Offshore Wind Energy in the Netherlands
Asset Management & Technical Innovations

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Mark de la Vieter

September 2014
Agenda

Dutch Energy Policy & Industry Policy

Offshore Wind Energy in the Netherlands

Cost, risks and asset management

Critical Offshore Implementation /Technical issues
Dutch Energy Policy

• Principles: available, affordable and clean
• Mix of energy from renewables (like wind and solar) and traditional sources, such as oil, gas and coal.
• Long term (2050): switch to sustainable, low carbon energy supplies.
• Towards a harmonized European energy market & climate neutral energy consumption
• Energy Agreement for Sustainable Growth with employers, trade unions, environmental organizations and others.
Dutch Energy Policy: Energy Agreement for Sustainable Growth

• More than forty organizations
• Purpose: wholly sustainable energy supply system by 2050.
• Objectives:
  • a saving in final energy consumption of averaging 1.5% annually;
  • a 100 petajoule saving in the country’s final energy consumption by 2020;
  • an increase of sustainable energy from 4.4% currently to 14% in 2020;
  • a further increase to 16% in 2023;
  • 15,000 full-time jobs.
DUTCH Industry Policy: Top Sector policy

- 9 high level top teams advising on innovation instruments.
- Strengthening competence for international competition
- Golden triangle: companies, knowledge centers and government
- Top Sector Energy:
  - Biobased Energy
  - Solar Energy
  - Gas
  - Smart Grids
  - Offshore Wind
  - Residential Energy Saving
  - Industrial Energy Saving
Taiwan Policy: NEP-II

Advisory Committee:
Officers from the Ministries, experts, leaders of research org.

Supervising Committee
- Project Investigator
  - CEO
  - Deputies
    - (Government)
    - (Academia)
    - (Gov’t, Academia)

Oversight Committee

Energy Policy Strategy Division

Energy Policy Bridging and Communication Division

International Collaboration Division

Program Office

Linkage Divisions

Focus Centers

Energy Conservation Focus Center
Alternative Energy Focus Center
Smart Grid Focus Center
Offshore Wind Power and Marine Energy Focus Center
Geothermal Energy and Gas Hydrate Focus Center
Carbon Reduction and Clean Coal Focus Center

Virtual Power Plant and Energy Management Architecture

Emerging Energy and Carbon Reduction Architecture
## Comparison between programs

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<td>Support by European Commission (NER300)</td>
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Current: Offshore Wind Farms in Operation and Development

Shell-NUON
36 x Vestas 3MW V90 → 108MW
10 – 18 km from the coast
18 m water depth
Monopiles 70 m above sea level, 30 m into seabed
total investment appr. M€ 260

E-Connection → Evelop
60 Vestas 2 MW V80 → 120 MW
23 km from coast
19 - 24 m water depth
mono piles
total investment appr. M€ 380

GEMINI (Under Development)
Appr 600 MW

Irene Vorrink (Special Mention)
28 MW (1997)

Luchterduinen (Under Construction)
Appr 150 MW

Source: TUDelft Offshore Engineering, Wybren de Vries
The Future: Scaling up renewable energy generation

6000 MW onshore wind power by 2020

Introduction of a participation model enabling local residents to participate actively in the planning and operation of wind farms.

For the period after 2020, additional capacity will eventually be sought within the frameworks discussed with the Association of Netherlands Provinces (IPO).

4450 MW offshore wind power by 2023

A total of 3450 MW will be contracted for by means of phased procurement procedures commencing in 2015 and increasing as follows: 450 MW (2015), 600 MW (2016), 700 MW (2017), 800 MW (2018), and 900 MW (2019). With the assumption that the cost of offshore wind power will be cut by some 40% in the years ahead. The Government ensures that there is a robust legal framework that makes it possible to scale up offshore wind power.
The robust legal framework: policy on spatial planning

1. National Water Plan decides where offshore wind energy is allowed.

2. Roadmap 2015-2019 decides which areas will be used until 2019.

3. Government designs sites of 300 MW to tender and provides detailed info of the site, like wind information, and states the boundaries for the project developers.

4. TenneT develops offshore grid from the North Sea to the national grid.

5. Tender per area
   Lowest bid wins the permit to build and qualify for receiving subsidy.

... and then the construction phase (3-5 years) starts.
Cost reduction target

• Levelized costs offshore wind at € 100 / MWh
Cost reduction pathways (abroad)

UK

Germany
Strong position Dutch industry in offshore wind
## The Dutch offshore track record (1/3)

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The Dutch offshore track record (2/3)

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### The Dutch offshore track record (3/3)

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[Image: Holland - Pioneers in international business]
Dutch companies top 3 world wide

• General offshore
  • Fugro: world market leader in soil investigations for offshore wind
  • Van Oord: number 2 offshore wind EPC contractor
  • Heerema / SHL / Ballast Nedam: top 5 installation companies for foundations
  • Damen: top 3 ship builder for offshore wind

• Installation:
  • SIF / Smulders: world market leader in monopile offshore wind foundations
  • Vroon / MPI: top 3 installation company for windturbines
  • IHC Merwede: world market leader in tooling for offshore wind

