

green energy in Adriatic sea



Ravenna, 28 Giugno 2013

From installation of the new experimental small wind turbine of Project Powered to a systematic project of green port in Ravenna

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Tozzi Nord // TRE – Tozzi Renewable Energy



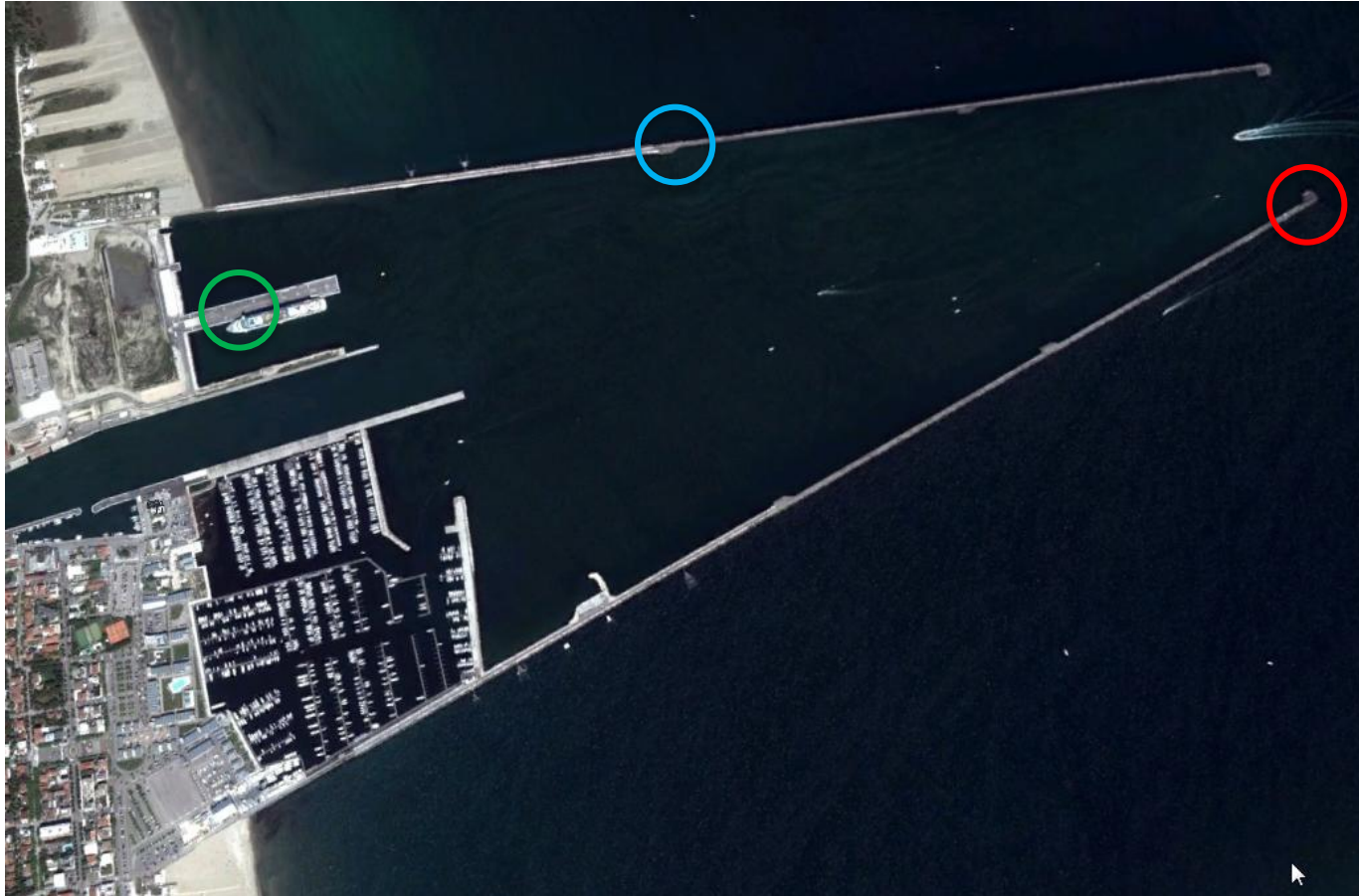
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PORT of RAVENNA – Powered



