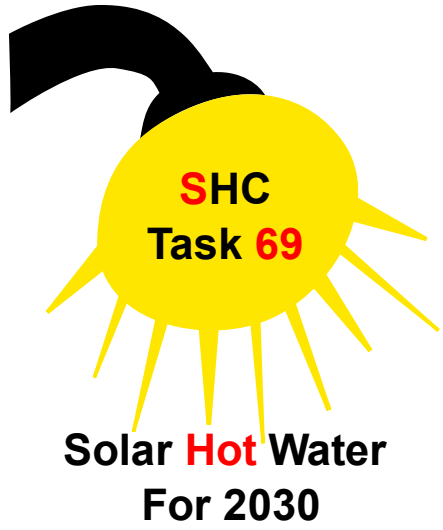
SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Task 69:
Solar Hot Water for 2030

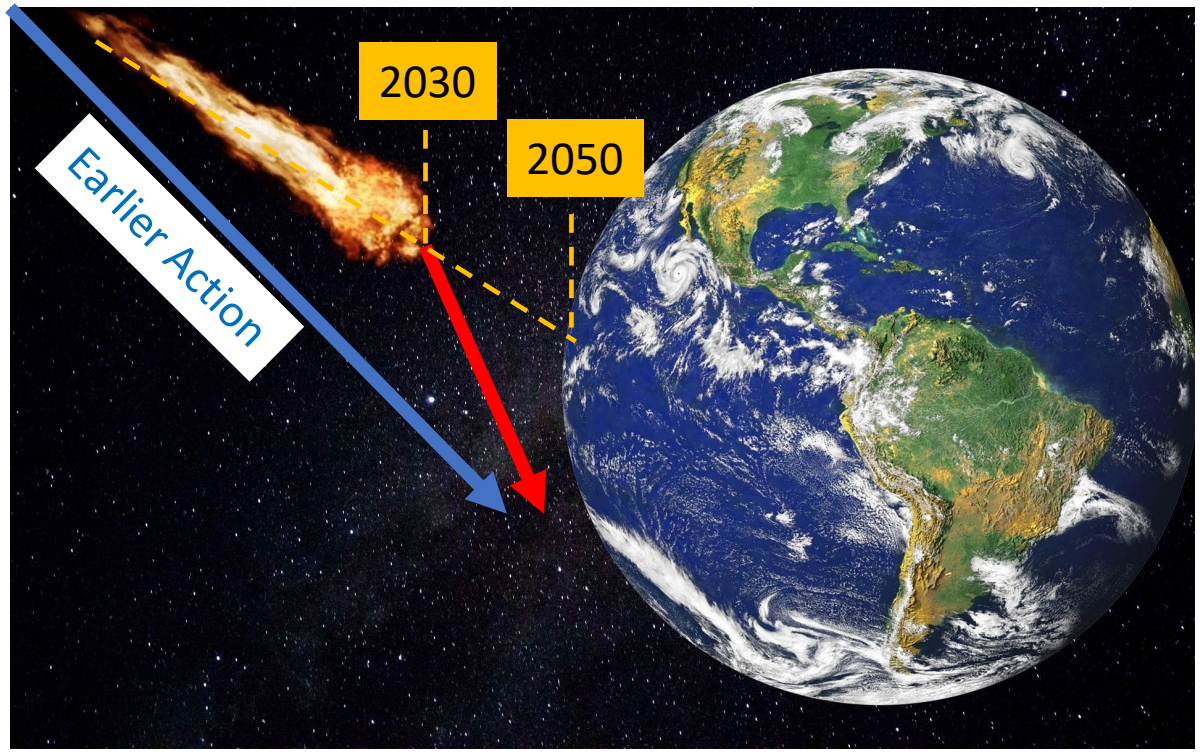


Robert A Taylor, UNSW & He Tao, CABR: Joint TMs
6 December 2022

Motivation for Solar Hot Water

Water heating accounts for ~5-10% of primary energy use globally[1], and above 50% of a building's energy in some markets!

➢Solar *vanguard* application which can **change** the trajectory for 2030.



SHC SOLAR HEATING & COOLING PROGRAMME INTERNATIONAL ENERGY AGENCY

[1] Solar thermal capacity and future outlook IEA (2019), Renewables 2019, IEA, Paris https://www.iea.org/reports/renewables-2019

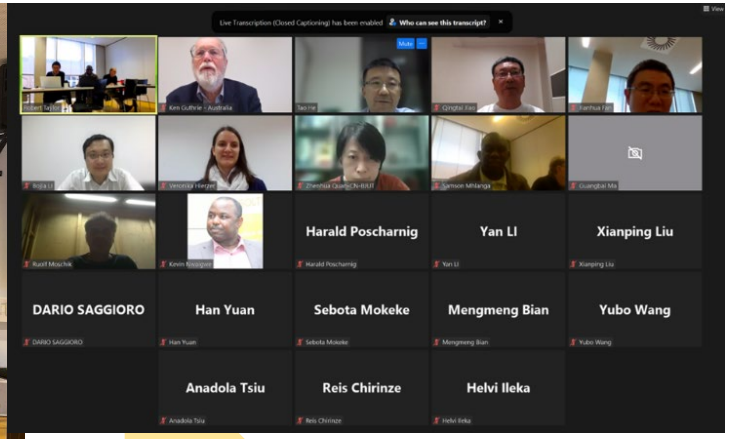
Scope

In this Task, we are focusing on **2** technologies:

- **Thermosyphons:** The most used solar heating system (~57% of domestic hot water systems in operation in 2019)
- **PV Hot Water:** Rapid PV growth! Can be simple (i.e., low cost) or advanced (i.e., soak up excess PV and power heat pumps).

Note: Both require very few moving parts, can be affordable and reliable, and provide opportunities for new products/components.

Timeline/Progression



91st Exco
Task 69
Approved
(June '22)

First Proposed
89th ExCo (May '21)

Update
90th ExCo
(Nov. '21)

September '22
(Eurosun)
Kick-off
Meeting

2023 – 2 Task Meetings Planned: April (hybrid) / Nov. (Melbourne)

2024–
30 June 2025
Semi-annual Task Meetings

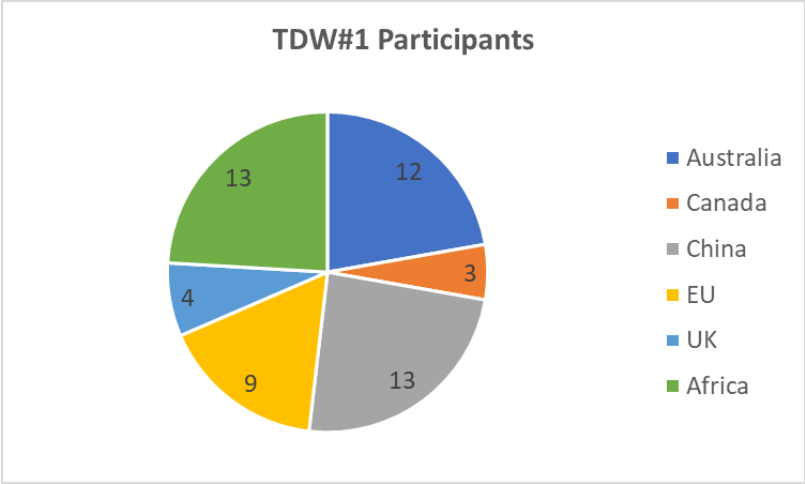
30 June 2025

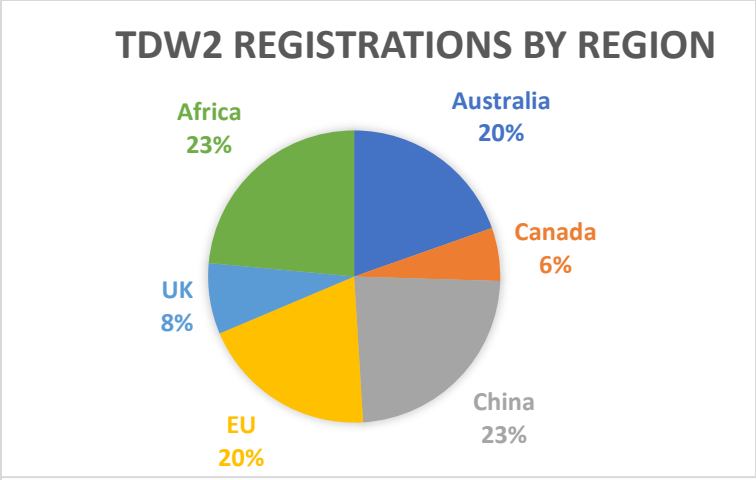
TDW#1 (Sept. '21)

