

European clean energy policy for the electricity sector

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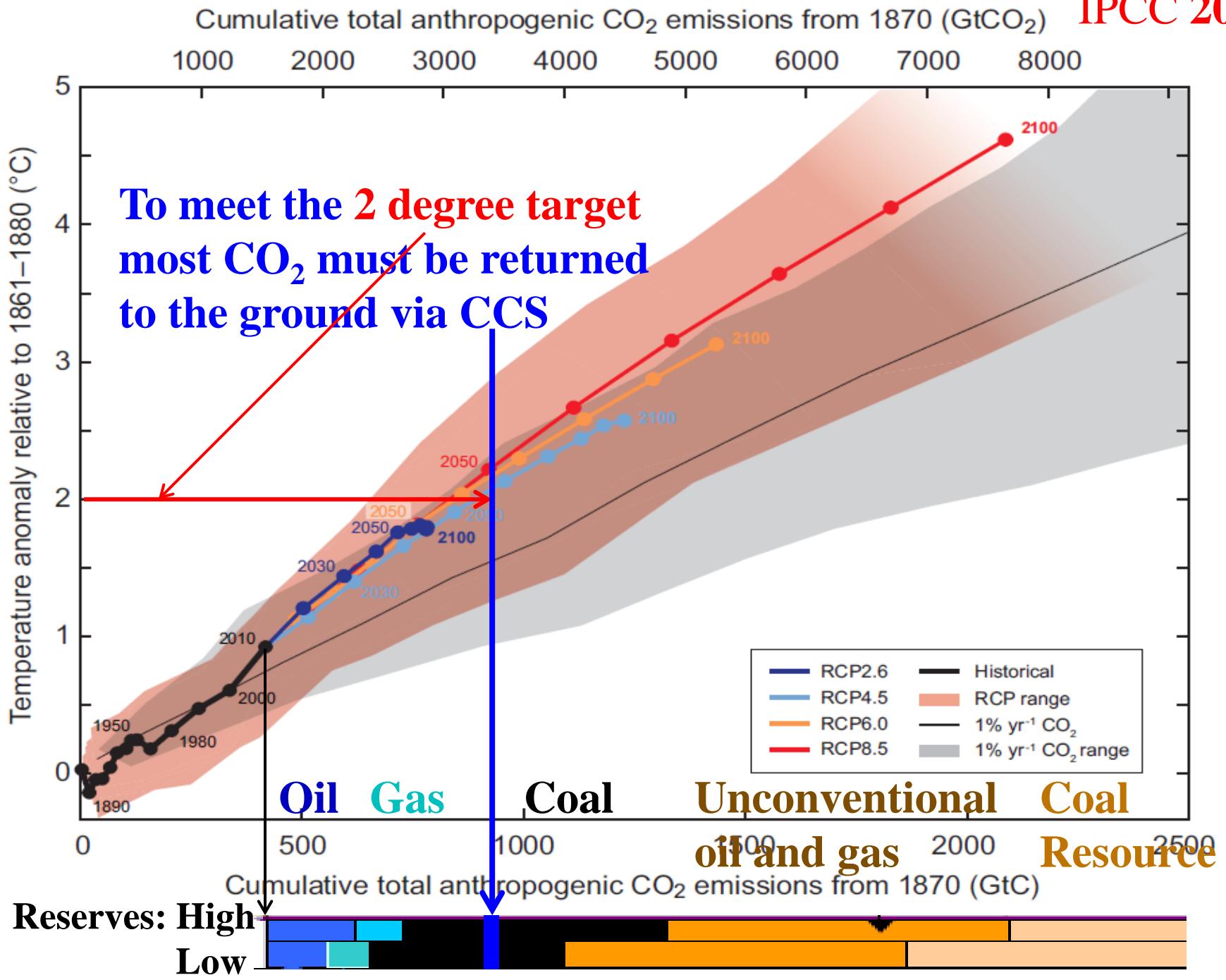
12th AEEE Conference

Salamanca Spain

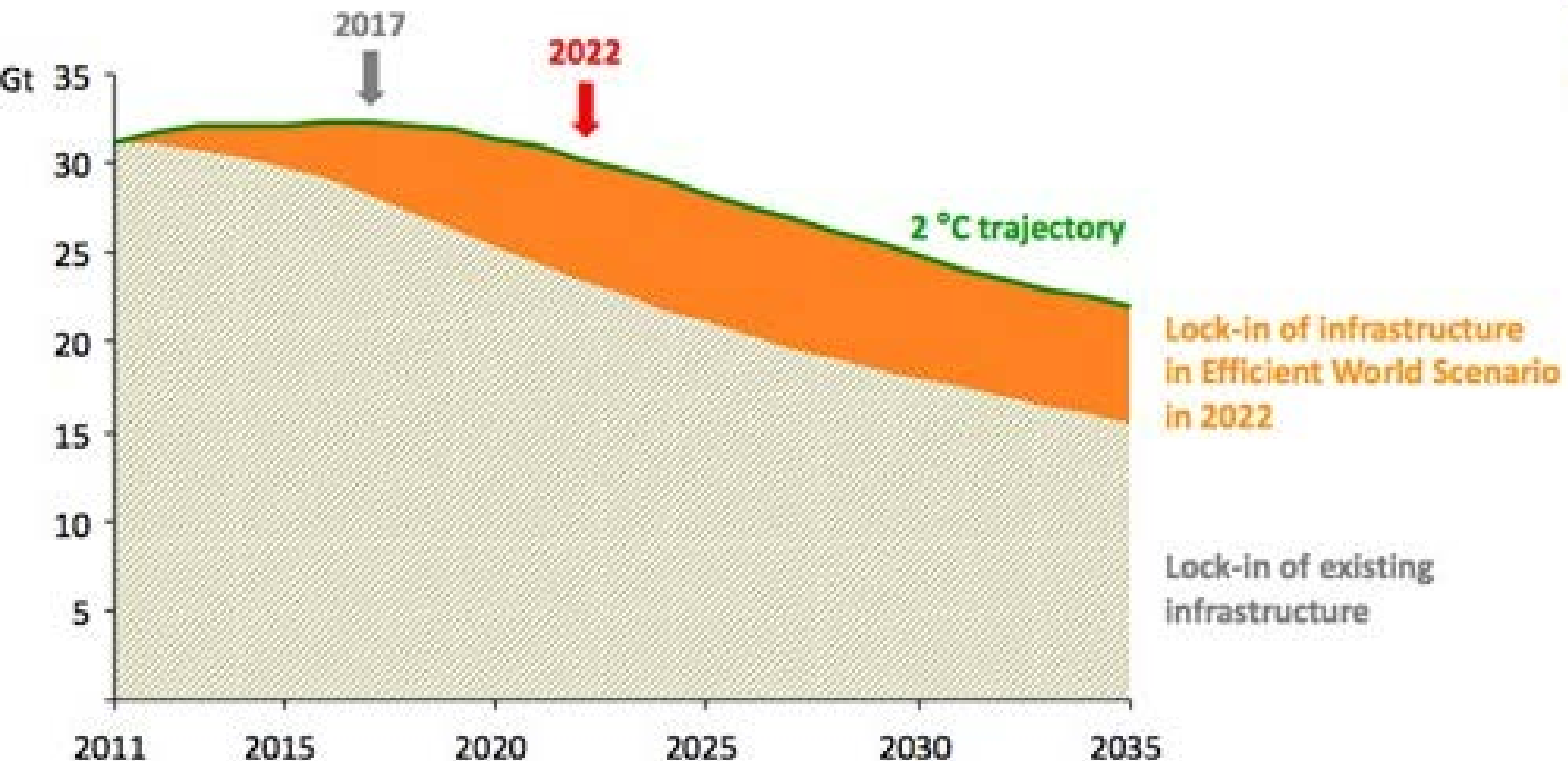
2nd February 2017



- The case for **decarbonizing power**
- The new **Clean Energy Directives**
- What implications for **RES-E support**?
- What implications for **market design**?
 - ⇒ long-term contracts, auctions
- What challenges for **regulation**?
 - growing divergence between marginal & average costs
 - **tariffs and cost-recovery can cause major distortions**
 - regulators need to be more agile and smarter



