

# Balancing profitability of energy production, societal impacts and biodiversity in offshore wind farm design

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Capacity4MSP Energy workshop

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# **Where to locate offshore wind farms?**





## I) Biodiversity

**Balanced  
solution**

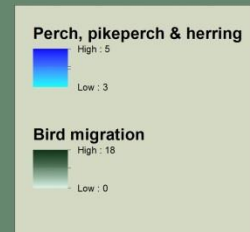


# Biodiversity

- Conservation areas
- Bird migration routes
- Fish reproduction areas
- Geodiversity
- Marine and terrestrial nature values



- Bird migration routes (Birdlife)
- Fish reproduction areas (LUKE)





## 1) Biodiversity



## 2) Profitability

**Balanced  
solution**





# Profitability



## Spatial Life Cycle Cost analysis

→ Includes all costs during the project lifetime

- Costs divided into 5 categories:
  - Development & Consenting
  - Production & Acquisition
  - Installation & Commissioning
  - Operation & Maintenance
  - Decommissioning & Disposal

Levelised Cost of Energy (LCOE):

$$\text{LCOE} = \frac{\sum_{t=0}^{T_{\text{project}}} \frac{\text{LCC}_t}{(1+\text{WACC}_{\text{real}})^t}}{\sum_{t=0}^{T_{\text{project}}} \frac{\text{E}_{\text{annual}}}{(1+\text{WACC}_{\text{real}})^t}}$$

Lappalainen, J. (2019)  
Economic potential of  
offshore wind energy in  
the Gulf of Bothnia





