AEE INTEC

SHC
SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Solar energy in industrial water and wastewater management

83rd ExCo MEETING of IEA SHC
Sweden

DI Christoph Brunner

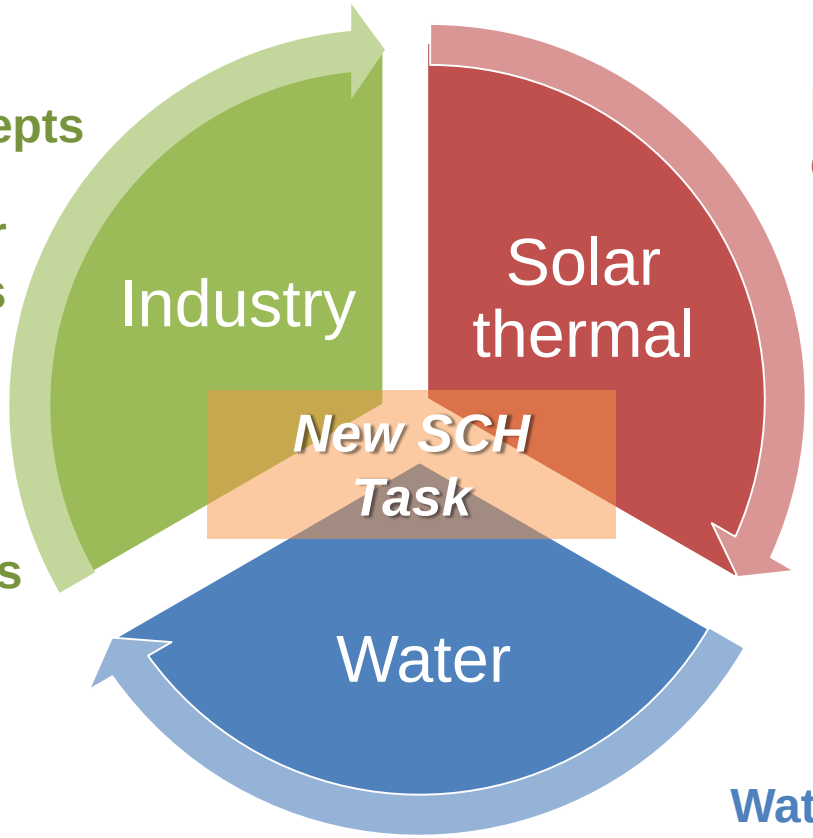
AEE - Institute for Sustainable Technologies (AEE INTEC)
8200 Gleisdorf, Feldgasse 19, AUSTRIA

Background

- Industry is the second-largest water consuming sector (after agriculture) (OECD, IEA, 2016)
- Almost 10% of global water withdrawals in 2014 were for industry (OECD, IEA, 2016)
- Water is used in industry for processing, but also for fabricating and washing
- Most of it becomes waste water after being used in the production process

