3encult

EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

Solar solutions in the historic context

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EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

Guidelines & Criteria

EURAC research

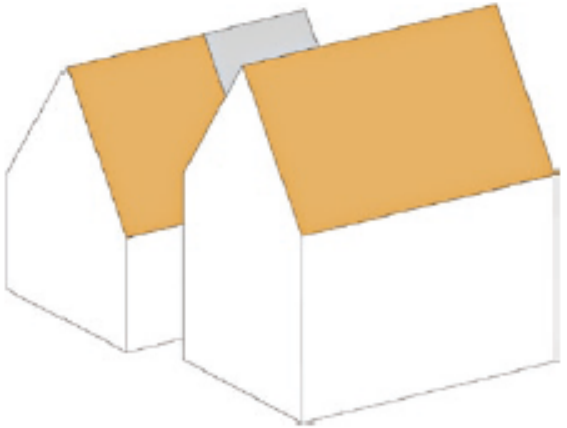

SOLARENERGIE
UND DENKMALPFLEGE
BAYERISCHES LANDESAMT
FÜR DENKMALPFLEGE

Nutzen Sie Flächen, die der Betrachter nicht einsehen kann

- **To utilize surfaces that are not visible from the street**

Bei frühzeitiger Beteiligung der Behörden können meist alternative Anbringungsorte gefunden werden, die vom öffentlichen Raum aus nicht einsehbar sind – beispielsweise in rückwärtigen Bereichen von Gebäuden.

Collaborating in time with the local administration, it is possible to localize aternative spaces not visible from public places such as the backyard of the building.

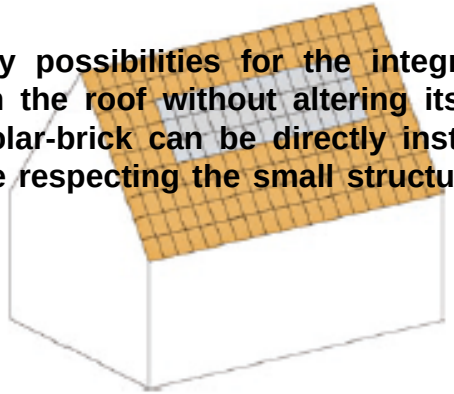


Integrieren Sie eine Solaranlage in die bestehende Dachfläche

• To integrate the solar system in existing surfaces

Es gibt verschiedene Möglichkeiten, Solaranlagen in eine bestehende Dachfläche zu integrieren, sodass keine nachteilige Wirkung auf das Erscheinungsbild eines Denkmals zu erwarten ist. Beispielsweise bieten viele Hersteller Lamellen oder so genannte Solarziegel an, die direkt in der Dachfläche verlegt werden und die kleinteilige Struktur der Dachziegel aufnehmen. Im Gegensatz zu auf dem Dach vollflächig aufliegenden Solarmodulen wirkt diese Lösung weniger dominant und fügt sich in den Gesamtcharakter des Gebäudes ein.

There are many possibilities for the integration of solar system in the roof without altering its aspect. For example solar-brick can be directly installed on the roof surface respecting the small structure of the roof bricks.

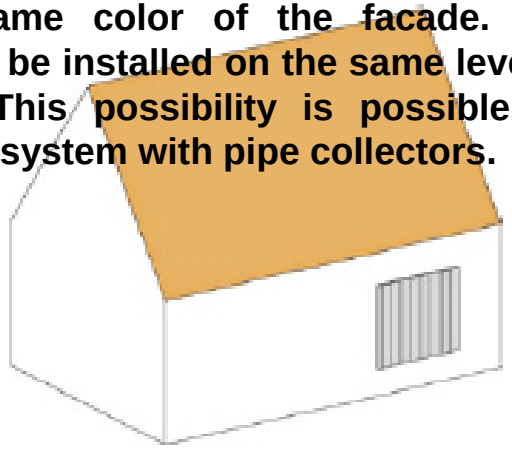


Ebenfalls denkbar – die Verwendung der Hausfassade

- **To think as well about the use of the facades**

Im Einzelfall kann auch die Anbringung von Kollektoren an der Fassade am verträglichsten für das Erscheinungsbild des Baudenkmals sein, beispielsweise wenn es hier weniger einsehbare Bereiche gibt, als auf den Dachflächen.
Wichtig ist auch hier, dass sich die Anlage optisch unterordnet und farblich eine Einheit mit der Fassade bildet.
Sie muss außerdem plan in der Ebene der Fassade liegen und kann nicht aufgeständert werden. Diese Möglichkeit eignet sich besonders für Solarthermieanlagen mit Röhrenkollektoren.

