



Technische Hochschule  
Ingolstadt

Institute of  
new Energy Systems

*Solar Keymark Database Analysis  
& Proposal of a more user-friendly  
CARNOT Block for  
Solar Thermal Collectors*

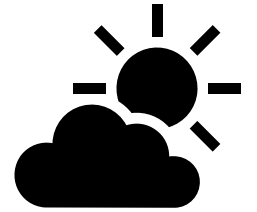
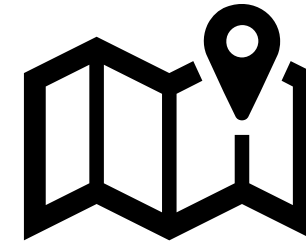
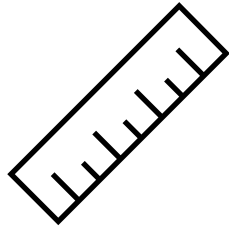
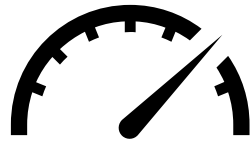
## Motivation

*The selection of solar thermal collector type depends on a variety of aspects ...*



## Motivation

The selection of solar thermal collector type depends on a variety of aspects ...



- There may be big differences in efficiency, costs, availability, etc.
- The selection of different models should be easy and fast
- CARNOT does not yet offer a list of collectors to choose from



**The Solar Keymark**  
CEN Keymark Scheme



# Extracting Data from Solar Keymark Database

How the data is currently accessible

**SOLAR KEYMARK**

COLLECTOR TANK SYSTEM CONTROL

1 8 9 10 11 12 13 14 ... 45

Licence holder company	Brand	Licence number
Guangdong Fivestar Solar Energy Co.,Ltd	Fivestar	011-7S3116F
Riello S.p.A.	RPS 25/4	011-7S2785F
MBM GROUP S.R.L.	STAR 1500, STAR 2000, STAR 2600	OEM9965-1-3
BSG CALDAIE A GAS S.P.A.	15 SOL TOP, 20 SOL TOP, 26 SOL TOP	OEM9965-1-1
Bio Energie op Maat BV	SolCol	011-7S2971R
DIMAS SA	ENERGY+ARGO 15, ENERGY+ARGO 17, ENERGY+ARGO 19, ENERGY+ARGO 20, ENERGY+ARGO 23, ENERGY+ARGO 25, ENER ..	011-7S1490F
ALPHA THERM SOLAR SYSTEMS Co	AES-2.50	OEM10110.1.2
Trigo Energies inc.	Calento SL - lanced	011-7S3104L
THERMIC SPLLC	THERMIC DELTA 1.5, THERMIC DELTA 1.7, THERMIC DELTA 2.0H, THERMIC DELTA 2.0, THERMIC DELTA 2.25, THE ..	011-7S2708F
Trigo Energies inc.	CALENTO SL G	011-7S3114L
August Brötje GmbH	FK 26 W B	011-7S1944F
KOLLECTOR BIOME BEJA - K.B.B. SA	K420-MS-AL, K423-MS-AL, K425-MS-AL	011-7S1683F
CLIMART S.R.L	SMART SOL	OEM10109.1.1
Zhejiang Kesun New Energy Co., Ltd	ENSUN	011-7S1076R
Solimpeks Solar Corp.	WUNDER ALS 1809, WUNDER ALS 2110, WUNDER ALS 2412, WUNDER ALS 2512, WUNDER ALS 2710, WUNDER ALS 3010	011-7S1911F
PAPAEMMANOUEL S.A.	OLC200	SKM10112.1
PAPAEMMANOUEL S.A.	ASL-1.50m <sup>2</sup> , ASL-1.82m <sup>2</sup> , ASL-2.00m <sup>2</sup> , ASL-2.37m <sup>2</sup> , ASL-2.72m <sup>2</sup>	SKM10126.1
NOBEL INTERNATIONAL EAD	AELIOS	OEM9999-2-4
PAPAEMMANOUEL S.A.	FOXAL 20-2019	SKM10045
SEVIL S.R.L.	SEVIL FM 1.50, SEVIL FM 1.50H, SEVIL FM 1.82, SEVIL FM 1.82H, SEVIL FM 2.00, SEVIL FM 2.00H, SEVIL F ..	OEM9999-1-7

TÜVRheinland®  
DIN CERTCO  
Precisely Right.