Source: EIP Water, 2013

Solar energy – water – industry NEXUS



Integration concepts

Guideline for stakeholders

Energy and CO2 savings

Emerging technologies

New solar collector concepts

Link to solar collector suppliers

New markets and market penetration

Water separation technologies

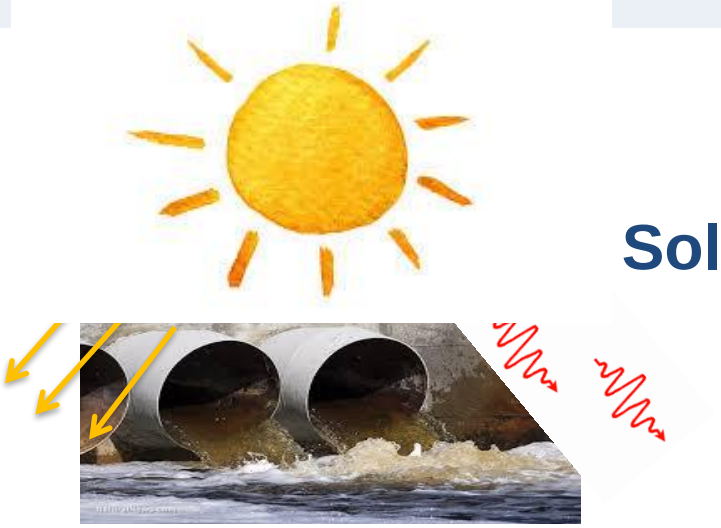
Recycling of valuable resources

Decontamination and disinfection

Purpose of the Task

- To improve the conditions and increase the applications of **solar driven separation and water purification technologies in industrial applications** in order
  - to push the solar water treatment market,
  - solve water problems at locations with abundant solar energy resources and
  - reduce the fossil-fuel consumption
- Reduce the water and energy demand (CO_2 emissions) in industry (process water) and water purification plants (communal and industrial)
- For solar turn key provider, water technology sector (e.g. membrane producer,…), engineering companies and producing industry

Scope of the Task



Solar Thermal

Solar photons

Membrane distillation, Pervaporation, Vacuum evaporation, Rectification, Humidification-Dehumidification,…

Photoctalytic Water Decontamination and Disinfection Systems

- Link between industrial separation demand, technologies and exergy heat sources
- new solar thermal collectors' concepts for industrial water treatment
- Technological, economic and political barriers for up-scaling systems and technologies

Subtasks

- **Subtask A**: Thermally driven water separation technologies and recovery of valuable resources *(Germany F-ISE)*
- **Subtask B:** Solar Water Decontamination and Disinfection Systems *(Spain CIEMAT)*
- **Subtask C:** System integration and decision support for end user needs (*Australia – Victoria University)*

Source: AEE INTEC

SUBTASK A

Thermally driven water separation technologies and recovery of valuable resources

(Lead: Germany, Joachim Koschikowski, F-ISE)

Subtask A - **Core Activities**

- Identification of separation technologies with high potential for solar thermal heat supply e.g.:
  - Membrane distillation, Pervaporation, Vacuum evaporation, Rectification, Humidification-Dehumidification, Collector integrated systems
- Identification of suitable fields of application (industrial sectors, processes, geographical sites…)
- Assessment of pro and cons of these technologies for different industrial applications and boundary conditions and comparison with state of the art technologies




Source: Fraunhofer

Subtask A - **Results**

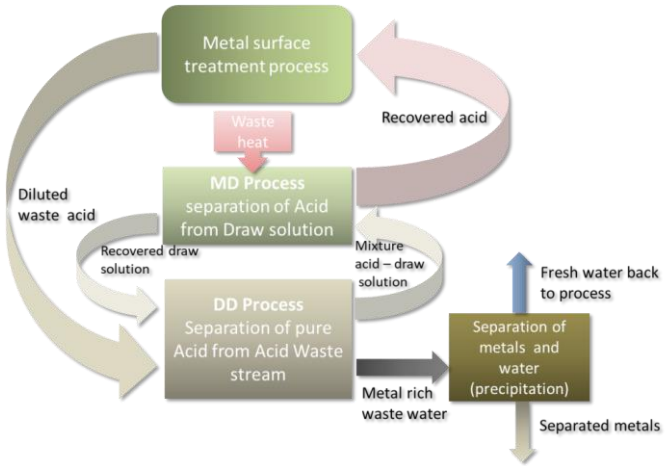
- Matrix of different industrial separation demands to be subjected to cutting edge thermal technologies versus availability of different low exergy heat sources *(D.A1)*
- Specification of System design and key performance indicators as basis for comparative simulation studies *(D.A3)*
- Comparative simulation calculations *(D.A4)*
- New solar thermal collectors' concepts/for industrial water treatment. **Link to Subtask B** *(D.A5)*
- Technical and economic studies *(D.A6)*
- Future R&D demand (*D.A2)*

