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ERRA
Workshop

RENEWABLE COLLECTIVE SELF-CONSUMPTION:
ENERGY COMMUNITIES AND MINI GRIDS

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ERRA
ENERGY REGULATORS
REGIONAL ASSOCIATION

Empowering local grids: How energy communities can enable variable renewable energy integration

Pálma Szolnoki
Zero Carbon Hub

Incentive schemes for energy communities

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Direct subsidies

Investment support

Interest subsidies

Feasibility study
Legal consultancy
Softwere development

Support provided within the electricity system

Grid fee discount

- Within the imbalance settlement period, on the shared pared, from the volumetric charge
- The discount is larger if the sharing is more limited within the network topology
  (exemption from cost cascading
  Network topology/vs km based limitation
- PV production capacity limit

Other volumetric based discounts

- Taxes
- Green fees

Production subsidies

- Exemption from tendering or advantage
- FIT
  - With criteria for high level of local consumption
- Premium after locally consumed energy

Regulatory background

Cost Benefit analysis is the key!!!

Clean Energy Package – CEC & REC

where electricity is shared, this shall be without prejudice to applicable network charges, tariffs and levies, in accordance with a transparent cost-benefit analysis of distributed energy resources developed by the competent national authority

Electricity Market Design

Member States shall ensure that active users participating in energy sharing:
a) are entitled to have the shared electricity injected into the grid deducted from their total metered consumption within a time interval no longer than the imbalance settlement period and without prejudice to applicable non-discriminatory taxes, levies and cost-reflective network charges;"

ACER

„Since some particular network users (e.g. energy communities) may only marginally require using other network levels, exemptions to cost cascading or application of partial cost-cascading may be justified."
„Exemptions on the application of the cost-cascading principle should be justified and regularly re-evaluated to avoid any discrimination."

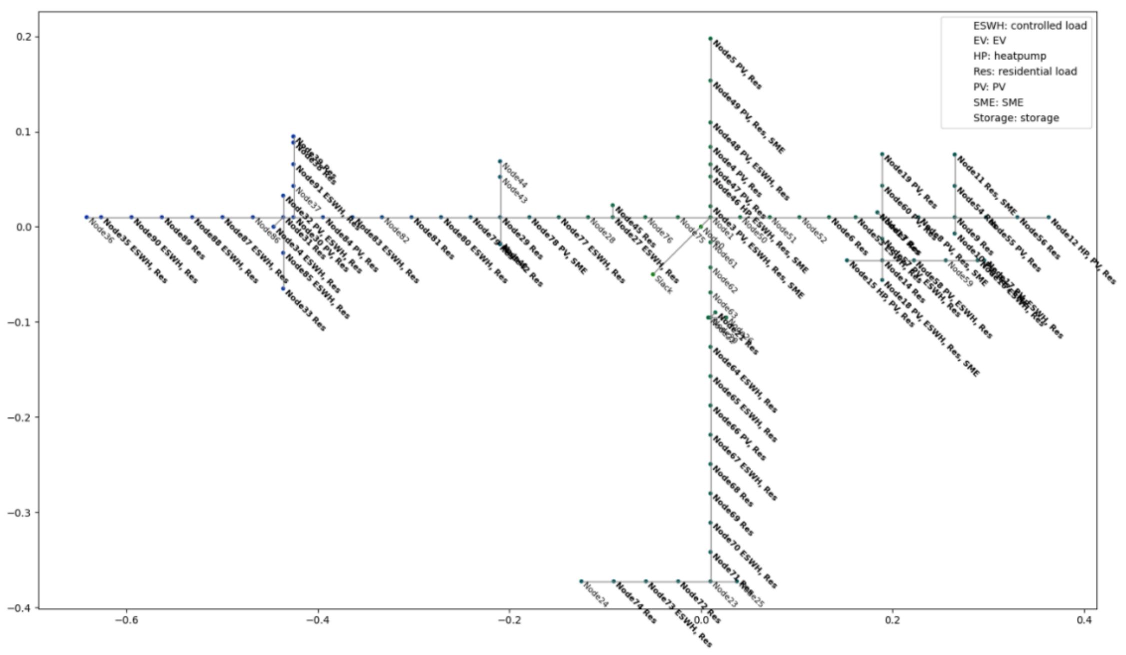
What energy community activities are beneficial to the grid, and in what extent?

