Conference on Brazilian-Norwegian Energy Research
28 October 2020

The Ocean as a Solution for Climate Change: 5 Opportunities for Action

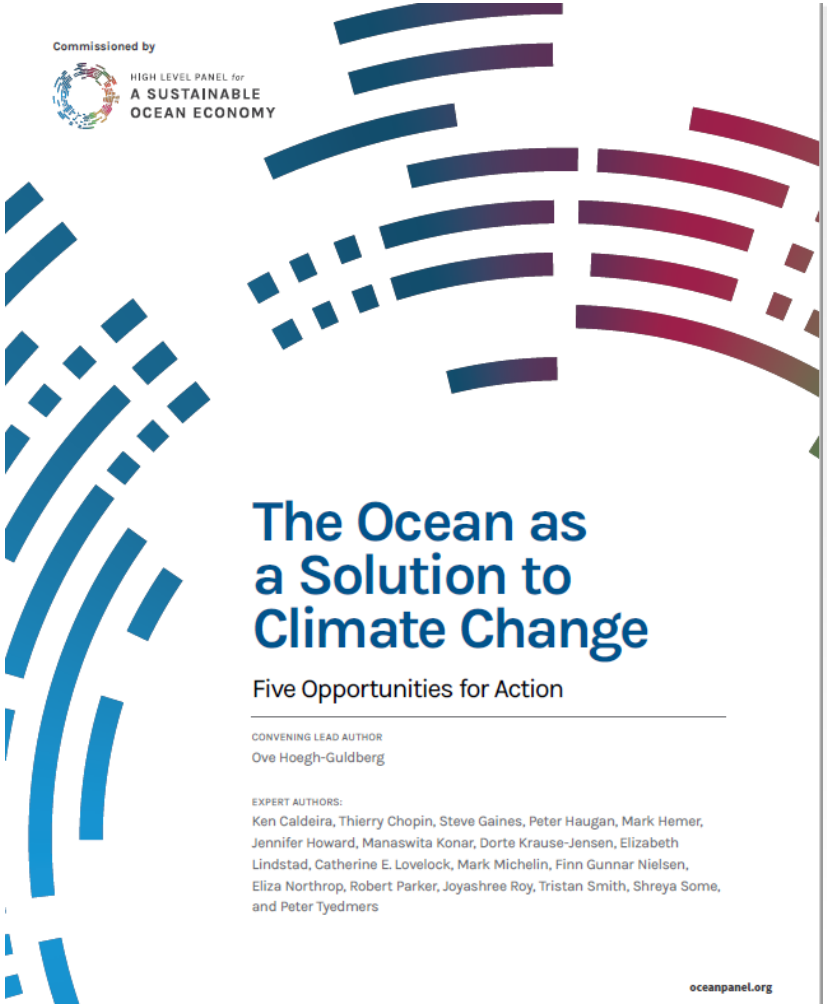
The High Level Panel for a Sustainable Ocean Economy.

Finn Gunnar Nielsen
professor
Geophysical Institute
Bergen Offshore Wind Centre
https://www.uib.no/en/bow

UNIVERSITETET I BERGEN

High Level Panel for a Sustainable Ocean Economy (HLP)

- Established September 2018
- Consists of the presidents or prime ministers of Australia, Canada, Chile, Fiji, Ghana, Indonesia, Jamaica, Japan, Kenya, Mexico, Namibia, Norway, Palau and Portugal.
- Supported by an Expert Group, Advisory Network and Secretariat that assist with analytical work, communications and stakeholder engagement.
- Secretariat at World Resources Institute.
- http://www.oceanpanel.org/climate



The Ocean:

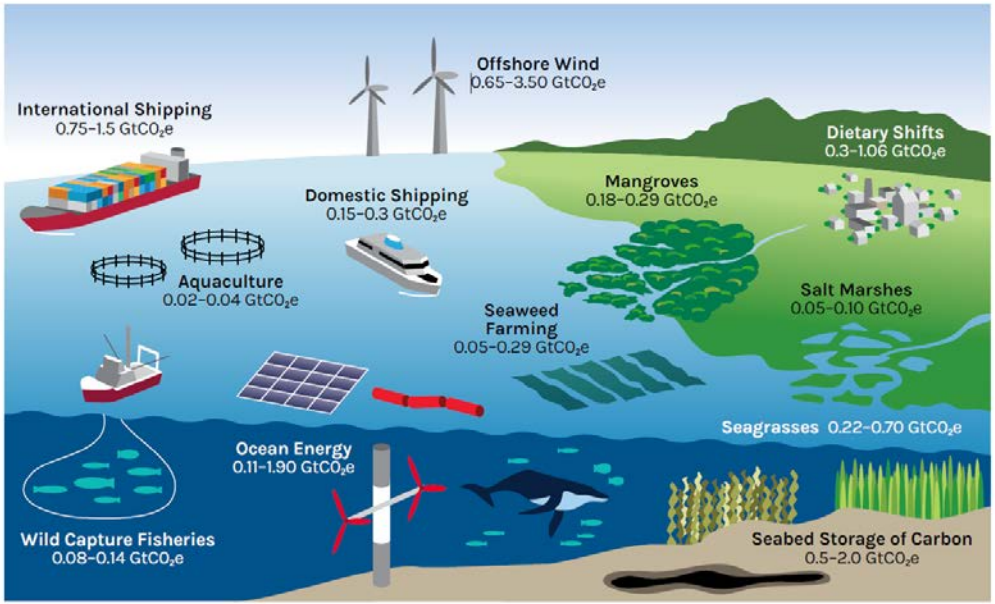
From Victim to Solution

Actions considered

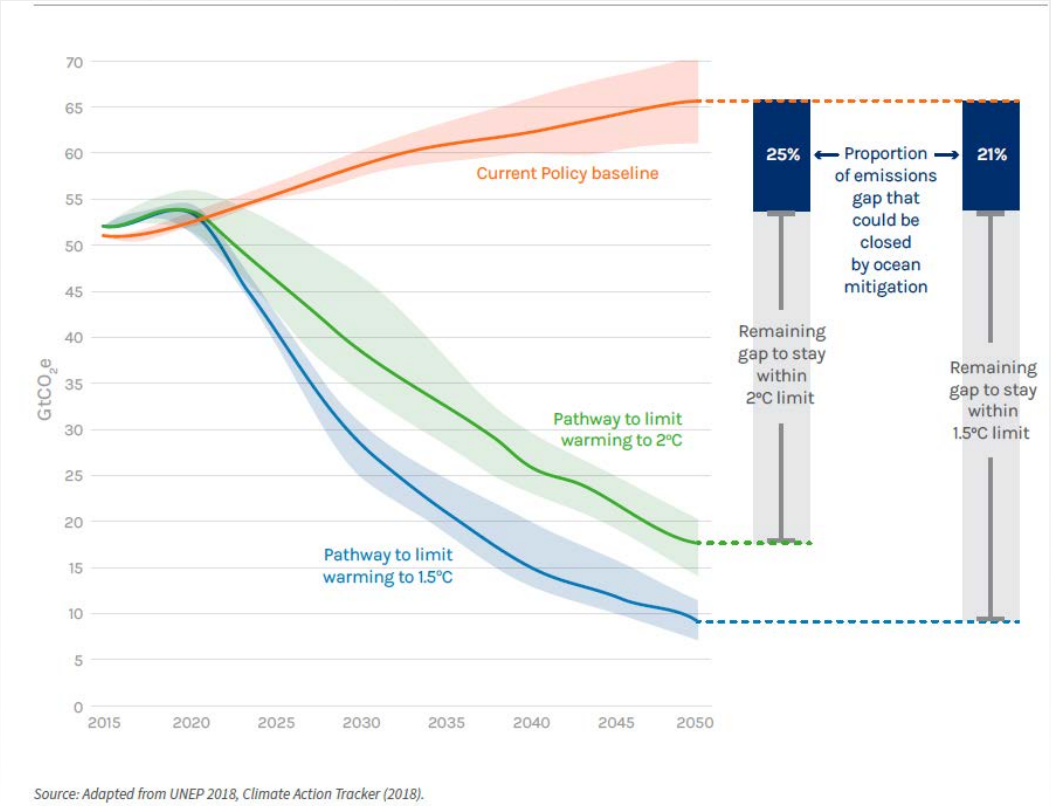
CO_2 mitigation potential from:

1. Ocean-based renewable energy
2. Ocean-based transport
3. Coastal and marine ecosystems
4. Fishery, aquaculture and dietary shifts
5. Carbon storage in the seabed

Figure ES-1. Ocean-based Mitigation Options Explored in This Report and Associated Annual Mitigation Potential in 2050



The mitigation gap



Source: Adapted from UNEP 2018, Climate Action Tracker (2018).

Life-cycle emissions

Table 4. Estimated Life-Cycle Emissions of Energy Generation Technologies

ENERGY TECHNOLOGY	LIFECYCLE CARBON EMISSIONS KG CO_2E/KWH	LIFECYCLE CARBON EMISSION RELATIVE TO CURRENT MIX (%)
Coal	1.0 (0.67-1.7)	217
Natural Gas	0.476 (0.31-0.99)	103
Current mix	0.46	–
Solar PV	0.054 (0.019-0.2)	12
Concentrated Solar Power	0.025 (0.007-0.24)	5.4
Nuclear	0.016 (0.008-0.22)	3.5
Onshore wind	0.012 (0.002-0.088)	2.6
Offshore wind	0.012 (0.005-0.024)	2.6
Ocean	0.008 (0.002-0.022)	1.7

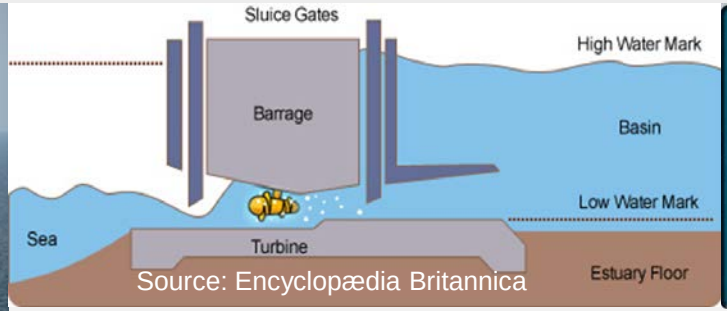
Source: OpenEI, 2019

Note: Bracketed values represent the range of reported emissions.

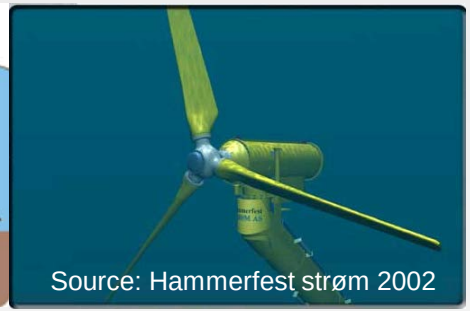
Ocean based renewable energy.

= Offshore wind (OSW) + Ocean Renewables (ORE)

Source: Equinor



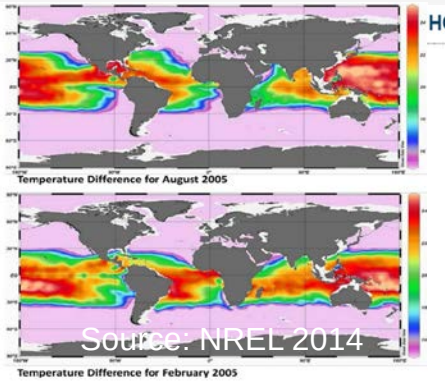
Source: Encyclopædia Britannica



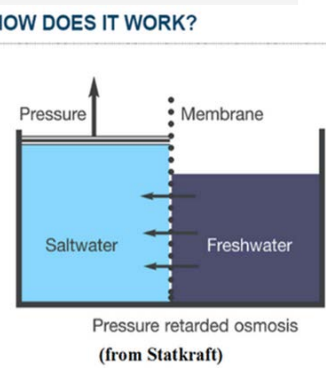
Source: Hammerfest strøm 2002

Photo: FGN

Source: Statkraft, 2020



Source: NREL 2014



Basis:

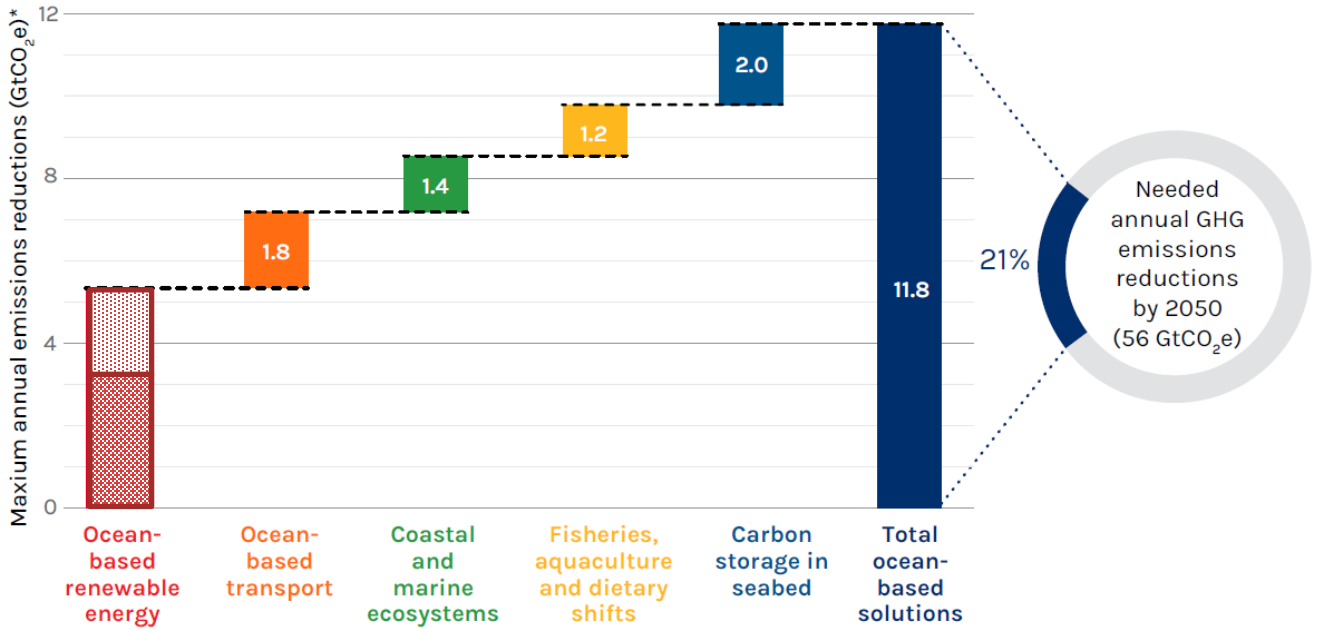
- Electricity and heat generation: 25% of GHG emissions
- Electricity demand increases significantly.
  - Gross el demand in 2050 estimated to 47 000 TWh/y.
- Mitigation potential:
  - 1.0 kg CO_{2e}/kWh by replacing
  - 0.46 kg CO_{2e}/kWh global average electricity generation.

