



# Impact of floating off-shore wind (FLOW) on the marine environment

Ben Lincoln & Tom Rippeth

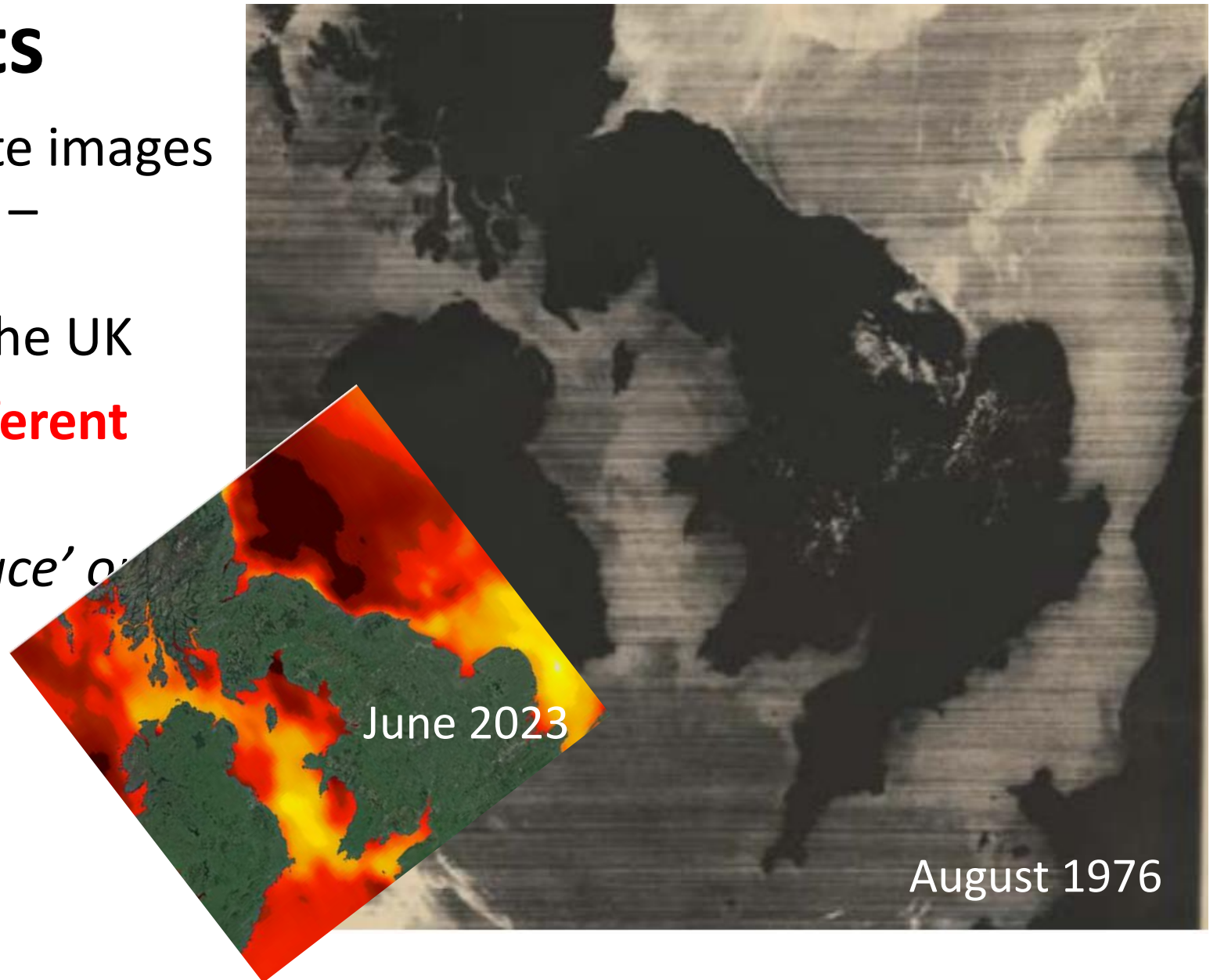


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# Shelf Sea Fronts

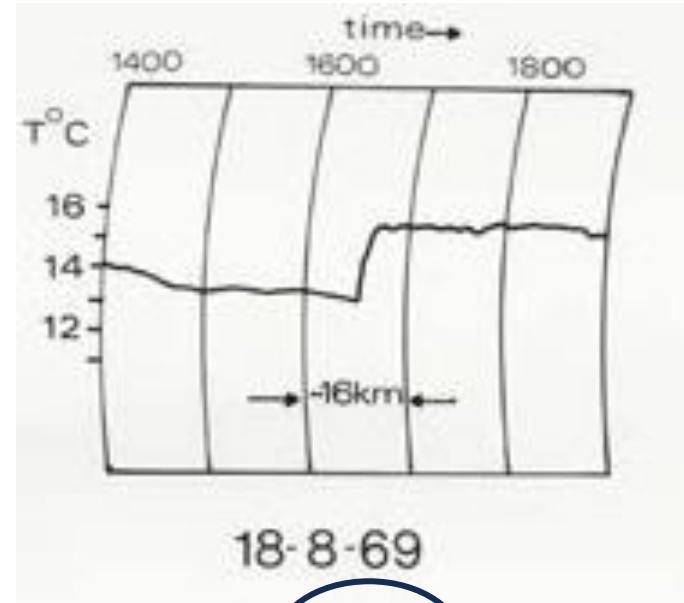
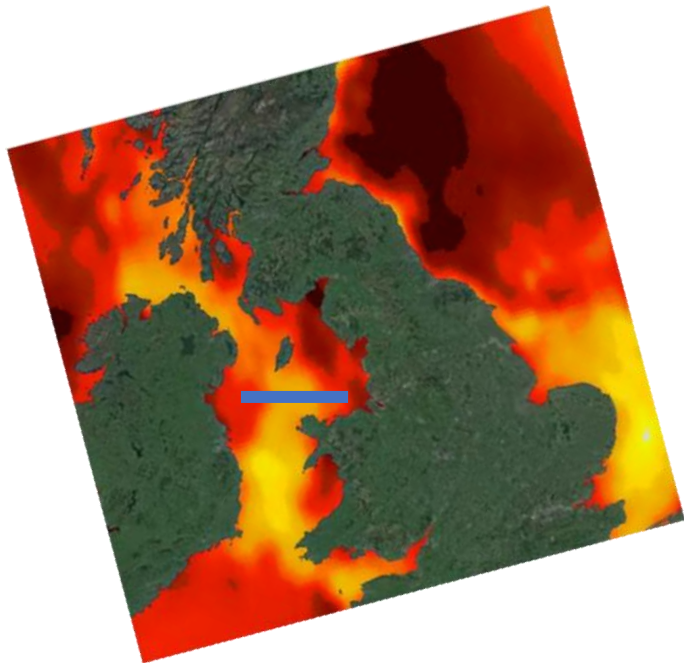
- One of the first satellite images used in oceanography – showing sea surface temperature around the UK
- **It shows two very different 'regimes'**

