

NOWITECH

Norwegian Research Centre for Offshore Wind Technology



NTNU – Trondheim
Norwegian University of
Science and Technology

NOWERI

From plan to establishment

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Norwegian Offshore Wind Energy Research Infrastructure (NOWERI)

Floating Experimental Wind Turbine (FLEXWT)



Offshore wind turbine technology
Department of Civil and Transport Engineering
NTNU

What is NOWERI?

- NOWERI is a unique and exciting chance for research on offshore wind energy – one of its kind in the world!
- One of the few projects funded by NFR under the INFRASTRUKTUR initiative





National Financing Initiative for Research Infrastructure (INFRASTRUKTUR)

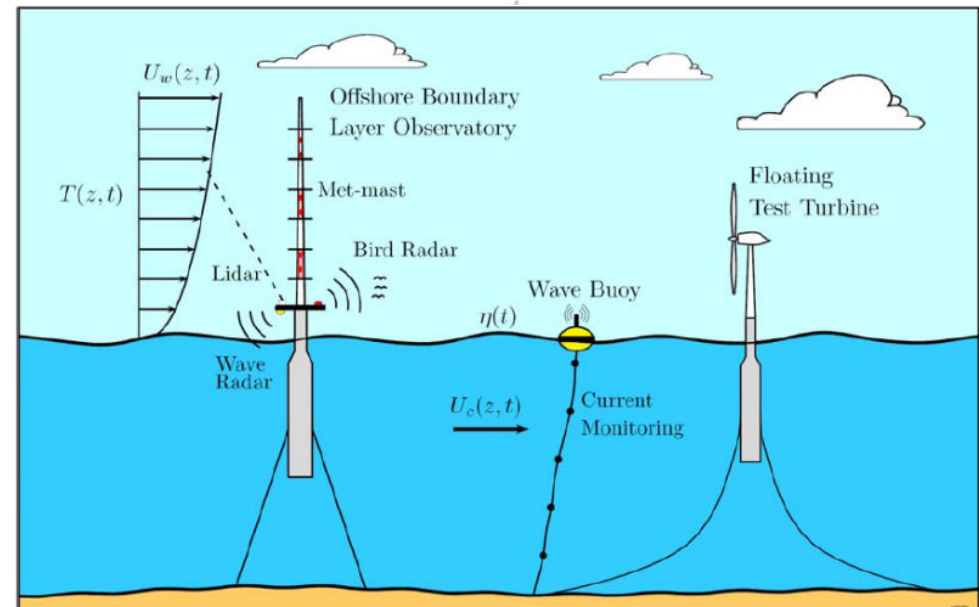
- Criteria for funding
 - must be of widespread national interest
 - must support strategic priorities specified in national strategies
 - must promote effective task-sharing and coordination between Norwegian research groups within the relevant research area
 - must be accessible to users outside the host institutions
 - must support national industrial priorities
 - must contribute to long-term competence building in research areas that are expected to be of major importance to Norway
 - must reflect and reinforce the host institutions' strategic plans and priorities
 - must be of relevance and benefit to Norwegian society
 - there must be plans in place for funding the operation of the infrastructure once the project period is concluded



