

- Solardidaktik
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- Solarspielzeuge

- solardidactics
- solar cells
- solar modules
- photovoltaic experiment devices
- solar experimentation manuals
- solar workshops
- solar consulting
- solar education
- solar training for teachers
- solar toys

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## Experimental learning stations on solar energy Photovoltaics, solar radiation, solar heat, optoelectronics

Experiments from the learning workshop NILS-ISFH for classes, training, workshops, project days, labs  
Execution in sunlight/daylight outdoors or with halogen spot lamps indoors

www.nils-isfh.de Field of application (FA): Secondary schools, Difficulty levels: 1 (easy), 2 (medium), 3 (advanced)

### Experimental learning stations

Group	Field of application; level	Time requirement ca. min	Age group ca. years
A	ISCED 2; 1,2	30 min	11 - 14
B	ISCED 2; 2,3	45 min	12- 15
C	ISCED 2; 2,3 Selection of experiments	> 45 min	14- 16
D	ISCED 3	60 min	16- >18
E	Self-assembly Solar modules, solar vehicles, solar boats	<b>≥60 min</b>	>12
F	For students aged 8- 11 years: 30 learning stations for primary school with the suncatcher box GS		
G	Short learning stations ca. 20 min for ISCED levels 2 and 3 for fairs, exhibitions, workshops		
H	Learning stations for groups ca. 30 min.		



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Each learning station includes an extensive experimentation manual with a bill of materials, setup instructions, experiments, basic information, and assignments. Info and offers can be obtained from [nils@isfh.de](mailto:nils@isfh.de) or [info@sundidactics.de](mailto:info@sundidactics.de)

## Overview of the learning stations A Age group 11-14 years

Group	No.	Topic	Time ca. min	Levels Notes
A	1	Connection of solar motors to a solar module with SUSE CM6MS or SUSE 4.2, SUSE 4.16	30	1,2
A	2	Measuring voltage, current, power of a solar cell with SUSE 4.33	30-45	1,2
A	3	SUSE 4.12 as solar energy storage with SUSE 4.3 RB, 4.12, 4.15, 4.16	30-45	1,2
A	4	Radio operation with solar module and solar storage with SUSE 4.3RB, 4.36, 4.12	30-45	1,2
A	5	Experiments with solar motors and generators with SUSE 4.3RB, 4.16	30-45	1,2
A	6	Series connection of solar cells with 2x SUSE 4.33	30-45	1,2
A	7	Series connection of solar cells with 6x SUSE CM6B	30-45	1,2
A	8	Parallel connection of solar cells with SUSE 4.33	30-45	1,2
A	9	Parallel connection of solar cells with 6x SUSE CM6B	30-45	1,2
A	10	Simple experiments with solar cell fragments	30-45	1,2
A	11	Charging a smartphone on a 10W solar module with SUSE 4.52, DC-DC converter SUSE 4.17	30-45	1,2
A	12	Experiments on solar radiation and light radiation with SUSE 4.24 and SUSE 5.23	30-45	1,2
A	13	Experiments with the solar vehicle 4 with solar vehicle 4 and solar filling station SUSE 4.34	30-45	1,2
A	14	Experiments with the solar vehicle 1.2 and solar filling station with SUSE 4.3 RB, 4.35, solar vehicle 1.2	30-45	1,2
A	15	Simple experiments with the solar vehicle 3	30-45	1,2
A	16	Experiments with the solar thermal collector (stagnation collector) with the stagnation collector GS	30-45	1,2
A	17	Experiments with solar toys with solar boat, solar cricket, solar racer, solar helicopter...	30-45	1,2
A	18	Experiments with a 10W solar module with SUSE 4.52	30-45	1,2
A	19	Experiments with the solar construction kit 6-in-1 with 6in1	30-45	1,2
A	20	Experiments with the SUSE solar vehicle 6USB and the solar filling station SUSE 4.50-10	30-45	1,2

