Ecological-economic analysis of instruments to govern future wind power deployment – Modelling results on minimum distance regulations for wind turbines

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Background and Motivation

- **Transition of the energy system** (“Energiewende”): extensive increase in **wind power** generation planned
- **Wind turbines (WT) have many advantages over fossil fuels**: renewable, climate friendly, no nuclear threat, etc.
- **However**: WT have some negative environ. impacts → **external costs**
- **Focus** of my work (partial analysis):
  - **Utility loss for residents**
    Frequently opposition to WT in direct vicinity
    → the closer a WT to residents, the more problematic

  - **Wildlife conservation problem: Red kite collision losses**
    → the closer a WT to red kite nests, the more problematic

Research Question

How can different policy options to govern the future spatial wind power deployment be assessed from an ecological-economic perspective?

→ *today:* **minimum distance regulations for wind turbines**

Method: Modelling approach

- **Study area: Federal State of Saxony**

  - **GIS-based determination of potential sites for WT**
    - physical and legal suitability
      (cf. Bovet 2015, Masurowski 2016)
      → e.g. waters, nature protection areas, infrastructure elements like streets, etc. are excluded (with certain buffers)

  - **Potential energy yield of all potential sites**
    - Weibull parameter + power curve of reference WT (Nordex N131)

Method: Modelling approach (cont‘d.)

- **Modelling of WT allocations under different policy scenarios**
  - Assumption: Private investment decisions (goal: profit maximization)

    → Optimization problem for each policy scenario (solved in GAMS):

    „Choose those potential sites that are the most profitable until an externally given (political) energy goal is met.“

- **Assessment of the allocations**
  - What are the (internal, external, and total) costs of the allocations?

Method: Modelling approach (cont‘d.)

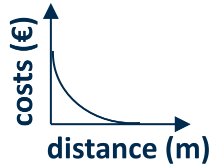
❖ **<u>Cost assessment</u>**
(all values discounted over 20 yrs)

I. Internal WT costs (assumed as site-independent)

- Literature values for investment + O&M costs

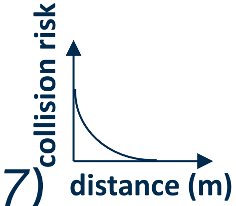
II. External costs for residents

- Increasing marginal costs with decreasing resident-WT-distance
→ hyperbolic cost function (*cf. Drechsler et al. 2011, Krekel & Zerrahn 2017, Wen et al. 2018)*

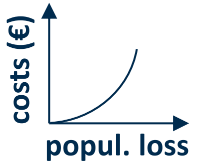


III. External costs for red kite population burden

- Exponential relationship of red kite collision risk and nest-WT-distance *(cf. Eichhorn et al. 2012, Rasran & Dürr 2017)*



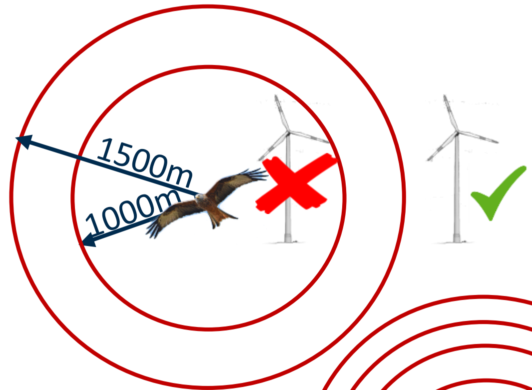
- Increasing marginal costs with increasing red kite exposure
→ parabolic cost function (*cf. Drechsler 2011)*



