

LILLGRUND WIND POWER OFFSHORE

**110 MW UNDER
CONSTRUCTION
IN SOUTHERN SWEDEN.**

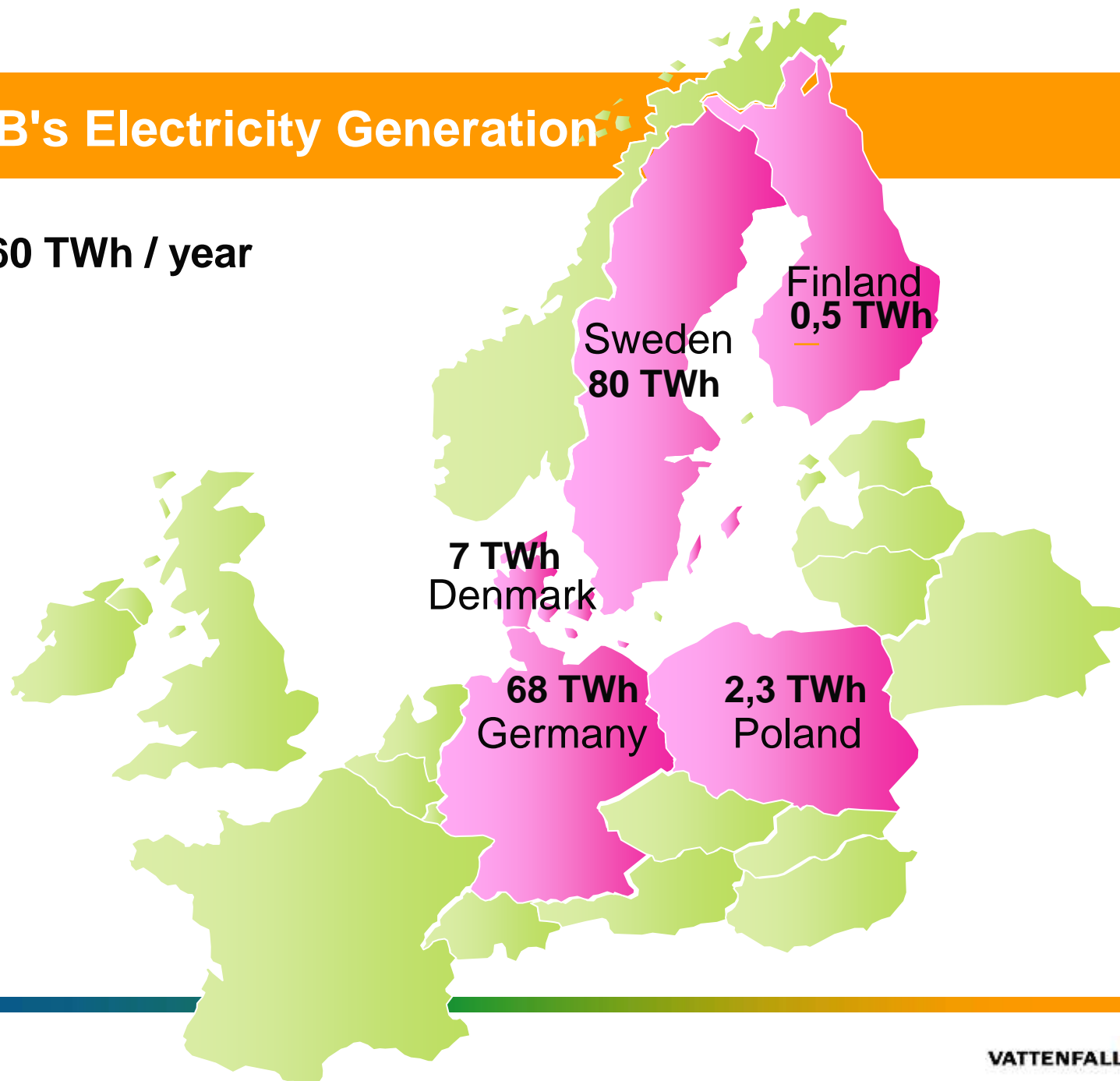
**Jeju, Korea, April 20, 2007
Kenneth Averstad,
Vattenfall AB Wind Power, Sweden**

Agenda

- **Short presentation of my company Vattenfall AB and our wind power development activities.**
- **Lillgrund Wind Power Offshore Project 110 MW.**
- **Other Offshore Wind Projects under Development in Sweden.**