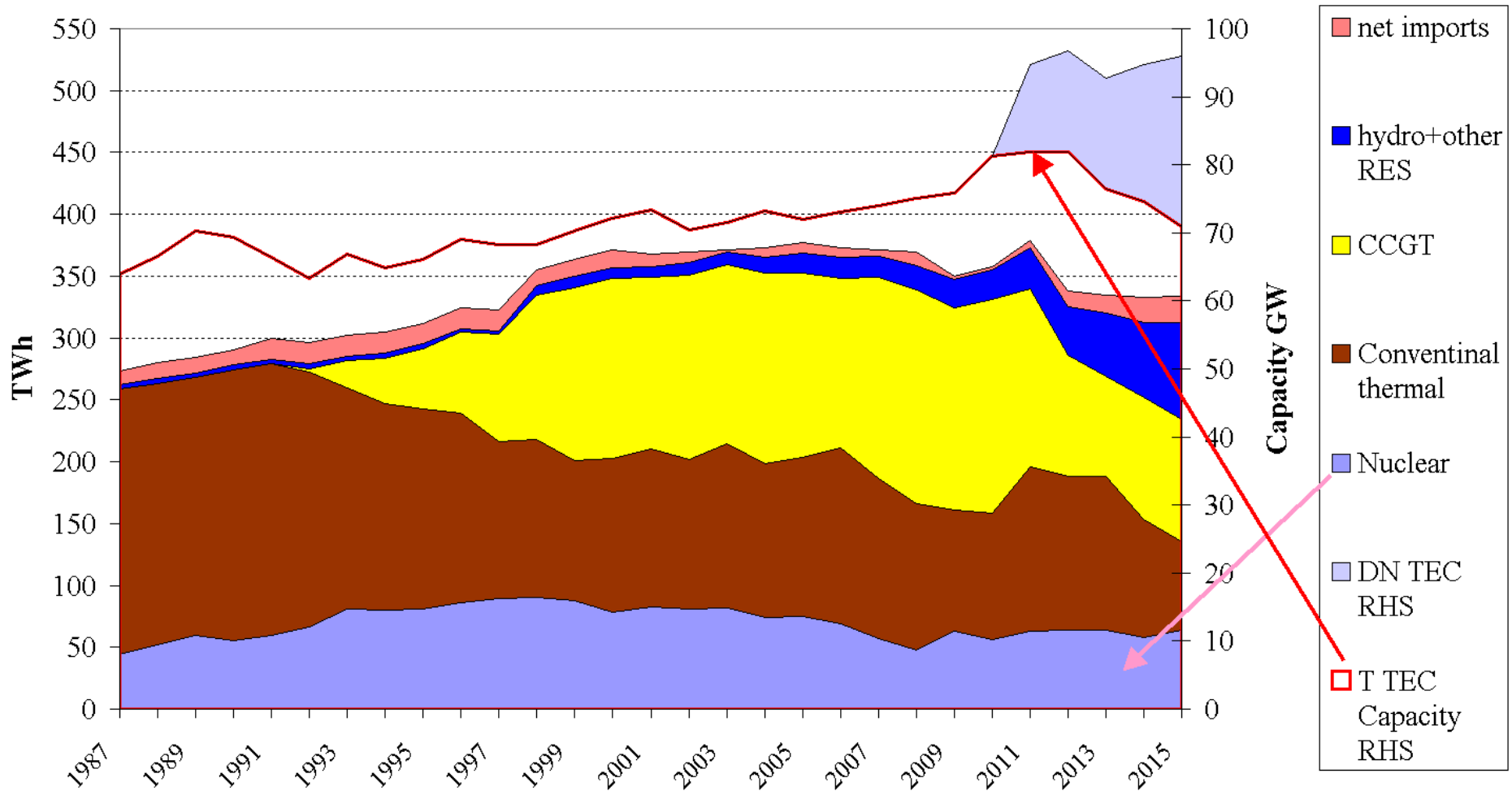
We are already locked in to high carbon emissions from past fuel choices





- **Power sector** key to decarbonising economy
 - Large, easiest, and capital **highly durable**
- Coal-fired electricity has more than **twice** the GHG emissions of gas *and* far higher air pollutants
 - **gas as transition fuel to the low carbon future**
 - But there is lots of coal => **CCS a long-run priority**
- Deployment has dramatically lowered cost of wind, PV
 - justifies **support for R&D and deployment**
- Adequate carbon pricing could **lower fossil fuel prices**
 - ⇒ hard to set the “right” carbon price
 - ⇒ Need contracts and emissions standards?

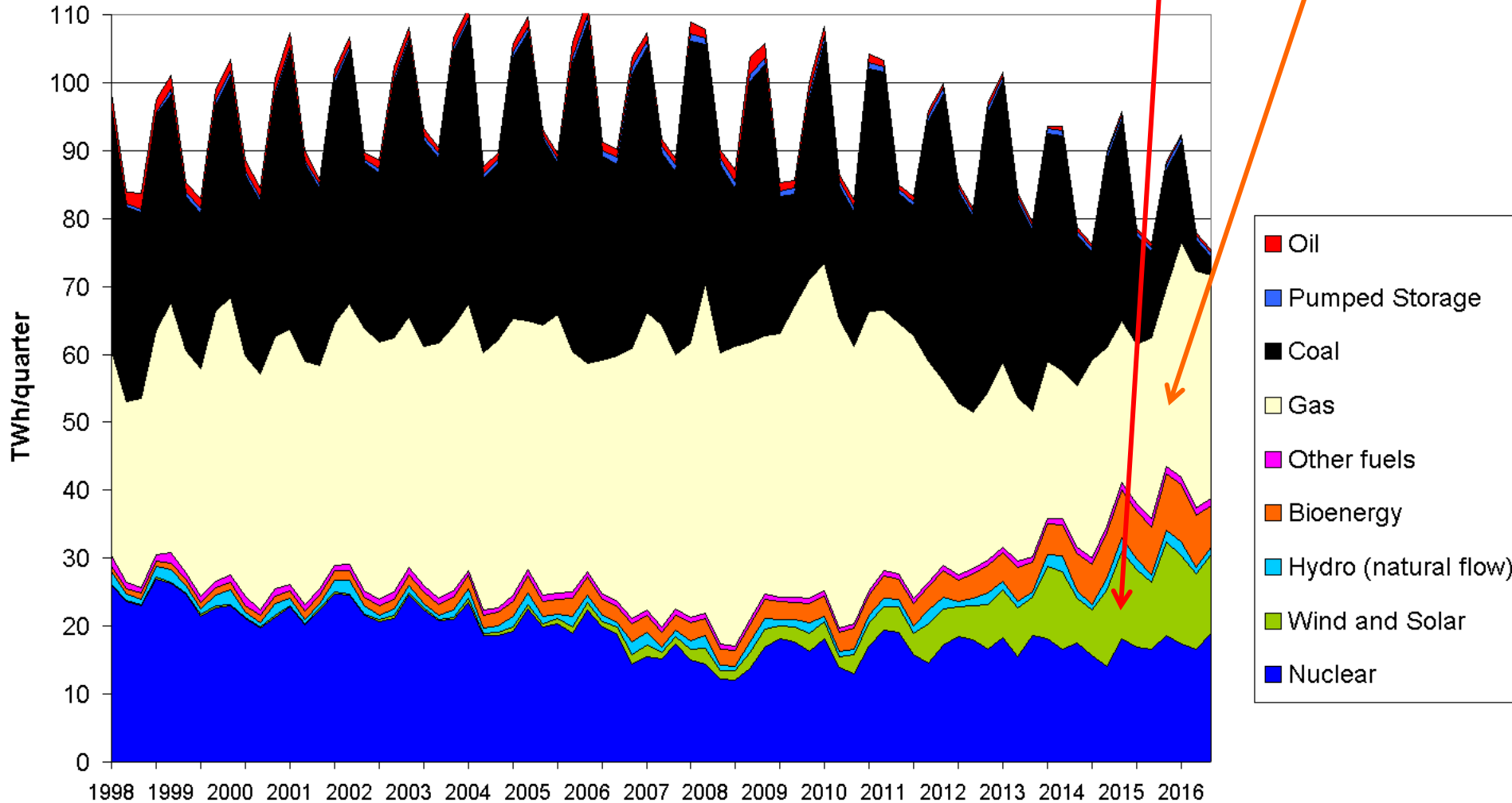
Electricity supplied by, and capacity of, UK generators, 1987-2015





Coal displaced by wind & gas

Quarterly GB electricity generated by fuel





- 3 pillars of EU **Electricity policy**
 - **reliability**, **efficiency** and **sustainability**
- 3 pillars of EU **Climate change policy**
 - price CO₂ via **ETS**, **RES targets**, Strategic Energy Technologies (SET) Plan
- **Energy Union 2015** called for reforms:
 - **Clean Energy COM(2016) 860**;
 - **Renewables** Directive COM(2016) 767
 - Accelerating Clean Energy **Innovation** COM(2016) 763
 - Proposed **reform of ETS** post 2020
 - Others on energy efficiency, security, etc.

