Global Insights for Electricity Regulators: Lessons Learned

Michael G. Pollitt
Cambridge Judge Business School, UK
Centre for Regulation in Europe, Brussels
Tsinghua University, Beijing

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Jean-Michel Glachant and Paul L.Joskow

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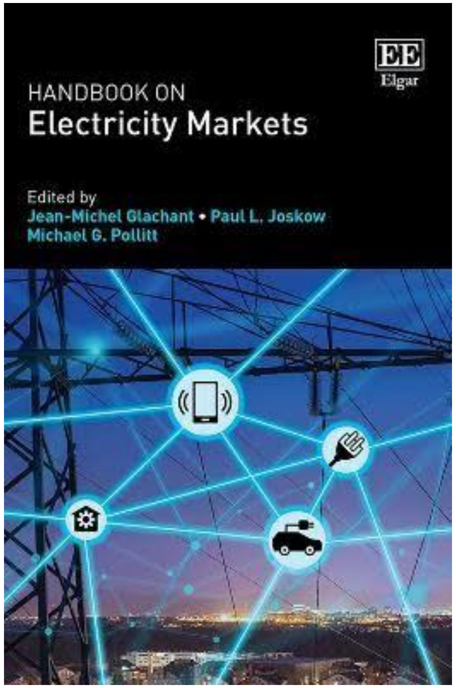
Handbook on Electricity Regulation

2021



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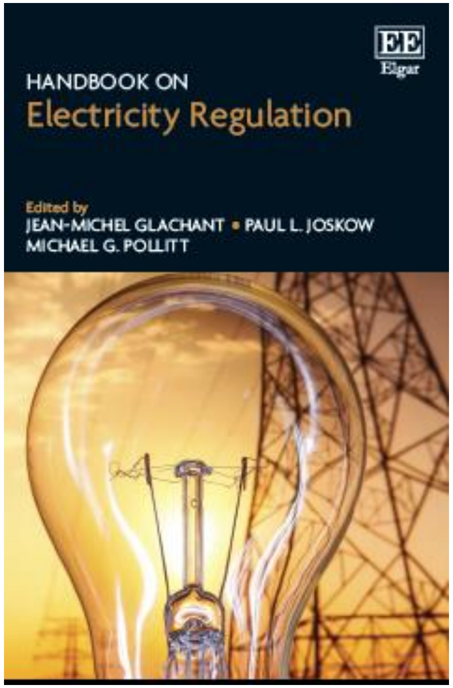


22 Chapters
37 Authors
542 pages

Co-edited with J-M.Glachant and P.L.Joskow

- *PART I:*

FOUNDATIONS OF ELECTRICITY REGULATION ANDRECENT REFORMS

- *PART II:*

REGULATION ON THE PATH TO NET ZERO

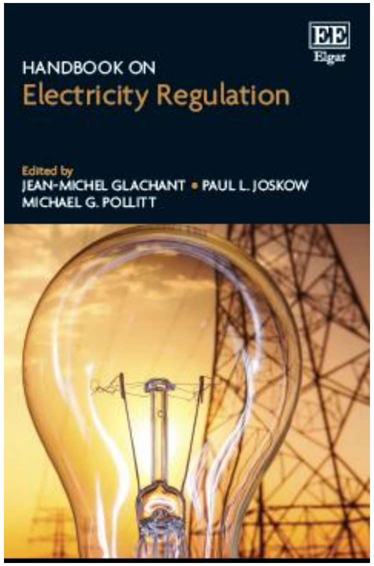
- *PART III:*

NON-OECD COUNTRIES

Available from Google Books (cheap) and in Hardback.

Overall themes

- **Incentive regulation is possible and is powerful** in driving costs down and encouraging quality of service and investment.
- The **regulation of transmission is increasingly complex** due to the difficulty of building new onshore transmission assets, the growing need to send clear cost signals.
- Third, the **regulation of distribution can adapted** to ensure quality of service and be more responsive to user preferences (on generation and demand) and avoid excessive investment.
- **Net zero targets are straining existing incentive based regulatory systems**. Automatic adjustment mechanisms, innovation funding and responsive regulation are becoming more important.
- **Net zero would seem to imply that existing institutional arrangements may need to be changed.** Substantial changes to institutional arrangements in network ownership, system operation and regulation may be necessary.
- **Many developing countries continue to struggle with even a basic level of effective independent regulation**.



