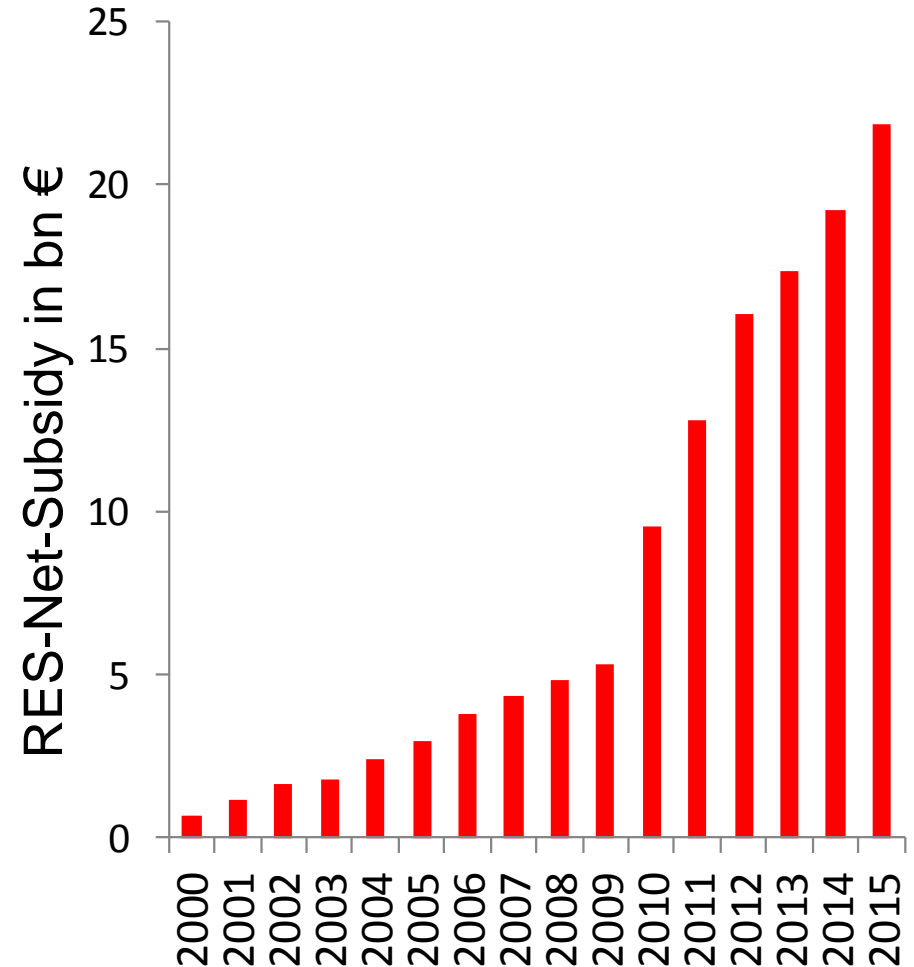
# Annual Photovoltaics Capacity Additions 2001 - 2015



