

Diversified Renewable Energy Portfolios for the UK

Graham Sinden



This presentation

- Background
 - Scenarios
 - Variability
- Resource characteristics
 - Wind
 - Wave
 - Tidal stream
- Electricity demand
 - Demand patterns
 - Relationship to renewable supply patterns
- A diversified renewable energy strategy

Renewable energy scenarios matter

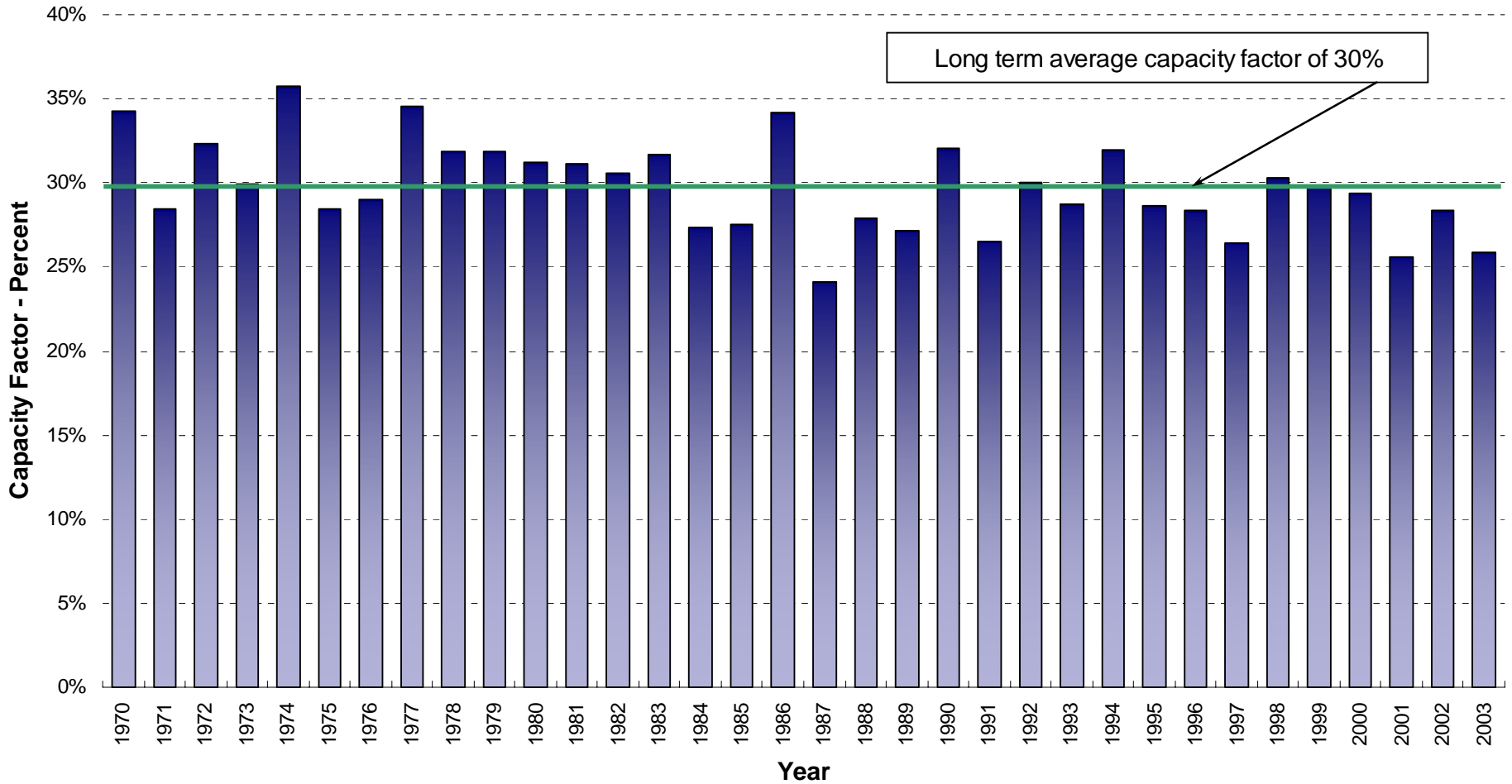
- Renewable energy scenarios matter!
 - What proportion of total electricity generation?
 - What proportion of renewable electricity generation is from variable resources?
 - What mix of variable resources are included?
- Example – the Renewable Networks Impact study (Carbon Trust, 2004)
 - 20% of demand met by renewable electricity by 2020
 - Around 75% of the renewable electricity supplied by variable resources
 - Range of renewable resources – wind, wave and tidal stream

