SIMULATION MODEL FOR RENEWABLE ENERGY SYSTEMS IN LIVESTOCK BARNS

three case studies

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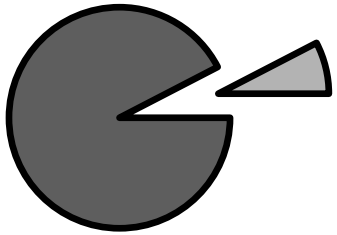
75th EAAP Annual Meeting

Monday 23 September 2024

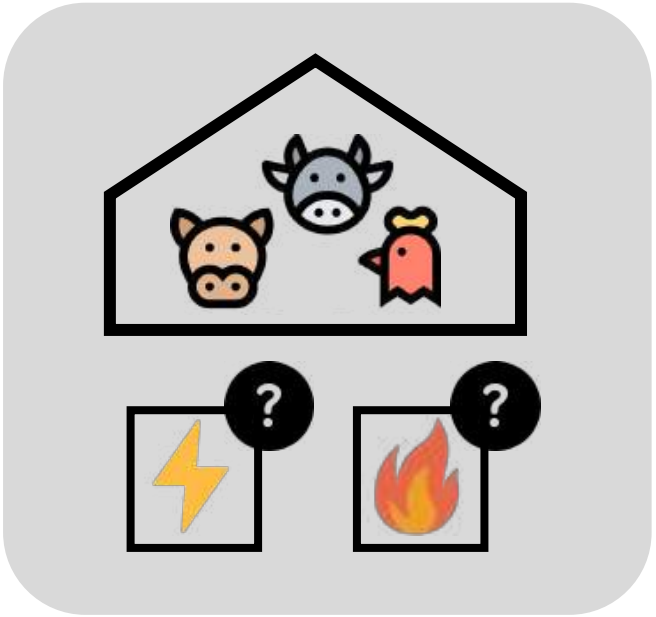
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000785

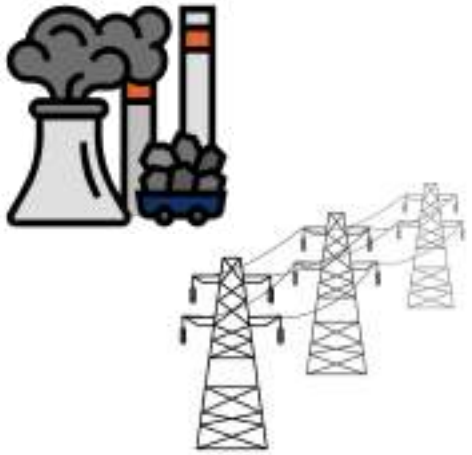
ENERGY PROVISION IN LIVESTOCK FARMS



7.6% of GHG emissions are from on-farm energy use

4% from renewable sources





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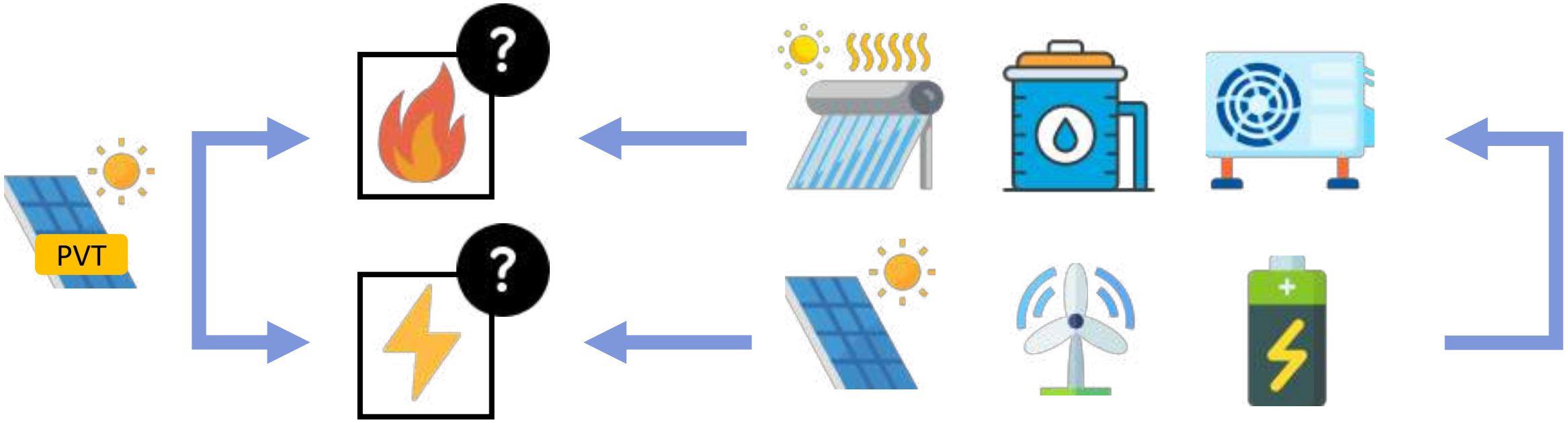
SATISFY THESE ENERGY DEMANDS RENEWABLY



RES4LIVE ENERGY SMART LIVESTOCK FARMING TOWARDS ZERO FOSSIL FUEL CONSUMPTION
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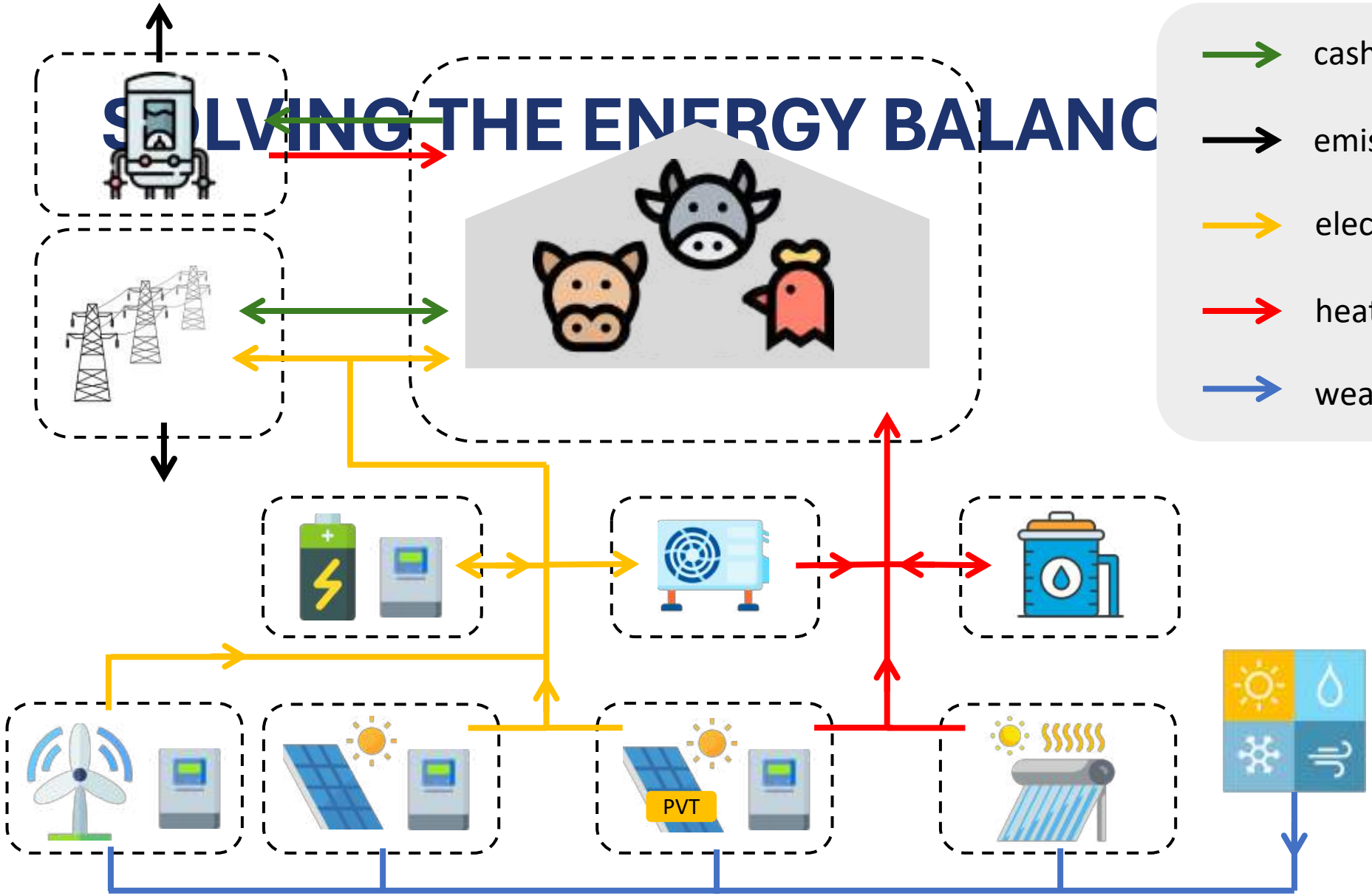
SOLVING THE ENERGY BALANCE



