SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

IEA SHC TASK 60 2018 - 2020

PVT systems

an introduction to the technology and Task 60

Jean-Christophe Hadorn OA

Industry workshop
Lyngby – Oct 9 2019


TASK60
PVT SYSTEMS

What is IEA SHC ? iea-shc.org

- Australia
- Austria
- Belgium
- Canada
- China
- Denmark
- France
- Germany
- Italy
- Mexico
- Netherlands
- Norway
- Portugal
- Slovakia
- South Africa
- Spain
- Sweden
- Switzerland
- Turkey
- United Kingdom

- Task 62 - Solar Energy in Industrial Water & Wastewater Management
- Task 61 - Integrated Solutions for Daylighting and Electric Lighting
- Task 60 - Application of PVT Collectors and New Solutions in HVAC Systems
- Task 59 - Deep Renovation of Historic Buildings Towards Lowest Possible Energy Demand and CO2 Emission (NZEB)
- Task 58 - Material and Component Development for Thermal Energy Storage
- Task 56 - Building Integrated Solar Envelope Systems for HVAC and Lighting
- Task 55 - Towards the Integration of Large SHC Systems into District Heating and Cooling (DHC) Network

What has been PVT in SHC ?
2005-2010

SHC Task 35

PV/Thermal Systems

The official participants in the Task are listed in the table below:

Country	Organization	Person
Canada	Dept. of Mechanical Engineering, University of Waterloo, Waterloo, Ontario, Canada	Mike Collins
Denmark	Esbensen Consulting Engineers A/S	Henrik Sørensen
	Solar Energy Center, Danish Technological Institute	Ivan Katic
Israel	Millennium Electric	Ami Elazari
Sweden	Lund Technical University	Björn Karlsson Johan Nilsson Bengt Perers
The Netherlands	ECN (Energy Research Centre of the Netherlands)	Wim van Helden Herbert Zondag Marco Bakker

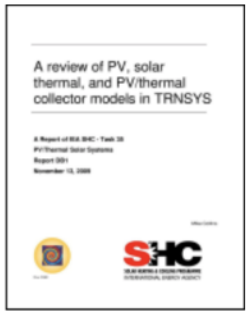
Project (Task) Publications

Deliverables Only | Advanced Search | Clear

Order by: Publication Date | Descending | Sort

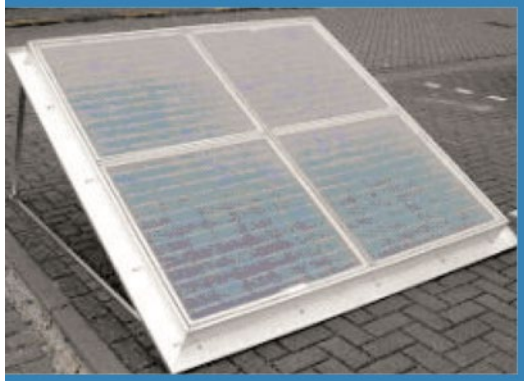
The following are publications developed under Task 35:

A Review of PV Solar Thermal and Thermal Collector Models in TRNSYS
November 2009 - PDF 0.96MB - Posted: 2012-04-30
By: Mike Collins, University of Waterloo, Canada
Document Number: DB1-A
This report assesses availability of PV and Solar Thermal system models. it is intended as a reference for those developing new models.



Recommended Standard for the Characterization and Monitoring of PV/Thermal Systems
November 2009 - PDF 0.92MB - Posted: 2012-04-30
By: Mike Collins, University of Waterloo, Canada and Herbert Zondag, ECN, Netherlands
Document Number: DB-2
This report covers the proposed practice to characterize and monitor PV/Thermal systems, and identifies and addresses gaps that currently exist in characterization and monitoring activities. It details schemes for flat-plate style thermal collect but not PV/Thermal systems based on concentrating collectors.

By using PV/T collectors instead of side by side systems it is possible to reduce the collector area by 40%.