IGTE

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Annex to Solar Keymark Certificate

Licence Number: 011-7S2708 F  
Date issued: 2022-07-13  
Issued by: DIN CERTCO

Licence holder: THERMIC SPLLC  
Country: Greece  
Brand (optional): THERMIC SPLLC  
Web: www.thermicso.com  
Street, Number: Loutsas & Mesologgiou  
E-mail: info@thermicso.com  
Postcode, City: 19600 Mandra, Attica  
Tel: +30 210 55 55 523

Collector Type: Flat plate collector

Collector name	Gross area (A <sub>g</sub> ) m <sup>2</sup>	Gross length mm	Gross width mm	Gross height mm	Power output per collector G <sub>b</sub> = 850 W/m <sup>2</sup> , G <sub>d</sub> = 150 W/m <sup>2</sup> & u = 1.3 m/s θ <sub>inc</sub> = θ <sub>opt</sub>					
					0 K	10 K	30 K	50 K	70 K	112 K
					W	W	W	W	W	W
THERMIC DELTA 1.5	1.51	1503	1007	85	1093	1037	921	797	666	367
THERMIC DELTA 1.7	1.66	1420	1183	85	1216	1154	1024	886	741	408
THERMIC DELTA 2.0H	1.96	1503	1305	85	1419	1348	1195	1034	864	476
THERMIC DELTA 2.0	2.02	2006	1007	85	1462	1388	1232	1066	890	490
THERMIC DELTA 2.25	2.24	1893	1183	85	1621	1539	1366	1182	967	544
THERMIC DELTA 2.5	2.52	2006	1257	85	1824	1731	1536	1330	1111	612
THERMIC DELTA 2.7	2.67	2261	1183	85	1933	1834	1628	1409	1177	648
THERMIC DELTA 3.0	2.92	2006	1457	85	2114	2006	1780	1541	1287	709

Power output per m<sup>2</sup> gross area: 724 687 610 528 441 243

Performance parameters test method: Quasi dynamic

Performance parameters (related to A<sub>g</sub>): n<sub>0</sub>, b, a1, a2, a3, a4, a5, a6, a7, a8, k<sub>d</sub>

Units: - W/(m<sup>2</sup>K), W/(m<sup>2</sup>K<sup>2</sup>), J/(m<sup>2</sup>K), a/m, W/(m<sup>2</sup>K), W/(m<sup>2</sup>K<sup>2</sup>), -

Test results: 0.725 3.62 0.006 0.000 0.00 13 660 0.000 0.00 0.0 0.99

Incidence angle modifier test method: Quasi dynamic - outdoor

Incidence angle modifier	Angle	10°	20°	30°	40°	50°	60°	70°	80°	90°
Transversal	K <sub>at, coll</sub>	1.00	1.00	1.00	0.99	0.96	0.87	0.63	0.32	0.00
Longitudinal	K <sub>at, coll</sub>	1.00	1.00	1.00	0.99	0.96	0.87	0.63	0.32	0.00

Heat transfer medium for testing: Water-Glycole

Flow rate for testing (per gross area, A<sub>g</sub>): dm/dt 0.020 kg/(s·m<sup>2</sup>)

Maximum temperature difference during thermal performance test: (θ<sub>inc</sub> - θ<sub>opt</sub>)<sub>max</sub> 82 K

Standard stagnation temperature (G = 1000 W/m<sup>2</sup>, θ<sub>inc</sub> = 30 °C): θ<sub>st, max</sub> 230 °C

Maximum operating temperature: θ<sub>max, op</sub> °C

Maximum operating pressure: P<sub>max, op</sub> 1000 kPa

Testing laboratory: Institut für Gebäudeenergie, Thermotechnik und Energiespeicherung (IGTE) <http://www.igte.uni-stuttgart.de>

Test report(s): 21COL16310EOM06, 21COL16310QEM06, 21COL16320EOM06

Dated: 22.06.2022, 22.06.2022, 22.06.2022

Comments of testing laboratory: Documented performance parameters are taken from 21COL16320EOM06 (THERMIC DELTA 1.5)  
This data sheet replaces the data sheet issued on 15.03.2021  
According to the Solar Keymark Scheme rules the collector was retested after 10 years after the previous test.

Ver. 6.2 (13.01.2022)

DIN CERTCO • Alboinstraße 56 • 12103 Berlin, Germany  
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- Browsing through the database is limited to license holder, brand, and license number
- Automated data extraction is not possible
- Finding a certain collector type is already a challenge
- Finding a collector with certain properties is even more complicated



