



TVP  **SOLAR**
Thermal Vacuum Power

SIG SolarCAD II installation: 3-year results (2021-2023)

January 2024

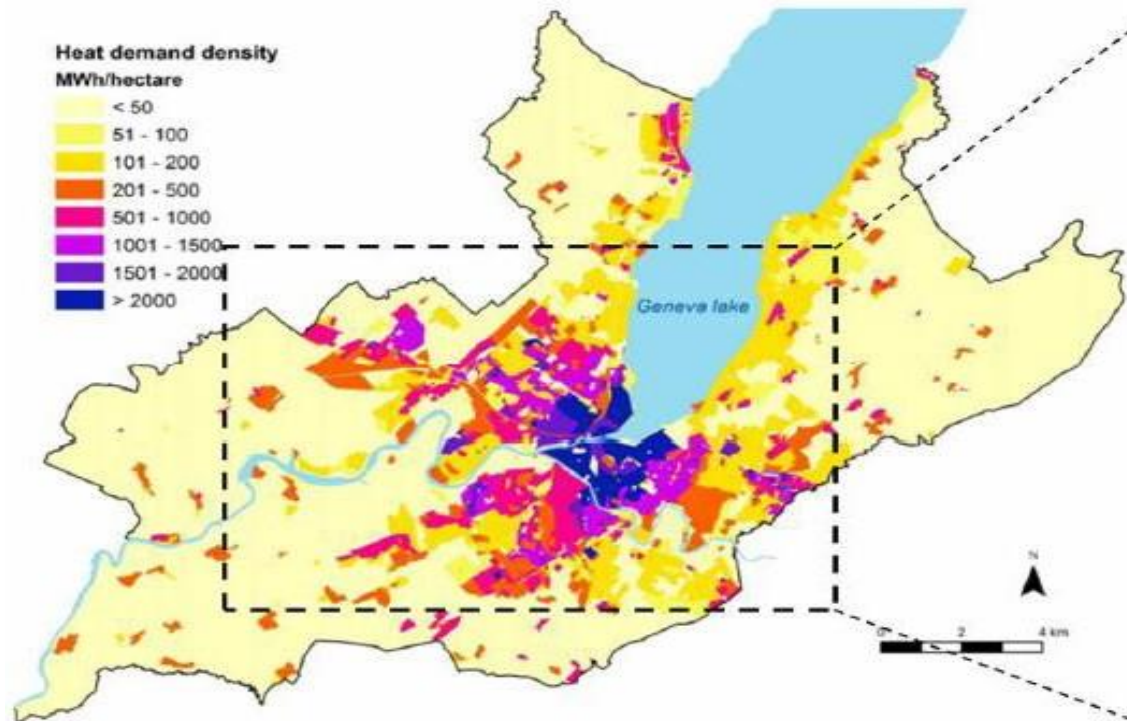
Geneva District Heating Network

The SIG DH is in operation since 1960. Operating temperatures: $T_{supply}=120^{\circ}\text{C}$ $T_{ret}=70^{\circ}\text{C}$. More than 105 km of pipes.

GWh delivered in 2010 : 200 GWh

GWh delivered in 2020 : 473 GWh (Heat: 438 GWh, Cooling : 35 GWh) – 50% fossil-free energy

2030 Goal (Geneva Plan) : 1'300 GWh with 80% renewable energy



Solar CAD II Project



TVP



SOLAR



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Fondation Suisse
pour le Climat

784 m² Solar Thermal Plant integrated on CAD SIG District Heating Network to produce >80°C hot water all year round

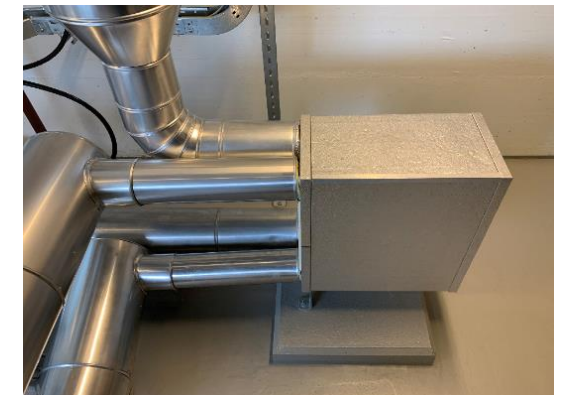


SolarCAD II - Specs

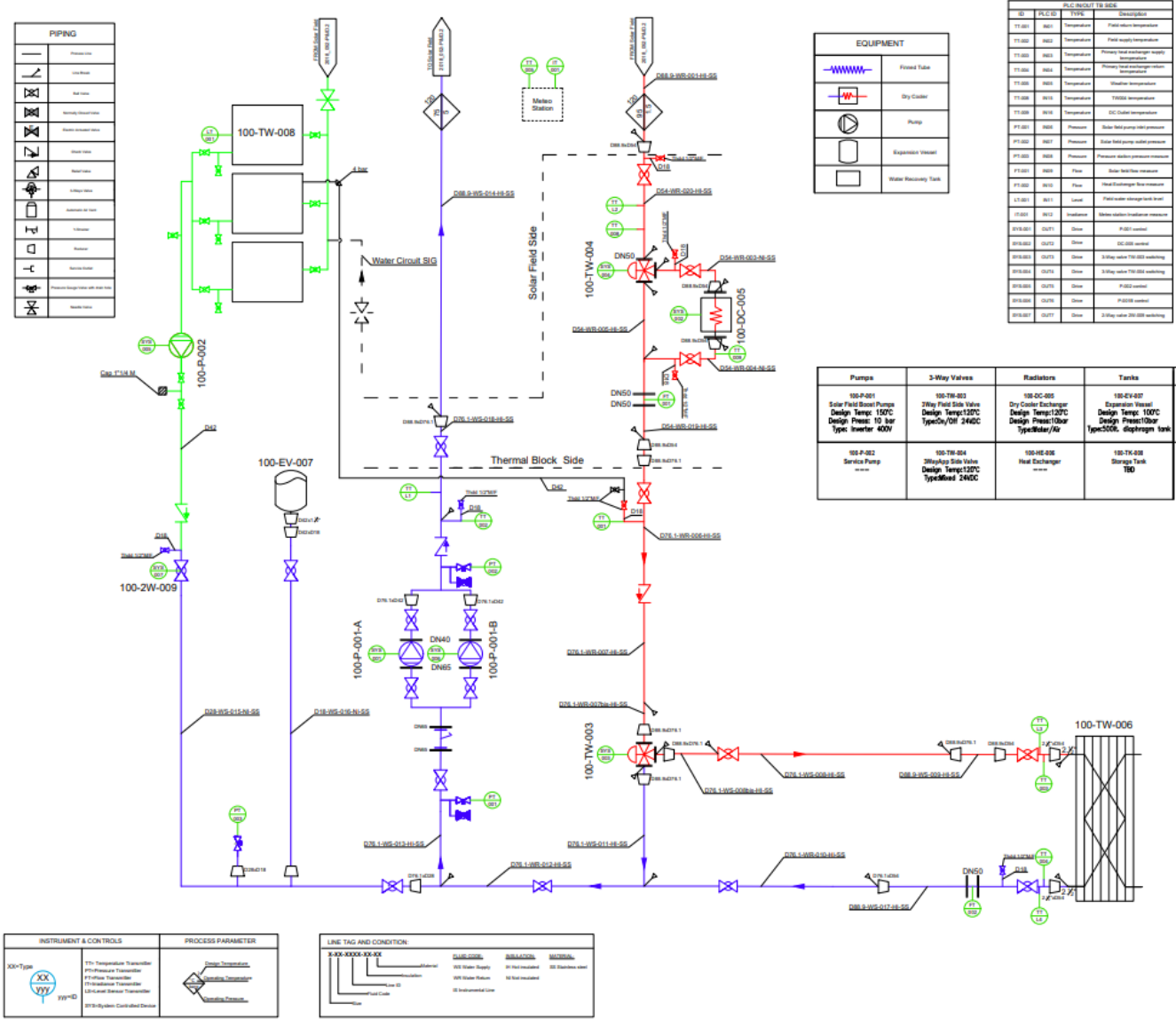
Services Industriels de Genève Switzerland

Installed Power	546	kW
Production Target	516	MWh/y
Operating T°C	>75	°C
Installation	Dec 2020	
Nb Panels	400	
Collector Gross Area	784	m ²
Fuel saved (year)	55'453	m ³ /gas
CO2 saved	130	tCO ₂ /y

GHI (kWh/m ² /y)	1'206
Inclination	17,5°
Orientation	South
Working Hours	daytime
Peak Eff.	67,3%
Storage	no



