Why consider PVT systems?

IEA SHC Task 60 2018-2020
Webinar March 25, 2020

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PVT strengths

Delivery of:
• Heating up to 170°C! Direct or indirect with a heat pump
• Cooling indirect or direct at night
• Electricity for all kind of usage

PROs
• Maximize output per area
• 100% solar in fav. cases
• Heat pump source at no noise
• Borehole regeneration
• Payback time if load is constant
What is PVT?

Hybrid tech

No cover:

Wind
Infrared
Sensitive Collector
Why more solar energy?

Spectral irradiance $E_{\lambda}$ [W/m²nm]

- solar irradiance
- optical losses
- heat losses
- heat gains
- electricity gains

$\lambda$: wavelength [nm]

$\sim 74\%$ thermal conversion

$\sim 16\%$ photovoltaic conversion

~74 % thermal conversion

~16 % photovoltaic conversion
Factors affecting the performance

1. (-) T efficiency

2. (--) T efficiency ?

3. (++) PV efficiency ?
Higher temperature for the cell or lower!

Cross section from: A Mellor et al. Solar energy 174, nov 2018
Classification of PVT collectors

Collector design
- flat plate PVT
  - unglazed
  - glazed
- concentrating PVT
  - fixed (low-con)
  - tracked (high-con)

Type of fluid
- liquid
- air
- bi-fluid

PV cell technology
- c-Si
- thin film
- other PV (organic, III-V, ...)

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Climate: mid Europe

- **PV & T Side-by-side**

**29 m²**
- Solar thermal collectors

**13 m²**
- PV modules

**42 m²**
- PVT collectors

**Heat**
- 22 MWh_{th}
- 759 kWh/m²
- 524 kWh/m²

**Electricity**
- 2.5 MWh_{el}
- 192 kWh/m²
- 138 kWh/m²

**Annual yield [MWh]**

**E+13%**

**Electricity : Heat**

1 : 3.8

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Cost limit?
Well design and sourced PVT can make it!

**Standalone components**

- T glazed: 250 €/m²
- PV: 0.6 €/W for 190 W/m² = 114 €/m²

**Hybrid**…suppose same productivity or same value of energy

- PVT glazed < 364 €/m²?
- + savings on components + time 50 €/m²
Examples of PVT collectors 1

Courtesy of 3FSolar, Naked energy, Meyer Burger
Example of PVT Collectors 2

WISC

Air

glazed

Courtesy of Abora, Dualsun, Systovi
Example of PVT concentration collectors 3

SunOyster in operation in Shuozhou, China

Courtesy of Sunoyster
PVT Technologies – Concept Efficiencies

![Graph showing efficiency of different PVT technologies versus temperature difference.]

- FPC - Standard
- PVT - covered
- WISC PVT (uncovered)
- PVT-concentrating
- PV Module

Equation: $G=1000 \text{ W/m}^2$
PVT Technologies – Concept Efficiencies

Importance of operating temperature
Here at nominal conditions

Electricity : Heat
1 : 3.8

PVT - covered

PV Module
Applications

https://en.wikipedia.org/wiki/Photovoltaic_thermal_hybrid_solar_collector
Examples
PVT heating / summer night cooling
injected in the ventilation system – renovation and low energy houses

20 m² | T 500 kWh/m² | E 150 kWh/m² | 1/3.3

Cell temp coeff. on Pmax: - 0.47 %/K

Courtesy of Systovi
Firemen house - Zaragoza Spain

28 PVT panels 46 kg – 66% SF
43.4 m²
7.28 kW

T 31'184 kWh = 718 kWh/m²
E 9'618 kWh = 1320 kWh/kWp 221 kWh/m²
Ratio Energy PVT: 1/3.2

Courtesy of Endef
Example: Ground coupled heat pump

GS-Regeneration - P&D project Oberfeld

Object
3 MFH, 100 flats, 5345 m² ERA (energy reference area)

Heating system
28 boreholes of 200 m
Decentralized heat pumps
1300 m² PVT collector area

Performance 1st year of operation
Thermal yield 330 kWh/m²
Electrical yield 163 kWh/m²
Degree of GS-regeneration 125 %

Monitoring
SPF Rapperswil

Courtesy of Meyer Burger
Large industrial projects
Greenhouses ground heating and ventilation fans 1MW – 2011 - I

Courtesy of Millenium Electric T.O.U Ltd
PVT Collectors – Market Development

~ 1.1 Mio m² installed PVT collector gross area

Distribution of PVT manufacturer by collector type *(Source: IEA SHC Task 60 survey, AEE INTEC)*

Data from 26 manufacturers, gathered and processed by Thomas Ramtschak, AEE intec within Task 60
Best applications for ROI

- **T**: High DHW demand + low seasonality
- **PV**: Feed in tariff or electricity tariff (high self consumption)
- **Payback time**: 4 to 8 years in latitude -40/+40 climate
Hotel case in Barcelona – 200 rooms
200 PVT modules - 314 m2 - 56 kWp

Annual demand: 833’000 kWh
Solar fraction: 34%

T: 295’000 kWh = 940 kWh/m2, 50% efficiency
PV: 70’000 kWh = 1’250 kWh/kWp, 80 % self

Investment: 730 €/m2
Payback time: 4 years!
Industry Involvement in Task 60

- DualSun, F
- Systovi, F
- GSE, F
- PA-ID, D
- Solarus, NL
- Abora, SP
- Endef, SP
- 3F-SOLAR, A
- Trigo energies, CDN
- Solink, I
- Consolar, D
- SunOyster, D
- Naked energy, UK
- Sunovate, Australia
- ....
Significant Developments & Results in Task 60 2018 – 2020
PVT challenges

- *Industrial reliable products:* OK
- *Models, Simulation and prediction:* OK
PVT challenges

• *Industrial reliable products*: OK

• *Models, Simulation and prediction*: OK

1. Awareness
2. Testing T and PV
3. Temperature influences and durability
4. Labels and certificates Solar keymark
PVT challenges

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1. Awareness
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5. Investment + TCO
7. Best practices – case studies
8. KPIs for fair comparisons… Seasonal Performance Factor of T + PV
9. BIPVT
So to conclude, we have a message:

If you consider PV, why not PVT?
If you need solar DHW, why not PVT?
Thinking to switch to heat pump, why not with PVT?
PVThanks

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Linkedin  #PVT

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