- cash flows [€/h]
- emission flows [kg CO2-eq./h]
- electricity flows [Wh/h]
- heat flows [Wh/h]
- weather data

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CREATING THE DESIGN SPACE

60 000 possible scenarios

Exclude options containing storage without renewables (not practical)

57 928 calculations

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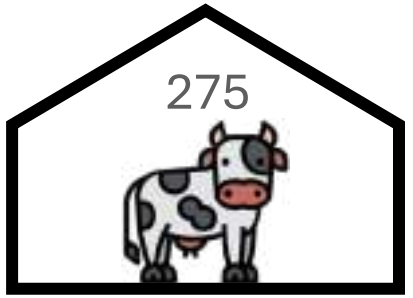
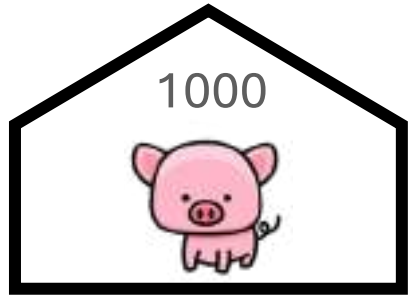
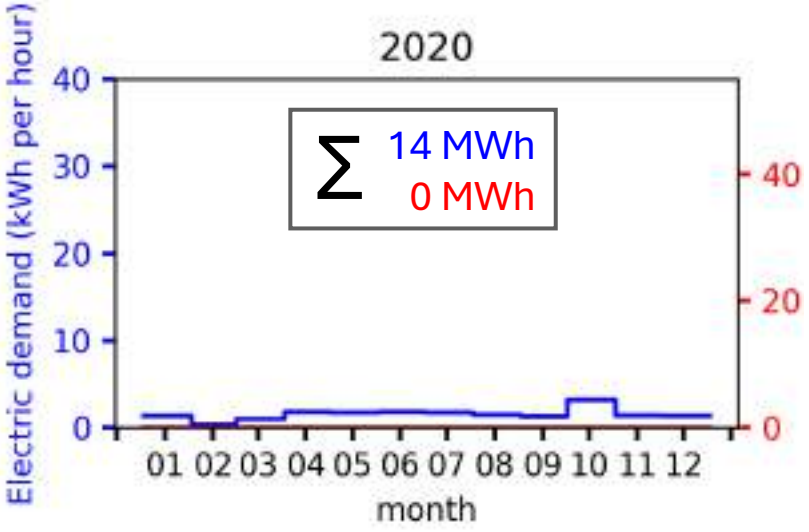
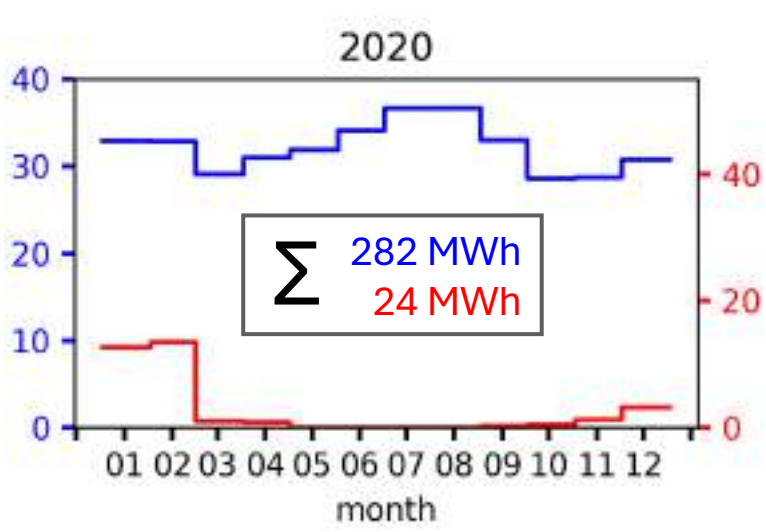
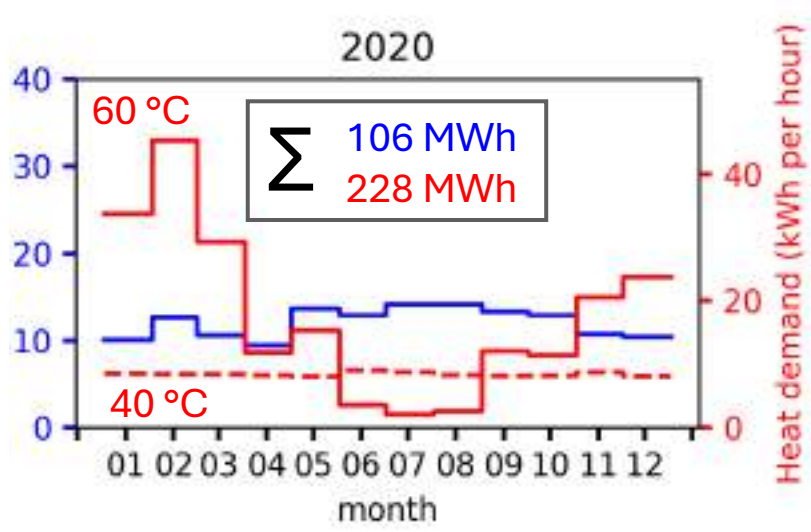
INPUTS FOR THE FARMS











