Deliverable M-C1.1 – Delivery Report: review of relevant international standards rating and incentive schemes

Date: 25/09/13

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IEA Solar Heating and Cooling Programme

The *International Energy Agency* (IEA) is an autonomous body within the framework of the Organization for Economic Co-operation and Development (OECD) based in Paris. Established in 1974 after the first "oil shock," the IEA is committed to carrying out a comprehensive program of energy cooperation among its members and the Commission of the European Communities.

The IEA provides a legal framework, through IEA Implementing Agreements such as the *Solar Heating and Cooling Agreement*, for international collaboration in energy technology research and development (R&D) and deployment. This IEA experience has proved that such collaboration contributes significantly to faster technological progress, while reducing costs; to eliminating technological risks and duplication of efforts; and to creating numerous other benefits, such as swifter expansion of the knowledge base and easier harmonization of standards.

The *Solar Heating and Cooling Programme* was one of the first IEA Implementing Agreements to be established. Since 1977, its members have been collaborating to advance active solar and passive solar and their application in buildings and other areas, such as agriculture and industry. Current members are:

Australia	Finland	Singapore
Austria	France	South Africa
Belgium	Italy	Spain
Canada	Mexico	Sweden
Denmark	Netherlands	Switzerland
European Commission	Norway	United States
Germany	Portugal	

A total of 49 Tasks have been initiated, 35 of which have been completed. Each Task is managed by an Operating Agent from one of the participating countries. Overall control of the program rests with an Executive Committee comprised of one representative from each contracting party to the Implementing Agreement. In addition to the Task work, a number of special activities—Memorandum of Understanding with solar thermal trade organizations, statistics collection and analysis, conferences and workshops—have been undertaken.

Visit the Solar Heating and Cooling Programme website - **www.iea-shc.org** - to find more publications and to learn about the SHC Programme.

Current Tasks & Working Group:

Task 36	*Solar Resource Knowledge Management*
Task 39	*Polymeric Materials for Solar Thermal Applications*
Task 40	*Towards Net Zero Energy Solar Buildings*
Task 41	*Solar Energy and Architecture*
Task 42	*Compact Thermal Energy Storage*
Task 43	*Solar Rating and Certification Procedures*
Task 44	*Solar and Heat Pump Systems*
Task 45	*Large Systems: Solar Heating/Cooling Systems, Seasonal Storages, Heat Pumps*
Task 46	*Solar Resource Assessment and Forecasting*
Task 47	*Renovation of Non-Residential Buildings Towards Sustainable Standards*
Task 48	*Quality Assurance and Support Measures for Solar Cooling*
Task 49	*Solar Process Heat for Production and Advanced Applications*

Completed Tasks:

Task 1	*Investigation of the Performance of Solar Heating and Cooling Systems*
Task 2	*Coordination of Solar Heating and Cooling R&D*
Task 3	*Performance Testing of Solar Collectors*
Task 4	*Development of an Insolation Handbook and Instrument Package*
Task 5	*Use of Existing Meteorological Information for Solar Energy Application*
Task 6	*Performance of Solar Systems Using Evacuated Collectors*
Task 7	*Central Solar Heating Plants with Seasonal Storage*
Task 8	*Passive and Hybrid Solar Low Energy Buildings*
Task 9	*Solar Radiation and Pyranometry Studies*
Task 10	*Solar Materials R&D*
Task 11	*Passive and Hybrid Solar Commercial Buildings*
Task 12	*Building Energy Analysis and Design Tools for Solar Applications*
Task 13	*Advanced Solar Low Energy Buildings*
Task 14	*Advanced Active Solar Energy Systems*
Task 16	*Photovoltaics in Buildings*
Task 17	*Measuring and Modeling Spectral Radiation*
Task 18	*Advanced Glazing and Associated Materials for Solar and Building Applications*
Task 19	*Solar Air Systems*
Task 20	*Solar Energy in Building Renovation*
Task 21	*Daylight in Buildings*
Task 22	*Building Energy Analysis Tools*
Task 23	*Optimization of Solar Energy Use in Large Buildings*
Task 24	*Solar Procurement*
Task 25	*Solar Assisted Air Conditioning of Buildings*
Task 26	*Solar Combisystems*
Task 27	*Performance of Solar Facade Components*
Task 28	*Solar Sustainable Housing*
Task 29	*Solar Crop Drying*
Task 31	*Daylighting Buildings in the 21st Century*
Task 32	*Advanced Storage Concepts for Solar and Low Energy Buildings*
Task 33	*Solar Heat for Industrial Processes*
Task 34	*Testing and Validation of Building Energy Simulation Tools*
Task 35	*PV/Thermal Solar Systems*
Task 37	*Advanced Housing Renovation with Solar & Conservation*
Task 38	*Solar Thermal Cooling and Air Conditioning*

Completed Working Groups:

CSHPSS; ISOLDE; Materials in Solar Thermal Collectors; Evaluation of Task 13 Houses; Daylight Research

Contents

1 Executive Summary

IEA Task 48 Subtask C "Market Support Measures" aims to produce a scientific evidence base and tools to inform policy makers and encourage the adoption of successful solar air conditioning support measures. The tools and evidence base is intended to be used worldwide by regulators, policymakers and strategists at all levels of government in the design and implementation of policy measures and in strategic direction setting.

By informing the development of future policy measures and assisting in the development of market mechanisms, the outcomes of this Subtask will encourage measures to be employed which are capable of supporting the development and growth of the solar cooling industry.

The development of this scientific evidence base requires the success and impact of current and past measures to be evaluated, and lessons learned regarding the link between technical assessment and successful market transformation. This Subtask C, IEA Task 48, Activity C1 has developed this report cataloguing the development of a *Database of international standards, rating and incentive schemes*, populating that database with data from six participating countries and presenting an analysis of that data.

Market support policy successes and failures were detailed, categorised and analysed in this Activity in order to understand the lessons learnt from prior experience. In this activity, work relevant to known market transformation options that are, or have been, implemented in various forms around the world was contributed by member countries in the form of a survey template developed by this Activity. The virtues of each measure were compared and contrasted in this report.

Analysis of the 65 incentive measures identified during this exercise lead to the key findings that:

- There is a dominance of direct financial incentives in the responses received. There is a lack of stamp of quality and information provision incentives as well as non-technical and non-financial measures
- It is desirable that implementing levels of Government cooperate with each other to minimise administrative burden, promote consistency and reduce exposure to the winds of political change
- More clarity as to the development requirements of the solar cooling industry is required
- A common format for incentive comparison is desirable – the template provided is suggested with the addition of public and educational buildings as an application niche
- Objective reviews of incentive effectiveness are required by both policymakers and industry

This database and the above findings are intended to provide insight into the needs of alternative policy interventions and hence guide the development of the standards, guides and rating framework being delivered in the subsequent work packages. It will also contribute to the work of Subtask D.

One issue identified during this activity is that many of the responding members appear to mainly consider direct incentive measures such as subsidies on capital cost, tax deduction and access to capital. However many other more subtle measures including compliance standards and planning approval may have been overlooked. It is recommended that the survey exercise be repeated with other industry actors.

2 Specific Objectives

Each country has a range of government incentive and industry development programmes, which have been designed with the intention of assisting the renewable energy and building energy efficiency industries.

These programmes call up procedures for *inter alia* quantifying benefits, rating effectiveness and achieving robust measurement and verification. A country by country database of relevant standards, processes and incentives was created and links to the needs of the solar heating and cooling industry were identified.

