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The Future Electricity System and Its Regulation

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Outline

- Technological change background with rise of: Wind and PV, Distributed Generation, Electrical Energy Storage, Electric vehicles, Smart Meters, Big Data, Blockchain, Artificial Intelligence etc...
- Future electricity market design?
- Future electricity market structure?
- Future electricity system regulation?

FUTURE ELECTRICITY MARKET DESIGN?

Some things to think about

- Technology disruption is not the same as technological progress.
 - Are things are changing faster than ever before in energy?
- How much money is on the table in highly regulated industry?
 - What percentage of costs can be reduced in an industry with relatively low transaction costs? (is there scope for an AirBnB in energy (see Kiesling et al, 2018)?)
 - What is the scope for value added services, especially when quality is at 99.99%?
- When will tipping points occur which might fundamentally change market design and or regulation?
 - Globally change is only 1% p.a. for RES share.
 - Even by 2030 fossil fuels and conventional low carbon technologies (hydro and nuclear) will likely still dominate supply and demand.
- We know a lot already about what consumers value in energy and how they use energy services.

Will the market design adapt to change?

- Via further interconnection & market integration, extension of single market areas (e.g. in Europe).
- Batteries / demand side management (DSM) may save us!
- Subsidies will fall, renewables will get cheaper, marginal prices will still be set by fossil fuels a lot of the time.
- Limited, competitive, zero expected cost contracts for differences *may* sufficiently de-risk renewables.
- Sharper real time, locational, 5 minute prices
- Better ancillary services markets for reserve, security, frequency and voltage.

Or will there be a tipping point towards a new market design?

- Empirical question: at what level of renewables do we observe discontinuities in volatility of hourly and annual prices?
- These could be only at very high levels of intermittent RES which may not be likely before 2030.
- At this point widespread long-term contracting might be necessary and short term reserve prices cannot drive long run investment. At this point radical redesigns might be imagined:
 - Indeed internet-type quantity rationing of load in priority order under shortage conditions might be preferable to price based rationing.
 - A return to vertically integrated utilities or contractual versions of them, with negotiated short term arrangements.
- This requires modelling for markets like the European single electricity market (SEM).

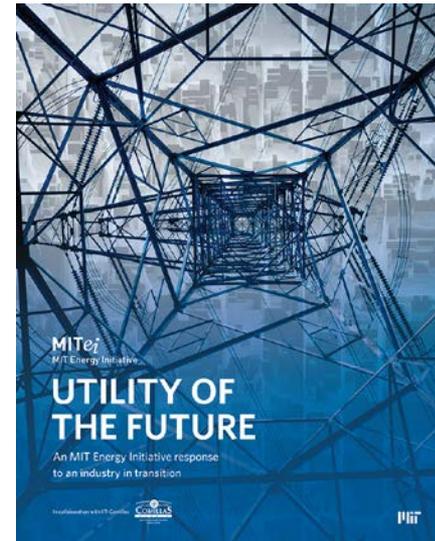
Future infrastructure economics

- Assume networks might compete, be duplicated or bypassed (gas, electricity and telecoms for parts of energy services) with each other and with customer or third party investment.
- Monopolist capital/hardware (i.e. wires / transformers / switchgear) will get more expensive relative to software/consumer equipment, but processes of competition different in each (see below).
- Information processing (and perhaps labour) will get cheaper relative to monopoly capital which is not subject to disruptive innovation.
- Legitimacy of regulated charges will subject to increasing scrutiny as more components are potentially competitive, especially if consumer provided.
 - Note that for domestic consumers in UK: 48% of price is already network charges, environmental charges and taxation.

FUTURE ELECTRICITY MARKET STRUCTURE?

What does the electricity system do?

- Traditional split between competitive generation and retail and regulated transmission and distribution, with relatively strong vertical separation between different stages.
- 4 crucial functions of electricity industry (MIT Utility of the Future Report, 2016):
 - Market platform
 - Network provider
 - System operation
 - Data management
- Electricity network as a platform market (see Weiller and Pollitt, 2016)



Some structure questions

- Which functions will be undertaken by the transmission operator (TO), distribution operator (DO) and system operator (SO)?
 - Network service
 - System operator
 - Platform markets
 - Data management
- If current/future functions are not undertaken by current party, who will undertake them?
 - TSO-TO-SO
 - DERs / Traditional generators / Aggregators / Prosumers
 - Customers / retailers

The future structure of the electricity system

- Total TSO vs Total DSO at heart of electricity system? (see Kristov et al., 2016, Kufeoglu et al., 2018) Currently battle for control of future by TSO and DSO can be observed for some ancillary services in the UK.
- A total DSO/TSO must be separate from retail (and generation and transmission/distribution).
- Microgrids, consumer capital may rise and lead to decline of centralised power system.
- But what about need for centralised power grid and seasonal/transnational transfers of power?
- Retail contracts continue to be under regulatory pressure and this limits scope for competition and long term investment, especially given how risky customer facing innovation is.