Variability is a complex issue

- Different renewable resources have different patterns of variability
- Variability occurs at different time scales
 - Years
 - Seasons
 - Months
 - **Hours**
 - Seconds
- Demand also varies!

Annual wind power output varies

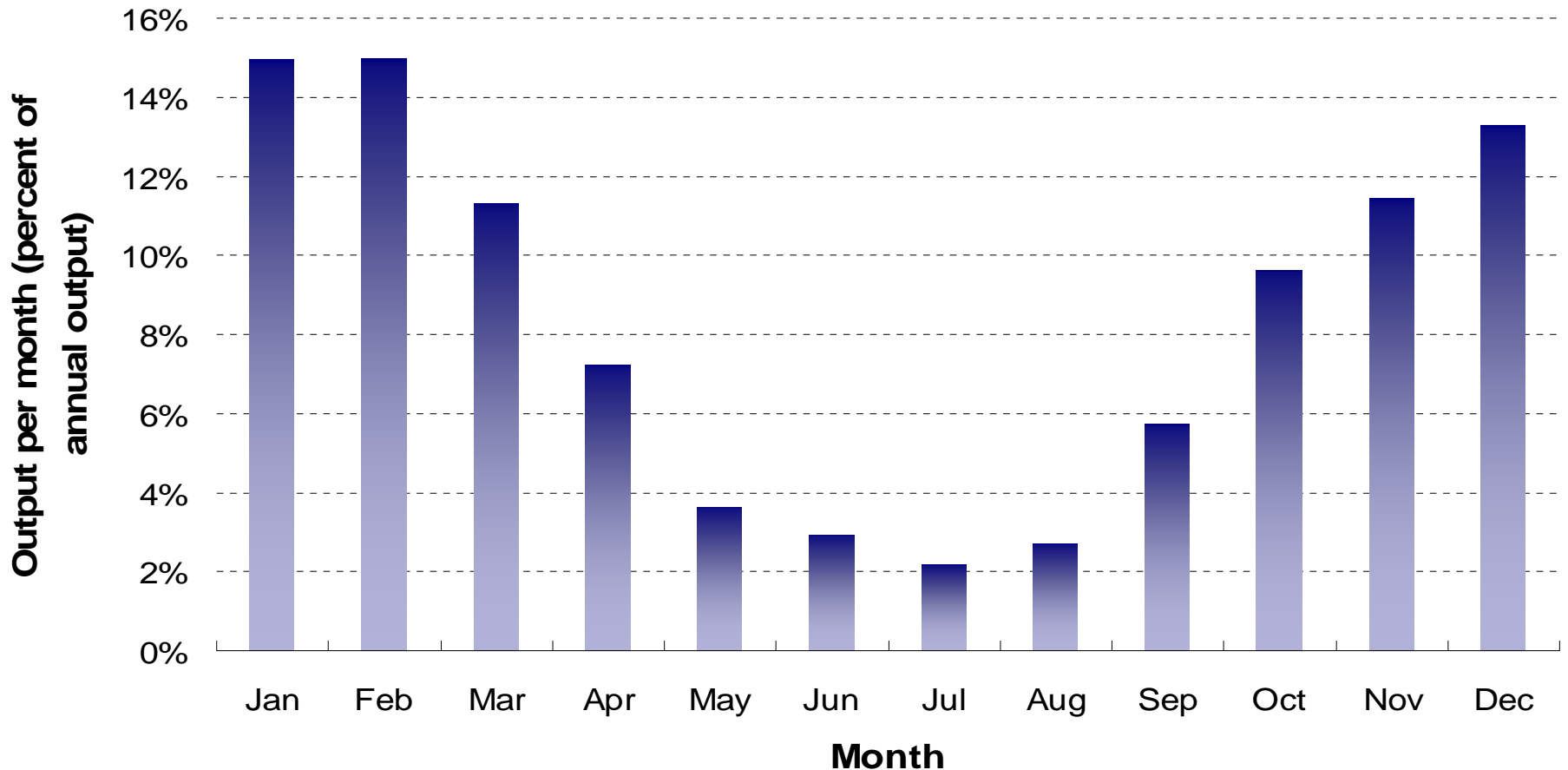
Annual Capacity Factor For UK Wind Power, 1970-2003