This database is intended to provide insight into the options for, and needs of, alternative policy interventions. This will help advise the development of the standards, guides and rating framework being delivered in subsequent work packages. It will also contribute to the work of Subtask D.

3 Participants

The following companies/institutions participated in this activity, contributing to the database and the review of this report.

Work Package Leader: Daniel Rowe, CSIRO (Australia)
Country Contributors:

Australia	Daniel Rowe, CSIRO
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4 Timeline

The schedule of deliverables for this activity is outlined below.

Subtask C: Market Support Measures		
No	**Description**	**Completed by month**
M-C1.1	Template for review of relevant international standards rating and incentive schemes	12 (October 2012)
M-C1.1	Delivery Report: review of relevant international standards rating and incentive schemes	18 (April 2013)

5 Introduction

Solar cooling is an emerging technology with the potential to reduce conventional energy consumption and carbon emissions in the building sector. The technology has been proven with a large number of demonstration projects around the world. Progress toward widespread uptake requires policy instruments which support industry efforts to establish the technology and enable fair competition with incumbent technologies. Successful support in these formative stages of market development would ultimately enable both the technology and the industry to become sustainable, competitive and self-sufficient in their own right. This report investigates which incentive programmes are likely to succeed in facilitating the expansion of solar cooling technology beyond the niche it currently occupies. In doing so this report aims to inform subsequent IEA Task 48 effort in developing policy support tools which are intended to underpin the policy measures which will enable the expansion and self-sufficiency of the industry worldwide.

As with many emerging technologies, solar cooling currently has higher costs than conventional technologies, has fragmented industry capability and market awareness is low. This is not surprising given the hidden transaction costs involved in early stage technology implementation (Figure 1). Ideally these early stage transaction costs would be reduced or eliminated through policy mechanisms that appropriately reveal the fundamental capital and operating costs.

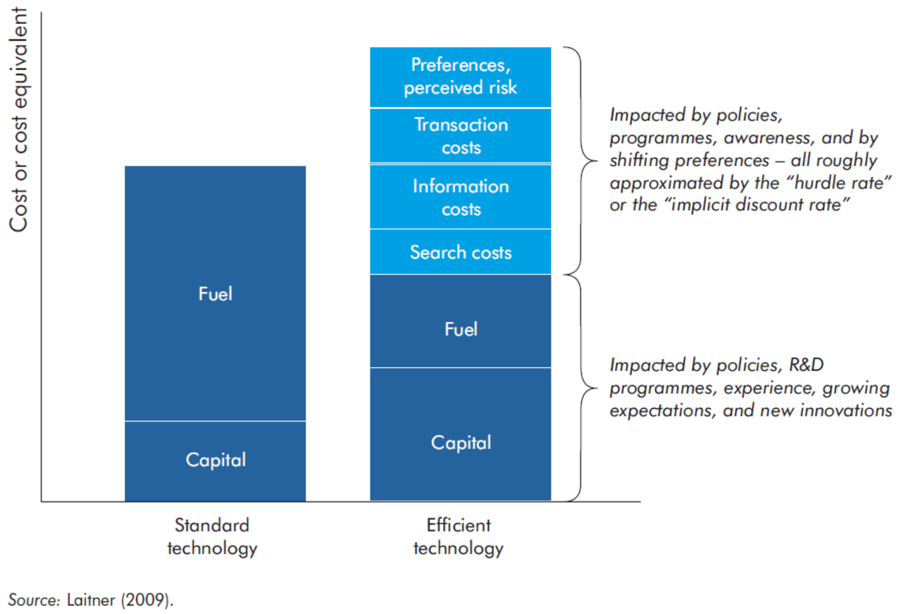
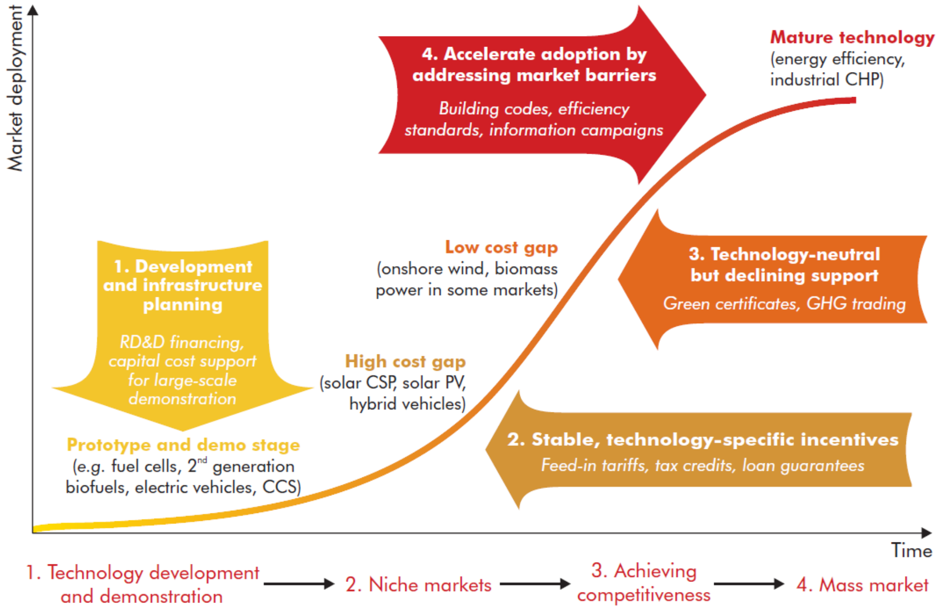


Figure 1 Many components of a switch to new technology are affected by policy and must be tackled in order to reduce the barriers to market transformation. [1]

Learning from research, development, demonstration and deployment (RDD&D) is required to address these issues to enable the solar heating and cooling (SHC) industry to become economic and established. Thus, governments and industry must pursue energy technology innovation through a number of parallel and interrelated pathways sympathetic to both the "push" of RD&D and the "pull" of market deployment [1].

As noted by the IEA in *Energy Technology Perspectives 2010 – Scenarios and Strategies to 2050*, the role of governments in developing effective technology policy is crucial: policy establishes a solid foundation and framework on which other stakeholders, including industry, can build and where appropriate, policies will need to span the entire spectrum of RDD&D [1]. In this way, governments can reduce the risk for other actors in the early phases of technology development and then gradually expose the technology to greater competition, while allowing participants to realise reasonable returns on their investments as a low-carbon economy takes hold [1]. This spectrum is shown below in Figure 2.



Note: The figure includes generalised technology classifications; in most cases, technologies will fall in more than one category at any given time.

Figure 2 Policies for supporting low-carbon technologies can have a significant impact on the RDD&D technology pathway, particularly if sympathetic to emerging industry needs. [1]

In relation to solar heating and cooling (SHC), to date system economics have favoured large systems where project economics are more favourable and demand and equipment limitations found in smaller capacity ranges are avoided [2]. Larger systems may also benefit from leveraging non-solar heat supplied by cogenerating plant and issues such as peak demand management are more noticeable and valuable to address. When combined with non-solar heat, SHC technology can provide firm capacity, given sufficient temperature and capacity requirements are met. Thus, non-solar heat may either supplement or even drive overall technical and economic system performance, however the latter case describes a trigeneration application rather than a solar cooling application.