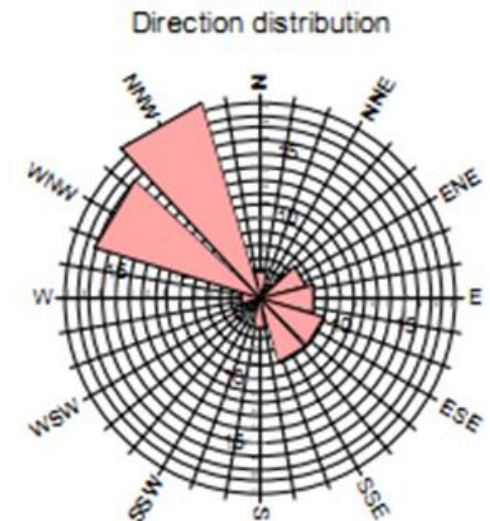
- Met mast;
- 1,5 kW VAWT met mast;
- 10 kW HAWT;

Experimental wind campaign and assessment



Periods	29/10/2009 31/01/2011	01/02/2011 14/12/2011	21/03/2012 28/06/2013
Sampling	10 min	1 min	1 min
Signals	ws, wd	ws, wd	ws, wd, T, P

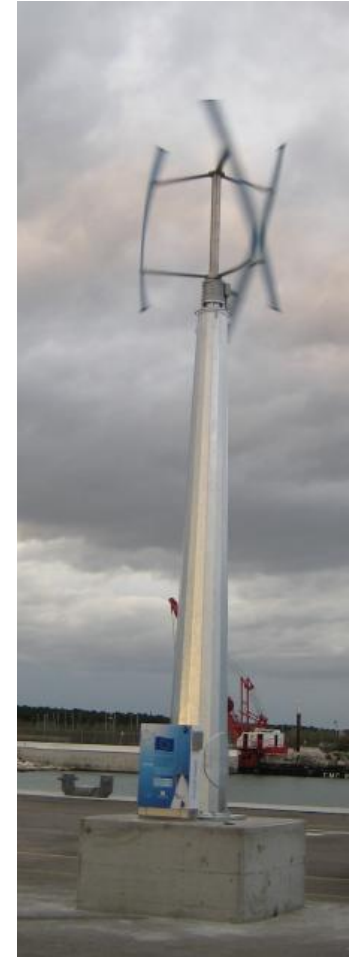
- Place: Marina di Ravenna (RA) – Diga foranea
- Height: 15m
- Sensors: ws, wd, T, P
- Data Logger: N2
- Data since: 29/10/2009
- Maintened by: Tozzi Nord S.r.l.
- Powered requirements evaluation: not passed but of interest for preliminary assessment.



