Acqua POWER

by Energia Italia

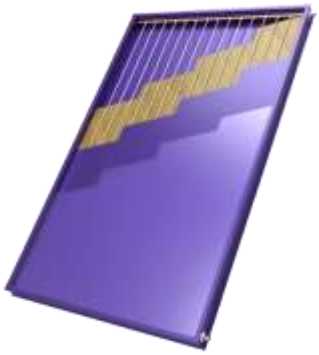
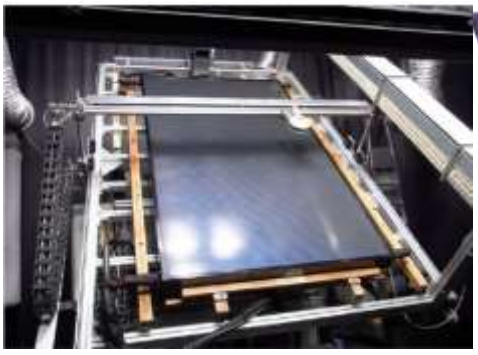
Full technical guide

Forced circulation closed loop solar systems

Standard supports








Contents

1 Introduction

There are 2 solar system function principals: Natural circulation and forced circulation.

Natural circulation system relies on gravity to circulate the hot water. When water is heated, it expands, it becomes lighter and rises. At the same time the cold water becomes denser, heavier and falls.

Forced circulation system relies to a circulation unit to circulate the thermal fluid.

Although at first sight seems simpler and more cost efficient a natural circulation system, at the long term a forced circulation system is actually more efficient in most circumstances. The main reason for this is that circulation is fully controllable when using a circulator, hence it can always be optimized. Several comparison studies have shown an efficiency increase 35 to 80%.

In many cases it is also the only solution, if someone considers that the tank can be located away or below the solar panels. In a natural circulation system, the tank must always be located higher and near the tank. Another drawback of the natural circulation loop is that it requires larger diameter piping and bigger heat exchange surface for similar heat gain.

The present handbook describes in detail our product solution for domestic hot water production and central heating, with a fully equipped forced circulation closed loop solar thermal system with optional backup heat generation with electric heating element. Closed loop means that sanitary water is in a separate circuit from the solar loop, as a result there is no mixing of thermal fluid and sanitary water.

2 Packing

A forced circulation system consists of:

1. One or more floor standing hot water storage tanks. The tanks are packed in cardboard boxes or polystyrene and stretch film. Depending on the size, they are packed separately on pallets or with the rest parts of the solar system.
2. One or more flat plate solar collectors. They are packed in cardboard or with stretch film, carton on glass surface and hard polystyrene on the corners. They can be packed on a pallet with the rest parts of the solar system, or separately.
3. One or more collector support structures. They are packed in cardboard boxes or polystyrene and stretch film.
4. Loop accessories kit. The kit contains pump station, control unit, hydraulic fittings for the collectors and expansion vessel with mounting bracket. (tubing is not included).

3 Transport, storing and handling



The boilers could be packed in stretch film packing where they must remain during all transportations and storage.
Collectors are packed in cardboard or with LDPE heat shrink film, carton on glass surface and hard polystyrene on the corners
Palletizing of collectors: Collectors are packed on special pallets in vertical position. Upon request special pallets for horizontal packaging are available.

Support structures are packed in LDPE heat shrink film. Inside the support are the connection accessories in cardboard box and the insulated tubes. Store both parts in dry place and unpack them only before installation.
Connections accessories are packed in cardboard boxes that must be transported and stored in vertical position according to the arrow direction on the box as they include the thermal fluid. They must be stored in dry places and put maximum 5 boxes in vertical position the one over the other when they are stored. The antifreeze liquid are packed in cardboard boxes.

4 Warranty

Manufacturer offers for forced circulation solar water heaters the following warranty:

- For the solar collectors ten (10) years.
- For the accumulator five (5) years.
- For the support structure five (5) years.
- For the electric heating element / solar pump station / controller / expansion vessel two (2) years.

5 Important information:

The safety of the installer / user, the proper function of the equipment and the warranty is guaranteed only when the following are valid:

- ⚠ The preparation, installation and commissioning must be performed by an authorized installer / service.
- ⚠ No changes to original components are made. Manufacturer carries no responsibility in case of use of non-original parts.
- ⚠ Installer / user are following the exact directions provided in this guide and the complementary guides also included. It's the user's / installer's sole responsibility for any loss or damage caused by improper or inadvertent use of the equipment.

⚠ Installer / user are complying with local norms and legislations.
⚠ Water temperatures above 52°C (126°F) can cause severe burns or death from scalding.

ATTENTION: Houses hosting small children, disabled, or elderly persons may require a 49°C (120°F) setting the thermostatic mixing valve to protect them and prevent contact with higher temperature water.

⚠ Maintenance and / or repair must only be carried out by authorized installer / service.
⚠ Safety devices are designed to eliminate risk of:

- Injury of persons and animals.
- Damage of the equipment.

Their removal or improper use may subject to their intended function failure.

⚠ **Startup:** During first operation please watch out for possible leaks in the circuit. In case of leakage from the tank cut-off the power and water supply.
⚠ The technical specifications of the equipment can be changed without prior notice.

5.1 System operation limits

- The pressure in the collector loop should be within 0.1÷5 bar (1.5÷72 psi), depending on installation.
- The pressure in the potable system should be within 2÷6 bar (29÷87 psi).
- The temperature of the water in the solar tank should be within 10÷99°C (50÷210°F).

Upper limits are maximum working pressures and temperatures. Upper limits are not the recommended normal working pressures and temperatures.

5.2 Safe operation

5.2.1 Hot water loop

Hot water loop main parts safe operation accessories	
	**Safety relief valve** regulated to 8 bars (116 psi) protects the sanitary water circuit against the risks of overpressure due to irregular overpressure in the urban water network or to overpressure created inside the tank due to high temperature (standard part).
	**Thermostatic mixing valve.** The systems produce hot water with temperature higher than 55˚C. Especially during summer months the temperature can reach very high level (near 95˚C) that can cause serious injuries or death in case of contact with human or animal body. For this reason, the use of thermostatic mixing valve is strongly suggested (optional part).
	**Non return valve.** Used for allowing only one direction for the supply, from the supply network to the tank (optional part).
	**Expansion Vessel** pre-charged to 2**/**3.5 bars (29/50 psi) protects the consumption network by limiting its pressure to the desired limits (optional part).
	**Pressure regulator.** Reduces and stabilizes the water pressure at the set level. Suggested to be set to no more than 4 bar (optional part).

5.2.2 Solar forced loop

Solar forced loop safe operation accessories	
	**Safety relief valve.** Regulated to 6 bars (87 psi) protects the closed loop circuit against the risks of overpressure created inside the loop due to high temperature of circulating thermal fluid or due to stagnation temperatures (standard part).
	**Expansion Vessel.** Pre-charged to 2.5 bars (36 psi) protects the closed loop by limiting its pressure to the desired limits. Protects both from overpressure and over heating (standard part).
	**Non return valve.** Used for allowing only one direction of the thermal fluid. Integrated in the pump station, or separate in on standard forced loops
	**Automatic air vent with shut-off cock**. Max discharge pressure 2.5 bar. Used to release air contained in the solar loop. Used only during filling or flushing (standard part).
	**Air separator- deaerator.** Operates similar but manually with the air vent. Integrated in the solar pump station, or separate in on standard forced loops

5.2.3 Valve draining

Safety relief valves have a provision to drain an amount of drinking water as a protection against overpressure. The hot water drain shall be constructed in such a way that no damage is done to the system or any other materials in the building, or to humans by the drained hot water (see also diagram in page 8, §2.14).

Any pressure relief valves from which steam can escape during normal or stagnation conditions shall be mounted, in such a way that no injuries, harm or damage can be caused by the escape of steam. For this reason, a relief pipe has to be installed with continuous inclination on all exits of valves. It can maximally include 2 bends and have a length of 2 meters. When a length exceeding 2m is necessary, the pipe must be one size larger. **Caution:** more than 3 bends and a length exceeding 4 meters are not admissible. The outlet of the relief pipe must be free from obstruction, controllable and positioned in such a way that persons are not endangered by steam relief. When the relief pipe ends over a tundish, it is indispensable that its drain pipe has at least the double cross section of the valve inlet. Free access to the pressure relief valve must be provided. Thoroughly flush the relief pipes prior to installation.All fittings, copper and stainless steel hoses used for the connections of close circuit of the solar systems have maximum working temperature 200°C and maximum working pressure 15bars.

5.2.4 Blow-off lines

The system shall be equipped with blow off pipes to avoid danger for the user. The blow-off shall be laid in such a way they cannot freeze up and that no water can accumulate in them. The orifices of the blow-off pipes shall be arranged in such way that any steam or heat transfer medium issuing from the safety valves does not cause any risk for people, materials or environment.

5.2.5 Pressure control in domestic hot water network

During the function of the Solar Flame solar water heating system the water is heated and expanded. It is recommended to install a potable water expansion tank, to the piping between the solar tank and any check valves or backflow preventers (safety non-return valve) that are installed

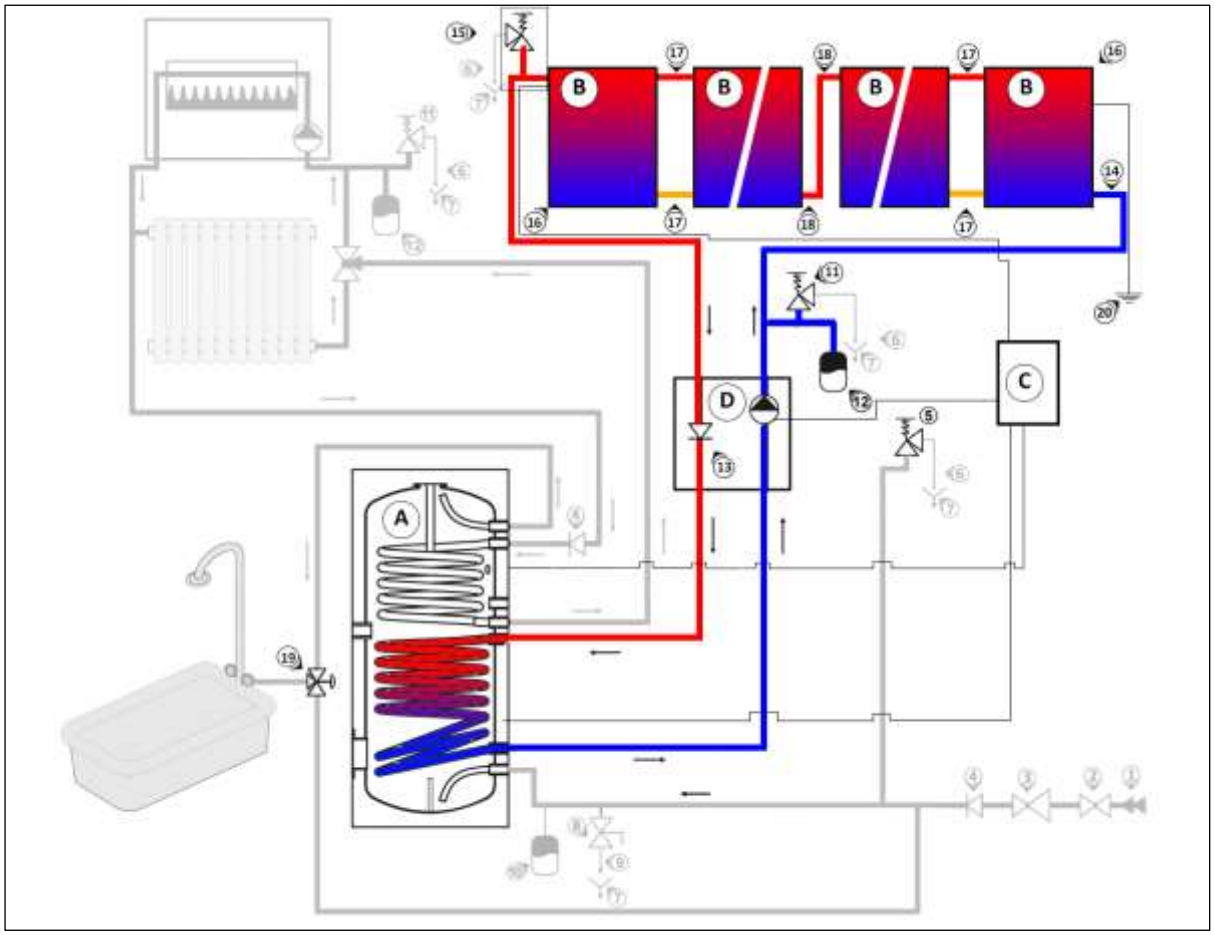
in the system. The potable water expansion tank shall be sized, charged and installed as required for the system pressure, the size of the solar tank and volume of water at the location.

It is advisable to determine the water pressure in the building using a pressure gage. The expansion tank's air chamber should be pre-charged to the same pressure as the building's water pressure. The city water supply network pressure must be between 2 and 5 bars (30 and 72.5 psi / 200 and 500 kPa). If the water pressure in the building network is above 6 bars (87 psi / 600kPa), it is absolutely necessary to install a pressure reducing valve on the incoming water supply pipe of the building.

5.2.6 Lightning protection

Use a copper wire 16 mm² to connect the collectors (metal parts) with lightning protection system if existing. Otherwise ground them to an earth rod using wire of the same size. The route of this wire should be always outdoors. All protection measures are according to standard IEC 61024-1.

6 General layout



A. Water tank	5. Safety valve	13. Non return valve
B. Collectors	6. Blow off pipe	14. Collector inlet
C. Control unit	7. Water drainage	15. Collector outlet w. air vent
D. Solar pump station	8. Drain cock	16. Collectors plug
1. City network	9. Hose	17. Parallel connection
2. Main tap	10. Potable water expansion vessel	18. Series connection
3. Pressure regulator	11. Closed loop relief valve	19. Thermostatic mixing valve
4. Non return valve	12. Closed loop expansion vessel	20. Ground

*Greyed out parts and closed loop piping not included in the standard kits. Piping also not included.

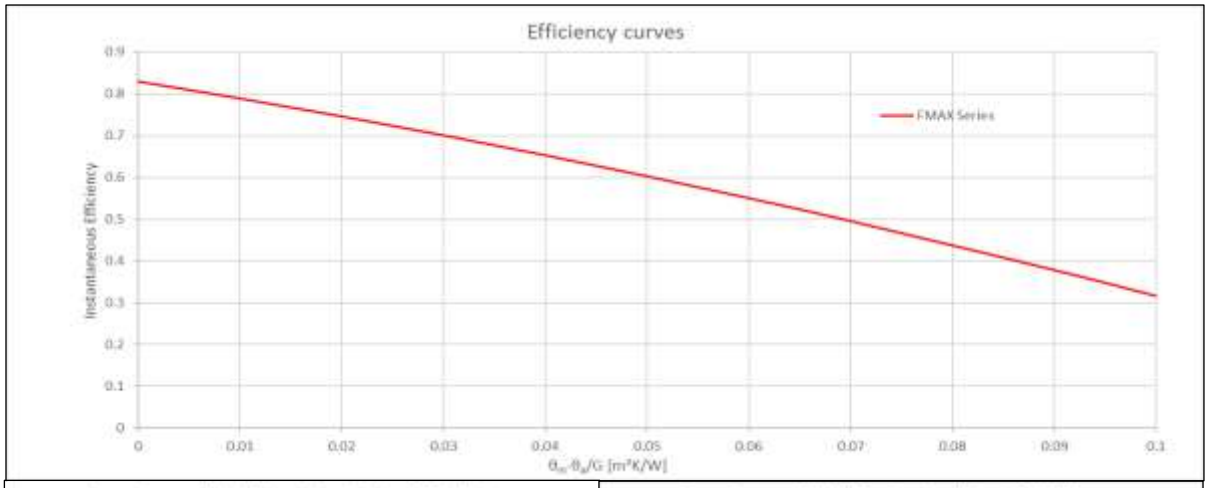
7 The Collectors

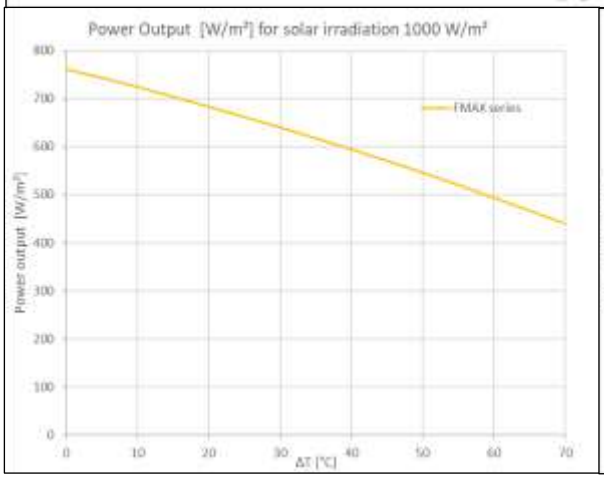
7.1 General description

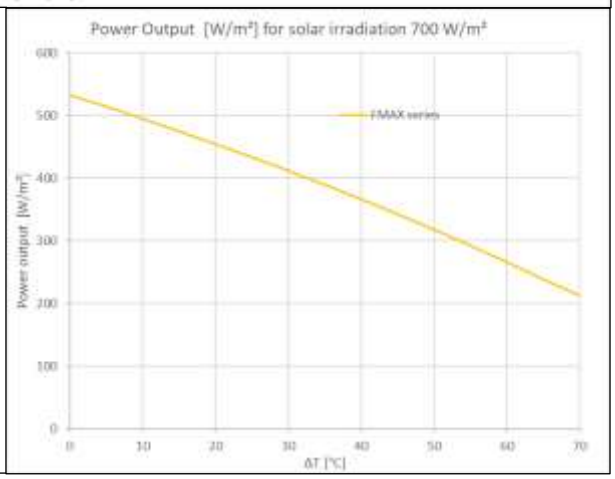
1. **Frame of the collector:** Aluminium profile powder coated for maximum protection in seaside areas.
2. **Absorbing surface:** Aluminum surface with blue titanium high selective treatment with high absorbance and low emission (α=95%, ε=4%), laser welded on the copper water frame.
3. **Transparent cover:** Security-Tempered prismatic solar glass for maximum protection against extreme weather conditions and temperature changes.
4. **Water frame:** Copper tubes Ø22, welded to the vertical tubes or serpentine (meander) tube with hard silver solder. Each water frame is tested at the pressure of 15 bars. The vertical risers or the serpentine is copper in diameter ø8mm.
5. **Thermal insulation:** Prepressed mineral wool special for solar panels for minimum thermal loss.
6. **Back cover:** Aluzinc 0,4mm thick. Great mechanical strength and 7 times more resisted to corrosion than common galvanized steel.
7. **Sealing materials:** For perfect waterproof finish and proper ventilation of collectors casing, all materials used (EPDM, polyurethane sealant) resist to extreme weather conditions and temperature changes.

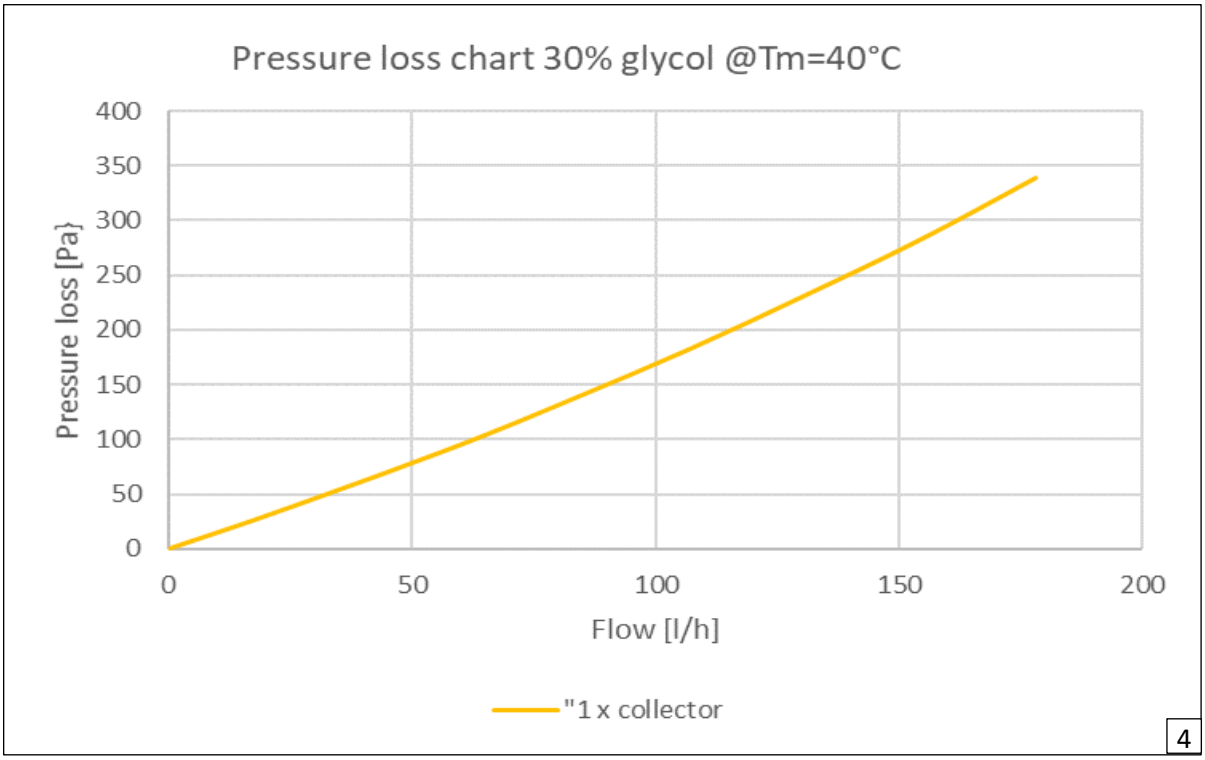
AS SERIES COLLECTORS TECHNICAL DATA / SPECIFICATIONS						
Model	**2.00 V**	**2.00 H**	**2.37 V**	**2.37 H**	**2.72 V**	**2.72 H**
Gross area [m²]	2.00	2.00	2.37	2.37	2.72	2.72
Dimensions [mm]	L:1980 W:1010H:86	L:1010 W:1980H:86	L:1930 W:1230H:86	L:1230 W:1930H:86	L:2160 W:1260H:86	L:1260 W:2160H:86
Weight empty [kg]	36.20	36.60	43.00	44.00	48.00	49.60
Max. operating Pressure [bar]	10					
Thermal Liquid Capacity [lt]	1.42	2.05	1.70	2.16	1.85	2.35
Glass-Thickness	LOW IRON TEMPERED GLASS 3.2mm					
Insulation	40mm-50kg/m³ MINERAL WOOL, λ=0.035 [W/(mK)]					
Casing Material	ALUMINUM POWDER COATED					
Sealing Materials	POLYURETHANE - SILICON - EPDM					
Absorber Area [m²]	1.86	1.86	2.23	2.23	2.57	2.57
Absorber Material-	ALUMINUM / PVD COATING / HIGH SELECTIVE – A=0.95±0.02 / e=0.05±0.02					
Heat transfer Medium	PROPYLENE GLYCOL + WATER MIXTURE					
	EFFICIENCY VALUES BASED ON EN12975 STANDARD		**EFFICIENCY VALUES BASED ON EN ISO 9806:2013 STANDARD (BASED ON GROSS AREA)**			
Efficiency η_0	0,83		For the AS family: 0.761		For the AS 2.72: 0.774	
Thermal loss a_1 [w/(m²K)]	3,93		For the AS family: 3.60		For the AS 2.72: 3.16	
IAM (K_θ at 50°)	0.96		0.96		0.96	
Thermal loss a_2 (w/(m²K²)	0.015		For the AS family: 0.014		For the AS 2.72: 0.012	
Stagnation temp. [°C]	-		190.5		190.5	
η_{col}	-		For the AS family: 59%		For the AS 2.72: 63%	

7.2 Useful curves of the collectors









4

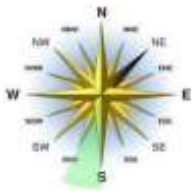
7.3 Output of the collectors

The following table represents the collectors' yield in kWh for each square meter of collectors' surface for 38 cities around Italy. The calculations are made according to ISO9806:2013 standard based on AS family (SOLAR KEYMARK Licence Nr. SKM9999-1).

Collectors' output per square meter table 1																	
Country	City / Orientation		Tilt	Collector Yield [kWh/m²] at Tm=50°C for several cities around the world													
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
GREECE	Athens	S	35°	45	44	55	76	95	105	118	123	105	77	49	35	928
	Thessaloniki	S	45°	29	53	65	72	92	104	109	114	97	67	45	29	876
	Heraklio	S	35°	59	55	106	100	124	136	146	148	124	106	63	48	1216
CROATIA	Zagreb	S	45°	20	29	48	52	81	79	88	86	54	42	20	9	608
ROMANIA	Bucharest	S	45°	25	44	64	69	85	92	103	104	78	60	29	19	771
ITALY	Milan	S	45°	18	34	49	64	72	81	94	92	65	42	23	18	650
	Rome	S	45°	50	51	78	80	91	97	112	115	100	83	54	40	952
	Palermo	S	35°	53	56	82	92	109	115	125	126	102	88	62	45	1052
GERMANY	Hamburg	S	45°	13	11	30	53	66	58	68	61	52	31	15	8	467
	Berlin	S	45°	14	18	35	64	69	72	74	76	55	36	15	8	537
	Frankfurt	S	45°	16	15	35	68	62	68	70	63	55	30	11	5	498
FRANCE	Paris	S	45°	16	19	35	56	61	67	71	67	59	41	18	11	521
	Nice	S	45°	52	60	75	77	88	98	110	108	90	69	54	46	930
SPAIN	Barcelona	S	45°	70	72	88	87	84	85	102	100	90	79	61	45	963
	Madrid	S	45°	52	64	85	86	89	100	118	119	106	75	58	42	994
	Seville	S	35°	69	66	98	87	107	113	131	124	114	101	55	55	1120
MOROCCO	Casablanca	S	35°	84	76	108	103	106	102	108	113	110	96	99	61	1168
ALGERIA	Algiers	S	35°	78	71	91	90	100	112	130	121	106	108	102	79	1191
TUNISIA	Tunis	S	28°	46	56	80	93	112	120	136	127	99	79	57	46	1053
EGYPT	Cairo	S	28°	60	66	97	110	120	119	127	126	118	103	75	62	1183
KENYA	Nairobi	W	28°	128	117	127	190	74	223	63	79	122	105	87	135	1450
NIGERIA	Benin City	W	28°	107	83	93	93	94	79	60	58	76	74	86	79	982
MADAGASKAR	Antananarivo	N	28°	81	77	88	94	92	86	85	104	114	103	87	80	1090
SOUTH AFRICA	Cape Town	N	35°	132	120	124	112	80	64	68	73	93	109	120	130	1224
ISRAEL	Tel Aviv	S	35°	68	76	103	108	119	122	130	137	133	121	91	65	1274
CYPRUS	Nicosia	S	35°	60	59	87	92	102	110	116	116	114	100	74	57	1087
UAE	Dubai	S	28°	89	86	102	115	127	119	119	123	122	121	105	85	1313
NEW ZEALAND	Auckland	N	28°	101	88	88	69	43	31	42	53	57	78	84	96	829
AUSTRALIA	Sydney	N	28°	109	95	95	89	71	53	54	68	77	91	88	101	990
	Melbourne	N	28°	104	91	92	66	39	33	38	50	65	82	90	99	849
	Townsville	N	28°	107	104	114	132	127	197	169	154	160	150	128	124	1665
INDIA	New Delhi	S	35°	97	111	133	130	125	105	85	88	110	130	112	106	1333
USA	Maiami	S	28°	81	81	101	101	91	80	96	93	91	91	75	73	1054
	Los Angeles	S	28°	60	60	90	97	99	103	120	121	106	93	79	69	1097
	Honolulu	S	28°	93	82	97	95	95	90	97	111	107	107	93	89	1157
	New York	S	45°	40	41	57	69	75	76	81	93	77	86	39	35	770
CHILE	Arica	N	28°	118	99	97	69	52	37	38	51	68	94	109	113	944
	Santiago	N	28°	127	111	100	72	47	28	48	48	71	92	111	122	976

For cities located around the area of these 6 cities, the data can be used with good approximation for field sizing calculations. In any other case, please select a city listed in the table above with similar latitude with the city of the project and take the values from that city.

7.4 Collector's orientation



For the northern hemisphere the optimized orientation is the geographic South. In many cases, especially for domestic hot water production in households, it is often preferred to face up to south-south-west (green range), due to more useful energy for load peaks later in the day. Outside this range the efficiency would drop accordingly and significantly. In the case of 2 fields, the preferred arrangement is one field facing east and the other field west. Approaching the equator it seems better to turn West-south-west and for the Southern hemisphere, starting from the equator West-north-west and then North.

7.5 Collector shading

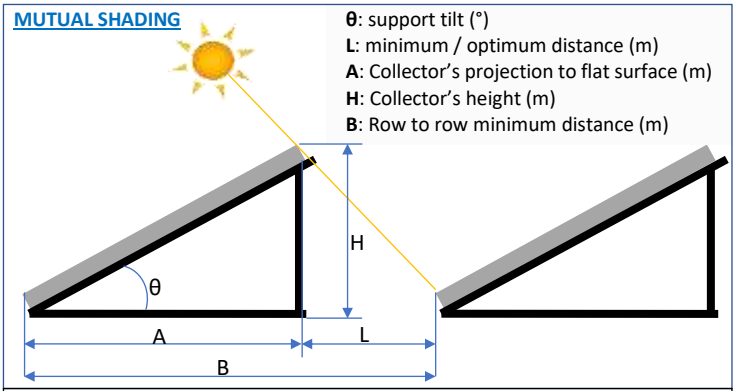
Mutual spacing between collectors as well as shading by obstacles must be avoided. For collector's tilt 28°-35°-45° (the standard tilts of the provided supports) please study next tables. 2 different options are presented, i) the minimum distance (**L_{min}**) between 2 collector rows in order to achieve at least 4 hours of unshaded exposure and ii) the optimum distance (L_{opt}) between 2 collector rows in order to achieve the minimum shading throughout the year with less than 5% total field loss. A similar approach for obstacle shading is also presented.

Minimum & optimized row distance for multi-row collector fields

		Col.	L_{min} [m]	L_{opt} [m]		Col.	L_{min} [m]	L_{opt} [m]		Col.	L_{min} [m]	L_{opt} [m]
Support tilt 28°	Latitude 25°-35°	200V	1.40	1.65	Support tilt 35°	200V	1.70	2.00	Support tilt 45°	200V	2.10	2.65
		200H	0.70	0.85		200H	0.85	1.05		200H	1.05	1.40
		237V	1.35	1.60		237V	1.65	1.95		237V	2.05	2.60
		237H	0.85	1.05		237H	1.05	1.30		237H	1.30	1.70
		272V	1.50	1.85		272V	1.85	2.25		272V	2.30	2.90
		272H	0.90	1.05		272H	1.10	1.30		272H	1.35	1.70
	Latitude 36°-45°	200V	1.85	2.15		200V	2.25	2.70		200V	2.80	3.50
		200H	0.95	1.20		200H	1.15	1.40		200H	1.45	1.80
		237V	1.80	2.10		237V	2.20	2.65		237V	2.75	3.45
		237H	1.15	1.45		237H	1.40	1.70		237H	1.75	2.25
		272V	2.05	2.45		272V	2.50	2.95		272V	3.05	3.90
		272H	1.20	1.45		272H	1.45	1.70		272H	1.80	2.25
	Latitude 46°-50°	200V	2.10	-		200V	2.80	-		200V	3.50	5.05
		200H	1.05	-		200H	1.45	-		200H	1.80	2.70
		237V	2.05	-		237V	2.75	-		237V	3.40	5.00
		237H	1.30	-		237H	1.75	-		237H	2.15	3.20
		272V	2.30	-		272V	3.05	-		272V	3.80	5.50
		272H	1.35	-		272H	1.80	-		272H	2.25	3.20

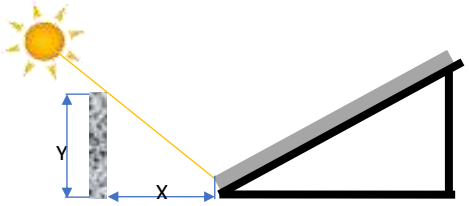
MUTUAL SHADING

θ: support tilt (°)
L: minimum / optimum distance (m)
A: Collector's projection to flat surface (m)
H: Collector's height (m)
B: Row to row minimum distance (m)



OBSTACLE SHADING

Minimum distance
Lat. 25°-35° : X ≥ 1.50Y
Lat. 36°-45° : X ≥ 2.00Y
Lat. 46-°50° : X ≥ 2.50Y
Optimum distance
Lat. 25°-35° : X= 1.75Y
Lat. 36°-45° : X= 2.30Y
Lat. 46-°50° : X= 3.60Y



Useful dimensions

	Col.	A (m)	H (m)
Support tilt 28°	200V	1.75	0.93
	200H	0.89	0.47
	237V	1.70	0.91
	237H	1.09	0.58
	272V	1.91	1.01
	272H	1.11	0.59
Support tilt 35°	200V	1.62	1.14
	200H	0.83	0.58
	237V	1.58	1.11
	237H	1.01	0.71
	272V	1.77	1.24
	272H	1.03	0.72
Support tilt 45°	200V	1.40	1.40
	200H	0.71	0.71
	237V	1.36	1.36
	237H	0.87	0.87
	272V	1.53	1.53
	272H	0.89	0.89

7.6 Field sizing example

In this chapter a simple approach for the solar field dimensioning is presented. Please study the next list of assumptions:

1. **The purpose of a solar field** is not to cover 100% of the heating demand, but only a considerable amount of it, in order to operate efficiently and trouble-free throughout the year. The daily consumption profile cannot always work in favor of a solar power source. For example, in many cases most of the demand occurs during evening or early in the night. In other cases, hot water is needed mostly during noon etc. An additional conventional heat source is necessary, to cover the desired heat demand, especially during colder months. A simple approach for the solar field sizing could be to calculate the demand during the hottest month and make the calculations in order the solar field alone to cover that demand and heat losses. This way it is achieved a safer operation of the solar system, because overheating is almost avoided. If the demand has a seasonal profile (for example Winter only demand or summer only demand), then a good practice is to calculate the maximum demand of this period and calculate the solar gain to cover this demand and heat losses during this season's hottest month.
2. **The actual demand** is not in the purpose of this manual to be determined. It is up to the engineer to take the correct decision, because it varies concerning mostly location, application, and a series of other factors. Peak demand is also important, but it should be covered by conventional heat sources.
3. **The capacity of the heater tank** is another important factor. In many cases it is calculated to be of volume 1-1.2 times the daily consumption of hot water. Depending heavily on the application and the consumption profile, this factor can go up to 2.
4. **Thermal losses** cannot be neglected. It is estimated that an average ratio of heat losses in well-insulated piping and tank is between 15-25% for a temperature difference between ambient and hot medium at 45°C. The same goes to the recirculation too, if there is recirculation, losses may go up to 30%. Again, these values are rough estimations (factors like piping length of both solar field and consumption water as well as tube insulation thickness and off course location's climate, vary significantly and they are influencing losses considerably), it is strongly suggested these calculations to be made by the specialized engineer for each individual project.
5. **Legionella** must be also taken into account, for the case of domestic hot water, but the measures of avoidance must be connected with the addition of a conventional heat source and the correct handling by the main controller unit. Nevertheless, an acceptable temperature to avoid growth of bacteria is 60°C. This will be the set temperature inside the tank for the calculations below.
6. **Tm** of the collector is optimally taken as 50°C from **table 4.**
7. **The demanded temperature rise** is depending on the initial temperature that will be taken to be **20°C** and on the set temperature. That desired temperature in terms of demand is usually around 50°C, but the temperature inside the tank could be higher. Taken into account the legionella avoidance, the desired temperature inside the tank will be taken to be **60°C**.

