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Offshore wind energy development in the North Sea +

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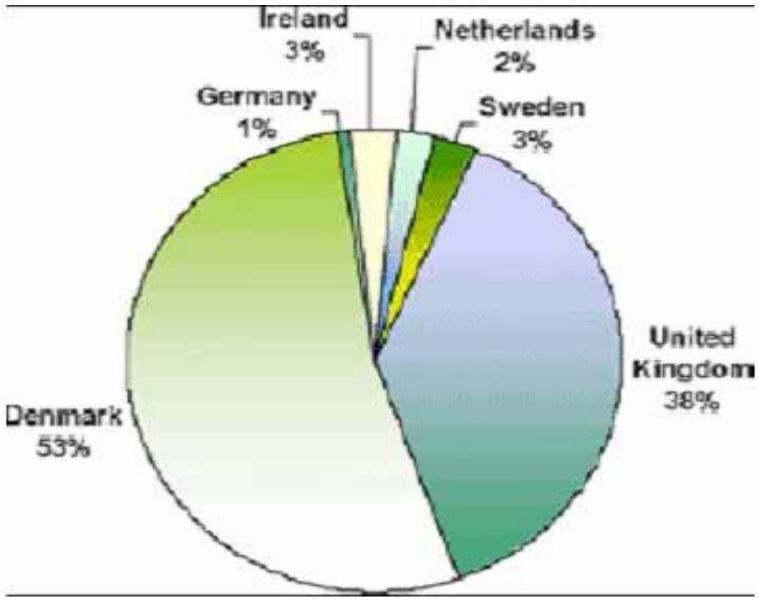
Introduction & Contents

- Some History
  - Development to date in:
    - Denmark
    - UK
- Experiences gained
  - Grid Connections
  - Environmental aspects
- Future Plans

