Cost and CO2 reduction potential of Renewable Energy Communities: Comparison of Selected European Countries

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Workshop “PV prosumers on the rise – how Europe can empower more people to produce, consume & sell their own electricity”

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www.pvp4grid.eu

Target Countries

Map data ©2019 GeoBasis-DE/BKG (©2009), Google, Inst. Geogr. Nacional, Mapa GISrael, ORION-ME United States

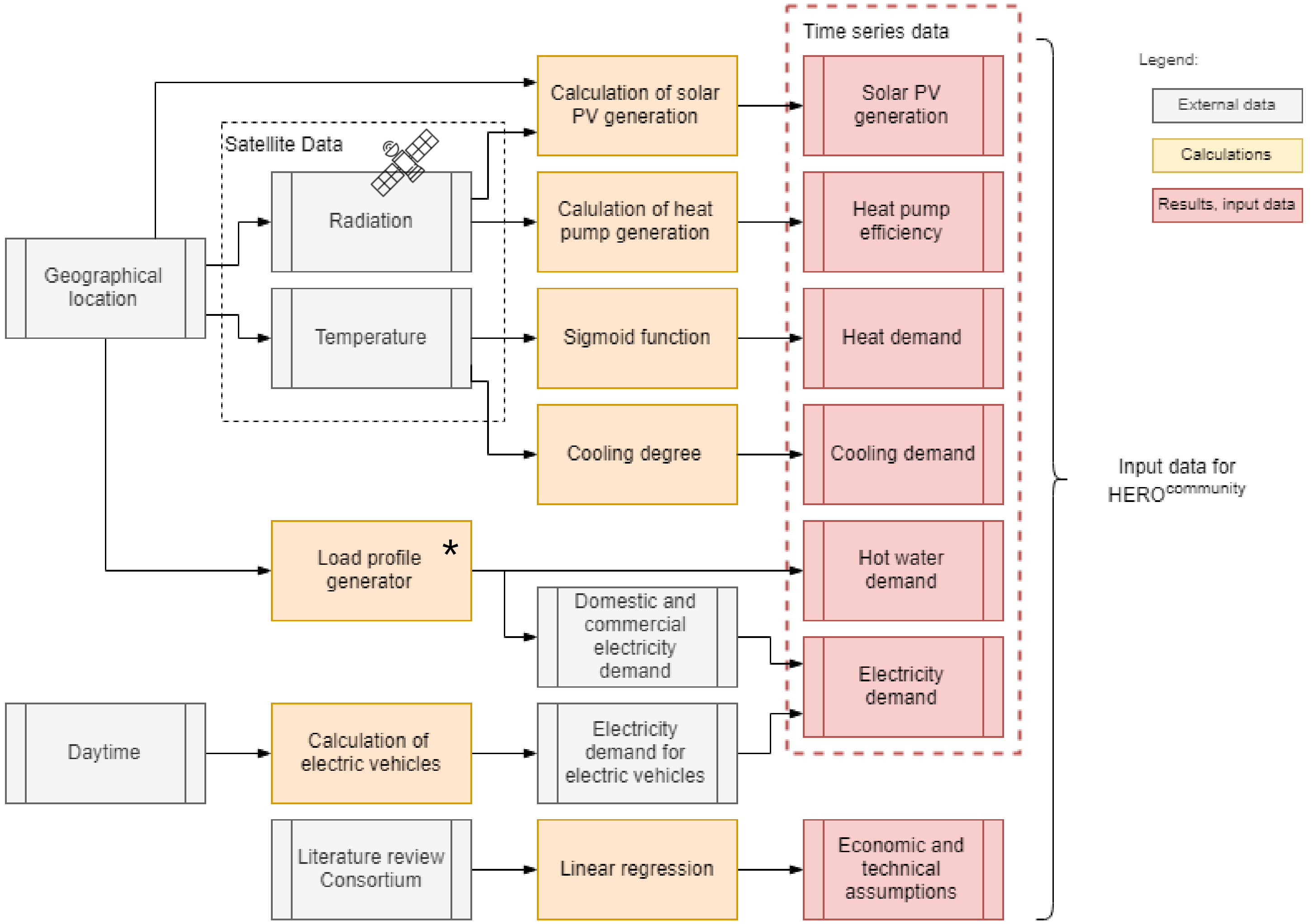
PVP 4Grid

Countries vary in:

- Electricity demand
- PV generation per kW-peak
- Grid tariff design

Calculation of the Input Data

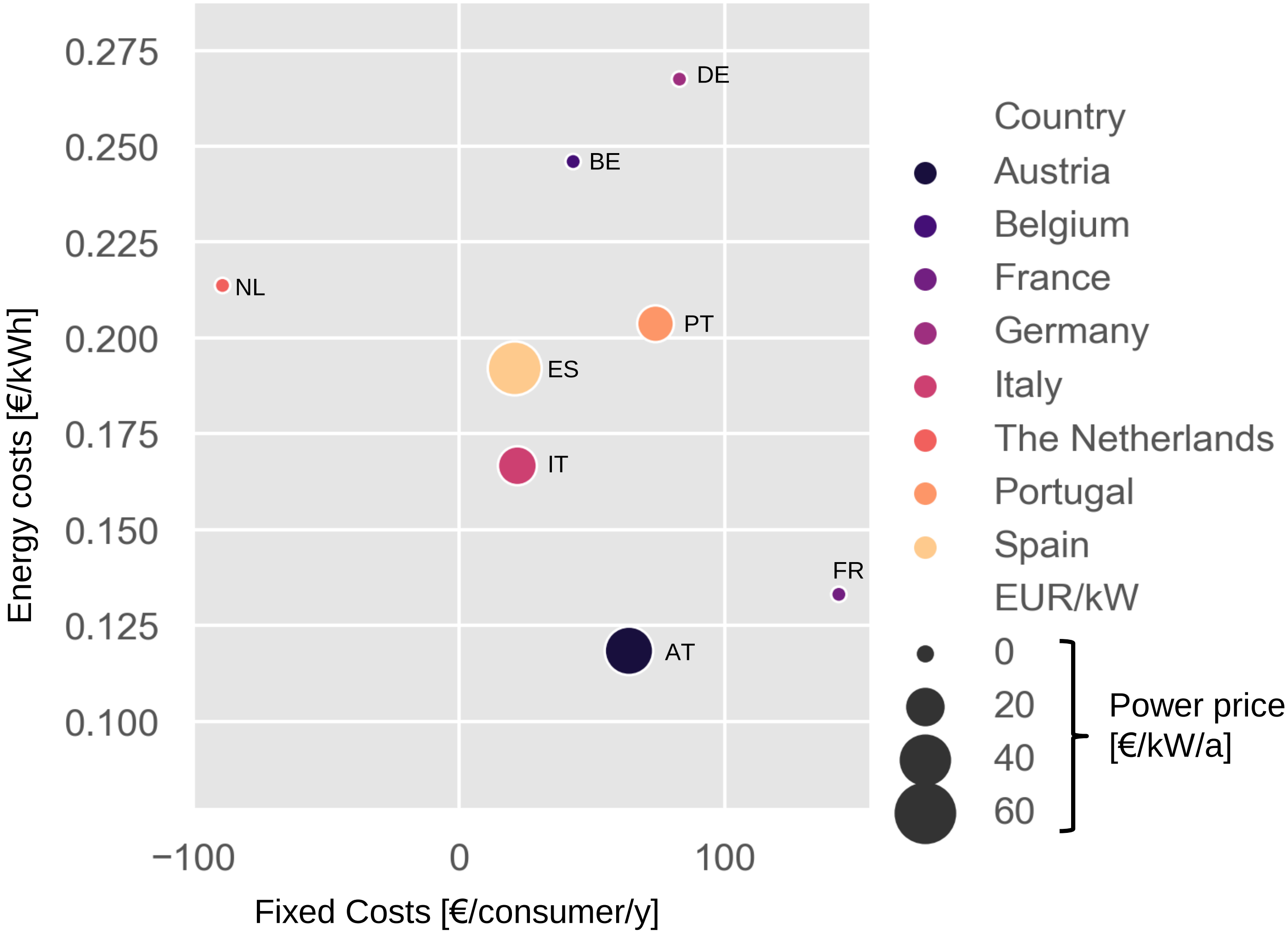
Sector Coupling: Heat Pumps and Electric Vehicles



*Load profile generator source: Pflugradt N., 2019. https://www.loadprofilegenerator.de

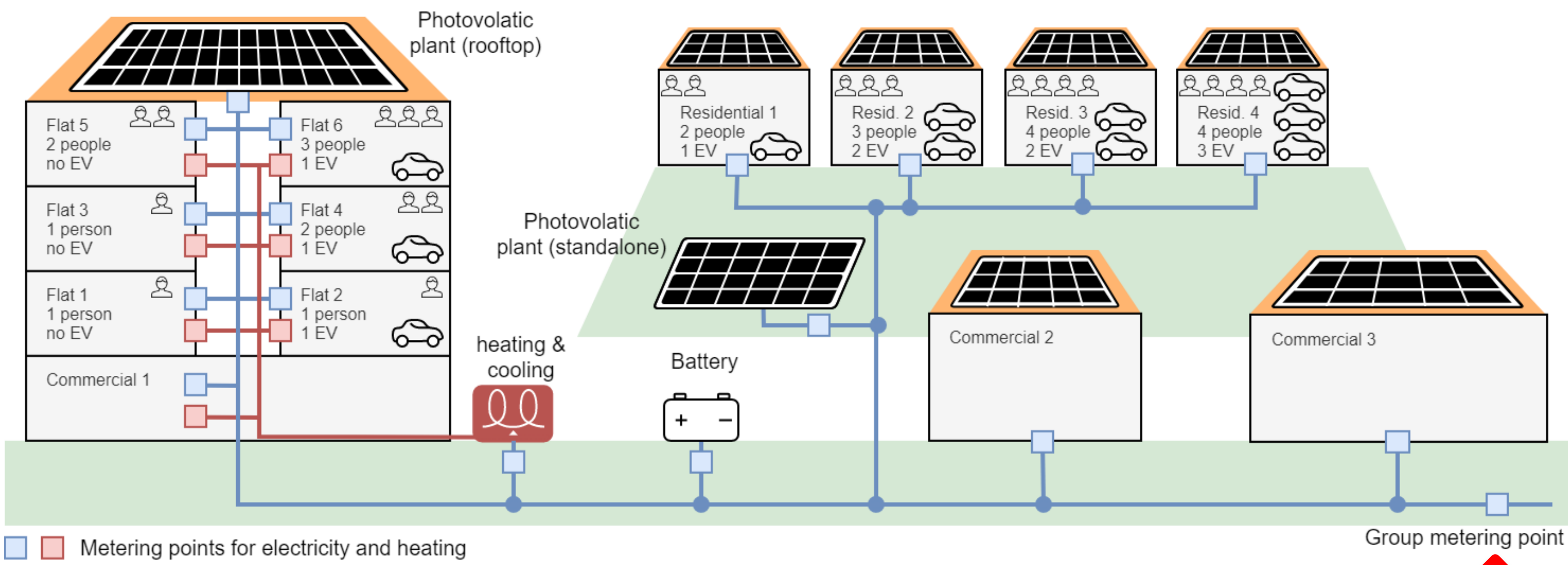
Current tariff design in the target countries

