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M.Sc. Sustainable Energy Planning and Management

# Model-based analyses to support investment decisions to reduce costs and carbon emissions

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# Agenda

- Short introduction to EMD
- Modelbased analyses
- Examples (energyPRO)

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# Renewable Energy Software & Consulting

EMD is a global company supplying software and consultancy services for design, planning, documentation and operation of wind and solar energy projects as well as complex distributed energy projects.



<https://www.emd-international.com/>

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# Model-based analyses to support investment decisions

- reduce costs and
- carbon emissions



**energyPRO**

- a software for modeling, analysing, and optimising complex energy systems

# Steps to building your model

1. Define scope and objective
2. Collect and prepare input data
3. Structure the model and system layout
  - Create components in energyPRO
  - Import time series data
  - Define operational strategy
4. Calibrate the model against historical data (your reference, digital twin)
5. Validate model performance
6. Develop and define scenarios
7. Analyse results and key outputs
8. Document assumptions, setup, and methodology
9. Perform quality assurance and review

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### District Energy Sector

Design efficient and economically viable district heating systems.



### Sector coupling

Optimise interactions between electricity, heat, cooling, and transportation for maximum efficiency and sustainability.



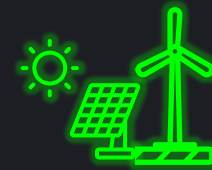
### Water Treatment

Integrate renewable sources, reduce costs, and enhance sustainability.



### Decarbonization strategy

Optimize energy systems, assess feasibility, and make strategic decisions.



### Hybrid projects

Integrate and develop Hybrid Projects (PV + Wind + BESS), maximize efficiency, and ensure economic viability.



### Environmental factors and ESG



### Integrated energy system

Increase efficiency, reduce costs, and achieve your sustainability goals.



### Power-to-X

Optimize energy conversion, analyze economic feasibility, and integrate renewable energy sources.

