Auctions for Renewable Energies
Model-based Analysis

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Presentation held at
Strommarkttreffen
05/08/16, VKU, Berlin.

AURES: Who we are

- A coordination and support action under the EU Horizon2020 programme
- Project runs from January 2015 to December 2017
- Eight partners from seven EU countries
- Cooperation with policy makers, market participants and other stakeholders.

AURES project at a glance

AURES combines

- **Target-oriented analysis**
  empirical analysis
  interviews with stakeholders
  lessons from other industries
  auction experiments
  simulations in energy models
- **Capacity building activities**
  workshops
  webinars
  case cooperations
  bi- and multilateral meetings
  interactive website

…find more information on:

auresproject.eu

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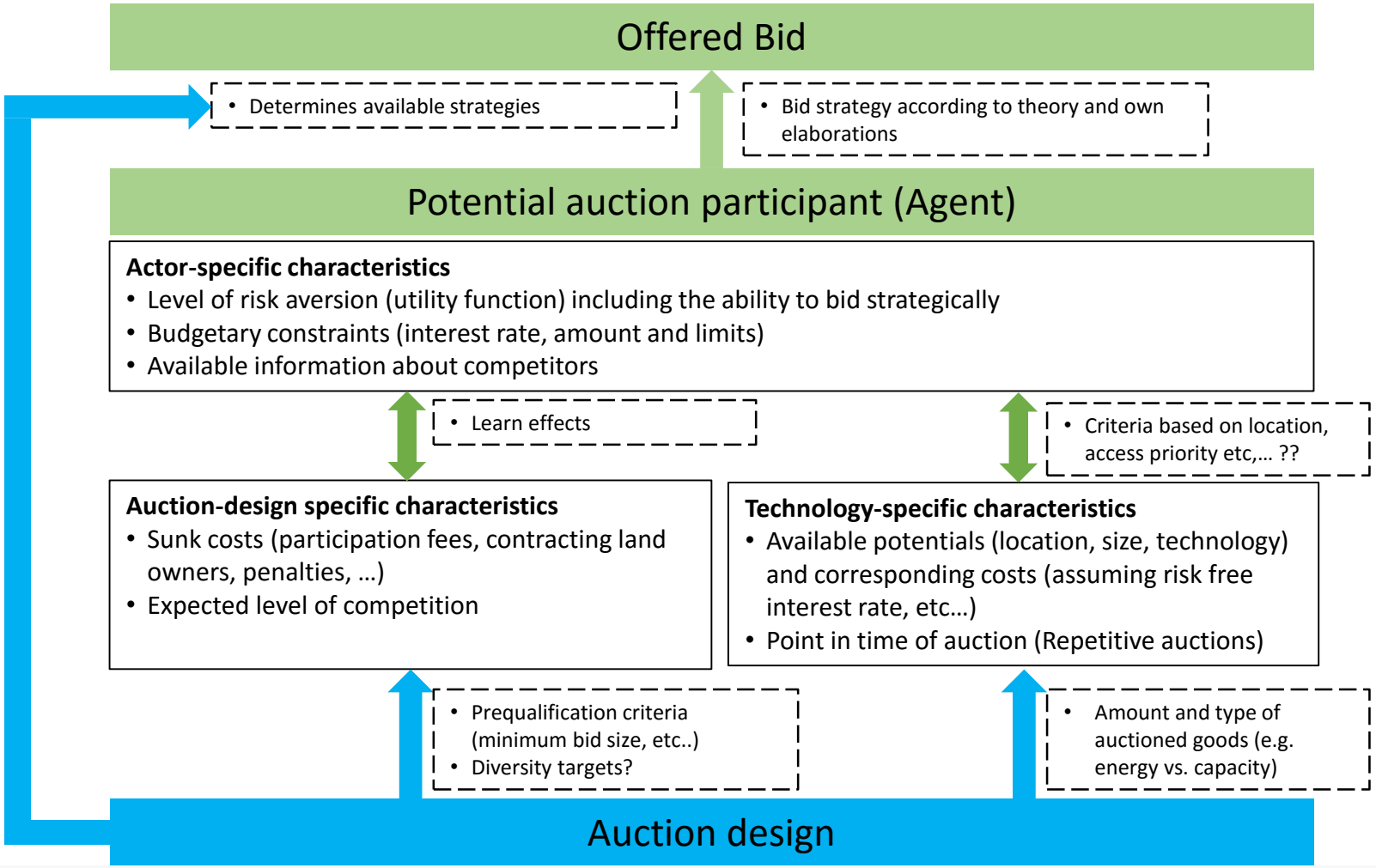
Research Question

- How do different auction designs influence auction outcomes?

