A cost of green energy:

Are offshore renewables a threat to porpoises?

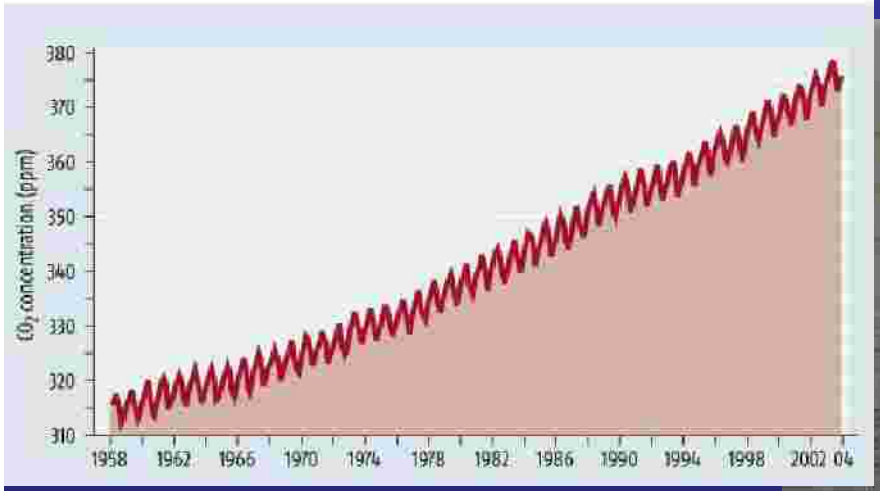
Ben Wilson, Robert Batty, Caroline Carter

SCOTTISH ASSOCIATION for MARINE SCIENCE

www.sams.ac.uk

CARBON DIOXIDE'S RELENTLESS RISE

Atmospheric CO_2 concentrations are now 35 per cent higher than pre-industrial levels, as indicated by readings taken at Mauna Loa in Hawaii



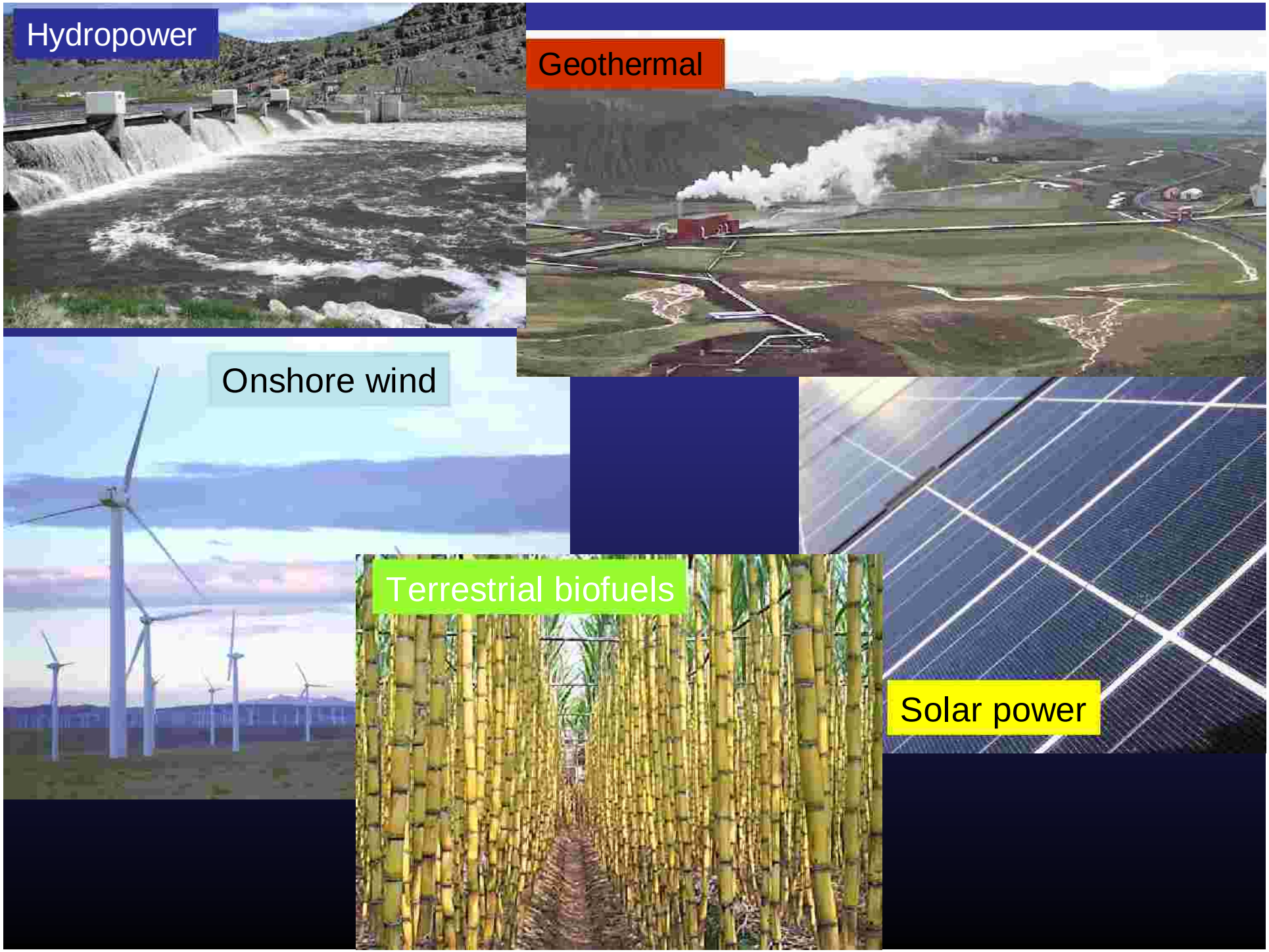
Government targets

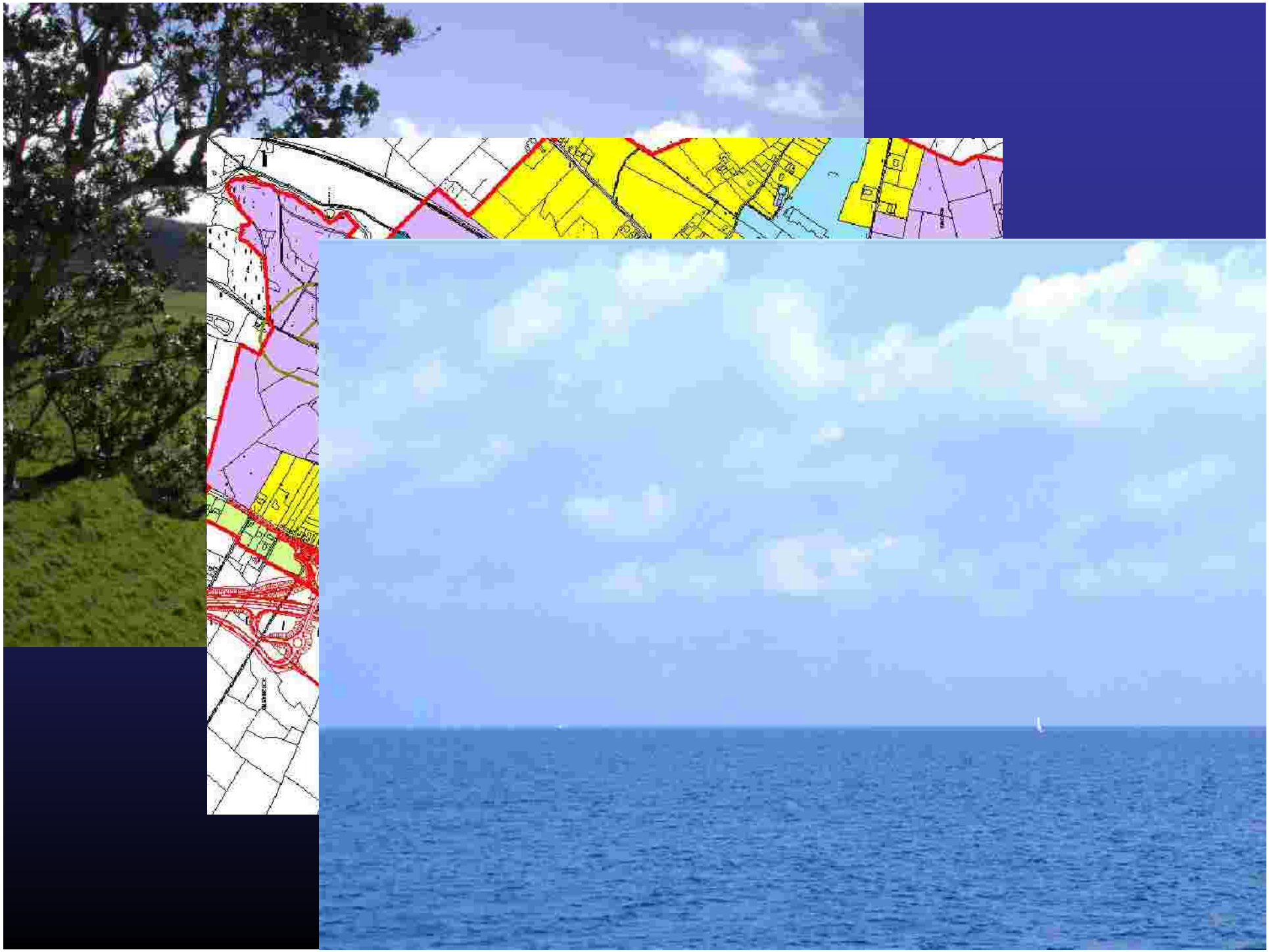
European Commission:
Cut carbon dioxide emissions by 20% from 1990 levels by 2020.

Scotland: 40% electricity from non-hydrocarbons by 2020.

