



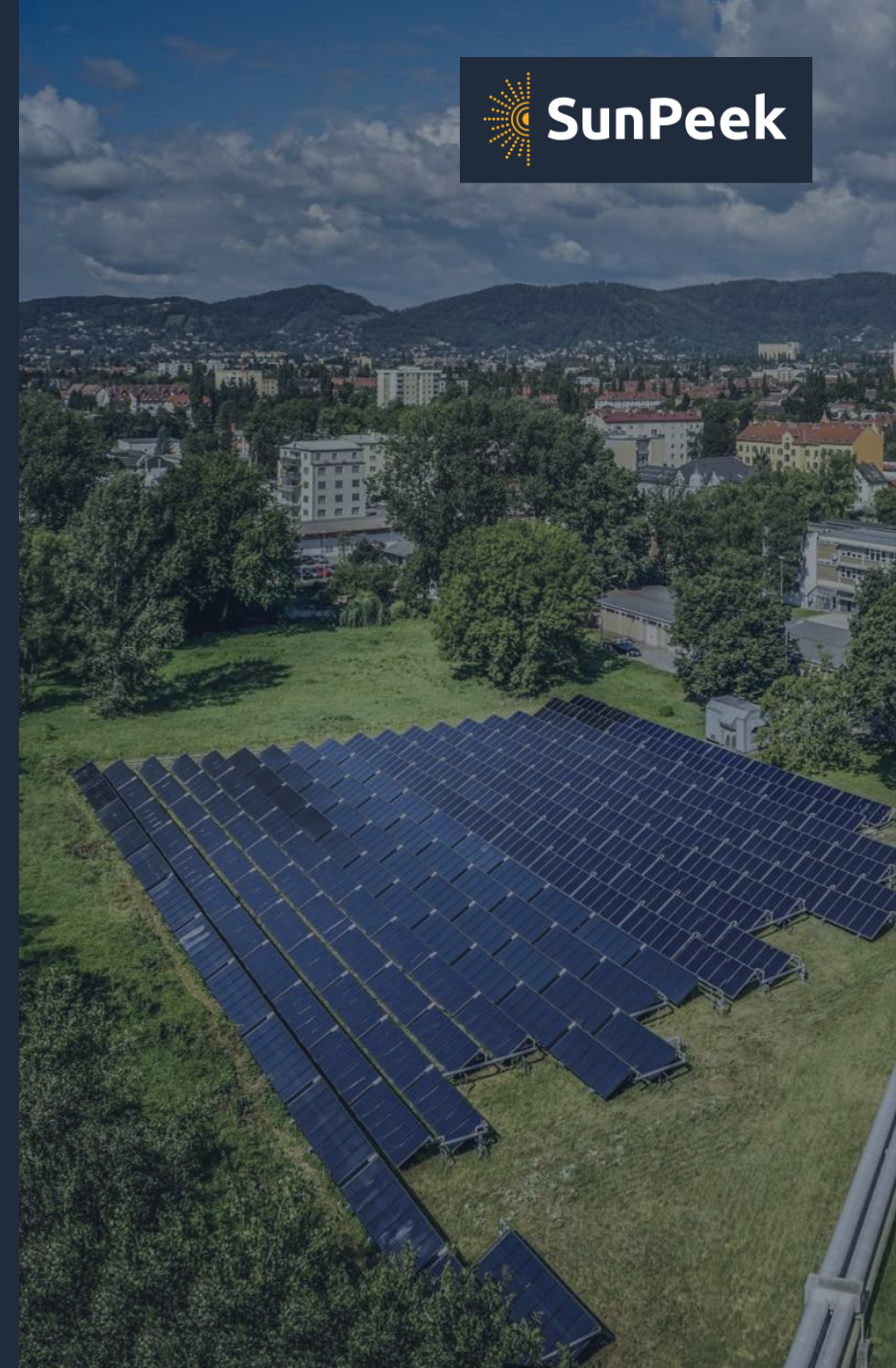
SunPeek

Open-Source Software for
Performance Assessment and Monitoring
of Large Solar Thermal Plants

Philip Ohnewein, Marnoch Hamilton-Jones,
Daniel Tschopp, Lukas Feierl, Maria Moser