- ... **renewable** production needs to be supported through **market-based schemes that address market failures, ensure cost-effectiveness and avoid overcompensation or distortion.** Low-cost financing for capital intensive renewables depends on having a stable investment framework that **reduces regulatory risk.**”
- **Action Point 5:** Creating a seamless internal energy market that benefits citizens, ensuring security of supply, **integrating renewables in the market** and remedying the currently uncoordinated development of **capacity mechanisms** in Member States ***call for a review of the current market design.***



- Nov 2016: **Revised RES Directive** COM(2016) 767
 - 2016 29% of electricity is renewable (RES-E)
 - 2030 target 50+%; **€1 trillion investment needed**
 - price reductions 2009-15: PV 80%; wind 30-40%
- New RES-E has **non-discriminatory grid access**
 - **Priority access** rights grandfathered
- EU target RES energy share 27%, **no MS targets**
 - current plans will fall short => **needs continued support**
 - => **National** energy and climate plans monitored
 - => encourages MS to invest in RES in other MSs
 - MSs **cannot fall below** its 2020 target



- Aim to **increase investor confidence**:
 - Protection against retroactive changes (Art 6)
 - greater policy stability
 - market based cost-effective support (Art 4)
 - => Reduces risk that the support will need modification
 - mandatory move towards **investments aid**
 - mandatory **partial** cross-border participation (Art 5)
 - reflecting **physical** interconnection and regional support funds
 - while respecting MS right to choose energy mix and RES technologies to support



Preamble to **revised RES Directive**

16. “When designing support schemes and when allocating support, Member States should seek to **minimise the overall system cost of deployment, taking full account of grid and system development needs, the resulting energy mix, and the long term potential of technologies.**”

26. ...”(allow) Member States to count energy from renewable sources **consumed in other Member States towards their own**”

- **Least system cost** to meet reliability and CO₂ targets
 - **Coordinate** generation, transmission, distribution
 - **Generation**: timely delivery at right place, size, technology
 - **Transmission**: built, sized and used for efficient dispatch
- Liberalized markets need good price signals
 - **Many of which are regulated (transmission, distribution)**
- Address missing markets to reduce missing money problem
 - Locational marginal pricing **LMP** - nodal not zonal pricing
 - Wholesale price = **SMC + CP** at each node (**LMP**)
 - **CP = LoLP*(VoLL – SMC); \sum LoLP=LoLE**
 - Ancillary service prices to incentivise efficient quality
- Location signals: **long-term** financial contract on LMP
- **Revenue shortfalls: Ramsey pricing on final consumer**
- **Targeted subsidies, efficient risk sharing**

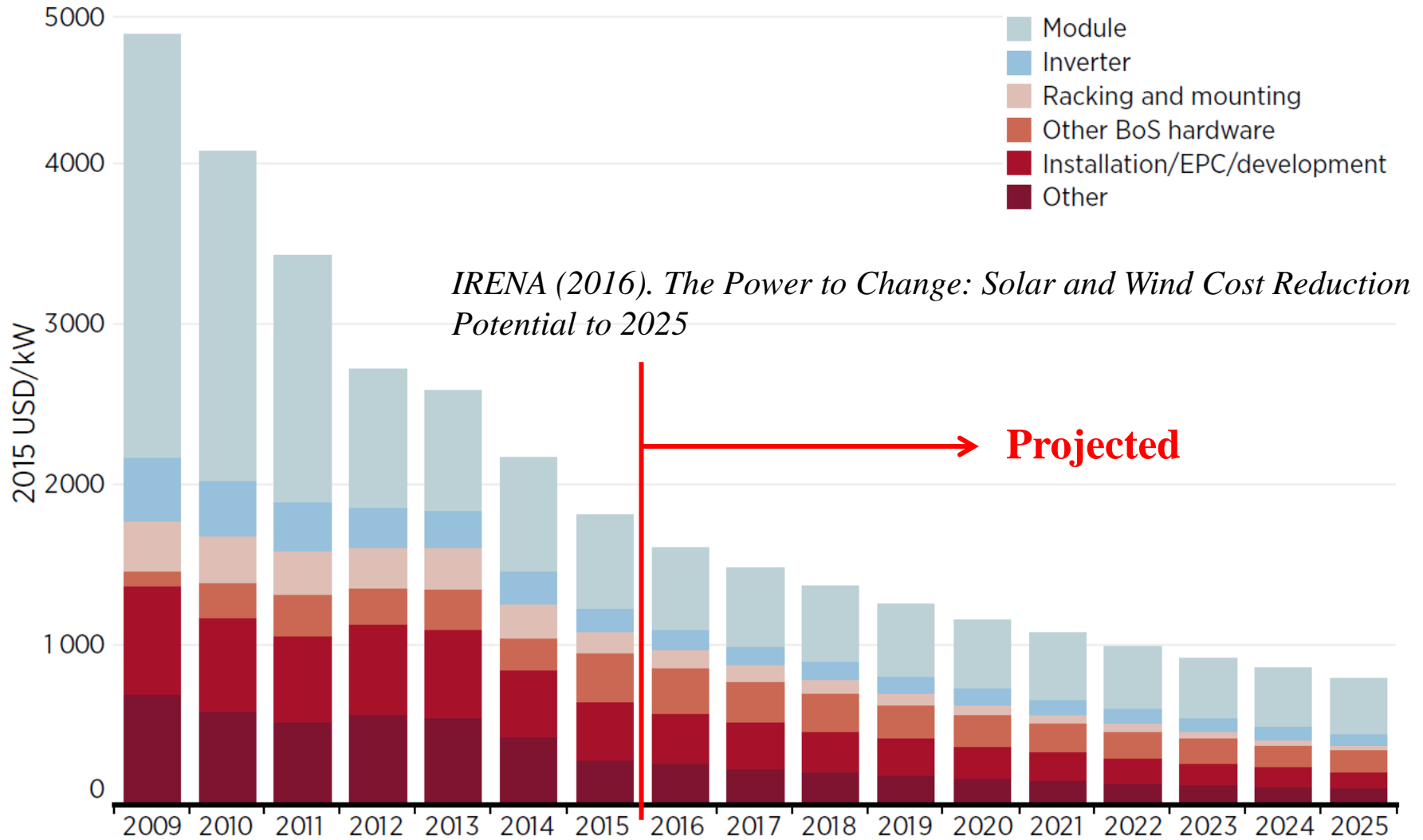


- Art 3 proposes Union funds (financial instruments) to **reduce cost of capital** for RES projects.
- Art 4: ensure RES **responds to market price signals** and support is granted in an open, transparent, **competitive**, non-discriminatory and **cost-effective** manner
- Art 5: support (10+% of new capacity) open to installations located in **other** Member States
- Art 21: Small RES-E self-generators are not deemed energy suppliers; are paid **market value of exports**



Dramatic fall in solar PV prices

FIGURE ES 1: GLOBAL WEIGHTED AVERAGE UTILITY-SCALE SOLAR PV TOTAL INSTALLED COSTS, 2009-2025

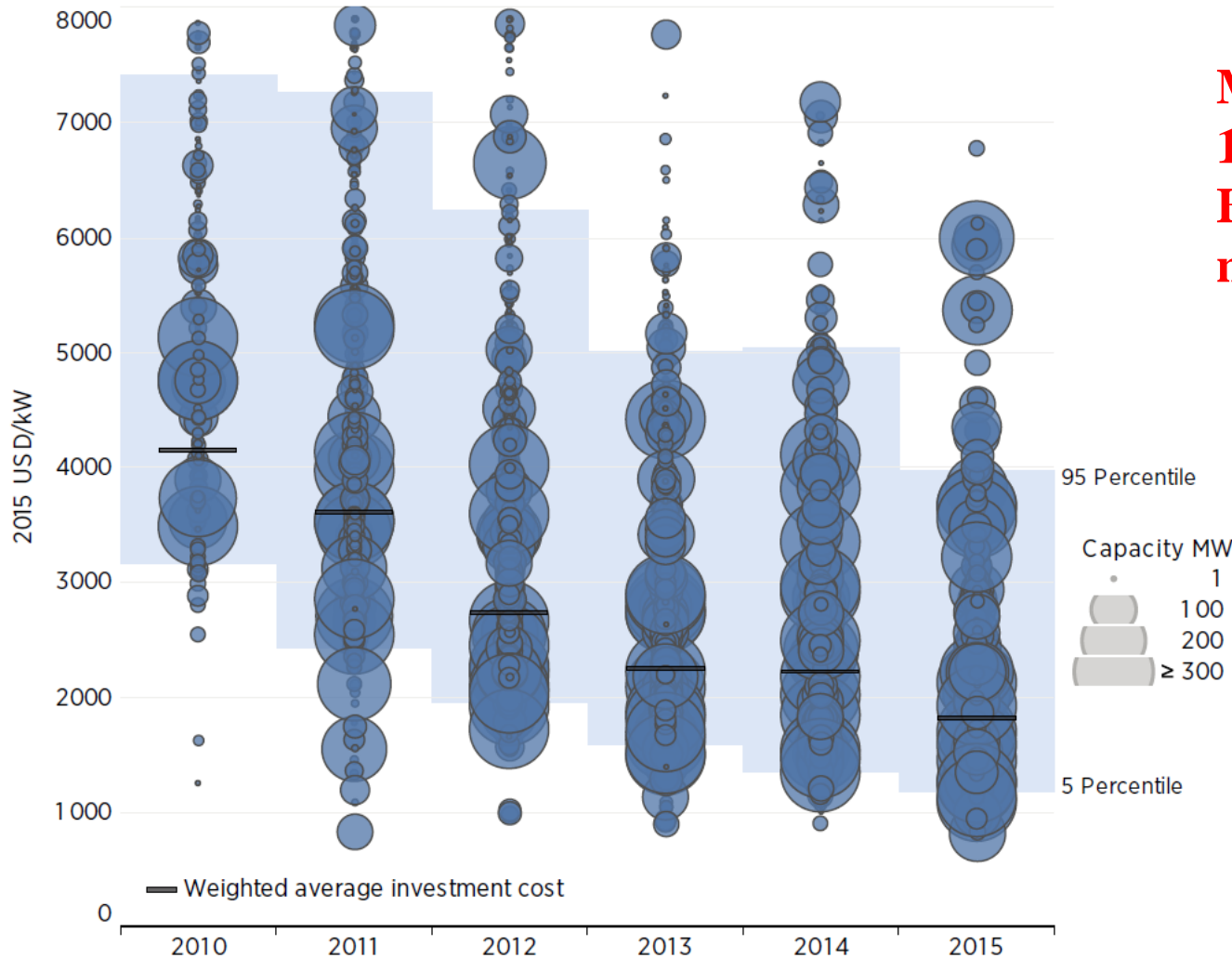


IRENA (2016). The Power to Change: Solar and Wind Cost Reduction Potential to 2025