SNP ? to 50%

Develop “Renewable Energy” sources


Hydropower
Geothermal
Onshore wind
Terrestrial biofuels
Solar power



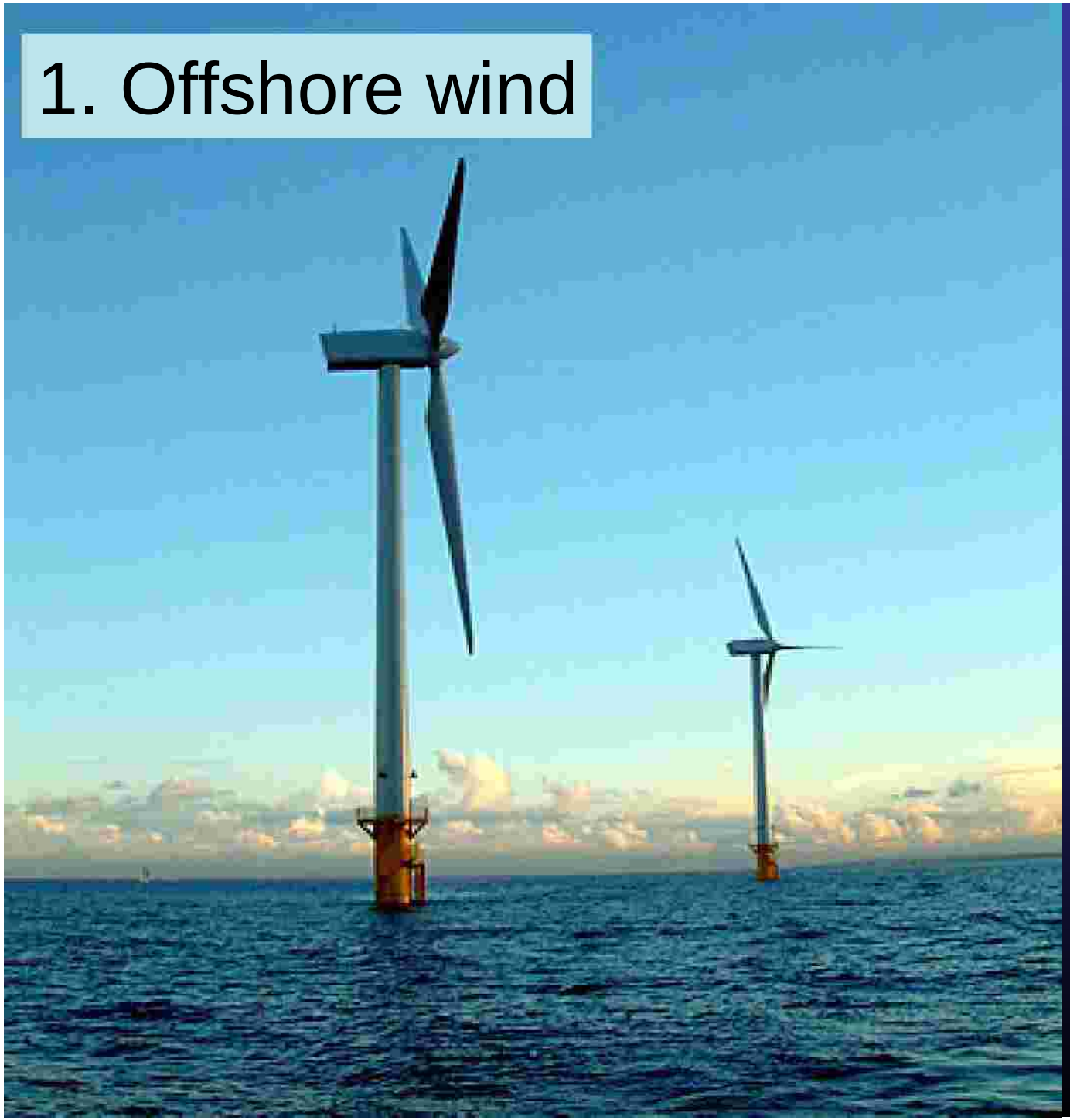
What technologies are out there?

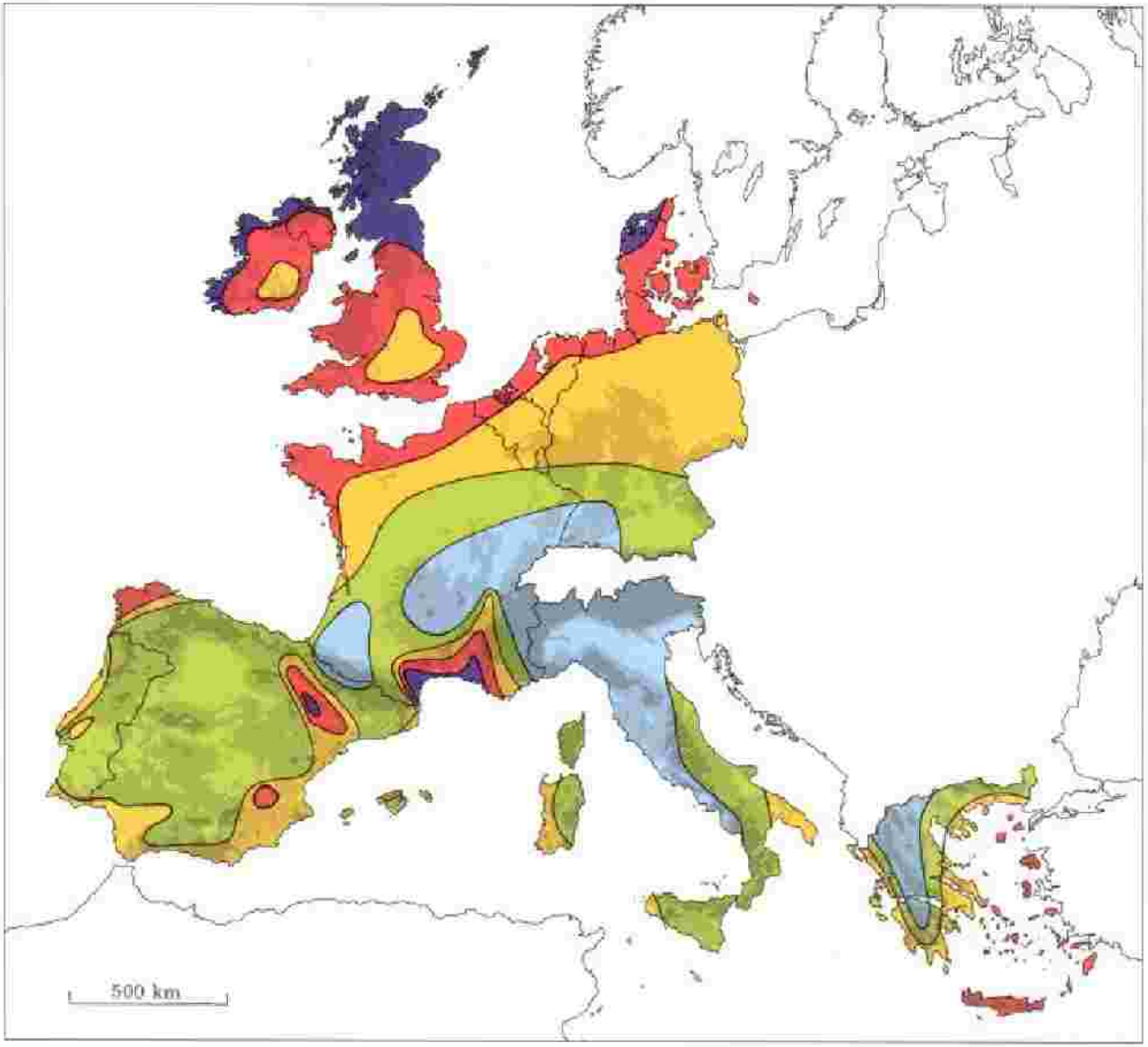
What technologies are out there?

1. Offshore wind
2. Wave
3. Tidal-stream
4. Marine biofuels
5. Tidal-barrage
6. Osmotic potential
7. Micoralgae etc etc

Muc Mhara relevant

1. Offshore wind





Wind resources[1] at 50 metres above ground level for five different topographic conditions

	Sheltered terrain[2]		Open plain[3]		At a sea coast[4]		Open sea[5]		Hills and ridges[6]	
	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}	$m\,s^{-1}$	Wm^{-2}
	> 6.0	> 250	> 7.5	> 500	> 8.5	> 700	> 9.0	> 800	> 11.5	> 1800
	5.0-6.0	150-250	6.5-7.5	300-500	7.0-8.5	400-700	8.0-9.0	600-800	10.0-11.5	1200-1800
	4.5-5.0	100-150	5.5-6.5	200-300	6.0-7.0	250-400	7.0-8.0	400-600	8.5-10.0	700-1200
	3.5-4.5	50-100	4.5-5.5	100-200	5.0-6.0	150-250	5.5-7.0	200-400	7.0- 8.5	400- 700
	< 3.5	< 50	< 4.5	< 100	< 5.0	< 150	< 5.5	< 200	< 7.0	< 400

