Study Committee C3-C5
POWER SYSTEM ENVIRONMENTAL PERFORMANCE
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Electric solidarity: modelling interdependence management in contemporary power system design

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Motivation: call for fair innovation

- Power systems are confronted to intensive innovation (low-carbon, sufficiency…) in a decentralized management regime
- But, justice is problematic in these changes (majors inequalities, representation issues… see Dworkin & Sovacool 2014, Jenkins et al. 2016)
- Electricity networks have historical solidarity principle: **tariff equalization in a geographical community**
  - Community members are interdependent because investment is limited
  - Actors are discriminated based on distance to the grid

Approach: modelling norms as objects

- Norms modelled as **designed objects**, which optimal design is given by the **decoupling design axiom** (Suh 1998)

	parameters	functions
	action	**fairness**
planning doctrine (invest.)	X	
tariff equalization (distance)		X

figure1: example of tariff equalization as a parameter for optimized & fair network development

problematic

How to preserve fairness in decentralized grid designs coping with intensive innovation ?

Case study: peaks in decentralized systems & capacity reserve mechanism (CRM)

Implemented recently, **CRMs** define an **obligation** for each consumer corresponding to their peak consumption (RTE 2021, Kodorowska 2020) as all power systems actors are independent on their peak consumptions.

figure2: CRM synoptic graph

before simulation	sizing	fair allocation	sufficiency
obligation	-/+	+/-	+/-

figure3: economic incentive theory models a fully coupled system

Simulation: role of suppliers as „obligation poolers"

- Population with heterogenous peak consumption (climate, heating…), with 3 pooling suppliers selecting consumers

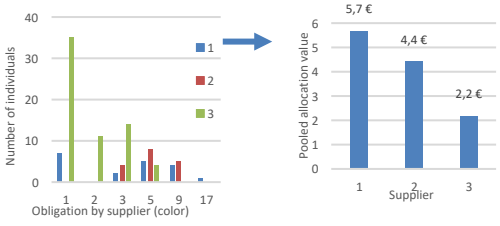

figure4: heterogenous population and pooled allocation classes

supplier marketing and policy set prices

after simulation	sizing	fair allocation	sufficiency
obligation	+/-		0
supplier's strategy		+/-	?

figure3: after simulation opportunity to decouple CRM design

Discussion: further research on CRM ?

- In decentralized systems, fair allocation depends on aggregator roles (suppliers…)
  - Opening path for regulation based on fairness criteria
- Fair allocation rules could be design for supply security
  - Further research: Winter 23 European energy crisis

Conclusion: designing fair allocation

Designing fair allocation requires to

1. model power system's actors interdependence
2. model actors' distribution on relevant variables
3. decouple design by delimitating responsibilities