UNIVERSITY OF THE AEGEAN
Department of Shipping Trade and Transport

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Renewable energies at sea.

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GREECE

Energy at sea: Old Problems, New Challenges
Thursday, 22 October - Friday, 23 October 2015
National and Kapodistrian University of Athens

Outlines

- Sea energy potential
- Tidal energy devices
- Wave energy devices
- Energy islands
- Offshore wind turbines
- Floating windturbines
- Floating autonomous ecological desalination unit
- Conclusions

Offshore potential

- Wind power, tides, wave energy, biofuels
- Mature technologies - Research applications

RENEWABLE ENERGIES AT SEA

Energy from tides

Πηγή: http://www.iset.uni-kassel.de/abt/w3-w/folien/magdeb030901/

Water's dynamic energy

↓

Kinematical energy

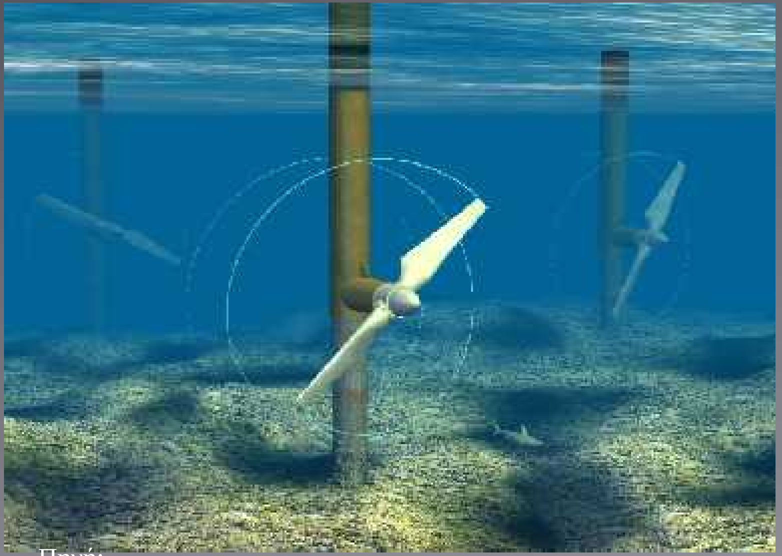
Disadvantages

•Few application's areas

•High construction cost

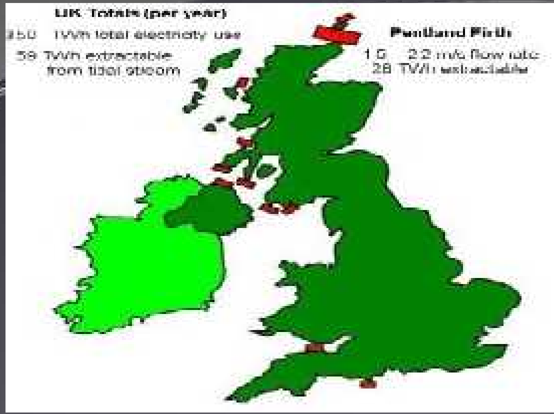
Energy from tides

Installation of submerged constructions

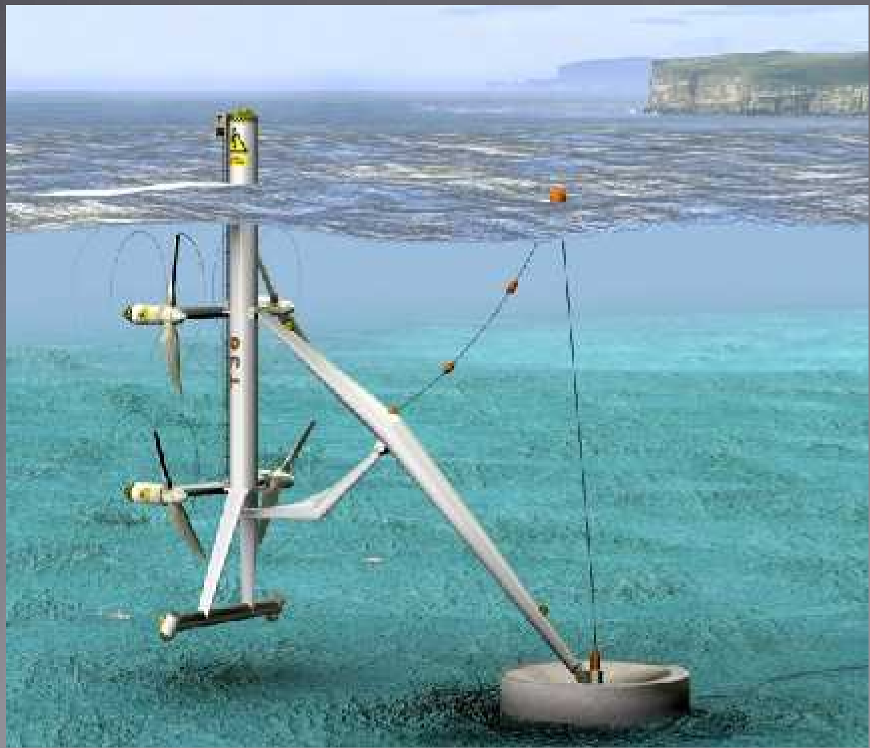


Πηγή:
http://www.johnarmstrong1.pwp.blueyonder.co.uk/Home.htm

Πηγή:
Bryden G. Ian and Couch J. Scott(2006),
ME1- marine energy extraction: tidal resource analysis,
Renewable Energy

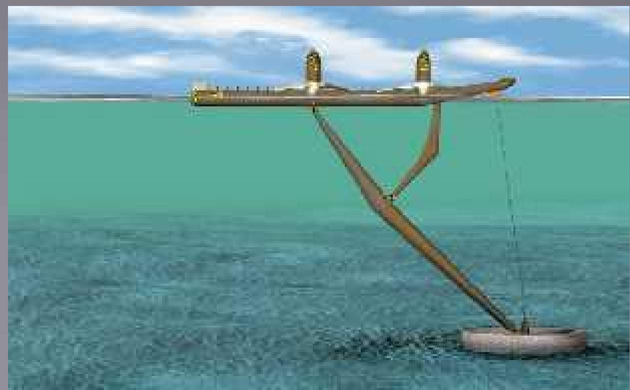


The case of Pentland Firth



Πηγή:http://www.johnarmstrong1.pwp.blueyonder.co.uk/Home.htm

- 4 propellers diameter 20m
- Power 4 MW
- maintainability



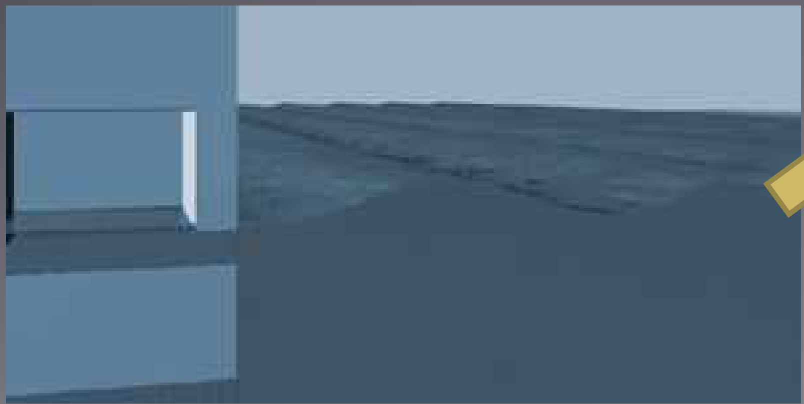
Wave Energy

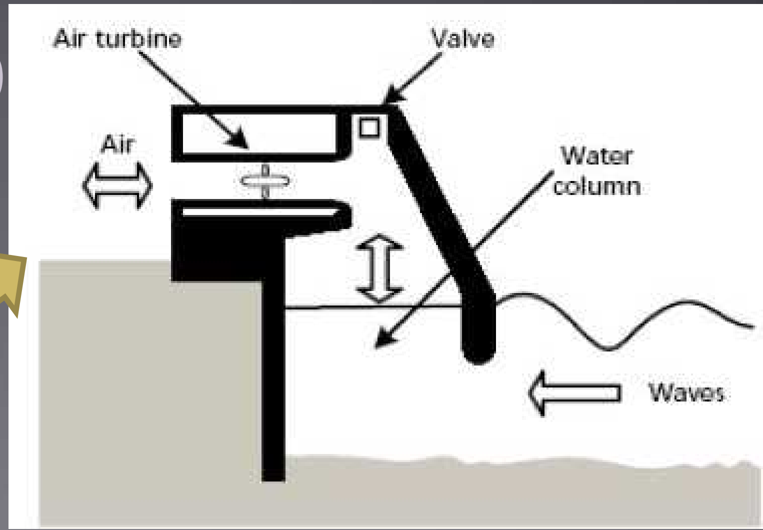
Solar → Wind → Wave

- Minimum Losses
- Precise prediction
- 1% ➡ 4x world energy demand!!
- Many advantages

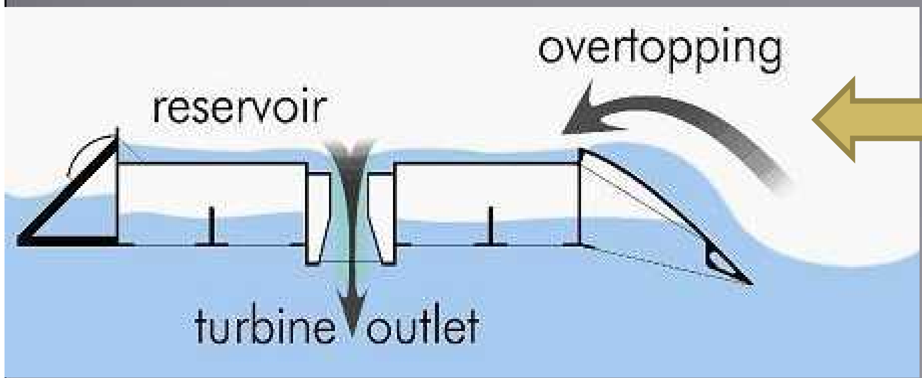
Wave energy Ap

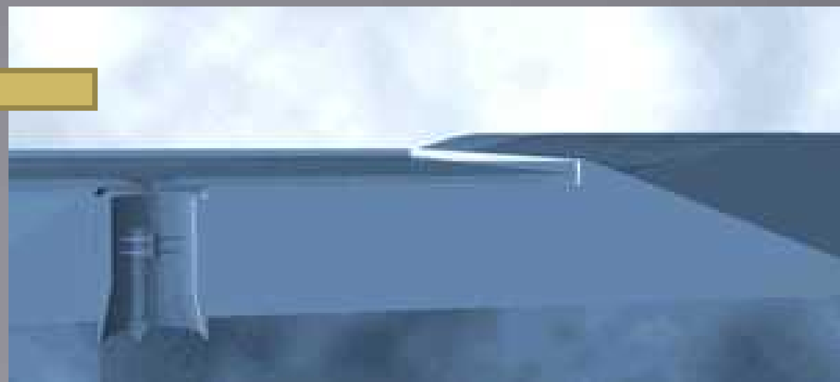
Oscillating Water Column





Overtopping Wave Energy Converter

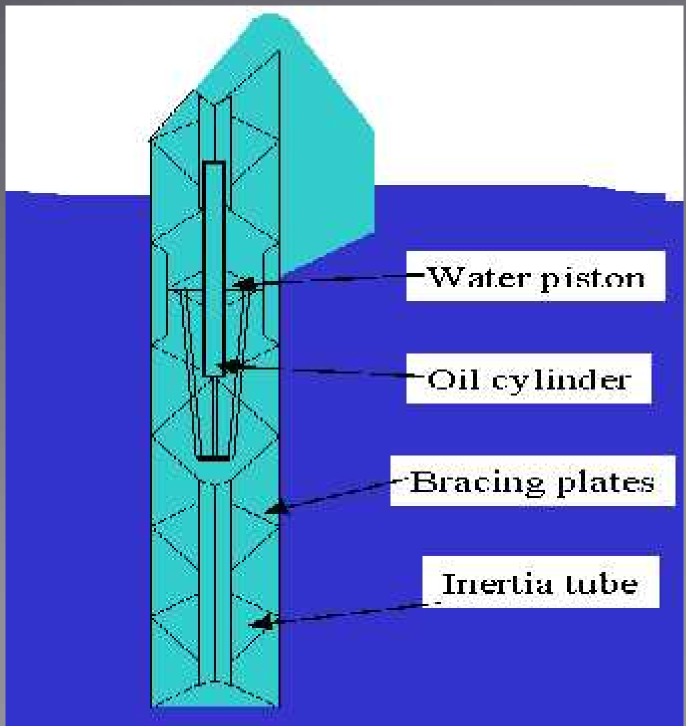




Wave energy Applications

"Point Absorbers"