  - Formally capture the incentive structures of RES investors from auctions and reveal the consequences on societal support costs
  - Strategic behaviour by market participants will be investigated as well as options of the policy maker to modify structures in order to achieve desirable outcomes
  - **Starting point is the analysis of wind power auctions in Germany**
  - From this a modular system will be constructed for Member States to look into their specific auction design planned and potential modifications

Modelling Framework



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Auction Specific Design Characteristics

	Dynamic vs. Static	Multi-criteria vs. Price only	Multi vs. Single-Unit	National vs. European
Theoretical implications	Important to model learning as a two step process in the dynamic auction	Start with a one-shot auction (rational agents) and build upon this	Focus on multi-unit (single unit as a special case (mostly wind offshore))	Design criteria change with a larger pool of competitors
Modelling	• There are two types of learning one has to consider: ○ 1. Learning over time (from auction to auction) ○ 2. Learning in the course of the dynamic auction • Interdependent or Independent Value Model (in dynamic auctions)	• Use prequalification criteria or rather quantify different aspects of agents (small actors etc.) and give additional weight to desired criteria	• Auction wind/solar PV and make use of recent auction trials in different Member States	• Begin with national auctions • If possible test runs with country-cluster examples • In 1-2 years, exercise case studies with empirical data

Wind power auctions in Germany

Background Information

- Renewable Power Act (EEG) 2016, Germany implemented auctions in order to determine the future feed-in tariff for the support of renewable energies
- For onshore wind parks, tendering will start in 2017
- Tenders take place for projects that already have a concession via the Bundesimmissionsschutzgesetz (so-called „late tendering“)
- Only a small security deposit of 30 €/kW installed capacity is mandatory
- The project is to be built in the upcoming two years after winning the bid. In case of non-realisation, sucessive penalties come into place. After three years of non-compliance, the awarded bid is cancelled

Source: EEG 2016, http://www.bmwi.de/BMWi/Redaktion/PDF/E/eeg-novelle-2016-kernpunkte-des-kabinettbeschlusses,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

Wind power auctions in Germany

Background Information

- Bid has to include amount of power in kW and bid price in ct/kW with two decimal figures
- 2,800 MW annual amount of capacity tendered, minimum size of 750 kW
- Sorting from the lowest price to the highest; equal price, the lower bid of power is preferred; until the cumulative amount matches the demand
- Accepted power amounts are published in detail, the lowest and highest accepted bid are published, together with a weighted average price
- Price limit: 7ct/kW for the first three auctions; from 01.01.2018: the average of the highest accepted bids of the last three auctions + 8%

Source: EEG 2016, http://www.bmwi.de/BMWi/Redaktion/PDF/E/eeg-novelle-2016-kernpunkte-des-kabinettbeschlusses,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

Wind power auctions in Germany

Model Features

- The first round for wind power in Germany, taking into account the country-specific agent distribution:
  - Financial investors (10-50 MW), Community wind projects (3-18 MW), Project developers (15-50 MW)
  - Costs are assumed to be the same for both and randomly distributed between 5.9 and 6.7 ct/KWh
- If an agent's bid wins, he does not participate in the next auction; new draws for every auction round
- Learning of agents over several rounds
  - 7 years as foreseen in the German EEG, 2,800 MW per year, three rounds per year
  - Agents adapt their bidding behavior according to the previous results
  - Uniform pricing and pay as bid has been implemented and compared

