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The role of storage systems in industrial and residential environments

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STORY

Goal: added value of storage in distribution systems for a flexible and secure energy system

- 5/2015 to 10/2020; budget: 15,8 Mio €
- 18 Partners from 8 countries
- 6 Demonstrations in 4 countries
- Diversity of Technologie and actors
  - TRL 5 to 7
  - Interoperability and ICT
  - Economic, social and enviromental effects
  - Development of innovative business models

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 646426

Project demonstrations

Aggregation of residential flexibilities, community battery (BE)
heat pumps, EVs, fuel cell, thermal storage, neighbourhood battery

Storage in a factory (ES)

PV, 50 kW Li-Ion battery

Boiler/ORC+thermal storage in wood processing company (BE)

Use of waste wood for electricity and heat

Small scale CAES/residential setting (UK)

Reduction of wind or PV curtailment

Community battery in a residential village (SI) implemented by the DSO
Li-Ion, 320kW
Avoidance of grid reinforcement services to the grid

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The role of storage to increase RES- our approach

- Large-scale simulations represent a typical European network with good grid conditions
- Assessment of demos cases representing real world constraints
- Comparison of simulations with demos from an environmental, technical and economic viewpoint

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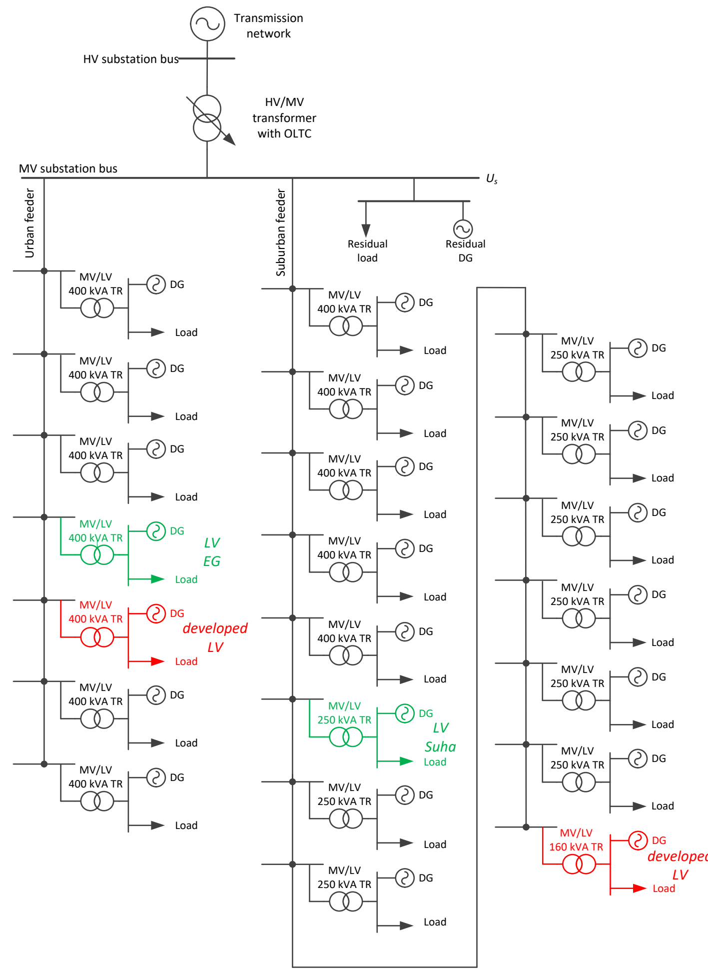
Large-scale simulations

of MV network with rural and urban grid sections

- Variation of parameters in scenarios
  - Peak power of PV units
  - Power + type of battery storage
    - Grid
    - Households

- Environmental impact assessment of 8 scenarios using LCA
  - Low PV_no Batt
  - Low PV_low Batt_Household
  - Low PV_medium Batt_Household
  - High PV_no Batt
  - High PV_low Batt_Grid
  - High PV_medium Batt_Household
  - High PV_high Batt_Household
  - High PV_high Batt_Grid



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Large-scale: Environmental analysis