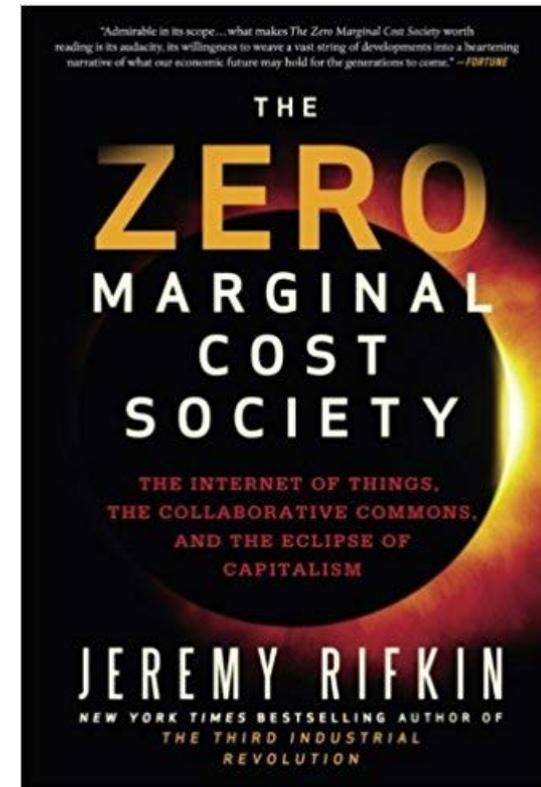
FUTURE ELECTRICITY SYSTEM REGULATION?

What is the future for electricity regulation?

- Energy regulators promote competition and regulate prices (average tariffs and tariff methodologies).
- New technologies have implications for competition policy and conventional price regulation of monopolists.
- The lines between competitive and monopoly activities becoming more blurred via competitive procurement by monopoly networks.
- The cost of the core monopoly network is already only a small part of the final price consumers pay.

Principles of competition in new energy economy (see Viscusi et al., 2018)

- Features of new economy:
 - Computer software
 - Internet based businesses
 - Communication services and equipment
 - Intellectual property important
- Fundamentals:
 - High fixed costs low marginal cost
 - Network effects
 - Rapid and disruptive innovation
- Problem is that conventional measures of competition such as price-cost margin and/or market share are no longer good guides to how competitive market is.



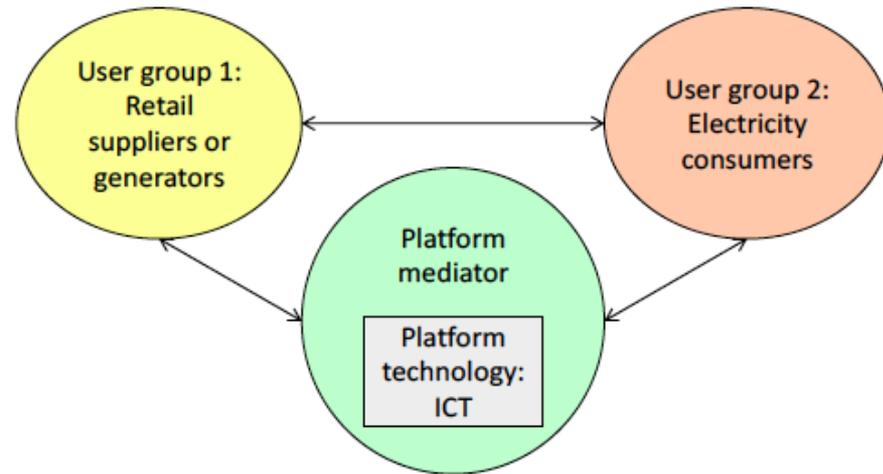
Issues with Big Data

- Big data is about mining users data to provide better user experience.
- The issue is it does allow dominance and creates ability to perpetuate monopoly.
- Difficult to establish interface programmes to mine data collected on other platforms even with user permission, because no obligation original platform to facilitate this (e.g. *Facebook vs Power Ventures, 2009*)
- Also difficult to protect start-ups from early takeover from incumbents because current size makes difficult to argue it would have been disruptive in future. (*Google takeover of mapping firm Waze Mobile in UK, 2013*).

