

# Turning wind R&D into sustainable industry



18 August 2021

# FME NORTHWIND



# Objective

**research and innovation to reduce the cost of wind energy, facilitate its sustainable development, create jobs and grow exports**

**Total budget 2021-2029: 320 MNOK  
financed by Research Council of Norway,  
industry and research partners**



**EE**  
**NORTH**  
**WIND**

# Research



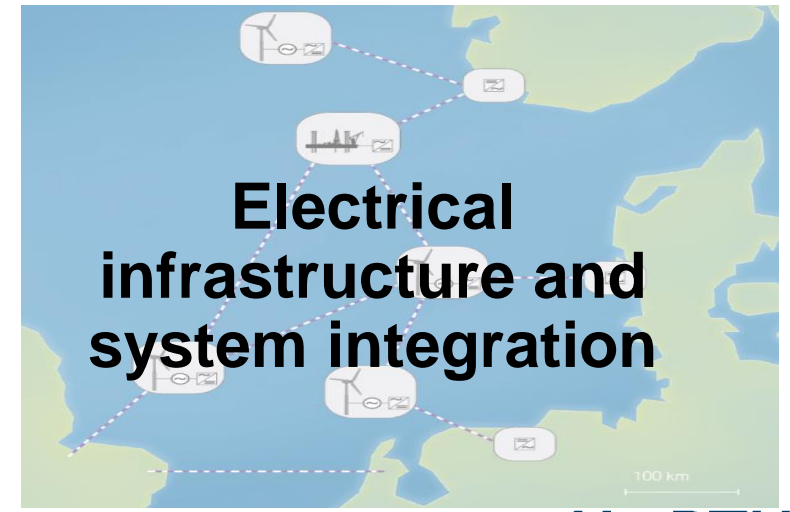
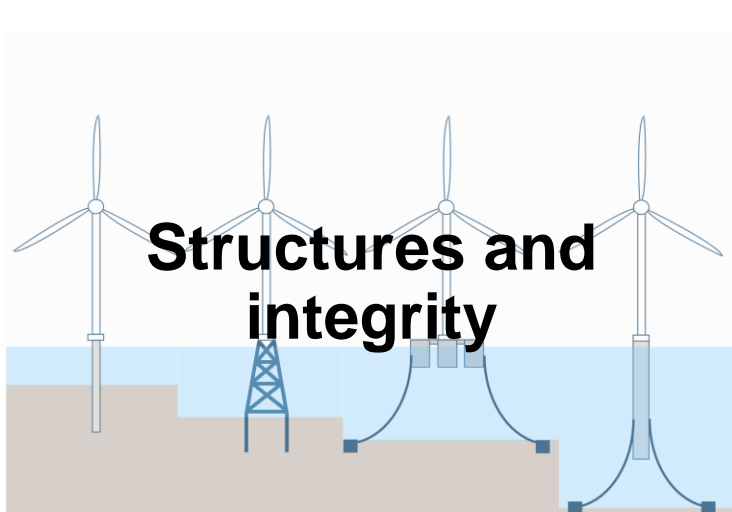
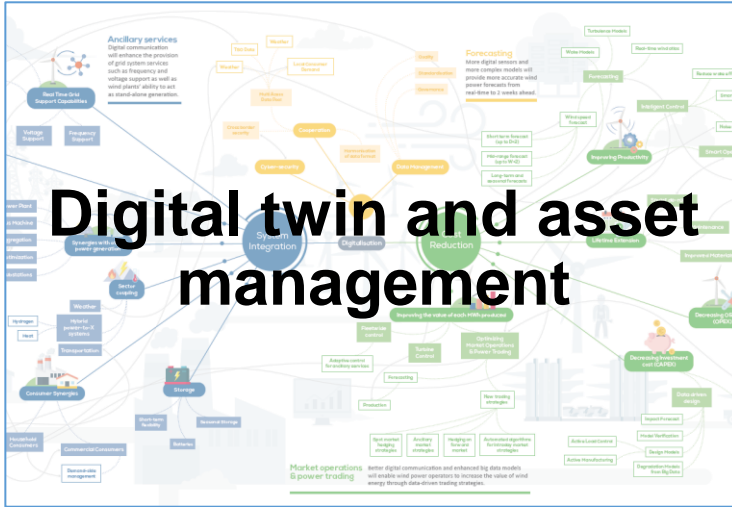
# Industry