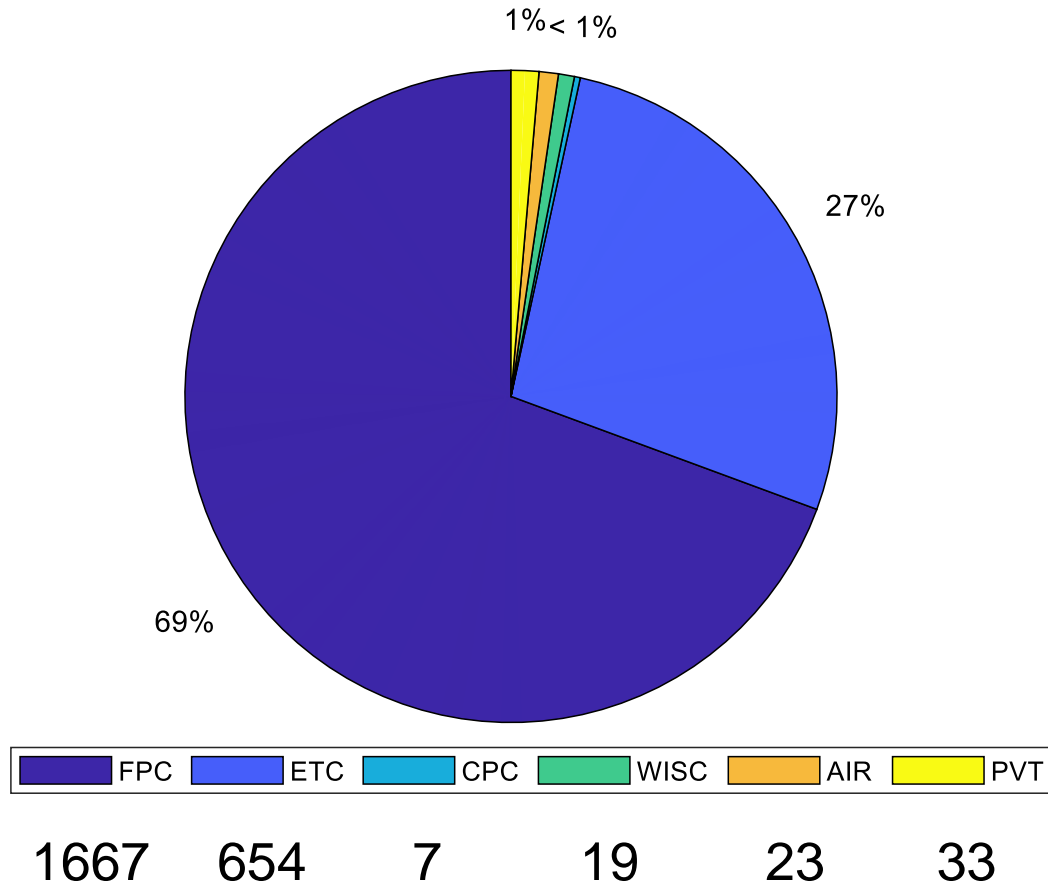
# Extracting Data from Solar Keymark Database