*Separated by an 'interface' or shelf sea front*

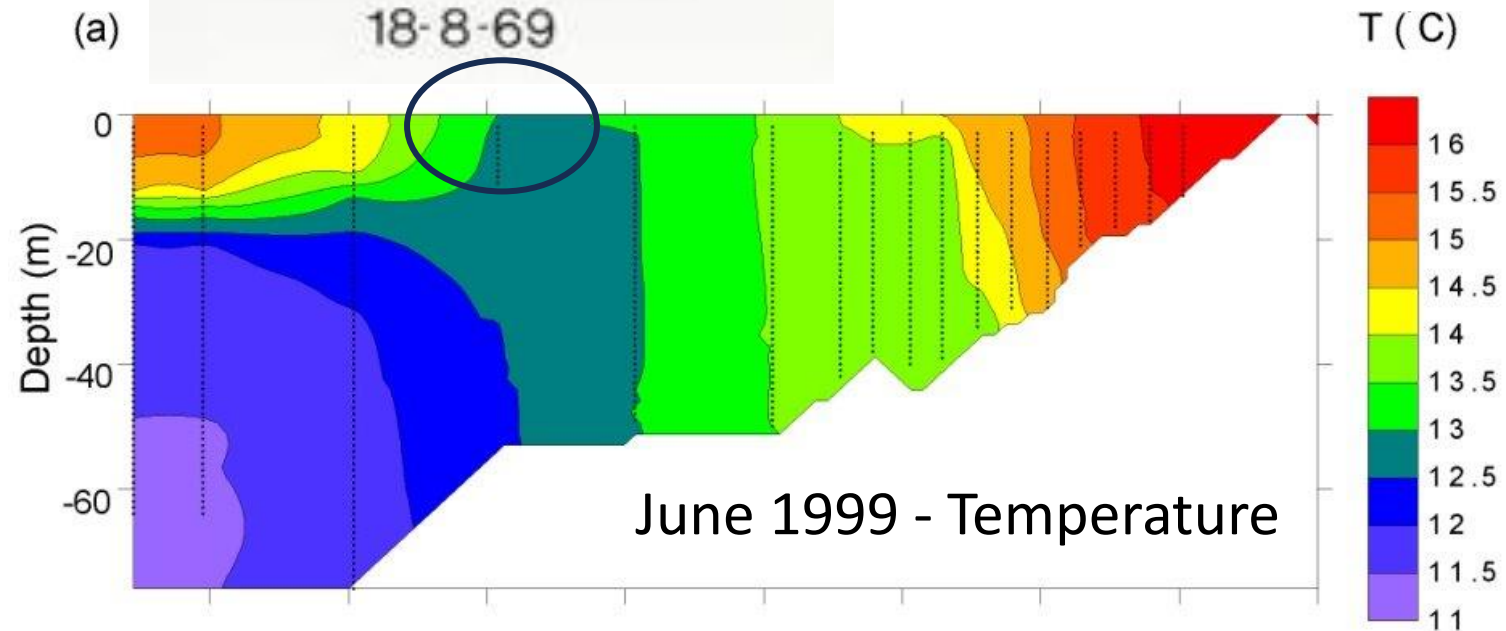


# Mixed & Seasonally Stratified

- Mixed in the east.
- Stratified in the west.
- Gradient in tidal mixing.



