



**SLOVENSKI STANDARD**  
**oSIST prEN ISO 24194:2021**  
**01-julij-2021**

---

**Sončna energija - Polja sprejemnikov sončne energije - Preverjanje zmogljivosti (ISO/DIS 24194:2021)**

Solar energy - Collector fields - Check of performance (ISO/DIS 24194:2021)

Sonnenenergie - Kollektorfelder - Überprüfung der Leistungsfähigkeit (ISO/DIS 24194:2021)

Energie solaire - Champs de capteurs - Vérification de la performance (ISO/DIS 24194:2021)

**iTeh STANDARD PREVIEW**  
(standards.iteh.ai)

**Ta slovenski standard je istoveten z: prEN ISO 24194**

[oSIST prEN ISO 24194:2021](https://standards.iteh.ai/catalog/standards/sist/2664b15e6-109-442b-94de-fcc2664b15e6/osist-pren-iso-24194-2021)

<https://standards.iteh.ai/catalog/standards/sist/2664b15e6-109-442b-94de-fcc2664b15e6/osist-pren-iso-24194-2021>

---

**ICS:**

27.160

Sončna energija

Solar energy engineering

**oSIST prEN ISO 24194:2021**

**en,fr,de**

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[oSIST prEN ISO 24194:2021](https://standards.iteh.ai/catalog/standards/sist/63b2a866-49c9-442b-94de-fec2664b15e6/osist-pren-iso-24194-2021)

<https://standards.iteh.ai/catalog/standards/sist/63b2a866-49c9-442b-94de-fec2664b15e6/osist-pren-iso-24194-2021>

# DRAFT INTERNATIONAL STANDARD

## ISO/DIS 24194

ISO/TC 180/SC 4

Secretariat: SAC

Voting begins on:  
2021-04-14Voting terminates on:  
2021-07-07

---

---

## Solar energy — Collector fields — Check of performance

ICS: 27.160

### iTeh STANDARD PREVIEW (standards.iteh.ai)

[oSIST prEN ISO 24194:2021](https://standards.iteh.ai/catalog/standards/sist/63b2a866-49c9-442b-94defc2664b15e6/osist-pren-iso-24194-2021)  
<https://standards.iteh.ai/catalog/standards/sist/63b2a866-49c9-442b-94defc2664b15e6/osist-pren-iso-24194-2021>

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

This document is circulated as received from the committee secretariat.

**ISO/CEN PARALLEL PROCESSING**



Reference number  
ISO/DIS 24194:2021(E)

## iTeh STANDARD PREVIEW (standards.iteh.ai)

[oSIST prEN ISO 24194:2021  
https://standards.iteh.ai/catalog/standards/sist/63b2a866-49c9-442b-94defc2664b15e6/osist-pren-iso-24194-2021](https://standards.iteh.ai/catalog/standards/sist/63b2a866-49c9-442b-94defc2664b15e6/osist-pren-iso-24194-2021)



### **COPYRIGHT PROTECTED DOCUMENT**

© ISO 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Fax: +41 22 749 09 47  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

## Contents

Foreword.....	iv
Introduction.....	v
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions .....	1
4 Symbols.....	2
5 Procedure for checking the power performance of solar thermal collector fields .....	5
5.1 Stating an estimate for the thermal power output of a collector field .....	5
5.2 Calculating power output.....	5
5.2.1 Equation 1 .....	6
5.2.2 Equation 2 .....	7
5.2.3 Equation 3 .....	7
5.3 Stating a performance estimate.....	7
5.4 Restrictions on operating conditions .....	8
5.5 Shadows.....	8
5.5.1 Shadows on fixed collectors in rows.....	8
5.5.2 Shadows on one-axis tracking collectors in row.....	9
5.6 Collector incidence angle.....	12
5.7 Example of setting up an equation for calculating performance estimate .....	12
5.8 Determination of potential valid periods .....	13
5.9 Checking performance estimates.....	13
5.9.1 Checking collector field performance.....	13
6 Measurements needed.....	14
6.1 Requirements on measurements and sensors.....	16
6.1.1 Time.....	16
6.1.2 Solar radiation measurement.....	17
6.1.3 Temperature measurements .....	18
6.1.4 Flow rate measurement .....	19
6.1.5 Power measurement / calculation.....	19
6.1.6 Measurement of wind speed.....	20
6.2 Valid data records.....	20
Annex A 1 (informative) Recommended reporting format - Power Method.....	21
Annex A 2 (informative) Recommended reporting format - Daily Yield Method.....	24
Annex B 1 (informative) Recommended format for stating the estimated performance- Power Method.....	25
Annex C (informative) Procedure for checking the daily performance of solar thermal collector fields .....	26
Bibliography .....	30

## ISO/DIS 24194:2021(E)

### Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 180, *Solar energy*, Subcommittee SC 4, *Systems - Thermal performance, reliability and durability*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

This document defines procedures for checking the performance of solar thermal collector fields. Measured performance is compared with calculated performance - and conditions for compliance are given.