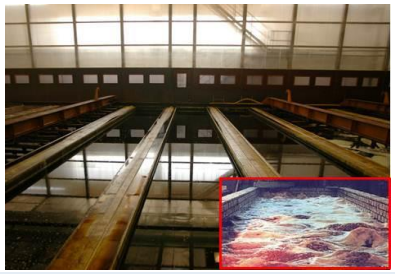
Subtask A – **Example**

- H2020 project **ReWaCEM**

- The project aims at reducing water use, wastewater production, energy use, valuable metal resource recovery in the metal plating, galvanizing and printed circuit board industry

- Recovery of **hydrochloric acid** (HCl), **sulphuric acid** (H2SO4), and **mixed acid** (HNO3-HF) by a combination of DD and MD
- and recovery of **Gold** and **Palladium** in printed circuit board industry by MD





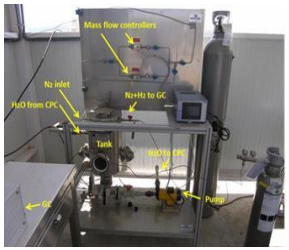
SUBTASK B

Solar Water Decontamination and Disinfection Systems

(Lead: Spain, Isabel Oller, CIEMAT)

Subtask B - **Core Activities**

- Comprehensive description of the state-of-the-art and potential applications of **solar water decontamination and disinfection systems** in industrial water management
- **Membrane solar photocatalytic systems** for industrial wastewater treatment and reuse.
- Design of **new solar collectors** for industrial wastewater decontamination and disinfection for reusing purposes
- Integration of water decontamination and disinfection technologies driven with solar energy with membrane separation technologies **for recovery of nutrients and products/wastes with added value**.

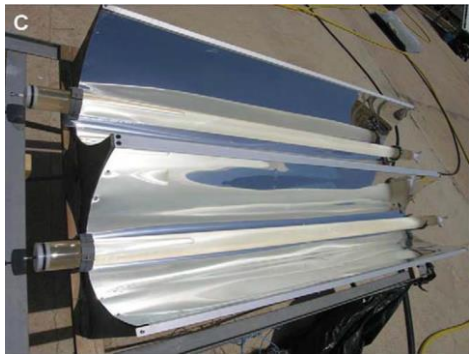


Subtask B – **Results**

- Potential applications on new sectors for industrial water decontamination and disinfection (real and research cases) *(D.B1)*
- New solar collectors' concepts for hydrogen production and industrial water decontamination and disinfection. **Link to Subtask A** *(D.B2)*
- Roadmap for technology implementation for defined applications and industries *(D.B3)*
- Technological, economic and political barriers for up-scaling new decontamination and disinfection systems *(D.B4)*
- Report on legal thresholds for accomplishing water quality required depending on the final application *(D.B5)*

Subtask B – **Examples from PSA**

- Water disinfection solar systems
- Solar photocatalytic generation of hydrogen (decarbonisation systems)



SUBTASK C

System integrations and decision support for end user needs

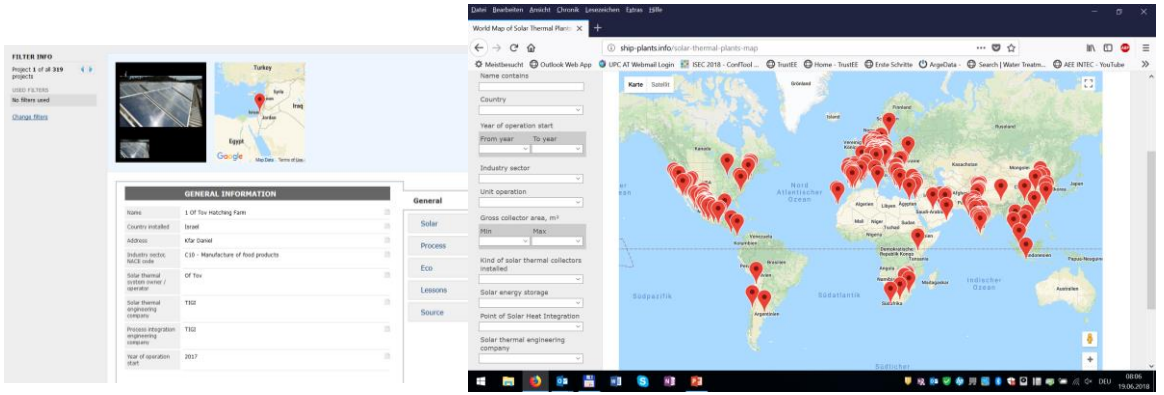
(Lead: Australia, Mikel Duke, Victoria University)

