SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

SunPeek

AEE INTEC

SunPeek Open-Source Platform for ISO 24194 Performance Analysis

Philip Ohnewein & SunPeek Team

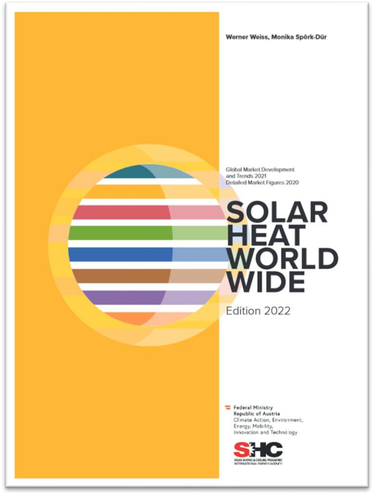
2024-11-19

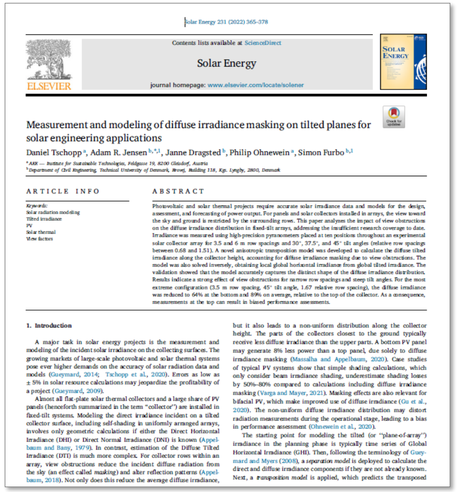
Solar Thermal Activities at AEE INTEC

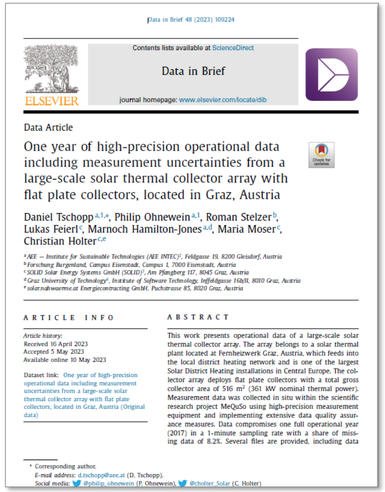
Selected Activities

SHC Activities, Publications
SHC Tasks 68, 67, 72.
“Solar Heat Worldwide”
Data & Journal Publications
→ zenodo

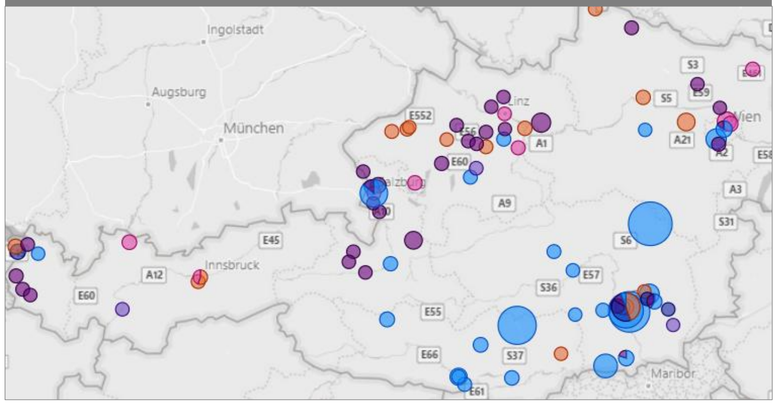
System integration
Solar thermal and District Heating, large storages, SHIP applications.
IndHeap project.



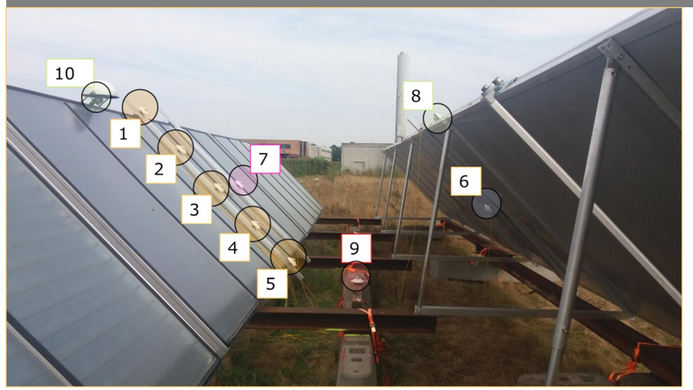




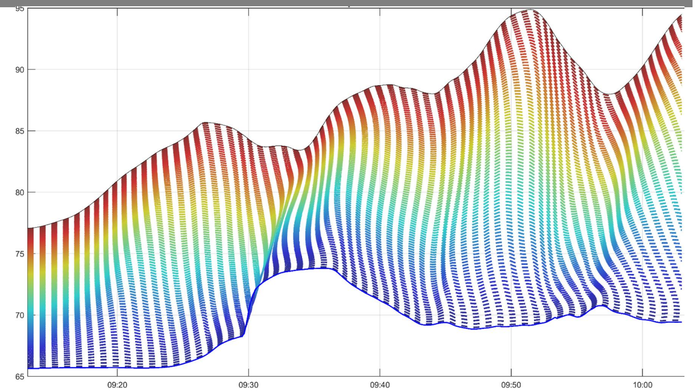
Accompanying Research / “Begleitforschung“
Large solar thermal plants in Austria



Scientific developments,
e.g., radiation modeling,



Digitalization, Performance assessment,
In-situ test & monitoring procedures



Large-scale solar thermal plants

Friesach,
Source: Solar Engineering Guggenberger

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

Högslätten Härnösand
Source: Absolicon

St. Ruprecht an der Raab,
Source: Gasokol GmbH

Fernwärme Ettenheim
Source: Peter Blaser

Stadtwerke Greifswald
Source: Ritter XL Solar

Standards & solar thermal monitoring

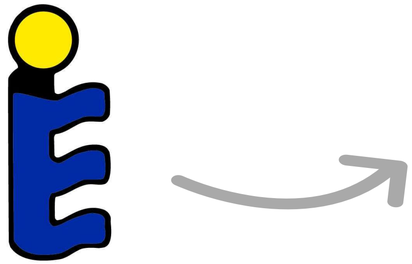
Plant Design
Manufacturing

Operation
Commissioning

ISO 9806
EN 12975
EN 12976

ISO 24194
“Solar energy – Collector fields – Check of performance”

Timescale:
Plant lifetime



SunPeek

ISO 24194 “Check of Performance”