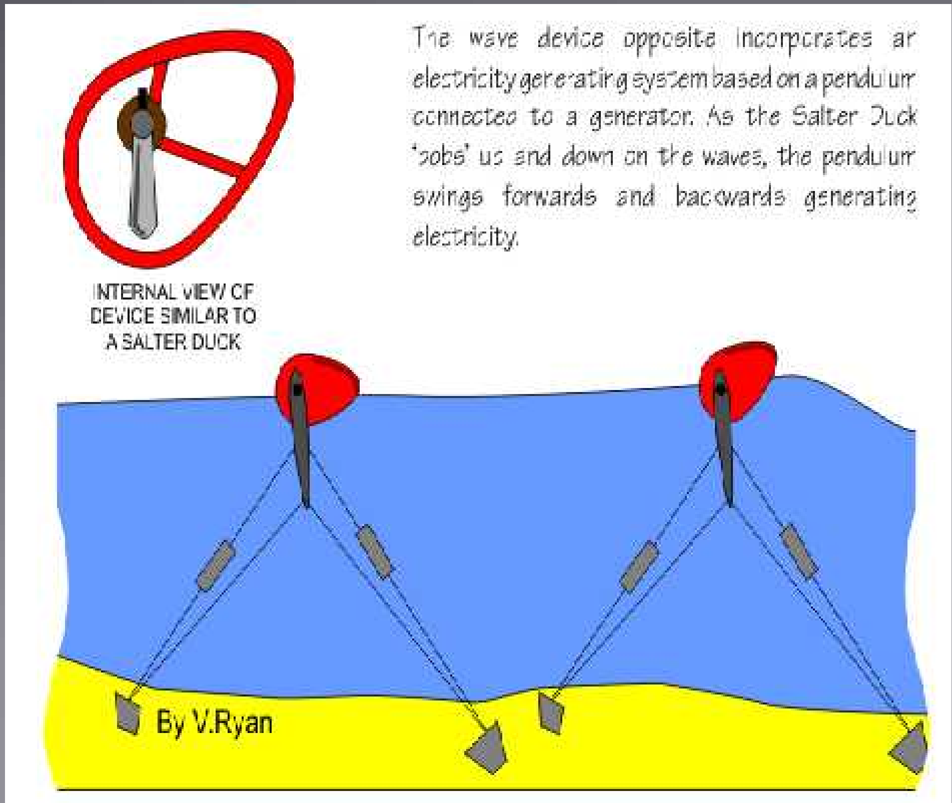
Tube type Buoy



Float type Buoy

Wave energy

Salter's Duck



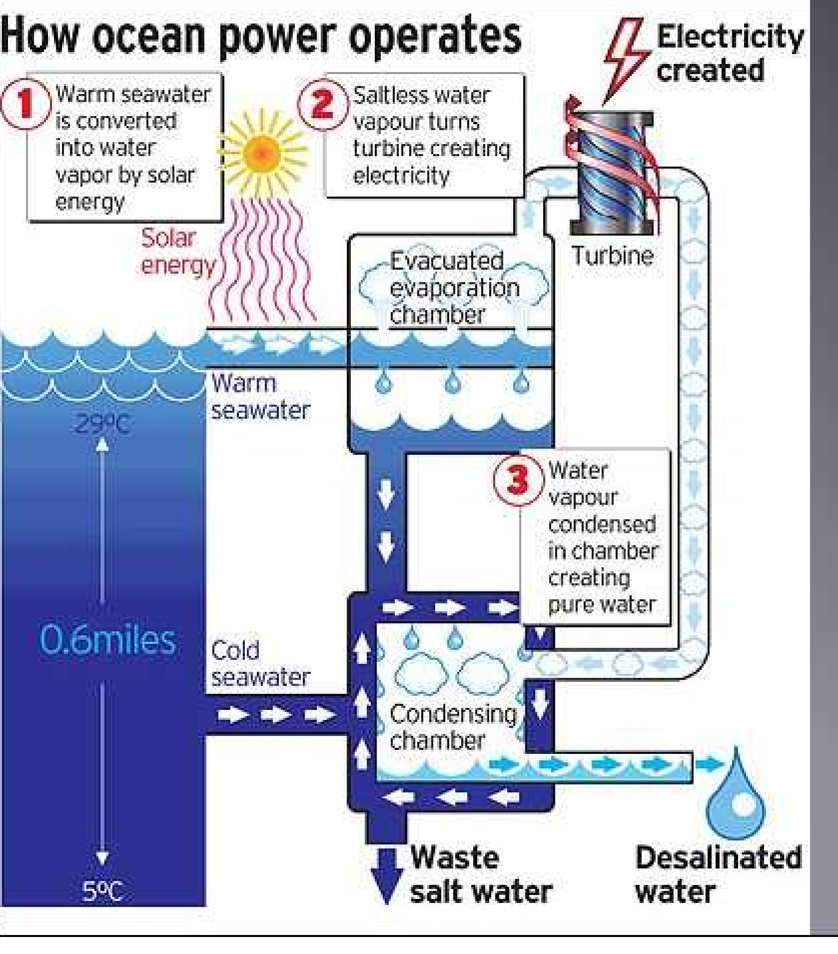
Pelamis

OTEC

- 60 mil. Km^2 absorb thermal energy equal to 250 billion barrels !
- Hot and cold water

sub products:

- Fresh water
- Hydrogen

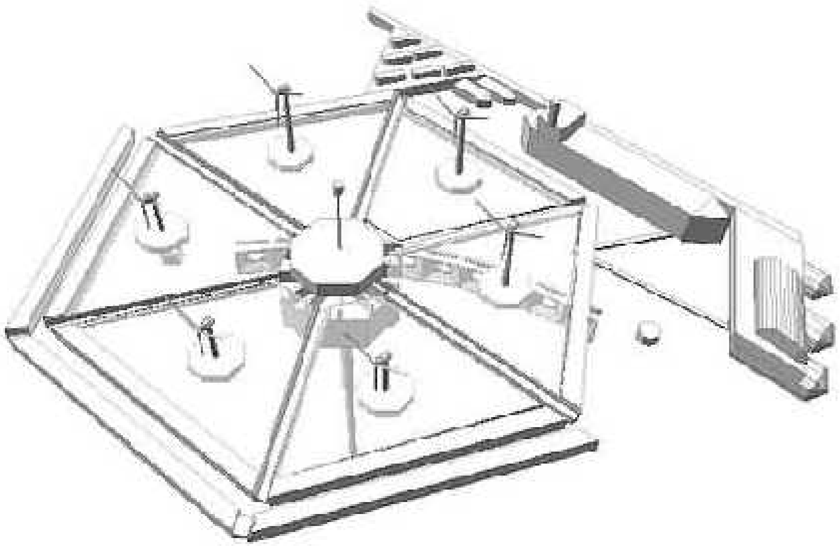


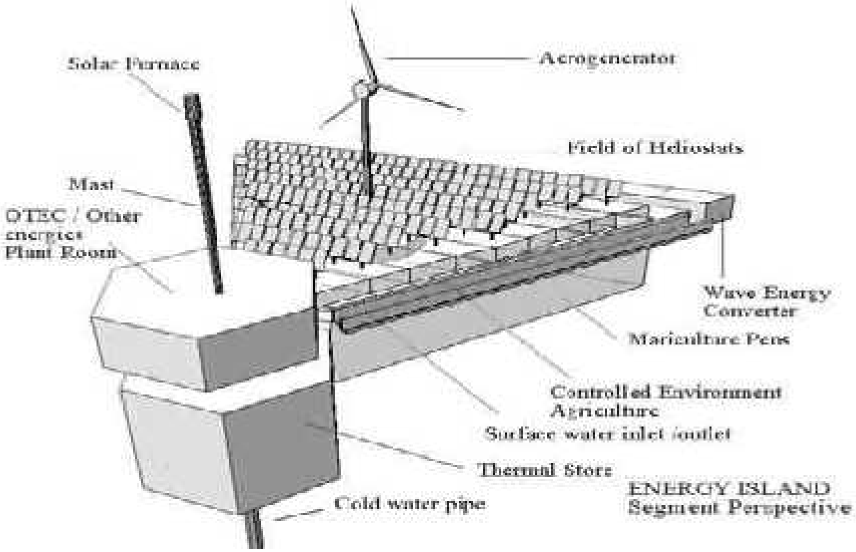
Energy Islands

50.000 islands

↓

Cover of total world energy demand

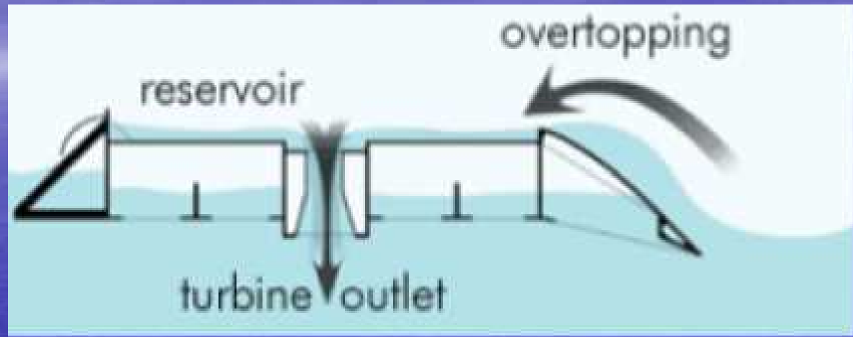




Wave energy
Pelamis & LIMPET

Wave Star

Wave Dragon

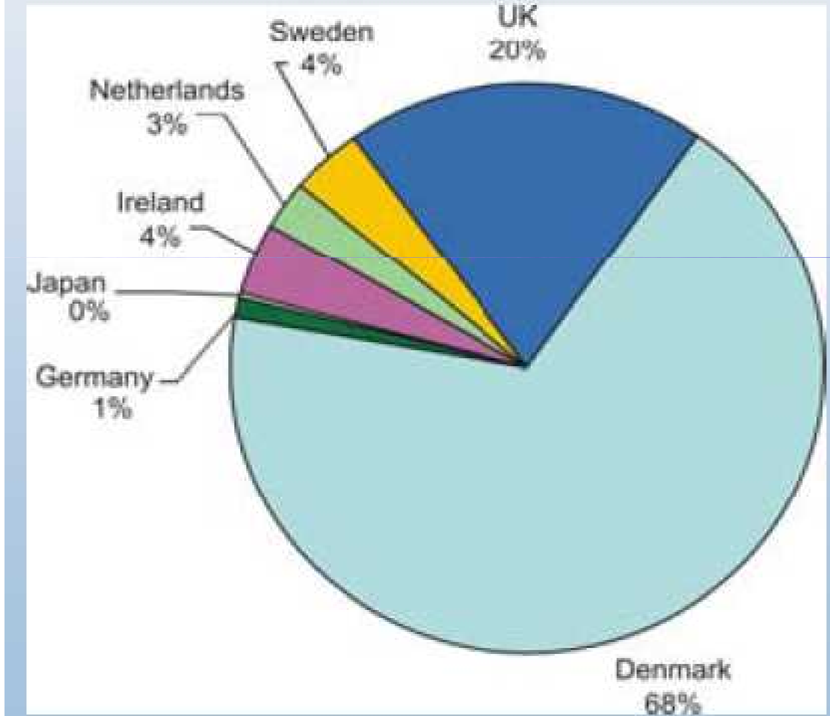


Energy from tides

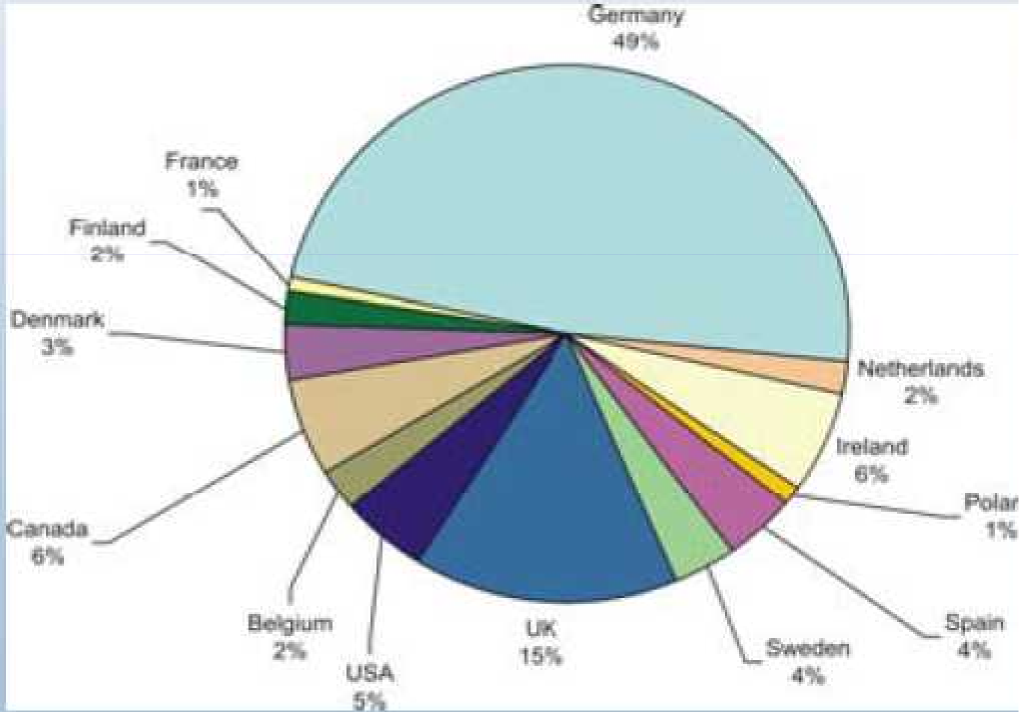
- 240 MW barrage on the Rance estuary in northern Brittany.
- The 0.8 km-long dam also serves as a highway bridge linking St. Malo and Dinard.
- 1961 and 1966 and has now completed 34 years of successful commercial operation.
- Annual generation is around 640 million kWh.