Solar Plant P&ID and Solar Field Layout



PIPING	
	Process
	Isolation Valve
	Solar Field Pump
	Dry Cooler
	Expansion Vessel
	Water Recovery Tank
	Control Valve
	Bypass Valve
	Instrument
	Electrical Connection
	Flow Indicator
	Temperature Measurement
	Pressure Measurement
	Level Measurement
	Density Measurement
	Viscosity Measurement

EQUIPMENT	
	Forced Fan
	Dry Cooler
	Pump
	Expansion Vessel
	Water Recovery Tank

P&ID PRODUCT TAG SIDE		
ID	P&ID ID	Description
T1.001	001	Temperature
T1.002	002	Temperature
T1.003	003	Temperature
T1.004	004	Temperature
T1.005	005	Temperature
T1.006	006	Temperature
T1.007	007	Temperature
P1.001	001	Pressure
P1.002	002	Pressure
P1.003	003	Pressure
P1.004	004	Pressure
P1.005	005	Pressure
P1.006	006	Pressure
P1.007	007	Pressure
L1.001	001	Level
L1.002	002	Level
L1.003	003	Level
L1.004	004	Level
L1.005	005	Level
L1.006	006	Level
L1.007	007	Level
D1.001	001	Density
D1.002	002	Density
D1.003	003	Density
D1.004	004	Density
D1.005	005	Density
D1.006	006	Density
D1.007	007	Density
V1.001	001	Viscosity
V1.002	002	Viscosity
V1.003	003	Viscosity
V1.004	004	Viscosity
V1.005	005	Viscosity
V1.006	006	Viscosity
V1.007	007	Viscosity

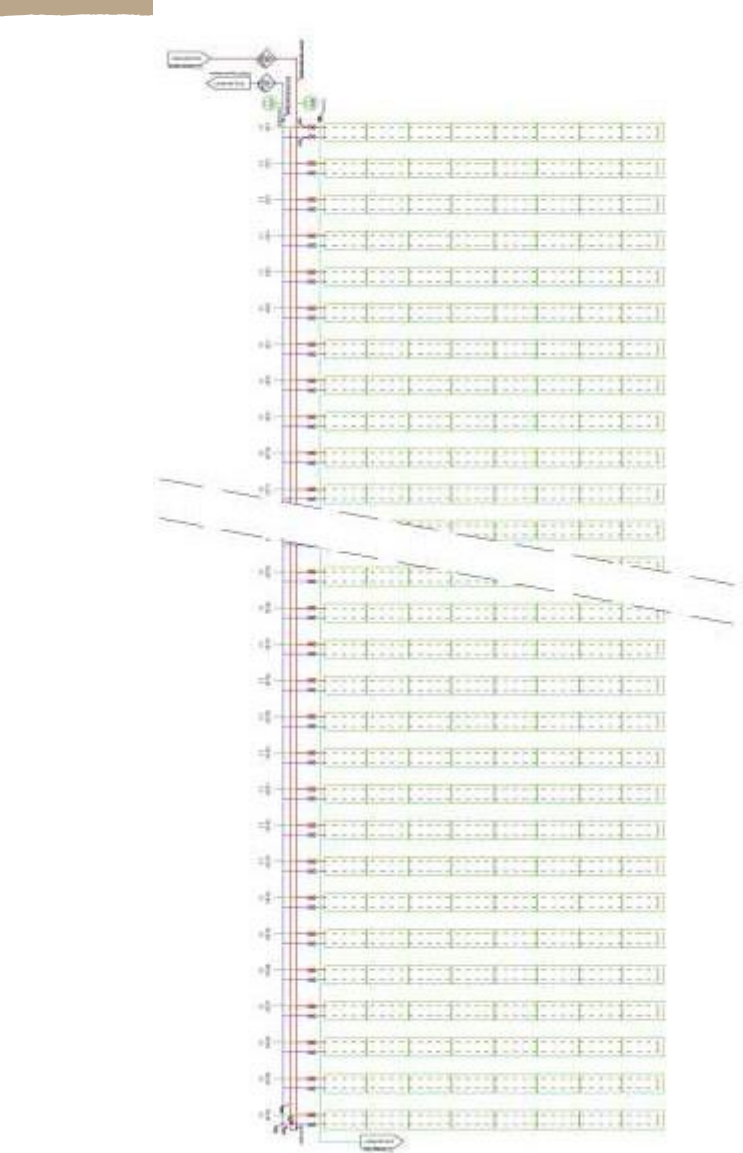
Pumps	3-Way Valves	Radiators	Tanks	2-Way Valves
100-P-001 Solar Field Boost Pump Design Temp: 150°C Design Press: 10 bar Type: Inverter 400V	100-TV-001 3-Way Field Side Valve Design Temp: 120°C Design Press: 10 bar Type: On/Off 24VDC	100-DC-002 Dry Cooler Exchanger Design Temp: 120°C Design Press: 10 bar Type: Solar/Air	100-EV-007 Expansion Vessel Design Temp: 100°C Design Press: 10 bar Type: 500L, diaphragm tank	100-SV-001 2-Way Ball Valve Design Temp: 200°C Design Press: 10 bar
100-P-002 Service Pump	100-TV-002 3-Way Field Side Valve Design Temp: 120°C Design Press: 10 bar	100-HE-001 Heat Exchanger	100-ST-001 Storage Tank 100	

INSTRUMENT & CONTROLS	
	Temperature Transmitter
	Pressure Transmitter
	Flow Transmitter
	Level Transmitter
	Density Transmitter
	Viscosity Transmitter
	Control Valve
	Isolation Valve
	Control Valve
	Isolation Valve
	Control Valve
	Isolation Valve
	Control Valve
	Isolation Valve

PROCESS PARAMETER	
	Temperature
	Pressure
	Flow
	Level
	Density
	Viscosity

LINE TAG AND CONDITION	
	Line Tag
	Condition
	Line Tag
	Condition
	Line Tag
	Condition
	Line Tag
	Condition
	Line Tag
	Condition

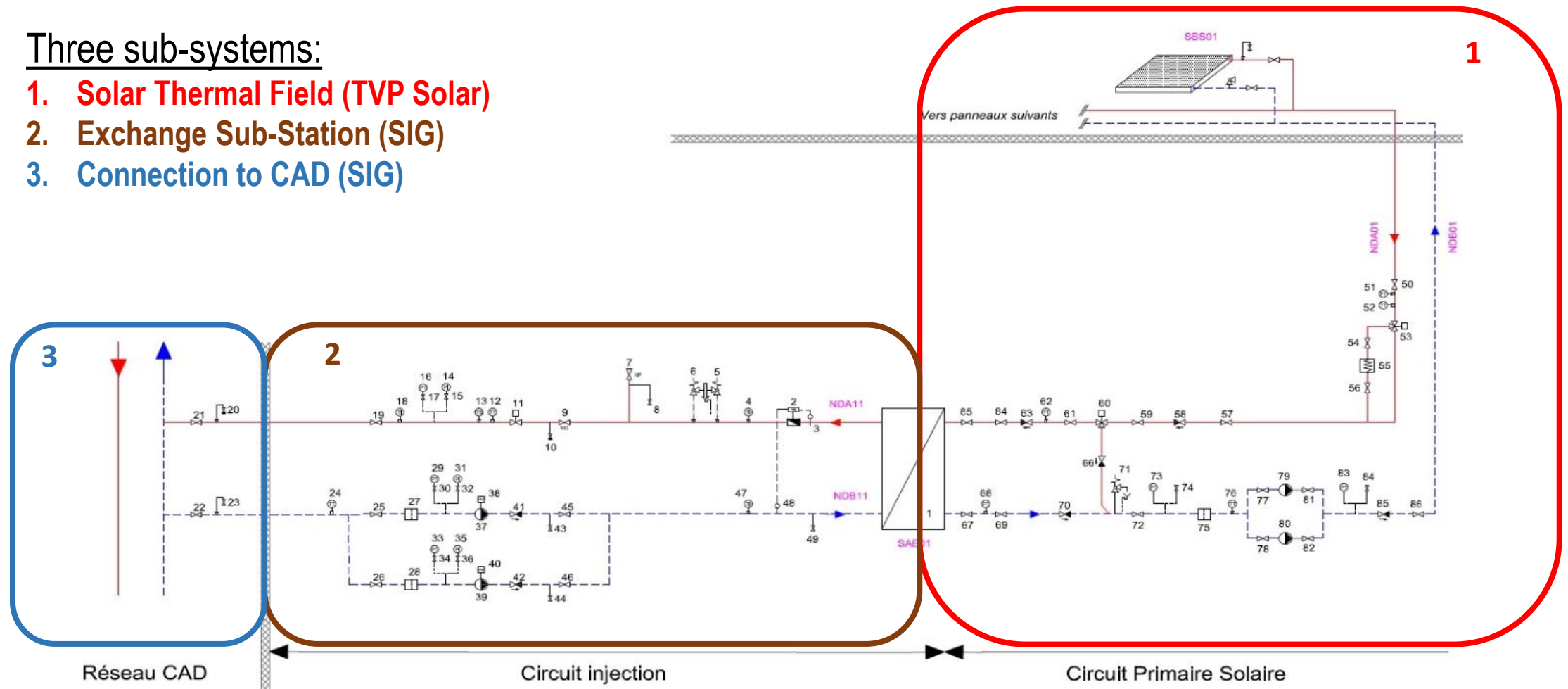
PROJECT NO.	2018-052		
PROJECT LOCATION	Chemin du Château-Bloch 2, 1219 Vernier, Svizzera		
CLIENT	Services Industriels de Genève		
TYPE:	P&ID Part 1: Thermal Block Side		
FILE:	2018_052-P&ID.1_V4.8		
14/12/2020	A.Di Genova	R.Vitabello	8
02/10/2020	A.Di Genova	R.Vitabello	7
07/09/2020	A.Di Genova	R.Vitabello	6
26/08/2020	A.Di Genova	R.Vitabello	5
16/04/2020	A.Di Genova	R.Vitabello	4
08/04/2020	A.Di Genova	R.Vitabello	3
04/03/2020	S.Frascogna	R.Vitabello	2
08/11/2019	S.Frascogna	V.Ruggiero	1
31/07/2019	S.Frascogna	M.Scarpellino	0
DATE	PREP'D	APP'D	REV



