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RETAIL AND WHOLESALE ELECTRICITY MARKETS UNDER STRESS

LESSONS LEARNT FOR THE FUTURE OF MARKET DESIGN IN EUROPE

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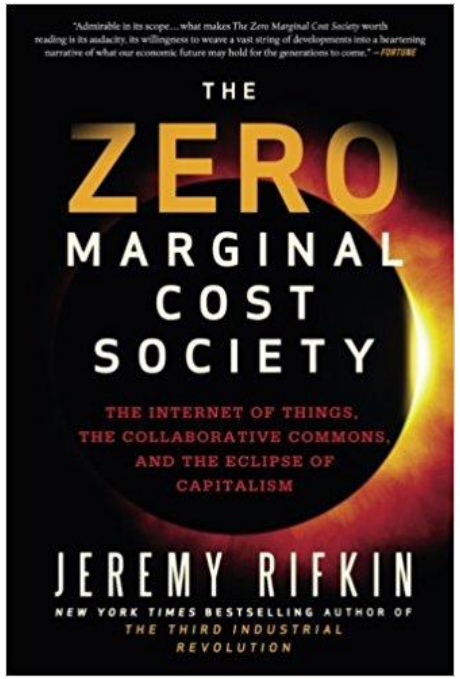
ISSUES IN MARKET DESIGN IN 2018

- The **theory of electricity markets <u>was</u>** creaking under the rise of renewable electricity supply (RES), very high RES is potentially an ‘zero marginal cost’ (a la Rifkin) system.
- **Competition policy will be influenced by** market design.
- Market design is a function of which technologies we seek to support and hence **will be significantly determined by wholesale prices,** hence we will include modeling in our analysis.
- **Mid-2020s prices likely to guide 2030 market design** discussions in reality in Europe.



KEY QUESTIONS THEN FOR EUROPEAN MARKET DESIGN

A.

How well is the current market design working, as the roll out of RES generation continues?

B.

What limited adaptions to the current market design might be possible in the timeframe to 2025?

C.

In the context of A. and B., will there be a tipping point in the current energy market, when the penetration of RES might be so high as to cause the need for a more radical market redesign to address the investment signal issue?

THREE OPTIONS FOR THE FUTURE THEN

- **A continuation of the current situation**, with most generation investment being determined by government and ad hoc ancillary services solutions to financing fossil fuel plants.

- **A gradual (successful) evolution in market design**, where subsidies to RES fall, energy market prices increase and reformed ancillary services markets become more significant to support fossil fuel power plants required for security of supply and VRE becomes self-financing in the market.

- A radical change in market design to move to a sustainable new arrangement, e.g. internet style rationing of electricity demand in response to system condition.

2018 PROBLEMS WITH EXISTING ELECTRICITY MARKETS

- **Problems of demand inelasticity** (Joskow and Tirole, 2007) heightened by VRE (Cramton, 2013).
- **The social and political acceptability of scarcity prices may be low.** This leads to a root cause of the "missing money" problem: politicians and regulators tend to impose price caps in wholesale electricity markets (Hogan, 2005), implicitly or explicitly, to dampen price rises and limit the potential for market power abuse.
- **Wholesale prices are uncertain** (e.g., due to potential price caps and other regulatory interventions) and hence investors are not able to recoup their capital costs through scarcity rents and there may be expectation of capping Neuhoff et al. (2016).
- Indeed, as Newell et al. (2012) noted, in practice, as is now well known, actual electricity markets often produce results where energy and ancillary services prices may not be sufficient to support new investment. Partly, this is because a **new investment relying on volatile market revenue streams is risky and subject to cannibalisation by future investments.**

