SOLAR X

SOLARX WP4 – 4.2

Unavoidable thermal losses in CSP plants: From Real-data to modelling

solarx-project.eu

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Co-funded by the European Union

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AGENDA

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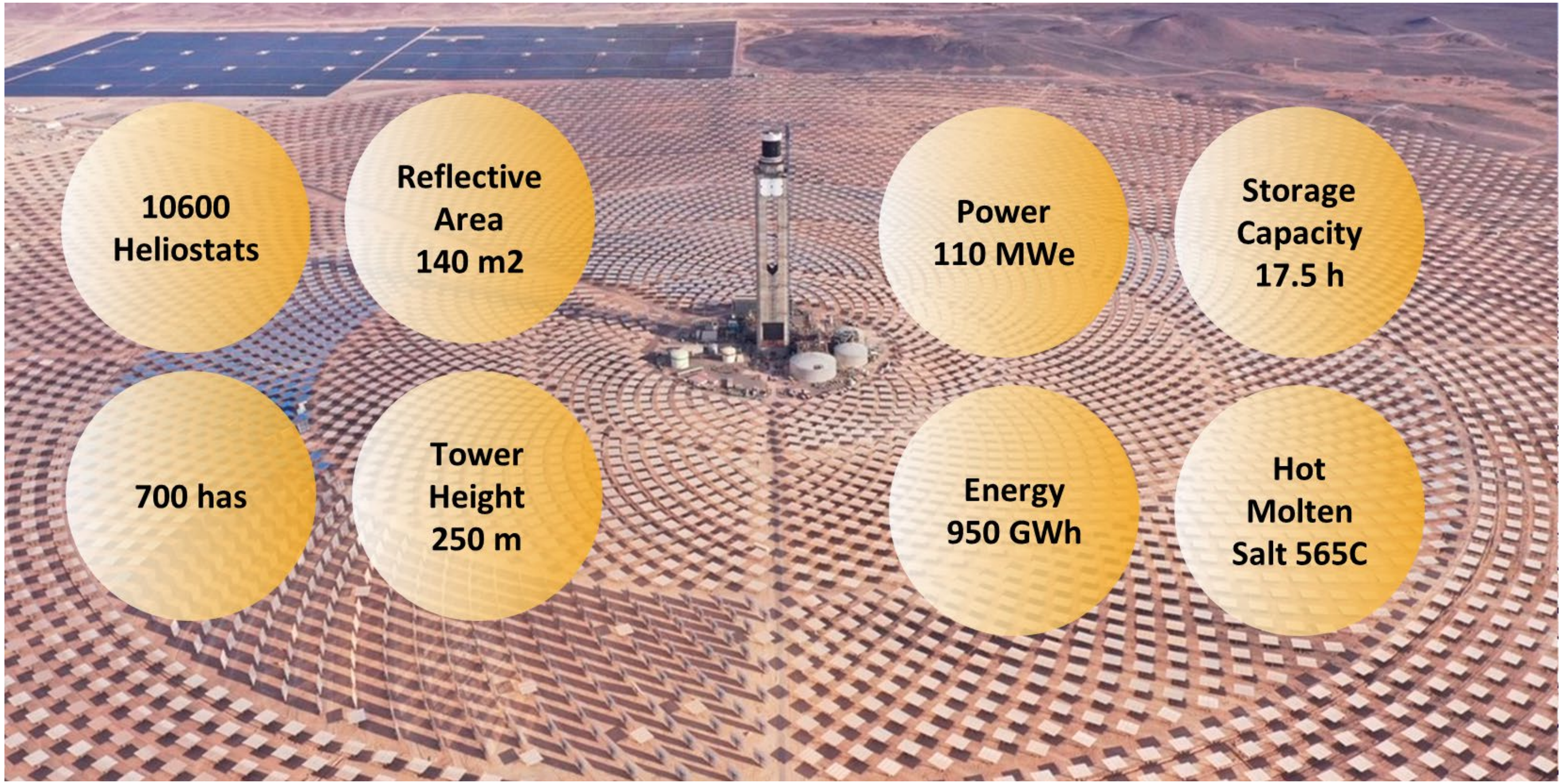
1. Introduction
2. Objectives
3. Performance Model of a CSP Plant
4. Main components of a CSP plant
5. Deeper operational data analysis of the main electric consumers.
6. Comparison with the model
7. Conclusions

1. Introduction: Cerro Dominador

- ACCIONA has experience in EPC and O&M in CSP Tower plants, such as **Cerro Dominador** in Atacama dessert (Chile).

1. Introduction: Cerro Dominador in numbers



Current situation:

- DCS updated system
- Renovated HW and SW in plant.
- Limited access to historic data.

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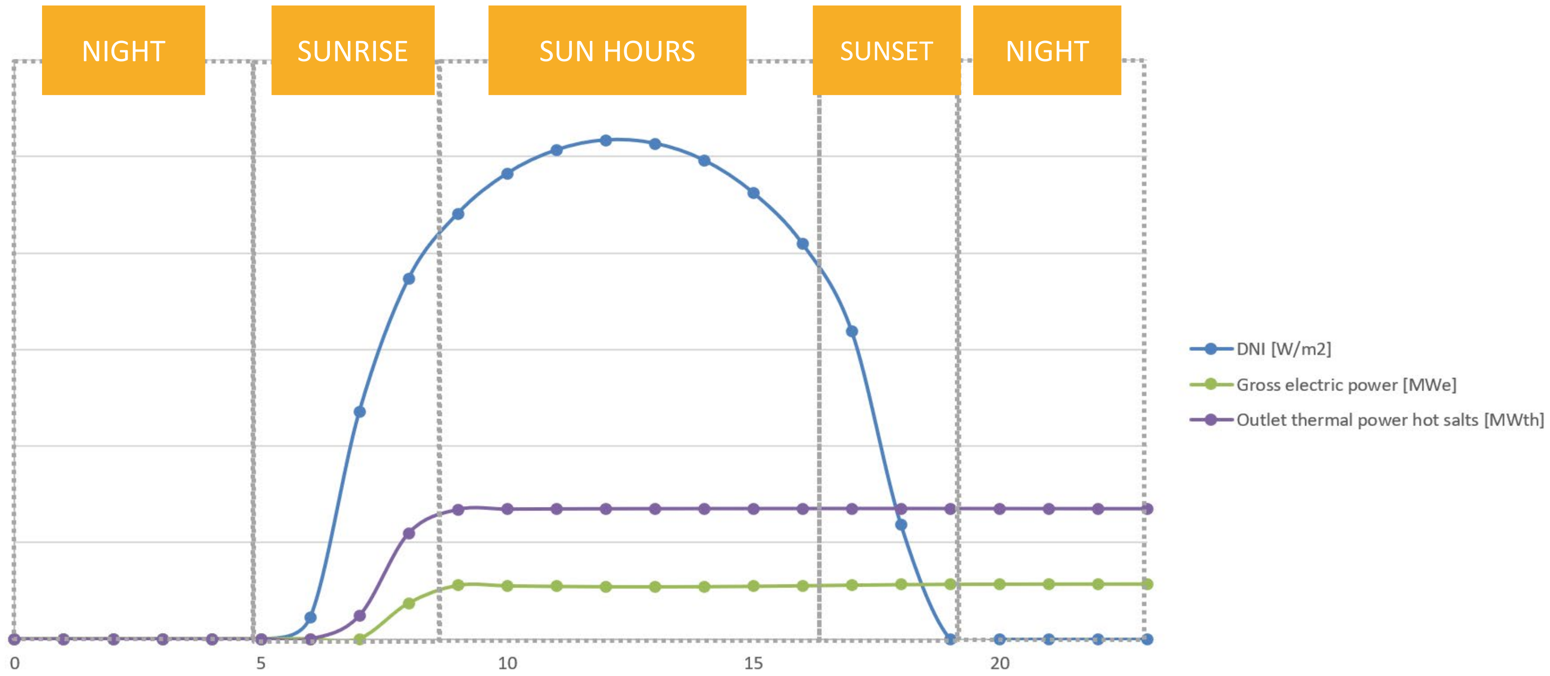
2. Introduction: Objective