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



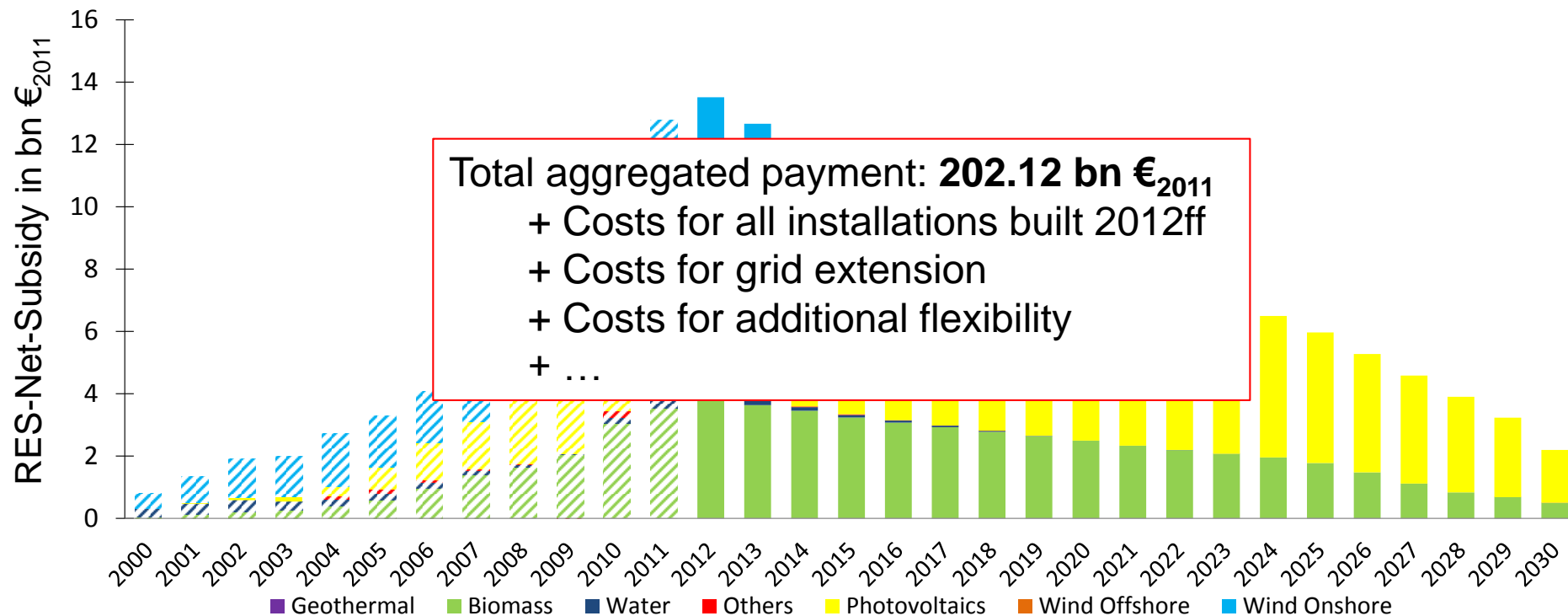
Source: AGEB



Source: Bundesregierung

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

- ◆ 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):



# Benefits of RES-Promotion

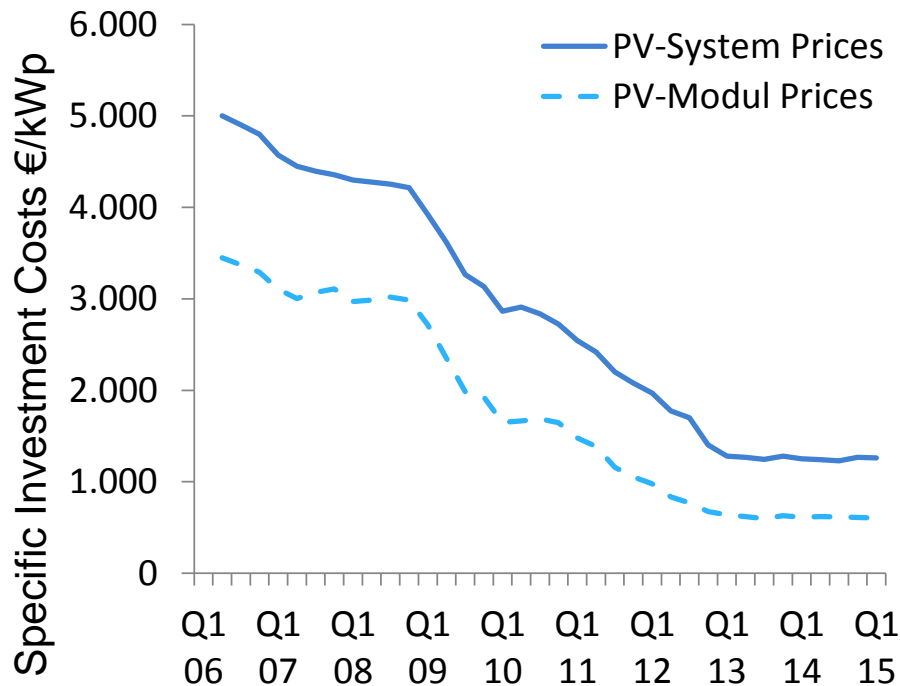
- ◆ Low carbon technology
- ◆ Correction of R&D externalities (i.e. market participants invest too little in renewables for fear of other companies copying advances)
- ◆ Correction of other negative externalities related to fossil fuels
  - Particulate matters (respirable dust)
  - NO<sub>x</sub>, SO<sub>2</sub>, ...
- ◆ „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 worldwide expansion