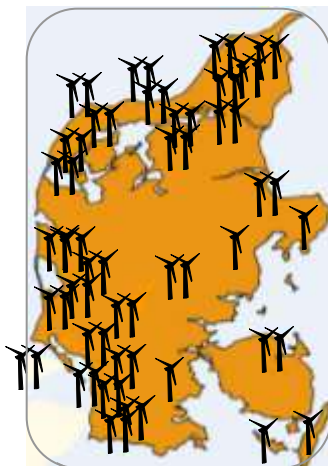
Vattenfall AB's Electricity Generation

About 160 TWh / year



Vattenfall Nordic Wind Power 2007: 487 MW ; 1200 GWh/yr

Denmark
406 WT,
309 MW,
750 GWh



Sweden 62 WT,
54 MW, 120 GWh

Finland 10 WT,
4 MW, 8 GWh

England 30 WT,
90 MW, 270 GWh

Poland 15 WT,
30 MW, 60 GWh

Own and operate total:
523 wind turbines

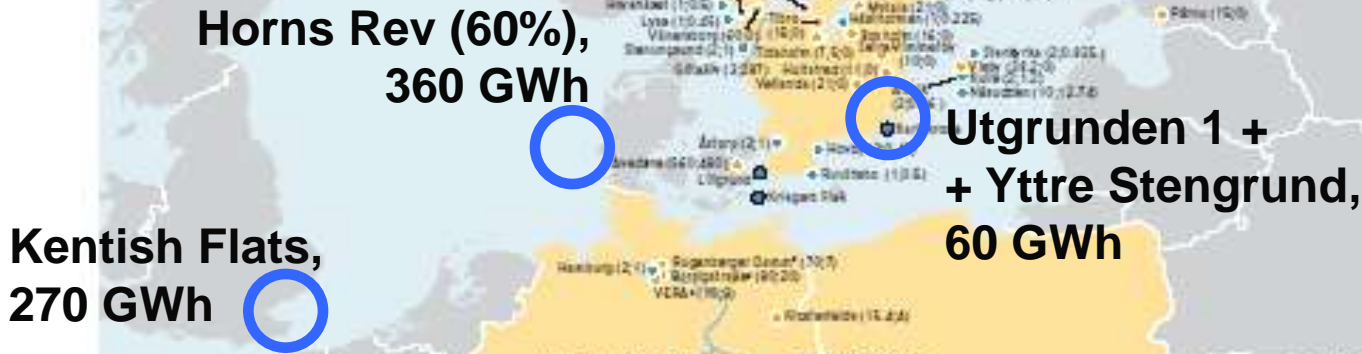
● = Offices

Vattenfall's Offshore
Wind Power in
Operation
2007

Renewable energy within Vattenfall

Biofuel, including waste (heat MW; electricity MW)
Wind power (number of plant; capacity MW)
Planned wind power plants
Hydro power (number of plants; capacity MW)
Aside from the hydro power plants on developed rivers, Vattenfall also has 52 fully or partly owned small-scale hydro power plants providing a total of 110 MW in Sweden and Finland, and 6 small-scale plants in Germany with a total capacity of 10 MW. Vattenfall has about ninety biofuel-fired plants, with the largest plants shown on the map. Many of the biofuel-fired plants can be run on both renewable and fossil fuel.

Place names ending in 'älv', 'även' or 'ån' are rivers providing hydro power.
1) Plants with heat capacity exceeding 50 GWh/year.
2) Majority owned by Vattenfall.



Map from Vattenfall's Corporate Social Responsibility Report
(www.vattenfall.com)

Näsudden = Vattenfall's O&M and Test Centre - since 1982

and prototype testing, for example:

Nordic Windpower 2, 1000 kW

Nordic Windpower 1, 1000 kW

Näsudden 2, 3000 kW

Located on the island Gotland in the Baltic Sea.



Näsudden 2, 3000 kW Gotland, Sweden

**61.4 GWh
WORLD RECORD**

Finally stopped
January 9, 2007 at 02:29,
after 61,469 generating hours
since start March 14, 1993.

Vibration alarms, low oil pressure in gear-box. Inspection showed severe damages in gearbox, many teeth in different gear-box steps have been damaged.



Vattenfall Renewable Strategy (May 2006): +10 TWh to 2016.

We focus on ...



Wind



Hydro



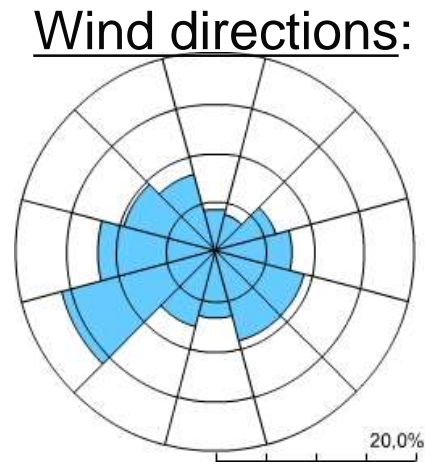
Bio

Wind power might take +7 to 8 TWh offshore and on land.