Chap 2 - Designing incentive regulation in the electricity sector

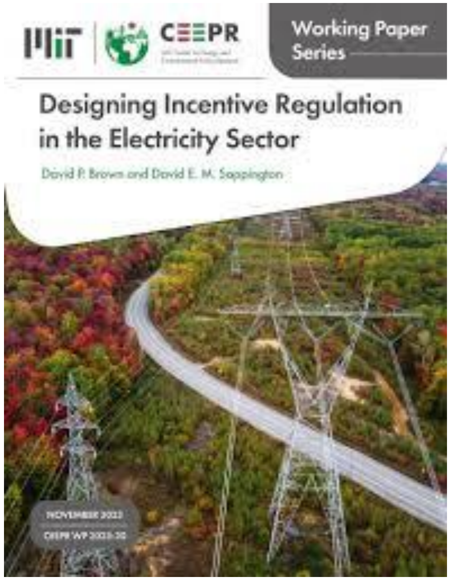
David P. Brown and David E.M. Sappington

This chapter refers to good regulatory frameworks as **incentive regulation or performance-based regulation** (PBR) regulatory mechanisms.

Consumers can be well served by regulation that strives to replicate the discipline that prevails in competitive markets (Alfred Kahn, 1970). Regulation needs to **replicate this discipline *and* is well-informed** about feasible production technologies, the associated efficient production costs, the precise magnitude of a normal profit, and consumer preferences.

Regulators may be better able to replicate competitive discipline and achieve other relevant goals if they can induce regulated suppliers to employ their superior knowledge of industry conditions to achieve the relevant goals.

This is the essence of incentive regulation, which can be viewed as the implementation of rules that induce a regulated firm to employ its privileged information to achieve regulatory goal.s (Sappington, 1994).



Chap 3 - Cost of service regulation of electricity distribution services in the U.S.

Paul L. Joskow and Richard Schmalensee

- State regulatory agencies in the U.S.: 49 state PUCs + DC
- **Slow expansion of PBR** across states
- **Focus on "revenue requirements" with some discussion of rate design for various customer classes**
  - Data requirements to reduce information asymetries
  - Rate base and depreciation (capital)
  - O&M costs
  - Financing and capital structure
    - Allowed rate of return
  - Inter-review adjustment mechanisms if any which have important incentive effects (good and bad)
- **Incentive properties in practice**
  - Capital biases (own vs. buy)
  - X-inefficiency due to soft managerial incentives
  - Regulatory lag
  - Effects of inter-review adjustment mechanisms

National Association of Regulatory Utility Commissioners

Chap 4 – Regulated distribution sector facing the future – the GB experience
Cloda Jenkins

- In 2010, a major regulatory review was completed **launching RIIO** (revenue = incentives + innovation + outputs).

- This emphasised a **wider range of network outputs** (such as happiness of external stakeholders with the network company) linked to sharper incentives.

- GB also focused on the sum of operating and capital costs (**so-called total expenditure or totex regulation**). This has encouraged the substitution of operating cost for capital cost.

- Another important feature has been **the use of automatic and reopener adjustment mechanisms** to handle changes in circumstances within price control periods.

Table 4.7 *Efficiency assumptions for the DNOs*

-	Frontier improvement	Catch-up
DPCR3 (2000–2005)	0% per year	Catch-up with upper quartile by end of period – glidepath to close 75% of gap
DPCR4 (2005–2010)	1% per year	Catch-up with upper quartile in first year – close 75% of gap at start of period
DPCR5 (2010–2015)	1.5% per year	Catch-up with upper quartile in first year – close 75% of gap at start of period
RIIO-ED1 (2015–2023)	0.8–1.1% per year	Catch-up with upper quartile in first year – close 75% of gap at start of period
RIIO-ED2 (2023–2028)	1% per year	Catch-up with top 15% in three years – glidepath to close 85% of gap

Source: Pollitt (2005), Ofgem (2004), Ofgem (2009b), Ofgem (2022a).

- Strong European decarbonization policy via electrification, encompassing mobility, heating & cooling and industrial processes, **can boost electricity consumption tremendously**.
- This calls for a radical leapfrogging of grid expansion.
- incentive regulation was needed to cater for a cost-increasing transformation of the network service: to facilitate the objectives of integrating electricity from renewable sources and leveraging the potential of digitalization in the energy sector, **network costs will increase rather than decline**.
- In view of the increasing urgency to limit climate change and the increasing cost of energy supply, **regulators and policymakers everywhere are struggling between getting it right and simply getting it done.**