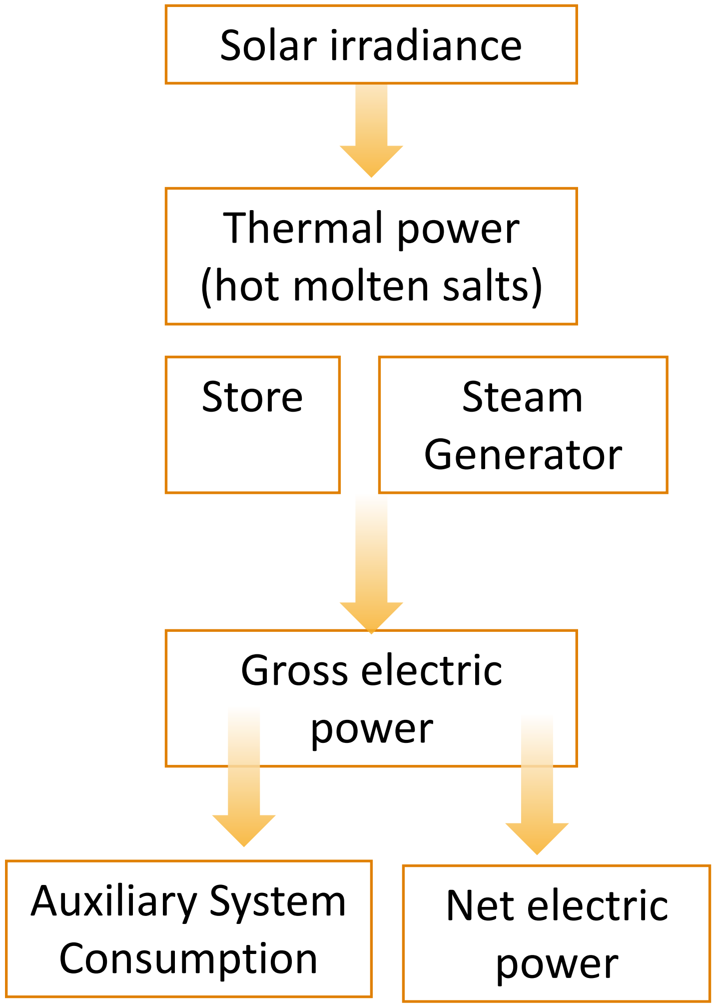
Validate quantitatively the electric parasitic consumption and starting/transients by using the operational data from Cerro Dominador.

Demonstrate that the hypothesis for the introduced EnergyPro model is consistent with the real operational data.

Analysis of the time evolution of the main electric-demanding equipment in different operational modes.