Subtask C -
Main activities

- System integrations concepts of solar thermal energy separation technologies – development of **decision support guidelines** for technology end users

- Role of SHIP and water separation in combination with other technologies/energy sources (e.g. reverse osmosis, heat pumps, fossil fuel, biomass, biogas, PV, excess heat)

- Development of additional sector in SHIP Database of realized installations

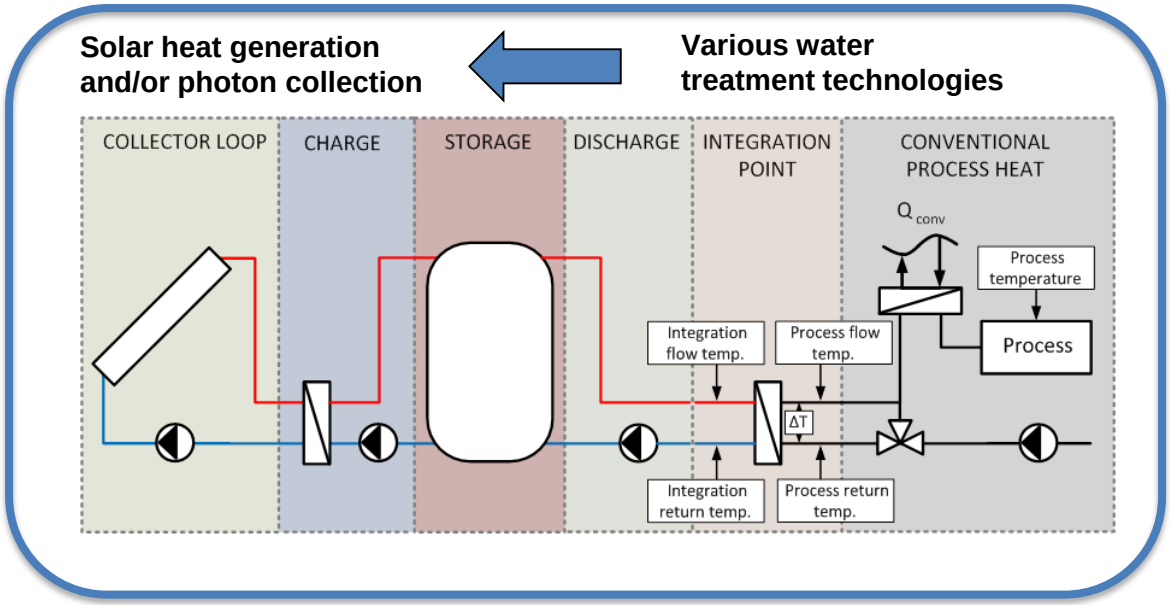


Subtask C - **Results**

- Report on how water-energy nexus concept is actually being applied in the industry *(D.C1)*
- Decision making framework/guidelines for stakeholders *(D.C4)*
  - Generic integration concept:

Industry requirements:
- Specific Water problem
- energy management
- Time to market
- economics
- Reliability

Boundary conditions:
- Solar radiation
- Space requirements
- Funding opportunities
- Existing treatment system



Contributors and Interest from 15 countries

1. **Australia**
2. **Austria**
3. Brazil
4. China
5. Cyprus
6. Denmark
7. **Germany**
8. Greece
9. **Italy**
10. Netherlands
11. South Africa
12. **Spain**
13. Sweden
14. Sitzerland
15. UAE