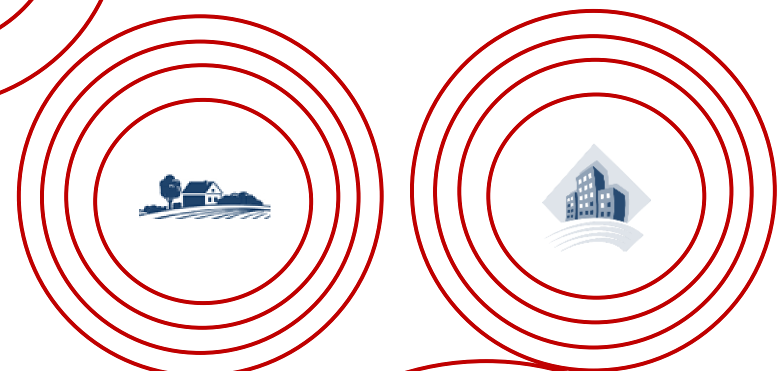
Policy Scenarios

<u>Minimum distance regulations</u>: affect availability of potential sites

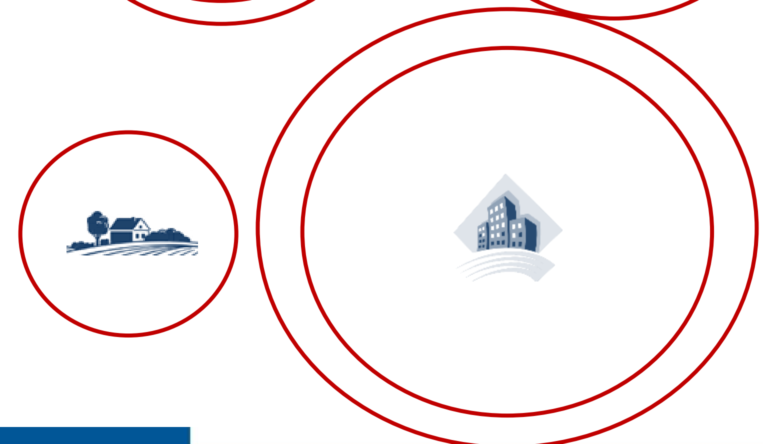
- **red kite nests:**
  - ➢ **0m, 1000m, 1500m**



- **settlements:**
  - **Uniform** for all settlements
    - ➢ **800m, 1000m, 1200m, 1400m**



  - **Differentiated** between settlements in the **outside area** (like single farm houses) and **inner area** (like cities)
    - ➢ **800m/1600m, 800m/1800m**



Policy Scenarios (cont'd.)

Minimum distance regulations:

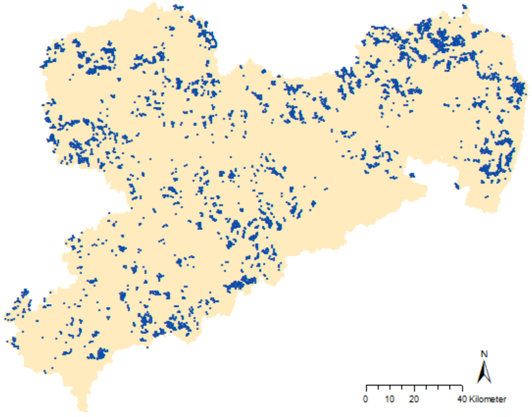
	R0	R1000	R1500
S800			
S1000			
S1200			
S1400			
S800/1600			
S800/1800			