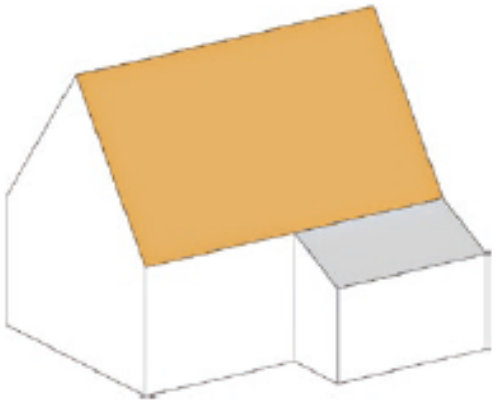
Sometimes it is also possible to install the solar collectors on the facade, for instance if there are some spaces less visible than the roof. The system must be optically integrated using the same color of the facade. The system must be installed on the same level of the facade. This possibility is possible for solar thermal system with pipe collectors.



Meist besser als das Hauptgebäude – das Nebengebäude

•The use of the auxiliary building, better than the main building

Oft besteht die Möglichkeit, Solaranlagen auf Nebengebäuden oder untergeordneten Anbauten zu installieren.
Diese weniger exponierten Flächen treten neben dem Hauptgebäude optisch in den Hintergrund und das Baudenkmal wird in seiner Erscheinung nicht beeinträchtigt.
Bei rechtzeitiger Planung kann so in vielen Fällen ein geeigneter Standort für die Installation einer Solaranlage gefunden werden.



Sometimes it is also possible to install the solar system on the auxiliary building. These less visible surfaces are optically less important and the main building remains unaltered.

Historisches Traufblech als Vorbild für den Traufbereich
Historic eave flashing as a good example for the eaves area

Landschaftstypische Gegebenheiten können bei der Planung von Solaranlagen einen positiven Nutzen haben.
Es gibt beispielsweise realisierte Solarthermieanlagen im Bereich einer Traufverblechung. Eine gute Detaillierung schon bei der Planung ist hier wichtig.
Die Module müssen oberflächenbündig direkt oberhalb der Traufkante befestigt werden. So entsteht optisch eine Annäherung an die historische Blechverkleidung und die Solarmodule fügen sich in das überlieferte Erscheinungsbild des Denkmals ein.

The design of solar systems can profit from landscape specific conditions or typical local construction methods. There have been implemented for example, solar thermal systems in the area of the eave flashing. In this case a good detail planning is important.
The modules must be mounted flush with their surface directly above the eaves. In this way the solution has a similar appearance to the original eave flashing and the solar modules fit into the traditional appearance of the historic building.

Gestaltungsziele

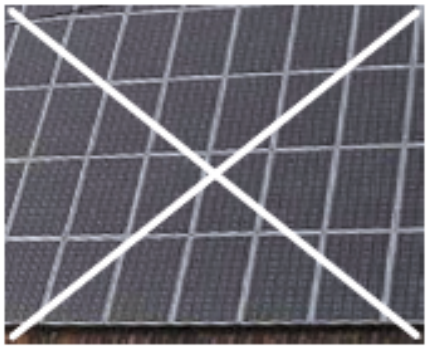
1. Eine geschlossene Fläche ist immer besser als eine unruhige Anordnung der Module.
2. Besser sind Paneele ohne Umrandung. Wenn sich eine solche nicht vermeiden lässt, ist eine gleichfarbige Umrandung immer von Vorteil.
3. Eine Paneelfarbe, die der Farbe der Dachdeckung entspricht, fällt weniger auf.

Composition examples

1- Closed surface are better than unsorted modules
2. Prefer panels without frames, or with coloured frame as the roof
3. Prefer panels with the same color of the roof.

1

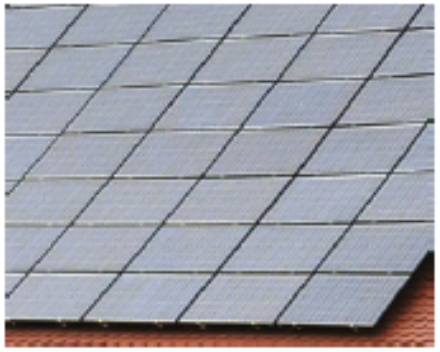
2



3

4. Auch unauffällige Befestigungshilfen sind die bessere Wahl.
5. Wenn Module in die Dachfläche integriert werden und bündig mit der Dachkante abschließen, entsteht ein ruhiger Gesamteindruck.
6. Keine „Sägezahn-Lösungen“!
   Die Solaranlage sollte an die vorhandenen Gegebenheiten angepasst werden.

