Energy communities in decarbonization of local energy systems: examples and challenges in the EU

10th anniversary of the Covenant of Mayors in the Eastern Partnership Region

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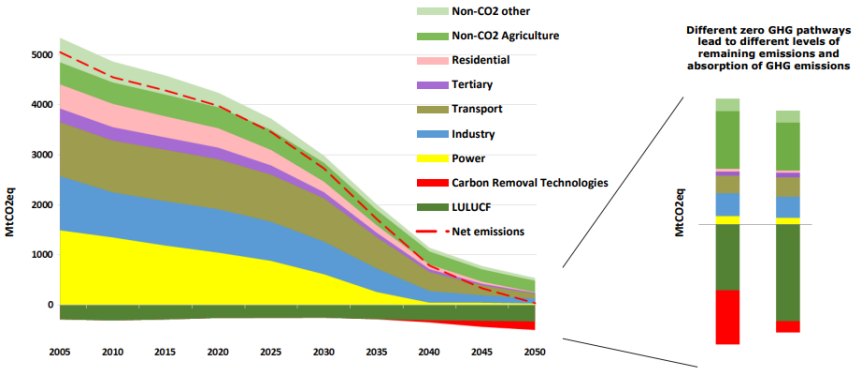
Outline

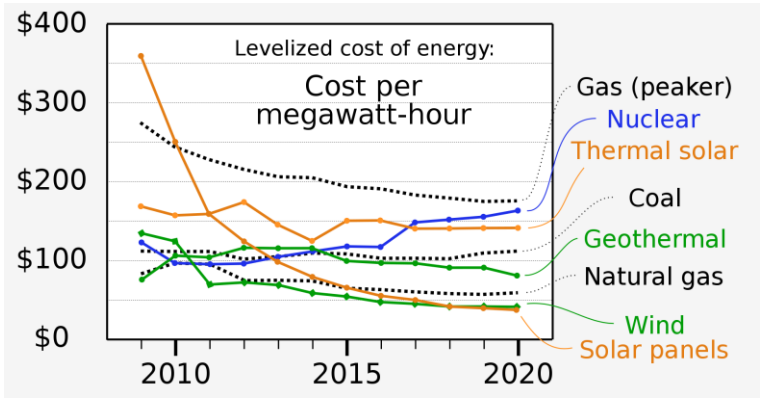
- Introduction
  - Trends in the energy sector
  - Challenges
- Decarbonizing local energy systems
  - Energy communities
  - Approaches and examples in the EU
  - Case study in Croatia
- Role of municipalities
- Conclusions

Introduction – trends in energy sector

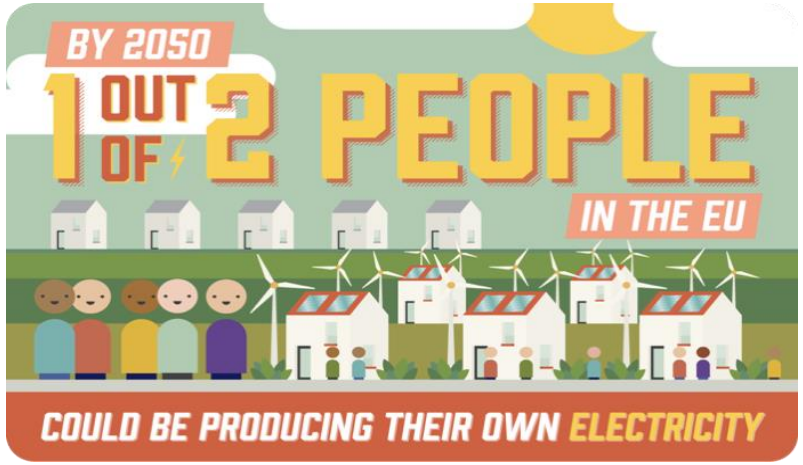
Decarbonization



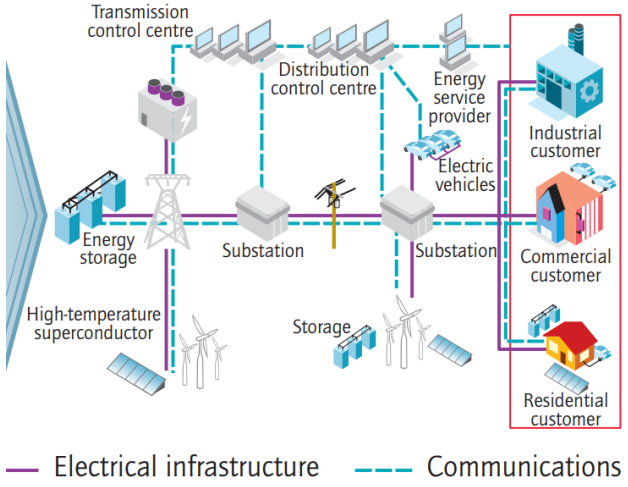
Decentralization



Democratization



Digitalization



Sources: Clean Planet for all COM(2018) 773 final,
The potential of energy citizens in the European Union, CE Delft, 2016.