Planned offshore wind farms in North Sea Area

Source
www.EWEA.org

- Europe leading the way in development of offshore wind



- Denmark 425 MW & UK 304 MW installed offshore

Danish Pilot projects

Vindeby

1991: 11 x 450kW,

2-3 km off-shore

Tunø Knob

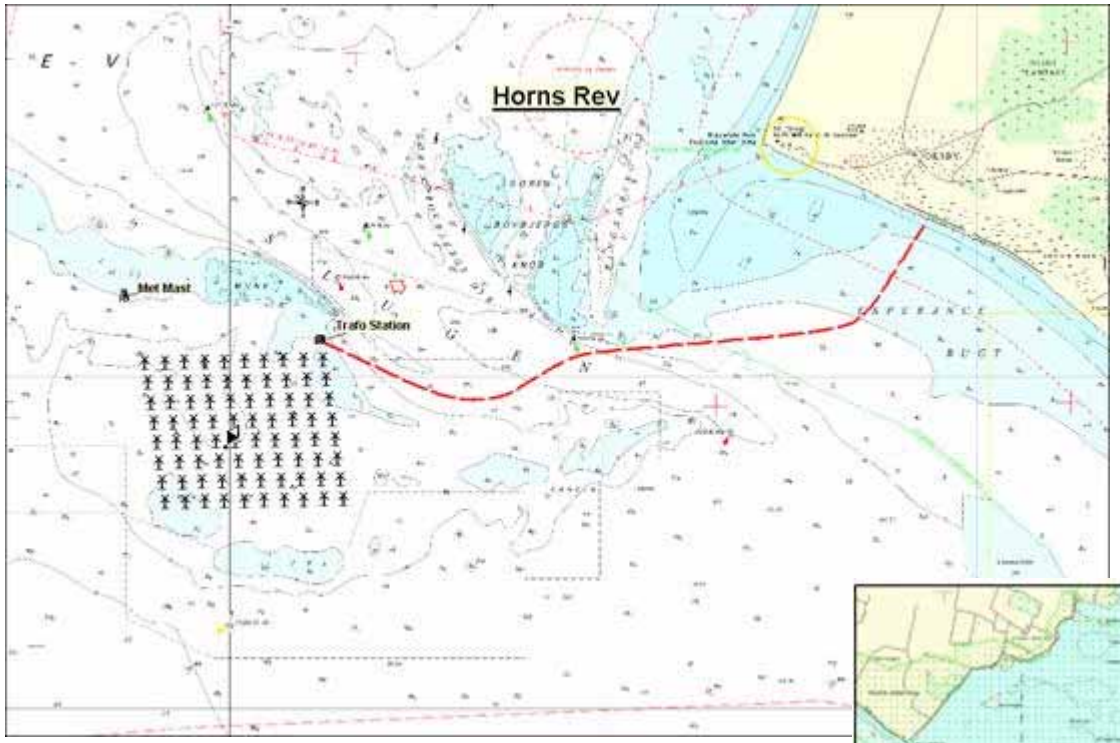
1995: 10 x 500kW,

5 -6 km off-shore

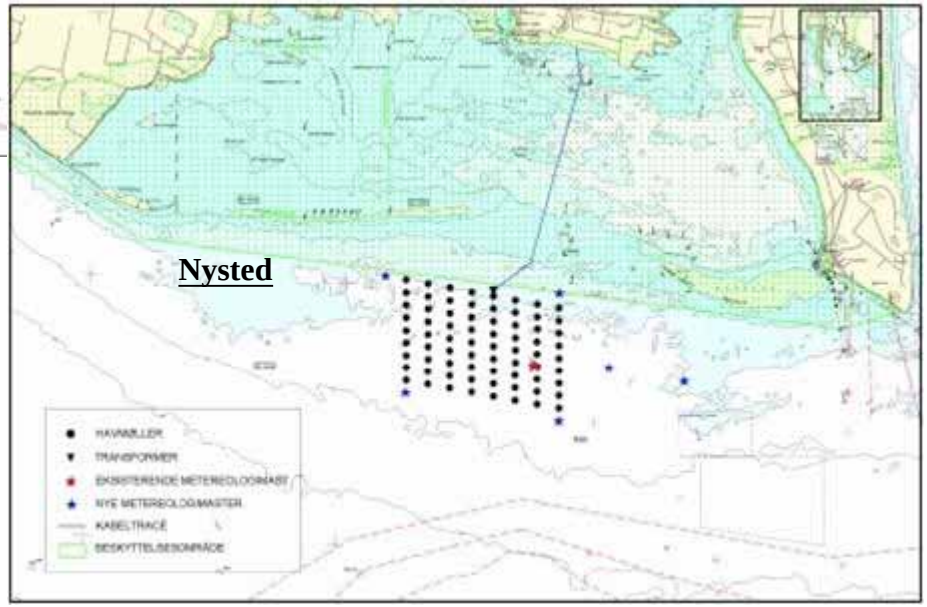
Middelgrunden

2001: 20 x 2 MW,

