WIND

An intelligent way of using the world's endless potential. Wind power with wpd.

Cost effective offshore wind energy in the Baltic Sea

wpd think energy

Göran Dalén, Vilnius 10 october 2013

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wpd Group - Facts

2,500 MW / 1,500 turbines installed (2012)

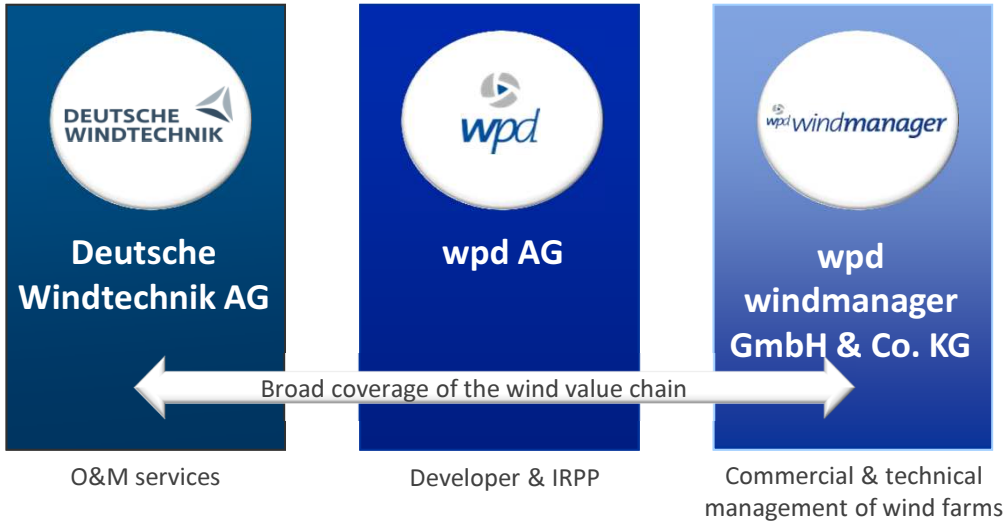
More than 860 employees in 20 countries

710 MW on own balance sheet (2012)

Commercial and technical management of 2,300 MW (>1,650 turbines)

Pipeline of more than 6.7 GW onshore and 10 GW offshore

Euler Hermes "A"-Rating (maintained since 2003)



Project Development
wpd offshore projects

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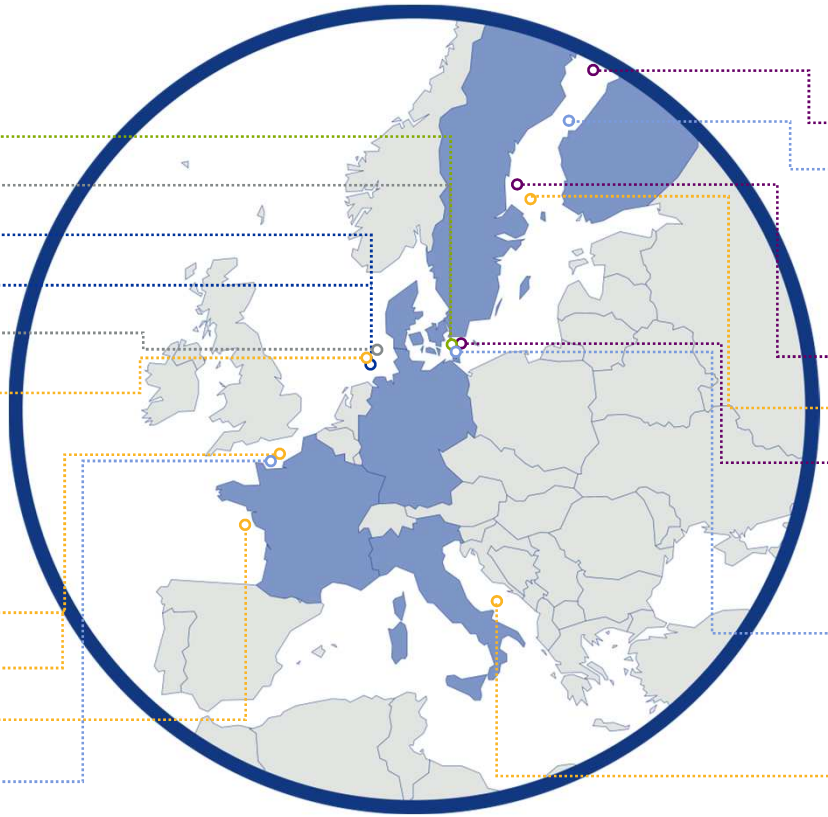
GERMANY

- Baltic 1 (48.3 MW)*
- Baltic 2 (288 MW)*
- Hohe See (400 MW)*
- He Dreiht (595 MW)*
- Butendiek (288 MW)
- Aiolos (1,182 MW)
- Kaikas (498 MW)
- Notos (318 MW)

FRANCE

- Courseulles(450 MW)**
- Fécamp (498 MW)**
- Vendée (504 MW)
- Somme Gr. Large, Fécamp II, Flamanville (500 + 500 + 360 MW)



FINLAND

- Suurhiekka (480 MW)
- Korsnäs (720 MW)

SWEDEN

- Storgrundet (420 MW)
- Finngrunden (up to 1,500 MW)
- Kriegers Flak II (640 MW)*