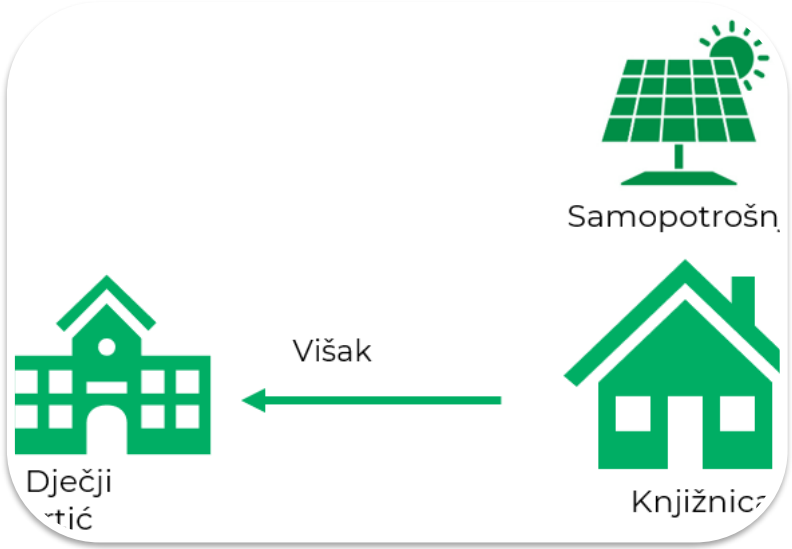
Lazard's 2017 LCOE Analysis, Lazard, 2017
Technology Roadmap Smart Grids, IEA, 2011

Challenges in electrical distribution systems

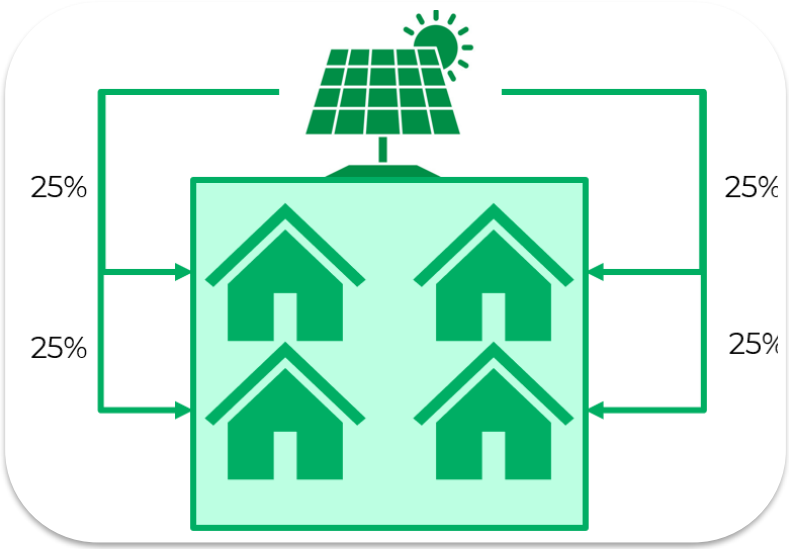
- Integration of low-carbon technologies:
  - PVs, Evs, Heat pumps
- Challenges:
  - Techno-economic
    - Variability of RES
    - Line constraints, transformer constraints
    - Voltage stability, frequency stability
    - Power quality
    - Costs and distribution of costs
  - Social
    - Social acceptance
    - Data privacy
  - Regulatory framework
- Way forward:
  - Techno-economical
    - Battery energy storage systems
    - ICT infrastructure
    - Sector coupling
    - Hydrogen economy
    - Smart charging
    - Grid upgrades
  - Social
    - Education
    - Citizen energy
    - New business models
  - Regulatory
    - Constant market evolution