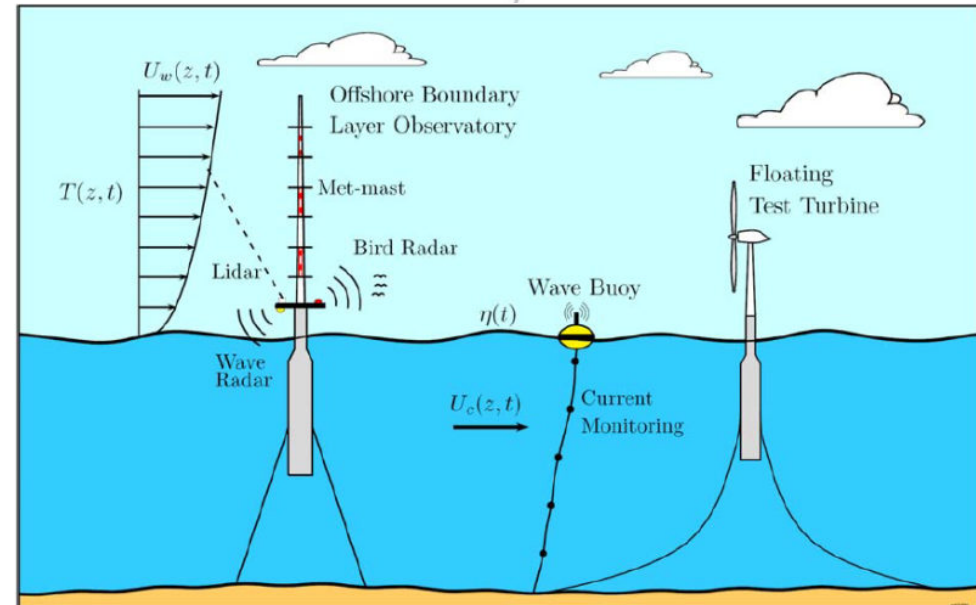
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History

- Original proposal
February 2010
 - Joint effort of the three Norwegian FMEs working in wind energy
NORCOWE / NOWITECH / CEDREN
 - Two facilities:
 - **Offshore Boundary Layer Observatory (OBLO)**
 - **Floating Experimental Wind Turbine (FLEXWT)**
 - Original budget:
 - 77.2 MNOK (10 Mill. EUR) from RCN
 - 4.8 MNOK industry contribution
 - 82 MNOK total



Goal



- Unique facilities
 - Become leading international laboratory for offshore wind energy research
 - Provide measurement data for validation of simulation models
 - Testing of new equipment, algorithms, protocols under realistic conditions
 - Platform for experiments and studies (scientific, basic and applied)

- Provide access for both
 - public research institutes (prioritized)
 - private companies



Negotiation phase

- Issue:
 - RCN only accepted **equipment expenses (establishment)**, no personnel costs, no operating expenses
 - Final budget: 63 MNOK
- Pre-project: 2010-2012
 - Based on establishment of NOWERI AS (limited company)
 - T1 report: Identification of possible suppliers and cost estimates
 - T2 report: Instrumentation
 - T3 report: Potential sites and cost estimates of O&M
 - T4 report: Business plan
 - Cost: 3 MNOK (0.4 Mill. EUR)



Challenges

- Ownership / Risk management
 - Long-term risk: need to be in place **until 2020**
 - Decommissioning
 - Limited company **not accepted** by RCN
- Distribution of funds
 - 50 percent split not acceptable for FLEXWT
- VAT: change of legislation in late 2011
 - not considered in cost estimates



Final agreement

- End of 2012
- Two separate subprojects
 - 42 MNOK (5.6 Mill. EUR) FLEXWT
 - 21 MNOK (2.8 Mill. EUR) OBLO
- Universities (UiB and NTNU)
 - take responsibility
 - manage risk
- Joint management structure