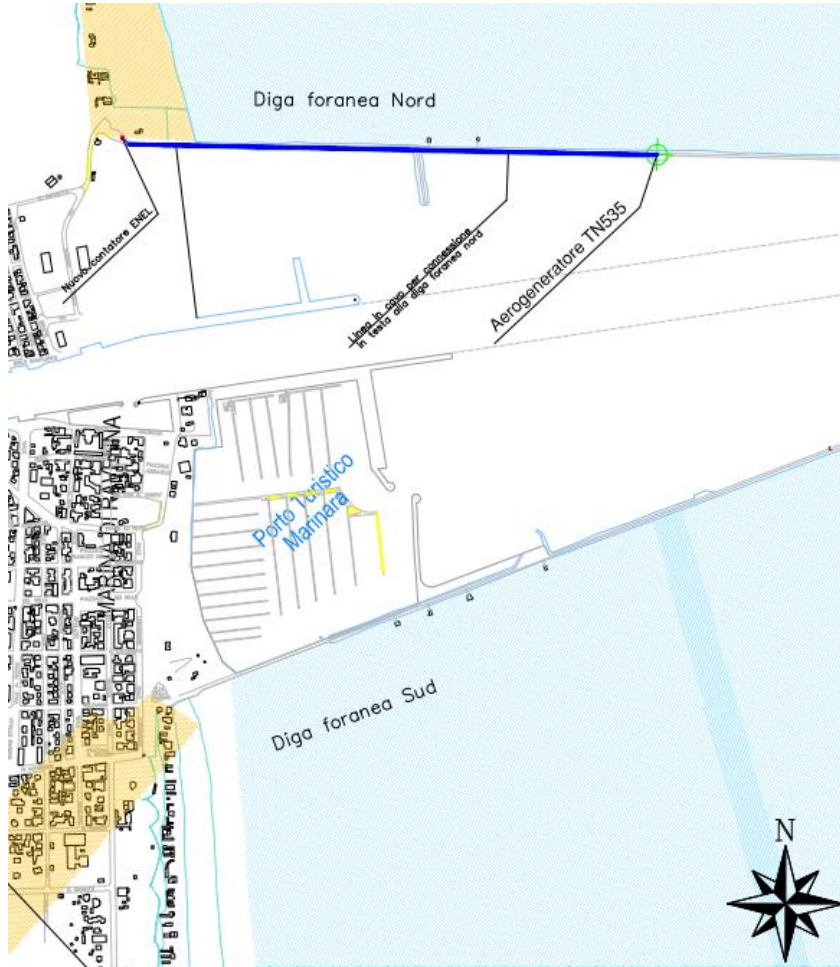
VAWT demonstrative installation

Aims:

- On-field experience;
- Wind energy exploitation on port areas;
- Wind data acquisition;
- Wind Turbine/Energy data evaluation;



HAWT demonstrative installation



Localization: Porto Corsini (RA) – Harbour dam

Permitting :

- The Port of Ravenna Authority (PRA) has been in charge for permitting applications;
- PRA - Verification of the State-Region Agreement done. Compliance verification to the land use plan;
- Tozzi Nord was in charge for grid connection application support and technical support for all the demonstrative project;
- Port Authority and IT Navy involved for electrical connection cable use (about 1300 m);
- Custom involved: permission for building in proximity of the State border.

HAWT demonstrative installation



HAWT demonstrative installation



HAWT demonstrative installation



HAWT demonstrative installation

Turbine Architecture:

Type	Upwind rotor with active pitch control and active yaw control
Direction of rotation	Clockwise (upwind view)
Number of blades	3
Rotor diameter	13.2 m
Hub height	15-18-24 m
Rated power	9.9 kW
Power regulation	Active pitch (pitch to feather)
Cut-in wind speed	2.5 m/s
Cut-out wind speed	16 m/s
Rated wind speed	6.7 m/s
Rotor diameter	13.2 m
Rotor swept area	136.7 m ²

Rotor

Type	LWTB535
Blade length	6.344 m
Material	GFRP
Lightning protection	Optional
Hub	Fixed (no tilt)

Drive train

Transmission	Belt drive
Main bearing	Single-row ball bearing
High speed shaft Rotational Speed	225-750 rpm
Low speed shaft Rotational Speed	20-66 rpm
Grid feed Inverter	ABB ACS M1

Generator

Nominal power	11.0 kVA
Type	Permanent Magnets Synchronous Generator 8 poles
Protection	IP54
Insulation class	F

Yaw System

Yaw Type	Active yaw control
Yaw Rate	3.35 deg/s

Controller

Type	PLC
Remote monitoring	Tozzi Nord SCADA / Real Time Viewer
UPS	2x12V BACK UP batteries

Breaking System

Aerodynamic brake	Collective pitch, (3 pitch linear actuator rates: 14, 21, 48 mm/s)
Redundant aerodynamic brake	Passive centrifugal system that brings blades to braking position
Rotor lock	Metal pin inserted for maintenance

Tower

Tower height	14.6m-17.6m-23.6m
Tower type	Polygonal steel Tower, 16 sides, 2 sections
Design wind class	IV

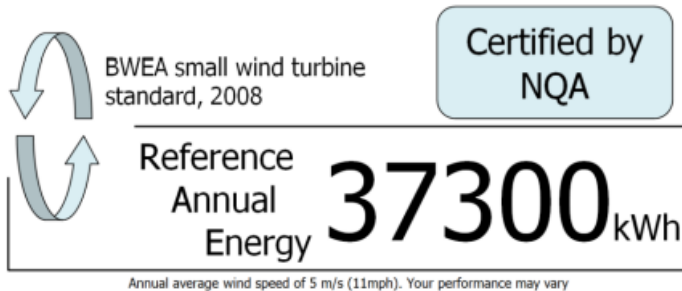
Weights

Nacelle (excluding Rotor and Hub)	783 kg
Rotor (including Hub)	332 kg
Tower	1300kg (14.6m) - 1750kg (17.6m) - 3350kg (23.6m)