**These advantages have often been discussed...**

**... but rarely quantified.**

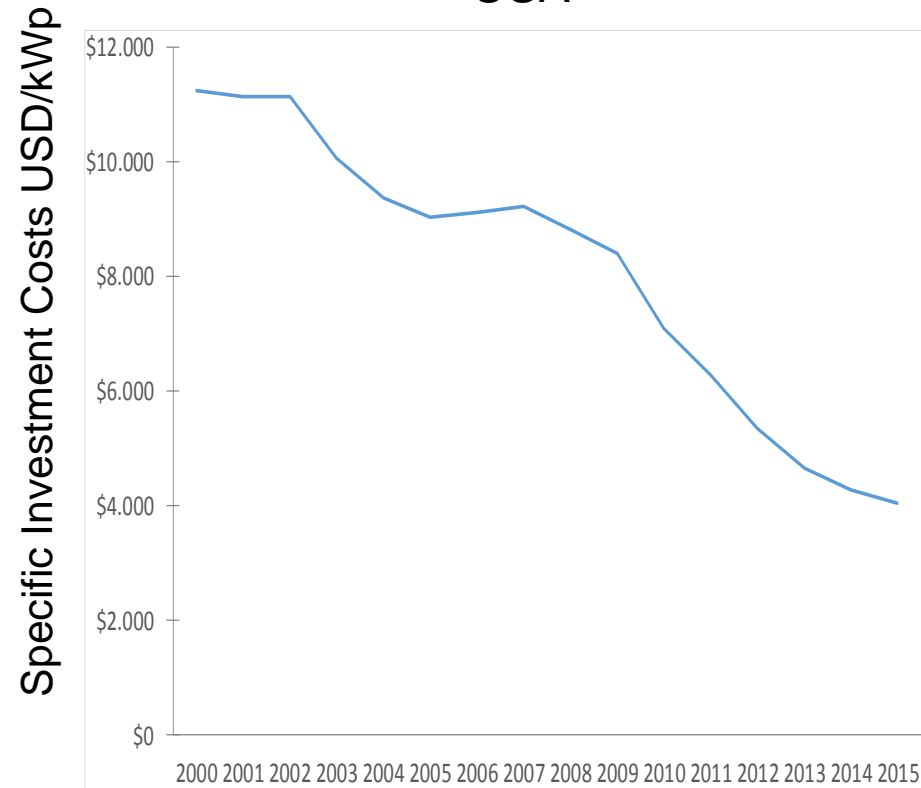
# Worldwide Reduction Investment Costs for Photovoltaics, Examples Germany and US

## Germany



Source: BSW (2015), Fraunhofer ISE (2015)

