

Wave & Tidal Power

Resource, Grid & Integration



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This presentation is based on work commissioned by the Carbon Trust as part of the Marine Energy Challenge.

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Key Topics

Variability in the UK Wave Resource

Variability in the UK Tidal Resource

Links to Demand, Integration & Grid Issues

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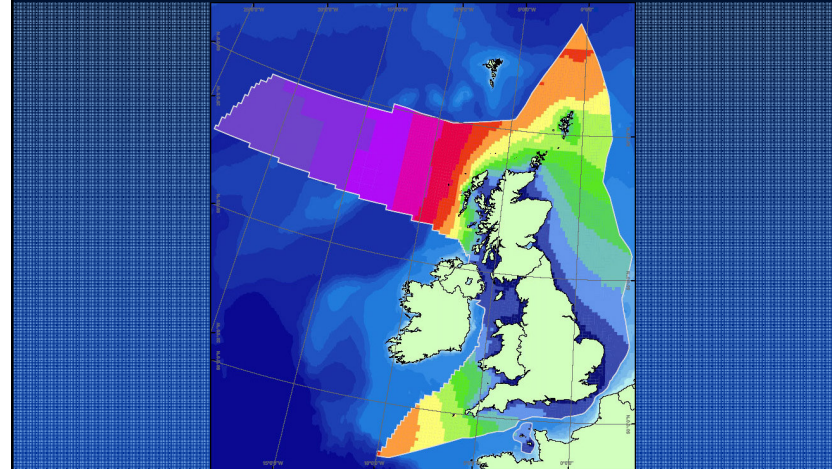
Marine Resource Fundamentals

- Wave Power
 - Large wave power resource
 - Estimated recoverable energy ~15% of UK electricity demand
- Tidal Power
 - Predictable power output
 - Varying estimates of resource size
 - Latest assessment (B&V) is ~6.5% of UK electricity demand

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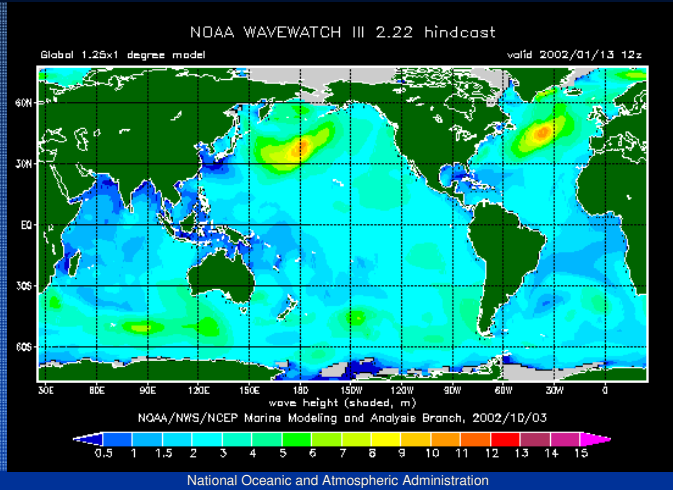
Wave Power



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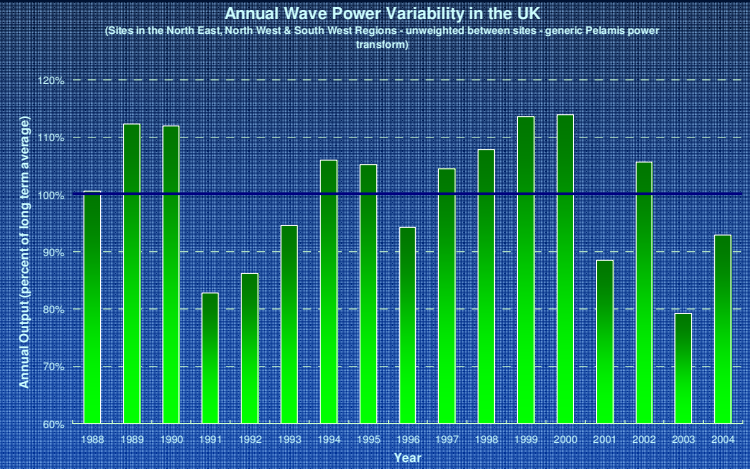
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Wave Power



