Make the Möschberg Even Greater

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Context

- **Research question:**

  What are the environmental impacts and hotspots for fulfilling the energy demand of the hotel, in 2022 and in 2050?

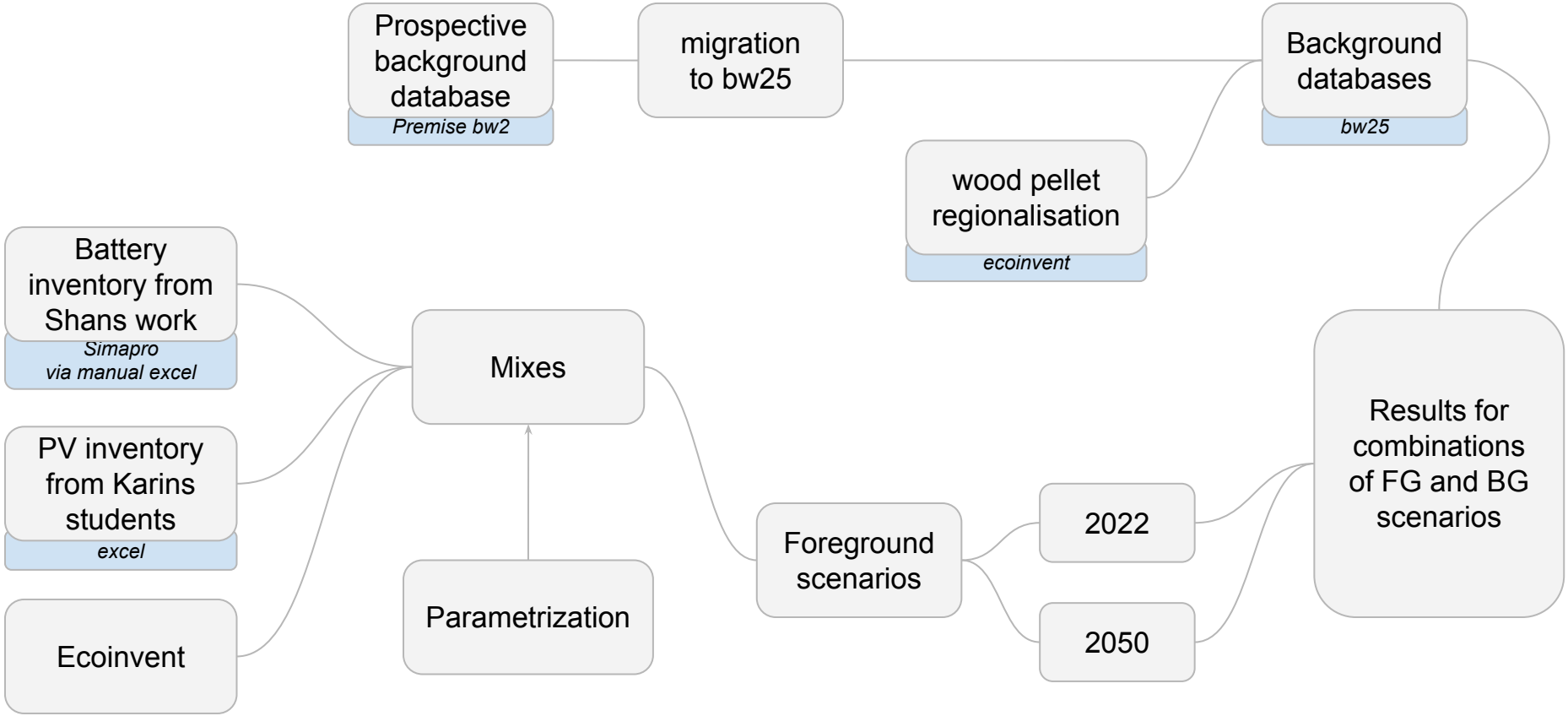
- **FU:** Möschberg operational energy consumption for 1 year (static)

- **Scope:**
  - Operational energy used for space heating, warm water, electricity is included (real data from invoices and assumptions from the owner).
  - Materials for the building = out of scope
  - Production of the new technologies are considered.

Methodology

1. Data collection on current situation
2. Modelling of the reference situation (baseline) using datapackages.
3. Contribution analysis of the baseline to select influential parameters.
4. Regionalization of influential parameters.
5. Creation of a prospective background database for 2050 (PREMISE).
6. Selection of a technology mix for 2050 and scenarios.
7. Results, analysis and conclusions.

Methodology



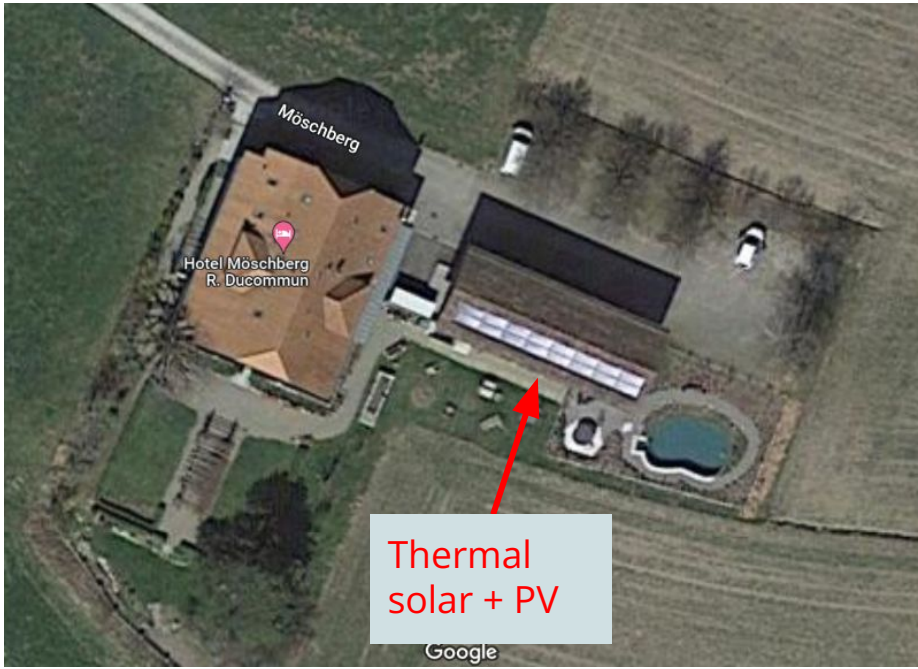
Current situation (baseline)