Modelling

Assessment of the proposed EC activities vs. traditional grid reinforcement options

- Detailed network simulations
- Real (Hungarian) and benchmark (CIGRÉ) grid topologies, consumption and production data
- Variations in asset penetrations PV, EV, heat pumps, electric storage water heaters

15-min resolution, 1 weekday and 1 weekend day, each month for 1 year



Advanced control of ESS

Reactive power control, DSM

Central PV and ESS at ideal locations

Distributed PV and ESS at ideal locations

Modelling results summary

scenarios	R network						Cigré benchmark network					
	PV hosting capacity			Tr. Max load (%)	Tr. Self-consump	Self Producti	PV hosting capacity			Tr. Max load (%)	Tr. Self-consump	Self Producti
	kW	Increase	%				kW	Increase	%			
Base case	535		70%	100	905 MWh	49%	348		24%	86%	1374 MWh	91%
Central PV	583	9%	76,50%	113%	5%	45%	645	85%	44%	88%	9%	63%
Concentric PV	720	35%	94%	143%	18%	39%	630	81%	43%	88%	8%	66%
Central Storage	596	11%	78%	87%	-20%	62%	537	54%	37%	88%	-11%	88%
Distributed storage community optimization	596	11%	78%	87%	-21%	62%	536	54%	37%	88%	-11%	88%
Distributed storage individual optimization	580	8%	76%	90%	-9%	56%	435	25%	30%	86%	-9%	94%
Distributed storage 50% individual 50% community optimization	580	8%	76%	107%	-32%	70%	463	33%	32%	88%	-10%	93%
DSR	580	8%	76%	93%	-12%	57%	348	0%	24%	88%	0%	92%
DSR + reactive power control	664	24%	87%	110%	-5%	52%	652	87%	45%	85%	7%	68%
DSR + distributed storage community (or 50% individual) optimization	596	11%	78%	90%	-38%	73%	464	33%	32%	86%	-11%	93%
DSR+central storage	617	15%	81%	72%	-30%	68%	536	54%	37%	86%	-11%	88%
Electrification base	535	0%	70%	98%	33%	52%	-	-	-	-	-	-
Electrification + central storage	603	13%	79%	85%	5%	69%	-	-	-	-	-	-
Electrification + DSR	535	0%	70%		4%	74%	-	-	-	-	-	-
OLTC	596	11%	78%	126%	6%	46%	464	33%	32	88%	1%	80%
Line replacement	596	11%	78%	114%	6%	45%	-	-	-	-	-	-

Optimal placement of PVs

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Base case: decentralized, placed based on the annual consumption

Central PV

With central PV and its optimal placement the PV integration capacity can be increased

- But reverse power flow increases to the underlying network

Optimal decentralized placement

It can raise the PV integration capacity even higher than centralised placement

- But reverse power flow further increases

This is only a sufficient activity if reverse power flow does not cause further problems

Conclusions regarding incentives

- The community will be interested in optimal placement only if the electricity shared through the public network and the electricity consumed behind the meter entail the same cost for the members.
- Since excessive PV generation compared to consumption places a burden on the underlying part of the network, it is advisable to introduce a relative limit on the installed PV capacity in relation to consumption for such an incentive (if there is no storage or demand-side response, DSR)

Storage

2 vs 4 hours: The 4-hour storage systems had a significant impact on PV integration

Centralized Storage

The PV hosting capacity increases to a level comparable with optimal PV placement

- While the load on the underlying network decreases

Decentralized storage - community level optimization

Same result as with a central storage system, with the minimal difference being related to network losses.

Decentralized storage - individual optimization

Both the PV hosting capacity and the load on the underlying network improve much less than in the central storage case.

Decentralized storage 50% individual 50% community optimization

Intermediate outcomes

It's not whether the storage is centralised or decentralised that matters, but the control principle!

OLTC and line upgrades provide only a local solution; they cannot reduce the reverse power flow to the higher voltage levels

Storage

Conclusions regarding incentives

- To encourage centralised control, it is necessary that storing energy in one place and consuming it at an other POD within the LV network area should not be more costly than using storage individually behind the meter.
    - Currently, grid fees (and other charges) are applied twice to storage operated with a community level optimisation, while there are no fees applied for behind-the-meter storage. At the same time, community optimisation of storage use is clearly more beneficial for the network than individual behind-the-meter optimisation.
- Currently, DSOs do not receive grid fee payments for the use of behind-the-meter storage.
- Community-level optimisation provides greater benefits to the network than individual optimisation.