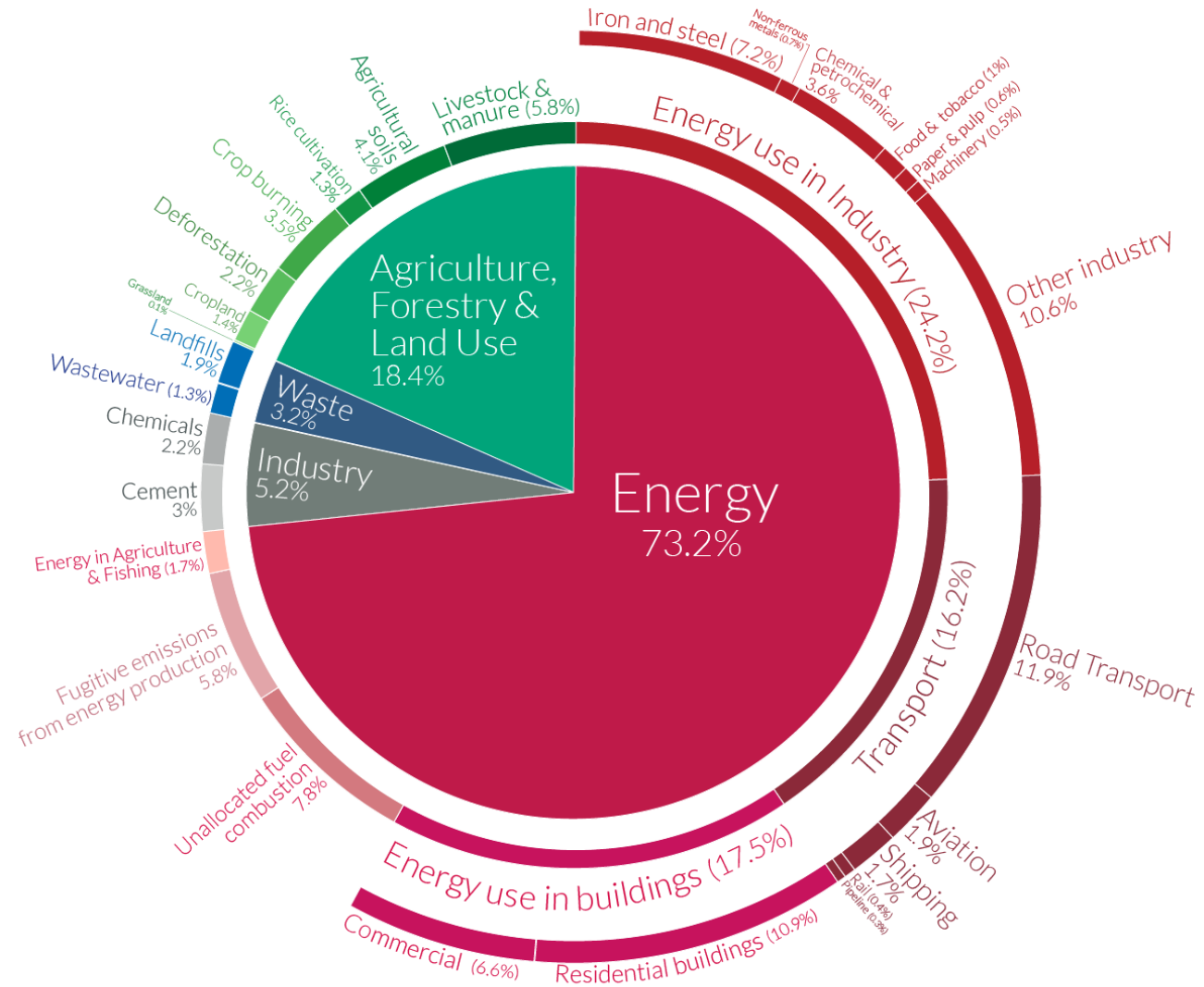
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Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO₂eq.

Our World
in Data

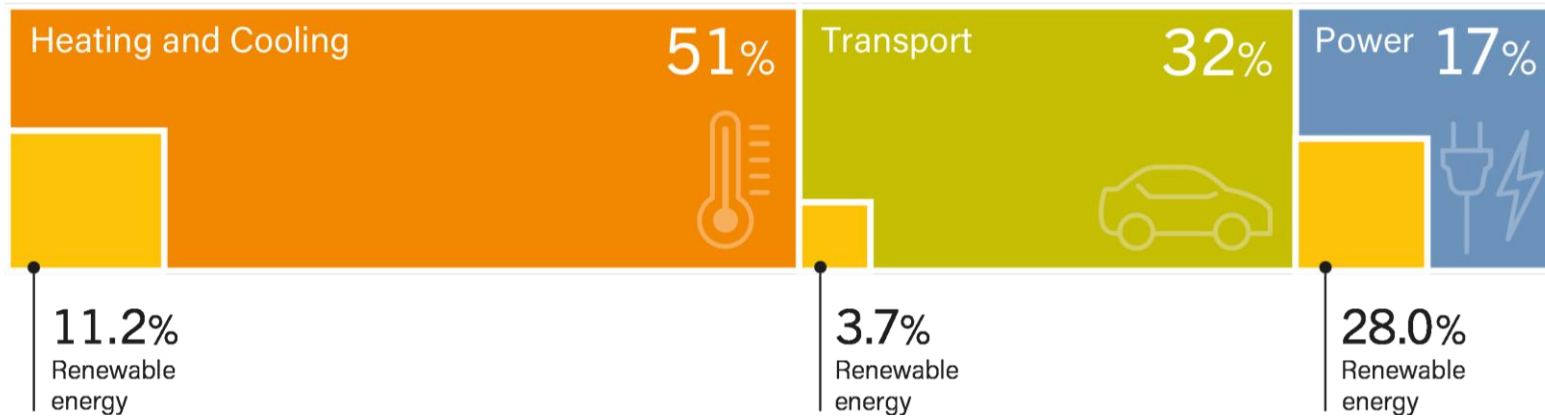


OurWorldinData.org – Research and data to make progress against the world's largest problems.
Source: Climate Watch, the World Resources Institute (2020).