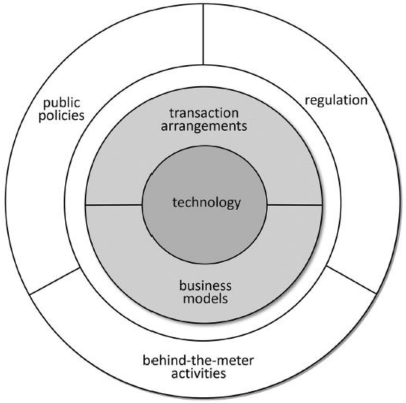


Figure 5.1 Key transformational factors for electricity distribution systems

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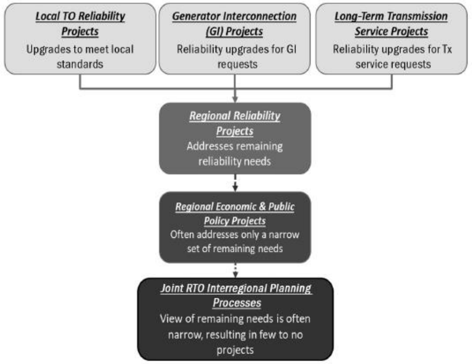
Chap 6 - Regulation of access, pricing, and planning of high voltage transmission in the U.S.

Joe DeLosa III, Johannes P. Pfeifenberger and Paul L. Joskow

- Confusion about federal (FERC), RTO/ISOs, state regulators
- RTO/ISOs are not regulated but subject to FERC orders.
- **FERC regulation of transmission in practice** due to:
  - Liberalized markets with unbundled transmission
  - Organized wholesale markets with partial VI
  - VI utilities outside of RTO/ISOs
  - Muni and coop utilities
- FERC role has increased due to open access, restructuring, IPPs, decarbonization policies
- **Transmission service prices rely on COSR**
  - Incentives focus on encouraging transmission investment
  - Essentially no regulation of costs and performance
  - Formula rates provide poor incentive properties
- **Some improvements to transmission planning by RTO/ISOs**



Note: Tx, transmission.
Source: Pfeifenberger (2022) with permission.

Figure 6.3 Typical US transmission planning processes

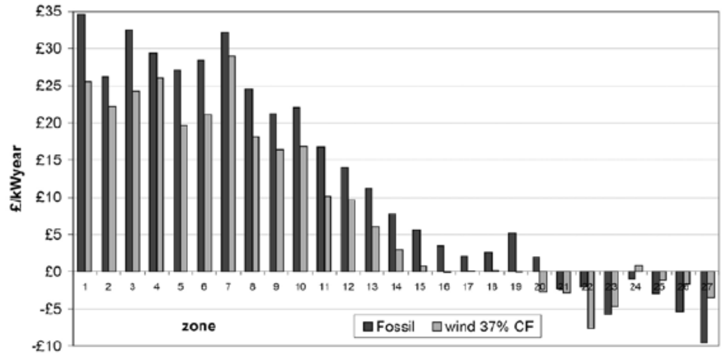
Chap 7 – Regulation of access, fees and investment planning of transmission in Great Britain

David Newbery

- The chapter opens up the discussion of two distinctive features of the GB regime which are related to **how it uses price signals in transmission**.

- GB **does have a system of annually varying zonal connection charges** which provide quite strong longer-run incentives for connection closer to load, but do not incentivize optimal transmission system use in the short run. Reforms to transmission price signals, including via more **cost reflective transmission charges and/or the use of zonal or nodal energy** prices are currently hotly debated.

- GB has some of the world's best offshore wind resources but these come with high offshore transmission costs. **GB has made use of auction processes to keep costs down.** The winning bidder is the one who bids to procure the transmission asset from the developer at the lowest annual cost.



Note: CF, capacity factor.
Source: NGESO (2021) gives the zone map: 1 is north Scotland, 27 is the far southwest.

Figure 7.3 Transmission use of system tariffs for generation in 2021/22

Chap 8 – The regulatory landscape and investment planning for transmission in the EU

Paul Nillesen, Otto Jager, and Joost Ornée

- Electricity transmission networks are under strain across Europe.

- The chapter identifies and discuses seven challenges:

1. **Supply chain shortages** in building new assets
2. **Extended time frames** for project delivery.
3. **Financing constraints** facing TSO asset bases.
4. **Regulatory frameworks are outdated**.
5. **Managing intermittency and lack of inertia**.
6. **Operational and system complexity**.
7. **Planning uncertainty** needs to be reduced.