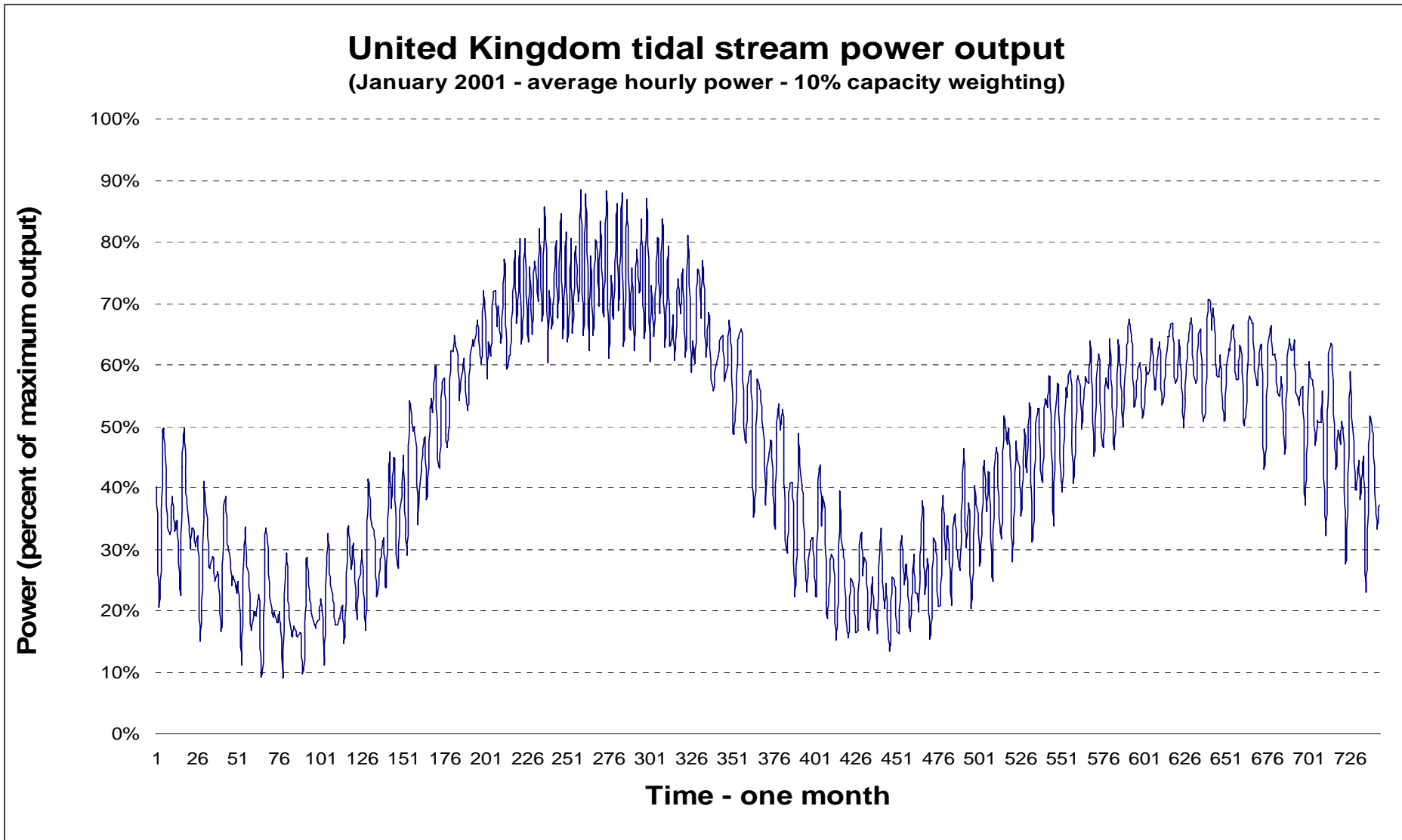
December, January and February see most wave power in the UK

