How to become Prosumer

Agris Kamenders

Vidzeme planning region

08/12/2020

Main steps towards prosumerism

Desk research – assessment of current achievements

Collection of Best practice examples

Implementation of the planned case studies

Guide for Prosumerism

1. Support tools Database

- *Calculation tools*
- *Technical guidelines*
- *Recommendations*
- *Financial instruments*

2. Country specific information on support schemes

3. Best practice examples from partner countries

- *Technical, financial aspects and real results*
- *Replicability*
- *Lessons learned and synthesis of good practices*

4. Feedback from real cases

- *Step by step how to implement prosumerism*
- ***Support tools for building managers***

Recommendations incorporated tools and guidelines
(White Paper)

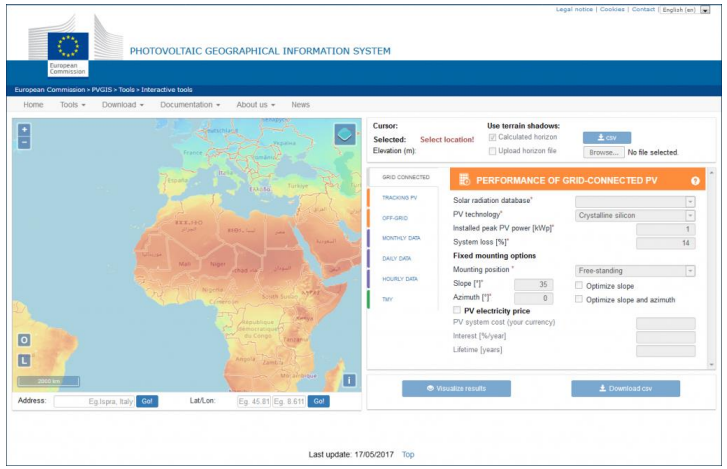
Prepared by VPR

Tools can be divided in 3 types:

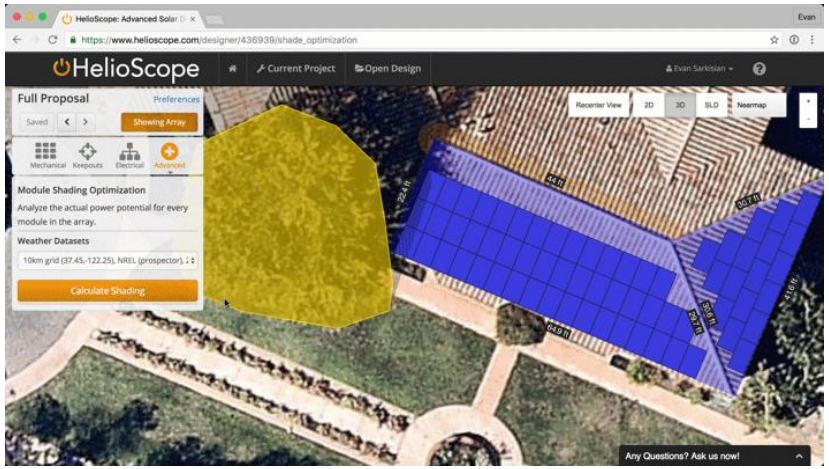
1. Solar maps and atlases
2. Web/online-based simulation tools
3. Downloadable simulation software

Examples

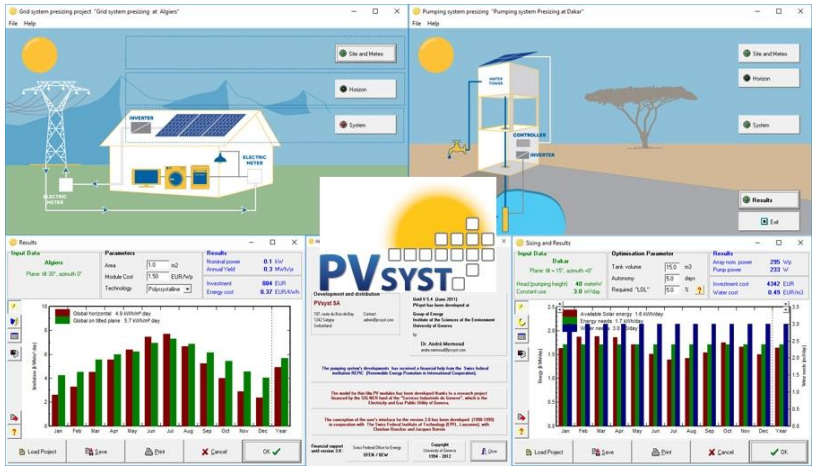
PVGIS



HelioScope



PVsyst



Description of the tools

1.	Solar maps and atlases	• Provide basic information necessary for PV projects • Do not provide detailed simulation of PV installation • Usually free of charge	• Photovoltaic Geographical Information System (PVGIS) • GLOBAL SOLAR ATLAS • IRENA GIS tools
2.	Web/online-based simulation tools	• Allow for designing and sizing PV systems on maps (Some include 3D support) • Allow defining parameters of solar panels or selecting components from a database • Some include pre-set load profiles to estimate more precise energy yield • Some are available free of charge, some as a free sample and some are available only for a charge	• SISIFO • HelioScope • SOLARGIS • PVP calculator
3.	Downloadable simulation software	• Often provides the most precise estimation of solar energy yield • Usually includes map or GIS support, PV sizing, component database, load profile database and 3D support • Usually available only for a charge • A certain level of expertise and knowledge is required in order to use it	• PV*SOL • PVComplete • iDistributedPV • Pvsyst • BlueSol • POLYSUN • Solar Pro

Guidelines and best practice examples

There are also many **guidelines** and **best practice examples** available, like:

PERFORMANCE PLUS	PVTRIN (Training of Photovoltaic Installers)	Solar Bankability	IEA Solar Heating & Cooling Technology Collaboration Programme	PV database

Tool rating
Solar maps and atlases projects/agencies

No.	Project / Agency	Global location support	PV simulation	GIS support	Meteorological simulation	Energy yield evaluation	Library of components	PV system sizing	PV system optimization	Export to CAD software or other	3D representation or simulation	Map / atlas included	Online / browser based	Installable software	Guidelines for PV	Best practice examples for PV
1.	PVGIS	■		■	■	■						■	■			
2.	WBG Solar Atlas	■	■	■		■						■	■			
3.	IRENA		■	■	■	■		■				■	■			

Web/online-based simulation tools projects/agencies

No.	Project / Agency	Global location support	PV simulation	GIS support	Meteorological simulation	Energy yield evaluation	Library of components	PV system sizing	PV system optimization	Export to CAD software or other	3D representation or simulation	Map / atlas included	Online / browser based	Installable software	Guidelines for PV	Best practice examples for PV
4.	PVCROPS	■	■	■	■	■	■		■			■	■			
5.	HelioScope	■	■	■	■	■	■	■	■	■	■	■	■			
6.	SOLARGIS	■	■	■	■	■	■		■	■		■	■	■		
7.	PVP4Grid						■						■		■	

Downloadable simulation software projects/agencies

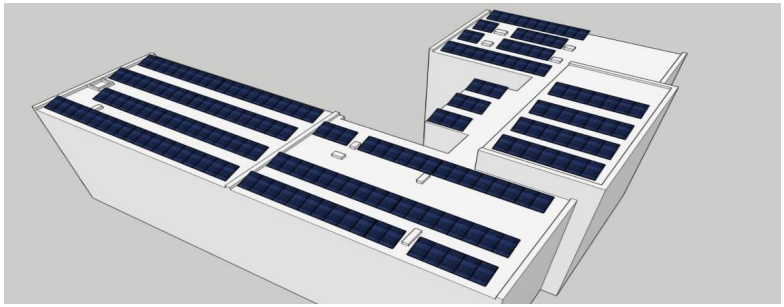
EFFECT4buildings

No.	Project / Agency	Global location support	PV simulation	GIS support	Meteorological simulation	Energy yield evaluation	Library of components	PV system sizing	PV system optimization	Export to CAD software or other	3D representation or simulation	Map / atlas included	Online / browser based	Installable software	Guidelines for PV	Best practice examples for PV
8.	PV*SOL	■	■	■	■	■	■	■	■	■	■	■	■	■		
9.	PVComplete	■	■	■	■	■	■	■	■	■	■	■	■	■		
10.	iDistributedPV	■	■	■	■	■								■		
11.	PVsyst	■	■	■	■	■	■	■			■			■		
12.	BlueSol	■	■	■	■	■	■	■	■		■			■		
13.	Polysun	■	■	■	■	■	■	■	■	■	■			■		
14.	Solar Pro	■	■	■	■	■	■	■	■		■			■		

EFFECT4buildings prosumer calculation tool

What can you achieve by using this tool?

1. To determine the optimal size of the PV system
2. To find out how much electricity can be produced from a selected area
3. To make financial calculations to identify savings, income, necessary investments, repayment time and the overall profitability of the system
4. To find out how a storage system would improve PV systems efficiency



Results on yearly basis

results	value	unit
solar electricity production	47 370,82	kWh
electrical demand/need	142 000,00	kWh
direct own consumption without storage	38 517,20	kWh
own production quota without storage	81,31%	%
degree of self-sufficiency without storage	27,12%	%
used electricity for charging the system	N/A	kWh
own consumption with storage	N/A	kWh
own production quota with storage	N/A	%
degree of self-sufficiency with storage	N/A	%
storage losses	N/A	kWh
share of production in storage losses	N/A	%
over production	8 853,62	kWh
remaining power outlet	103 482,80	kWh

EFFECT4buildings

Global irradiation *[kWh/m²]*

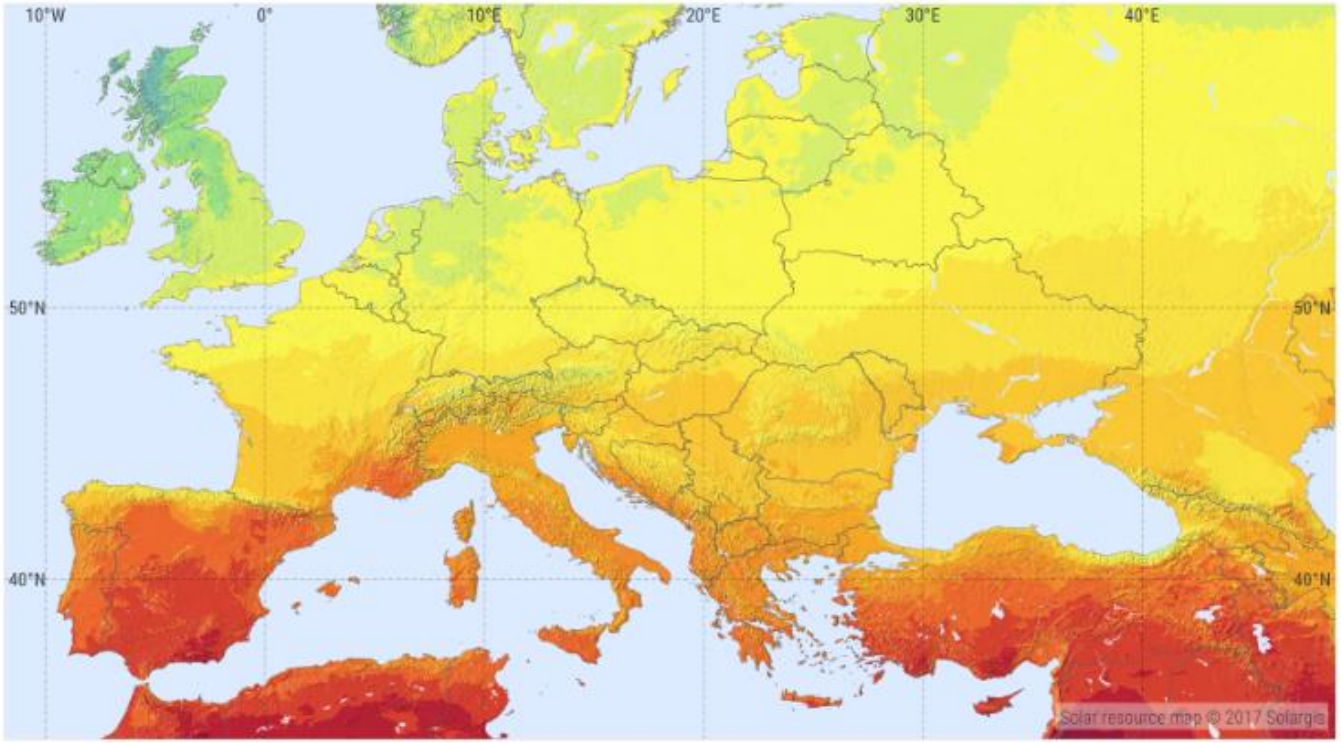
Yearly sum of global irradiation incident on optimally-inclined south-oriented photovoltaic modules