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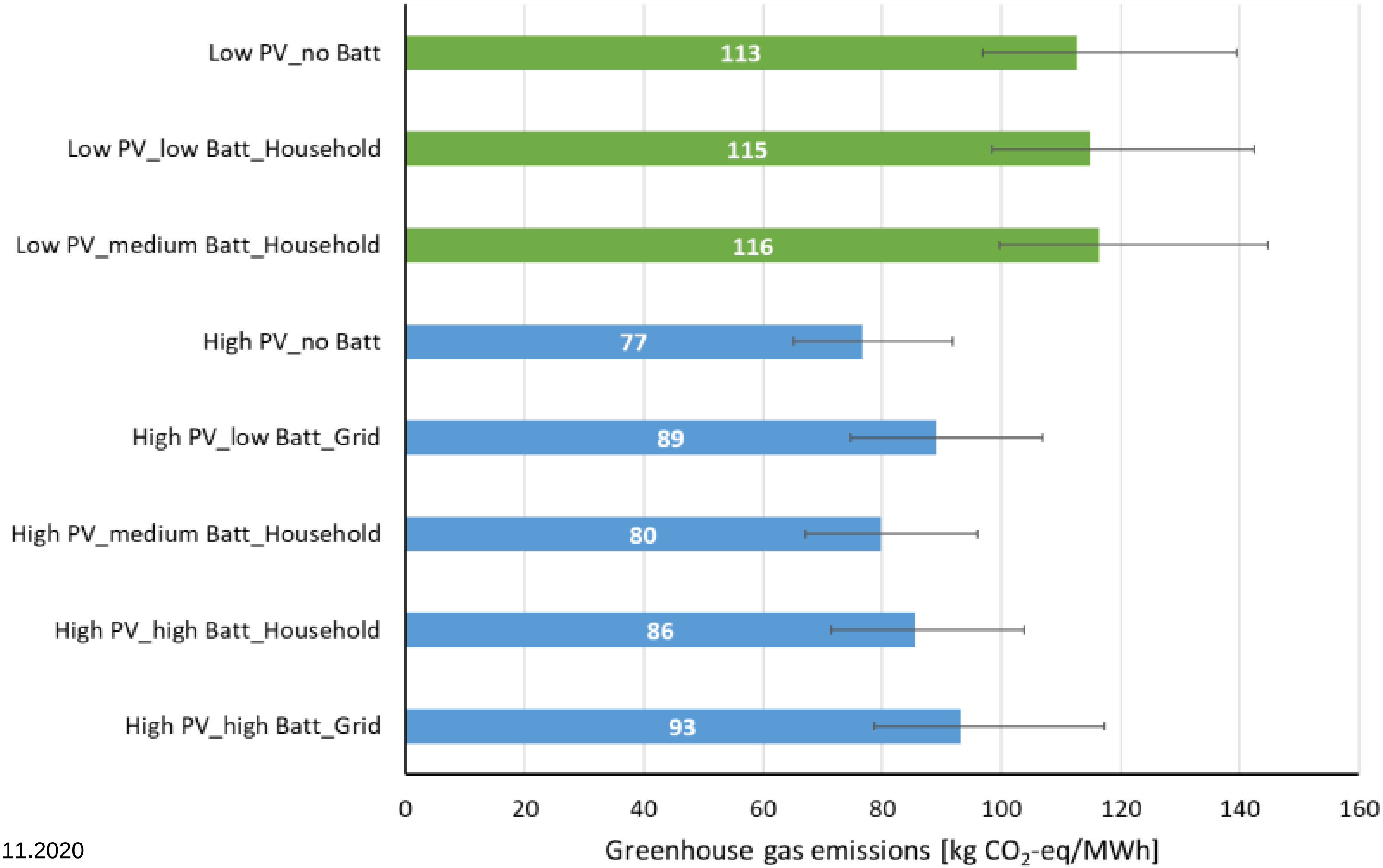

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Demo case storage in a factory, Spain

STORY

Pre-Project situation

– Facility produces professional fridge rooms and requires high power peak values
– Installed 113 kWp PV

STORY objectives and technologies

– 50 kW, 200 kWh Li-Ion to improve the business case
– demand charge reduction on the energy bill for industrial sector combining storage/batteries with PV integration

Use Cases

– UC0: no PV, no battery
– UC1: PV
– UC2: PV + battery peak shaving: no charging from grid
– UC3: PV + battery peak shaving: charging from grid

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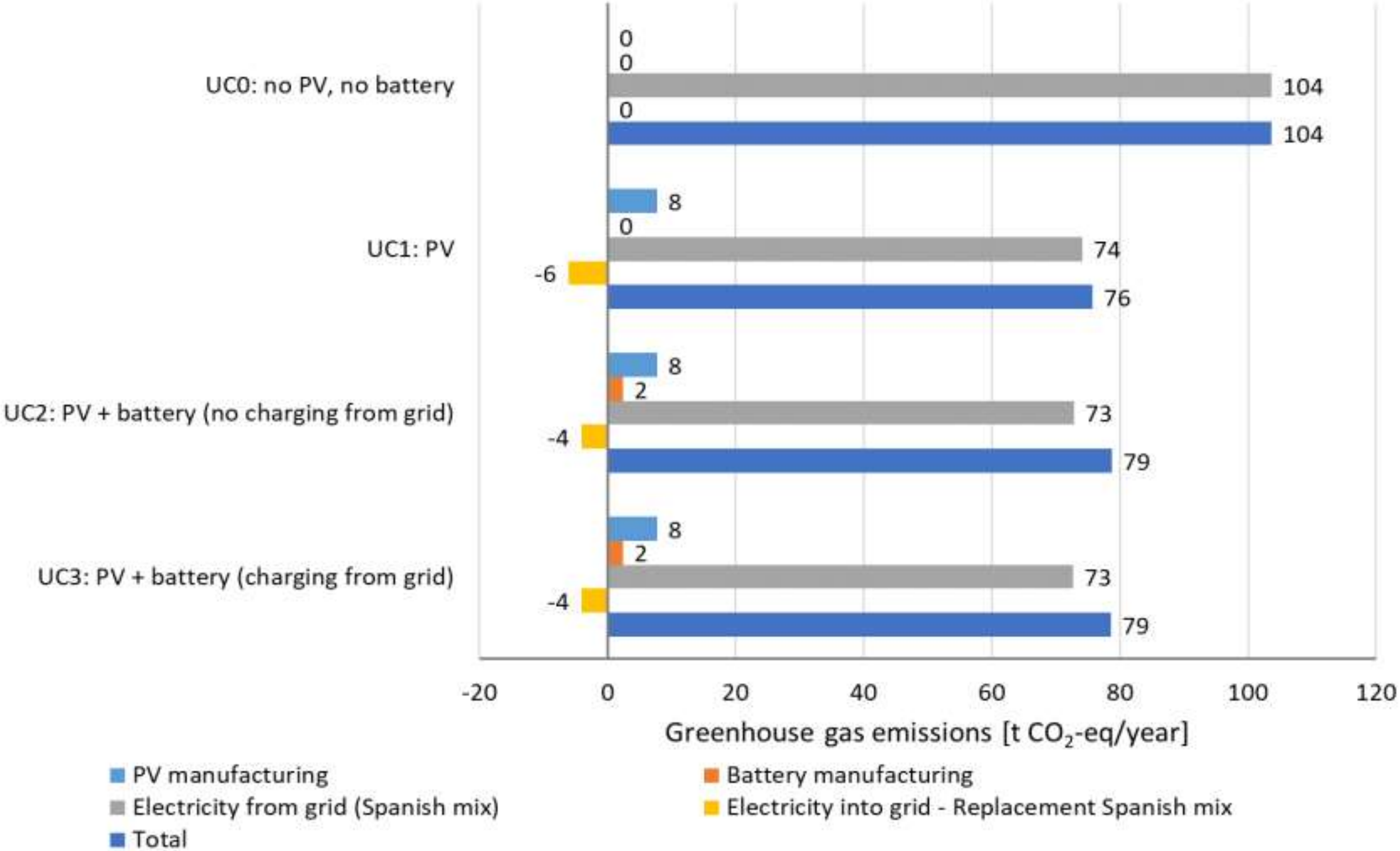
Storage in a factory, Spain: environmental assessment (1)



