NaREC

AT THE HEART OF **INNOVATION**

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Ensuring Reliability for Offshore Wind Turbines – Large Testing Facilities

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Outline of Presentation

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- The Move Offshore (*1 slide*)
- Risks and Problems (*1 slide*)
- Needs and Solutions (*1 slide*)
- Full-scale Drive Train Test-rig (*3 slides*)
- Increases in Installation Rate (*3 slides*)
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NaREC: At the Heart of Innovation

- Independent, Cross-disciplined R&D Platform
- Mission: Enable energy industry to advance technology in order to reach sustainability
- New breakthroughs in design, deployment and commercialisation of sustainable energy technologies

The Move Offshore

- Larger turbines installed:
  - E.g. 5MW machines from
  - RE Power
  - Multibrid
  - Bard
  - Others in development
- Minimises number of units to install.
- Maximises energy yield per unit installed.

RE Power 5M at Beatrice. The Engineering Business's BOWTIS and Rambiz vessel.

Risks and Problems

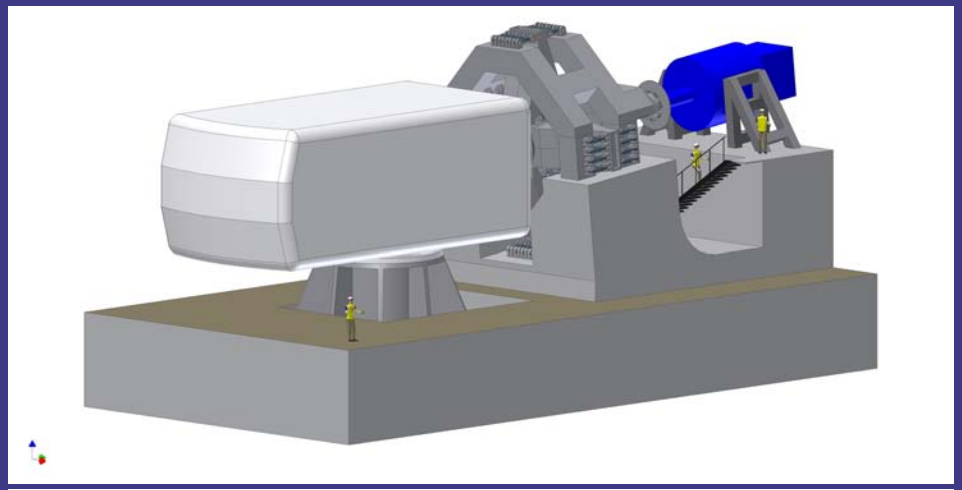
- The offshore environment is demanding.
- Difficulties in installing and operating turbines:
  - Variable weather
  - Extreme load cases
  - Marine air / salt water
- Access for maintenance and repair – not guaranteed.
- With large turbines financial losses from not generating become significant.