TDW#2 (April 22)

92st Exco
Task 69
Approved
(June '22)

Participation





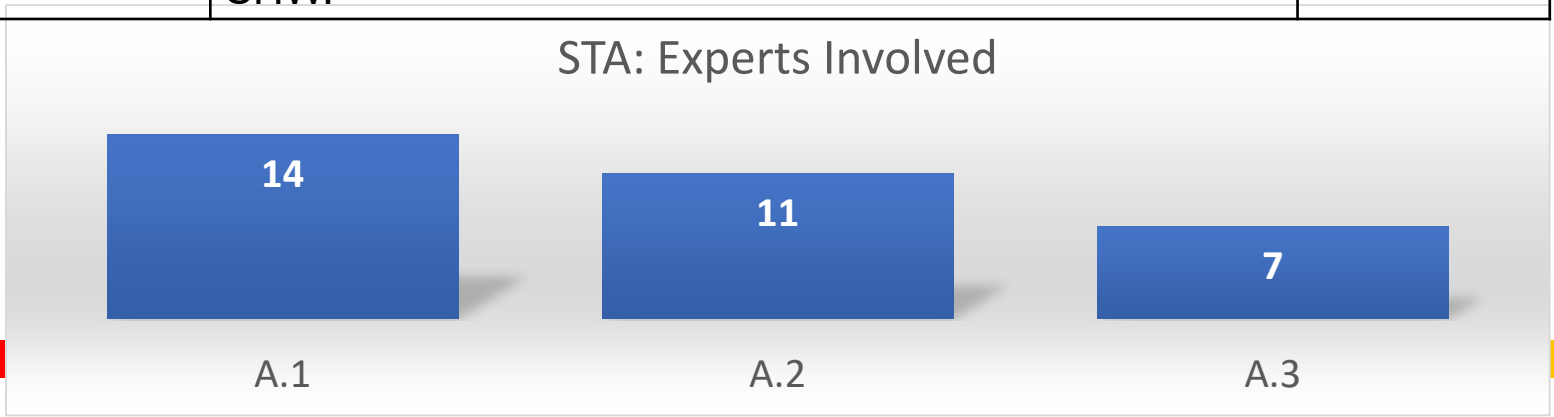
- **19** countries (represented in TDW#2, 14 April)
  - *Australia, Canada, China, UK, Albania, Austria, Denmark, Germany, Greece, Norway, Portugal, Switzerland, Italy, Zimbabwe, Botswana, Lesotho, Namibia, South Africa (and representatives from EACREE, SACREE)*
- **90** total experts registered
- **54 a**ttended the TDW#1 / **53** signed up for Deliverables in TDW#2.
- **~30** experts came to the Kick-off Meeting (12 in-person, 18 online)

Subtask A: State-of-the-art and operating environments. Lead: Daniel Tschopp, Austria

Aim: Analyze global solar hot water installation data, including the operating environment, trends, best practices, current regulations, and the major technical and non-technical barriers to adoption. Findings and results to into subtask B and C.

No.	Deliverable	Month
A.1	Report on most dominant solar water heating systems and state-of-the-art reviews for thermosyphon and PV hot water technologies, analysis of market regions and potential for solar water heating.	30
A.2	Documentation of success stories and market barriers in relevant regions.	30
A.3	Report on emerging products and research trends for SHW.	36

*Building upon Solar Heat Worldwide Data



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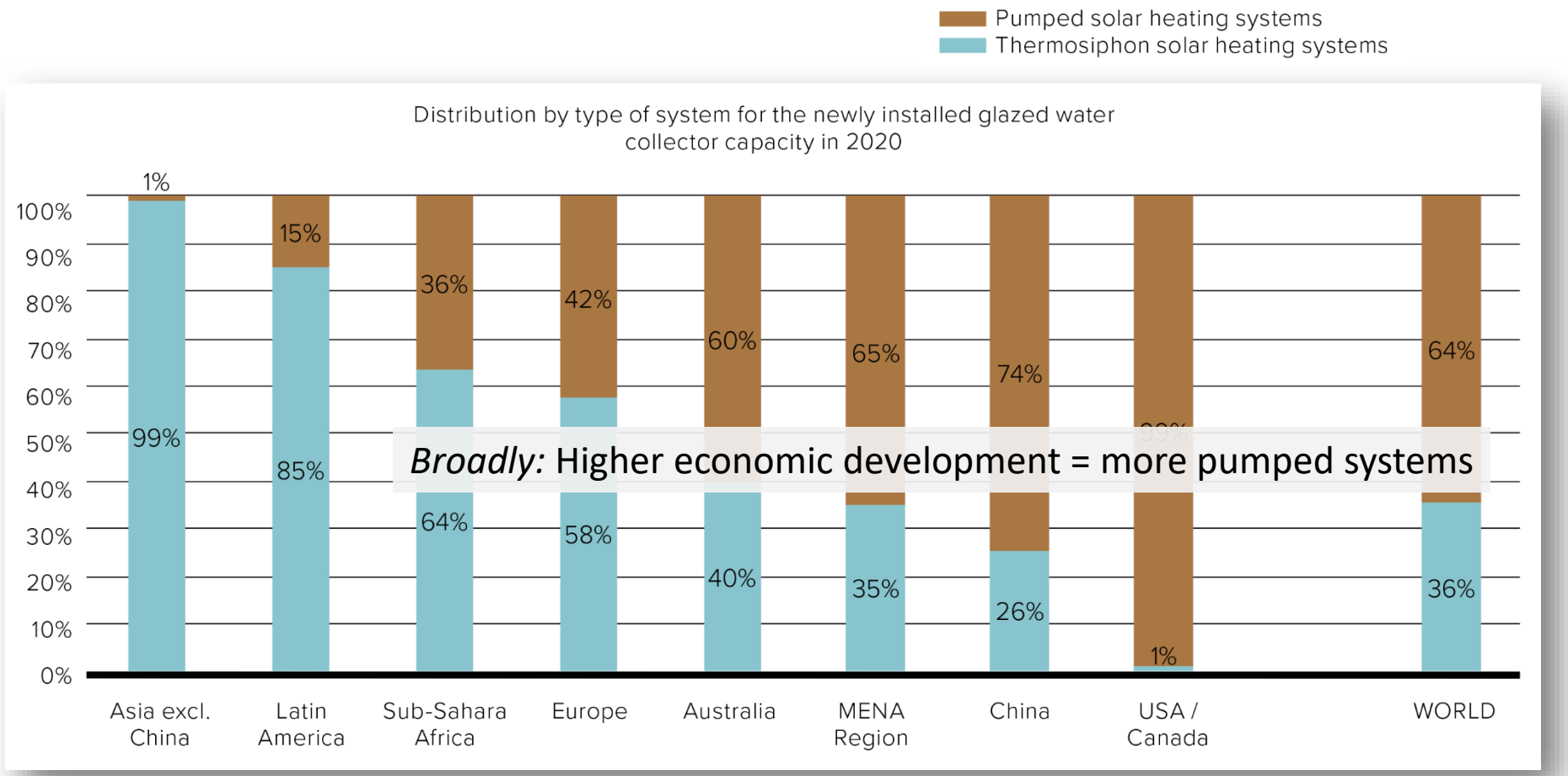
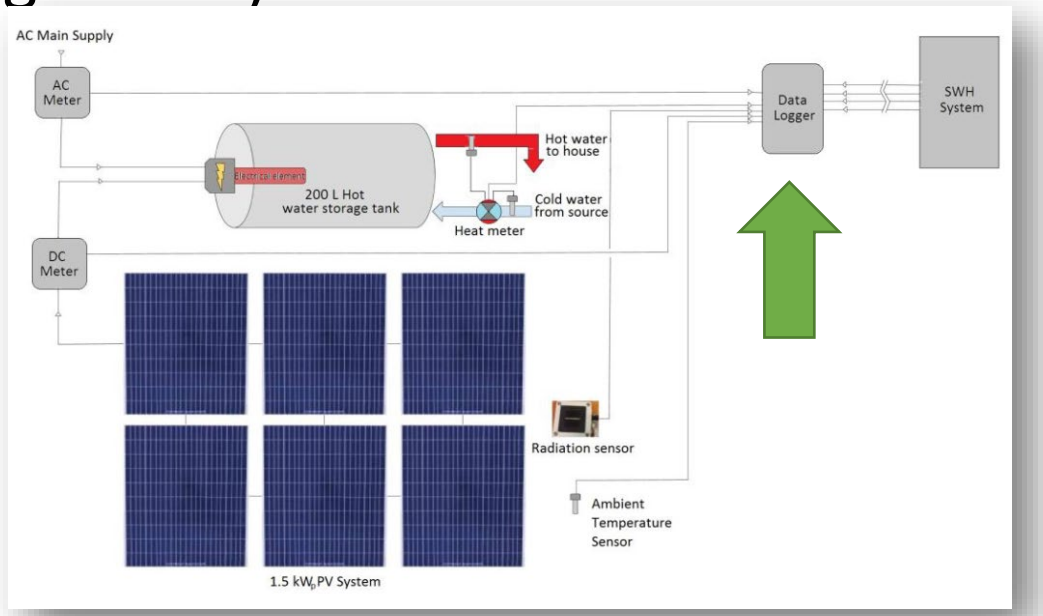
Thermosyphon – Newly installed capacity



