

ENERGY INNOVATION

– a NorSea and IKM Company



*Centre of Excellence
On- and Offshore Wind
& Green tech*

*Sustainability, once a pretty
word in speeches.*

We are beyond that.

CEO / Managing partner

Frank Emil Moen

www.energyinnovationglobal.com



The Greater Stavanger area

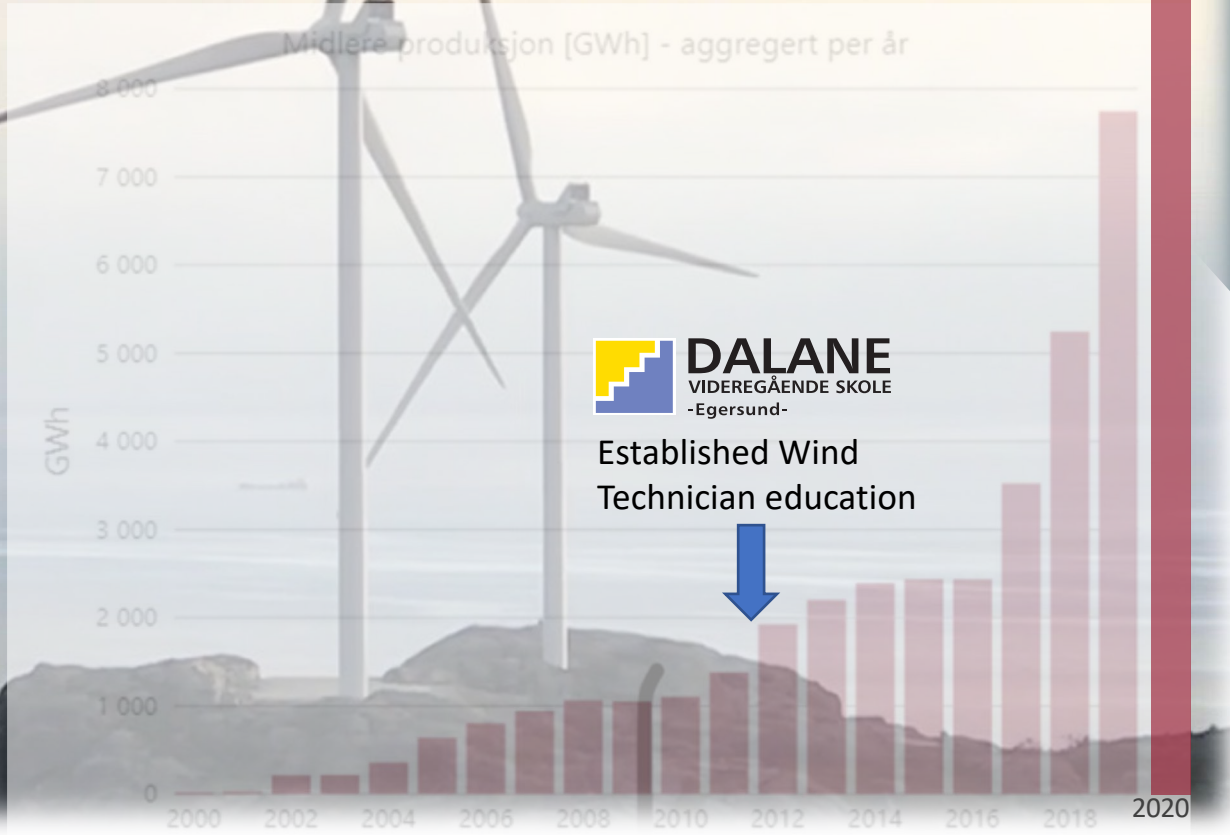
SOUTH WEST NORWAY

- The Energy Capital of Europe
- Strong maritime, marine and Oil & Gas traditions
- 360.000 inhabitants
- 190.000 employed
- A highly international business region – 189 nationalities represented
- Strong international airline connections



Onshore wind in Norway

MARKET



DALANE
VIDEREGÅENDE SKOLE
-Egersund-

Established Wind Technician education



15,4 TWh end 2021

Installed capacity:

- 4650 MW
- 64 Wind farms
- 1305 WTG's
- CF: 37,9 %
- 3324 FLH

First – and so far the only – education of Wind Technicians was established in Egersund back in 2011, due to need of qualified personnel for onshore wind.