The general equation for the thermal energy calculations will be: $$\boldsymbol{Q_{tot} = Q_d + Q_L}$$ **[1]**

Where $\boldsymbol{Q_d}$ is the daily heat demand free of losses, $\boldsymbol{Q_L}$ is the heat losses due to piping and recirculation (units for the equation: [J]). According to point 4 of this chapter, the losses can be calculated as a percentage of the $\boldsymbol{Q_d}$

The general equation for $\boldsymbol{Q_d}$ is: $$\boldsymbol{Q_d = m \times c \times \Delta T}$$ **[2]**

Where m=ρ*V [kg],ρ=0.995kg/m³ and V= the volume [m³]

Where, $\boldsymbol{m}$ is the mass of water that is going to be heated daily (units for the equation: [kg]), $\boldsymbol{c}$ is the water's specific heat capacity (use this value: 4,182.0 J/(kg*K), and $\boldsymbol{\Delta T}$ is the desired temperature rise daily. $\boldsymbol{m}$ will be the biggest value between daily consumption and tank capacity.

The next equation will be: $$\boldsymbol{Q_{sol,t} = Q_{sol} \times A_g \times n}$$ **[3]**

Where $\boldsymbol{Q_{sol,t}}$ is the total solar heat gain for the desired time frame (units [kWh]), $\boldsymbol{Q_{sol}}$ is the solar heat gain for the desired time frame for 1m² of gross area (the value is given in table 4), (units [kWh/m²]), $\mathbf{A_g}$ is the gross area of the collector (units in m²) and **n** is the number of the collectors

What has to be achieved is: $$\boldsymbol{Q_{tot} = Q_{sol,t}}$$ **[4]**

Useful conversions: 1J=1/3,600,000kWh
1J=1/4,187kcal
1lt water/glycol = 0.995kg

Equations [1] and [2] can be used for the calculation of the heat demand for both space heating, domestic hot water as well as for the combination of the 2.

The following example is the implementation of these calculations for the solar field sizing:
Input data:

City	Hottest month	Daily demand DHW [lt] for August	Tank capacity [lt]	T_{min} [°C]	T_{set} [°C]	Shade	Demand profile	Total Losses with recirculation enabled
Rome	August	900	1000	20	60	Unshaded	All year/ consumption during evening hours	25%

a. Calculate the Q_d from eq. [2] : $Q_d = (1{,}000 \times 0.995) \times 4{,}182 \times (60 - 20) \leftrightarrow Q_d = 166{,}443{,}600\, J \leftrightarrow \boldsymbol{Q_d = 46.23 kWh}$

b. $Q_L = 0.25 \times Q_d \leftrightarrow \boldsymbol{Q_L = 11.56 kWh}$

c. From eq. [4] and [1] : $\boldsymbol{Q_{sol.t} = 57.79 kWh}$

d. Going back to table 4 for Rome at Tm=50°C: $Q_{sol,FMAX,m} = 116\ kWh/m^2$

The values above are for the whole month. For one day divide by 31 days:
$\boldsymbol{Q_{sol,FMAX,d} = 3.74 kWh/m^2}$,

e. Then from **eq. [4]**

$$\boldsymbol{A_g \times n = \frac{Q_{sol,t}}{Q_{sol,FMAX,d}} = \frac{57.79 kWh}{3.74\ kWh/m^2} = 15.45\ m^2}$$

That means that 7x2.37m² (16.59m²), or 8x2.00m² (16m²), or 6x2.72m² (16.32m²) AS will do the job.

Notes:

- The purpose of the field sizing procedure presented here is to give an example where the demand and set conditions are given. Please use this calculation procedure to find the optimum solution according to your exact needs.
- Always have in mind that an oversized solar field could possibly lead either to troubles and defects or to extra initial cost, for measures against overheating. Please assess your options seriously.

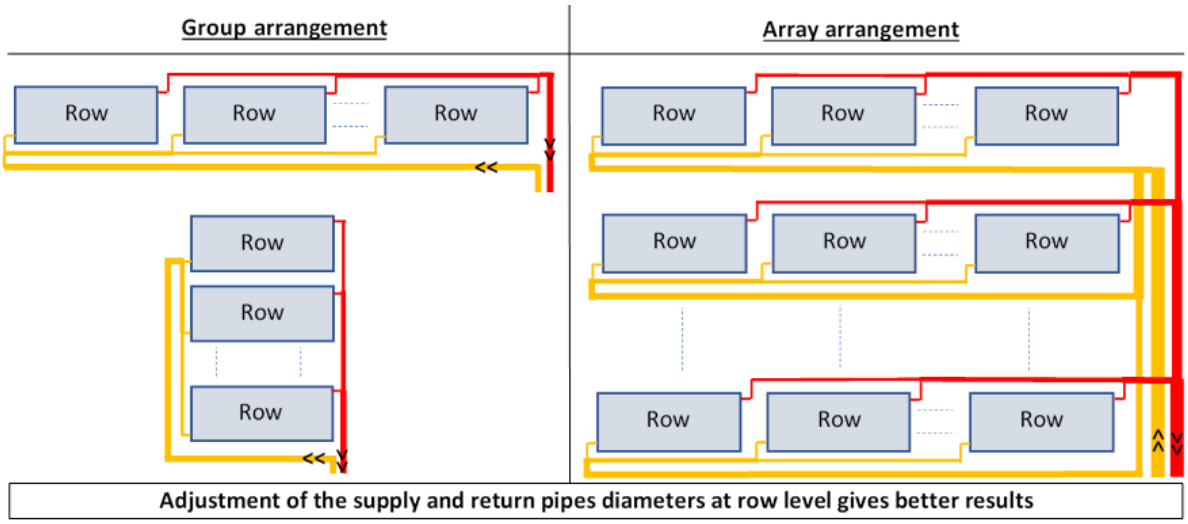
7.7 Solar field arrangement

What will be the collectors' arrangement in a solar field depends mostly on the field size. The main reasons behind the best arrangement is the cost / labor as well as the optimization of the flow distribution of the thermal medium inside the field. In this chapter suggestions for the best solution are illustrated.

AS collector row arrangement		
Vertical collectors		
1		Up to 4 collectors connected in parallel
2		5 collectors with parallel/ series connection
3		6 collectors with parallel/ series connection
4		7 collectors with parallel/ series connection
5		8 collectors with parallel/ series connection (maximum number)
Horizontal collectors		
1		Up to 3 collectors connected in parallel
2		4 collectors with parallel/ series connection
3		5 collectors with parallel/ series connection
4		6 collectors with parallel/ series connection (maximum number)

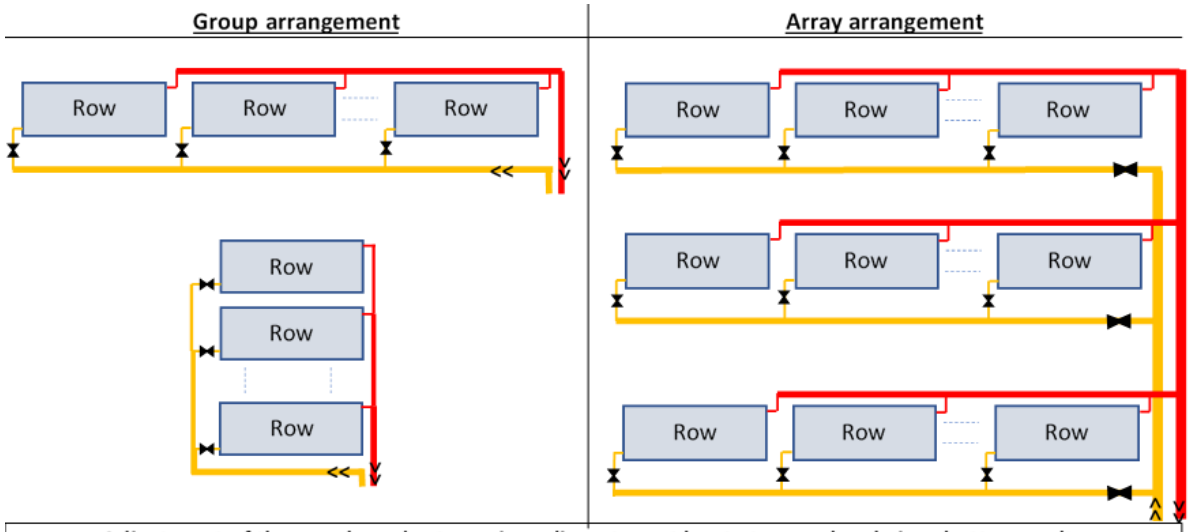
AS collector field arrangement

Solution A: FIRST IN LAST OUT



Adjustment of the supply and return pipes diameters at row level gives better results

Solution B: Balancing valves method



Adjustment of the supply and return pipes diameters at least at group level gives better results

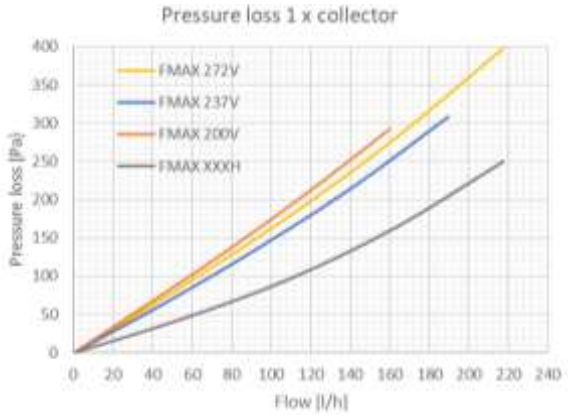
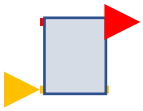
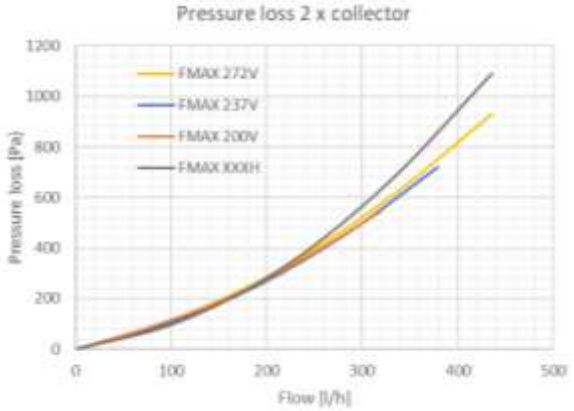
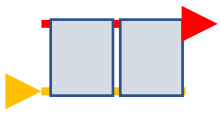
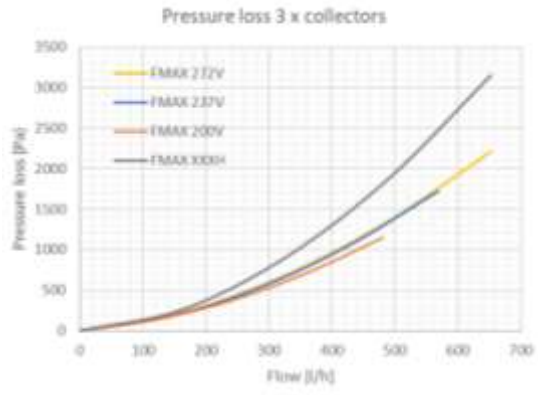
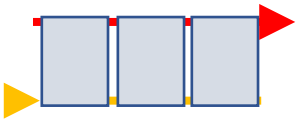
7.8 Solar field properties

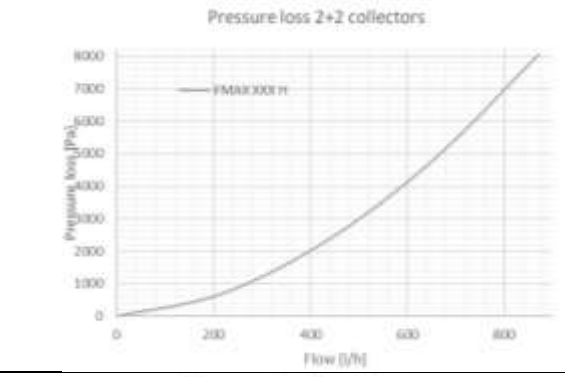
The following calculations are made with the following assumptions:

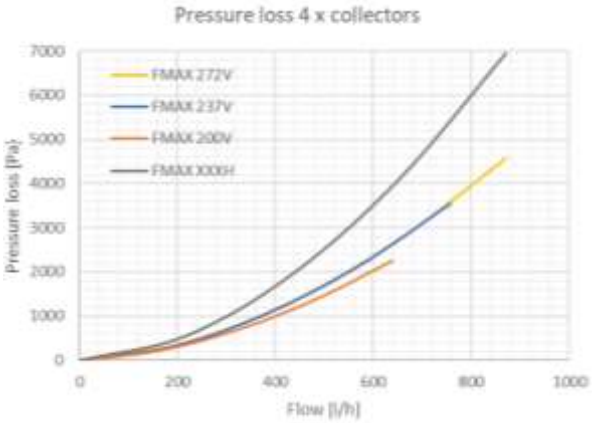
- Thermal fluid average temperature inside the collector ***Tm=40°C*** (above 40°C pressure drop decreases)
- Thermal fluid is 30% propylene glycol – 70% water

The optimized flow range for each application is indicated with a red strip in the following diagrams.

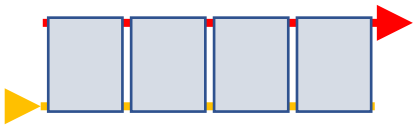
Note: In diagrams in tables 7 & 8, the red area indicates the suggested flow range

Pressure drop for 1÷4 collectors	Tubing / Pump station
	1 collector 
	Solar loop: Use **DN16** Inox corrugated tube or **ø15x1mm** copper tube or equivalent. **Pump station: 2-12**
	2 collectors with parallel connection 
	Solar loop: Use **DN16 / DN20** Inox corrugated tube or **ø15x1mm / ø18x1mm** copper tube or equivalent. **Pump station: 2-12**
	3 collectors with parallel connection 
	Solar loop: Use **DN16 / DN20** Inox corrugated tube or **ø15x1mm / ø18x1mm** copper tube or equivalent. **Pump station: 2-12**





4 vertical collectors with parallel connection



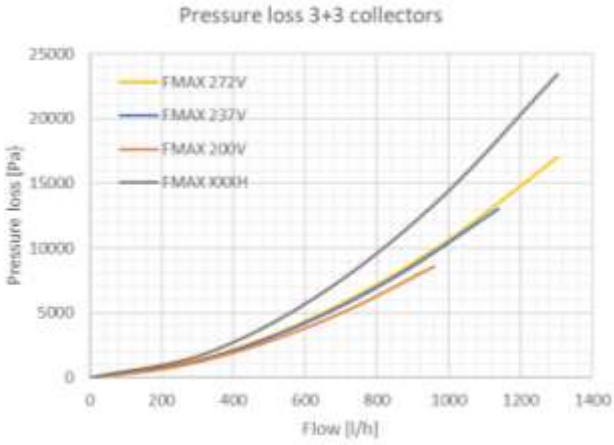
Solar loop: Use **DN20** Inox corrugated tube or **ø18x1mm** copper tube or equivalent.

Pump station: 2-12

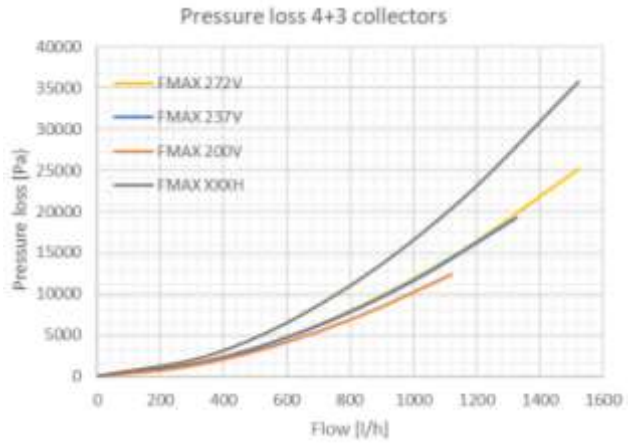
3+2 collectors with parallel/ series connections

Solar loop: Use **DN20** Inox corrugated tube or **ø18x1mm** copper tube or equivalent.

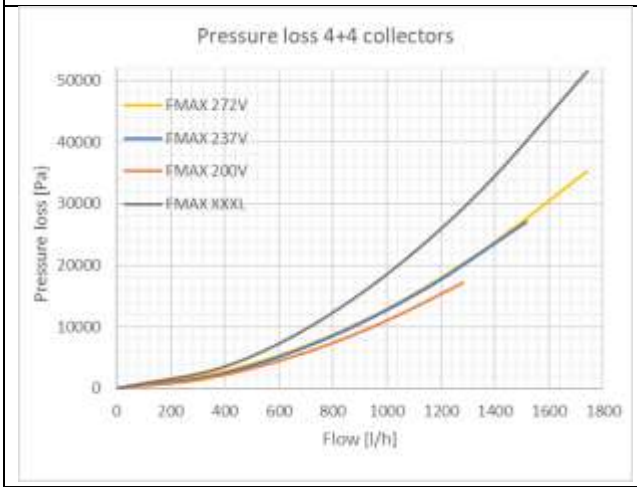
Pump station: 2-12



3+3 collectors with parallel/ series connections



4+3 collectors with parallel/ series connections



4+4 collectors with parallel/ series connections

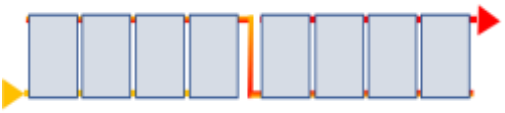


Table 24

8 Solar loop accessories

8.1 Hydraulic connections of collectors

8.1.1 Overview

List of collectors' hydraulic accessories											
a/a	Description	Image		Qty/Nr. Of collectors							
				1	2	3	4	5	6	7	8
1	Auto air vent with shut off cock			1							
2	Cross fitting with nut and compression ring for copper pipe ø22x3/4"M			1							
3	Temperature sensor sleeve			1							
4	Straight fitting with nut and compression rings for copper pipe ø22xø22			0	2	4	4	6	8	10	12
				0	2	4	6	6	8	-	-
5	Elbow fitting with nut and compression rings for copper pipe ø22xø22		Vert Coll.	0	0	0	0	2	2	2	2
			Hor. Coll.	0	0	0	2	2	2	2	2
6	Elbow fitting with nut and compression ring for copper pipe ø22x3/4" M		Vert./ Hor.	1	1	1	1	1	1	1	1
7	End plug with nut and compression ring for copper pipe ø22		Vert Coll.	2	2	2	2	4	4	4	4
			Hor. Coll.	2	2	2	4	4	4	4	4
8	Straight reducing ¾" Female x 1" Male			0	0	0	0	0	0	2	2
9	Solar ball valve ¾"M-F ***optional part***			1	1	1	1	1	1	1	1

8.1.2 Connection general instructions

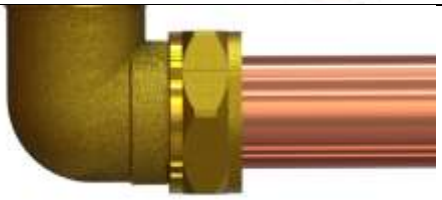
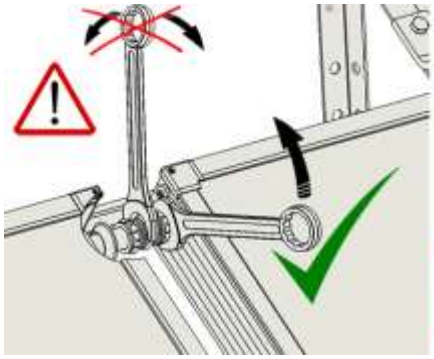
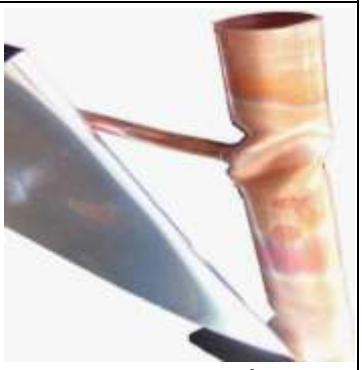
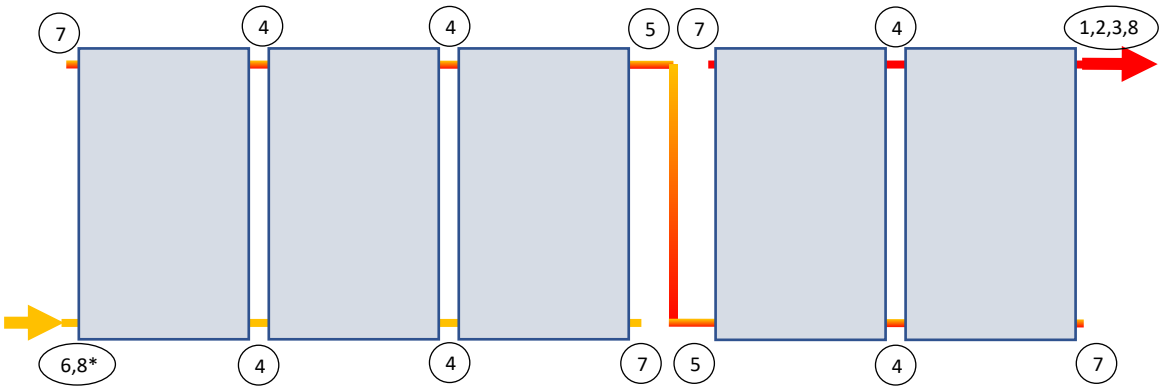
Copper tubing: Standard compression fittings assembly	
STEP 1: INSERT THE Φ22 COPPER NUT AND THEN THE RING FOR COPPER FITTING ON THE COPPER TUBE	
STEP 2: INSERT COPPER TUBE IN THE MAIN CORP OF THE FITTING, UNTIL THE TUBE CAN'T GO FURTHER IN.	
STEP 3: TIGHTEN UP THE NUT.	
  	
ATTENTION: WHEN TIGHTENING THE CONNECTION FITTINGS OF THE COLLECTOR (PLUGS, RACCORDS, CONNECTORS, ETC) USE COUNTERACTION FORCE TO AVOID DAMAGING THE PIPE INSIDE THE COLLECTOR.	

Table 13

8.1.3 Connections example

Going back to table 7 and connect the collectors accordingly.
For example for 5 collectors the connections are as below:



Collectors' hydraulic accessories

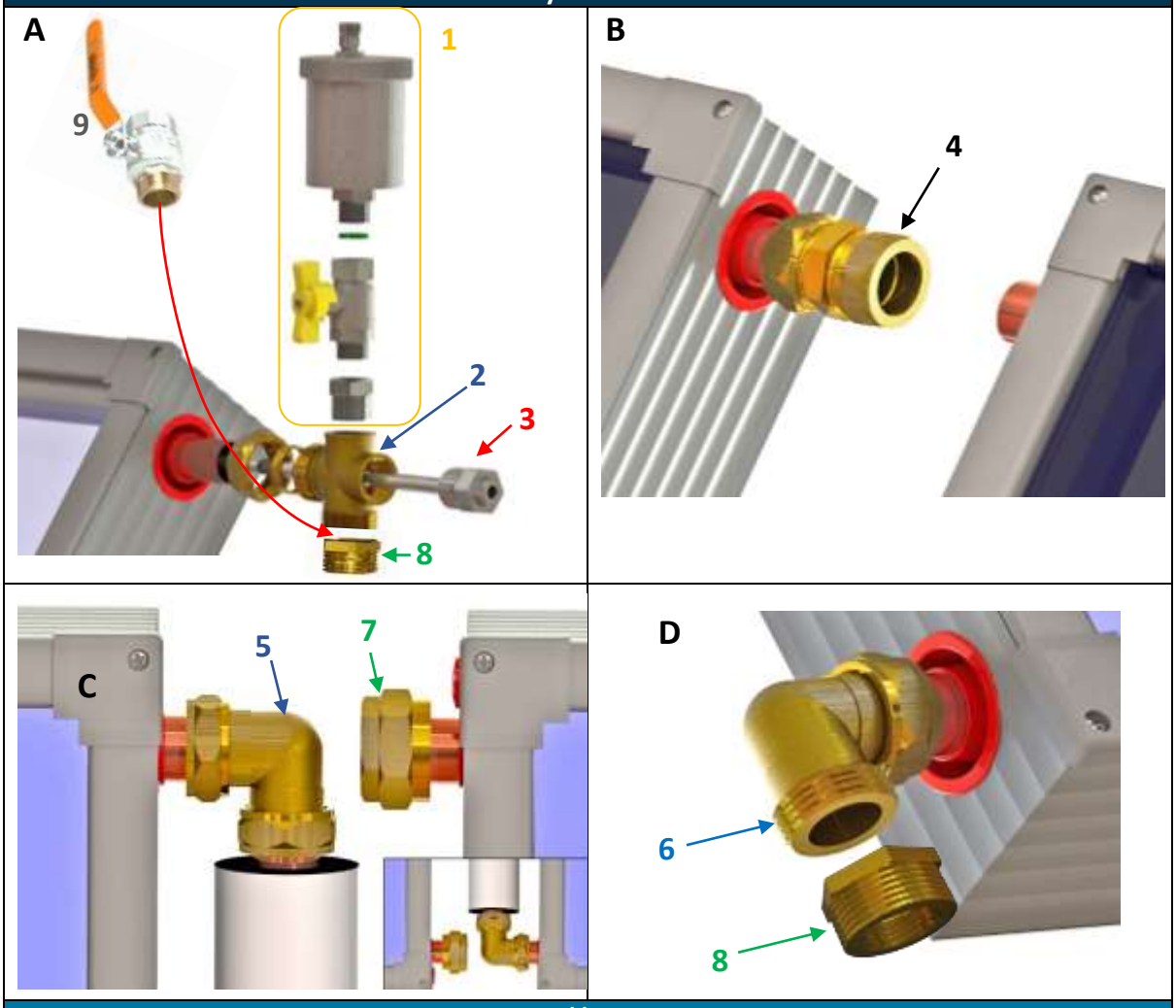



Table 14

Image A: Collector outlet. Connects the collector row to the next row or to the pump's suction side (before the heat exchanger). **Set Nr.1** is the automatic air vent unit. It is used in a closed system to allow air contained in the fluid to be released automatically. The shut off valve is used in combination with the air vent. This unit is needed during the filling process of the circuit, where the shut off valve remains open during filling and afterwards the valve is closed to cut-off the air vent. **Nr.2** is the cross connection, where on it **Nr.1**, **Nr.3** (the temperature sensor sleeve) and **Nr.8** (for 7 or 8 collectors) are connected. Optionally a solar ball valve **Nr.9** could be connected too.

Image B: Collectors straight connector. For all the parallel connections between collectors.

Image C: **Nr.5** is the elbow connector which when needed (for more than 4 collectors) it is connecting the collectors on the left side in series with the collectors on the right side. The copper tube connecting the upper left of one connector to the lower right of the next collector is always insulated ø22x0.7mm. **Nr.7** is the end plug, always connected to the dead ends of the outer collectors.

Image D: Collector inlet. **Part Nr.6** connects the collector row to the next row or straight to the pump's discharge port. **Part Nr. 8** is needed for more than 6 collector, for increasing the dimension of the port to 1".

8.2 Solar loop piping

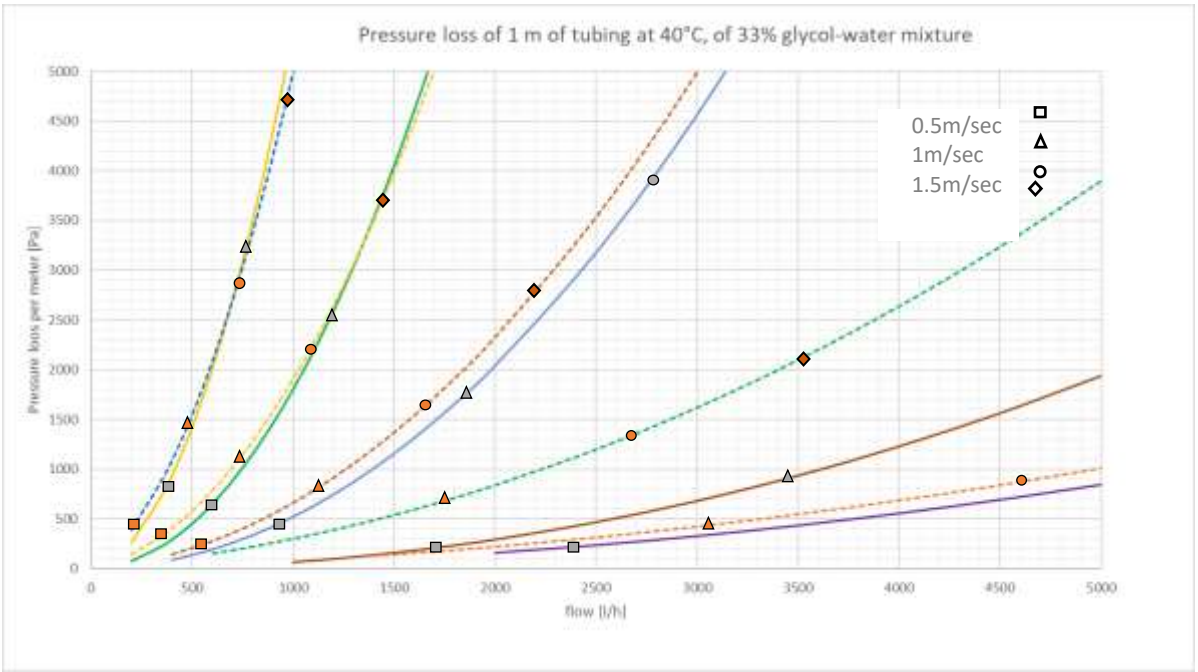
The main suggested options are:

1. **Copper pipe:** For the systems described within this manual, the suggested dimensions are a) ø15x1mm b) ø18x1mm c) ø22x1mm. Insulation thickness for these dimensions are suggested to be minimum 13mm. Copper tubes must be provided by third party, except of series connection tube.
2. **Inox 316L corrugated flexible tube:** For the systems described within this manual, the suggested dimensions are a) DN16 b) DN20 c) DN25. Insulation thickness for these dimensions are suggested to be minimum 13mm. They can be single or double channel with integrated sensor cable. Inox corrugated tubes could be provided by Energia Italia srl.

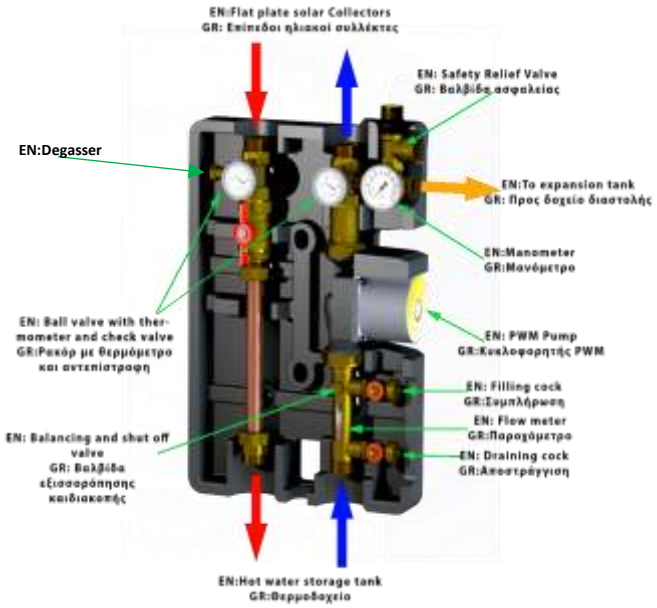
Tubing		
Type	**Description**	**Image**
Copper tube	Copper tube ø15x1mm- ø18x1mm – ø22x1mm, single, Insulated with with minimum 13mm synthetic rubber, UV protected	
Single channel corrugated flexible tube	Inox 316L DN16-DN20-DN25 flexible corrugated tube, single, Insulated with with minimum 13mm synthetic rubber, UV protected	
Double channel corrugated flexible tube	Inox 316L DN16-DN20-DN25 flexible corrugated tube, double, Insulated with minimum 13mm synthetic rubber, UV protected, with cable for temperature sensor	

Table 15

8.2.1 Pressure loss of tubes



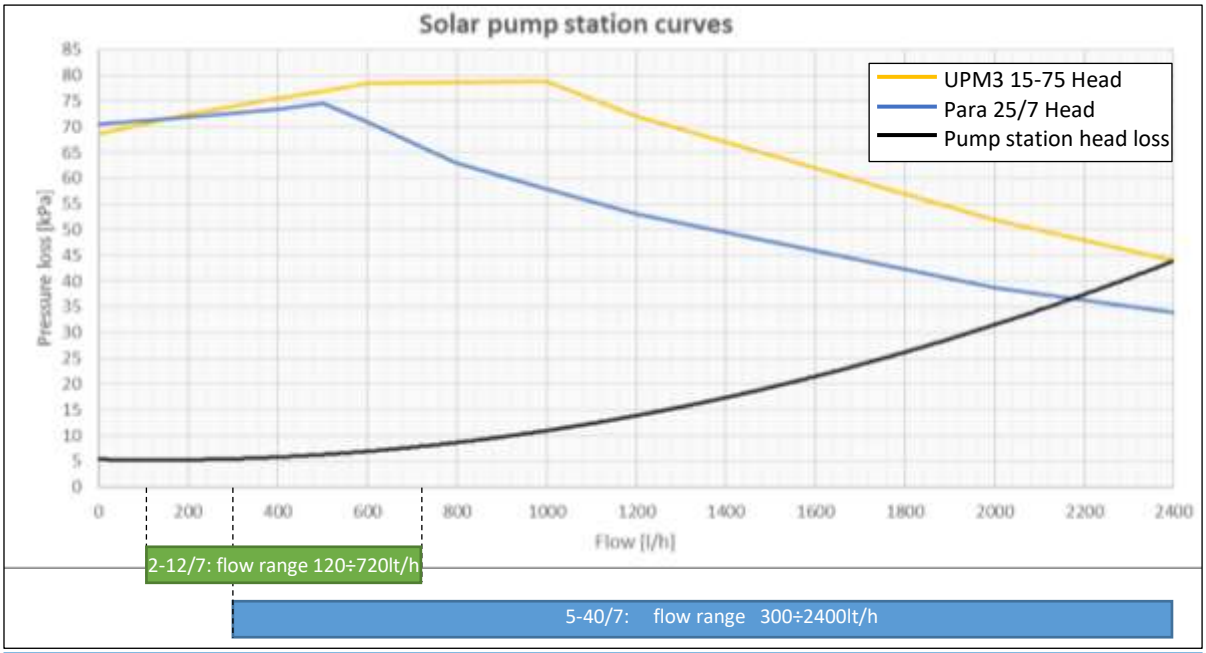
8.3 Pump stations



1. Filling, draining and flushing of the system and disassembly of the pump without having to empty the system
2. Internal degasser of the system (standard option)
3. Safety valve, manometer and flexible connection of the expansion also included
4. On-wall assembling or directly to the storage tank
5. Insulation cover for minimizing heat losses
6. Flange ball valves, thermometer and check valves to both flow / return line
7. All seals are assured by flat fittings and gaskets

Technical characteristics			
Model		**2-12/7**	**5-40/7**
Max collector surface	**[m²]**	20	80
Pump		GRUNDFOS UPM3 SOLAR 15-75 130 PWM / WILO Yonos Para 25/7 130 PWM	WILO Yonos Para 25/7 180 PWM GRUNDFOS UPM3 SOLAR 15-75 180 PWM
Flow rate regulator	**[l/min]**	2-12	5-40
Connections		¾"M-	1"F-
Max operating pressure	**[bar]**	10	10
Max operating Temperature	**[°C]**	120	120
Pressure safety valve	**[bar]**	6	6

Table 16



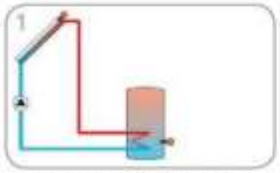
For installation instructions please refer to the specialized accompanied manual

8.4 Solar and system controller

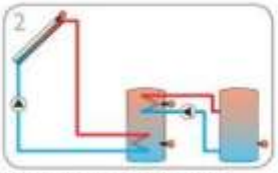
Kit includes 3x temperature sensors
Upon request: additional sensors, flow meters, controlled mixing / bypass / three port valves or other types of controllers.