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)

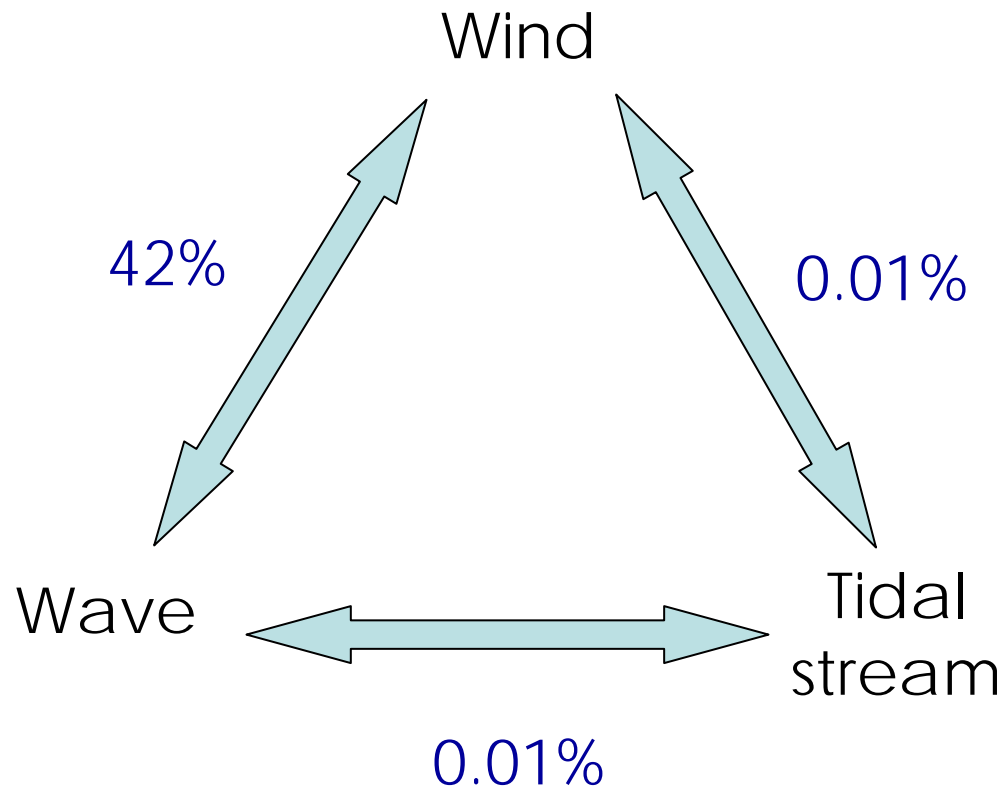


Hourly and 14-day patterns of variability in UK tidal stream energy