3. Performance Model curve of a CSP plant with thermal storage: Unavoidable losses

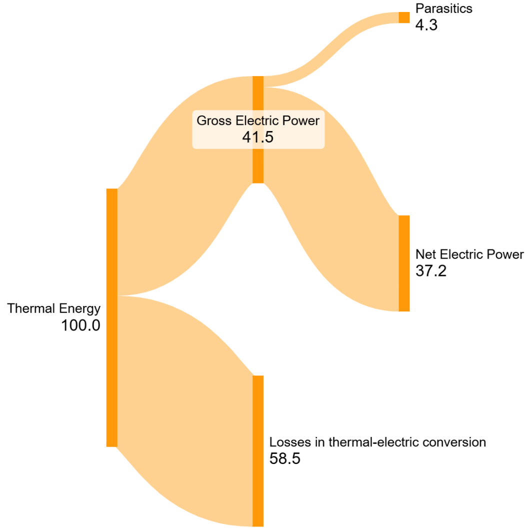


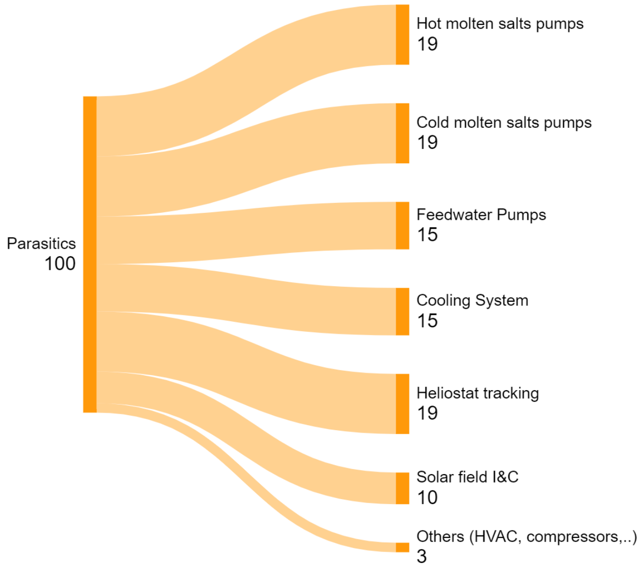


3. Performance Model curve of a CSP plant with thermal storage: Unavoidable losses

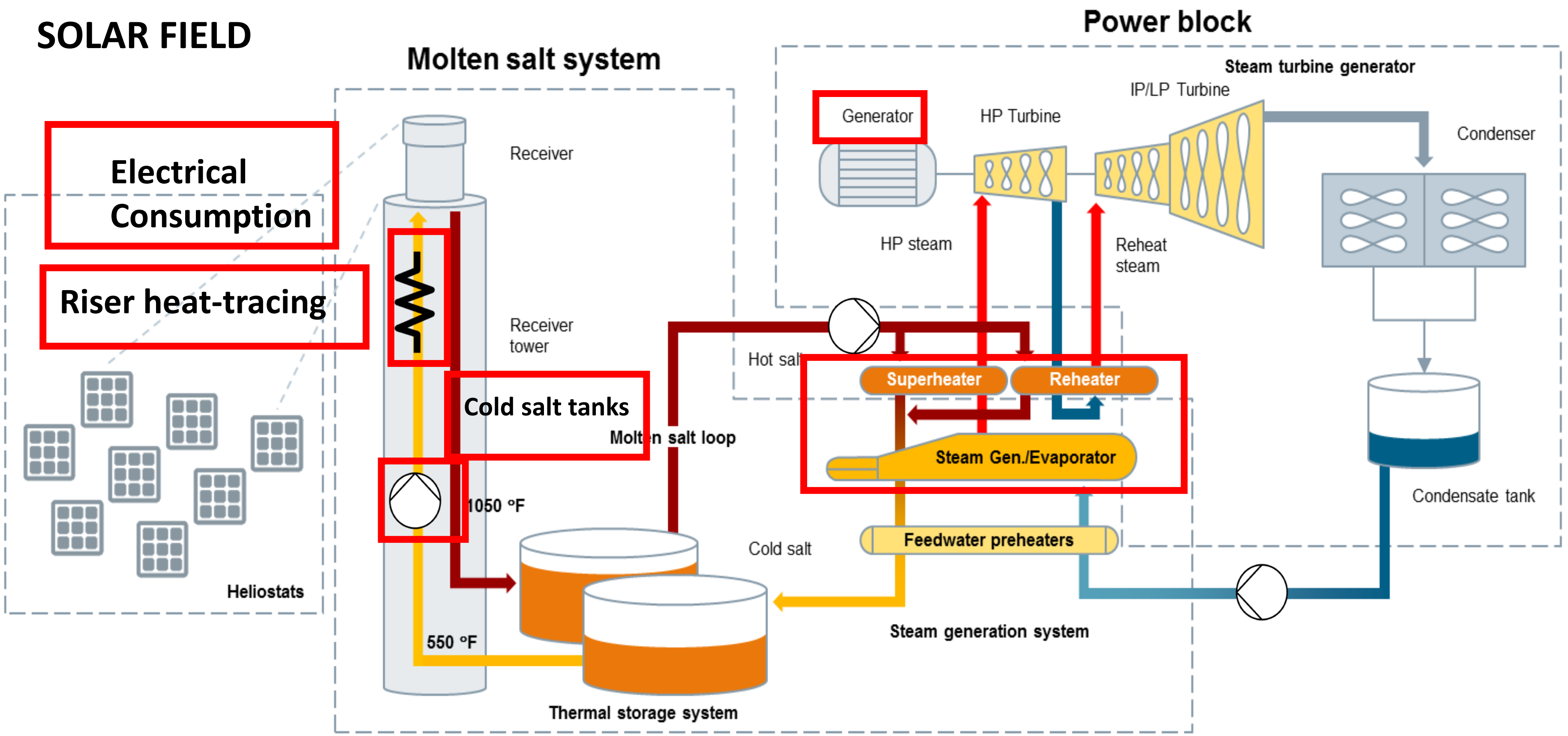
List of equipment	Consumption Share	Daytime (operation)	Night (operation)	Night (no operation)
Cold/Hot salt pumps	35%-45%	Yes	No	No
Steam cycle: Feedwater and condensate pumps…	20%-30%	Yes	Yes	No
Solar field	5-10%	Yes	No	No
Antifreezer Riser/Downcomer heat-tracing system	3-5%	No	Yes	Yes

The total parasitic consumption is between **7% and 12%** of gross electricity production



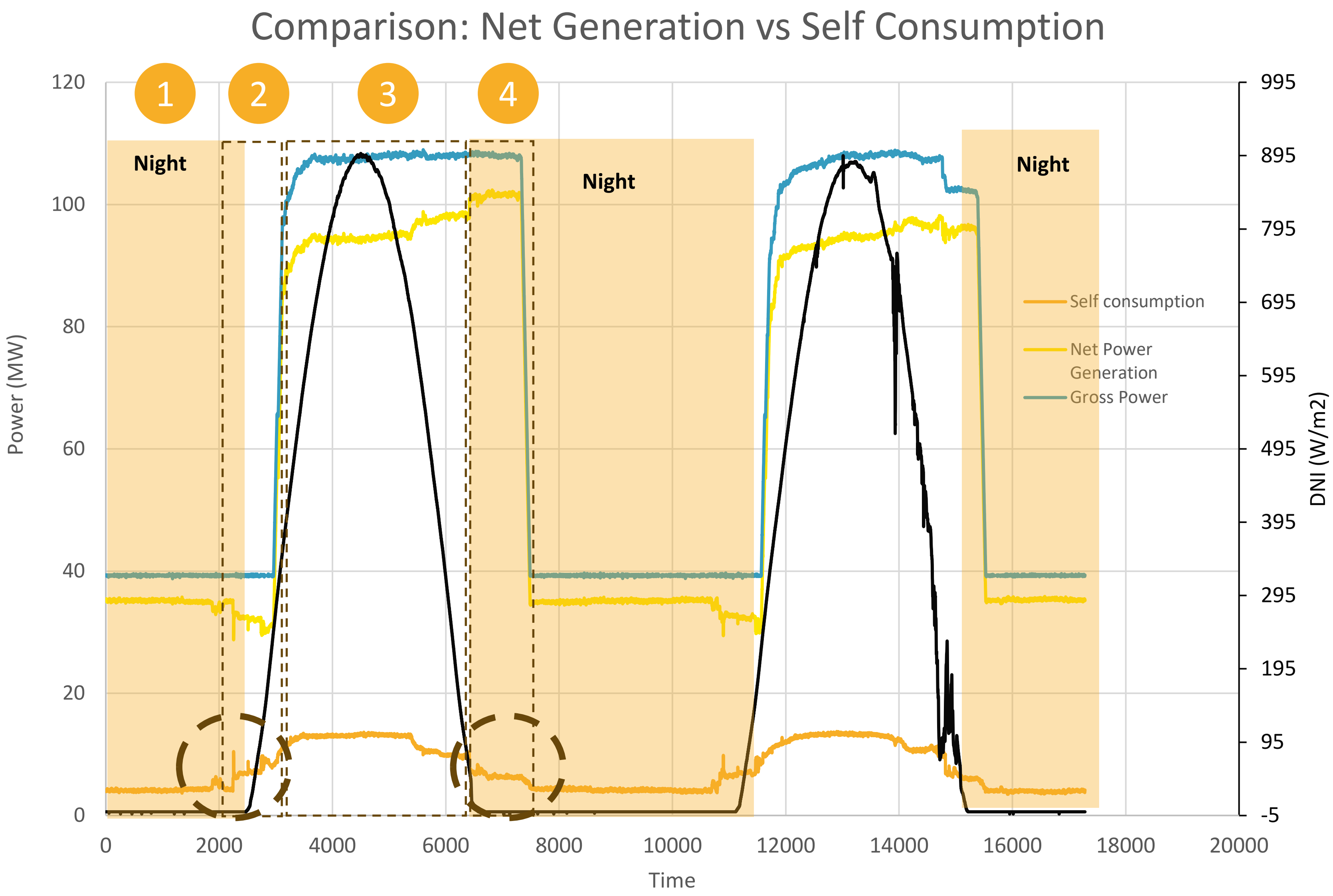


4. Main components of a CSP plant



Note: the systems or equipment highlighted contribute to parasitic consumption.