4



5

6

4. Prefer panels with invisible fixing system
5. Install the panels close to the border of the roof
6. Avoid solutions with saw tooth

PV Integration in Historic Buildings

Conservation aspects:

- The existing roof structure must be strong enough to accommodate the combined weight of the panels.
- If the installation entail removing an area of the roof covering; this should be stored and reinstated if the solar panels are ever removed.
- Where a tiled or slated roof needs to be replaced, it can be particularly cost-effective to install PV roof tiles as the new roof covering.
- Avoid installing equipment on the main elevation or on a dominant roof line.
- Building-integrated PV products may be suited for applications on historic buildings. There are photovoltaic tiles, which are less visually intrusive than older systems.
- It is very important to ensure that new buildings, extensions and tree growth, will not overshadow the solar panels.
- Before doing anything, it is important to know which permissions may be needed for a PV installation.

PV Integration in Historic Buildings

Conservation aspects:

- A PV installation on a roof could be timed to coincide with replacing the roof covering. Where a tiled or slated roof needs to be replaced, it can be particularly cost-effective to install PV roof tiles as the new roof covering.
- A PV system should always be sized to match the individual needs of a property. It is also important to consider future needs.
- If it is possible, is always better to replace the whole roof instead of part of the roof due to compatibility problems.
- It is important to ensure the array is as close as possible to the optimum angle and orientation.
- To maintain high efficiency, the panels must be kept clean.

Solar Thermal Integration in Historic Buildings

Conservation aspects:

- The existing roof structure must be strong enough to accommodate the combined weight of the panels.
- If the installation entail removing an area of the roof covering; this should be stored and reinstated if the solar panels are ever removed.
- It will not be acceptable to install equipment on the main elevation or on a dominant roof line. A potential solution to this is to use a recessed panel system.
- It is not advisable to fix a collector to a thatched roof of organic material, the thickness of the thatch decreases over time.
- When installing panels on a lead roof, must be taken into account the natural expansion and contraction of lead over time.

Solar Thermal Integration in Historic Buildings

Conservation aspects:

- If it is not acceptable to fix collectors to the roof, or it is not physically possible to accommodate them, one alternative is to position them elsewhere with the pipes buried and routed back to the storage tank.
- It is very important to ensure that new buildings, extensions and tree growth, will not overshadow the solar panels.
- Before doing anything, it is important to know which permissions may be needed for a solar water heating installation.

Solar Thermal Integration in Historic Buildings

Conservation aspects:

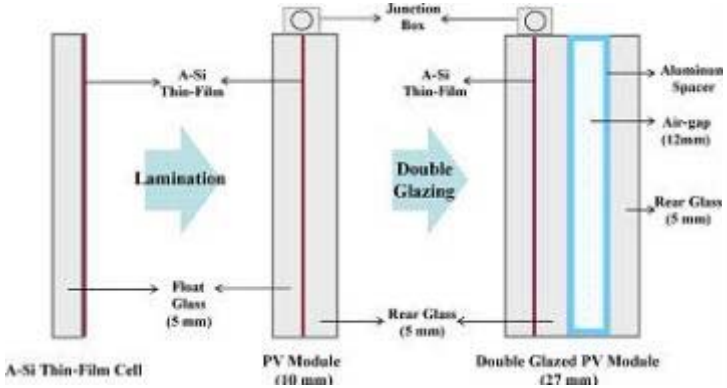
- As the pump needs electricity to run, installing other microgeneration technologies to generate electricity such as PV would increase the system's efficiency.
- A solar water heating system, should be sized according to the potential hot water demand or according to actual hot water demand. It is also important to consider future needs.
- Solar water heating systems work best when the water in the hot water cylinder is cool, therefore this makes larger, taller cylinder more effective.
- The panel surfaces may need cleaning from time to time although rain will help keep the panels clean.