Projected

PV learning rates are high econs of scale important

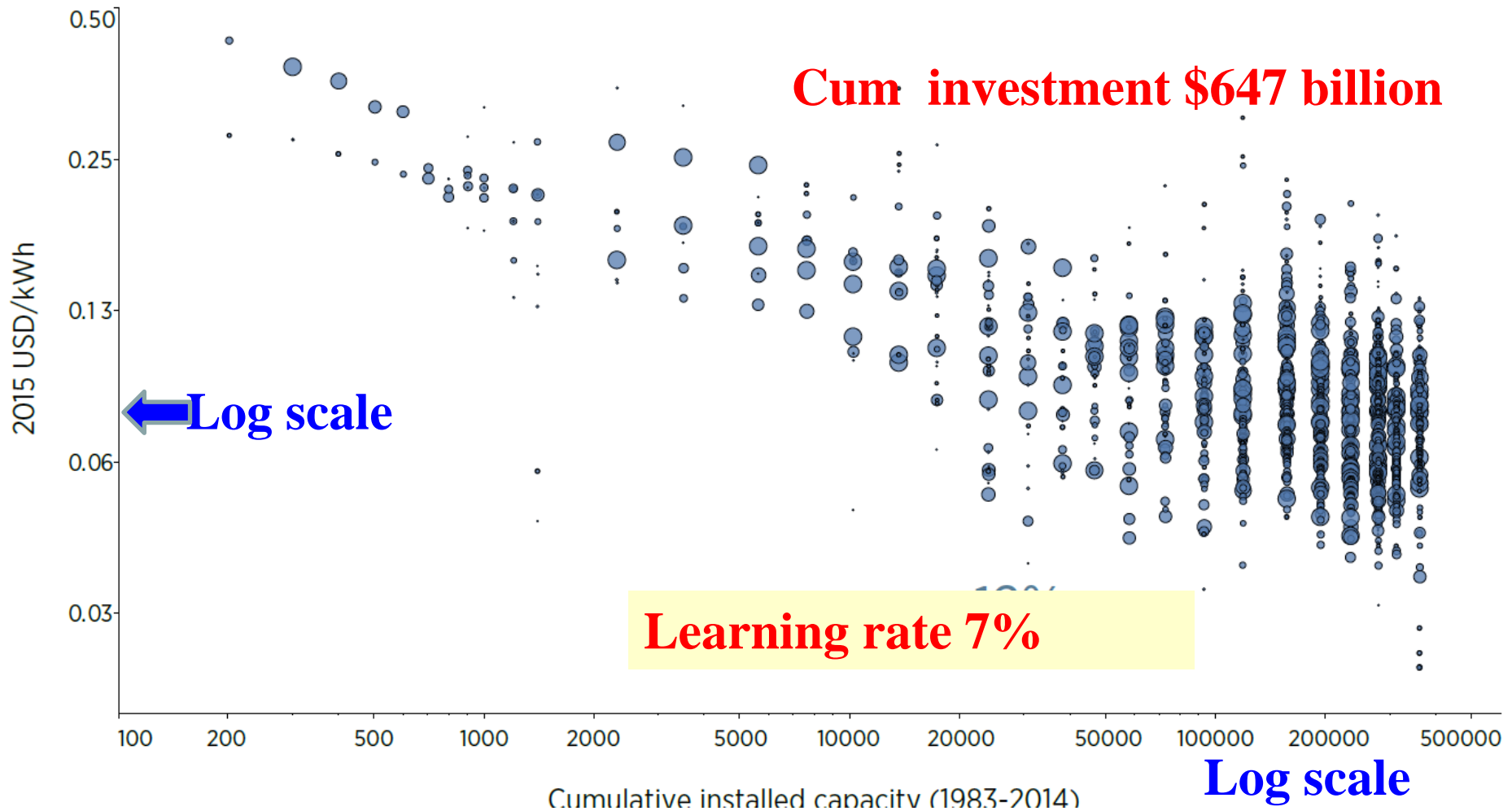
FIGURE 4: TOTAL INSTALLED PV SYSTEM COST AND WEIGHTED AVERAGES FOR UTILITY-SCALE SYSTEMS, 2010-2015



**Module learning rate
18-22%**
**BOS cost excl inverter
now 60% of total**

On-shore wind: taller towers give higher capacity factors

FIGURE ES 3: GLOBAL ONSHORE WIND LEARNING CURVE ANALYSIS, 1983-2014



Source: IRENA (2016)



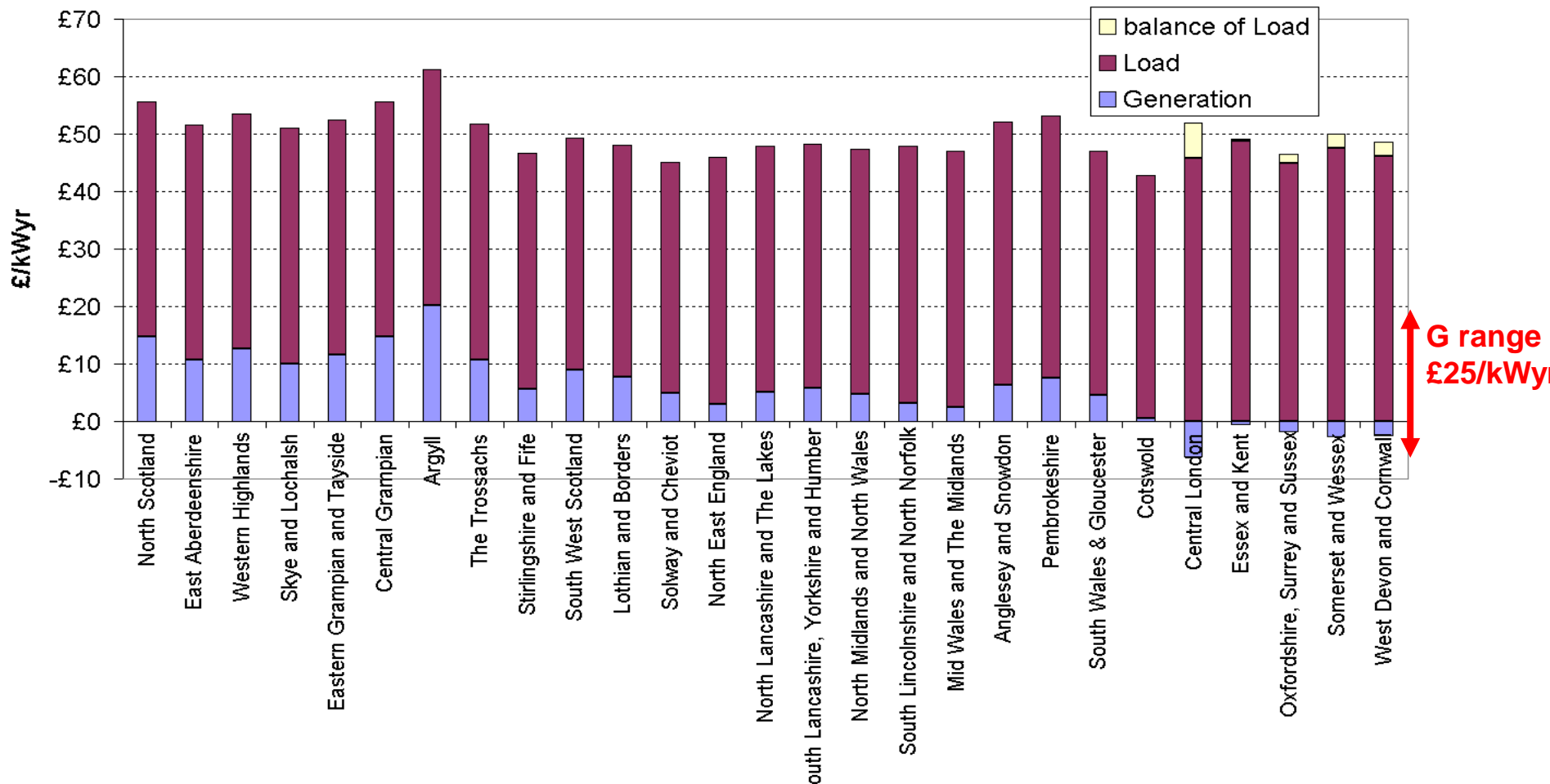
- **Learning spill-overs** need remuneration
 - Almost entirely from **making and installing** equipment
- ⇒ Contract **€X/MWh** for **N MWh/MW**, **Auction** determines **X**
- Reasons:
 - Subsidy **targeted** on source of learning = **investment aid**
 - **Reduces cost** of capital and risk via **debt finance**
 - Addresses failure to set **right CO₂ price**
 - Exposes RES to **current locational spot price**
 - ⇒ incentivizes efficient **location, connection**
 - Does not amplify benefits of high wind/sun
 - Not over-reward favoured locations with same learning
 - **Auction** better than bureaucrats at minimizing cost

