FLOATING AUTONOMOUS ENVIRONMENTAL FRIENDLY AND EFFICIENT DESALINATION UNIT

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University of the Aegean

Offshore potential

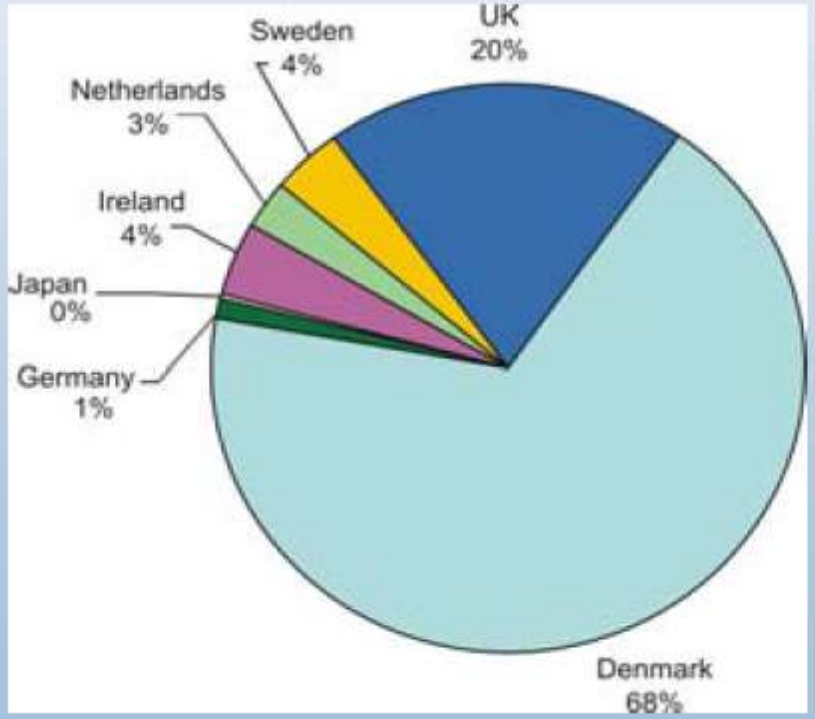
- Wind power, tides, wave energy, biofuels
- Mature technologies - Research applications

Energy from tides

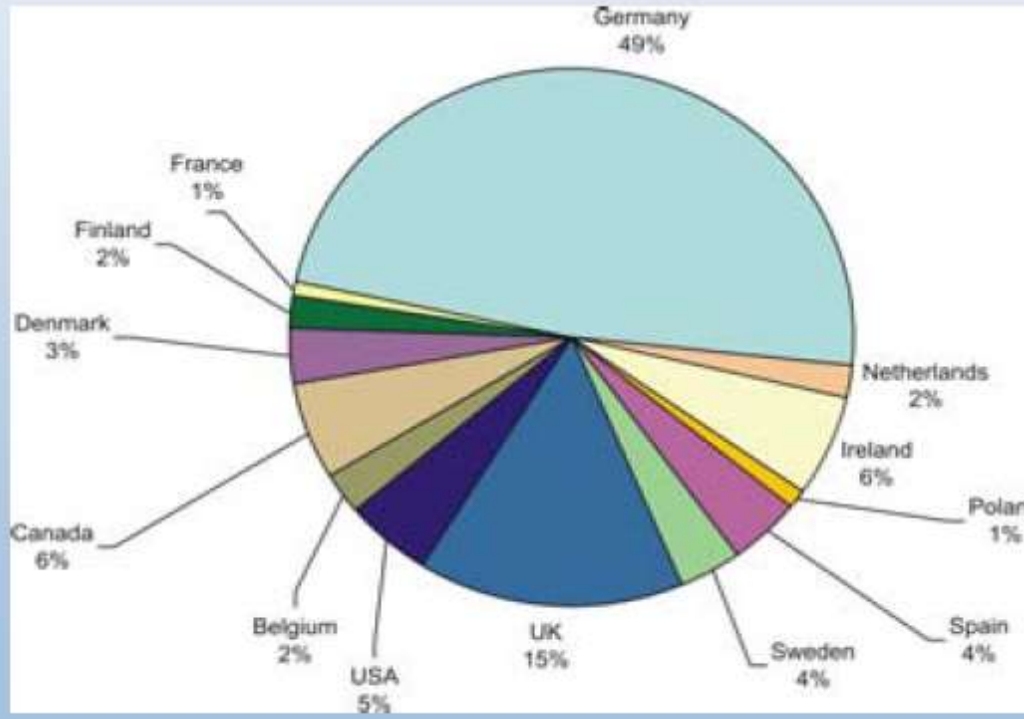
- 240 MW barrage on the Rance estuary in northern Brittany.
- The 0.8 km-long dam also serves as a highway bridge linking St. Malo and Dinard.
- 1961 and 1966 and has now completed 34 years of successful commercial operation.
- Annual generation is around 640 million kWh.

Offshore wind projects

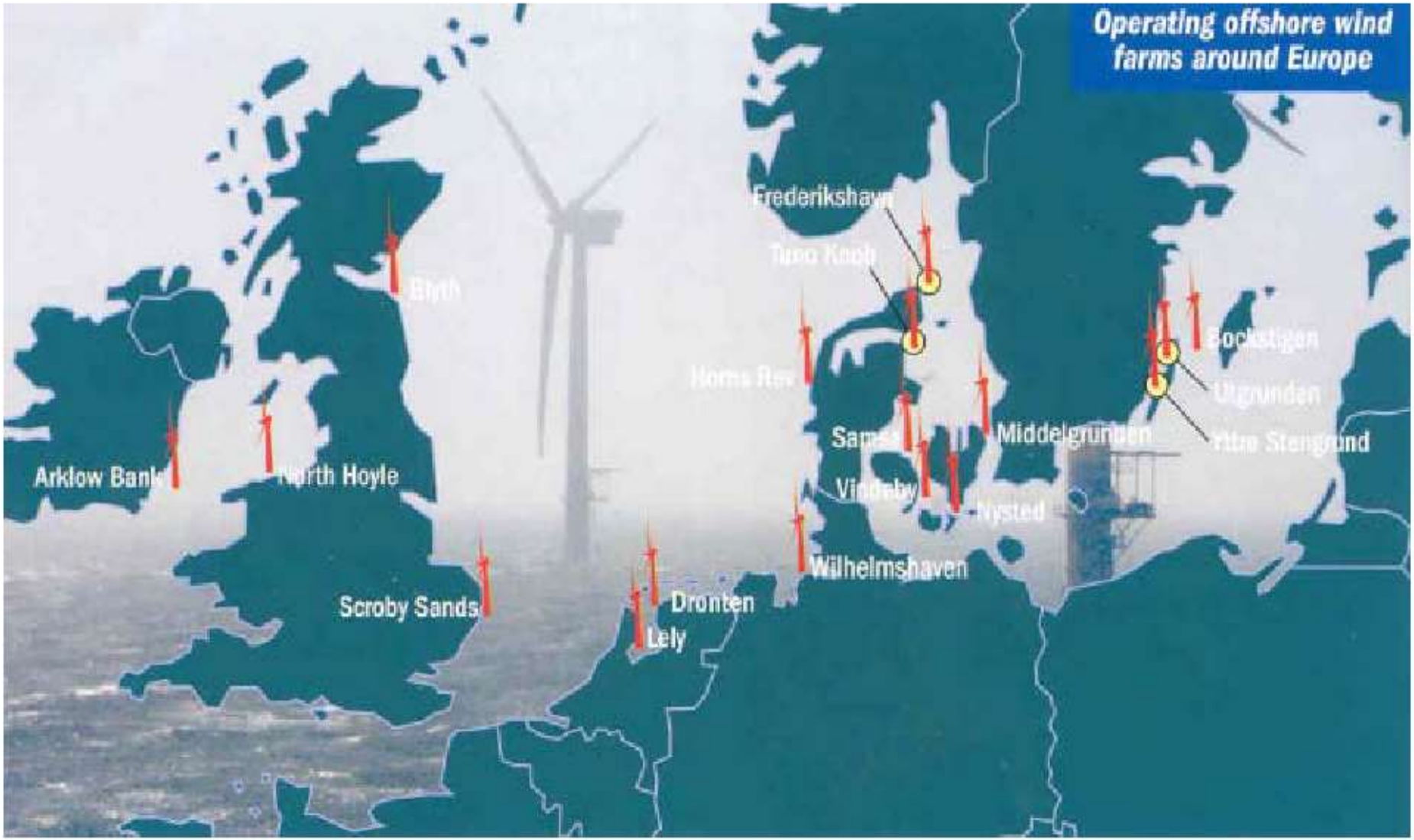
Offshore Wind Projects Worldwide: 617 MW
(2004)