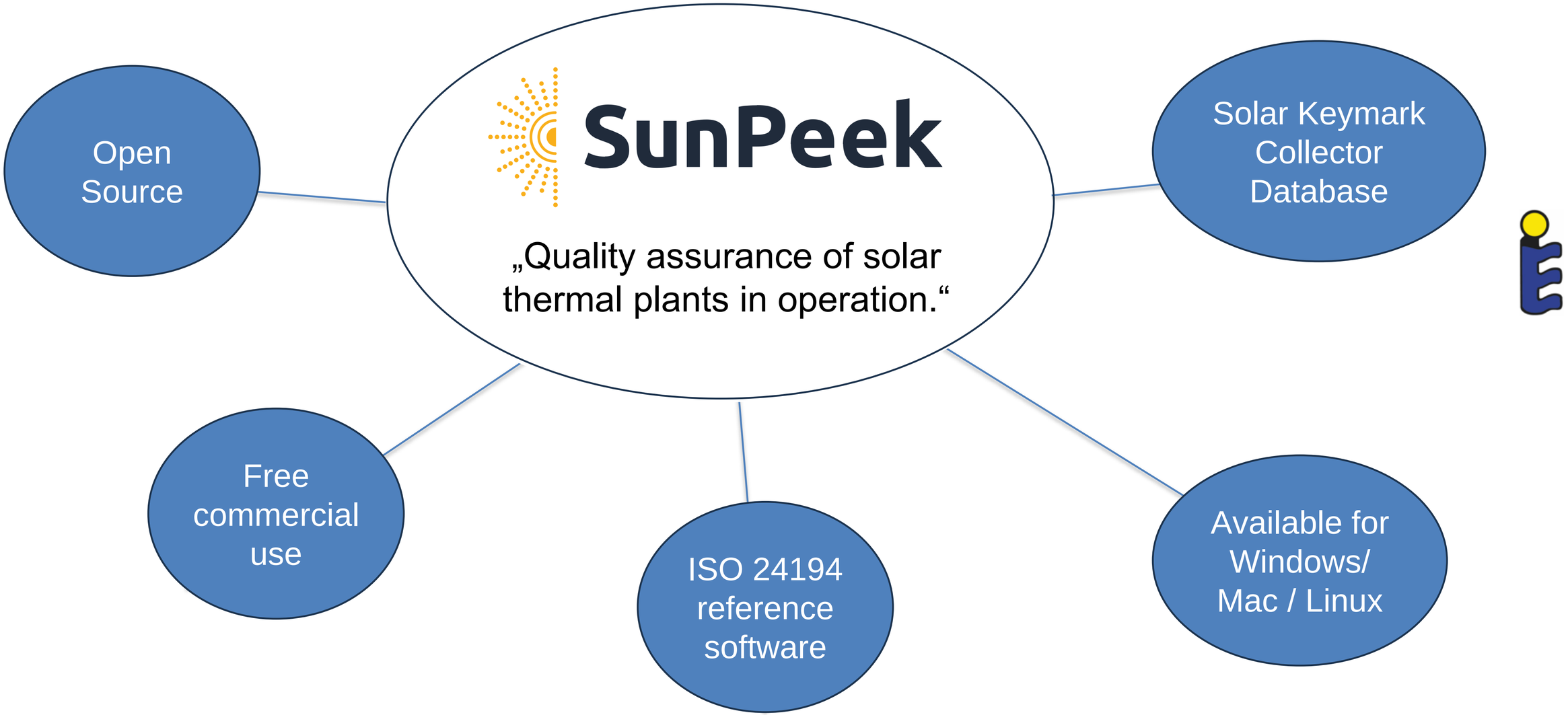
Solar energy — Collector fields — Check of performance

(ISO 24194:2022)

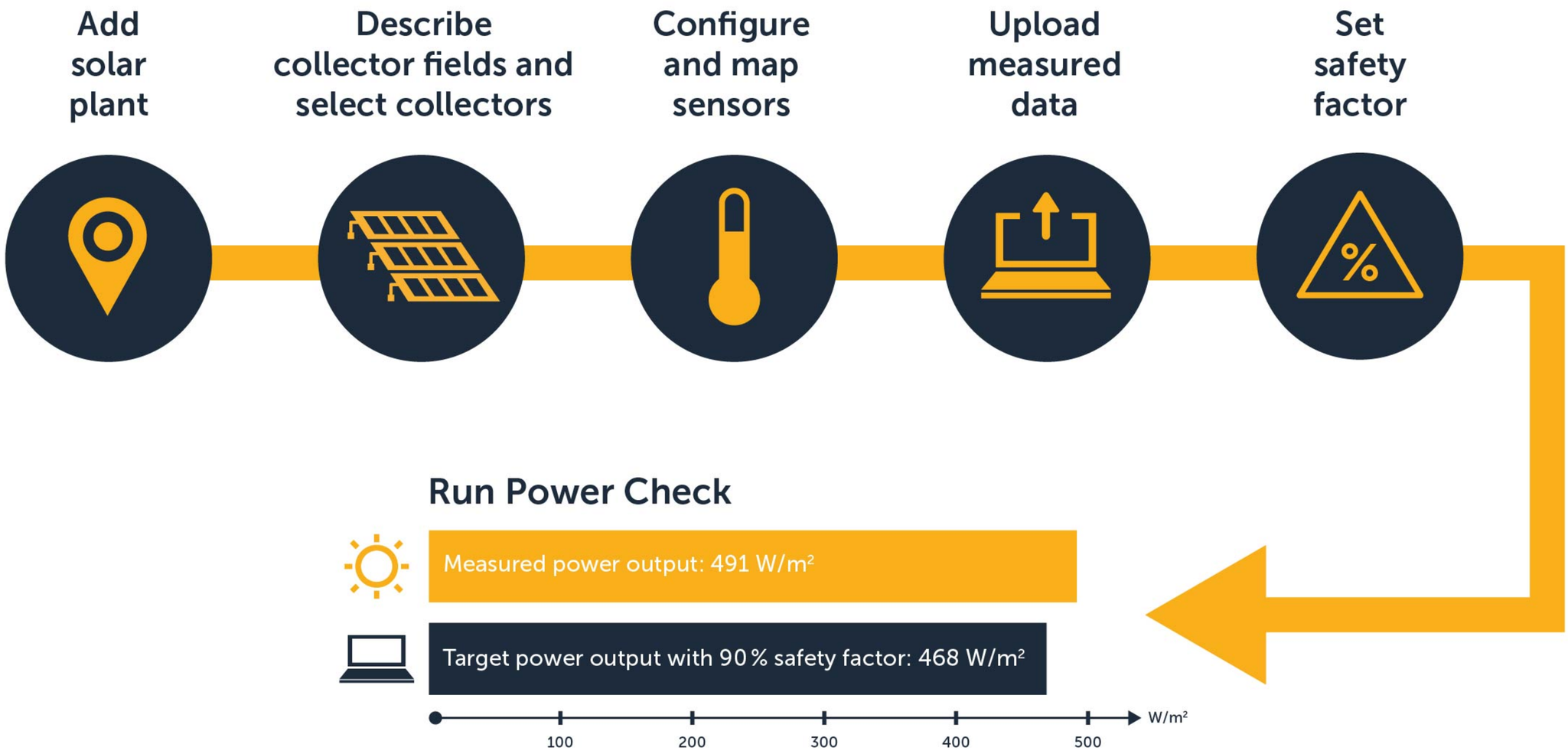
- New ISO standard for assessing performance of solar thermal collector fields / plants.
  - ✓ **In-situ**, for plants in operation!
  - ✓ Refers to ISO 9806 (single collector lab tests)
  - ✓ Refers to ISO 9060 (instruments for solar radiation)
  - ✓ Refers to ISO 9488 (solar vocabulary)

- Defines **2 / 3 methods** on paper:
  - ✓ *Power Check*
  - ✓ Daily Yield Check
  - ✓ (Annual Yield Check)

- Applicable **Collector types**:
  - ✓ Glazed flat plate collectors
  - ✓ Evacuated flat plate collectors
  - ✓ Evacuated tube collectors
  - ✓ Tracking, concentrating collectors