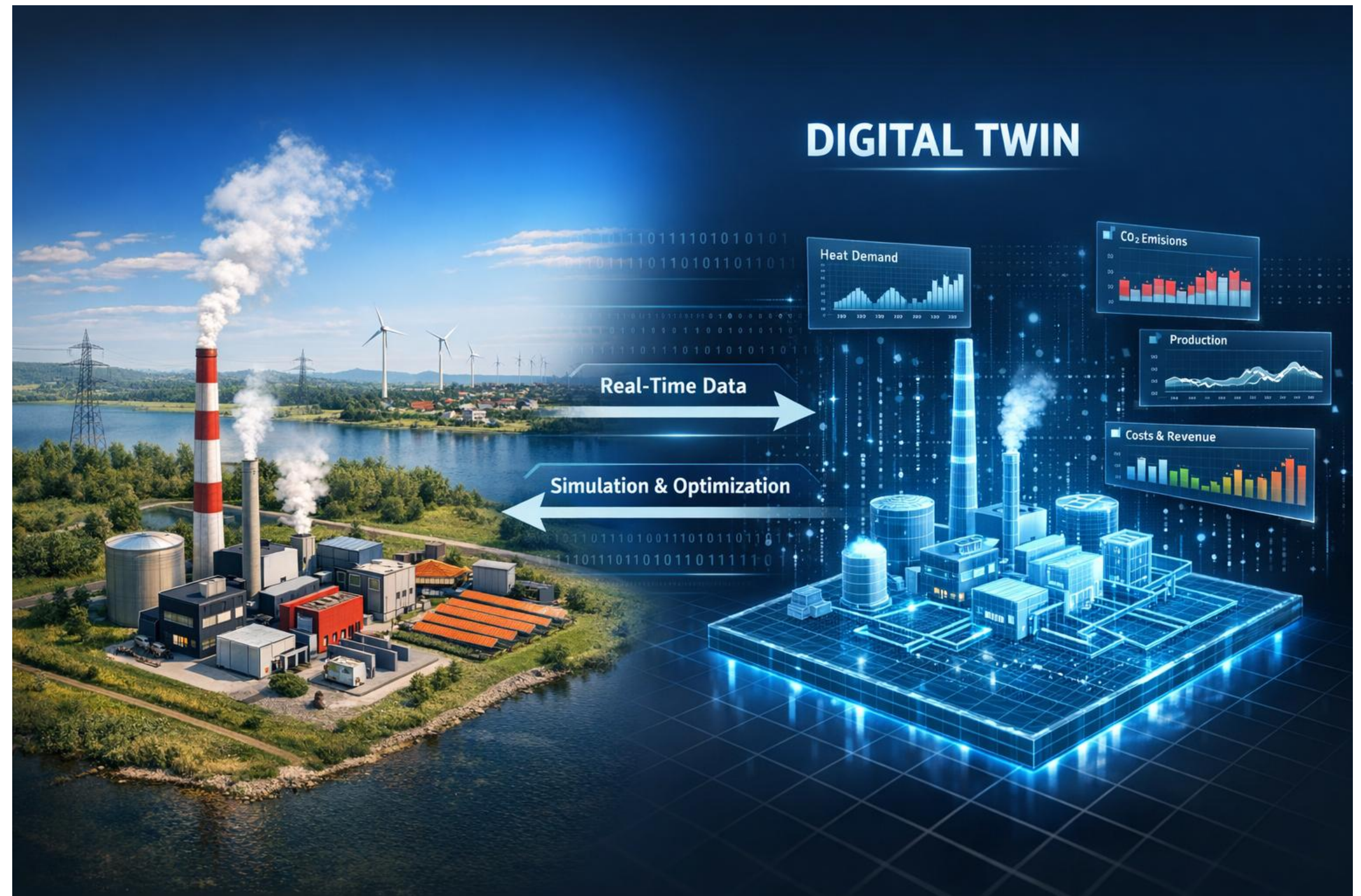


### And more!

# Steps to building your model

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