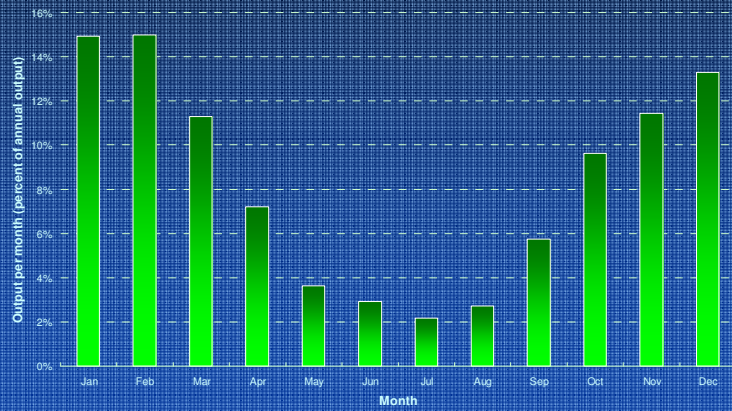
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Monthly Distribution of Wave Power Generation

(Sites from the North East, North West and South West Regions - unweighted between sites - generic Pelamis power transform - 1988 to 2004)



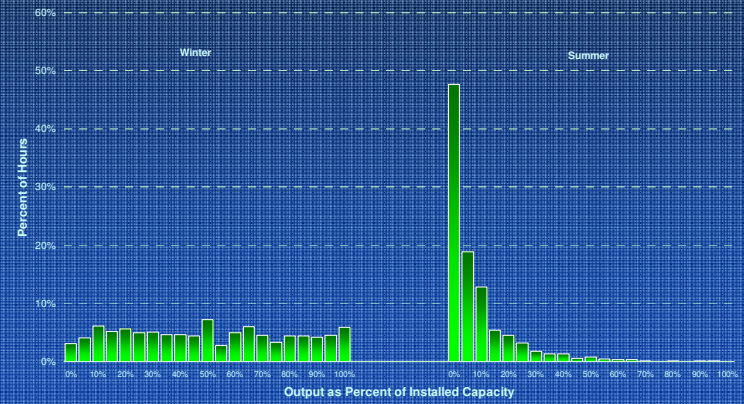
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Wave Power

Distribution of Hourly Output Level - Summer & Winter

(EWM Data - 1988 to 2004 - Orkney & Shetland sites - generic Pelamis device transform)

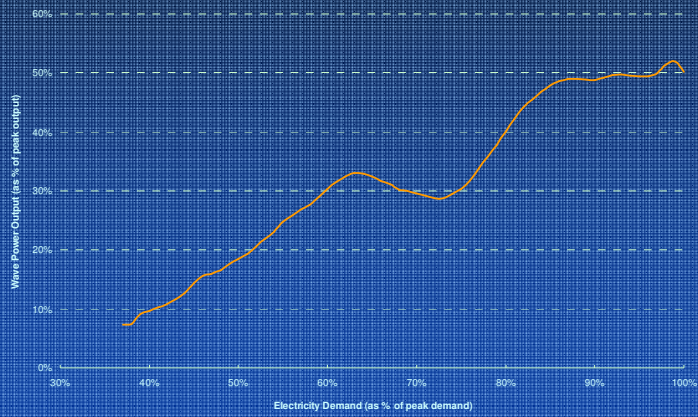


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Capacity FactorXXX

Relationship Between Wave Power Output and Electricity Demand
(Shetland - EWM Data - 1988-2004)



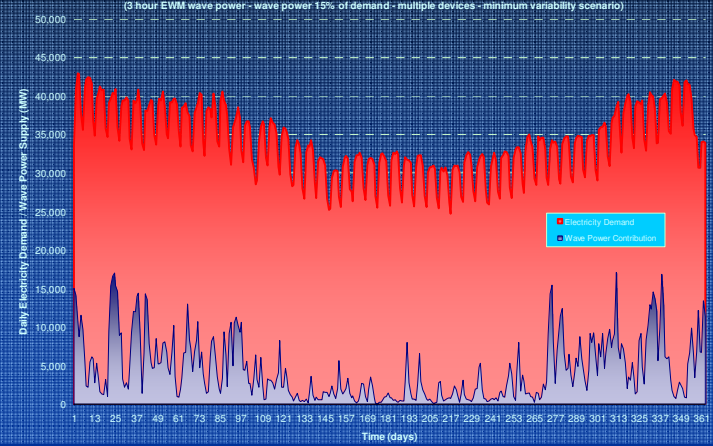
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Contribution of Wave Power to UK Electricity Demand - 2001