Installation P&ID

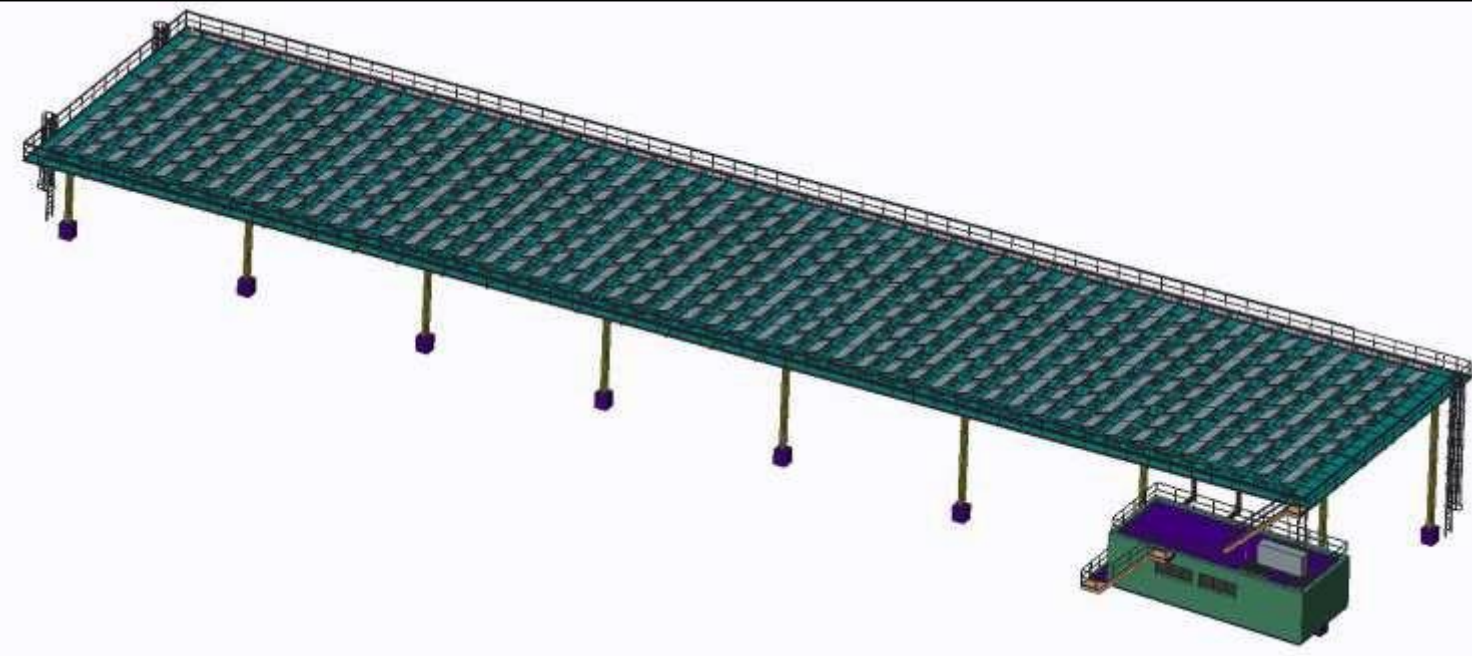
Three sub-systems:

1. Solar Thermal Field (TVP Solar)
2. Exchange Sub-Station (SIG)
3. Connection to CAD (SIG)

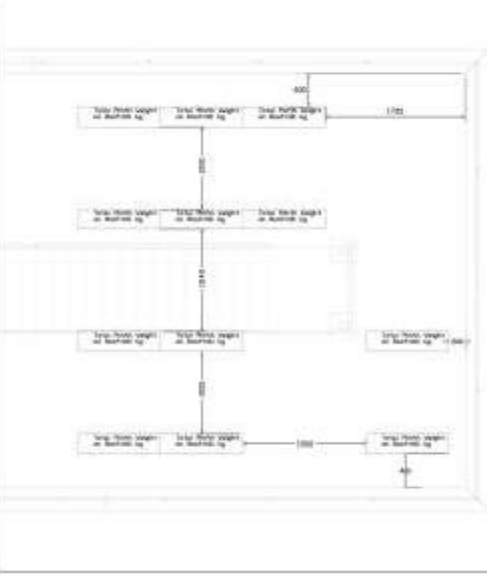


Solar Plant Engineering: 3D Layout

TVP SOLAR
 SIG
 SHIP Project - Case D
 PROJECT NO. PROJECT LOCATION
 DRAWING NO. SHEET NO.
 Panel's Positioning



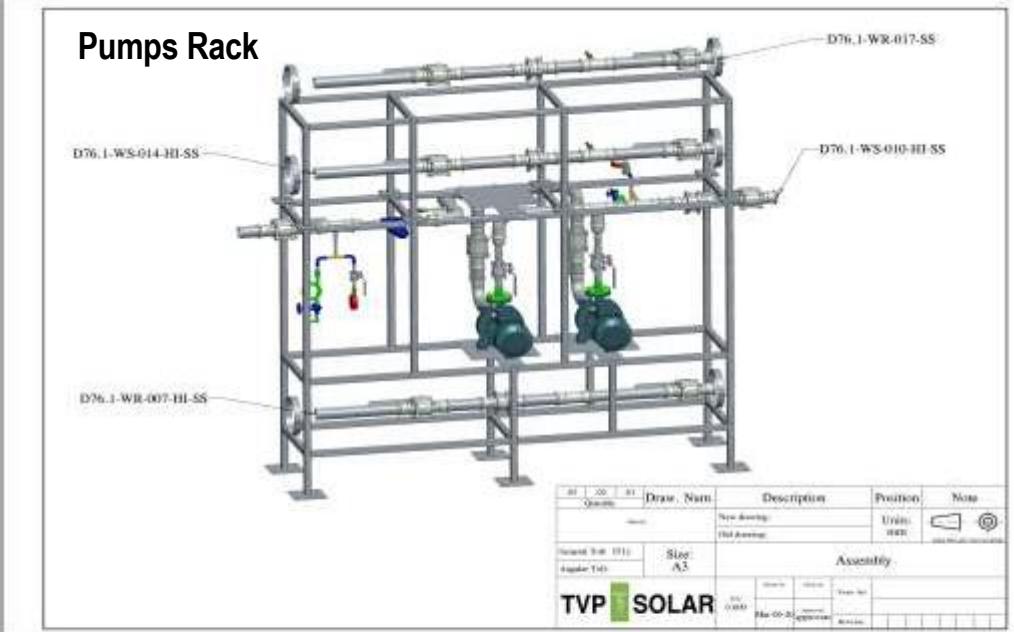
TVP SOLAR
 Description: Inverter
 Project: SIG
 Scale: A3
 General Layer



TVP SOLAR
 Solar Cdd2 SIG Geneve
 PROJECT NO. 2008-002 SHEET NO. 002
 Concrete plinths positioning

