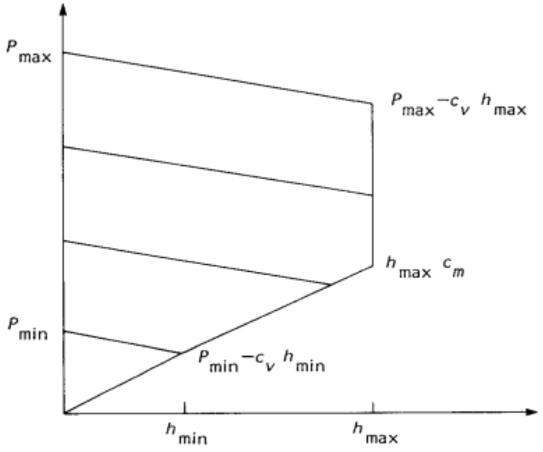
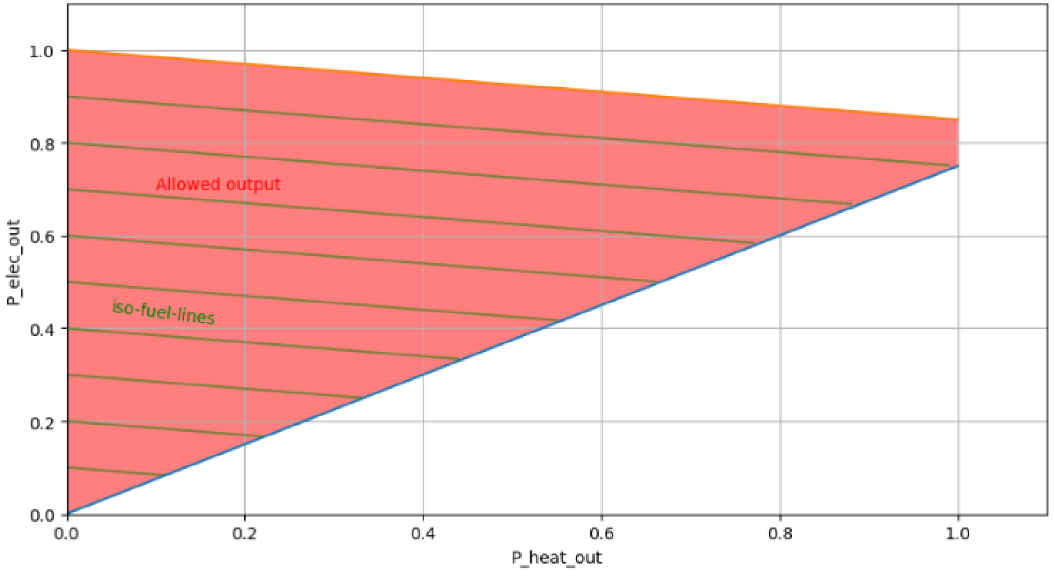
PyPSA-Eur version

Modelling CHP within a national power system, Grohnheit 1993

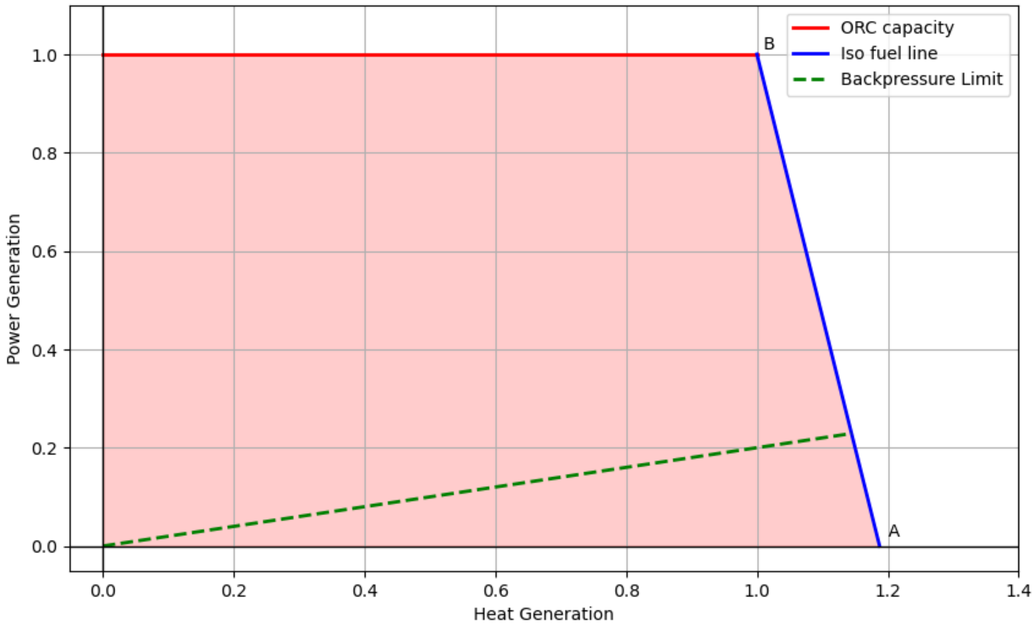


Problem: In the EGS case, peak electricity generation produces waste heat that still has utility for DH. Hence, the line starting at (0., 1.) being sloped is not appropriate: 100% electricity generation should still allow some DH generation.

