
# STRABAG OFFSHORE WIND

Dipl.-Ing. Robert Foyle

ENERGY IRELAND CONFERENCE 6th September 2012

STRABAG

# STRABAG OFFSHORE WIND

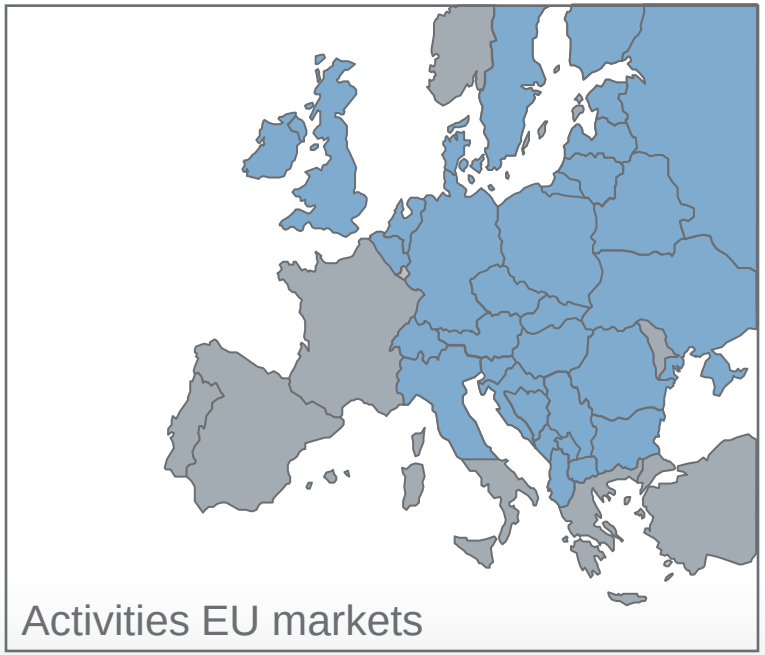
| STRABAG OFFSHORE WIND | | |
|---|---|---|
| **TECHNICAL**<br>■ DESIGN PHILOSOPHY<br>■ COMPONENTS & MATERIALS<br>■ FULL SCALE TEST | **PROCESS**<br>■ PORTS AND PLANT<br>■ SERIAL FABRICATION ONSHORE<br>■ TRANSPORT & INSTALLATION | **COMMERCIAL**<br>■ IMPACT ON COST OF ENERGY<br>■ CHALLENGES & OPPORTUNITIES<br>■ RISKS AND DERISKING<br>■ TIME TO MARKET |
| **SUMMARY AND OUTLOOK** | | |

# STRABAG OFFSHORE WIND
## STRABAG SE GROUP

- Leading European Contractor
- **76,866** employees
- **13,713** € Mio (2011)
  - 36% Building Construction / Civil Engineering
  - 46% Transportation Infrastructures
  - 16% Special Divisions and Concessions

- **Corporate Social Responsibility**
  - Renewables part of our Sustainability Philosophy: Energy efficiency and reduction, $CO_2$ reduction, CDP top score

- More than 100 years of experience
- Strong and solid financial background


Activities EU markets

# STRABAG OFFSHORE WIND

## STRABAG OFFSHORE WIND AS PART OF THE STRABAG GROUP

**STRABAG Offshore Wind**
**Cuxhaven/Hamburg/Stuttgart/Dublin**

- **80 In House Offshore Engineers**
  - Structural Design
  - Mechanical & Electrical
  - Geo-technical Design
  - Hydraulic & Soil Mechanics
  - Ship & Vessel Design
  - Logistics
  - Wind Tide and Wave Analysis
  - Etc.

**STRABAG Inhouse**

- **Zentrale Technik (In-house engineers)**
  - 650 Engineers
  - “Brain Pool” to support STRABAG Projects worldwide.
- **Strong Research, Development and Innovation**

Broad knowledge
Interface competence
**Reliable, experienced and long-term partner**

# LIVING KNOW-HOW
## CO-OPERATIONS STRABAG OFFSHORE WIND

**Mott MacDonald**

- **Co-operations with Research and Development Institutions**
  - Universities Braunschweig, Trinity & Bolton Street Dublin, Hamburg, Hannover, Karlsruhe, Stuttgart, Vienna
  - Fraunhofer Gesellschaft

approx. £150 per MW/hr

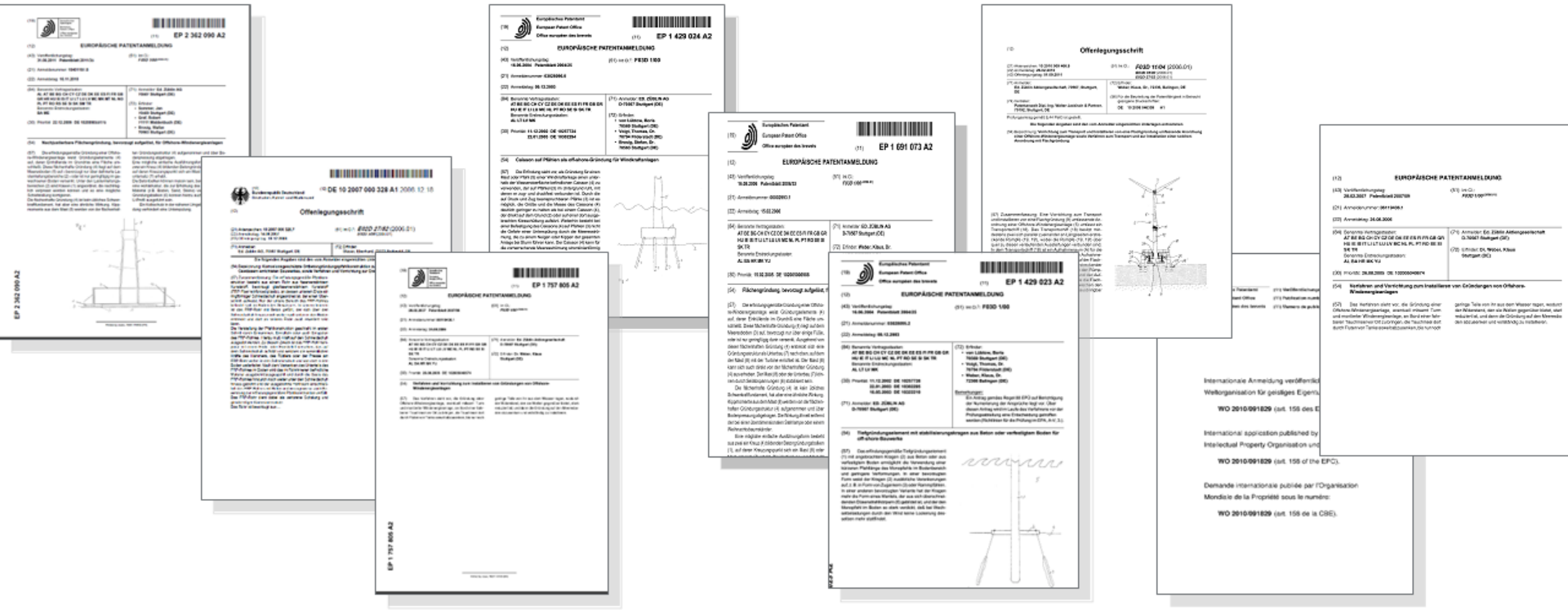
to below £100 per MW/hr

- **Networks UK and Ireland**
  - Crown Estate London Cost Reduction Program
  - Concrete Centre London Promoting Concrete Gravity Base Foundations
  - DECC London Offshore Accelerator Program
  - NOW National Offshore Wind Association of Ireland

- **Networks Germany and EU**
  - WAB Windenergie Agentur Bremerhaven / Bremen e.V.
  - Stiftung Offshore Windenergie
  - ENCORD - European Network of Construction Companies for Research and Development

# LIVING KNOW-HOW

## STRABAG OFFSHORE WIND PATENTS, PATENT APPLICATIONS, IP



# LIVING KNOW-HOW

## STRABAG OFFSHORE WIND PROJECT CERTIFICATIONS

SGS

Projektzertifizierung
Ref. Nr.: 49 10118 2
Prüfbericht über die Vorstufe zum Basic Design zur
Wetfeet Offshore Windenergy GmbH
23. Juni 2010

PRÜFBERICHT

FÜR DIE

VORSTUFE ZUM BASIC DESIGN
(VORENTWURF)