# Associates

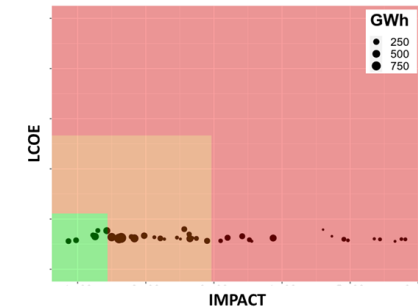
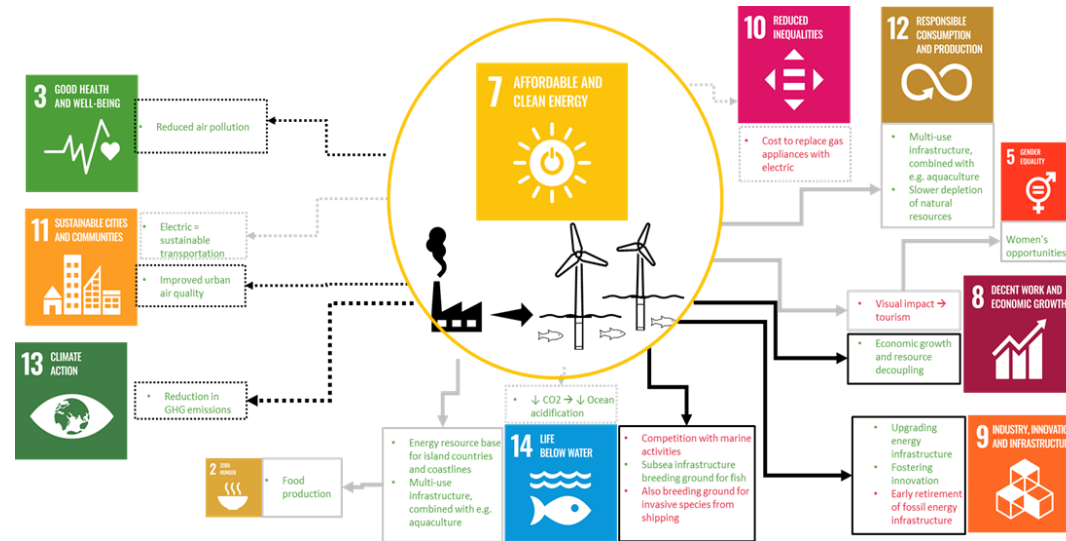
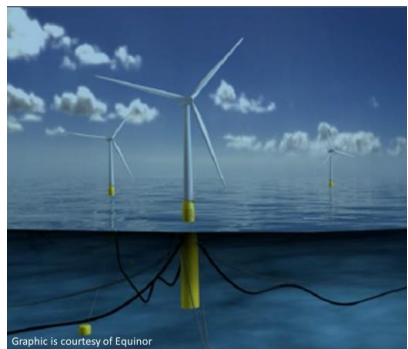
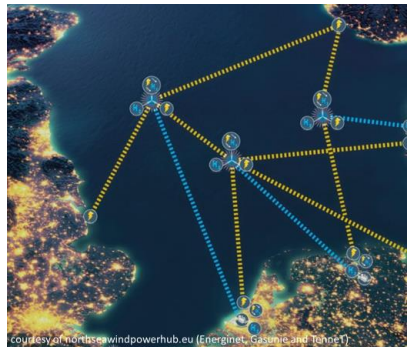
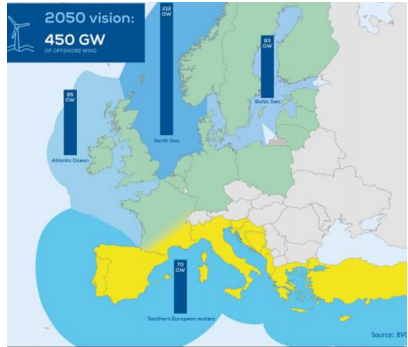