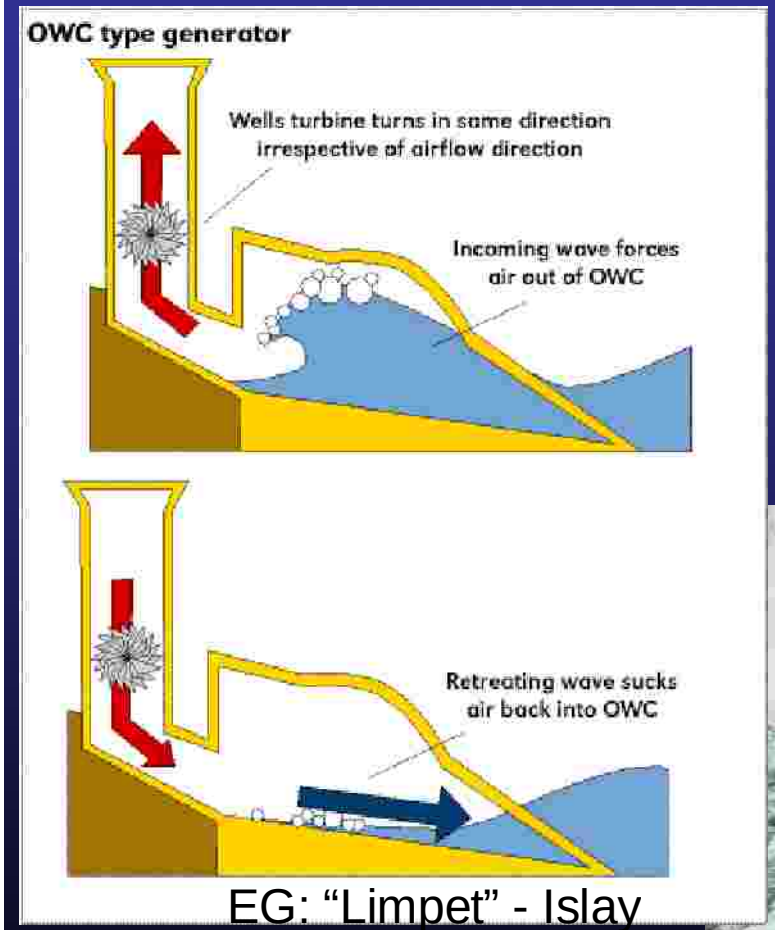
Offshore wind worldwide

Location	Country	Online	MW	No	Rating
Vindeby	Denmark	1991	4.95	11	Bonus 450kW
Lely (Ijsselmeer)	Holland	1994	2.0	4	NedWind 500kW
Tunø Knob	Denmark	1995	5.0	10	Vestas 500kW
Dronten (Ijsselmeer)	Holland	1996	11.4	19	Nordtank 600kW
Gotland (Bockstigen)	Sweden	1997	2.5	5	Wind World 500kW
Blyth Offshore	UK	2000	3.8	2	Vestas 2MW
Middelgrunden, Copenhagen	Denmark	2001	40	20	Bonus 2MW
Uttgrunden, Kalmar Sound	Sweden	2001	10.5	7	GE Wind 1.5MW
Yttre Stengrund	Sweden	2001	10	5	NEG Micon NM72
Horns Rev	Denmark	2002	160	80	Vestas 2MW
Frederikshaven	Denmark	2003	10.6	4	2 Vestas 3MW,1 Bonus 2.3MW and 1 Nordex 2.3MW
Samsø	Denmark	2003	23	10	Bonus 2.3 MW
North Hoyle	UK	2003	60	30	Vestas 2MW
Nysted	Denmark	2004	158	72	Bonus 2.3MW
Arklow Bank	Ireland	2004	25.2	7	GE 3.6 MW
Scroby Sands	UK	2004	60	30	Vestas 2 MW
Totals			**587**	**316**	