Wind power auctions in Germany

- The agent maximizes his expected utility taking into account the possibility to win in one of the following rounds
- **T = 0:**

$$E\big(u(\boldsymbol{b})\big) = (b_0 - c) \cdot \big(1 - F(b_0)\big)$$

- **T > 0:**

$$E\big(u(\boldsymbol{b})\big) = (b_0 - c) \cdot \big(1 - F(b_0)\big) + \sum_{t=1}^{T} \delta^t \cdot (b_t - c) \cdot \prod_{x=1}^{t} F(b_{t-x})$$

b_t = bid; c = costs; *F(.)* = cumulative distribution function of the marginal bid

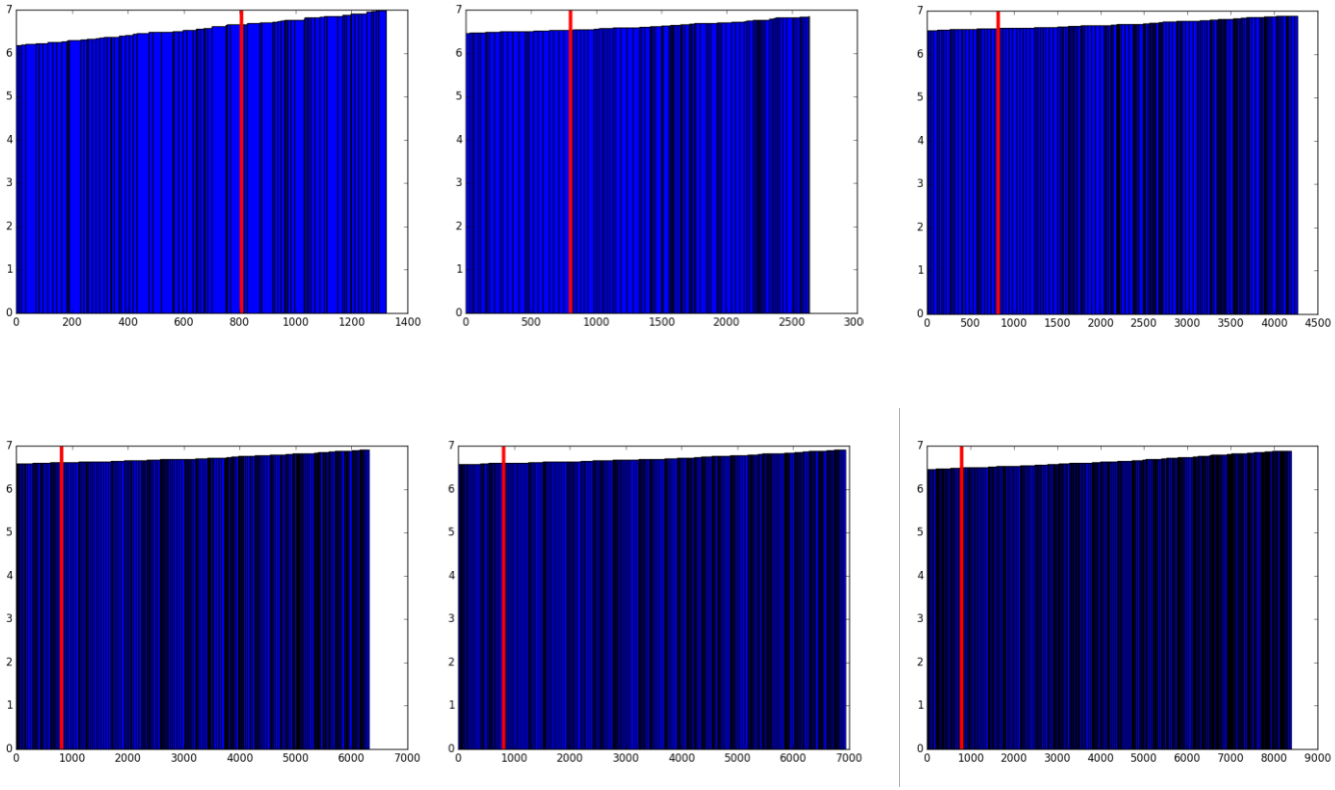
Wind power auctions in Germany

Preliminary results

- The bid vector is calculated in every round by using the “Truncated Newton (TNC) algorithm“. So far, the algorithm and model generate realistic values:
- Uniform:
  - Within each bid vector, the corresponding bids are decreasing in each round, i.e. the later an auction takes places, the more aggressive the bids become for each agent
  - The current bid (b_0) – which is solely important for the model – can be observed to decrease ceteris paribus in every round for each bidder
- Pay as Bid:
  - In the first rounds, we observe an increase in the average price, as the “cheapest” bidders drop out
- A direct comparison is not yet possible, but policy conclusions are forthcoming

