

**WALES LOW CARBON ENERGY  
OBJECTIVES  
: with a focus on marine energy  
opportunities**

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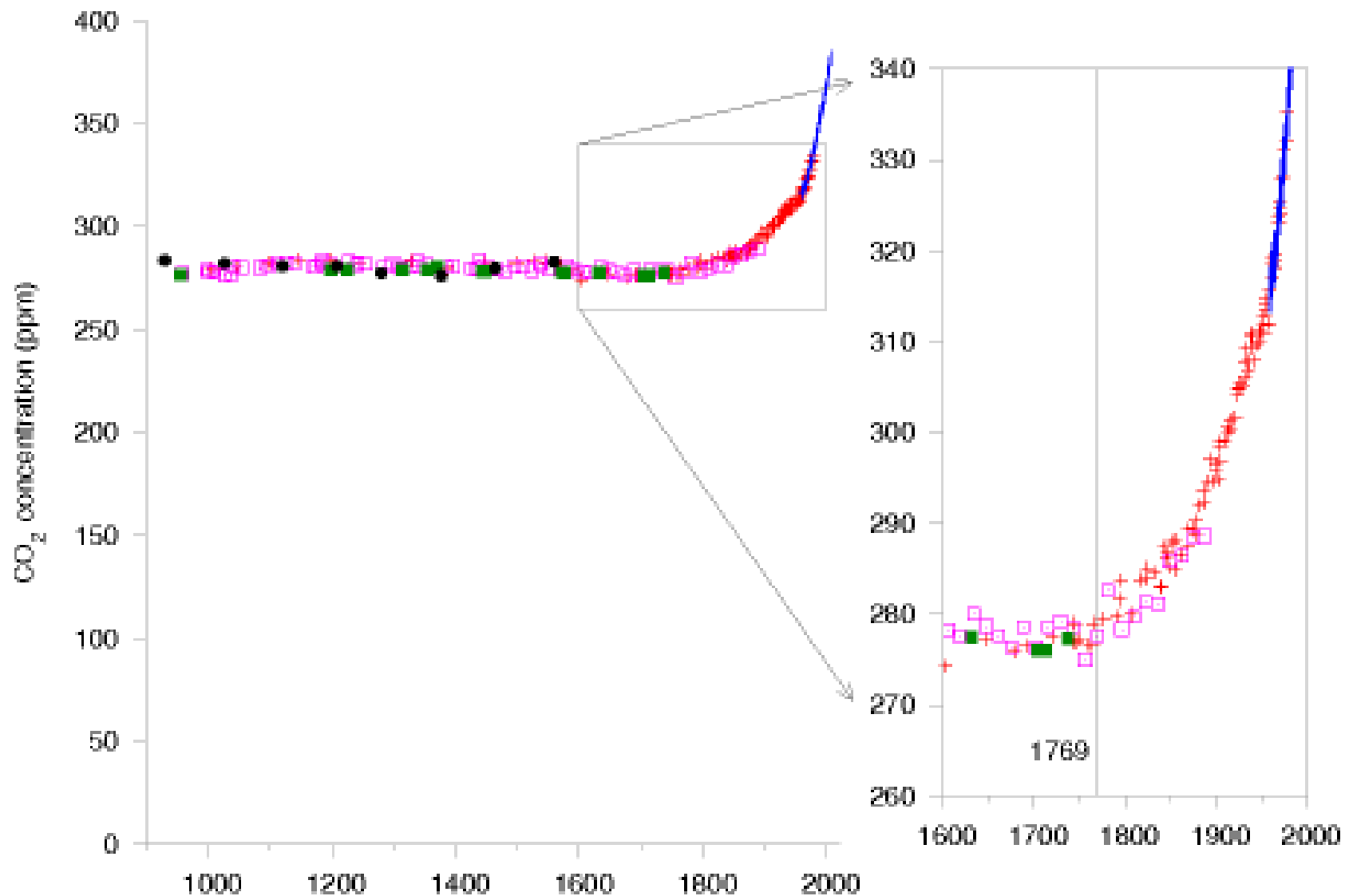
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*Pembs marine workshop, January 2010*



Llywodraeth Cynulliad Cymru  
Welsh Assembly Government

# The global warming 'big CO2 stick'



# Importance of acceleration of mitigation

At present, best science is indicating on present course 4C global temperature increase by 2060

*-this carries enormous risks ;*

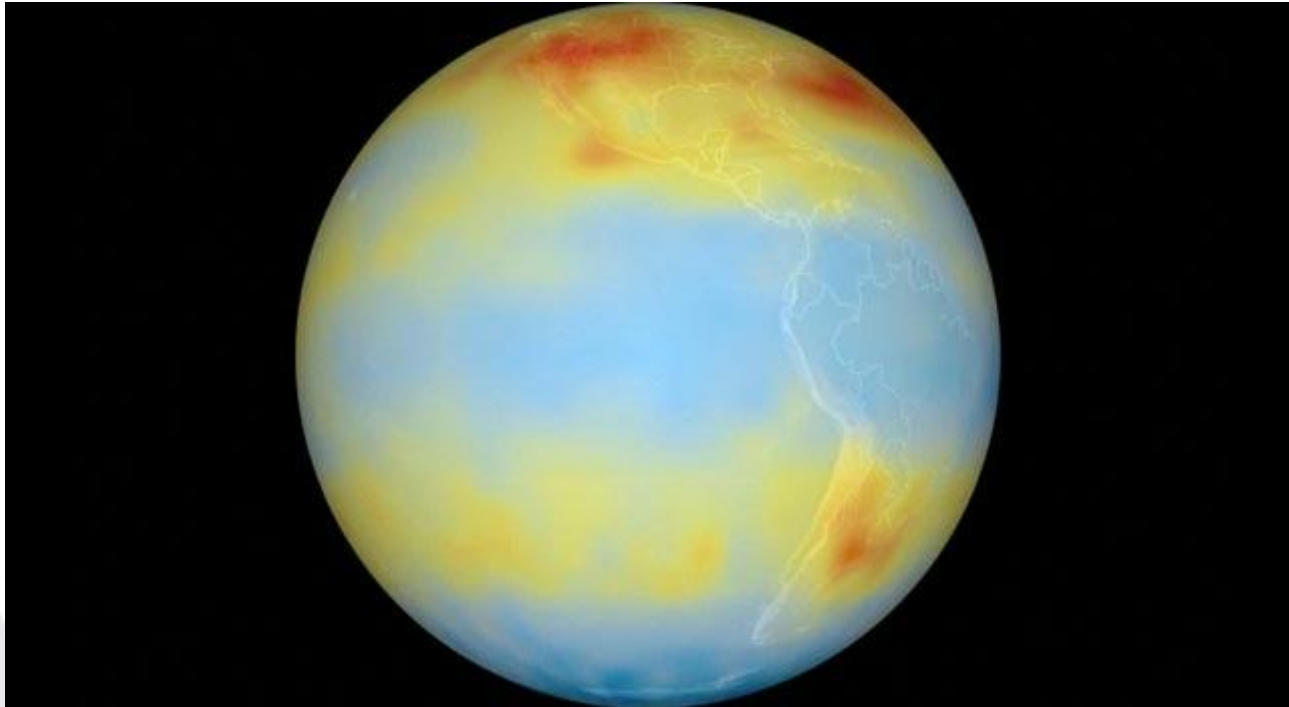
*-whatever we do now can not influence climate situation in 2030;*