The liquid PV/T collector (PVTWIN 422 from PVTWINS of The Netherlands) tested at the Danish Technological Institute, Denmark

IEA SHC Task 35 Subtask A
DA 1-2 Outcome of PV/T market survey interviews

Interviews in Canada, Germany, Denmark, Sweden, Italy and Spain

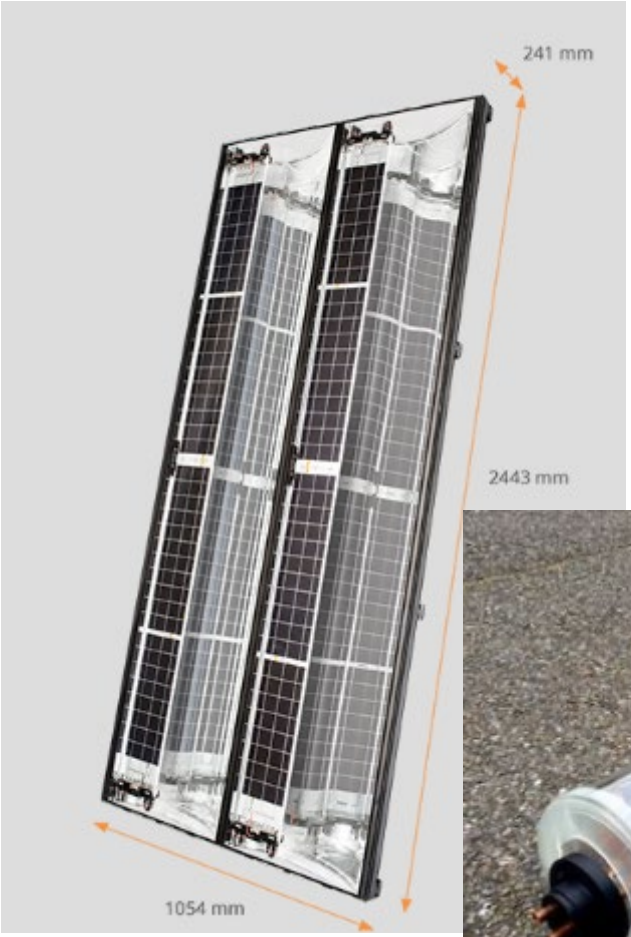
Compilation and analyze of interviews conducted October 2006 to May 2007 with "Architects, Engineers & building owners" and PV and thermal "Solar Dealers"

PVT systems
Findings 2017 for 2018 - 2020

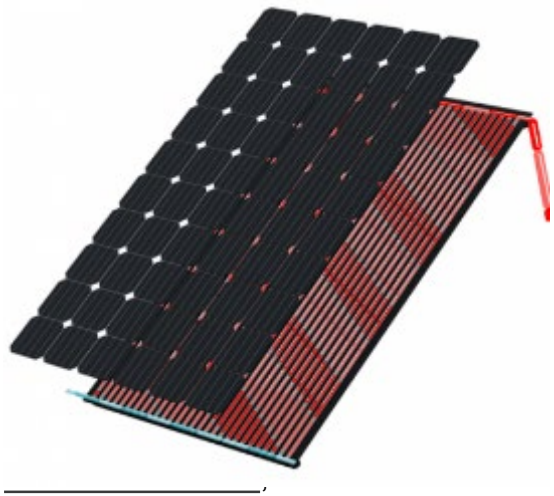
- Recognition of a potential market for PVT solutions not yet mature
- Clear Interests for a new Task from scientists
- Actors from industries on the move to capture a new market