Lillgrund Offshore Wind Power

- Pilot Project Offshore. In operation late 2007.
- 48 wind turbines à 2.3 MW = 110.4 MW.
- Good wind 8.5 m/s at 65 m, mainly SW.
- 330 GWh per year. Electricity for 60,000 households.
- Hub height 70 m.
- Rotor diameter 92.4 m.
- Tip height: 115 m.
- Transformer platform 30/130 kV.



Map of Lillgrund Offshore Wind



Relatively low waves.

Shallow water 4-6 m.

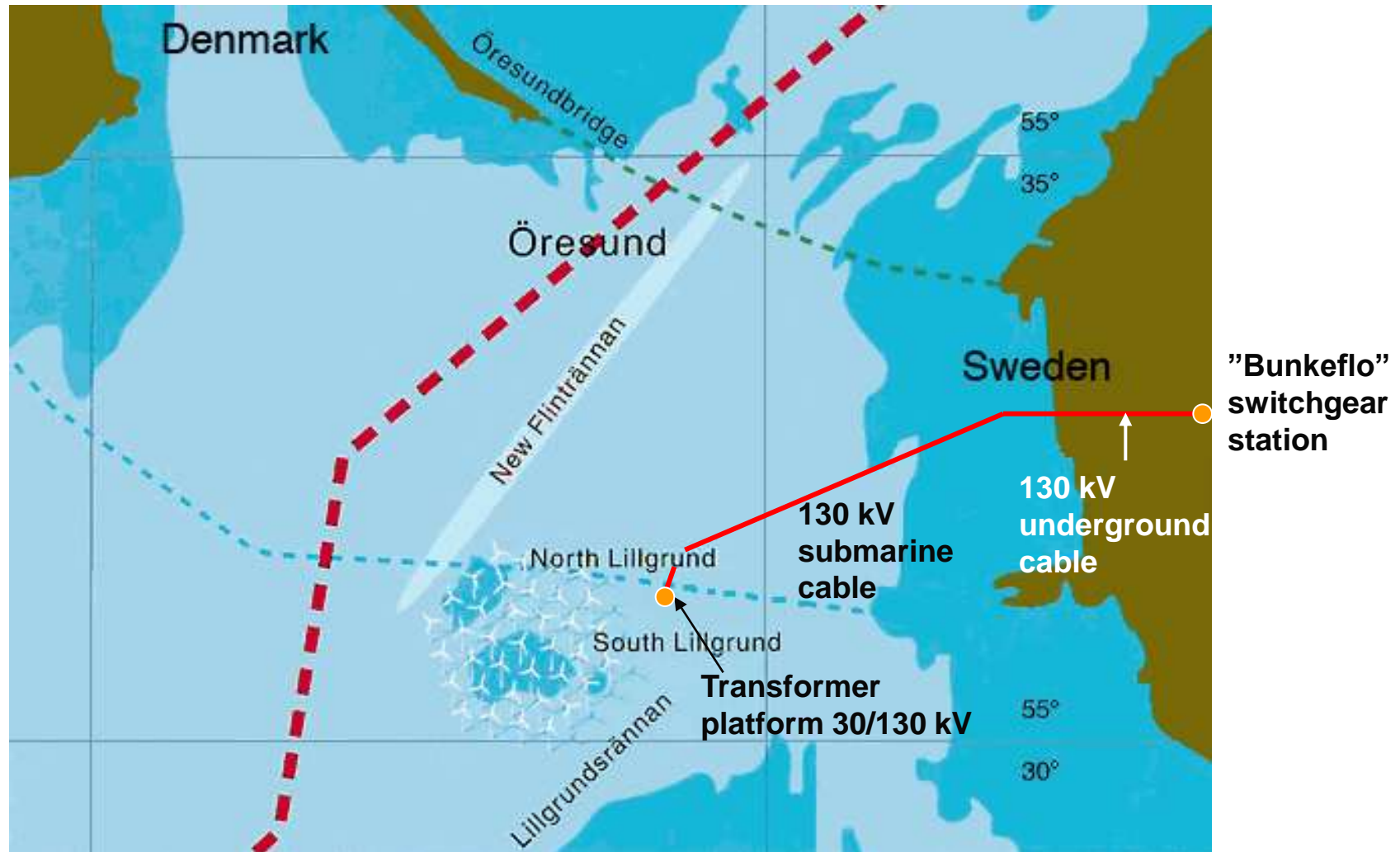
Gravity foundations.

