Overview of the PVT Industry and Perspectives

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Cofounder and head of innovations
task60.iea-shc.org
DualSun – PVT manufacturer since 2010

- > 1,100 installations around the world
- 15,000 m² of panels sold
- 573% growth over 3 years (Deloitte Fast 50 Prize)
- 6 international family patents
- 3rd version of PVT module Wave, Flash, now Spring
- 17 trophées of best product over the world

Production and innovation Made in France

François – 600 PVT

Norway – 110 PVT

Netherlands – 308 PVT

Switzerland – 40 PVT

France – 12 PVT

Australia – 30 PVT

Hong Kong – 128 PVT
PVT = profitable electricity + cheap heat

Photovoltaic market
Total capacity: 505 GW (2018) (i)
LCOE residential PV <9kWc:
DE, 2016: 155€/MWh (iii)
FR, 2017: 130€/MWh (iv)
20-25 gCO2e /kWh (v)

Solar thermal market
Total capacity: 473 GW (2017) (vi)
Average LCOH:
Pool heating: 10€/MWh (vi)
District heat: 40€/MWh (vi)
Residential DWH:
WORLD: 80€/MWh (vi)
Carbon impact 2 times lower than PV (vii)

Photovoltaic market is more profitable and fast growing.
Solar thermal is the cheapest solar solution for heating.

(i) REN21, renewables global status report, 2019
(ii) Irena, Renewable Power Generation Costs in 2018
(iii) Taylor et al., Irena, True-costs-of-renewables, Lecture at Bonn, 2017
(iv) Etude de la compétitivité filière solaire française, iCare, Enerplan, Ademe, 2017
(v) Louwen et al., 2016, https://www.nature.com/articles/ncomms13728
(vi) Solar Heat Worldwide, 2019
Towards positive energy and low carbon buildings

Buildings and construction: 39% of energy-related carbon dioxide (CO2) emissions
World Green Building Council: Coordinated action towards 100% Net Zero carbon buildings by 2050

In the French label E+C- (2019): constraints in energy consumption and GHG emissions (LCA).

GHG emissions threshold: LCA of the building

<table>
<thead>
<tr>
<th>Global</th>
<th>Ex: multihouse building</th>
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<td>&lt;1550</td>
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For construction products and equipments

| <800 |

« One thing is certain: we will always need to produce domestic hot water (DHW) and the space on our buildings’ rooftops is not infinite... … the “2-in-1” technology (DHW and photovoltaic production), that combines two essential energy needs of buildings today and tomorrow, is very efficient. We use this technology for our own buildings and we observe its excellent performance every day.»

- Martin Bouygues, CEO of Bouygues

https://positive-energy-buildings.eu
H2020 EXCESS PEB demosites: PVT + GSHP for refurbishment and new building
Price learning curve

PVT is an opportunity for solar thermal to benefit from the quick reduction in PV costs. The clients expect to see the same % in price reduction for PVT than they have with PV: a challenge as the selling volume is really not the same.
PVT = \{PV + ST\}, design variations in all layer

| Solar flux | Flat plate collector
| Concentration CPVT
| Trackers |
| Front face insulation | « WISC »*
| Low emissivity coating
| Overglazed
| Vacuum |
| PV | Crystalline cells
| Thin film
| Semi-transparent
| Lower packing factor |

* « WISC »: Wind and Infrared Sensitive Solar Collector sometimes said “uncovered”

| Fluid | Water/ glycol water
| Air
| Nanofluid
| Heat pipe
| Refrigerant
| Bi-fluids |
| Exchanger material | Copper
| Aluminium
| Stainless steel
| Polymer |
| Exchanger geometry | Sheet-and-tube
| Serpentine
| Roll bond
| Channel
| Free
| With fins |
| Contact exchanger (or fluid) with PV module | Below
| Above
| Both
| Multiple passes
| Direct (without PCM)
| Indirect via PCM |
| Exchanger fixation (if applicable) | Gluing
| Encapsulation
| Mechanical fixing |
| Back face insulation | With rear insulation
| Without insulation
Illustration of the wide diversity in PVT concepts in the market

