WEBINAR

TVP SOLAR

Hubs4Circularity
COMMUNITY OF PRACTICE

FROM DESIGN TO IMPLEMENTATION: SOFTWARE TOOLS IN DISTRICT HEATING

A CASE OF THESEUS AND HURRICANE PROJECT

SESSION 2

PERFORMANCE ASSESSMENT AND OPTIMIZATION OF SDHC SYSTEMS

Funded by the European Union

Michele Musto, Project Engineer, TVP Solar SA
Dimitris Papageorgiou, Innovation Funding Manager, TVP Solar SA

11 March 2026

Performance assessment of SDH Systems

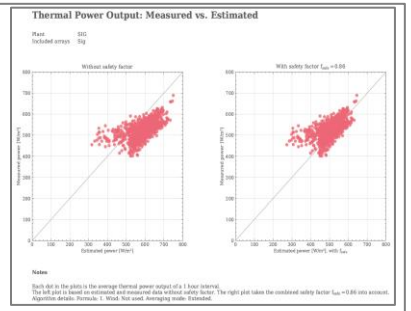
EN ISO 24194

Hubs4Circularity
COMMUNITY OF PRACTICE

Funded by the European Union

TVP SOLAR

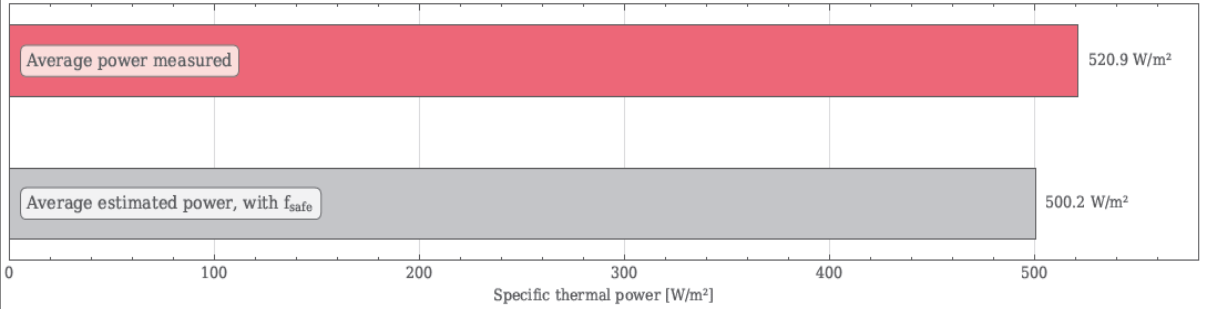
Power Check according to ISO 24194:2022



Plant SIG
Included arrays Sig

Power Check fulfilled:

Ratio measured / estimated power = 104.1%
This takes a combined safety factor f_{safe} = 0.86 into account.



Notes

The minimum number of intervals (20, defined in ISO 24194:2022) has been reached: n=859 intervals found, each 1 hour long.
Data from 2023-01-01 12:03 (UTC+1) to 2026-01-06 07:49 (UTC+1).

Power Check according to ISO 24194:2022
Algorithm details: Formula: 1. Wind: Not used. Averaging mode: Extended.

5. Procedure for checking the power performance of solar thermal collector fields

Daily Yield Method Report - ISO 24194:2022

Owner of Plant:	SIG	Check done by:	TVP Solar SA		
Mesauring Period:	01/08/2025 to 31/08/2025	Date:	01/09/2025		
Level of Check:	III	Equation used:	(20)		
Imput data Collector		**Imput data system**			
Manufacturer:	TVP Solar	Location Name	Geneve		
Collector Name:	MT-Power V4	Longitude	6.10°		
Certification type:	Solar Keymark	Latitude	46.21°		
Certificate No.	011-7S1890F	Agf:	[m²]		
Parameters		w/S	[-]	55.71%	
- Ag: [m²]	1,96	Vpipe:	[m³]	1.61	
- n0,hem:	0,732	Lpipe:	[m]	870	
- n0,b:	-	fSH:		0,98	
- Kd:	0,95	fsafe:		0,9	
- Khem,av:	0,9785				
- a1,dQ: [W/(m²K)]	0,5	**Project TVP ID: 2018_052**			
- TdQ (a2) [W/(m²K²)]	0,006				
- C/Ag (a5) [J/(m²K)]	15320				