Although economics may favour large, research and demonstration systems, the installation of small (<20kW) solar cooling kits for residential and small commercial use has increased considerably in recent years [3]. However, even including large systems only about 750 solar cooling systems currently exist worldwide [3]. In colder climates the cooling aspect of SHC systems is often motivated by the question of what to do with surplus heat generated in summer by systems which target winter space heating and hot water production. That is to say that cooling essentially comprises a 'bonus' and may or may not be desirable to the end user due to unfamiliarity with, or low demand for, cooling in these climates. In warm climates the technology would more usually target space cooling, dehumidification and peak electrical demand reduction along with hot water production. Correspondingly, any space heating generated in winter forms an additional benefit which may or may not be desired or useful. In both cases SHC systems are generally readily able to supply three sources of thermal energy (space heating, space cooling and hot water) in varying amounts depending on application requirements.

In defining a SHC system, generally, any solar heat driven thermal comfort technology is included. Additionally the special case of electrically-driven cooling machines directly coupled with photovoltaics (PV) is included. An exception to this is where solar PV is not directly coupled to the cooling machine as this is considered to be conventional electrically-driven technology. Further, it is important to note that SHC systems are often referred to in shorthand as 'solar cooling' systems - particularly in warm climate countries. Despite the presence of the word 'cooling' - and the implied limitation to cooling applications - solar cooling systems typically provide both space cooling *and* space heating. Supplying the heating component is essentially a trivial exercise in re-routing and accommodating air and fluid flows. In many cases SHC systems are often also able to supply domestic hot water and dehumidification depending on the technology variant.

With the technical scene set, definitions of a successful measure must also be established. In other words, in order to begin to understand which international policies have been successful and which have been unsuccessful, definitions of success must be developed. Further, in order to obtain data on international developments, a template enabling entry and categorisation of measures is required.

In aiming to define success, it is firstly important to appreciate that "successful" is a relative term and may be interpreted differently by policymakers and industry. For example a well-developed policy may not achieve a desired effect, resulting in an unsuccessful outcome for industry. Alternatively a measure that is able to obtain a desirable response for industry may be unfavourable due to cost or other factors, rendering it an unsuccessful outcome through policy and governance eyes. Separately again, a policy may obtain a response but in a group other than that targeted by the measure which may result in an unsuccessful outcome for both industry and policymakers. The 'sweet spot' is clearly where a policy is deemed successful in both arenas and benefits an intended technology or market area.

In this Activity, success is defined as achieving a substantial result for the solar cooling industry by way of development, deployment or publicity. Unsuccessful results are obtained where either no, negative, or a disproportionately small result is obtained for the industry. While these are subjective outcomes, the indicators of a measure's success may be quantitative or qualitative or a mixture of the two. As may be expected more weight is given to the quantitative, however this data is often far harder to obtain and in many cases is not available in the public domain in a raw form.

6 Solar Cooling Market Situation

Regardless of the geographical, technological and economic setting, solar cooling technology requires market confidence and capability to expand and achieve widespread uptake. Ultimately, this requires the technology to transition from the *technical development* stage, characterised by high cost per unit energy produced and suboptimal performance, toward the *mass market deployment* stage, characterised by the converse.

A depiction of this market and technological development journey for solar cooling is shown in Figure 3 below, charting the progress of a technology through technical and market development stages, illustrated as a function of cost and performance metrics.

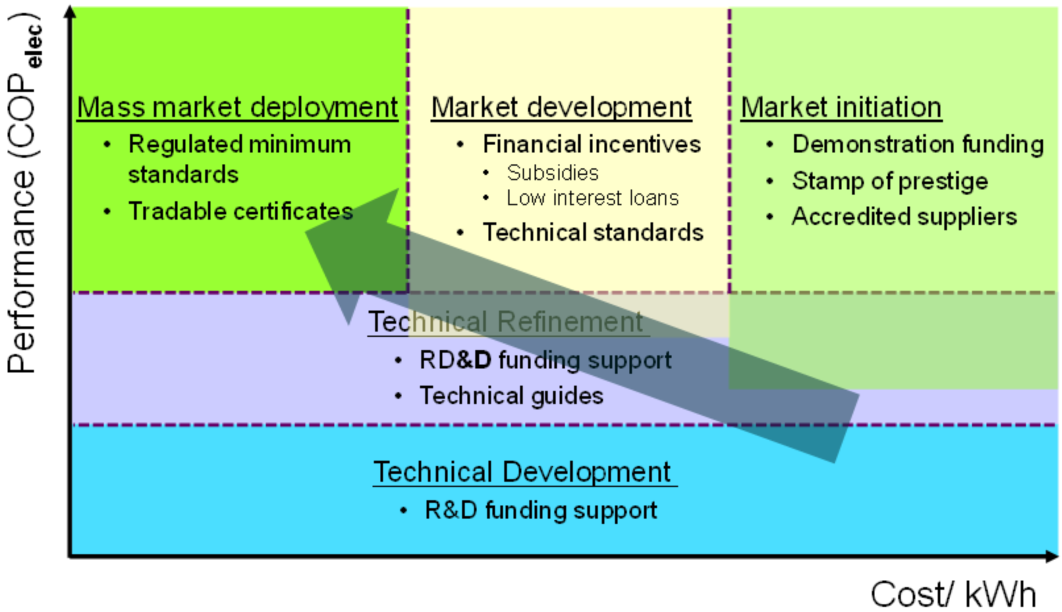


Figure 3 The path from technical development to mass-market deployment is characterised by improved performance and lower cost per unit energy produced. (Source: CSIRO)

Progress towards mass market deployment progressively transforms the task from a purely technical mission (bottom right in Figure 3) to a marketing and awareness exercise (top left in Figure 3). In the early stages the journey is reliant largely or entirely on R&D funding support and the cost per unit performance is high due to laboratory scale and one-off demonstration projects. Mass market deployment represents a stage where the benefit is clear and incentives can be accessed through performance-based market mechanisms such as tradable certificates.

To date, efforts to encourage the adoption of energy-efficient and low-carbon technologies have focused primarily on overcoming technological and economic barriers when, in fact, research suggests that consumer choices can often be heavily influenced by social and behavioural factors [1]. In particular, while cost and performance are important, the development challenge must now begin to include the need to develop capability and evolve the technology offering into an appealing ‘package’ to encourage mass market uptake and reduce implementation risk. This 'wrapping' may include non-technical performance characteristics such as system quality, user interface and engagement, risk, market education, industry training and support, attractive business models and general market appeal or 'buzz'.

This is because reducing CO_2 emissions ultimately depends on the uptake of low-carbon technologies by industry, businesses and individual consumers. To date, efforts to encourage the adoption of energy-efficient and low-carbon technologies have focused primarily on overcoming technological and economic barriers when, in fact, research suggests that consumer choices are more heavily influenced by social and behavioural factors [1]. Thus the more intangible but more critical policy strategies could be those that influence consumer choices by targeting, informing, motivating and empowering consumers.

A pyramid model depicted in Figure 4 emphasises and clarifies five different interrelated layers of SHC industry and technology development. In this way the model can help understand how the technology is presented to the market and where different actors can contribute to benefit the overall technology offering. Though the model does not imply a strict sequence a maturing of the technology results in growth towards the apex. The establishment of IEA Task 48 *Quality Assurance & Support Measures for Solar Cooling* is an indicator of the maturing solar cooling industry by tackling the 'System Quality and Promise Delivery' layer .