<600 800 1000 1200 1400 1600 1800 2000 >2200

Solar electricity *[kWh/kW$_{peak}$]*

<450 600 750 900 1050 1200 1350 1500 >1650

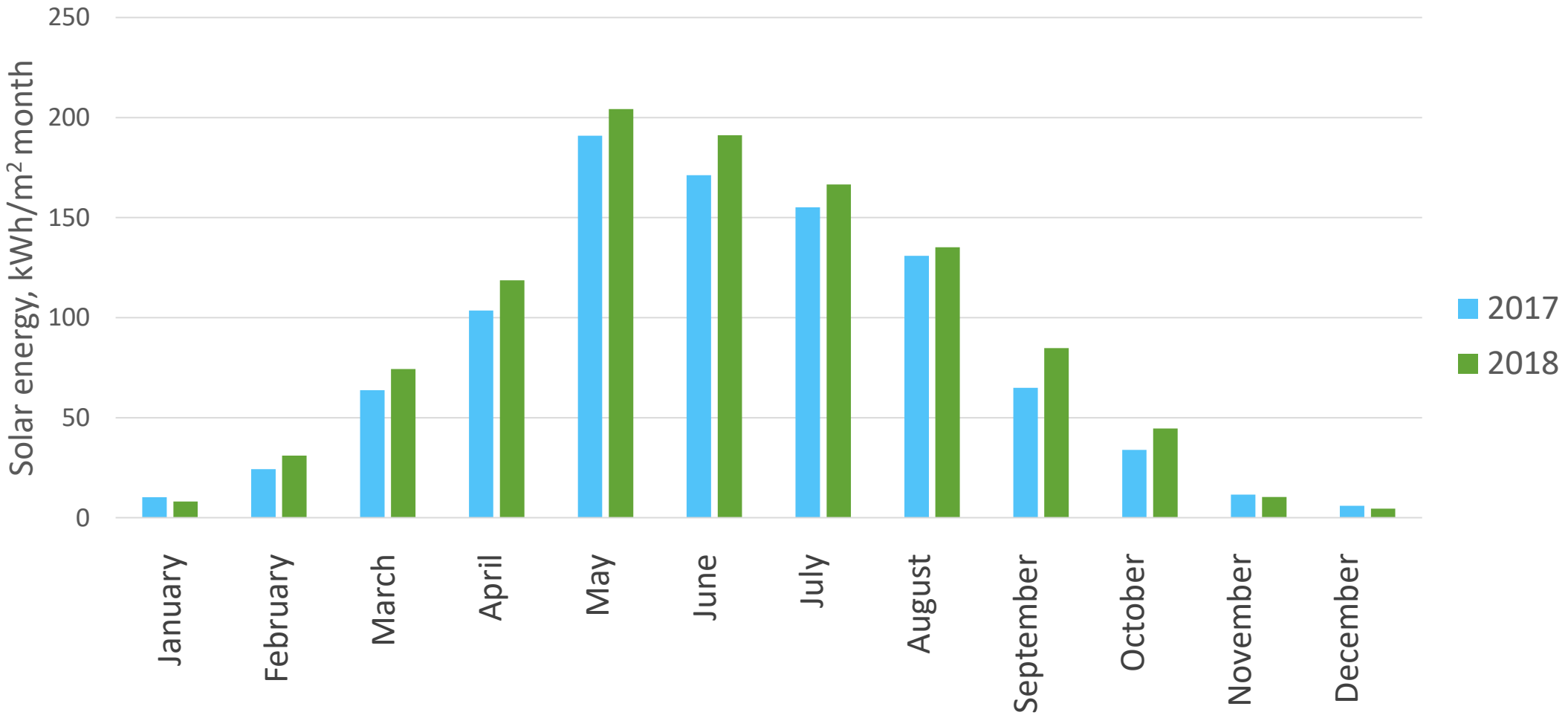
Yearly sum of solar electricity generated by optimally-inclined 1kW$_P$system with a performance ratio of 0.75