Offshore wind projects

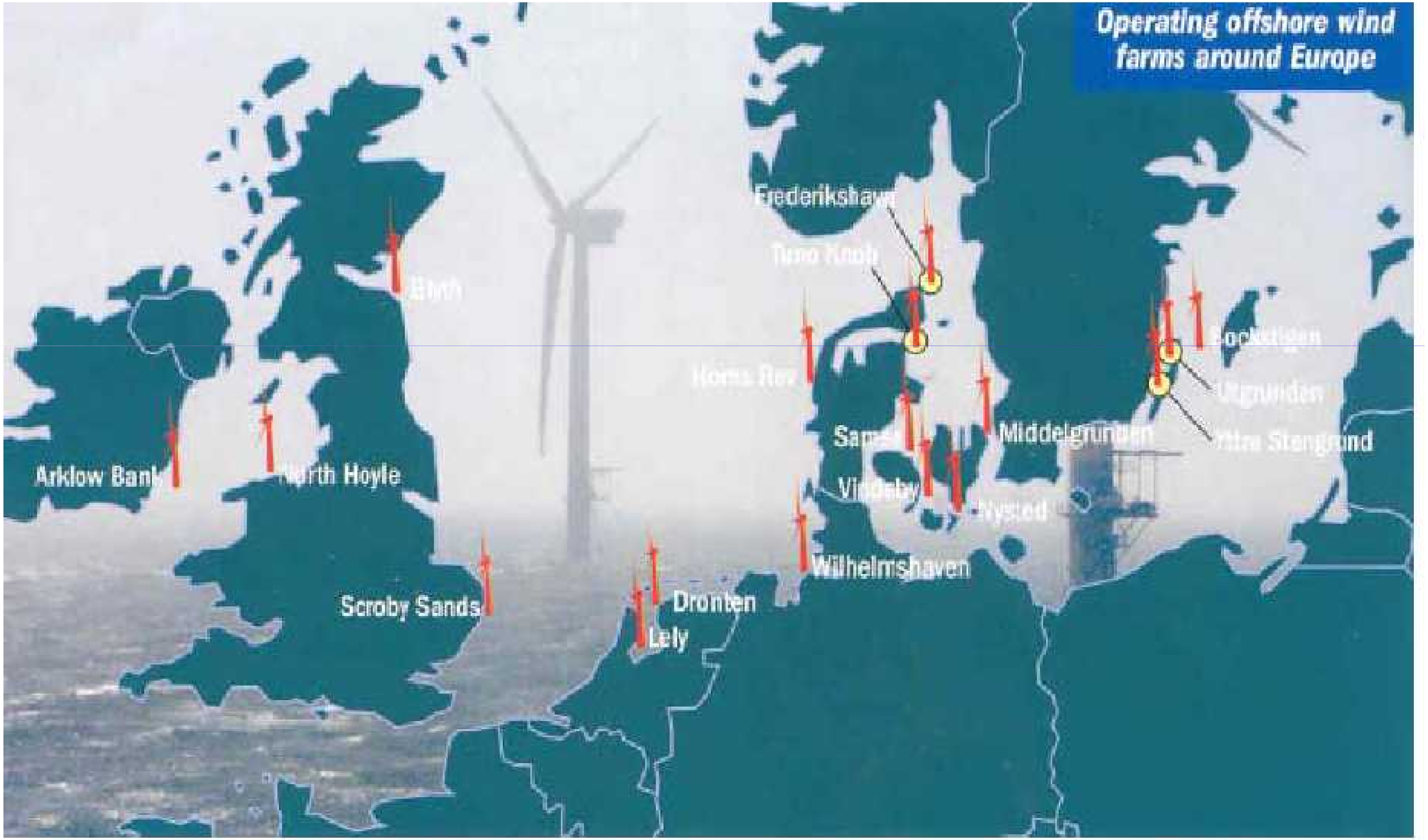
Offshore Wind Projects Worldwide: 617 MW (2004)



Proposed Offshore Wind Projects: 11,455 MW (through 2010)



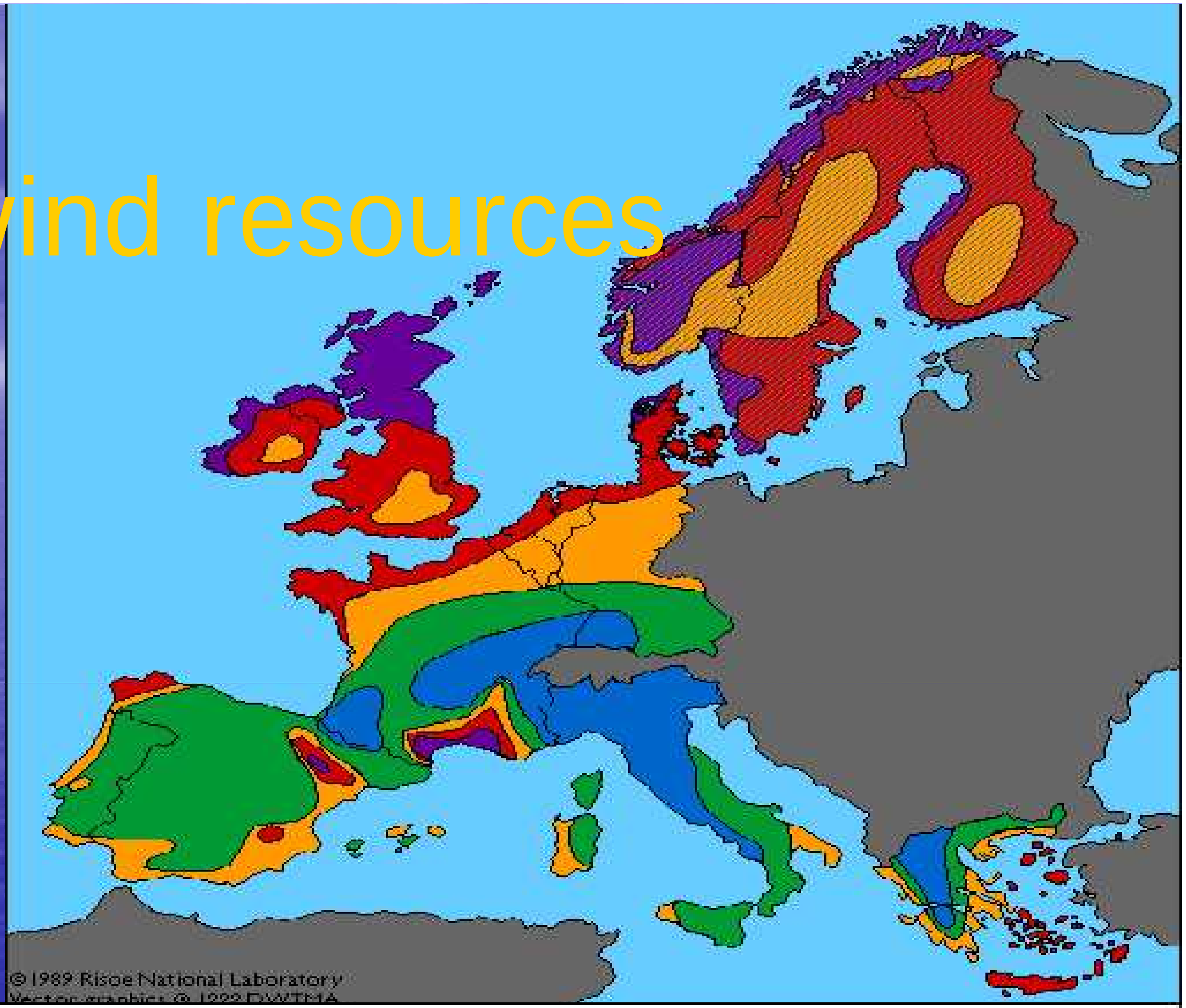
Offshore wind farms in Europe



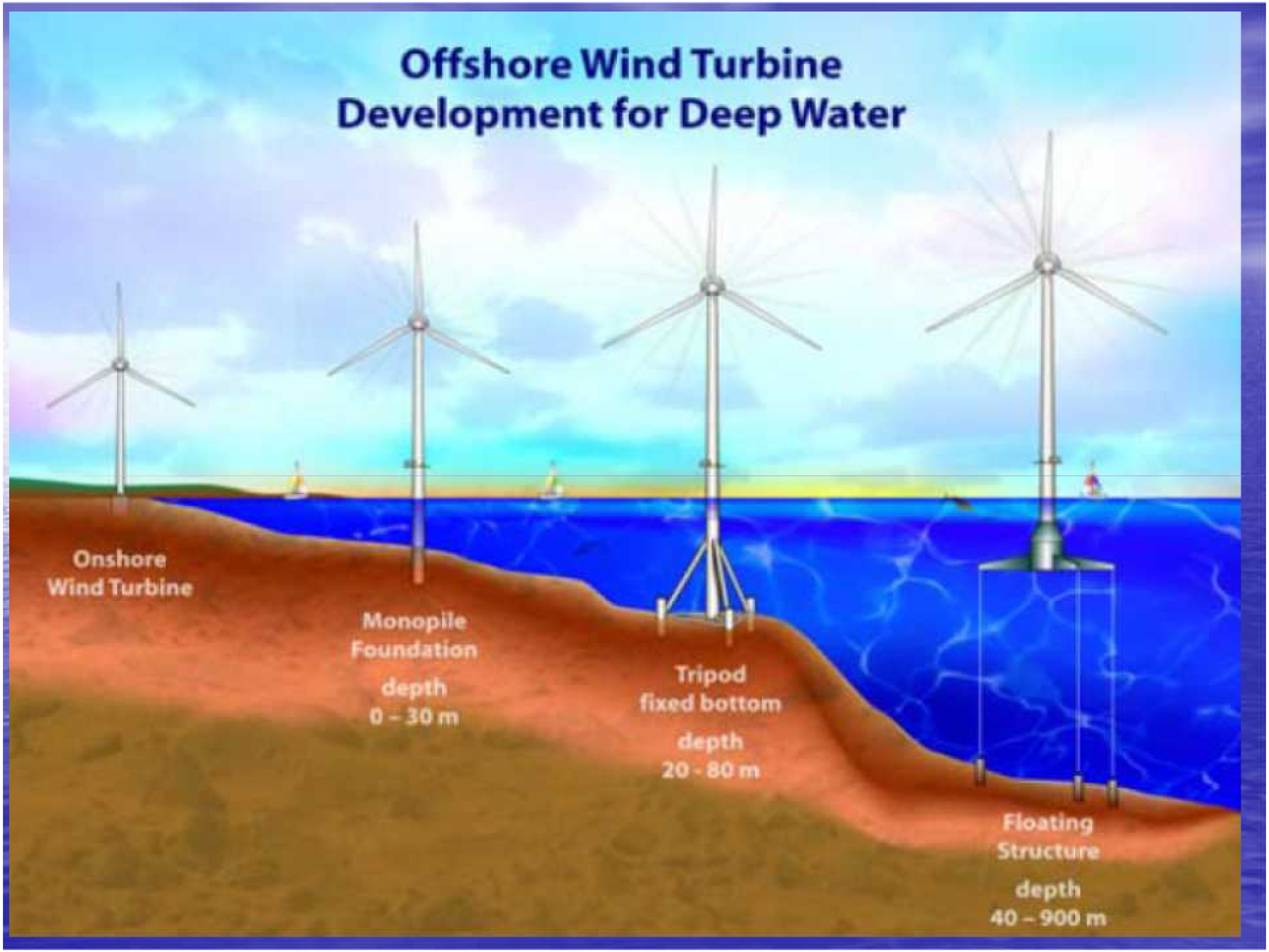
Source: Wind Directions, September 2004

European wind resources

Wind resources at 50 meters above ground level for five different topographic conditions: 1) Sheltered terrain, 2) Open plain, 3) At a coast, 4) Open sea and 5) Hills and ridges.



