Beyond Retail Competition…
a new electricity world is coming

IIT Kanpur – 18 December 2021

Jean-Michel Glachant
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Sharing knowledge at world level: a noble cause

Power sector enters an interactive digital world…

-- Part I -- Innovations start to disrupt the power sector- -- -- --

- 1- (Incentive Regulation) + Innovation(s) = RIIO
- 2- The "Coupling Regulation" looking for Sector Integration
- 3- The "Dynamic Regulation" responding to "Prosumer" revolution
- 4- The "3D Dynamic Regulation" pushed by Digital interactions in a multi-level power system

-- Part II-- The case of flexibility from the demand side - -- -- --

- 1- The 4 types of "Demand Flexibility"
- 2- The 3 levels of usage of "Demand Flexibility"

➢ *You can ask Pr Anoop Singh for an adaptation to India's realities*


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Dynamic Retail Electricity Tariffs: Choices and Barriers
Highlights
POLICY BRIEF


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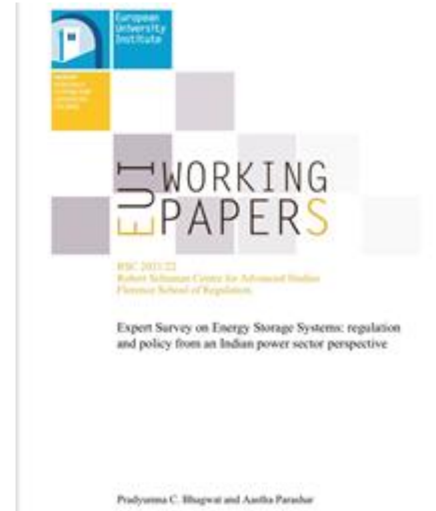
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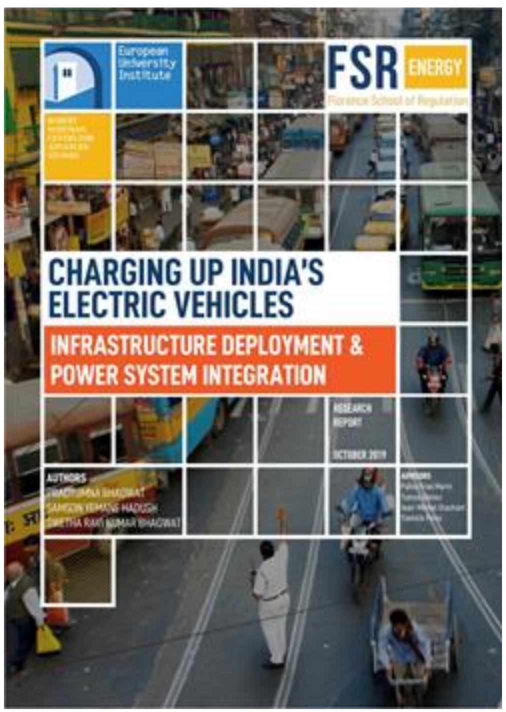
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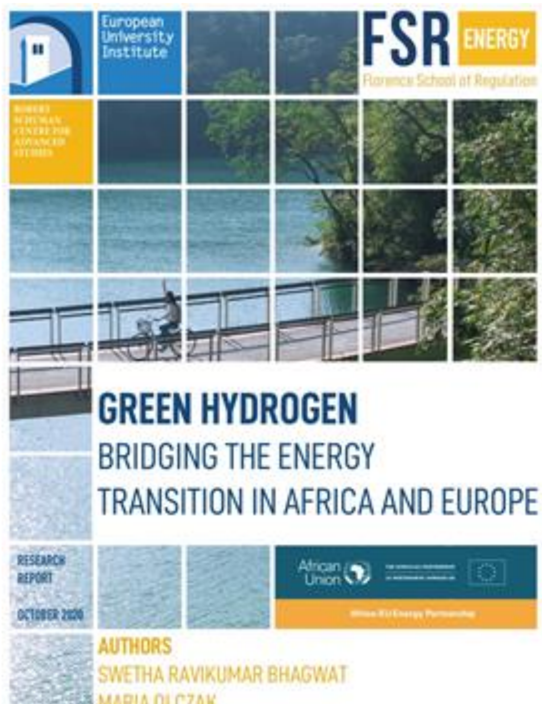
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AUTHORS
SWETHA RAVIKUMAR BHAGWAT
MARIA OLCZAK


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21st Century Novelty 1: Innovation(s)

Incentive Regulation assumed that companies innovate on their own:

Getting Opex lowered, Performances increased, to handle risky contracts taken from the Menus, etc.