Table 8.2 *Share of renewable energy sources as per cent of total domestic generation capacity*

Country	% RES 2013	% RES 2022
The Netherlands	14.34	54.30
Germany	49.20	67.62
France	31.27	45.63
Spain	47.60	63.36
Italy	43.00	52.92
Belgium	37.87	58.75
Sweden	63.07	78.89
Norway	96.02	97.83
Finland	33.15	51.41
Total country group	51.22	66.32

Source: Data based on GlobalData database.[6]

Chap 9 – The regulation of electricity networks in Australia's NEM: user charges, investment and access

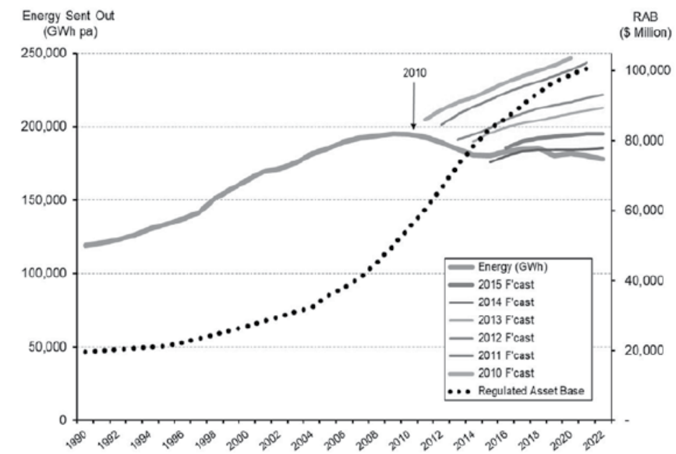
Paul Simshauser

- During 2007-2015 real residential tariffs increased by 8.3 percent per annum in real terms in Queensland **driven by network overinvestment**.

- One interesting experience was the use of **Renewable Energy Zones and transformational transmission investment in Queensland**.

- Transmission connection queues have been reduced by moving from "first come, first served," to **"first ready, first served" connection model**.

- **A key strength of the NEM has been its institutional arrangements.** However, problems have arisen from the lack of federal policy direction given to the Energy and Climate Change Ministerial Council, the nature of Australian Energy Market Commission (AEMC) rules, and the limited room for the Australian Energy Regulator (AER) to adapt on the path to net zero.



Source: Simshauser (2017).

Figure 9.2 Final (grid) electricity demand vs. regulatory asset base (1990–2022)

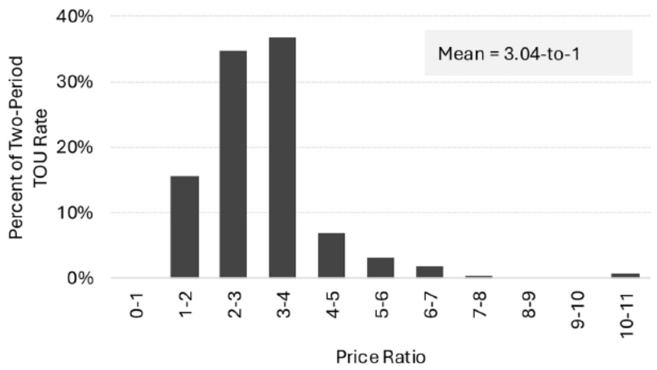
Chap 10 – Retail rate design in the US: time-varying rates for residential customers

Ahmad Faruqui and Ziyi Tang

- After the first oil shock, in the 1970s, a new Act was passed (PURPA) making energy conservation a priority. **Time-of-use pricing (TOU) emerged in a few states, and 16 pilots were launched by the Federal Energy Administration**. In 2000-01, the California's energy crisis triggered a second generation of TOU pilots.

- Simultaneously, smart meters began to be rolled out. **In 2022, 9.4% of all US households were on TOU rates.** One expects 25-35% of households may be on TOU rates by 2030.

- The authors conclude that, for decades time varying rates (TVR) was viewed as an "exotic service offering" but that the new technological wave of solar PV, electric vehicles (EVs) and heat pumps (HPs) will push more utilities to consider and seriously offer TVR. **It may even encourage states to make TVR the "default option" or the "mandatory. option".**



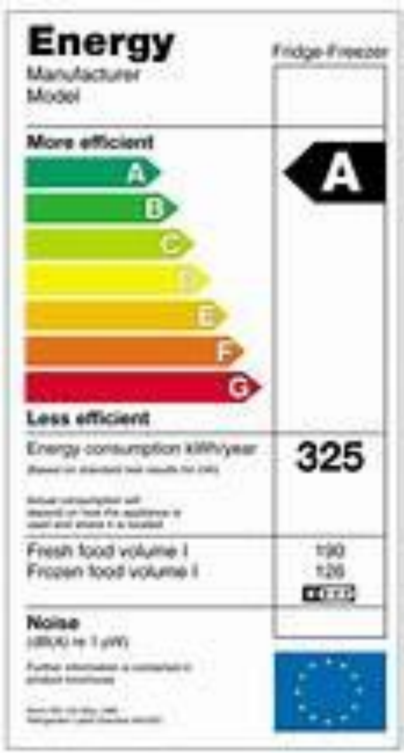
Source: Data from Utility Rate Database, OpenEI, accessed at https://openei.org/wiki/Utility_Rate_Database.