## Overview of the learning stations B Age group 12-15 years

Group	No.	Topic	Time ca. min	Levels Notes
B	1	Experiments with the solar module SUSE 4.33 with SUSE 4.33	45	2,3
B	2	Experiments with the solar module SUSE 4.3 with SUSE 4.3	45	2,3
B	3	Experiments with the solar module SUSE 4.3RB with SUSE 4.3 RB	45	2,3
B	4	Experiments with the 10W solar module SUSE 4.52 with SUSE 4.52, charge controller SUSE 4.17, LED reading lamp, solar vehicle SF6USB	45	2,3
B	5	Experiments with the 10W solar module SUSE 4.41 with SUSE 4.41, charge controller SUSE 4.17, LED reading lamp, solar vehicle SF6USB	45	2,3
B	6	Determination of the light intensity = irradiance with SUSE 5.22	45	2,3
B	7	Experiments with the solar vehicle 1.2 with SUSE 4.36,4.35, solar vehicle 1.2	45	2,3
B	8	Experiments with the solar thermal collector with the thermosiphon solar collector	45	2,3
B	9	Quality determination of solar cells with SUSE 5.22, solar cell fragments	45	2,3
B	10	Dependence of V,I,P from the solar cell area with SUSE CM6MS	45	2,3
B	11	Solar module as charging station for a smartphone + powerbank with SUSE 4.52, 4.17, powerbank battery pack	45	2,3
B	12	Experiments with the 20W solar module SUSE 4.42 with SUSE 4.42, charge controller SUSE 4.17, LED reading lamp, solar vehicle SF6USB	45	2,3
B	13	LEDs as solar cells with SUSE 4.20IRRB, SUSE 5.16	45	2,3
B	14	Angle dependence of V,I,P of a solar cell with SUSE 5.22alpha, SUSE 5.16	45	2,3
B	15	Efficiency factor determination of solar cells with SUSE 5.22, solar cell fragments, raw solar cells	45	2,3
B	16	Reduced output of solar modules: clouding/shadowing with SUSE 5.22	45	2,3
B	17	Experiments with the solar vehicle 3 with solar vehicle 3	45	2,3
B	18	Experiments on solar radiation/light radiation with SUSE 5.23/4.24A	45	2,3
B	19	Experiments with the LED module SUSE 4.20IRRB with SUSE 4.20IRRB, 4.3RB	45	2,3
B	20	Intensity measurements with solar cells on an overhead projector with SUSE CM6B or CM6MS	45	2,3
B	21	Experiments with a vacuum tube solar thermal collector and with a heat pipe solar collector	45	2,3
B	22	Experiments with the solar boat 4	45	2

# Overview of the learning stations C

Age group 14-16 years

Group	No.	Topic	Time ca. min	Levels Notes
C	1	Experiments with the solar module SUSE CM4MBV with SUSE CM4MBV, 4.16, 4.15, 4.36, 4.12	≥45 <small>Selection possible</small>	2,3
C	2	Experiments with the solar module SUSE CM6MS with SUSE CM6MS, 4.16, 4.15, 4.36	≥45 <small>Selection possible</small>	2,3
C	3	Experiments with the solar module SUSE 4.3RB with 4x SUSE 4.3RB, 4.15, 4.16, 4.17, 4.19, solar vehicle 1.2	≥45 <small>Selection possible</small>	2,3
C	4	Experiments with the solar thermal collector GS Taking temperature curves	≥45 <small>Selection possible</small>	2,3
C	5	Experiments with the solar module SUSE 4.3 with SUSE 4.3, solar motor SUSE 4.16, LED module SUSE 4.15, radio SUSE 4.36	≥45 <small>Selection possible</small>	2,3
C	6	Experiments with 2 solar modules by comparison 5 W- 10W with 2 solar modules SUSE 4.51-5W and 4.41-10W, charge controller SUSE 4.17, powerbank battery pack	≥45	2,3
C	7	Experiments with 2 solar modules by comparison 5W- 20W with solar modules 5W (SUSE 4.51), 20W (SUSE 4.42), charge controller SUSE 4.17, powerbank battery pack	≥45	2,3
C	8	Experiments with 2 solar modules by comparison 5W- 5W with 2 solar modules 5W (SUSE 4.43 and 4.51), charge controller SUSE 4.17, powerbank battery pack	≥45	2,3
C	9	Experiments with 3 solar modules by comparison 5W- 10W- 20W with solar modules SUSE 4.51 (5W), SUSE 4.41 (10W), SUSE 4.42 (20W), charge controller SUSE 4.17, powerbank battery pack	≥45	2,3
C	10	Experiments with a solar module 125 W with solar module 125 W	≥45	2,3
C	11	Experiments with the solar measurement module SUSE 5.23 with SUSE 5.23	≥45	2,3
C	12	Experiments with the solar vehicle 3 with solar vehicle 3 + PC interface	≥45	2,3
C	13	Taking I-V and P-V characteristic curves with SUSE 5.15 + PC interface	≥45	2,3
C	14	Experiments with the solar module SUSE 4.41 10W	≥45	2,3
C	15	Experiments with the solar module SUSE CM312 with SUSE CM312, 4.36, 4.16	≥45 <small>Selection possible</small>	2,3
C	16	Experiments with the solar module SUSE CM315 with SUSE CM315, 4.36, 4.16	≥45 <small>Selection possible</small>	2,3
C	17	Experiments on the decrease of V,I,P from shadowing with SUSE 5.22, PC interface	≥45	2,3
C	18	Experiments with the 5W solar module SUSE 4.51 with 2x SUSE 4.51	≥45	2,3
C	19	Experiments with the 10W solar module SUSE 4.41 with 2x SUSE 4.41	≥45	2,3
C	20	Experiments with the 20W solar module SUSE 4.42 with 2x SUSE 4.42	≥45	2,3
C	21	Mini USB off-grid system with SUSE 4.52, reading lamp 4.15USB, powerbank battery pack, USB measurement technology, radio SUSE 4.36USB, short-time storage 4.12 USB, solar motor 4.16 USB	≥45	2,3
C	22	Experiments with the 2 solar cell solar module SUSE CM318 with switch to toggle parallel and series connection	≥45	2,3
C	23	Experiments with the solar module SUSE 4.2	≥45	2,3
C	24	Experiments with the 10W solar module SUSE 4.52	≥45	2,3