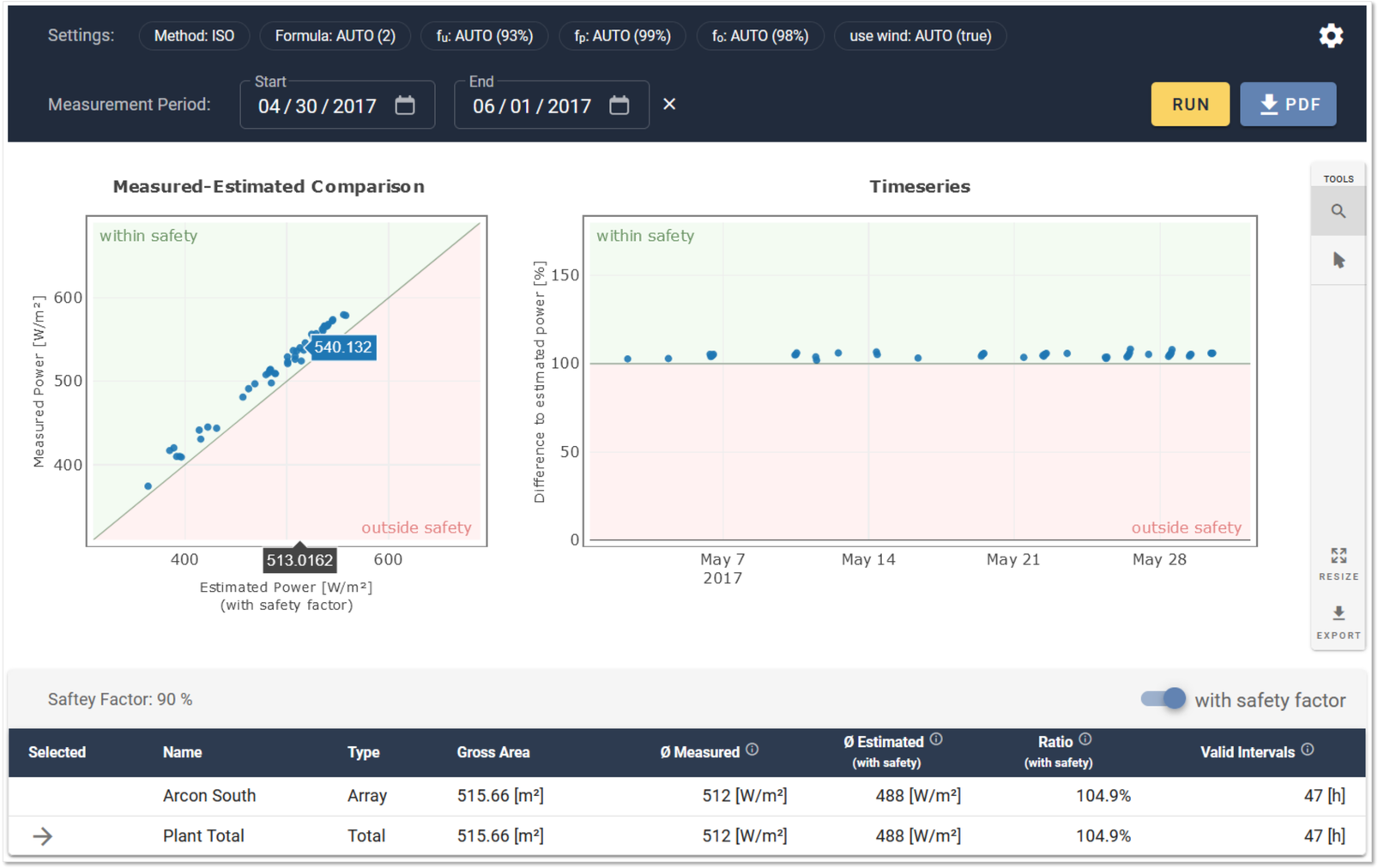

SunPeek
„Quality assurance of solar thermal plants in operation.“
Open Source
Solar Keymark Collector Database
Free commercial use
ISO 24194 reference software
Available for Windows/ Mac / Linux

Steps to SunPeek Power Check



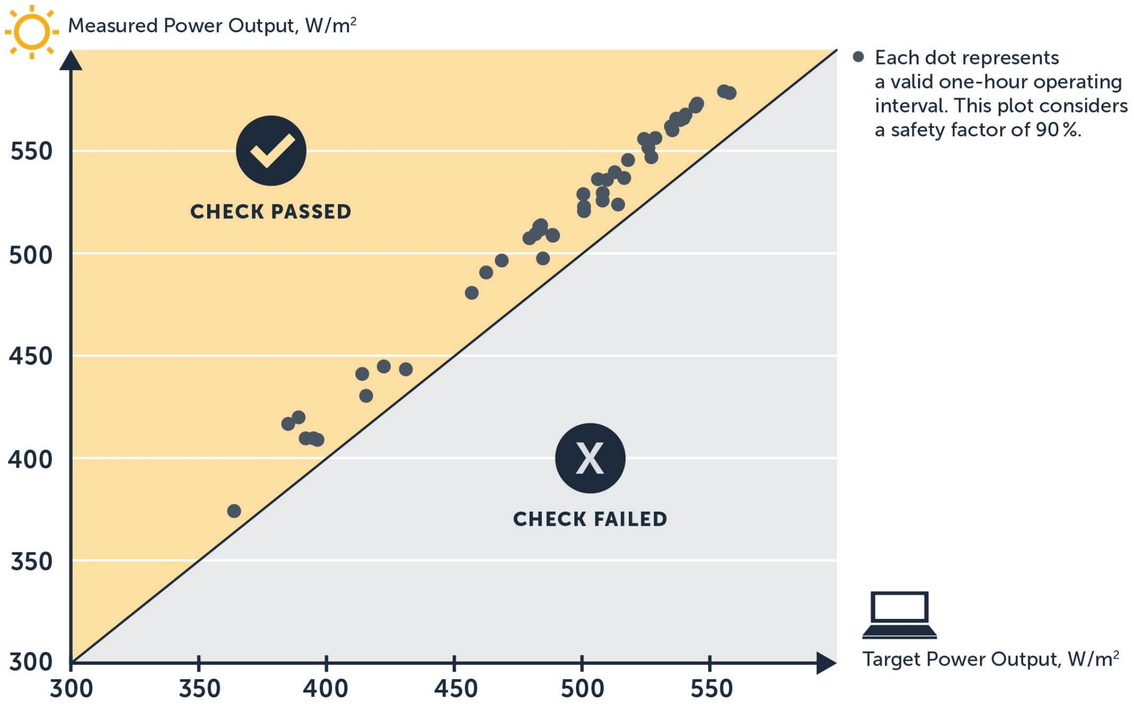
SunPeek: Demo & Graphical User Interface

https://demo.sunpeek.org/



SunPeek Usage: Power Check Benchmarks

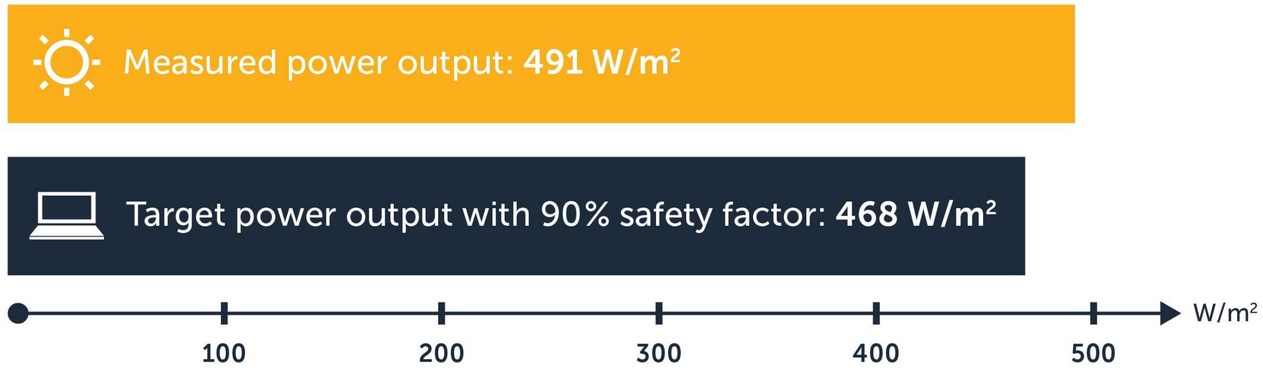
Check performance of large collector fields



