SOLARX

WP4: Roadmap towards system integration and technology commercialization

Presented by Anders N. Andersen, ana@emd.dk, at the final SOLARX Workshop, which take place on Thursday, September 25th, from 14:00 to 16:00, at the SolarPaces conferences, Almeria

Dispatchable concentrated Solar-to-X energy solution for high penetration of renewable energy

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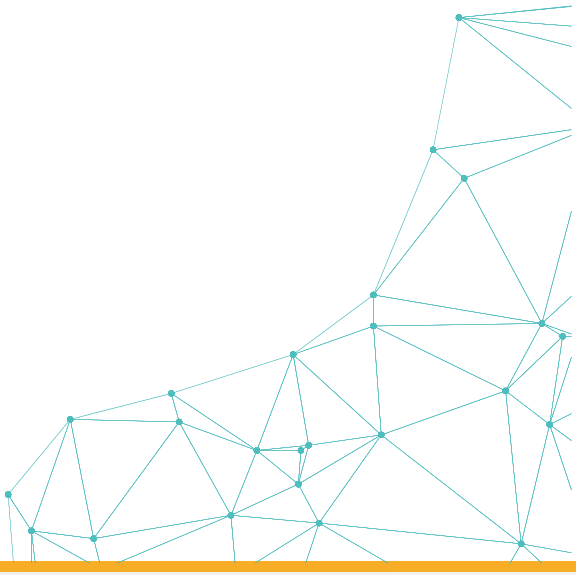
AGENDA for the presentation

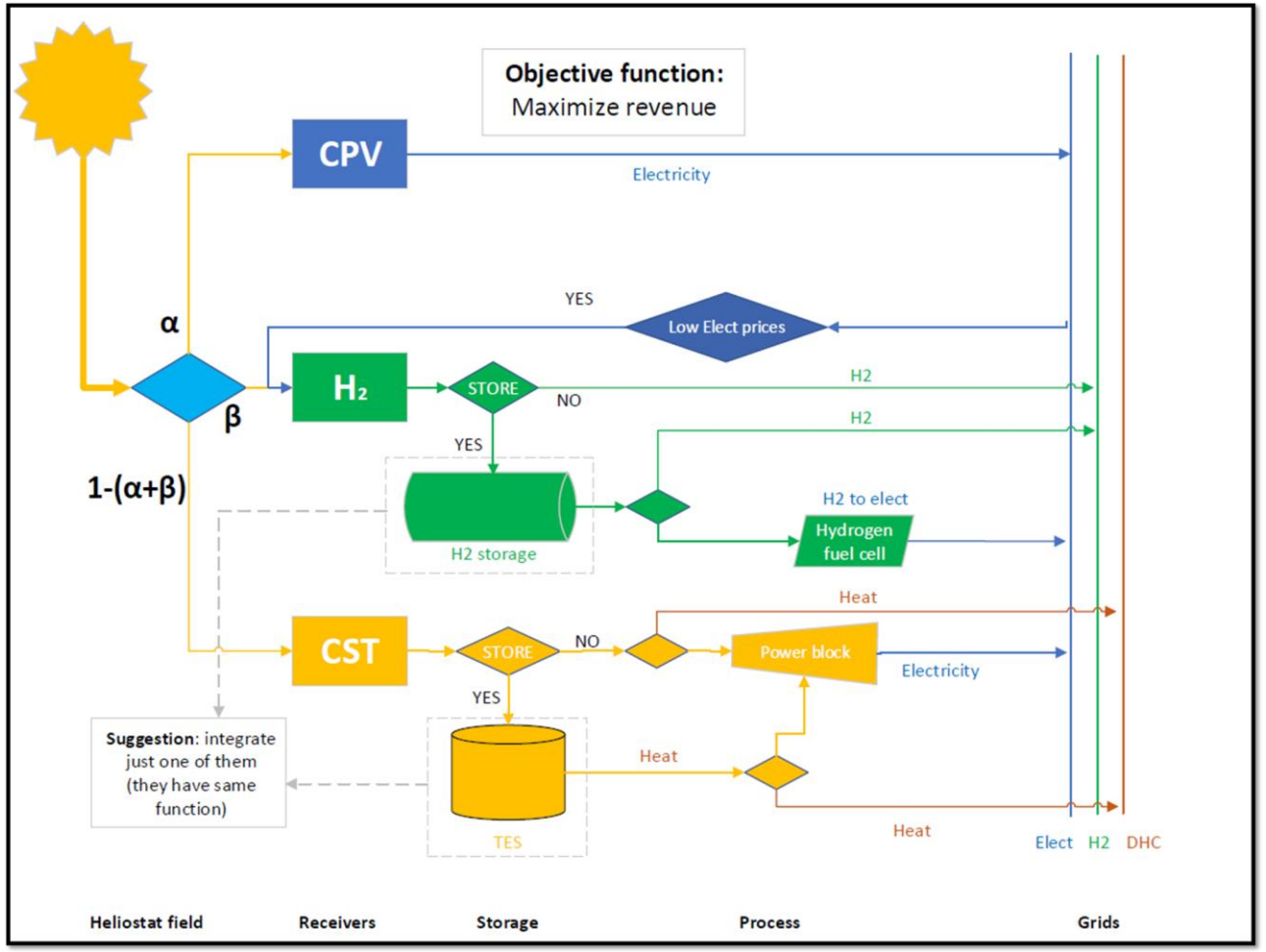
1. Solar Field is superior to PV for SHIP
2. Examples of multi-vector energy systems analysed in SOLARX
3. CPV & CST
4. CPV & CST receiver on both solar field and Electricity
5. CPV and H2 production
6. CPV and H2 production on both Solar Field and Electricity
7. Methanol production on syngases



