UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

cerre Centre on Regulation in Europe
Improving network and digital industries regulation

Whither European electricity markets in the short and long term?

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and
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EPRI-IEA
Challenges in Energy Decarbonisation Workshop

Outline and Background

Thanks for the invite!

Acknowledging my recent work with Centre on Regulation in Europe (CERRE):

- Sector coupling and net zero in 2050 (2021);
- Retail market design (2022);
- The wartime energy economy (2022);
- Wholesale market design (2022).

Plan:

- What net zero modelling tells us about what the energy system has to deliver
- The energy market in wartime
- Some recent reviews of electricity market design
- The future design of the electricity market

Net Zero and its implications for the European Energy System

Our modelling of Net Zero showed (Chyong et al., 2021; Pollitt and Chyong, 2021) :

- Large increase in **energy efficiency** (relative to business-as-usual);
- Large increase in **fixed costs** and in the level of investment;
- Large increase in **cross-border trading of electricity**;
- Very large increase in **long-run system marginal cost** (to 2018);
- Need to address **substantial payment issues** due to fixed costs;
- Likely need for support from **general taxation and cross-subsidies** between energy sources;
- New technologies need to be **massively scaled up** (RES, hydrogen, biomethane and CCS).

The current energy crisis is a wake-up call on the implications of a Net Zero energy system with very high-priced marginal units of energy.

The Energy Market in Time of War

(see Pollitt, 2022)

- *We need:*
- 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:

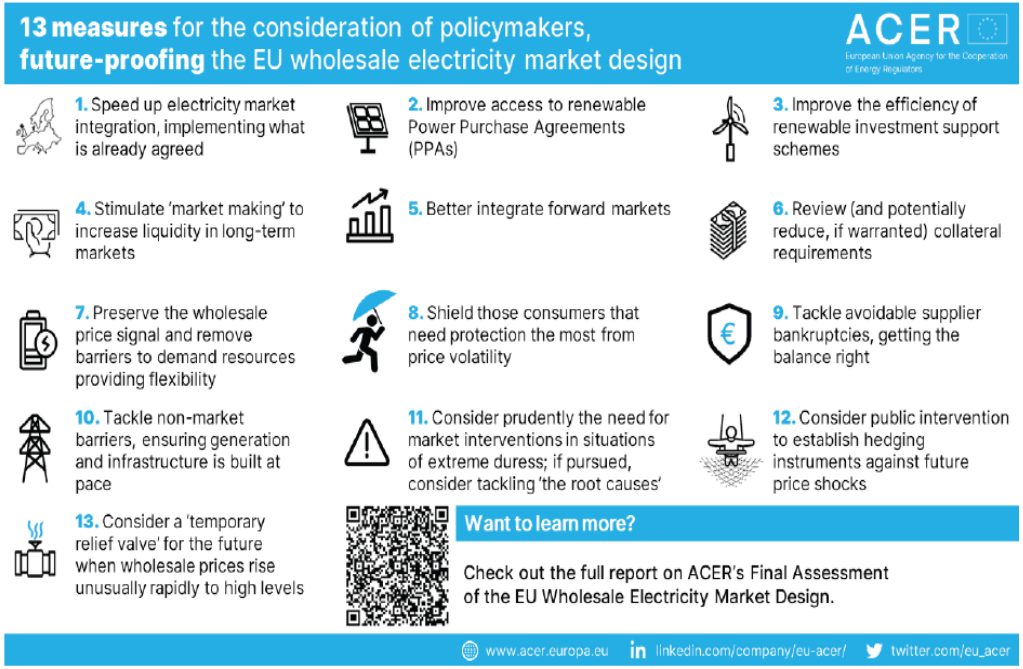
Cairncross, A.(1995),'Economists in Wartime',*Contemporary European History*,4(1):19-36.

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.