The correlation between different renewable resources

Correlation (r^2) of power output patterns

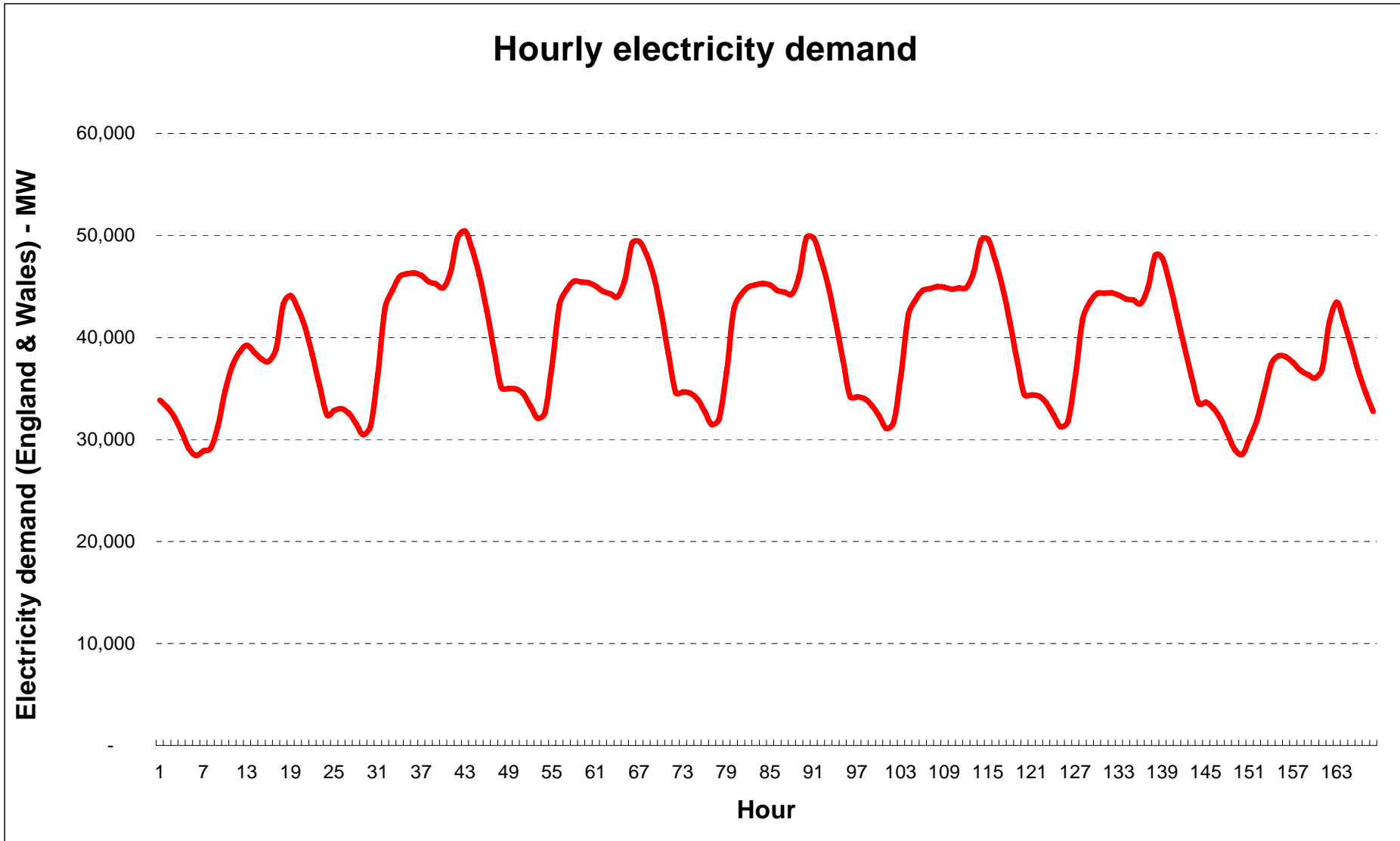


Electricity demand

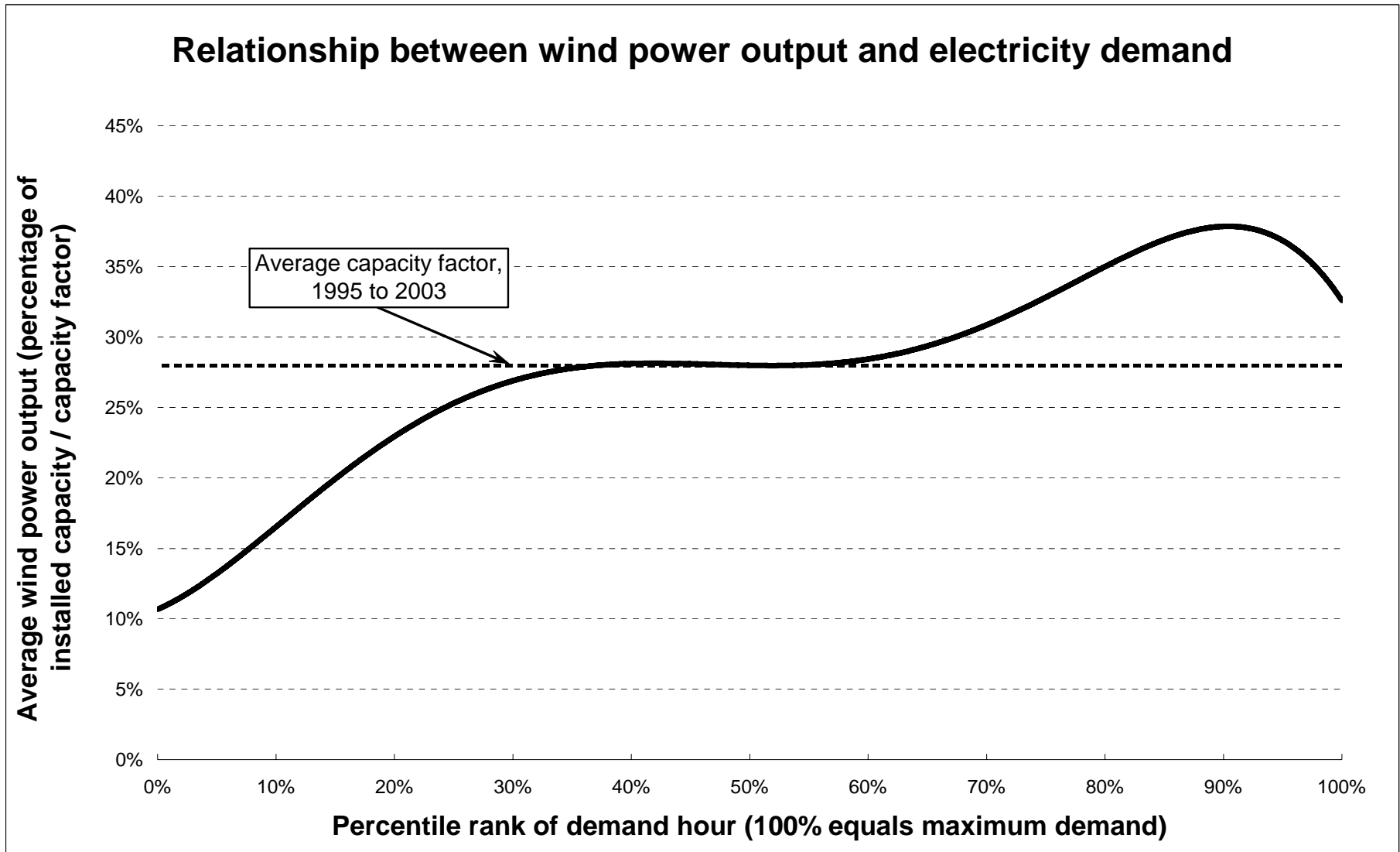
- Constantly varying
- Seasonal and diurnal patterns
- High degree of predictability

- Is there a relationship between electricity demand pattern and renewable electricity supply pattern?