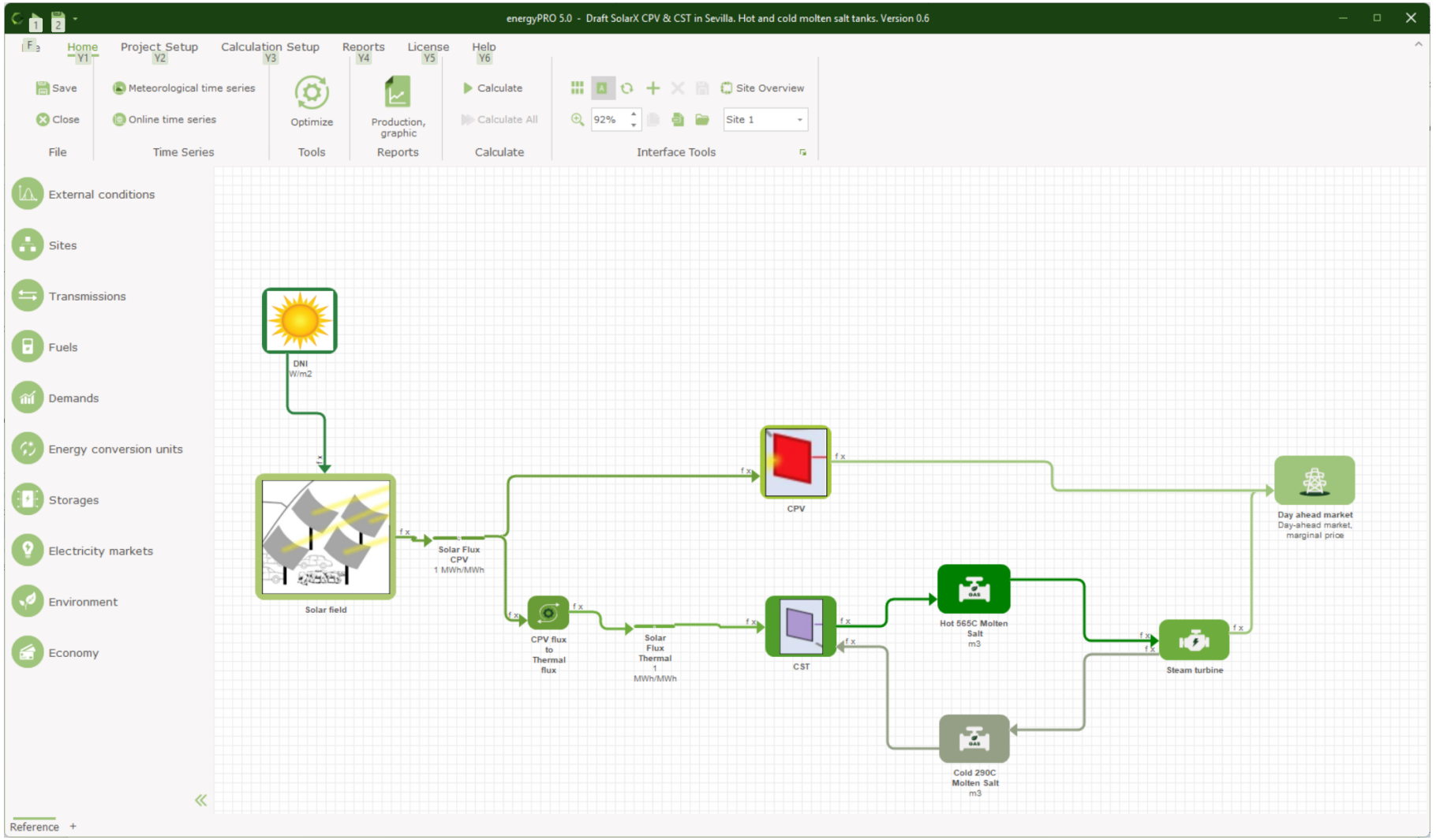
2 Solar Field is superior to PV for SHIP

Using the same area Solar Field will produce twice the amount of Solar Heat in Industrial Processes (SHIP) that could be generated by a PV-plant, where the produced electricity was converted to industrial high temperature heat in an electrical boiler (https://solarx-project.eu/news/2025/06/13/solarx-white-paper-published-pioneering-pathways-to-solar-to-x-energy-systems/).