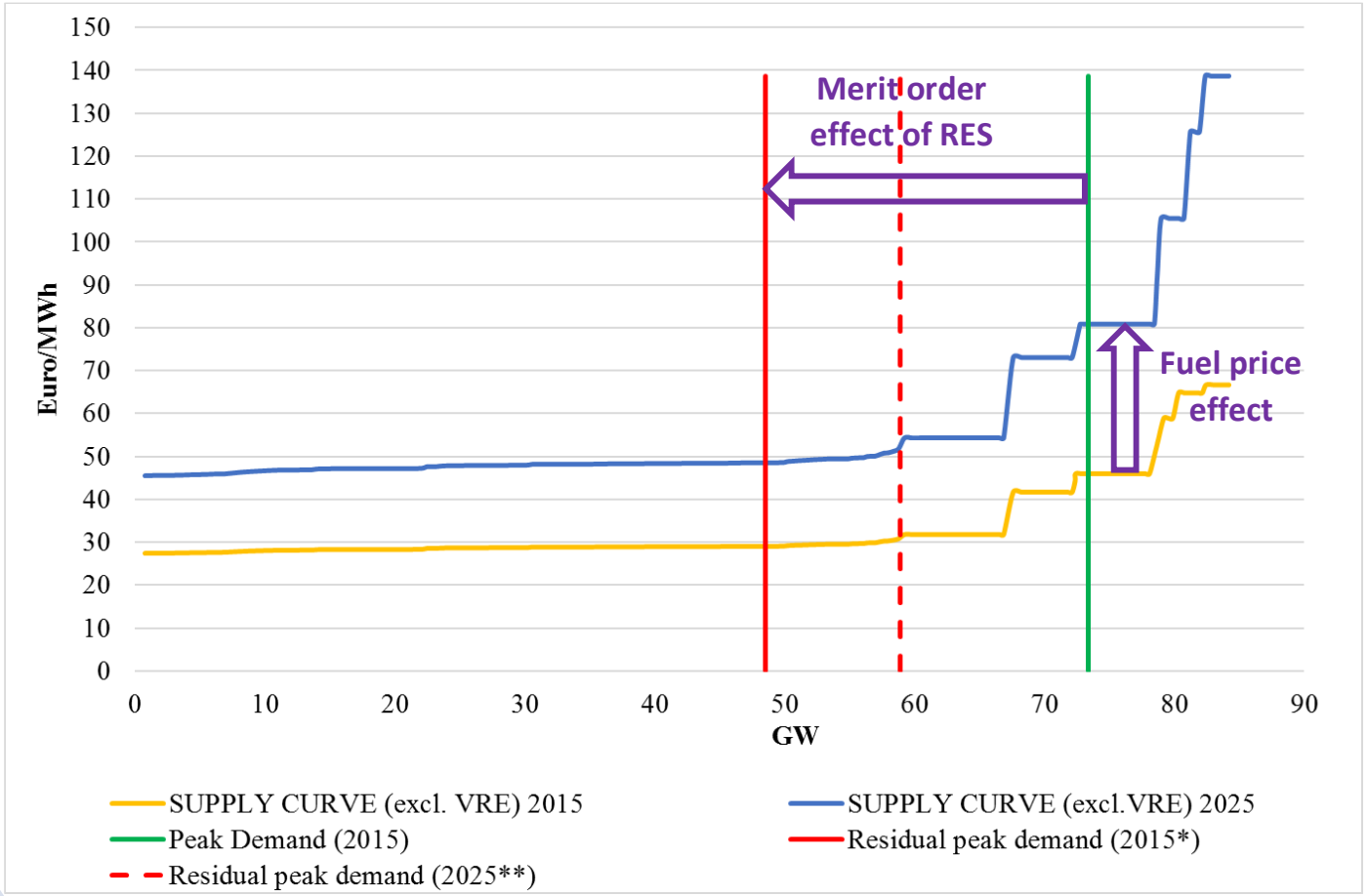
2018 SUGGESTIONS FOR IMPROVEMENTS TO EXISTING MARKETS

- Hogan (2005) proposed energy-only market design to address the lack of a market for reliability: to **price scarce reserve at the opportunity cost of energy through a regulated operating reserve demand curve (ORDC).**
- Joskow (2007) **concludes a forward capacity market is needed** to ensure resource adequacy.
- Newbery (2016) noted that even if the revenue is potentially adequate to cover capital costs but is not perceived to be so by generators and/or their financiers then **there is a "missing market" problem. Hence capacity markets.**
- A fundamentally different approach would be to shift the **focus of provision of adequate capacity away from the generators on to retailers.** A related suggestion to this is that (see Bidwell, 2005), retailers should contract for reliability options with generators.
- **The SEM in Ireland had implemented the DS3** (Delivering a Secure Sustainable Electricity System) **- 14 ancillary service products,** including a new frequency response product for delivery of frequency response within 0.15 seconds.

SOME MODELLING OF 2025

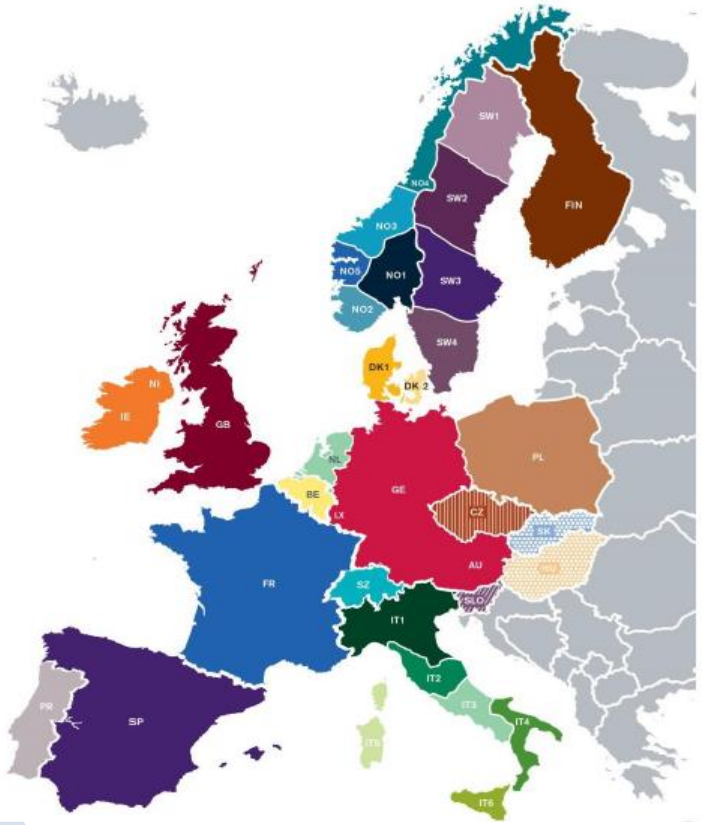
- **We did some modelling of the European electricity market in 2025 and to consider wholesale electricity prices.**
- We did this because the performance of the electricity market in 2025 would likely guide market design changes out to 2030.
- *Limitations of modelling:*
- A tool for showing significance of the impact of certain changes.
- Any modelled scenarios cannot completely capture all of the issues.

IS A NEW MARKET DESIGN REALLY NECESSARY? MIGHT NOT BE.



1. **An empirical question** requiring some modelling
2. **Depends on fossil fuel/carbon prices**, VRE capacity in a generation mix

MODELLING THE EUROPEAN WHOLESALE ELECTRICITY MARKET



Existing market zones in Europe.
Source: Ofgem (2014)

Market zones in the European power market model

AT	IT-Centre-North	GB	SE3	NO5
BE	IT-Centre-South	SEM	SE4	
DK1	IT-Centre-South	NL	NO1	
DK2	IT-North	CH	NO2	
DE	IT-Sardinia	SE1	NO3	
FR	IT-Sicily	SE2	NO4	

The model is an LP, large-scale market simulation model

Hourly resolution.

