

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**



Research



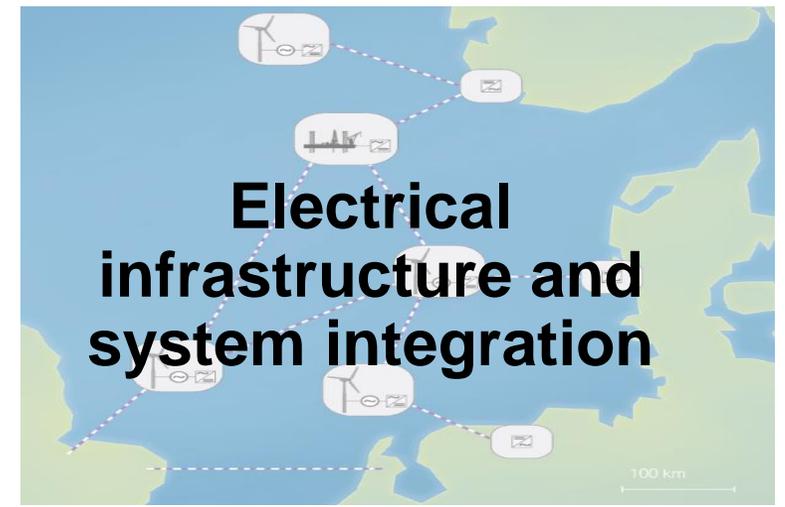
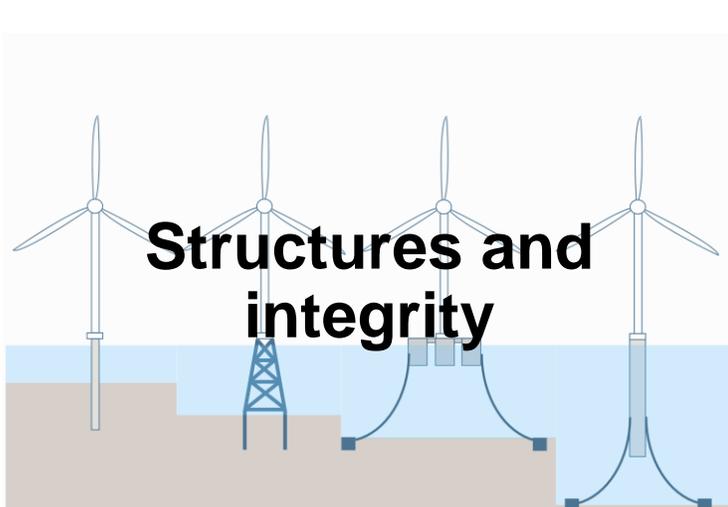
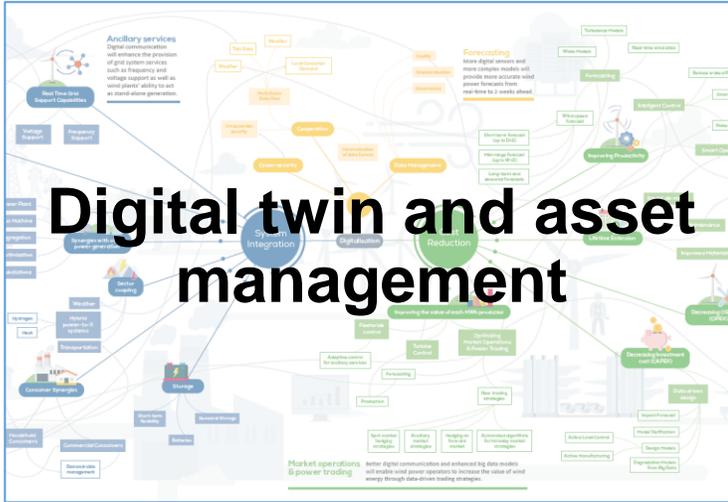
Industry