Concept of energy trading in local systems

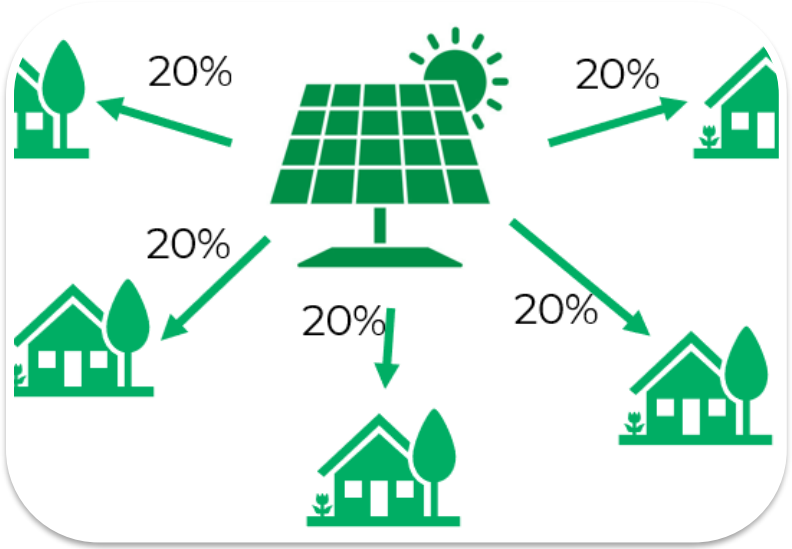
- Motivation:
  - Improving social welfare, integration of RES
  - Active participation of citizens, optimization of power system operation



