Christiani

Technical Institute for
Vocational Training

Teaching system
Heat pump and solar heat

Technical Training

Renewable Energy

www.christiani-tvet.com

Teaching system f
The specialist for

S2 compressor convector as the source or the sink

Information on pages 8

S6 hybrid collector

Information on pages 15

S5 heat pump

Information on pages 14

for the Solarteur® - renewable energy

S1 geothermal energy source or floor heating

Information on pages 6

S4 hydraulic switch, plate heat exchanger and buffer storage

Information on pages 12

S3 solar collectors with solar simulation

Information on pages 10




Christiani – Partner and supplier for solarteur schools

The Solarteur® – Specialist for renewable energy

Together with our partner, the municipal education centre for solar technology in Munich, we have developed, tested and realised a comprehensive hands-on training concept for the field of renewable energy.

Decades of experience from solateur schools, didactics and the field of renewable energy have been applied in developing the teaching system and the didactic documents.

In close collaboration with Willi Kirchensteiner, an advocate of renewable energy for more than 30 years, we have a world-wide recognised specialist on our side. His solarteur school is pioneering the way in educational concepts and the realisation of these for practical use. This concept has been applied in the solarteur schools for over 10 years now and is continually being optimised further.

This has resulted in a complete training package that starts with the vocational means for basic training in the field of energy. The generator and adventure bike is the ideal way to start learning about renewable energy. The solar power case follows the generator bike and constitutes the second stage of the didactic overall concept from Christiani for renewable energy. This is then followed by the solar power laboratory with the off-grid and the on-grid technology. The latest addition to the programme is the new teaching system for heat pumps and solar heat for all the requirements experienced in practice.

Watch a demonstration of the teaching system and you will see that this can only be realised from decades of development and experience.

Our partner from the education centre for solar technology in Munich

Wilhelm Kirchensteiner is the director of studies at the education centre for solar technology and is also a lecturer on energy consultancy for the Bavarian Chamber of Engineers - Civil.
He worked for more than 10 years in the electrical, heating and plumbing trade after completing his studies to become an electrician. This was followed by course in electrical engineering and physics at the Technical University of Munich. He has been teaching electrical engineering and physics at the federal state capital Munich since 1979.

Other activities:

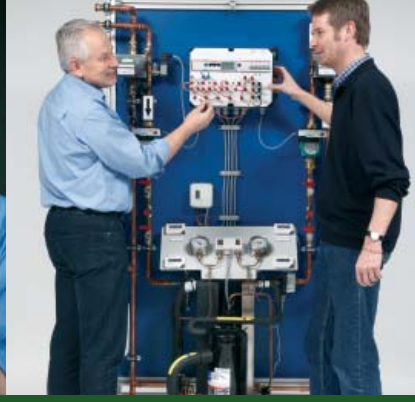
Since 1976	Lectures on harnessing solar energy and climate protection
Since 1982	Member of the trade examination board
Since 1983	Setting up solar projects at schools in Bavaria
Since 1986	Further education for teachers in solar engineering and climate protection
Since 1989	Establishing courses in solar engineering at the vocational training school
Since 1995	Energy and solar commissioner for schools and colleges in Munich
Since 1995	Project management for the Leonardo project D 177 from the EU for using solar energy in Europe, and participation in follow-on projects
As of 1995	Founding and set-up of the education centre for solar technology at the LH Munich – Organisation of solarteur further education, both national and international
Since 1997	Director of studies at the education centre for solar technology
Since 2005	Lecturer in energy consultancy for the Bavarian engineering chambers

For many years now, Wilhelm Kirchensteiner has been holding further education seminars on a regular basis for teachers from all types of educational institutes throughout the whole of Bavaria.

Awards:

1993	"Bavarian Environmental Medal"
1994	"Green Environmental Oscar from TV Bavaria"
2000	"Energy Award 2000" from the State Capital Munich



Christiani – The heat pump and solar heat teaching system

Didactic concept

Decisive for the quality of the training given is that practical exercises are possible and that measurements with real equipment can be performed. It is only by literally "grasping" and "touching" that the technical processes will be understood, and hence can be managed as well. That which cannot be directly observed and sensed, has to be perceived by suitable experimental measurements.