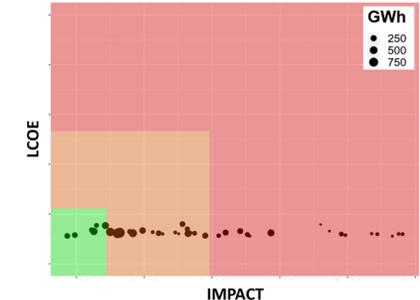
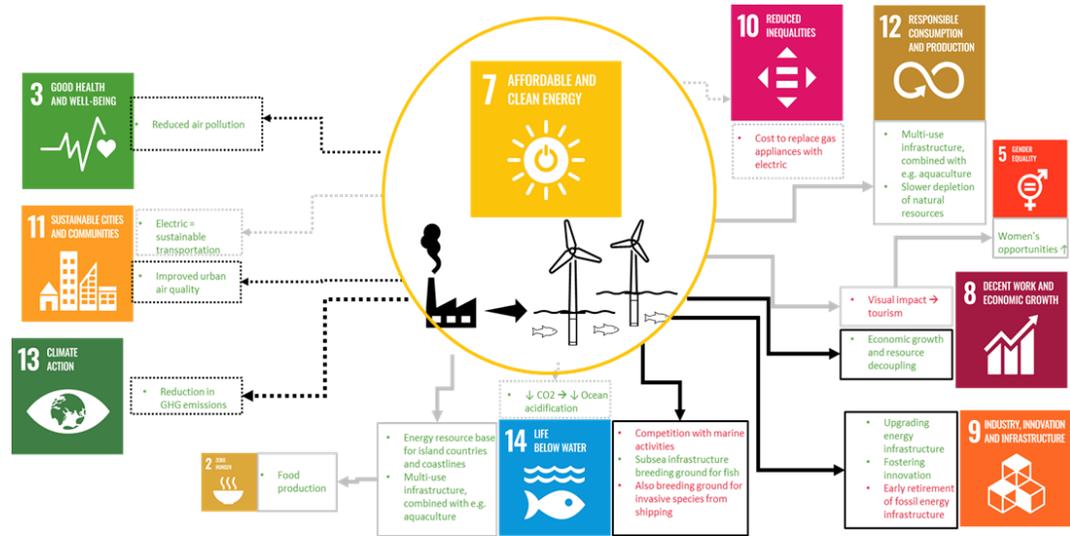
Associates



Research programme



A giga opportunity with challenges



Technology

Society

Environment
WIND

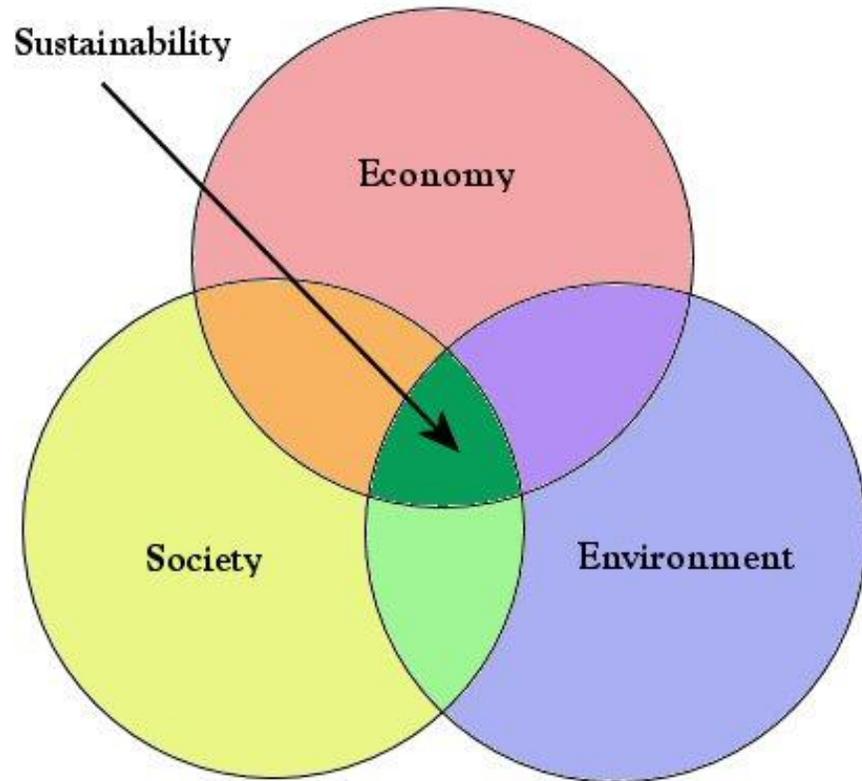
Reconciling these challenges requires integrated Social-Technological-Ecological Systems approaches to support sustainability