DES
SCHWERGEWICHTSFUNDAMENTS
FÜR DEN
OFFSHORE WINDPARK

GLOBAL TECH I

DEWI-OCC Offshore and
Certification Center GmbH
Am Seedeich 9, D-27472 Cuxhaven

**Stellungnahme**

**zum Vorentwurf der Gründungskonstruktionen für den**

**Auftraggeber:**

**Anlagenbezeichnung:**

**Entwurfsverfasser:** STRABAG AG
Zentrale Technik
Albstadtweg 3
D-70567 Stuttgart

TÜV SÜD Industrie Service GmbH
Department Offshore Wind Energy

TÜV SÜD
Industrie Service

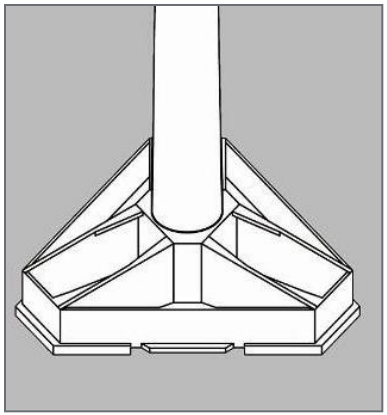
**Statement of Compliance**
**for the 1st Release Assessment**

Registration No.: **01.01.11.21.00**

This statement of compliance is issued to: **Windkraft FIT**
**Lübecker Strasse 128**
**22087 Hamburg**

For the project: **Offshore Wind Farm**
**Demonstrationsprojekt Albatros I**

- **Global Tech I**
- **North Sea Project (confidential)**
- **Project Albatros I**
- **FINO**
- **Arkona**
- **Anholt Substation**
- **etc.**

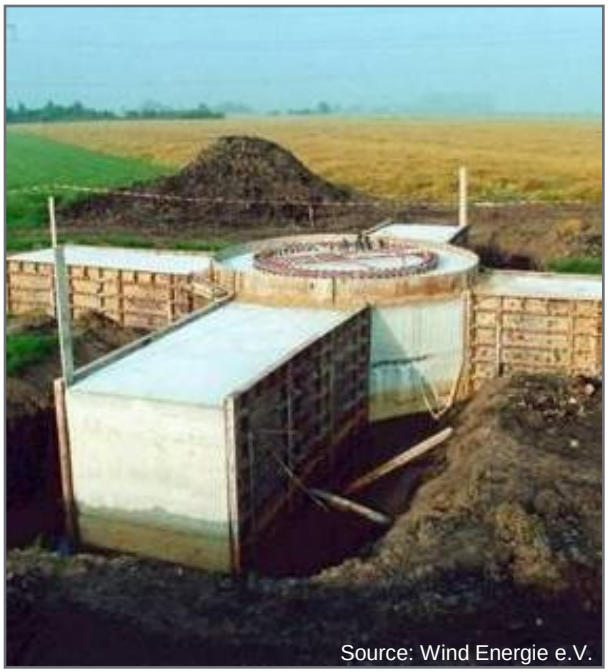


# TECHNICAL

# TECHNICAL
## DESIGN PHILOSOPHY

### Onshore Foundations

- Gravity as standard for good soil conditions
- Simple and proven
- Robust concrete construction technology
- Decades of experiences within STRABAG Group


Source: Wind Energie e.V.

# TECHNICAL
## DESIGN PHILOSOPHY

### STRABAG GBF Offshore Foundation

- Foundation system for industrial mass production
- Water depths up to 55 m
- Minimal environmental impact
  - no pile driving noise
  - low operating noise
  - minimal blockage effect
- Designed for ~ 90 % of North Sea / Irish Sea
- Serial production, Onshore assembly,
  Transport and Installation pre-assembled unit
- Minimise time between Invest and ROI
- Up to 10MW
- Life Cycle Design: Lower maintenance,
  Longer operation designed for 25 years ++ to 50 years
  Repowering capacity, 100% removable

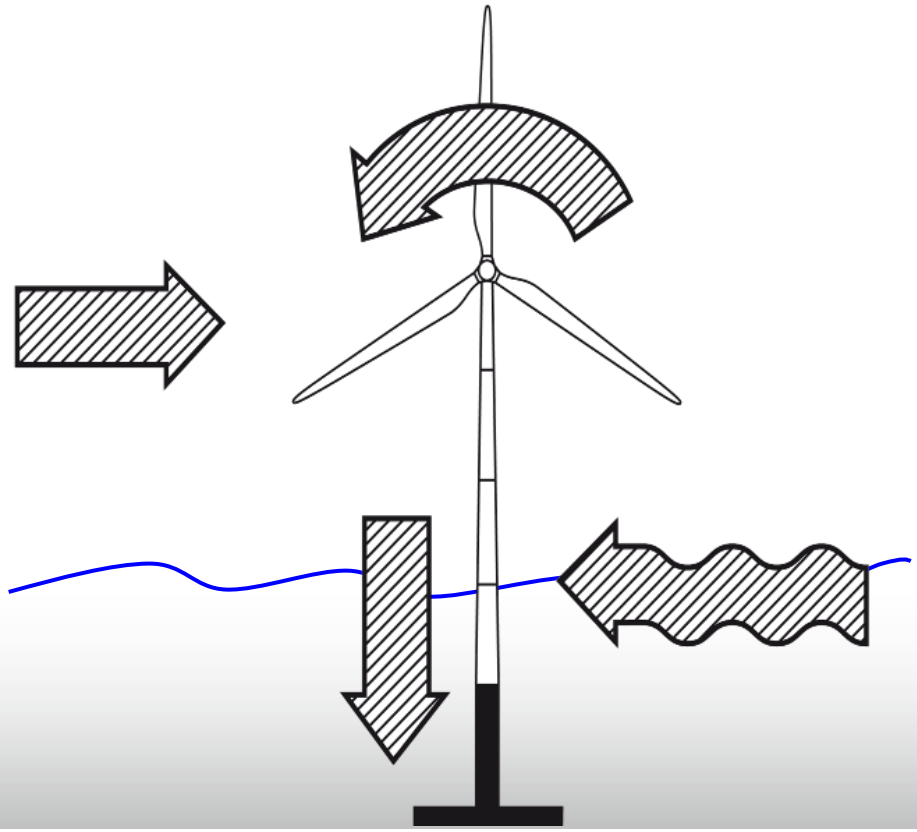
# TECHNICAL

## DESIGN PHILOSOPHY - 360° ENGINEERING

### STRABAG GBF Offshore Foundation

- Integral load calculation
- Holistic understanding of specific offshore requirements
- Engineering Know How
- Interface Competence

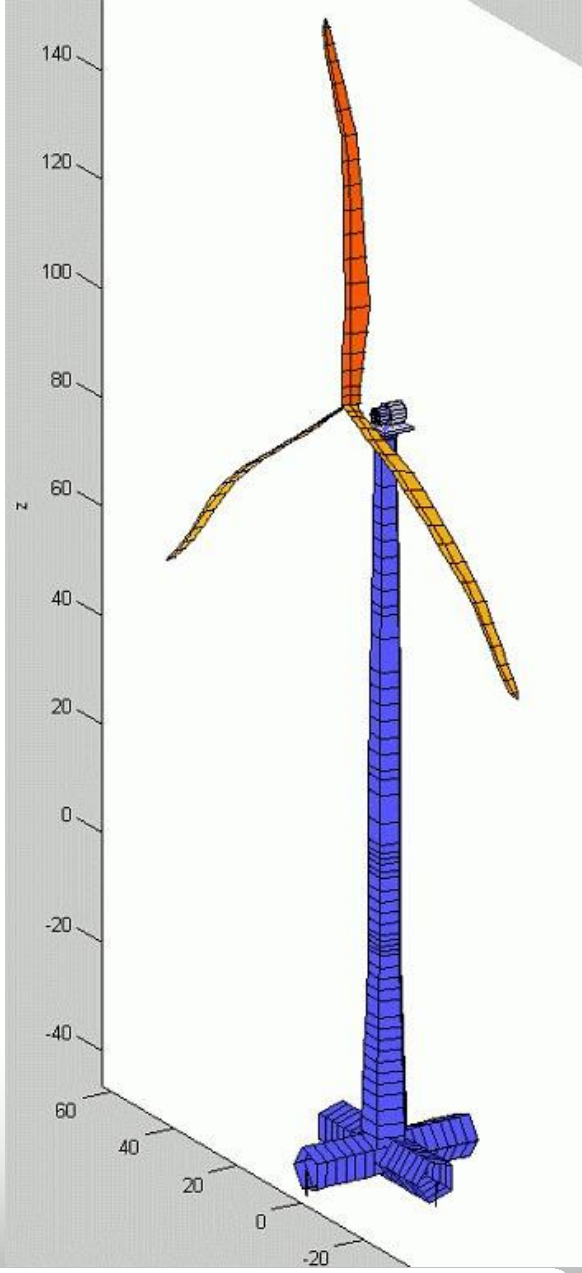
- **Optimisation of the entire system**
- **Minimising risk**