Example 1: Sharing of surpluses between the neighbouring buildings

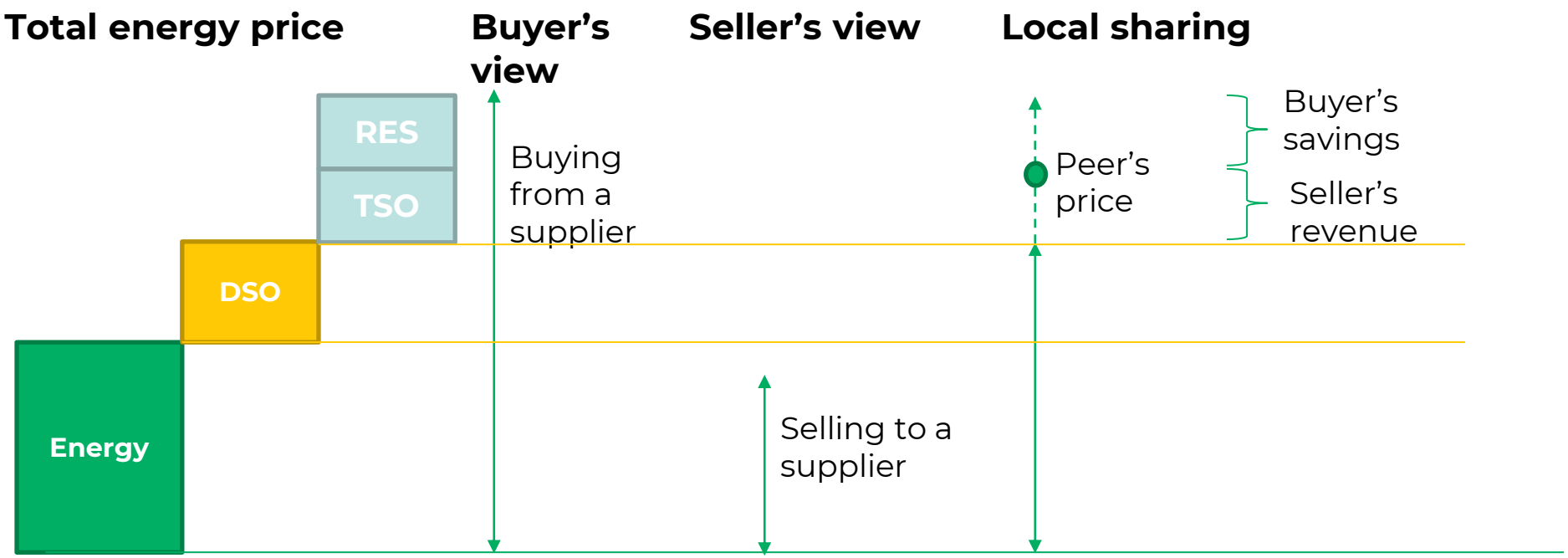


Example 2: Energy sharing in multi-apartment building



Example 3: Community non-integrated power plant owned by multiple households

Motivation for the users



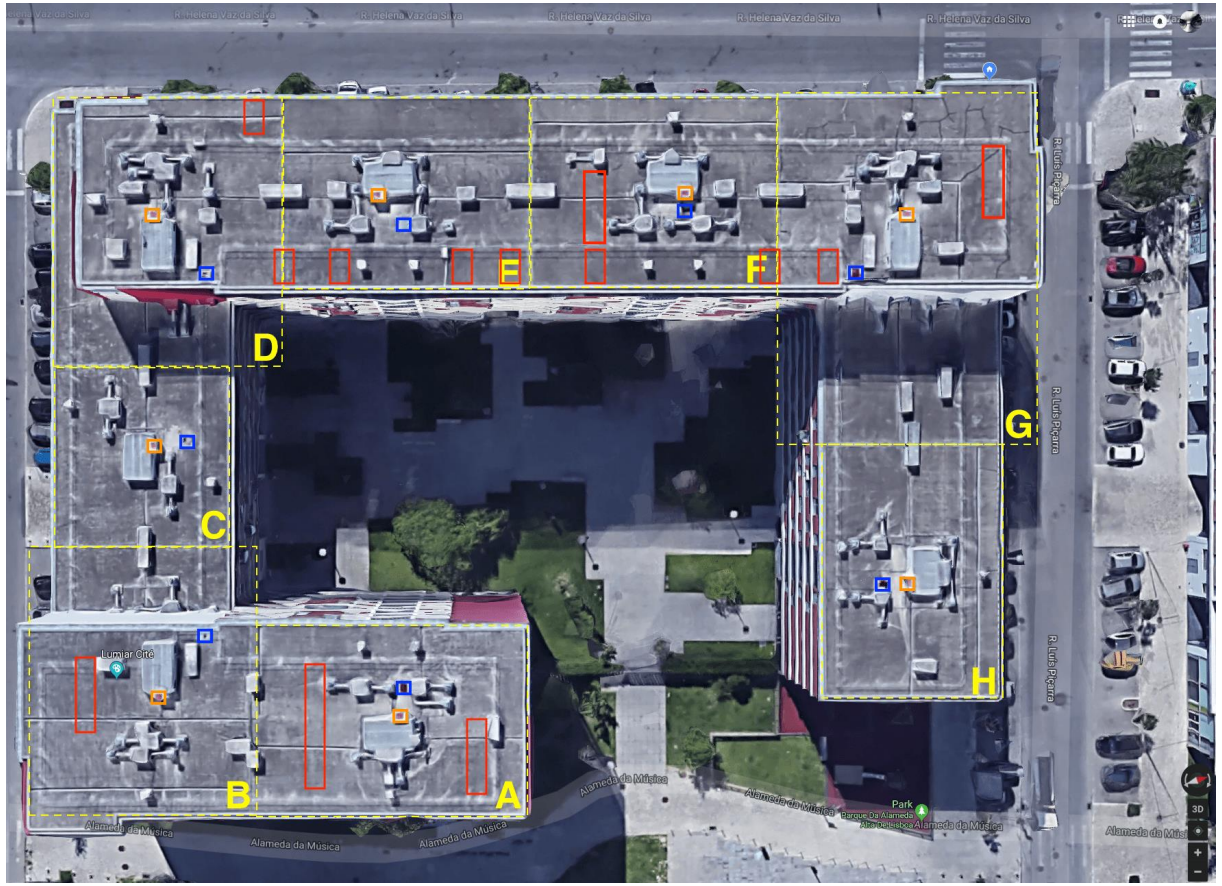
Regulatory framework for energy communities in the EU

- EU Winter Package 2019: Directive on RES (2018/2001), Directive on internal electricity market (2019/944)
  - 'Renewable energy communities', 'Citizen energy communities'
  - 'Peer-to-peer renewable energy trading'
  - 'Active customer', Collective self-consumption
- Inter alia, members can produce, consume, store, or share energy within
- Transposition in MSs differs
  - Energy sharing and responsibilities:
    - How energy is shared, is legal entity needed
  - System boundaries and limits
    - Can be linked with electrical grid /municipality/ distance
  - Network tariffs and taxes
    - Typically transmission fee removed, distributin fee reamins/decresed
    - Treatment of taxes and levies

Sourcee Automated energy sharing in MV and LV distribution grids within an energy community: A case for Croatian city of Križevci with a hybrid renewable system, Renewable Energy, 191, 2022, Authors: Lin Herenčić, Mislav Kirac, Hrvoje Keko, Igor Kuzle, Ivan Rajšl

Examples of projects (1)

Project	Technologies	ICT infrastructure	Control functions	Econnmic model	Main challenges
Group of multi-apartment buildings Alta de Lisboa, Portugal	Solar PVs, EV chargers, public distribution grid.	DSO's smart meters, could be expanded with smart management tools in the future when PV capacity will be increased.	Not implemented at present, energy management system planned for the future.	Operated as a CSC, reduced network tariffs, planned to be transformed to EC by the Copernico cooperative.	Lack of smart meters, unclear procedures for registration of the EC and application of LES.



Sources: COMPILE project, https://main.compile-project.eu/sites/

Examples of projects (2)

Project	Technologies	ICT infrastructure	Control functions	Econnmic model	Main challenges
Remote village Luče, Slovenia	Solar PVs, community BESS, home BESSs, EV charging point, restricted to public LV feed-er.	DSO's smart meters, third-party SCADA and microgrid management system.	Supply-demand management system, EC organized and run as a microgrid, the operation can be over-ruled by the DSO.	Regulatory exception - reduced grid fees, CSC scheme over the distribution network, LES planned to be implemented.	Restricted to LV feeder, no formal responsibilities and procedures between DSO and microgrid operator.

