

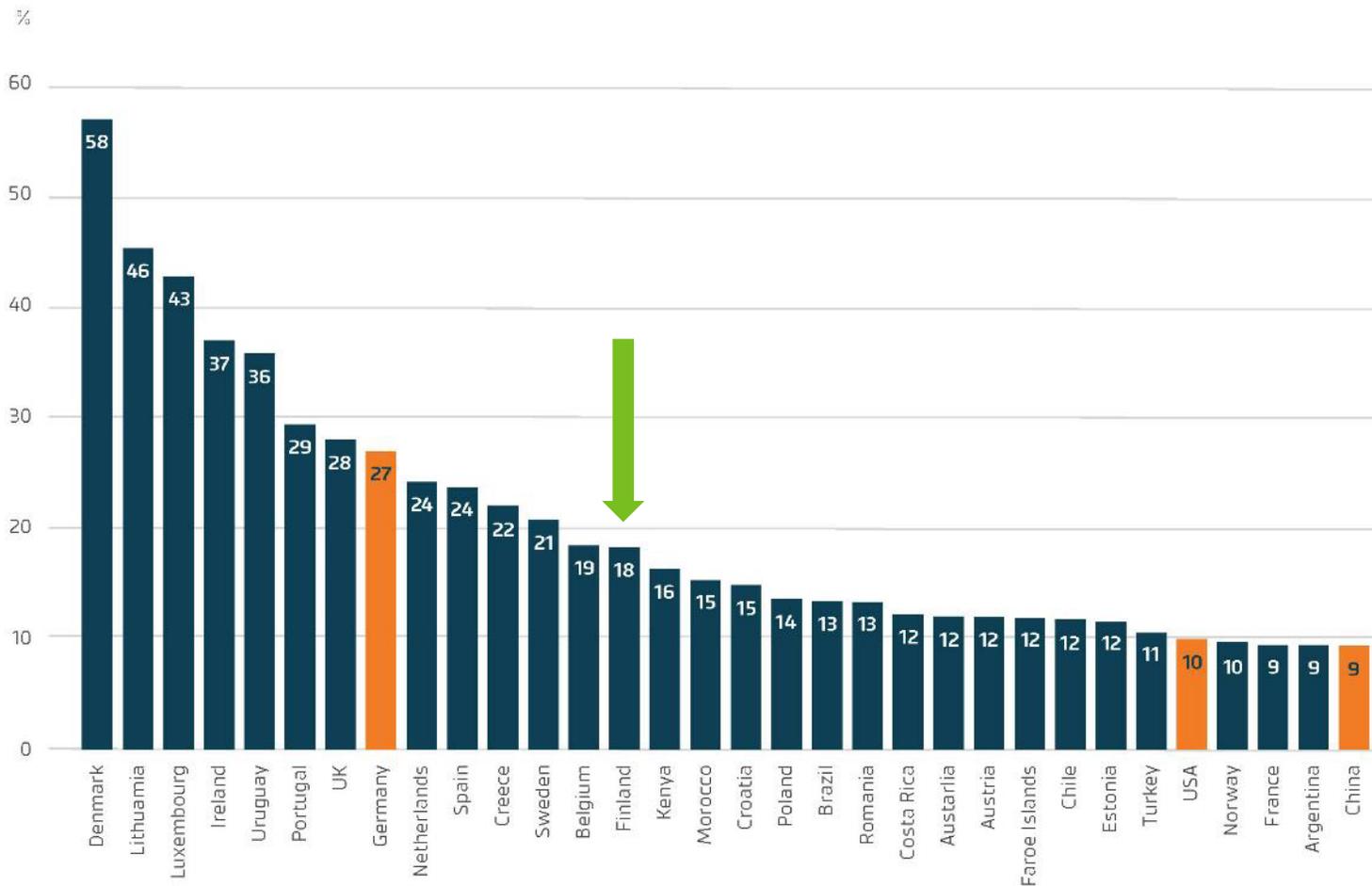
# Wind power and land use – ecological, economic and social perspectives

Anne Tolvanen  
Program director, professor



# LandUseZero project

## Model of sustainable climate change mitigation options through land use



## Wind power, forests, peatlands

- Climate and biodiversity impacts
- Cost-efficient optimization of wind turbines
- Social acceptance

