Alliance Nationale de Coordination de la Recherche pour l'Énergie

Decarbonization Wedges Exercise

December 2015 – www.allianceenergie.fr

SOLAR THERMAL ENERGY

1. State of the art and current development

The main technologies associated with solar thermal energy can be divided according to their use. They include:

Solar domestic hot water (SDHW) systems are designed to supply individual and collective buildings with hot water heated with solar thermal energy.

Solar heating refers to solar energy for building heating.

Solar district heating systems involve producing heat for heat networks.

Solar process heat is a technology which involves producing heat for industrial processes, usually up to 250°C.

Solar cooling involves converting solar energy for housing or industrial uses. Solar heat is collected through solar collectors and supplied to a thermally driven process. This converts solar energy useful for generating chilled water or conditioned air.

2. Maturity level and technological perspectives

Maturity of technologies associated with solar thermal energy

Methodological information:

The maturity level is the TRL, reduced to 5 levels with market deployment enclosed in the higher TRL classes; maturity level scaling: 0 = none; 1 = fundamental research; 2 = R&D; 3 = demonstrator; 4 = low deployment; 5 = large deployment.

	2015	2020	2030	2040	2050
SDHW	4	5	5	5	5
Solar heating	3-4	4	4-5	5	5
District heating	3	4	5	5	5
Solar process heat	2-3	3	4-5	5	5
Solar cooling	2-3	3	4-5	5	5

SDHW: In some countries deployment is significant —considering SDHW is the reference technology—, but on the global scale deployment is rather limited. Further deployment could occur if favorable public policies are implemented.

Solar heating: Solar heating is not as deployed as SDHW. Solar heating has more inertia when used for heating purposes. No large deployment is expected before 2030 or 2040.

District heating: District heating is deployed in some countries and its deployment could continue rapidly.

Solar process heat: Solar process heat is a less mature technology. However low-temperature applications — i.e. up to 90°C— could be deployed quite rapidly. For temperatures ranging between 90°C and 250°C, scientific and technical innovations are essential.

Potential development of technologies related to solar thermal energy

Methodological information:

Potential development is measured as the percentage of the technology's contribution to environmental protection. This means evaluating, in terms of carbon emissions and of carbon emissions reduction, to what extent this new technology can contribute to limiting temperature increase to 2°C above pre-industrial level according to the time horizon considered in this study. Potential development scaling: 0 = not significant; 1 = significant (i.e. more than 1% of global emissions reduction) in some countries; 2 = significant on the global scale; 3 = very significant on the global scale (i.e. up to 3% of global emissions reduction); 4 = major technology vs. climate change (i.e. more than 3% of global emissions reduction).

	2020	2030	2040	2050	
Solar thermal energy	2	2-3	3	3	4

Results are based on solar thermal energy contribution to CO emissions reduction according to the IEA's Technology Roadmap —i.e. 10% of total demand for heating and cooling, SDHW and process heat in 2050.

3. Technological, economic and social bottlenecks

Methodological information:

The following table ranks the bottlenecks according to their impact on the development of the technology. A bottleneck ranking at 6 on the scale will hinder or stall the deployment of the technology compared with bottlenecks ranking at 1; conversely, a bottleneck ranking at 1 will hinder the deployment of the technology much less than bottlenecks ranking at 6. Note that the ranking is relative, meaning that a bottleneck ranking at 6 is not necessarily hard to remove; conversely, a bottleneck ranking at 1 is not necessarily easy to remove. Technologies rank according to: research, finance, regulations, resources & environment, security and acceptability. The table also contains keywords associated with each bottleneck.

It must be stressed that the ranking of such different factors must be considered with caution; as an expert's judgement, not a quantitative assessment.

Technology		**Research & technological bottlenecks**	**Economy and financial bottlenecks** (investment, risks)	**Regulation & institutional environment**	**Resources & environmental impacts** (including scarcity of raw materials, water, land, climate)	**Safety & security** (impacts on health, people and security assets)	**Socio-technical feasibility**
SDHW	Rank	4	5	6	2	1	
	Key-words	High costs Industrialization Better performances	Long return on investment time High investment costs	No regulatory obligation			Access to resource in urban areas
Solar heating	Rank	4	5	6	2	1	
	Key-words						
District heating	Rank	4	5	6	3	1	2
	Key-words				Issue of available land		Collective decision
Solar process heat	Rank	5	6	4	2	1	3
	Key-words	Expected innovations	Economic context Very low return on investment expected in the industry		No rare metals (see European classification of rare metals)		
Solar cooling	Rank	5	6	4	2	1	3
	Key-words		Too high costs vs. regulation		Idem		

Regulation is the most significant bottleneck for SDHW, for solar heating and for district heating: just like compulsory insulation, incentive measures and regulatory environment are the major thrusts for the development of those technologies. Technological innovation and process innovations might also lead to lower costs, thus increasing the competitiveness of those technologies.

Solar process heat and solar cooling are less mature and are hindered by financial bottlenecks, especially in the industry. Current costs are too high compared to the return on investment time. This is why technological improvements are crucial.

4. Potential radical and incremental innovations

Methodological information:

The following table lists the nature of innovations needed to overcome the bottlenecks mentioned earlier. There are two types of innovations: I stands for 'incremental innovation' (i.e. improving existing products and processes) and R stands for 'radical innovation' (i.e. developing new products and processes).

Technology		**Research & technological bottlenecks**	**Economy and financial bottlenecks** (investment, risks)	**Regulation & institutional environment**	**Resources & environmental impacts** (including scarcity of raw materials, water, land, climate)	**Safety & security** (impacts on health, people and security assets)	**Socio-technical feasibility**
SDHW	I or R	I	R	I	I	I	R
	Key-words						
Solar heating	I or R	I	R	I	I	I	R
	Key-words						
District heating	I or R	I	R	I	I	I	R
	Key-words		Investment pattern (e.g. third-party investment, citizen funding) Cost of access to finance				
Solar process heat	I or R	I	R	I	I	I	R
	Key-words						
Solar cooling		I	R	I	I	I	R

Most radical improvements involve innovative financing methods, —third-party investment and citizen funding: these innovations should help reduce costs for access to credit, especially in the industrial sector.

Radical innovations are also expected concerning systems installation. Such innovations would involve reassessing completely operations on building sites, improving training, valorizing career pathways and industrializing processes to guarantee performance, in particular for implementation processes.