



Imperial Centre for Energy Policy and Technology



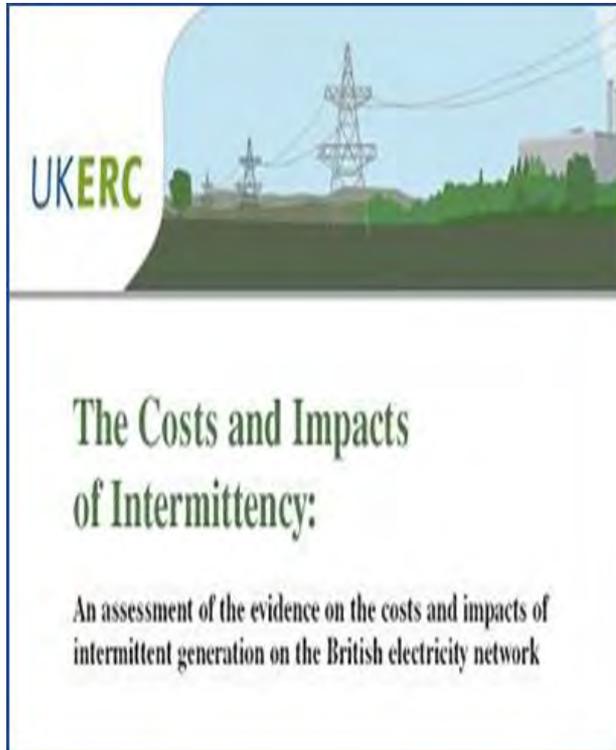
# The costs and impacts of intermittency – what have we learned? What do we need?

Integrating VRE conference  
World Bank, ESMAP, DTU

Dr Robert Gross,  
Director, Imperial College Centre for Energy Policy and Technology  
Policy Director, Imperial College Energy Futures Lab  
Co-Director, UK Energy Research Centre



# Why am I here?



First comprehensive systematic review of intermittency

Meta-analysis of over 200 international studies

Primary research from statistical first principles

Engineering and economics into layman's terms

Consensus built between 'opponents'

Extensively cited in policy documents

2015 update underway now

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# The debate has not gone away



## UK's wind farm 'folly': Electric bills to soar by £1000 thanks to reliance on wind power

HOUSEHOLDERS are facing soaring energy bills and winter power cuts thanks to the “folly” of relying on wind power, experts said last night.

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### Wind turbines 'only lasting for half as long as previously thought' as study shows they show signs of wearing out after just 12 years

- Study of almost 3,000 turbines in Britain sheds doubt on manufacturers claims that they generate clean energy for up to 25 years
- The research will fuel criticism of wind farms