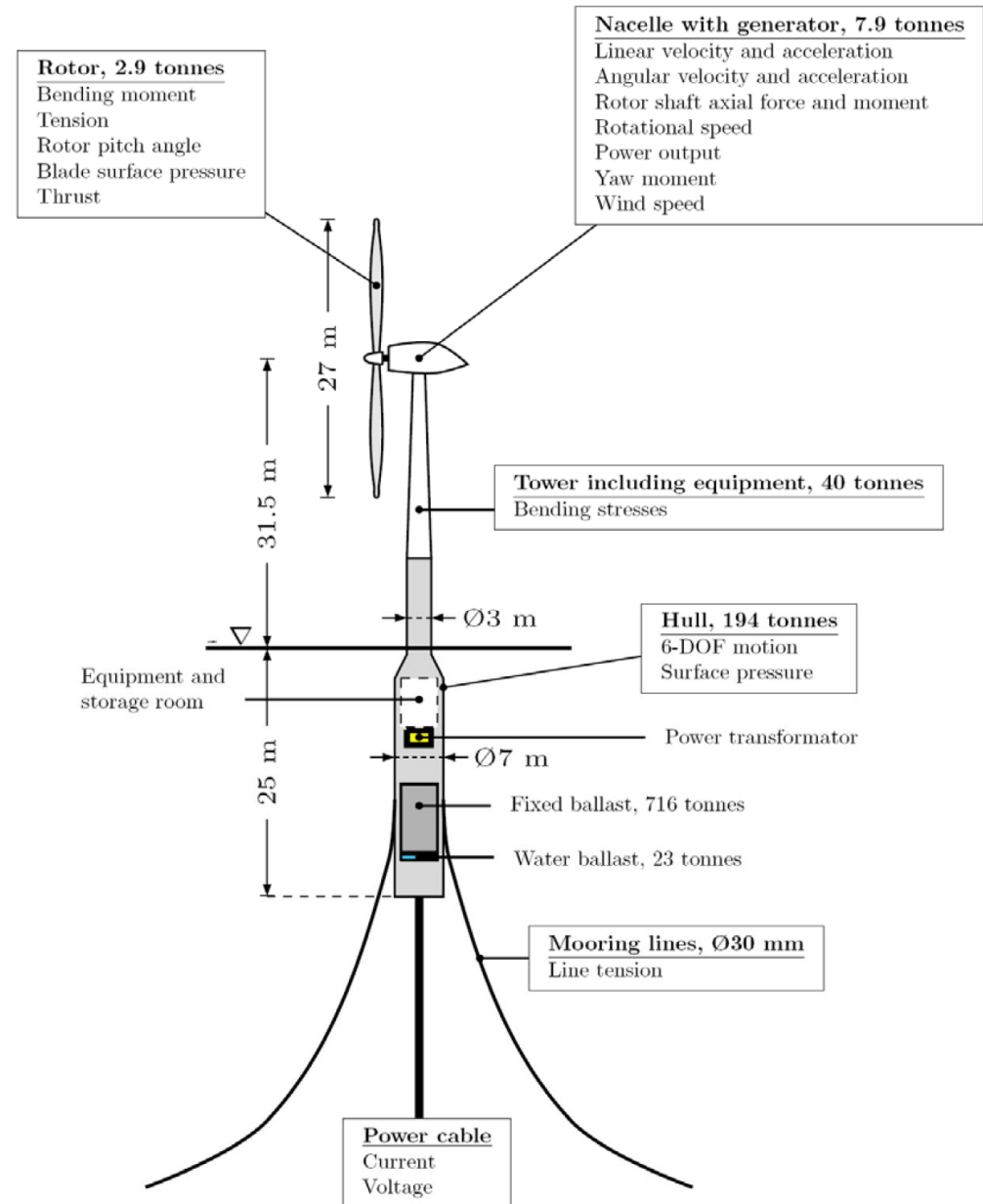
OBLO

- Biggest change:
 - No floating met-mast anymore, but instead a set of state-of-the-art moveable instruments
- Set of high-fidelity instruments for offshore measurements
 - 2 SODAR
 - 2 Temperature profilers
 - 2 Scanning LiDAR
 - 1 Windcube V1 LiDAR (EFOWI)
 - 1 Zephyr LiDAR (EFOWI) for horizontal nacelle mounting
 - 1 Wavescan buoy (EFOWI)
 - 2 Scintillometers



FLEXWT

- Wind turbine:
medium-scale (100-300 kW)
- Floating structure:
open design (tendering)
- Instrumentation:
motions, forces, environment
- Site:
close to Trondheim