The CO_2 mitigation potential

ORE (1.9)

Wind (3.5)

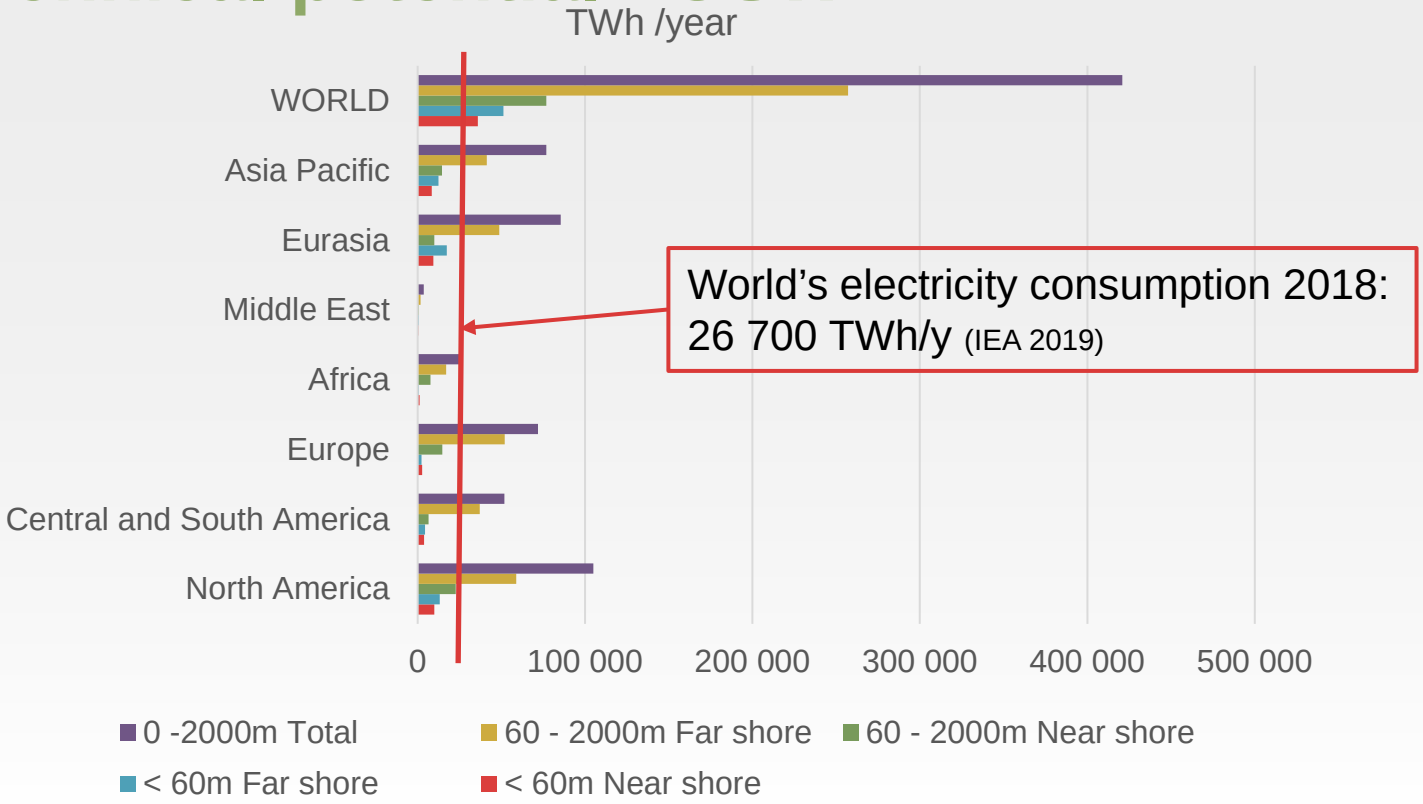
Figure ES-4. Contribution of Five Ocean-based Climate Action Areas to Mitigating Climate Change in 2050 (Maximum $GtCO_2e$)



*Notes: * To stay under a 1.5°C change relative to pre-industrial levels*

Hoegh-Guldberg. O., et al. 2019. ‘‘The Ocean as a Solution to Climate Change: Five Opportunities for Action.’’ Report. Washington, DC: World Resources Institute. Available online at http://www.oceanpanel.org/climate