PV2Heat Systems in South Africa – System design

- Data has been collected as part of SOLTRAIN project in South Africa (12,000 ~ 1kW systems through 2020)



Buckley, A. et al. (2019): Comparison of Photovoltaic and Solar Thermal Hot Water Systems in the South African Context. Proc. ISES SWC 2019, doi:10.18086/swc.2019.09.01

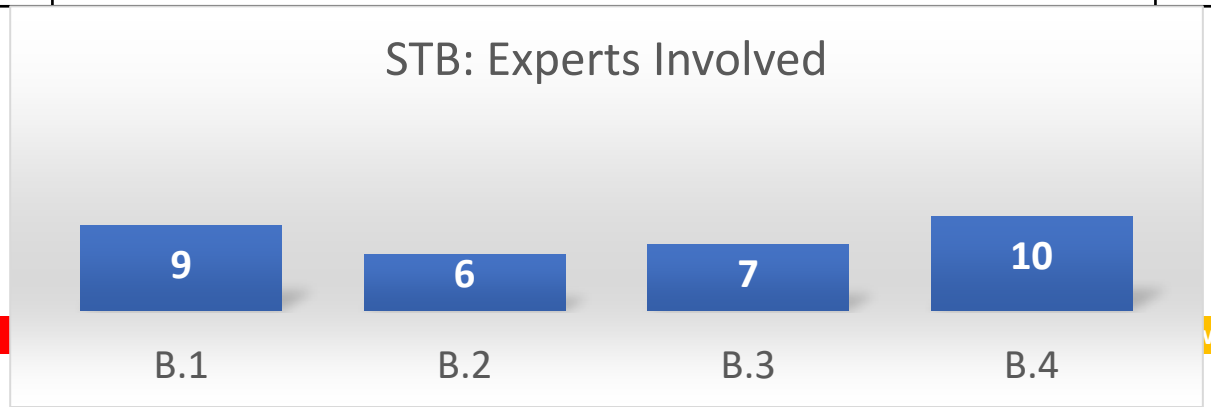
SubTask A: Progress to date

1) Funding was obtained by the Subtask A leadership
    - Funding body: Federal Ministry of Austria for Climate Action, Environment, Energy, Mobility, Innovation and Technology
    - Duration: 11/2022 to 06/2025
    - 120.000 € funding for Austrian consortium (led by AEE INTEC)
    - Project: SOLTRAIN+ Southern African Renewable Heating and Cooling Training and Demonstration Initiative (A rich data set!)
2) Global Thermosyphon/PV hot water market has been divided into **8** market regions with **5** regional experts confirmed to coordinate data collection for their market region
3) Collection of first insights from Task experts on SHW technologies in different countries/regions based on expert discussion at Kassel Task Meeting

Subtask B: Thermosyphon hot water systems
Lead: Li Bojia, China

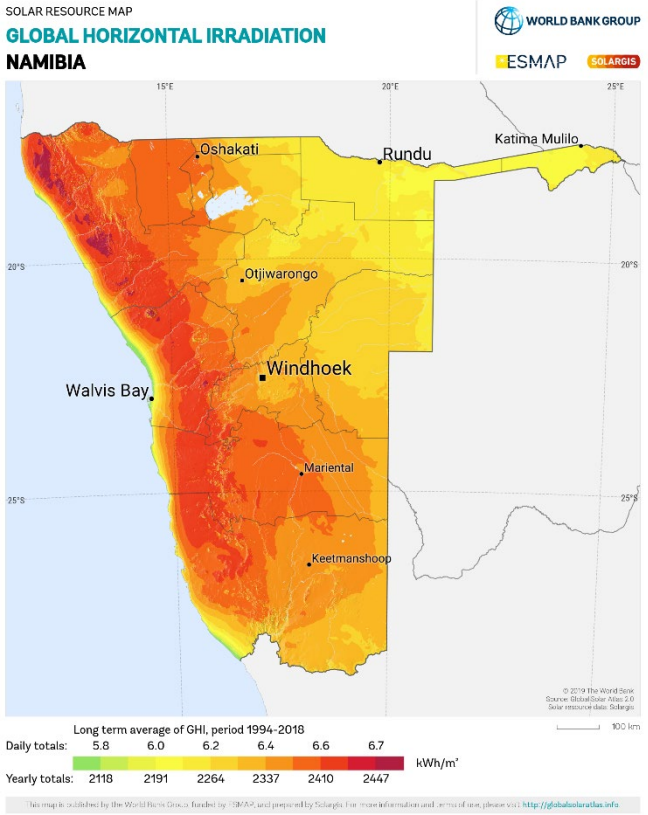
Aim: Investigate durability and reliability of these systems, accounting for their relatively poor track record in GN SEC regions. The subtask will also investigate the potential of new technologies to save energy and reduce GHG emission as compared to conventional systems.