Automated Power Check according to ISO 24194

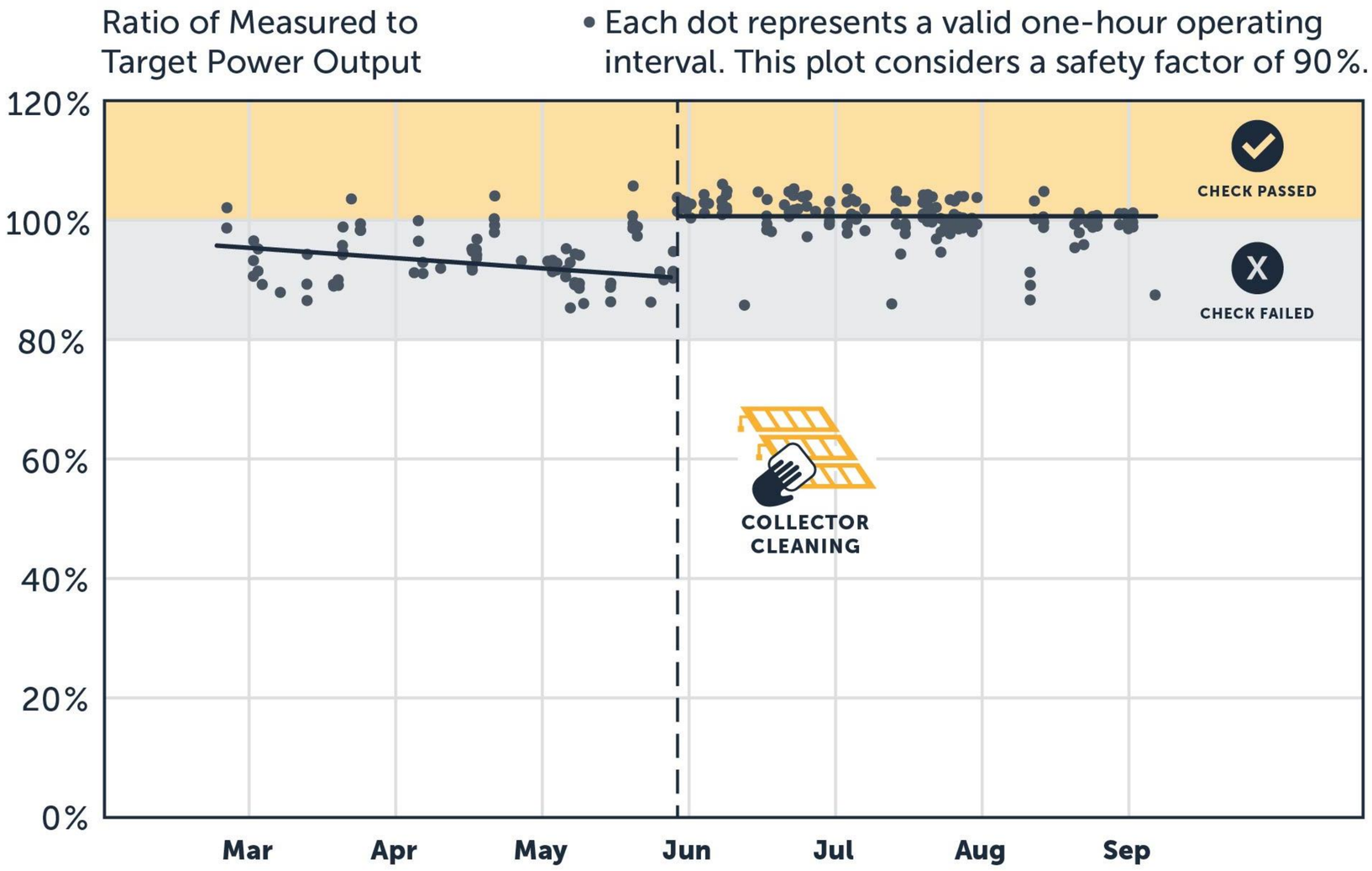
Power Check is fulfilled if measured power output during valid operating intervals is greater than target power output including safety margin.

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



SunPeek Usage: Ongoing Monitoring

Before / After Cleaning Collectors



SunPeek Usage: pdf Reporting, Guarantees

ISO 24194 Power Check

Power Check according to ISO 24194:2022

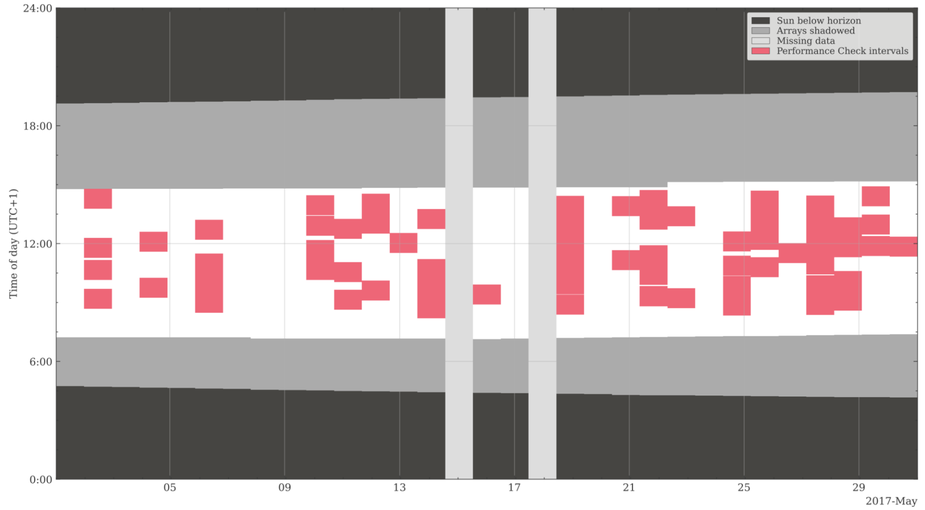
Power Check fulfilled:

Ratio measured / estimated power = 104.8%
This takes a combined safety factor $f_{safe} = 0.9$ into account.
The minimum number of intervals (20, defined in ISO 24194:2022) has been reached: n=64 intervals found, each 1 hour long.

Power Check according to ISO 24194:2022

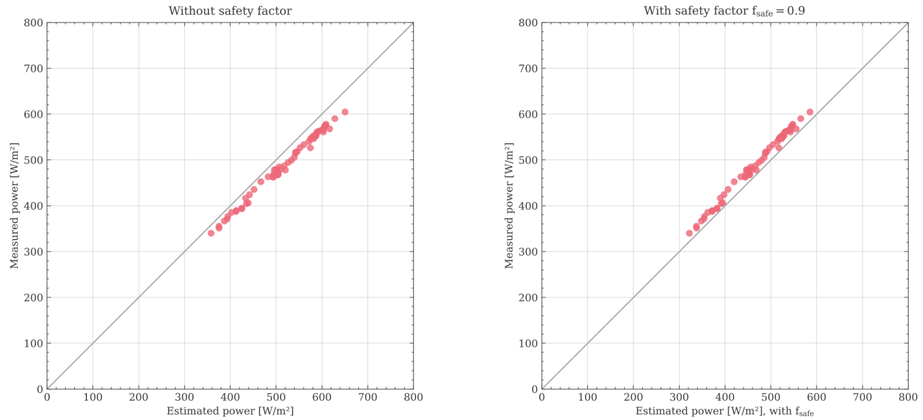
Intervals used for Power Check

n=64 intervals, each 1 hour long. Total interval duration: 64 hours 0 minutes.
Algorithm details: Formula: 2. Wind: Used. Averaging mode: Extended.



