EVOLVE

Place, Time and Value study for Blue Energy across Europe

System benefits of ocean energy

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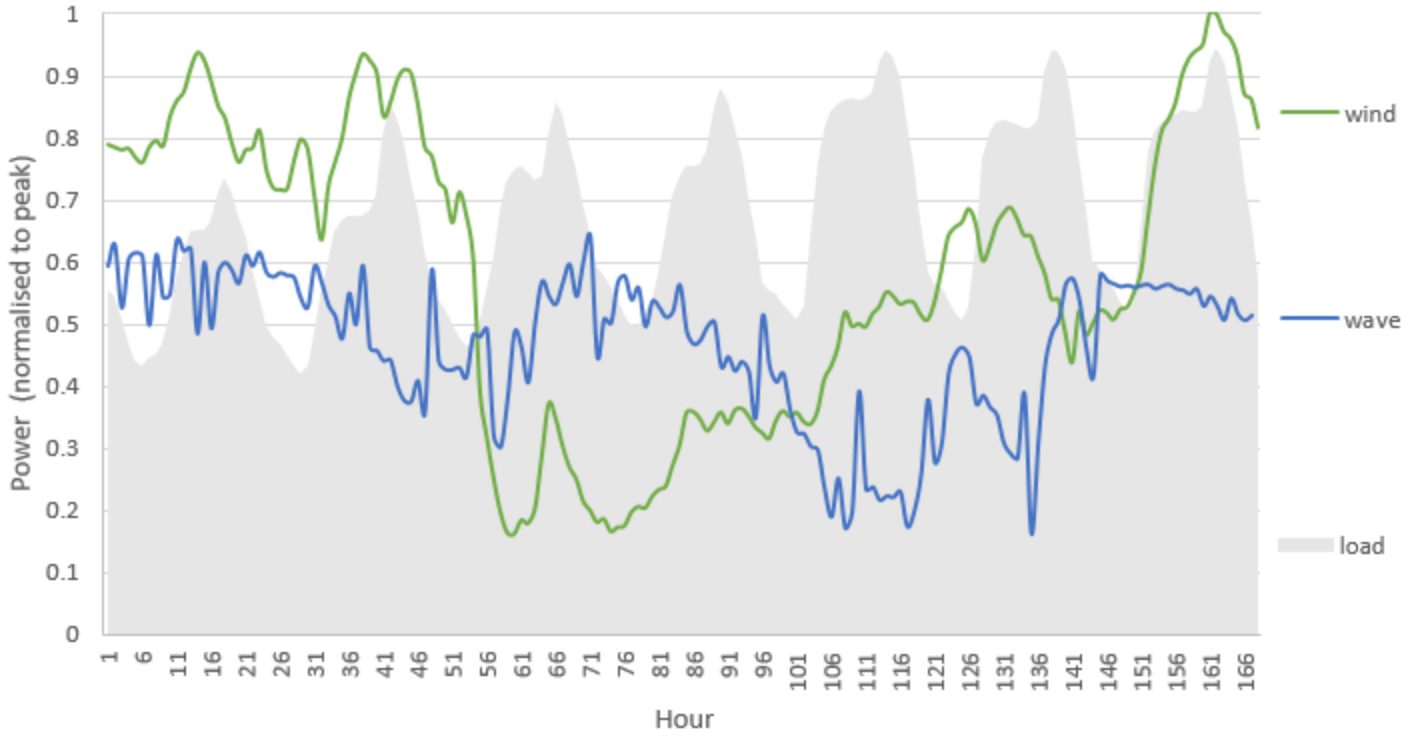
System benefits of ocean energy

Hypothesis: ocean energy can provide additional benefits to low carbon energy systems due to offsetting of resource with established renewable generation – such as wind and solar PV

GB load and generation comparison - first week of January 2015



The EVOLVE Project

Key question: Can blue energy make an effective contribution to European energy systems and markets, with particular reference to where, what, when, how and at what price?