No.	Deliverable	Month
B.1	Report of thermosyphon system potential	12
B.2	Survey of failure modes and effects and suggestions	18
B.3	Report on durability and reliability	18
B.4	Report on energy-saving & GHG reduction methods along with current and future trends	36



Typical applications of thermosyphons

- **Simple** thermosyphon systems are very common in the **Sunbelt** (between the 20th and 40th degrees of latitude in the northern and southern hemispheres)



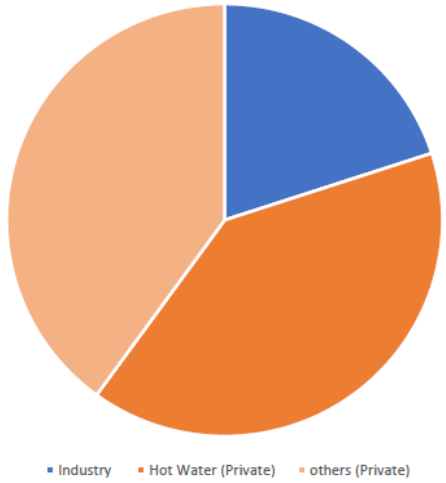
Many locations in Africa have >6.5 kWh/m²/day

(Compared to east coast of Australia, which has ~4.5 kWh/m²/day)

Installation at Susanne Old age home

GN SEC Barriers and Opportunities

Namibia Energy Consumption



Barriers

- Unreliable water supply + high GHI = Dry out and failure
- Limited qualified suppliers/installers
- High up-front cost (particularly for an unreliable system!)
- No frameworks for implementation, funding, or carbon trading to reduce cost
- No local manufacturers of SWH products perpetuated the relatively high prices
- Limited awareness (including consumers, financial institutions, and technology suppliers

Opportunities

- 65% of energy is imported (partly coal-power), can be unreliable
- 35% is produced locally (mainly hydropower with some small RE)
- Half of it is for hot water (40% of total production)

SubTask B: Progress to date

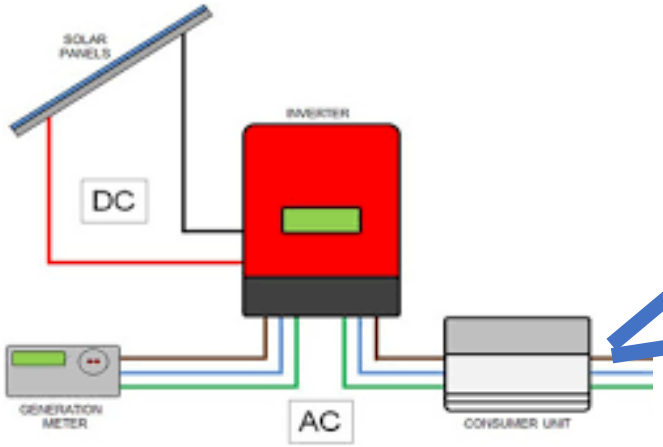
- Funding was obtained by the Subtask B leadership
  - Funding Name: China National Key R&D Project: *Key technologies and demonstration on zero carbon building in solar energy rich region*
  - Duration: *Nov 2022 to Oct 2026*
  - RMB 1,421,300 (~200.000 €)
- The activities and expert list were confirmed
- Collection of first insights from some Task experts on thermosyphon SHW technologies at Kassel Task Meeting

Subtask C: Solar Photovoltaic Hot Water
Joint Leads: George Bennett (UK- Temp) & Dean Clift (AU)

- **Aim:** Evaluate the environmental, social and economic implications of the increased deployment of PV water heating technologies
- **Why?:** Similar efficiency for COP =3 heat pump, reliable, affordable ($/L), offers new opportunities for grid/consumers, and we need all hands-on deck!

Close Coupled

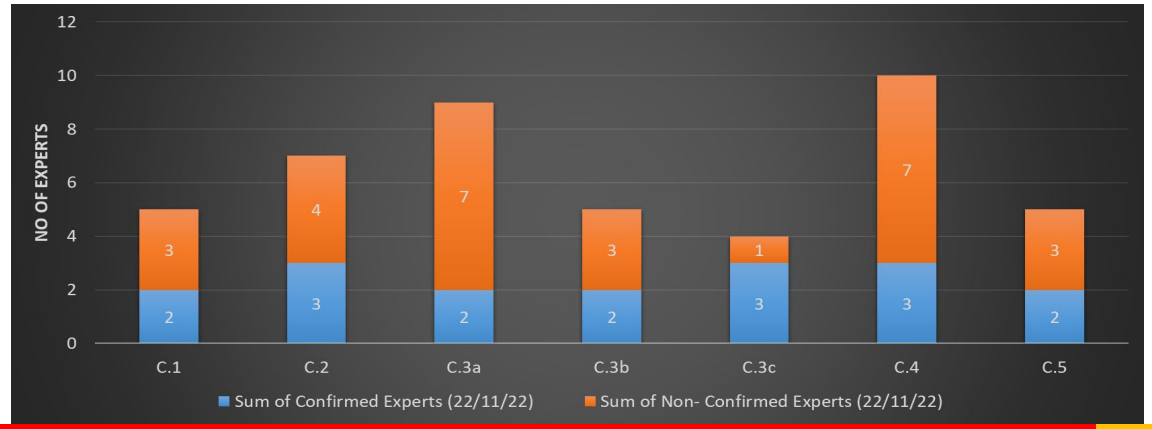
Coupled: Self-Consumption



Uncoupled:
Relatively trivial case

SubTask C: Deliverables and Timeline

No.	Deliverable	Month
C.1	Expert Network, Expert Questionnaire / Interviews and Case Studies	12
C.2	Systematic International Literature Review + Market Review	24
C.3a	Technology / Policy Brief	24
C.3b	New ISO Solar Energy Vocabulary	36
C.3c	Reference Models + Solar Heat Worldwide Chapter	24
C.4	Solar PV Hot Water Technology Harmonisation Strategy	36
C.5	Implementation of Solar PV Hot Water Technology Harmonisation Strategy	36



SubTask C: Progress to date

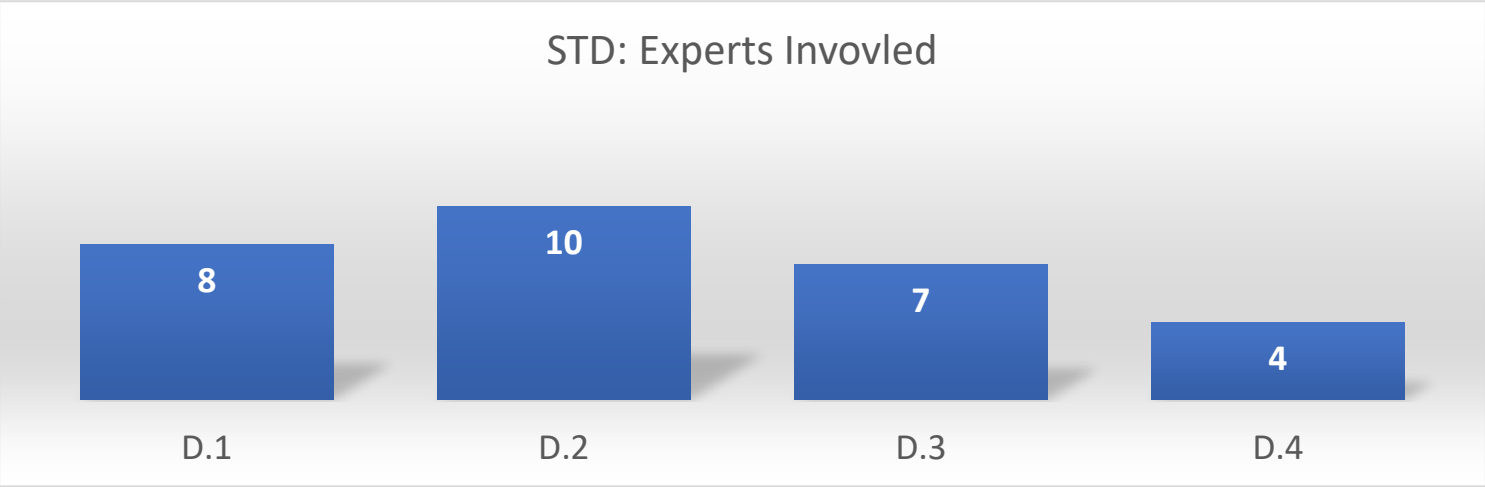
- Funding was obtained by the Subtask C leadership for the UK (UK Government direct funding for Operating Agent to cover task leadership from Q2 2023)
- The activities and expert list were confirmed
- Funding in **Australia** = SolarShift: Turning electric water heaters into megawatt batteries (A **RACE CRC** Project, €)
  - 3,000 households (historical + add controls) operating as part of the trial
  - PV hot water via esistive heating elements, heat-pumps and more advanced water tanks & heat exchangers
  - Comparison of different control methods: fixed time schedule vs. more dynamic and smart controls