# TECHNICAL
## DESIGN PHILOSOPHY

**STRABAG GBF designed for large OWT**

- In-House global load calculation program Garrard Hansons “Bladed”
- Existing basic design for turbine types of 5-8 MW
- Feasibility study successful up to 10 MW
- Easy to adapt GBF design to all tower diameters
- Design Frequencies comply with requirements of established 5-8 MW turbine types
- Design co-ordination with 8 of the leading turbine manufacturers

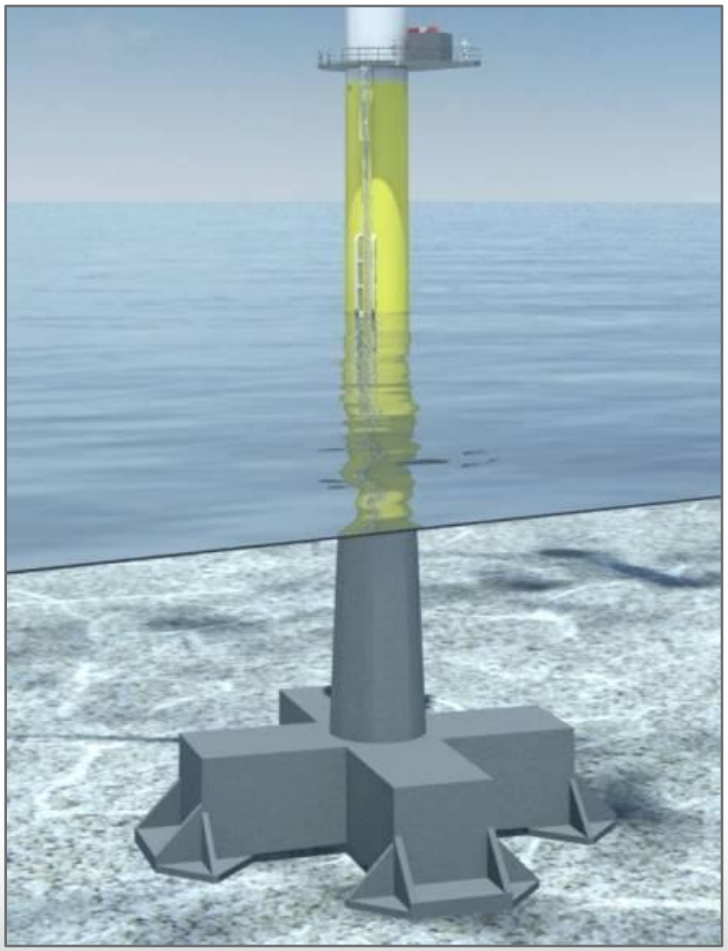


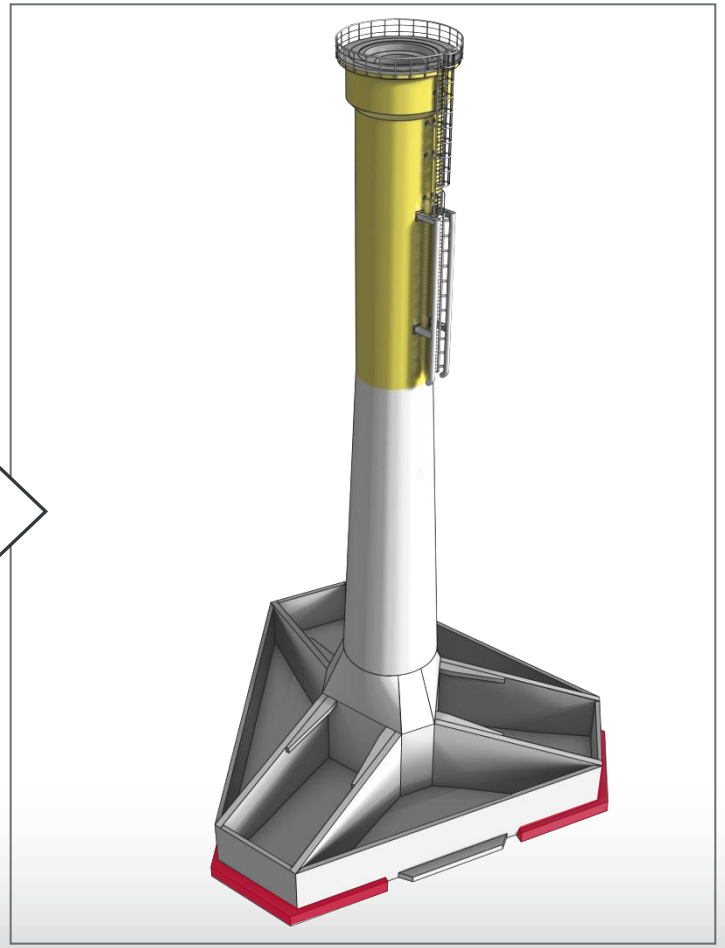
# TECHNICAL
## CUSTOMISED PROJECT DESIGN

- Monopiles, Jackets and Gravity Base Foundations: personalised solution for your project
- We cover 100%
- For UK & Ireland we focus on Gravity Base, >3MW >25m