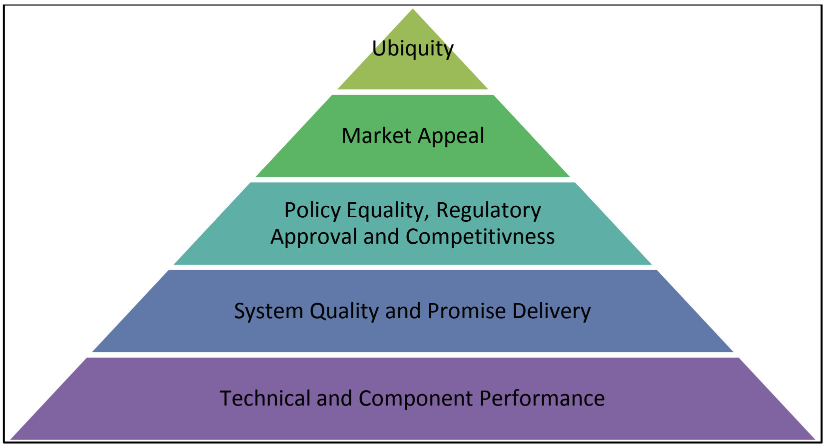


Figure 4 A hierarchy of needs for solar cooling representing the development requirements for solar cooling industry development.

Although it may be difficult to integrate the worlds of engineering and marketing - each with a different focus and innate sense of what's important - this model and the journey indicated previously suggests expansion into the policy and market-appeal domains is required in order to promote demand and achieve market success. These market pull activities describe development activities which motivate, educate and stimulate demand in the marketplace. However, continued effort regarding technology push is still required to ensure authenticity of the marketing message and to ensure the technology side can follow through and live up to the hype.

Despite this, it is also important to note that although the stages are related and the goal to achieve a widespread technology is common, the pyramid concept does not necessarily imply sequencing. In reality, development may be achieved to differing degrees, in parallel or when activity in one layer prompts progress in another. For example, market appeal efforts may encourage demand and thus motivate progress in the system quality and promise delivery domain or vice versa. Practically, combined or sympathetic efforts may lead to more effective or faster industry development outcomes, however this likely requires a high degree of cooperation between different – and possibly competitive – industry players.

Targeting the base of the pyramid, the preceding IEA Solar Heating and Cooling (SHC) Programme Tasks 25 and 38 focused considerable collaborative international effort on developing SHC technology from pure R&D to first market introduction [3]. IEA-SHC Task 25 (from 1999 to 2004) mainly targeted creation of a technology outlook and initiated industrial and system maturation. Task 38 (2006-2010) created tools and methods to assist market introduction of the emerging technology and analysed the efficiency and reliability of newly available SHC systems in demonstrations, pilot installations and commercial market deployments [3].

The current task, Task 48 *Quality Assurance & Support Measures for Solar Cooling Systems,* began in late 2011 and focuses on developing system quality in order to secure long term energy performance and boost economic competitiveness. A key Task 48 goal is to develop and provide support for measures which lead to highly reliable, durable, efficient, robust and economic solar cooling (and heating) systems [3]. Accordingly this report undertakes an analysis of current SHC support measures worldwide and aims to compare their effectiveness.

This understanding is intended to inform and guide the development of Task 48 tools which will underpin and encourage the development of new measures to support solar cooling technology and industry development. The following sections investigate and analyse existing measures from six member countries with respect to developments in other policy arenas.

7 Solar Cooling Actors

In addition to understanding the desired effect of an intervention a critical consideration is the change agent or agents involved. These actors may be a target, an implementer or a competitor. Their needs are critical to a policy instrument's success.

Solar cooling actors were classified by a recent roadmap for solar cooling [4] as belonging to four main groups including component manufacturers, real estate developers and owners, engineering designers and planners and research institutions. With the addition of installer/contractors and financiers, Table 3 shows the situation these actors face in solar cooling.

Table 1 Solar cooling actors and the situation they encounter in the solar cooling industry.

Actor	Solar Cooling Situation
Component Manufacturers (eg collector manufacturers, chiller manufacturers)	Weakly excited by market opportunity, but with a limited appetite for additional effort outside of core business. Equipment for solar cooling market is largely mature market equipment with limited profit margins. Aim is to sell more product.
Real Estate Developers and Owners	Poor visibility of performance and aversion to high capital cost items. Opportunity for publicity and differentiation. Aim is to develop buildings that appeal to the real estate market.
Engineering Designers and Planners	Opportunity for publicity and to generate high profile case studies and knowledge. There are a small number of specialist companies looking for a competitive advantage. These companies are typically small with limited market power. Some generalist contractors are taking on jobs with insufficient specific solar thermal knowledge. Aim is to secure the next job.
Research Institutions	Interested in technical development and application of science. Also interested in monitoring, development of future technology and publishing papers. Industry benefits from public communication via scientific publications or through commercialisation. Aim is to develop technology and receive funding to continue research.
Installers and Contractors	Often emerge from the Heating Ventilation and Air Conditioning (HVAC) industry with limited experience in solar technology. High costs result from additional risk margin applied due to lack of familiarity with the technology. Motivation once a project is secured is to get in and out and stick to the letter of the contract. The recent emergence of specialist Energy Service Companies (ESCOs) addresses many of these issues. Aim is to complete a project as required under a contract and move onto the next job.
Financiers	The financier may play an important role in facilitating Energy Service Companies (ESCOs) – who build, own and operate the system and sell services to building occupants. Their key motivation is to reduce risk. Lending collateral is usually tied up in the building rather than the solar system. Aim is to obtain a secure return on capital.

8 Types of Incentive Schemes

Numerous renewable energy and other policy incentive schemes exist around the world. These have been summarised in a recent the United Nations Environment Programme (UNEP) study which defined and categorised 20 policy instruments in five categories with wide relevance across the Environment field [5]. These five categories and the 20 policy instruments selected by UNEP are shown below in Figure 5.

Control and regulatory instruments		*Economic and market-based instruments*	*Fiscal instruments and incentives*	*Support, information and voluntary action*
Normative: – Appliance standards – Building codes – Procure-ment regulations – Energy efficiency obligations and quotas	Informative: – Mandatory audits – Utility De-mand-side manage-ment (DSM) programs – Mandatory labelling and certifica-tion programs	– Energy performance contracting – Cooperative procurement – Energy efficiency certificate schemes – Kyoto Proto-col flexible mechanisms	– Taxes – Tax ex-emptions / reductions – Public benefit charges – Capital subsidies, grants, subsidized loans	– Voluntary certification and labelling – Voluntary and negotiated agreements – Public leade-ship programs – Awareness raising, education, information campaigns – Detailed billing and disclosure programs

Figure 5 Policy instruments analysed in the UNEP Assessment of Policy Instruments for Reducing Greenhouse Gas Emissions From Buildings – Summary and Recommendations report [5].

These policy instruments have been considered in the context of the solar cooling actors and their needs described in Table 2. For each solar cooling actor, Table 2 shows the barrier or issue they face and relevant policy options.

Table 2 The barriers and issues experienced by solar cooling actors and corresponding policy options.