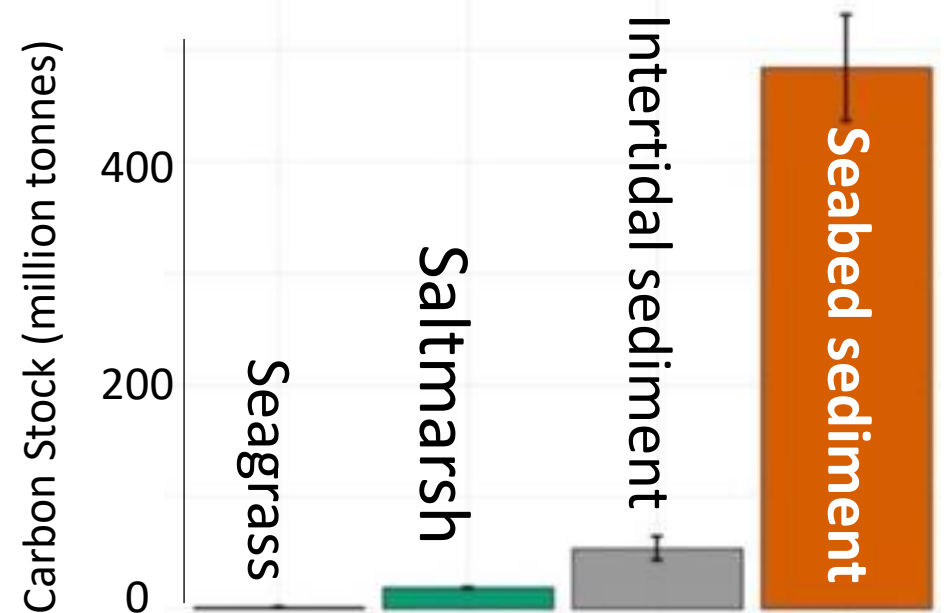
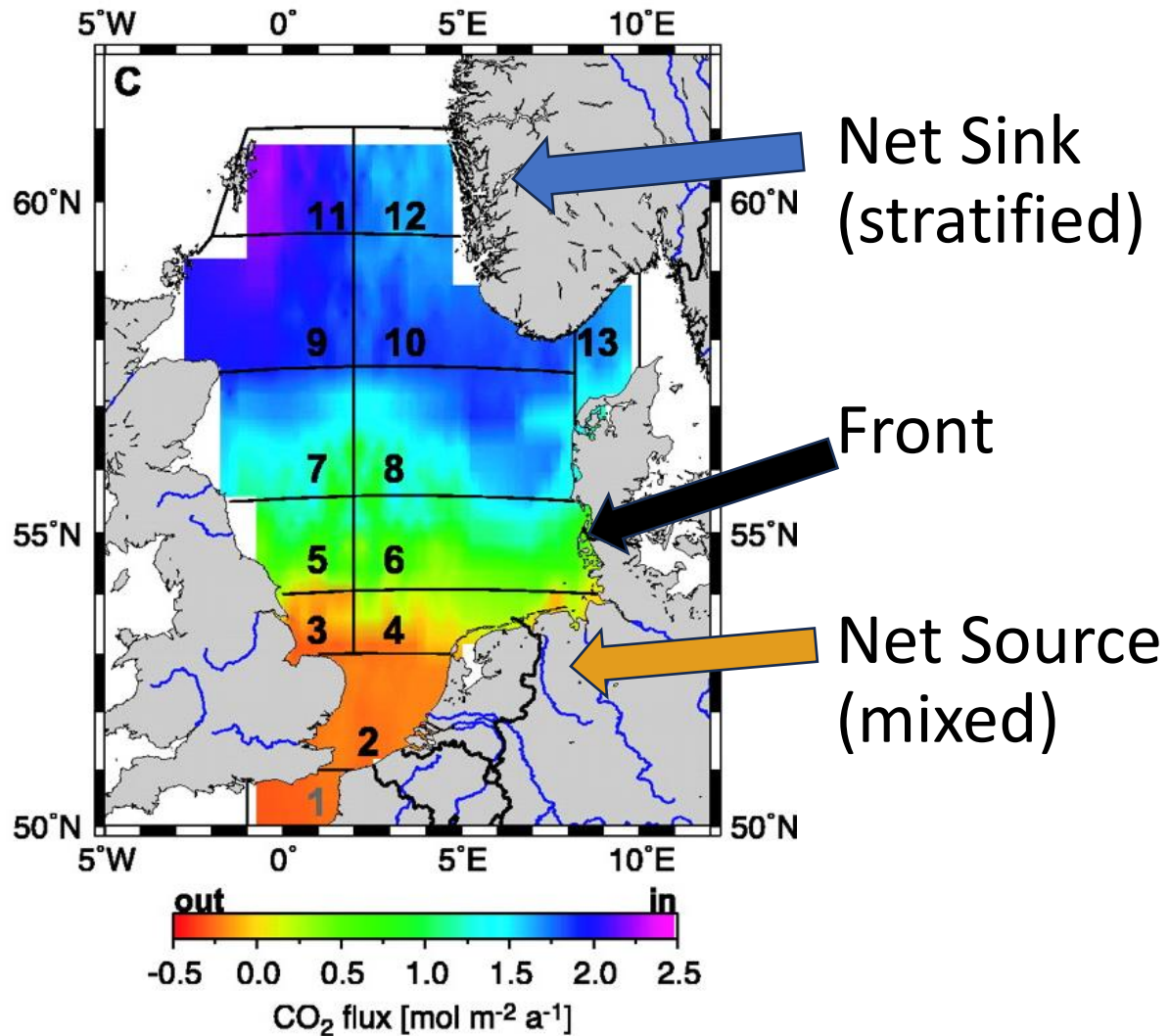
John H Simpson