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HAWT demonstrative installation



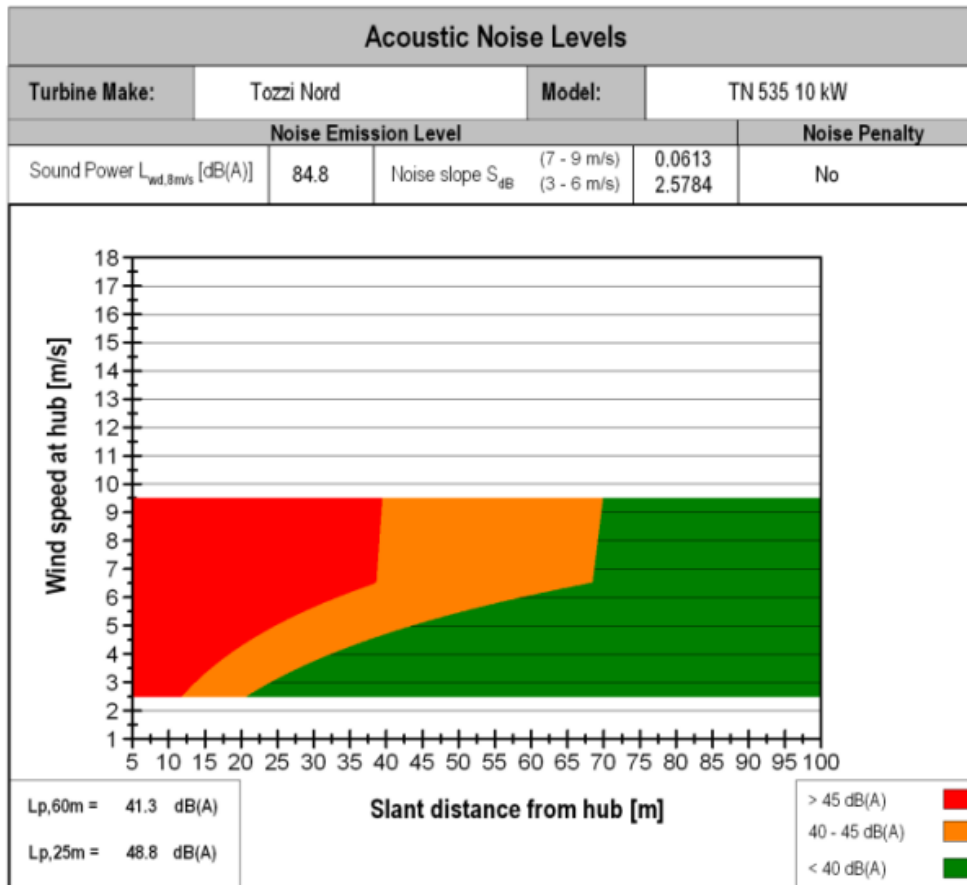
Aims:

- On-field experience
- Wind energy exploitation on port areas
- Wind Turbine/Energy data acquisition

ESTIMATED ANNUAL ENERGY PRODUCTION (AEP) (database A)				
extrapolation of the power curve between the highest measured wind speed and the cut-out wind speed with the average power at highest measured wind speed		WT: TN 535		
		cut-out wind speed: 16 m/s		
		reference air density: 1.225 kg/m ³		
		coverage factor k: 1		
hub height annual average wind speed (Rayleigh) [m/s]	AEP-measured (measured power curve) [MWh]	Expanded uncertainty of AEP- measured		AEP-extrapolated (extrapolated power curve) [MWh]
		[MWh]	[%]	
4.0	24.59	1.90	7.71	24.59
5.0	37.36	2.09	5.59	37.41
6.0	47.24	2.12	4.48	47.59
7.0	53.52	2.05	3.83	54.54
8.0	56.39	1.94	3.44	58.30
9.0	56.61	1.81	3.19	59.40
10.0	55.03 *	1.66	3.02	58.54
11.0	52.39 *	1.52	2.91	56.39

values marked with *: power curve incomplete acc. to IEC criteria for database

HAWT demonstrative installation



Aims:

- On modern SWT noise it is not an issue anymore.