Actor	Solar Cooling Barrier or Issue	Policy Option
Component Manufacturers	Skills in solar cooling Market and company inertia Effort in adapting product line to new applications Transaction cost on relatively small size of market opportunity	Training R&D Funding Stimulation of market demand
Real Estate Developers and Owners	Uncertain performance and cost Lack of awareness of solar cooling Appeal of general technology offering	Education and information Subsidies and incentives (eg. tax credits, low interest loans and tradable certificates) Cooperative procurement Standardisation Access to finance (including ESCOs) Labelling and certification
Engineering Designers and Planners	Lack of skills in solar technology Project accountability risk Uncertain performance and cost	Training Standardisation and technical guides
Research Institutions	Access to funding Industry engagement Access to technology and market data Technology transfer	R&D Funding Access to venture capital Business incubators
Installers and Contractors	Skills and equipment Performance risk Commissioning costs Transaction costs Pricing and sourcing of equipment Warranties Low enquiry to uptake ratio	Subsidies and incentives (eg. tax credits, low interest loans and tradable certificates) Technical guides and standards ESCO offers
Financiers	Technical risk Commercial risk	Low cost finance ESCO support

The effectiveness of the selected instruments in reducing GHG emissions, achieving cost-effectiveness for society and other key success factors were used by UNEP as assessment criteria. In analysing the 20 policy instruments selected, UNEP found that many policy instruments evaluated were able to achieve high savings at low or even negative costs for society. Despite this, the technical (emissions reduction) potential and economic (cost effectiveness) potential varied significantly over the instruments analysed. Moreover, many instruments carried significant special conditions and constraints as can be seen in the analysis summary's rightmost column in Figure 6 below.

A similar exercise to determine technical and economic performance and special conditions was performed for solar cooling. A survey template was developed for this report and is described in the next section.

Policy instrument	*Emission Reduction Effectiveness*	*Cost-effectiveness (a)*	*Special conditions for success, major strengths and limitations, co-benefits*
Appliance standards	High	High	Factors for success: periodical update of standards, inde-pendent control, information, communication, education
Building codes	High	Medium	No incentive to improve beyond target. Only effective if enforced
Public leadership programs, incl. procurement regulations	Medium/High	High/Medium	Can be effectively used to demonstrate new technologies and practices. Mandatory programs have higher potential than voluntary ones. Factors for success: ambitious energy efficiency labeling and testing.
Energy efficiency obligations and quotas	High	High	Continuous improvements necessary: new energy efficiency measures, short term incentives to transform markets
Mandatory audit requirement	High, but variable	Medium	Most effective if combined with other measures such as financial incentives
Demand-side management programs (DSM)	High	High	Tend to be more cost-effective for the commercial sector than for residences.
Energy performance contrac-ting (EPC)/ESCO support (b)	High	Medium	Strength: no need for public spending or market intervention, co-benefit of improved competitiveness.
Cooperative procurement	High	Medium/High	Combination with standards and labeling, choice of products with technical and market potential
Energy efficiency certificate schemes/white certificates	Medium	High/Medium	No long-term experience. Transaction costs can be high. Institutional structures needed. Profound interactions with existing policies. Benefits for employment.

Kyoto Protocol flexible mechanisms (c)	Low	Low	So far limited number of CDM &JI projects in buildings
Taxation (on CO2 or fuels)	Low	Low	Effect depends on price elasticity. Revenues can be earmarked for further efficiency. More effective when combined with other tools.
Tax exemptions/ reductions	High	High	If properly structured, stimulate introduction of highly efficient equipment and new buildings.
Public benefit charges	Medium	High	Success factors: independent administration of funds, regular monitoring &feedback, simple &clear design.
Capital subsidies, grants, subsidized loans	High	Low	Positive for low-income households, risk of free-riders, may induce pioneering investments.
Labelling and certification programs	Medium/High	High	Mandatory programs more effective than voluntary ones. Effectiveness can be boosted by combination with other instrument and regular updates.
Voluntary and negotiated agreements	Medium / High	Medium	Can be effective when regulations are difficult to enforce, combined with financial incentives, and threat of regulation
Education and information programs	Low / Medium	Medium/High	More applicable in residential sector than commercial. Success condition: best applied in combination with other measures.
Detailed billing and disclosure programs	Medium	Medium	Success conditions: combination with other measures and periodic evaluation.

(a) Cost-effectiveness is related to specific societal cost per carbon emissions avoided. (b) Energy service companies (c) Joint Implementation, Clean Development Mechanism, International Emissions Trading (includes the Green Investment Scheme)

Figure 6 Instruments compared in the UNEP report along with their relative technical and cost effectiveness and comments on limitations, strengths and special cases.

9 SHC Measures and Survey Template Development

In the previous section, policy categorisation and high-level comparison of categories in the wider Environmental field was discussed. Naturally, the question of policy performance in SHC fields now arises. To investigate this, a survey template was assembled to obtain data on SHC support measures around the world. Following discussion at the Milano Task meeting in March 2012 the survey template discussed in this report was agreed by Task 48 members.

This template was designed to obtain data on the nature, effectiveness and requirements of existing and historical solar cooling-related incentive schemes from around the world. The survey results provided a database enabling the analysis of worldwide incentive efforts, their relevance to solar cooling and effectiveness.

The Incentive Review Survey Template includes fifteen descriptors which are used to categorise past, present and possible future standards, rating and incentive schemes. These descriptors prompt respondents to enter relevant details about historical and current policy measures and allow each measure to be compared and contrasted. This analysis also enables evaluation of each measure's potential to support the development of the solar cooling industry, and provides a base for trend analysis to investigate the success or otherwise of measures from certain categories, geographical regions and levels of government.

Solar cooling policy instruments were summarised and categorised using, in all, eleven categories covering each of UNEP's four policy instrument categories. These measures and the corresponding UNEP policy instrument category are shown below in Table 3.

Table 3 Measure categories used in the survey template and the corresponding UNEP Policy Instrument category.

Policy Instrument Categorisation	Corresponding UNEP Policy Instrument Category
Certificate trading scheme	Economic and market-based instruments
Technical compliance standard	Control and regulatory instruments
Development planning requirement	Control and regulatory instruments
Competitive grant	Fiscal instruments and incentives
Subsidy on capital cost	Fiscal instruments and incentives
Feed in tariff	Fiscal instruments and incentives
Access to capital	Fiscal instruments and incentives
Information or promotional service	Support, information and voluntary action
Stamp of quality/ performance or prestige	Support, information and voluntary action
Tax deduction	Fiscal instruments and incentives
Other	

The categorisation of "Other" was included to permit respondent flexibility, to evaluate the appropriateness of the categories selected for use in the template and to ensure the integrity of responses entered into these defined categories.

The survey template required the IEA country experts to fill in a survey for each of the interventions, further describing and categorising their characteristics. This included:

- ten 'free-form' fields allowing respondents to describe the structure, pros, cons and effectiveness of a given policy instrument; additionally
- five pre-set drop-down fields are defined allowing more targeted categorisation.

Such a design affords the respondent freedom while also providing some more uniform fields allowing better cross-comparison of each measure. The classification descriptors and an explanation of each are detailed in Table 4 and Table 5.

Survey results are included in the next section of this report.

Table 4 Free-form template descriptors used in the incentive scheme survey template.