Simpson and Hunter, 1974. Nature

# Blue Carbon

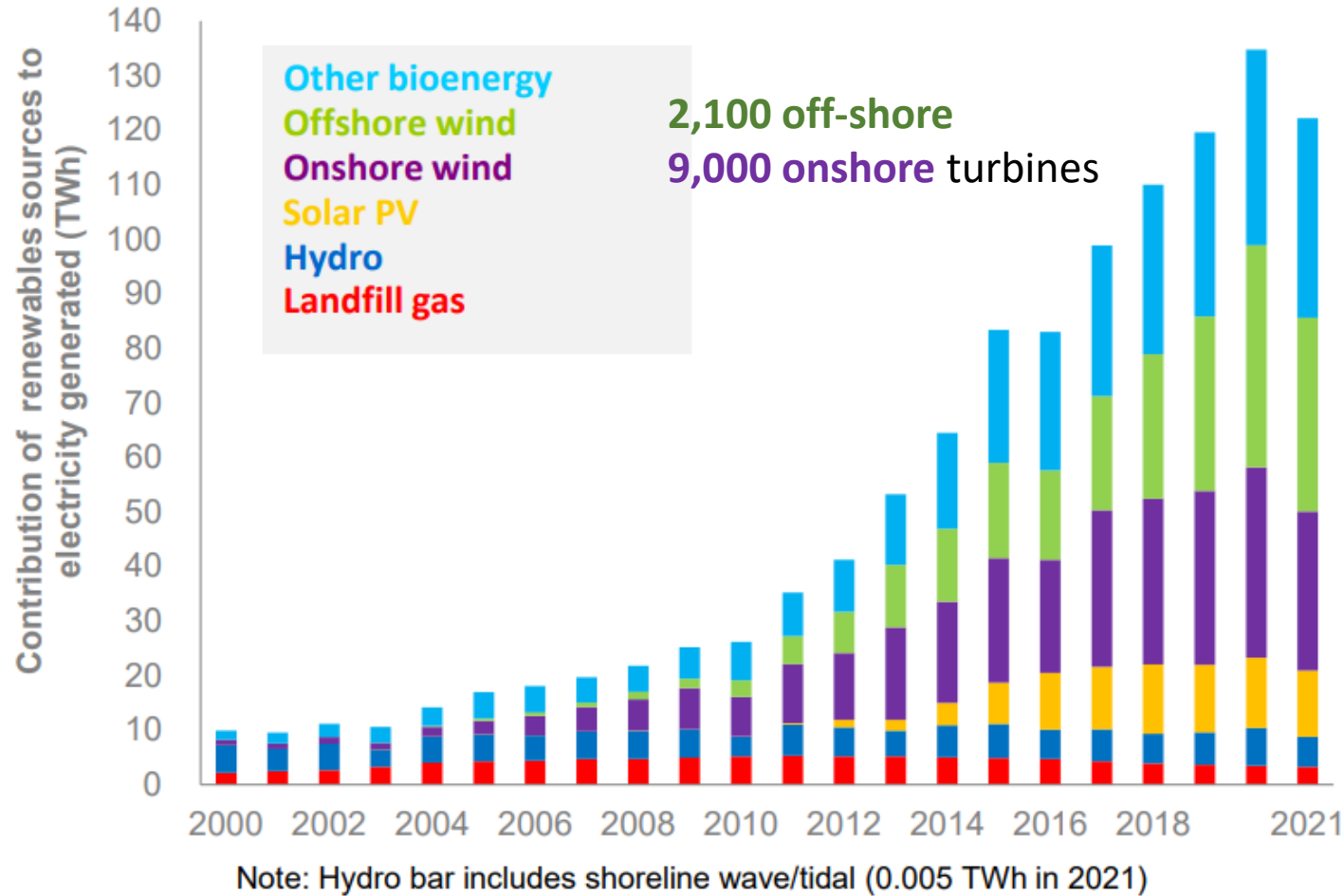
*"the carbon captured by the world's ocean and coastal ecosystems."*



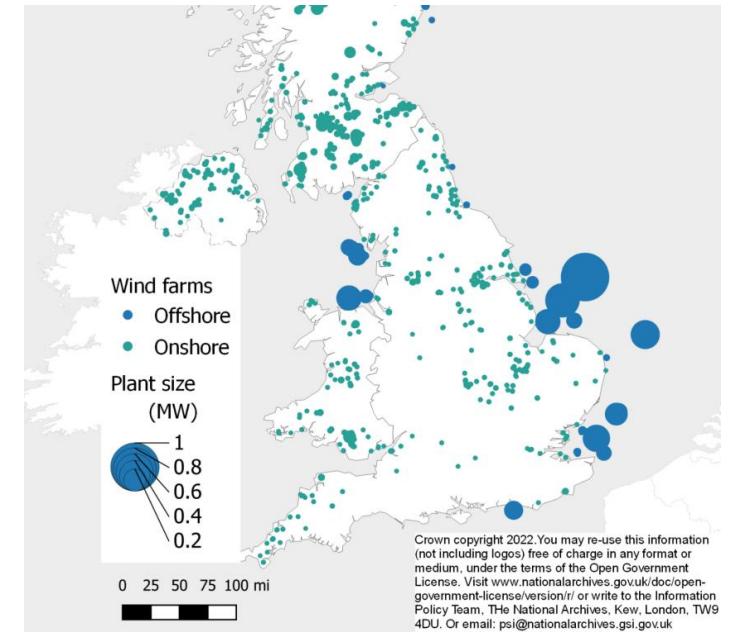
Parker R, Benson L, Graves C, Kröger S, Vieira R. Carbon stocks and accumulation analysis for Secretary of State (SoS) region, Cefas Report for Defra project ME5439, 42 pp. 2020.