10 years ago, it became clear that innovation had to accelerate (digitalization as smart grids, smart metering) and had to enter into all parts of incentive regulation. British regulator redefined regulation:

>> RIIO >> Regulation as "*Revenues = Incentives + Innovation + Outputs*"

- **What's new for regulation?**
- **Innovation is to face the unknown, to take risks, to do trials & errors. Regulator has to be lenient: it can return to 'cost of service' for testing & running experiences; to grants for undertaking innovation; to increased ROR for Capex uncertainty**
- **Big novelty = "Sandboxing": where companies learn; the regulator too. With more knowledge, innovation can marry better with the 'classic' incentive regulation**

21st Century Novelty 1: Innovation(s)

- Incentive Tools can adapt to innovation

*If innovation lowers costs, it can enter Price Cap; Capex too can enter Price Cap: TOTEX can substitute to (Opex Price Cap + RoR for Capex) > future decrease of TOTEX to be shared between company & society

**If innovation increases performances that can be measured; Performance Based Regulation

Renewables capacity hosted by the grid: performance better than predefined targets = extra reward; worse = punishment

***If innovation requires strong skills: Menu of Contracts Only people with strong skills will take more rewarding / more risky contract

UK offshore sea grid: generators can define & build them if they want; then reselling these sea grid assets to sea grid franchisee by auctioning, before starting normal offshore operation.

¤ More innovation to come offshore

To come: Danish offshore hub; 10-20 GW energy islands. What regime?

Novelty 2: "Coupling Regulation(s)" to get <u>Sector Integration</u>

Just seen that "Incentive Regulation + Innovation" can create structural changes like "*<u>new modules of regulation</u>*" separated from the general regime of regulation (UK: Offshore grids; Denmark: Offshore hubs)

Many other cases of "*<u>New</u>* regulatory <u>modules</u> / *<u>Local</u>* regulatory <u>regimes</u>" like:

- **Rural microgrids, minigrids to give access to electricity**
- **Auctions for utility-scale solar parks, or wind farms, with FiT**
- **Local storage, for grids to balance RES intermittency**
- **Planning of charging stations, for EVs & El.bikes**
- **Creation of city gas infrastructures, to decrease local air pollution**
- **Green Hydrogen industrial valleys**

>> All these new modules de-integrate the regulatory frame; create new particular regulatory regimes for particular classes of infrastructure assets or technological systems.

Novelty 2: "Coupling Regulation(s)" to get Sector Integration

However these new modules can enter the 'general regulatory frame' in a 4 step process

Step 1- Rolling out of the new infrastructure, or infant technical system, with its particular set of rules

Step 2- At a maturity point; decision if (Unbundling) & (Nomination of a regulated operator) is needed

Step 3- Definition of a maturity regime: (Definition of a Code of operation of this infrastructure or system)< < Alignment >> (Rules of Market Design; maybe with market operator)

Step 4- This modular maturity regime evolves with successive realignments of the pair { infrastructure operation code) & (rules of market design} to operate smoothly this pair, in coordination of general regime of regulation

"Coupling of all Regulatory Regimes" might end up in a general "Sector Integration": all different energy sectors & vectors get aligned

Novelty 3 "Dynamic Regulation" to respond to "Prosumer Revolution Spiral"

"Innovation(s)" created "new modules of regulation"…

NOW: one single structural change can transform the entire regulation landscape…

Classics of regulation (*Monopoly + Costs of service*) or (*Markets + Incentive regulation*) were both assuming that consumers need access to monopoly grid to get served: a state of dependence

"Prosumer" breaks that by investing: into self-generation, self-consumption, self-storage, self-management of individual load

Any decision by regulator, or any regulated operator, is followed by *prosumers striking back*: in their behaviour, investments, operation of assets, new decisions to become prosumer, etc.

Novelty 3 “Dynamic Regulation” to respond to “Prosumer Revolution Spiral”

Regulator & Regulated Operator cannot assume that their own alignments - just seen in Update2- will work as they would like

[[(Code of operation of the infrastructure or technical system)< < *Alignment* >> (Rules of Market Design; maybe with market operator)]]

“*Prosumer Revolution Spiral*”: the whole regulatory regime has to evolve - with successive realignments of its various pairs {infrastructure operation code} & {rules of market design} to respond to actual decisions taken by active prosumers

>> “Dynamic Regulation” = continuously coupling the various “Regulatory Regimes” with new reactions / new decisions taken by Prosumers

Novelty 4 "Dynamic Regulation" becoming 3D pushed by Multilevel digital interactions

The idea of "dynamic regulation" acknowledges that a new player (the *prosumer*) has enough incentives & liberty of decision-making to always react to regulator & regulated operators' decisions.

"*3D Dynamic Regulation*" is the new system we are entering in.
The electricity system is incredibly changing, in all its dimensions: it's becoming 3D. ..