This benefit can be realised if we waive the volumetric charges for withdrawals of community storage operations

Incentivising the installation of 4-hour storage systems instead of 2-hour ones

DSR

Shifting flexibly schedulable consumption to periods of solar PV generation

The PV hosting capacity increases
- while the load on the underlying network decreases.

An effect comparable to that of storage

A positive impact on the underlying network compared to OLTC and line upgrade

Conclusions regarding incentives

- Consumption during the solar generation period should be more favourable than outside it
  - For shared electricity, apply zero grid fee and other volumetric charges
- It is worth providing targeted subsidies for the development of control systems required for DSR
- Enable access to flexibility markets

Further scenarios analysed

DSM+Storage combined scenarios

The network impact results further improve.

It is advisable to implement community energy activities in a combo

Incentive and support schemes should encourage communities to engage in multiple types of activities

Electrification scenarios

- Network development will be needed almost immediately.
- Even in this case, energy community activities remain effective in integrating PV generation.
- DSR will play an even more important role.

Cost-Benefit Analysis

Calculating the PV integration benefits

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PV integration Local benefits

- An effect equivalent to that of OLTC and line upgrade
- OLTC and line upgrading investments can only be carried out in limited number of cases

PV integration benefits Due to avoiding indirect network development

- Avoiding reinforcement of the underlying network
- Estimate based on the indirect connection fee component off the connection charge for PVs

Scenarios	Value of avoided annual costs EUR	What discount could be covered on the shared energy's grid fee by the avoided investments
1.1 Central PV	4 727	34%
1.2 Concentric PV	4 936	36%
2.1 Central Storage	5 943	38%
2.2 Dec storage - comm opt.	5 943	38%
2.3 Dec storage - individual opt.	5 435	42%
2.4 Dec storage 50-50 opt.	6 356	34%
3. DSM	5 501	48%
5.1 DSM+dec storage 50-50	6 686	37%
5.2 DSM+centralized storage	6 510	41%

34-48%

Investments in OLTC, line replacement, and reinforcement of the underlying network can only be carried out in limited numbers, whereas energy community activities can be implemented simultaneously in all problematic areas.

Benefits - Reduction of network loss

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By supplying part of local consumption from local production, energy communities reduce the amount of electricity that has to be transported across the grid

- Thus they can lower network losses
- Network loss is a significant component of the operating costs incurred by DSOs

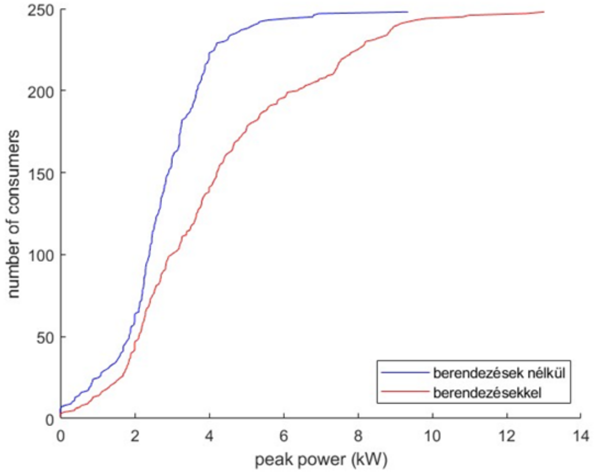
Scenarios	Value of avoided annual costs EUR	What discount could be covered on the shared energy's grid fee by the avoided costs
1.1 Central PV	4 731	34%
1.2 Concentric PV	5 280	39%
2.1 Central Storage	7 920	51%
2.2 Dec storage - comm opt.	7 920	51%
2.3 Dec storage - individual opt.	6 589	51%
2.4 Dec storage 50-50 opt.	9 006	48%
3. DSM	6 762	59%
5.1 DSM+dec storage 50-50	9 871	55%
5.2 DSM+centralized storage	9 410	59%

34-59%

Decreasing Peak Consumption

Based on Belgian NRA Study

	BRUGEL	ZKK
Quantity	All participants reduce peak consumption by 0.5 - 1 kW	0.5 kW and just in case of consumers that are applied with flexible consumer appliances
Avoided cost	Annual DSO cost * peak reduction / synchronized peak	(Depreciation+CAPEX)* Peak reduction/contracted capacity