Subtask D: Training and standards
Lead: Jianhua Fan (DK), Denmark

- This subtask aims to develop new standards to add the new technologies/ configurations and revise the current standards.
- The following activities will be undertaken:
  - *Training* – Provide training to SHW installers and designers
  - *Standards* – Recommendations on revision(s) of current standards for new technologies
  - *Status report of selected warranty and certification networks*
  - Needs Assessment Report
  - Report on success stories

SubTask D: Deliverables and Timeline

No.	Deliverable	Month
D.1	Report on needs for new Standards or Standards updates and the status of selected warranty and certification networks	18
D.2	Facilitate Training	15 & 30
D.3	Needs Assessment Report (Training for Solar Energy Practitioners)	24
D.4	Report on success stories	36



Standards

- Task Experts are in **ISO** TC 180.

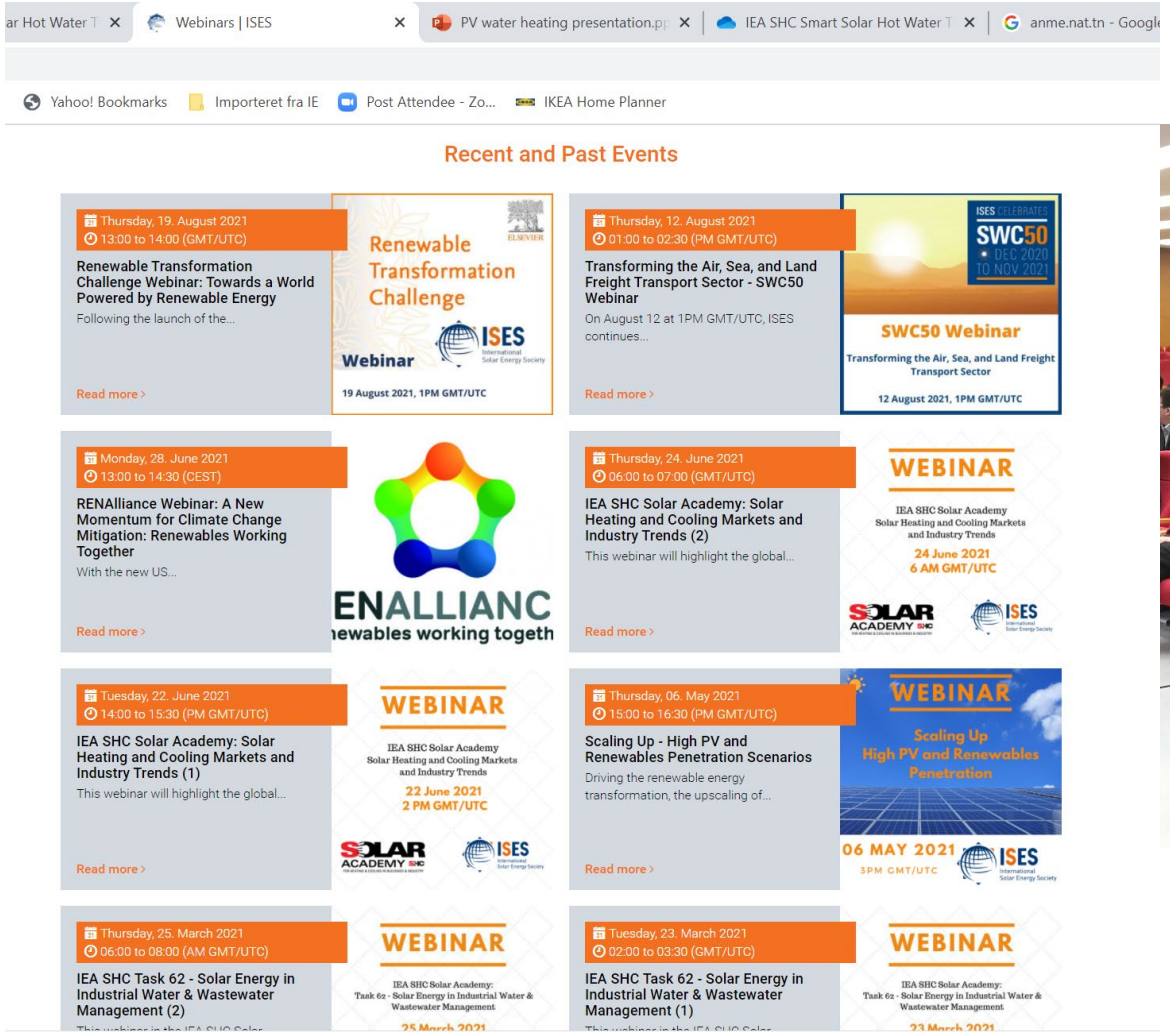
  Looking into possible updates for:

  - ISO 9459-4, Solar heating — Domestic water heating systems — Part 4: System performance characterization by means of component tests and computer simulation,
  - ISO 9459-5, Solar heating — Domestic water heating systems — Part 5: System performance characterization by means of whole-system tests and computer simulation
- Task Experts on **Australian** Standards Committee as well
- Task Experts on **China** Standards Committee SAC/TC 402:

  Looking at possible updates for **China** :

  - *GB/T 35606-2017:* Green product assessment- Solar water heating system
  - *GB/T 18708-2002:* Test methods for thermal performance of domestic solar water heating systems
  - *GB/T 19141-2011:* Specification of domestic solar water heating systems
  - *GB/T 25966-2010:* Specification of domestic solar water heating systems with electrical auxiliary heat source
  - *GB/T 25967-2010:* Test methods for thermal performance of domestic solar-plus-supplementary water heating systems

Training Plans – ISES/SHC Webinar and/or Solar Academy



Organized for installers, engineers and manufacturers

SubTask D: Progress to date

- Funding was obtained by the Subtask D leadership (Danish Energy Agency, EUDP project, ~260.000 **€**)
- The activities and expert list were confirmed.
- Preliminary inputs from the participants of the kick-off meeting regarding aim and target groups of the training needs

Summary & Items for the ExCo

- All subtasks have funding (w/ more proposals pending)
- We reduced the # of Deliverables (by 4)

- How to get more engagement from:
  - PVPS and Heat Pump Experts
  - STA survey participants (manufacturers, system owners)

Questions?