From the top to the bottom within its frontiers,
as well as *behind* or *beyond* its frontiers (think EVs, interactive buildings, Green H2…)

"3D Dynamic Regulation" = continuously coupling the classical "Regulatory Regimes" with novelties popping anywhere…

Novelty 4 "Dynamic Regulation" becoming 3D pushed by Multilevel digital interactions

*Distributed energy resources, *self-generation & self-consumption, *self-storage, *demand response, *charging electric vehicles, etc. are managed with decisions taken "beyond electricity regulation" and "behind the meter"…

The classical electricity system was made of "Transmission & Distribution" encapsulating Generation

A new level of electricity system appears today at its "bottom": the individual decisions taken "Behind-the-Meter"

"3D Dynamic Regulation" = the electricity system is become multilevel… not anymore controlled by a single "system operator" & its "central dispatch"…

Novelty 4 "Dynamic Regulation" becoming 3D pushed by Multilevel digital interactions

Electricity system is not only become "Multilevel"; it is also become "digitally interactive" in all its dimensions

Digitalisation continuously enables new players, permits new products, favours new types of trade arrangements: towards generalized digitalization, with 5G & "*Internet of Things*"

❖ **New Players**

Aggregators, prosumers, energy communities, asset fleet managers, platforms

❖ **New Products**

Realtime green energy, blockchained generator, sharing local storage, "smart" charging EV, flexibility as "V2Grid", automated load management

❖ **New Trade arrangements**

C2B, C2C (Peer2Peer – Blockchain), two-sided Markets (platforms)

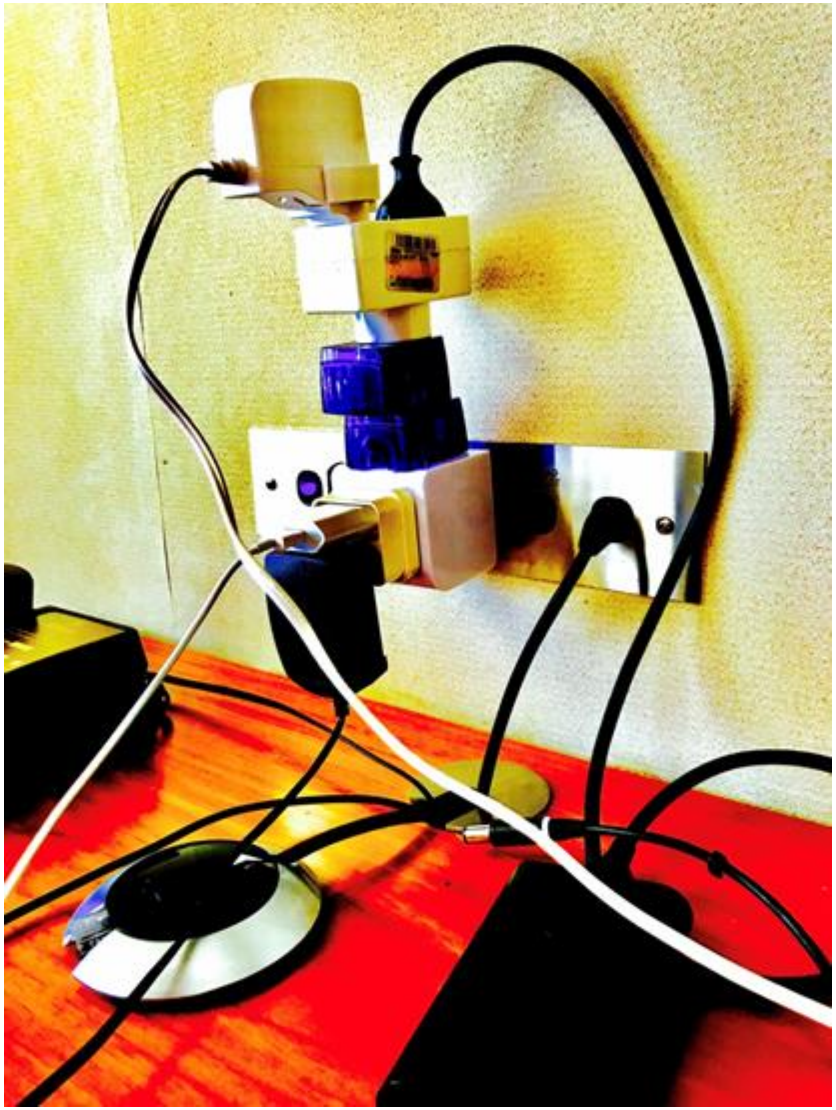
“3D Dynamic Regulation” in Multilevel digital interactions

Ones still have to align (Operation of Infrastructures & Technical Systems) with (Rules of Market Design) but…

	Infrastructures & Technical Systems Levels		
	TRSM level -	DSTRB level -	BthM level
Market Designs Rules B2B			
B2C			
C2B			
C2C			

A Multilevel Regulation World

become Digitally interactive…



IF re-arranged as…

"*Internet of Energy*"

Conclusions: a lot of challenges for regulation, and regulators

<:> Towards a “*New Regulatory Frame*”
to favour structural business innovations
Innovative Business Models to come <through> “Modular Regulatory Regimes” + Their reciprocal “Couplings”

<:> Towards a “3D *Dynamic Regulation*”
interacting with New Players, New Products,
New Trade Arrangements, with growing
“*Beyond el. Regulation* + *Behind the Meter*” activities

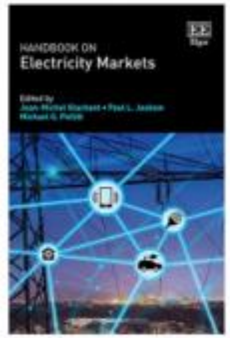

United, yes we can

Part II:
Towards flexible energy systems on the demand side: Markets & Regulation