Two levels for accuracy in the checking can be chosen:

- Level I - giving possibility for giving a very accurate estimate (with low safety factor) - but with requirements for use of expensive measurement equipment.
- Level II - allowing for a less accurate estimate (with higher safety factor) - but possibility to use less expensive measurement equipment..

## iTeh STANDARD PREVIEW (standards.iteh.ai)

[oSIST prEN ISO 24194:2021](https://standards.iteh.ai/catalog/standards/sist/63b2a866-49c9-442b-94defc2664b15e6/osist-pren-iso-24194-2021)

<https://standards.iteh.ai/catalog/standards/sist/63b2a866-49c9-442b-94defc2664b15e6/osist-pren-iso-24194-2021>

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[oSIST prEN ISO 24194:2021](https://standards.iteh.ai/catalog/standards/sist/63b2a866-49c9-442b-94de-fec2664b15e6/osist-pren-iso-24194-2021)

<https://standards.iteh.ai/catalog/standards/sist/63b2a866-49c9-442b-94de-fec2664b15e6/osist-pren-iso-24194-2021>



# Solar energy — Collector fields — Check of performance

## 1 Scope

This document specifies two procedures to verify the performance of solar thermal collector fields. The collectors in the fields can be glazed flat plate collectors, evacuated tube collectors and/or tracking, concentrating collectors.

The check can be done on the thermal power output of the collector field - this is described in the main part of the document.

The check also be done on the daily yield of the collector field - this is described in informative annex.

The document specifies for the two procedures how to compare a measured output with a calculated one.

The document applies for all sizes of collector fields.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9060, Solar energy — Specification and classification of instruments for measuring hemispherical solar and direct solar radiation

ISO 9488, Solar energy — Vocabulary

ISO 9806, Solar energy — Solar thermal collectors — Test methods

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9488 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

### 3.1

#### **reflector**

surface intended for reflecting radiant energy

### 3.2

#### **transversal plane**

plane defined by the normal to the plane of the collector and the line orthogonal to the concentrator axis, or the shortest symmetry line for flat biaxial geometries

## ISO/DIS 24194:2021(E)

## 4 Symbols

$A_G$	Gross area of collector as defined in the ISO 9488	$m^2$
$A_{GF}$	Gross area of collector field	$m^2$
$a_1$	Heat loss coefficient at $(\vartheta_m - \vartheta_a) = 0$	$W/(m^2 \cdot K)$
$a_2$	Temperature dependence of the heat loss coefficient	$W/(m^2 \cdot K^2)$
$a_3$	Wind speed dependence of the heat loss coefficient	$J/(m^3 \cdot K)$
$a_4$	Sky temperature dependence of the heat loss coefficient	—
$a_5$	Effective thermal capacity. In some literature and data sheets denoted $C_{eff}$	$J/(m^2 \cdot K)$
$a_6$	Wind speed dependence of the zero-loss efficiency	$s/m$
$a_7$	Wind speed dependence of IR radiation exchange	$W/(m^2 \cdot K^4)$
$a_8$	Radiation losses dependence	$W/(m^2 \cdot K^4)$
$b_u$	Collector efficiency coefficient (wind dependence)	$s/m$
$C$	Effective thermal capacity of collector	$J/K$
$C_R$	Geometric concentration ratio	—
$c_f$	Specific heat capacity of heat transfer fluid	$J/(kgK)$
$c_{f,i}$	Specific heat capacity of heat transfer fluid at the collector inlet	$J/(kgK)$
$c_{f,e}$	Specific heat capacity of heat transfer fluid at the collector outlet	$J/(kgK)$
$DNI$	Solar radiation received per unit area by a surface that is always held perpendicular (or normal) to the rays that come in a straight line from the direction of the sun at its current position	$W/m^2$
$E_L$	Longwave irradiance ( $\lambda > 3 \mu m$ )	$W/m^2$
$f_P$	Safety factor taking into account heat losses from pipes etc. in the collector loop.	-
$f_U$	Safety factor taking into account measurement uncertainty.	-
$f_0$	Safety factor for other uncertainties e.g. related to non-ideal conditions such as non-ideal flow distribution and unforeseen heat losses - and uncertainties in the model/procedure itself.	-
$f_{safe}$	$f_{safe} = f_P \cdot f_U \cdot f_0$	-
$f_{sh}$	Shading factor	-
$G$	Gap in between adjacent collectors	$m$
$G_{hem}$	Hemispherical solar irradiance on the plane of collector	$W/m^2$
$G_b$	Direct solar irradiance (beam irradiance) on the plane of collector	$W/m^2$
$G_d$	Diffuse solar irradiance on the plane of collector	$W/m^2$
$H_{hem}$	Total daily irradiation sum on collector plane without shadow	$kWh/m^2$