Contributors and Interest from following companies and instituteions

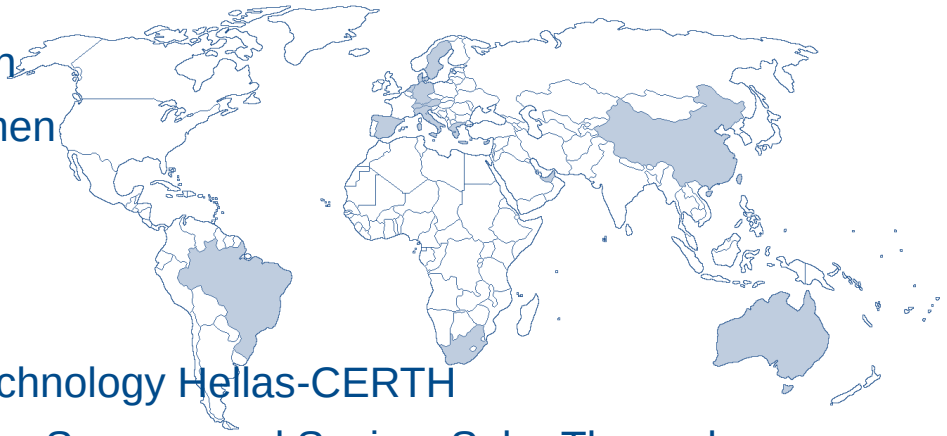
- **Australia**
  - Activated Logic
  - Australian PV Institute Limited
  - Commonwealth Scientific and Industrial Research Organization (CSIRO)
  - Future Industries Institute
  - James Cook University
  - Macquarie University
  - Monash University
  - NEP Solar Pty Ltd
  - Pinches Consolidated Industries
  - Queensland University of Technology
  - SunSpin Pty Ltd
  - Sustainable Energy Transformation Pty Ltd
  - University of New South Wales
  - University of South Australia
  - University of Technology Sydney

Contributors and Interest from following companies and instituteions

- **Austria**
  - Johannes Kepler University Linz
  - S.O.L.I.D. Gesellschaft für Solarinstallation und Design mbH
- **Brazil**
  - Universidad Federal de Uberlândia
  - Universidade Federal do Oeste da Bahia
- **China**
  - Jiangsu Product Quality Testing & Inspection Institute
  - YUBO Shandong Yuanbeo Environmental Protection Equipments Co., Ltd.
- **Cyprus**
  - GAIA-Laboratory of Environmental Engineering, University of Cyprus
- **Denmark**
  - Acron-Sunmark GmbH

Contributors and Interest from following companies and instituteions

- **Germany**
  - BFI
  - EvCon, Germany
  - Industrial Solar GmbH
  - SolarSpring
  - Technical University of Berlin
  - Technical University of Bremen
  - University of Hannover
  - University of Kassel
- **Greece**
  - Centre for Research and Technology Hellas-CERTH
  - Centre for Renewable Energy Sources and Saving; Solar Thermal Department
  - Middle East Technical University