Electricity costs = Energy costs + Grid tariffs + taxes and fees



Setup for the renewable energy community

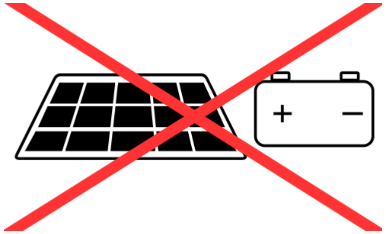
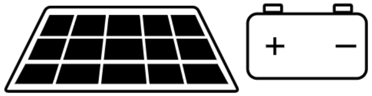
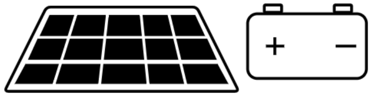
- “European Village” represents average housing situation in Europe



Reduced grid fee when sharing energy within the community

Community Scenarios

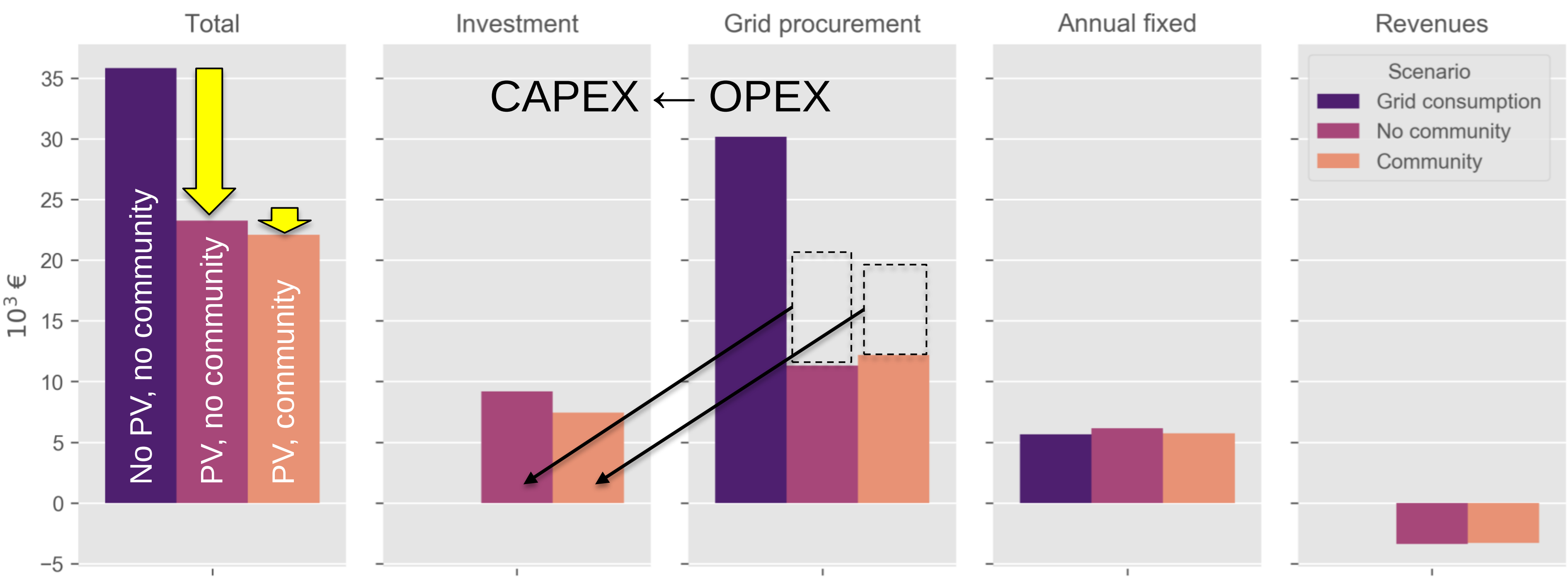
- ***Grid consumption***:
  - No investments in PV and storages
  - Demand is satisfied via the grid
- ***No community***:
  - Investments in PV and storages are possible
  - Energy sharing not allowed
- ***Community***:
  - Investments in PV and storages are possible
  - Energy sharing allowed