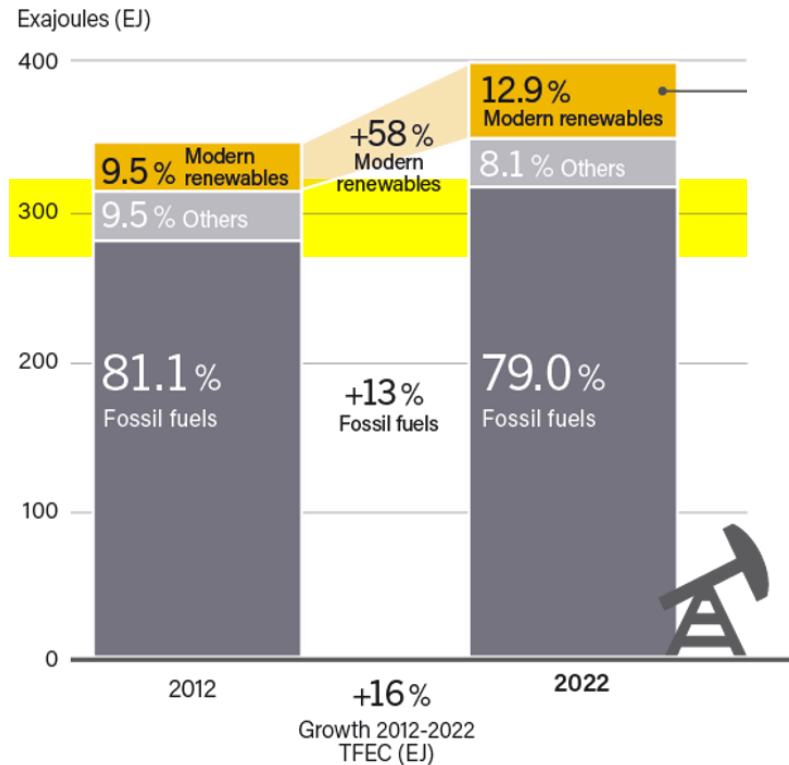
Licensed under CC-BY by the author Hannah Ritchie (2020).

Energy Overview

Source: REN21 Renewables 2023 GSR



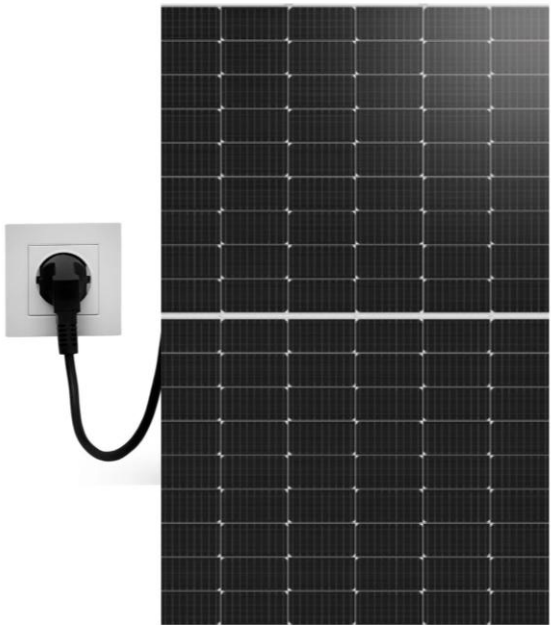
Source: REN21 Renewables 2024 GSR



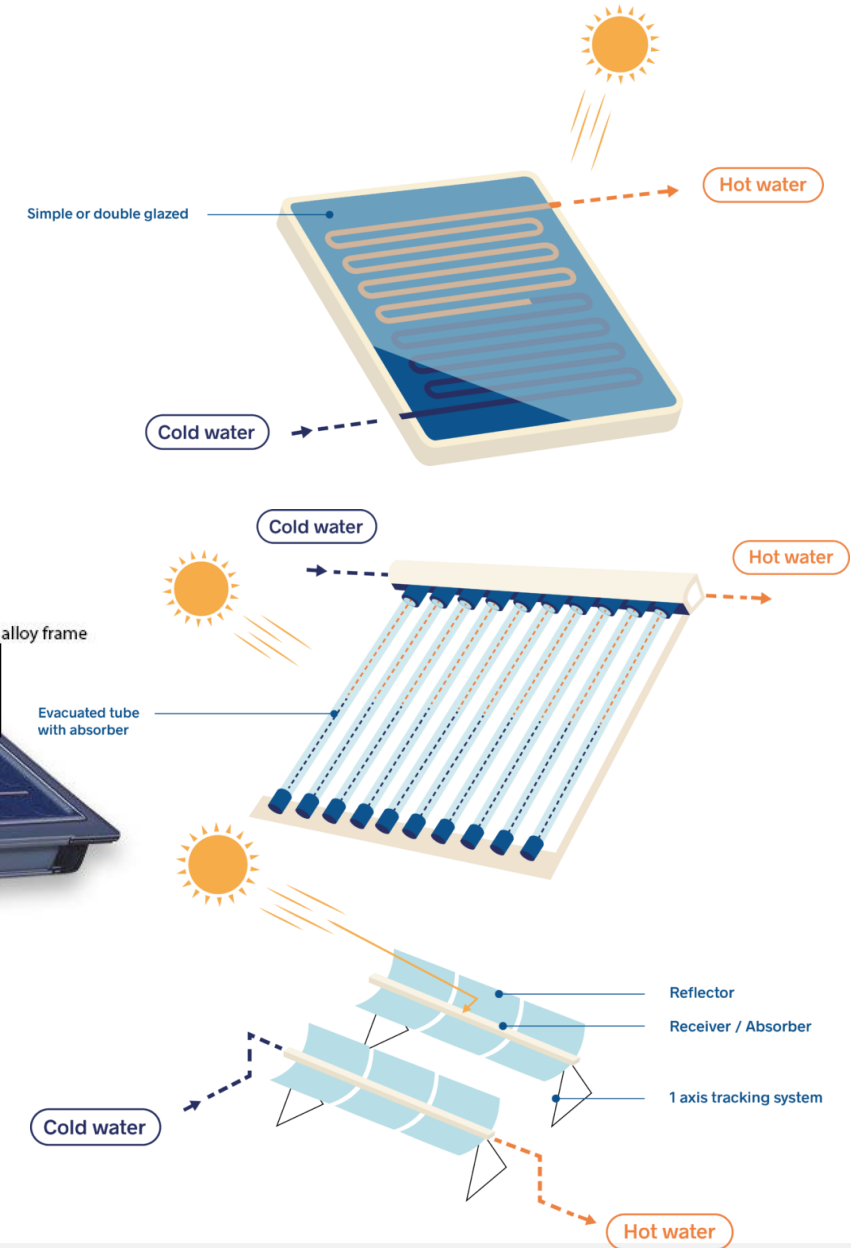
Source: IRENA World Energy Transitions Outlook 2022