By TAMARA COHEN

PUBLISHED: 16:48, 30 December 2012 | UPDATED: 08:13, 31 December 2012

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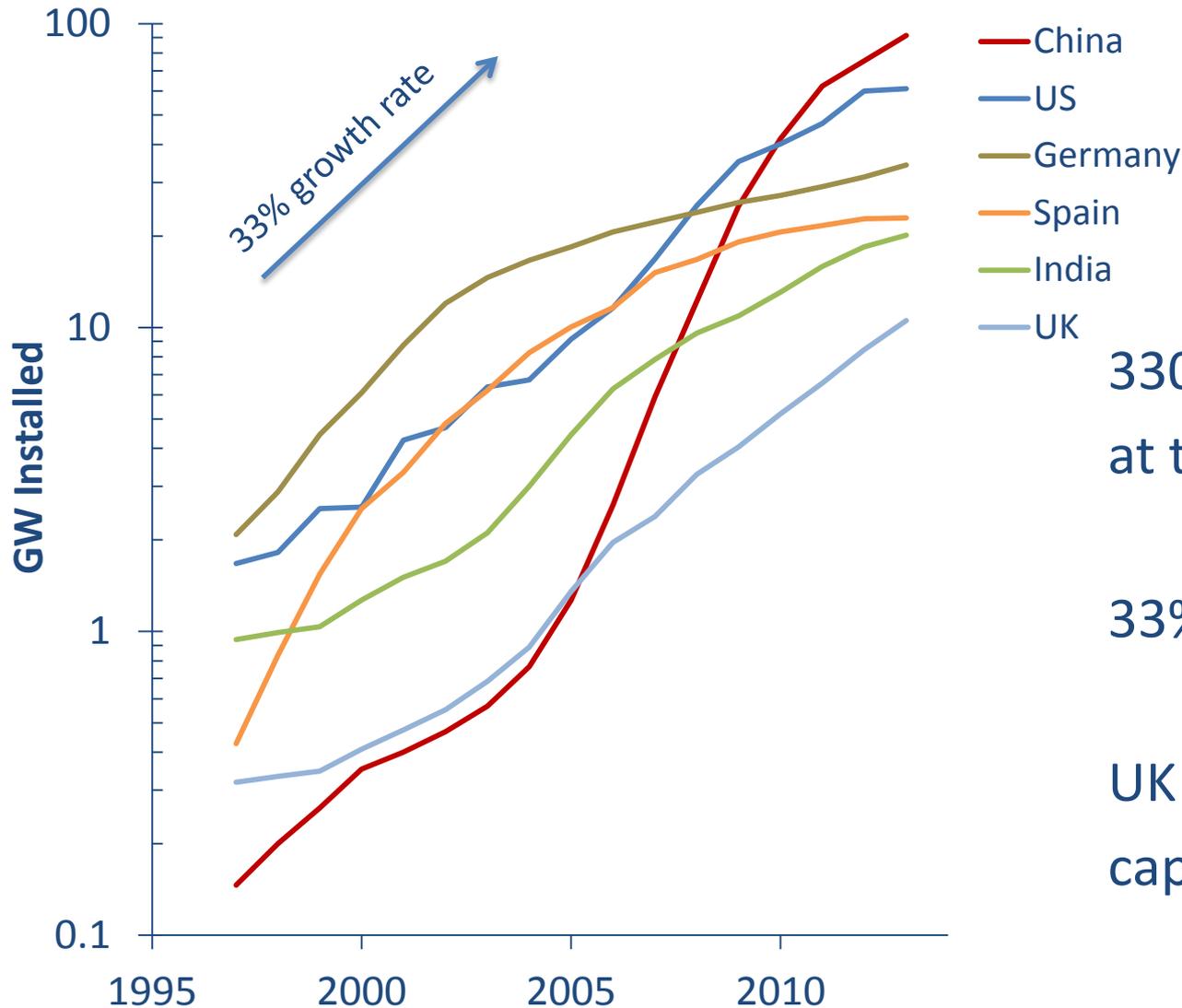
Wind farms have just half the useful lifespan which has been claimed, according to new research which found they start to wear out after just 12 years.

A study of almost 3,000 turbines in Britain – the largest of its kind – sheds doubt on manufacturers claims that they generate clean energy for up to 25 years, which is used by the Government to calculate subsidies.

Professor Gordon Hughes, an economist at Edinburgh University and former energy advisor to the World Bank, predicts in the coming decade far more investment will be needed to replace older and ineffective turbines – which is likely to be passed on in higher household electricity bills.

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# Wind power is becoming **big**