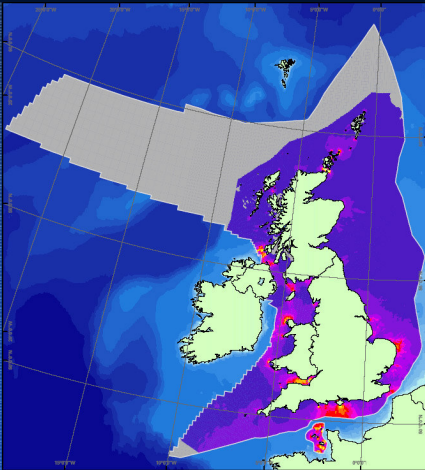
(3 hour EWM wave power - wave power 15% of demand - multiple devices - minimum variability scenario)



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Tidal Current Power

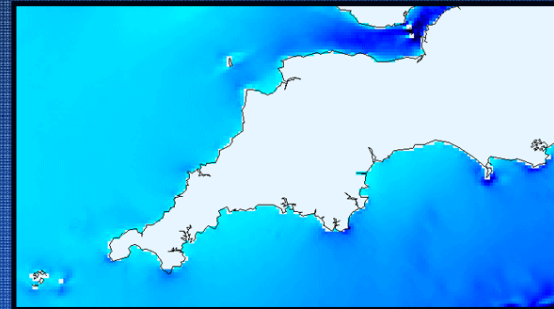


Source – DTI: Atlas of UK Marine Renewable Energy Resources

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Tidal Current Power



Base Data – POL CS20 Model

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Tidal Current Power

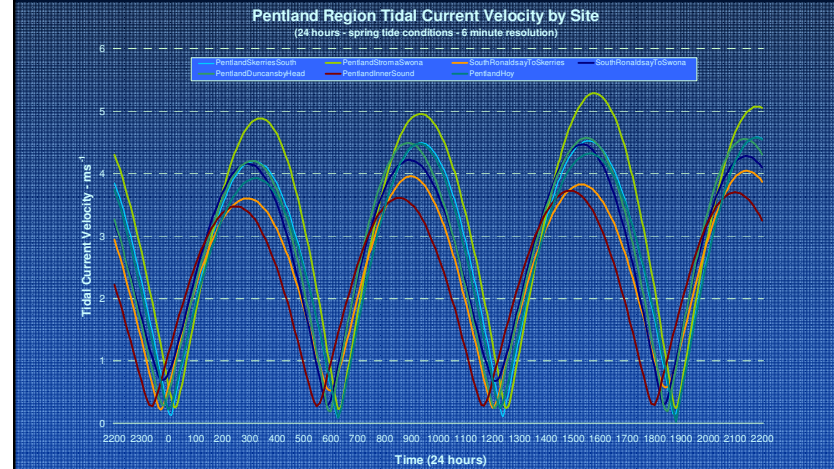
■ Daily Tides

- Driving forces are
 - Gravitational effect of the moon
 - Rotational effect of the earth-moon system
- UK experiences semi-diurnal tides
 - Roughly two high and two low tides per day
 - Time between subsequent high tides is 12h25min
- Peak in tidal current velocity 4 times per day

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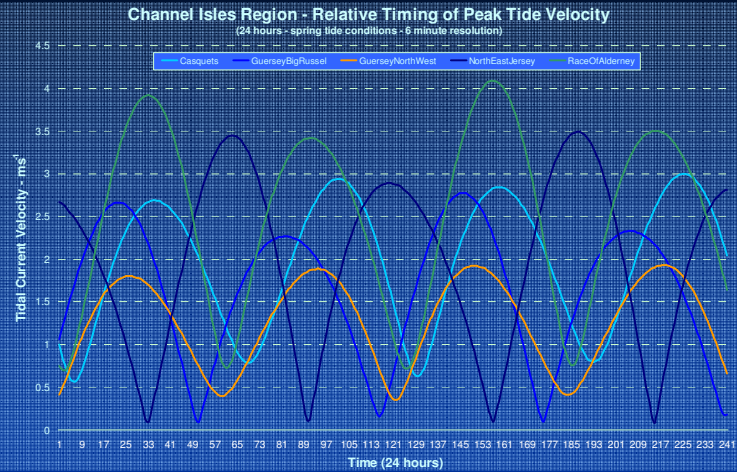
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Tidal Current Power