# Research programme





# A mega opportunity with challenges



Technology

Society

Environment

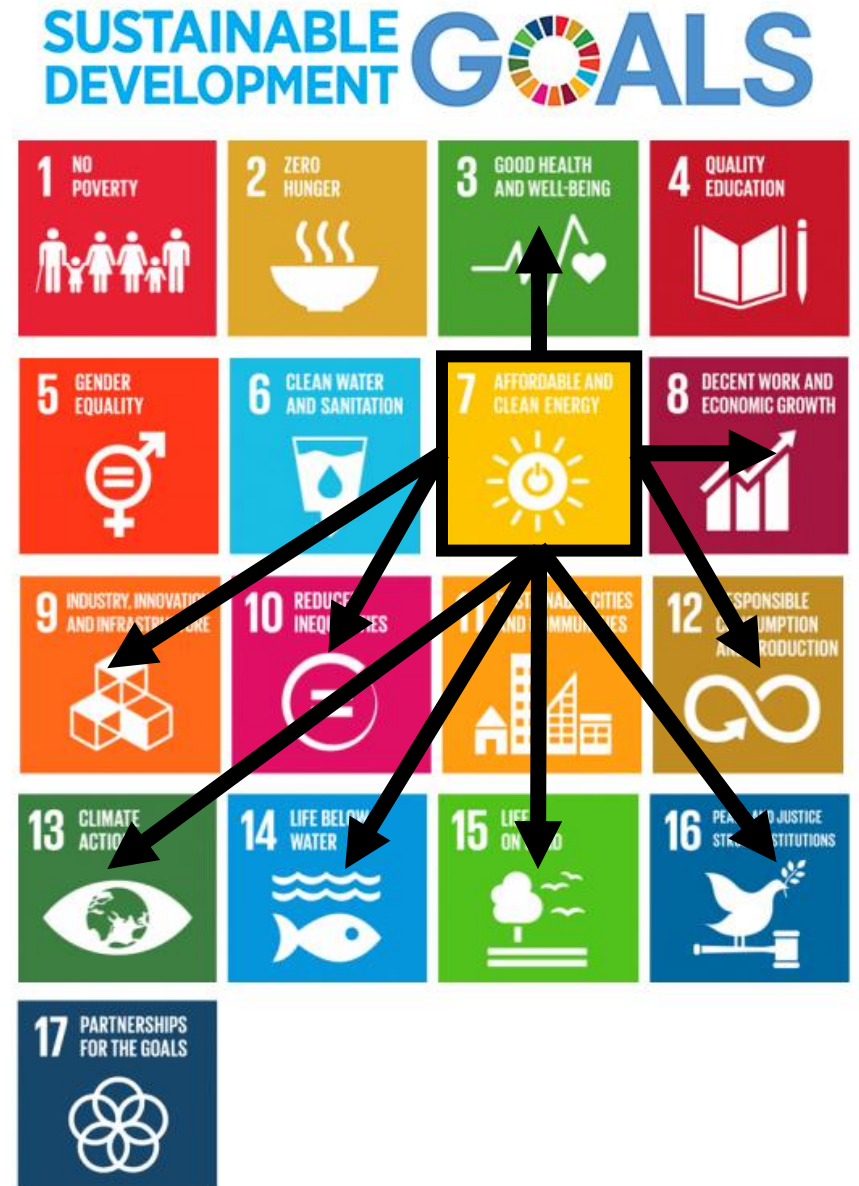
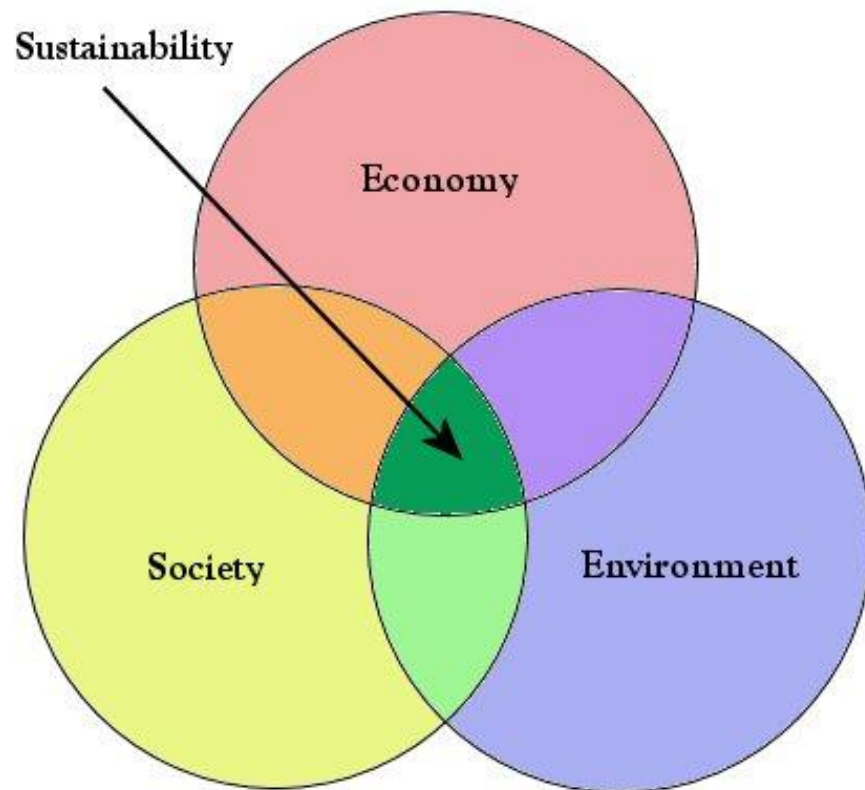
*Reconciling these challenges requires  
integrated Social-Technological-  
Ecological Systems approaches to  
support sustainability*



## WP5 Sustainable wind development

**NORTH**  
WIND

# Motivation



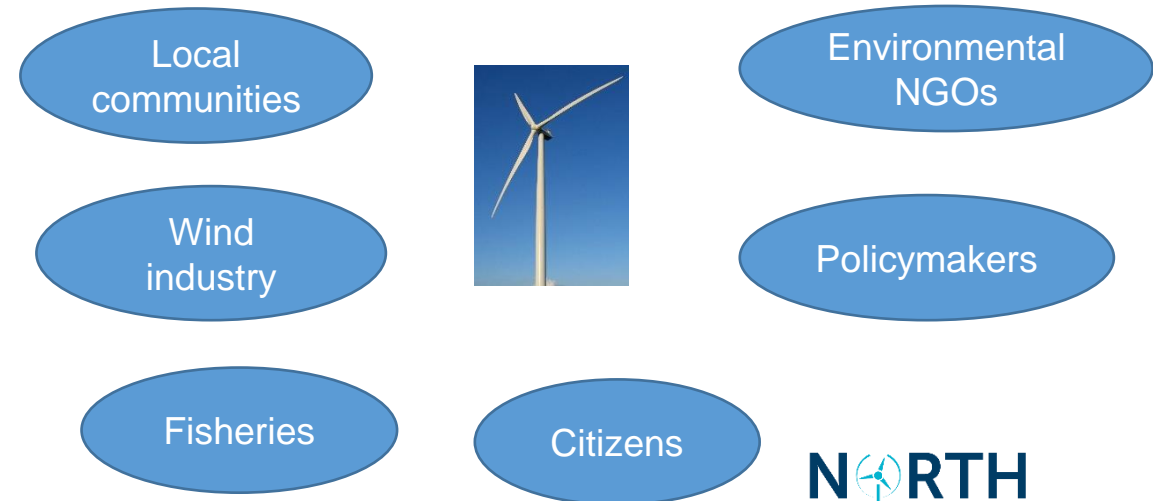
# Objective

Develop tools and insights for sustainable development of wind energy to create a successful export industry, reduce cost and uncertainty, and resolve environmental and societal conflicts