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

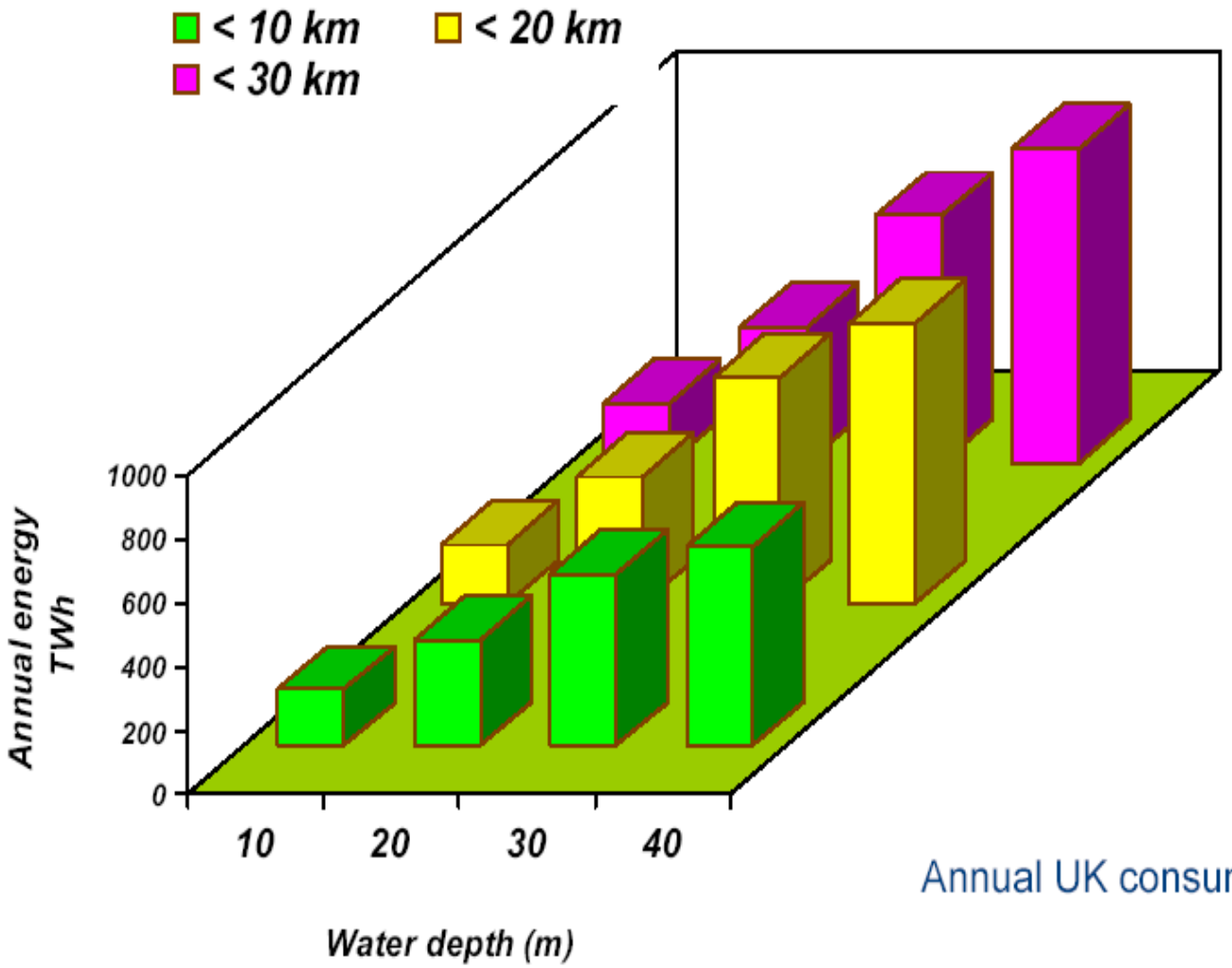


Offshore wind farms in Europe



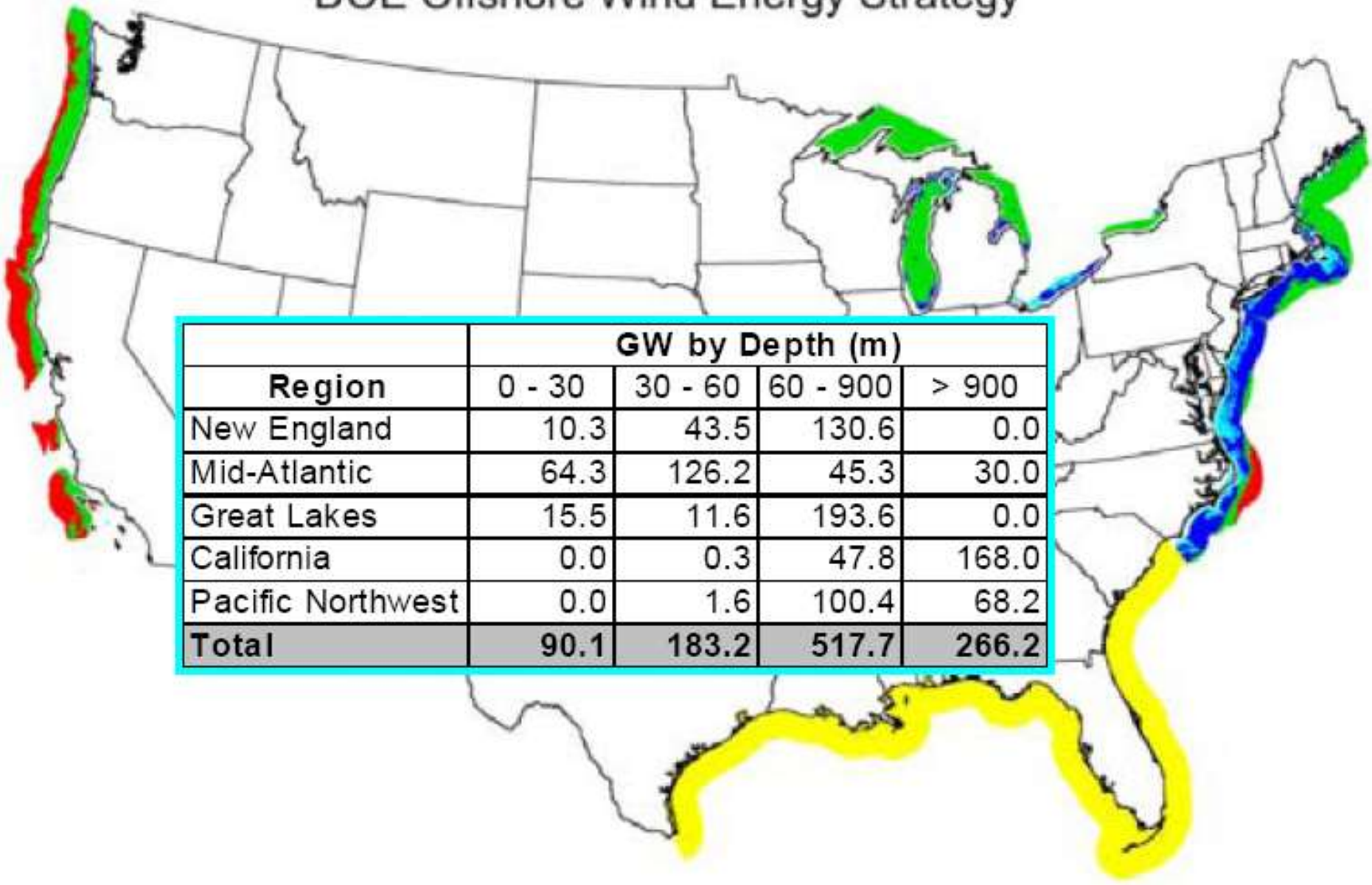
Source: Wind Directions, September 2004

Offshore wind potential in the UK



Annual UK consumption: 320TWh

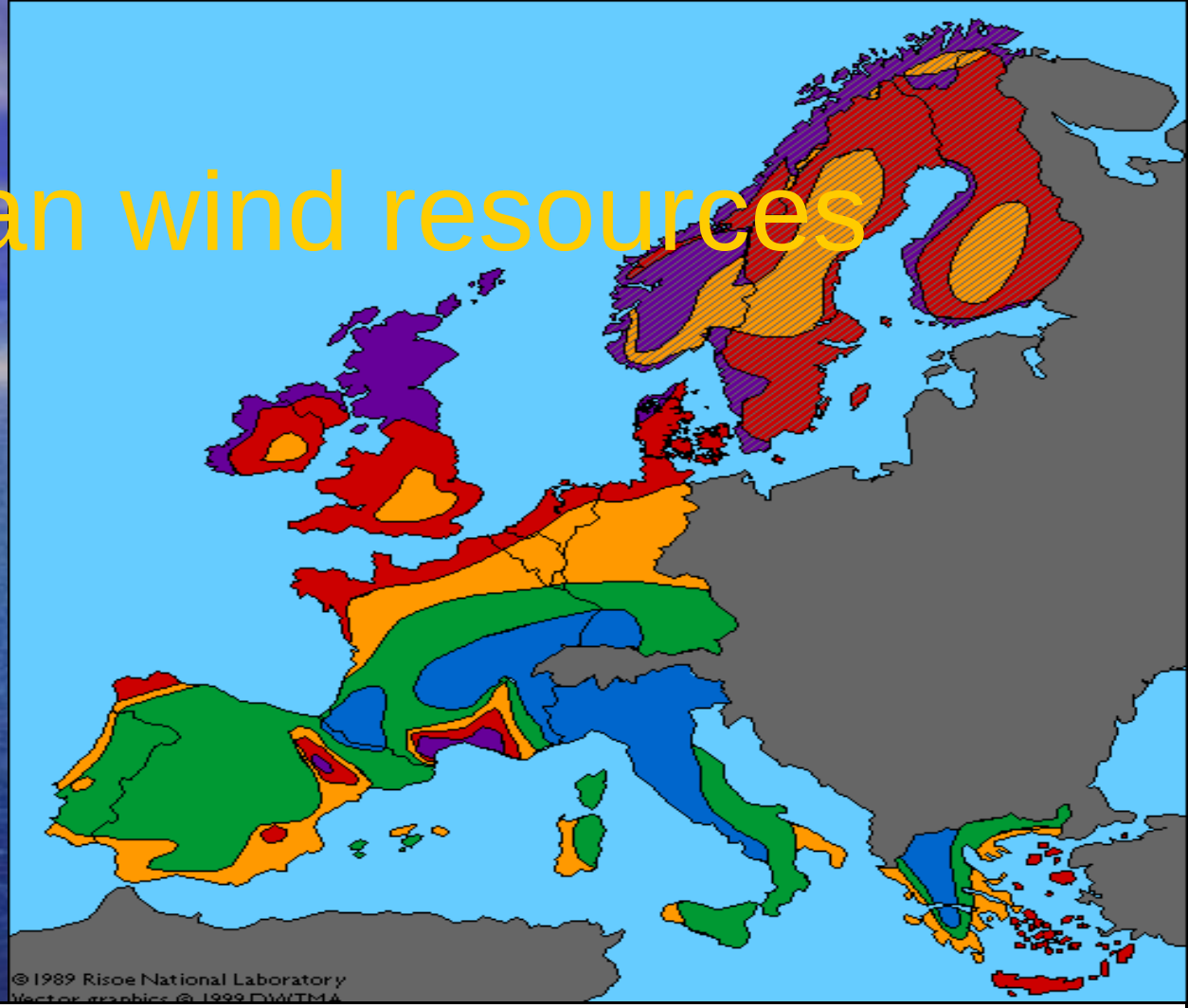
DOE Offshore Wind Energy Strategy



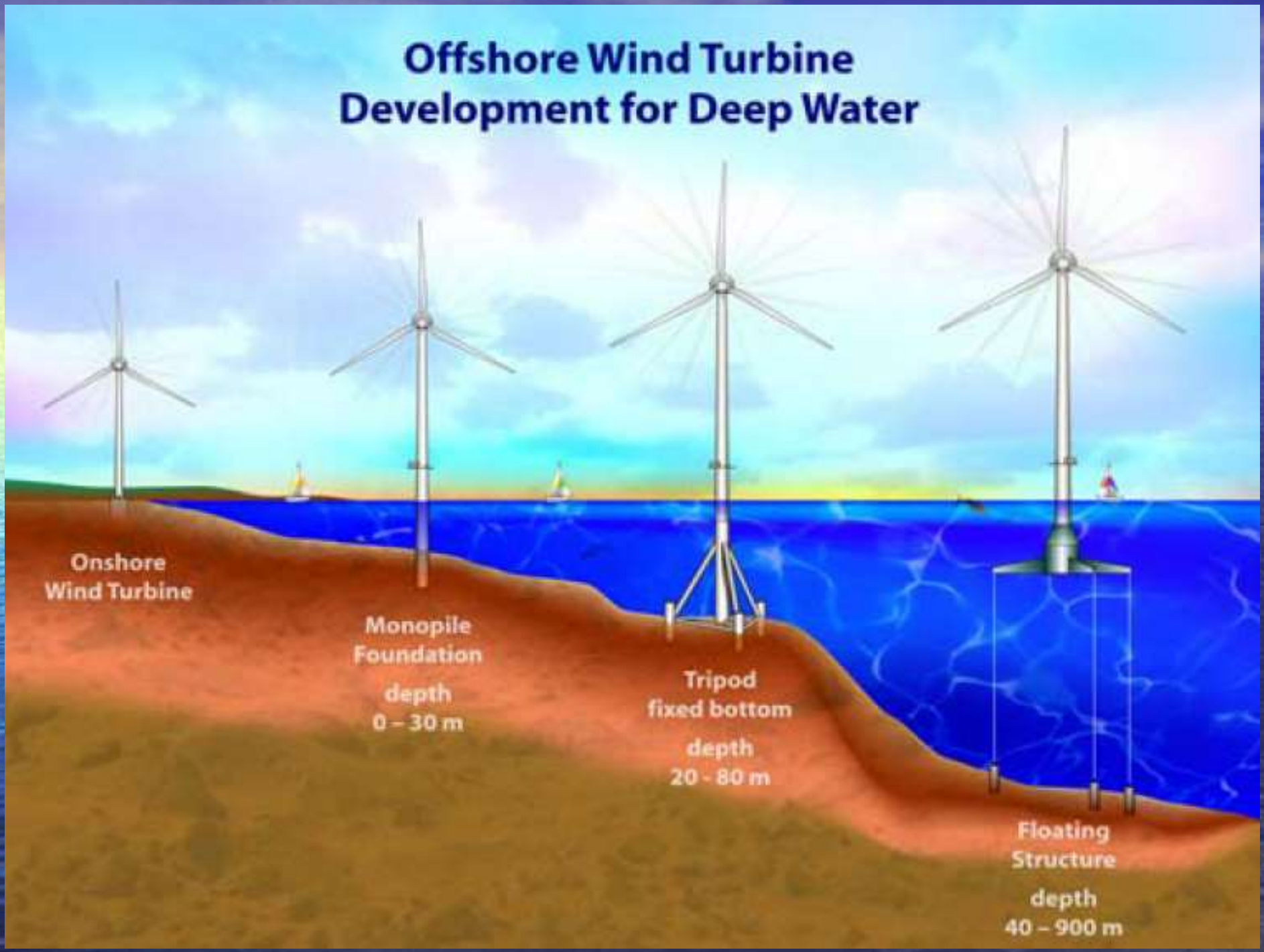
	GW by Depth (m)			
Region	0 - 30	30 - 60	60 - 900	> 900