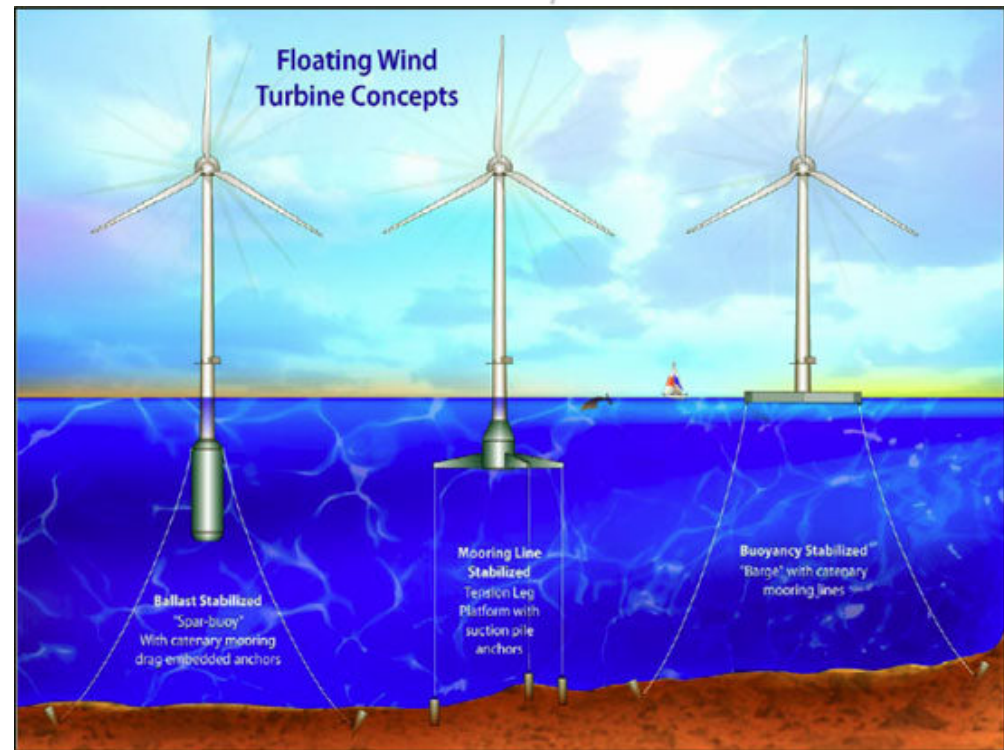
FLEXWT – Turbine

- Second-hand wind turbine
 - Ex.: Vestas V27 (225 kW)
- Additional rebuilding
 - Needs to be sealed and strengthened
 - Individual pitch control
 - Power frequency convertor
 - New controller (interface)



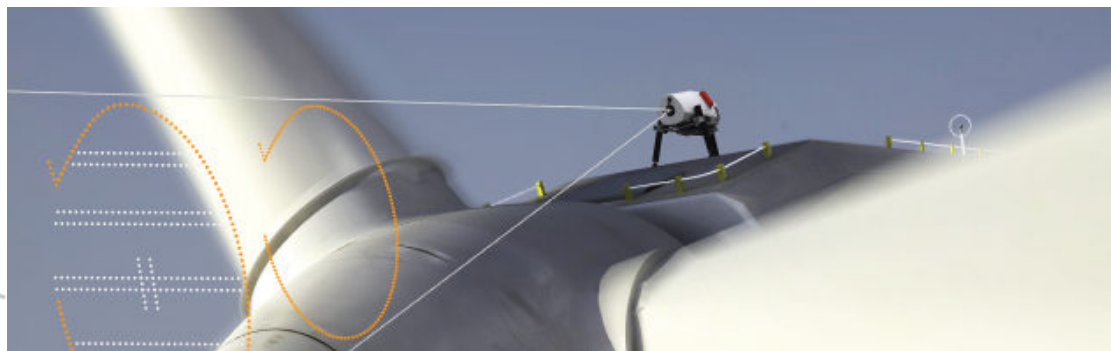
FLEXWT – Floater

- Concept: OPEN
- Water depth:
 - Still to be specified
 - 35-80 m
- Environmental conditions:
 - Benign (offshore, but not extreme)
 - Relevant range of wind speeds and wave heights
 - Should allow access during long periods

