

# Offshore Wind Update

Copenhagen Offshore Conference  
27<sup>th</sup> October 2005

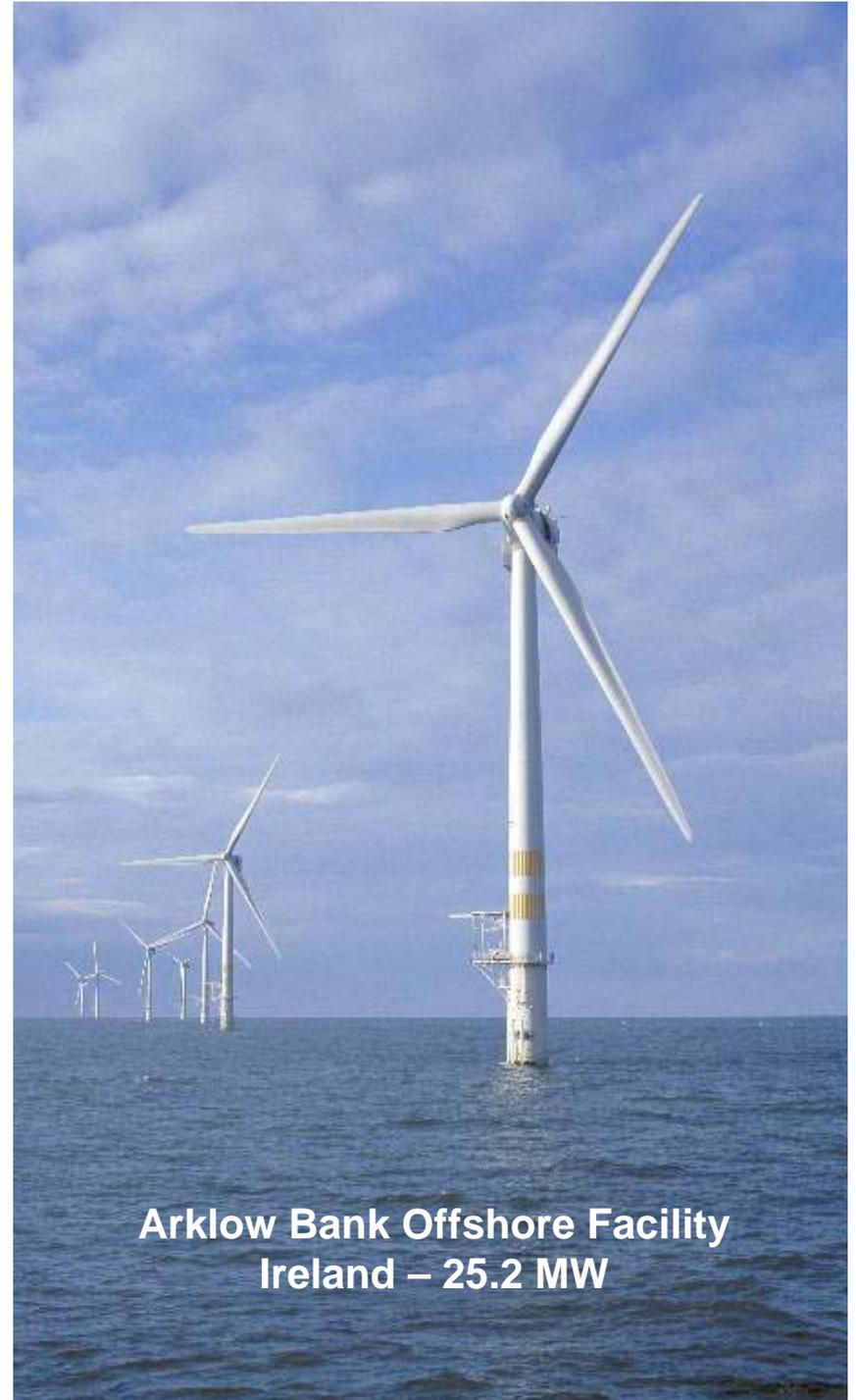


imagination at work

**ecomagination**  
a GE commitment

# Agenda

- Offshore Market View
- Arklow Update
- Cable Lessons Learned ..... Next Steps
- Offshore Future & GE



# General Electric Company

## Who We Are



Operations in over **100** countries  
**300,000+** employees worldwide  
Manufacturing facilities in **32** countries  
2004 Revenues = \$165B

## Integrity



## What we do



imagine



solve



build



lead



# Commitment to **ecomagination**<sup>SM</sup>

- 1** Doubling our research investment
- 2** Introducing more ecomagination products
- 3** Reducing greenhouse gas emissions
- 4** Make customers true partners
- 5** Keeping the public informed