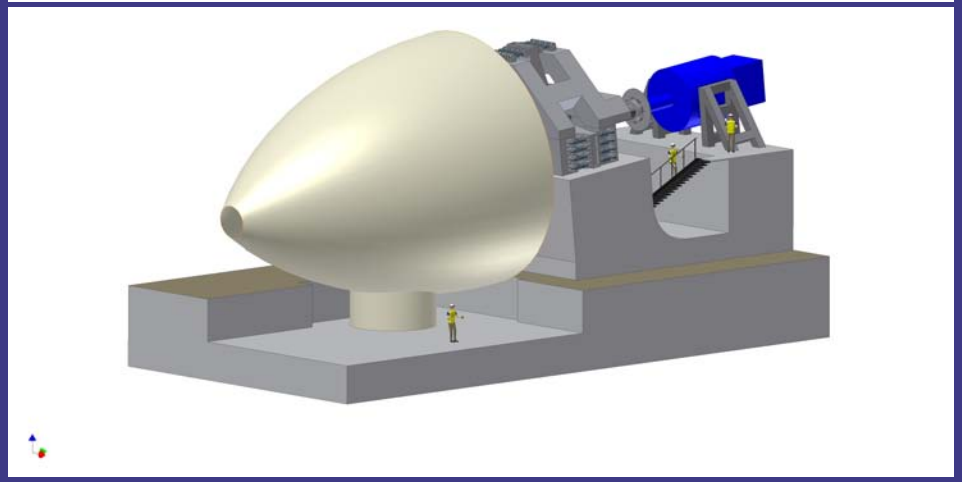
Need and Solutions

- The need is to improve reliability prior to deploying turbines offshore.
- Better reliability comes from enhanced and rigorous testing onshore.
- Better testing de-risks the deployment of turbines.
- De-risking enhances the attractiveness of the investment.
- Solution - NaREC is developing a new, large drive train and full nacelle test-rig.

Drive train / Full nacelle Test-rig

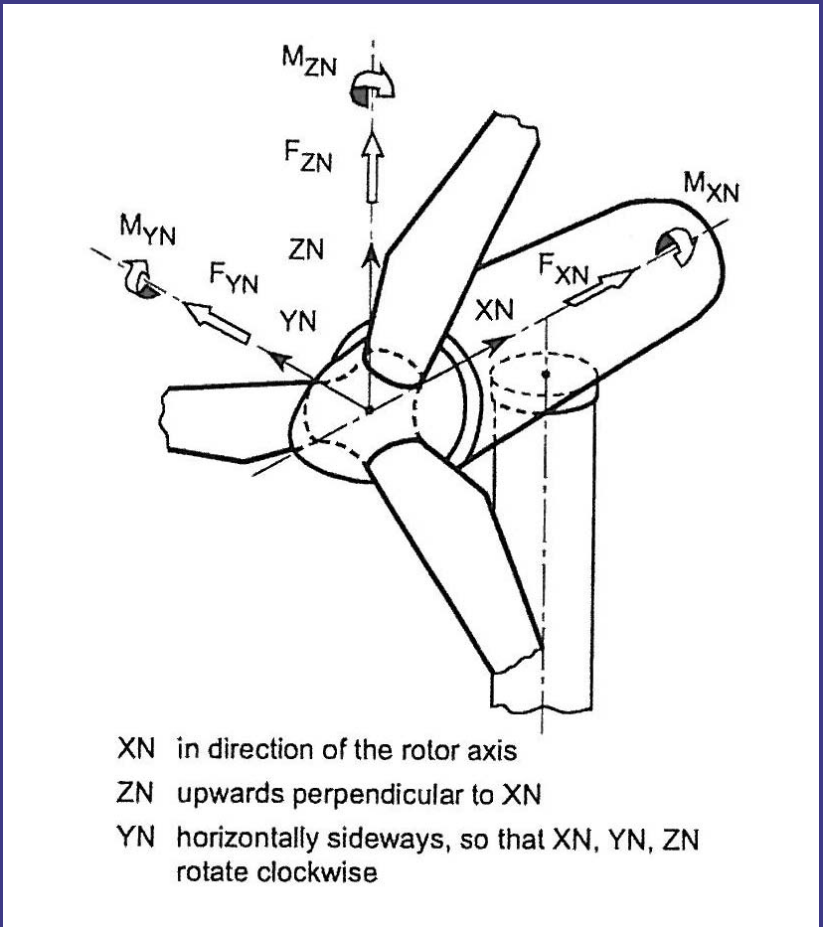
- 15MW drive system capable of testing the full nacelle of a 10MW turbine
  - with either gearbox or direct drive
  - includes drive shafts, bearings, gearbox, generator, convertor
- Mechanical loads:
  - ultimate
  - fatigue
- Electrical loads and grid faults