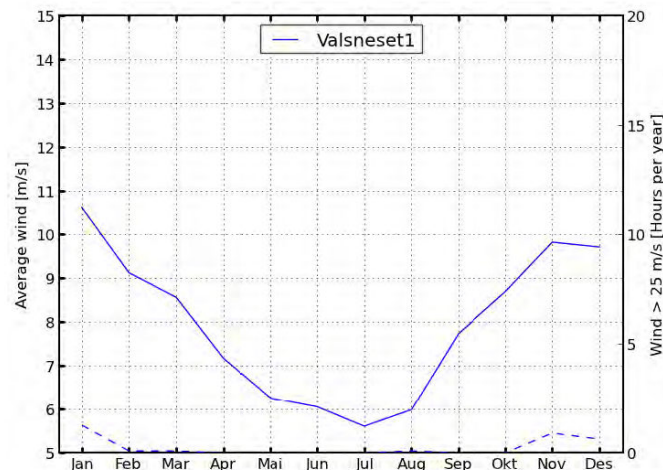


FLEXWT – Instrumentation

- Monitoring system
 - Global motions, forces and structural response
- Wind measurements
 - LiDAR mounted on nacelle (from EFOWI)
- Wave and current measurements
 - Wavescan buoy (from EFOWI)



FLEXWT – Site conditions



- Outcome of pre-project
- What is still missing...
 - Detailed seabed evaluation
 - Information on wave climate
 - Additional candidate sites
 - Trondheimsfjord
 - Åfjord kommune

		Frøya	Valsneset
1	Research relevance		
1.a	Meteo. cond. turbine	3	3
1.b	Ocean. cond. turbine	3	2
1.c	Research: MBL	2	0
1.d	Research: Oceanography	1	0
	Research: Waves	3 ¹	0
1.e	Synergistic research effects	4	4
2	Project economy		
2.a	Anchoring	Missing information about s	
2.b	Cable NOWERI - shore	Missing information about s	
	Grid ashore	3	3
2.c	Travelling to base	2	3
	Distance base – site	4	5
	Bølgeforhold/adkomst	2	5
2.d	Service/innovative infrastr.	3	3
2.e	Telecommunication	2	3
3	Licence and opinion		
3.a	Licence	1	2
3.b	Public opinion	3	3

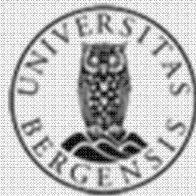


Ownership

- Requirement of RCN:
Infrastructure hosted by universities
- FLEXWT: NTNU
- OBLO: UiB



Partners



cmr



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SINTEF



Institute for Energy Technology



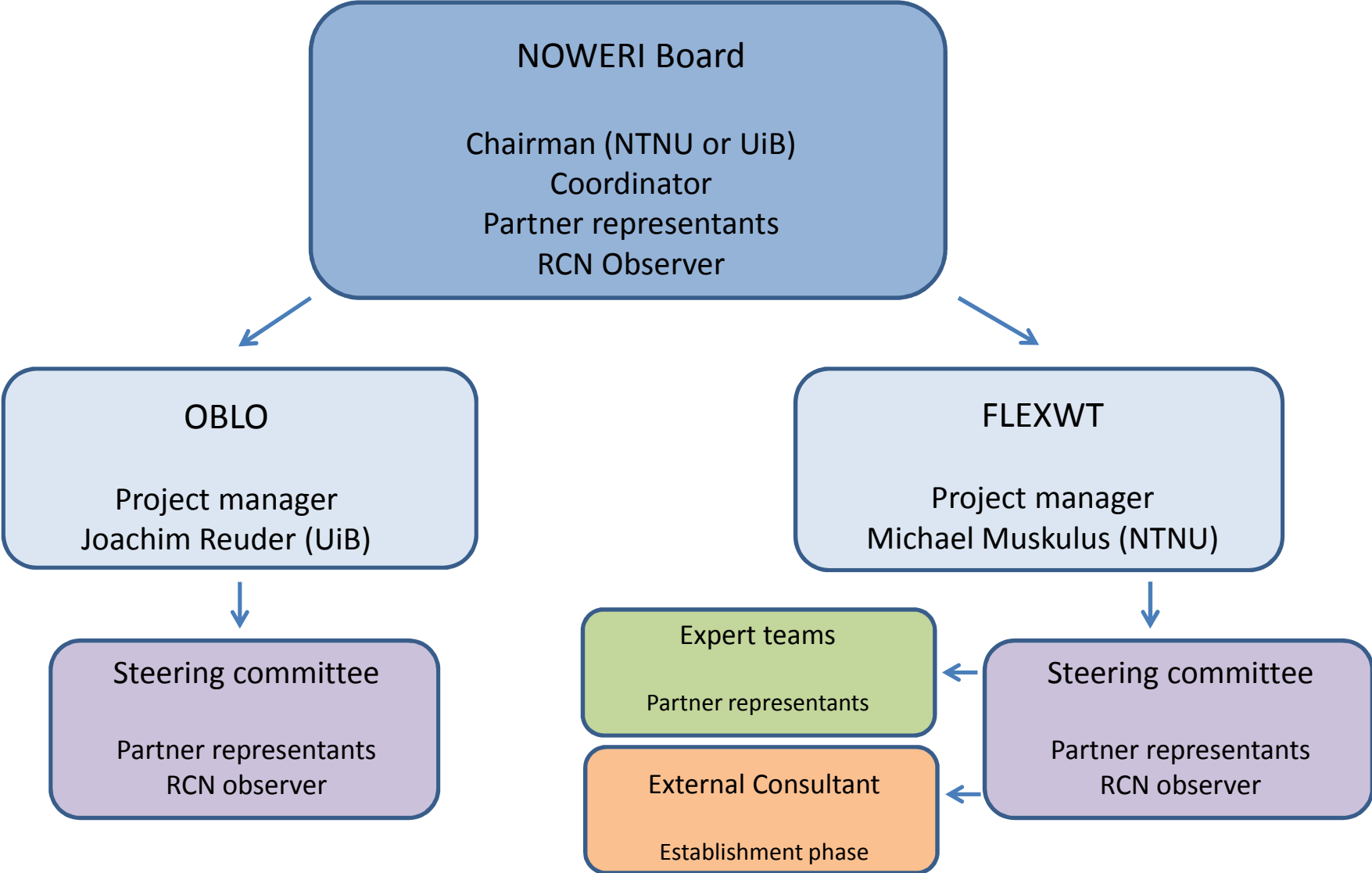
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Organisation