Technical potential - OSW



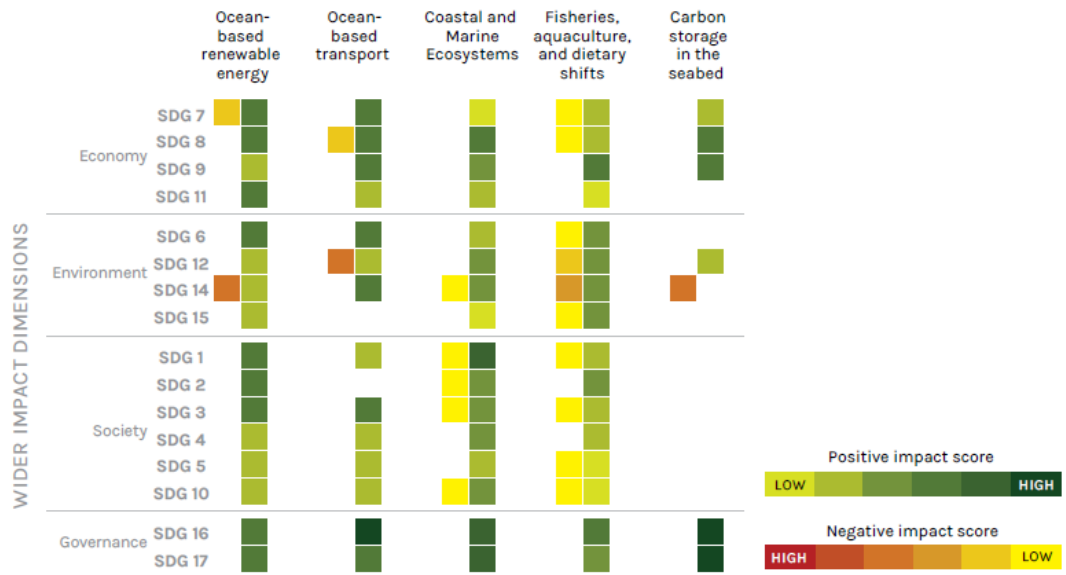
Energy resource estimates

Figure 5. Geophysical, Technical, Economic and Social/Political Potential of Wind or other Energy Resources across the Global Ocean

Source: Adapted from Hoegh-Guldberg et al. 2019.