*-world should be on a fast track to 50% plus greenhouse savings by 2050, thus*

*-world's global greenhouse gas emissions should peak by middle of next decade!!!!*

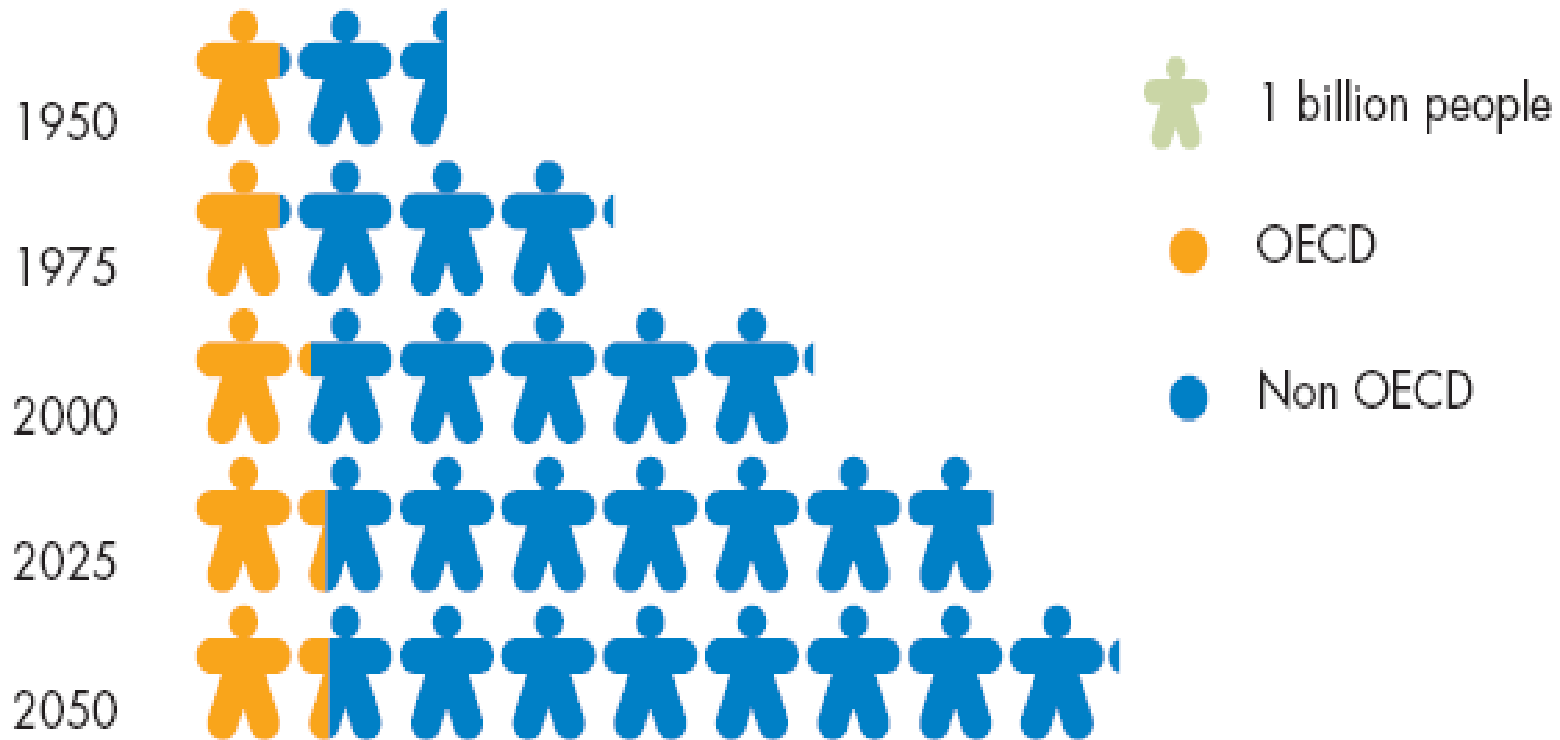
Thus time for action is very limited- but we should avoid scaring people into a denial mode