Average annual sum of PVOUT, period 1994-2016

800 1000 1200 1400 1600 1800 kWh/kWp

Solar energy in Riga



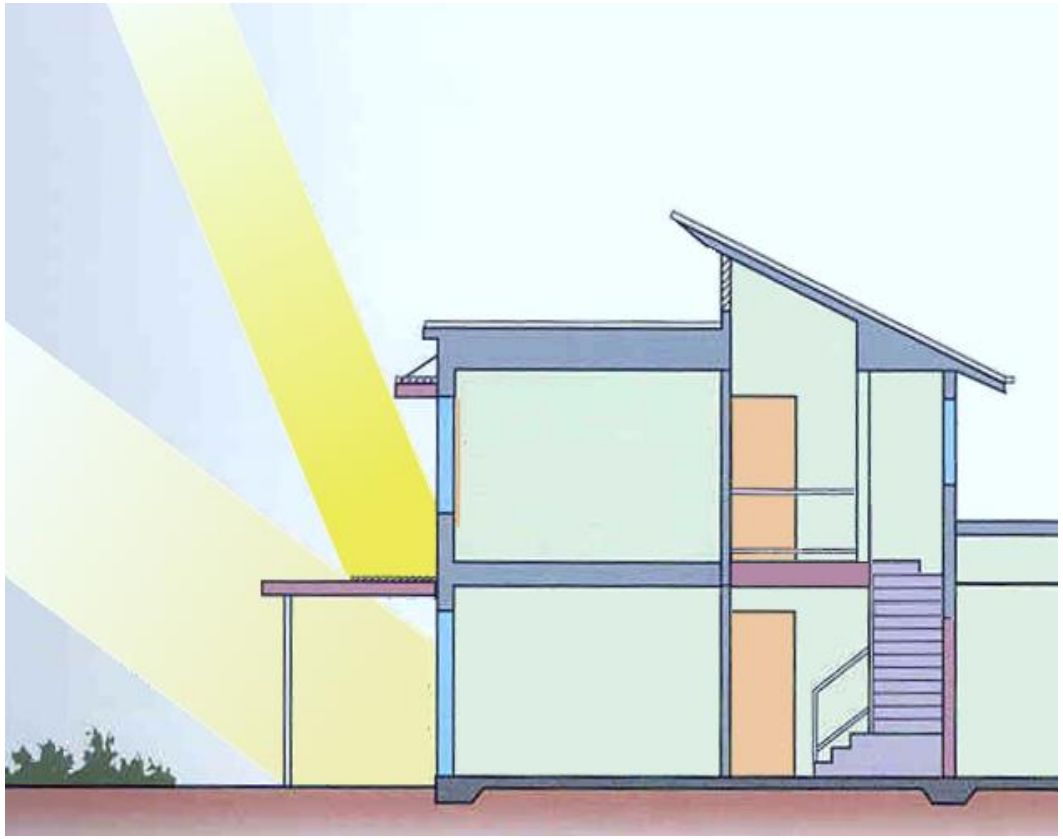
Available solar technologies

Solar thermal for heat generation

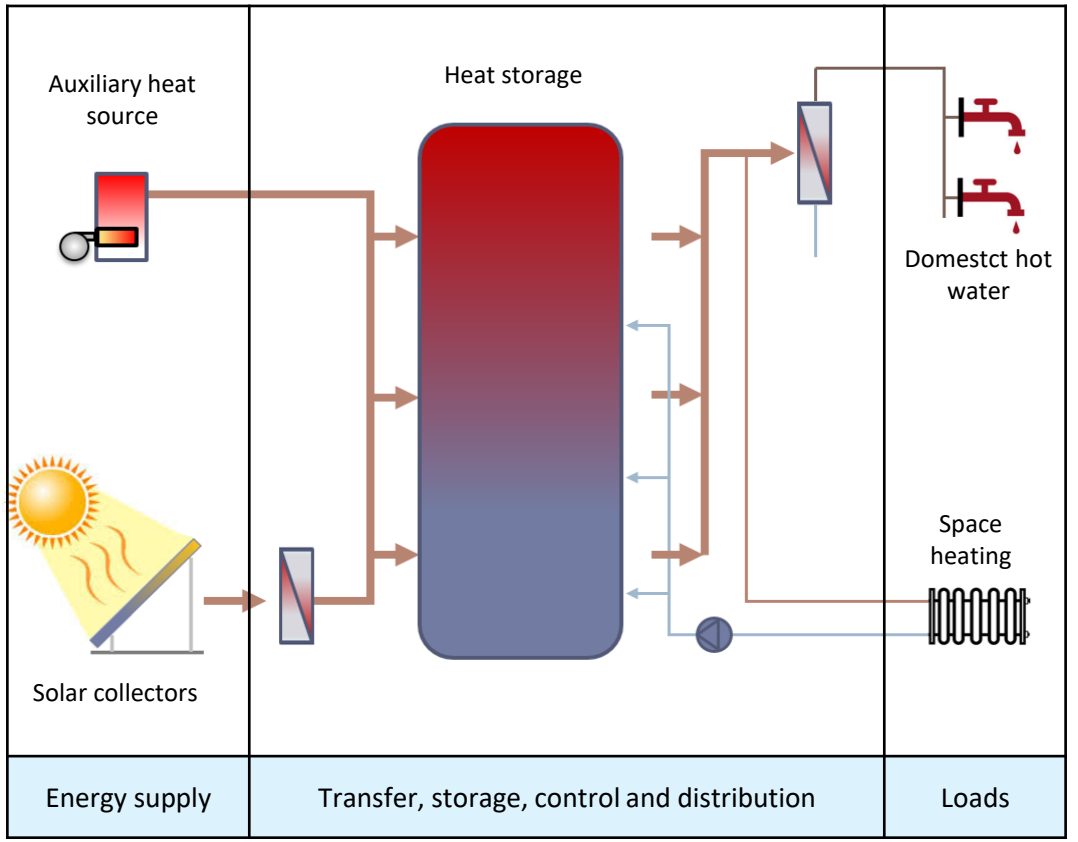
PV panels for electricity generation

Solar thermal

Passive design

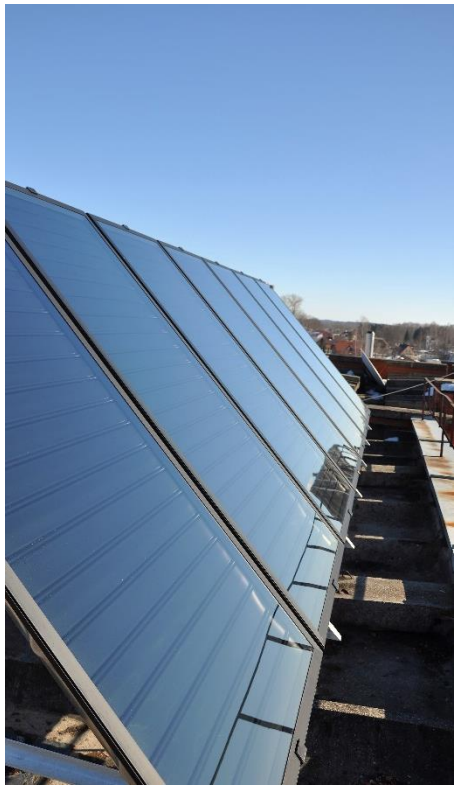


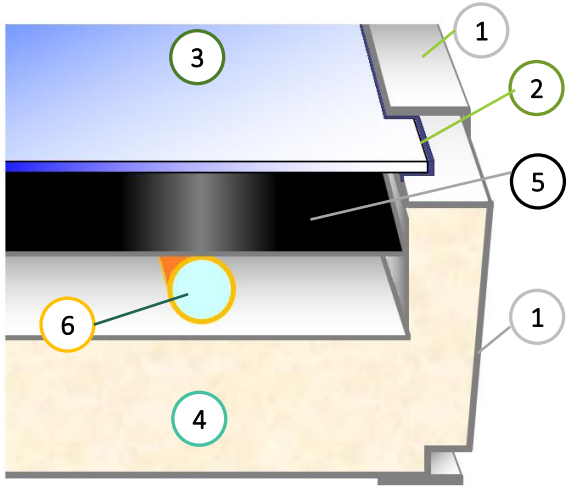
Active solar thermal systems



Solar Collectors

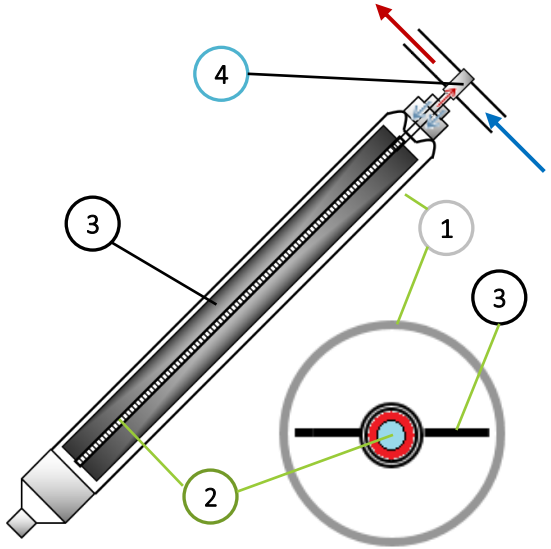
Flat plate





1. Frame
2. Sealing
3. Cover (glazing)
4. Thermal insulation
5. Absorber
6. Fluid pipe

Evacuated vacuum tubes

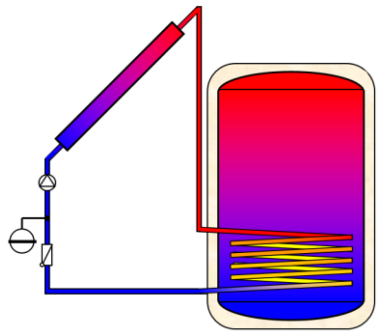
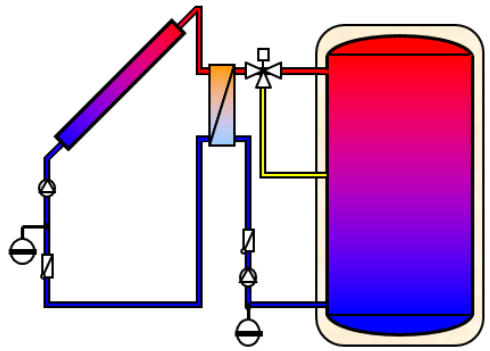
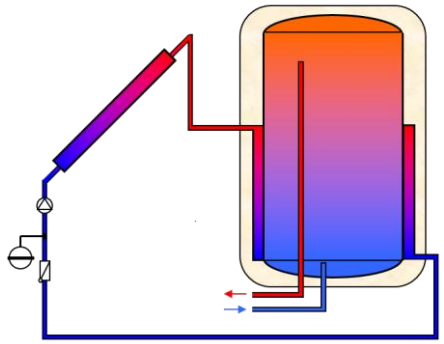
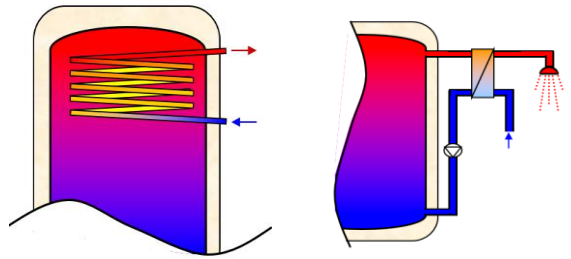
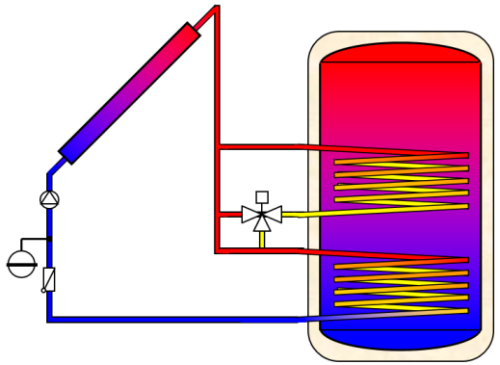
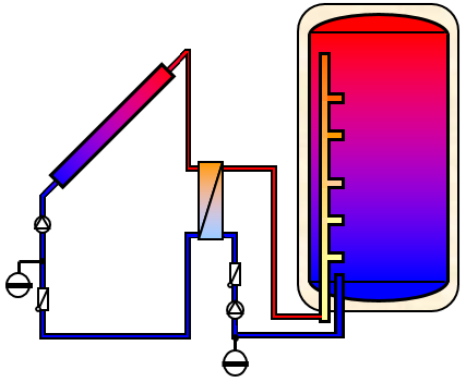
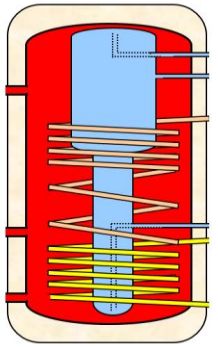
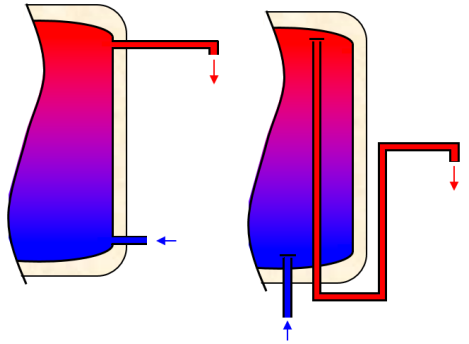


1. Transparent glass tube (under vacuum)
2. In/out of heat transfer fluid
3. Absorber
4. Heat exchanger/condenser

Storage – examples of configurations

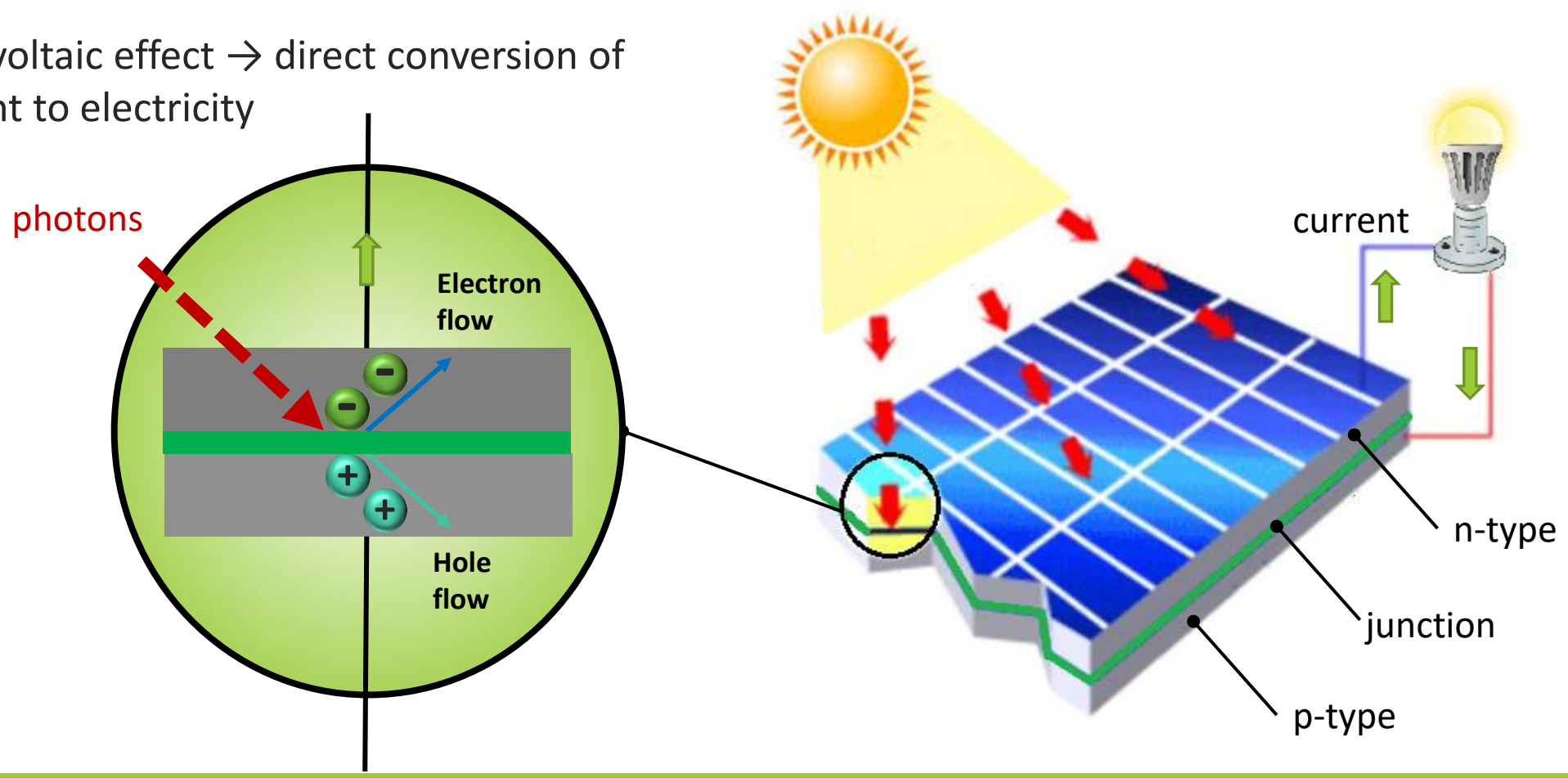
CHARGING

DISCHARGING

			
Immersed/internal heat exchanger at one level	External heat exchanger two pipe connection at different level (stratification with switching valve)	Mantle tank, heat transferred by a surrounding mantle heat exchanger	Discharging with heat exchangers
			
Immersed/internal heat exchangers at two levels	External heat exchanger and internal stratifier	Tank in tank system. The DHW tank is integrated inside the heat store	Direct discharging with double ports

PV panels

- Photovoltaic effect → direct conversion of sunlight to electricity



Main PV panel technologies

- Crystalline silicon cells
  - Polycrystalline 12%-16%
  - Monocrystalline 15%-24%.
- Hybrid cells
- Thin film cells 7%-13%
  - Thin film silicon
    - Amorphous
    - Microcrystalline
  - Cadmium-teluride cells
  - Copper-indium diselenide cells

Shading

Shading can have a huge impact on the performance of solar photovoltaic panels.