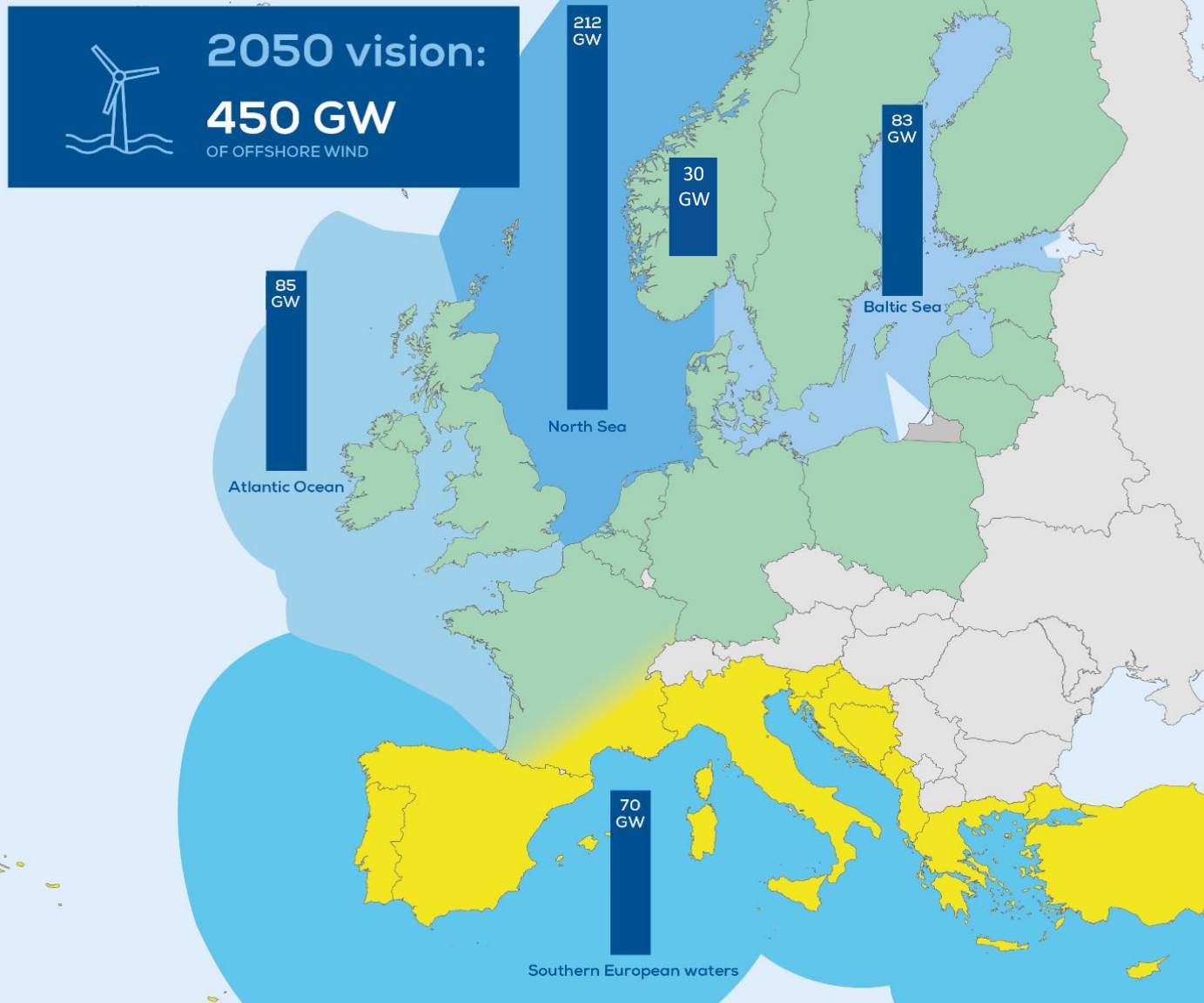


CLICK FOR VIDEO

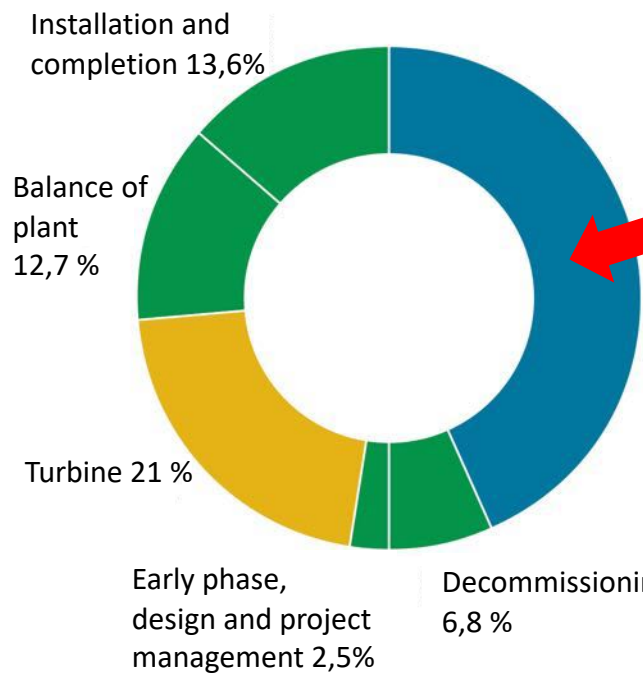
Norway – 30 GW by 2040



EUROPE



Supply chain offshore wind



Development	PM & Engineering	Turbine Supply	Balance of Plant	Installation	Commissioning	Operations, maintenance and services	Integrity management and life time extension	Decommissioning
Environmental surveys	Project management	Marshalling yards	Turbine foundations	Turbine installation	Commissioning services	Maintenance services	Monitoring	Port
Consenting and development services	Procurement	Marshalling ports	Transition piece	Foundation installation	Commissioning logistics	Inspection services	Surveillance and analyses services	Logistics
Establish basis for design	FEED and Detail Engineering	Assembly yard	Equipment for foundation and transition piece	Offshore and onshore cable installation	Commissioning port	Vessels	Inspection services	Marine operations
	Information management	Drive chain	Electrical cables	Offshore and onshore substation installation		O&M ports		Salvage and recycling
	Life cycle documentation (analyses)	Power conversions and supplies to the turbine and tower production	Electrical systems	Offshore HVDC installation		Training and certification		
			HVAC/HVDC topside	Installation port				
			Secondary steel work	Installation logistics				
			Mooring systems					

Figur 1.4 Kilde: Norsk Industri

<https://www.norskindustri.no/dette-jobber-vi-med/energi-og-klima/fornybar-energi-til-havs/leveransemodeller-for-havvind/>

This poster gives an overview of the key offshore wind operations and maintenance activity covered by this guide. Activity is centered on the seven categories which are colour-coded and used throughout the guide.

Offshore logistics 60 % of revenue

Back office, administration and operations

10 % revenue

Onshore logistics

Export cable and grid connection

30 % of revenue

Turbine maintenance

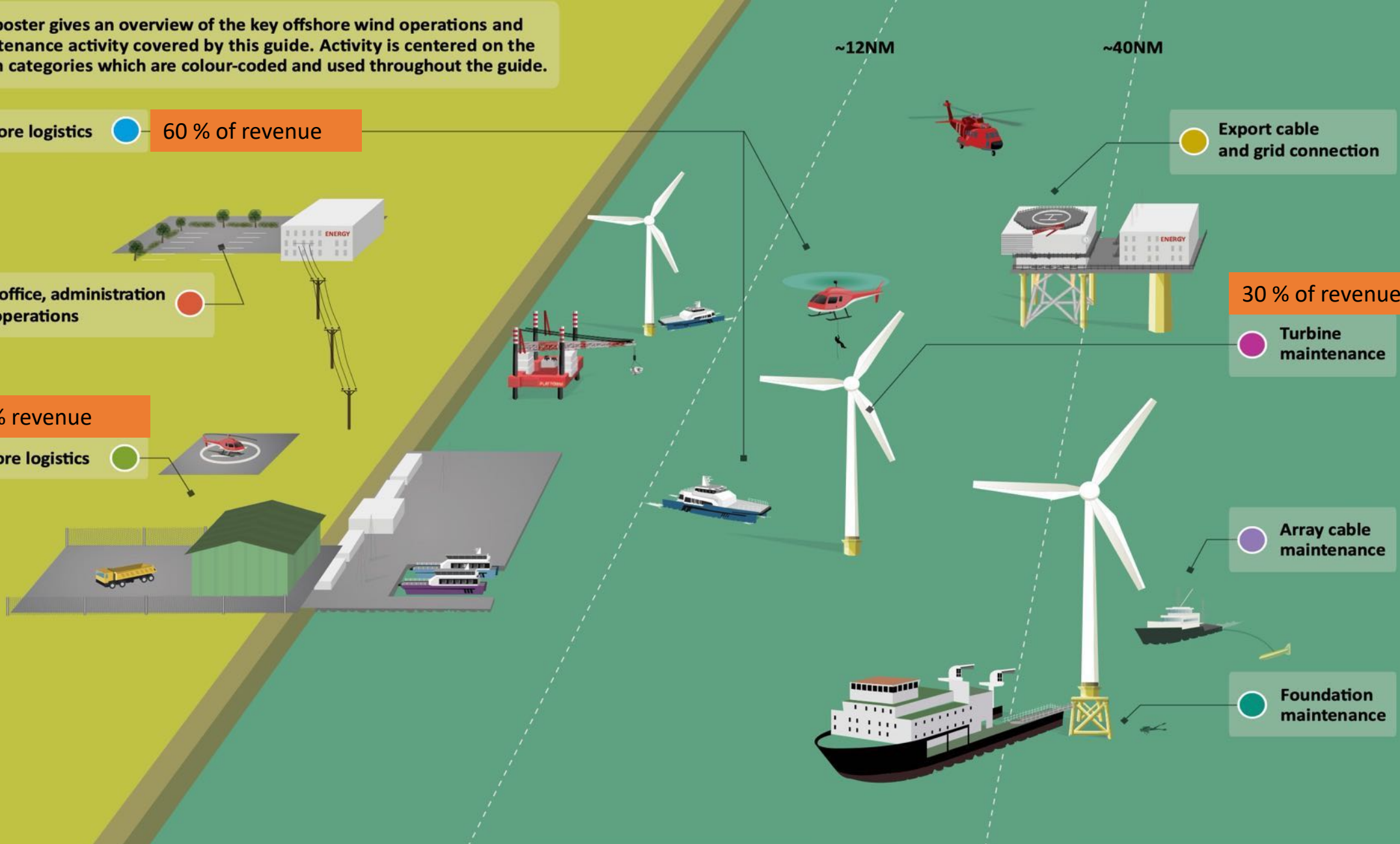
Array cable maintenance

Foundation maintenance

WORKBOATS

WORKBOATS WITH HELICOPTER SUPPORT

OFFSHORE BASE



Competitive strength Norway

	Total score	Competitiveness	Antall registrerte selskap	Har svart på undersøkelse	Internasjonalt potensial
Tier 1 HVAC, HVDC, kabel (EPC)	5,9	Meget høy	25	25	8
Produktleverandør Fundament bunnfast Tier 1-3	2,7	Lav	19	19	2
Produktleverandør Fundament flytende inkl. forankring Tier 1-3	3,5	Lav	13	13	5
Produktleverandør Utstyr Tier 2	5,1	Høy	47	20	30
Produktleverandør Utstyr Tier 3	4,0	Verken høy eller lav	115	64	57
Marine operatører Installasjon/sjøtransport/logistikk Tier 1-3	4,9	Høy	79	41	23
Havner og sammenstillingsverft	3,3	Lav	13	9	4
Skipsverft	5,3	Høy	12	7	9
O&M operators → Drifts- og vedlikeholdsleverandører inkl. levetidsforlengelse og integrity management tier 1-3	2,8	LOW	52	36	5
Engineering & konsultentselskaper testsentere og digitale tjenester	4,3	Verken høy eller lav	146	83	20

1 Svært lav
 2 Meget lav
 3 Lav
 4 Verken høy eller lav
 5 Høy
 6 Meget høy
 7 Svært høy

SEPT 2017

HISTORY

THE PROGRESS OF:



ENERGY
:NNOVATION



May 2018

Training Tower built May 2018
delivered from Germany



August 2018



ENERGY
INNOVATION

Only education of wind technicians in Norway



Wind Technician Education



ENERGY
INNOVATION
- a NorSea and IKM Company

Centre for Education and training, O&M@ and R&D
for on- and offshore wind and Green Tech



Triple Helix => Innovation through collaboration, development and interaction between business, R&D, education and government.