Spatial modelling:

- 250m RADMAPP model of north-west Europe
  - Resource, demand, grid
  - Technical feasibility, cost of delivery, access to markets

Power systems modelling:

- Country-scale studies (GB, IE, PT)
  - Hourly economic dispatch of net zero deployment 2030 to 2050
  - Marginal electricity prices, balancing costs, system security indices
- Microgrid studies (GB)
  - 100% renewable systems
  - Supply-demand matching, storage requirements, system cost

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EVOLVE country-scale GB model

- Great Britain model split into nine zones based on selected National Grid boundaries
- Computes hourly optimal dispatch: supply-demand matching
- Key model inputs:
  - Hourly demand profile data
  - Hourly availability of intermittent renewables
  - Fuel prices, carbon costs
- Key model outputs:
  - Hourly generation, prices, carbon emissions

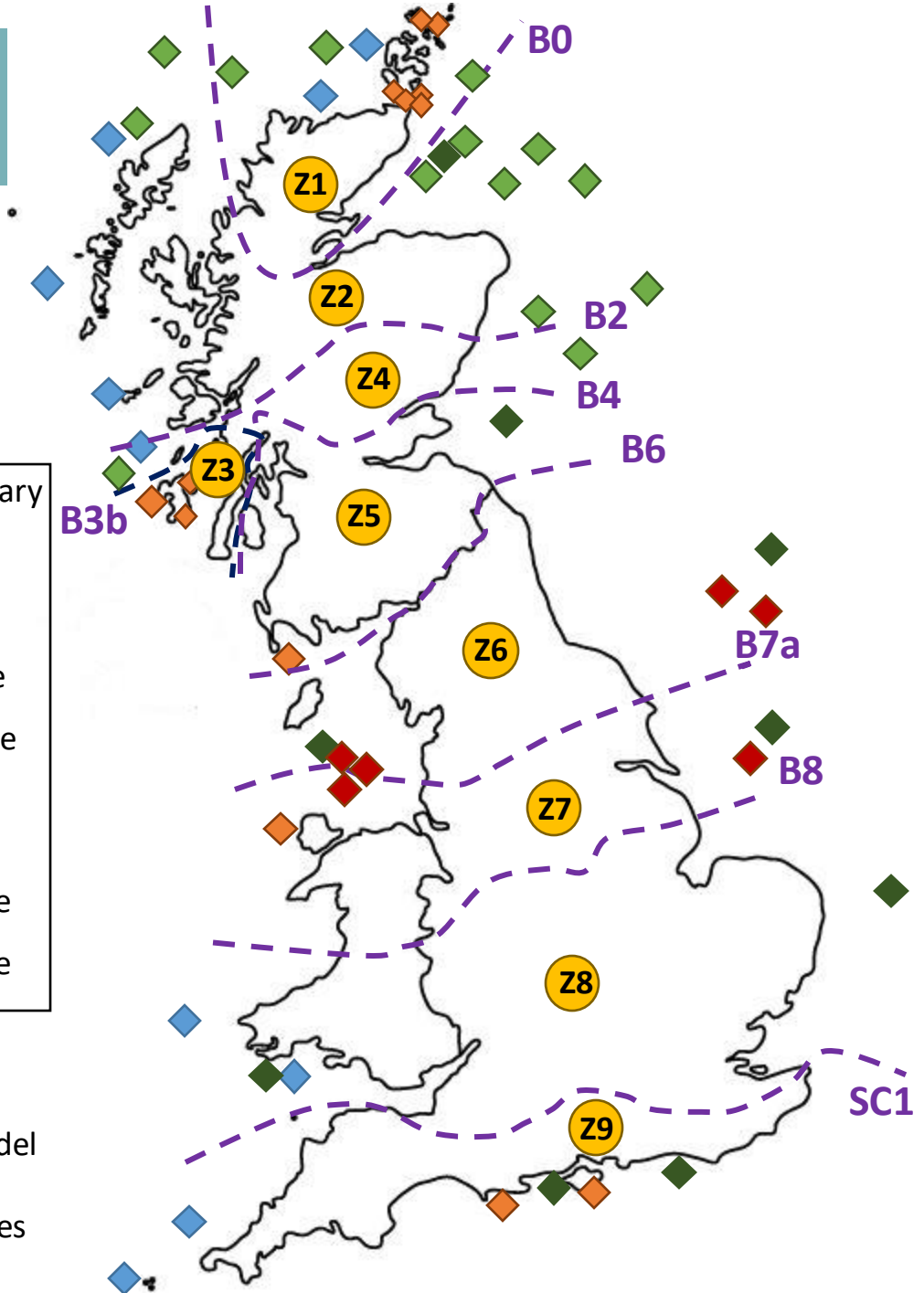


Figure: EVOLVE GB model zones and prospective offshore renewable sites

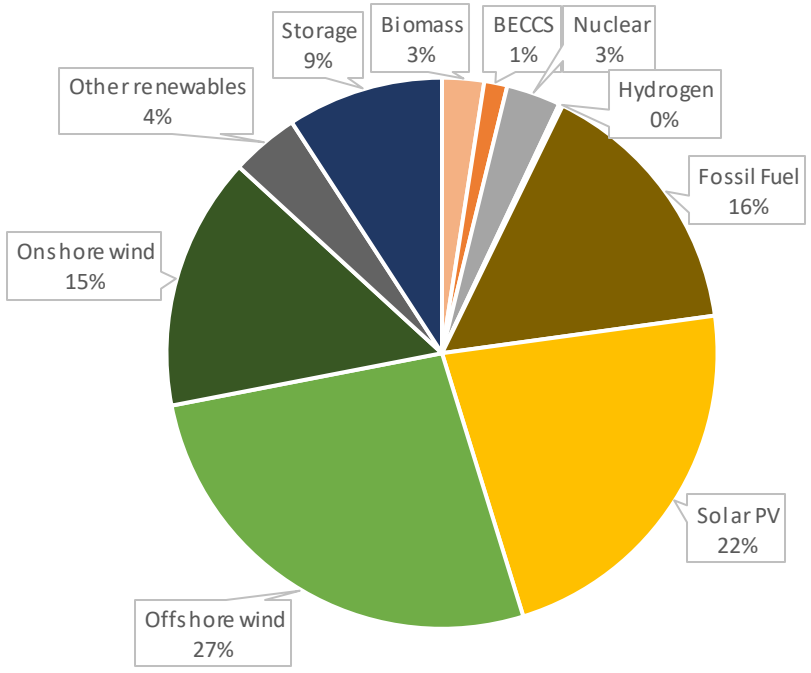
GB 2030 Modelling – Leading the Way Scenario

2030 Scenario selected is National Grid's Leading the Way Scenario:

- High renewable scenario:
  - 4x current offshore wind capacity
  - 2x current onshore wind capacity
  - 3x current solar PV capacity
  - Initial demonstration plants for BECCs and Hydrogen
  - No wave or tidal

Technology	LTW
Biomass	4.36 GW
BECCS	2.40 GW
Nuclear	5.64 GW
Hydrogen	0.39 GW
Fossil Fuel	27.63 GW
Solar PV	39.70 GW
Offshore wind	47.33 GW
Onshore wind	26.33 GW
Other renewables	7.09 GW
Storage	16.26 GW
Wave & Tidal	0 GW