# Overview of the learning stations

## D - ISCED 3 College

Age group 16->18 years with key subjects

Group	No.	Topic	Time ca. min	FA Notes
D	1	Experiments with the characteristic curves module SUSE 5.15, PC interface Taking of characteristic curves and efficiency factor determination <i>Radiation, semiconductor physics, el. fields, energy conversion</i>	90	ISCED 3
D	2	Experiments with the solar vehicle 3 with capacitor charging and discharging <i>El. fields, energy conversion, radiation</i>	60	ISCED 3
D	3	Experiments with the solar vehicle 1 with capacitor charging and discharging <i>El. fields, energy conversion, radiation</i>	60	ISCED 3
D	4	Experiments with the solar vehicle 1.2 with capacitor charging and discharging <i>El. fields, energy conversion, radiation</i>	60	ISCED 3
D	5	Experiments with the LED module SUSE 5.9-6 with SUSE 5.9-6 <i>Radiation, semiconductor physics, el. fields, quantum physics, wave physics</i>	60	ISCED 3
D	6	Spectral analysis with the LED module SUSE 5.9-6 Quantum physical effects on LEDs <i>Radiation, semiconductor physics, el. fields, quantum physics, wave physics</i>	60	ISCED 3
D	7	Collector cooling and capacitor in comparison with solar collector and GoldCap capacitors <i>Thermodynamics, el. fields, energy conversion, radiation</i>	60	ISCED 3
D	8	Capacitor charging on a solar module with SUSE 4.3RB, 4.12 <i>El. fields, radiation</i>	60	ISCED 3
D	9	Capacitor discharging on a solar module with SUSE 4.3RB, 4.12, 4.16 <i>El. fields, energy conversion, radiation</i>	60	ISCED 3
D	10	Angle dependence of V,I,P of a solar cell with SUSE 5.22alpha, 5.16 <i>Semiconductor physics, radiation</i>	30	ISCED 3
D	11	Heating and cooling a solar thermal collector Measurement and calculation of stagnation temperature, efficiency factor determination <i>Thermodynamics</i>	60	ISCED 3
D	12	PV experiments with the solar module SUSE CM6MS <i>Semiconductor physics, radiation</i>	90	ISCED 3
D	13	Experiments with the SUSE solar vehicle 4 and solar filling station SUSE 4.34, energy conversion processes, capacitor charging and discharging <i>Energy conversion, Mechanics, el. fields</i>	90	ISCED 3
D	14	Efficiency factor determination at 2 solar cells in comparison through MPP measurements with 2x SUSE 5.15 (1 monocrystalline cell from 2017 and 1 multicrystalline cell from 2011) with the measurement value acquisition system CassyLab <i>El. fields</i>	45-60	ISCED 3
D	15	Shadowing experiments with SUSE 5.22, CassyLab, SUSE 5.16, Display of exponential absorption	45	ISCED 3

# Overview of the learning stations E

Age from 12 years Self-assembly of solar modules

For the self-assembly of solar devices material expenses are incurred.