Meaning when the power output of a single cell is significantly reduced, the power output for the whole system in series is reduced to the level of current passing through the **weakest cell.** Therefore, a **small amount of shading can significantly reduce the performance of entire solar photovoltaic panels system.**

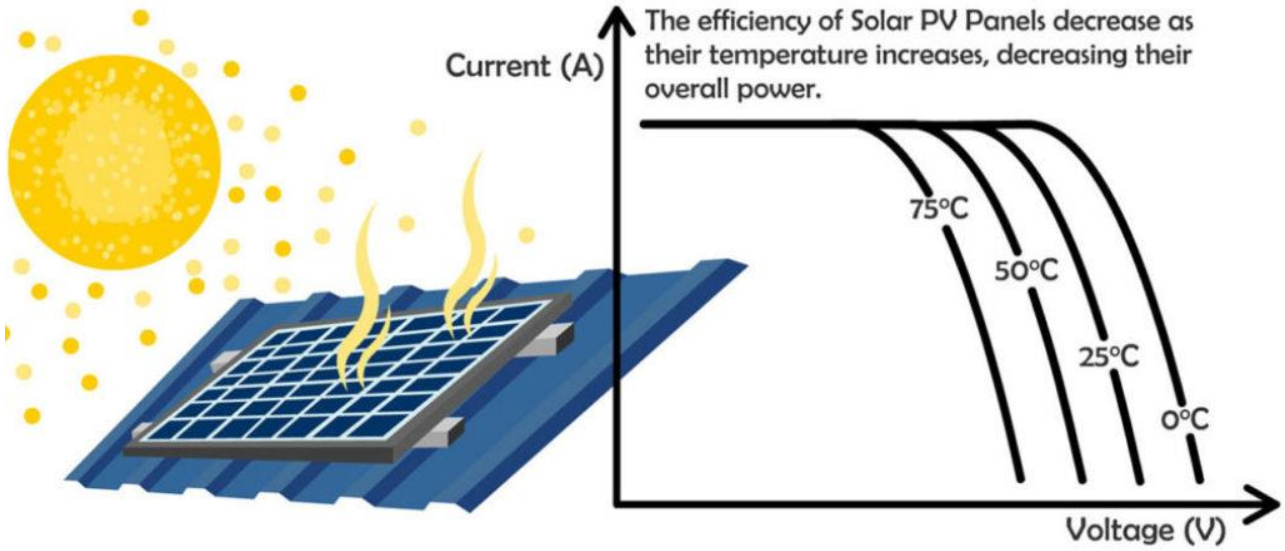
https://sunsolar.com.pl/kiedy-nie-zakladac-fotowoltaiki/

Temperature

PV performance decreases with increasing temperature. **Higher temperatures** cause the semiconductor properties to shift, resulting in a slight increase in current but **large decrease in voltage**

There are PV panels which are suitable for low or high temperature regions.

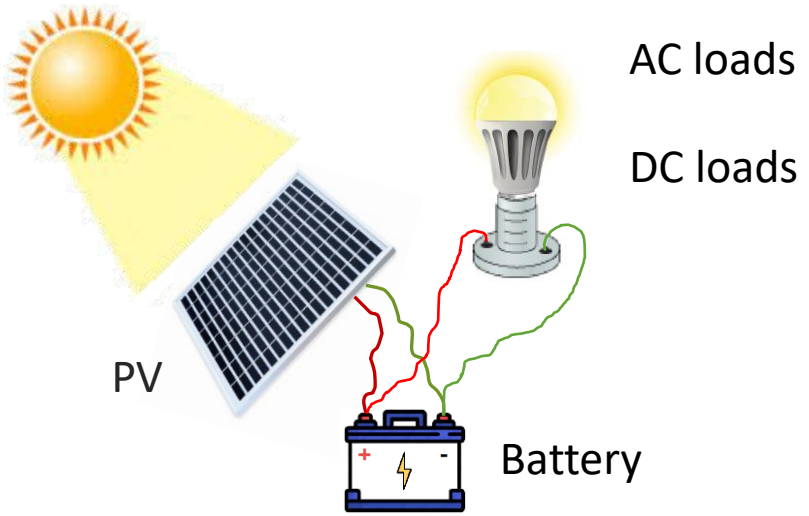
Solar panels should be positioned to receive sufficient amounts of airflow to induce natural cooling and helps keeping the efficiency rates up.



https://couleenergy.com/datasheet-values-rating-of-a-solar-panel/

General solar PV set up

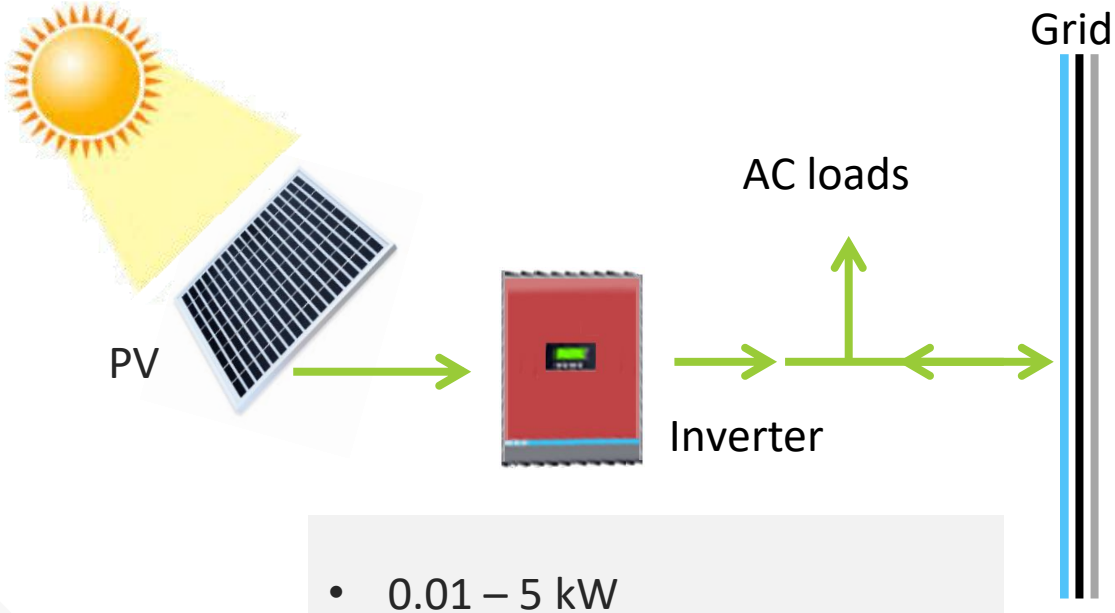
Stand-alone systems



APPLICATIONS:

- Rural electrification
- Mini-grid systems
- Residential house
- Industrial/agricultural roofs
- Utility scale power plants

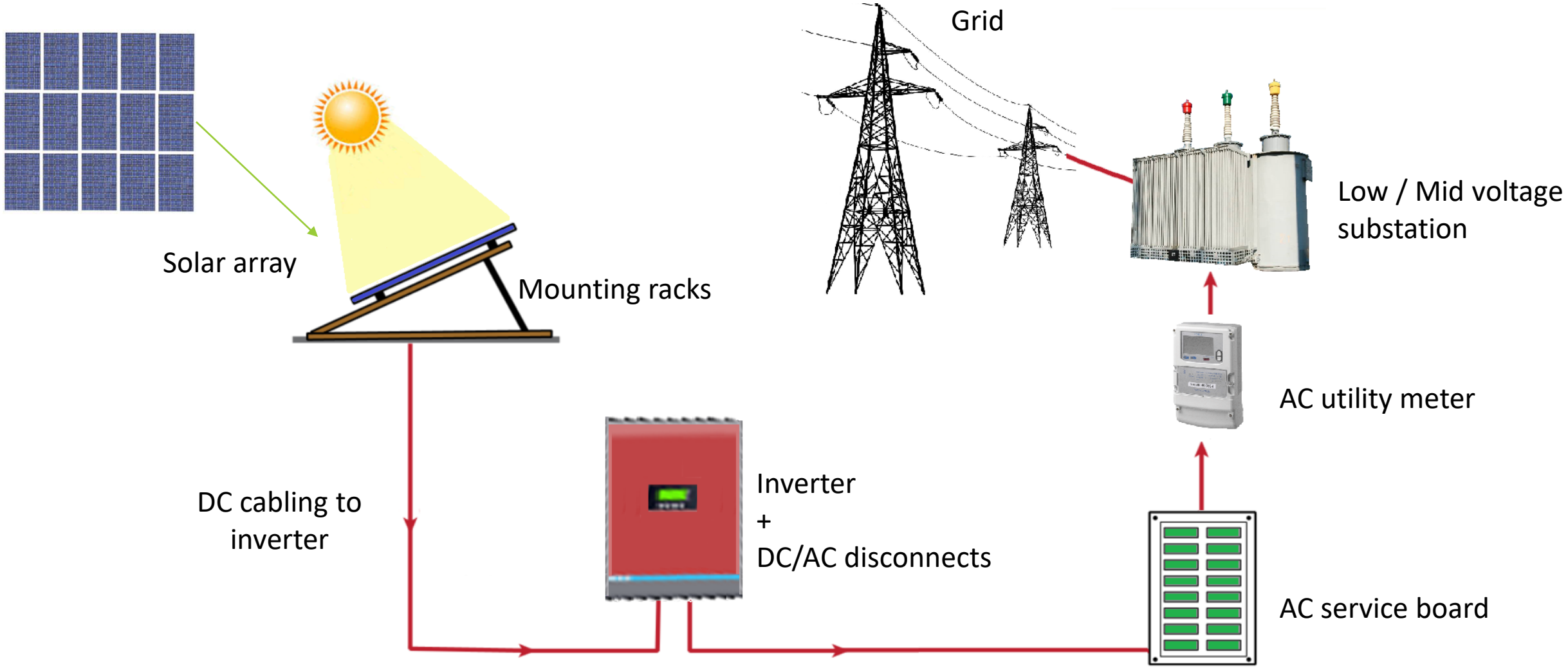
Grid connected systems



SIZE:

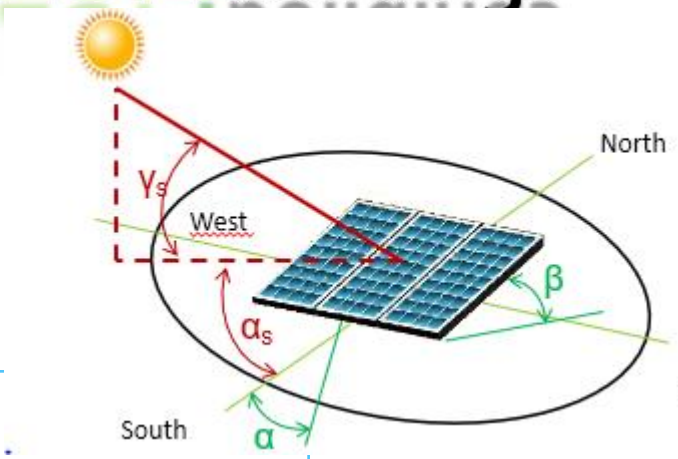
- 0.01 – 5 kW
- 5-500 kW
- 2-8 kW
- 200 – 5000 kW
- 10 – 1000 MW and more

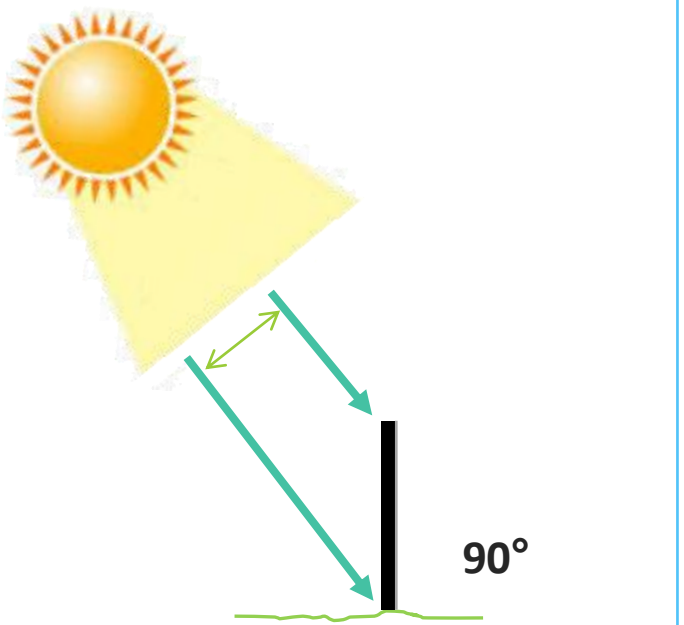
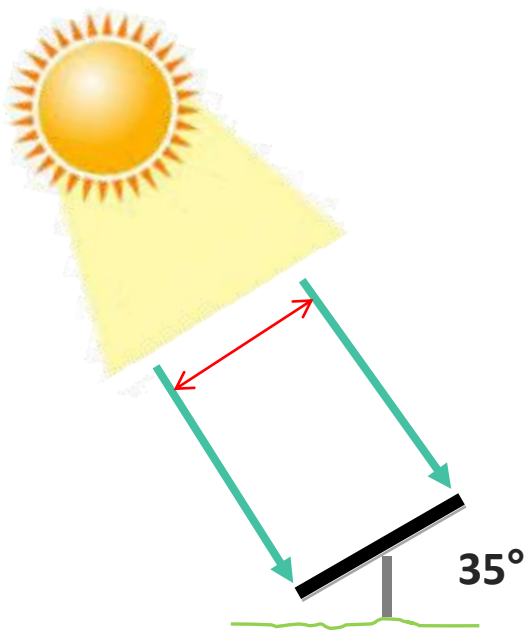
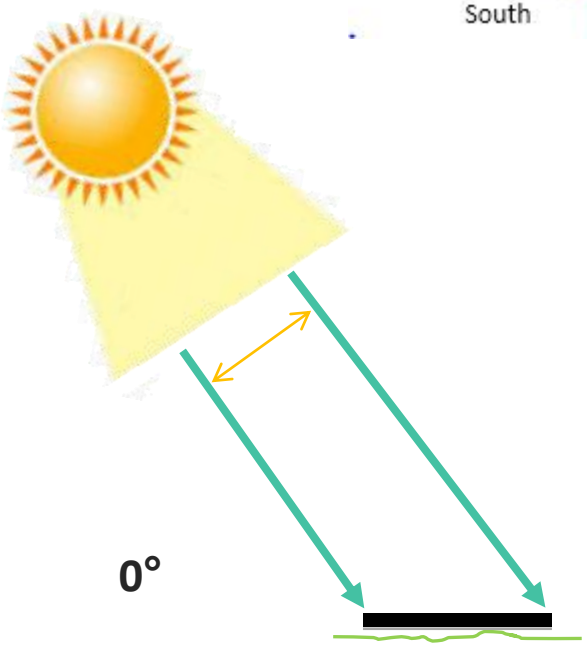
Grid connected systems



Initial project design

Module tilt and azimuth. Indicative example from **Riga** with south orientation installation



		
kWh/kWp 742	**kWh/kWp 1100**	**kWh/kWp 952**

STEP BY STEP HOW TO IMPLEMENT PROSUMERISM

1. PLANNING OF THE INSTALLATION

2. HARMONISING THE PROJECT WITH LOCAL AUTHORITIES AND DNO

3. INSTALLATION AND CONNECTING TO THE GRID

PROJECT IMPLEMENTATION PROCESS

EFFECT4buildings

PLANNING

- Assess the orientation of the roof or wall and the availability of sunlight
- Identify the potential for using solar PV for a given site
- Define your electricity consumption profile
- Determine the optimum capacity of PV system
- Determine the size of the required system and possible technical solution
- Carry out an economic assessment of the project
- Prepare project documentation

2. HARMONIZING

- Obtain a permits needed
- Receive technical connection regulations
- Signing a connection agreement

3. INSTALLATION AND CONNECTING TO THE GRID

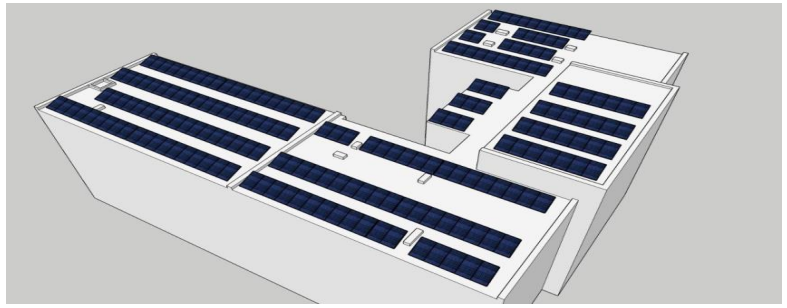
For power plants

- Receipt of technical regulations for connection
- Signature of an agreement for the development of an electrical installation building project
- Choice of designer, submission of consent
- Signing a connection agreement and paying invoices
- Construction merchant performs connection construction
- Submission of an application regarding the readiness for inspection
- Inspection of the construction of a power plant
- A successful test act must be submitted
- Signature of an act, receipt of an authorization
- Connecting to the grid

EFFECT4buildings prosumer calculation tool

What can you achieve by using this tool?

1. To determine the optimal size of the PV system
2. To find out how much electricity can be produced from a selected area
3. To make financial calculations to identify savings, income, necessary investments, repayment time and the overall profitability of the system
4. To find out how a storage system would improve PV systems efficiency



EFFECT4buildings

Results on yearly basis

results	value	unit
solar electricity production	47 370,82	kWh
electrical demand/need	142 000,00	kWh
direct own consumption without storage	38 517,20	kWh
own production quota without storage	81,31%	%
degree of self-sufficiency without storage	27,12%	%
used electricity for charging the system	N/A	kWh
own consumption with storage	N/A	kWh
own production quota with storage	N/A	%
degree of self-sufficiency with storage	N/A	%
storage losses	N/A	kWh
share of production in storage losses	N/A	%
over production	8 853,62	kWh
remaining power outlet	103 482,80	kWh

EFFECT4buildings

Step 1

Data input

Input the values of:

- PV system
- Electricity consumption
- Storage system

Step 2

Find out how much electricity your roof can produce

By using solar maps and tools that are public supported or provided by companies promoting solar energy.

Step 3

Simple financial calculation for investment in PV plant

Step 4

Results

Results on yearly basis

results	value	unit
solar electricity production		kWh
electrical demand/need		
direct own consumption without stor		
own production quota without storag		
degree of self-sufficiency without st		
used electricity for charging the syste		
own consumption with storage		
own production quota with storage		
degree of self-sufficiency with storag		
storage losses		
share of production in storage losses		
over production		
remaining power outlet		

Step 3 Simple financial calculation for investment in PV plant

Data from solar energy maps calculations
Data that should be entered for each case
Data that becomes more accurate if it comes from real calculations

		Annually
Savings	Estimated production from solar energy maps, kWh	
	Electricity not needed to buy, kWh	
	Price per kWh for purchased energy, €cents/kWh	
	Energy tax (is only payed for purchased energy), €cents/kWh	
	The netowners fee for transporting the electricity to you, €cents/kWh	
	VAT, €cents	
	Sum of saved fees and taxes, €cents/kWh	
	Payment for saved electricity from electricity certificate, €cents/kWh	
	Savings for one year, EUR	
Income	Sold ownd produced electricity, kWh	
	Tax deduction for sold electricity, €cents/kWh	
	Grid value (payment from grid owner for no transport of electricity) €cents/kWh	
	Payment for produced electricity from electricity certificate, €cents per kWh	
	Payment for sold electricity, €cents/kWh	
	Sum of payments and tax deductions for sold electricity, €cents/kWh	
	Income for one year, EUR	
	Total of savings and income one year, EUR	
stment	Area of PV plant, m^2	
	Efficiency	
	Size of PV plan, kWp (Area of PV plant, m^2 x efficiency)	
	Possible price adjustment due to higher efficiency (premium) solar cells	
	Rough price per kWp, including VAT and installation (15 000-21 000 kr/kWp)	

Required information for calculations?