TVP SOLAR
 Description: Piping System
 Project: SIG
 Scale: A3
 General Layer

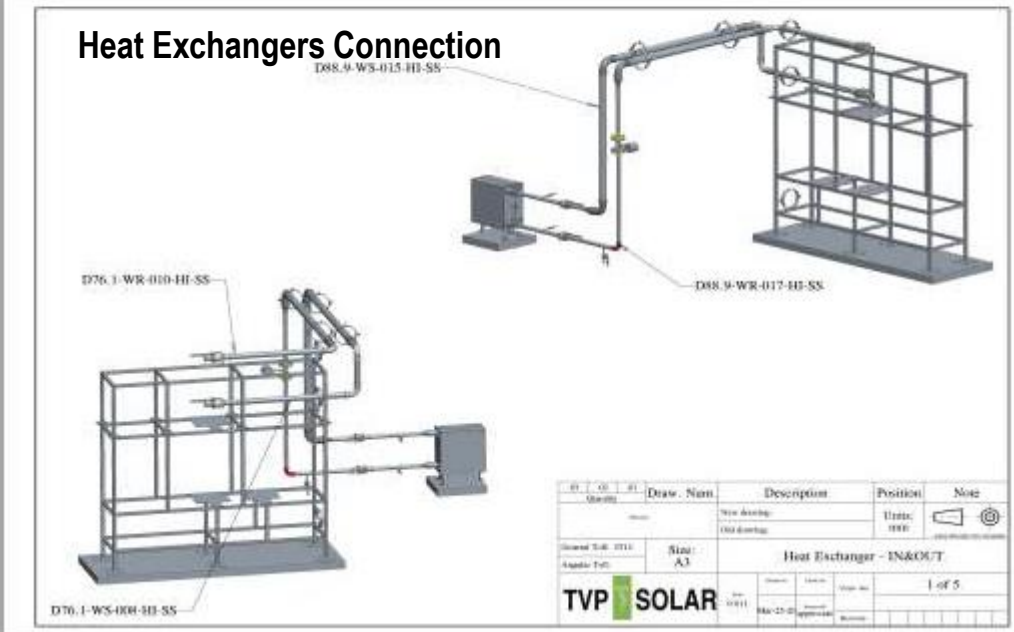
Technical Room Engineering: Thermal Bloc, HE and Control System



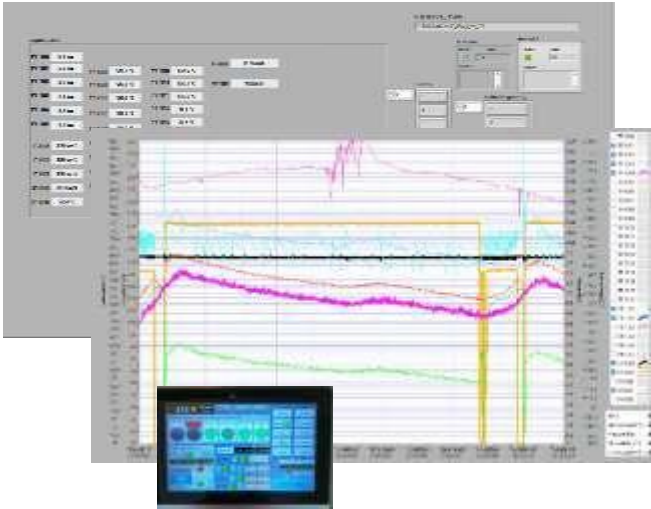
Solar plant supply energy to the client Heat Exchanger positioned in a dedicated technical room nearby the Solar Field

End-client PLC and Solar System PLC automatically exchange signals and real time measure.

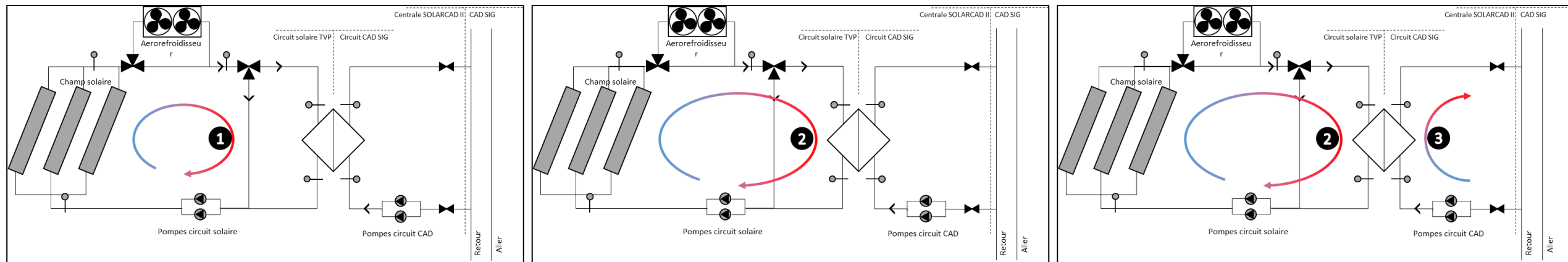
Real time remote access and performance analysis is available via web interface.



PLC based control system



Control Logic Description



If the irradiance is over a threshold, ($200\text{W}/\text{m}^2$), pumps are activated and heat transfer fluid is raised to nominal temperature

HTF flow is circulated to the heat exchanger once HTF reaches threshold temperature (80°C)

Once flow is active in the heat exchanger, CAD subsystem pumps engage relative to the solar flow

Monitoring done by HEIG-VD University

The Swiss Ministry of Energy is subsidizing monitoring and communication activities lead by SIG and LESBAT via the P+D incentives program



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Energie BFE
Office fédéral de l'énergie OFEN

	2019 SOND	2020 JFMAMJJASOND	2021-2023 JFMAMJJASOND
Volet0- Pré étude/ dimensionnement	█		
Volet 1 - Construction/ réalisation		█ Chantier stoppé (COVID19)	█
Volet 2 – Montage de l'équipement de mesure		█	█
Volet 3 - Paramétrage et mise en service			█
Volet 4 - Acquisition de données/ Premières analyses			█
Volet 5 - Modélisation numérique de l'installation			█
Volet 6 - Optimisation du paramétrage de régulation			█
Volet 7 - Mesures des performances de l'installation optimisée			█
Volet 8 - Analyse environnementale et économique			█
Volet 9 - Transfert de technologie & communication		█	█

P+D AGENDA

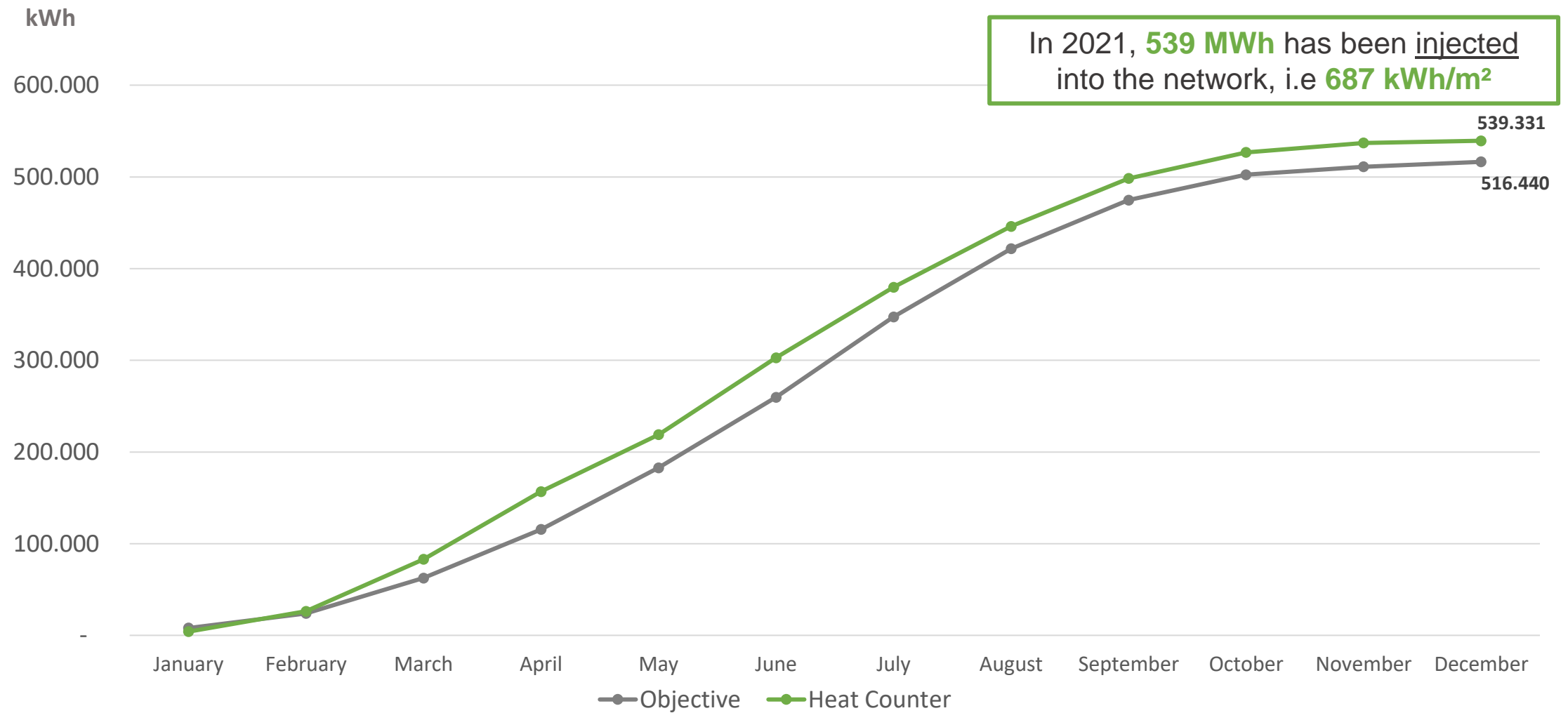
- Solar field and heat transfer station finalized
- Monitoring system : sensors installed and wired
- Solar field Start-up : December 2020
- Data collection functional up to the SIG PLC