WP5 Sustainable wind development

NORTH
WIND

Motivation



SUSTAINABLE DEVELOPMENT GOALS



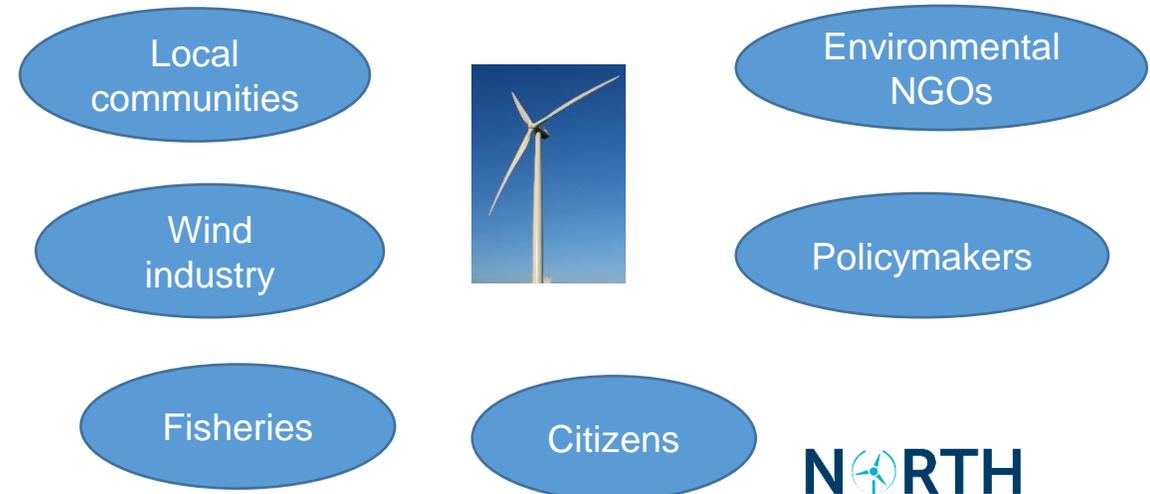
Objective

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

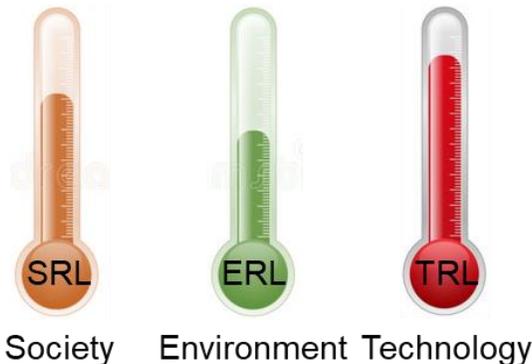
Psychology
Science and Technology Studies
Geography
Ecology
Maritime Law
Engineering
Biology
Economics

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

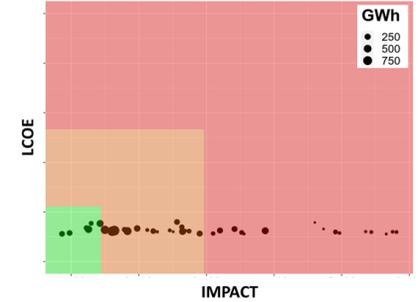
- Mapping of seabird life-cycle impacts
- Reviewing artificial reef effects in Scandinavia
- Online application for LCA impacts on onshore biodiversity