## Gathering all Solar Keymark Datasets in a single data file

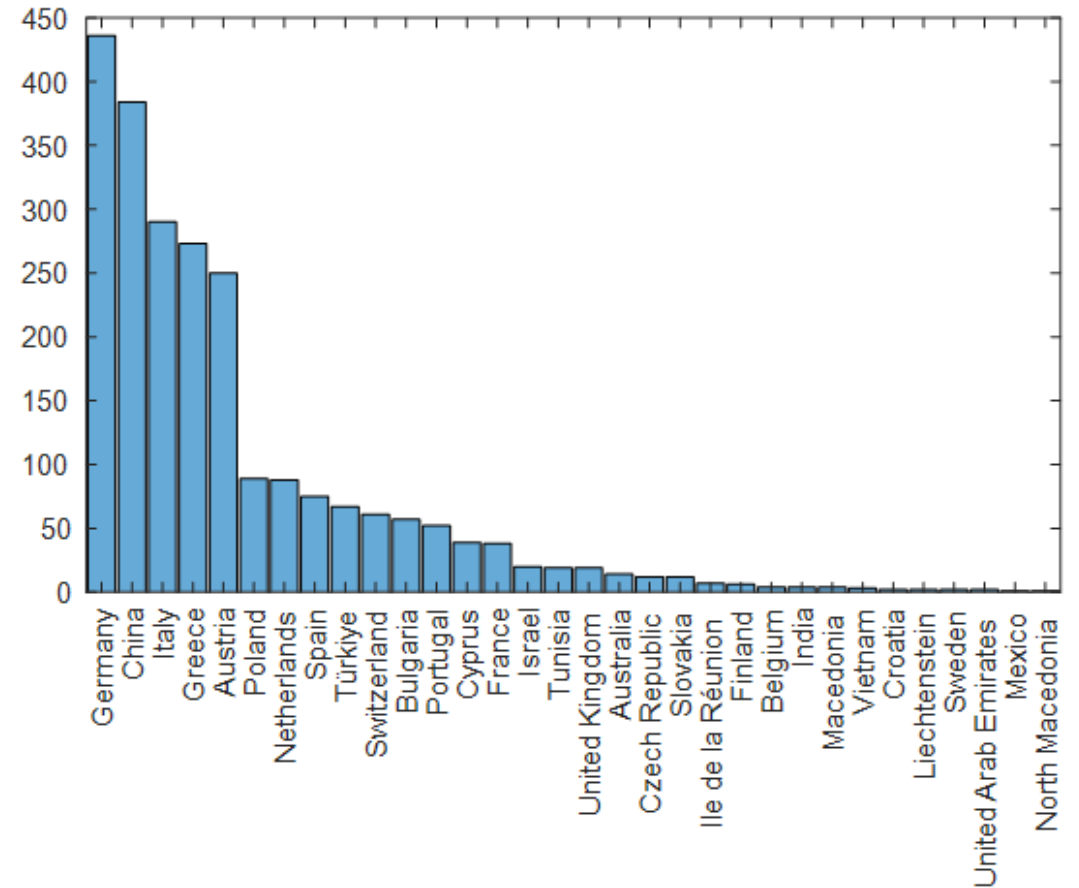
Organisational Details				Collector General Details										
Company Name	Issue Date	License Number	Country	Collector Type	Collector Name	Aperture Area	Gross Length	Gross Width	Gross Height	Gross Area	Roof integration	Stagnation Temp.	c_eff	
-	-	-	-	-	-	m <sup>2</sup>	mm	mm	mm	m <sup>2</sup>	-	°C	kJ/(m <sup>2</sup> K)	
Solahart Australia Pty Ltd	13.10.2014	011-7S012F	Australia	FPC	Bt Collector	1,87	1942	1032	83	2,00	no	189	10,614	
Solahart Australia Pty Ltd	13.10.2014	011-7S013F	Australia	FPC	KF Collector	1,87	1942	1032	83	2,00	no	176	19,850	
GREENoneTEC Solarindustrie GmbH	03.02.2015	011-7S016R	Austria	ETC	VRK 14	2,23	1647	1558	107	2,57	no	272	30,187	
GREENoneTEC Solarindustrie GmbH	03.02.2015	011-7S016R	Austria	ETC	VRK 10	1,60	1650	1120	108	1,85	no	272	30,187	
GREENoneTEC Solarindustrie GmbH	03.02.2015	011-7S016R	Austria	ETC	VRK 14	2,23	1647	1558	107	2,57	no	272	30,187	
GREENoneTEC Solarindustrie GmbH	03.02.2015	011-7S016R	Austria	ETC	VRK 10	1,60	1650	1120	108	1,85	no	272	30,187	
Gasokol GmbH	20.11.2019	011-7S019F	Austria	FPC	sunnySol 23V	-	2100	1070	105	2,25	-	200	15,690	
Gasokol GmbH	20.11.2019	011-7S019F	Austria	FPC	sunnySol 23H	-	1070	2100	105	2,25	-	200	15,690	
ESTEC EnergieSparTechnik GmbH	04.05.2010	011-7S038F	Germany	FPC	IDMK Integra 1,25	1,11	1016	1228	109	1,25	yes	191	13,230	
ESTEC EnergieSparTechnik GmbH	04.05.2010	011-7S038F	Germany	FPC	IDMK Integra 2,5	2,33	2061	1225	109	2,52	yes	191	13,230	
Gasokol GmbH	20.11.2019	011-7S073F	Austria	FPC	topSol 22	-	2098	1050	122	2,20	-	200	15,930	
Solahart Australia Pty Ltd	23.11.2020	011-7S084F	Australia	FPC	LCS Collector	-	1940	1023	80	1,98	-	183	13,930	
Ernst Schweizer AG	15.11.2017	011-7S085F	Switzerland	FPC	FK1-H2	-	1234	2092	108	2,58	-	199	9,770	
Ernst Schweizer AG	15.11.2017	011-7S085F	Switzerland	FPC	FK1-V2	-	2092	1234	108	2,58	-	199	9,770	
Ernst Schweizer AG	15.11.2017	011-7S085F	Switzerland	FPC	FK1-V2V	-	2092	1234	108	2,58	-	199	9,770	