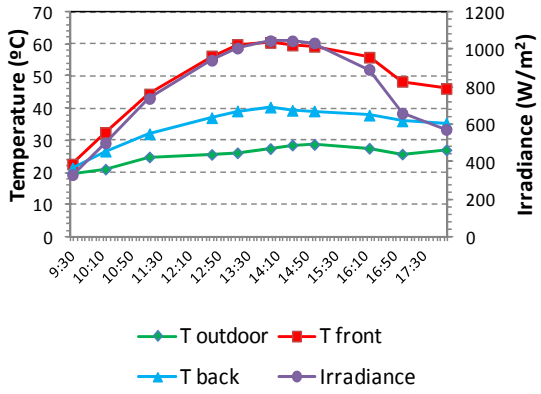
Flexible solar panel design

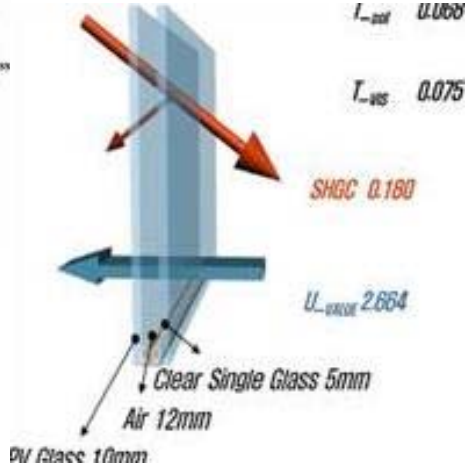
PV Solutions

Semitransparent PV glass

The main problem of semitransparent PV glass when used close to the inhabitants is the heat that the glass can reach. For avoiding this, a possible solution is a semitransparent insulating PV glass, consisting in a semitransparent double glazed PV device plus an air chamber done with aluminium spacers and a back glass.



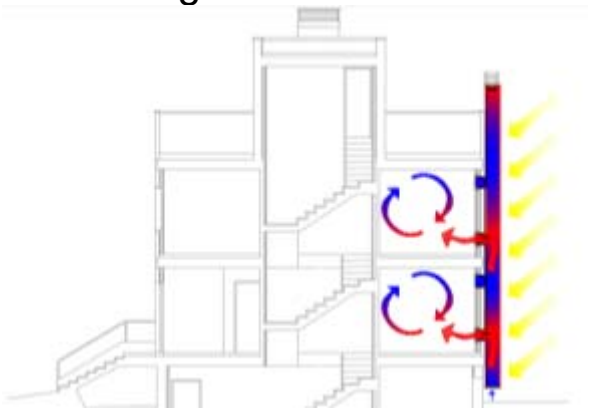




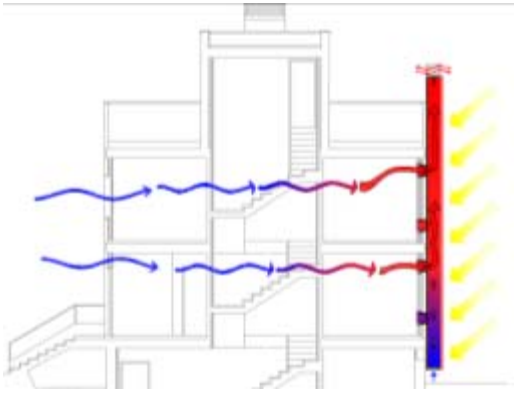
PV Solutions

Ventilated façades with heat recovery properties

Apart from the PV energy production, the air is heated up, flows up and introduced in the building.