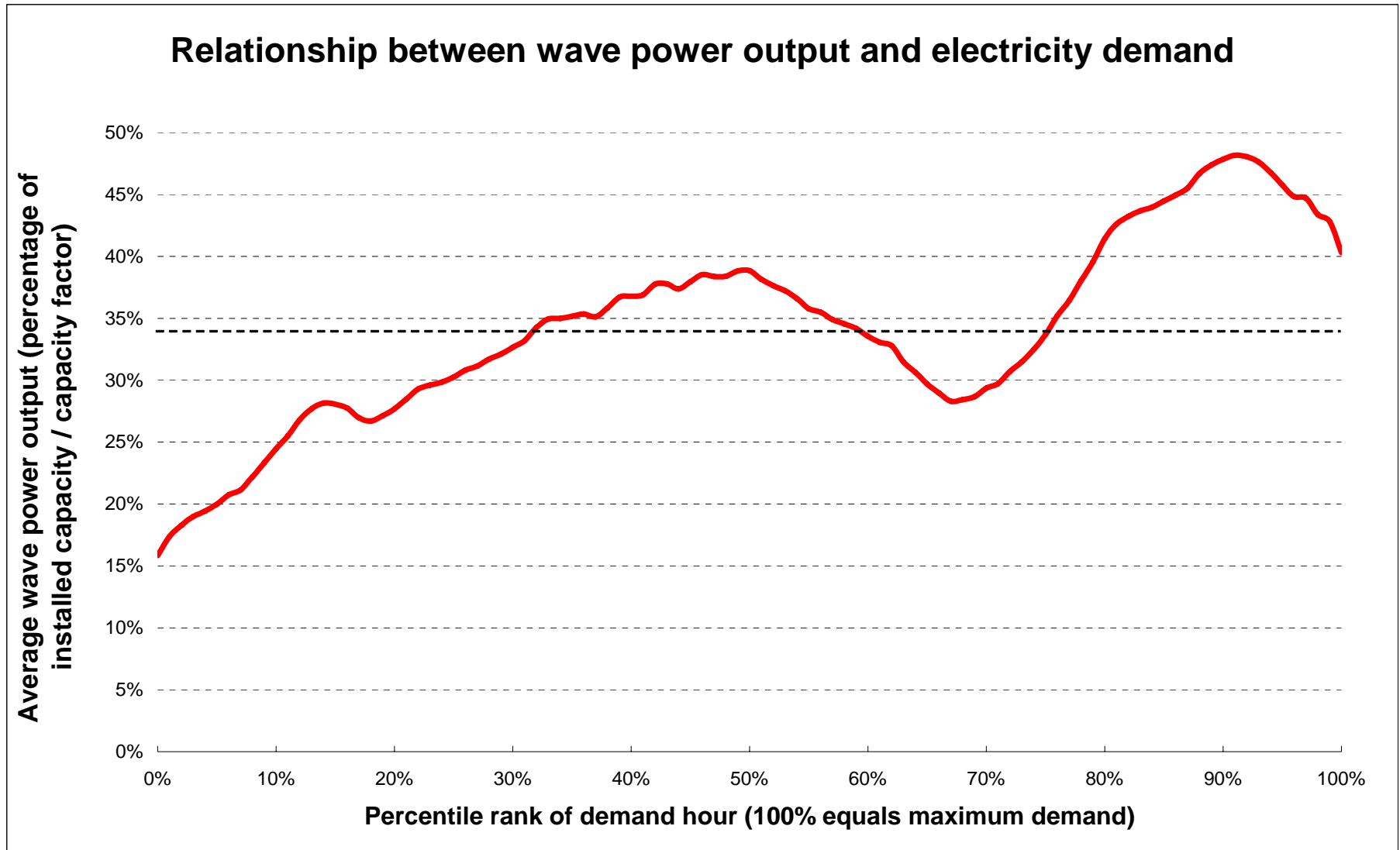
Electricity demand varies over time



Wind power delivers more energy at times of high electricity demand



Wave power delivers more energy at times of high electricity demand



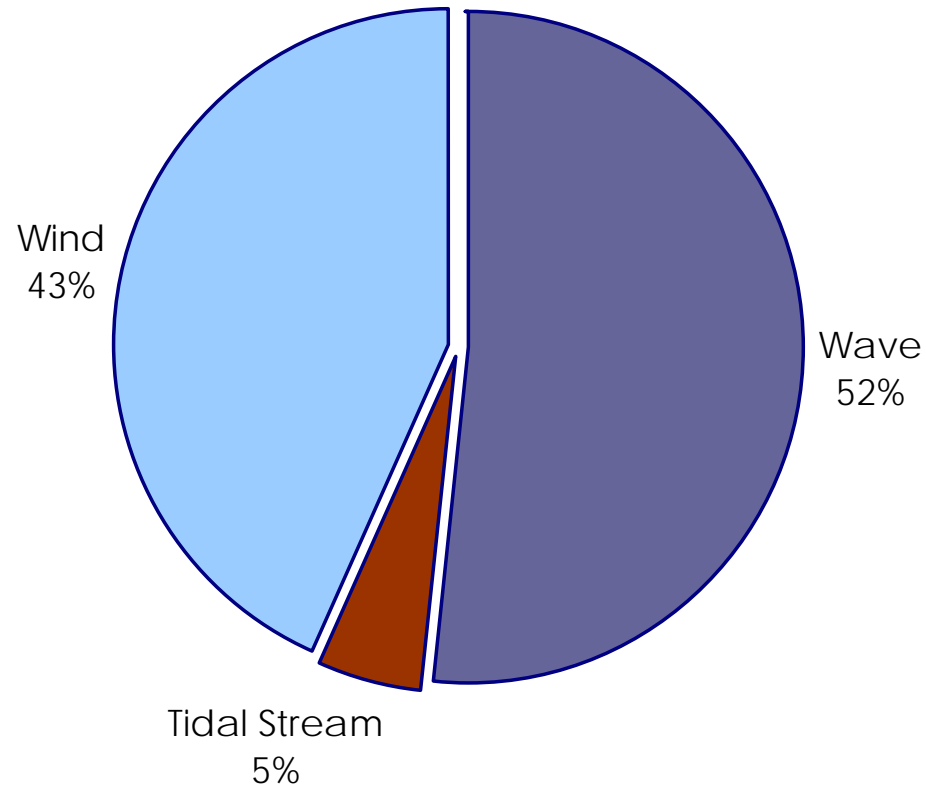
Diversified portfolios

- Different resources, different properties
- Different resources, different relationships with demand

- Can these different properties of different renewable resources be combined so that a “better” result is achieved?

A diversified portfolio – UKI scenario

- Wind power – range of sites throughout the UK.
- Wave power – range of sites in three high-energy coastal regions in northern and south-western UK.
- Tidal stream power – range of sites throughout the UK.
- **The contribution of different sites and resources was modelled to achieve low variability in the overall renewable energy supply.**



Diversified portfolios reduce variability

- The variability of the renewable electricity supply profile shows the degree to which electricity output changes from hour to hour.

Renewable supply	Variability – percent of installed capacity
Tidal stream power only	6.3% - 22.4%
Wind power only	3.2%
Wave power only	2.6%
UKI scenario	2.0%

Diversified portfolios increase capacity credit

- Capacity credit measures the extent to which renewables can reduce the need for conventional capacity. In this scenario, 20% of UK electricity demand is met by wind, wave and tidal stream power.

Scenario	Conventional Capacity	Capacity credit
Conventional system	84GW	- - -
Wind-only scenario ¹	79GW	5GW
UKI scenario	76GW	8GW

1 – from Dale et al, 2004

Diversified portfolios reduce balancing costs

- Balancing cost arise from the need to respond to changes in renewable output – by reducing the variability of the renewable electricity supply, the additional balancing costs are also reduced.

Scenario	Additional balancing cost
Wind-only scenario ¹	£2.85/MWh
UKI scenario ²	£1.80/MWh

1 – NGC data, reported in Mott MacDonald (2004)

2 – Analysis by David Milborrow

Summary

- Scenarios for renewable energy will affect the overall characteristics of the renewable electricity supply
- By developing a portfolio of wind, wave and tidal stream resources in the UK:
 - Variability is reduced
 - Capacity credit is increased
 - Balancing costs are reduced
- The benefits of this diversified portfolio are achieved through a combination of all three renewable resources, despite the relatively high variability of some sites and resources.

The end

We are happy to acknowledge and thank the following organisations for providing data used in this work:

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For further information on UK renewable resource characteristics visit:
www.eci.ox.ac.uk/energy

graham.sinden@eci.ox.ac.uk