1,5-2,5 km off-shore



Offshore Wind Farm layouts



Horns Rev 160MW

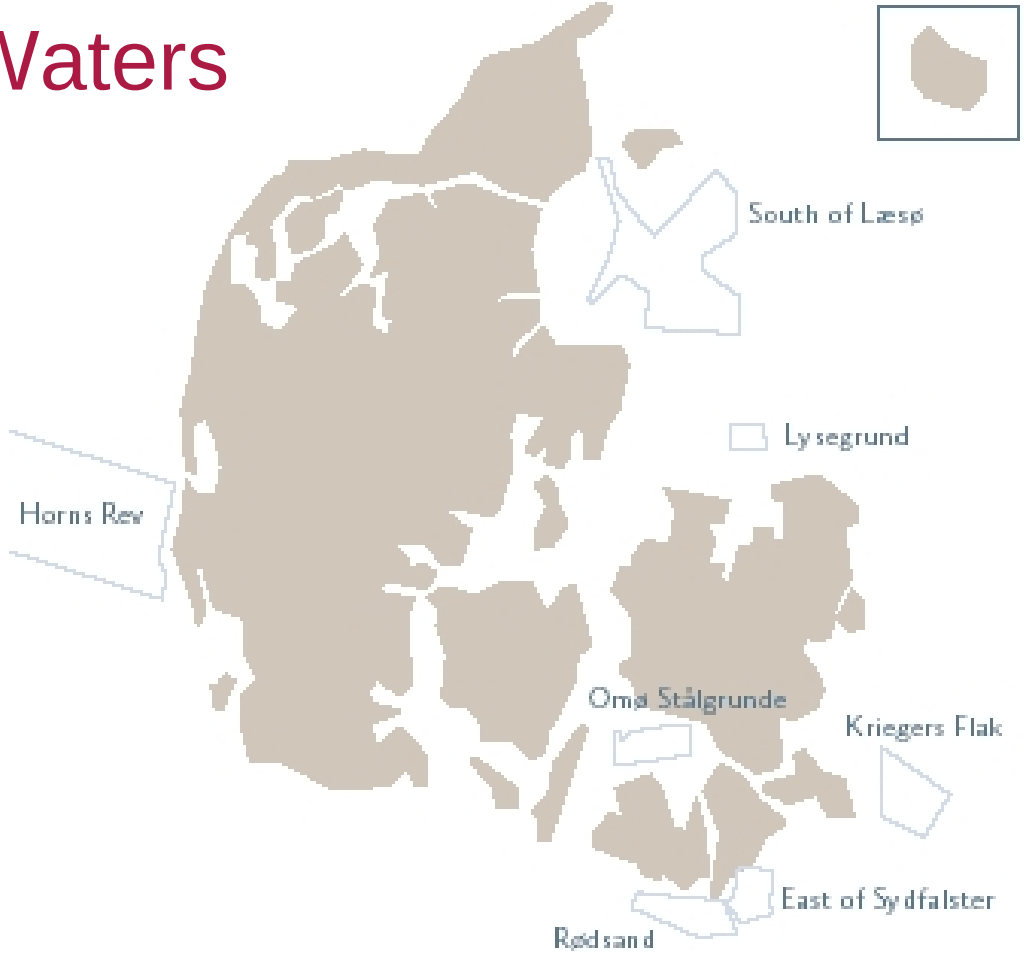
Installing turbines at Nysted

Offshore development in Denmark

1. Vindeby 5 MW (1991)
2. Tunø Knob 5 MW (1995)
3. Middelgrunden 40 MW (2001)
4. Horns Rev I 160 MW (2002)
5. Samsoe 23 MW (2003)
6. Roenland 17 MW (2003)
7. Frederikshavn 10.6 MW (2003)
8. Nysted-Roedsand 165 (2003)