330 GW of capacity  
at the start of 2014

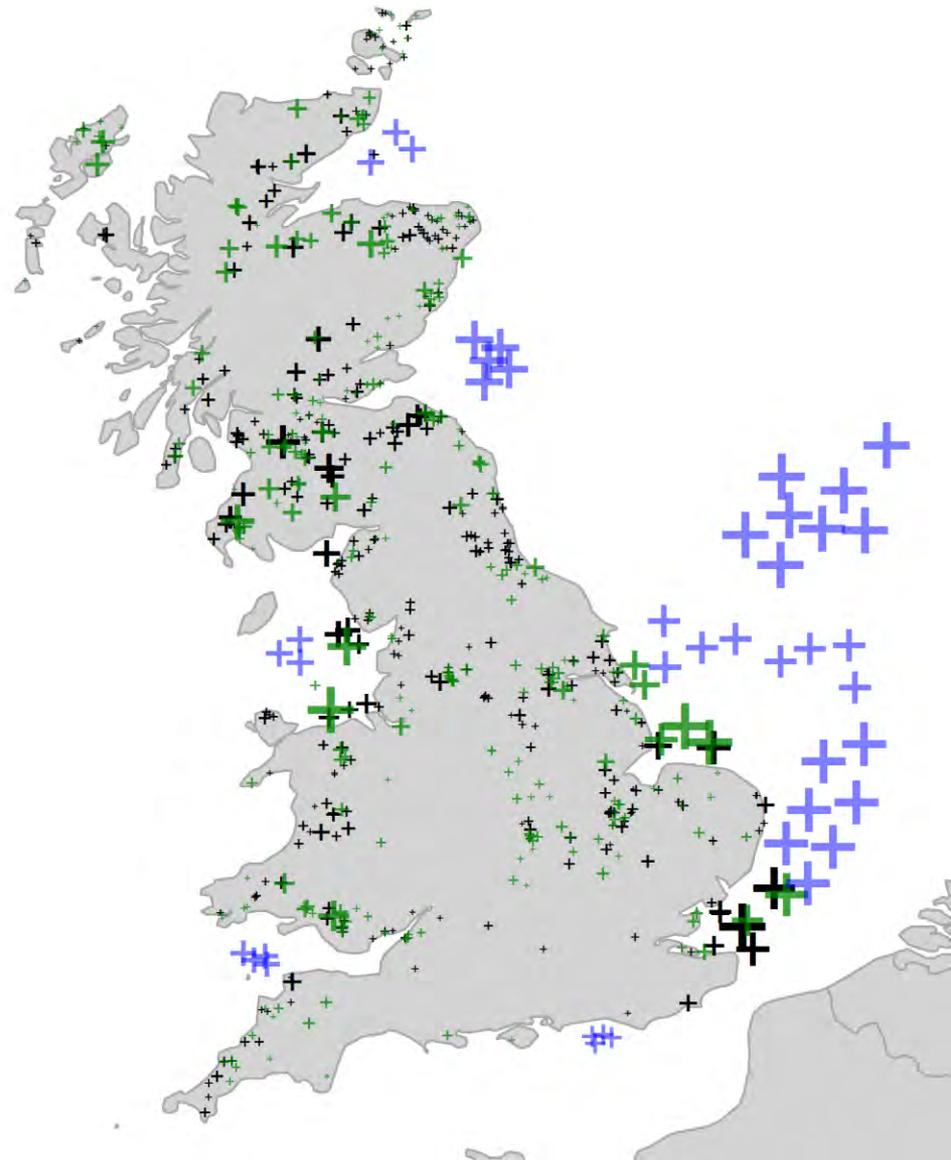
33% growth globally

UK has 6<sup>th</sup> largest  
capacity (*1<sup>st</sup> for offshore*)