Wind power auctions in Germany

Preliminary results: Pay-as-Bid



Price development over six auction rounds; average prices in ct/kWh, upper left to lower right graph:

1. 6.37
2. 6.5
3. 6.57
4. 6.6
5. 6.59
6. 6.48

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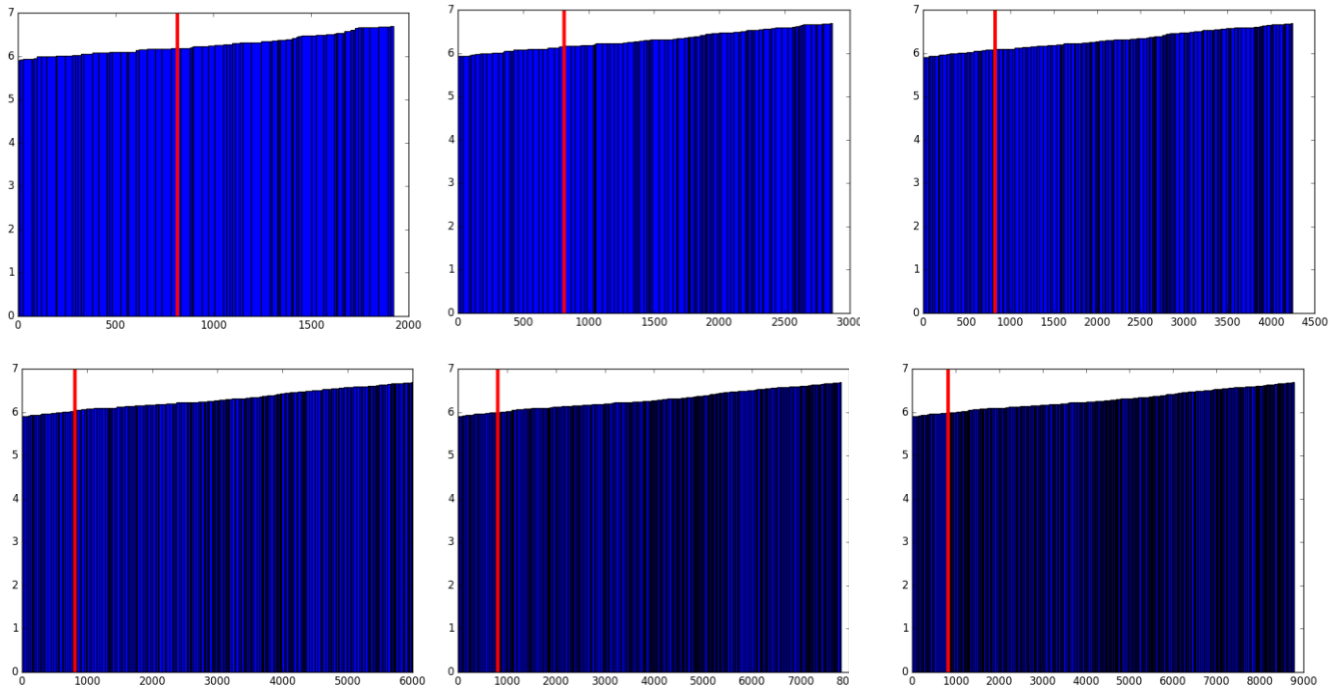
Preliminary results: Uniform



Price development over six auction rounds; Prices in ct/kWh, upper left to lower right graph:

1. 6.19
2. 6.17
3. 6.09
4. 6.05
5. 6.0
6. 6.0

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Next steps

- August 2016: Simulate PV Auction for Germany to verify results in comparison with test rounds executed in 2016
- December 2016: Implement modular stand-alone tool to model different designs and market situations (open source to trigger interest discussion on assumptions)
- Construct case studies and compare to actual data from auction results if available

Any Questions?

Thank you!

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