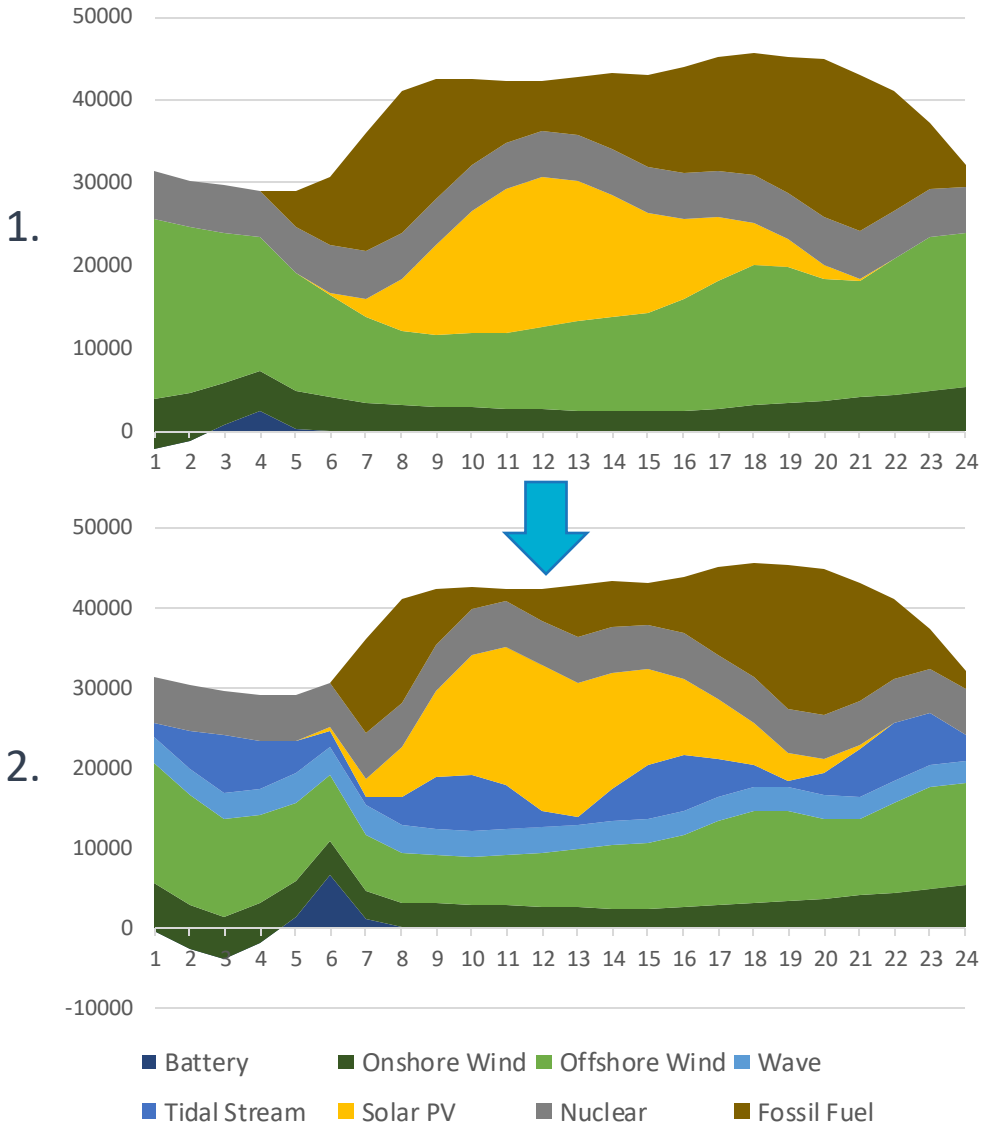
Table: Installed capacities – FES 2030 Leading the Way Scenario



GB 2030 Modelling Results – example summer day

1. GB 2030 scenario 1 (no marine)
2. GB 2030 scenario 2 (15GW marine)

Metric	0GW marine	15GW marine
Average marginal price	£60/MWh	£60/MWh
% renewable generation	61.0%	68.9%