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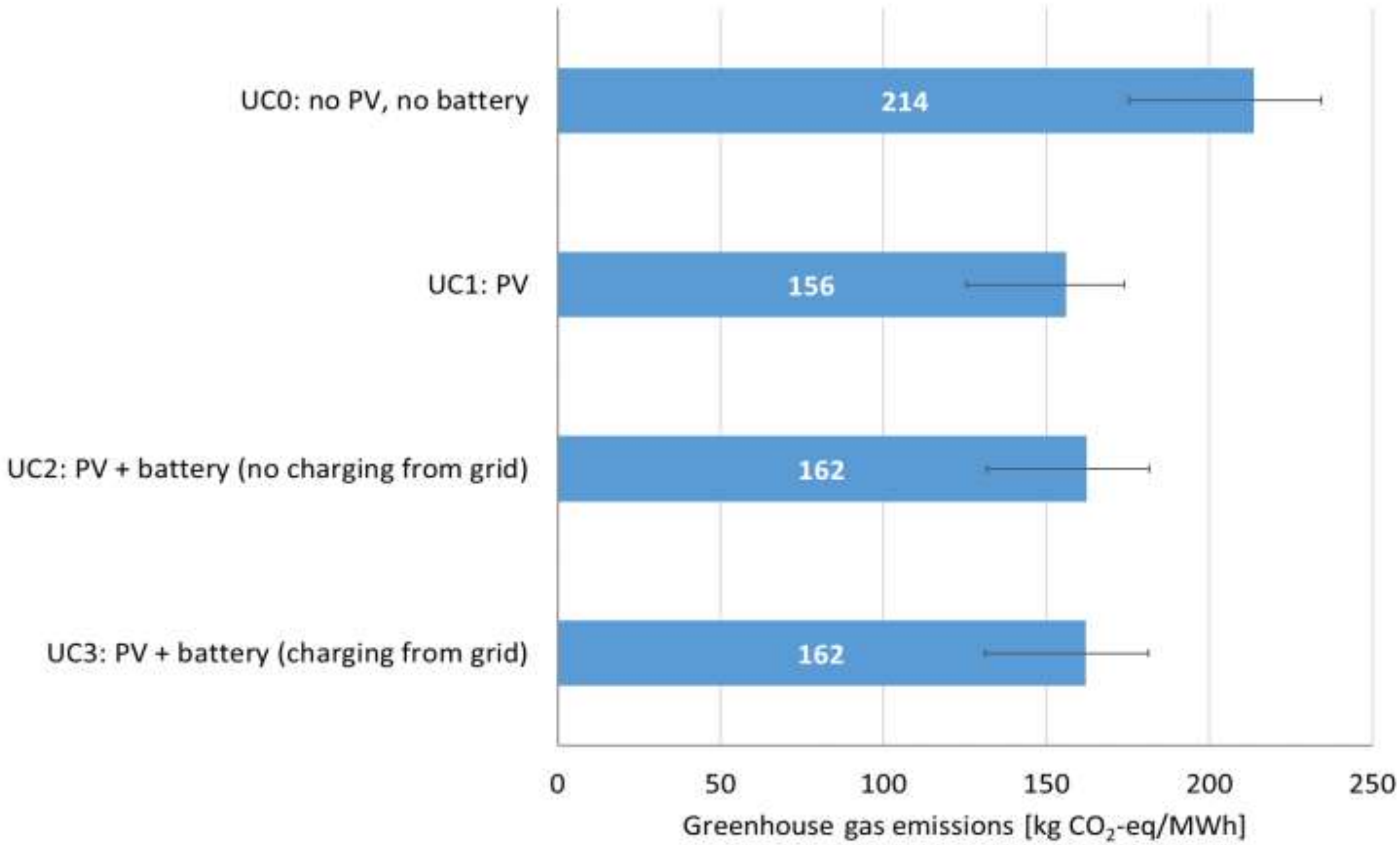
Storage in a factory, Spain: environmental assessment (2)



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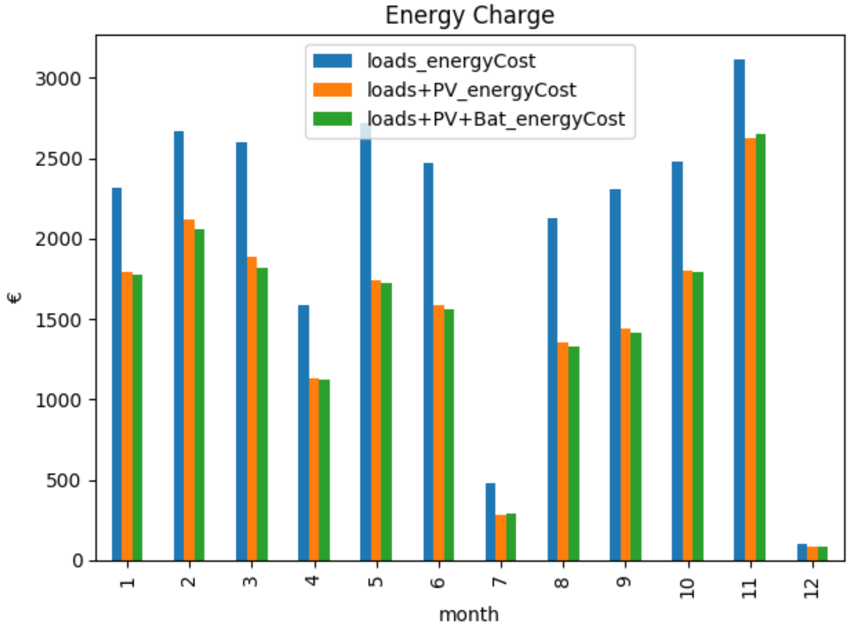
Storage in a factory, Spain: economic assessment