Winter condition



Summer condition

The appearance of the prototyped device and a typical working

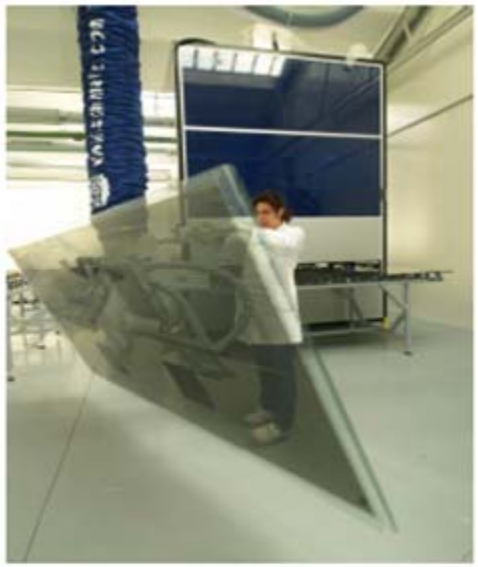
PV Solutions

Semitransparent Windows: Single Lamination

Applying with conservation issues and favouring shadow

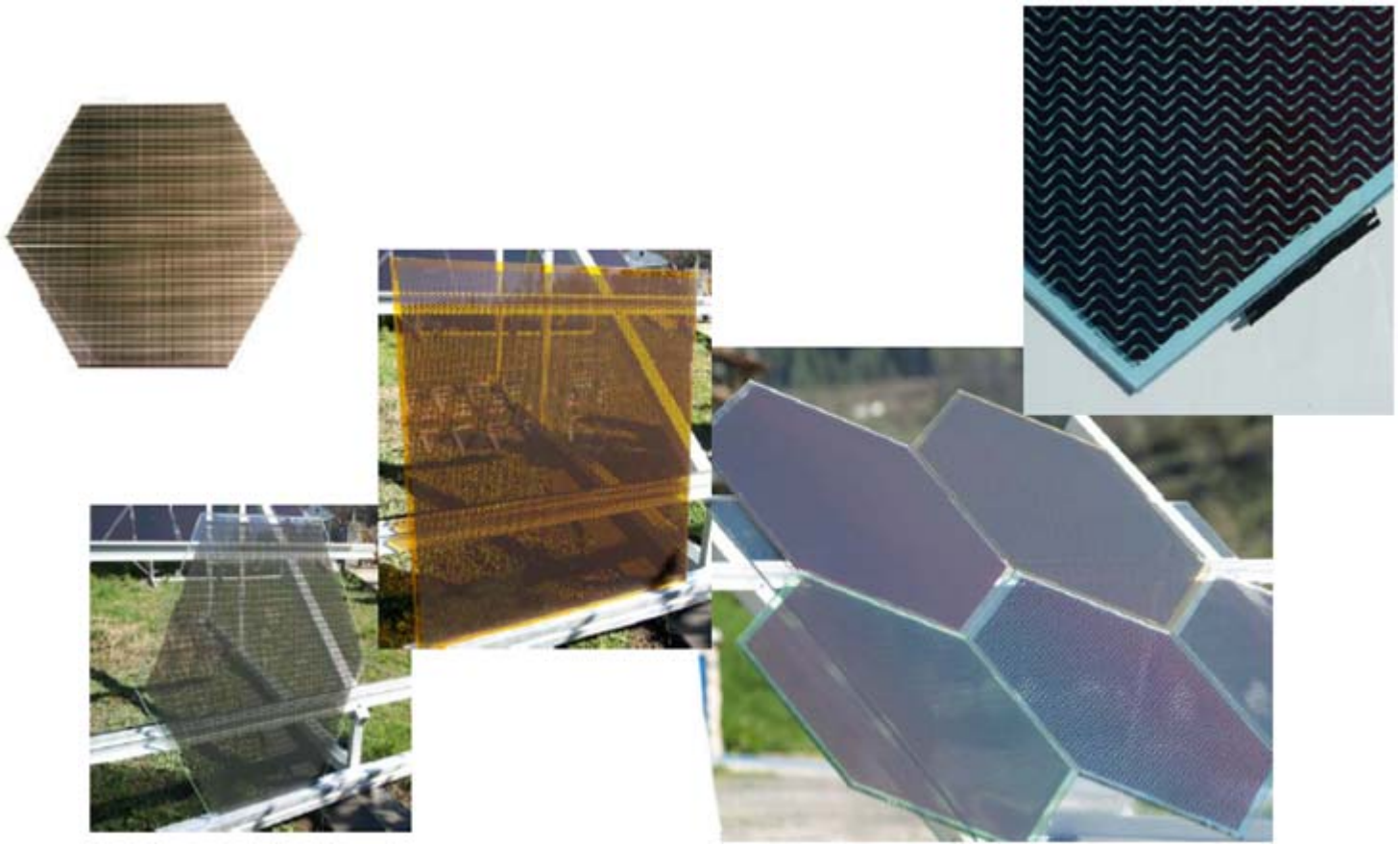
PV Solutions

Semitransparent Windows: big size and coloured PV



PV Solutions

Semitransparent Windows/Façades: special designs



PV Solutions

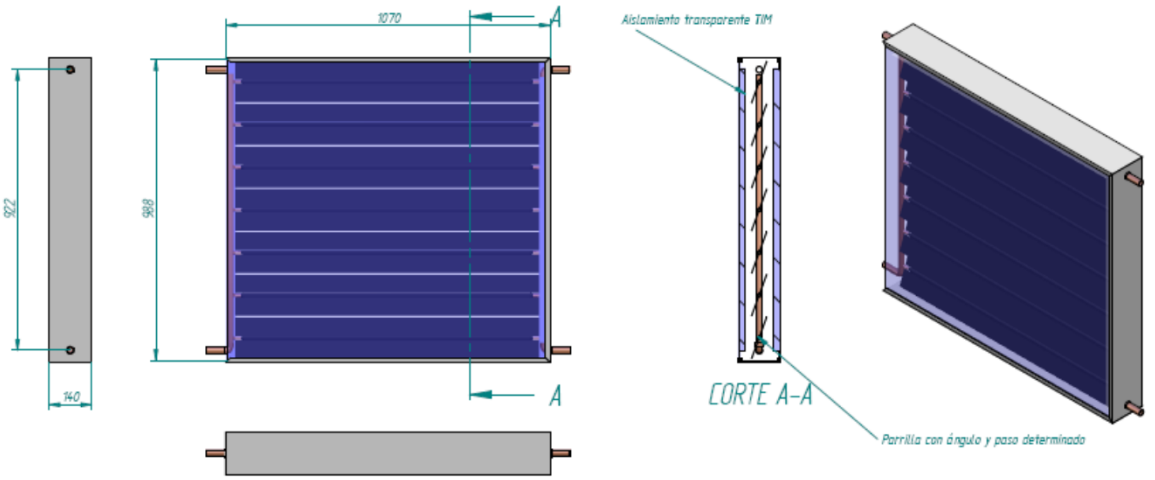
Integration in roof tiles

Solar Thermal Solutions

Semitransparent solar thermal panel

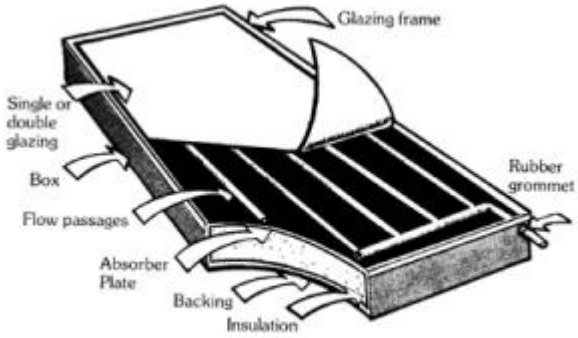
Both sides of the collector are covered by a Transparent Insulating Material (TIM), enabling at the same time thermal insulation and transparent properties.

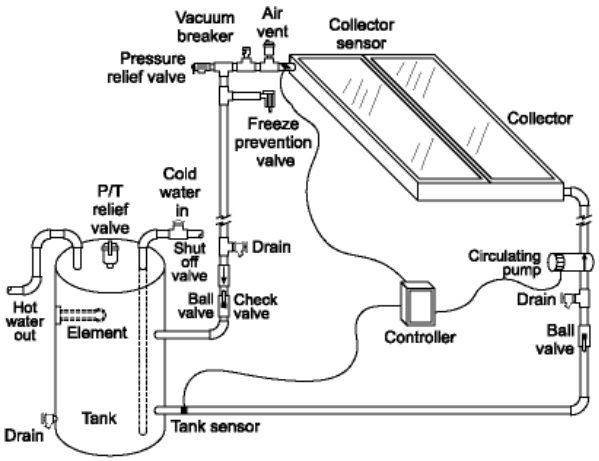
The solar thermal collector is based on a metal selective absorber, welded to a copper pipe grid for transferring heat from the sun to a primary water circuit.



Solar Thermal Solutions

Solar thermal panels





The solar thermal collector is based on a metal selective absorber, welded to a copper pipe grid for transferring heat from the sun to a primary water circuit. Thermal isolation is achieved by an isolator board. The front side can be encapsulated by the metal absorber plate or can have a glass finish. Water is stored in a tank with a heat exchanger or the heat is exchanged by a thermo-siphon. A control unit pumps the water and checks temperatures.

Product development and integration

PV Integration

Façade

Poor integration of opaque PV glass. Note the openings for the windows

Integration of semitransparent PV glass in a curtain wall

Dwelling houses Spinnereistraße with sliding shaders

Outer blinds with c-Si

PV Integration

Façade

Architectural integration is an important topic in an old building compared to a new one if the integration adds value to the aesthetics of the building as is done in one of the buildings at NTNU.
A glass facade with PVs is added on the south facing wall of the building.