5. Operational data from a real CSP plant



State	Name	Ratio self-consumption
1	Night	7-9%
2	Receiver Preheating	10-12%
3	Power	9-11%
4	Receiver Cooling-down	7-9%

5. Operational data from a real CSP plant SOLAR FIELD

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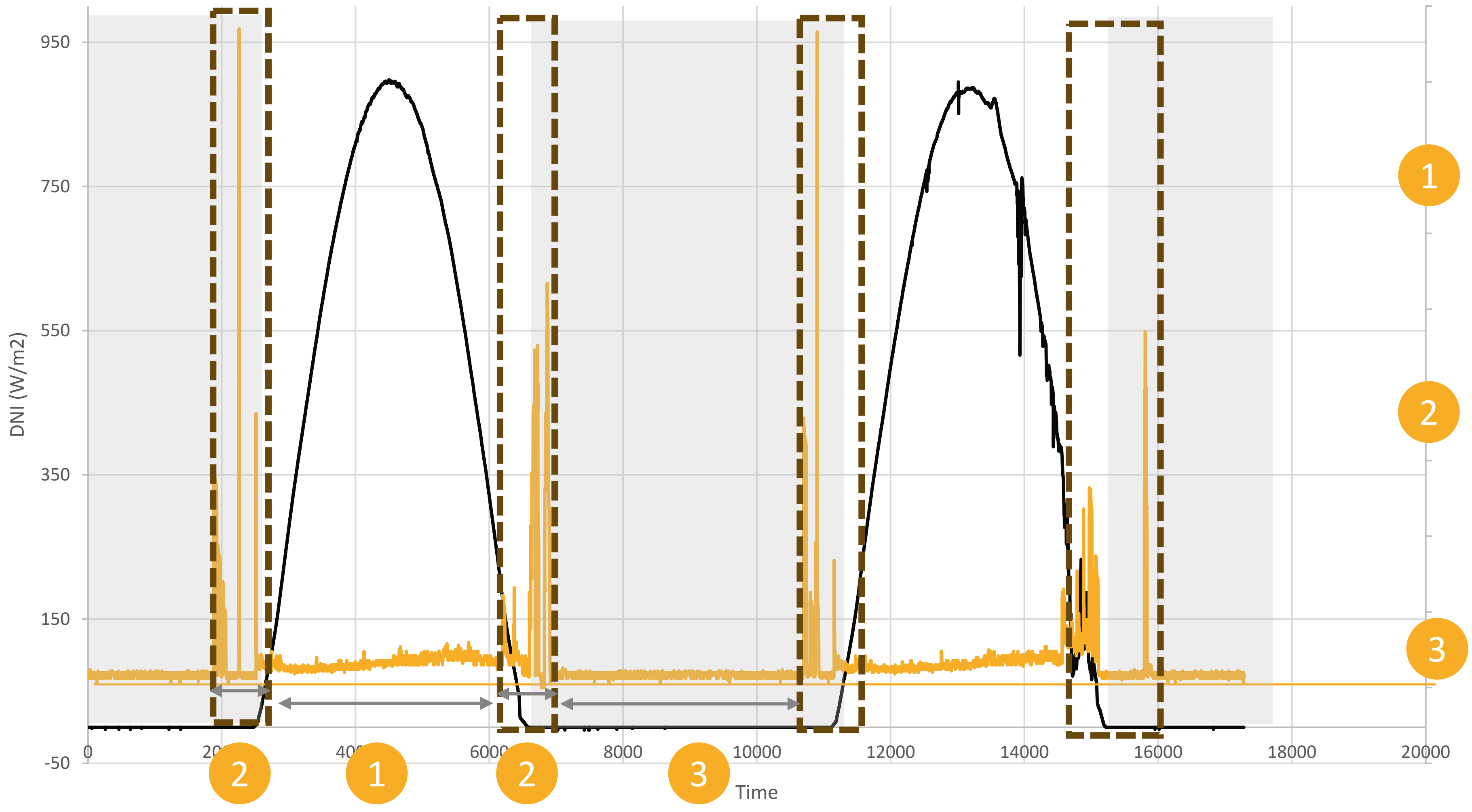


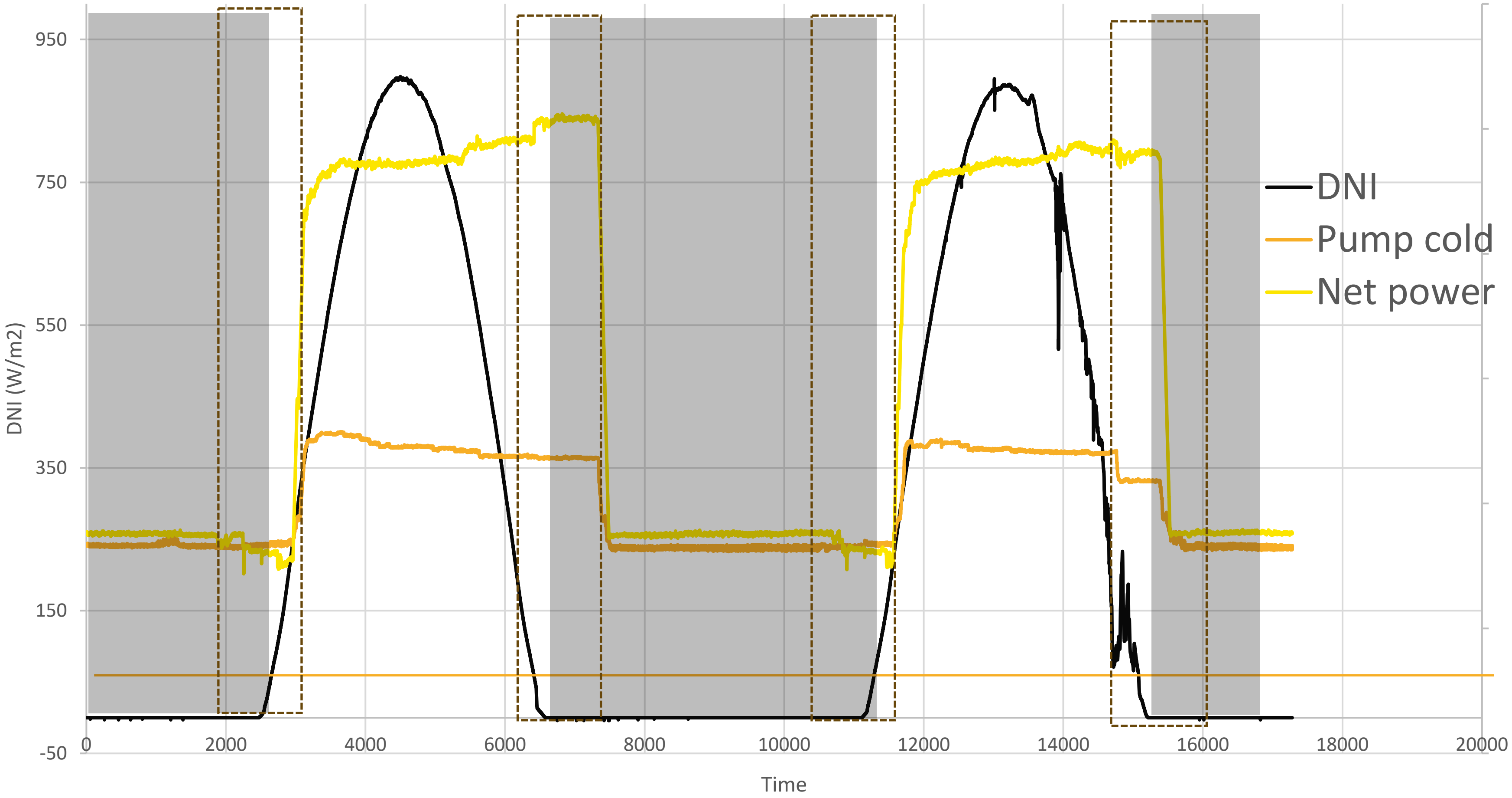
Main KPI of energy consumption:

50% of energy consumption during tracking (day). (8-10h)

30% starting and closing shut down of solar field (2-3h). Stow position and tracking

20% Standy overnight (12-14h)

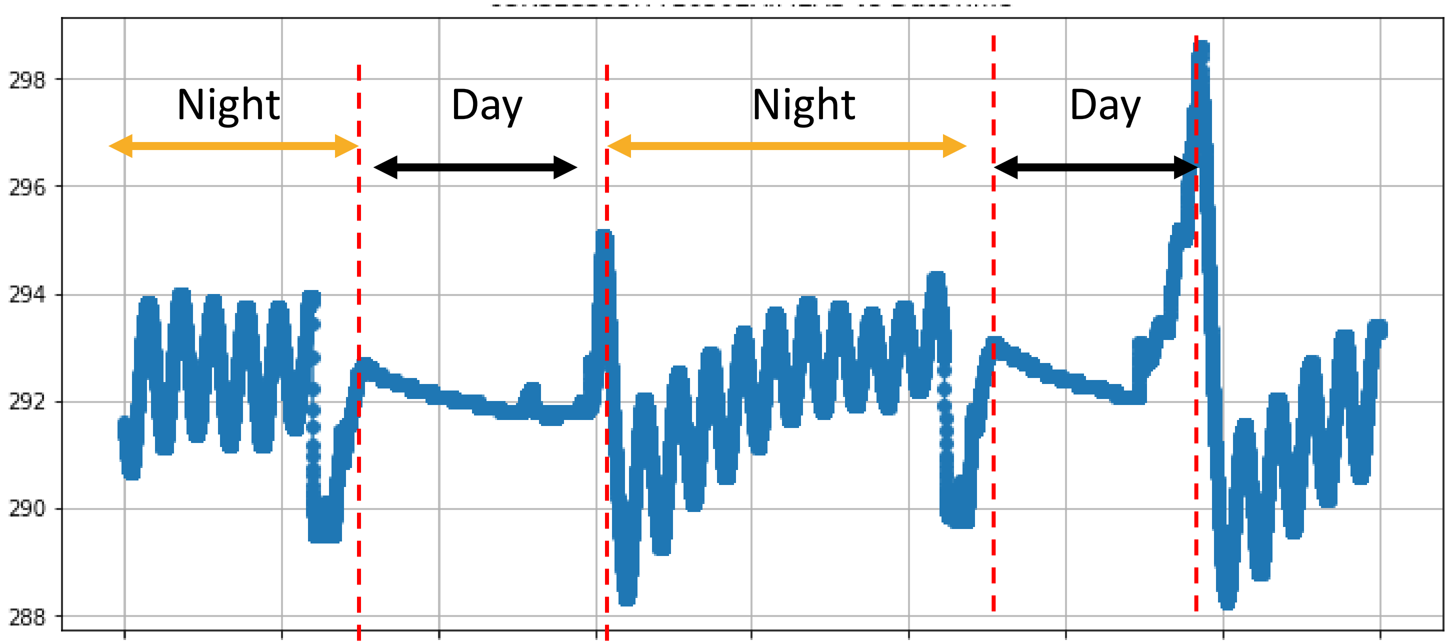
5. Operational data from a real CSP plant
SALT PUMP



Main KPI of energy consumption:

The pump electric consumption is proportional to the electric Generator.