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

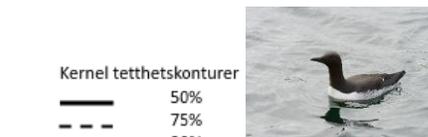
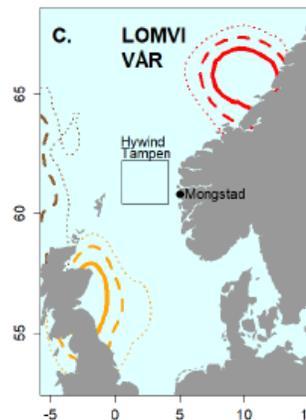
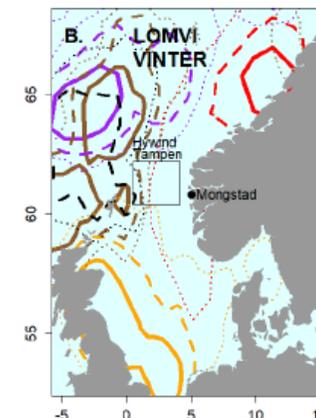
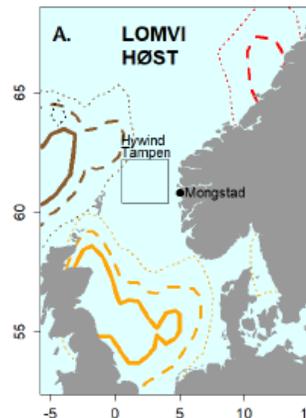
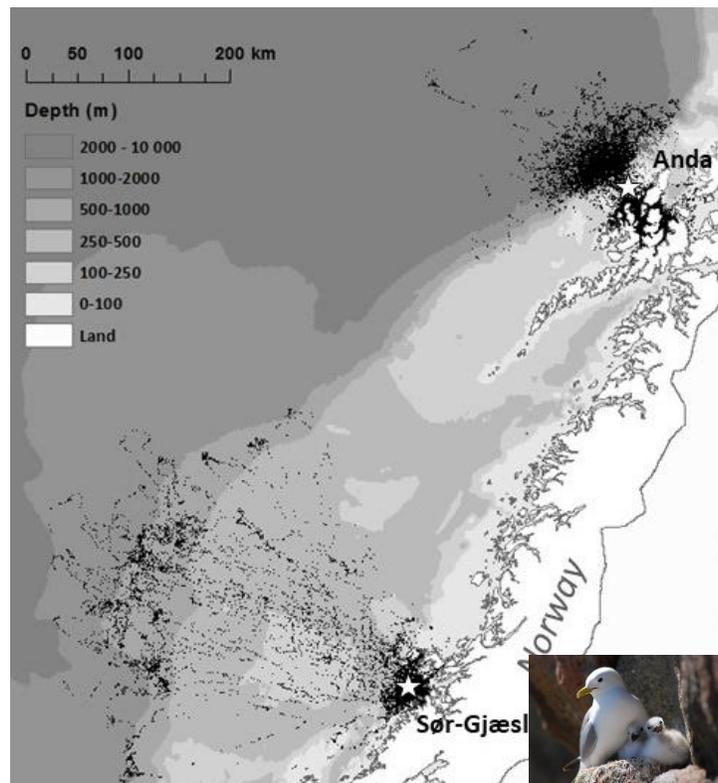
*Dra til sjøs, for noen muligheter!
Dette er vind-vinn*

Glem
akkur
erobr

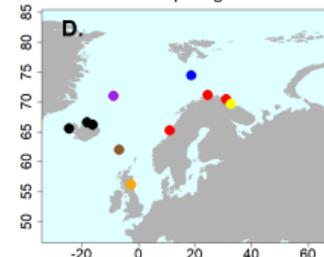
Kronikk

*Havvind – ut av syne ut av
sinn?*

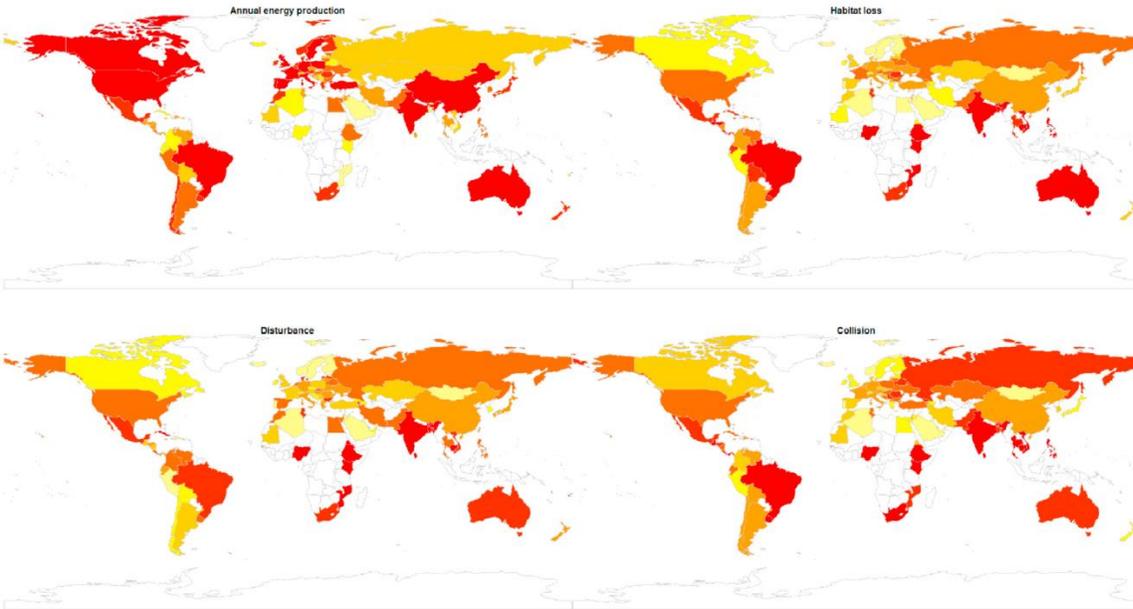
*I takt med en økende kritikk mot de store naturinngrepene fra landbaserte
vindkraftanlegg er det mange som ønsker at vindparkene skal flyttes til havs.*