In total: 3x6 = 18 scenarios

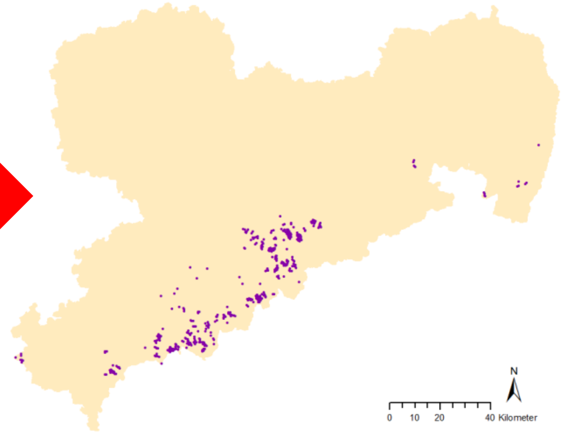
Results

Example: S800_R0-Scenario

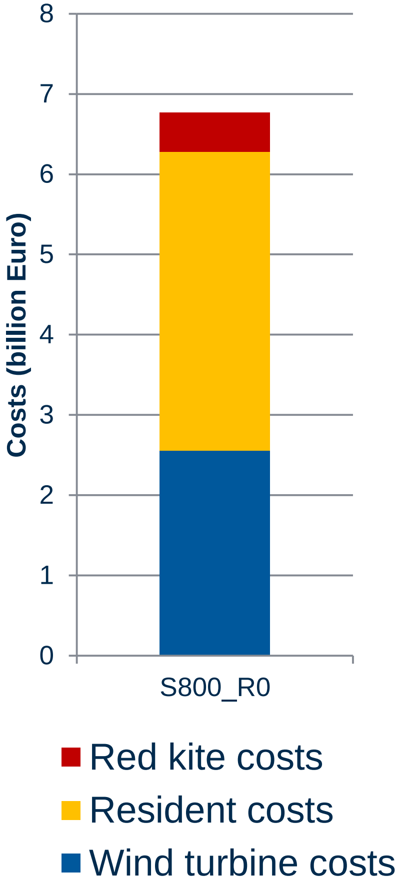
Potential sites



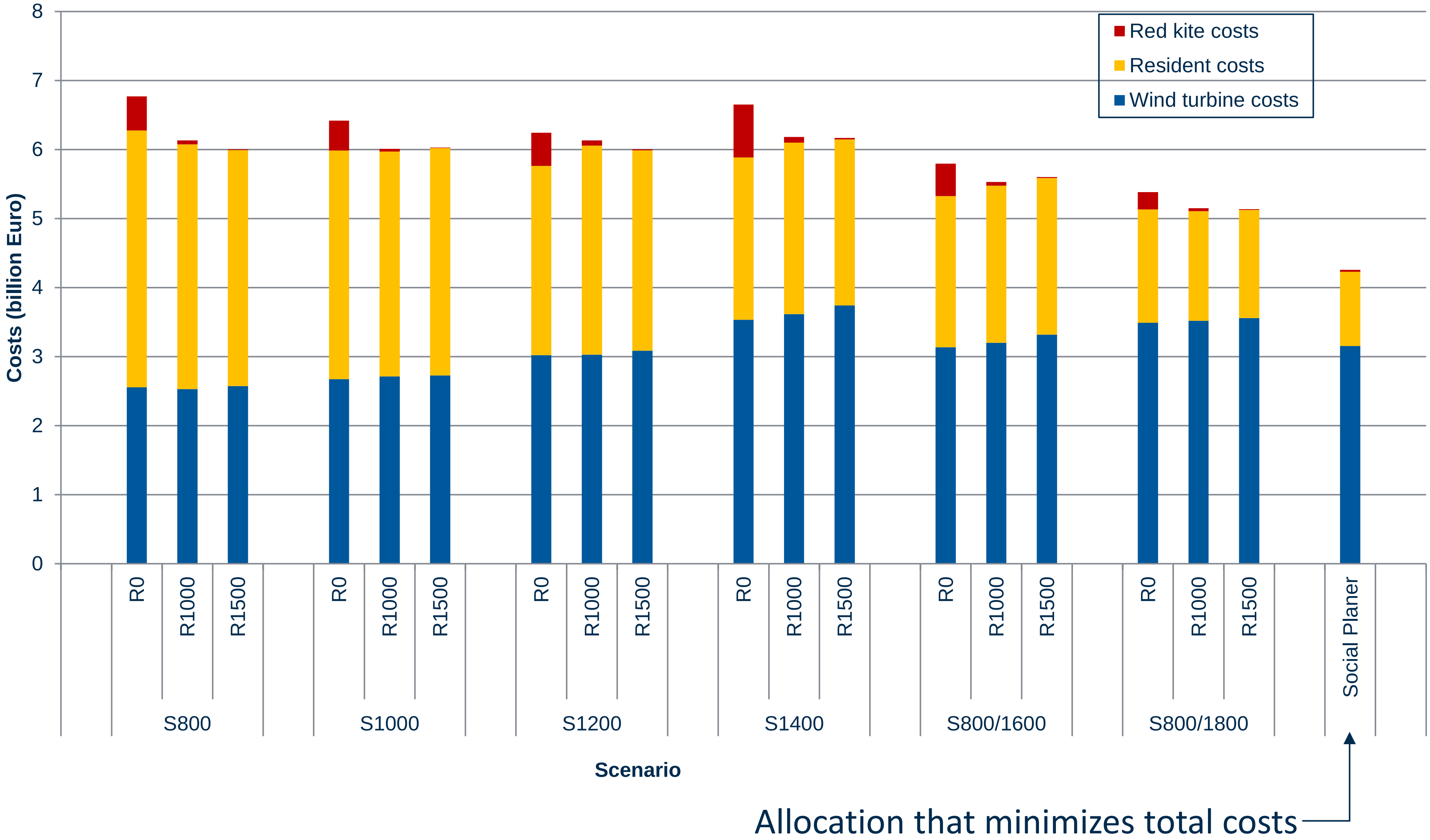
Selected sites



Modelled costs



Results (cont‘d.)



Conclusions

Minimum distances to red kite nests

- Virtually no cost argument against 1000m or 1500m instead of 0m
- Modelled impacts on red kite costs and total costs indicate advantages of 1000m or 1500m instead of 0m
- With respect to most modeling results (costs) 1500m have either advantages or at least no disadvantages over 1000m
- 1500m allow to limit red kite (exposure and) costs on a very low level

→ **Recommendation for policy makers: 1500m**

Conclusions (cont‘d.)

Impact of minimum distances to settlements on total costs:

- Ambiguous with uniform minimum distances (resident c. ↓ *vs*. WT c. ↑)
- Beneficial with differentiated minimum distances are (resident c. ↓↓)
  - Superior having higher min. distances if many residents are affected and lower if only a few are affected over (restrictive) uniform min. dist.
- Social planer level by far not reached (because of resident costs gap)

→ **Recommendation: (restrictive) differentiated minimum distances!**

- at least if…
  - increase in WT costs is accepted
  - no further siting instrument is considered
  - only a mid-term perspective is chosen
    (later less restrictive minimum distances might be necessary for reaching long-term energy goals)

References