Pedagogic requirements

- Maximum learning efficiency from closely linking theory and the practical side of the subject with hands-on learning processes.
- The contents of learning must be made "graspable" in both meanings of the word!
- To avoid any waste of time in the learning organisation, all learning processes have to provided at the place of learning in a qualified and optimised manner, and the system technology must be designed for practical applications such that these processes can be realised in a mutually complementing way.
- This calls for "integrated specialist classrooms" where both theory and the practical side of the area of technology concerned can be mediated.
- The efficiency in conveying the knowledge and findings is part of the balanced concept which includes written information and exercises organised using modern media techniques, PC workplaces, experimental, laboratory and demonstration equipment to practice on.
- All learning processes are designed in the context of "complete action" with the problem assignment (job, information), conditional analysis (analysis of the knowledge relevant to the organisation, planning), project realisation (execution, realisation, test record) and transfer (documentation, assuring the results, testing).

The learning objectives:

- Understand the technical system requirements for heat-pump heater systems and solar-heat equipment.
- Knowledge of the electrical, hydraulic and control requirements needed for operation, using a heat-pump heater system or solar-heat equipment as an example.
- Knowledge of the physical processes in the cold circuit of a heat pump.
- Systematic approach to commissioning a heat-pump heater system or solar-heat equipment.
- Capability to plan, set up and commission heat-pump and solar-heat heater systems in a concerted manner.
- Capability to prepare test records for heat-pump heater systems and solar-heat equipment.
- Skills in recording measurements and evaluating the results from electrical and hydraulic processes using a heat-pump and solar-heat systems as examples.
- Understanding the processes to optimise the energy in heater systems using heat pumps and solar heat.
- Knowledge of the terms and operating resources used for heat-pump and solar-heat systems.
- Capability to judge the electrical and hydraulic values measured in heat-pump heater systems and to plan any thereby related process changes.
- Understanding of the technical controls and optimisation of the energy in the circulation pumps used in heater systems.
- Skills for optimising energy processes in heater systems.

Teaching system
Heat pump and solar heat

Training stand 1: Geothermal energy source or floor heating

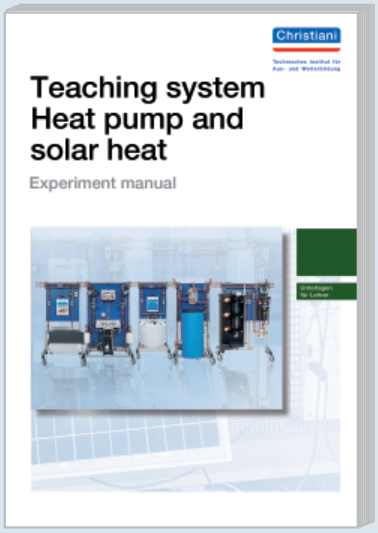
This training stand can be used as a source of heat in the configuration "Brine heat pump" (training stand 5) or as the heat sink in combination with the heat pump or the solar heat stand (training stands 3 and 4).

Operation with or without filling with water is possible here!

- 200-litre water tank
- 3 pipe systems (10, 20 and 30 metres in length)
- Integrated hot-medium meters to measure the overall flow, the hot and the cold outputs as well as the admission and return temperatures
- Bypass valve between the heating circuits for the experiments to bypass the three pipe systems
- Experiments on "hydraulic adjustment" with the three pipe systems routed in parallel using the volumetric flowmeters and throttle valves

S1 geothermal energy source or floor heating

Experiment manual



All the experimental set-ups together with other combinations and possible uses are described in detail in the experiment manual.
The experiment manual contains an information section, an exercise section and a section with the solutions, and is included free-of-charge in the delivery when the training stand S5 (heat pump) is ordered.