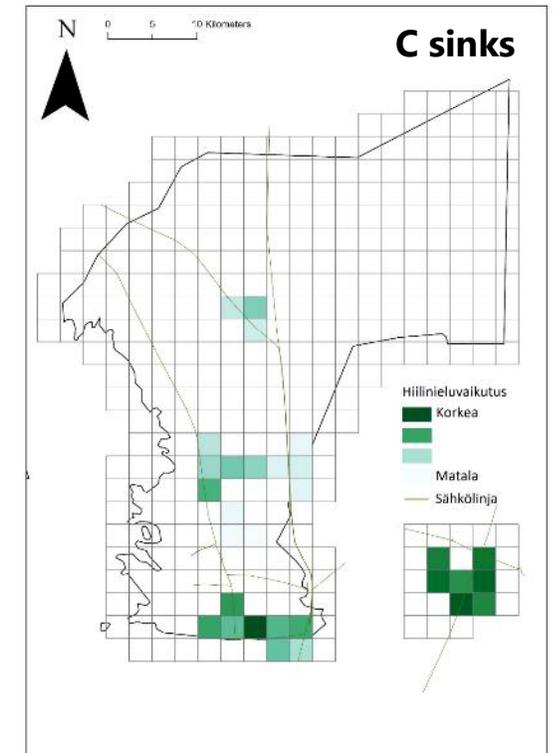
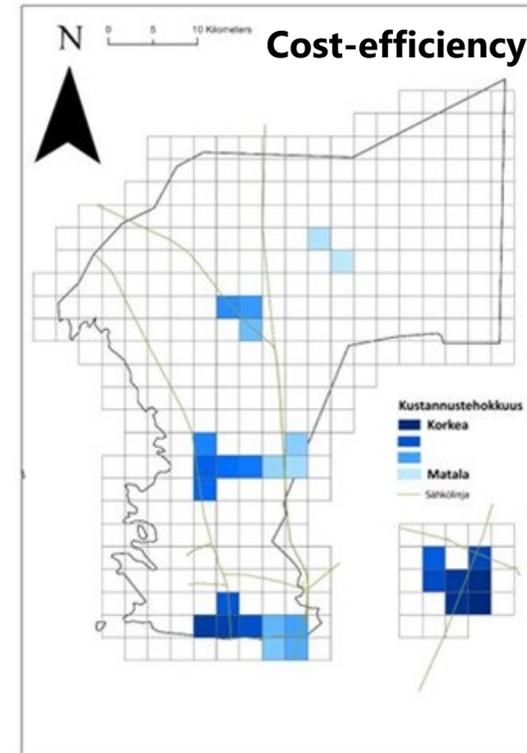
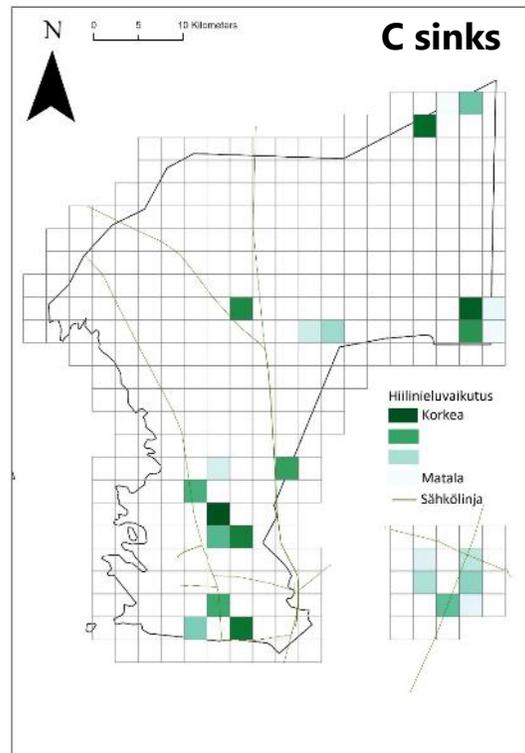
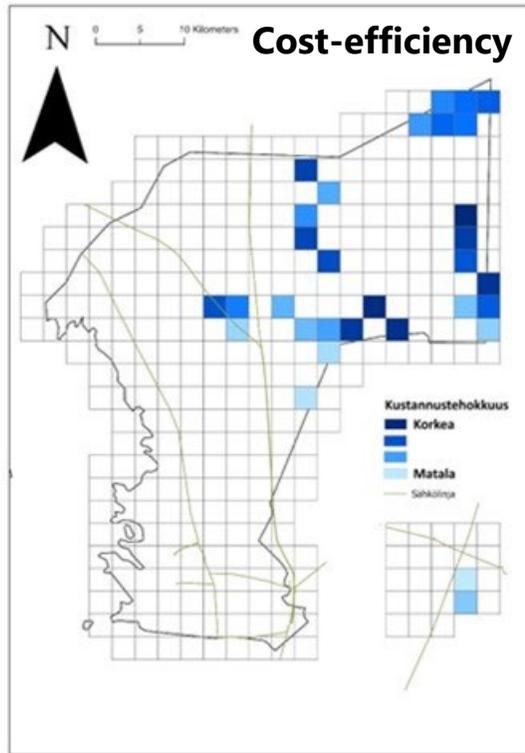
Share of wind in total electricity production as a percentage (%) in 2023. Countries with the highest wind power capacity are highlighted in orange. Data from <https://ember-climate.org/topics/wind/>.