Existing and approved offshore capacity (MW) by 2005: 423 MW

Screened offshore wind areas in Danish Waters



Areas screened by the Danish Energy Authority

Sites for next Offshore Wind Farms

Horns Rev II

Owner: Energy E2

Developer Energy E2

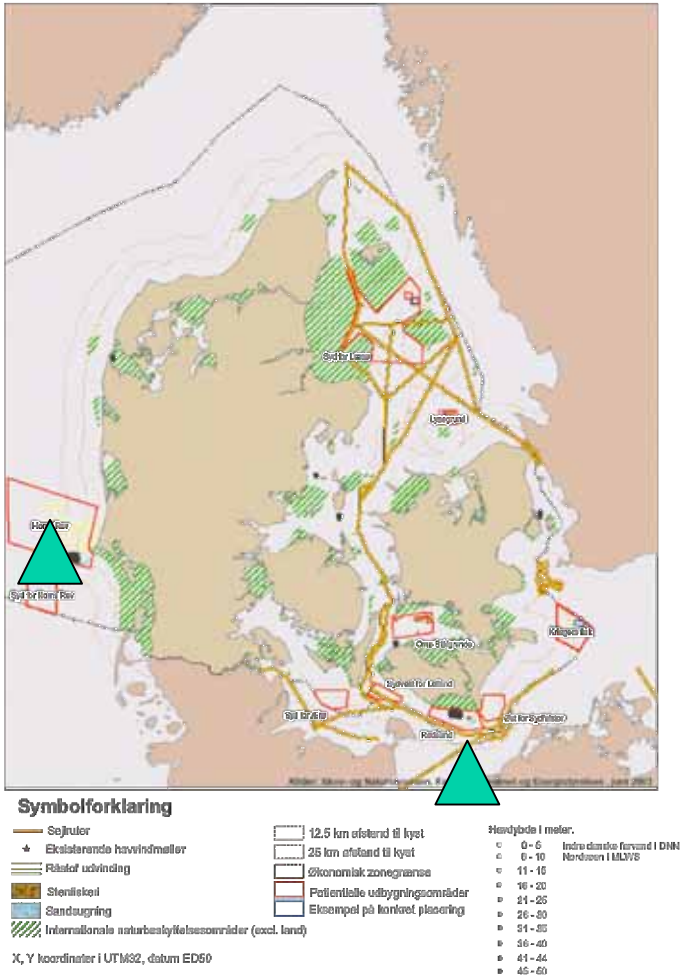
Roedsand II

Owner: E2

DONG Energy

and E.ON Sweden (20%)

Developer Energy E2



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UK Round 1 - Locations

Round 1 - Build Progress & Capital

Round 1 Offshore Wind Farm	Capacity (MW)	Status	Online	Grant Value (£M)
North Hoyle Offshore Wind Farm	60	Commissioned	Jul-04	10
Scroby Sand Offshore Wind Farm	60	Commissioned	Dec-04	10
Kentish Flats Offshore Wind Farm	90	Commissioned	Nov-05	10
Barrow Offshore Wind Farm (Barrow)	90	Commissioned	Apr-06	10
Burbo Offshore Wind Farm*	90	Constructing	Dec-07	10
Rhyl Flats Offshore Wind Farm	100	*Pre-construction*	Nov-08	10
Robin Rigg Offshore Wind Farm (OERL)	90	*Pre-construction*	Nov-08	9
Inner Dowsing Offshore Wind Farm	97.2	*Pre-construction*	Dec-08	10
Lynn Offshore Wind Farm	97.2	*Pre-construction*	Dec-08	10
Robin Rigg Offshore Wind Farm (Solway)	90	*Pre-construction*	Mar-09	9
Gunfleet Sands Offshore Wind Farm	108	*Pre-construction*	Dec-09	9
Norfolk Offshore Wind Farm	100	Shelved for 2 years		10
Total	**1072.4**			**117**