Date	Time start	Time End	H_beam [kWh/m²]	H_global_tilted [kWh/m²]	T_mean_fluid [°C]	T_mean_fluid_start [°C]	T_mean_fluid_end [°C]	T_mean_fluid_se [°C]	ρm [kg/m³]	c_p_fluid [kJ/kg·K]	Q_est_system [MWh]	Q_measured_system [MWh]	Performance Energy (PE) ratio	Performance Energy (PE) ratio
2025-08-01	2025-08-01 10:33:00	2025-08-01 17:39:00	4,09	576,70	77,34	76,34	76,14	76,24	982,93	3,98	1,77	2,02	1,14	114,2%
2025-08-02	2025-08-02 10:35:00	2025-08-02 18:15:00	4,81	627,86	77,91	80,06	72,09	76,07	982,53	3,98	2,11	2,28	1,08	108,1%
2025-08-03	2025-08-03 10:44:00	2025-08-03 16:56:00	4,53	731,36	77,54	75,10	72,83	73,96	982,80	3,98	2,01	2,20	1,10	109,5%
2025-08-04	2025-08-04 10:47:00	2025-08-04 17:47:00	5,00	714,85	76,87	74,63	73,57	74,10	983,26	3,98	2,24	2,41	1,08	107,6%
2025-08-05	2025-08-05 10:42:00	2025-08-05 17:54:00	4,92	682,96	77,89	72,97	74,48	73,72	982,55	3,98	2,19	2,35	1,07	106,9%
2025-08-06	2025-08-06 11:10:00	2025-08-06 17:33:00	4,28	670,08	75,80	75,42	73,29	74,36	983,99	3,98	1,89	1,95	1,03	102,9%
2025-08-07	2025-08-07 10:44:00	2025-08-07 18:13:00	6,38	852,06	78,49	77,19	72,25	74,72	982,14	3,98	2,95	3,09	1,05	104,9%
2025-08-08	2025-08-08 10:45:00	2025-08-08 18:07:00	5,72	776,42	78,29	76,01	72,61	74,31	982,28	3,98	2,64	2,81	1,06	106,5%
2025-08-09	2025-08-09 10:44:00	2025-08-09 17:57:00	5,52	764,43	78,20	75,04	72,88	73,96	982,34	3,98	2,56	2,75	1,07	107,4%
2025-08-10	2025-08-10 10:44:00	2025-08-10 17:54:00	5,65	788,99	78,40	75,54	72,85	74,20	982,20	3,98	2,61	2,77	1,06	106,2%
2025-08-11	2025-08-11 10:45:00	2025-08-11 17:55:00	5,56	775,65	78,34	74,61	74,12	74,37	982,24	3,98	2,54	2,70	1,07	106,5%
2025-08-12	2025-08-12 10:46:00	2025-08-12 17:50:00	5,40	764,54	78,07	75,51	72,65	74,08	982,43	3,98	2,50	2,68	1,07	107,0%
2025-08-13	2025-08-13 10:48:00	2025-08-13 17:44:00	5,21	751,53	77,75	74,11	73,02	73,57	982,65	3,98	2,40	2,54	1,06	105,7%
2025-08-14	2025-08-14 10:47:00	2025-08-14 16:20:00	4,62	832,96	78,63	76,40	76,15	76,27	982,04	3,98	2,13	2,48	1,17	116,5%
2025-08-15	2025-08-15 10:50:00	2025-08-15 18:38:00	3,86	494,72	78,49	76,17	73,50	74,84	982,14	3,98	1,66	1,92	1,15	115,4%
2025-08-16	2025-08-16 10:52:00	2025-08-16 17:58:00	4,82	678,39	77,44	74,88	71,53	73,20	982,86	3,98	2,19	2,32	1,05	105,5%
2025-08-17	2025-08-17 10:48:00	2025-08-17 17:30:00	5,36	800,16	78,07	73,76	74,30	74,03	982,43	3,98	2,43	2,57	1,06	105,6%
2025-08-18	2025-08-18 10:52:00	2025-08-18 17:35:00	5,58	830,27	78,28	74,62	73,75	74,19	982,28	3,98	2,55	2,72	1,06	106,5%
2025-08-19	2025-08-19 10:44:00	2025-08-19 17:54:00	5,65	788,99	78,40	75,54	72,85	74,20	982,20	3,98	2,61	2,77	1,06	106,2%
2025-08-20	2025-08-20 10:45:00	2025-08-20 18:07:00	5,72	776,42	78,29	76,01	72,61	74,31	982,28	3,98	2,64	2,81	1,06	106,5%
2025-08-21	2025-08-21 10:46:00	2025-08-21 17:50:00	5,40	764,54	78,07	75,51	72,65	74,08	982,43	3,98	2,50	2,68	1,07	107,0%
2025-08-22	2025-08-22 10:56:00	2025-08-22 17:57:00	5,39	768,05	77,80	75,66	71,39	73,53	982,61	3,98	2,43	2,55	1,05	104,9%
2025-08-23	2025-08-23 10:59:00	2025-08-23 17:31:00	4,89	747,78	76,97	76,40	77,27	76,84	983,19	3,98	2,18	2,50	1,15	114,6%
2025-08-24	2025-08-24 10:57:00	2025-08-24 17:36:00	5,51	828,40	78,00	76,78	73,49	75,13	982,47	3,98	2,50	2,75	1,10	110,0%
2025-08-25	2025-08-25 11:00:00	2025-08-25 17:21:00	4,78	752,78	77,40	75,80	71,98	73,89	982,89	3,98	2,17	2,42	1,11	111,4%
2025-08-26	2025-08-26 10:59:00	2025-08-26 17:06:00	4,35	711,17	77,39	75,43	71,95	73,69	982,90	3,98	1,98	2,20	1,11	110,8%
2025-08-27	2025-08-27 10:57:00	2025-08-27 17:36:00	5,51	828,40	78,00	76,78	73,49	75,13	982,47	3,98	2,50	2,75	1,10	110,0%
2025-08-28	2025-08-28 11:00:00	2025-08-28 17:21:00	4,78	752,78	77,40	75,80	71,98	73,89	982,89	3,98	2,17	2,42	1,11	111,4%
2025-08-29	2025-08-29 11:16:00	2025-08-29 16:46:00	2,31	419,31	75,85	72,88	79,13	76,00	983,96	3,98	0,87	1,19	1,36	136,4%
2025-08-30	2025-08-30 11:43:00	2025-08-30 17:47:00	3,54	582,82	77,06	77,91	73,07	75,49	983,12	3,98	1,52	1,85	1,22	121,8%
2025-08-31	2025-08-31 11:02:00	2025-08-31 17:37:00	5,06	768,35	77,87	75,66	73,56	74,61	982,57	3,98	2,28	2,53	1,11	111,1%