# Latest NASA work on global distribution of CO<sub>2</sub>

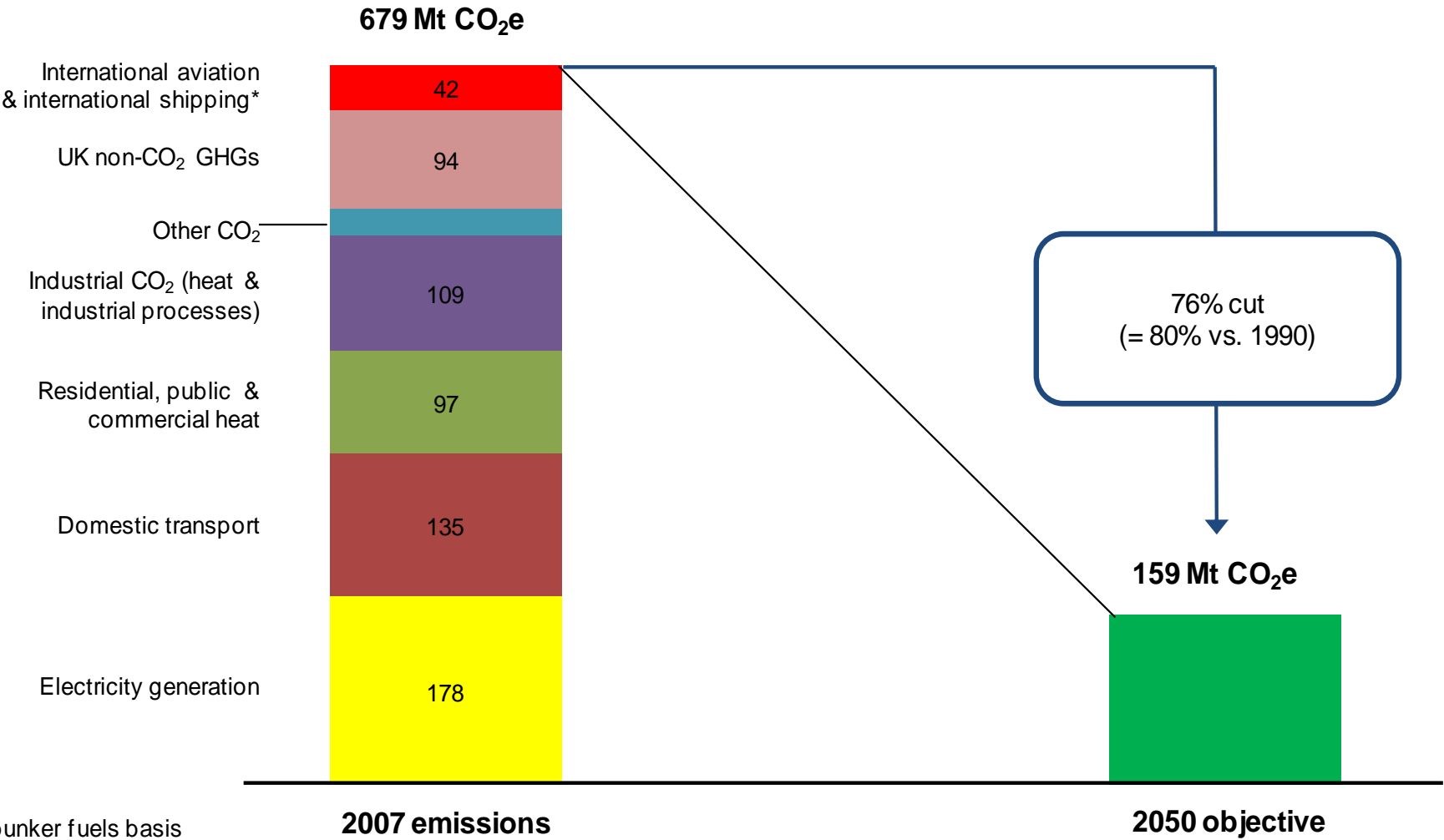


# But in the future?

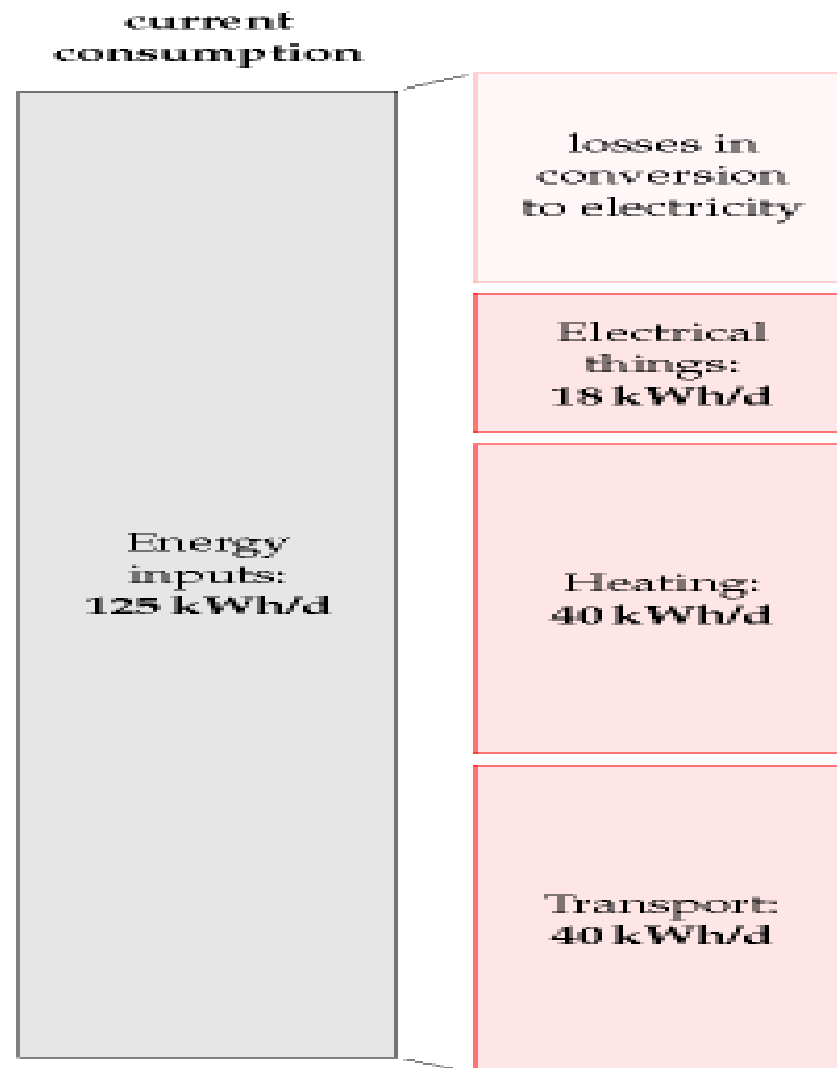
## World population<sup>1</sup>



# The carbon budgets to put the UK on a path to reducing emissions by 80% by 2050 : Lord Turner/UK CCC October 2009



# Now in UK : individual's daily energy( mostly fossil fuel sourced) consumption



# 2050: the almost all electric world?

current  
consumption

losses in  
conversion  
to electricity

Electrical  
things:  
18 kWh/d

Heating:  
40 kWh/d

Transport:  
40 kWh/d

Energy  
inputs:  
125 kWh/d

2008

future  
consumption

Electrical  
things:  
18 kWh/d

Heating:  
30 kWh/d

Transport:  
20 kWh/d

consumption  
breakdowns

Electricity:  
18 kWh/d

Electricity:  
12 kWh/d

Pumped  
heat:  
12 kWh/d

Wood: 5 kWh/d

Solar HW: 1 kWh/d

Biofuel: 2 kWh/d

Electricity:  
18 kWh/d

2050

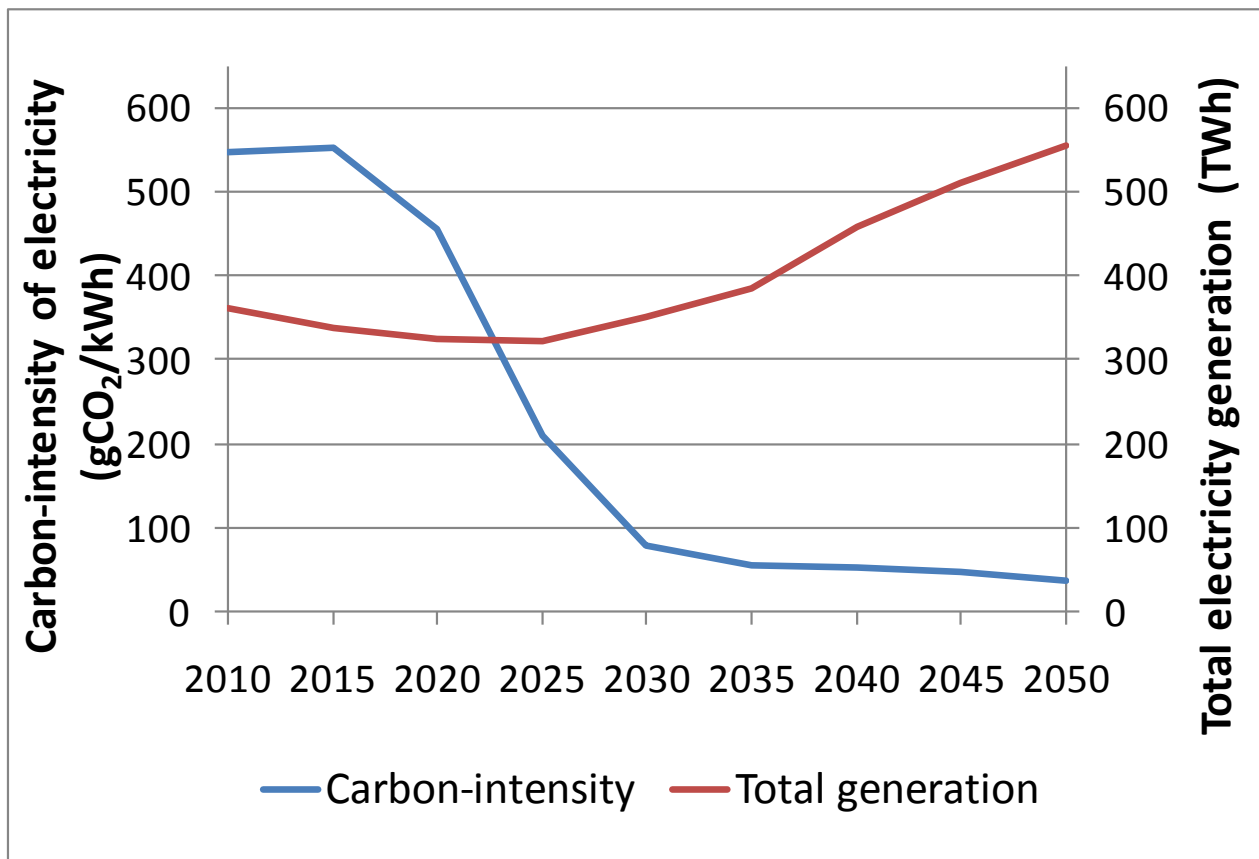
*efficiency*

*efficiency*

# UK electrical power decarbonisation and growth-with 2020/2030 as key grid decarbonisation period

The **electrification** of other sectors will see demand increase in 2020s and 2030s and beyond

Therefore we need to **significantly** decarbonise electricity generation by 2030



# Energy production in Wales

- In past( and present) , Wales strong involvement in coal, oil and steel industries
- Now, wide range of modern gas( inc LNG) coal, nuclear, wind (onshore and offshore), biomass, PV manufacturing, hydro and pumped storage operations
- Future, expect to be very strong in renewable electricity production, especially marine.

# Way forward: the first trinity

- Energy savings: requires behavioural changes which will be driven in Wales through major climate change awareness programmes.
- Energy efficiency/low carbon buildings: requires will and investment.
- Low carbon energy production (for heat, electricity and transport)- but has to be within a sustainable development framework.

# Strategic energy efficiency/buildings investment in Wales

- “Arbed” Strategic Energy Performance Investment Programme: this will be:
  - a £100m WAG/ERDF investment into domestic energy performance, in order to stimulate £350m + of low carbon related buildings investments over next 3 years
  - and is targeted at strategic regeneration areas in Wales to generate supply chains, jobs and skills in energy efficiency and local renewable energy systems

# Way forward: the second trinity

- Production of low carbon electricity on a large scale
  - Renewables
  - Gas and coal (and large biomass) with carbon capture and storage (CCS)
  - Nuclear power

For all three options significant cost and environmental issues which have to be addressed