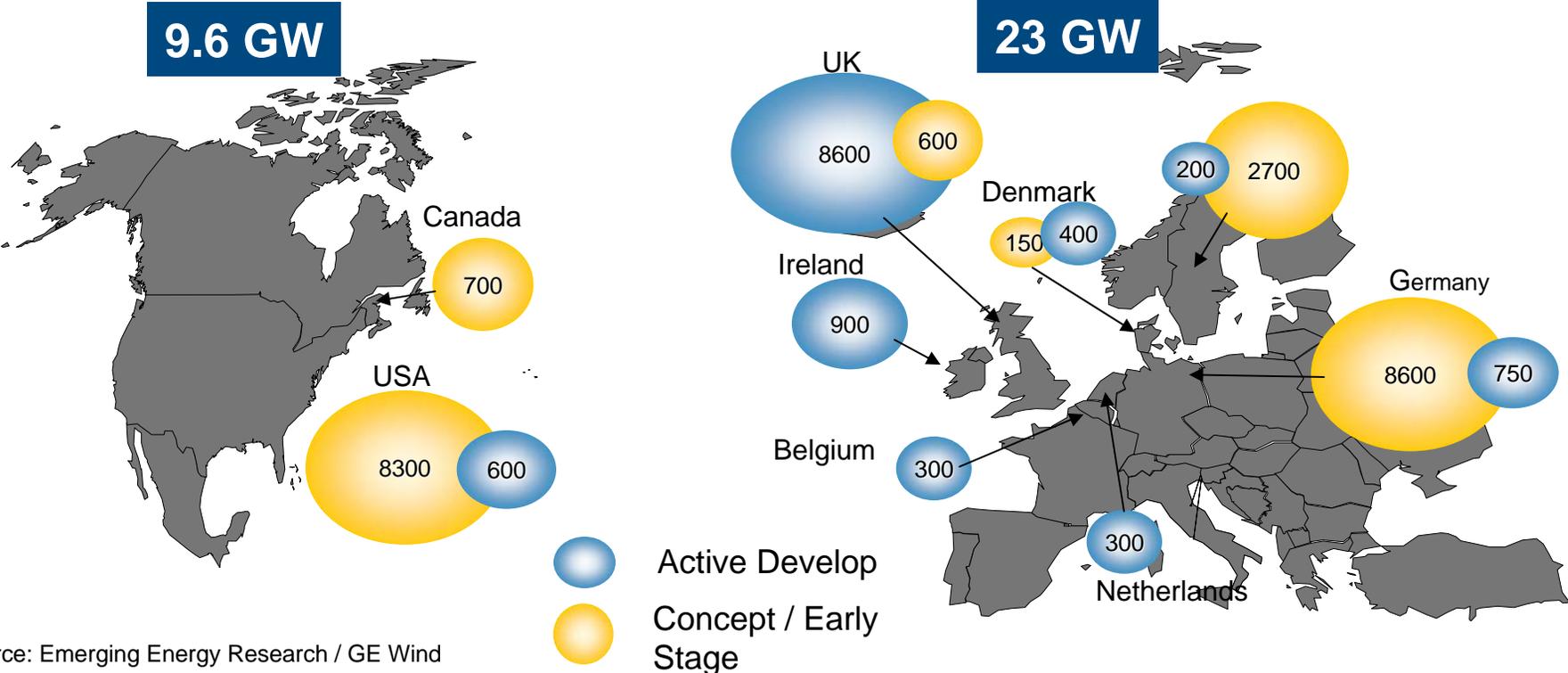


# Offshore Wind Potential

Significant Offshore Growth Potential . . . Drivers Are:

- Renewable Obligations (UK, US)
- Kyoto compliance (Germany, Ireland)

Over 30GW Of Specific Sites In Various Stages Have Been Announced



Source: Emerging Energy Research / GE Wind

# Arklow .... A Step in GE's Strategy

## Background

- 25.2 MW project consisting of 7 x 3.6s GE Offshore Wind Turbines located 10 km off coast of Ireland
- GE has built, owns & operates project to demonstrate new technology
- Challenging site dynamics allowing GE to compare project risks with representative open water projects
- Co-developed project with Airtricity
- During Ownership period GEWE is ensuring acceptance of:
  - Basic reliability of design
  - Necessary operating hours to prove new technology
  - Warranty provisions and weather exclusions adequate for financing
  - Optimization of O&M – Cost effective and safe



# Arklow Operations Update

- **Commenced official commercial operations in Dec-04**
  - Engineering testing underway
  - Documenting many technical lessons learned
  - Incorporating lessons into next turbine design
- **GE pleased with turbine performance**
  - Power curve testing at levels above reference
  - **Availability** during commercial operations above **95%** (including weather)
- Proud **Health & Safety record** – no recordable injuries since start of construction
- Continue to develop **best in class** access practices



# Arklow Lessons Learned

## Construction

- Partner on non GE core activities
- Plan to capitalize on weather windows, 24/7 work schedule
- Vessel productivity primary cost driver
- Self propelled DP vessels key to productivity & risk management
- Contract for Installation Vessels early > 12 months
- EHS compliance is vital, enforce zero tolerance policy on all parties
- **Logistics, logistics, logistics**

