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# Environmental and non-technical impacts of lean principles applied to offshore wind farms



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# Presentation outline

- Introduction
- Methodology
- Construction phase – positive and adverse environmental impacts
- Mitigating wind farm construction impacts
- Social acceptance of offshore wind farm



# Introduction

**Objective:** examine the environmental and non-technical impacts of lean principles applied to offshore wind farms with a particular focus on life cycle analysis.

- environmental impacts resulted from new foundation systems: fixed and floating, from installation activities, operation and maintenance strategies deployed as well as decommissioning activities.
- non-technical impacts refers to creation of local employment, local growth, training and skills as well as synergies with other sea users.
- Community engagement for offshore wind farms.



# Methodology

- EWEA proceedings 2010 to 2015 (sessions dedicated to environment and social acceptance)
- Scientific papers and journals
- Policy reports and studies
- EU funded projects
- Input from industry environmental experts

# Positive environmental impacts of Offshore Wind Farms



- *Effectively mitigating climate change, the single largest threat to biodiversity*
- *Trawling exclusion and impacts on fish*
- *Artificial reef effects*
- *Habitat enhancement*
- *Synergies with aquaculture*

# Trawling exclusion and impacts on fish



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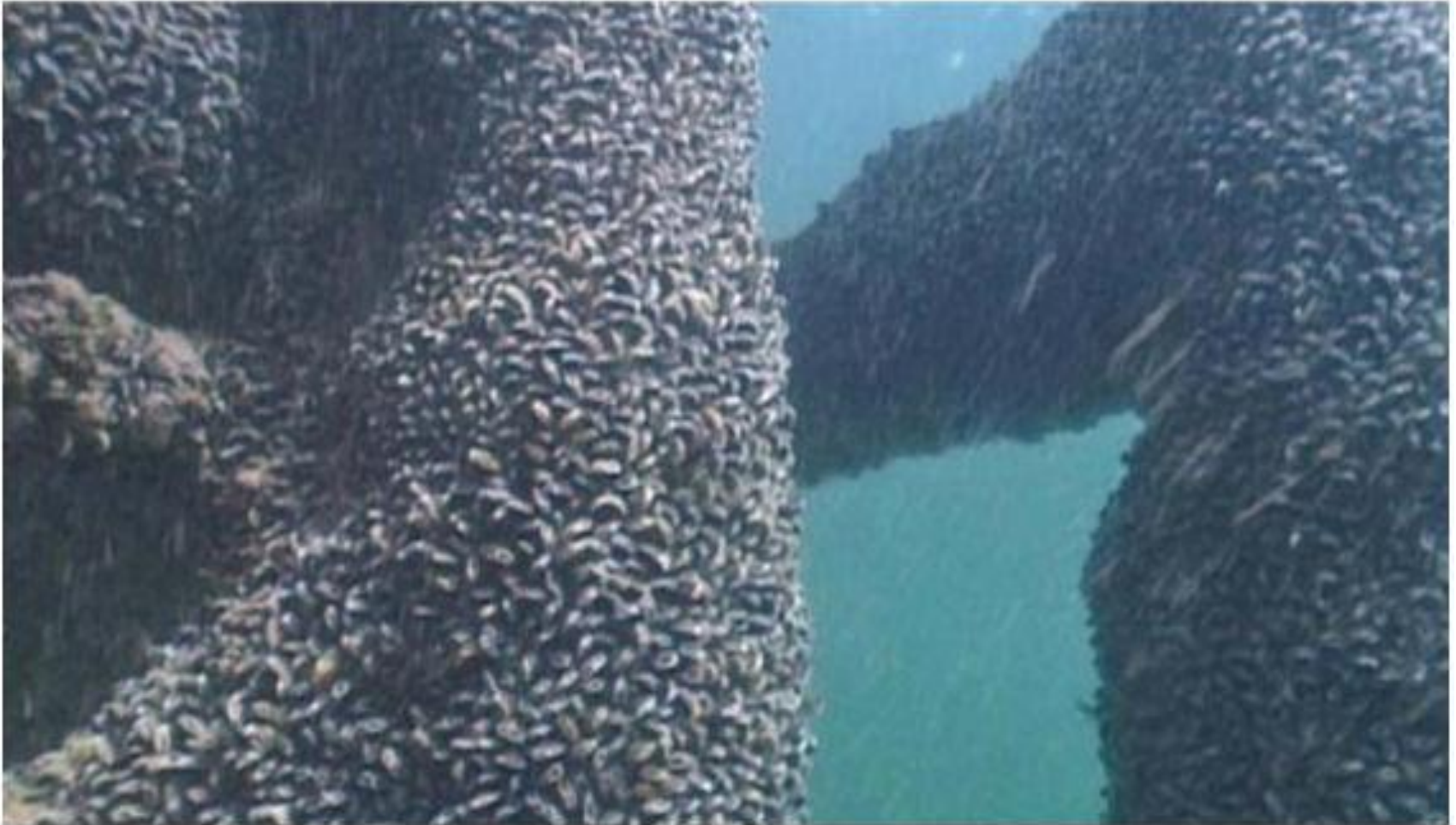
Ban on fishing, especially demersal trawling in the wind farm area is resulting in increased local fish populations.