PUBLIC EDUCATION

University
3-5 years

Higer
Education

Technical
College
EQF 5
0,5-2 years

VOCATIONAL
EDUCATION
& TRAINING
4 years

Universitetet
i Stavanger

NORCE

Other national &
international
Universities &
R&D institutes

FAGSKOLEN
ROGALAND
ROGALAND POLYTECHNIC
COLLEGE

ROGALAND
FYLKESKOMMUNE

DALANE
VIDEREGÅENDE SKOLE
-Egersund-

ENERGY
INNOVATION



PARTNER OF

SUSTAINABLE ENERGY | NORWEGIAN
CATAPULT CENTRE

equinor

SIEMENS Gamesa
RENEWABLE ENERGY

Vestas

NORDEX

Norsk Vind

Fred. Olsen Renewables

Statkraft

Aker Offshore Wind

NorSea

IKM

AAK Energy

Windco

AXESS

VERTIKALSERVICE

ENERGY
INNOVATION

INDUSTRY

Commercial Training & certification

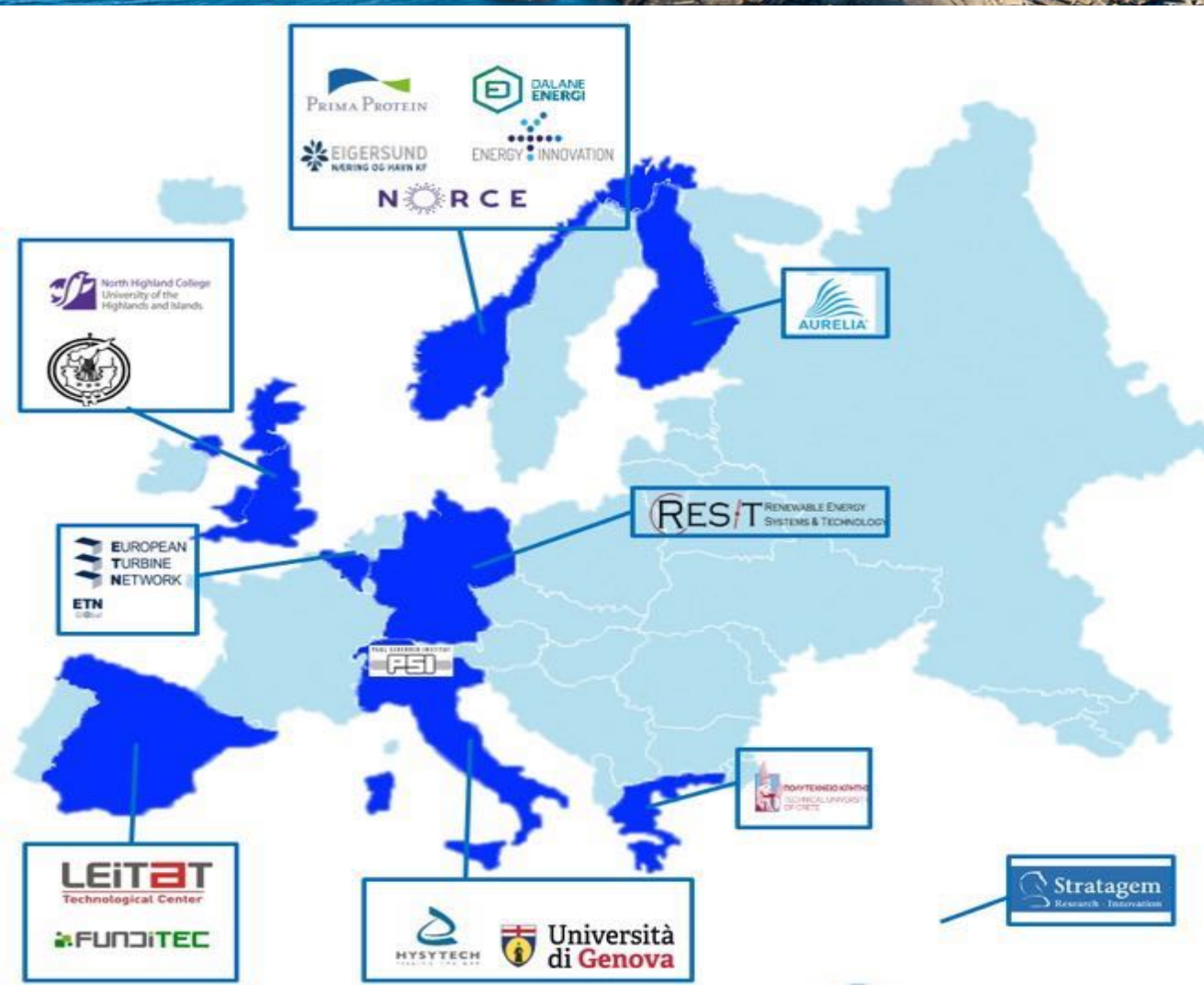
R&D Test
facilities

Incubator

smart integRation Of local energy sources and innovative storage for flexiBle, secure and cost-efficient eNergy Supply ON industrialized islands

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Energy Innovation is initiator of the project



18
Partners

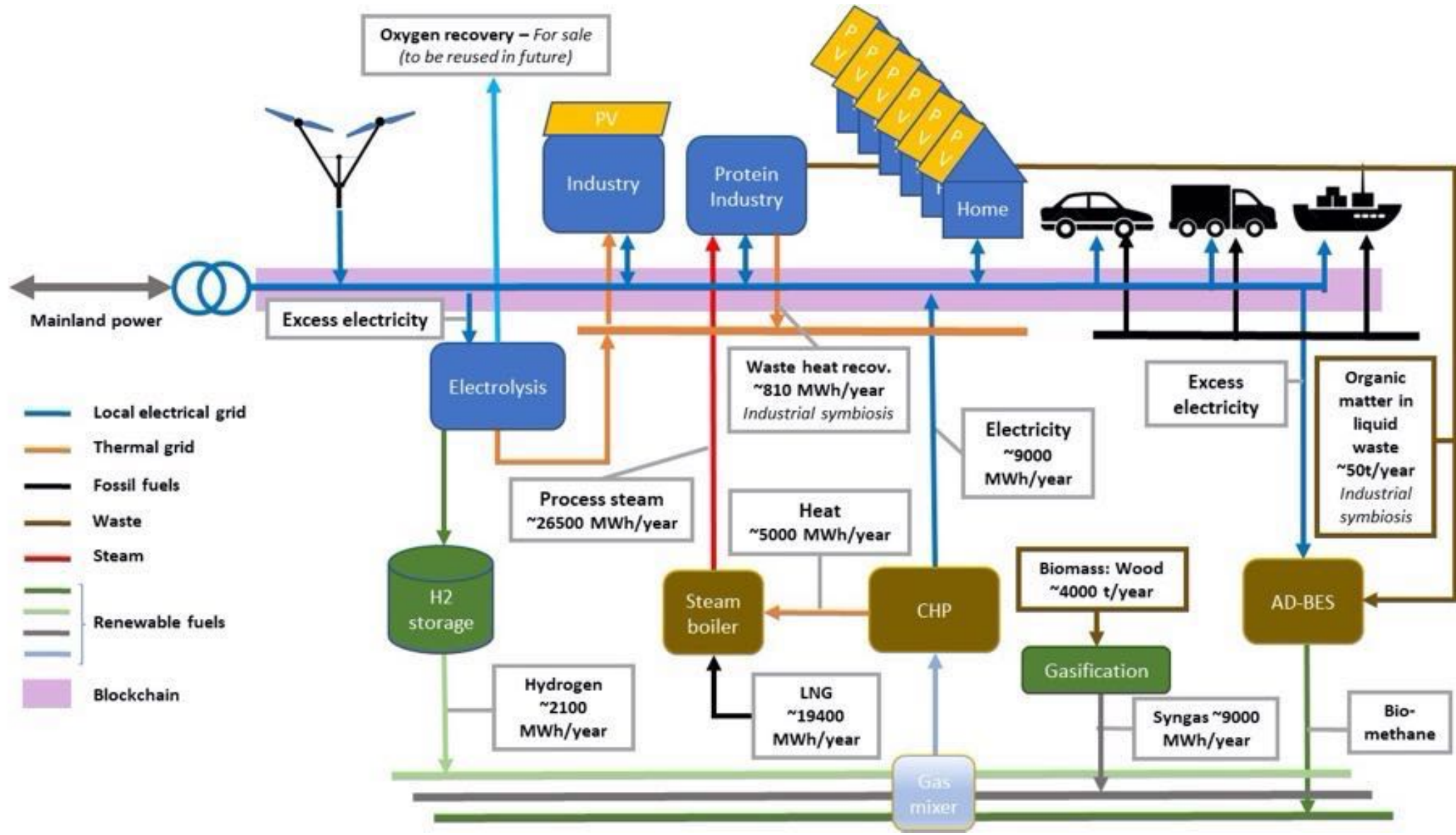
10
European countries

4
Years
Oct 2020 - Sep 2024

1
Demo island
Eigerøy (NO)

2
Follower islands
Crete and Western Isles

€8.37
Budget
(EU contribution: ~€7M)