Supergrid

the power to connect

2. Wave



EG: “Limpet” - Islay

Pelamis Wave Power

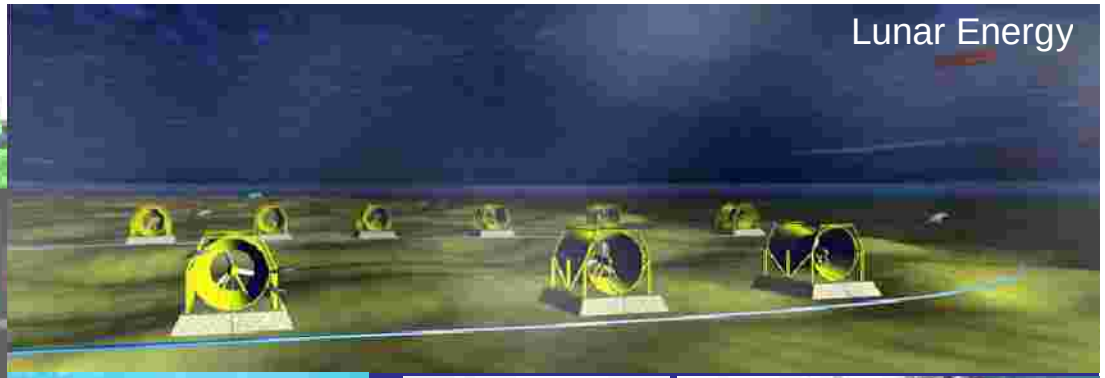
Wave Dragon

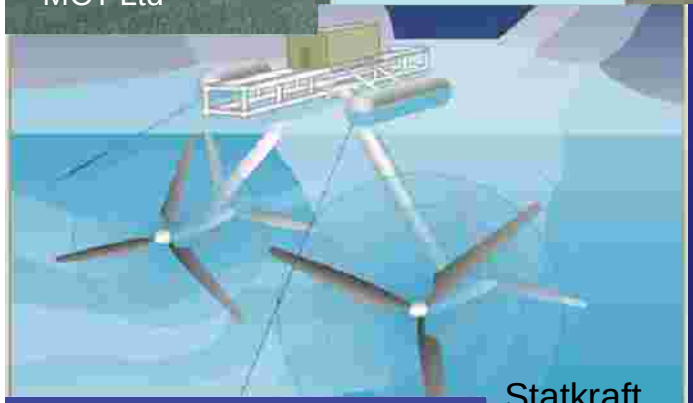
3. Tidal-stream

Tidal Generation Ltd


MCT Ltd


Rochester Venturi


Lunar Energy


Statkraft

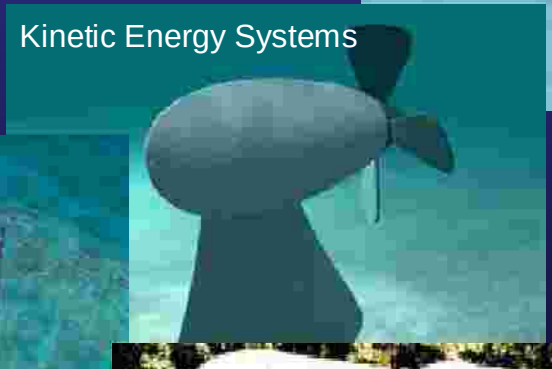

HAMMERFEST STRØM AS


TidEL


TidEL

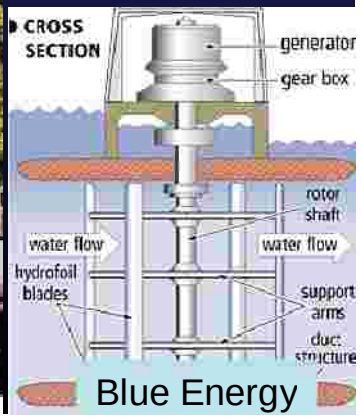

Verdant Power


Blue Energy

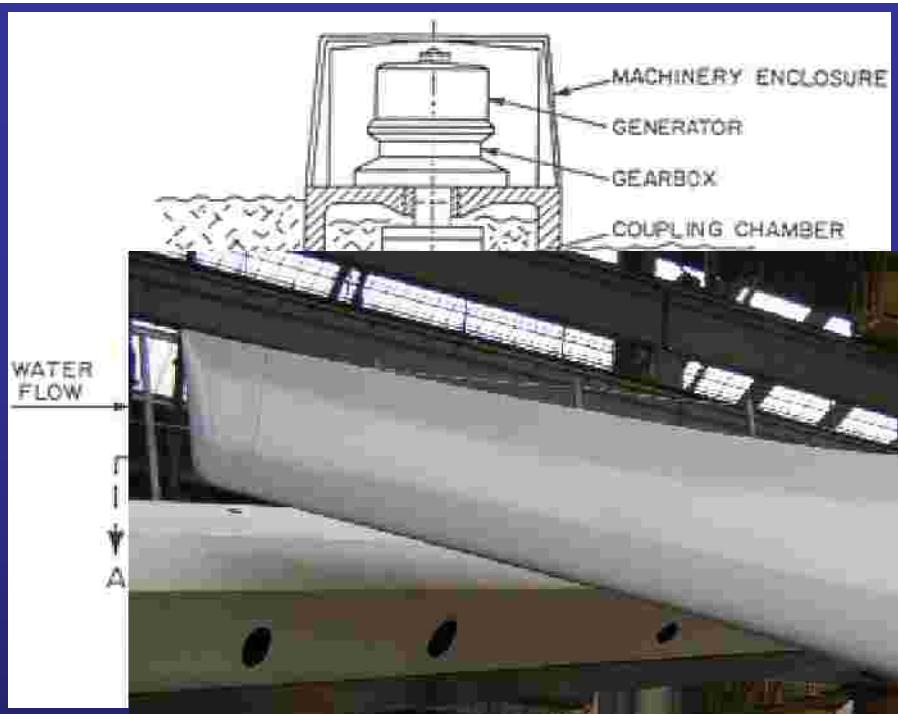

Kinetic Energy Systems


Openhydro

UW electric kite



Blue Energy



Blue Energy The Davis Hydro Turbine

OpenHydro

4. Biofuels from algae: macro (sea weed)

1. Marine biomass circumvents terrestrial crops vs fuel issue

2. Kelp fastest growing plant

3. No lignin or cellulose - digestion easier

4. Scotland / Ireland an excellent place to grow it

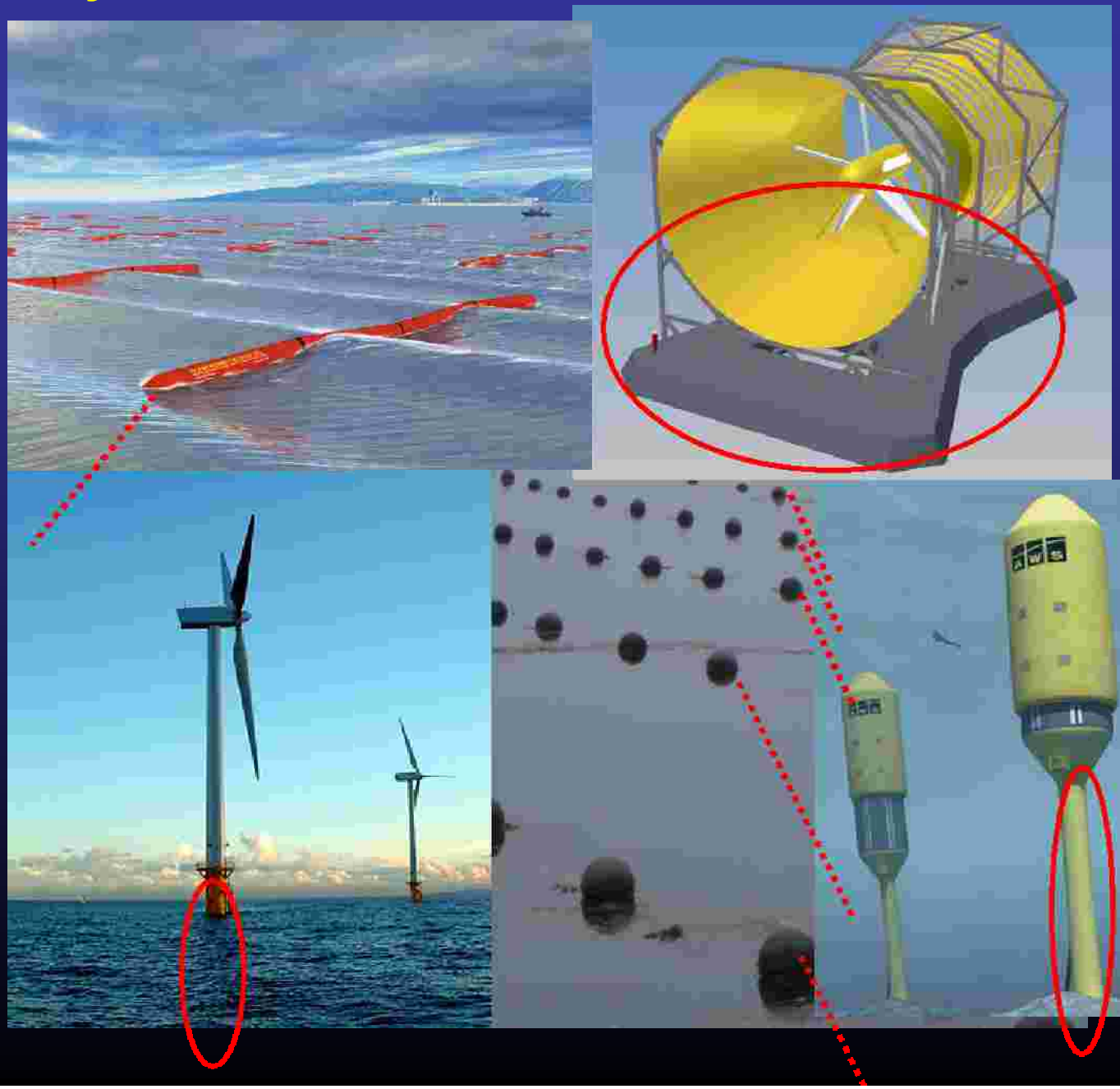

China grows 9 million tons L. japonica grown annually
BioMara: 5M € research project – Scotland & N. Ireland

So what’s the concern for Porpoises?

Physical structures in common

1. Offshore wind
2. Marine biofuels
3. Wave
4. Tidal-stream

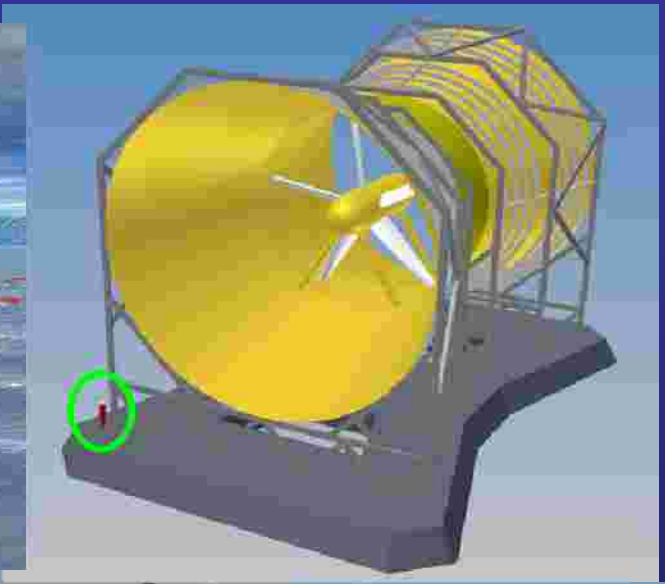
Attached to sea bed

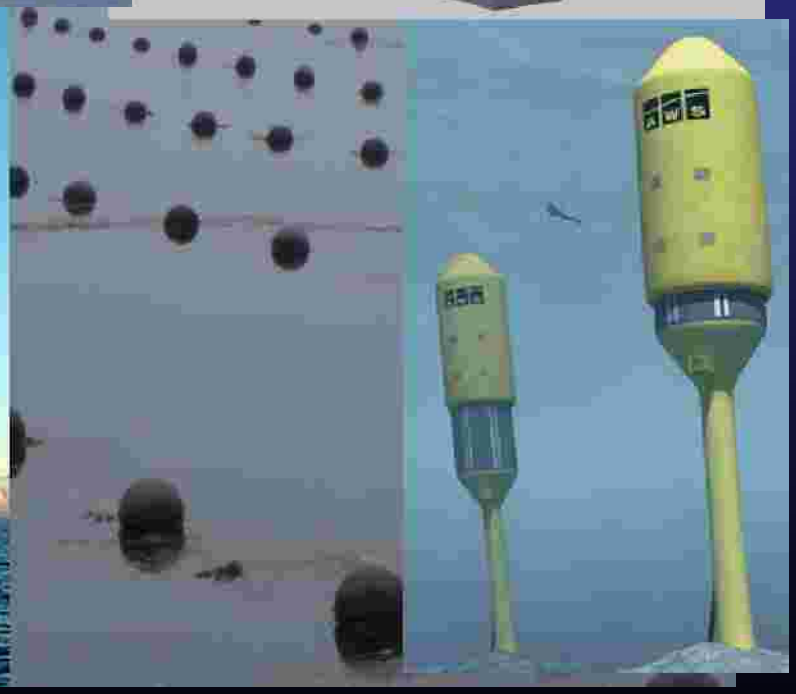


Structures in common

1. Offshore wind
2. Marine biofuels
3. Wave
4. Tidal-stream

Attached to sea bed
All large / physical presence





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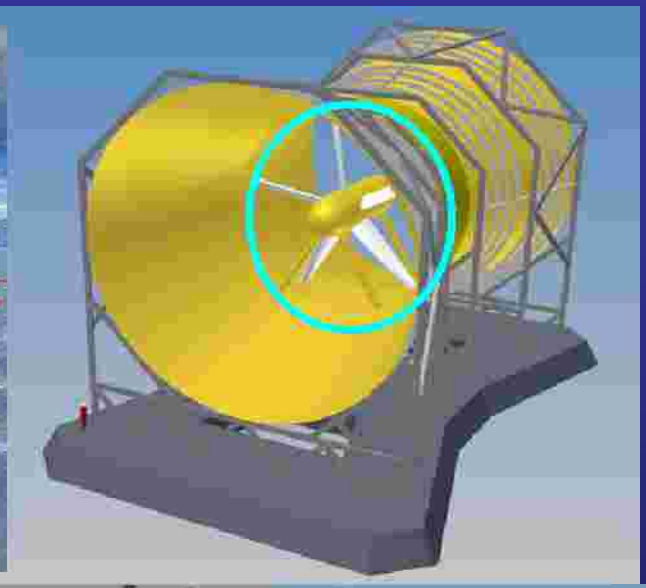