Indicators	Recent years	2030 ¹⁾	2050 ¹⁾	Progress (off / on track)
DIRECT RENEWABLES IN END-USES AND DISTRICT HEAT				
Share of renewables in final energy consumption	17% ⁹⁾	35%	82%	7
Solar thermal collector area	585 million m ² /yr ¹⁰⁾	1 552 million m ² /yr	3 882 million m ² /yr	7
Modern use of bioenergy (direct use)	21 EJ ¹¹⁾	46 EJ	53 EJ	7
Geothermal consumption (direct use)	0.9 EJ ¹²⁾	1.4 EJ	2.2 EJ	7
Renewables based district heat generation	0.9 EJ ¹³⁾	4.3 EJ	13 EJ	7
Investment needs for renewables end uses and district heat	13 USD billion/yr ¹⁴⁾	290 USD billion/yr ¹⁵⁾	210 USD billion/yr	7

PV module



Solar thermal collector



Large-scale solar thermal systems

Friesach,
Source: Solar Engineering Guggenberger



Högsätten Härmösand
Source: Absolicon



Fernheizwerk Graz (FHW)
Source: Picfly.at Thomas Eberhard



St. Ruprecht an der Raab,
Source: Gasokol GmbH



Fernwärme Ettenheim
Source: Peter Blaser



Stadtwerke Greifswald
Source: Ritter XL Solar



Friesach,
Source: Solar Engineering Guggenberger



Högsätten Hämösand
Source: Absolicon



Fernheizwerk Graz (FHW)
Source: Picfly.at Thomas Eberhard



Performance Verification

„Does the solar plant perform as expected?“



Performance Monitoring

„Does performance change over time?“



Design

ISO 9806
EN 12975
EN 12976

Operation

ISO 24194

“Solar energy — Collector fields —
Check of performance”



SunPeek



Performance Verification

„Does the solar plant perform as expected?“



Performance Monitoring

„Does performance change over time?“

How does it work?



Each dot represents a valid one-hour operating interval. This plot considers a safety factor of 90%.

Power Check is fulfilled if measured power output during valid operating intervals is greater than target power output including safety margin.

A check requires at least 20 hours with stable plant operation.

Measured power output: 491 W/m²

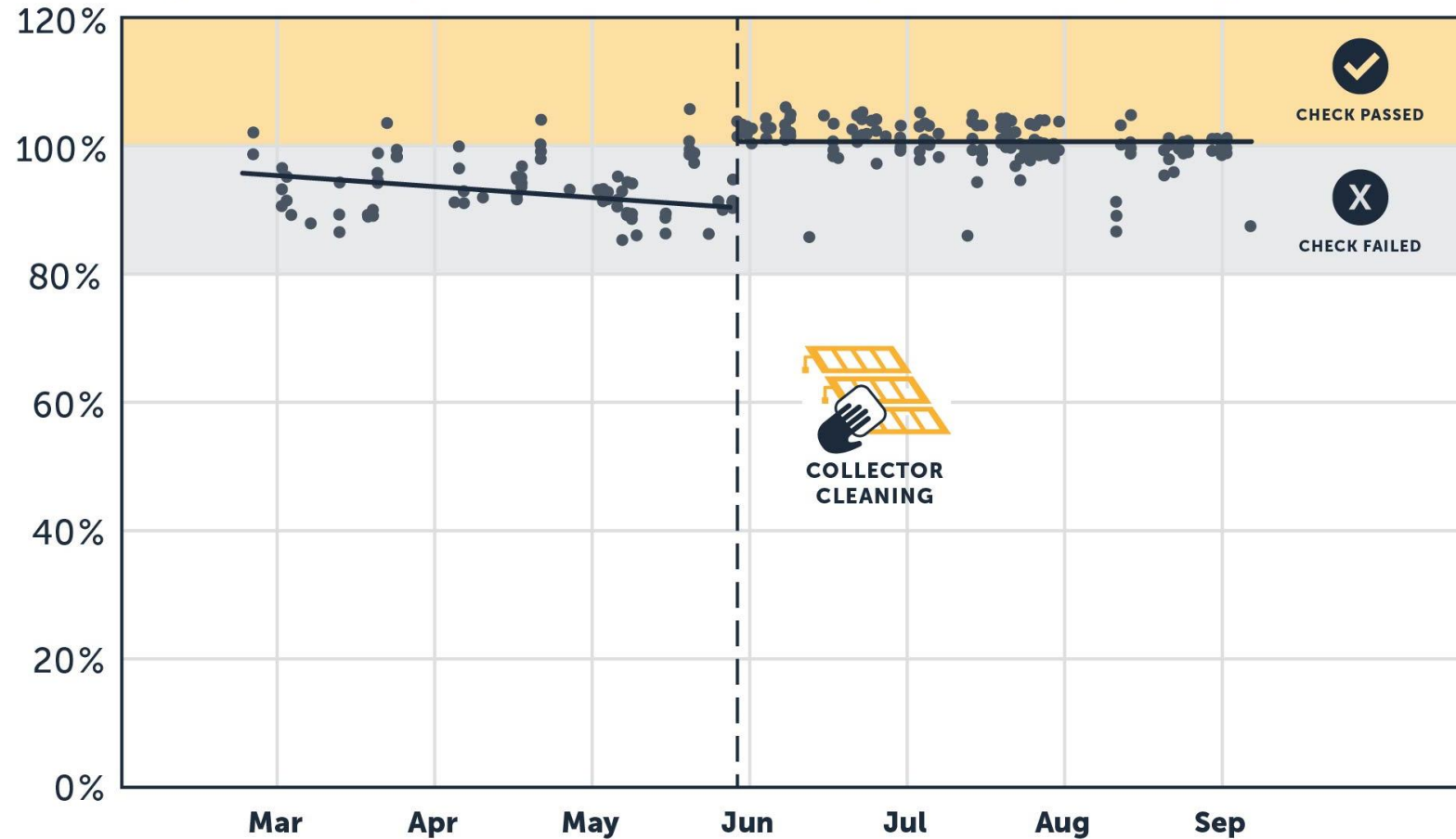
Target power output with 90% safety factor: 468 W/m²