New England	10.3	43.5	130.6	0.0
Mid-Atlantic	64.3	126.2	45.3	30.0
Great Lakes	15.5	11.6	193.6	0.0
California	0.0	0.3	47.8	168.0
Pacific Northwest	0.0	1.6	100.4	68.2
Total	**90.1**	**183.2**	**517.7**	**266.2**

European wind resources

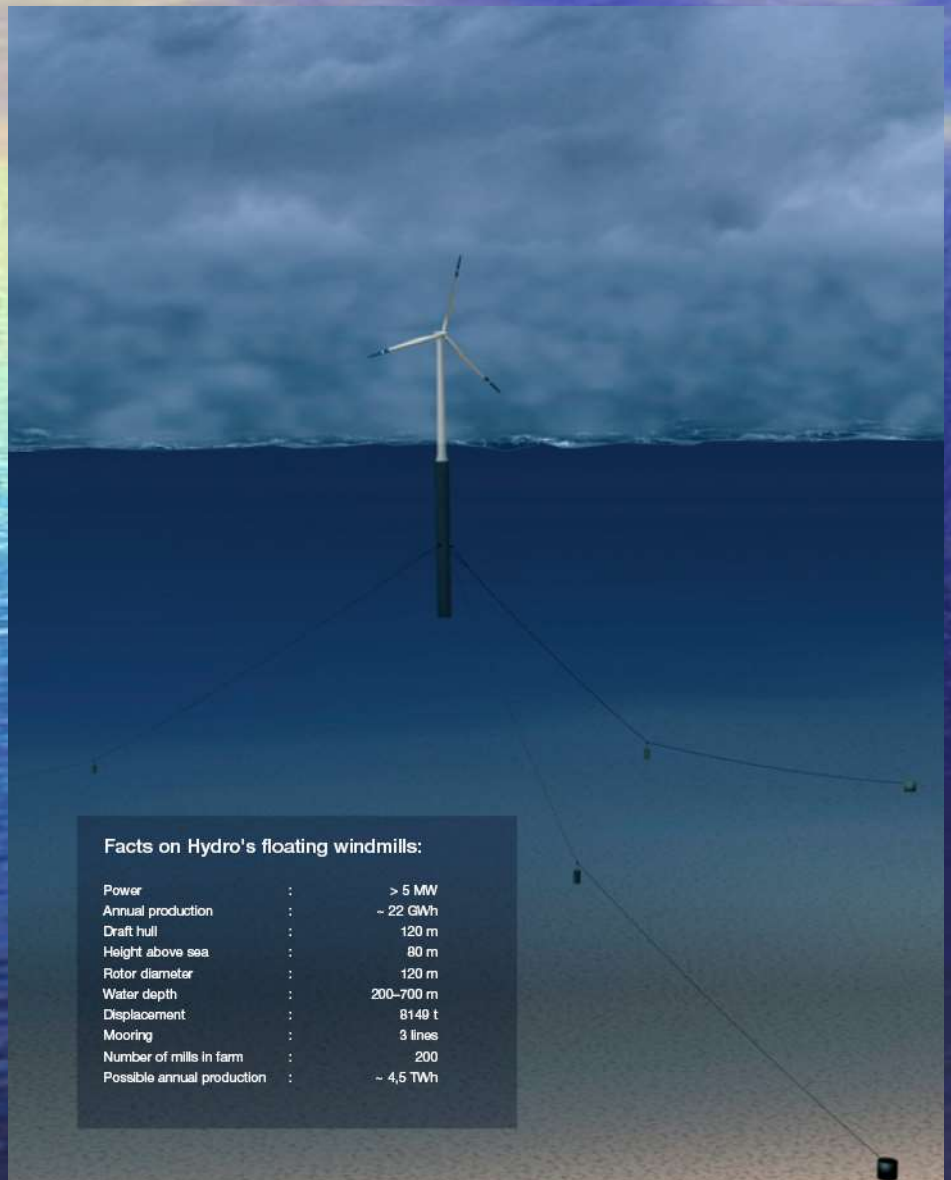
Wind resources at 50 meters above ground level for five different topographic conditions: 1) Sheltered terrain, 2) Open plain, 3) At a coast, 4) Open sea and 5) Hills and ridges.