## Interdisciplinary collaboration

Psychology  
Science and Technology Studies  
Geography  
Ecology  
Maritime Law  
Engineering  
Biology  
Economics

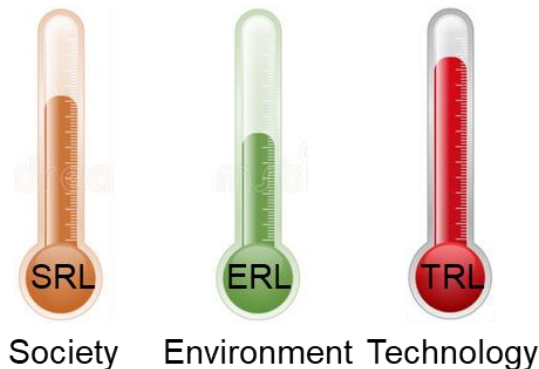
## Transdisciplinary collaboration





# Focal areas

- Task 5.1 – The role of (Norwegian) wind in the sustainable energy transition
- Task 5.2 – Environmental impacts and options for environmental design
- Task 5.3 – Public engagement, participation and controversy
- User cases – Sustainability Readiness Levels



# Task 5.2 – Environmental impacts and options for environmental design

- **Environmental impacts** will assess multiple-stressor impacts of onshore and offshore operations on biodiversity using integrated monitoring and spatio-temporal modelling to support cumulative effect assessments and siting of wind energy facilities.
- **Environmental design** will develop tools and methodology to assess risks of impact caused by the ecological footprint of development and develop innovative technical solutions to mitigate impacts, including best practice guidelines for ecological restoration.
- **Environmental assessment** will develop best regulatory practices and tools for (strategic) Environmental Impact Assessments to enable cumulative effect assessments for sustainable licensing and siting.



## ENVIRONMENTAL IMPACT

### OFFSHORE

*Above-water impacts  
on seabirds*

*Below-water impacts  
on marine biodiversity*

### ONSHORE

*Land-based impacts  
on biodiversity*

## ENVIRONMENTAL DESIGN

### ASSESSMENT TOOLS

*Offshore avian radar  
technology*

*Probabilistic collision  
risk model*

*Integrated ecological  
footprint model*

### MITIGATION SOLUTIONS

*Avian collision  
curtailment system*

*Life-cycle based  
restoration*

*Nature-inclusive  
designs*

## ENVIRONMENTAL ASSESSMENT

### INTEGRATED PROCESS

*Best-practice SEA/EIA  
processes*

*Cumulative effects*

### INTEGRATED TOOLS

*Consensus-based  
Siting*

*Sustainability  
Readiness Levels*

# Activities 2021-2022

## Environmental impacts

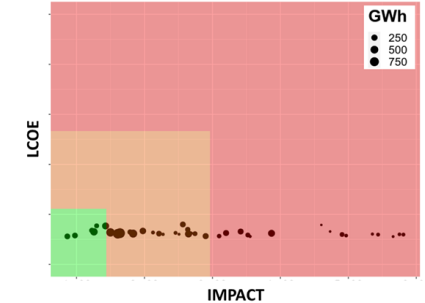
- Mapping of seabird life-cycle impacts
- Reviewing artificial reef effects in Scandinavia
- Online application for LCA impacts on onshore biodiversity

## Environmental design

- Options for inclusion of environmental and societal risks in the Digital Twin concept
- Review of technology for bird detection and collision prevention
- Review of decommissioning and restoration practice at onshore wind farms

## Environmental assessment

- Review of SEA, EIA and CEA requirements in the Norwegian permitting regime for onshore and offshore wind
- Mapping wind energy relevant ecosystem services for the integrated siting and planning tool ConSite