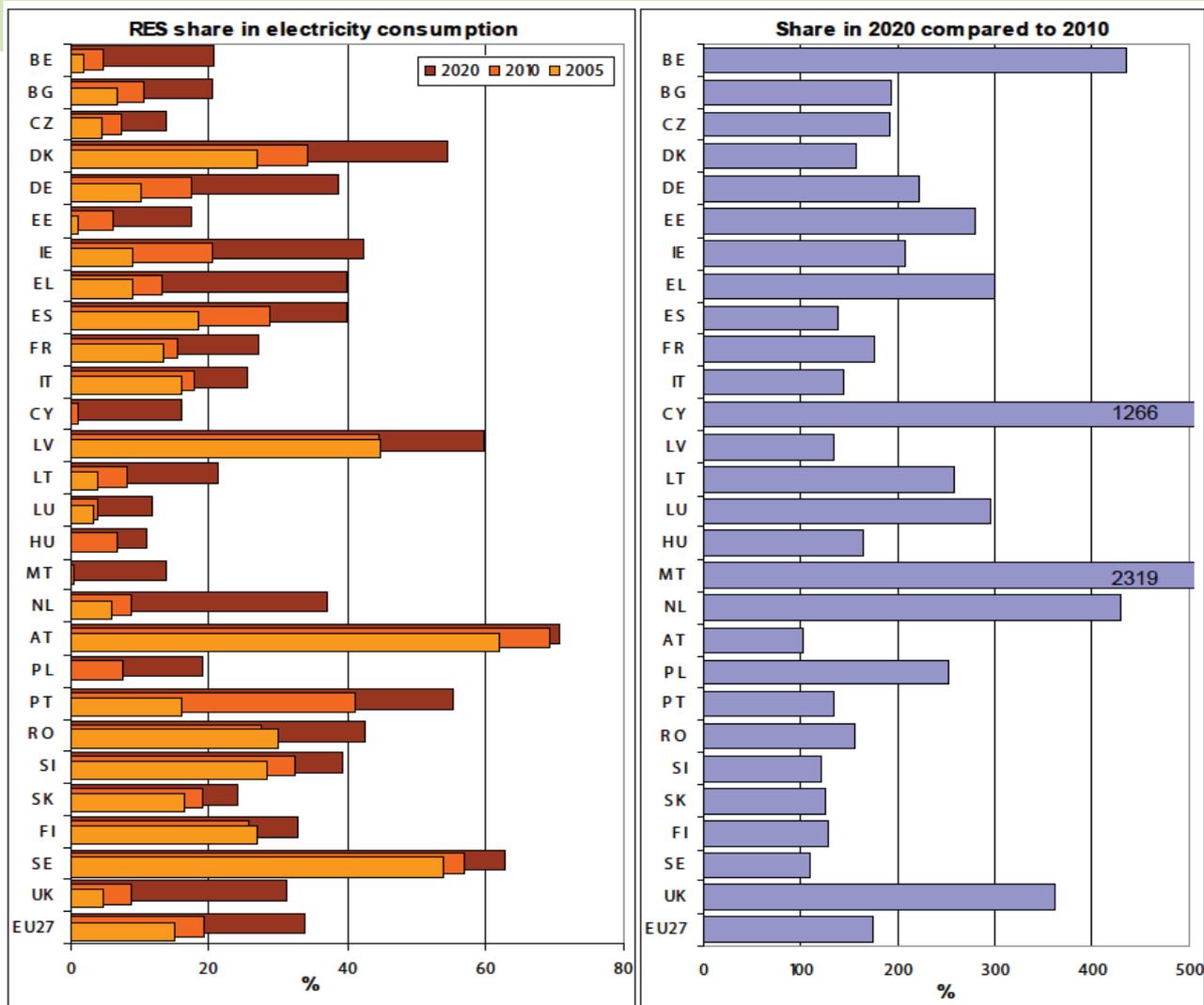
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# UK wind farms – a case in point

- 10 GW of wind currently on the system
- Another 10 GW under construction or with approval
- Another 30 GW of ‘super’ offshore in planning
- In 2020:
  - 10 GW in Scotland
  - 13 GW in England & Wales