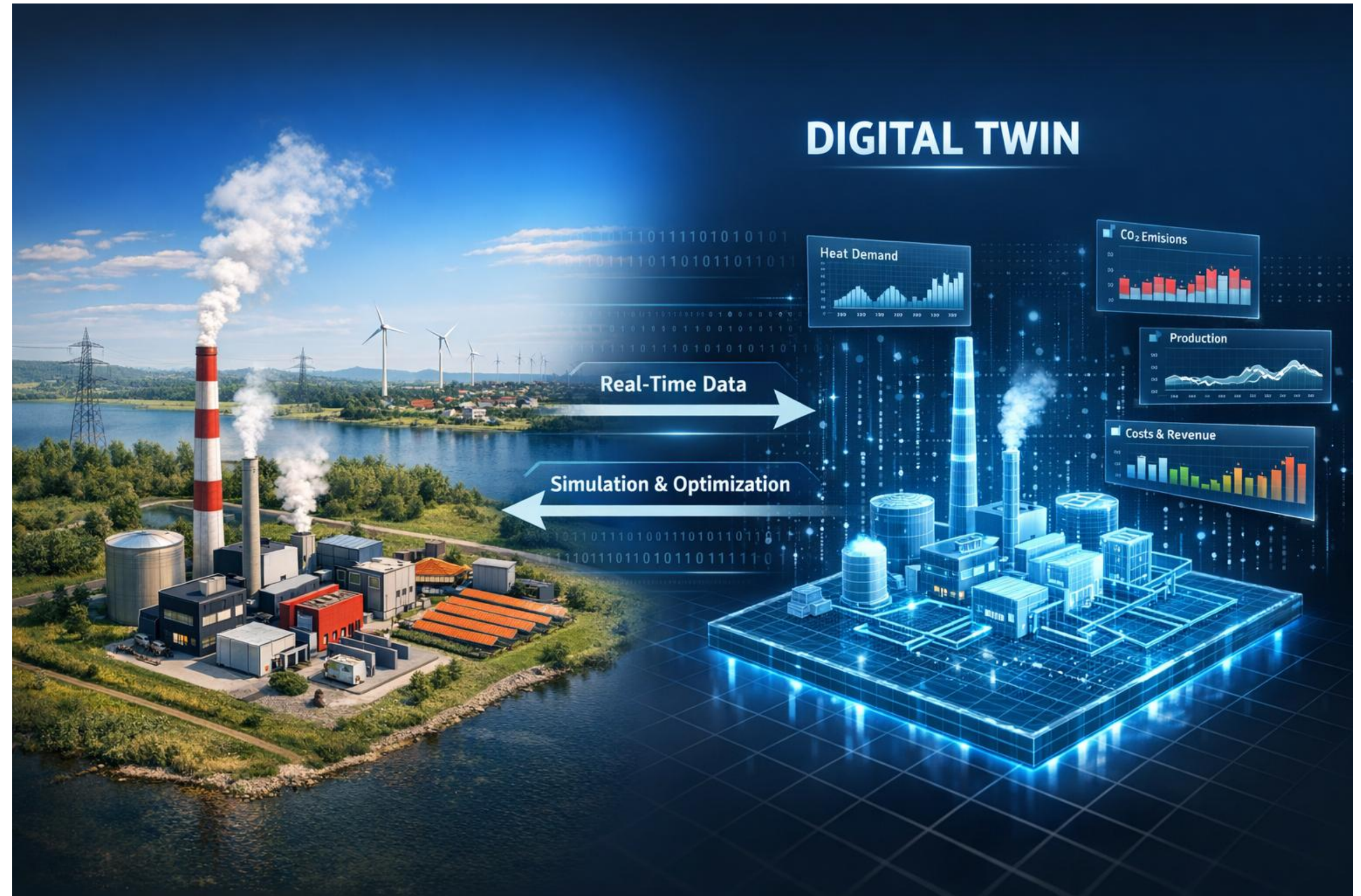
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# Steps to building your model