S1 geothermal energy source or floor heating

Order no. 89-82125	EUR 4.700,–

Combination of training stands – example 1

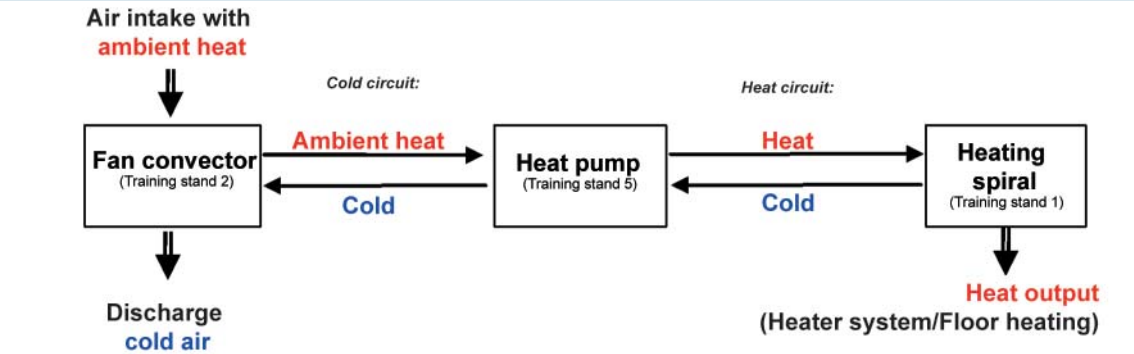
Heater system with ambient air as the heat source and heater core or floor heating as the heat sink

S2 fan convector
as the source or the sink

S5 heat pump

S1 geothermal energy
source or floor heating

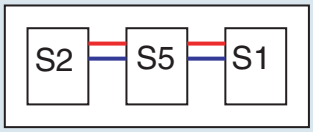
Diagram of the principle:



Experimental set-up

The ambient air is taken in at the fan convector (training stand S2) with the ambient temperature, and the ambient air is fed to the heat pump (training stand S5). Here the heat is removed and transferred via the hot circuit to the three pipe systems (training stand S1) which in this experiment, can be considered to be the floor heating or the heater core. The cold which is generated in this process at the same time is discharged by means of the fan convector (training stand S2).

Simplified view of the experimental set-up:



Teaching system
Heat pump and solar heat

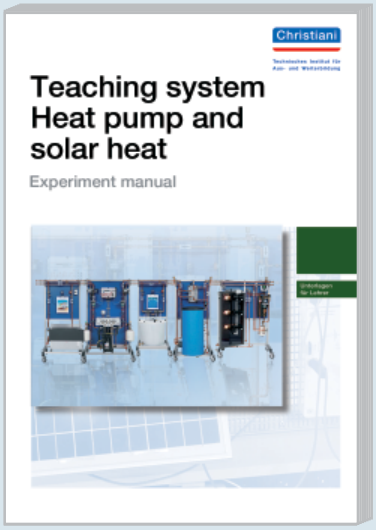
Training stand 2: Fan convector as source or sink

Both the source of energy and the energy sink with discharge of warm air can be realised with the fan convector in these experiments.

Two convectors are interconnected here to increase the performance

- Adjustable fan power (4 power stages) in the air throughput from 450 – 1040 m³/h
- Adjustable heating power from 6.8 to 13.4 kW at 75/65/20°C
- Adjustable cooling performance from 3 to 5.4 kW at 7/12/27°C
- Continuous throttle action in the hydraulic circuit by turning valves on the convector
- Series of experiments to optimise the energy between the heating power available from the heating circuit and the energy conveyed from the convector to the air in the room
- Integrated hot-medium meter

Experiment manual



All the experimental set-ups together with other combinations and possible uses are described in detail in the experiment manual.
The experiment manual contains an information section, an exercise section and a section with the solutions, and is included free-of-charge in the delivery when the training stand S5 (heat pump) is ordered.

S2 fan convector as the source or the sink

Order no. 89-82126 **EUR 5.200,–**

Combination of training stands – example 2

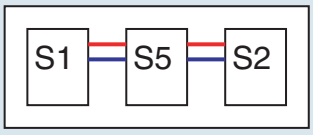
Heater system with geothermal energy as the source of heat and fan convector as the heat sink

S1 geothermal energy source or floor heating

S5 heat pump

S2 fan convector as the source or the sink

Simplified view of the experimental set-up:



Basic experimental set-up

The heat is tapped from the water in the reservoir (training stand S1) by the heat pump (training stand S5) and conveyed to the fan convector (training stand S2). Here the heat is discharged as hot air.

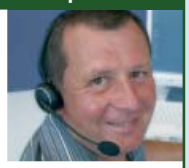
▸▸ Any questions about the product?