Thermal Power Output: Measured vs. Estimated

Plant FHW Arcon South _Test_
Included arrays Arcon South



Notes

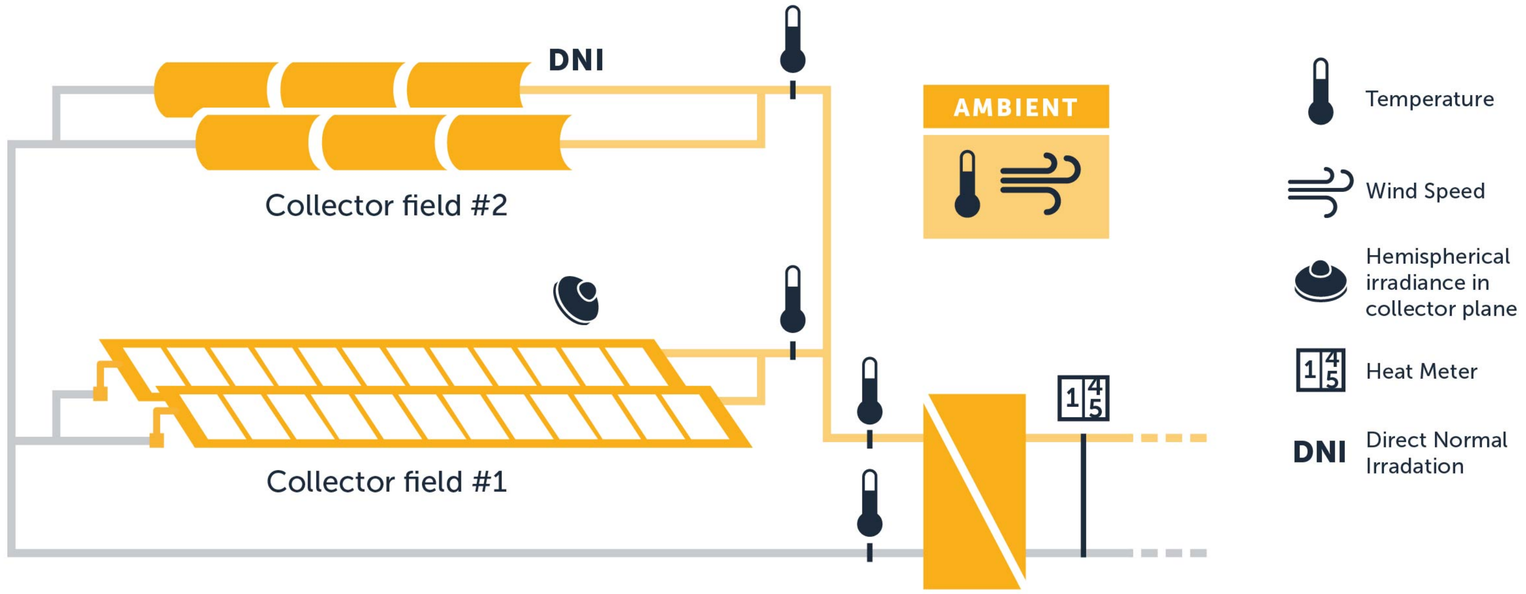
Each dot in the plots is the average thermal power output of a 1 hour interval.
The left plot is based on estimated and measured data without safety factor. The right plot takes the combined safety factor $f_{safe} = 0.9$ into account.
Algorithm details: Formula: 2. Wind: Used. Averaging mode: Extended.

Power Check: Required Data

Case example

Which sensors do you need to run the Power Check?

The required sensors depend on the system hydraulics.
This is one possible measurement setup.



SunPeek: Enhanced Implementation
of ISO 24194:2022 Power Check

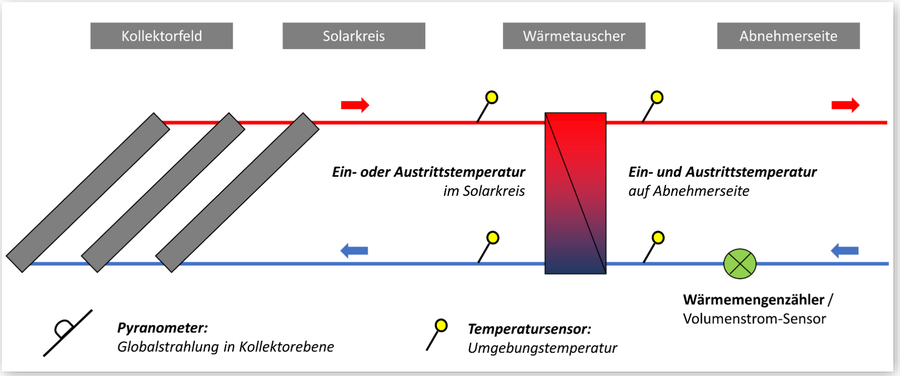
1) Multiple collector fields
- ✓ Data treatment & estimated power per array

2) Mixed collectors
- ✓ E.g., single & double glazed, flat-plate & concentrating
- ✓ Different collector data sheets (ISO 9806 versions SST/QDT, IAM,…)

3) Non-standardized measurements
- ✓ E.g. Heat transfer fluid properties, database

4) Nasty data
- ✓ Auto-treat data formats, valid data, time zones, …

5) Extended filtering method
- ✓ Modern data analysis
- ✓ Faster results, more partial loads



SunPeek: Planned Features

1) Link to Solar Keymark Database

- ➢ Open-source access to all collectors in Solar Keymark Database

2) More Automation

3) Radiation modelling

- ➢ Concentrating collectors, and radiation modeling
- ➢ Multiple collector fields
- ✓ Internal Shading (done)

The Solar Keymark
CEN Keymark Scheme

Feedback to Standardization

Inputs to ISO 24194 via *TC 180 / SC4*

Roadmap

https://gitlab.com/sunpeek/sunpeek-governance/-/wikis/Roadmap/

SunPeek: Platform

Open-source, web-based software

- Designed as *Reference Implementation* of ISO 24194 & and more.
- **Objective:** Simplify operation & increase trust in solar thermal plants → **Reduce LCOH**
- **Features:** Transparency, Automation, High quality implementation

Platform / Development Hub

- *Governed by* community / Research, Industry. *Open to new stakeholders.*
- **Objective: Extend methods** & useful implementations.
- **Objective:** Efficient development, exchange with **ISO 24194 / TC 180.**

Contributors are Welcome.

- Initial development by AEE INTEC, SOLID, GASOKOL, Schneid.
- **Objective: Participation**
- **How?** Project Governance Basics (“How to be SunPeek?”) are defined.

Who is SunPeek?

Initiators

AEE INTEC

SOLID solar energy systems

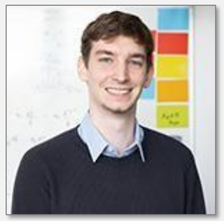
GASOKOL Solar. Seit 1981.

SCHNEID

Steering Committee & Maintainers







Community, Users & Enablers

NUMFOCUS OPEN CODE = BETTER SCIENCE

GitLab

SHC TASK 68

LESBAT

Fraunhofer ISE

Technische Hochschule Ingolstadt

DLR Deutsches Zentrum für Luft- und Raumfahrt

ISFH

SolarEngineering GUGGENBERGER

nahwärme ST. RUPRECHT

Funding

acr

klima+ energie fonds

FFG Promoting Innovation.