DENMARK

- Kriegers Flak III (570 MW)

ITALY

- Gargano Sud (342 MW)

1 project with a capacity of 48.3 MW in operation

2 project with a capacity of 576 MW under construction

2 projects with a capacity of ~ 1,000 MW consented and under procurement

3 projects with a capacity of ~ 1,500 MW consented

8 projects with a capacity of ~ 5,300 MW (net) in advanced permission process

5 projects with a capacity of ~ 2,600 MW (net) in early stage of permission process

* Sold – wpd was further involved by cooperation agreement
** minority, JV with EdF/ Dong/ Alstom

Project Execution
Reference Baltic I

- Comprehensive co-operation agreement with EnBW in line with sale of the project in 2008
- wpd engaged as project manager for the realization of the project.
- wpd negotiated all work packages with suppliers (turbines, foundations, substation and cabling) including installation equipment and harbor infrastructure and was deeply involved in pre-construction monitoring and construction management.

Main Work Packages		
	Turbine:	21 x Siemens SWT 2.3-93
	Foundation:	Monopile, Design & Installation Ballast Nedam, Manufacturing EEW
	OSS:	Electric Construction by ABB, Transformer by Etra, Steel construction by Weserwind
	Cables:	nkt cables

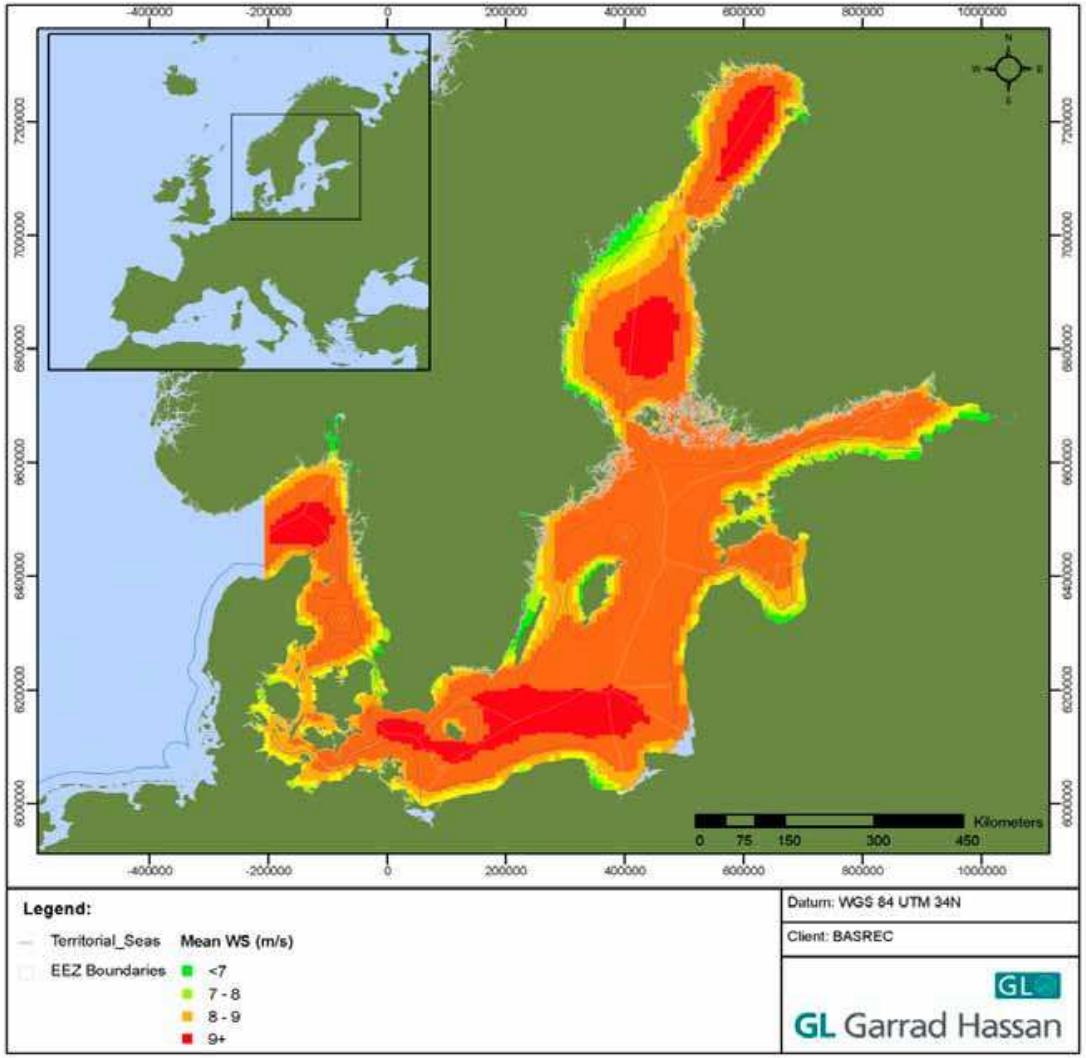
- Installation of Baltic I started in April 2010 and was completed at the end of 2010.
- **Construction was on time and within budget.** The wind farm was inaugurated on May 2nd 2011.