Reinhold Henkelmann will be pleased to help you by phone

+49 7531 5801-52

or by e-mail

henkelmann@christiani.de



Experiment 1 in detail:

It is beneficial to use this configuration for the first experiment to investigate a water / water - heat pump. In this way, fresh water (10 °C from the cold-water pipe) can be routed over the fittings for flushing and filling of the S5 like for a ground water heat pump over the evaporator heat exchanger and flow in the circuit over the S1, the opened bypass valve and back to the outlet from the fittings for flushing. From here, this water is used for filling the water reservoir of S1.

Experiment 2 in detail:

Three brine circuits tap environmental energy from an energy accumulator (water tank) to investigate a brine / water heat pump. This source circuit can be filled with water for brine-circuit temperatures above 3 °C. Additional experimental variant with "hydraulic adjustment" of the brine circuits and the effects of this on the energy efficiency.

Experiment 3 in detail:

The brine circuit is filled with a water-glycol mixture to investigate a brine / water heat pump with source-circuit temperatures below 3 °C.

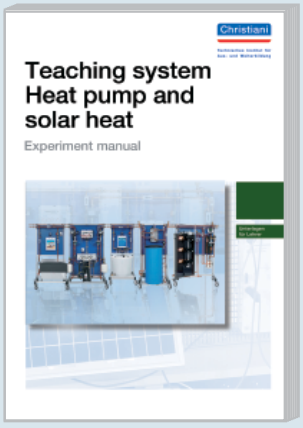
Teaching system
Heat pump and solar heat

Training stand 3: Solar collector with solar simulation

The main components of this training stand are the flat plate collector, the solar heat regulator and the circulation pump

- Clear glass collector with copper absorber
  (collector area 0.93 m³, liquid content 0.9 litre, flow from left or right, stand-still temperature to about 185 °C)
- System regulator with diverse regulating functions and energy measuring / sensing for the functional value using an erasable memory device for the data
- High-efficiency pump (minimum power input 5.8 W and maximum delivery height 5 m) as the wet running meter with EC motor, and with automatic adjustment of the power
- 6 x 500 W halogen spotlights for simulation of the irradiated solar power
- Safety devices with diaphragm expansion vessel and 6-bar pressure control valve
- 2 ball valves, with integrated thermometer and gravity braking system in the collector circuit
- Flowmeter and "FlowCheck" for controlling the flow (5 to 40 L/min)
- Fittings for filling and flushing

Experiment manual



All the experimental set-ups together with other combinations and possible uses are described in detail in the experiment manual.
The experiment manual contains an information section, an exercise section and a section with the solutions, and is included free-of-charge in the delivery when the training stand S5 (heat pump) is ordered.

S3 solar collector with solar simulation

Order no. 89-82127 **EUR 6.200,–**

Combination of training stands – example 3

Solar heat coupling in the source circuit

S3 solar collector with solar simulation

S4 hydraulic switch, plate heat exchanger and buffer storage

S1 geothermal energy source or floor heating

S5 heat pump

S2 compressor convector as the source or the sink

▸▸ Any questions about the product?

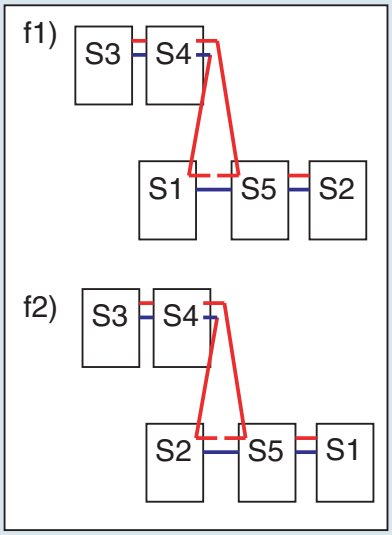
Reinhold Henkelmann will be pleased to help you by phone

+49 7531 5801-52

or by e-mail

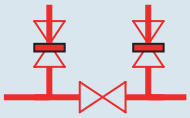
henkelmann@christiani.de

Simplified view of the experimental set-up:



Experimental set-up

S1 + S3 + S4 + S5 + S2 = Brine / water heat pump (f1) or as an air / water heat pump (f2) with additional temperature rise in the source circuit by means of solar heat.
S3 + S4 are included at right angles behind the S1 – S5 line with S2 between S1 and S5 using flexible metal hose and the coupling piece in the feed, see f1 and f2. Solar heat can raise the temperature of the brine in the brine circuit of the air / water heat pump as well. This circuit is shown in f2