# Climate and biodiversity impacts

- Climate impact (Radiative forcing W/m<sup>2</sup>) depends on the speed of replacing fossils
  - Wind power reduces greenhouse gas emissions by replacing fossil energy sources
  - As the share of fossil fuels decreases, the emission reduction effects of wind power also decrease\*
- Biodiversity impacts are mainly negative
  - Functional habitat loss for wildlife through displacement
  - Review: Distances of birds, bats and mammals range from 500 m to over 5000 m\*\*



# Siting of turbines based on the cost-efficiency and forest carbon sink losses



Power transmission lines not considered: Optimal sites are different

Transmission lines considered: Optimal sites are almost the same

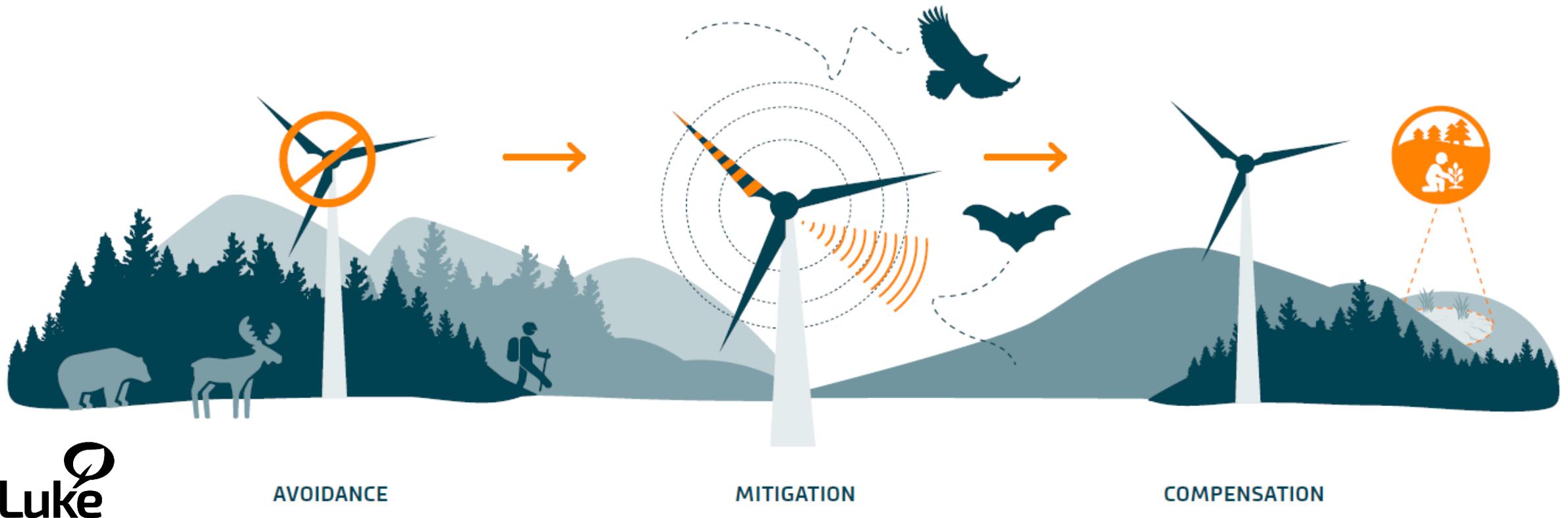
# Acceptance is crucial for the overall sustainability of wind power