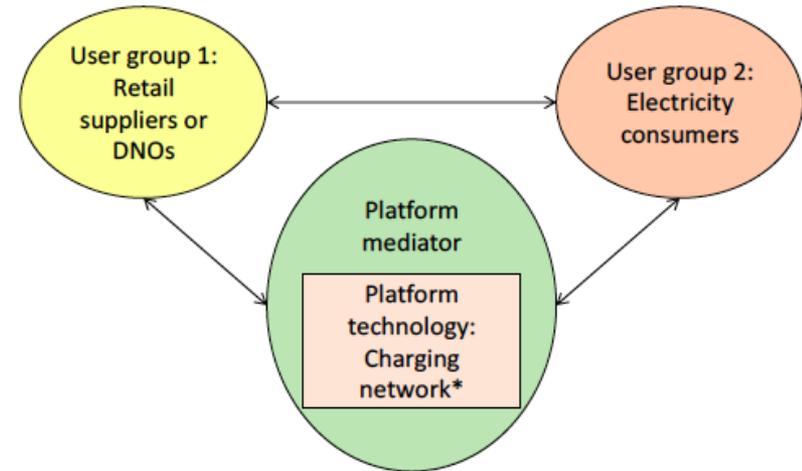


Two sided platforms in electricity

Platform for household balancing services provision



Platform for EV charging



* The term "network" refers to the combination of ICT and hardware infrastructure

Classic platforms: e.g. Credit cards (Mastercard/Visa): user group 1 – retailers, user group 2 – consumers (see Weiller and Pollitt, 2016)

Now optimal pricing may involve prices which are above or below cost due to interaction of network effect (more users in each group increases value to each user) and nature of externality (e.g. one way or two way) between user group 1 and group 2.

Platforms compete on quality and compete more aggressively for the user group that more inclined to single home (rather than participate in multiple platforms).

Note: platforms can be set up by one user group as a club good (e.g. datahub). 17

Promoting consumer interests

- Need to remember that electricity is a well regulated sector with a distinguished history of protecting consumer interests...
- Monopoly network procurement should explicitly promote competition, overweight new entrants and take third party anti-trust cases (e.g. National Grid against cable manufacturers)
- Surge pricing and excessive price discrimination should not be allowed (e.g. Uber business model not valid in electricity)
- Data ownership should lie with consumers/system (in centralised data-hub). Tech companies should not be allowed to develop data monopoly (e.g. no private third party network data accumulation).
- Platform mergers in energy scrutinised carefully (e.g. competition in platform providers necessary).
- If new core monopoly, emerges it should be regulated.

Future infrastructure regulation

- Regulators will face the choice between becoming more or less involved in electricity network company decision making in the face of rising complexity.
- Is this choice even possible at the DSO level as distribution systems become more active networks? Regulators may have no choice but to delegate to trusted third party/market (such as an independent system operator or ISO (Strbac et al, 2013)).
- Regulators should rightly encourage 'smart' and 'labour' based (i.e. local) solutions rather than expensive unique capital investments (e.g. via some innovation funding to encourage new entrants).
- However regulators need be careful not to over-incentivise risky innovation or new business models which arbitrage existing regulated investment recovery schemes.

The interests of future regulation (see Pollitt, 2016)

- If the future will be characterised by more distributed generation (DG) and demand side management (DSM) (=DERs).
 - This must mean active DSO networks.
 - Increasing potential conflict between distribution, retail and DERs and new platforms.
- Economic Regulation will continue to focus on:
 - Monopoly power of DSOs with respect to both
 - Development of competition for DSO services
 - Quality of service effects of DG/DSM
 - Data protection/privacy issues
 - Financial regulation of entities selling to consumers
 - (c.f. note use of bitcoin to pay consumers)
 - Implications for particular consumer groups
 - Fair return to network investors

Concluding thoughts

- There are exciting technologies being introduced to energy.
- Competition policy, regulation, government policy and market structures always need to evolve in the light of new technology.
- However we should be careful not to exaggerate the need for change or to forget the fundamental objectives of energy policy to achieve security of supply, lower environmental impact and to give value for money.
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- Only appropriate regulatory oversight will ensure the energy system delivers this in a politically acceptable way.

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Memo: Transactive Energy

- Transactive energy refers to ‘techniques for managing the generation, consumption or flow of electric power within an electric power system through the use of economic or market based constructs while considering grid reliability constraints’
- Source:
https://www.gridwiseac.org/about/transactive_energy.aspx