SOLARUPDATE

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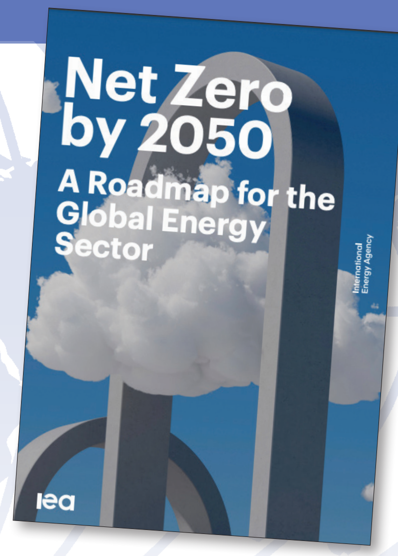
Newsletter of the International Energy Agency Solar Heating and Cooling Programme

INTERNATIONAL ENERGY AGENCY
Solar Heating & Cooling Programme

#SolarHeat
#SolarThermal
#SolarProcessHeat
#SolarCooling
#SolarDistrictHeating

In This Issue

Future Role of Solar Heat in the IEA's Net Zero Roadmap



In May, the International Energy Agency published the 224-page report, Net Zero by 2050: A Roadmap for the Global Energy Sector, challenging policymakers with 400 milestones that governments need to realize to achieve the 1.5 °C target. At the report's online press conference, IEA Executive Director Dr. Fatih Birol made some surprisingly forceful statements about the global net-zero emission targets for 2050 – statements widely quoted in the media since. "This is not a race between nations but a race against time. And no one wins unless everyone finishes," he said. He also underlined that there is no longer a need for further investment in oil, gas, and coal.

The IEA's recent publication, Net Zero by 2050: A Roadmap for the Global Energy Sector, represents a paradigm shift within the IEA. The co-authors Chief Energy Modeler Laura Cozzi and Head of Energy Technology Policy Timur Gül see a "narrow but still achievable pathway" to a net-zero world by 2050. When Dr. Birol opened the May press conference, he listed the following as the "three biggest homework assignments for all of us – governments, industry, citizens, and academia:"

1. Make the most of available clean energy technologies (solar, onshore/offshore wind, electric vehicles, energy efficiency solutions and – in some countries – nuclear power).
2. Encourage innovation to bring new products, such as novel battery technology and hydrogen equipment, to market after 2030 – including solutions for industrial, long-haul transport, and aviation – in order to cut emissions even further.
3. Substantially reduce the use of fossil fuel.

Solar heat may not have been a focus of the press conference, but the IEA roadmap does list significant milestones for solar heat in the building sector (see the table below). According to the roadmap, the number of buildings using solar thermal energy to provide hot water and space heating will need to increase from 250 million in 2020 to 1.2 billion by 2050, while the share of those using electricity will have to grow from nearly 20% of today's total to 35% by 2030 and about 55% by 2050.

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SHC Members

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EUROPEAN COMMISSION
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NETHERLANDS
NORWAY
PORTUGAL
RCREEE
SACREEE
SICREEE
SLOVAKIA
SOUTH AFRICA
SPAIN
SWEDEN
SWITZERLAND
TURKEY
UNITED KINGDOM

Key milestones in transforming the global building sector

Category	
New buildings	• From 2030: all new buildings are zero-carbon-ready.
Existing buildings	• From 2030: 2.5% of buildings are retrofitted to be zero-carbon-ready each year.

Category	2020	2030	2050
Buildings			
Share of existing buildings retrofitted to the zero-carbon-ready level	<1%	20%	>85%
Share of zero-carbon-ready new buildings construction	5%	100%	100%
Heating and cooling			
Stock of heat pumps (million units)	180	600	1 800
Million dwellings using solar thermal	250	400	1 200
Avoided residential energy demand from behaviour	n.a.	12%	14%

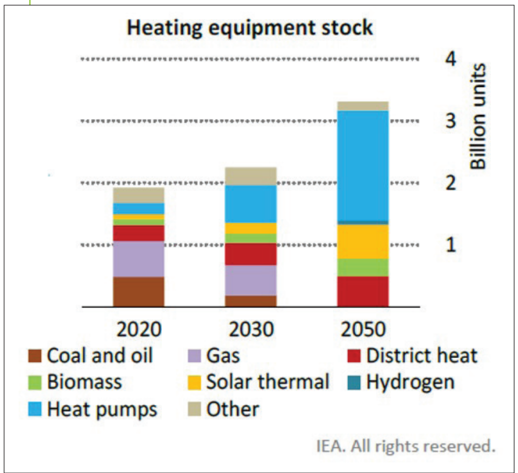
(Source: IEA (2021), Net Zero by 2050, IEA, Paris)