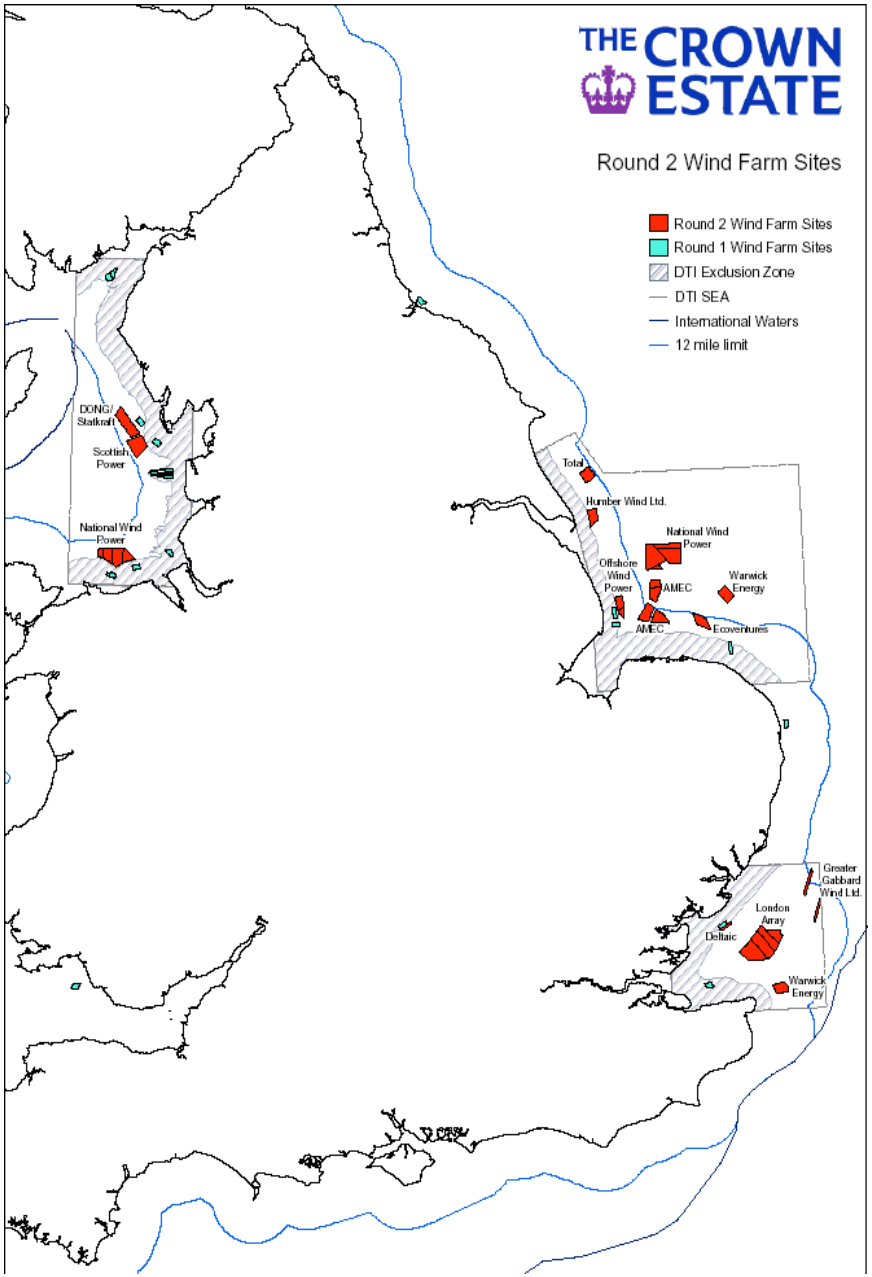
* Funded by the Big Lottery

UK Round 1 Projects

Offshore Wind Energy Development on the North Sea +

UK Round 2 Development

- 3 Strategic development areas:
  - Greater Wash
  - Thames Estuary
  - North West (Liverpool Bay)
- Expected Capacity 5.4 to 7.2 GW.
- 15 Wind Farms sites