Heating:

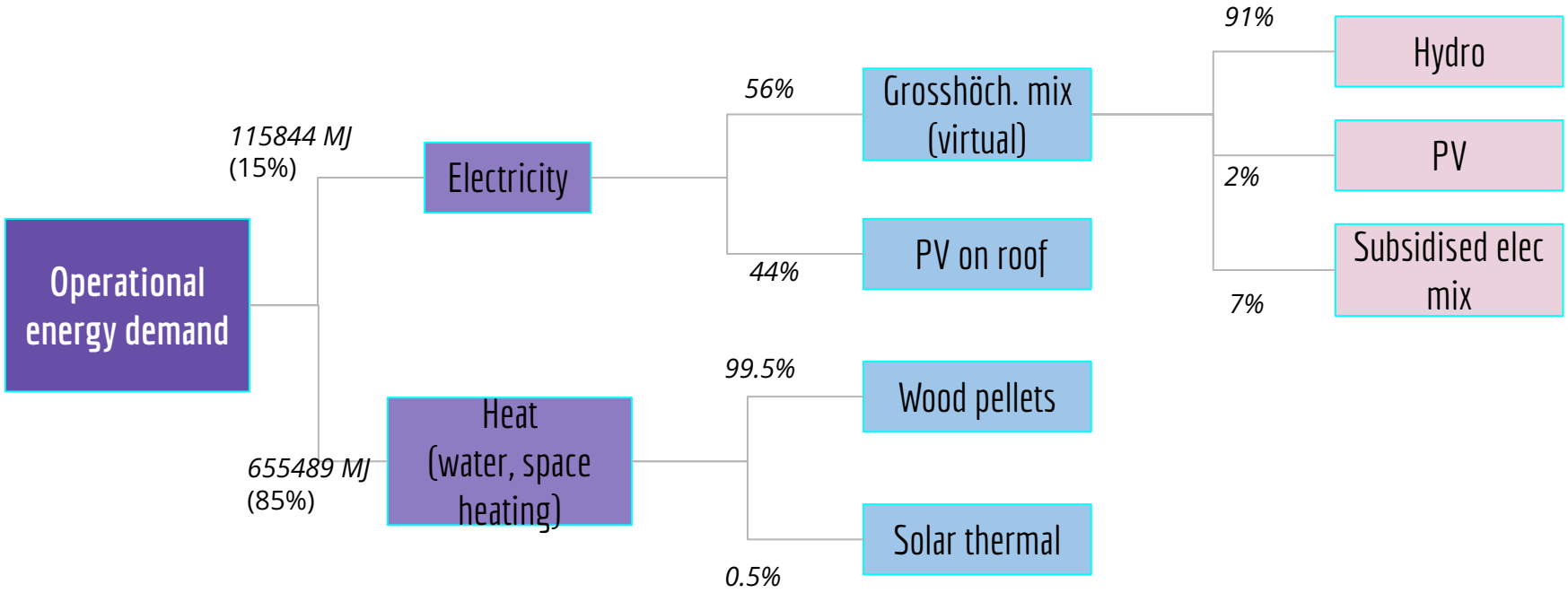
- Wood pellets for space heating
- Thermal solar for hot water

Electricity:

- 23,53% Self produced: rooftop PV
- 76.47 % Grosshöchstetten mix

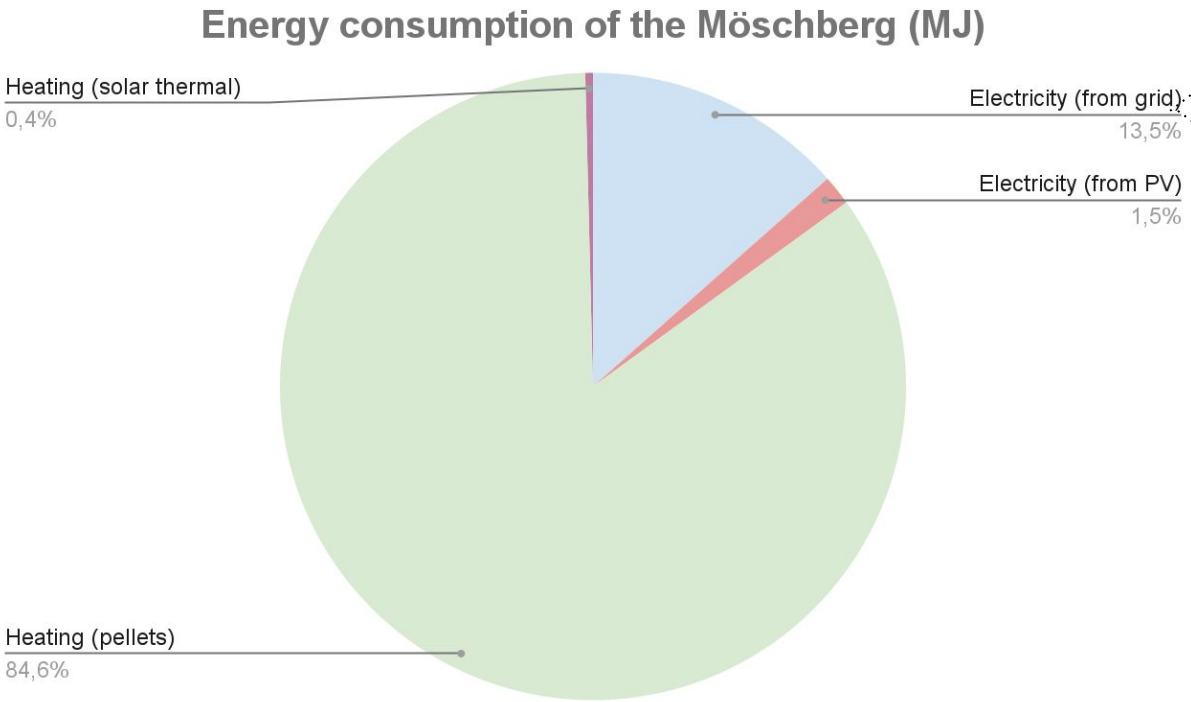


Flow diagram of the foreground (baseline)