6. Procedure for checking the daily yield (Energy Performance) of solar thermal collector fields

Performance assessment of SDH Systems

EN ISO 24194 – PE ratio Monitoring

Hubs4Circularity
COMMUNITY OF PRACTICE

Funded by the European Union

TVP SOLAR

- $Q_{HM,d}$ Daily yield measurement of the heat meter
- $Q_{estimate\text{-}sys,d}$ Daily yield estimation of solar thermal system

$$PE_{ratio} = Q_{HM,d} / Q_{estimate\text{-}sys,d} \geq 1 \rightarrow \text{Estimate verified}$$

KEY INDICATOR

PE Ratio

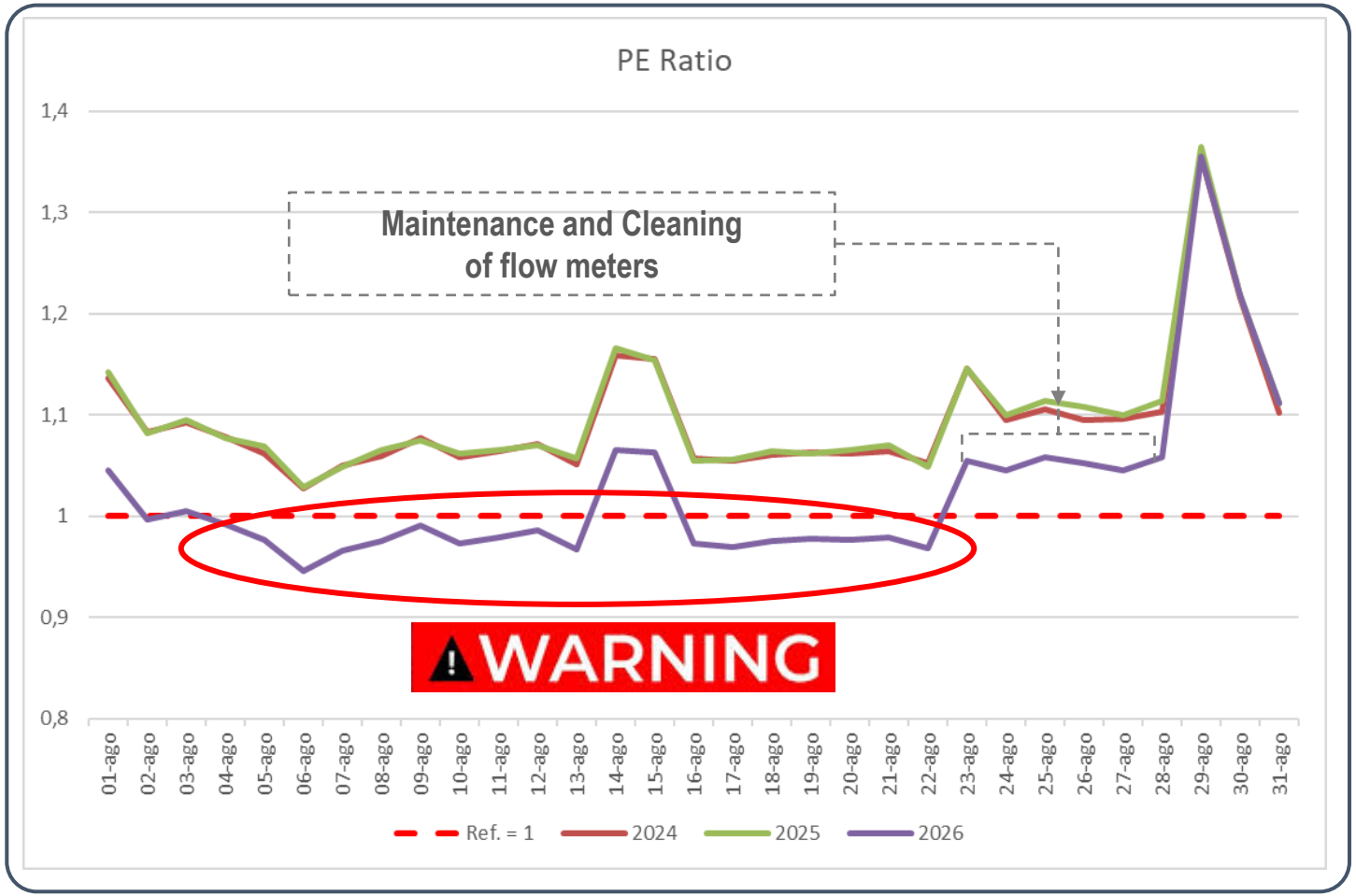
$$Q_{HM,d} / Q_{estimate\text{-}sys,d}$$

Ratio between the energy measured by the heat meter (SCADA) and the energy estimated under the same boundary conditions (ISO 24194 model).