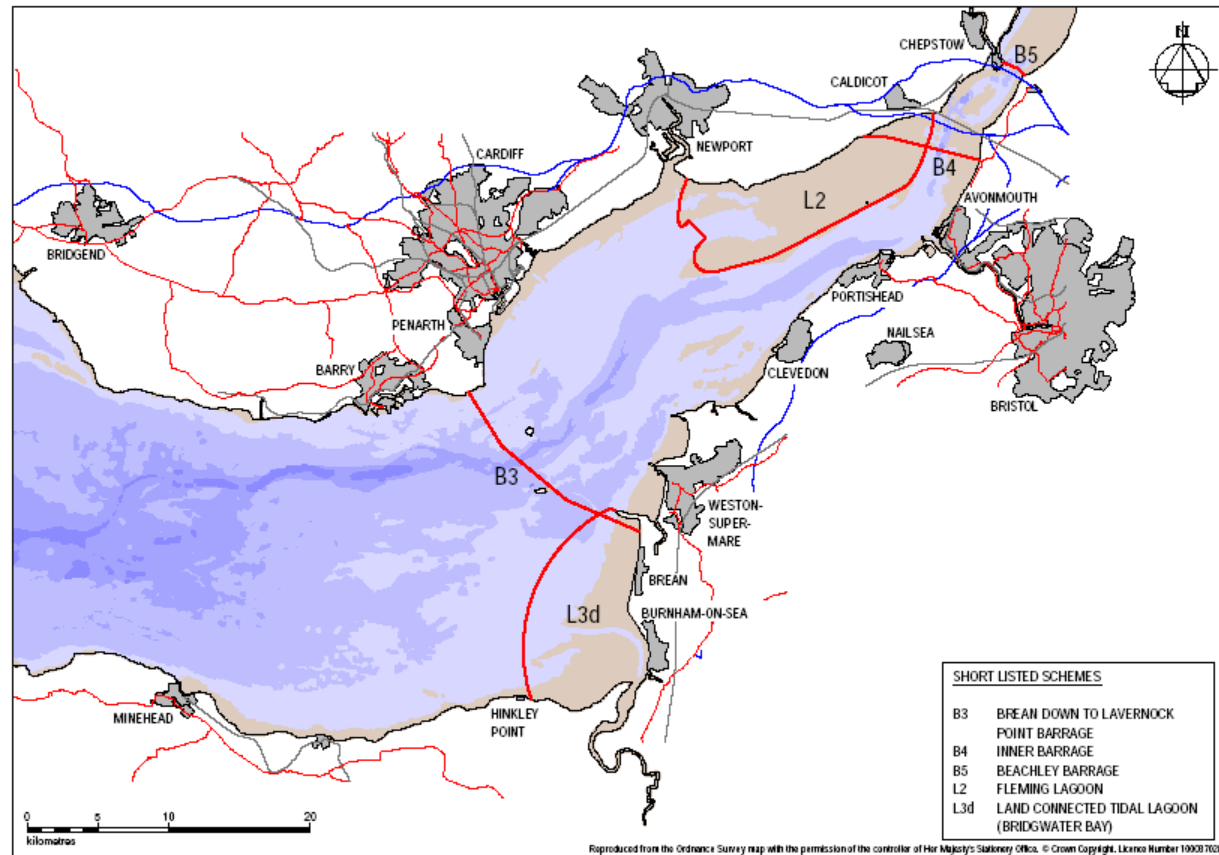
# Way forward: the second trinity

- Production of low carbon electricity on a large scale in Wales
  - **Renewables**
  - Gas and coal (and large biomass) with carbon capture and storage (CCS)
  - Nuclear power

# Some big renewable energy options for Wales

- **Wind** (onshore and offshore).
- **Marine** (tidal range, tidal stream and wave).
- **Biomass**-inc waste (for heat, electricity and vehicle fuels): but serious sustainability issues?
- **Solar** -thermal, photo-voltaic: but not concentrator stations!
- **Heat pumps** (air, ground and geothermal).
- **Hydro**- mainly small run of river but also new **large pumped-storage** opportunities?

# Severn tidal power study : 5 shortlisted projects



# Early electricity price estimates -but subject to revision

- **Beachley Barrage -£137 MWhr**
- **Bridgwater Bay Lagoon - £142 MWhr**
- **Cardiff/Weston Barrage -£127 MWhr :benchmark project**
- **Fleming 'Welsh Grounds' Lagoon -£183MWhr**
- **Shoots Barrage-£104 MWhr**

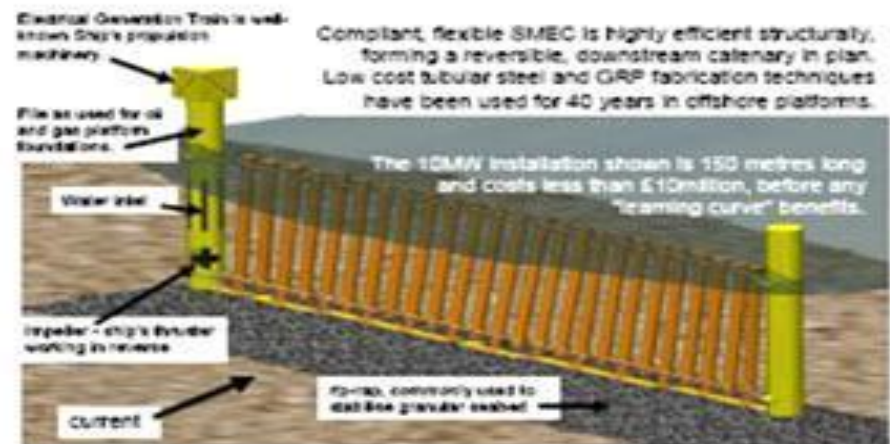
**C.f.** Current long term cost estimates for other renewables:

- high wind onshore - £65 to 72 MWhr
- high wind offshore- £71 to 81 MWhr (more for low-wind offshore);
- biomass £109 - 116,
- tidal stream £129 - 148;
- wave £145 to 163.

# Severn tidal power: also 3 embryonic technologies under consideration

## ***EG: Severn Tidal Fence – VerdErg***

- Radical new fence design using tidal stream technology
- A large proportion of tidal flow passes through a fence structure formed of a series of vertical and horizontal tubes.
- When water passes through the vertical ‘venturi’ tubes a pressure difference is created causing water to flow at high speed in the horizontal connecting tubes, which then drives turbines.
- Minimum moving parts and a perforated structure provides the potential to have less impact on inter-tidal habitats and be more fish friendly.