Demand charge reduction	Jan	Feb	Mar	Average reduction	Sept	Oct	Nov	Average reduction
Loads (€)	384.44	367.34	429.87		365.00	447.13	486.00	
Loads-PV (€)	384.44	365.56	428.77	**-0.24%**	264.47	353.26	488.34	**-14.80%**
Loads-PV+Bat (€)	355.95	357.45	398.91	**-5.87%**	316.13	359.10	488.34	**-10.37%**



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Source: CENER, 2020

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Storage in a factory: Conclusions

- PV decreases demand charge significantly, in winter the battery further the decreases demand charge
- For this use case the battery does not yet provide a business case
- GHG emissions increase to a small extent compared to only injecting PV into the grid

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Community battery in a residential village (SI) implemented by the DSO

STORY

Li-ion battery, 320 kWh, 170 kW

Grid issues expected at higher PV levels

- <u>Scenario low RES – 210 kWp PV</u>
  - UC1: PV curtailment
  - UC2: BESS implementation
- <u>Scenario high RES – 630 kWp PV</u>
  - UC1: PV curtailment
  - UC2: BESS implementation

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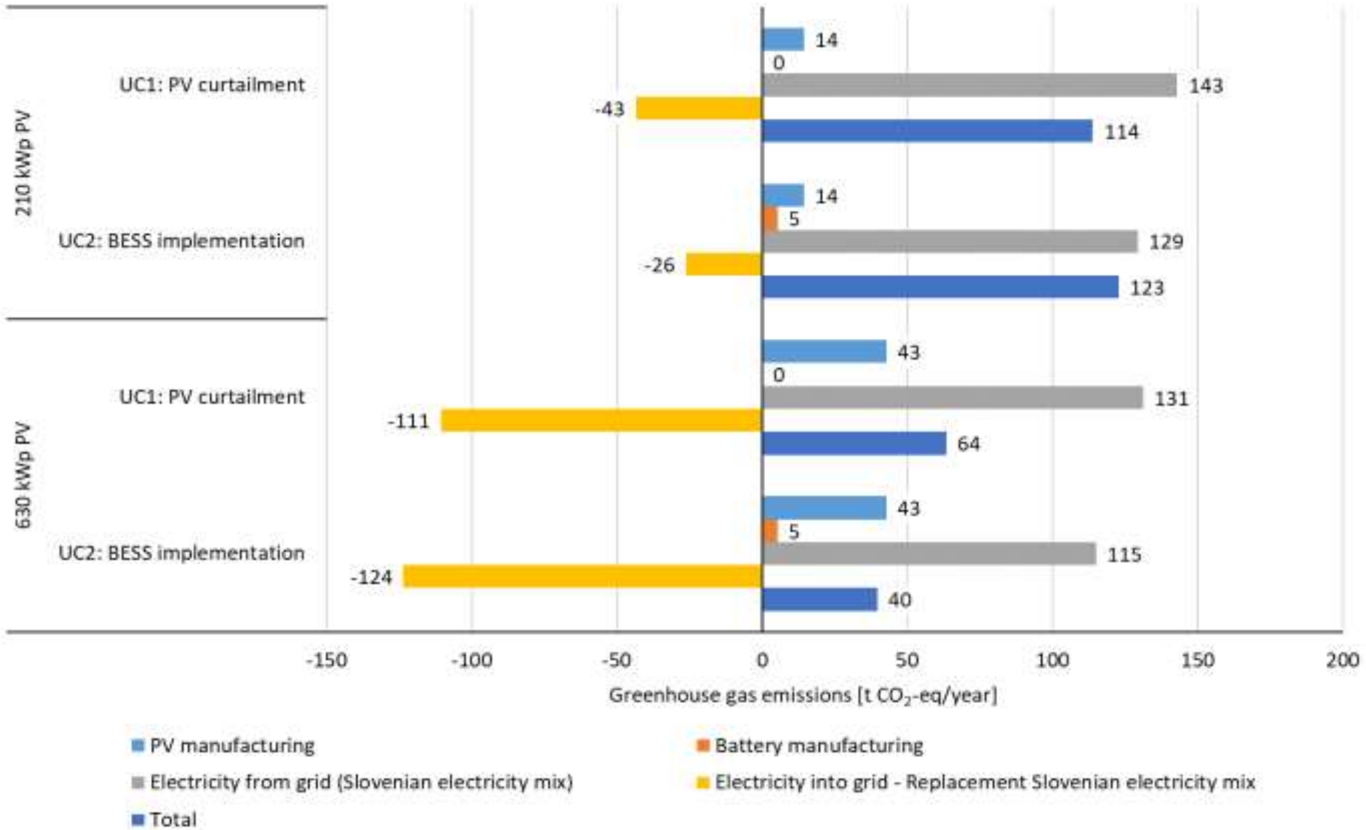
Community battery in a residential village: environmental analysis (1)