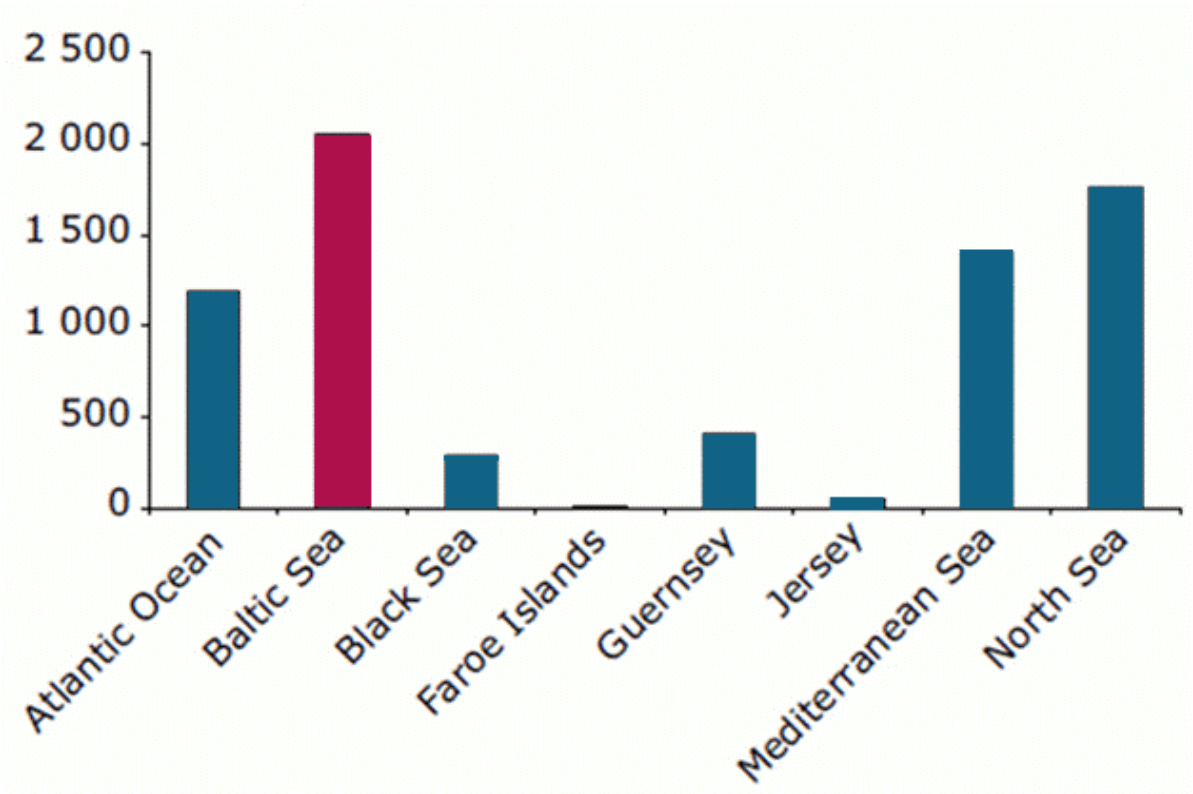


Baltic Sea Potential

Wind conditions in the Baltic Sea



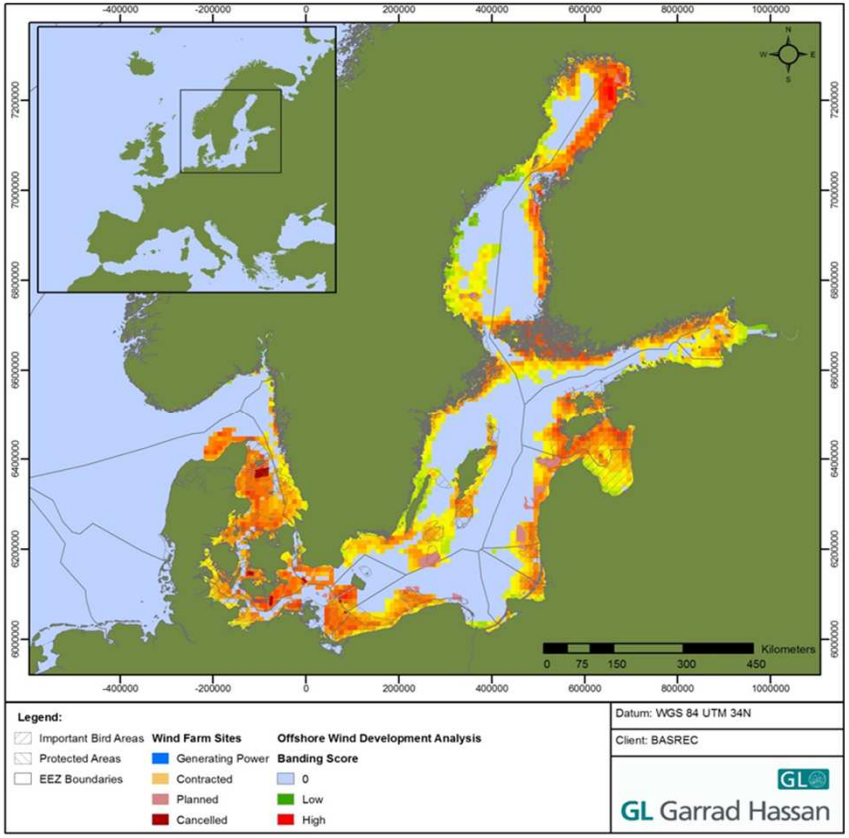
Potential of Offshore Windenergy in TWh/year