- **https://en.wikipedia.org/wiki/Photovoltaic_thermal_hybrid_solar_collector**

Example of types on the market



Courtesy of Dualsun , Solarus, Naked energy, Meyer Burger



www.abora-solar.com, Spain

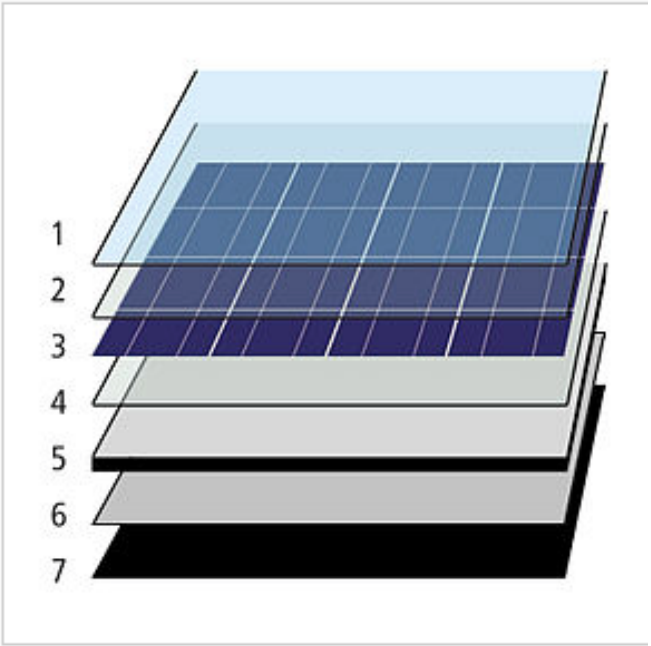
www.hakedenergy.co.uk, UK

www.endef.com, Spain

www.sunoyster.com, Germany

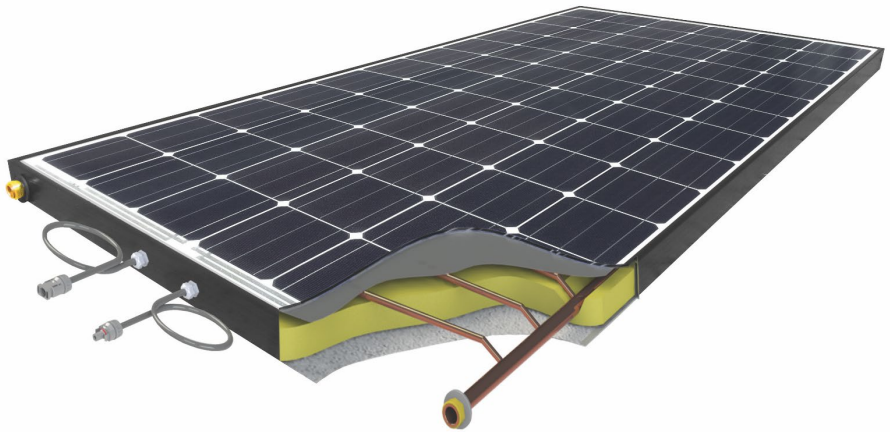
Some of the solar industries within Task 60

PVT collectors



Schematic of a hybrid (PVT) solar collector:
1 - Anti-reflective glass
2 - EVA-encapsulant
3 - Solar PV cells
4 - EVA-encapsulant
5 - Backsheet (PVF)
6 - Heat exchanger (copper)
7 - Insulation (polyurethane)

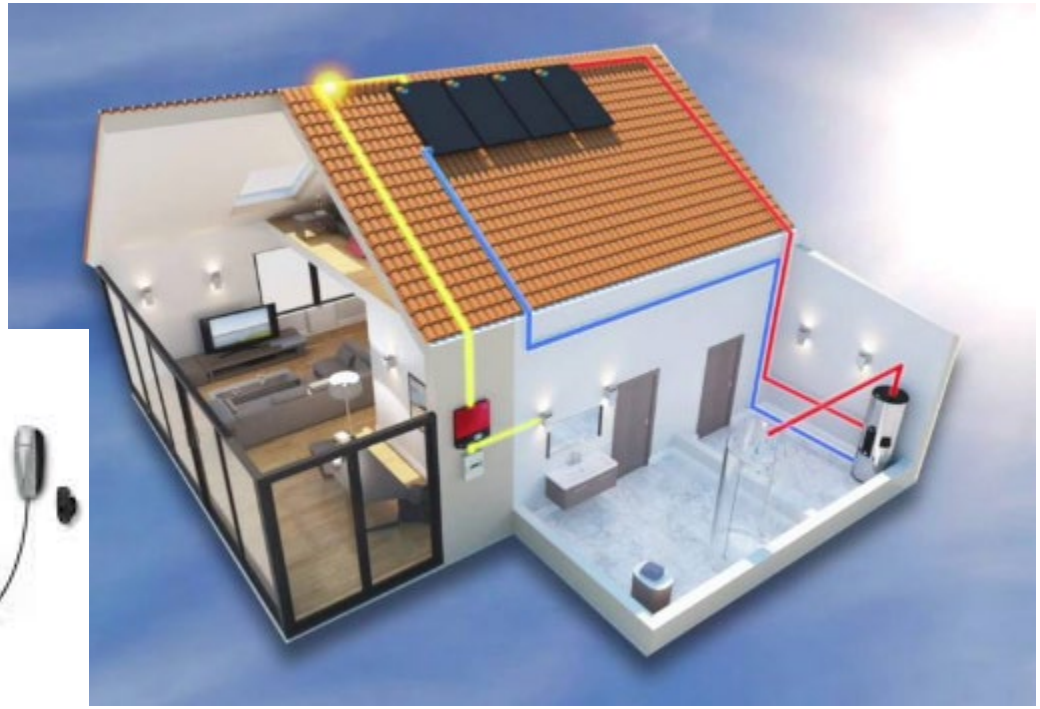
- PVT liquid heating collector
- PVT air heating collector
- PVT Liquid /and air heating collector
- WISC (formaly known as glazed / unglazed)
- PVT concentrating collectors (CPVT)