Source: Shooting otter trawl in Thanet Wind Farm, Fisherman's voice, June 2014, Vol. 19, No. 6



# Artificial reef effects



*Jens Christensen. Common mussel on turbine structures at Horns Rev. Danish Offshore Wind - Key Environmental Issues*



# Habitat enhancement

- At Thanet (UK) offshore wind farm, marine research suggests that certain fish species, such as cod found shelter inside the farm.
- New hard substratum and the scouring protection led to the establishment of new species and new fauna.
- Wind farm acts as a new type of habitat with a higher biodiversity of benthic organisms

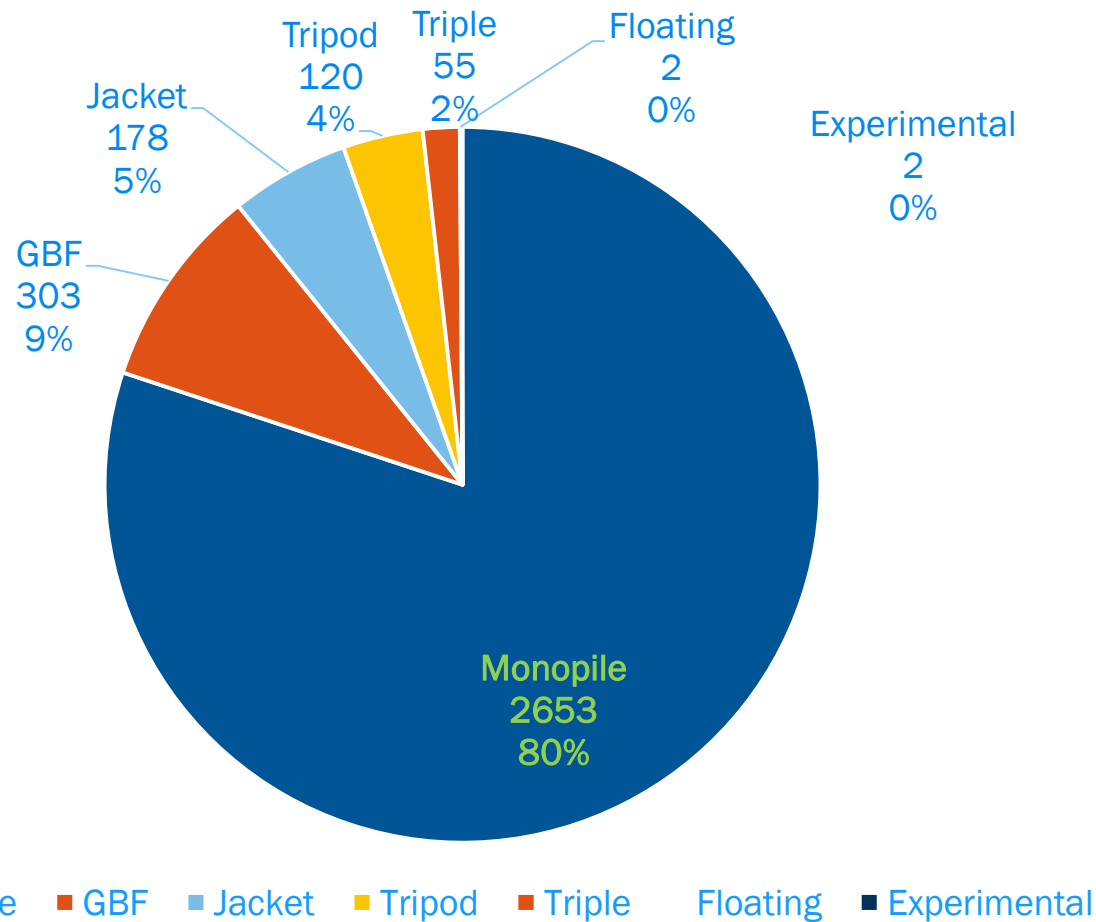




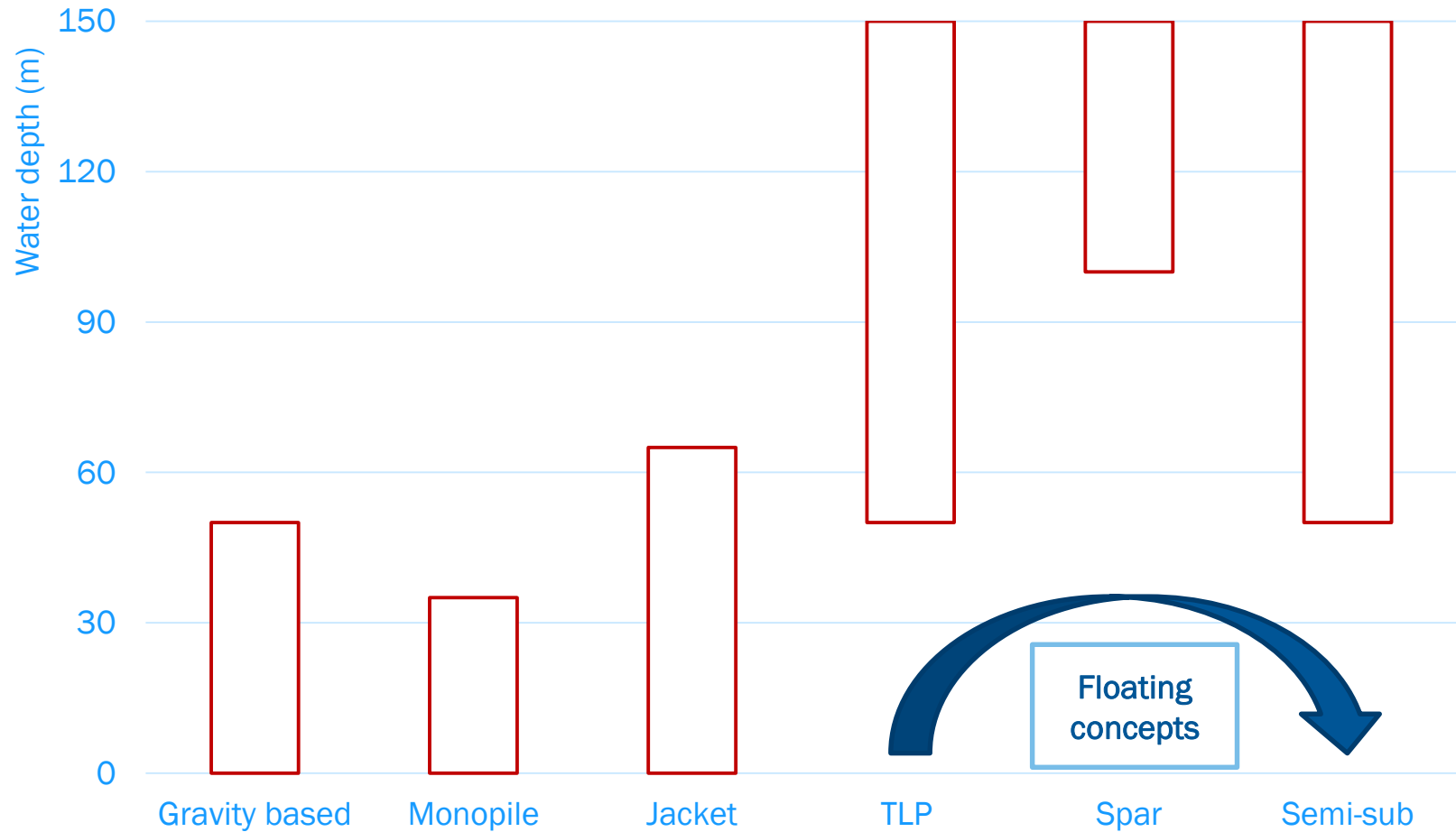