# TECHNICAL

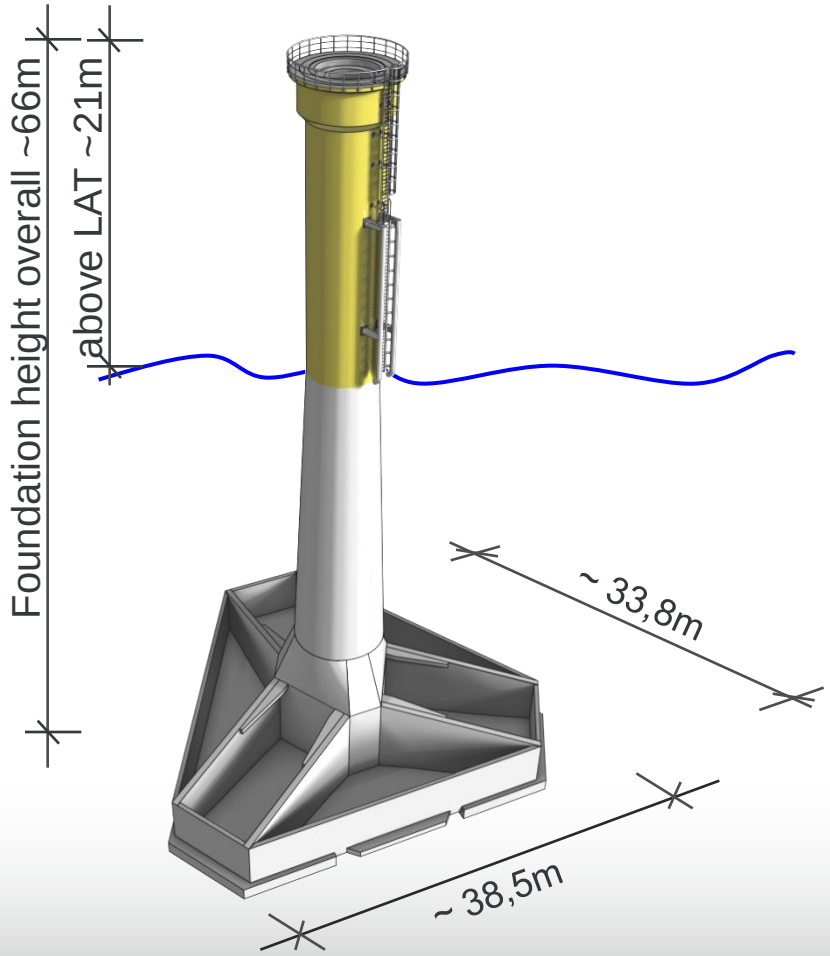
## OPTIMIZED LEAN DESIGN 2012 FOR SERIAL PRODUCTION & INSTALLATION





# TECHNICAL

## MAIN COMPONENTS, DATA SHEET, MATERIALS



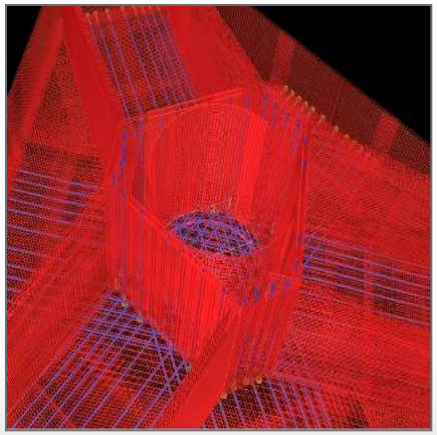
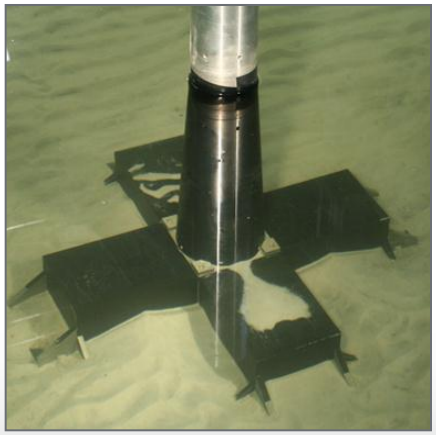

| Example 45 m water depth | |
|---|---|
| Ø shaft | Base: 8,50m<br>LAT: 5,80m |
| Base plates | 3 x ~128m² = 384m² |
| Concrete | ~ 7000 t |
| Reinforcement steel | ~ 620 t |
| Pre-stressed reinforcement steel | ~ 80 t |
| Secondary Steel | ~ 62 t |
| Volume Ballasting, sandbags (or stones) | ~ 2800 m³ |

# TECHNICAL
## ANALYSIS

This project has been co-funded by the European Union under the European Energy Programme for Recovery

- Numeric simulations and predictions
- Scale model wave tank testing
- Full size testing wave loadings

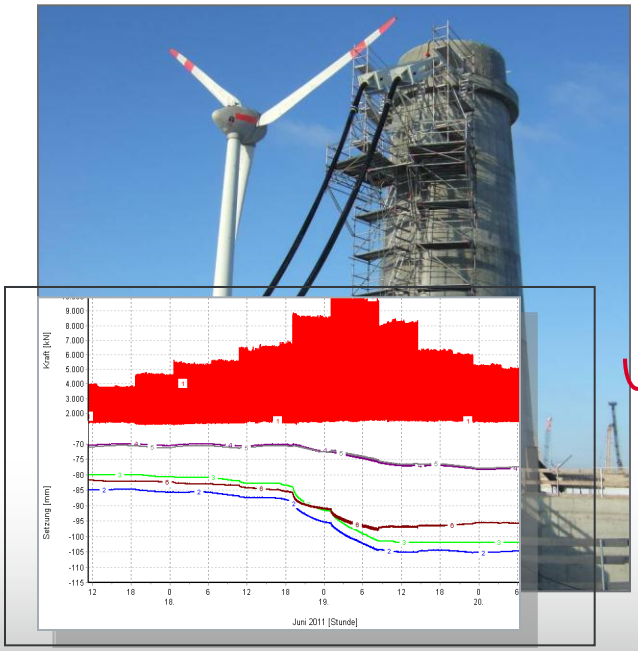
Numeric simulation | Wave Channel M 1:50 | Big wave flume M 1:17 | Full Size M 1:1

# TRIAL STRABAG GRAVITY FOUNDATION

## ANALYSIS – LIVE 1:1 FULL SCALE TEST

This project has been co-funded by the European Union under the European Energy Programme for Recovery

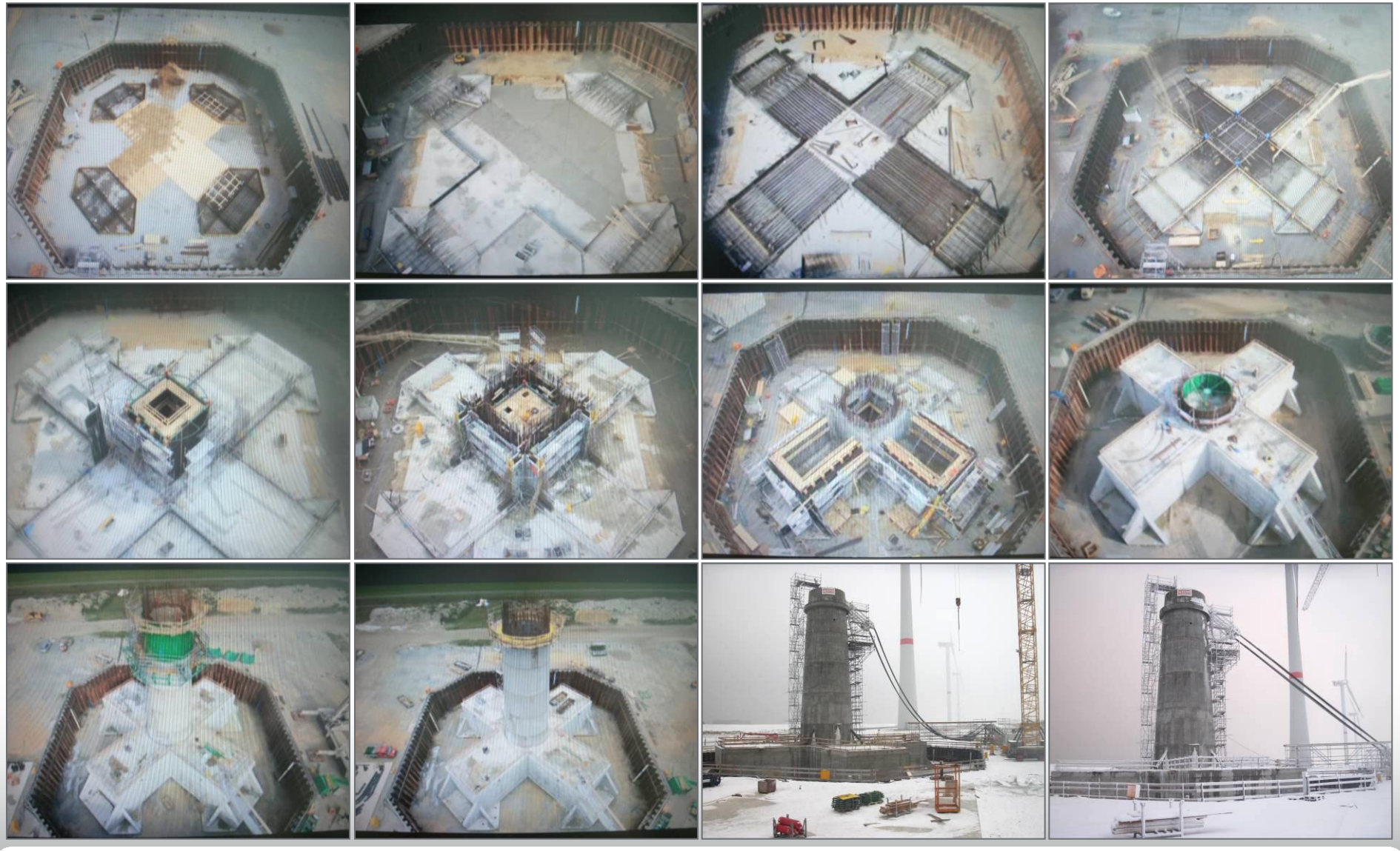


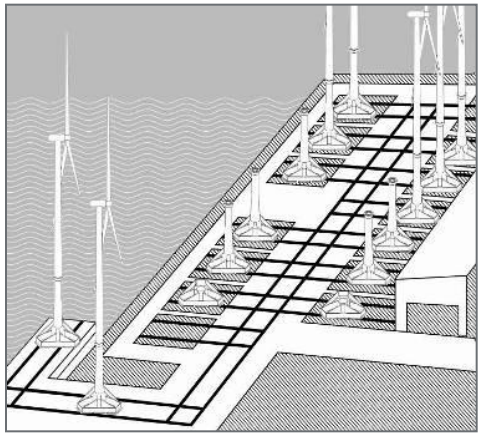

- First systematic full scale test of offshore load cases
- R&D program Geotechnical Aspects with cyclic impacts
- Subsoil like North Sea conditions
- Over 300 sensors
- Simulation of
  - Real load assumptions
  - Realistic severe North Sea storms
  - Cyclic wave loads (≠ Oil and Gas)
  - Loads up to 1100 to every 12 seconds
  - 1.2 million cycles