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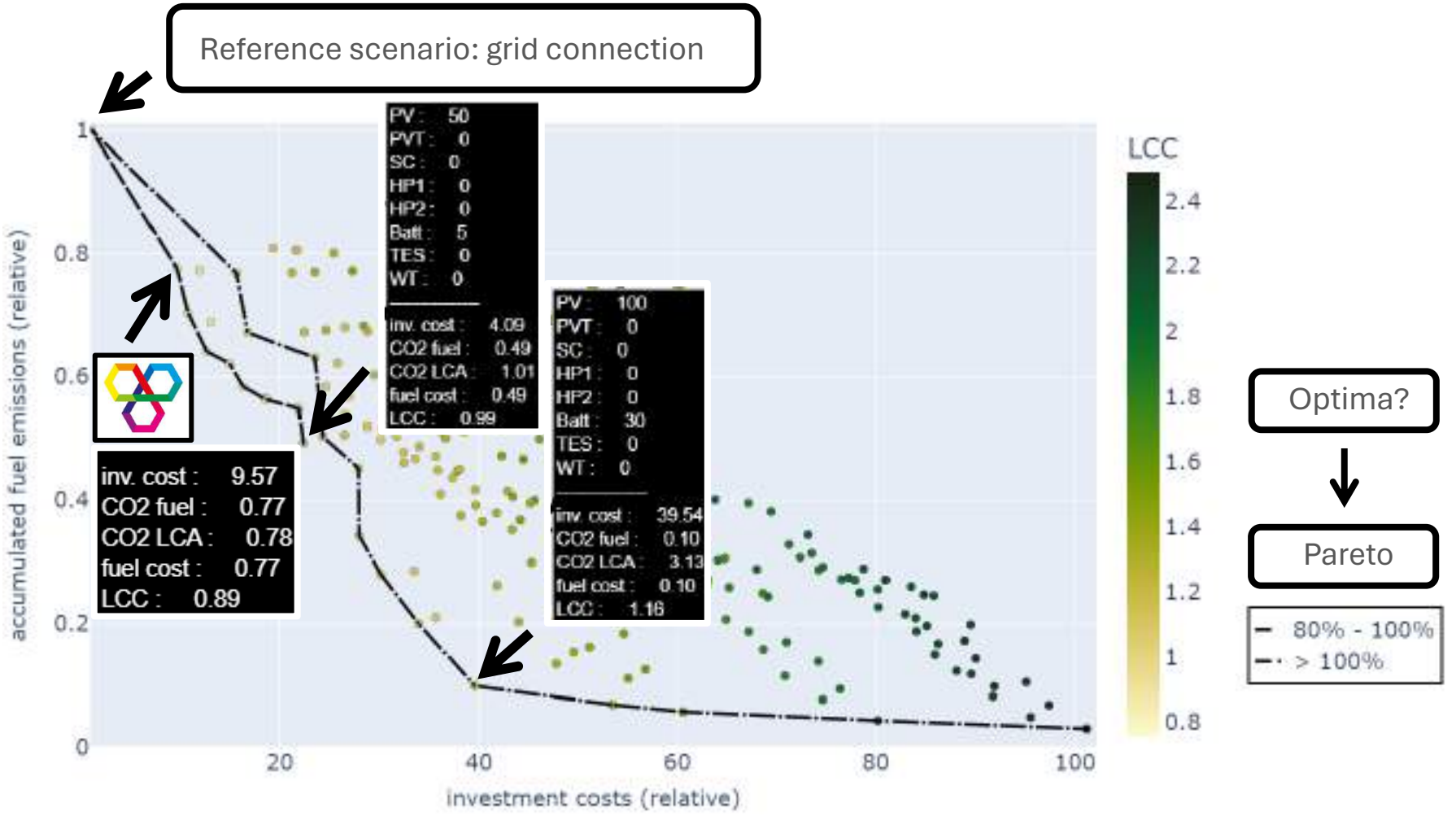
RESULTS FOR AUA CHICKEN FARM



Let's simulate...

PV: [0, 10, 15, 25, 50, 100]

SC: [0]

PVT: [0]

WT: [0, 5, 10, 30, 60]

HP: [0]

BAT: [0, 1, 5, 15, 20, 30]

TES: [0]

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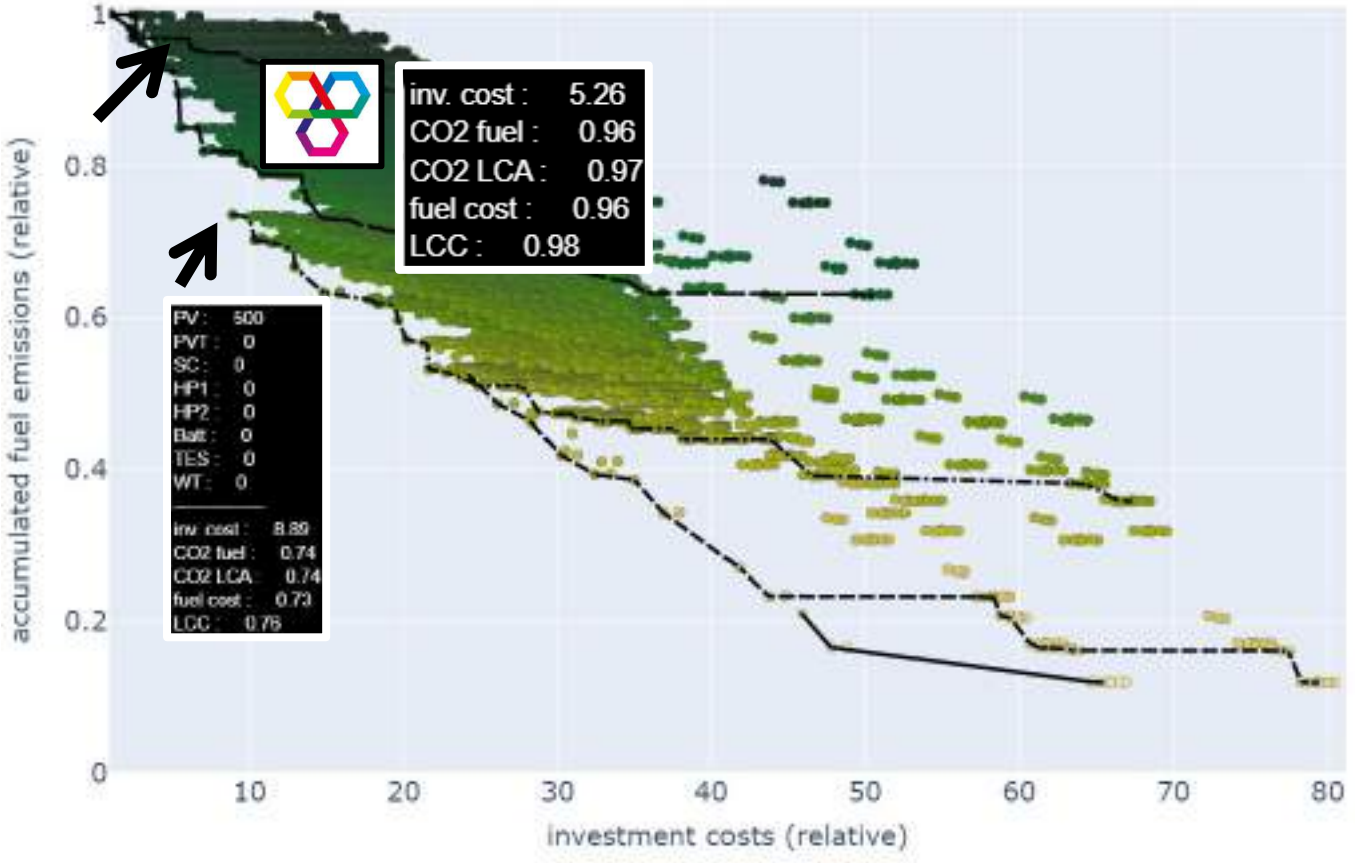
RESULTS FOR LVAT DAIRY FARM

Original installation: boiler on fuel oil (+ biomass)

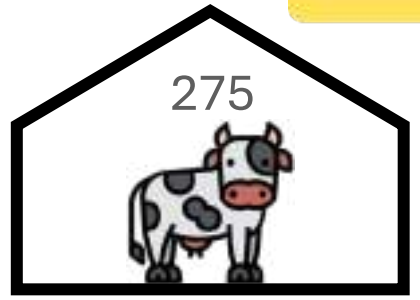


Optima?

↓

Pareto

- 20% - 40%
- 40% - 60%
- 60% - 80%
- 80% - 100%
- > 100%



Let's simulate…

PV: [0, 25, 50, 100, 200, 500, 1000]

SC: [0, 25, 50, 100, 200, 1000]

PVT: [0, 25, 50, 100, 200, 500]

WT: [0, 5, 10, 30, 60, 100]

HP: [0, 25, 35, 50, 60, 100]

BAT: [0, 5, 15, 30, 100, 500]

TES: [0, 250, 800, 1500, 5000]