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IEA Solar Heating and Cooling Programme (group 4230381)

Back-Up Slides

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Final Thought

A few millennia

Solar water heaters on Northern Territory Housing Commission Units at Palmerston. [Source: *Solahart* in Morse RN, 1988]

A few decades (+ Task 69)

Objectives

- Define the market status, core technical issues for development, and the trainings/standards needs for the global solar hot water industry as it moves towards 2030.
- Pool international knowledge from experts/participants from the different IEA SHC member countries/orgs., to consider differences in economic development, solar resources, regulations, and other factors (i.e., GN SEC vs. Europe).
- Identify the potential for ‘smart’ systems for thermosyphons and better ‘integrated’ systems for PV-driven systems.
- Consider how to overcome barriers to further deployment (e.g., harmonisation) in these different climates and markets.
- Determine and lay the groundwork for key, missing training, standards, and certifications that can pave the way for these technologies. copy

Information Plan

Task Duration: July 2022 - June 2025	Target Audience															
													#	Title/Proposed Title	Format	Task Month
Subtask A	x	x	x	x		x		x	x		X	X	A1	White paper on most dominant solar water heating systems and State-of-the-art reviews	Academic outlet, SHC Website, Task Website	18
	x	x		x	x					X	X	X	A2	Report on market regions and potential for solar water heating	SHC website, Task Website Webinar	20
	x	x	x	x	x	x	x		x		X	X	A3	Documentation of success stories and market barriers in relevant regions	SHC Website, Task Website	30
	x	x		x	x	x					x	X	A4	Report on emerging products and research trends for SHW.	SHC website, Task Website Webinar	36
Subtask B	X	X		X							X		B1	Report of thermosyphon systems potential	SHC website	12
		X									X		B2	Survey of failure modes and effects and suggestions	Internal document (not public)	18
		X				X	X			X		X	B3	Report of durability and reliability improving research and technical results	SHC website	18
		X		X							X		B4	Report of Energy-saving & GHG reduction performance of typical systems	SHC website	24
		X					X	X		X	X		B5	Report of Energy-saving & GHG reduction performance calculation and testing methods	Internal document (not public)	24
	X	X	X								X	X	B6	GHG reduction of current installed systems and future trends in main region	SHC website	36
Subtask C	X	X		X		X	X						C1	Expert Network, Expert Questionnaire / Interviews and Case Studies	SHC website	12
		X											C2	Systematic International Literature + Market Review	Multi-Author Journal Article	24
	X	X	X	X	X	X	X	X	X	X			C3a	Technology / Policy Brief	SHC Public & SHC Website	24
		X								X			C3b	New ISO Solar Energy Vocabulary	Report to ISO 180 Committee	36
		X						X					C3c	Reference Models / Solar Heat Worldwide Chapter	SHW Chapter	24
		X											C4	Solar Diverter Technology Harmonisation Strategy	SHC Internal Document	36
	X	X	X	X	X	X	X	X	X	X			C5	Implementation of Solar Diverter Technology Harmonisation Strategy	Hybrid approach	36
Subtask D	X	X			X		X		X	X			D1	Report on needs for new Standards or Standards updates	SHC website	18
		X	X			X					X		D2	Facilitate Training	Workshop, etc.	15 & 30
		X				X						X	D3	Status report of warranty and certification networks	SHC website	18
	X	X	X			X	X				X	X	D4	Needs Assessment Report (Training for Solar Energy Practitioners		24
	X	X	X	X	X	X						X	D5	Report on success stories	SHC website	36
TCP/Other		X						x		X	X	X		Task webpage	SHC website	12
		X				x				X	X	X		Task brochure (optional)	SHC website	12
		X				x				X	X	X		Task newsletter (optional)	SHC website	12
	x	X												TCP Annual Report contribution (1 per year)	IEA	12
	x	X										X		Task Highlight report (1 per year)	SHC ExCo	12
		X					x					X		Position Paper (ExCo needs to approve request to cont)	SHC ExCo	24
		X	x	x										Solar Update articles (minimum during and end)	Publishers	24
		X												Task Status report (2 per year)	SHC ExCo	24
	x	X												Final Management report	SHC ExCo/Funding Orgs.	36
	x	X			x									Mid-term Task evaluation	SHC ExCo/Funding Orgs.	36
	x	X			x									Final Task evaluation	SHC ExCo/Funding Orgs.	36
			x	x		x				X	X	X		Solar Academy webinar		

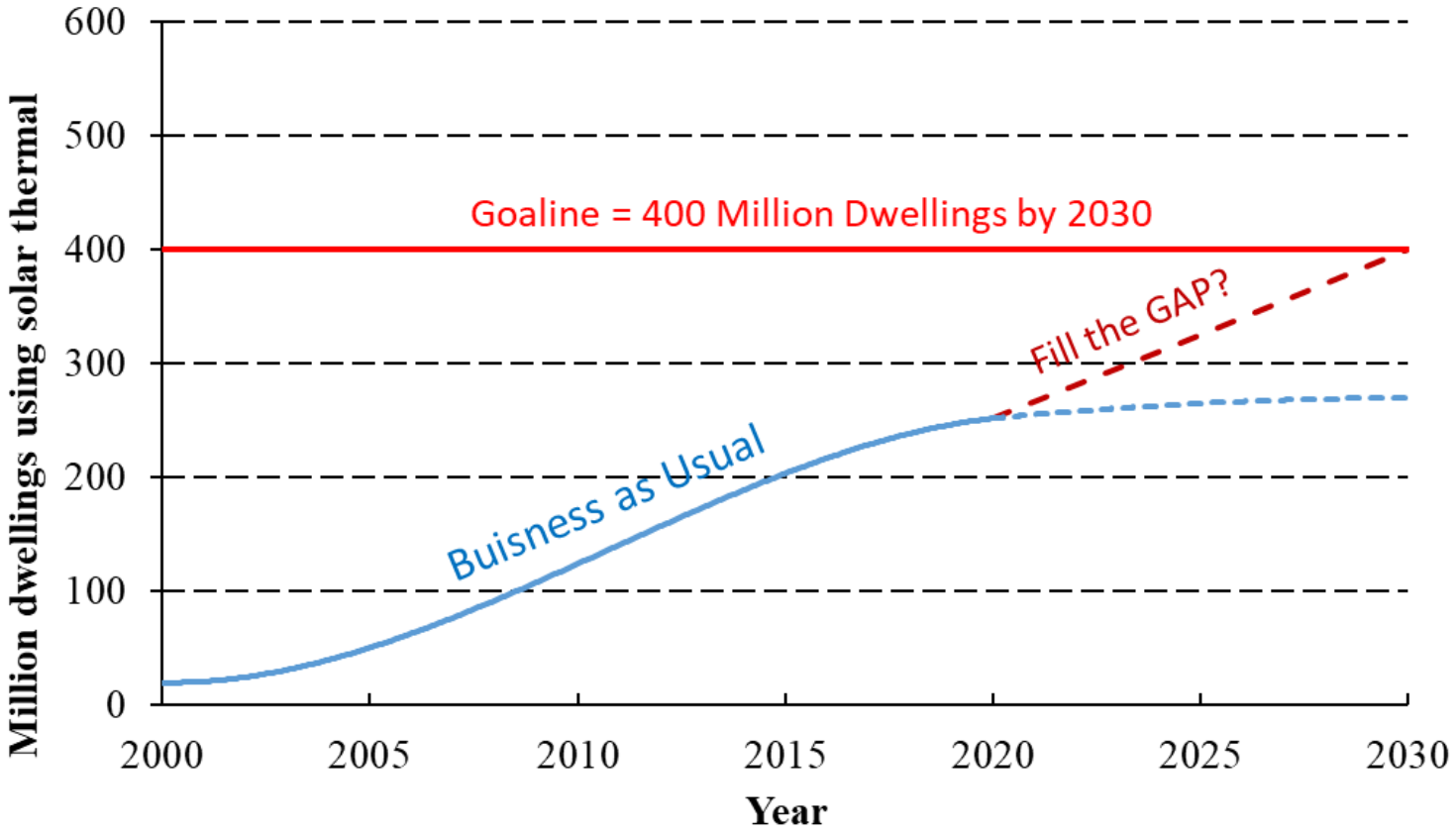
Notes:

1) For STA, we have very good experience with Webinars to diversify our dissemination portfolio. These are internationally much more accessible than regular Workshops.