Sources: COMPILE project, https://main.compile-project.eu/sites/

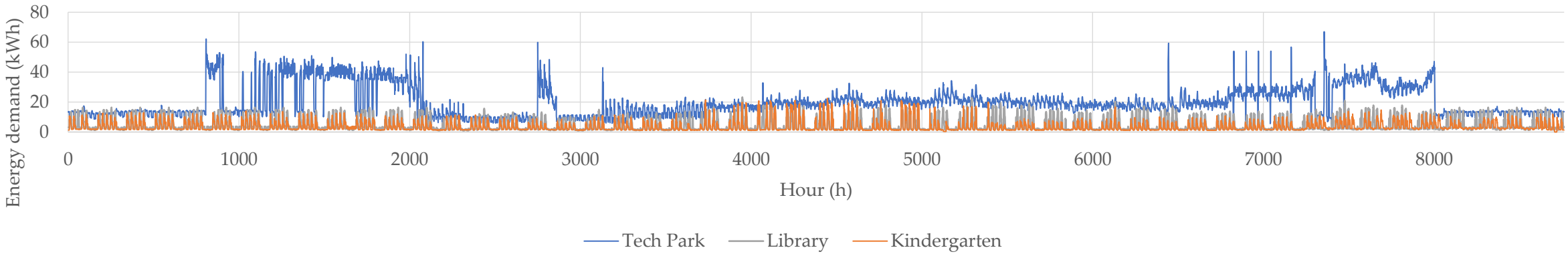
Examples of projects (3)

Project	Technologies	ICT infrastructure	Control functions	Econnmic model	Main challenges
Cooperative-operated grid in municipality Crevillent, Spain	Municipal and household solar PVs, public distribution grid.	Installation of smart meters in progress.	Not implemented in the present, flexibility and demand response measures planned.	Municipal generation owned by the cooperative, reduced electricity fee for EC members, static percentage of pro-duction for energy sharing.	Limit of LV feeder and 500 meters for the members means several EC should be established, lack of smart meters.

Sources: COMPILE project, https://main.compile-project.eu/sites/

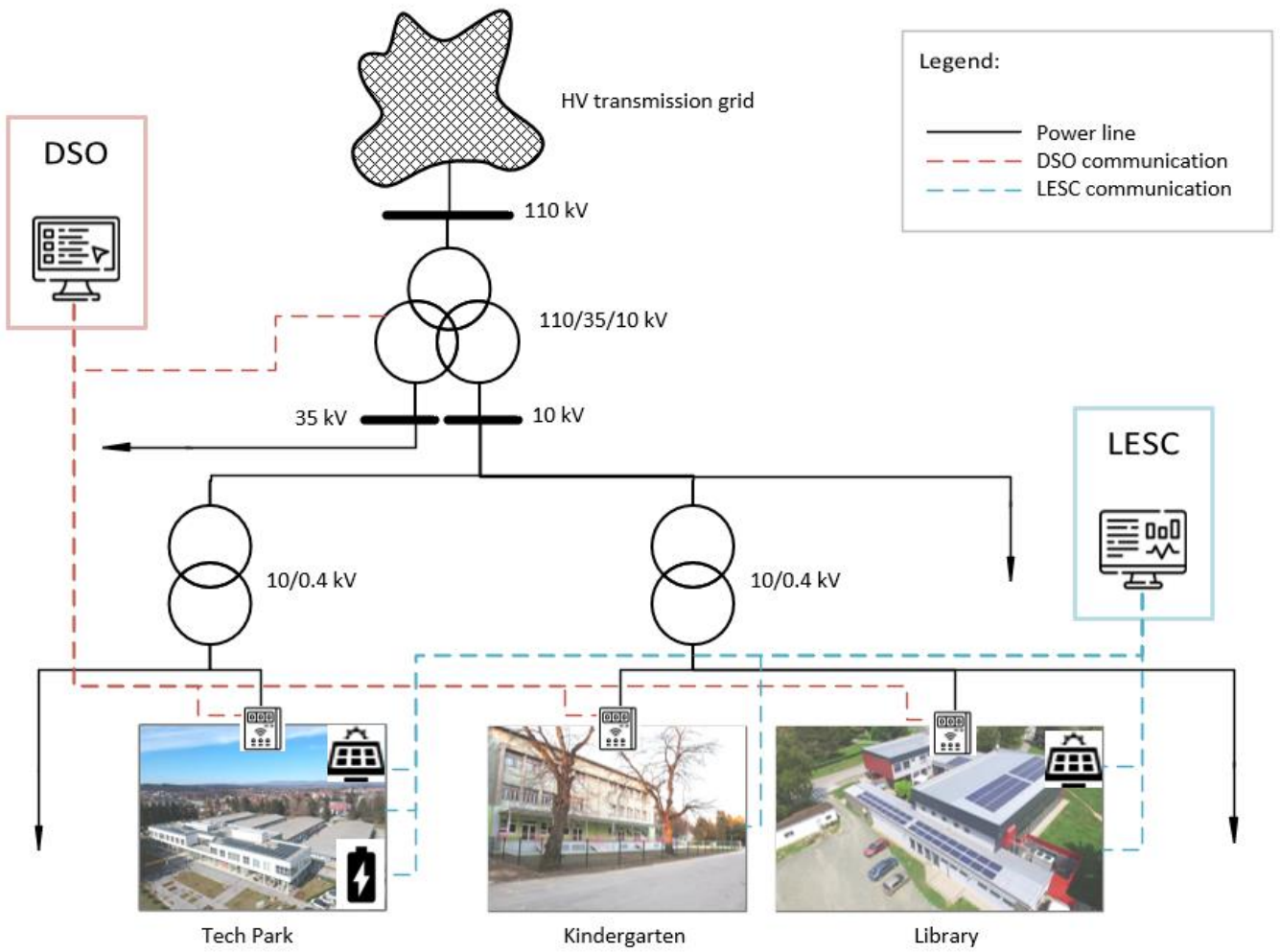
Case study Croatia (1)