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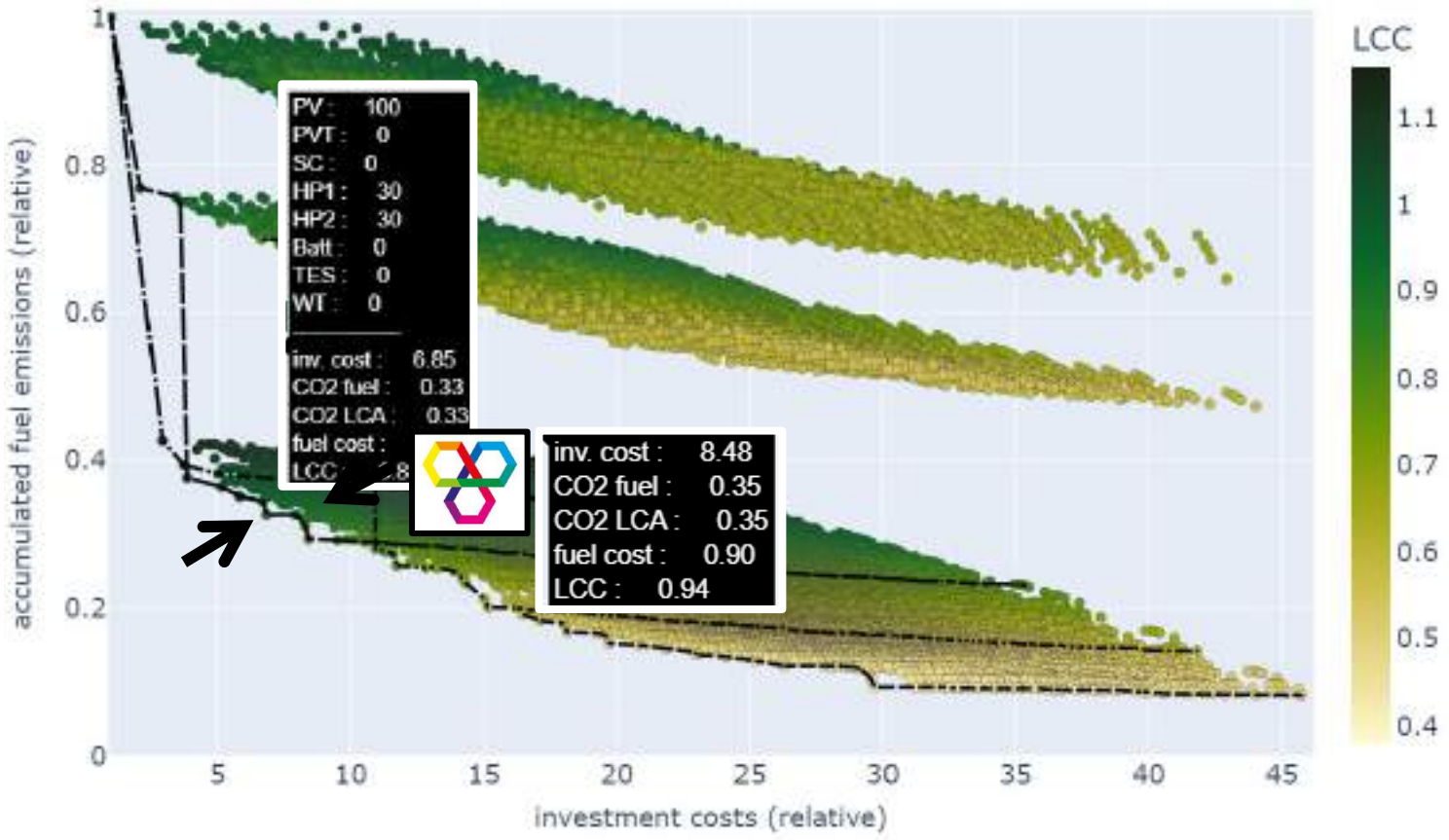
RESULTS FOR ILVO PIG FARM

Original installation: grid connection + natural gas boiler



Optima?

↓

Pareto

- - 40% - 60%
-·- 60% - 80%
— 80% - 100%
—·· > 100%

Let's simulate...

PV: [0, 25, 50, 100, 200, 500]

SC: [0, 25, 50, 100, 200]

PVT: [0, 25, 50, 100, 200]

WT: [0, 5, 10, 30, 60]

HP1: [0, 25, 35, 50, 60, 100]

HP2: [0, 30, 50, 60]

BAT: [0, 5, 15, 30, 100, 500]

TES: [0, 250, 800, 1500, 5000]

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CONCLUSIONS

- Zero fuel solutions rapidly increase investment cost → trade-off
- The new installations at AUA and ILVO should be beneficial for emission reductions and LCC, but come at an increased investment costs
- At LVAT, the potential of bioCNG was investigated

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THANKS FOR YOUR ATTENTION

RES4LIVE

ENERGY SMART LIVESTOCK FARMING
TOWARDS ZERO FOSSIL FUEL CONSUMPTION

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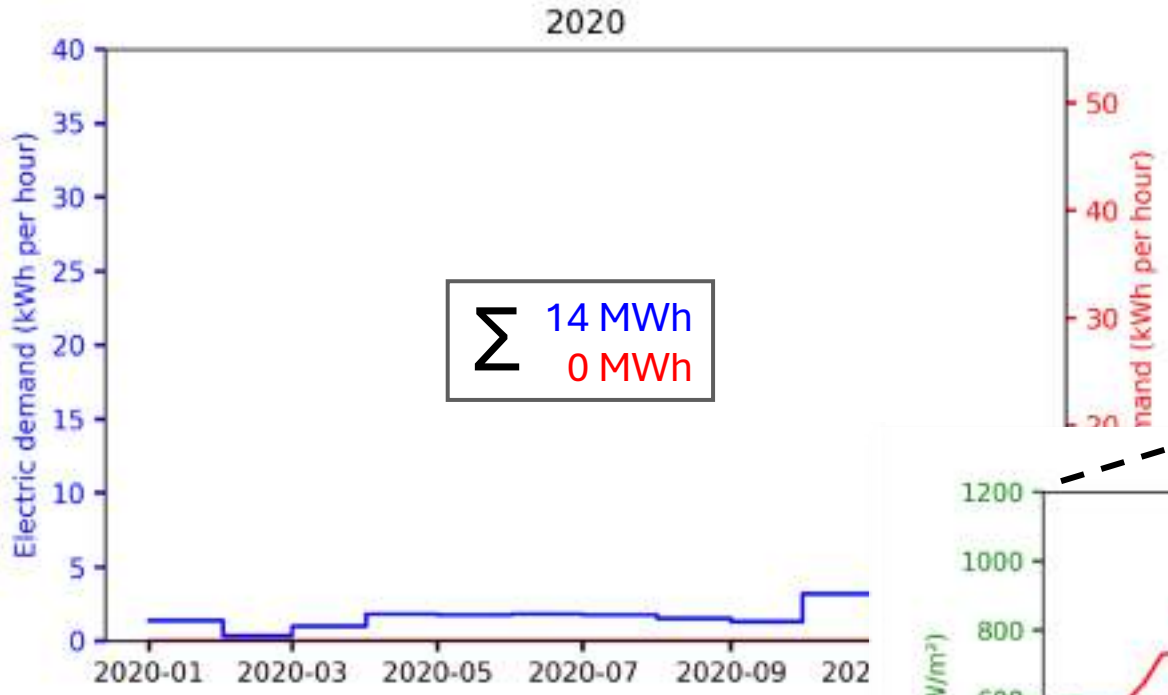
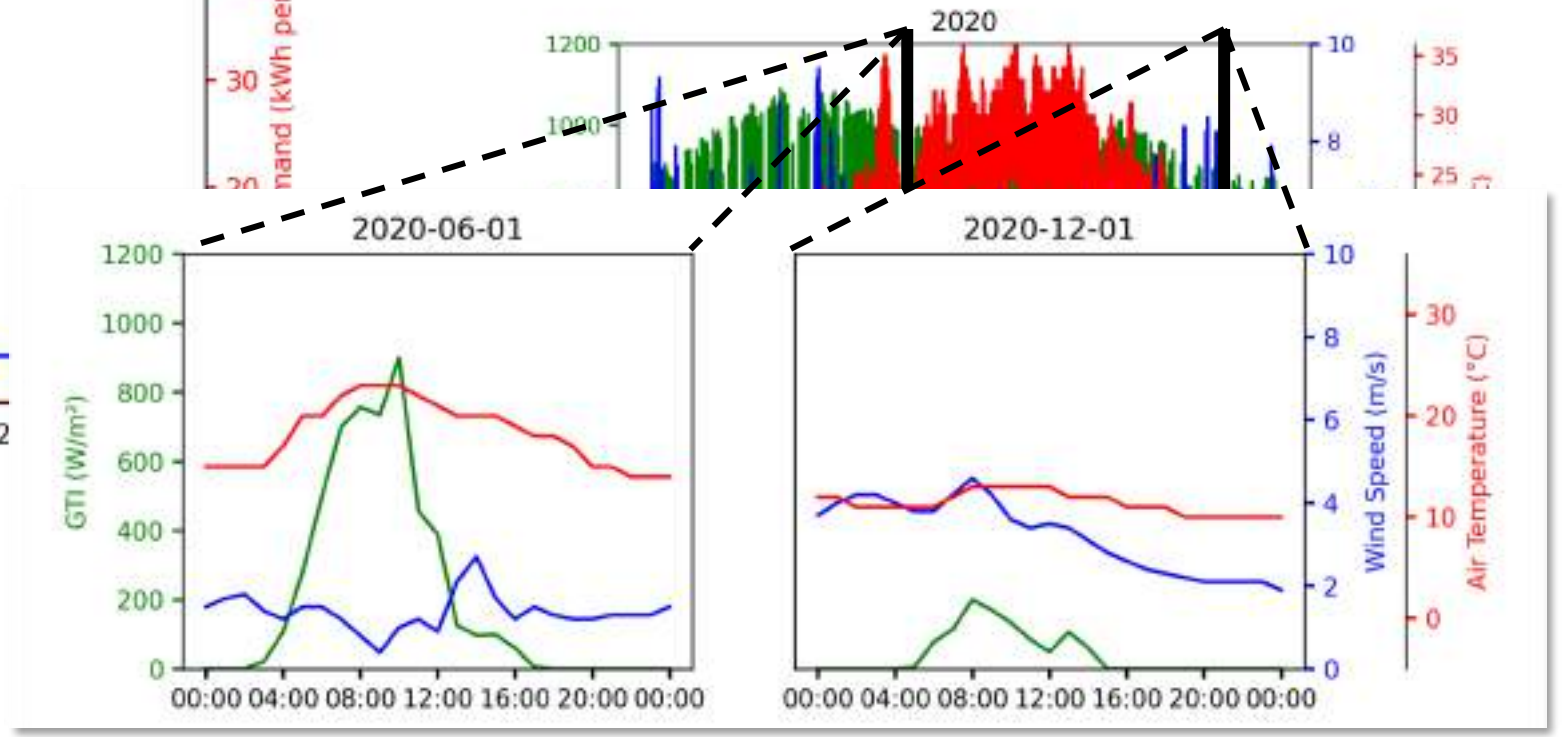
INPUTS FOR AUA CHICKEN FARM