Gas, coal, oil fired generation and pump storage are modelled.

Biomass, nuclear and all other generation tech are exogenous.

WE MODELLED DIFFERENT PRICING SCENARIOS, INCLUDING 'HIGH' GAS AND CARBON PRICES

<table>
<tr><th rowspan="2">Scenarios</th><th colspan="2">VRE capacity</th><th rowspan="2">Fossil fuel capacity</th><th rowspan="2">Interconnection capacity</th><th colspan="3">Fossil fuel prices</th><th rowspan="2">Carbon cost</th></tr>
<tr><th>wind</th><th>solar</th><th>Gas</th><th>Coal</th><th>Oil</th></tr>
<tr><td>Baseline</td><td colspan="2">2015</td><td>2015</td><td rowspan="7">2015</td><td>$7.9/mmbtu</td><td>$77/tonne</td><td>$83/bbl</td><td rowspan="6">€25/tCO2</td></tr>
<tr><td>A</td><td colspan="2">50% higher than baseline</td><td rowspan="2">as in baseline</td><td colspan="3" rowspan="3">as in baseline</td></tr>
<tr><td>B1</td><td colspan="2">100% higher than baseline</td></tr>
<tr><td>B2</td><td colspan="2" rowspan="3">as in B1</td><td>Partly decommissioned (see Section 7.4)</td></tr>
<tr><td>C1</td><td rowspan="2">as in baseline</td><td rowspan="2">$9.6/mmbtu</td><td rowspan="2">$82/tonne</td><td rowspan="2">$111/bbl</td></tr>
<tr><td>C2</td><td>€57/tCO2</td></tr>
<tr><td>D</td><td colspan="2"></td><td>unlimited</td><td colspan="4">as baseline</td></tr>
</table>

Source: fossil fuel prices are from IEA (2018).

Scenario C2 had 'high' gas and carbon prices

WE SHOWED THAT WIND AND SOLAR COULD ENJOY 'HIGH' AVERAGE MARKET PRICES

	DE				IT		
	Onshore wind	Offshore wind	Solar PV	Average wholesale price	Onshore wind	Solar PV	Average wholesale price
Baseline	44.17	44.67	43.86	49.68	45.24	45.29	50.68
Scenario A	47.87	48.86	46.39	48.23	48.96	46.76	49.32
Scenario B1	45.48	47.39	42.59	46.34	43.19	33.43	45.01
Scenario C1	46.95	49.32	43.66	47.97	46.57	36.50	48.40
Scenario C2	70.76	72.67	67.64	71.63	67.13	57.39	69.00
Scenario D	46.91	47.19	44.35	47.40	47.31	44.72	47.44

"Captured" prices by wind and solar in Germany & Italy under various scenarios

- **Offshore wind can consistently achieve prices above** the average wholesale prices (DE)
- Onshore wind captured prices are **marginally below** the actual annual average prices (DE&IT)
- Solar achieves lower prices than the actual wholesale prices
- More wind and solar capacity means lower captured prices for solar PV

CONCLUSIONS FROM 2018 MODELLING

- Our 2018 modelling results suggested:

- **Substantial decrease in the capex needed** (on 2016) for “subsidy-free” VRE.
- **Solely relying on wholesale energy markets remains very challenging**, even if we take a rather bullish view that by 2025 commodity markets are going to be very tight.
- **CCGT required for system adequacy unlikely to be self-financing** at high commodity prices.
- **More VRE reduces revenue for existing CCGTs**, exacerbating their missing money problem.
- **Interconnection reduces volatility** but does not solve financeability problems on its own.
- **Closures of fossil fuel power plants would make a difference to market prices** - in response to low profitability - but it would put more pressure on ancillary services markets.
- **Raising carbon prices does help** and remains a good policy within the current market design.