Kolonier med sporingsdata i kartene



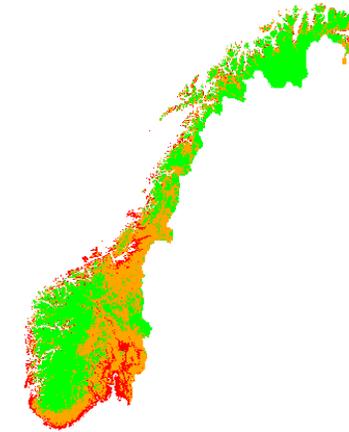
LCA for avian impacts of wind energy siting



LCOE zoning



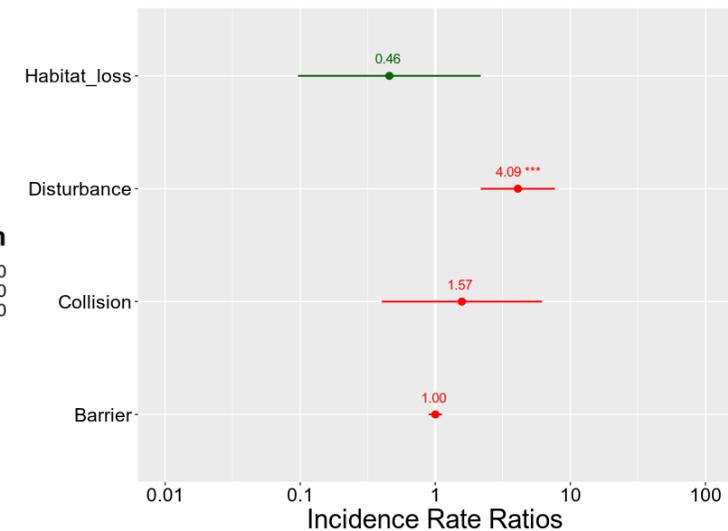
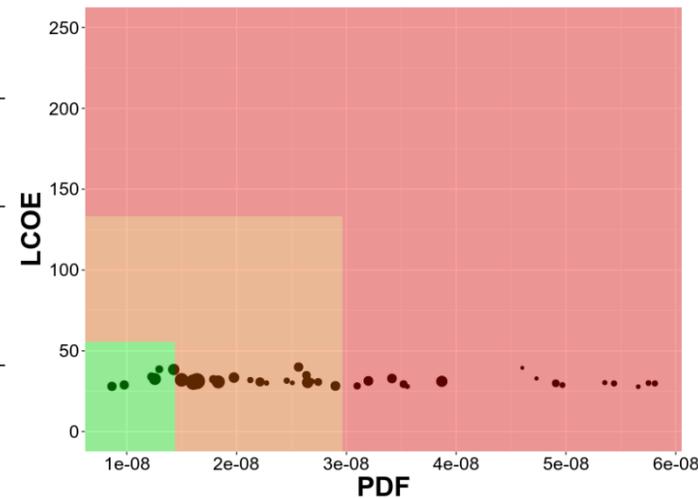
Cumulative PDF zoning