Källa: EEA

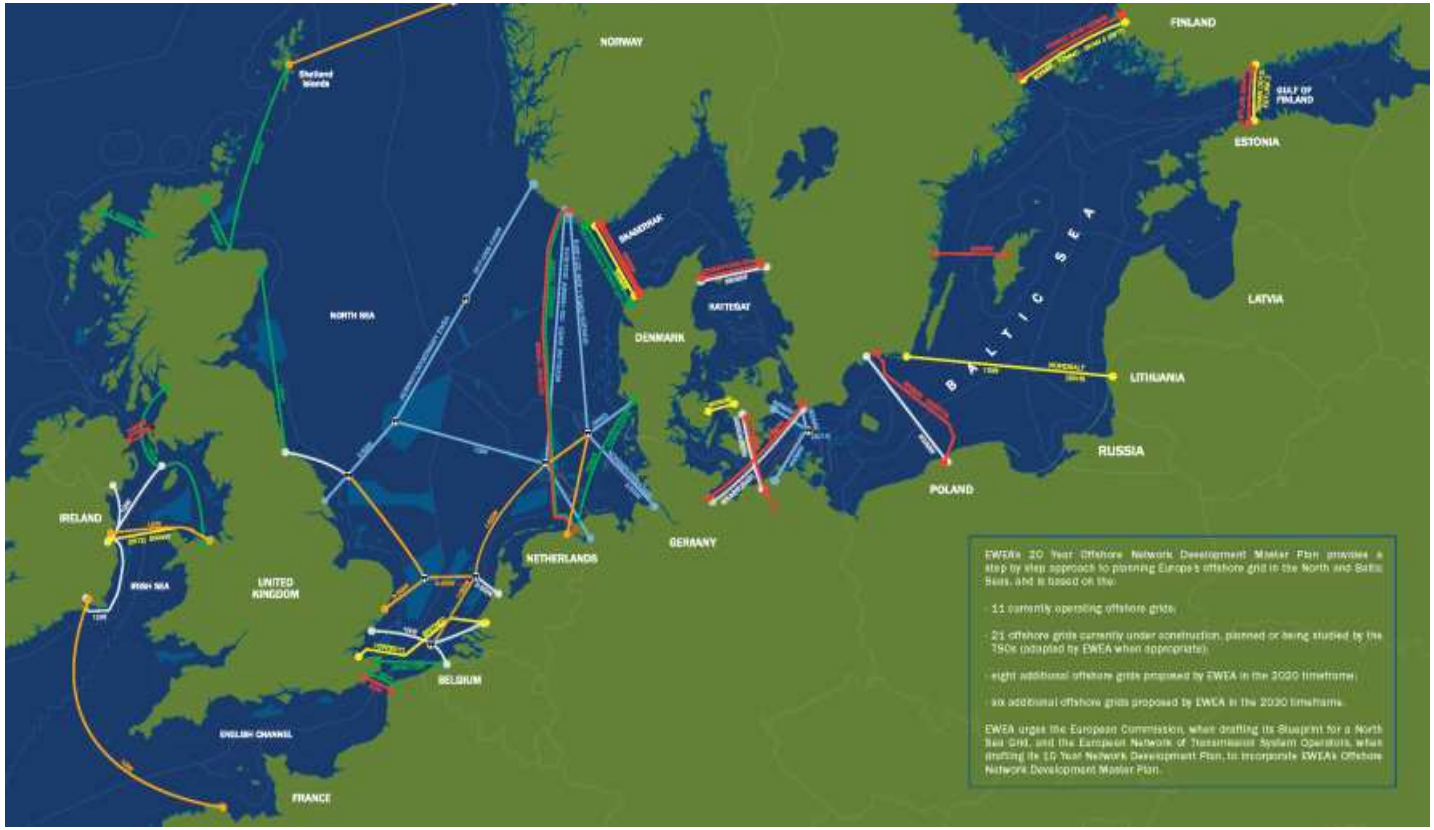
BASREC

Identifying space for 300 GW of offshore wind energy capacity in the Baltic Sea



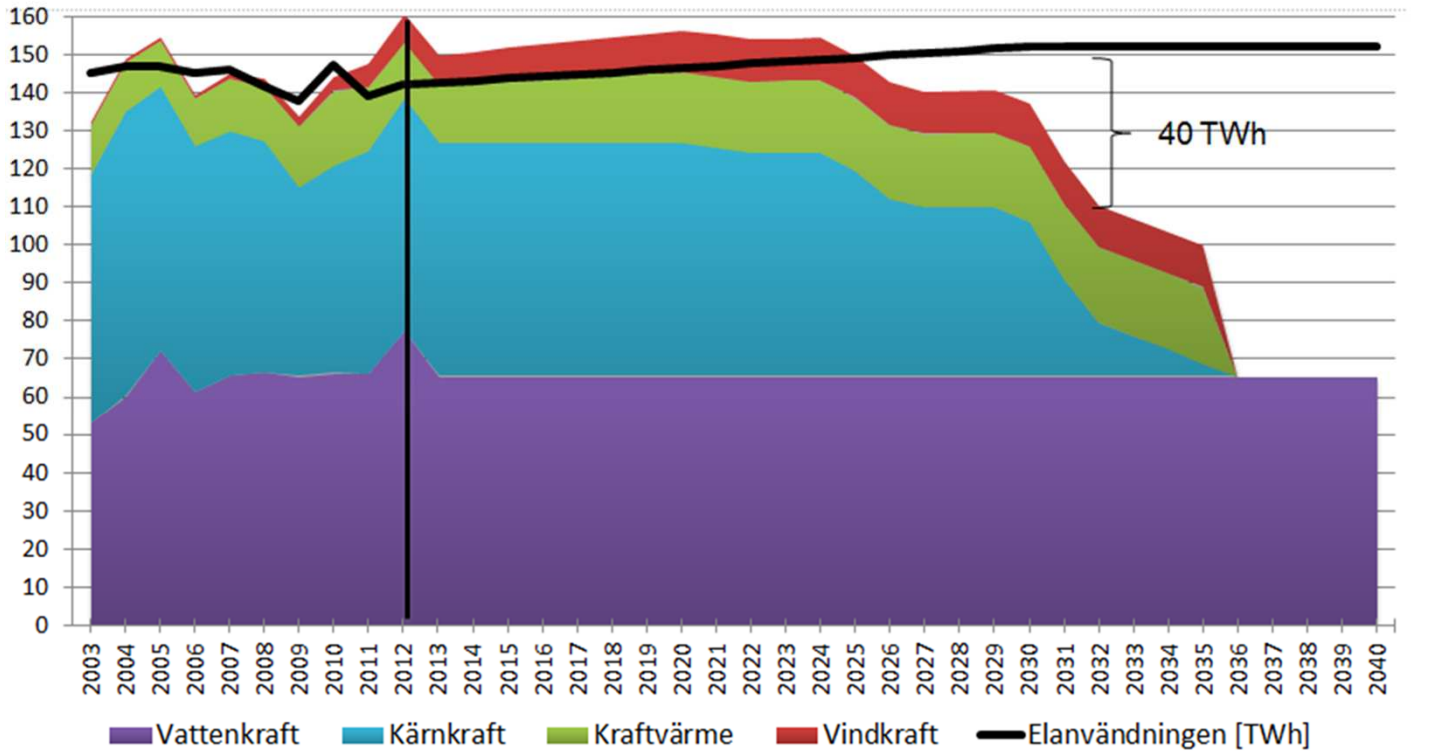
Source: BASREC 2011

Offshore Network Development Plan



Source: Oceans of opportunity, EWEA 2009

Sweden's energy challenge:
Old nuclear power supply – "The utility scenario"