■ Spring & Neap Tides

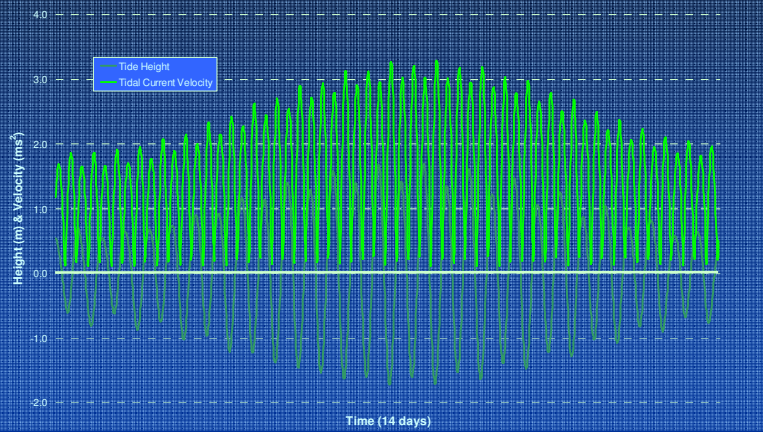
- Highest tidal current velocities occur during Spring tides
- Driving force is the relative position of the moon and sun in relation to the earth
- World experiences Spring & Neap tides on a 14 day cycle.

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Tidal Current Power

Spring/Neap Tide Height and Current Velocity



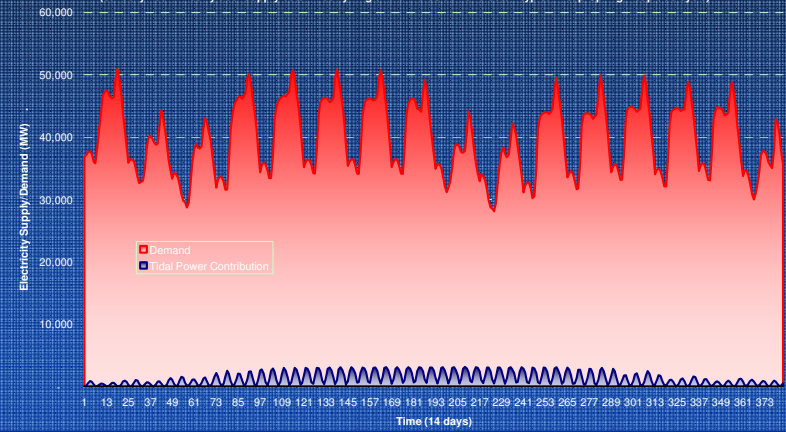
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Tidal Current Power

Tidal Power Contribution to Electricity Demand

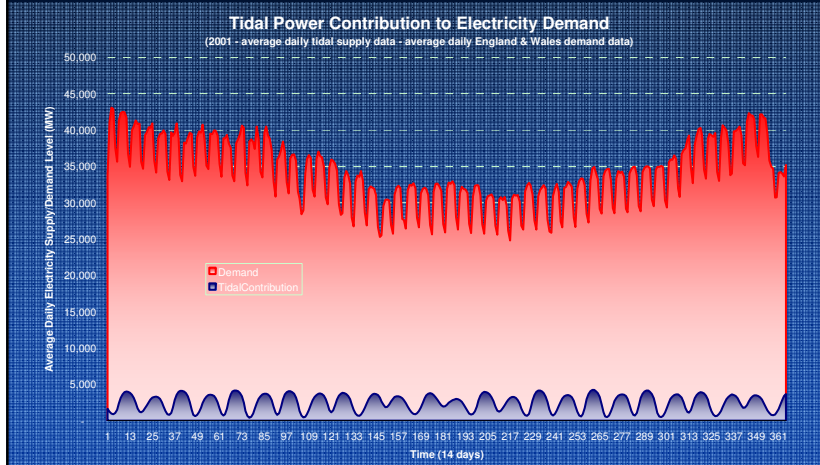
(January 2001 - hourly tidal supply data - hourly England & Wales demand data - typical Neap-Spring-Neap tide cycle)



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Tidal Current Power



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Previous examples have looked at high levels of development. What if...

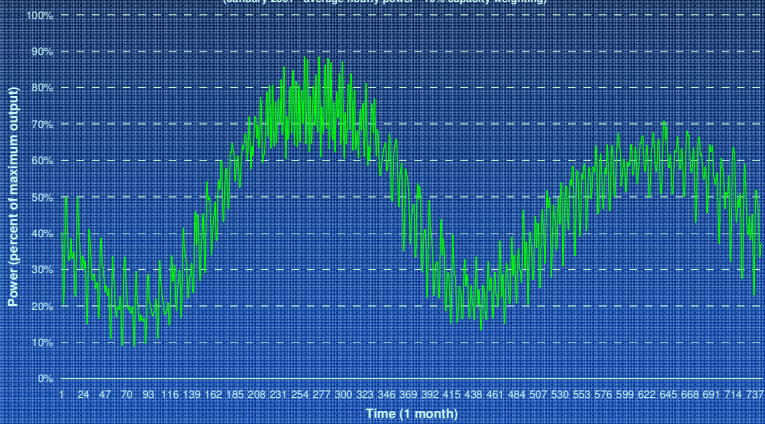
- A portion of the tidal power resource was developed, or
- A mix of wave & tidal was developed