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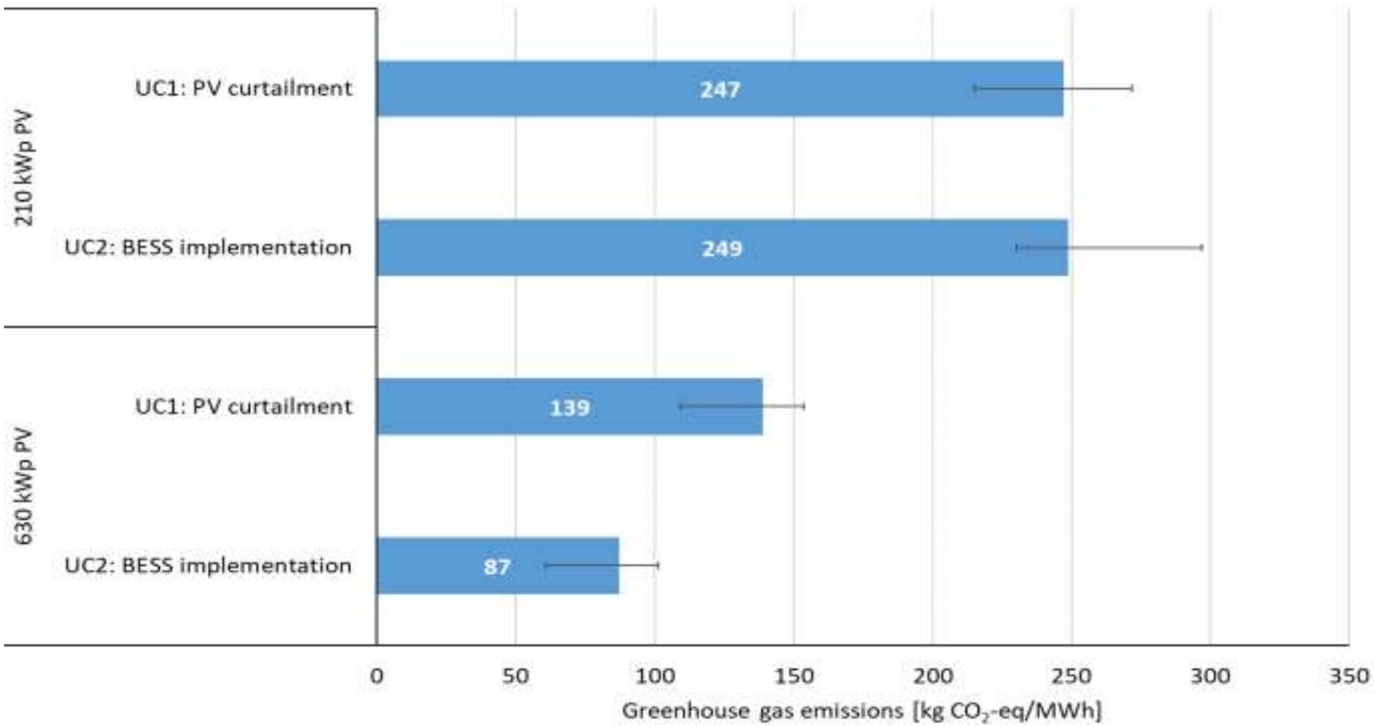
Community battery in a residential village: environmental analysis (2)



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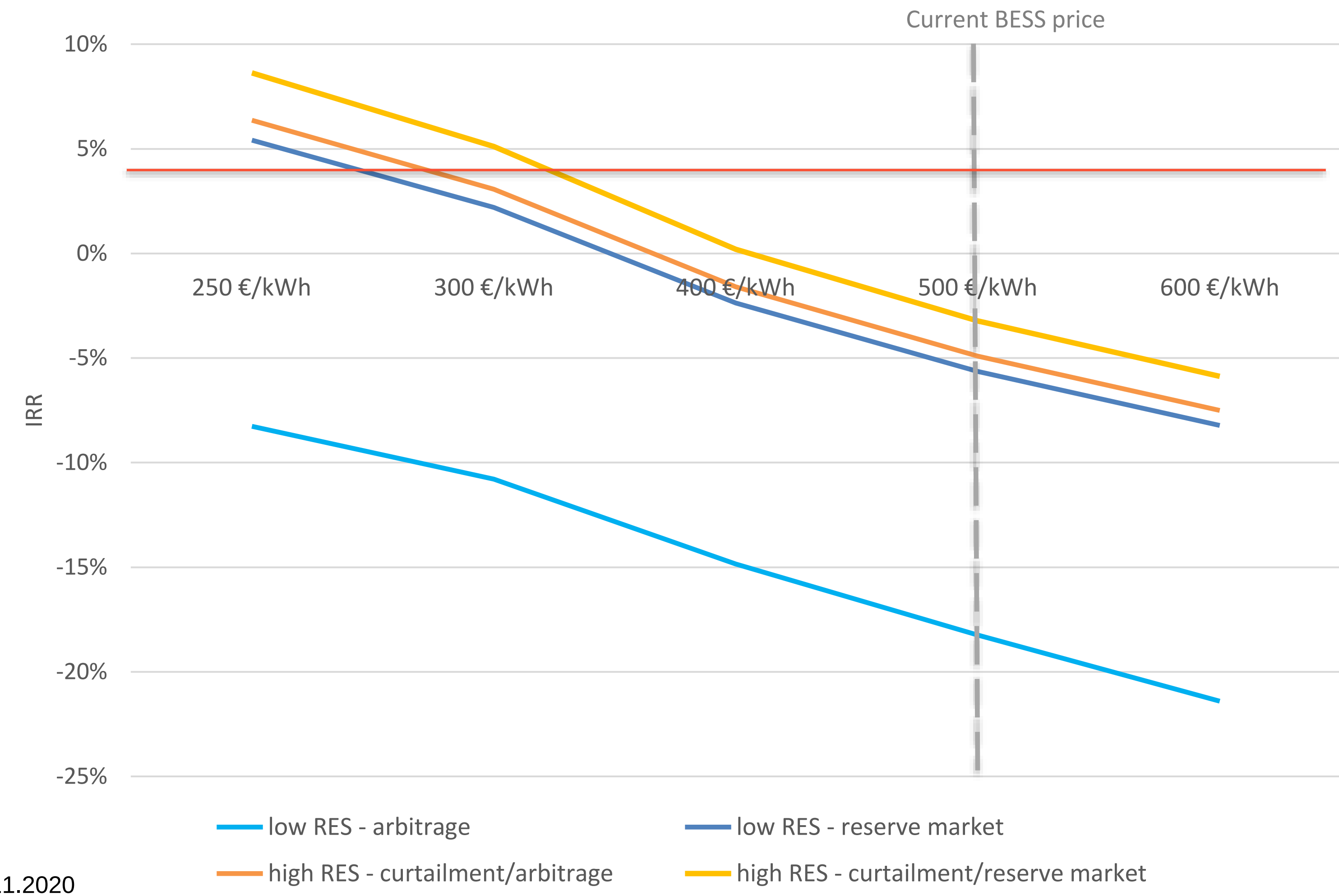
Community battery in a residential village: economic analysis