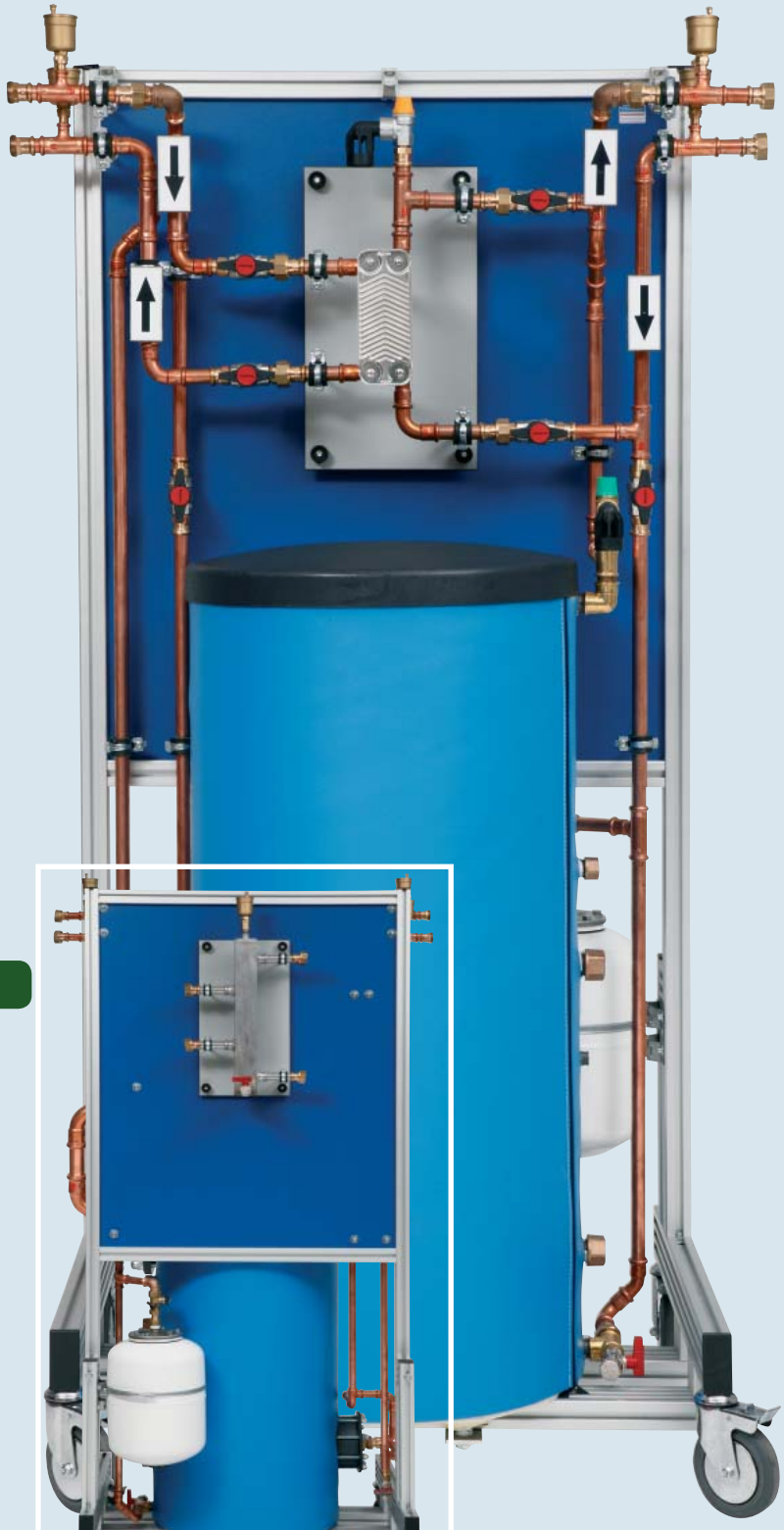


Teaching system
Heat pump and solar heat

Training stand 4: Hydraulic switch, plate heat exchanger and buffer storage

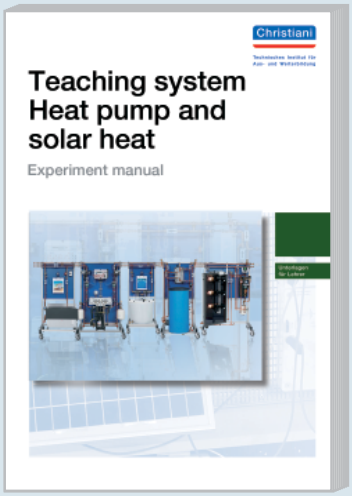
This training stand is used for adaptation to the hydraulic conditions. The uses for the hydraulic switch, the plate heat exchanger or the heat exchanger integrated in the storage system are diverse.