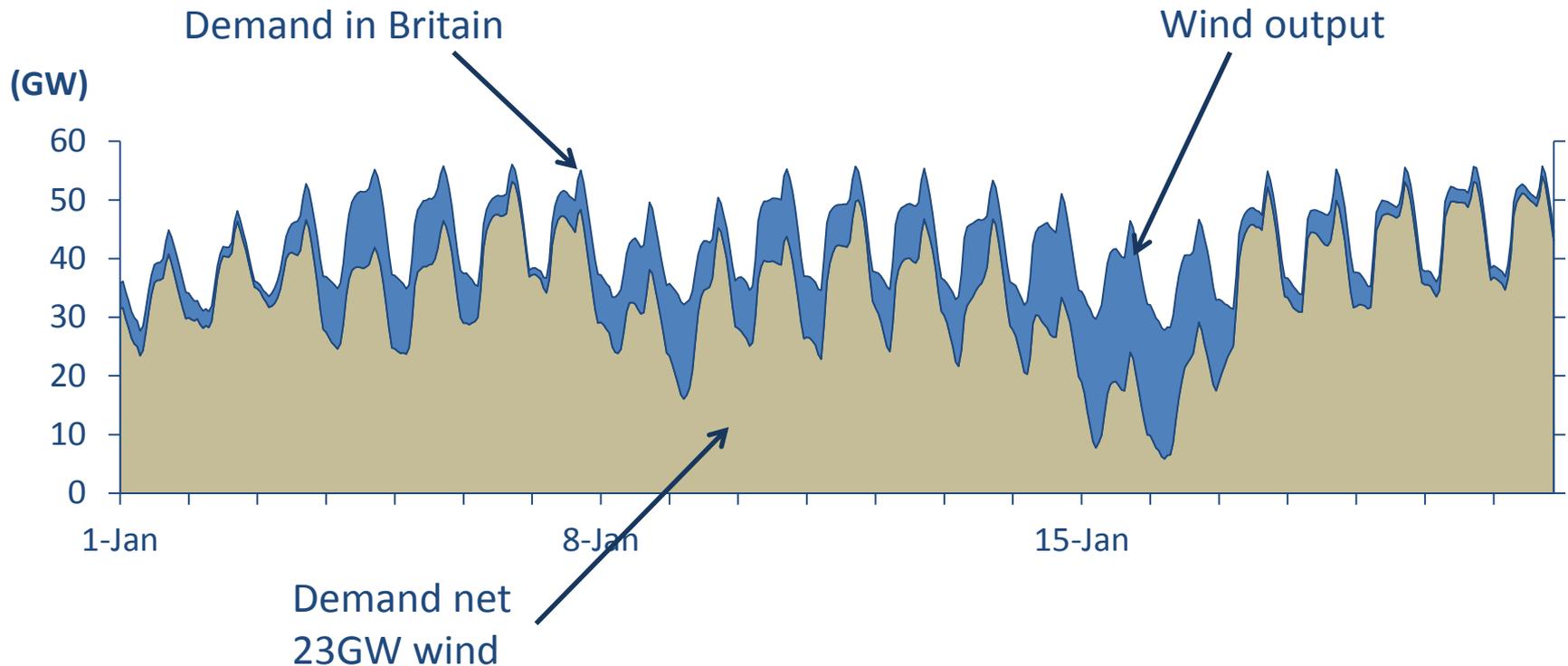
# EU RE aspirations



From: *Technical Assessment of Renewable Energy Action Plans*, JRC 2011

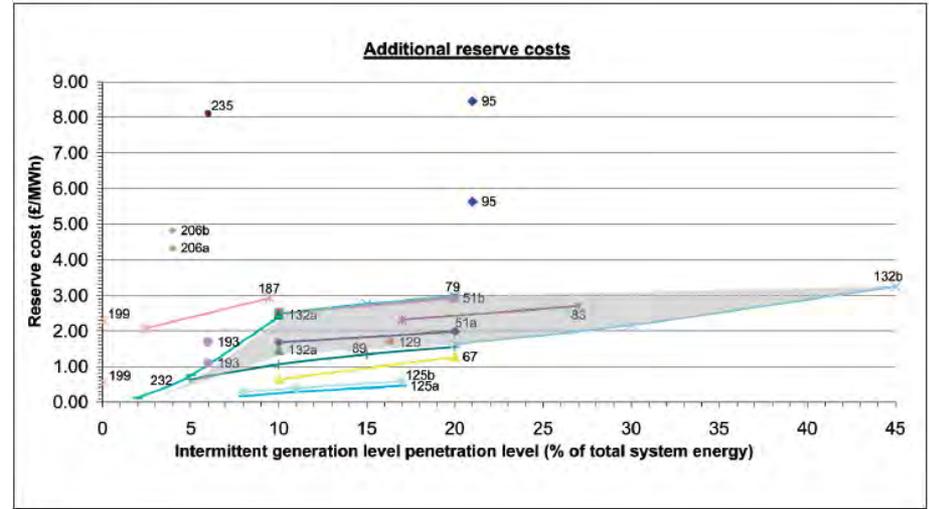
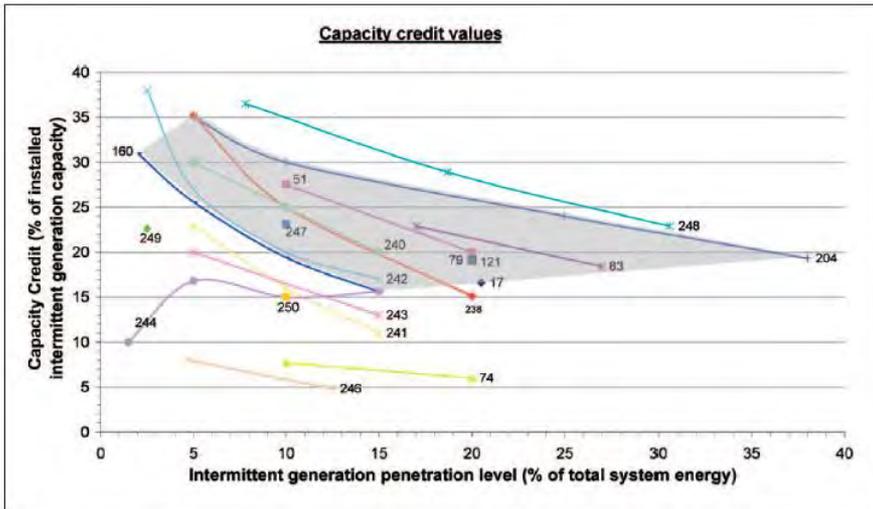
# UK Demand showing impact of 23 GW wind output

- First three weeks of January 2020



Modelling by Iain Staffell and Richard Green, Imperial College Business School

# What we found in 2006



If intermittent generation primarily wind, 20 % of electricity, and is geographically widespread:

- Intermittency costs in Britain would be of the order of 5 to 8 £/MWh of wind output. ~10% of wind costs
- Costs would be higher if renewables are not geographically dispersed, but lower if wider range of renewables developed
- Increases average electricity prices by around 1 %.
- Comparisons between Britain and other countries require caution

## A growing evidence base: Reports reviewed for 2015 update

- 70% address penetration levels beyond 20%
- 50%+ address capacity credit/reliability, balancing, curtailment, CO<sub>2</sub> savings, and network/grid impacts
- 40% deal with impacts on thermal plant operation and longevity
- 30% on impacts on electricity markets and regulation
- Starting to see more attention (around 10% of studies) towards the valuation of renewable output e.g. taking into account time of day and value of dispatchability

# A shifting balance of concerns

## From (2000s)

- Impact on short term balancing capacity needs
- Extent of capacity credit
- Costs of balancing and margins