Figure 10.3 Price ratio in two-period TOU rates

Chap 11 – Economics of energy efficiency

Kenneth Gillingham and Erica Myers

- **More efficient appliances and equipment** can play an important role in achieving deep decarbonization targets.
- If energy efficiency investments can reduce customer costs, why don't consumers do so voluntarily? The **"energy efficiency paradox."**
- While there is **no simple consensus in the literature** but hidden costs and overestimated energy savings may account for some of the gap, but how behavioral anomalies and principal-agent issues (along with environmental externalities) also play a role.
- **Policies include** residential weatherization programmes, consumer rebate programmes, consumer information provision and labeling programmes, and minimum energy efficiency standards.
- Ex post analysis of energy efficiency programmes demonstrates that **achieving ex ante "modelled" energy savings remains a significant challenge**.



Chap 12 - The grid of the future and what regulators need to know about it

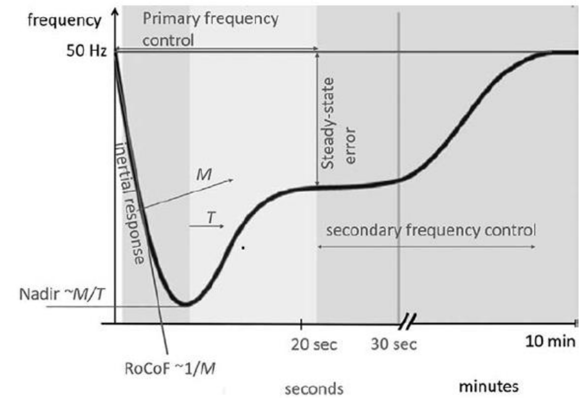
Janusz Bialek and Mark O'Malley

- The focus is on the **replacement of synchronous machines (SMs) with inverter-based resources (IBRs).** IBRs require an inverter to convert the direct-current power from their generator to alternating-current power (or vice versa) and this means that the generator does not automatically respond to changes in system frequency.

- Most current IBRs, which are grid-following inverters, operate in response to the frequency and voltage that they detect. This can involve simply detaching their generator from the grid if they detect low frequency. However, there are **other inverters that are classified as grid-forming inverters, which can be programmed to behave similarly to SMs.**

- A lack of SMs in future leads to increased demands for synchronization services, in addition to the **need for additional services from alternative sources of frequency control, voltage control, damping, protection, and system restoration** that are provided cheaply by SMs.

- SMs can be paid to stay connected to the system to provide these services but at a cost. **Appropriate IBR programming can provide these services** within the limits of the underlying availability of wind and solar energy.



Note: M, inertia; RoCoF, rate of change of frequency; T, combined time constant of turbine speed governors.

Figure 12.2 A response of a traditional grid to a loss of a large plant.

Chap 13 - Decarbonizing the U.S. electricity grid: federal and state regulatory frameworks and challenges

Judy W. Chang and Henry Lee

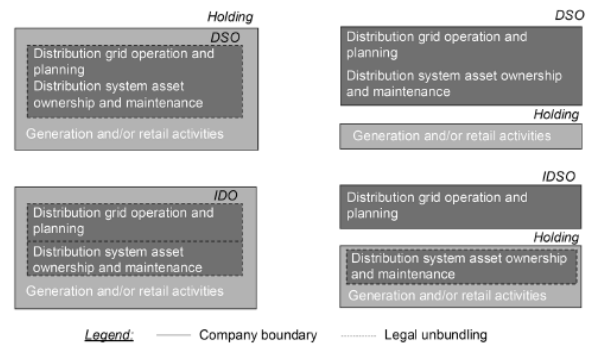
- **Federal policies until early 2025: Goals, targets, and pledges but no national policies**
- **Some "command and control" policies:**
  - Fuel economy standards for vehicles
  - Emissions standards for power plants
- **State decarbonization policies:**
  - 25 states have made "net zero" commitments
  - 25 states have binding renewable electricity portfolio or clean energy standards
  - 14 states of adopted (tighter than EPA) California vehicle emissions standards
- **State policies include:**
  - State managed procurement (PPA) of wind, solar, storage
  - State energy efficiency standards
  - Tax and direct subsidies for EVs, rooftop and community PV, heat pumps, energy efficiency
  - RECs and their monetization
- **Voluntary "Corporate" end-use decarbonization commitments**
  - Long term PPAs (financial and physical)
  - 10-20 years
  - Apple, Google, Walmart, Microsoft, MIT
- **A lot of progress but also challenges**
  - Coal plant retirements
  - Wind, solar, and batteries almost all new generation in 2024
  - Off-shore wind development has been challenging
  - Retail rate design innovations have been too slow