**Proof of function and viability under real conditions**

- **No soil liquefaction**
- **Foundation well suited for all sea states**

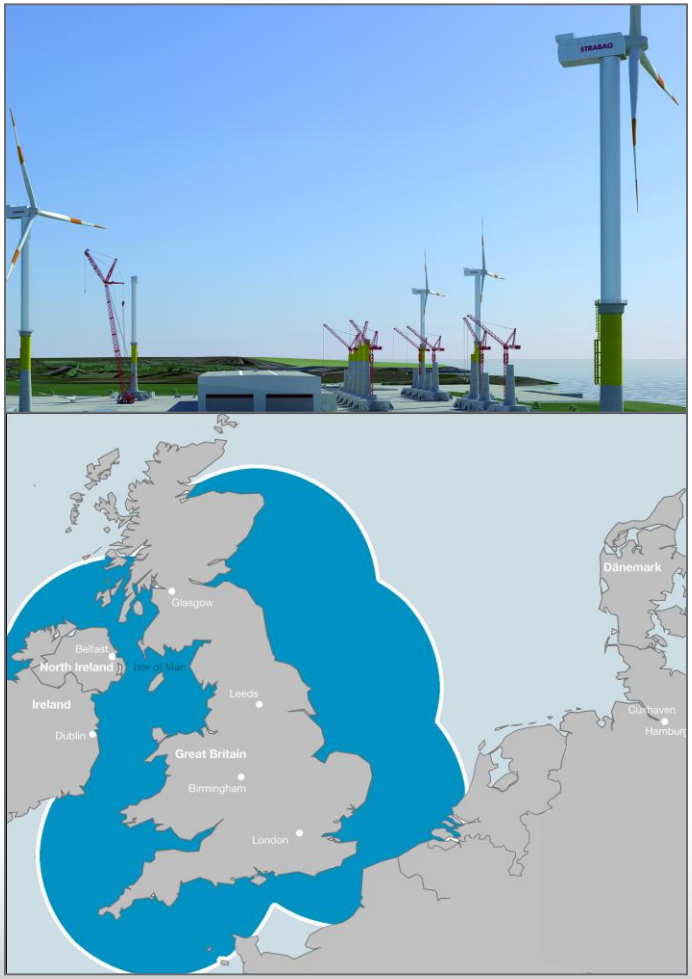
# TRIAL STRABAG GRAVITY FOUNDATION





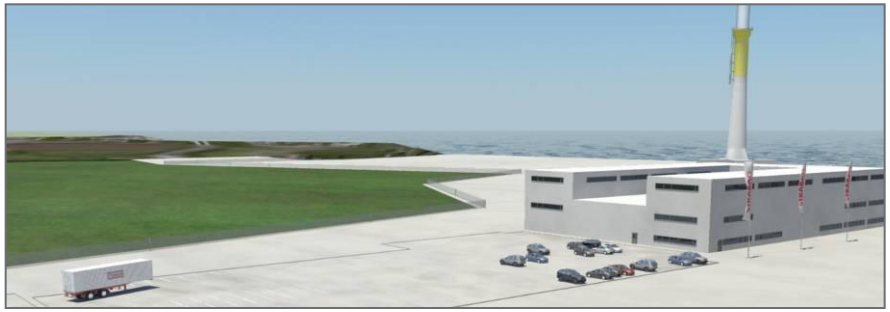
# PROCESS

# PROCESS
## FABRICATION – PORTS AND PLANT

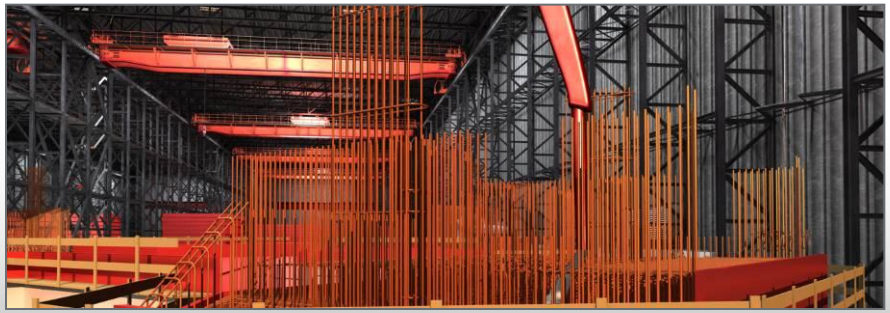



- **Ports**
  - Cuxhaven for German North Sea
  - Negotiations & Pre-Agreements with ports in England, Scotland, & Ireland
- **Requirements for fabrication yards**
  - Production Area with sea access
  - Area required ~ 30 ha.
  - Local labor (engineering and production)
  - Storage areas for blades, turbines, towers
- **Industrial plant for large-scale production**
  - High automation
  - Flexible capacity
  - Complete pre-installation onshore
  - Safeguarding the coastal regions – creating jobs at the UK & Ireland locations

# PROCESS
## SERIAL FABRICATION FOUNDATION



- Serial Production
  - Foundation
  - Concrete shaft
- Weather-independent production
- Quality assurance
- Reduced H&S risks



# PROCESS

## ONSHORE INSTALLATION TOWER, TURBINE AND BLADES

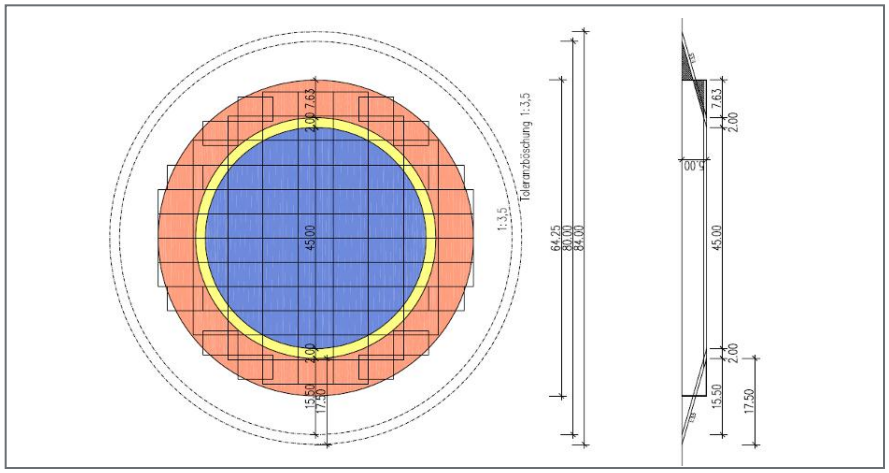

**Full onshore assembly**

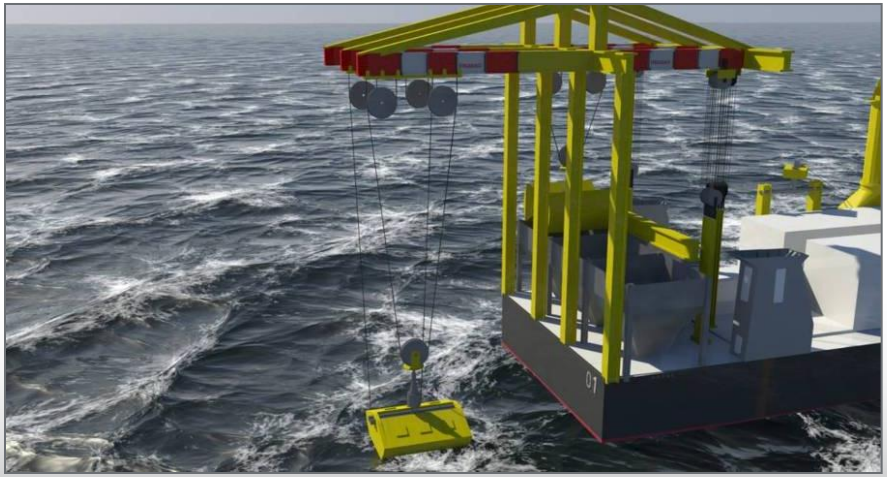
- 80++ completed foundations per year
- Duration production 9 weeks
- Onshore pre-installation of tower, turbine and rotor blades
- Onshore Turbine testing and trial operation