DIHSÜD Digital Innovation Hub

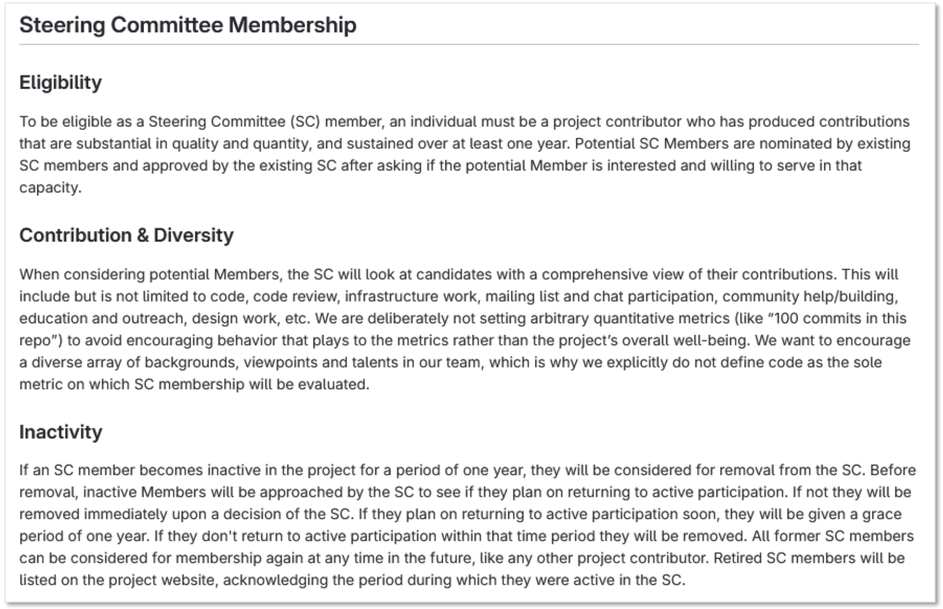
SunPeek Governance

https://gitlab.com/sunpeek/sunpeek-governance/

Steering Committee

SunPeek is **governed** by the Steering Committee:
Anybody can become SC member: research, industry, associations, private.

How to join Steering Committee, rules, voting.
Defined in an open repository.



Steering Committee Membership

Eligibility

To be eligible as a Steering Committee (SC) member, an individual must be a project contributor who has produced contributions that are substantial in quality and quantity, and sustained over at least one year. Potential SC Members are nominated by existing SC members and approved by the existing SC after asking if the potential Member is interested and willing to serve in that capacity.

Contribution & Diversity

When considering potential Members, the SC will look at candidates with a comprehensive view of their contributions. This will include but is not limited to code, code review, infrastructure work, mailing list and chat participation, community help/building, education and outreach, design work, etc. We are deliberately not setting arbitrary quantitative metrics (like "100 commits in this repo") to avoid encouraging behavior that plays to the metrics rather than the project's overall well-being. We want to encourage a diverse array of backgrounds, viewpoints and talents in our team, which is why we explicitly do not define code as the sole metric on which SC membership will be evaluated.

Inactivity

If an SC member becomes inactive in the project for a period of one year, they will be considered for removal from the SC. Before removal, inactive Members will be approached by the SC to see if they plan on returning to active participation. If not they will be removed immediately upon a decision of the SC. If they plan on returning to active participation soon, they will be given a grace period of one year. If they don't return to active participation within that time period they will be removed. All former SC members can be considered for membership again at any time in the future, like any other project contributor. Retired SC members will be listed on the project website, acknowledging the period during which they were active in the SC.

SunPeek: Software & Licenses

https://demo.sunpeek.org/

web UI

Graphical user interface.
Interactive use in browser.

web API

Restful API. Automate
with other software tools.

Python package

Algorithm development.
Integrate with other projects.

Docker

Standardized distribution
and installation.

BSD-3 Clause

- „Permissive“, virtually no restrictions
- Used in similar open-source projects (e.g., pvlib).
- Simplifies integration with own software.

Summary

- ✓ SunPeek is **free** to use, also **commercially**, free to modify and distribute.
- ✓ **Open Data is optional**. No need to share measurement data!

Backend: LGPL (GNU General Public License)

- „Weakly Protective“
- Must release changes under same license.
- Ensures *consistent implementation* of ISO 24194.

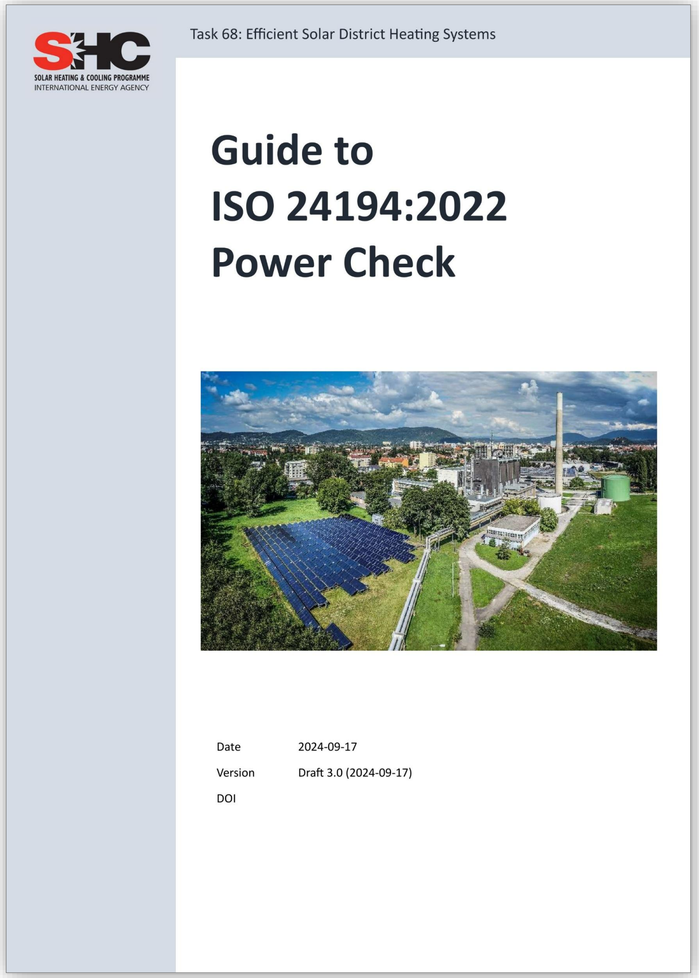
SunPeek
Testimonials

PIERRE DELMAS
CTO and Co-founder NewHeat,
France

"SunPeek is a great service tool for project developers of large collector fields. In the future, we plan to use it to check our performance guarantee agreements between different stakeholders being part of EPC contracts, or eventually to contribute to our periodic performance checks during operation phase.