	m/s	W/m²	m/s	W/m²	m/s	W/m²	m/s	W/m²	m/s	W/m²
	>6.0	>250	>7.5	>500	>8.5	>700	>9.0	>800	>11.5	>1800
	5.0-6.0	150-250	6.5-7.5	300-500	7.0-8.5	400-700	8.0-9.0	600-800	10.0-11.5	1200-1800
	4.5-5.0	100-150	5.5-6.5	200-300	6.0-7.0	250-400	7.0-8.0	400-600	8.5-10.0	700-1200
	3.5-4.5	50-100	4.5-5.5	100-200	5.0-6.0	150-250	5.5-7.0	200-400	7.0-8.5	400-700
	<3.5	<50	<4.5	<100	<5.0	<150	<5.5	<200	<7.0	<400
			>7.5							
			5.5-7.5							
			<5.5							


Offshore Wind Turbine
Development for Deep Water
Onshore
Wind Turbine
Monopile
Foundation
depth
0 – 30 m
Tripod
fixed bottom
depth
20 - 80 m
Floating
Structure
depth
40 – 900 m

Floating wind generator Hywind

Floating autonomous ecological desalination unit

Target

Design and Implementation of an environmental friendly floating desalination plant using renewable energies in order to support the fresh water demand of isolated Greek islands.

Main Concept

Desalination Units already exists on board of ships using fuel energy.

Integration of desalination unit with windpower in the same structure to achieve:

- Reduced cost due to absence of network to transfer energy.
- Ability of installation far from populated areas. Minimize disturbance problems, such as noise.
- Ability to move the unit in different areas for better utilization depending on conditions.

OBJECTIVES

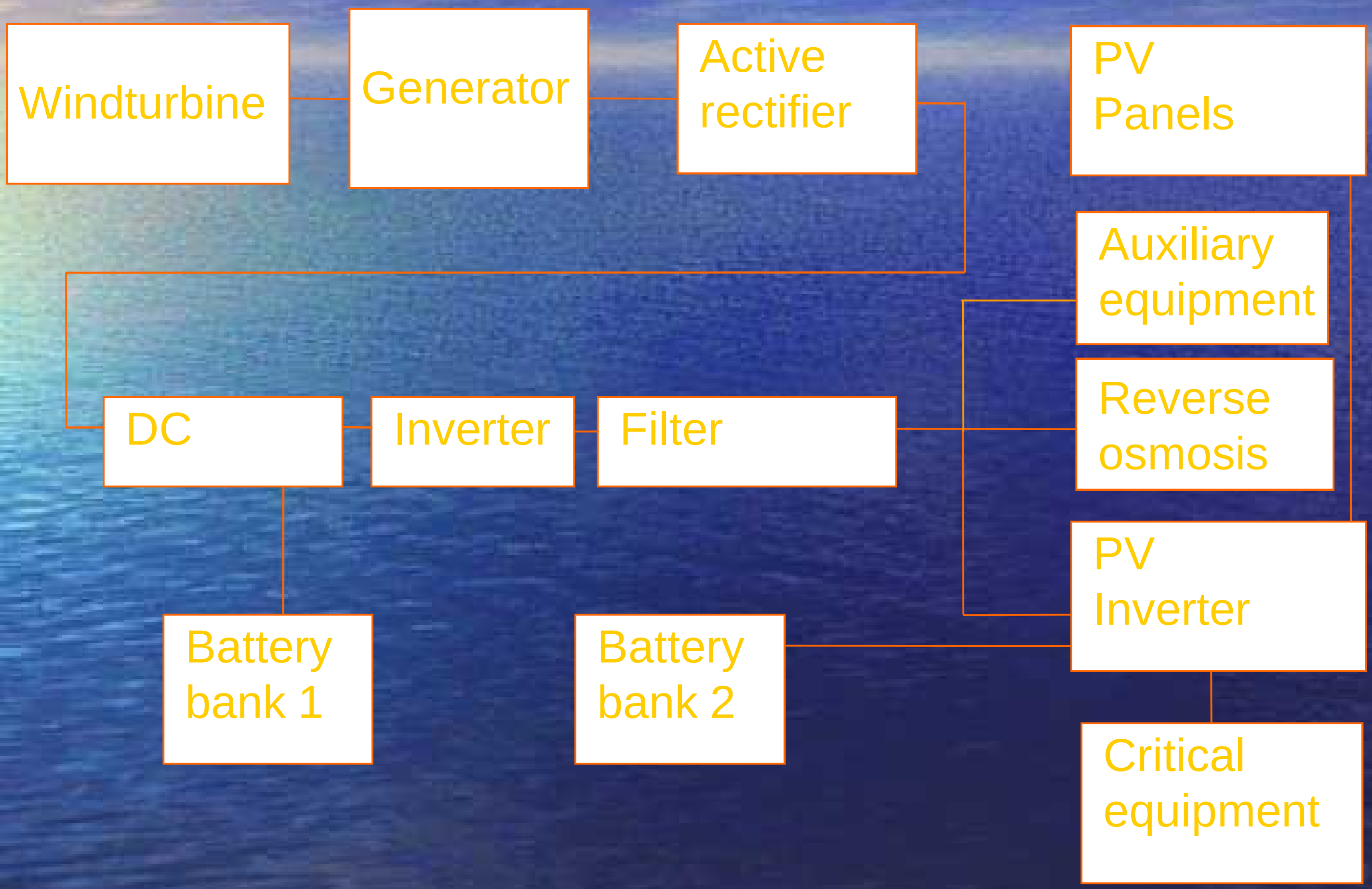
- Autonomous Operation
- Ecological
- Scalable
- Transferable

Technical Problems

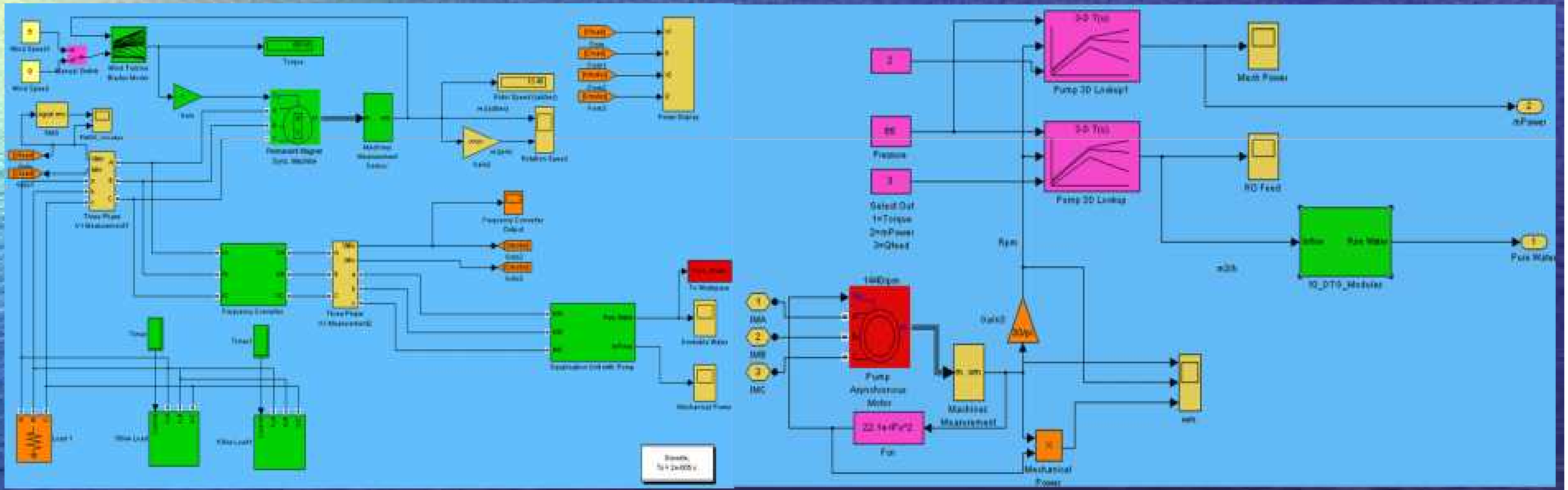
- Operation of wind turbine on a floating structure.
- Energy autonomous operation leads to complex solutions.
- Variable power input -> variable water production.
- No chemical treatment -> increase membrane scaling.
- Variable production -> increase scaling additionally.
- Unmanned automatic control of all system components and fail safe devices.
- Towing of complete system, no erection on site.