PVT strength

Delivery of:

- **Heat up to 170 C !**
- **Cold**
- **Electricity for all kind of usage**



Millennium 1 megawatt green house done

Example CH

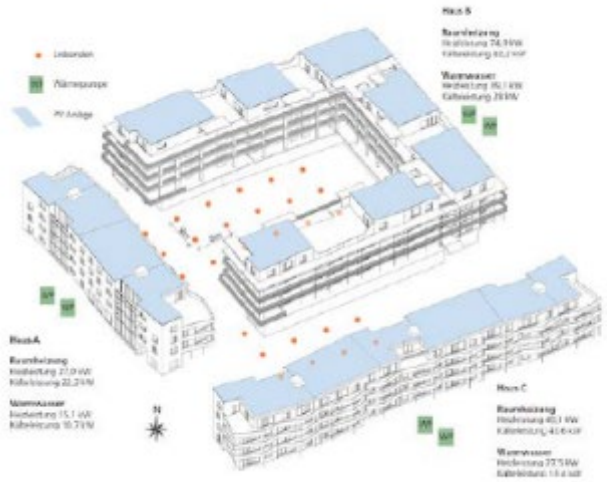
GS-Regeneration - P&D project Oberfeld

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



Bildquelle: «Solararchitektur» EnergieSchweiz

PVT advantage / Survey 1 - 20 experts May 2018

with PVT experience	50%
without PVT experience	50%

What are the advantages of PVT?

	n°
area saving (space efficiency)	12
noiseless compared to air heat pump	2
direct electricity supply	2
PV efficiency improvement	2
cost efficient	1
sector coupling	1
downsizing of ground heat exchanger	1
HP COP improvement	1

What ist the best application for PVT?

combination with HP	13
ground heat exchangers	3
swimming pool heating	2
heating and hot water	2
cold heat networks	1
component aktivation	1
high electricity need	1

PVT replaces……?

shallow geothermal	5
Air heat pump	4
ST + PV side by side	4
PV	2
solar thermal	2
fossile fuels	2
swimming pool ST collector	1
empty roof ;-)	1

Problems and barriers?

Material research compared to PV
Legal approval of the PVT product
Interaction of installation companies
Funding not well knwon

And…testing ? certification ? cost ?

Task Organisation

Operating Agent
JC Hadorn, Switzerland

A
PVT systems in operation

T. Ramschak,
AEE, Austria

In situ monitoring

B
PVT Performance Characterization

K. Kramer, Fraunhofer ISE, Germany

Performance Characteristics

C
PVT Modeling

As. Sanz
Tecnalia, Spain

System Simulation

D Systems Design Examples
best practice of solutions from B and C with A constraints – KPIs – Basic recommended control strategies