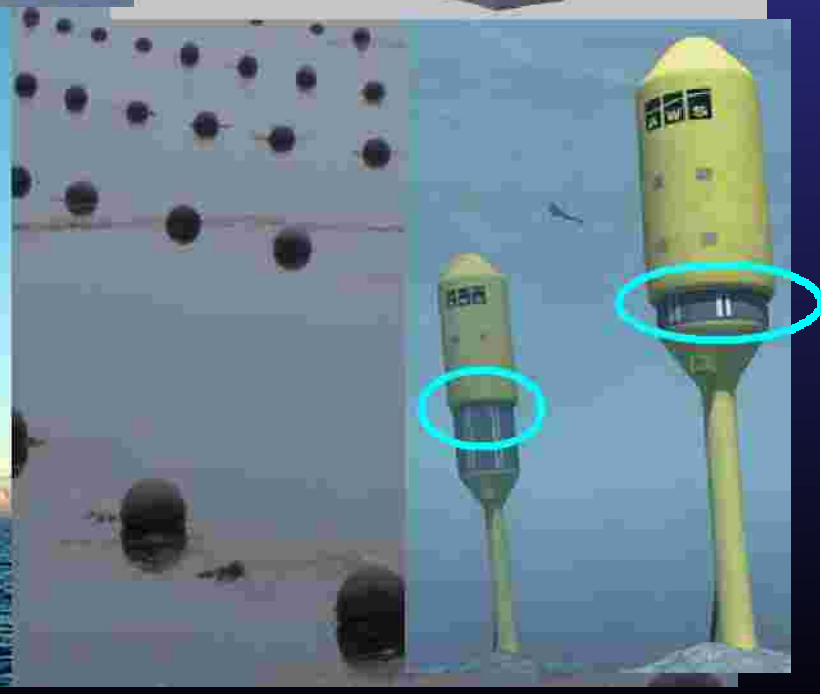

Attached to sea bed
All large / physical presence
Moving parts
Require servicing

Typical cetacean issues

- Entanglement
- Habitat alteration
- Noise
- Contaminants
- Collisions

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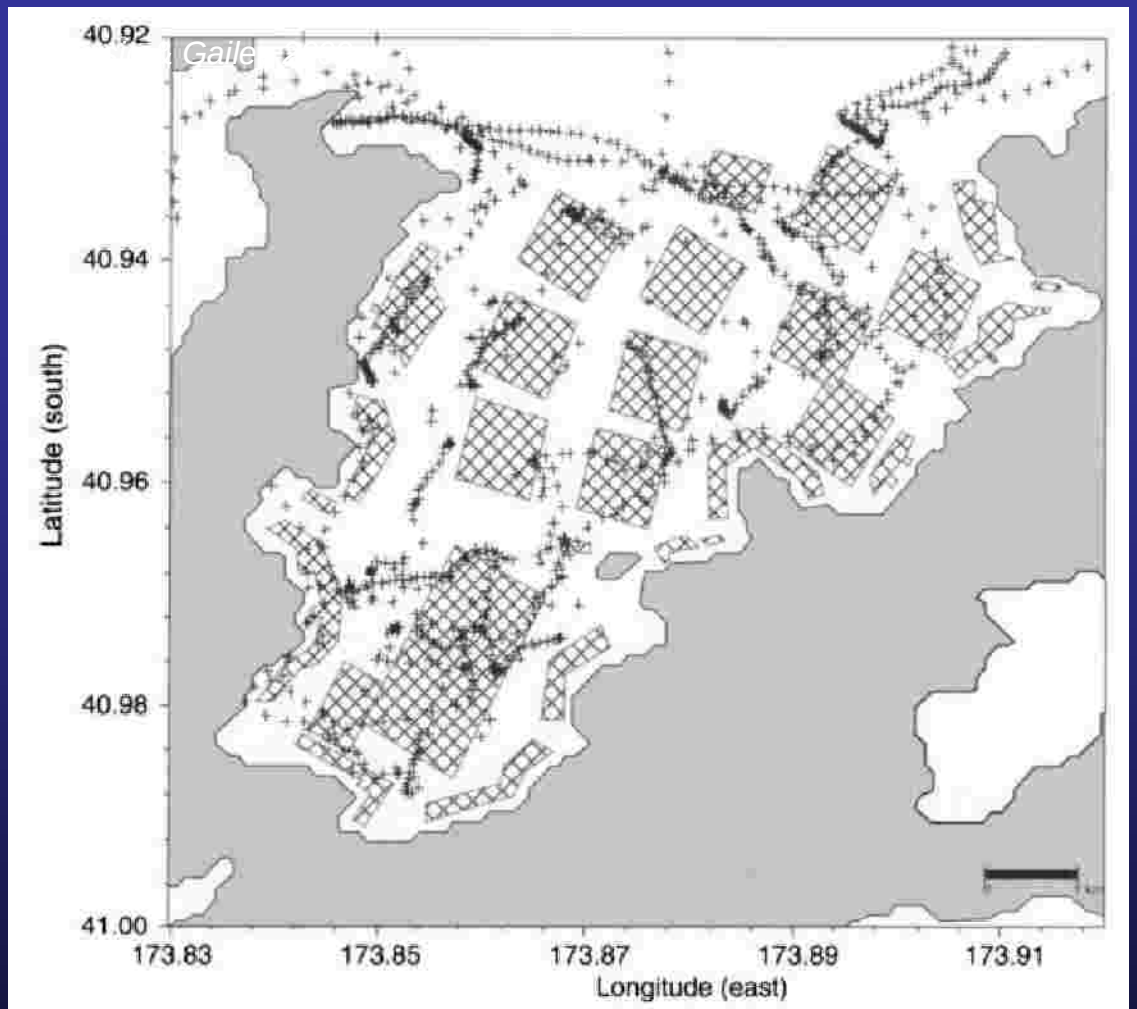


Fig. 3.1. Admiralty Bay in the Marlborough Sounds, South Island, New Zealand. Cross-hatched squares represent proposed shellfish farms, and near-shore cross-hatched longish patterns represent both proposed (in the west) and existing (in the east) farms. The small '+' marks represent dusky dolphin tracks

Equivalent to open-savanna lion forced to chase prey in forest

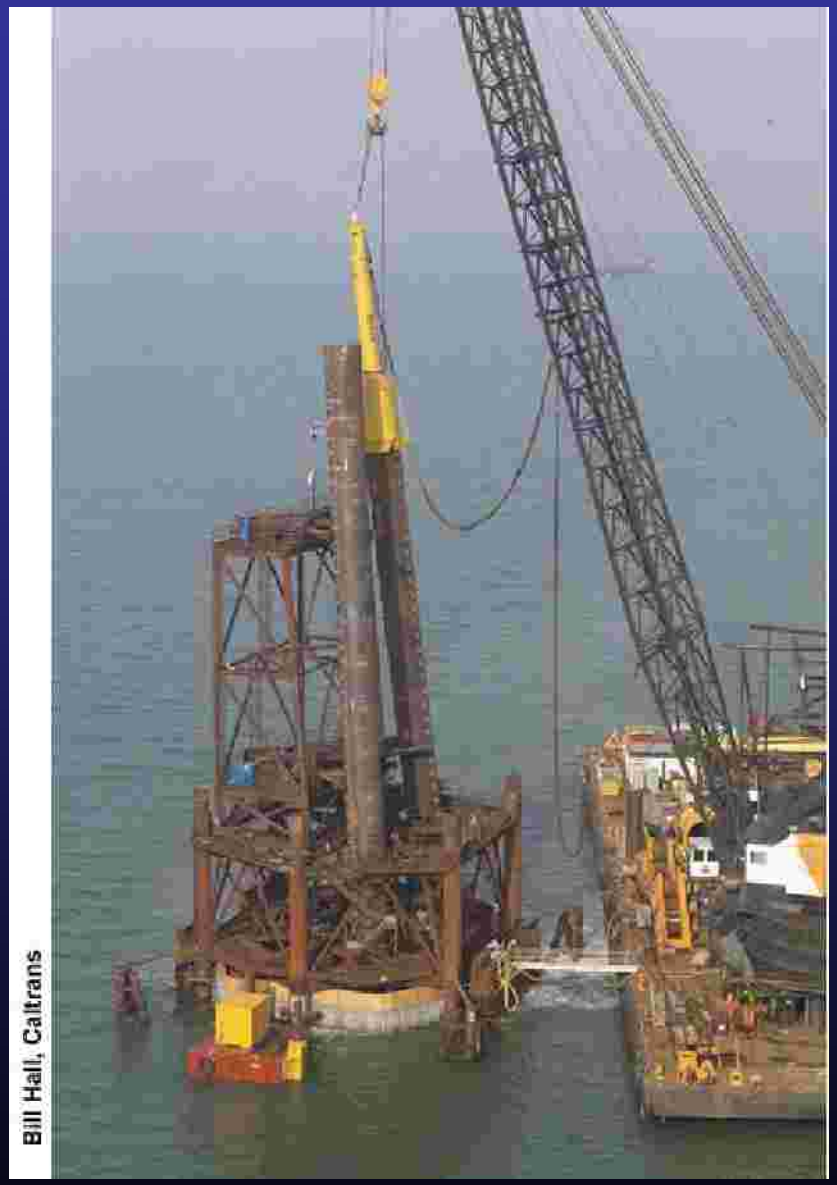
Problem for Dusky & bottlenose dolphins what about "neophobic" porpoises?