# Off-shore wind – a renewables success story!

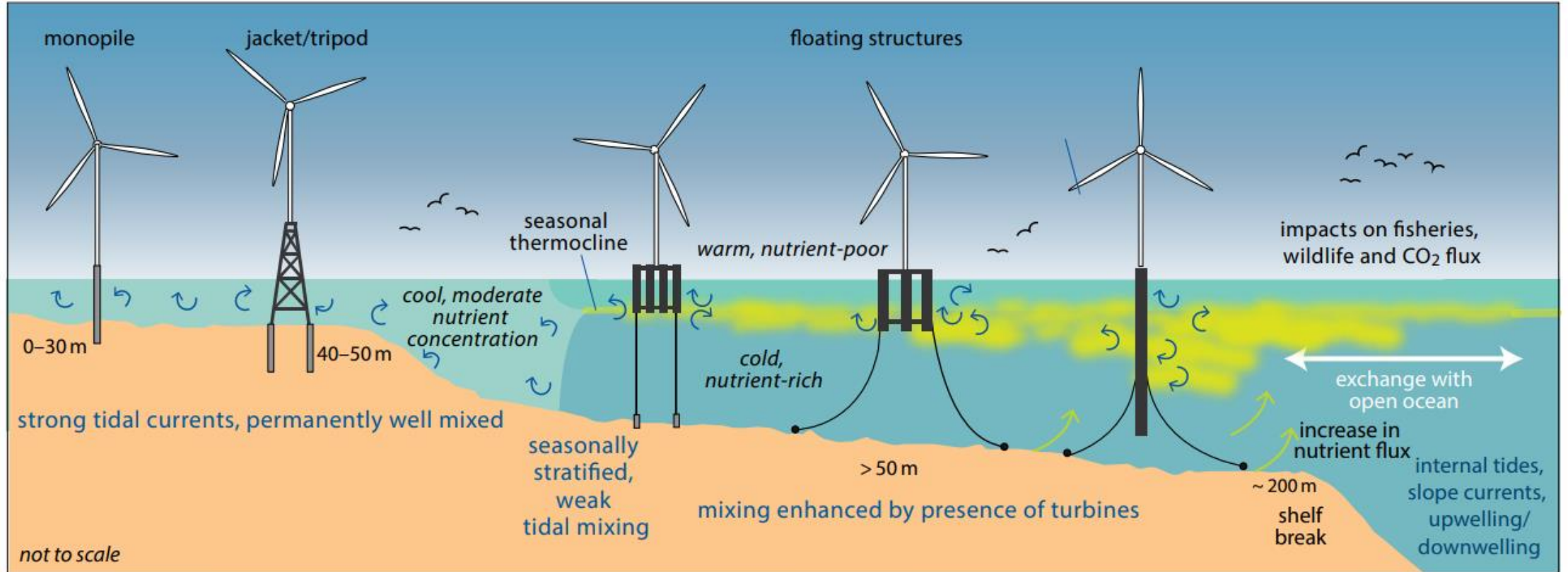
## Electricity generation from renewable sources since 2000



- Capture of wind energy has dominated the growth in renewable electricity generation.
- **Offshore wind** has grown from ~ 0 TWh in 2005 to 35.5 TWh (29% of total) by 2021.
- But we are running out of space!



# The direction of travel is further off-shore

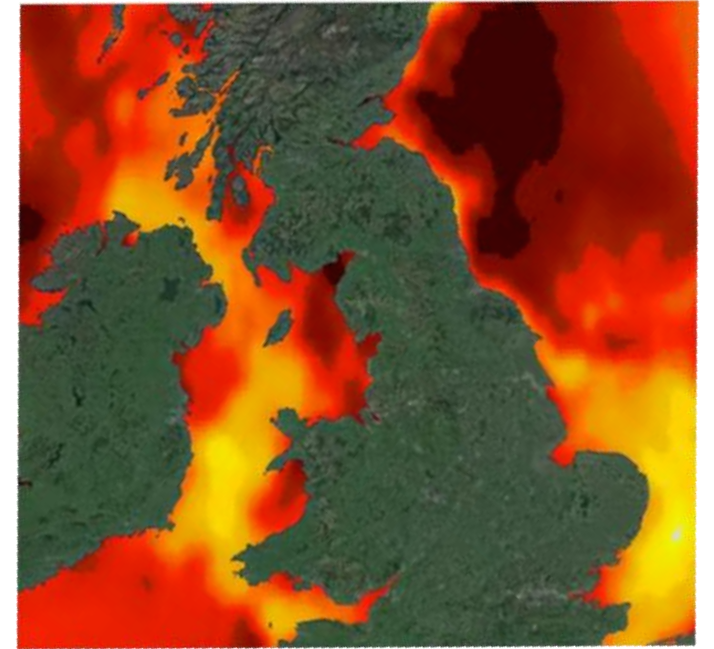
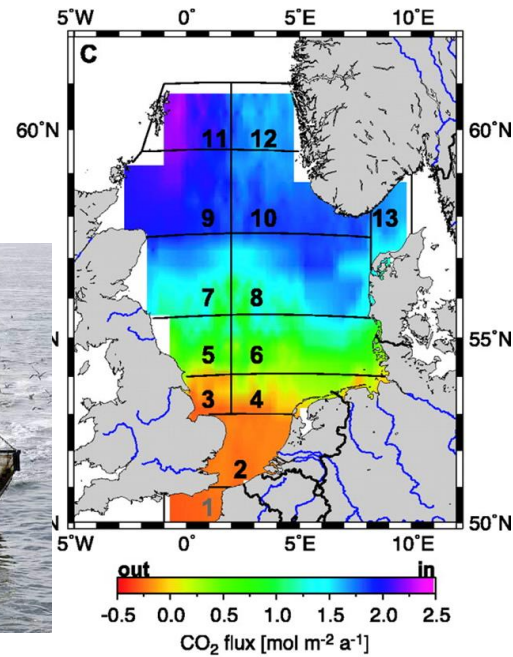