- Hydraulic switch and plate heat exchanger are interchangeable using an exchangeable disc (the component not being used is fastened to the rear of the stand)
- Hydraulic switch:
  Stainless steel vessel (volume approx. 1 litre) Primary circuit and secondary circuit are at the same pressure but are not hydraulically coupled
- Plate heat exchanger:
  16 exchange plates, exchanger performance 17 kW at 70/50°C primary and 35/45°C secondary
- Enamel reservoir for holding 160 litres of water, with integrated straight-tube heat exchanger



Rear view of S4

Experiment manual



All the experimental set-ups together with other combinations and possible uses are described in detail in the experiment manual.
The experiment manual contains an information section, an exercise section and a section with the solutions, and is included free-of-charge in the delivery when the training stand S5 (heat pump) is ordered.

S4 coupling component hydraulic switch, plate heat exchanger and buffer storage

Order no. 89-82128 **EUR 4.700,–**

Combination of training stands – example 4

Using training stand 4 (buffer storage, hydraulic switch and plate heat exchanger)

S1 geothermal energy source or floor heating

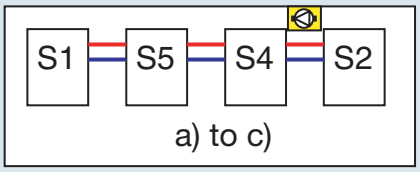
S5 heat pump

S4 hydraulic switch, plate heat exchanger and buffer storage

S2 compressor convector as the source or the sink

Possible uses for the training stand S4 in this constellation:
a) Use with the hydraulic switch
b) Use with the plate heat exchanger
c) Use of the buffer storage
d) Use as storage in series in the return line

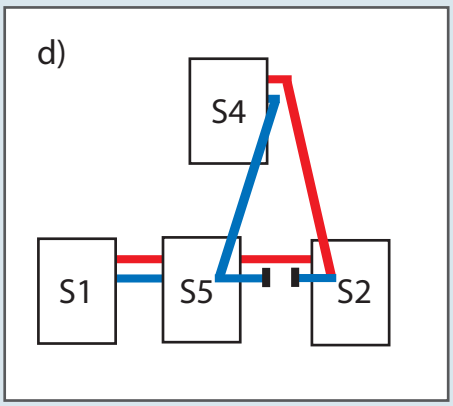
Simplified view of the experimental set-up: a) to c)



Experimental set-up

For a) to c) the training stands are included in the series arrangement by using the additional circulation pump.

Simplified view of the experimental set-up: d)



Experimental set-up

For d) the training stand S4 is in included at right angles using flexible metal hose in the heating circuit feed or return line of the connection between the training stand S5 and the training stand S2 with the coupling piece from 3 ball valves.

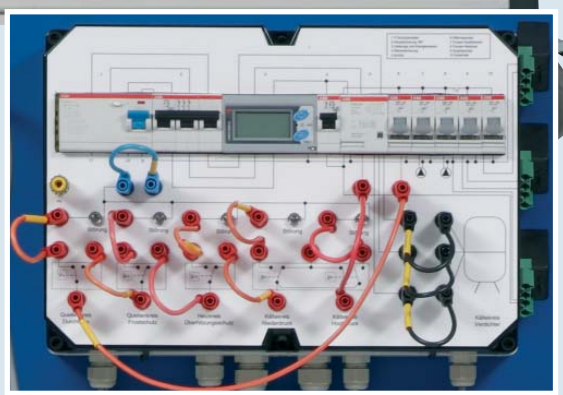
Teaching system
Heat pump and solar heat

Training stand 5: Heat pump

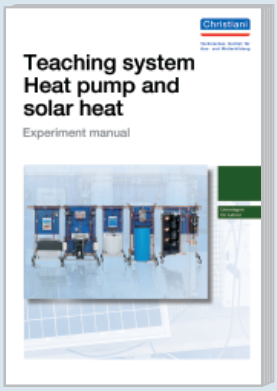
This training stand constitutes the central element of the teaching system.