Not included: Energy use for laundry (external), diesel for diesel car

Current situation (baseline)

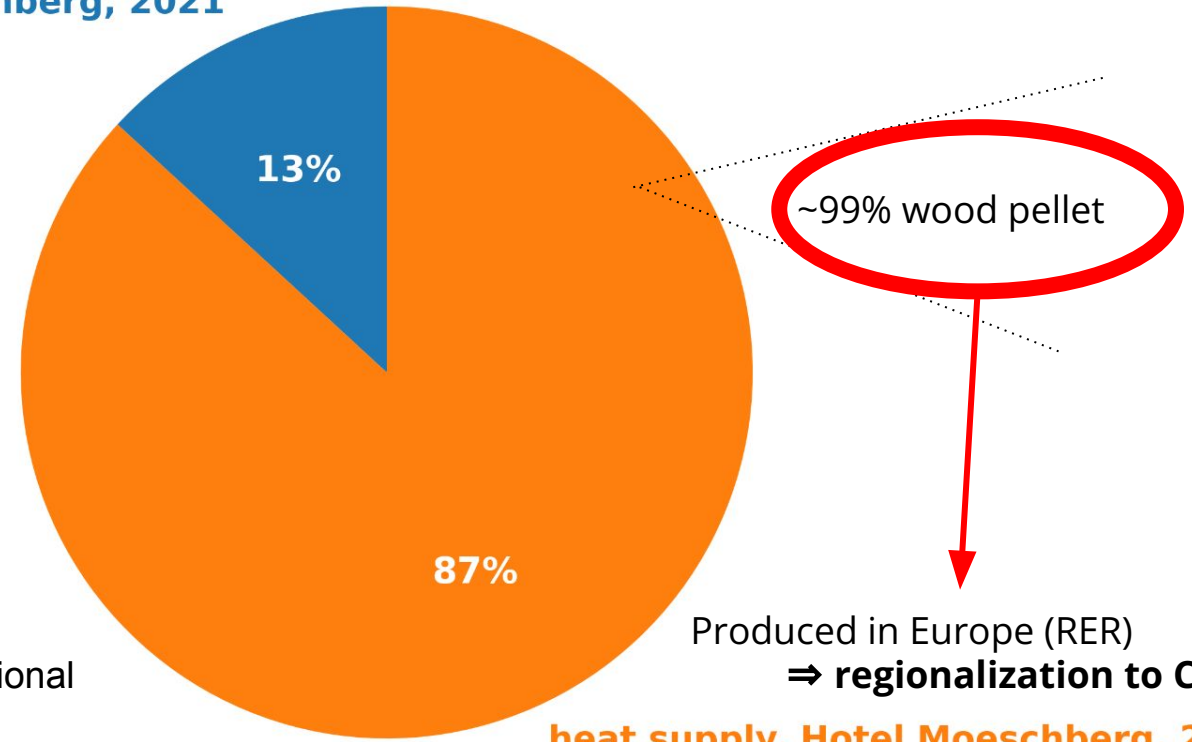


- 90,7 % hydro
- 2.6% PV
- 6.7% subsidised mix (renewables)

Baseline results: contribution analysis GWP

electricity supply, Hotel Moeschberg, 2021

ecoinvent inventories for PV are outdated ⇒ **replace with more recent LCI**



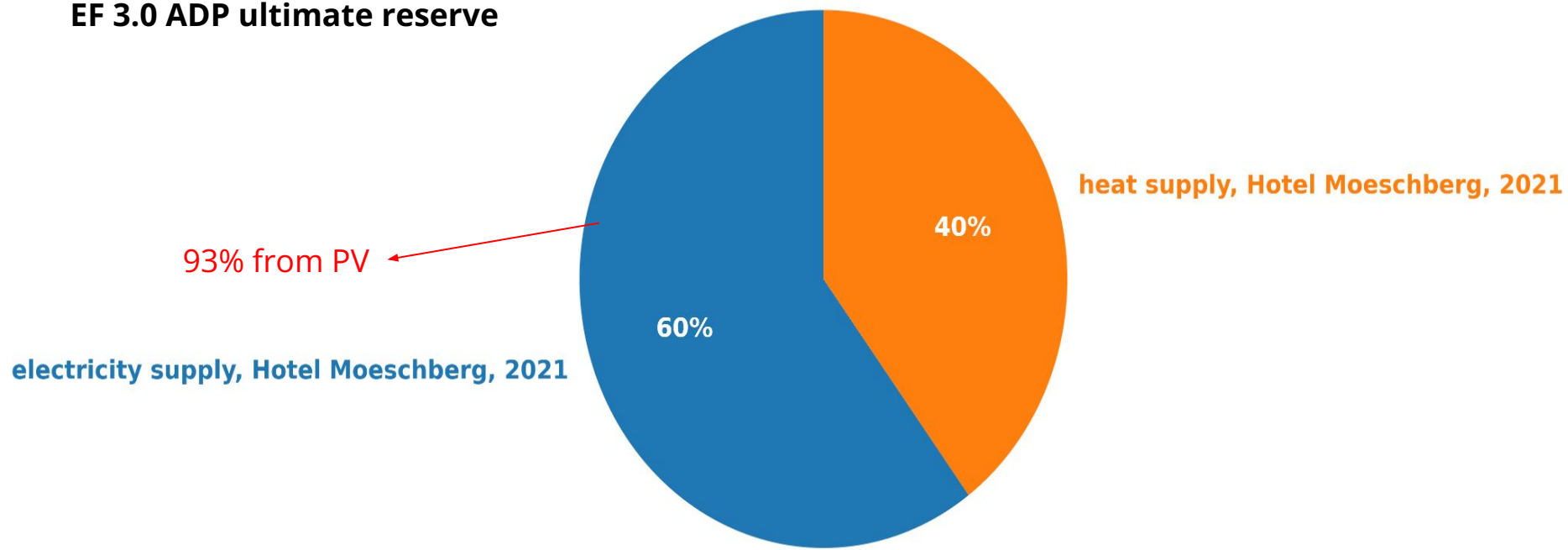
GWP 100 (IPCC 2013):
→ 9.3 **t CO_2-eq** to meet the operational energy demand of one year