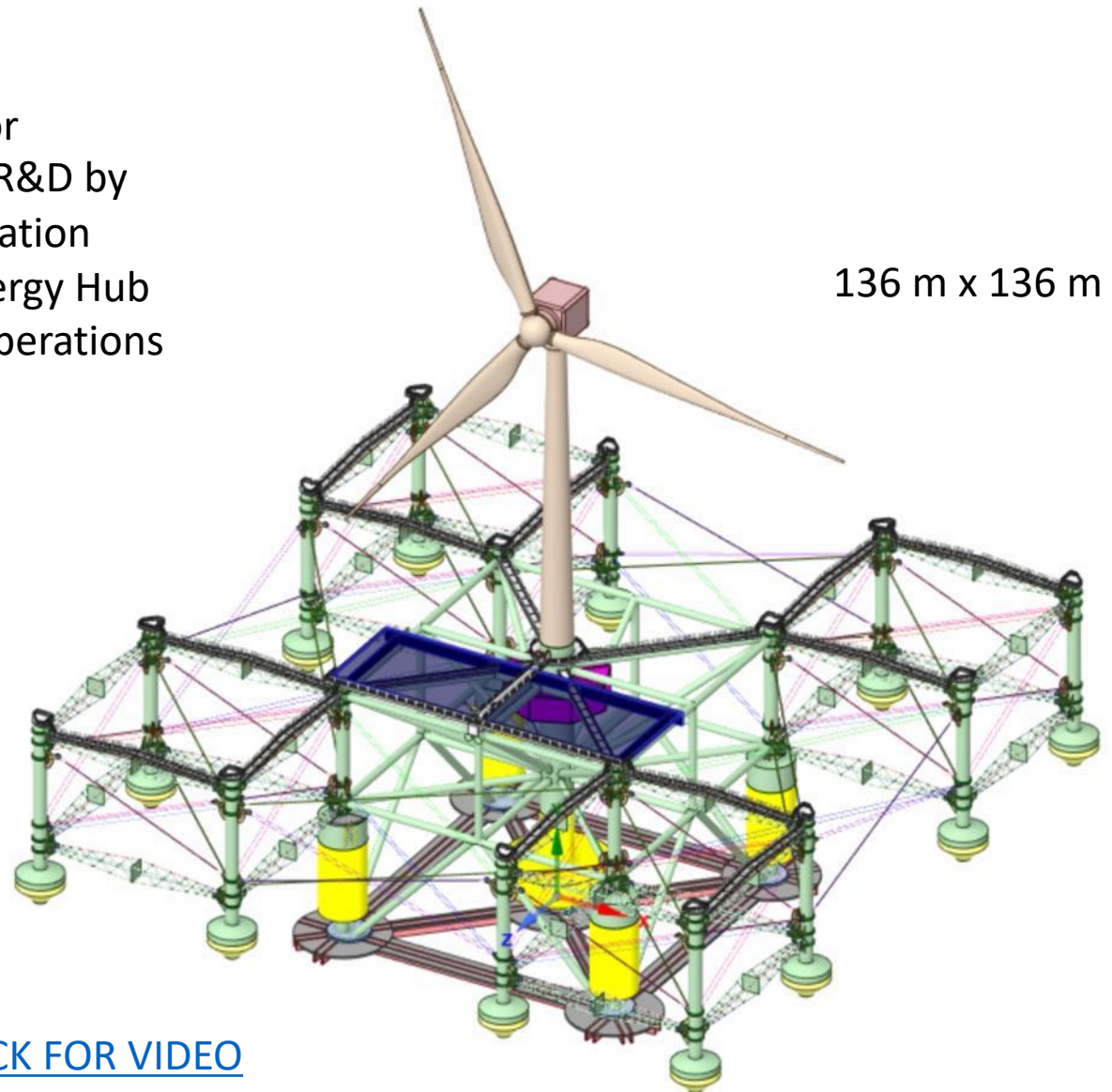
Main goal is: Demonstrate an integrated energy system to cover **energy demand**, **reduce the use of fossil fuel and emissions**. This will be done via smaller size integrated components which are extendable towards 100% coverage

Flex2power S1 11,2 MW – Pilot outside Eigerøy Island

- Combined floating wind (5 – 8 MW), wave (6 MW) and solar (0,2 MW)
- Powerprice PILOT: 55 Euro/MWh
- Full Scale: 35 Euro/MWh

- To be used for training and R&D by Energy Innovation
- Egersund Energy Hub as base for operations

136 m x 136 m



*23rd May 2022
Exception from
"Havenergiloven"
And now ready for
concession.*

- In preparation for a R&D project combining FlyWheel barges to the Flex2power pilot as an offgrid solution



Ifølge liste

Deres ref: 22/656-7
Vår ref: 22/656-7
Dato: 23. mai 2022

Marin Energi Testsenter AS - Unntak fra åpning av areal

Innledning
Olje- og energidepartementet viser til Marin Energi Testsenter AS (Metcentre) henvendelse av 15. mars 2022 hvor de ber om unntak fra åpning av areal for å søke om konsesjon til bygging og drift av Flex2power, en flytende installasjon som kombinerer produksjon av elektrisitet fra bølge-, vind- og solenergi.

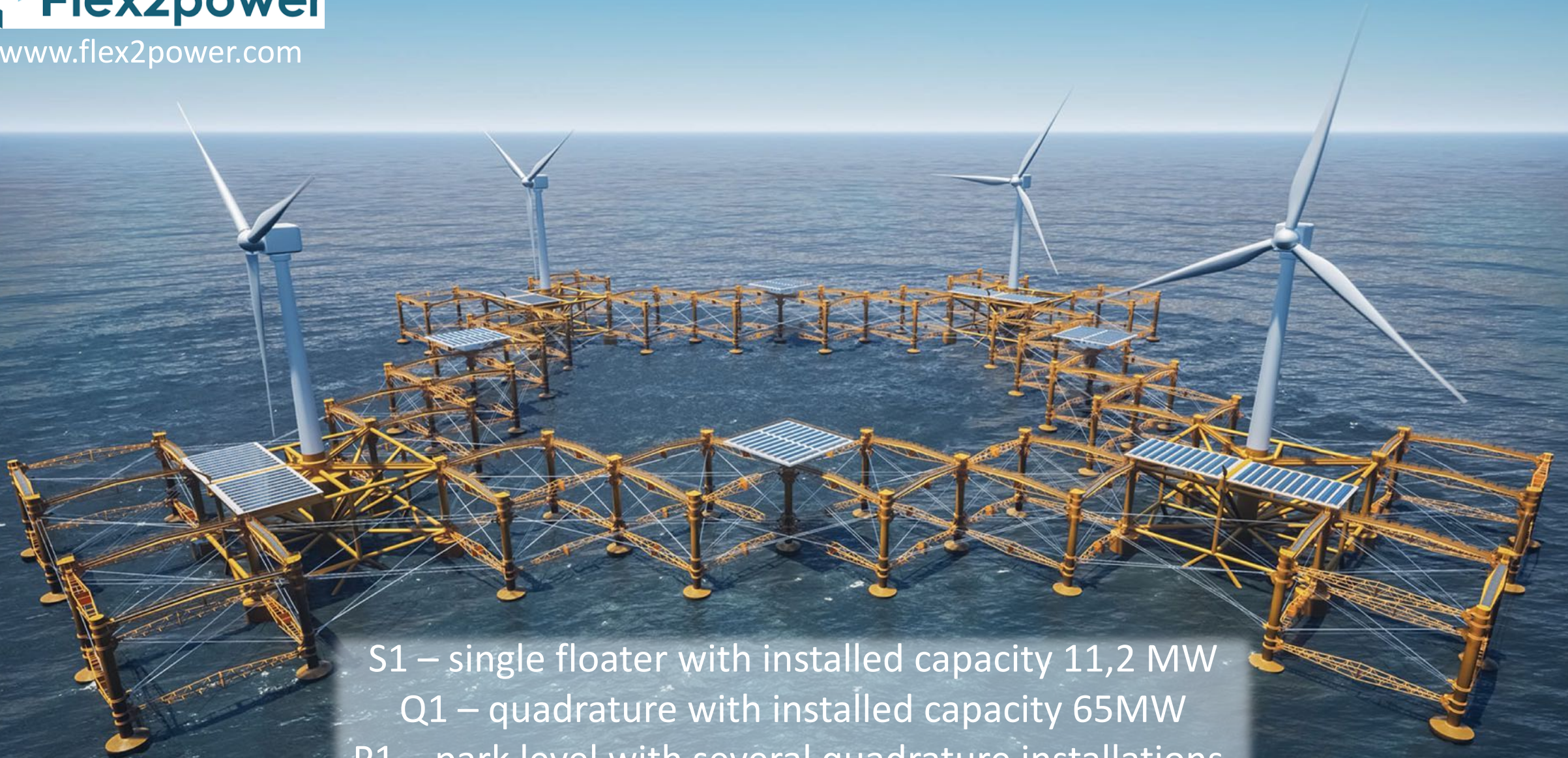
Anlegget er planlagt utenfor grunnlinjen, sørvest av Eigerøy i Eigersund kommune. I denne forbindelse søkes det i første omgang om unntak fra regelen om åpning av areal.