Typical cetacean issues

- Entanglement
- Habitat alteration
- Noise
- Contaminants
- Collisions

Danish porpoises
Scorby Sands fish

UK - 7000 by 2020



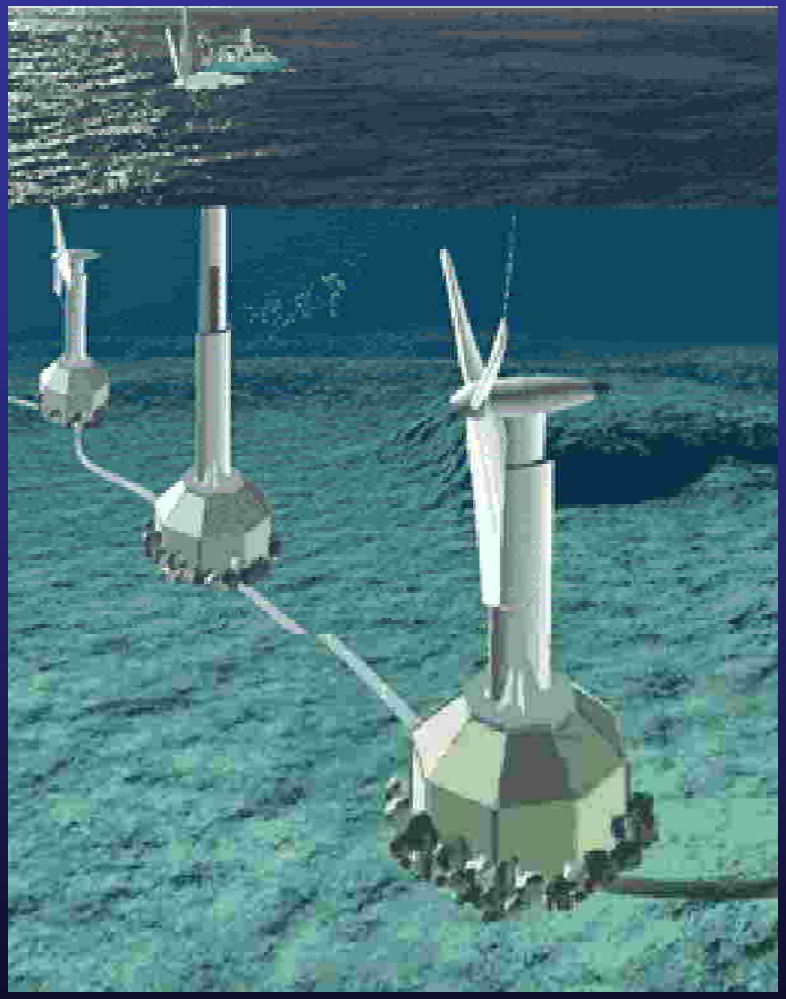
Typical cetacean issues

- Entanglement
- Habitat alteration
- Noise
- Contaminants
- Collisions

Lubricants
Anti-fouling

Typical cetacean issues

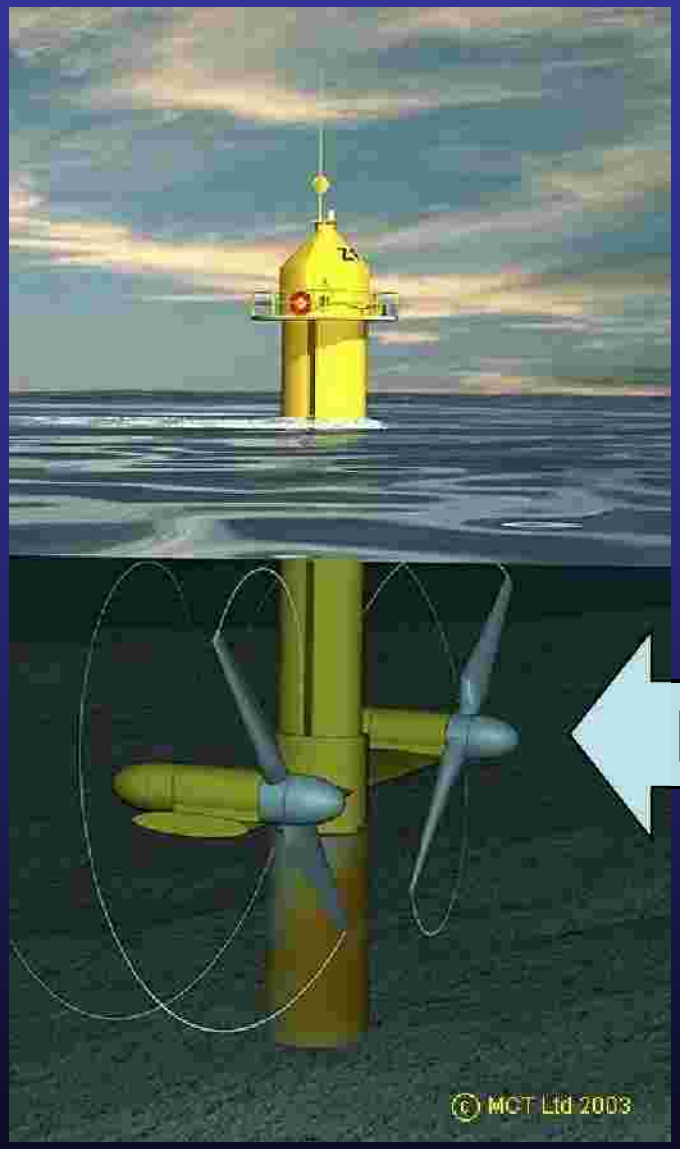
- Entanglement
- Habitat alteration
- Noise
- Contaminants
- Collisions



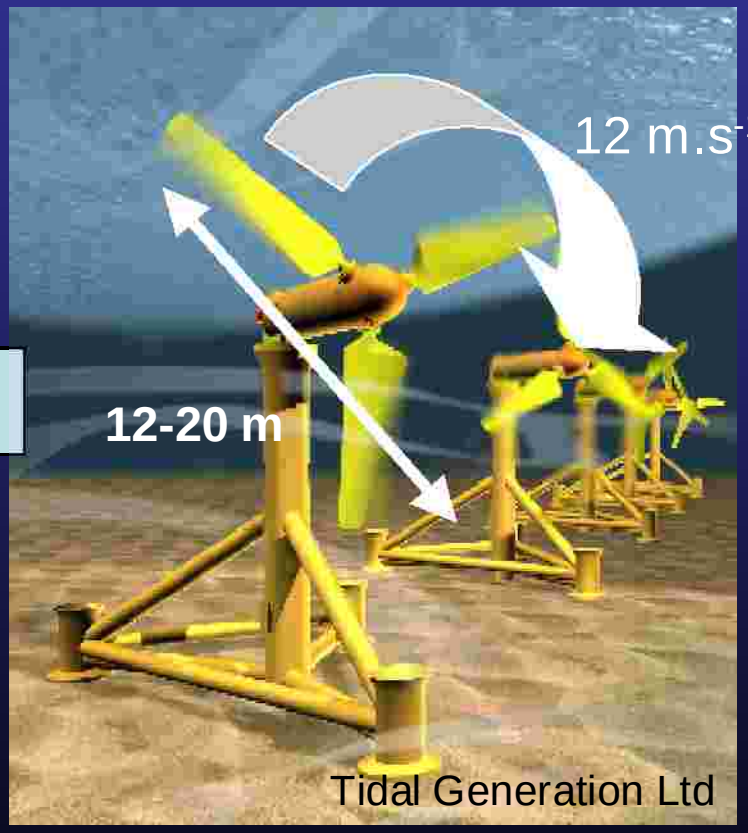
SwanTurbines


Chris Johnson

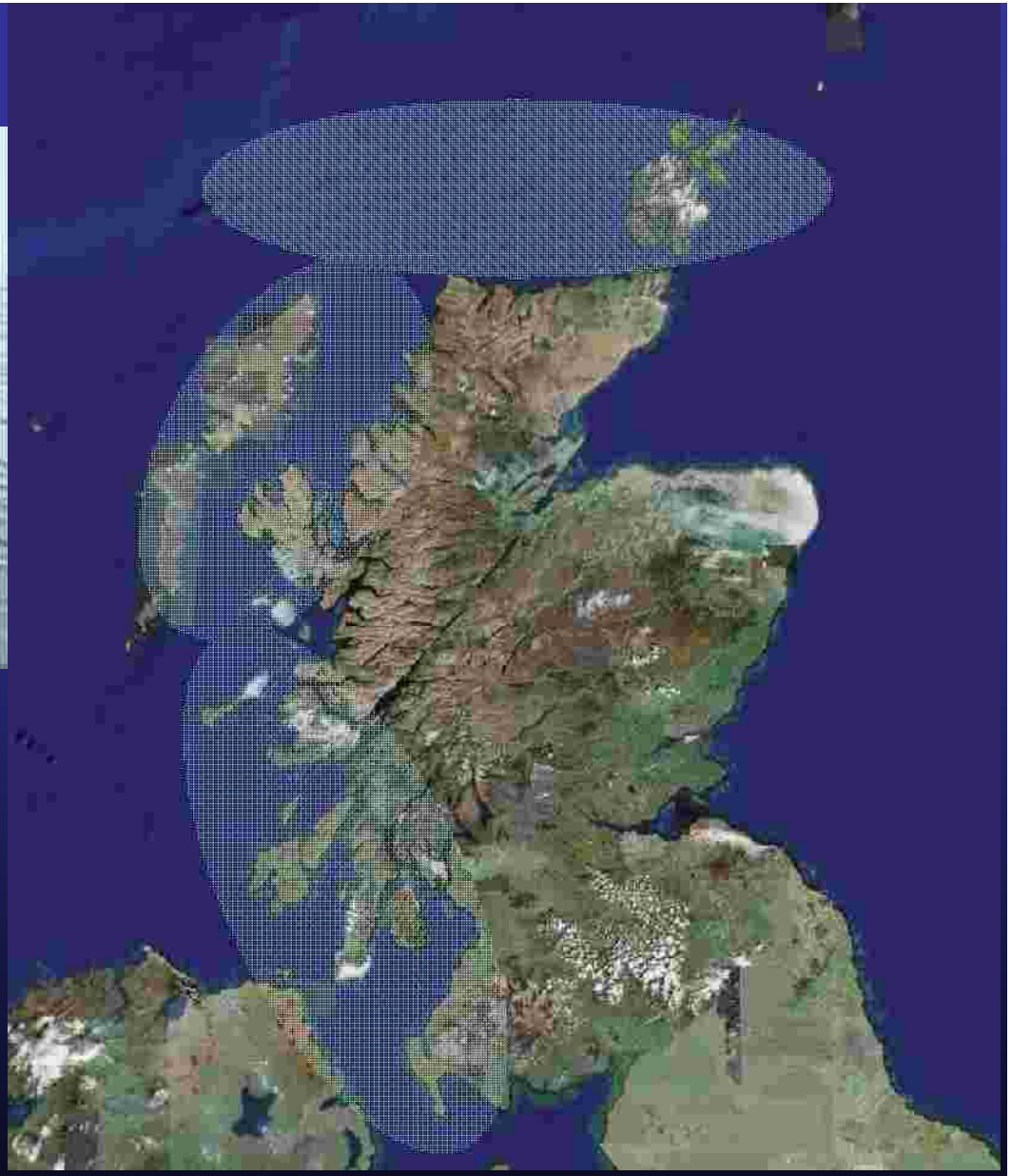

Fernando Felix



Flow



Encounter rates



Model predicts:
Number times porpoises & turbine blades share same point in space & time.

I.E. Opportunities for collisions to occur

Standard predator-prey encounter model

Modified for 3-D (Gerritsen & Strickler 1977; Bailey & Batty 1983)

Volume water swept by turbines
- Water depth 50 m
- Rotation 10 rpm
- n = 100
- 16 m Ø
- Max flow 3.5 m.s-1

Porpoise density, size, swim speed
- Randomly distributed
- Moving @ 2 $m.s^{-1}$
- Density 0.394 km^{-2} (SCANS-II block N)
- Mean body length 1.4 m

Model assumes no responsive movement

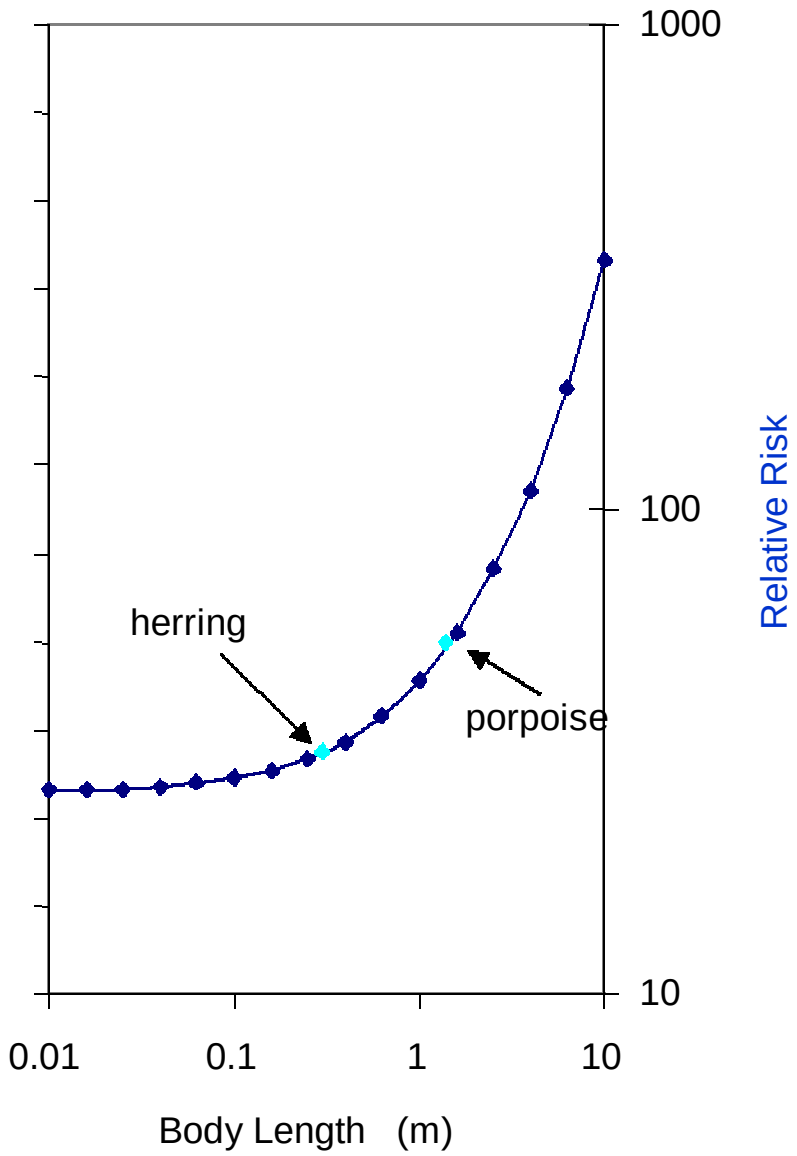
Potential encounter rates

In a year,

13 porpoise encounters / turbine

3.6 – 10.7 % porpoise “population”