Besides the heat pump, the stand contains all the power supply points for the other training stands. With the brine and heating circuit connection, the circulation pumps and the safety devices are already installed for the professional operation of a heat pump.

- Conventional heat pump with evaporator, scroll compressor, liquefier and expansion valve in line with state-of-the-art technology.
- Permanently fitted cold circuit (not accessible for experimental interventions), refrigerant R134a.
- Manometer for sensing and measuring physical events in the cold circuit.
- Digital thermometers for measuring the temperatures in the cold circuit downstream of the evaporator, air compressor, liquefier and expansion valve.
- Low and high-pressure control devices, energy measuring device, high-efficiency circulation pumps and other components.
- Power supply, measuring and switching unit with RCT, main fuses, energy measuring device, control-circuit fuse and contactor relay.



Experiment manual



All the experimental set-ups together with other combinations and possible uses are described in detail in the experiment manual.
The experiment manual contains an information section, an exercise section and a section with the solutions, and is included free-of-charge in the delivery when the training stand S5 (heat pump) is ordered.

S5 heat pump	
Order no. 89-82129	EUR 12.200,–

Training stand 6: hybrid collector

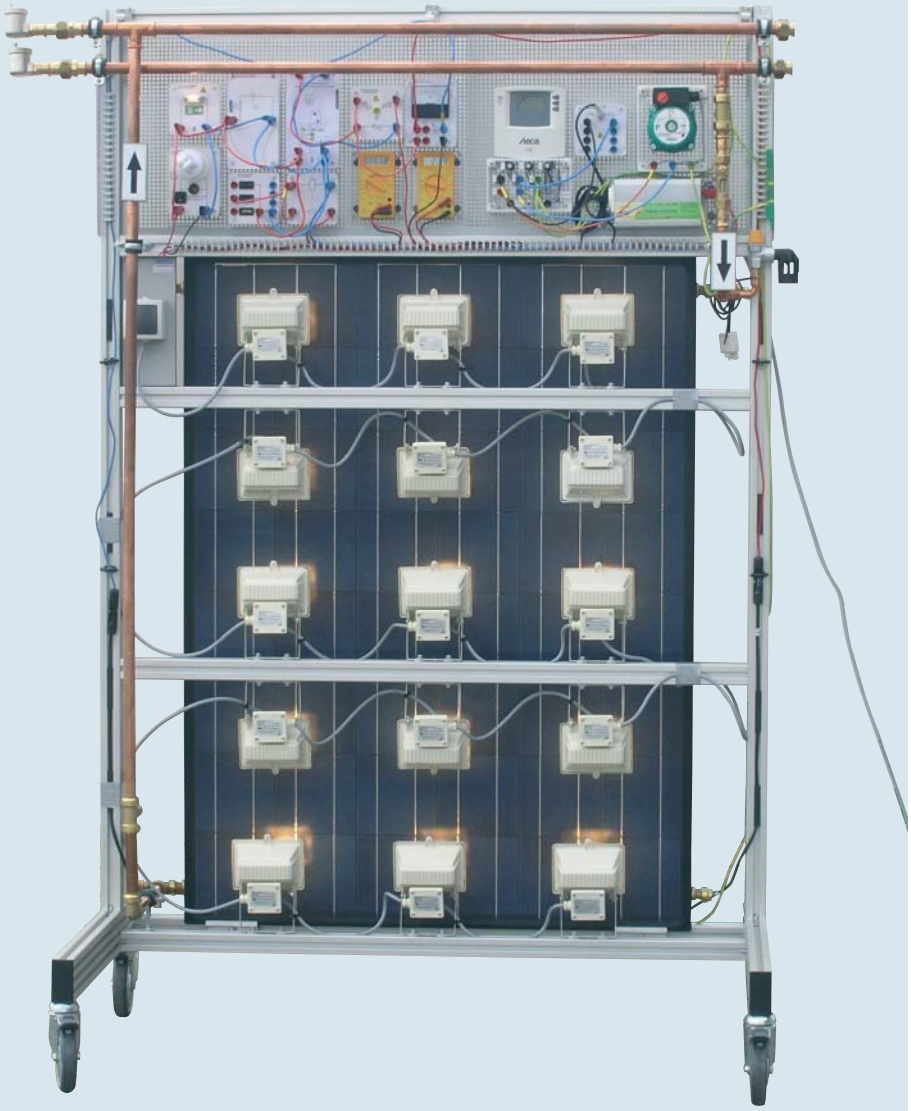
This training stand adds a further key technology - photovoltaics - to the teaching system. This also allows a solid fundamental knowledge of hybrid collectors to be accumulated and built upon.