• Connectivity
  • VSMC: top 3 cable installation company for offshore wind
  • Tennet: top 3 investor and operator of grid connections
  • Heerema / Strukton Hollandia: top 5 EPC contractors Offshore high voltage stations
Offshore wind in the Netherlands

• The Netherlands are perfectly situated for offshore wind on the North Sea
• The Dutch Government is highly committed to strengthening the position of Dutch companies
• The Netherlands are an open economy with a highly qualified laborforce on offshore wind
• The Netherlands have excellent infrastructure and other provisions for foreign companies and investors in offshore wind
• The Netherlands has a strong background in innovation and specified innovation programs for future cost reductions
Agenda

Dutch Energy Policy & Industry Policy

Offshore Wind Energy in the Netherlands

Cost, risks and asset management

Critical Offshore Implementation /Technical issues
Land based wind energy benefits more from cost reduction oriented wind turbine innovations than offshore wind does.
Risk Management

• Risk = Probability x Impact

• Two strategies:
  • Avoiding – Reducing the Probability
  • Mitigating – Reducing the Impact
Asset Management

O&M cost are 25% - 30% of kWh cost (LCOE)
Revenue losses approximately 50% of O&M cost and comparable with corrective maintenance (ref.: ECN)
Asset Management: Access technology

Transfer and transport systems
Repair time for mission of 40 resp. 20 hr?

$H_s = 1.5 \text{ m} \quad V_w = 12 \text{ m/s}$

$T_{wait \_40\_uur} = 96 \text{ hr}$

$T_{wait \_20\_uur} = 56 \text{ hr}$

ECN; Braam, Rademakers
Agenda

Dutch Energy Policy & Industry Policy

Offshore Wind Energy in the Netherlands

Cost, risks and asset management

Critical Offshore Implementation /Technical issues

Pioneers in international business
Typical offshore R, D & D issues (Fundamentally different from onshore technology)

A. External conditions
B. Wind farm design
C. Wind turbines & Components
D. Support structures
E. Transport & Installation
F. Operation & maintenance (O&M)
G. Grid Connection & Integration
H. Ecology
A. External Conditions

Wind (low turbulence intensity)

Waves

Ocean currents

Saline atmosphere

Morphology
Wave & current characteristics

Waves (surface and wind) relevant for:
- Access levels
- Extremes (breaking waves)
- Fatigue
- Installation & Maintenance

Currents relevant for:
- Loads (Extremes)
- Installation & Maintenance
- Scour
Understanding the effects of extreme waves on offshore wind turbines (TKI-project WiFi JIP)
B. Wind Farm Design

More energy at same investment level (optimising lay-out & wake control)

Improve power quality (reduced power fluctuations)
More energy output by wake control
C. Optimisation of wind turbines for offshore wind farms

TKI participants
D. Support structures
Support structures (TKI projects)

• Drilled concrete monopile
• Integrated design mast and support structure
Support structures (TKI projects)

- Smart scour protection (erosion protection)
- Slip joint (no grout, no transition piece)
Support structures: acoustic noise reduction. (TKI project)

- Drilled concrete monopile
- Noise barrier
Accurate life time prediction of support structures. (TKI project FeLoSeFI)

• Estimates the expected lifetime of offshore wind structures accurately.
E. Transport & Installation

- Just in time delivery at construction site from manufacturer
- Parts by part
- Complete wind turbine

Who will be the winner? A or B?

A

B

Van Oord

Ballast Nedam

40
Service islands and energy storage

Service island at sea

Service island & energy storage at sea

Floating harbour
F. Operation & Maintenance

Who is better off?

Ampelmann test & demo

Photo: Jos Beurskens
From optimised O&M to Asset management

- Preventive Maintenance (PM)
- Corrective Maintenance (CM)
  → Condition Based Maintenance (CBM)

Availability!

Reliability
Accessibility

Asset Management

O&M cost are 25% - 30% of kWh cost (LCOE)
Revenue losses approximately 50% of O&M cost and comparable with corrective maintenance (ref.: ECN)
Access technology (TKI project)

• Z-Bridge: Innovative access bridge for offshore wind turbines
G. Grid Connection & Integration
Grid Connection

HVAC vs. HVDC connection

(~10 km, OWEZ Egmond aan Zee)

(~23 km, Q7 IJmuiden)

Future (>120 km)
Grid Connection

Multi-terminal HVDC
Grid Connection (TKI project: Synergies at Sea (SAS))

• Integration of infrastructure and interconnection of multiple offshore wind farms
H. Ecology

Most important ecological issues:

- **Birds**
  (migration, collisions)

- **Marine mammals**
  (sound during installation)

- **Fish**
  (Positive effects, negative effects during hammering?)
The more research is conducted .....  
the less anticipated problems appear to be real ones,  
the more mitigating measures appear possible and effective,  
However, cumulative effects are still unknown
And finally ........
Offshore wind in the Netherlands

- The Netherlands are perfectly situated for offshore wind on the North Sea
- The Dutch Government is highly committed to strengthening the position of Dutch companies
- The Netherlands are an open economy with a highly qualified laborforce on offshore wind
- The Netherlands have excellent infrastructure and other provisions for foreign companies and investors in offshore wind
- The Netherlands has a strong background in innovation and specified innovation programs for future cost reductions and is willing to collaborate
Thank you for your attention!