Produced in Europe (RER)
⇒ **regionalization to CH**

heat supply, Hotel Moeschberg, 2021

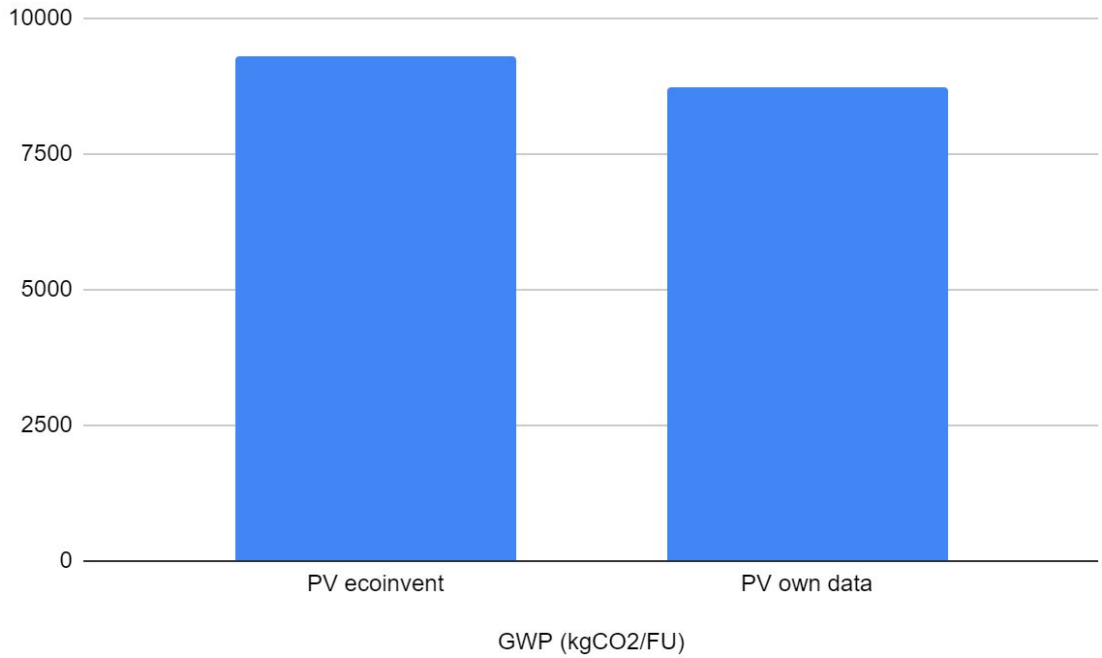
Baseline results: contribution analysis ADP