Development of new foundation types

A Monopile

A Gravaty Foundation

Gravity foundation for Nysted

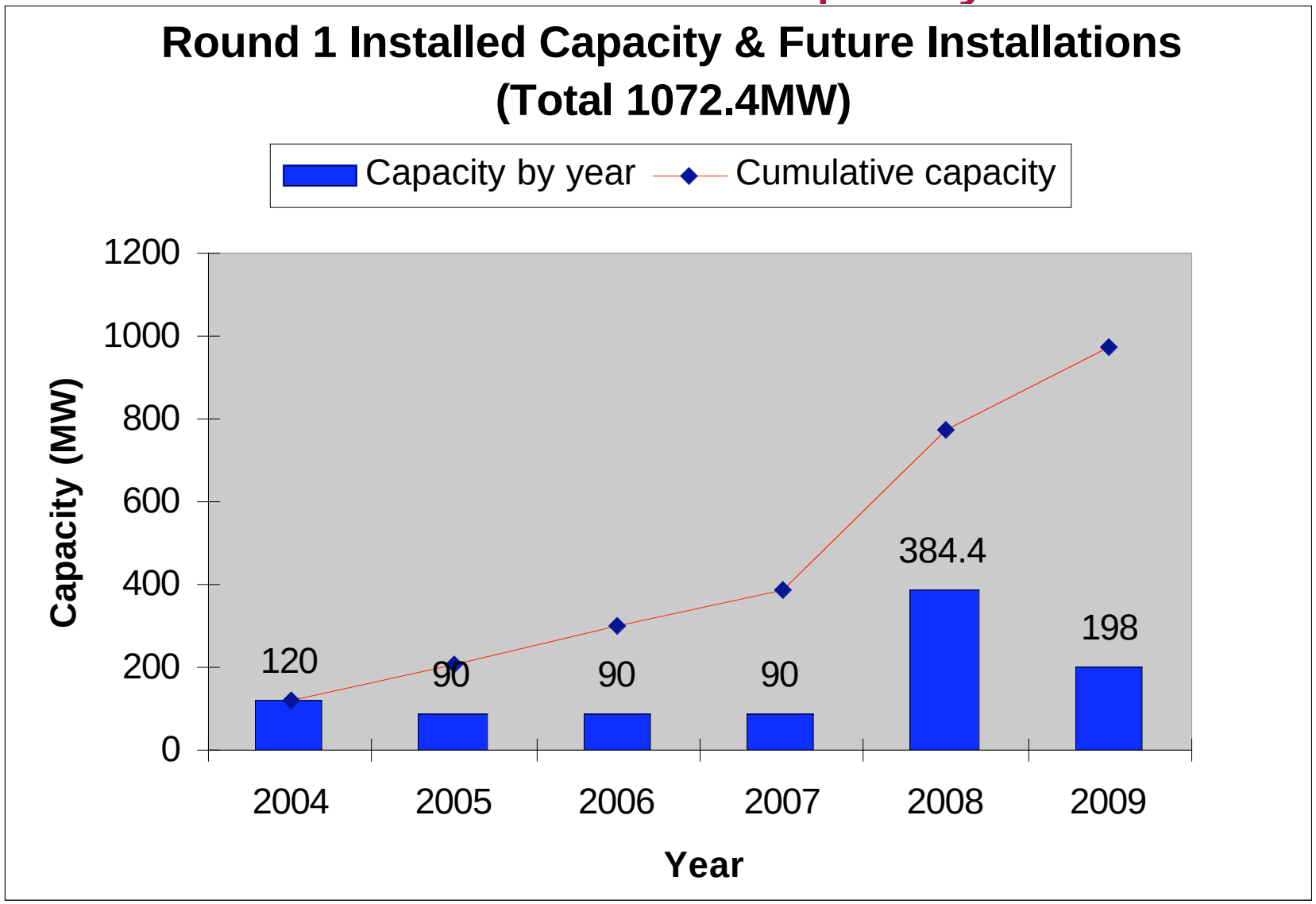
Operation and Maintenance

Horns Rev:
Access by Boat

Horns Rev:
Access by Helicopter
Hoist

Elsam

Round 1 – Capacity



Round 1 - Status

- The rate of project development has slowed significantly cf. earlier forecasts.
- Developers unable to secure EPC contracts and so forced to use multi-contract route to secure build
- High international demand for turbines has affected supply to offshore projects. Turbine delivery for many projects now delayed until 2008 or 2009.
- Turbines prices continue to rise steeply.

Round 1 - Status

- Total installed costs of existing operational projects was typically £1.22M to £1.36 M /MW.
- Cf. with estimates of £1.55M to £1.85M /MW for the remaining planned projects.
- Norfolk Offshore Wind – now shelved for 2 years.