# Mapping seabird impacts

Kronikk

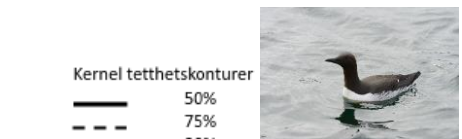
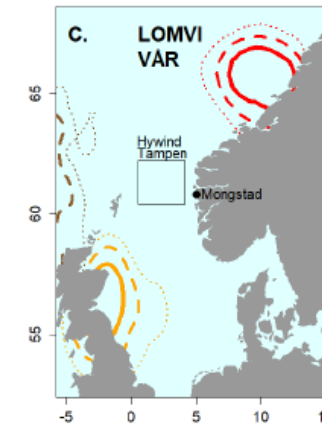
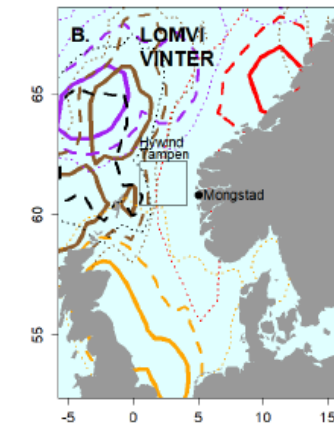
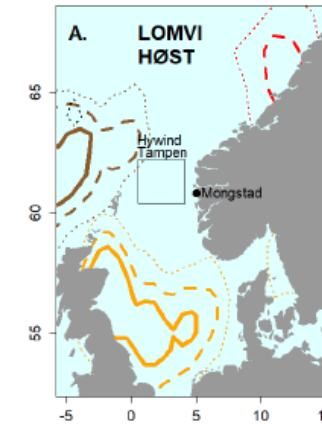
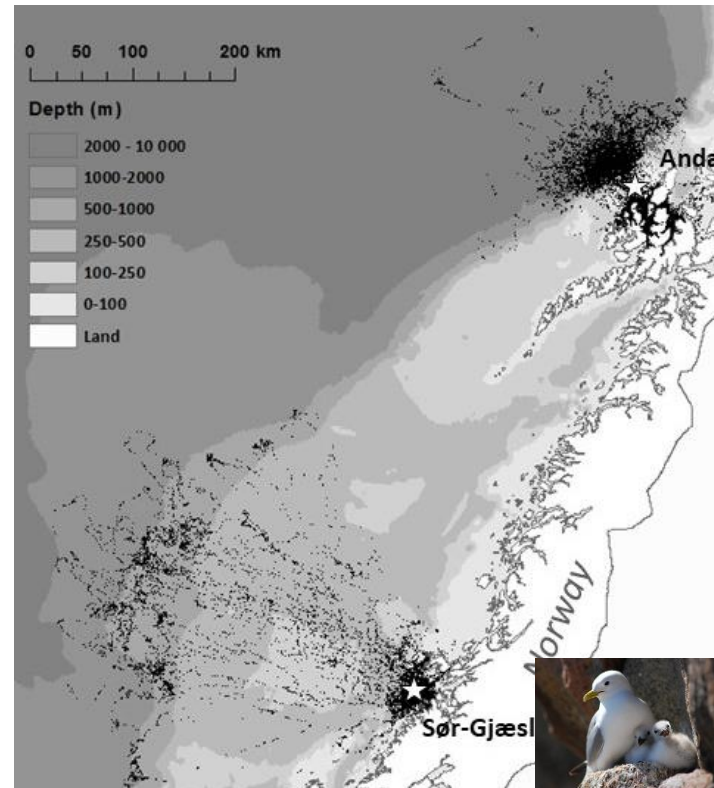
*Dra til sjøs, for noen muligheter!  
Dette er vind-vinn*

Glem  
akkur  
erobri

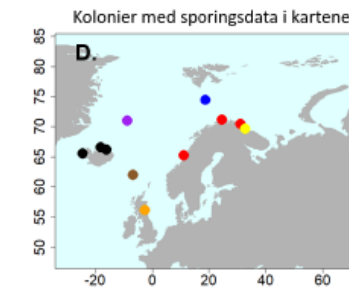
Kronikk

*Havvind – ut av syne ut av  
sinn?*

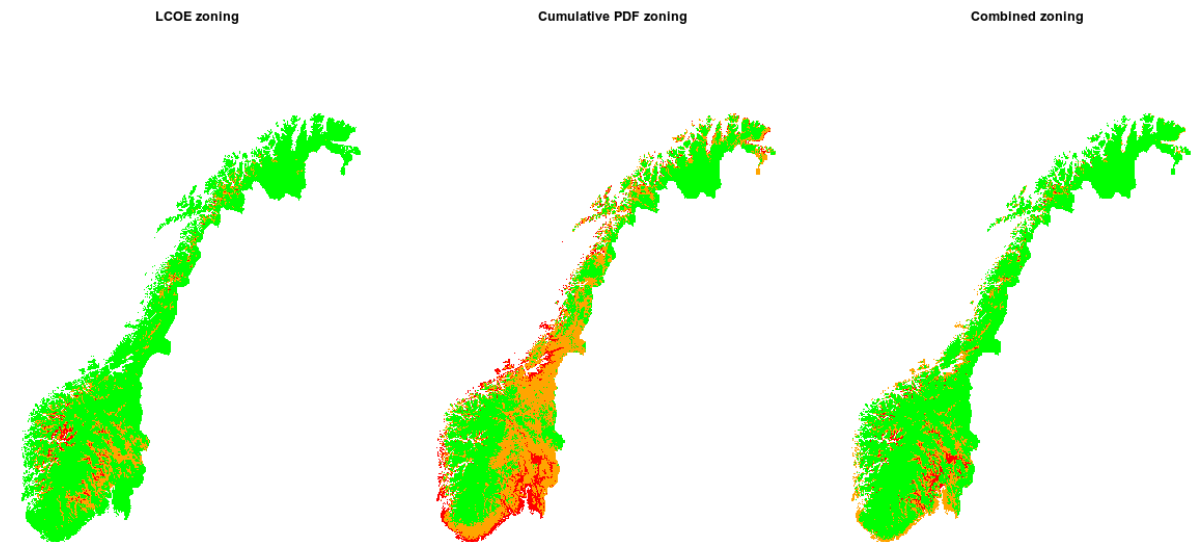
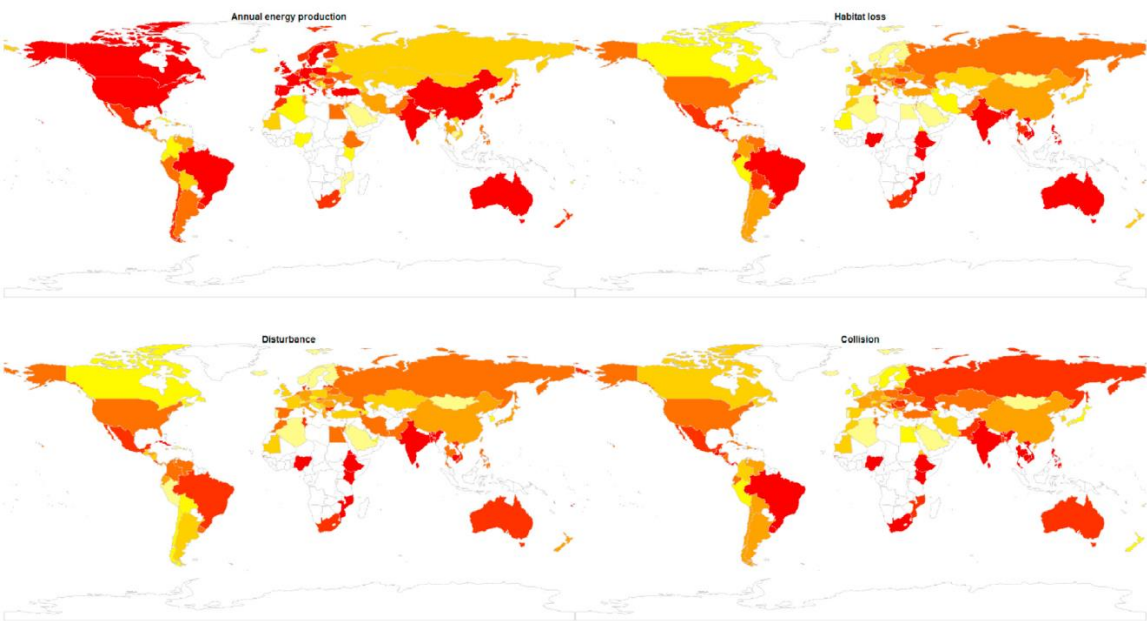
*I takt med en økende kritikk mot de store naturtngrepene fra landbaserte  
vindkraftanlegg er det mange som ønsker at vindparkene skal flyttes til havs.*