Jean-Michel Glachant
Director of the Florence School of Regulation

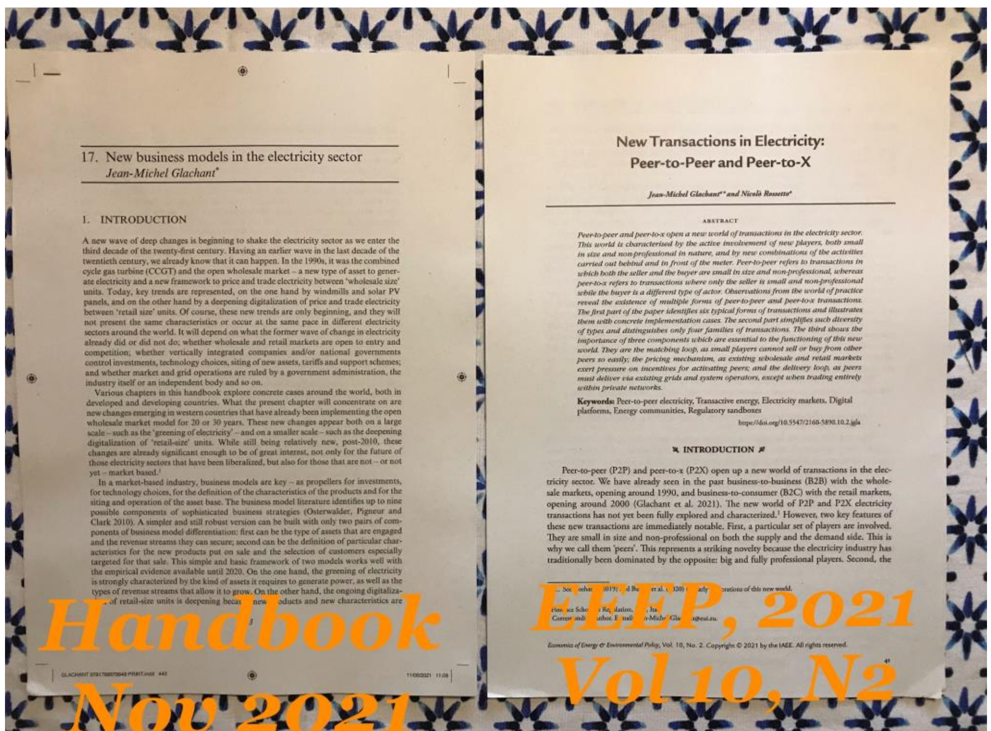
Add to Wish List ☆

Nov.
2021



Handbook on Electricity Markets

Edited by Jean-Michel Glachant, Paul L. Joskow, Michael G. Pollitt



Flexibility at core of EU decarbonization strategy

- At the core of EU decarbonization strategy is **electrification** with **clean electricity**. This implies 6 times more Green electricity.

- 1- Decarbonizing the electricity EU consumes today 2,500 TWh
- +2 Direct electrification of road mobility 3,100 TWh , heating & cooling buildings & households 2,900 TWh, parts of industrial processes 1,000 TWh
- +3 Indirect electrification of maritime & aviation, other parts of industrial processes (via Green Hydrogen & Ammonia, etc.) 2,000 TWh. Competing with Biofuels? Synthetic fuels from gas + CCUS?

- Today's EU gas crisis reminds:'**'Flexibility of electricity systems**'' is key

Overview of electricity flexibility seen from consumer side

- First, **the supply of flexibility** on the consumer side, distinguishing 4 types of consumer flexibility (from demand response to system peaks, to integrating consumption in a transactive process)

- Then, **the uses of flexibility**, distinguishing 3 levels of flexibility use (¤ at transmission level, ¤ at distribution level, ¤ and ‘’*Behind-the-Meter*’’)

Consumer Flex (1) Demand response to system peak pricing

- Not new, exists since decades that certain consumers gain by not consuming at peaks
- Tradition in France is ‘’*EJP*’’ = <u>Demand response to seasonnal peaks</u>. Mainly professionals do that. But even households: in 2021, 22 ‘Red Days’ at 374 Euro a MWh (retail rate)
- New business for ‘’*Aggregators*’’ = <u>Demand response at all peaks</u>, incl. daily peaks. Made EU legal by *Clean Energy Package*, but rules (*Aggregators vs Suppliers*) left national. Leading French: *Voltalis*. Leading German: *Next Kraftwerke* (10,000 clients & 9GW in 2020). Business of ‘’*Light Assets*’’ intermediary & trader

Consumer Flex (1) Demand response to system peak pricing

- Expansion of electricity consumption via electrification of industrial processes will expand the potential business of demand response; and I have already seen industrials studying what could be the ‘’right flexibility potential’’ to give to their new investments.