Installation monitoring up to the end of 2023

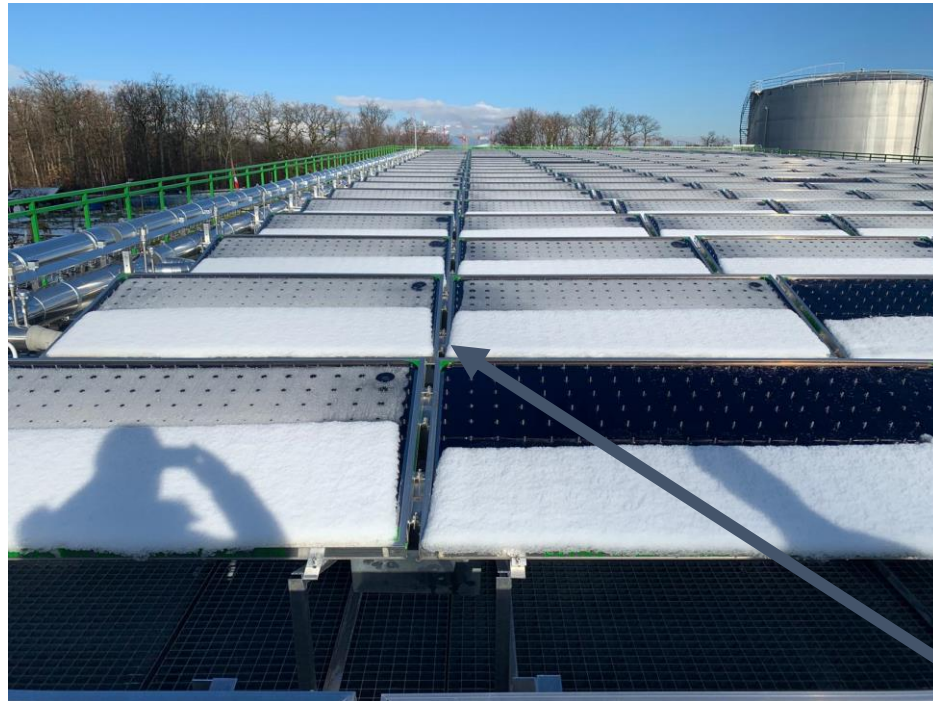
Technology transfer and Communication up to 2023