EFFECT4buildings

1. Information needed for **energy production** calculations:

green cells may be changed

blue cells can not be changed

PV system	value	unit
installed effect	54,60	kW_p
production profile:	PV Sun south 30°	-
production first year	966,30	kWh/kW_p

Electricity use	value	unit
energy load profile	Office	-
yearly electricity need	142 000,00	kWh

Storage system	value	unit
Should battery storage system be included?	no	-

Results on yearly basis

results	**value**	**unit**
solar electricity production	47 370,82	kWh
electrical demand/need	142 000,00	kWh
direct own consumption without storage	38 517,20	kWh
own production quota without storage	81,31%	%
degree of self-sufficiency without storage	27,12%	%
used electricity for charging the system	N/A	kWh
own consumption with storage	N/A	kWh
own production quota with storage	N/A	%
degree of self-sufficiency with storage	N/A	%
storage losses	N/A	kWh
share of production in storage losses	N/A	%
over production	8 853,62	kWh
remaining power outlet	103 482,80	kWh

2. Information needed for **financial calculations**:

EFFECT4buildings

Savings

- Price per kWh for purchased energy, €centi/kWh
- Energy tax (is only payed for purchased energy), €centi/kWh
- The network fee for transporting the electricity to you, €centi/kWh
- VAT

Income

- Grid value (payment from grid owner for no transport of electricity), €cents/kWh
- Payment for produced electricity from electricity certificate, €centi per kWh
- Payment for sold electricity, €centi/kWh

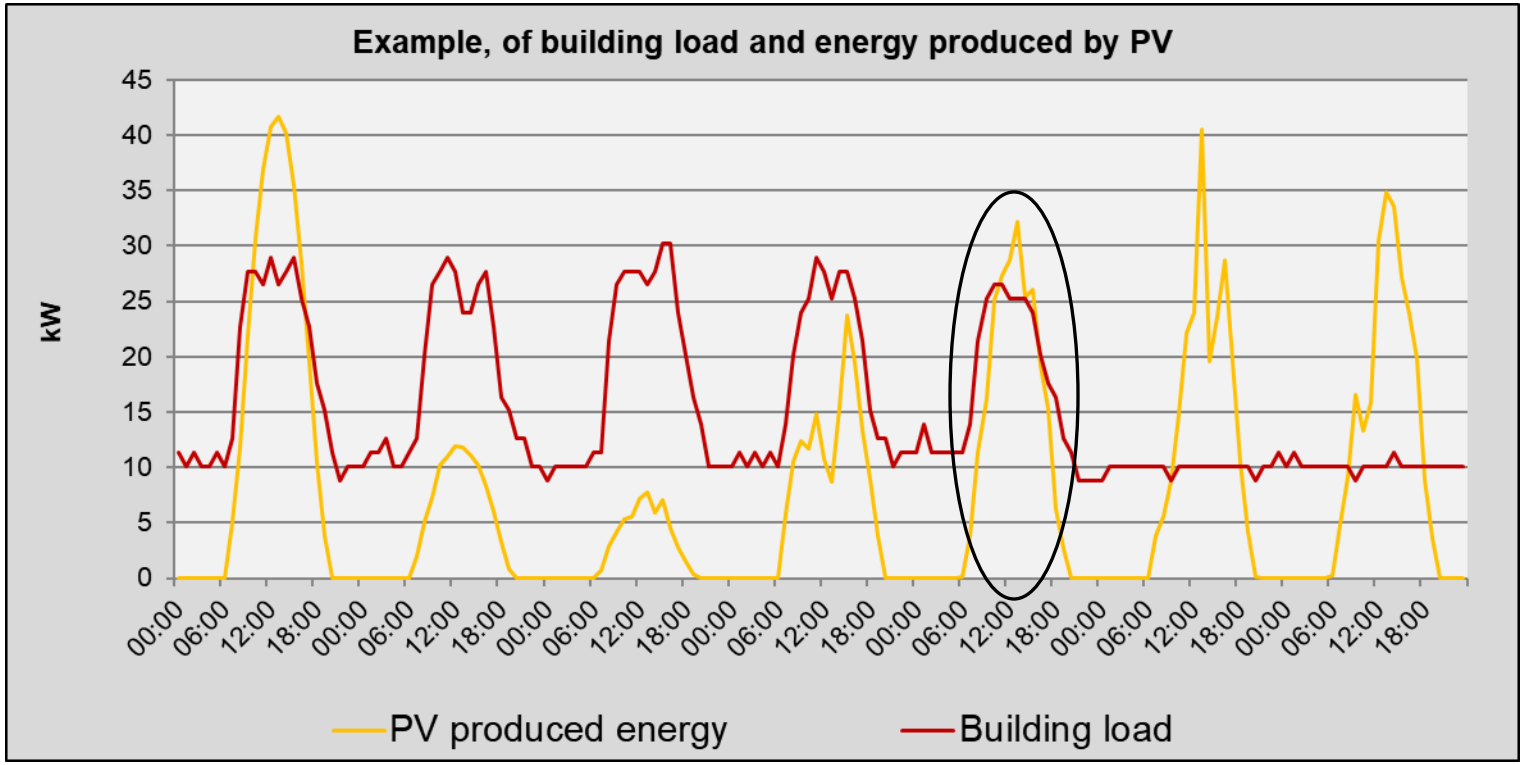
Investments

- Area of PV plant, m2
- Efficiency
- Rough price per kWp, inkluding VAT and installation (1400-2000 EUR/kWp)

Results

Savings (from less purchased energy, fees and taxes)	**5 933**
Income from sales (tax free for private persons)	**332**
Total of savings and income	**6 265**
Internal rate of return	**0,10**
Pay-back-time, year	**12,8**

How to determine the optimal size of the PV system?

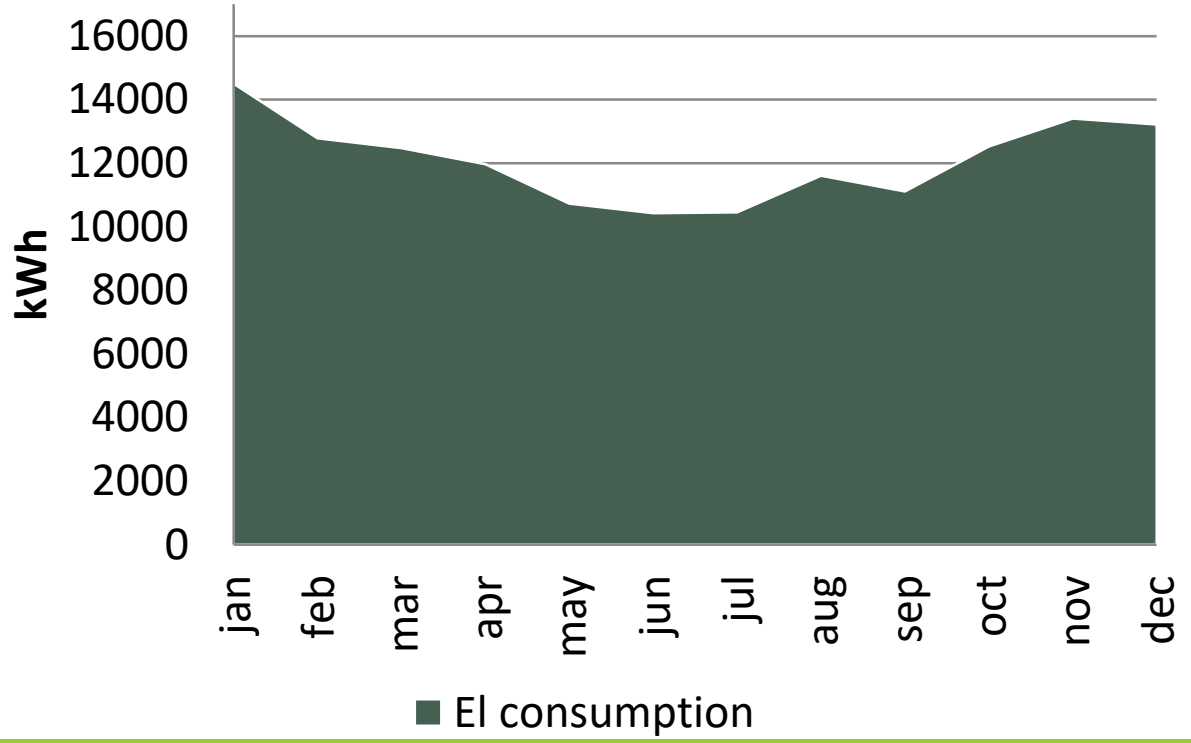


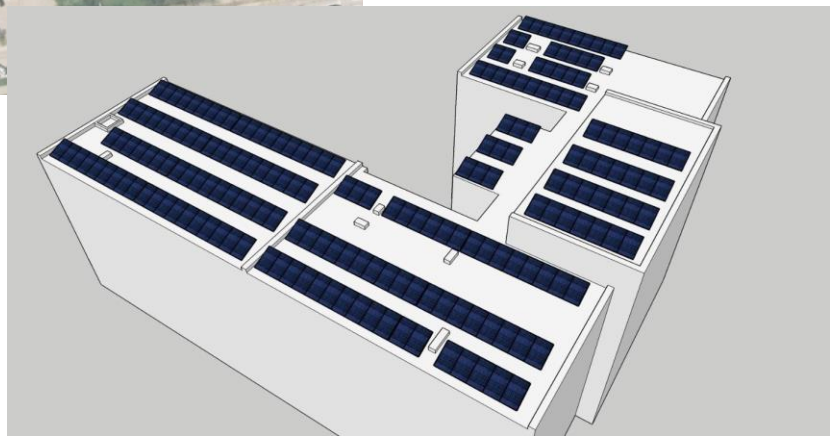
date	hour	own energy load profile (kWh)	own production profile (kWh/kWp)
01.01.2018	00:00		
01.01.2018	01:00		
01.01.2018	02:00		
01.01.2018	03:00		
01.01.2018	04:00		
01.01.2018	05:00		
01.01.2018	06:00		
01.01.2018	07:00		
01.01.2018	08:00		
01.01.2018	09:00		
01.01.2018	10:00		
01.01.2018	11:00		
01.01.2018	12:00		
01.01.2018	13:00		
01.01.2018	14:00		
01.01.2018	15:00		
01.01.2018	16:00		
01.01.2018	17:00		
01.01.2018	18:00		
01.01.2018	19:00		
01.01.2018	20:00		
01.01.2018	21:00		
01.01.2018	22:00		
01.01.2018	23:00		

Instructions | Step 1 Data input | Step 1 Own profiles | Step 1 Ener

Gulbene municipality pilot project (Example)

- City council building: 2249,7 m^2
- Electricity consumption in 2018: 145 MWh/year
- Roof size: 920 m^2





Assessment of energy produced using the EFFECT4building tool

Scenario No. 1

Data input

PV system	value	unit
installed effect	54,60	kW_p
production profile:	PV Sun south 30°	-

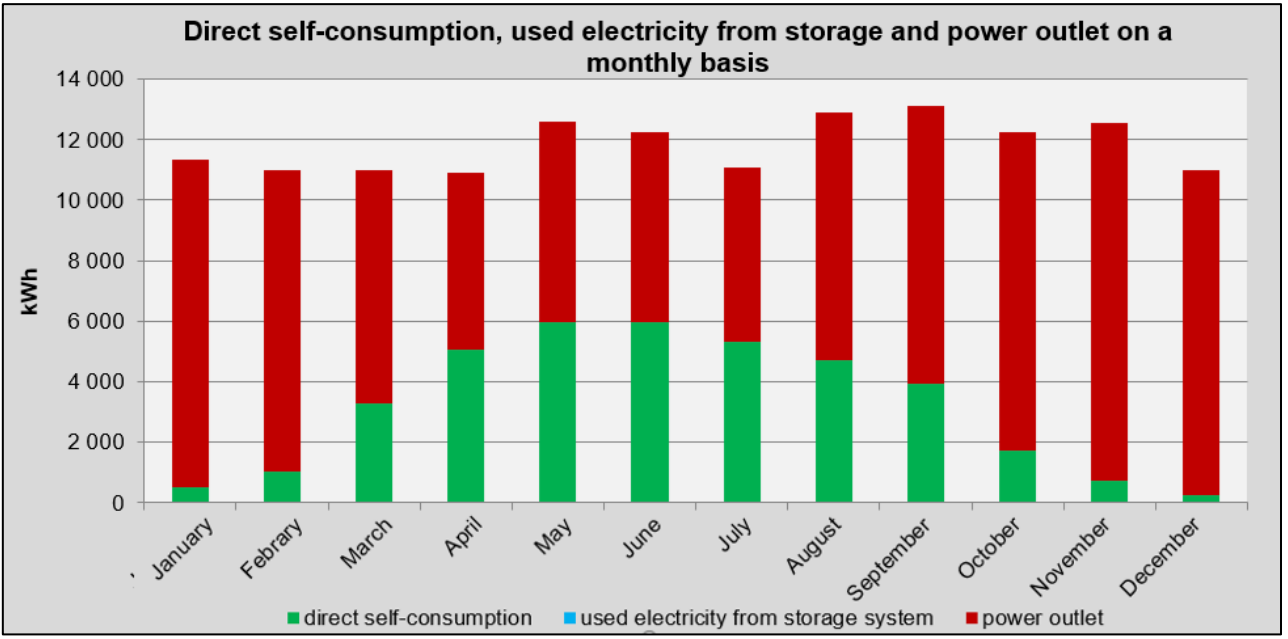
Electricity use	value	unit
energy load profile	Office	-
yearly electricity need	142 000,00	kWh