Thus, heat pump system concepts can be developed and tested using photovoltaics and hybrid collectors.

The process of system integration as a solution with many benefits is therefore convincingly practical.

Learning objectives

- To understand the function of a hybrid collector on the basis of experiments and measured values
- To plan heat pump systems with hybrid collectors as an energy source for the heat pump
- To understand the effect of the temperature profile on the thermal collector and PV module
- To record and analyse measured values
- To plan and execute an emergency power system for a circulation pump with regulator
- Sensible use of PV electricity in off-grid systems or in the emergency power system
- Experimental derivation
- To understand the physical process of a hybrid collector in thermal energy extraction through the brine circuit of a heat pump
- To understand the process of water extraction through condensation at the hybrid collector



Technical data:

- **Set dimensions**
  (W/D/H in mm) approx. 1,450 x 800 x 1,980
- **Weight** approx. 100 kg
- **Power supply** via training stand S5

Scope of delivery without PV add-on package:

For users who already have the solar power laboratory off-grid technology components

- Training stand S6 hybrid collector
- Circulation pump and solar heat regulator modules
- Connecting cable

Scope of delivery with PV add-on package:

For users who do not yet have the solar power laboratory off-grid technology components

- Training stand S6 hybrid collector
- Modules: circulation pump and solar heat regulator
- Modules: safety lamp, consumers, lead-gel battery, fuse distributor, 12 V relay, overvoltage protection, generator connection, multimeter (2 pieces), power connection module, inverter 300 W
- Connecting cable

S6 hybrid collector without PV components	
Order no. 89-85316	EUR 6.800,–

S6 hybrid collector with PV components	
Best.-Nr. 89-85317	EUR 7.800,–

The learning process as an experience

Christiani

Technical Institute for Vocational Training

MobileLab

DC case

mobileLab DC case

Order no. 89-76801 EUR 1.198,–

AC case

mobileLab AC case

Order no. 89-76806 EUR 2.559,–

mobileLab®

Experiment manual for DC trainer / teacher

Order no. 89-80972 EUR 19,80

Experiment manual for DC trainee / student

Order no. 89-80971 EUR 9,80

Generator bike

Experiment manual

Generator bike basic equipment

Order no. 89-75637 EUR 1.990,–

Experiment Manual – Basic Equipment	Order no.	EUR
Teacher documents (in colour, bound)	89-76634	36,–
Students' copy (b/w, loose sheets)	89-82806	12,90

Solar Power Case

Experiment manual

Basic solar power case equipment

Consisting of: Function case • Photovoltaic module • Ammeter • Voltmeter • Low-voltage socket and lamp socket E27 • Motion sensor • Lead-gel battery • Charging regulator and charging device • Cables, Schottky diode, spare fuses • 12V energy-saving lamp and 12V filament bulb

Order no. 89-75636 EUR 1.298,–

Experiment Manual – Basic Equipment	Order no.	EUR
Teacher documents (in colour, bound)	89-76632	36,–
Students' copy (b/w, loose sheets)	89-82805	12,90

Solar power laboratory

Solar power laboratory, complete

Consisting or:
Laboratory bench • Roller container • Individual components for the solar power laboratory for off-grid technology • Individual components for the solar power laboratory for on-grid technology • Experiment manual, teacher documents

Order no. 89-82371 EUR 8.540,–

Experiment Manual – Basic Equipment	Order no.	EUR
Teacher documents (in colour, bound)	89-82017	98,–
Students' copy (b/w, loose sheets)	89-82807	19,90

Dr.-Ing. Paul Christiani GmbH & Co. KG
Technical Institute for Vocational Training
Hermann-Hesse-Weg 2
78464 Konstanz
Germany

Tel.: +49 7531 5801-26
Fax: +49 7531 5801-85
info@christiani-tvet.com
www.christiani-tvet.com