- **Local supply chain**
  - Concrete delivered or mixed on site
  - Standard reinforcement
  - Secondary Steel

# PROCESS

## SEA BED PREPARATION AND TEST SITES



### Process

- Excavation 2 m to 8 m
- Levelling

### Test Excavation Pits

- Numerical simulation completed
- Full scale demonstration pits 05/2013
  - Optimising excavation method
  - Tool optimisation
  - Verification of best inclination angle
  - Sedimentation issues in pit
  - Current & tidal effects

# PROCESS
## TRANSPORT

**Offshore-transport & installation vessel**

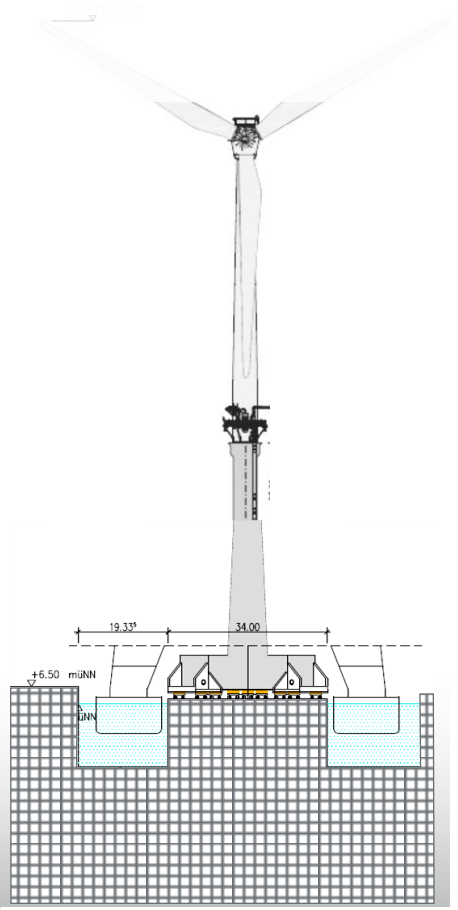
- Self propelled (high capacity)
- Proven semi-submersible technology - like Gas-Platforms (low motion and acceleration)
- Dynamic Positioning DP2
- Up to 2.5m significant wave height
- Heave compensation
- Transport & Installation ~ 2 days

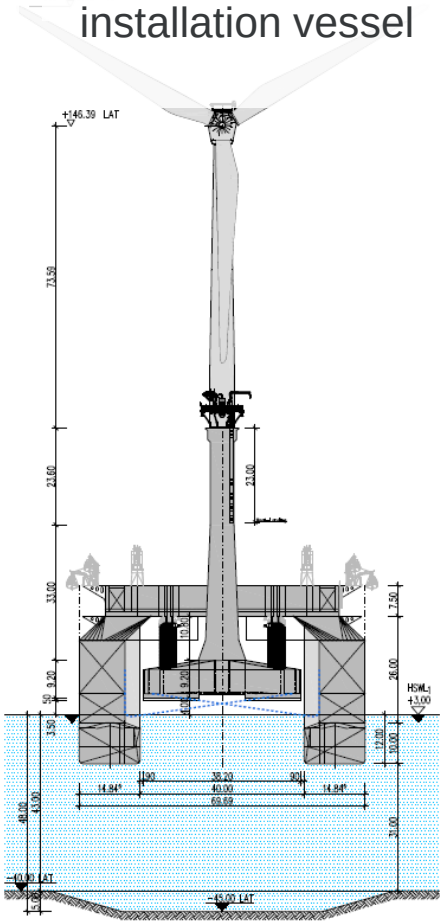
- Foundation is designed for offshore wind use - not for floating out to install.

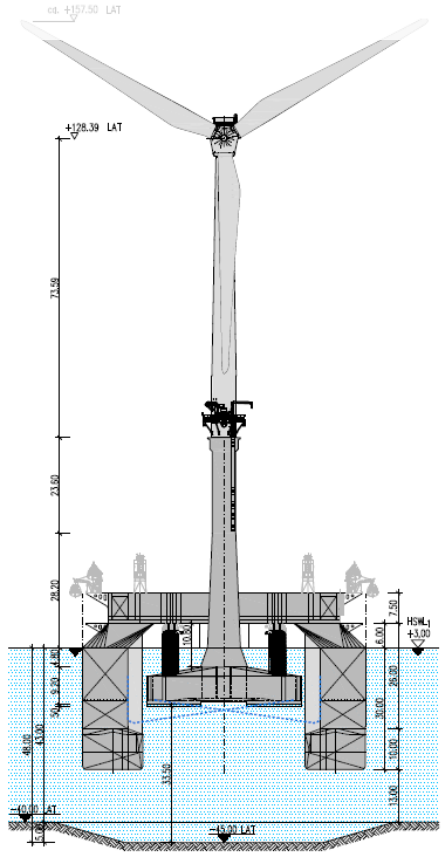
# PROCESS

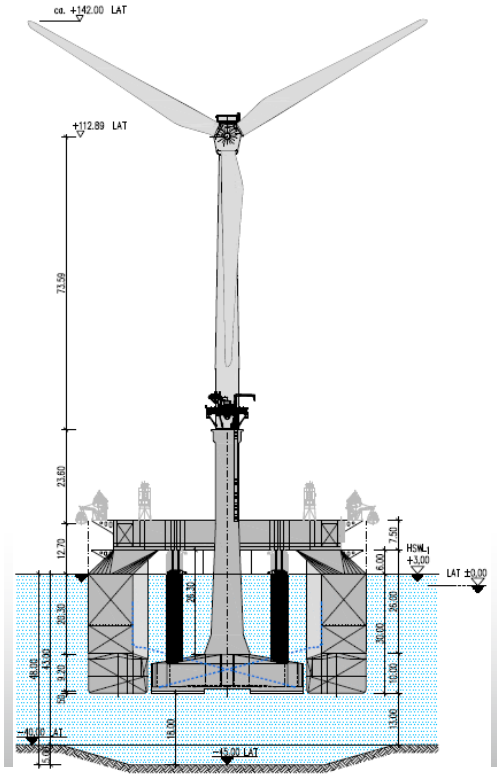
## TRANSPORT AND INSTALLATION

- Pickup at plant from finger pier
- Transport with semi-submersible installation vessel
- Set down process by ballasting the vessel
- Lowering with winch-system