% fossil generation	39.0%	31.1%
Carbon emissions	82.9 ktonnes	56.9 ktonnes



- ✓ 20% reduction in fossil fuel generation
- ✓ 31% reduction in CO_2 emissions from including marine energy

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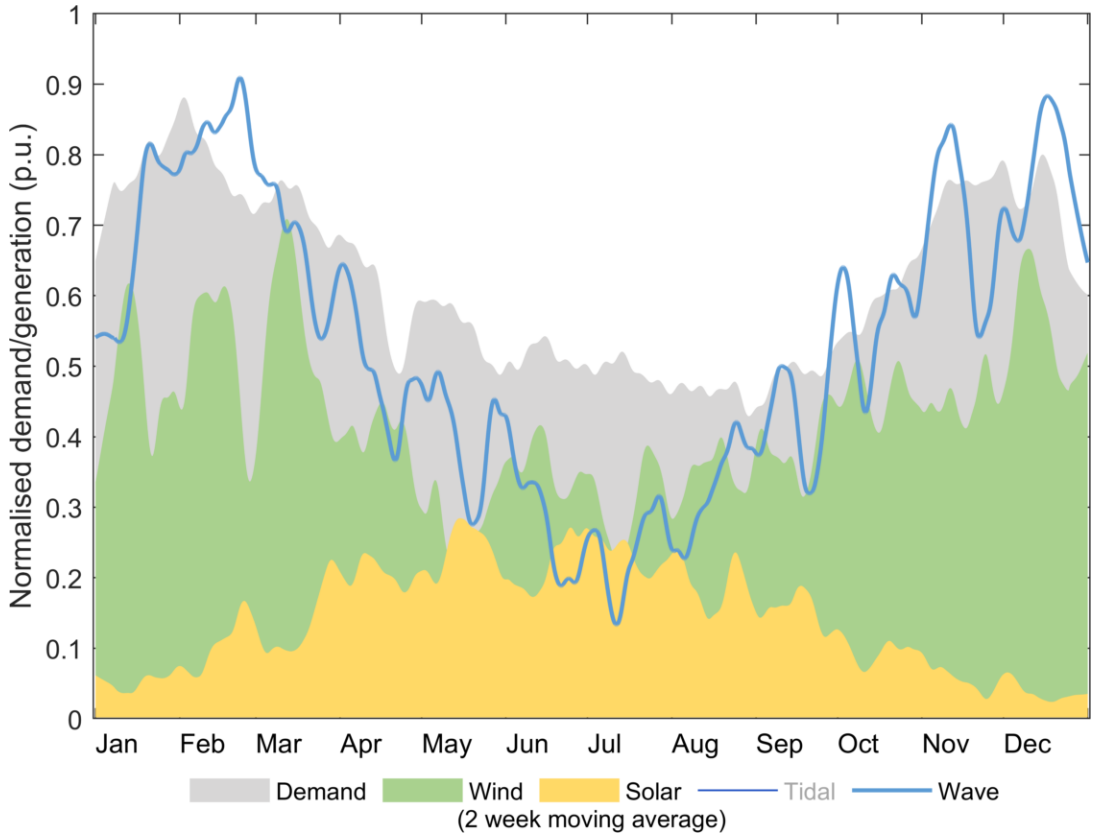
GB 2030 Modelling Results - full year