The NOWERI Board

- Each partner institute has one seat in the board
- NTNU and UiB have two seats each
- The Board decides on:
 - Rules and principles for use and pricing
 - Actual users and access
 - Common dissemination and PR activities (e.g., webpage, flyers)



Financing

- RCN provided funds for **procuring** the facility
- No funds for performing research
- No funds for operation & maintenance of the facility
- Non-commercial project

- NOWERI will provide public access to the facility and its data...
... but users will need to pay (in addition to their own costs)

- Typical setup for research infrastructure
(e.g., Large Wave Flume in Hannover)



Budget

- Total funding by RCN: **42 MNOK**
- Tentative budget for the first three years:
 - **Management 4 MNOK**
 - **Equipment 35 MNOK** (original proposal: 30 MNOK)
 - **Operation 3 MNOK** (first year)
- Other aspects:
 - Training / Teaching laboratory for NTNU:
 - Used for PhD and MSc work (full costing + teaching fund)
 - Public awareness of wind energy:
 - Site visits (excursions)



FLEXWT – Practicalities

- NTNU will **subcontract**:
 - Webpage & PR materials
 - Project management for establishment phase
 - EPCI: wind turbine + floating structure + instrumentation
 - Operation & maintenance
- NTNU's **rules and regulations** need to be followed:
 - European Public Procurement
 -  **Ted**.tenders electronic daily
 - 45 days response time



FLEXWT – Status

- Consortium agreement FLEXWT
 - draft almost finished
- Additional site evaluation & permitting process
 - under way
- Need for external project management
 - responsibilities: preparation of tender, follow-up, until established
 - tendering under way



FLEXWT – Schedule

Prosjektaktivitet:

I kvartal:

Preparation of procurement

Site selection

Building permits

Procurement EPCI

Commissioning test & running in

Operation

NOWERI coordination

2013	2014	2015	2016	2017	2018	2019	2020
1234	1234	1234	1234	1234	1234	1234	1234
XXX							
XXX							
	XX						
		XXXX					
			XXX				
			X	XXXX	XXXX	XXXX	XXXX
XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

- Invitation to tender consultant: summer 2013
- Invitation to tender establishment: late 2013
- Installation of FLEXWT: 2015
- First year of operation: 2016