- vacuum [Naked]
- concentration on tracker [SunOyster]
- without tracking [Solarus]
- air-based [Systovi]
- overglazed [Endef]

- stainless steel [DualSun Wave]
- polymer [DualSun Spring]
- copper [Fototherm]
- aluminium: serpentine [3S]
- roll bond [Sunerg]
- extruded [Li-Mitra]
Since 2013, SolarKeymark clearly identifies the quality norm approval for flat plate PVTs:

- the **whole PVT module** has to repass the **IEC61215+61730** for photovoltaic quality, even if the PV laminate is already certified

- the whole PVT module has to pass **ISO9806** in MPPT mode, for solar thermal quality.

/!/\ PV ageing cycling = up to +85°C only

*If stagnation >85°C, no guaranty with the certifications that the PV part of the PVT stands cycles at the stagnation temperature with no degradation on PV performances*
PVT manufacturers are mainly European.

Each manufacturer mainly sells in its domestic market.

Number of manufacturers per country

Data from: PVT wrap, Zenhäusern, 2017
SolarHeat Worldwide, Ramschak, 2019

Water PVT cumulated market (m²) in Europe

Data from:
SolarHeat Worldwide, Ramschak, 2019

USA  China  Israël  Australia
Excluding France (air), WISC wPVT largely dominates the market

WISC water PVT cumulated market
0.6 M m²
Asia: 68%  
Europe: 23%  
Israël: 9%  
USA: 1%

Glazed and vacuum cumulated market
0.02 M m²
Europe: 85%  
Unknown location: 15%

Concentrated cumulated market
0.003 M m²
Europe: 60%  
Africa: 23%  
Asia: 13%

WISC air cumulated market
0.44 M m²
Europe: 100%

Data from: SolarHeat Worldwide, Ramschak, 2019
Applications: wide typology of clients, and systems

- Individual homes (DHW, Pools)
- Multihouse building, social housing
- Schools, nursery
- Campsites, restaurants and hotels
- Public pools, gymnasium
- Establishments for Elderly, hospitals

- Direct SDHW
- Direct pool heating
- Direct glycol to heat pump
- Cold side storage to heat pump
- To ground
Barriers: unfair supports

For the same production, PVT most of the time is less supported than the side by side PV+ST due to unfavorable criteria for PVT:
(power at high temperature, minimum kWh/m², energy labelling*, classified as « unglazed », PVT excluded ...)

* Data required for CDR (EU) N°811/2013 and N°813/2013 for energy labelling is not adapted to PVT (calculated at dT=40°C)!

### Production: 6000kWh$_{el}$ + 1500kWh$_{th}$

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<thead>
<tr>
<th>(6kWc+SDHW in France)</th>
<th>PV+ST</th>
<th>PVT</th>
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<td>PV support</td>
<td>1740€</td>
<td>1740€</td>
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<tr>
<td>ST support</td>
<td>2000€</td>
<td>1000€</td>
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SWOT : GO PVT !

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<tr>
<th>Strengths</th>
<th>Weaknesses</th>
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<td>- PVT already competitive //PV</td>
<td>- Lack of awareness from prescribers (still a young technology)</td>
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<td>- &gt;55 manufacturers in the market</td>
<td>- More complex than PV</td>
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<td>IEA Task 35 : technical issues behind us</td>
<td>- Unfair public supports</td>
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<td>- Norms IEC/ISO already in place</td>
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<td>- Already thousands of successful PVT installations</td>
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<tr>
<th>Opportunities</th>
<th>Threats</th>
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<td>- Taking advantage of PV costs</td>
<td>- As all REN : fossil price !</td>
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<td>- Best energy solution for positive buildings</td>
<td>- Follow the rhythm of PV prices</td>
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<td>- Many plumbers already qualified in solar heating</td>
<td>- Difficulty in Europe in financing massive investments for industrial companies in fast growing</td>
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<td>- Synergy with heat pumps</td>
<td>- Emergence of poor quality with a growing market?</td>
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