Group	No.	Topic	Time ca. min	Levels Notes
E	1	Self-assembly of the solar module SUSE CM312 Experiments with the solar module SUSE CM312 and additional devices	>60	Self-assembly + experiments
E	2	Self-assembly of the solar module SUSE CM315 Experiments with the solar module SUSE CM315 and additional devices	>60	Self-assembly + experiments
E	3	Self-assembly of the solar module SUSE CM4MBV Experiments with the solar module SUSE CM4MBV and additional devices	>60	Self-assembly + experiments
E	4	Self-assembly of the solar module SUSE CM6MS Experiments with the solar module SUSE CM6MS and additional devices	>60	Self-assembly + experiments
E	5	Self-assembly of a solar module from solar cell fragments Experiments with the solar module and additional devices	>60	Self-assembly + experiments
E	6	Self-assembly of the solar boat 4 Experiments with the solar boat	>60	Self-assembly + experiments
E	7	Self-assembly of the solar vehicle 1	ca.60	Self-assembly + experiments
E	8	Self-assembly of the solar vehicle 1.2	>60	Self-assembly + experiments
E	9	Self-assembly of the solar vehicle 3B	>60	Self-assembly + experiments
E	10	Self-assembly of the solar vehicle 4	>60	Self-assembly + experiments
E	11	Self-assembly of the solar vehicle 5	ca. 60	Self-assembly + experiments
E	12	Self-assembly of the solar module 4.34 (Solar charging station for SF1,SF4)	ca. 45	Self-assembly + experiments
E	13	Self-assembly of the solar vehicle solar racer	ca.30	Self-assembly + experiments
E	14	Self-assembly of the solar module 4.35 (Solar charging station for SF1.2)	ca. 45	Self-assembly + experiments
E	15	Self-assembly of the beginner's solar module SUSE CM310	ca.45	Self-assembly + experiments
E	16	Self-assembly of the solar module SUSE CM318	> 60	Self-assembly + experiments
E	17	Self-assembly and calibration of the solar radiation measurement module SUSE 4.24A	> 60	Self-assembly + calibration
E	18	Self-assembly of the solar module SUSE CM316	ca.60	Self-assembly + experiments
E	19	Self-assembly of the solar module SUSE CM319	ca.45	Self-assembly

# Overview of the learning stations F - Primary school

For Primary Schools, NILS-ISFH developed Hamelin's suncatcher box with 30 experimental learning stations and an extensive teacher's manual with solutions, as well as a students' booklet.