Main characteristics		
Inputs / outputs		**Main functions**
Max Nr. Of collector fields	2	10 system layouts
Max Nr. Of stores	2	Auto function
Speed control of HE pumps via PWM	✓	System/store protection (high temp /antifreeze)
Temperature sensor inputs	4	Drainback
Inputs for flow metering devices	1	DT adjustment
Relay outputs total	3	Thermostat function
PWM outputs	2	DHW hygiene functions / thermal disinfection
Power supply	100….240V	Solid fuel boiler
Data Interface	VBus	
Heat quantity measurement	With flow meter	
Table 17		

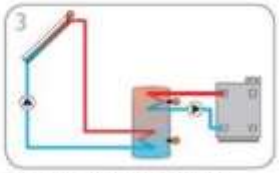
8.4.1 System overview



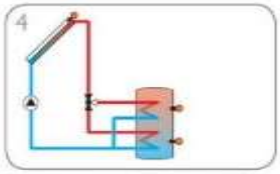
Solar system with 1 store



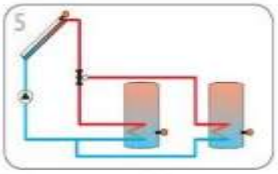
Solar system with 2 stores and heat exchange



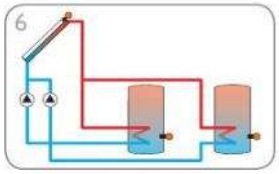
Solar system with 1 store and afterheating



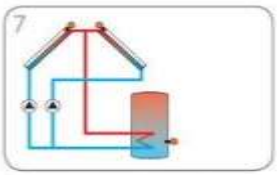
Solar system with 1 store and 3-port valve for store loading in layers



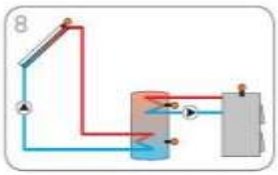
Solar system with 2 stores and valve control (page 12)



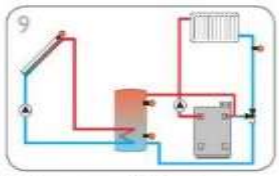
Solar system with 2 stores and pump control (page 13)



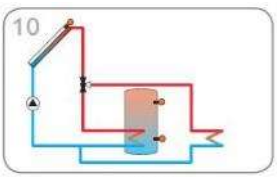
Solar system with east-/west collectors (page 14)



Solar system with 1 store and solid fuel boiler

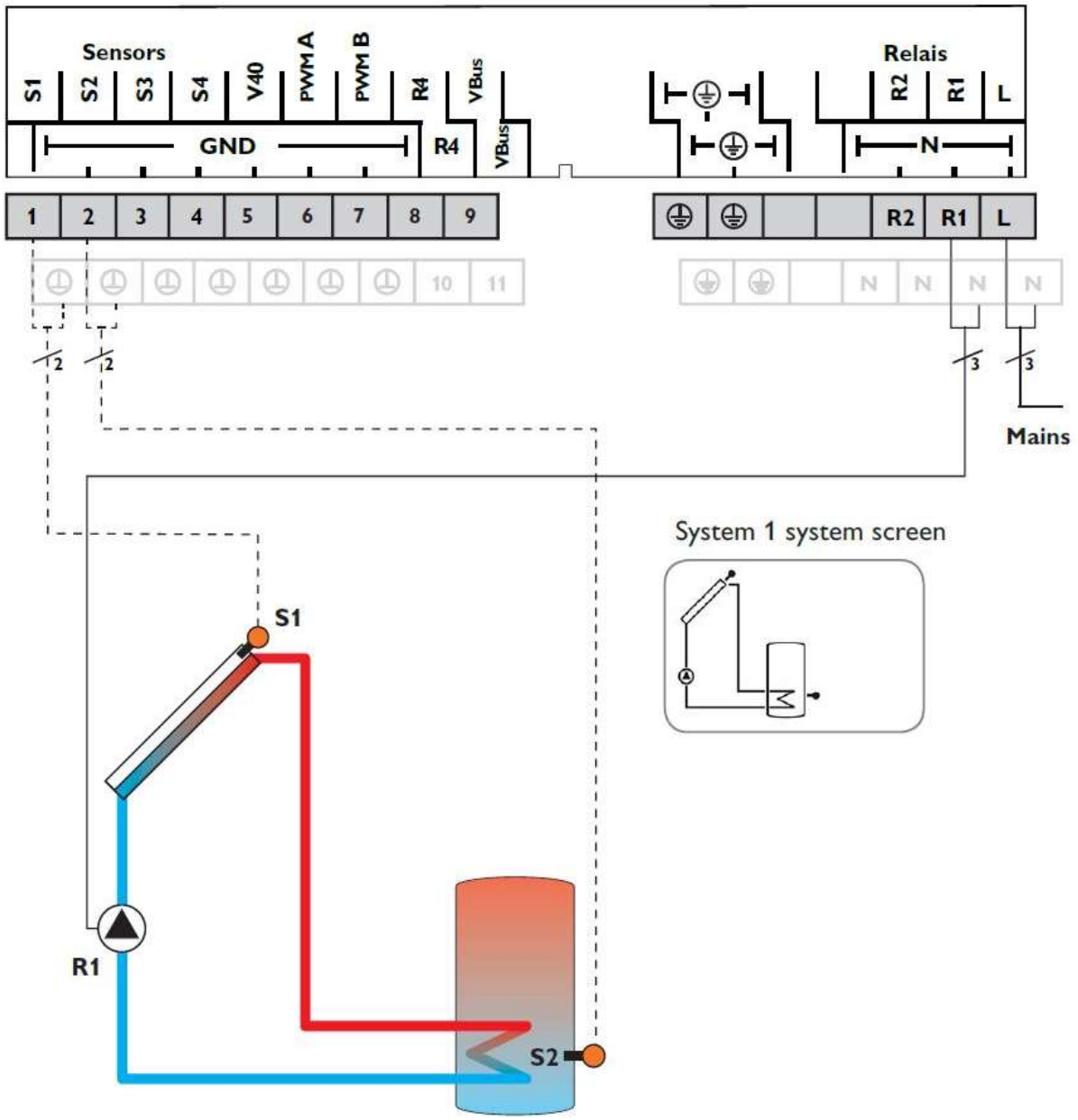


Solar system with 1 store and return preheating



Solar system with 1 store and heat dump

8.4.2 Standard System



The controller calculates the temperature difference between collector sensor S1 and store sensor S2. If the difference is larger than or identical to the adjusted switch-on temperature difference, the pump (R1) will be switched on and the store will be loaded until the switch-off temperature difference or the maximum store temperature is reached.

Main characteristics					
Temperature sensors			Relays		
S1	Temperature collector	1 / GND	R1	Solar pump	R1 / N / PE
S2	Temperature store base	2 / GND	R2	Free	R2 / N / PE
S3	Free	3 / GND	R4	Free	R4 / R4
S4	Free	4 / GND			

Table 18

For operation instructions and more please refer to the specialized accompanied manual

8.5 Expansion vessels

The solar expansion vessels have the following properties:

- Membrane resistant to peaks of 130°C.
- Precharge pressure 2.5 bars.

Solar expansion vessels main characteristics					
	Capacity [lt]	Max Pressure [bar]	Connection [inch]	Dimensions [mm]	Mounting
	8	8	3/4	200x330	Wall bracket
	12	8	3/4	270x310	Wall bracket
	18	8	3/4	270x415	Wall bracket
	25	8	3/4	290x460	Wall bracket
	40	8	3/4	320x580	Wall bracket
	50	10	3/4	380x620	Floor
	60	10	3/4	380x670	Floor
	80	10	3/4	450x650	Floor

Table 19

8.5.1 Sizing of solar expansion vessel

The general equation for the expansion vessel volume calculation is: $$V = \frac{V_u \times (P_{er}+1)}{P_{er}-P_0} \quad [5]$$

Where V_u is the useful volume of the vessel [lt], P_{er} is the maximum system working pressure [bar], P_0 is the vessel precharge pressure [bar].

V_u equals to: $$V_u = (C \times e + V_p) \times 1.1 \quad [6]$$

Where: e is the water expansion coefficient (see table 17), C is the total volume of the thermal fluid inside the solar loop [lt] (collectors, piping, heat exchanger), V_p is the volume of the thermal fluid in the solar panels [lt]

P_{er} equals to: $$P_{er} = P_{vs} - 0.5 \quad [7]$$

Where: P_{vs} is the safety relief setting pressure [bar]

P_0 equals to: $$P_0 = P_{st} + 0.5 \quad [8]$$

Where: P_{st} is the hydrostatic pressure [bar], equals to the height difference between the expansion vessel and the highest point of the thermal fluid loop in meters divided by 10

Medium expansion coefficient e for glycol / water 30%													
Temperature [°C]	10	20	30	40	50	60	70	80	90	100	110	120	130
e coefficient	0.007	0.01	0.013	0.016	0.021	0.026	0.031	0.038	0.044	0.052	0.06	0.069	0.078

Table 20

Evaporation pressure for glycol / water 30%									
Temperature [°C]	100	120	130	140	150	160	170	180	190
e coefficient	0.007	0.01	0.013	0.016	0.021	0.026	0.031	0.038	0.044

Table 21

The following example is the implementation of these calculations for the solar expansion vessel sizing sizing:
Input data:

Nr. of collectors FMAX237	Boiler	Thermal liquid temperature at stagnation	Length of ø18x1mm piping	Height difference	Safety relief valve setting	Vessel precharge pressure
4	500 lt	130 °C	50 m	20 m	6 bar	2.5 bar

a. Thermal fluid capacity of the collector: 1.7lt (table 3). As a result, $\boldsymbol{V_p}$=6.8lt.
b. Capacity of the solar coil of the tank: 13.7lt (table 9).
c. Capacity of the piping: 50x3.14x(0.018-0.001x2)^2 /4=0.01005m^3 = 10.05lt
d. $\boldsymbol{e}$=0.078 (for 130°C from table 17)
e. $\boldsymbol{P_{st}}$= 20/10=2bar

From equation [6]: $\boldsymbol{V_u = (30.55 \times 0.078 + 6.8) \times 1.1 = 10.1\ lt}$
From equation [7]: $\boldsymbol{P_{er} = 6 - 0.5 = 5.5\ bar}$
From equation [8]: $\boldsymbol{P_0 = 2 + 0.5 = 2.5\ bar}$

Eventually going back to [5]: $\boldsymbol{V = \frac{10.1 \times 6.5}{5.5 - 2.5} = 21.88 lt}$.

Finally from table 16 the expansion vessel that best fits is the 25lt.

8.6 Antifreeze liquid

The antifreeze liquid included is concentrated monopropylene glycol (except otherwise mentioned in the container can). In any case the concentrated antifreeze liquid contains a finely balanced combination of corrosion inhibitors (free of nitrites, amines, borates, phosphates, silicates and carcinogenic, mutagenic and reprotoxic substances) for a reliable protection against corrosion and ageing of various metallic materials. The recommended concentration with water is between 30 and 50% v/v, which corresponds to frost resistance from -13 to -33 °C.

Antifrogen Solar Concentrated main properties	
Appearance	Clear red liquid
Service temperature range	-33 to +150 °C (-9.4 to 392 °F)
Kinematic Viscosity at 20 °C & 30% v/v(DIN 51562)	2.98 mm^2/s
Kinematic Viscosity at 80 °C (DIN 51562)	0.67 mm^2/s
Freezing Point at 30% v/v (ASTM D 1177)	-13 °C (about -8.6 °F)
Boiling point at 1013 mbar (ASTM D 1120)	about 106°C (about 223 °F)
Density at 20° C & 30% v/v (DIN51757)	1026 kg/m^3
Density at 80° C & 30% v/v (DIN51757)	989 kg/m^3
Specific heat at 20 °C	about 3.2 kJ/kg*K
Thermal conductivity at 20° C & 30% v/v	0.449 W/m*K
Thermal conductivity at 80° C & 30% v/v	0.465 W/m*K
Heat capacity at 20° C & 30% v/v	3.88 kJ/kg*K
Heat capacity at 80° C & 30% v/v	4.00 kJ/kg*K

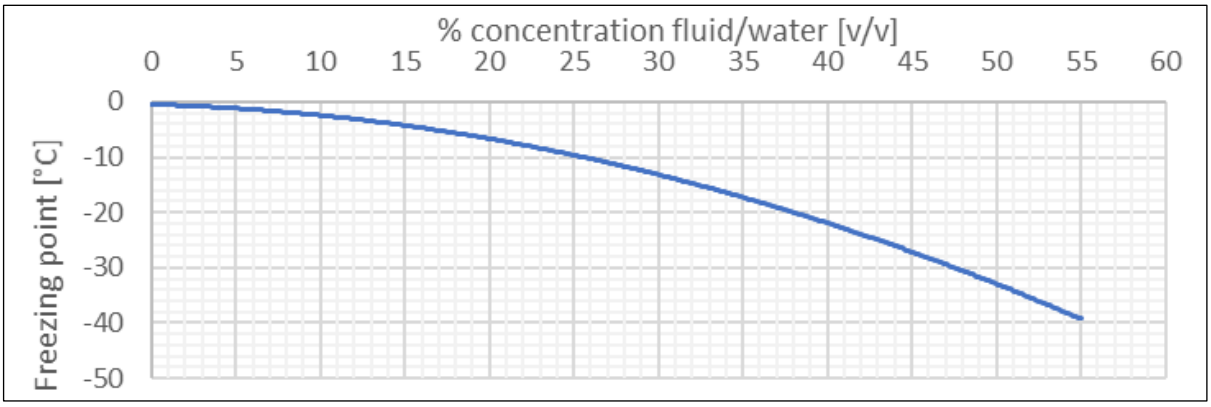
First aid measures

- *Description of first aid measures*

1. General information: Remove soiled or soaked clothing immediately. Seek medical assistance if discomfort continues.
2. After inhalation: When inhaled remove to fresh air and seek medical aid.
3. After contact with skin: In case of contact with skin wash off immediately with soap and water
4. After contact with eyes: In case of contact with eyes rinse thoroughly with plenty of water and seek medical advice
5. After ingestion: Summon a doctor immediately.

- *Most important symptoms and effects, both acute and delayed*
  Symptoms: No symptoms known currently.
  Hazards: No hazards known at this time.
- *Indication of any immediate medical attention and special treatment needed*
  Treatment: Treat symptomatically.

Table 22



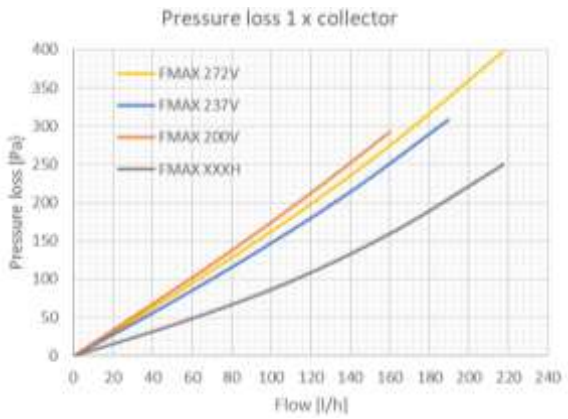
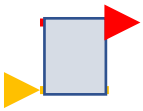
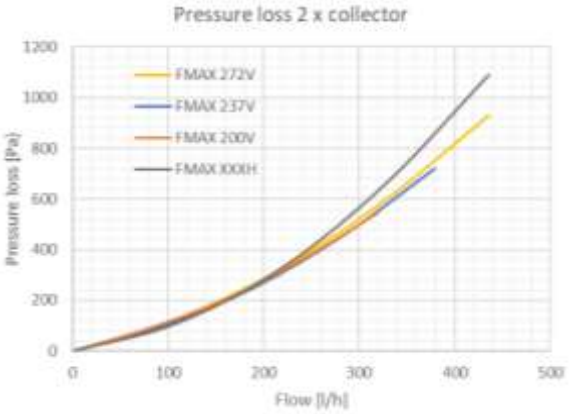
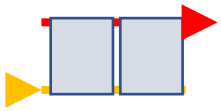
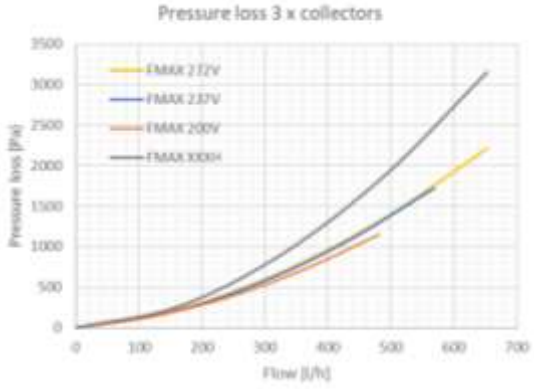
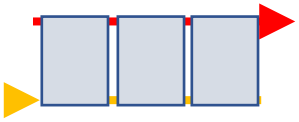
8.7 Solar field properties

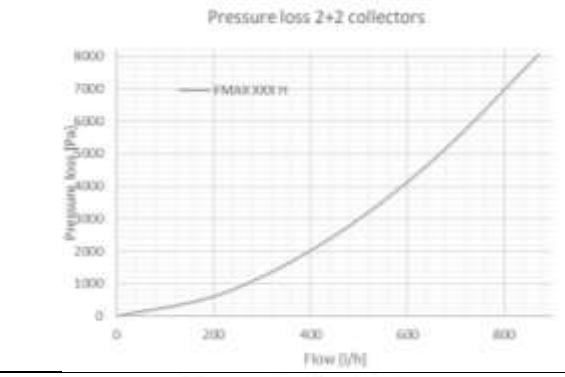
The following calculations are made with the following assumptions:

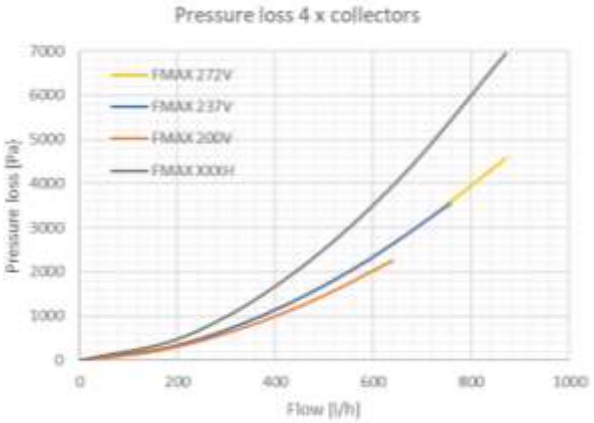
- Thermal fluid average temperature inside the collector ***Tm=40°C*** (above 40°C pressure drop decreases)
- Thermal fluid is 30% propylene glycol – 70% water

The optimized flow range for each application is indicated with a red strip in the following diagrams.

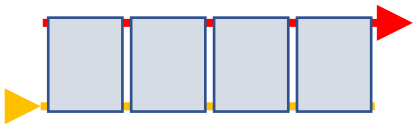
Note: In diagrams in tables 7 & 8, the red area indicates the suggested flow range

Pressure drop for 1÷4 collectors	Tubing / Pump station
	1 collector  **Solar loop:** Use **DN16** Inox corrugated tube or **ø15x1mm** copper tube or equivalent. **Pump station: 2-12**
	2 collectors with parallel connection  **Solar loop:** Use **DN16 / DN20** Inox corrugated tube or **ø15x1mm / ø18x1mm** copper tube or equivalent. **Pump station: 2-12**
	3 collectors with parallel connection  **Solar loop:** Use **DN16 / DN20** Inox corrugated tube or **ø15x1mm / ø18x1mm** copper tube or equivalent. **Pump station: 2-12**





4 vertical collectors with parallel connection



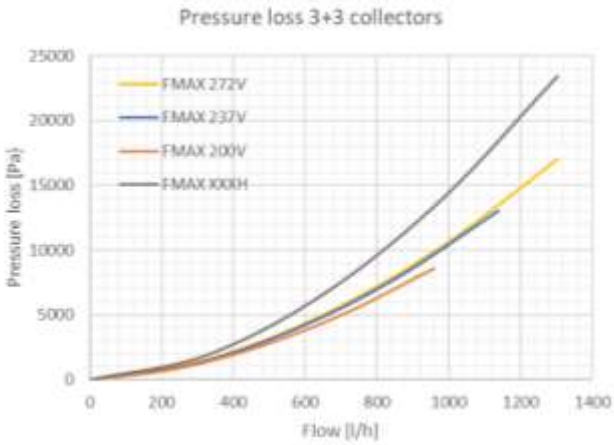
Solar loop: Use **DN20** Inox corrugated tube or **ø18x1mm** copper tube or equivalent.

Pump station: 2-12

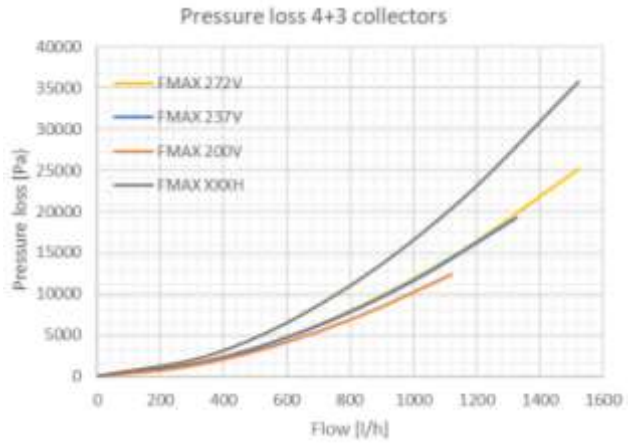
3+2 collectors with parallel/ series connections

Solar loop: Use **DN20** Inox corrugated tube or **ø18x1mm** copper tube or equivalent.

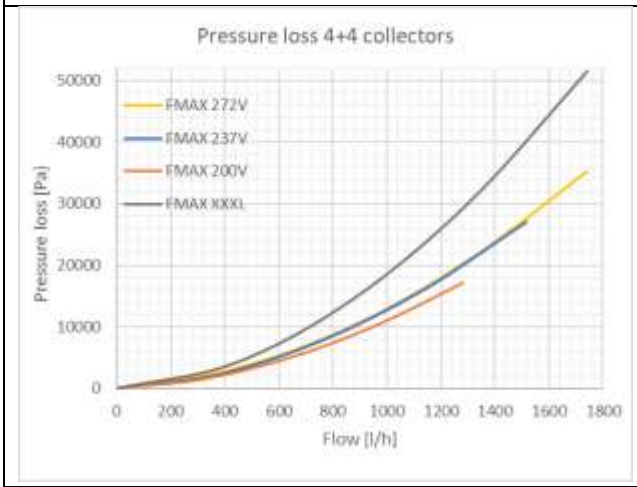
Pump station: 2-12



3+3 collectors with parallel/ series connections



4+3 collectors with parallel/ series connections



4+4 collectors with parallel/ series connections

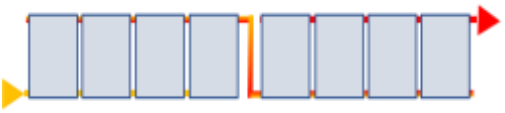


Table 24

9 Support structures

9.1 Validity

This chapter describes the assembly and installation of galvanized steel support structures used for supporting collectors of dimensions 2.00/2.37/2.72m². The supports described below can be used either for mounting on horizontal surface and tilt 45° or for mounting on inclined surface.

9.2 Safety regulations

⚠ ***Failure to follow the safety instructions may cause serious damage and risk to persons of even a mortal nature as well as materials and environmental damage.***

⚠ This section explains how the present assembly and maintenance instructions are organized and recommends general safety precautions to assure safe and efficient use. The specific use and safety instructions are indicated in the assembly diagrams.

⚠ Read the safety instructions before beginning the assembly.

⚠ The various assembly sets are to be used for the specific purposes for which they are intended. Incorrect use of the various components will not assure minimum safety requirements.

⚠ Check with the constructor of the building that the roof can withstand the load of the collectors full of water and ask for a written confirmation. Check the same with the local technical authorities if needed.

⚠ The roof structure must be able to take the wind and snow loads (Note: 1m² powder snow ≈ 60kg / 1m² wet snow ≈ 200kg). It must be taken under consideration the local conditions regarding snow and wind loads. Please contact to the local dealer for more information.

⚠ In case of using ladders, check them in order not to be damaged, and place them on secure surfaces in inclination ≈70°. For maximum protection for the installer it is recommended to use safety belts.

⚠ We suggest the installer to wear protective gloves, safety shoes and helmet. Also, protective glasses are necessary in some cases.

⚠ In case that the place of installation is near electrical wires, keep safety distance (minimum 5 meters) and pay maximum attention when handing long parts of the support structures or tools for the installation.

Important safety instructions	
	Wear the right shoes to avoid slipping on the roof
	Pay attention to the electrical cables that are on the roof, unprotected and the cables of the electricity main that are close to the roof
	Use all the safety equipment and follow the regulations.
	Always wear a helmet.
	Wear protection gloves during the installation.
	Pay attention to the roof limits to avoid the risk of any falls.

	Use anti-fall equipment.
	Always use protective glasses.

Table 25

9.3 Installation regulations

⚠ ***Failure to follow the installation regulations may cause serious damage and risk to persons of even a mortal nature as well as materials and environmental damage.***

⚠ Our collectors are tested according to the standards EN 12975-2. According to mechanical load tests of EN 12975-2 standards, our collectors resisted to maximum pressure load on the cover 1000Pa. The Collectors can resist without any failure to a snow load of up to 500 Pa. These collector systems may only be installed in locations with a value of possible snow load lower than 1000 Pa.

⚠ According to the characteristics of their support frame and the standard ENV 1991, these support systems may not be installed in locations where the maximal mean wind velocity exceeds 55 m/s (value for islands exposed to high winds).

⚠ Before the installation of the solar water heater, it is very important that customer and installer agree on all the details concerning the correct and safe installation of the appliance, such as location, placement point, static resistance and control of the surface on which the appliance will be placed, piping and wiring run etc.

⚠ The position you will choose for the installation of the solar water heater, should not be shaded by any obstacles (trees, buildings, mutual, ... etc) during all the seasons of the year (details in chapters 7.3÷7.6).

⚠ The installation should be done according to the electric and plumbing regulations applicable in your area.

⚠ The surface of the roof, where the installation will take place, must be normal and flat for the proper function and safe installation of the solar system.

⚠ The static resistance of the roof must be appropriate to ensure the stability and safe installation of the solar system.

⚠ In order to avoid humidity problems or water ingress on the roof, the pipes which are entering the roof must be very well sealed. The entrance of piping into the building shall be finished through usual ventilation devices for roof. The building engineer should provide you the precise guidelines, depending in the kind of roof construction.

⚠ All the connection pipes must be very well insulated to avoid freezing or destruction of them due to UV radiation. Depending on the local weather conditions, it must be chosen the correct insulation material. For more information contact to the local dealer.

⚠ The distance between the solar water heater and the hot water consumption must be the shorter possible.

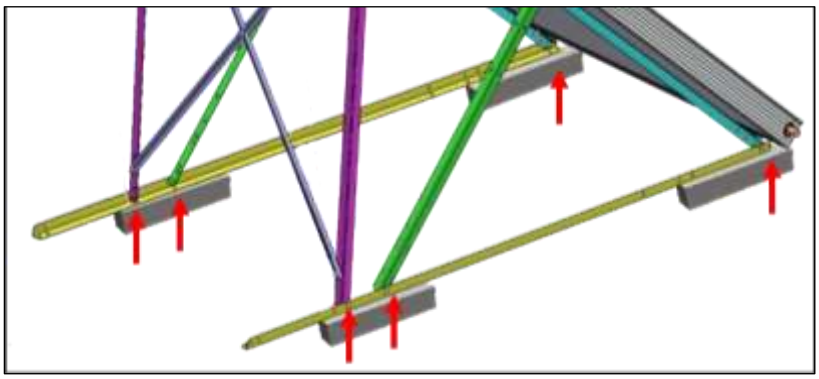
⚠ The area of collector's installation should have an easy and safe access for maintenance.

⚠ When installing our system on a flat roof, we propose not be screwed directly on the roof, to avoid any water penetration or roof insulation damage. It shall be screwed on concrete slabs. In case that it is not possible to use concrete slabs all the points that the support structure is fixed on the roof must be sealed perfectly using proper sealing materials (silicon, polyurethane sealants or other). In case of using concrete slabs, they must be laid down on the roof, below the support frame. The thickness of slabs should be at least 10cm. The whole weight of the full solar system with the slabs (in case that they exist) should be:

- 290 kg per m² of collectors for an installation height up to 20m and a maximum mean wind velocity of 43 m/sec.
- 490 kg per m² of collectors for an installation height up to 20m and a maximum mean wind velocity of 55 m/sec.

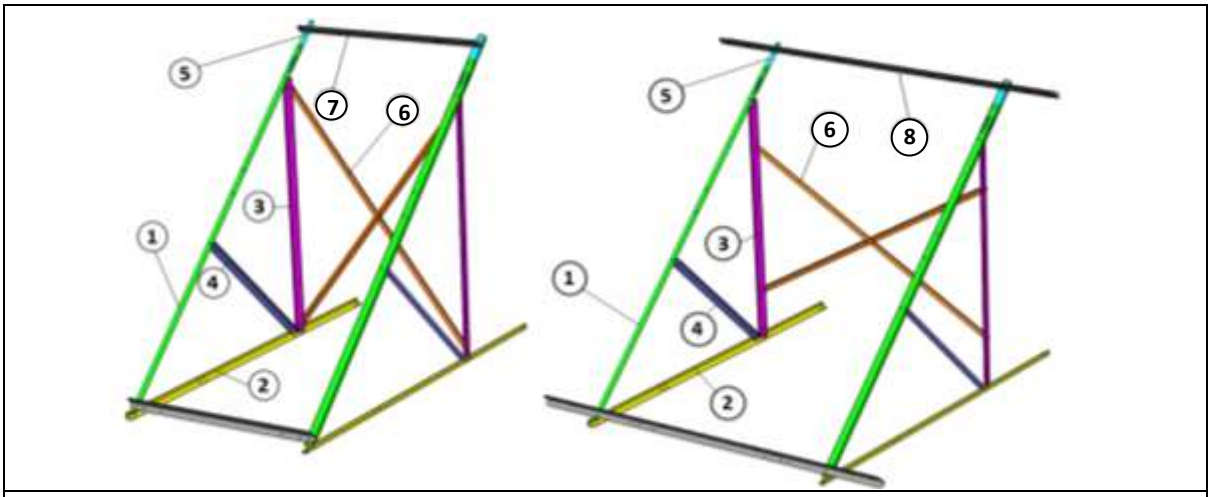
IMPORTANT NOTICE: According to the standard ENV 1991, these values are valid under the following conditions:

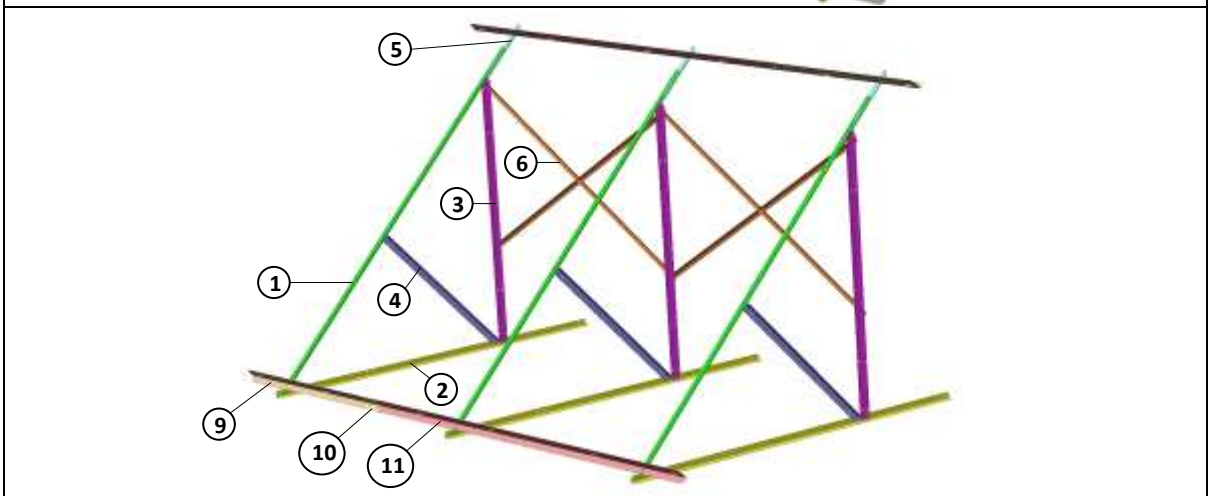
- ✓ The system must be installed on a roof covering a closed volume.
- ✓ The roof area must be at least 5m².
- ✓ The system must not be installed on the extreme sides of the roof.
- ✓ A static calculation of the roof must be carried out by a civil engineer to ensure that the roof can support the above-mentioned loads.