Two contracts:

- a) Foundations**
(Pihl Hochtief JV).
- b) Turbines + cables**
(Siemens/Bonus).



Lillgrund Export Cable 130 kV. Offshore 7 km, On Land 2 km



Lillgrund. Time Schedule.

Permit process started	1997	(Developer = Eurowind)
Permit process finalised	2005	(8 years!)
Vattenfall Board invest. decision	26 October 2005	
Procurement finished	February 2006	
Construction start on site	March 2006	
Installation of foundation	June - December 2006	
Installation of turbines	May - September 2007	
Taking Over	Late 2007	

Lillgrund. Economy.

- Investment cost 1800 MSEK = 195 MEuro.
- Partly financed by Pilot Project Support from Swedish National Energy Agency with 213 MSEK = 23 MEuro = 12%.
- Income: Lillgrund will receive Nordpool electricity price + Electricity Certificates (15 years) + Environmental Bonus (20,000 hours) for generated kWh:s.



Lillgrund is being built with great regard for the Environment



Lillgrund and Environment

Air / Atmosphere

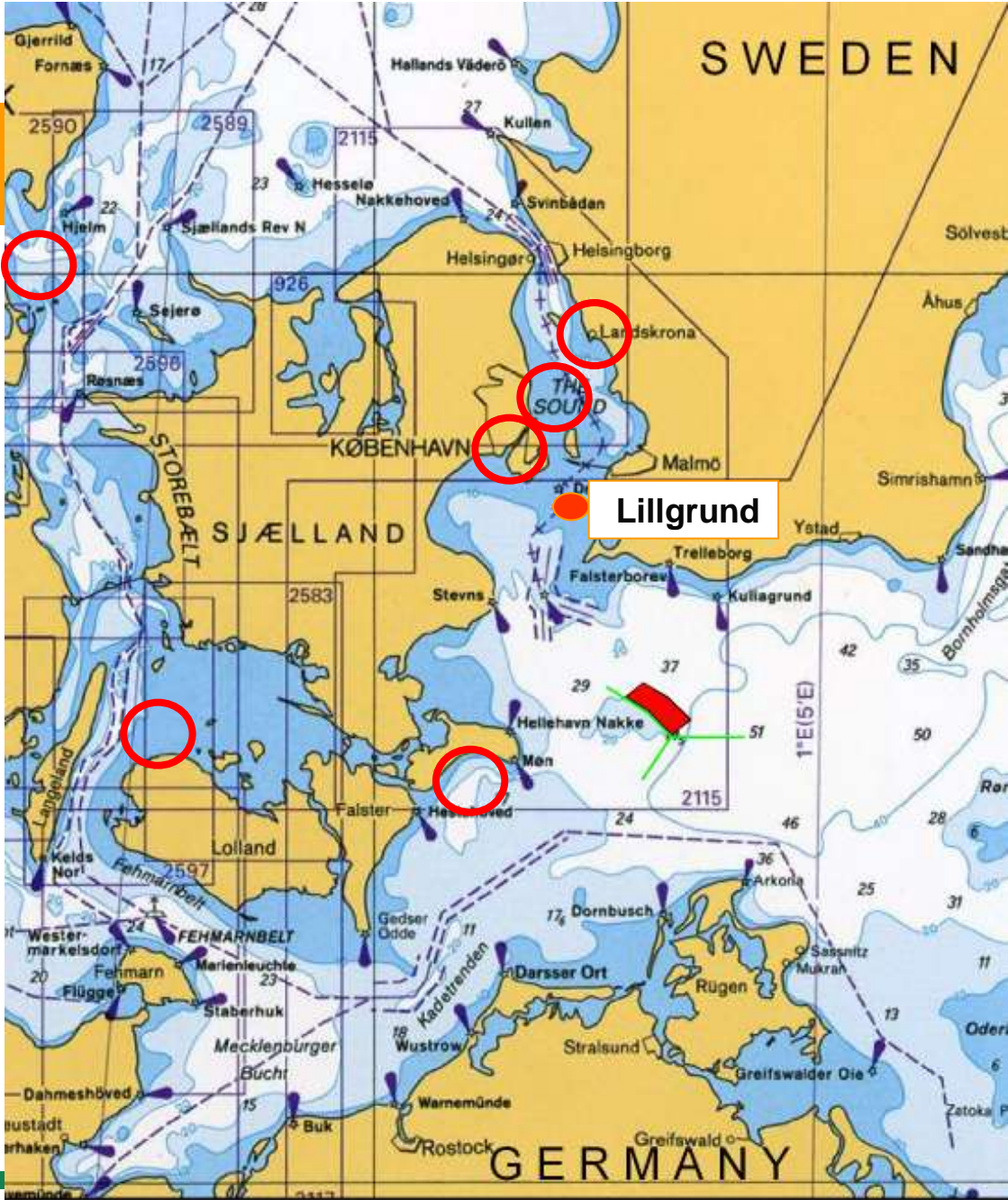
- Lillgrund contributes to reducing the emissions of CO₂ by more than 200 000 ton/year.