Drive train load cases

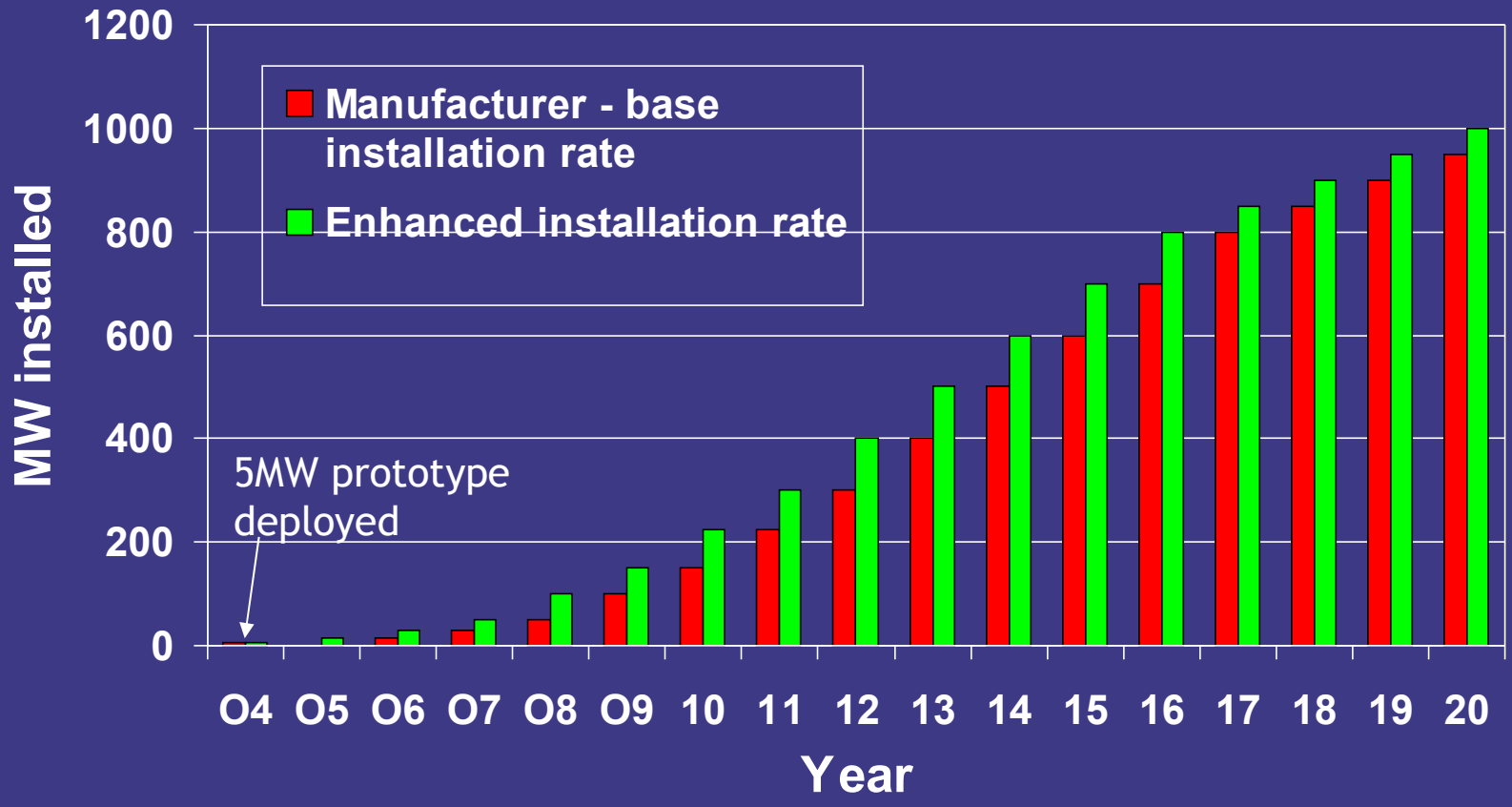
- Mechanical full envelope including side loads
  - Fx – Axial Force
  - Fy – Radial Force
  - Fz – Radial Force
  - Mx –Shaft Torque
  - My – Moment about y axis
  - Mz – Moment about z axis
- Max side loading 70,000kNm
- Axial load continuous 4,000kN