Table 13.1 Sample state decarbonization policies and impacts on power sector

	California	Massachusetts	New Jersey	New York
Overall target	Net zero by 2045[1]	Net zero by 2050[2]	Reduce emissions by 80% (relative to 2006) by 2050[3]	Reduce emissions by 85% (relative to 1990) by 2050[4]
Renewable portfolio/clean energy standards	60% carbon-free electricity by 2030; 100% by 2045[5]	80% "clean" electricity by 2050,[6] including 60% renewables[7]	35% of power from renewables by 2025 and 50% by 2030;[8] 2023 executive order commissions a plan for 100% clean electricity by 2035[9]	70% renewable electricity by 2030; 100% zero-emission electricity by 2040[10]
Renewable energy procurement approaches	State policymakers and regulators set targets for portfolio of renewable energy needed in a state-level Integrated Resource Plan; load-serving entities submit proposed long-term procurement via applications[11]	State legislation authorizes electric distribution utilities to procure new renewable and clean energy resources, and the regulator Department of Public Utilities approves the competitive procurement process and the resulting long-term power purchase contracts for the payments for the energy and RECs[12]	New Jersey conducts competitive solicitation for offshore wind projects and awards the long-term contracts for offshore wind RECs or "ORECS" to developers[13]	New York State Energy Research and Development Authority conducts competitive procurement processes to purchase the relevant RECs and assigns the costs to the electric distribution utilities
Electric vehicle mandates	All new light-duty passenger vehicles must be zero-emission vehicles by 2035[14]	All new light-duty passenger vehicles must be zero-emission vehicles by 2035[15]	Proposed rule to require that all new light-duty passenger vehicles must be zero-emission vehicles by 2035[16]	All new light-duty passenger vehicles must be zero-emission vehicles by 2035[17]
Building electrification goals and mandates	Goal of reducing building emissions by 40% (relative to 1990) by 2030;[18] zero-emission standard for new residential space and water heating by 2030[19]	Developing clean heat standard[20]	Goal of electrifying 400,000 homes and 20,000 commercial spaces by 2030; considering clean heat standard for natural gas utilities to comply with state emissions targets[21]	Phasing in new state law requiring electric heating and appliances in most new buildings[22]
Estimated decarbonization impact on power sector	Tripling of current electric power capacity by 2045; electric vehicle stock grows 15-fold by 2035 and accounts for 10% of peak power demand[23]	Power demand grows 140% between 2020 and 2050, with electric vehicles and electrified space and water heating accounting for most of the increase[24]	Doubling of electricity demand by 2050[25]	Electricity demand grows by 100–110% by 2050[26]

Chap 14 - Regulating European distribution systems to achieve net zero: untapping flexibility efficiently - *Tim Schittekatte*

- Distribution grids may evolve along two lines: **a massive expansion of grid distribution capacity** to enable a deep electrification of the economy, and the development of **complementary new tools to cost-efficiently untap flexibility.**
- Three tools can do this: distribution **network access tariffs; smart connection agreements; and local congestion markets**.
- **A right regulatory framework around the DSOs also needs to be in place**: the unbundling rules, possibly the local market operator independence; plus, the EU debate around assets to be owned and operated such as storage and EV charging stations.
- There are important seams issues between TSOs and DSOs. **In the longer run there may be task reorganization between TSOs & DSOs**.



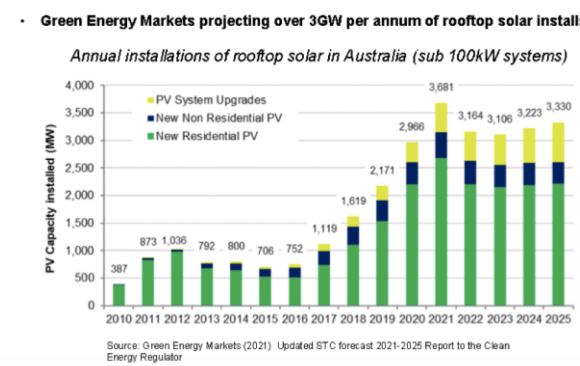
Note: Top left: current typical setup in the EU. Top right: ownership unbundling between the distribution system operator (DSO) and competitive activities. Bottom left: independent distribution operation (IDO). Bottom right: independent distribution system operator (IDSO).