# Synergies with aquaculture



# Substructures installed in EU waters (end 2015)



# Range of applicability of the available foundation technologies



# Foundation concepts and their associated impact upon local environment



## Monopile

- Piling noise disturbance -highest
- Hydrodynamics and sedimentology
- Disturbance to sea bed
- Habitat loss
- Magnetic fields



## Jackets

- Piling noise disturbance - high
- Hydrodynamics and sedimentology
- Disturbance to sea bed
- Habitat loss
- Magnetic fields



## Gravity based

- Moderate underwater noise
- Hydrodynamics and sedimentology
- Disturbance to sea bed – dredging
- Habitat loss
- Magnetic fields



## Floating

- No underwater noise from piling thus lower environmental impact
- Hydrodynamics and sedimentology
- Habitat loss
- Magnetic fields



# A Review of Marine Environmental Considerations associated with Concrete Gravity Base Foundations in Offshore Wind Developments



Parameter	CGBFs	Monopiles	Tripods	Steel Jackets	Suction Caissons	Floating platforms
Experience (No. of foundations currently installed)	Good (332)	Good (1810)	Moderate (86)	Moderate (88)	Low (1)	Trial only (2)
Water Depth	All	Shallow	All	All	All	Deep
Emplacement weather window	Good	Restricted	Restricted	Restricted	Moderate	Unknown
Maintenance required	L	H	H	H	L	Unknown
Price	L	H	H	H	Unknown	Unknown
Availability – UK R3	Fav	Unfav	Fav	Fav	Low	Low
Environmental Effects/Impacts						
Ground preparation (temp habitat loss)	L	H	L	L	M	L
Sound emitted during installation	L	H	H	H	L	L M
Seabed footprint (habitat loss)	H	M	H	H	H	L
Scour	L	H	L	L	L	L M
Blockage effects	M H	M	M H	H	H	Negligible
Reef effects	H	M	H	H	H	L
Decommissioning	L	H	H	H	L	H