	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



Facts on Hydro's floating windmills:

Power	:	> 5 MW
Annual production	:	~ 22 GWh
Draft hull	:	120 m
Height above sea	:	80 m
Rotor diameter	:	120 m
Water depth	:	200–700 m
Displacement	:	8149 t
Mooring	:	3 lines
Number of mills in farm	:	200
Possible annual production	:	~ 4,5 TWh

PARTNERS:

1. UNIVERSITY OF THE AEGEAN
2. ALGOSYSTEMS
3. CRES
4. EPISEY - NTUA
5. J.KOUIMANIS
6. LAMDA SHIPYARDS
7. TECHNAVA
8. SOUTH AEGEAN REGION
9. REFLEXION
10. HELLENIC REGISTER OF SHIPPING

Financial Support:

GENERAL SECRETARY RESEARCH AND TECHNOLOGY

EUROPEAN UNION

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

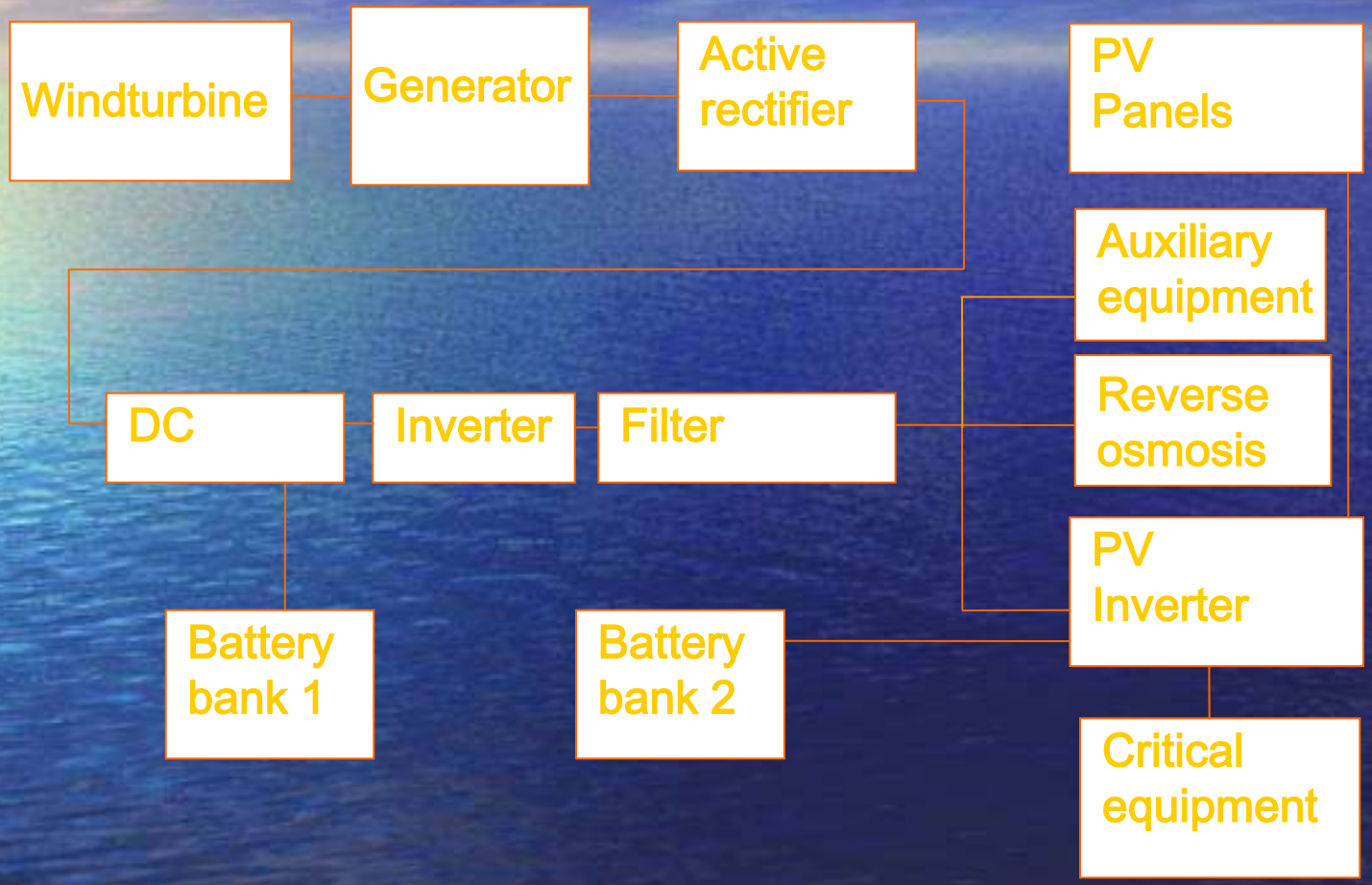
- Autonomous Operation
- Ecological
- Scalable
- Transferable

Technical Problems

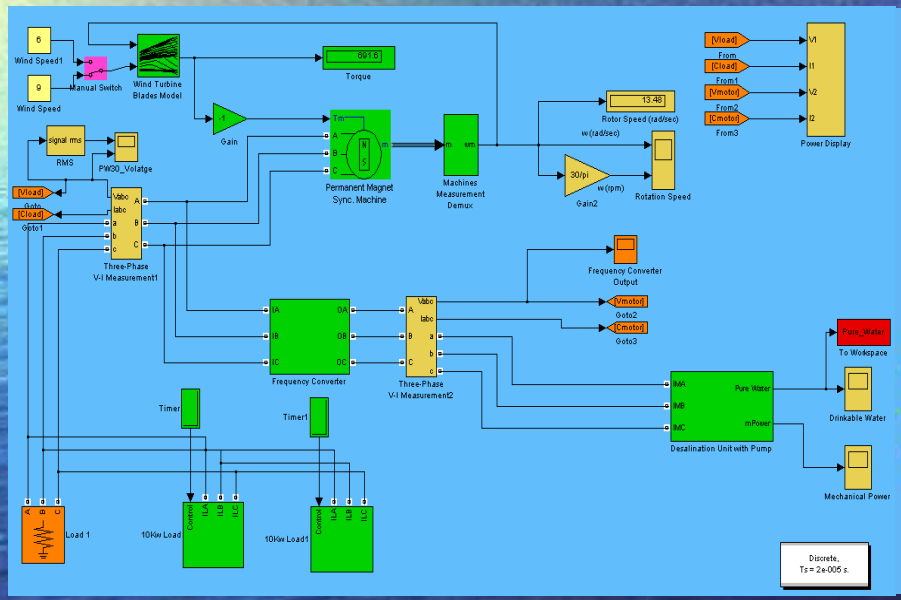
- Operation of wind turbine on a floating structure.
- Energy autonomous operation leads to complex solutions.
- Variable power input -> variable water production.
- No chemical treatment -> increase membrane scaling.
- Variable production -> increase scaling additionally.
- Unmanned automatic control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