5. Operational data from a real CSP plant
RISER HEAT-TRACING

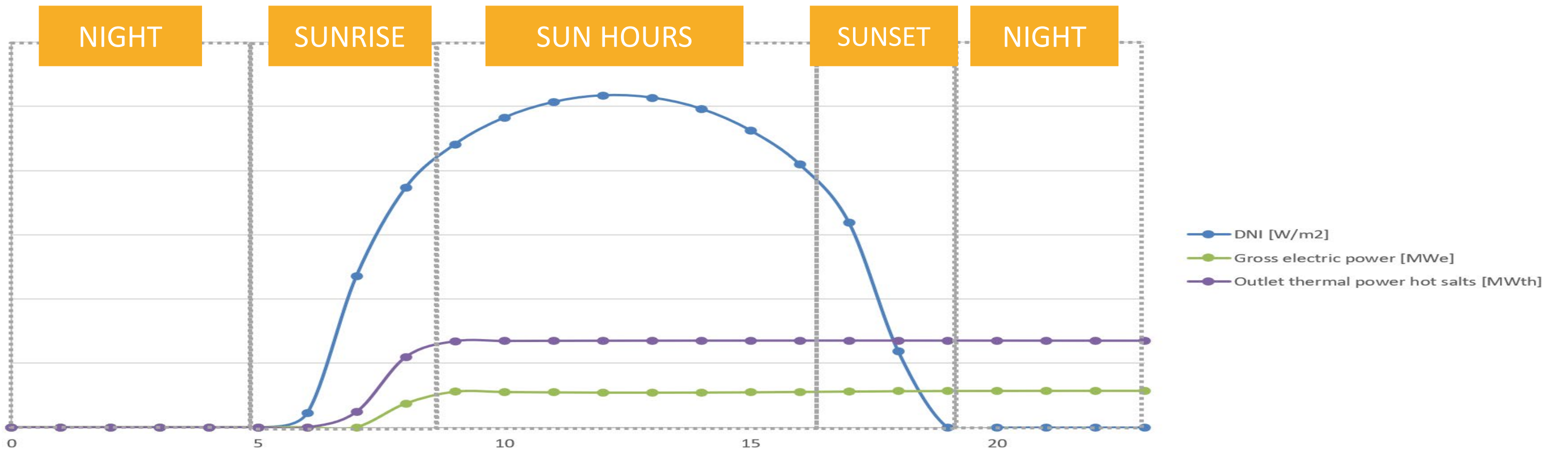


Objective: Prevent salts from freezing

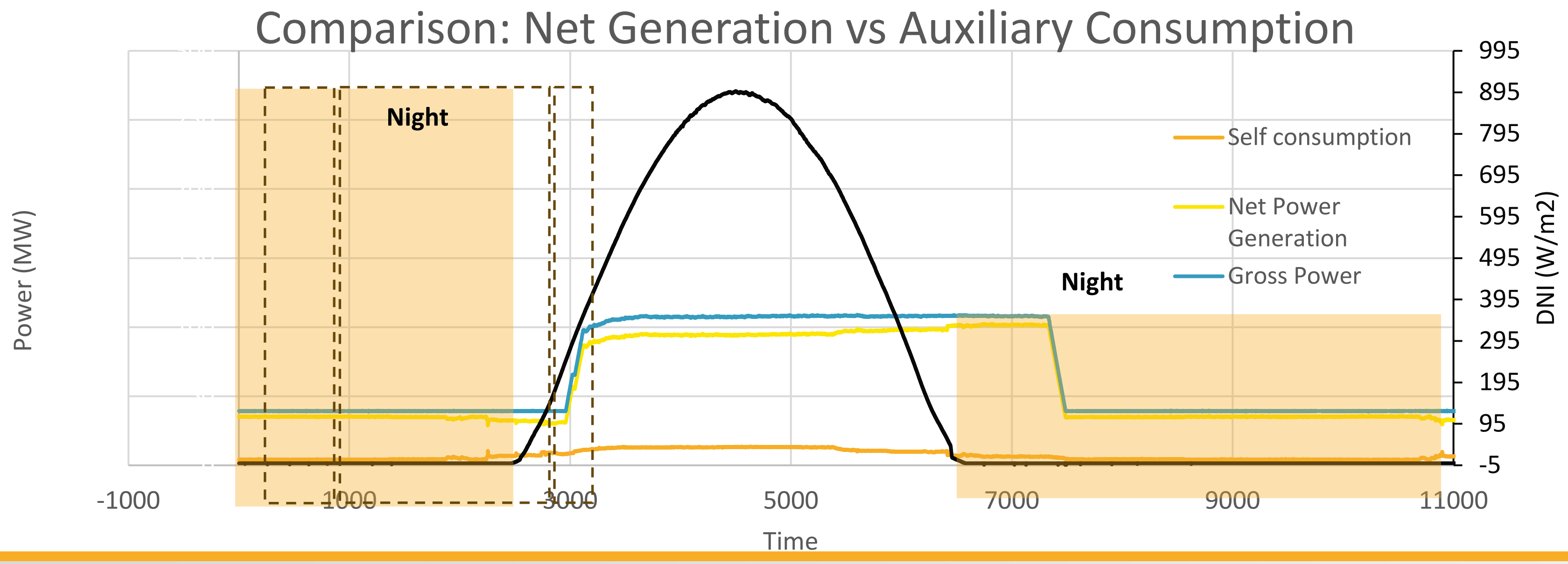
Temperature Control ON-OFF overnight

Source of energy consumption between days

6. Comparison between Model and Data



Load: The performance model only consider full capacity. The selected data represents a day at partial load.



7. Conclusions

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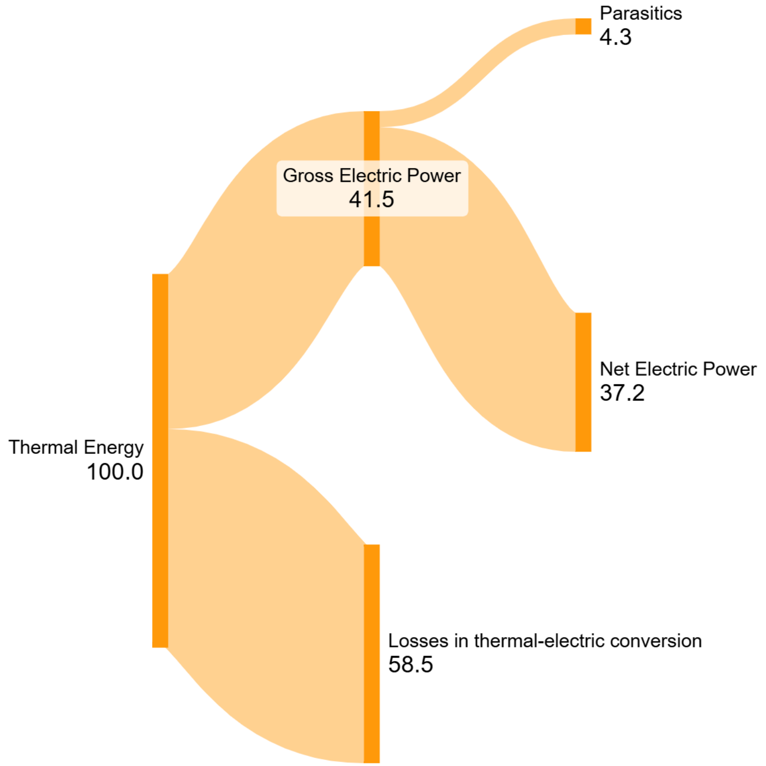
- The final results of this initial analysis that could be implemented in a simulation software for the SolarX project are:

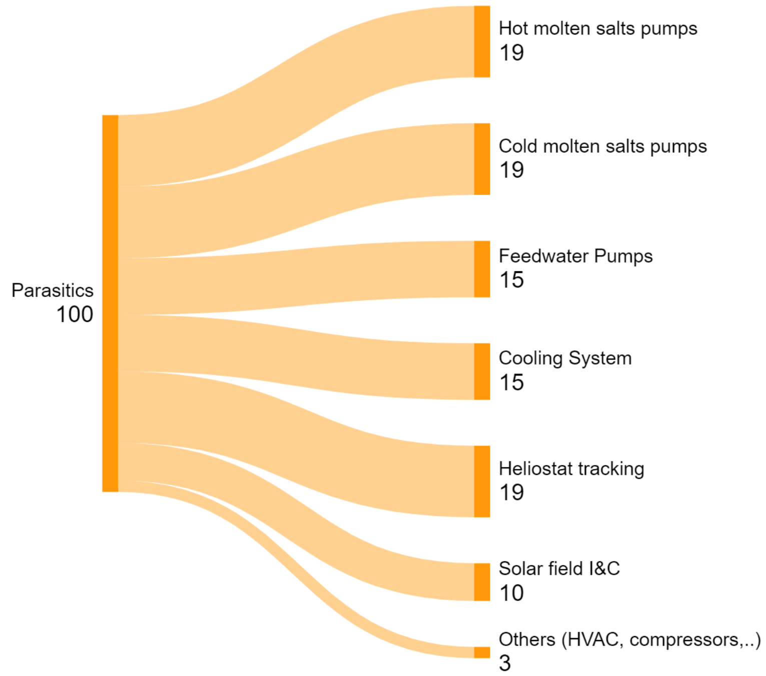
Type of operation	Parasitic consumption	Electric Consumption with respect to the gross	Probability
Continuous generation overnight	0.5 MWe	7-10%	Very likely (95%)
Turbine start-up	1.1 MWe	11-13%	Very unlikely (4%)
Including steam generation	1.7 MWe	15-17%	Very unlikely (1%)

Thank you!

7.1. Distribution of energy in a CSP plant.

Operation case: during day with salt heating and electric production





Note: All units are in percentage. Values are pending confirmation from Cerro Dominador.