Examples of multi-vector energy systems analysed in SOLARX

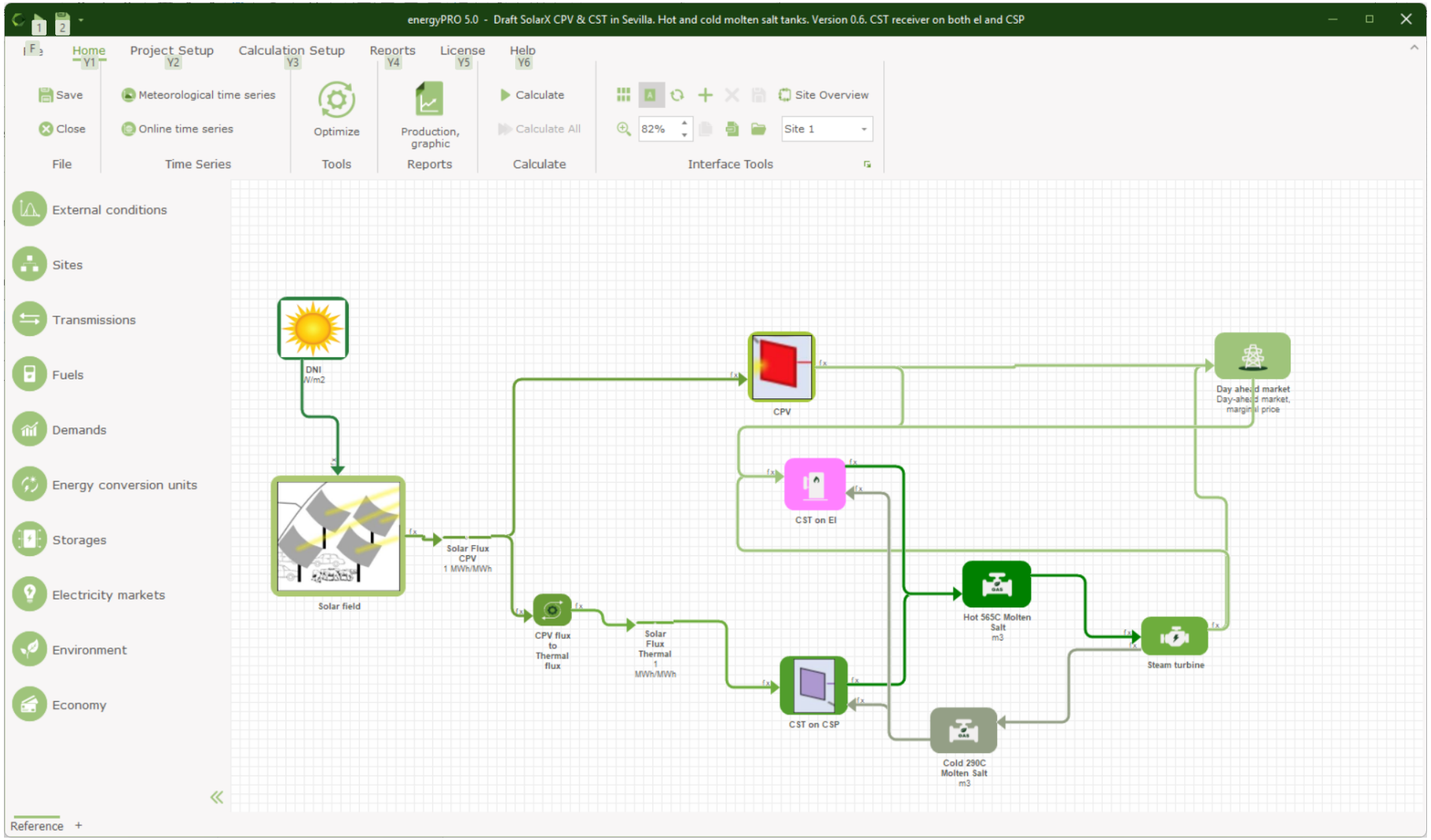


CPV & CST


energyPRO 5.0 - Draft SolarX CPV & CST in Sevilla. Hot and cold molten salt tanks. Version 0.6
Home
Project Setup
Calculation Setup
Reports
License
Help
Save
Close
Meteorological time series
Online time series
Optimize
Production, graphic
Calculate
Calculate All
Site Overview
92%
Site 1
File
Time Series
Tools
Reports
Calculate
Interface Tools
External conditions
Sites
Transmissions
Fuels
Demands
Energy conversion units
Storages
Electricity markets
Environment
Economy
DNI
W/m2
Solar field
Solar Flux CPV
1 MWh/MWh
CPV
CPV flux to Thermal flux
Solar Flux Thermal
1 MWh/MWh
CST
Hot 565C Molten Salt
m3
Cold 290C Molten Salt
m3
Steam turbine
Day ahead market
Day-ahead market, marginal price
Reference


energyPRO 5.0 - Draft SolarX CPV & CST in Sevilla. Hot and cold molten salt tanks. Version 0.6 (Modified) (Calculated)
Home
Project Setup
Calculation Setup
Reports
License
Help
Production, graphic
Production, carpets
Transmission, graphic
Cash flow, graphic
Duration Curves
Graphics
Annual
Summary
Monthly
Production Plan
Energy
Annual
Summary
Monthly
Environment
Annual
Summary
Monthly
Key Figures
Cash Flow
Operational Strategy
Technical
Economic
Graphical Layout
Inputs
Charts
Calculation Log
Project Report
Export Results
Report Tools
Days 7
Checkboxes
Imbalances
Export/import
Charge/Discharge
Group demands
Synchronize
Operation income: 2.492.243 EUR
External conditions
Sites
Transmissions
Fuels
Demands
Energy conversion units
Storages
Electricity markets
Environment
Economy
[W/m2]
Direct Normal Irradiance
[EUR/MWh]
Spot Prices Spain 2023
Electricity [MW]
Steam turbine
CPV
Day ahead market import
Day ahead market export
Hot 565C Molten Salt storage
Storage capacity
Storage content
Thu 22/06/23
Fri 23/06/23
Sat 24/06/23
Sun 25/06/23
Mon 26/06/23
Tue 27/06/23
Wed 28/06/23
Thu 29/06/23
External conditions
Payments
Electricity
Fuels
Fuel stores
Reference