Consumer Flex (2) Managing distributed generation with storage

- Expansion of rooftop PV questions the right size of PV assets vis-à-vis size of self-consumption; plus the lower storage costs expand set of choices for prosumers (1.2m in California)
- Management of distributed generation with storage opens the box of 'price arbitrage': grid tariffs for peak injection or withdrawal; supplier tariff for energy; support schemes for renewables… The prosumer can decide, act & react
- German company Sonnen sold > 60,000 home storages

Consumer Flex (3) Managing a flexible load being a storage: Electric Vehicles

- An EV is both a flexible load (it can charge at different points & different times) and a storage…
- '*Smart Charging*' means making arbitrage for EV charging
- '*Vehicle to Grid*' (V2G) adds options of injecting electricity into the grid > wider arbitrage perimeter.
- EV owners have to choose being active or passive; incl. for their car to be able to do V2G. But VolksWagen now installs V2G on all its EVs.
- EV owners can also arbitrage charging at home, work, or station
- 15% EU fleet to EV = 40 m cars = > 2 TWh batteries ''On Wheels''

Consumer Flex (4) ***Integrating*** key consumption devices ***into a transactive process***

- Not so easy for consumers to evaluate all options & manage well flexibility of home (or shop, or building) consumption
- But it can be automatized: via a proper digitalization of key consumption devices ('sensors' + 'actuators' + 'controller')
- Let's look at cases of '*'transactive energy*'' in the US

Proof of concept *''RATES''* in suburb of Los Angeles, for 3 years

Tested at scale in Colorado, *''TESS''*, with 58,000 participants.

Each key device gets sensors + an actuator

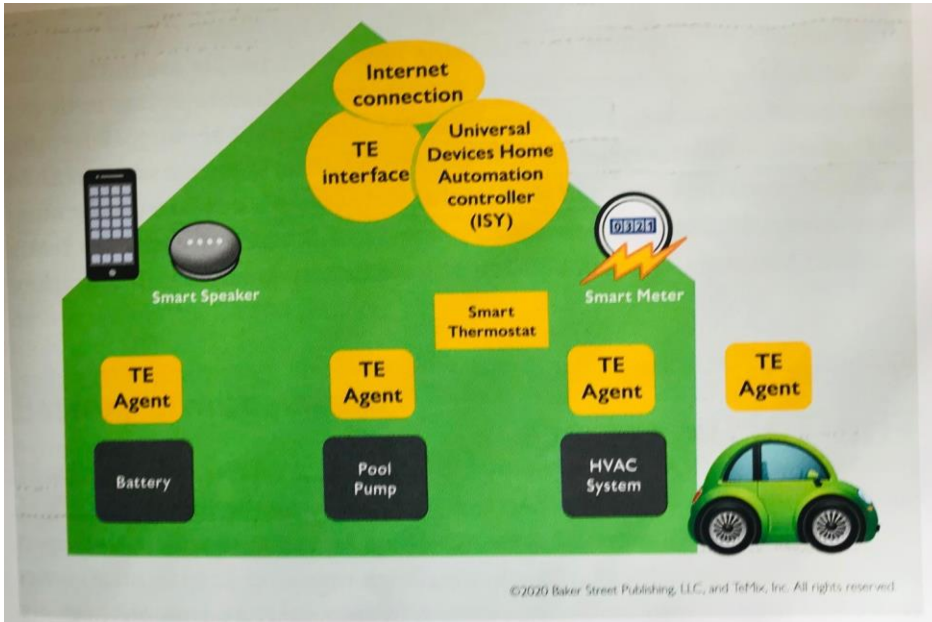
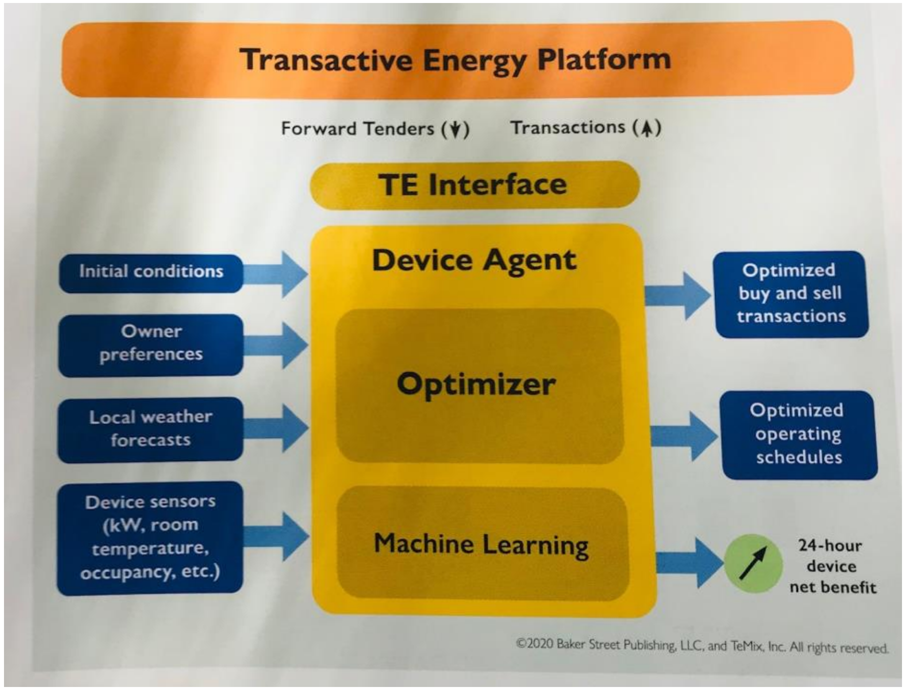