## Commissioning

- Safety train start up engineers and key vendor reps with contingencies in advance
- Select access system & vessels early
- 24/7 work schedule as base plan, staff accordingly
- EHS compliance is vital, enforce zero tolerance policy
- Ensure project contingencies in place

# GE 3.6sl Turbine Design Enhancements



## Improved Energy Capture

- Rotor diameter of 111m versus 104m on 3.6s turbine
- Increased swept area by 14%
- 5-7% increase in Annual Energy Production

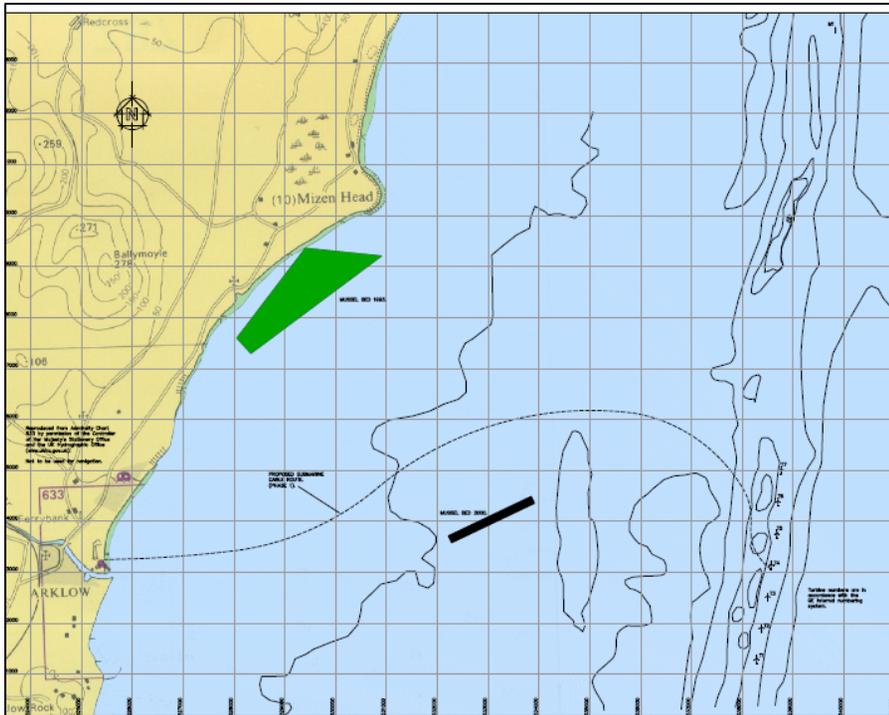
## Reduced Weight Aloft

- Nacelle, blade and transition piece lighter than on the 3.6s

## Optimized Design to Improve Availability

- Introduce redundancy in the WTG electrical system
- Enhanced grid capability including Low Voltage Ride Thru (LVRT)
- New Power Pack Module (PPM) in transition piece
- Arklow lessons-learned data base of design related improvements

# Arklow Sea Cable



## Sea Cable Damage

- Cable damaged by anchor on 08-Jan-05
- New section of cable spliced into place and project **returned to operation in ~4 weeks**
- Documented lessons learned and identified strategic spares necessary

## Next Steps

- Developed **contingency plan** for potential future events
- Completed **industry benchmarking** study on offshore cables – issued technical paper
- **Sharing lessons** with government agencies, customers and insurance companies
- **Monitoring** cables during operations period and taking necessary remedial action to **lower remaining risk**

# Cable Burial Guidelines

## Two Initiatives Launched

- **Remediation Analysis** including a review of the cable installation cycle
- Establish what **best practice** should be used for future reference

## Approach to Cable Burial Guidelines

- Summary of wind farm cable **installation experience to date**
- Analyze **various seabed conditions** & potential impact
- Select preferred **cable industry expert** to advise GE on basis of experience & capability
- Ongoing meetings with **government agencies** – studies and permitting requirements
- Commission **industry benchmarking study**

# Technology Pipeline



**Stepped path to 5+ MW turbines**

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# Cable Burial Guidelines – Key Findings

## **Review of Difficulties**

- Access, ground (hard, soft, topography), seasonality, installation spread
- Design (scour/j-tubes), dynamics post burial
- Slow damage due to poor installation

## **Cable Protection Planning**

- Typically burial across array & export (whether jet or plough)
- With scour protection around foundations to secure cables
- Other protection methods introduced when remediation required

## **Remediation**

- Reburial (jetting or trenching)
- Mechanical protection (mattressing, frond mats, soft fronds, articulated piping, rock dumping)
- GE envisage the future of cabling of offshore wind farms to adopt above best practices

## **Why are problems encountered?**

- Unrealistic permit conditions, lack of consultation with installers, manufacturers
- Poor site assessment & route selection; poor understanding of site conditions
- Cable installation operational control being vested in inexperienced teams