Dissemination and market support

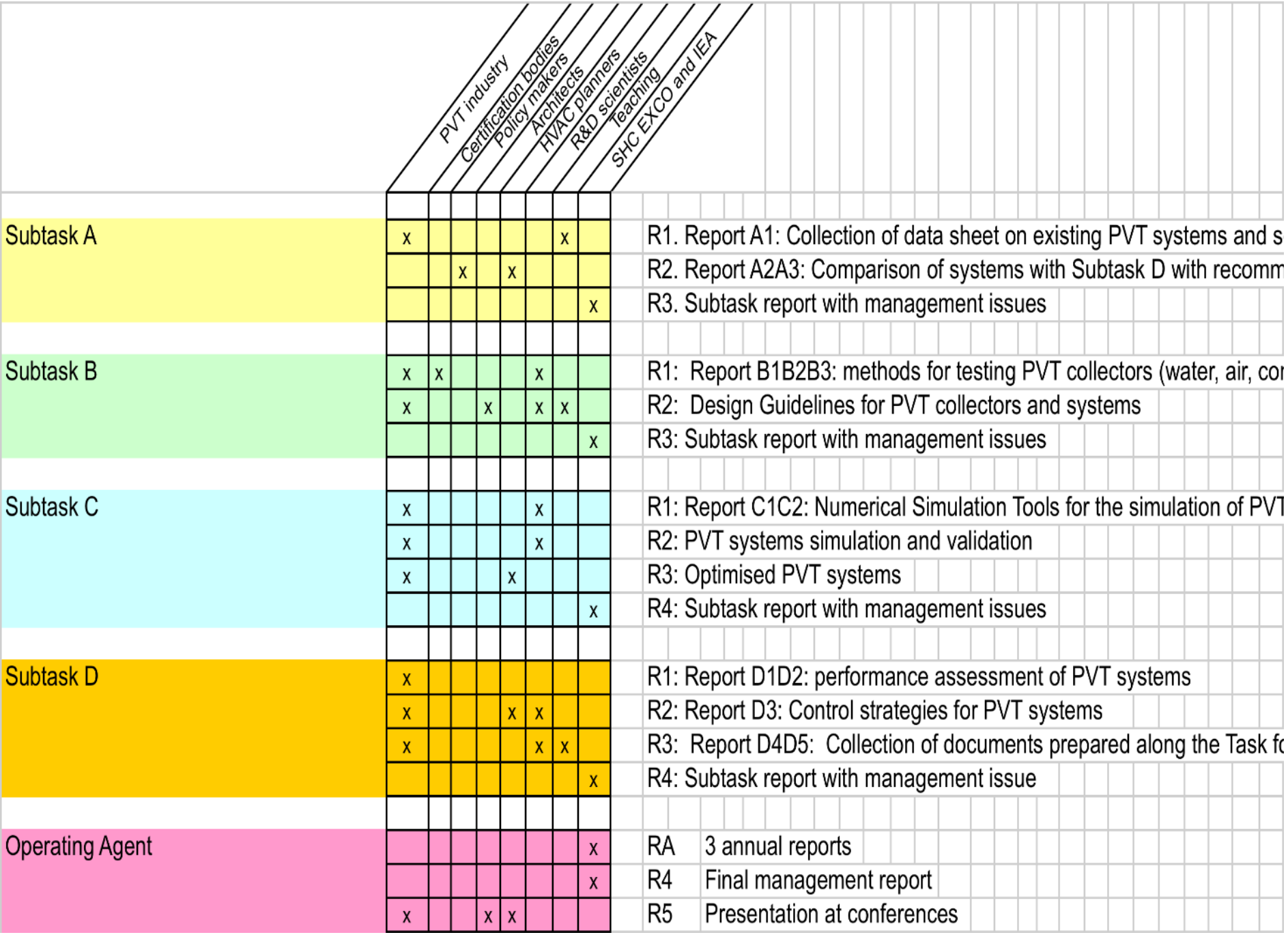
A. Haeberle, SPF, Switzerland

System Design examples

Participation from:

- **Australia** Sunovate
- **Austria** ASIC FH Wels, AEE Intec, *3-F*
- ***Canada*** *Trigo energies*
- **Denmark** DTU BYG, Ramboll
- **France** Univ Perpignan CESP, CEA INES, Dualsun, *Systobvi, GSE*
- **Germany** Fraunhofer ISE, Berlin HTW, ISFH, Univ Saarland, HTW Saar, Stutgart IGTE, ZAE Bayern, easy-tnt, Consolar , Sunoyster, PA-ID (2Power), Grammer
- **Italy** Politecno Milano , Uni Catania, Uni Bologna, Solink
- **RSA** Conver-TEK (CogenX solar)
- **Spain** Uni Zaragoza, Uni Lleida, Tecnalia, Endef, Abora
- **Sweden** *Darlana,* Univ. Gävle, BDR Thermea bv, Solarus AB
- **Switzerland** SPF, ZHAW, ETHZ LKE, Vela Solaris, ESSA, Hadorn, 3S solar ?
- **NL** SEAC-TNO, Eindhoven Univ, Solarus BV
- **UK** Naked energy, Solar Speedflex

Observers from: USA (Univ Charlotte EPIC, Tyll solar), Macedonia (Camel Solar), Czech (Tech. Univ. Prag), India (Solar Thermal Fed of India), Malaysia through Ireland EBC contact person , Israel Millenium, Greece Prime Laser technology, Korea (Kongju Univ)