## The 30 learning stations of the suncatcher box GS

No.	Experiment	Required devices plus indoors: halogen lamp 120 W
1	Experiments with the solar vehicle solar racer	Solar racer, folding rule, stopwatch
2	How does a solar cell perform best?	Solar module SUSE CM6MS, multimeter, lab wires
3	Who measures the highest current?	Solar module SUSE CM6MS, multimeter, lab wires
4	Comparison solar cell vs. battery	Solar module SUSE CM6MS, multimeter, mignon battery, lab wires
5	Series connection of batteries	Multimeter, mignon batteries, lab wires
6	Series connection of solar cells	Solar module SUSE CM6B, multimeter, lab wires
7	Operation of a radio with solar modules in series connection	Solar module SUSE CM6B, solar radio SUSE 4.36, lab wires
8	Operation of a radio with the solar module SUSE 4.3RB	Solar module SUSE 4.3RB, solar radio SUSE 4.36 multimeter
9	Storage of solar current, LED module	Solar module SUSE CM6B, lab wires, solar storage SUSE 4.12, LED module SUSE 4.15 rainbow
10	Storage of solar current, solar motor	Solar module SUSE CM6B, solar storage SUSE 4.12, solar motor SUSE 4.16, lab wires
11	Solar car with solar charging station	Solar module SUSE 4.3RB, SUSE solar vehicle 1.2, lab wires
12	When does the rainbow LED glow?	Solar module SUSE 4.3RB, LED module SUSE 4.15 rainbow, lab wires, multimeter
13	Which air screw rotates the fastest?	Solar module SUSE 4.3RB, solar motors SUSE 4.16, lab wires, multimeter
14	How many solar motors can a solar cell fuel?	Solar module SUSE CM6B, solar motors SUSE 4.16, lab wires, multimeter
15	Changing the solar cell area by covering	Solar module SUSE CM6B, multimeter, lab wires
16	Positioning of a solar cell in different cardinal directions	Solar module SUSE CM6B, multimeter, compass, lab wires
17	Experiments with the solar radiation meter	Solar radiation meter SUSE 4.24, compass
18	Experiments with solar cell fragments	Solar cell fragments, solar motor SUSE 4.16, lab wires, multimeter
19	Who measures the highest current with a solar cell fragment?	Solar cell fragments, multimeter, lab wires
20	The solar motor as a wind power plant	Solar motors SUSE 4.16, multimeter, lab wires
21	Wind power lets the LED glow	Solar motor SUSE 4.16, LED module SUSE 4.15, lab wires
22	Solar toys	Solar toys 6in1, solar butterfly, solar helicopter
23	Experiments with the thermometer	Digital thermometer
24	Experiments with the solar thermal collectors	Digital thermometers, solar thermal collectors
25	Heating of water in the solar thermal collector	Digital thermometers, solar thermal collector, test tube, water
26	Charging a phone with solar energy at the solar module SUSE 4.50-10GS and charging powerbank battery packs	Solar module SUSE 4.50-10, smartphone with USB charging cable, powerbank battery pack
27	Solar module SUSE 4.50-10 as a solar charging station	Solar module SUSE 4.50-10, solar vehicle SF6USB, USB cable (2x plug USB A)
28	Operating a radio and LED lamp at the solar module SUSE 4.50-10	Solar module SUSE 4.50-10, solar radio SUSE 4.36 USB, LED lamp with USB plug

29	Comparative experiments with big and small solar cells	Solar module SUSE CM6MS, solar module SUSE CM315, multimeter, 2 lab wires
30	Discover your own experiments with the solar module SUSE CM400	Solar module SUSE CM400



# Overview of the short learning stations G – ISCED 2 and 3

ISCED 2: Age group 12->16 years    ISCED 3: Age group >16 years    Time: ca. 20 min

If there is only a limited amount of time available for experiments with learning stations, for example at fairs, exhibitions, workshops, the **short learning stations**, that only require ca. 20 min. to be conducted, fit perfectly. The experimental set up is usually already done previously. For each learning station there is a short, illustrated manual.