Performance Target

≥ 1.0

(Measured ≥ Estimated)



Illustrative Example

Hypothesis: PE Ratio trend under the same boundary conditions

Performance assessment of SDH Systems

Supervisory Control and Data Acquisition (SCADA) System

Hubs4Circularity
COMMUNITY OF PRACTICE

Funded by the European Union

TVP SOLAR

SCADA System

Real-Time Supervision & HMI

Intuitive graphical interfaces (HMI) to monitor processes in real time, visualize plant status, and access all operational parameters remotely.

Data Acquisition & Storage

Continuous collection of data from sensors, motors, and field instrumentation, with historical storage for further analysis and reporting.

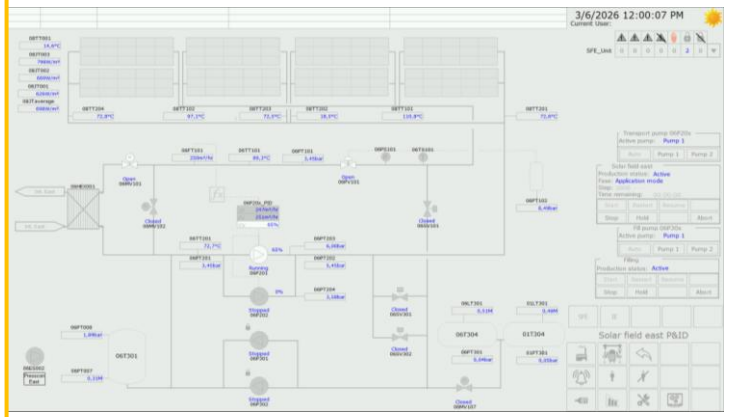
Remote Device Control

Direct management of actuators such as pumps, control valves, and Variable Frequency Drives (VFDs) to modulate plant operation.

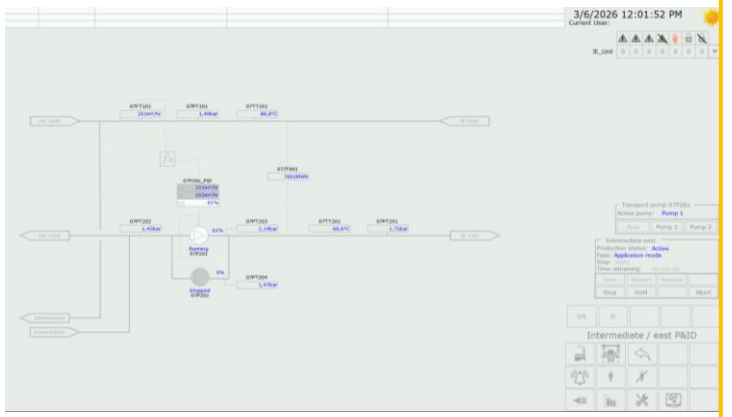
Alarm & Event Management

Real-time alerting system for anomalies and critical alarms, enabling operators to intervene promptly and ensure system safety.

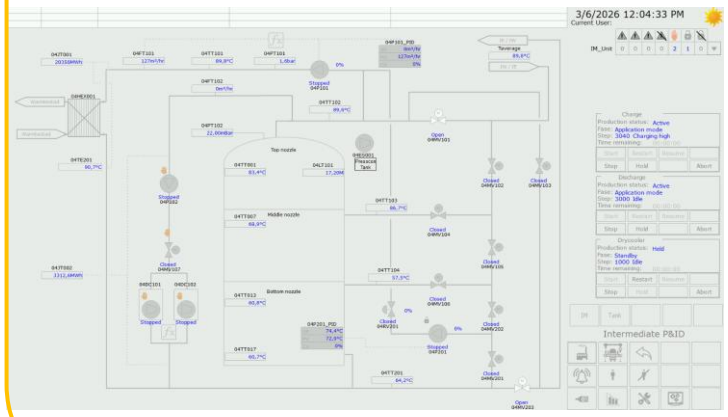
Zonthermiepark Dorkwerd SCADA



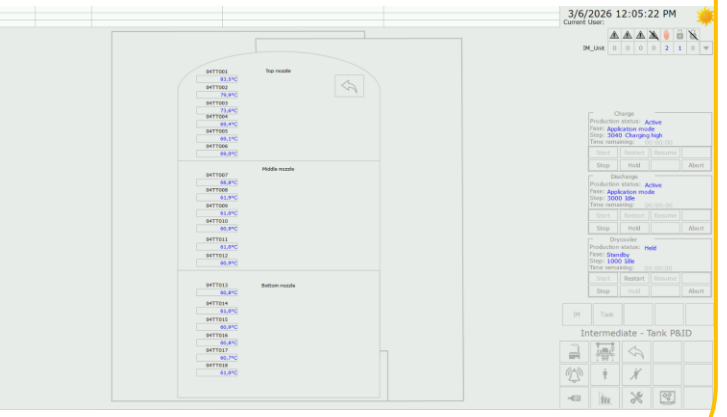
East Section Solar Field (Primary Side)