Σ 14 MWh
0 MWh



€ 0.233
€ -

0.416 kg per kWh_{el}
- kg per kWh_{th}

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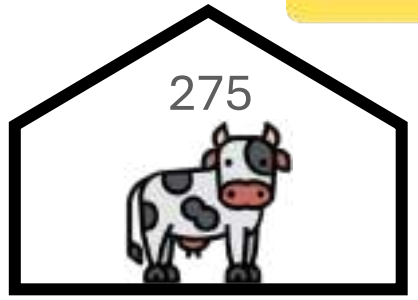

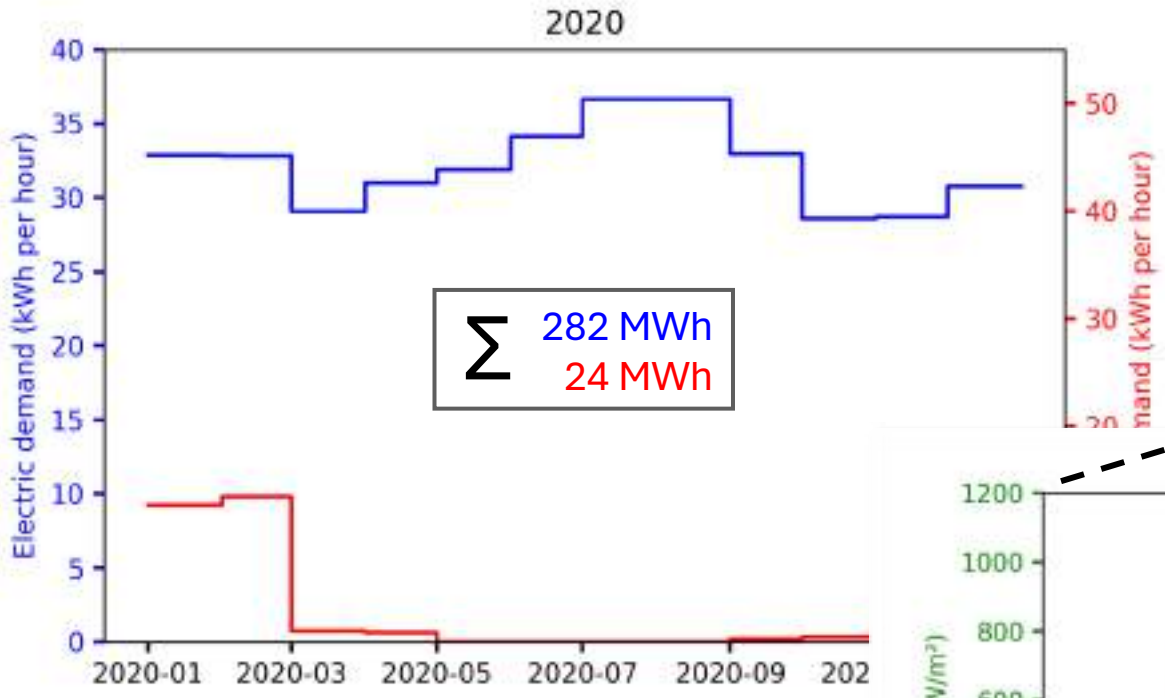

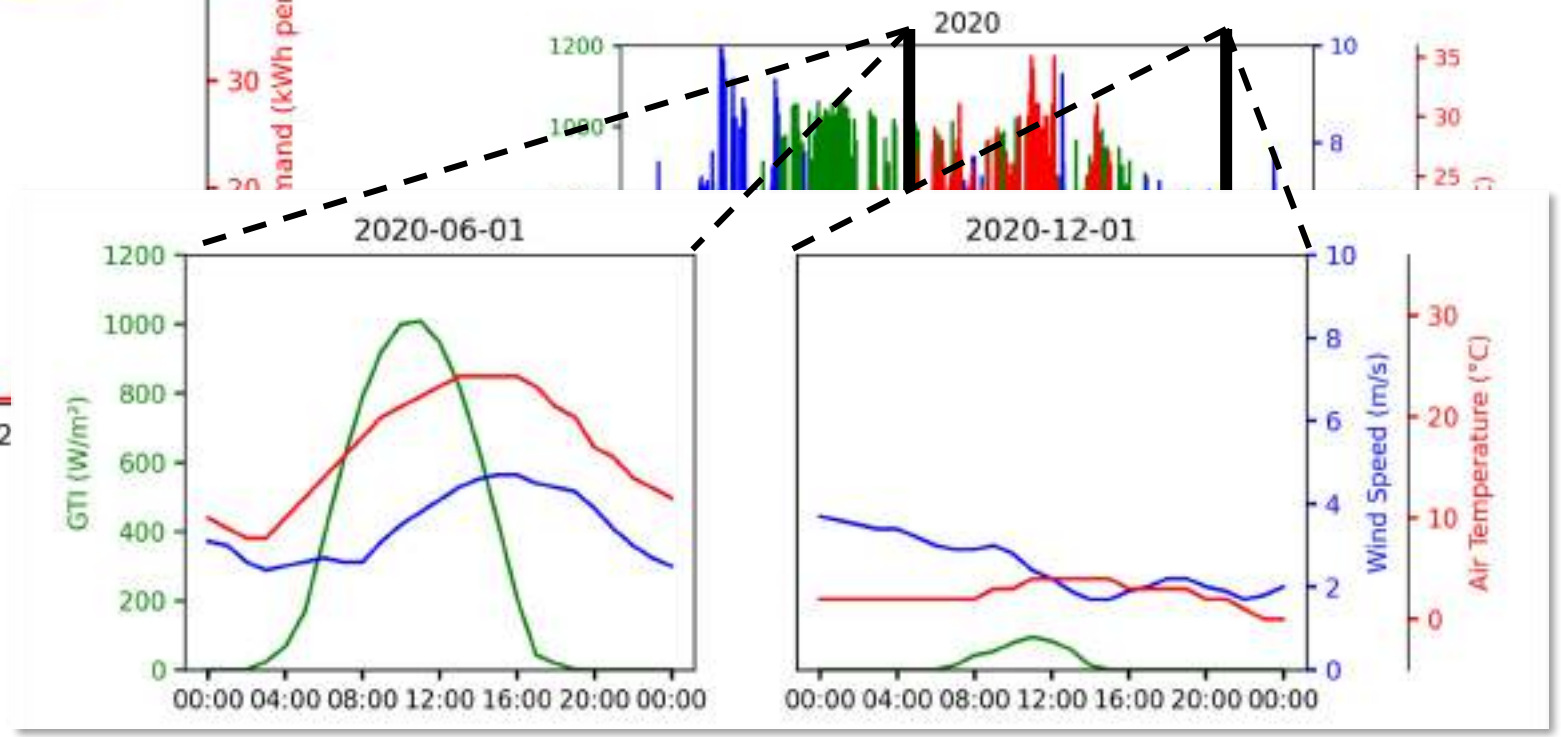

€ 0.4125