The 2 yellow horizontal beams must be either mounted with full contact to a rigid horizontal surface and anchored preferably at the points indicated with the red arrows, or in case it is demanded to be mounted on slabs, **these slabs** must either be in full contact with the horizontal yellow beams or **at least must be placed at the points illustrated in the picture on the left and anchored only at the points also illustrated with the red arrows**.

9.4 Flat roof slope 45°

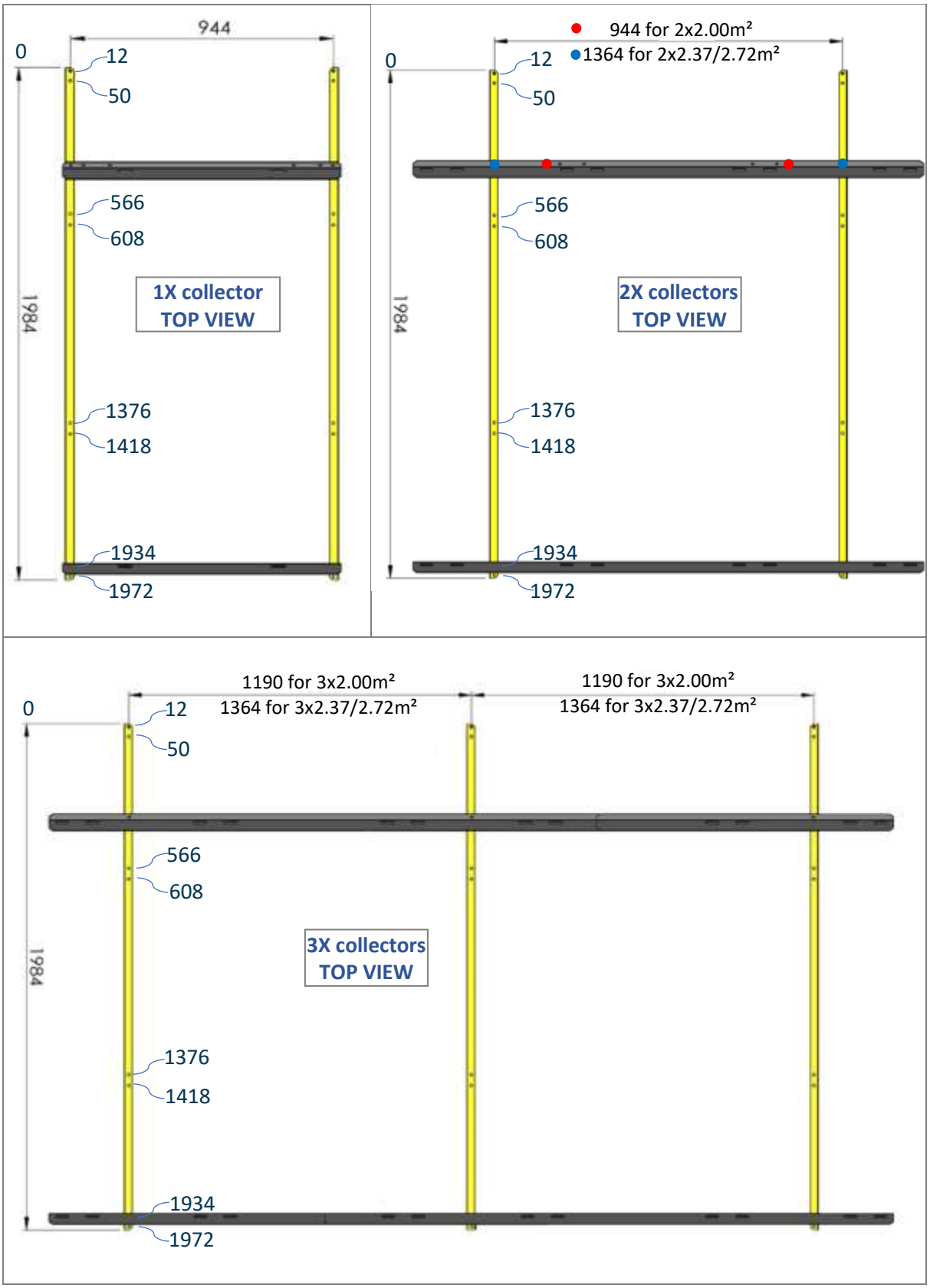




Support structure Parts list								
a/a	Description	1x 2.00-2.37	1x 2.72	2x 2.00-2.37	2x 2.72	3x 2.00	3x 2.37	3x 2.72
1	"L" profile 2140mm	2	2	2	2	3	3	3
2	"L" profile 1984mm	2	2	2	2	3	3	3
3	"L" profile 1380mm	2	2	2	2	3	3	3
4	"L" profile 960mm	2	2	2	2	3	3	3
5	"L" profile 325mm	0	2	0	2	0	0	3
6	Cross bar 1620mm	2	2	2	2	4	4	4
7	"L" profile 1000mm	2	2	0	0	0	0	0
8	"L" profile 2000mm	0	0	2	2	0	0	0
9a	"L" profile split 960mm	0	0	0	0	2	0	0
9b	"L" profile split 1000mm	0	0	0	0	0	2	0
9c	"L" profile split 1015mm	0	0	0	0	0	0	2
10	"L" profile 100mm	0	0	0	0	2	2	2
11a	"L" profile split 2000mm	0	0	0	0	2	0	0
11b	"L" profile split 2300mm	0	0	0	0	0	2	0
11c	"L" profile split 2345mm	0	0	0	0	0	0	2
12	DIN933 bolts M8x20	23	27	27	31	47	47	53
13	DIN933 bolts M8x30	0	0	0	0	2	2	2
14	DIN6923 nuts 8mm	19	23	19	23	37	37	43
15	DIN9021 washers 8.5mm	4	4	8	8	12	12	12
16	DIN574 8x60mm anchors	4	4	4	4	6	6	6
17	Plastic anchors 10x60mm	4	4	4	4	6	6	6

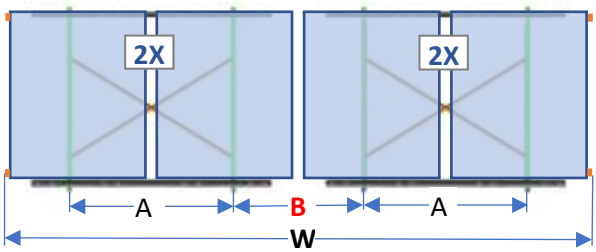
Table 26

9.4.1 Important dimensions of beams Nr.2

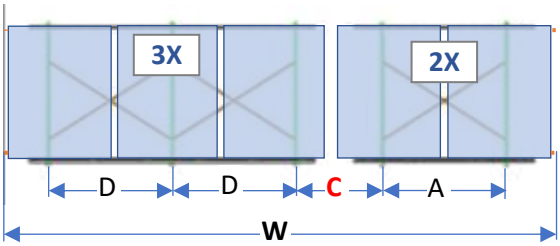


9.4.2 Spacing between supports

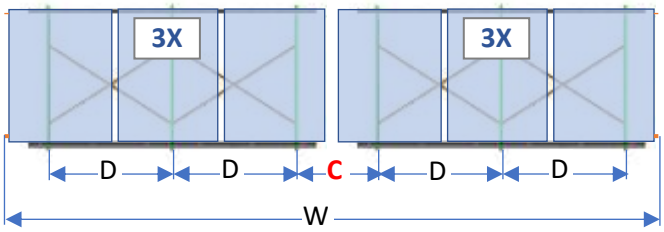
Conf.	A	B	W
4x2.00	944	1225	4330
4x2.37	1364	1245	5210
4x2.72	1364	1305	5330



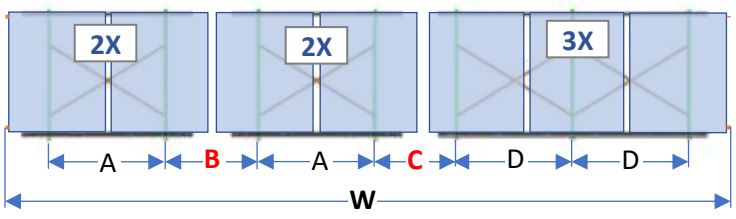
Conf.	A	B	C	D	W
5x2.00	944	1225	1080	1190	4330
5x2.37	1364	1245	1245	1364	5210
5x2.72	1364	1305	1320	1364	5330



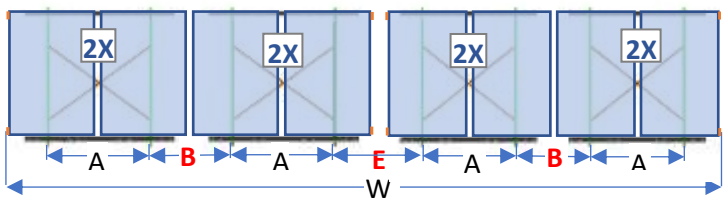
Conf.	D	C	W
6x2.00	1190	905	6525
6x2.37	1364	1217	7845
6x2.72	1364	1307	8025



Conf.	A	B	C	D	W
7x2.00	944	1225	1080	1190	4330
7x2.37	1364	1245	1245	1364	5210
7x2.72	1364	1305	1320	1364	5330



Conf.	A	B	E	W
8x2.00	944	1225	1255	8635
8x2.37	1364	1245	1275	10395
8x2.72	1364	1305	1335	10635

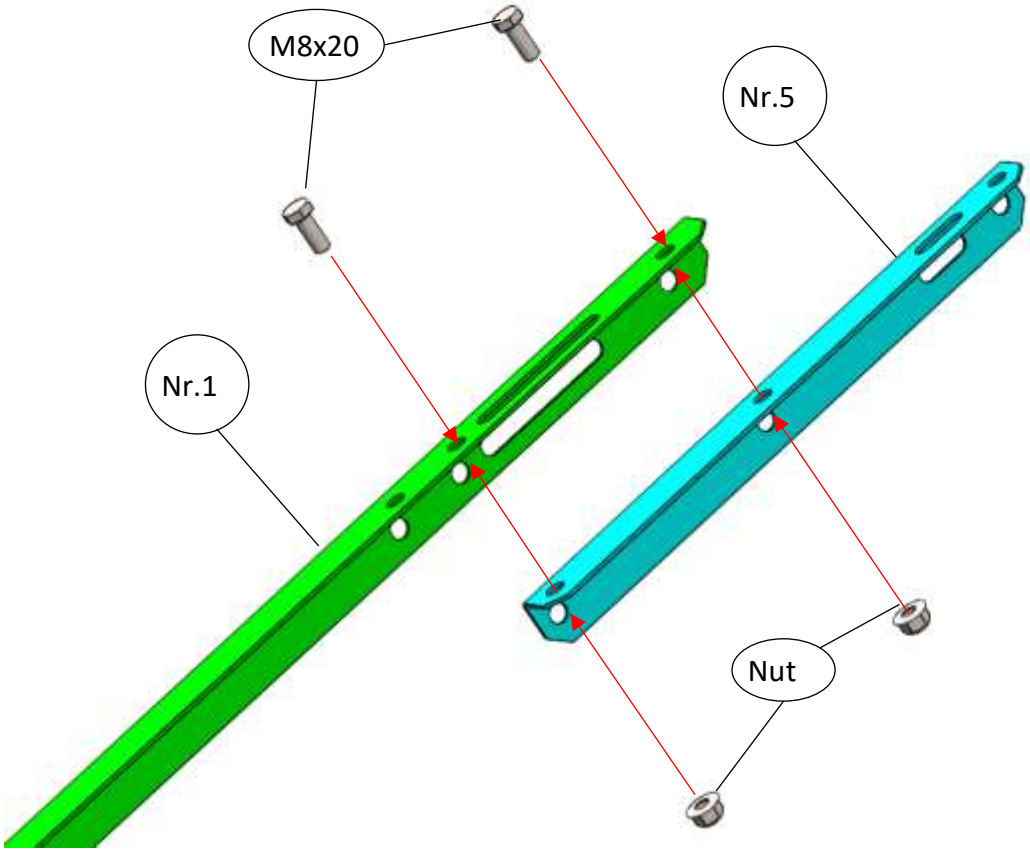


***All of the above dimensions are valid for inclined roof installations too.**

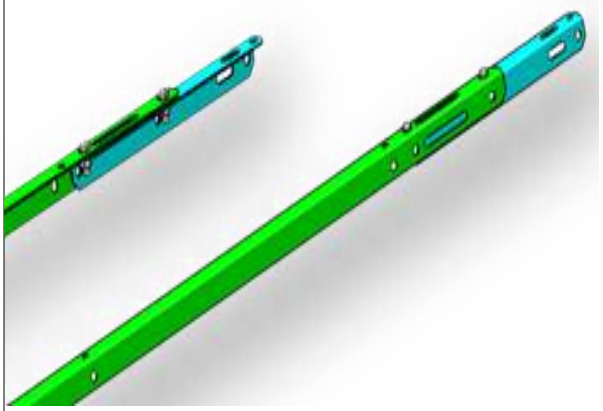
9.4.3 Support Assembly

STEP A

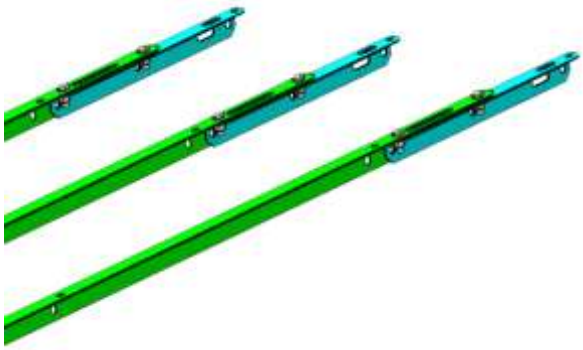
VALID FOR 1X OR 2X OR 3X 2.72m² COLLECTORS



Repeat for all sides

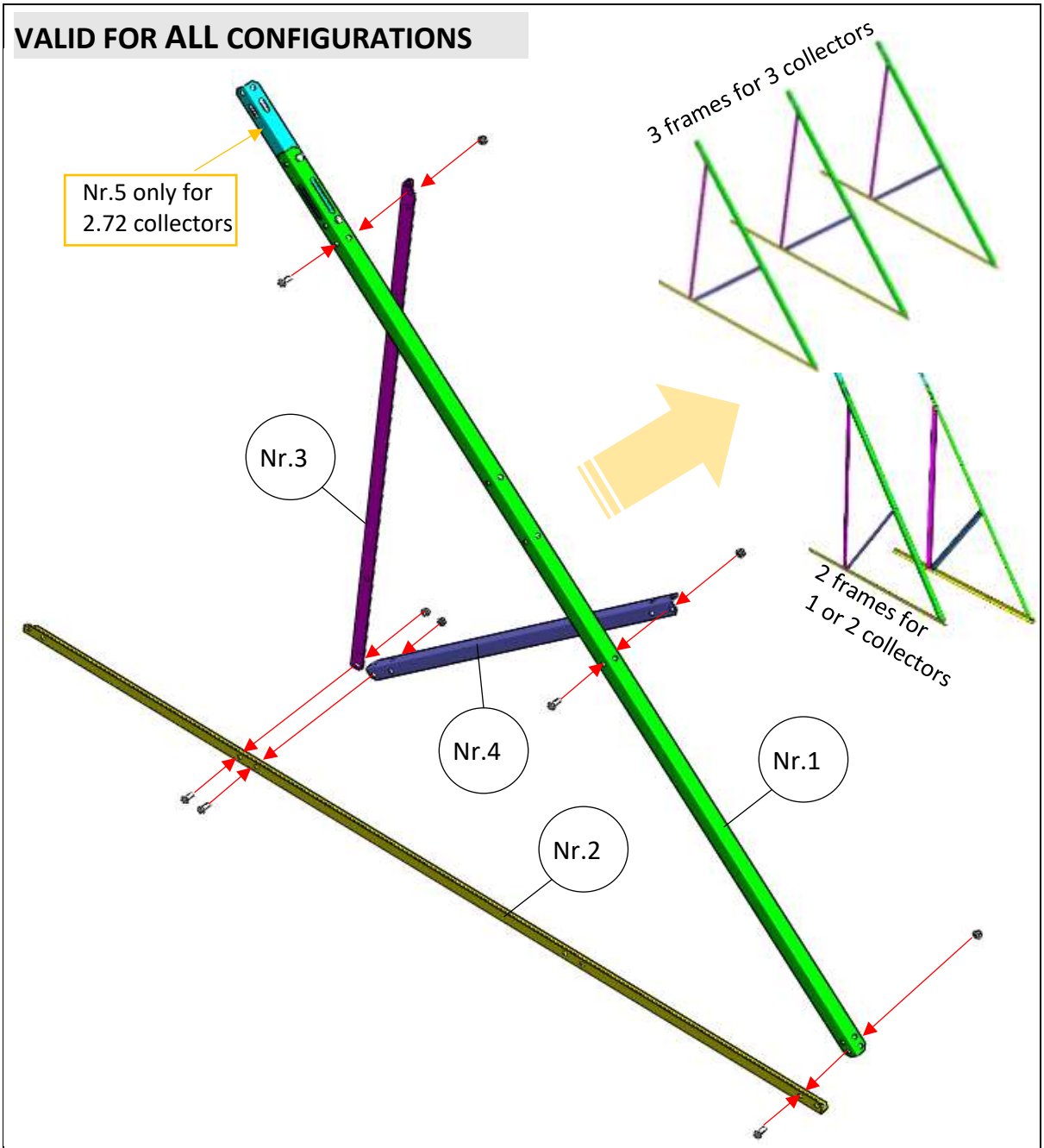


For 1 or 2 collectors assemble Nr.1 with Nr.5 as shown above (one side facing the other "mirror-like").



For 3 collectors assemble Nr.1 with Nr.5 as shown above (all facing the same side)

STEP B: Lateral frames



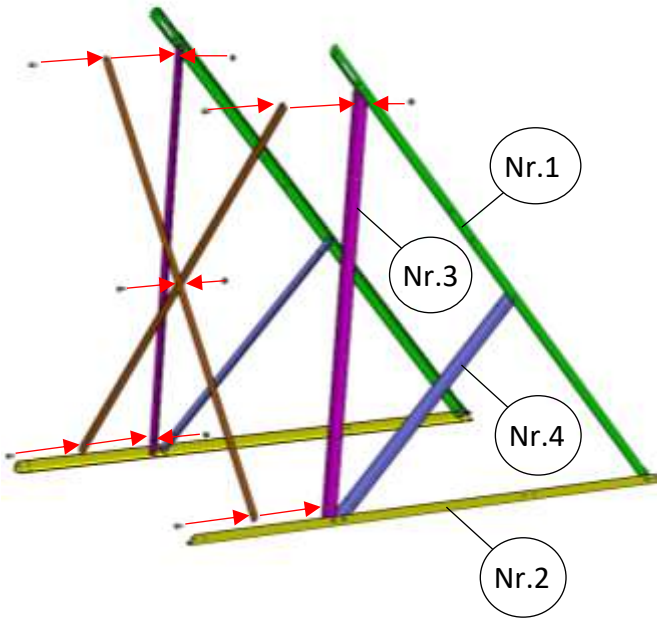
For all connections described in step B use bolts Nr.12 (M8x20) and corresponding flanged nuts Nr.14 (8mm).
Beams in step B are:
Nr.1: 2140mm
Nr.2: 1984mm
Nr.3: 1384mm
Nr.4: 960mm

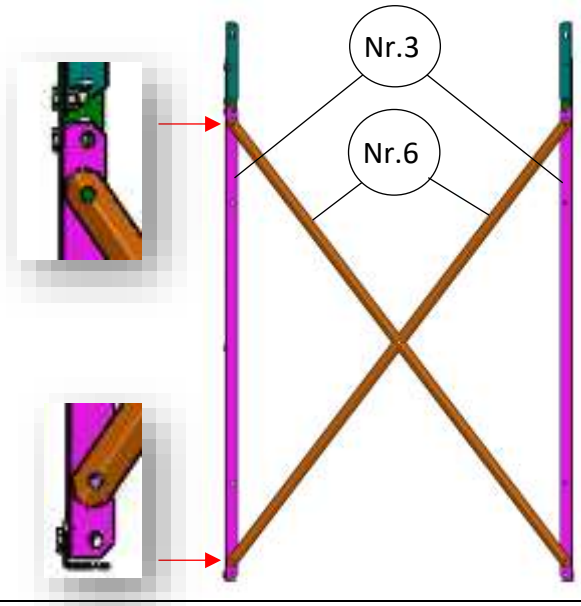
Assemble 2 lateral frames for 1 or 2 collectors and 3 lateral frames for 3 collectors

STEP C: Back cross bars

I) VALID FOR 1X COLLECTOR OR 2X2.00m² COLLECTORS

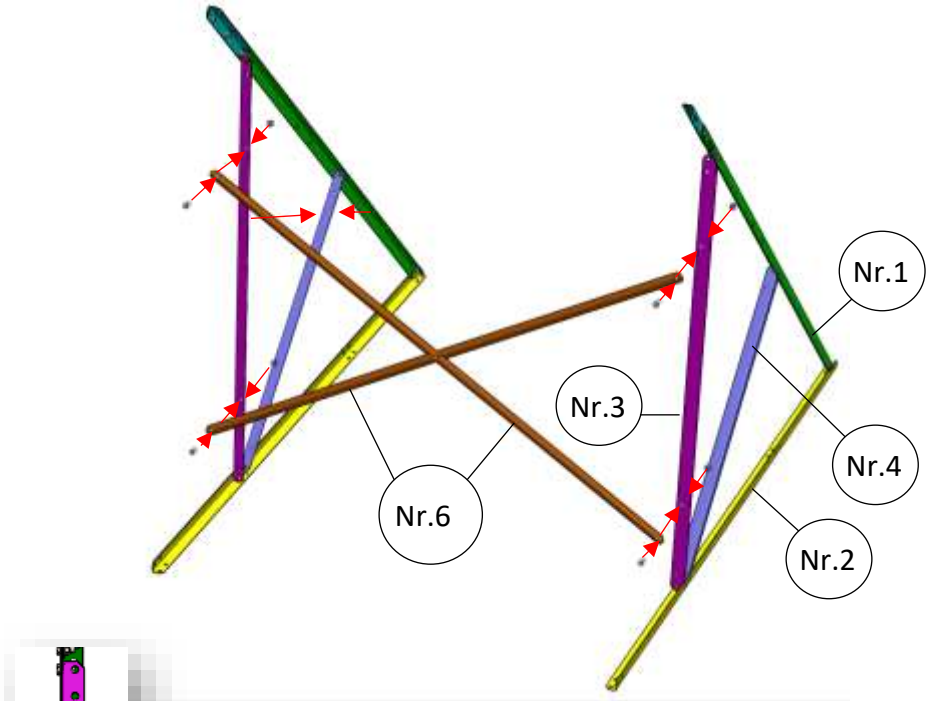
G

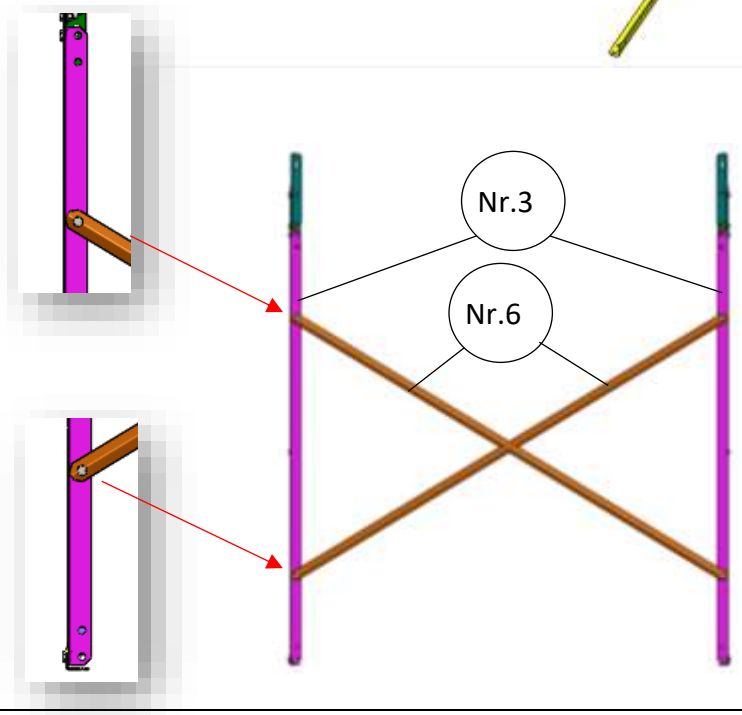




For all connections described in step B use bolts Nr.12 (M8x20) and corresponding flanged nuts Nr.14 (8mm). Beams in step C are:
Nr.1: 2140mm
Nr.2: 1984mm
Nr.3: 1384mm
Nr.4: 960mm
Nr.5:325mm (only for 2.72m² collector/s)
Nr.6: 1620mm

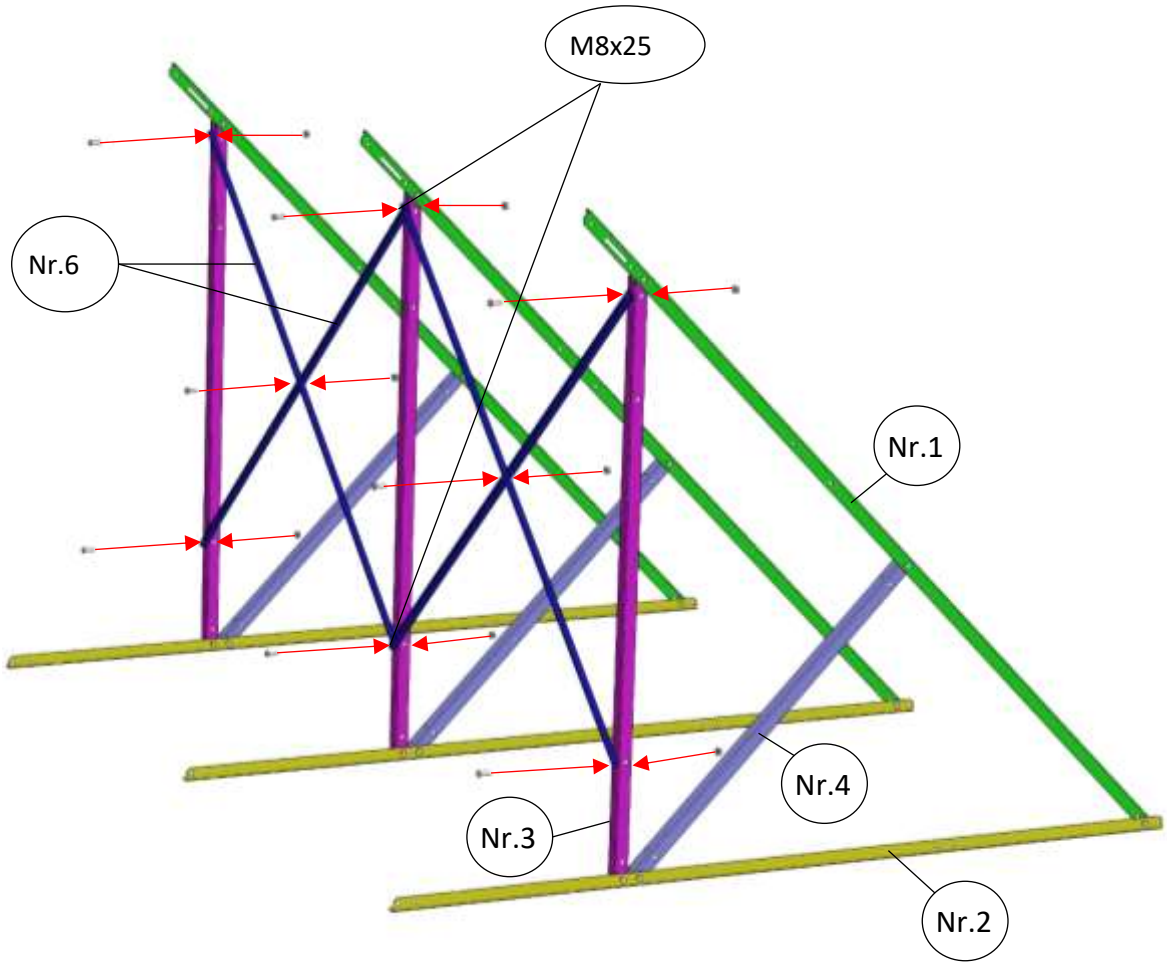
II) VALID FOR 2X2.37/2.72m² COLLECTORS





For all connections described in step B use bolts Nr.12 (M8x20) and corresponding flanged nuts Nr.14 (8mm). Beams in step C are:
Nr.1: 2140mm
Nr.2: 1984mm
Nr.3: 1384mm
Nr.4: 960mm
Nr.5:325mm (only for 2.72m² collectors)
Nr.6: 1620mm

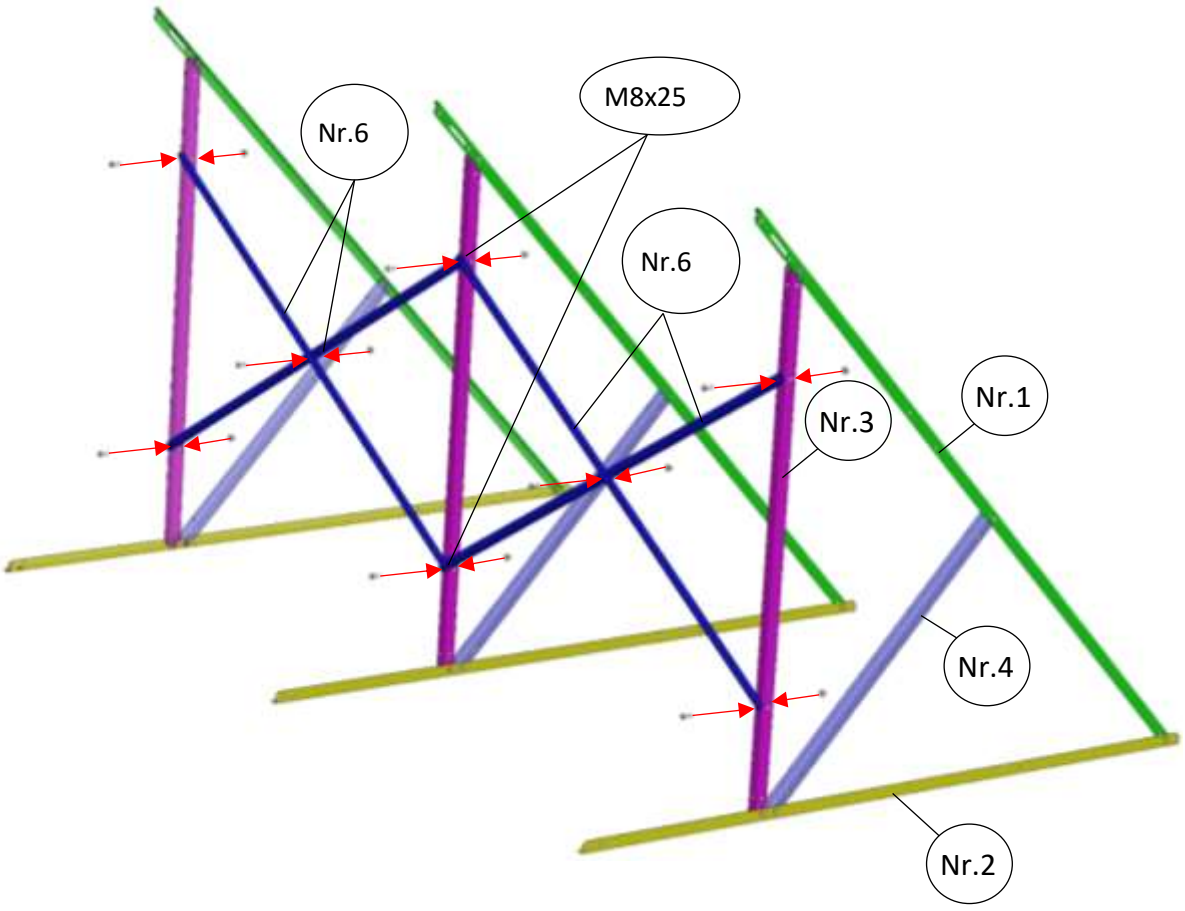
III) VALID FOR 3X2.00m² COLLECTORS



For all connections described in step B use bolts Nr.12 (M8x20) except where indicated and corresponding flanged nuts Nr.14 (8mm). Beams in step C are:

Nr.1: 2140mm
Nr.2: 1984mm
Nr.3: 1384mm
Nr.4: 960mm
Nr.6: 1620mm

IV) VALID FOR 3X2.37/2.72m² COLLECTORS

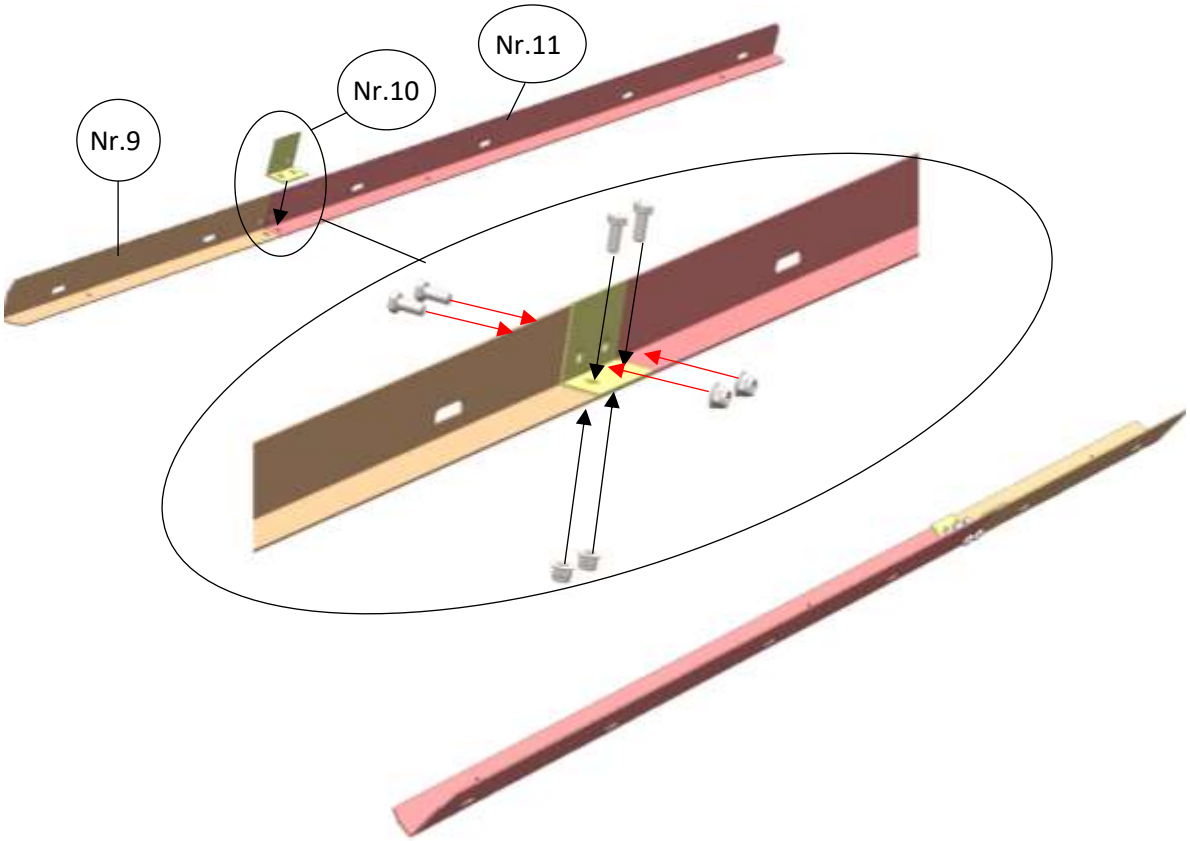


For all connections described in step B use bolts Nr.12 (M8x20) except where indicated and corresponding flanged nuts Nr.14 (8mm). Beams in step C are:

Nr.1: 2140mm
Nr.2: 1984mm
Nr.3: 1384mm
Nr.4: 960mm
Nr.6: 1620mm

STEP D: Assemble the collector beams

VALID FOR 3X COLLECTORS



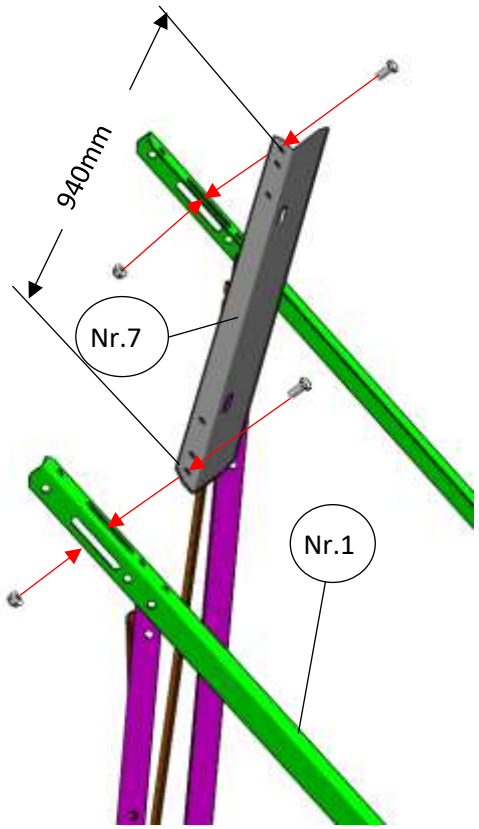
For all connections described in step D use bolts Nr.12 (M8x20) and corresponding flanged nuts Nr.14 (8mm). Beams in step D are:

- **For 3x2.00m²** collectors:
  a. Nr.9 is 960mm
  b. Nr.11 is 2000mm
- For **3x2.37m²** collectors:
  a. Nr.9 is 1000mm
  b. Nr.11 is 2300mm
- For **3x2.72m²** collectors:
  a. Nr.9 is 1015mm
  b. Nr.11 is 2345mm

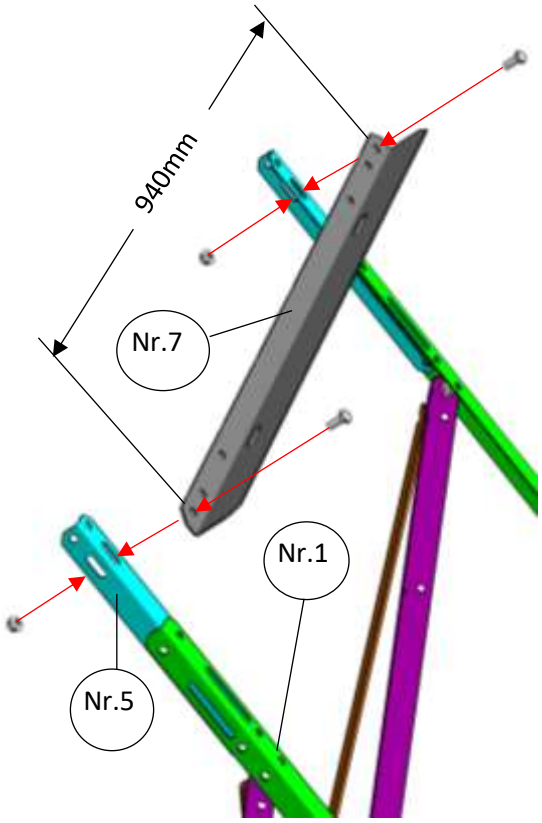
Nr.10 is the connecting link

STEP E: Attach the collector beams

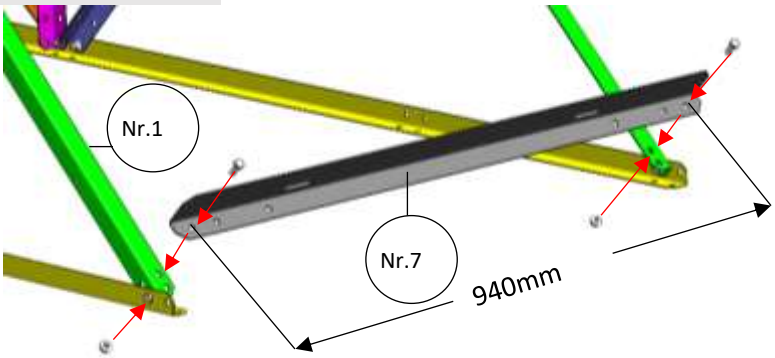
VALID FOR 1X2.00/2.37m²



VALID FOR 1x2.72m²

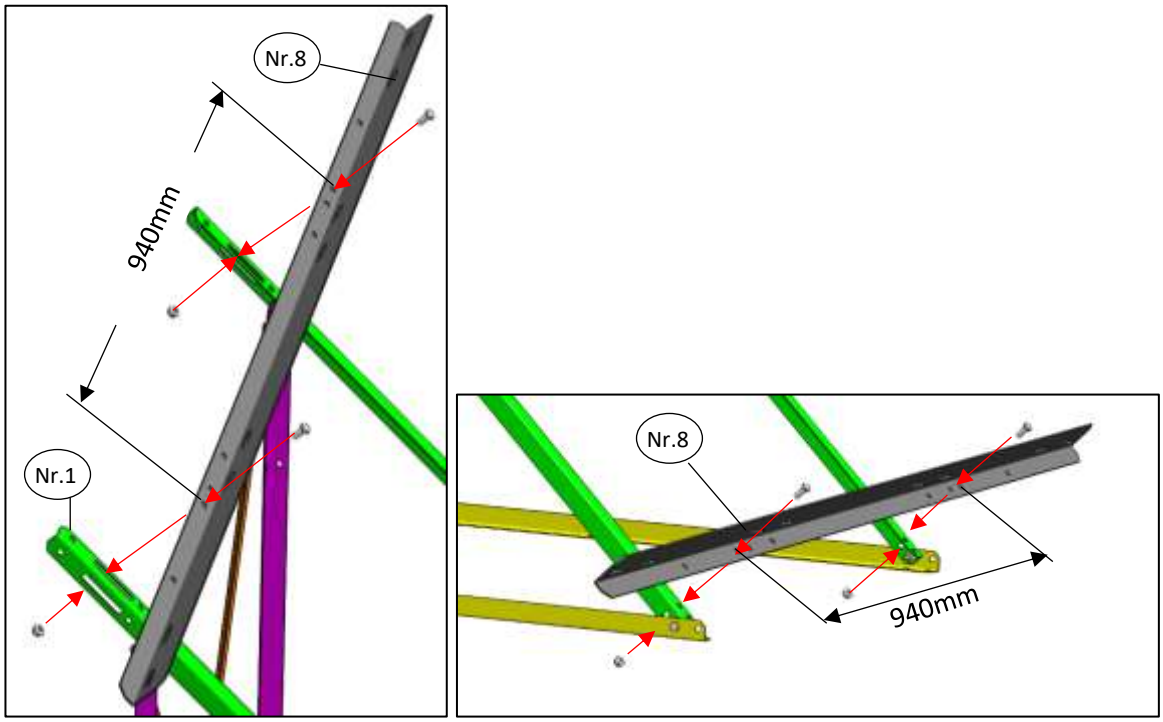


VALID FOR 1X COLLECTOR

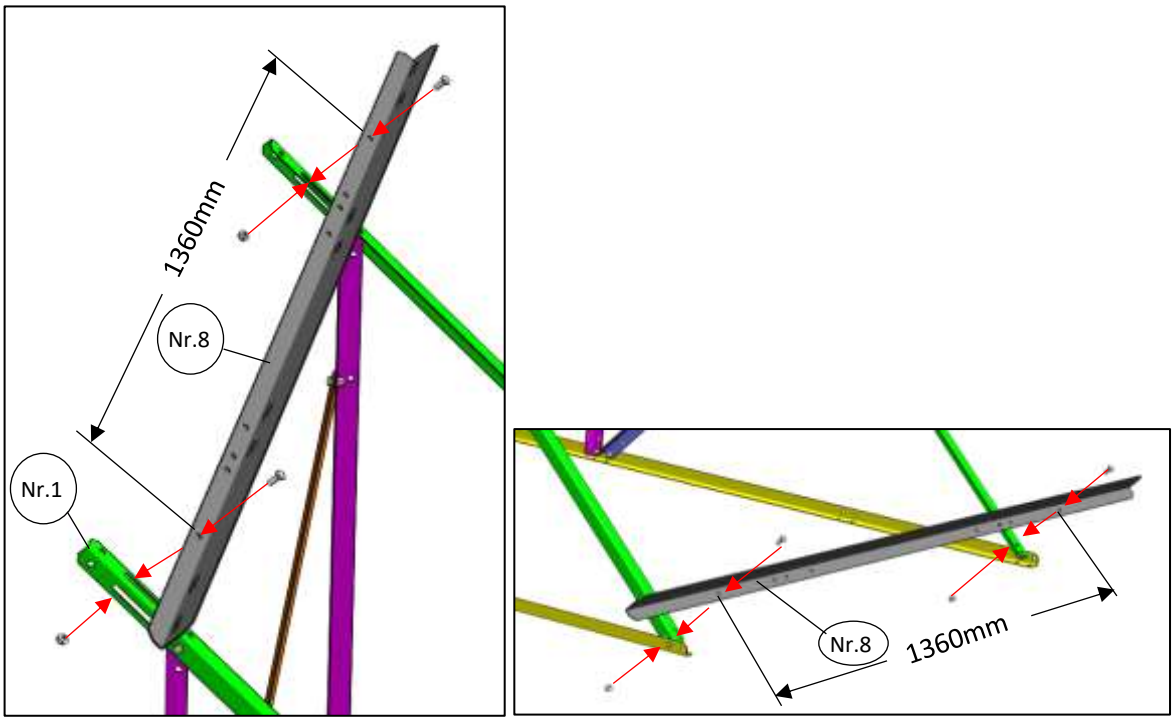


For all connections described in step E use bolts Nr.12 (M8x20) and corresponding flanged nuts

I) VALID FOR 2X2.00m² COLLECTORS

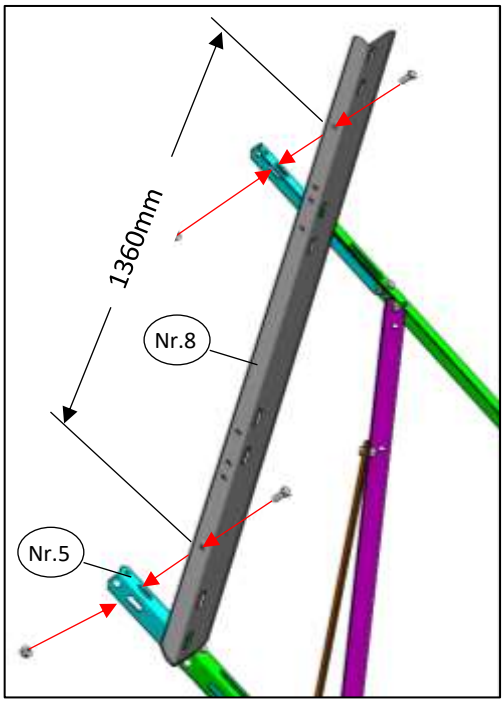


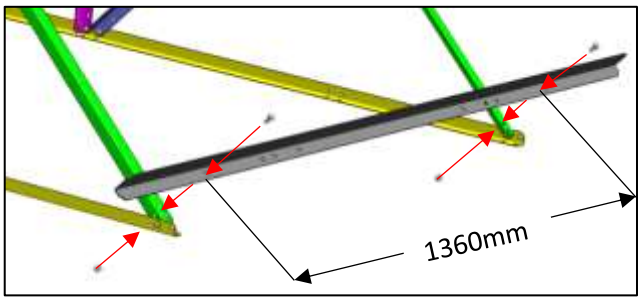
II) VALID FOR 2X2.37m² COLLECTORS



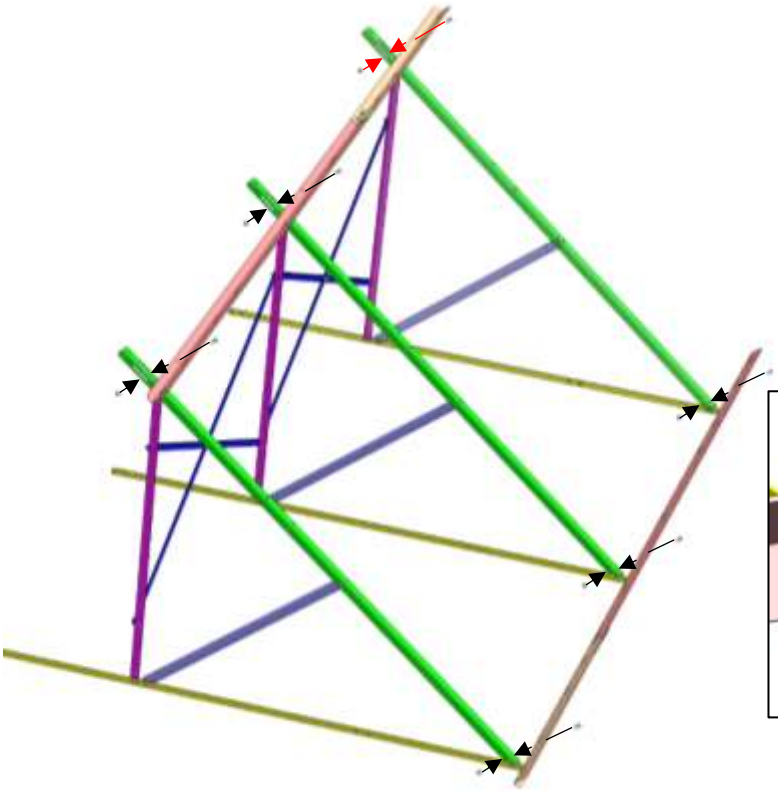
For all connections described in step E use bolts Nr.12 (M8x20) and corresponding flanged nuts

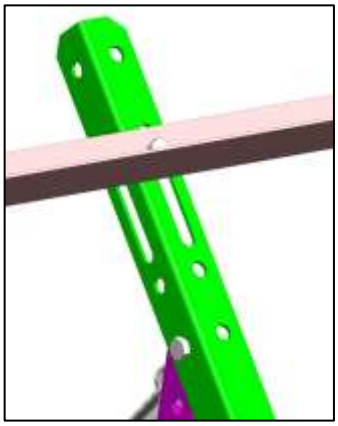
III) VALID FOR 2X2.72m² COLLECTORS

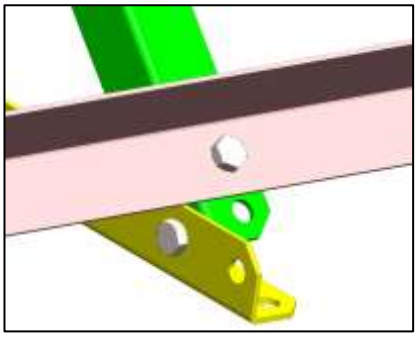




IV) VALID FOR 3X2.00/2.37m² COLLECTORS

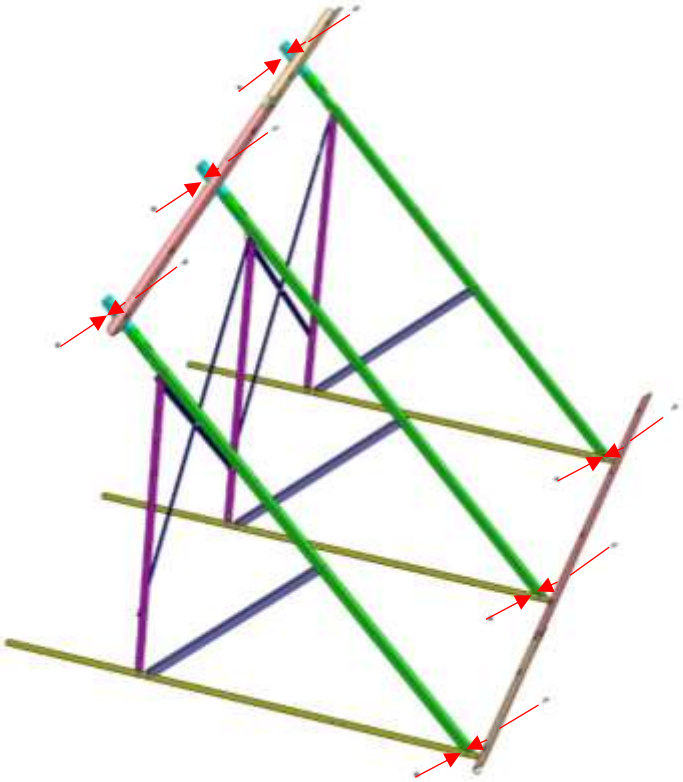


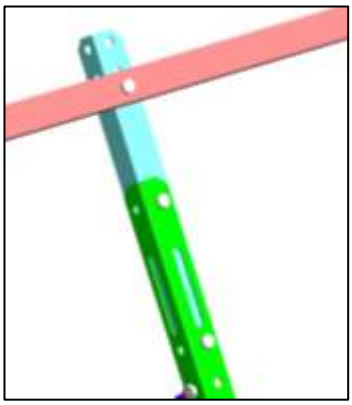


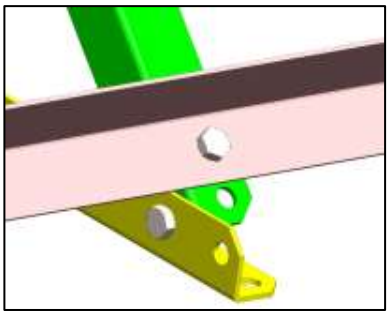


For all connections described in step E use bolts Nr.12 (M8x20) and corresponding flanged nuts

V) VALID FOR 3X2.72m² COLLECTORS



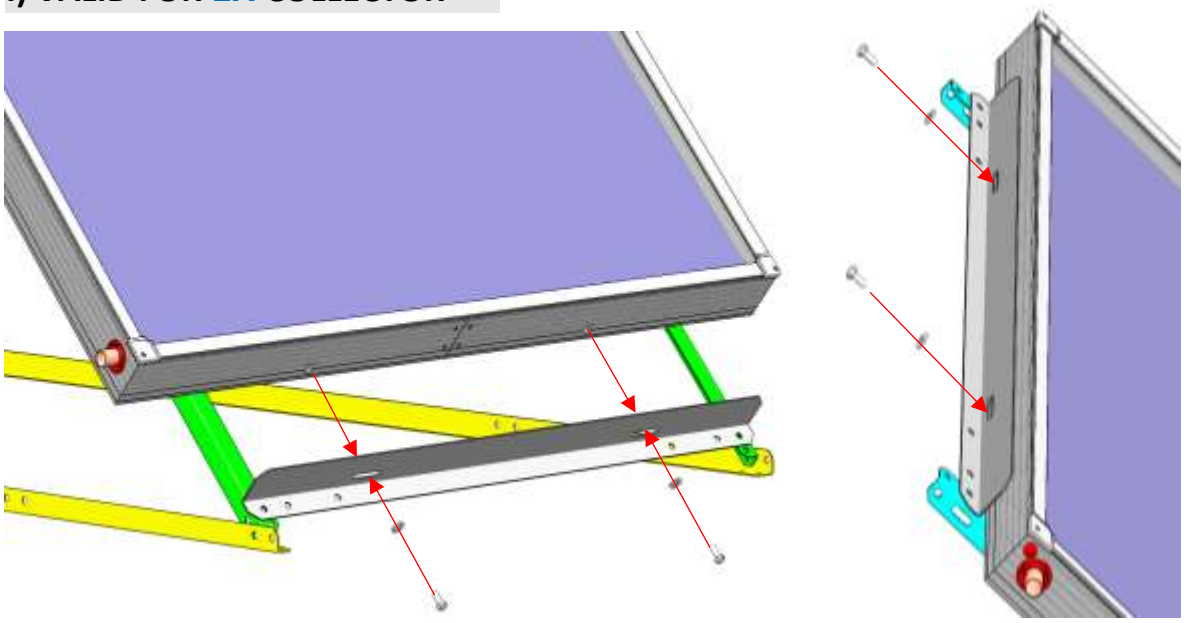




For all connections described in step E use bolts Nr.12 (M8x20) and corresponding flanged nuts

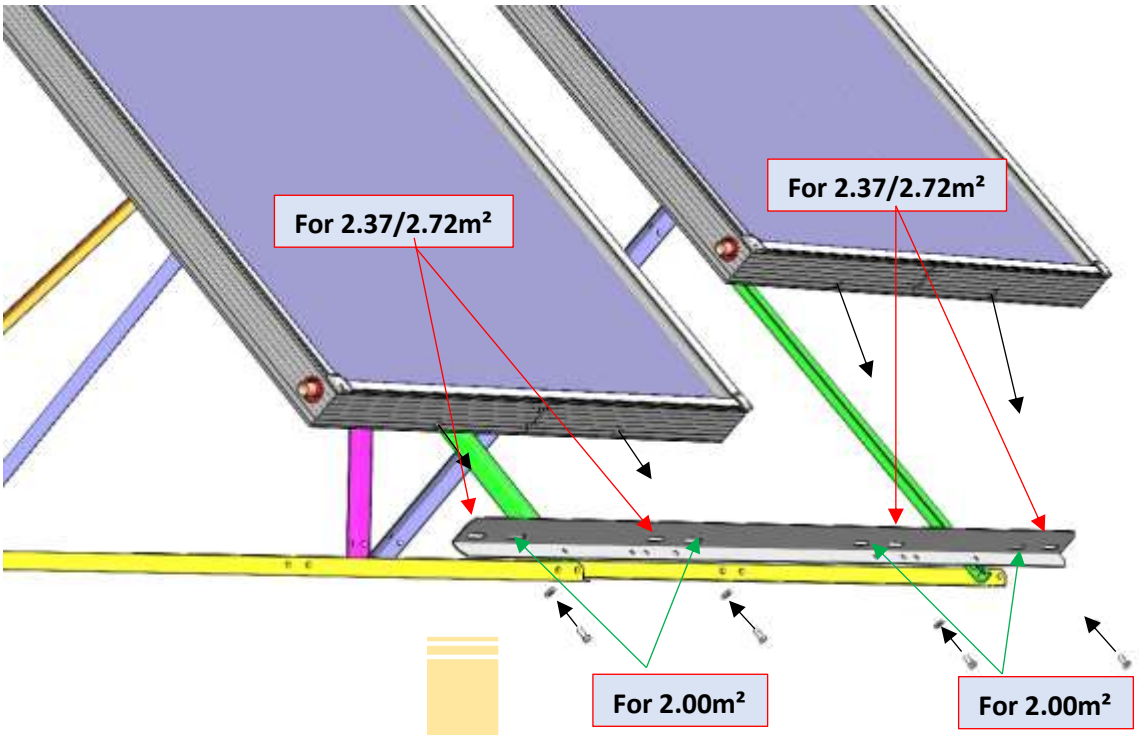
STEP F: Attach the collectors

I) VALID FOR 1X COLLECTOR

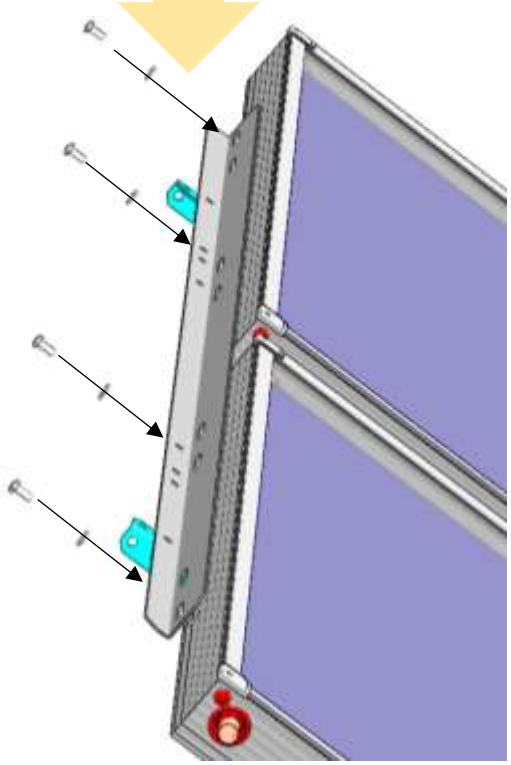


Connect the lower part and then adjust upper No.7 and tight all 4x M8 bolts and washers through the rivets of the collector. Same for all sizes.

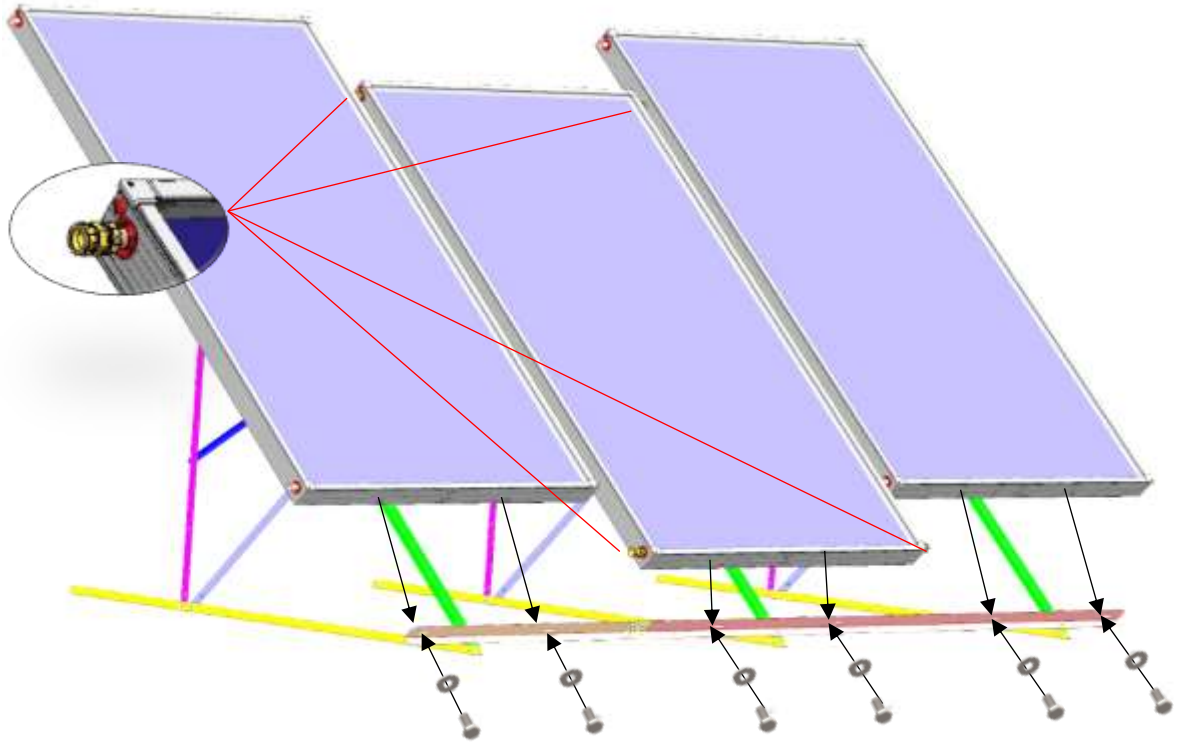
II) VALID FOR 2X COLLECTORS



First place the left collector. Connect lower collector's support frame Nr.7 with the collector through the M8 rivets, using two M8x20 bolts and washers, but don't tighten them up yet. Then connect the collector on the right like before, but do not tighten them up yet, but after hydraulic fittings are placed. Then move the upper support Nr.7 on the collector and tighten up in the same manner

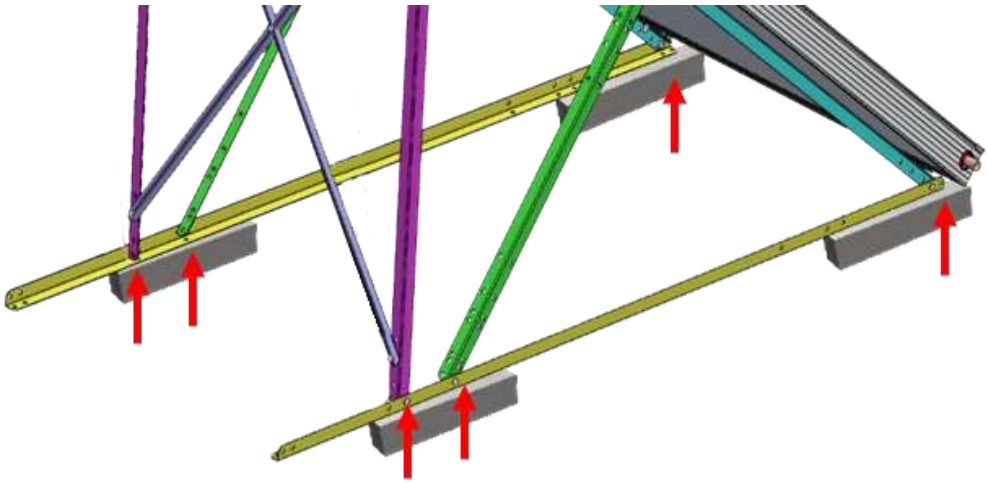


III) VALID FOR 3X COLLECTORS



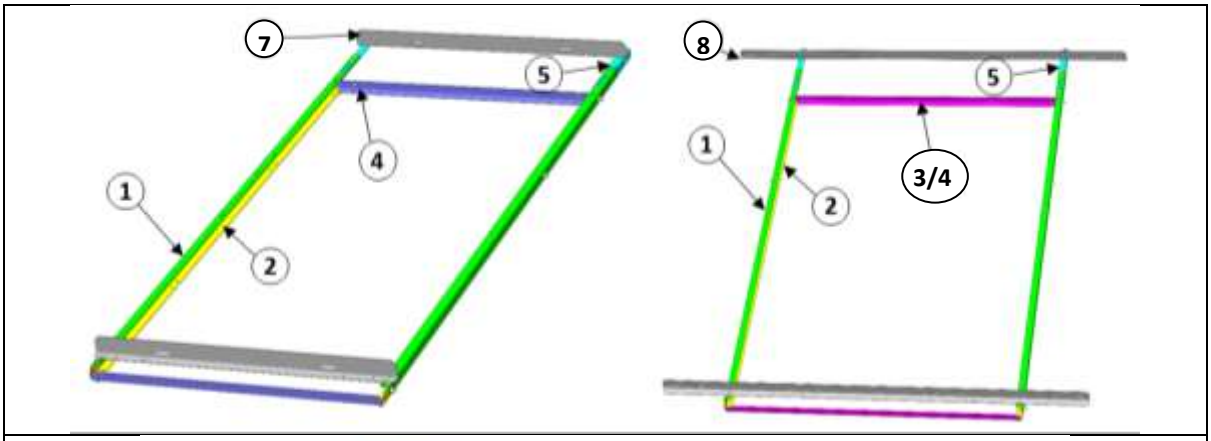
Install first the collector in the middle. Install hydraulic connectors. Then attach left & right. Connect at the exact positions illustrated. Use M8x20 bolts and washers.