PVT industry
Certification bodies
Policy makers
Architects
HVAC planners
R&D scientists
Teaching
SHC EXCO and IEA
Subtask A
x x
x x
x
Subtask B
x x x
x x x x
x
Subtask C
x x
x x
x x
x
Subtask D
x
x x
x x x
x
Operating Agent
x
x
x x x
R1. Report A1: Collection of data sheet on existing PVT systems and s
R2. Report A2A3: Comparison of systems with Subtask D with recomm
R3. Subtask report with management issues
R1: Report B1B2B3: methods for testing PVT collectors (water, air, co
R2: Design Guidelines for PVT collectors and systems
R3: Subtask report with management issues
R1: Report C1C2: Numerical Simulation Tools for the simulation of PVT
R2: PVT systems simulation and validation
R3: Optimised PVT systems
R4: Subtask report with management issues
R1: Report D1D2: performance assessment of PVT systems
R2: Report D3: Control strategies for PVT systems
R3: Report D4D5: Collection of documents prepared along the Task fo
R4: Subtask report with management issue
RA 3 annual reports
R4 Final management report
R5 Presentation at conferences

PVT Systems

Collection of data sheet on existing PVT systems and solutions

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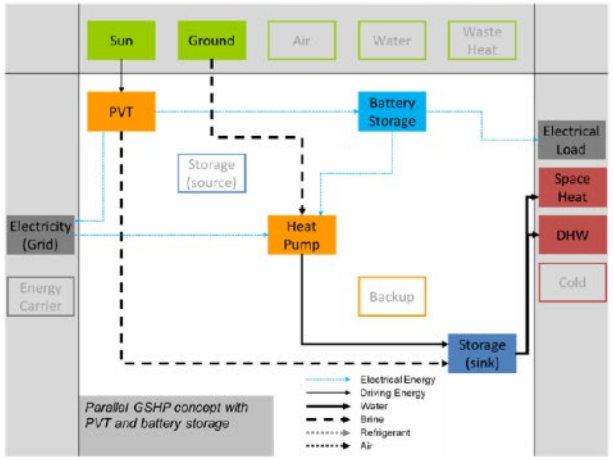
Visualization of energy flows in PVT systems



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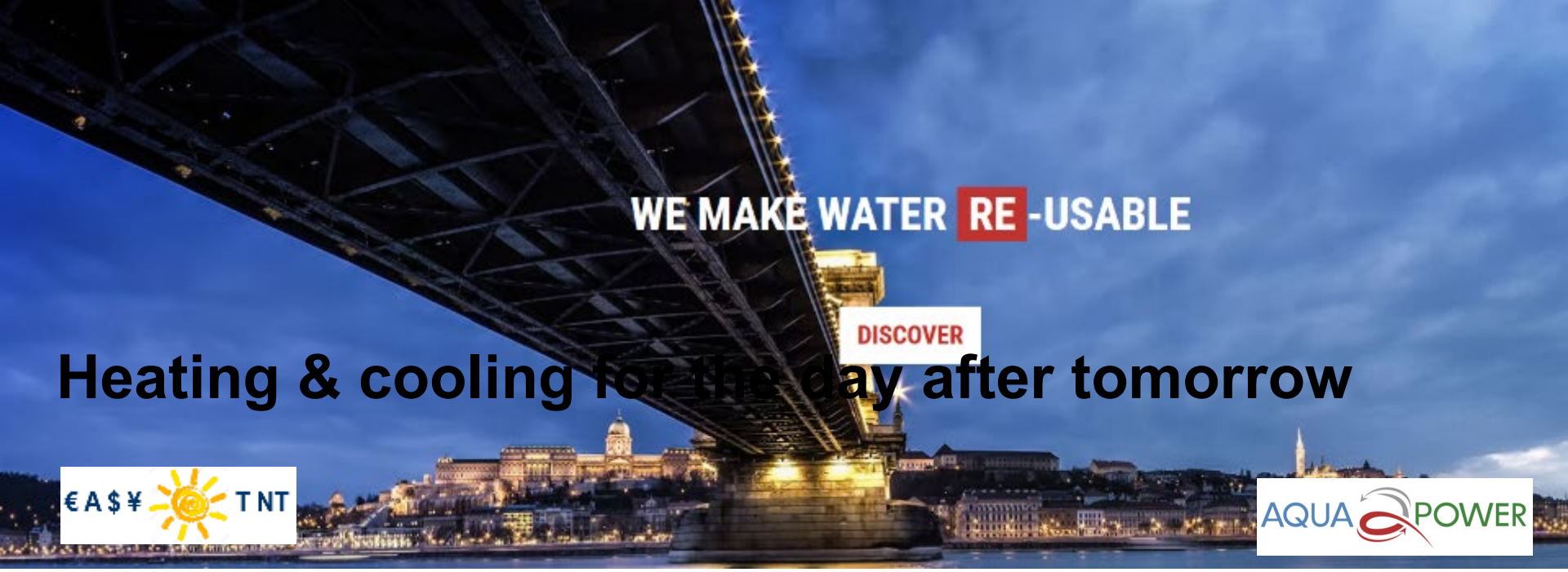
Report D4