Acceptance - Offshore

Wind farms already operating
and visual at sea in the region:

- On shore, in harbour areas
 - Landskrona, Vindön
 - Copenhagen, Lynetten
 - Copenhagen, Avedöre
- Offshore
 - Vindeby
 - Tunö Knob
 - Middelgrunden
 - Nysted 1



Lillgrund. Communication.

Activities before start on site at Lillgrund:

Many open meetings in many local villages.

Exhibitions Klagshamn, Malmö library, Town Hall.

Info screens at Klagshamn udde and in Dragör = DK.

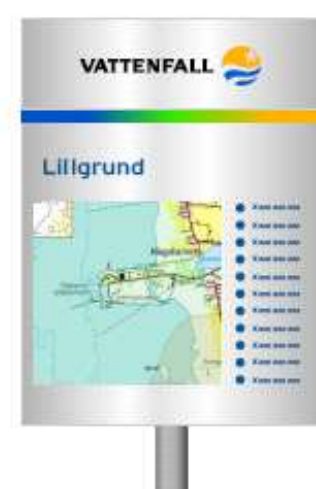
ADs och articles in local newspapers in SWE + DK.

Web site: www.vattenfall.se/lillgrund

"Climate forum" with Malmö city.



VATTENFALL



– Kan man göra något åt
klimatförändringarna?



– Ja, man kan bygga ut vindkraften.
Som Vattenfall gör i Öresund.

Nu börjar Vattenfall att bygga
Sveriges största vindkraftpark
i Öresund. Lillgrund vindkraftpark
kommer att ge hushållsel till drygt
60 000 hem.

Det är smart. Klimatsmart.

www.malmo.se/klimat

VATTENFALL



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**SNART KAN 60 000 HEM
LYSAS UPP MED HJÄLP AV
VINDKRAFT.
TACKA DE SKÅNSKA
VINDARNA FÖR DET.**

Lillgrund i Öresund är ett av de områden som har bästa förutsättningar för vindkraft. Vindarna är och jämna. Havet har ett bra djup. Det är med andra ord ingen slump att Sveriges största vindkraftpark bygger här - ca en mil utanför den skånska kusten. Först get tar vi 2006. Drygt ett år senare kommer vindken stå färdig. Redo att leverera el som täcker behövet för drygt 60 000 hem.

Läs mer på www.vattenfall.se/lillgrund

www.malmo.se/klimat



Lillgrund. Foundation construction in Swinoujscie, Poland

4 concrete foundations casted on each barge.



Lillgrund. Start of concrete work on a barge.

Reinforcement for one foundation
16 x 16 meter.



Casting of foundations in Poland



- Started in May 2006.
- Finished in December 2006.
- Concrete casting made on barges.
- Same method as used for Nysted 1.

Transport of foundations from Poland to Lillgrund



1400 tons each. Filled = 2000 tons.



Dredging for foundations and cables



**Dredging for the foundations.
Sediment spreading within limits.**



Rock material for levelling the
sea bed under each foundation.



Foundations lifted in place.