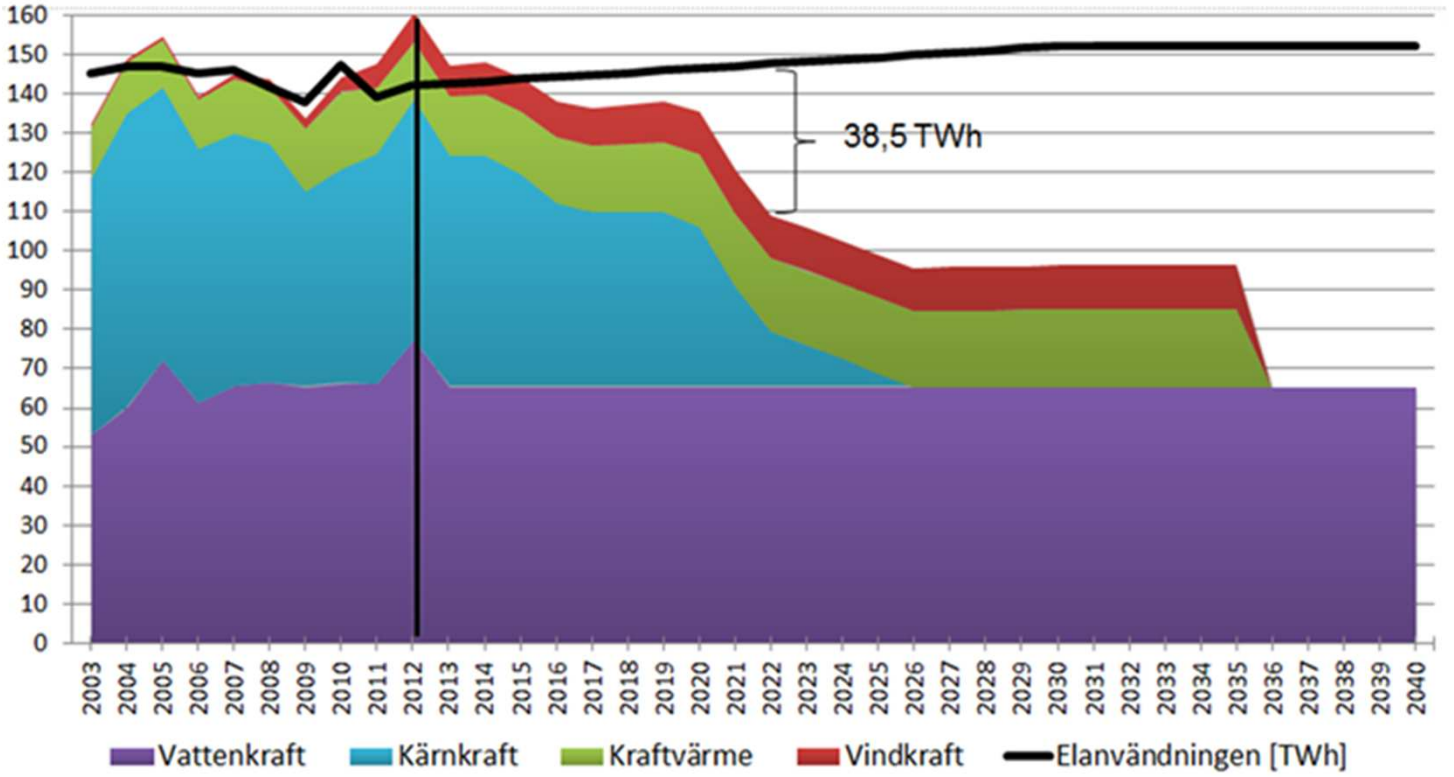


Source: Staffan Jacobsson/ Fredrik Dolff

Extensive new capacity is needed to keep competitive electricity prices.

- According to the utilities, who are the owners of Swedish nuclear, some of the oldest reactors will reach its economic and technical lifetime by 2022-2025. By 2035, all reactors will be phased out.
- New capacity of 40 TWh available by 2030 is needed to avoid a "production gap".
- With 15 years of leadtime to get new nuclear production, decisions need to be taken at the latest by 2015.

Sweden's energy challenge:
Old nuclear power supply – "The pessimistic scenario"



Source: Staffan Jacobsson/ Fredrik Doff

- Extensive new capacity is needed to keep competitive electricity prices.

- Big uncertainties with current nuclear production. How long will it last?
- The scenario above show that reactors do not last as long as stated by the utilities.
- The "production gap" could occur already by 2022.
- This would put a lot of pressure on industry to replace such a large amount of production.
- Offshore wind is an attractive choice.

Why more cost effective in the Baltic Sea?
Technical Concept – "Offshore Light (innanhavsteknik)"

Region	North Sea	Northern Baltic Sea