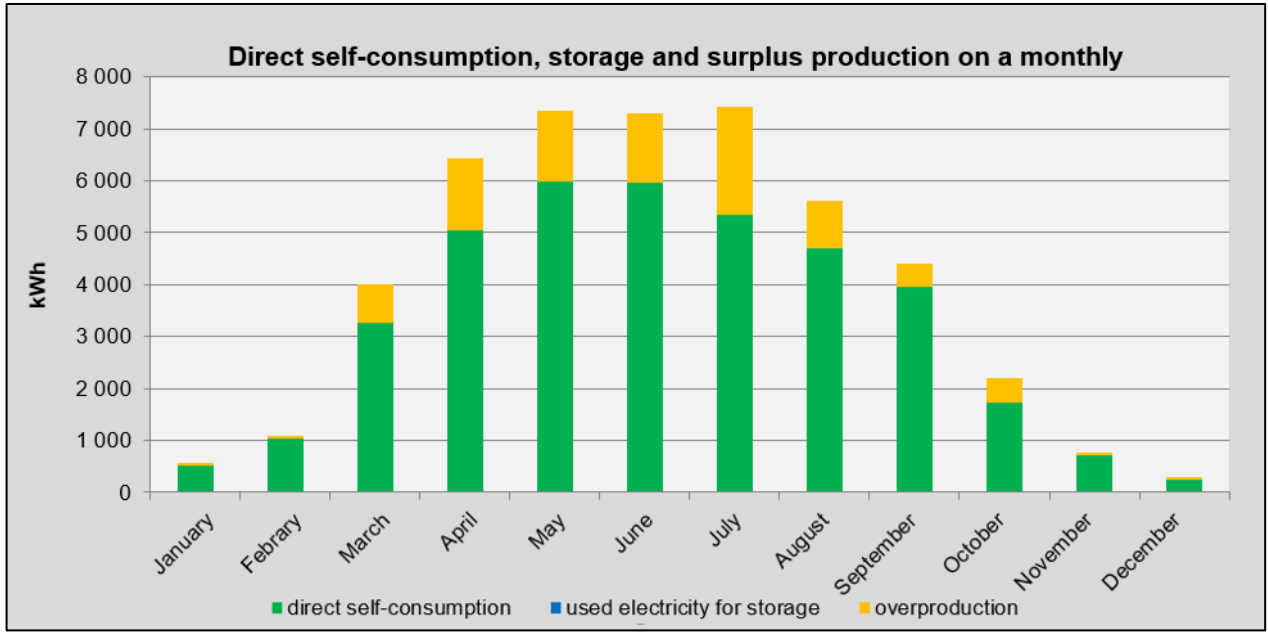
Storage system	value	unit
Should battery storage system be included?	no	-

Results

Results on yearly basis

results	value	unit
solar electricity production	47 370,82	kWh
electrical demand/need	142 000,00	kWh
direct own consumption without storage	38 517,20	kWh
own production quota without storage	81,31%	%
degree of self-sufficiency without storage	27,12%	%
used electricity for charging the system	N/A	kWh
own consumption with storage	N/A	kWh
own production quota with storage	N/A	%
degree of self-sufficiency with storage	N/A	%
storage losses	N/A	kWh
share of production in storage losses	N/A	%
over production	8 853,62	kWh
remaining power outlet	103 482,80	kWh


Direct self-consumption, used electricity from storage and power outlet on a monthly basis
kWh
14 000
12 000
10 000
8 000
6 000
4 000
2 000
0
January
Febrary
March
April
May
June
July
August
September
October
November
December
direct self-consumption
used electricity from storage system
power outlet


Direct self-consumption, storage and surplus production on a monthly
kWh
8 000
7 000
6 000
5 000
4 000
3 000
2 000
1 000
0
January
Febrary
March
April
May
June
July
August
September
October
November
December
direct self-consumption
used electricity for storage
overproduction

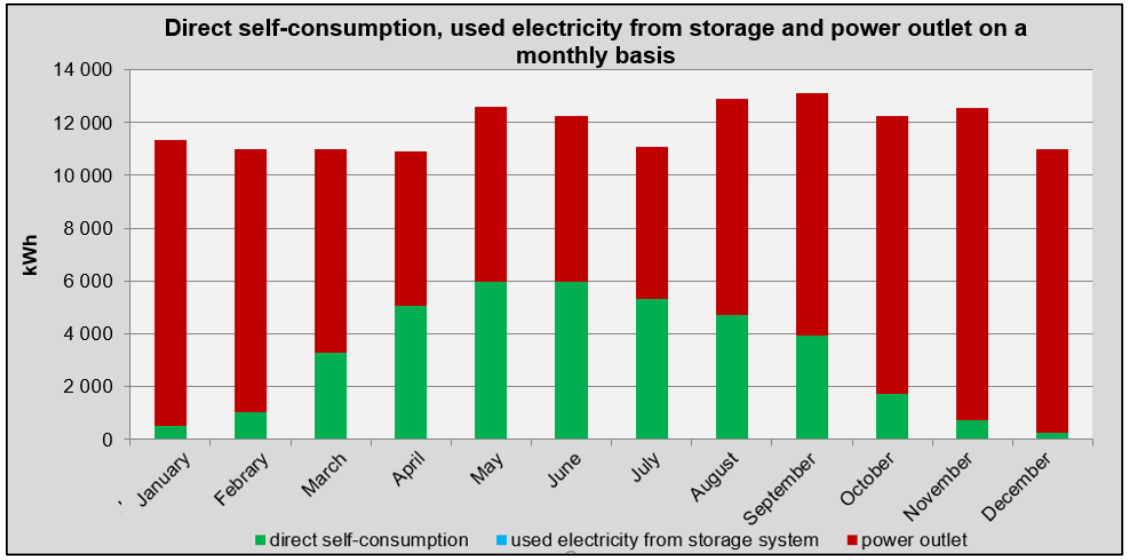
Scenario No. 2

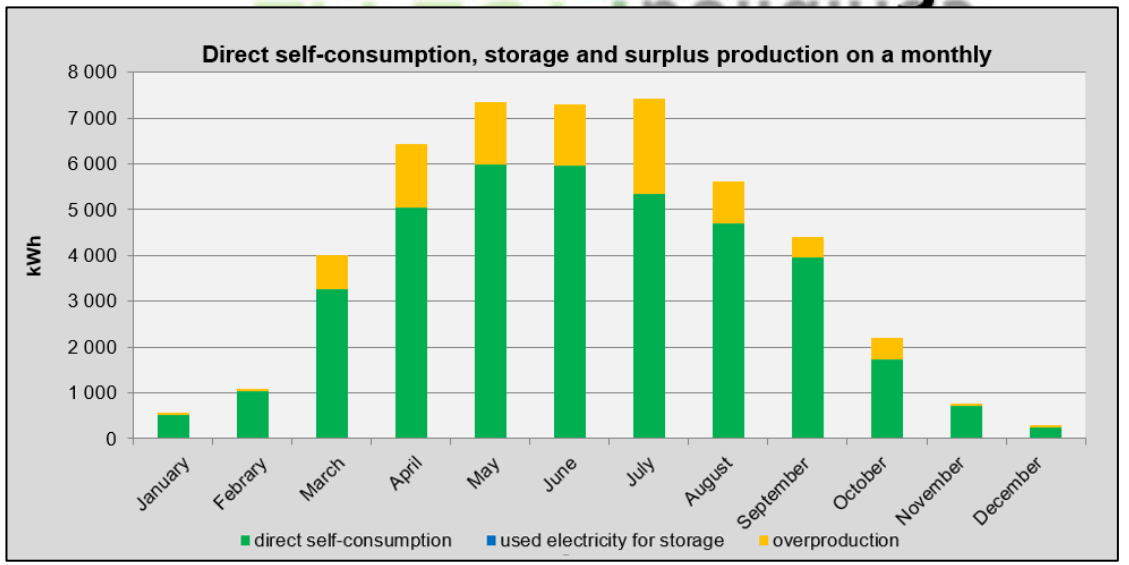
- introduces storage system

Storage system	value	unit
Should battery storage system be included?	yes	-
total capacity	94,5	kWh
DOD (*depth of discharge*)	100%	%
maximum power when charging	35,0	kW
maximum power output	35,0	kW
charging efficiency	95,0%	%
discharge efficiency	95,0%	%

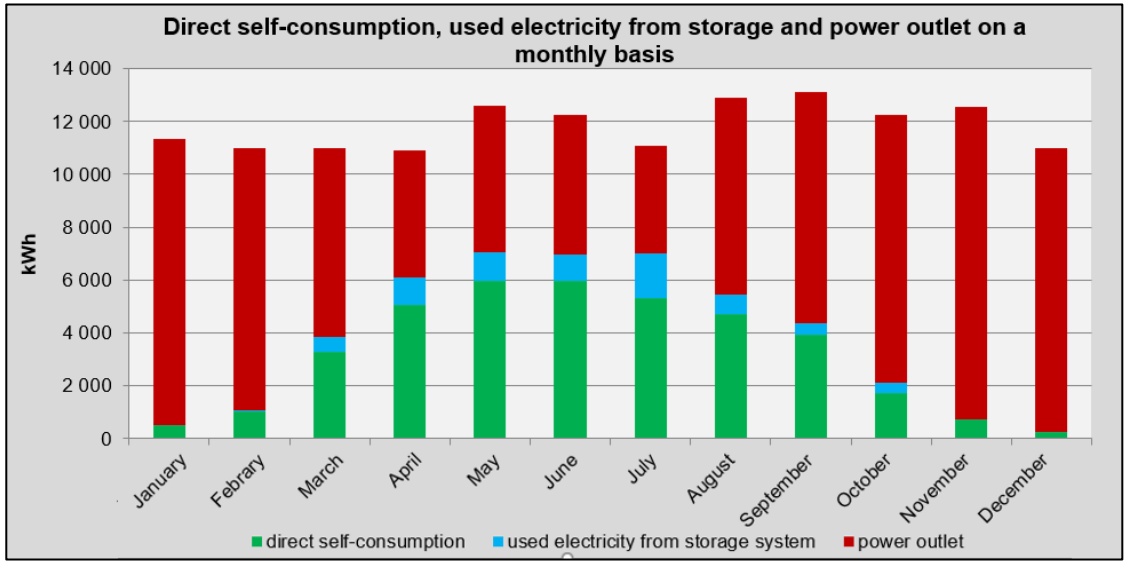
results	value	unit
solar electricity production	47 370,82	kWh
electrical demand/need	142 000,00	kWh
direct own consumption without storage	38 517,20	kWh
own production quota without storage	81,31%	%
degree of self-sufficiency without storage	27,12%	%
used electricity for charging the system	7 724,00	kWh
own consumption with storage	46 241,20	kWh
own production quota with storage	97,62%	%
degree of self-sufficiency with storage	32,03%	%
storage losses	753,09	kWh
share of production in storage losses	1,59%	%
over production	0,00	kWh
remaining power outlet	96 511,89	kWh