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Community battery in a residential village: technical analysis

	Low RES (June)	High RES (June)
Peak power change	-42%	-44
Peak to average ratio	-40%	-40%
Grid losses	-7%	-21%
Local voltage grid energy consumption	+20%	+20%

→ Infrastructure upgrade can be delayed

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Community battery in a residential village: Conclusions

- Possible business case with revenues from reserve markets/mitigating curtailment in reach
- Environmental benefits only in case of mitigating curtailment
- Important technical benefits to the DSO by peak reduction, reduction of losses, and increased local RES generation

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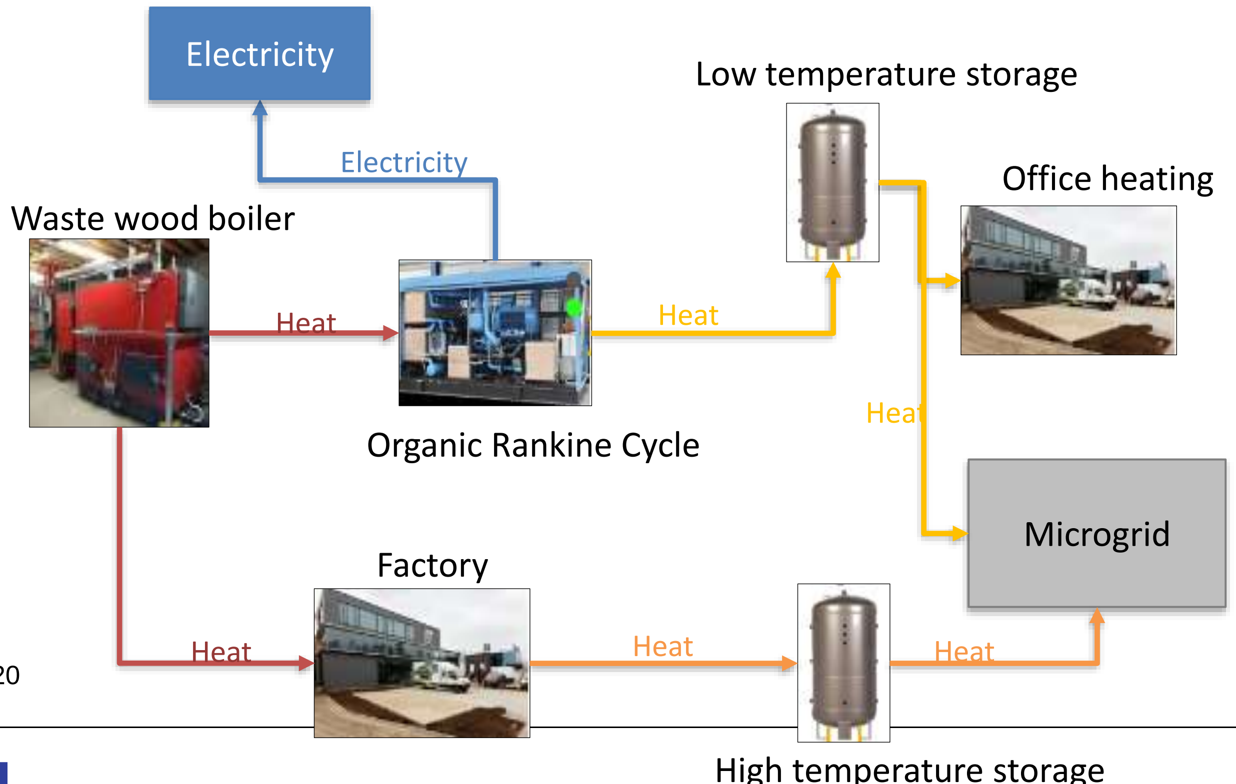
Beneens multi-energy grid (Belgium)

- Biomass boiler plus ORC, and thermal storage
  - Active control of the ORC though the use of thermal storage
  - Reduced peak power demand
  - Possible heat supply to neighbors