Technologies	***Metering point***
	separately
	separately
	aggregated

Results for “European Village“

Electricity costs with investments

$$Total\ Costs(Year) = \alpha * Investment + Grid + Fixed - Revenues$$

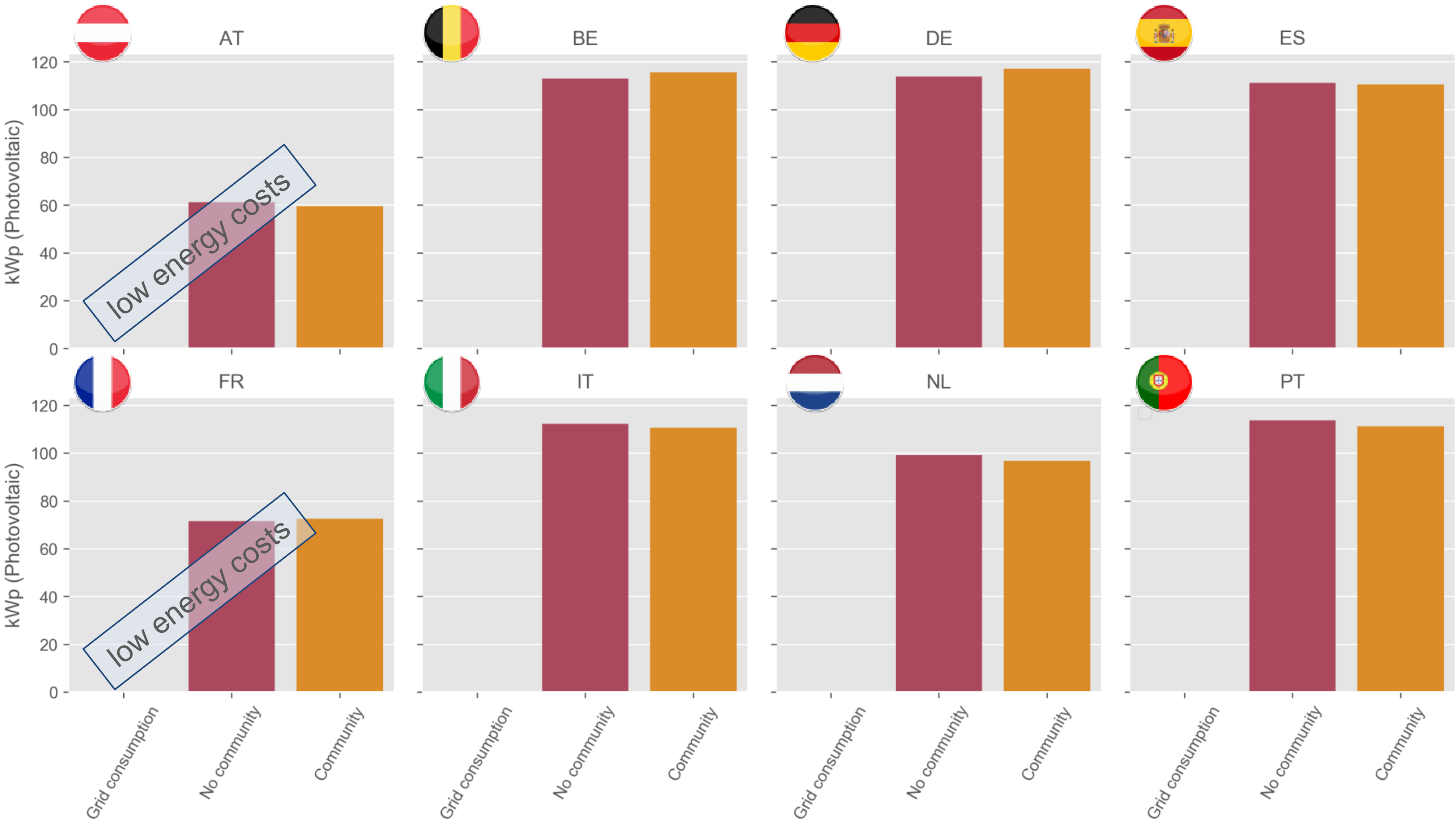


Results for “European Village“

Change in Total Costs (compared to Grid Consumption)