itter Energie- und Umwelttechnik GmbH & Co. K	30.11.2015	011-7S089R	Germany	ETC	Star 15/26	2,33	1616	1627	122	2,63	no	301	9,180	
itter Energie- und Umwelttechnik GmbH & Co. K	30.11.2015	011-7S089R	Germany	ETC	Star 15/39	3,49	1616	2432	122	3,93	no	301	9,180	
itter Energie- und Umwelttechnik GmbH & Co. K	30.11.2015	011-7S089R	Germany	ETC	Star 15/33	3,00	2033	1627	122	3,31	no	301	9,180	
itter Energie- und Umwelttechnik GmbH & Co. K	30.11.2015	011-7S089R	Germany	ETC	Star 15/49	4,50	2033	2432	122	4,94	no	301	9,180	
Max Weishaupt GmbH	13.04.2015	011-7S094F	Germany	FPC	WTS-F1 K1/K2	2,32	2090	1234	108	2,58	Yes	201	9,675	
SOLARFOCUS GmbH	29.11.2016	011-7S095F	Austria	ETC	CPC S1	-	2404	1155	68	2,78	no	163	7,805	
SOLARFOCUS GmbH	06.12.2016	011-7S096F	Austria	FPC	Sunnyline 28	-	2404	1155	91	2,78	-	189	7,551	
Sunex S.A.	27.07.2022	011-7S1008F	Poland	FPC	Basicx 2.0 4C	-	1900	1060	89	2,02	-	210	4,600	
Sunex S.A.	27.07.2022	011-7S1008F	Poland	FPC	Basicx 2.38 4C	-	2240	1060	89	2,38	-	210	4,600	
Sunex S.A.	27.07.2022	011-7S1008F	Poland	FPC	Basicx 2.51 4C	-	2240	1120	89	2,51	-	210	4,600	
Sunex S.A.	27.07.2022	011-7S1008F	Poland	FPC	Basicx 2.85 4C	-	2240	1270	89	2,85	-	210	4,600	
Consolar Solare Energiesysteme GmbH	29.11.2009	011-7S1015F	Switzerland	FPC	KF500, SOLAERA Hybridkollector	2,29	2375	1150	121	2,73	no	175	5,700	
Daikin Europe N.V.	20.12.2019	011-7S1016F	Belgium	FPC	V21P	-	2000	1006	85	2,01	-	200	5,051	
Daikin Europe N.V.	20.12.2019	011-7S1016F	Belgium	FPC	V26P	-	2000	1300	85	2,60	-	200	5,051	
Daikin Europe N.V.	20.12.2019	011-7S1016F	Belgium	FPC	H26P	-	1300	2000	85	2,60	-	200	5,051	
Retec Solar GmbH	20.01.2020	011-7S1020F	Germany	FPC	RS	-	1272	1303	95	1,66	-	180	4,975	
Sailer GmbH	05.03.2016	011-7S1067F	Germany	FPC	Focus AR	2,36	2151	1215	110	2,61	no	209	5,300	
Viessmann werke GmbH & Co. KG	19.08.2021	011-7S1124F	Germany	FPC	Vitosol 100-F SV1A	-	2380	1056	72	2,51	-	220	6,412	
Viessmann werke GmbH & Co. KG	07.05.2010	011-7S1125F	Germany	FPC	Vitosol 100-F SV1B	-	2380	1056	72	2,51	-	196	4,170	