Round 1 - Operational History

North Hoyle – 60MW (30x 2MW - Vestas V80)

- Operating for > 2 years
- 2nd Annual Report expected October 2006
- 1st year annual report now available

Scroby Sands – 60 MW (30x2MW - Vestas V80)

- Operating for > 18 months
- 2ndAnnual Report expected in February 2007
- 1st year annual report now available

Kentish Flats – 90 MW (30x3MW - Vestas V90)

- Operating for ~10 months
- 1st Annual Report expected in Nov/Dec 2006

Barrow – 90 MW (30x3MW - Vestas V90)

- Operating for ~ 6 months
- 1st Annual Report expected in May/June 2006

Round 1 - Operational Data

Wind Farm Operational Information						
	Installed Capacity	Turbines	Output GWh	Capacity Factor %	Mean Availability %	Year Period Covered
North Hoyle	60 MW	V80 2MW	190.7	36	84	Jul 2004 to Jun 2005
Scroby Sands	60 MW	V80 2MW	152.6	28.9	84.2	2005

A copy of the North Hoyle report can be found here (2 parts):
www.dti.gov.uk/files/file32843.pdf
www.dti.gov.uk/files/file32844.pdf

A copy of the Scroby Sands report can be found here:
www.dti.gov.uk/files/file32785.pdf

Offshore Grid Connections

- *The transformer platform at the Nysted Offshore Wind Farm is owned by SEAS Transmission.*

- *Barrow offshore transformer platform. Photo BOWind*

UK Grid Work
Scope of cost-benefit analysis

- Offshore networks
  - Switchgear reliability, installation cost, platform cost, ratings, maintenance requirements
  - Cable reliability, installation cost, maintenance requirements, ratings, electrical parameters
    - Transmission mode (AC vs DC)
  - Compensation requirements
  - Losses

UK Grid Work - Key findings

- Differences between offshore and onshore networks
  - Significantly higher capex requirements
  - Technology constraints
  - Wind generation operates at lower load factors than conventional plant
- Analysis of a wide range of connection options suggests that redundancy cannot be justified for offshore transmission networks (in contrast to onshore transmission networks)

Scope of cost-benefit analysis cont.

- Windfarms
  - Wind resource characteristics
  - Typical turbine ratings, availability, cost
  - Windfarm size
  - Windfarm distances from shore
- Future value of energy and ROCs
- Impact on onshore system operation
  - Additional reserve costs

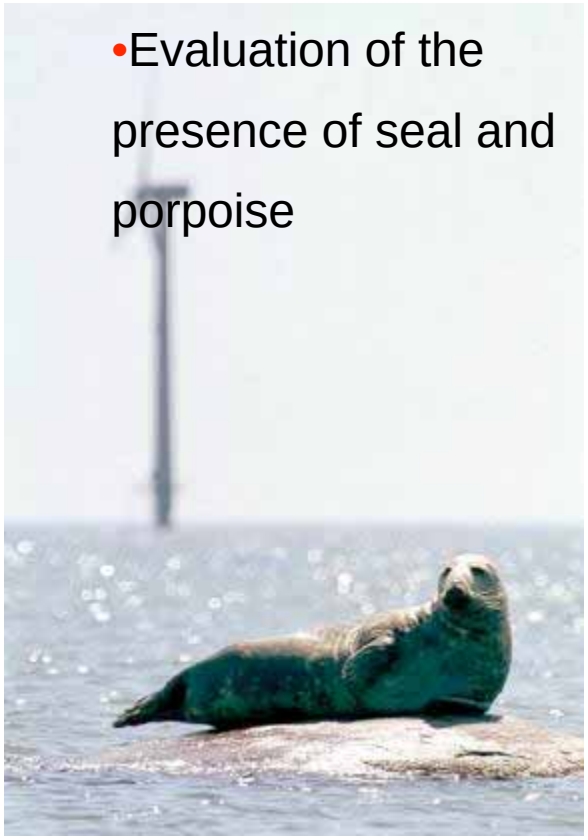
Flying pattern for migrating birds from Danish wind farms

The flying patterns of migratory birds were studied as part of the environmental monitoring programme for Horns Rev. It was found that the birds are able to find their way around wind farm by means of various routes,