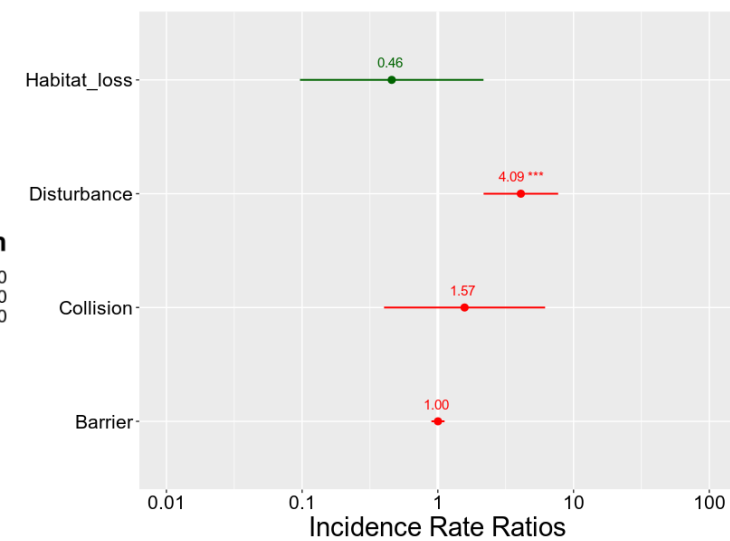
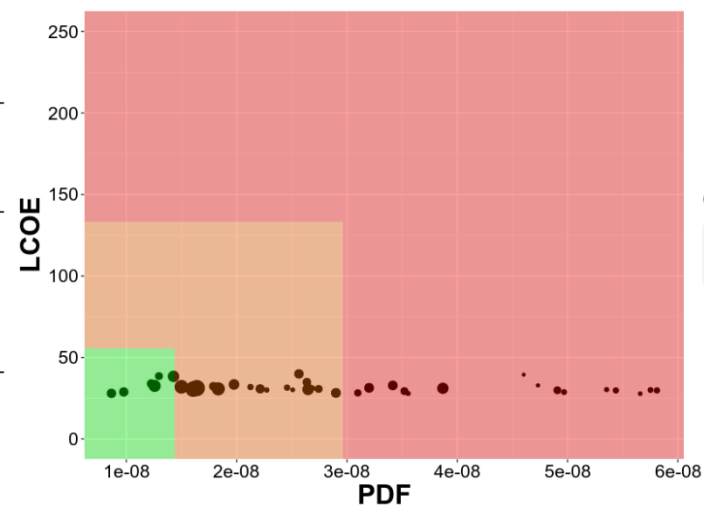
Kernel tetthetskonturer  
— 50%  
- - - 75%  
..... 90%