- Because it covers people, environment, economy, and the processes of wind power planning



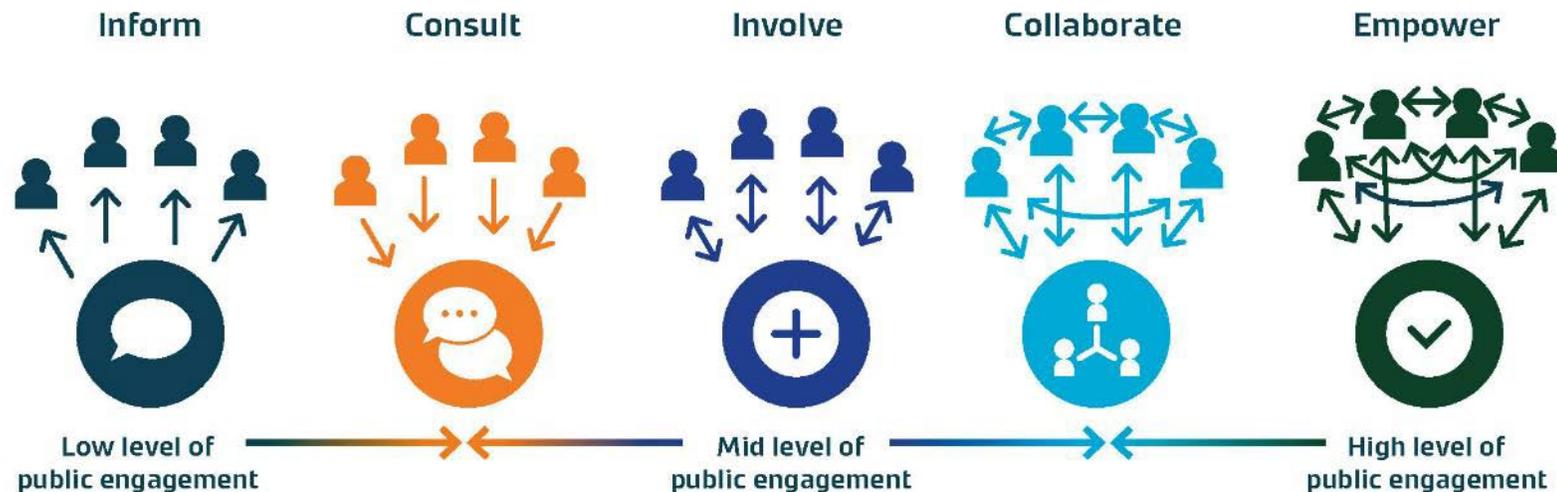
# Recommendations for the decision -makers and wind power developers 1/2

1. Take concerns about the impacts of wind turbines on people seriously and address them transparently by leveraging scientific knowledge.
2. Apply the mitigation hierarchy to minimize the negative impacts of wind power on nature.



# Recommendations for the decision-makers and wind power developers 2/2

- Clearly articulate both market and non-market benefits and costs and integrate them into the decision-making process.
- Involve communities in the planning process from the very beginning of projects.
- Ensure that all voices, including the silent majority and ethnic minorities, are appropriately considered in decision-making.
- Support communities in understanding the connection between wind power and the broader benefits of the clean energy transition.