Impact on SDGs

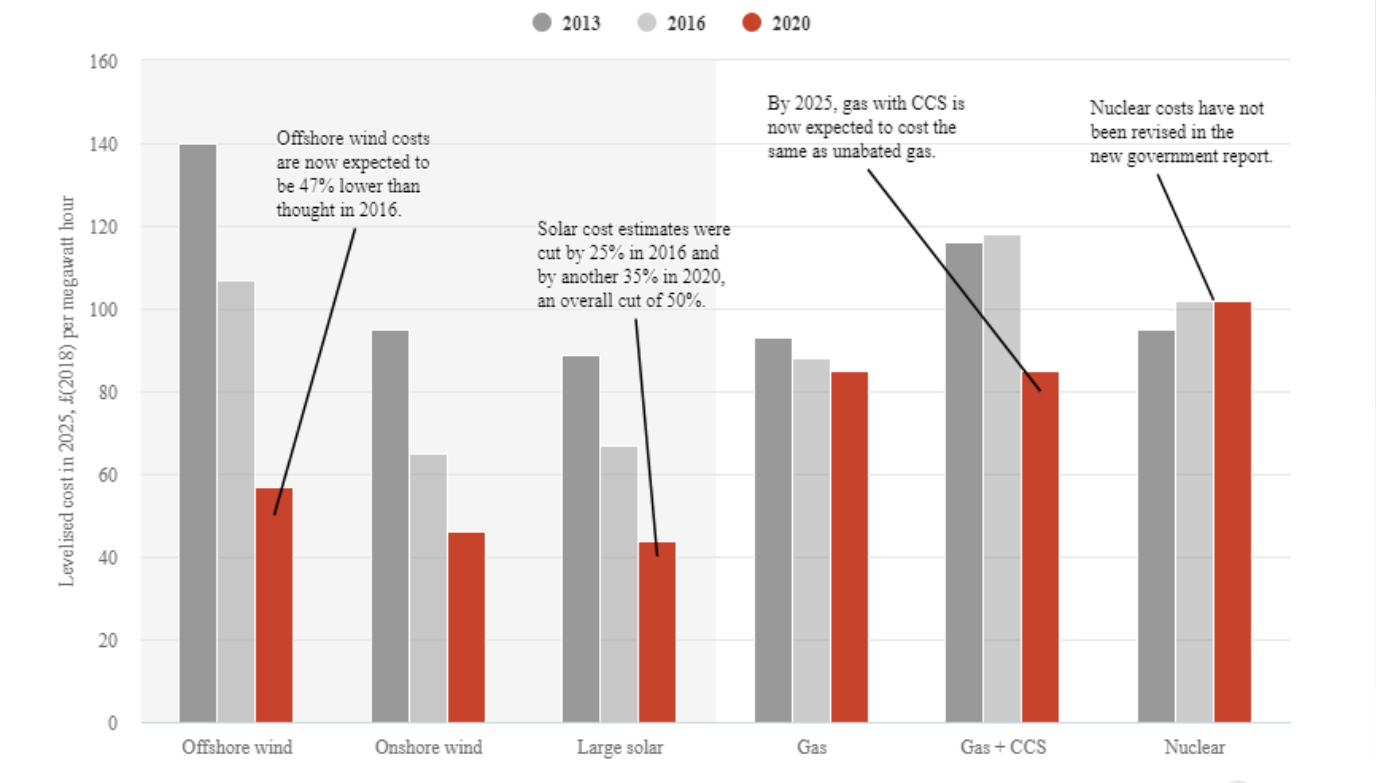
Figure ES-5. Summary of Wider Impact of Ocean-based interventions on Sustainable Development Dimensions



List of Sustainable Development Goals reviewed:

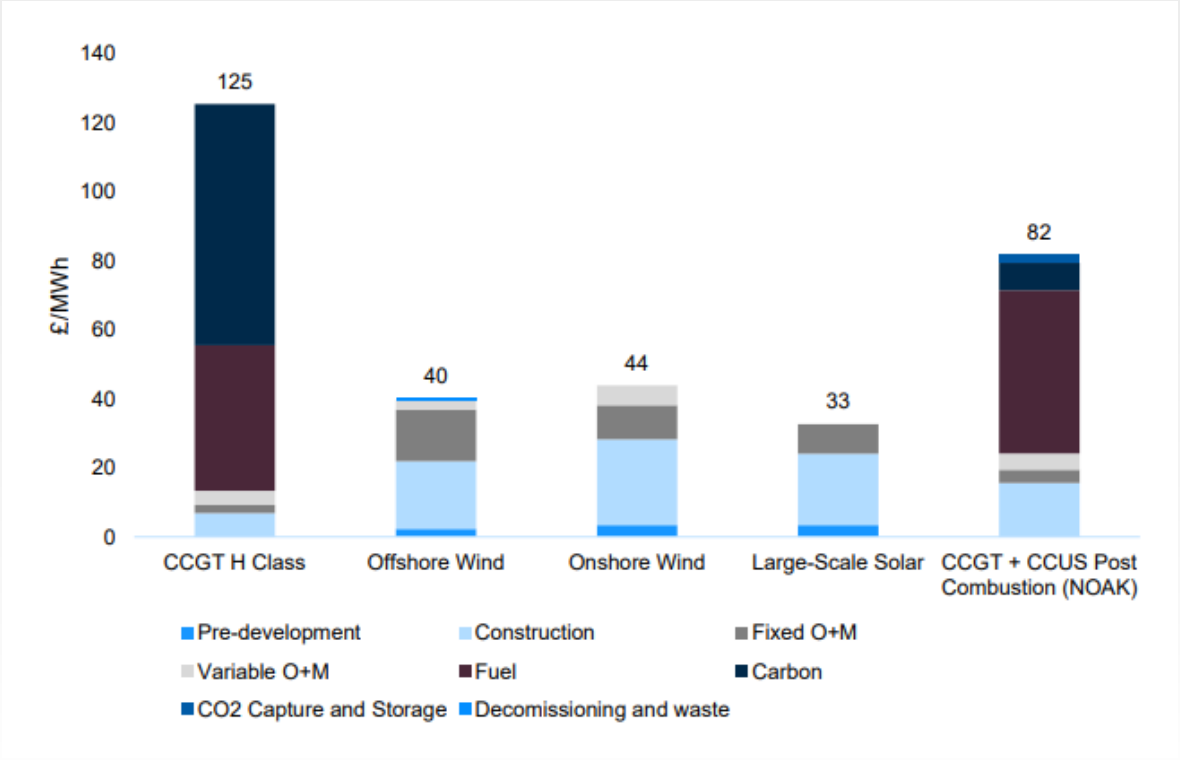
Source: Authors

UK gov. cost estimates for 2025



Source: CarbonBrief 27.08.2020.
Numbers from UK dept of Business, Energy and Industrial Strategy, Aug 2020

UK gov. cost estimates for 2040



Source: UK dept of Business, Energy and Industrial Strategy, Aug 2020

Policy needs

PRESENT DEPLOYMENT RATE TOO SLOW. NEEEDS:

- Incentives (e.g. carbon taxes)
- Marine spatial planning and legislation incl. grid
- National targets and strategies
- Stable economic and regulatory framework

Research and technology needs

- Understand ecological impacts
- Map global potential
- Explore benefits of co-location
- Explore potential for ocean base solar PV
- Advance storage capacity
- Improve performance and reliability while reducing costs
- Develop deep water technologies
- Piloting

Summary

- Significant GHG mitigation potential from Ocean renewables.

- **OSW:** Mature, significant up-scaling expected.
- **Tidal stream and range:** Technology available, geographical limited.
- **Waves:** Large potential, Several systems tested.
- **Floating solar:** From water reservoirs to ocean area.
- **Ocean thermal:** Tropical area.
- **Salinity gradient:** Laboratory scale.
- ACTIVE POLICIES NEEDED

UNIVERSITY OF BERGEN

Bergen Offshore Wind Centre

Wide range of estimates

Table 3. Summary of Energy Scenarios Reviewed for Ocean-based Renewable Energy

SCENARIO	OSW GENERATION (TWH/YR)	ORE GENERATION (TWH/YR)
2018 (30) (Bahar, 2019)	53	1.2
2050 Reference (50). Same fraction as current, for assumed 2050 electricity demand of 50,000 TWh	112	2.5
2050 Drawdown Reference (50) (Project Drawdown, 2017)	57.2	2.1
2050 IEA WEO 2009 (45) (IEA, 2009)	555	25
2050 Teske (Reference (45) (Teske et al. 2011)	805	25
2050 IEA RTS (40) (IEA, 2017)	651	108
2050 ETP BLUE MAP (14) (IEA, 2010)	1568	133
2050 IEA 2DS (13) (IEA, 2017)	1436	536
2050 Teske E[R] (10) (Teske et al. 2011)	2711	678
2050 IEA B2DS (4.7) (IEA, 2017)	1531	637
2050 Teske Adv E[R] (3.7) (Teske et al. 2011)	3469	1943
2050 DRAWDOWN Plausible (Project Drawdown, 2017)	2078	1486
2050 DRAWDOWN (Project Drawdown, 2017)	3029	1745
2050 DRAWDOWN Optimum (Project Drawdown, 2017)	3159	1823
2050 OES Vision (OES, 2017)	–	1051
2050 IRENA (IRENA, 2018a)	1822	

Source: Authors

Note: OSW = Offshore wind; ORE = Ocean-based renewable energy.