Status Quo of PVT Characterization



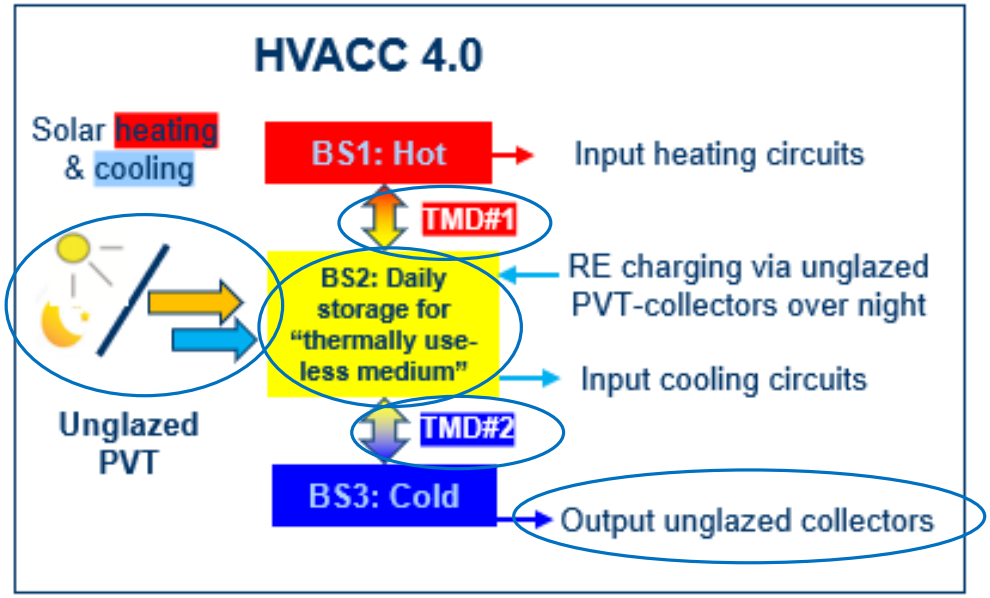
Heating & cooling for the day after tomorrow

Dr. Thomas Noll

TASK60
PVT SYSTEMS

HVACC4.0: System architecture 1/4

Storage concept



PATENT PENDING

Main Features & Q7

Q&A

1. Storage cascade with n ≤ 3 Buffer Storages (BS1, BS2, BS3) with disjunct T-profiles
2. BS2 designed as a Daily storage for "thermally useless medium" — Q3
   * cold is harvested in summer via PVT during night
   * heat is harvested in winter via PVT during day @ $T>T_{brine}$ — Q4
3. Two Temperature Modification Devices (TMD) for adjusting the T-profiles in the storages for operation of the heating & cooling circuits — Q1
4. Specific thermal collector yield is maximized by sourcing in winter from BS3 — Q5

Q7: "In which climate zones does this concept work w/o reliable geothermal heat source?"

HVACC 4.0
Summary and next steps

New system architectures in combination with new RE-sources like PVT-collectors or thermally activated Sheet Pile Systems are door openers to

1. Triple COP compared to air-water heat pumps
2. Boost EER from 2,5 (split devices) beyond 50 (night-time cooling via PVT)
3. Allow more sector coupling, because BS2 behaves like a virtual power storage when loaded

- **Start project with partners** → Q7, Q8, Q9, Q10

Projektträger Jülich Forschungszentrum Jülich

Fraunhofer ISE

€A$¥ TNT

BARTL Wärmepumpen

Vision Green Solutions

res

- Exploration of new opportunities for combination of sheet piles systems with next generation district grids

Q6

AQUA POWER

PVThanks

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