Descriptor	Explanation
Affected Country / Jurisdiction (Domain)	Identify the breadth of the implementation Identify the potential for measure influence and replication
Intervention Mechanism (Title)	The official label given to the measure Also included in some responses the colloquial label
Contact Organisation (incl. contact details)	Contact details for the administering organisation
The Intervention's General Intent and Operating Principles	General explanation of how the measure works General explanation of what the measure aims to achieve
Summary of the Benefits for Solar AC contractors (dot points)	Potential benefit solar air conditioner installers may derive from the measure (especially important for measures targeting technologies other than solar AC)
Summary of the Disadvantages for Solar AC contractors (dot points)	Potential disadvantages solar air conditioner installers may experience regarding the measure (eg. subsidised competing technologies)
Effectiveness - outcomes to date (or likelihood of) stimulating solar cooling	Evidence of measure's success in stimulating the solar cooling market Likelihood of measure stimulating the solar cooling market in the future
Administrative forms, timelines & processes for accessing support	Information on the administrative burden accompanying the measure
Comments	Free field for any other feedback which does not fit into the other categories Space for information on the historical or current context of the measure and information on its creation
References	Sources of external information and data about the measure and its implementation

Table 5 Pre-set drop-down options in the template provided improved measure categorisation and classification.

Descriptor	Options	Explanation
Category/Type of Intervention (Select)	Certificate trading scheme Technical compliance standard Development planning requirement Competitive grant Subsidy on capital cost Feed in tariff Access to capital Information or promotional service Stamp of quality/ performance or prestige Tax deduction Other (type into cell)	Common types of intervention measures are listed – only one measure may be selected The pre-set fields surround financial, regulatory and prestige motivators
Eligibility/ Assessment Approach	Deemed Savings Engineered Design/ Eligibility Criteria Measured Performance Combination (type in cell) Other (type into cell) Unknown	Common methods that can be used to quantify, rate or assess the eligibility of an installation for support under the given intervention – only one measure may be selected
Implementing Level of Government	Local/City State/Regional Federal/National Combination (type into cell) Other (type into cell)	Identify the breadth of the implementation Identify the potential for measure influence and replication Identify whether other areas may be eligible for the measure
Solar Cooling Opportunity Size	No limit (or close to) Finite budget (type euro limit into cell) Finite capacity (type MW(refrig) limit into cell) Other (type into cell)	Evaluate the magnitude of the potential opportunity Identify the likely lifetime of the measure
Application Niche	Residential Commercial & Industrial All Other (type into cell)	Evaluate the magnitude of the potential opportunity Estimate the likely suite of suitable technologies

10 Survey Result Analysis

The survey template was populated by representatives from country contributors. Input from six member countries was obtained, including Australia, Austria, France, Germany, Italy and the USA.

This input identified some 65 support mechanisms which were categorised and assessed. The responses indicate a large number of direct financial incentives present in member countries – with the top four schemes being subsidy, tax deduction, grant-based and access to capital measures. These direct incentives provide a benefit to a proponent directly from the incentive administrator. A chart showing responses by type of intervention is included in Figure 7.

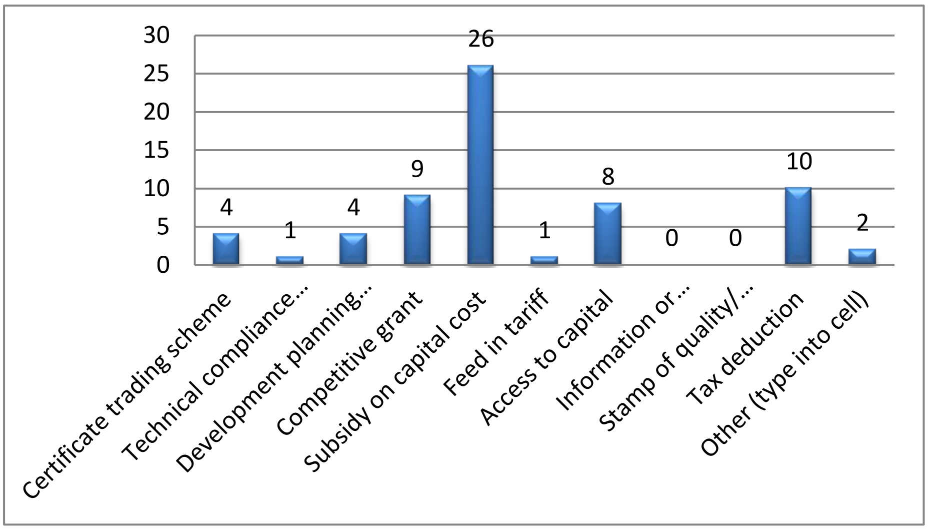


Figure 7 Responses by category show the dominance of direct financial measures.

While more direct instruments were reported it is likely that respondents have considered the most direct and obvious measures first when completing this template, possibly overlooking other relevant incentives. Alternatively these direct measures may simply be more attractive to policymakers as they are more obvious to eligible parties, simpler to administer or easier to evaluate as they are more quantifiable.

Responses by region are shown in Figure 8 and indicate that either more supporting programs for solar cooling exist in Australia, Italy and the US or that a smaller number of larger programmes are on offer in the European responding countries. It is unclear whether a large number of smaller opportunities or a smaller number of large opportunities is beneficial for solar cooling.

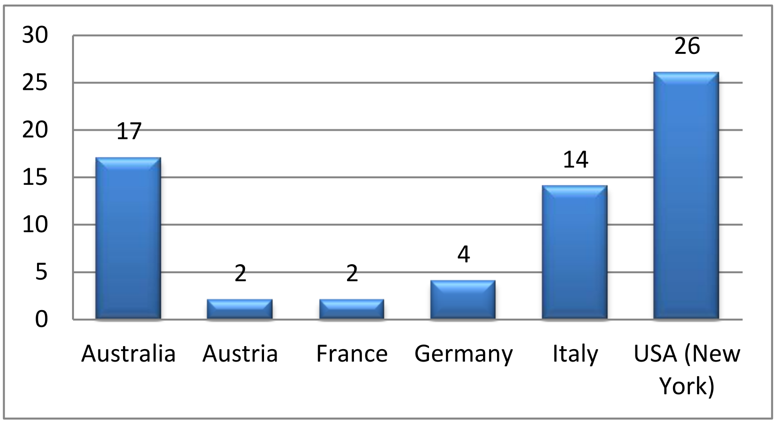


Figure 8 Responses by region show larger numbers of reported incentives from New York, Australia and Italy.

Figure 9 shows that a majority of responses were implemented by State/Regional governments, closely followed by National/Federal governments. A smaller number of programmes were administered by Local/City governments. No programmes were administered by a combination of entities. This may be due to a very "jurisdictional" approach in government, but also provides a clear opportunity for policy harmonisation and cooperation.

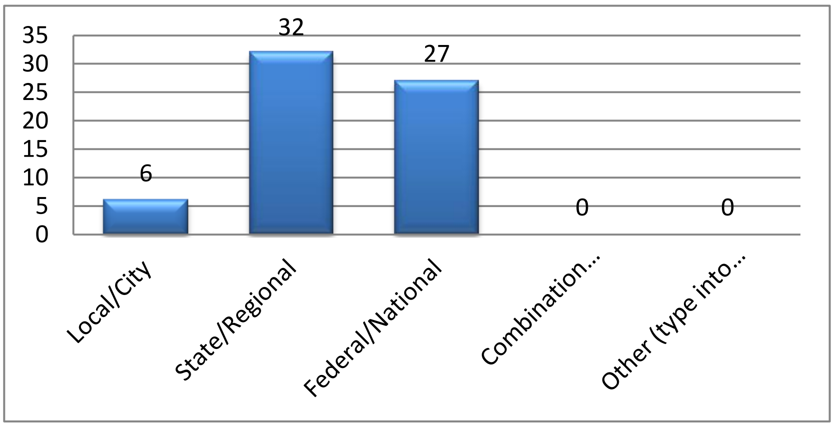


Figure 9 Responses analysed by implementing body show that 50% of reported incentives are administered by State/Regional bodies with Federal/National accounting for 41% and only 9% by Local/City.