Environmental Parameters

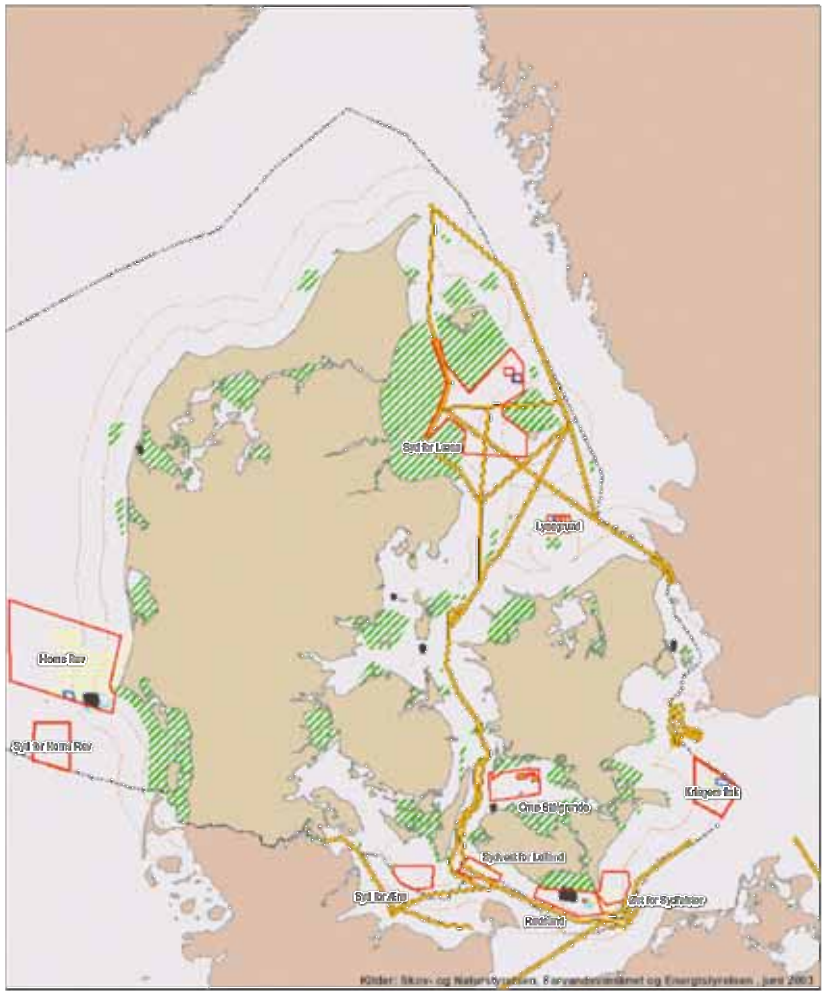
- Hydrography
- (Bottom) flora and fauna
- Artificial reef effects (bottom flora & fauna)
- Water quality
- Fish and fishing
- Birds
  - monitoring of bird species
  - Collision evaluation during operation

- Landscape aspects (visual impact)
- Marine mammals
  - Evaluation of the presence of seal and porpoise



Danish Plans for future offshore wind farms

- Danish Energy Strategy 2025
- Committee appointed by the Minister for transport and Energy will evaluate
  - Update of action plan from 1997
  - grid connection possibilities for large scale offshore wind farms
  - Economic, environmental and technical aspects for grid, turbine technology and water dept
  - Future test sites
- Report by the end of 2006



Potential locations for future Danish wind farms are shown. Black spots indicate existing Danish offshore wind farms. Restricted areas are hatched and shipping routes are indicated.

Round 2 - Status

- Round 2 – seven projects submitted applications

  - Process expected to ~1 year

	Offshore Project	Capacity (MW)	Submission Date
1	London Array	1000	03/06/2005
2	Greater Gabbard	500	17/10/2005
3	Thanet	300	07/11/2005
4	Gwynt y Mor	750	23/11/2005
5	Walney	450	16/03/2006
6	West of Duddon Sands	500	07/04/2006
7	Sheringham Shoal	315	30/05/2006
	Total	**3815**	