### Solar thermal collectors per type



### Solar thermal collectors per license holder country



# The Solar Keymark Database in numbers

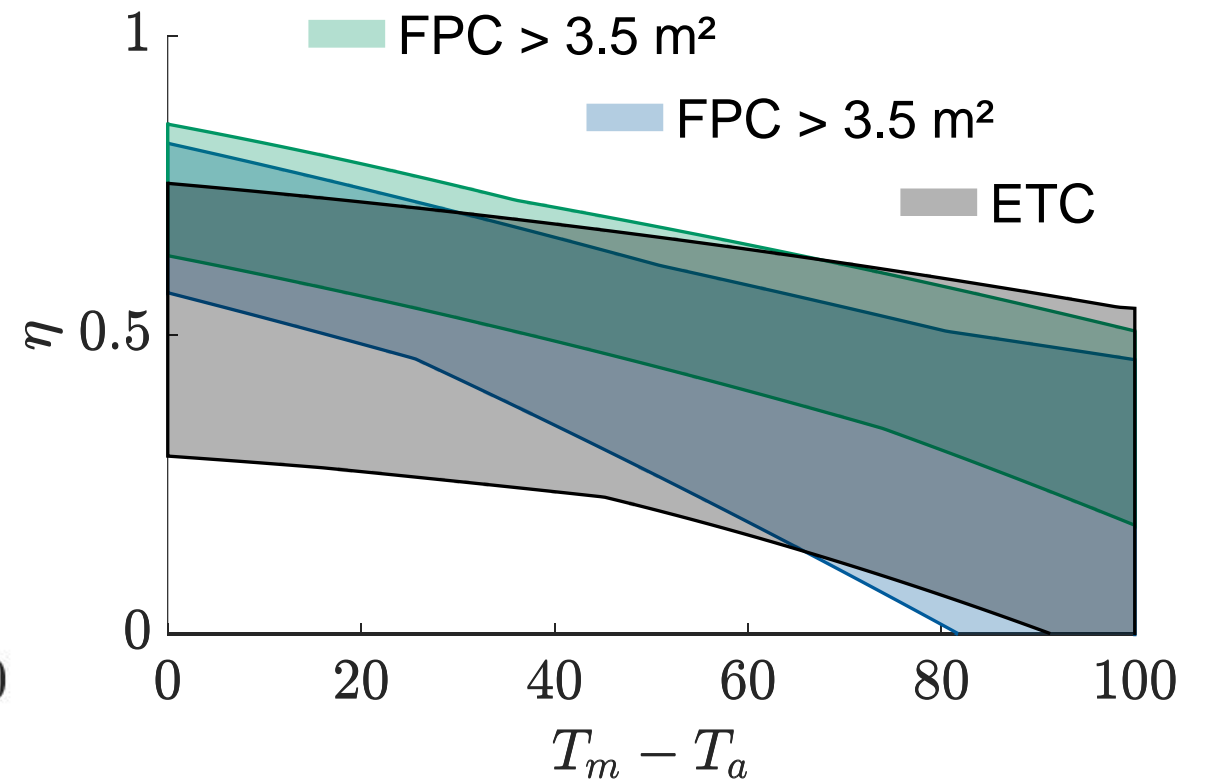
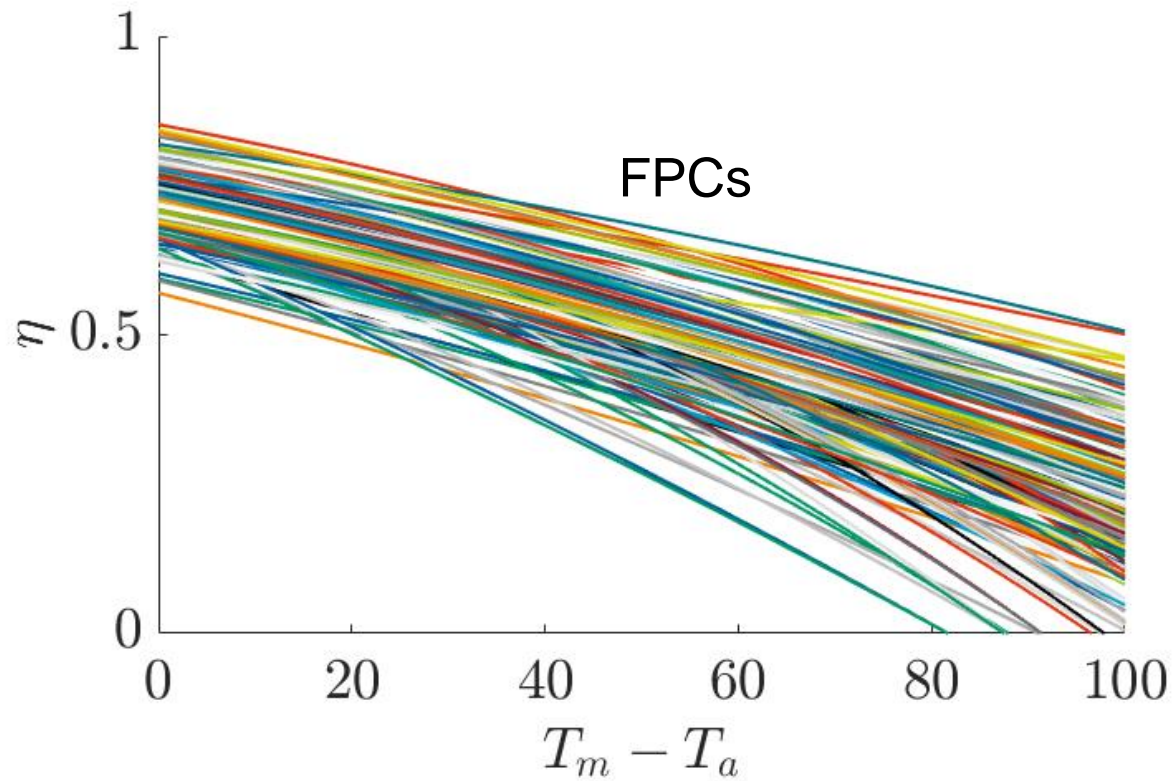
General statistics of numerical parameters in the data sheets

## Flat-plate collectors

	Median	Mean	Min	Max	STD	1 <sup>st</sup> Qrt	3 <sup>rd</sup> Qrt
$\eta_0$	0.727	0.726	0.570	0.852	0.039	0.698	0.753
$a_1$	3.534	3.550	1.861	7.098	0.477	3.280	3.750
$a_2$	0.012	0.012	0.000	0.051	0.006	0.009	0.014
$A_G$	2.430	3.166	1.000	24.02	2.943	2.020	2.605
$W$	1200	1690	835	7980	1337	1063	1500
$L$	2000	1893	830	6250	473	1625	2080
$H$	86	91	45	213	18	81	98
$T_{stg}$	195.0	191.0	102.1	250.0	21.1	183.0	203.0
$C_{eff}$	7.65	8.03	0.00	34.00	4.16	5.33	10.36