2) The TCP Task Reports will be of those documents for approval by the Task Publication Committee, not including conference papers or presentations.

How to close the gap?

Identify opportunities to improve the performance, cost, and reliability of solar water heaters, aiming to accelerate the rollout of best practices to help meet national and international 2030 targets.



IEA Net Zero by 2050 (Intermediary goal)

Structure

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

ExCo

TMs

Subtask A
(State-of-the-Art)

Subtask B
(Thermosyphons)

Subtask C
(PV Water Heating)

Subtask D
(Training and Standards)

Governance Structure

SubTasks/Leadership

- **Subtask A**: State-of-the-art and Operating Environments in Different Regions (Leader: Daniel Tschopp/Christoph Rohringer – AEE INTEC, Austria, d.tschopp@aee.at)
- **Subtask B**: Thermosyphon Hot Water Systems (Leader: Bojia Li – China Academy of Building Research, China, libojia@outlook.com)
- **Subtask C**: Solar Photovoltaic Hot Water Systems (Co-Leaders: Dean Clift - RMIT/Rheem, Australia, dean.clift@rheem.com.au & George Bennett - Department for Business, Energy and Industrial Strategy (BEIS), UK, George.Bennett2@beis.gov.uk)
- **Subtask D**: Training and Standards (Leader: Jianhua Fan – Technical University of Denmark, Denmark, jifa@dtu.dk)

Deliverables Schedule

IEA SHC Task: Solar Hot Water for 2030		Year 1												Year 2												Year 3											
#	Deliverable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Subtask A: State-of-the-art and operating environments in different regions																																					
A1	White paper on most dominant solar water heating systems and State-of-the-art reviews	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																		
A2	Report on market regions and potential for solar water heating			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																
A3	Documentation of success stories and market barriers in relevant regions							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
A4	Report on emerging products and research trends for SHW.													X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Subtask B: Thermosyphon hot water systems																																					
B1	Report of thermosyphon systems potential	X	X	X	X	X	X	X	X	X	X	X	X																								
B2	Survey of failure modes and effects and suggestions						X	X	X	X	X	X	X	X	X	X	X	X	X																		
B3	Report of durability and reliability improving research and technical results						X	X	X	X	X	X	X	X	X	X	X	X	X																		
B4	Report of Energy-saving & GHG reduction performance of typical systems												X	X	X	X	X	X	X	X	X	X	X	X	X												
B5	Report of Energy-saving & GHG reduction performance calculation and testing methods												X	X	X	X	X	X	X	X	X	X	X	X	X												
B6	GHG reduction of current installed systems and future trends in main region																X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Subtask C: Solar Photovoltaic Hot Water																																					
C1	Expert Network, Expert Questionnaire / Interviews and Case Studies	X	X	X	X	X	X	X	X	X	X	X	X																								
C2	Systematic International Literature + Market Review											X	X	X	X	X	X	X	X	X	X	X	X	X	X												
C3a	Technology / Policy Brief											X	X	X	X	X	X	X	X	X	X	X	X	X	X												
C3b	New ISO Solar Energy Vocabulary																							X	X	X	X	X	X	X	X	X	X	X	X	X	X
C3c	Reference Models / Solar Heat Worldwide Chapter															X	X	X	X	X	X	X	X	X	X												
C4	Solar Diverter Technology Harmonisation Strategy																				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
C5	Implementation of Solar Diverter Technology Harmonisation Strategy																				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Subtask D: Training and standards																																					
D1	Report on needs for new Standards or Standards updates							X	X	X	X	X	X	X	X	X	X	X	X																		
D2	Facilitate Training				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
D3	Status report of warranty and certification networks	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																		
D4	Needs Assessment Report (Training for Solar Energy Practitioners							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X												
D5	Report on success stories																								X	X	X	X	X	X	X	X	X	X	X	X	X

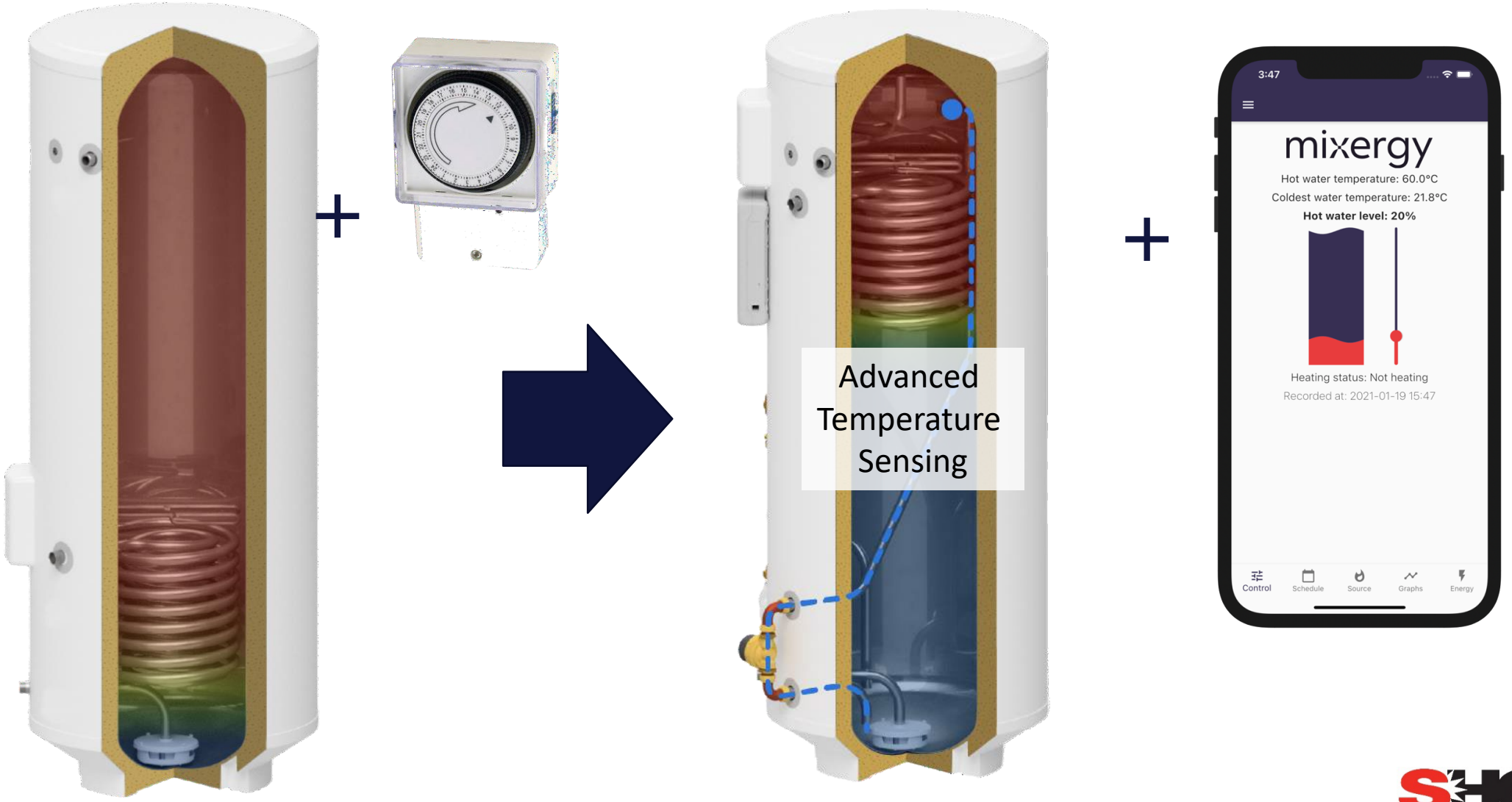
One Example (Smart Tank & PV Diverter)