# LCA for avian impacts of wind energy siting



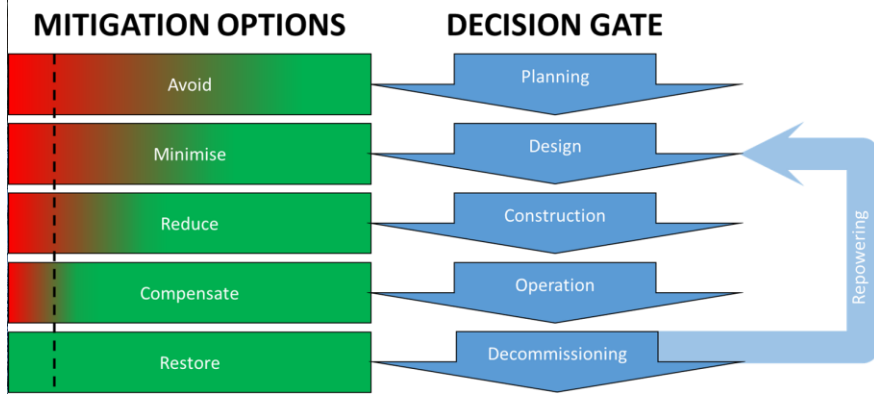
Covariate	Impact pathway			
	Habitat loss	Disturbance	Collision	Barrier
Turbine capacity (MW)	94.511***	9.857**	125.329***	5.465*
Number of turbines	66.151***	53.949***	77.239***	0.772
Interactive effect	-11.723**	-7.447*	-10.259**	6.466*
adjusted R <sup>2</sup>	0.817	0.642	0.847	0.2034