€ 0.1511

0.366 kg per kWh_{el}
0.213 kg per kWh_{th}

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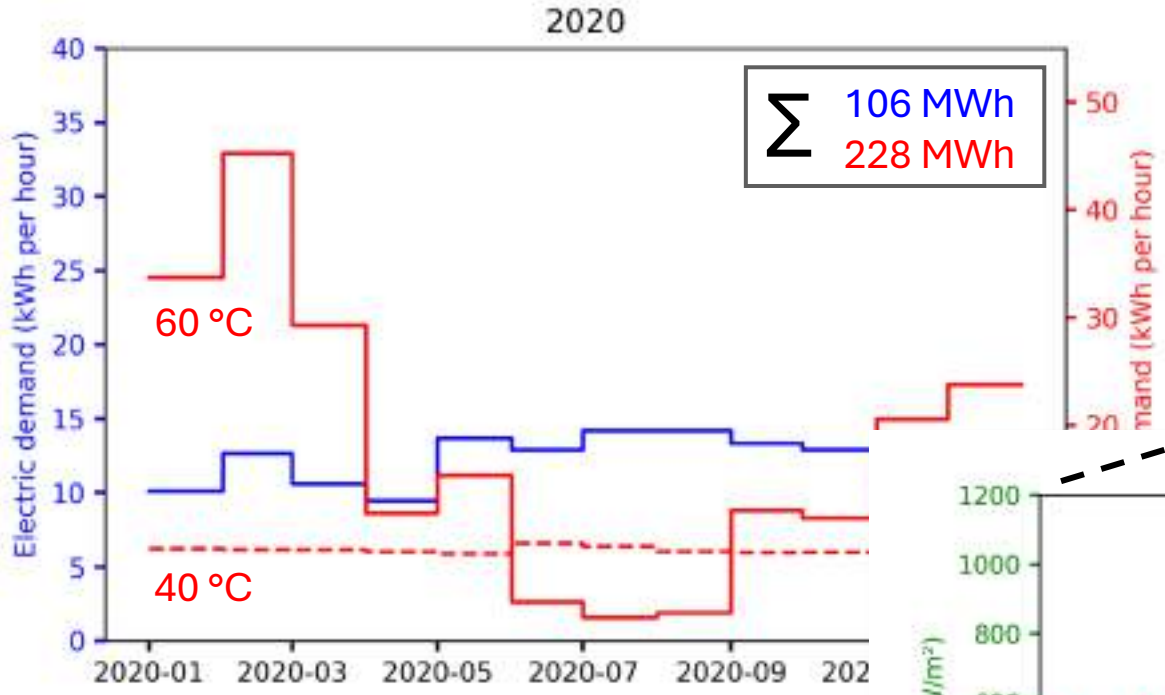
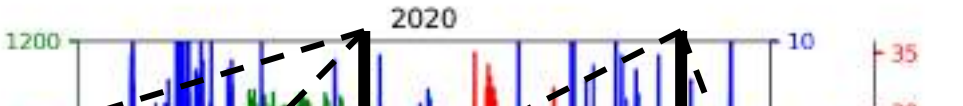
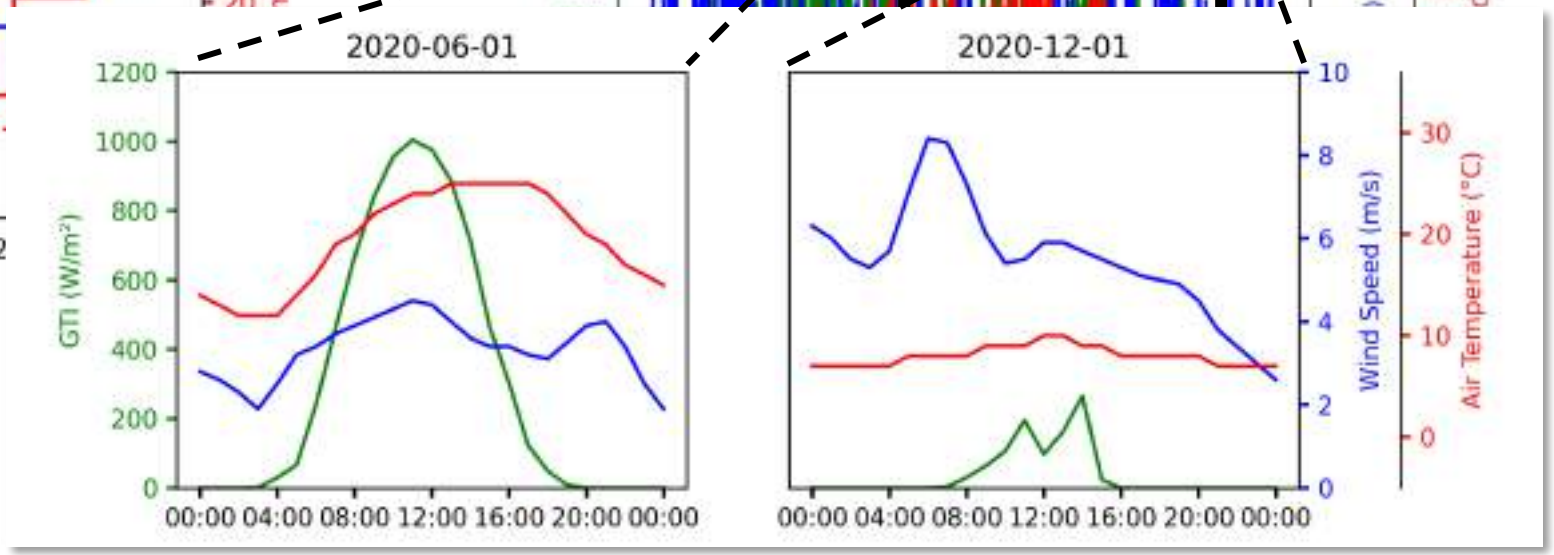
INPUTS FOR ILVO PIG FARM