Distance to coast	Long	Moderate/short
Water depth range	20…40	5…25
Tide	Yes	No
Swell	Yes	No / insignificant
Max wave	High	Moderate
Mean wind	IEC I	IEC I/II
Extreme wind	IEC I	IEC I/II
Water salinity	High	Low
Salt spray	Yes	Insignificant
Corroding air	Yes	Insignificant?
Operating temp. range	-10…+30 C	**-30…+30 C**
Drift ice	No	**Yes**
Pack ice	No	**Yes**
Turbine design	Offshore	Onshore/ semi-offshore Cold Climate Version
Remuneration offshore	> 150 €/MWh	No offshore-specific remuneration system

- North Sea turbines are overdimensioned – and too expensive – for Northern Baltic
- Design Basis for foundations and other marine structures: very different from the North Sea
- Accessibility, O&M vessels, O&M strategy etc. need to be studied from fresh perspective
- Realizing of the first project will open up opportunities for repetition & exports

Examples from ongoing projects
Overview Swedish offshore projects

Storgrundet

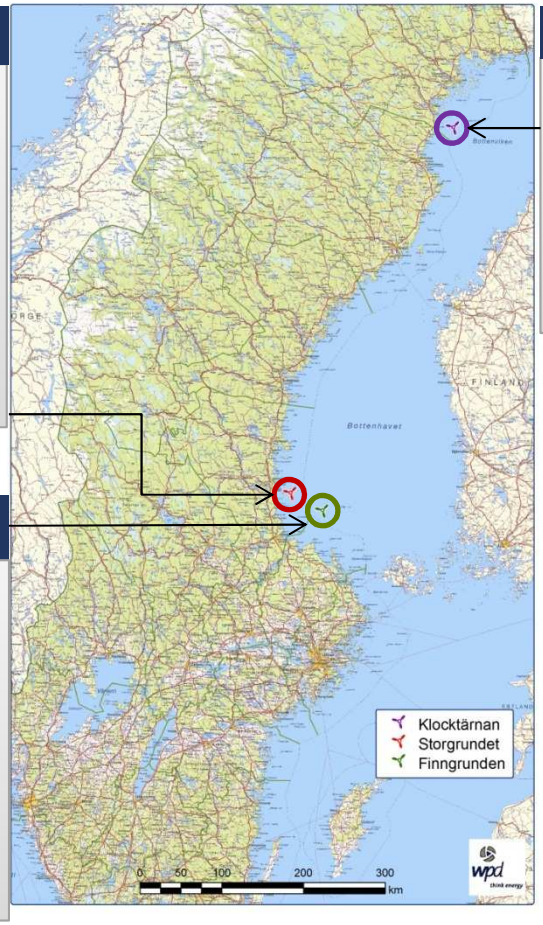
Name:	Storgrundet
Municipality:	Söderhamn
Capacity:	300 MW
No. of turbines:	70
Distance to coast:	11 km
Production:	0,9-1,2 TWh
Start of construction phase :	2016

Permitted to build
Application for grid concession submitted
Drillings to verify the anticipated soil conditions are done.