Bovet, J. (2015): **Steuerung der Windenergie durch Raumordnung – Aktuelle Rechtsprechung als Herausforderung für die Planung**. *Informationen zur Raumentwicklung*, Heft 6.2015, 591–602.

Drechsler, M., Ohl, C., Meyerhoff, J., Eichhorn, M. & Monsees, J. (2011): **Combining spatial modeling and choice experiments for the optimal spatial allocation of wind turbines**. *Energy Policy*, vol. 39**,** 3845–3854.

Eichhorn, M., Johst, K., Seppelt, R. & Drechsler, M. (2012): **Model-Based Estimation of Collision Risks of Predatory Birds with Wind Turbines**. *Ecology and Society*, vol. 17, art. 1.

Krekel, C. & Zerrahn, A. (2017): **Does the presence of wind turbines have negative externalities for people in their surroundings? Evidence from well-being data**. *J. Environ. Econ. Manag.*, vol. 82**,** 221–238.

Masurowski, F. (2016): **Eine deutschlandweite Potenzialanalyse für die Onshore-Windenergie mittels GIS einschließlich der Bewertung von Siedlungsdistanzenänderungen**. *PhD thesis*, University of Osnabrück.

Rasran, L. & Dürr, T. (2017): **Collisions of Birds of Prey with Wind Turbines – Analysis of the Circumstances**. In: Hötker, H., Krone, O. & Nehls, G. (eds.): Birds of Prey and Wind Farms – Analysis of Problems and Possible Solutions. Springer. Chapter 12, 259–282.

Wen, C., Dallimer, M., Carver, S. & Ziv, G. (2018): **Valuing the visual impact of wind farms: A calculus method for synthesizing choice experiments studies**. *Science of the Total Environment*, vol. 637–638, 58–68.

Thank you for your attention!

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