Source: Ian Reach, Principal Marine Ecologist, Marine Space



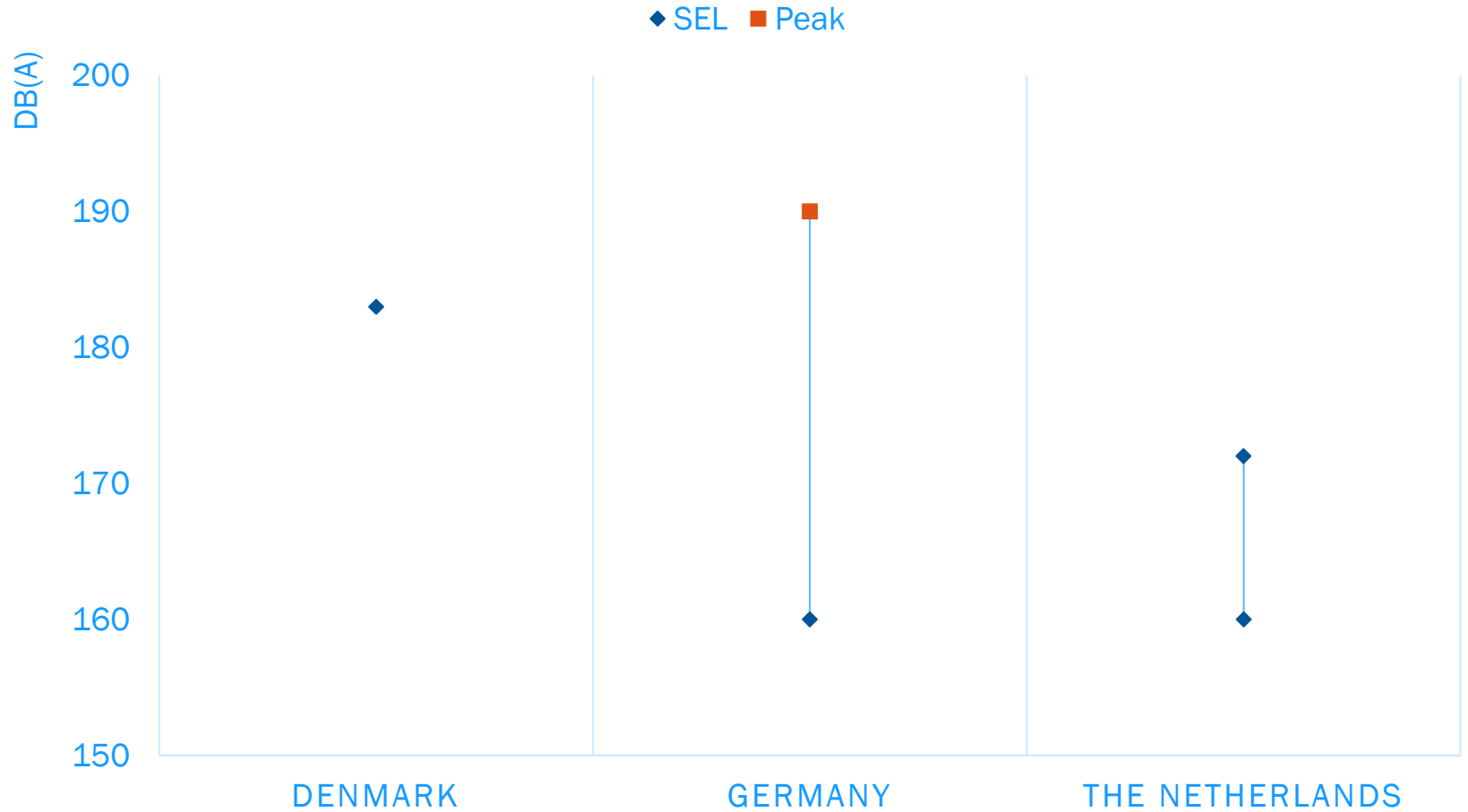
# Example of detailed environmental impact: **underwater noise**

- Sensitive species
  - Certain fish (incl. eggs and larvae) and marine mammals
- Disturbance
  - Displacement
  - Behaviour reactions
  - Reduced predation success
- Damage, Mortality
- Population and Ecosystem-scale effects