Figure 14.1 DSO unbundling regimes

Chap 15 - “Behind the meter” developments

Fereidoon Sioshansi

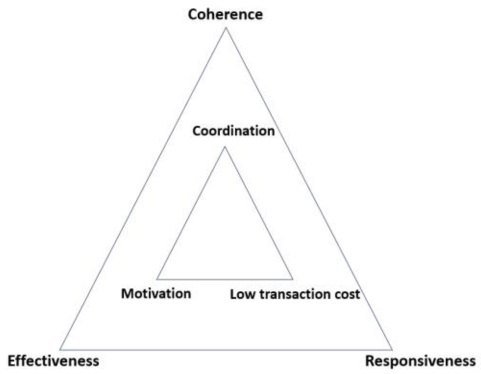
- A kind of **new “electricity territory” has emerged “Behind-the-Meter” (BTM).** This builds on new assets permitting new behavior.
- In Australia and California there were each more than five million self-generating solar customers in 2023. **In South Australia and Queensland, rates are c.50% of households.**
- With appropriate investments in EVs and / or storage, these **“prosumagers” can be self-sufficient for 90+ % of the hours in the year.** All these customers do not need the same distribution network services than the traditional customers.
- Digitalization of all devices is another fundamental trend “BTM”. **New markets too can be conceived**, based on individual device activation as with a “market-informed demand automation server” implementing “price-to-devices” relations, into new “transactive energy” schemes.
- All these innovative or transformative developments “BTM” **call for a profound rethinking of electricity regulation**, reconsidering the tools and the options used in the regulation.



Chap 16 - Uncertainty, regulation and the pathways to net zero

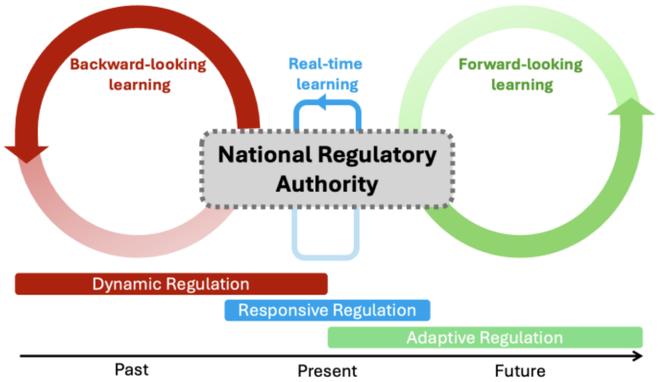
Michael Pollitt, Daniel Duma, and Andrei Covatariu

- The authors make the point that **net zero modeling suggests a lot of uncertainty.**



- **Energy regulators currently grapple with a trilemma:** the need to coordinate across stakeholders, the need to motivate regulated companies to respond appropriately, and the transaction costs of regulation. **A regulatory trilemma also exists** between the effectiveness of regulatory incentives, responsiveness to new information, and coherence between regulatory decisions. Net zero heightens these trilemmas.

- The chapter makes two basic suggestions:
  - It may be desirable to **change institutional arrangements**.
  - The regulatory authority should become a **"learning" regulator**.



Chap 17 - How can regulated electricity network companies promote innovation? Lessons from the field of practice *Leonardo Meeus and Nicolò Rossetto*

Despite being monopolies, network companies can still have incentives to innovate.

A first reason is that the **mandate of network companies can change over time**. A second reason is that network companies **can be interacting with commercial activities with innovation potential**. A third reason is the **financial incentives they get from regulatory authorities**.

The chapter calls for innovation from the regulated network companies: their mandate can be changed by regulation; their connection to commercial activities can be activated; and, final, their financial incentives can also be reconsidered.

Although many of the considerations presented in this chapter are of a general nature, they are particularly relevant for liberalised electricity systems, where generation and supply of electricity have been unbundled, at least to some extent, from transmission and distribution.

Chap 18 - Regulation of hydrogen networks and potential market structure

Chi Kong Chyong and Jackson Dalman

- **Net zero modeling consistently shows a role for hydrogen** as a way of decarbonizing parts of industrial and transport demand that are difficult to decarbonize directly with electricity.