Finngrunden

Name:	Finngrunden Östra Bank
Capacity:	Everything with total height less than 250m
No of turbines:	185
Min distance to coast :	40 km
Production :	5,5 TWh
Start of construction phase:	2019

Application submitted to the Government (SEZ)
Application rejected, Nature 2000
Appealed to higher court

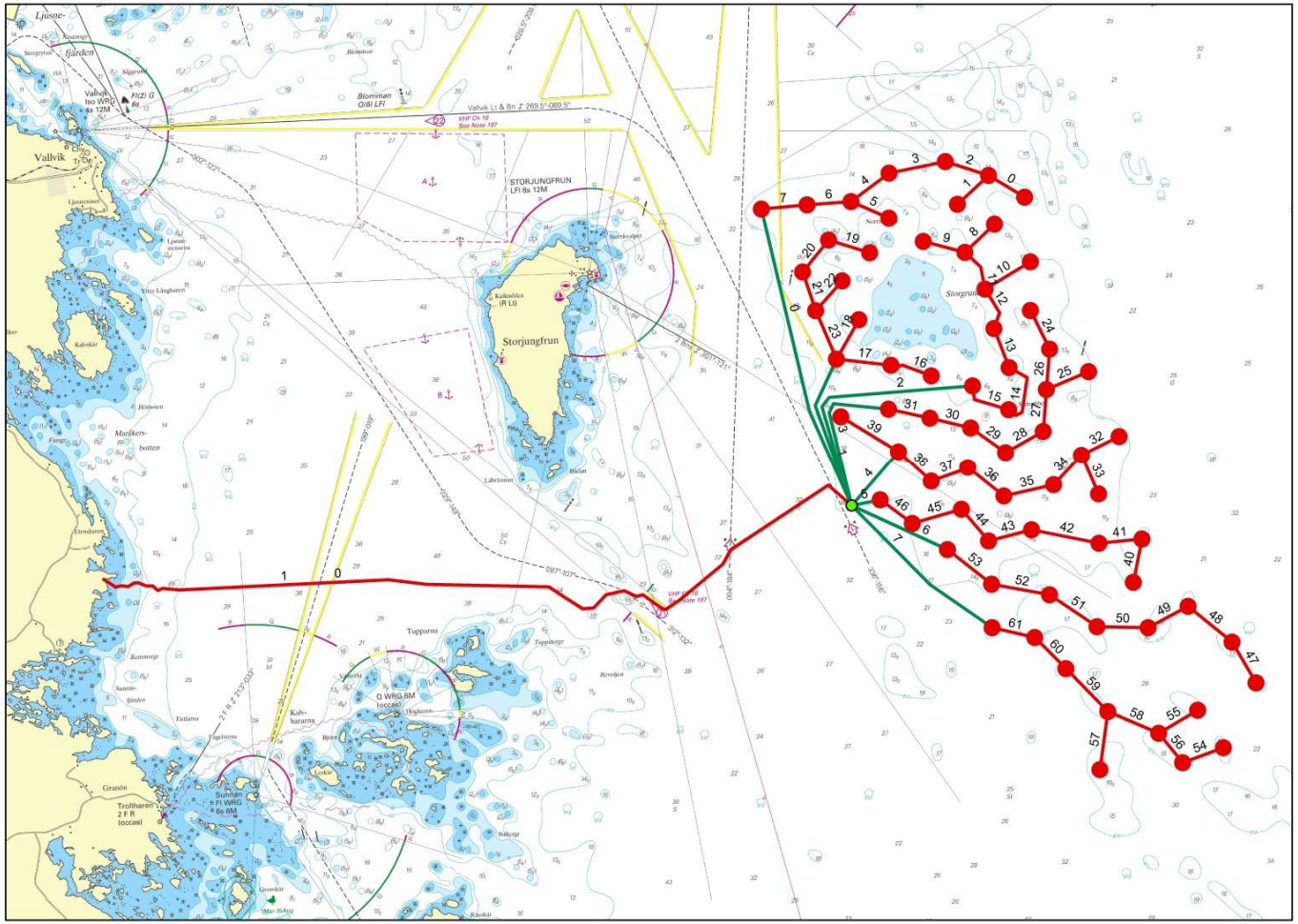


Klocktärnan (on hold)

Name :	Klocktärnan
Municipality :	Piteå
Capacity :	660 MW
No. of turbines :	132
Distance to coast :	19 km
Production :	1,9 TWh

Not active.

Electricity grid, offshore
Storgrundet Offshore Wind Farm



Storgrundet
Site Conditions

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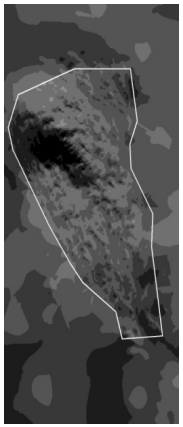
Soil

- Geotechnical surveys (seismic and bathymetric studies) have been finished.
- Drillings at 4 typical location was conducted 2012
  - Examining best and worst locations regarding soil condition
  - Expected soil conditions were confirmed by test drillings
  - Ready to approach designers of foundations



Waves

- Wave conditions are modest.
- The highest measured wave from 1970 was around 10m in the Bothnian sea. Significant wave height 5,3 m.
- wpd does not expect higher waves at the site. (See table.)