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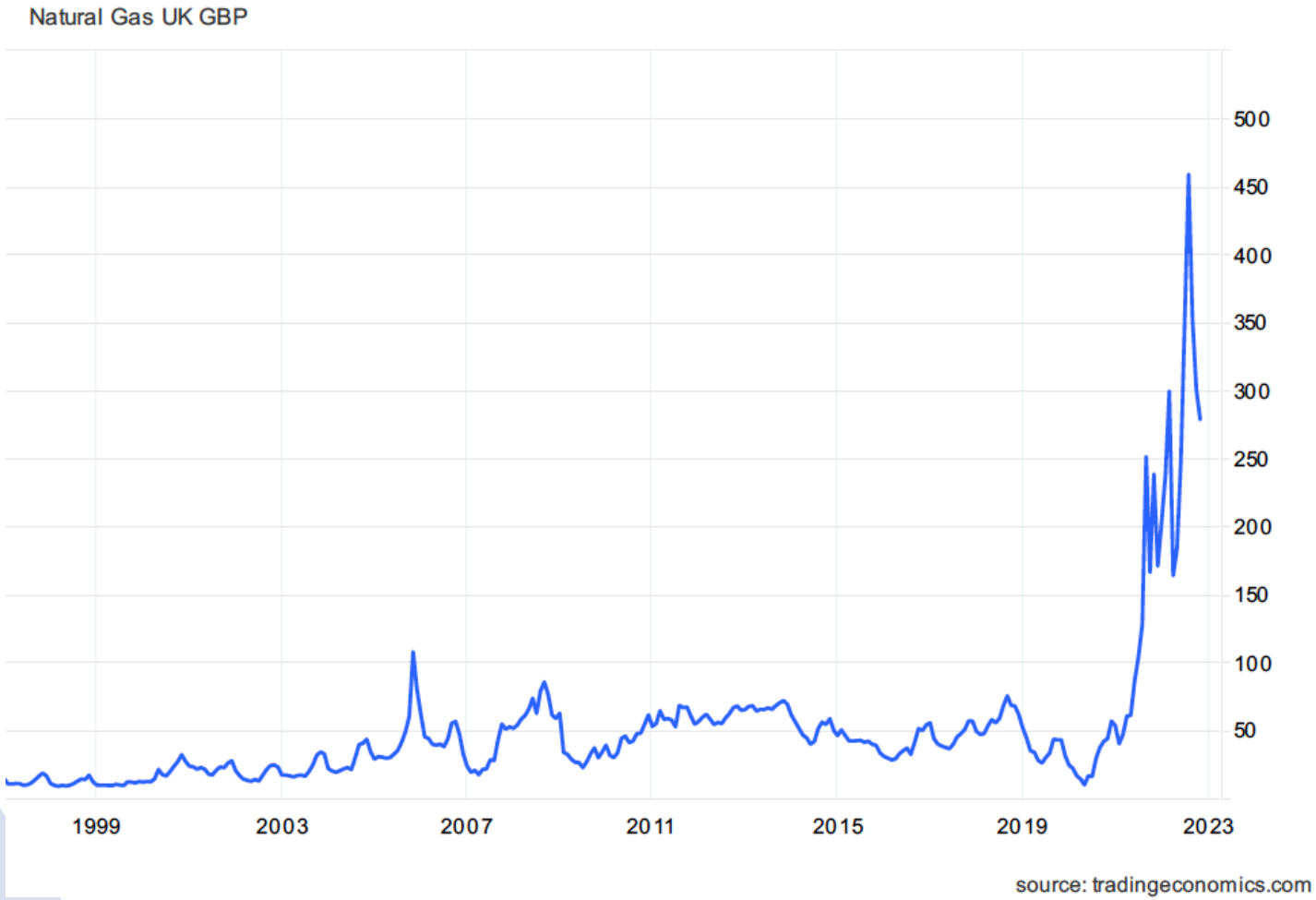
NOW:
WHOLESALE NATURAL GAS PRICES ARE AT HISTORICALLY UNPRECEDENTED LEVELS

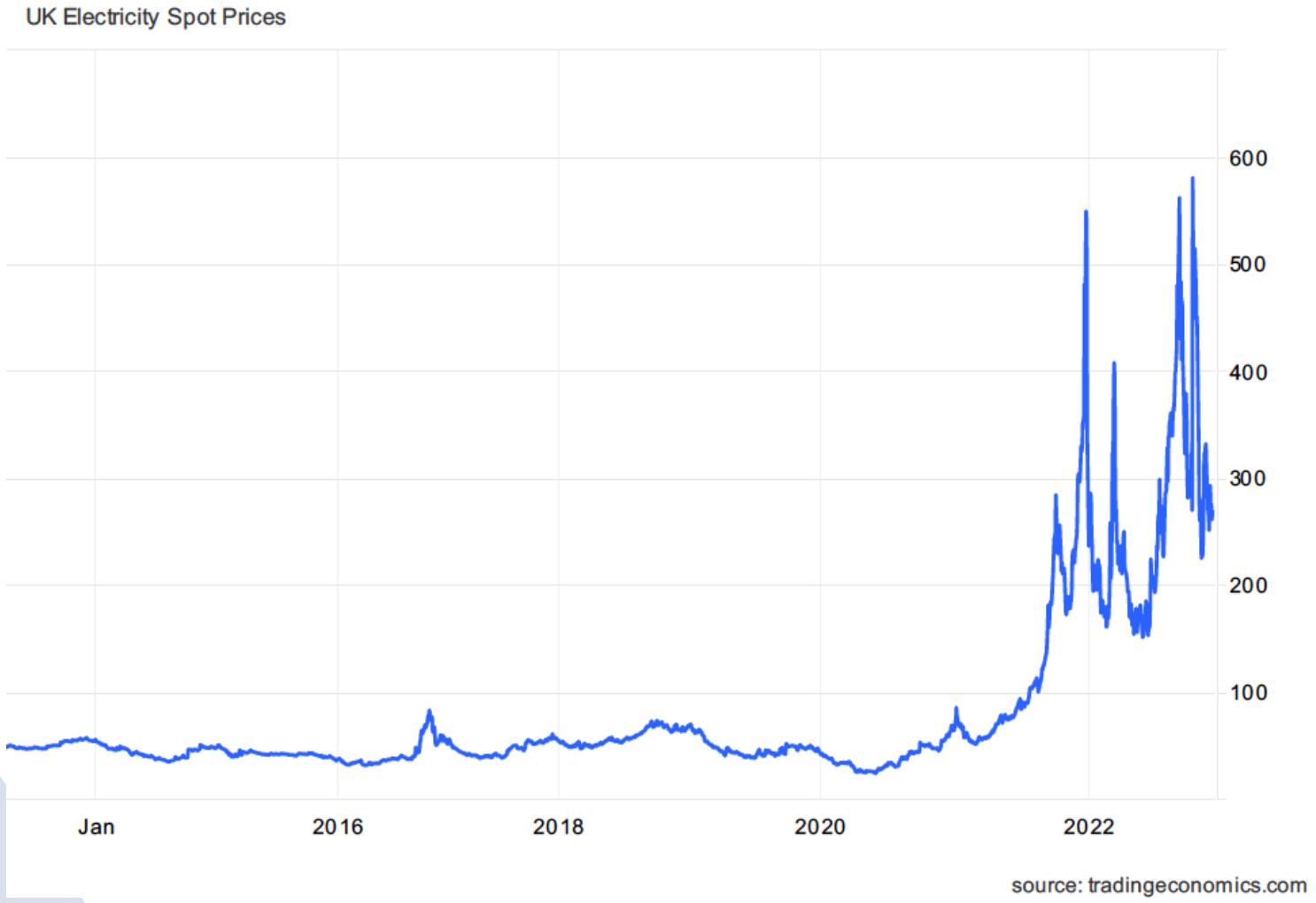


GBP pence per therm

In August 2021, 41% of residential gas bill was wholesale costs.