# Underwater noise thresholds per country

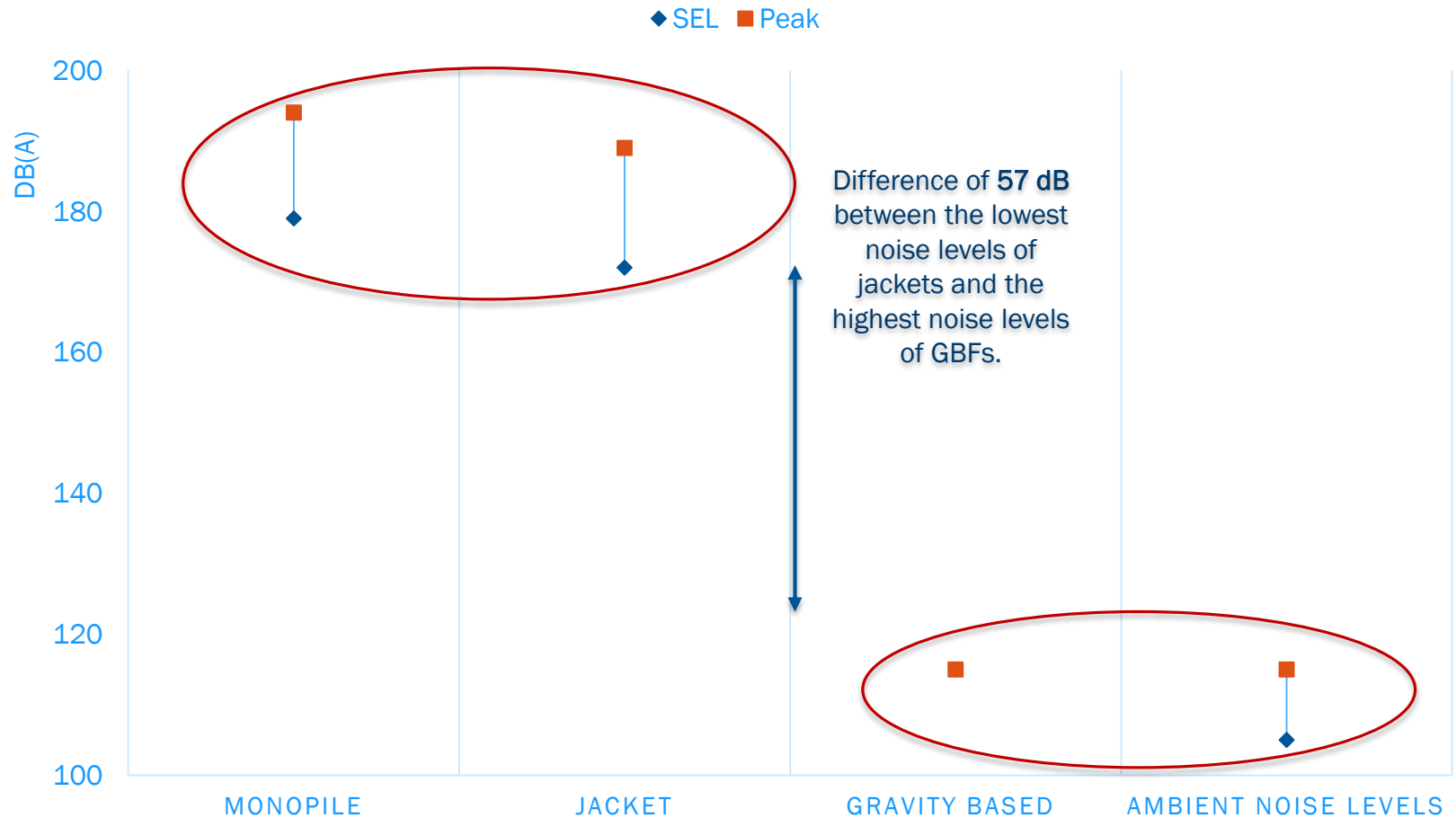


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Source: WindEurope

# Measured underwater noise levels at fixed offshore wind substructures – Belgium



Source: Environmental impacts of offshore wind farms in the Belgian part of the North Sea, Degraer Steven

# Overview of noise mitigation measures

Noise mitigation measures						
Country	Exclusion zone	Acoustic Deterrent Devices	Seasonal restrictions	Soft start	Noise threshold	Passive acoustic monitoring
Belgium		x	x	x	185 dB SEL at 750m	x
Denmark		x		x	183 dB SEL	
Germany		x		x	160 dB SEL - 190 dB SPL at 750m	x
The Netherlands		x	x	x	160 dB SEL - 172 dB SEL at 750m	
The United Kingdom	x	x		x		x (incl. MMOs)

Source: Underwater noise caused by pile driving. Impacts on marine mammals, regulations and offshore wind developments, Pondera Consult, 2014.