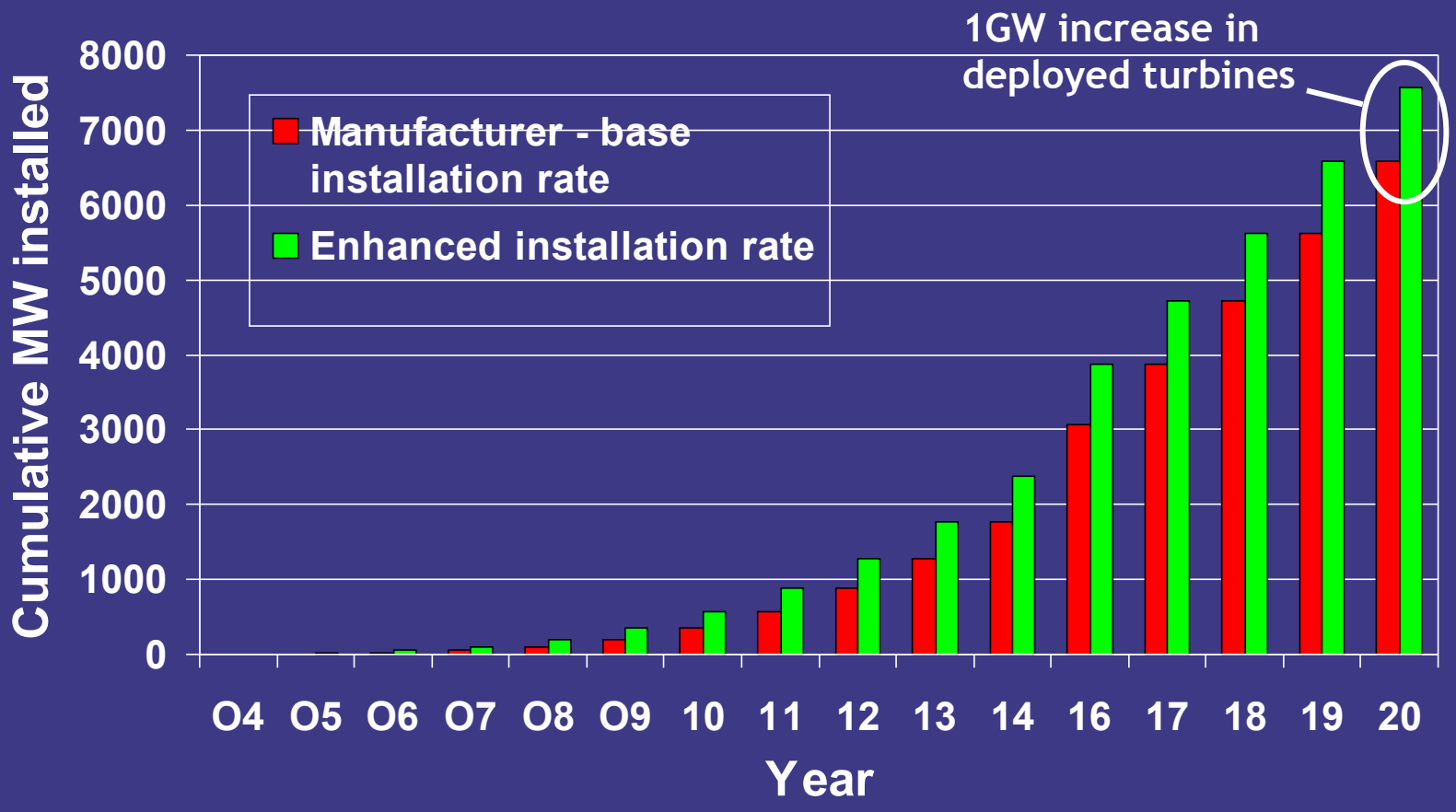
Full scale nacelle test-rig

- Existing route to turbine deployment relies on field testing on a wind turbine test site.
- Can only test with the loads provided by the wind at the test site.
- A test-rig allows all combinations of loads to be applied – as needed.