- City of Križevci, Croatia
  - City Library with solar PV
  - Kindergarten as passiv user
  - Tech Park with solar PV, BESS and a EV charging station
  - Development under Compile Horizon 2020 project



Case study Croatia (2)

- Legal framework
  - EC members should be connected to the same LV substation
  - The members determine the energy sharing key and submit it to the DSO
  - An energy distribution fee should be payed for the shared energy
  - Participants are in the net billing system, according to which excess energy is taken at the price of energy times 0.9 (without other charges) in every 15-minute interval
- ICT infrastructure
  - Additional meters and a SCADA



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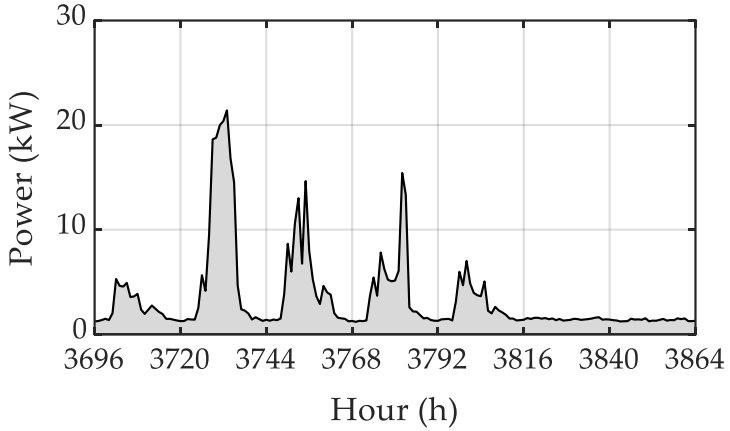
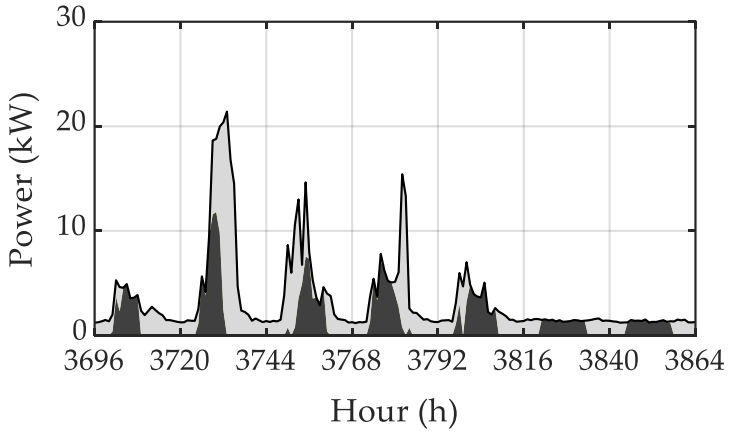
Effects on the energy balance