CPV & CST receiver on both solar field and Electricity




energyPRO 5.0 - Draft SolarX CPV & CST in Sevilla. Hot and cold molten salt tanks. Version 0.6. CST receiver on both el and CSP (Modified) (Calculated)
Home
Project Setup
Calculation Setup
Reports
License
Help
Production, graphic
Production, carpets
Transmission, graphic
Cash flow, graphic
Duration Curves
Graphics
Annual
Summary
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Production Plan
Energy
Annual
Summary
Monthly
Environment
Annual
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Monthly
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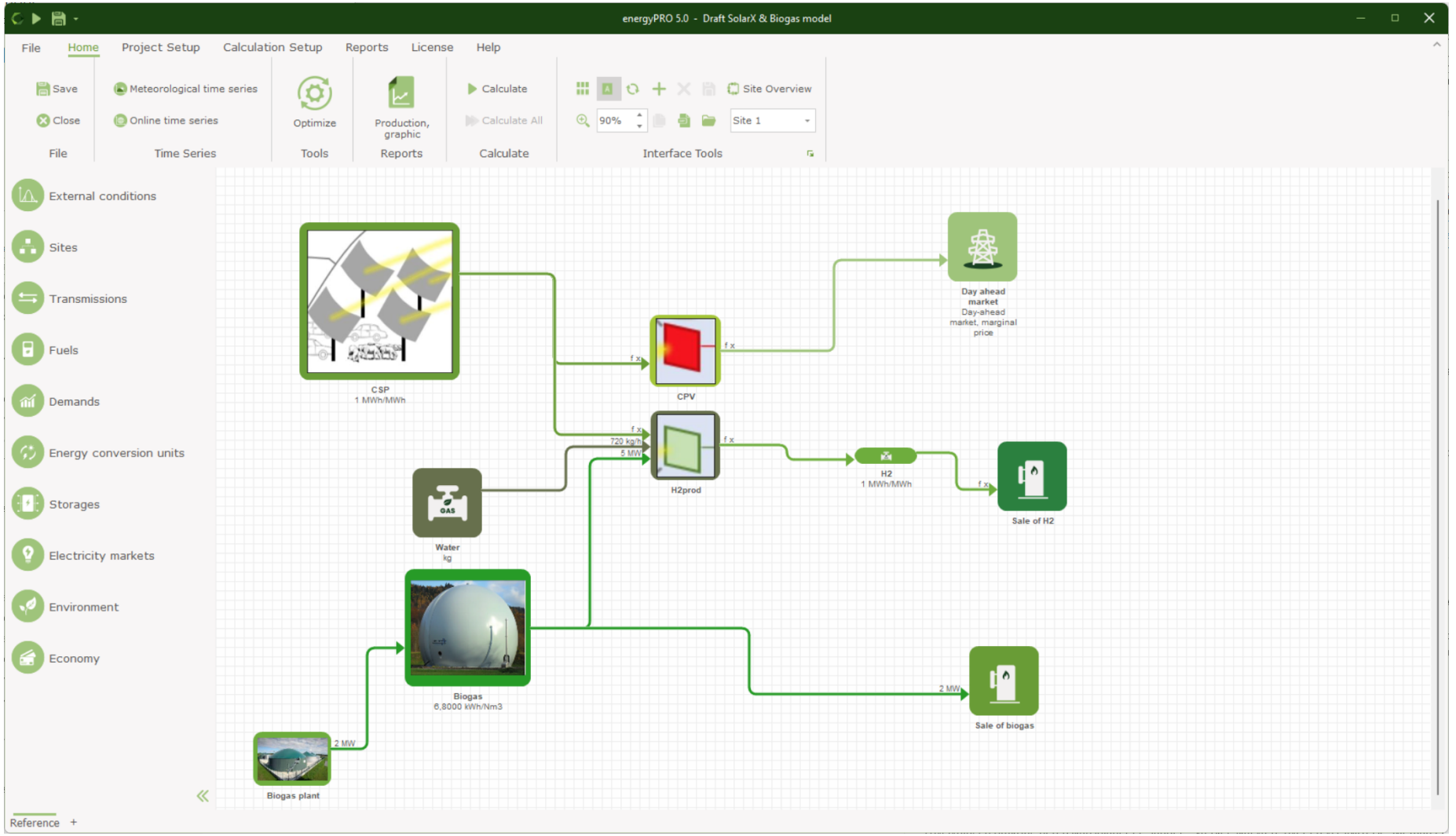
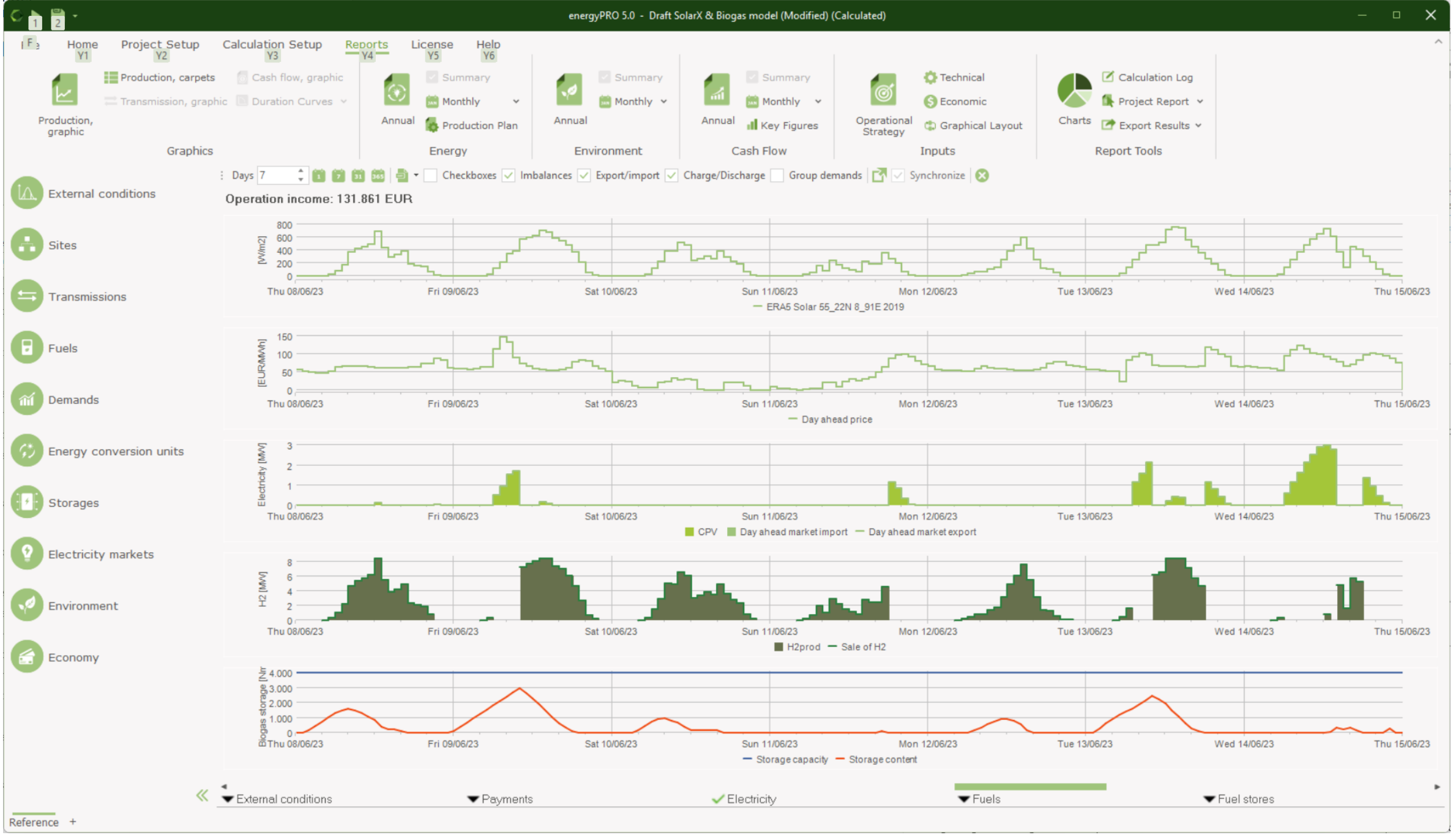
Calculation Log
Project Report
Export Results
Report Tools
Days 7
Checkboxes
Imbalances
Export/import
Charge/Discharge
Group demands
Group consumptions
Synchronize
External conditions
Sites
Transmissions
Fuels
Demands
Energy conversion units
Storages
Electricity markets
Environment
Economy
Operation income: 5.268.067 EUR
[W/m2]
Direct Normal Irradiance
[EUR/MWh]
Spot Prices Spain 2023
Electricity [MW]
Steam turbine
CPV
Day ahead market import
CST on El
Day ahead market export
Hot 565C Molten Salt storag
Storage capacity
Storage content
Sat 11/03/23
Sun 12/03/23
Mon 13/03/23
Tue 14/03/23
Wed 15/03/23
Thu 16/03/23
Fri 17/03/23
Sat 18/03/23
External conditions
Payments
Electricity
Fuels
Fuel stores
Reference