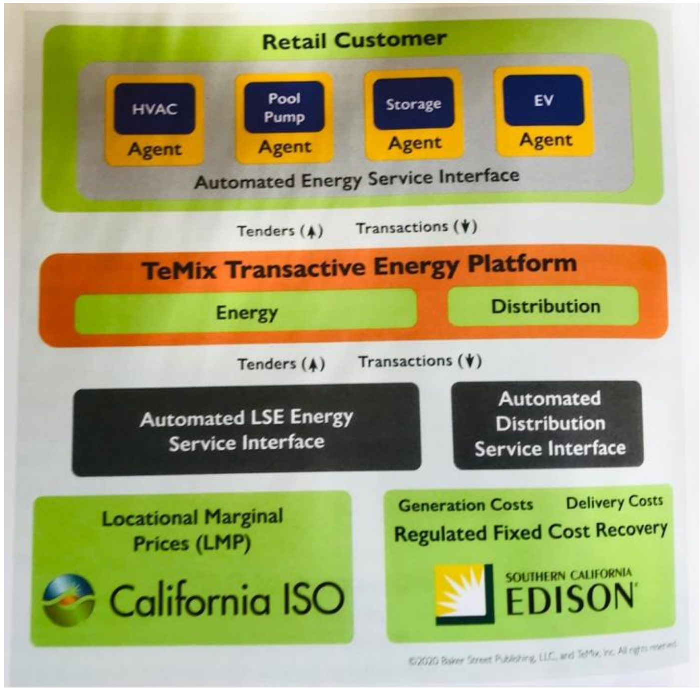
FIGURE 5-1 *RATES customer architecture for the Moorpark project*

Each device obeys ‘owner preferences’ + ‘machine learning advices’ via a *Home Integrating Controller*



Txs to dedicated Platform

the *Home Controller* interacts with the System Operator pricing & the Supplier tariffs