Departementets vurdering
Piloten vil bestå av en vindturbin plassert på en flytekonstruksjon som tar opp bølgeenergi gjennom tilkoblede flytere. På flyterne vil det også bli installert solceller. Planlagt installert effekt er oppgitt til 6 MW bølgeenergi, 4 MW vindenergi og 200 kW solenergi. Piloten planlegges å forsyne Eigerøy med strøm på permanent basis. Det planlegges derfor å søke om konsesjon som gjelder for 25 år.

Havenergilova § 2-2 fastslår at områder til havs må åpnes av Kongen i statsråd før det kan tildeles konsesjon. Dette betyr at reglene om åpning av areal for konsesjonsbehandling, gjelder for denne piloten. I særlige tilfeller kan imidlertid departementet gi unntak fra denne bestemmelsen, jf. § 2-2 fjerde ledd. Departementet viser til merknadene til bestemmelsen i Ot.prp.nr.107 (2008-2009) der det heter at "Slike særskilte tilfelle kan for eksempel være etablering av ulike former for testprosjekt som enkeltstående innretninger med avgrensa levetid, eller der mindre anlegg for fornybar energiproduksjon kan tenkjes knytt opp mot forsyning av petroleumsanlegg."

Postadresse: Postboks 8148 Dep, 0033 Oslo, postmetstak@oed.dep.no
Kontoradresse: Akersgate 59, oed.dep.no
Telefon: 22 24 90 90, Org.nr. 977 181 630
Aurling: Energi- og vannressursavdelingen
Saksbehandler: Gro Caroline Sjelle, 22 24 62 91

[CLICK FOR VIDEO](#)



S1 – single floater with installed capacity 11,2 MW
Q1 – quadrature with installed capacity 65MW
P1 – park level with several quadrature installations.
260MW with four Q1



REGIONALT FORSKINGSFOND
ROGALAND

Condition Based Operation & Maintenance Services on Blades for On- and Offshore Wind Turbines



Project lead



Research partner



Industrial partners



Supporting partners



Norwegian
Offshore Wind

Background



Condition Based Operation & Maintenance Services on Blades for On- and Offshore Wind Turbines *Prosjektnummer: 327444 - RFFROGALAND*

Production loss:

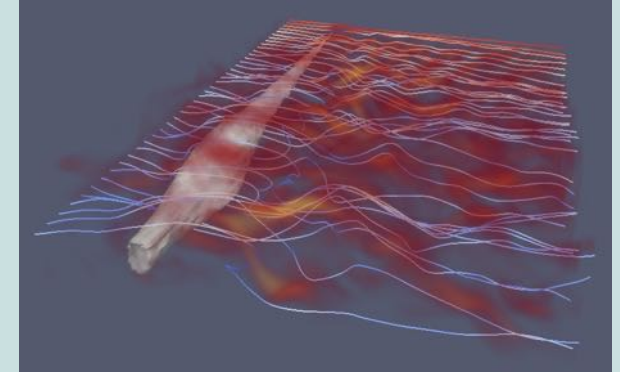
- low-to-moderate leading edge erosion damage -> loss of 1-5% energy production for a turbine (assume 4 %).
- If we assume
 - capacity factor 50% at South North Sea II
 - Price **38 Euro/MWh** (Nordpool energy price average 2010-2019)
- Production per year at SNII: 13,14 TWh => NOK 5 Billion/year
- 4 % loss = 20 MEuro / Year
- If 15 MW turbine: 100.000 Euro loss per turbine/year



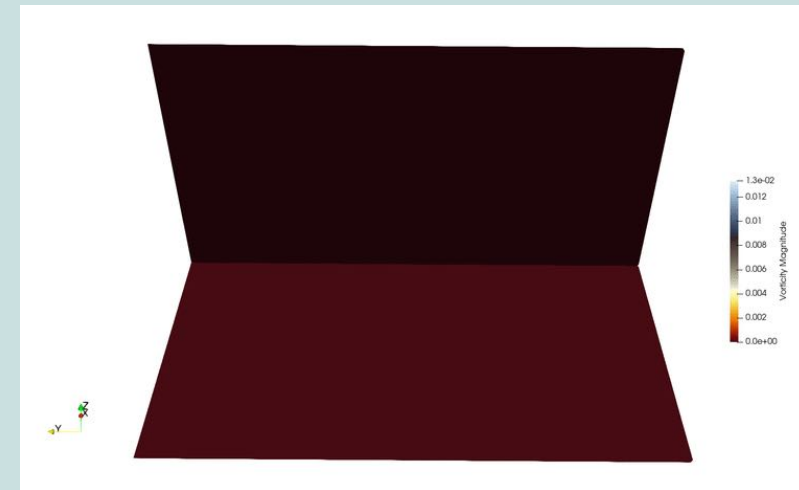
Sørlike Nordsjø II - Capacity: 3 GW
(#200 15 MW bottomfixed)

R&D efforts

- Calculation of changes in *lift and drag* for a *wind turbine profile* taking as input measurements of surface erosion profiles (“digital wind tunnel” through multiphysics modelling)
- Conversion of the change in lift/drag to *losses (or gains) in annual energy* production for a full wind turbine blade
- Estimation of the evolution of *surface erosion* profiles with time
- Enable calculations of cost/benefit of blade repair
- Develop condition-based maintenance strategy



Aursjø and Jettestuen NORCE in-house Navier-Stokes sim



Aursjø and Jettestuen NORCE in-house LES code

EU - CATION



2010 – 2012

VET-WIND I ONSHORE

EU project lead from Egersund with broad international collaboration.

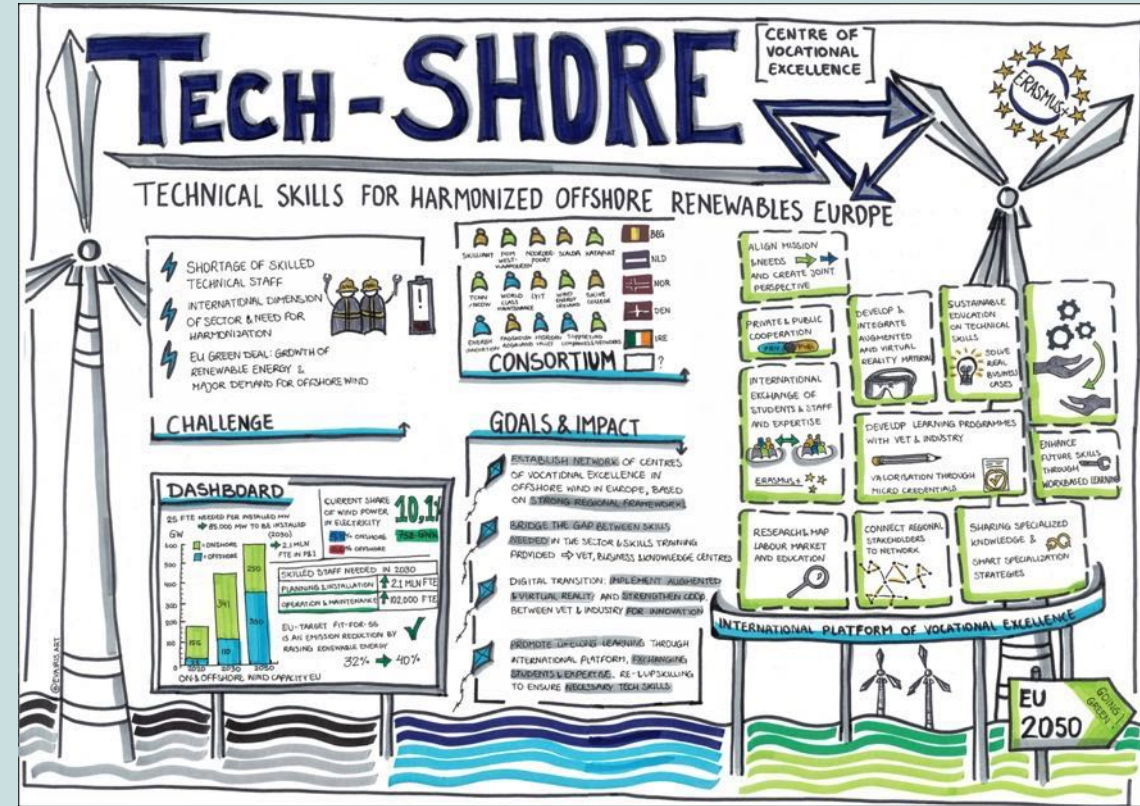
Basis for the education of wind technicians in Egersund/Norway.