€ 0.435

€ 0.115

0.145 kg per kWh_{el}

0.180 kg per kWh_{th}

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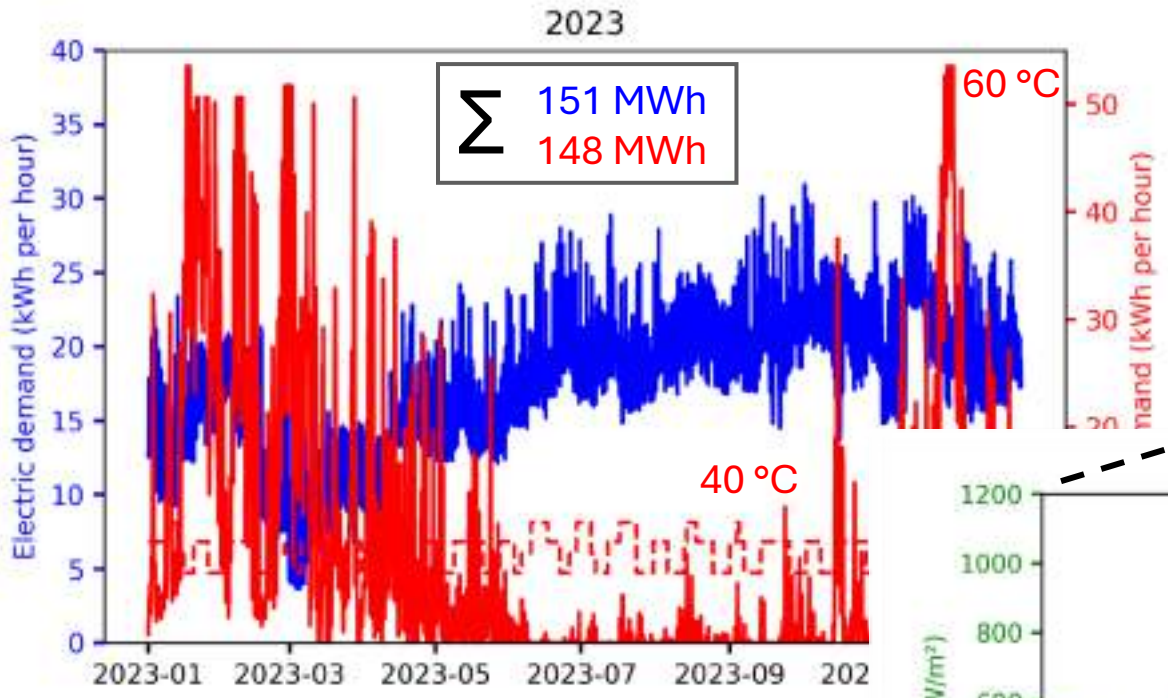
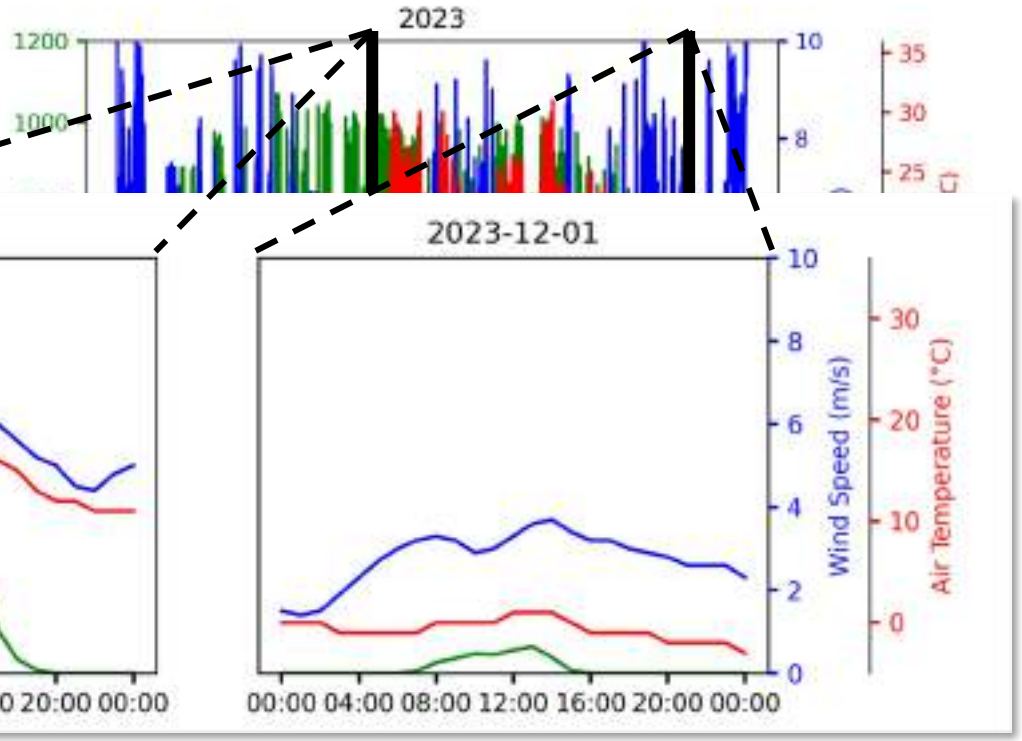
RECENT INPUTS FOR ILVO PIG FARM





€ 0.435
€ 0.115

0.145 kg per kWh_{el}
0.180 kg per kWh_{th}

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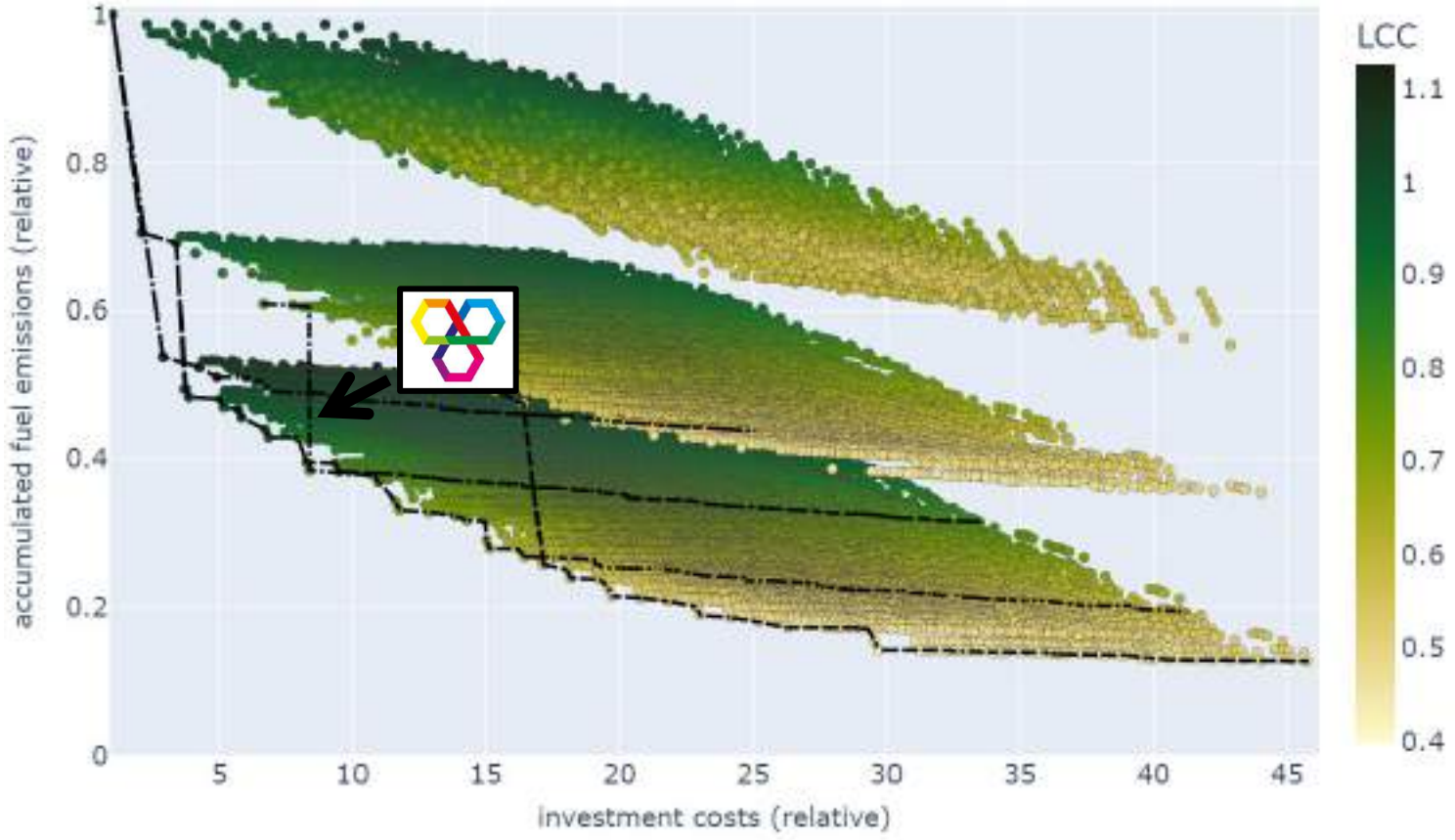
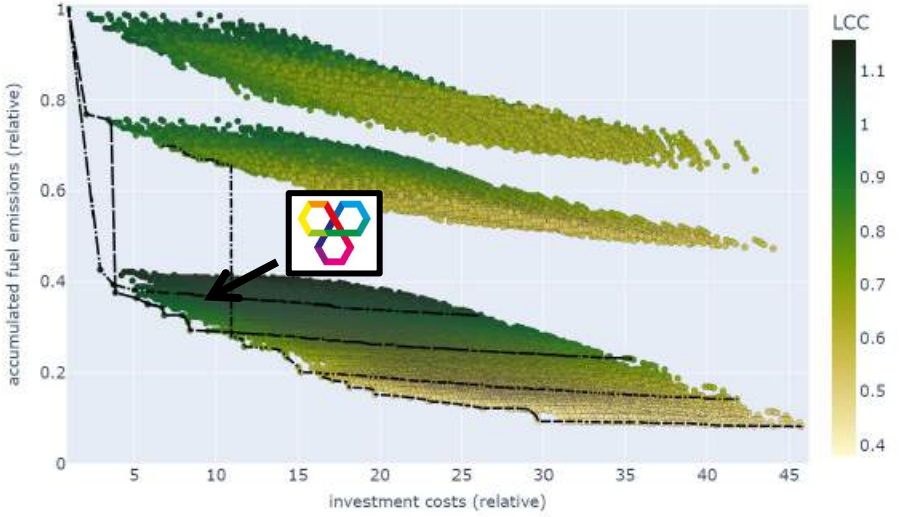
RECENT RESULTS FOR ILVO PIG FARM