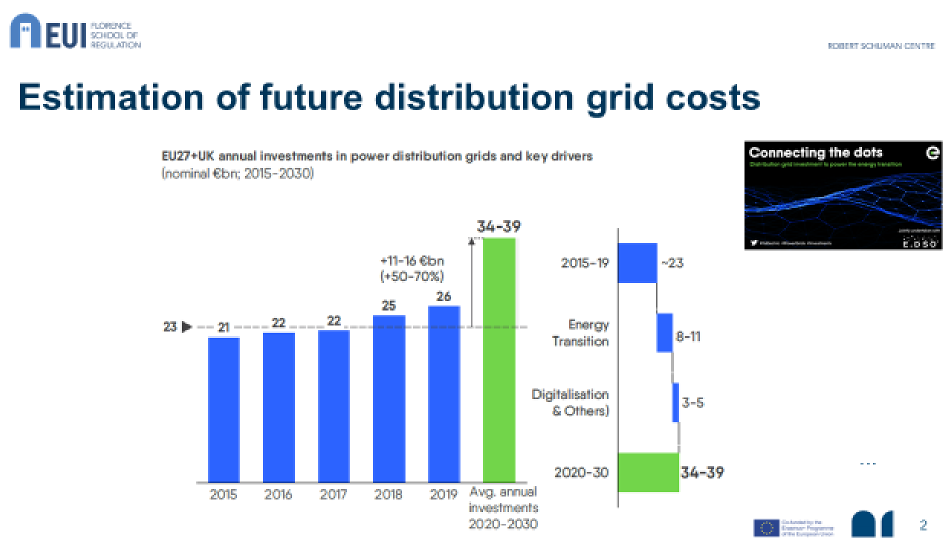


Flex. Use Level (1) At Transmission level

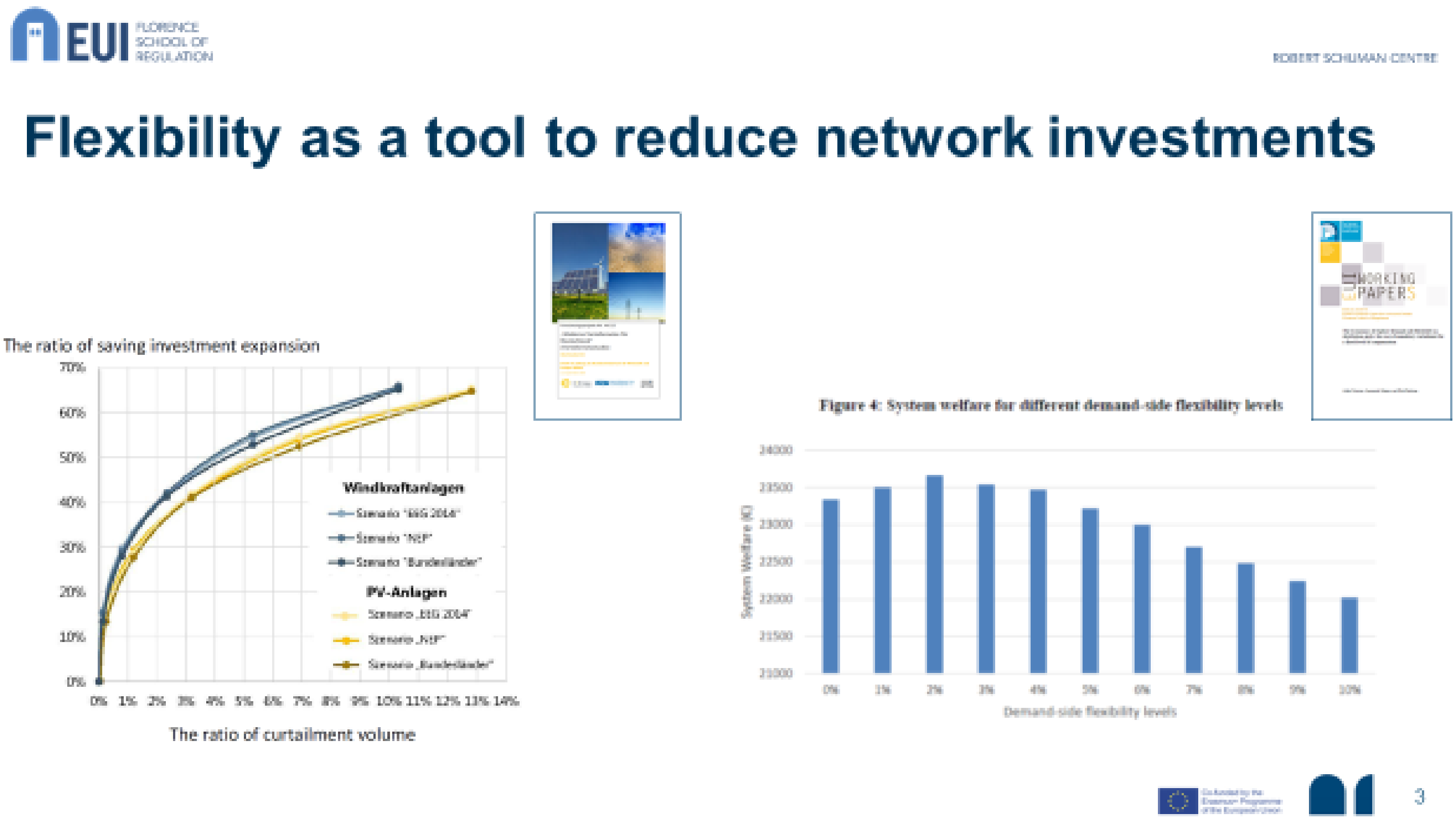
- Needs of flexibility at transmission level vary from one country to another; in same country from one electricity mix to another
- French Transmission System Operator 'RTE' just released its '2050 Net Zero' study. Central scenario sees electricity consumption in 2050 at +200 TWh (+40%)
- IF 51 GW nuclear in 2050 (today 61 GW) & 135 GW renewables, Flexibility by demand response & V2G is at 15 GW ~ France SoS needs additional 1 GW system battery.
- IF 0 Nuclear & 345 GW renewables, France SoS needs additional 26 GW system battery & 29 GW decarbonized thermal plants.

Flex. Use Level (2) At Distribution level

- Another story… French TSO RTE expects 135GW to 345GW renewables in France 2050: 110 GW to 285 GW connected to distribution grids



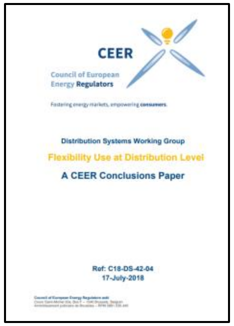
Flex. Use Level (2) At Distribution level



Flex. Use Level (2) Distribution level Flex. Toolbox

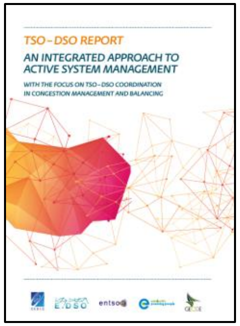
CEER = EU regulators

- Network tariffs
- Connection agreements
- Market-based procurement
- Rules-based approach



E.DSO = EU DSOs

- Tariff solutions
- Connection agreement solutions
- Market-based solutions
- Rule-based solutions
- Technical solutions using grid assets