2021

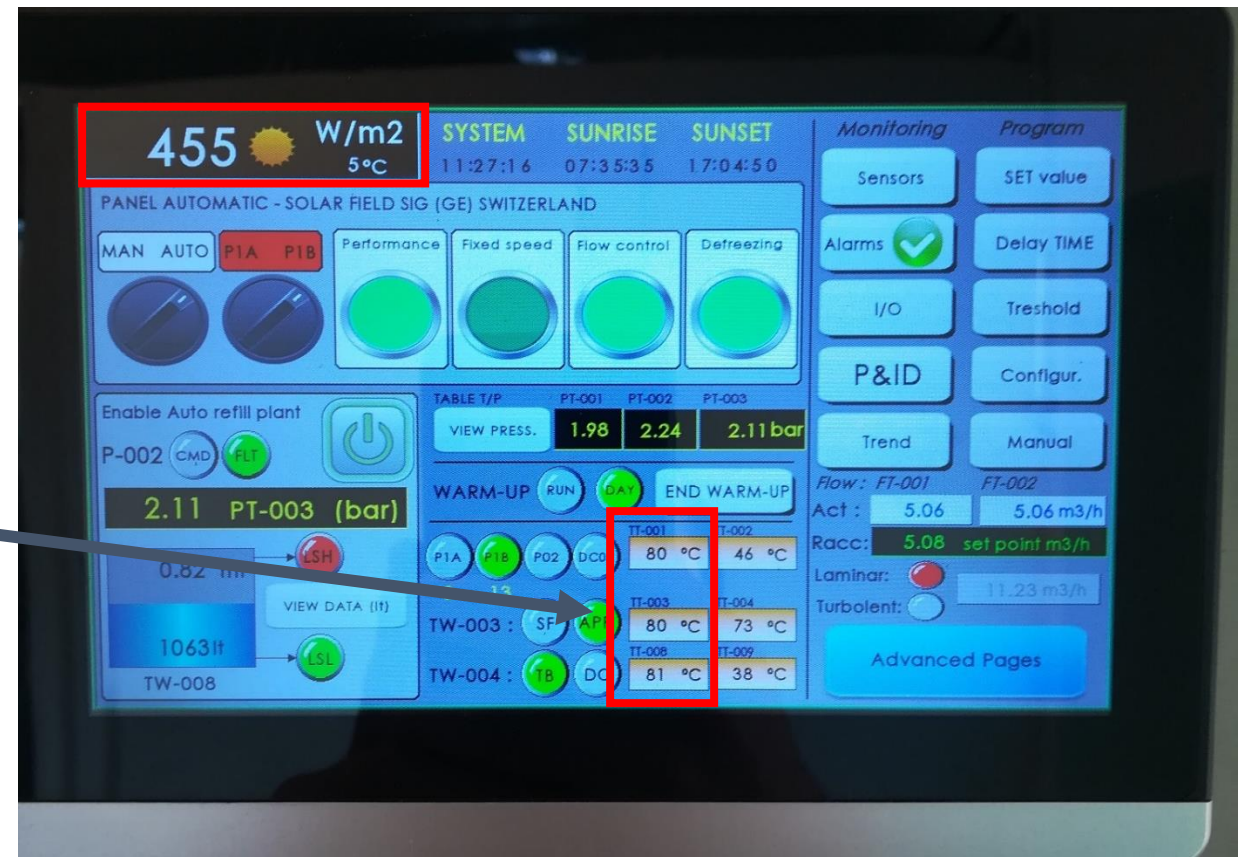
Energy delivered in 2021



Focus on Winter performance

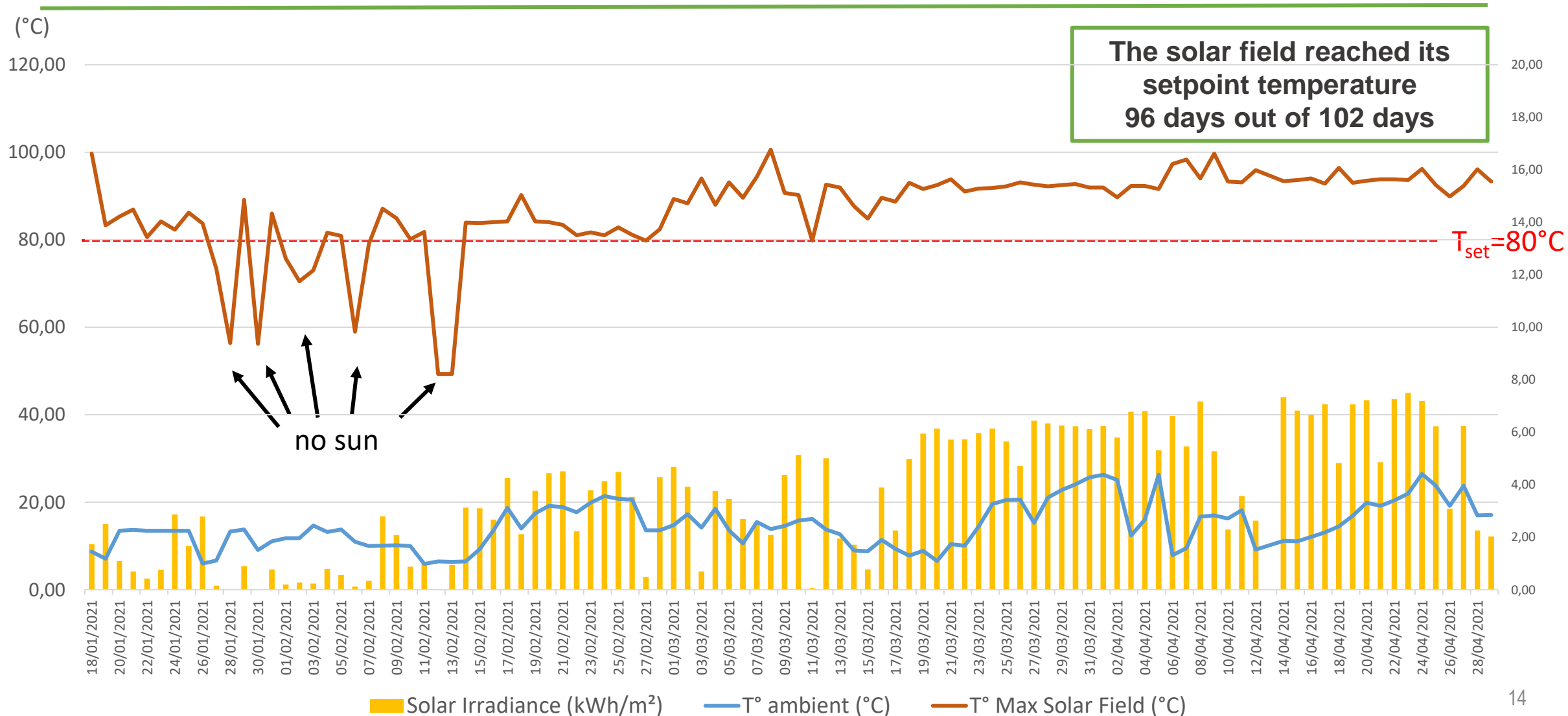


80°C reached even when panels are covered with snow

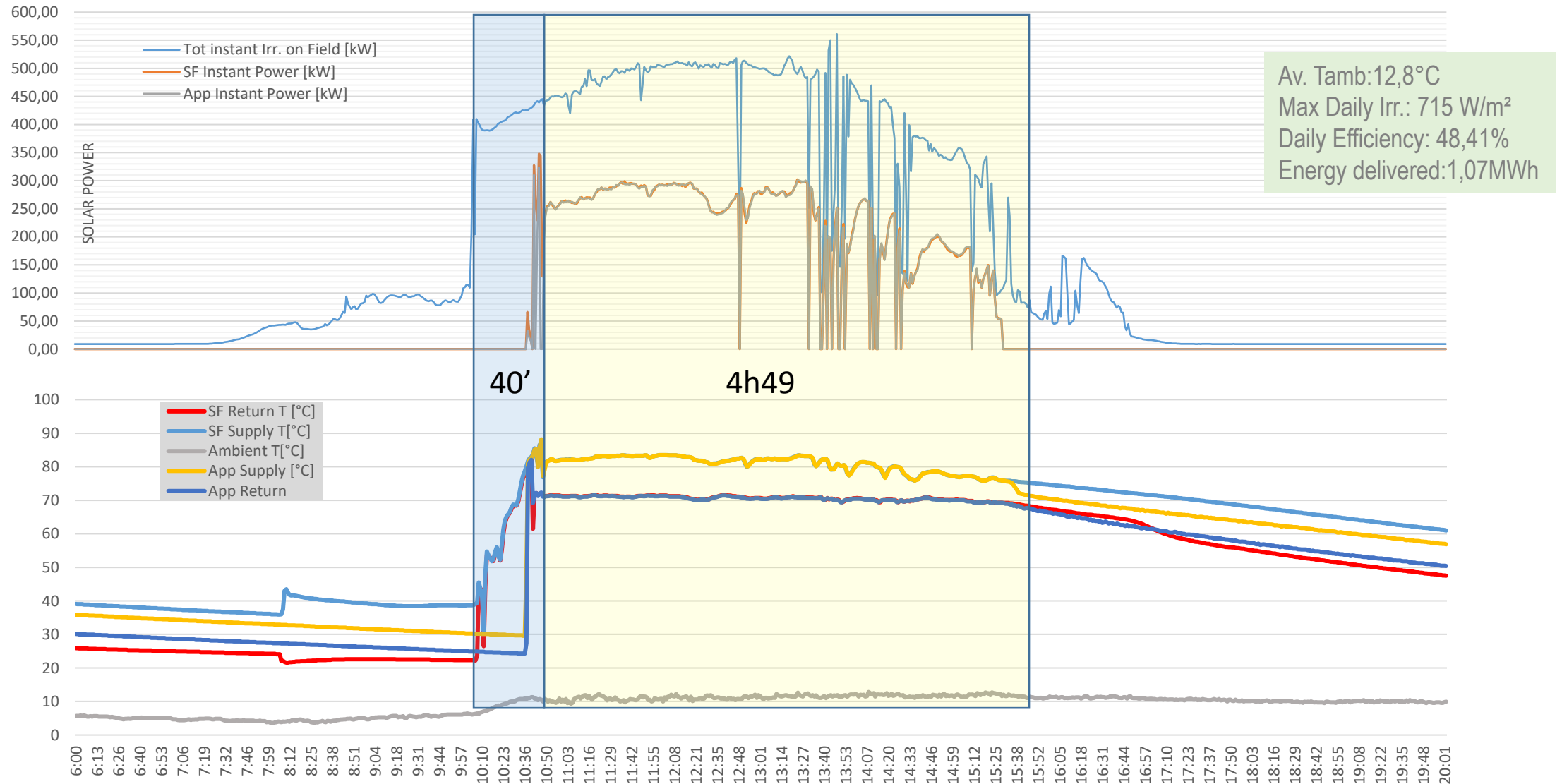


26 MWh delivered to the network in January and February 2021 with poor weather conditions

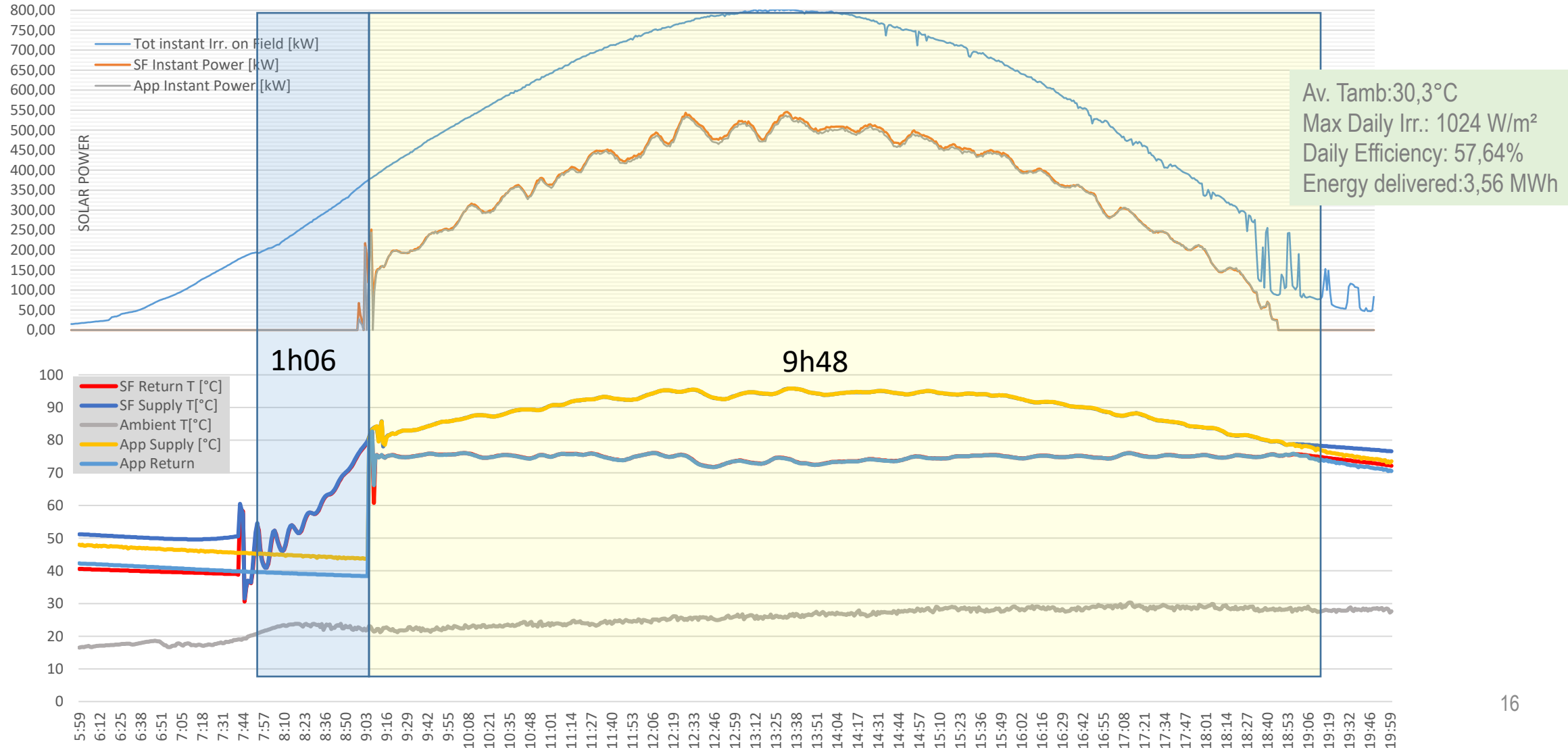
80°C heat delivered during Winter time!