x 6 rise =
300% rise in residential price

WHOLESALE ELECTRICITY PRICES ARE AT HISTORICALLY UNPRECEDENTED LEVELS



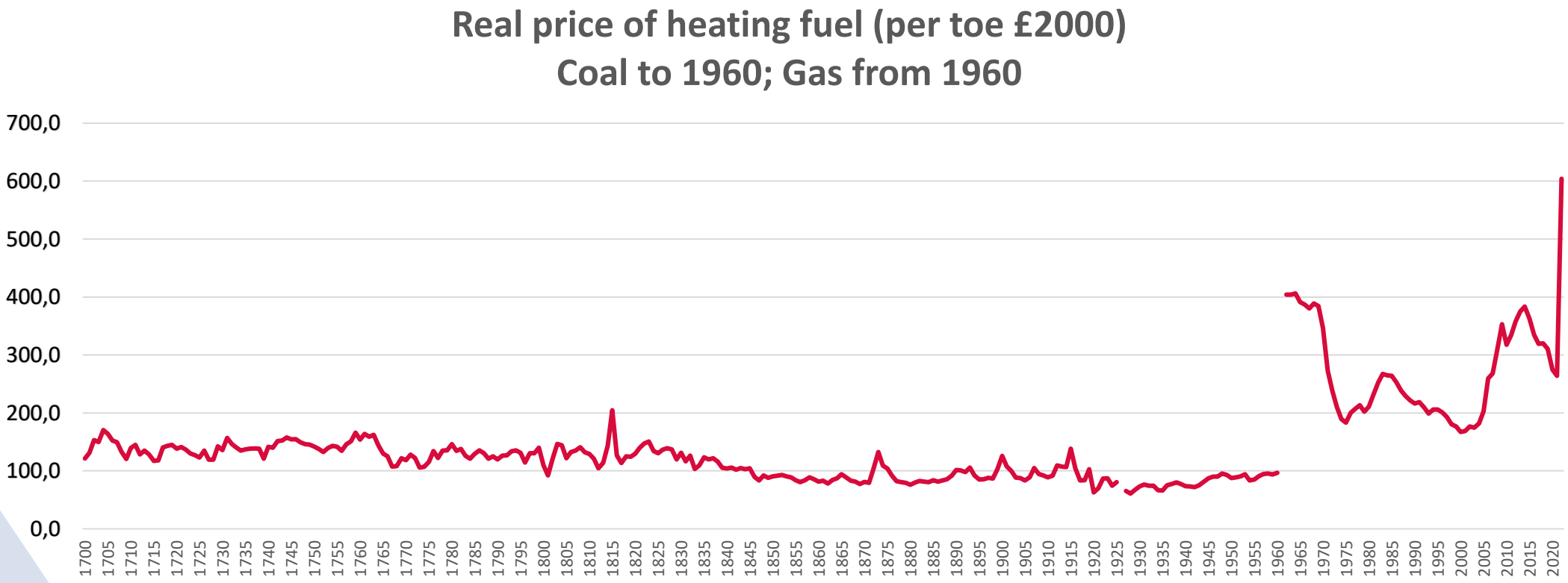
GBP £ per MWh

In 2020/21, 34% of residential bill was wholesale cost.