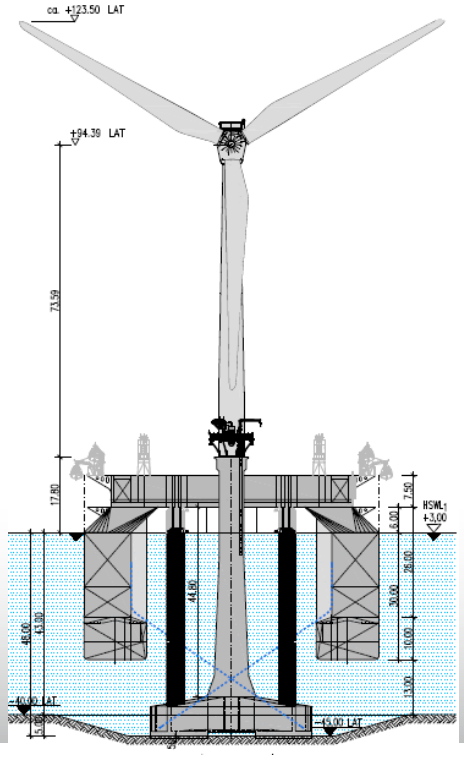



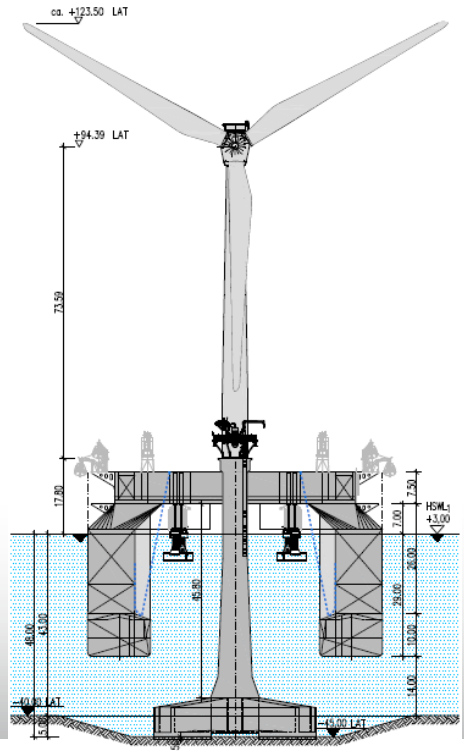



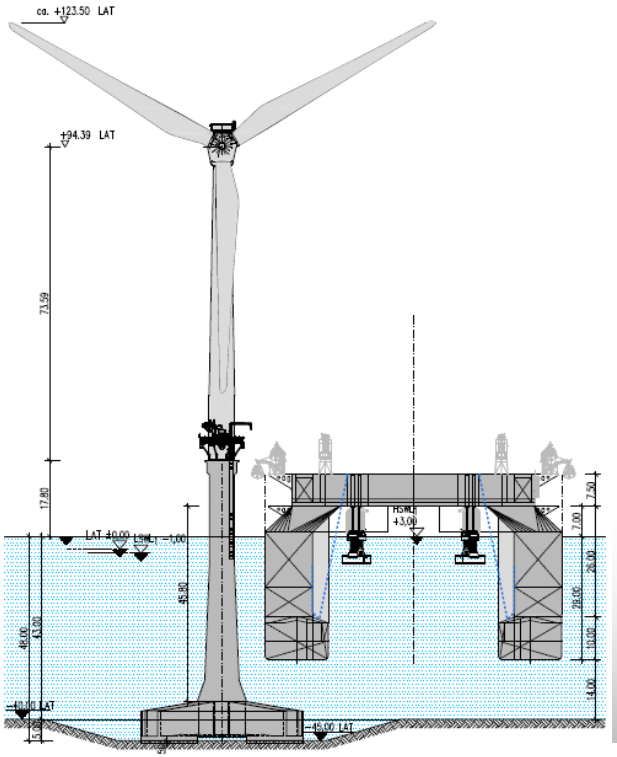



# PROCESS
## TRANSPORT AND INSTALLATION

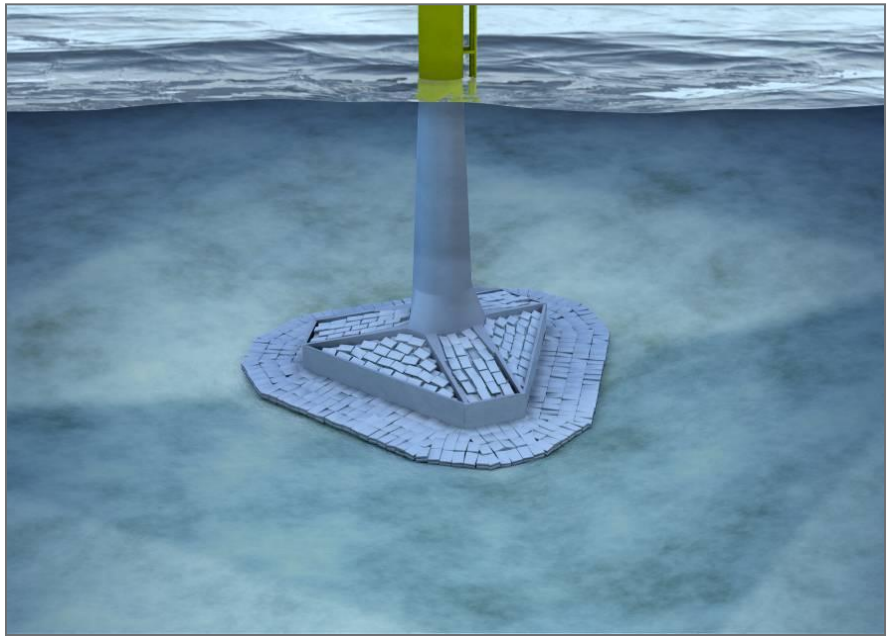
- Set down into the prepared pit
- Disconnect the load handling device
- Vessel departs



# PROCESS
## BALLASTING AND SCOUR PROTECTION

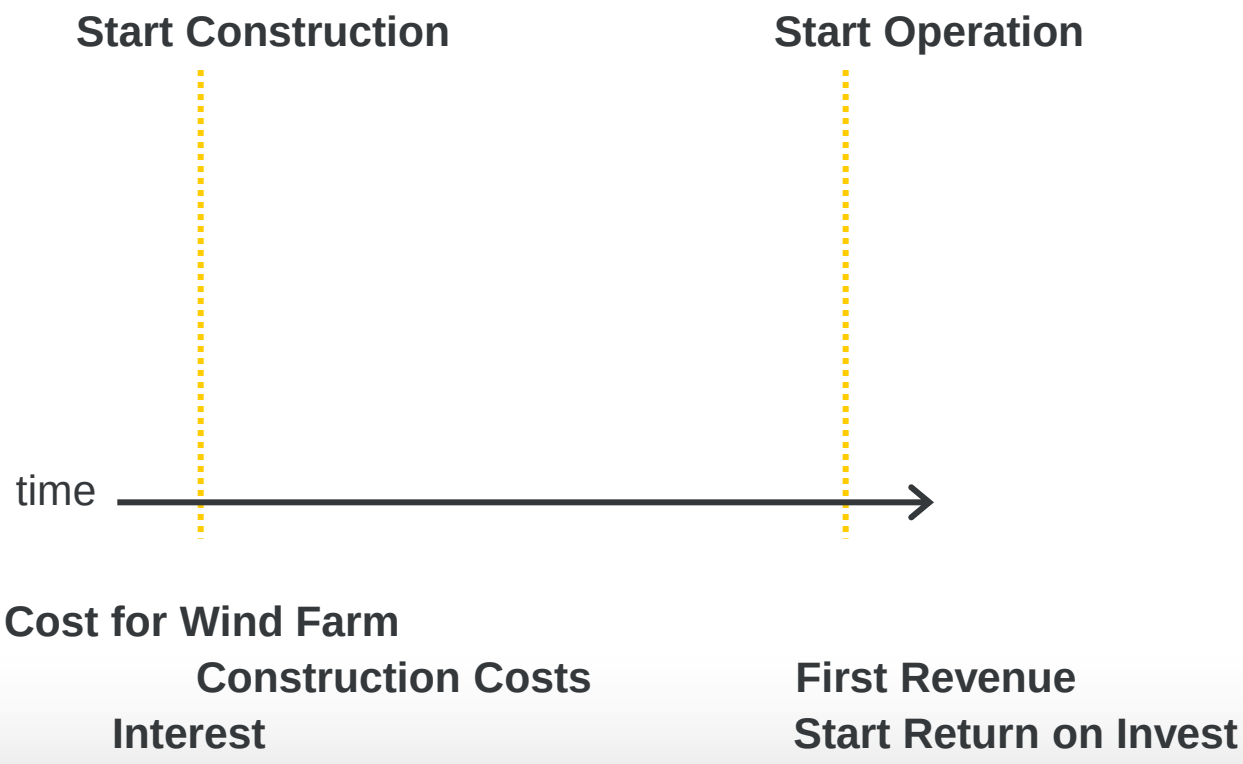


### Ballasting and Scour Protection

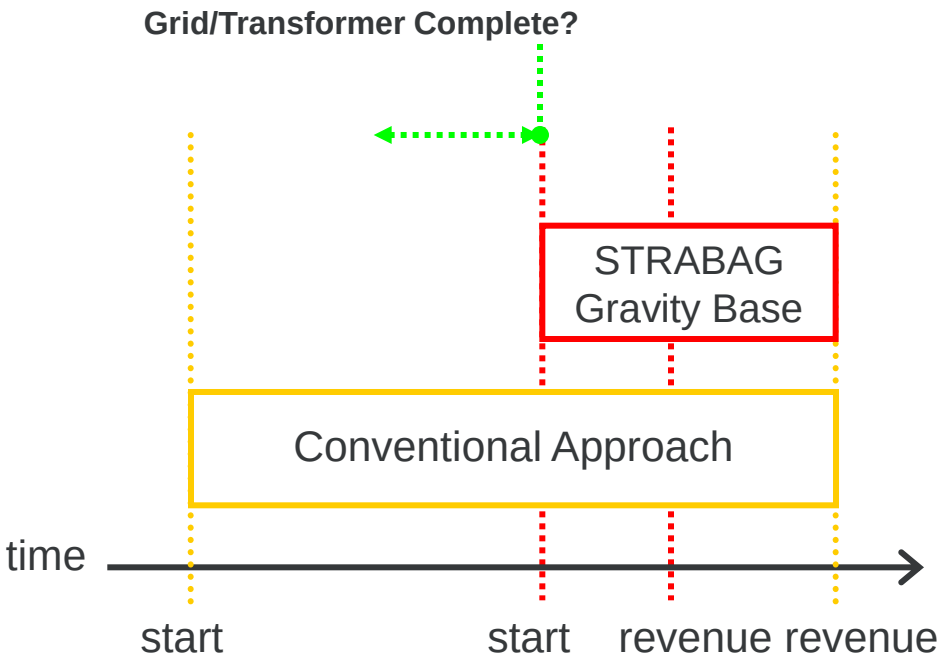
- Ballasting of concrete boxes (open top)
- Sand bags (rock armor) as scour protection
- Refilling construction pit