CPV and H2 production




energyPRO 5.0 - Draft SolarX & Biogas model (Modified) (Calculated)
Home
Project Setup
Calculation Setup
Reports
License
Help
Production, carpets
Cash flow, graphic
Transmission, graphic
Duration Curves
Production, graphic
Graphics
Annual
Summary
Monthly
Production Plan
Energy
Annual
Summary
Monthly
Environment
Annual
Summary
Monthly
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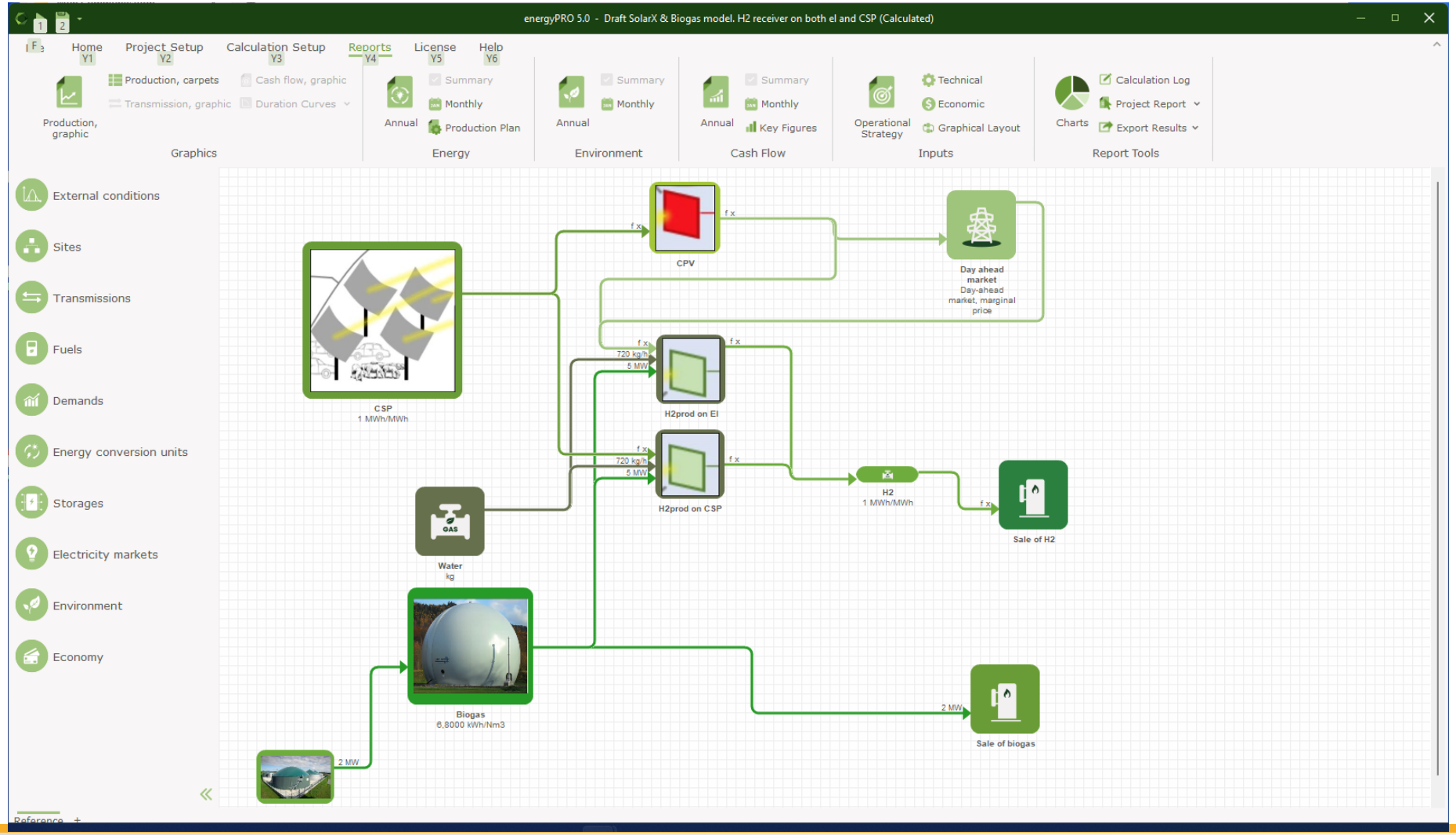
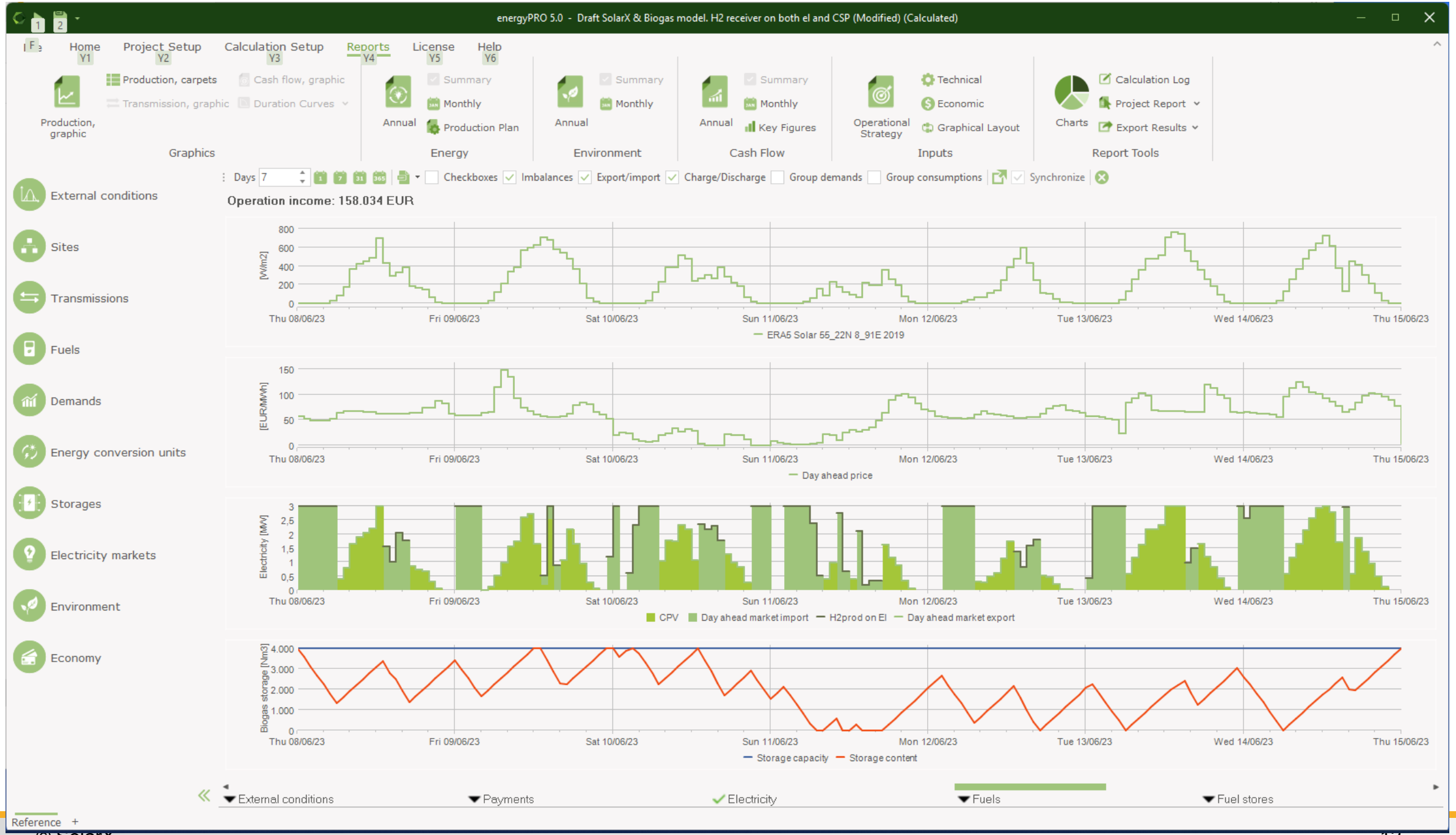
Export/import
Charge/Discharge
Group demands
Synchronize
External conditions
Sites
Transmissions
Fuels
Demands
Energy conversion units
Storages
Electricity markets
Environment
Economy
Operation income: 131.861 EUR
[W/m2]
ERA5 Solar 55_22N 8_91E 2019
[EUR/MWh]
Day ahead price
Electricity [MW]
CPV
Day ahead market import
Day ahead market export
H2 [MW]
H2prod
Sale of H2
Biogas storage [Nm
Storage capacity
Storage content
Thu 08/06/23
Fri 09/06/23
Sat 10/06/23
Sun 11/06/23
Mon 12/06/23
Tue 13/06/23
Wed 14/06/23
Thu 15/06/23
External conditions
Payments
Electricity
Fuels
Fuel stores
Reference