East Section Secondary Side



TES Tank Charging / Discharging Section



Thermal Energy Storage Tank

Performance assessment of SDH Systems

Data Analysis Tools

Hubs4Circularity
COMMUNITY OF PRACTICE

Funded by the European Union

TVP SOLAR

Data Analysis Tools Grafana

Open-Source Platform

Grafana is a leading standard for data analysis and interactive visualization. It enables the aggregation of metrics from multiple sources into a single, consistent interface.

Dynamic Dashboards

Creation of customizable dashboards that provide an immediate visual representation of processes, helping to quickly interpret large volumes of operational data.

Query & Alerting

Advanced capability to run complex queries and set automatic alerts on critical thresholds, enabling proactive monitoring of anomalies.

Decision Support

Facilitates the identification of trends, inconsistencies, and hidden correlations, supporting operators in improving process efficiency and optimizing performance.

Zonthermiepark Dorkwerd – Grafana Data Analysis

Optimization of SDH Systems

Operating Logic & Functional Design Specification

Hubs4Circularity
COMMUNITY OF PRACTICE

Funded by the European Union

TVP SOLAR

The control logic represent the operational philosophy of the solar thermal plant
It defines how the system automatically manages the different operating conditions.

1. Design

- ❑ Definition of the Operating Philosophy
- ❑ Integration of the Solar Field and TES
- ❑ Optimized Hydraulic Sizing
- ❑ Strategic Component Selection

2. Commissioning

- ✓ Fine Tuning of Setpoints
- ✓ PID Parameter Tuning
- ✓ Alarm Threshold Configuration
- ✓ Source Priority Definition

3. Operation

- ○ Continuous KPI Monitoring (PE Ratio)
- ○ Performance and ΔT Analysis
- ○ Fine-tuning based on Real Data
- ○ Predictive Maintenance