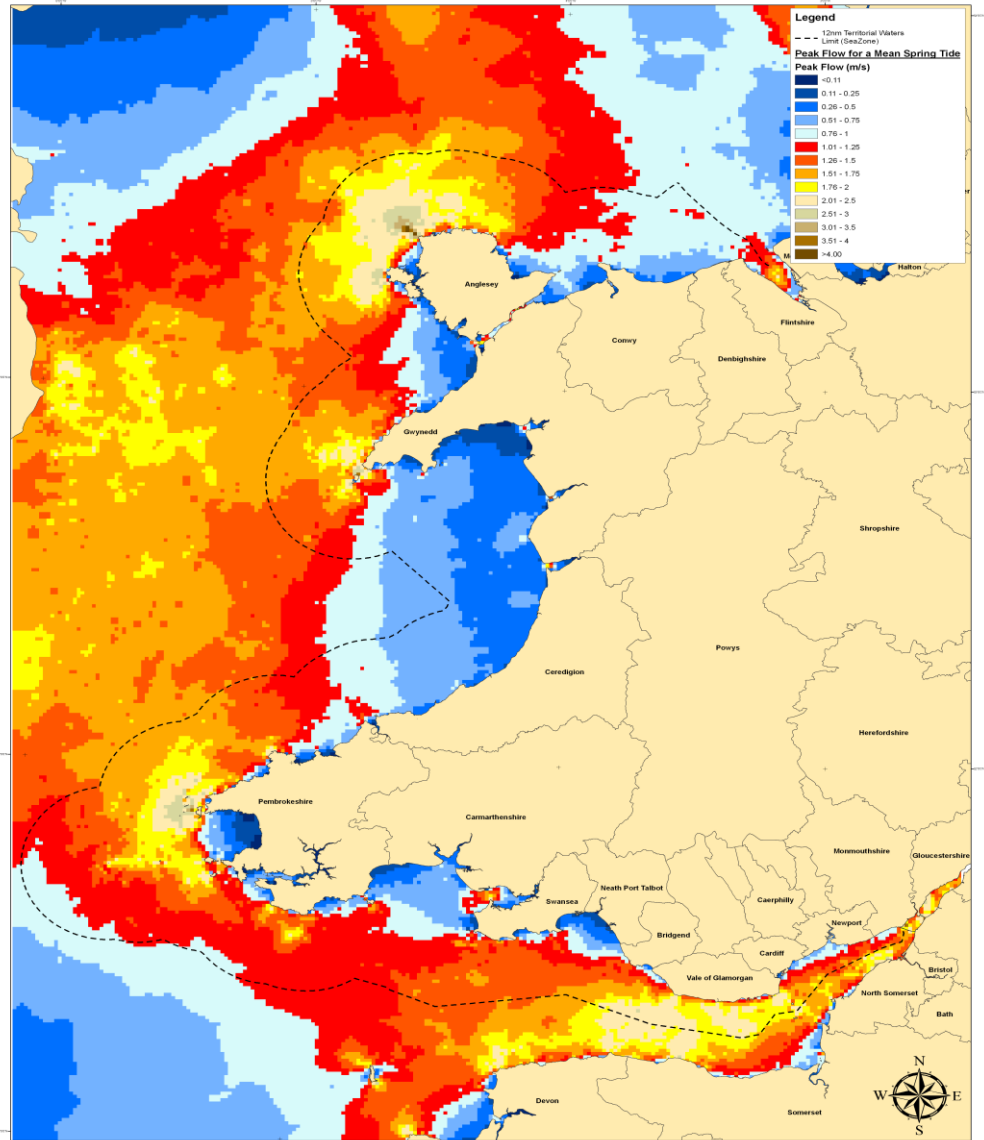
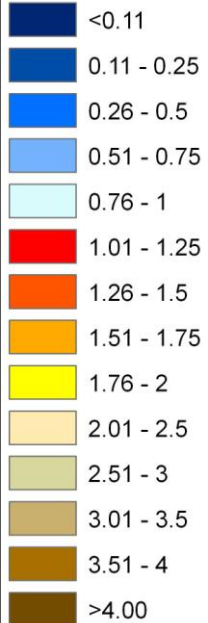
# Wales' tidal stream resource

## Legend




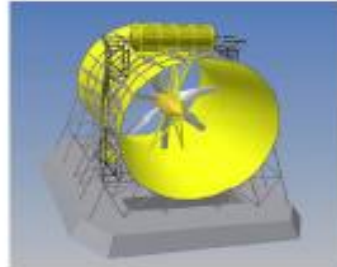
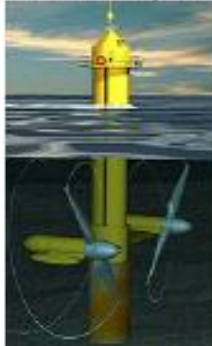
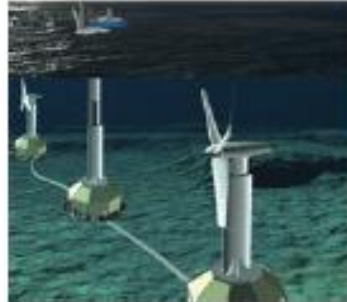
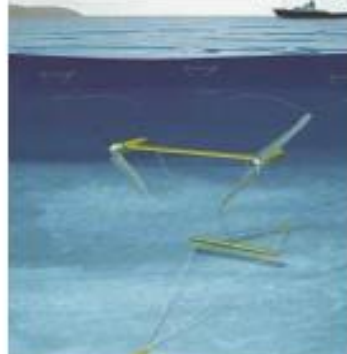
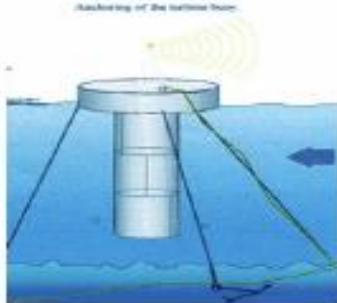

--- 12nm Territorial Waters Limit (SeaZone)