2023



2020



- - 40% - 60%
-·- 60% - 80%
— 80% - 100%
-·· > 100%

Hourly fluctuations in the demand profiles have a significant influence on the pareto fronts

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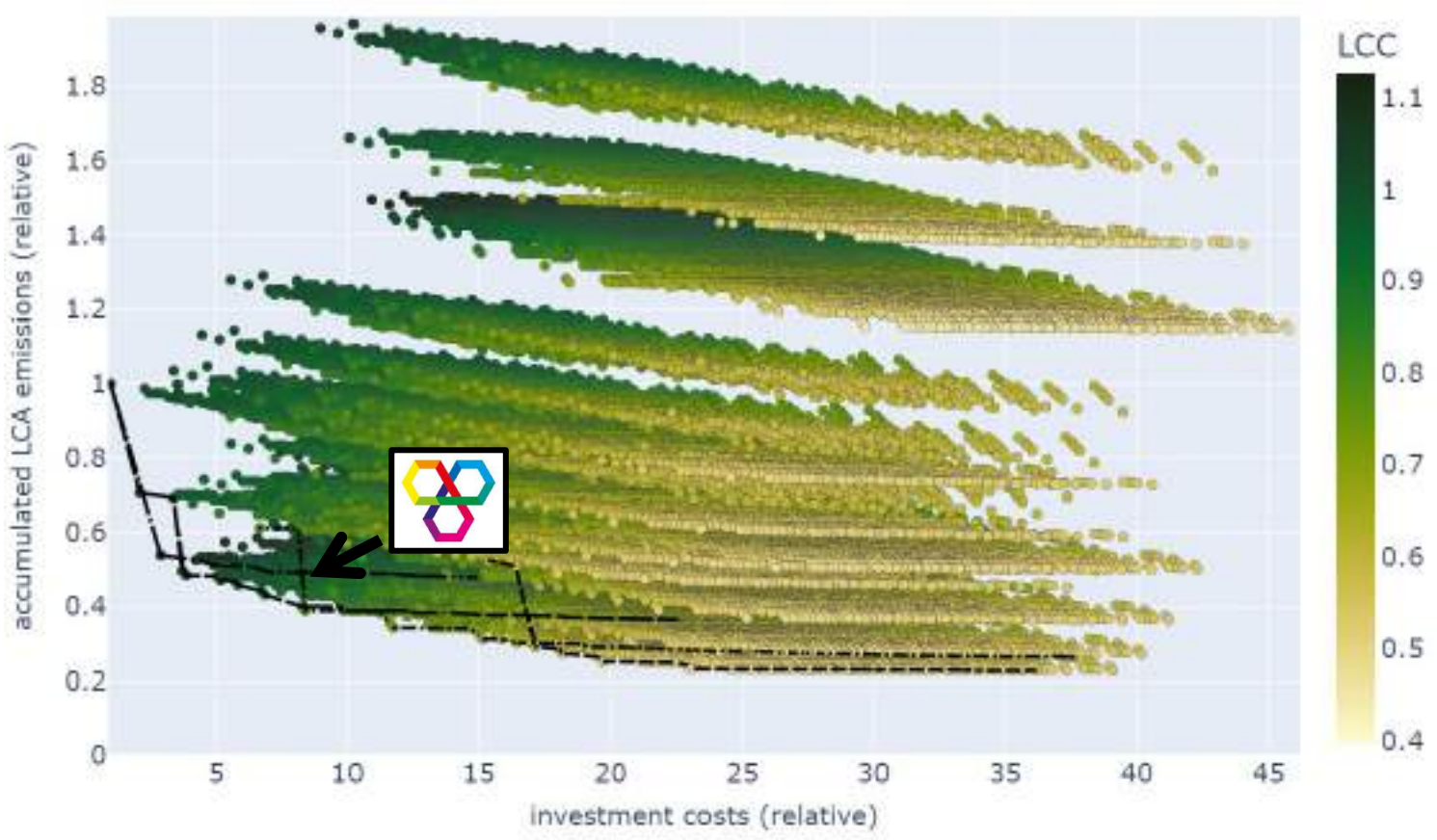
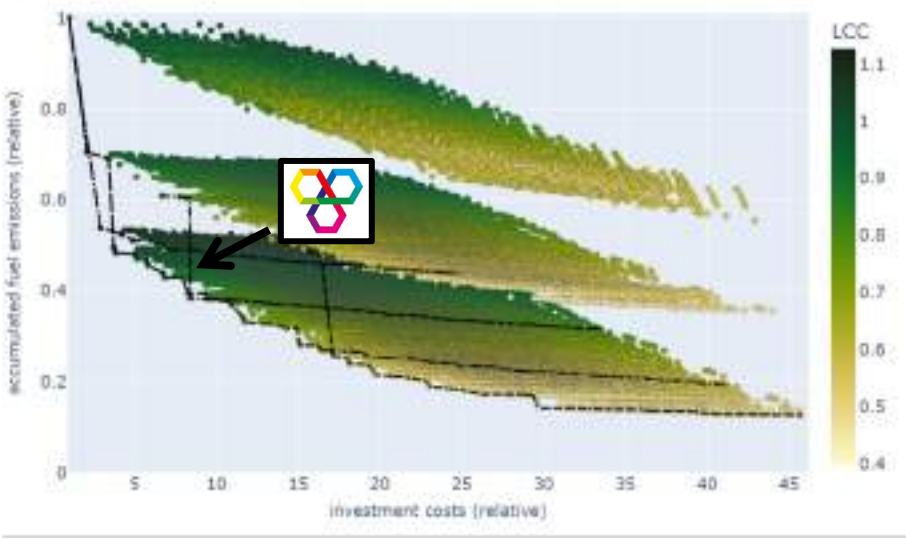
INFLUENCE OF LCA FOR ILVO PIG FARM

2023: including LCA



2023: no LCA



- - 40% - 60%
-·- 60% - 80%
— 80% - 100%
—·· > 100%

Influence of LCA is detrimental to scenarios with electrochemical batteries

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