Combined zoning

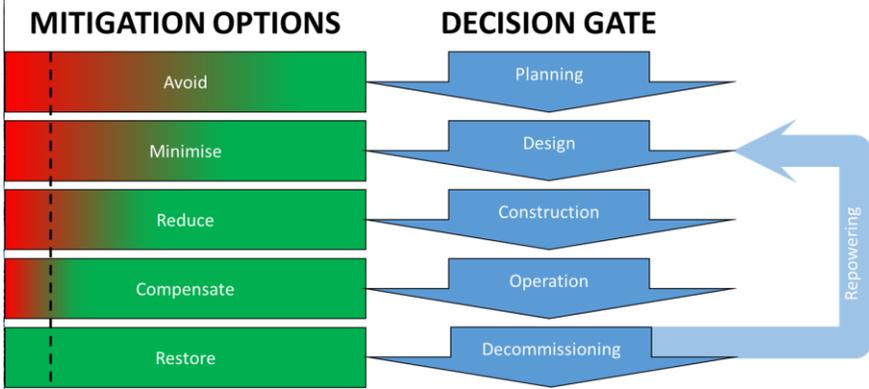


Covariate	Impact pathway			
	Habitat loss	Disturbance	Collision	Barrier
Turbine capacity (MW)	94.511***	9.857**	125.329***	5.465*
Number of turbines	66.151***	53.949***	77.239***	0.772
Interactive effect	-11.723**	-7.447*	-10.259**	6.466*
adjusted R ²	0.817	0.642	0.847	0.2034



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

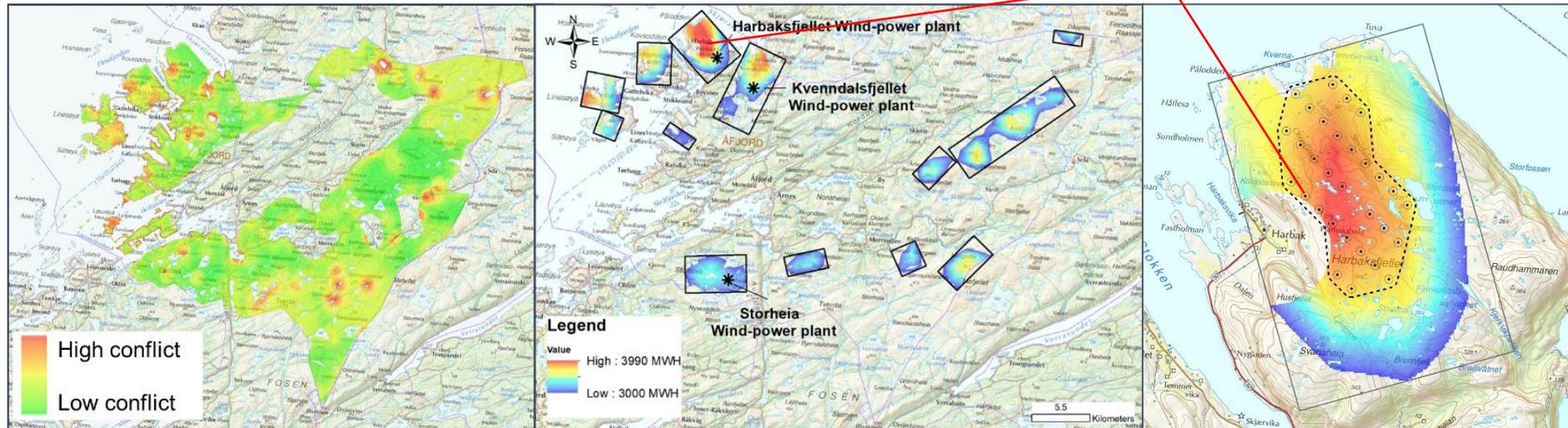


Consensus-based siting of onshore wind (ConSite)