The targets in the Net Zero by 2050 scenario for solar heat in buildings are fairly progressive despite solar district heating and solar industrial heat not really mentioned among the milestones. To better understand this observation, solarthermalworld.org reached out to the roadmap team members responsible for the building sector, Thibaut Abergel (Energy Analyst) and Timothy Goodson (Energy Modeler and Analyst), who were quick to respond. "Your questions regarding the role of solar thermal in the Net Zero by 2050 pathway and the report are very valid since, despite the report being explicit about the technology pathways for a number of subsectors or end-uses, we could not present an exhaustive picture of all the contributions of all technologies modeled." They did provide, however, several elements to help clarify the role of solar thermal technologies in the scenario.

In buildings, solar thermal plays a predominant role as a decentralized energy resource for water heating. In the Net Zero by 2050 Scenario, it meets 35% of demand by 2050, up from under 10% in 2020.

We see a more rapid growth for solar thermal applications where heating needs are low. About 70% of the global population in 2050 will have cooling needs with no or limited space heating needs. For such regions, coupling solar thermal water heating with affordable cooling-only, refrigerant-free solutions (e.g., evaporative cooling with a membrane for humidity control) can be cost-optimal. Further, many such regions have ideal conditions for high solar thermal performance, notably the Middle East and North Africa, parts of China and India, and Australia, just to name a few regions. Technology choices in the Net Zero by 2050 Scenario also account for the ability of equipment to shift electricity demand away from peak times. Solar thermal technologies are a beneficial solution in this respect as they avoid electricity demand, maximize the use of solar irradiation during the middle of the day, and store hot water for later use. In the Net Zero by 2050 Scenario, all buildings with available roof space and sufficient solar insolation are equipped with solar thermal water heaters by 2050 (some of which may be PV-thermal).

In industry, solar thermal heat sees rapid growth in the Net Zero by 2050 Scenario as a key available mature technology that can be rapidly deployed for medium and low-temperature heat provision. Despite competition with heat pumps or electric boilers (for low and medium temperature), solar thermal is expected to continue



▲ **Global building heating equipment stock by type in the Net Zero by 2050 Scenario. By 2050, over 85% of buildings will be zero-carbon-ready, with heat pumps meeting over half of heating needs. The installed stock of heating equipment increases +45% over the next 30 years primarily due to the combined effect of population growth and improved living standards, which tends to reduce average household occupancy.** (Source: IEA (2021), Net Zero by 2050, IEA, Paris)

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to grow and, by 2050, cover 11% of industrial heat demand below 200 °C, up from 3% in 2030. Applications are mostly restricted to non-energy-intensive industries and ancillary or downstream processes in heavy industries. The share of heat provided by solar thermal technologies is lower for high-temperature heat applications, where emerging electrolytic hydrogen technologies and natural gas with CCUS (carbon capture, utilization, and storage) play a stronger role.

Select key milestones

	2020	2030	2050
Million dwellings using solar thermal	250	400	1,200
Share of solar thermal and geothermal in buildings	2%	5%	12%
Million dwellings with a PV rooftop system	25	100	240
Stock of heat pumps (million units)	180	600	1,800

(Source: IEA (2021), Net Zero by 2050, IEA, Paris)

For solar district energy, there is a role in the Net Zero by 2050 Scenario, but its use is tailored to where such technologies are most suitable. Existing district energy systems today are generally located in areas with high heating densities – typically in very cold or very densely-populated cities – while the installation of solar collectors is often limited by land availability constraints. While power-to-heat, waste heat recovery, and bioenergy remain the backbone of district heat decarbonization in many areas, solar thermal plays an increasing role in new district energy network expansions, typically in medium-size cities where climate and land space conditions are favorable.

For power generation, concentrating solar power (CSP) plays an important role in decarbonizing electricity while maintaining electricity security in the Net Zero by 2050 Scenario. For example, global CSP capacity increases 12-fold by 2030 in the Net Zero pathway, as shown in Annex A of the report. CSP is also noted in the report as providing system benefits, especially when coupled with thermal storage. Together with demand-side response, energy storage and electricity network robustness, it contributes to maintaining electricity security.

Visit https://www.iea.org/reports/net-zero-by-2050 to find more data and download the report. And don't miss the new Renewables 2021 publication, and the report's Renewable heat extract.