- Electricity demand is highly seasonal in GB
- Wind generation higher in winter
- Solar generation higher in summer
- Tidal consistently available - in cycles
- Wave generation higher in winter – coinciding with peak demand

GB 2030 Modelling Results - full year

Scenario 1: 0GW marine, **Scenario 2: 1GW marine** (0.5GW Wave + 0.5GW Tidal)

Scenario 2 (1GW marine) performs best over all metrics

- 1% lower dispatch cost for marine scenario - £114M in savings
- 3% lower carbon emissions - 113ktonCO_2 in savings
- 300 GWh less gas generation dispatched
- 73 GWh less storage required

Metric	0GW marine	1GW marine	% change
Average marginal price* (£/MWh)	36.87	36.56	-0.84%
Total cost of dispatch** (£bn)	12.88	12.74	-0.89%
% renewable generation	85.59%	85.71%	+0.14%
% fossil generation	3.26%	3.17%	-2.72%
Carbon emissions (MtonCO_2)	3.97	3.86	-2.85%

*Marginal price capture represents income from wholesale electricity markets
**Total cost of dispatch represents total spend in wholesale electricity markets

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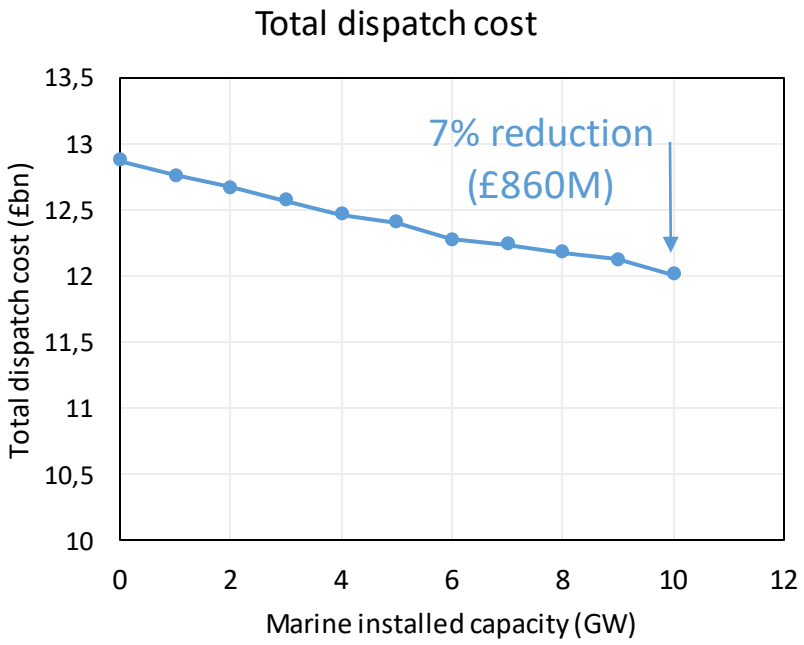
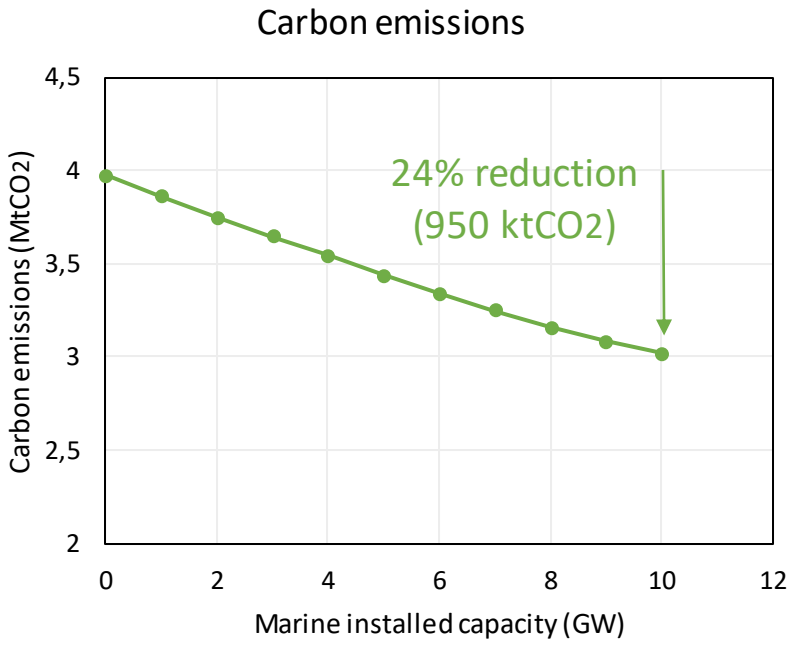
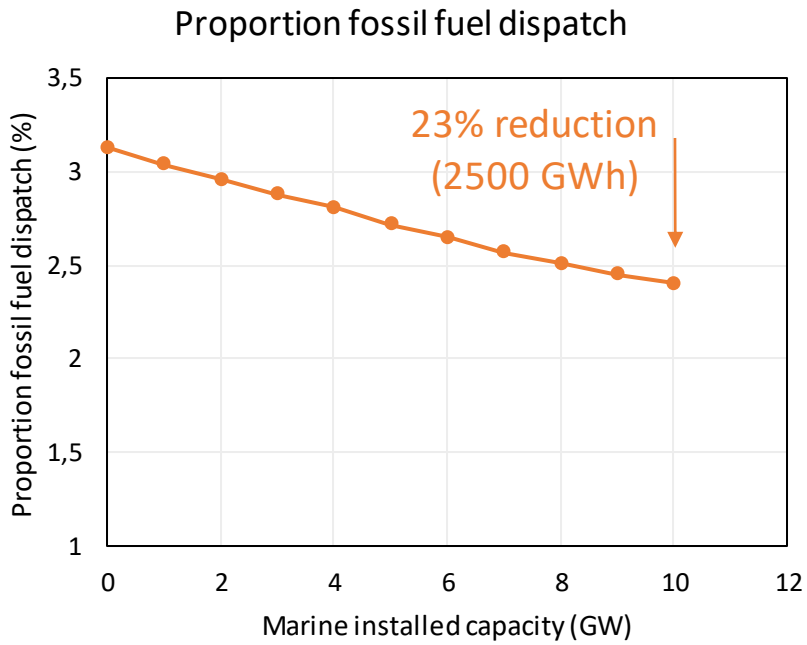
GB 2030 Modelling Results - full year

All metrics continue to improve with increasing marine energy installed capacity:







Marine energy installed capacity increases

GB 2030 Modelling Results – Price Capture

Marginal price capture represents income from wholesale electricity markets

- Wave captures highest prices:
  - Over £10/MWh than wind and solar
  - 64% higher price capture with 1GW marine deployment (500MW wave)
  - Still 47% higher price capture with 10GW marine deployment (5GW wave)

Price capture (£/MWh)	0GW marine	1GW marine	10GW marine
Solar PV	24.28	24.14	21.60
Onshore wind	22.22	21.89	19.72
Offshore wind	25.44	25.19	24.66
Wave	n/a	38.87	34.81
Tidal Stream	n/a	35.32	23.94

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Summary:

- It is postulated that wave and tidal generation can provide additional value to low carbon energy systems due to offsetting with existing intermittent renewables

- The EVOLVE project is producing quantifiable results to show that marine energy:
  - Reduces system dispatch costs
  - Reduces generation required from fossil fuels
  - Reduces system carbon emissions
  - Captures higher market prices

- Future work will include modelling a number of scenarios for British, Irish and Portuguese systems – including net zero (2050) energy mixes

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https://evolveenergy.eu/

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Thanks for your attention!

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