EF 3.0 ADP ultimate reserve

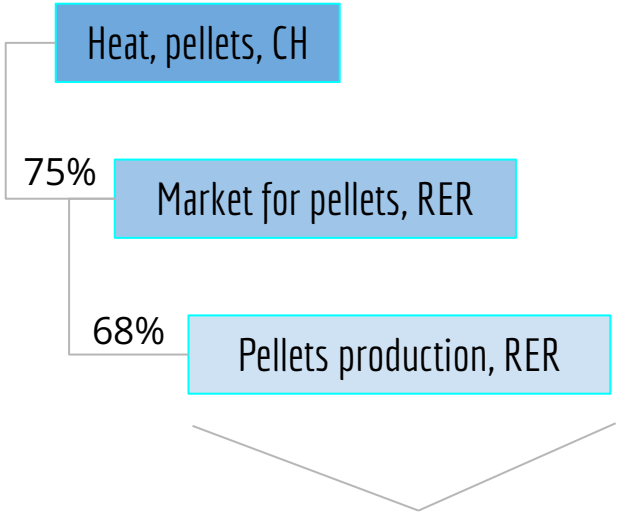


Influence by using our own PV inventory

ecoinvent inventories for PV are outdated ⇒ **replace with more recent LCI**

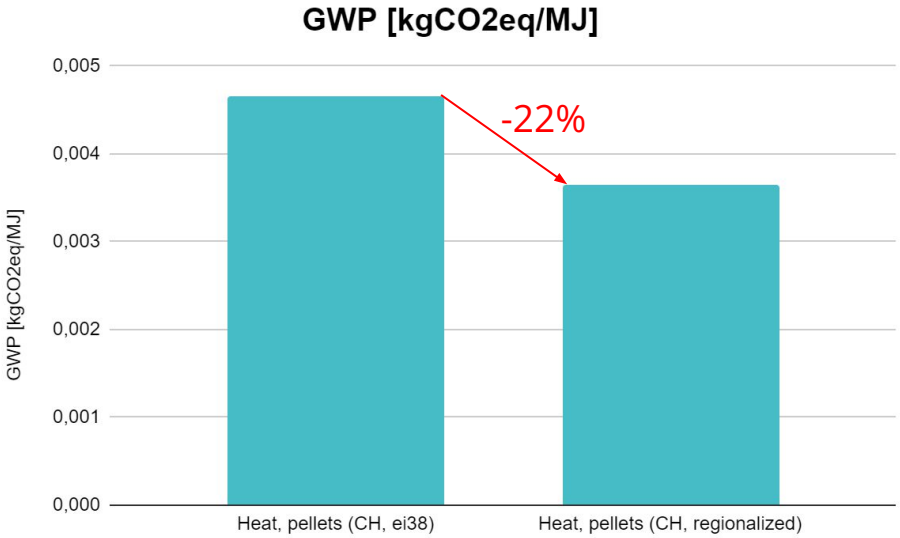


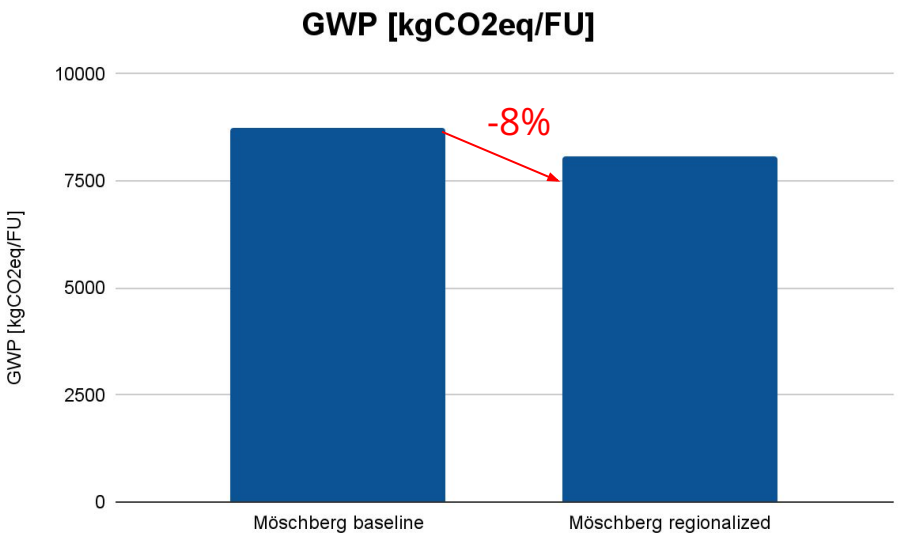
Regionalization - method




```
tech_edges = [
    {"row": new_wood_pellets_heat.id, "col": new_wood_pellets_heat.id, "amount":1},
    {"row": wood_pellets_heat.id, "col": new_wood_pellets_heat.id, "amount":1, "flip":True},
    {"row": new_wood_pellets_market.id, "col": new_wood_pellets_heat.id, "amount":0.0229911254795743, "flip":True},
    {"row": wood_pellets_market.id, "col": new_wood_pellets_heat.id, "amount": 0.0229911254795743},
] + [
    {"row": new_wood_pellets_market.id, "col": new_wood_pellets_market.id, "amount":1},
    {"row": wood_pellets_market.id, "col": new_wood_pellets_market.id, "amount":1, "flip":True},
    {"row": new_pellets_prod.id, "col": new_wood_pellets_market.id, "amount": 1, "flip":True},
    {"row": wood_pellets_prod_RER.id, "col": new_wood_pellets_market.id, "amount": 1},
] + [
    {"row": new_pellets_prod.id, "col": new_pellets_prod.id, "amount": 1},
    {"row": wood_pellets_prod_RER.id, "col": new_pellets_prod.id, "amount": 1, "flip":True},
    {
        "row": bd.get_activity(
            database="ei 3.8 cutoff",
            name='market group for electricity, medium voltage',
            location='RER'
        ).id,
        "col": new_pellets_prod.id,
        "amount": 0.096
    },
] + [
    {"row": key.id, "col": new_pellets_prod.id, "amount": value}
    for key, value in new_pellets_tech.items() if key['location']=="Europe without Switzerland"
] + [
    {
```

Regionalization - results

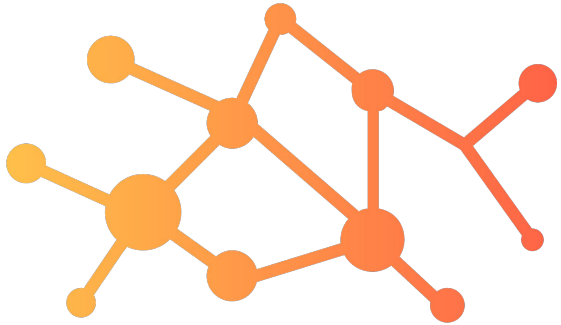




Prospective background database

IAM + RCP scenario

ei 3.8 cutoff



premise

Parametric naming in notebook:

+ *name has relevant metadata*
+ *no human error (wrong naming)*
- *ugly code*

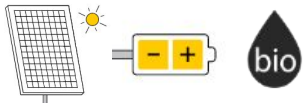
```
Databases dictionary with 10 object(s):
    EI 3.8 cutoff image SSP2-Base 2050
    EI 3.8 cutoff image SSP2-RCP19 2050
    EI 3.8 cutoff image SSP2-RCP26 2050
    EI 3.8 cutoff remind SSP2-Base 2050
    EI 3.8 cutoff remind SSP2-PkBudg1150 2050
    EI 3.8 cutoff remind SSP2-PkBudg500 2050
    biosphere3
    ei 3.8 cutoff
    super_db_2022-10-26
    super_db_2022-10-27
```

Technology mixes for 2050

Scenario 1

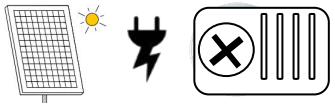
- **New installed PV** capacity of 42,2 kWp on the roof (maximum)
- **Battery** to cover remaining electricity needs
- Heating unchanged (pellets and solar thermal)