Wind

- The strong winds at the Storgrundet site allow for high energy yields and good utilization of the turbines.
- Main sources of data are the wind measurement operating at hub height since 2008 at the Storjungfrun.
- A wind assessment has been undertaken by DEWI (2010) and Natural Power (2012)
- The measurements have shown an average wind speed of 8.6 m/ s at a height of 100 m based on Natural Power assessments (2012).

Hs (6h)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0,5	59,2	62,1	67,2	70	78,8	81,1	80,4	73	60,1	57,9	52,3	57,6
0,8	80,1	84,1	86,3	85,6	92,2	94,4	93,8	92,4	82	79,3	77,7	78,9
1	87,6	90,4	91,3	90,8	95,3	97,4	96,9	96,4	88,5	85,3	85,6	86,6
1,1	89,6	92	92,6	92,3	96,5	98,1	98	97,8	91	88,4	88,2	88,9
1,25	91,7	93,9	94,5	94	97,8	99	98,6	98,7	94,6	91,9	90,8	91,3
1,5	94,4	95,6	97,2	96,2	99	99,6	99,5	99,4	97,4	95,2	94,3	94,1
2	97,4	98,2	99,1	98,4	99,8	100	100	99,9	99	98,5	97,4	97,3
2,25	98,5	98,8	99,6	99	99,9	100	100	100	99,4	99,1	98,2	97,8
2,5	98,9	99,4	99,9	99,3	99,9	100	100	100	99,8	99,5	98,8	98,4

Calculated wave exceedance table (will be updated based on ongoing measurements)

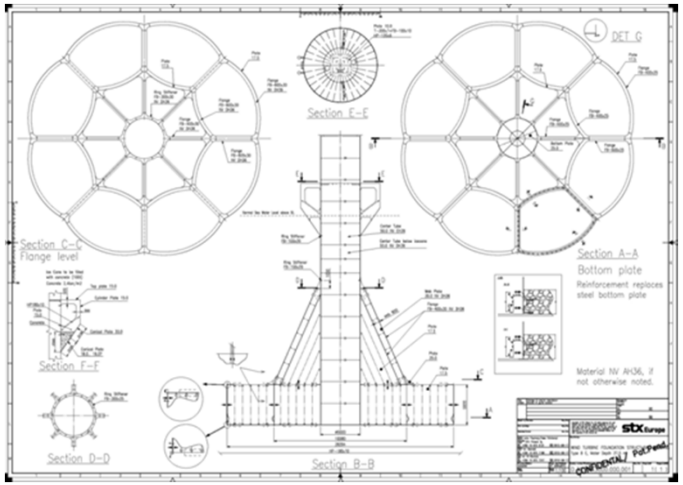
Technical Concept

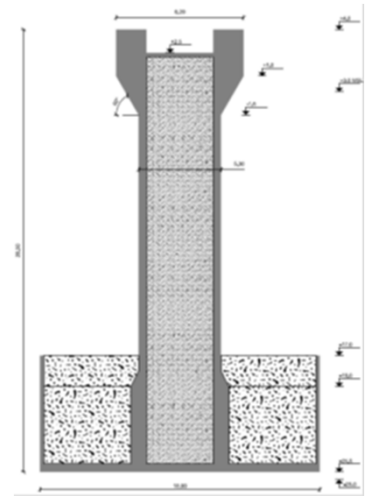
Turbines

- Class II turbines are preferred. Physical limits are a total height of 180 m and a rotor diameter of 150 m.

Foundations

- Gravity based and pile structures can be used. The final decision depends on a WTG tender result. Both options have been included in the application.
- Studies show that conventional foundations with an ice cone can handle the ice loads.
- Standard type of gravity based foundations and drilled monopiles can be used. The weight of the foundations (without ballast) is approx. 550 t to 2,350 t depending on the type.





“Innanhavsteknik” – significant cost reductions possible

“Innanhavsteknik” in numbers - Comparison between “North Sea” and “Baltic Sea”

▪ Turbines	- 40 %	*Class II turbines*
▪ Installation cost	- 60%	*Smaller turbines, lower waves -> simplier installations concepts*
▪ Invest cost €/kWh	- 28%	*Good wind conditions combined with lower capital costs*
▪ O& M	- 30%	*Short distances to shore, smaller waves*

Why offshore in the Baltic Sea?
Conclusion

Big Potential and favorable conditions
- More than 2000 TWh/year identified by EEA
- Open up a new market for Baltic Offshore technology and projects

Need of new large-scale capacity when old nuclear phase out
- IEA reviewed the Swedish Energy Policy (Feb 2013) and highlighted the lack of policy to replace old nuclear.
- Offshore is an attractive "large scale renewable" alternative which is less expensive than nuclear.
- Possible "production gap" ahead. Long lead-times to establish new large-scale production.
- The Swedish Energy Agency is conducting studies how the energy system will look without nuclear.

wpd has established a strong lobby for:
- Better conditions for offshore wind
- Promote "Offshore Light" = technology for coastal waters and similar to the Baltic Sea. Resulting in a decrease of the costs of approx. 30 %
- Promote "infrastructure offshore" where grid is made available at no cost to offshore energy. Possible extended to a "Baltic Super Grid".

"Offshore coalition and network "Havsvindsforum" launched in May 2013
- Now is the time for more cooperation between the Baltic countries

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