## USA



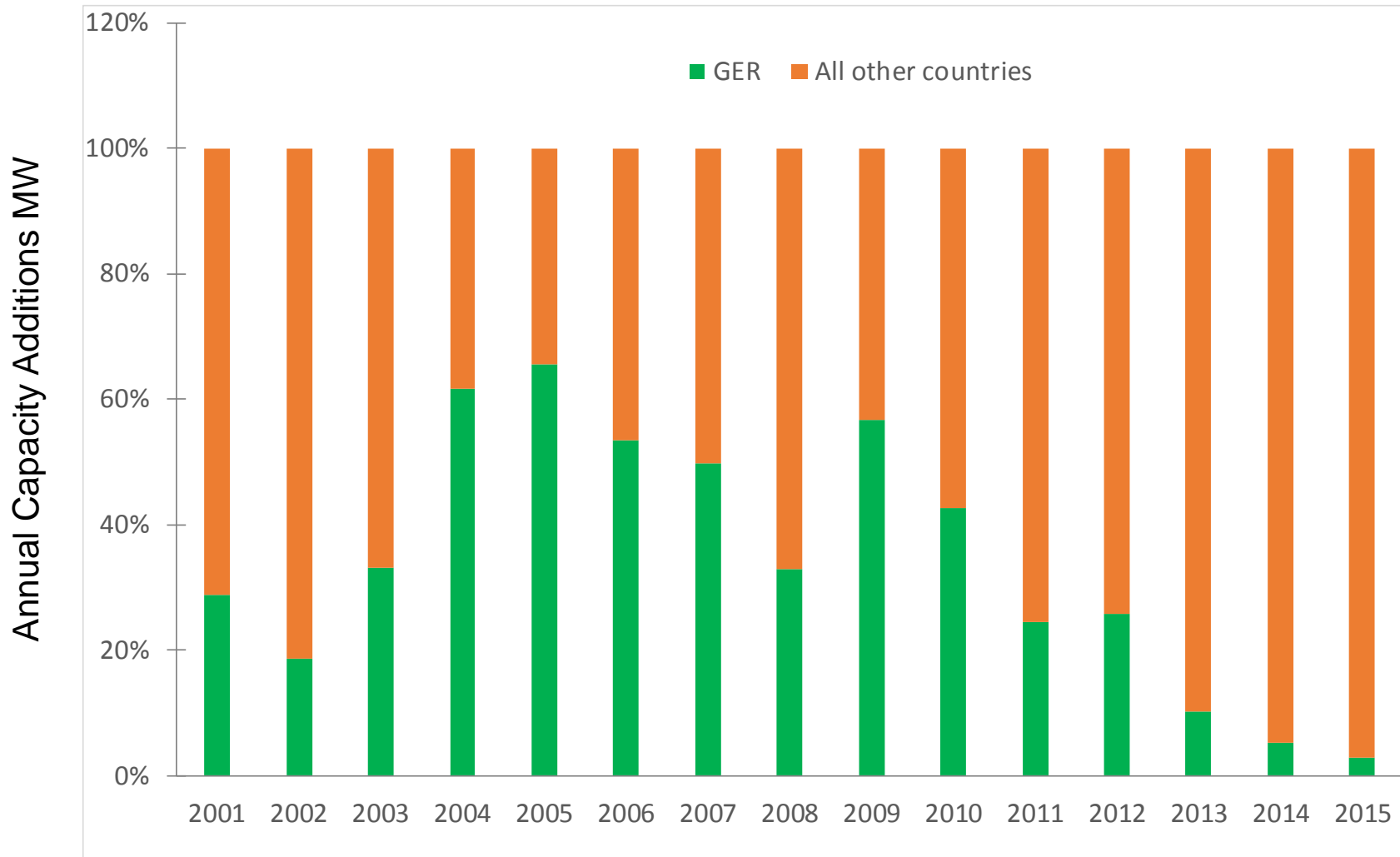
Source: Barbose, G. and Darghouth, N. (2016)