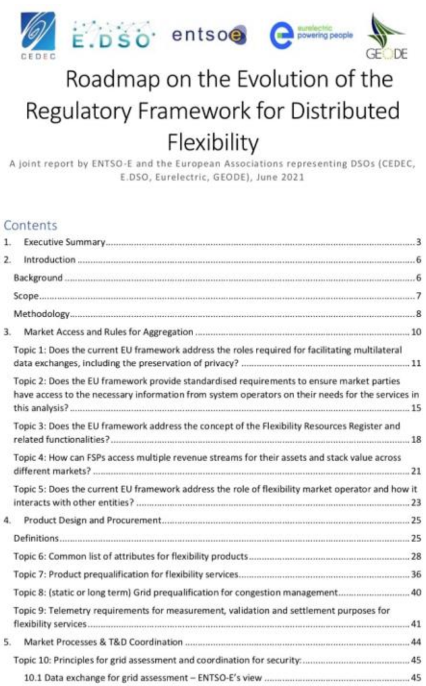


But there are 22 options: not agreed upon…

- Use case and voltage level
  - Congestion management and/or voltage control
  - Deferral of network investments
  - Planned maintenance
  - Incidents
- Market integration
  - TSO-DSO coordination
  - Timing and sequence in DAM/IDM
  - Single market vs series of call markets vs continuous market
- Market rules
  - Market objective
  - Integration of network constraints
  - Pricing scheme
  - Baseline approach

- Product definition
  - Tailored vs generic products
  - Fixed vs open attributes
  - Short vs long-term products
  - Active vs reactive power
- Roles and responsibilities
  - Market operator role
  - Market clearing role
  - Meter data operator role
  - (independent) aggregators
- Financial vs reputation vs regulatory incentives
- Calculation of cost and benefits flexibility markets
- Customer engagement

But EU Transm. & Distrib. Roadmap in June



CEDEC E.DSO entsoe eurelectric powering people GEODE

Roadmap on the Evolution of the Regulatory Framework for Distributed Flexibility

A joint report by ENTSO-E and the European Associations representing DSOs (CEDEC, E.DSO, Eurelectric, GEODE), June 2021

Contents

June 2021 EU Roadmap Transmission – Distribution

"A Regulatory Framework for Distributed Flexibility"

With 24 recommendations, in 4 areas

but… > 1/3 disagreements

¤ **Market Access & Rules for Aggregation** 5 Topics 100% agreement

¤ **Measurement, Validation & Settlement** 5 Topics 100% agreement

¤ **Product Design & Procurement** 5 Topics 100% disagreement

¤ **Market Processes & Transmission – Distribution coordination**

10 topics 40% disagreement

Flex. Use Level (3) *Behind-the-Meter*

- Aggregators & retailers play in the wholesale market. Retailers buy wholesale & fraction it for the consumers. Aggregators buy at consumers & repack at a wholesale size.
- Many other actions stay at the consumption level: ***behind the meter*** of the distribution grid. As: decentralized generation, decentralized storage, management of EV charging & V2G, etc.
- Here consumption flexibility can be directly integrated with operation of decentralized generation & decentralized storage. It is the 3d level of flexibility: the ***Behind-the-Meter flexibility***.

Flex. Use Level (3) *Behind-the-Meter*

- Prosumers & Prosumagers can prefer to get the integration of their assets & consumption from an 'asset light' professional
- UK supplier Octopus does it for owners of a Tesla + Powerwall storage + RoofPV, guaranteeing the smallest price for all complementary energy supply
- Sonnen in Germany does something similar with the batteries it sells, offering an "Energy Community" to their owners. Highest Sonnen battery "*Econlix*'' (10 kWh) also offered to control the consumption devices at home.
- Ausgrid & Reposit Power, in Australia, guarantee 5 years of free energy supply to all households investing into 6.6kW PV + 11.8kWh storage monitored & managed by Reposit Power 'home controller'

Flex. Use Level (3) *Behind-the-Meter*

- The EU legal definition of ‘*’Energy Communities*’’ (in “Clean Energy Package”) might open the way to collective actions, independent of market-based suppliers’ undertaking.
- See coming pioneering community “Solar” in city of Allensbach (Baden-Wurtemberg) [***Innovation Award 2021*** by RGI]
- Empowerment of prosumers & prosumagers can also give rise to “*Peer-to-Peer*” sharing of PV, storage, EV charging in a “*sharing economy*” scheme. *Digital Platforms* can play there a big role to simplify trade & transactions.

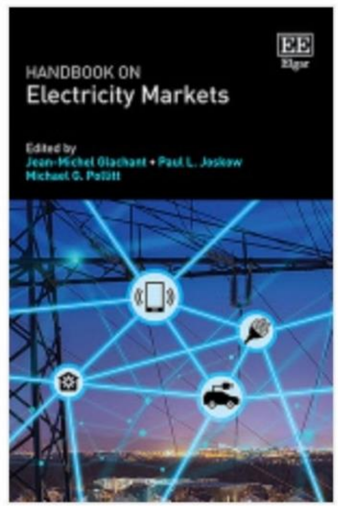
Conclusions

- 1¤ Wider electrification of EU energy systems will increase the role of decentralized resources, be they generation or storage, and the value of a deeper digitalisation of consumption devices, *Heat Pumps* or EVs. *Internet of Things* will permit billions of devices to emit, receive, act and interact.
- 2¤ Proper regulatory frame to reach the full potential of this wave is not yet defined. But regulators, grid operators, utilities, independent businesses, prosumers, communiites, EV owners are already thinking & testing. For the success of EU 2030 decarbonisation targets, one needs this EU Big Bang to succeed.

Many thanks to you all… If any wish list…

Add to Wish List ☆

Nov. 2021



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United, yes we can