2018 – 2019

VET-WIND II OFFSHORE

KA2 Strategic partnerships
Erasmus+

Partners from:
Norway, Netherlands, Belgium,
Ireland, Denmark, Germany



2022 - 2026

€ Mill. 5 Erasmus+ Centre of Vocational Excellence to elevate the collaboration cross borders for the development of a well skilled workforce for the fast growing offshore wind market.

Technical Skills for Harmonized Offshore Renewable Energy

Goals of T-shore

1. Development and creation of a **European network of VET** (Vocational Education and Training) schools and VET training centers in offshore wind energy.
2. The establishment of **strong links between businesses and VET** providers and combining these stakeholders to meet the industry's real skills and training needs.
3. Defining a range of **new competency profiles** and developing **advanced digital and evidence based educational training methods** and materials in a work-based learning environment.



Partners

Atlantic Technological University		Scalda	
Energy Innovation		Skilliant	
Fagskolen Rogaland		Skive College	
Hydrogen Valley		TCNN	
Katapult		Wind Energy Ireland	
Noorderpoort		World Class Maintenance	
POM West-Vlaanderen			

Project Period: 2022 - 2026

VOCATIONAL EDUCATION & TRAINING FOR INSTALLATION, O&M OF OFFSHORE WIND & OSW-POWER-TO-X

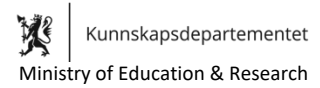
Triple Helix => Innovation through collaboration, development and interaction between business, R&D/ Education and government.



T-shore CoVE* Norway



GOVERNMENTAL STAKEHOLDERS



[National Cooperative Council for VET advisory boards](#)

[National VET advisory board for electrical and ICT](#)



PUBLIC EDUCATION

University
3-9 years
EQF 6 - 7 - 8



Higher Education
Technical College
EQF 5
0,5-2 years



VOCATIONAL EDUCATION & TRAINING
4 years
EQF 3 - 4



Secondary School
Primary School



ENERGY INNOVATION
CoVE lead



WIND FARM DEVELOPERS

SUPPORTING ORGANISATIONS



Supply Chain & R&D support



ENERGY INNOVATION

STAKEHOLDERS / INVITED PARTICIPANTS IN: T-SHORE CoVE* OFFSHORE WIND NORWAY

*CENTER of VOCATIONAL EXCELLENCE

WORKFORCE

Global Wind Workforce Outlook

2022 - 2026



GLOBAL WIND
ORGANISATION



GWEC
GLOBAL WIND ENERGY COUNCIL



Key findings:

- Global onshore and offshore wind capacity is set to grow by 67% from 837GW in 2021 to 1,394GW in 2026, and a skilled workforce is needed to safely and efficiently install and maintain this fleet.
- The number of technicians that will require wind industry training to construct and maintain the global wind fleet will increase 33% from 426,700 in 2021 to 568,800 in 2026. The number of new technicians is expected to increase by 28,400 per year from 2022 to 2026, resulting in a 36% compound annual growth rate (CAGR) for trained wind technicians in the C&I and O&M segments from 2021 to 2026.
- 119,000 technicians (corresponding to 28% of the C&I and O&M workforce) already hold at least one valid certificate from GWO's Basic Safety Training (BST) Standard, as of the end of 2021. This means that wind industry training is needed for an additional workforce of 449,800 technicians from 2022 to 2026.
- 86% of these 449,800 technicians needed by 2026 will be required in nine countries: China, USA, Germany, India, Brazil, Japan, South Africa, Vietnam, and South Korea.
- The number of C&I and O&M technicians is expected to grow more rapidly in offshore wind (92% higher in 2026 compared to 2021) rather than onshore wind (27% higher in 2026 compared to 2021). However, in 2026, 87% of the C&I and O&M technicians will still be working onshore, mostly within the O&M segment.

28.400 NEW technicians EACH year

Need for GWO training of additional workforce of 449.000 technicians from 2022 - 2026

Figure 1 - Forecast Capacity Installations and Number of People Requiring C&I and O&M Training from 2022-2026¹

Country	Onshore		Offshore		Total People
	Installations (MW)	Training Needs (# of technicians)	Installations (MW)	Training Needs (# of technicians)	
China	249,000	241,750	39,000	29,271	271,021
USA	42,000	55,902	11,537	4,765	60,667
Germany	19,700	28,628	4,084	5,374	34,002
India	19,400	20,182	0	722	20,904
Brazil	15,600	14,154	11	246	14,400
South Africa	5,380	6,636	0	0	6,636
Japan	3,500	3,998	985	1,118	5,116
Vietnam	2,550	3,356	2,240	1,288	4,644
South Korea	1,000	1,001	1,200	5,555	6,556
Total Nine Countries	358,130	375,607	59,057	48,339	423,946
Global	466,269	494,408	90,513	74,382	568,790

¹ Source: GWO, GWEC, 2022.

30 GW in NORWAY BY 2040:

CAPEX: € 69 Billion (if 2,3 B€ per GW)*

OPEX: € 1,5 Billion/year (if 50 M€/Yr per GW)*

Employment estimations:

- **Construction & installation: 750.000 FTE** (25 FTE/MW)*
- **Operation & Maintenance: 36.000 FTE/yr** (1,2 FTE/MW)*
 - A large portion of these will need **GWO certification** (and recertification).
 - **~ 1.500 Wind Technicians** working directly in the offshore wind farms.
 - **~ 1.500 Wind Technicians** in supply chain.
 - Considerable vertical and horizontal job migration
=> need for educating **5.000? 8.000? 10.000?**

=> NEED OF LONG TERM RECRUITEMENT AWARENESS

FTE: Full time employees

*Estimation from EnBW based on bottom fixed, without subsidies



Wind Works Jelsa – Need of Workforce

- Large-scale production facility for floating concrete foundations and for assembly of up to **70 FWT per year**.
- Approx. **3.000 direct** and **2.000 indirect** FTE created by the establishment of the foundation factory and assembly site (full production = **1 GW/year**).
- Concrete, formwork and rebar workers.
- Scaffolders, crane operators, maritime and logistics, wind technicians etc.
- Supporting functions; administration, accommodation, cleaning, canteen, transport etc.



GWO COURSES & EDUCATION OFFERED BY EI

- *Probably the most comprehensive GWO training & wind tech education center in the world* -

GWO HSE ON-/OFFSHORE:

- GWO Working at Heights
- GWO First Aid
- GWO Manual Handling
- GWO Fire Awareness
- GWO Sea Survival
- GWO Advanced Rescue
- GWO Enhanced First Aid
- GWO Wind Limited Access



GWO TECHNICAL COURSES:

- GWO Basic Technical Training
- GWO Blade Repair
- GWO Rigger / Signalling - Q4 2023*
- GWO Control of Hazardous Energies – Q4 2023*
- GWO Lift User – Q4 2023*
- GWO Bolt Tightening (when module ready)*

OTHER COURSES:

Service Technician education

- Industry/urban rescue techniques
- Rescue techniques for SAR-crew
- Rescue techniques for industry
- Course Emergency services
- Boat Transfer / Boat landing
- Fall protection courses
- FSE First Aid
- Pole climbing and rescue