Scenario 2



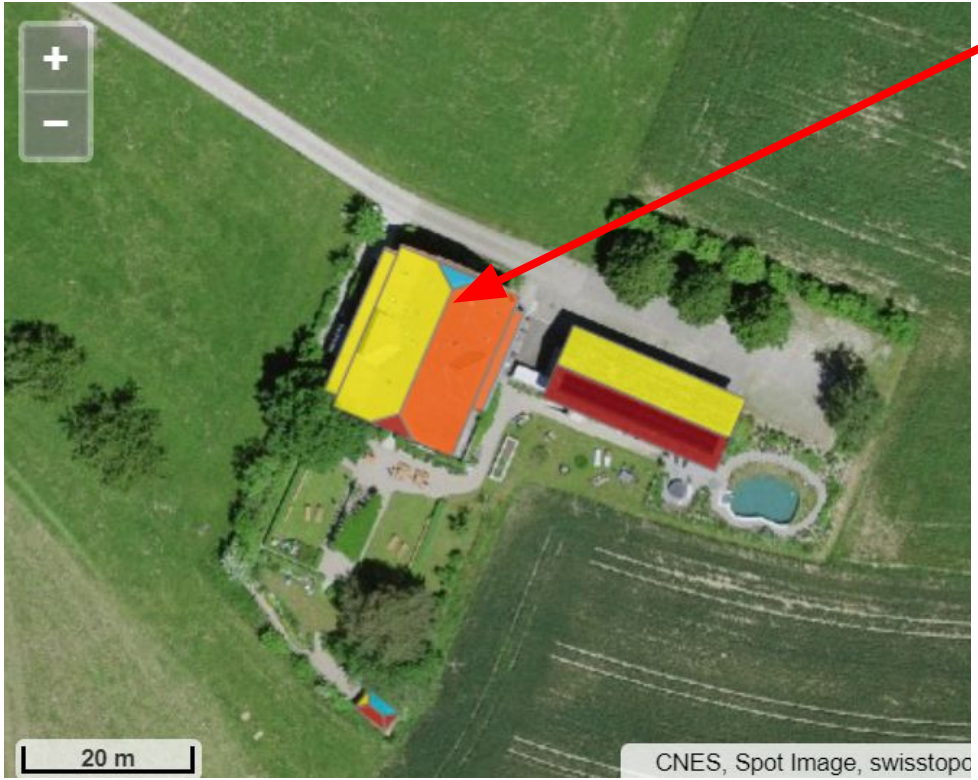
- **New installed PV** capacity of 42,2 kWp on the roof (maximum)
- **Battery** to cover remaining electricity needs
- Heating from pellets changed to **biogas boiler** (solar thermal remaining)

Scenario 3

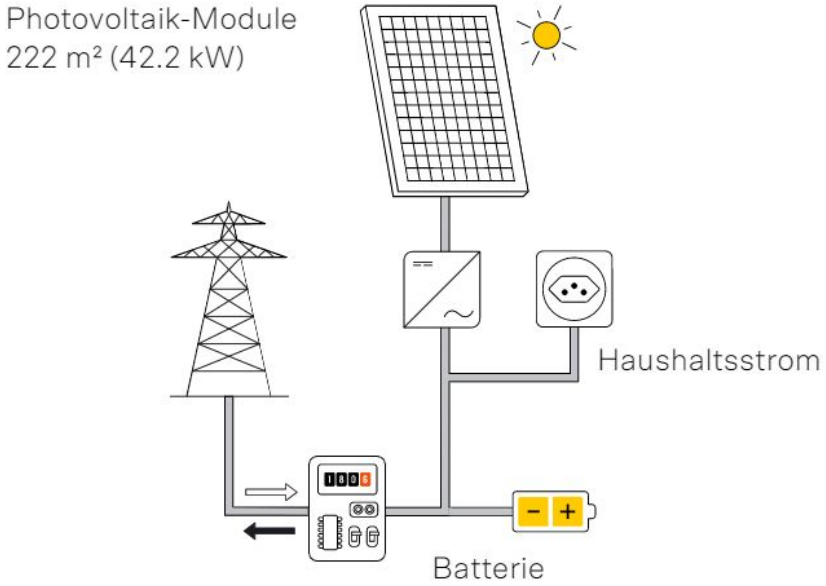


- No additional PV capacity (only existing)
- Heating from pellets changed to **air-water heat pump** (solar thermal remaining)
- Additional electricity needs for the heat pump from the regional mix