Scenarios	Value of avoided annual costs EUR	What discount could be covered on the shared energy's grid fee by the avoided costs
1.1 Central PV	4 731	34%
1.2 Concentric PV	5 280	39%
2.1 Central Storage	7 920	51%
2.2 Dec storage - comm opt.	10 885	70%
2.3 Dec storage - individual opt.	9 554	73%
2.4 Dec storage 50-50 opt.	11 971	64%
3. DSM	9 727	85%
5.1 DSM+dec storage 50-50	12 836	71%
5.2 DSM+centralized storage	12 374	77%

34-85%

Additional Public Benefits

- PV integration capacity increases
- The additional renewable generation results in CO_2 emission reductions
  - It replaces natural gas-based generation: 368 kg CO_2/MWh
- Benefit calculated under different CO_2 price scenarios.

	PV integration, kW	Surplus renewable energy generation, MWh	Avoided CO2, tons	Value of avoided CO2, EUR (60 EUR/ton ETS price)	Value of avoided CO2, EUR (80 EUR/ton ETS price)
Base case	535	-			
1.1 Central PV	583	700	257,5	1 272	1 696
1.2 Concentric PV	720	864	318,0	4 902	6 536
2.1 Central Storage	596	715	263,2	1 616	2 155
2.2 Dec storage - comm opt.	596	715	263,2	1 616	2 155
2.3 Dec storage - individual opt.	580	696	256,1	1 192	1 590
2.4 Dec storage 50-50 opt.	580	696	256,1	1 192	1 590
3. DSM	580	696	256,1	1 192	1 590
5.1 DSM+dec storage 50-50	596	715	263,2	1 616	2 155
5.2 DSM+centralized storage	617	740	272,5	2 173	2 897

Comparable with the VAT revenue loss

Proposal for appropriate support scheme and regulatory framework enabling the spread of grid-friendly energy communities

Subsidies

Based on the modeling results, the integration of energy storage and DSR has the most beneficial impact on the grid -> future subsidy schemes should focus on the installation of both energy storage systems and DSR capabilities:

- Implementing DSR Control for Flexible Loads

  The establishment of DSR control systems could be supported even as a stand alone dedicated subsidized activity
- Recommendations for Supporting Energy Storage Deployment:
  - A minimum storage duration of 4 hours should be required, replacing the current 2-hour standard.
  - No preference should be given to centralized or decentralized storage solutions
  - Storage deployment should be accompanied by the development of a control system capable of optimizing the operation of either a central or multiple decentralized storage units, along with associated generation and consumption points on a community level.
    - A specific focus could be the targeted support of community groups formed around already installed decentralized storages.

- The support should give preference to geographically limited projects (e.g. within a low-voltage network area).
- The focus should be on local consumption, with a requirement for a high share of local use — e.g. 80%.

Other possible incentives

Feed-in tariffs and other production subsidies

- Not recommended, or only allowed if a very high self-consumption rate is achieved

Grid Connection:

- Faster connection could be offered in exchange for commitments, such as:
  - Adopting a new type of flexible connection: under which no electricity is exported from the project area to the upstream network
  - In exchange for faster connection of the PV and storage systems, participants commit to taking part in the distribution-level flexibility market organized by the DSO.
  - Flexible connection agreements for the PV and for the storage units.

Enable the participation of (small) energy community units on the flexibility markets

Recommended Tariff system design

Unlike the general international practice, it is not a simple network tariff discount

New special tariff for energy sharing:

- Zero energy-based network tariff for the shared volume, in order to incentivize community-level optimization over individual strategies.
- For non-shared consumption, the introduction of a time-of-use (ToU) energy-based component is recommended. This would encourage consumption to be shifted away from peak periods.
- The fixed fee element compensates for the revenue loss resulting from waived energy-based charges on shared volumes. This fixed fee should be calibrated based on the system-wide benefits provided by local community energy projects. Modeling results indicate that only 15–48% of the discount granted on the shared volume needs to be recovered through this fixed fee to maintain revenue neutrality.
    - This fixed fee should be differentiated by the network extent of the energy sharing. The larger the network topology scope of the energy community the smaller the grid benefit, and thus, the higher should be the fixed fee.
- For community energy projects that extend beyond a HV/MV transformer district, we do not recommend eligibility for this specific energy sharing tariff system.

THANK YOU
FOR YOUR ATTENTION!

Pálma Szolnoki
szolnoki.palma@bme.hu