→ *SOFT Rope Access Q3 2023*



ONLINE GAMIFICATION COURSES

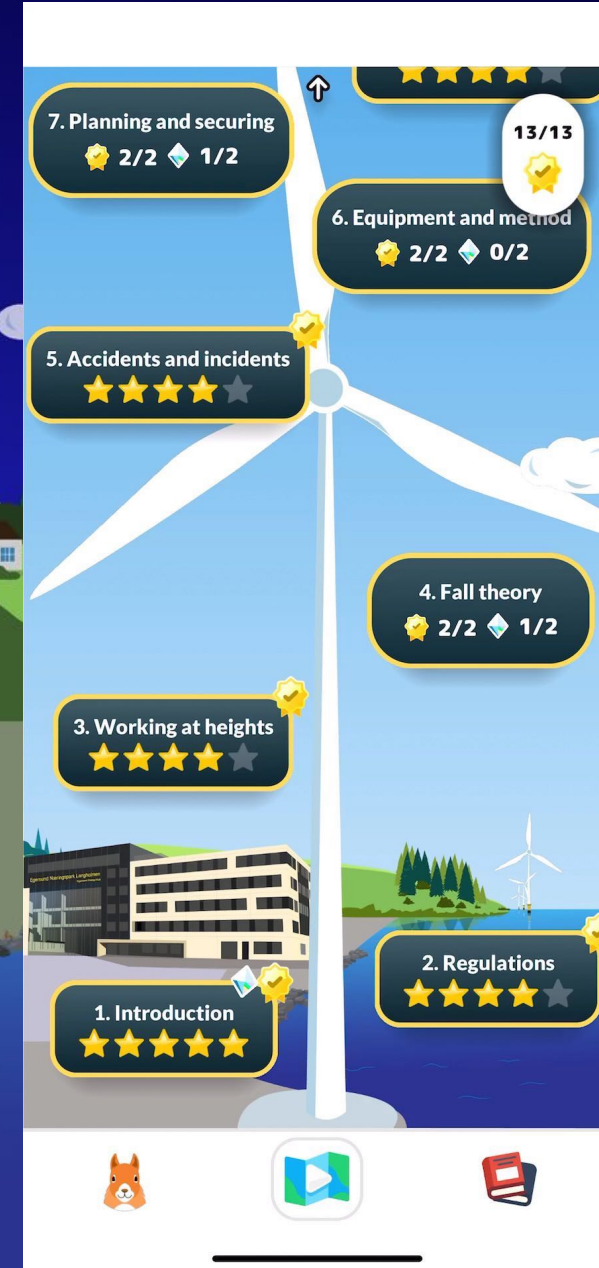
Energy Innovation has developed ONLINE GAMIFICATION COURSES for several languages (more will come).



THEORY PART OF:

- GWO First Aid
- GWO Fire Awareness
- GWO Manual Handling
- GWO Working At Heights

The training takes place on a mobile phone, tablet or PC and is quality assured by the leading experts in this type of training.



TRAINING IN WIND FARMS

GWO training

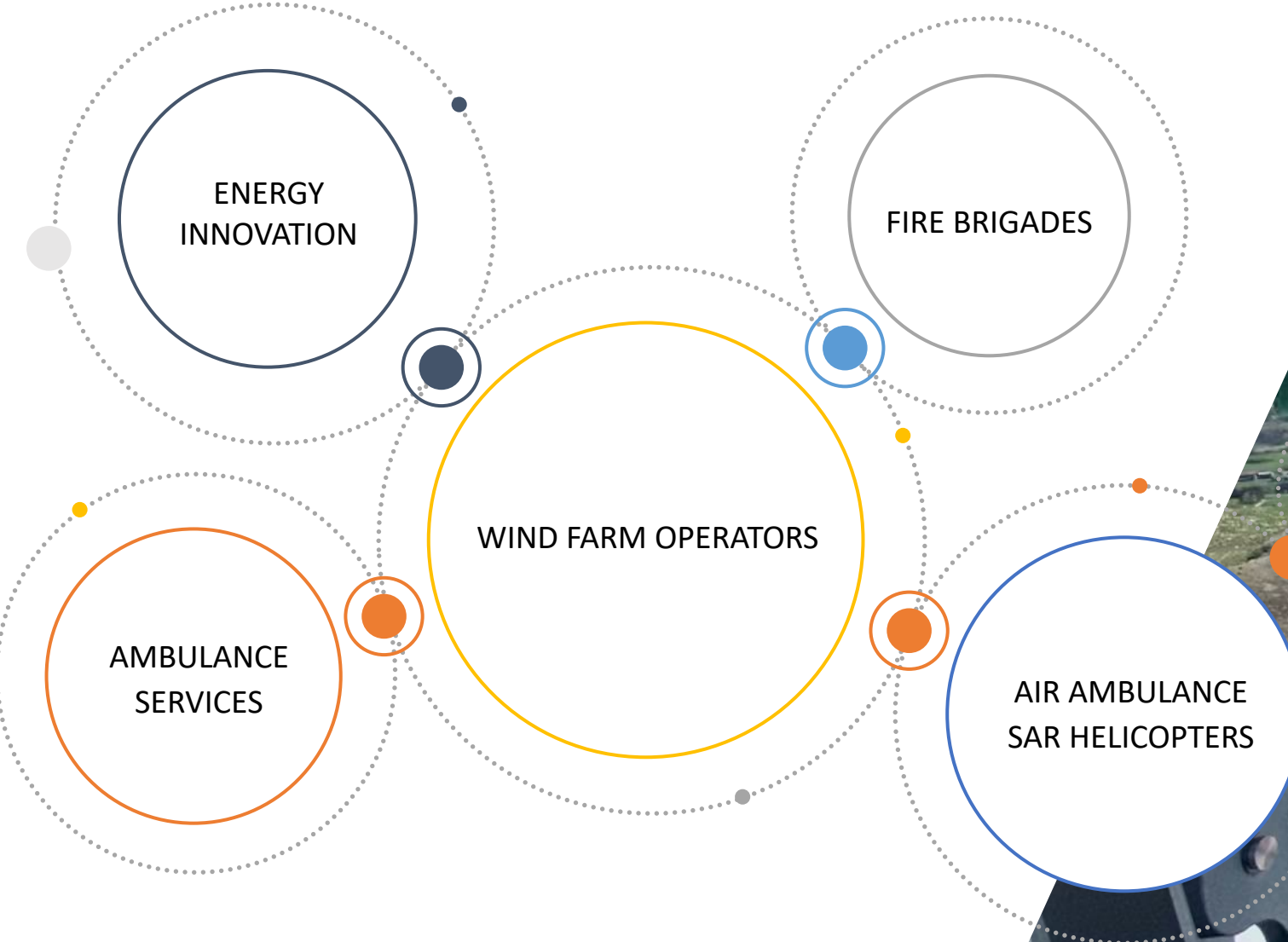
Accident management
training

Crisis management
training

Environment incident
training



COLLABORATORS - TRAINING



NORWEGIAN PUBLIC VOCATIONAL TRAINING

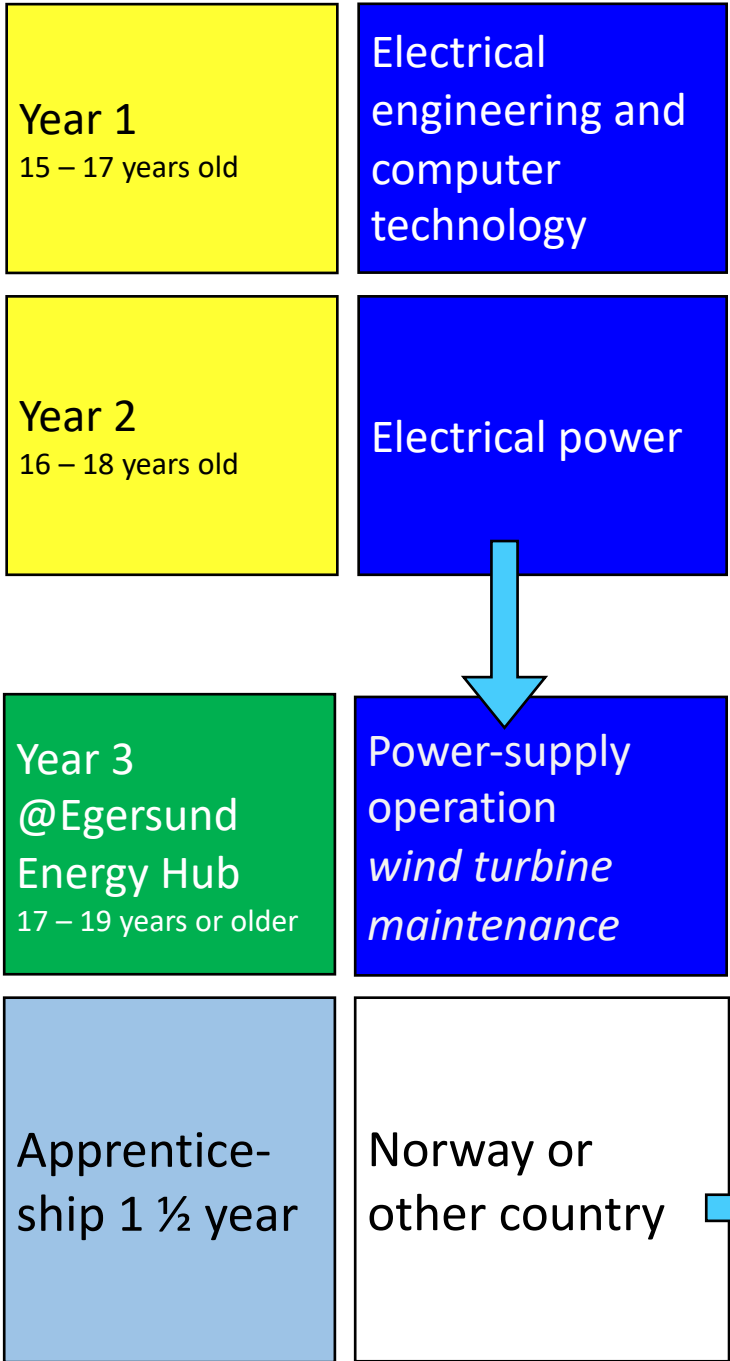
First two years at any vocational school with electronics