See IEA (2005), *Saving Electricity in a Hurry: Dealing with Temporary Falls in Electricity Supplies*, Paris: OECD (and 2011 Update)

ACER Assessment of EU wholesale market (April 2022)

(See Pollitt et al., 2022)



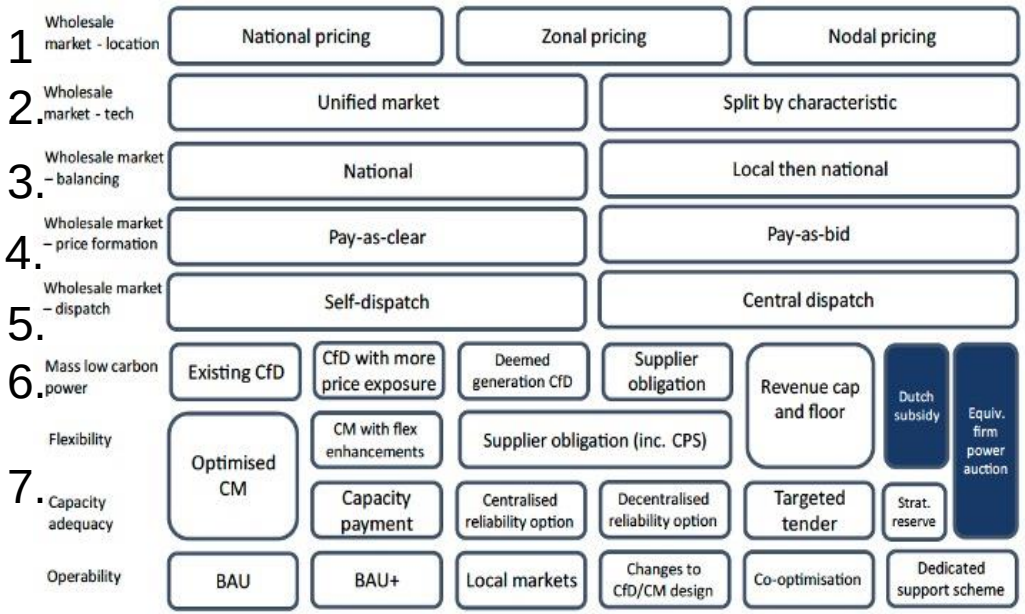
Source: ACER (2022, p.7)

- *1, 4, 5: All current objectives of design*
- *2, 3: Sensible RES scheme design*

- *1. Includes better use of locational signals.*
- *4. Need to worry about interventions doing the reverse of this.*
- *5. Do current interventions help with developing forward markets?*

- *2. If government signs PPAs does that help develop private PPA market?*
- *3. Already true that EU has failed to develop a pan-European RES support framework, raising costs by 100bn Euros to 2014.*

UK Review of Electricity Market Arrangement (July 2022)



Source: BEIS (2022, p.109).

Row 1: More locational signals?

Row 2: Two market solution?

Rows 3, 4, 5: Minor and limited evidence?

Row 6: Changes to renewable procurement?

Row 7: Changes to capacity mechanism?

One idea: Two market solution(s)

- **Not new…and not just about crisis**
- Keay and Robinson proposed one 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, if simply about revenue smoothing.
- ***Basically, short-run version does not make sense…***

The choice: Schweppe vs Coase

(See Pollitt, 2021)

- Future market design rests on whether the future electricity system will favour more or less formal use of markets and the nature of the markets that it might favour.
- Some views of the internet of energy foresee pricing to devices, not just customers (this is an extreme version of the transactive energy future as exemplified by the Pacific Northwest Demonstration project in the US). This is Schweppe+ (1988). *Spot Pricing of Electricity*. Springer.

- (Spot) Markets work best when the product being procured via the market is standardized and provided competitively.
- Large firms work best in dealing with complex multi-level optimisation problems which are actually quite difficult to write down (e.g. Apple's optimisation problem).
- A key idea in Coase (1937) *The Nature of the Firm* is that the capitalist firm is a planned system and that ebb and flow of market shares and vertical integration within the market is a reflection of the optimal scope of planning versus market competition.

How markets work

- Markets have to be formal and follow well publicised rules. This is especially true of the organized markets run by system operators in the US and in Europe.