2% herring population


1000
100
10
Relative Risk
herring
porpoise
0.01
0.1
1
10
Body Length (m)

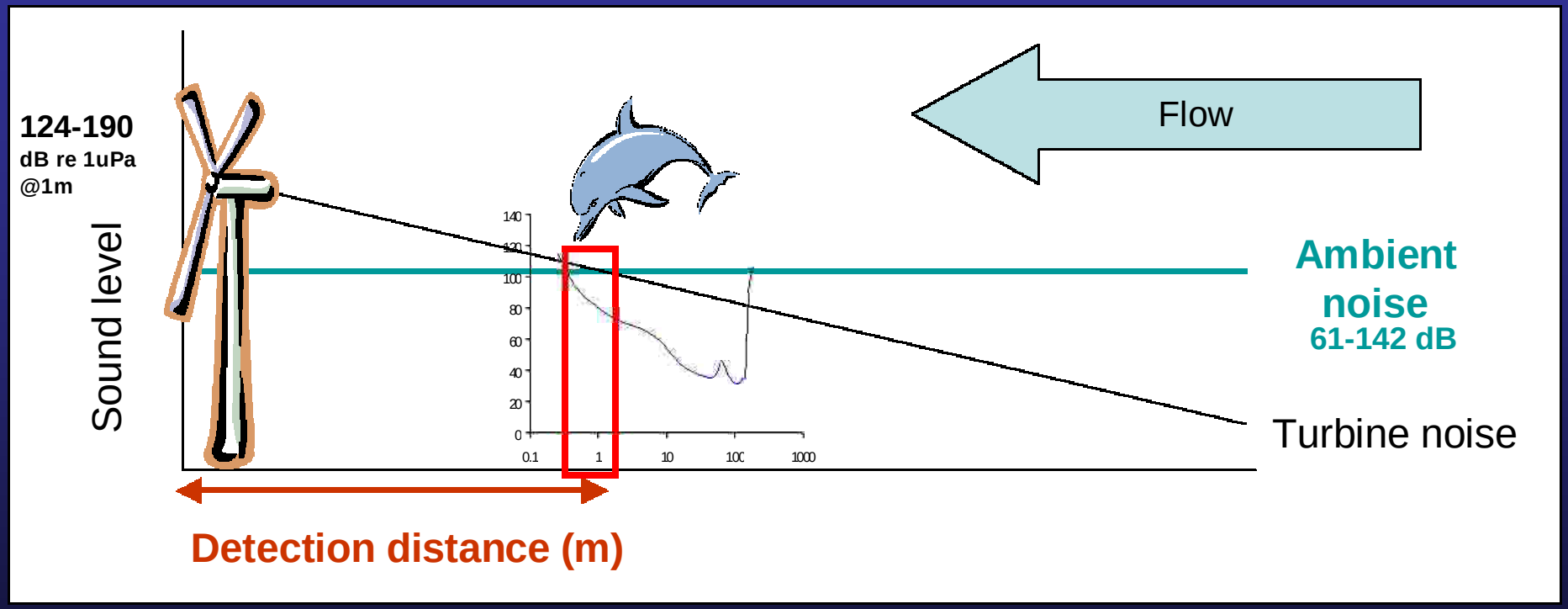
Opportunities to perceive - visual

What artist shows

What porpoise sees

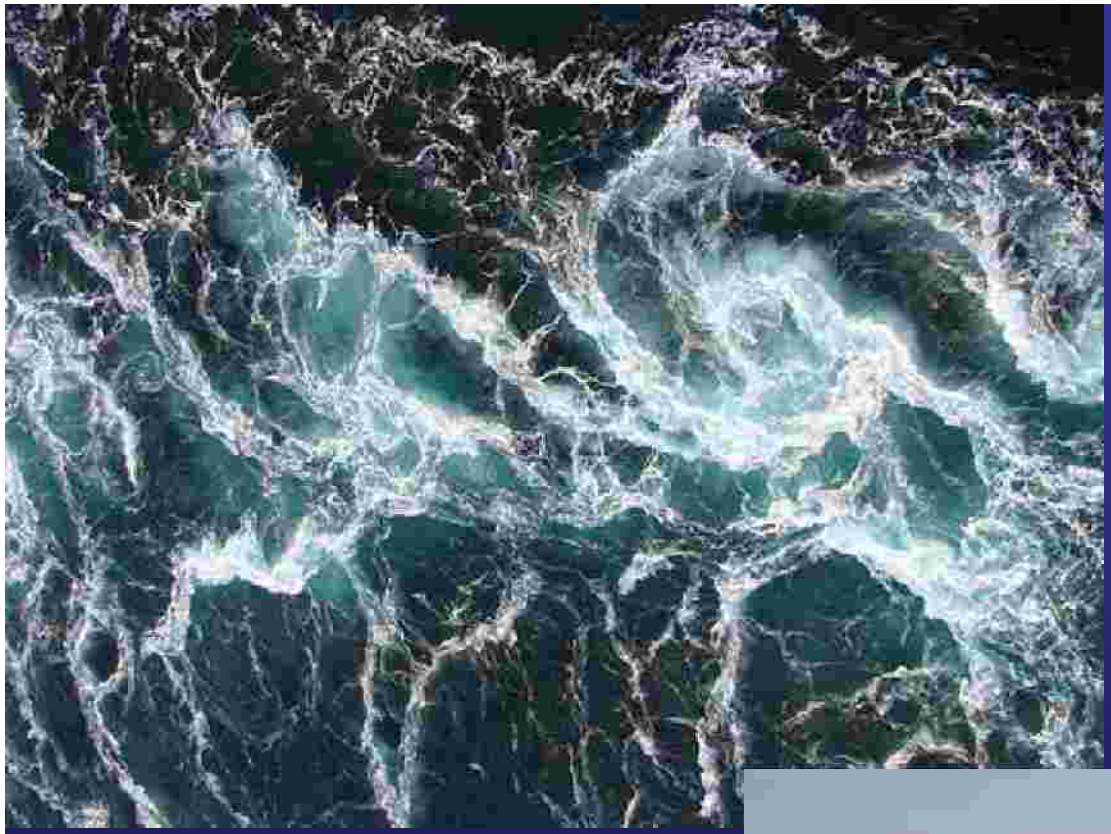
Opportunities to perceive - acoustic

Frequencies 0.3 -10 KHz



2 hrs to < 1 second

Killer whales
Bottlenose dolphins
Harbor porpoises
Harbor seals



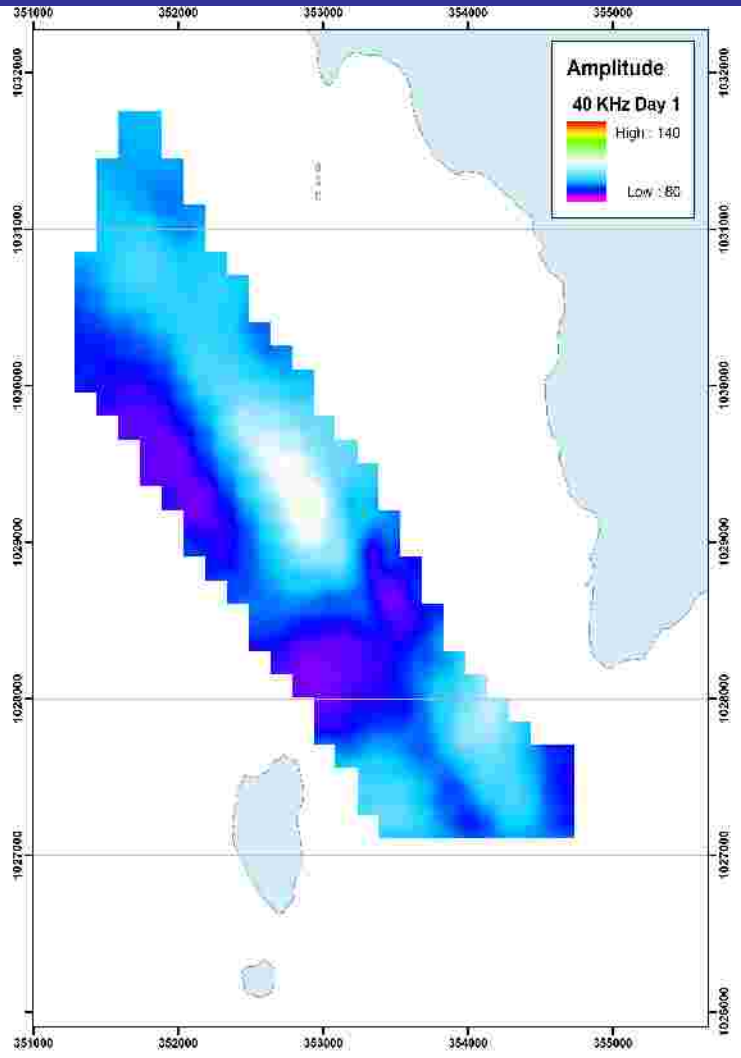
Acoustic Monitoring - Orkney

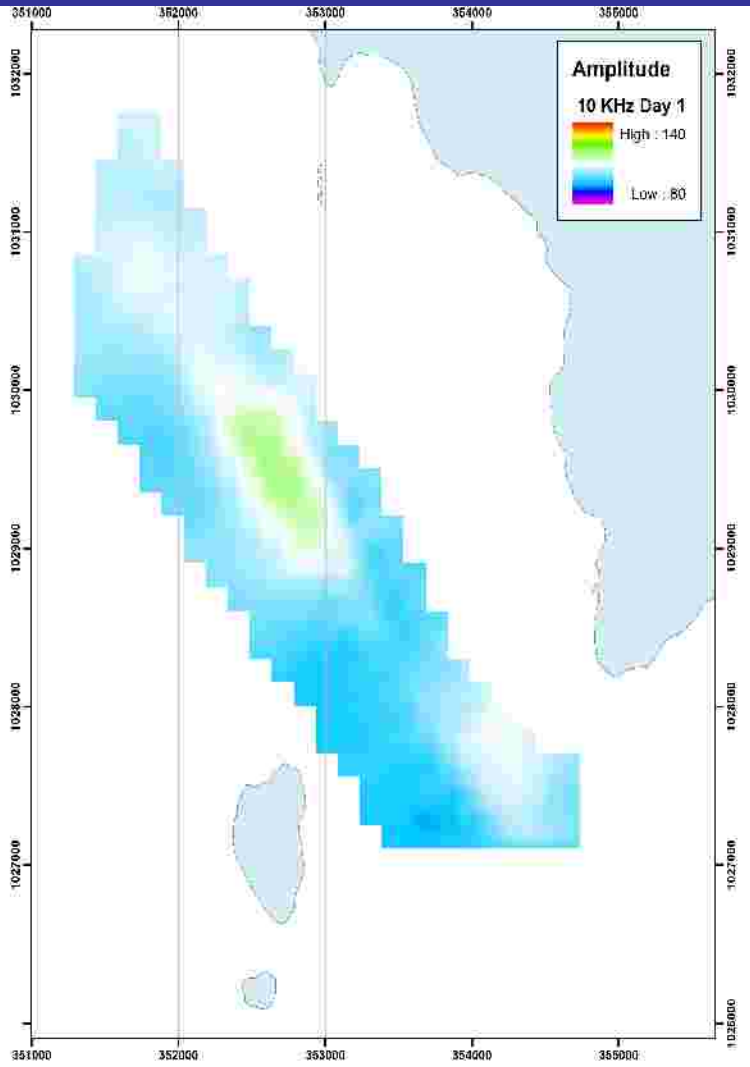
EMEC
The European Marine Energy Centre Ltd

Falls of Warness - Orkney

SAMS developed for EMEC drifting hydrophones to measure sound in flows up to 6 Knots

Example sound maps produced by the “Drifting Ears” technique





Acoustic warning devices – **LOUD!**

Summary

1. Renewable energy industries poised move into porpoise habitat
2. Limited threat information - existing industries give cause for concern