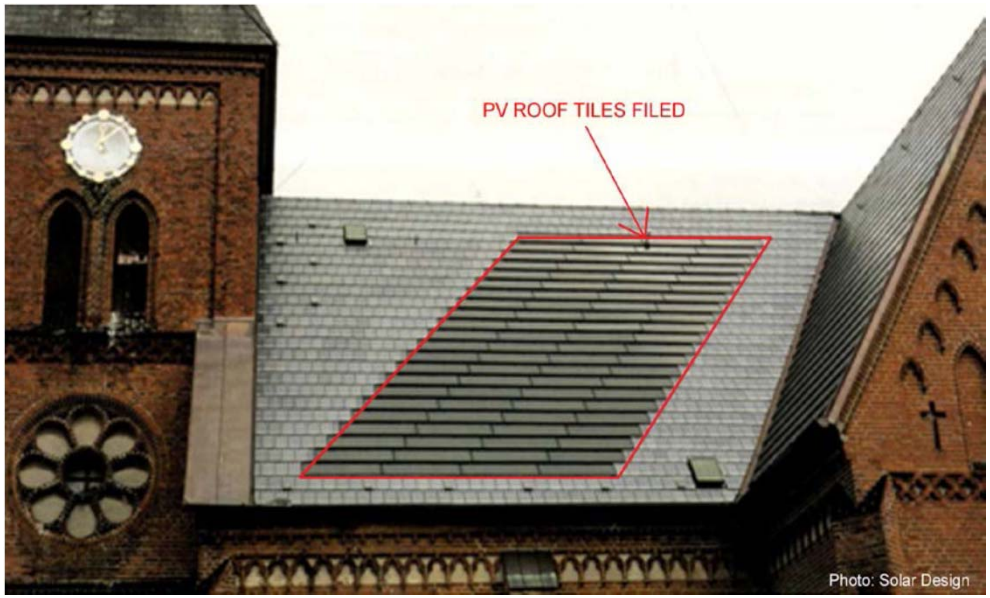
PV Integration

Roof tiles

St Silas Church, Pentonville showing integrated solar PV tiles

PV Integration

Roof tiles: Heritage example



In some cases small intervention is allowed like the church in Carlow, Germany. The church was equipped with PV in the course of roof repairs. The polycrystalline module was produced to match the existing roof tiles in shape and colour; one photovoltaic module replaced six roof tiles.
The PVs are integrated into only a small part of the roof replacing the normal roofing material. Thus the historical appearance of the church was maintained as stipulated by the monument protection authority

PV Integration

Atria and skylights

Examples of PV atria integrations


Examples of glass substitution by PV glass with shading properties (c-Si)



PV Integration

Semitransparent PV glass

Atrium

Ventilated Façade

Skylights

Novel surfaces with special shapes

PV Integration

Semitransparent PV glass

Curtain wall with solar semitransparent double glazed PV

Solar semitransparent double glazed PV solution for atria

Solar Thermal Integration

Solar thermal panels

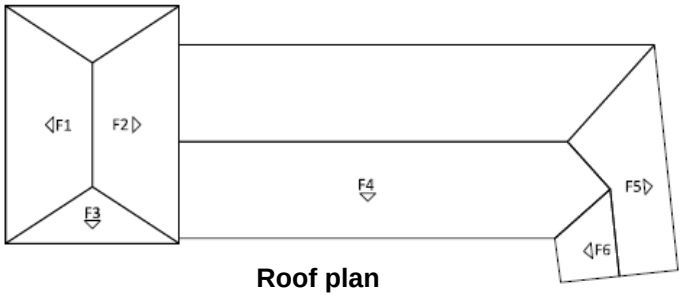
Domestic Water Heating and swimming pool

Big shape façade with thermal collectors

Domestic Water Heating and air conditioning

Solar Integration in Cases Studies

CS5 Monumental School. Innsbruck. Austria



Roof plan

PV Simulation

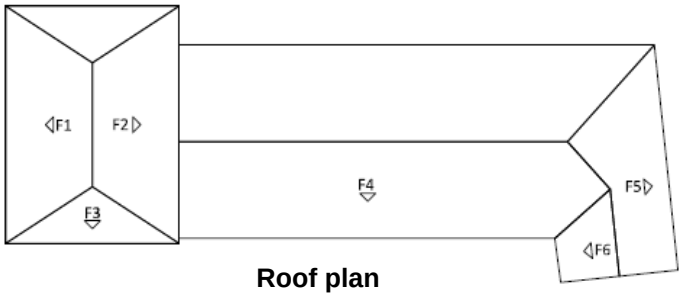
For this purpose, seam clamps can be used for metallic roofs, whereas for titanium-zinc metal roofs direct attachment to the substructure is recommended. Initial suggestion for fixation is the VHB tape from 3M.