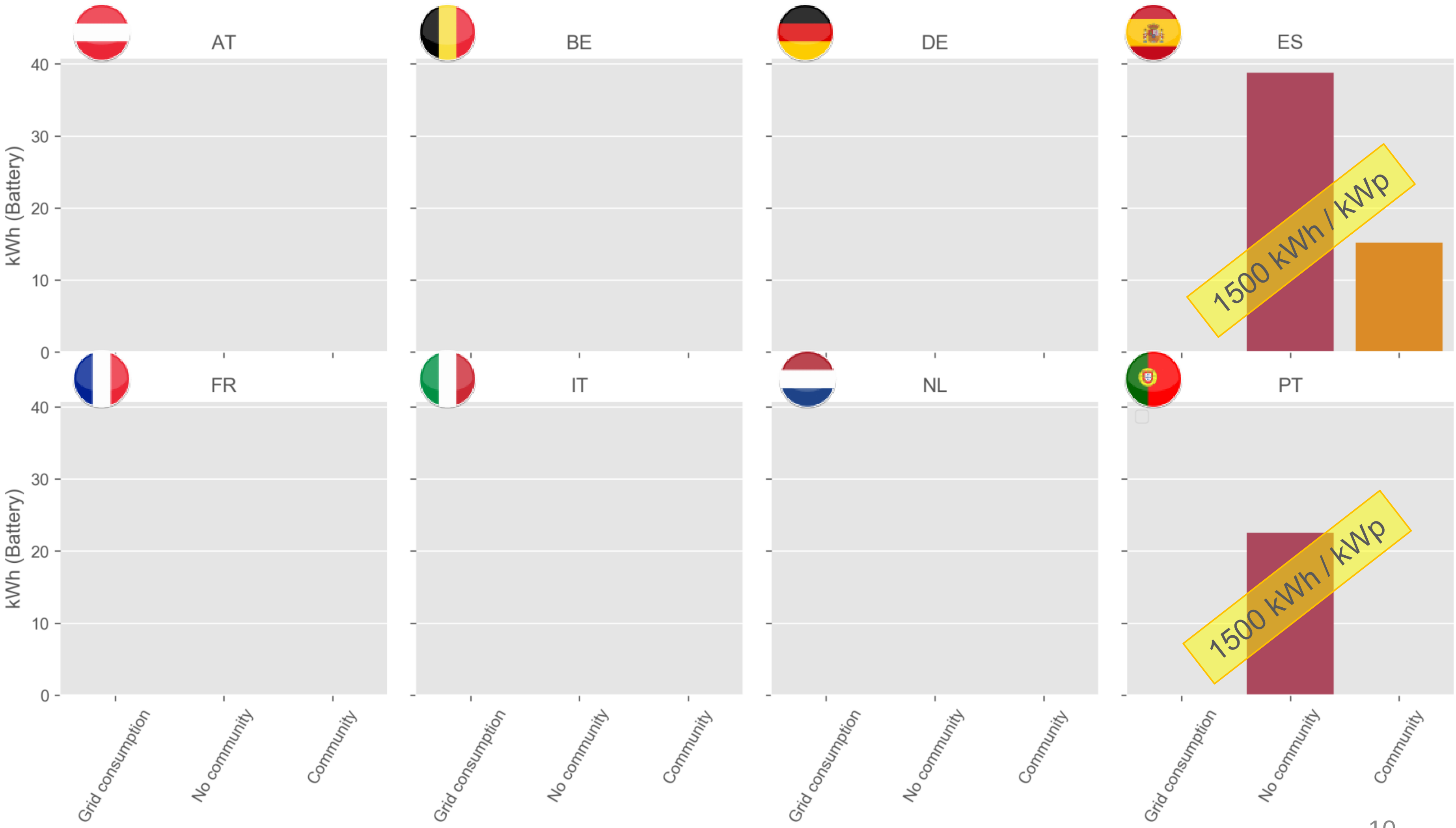
Results for “European Village“

Installed PV capacity in kWp



Results for “European Village“

Installed battery capacity in kWh



Conclusions (Part I)

- The **value of PV and renewable energy communities** depends not only on **PV generation** but as well on **grid tariff design / electricity prices**

- **Renewable energy communities** make PV **more profitable**, reducing the need of subsidies, due to:
  - **Lower investment costs** due to community investments
  - More beneficial due to **increased self-consumption**

- **Energy communities** give **everyone access to PV** in case of building restrictions or rooftop limitations

Part II: Greenhouse Gas Emissions of Renewable Energy Communities

Greenhouse Gas Emissions are released (indirectly) due to:

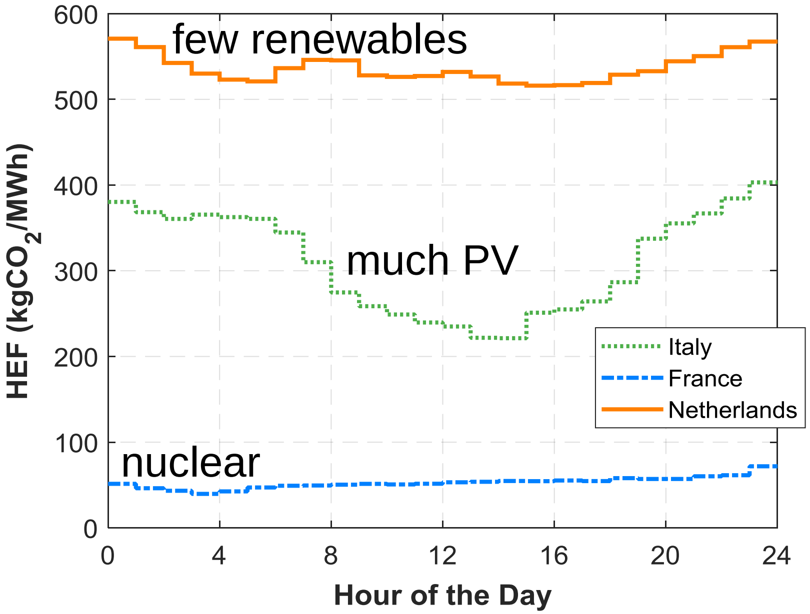
1. Manufacturing of **PV systems**, **Batteries**, **Electric vehicles**, **Heat pumps**
   - **Life-cycle assessment** (LCA). All data taken from ecoinvent v3 database (for consistency)