Short learning stations for ISCED level 2    Difficulty level 2		
No. <20	Description of the experiment	Required devices
G1	Measuring voltage, current, power of a solar module with 1 solar cell at different light intensities	Solar module SUSE 4.2/CM6MS/CM6B, 1 multimeter, 2 lab wires red/black, 1 basic device SUSE 4.0, 1 switchable desk power socket, poss. overhead projector
G2	6 solar cells in series connection with solar module SUSE 4.3RB, connection to an LED module SUSE 4.15 or solar motor SUSE 4.16	Solar module SUSE 4.3RB, 1 multimeter, 4 lab wires 2x red/2x black, LED module SUSE 4.15, solar motor SUSE 4.16, 1 basic device SUSE 4.0, 1 switchable desk power socket
G3	Outdoor experiments with SUSE 4.3RB, multimeter and radio	Solar module SUSE 4.3RB, multimeter, 2 lab wires red/black, solar radio SUSE 4.36, 1 basic device SUSE 4.0, 1 switchable desk power socket
G4	Series connection with single modules SUSE CM6B, Connection to an LED module SUSE 4.15 or solar motor SUSE 4.16	6 solar modules SUSE CM6B, 5 metal filing strips or 5 short lab wires, 1 multimeter, 4 lab wires red/black, 1 LED module SUSE 4.15, 1 solar motor 4.16, 1 basic device SUSE 4.0, 1 switchable desk power socket
G5	Experiments with the solar electric car SF1.2, solar module SUSE 4.3RB or solar charging station SUSE 4.34	1 solar electric car SF1.2, 1 multimeter, 4 lab wires red/black, 1 solar module SUSE 4.3RB, 1 solar charging station SUSE 4.34, 1 basic device SUSE 4.0
G6	Experiments with solar modules SUSE 4.51 (5W) and SUSE 4.52(10W) in comparison: voltage-current-power	1 5W solar module SUSE 4.51 and 10W module SUSE 4.52, 1 multimeter, 2 lab wires red/black Indoors: spot light 400W + switchable desk power socket
G7	Experiments with the solar vehicle SF6USB and the solar module SUSE 4.51 (5W) or 4.52 (10W)	1 solar module SUSE 4.51 or 4.52, 1 multimeter, 2 lab wires red/black, 1 DC-DC converter SUSE 4.17, 1 solar vehicle SF6USB, 1 USB cable A-A, 1 USB measurement device, Indoors: spot light 400W + switchable desk power socket
G8	Outdoor experiments with SUSE 5.23 or SUSE 4.24A: Measuring the light intensity = irradiance S of the light	1 radiation meter SUSE 5.23 (digital) or 4.24A (analog), compass
G9	Solar thermal experiments with the solar thermal collector GS	1 solar thermal collector GS, 1 thermometer, 1 halogen lamp 120 W with handle
G10	Outdoor photovoltaic experiments with the 20W solar module SUSE 4.42 with solar smartphone charger SUSE 4.17	1 20W solar module SUSE 4.42, 1 multimeter, 2 lab wires red/black, 1 charging device SUSE 4.17, 1 USB measurement device, personal smartphone, halogen lamp 400W
G10A	Outdoor photovoltaic experiments with the 10W solar module SUSE 4.52 with solar smartphone charger SUSE 4.17	1 10W solar module SUSE 4.52, 1 multimeter, 2 lab wires red/black, 1 charging device SUSE 4.17, 1 USB measurement device, personal smartphone Indoors halogen lamp 400W
G11	Photovoltaic experiments with the solar module SUSE CM312/CM315/CM316 Short manual	Solar module SUSE CM312/315/316, multimeter with 2 lab wires red/black, 6 additional lab wires, 1 LED module SUSE 4.15, 3 solar motors SUSE 4.16, 1 solar radio SUSE 4.36
G12	Photovoltaic experiments with the solar module SUSE CM6MS Short manual	Solar module SUSE CM6MS, 1 multimeter with 2 lab wires red/black, 6 additional lab wires, 1 LED module SUSE 4.15, 4 solar motors SUSE 4.16, 1 solar radio SUSE 4.36
G13	Storing solar current I with a solar module with 1 solar cell with SUSE CM312 or CM315/CM316/CM6MS/CM6B	Solar module SUSE CM312(or CM315, CM6MS, CM6B), 1 multimeter with 2 lab wires red/black, 2 additional lab wires, 1 storage module SUSE 4.12, 1 solar motor SUSE 4.16, basic device SUSE 4.0 + switchable desk power socket
G14	Storing solar current II with a solar module with 6-8 solar cells in series connection with SUSE 4.3RB (6 cells) or 4.35 (8 cells)	Solar module SUSE 4.3RB or solar module SUSE 4.35, 1 multimeter with 2 lab wires red/black, 4 additional lab wires, 1 storage module SUSE 4.12, 1 solar motor SUSE 4.16, 1 LED module SUSE 4.15, 1 radio SUSE 4.36 Indoor: basic device SUSE 4.0 + switchable desk power socket
G15	Storing solar current III with solar module SUSE 4.51 (5W, 18 solar cells) or 4.52 (10 Watt, 18 solar cells) with GoldCap storage SUSE 4.12-USB, Powerbank battery pack, LED lamp SUSE 4.15USB + charging module SUSE 4.17 + radio SUSE 4.36USB, solar motor SUSE 4.16USB and USB measuring device	Solar module SUSE 4.51 or 4.52, 1 USB measurement device, 1 Powerbank battery pack, 1 USB cable 2x plug A, 1 charging device SUSE 4.17, 1 LED lamp, multimeter with 2 lab wires red/black 1 solar radio SUSE 4.36 USB, 1 solar motor SUSE 4.16USB. Indoor: spot light 400 W + switchable desk power socket
G16	Solar motor as a generator or wind power plant with SUSE 4.16 or SUSE CM316	2x solar motor SUSE 4.16 or 2x SUSE CM316 1x multimeter, 4 lab wires 2x red + 2x black, 1 LED module red SUSE 4.15, 1x storage module SUSE 4.12

