

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

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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 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*” = Demand response to seasonal peaks. Mainly professionals do that. But even households: in 2021, 22 ‘Red Days’ at 374 Euro a MWh (retail rate)
- New business for “*Aggregators*” = Demand response at all peaks, 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 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

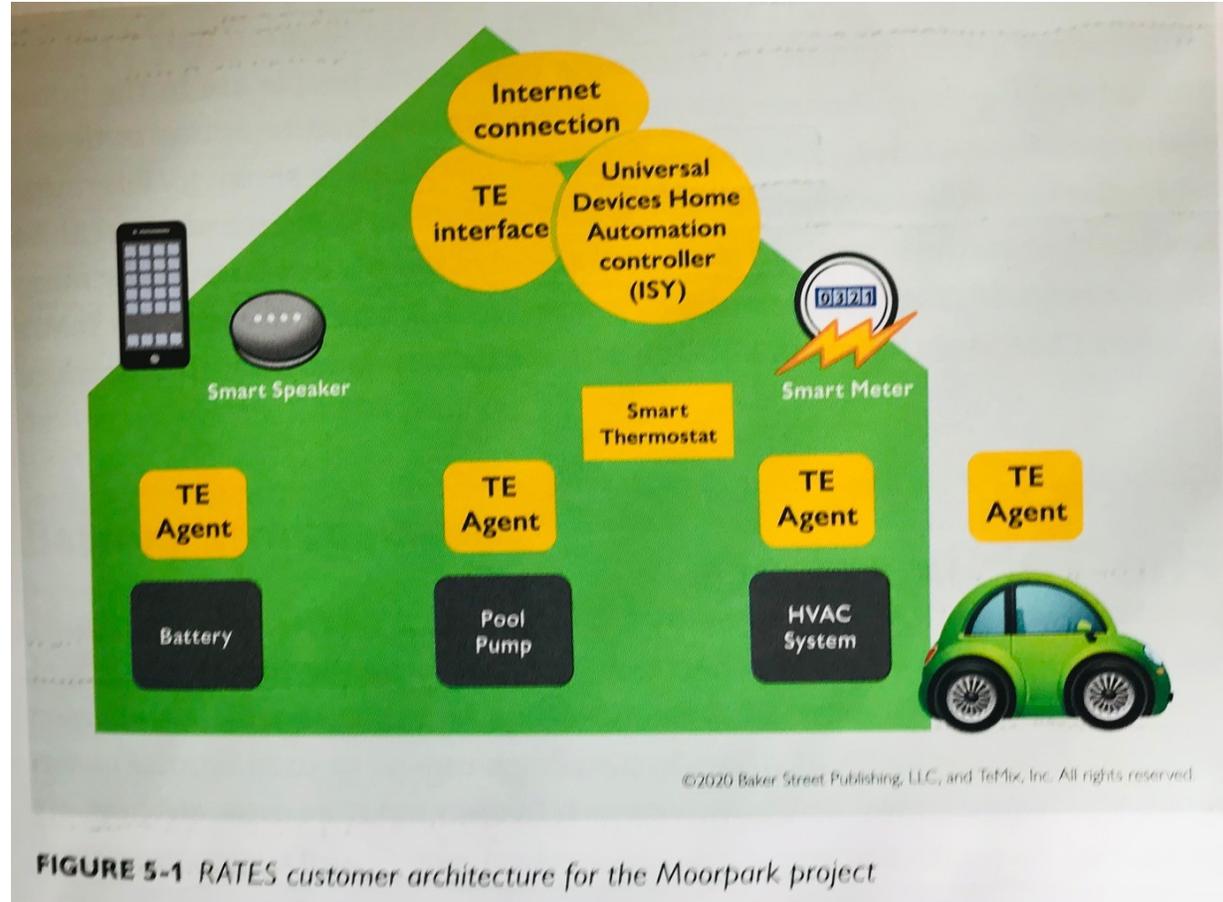
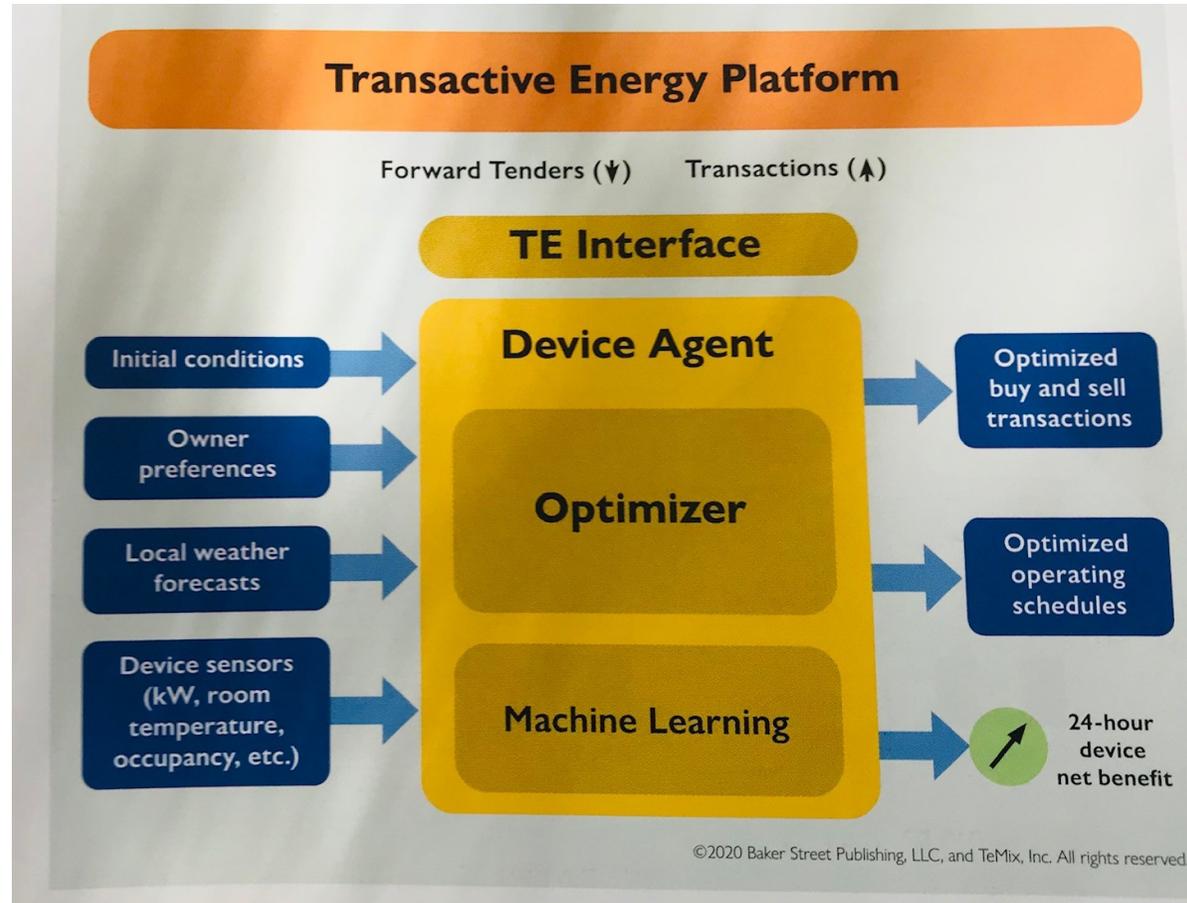
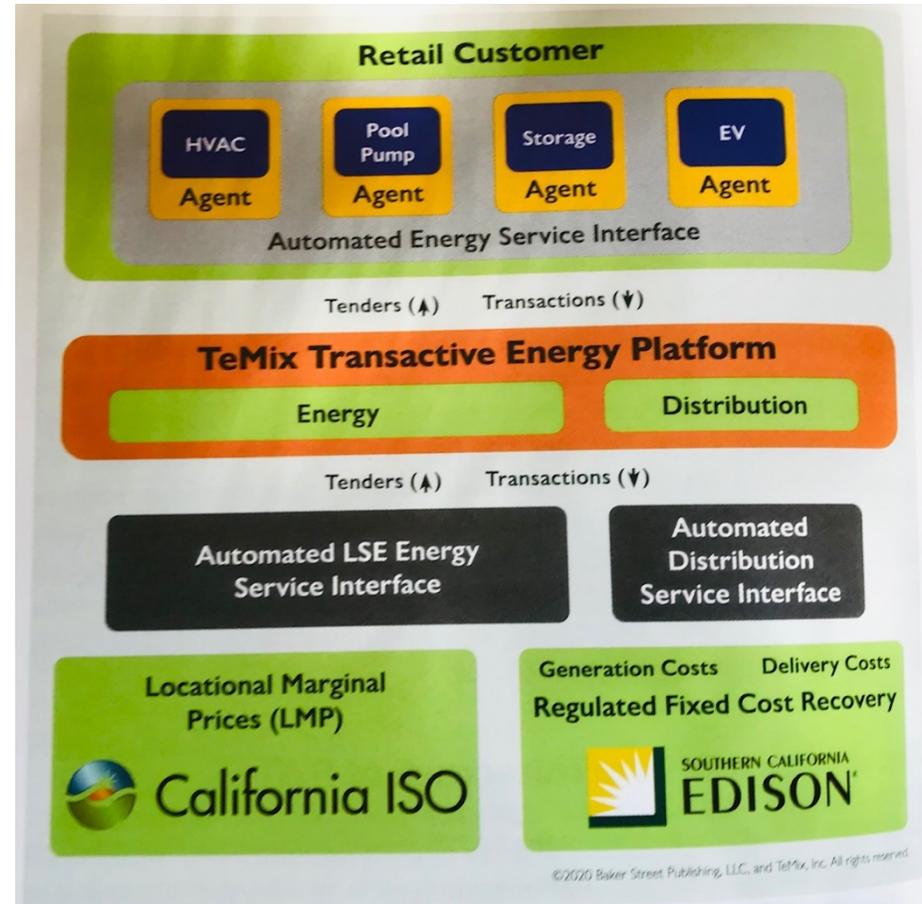