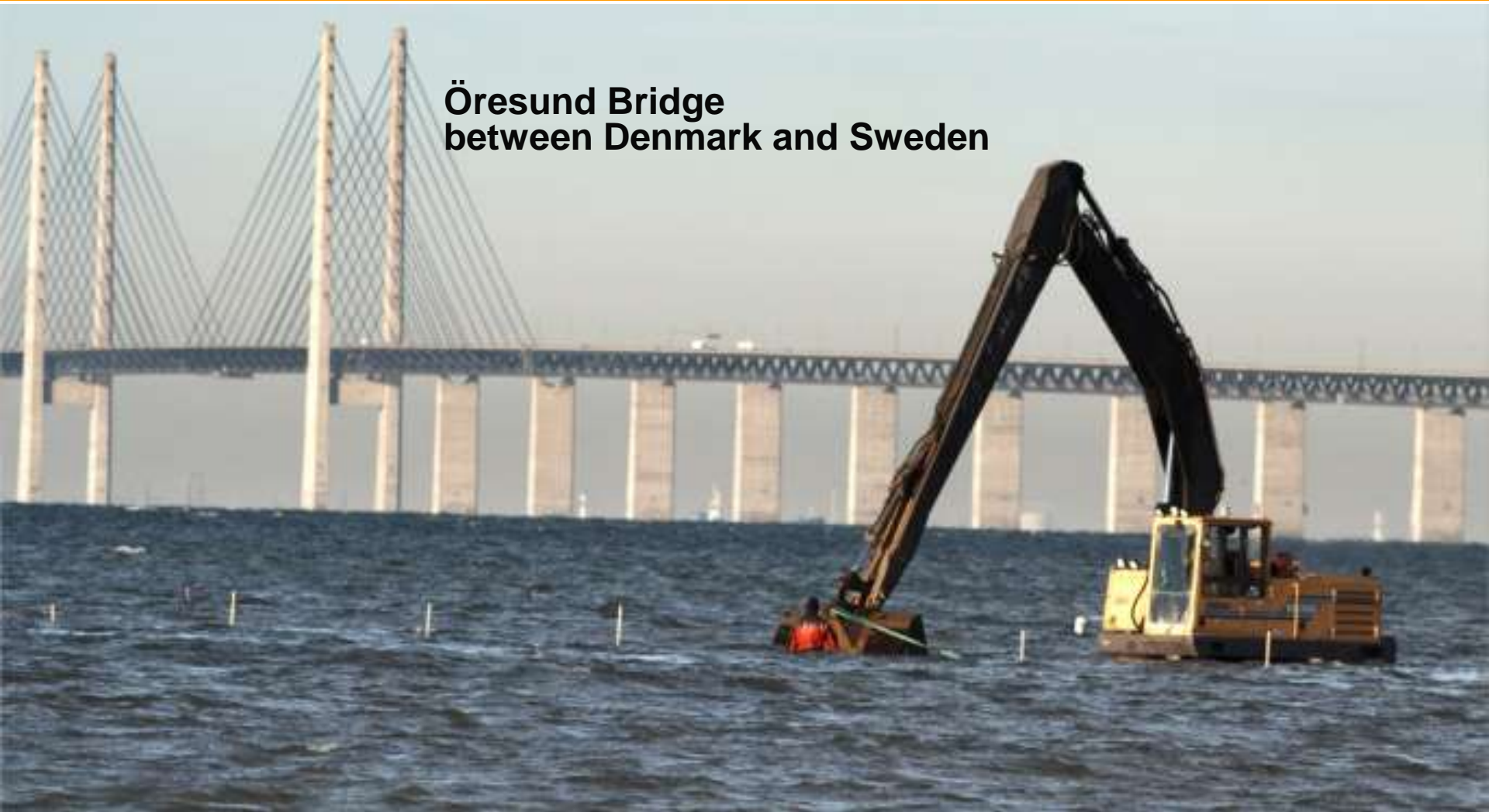


Lifting one foundation in place.



Digging for export cable near land

**Öresund Bridge
between Denmark and Sweden**



Cable installation



Cable installation at connection to land



Installation of 2.3 MW turbines (planned to August 2007)

Picture from Nysted 1 in 2003.

Siemens Bonus will use the same method at Lillgrund.



Lillgrund. Project Status now.

- All 49 foundations in place.
- Export cable to land is laid in the dredged cable ditch.
- Internal cable installations have started between 48 WT and Transformer Platform.
- Construction is generally delayed 8 weeks due to a extremely long period with high wave + wind November – February.
- Unforeseen ground material (rock) at some foundation sites.
- More time than planned has been laid on control and supervision of the work offshore.
- Two protests against the higher building permission 115 meter tip height. Will be decided in 3rd court level this summer.

Continuation in the project:

- There has been enough reserve time in the Project's Time Schedule, so the project will be able to be ready according to schedule.
- Erection of 48 wind turbines will start in August 2007.
- Ready for operation as planned December 2007.

Wind Power Offshore. Lessons learned in Lillgrund Project.

Long permission processes, started 1997 !

- * On way to be solved in Sweden.

Severe cost increases since 2003 !

- * More manufacturers and factories needed.

Unstable support systems !

- * Overview of existing systems.

A lack of industrial system solutions offshore !

- * Divide in more procurement packages.

Extreme weather during construction increases costs !

- * Risk analyses, more planning, more effective ship capacity.

Immature technology and manufacturer market offshore !