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United Kingdom Tidal Stream Power Output
(January 2001 - average hourly power - 10% capacity weighting)

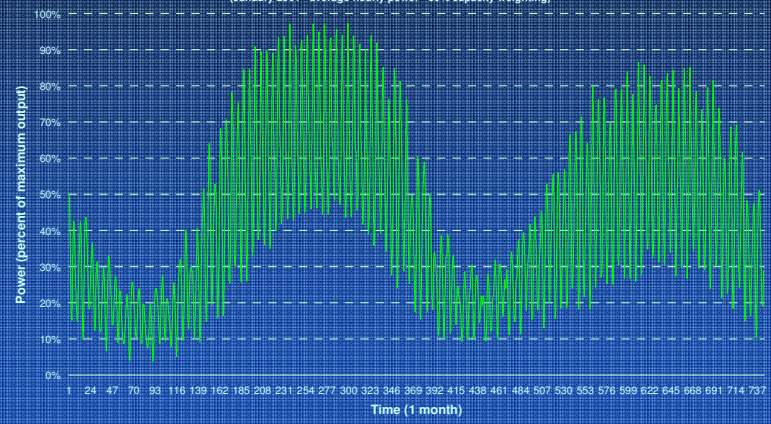


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United Kingdom Tidal Stream Power Output
(January 2001 - average hourly power - 50% capacity weighting)

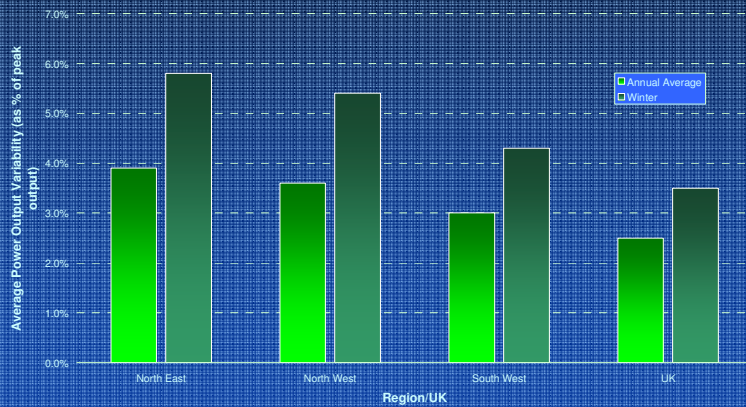


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Average Variability in Wave Power Output
(3 hour EWM data - high energy wave sites)

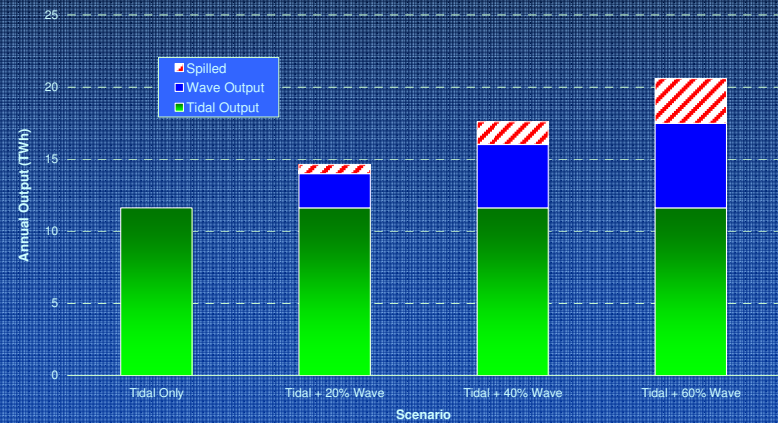


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Diversified Marine Renewables & Transmission
(Pentland Region - maximum tidal development)



Note - All scenarios assume transmission capacity is constant, and scaled to meet maximum tidal power output only.

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Key Points

- Tidal Power
 - Hourly to fortnightly variability patterns
 - No seasonal variability
 - Limited smoothing potential
- Wave Power
 - High seasonal variability
 - Site diversification reduces variability
- Combined Marine Renewables
 - Improved transmission utilisation
 - Increased output with little impact on system variability

For further information on renewable electricity generation, intermittency and system security, contact:

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This presentation is based on work commissioned by the Carbon Trust as part of the Marine Energy Challenge.

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