2010s

2025+

2050

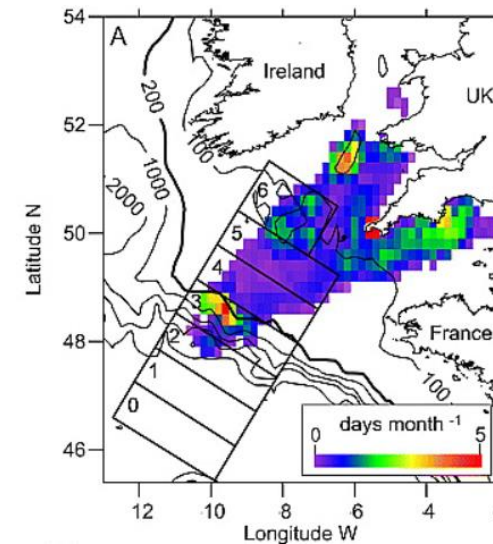
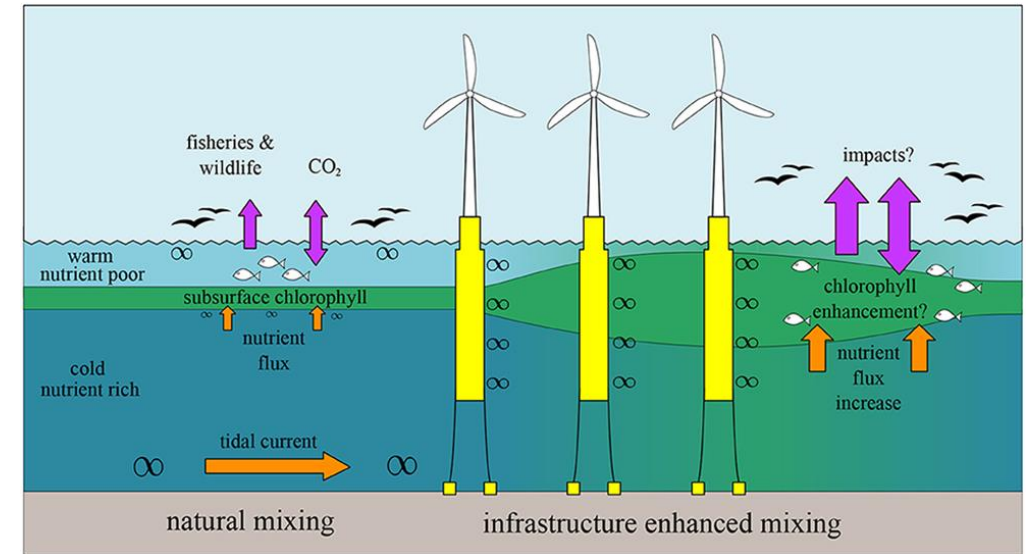
# Seasonally stratified shelf seas: competing factors



- Are rich in wildlife and an important fishery
- Are a major global carbon sink
- Are vulnerable to climate change (heat waves and deepwater oxygen deprivation).

# Impacts of floating wind farms

- Tidal flow generates mid-water mixing.
- Off-set climate change impacts?
- Delay onset of stratification
- Weaken stratification
- Enhance biological productivity?
- Enhance fish stocks?



Fishing boat visits  
(days/ month)  
across  
the Celtic Sea

Sharples et al (2009)