The simulation results are summarized in the following table:

ROOFTOP	F1	F2	F3	F4	F5	F6
SLOPE	10°	10°	10°	13°	13°	13°
ORIENTATION (AZIMUTH)	SW (56°)	NE (-126°)	SE (-36°)	SE (-36°)	NE (-132°)	SW (48°)
INSTALLATION PEAK POWER (kWp)	5,390	5,390	1,715	13,818	4,704	1,470
PV MODULES	110	110	35	282	96	30
MODEL	SOLIKER PV-49	SOLIKER PV-49	SOLIKER PV-49	SOLIKER PV-49	SOLIKER PV-49	SOLIKER PV-49
MODULES PER STRING	5	5	5	6	6	6
STRINGS	22	22	7	47	16	5
INVERTERS	1	1	1	3	1	1
MANUFACTURER/MODEL	Fronius IG 60HV	Fronius IG 60HV	Fronius IG 15	Fronius IG 60HV	Fronius IG 40	Fronius IG 15
ENERGY PRODUCTION (kWh/Year)	5055	4599	1614	13400	3902	1372
SPECIFIC PROD. (kWh/kWp/Year)	938	853	941	970	830	933

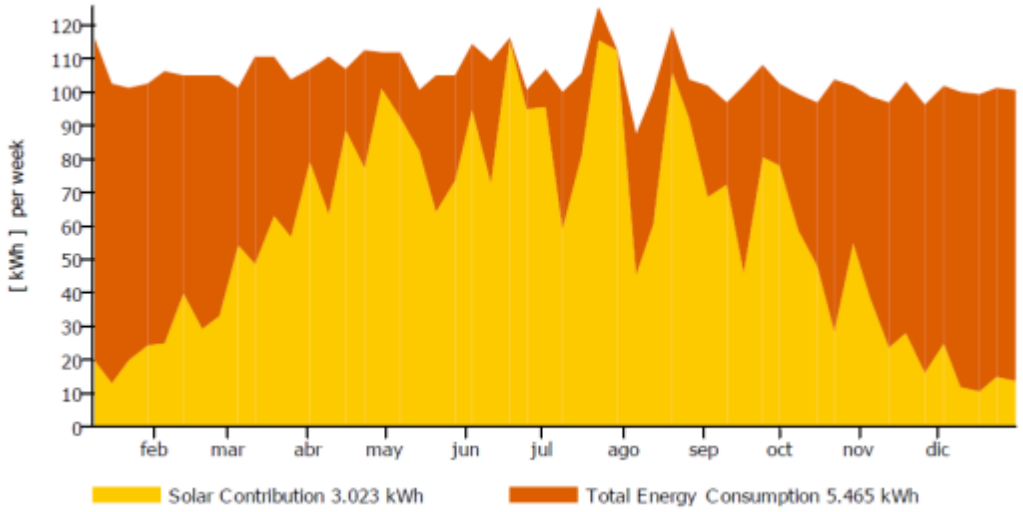
Solar Integration in Cases Studies

CS5 Monumental School. Innsbruck. Austria



Roof plan

Solar Thermal Simulation



Solar Integration in Cases Studies

CS7 Engineering School Bejar. Salamanca. Spain

PV Integration

Problems due to its orientation east-west, is the solar radiation through the windows: users are forced to close the blinds with the corresponding electricity consumption for lighting of the premises.

To minimize this factor: implementation of photovoltaic glasses to mitigate the filtering of this radiation and consequently the glare of the users. On the physic laboratory, second floor, and west orientation: possibility of having at the lab of a line of direct current (DC) for the practices of the Industrial Engineering student.

Solar Integration in Cases Studies

CS7 Engineering School Bejar. Salamanca. Spain

Solar Thermal Integration

The Industrial Engineering School is not a major consumer of Domestic Hot Water, this consumption occurs only in the gym showers (an electric water heater has installed) and in the Chemistry Lab.

The Chemistry Lab present the higher consumption and complexity, as the production will have east orientation, considering this orientation energy storage should be made at certain hours of the day and partly this should not coincide with the consumption of such energy.

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