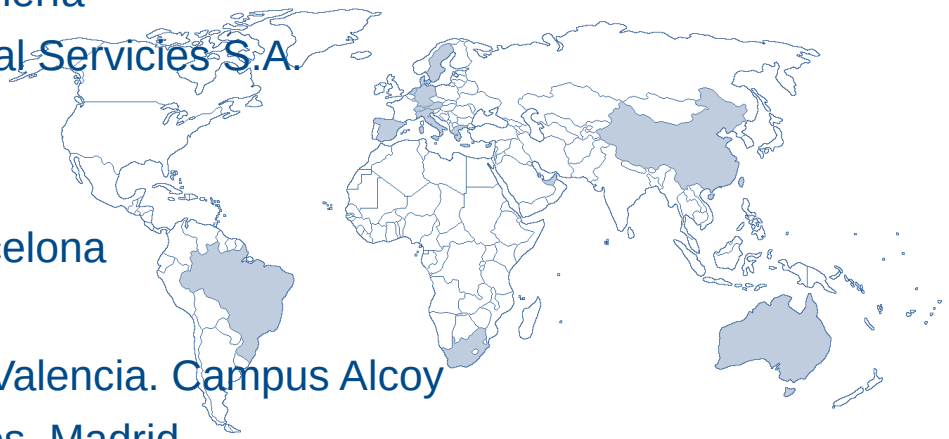


Contributors and Interest from following companies and instituteions

- **Italy**
  - CNR-ITM
  - CNR-INO
  - ENEA
  - University of Salerno
  - University of Palermo
  - Università degli Studi di Firenze; Dipartimento di Ingegneria Industriale
- **Netherlands**
  - Aquastil
  - SolarDew International
- **South Africa**
  - North-West University, Potchefstroom, South Africa (Dave Rodgers, Jan van Ravensvaai)
  - SolarEnergy
- **Sweden**
  - Absolicon Solar Collector AB

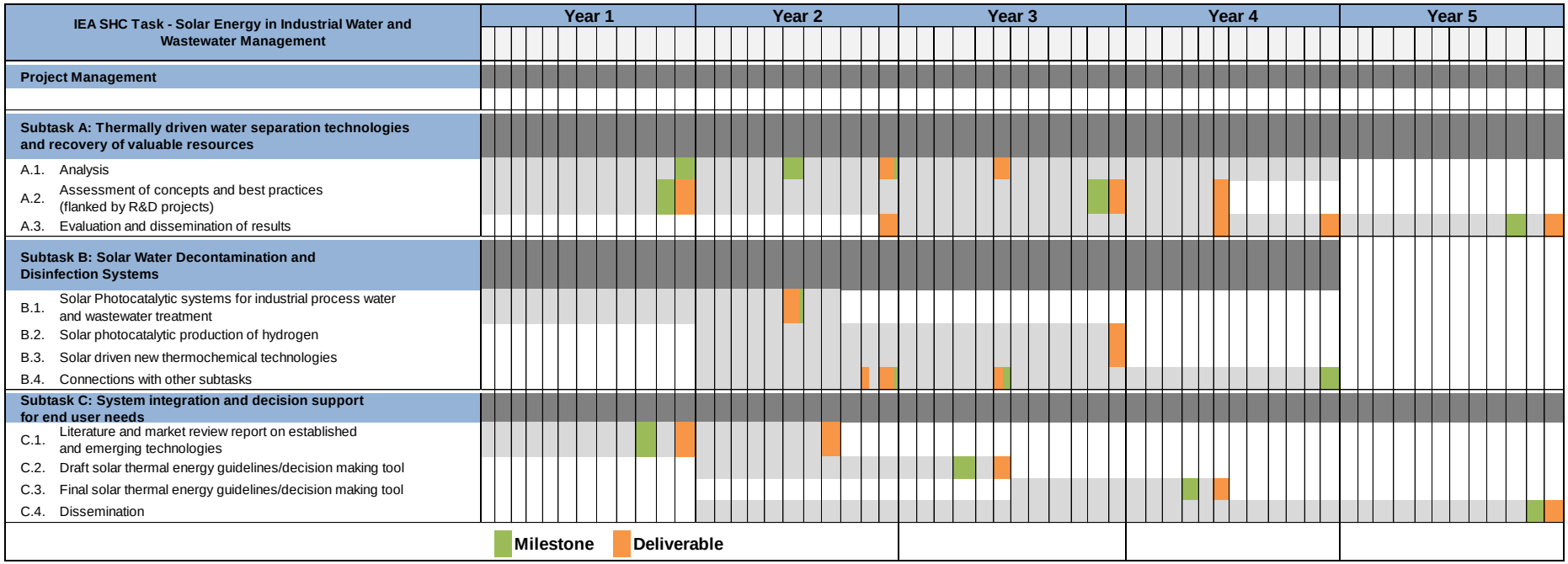
Contributors and Interest from following companies and instituteions