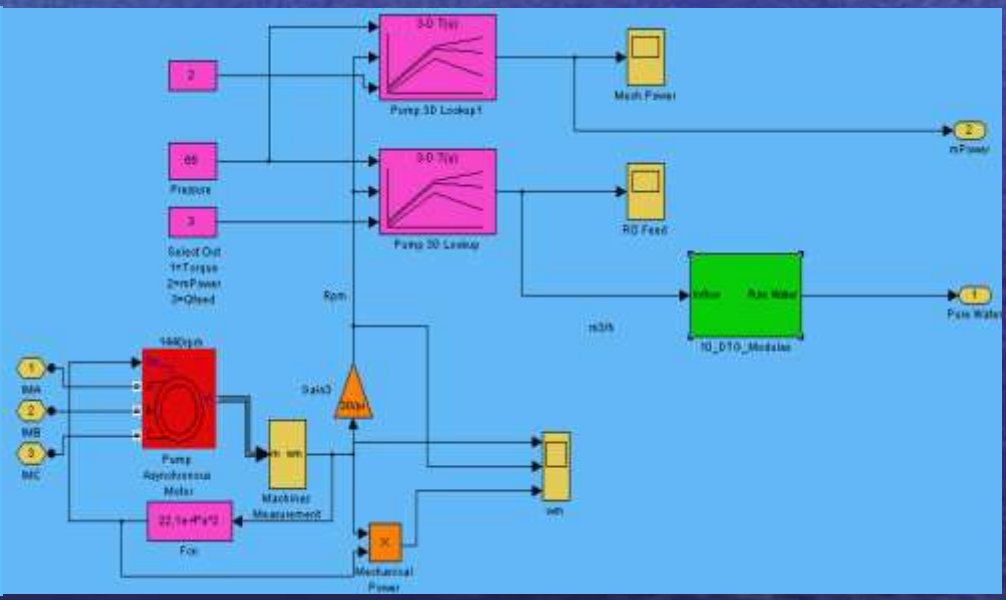
Design and Operation

Electrical Design

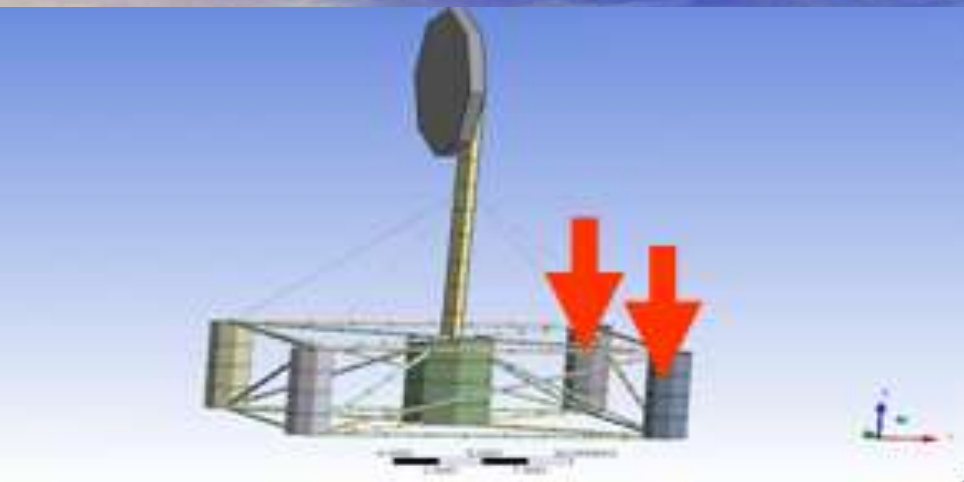


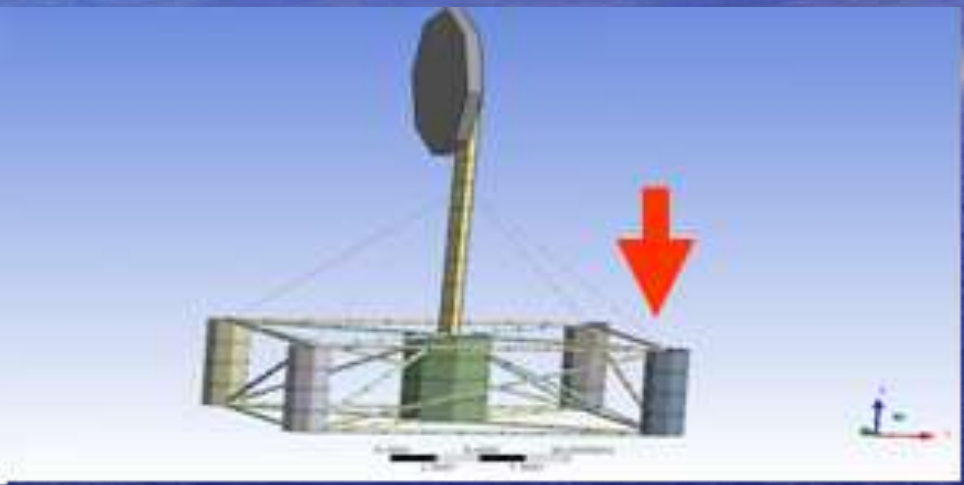
Block simulation of components



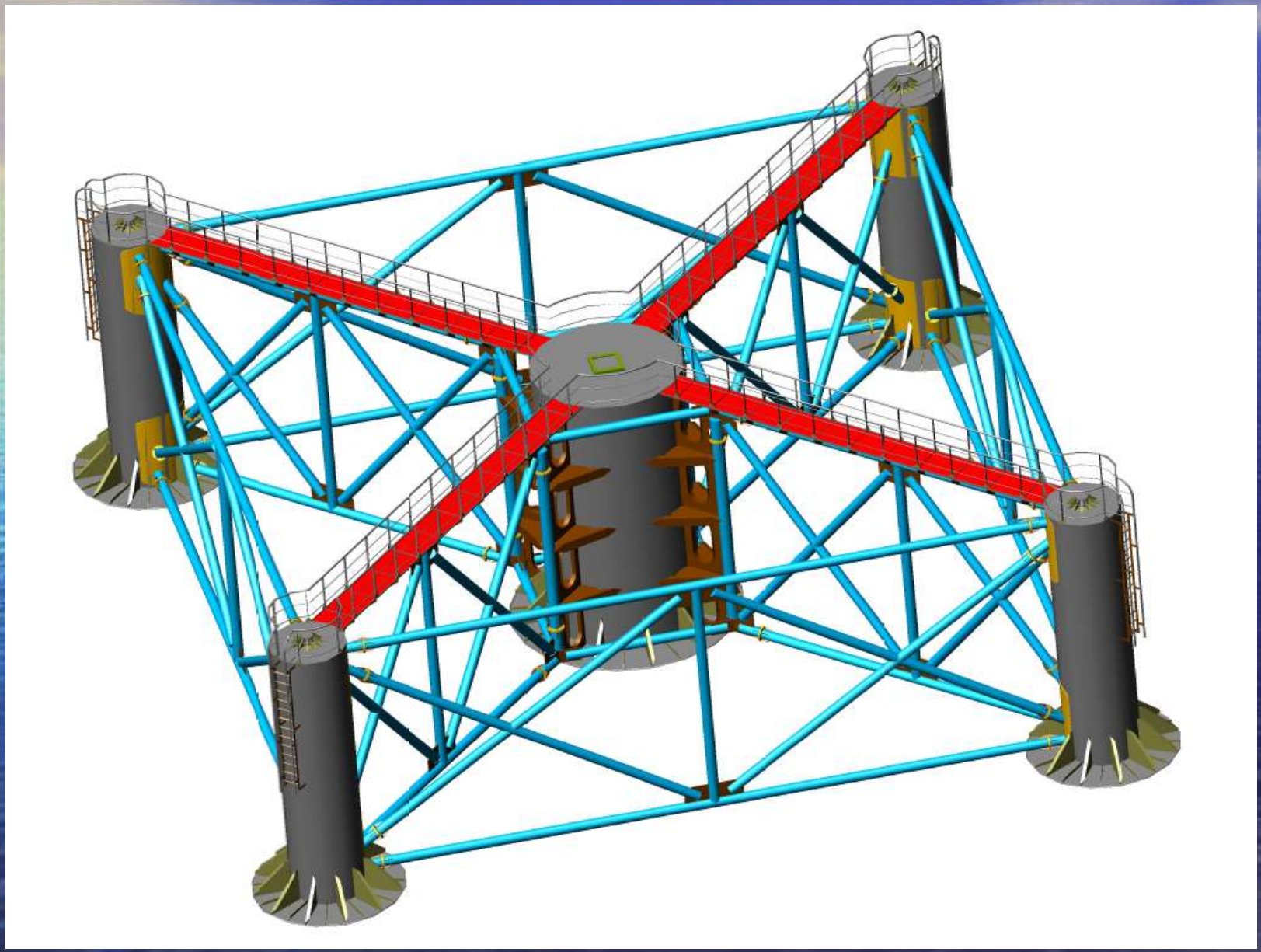


Floating Structure Simulation





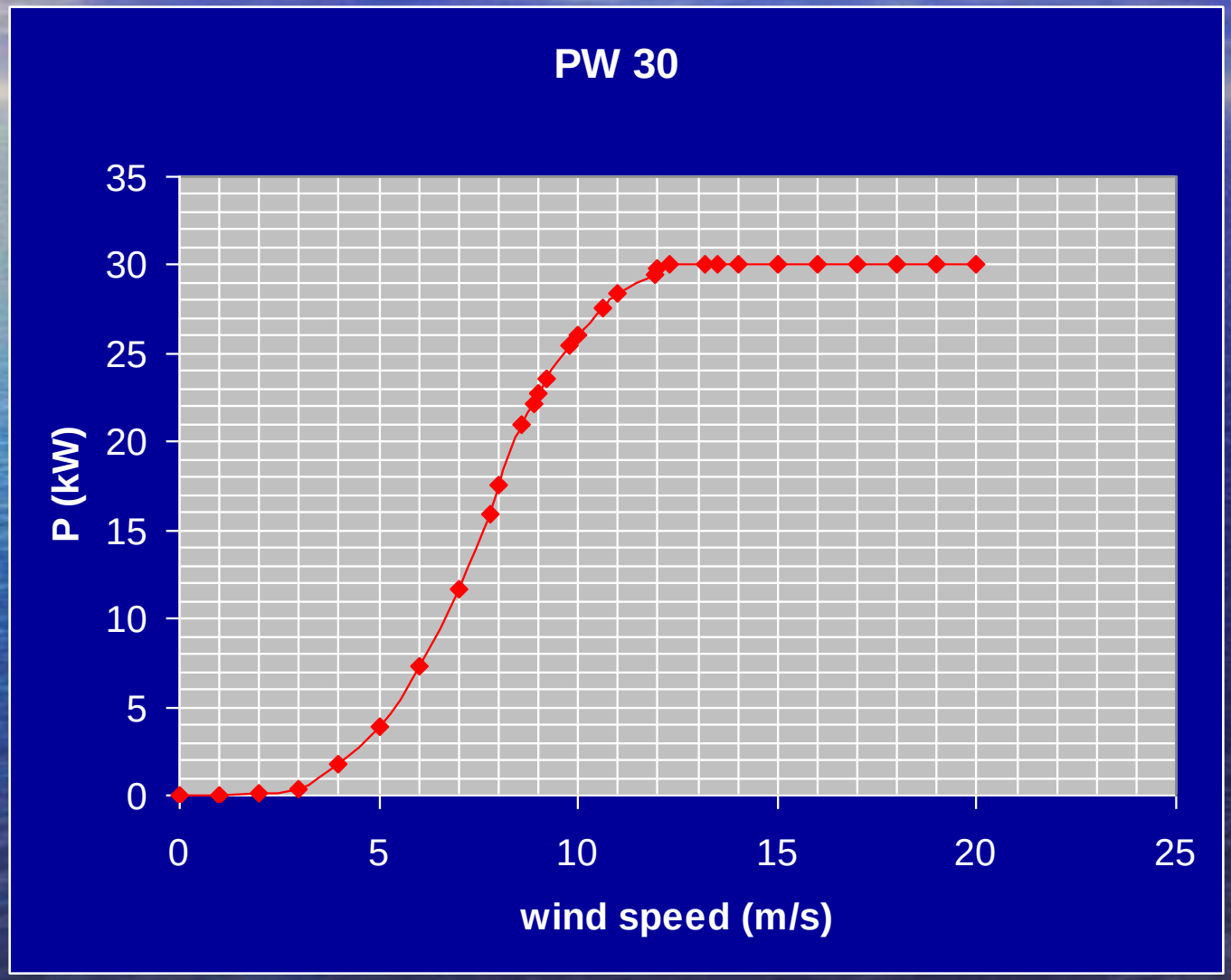
Final Design of the Floating Platform



Wind Turbine

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

POWER DIAGRAM

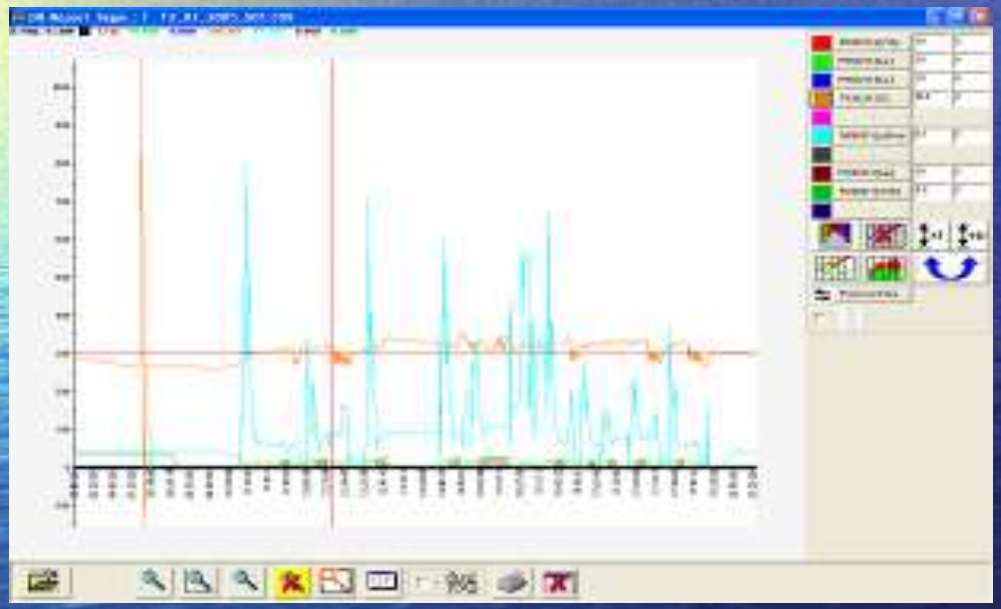


Improvement of Desalination Unit

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