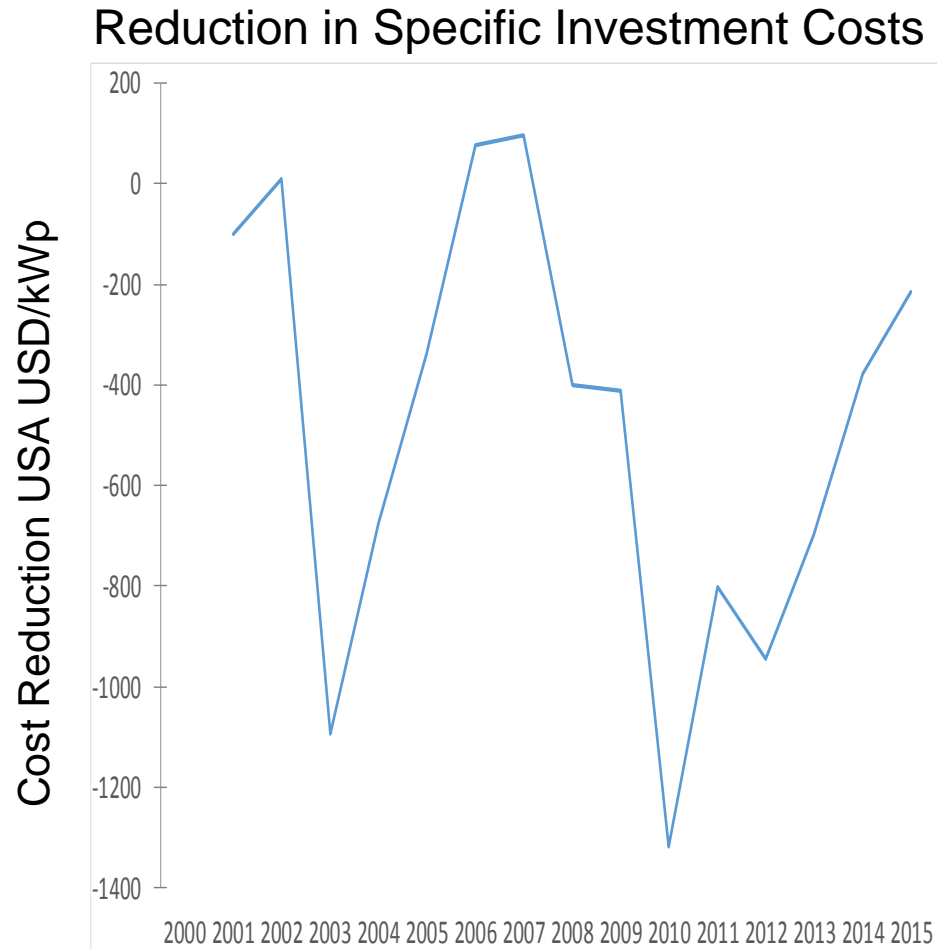
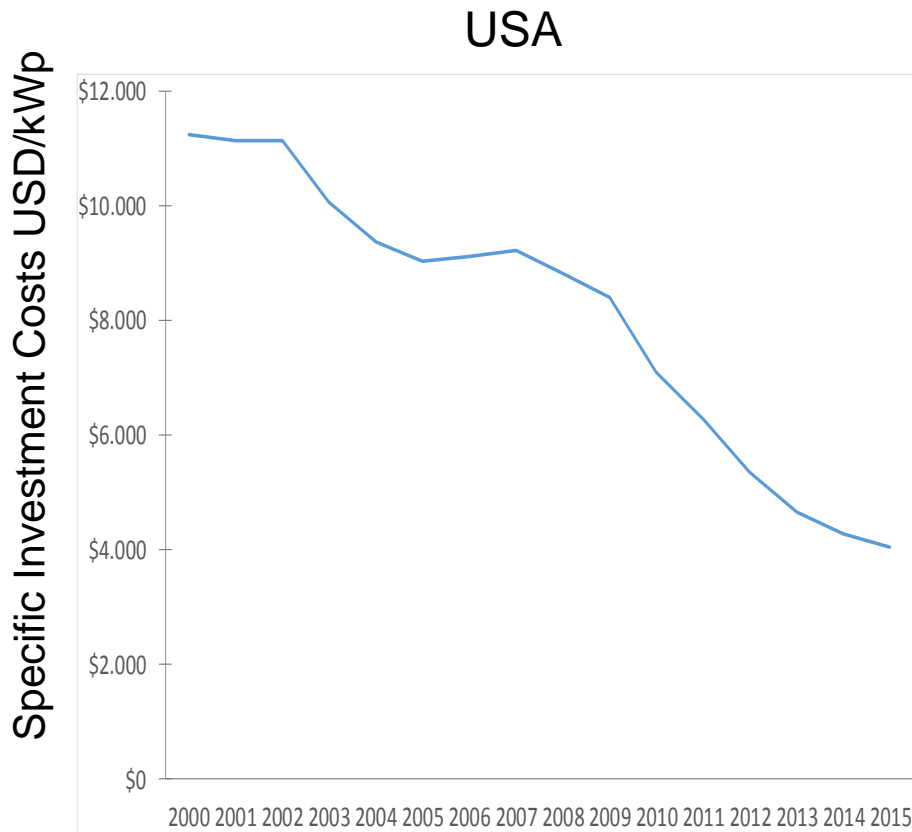
# Learning

- ◆ Cost reductions are assumed to correlate with output (due to learning)
- ◆ Rubin et al. even argue: „[...] by far the most common model used in the energy literature to forecast changes in technology cost is the ‘*one-factor learning curve*’ (or ‘*experience curve*’).“
- ◆ Hence, we assume the following:
  - Cost reductions can be exclusively attributed to installed capacity
  - Every MW of installed capacity (in a year) contributes symmetrically to cost reduction (in that year)
- ◆ Based on these assumptions we can quantify: What was the German contribution to the cost reduction in investment costs for photovoltaics?