FLEXWT – Involvement of industry & Constraints

- Roles of industry in the establishment phase
 - Project management: tender process, contracts, follow-up
 - Turbine rebuilding
 - Floater design, construction, installation
 - Instrumentation
 - Cables & grid connection
 - ?
- Major constraints
 - Budget
 - Relevant design data needs to be available to users (public)





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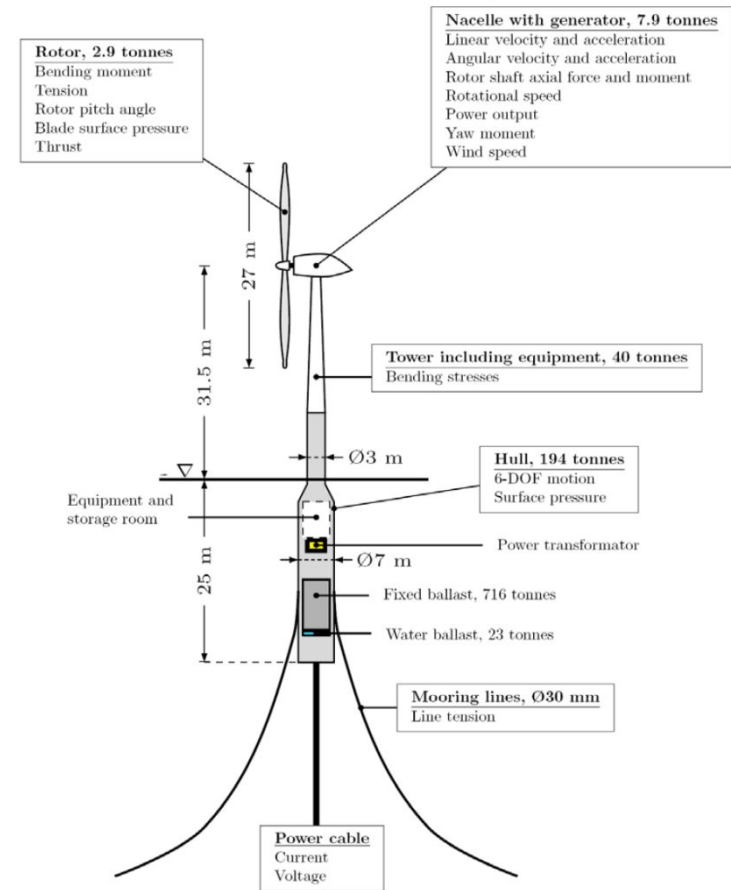
Floating Experimental Wind Turbine (FLEXWT)



Offshore wind turbine technology
Department of Civil and Transport Engineering
NTNU

Recap FLEXWT

- A floating experimental wind turbine facility
 - Wind turbine (scale 1:30)
 - Floating support structure + Mooring system
 - Additional instrumentation
 - Modifications: e.g., possibility for control system studies
- Project economy
 - Establishment of FLEXWT: 42 MNOK
 - Operation: estd. 3-5 MNOK / year
- Project results
 - Design data
 - Operational data
 - Experimental data
- Issues:
 - risk, quality control and access to data



FLEXWT – Ownership and IPR

- NTNU will be the owner and formal operator of FLEXWT
- Data will be recorded, annotated and archived for long-term use by NTNU
- Publicly funded research projects:
 - All measurement data will be made publicly available (possibly with delay)
 - Publications need to acknowledge NOWERI
- Privately funded research projects (renting of the facility):
 - Results, data and experiments can be confidential
 - Possibility for companies to test and develop their own additional equipment, ideas, protocols, algorithms, etc... without IPR issues
 - However: Publicly funded projects will have priority in resource allocation



FLEXWT – Operation

- Site-manager
- Control center
- Need for transport & access
- Not much detail specified yet