EXPERIMENTS

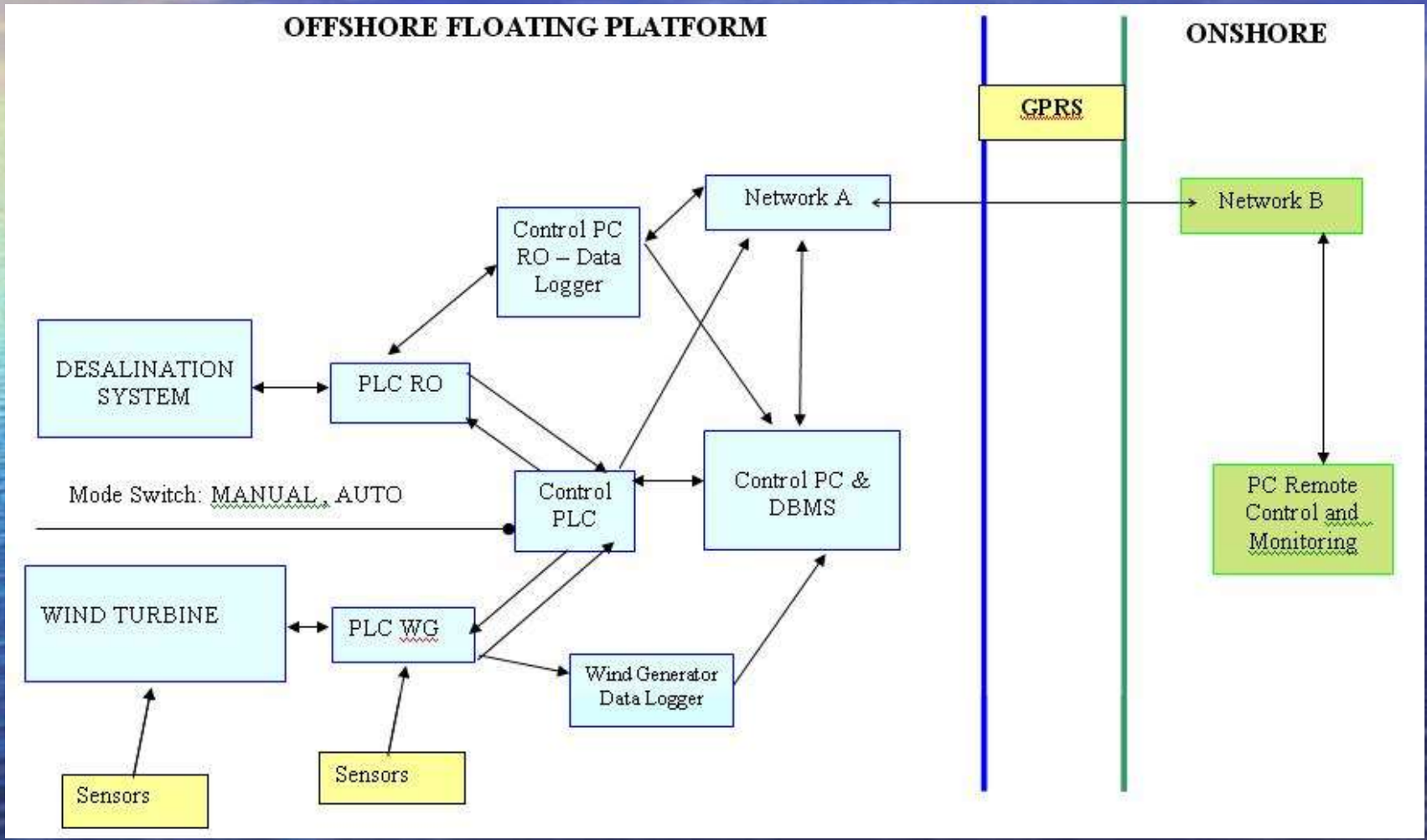
Operational Data



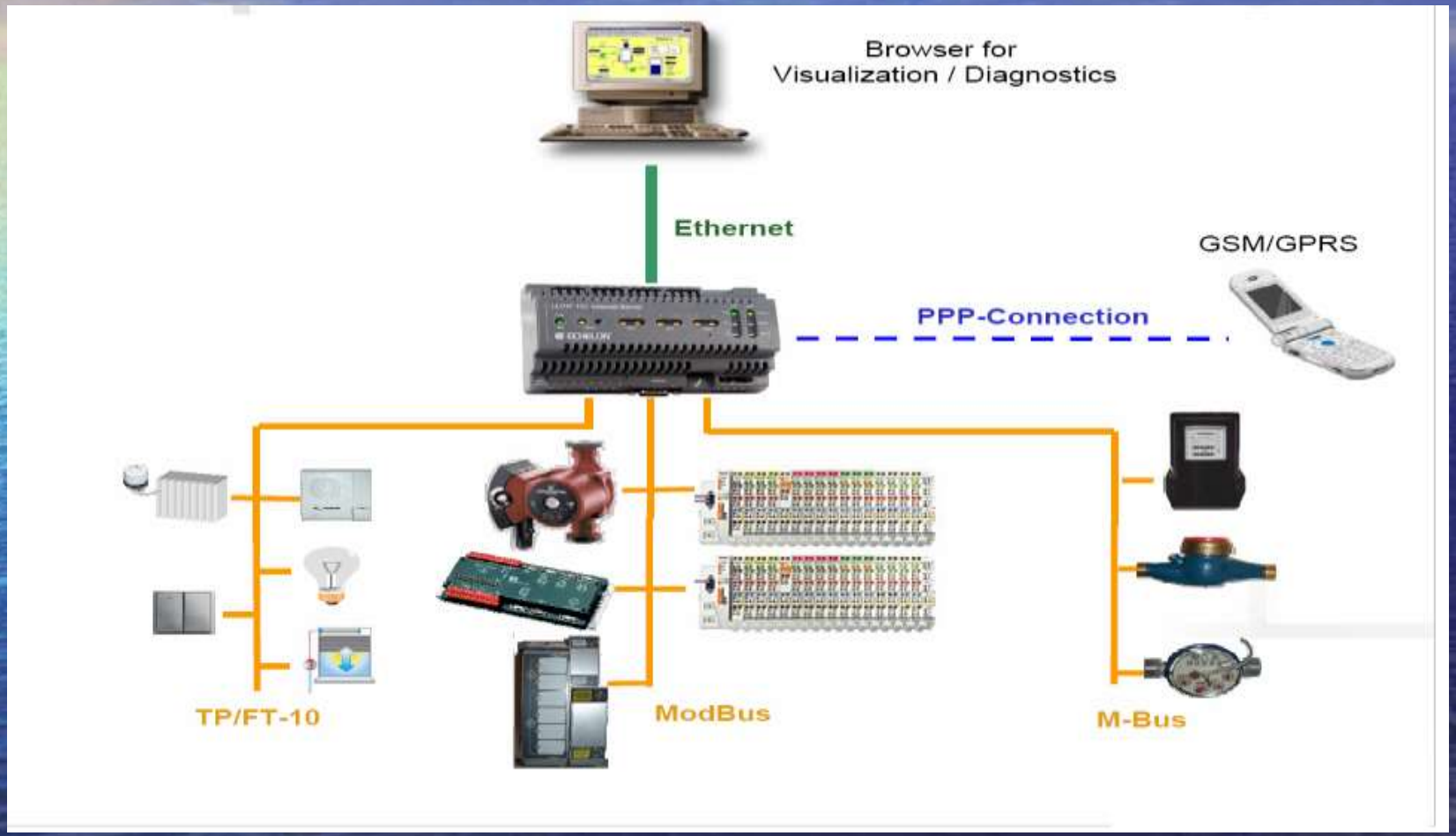
DB-Report Segm.: 1 06_02_2005_S01.CSV

Protocol Date	Protocol Time	Unit11_Faultcode_1	Unit11_Faultcode_2	Unit11_Servicecode_1
06:02:05	11:47:46	0	0	0
06:02:05	11:49:04	0	0	0
06:02:05	11:49:51	0	0	0
06:02:05	11:50:00	0	0	0
06:02:05	11:51:08	0	0	0
06:02:05	11:51:30	0	0	0
06:02:05	11:53:46	0	0	0
06:02:05	11:56:56	0	0	0
06:02:05	11:59:22	0	0	0
06:02:05	12:06:10	0	0	0
06:02:05	13:00:22	0	0	0
06:02:05	13:24:40	0	0	0
06:02:05	13:25:00	0	0	0
06:02:05	13:30:00	0	0	0