Continuous Optimization Cycle 🔄

Optimization of SDH Systems

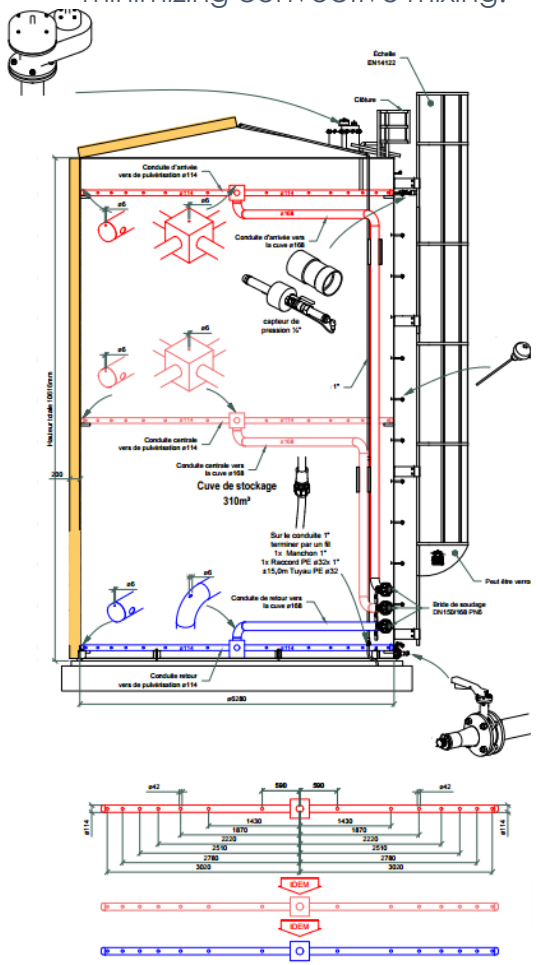
Thermal Energy Storage (TES) Management

Hubs4Circularity
COMMUNITY OF PRACTICE

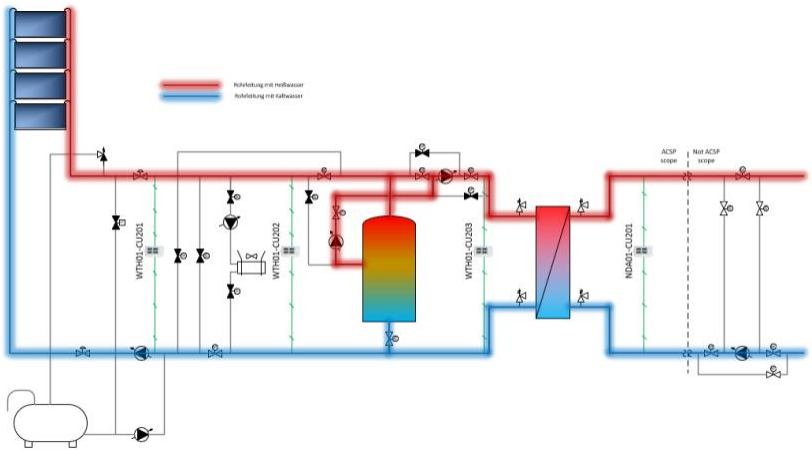
Funded by the European Union

TVP SOLAR

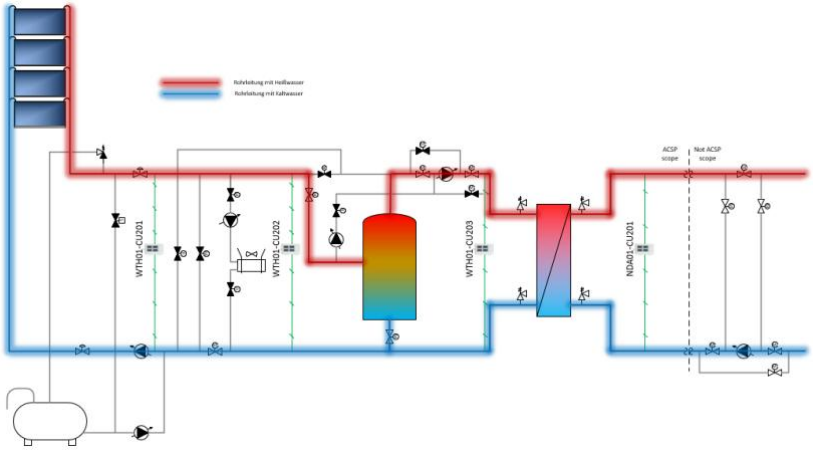
TES internal diffusers design to ensure outlet water velocities typically ≤ 0.03 m/s, minimizing convective mixing.



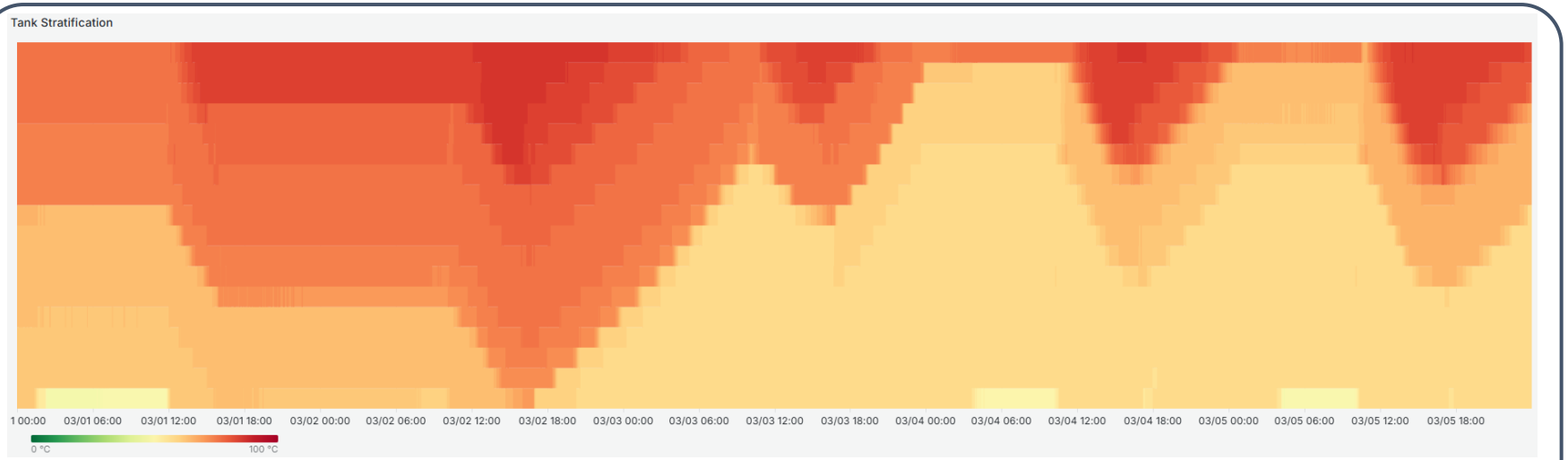
Charging control logic dynamically selects the appropriate inlet to preserve the stability of the thermocline



Normal operation - Tank Charging Top-Nozzle



Solar Field Shutdown - Tank Charging Middle-Nozzle



Zonthermiepark Dorkwerd (Grafana) – TES Tank Temperatures and Stratification Monitoring