Example : November 5th 2021

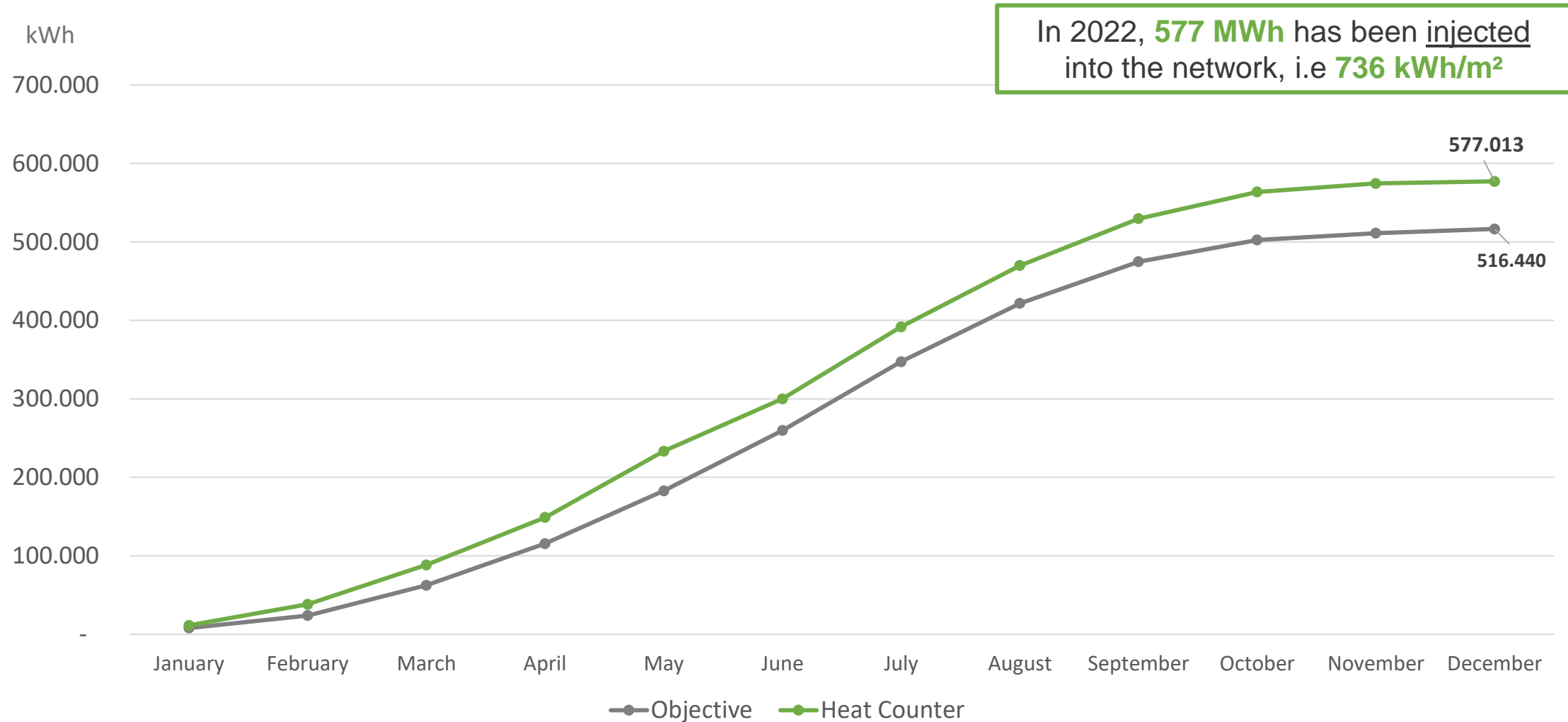


Example : June 11th 2021



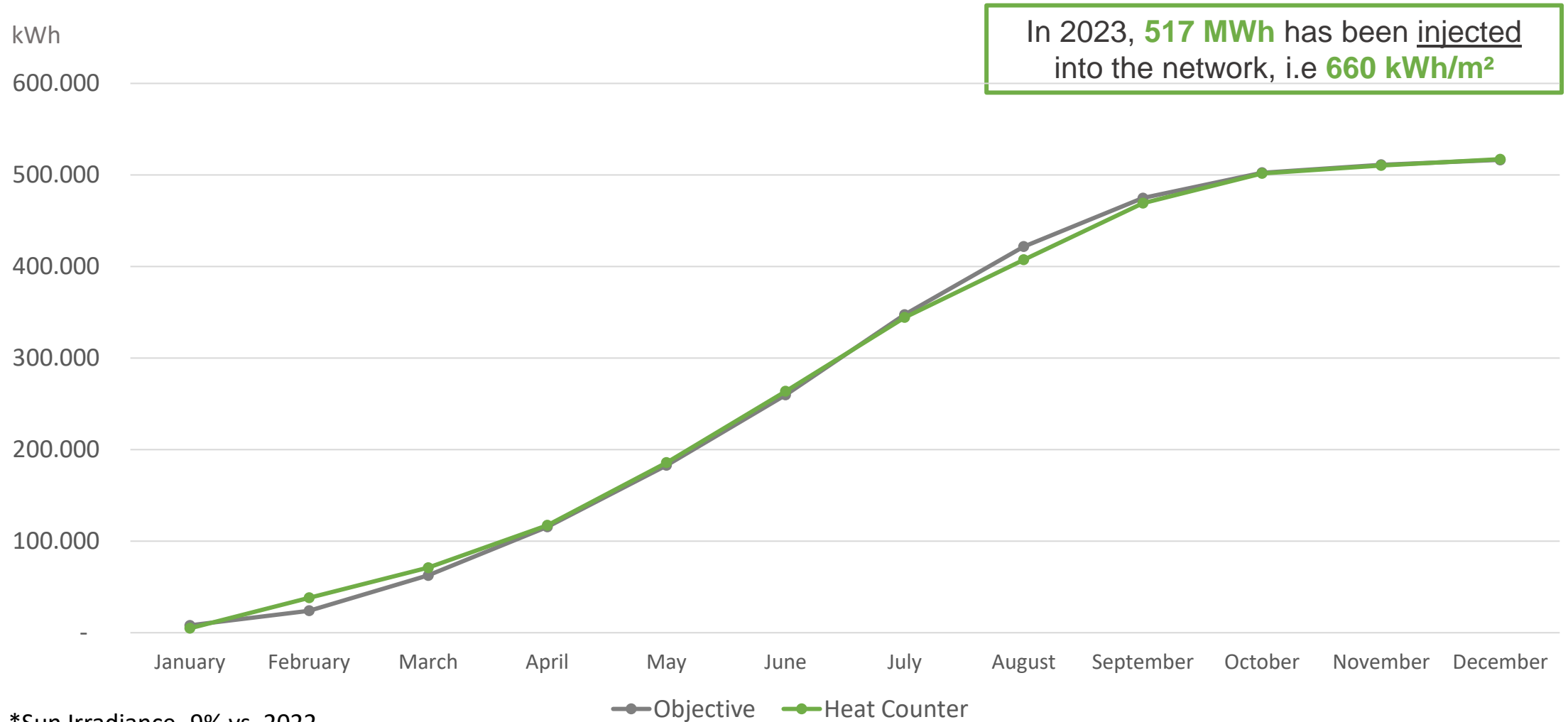
2022

Energy delivered in 2022



2023

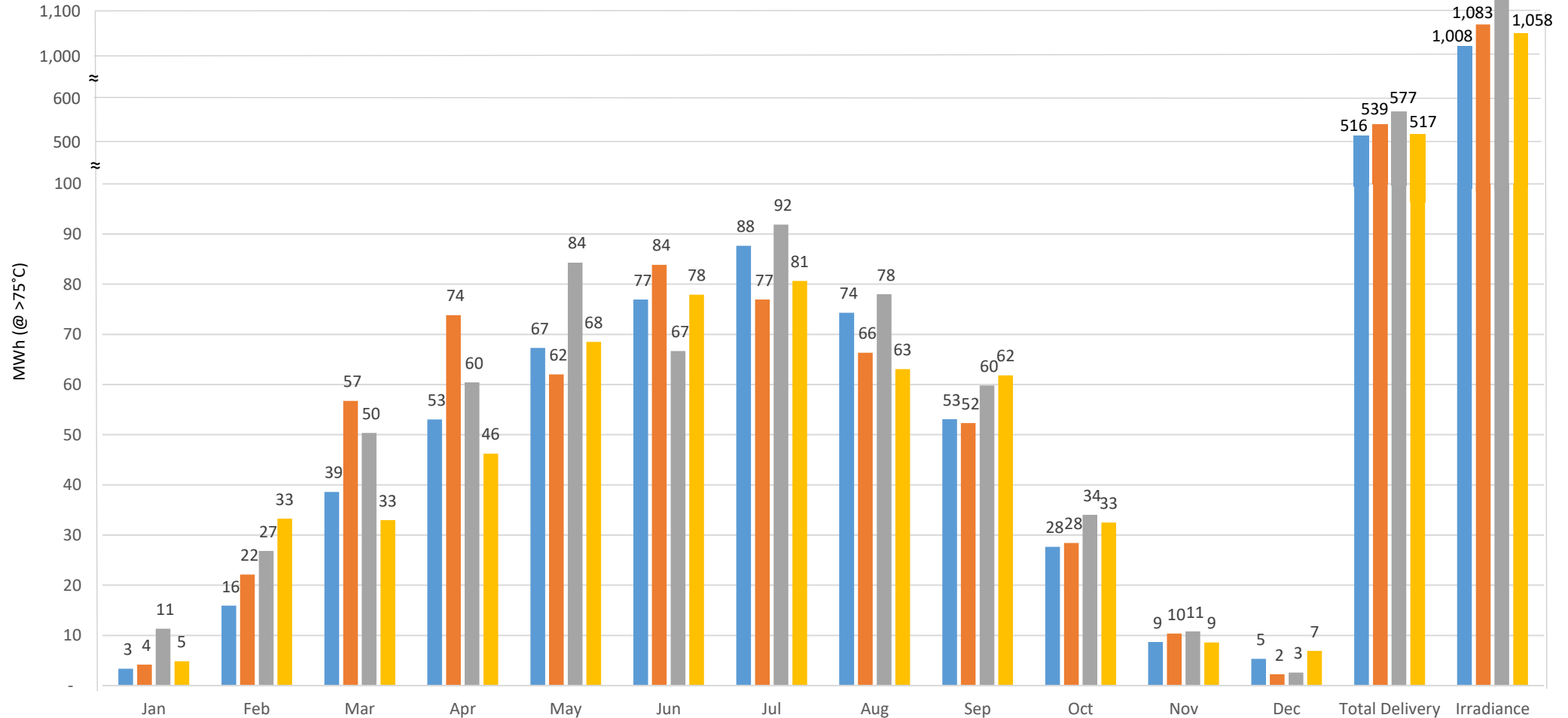
Energy delivered in 2023



*Sun Irradiance -9% vs. 2022

Summary 2021-2023

TVP solar district heating plant at SIG in Geneva (784 m² gross area)



Sources: SIG, for measured energy delivered
MeteoSuisse, for measured irradiance in Cointrin Airport

■ Simulated Energie ■ 2021 SIG Meter ■ 2022 SIG Meter ■ 2023 SIG Meter

Revenue Sharing Agreement (details)

Annexe 6

Formule de paiement de la 2^{ème} Tranche et schéma de principe de la fourniture de TVP Solar SA

En se basant sur l'hypothèse d'une irradiation solaire globale annuelle de référence mesurée sur le plan horizontal de 1200 kWh/m²/an, l'Entrepreneur estime que la production annuelle nette de la centrale solaire sera de 516 MWh.

On entend par production annuelle nette (ci-après : la « **Production** »), la quantité de chaleur livrée par l'installation solaire pendant une année solaire. En prenant comme référence le schéma de principe représenté en Figure 1, la Production de référence est mesurée par les SIG sur le côté CAD de l'échangeur solaire. Si la température T_{haut} du ballon tampon est > 90°C et la pompe P_{CAD} n'est pas disponible (en raison d'une panne, d'un arrêt pour maintenance ou toute autre raison imputable aux SIG), la Production sera augmentée de la quantité de chaleur évacuée par l'aéro-refroidisseur de secours et mesurée par l'Entrepreneur.

À compter de la Réception Provisoire de l'Ouvrage et durant une période de 20 ans, SIG s'engage à verser chaque année à l'Entrepreneur la rémunération annuelle suivante (ci-après : la « Rémunération annuelle ») en fonction des hypothèses suivantes :