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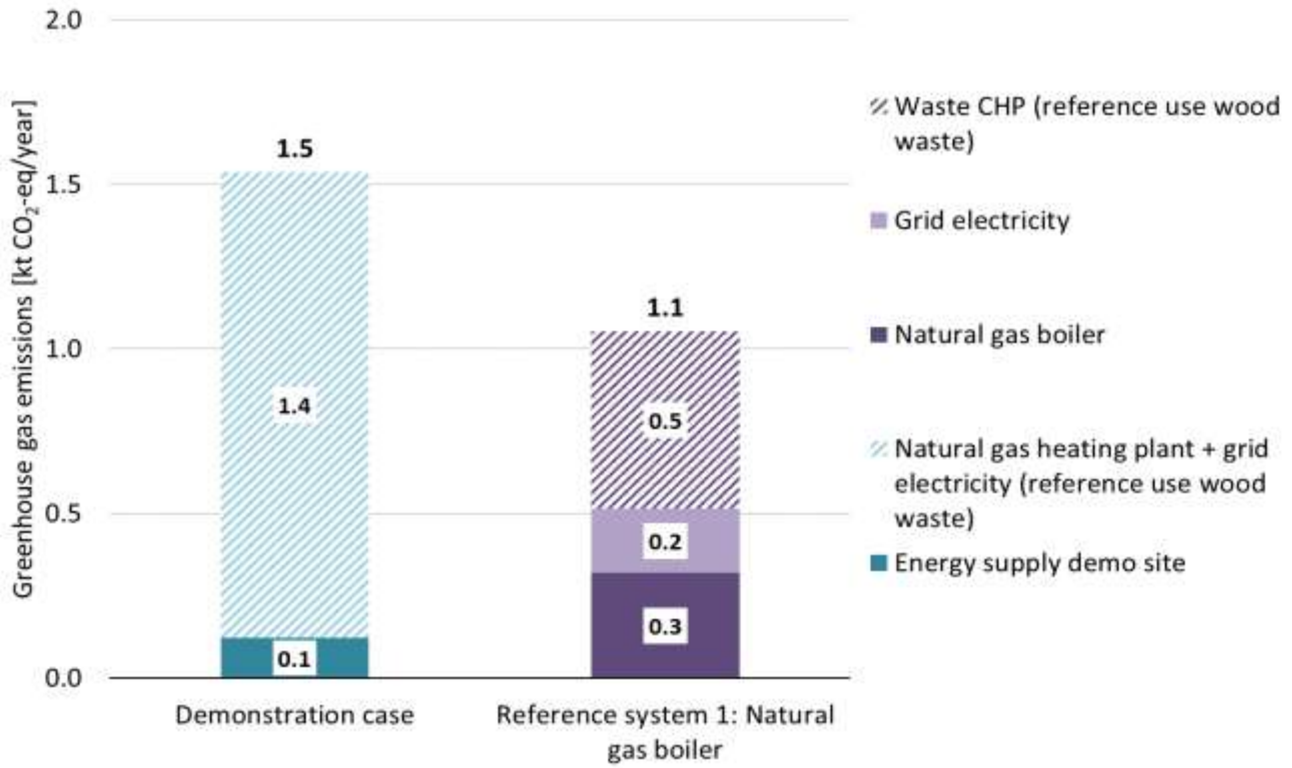
Beneens multi-energy grid- environmental assessment



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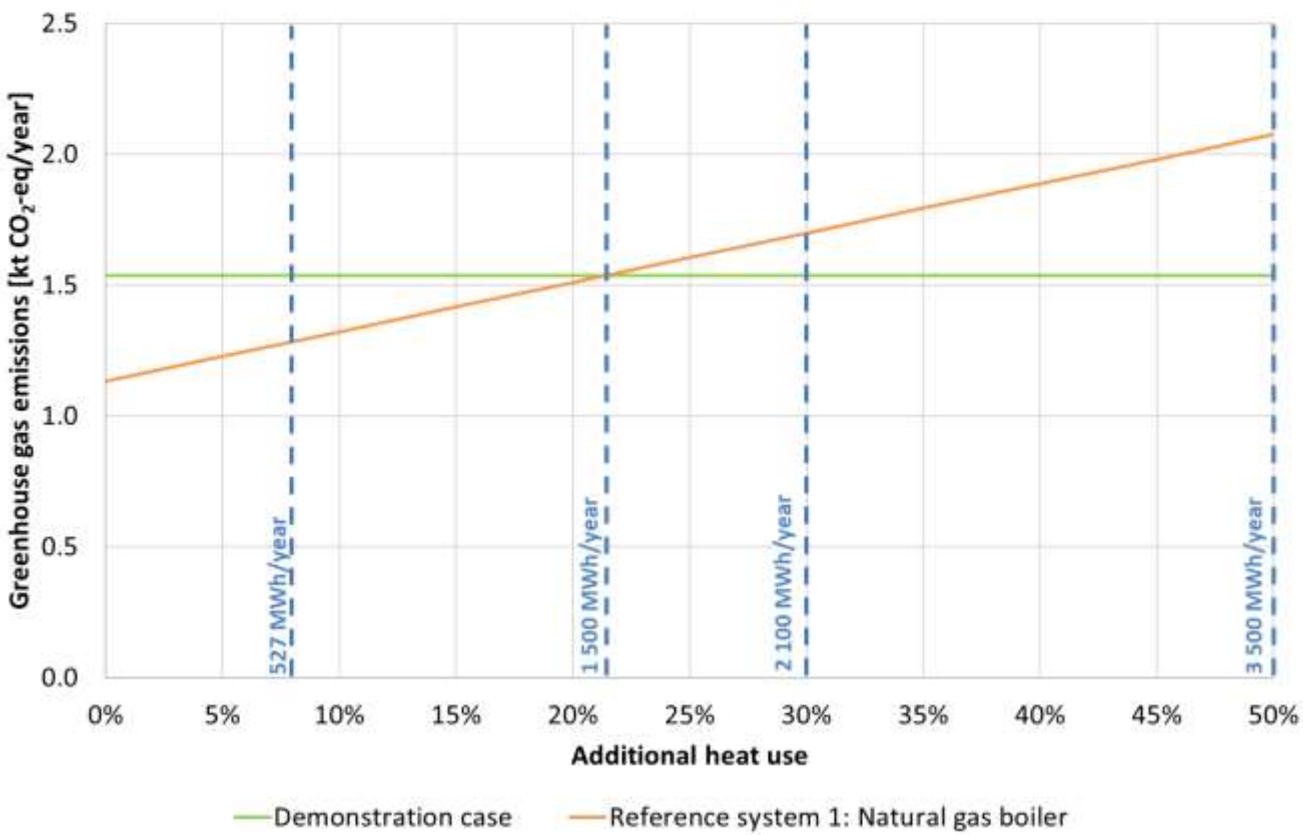
Beneens multi-energy grid- environmental assessment- sensitivity