## Peak Flow for a Mean Spring Tide

### Peak Flow (m/s)

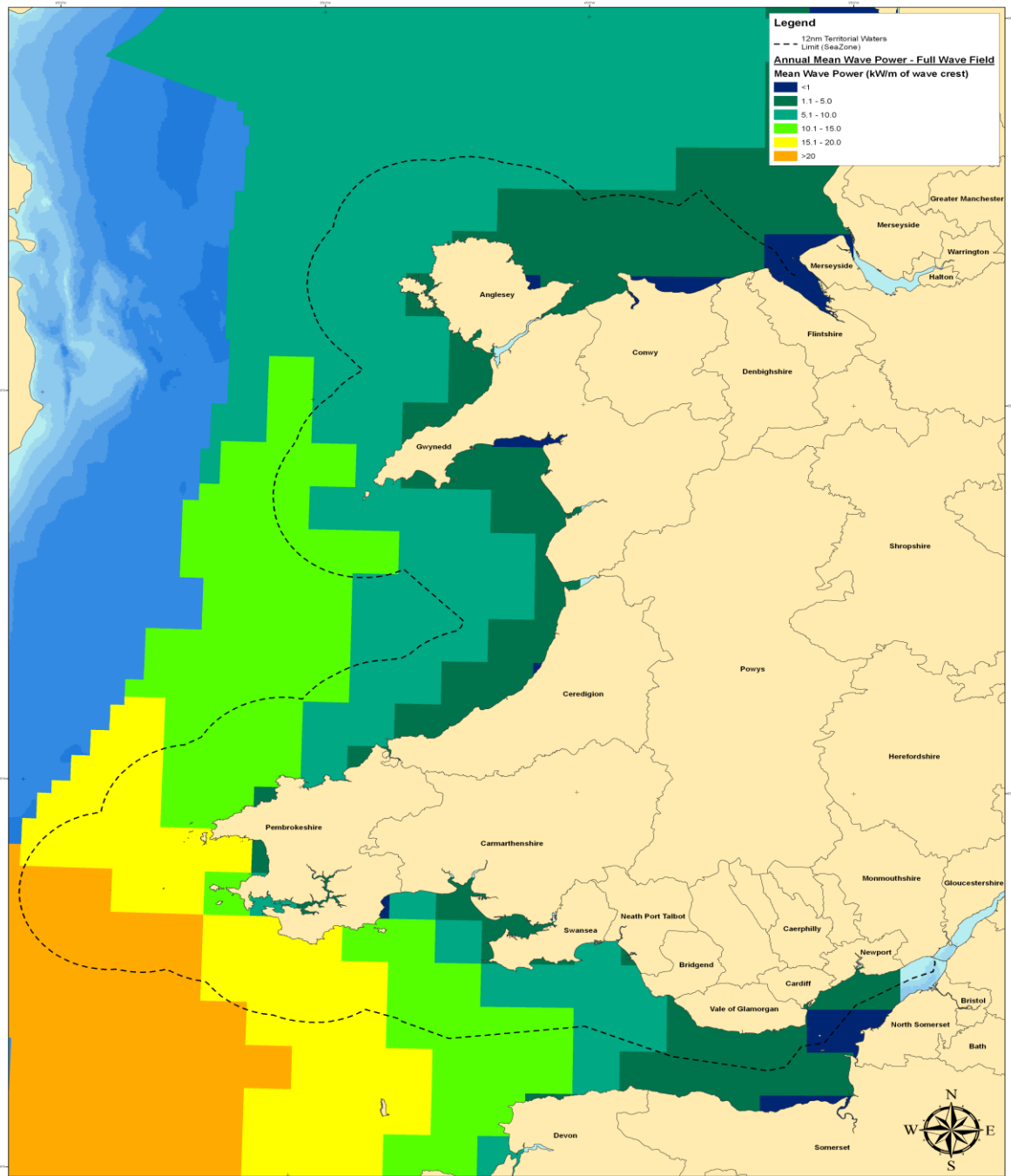
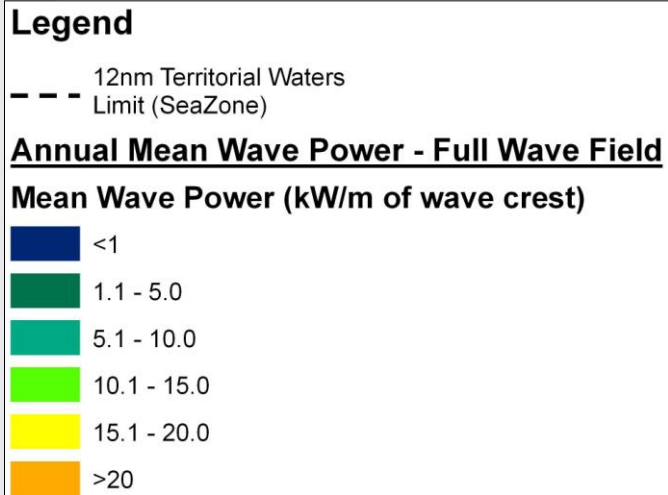


# Some tidal stream devices

<p>Marine Energy Generation's "Deltastream". Source: Bacon (2003).</p>	<p>Verdant's "Kinetic Hydro Power System (KHPS)". Source: Hagerman (2006).</p>	<p>Open Hydro's "Open Centre Turbine - OCT". Source: Bedard et al. (2005).</p>
		
<p>Lunar's "RTT2000". Source: Hagerman (2006).</p>	<p>Marine Current Turbine's "Seagen". Source: MCT (2002).</p>	<p>Swanturbine's underwater turbine. Source: Anon. (2006).</p>
		
<p>SMD Hydrovision's "TidEL". Source: Bedard et al. (2005).</p>	<p>Seapower's "Exim". Source: Bedard et al. (2005).</p>	<p>GCK's "Gorlov Helical Turbine". Source: Bedard et al. (2005).</p>
		



# Wales' wave resource



Building on BERR sponsored resource mapping

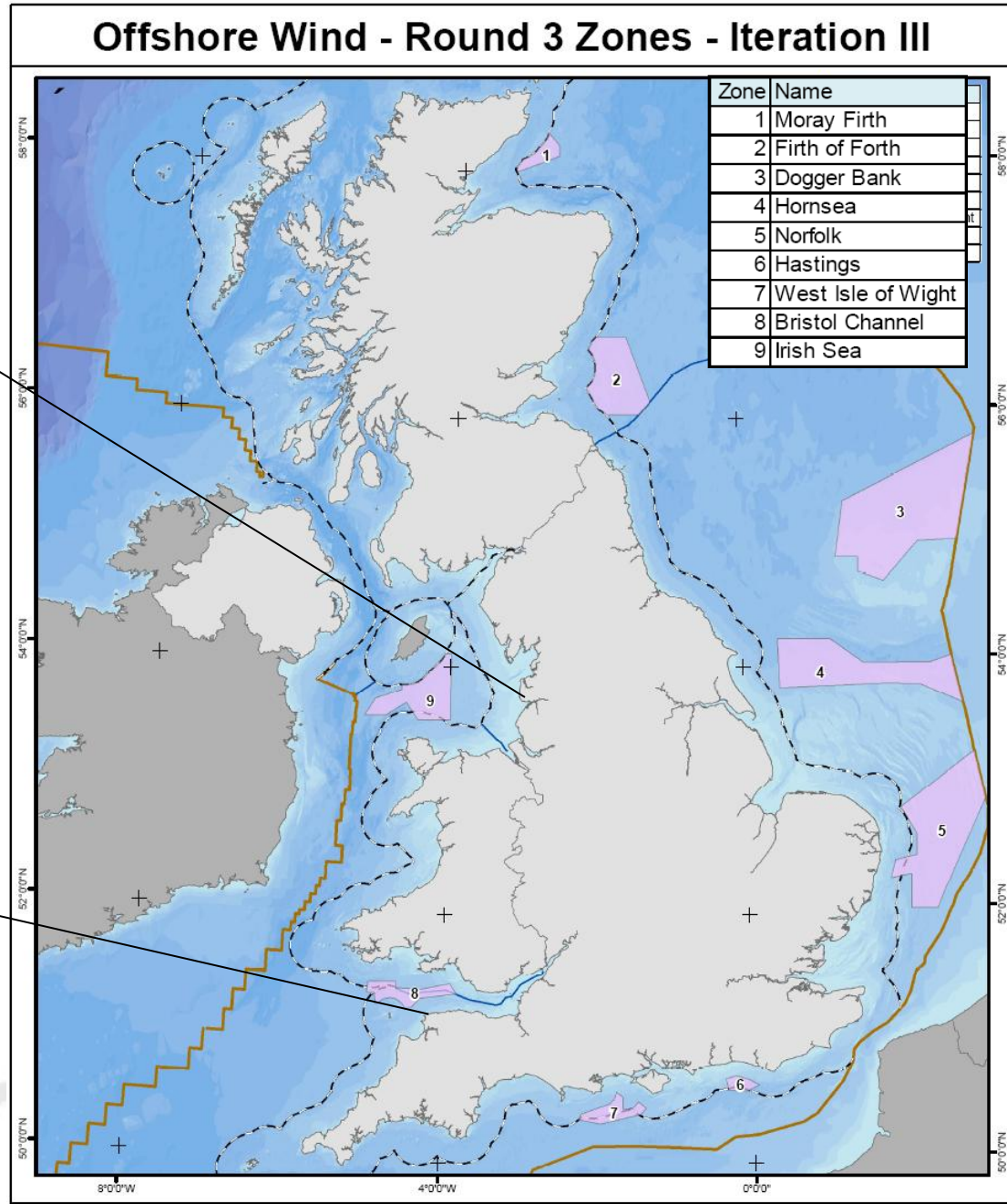
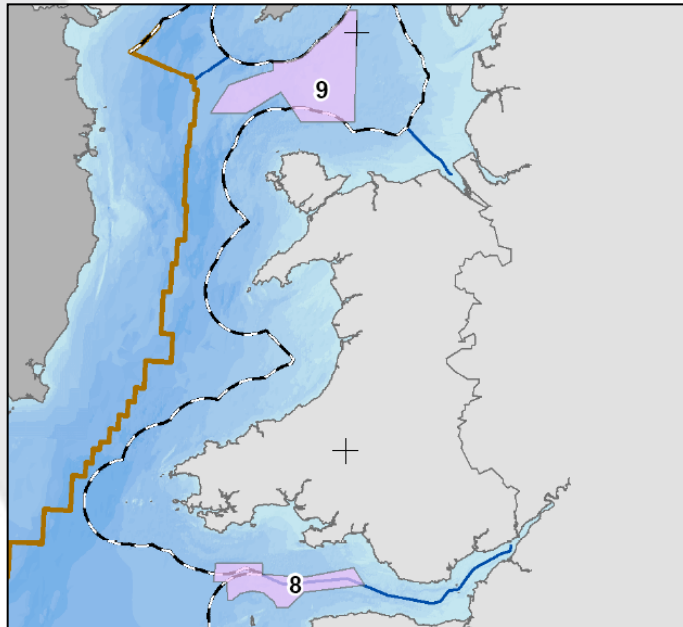
# Major offshore wind power projects off Wales' coasts