- With the result that a more comprehensive and thorough test of the turbine is conducted.
- Potential problems with components identified early – before offshore deployment.
- The key prize is that of a more rapid insertion into service – with increased revenue to manufacturer.

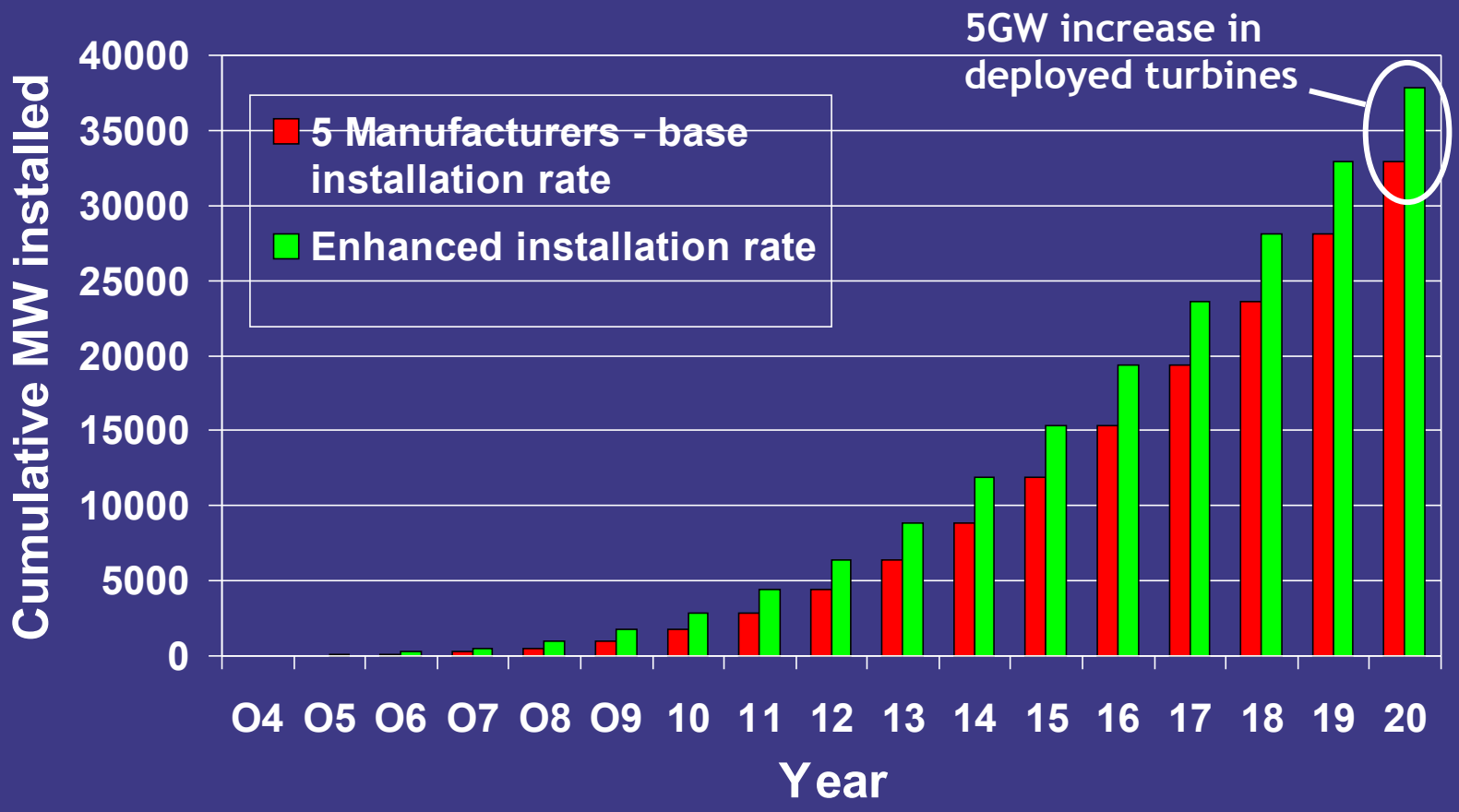
Example of Increase in Installation Rate