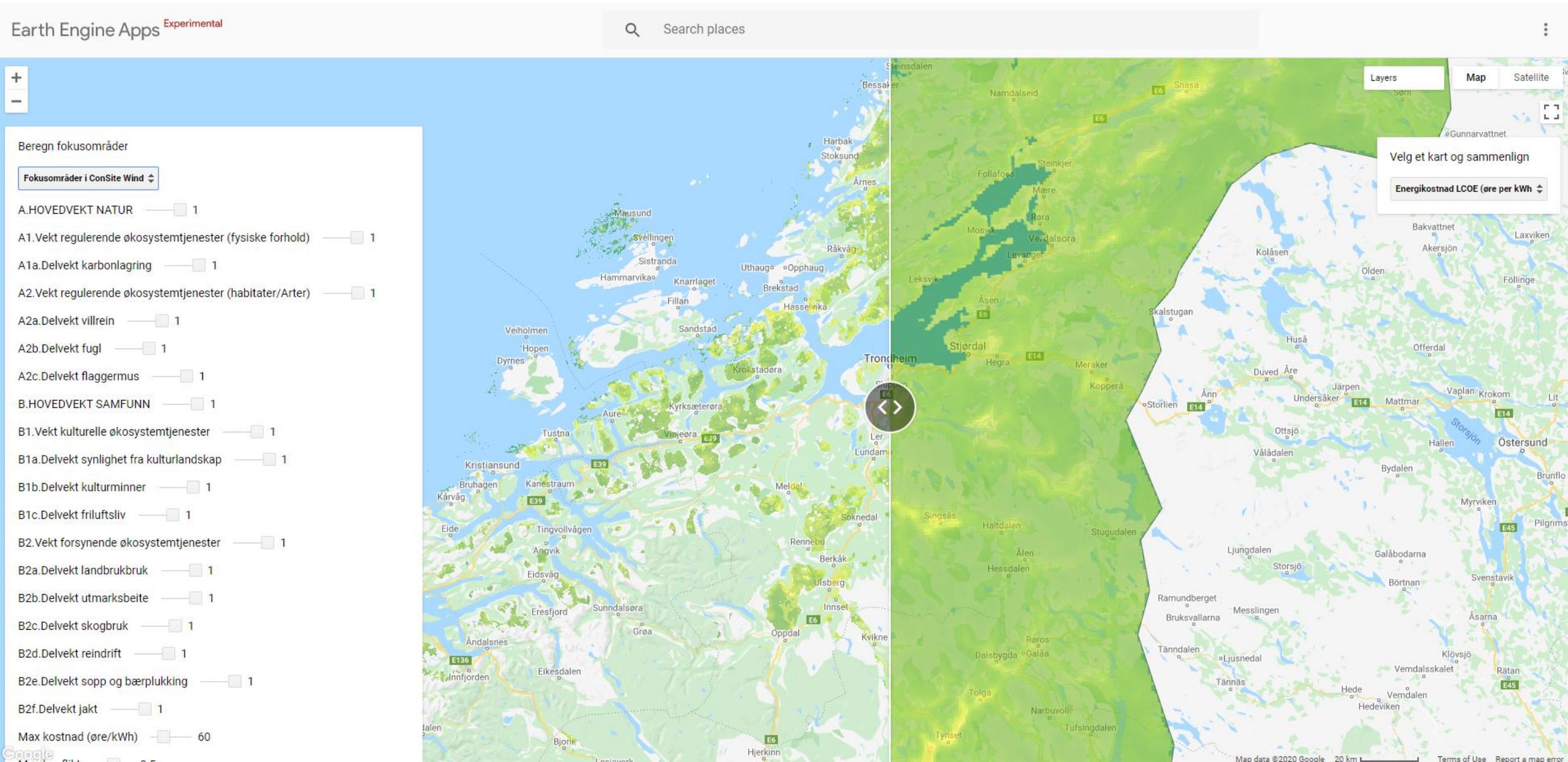


Spatial multi-criteria decision support tool for optimal siting of wind-power plants based on **ecological**, **societal** and **technological** criteria

Field	Value
Id	306
2A.Wind resources: Minimum suitability	0.234921
2A.Wind resources: Maximum suitability	0.351201
2A.Wind resources: Mean suitability	0.28996
2B.Distance to powerlines: Minimum conflict	0.489792
2B.Distance to powerlines: Maximum conflict	0.981589
2B.Distance to powerlines: Mean conflict	0.537115
2C.Distance to roads: Minimum conflict	0.196655
2C.Distance to roads: Maximum conflict	1
2C.Distance to roads: Mean conflict	0.945275
2D.Topographical variations: Minimum conflict	0.5
2D.Topographical variations: Maximum conflict	0.99995
2D.Topographical variations: Mean conflict	0.891242
2A.Distance to cultural heritage: Minimum conflict	0.168344
2A.Distance to cultural heritage: Maximum conflict	0.474351
2A.Distance to cultural heritage: Mean conflict	0.342315
2B.Distance to cultural landscapes: Minimum conflict	0.001053
2B.Distance to cultural landscapes: Maximum conflict	0.006137
2B.Distance to cultural landscapes: Mean conflict	0.002893
2C.Visual disturbance: Minimum conflict	0.195814
2C.Visual disturbance: Maximum conflict	0.676145
2C.Visual disturbance: Mean conflict	0.393569
2D.Fragmentation of productive agricultural and forestry land: Minimum conflict	0
2D.Fragmentation of productive agricultural and forestry land: Maximum conflict	1
2D.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	0.999999
4A.Distance to important sites for biodiversity: Mean conflict	0.122373
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)



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