Excess rooftop PV
(when people are at work)

PV Diverter by myEnergy

Smart Tank by mixergy

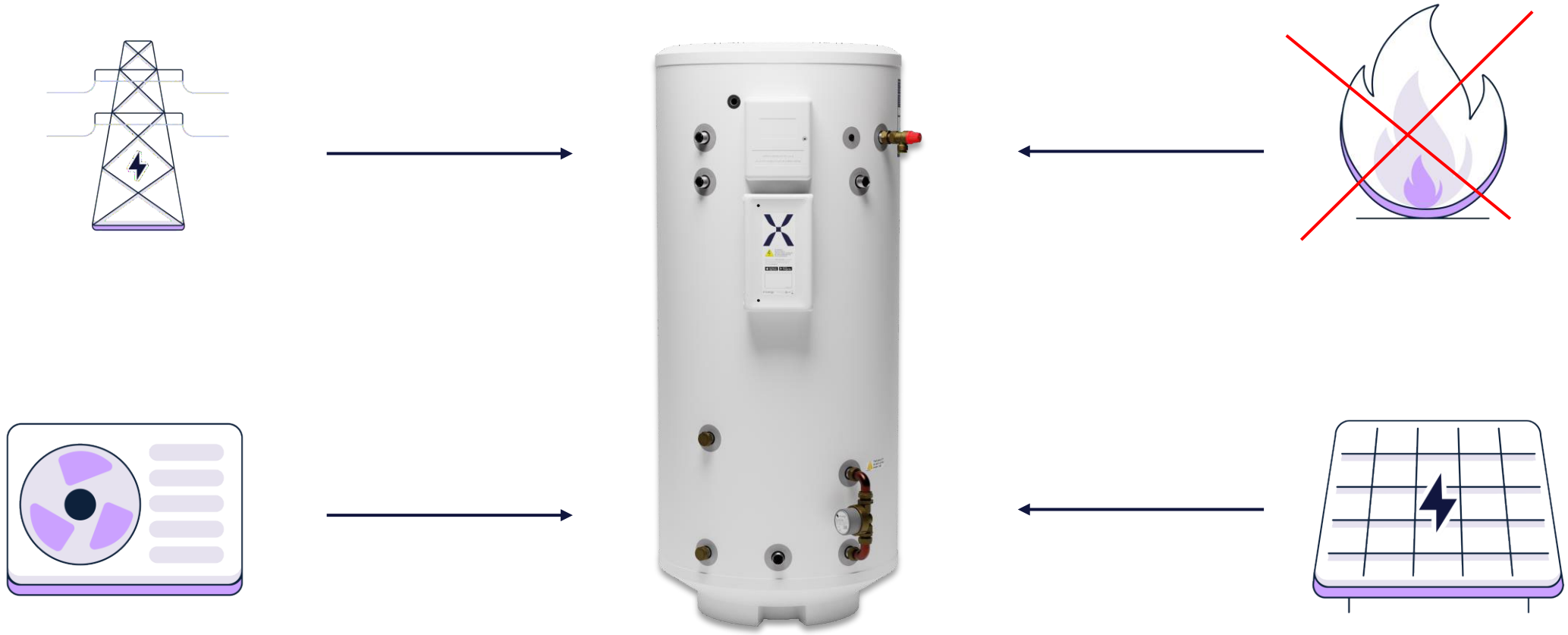
Conventional V Adaptive Top Up Technology.



Flexible heat energy sources.

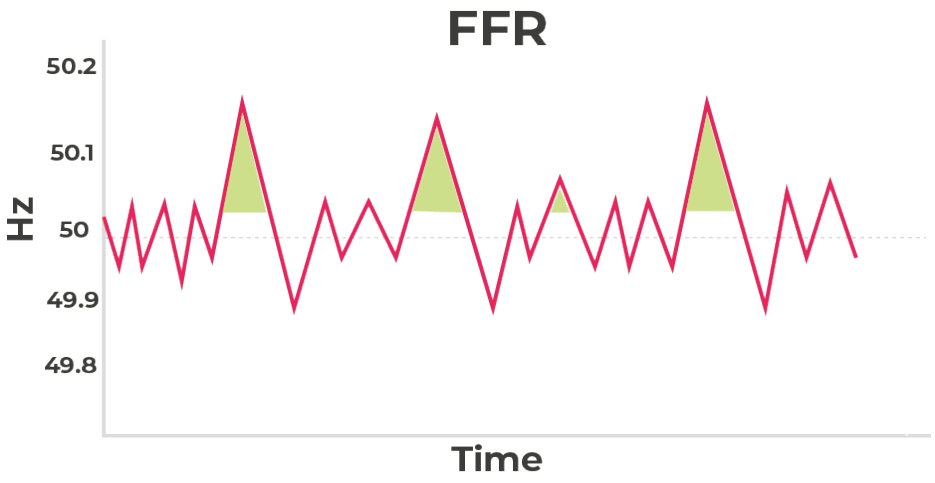
mixergy

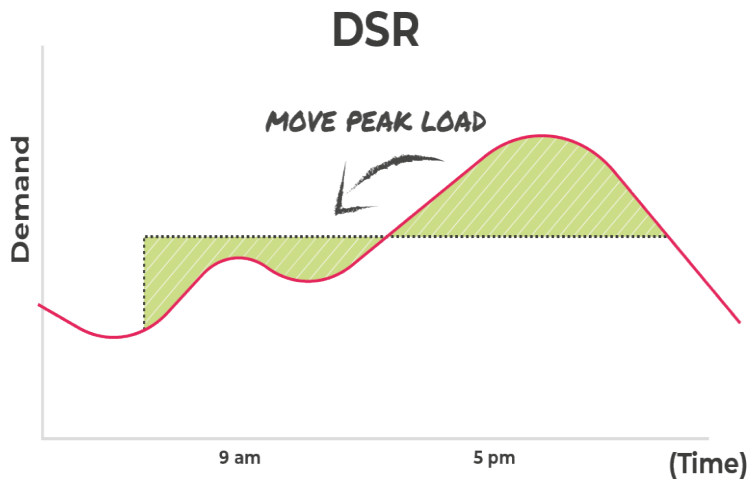
Whether it be working with a gas boiler, direct electric heating, a heat pump, solar thermal or solar PV, the Mixergy tank helps you save energy, reduce your bills, and cut carbon emissions.



Mixergy's 'internet of tanks' provides grid flexibility

We are developing an ever-expanding digital network of hot water tanks which provides flexibility to the grid and supports the clean energy transition.





Mixergy are delivering >5MW to National Grid in the UK, as well as intelligent arbitrage on flexible tariffs.

PV2Heat Systems in South Africa – Installed Capacity