# Noise Mitigation Measures Applied at GWYNT Y MÔR Offshore Wind farm - UK

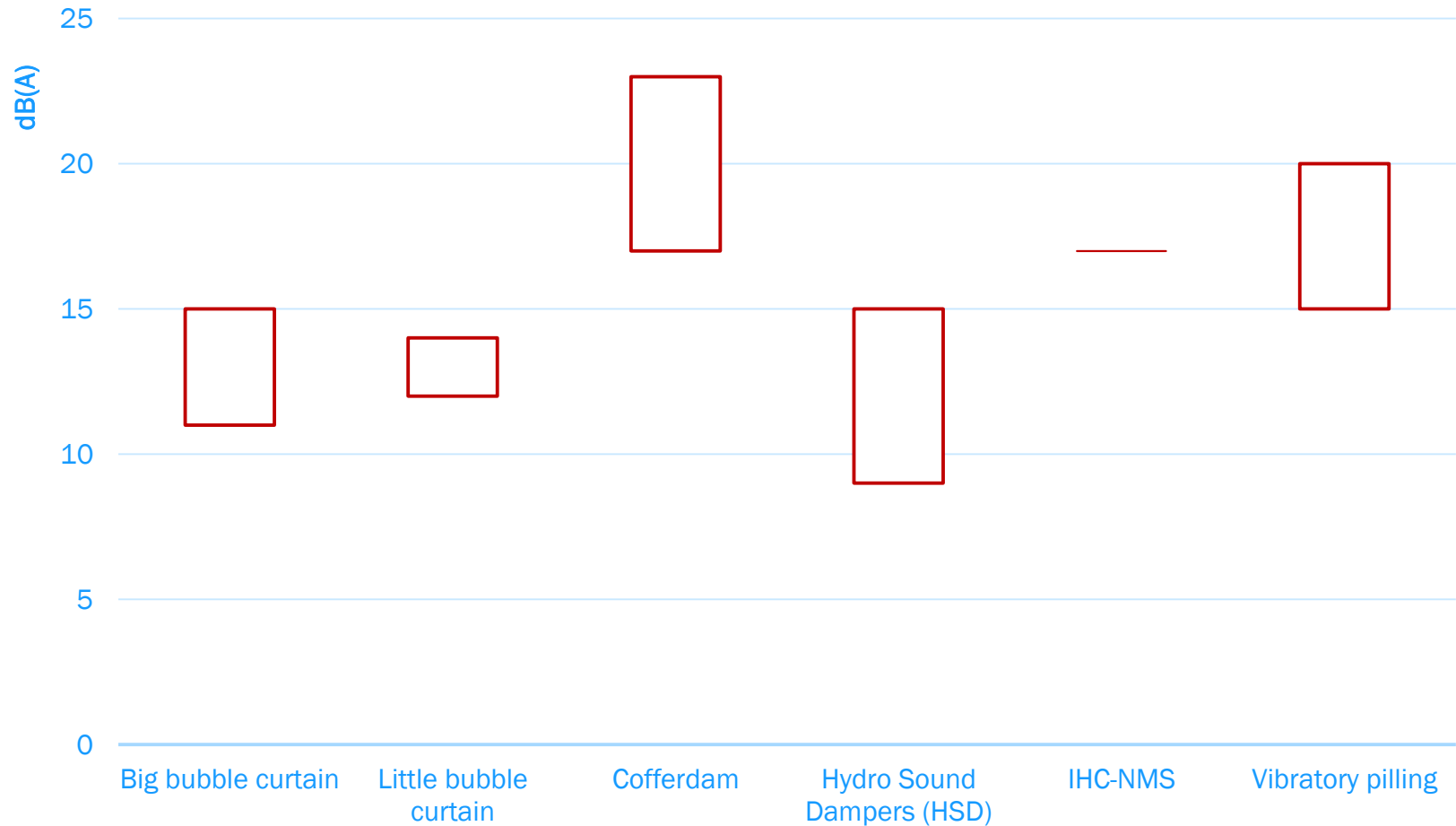


Combination of mitigation measure applied, established through the Conditions of the Marine Licence:

- Piling restrictions in sole spawning periods
- Noise modelling at consent application stage
- Noise measurements on first piling
- Marine mammal observers
- Soft start piling
- Acoustic deterrent devices used
- Onshore noise monitoring



# Noise potential reduction of different mitigation techniques used mostly in Germany – **very strict noise levels!**



Source: Development of Noise Mitigation Measures in Offshore Wind Farm Construction 2013, Federal Agency for Nature Conservation (Germany).

# Noise mitigation - Bubble curtain



# Community engagement strategy

- Community benefit for onshore wind received positively, transfer of the experience to offshore?
- However, differences in identifying nearby communities, maturity of the industry, technology and project economics?

## Providing Information

- 1 way information to targeted stakeholders.

## Engaging local communities

- 2 way interaction: dialogue & exchange of views.