As shown in Figure 10, analysis of eligibility/assessment approaches shows strong representation by the Engineered Design/Eligibility approach. This approach assesses a design for incentives prior to construction, based on the size of some feature (e.g. m^2 of collector area or kW capacity). This may be due to the ease of implementation and clarity of this approach. Both this and the deemed savings approach result in high levels of certainty and clarity about what is on offer and what will be achieved.

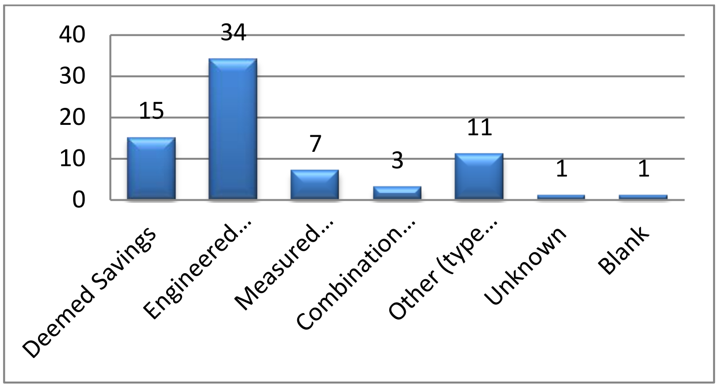


Figure 10 Responses analysed by assessment approach show dominance of design and eligibility criteria methods with a 47% response rate. NB: The response count is 72 (rather than 65) as the three combination cases result in multiple counts.

Measured performance, where a project or product is tested and/or monitored to determine incentive magnitude or eligibility, is also prominent in the response and is a desirable incentive from a technical and policy point of view. However this approach may create uncertainty and thus risk for the applicant because the size of the incentive is tied to performance which is not certain during the investment phase. Performance-based policy instruments may also create implementation complexity resulting from measurement and verification requirements.

Figure 11 shows a bias towards residential and application independent ('All') instruments in responses. In a similar way to the direct incentives result mentioned earlier, this may represent a clear desire to communicate with residential occupants, as voters, in a political conversation or, may indicate a recognition that resource limitations are greater in residential applications and thus this application requires more support. Alternatively the view may also be formed that commercial and industrial entities are supported in other ways, are better served by a smaller number of larger incentives (eg. tax incentives) or are more able to act to respond to drivers in a business-as-usual way (eg. investing in new equipment).

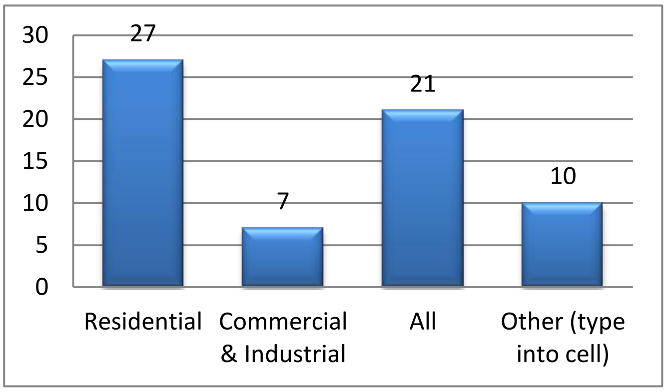


Figure 11 Responses analysed by application niche show a bias towards residential support, closely followed by the "all" case. Many of the "other" responses related to public and educational buildings.

This targeted application by implementing level of government in Figure 12 shows a bias towards residential incentives in State and Regional programmes but a fairly even breakdown in all three application categories at the Federal/National level.

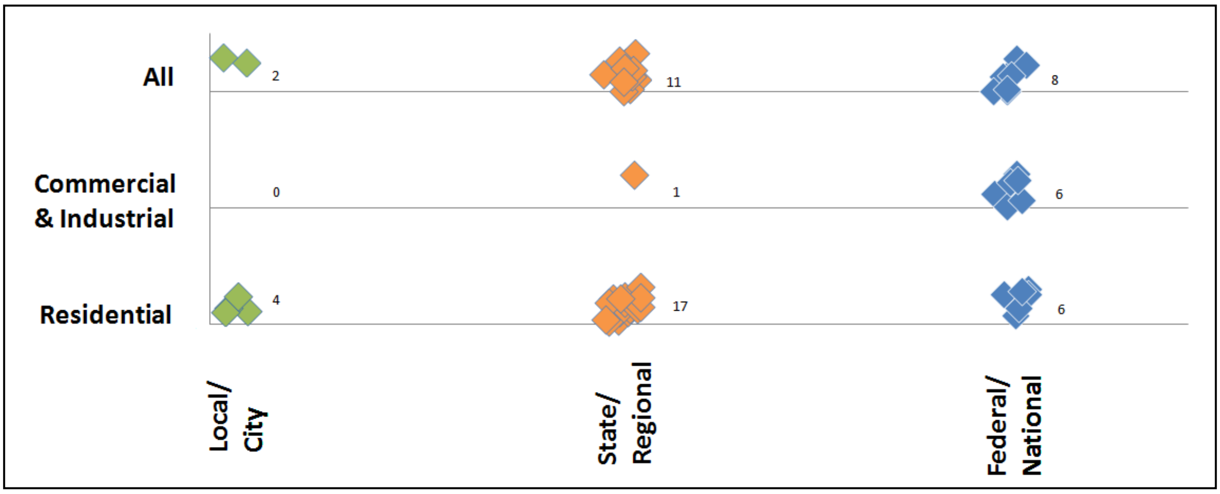


Figure 12 Comparing Application Niche against grouped results by implementing level of Government shows a fairly even count in the breakdown of Federal/National programmes and a bias towards residential incentives in State/Regional administered programmes.

11 Discussion

A number of interesting features are present in the survey results and the question of what is required to support solar cooling industry development can begin to be addressed.

The dominance of direct financial support in the survey results - particularly in the top four schemes covering subsidy, tax deduction, grant-based and access to capital measures - suggests that an under-utilisation of non-financial measures might exist worldwide. Thus an opportunity exists to implement measures which address education and market appeal.

A related issue is the carriage, ownership and appetite for risk in a solar cooling deployment exercise. This issue arises in the strong focus on Engineered Design/Eligibility approaches which essentially apportion risk to the funder. That is, if the system does not perform as expected, the funding entity is left with the liability. Conversely with the measured approach the risk is carried by the developer or end-user. While neither approach is right or wrong this acceptance is a non-technical, non-financial issue with financial implications and presents an opportunity to either de-risk the funding application or market offering or to clarify and justify the risk in other ways. However, as technology confidence improves moving the risk to the end-user may be acceptable although in the current initiating phase of industry development this approach poses a significant hurdle to market demand and industry development.

Another interesting feature which also relates to risk is the recurrence of the many vs few issue. The issue relates to whether a large number of presumably smaller opportunities is more beneficial for SHC industry and technical development or if fewer, larger and more targeted opportunities are more appropriate. The risk with a larger number of opportunities is to perhaps dilute and fragment the macro industry effort, increase overall administrative burden or induce confusion as to which measures are intended for which purpose. The benefit to this approach may be in the greater opportunity and inclusiveness associated with more options. Conversely a more exclusive approach may provide larger more targeted efforts but may reduce the breadth of overall effort and provide a larger target for political scrutiny and cost cutting.