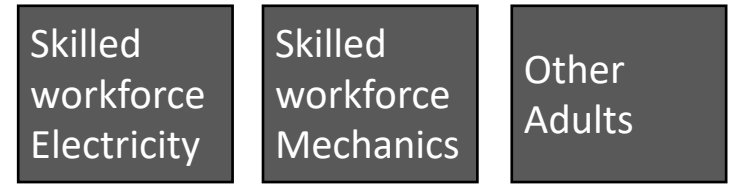
DALANE
VIDEREGÅENDE SKOLE
-Egersund-

Only vocational training program for wind technicians in Norway @Egersund Energy Hub

ENERGY
INNOVATION



UP-SKILLING



ENERGY INNOVATION
GW
CERTIFIED TRAINING PROVIDER / 2021

Service technician courses – incl. GWO
3,5 MONTHS – from March 2022

3 MONTHS
Work training



FAGSKOLEN ROGALAND ENERGY INNOVATION

10 Student points per subject

Polytechnical subject for HSE Offshore Wind

Polytechnical subject for O&M and installation Offshore Wind

Polytechnical subject for batterie technology

Energy Innovation Entry Level Wind Technicians <# days duration – each day 8 hours >

GWO Minimum requirements	GWO Basic Safety Training <5>: <ul style="list-style-type: none"> GWO Working at heights GWO First Aid GWO Manual Handling GWO Fire Awareness GWO Sea Survival incl. Boat Transfer - OSW 	GWO Basic Technical Training <6> <ul style="list-style-type: none"> Mechanical Electrical Hydraulics Installation
Optional	<ul style="list-style-type: none"> GWO Advanced rescue - <3> GWO Enhanced First Aid - OSW <3> GWO Control of hazardous energies <2,7> GWO Lift training <0,5> 	<ul style="list-style-type: none"> GWO Blade repair <10> ANSI Rope Access training <?> EI Blade repair rope access training <5>



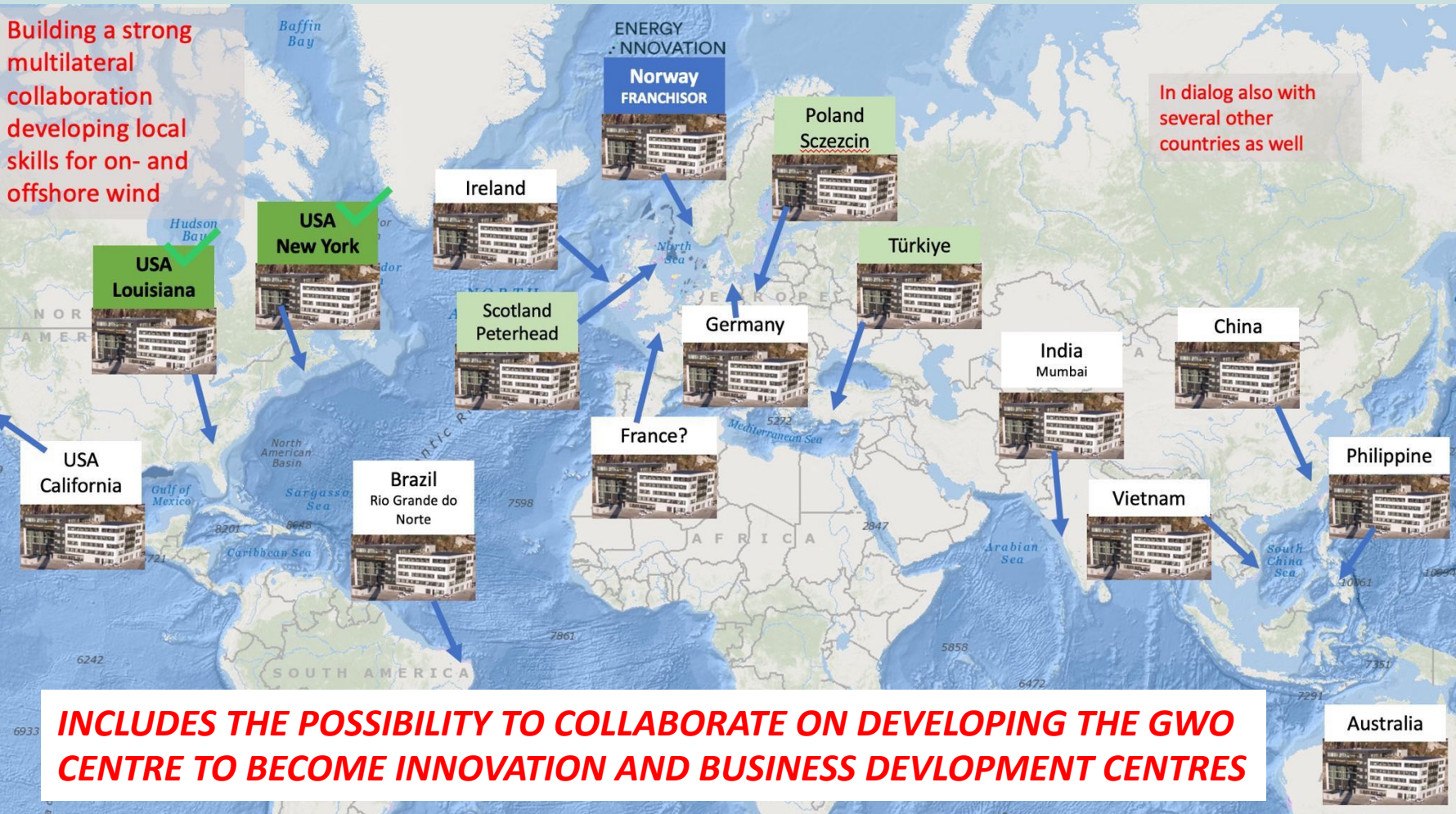
Energy Innovation Technical courses	EI – ELECTRONICS <22,5>	EI – MECANICHS <14,5>	EI – HYDRAULICS <14>
	Principles of electrical engineering	Materials engineering	Hydraulic principles
	Cable finishing	Mechanical systems and components - basics	Assembly and maintenance of hydraulic units
	Generators and electric motors	Inspection of bearings, shafts, gears	Assembly and maintenance of hydraulic pumps and valves
	Transformers	Brake systems maintenance	Assembly and maintenance of hydraulic systems
	Inverter maintenance and trouble- shooting	Lubricants functions and deployment	Assembly and maintenance of electro- hydraulic controls
	Electrical measurement techniques	Power drive sockets (hydraulic, electric, mechanical)	
	Sensor installations in wind turbines	Function and maintenance of yaw systems	
	Wind turbine electronics	Tightening bolts	
	Wind farm networks, data transmission, optical fiber technology	Coating systems and corrosion protection	
Lightning protection maintenance			

ENERGY INNOVATION

GWO Coming	<ul style="list-style-type: none"> GWO Limited Access wind turbine <1> GWO Bolt Tightening Training <1> GWO Train the trainer <9> 	Totals	<ul style="list-style-type: none"> GWO Basic Safety: 5 days GWO Basic Technical Training: 6 days EI – EL+ME+HE: 51 days TOTAL FOR ENTRY LEVEL EXCLUDING OPTIONAL 62 days.
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Through global franchising, Energy Innovation provides a secure way to **develop high quality GWO training and Wind Technician Education Centers around the world through strong Multilateral collaboration.**

Building a strong multilateral collaboration developing local skills for on- and offshore wind



INCLUDES THE POSSIBILITY TO COLLABORATE ON DEVELOPING THE GWO CENTRE TO BECOME INNOVATION AND BUSINESS DEVELOPMENT CENTRES



**FIRST CENTER IN NEW YORK
Operation Febr. 2023**



**SIGNATURE FOR THE SECOND
CENTER WITH NUNEZ COLLEGE
NEW ORLEANS
Operation Q4 2023**