Set up your reference  
→ digital twin

Analyse different  
scenarios

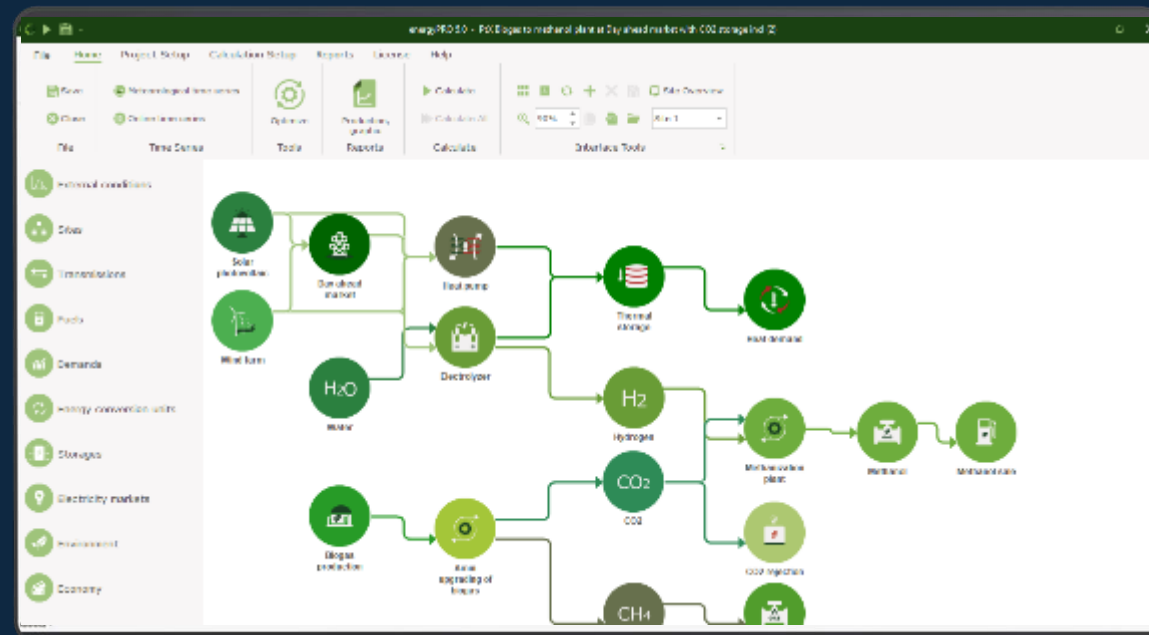


# Model, analyze & optimize

## A modelling tool supports every stage of this process

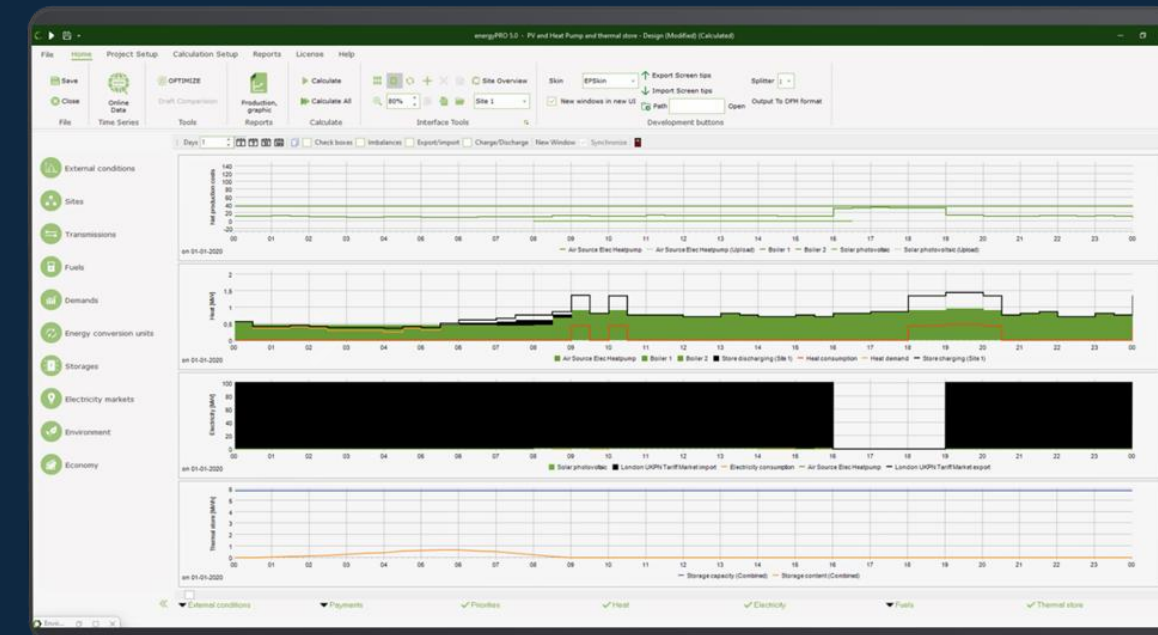
### Graphical interface

Model an arbitrary energy system to see the relevant connections



### Calculation

Automatically calculate the optimal operation



### Interactive plots

Visualize data, set the desired constraints & analyze your model

### Reports

Export detailed reports for your stakeholders

### Iterative process

Continuously optimize and improve your system

energyPRO 5.0.121

PV and Heat Pump and thermal store - Design.rpt

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EMD International AUS  
Nash-jerome.Veg.10  
+45 6916 4850