- **Spain**
  - ACCIONA (Water/Energy)
  - APRIA SYSTEMS (Consistent, comprehensive and operational solutions for the Chemical Industry)
  - CIESOL-Universidad de Almería
  - ECOSYSTEM Environmental Services S.A.
  - GAIKER-IK4
  - IMDEA Water
  - Universidad Autónoma Barcelona
  - University of Barcelona
  - Universidad Politécnica de Valencia. Campus Alcoy
  - Universidad Rey Juan Carlos, Madrid
- **Switzerland**
  - École Polytechnique Fédérale de Lausanne
  - SPF Institut für Solartechnik
- **United Arab Emirates**
  - Masdar Institute



Time schedule

- Foreseen start / end: October 2018 – September 2022



Joint cooperation with SolarPaces

- Contact with Christoph Richter (Chair of Solar Paces)
- Diego Alarcon from Ciemat and Annex 6 coordinator will be the contact person
- Presentation of the Task at the next SolarPaces ExCo meeting in Granada (September 2011) Diego Alarcon
- Decision of cooperation: „maximum level of collaboration“
- After approval of Workplan by SHC ExCo – delivering to SolarPaces ExCo Chair (Christoph Richter)

Task Definition Meetings and Webinar

- **1st Task Definition Meeting**
  - held on 18 September 2017 in Gleisdorf, Austria
- **2nd Task Defintion Meeting**
  - held on 7 February 2018 in Frankfurt, Germany
- **Webinar**
  - Held on 9 May 2018 via Webex
  - Awareness raising and partner acquisition
  - Promoted on IEA SHC Website
  - https://www.iea-shc.org/event?EventID=6120
- **Kick off Meeting**
  - planned on 2nd and 3rd of October 2018 in Graz before ISEC conference

AEE INTEC

IDEA TO ACTION

Thank you
for your Attention

Scope of the Task

The scope of work covers all **low temperature solar radiation technologies** supplying either

- thermal or photon primary energy
- for fluid separation and water treatment
- in regard to industrial applications and sewage plants