## LandUseZero project team:

Anne Tolvanen / Artti Juutinen / Eija Pouta / Erkki Mäntymaa / Parvez Rana / Kyle Eyvindson / Anna Laine-Petäjäkangas / Timo Tokola / Mari Selkimäki / Hannele Holttinen / Maija Lampela / Liisa Maanavilja / Kati Koponen / Timo Karlsson / Marko Antila / Tomi Lindroos



# Literature

- Hübner et al. 2019. Monitoring annoyance and stress effects of wind turbines on nearby residents: A comparison of U.S. and European samples. *Environment International* <https://doi.org/10.1016/j.envint.2019.105090>.
- Hübner et al. 2023. Broadening the social acceptance of wind energy – An Integrated Acceptance Model. *Energy Policy* <https://doi.org/10.1016/j.enpol.2022.113360>
- Mäntymaa et al. 2024a. Feasibility of Landscape Value Trade between Landowners and Citizens in Reducing the Landscape Damage Caused by Wind Power. *Journal of Forest Economics*. <http://dx.doi.org/10.1561/112.00000575>
- Mäntymaa et al. 2024b. People are willing to pay for climate- and biodiversity-friendly policies in Finland: Opportunities of wind power, forest management, and peatland restoration. *Journal of Environmental Planning and Management* <https://doi.org/10.1080/09640568.2024.2364763>
- Tolvanen et al. 2023. How far birds, bats, and terrestrial mammals displaced from onshore wind power development? – A systematic review. *Biological Conservation* <https://doi.org/10.1016/j.biocon.2023.110382>
- Tolvanen et al. 2024. Build public trust: Six factors for increasing wind power acceptance. Policy Brief, Natural Resources Institute Finland. <http://urn.fi/URN:ISBN:978-952-380-953-6>

# Review article: wind power and wildlife

- “Displacement”: Any impact of wind power that includes distance data (behavior, abundance, survival, avoidance, etc.)
- 82 papers from 22 countries, 160 specific distance cases
- 63 % of birds, 72 % of bats, 67 % of terrestrial mammals showed displacement on average between 500 – 5000 m
- Huge variation depending on the species, site, and sex and age of the individuals
- Also non-displacement found, due to methodology, species characteristics, habitat characteristics
- More info needed: habituation to turbines, impacts of modern large turbines, impacts of offshore wind power



Biological Conservation 288 (2023) 110492

Contents lists available at ScienceDirect

**Biological Conservation**

journal homepage: [www.elsevier.com/locate/bioco](http://www.elsevier.com/locate/bioco)

ELSEVIER

Review

How far are birds, bats, and terrestrial mammals displaced from onshore wind power development? – A systematic review

Anne Tolvanen<sup>a,\*</sup>, Henri Routavaara<sup>a</sup>, Mika Jokikokko<sup>a,b</sup>, Parvez Bana<sup>a</sup>

<sup>a</sup>Natural Resources Institute Finland, P.O. Box 66, 00571 Oulu, Finland  
<sup>b</sup>Poljetele Poljetelemit ELY keskus, Vuorimäentie 2, P.O. Box 36, 90101 Oulu, Finland

# Socio-economic articles

- People are willing to pay (WTP) for climate- and biodiversity-friendly policies
- Large heterogeneity in WTP among respondents depending on the region and socio-economic background
- Landscape trade potential: local residents can pay to forest owners to keep the neighboring forests covered (to protect from the noise and sight of wind turbines)
  - WTP of local residents to pay for maintaining the forest cover 81 eur/ person / year
  - Compensation request of forest owners to maintain the forest cover: 298 eur / person / year
  - → 4 residents needed per one forest owner for landscape value trade to happen

## **People are willing to pay for climate- and biodiversity-friendly policies in Finland: opportunities of wind power, forest management, and peatland restoration**

Erkki Mäntymaa<sup>a\*</sup>, Artti Juutinen<sup>a</sup>, Anne Tolvanen<sup>a</sup> and Eija Pouta<sup>b</sup>

<sup>a</sup>Natural Resources Institute Finland (Luke), Oulu, Finland; <sup>b</sup>Natural Resources Institute Finland (Luke), Helsinki, Finland

## **Feasibility of Landscape Value Trade between Landowners and Citizens in Reducing the Landscape Damage Caused by Wind Power**

Erkki Mäntymaa\*, Katja Kangas, Jouni Karhu and Eija Pouta

*Natural Resources Institute Finland (Luke), Finland*