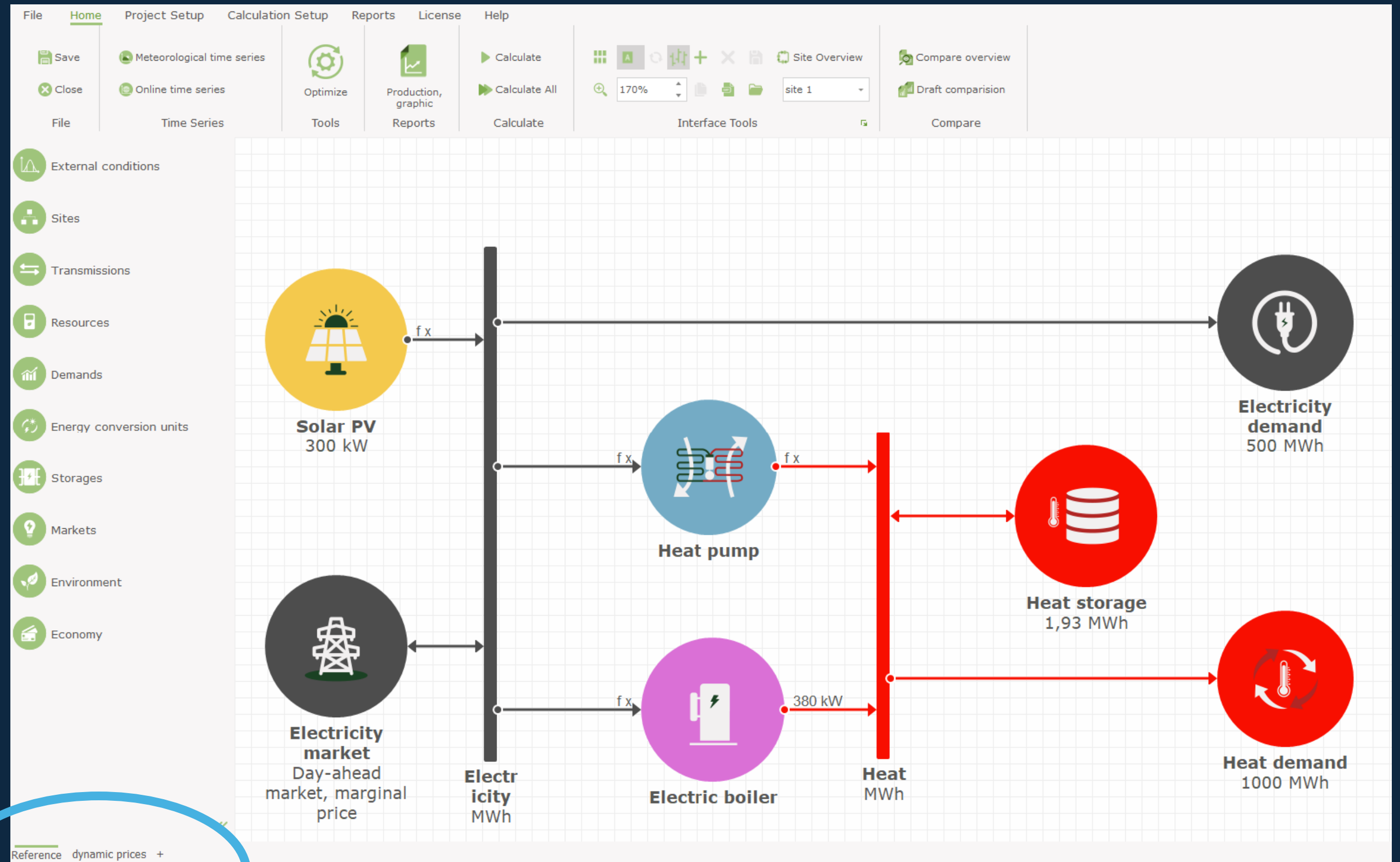
Operation [Income from 01-01-2020 00:00 to 31-12-2020 23:59]

(All amounts in €)