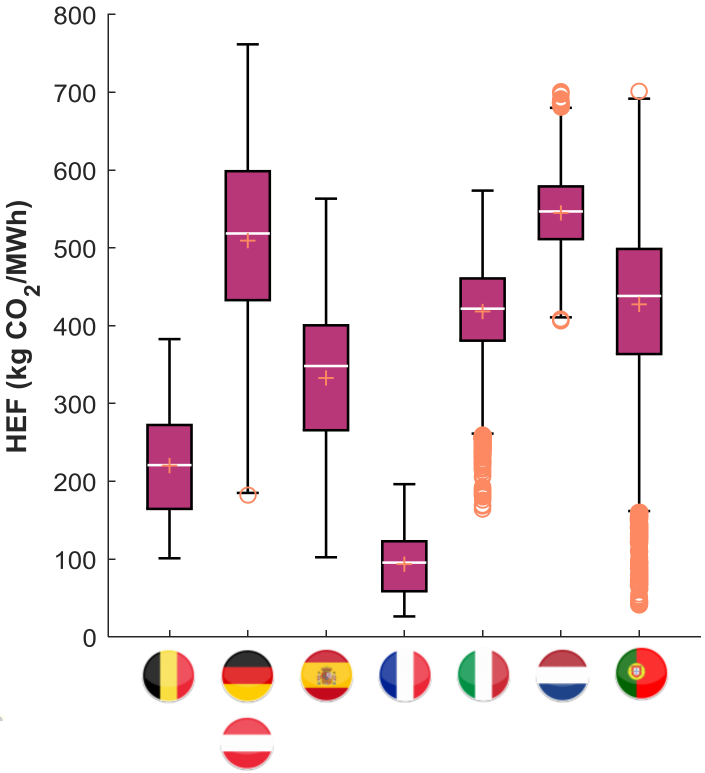
2. Electricity **use** from the grid and electricity **feed-in** PV electricity to grid ("negative" emissions!)
   - Electricity-related emissions are calculated with timeseries of **Hourly Emissions Factors** and Electricity Consumption*

Since the emission factor of grid electricity fluctuates every hour, timing of electricity use (or grid feed-in) is important

*We use the configuration, scenarios and electricity use time series of the "European Village"

Hourly Emission Factor (HEF, in [kg CO_2 / MWh])