Ultimately a mix of many smaller, more targeted measures is likely to be beneficial for early stage technology while larger more universal and substantial measures would suit later stages of development. For example, support for development of different components and component combinations may be available through various funds, while market-wide incentives such as feed in tariffs, subsidies or awareness campaigns are supported on a larger scale. Solar cooling is currently likely placed somewhere in the transition between the early and later stages of development. An indication of this increasing maturity is in Task 48's focus on quality and market offering, not just technical performance and development. This focus is now preparing the groundwork for policy measures which support the kind of large industry-wide coordinated action to bring solar cooling into the mainstream.

This development architecture can essentially be described as an integrated system of 'small bets' which support both the technology push stage through technical development while also encouraging market transformation through larger 'bigger picture' efforts through the market pull stage. A mix of both approaches is ultimately a strength and is an indicator of an innovative industry. Development of a continuum or 'pipeline' of technology options may encourage political buy-in among different implementing levels of government if the pathway is made clear and policy support 'exit points' are identified. As noted by the IEA, "[policies] need to have exit routes: the level of government support should decrease over time and be removed altogether as technologies become competitive – or indeed, if it becomes clear that they are unlikely to do so" [1]. This exit is key to the integrity of the message policy assistance rather than institutionalisation. The aim must be to level the playing field and allow the SHC industry equal access to incentives accessible by other renewable energy technologies. Ultimately the target is for SHC to compete fairly with conventional and other renewable energy technologies, enabling the industry to become self-sufficient. While this is easy to say, it may be difficult to forgo incentives once gained. Although potentially a complicated task, the merits of technologies such as SHC - which have multiple benefits environmentally, economically and socially - should aim for checkpoint progress towards mainstream use and achieve this aim decoupled from the winds of political change.

Another issue present, regardless of the approach used surrounds administrative burden. In some cases, such as that of the French Emergence programme (see breakout box below), a programme that is well targeted to SHC may be sufficiently attractive, but overall may be affected by administrative burden. This administration burden may threaten the effectiveness of a program by dissuading applications due to complexity and administrative overhead. On the contrary, a program that is sufficiently broad so as to be vague or non-specific about eligible technologies may permit a wide range of non-targeted technologies and not boost any particular technology substantially. An example of this is the New York Energy Smart New Construction Program which permits a wide range of non-specific technologies. Such a programme may not achieve the aim desired by the funder and is unlikely to support the development of the SHC industry. This approach constitutes a short burst or spray of activity in a wide range of fields and its effectiveness in progressing a particular technology or achieving a tangible benefit may be correspondingly low.

Emergence Programme

Region of application:

France

Why it is interesting:

The programme is specific to solar cooling and heating only, has a high level of incentive (up to 80% of the solar cost), is open to all contractors (public and private) and targets high performance levels and guaranteed results.

Value of opportunity:

No limit publicised, but incentive is performance based - if successful: 50% of the incentive is paid upon start of works, 30% on commissioning and 20% after two years of monitoring.

Performance so far (amount of funding delivered, projects funded etc):

Since 2010, two installations were built within the framework of the Emergence programme and another is due for completion soon.

Name of the project	Investment cost (€)	Grant amount (€)	Collector area	Absorption capacity	Year of completion
SERM	312 751.20	49 912.68	240 m²	35 kW	2012
Airbus	388 413.79	167 017.93	80 m²	35 kW	2012
Ereco	103 870	80 000.00	33 m²	8 kW	2013

Pros:

- Specific to solar cooling and heating only
- Up to 80% of the solar cost is covered by the incentive
- Encourages development of quality systems
- Is open to all contractors (public and private)
- Selection of the best projects on efficiency criteria
- Standardised monitoring system used for performance evaluation

Cons:

- Heavy procedure: the project has to get through two selection steps
- Program not well known
- 20% of the subsidy is given to the system owner only after 2 years monitoring and only if the performances reaches the targets

What can this incentive do for the future of solar cooling?

This programme has generous incentives, targets only solar heating and cooling with and focuses on quality systems. If some of the administrative challenges can be eased this programme could encourage the installation of many new, quality solar cooling systems and demonstrate that high performing and efficient best practice.

Finally, the analysis illustrated a bias towards measures supporting residential applications. Political or not, it is strongly recommended that a specific focus be placed on policy support for SHC in commercial or industrial applications as a potential driver of high-volume or high-capacity SHC deployments. Although the number of residential applications may outweigh the number of industrial applications in number, the application context is very different in terms of capacity or ability to deploy the technology. Without a focus on this segment it is more difficult for both the end-user and the SHC industry to target offerings for these commercial and industrial applications.

12 Conclusion

The solar cooling market is developing quickly. A range of policy interventions were identified in 6 countries around the world that could potentially be used to support solar cooling. Many of these policy incentive schemes are focussed on awarding subsidies to systems based on technical parameters such as solar collector area. These incentives, created with solar hot water applications in mind are not targeted to the cost/ performance situation of the emerging solar cooling industry.

There has been some policy foray into system quality support through performance-based incentives. However, given the maturity of the solar cooling industry this approach has risks for industry actors as it is difficult to accurately predict performance during the design/investment phase. Measurement and verification costs may also create undue administrative burden and project risk for actors including the system designer or developer and the proponent.

There is a need for non-technical policy support addressing characteristics such as system quality, user interface, risk, market education, industry training and support, attractive business models and general market appeal or ‘buzz’. These less tangible but critical policy strategies could be those that influence consumer choices by targeting, informing, motivating and empowering consumers.

This database and the above findings are intended to provide insight into the needs of alternative policy interventions and hence guide the development of the standards, guides and rating framework being delivered in the subsequent work packages. It will also contribute to the work of Subtask D.

One issue identified during this activity is that many of the responding members appear to mainly consider direct incentive measures such as subsidies on capital cost, tax deduction and access to capital. However many other more subtle measures including compliance standards and planning approval may have been overlooked. It is recommended that the survey exercise be repeated with other industry actors.

13 References

[1] Energy Technology Perspectives 2010, Scenarios & Strategies to 2050, IEA 2010

[2] Technology Roadmap, Solar Heating and Cooling, IEA 2012 http://www.iea.org/publications/freepublications/publication/2012_SolarHeatingCooling_Roadmap_FINAL_WEB.pdf

[3] Task 48 Quality assurance and support measures for Solar Cooling – Task description and Work plan, IEA October 2011 http://task48.iea-shc.org/Data/Sites/6/documents/Work-Plan-TASK48-Solar-Cooling.pdf

[4] Technologie-Roadmap für solarthermische Kühlung in Österreich, Bundesministerium für Verkehr, Innovation und Technologie, 2012.

[5] UNEP Assessment of Policy Instruments for Reducing Greenhouse Gas Emissions From Buildings – Summary and Recommendations, United Nations Environment Programme and CEU, 2007

14 Acknowledgements

The survey template was populated by representatives from country contributors. Input from six member countries was obtained, including:

- Australia – Daniel Rowe
- Austria – Hilbert Focke
- France – Romain Siré
- Germany – Uli Jakob and Matthias Schicktanz
- Italy – Roberto Fedrizzi, Simon Pezzutto and Marco Calderoni
- USA – Khalid Nagidi

15 Appendix

The file *Task 48 - Appendix to Activity C1 Final Report - Table of Incentives and Regulations - September 2013 – Submitted.xlsx* is to be attached electronically to this report.

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