# The Solar Keymark Database in numbers

Thermal efficiency for different collector types (@1000 W/m<sup>2</sup>)







Basic	Control	Hydraulics	Load	Outputs	Source	Storage	Toolbox	Weather
	<p>Carnot 7.1 for MATLAB R2018b Copyright Solar-Institute Juelich</p> <p><a href="#">License</a></p>				<p>double click to load Carnot Internal</p>	<p>double click to load examples</p>		
Help								

# Extracting data from Solar Keymark Database

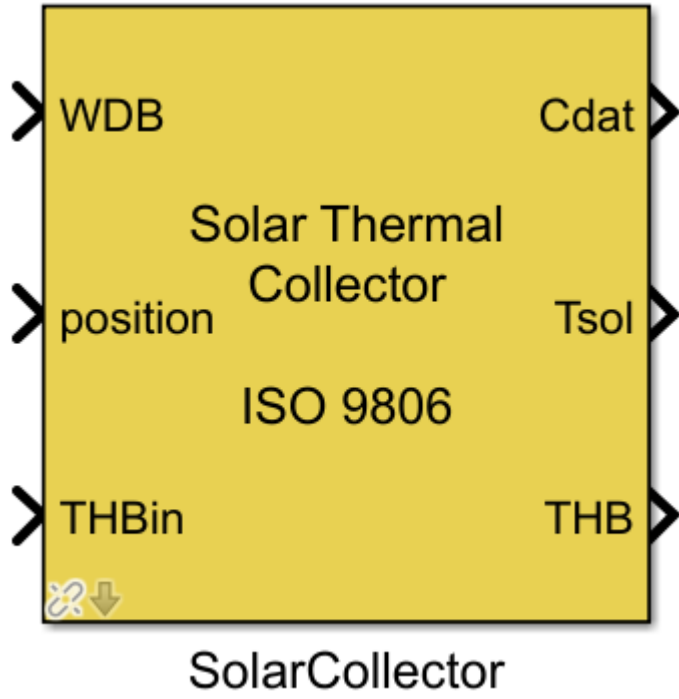
## Gathering all Solar Keymark Datasets in a single data file



Organisational Details				Collector General Details									
Company Name	Issue Date	License Number	Country	Collector Type	Collector Name	Aperture Area	Gross Length	Gross Width	Gross Height	Gross Area	Roof integration	Stagnation Temp.	c_eff
-	-	-	-	-	-	m <sup>2</sup>	mm	mm	mm	m <sup>2</sup>	-	°C	kJ/(m <sup>2</sup> K)
Solahart Australia Pty Ltd	13.10.2014	011-7S012F	Australia	FPC	Bt Collector	1,87	1942	1032	83	2,00	no	189	10,614
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Sunex S.A.	27.07.2022	011-7S1008F	Poland	FPC	Basicx 2.38 4C	-	2240	1060	89	2,38	-	210	4,600
Sunex S.A.	27.07.2022	011-7S1008F	Poland	FPC	Basicx 2.51 4C	-	2240	1120	89	2,51	-	210	4,600
Sunex S.A.	27.07.2022	011-7S1008F	Poland	FPC	Basicx 2.85 4C	-	2240	1270	89	2,85	-	210	4,600
Consolar Solare Energiesysteme GmbH	29.11.2009	011-7S1015F	Switzerland	FPC	KF500, SOLAERA Hybridkollector	2,29	2375	1150	121	2,73	no	175	5,700
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Daikin Europe N.V.	20.12.2019	011-7S1016F	Belgium	FPC	V26P	-	2000	1300	85	2,60	-	200	5,051
Daikin Europe N.V.	20.12.2019	011-7S1016F	Belgium	FPC	H26P	-	1300	2000	85	2,60	-	200	5,051
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Sailer GmbH	05.03.2016	011-7S1067F	Germany	FPC	Focus AR	2,36	2151	1215	110	2,61	no	209	5,300
Viessmann werke GmbH & Co. KG	19.08.2021	011-7S1124F	Germany	FPC	Vitosol 100-F SV1A	-	2380	1056	72	2,51	-	220	6,412
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Currently, all parameters can be modified individually