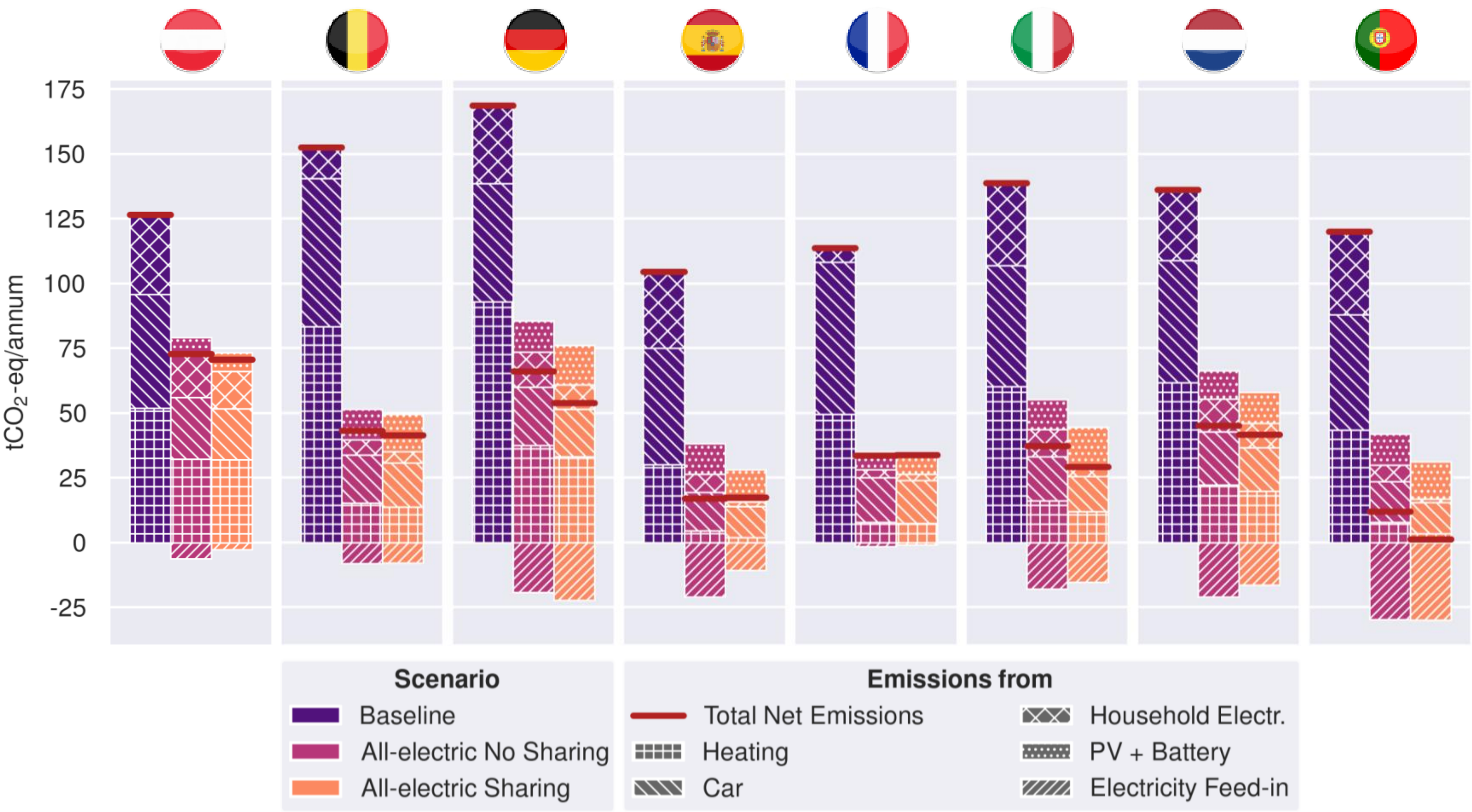




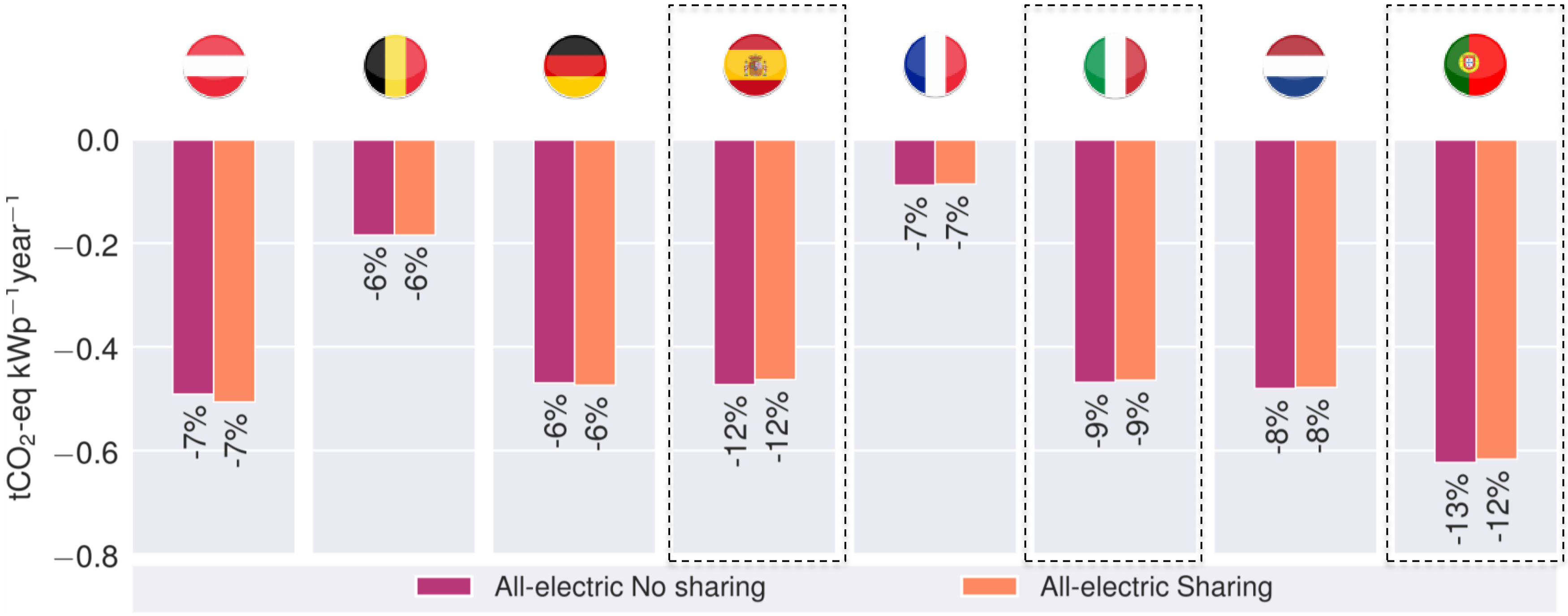
- If you feed-in PV electricity in hour *x*, you mitigate emissions **in that hour**
  - Shows where in Europe energy transition technologies can have highest CO_2 mitigation potential

Schram, W., Louwen, A., Lampropoulos, I., & Sark, W. van. (2019). Comparison of greenhouse gas emission reduction potentials of energy communities in Europe. *Energies* (forthcoming)

GHG reduction potential of all-electric energy communities



Change in annual GHG emissions
(Per kWp of installed PV capacity)