Photos: Project Newheat | IMAGESinAIR Productions

Guide to ISO 24194 Power Check



„SHC Task 68“
Efficient Solar District Heating Systems
Deliverable

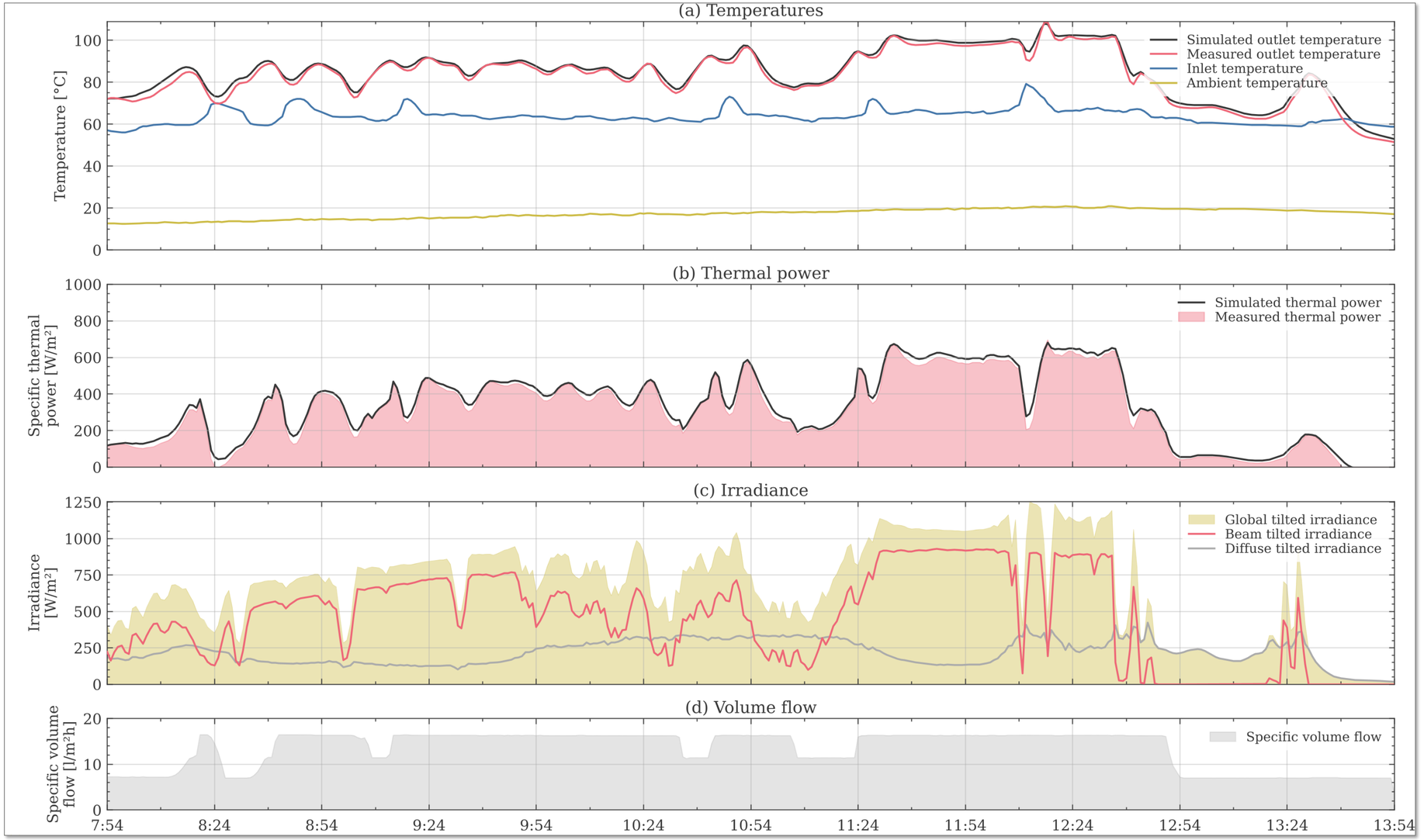
- Comprehensive: **100+ pages** document, **47 authors**.
- **Application** of ISO 24194 Power Check & SunPeek.
- **Target groups:** Plant operators, Plant designers, Collector manufacturers, Researchers.

Publication expected early 2025.

SunPeek: Development Platform

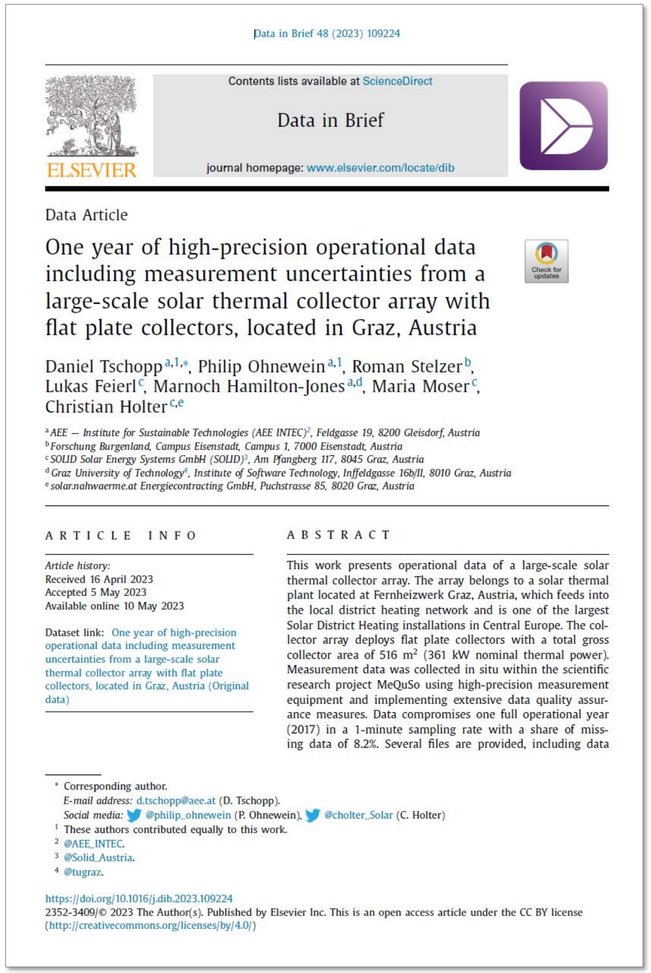
Open-source scientific platform for solar thermal analysis

D-CAT
Energy Yield
Check



Open Data

E.g., FHW Open dataset, Solarheatdata, Lukas Emberger presentation



Data in Brief 48 (2023) 109224

Contents lists available at ScienceDirect

Data in Brief

journal homepage: www.elsevier.com/locate/dib

Data Article

One year of high-precision operational data including measurement uncertainties from a large-scale solar thermal collector array with flat plate collectors, located in Graz, Austria

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[c] SOLID Solar Energy Systems GmbH (SOLID)[3], Am Pfangberg 117, 8045 Graz, Austria
[d] Graz University of Technology[4], Institute of Software Technology, Inffeldgasse 16b/II, 8010 Graz, Austria
[e] solar.nahwaerme.at Energiecontracting GmbH, Puchstrasse 85, 8020 Graz, Austria

ARTICLE INFO

Article history:
Received 16 April 2023
Accepted 5 May 2023
Available online 10 May 2023

Dataset link: One year of high-precision operational data including measurement uncertainties from a large-scale solar thermal collector array with flat plate collectors, located in Graz, Austria (Original data)

ABSTRACT

This work presents operational data of a large-scale solar thermal collector array. The array belongs to a solar thermal plant located at Fernheizwerk Graz, Austria, which feeds into the local district heating network and is one of the largest Solar District Heating installations in Central Europe. The collector array deploys flat plate collectors with a total gross collector area of 516 m² (361 kW nominal thermal power). Measurement data was collected in situ within the scientific research project MeQuSo using high-precision measurement equipment and implementing extensive data quality assurance measures. Data compromises one full operational year (2017) in a 1-minute sampling rate with a share of missing data of 8.2%. Several files are provided, including data

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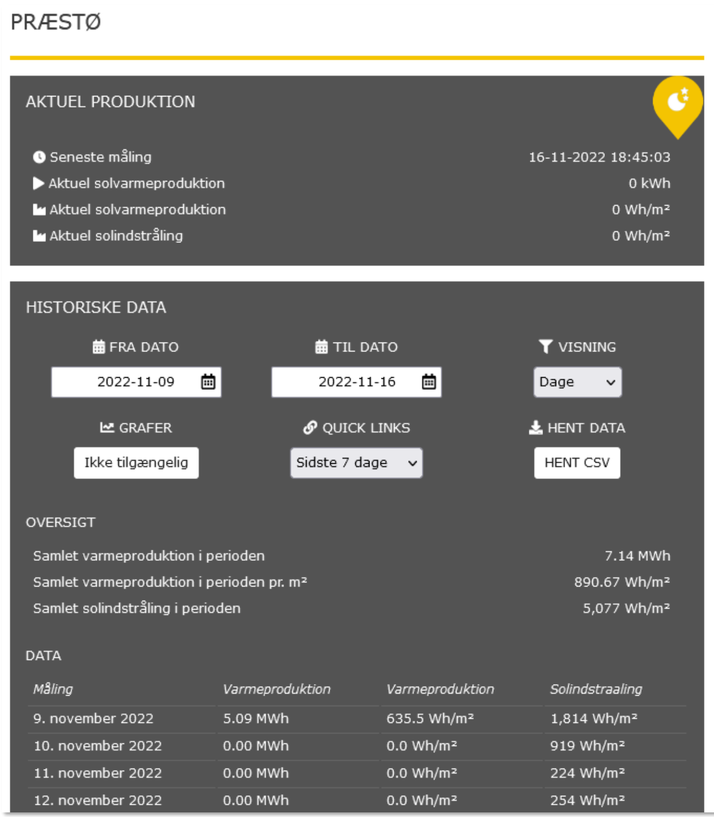
https://doi.org/10.1016/j.dib.2023.109224