FIGURE 5-1 RATES customer architecture for the Moorpark project

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



Txs to dedicated Platform, the *Home Controller* interacts with System Op. pricing & Supplier tariffs



Flex. Use Level (1) At Transmission level

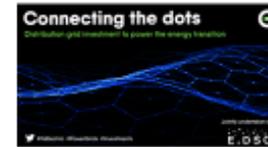
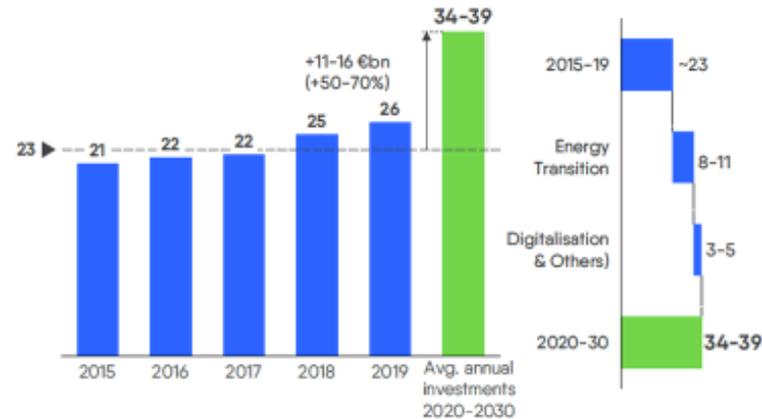
- Needs of flexibility at transmission level vary from one country to another; in same country from one electricity mix to another
- French Transmission System Operator 'RTE' just released its '2050 Net Zero' study. Central scenario sees electricity consumption in 2050 at +200 TWh (+40%)
- IF 51 GW nuclear 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... RTE expects 135GW to 345GW renewables in France 2050: 110 GW to 285 GW connected to distribution grids

Estimation of future distribution grid costs

EU27+UK annual investments in power distribution grids and key drivers
(nominal €bn; 2015-2030)