Category	Value	Unit	Value	Unit	Value	Unit
<b>Revenue</b>						
Electricity Export	806,490.1	a	52.39	€	42,252,018	
GDUS Red	806,490.1	MWh	9.87	€	7,962,058	
GDUS Green	806,490.1	MWh	0.32	€	2,58,077	
Spot Market Export	806,490.1	MWh	32,281	€	26,539,022	
Traded	806,490.1	MWh	8,628	€	1,250,160	
<b>Electricity Export Total</b>					<b>78,319,334</b>	
RH I	806,490.1	a	-	€	-	
A-3-1-1-P	806,490.1	MWh	27.5	€	117,628	
<b>RH Total</b>					<b>117,628</b>	
<b>Total Revenue</b>					<b>78,436,961</b>	
<b>Operating Expenditures</b>						
Gas cost	918.8	a	25.3	€	23,245	
Gas CCL	918.8	MWh	4.65	€	4,272	
<b>Maintenance</b>					<b>15,000</b>	
<b>Maintenance Total</b>					<b>15,000</b>	
<b>Electricity Import</b>						
Import Spot	806,865.5	MWh	32,984	€	26,613,310	
DUS Red	3,807.3	MWh	43.72	€	169,077	
DUS Amber	341,952.4	MWh	2.57	€	878,943	
DUS Green	461,036.8	MWh	0.0	€	0	
IT (C) CMC AAHEDCRO	806,865.5	MWh	920	€	40,343,334	
Traded	806,865.5	MWh	8,623	€	895,772	
CCL	806,865.5	MWh	7.75	€	6,253,215	
<b>Electricity Import Total</b>					<b>74,953,541</b>	
<b>Total Operating Expenditures</b>					<b>74,968,541</b>	
<b>Operation Income</b>					<b>3,440,903</b>	
* Average price						

Set up your reference  
→ digital twin

Analyse different  
scenarios



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Set up your reference  
→ digital twin

Analyse different  
scenarios

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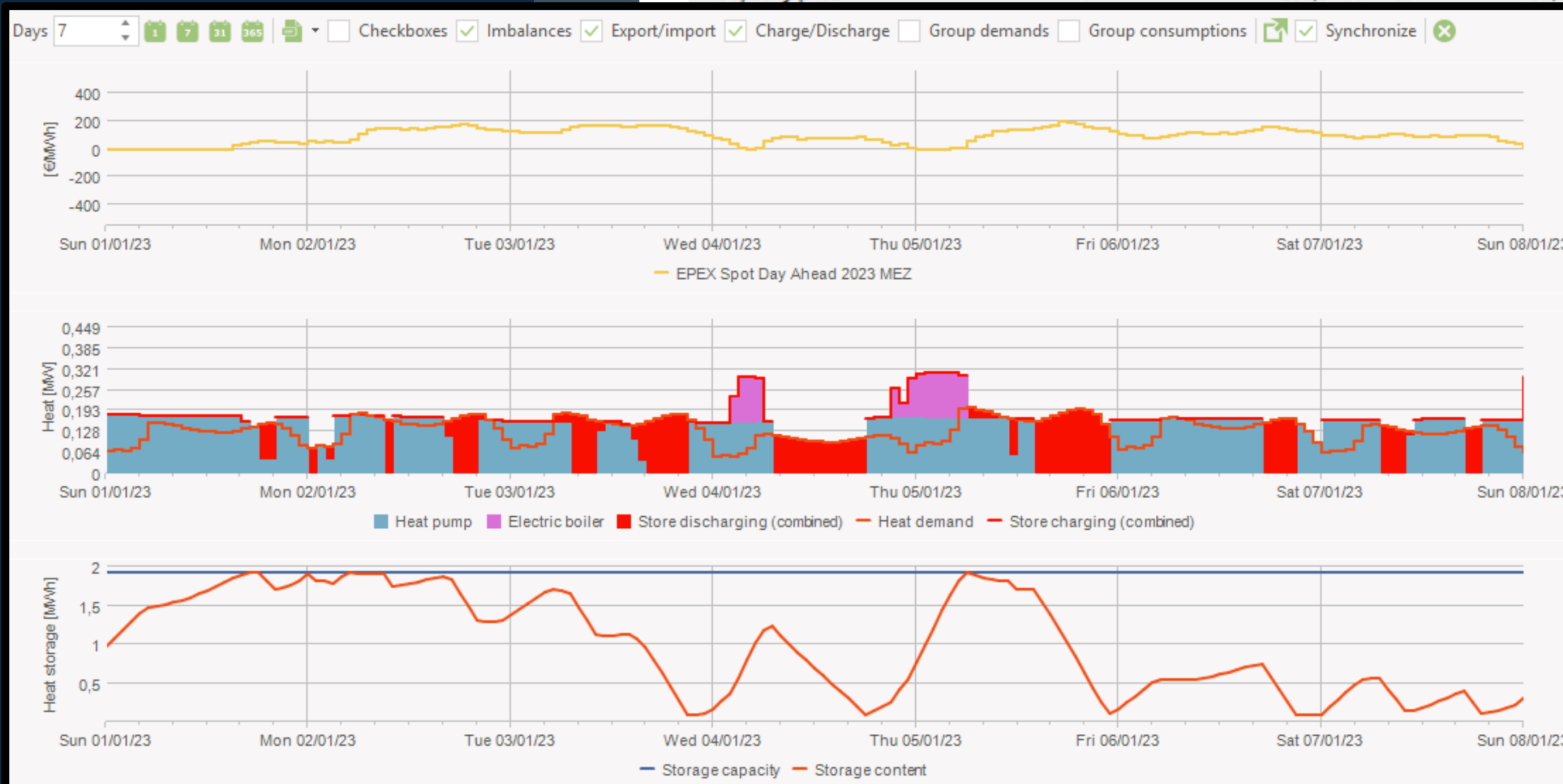
Operation Income from 01-01-2023 00.00 to 31-12-2023 23.59, Reference