Technology		admin price	lowest clearing price	2015/16	2016/17	2017/18	2018/19	Total Capacity (MW)
Advanced Conversion Technologies	£/MWh MW	£140	£114.39			£119.89 36	£114.39 26	62
Energy from Waste with Combined Heat and Power	£/MWh MW	£80	£80				£80.00 94.75	94.75
Offshore wind	£/MWh MW	£140	£114.39			£119.89 714	£114.39 448	1162
Onshore wind	£/MWh MW	£95	£79.23		£79.23 45	£79.99 77.5	£82.50 626.05	748.55
Solar PV	£/MWh MW	£120	£50.00	£50.00 32.88	£79.23 36.67			69.55

Source: DECC (2015)

Foolish bid - withdrew

Generation and Load TNUoS 2016/17



Location choices under LMP and spot pricing for wind

N: 2,500 hrs/yr **With ROCs wind farm inefficiently locates at N**
 $P_N \text{ } \pounds 35/\text{MWh}$
 $\Rightarrow \pounds 87.5\text{k}/\text{MW}/\text{yr}$
 $\Rightarrow \pounds 212.5\text{k with ROC}$ **ROC = $\pounds 50/\text{MWh}$**

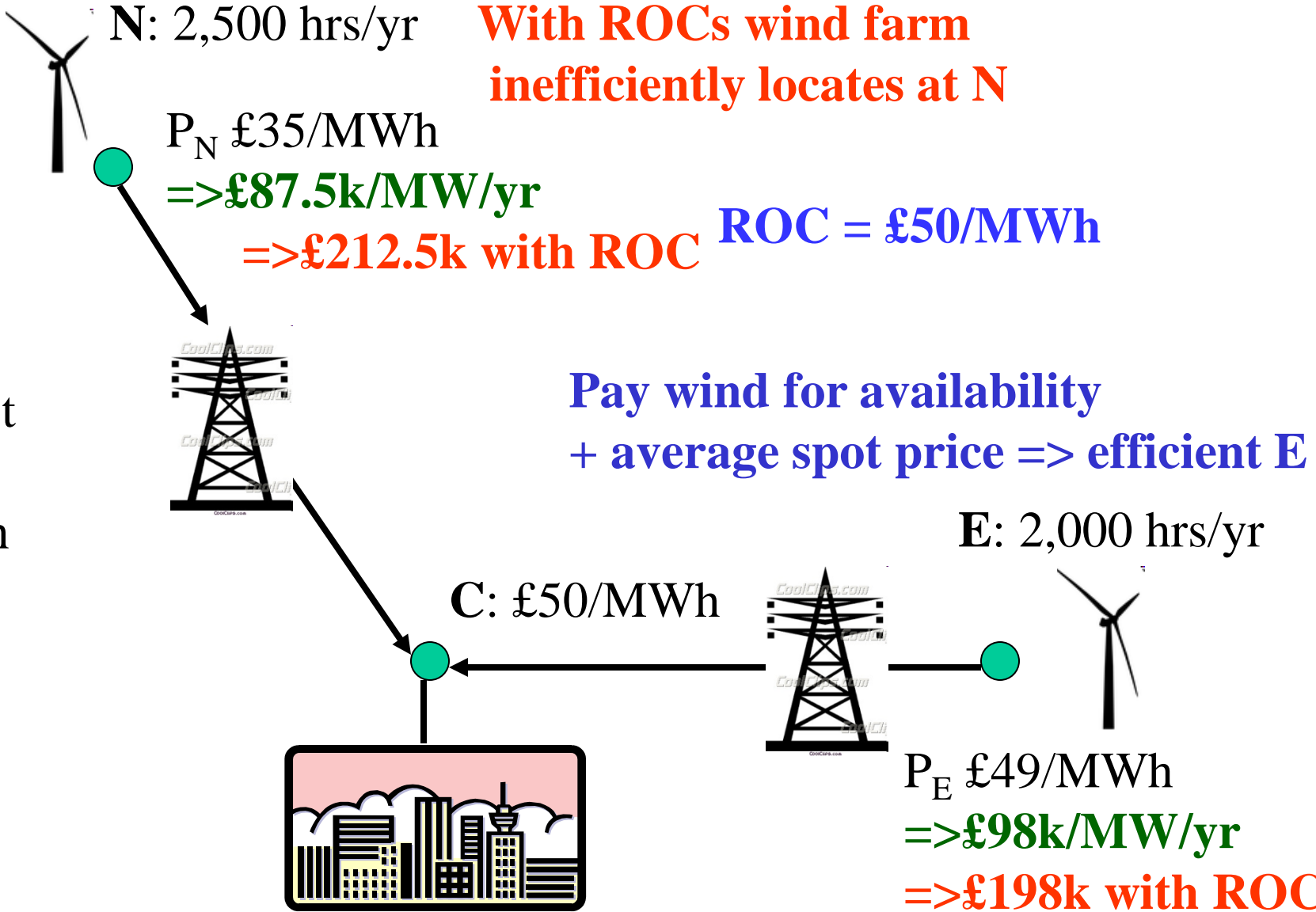
Pay wind for availability + average spot price \Rightarrow efficient E

T cost
 $\pounds 15/\text{MWh}$

E: 2,000 hrs/yr

C: $\pounds 50/\text{MWh}$

$P_E \text{ } \pounds 49/\text{MWh}$
 $\Rightarrow \pounds 98\text{k}/\text{MW}/\text{yr}$
 $\Rightarrow \pounds 198\text{k with ROC}$





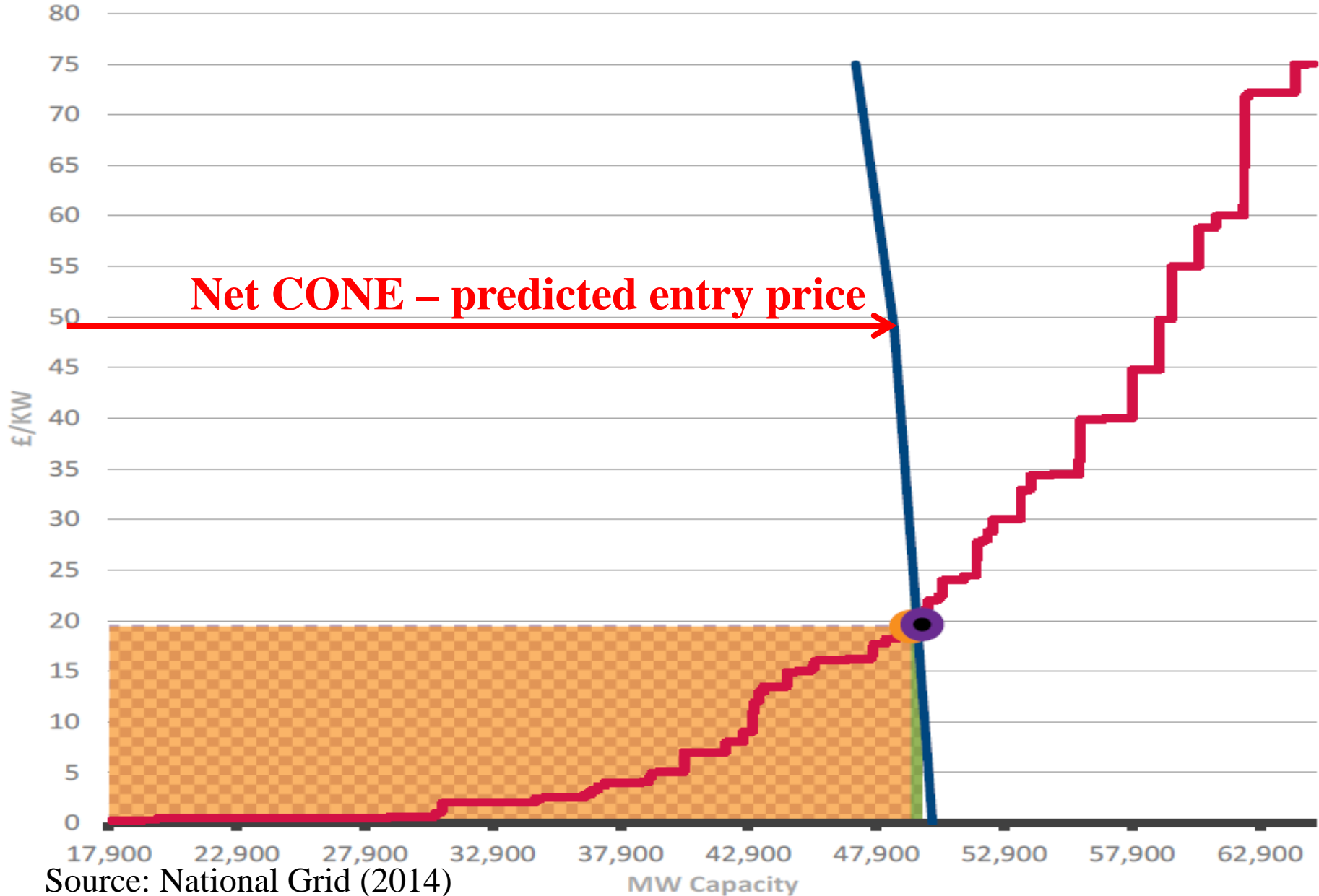
- Ambitious RES targets need **flexible back-up**
 - Normally comes from old high-cost plant = coal
 - EU Large Combustion Plant Directive 2016 limits coal
 - Integrated Emissions Directive further threat to coal
 - GB Carbon price floor + hostility to coal => close old coal
 - high (pre-2015) EU gas prices and low load factors
 - gas unprofitable, new coal prohibited by GB EPS
- **Future prices** now depend on **uncertain policies**
 - on carbon price, renewables volumes, other supports
 - on policy choices in UK, EU, COP21, ...