SunPeek for ongoing Monitoring

Ratio of Measured to Target Power Output

- Each dot represents a valid one-hour operating interval. This plot considers a safety factor of 90%.








1 SunPeek: Open-Source Tool for Performance 2 Analytics of Solar Thermal Plants

3 Marnoch Hamilton-Jones ^{1,3*}, Lukas Feierl ^{2*}, Philip Ohnewein ^{1*}¶,
4 Daniel Tschopp ^{1,4*}, Peter Zauner ¹, Jonathan Cazco Gonzalez ¹, Maria
5 Moser ², Hannes Poier ², and Christopher Albert ⁵

6 ¹ AEE – Institute for Sustainable Technologies, Austria ² SOLID Solar Energy Systems GmbH, Austria ³
7 Graz University of Technology, Institute of Software Engineering and Artificial Intelligence, Austria ⁴
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DOI: [10.xxxxx/draft](https://doi.org/10.26434/chemrxiv-2023-12345)

Software

- [Review](#) 
- [Repository](#) 
- [Archive](#) 



11 Editor: [Open Journals](#) 

Reviewers:

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12 Submitted: 01 January 1970

13 Published: unpublished

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12 Summary

13 SunPeek is an open-source software designed to automate the performance evaluation of solar
14 thermal plants, with a focus on large-scale installations. Addressing both researchers and
15 commercial plant operators, SunPeek offers an application-oriented framework for analyzing
16 operational performance. Built on standardized methodologies, SunPeek employs scientifically
17 validated models to compute the expected solar thermal output and integrates automated
18 features such as data ingestion and cleaning, performance modeling, interactive data analytics,
19 and report generation. Designed as a containerized web application, SunPeek includes a web
20 interface and a Python backend with a REST API. All SunPeek repositories are accessible
21 via [GitHub](#). The backend is also available as a standalone Python package, listed on [PyPI](#).

Fresh off the press 😊 Pre-Print:

<https://zenodo.org/communities/sunpeek/>



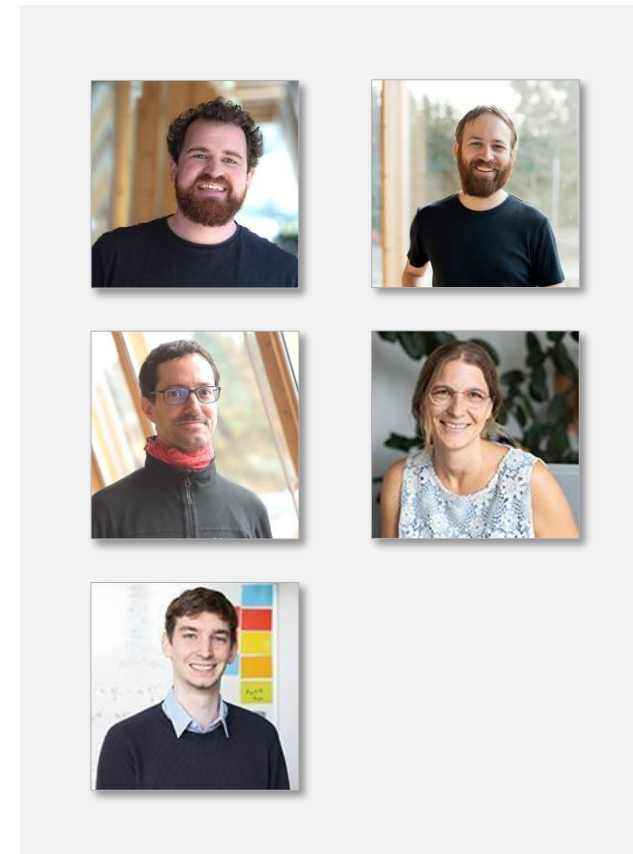
Funding



Community, Users & Enablers



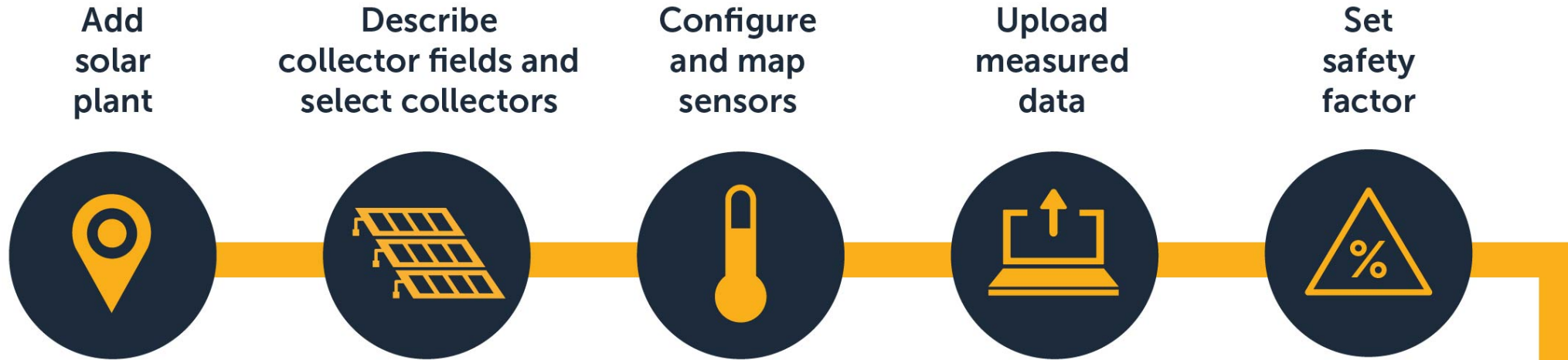
Steering Committee & Maintainers



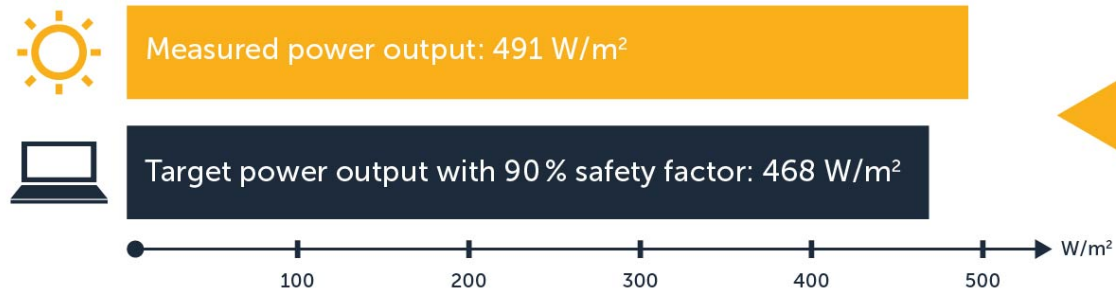
Initiators



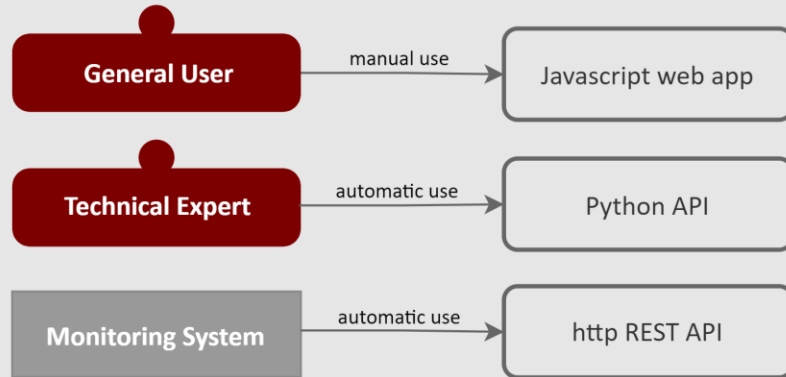
Steps to SunPeek Power Check



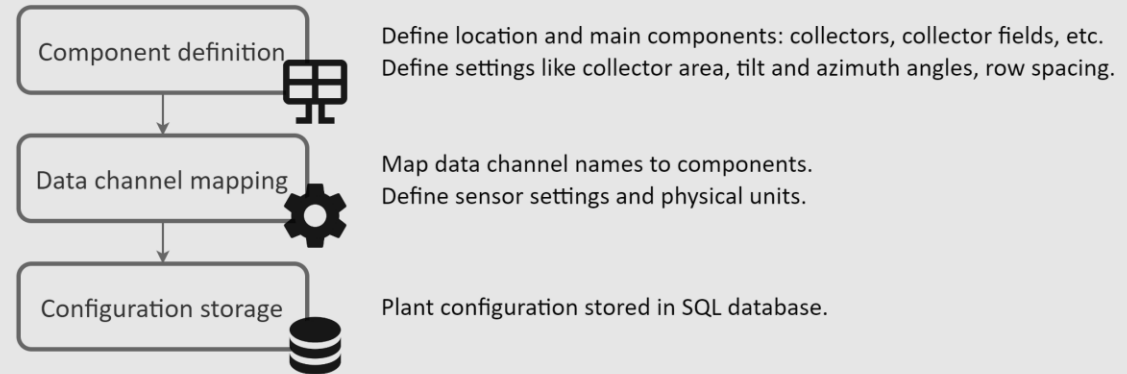
Run Power Check



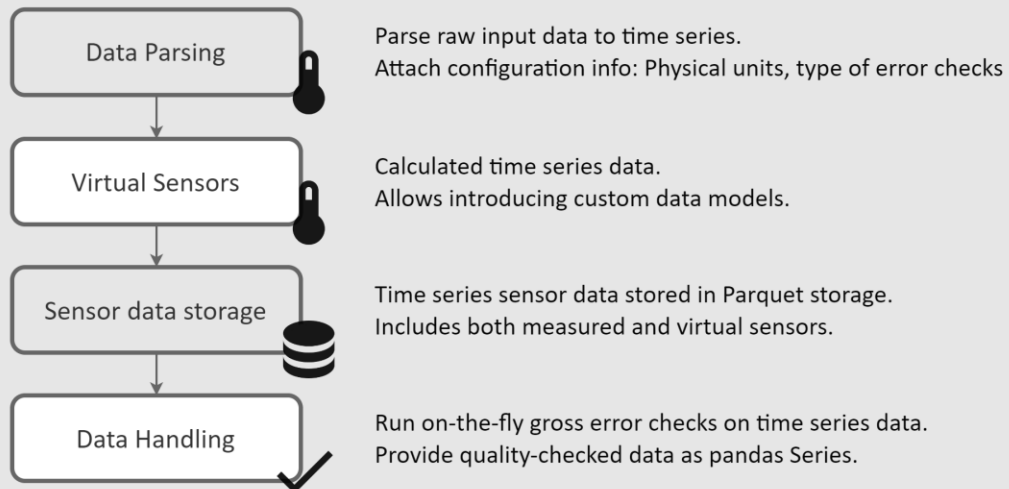
Triggering SunPeek Data Ingestion and Analysis