Design and Operation

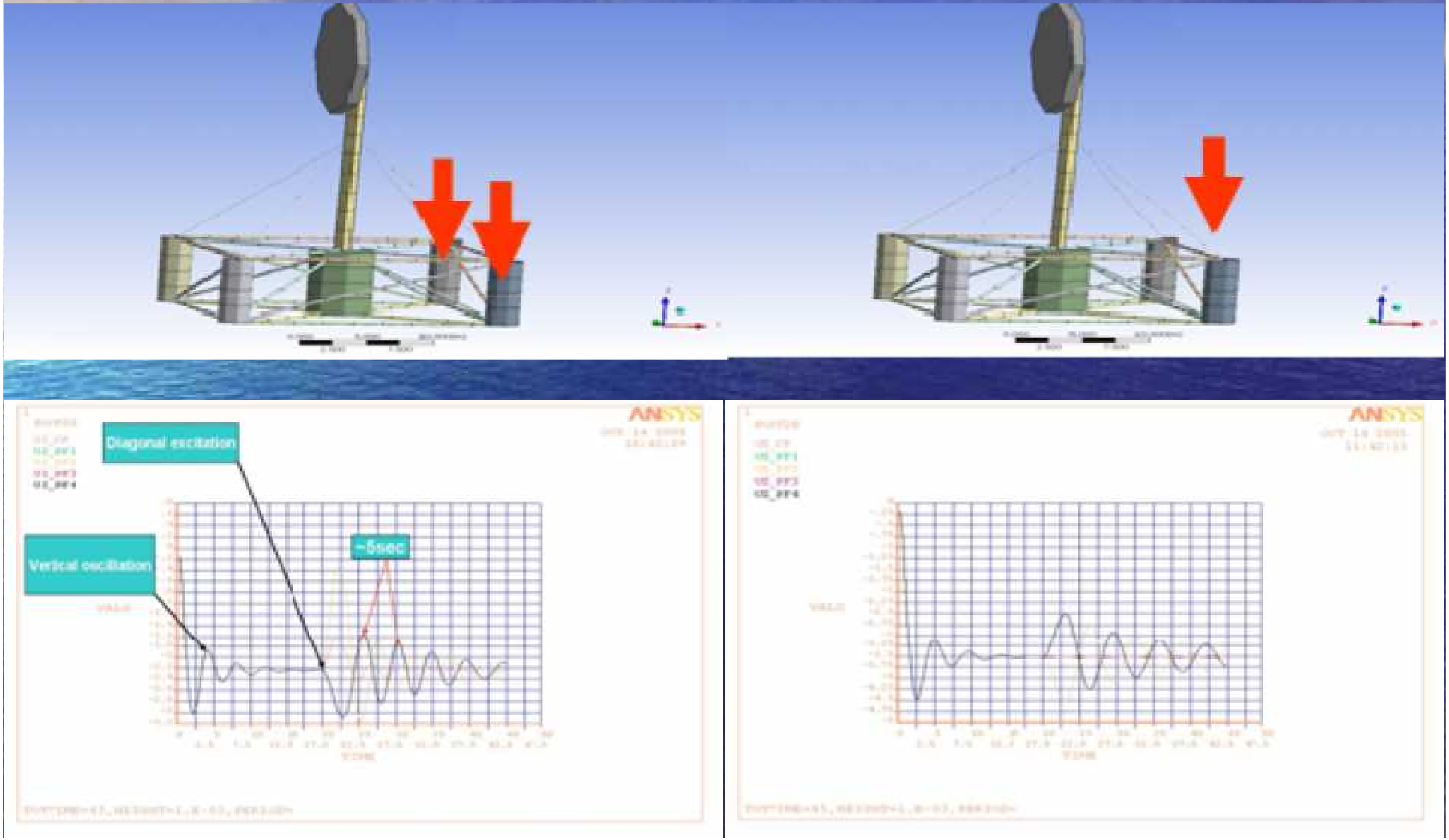
Electrical Design



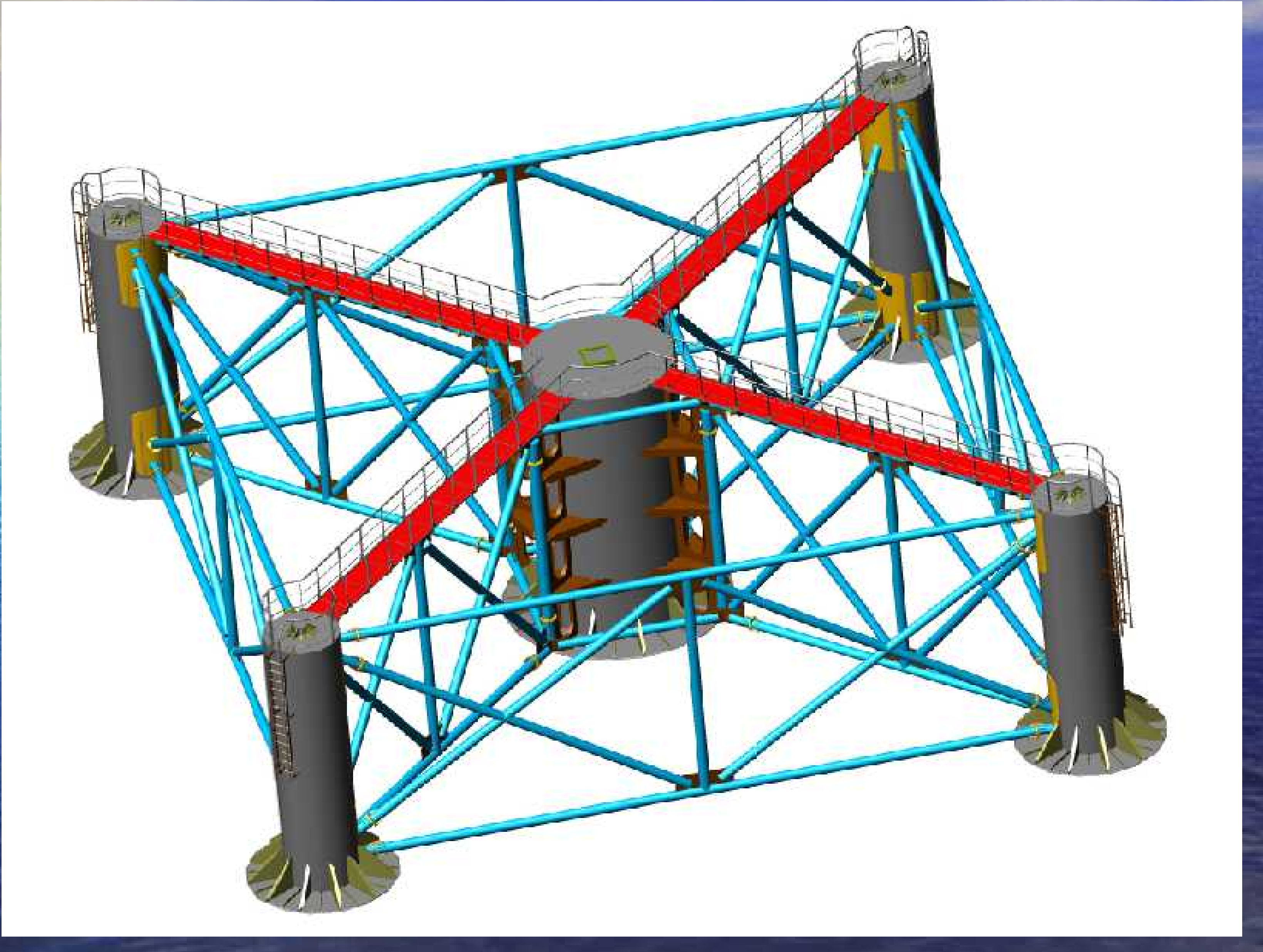
Block simulation of components



Floating Structure Simulation



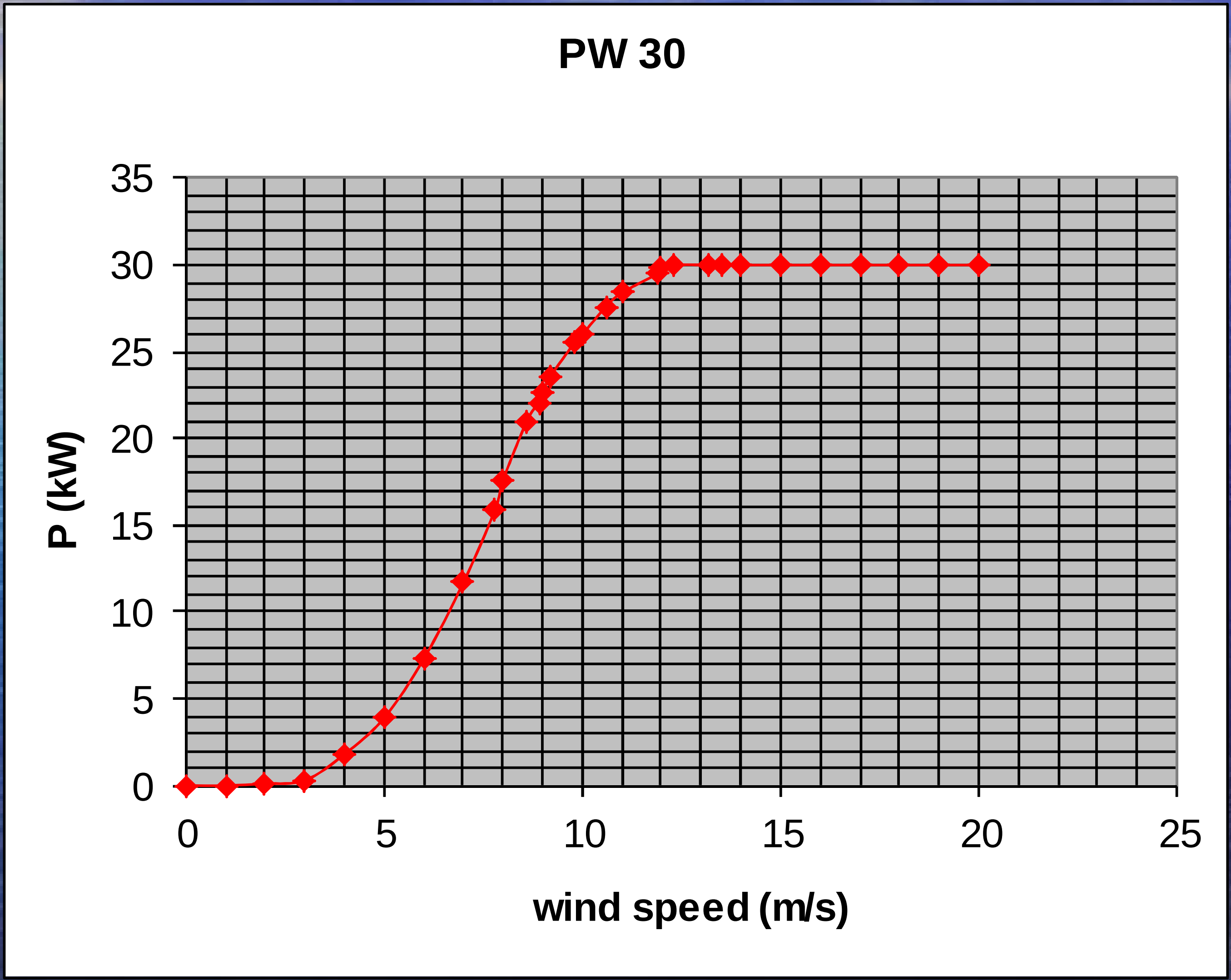
Final Design of the Floating Platform



Wind Turbine

- Variable pitch, variable speed
- Direct transmission
- Modified control mode of operation
- Optimum – stable power tracking

POWER DIAGRAM

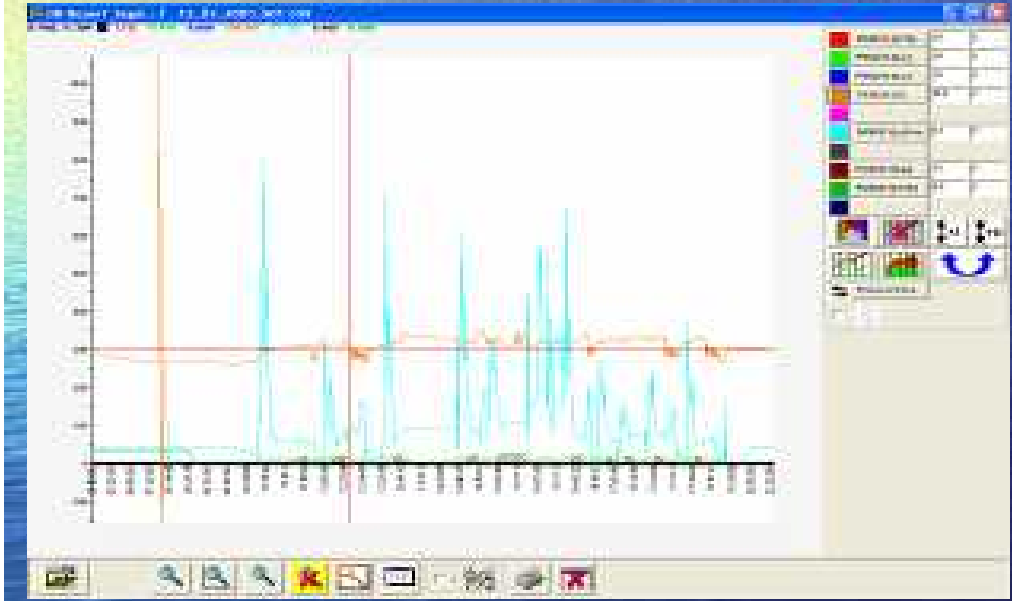


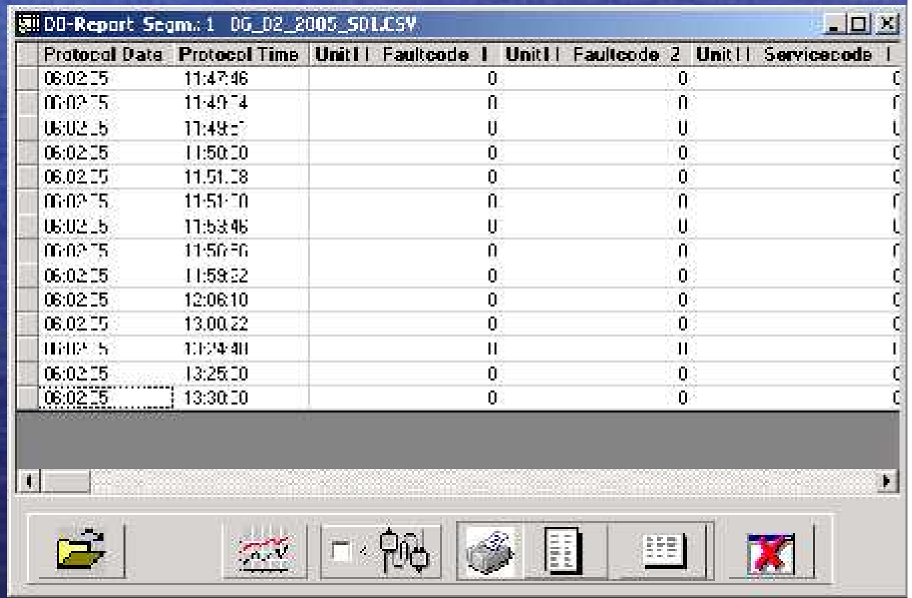
Improvement of Desalination Unit

- Minimum Maintenance
- Maximum Energy Recovering
- No chemical treatment
- Minimize cost of water production