- Three consented off-shore wind farms (North Hoyle (**60MW**), Rhyl Flats (**100MW** ) and GyM(**750MW**)
- Major circa **1.5GW** and **4GW** off-shore wind farms in near future



# Offshore Wind – Round 3 Zones

## Offshore Wind - Round 3 Zones - Iteration III



- Round 3 Zones - Iteration III
  - 12 nm Limit
  - Territorial Waters
  - UK Continental Shelf
  - Europe
  - United Kingdom
- Bathymetry**
- Shallow
  - Deep

# Wales 'marine' energy resources

- Offshore wind- 5 GW (plus) in next phase alone;
- Tidal stream/wave - 40 GW: initial target 4GW by 2025
- Severn tidal power- up to 9 GW
- Other tidal range projects ?

**Multi £10s billions investment opportunities.  
Marine energy key part of Wales' 2025 opportunity  
to produce more electricity  
from renewable sources than we consume as a nation .**

# Practical marine energy support measures

(in addition to those from UK Government)

- Wales EU convergence fund £multi-million financial support available;
- Energy recognised as a key sector for WAG business support and green jobs activities;
- £34 million Wales low carbon institute research programme;
- Consideration of a tidal stream device test deployment area and other test facilities;
- Supportive stance from environmental bodies on tidal stream and wave energy projects;
- Major environmental data collection exercise and close working with UK Government on strategic environmental assessment for waters off Wales;

# Wales 2025 renewable energy potential?

- Circa 50TWhr pa of renewable electricity (45 kWhr ppd)
- 2.5/3TWhr pa of renewable heat

*Compared with current annual electricity consumption in Wales of circa 23TWhr*



# Way forward: the second trinity

- Production of low carbon electricity in Wales
  - Renewables
  - **Gas and coal (and large biomass) with carbon capture and storage (CCS)**
  - **Nuclear power**

Big legacy waste issues for fossil fuel and nuclear!

# Sustainable development framework for all large energy projects- look at:

- environmental consequences- global, regional and local;
- economic (including energy price and appropriate investment discount-rate issues), job creation and skills aspects;
- social, including fuel poverty, well-being, community, public understanding and privacy issues;
- energy security of supply-since without this our civilisation is at risk;
- physical infrastructure, especially energy-grids, ICT networks and transport facilities;
- new technology research, development and deployment opportunities.

# Proposed sites for new nuclear power stations in England and Wales





Figure 7 - Artists impression of the completed EPR reactor at Okiluoto



# Other steps to a Wales low carbon energy economy: R&D

Wales has a strong network of high technology incubator/development centres (*Techniums*) with strong university links: with three of these with an energy-related focus

[www.wda.co.uk/index.cfm/technium/about\\_technium](http://www.wda.co.uk/index.cfm/technium/about_technium)

- Wales has created a world-class '*Wales Low-Carbon Energy Research Institute*' with strong interests in:
  - energy efficiency (*buildings and processes*);
  - solid state lighting and power electronics;
  - renewables (*large and micro scale*);
  - bio-refining and advanced biomass growth;
  - advanced fossil fuel combustion systems;
  - underground coal gasification;
  - smart grids/smart homes;
  - hydrogen.
- Major new Wales climate change university consortium just launched.



# Economic way forward to a low carbon Wales

- **Chase hard the economic development, supply chain and research opportunities associated with transition to low carbon energy economy, including those in the transport sector:**
  - Large electricity plants in prospect- £50 billion
  - Includes opportunity to develop a new marine energy industrial sector in Wales-and strengthen ports infrastructure
  - At £20K home for low carbon houses= £25 billion in Wales
  - Significant low carbon research investments underway
  - Potential to be at the leading edge of smart-grid/smart-home/energy-demand management and energy storage projects
  - Further Ford, Toyota and Airbus efficient-transport projects

# Joined-up government policies are essential: example of clean energy generation