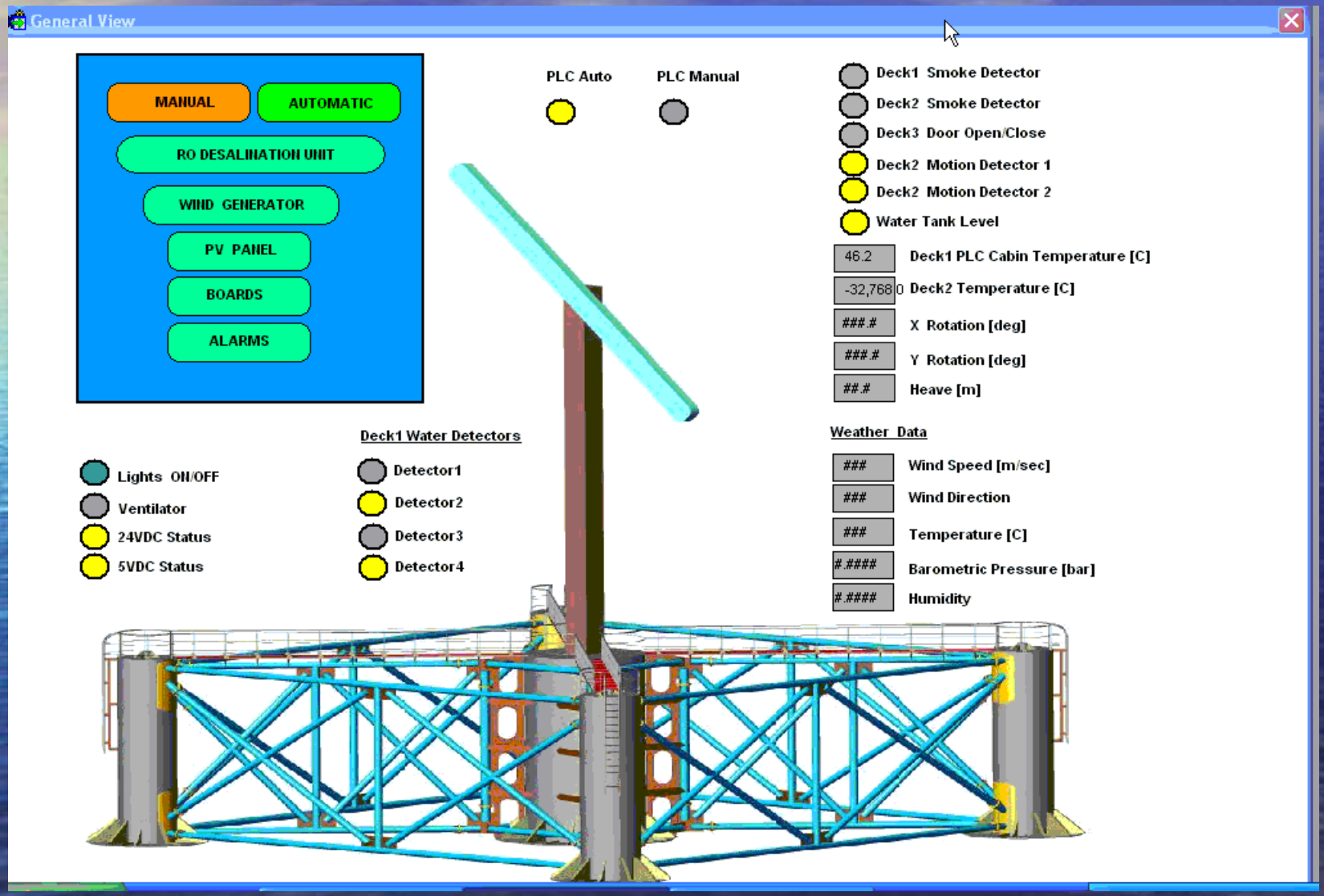
Control and Communication Systems



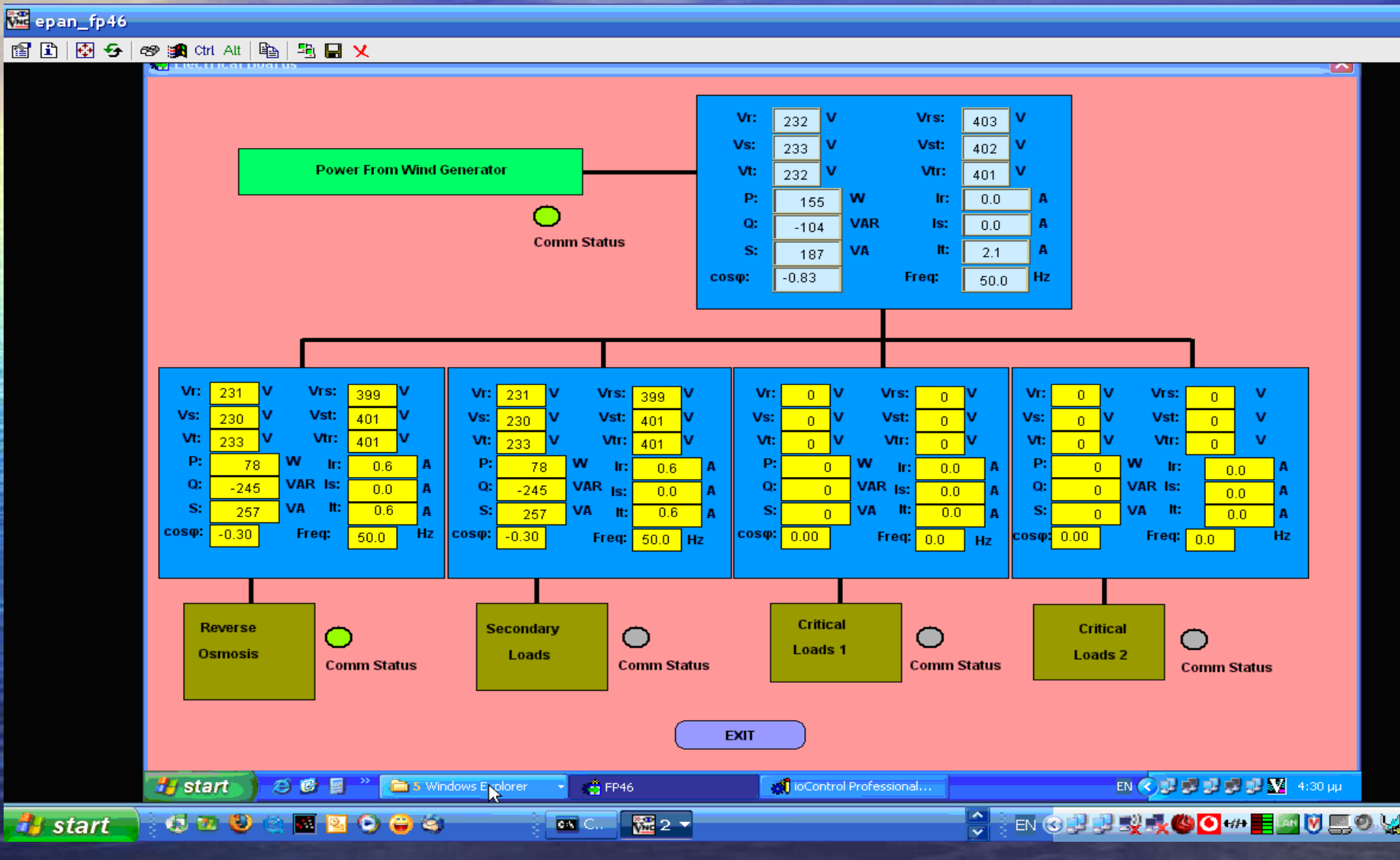
Local Connection network – GPRS



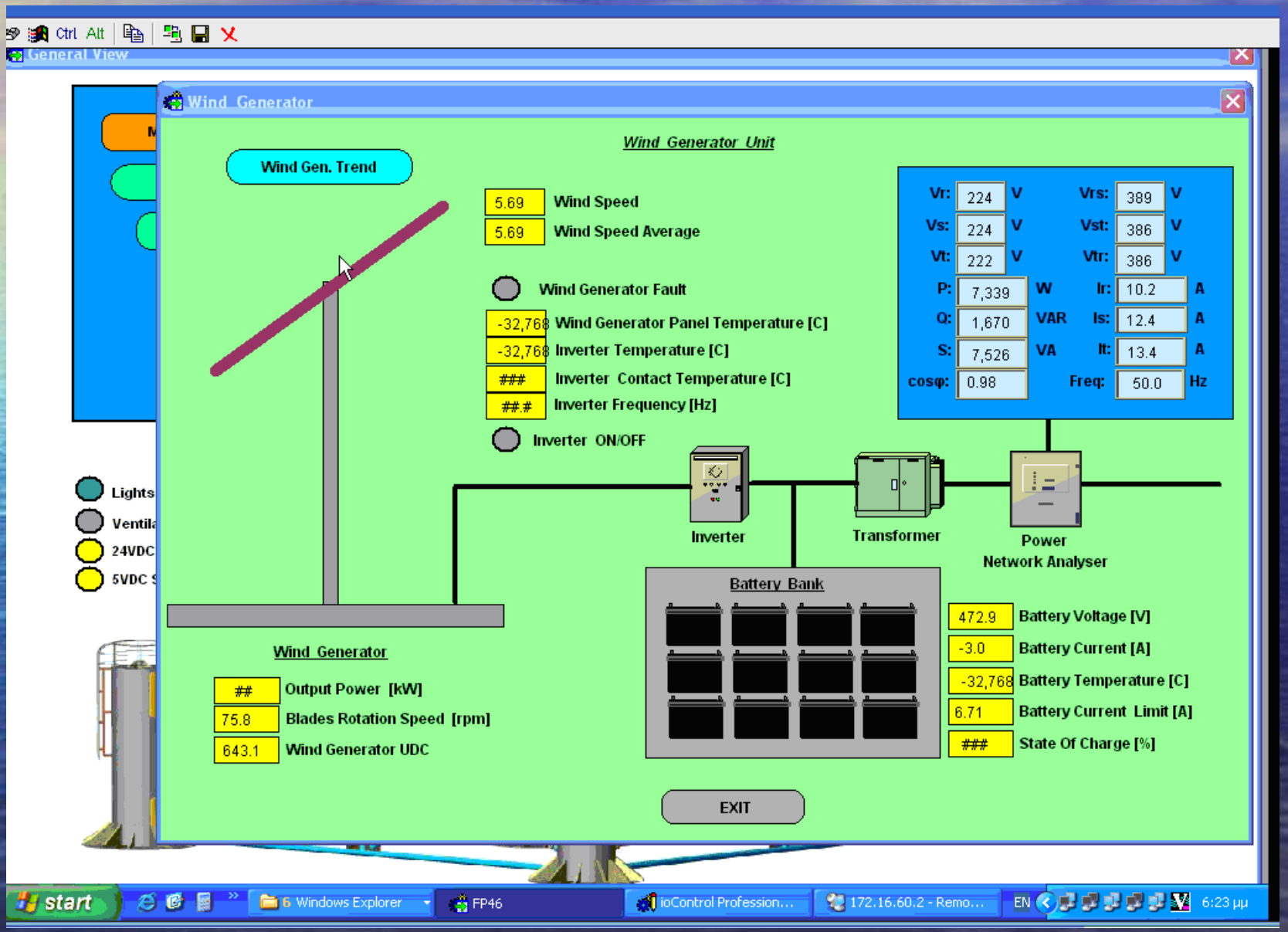
SCADA (1)


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
46.2
Deck1 PLC Cabin Temperature [C]
-32,768
0
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

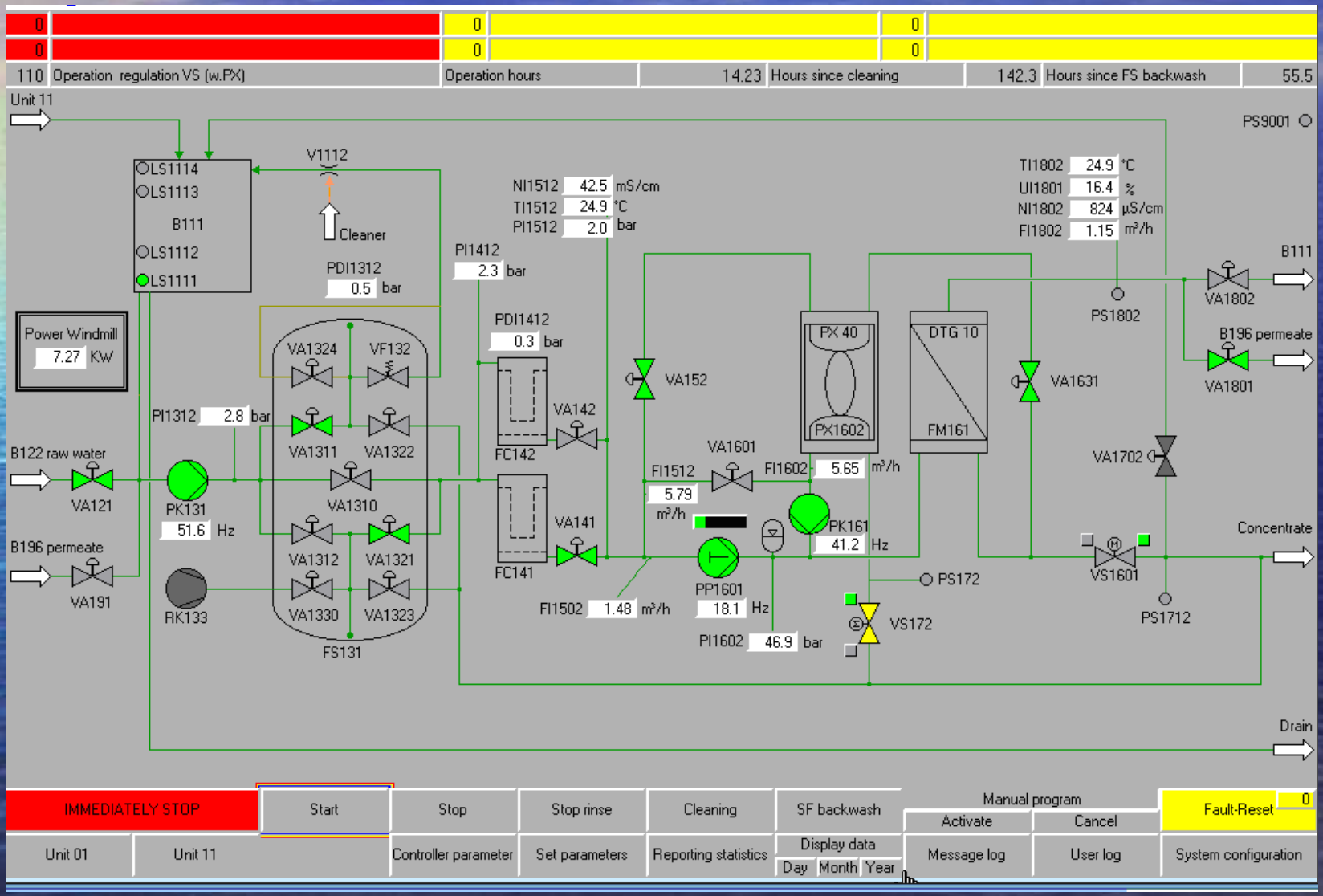
SCADA (2) LOADS



SCADA (3) WT


Ctrl Alt
General View
Wind_Generator
Wind_Generator_Unit
Wind Gen. Trend
5.69 Wind Speed
5.69 Wind Speed Average
Wind Generator Fault
-32,768 Wind Generator Panel Temperature [C]
-32,768 Inverter Temperature [C]
Inverter Contact Temperature [C]
##.# Inverter Frequency [Hz]
Inverter ON/OFF
Vr: 224 V
Vs: 224 V
Vt: 222 V
Vrs: 389 V
Vst: 386 V
Vtr: 386 V
P: 7,339 W
Q: 1,670 VAR
S: 7,526 VA
cosφ: 0.98
Ir: 10.2 A
Is: 12.4 A
It: 13.4 A
Freq: 50.0 Hz
Inverter
Transformer
Power Network Analyser
Lights
Ventil
24VDC
5VDC
Battery_Bank
472.9 Battery Voltage [V]
-3.0 Battery Current [A]
-32,768 Battery Temperature [C]
6.71 Battery Current Limit [A]
State Of Charge [%]
Wind_Generator
Output Power [kW]
75.8 Blades Rotation Speed [rpm]
643.1 Wind Generator UDC
EXIT
start
6 Windows Explorer