- Net zero itself, however, strongly **favors green hydrogen** given that SMR with CCS only captures, perhaps, 60 percent of the well-to-pipe methane emissions. Thus, hydrogen will likely be tied to electricity.

- The chapter raises the issue of **how the hydrogen networks themselves would be regulated**. The EU has recently moved to promote hydrogen networks across Europe and to lay out similar unbundling rules to those for natural gas.

- A large integrated market in net-zero-consistent hydrogen seems some way off but the **EU's insistence in following the methane model may not be right given the uncertainties**, smaller scale, and competitive disadvantages of hydrogen as a low carbon fuel.

Chap 19 - Challenges to expanding EV adoption and policy responses

Christopher R. Knittel and Shinsuke Tanaka

- **Analyses of policies to support the expansion of EV charging infrastructure are still limited.** The expansion and regulation of EV charging networks often relies at least partially on regulated electric distribution infrastructure and the associated use of regulatory mandates and cost of service regulation to lead the expansion of EV charging infrastructure.
- The chapter does provide an **overview of policy initiatives specifically designed to promote and boost EV charging adoption**.
- The chapter focuses primarily on the U.S., but also provides an overview of policies adopted by some other countries which are **notable for their efforts to encourage both EV adoptions** and the expansion of EV infrastructure which are interrelated.

Table 19.2 *Number of public EV chargers by country and type*

Year	Slow			Fast		
	China	Europe	US	China	Europe	US
2015	47	61	28	12	6	4
2016	86	113	35	55	9	3
2017	131	122	40	83	11	3
2018	164	136	50	111	16	4
2019	301	187	64	215	25	13
2020	498	236	82	309	38	17
2021	677	307	92	470	49	22

Note: This table presents the number of public EV chargers (in thousands) categorized into slow chargers and fast chargers.
Source: IEA (2022).

Chap 20 - Power sector reform in China: economic logic and political reasoning

Xu Yi-chong

- **Power market reform has been a policy priority for 40 years.** While China has accepted that its power sector is inefficient and could benefit from the introduction of markets, regulated network tariffs, and competition, it remains **reluctant to fully embrace reform models** seen in the US or Europe.

- The **CCP is unwilling to set up an authority that might operate as an arms-length independent regulatory agency.**

- Thus, the **regulatory regime lacks stakeholder trust** in an ill-defined legal environment with outdated legislation that does not reflect the stated intentions of the 2015 No.9 Document on power market reform.

- Electricity policy continues to emphasize short-term affordability and wider social development, and **this has stood in the way of objectives of energy economics, namely, fairness, optimal investment, and optimal operation**.

- **Progress has been made** in generation at the federal level, particularly in the setting up of national power markets and the development of competitive **auctions for the procurement of renewables**. At the transmission level, there have been positive experiences from 2003, with the **setting up of a national transmission company**, the setting up of separate state transmission companies, the promotion of third-party access, and private ownership of transmission assets.

- **Much still needs to be done particularly at the level of individual states**. Here state electricity boards (SEBs) have been under-regulated for decades with the failure to enforce a target of 3 percent annual return on net capital. Attempts to restructure and privatize SEBs in Orissa (from 1999) and Delhi (from 2002) had mixed success, failing in Orissa, but leading to significant improvements in performance in Delhi.

- **An independent federal regulator has been set up** - Central Electricity Regulatory Commission (CERC). Federal legislative proposals have sought to give the CERC powers in tariff setting and placing hard budget constraints on SEBs. **While these reforms have yet to be implemented, they do suggest a promising direction of travel.**

Chap 22 - Distinctive regulatory challenges in developing countries

Debabrata Chattophadyay and Vivien Foster

- The benefits of power market reform are **widely acknowledged by the countries themselves**. However, the elements of reform are only partly implemented.

- The chapter highlights recent work which finds that **many LMICs struggle to undertake the basics of regulation** such as: reporting the formula by which regulated tariffs are calculated; undertaking efficiency reviews; and implementing inflation indexation of tariffs. Around half of these countries do not even have formal decision-making powers to set tariffs and even where they do they are frequently overturned by politicians, with the removal of the senior regulators who recommended them. The chapter discusses examples: **Egypt (bad); Colombia (good) and Kenya (interesting).**

- Serious commitment to regulatory reform remains limited in many LMICs, only 20 percent of whom have a wholesale electricity market. Regulators in LMICs often lack the skills to do their job effectively. **Progress seems to have stalled since 2010.**

- **The potential for renewable generation and positive auction experiences** could help prompt renewed focus on better regulation.

High / Middle / Low Income Countries