- Thus, though these market arrangements are potentially very competitive they are also difficult to change.

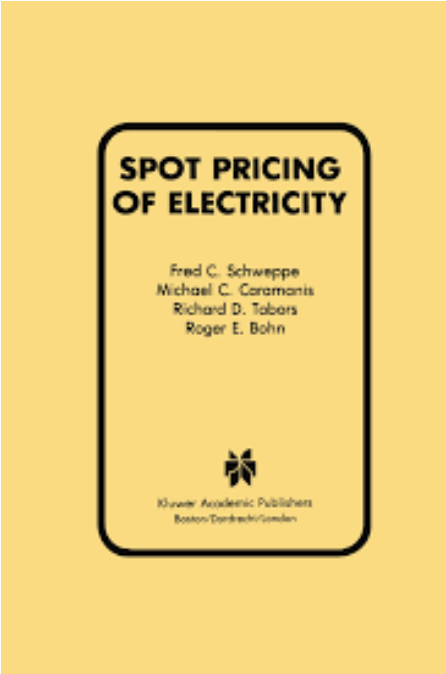
- In-house arrangements to manage voltage and local constraints in the distribution system may be more efficient because they are flexible and do not require formal recourse to the market.

- 'Local' energy markets are problematic because of the largely arbitrary boundaries that they would introduce and the fact that once introduced they become difficult to change, even though some might be successful and some would not prove viable.

More markets (or more prices)?

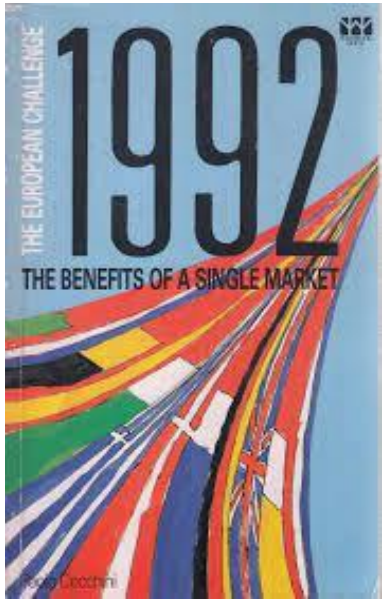
- A move to self-consumption with own storage is a move towards in-house production, while more use of wide area markets with locational marginal prices (LMPs) would be a move towards more use of markets.

- Engineers often see the future of the power system as being about more use of market prices which are explicitly communicated to all consumers and all generators (Schweppe et al. 1988; Burger et al. 2019).



More markets/prices?

- It is important for economists to point out just **how extreme** a view of the use of a spot market with excessively granular prices is.
- Most products are subject to simple pricing and customers expect the providers of the products to manage their own internal costs of provision to different customers.
- Only certain types of price discrimination are acceptable and worth doing in conditions where simple advertising messages, corporate trust and perceived fairness in pricing are important considerations for corporate pricing policy.
- That is not to say that some providers of services to the electricity system cannot be exposed to time and space varying prices, but that ability to expose **all parties** to these sorts of prices is limited.



Issues raised by nodal pricing (LMPs)

- What exactly is the problem being solved by nodal pricing?
  - constraint payments, interconnector and offshore wind landing points signals, local constraint management problems due to DG export, etc.?
- Calculating LMPs is the easy bit, knowing what they mean and what to do with them is not at all obvious.
- Which nodes? In theory it should be all nodes, otherwise not an inefficient nodal system.
- Why are they mostly ignored in other networks? Nodal prices exist in all networks (they are just marginal shadow values from a linear program).
- Who should be exposed to nodal prices? In theory this should be all loads and generators with potential to respond to them, otherwise inefficient.
- What is the behavioural value of nodal pricing? Fixed costs and charges still must be recovered and nodal price a small fraction of total delivered price.
- What is the net impact of nodal pricing in systems where they are implemented? In the presence of demand averaging, limited nodes, market power mitigation and financial transmission rights (FTRs) not clear the net impact not better achieved some other way.