9. Next steps

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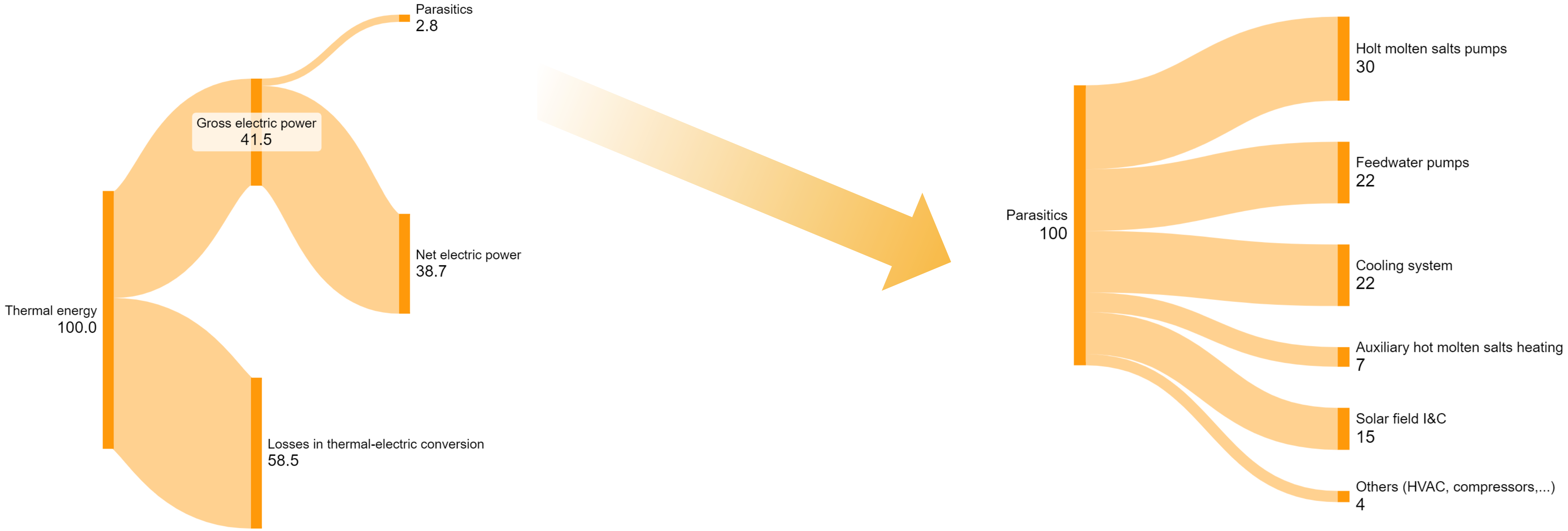
- Validate the performance model results with real operational data from Cerro Dominador
- Redifine the scaling losses factor by reducign from 110 MW to 12,5 MW (aprox 10 times less)
- Include this information as part of the deliverable

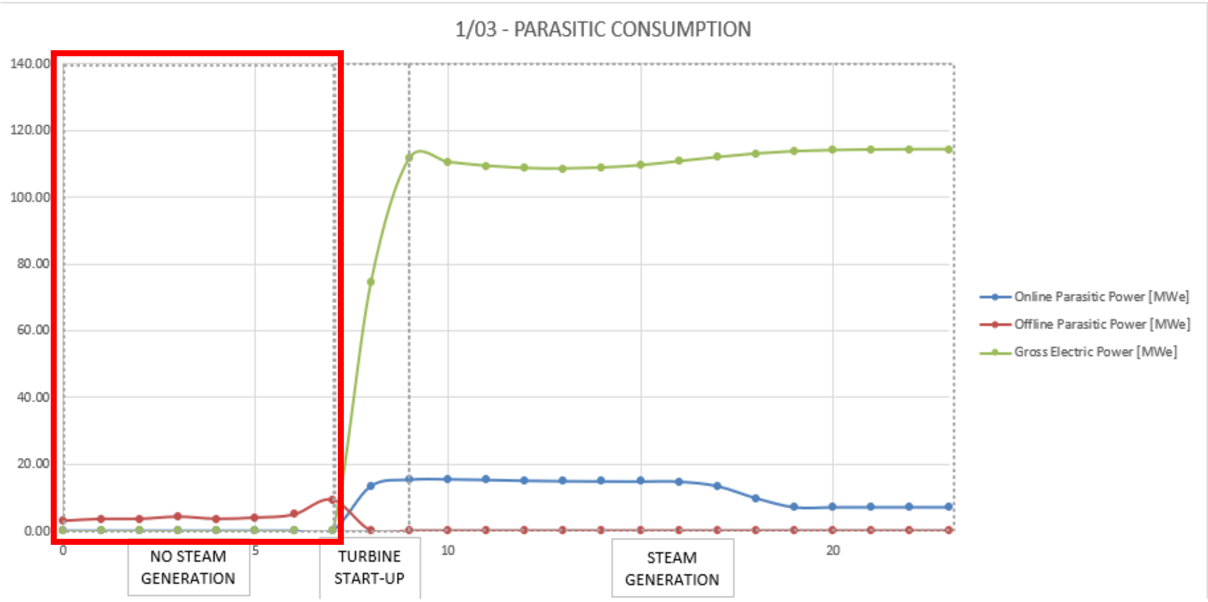
7.1. Distribution of energy in a CSP plant.

Operation case: during night with electric production.



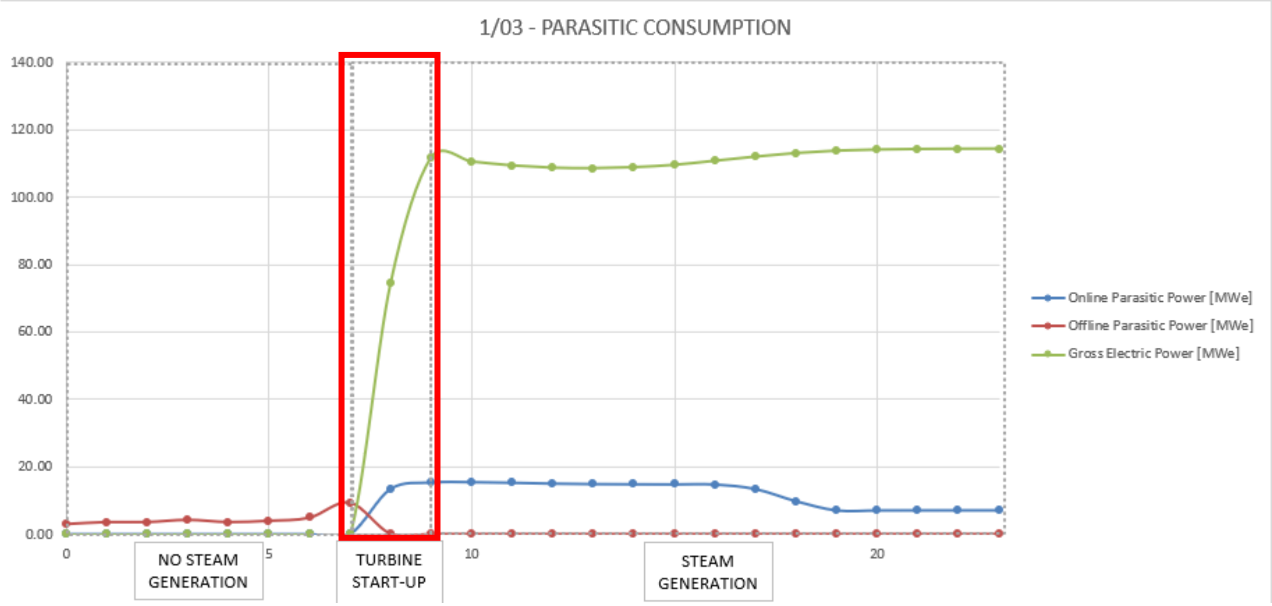
Note: All units are in percentage. Values are pending confirmation from Cerro Dominador.