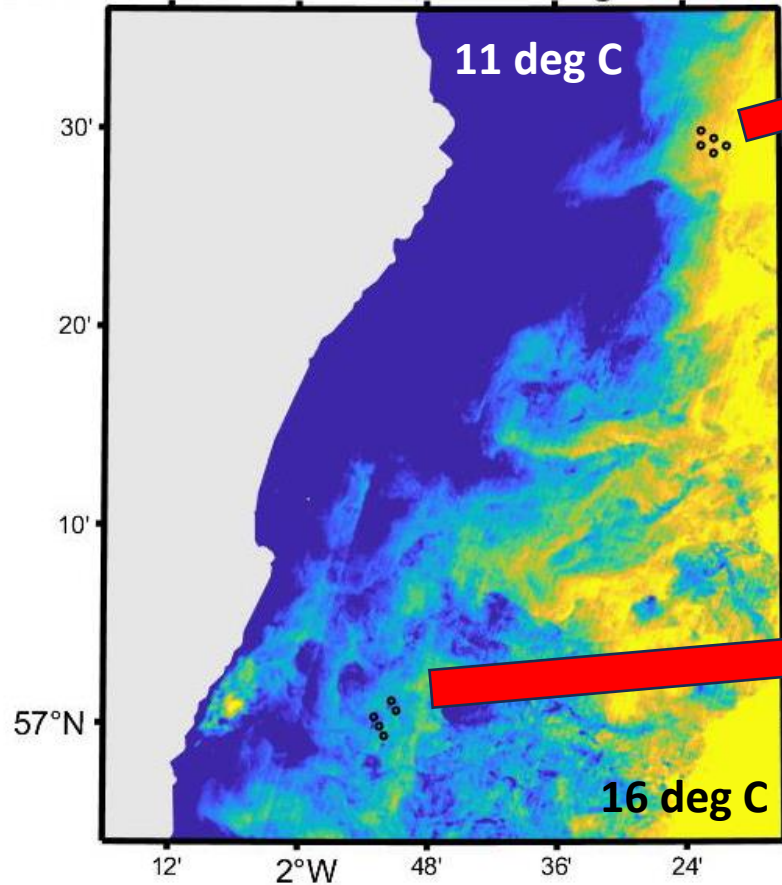


# Remember the Heatwave?

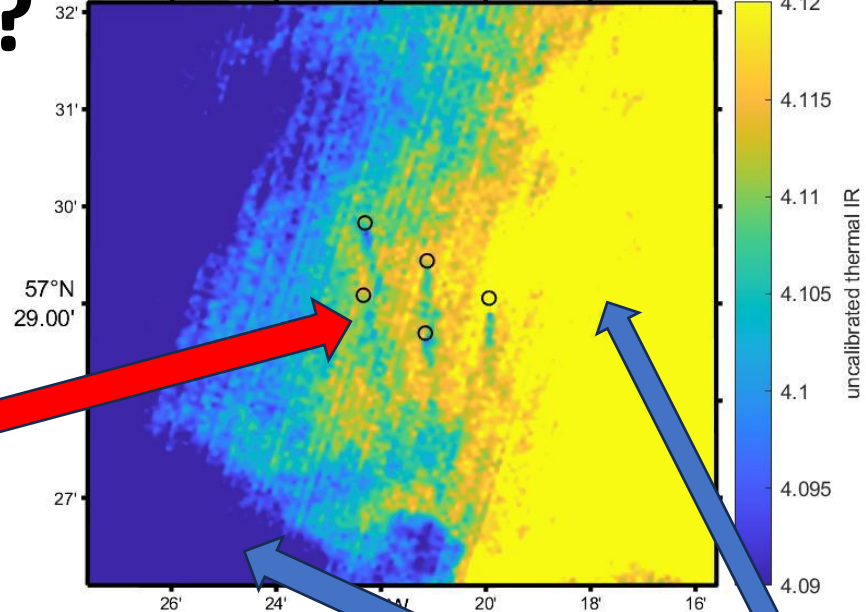
- reveals mixing associated with turbulent wakes



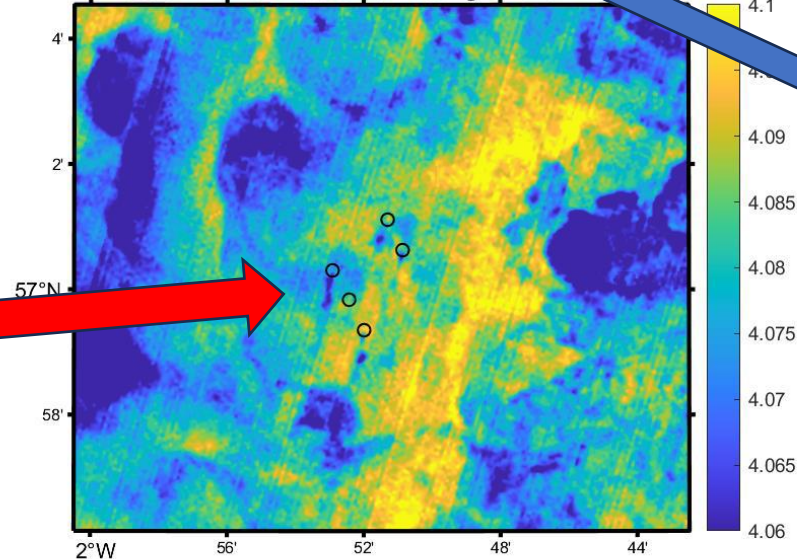
Landsat TIR B10 Aberdeenshire floating windfarms



Landsat TIR B10 Hywind floating windfarm 23/06/16



Landsat TIR B10 Kincardine floating windfarm 23/06/16

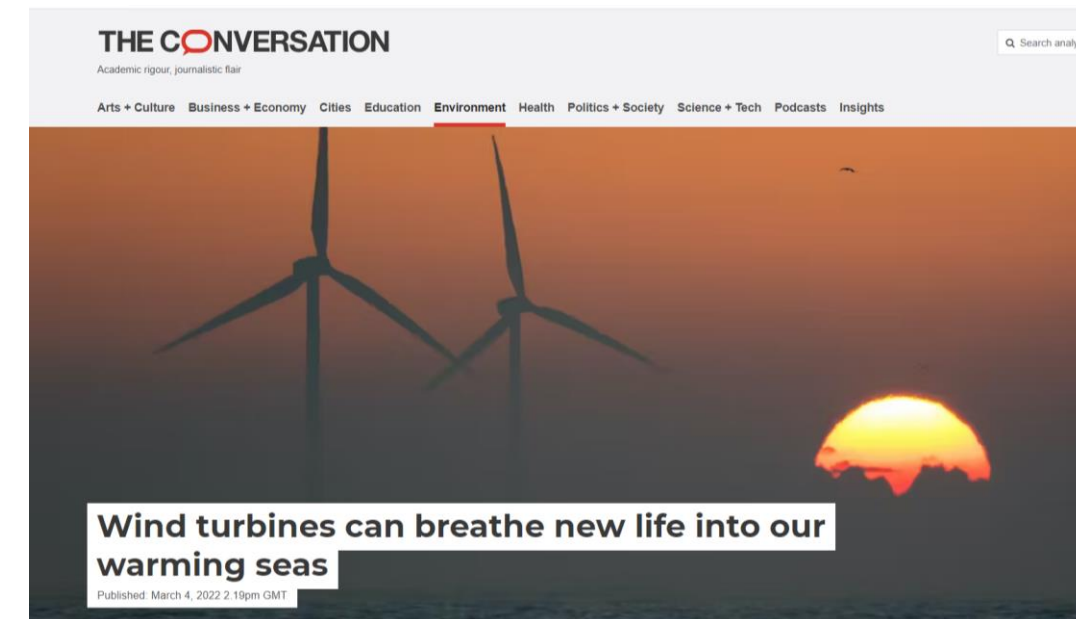
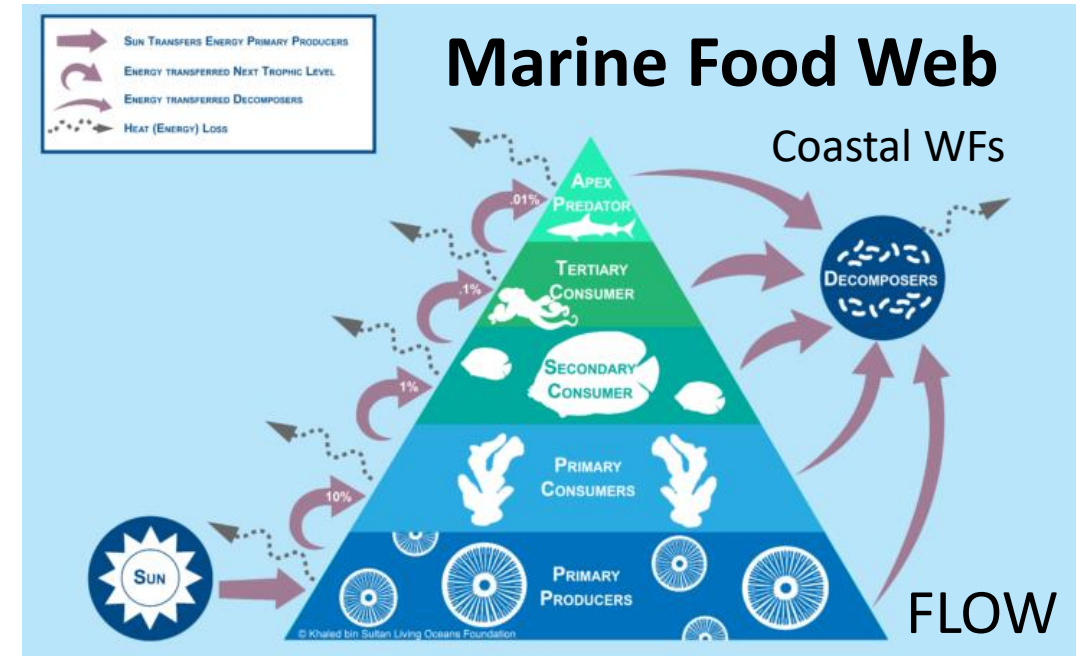