Market power and regulation

- Engineers also fail to take seriously the reality of market power and the linkages between markets.
- There is also no reason to assume that unregulated markets for related activities (energy, non-energy ancillary services and network investments) will cumulatively add up to a social optimum, according to the theory of the second best.

- As Joskow (1996, p. 381) argues the task of regulators of the electricity sector is to achieve 'a favourable trade off' between short-run and long-run costs and benefits in conditions where some co-ordination is necessary (at the level of short-run system operation and in lumpy transmission investments) and where the benefits of competition are often long-term.

Future market design

- One issue for the future market design is whether rising distributed generation and flexible demand mean that markets are zonal, local or nodal, rather than national (or even regional), especially if overall demand is falling.
- It is highly likely that there will be more distributed energy resource (DER) participation within existing markets. Falling platform costs and increases in distributed generation and storage suggest that the trend to more DER participation in energy and non-energy ancillary service markets must increase.
- This will require minor, conceptually speaking, changes to existing markets to lower participation thresholds and allow greater roles for aggregators of small DERs.
- This is at the same time as there will be greater pressure to integrate markets over a wider area to manage intermittent energy resources with large negative correlations over long distances, as we have seen with the European single electricity market.

Which world (Schweppe or Coase)?

- One suspects that a truly nodal or fully distributed pricing system is not sustainable in a smart world partly because of the computational complexity involved.
- Rather like the internet, the greater likelihood is that capacity should be expanded to reduce nodal (actual or virtual) price differences and that any 'rationing' that does occur should be on a non-price basis for residential and small non-residential users.
- This gives rise to a new potential market design which is based on non-price rationing of the available intermittent generation to loads in priority order.
- This would exploit the ability of smart meter enabled systems to communicate with individual devices to switch them on/off behind the meter.

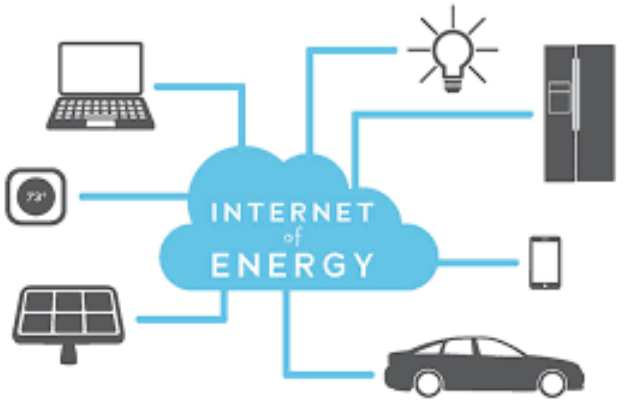
TABLE 2: APPLIANCE PRIORITY LIST USED TO DETERMINE LOAD SHIFTING

Appliance type	Priority allocation
Vacuum cleaner	1
Water heating top up	2
Laptop	3
Freezer	4
Refrigerator	5
Electric iron	6
Play station	7
Video cassette recorder	8
Sound system (Hi-fi)	9
Television	10
Central heating	11
Electric Shower	12
Electric oven	13

1: Highest Priority/least shiftable
Source: Infield et al., 2007, p.3.

The internet of energy?

- A fully flexible system would have every device prioritized and supplied on the basis of customer specified priority.
- Customers might be able to override contracted priorities for a fee or choose more or less items in higher priorities for higher fees.
- This sort of market design whereby demand was rationed by priority order would move the emphasis from price flexibility to quantity flexibility.
- This is what happens with the internet, whereby users can pay for the size of their connection but packet speeds are reduced for everyone when the internet is congested at peak times, rather than rationed by price via charging more at the peak times to maintain packet speeds.
- This would be a true internet of energy, even though it would – no doubt – be complex to set up.

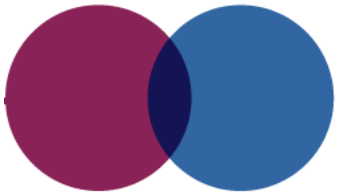


https://www.energyly.com/blog/internet-of-energy/

A hybrid market design?