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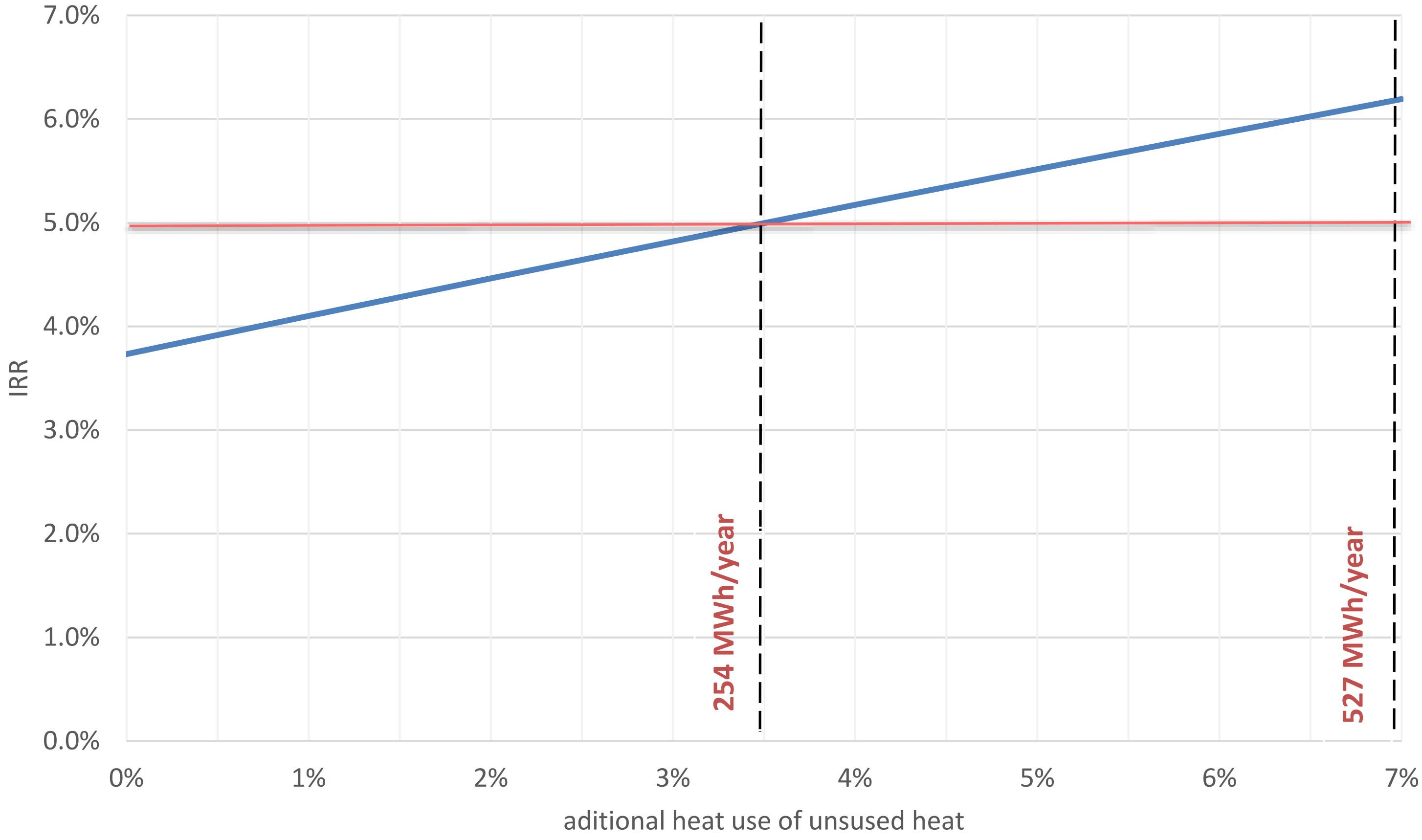
Beneens multi-energy grid economic assessment - sensitivity



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Conclusions

- Environmental assessment needs to consider entire energy system
  - Demo alone seems environmental beneficial
- Additional heat use: Boiler/ORC system economically viable earlier than from an environmental viewpoint
  - Risk of business case that doesn't lead to decarbonisation

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Project STORY - H2020-LCE-2014-3

Smart systems integration

- **Electrical storage**: Interoperability in IT domain
  - Control and communication of multiple devices
  - Interplay between battery, inverter, overall system
- **Electrical and thermal storage**: Interoperability and interplay of devices in energy domain
  - Lack of technology integrators that can adjust system to each others

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Overall Assessment

Demo	Increased use of local RES	Economic return	Grid value	Smart system integration	Environmental results
Beneens (heat to neighbours)	++	++	Neutral	-	+
Exkal	+	--	Neutral	--	-
Suha (high RES)	++	-	++	--	++

Rankings key:

++	+	Neutral	-	--

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Conclusions

- Storage needs to be tailored to specific issues it should solve, instead of a general roll-out
- Different break even points for economic and environmental benefits
- Energy system view important. As long as the grid can act as a storage environmentally more sound solution
- RES deployment can be supported by storage in a more indirect way, by delaying infrastructure reinforcements or improving power quality

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THANK YOU!

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