x 5 =

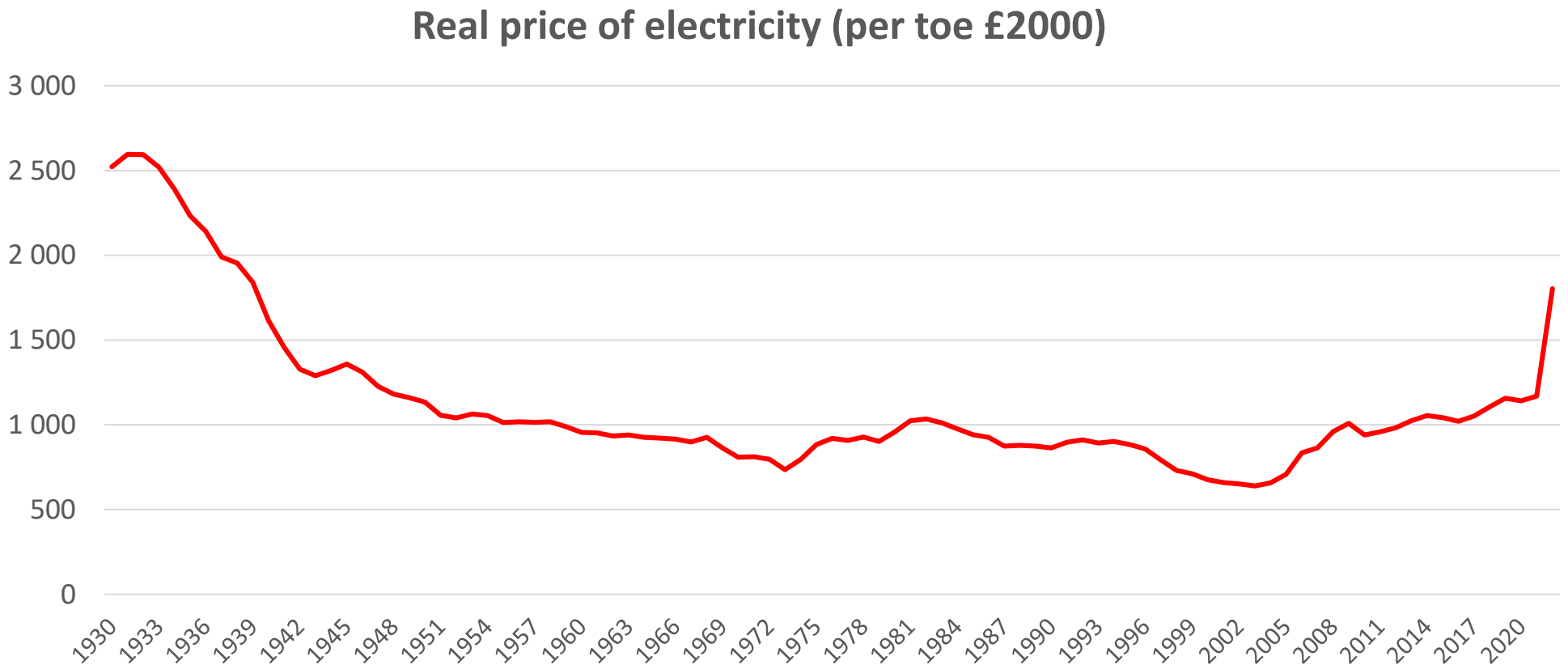
c. 250% rise in residential price

UK RETAIL HEATING FUEL PRICES ARE HIGHER THAN IN RECORDED HISTORY



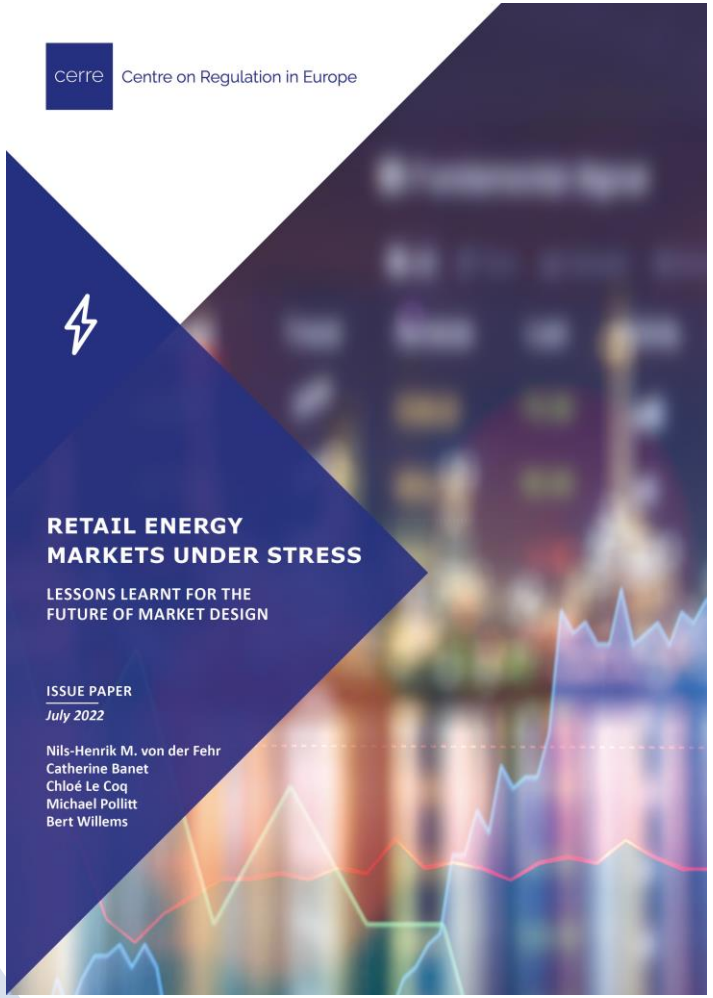
Source: Fouquet (2020), updated to October 2022 using ONS data