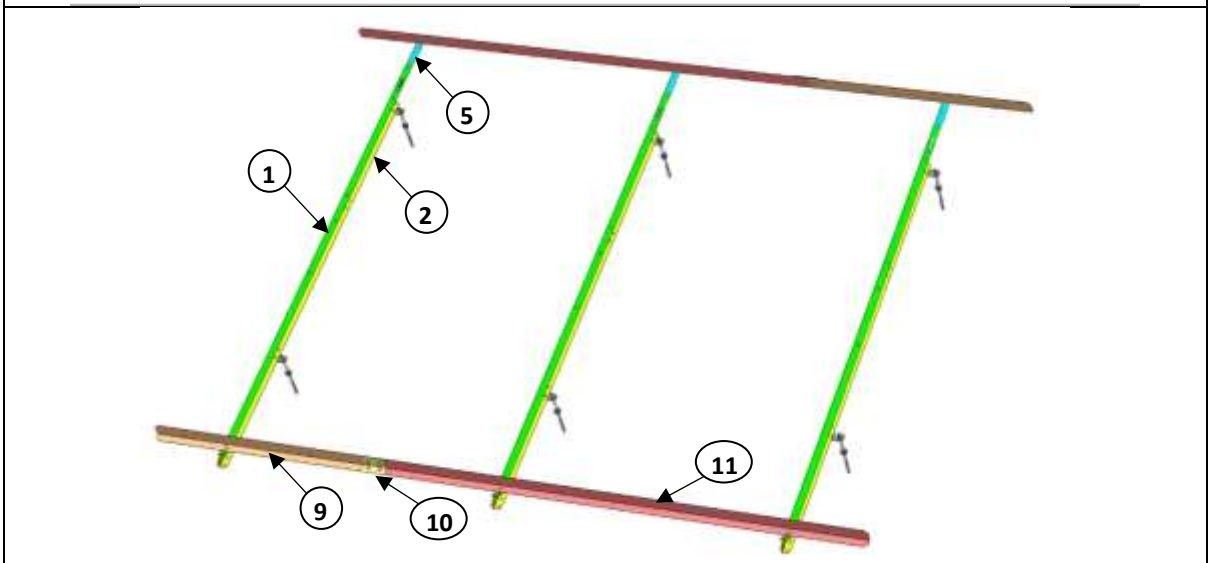
STEP G: Mount the support



Please attach all beams Nr.2 (yellow) either on the flat roof or on slabs like seen above. Anchors must be in the front of the support as indicated above and choose one of the 2 positions indicated above on the back side of the support. 4 x anchor bolts and 4 x anchors are included in the kit.

9.5 Inclined roof

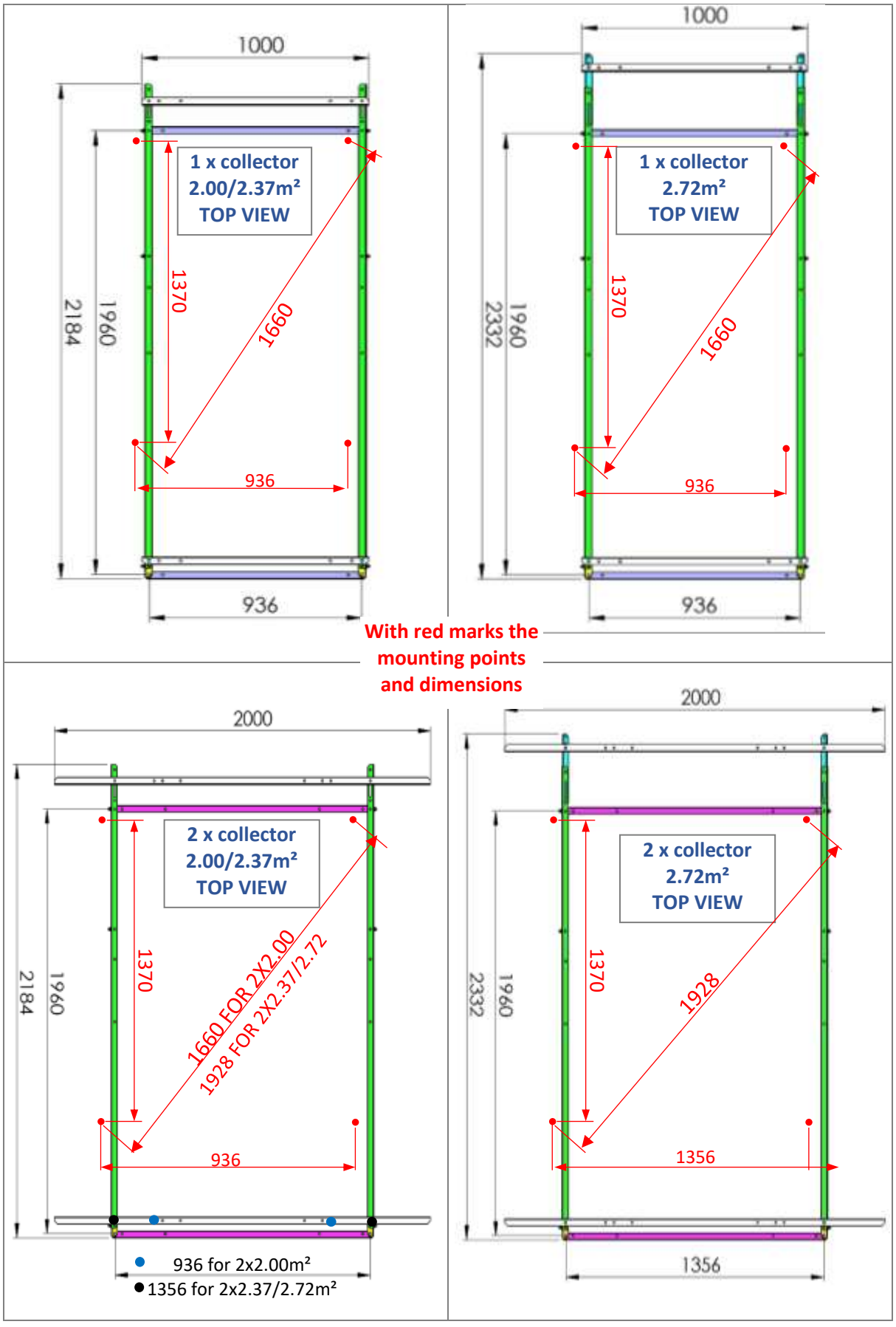


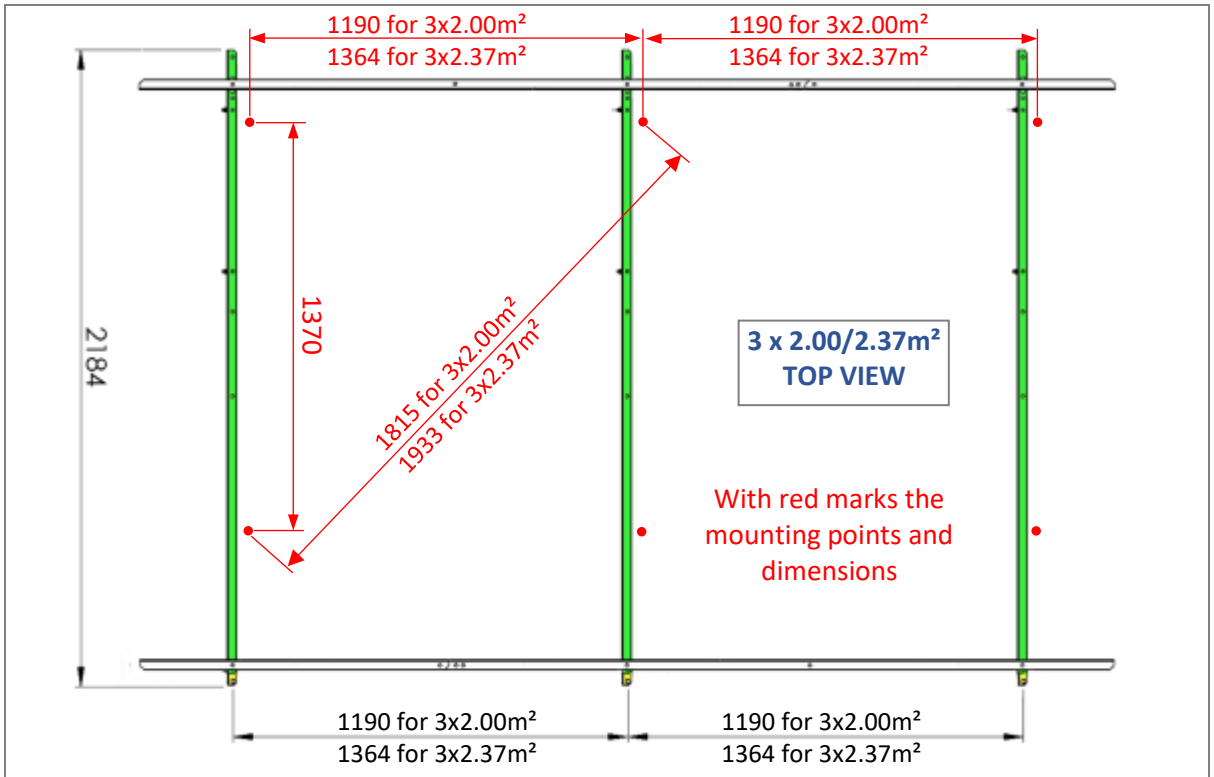


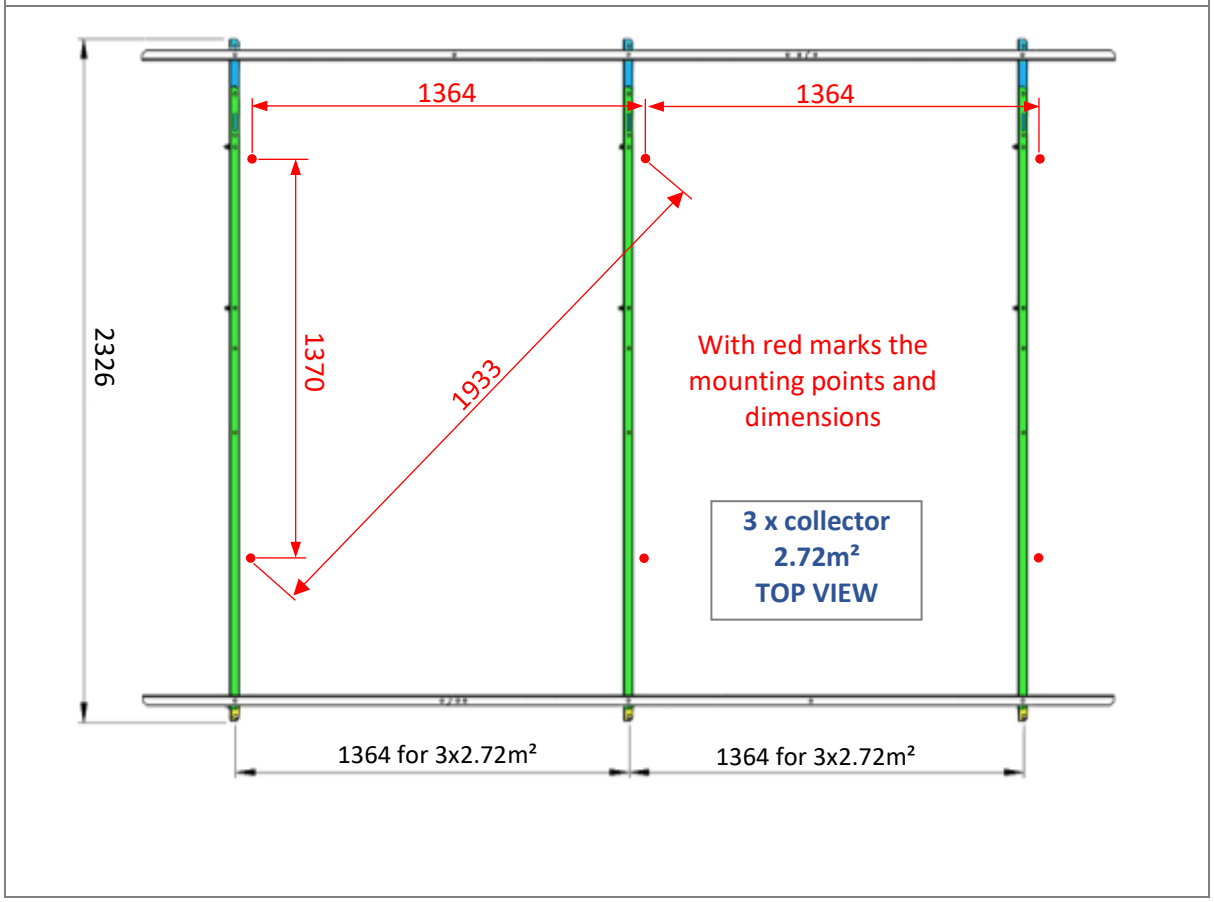
Support structure Parts list									
a/a	Description	1x 2.00-2.37	1x 2.72	2x 2.00	2x2.37	2x 2.72	3x 2.00	3x 2.37	3x 2.72
1	"L" profile 2140mm	2	2	2	2	2	3	3	3
2	"L" profile 1984mm	2	2	2	2	2	3	3	3
3	"L" profile 1380mm	0	0	0	2	2	0	0	0
4	"L" profile 960mm	2	2	2	0	2	0	0	0
5	"L" profile 325mm	0	2	0	0	2	0	0	3
6	Cross bar 1620mm	0	0	0	0	0	0	0	0
7	"L" profile 1000mm	2	2	0	0	0	0	0	0
8	"L" profile 2000mm	0	0	2	2	2	0	0	0
9a	"L" profile split 960mm	0	0	0	0	0	2	0	0
9b	"L" profile split 1000mm	0	0	0	0	0	0	2	0
9c	"L" profile split 1015mm	0	0	0	0	0	0	0	2
10	"L" profile 100mm	0	0	0	0	0	2	2	2
11a	"L" profile split 2000mm	0	0	0	0	0	2	0	0
11b	"L" profile split 2300mm	0	0	0	0	0	0	2	0
11c	"L" profile split 2345mm	0	0	0	0	0	0	0	2
12	DIN933 bolts M8x20	22	26	26	26	30	41	41	47
13	DIN933 bolts M8x30	0	0	0	0	0	0	0	0
14	DIN6923 nuts 8mm	18	18	18	18	22	29	29	35
15	DIN9021 washers 8.5mm	4	4	8	8	8	12	12	12
16	Dowel screw kit M10x300	4	4	4	4	4	6	6	6

Table 27

9.5.1 Important dimensions



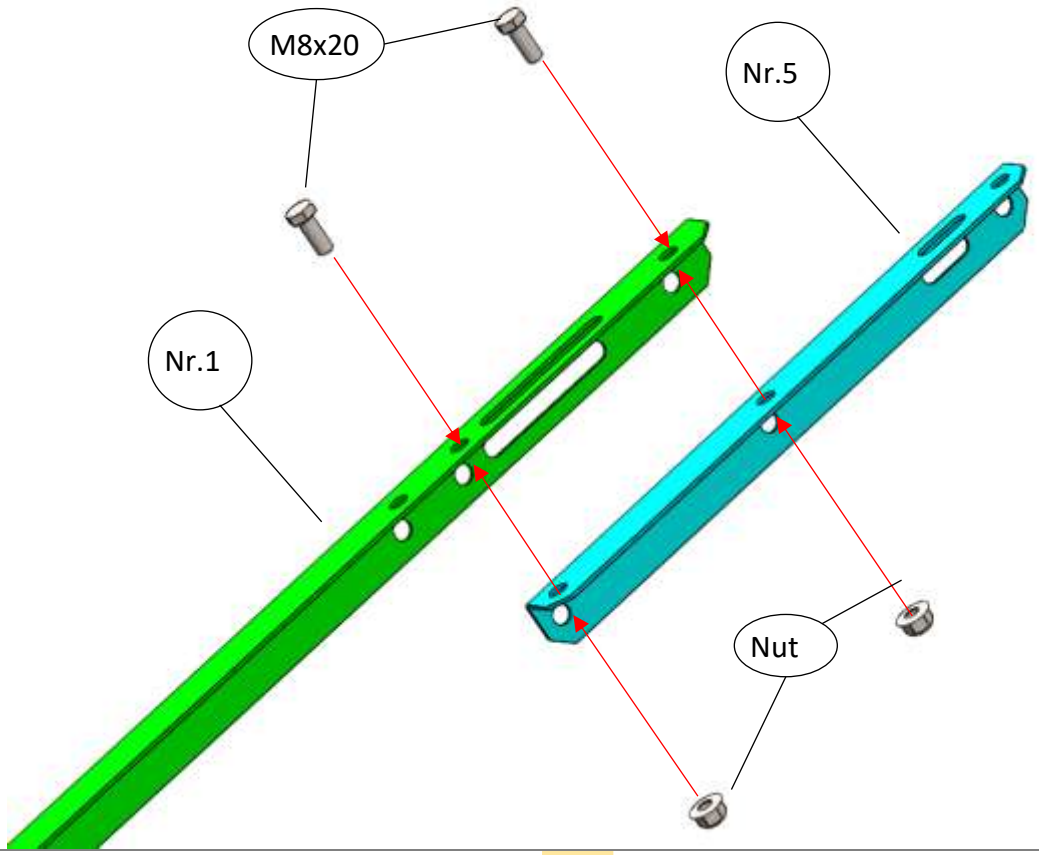

1190 for 3x2.00m²
1364 for 3x2.37m²
1190 for 3x2.00m²
1364 for 3x2.37m²
2184
1370
1815 for 3x2.00m²
1933 for 3x2.37m²
3 x 2.00/2.37m²
TOP VIEW
With red marks the mounting points and dimensions
1190 for 3x2.00m²
1364 for 3x2.37m²
1190 for 3x2.00m²
1364 for 3x2.37m²


1364
1364
2326
1370
1933
With red marks the mounting points and dimensions
3 x collector
2.72m²
TOP VIEW
1364 for 3x2.72m²
1364 for 3x2.72m²

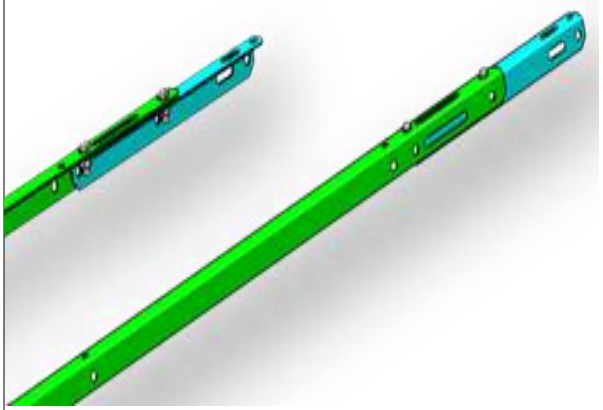
9.5.2 Support Assembly

STEP A

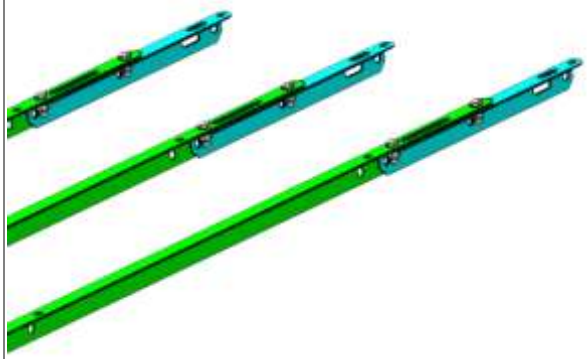
VALID FOR 1X OR 2X OR 3X 2.72m² COLLECTORS



Repeat for all sides



For 1 or 2 collectors assemble Nr.1 with Nr.5 as shown above (one side facing the other "mirror-like").

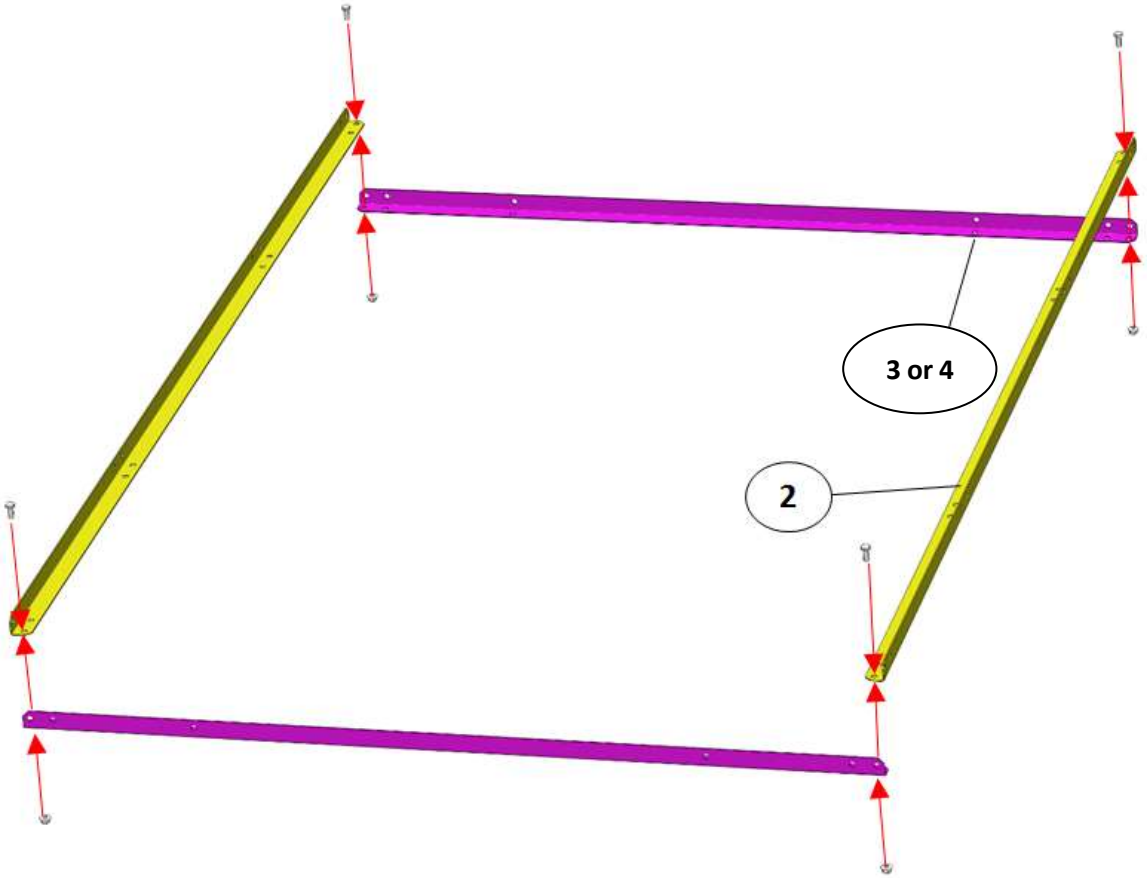


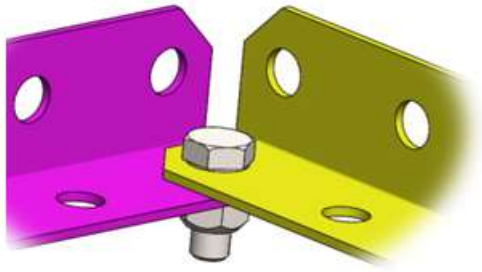
For 3 collectors assemble Nr.1 with Nr.5 as shown above (all facing the same side)

STEP B

VALID ONLY FOR 1X OR 2X COLLECTORS

LOWER FRAME ASSEMBLY

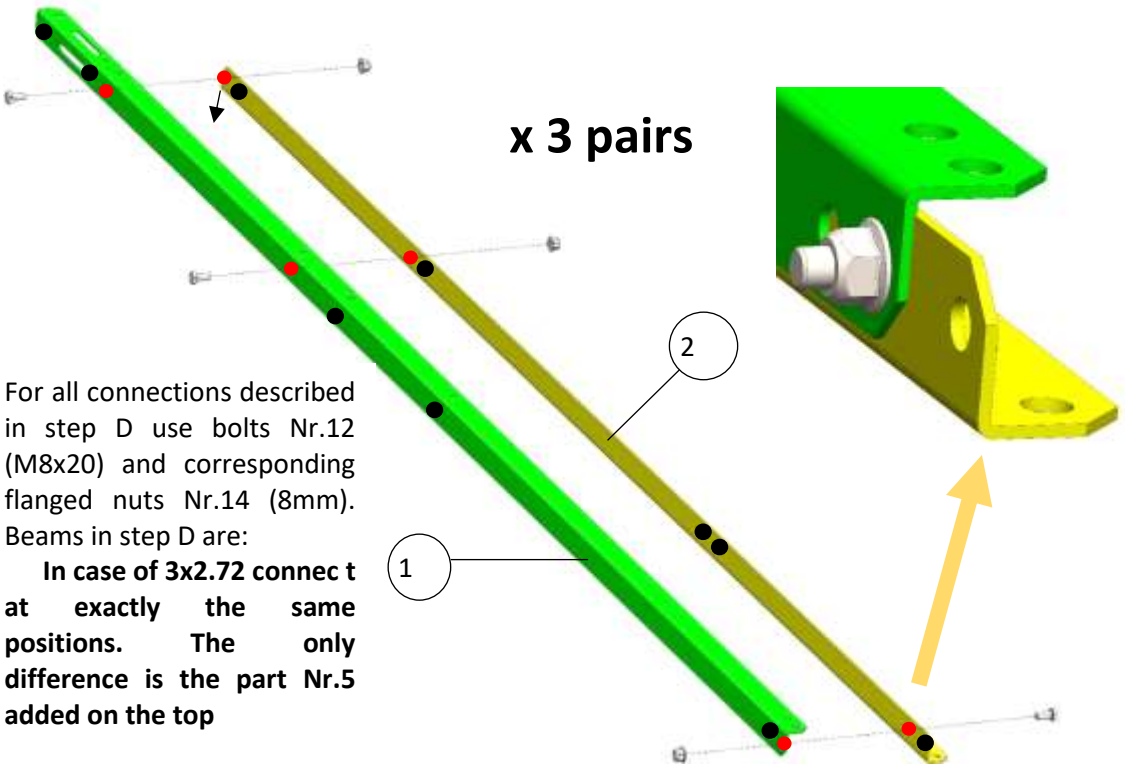




For all connections described in step D use bolts Nr.12 (M8x20) and corresponding flanged nuts Nr.14 (8mm). Beams in step D are:

- **For 1x2.00/2.37/2.72m² or 2x2.00m²** collectors use beam Nr.4 (960mm)
- **For 2x2.37/2.72m²** collectors use beam Nr.3 (1380mm)

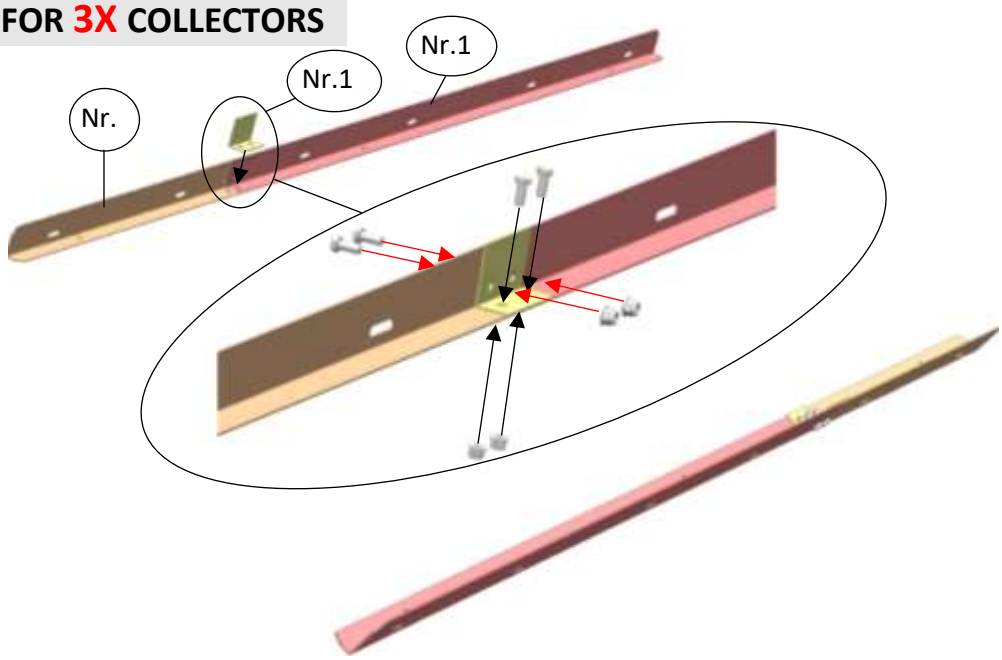
VALID FOR 3X COLLECTORS



For all connections described in step D use bolts Nr.12 (M8x20) and corresponding flanged nuts Nr.14 (8mm). Beams in step D are:

In case of 3x2.72 connec t at exactly the same positions. The only difference is the part Nr.5 added on the top

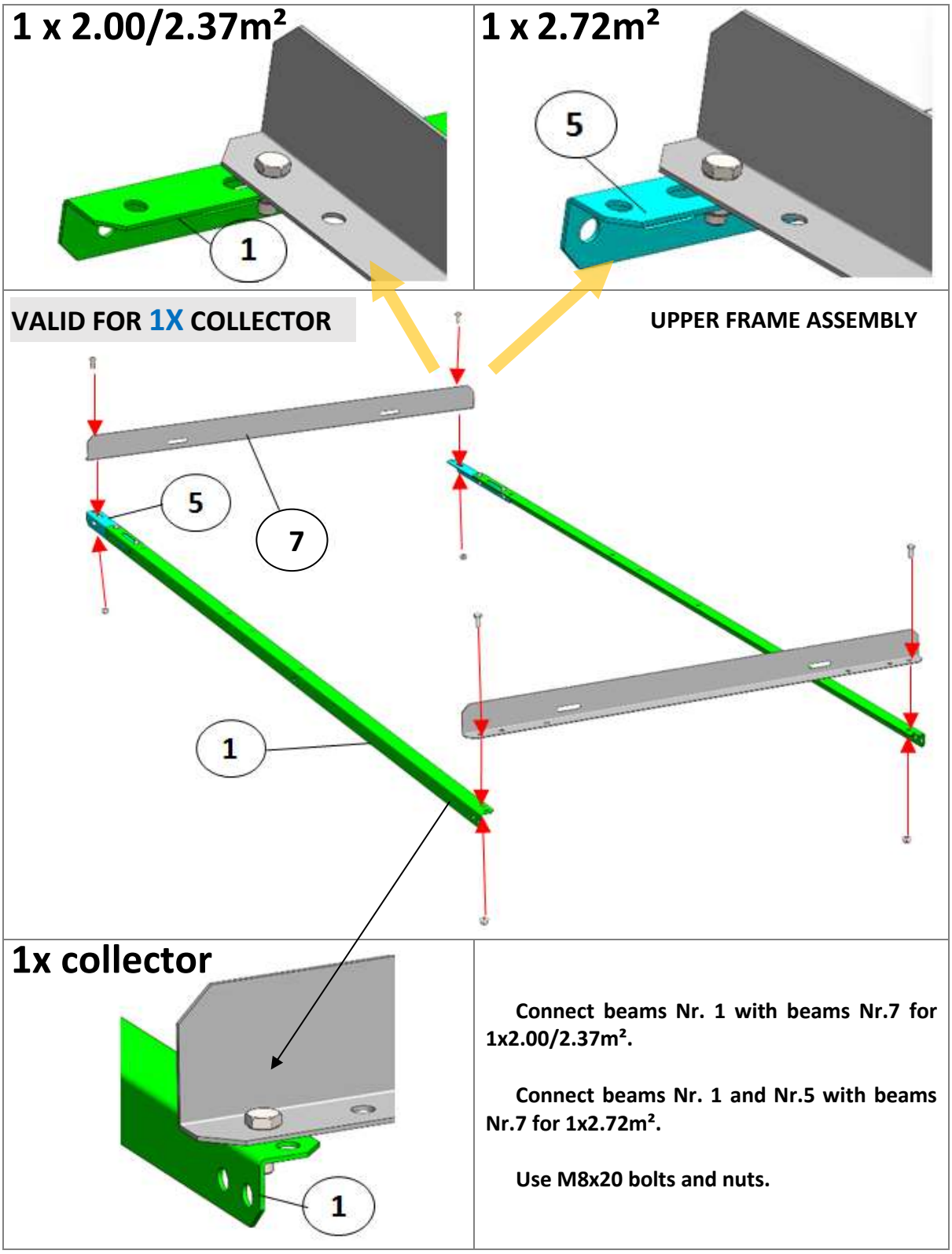
VALID FOR 3X COLLECTORS



For all connections described in step D use bolts Nr.12 (M8x20) and corresponding flanged nuts Nr.14 (8mm). Beams in step D are:

For 3x2.00m² collectors: Nr.9 is 960mm Nr.11 is 2000mm	For 3x2.37m² collectors: Nr.9 is 1000mm Nr.11 is 2300mm	For 3x2.72m² collectors: Nr.9 is 1015mm Nr.11 is 2345mm	Nr.10 is the connecting link

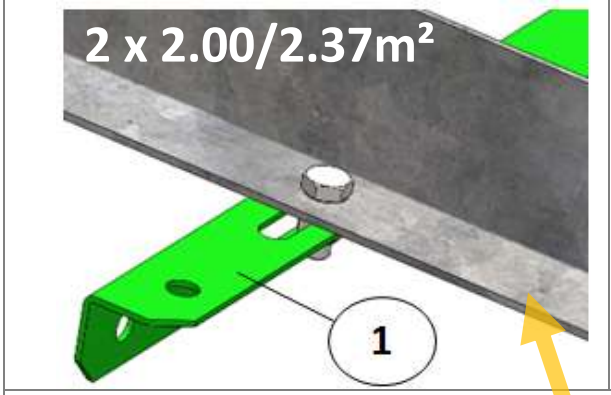
STEP C

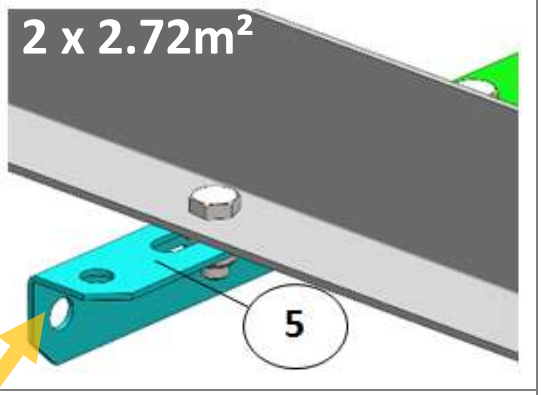


Connect beams Nr. 1 with beams Nr.7 for 1x2.00/2.37m².

Connect beams Nr. 1 and Nr.5 with beams Nr.7 for 1x2.72m².