PV and battery installation design

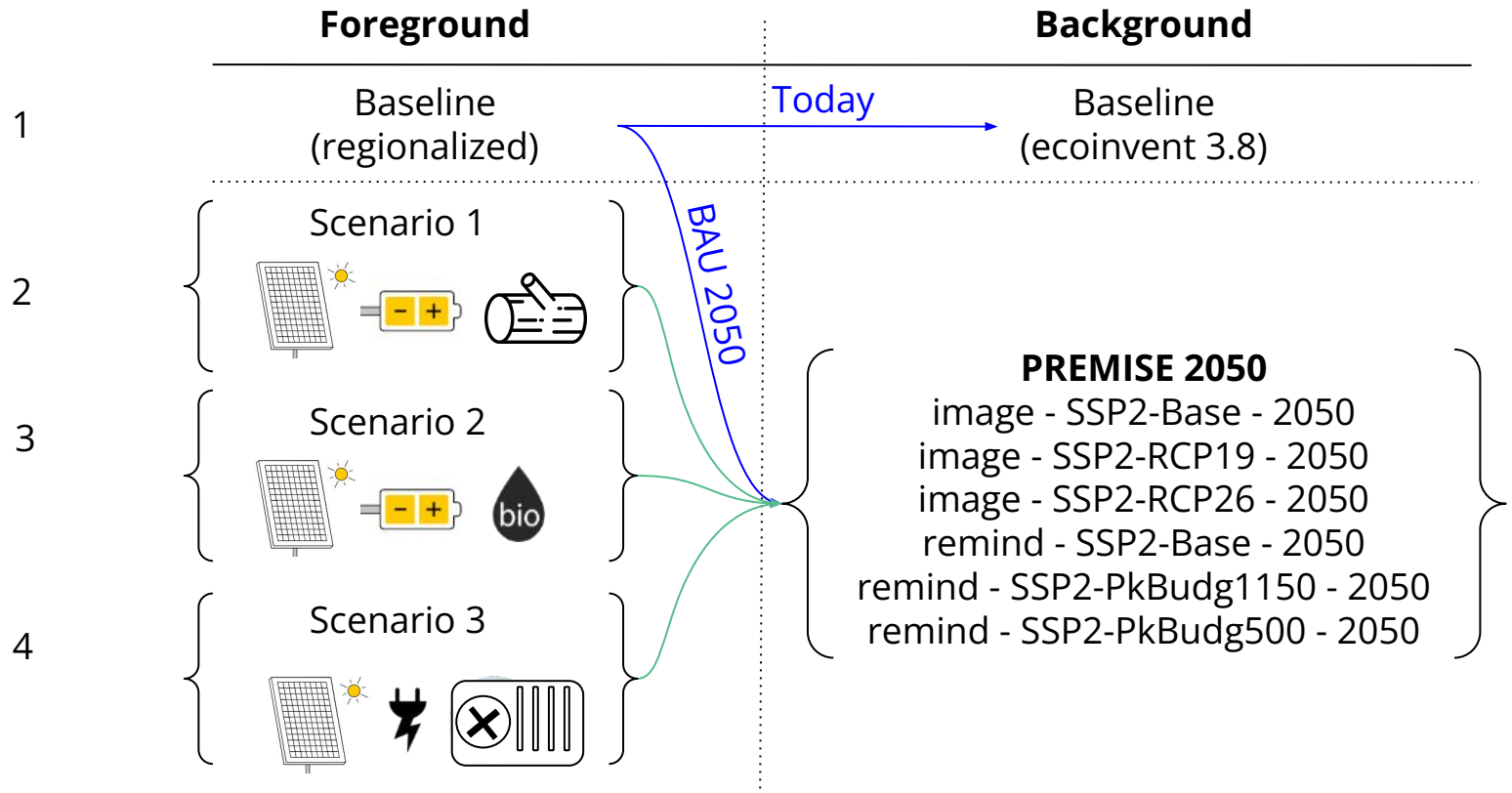


New installed capacity of 42,2 kWp + battery



https://www.energieschweiz.ch/tools/solarrechner

Foreground and background scenarios - overview



Parametrisation

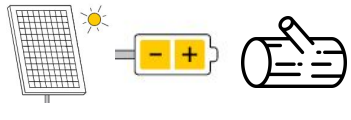
Technology	
Multi-Si PV	use virgin material vs. recycled material
Sodium-ion battery	new battery vs. reuse vehicle battery

Results

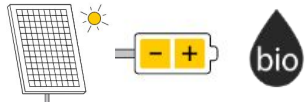
Sc_number:

1 Baseline

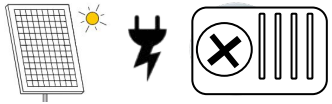
2 Scenario 1



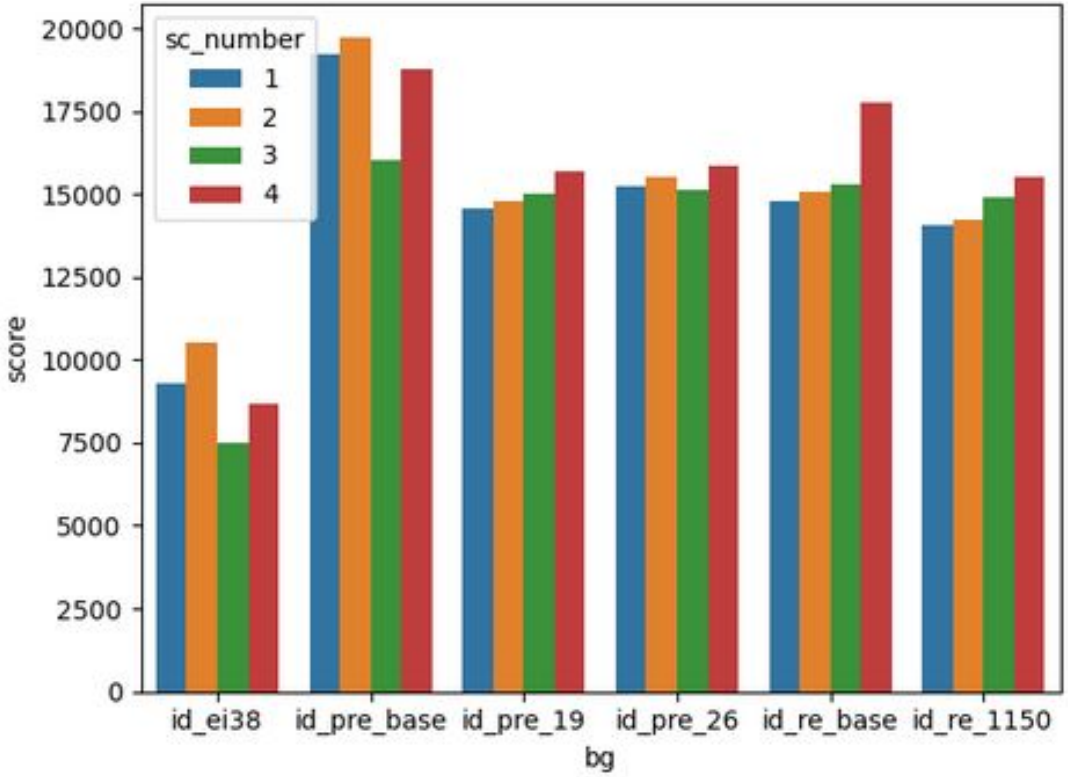
3 Scenario 2



4 Scenario 3



```
sce_names_dict={
    "id_ei38":"ei 3.8 cutoff",
    "id_pre_base":"EI 3.8 cutoff image SSP2-Base 2050",
    "id_pre_19":"EI 3.8 cutoff image SSP2-RCP19 2050",
    "id_pre_26":"EI 3.8 cutoff image SSP2-RCP26 2050",
    "id_re_base":"EI 3.8 cutoff remind SSP2-Base 2050",
    "id_re_1150":"EI 3.8 cutoff remind SSP2-PkBudg1150 2050",
    "id_re_1150":"EI 3.8 cutoff remind SSP2-PkBudg500 2050"
    }
```



Technical learnings

BW2.5 logic :

- Datapackages
- Regionalization

PREMISE:

- Impact categories
  - climate change ✓
  - land use ✓
  - energy use ✓
  - metals/minerals (✓) *conservative future projections*
- super_db != standard_db
  - only use for scenario LCA - not for standard lca