G17	<b>Experiments with solar modules 5W...40W</b> Power and quality analysis with SUSE 4.41/4.42/4.43/4.51/4.50...	1-2 solar modules of own choice, multimeter with 2x lab wires red/black, folding rule, ruler, calculator or calculator app on the smartphone
G18	Experiments with solar cell fragments Are solar cell fragments usable?	Raw solar cells 52x52 mm Solar cell fragments, cell connectors, multimeter, crocodile clips, set square, mm paper, soldering station with tin solder, overhead projector
G19	Experiments with the solar module SUSE CM319 Experiments on series connections (short version)	2-3 solar modules SUSE CM319, multimeter, 4x lab wires, 3x red, 1x black, 1 solar motor SUSE 4.16, 1 LED module SUSE 4.15
<b>ISCED level 3</b> Difficulty level 3		
No. >20	Description of the experiment	Required devices
G21	Voltage, current, irradiance measurements with the solar module SUSE CM6MS, comparison to characteristic curves	Solar module SUSE CM6MS, basic device SUSE 4.0, 1 multimeter, overhead projector, 2 lab wires
G22	Determination of the efficiency factor and power with the solar module SUSE CM6MS and measuring system CassyLab, recording of the I(V) and P(V) characteristic curves	Solar module SUSE CM6MS, basic device SUSE 4.0, load module SUSE 4.55-1, measuring system CassyLab, laptop
G23	Operation of the solar vehicle SF4 with solar module SUSE 4.34 (4 cells in series connection), observation and measurement of the charging and discharging of the GoldCap capacitor	1 solar module SUSE 4.34, 1 basic device SUSE 4.0, 1 SUSE solar vehicle 4, 1 multimeter, 8 lab wires poss. CassyLab with laptop
G24	Outdoor experiments with the 5W solar module SUSE 4.51 or 10W module SUSE 4.52, determination of V,I,P,S, comparison to characteristic curves and manufacturer data	1 solar module SUSE 4.51, 1 multimeter, 1 compass
G25	Shadowing experiments with SUSE 5.22 and CassyLab	1 optical bank SUSE 5.0alu, 1 halogen spotlight SUSE 5.16 with power supply 12V, 2 pipe collars, 6 lab wires (red, black, 2x yellow, green, blue) CassyLab with power supply, USB cable, PC or laptop
G26	Recording the I(V) characteristic curve on a solar cell with SUSE 5.15 and CassyLab, determination of MPP, efficiency factor, filling factor	1 optical bank SUSE 5.0alu, 1 halogen spotlight SUSE 5.16 with power supply 12V, 2 pipe collars, 6 lab wires (red, black, 2x yellow, green, blue) CassyLab with power supply, USB cable, PC or laptop

## Overview of the learning stations H for groups of up to 15 participants

These learning stations are applied with students groups at the ISFH for partial groups that don't work in the NILS lab.

No.	Description of the experiment	Required devices
H1	Experiments on energy conversion and voltage measurements on solar cells and solar modules with various solar cells, solar modules, Peltier element, solar motor SUSE 4.16, LED module SUSE 4.15	Experiments outdoors or indoors 8 different solar cells + solar modules, 1 Peltier element, 1 x SUSE 4.16, 1x SUSE 4.15, 1 halogen spotlight 120W, 1 halogen spotlight 400W, 1 red light lamp, 5 multimeters
H2	Experiments on energy conversion, reversibility, and voltage, current, and power measurement on solar cells, LEDs, and on a Peltier element	Experiments outdoors or indoors 4 different solar cells (twice each), LED module SUSE 5.9-6 (twice each), power supply 5V, battery 9V, 1 Peltier element, halogen spotlight 400W, 1 overhead projector, 5 multimeters, lab wires