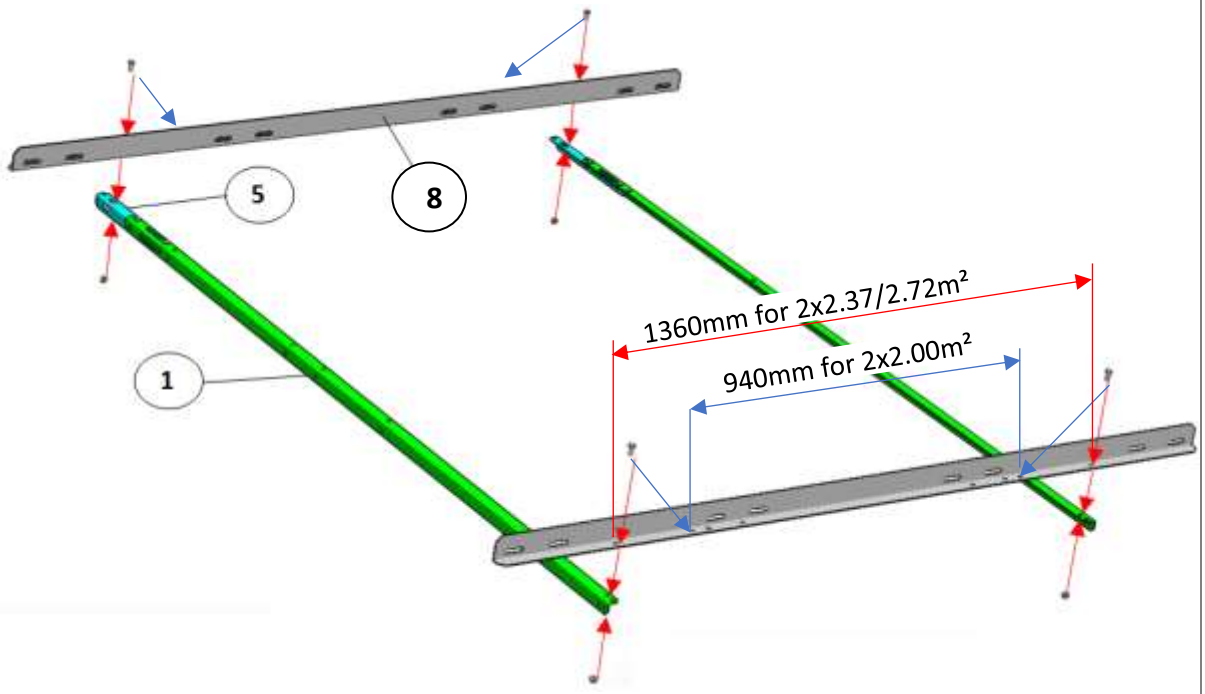
Use M8x20 bolts and nuts.

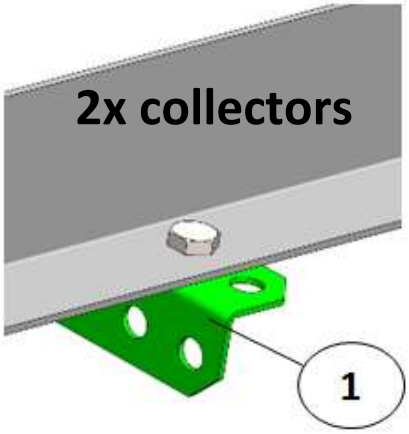




VALID FOR 2X COLLECTORS

UPPER FRAME ASSEMBLY





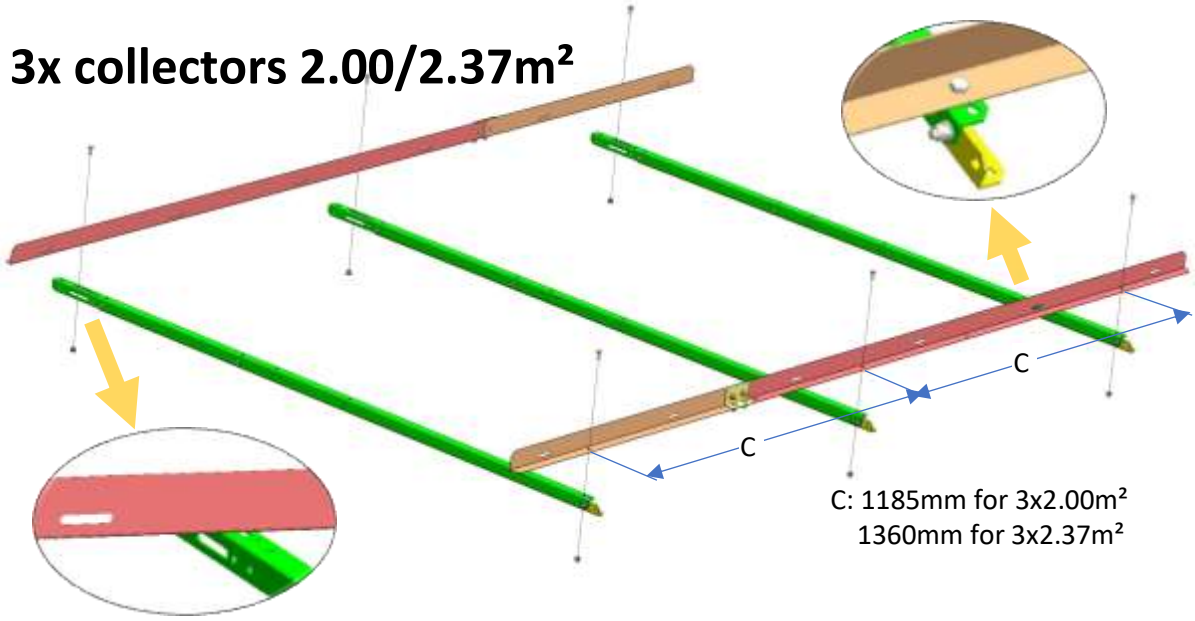
Connect beams Nr. 1 with beams Nr.7 for 1x2.00/2.37m².

Connect beams Nr. 1 and Nr.5 with beams Nr.7 for 1x2.72m².

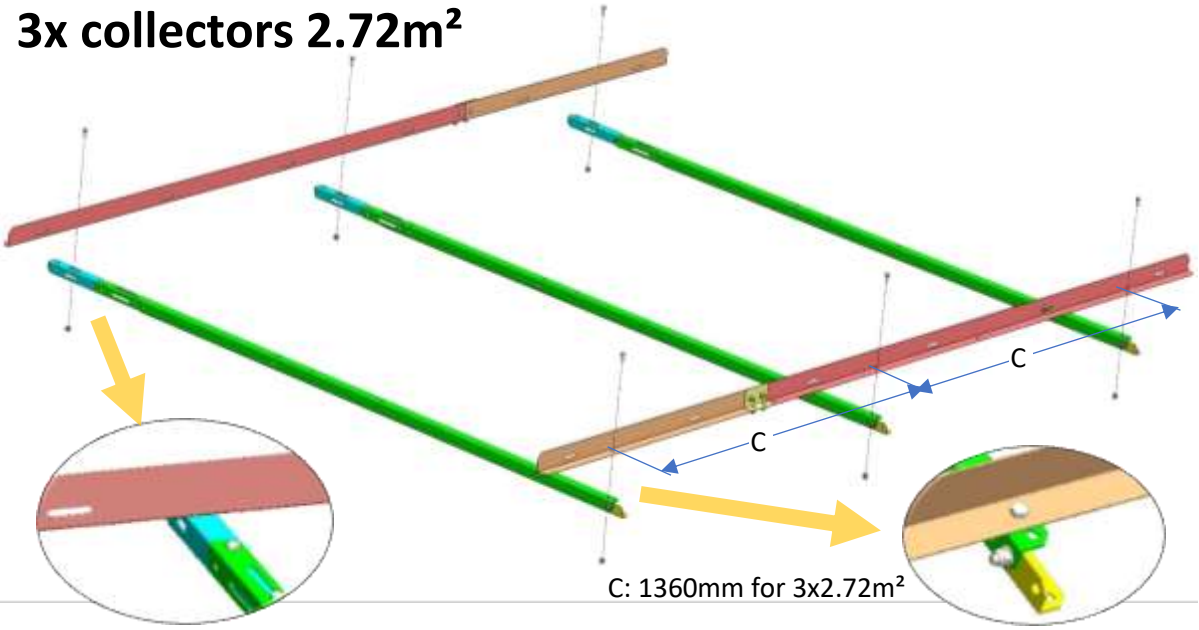
Use M8x20 bolts and nuts.

VALID FOR 1X OR 2X OR 3X 2.72m² COLLECTORS

3x collectors 2.00/2.37m²



3x collectors 2.72m²



Connect like illustrated above. Use always M8x20 bolts and nuts. The upper side is connected on:

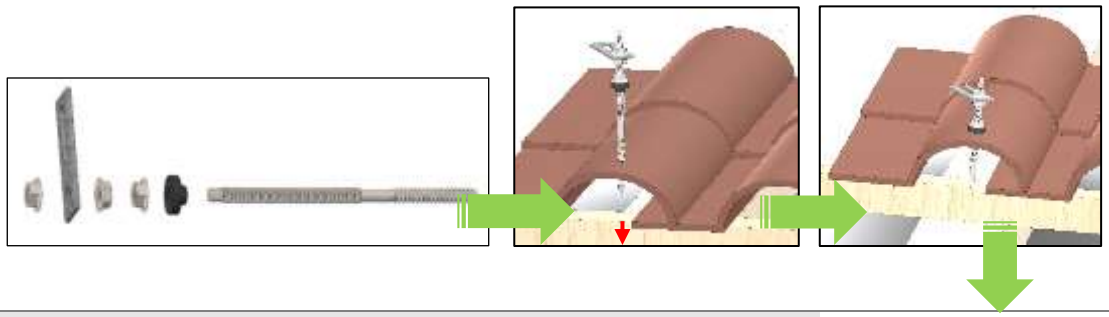
The oval hole of beam Nr.1 for 3x2.00/2.37m²

The oval hole of beam Nr.5 for 3x2.72m²

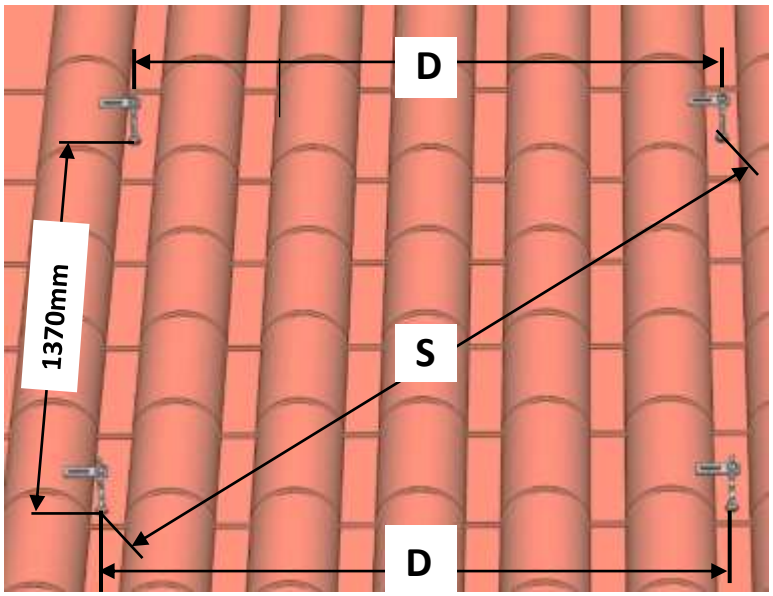
The lower side is always connected at the same hole (second hole) of Nr.1

STEP D

ON- ROOF MOUNTING WITH M10X300 DOWEL SCREWS

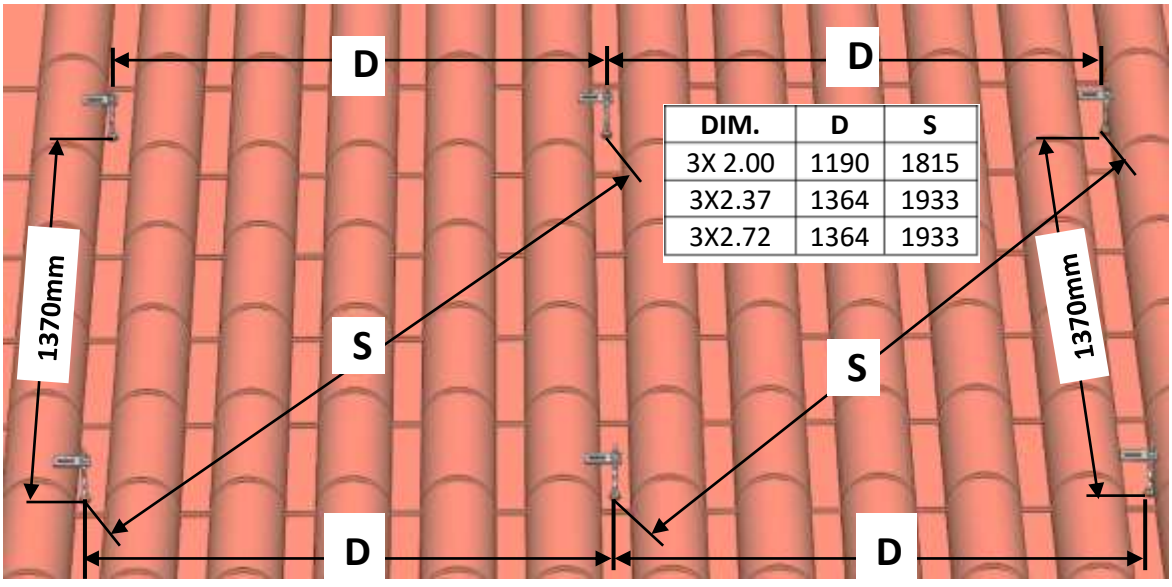


ON-ROOF MOUNTING POINTS 1X OR 2X COLLECTORS



DIM.	D	S
1X COL	936	1660
2X2.00	936	1660
2X2.37	1356	1928
2X2.72	1356	1928

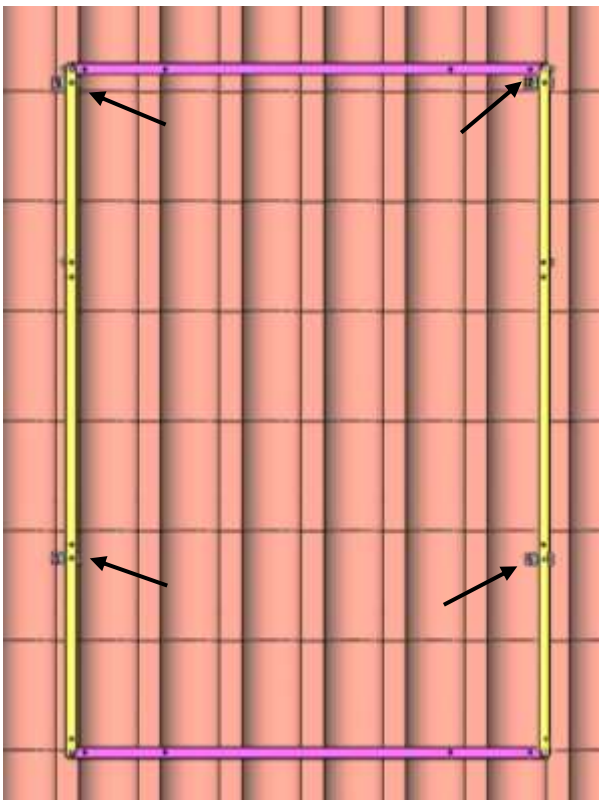
ON-ROOF MOUNTING POINTS 3X COLLECTORS

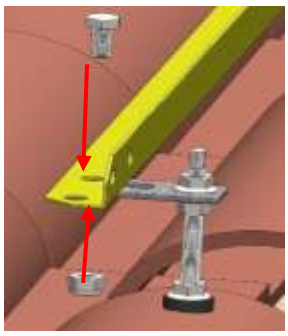


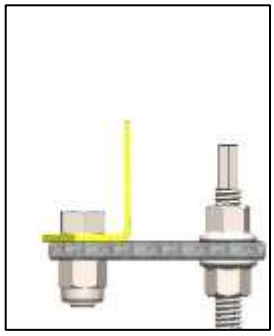
DIM.	D	S
3X 2.00	1190	1815
3X2.37	1364	1933
3X2.72	1364	1933

STEP E

FIXING OF LOWER FRAME FOR 1X OR 2X COLLECTORS



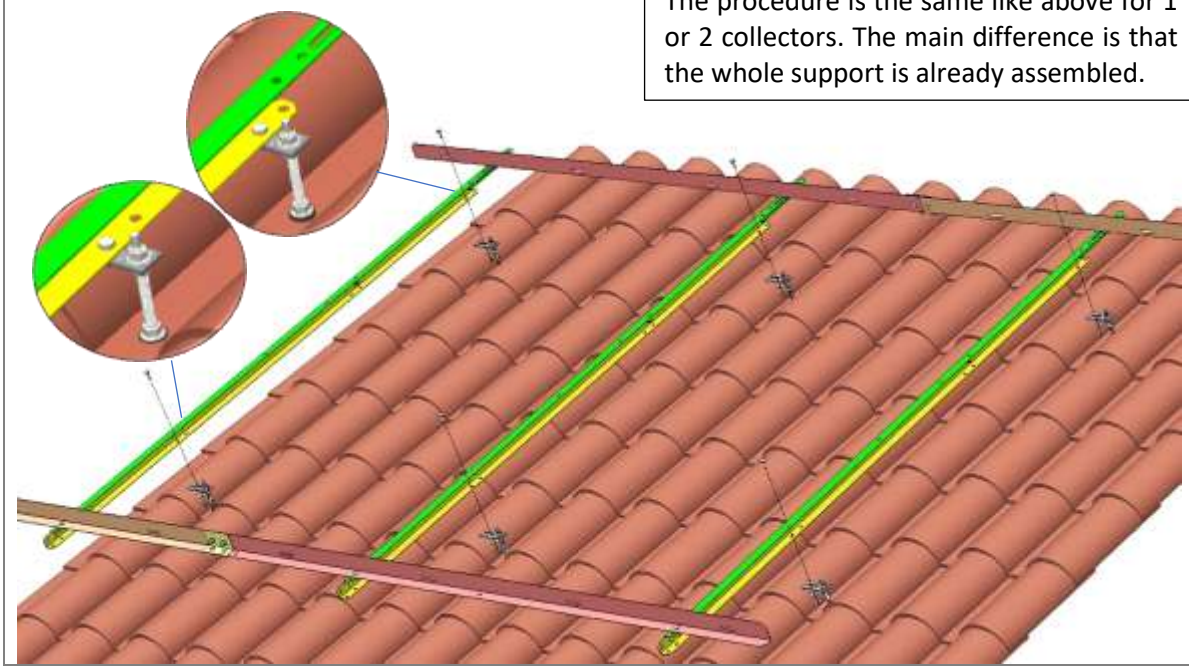




LOWER FRAME ASSEMBLY:
Fix the lower frame on the dowel screws from the previous step. Use M8x20 screws and M8 bolts. Please refer to previous step as well as to the tables with the important dimensions for correct position of the frame on the dowel screws.

FIXING OF FULL SUPPORT FOR 3X COLLECTORS

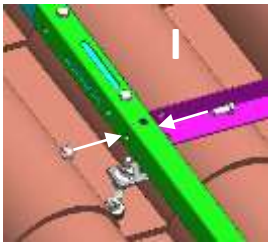
The procedure is the same like above for 1 or 2 collectors. The main difference is that the whole support is already assembled.

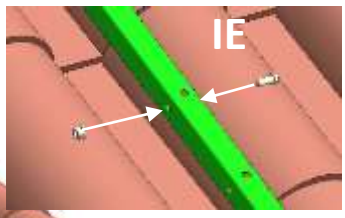


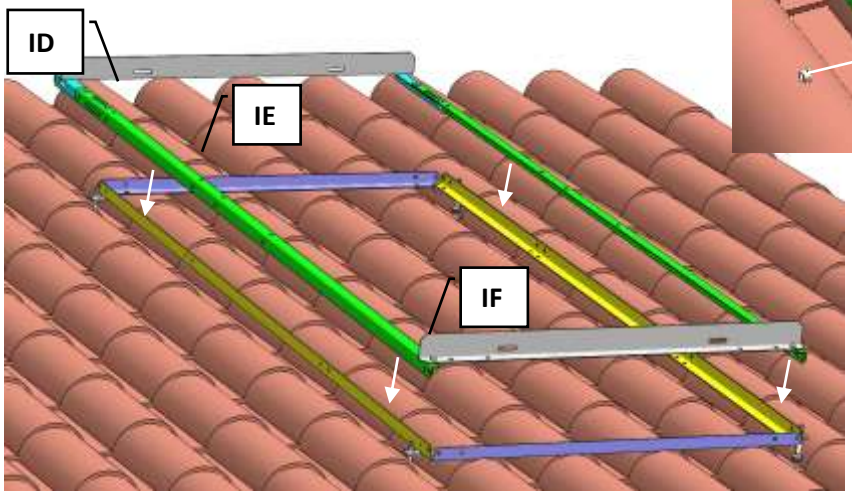
STEP F

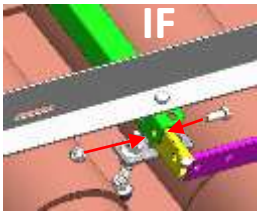
FIXING OF UPPER FRAME FOR 1X COLLECTOR

Connect at the exact points illustrated. Use bolts M8x20 and M8 nuts.



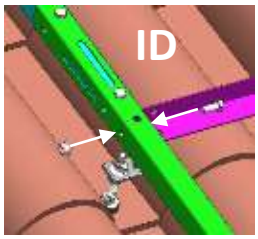


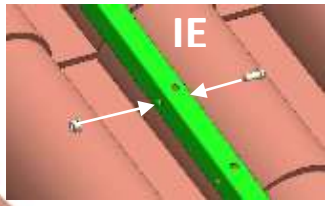


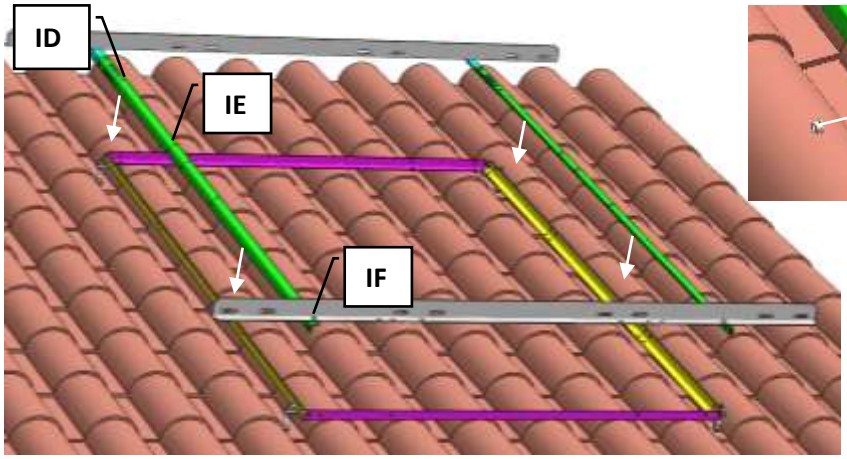


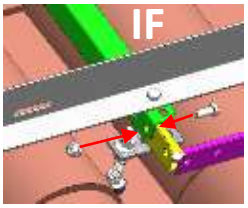
FIXING OF UPPER FRAME FOR 2X COLLECTORS

Connect at the exact points illustrated. Use bolts M8x20 and M8 nuts.



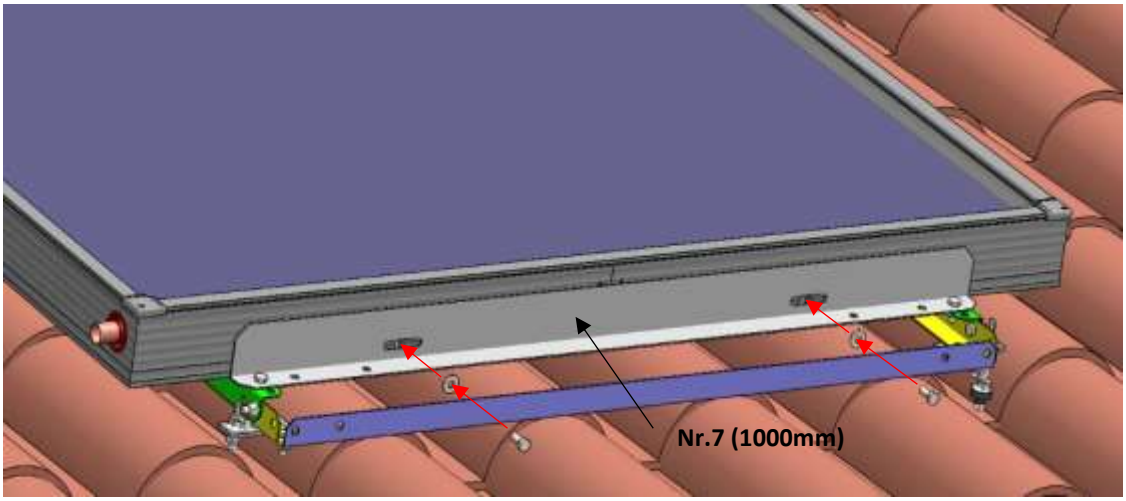






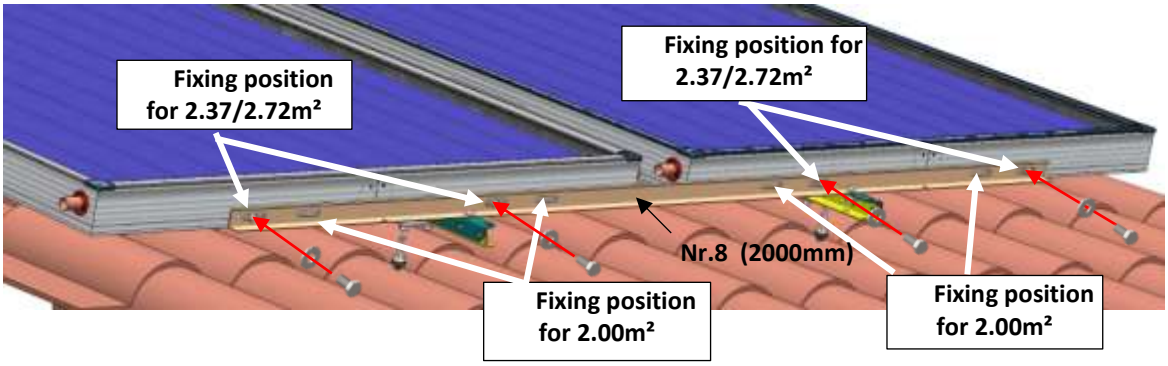
STEP G

PLACE THE COLLECTOR FOR 1X COLLECTOR



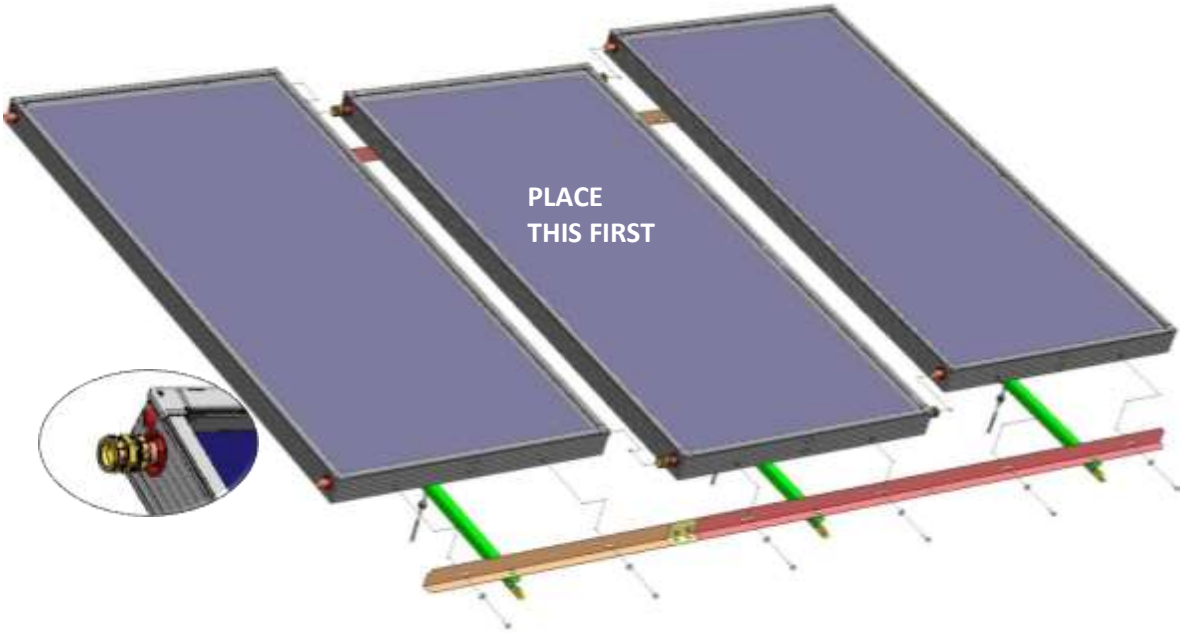
Connect at the exact points illustrated. Use bolts M8x20, washers and M8 nuts.

PLACE THE COLLECTORS FOR 2X COLLECTORS



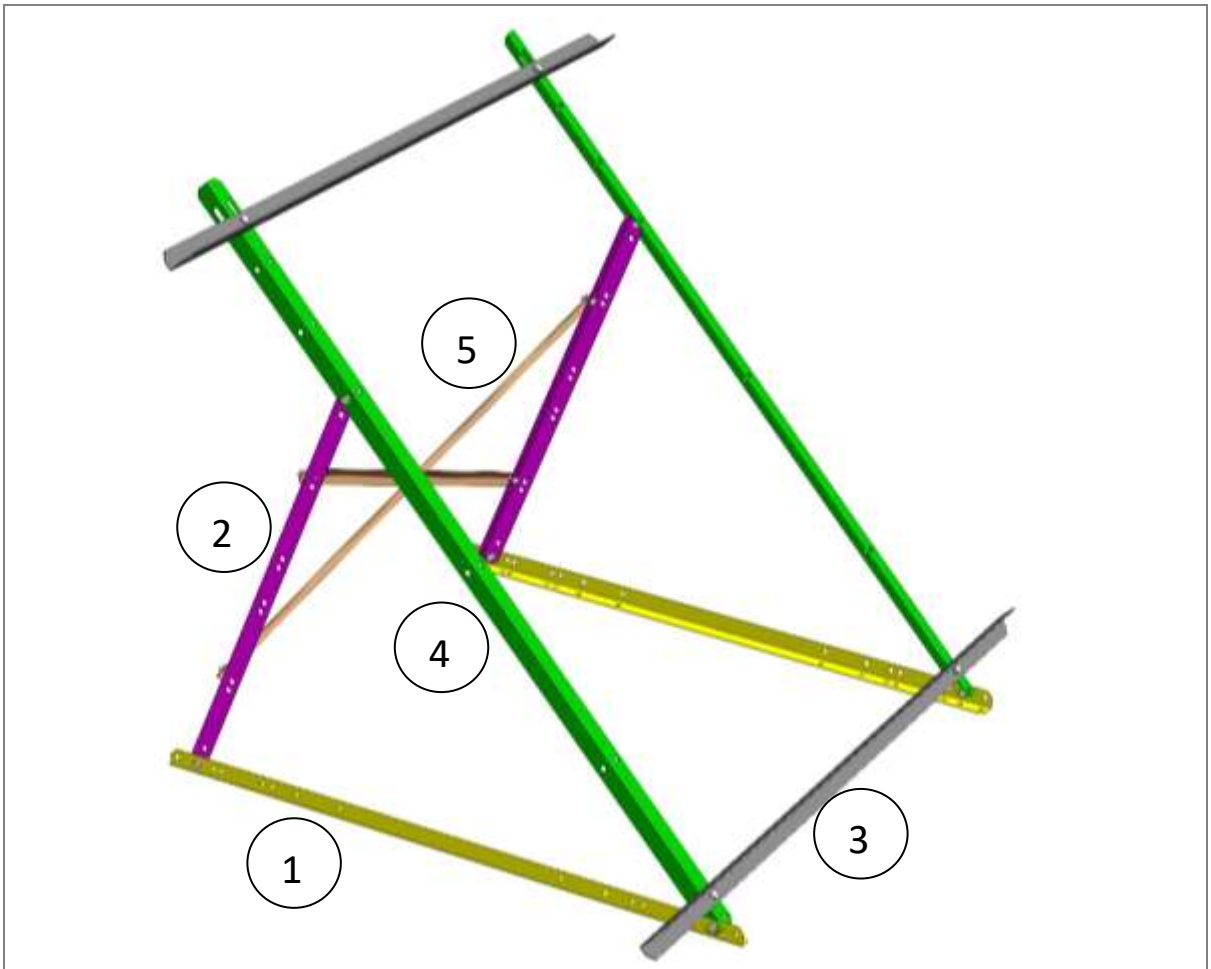
Connect at the exact points illustrated. Use bolts M8x20, washers and M8 nuts. Before tightening the bolts place the ø22xø22 hydraulic fittings between the collectors.

PLACE THE COLLECTOR FOR 3X COLLECTORS



Place the middle collector first. Connect at the exact points illustrated. Use bolts M8x20, washers and M8 nuts. Before tightening the bolts place the ø22xø22 hydraulic fittings between the collectors.