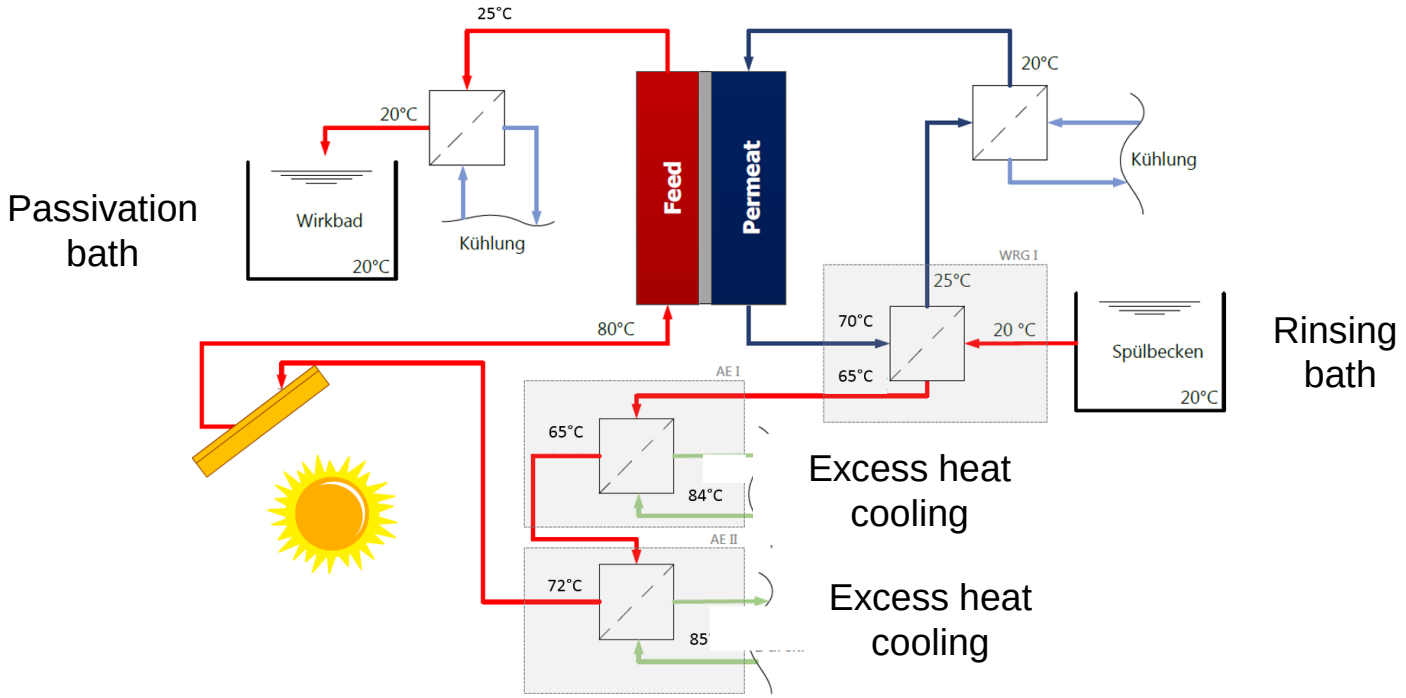
Source: REWACEM

Subtask A - **Main Objectives**

- Fostering the **development** and **promotion** of **new energy efficient solar driven separation technologies** for industrial waste water and process fluid treatment
- Supporting the development of environmentally and economically sound solutions for the recovery of valuable resources from waste water streams
- Contributing to a clean and environmentally friendly circular economy in process industry

Subtask C - **Results**

- Report on how water-energy nexus concept is actually being applied in the industry *(D.C1)*
- Decision making framework/guidelines for stakeholders *(D.C4)*
  - Example from national project GALVANO-MD:



Subtask A: Thermally driven low temperature water separation technologies and recovery of valuable resources

Financing Task Activities

- The preparation of the task is currently financed by ISE in kind funds
- For the financing of the sub task lead we will allocate 2 to 3 person months per year in a new project proposal which is currently in preparation. The scope of the project will be “Green PV production” aiming at a zero emission fabrication of solar cells. Water and process fluid recycling will be a important part of the proposal as well as energy supply by PV and solar thermal. The proposal will be submitted to PTJ / BMWI by autumn 2018
- It is anticipated that project partners will also join the TASK 49




Subtask A: Thermally driven low temperature water separation technologies and recovery of valuable resources

Potential Partners

- Academia
  - Technical University of Berlin (GE)
  - Technical university of Bremen (GE)
  - BFI
  - Ciemat (SP)
  - AEE Intec (AT)
  - CNR-ITM (IT)
  - Masdar Institute (UAE)
  - Victoria University (AU)
- Industry
  - EvCon (GE)
  - SolarSpring (GE)
  - Aquastil (NL)
  - …
  - H2O
  - GEA




Funding - **Subtask B**

- No special national funding coming from the Spanish Government for this activity in IEA
- Partners involved in Subtask B arranged to use own funding coming from projects (specially national) closely related to the activities of the new IEA SHC task
- Estimated funding per active partner for Subtask B: 3,000 € per year for 4 years
- Related projects at national and European level
  - INSHIP (H2020-LCE-2016-2017)
  - RATOCAT (M-ERA.NET, 2017-2019)

Funding – **Subtask C**

- Funding approved from Australian Renewable Energy Agency (ARENA)
- Lead organization: Australian Photovoltaic Institute (APVI)
- Small funding for Subtask C: $8,000 per year for 4 years
- Plan to compile technologies with examples from various partners for end user application
- Funding approved: first meeting held. Currently in contracting stage.