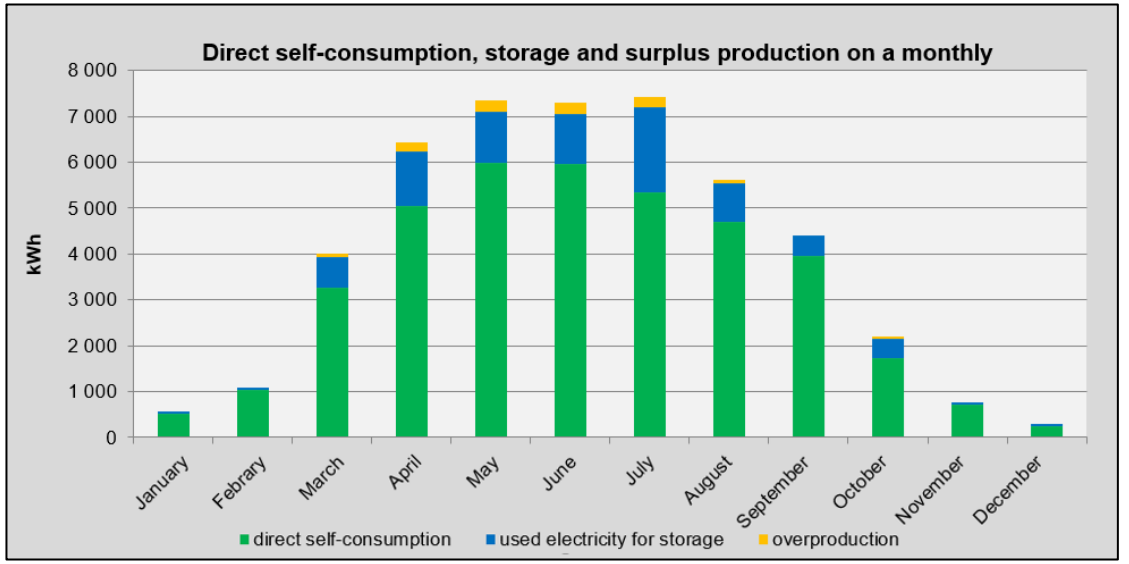
Without storage system





With storage system





Scenario No. 3

- increases system capacity

PV system	value	unit
installed effect	75,00	kW_p
production profile:	PV Sun south 30°	-

- System capacity: 75 kW_p
- Area of the system: 440 m^2

Results on yearly basis

results	value	unit
solar electricity production	65 069,81	kWh
electrical demand/need	142 000,00	kWh
direct own consumption without storage	44 904,67	kWh
own production quota without storage	69,01%	%
degree of self-sufficiency without storage	31,62%	%
used electricity for charging the system	N/A	kWh
own consumption with storage	N/A	kWh
own production quota with storage	N/A	%
degree of self-sufficiency with storage	N/A	%
storage losses	N/A	kWh
share of production in storage losses	N/A	%
over production	20 165,13	kWh
remaining power outlet	97 095,33	kWh

Scenario No. 4

- reducing system capacity

PV system	value	unit
installed effect	40,00	kW_p
production profile:	PV Sun south 30°	-

- System capacity: 40 kW_p
- Area of the system: 235 m^2

Results on yearly basis

results	value	unit
solar electricity production	34 703,90	kWh
electrical demand/need	142 000,00	kWh
direct own consumption without storage	31 514,67	kWh
own production quota without storage	90,81%	%
degree of self-sufficiency without storage	22,19%	%
used electricity for charging the system	N/A	kWh
own consumption with storage	N/A	kWh
own production quota with storage	N/A	%
degree of self-sufficiency with storage	N/A	%
storage losses	N/A	kWh
share of production in storage losses	N/A	%
over production	3 189,23	kWh
remaining power outlet	110 485,33	kWh

Scenario No. 5

- changes the orientation of the panels, thereby changing the production profile

PV system	value	unit
installed effect	54,60	kW_p
production profile:	PV Sun south 15°	-

- Production profile: «PV Sun south 15˚»
- System capacity : 54,6 kW_p
- Area of the system : 321 m^2

Results on yearly basis

results	value	unit
solar electricity production	43 633,88	kWh
electrical demand/need	142 000,00	kWh
direct own consumption without storage	37 150,56	kWh
own production quota without storage	85,14%	%
degree of self-sufficiency without storage	26,16%	%
used electricity for charging the system	N/A	kWh
own consumption with storage	N/A	kWh
own production quota with storage	N/A	%
degree of self-sufficiency with storage	N/A	%
storage losses	N/A	kWh
share of production in storage losses	N/A	%
over production	6 483,32	kWh
remaining power outlet	104 849,44	kWh

Financial calculations using the EFFECT4building tool

EFFECT4buildings

6		Data that should be entered for each case	
7		Data that becomes more accurate if it comes from real calculations	
8			Annually
9	Savings	Estimated production from solar energy maps, kWh	47 371
10		Electricity not needed to buy, kWh	38517
11		Price per kWh for purchased energy, EUR/kWh	6,00
12		Energy tax (is only payed for purchased energy), EUR/kWh	2,20
13		The netowners fee for transporting the electricity to you, EUR/kWh	4,53
14		VAT, EUR	2,7
15		Sum of saved fees and taxes, EUR/kWh	15,40
16		Payment for saved electricity from electricity certificate, EUR/kWh	0
17		**Savings for one year, EUR**	**5933**
18			
19	Income	Sold ownd produced electricity, kWh	8854
20		Tax deduction for sold electricity, EUR/kWh	
21		Grid value (payment from grid owner for no transport of electricity) EUR/kWh	
22		Payment for produced electricity from electricity certificate, EUR/kWh	
23		Payment for sold electricity, EUR/kWh	6,00

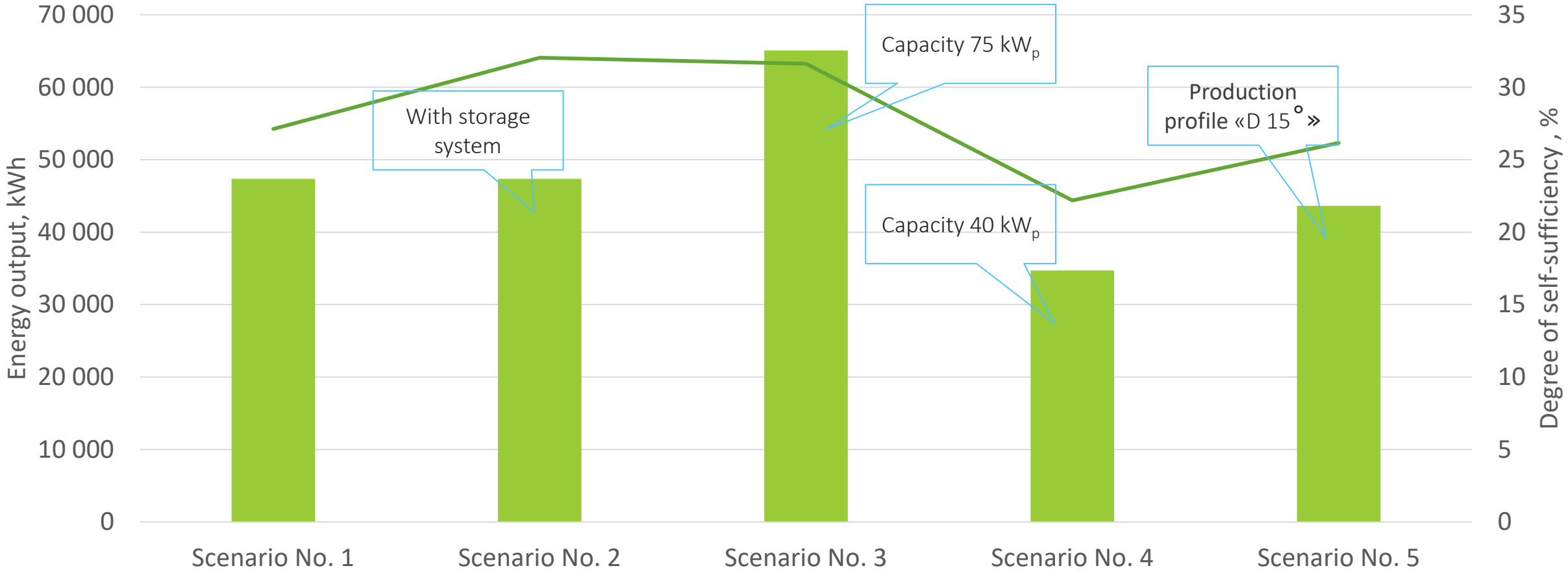
Results		
	Savings (from less purchased energy, fees and taxes)	**5932,9**
	Income from sales (tax free for private persons)	**531,2**
	Total of savings and income	**6464,1**
	Internal rate of return	**0,2**
	Pay-back-time, year	**6,2**

Comparison of the results of all scenarios

EFFECT4buildings

	Scenario No. 1	Scenario No. 2	Scenario No. 3	Scenario No. 4	Scenario No. 5	Scenario No. 6
Capacity [kW_p]	54,6	54,6	75	40	54,6	54,6
Area [m^2]	321	321	440	235	321	321
Production profile:	D 30°	D 30°	D 30°	D 30°	Di 15°	D 30°
Is there a storage system, if yes, its costs.	No	Yes, (4 780 EUR)	No	No	No	No
Solar electricity production [kWh]	47 371	47 371	65 069,81	34 704	43 633,88	47 371
Consumption [kWh]	38 517	46 241	44 904,67	31 515	37 150,56	38 517
Degree of self-sufficiency [%]	27,12	32,03	31,62	22,19	26,16	27,12
Total investment cost [EUR]	80217,9	80217,9	54 978	29 363,3	40109	40 108,95
Savings [EUR]	5 933	7122,7	6 917	4854	5 722	5 933
Income [EUR]	531	0	1 210	191	389	531
Financial aid,% of total costs	0	0	0	0	0	50
Internal rate of return	0,1	0,1	0,1	0,2	0,2	0,2
Pay-back-time [year]	12,4	12,6	15,9	11,6	13,2	6,2

Energy output and level of self-sufficiency for all scenarios



Pay-back-time [year]	12,4	12,6	15,9	11,6	13,2

PV panel procurement guidline

Procurement should include at least main requirements:

1. Purpose
2. Excisting conditions
3. Regulations
4. Power Quality (PQ)
5. Equipment for electricity production
6. Marking, testing and documentation
7. After final inspection

More available in EFFECT4buildings Prosumer guideline