9.6 Horizontal collector flat roof support

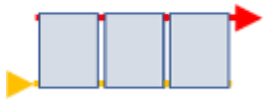


Support structure Parts list		
a/a	Description	Qty
1	"L" profile 1035mm	2
2	"L" profile 750mm	2
3	"L" profile 1500mm	2
4	"L" profile 1400mm	2
5	Cross bars 1125mm	2
6	DIN933 bolts M8x20	19
7	DIN6923 nuts 8mm	15
8	DIN574 Anchor bolts M8x60	4
9	10x60 anchors	4

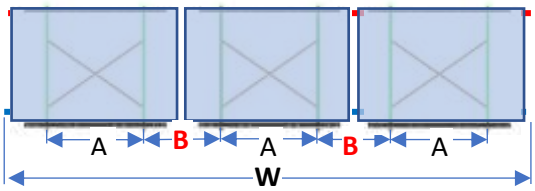
This support can be configured for 4 inclinations:

- **36°**
- **40°**
- **45°**
- **48°**

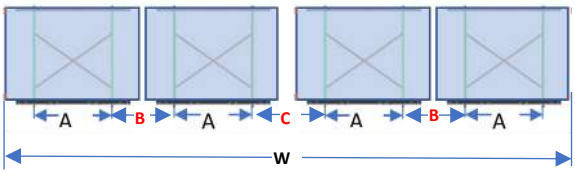
9.6.1 Important dimensions



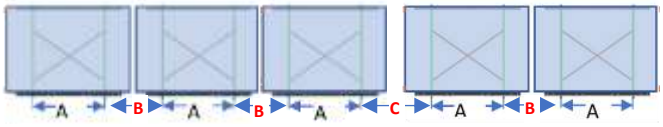
Conf.	A	B	W
3x2.00	1025	1030	6170
3x2.37	1025	980	6020
3x2.72	1025	1210	6710



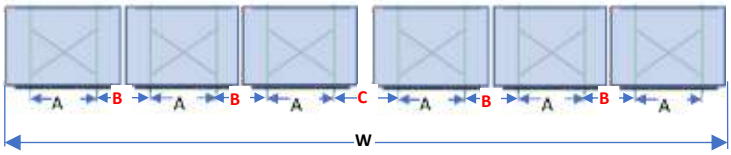
Conf.	A	B	C	W
4x2.00	1025	1030	1060	8260
4x2.37	1025	980	1010	8060
4x2.72	1025	1210	1240	8980



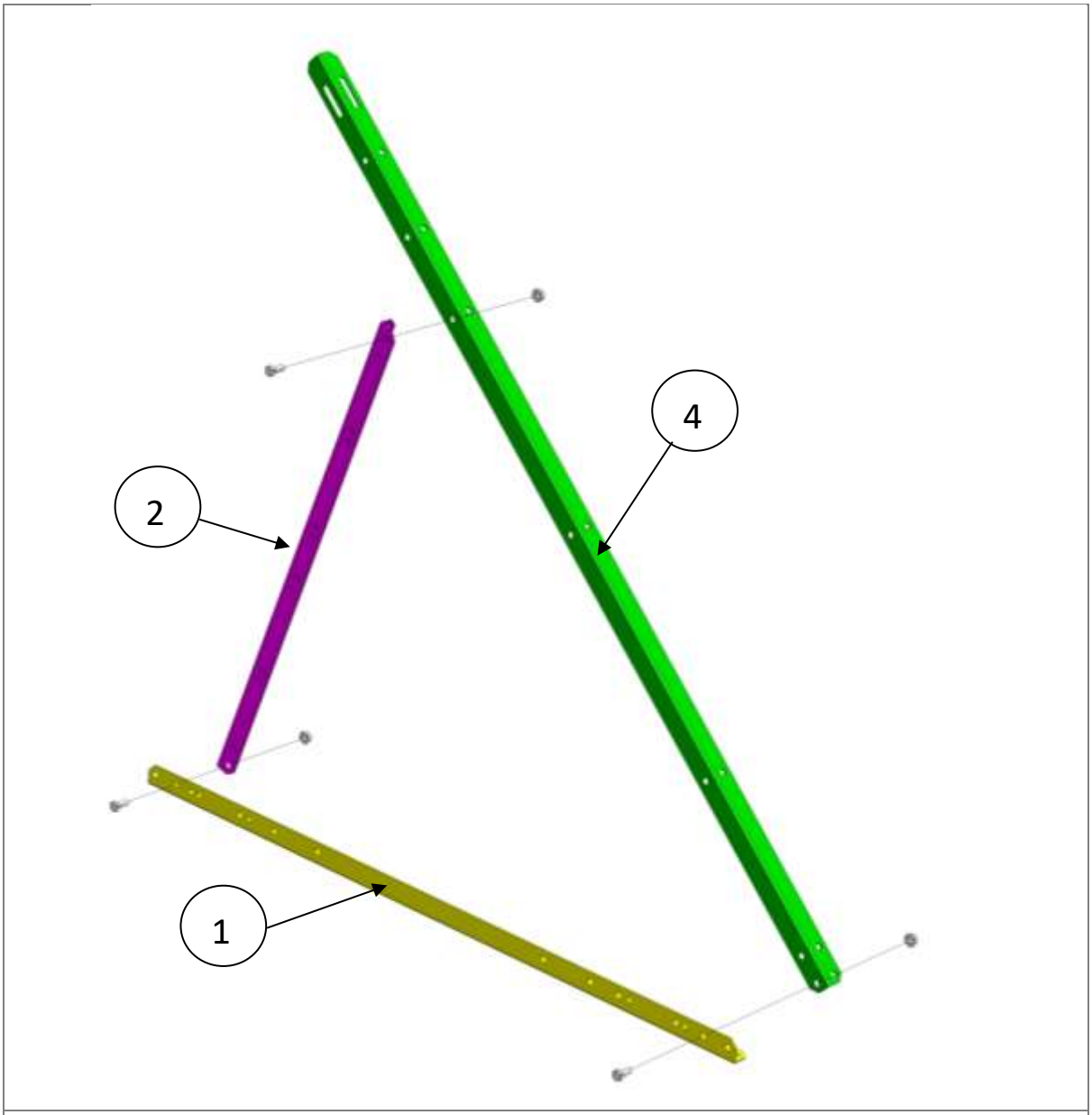
Conf.	A	B	C	W
5x2.00	1025	1030	1060	10390
5x2.37	1025	980	1010	10060
5x2.72	1025	1210	1240	11210



Conf.	A	B	C	W
6x2.00	1025	1030	1060	12445
6x2.37	1025	980	1010	12065
6x2.72	1025	1210	1240	13445

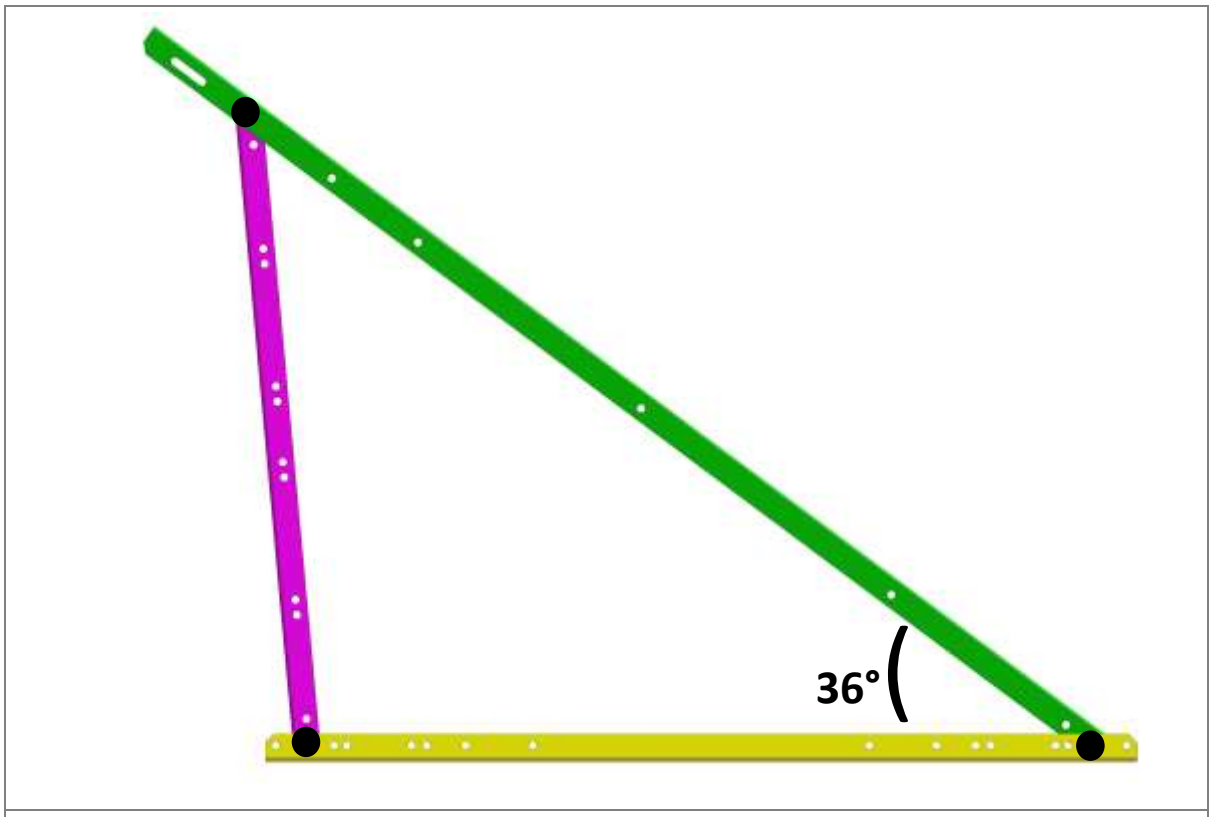


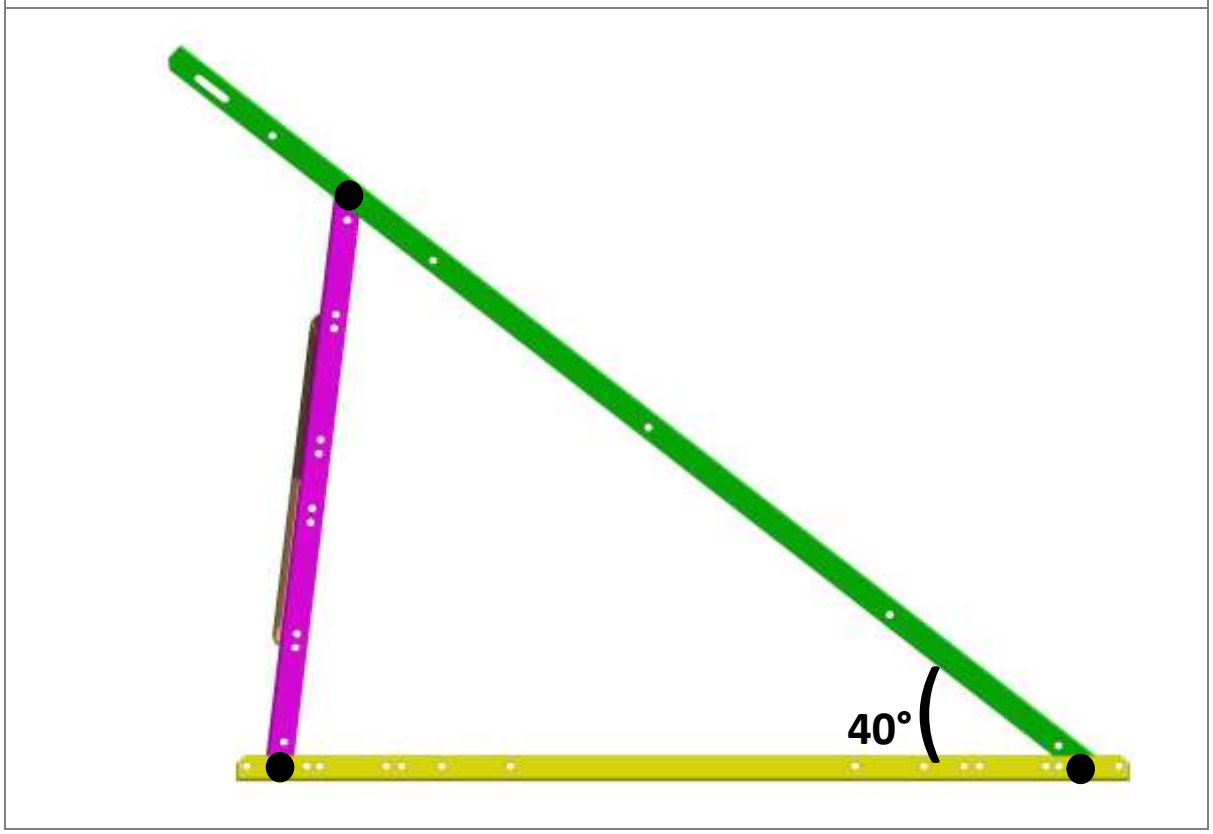
STEP A

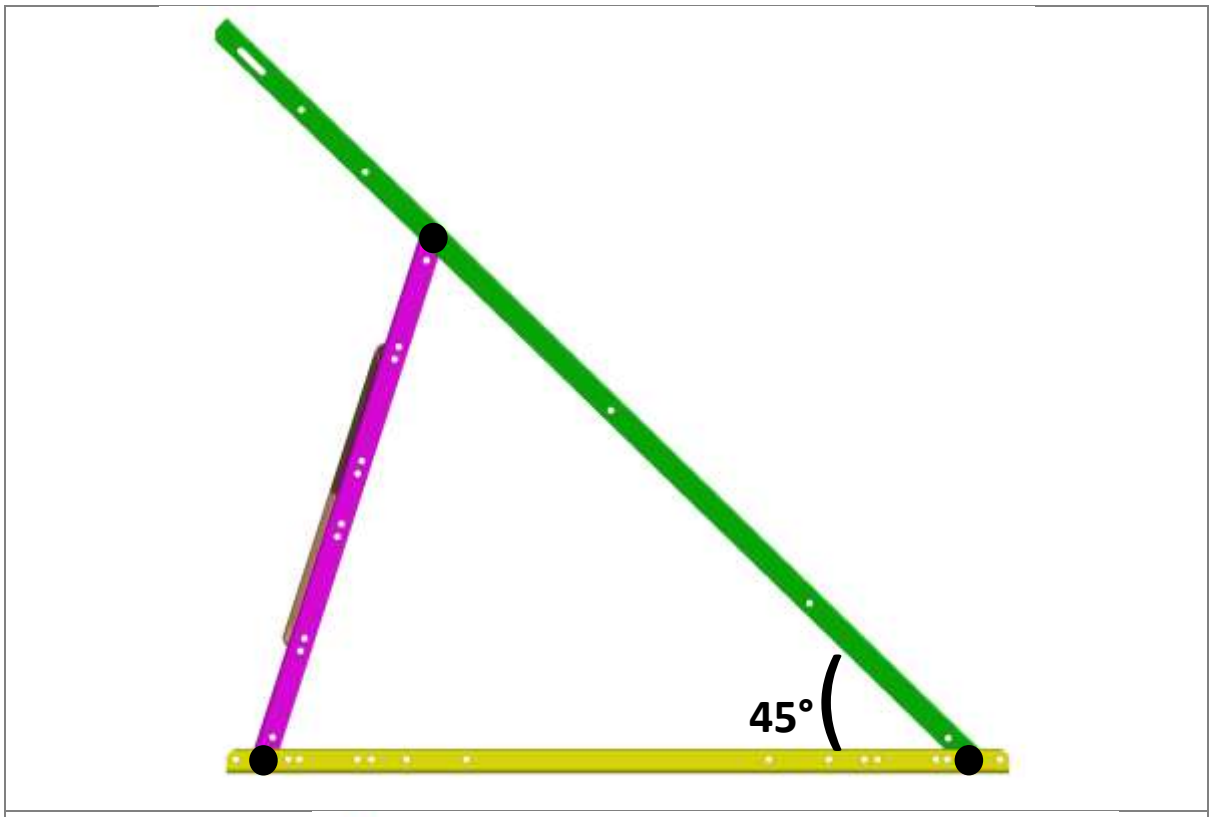


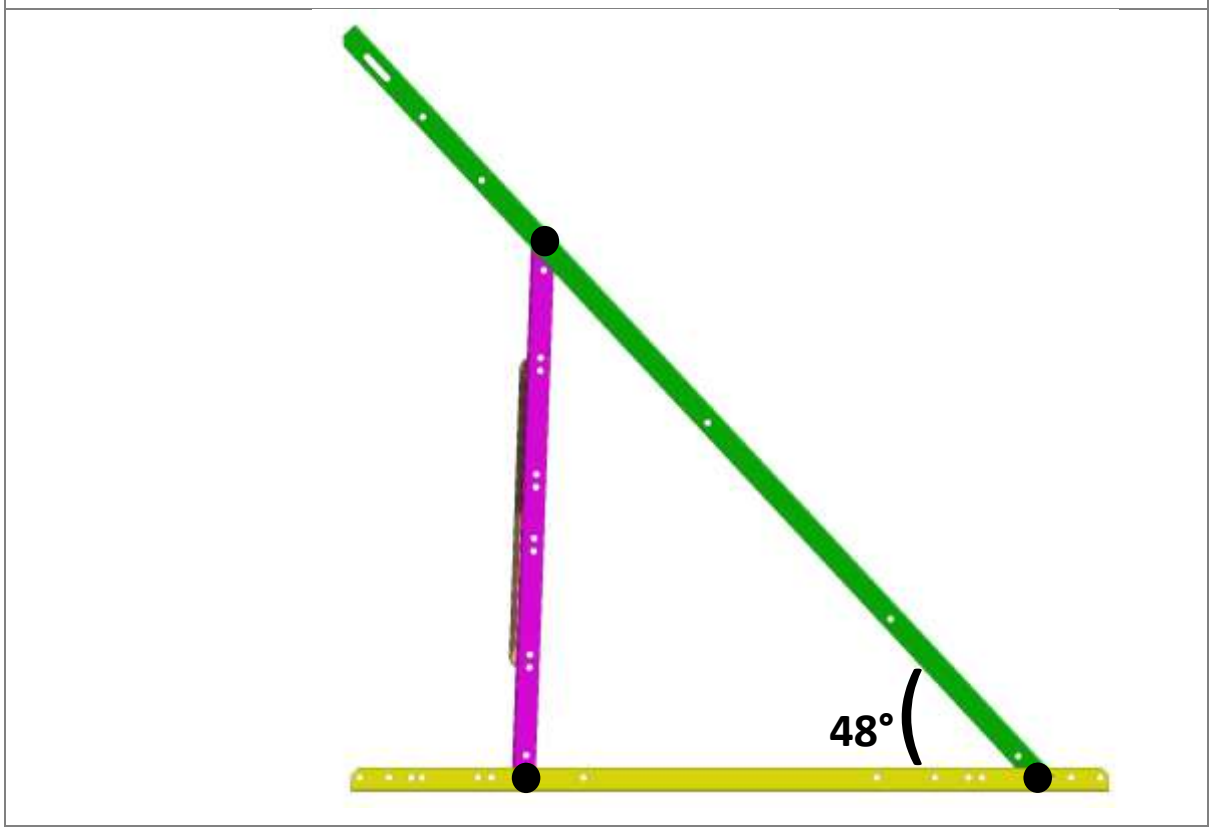
Use beams Nr.1 (1035mm), Nr.2 (750mm) and Nr.4 (1400mm). Connect them at the points illustrated in the next images. Use M8x20 bolts and pairing nuts. 4 different configurations presented:

4 different configurations

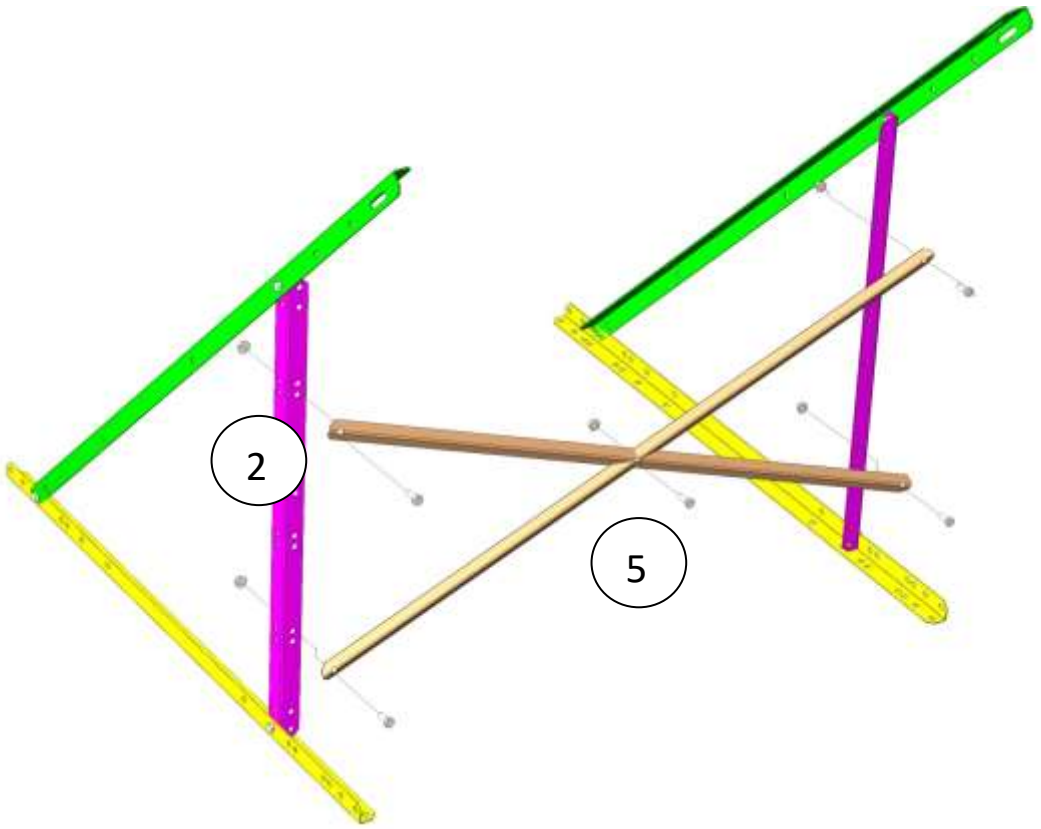


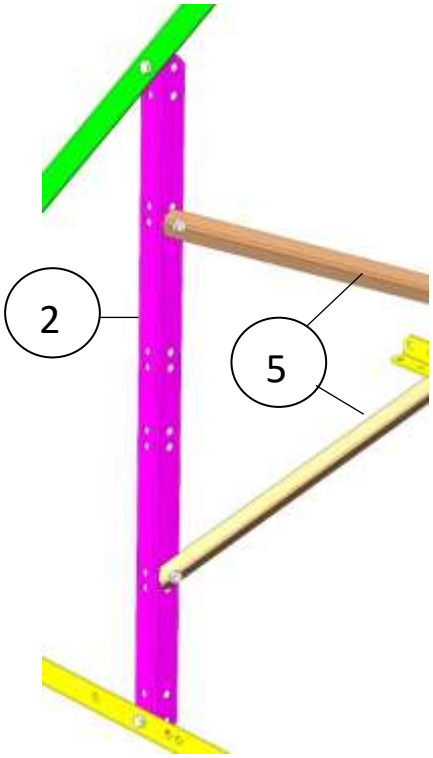



45°


48°

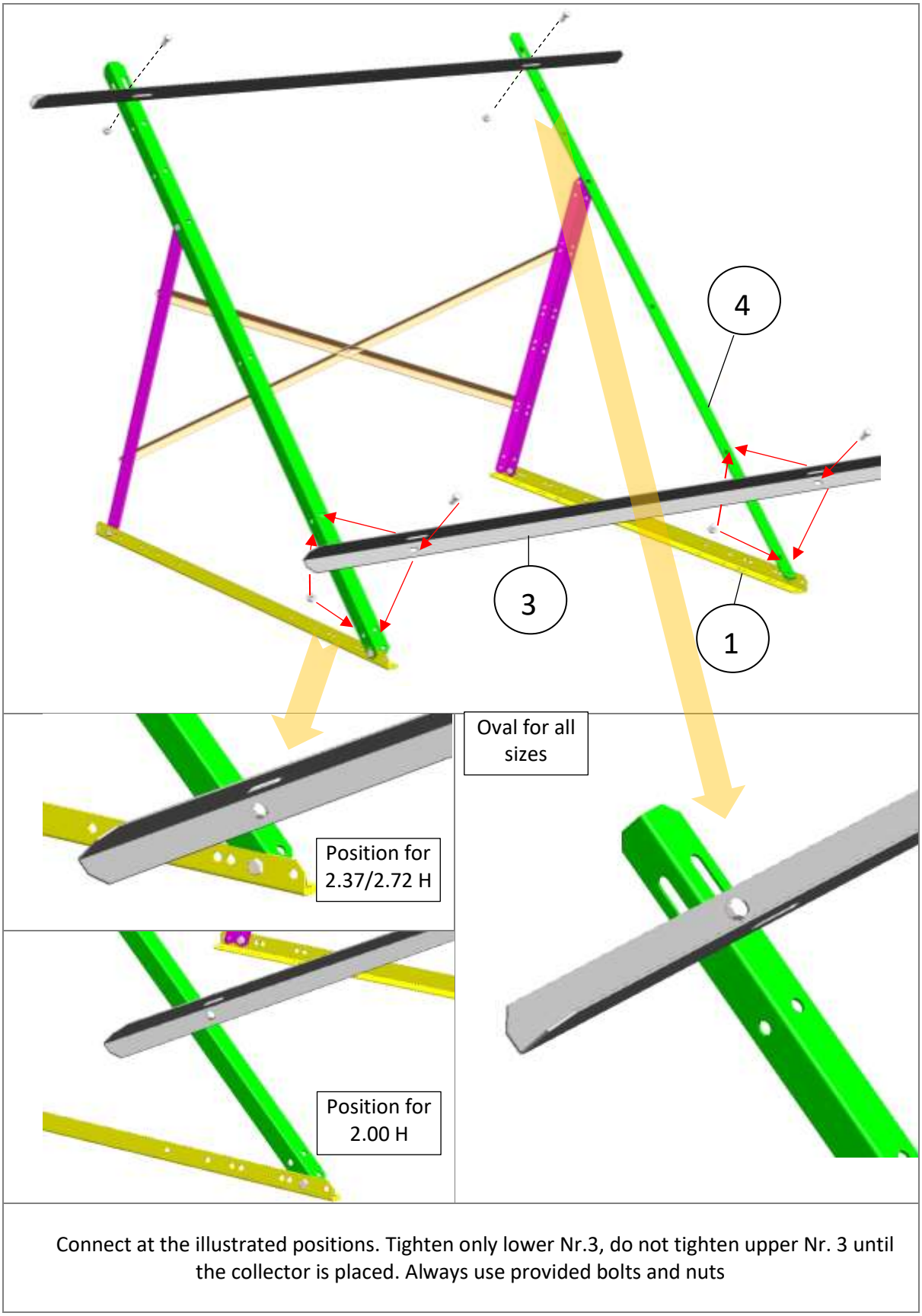
STEP B





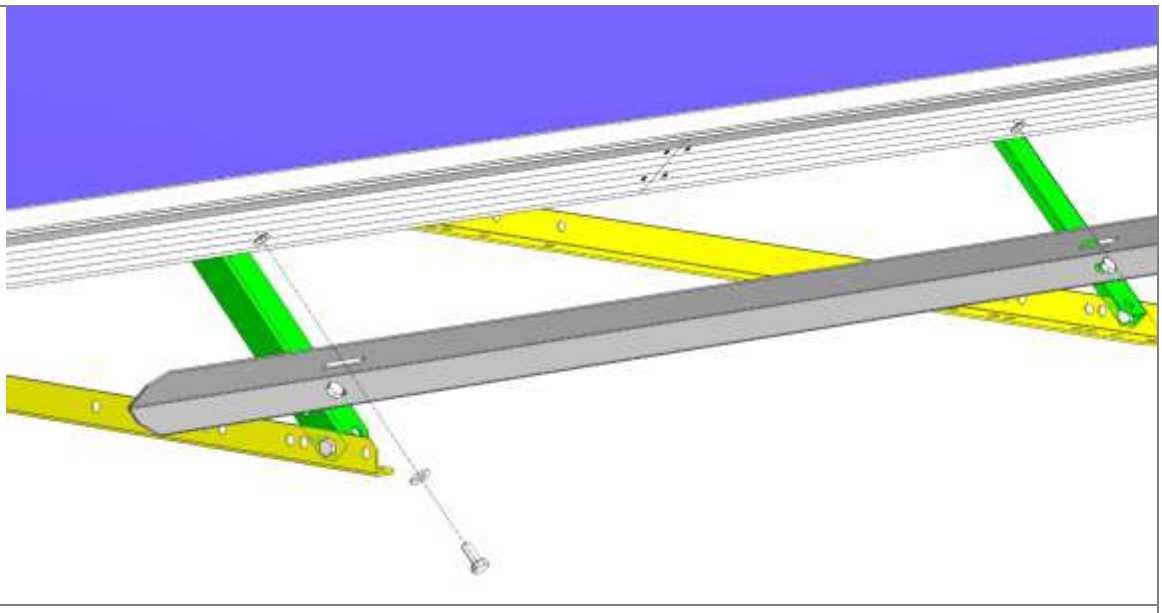
Connect cross bars Nr.5 at the exact points illustrated, or else part Nr. 3 will not fit correctly.

STEP C

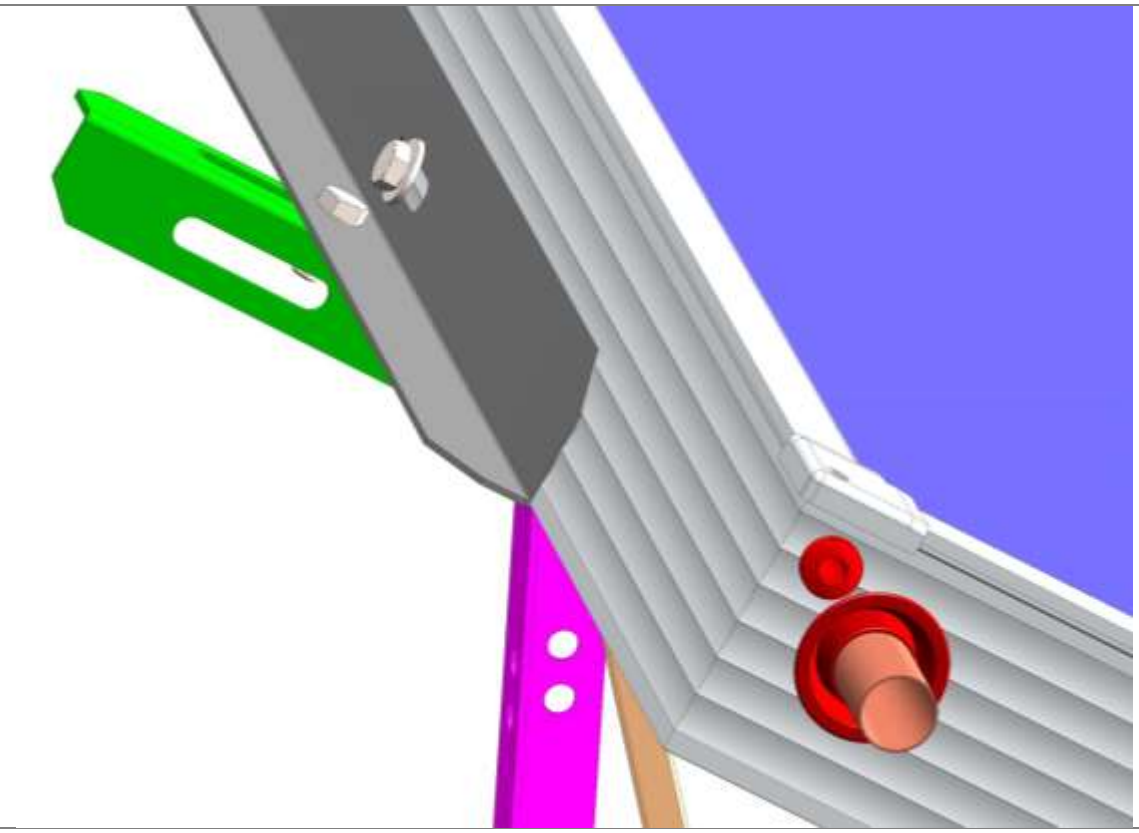


Connect at the illustrated positions. Tighten only lower Nr.3, do not tighten upper Nr. 3 until the collector is placed. Always use provided bolts and nuts

STEP D

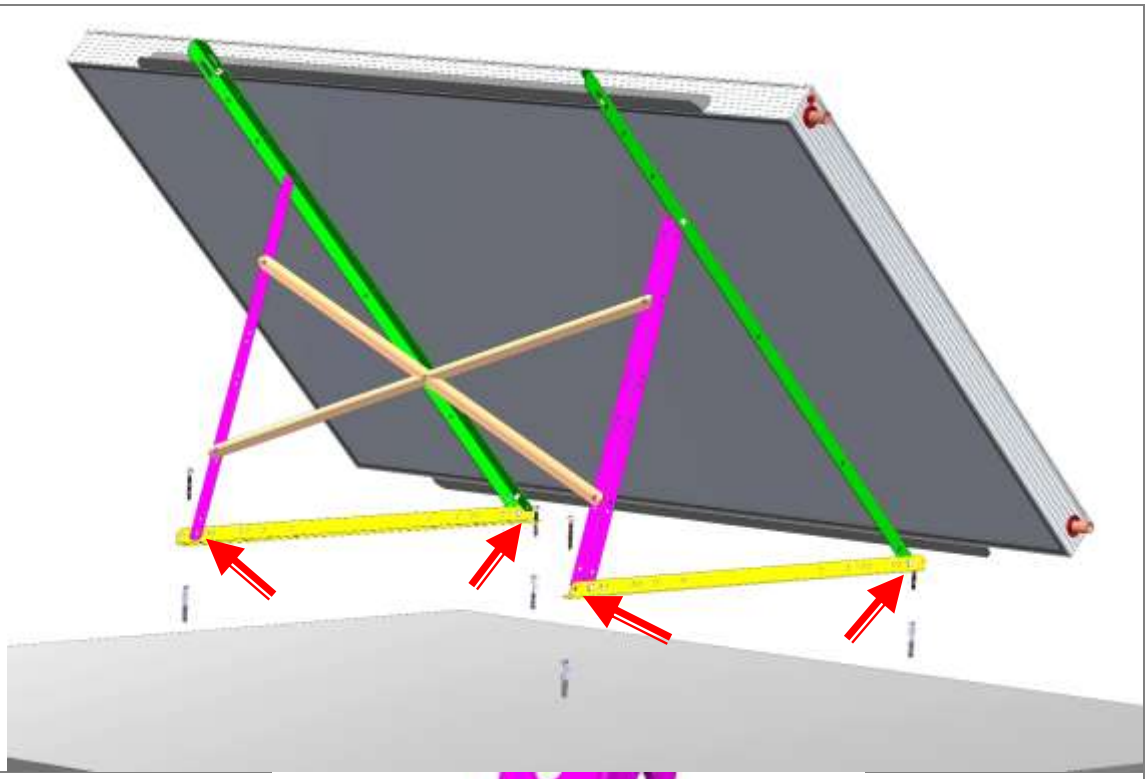


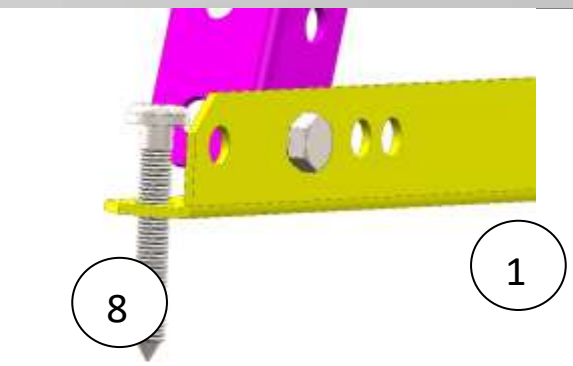
Connect at the illustrated positions. Use M8x20 bolts and washers.



Connect at the illustrated positions. Tighten the Nr.3 bar which was left loose in previous step. Use M8x20 bolts and washers.

STEP D





Select the points of fixture that best suit you. In case that the support is placed on slabs please fix with the anchors been closer to the points where Nr.1 is connected with Nr.2 and Nr.4 Use the anchors 8x60 provided.

Energia Italia S.r.l.
Indirizzo: Via V. Emanuele II, n° 294
91021 Campobello di Mazara (TP)
Partita IVA: 02160470817
Telefono: 0923.188 5440 • centralino
Sito 1: www.energiaitalia.info
Sito 2: shop.energiaitalia.info
postacertificata@pec.energiaitalia.info