- Of course, the likelihood is that some sort of new hybrid market design might develop.
- This would make use of some price-based elements, particularly towards non-energy ancillary services, and of non-price quantity based rationing, potentially linked to social welfare criteria.
- One could imagine the default contracts being rationing contracts and these would exist on the basis of public desire for net zero energy systems and fairness in allocation of scarce resources.
- Retailers or energy communities (such as exist in California or the EU) might provide power on this basis to their own customers, acting as intermediaries between price-based charging and quantity-based rationing.
- We might imagine that households would have two contracts – for basic service *and* for EV charging.

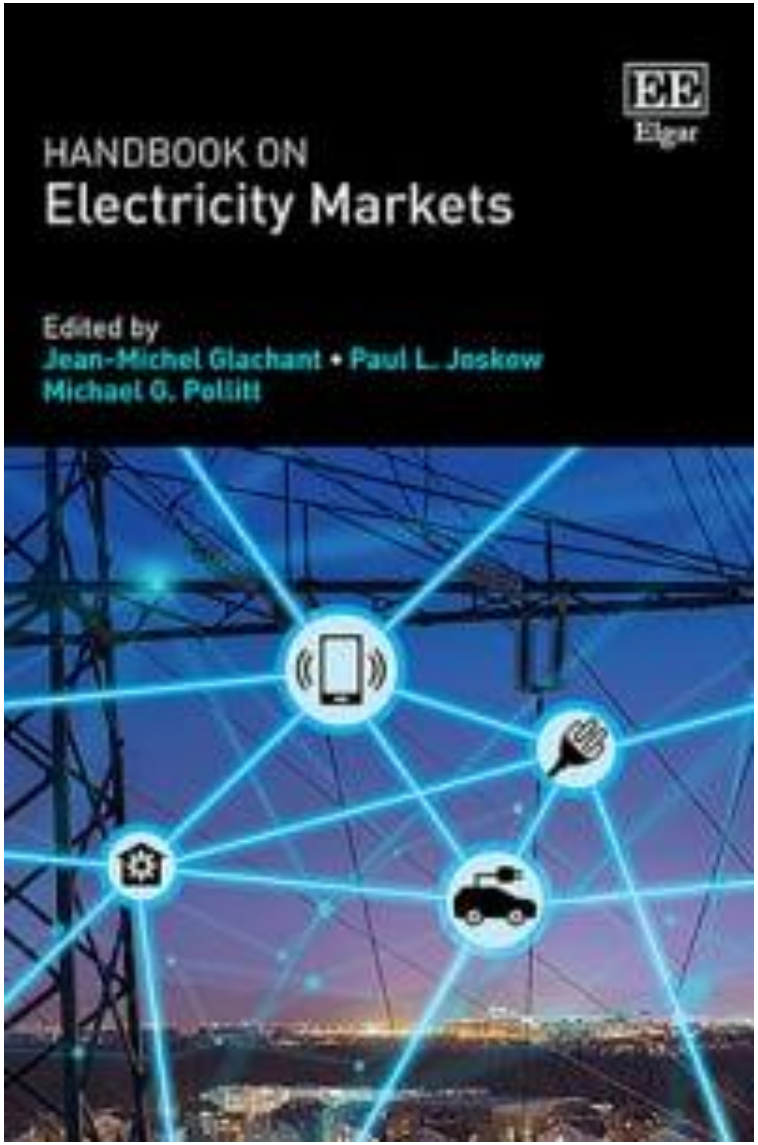
National Audit Office



The energy supplier market

The Department for Business, Energy & Industrial Strategy and Ofgem

Handbook on Electricity Markets



Edited Volume on current and future electricity markets, published in 2021. Available online.

22 Chapters by global experts

10 chapters on
'Taking Stock: The Legacy'

11 chapters on
'Adapting to New Technologies and New Policy Priorities'

For example:
'The Future of Electricity Market Design'
(Chapter 16 by M.G.Pollitt)

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