3.4 CPV and H2 production on both Solar Field and Electricity




energyPRO 5.0 - Draft SolarX & Biogas model. H2 receiver on both el and CSP (Modified) (Calculated)
Home
Project Setup
Calculation Setup
Reports
License
Help
Production, graphic
Production, carpets
Transmission, graphic
Cash flow, graphic
Duration Curves
Graphics
Annual
Summary
Monthly
Production Plan
Energy
Annual
Summary
Monthly
Environment
Annual
Summary
Monthly
Key Figures
Cash Flow
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Graphical Layout
Inputs
Charts
Calculation Log
Project Report
Export Results
Report Tools
Days 7
Checkboxes
Imbalances
Export/import
Charge/Discharge
Group demands
Group consumptions
Synchronize
External conditions
Sites
Transmissions
Fuels
Demands
Energy conversion units
Storages
Electricity markets
Environment
Economy
Operation income: 158.034 EUR
[W/m2]
ERA5 Solar 55_22N 8_91E 2019
[EUR/MWh]
Day ahead price
Electricity [MW]
CPV
Day ahead market import
H2prod on El
Day ahead market export
Biogas storage [Nm3]
Storage capacity
Storage content
Thu 08/06/23
Fri 09/06/23
Sat 10/06/23
Sun 11/06/23
Mon 12/06/23
Tue 13/06/23
Wed 14/06/23
Thu 15/06/23
External conditions
Payments
Electricity
Fuels
Fuel stores
Reference

3.5 Methanol production on syngases

H_2 Receiver Reactor

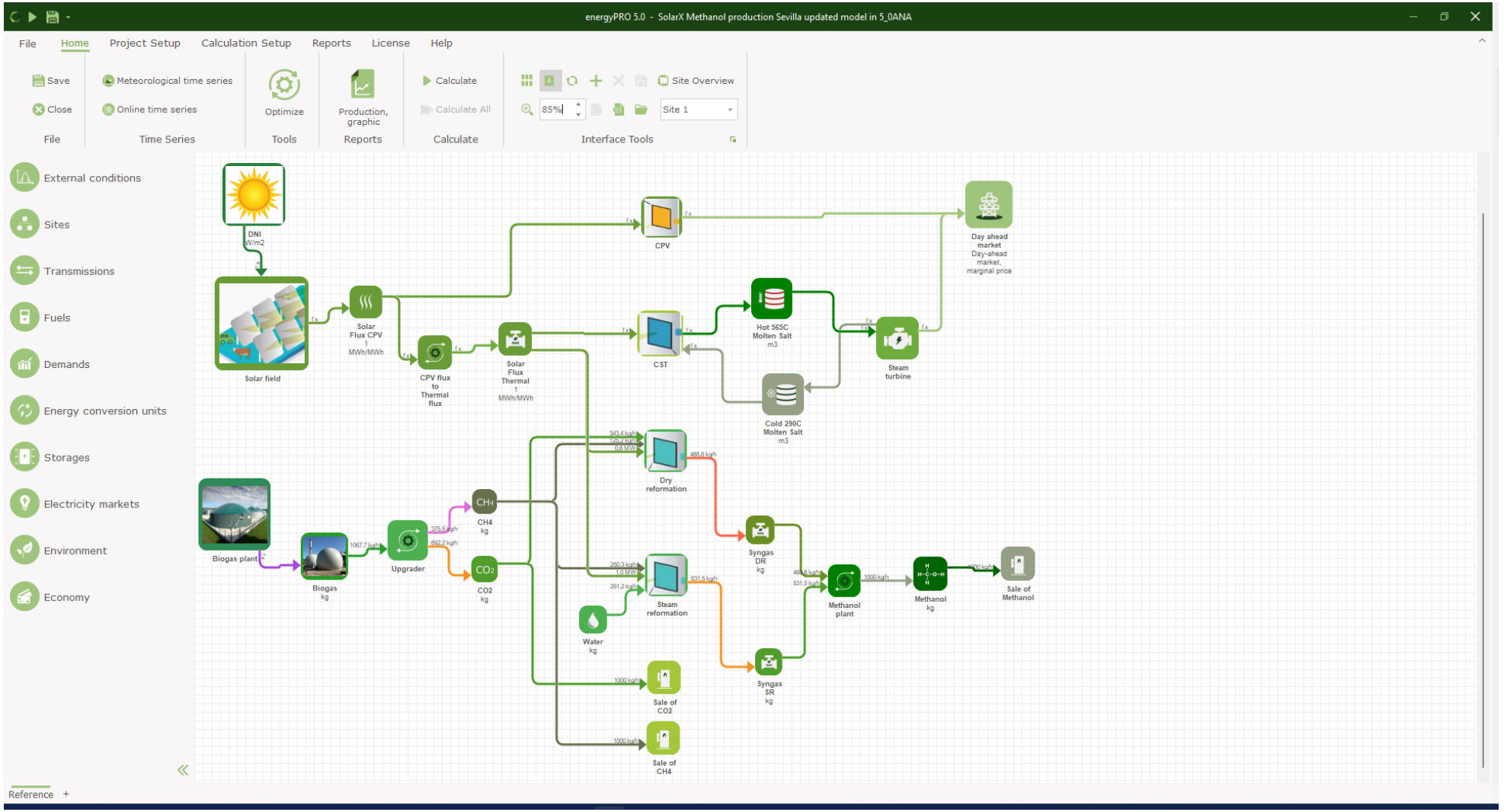
Making synthesis gas

	Reaction		Inlet	Outlet
- Dry reforming:	$CH_4 + CO_2$	-> $2CO + 2H_2$	$CO_2/CH_4=1$	$H_2/CO=1$
- Steam reforming:	$2CH_4 + 2H_2O$	-> $2CO + 6H_2$	$CO_2/CH_4=0$	$H_2/CO=3$
- Combined	$3CH_4 + CO_2 + 2H2O$	-> $4CO + 8H_2$	$CO_2/CH_4=1/3$	**$H_2/CO=2$**

