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Survey of technologies for formulating guidelines for decision-making support to end-users

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The International Energy Agency (IEA) runs The Solar Heating and Cooling (SHC) program, which includes Task 62 that aims to improve the solar energy and water nexus. IEA SHC Task 62, led by Christoph Brunner (AEE INTEC, Austria), seeks to increase the use of solar thermal/photon energy in industry, promote the development of new collector technologies and opening up of industrial and municipal water treatment as a new area of application of solar energy with a high market potential. This is motivated by the shift to renewable energy supplies to support sustainable industries and the need for supplementing scarce fresh water resources by non-conventional water resources such as seawater and brackish water.

Task 62 is organized into three subtasks. Subtask A, led by Dr Isabel Oller (CIEMAT-PSA, Spain), deals with thermally driven water separation technologies and recovery of valuable resources while Subtask B, Dr Joachim Koschikowski (Fraunhofer-Institute for Solar Energy Systems ISE, Germany), reviews solar water decontamination and disinfection systems. Subtask C, reported in this abstract and led by Prof Mikel Duke (Victoria University, Australia), is aimed at system integration and decision support for end user needs. The main objective of the subtask is to develop a guideline for decision support, designed purposefully for end users or technology adopters to select the optimized combination of water technology coupled with solar thermal/photon energy supply technology to achieve a certain practical outcome. Typical end users include, among others, solar thermal companies, manufacturers, food producers and water utilities operating wastewater treatment plants.

Subtask C has conducted a lliterature and market review through contacting external partners, including companies, to gather information on current examples, established technologies and emerging technologies that fall within the scope of the task. Information from interested stakeholders that is publicly available has also been harnessed, including from papers presented at previous task meetings. This led to the compilation of a summary report that isolates the technologies by category and parameters including current suppliers, maturity, solar thermal, photocatalytic or other, relative cost information and variants, as well as possible and confirmed application.

From the 18 technologies included in the report and shown in Table 1, the largest technology category is direct solar oxidation reactor, making up one third of the individual organisations captured in the survey. This is followed closely by solar thermal collector, while the remaining categories where mostly singular activities. The technology readiness level (TRL), categorised from a scale of 1 to 9, shows that many of the technologies have already been demonstrated and are available at the commercial scale (TRL 9), while some are in early stage development (TRL 1).

Table 1. Technology provider categories – based on results from information provided directly by contacts and publicly available information

Technology category	Provider type	Number of providers	Technology readiness	Headquarters
Direct solar oxidation reactor	University, Research institute	6	TRL 4-6 TRL 9	Chile, Italy, Spain
Solar thermal collectors	Companies	5	TRL 1, TRL 7, TRL 9	Australia, Austria, Italy, Sweden, Spain
Solar thermal collector + desalination	Companies	2	TRL 8-9	Australia, Netherlands
Membrane distillation	Company	1	TRL 7	Netherlands
Membrane distillation hybrid photo oxidation	Research institute	1	TRL 1	Australia
Direct solar disinfection reactor	Research institute	1	TRL 7	Spain
Solar oxidation membrane cleaning	University	1	TRL 1	Australia
Capacitive deionisation	University	1	TRL 7	Australia
Wet Air Oxidation + solar thermal collectors	Research Institute	1	TRL 2	Spain

The report presents each technology in terms of the developer, operating features, performance characteristics, as well as benefits and limitations (based on provided or available information). Channels where more information can be obtained by interested stakeholders are also given. Application of these technologies include, among others, urban and industrial wastewater treatment (including mining, hospital, and fracking wastewater), remediation of contaminated agricultural water, sludge drying, concentration of ammonia nitrate, and preheating of desalination modules. Considering there is a sufficient range of technologies that can harness solar energy for industry use, the next phase of the task will be to utilise these technology profiles to form concept processes and tools for end users and technology developers to further harness these technologies for industry water treatment. This information will be disseminated through flyers, media releases (including social media) and conference presentations. The guidelines will also undergo external consultation and revision. A workshop to discuss the findings of the subtask will also be organised later in 2020. The final report and decision making tool will be available on the website: http://task62.iea-shc.org/

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