# Annual Photovoltaics Capacity Additions 2001 - 2015

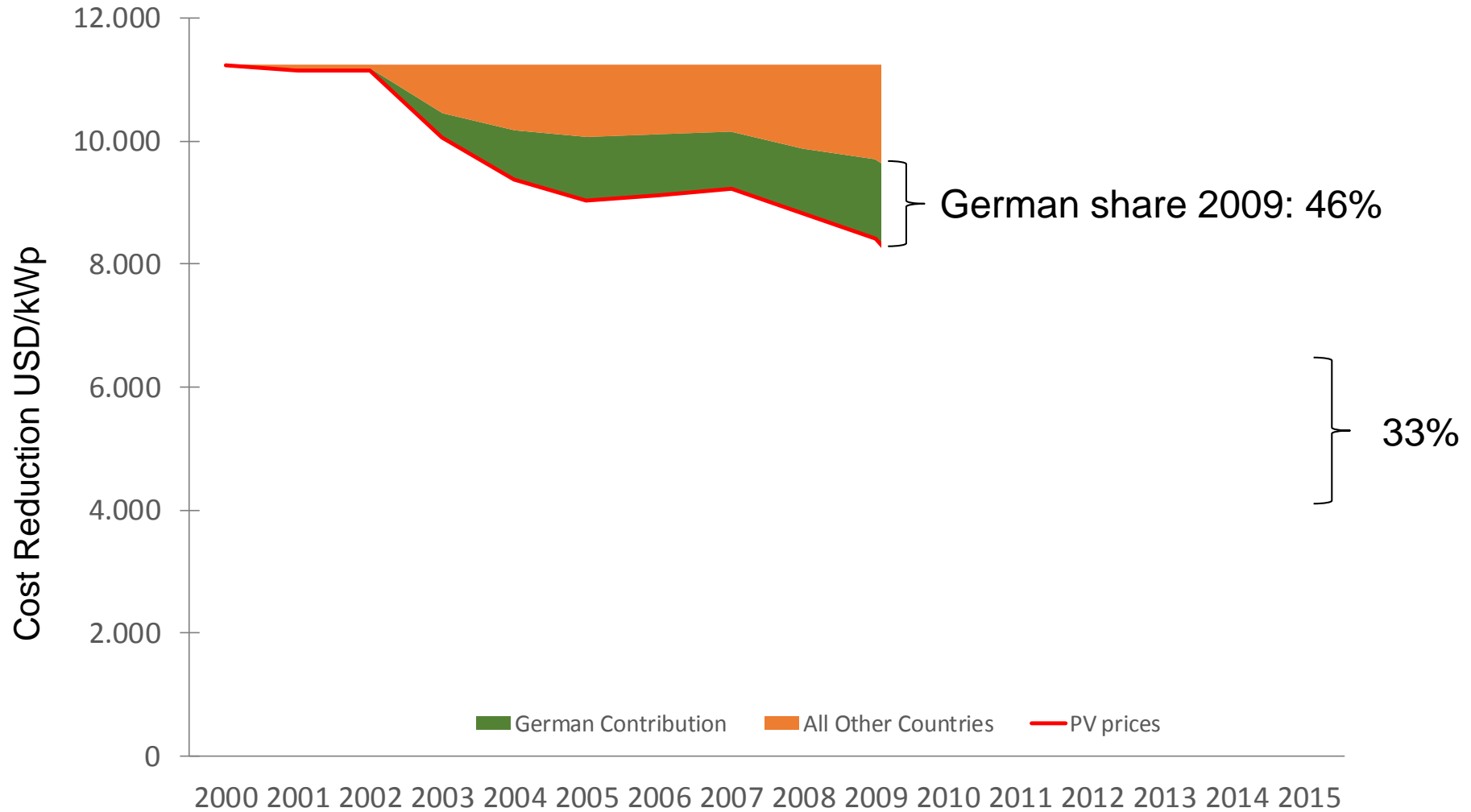


# Worldwide Reduction Investment Costs for Photovoltaics, Examples Germany and US



Source: Barbose, G. and Darghouth, N. (2016)

# Results



# Work in Progress

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- ◆ One global market?
  - If so, what is the price for PV
    - US-prices? (assumed in this presentation)
    - Chinese prices?
- ◆ One factor learning model?
  - How could it be extended?
    - R&D expenditures? **Data?**
    - Other?
- ◆ Use empirical data on costs directly or use learning rates from the literature?

# Thank you for your attention!

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Chair of Energy Economics

<https://www.tu-cottbus.de/fakultaet3/de/energiewirtschaft/lehrstuhl/profil.html>

# References

- ◆ BSW (2015): Photovoltaik-Preismonitor Deutschland, Bundesverband Solarwirtschaft e.V. (BSW-Solar), 2015
- ◆ DOE (2015, ed.): 2014 Wind Technologies Market Report
- ◆ Fraunhofer ISE (2015): Photovoltaics Report, Fraunhofer Institute for Solar Energy Systems, ISE
- ◆ Rubin, E., Azevedo, I., Jaramillo, P. and Yeh, S. (2015): A review of learning rates for electricity supply technologies, *Energy Policy*, 86, pp. 198–218.