PRÆSTØ

AKTUEL PRODUKTION

Seneste måling	16-11-2022 18:45:03
Aktuel solvarmeproduktion	0 kWh
Aktuel solvarmeproduktion	0 Wh/m²
Aktuel solindstråling	0 Wh/m²

HISTORISKE DATA

FRA DATO: 2022-11-09 | TIL DATO: 2022-11-16 | VISNING: Dage

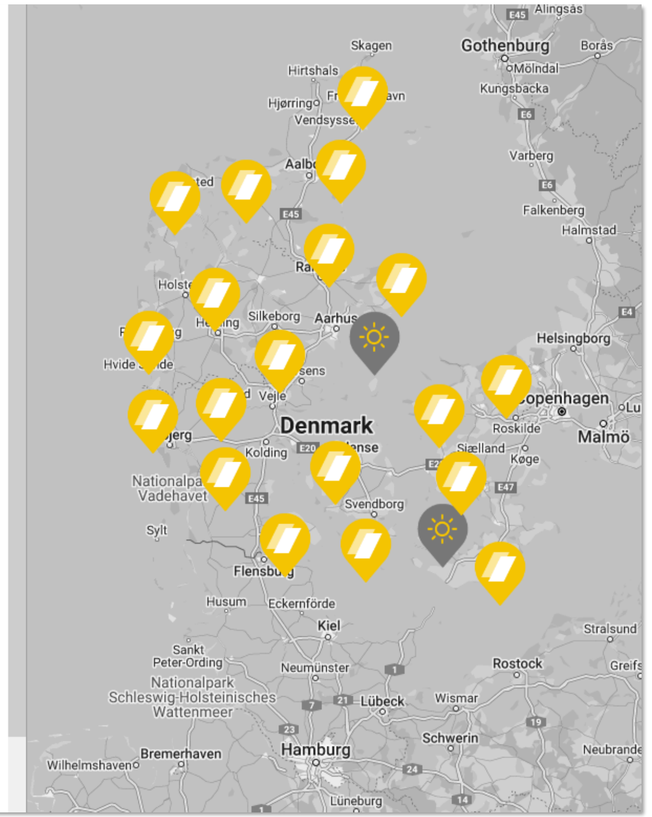
GRAFER: Ikke tilgængelig | QUICK LINKS: Sidste 7 dage | HENT DATA: HENT CSV

OVERSIGT

Samlet varmeproduktion i perioden	7.14 MWh
Samlet varmeproduktion i perioden pr. m²	890.67 Wh/m²
Samlet solindstråling i perioden	5,077 Wh/m²

DATA

Måling	*Varmeproduktion*	*Varmeproduktion*	*Solindstraaling*
9. november 2022	5.09 MWh	635.5 Wh/m²	1,814 Wh/m²
10. november 2022	0.00 MWh	0.0 Wh/m²	919 Wh/m²
11. november 2022	0.00 MWh	0.0 Wh/m²	224 Wh/m²
12. november 2022	0.00 MWh	0.0 Wh/m²	254 Wh/m²

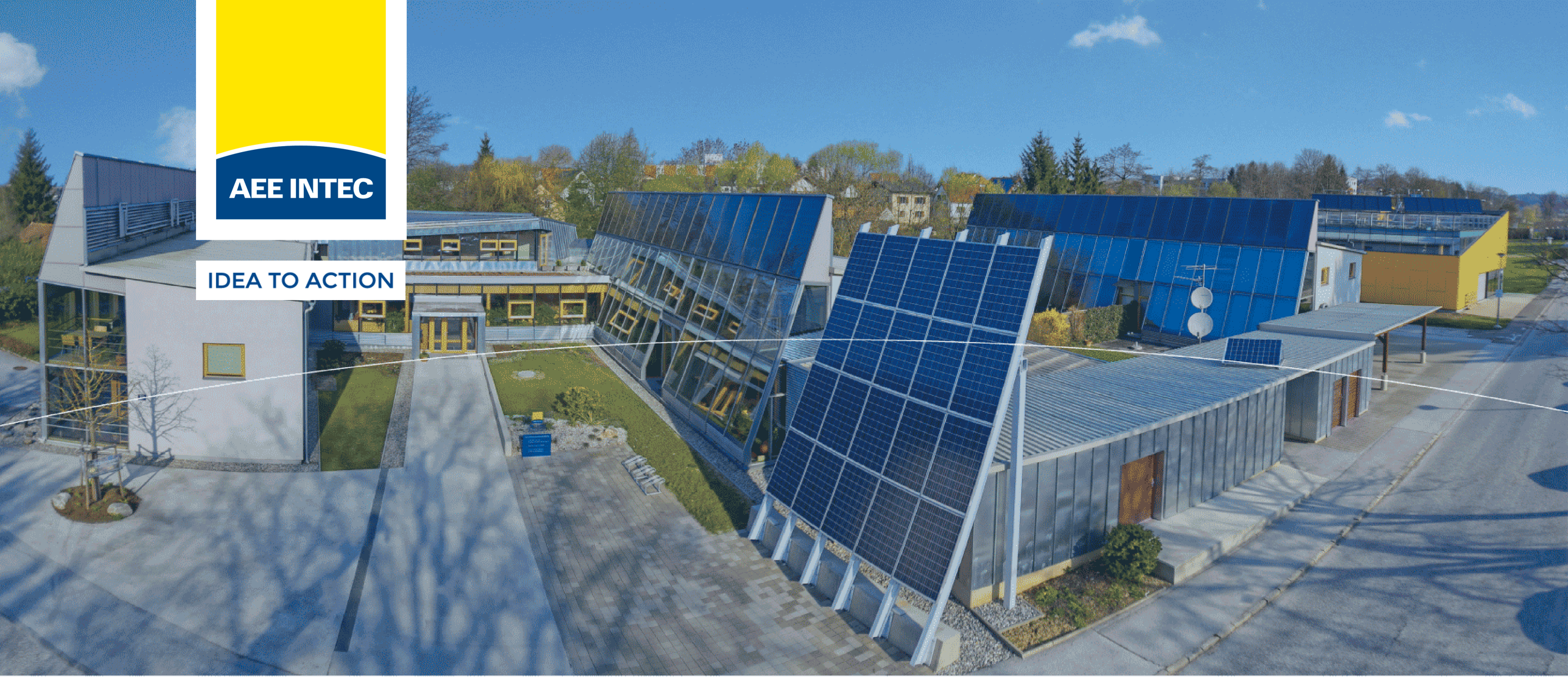


SunPeek Information

https://www.sunpeek.org

✓ **Support**	support@sunpeek.org
✓ **Software Repository**	https://gitlab.com/sunpeek/
✓ **Public Demo**	https://demo.sunpeek.org/

✓ **Open FHW Dataset**	https://doi.org/10.5281/zenodo.7741083
✓ **Data-in-Brief Article**	https://doi.org/10.1016/j.dib.2023.109224
✓ **Publications Hub**	https://zenodo.org/communities/sunpeek



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