## 1) Biodiversity



## 2) Profitability



## 3) Societal impacts

**Balanced  
solution**

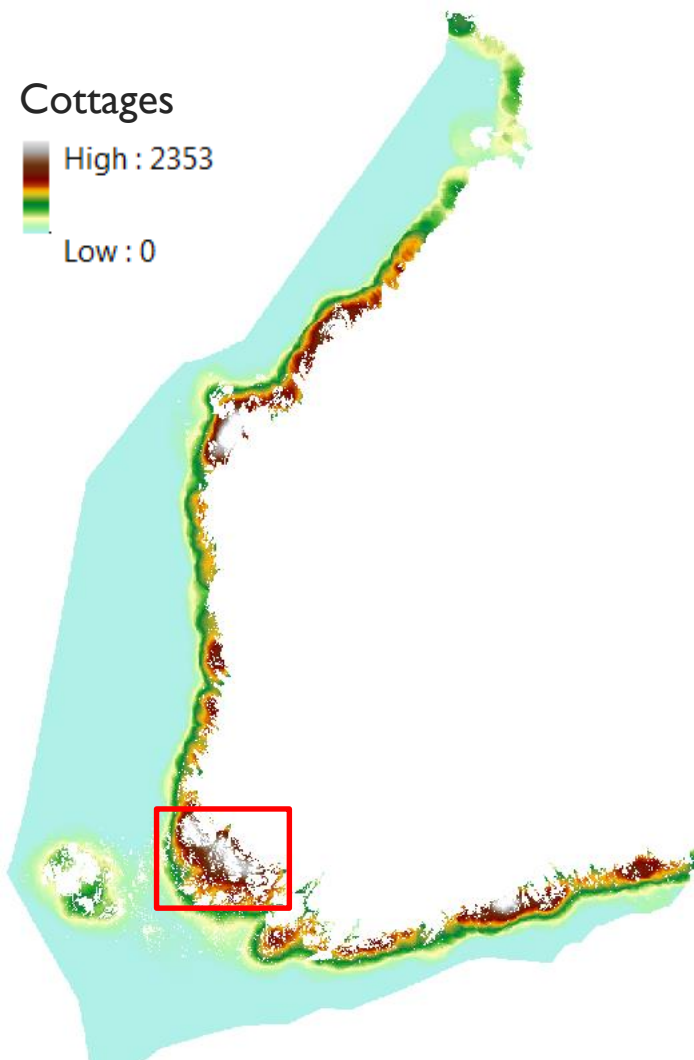
# Societal impacts



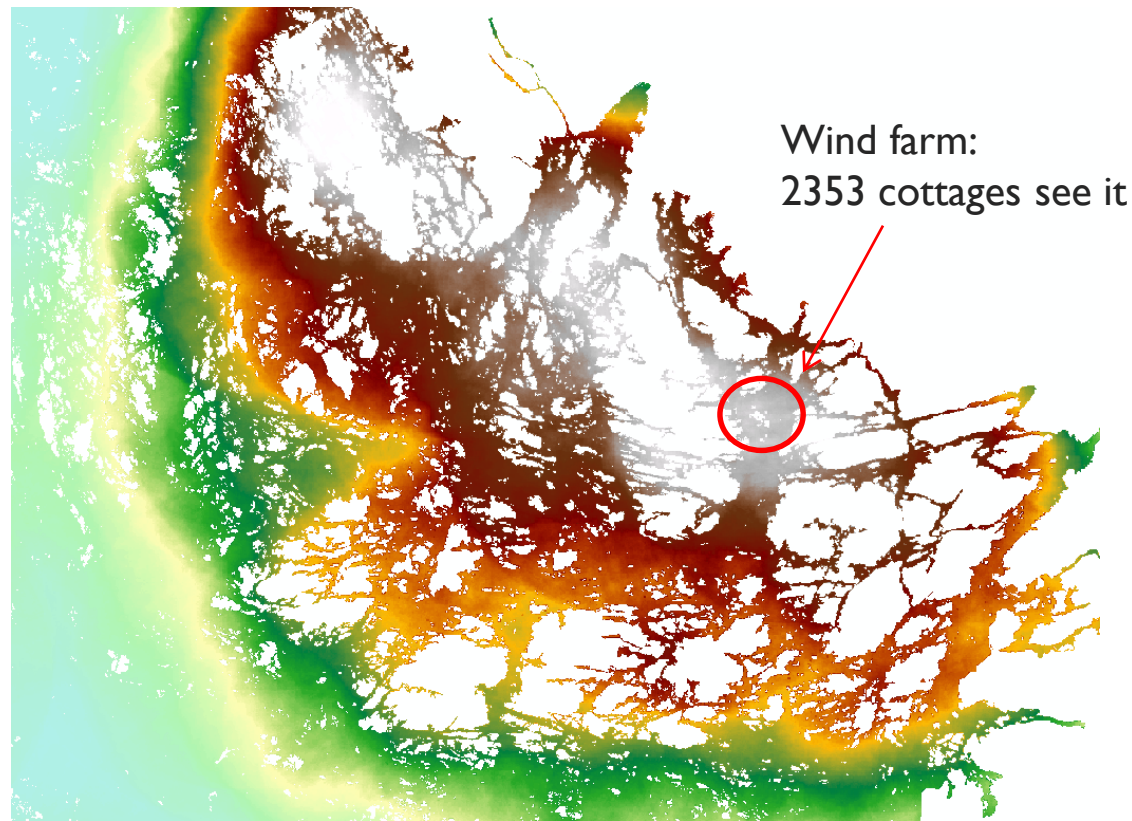
- Visual and noise impacts, boating intensity, etc.
- Livelihoods, e.g. :
  - fishing effort
  - Aquaculture
  - Coastal fishing areas

## Cottages

High : 2353  
Low : 0



## Visual impact for summer cottages







## 1) Biodiversity



## 2) Profitability



## 3) Societal impacts

**Balanced  
solution**

## 4) Restrictions



# Restrictions

- Army areas
- Weather radars
- Anchoring areas
- Nature reserves



YMPÄRISTÖHALLINNON OHJEITA 5 | 2016

Tuulivoimarakentamisen  
suunnittelu

Päivitys 2016

RAKENNETTU  
YMPÄRISTÖ







## 1) Biodiversity



© YLE

© Parks & Wildlife Finland



## 2) Profitability



## 3) Societal impacts

**Balanced  
solution**

## 4) Restrictions



## 5) Enablers



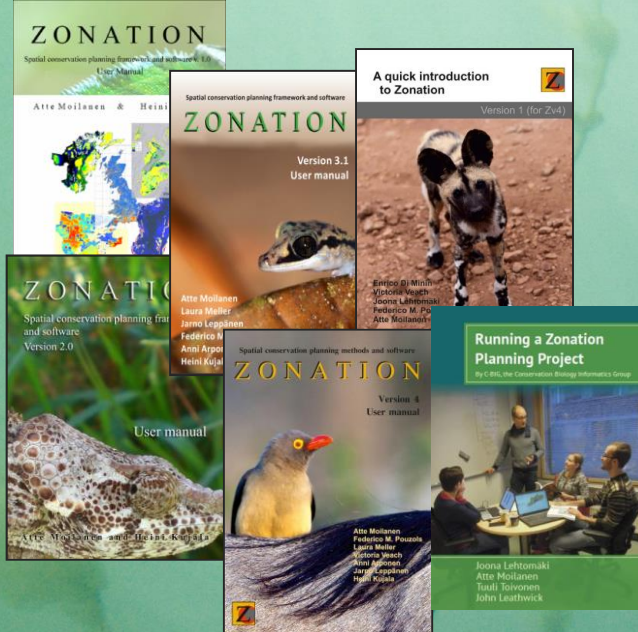


The background of the slide is a photograph showing the silhouettes of several large port cranes against a bright, low sun. The sun is positioned in the center of the frame, creating a strong backlight effect. The cranes are dark, intricate structures with long jibs. The sky is a mix of orange and blue, indicating twilight. The overall mood is industrial and dramatic.

# 5/5: Enablers

- Extension of industrial areas
- Hypoxia

# Zonation



Decision support-tool  
for ecologically based  
land use planning

Zonation:Atte Moilanen

# Optimal areas for offshore wind farms

Nature + people

+ Economy

Priority value

Priority value

Lowest

Lowest

Most potential  
areas located in the  
Bothnian Sea and  
Bothnian Bay



# **Analyses solutions used in the national MSP process**

Impacts on marine biodiversity and society minimized

Suitable wind energy areas identified in the analysis were reconciled in the planning process with the needs of other uses

→ Best compatible areas with other activities were selected

Finnish MSP is a strategic plan, not an area reservation plan

→ more areas indicated for wind farms than needed

Implementation of wind energy farms requires still more detailed plans and impacts assessments