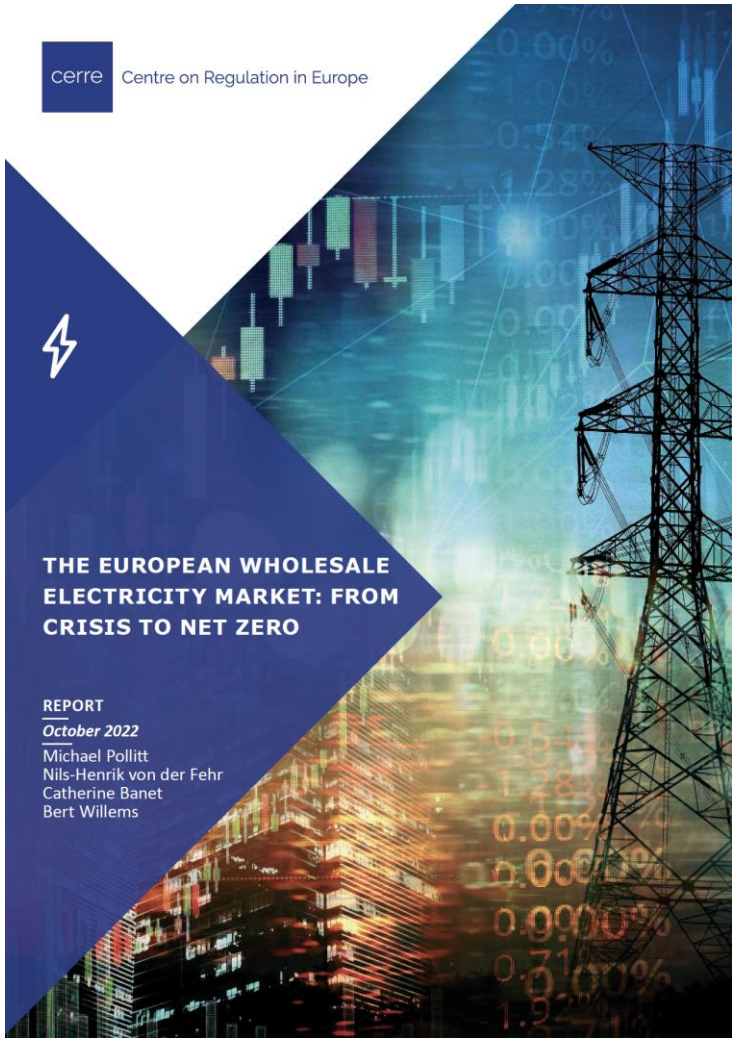
UK RETAIL PRICES ARE HIGHER THAN SINCE MASS ELECTRIFICATION BEGAN



Source: Fouquet (2020), updated to October 2022 using ONS data

PAPERS ON ELECTRICITY MARKET DESIGN





Final integrated report is forthcoming shortly.

RETAIL MARKETS: THE NEED FOR DESIRABLE CHANGE

- The recent unexpected higher energy prices have highlighted the challenges of designing well-performing retail markets. **More specifically, we want to facilitate behavioural change in energy consumption that increases energy efficiency and supports the energy transition.**
- A key priority in wartime is that retail customers do reduce their electricity and gas demand. Retail tariffs and behavioural interventions must reflect this. **All European countries need to engage in campaigns to reduce demand and have associated tariff settings which encourage large reductions in consumption for non-vulnerable customers.**
- Prosumers are to be encouraged to increase the use of photovoltaic panels, battery storage and electric heating system installation. **Large amounts of distributed installation can be done relatively quickly with beneficial aggregate demand and fiscal effects.**
- **Smart meters need to be used more effectively in an energy crisis to ration energy** and more needs to be done to work towards smarter contracts (by companies with the encouragement of regulators and governments).

COMBINING DEMAND REDUCTION AND EQUITABLE ENERGY BILLS

- Equitable compensation of retail bills is important, however this should be combined with **high marginal prices for the final uses of energy. The German gas proposal could be more generally applied to electricity at the MS level.** The scheme offered tailored price reductions for up to 80 per cent of household consumption and 70 per cent of industrial consumption, with the rest being priced at market prices.
- According to the theory of optimal taxation, consumer support is best administered through the regular tax and welfare system. **Priority should be given to better communication between the databases of electricity retailers and government welfare programmes.**
- Consumers should be allowed to hedge market risk while encouraging demand flexibility and energy conservation. **One way to do that would be to combine real-time pricing with financial difference payments for a fixed quantity of energy.**
- **Tariff models can help stabilise bills by allocating the benefits (and costs) of fixed-price long-term contracts to all consumers or all of a particular group of consumers.**

REGULATION OF RETAIL OFFERS

- **Stricter requirements on the financial position of suppliers are likely warranted, including supplier stress-testing and specification of minimum forward hedging requirements.**
- **Consumers must, to some extent, be held responsible for their choice of supplier – otherwise the door would be wide open to offers that are "too good to be true" – but they must also have ways of entering into a new contract on reasonable terms when warranted.**
- **Given that both financial regulation and customer protection come at a cost, finding the right trade-off should be a priority for national energy regulators.**
- In the Netherlands, the cap on penalties that consumers pay for early contract termination seems to have undermined the market for long-term contracts. **Regulation of contractual terms must therefore better balance consumer protection and incentives of suppliers.**
- **Good commercial practices corresponding to national circumstances should continue to be the preferred approach, while the requirements for hedging of suppliers should be reinforced via harmonised EU legislation.**

WHOLESALE MARKET LESSONS LEARNT

- **Wholesale electricity (and gas) markets work in delivering energy security!** Especially the larger and deeper they are! We should complete and extend the ones we have!!
- Markets deliver security of supply by **raising prices in times of scarcity**, creating profits for some, and leaving some market parties exposed to unhedged high prices or certain customers' inability to pay.
- The **distributional impact** of high prices on European households and industry and the competitiveness of national industries is a concern and **at very high prices intervention of some kind has become inevitable.**
- **This is a wake-up call for the impact of net zero policies**, where tight linkage between power, heat and transport prices is **the consequence of sector coupling** AND **high unit prices of energy** are also to be expected.

KEEP MARKET DESIGN ISSUES IN PERSPECTIVE

- There is a need to clearly **distinguish between what should be a future-proof market design under net zero objectives and medium- to long-term constraints, and the toolbox of temporary measures** that can be adopted by governments or market agents to respond to short-term disruptions.
- Empirical evidence shows the impact of market design on market outcomes is small and the day-ahead auction rules do not matter much. **Thus monitoring demand, supply and anti-competitive behaviour are more important than changes to electricity market design.**
- A more significant move would be to a US standard market design, involving central dispatch and nodal prices. **The net benefits of the US market design in delivering Europe's ambitious energy and climate goals is unproven and not easy to quantify once innovation, market liquidity and private contracting are taken into account.**
- A future-proof market design legislation will need to not only **enable the integration into the market of a higher share of renewables and flexibility**, but also ensure that **market rules function with a higher share of renewables**. This applies to both renewable energy produced onshore and offshore. A comprehensive market design for the whole energy system will need to consider new offshore renewable energy generation capacity added offshore, including hybrid assets.