# COMMERCIAL

# COMMERCIAL
## INVEST TO OPERATION



# COMMERCIAL
## IMPACT ON COST OF ENERGY



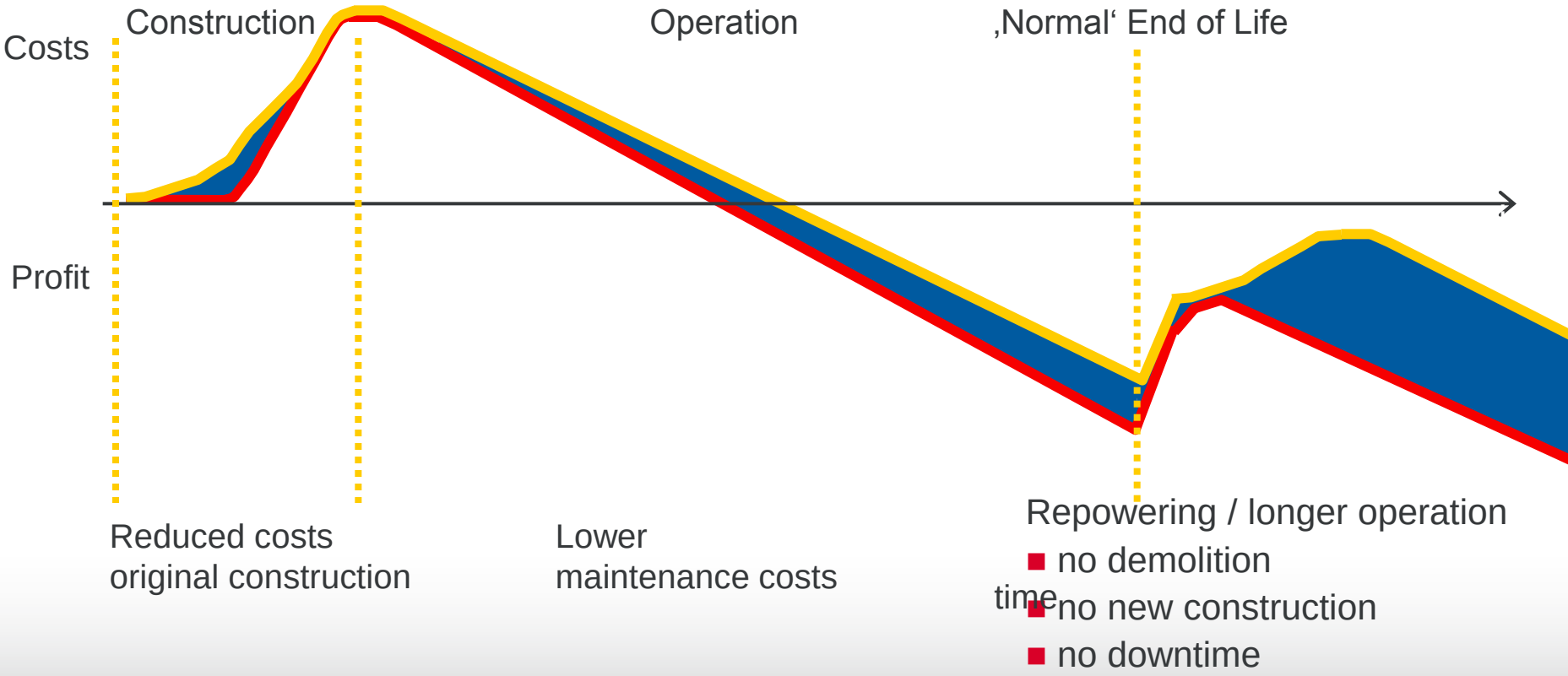

Reducing costs: Short project duration STRABAG Gravity Base

- short construction cycles
- one season installation
- serial production
- quality control
- smart engineering
- reduced risks
- reliable logistics
- low health, safety and environmental risks

# COMMERCIAL

## IMPACT ON COST OF ENERGY

STRABAG Gravity Base
Conventional Approach
Reduced Costs
STRABAG Gravity Base
versus
Conventional Approach



# COMMERCIAL
## CHALLENGES AND OPPORTUNITIES

| Challenges | Opportunities |
|---|---|
| **Global**<br>▪ Climate Change<br>▪ EU $CO_2$ reduction targets<br>▪ Rethinking Energy Mix<br>▪ Grids<br>▪ Legislation<br>▪ Most significant challenge since Industrial Revolution | **Global**<br>▪ Renewables<br>▪ New Jobs & Skills,<br>▪ Competetiveness EU<br>▪ New Markets |
| **STRABAG**<br>▪ Technical uncharted territory<br>▪ New ways of thinking<br>▪ Amazing dimensions of market and solutions | **STRABAG**<br>▪ 'Frontier Spirit'<br>▪ Industrial Production & Processes<br>▪ Living our responsibility<br>▪ Use of proven, solid technology in a new and smart combination |

# COMMERCIAL
## RISKS AND DERISKING

| | |
|---|---|
| **Technical Risks**<br>▪ High cyclic loads<br>  ▪ Material behaviour<br>  ▪ Structural soil interaction<br>▪ Construction and material quality<br>▪ New technologies and new approaches | **Derisking**<br>▪ Robust construction materials<br>▪ Proven technology<br>▪ Numeric simulation **and**<br>▪ Scale tests **and**<br>▪ Real life 1:1 tests |
| **Environmental Risks**<br>▪ Construction / Operating noise<br>▪ Poisonous coatings<br>▪ High volume construction vessels traffic | **Derisking**<br>▪ Use of environmental friendly technology<br>▪ Close cooperation with authorities and research institutions |
| **Commercial Risks**<br>▪ Interface risks in multi-contracting<br>▪ Risks of delays<br>▪ Production capacity<br>▪ Complex logistics<br>▪ Completion risk<br>▪ Price of materials | **Derisking**<br>▪ EPCI contractor<br>▪ Predictable construction processes<br>▪ Industrial serial production<br>▪ Use of proven technology<br>▪ Experienced and powerful builder<br>▪ Use of local materials, eg concrete<br>▪ Reinforcement made of recycled steel |

# [...] SUMMARY AND OUTLOOK

# SUMMARY
## STRABAG OFFSHORE WIND

**STRABAG Offshore Wind offers:**

- Industrial local production
- Optimal technical and commercial EPCI solution packages
- Cost, scheduling and quality certainty

# OUTLOOK

## THE MARKET

**Department of Energy and Climate Change**
**Targets for UK:**
The central range indicates that up to **18 GW** could be deployed Offshore **by 2020**. Beyond 2020 there is a very high potential for deployment Offshore with over **50 GW** possible **by 2030" That's potentially 10,000 Turbines!!**

**'Irish must spend extra €5bn to meet 2020 targets' 21st August 2012**

**Irish wind-farm operators will need to spend another €5bn or so in capital investment and construct an additional 3-3.5GWof onshore wind power if Ireland is to meet its 2020 EU climate change targets, according to a new report by Davy Stockbrokers.**

**In Ireland the Government has to implement the OREDP which has been "on hold" for the past 3 years and give Offshore Planning Consents. Industry and Investors will then look after the rest and start creating opportunities and jobs for offshore wind energy sector in Ireland.**

# OUTLOOK
## TIME TO MARKET

2.5 years

# STRABAG OFFSHORE WIND IS READY TO GO …


STRABAG OFFSHORE WIND GMBH
**WWW.STRABAG-OFFSHORE.COM**

Klaus Weber | klaus.weber@strabag.com
Robert Foyle | robert.foyle@strabag.com
Thomas Rau | thomas.rau@strabag.com
Jens Grunau | jens-peter.grunau@strabag.com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