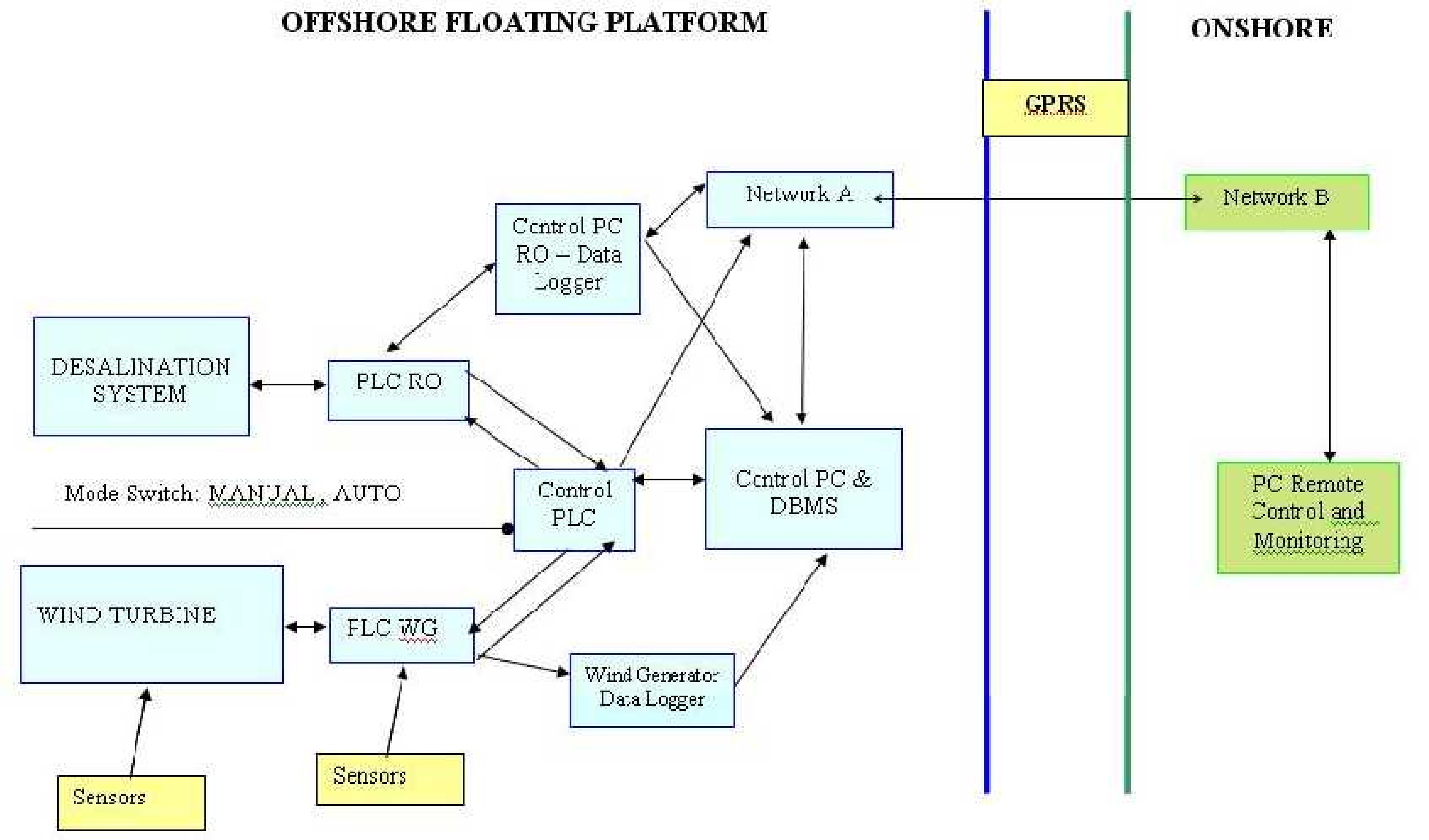
EXPERIMENTS

Operational Data

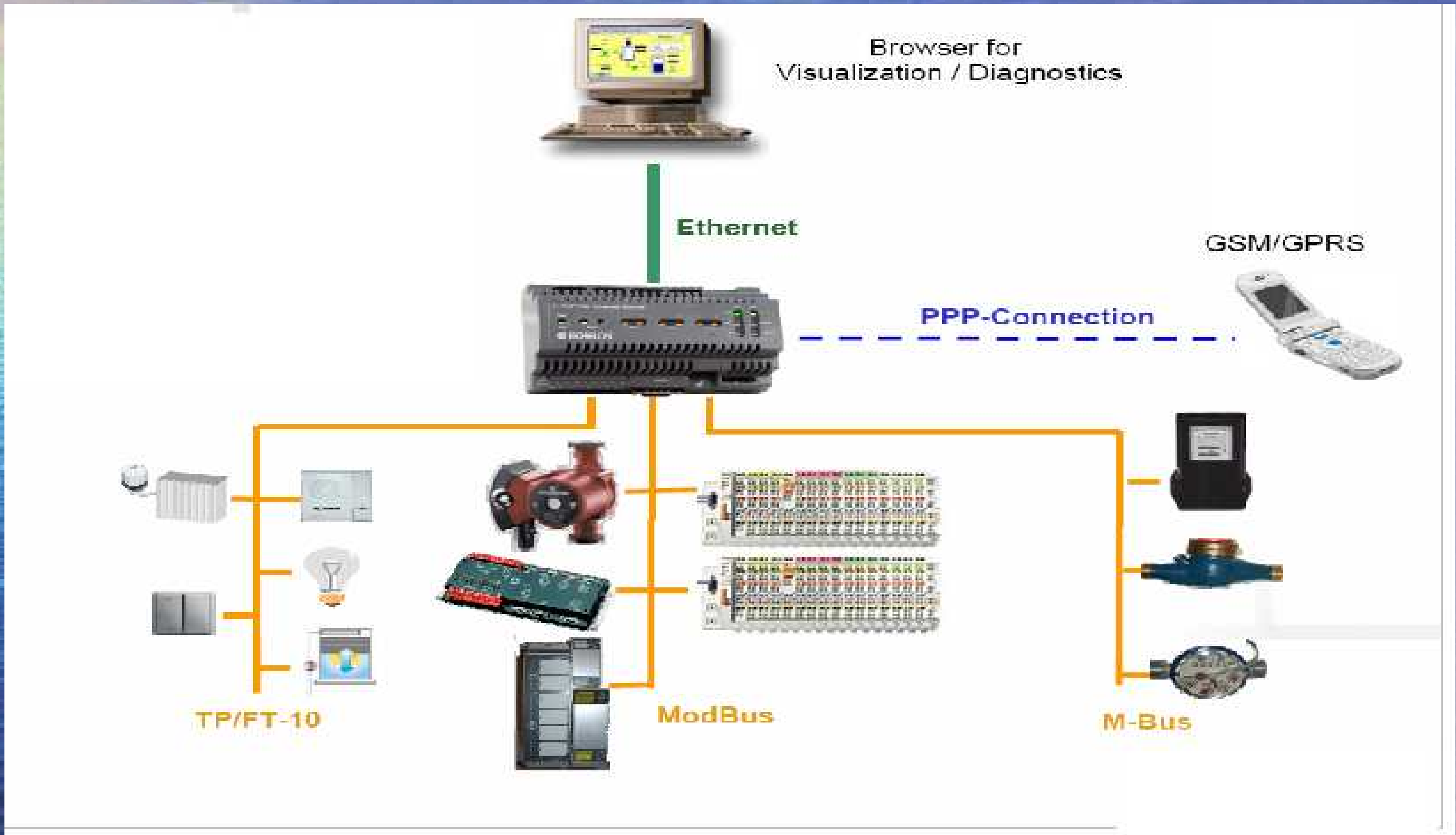




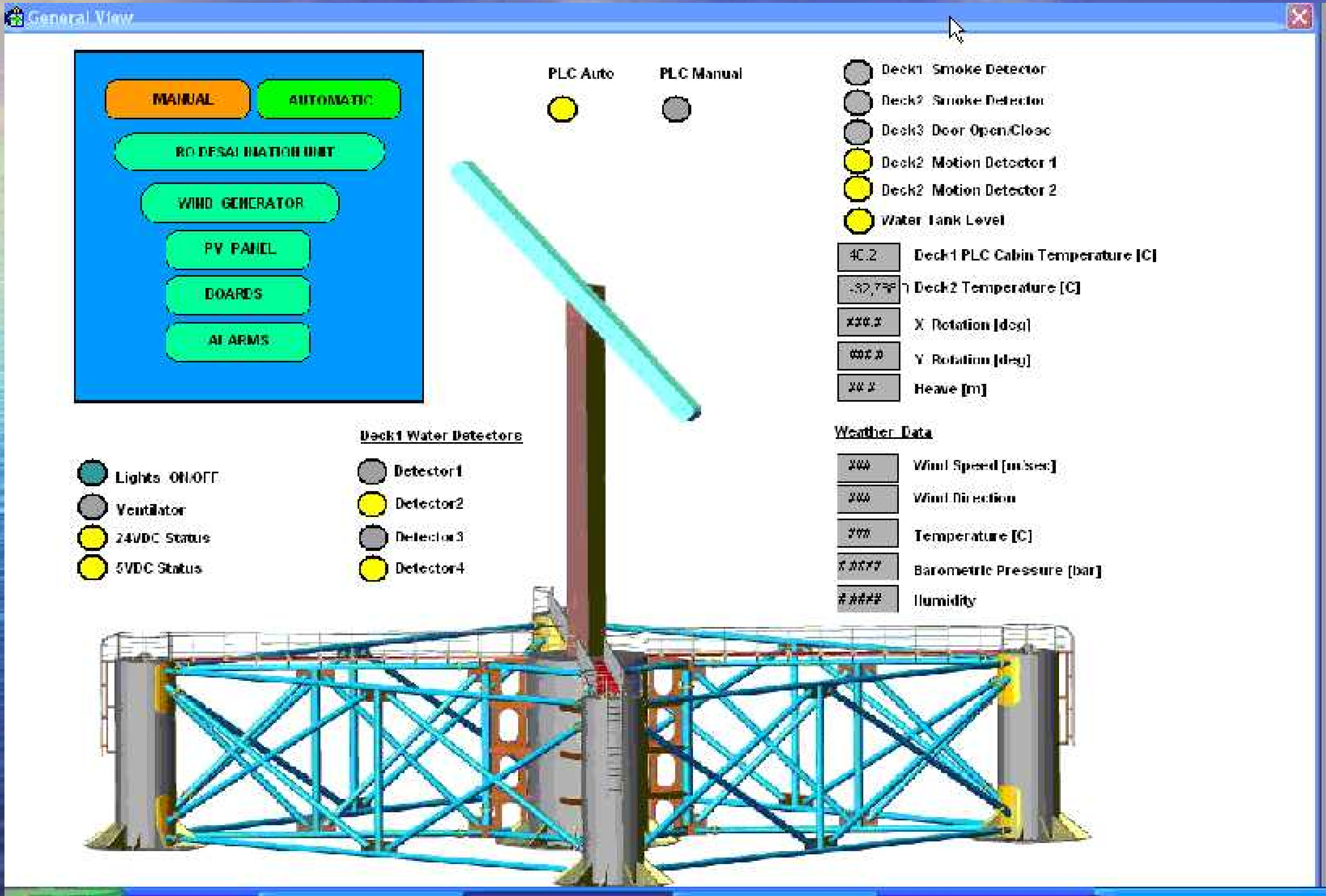
Control and Communication Systems



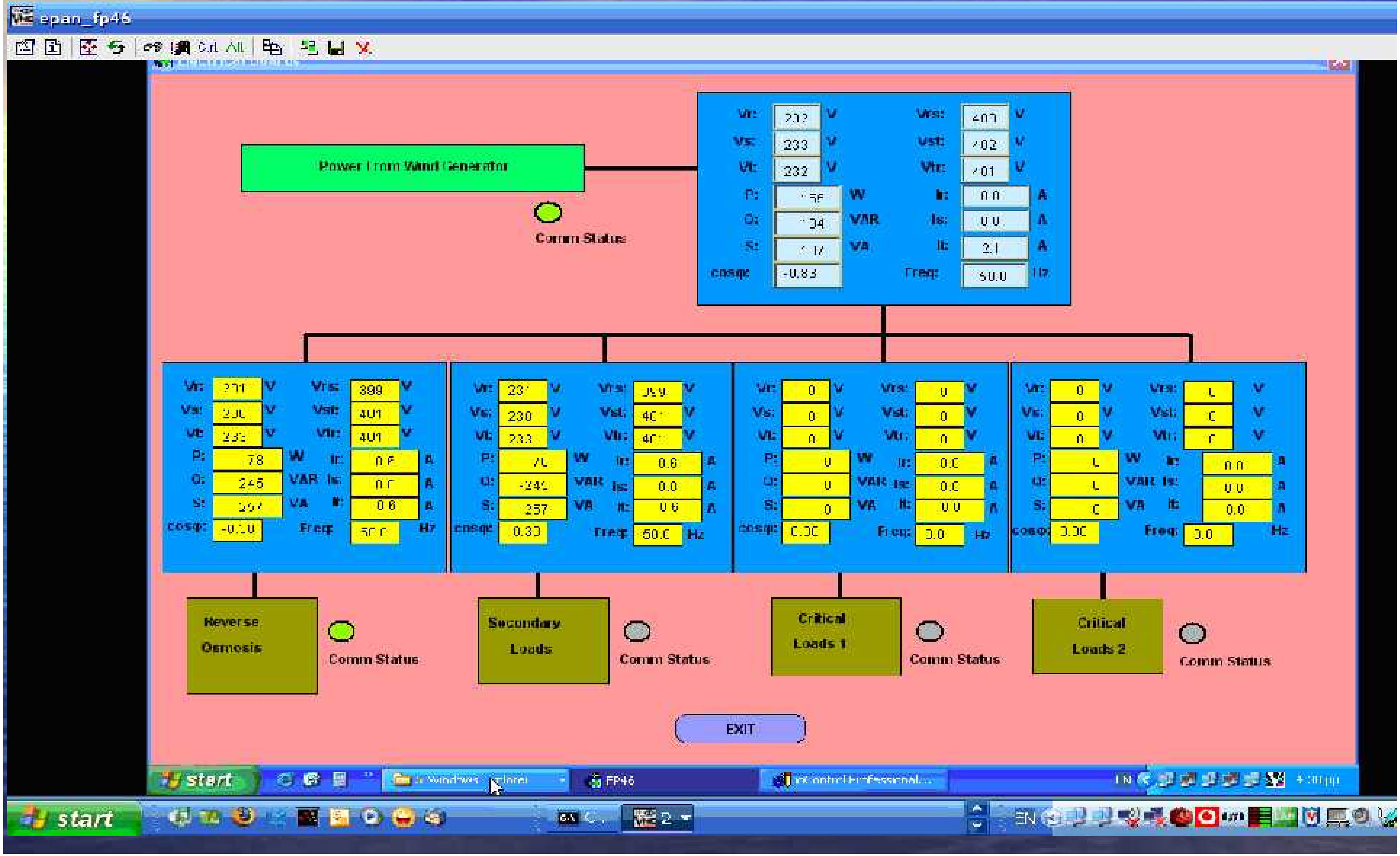
Local Connection network – GPRS



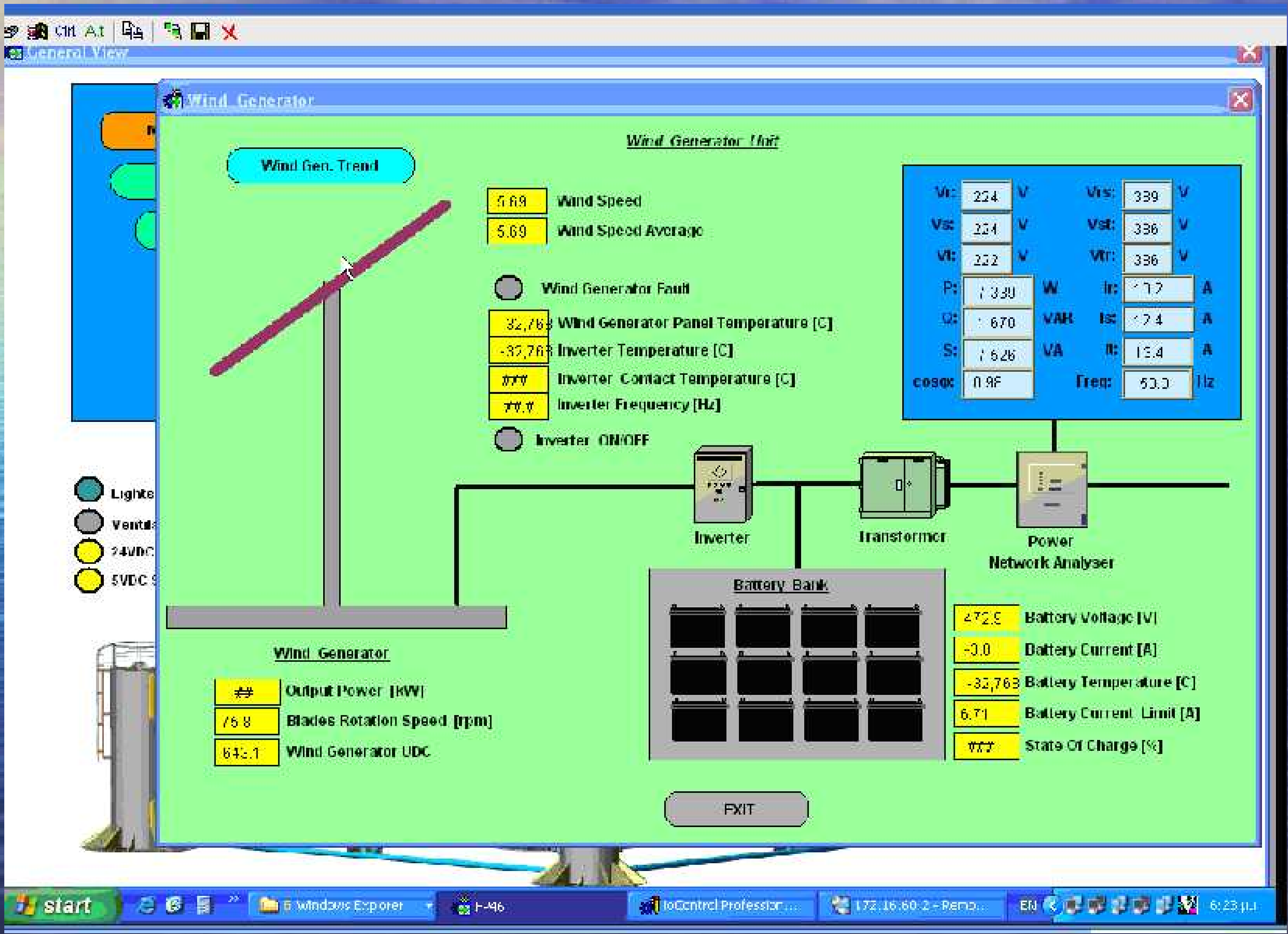
SCADA (1)


General View
MANUAL
AUTOMATIC
RO DESALINATION UNIT
WIND GENERATOR
PV PANEL
BOARDS
ALARMS
PLC Auto
PLC Manual
Deck1 Smoke Detector
Deck2 Smoke Detector
Deck3 Door Open/Close
Deck2 Motion Detector 1
Deck2 Motion Detector 2
Water Tank Level
40.2
Deck1 PLC Cabin Temperature [C]
Deck2 Temperature [C]
X Rotation [deg]
Y Rotation [deg]
Heave [m]
Weather Data
Wind Speed [m/sec]
Wind Direction
Temperature [C]
Barometric Pressure [bar]
Humidity
Deck1 Water Detectors
Detector1
Detector2
Detector3
Detector4
Lights ON/OFF
Ventilator
24VDC Status
5VDC Status

SCADA (2) LOADS