Flex. Use Level (2) At Distribution level

Flexibility as a tool to reduce network investments

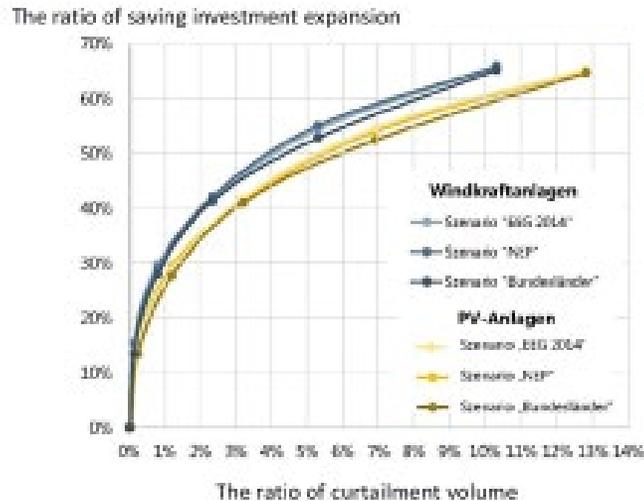
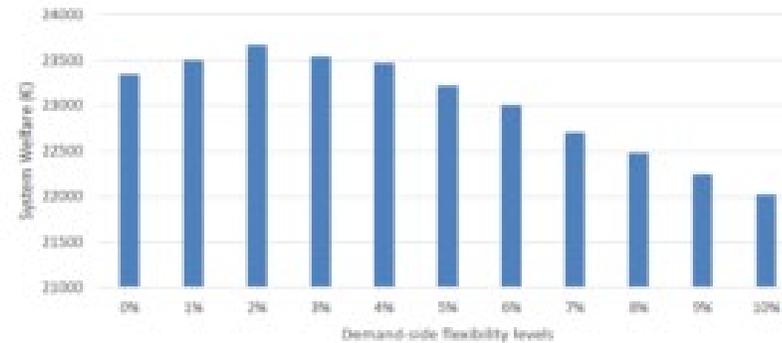


Figure 4: System welfare for different demand-side flexibility levels



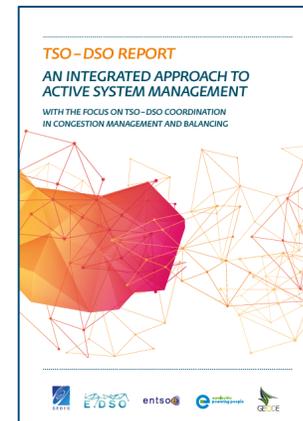
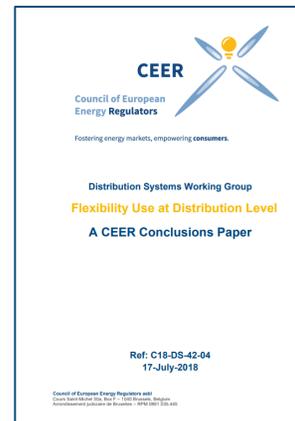
Flex. Use Level (2) Distribution level Flex. Toolbox

CEER

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

E.DSO

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



But 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



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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.

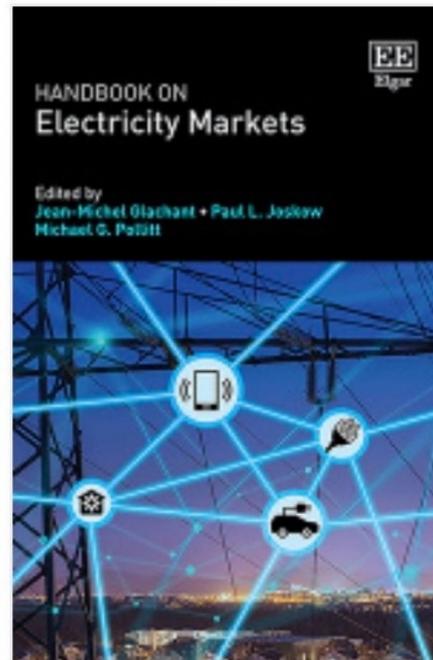
Conclusions

- 1st 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.
- 2nd Proper regulatory frame to reach the full potential of this wave is not yet defined. But regulators, grid operators, utilities, independent businesses, prosumers, communities, EV owners are already thinking & testing. For the success of EU 2030 decarbonisation targets, one needs this EU Big Bang to succeed.

Grazie Mille Tutti! E per Natale ...

Add to Wish List ☆

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Handbook on Electricity Markets

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Anche President-elect IAEE on 1 January 2022