From demonstrative projects to a systematic ideas of green ports

Port Authorities are hence more and more committed towards a sustainable management of their areas



From demonstrative projects to a systematic ideas of green ports



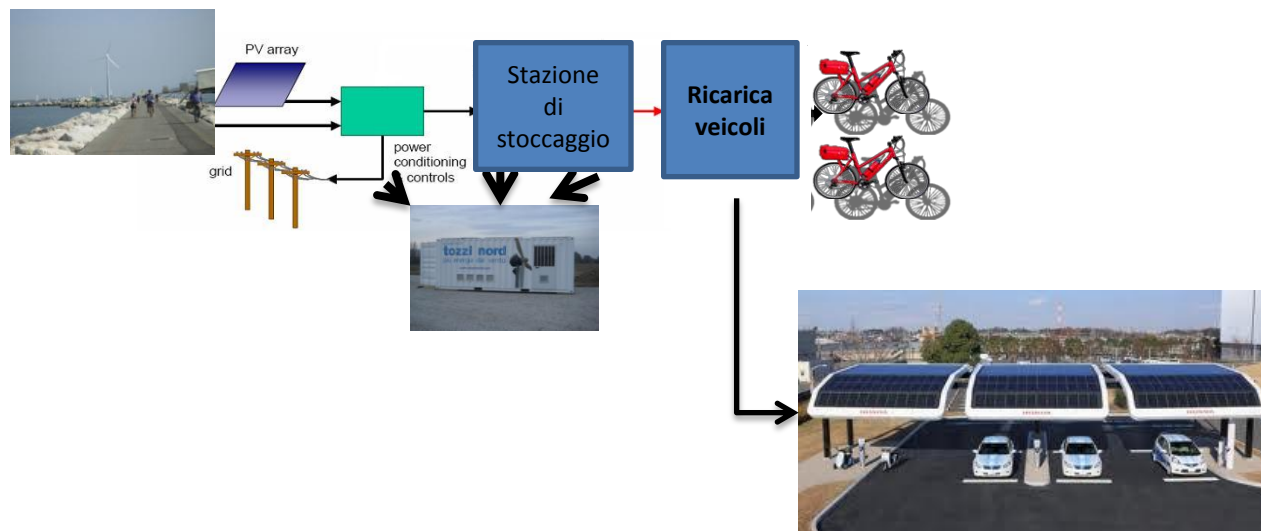
ZERO – EMISSION MOBILITY

Energy generation – renewable energy (wind, photovoltaic, biomass, geothermal)

Energy Storage – energy storage system (ESS) / batteries + power conversion system (PCS)

Recharging station – powered by ESS

Mobility – electric vehicles (bikes, cars, mini-van, buses, forklifts, etc...)



LIFE RE-PORT Project

Partners

Autorità Portuale di Ravenna (Lead Partner)

Autorità Portuale di Taranto

Autorità Portuale di La Spezia

Provincia di Ravenna

Centuria Agenzia per l'Innovazione

CNR – ITAE Messina

TRE – Tozzi Renewable Energy

General Objective

Therefore, the LIFE RE-PORT Project aims at enhancing the role of ports in contributing to the implementation of the EU's Climate Goals towards 20-20-20 targets and the roadmap moving towards an EU low-carbon economy in 2050.



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LIFE RE-PORT Project

Project deliverables

- To outline the energy-environment assessment;
- To develop a model of zero-emission actions within the port area providing both technical and financial feasibility framework;
- To demonstrate the model by implementing pilot projects applied to port mobility, validating technologies/approaches to the different ports' conditions and needs;
- To elaborate a strategy for cooperation among local administrations, stakeholders, public and private actors to support the achievement of the EU's Climate Goals at local/regional level;
- To disseminate results to other port authorities, national and European port networks, port supply chain operators, innovation centres, public environmental agencies, local/regional/national administrators, EU institution, civil society.

Aknowledgements

Ravenna Port Authority



Powered Project



Province of Ravenna



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