7.2. Parasitic consumption without steam generation



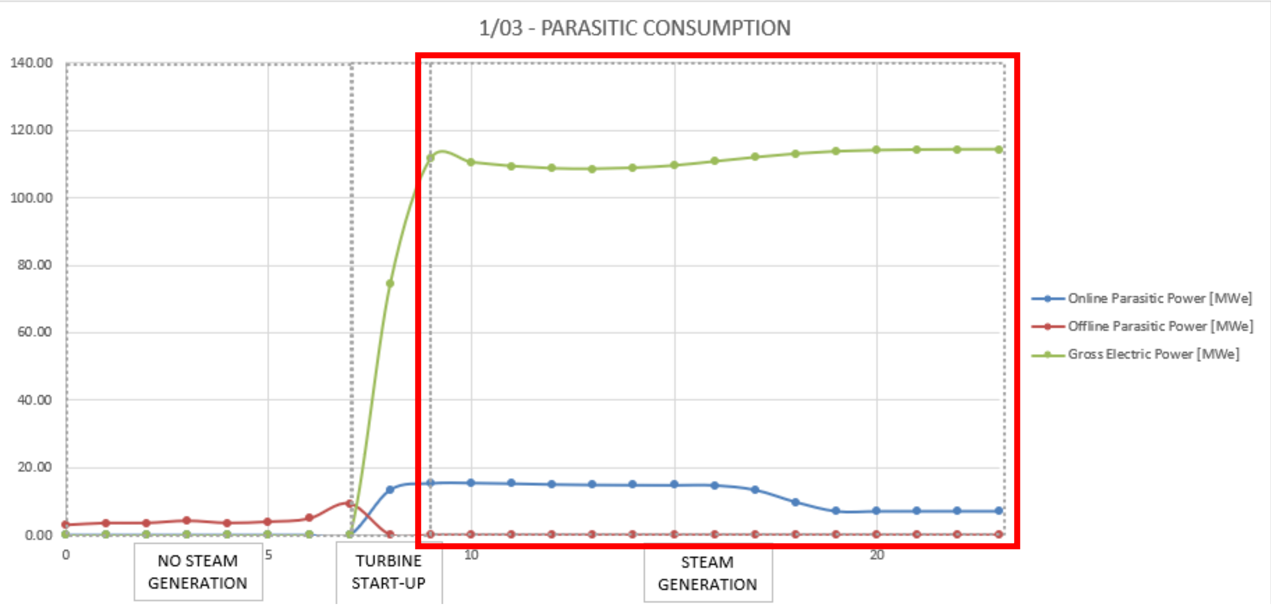
- Cerro Dominador has a parasitic consumption, when it is not generating steam, of 4.33 MWe.
- Down-scaling to SolarX size represents a parasitic power of 0.5 MWe

7.3. Parasitic consumption at turbine start-up



- Cerro Dominador has a parasitic consumption, at the start-up of the turbine, of 10.2 MWe.
- Down-scaling to SolarX size represents a parasitic power of 1.1 MWe.

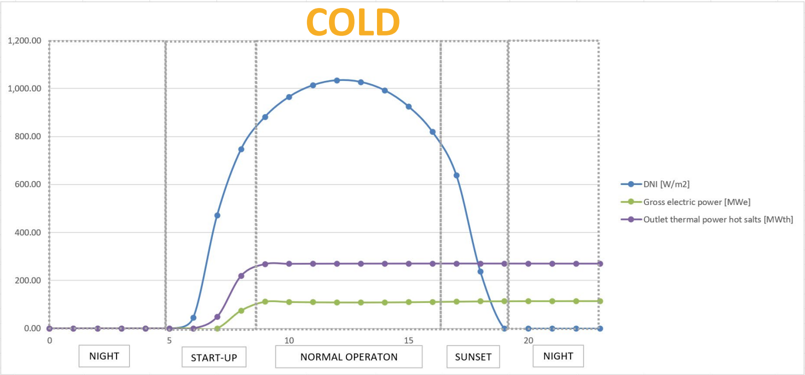
7.4. Parasitic consumption with steam generation

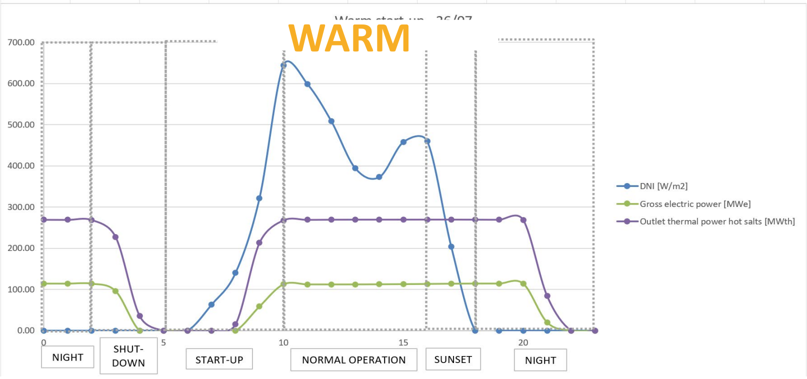


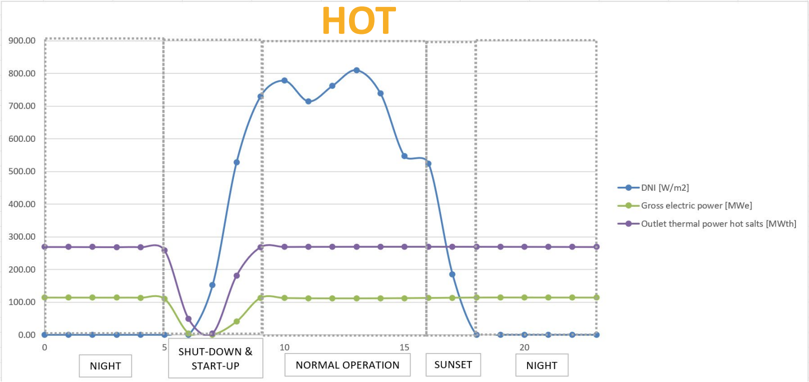
- Cerro Dominador has an avarage parasitic consumption, at the start-up of the turbine, of 15,5 MWe.
- Down-scaling to SolarX size represents a parasitic power of 1.7 MWe.

8. Conclusions

- The final results of this initial analysis that could be implemented in a simulation software for the SolarX project are:







Start-up type	Time from the last start	Thermal energy required	Hours required
Cold	More than 24h	30 MWth	3h*
Warm	Between 4h and 14 h	25 MWth	1,5h
Hot	Less 4h	20 MWth	30 min

Cold start-up not have been fully characterized.