User-needs versus project-needs

- Main challenge:
 - Project needs to be attractive to attain enough users to finance the considerable operational costs
- Academic users (universities / research institutes)
 - Strong interest in design data + operational data (e.g., for the validation of simulation models)
 - Not keen to spend a lot for access (e.g., typical use during a PhD or MSc project)
 - Experimental data: potential competition (bottom-fixed offshore wind industry)
 - Need for open publication of project details
- Industry users
 - Some interest in design data + operational data
 - Interest for testing new equipment and protocols
 - Need for IPR protection and confidentiality



Summary of user needs

- Users need:
 - Access to design + operational data
 - Access to their own experimental data
 - Access to the structure (transport, good weather) for placing equipment and testing
 - Monitoring & control center
 - Transport & accommodation
- Special issues:
 - Quality control and annotation of data
 - Long-term storage
 - Support in the design of experiments (protocols, documentation, risk analysis)
 - Support in funding applications (EU, NFR, National)
 - All publicly-funded project data will be made publicly available at some point
 - Time of access matters (weather conditions)



Potential conflicts with users

- **Potential conflict #1: Cheap users**
 - Users only interested in getting access to design data + operational data
 - Applying for minimal projects / or not at all
 - May also include users from developing countries
- **Potential conflict #2: Super-users**
 - Large consortium applying for access to data and sharing it with all partners
 - Ex.: European projects, EERA
- **Potential conflict #3: Dangerous users**
 - Projects very interesting, but too risky
- **Potential conflict #4: Too many applications**
 - Resources for project support and selection limited
- **Potential conflict #5: Seasonal crowding**
 - Most users only interested in summertime (academic calendar, access)
- **Potential conflict #6: Large users**
 - Only interested in long-term exclusive use (e.g., rent of 1-2 years)



Solutions?

- Involvement of end-users in design + establishment phase
 - Meetings and presentations for relevant industry (e.g. Windcluster Mid-Norway)
 - Presentation and discussion at international conferences (e.g., ISOPE, EWEA Offshore 2013)
- Use of experience from similar projects
 - Visits and meetings with NREL (Boulder, Colorado), DTU Wind Energy, etc.
- Access to the facility
 - Involvement already in the design of experiments
 - According to scientific relevance: Structured proposals (two stages) + Expert ranking
 - Risk needs to be managed
- Incentives for mitigating potential conflicts
 - One-time fee for getting access to design + operational data?
 - Multiple users need to pay accordingly
 - Different prices for different seasons
 - Delayed public access to project data?
 - Additional support for project users



Prioritization

- Goal: Maximization of use and scientific relevance
 - Access on a per-project basis
 - Scenario: fixed minimum available allocations for different user groups
 - Project partners
 - Publicly funded research projects
 - Industry partners in NOWITECH/NORCOWE
 - Norwegian industry
 - World-wide industry
 - Internal projects
 - Involving project partners (NTNU, SINTEF Energy, IFE)
 - If no external projects running
 - Public access to selected data?
 - To raise interest



Using NOWERI

- Private funding
 - Rent of the facility
 - Access to data
 - Access to technical expertise
- Public funding
 - RCN projects (ENERGIX IPN/KPN)
 - European projects (multi-national, multi-partner)
- Talk to us...
 - Support for grant applications
 - pricing
 - risk assessment,
 - planning & writing
 - Technical expertise
 - Joint projects



Suggested research topics

- Validation of computer models and simulation tools
 - Adjusting ballast / hydrodynamic stability
 - Operational modal analysis
- Mooring system & dynamic cable
 - Adjusting mooring system parameters - changing tensions, load cells
 - Novel mooring systems...
- Modified blades
- Testing new monitoring and SHM solutions
- Marine growth studies?
- Environmental impact studies (Noise)?
- Damping
 - Structural, aerodynamic; heave plates? mooring lines?
 - Studies with idling, stops & decay tests
- Wake studies
 - Additional instrumentation from OBLO
 - Changing turbine parameters (e.g., pitch)
- Control system studies
 - Plug & play interface
 - Supervisory control (cf. NREL CART turbines)
- Access systems
 - but: impact loads / risk



Further research topics

- Materials
 - properties, durability
- Power system
- Communication systems & data transfer
 - e.g. wireless systems



Question & Aim for the discussion

- What design choices and features will make the project relevant for you?
- Possibilities for a joint project application (public funding)?