$h$	Solar altitude angle. $\sin h = \cos \theta_z$	°
$h_{min}$	Minimum solar altitude angle	°
$H_{sh}$	Height of the shaded area	m
$K_{hem}(\theta_L, \theta_T)$	Incidence angle modifier for hemispherical solar radiation	—
$K_b(\theta_L, \theta_T)$	Incidence angle modifier for direct solar irradiance	—
$K_{\theta_L}$	Incidence angle modifier in the longitudinal plane	—
$K_{\theta_T}$	Incidence angle modifier in the transversal plane	—
$K_d$	Incidence angle modifier for diffuse solar radiation	—
$L$	Length of a collector	m
$L_{pipe}$	Overall Length of the pipe system without collectors	m
$L_{sh}$	Length of the shaded area	m
$\dot{m}$	Mass flow rate of heat transfer fluid	kg/s
$N_c$	Number of collectors in a row	-
$P_x$	Coordinate of the point C on the x-axis (C is the point that would reach the shadow formed by the top of the sun facing side of a collector row if it were unobstructed)	-
$P_y$	Coordinate of the point C on the y-axis	-
$\dot{Q}_{measured}$	Measured power output	W
$\dot{Q}_{estimate}$	Estimated power output	W
$Q_{cap,d}$	Daily capacity heat losses of solar thermal system	J
$Q_{estimate-sys,d}$	Daily yield estimation of solar thermal system	J
$\dot{Q}_{estimate-col,d}$	Daily average gross power output collector field	W
$Q_{HM,d}$	Daily yield measurement of the heat meter	J
$\dot{Q}_{pipe,d}$	Daily average heat losses of piping	W
$q_{l-pipe}$	Empirical specific heat loses per m pipe	W/m
$S$	Spacing center to center in between adjacent rows	m
$T$	Absolute temperature	K
$t$	Time	s
$t_s$	Time start of measurement	s
$t_e$	Time end of measurement	s
$u$	Surrounding air speed (wind speed)	m/s
$u'$	Reduced surrounding air speed $u' = u - 3$ m/s	m/s

## ISO/DIS 24194:2021(E)

$V_f$	Fluid capacity of the collector	$m^3$
$\dot{V}$	Volumetric flow rate	$m^3/s$
$\dot{V}_e$	Volumetric flow rate at the outlet of the solar collector	$m^3/s$
$\dot{V}_i$	Volumetric flow rate at the inlet of the solar collector	$m^3/s$
$V_{\text{pipe}}$	Volume of the pipe system without collectors	l
$W$	Width of a collector	
$\Delta t$	Time interval	s
$\Delta T$	Temperature difference between fluid outlet and inlet ( $\vartheta_e - \vartheta_i$ )	K
$\beta$	Slope (or tilt), the angle between the plane of the collector and the horizontal.  <i>Note: For collectors rotating around a North-South axis, <math>\beta</math> is positive in the morning when facing eastwards - and negative in the afternoon when facing westwards</i>	
$\gamma$	Surface azimuth angle, the deviation of the projection on horizontal plane of the normal to the surface from the local meridian, with zero due south, east negative and west positive	$^\circ$
$\gamma_s$	Solar azimuth angle, the angular displacement from south of the projection of beam radiation on the horizontal plan, east negative and west positive	$^\circ$
$\delta$	Declination, the angular position of the sun at solar noon with respect to the plane of the equator, north positive	$^\circ$
$\phi$	Latitude, the angular location north or south of the equator, north positive	$^\circ$
$\eta_b$	Collector efficiency based on beam irradiance $G_b$	—
$\eta_{\text{hem}}$	Collector efficiency based on hemispherical irradiance $G_{\text{hem}}$	—
$\eta_{0,b}$	Peak collector efficiency ( $\eta_b$ at $\vartheta_m - \vartheta_a = 0$ K) based on beam irradiance $G_b$	—
$\eta_{0,\text{hem}}$	Peak collector efficiency ( $\eta_{0,\text{hem}}$ at $\vartheta_m - \vartheta_a = 0$ K) based on hemispherical irradiance $G_{\text{hem}}$	—
$\eta_{\text{hem},\dot{m}_i}$	Collector efficiency, with reference to mass flow $\dot{m}_i$	—
$\omega$	Hour angle, the angular displacement of the sun east or west of the local meridian due to rotation of the earth on its axis at $15^\circ$ per hour; morning negative, afternoon positive	$^\circ$
$\theta$	Angle of incidence	$^\circ$
$\theta_L$	Longitudinal angle of incidence: angle between the normal to the plane of the collector and incident sunbeam projected into the longitudinal plane	$^\circ$
$\theta_T$	Transversal angle of incidence: angle between the normal to the plane of the collector and incident sunbeam projected into the transversal plane	$^\circ$