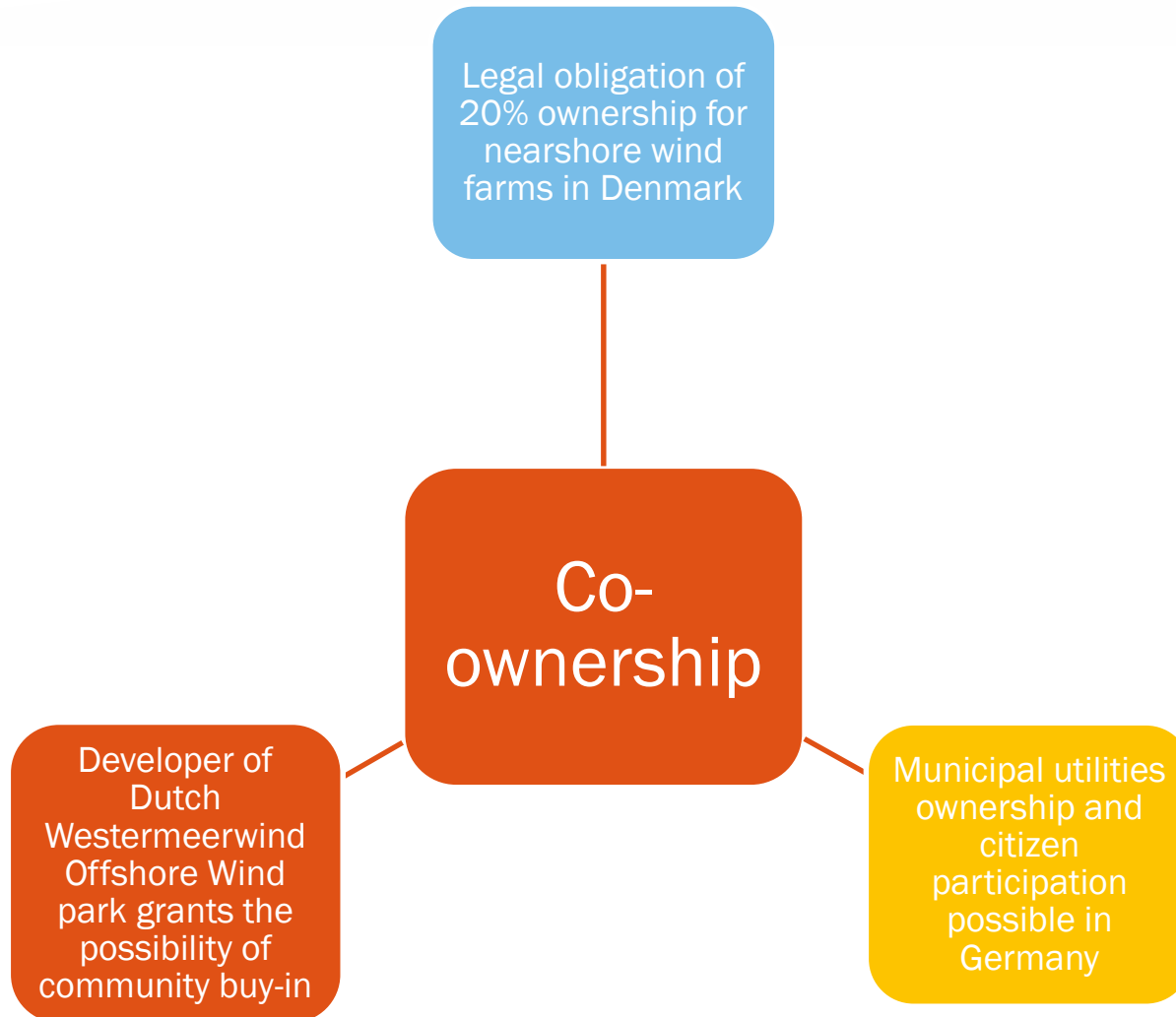
## Innovative Financing / Benefit sharing

- Partnership models.

## An example of supporting local development: Gwynt y Môr (576MW)

- **Community fund: £19 mln over 25 years**
  - Privately funded grant and loan scheme
  - Fully flexible fund objectives
- **Tourism fund: £690,000**
  - Facilitating pier upgrade for cruise liners
  - Achieving blue flag status for beach
- **RNLI partnership: £3.8 mln**
  - 5 year partnership to support lifeguards

# Co-ownership







# Conclusions

- Well documented positive impacts of offshore wind farms,
- All types of foundations have an environmental impact but recovery from these effects is expected within the lifespan of the windfarm project,
- Several mitigation solutions available for underwater noise but bear in mind the costs,
- Community engagement and benefit sharing are core aspects of a successful social acceptance strategy.