THE USE OF PPAs

- **Corporate PPAs make sense for companies that are long-lived and can commit to, say, 15 years of purchasing the output of their generation counterparty** (e.g. Microsoft, Amazon or the Finnish paper industry).
- **Retailer PPAs make sense for large incumbent retailers with relatively stable customer bases for part of their demand.** Secondary markets for PPAs and additional risk regulation for retailers is likely to grow this market.
- **Government PPAs have been successful in driving down the cost of capital, particularly for emerging technologies (such as offshore wind)**, and where retailer or corporate PPAs are not competitive or available in sufficient quantity. Government PPAs can significantly improve on older support schemes such as feed-in tariffs, if they provide incentives for technologies to participate in short-term markets.
- **Corporate and retailer PPAs will become increasingly desirable in the future as a way of diversifying the contract terms of the PPAs signed**, because government PPAs often offer a one-size-fits-all standard contract (e.g. 15 years, indexed to CPI, take all output of the project) and because we would expect private investors to offer increasingly competitive PPA contracts as the market develops (and if government finances worsen).

THE USE OF PPAs 2

- **So far, legal barriers to corporate PPAs have stemmed from certain national legislation, not EU legislation. To removed such barriers, the Renewable Energy Directive now contains some facilitating provisions that could be further reinforced.**
- **While the European Union can recommend the use of PPAs and make observations on which types of PPAs have worked well, it is unwise for the Commission to recommend the use of a standard PPA contract to cover a fixed proportion of all national output.**
- Whether and to what extent Member States provide **long-term government-backed financial PPAs**, should be left to the **subsidiarity principle**, and depends on the preferences of individual member states.
- **Auction-based competitive PPAs to bring forth new investment are a good way to introduce competition for all types of PPAs**. These lower costs of low carbon generation.
- **The use of auctions for long term PPAs combined with current short-run power markets can lead to a desirable hybrid market arrangement**, introducing competition for the market in combination with competition in the market.
- **The signing of retrospective PPAs with existing generators is simply a way of smoothing payments at private sector discount rates. This should be a matter of national preferences.**

TWO ELECTRICITY MARKETS OR ONE? ONE FOR AS AVAILABLE, ONE FOR ON DEMAND

- **Not new…and not just about crisis**
- Keay and Robinson proposed this in 2017. Grubb and Drummond proposed a similar idea in 2018. Greek proposal to Council proposes one in 2022.
- Gross et al. (2022) proposal for switching low carbon generators to long term contracts.
- Some questions: alteration to short run market? Or long-term market?

  ➢If short run, what inefficiency would this introduce via arbitrage or reduction of incentive for short run optimization of renewables?

  ➢If long run, would this reduce NPV of payments for renewables and, if so, how? In theory tax-payer subsidy/levy would lower financing cost

  ➢***Basically, short-run version does not make sense…***

LOCATIONAL MARGINAL PRICES (LMPs)

- **The single electricity market in Europe is characterized by self-dispatch and zonal pricing.**
- **A move towards a US style SMD being debated in the UK** as part of a Review of Electricity Market Arrangements (REMA).
- Nodal pricing is a proven method of **providing short run pricing signals to the marginal value of injections and withdrawals from the electricity network**.
- **The overall efficiency benefits of nodal pricing are small**, but it may be valuable in signaling scarcity of transmission capacity in a system characterized by increasingly active distributed energy resources (DERs).
- **However the distributional implications for potentially large for consumers and generators**, the impact on long run transmission investment small and investment impact of exposure to nodal pricing negative for energy transition.
- **This suggests not likely to deliver much benefit in the short run**.

PROFITS TAXES

- **Windfall taxes now being imposed on oil and gas production and on electricity generation, across Europe.**
- **EU agreed a 33% tax rate on supernormal profits for gas, oil, coal and refinery companies** on 2022 and 2023 profits. **And a revenue cap on renewables, nuclear and lignite at 180 Euros / MWh.**
- In the UK, **oil and gas production to be subject to a supplementary 35% profits tax** until 2028. **Electricity generators subject to a 45% supplementary profits tax.** These are in addition to 25% normal profits tax.
- Profits taxes are at least **not distortionary of short-run dispatch decisions**, and don't threaten real time energy security.

THE ENERGY MARKET IN TIME OF WAR

(see Pollitt, 2022, Stiglitz, 2022)

- *In war time…*
- In wars you don't let the market allocate production by price
- a significant **programme of co-ordinated demand reduction**;
- to target the **reduction of European gas demand** specifically;
- a **collective 'dig for victory' in energy**;
- **'fair' and energy efficient pricing schemes** for energy;
- a **temporary system to deal with profiteering** in energy sector.

- *Recommended reading:*
- Cairncross, A.(1995),'Economists in Wartime', *Contemporary European History*,4(1):19-36.
- Shin, H. and Trentmann, F. (2019), 'The Material Politics of Energy Disruption: Managing Shortages Amidst Rising Expectations, Britain 1930s-60s', in D. C. Needham (ed.), *Money and Markets: Essays in Honour of Martin Daunton*, Boydell and Brewer.

SOME CONCLUDING THOUGHTS

- We should **distinguish carefully between actions which are short-term**, but need to be robust to a prolonged war **and those that are genuinely about a net zero energy system.**
- Even if the **European wholesale markets in electricity and gas** collapsed tomorrow they **have withstood a globally unprecedented stress test** for a prolonged period.
- **We have seen a taste of the net zero future: coupled energy markets, high unit energy prices, high carbon prices and no 'missing' money.** Because we have tasted the future and wholesale markets have worked then this means we don't need to radically change the operation of wholesale gas and electricity markets just yet.
- **There clearly are issues for retail markets.** These are currently suspended and it will be difficult to put them back together, where they existed before.
- There are some good and bad proposals for change, but the arguments for and against them are not altered by the crisis, though some are exposed to more scrutiny, e.g. **long term CfDs have had a boost, more use of LMPs seems less likely**.

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- Stiglitz, J. (2022), *Wars Aren't Won with Peacetime Economies*, Project Syndicate, October 17, 2022, https://www.project-syndicate.org/commentary/west-needs-war-economics-energy-food-supply-shortages-by-joseph-e-stiglitz-2022-10