# PhD on life-cycle restoration

Mitigate impacts from development of wind power



Footprint: Impact on ecosystems, vegetation and soil



Restoration potential: Mitigate – restore - compensate



Relationship between biodiversity loss and carbon equivalents



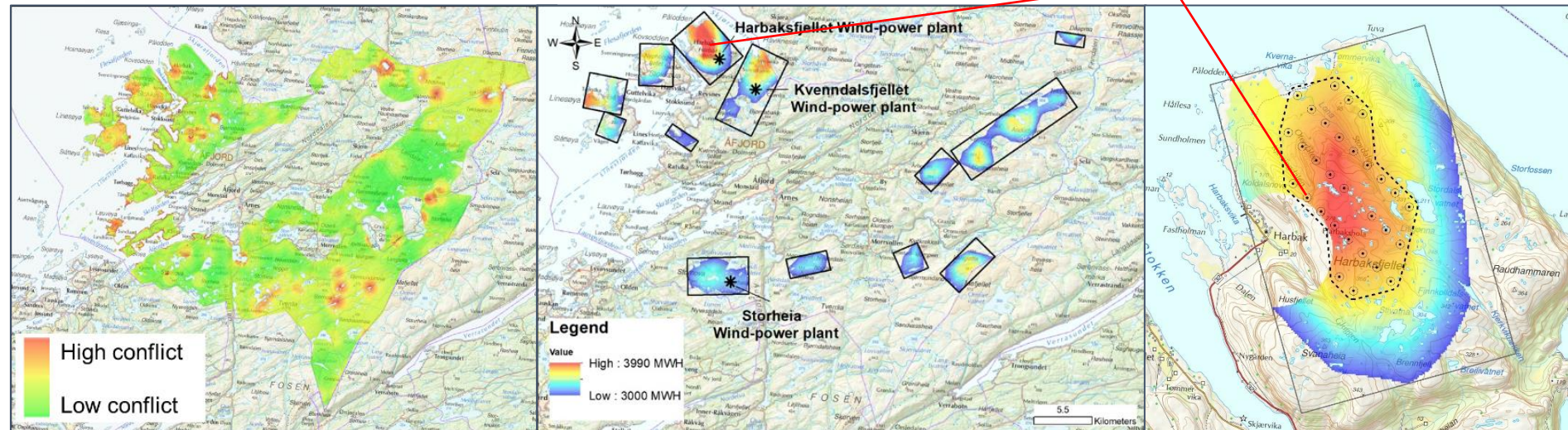


# Consensus-based siting of onshore wind (ConSite)



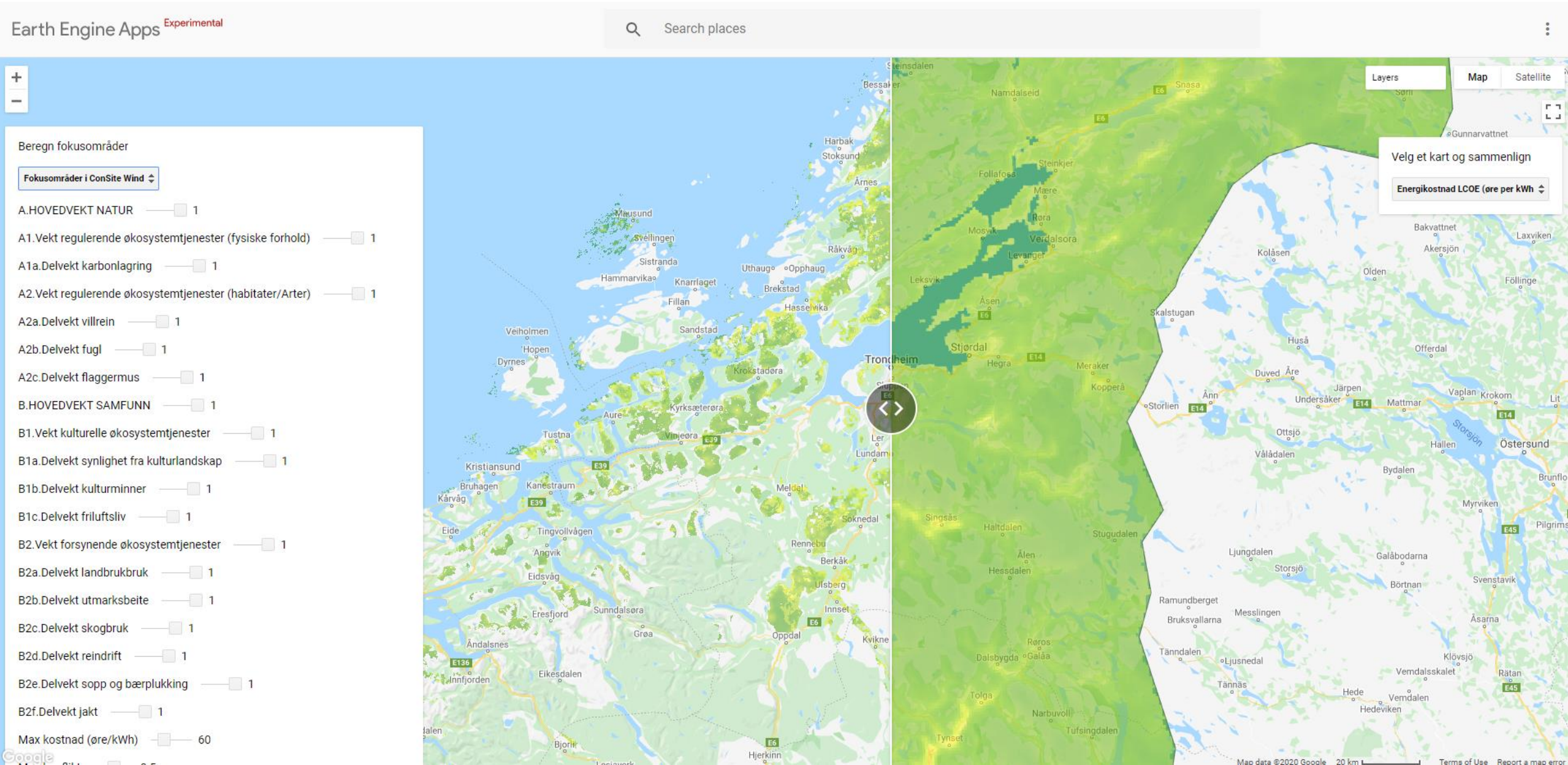
Spatial multi-criteria decision support tool for optimal siting of wind-power plants based on **ecological**, **societal** and **technological** criteria

Identify	
Identify from: Conflict zone statistics	
Location: 239 074.903 7 113 876.943 Meters	
Field	Value
lat	306
2A.Wind resources: Minimum suitability	0.234921
2A.Wind resources: Maximum suitability	0.351201
2A.Wind resources: Mean suitability	0.28696
2B.Distance to powerlines: Minimum conflict	0.489792
2B.Distance to powerlines: Maximum conflict	0.581589
2B.Distance to powerlines: Mean conflict	0.537115
2C.Distance to roads: Minimum conflict	0.186605
2C.Distance to roads: Maximum conflict	1
2C.Distance to roads: Mean conflict	0.945275
2D.Topographical variation: Minimum conflict	0.5
2D.Topographical variation: Maximum conflict	0.99995
2D.Topographical variation: Mean conflict	0.891242
3A.Distance to cultural heritage: Minimum conflict	0.168344
3A.Distance to cultural heritage: Mean conflict	0.474351
3A.Distance to cultural heritage: Maximum conflict	0.942315
3B.Distance to cultural landscapes: Minimum conflict	0.001053
3B.Distance to cultural landscapes: Maximum conflict	0.006127
3B.Distance to cultural landscapes: Mean conflict	0.002893
3C.Visual disturbance: Minimum conflict	0.195814
3C.Visual disturbance: Maximum conflict	0.676145
3C.Visual disturbance: Mean conflict	0.393569
3D.Fragmentation of productive agricultural and forestry land: Minimum conflict	0
3D.Fragmentation of productive agricultural and forestry land: Maximum conflict	1
3D.Fragmentation of productive agricultural and forestry land: Mean conflict	0.023412
4A.Distance to important sites for biodiversity: Minimum conflict	0.000001
4A.Distance to important sites for biodiversity: Maximum conflict	0.999102
4A.Distance to important sites for biodiversity: Mean conflict	0.122573
4B.Distance to coastal areas: Minimum conflict	0
4B.Distance to coastal areas: Maximum conflict	0.5
4B.Distance to coastal areas: Mean conflict	0.000271
4C.Distance to protected nature areas: Minimum conflict	0.000006
4C.Distance to protected nature areas: Maximum conflict	0.000278
4C.Distance to protected nature areas: Mean conflict	0.000079
4D.Distance to undeveloped nature areas: Minimum conflict	0
4D.Distance to undeveloped nature areas: Maximum conflict	0
4D.Distance to undeveloped nature areas: Mean conflict	0





# Consensus-based siting of onshore wind (ConSite)





[www.northwindresearch.no](http://www.northwindresearch.no)



NORTH  
WIND