3. Potential threats diverse but collisions with turbines an obvious issue
4. Marine mammal - turbine encounters could be common
5. +ve outcome of “encounters” behaviour dependant

Remarks

1. Many good reasons to encourage marine renewables

2. Major competition for successful designs
   Output, reliability, cost**, animal safe**

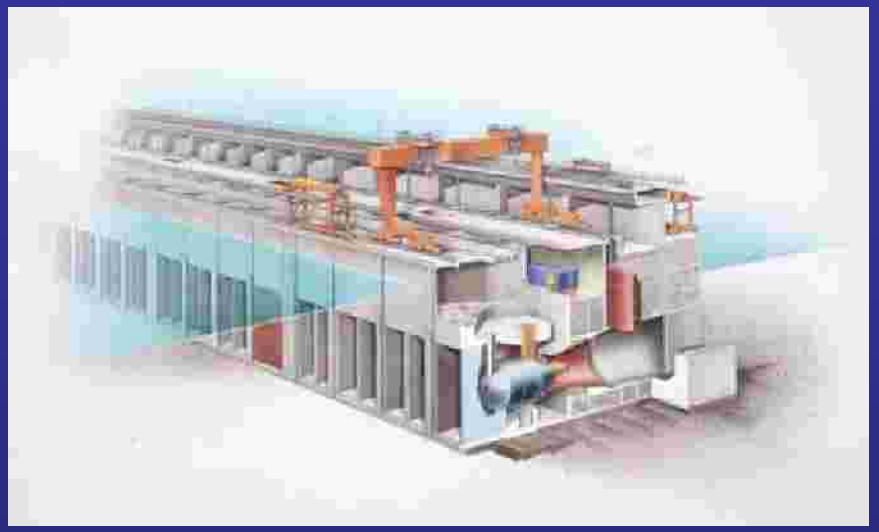
3. Race for £$€¥ - design first, address environmental concerns after

4. To avoid future conflict, the sooner we get involved the better

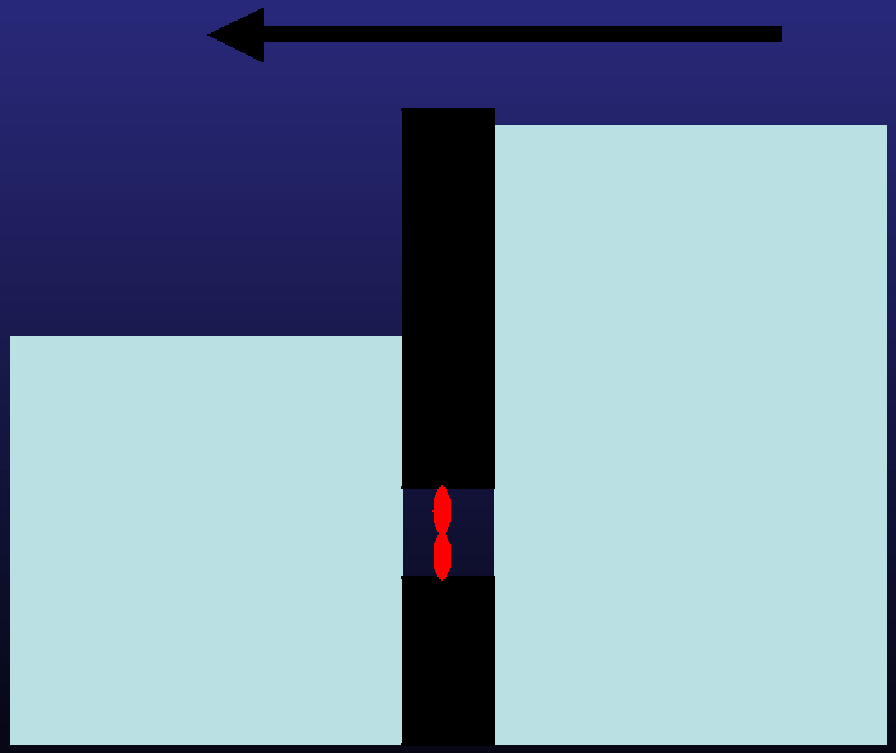
Funding provided by:

Thank you for your attention

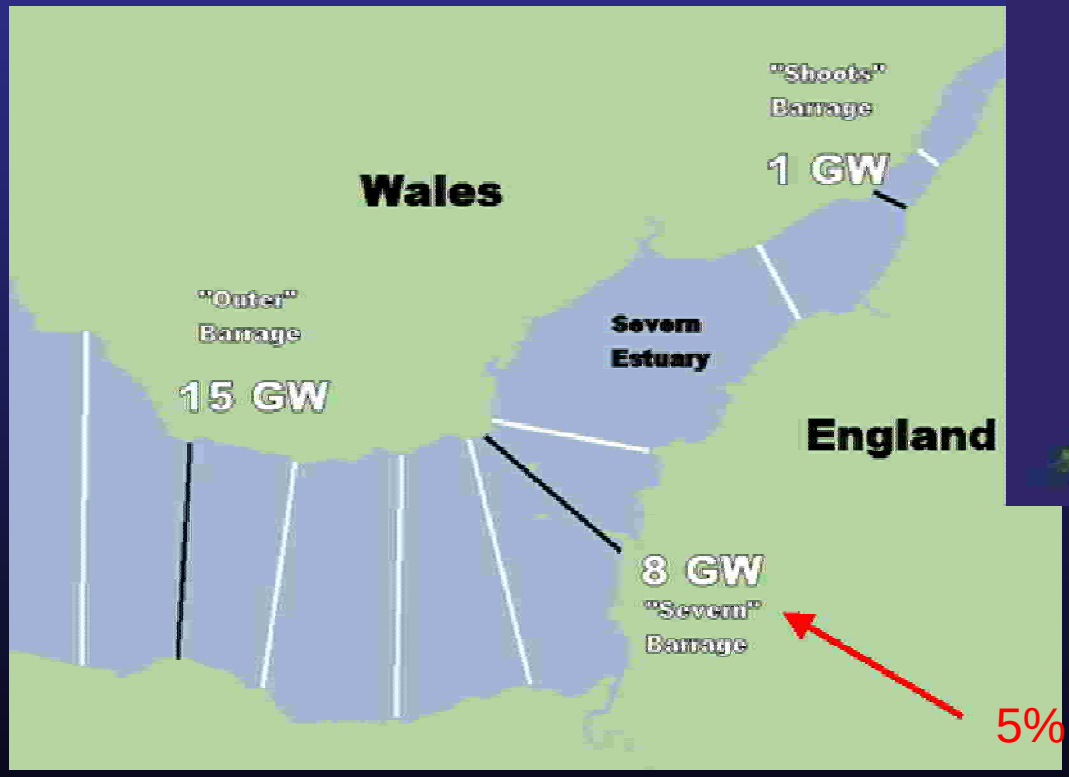
3. Tidal-barrage



La Rance Tidal Barrage



Severn estuary / Bristol Channel Barrage
Tidal power generation
Transport links
Flood protection
Harbour creation
Not a terrorist target!



18 Billion Euros

5% Britain's power needs

Barrage locations considered.
Black = lines of most interest.

20x size of La Rance