Long-term contracts the solution?

=> Auctions for contracts



GB 2014 Capacity Auction

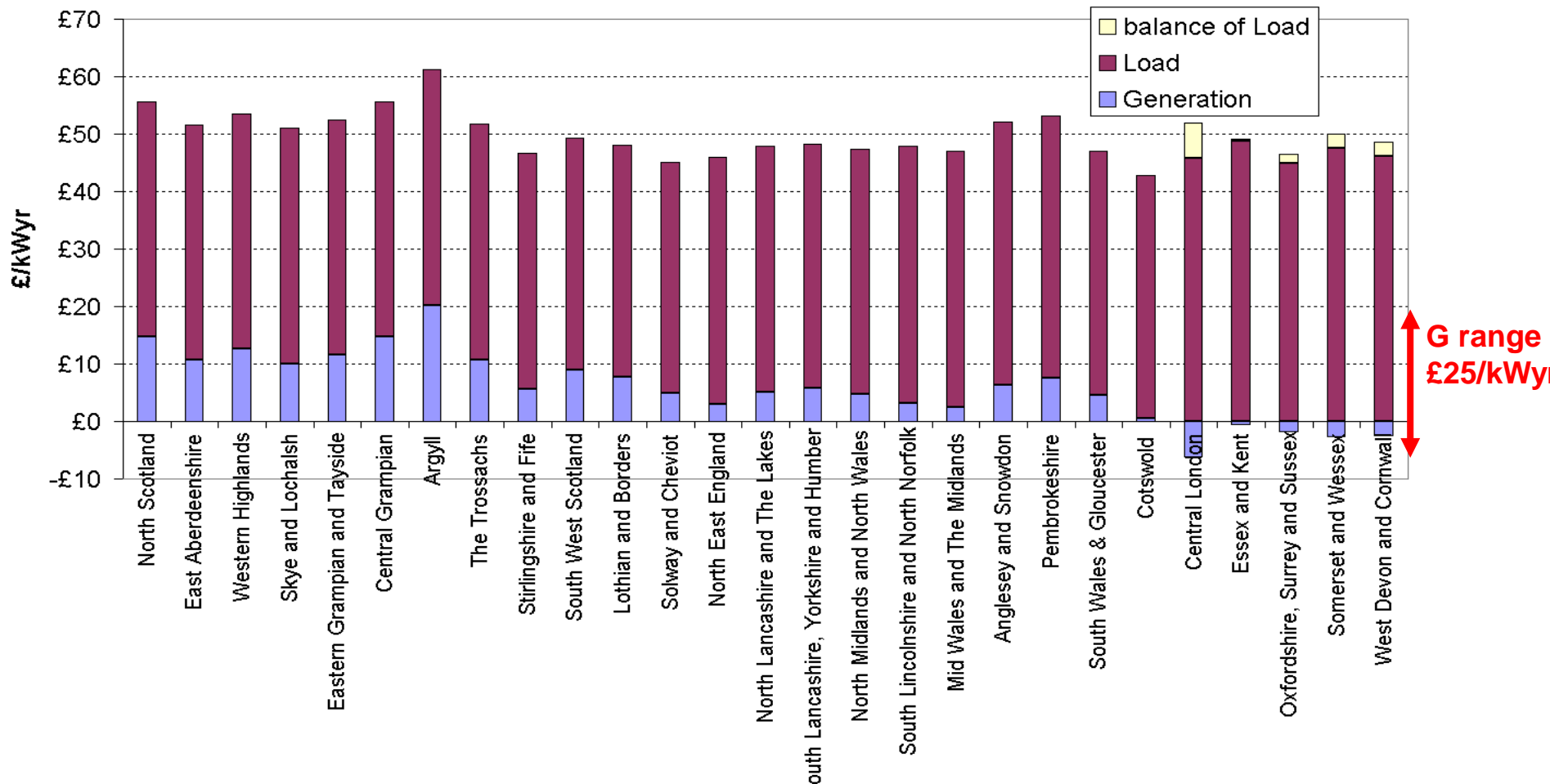


Source: National Grid (2014)

- Transmission-connected generation TG **pays** G TNUoS
 - And 50% of BSUoS
 - Distribution-connected generation DG **receives** L TNUoS
 - And avoids BSUoS
 - TNUoS G + L charge **roughly constant** across zones
 - Rapidly rising from £20/kWyr to £66/kWyr
- => represents **extra** £53/kWyr embedded benefit in 2018/19
- => DG gets £73/kWyr and TG gets £20/kWyr
- => **efficient** locational charge = 10-20% total charge?
 - Rest is revenue levy to pay for grid
- => should be levied on **gross not net final consumption**

Massive distortion

Generation and Load TNUoS 2016/17



- Distinguish **efficient price** and resulting short-fall in **required revenue**
 - Efficient peak T price is marginal expansion cost
 - At best 30% average cost, less if demand falling
 - Ramsey-Boiteux pricing => “tax” inelastic demand
 - Diamond-Mirrlees: **tax only final consumers**
- ⇒ T&D revenue shortfall on final consumption **not** net demand (at GSP or premises)
- ⇒ reduces embedded G benefit from £60 to < £10/kWyr
- ⇒ **Regulators** need to compute **efficient T&D tariffs**
- ⇒ **and move faster. Auction in 1 day grants 15-yr contract**



- ETS CO₂ price is neither **adequate, durable nor credible**
 - Reforms to date had no impact
- setting the right CO₂ price is **difficult**
 - **social cost** of future harm **hard to estimate**
 - **break-even price highly sensitive to price of fossil fuel**
- Ideally fossil generation should pay corrective tax
 - GB has **carbon price support**- brings EUA price up to “right” level
- If not use emissions performance standards?
- Or, RES subsidy = shortfall in efficient wholesale price?

But auctioned capacity subsidy simpler



For supporting zero-carbon generation:

- CO₂ intensity of natural gas is 0.19 tonnes/MWh_{th}
- Gas price ↓ \$1/MWh_{th} => CO₂ price ↑ \$5.3/tonne
- CO₂ intensity of coal is 0.34 t/MWh_{th}
- Coal price ↓ \$1/MWh_{th} => CO₂ price ↑ \$2.9/tonne
- Prices of both coal and gas very volatile
 - UK 2020 gas price range: £15.7/MWh_{th} => CO₂ range £82/t