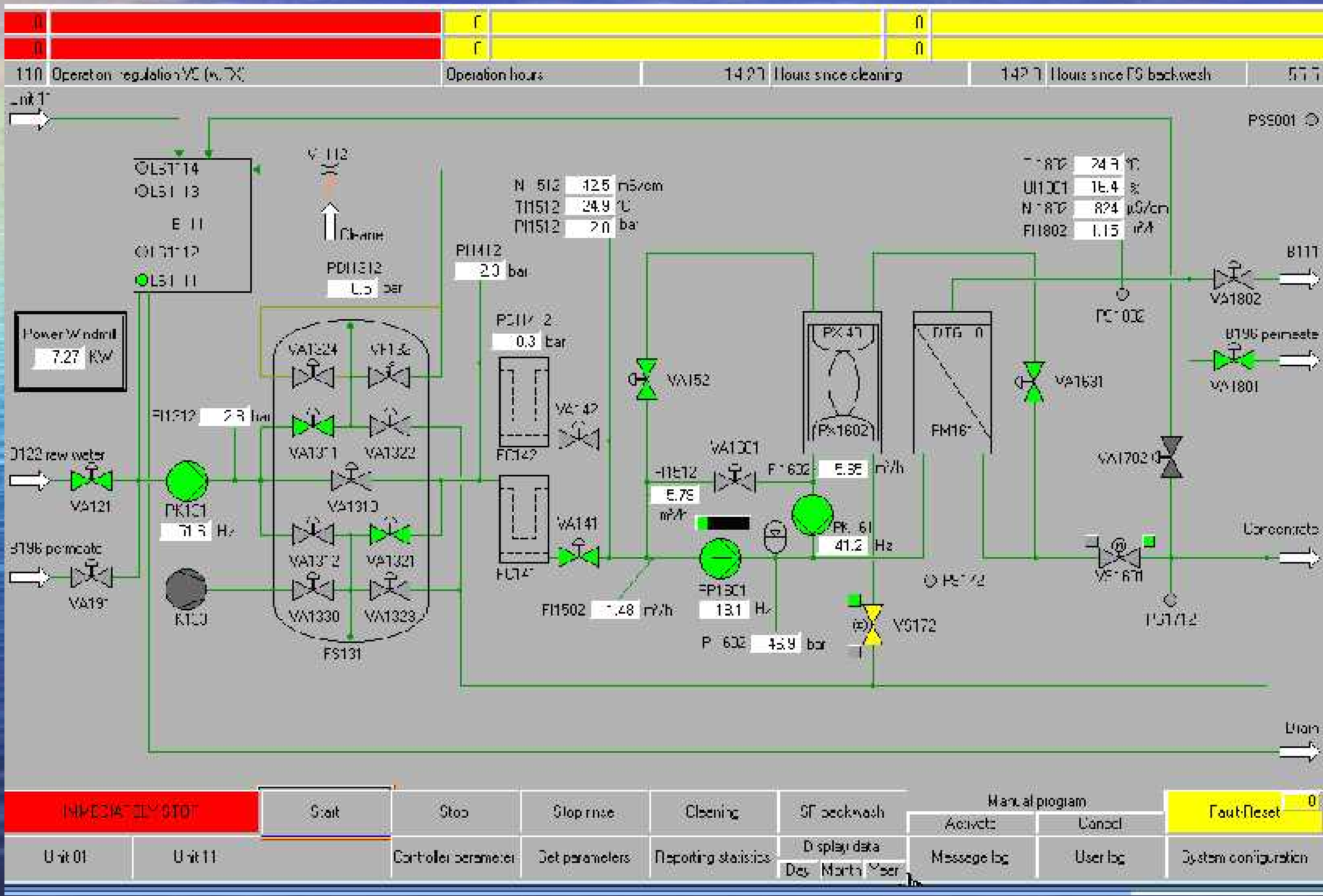


SCADA (3) WT



Wind Generator
Wind Generator Unit
Wind Gen. Trend
5.69 Wind Speed
5.69 Wind Speed Average
Wind Generator Fault
Wind Generator Panel Temperature [C]
Inverter Temperature [C]
Inverter Contact Temperature [C]
Inverter Frequency [Hz]
Inverter ON/OFF
Inverter
Transformer
Power Network Analyser
Battery Bank
Battery Voltage [V]
Battery Current [A]
Battery Temperature [C]
Battery Current Limit [A]
State Of Charge [%]
Wind Generator
Output Power [KW]
Blades Rotation Speed [rpm]
Wind Generator UDC
EXIT
start

SCADA (4) RO



Operation hours
Hours since cleaning
Power Windmill
7.27 KW
raw water
VA121
VA1801
VA1802
VA152
VA1631
VA141
FS131
FP1301
13.1
41.2
45.9
0.3
Concentrate
Drain
Start
Stop
Stop rinse
Cleaning
SF backwash
Manual program
Activate
Cancel
Fault Reset
Unit 01
Unit 11
Set parameters
Reporting statistics
Display data
Message log
User log
System configuration