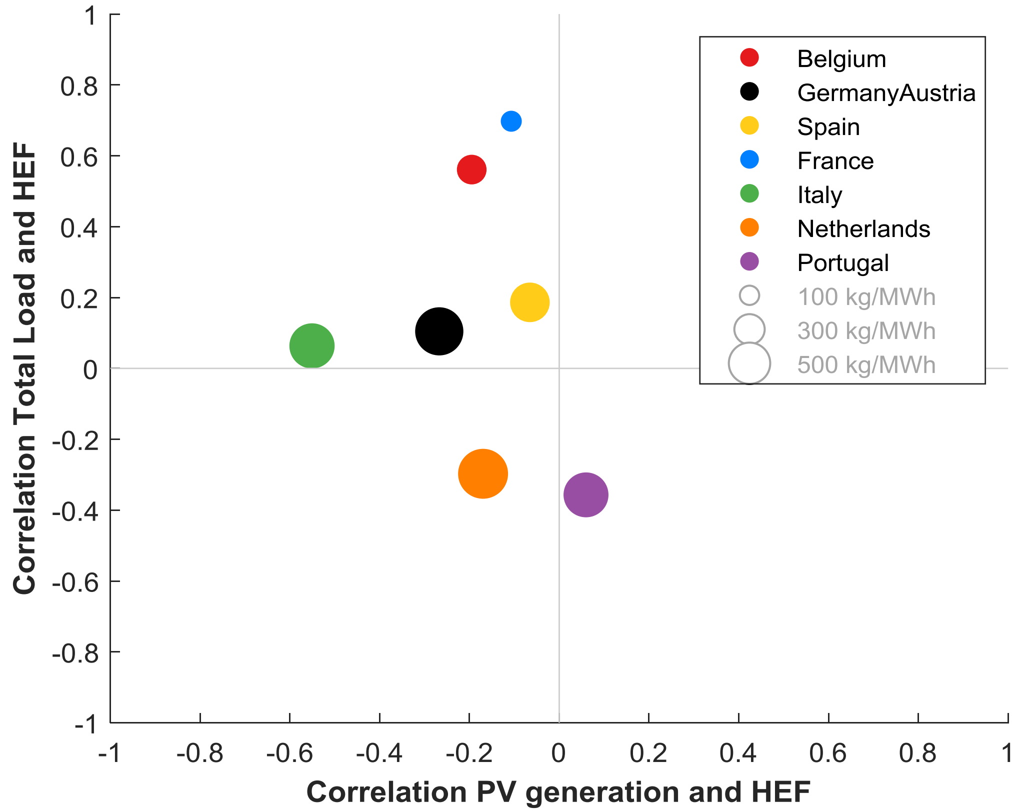
Factors affecting GHG reduction potential of PV

GHG reduction potential of PV is determined by:

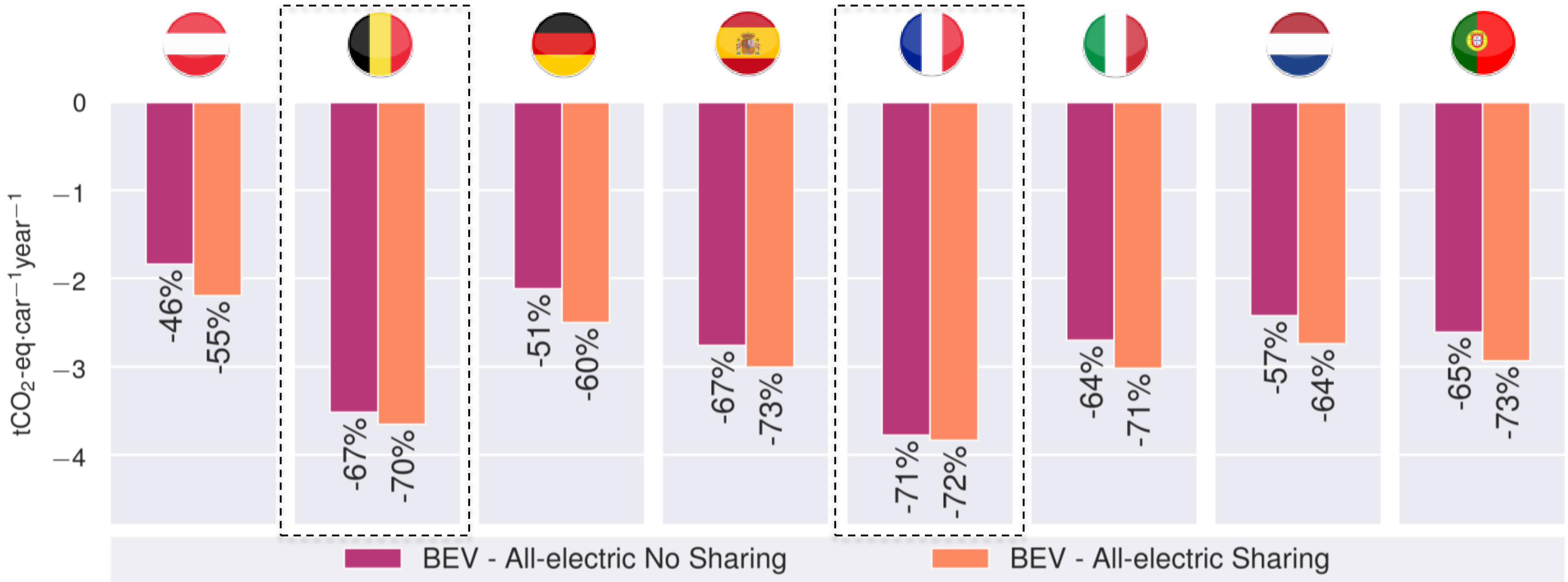
- Solar irradiation

But also:

- Emission factor of a country's generation mix
- **Timing of PV generation**



Change in annual GHG emissions ICEV vs BEV
(Per vehicle)



Key take-aways

- **Installation of PV** reduces total emissions.
  - Moderated by **attractiveness** to invest in PV
  - Moderated by country-specific **solar irradiation** and **hourly emission factors**
  - Installing PV increases impact switching to heat pumps and electric vehicles

- Emission factors generation mixes determine GHG reduction impact of different transition technologies:
  - Currently **high** emission factors: stimulate installing PV
  - Currently **low** emission factors: stimulate deployment HPs and EVs

- Note: Hourly Emission Factors of 2017 are used – future generation mix will be different

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