Premise + server + git

use bash terminal to move generated files

- scenario diff file, move to github folder in server

- bw project backups (not allowed on public github due to including ei 3.8)
  share via server

```
bw.backup_project_directory("moeschpond1")
```

```
Creating project backup archive - this could take a few minutes...
```

```
things=! ls ~/

! ls ~/
```

```
Autumn-School-2022
brightway2-project-moeschpond1-backup.26-October-2022-03-51PM.tar.gz
brightway2-project-moeschpond1-backup.26-October-2022-03-59PM.tar.gz
brightway2-project-moeschpond1-backup.27-October-2022-08-40AM.tar.gz
brightway2-project-moeschpond1-backup.27-October-2022-09-49AM.tar.gz
brightway2-project-moeschpond1-backup.27-October-2022-09-50AM.tar.gz
brightway2-project-moeschpond1-backup.27-October-2022-12-53PM.tar.gz
hybridization_data
moeschpond
pylcaio
scratch
Start-here.ipynb
teaching-material
```

```
#automatic update the string to the msot recent backup filename from above
backups = [key for key in things if key.startswith('brightway2-project-')]
backups.sort()#make sure they are sorted
backup=backups[-1]#take the last one
print(backup)
```

```
brightway2-project-moeschpond1-backup.27-October-2022-12-53PM.tar.gz
```

```
#DO NOT PUT ECOINVENT ON PUBLIC GITHUB
#copy the file to shared directory on server.
!cp ~/$backup /srv/scratch/u.2/
```

restore bw2 db in bw25

Cannot restore bw2 project in bw25 notebook

gives no errors; restores with 0 db’s

need to restore project from a separate bw2 notebook,

then open project in bw25 notebook

useful stuff for datapackages

```python
def matrix_raw(object_dp):
    data, _ = object_dp.get_resource("energy_moeschberg_technosphere_matrix.data")
    indices, _ = object_dp.get_resource("energy_moeschberg_technosphere_matrix.indices")
    flip, _ = object_dp.get_resource("energy_moeschberg_technosphere_matrix.flip")
    unique_indices = set([a for b in indices for a in b])
    mapping_act=dict.fromkeys(int(i) for i in unique_indices) #json accepts only int not int32
    for i in unique_indices:
        mapping_act[i]=bd.get_activity(i)['name']
    rows = [tup[0] for tup in indices]
    cols = [tup[1] for tup in indices]

    import pandas as pd
    matrix_raw = pd.DataFrame({"row":rows,
                               "col":cols,
                               "from":[mapping_act[idx] for idx in rows],
                               "to":[mapping_act[idx] for idx in cols],
                               "data":data
                              })
    matrix = matrix_raw.pivot(index='row',columns='
    return matrix_raw
```

	row	col	from	to	data
0	6599	213979	electricity production, hydro, run-of-river	electricity supply, Energie Grosshoechstetten ...	0.907000
1	6599	213980	electricity production, hydro, run-of-river	electricity, subsidised, 2021	0.320000
2	8302	213981	operation, solar collector system, Cu flat pla...	heat supply, Hotel Moeschberg, 2021	0.004668
3	9036	213981	heat production, air-water heat pump 10kW	heat supply, Hotel Moeschberg, 2021	0.000000
4	10319	213980	electricity production, wind, 1-3MW turbine, o...	electricity, subsidised, 2021	0.020000
5	18352	213978	electricity production, photovoltaic, 3kWp sla...	electricity supply, Hotel Moeschberg, 2021	0.440600
6	18352	213979	electricity production, photovoltaic, 3kWp sla...	electricity supply, Energie Grosshoechstetten ...	0.026000

useful stuff for datapackages

```
def create_scenario_ids_df(sce_names_dict):
        for idx, row in df.iterrows():
    act_name = row["name"]
    act_location = row["location"]
    act_ref = row["reference product"]
    row_for_df = {"name":row["name"]}

    for name_short, name_long in sce_names_dict.items():
        try:
            act_bg_id = bd.get_activity(database = name_long,
                                        name=act_name,
                                        location=act_location,
                                        product = act_ref).id
        except:
            act_bg_id =row["id"]
        row_for_df[name_short] = act_bg_id

    id_all.append(row_for_df)
    scenarios_ids=pd.DataFrame(id_all)
    scenarios_ids = scenarios_ids.set_index("id_ei38", drop=False)

    return scenarios_ids
```

id_ei38	name	id_ei38	id_pre_base	id_pre_19	id_pre_26	id_re_base	id_re_1150
6599	electricity production, hydro, run-of-river	6599	92881	140945	116913	164977	209765
9036	heat production, air-water heat pump 10kW	9036	75509	123573	99541	147605	192393
8302	operation, solar collector system, Cu flat pla...	8302	89605	137669	113637	161701	206489
10319	electricity production, wind, 1-3MW turbine, o...	10319	91387	139451	115419	163483	208271
18352	electricity production, photovoltaic, 3kWp sla...	18352	92843	140907	116875	164939	209727
20079	heat and power co-generation, wood chips, 6667...	20079	89007	137071	113039	161103	205891
21426	heat production, biomethane, at boiler condens...	21426	91631	139695	115663	163727	208515
23758	heat production, wood pellet, at furnace 25kW,...	23758	87162	135226	111194	159258	204046
213978	electricity supply, Hotel Moeschberg, 2021	213978	213978	213978	213978	213978	213978
213979	electricity supply, Energie Grosshoechstetten ...	213979	213979	213979	213979	213979	213979
213980	electricity, subsidised, 2021	213980	213980	213980	213980	213980	213980
213981	heat supply, Hotel Moeschberg, 2021	213981	213981	213981	213981	213981	213981
213982	energy demand, operational, Hotel Moeschberg	213982	213982	213982	213982	213982	213982

Other learnings

Jupyter + GitHub + server

Interfacing challenge

Ceremonial follow-up on milestones

split work in smaller groups

parallel work with frequent discussions across

Iterations with placeholders

adapt scope/ambition continuously

Autumn school feedback

Good social facilitation & vibes

Good help from instructors

(Too?) many high level classes in short time

Wonderful location

Long days is great for project work - but tough for classes

Thank you!

Regionalization

Storyline:

This is the baseline mix with the wood pellets from RER as available in ei38cutoff.

→ We regionalise and take the wood pellets from CH (because they were the most contributor to CC from the contribution analysis). What did change?

-> Then we apply the prospective background database

-> Then we use different technology mixes for the foreground using the prospective backgrounds