Without sharing

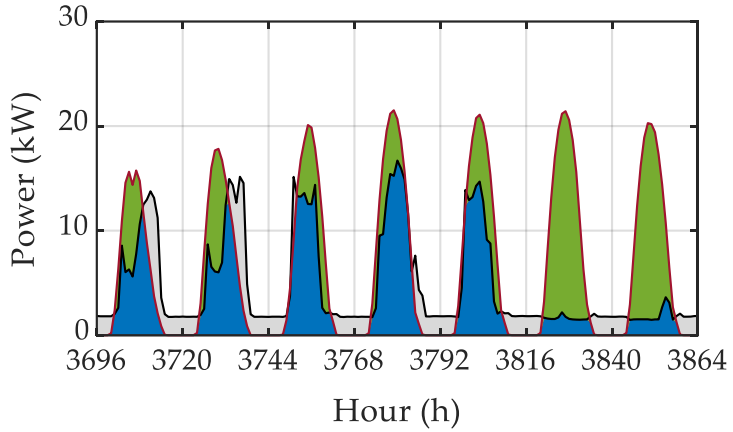
With sharing

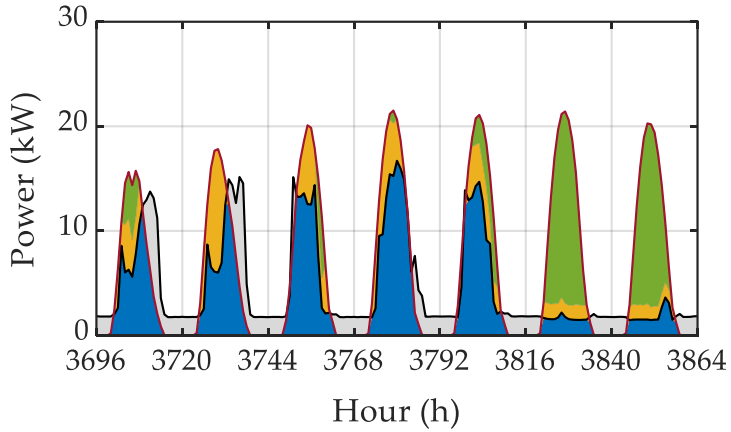
Kindergarten

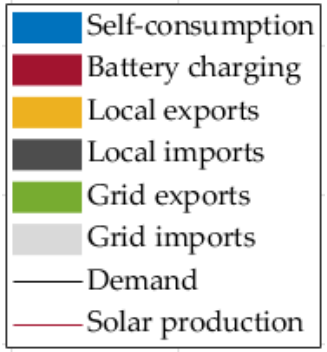




Library

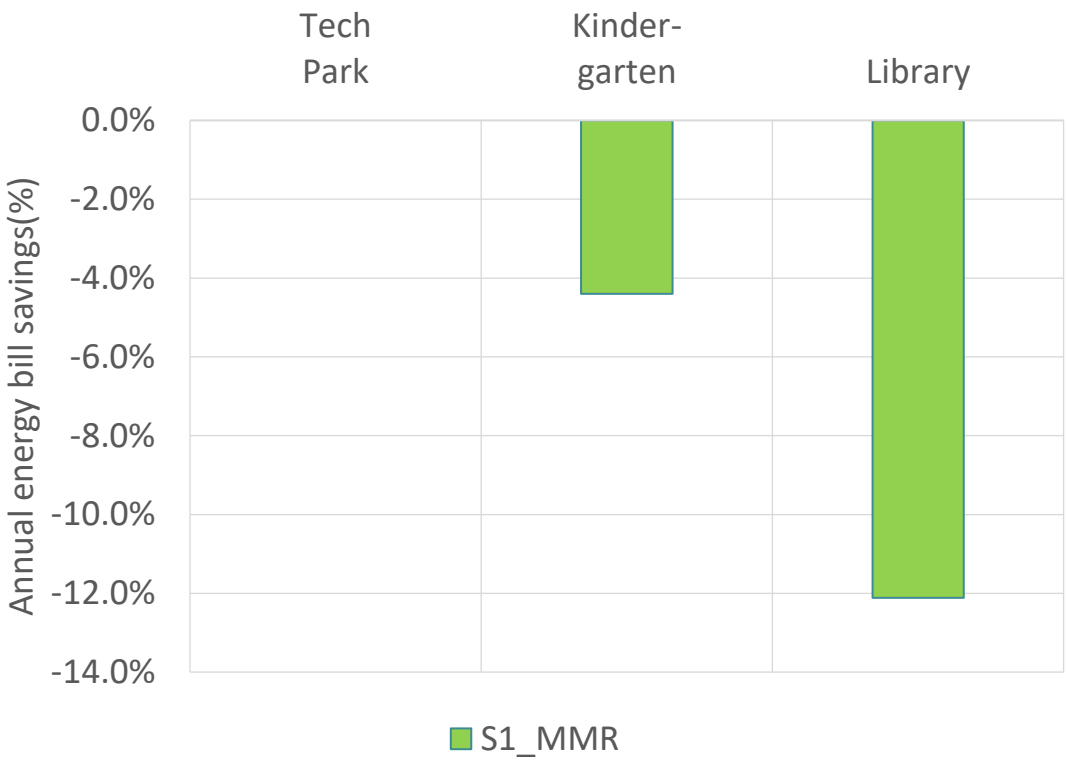




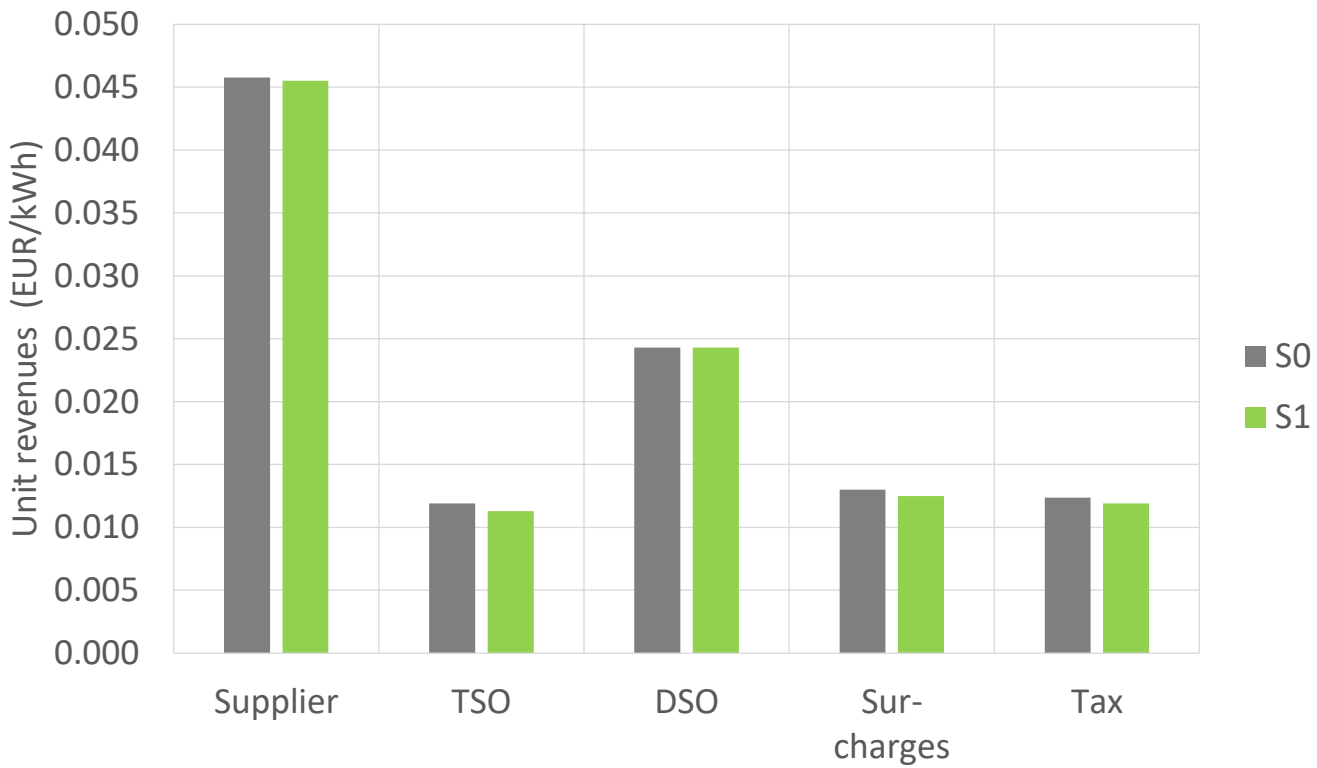


Effects on the members and market participants

- Energy bill savings



- Revenues for market participants



Role of municipalites in supporting decarbonization

- Planning process
  - Energy, infrastructure and spatial planning to serve as the basis for the projects
- Private-public partnership
  - Innovative models and partnerships
- Supports and subsidizes
  - Funding of project development
  - Subisidizing equipment
- Education and dissemination
  - Workshops to educate citizens and promote solutions

Conclusions

- Implementation of some of the novel business models depend on national regulatory framework
  - Advanced provisions, like adjustment of tariffs, levies, and taxes for LES, can lead to the increased economic attractiveness of LES for the members
  - EU Member States are still learning and developing the regulatory framework
- All members can benefit from participating in the EC
  - The effects on the distribution of benefits across the members are subject to price-forming method
- Municipalities can do a lot without depending on the national framework for energy communities
  - Provide support for the citizens and businesses for the uptake of low-emission technologies
  - Advocate for national legislation
  - Educate citizens and promote examples of good practice

Thank you for your attention!

Discussion...

Contact: lin.herencic@fer.hr

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