- Simulation based studies
- Potential for in country smoothing
- Assessing scale of problem

## To (2010s)

- Impact on balance of plant (and generator margins)
- Impact on prices
- Potential for curtailment
- Role of solar and impact on DNOs
- Real world data
- Improved forecasting and regional wind data
- Finding solutions

# What do we need to do?

- Abandon business as usual – accept change and design a way forward, create a system fit for purpose
  - Interconnect
  - Implement best practice in flexible CCGT
  - Maintain capacity margin as cheaply as possible (old plants are only highly polluting if load factors are high)
  - Reduce the costs of storage through international RD&D
  - Accelerate progress in demand management – more data on consumers
  - Smart meters are for *active* demand management not just reduction
- Think about markets
  - Continue to bear down on RE costs (still the major issue)
  - Is a mix of fixed FiTs with energy-only markets a long term option?
  - Ensure capacity markets encourage storage, DSM and interconnection
  - Encourage market coupling/integration but link it to RE goals not incumbent interests
  - Allow enlightened companies to make profits

# Thank you

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Wind power across Europe Jan 13. darkest blue is a 100% capacity factor, white is 0%. Source of the data is the NASA MERRA reanalysis.

With thanks to Iain Staffell of Imperial College Business School

<http://tinyurl.com/wind-decline>

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