Electricity based heat network with dynamic prices.eppx

Neighborhood supply with static and dynamic electricity price

(All amounts in €)

Revenues					
Heat sale	:	1.001,2 MWh	at	130,0	= 130.161
Electricity sale	:	500,0 MWh	at	250,0	= 125.000
Electricity export	:	46,6 MWh	at	60,0	= 2.794
<b>Total Revenues</b>					<b>257.955</b>
Operating Expenditures					
Electricity import	:	757,3	at	130,0	= 98.445
Electricity tariffs	:	757,3 MWh	at	35,0	= 26.504
Capacity price	:	283,6 kW	at	195,0	= 51.404
					<b>176.353</b>
					<b>81.602</b>



dynamic prices

=	130.161
=	125.000
*=	3.989
	<b>259.130</b>
*=	78.785
=	27.226
=	51.404
	<b>157.394</b>
	<b>101.736</b>

# Set up your reference → digital twin

# Analyse different scenarios

File Home Project Setup Calculation Setup **Reports** License

Production, graphic  
Transmission, graphic  
Duration Curves  
Annual

Graphics

Color 3 Name: London UKPN Tariff M Resource: Electricity  
Market type: Fixed Tariffs

Tariff element name	From time	To time	From day	To day	Holidays	From date	To date
Red	16.00	19.00	Monday	Friday	Excluding		
Red	11.00	14.00	Monday	Friday	Excluding		
Amber	07.00	23.00	Monday	Friday	Excluding		

CO2 emission factor for import: 136 g / kWh  
Replaced CO2 emission factor for export: 136 g / kWh

**Set up your reference**  
→ **digital twin**

**Analyse different scenarios**  
→ **potential future digital twin**

## **DH related examples**

- **A new system**
- **Decarbonisation of an existing system**
  - **electrification**
  - **RE technologies**
- **Storage**
- **Changes in heat demand**
  - **expansions**
- **Sector coupling (excess heat)**
- **Changes in markets – volatile prices and (the growing) need for resilience**

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The background of the slide features a series of wavy, concentric lines in a light green color, creating a sense of motion and depth. The lines are most prominent on the left side and fade towards the right.

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