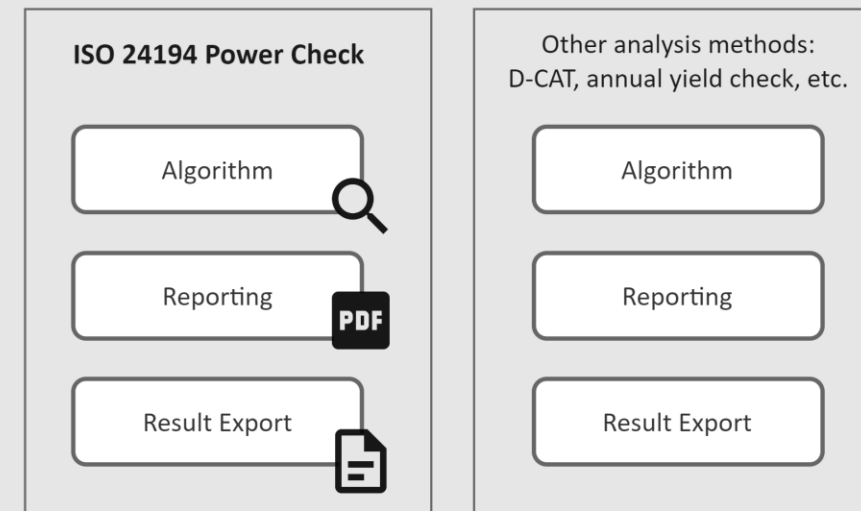
Plant Configuration *[manual, one-off]*

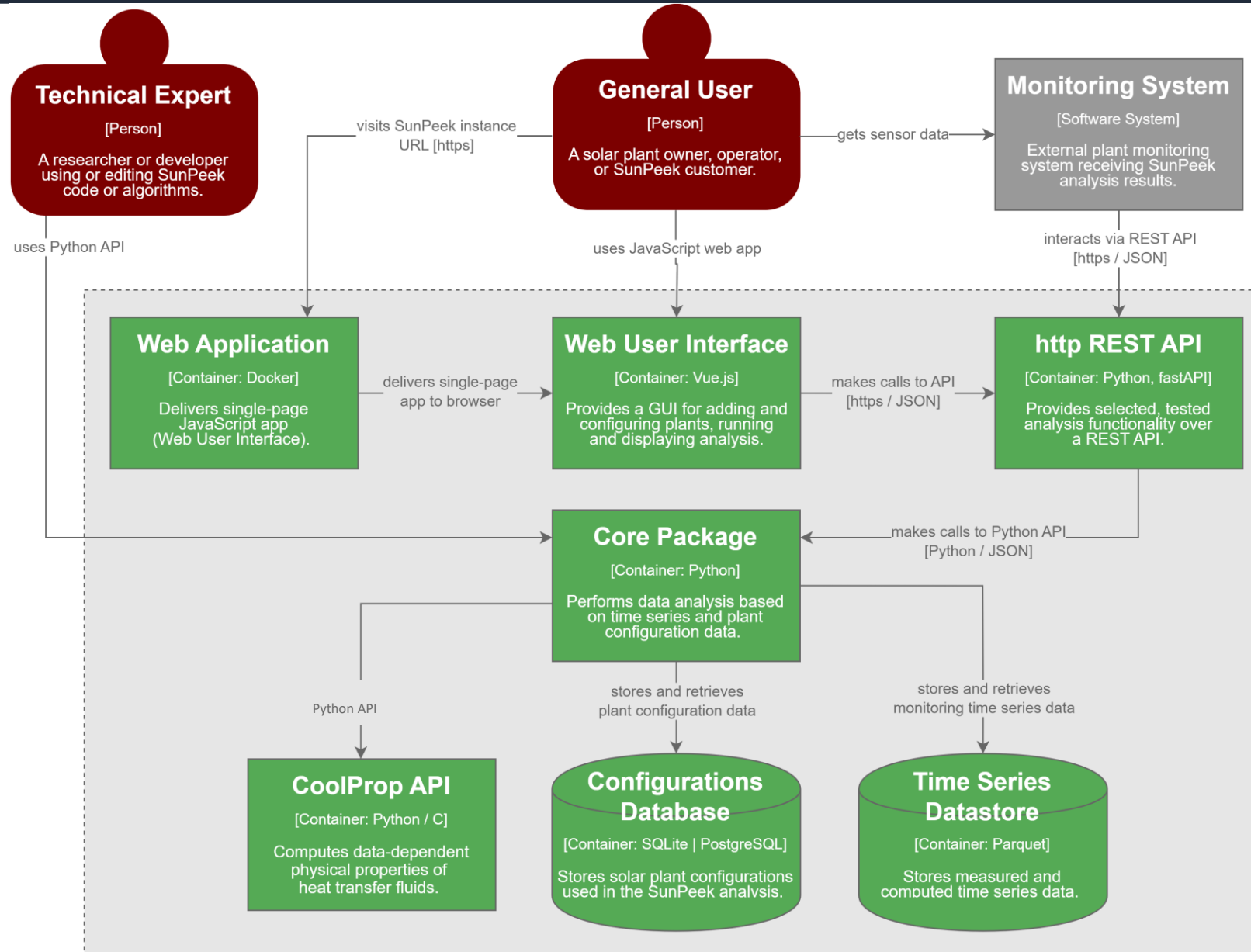


Data Ingestion *[automatic]*



Data Analysis *[automatic]*





- For long term installation or use with the UI, docker images are provided, along with a docker compose file.
 - See https://docs.sunpeek.org/quick_start/installation/index.html
- Main application can run as a stand-alone container if only the REST API is needed.
- For researchers, or integrating directly into other software: Python package, `pip install sunpeek` (optional install extras: `demo`, `db`, `api`). <https://pypi.org/project/sunpeek/>

<https://demo.sunpeek.org/>



SunPeek SunPeek API (0.4.3) (Docker)

72 demoplant_202501...

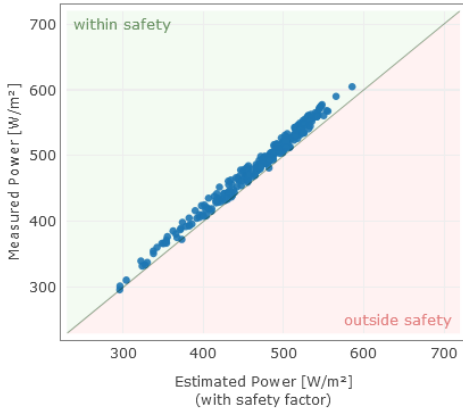
- Overview
- Configuration
- Data Upload
- Sensor Data
- Performance Check

Thermal Power Check

Settings: Method: extended Formula: AUTO (2) f_u: 90% f_p: 100% f_o: 100% use wind: true

Measurement Period: Start 05/01/2017 End 10/01/2017 **RUN** **PDF**

Measured-Estimated Comparison



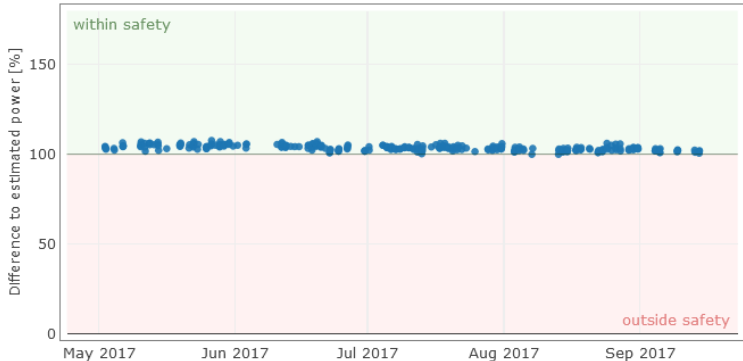
Measured Power [W/m²]

Estimated Power [W/m²] (with safety factor)

within safety

outside safety

Timeseries



Difference to estimated power [%]

within safety

outside safety

Safety Factor: 90 % with safety factor

Selected	Name	Type	Gross Area	Ø Measured	Ø Estimated (with safety)	Ratio	Valid Intervals
	Arcan South	Array	515.66 [m ²]	486 [W/m ²]	469 [W/m ²]	103.6%	273 [h]

- ✓ Software Repository <https://gitlab.com/sunpeek/>
- ✓ Support support@sunpeek.org
- ✓ Zenodo Community <https://zenodo.org/communities/sunpeek>
- ✓ Public Demo <https://demo.sunpeek.org/>



Open-Source Software for Optimized Operation of Large Solar Thermal Plants



About SunPeek