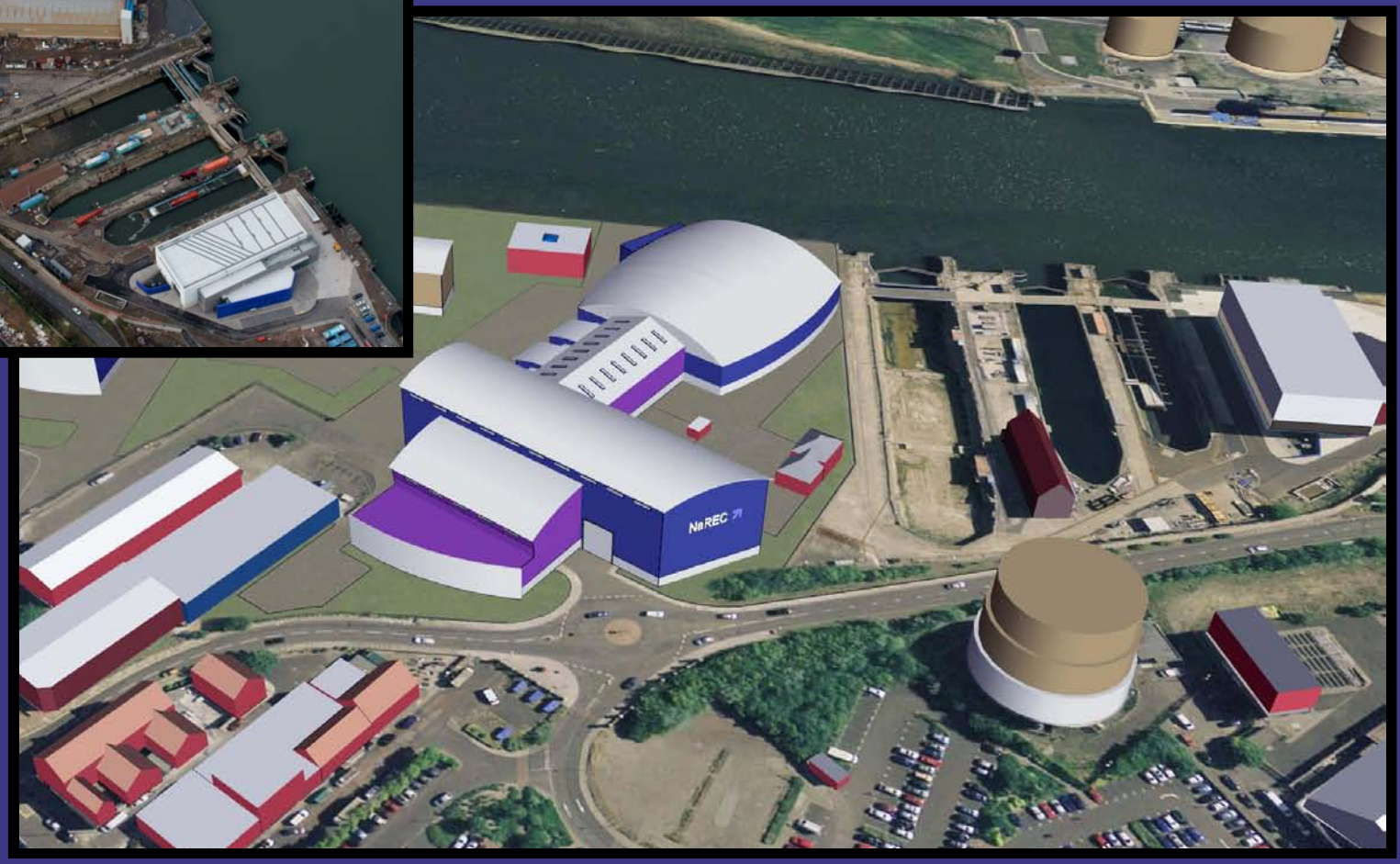
Effect on Cumulative Installation Rate



Cumulative Installation Rate – Scenario if 5 manufacturers could deploy 1 year earlier

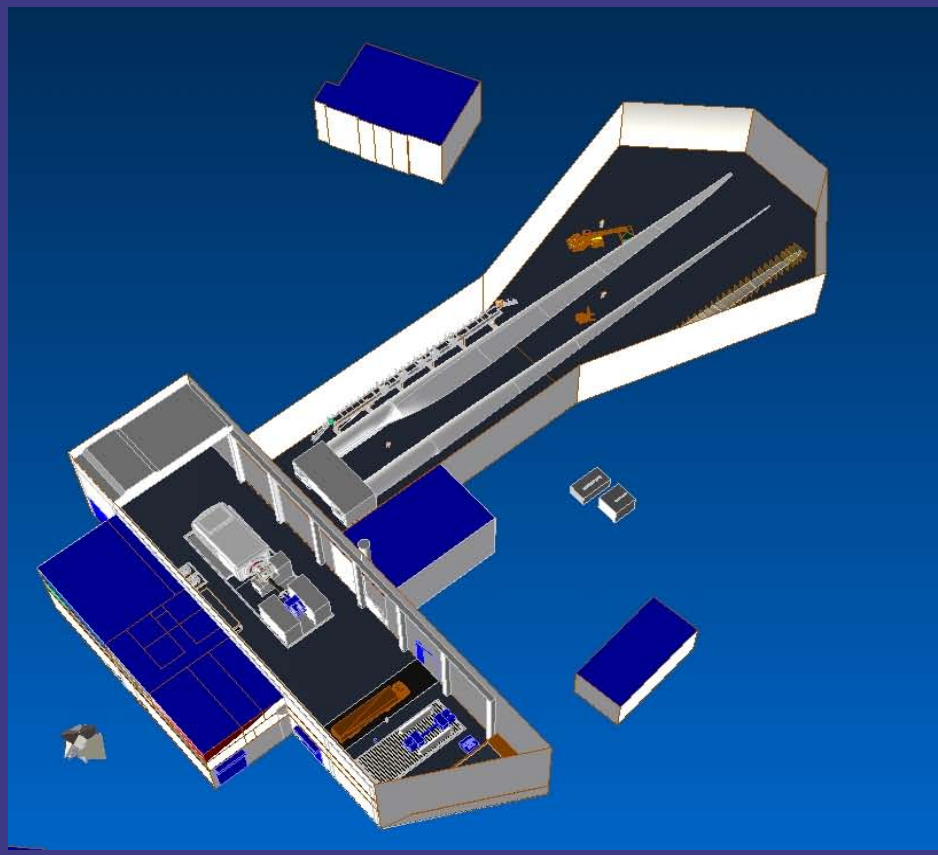


NaREC's Future facility development



Blade and Nacelle Test Facility – for Large & Offshore Turbines

- First stage industry consultation complete.
- Building design nearing completion.
- Test-rig concept design freeze in Sept ‘09.
- UK funding in final stages of negotiation.
- Industry involvement – discussions with NaREC actively sort.



Thank you

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Questions?