FP46
ioControl Profession...
172.16.60.2 - Remo...
EN
6:23 μμ

SCADA (4) RO


0
0
0
0
0
0
110
Operation regulation VS (w.PX)
Operation hours
14.23
Hours since cleaning
142.3
Hours since FS backwash
55.5
Unit 11
PS9001
V1112
LS1114
LS1113
B111
LS1112
LS1111
Cleaner
PDI1312
0.5 bar
NI1512 42.5 mS/cm
TI1512 24.9 °C
PI1512 2.0 bar
PI1412
2.3 bar
PDI1412
0.3 bar
TI1802 24.9 °C
UI1801 16.4 %
NI1802 824 µS/cm
FI1802 1.15 m³/h
B111
VA1802
PS1802
B196 permeate
VA1801
Power Windmill
7.27 KW
VA1324
VF132
VA152
PX 40
PX1602
DTG 10
FM161
VA1631
PI1312 2.8 bar
VA1311
VA1322
VA142
FC142
VA1601
VA1702
B122 raw water
VA121
PK131
51.6 Hz
VA1310
FI1512
5.79
m³/h
FI1602 5.65 m³/h
PK161
41.2 Hz
Concentrate
B196 permeate
VA191
VA1312
VA1321
VA141
FC141
VS1601
RK133
VA1330
VA1323
FS131
FI1502 1.48 m³/h
PP1601
18.1 Hz
PS172
PS1712
PI1602 46.9 bar
VS172
Drain
IMMEDIATELY STOP
Start
Stop
Stop rinse
Cleaning
SF backwash
Manual program
Activate
Cancel
Fault-Reset
0
Unit 01
Unit 11
Controller parameter
Set parameters
Reporting statistics
Display data
Day
Month
Year
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

UNIVERSITY OF THE AEGEAN

Department of Shipping
Trade and Transport

Thank you for your attention

nnik@aegean.gr