CARNOT Block - Solar Thermal Collector ISO 9806



User defined parameters

Geometry Coll.Params Optics Hydraulic Sensors

A: surface of one collector module in m<sup>2</sup> 3.5

Length between collector inlet and outlet in m 0.1

Save in Carnot internal data Save in selected path

OK Cancel Help Apply

User defined parameters

Geometry Coll.Params Optics Hydraulic Sensors

Fin Efficiency \* Transmission \* Absorption (F'(tau alfa)) 0.7

c1 : heat loss coefficient at (Tm-Ta)=0 [W/(m<sup>2</sup>\*K)] 1.1

c2: temperature dependence of the heat loss coefficient [W/(m<sup>2</sup>\*K)<sup>2</sup>] 0.001

c3 : wind speed dependence of the heat loss coefficient [J/(m<sup>3</sup>\*K)] 0

c4 : sky temperature dependence of the heat loss coefficient [W/(m<sup>2</sup>\*K)] 0

c5 : effective thermal capacity [J/(m<sup>2</sup>\*K)] 5000

c6 : wind dependence in the zero loss efficiency [s/m] 0

Save in Carnot internal data Save in selected path

OK Cancel Help Apply

User defined parameters

Geometry Coll.Params Optics Hydraulic Sensors

Kb: angles for longitudinal and transversal IAM [degree] [0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90] <1x19 double>

KbL: values for longitudinal incidence angle modifier (0..1) [982 0.9965 0.9935 0.9886 0.9807 0.9678 0.9473 0.9148 0.8638 0.7846 0.6644 0.4907 0.2599 0]

KbT: values for transversal incidence angle modifier (0..1) [1 1 1 1 1 1 1 1 1 0.875 0.75 0.625 0.5 0.375 0.25 0.125 0] <1x19 double>

Kd : Incidence angle modifier diffuse radiation 0.92

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User defined parameters

Geometry Coll.Params Optics Hydraulic Sensors

lin: linear pressure drop in Pa/(kg/s) 10

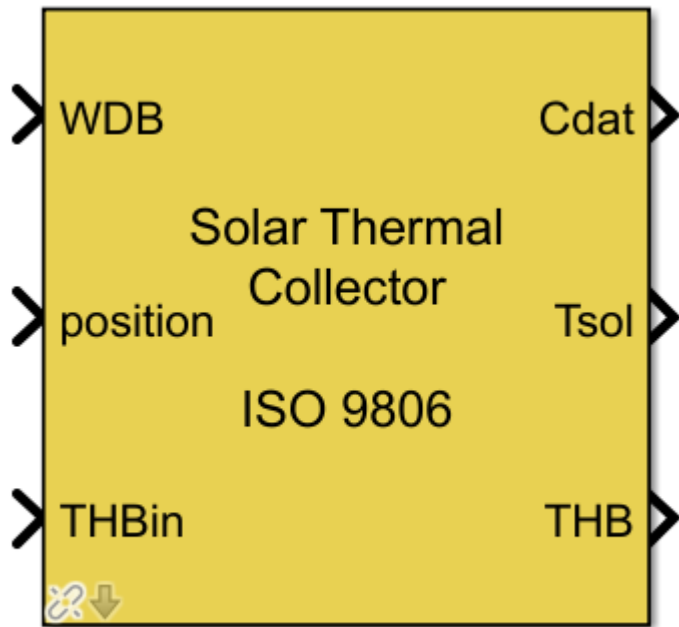
qua: quadratic pressure drop in Pa/(kg/s)<sup>2</sup> 10

Save in Carnot internal data Save in selected path

OK Cancel Help Apply

With the new block any collector can be selected from the database

Modified CARNOT Block - Solar Thermal Collector ISO 9806



SolarCollector

User defined parameters

**Collector** Geometry Coll.Params Optics Hydraulic Sensors

Filter table contents

Selected	Company	Issue Date	Issue Numb	Country	Type	Name	Surface Area	Length	Width	Height	Gross Area	of Integ
<input type="checkbox"/>	A. GAMPI...	15-Sep-20...	SKM9901-1	Greece	FPC	SH T250S	3.78	1992	1265	95	2.51	yes
<input type="checkbox"/>	A. GAMPI...	15-Sep-20...	SKM9901-1	Greece	FPC	SH T250S	3.78	1992	1265	95	1.96	yes
<input type="checkbox"/>	A. GAMPI...	15-Sep-20...	SKM9901-1	Greece	FPC	SH T230S	2.17	1877	1265	95	2.37	yes
<input type="checkbox"/>	A. GAMPI...	15-Sep-20...	SKM9901-1	Greece	FPC	SH T150S	1.41	1592	992	95	1.57	yes
<input type="checkbox"/>	A. O. Smith	04-Feb-20...	0110242F	Netherlands	FPC	ACFB 240	2.344	2005	1300	111	2.514	yes

Confirm Collector Parameters (Please apply changes first!)

Save in Carnot internal data      Save in selected path

OK Cancel Help Apply

DEMO



Technische Hochschule  
Ingolstadt

Institute of  
new Energy Systems

*THANK YOU*