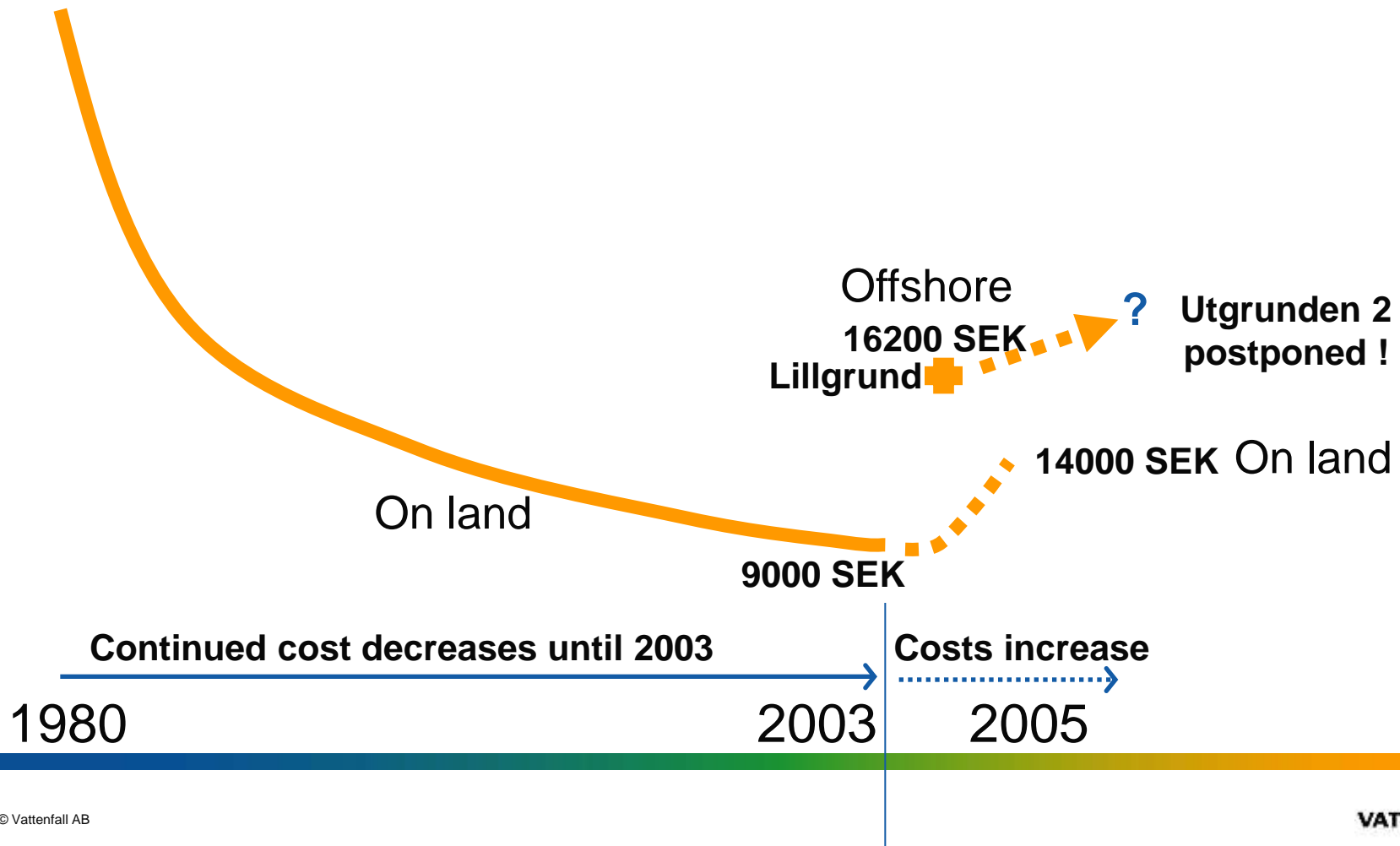
- * Focused R&D, D and Test Sites.

Too few offers from manufacturers!

- * New manufacturers and products for offshore.

Wind Power, experienced cost development in Sweden.

SEK / MW



Offshore has Great challenges for Operation and Maintenance.....

**Availability not high enough,
during 2006 it was 87%**



Technical reasons:

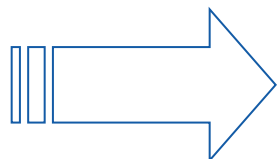
- Transformers
- Gearboxes
- Erosion, corrosion
- Extreme weather gives higher loads, damage platforms

O&M reasons:

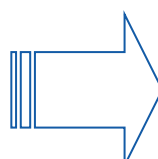
- Costly
- Weather, waves hinder
- Demands more planning

Vattenfall Nordic develops wind power both on land and offshore - with a large offshore portfolio.