SunPeek is an open-source tool for **performance monitoring** and **guarantee procedures** of large-scale solar thermal plants. SunPeek introduces the **first open-source implementation** of the Power Check method and is intended as the reference software tool for ISO 24194:2022 ("Collector fields - Check of Performance"). SunPeek has been successfully deployed to several large-scale solar plants. Included with SunPeek is a pre-configured demo plant, featuring one year of open measurement data from the "Fernheizwerk" plant in Graz, Austria. Featuring simple software licenses, SunPeek is available for free for **scientific and commercial use**. Our vision is to advance the state-of-the-art of quality assurance in large solar thermal plants and evolve SunPeek towards an **industry-standard solution** in plant monitoring. Explore the public SunPeek demo, visit <https://demo.sunpeek.org>

Screenshots

Automated Power Check according to ISO 24194
Power Check is fulfilled if measured power output during valid operating intervals is greater than target power output including safety margin. A check requires at least 20 hours with stable plant operation.

Measured power output: 432 kWh
Target power output with 90% safety factor: 448 kWh

Power Check benchmarks

Power Check according to ISO 24194:2022

Power Check PDF report

GUI: interactive Power Check results

SunPeek for ongoing monitoring

Demo Plant "Fernheizwerk Graz"

Location Graz, Austria
Application Solar District Heating (SDH) for the Graz DH network
Operator solar.nahwaerme.at Energiecontracting GmbH
Collector Area 8 206 m² / 5.7 MW (total)
516 m² / 361 kW (subfield for demo dataset)

Image source: Picfly.at/Thomas Eberhard

Join us!

Join SunPeek! Whether you're a researcher, developer, solar professional, or enthusiast, your participation is welcome. Let's create a brighter solar thermal future together!

www.sunpeek.org