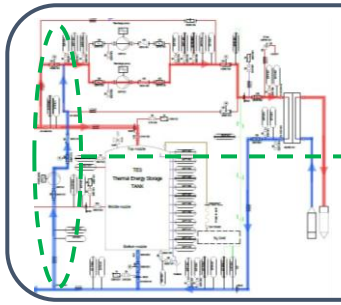
Optimization of SDH Systems

Integrated Control Loops

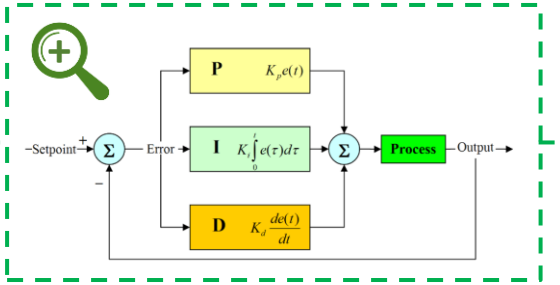
Hubs4Circularity
COMMUNITY OF PRACTICE

Funded by the European Union

TVP SOLAR



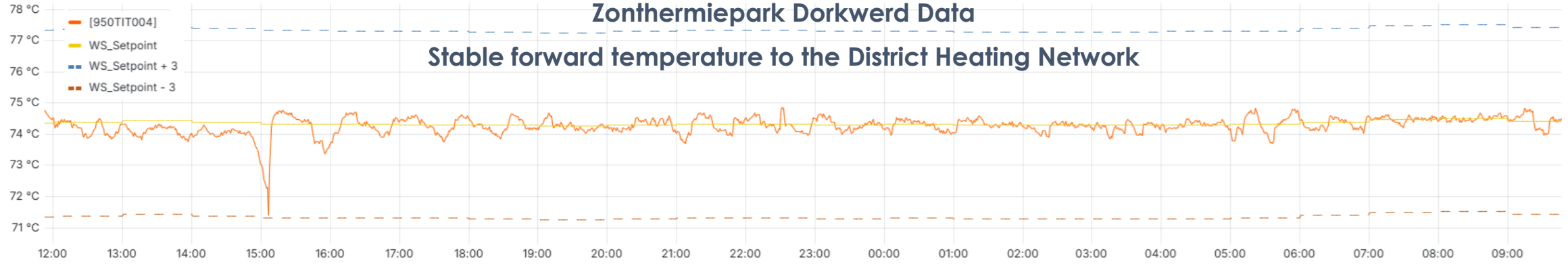
Shunting Branch
Double PID control

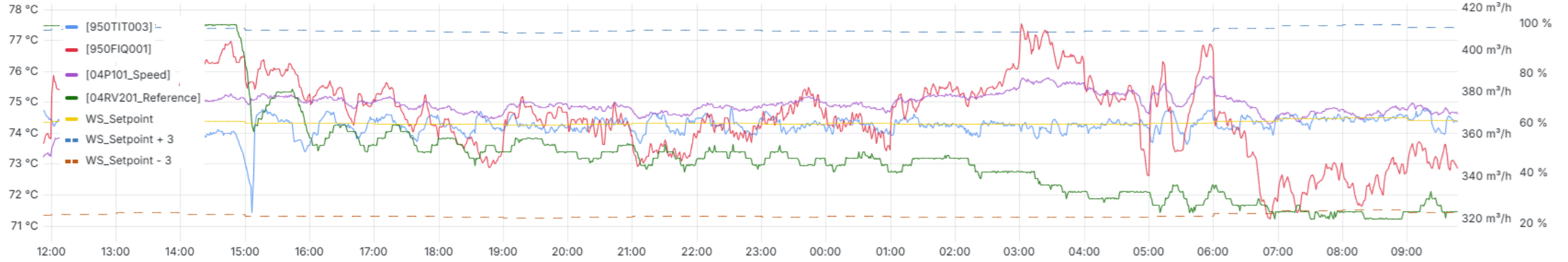


- Advanced PID Controls
- VFD-Based Modulation
- Control Valve Coordination

Zonthermiepark Dorkwerd Data

Stable forward temperature to the District Heating Network





Optimization of SDH Systems

Performance Examples of Real SDH TVP's Systems

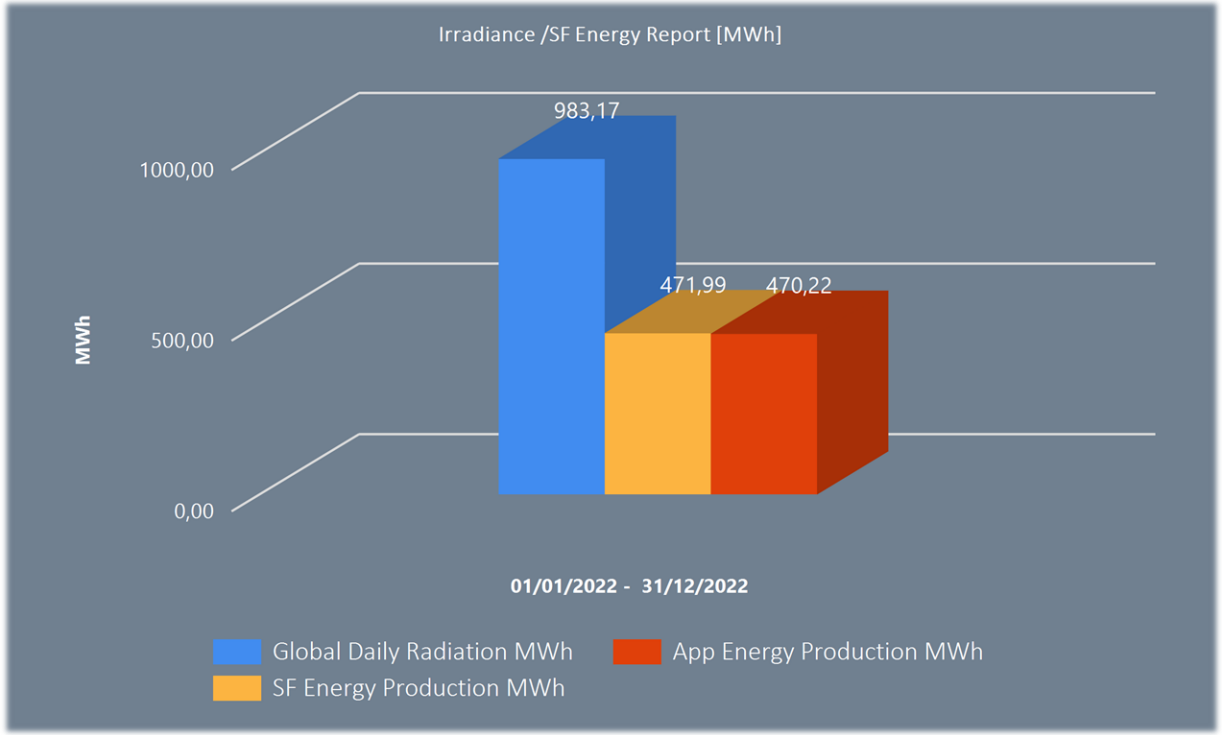