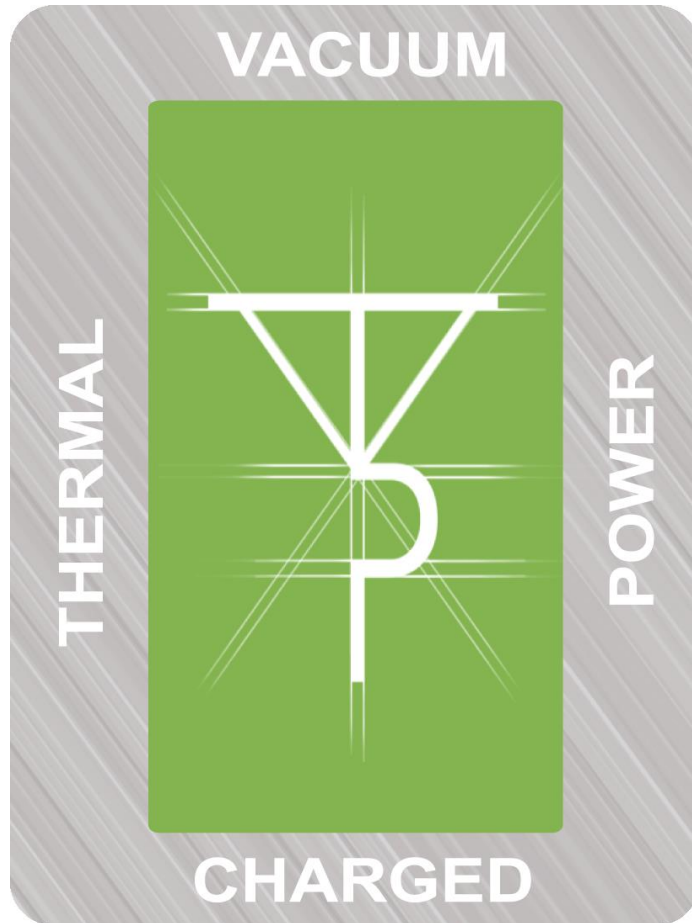
- a) Si la **Production** est inférieure à 405 MWh par année, SIG ne verse aucune Rémunération Annuelle pour l'année en question ;
- b) Si la **Production** est supérieure à 405 MWh par année mais inférieure à 516 MWh par année, SIG verse à TVP SOLAR SA une Rémunération Annuelle égale à : 16.1 cts/kWh x (Production – 405 MWh) ;
- c) Si la **Production** est supérieure à 516 MWh par année, SIG verse à TVP SOLAR SA une Rémunération Annuelle égale à CHF 17'924.- + 8 cts/kWh x (Production – 516 MWh).

La Rémunération Annuelle sera indexée en fonction de la valeur d'irradiation solaire réelle sur le plan horizontal pour l'année en question (ci-après : « I_N »), mesurée par la station météorologique de la Centrale solaire ainsi que par la station MeteoSuisse de Cointrin, selon la formule suivante :

$$R_N = \{R_{(N-1)} * I_{(N-1)}\} / I_N$$

Key points

- The **usable heat produced and delivered to the network** is **1,6 GWh saving 385 of tCO₂** during 2021-2023: 517 MWh in 2023 + 577 MWh in 2022 + 539 MWh in 2021
- **After 3 years of operation, the system is still overachieving the production target**, demonstrating a massive contribution of the solar thermal system **even in wintertime**
- According to revenues sharing agreement **SIG paid TVP CHF 18,500 in 2023, CHF 21,390 in 2022 and CHF 19,790 in 2021 for the energy delivered** exceeding 405 MWh/y target
- **No extraordinary maintenance or cleaning on solar panels** has been performed
- The system reached its setpoint temperature (80°C) in any climate conditions as soon the threshold irradiance of 200W/m² is reached, showing consistent heat supply to the district heating network almost everyday



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