Offshore O&M experiences



On-going construction



Large project portfolio offshore

Utgrunden 1 (Sweden) 2000

Yttre Stengrund (Sweden) 2001

Horns Rev (Denmark) 2002

Kentish Flats (UK) 2005

122 WT

206 MW

633 GWh

Lillgrund (Sweden)

48 WT

110 MW

330 GWh

Trolleboda (Sweden)

Taggen (Sweden)

Kriegers Flak (Sweden)

Borkum West (Germany)

>1100 MW

>4000 GWh

Other on-going Project Development – Offshore.

- **Lillgrund** 110 MW; 330 GWh/yr; Operation late 2007.

- **Kriegers flak** (Government permit)

- 600 MW Depth 20 – 40 m
- 2,100 GWh/yr
- Decision 2009?
- Operation 2011-14?

- **Trolleboda** (Old project Gov. permit)

- 150 MW Depth 11 – 22 m
- 500 GWh/yr
- Decision 2008?
- Operation 2010?

- **Taggen**

- 300 MW
- 1,000 GWh/yr
- Decision 2008?
- Operation 2011?



Conclusions

- **Lillgrund is on good way and planned to be in operation late 2007. Still risk for delays due to continued protests to high court.**
- **Many new experiences learned during the Lillgrund Pilot Project.**
- **Unclear when the next offshore investment decision can be decided, if high costs continue.**
- **In the long term Vattenfall see a large resource in wind power offshore.**



Thank You !



Lillgrund Wind Power, from harbour Klagshamn late 2007

Back-up slides

Lillgrund. Late decisions about max height.

- Original building permission said max tip height = 105 meter.
- We analysed that 115 m would increase electr.generation with 10%=6000 households.
- Municipally Malmö gave new building permission = 115 meter in 2005.
- Agreed by Regional County Skåne län and the County Court.
- It was protested by two parties.
- The municipally has started to do a new building plan including 115 m.
- The 3rd level Court (Kammarrätten) will decide this summer.

Lillgrund and Environment

Fish and fisheries

- The Swedish National Board of Fisheries runs a monitoring programme on fish and fisheries. Data already collected since construction of Öresund Bridge 90's and for Lillgrund 2002---

The programme comprises the following investigations:

- Biotope changes or direct effects of sound and vibrations.
- Eco-sounder studies of possible attraction or avoidance at individual wind turbines.
- Effect on fish migration and fish spawning.
- Detailed measurements of the intensity, nature and extent of sound around the wind farm.
- Influence of magnetic field on fish migration.
- Studies of possible reef effects.



Lillgrund and Environment

Other marine flora and fauna

- A long-term monitoring programme 2 years before start construction until 5 years after commissioning.
- Eelgrass and common sea mussel is chosen as indicators for important biological conditions.
- The eelgrass provides indication of floating sediments in water.
- The common sea mussel provides indication of possible disturbance by re-sedimented material.



Lillgrund and Environment

Birds

- South Öresund is of great importance to bird life. During cold periods, significant numbers of sea ducks gather on the shallow areas. These areas are also of importance to cormorants and other birds.
- A long-term monitoring programme for the influence on bird life is being run by Lund University, 2 years of field studies before start construction and 5 years under operation.



Lillgrund and the Environment

Local environment

- Weather conditions, wind intensity and wind direction influence the sound emitted by the wind turbines.
- Influence on landscape is debated, but there are already wind turbines in the coastal region.



New Parliament Law for a Long Term Certificate system

Swedish Parliament decision June 2006:

- + Increased quota demand to 17 TWh year 2016. Before the goal was 10 TWh 2010.
- + System extended until year 2030. Before it was limited to 2010.
- A new limitation in time per plant 15 years.



Lillgrund. Financing.

Partly financed by Swedish National Energy Agency as a Pilot Project with Support of 213 MSEK (=12% of investment 1800 MSEK) with reasons:

- Early large scale and offshore wind power.
- Possibilities to study real park effects, both technical and environmental issues.
- Experience from construction offshore.
- Analyse possibilities for future cost effective large scale wind power.
- Knowledge about operation and maintenance of offshore wind power.

= 23 MEuro (of 197 MEuro)



The Nordic Deregulated Market for Electricity (Nordpool) has a large proportion of Renewables and low CO2.

Sweden: **Hydro ~47%**, nuclear, **wind 1%**, ...

Norway: **Hydro ~100%**, ...

Finland: Coal, nuclear, **hydro**, peat, ...

Denmark: Coal, **wind ~18%**, ...

Map from Vattenfall's Corporate Social Responsibility Report (CSR) (www.vattenfall.com)