Converting synthesis gas

- Pure H2	$CH_4 + 2H_2O$	-> $CO_2 + 4H_2$	$H_2/CO=\infty$
- Methanol	$CO + 2H_2$	-> CH_3OH	$H_2/CO=2$
- Kerosene	$nCO + 2nH_2$	-> $(CH_2)n + nH_2O$	$H_2/CO=2$

3.5 Methanol production on syngases



Thanks for your attention

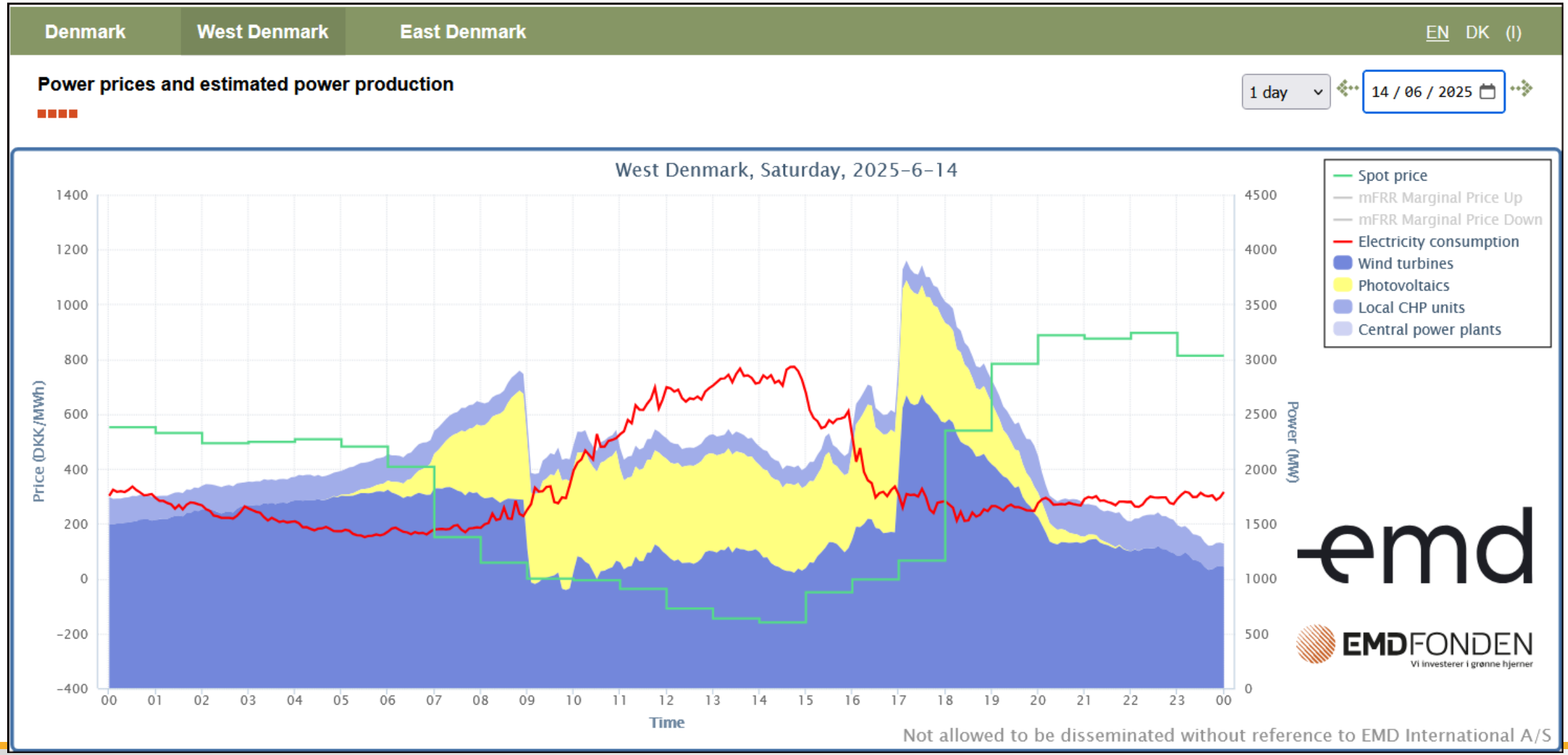
Contact Anders N. Andersen at ana@emd.dk

Furthermore, you will be able to download the shown models from https://solarx-project.eu/ - and adapt these to your needs

White paper including technological and policy recommendations

Extra

www.emd.dk/el


Denmark
West Denmark
East Denmark
EN DK (I)
Power prices and estimated power production
1 day
14 / 06 / 2025
West Denmark, Saturday, 2025-6-14
Spot price
mFRR Marginal Price Up
mFRR Marginal Price Down
Electricity consumption
Wind turbines
Photovoltaics
Local CHP units
Central power plants
Price (DKK/MWh)
Power (MW)
Time
1400
1200
1000
800
600
400
200
0
-200
-400
4500
4000
3500
3000
2500
2000
1500
1000
500
0
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 00
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