Hubs4Circularity
COMMUNITY OF PRACTICE

Funded by the European Union

TVP SOLAR

Geneva (Switzerland) SDH System

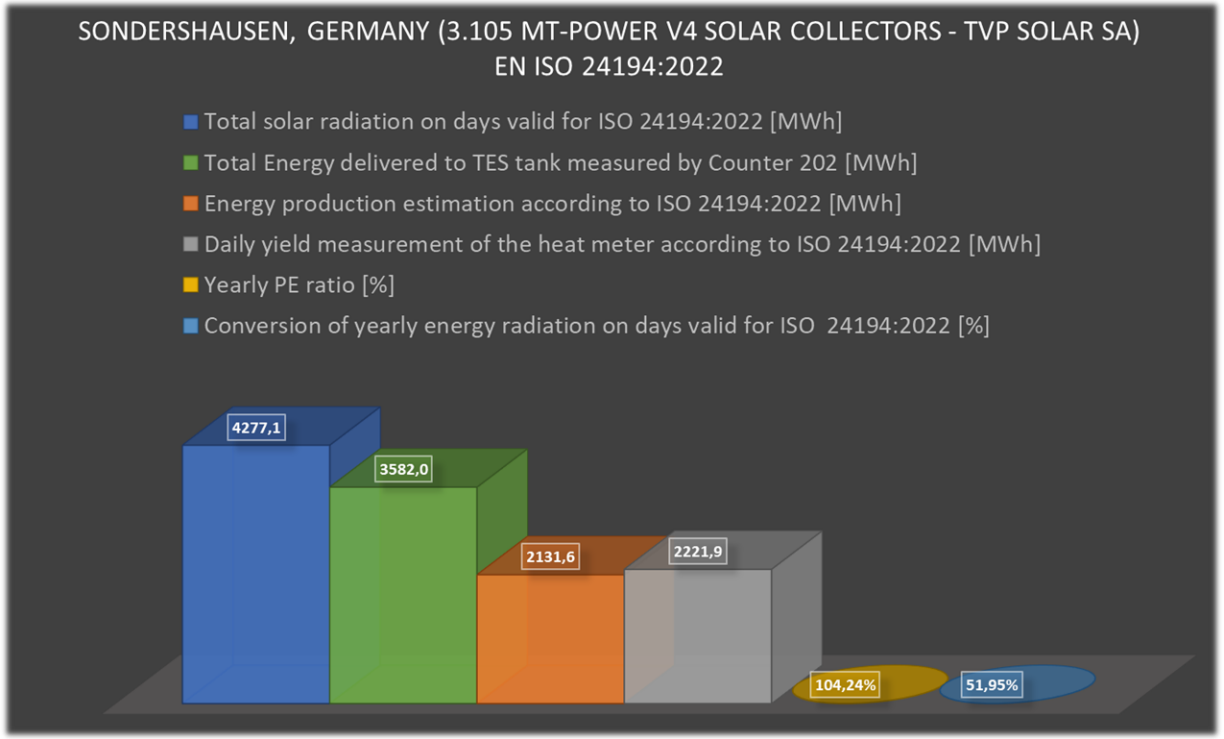
Year: 2022



400	470	50 %
MT-Power panels	MWh Delivered	Conversion

Sondershausen (Germany) SDH System

Year: 2025



3.105	3.582	52 %
MT-Power panels	MWh Delivered	Conversion

« I think having land and not ruining it is the most beautiful art that anybody could ever want »

- ANDY WARHOL -

Thank you for your attention!

🙏

Michele Musto,
Project Engineer, TVP Solar
musto@tvpsolar.com

Dimitris Papageorgiou,
Innovation Funding Manager, TVP Solar
papageorgiou@tvpsolar.com