https://pypsa.readthedocs.io/en/latest/examples/power-to-gas-boiler-chp.html



Proposal



Point **B:**
Maximum electricity generation, maximum heat generation with the assumed efficiencies: $\eta_{el} = 10\%$ for electricity, $\eta_{dh} = 80\%$ for district heat from waste heat.

Let η_{direct} be the efficiency of using the geothermal heat directly from the well for district heating, skipping the generation of electricity.

Point **A:**
Electricity generation is skipped, resulting in an efficiency gain and
p_max_pu = $\eta_{direct} / \eta_{dh}$

If the backpressure limit is included, the feasible region is shrunk.

Question: What are realistic values for η_{direct}, and how does it depend on well temperature?

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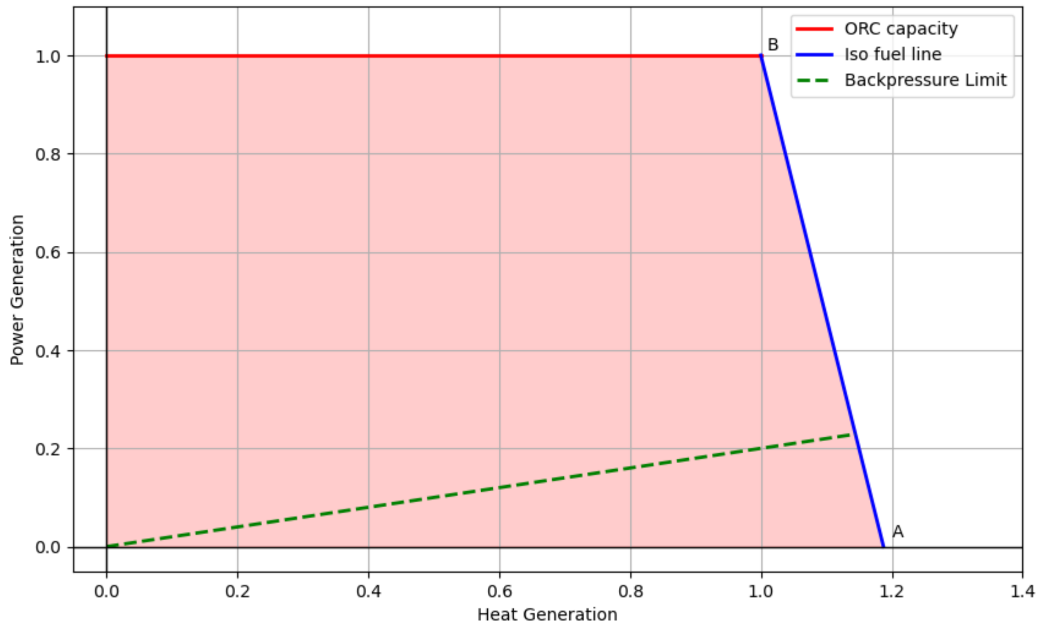

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Implementation

```
eta = eta_direct / eta_dh

n.add(
    "Link",
    "geothermal CHP electricity",
    bus0='geothermal well',
    bus1='AC bus',
    efficiency=eta_el * (1. + eta),
    capital_cost=el_capital_cost * eta_el,
    p_max_pu=0.5,
)
n.add(
    "Link",
    "geothermal CHP district heat",
    bus0='geothermal well',
    bus1='DH bus',
    efficiency=eta_dh * (1 + eta),
    capital_cost=dh_capital_cost * eta_dh,
    p_max_pu=eta / 2.,
)

# Plus additional constraints

# 1. p_nom of both links equal                                          -> CHP operation
# 2. p_el > alpha p_dh                                                  -> backpressure limit
# 3. p_el = p_nom * (eta_direct - (p_dh / p_nom)) / (eta_direct - 1)    -> iso fuel

# recall p_nom = p_nom_el = p_nom_dh
```

Notes:

The scaling factor ensures that the continuity at the geothermal well is satisfied despite ‘doubly using’ the heat compared to the *Multilink* setup. In the plot this factor is approximately 1 + 1.19 (i.e. *1 +* η in the code snippet).