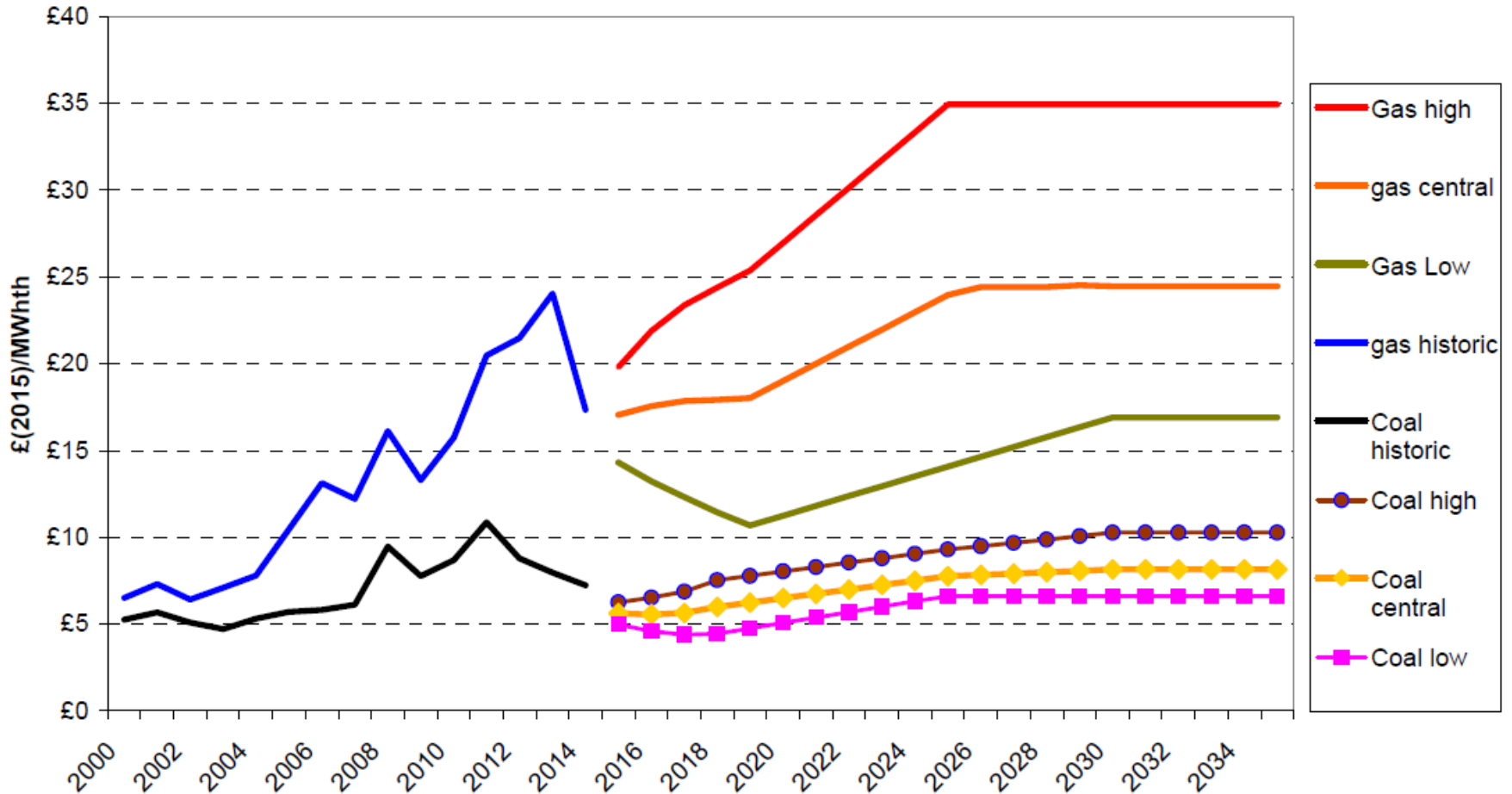
⇒ setting a CO₂ price highly sensitive to fuel price

For switching from coal to gas:

- Gas price ↑ \$1/MWh_{th} => CO₂ price ↑ \$3.9/tonne

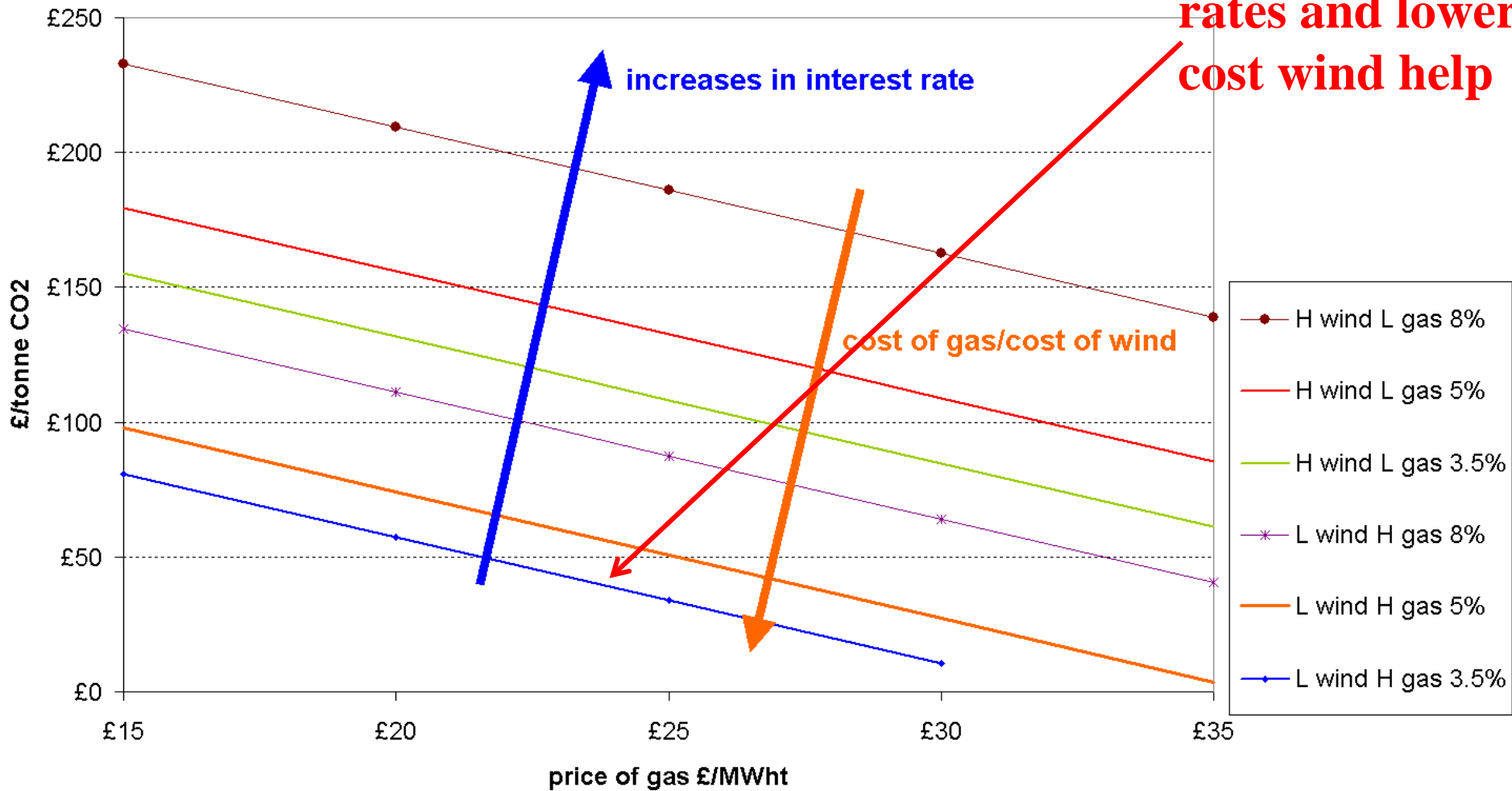


UK major generators: real fuel prices

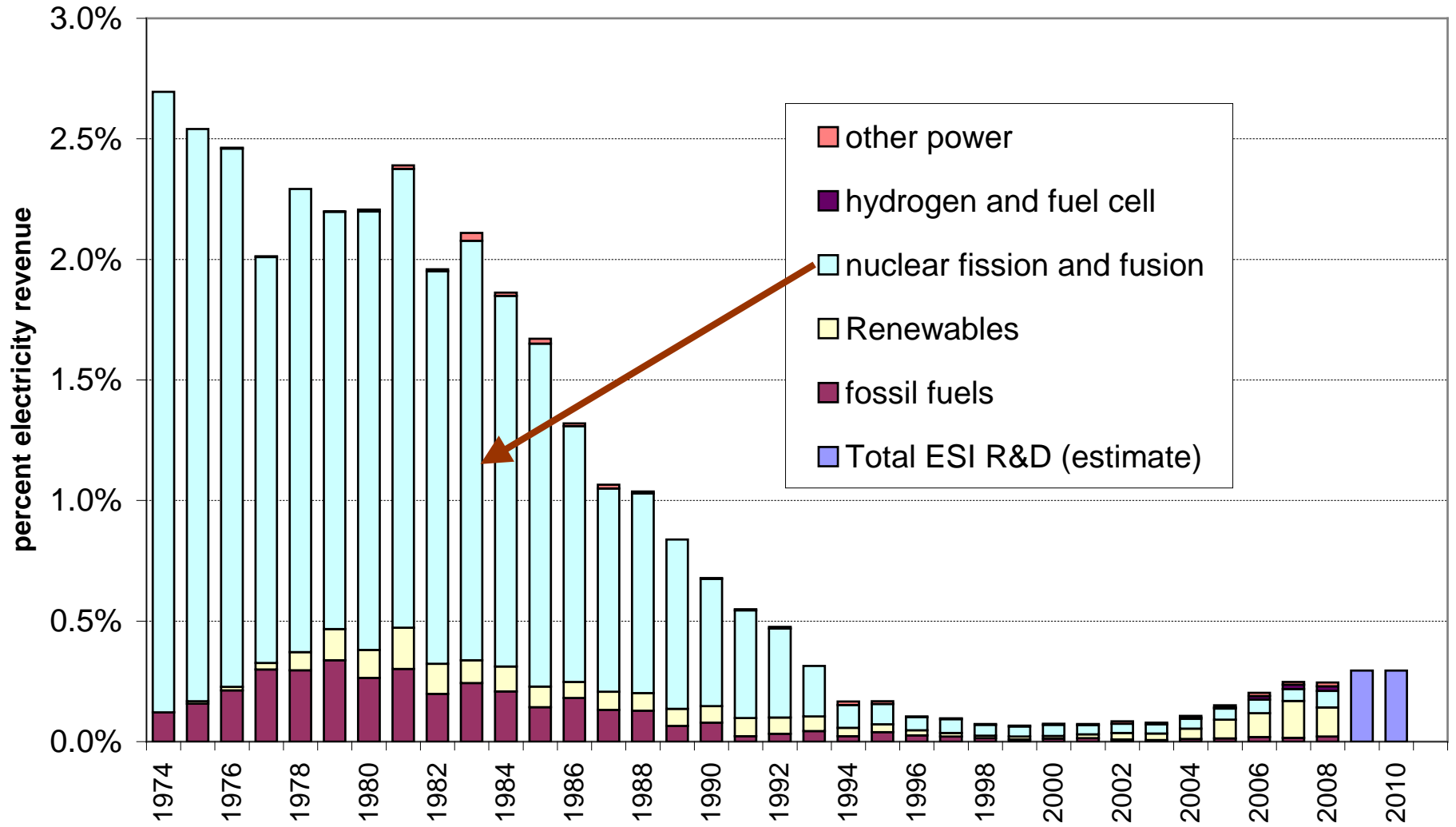


Hard to set the “right” carbon price

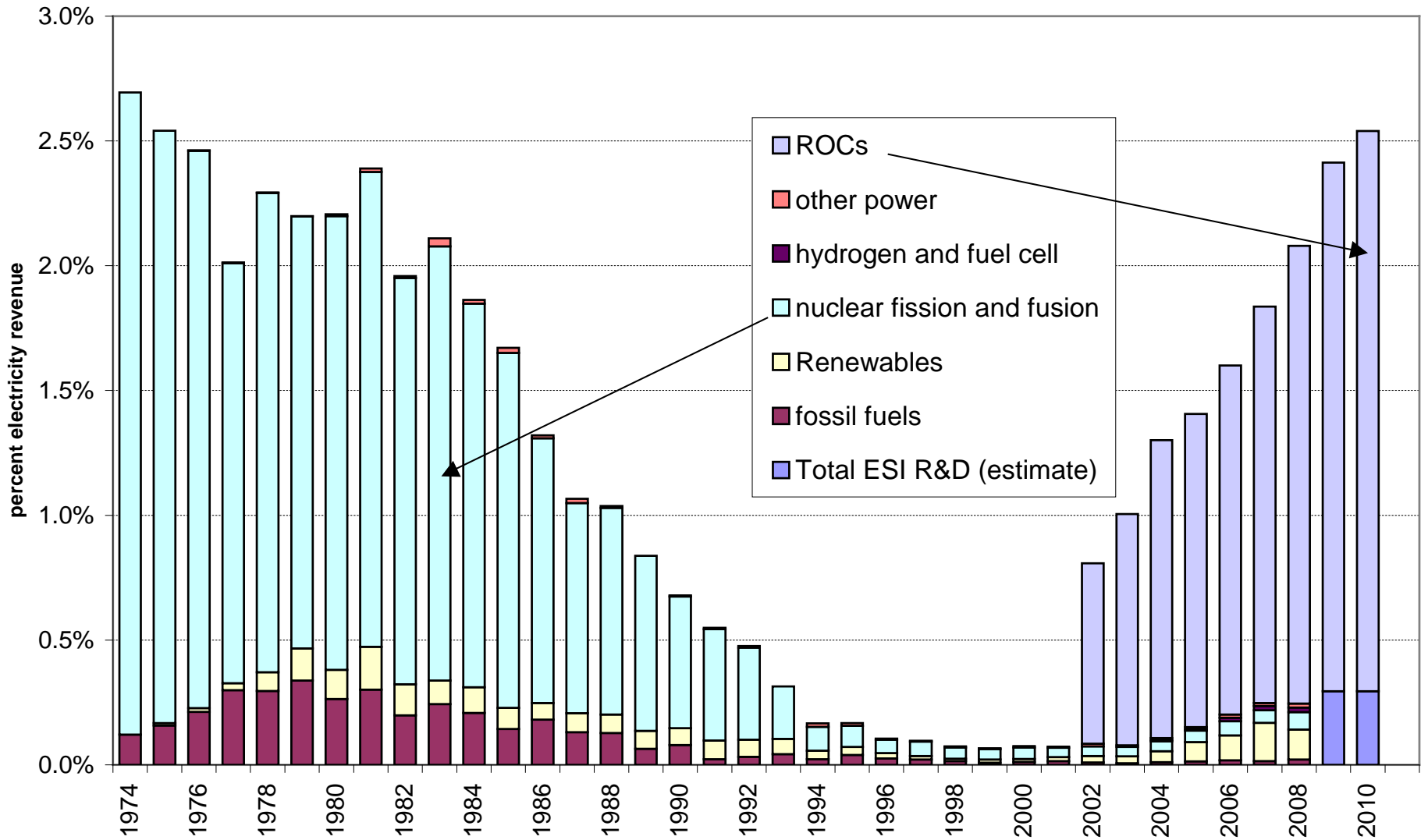
Breakeven CO2 price vs gas price



UK Electricity R&D intensity



UK Electricity R&D intensity





- Third pillar of climate policy was the **Strategic Energy Technology (SET) Plan**, updated 2015
 - **Doubled** low carbon innovation spending 2007-15 (from low level)
 - supported via Horizon 2020 (Energy Demo projects), European Fund for Strategic Investments, NER, etc.
 - prospective **2021 Innovation Fund** to imitate ARPA-E
 - but **too little funding** - **€1 trillion for RES** investment, **€10 bn for clean energy research**
- success of original **20-20-20 Directive** was **club funding**
 - Each MS allocated a target RES share and then funds it
- Do the same for clean energy funds **including innovation**
Specify share of GDP, funds allocated by competition
 - support cost for RES as well as R&D – **EU-wide auction**



- Need an efficient way of raising **revenue shortfall**
 - => Ramsey mark-up: cause **equi-proportional demand fall**
 - => Diamond-Mirrlees: distortions on **final consumption**
- Efficient retail tariffs more often closer to wholesale prices
 - => cost-recovery mark-ups on less elastic demand
 - => embedded generation (e.g. PV) paid same as other RES
adjusted for marginal T&D costs and losses
 - => **avoid net metering**: domestic generation paid efficient price, consumption pays additional cost-recovery charge
- encourages **efficient scale/location of RES**



The good, the bad and the ugly

- **Good**: Each jurisdiction is facing similar problems
 - *and trying out a variety of solutions*
- Learning from elsewhere and experimenting essential
 - ⇒ challenge funds to try new ideas and test regulations
 - ⇒ copy Ofgem's Network Innovation Competitions
- **Bad**: Auctions + new technology => **rapid irreversible decisions**
 - need smarter, quicker responses to ensure tariffs are suitable
- **Ugly**: tension between efficient and “fair” pricing can led to **inefficient and inequitable outcomes**



- The priority is to **decarbonise electricity**
 - To avoid long-term lock-in
 - EC Clean Energy Directive identifies **good principles**
=> clear guidance for good policy instruments
- Setting **a carbon price** is problematic
 - complementary instruments and contracts needed
- Subsidiarity – MS's design RES & CRM policies
 - market responsive requires auctions and good network tariffs
 - **auctions and contracts** avoiding trade distortions between MSs
- Solidarity – MS agree **joint funding for innovation**
 - fund public goods like innovation, learning from general taxation
 - allocated funds raised competitively across all MSs

CCS	Carbon Capture and Storage
CfD	Contract for Difference
CONE	Cost of New Entry
CP	Capacity payment
CRM	Capacity Remuneration Mechanism
DG	Distribution-connected Generation
ETS	Emissions Trading System
FTR	Financial Transmission Right
GHG	Greenhouse gas
GSP	Grid Supply Point (connection to grid)
G	Generation
L	Load
LMP`	Locational Marginal Pricing (Nodal pricing)
LoLP	Loss of Load probability
LoLE	Loss of load expectation in hrs/yr = reliability standard
MS	Member State
R&D	Research and Development
RES	Renewable energy/electricity supply
RES-E	Renewable energy supply in electricity
ROC	Renewable Obligation (i.e. green) Certificate
SMC/P	System Marginal Cost/Price
T&D	Transmission and Distribution
TG	Transmission-connected generation
TNUoS	Transmission Network Use of System, G =Generation, L=Load
VOLL	Value of Lost Load

References to the EU *Clean Energy* proposals

- <http://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition> gives links to the various directives
- Clean Energy For All Europeans, COM/2016/0860 final at <http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1481278671064&uri=CELEX:52016DC0860>