Yellow - High temperature  
Blue - more normal temperature

Ben Lincoln

# Moving Forward

- **Threats:** *Climate Change:* heat waves, deep water oxygen deprivation, reduced biological productivity.
- **Opportunities:** tidally generated turbulent wakes behind FLOW mitigate against climate change impacts.
- **Challenges:** design and planning key to maximizing opportunities. BUT there are significant knowledge gaps to achieve this.



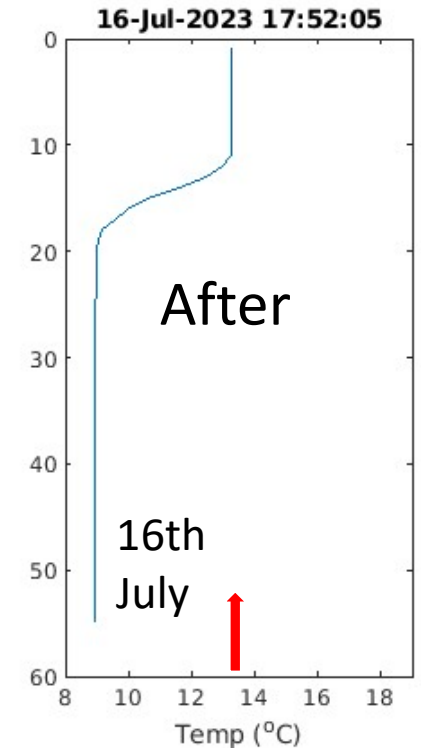
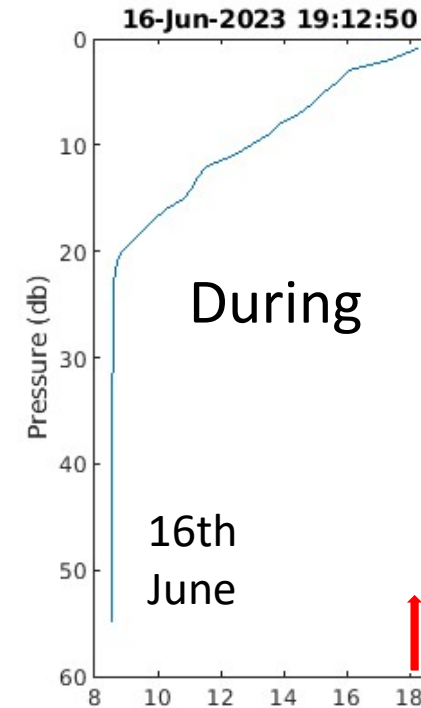
Extra slides for questions

# June 2023 Marine Heat Wave

Charlotte  
Williams  
(NOC)



- 16th June 2023 SST > 18°C.
- 16th July 2023 SST < 14°C.
- Note change in surface mixed layer stratification.
- Removed by a storm?
- Heatwave caused by calm weather and resultant very thin surface layer? **Vertical mixing is key.**
- *Not advection of warm water from the North Atlantic as claimed by some!*



# Floating Wind Farms

- Celtic Sea quoted potential 50 GW of resilient renewable energy (5-10 times current UK offshore wind generation).
- UK Government target of 50 GW by 2030 to help achieve NetZero.
- EU target 150 GW by 2050.
- **But this involves moving into deep, seasonally stratified seas.**
- And a move to floating bases.
- What impact on the seasonally stratified shelf seas?