EXPECTED LIFETIME

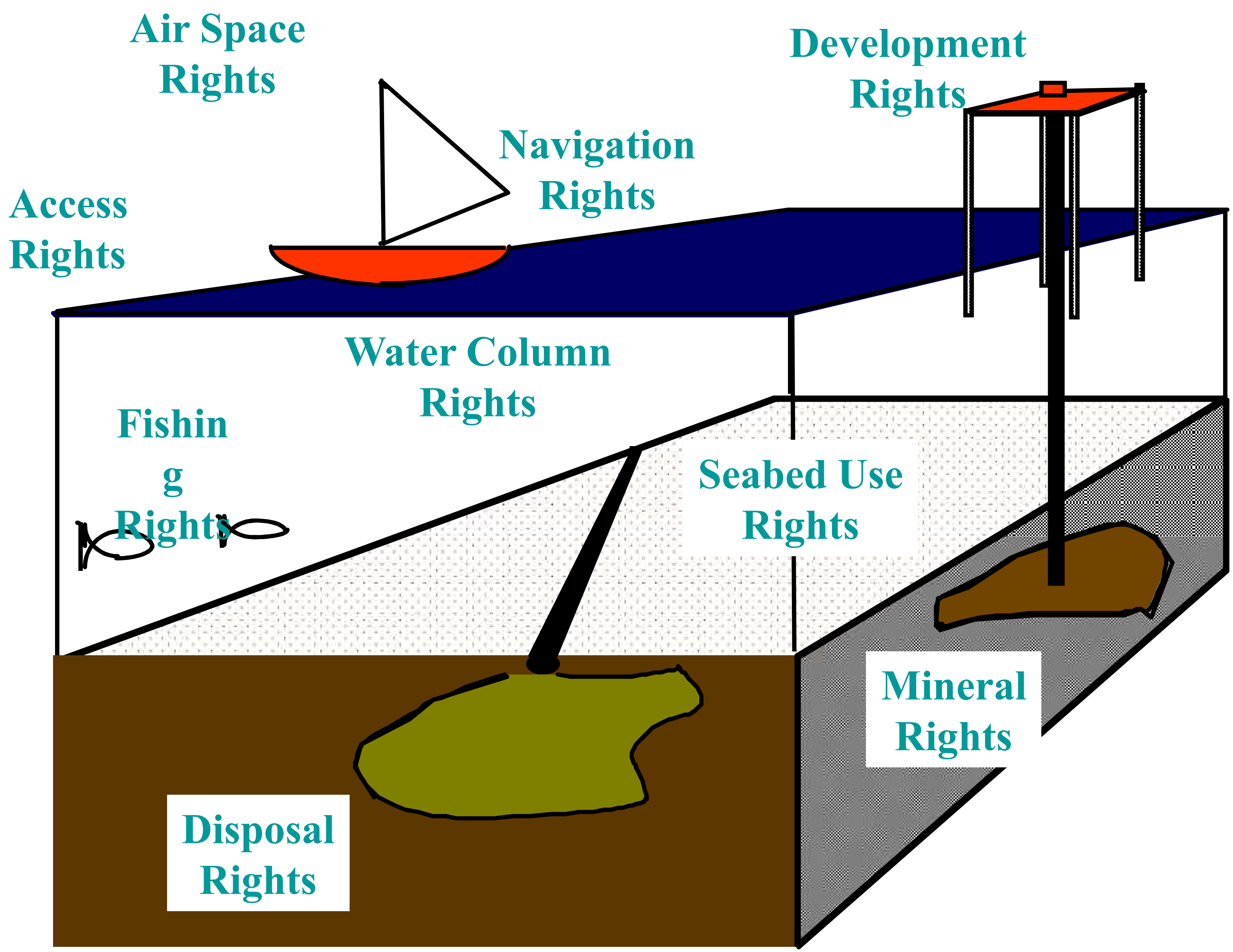
- Platform >30 years
- Windturbine >20 years
- RO >20 years
- TOTAL SYSTEM 20 YEARS

Conclusions

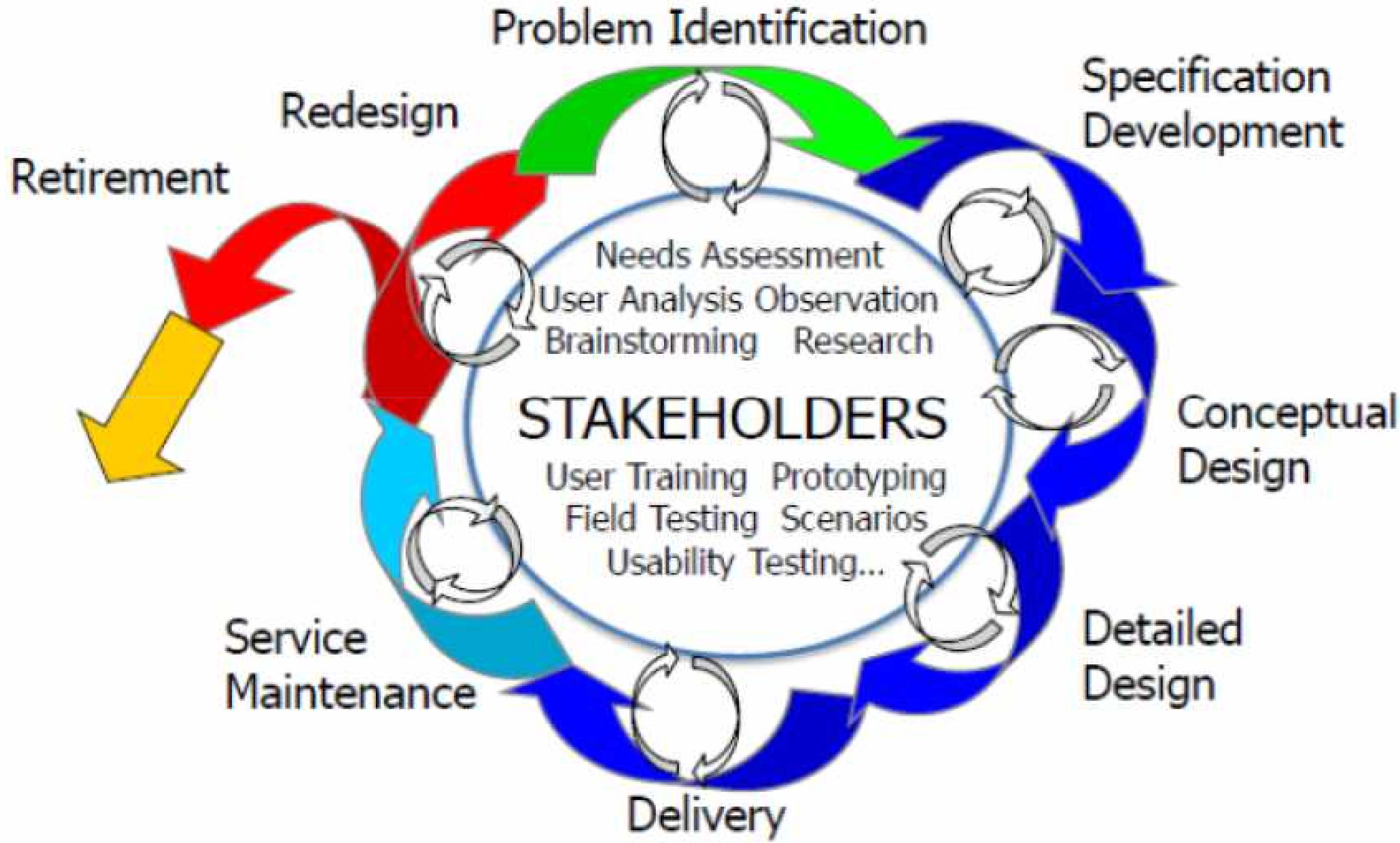
- Operational in actual environment
- Autonomous
  - Energy
  - Unmanned
  - Compact
- Ecological
  - RENES
  - Deep seawater
  - No chemical treatment
- Scalable
- Transferable

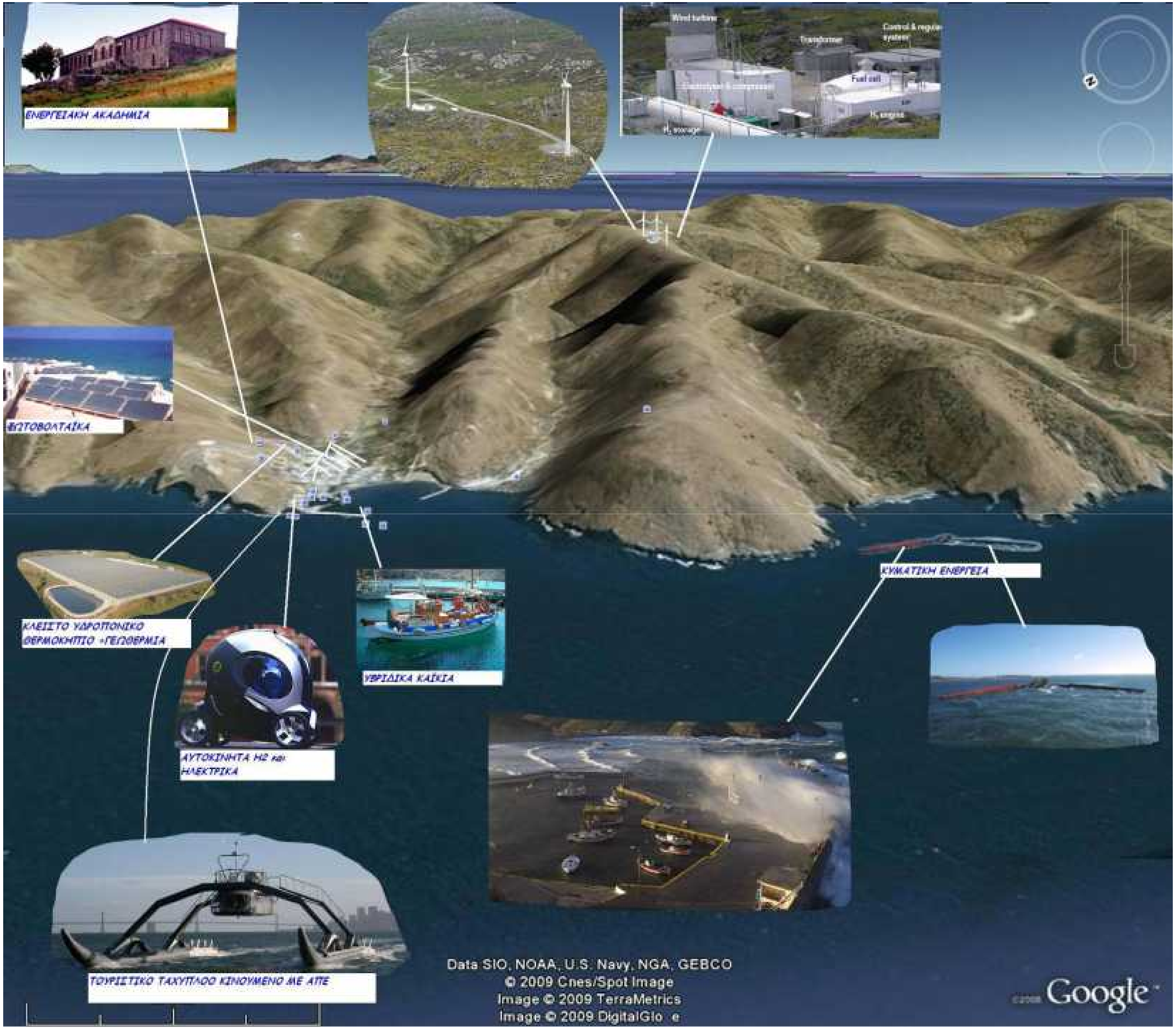
Barriers to Progress

- Grid connection & competition Funding
- Skills & industrial capacity
- Environmental lobby
- Technical challenges
- Political uncertainty



Nichols, S., It's Our Ocean: How Well Will We Govern It? Presented at the Offshore Issues Consultation Workshop. Viewed at http://gge.unb.ca/Research/OceanGov/documents/LUNCH.PPT (July 28, 2003).


Problem Identification
Specification Development
Conceptual Design
Detailed Design
Delivery
Service Maintenance
Redesign
Retirement
Needs Assessment
User Analysis Observation
Brainstorming Research
STAKEHOLDERS
User Training Prototyping
Field Testing Scenarios
Usability Testing...


ΕΝΕΡΓΕΙΑΚΗ ΑΚΑΔΗΜΙΑ
Wind turbine
Transformer
Fuel cell
ΦΩΤΟΒΟΛΤΑΪΚΑ
ΚΛΕΙΣΤΟ ΥΔΡΟΠΟΝΙΚΟ
ΘΕΡΜΟΚΗΠΙΟ +ΓΕΩΘΕΡΜΙΑ
ΥΒΡΙΔΙΚΑ ΚΑΪΚΙΑ
ΚΥΜΑΤΙΚΗ ΕΝΕΡΓΕΙΑ
ΑΥΤΟΚΙΝΗΤΑ Η2 και
ΗΛΕΚΤΡΙΚΑ
ΤΟΥΡΙΣΤΙΚΟ ΤΑΧΥΠΛΟΟ ΚΙΝΟΥΜΕΝΟ ΜΕ ΑΠΕ
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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Thank you

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