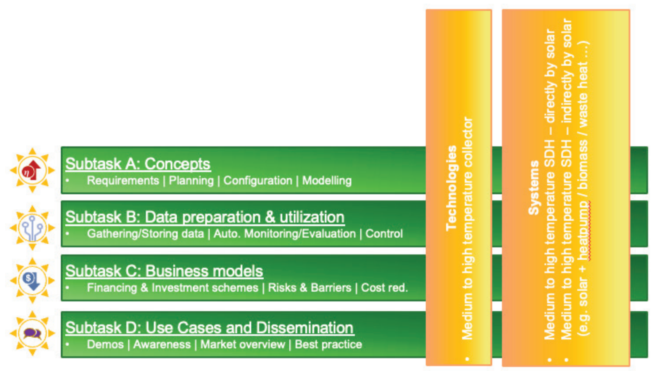
This article highlights two solarthermalworld.org news articles, "IEA Net Zero by 2050 Roadmap: 400 milestones but very few for solar thermal" and "Future role of solar heat in IEA's Net Zero Roadmap".

Coming in 2022

Three New SHC Projects

Under Way

Efficient Solar District Heating



Solar district heating has a long history with IEA SHC and one that will continue into 2024. It all began in 1979 with Task 7 on Central Solar Heating Plants with Seasonal Storage, followed in 2011 by Task 45 on Large Solar Heating/Cooling Systems, Seasonal Storage, Heat Pumps, which pushed for the market development of strong and sustainable systems. Next came Task 55 on the Integration of Large SHC Systems into DHC Networks that supported the transition of solar heating and cooling systems into district heating networks. And now, the new Task 68 on Efficient Solar District Heating Systems will continue this work. In this Task, participants will investigate three types of efficiency 1) efficient heat generation in dedicated solar systems and those that combine solar with other technologies, 2) efficient data preparation and use in digitalization measures, and 3) efficient cost reductions in SDH systems. A collection of Use Cases, future scenarios, and qualitative and quantitative targets for the solar sector and policymakers along with industry workshops will cap off the work.

If you are interested in joining other experts from industry and research institutions, send Viktor Unterberger, the Task Operating Agent, an email, viktor.unterberger@best-research.eu, and reach out to your IEA SHC Executive Committee member. Note: the webpage for this new Task will be online soon.

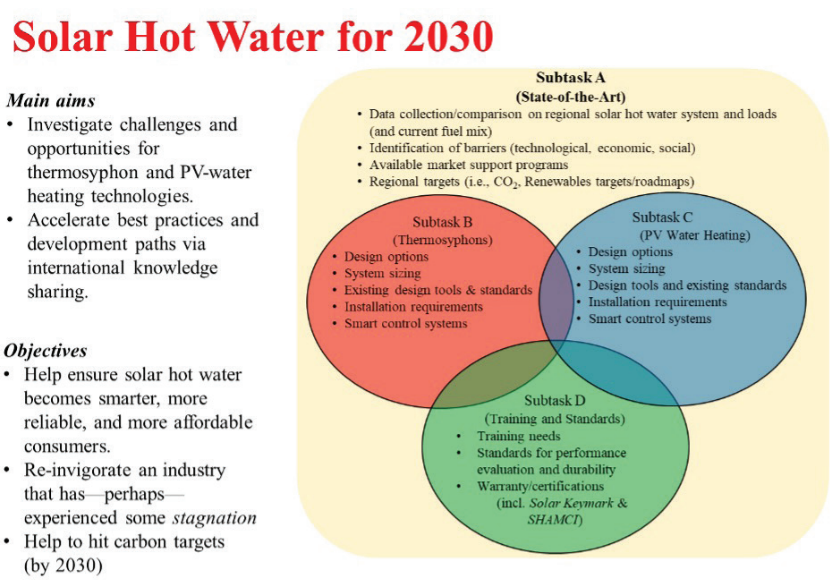
Under Construction

Smart Solar Water Heating for 2030

A joint Australia and China led IEA SHC Task is now 'under construction' to investigate leading solar hot water technologies (namely, thermosyphons and photovoltaics) to help meet global renewable energy and carbon emissions targets by 2030. The architectural drawings for this newly proposed Task call for a broad mix of international knowledge and expertise to ensure these solar hot water systems become smarter, more reliable, and better fit-for-purpose in key regions around the world.

As an update on the construction progress, we poured the foundation during a Task Definition Workshop in September 2021, with 55 experts attending Day 1 and 43 experts attending Day 2.

The workshop helped to define the scope of work



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and set up our building crews for the major subtasks of the project, which will have leaders from Austria, China, Australia, the UK, and Denmark:

- Subtask A – State-of-the-art and operating environments in different regions
- Subtask B – Smart thermosyphon systems
- Subtask C – PV self-consumption and PV2Heat systems, including smart controls
- Subtask D – Training and standards

If you missed the workshop, it is not too late to join the project! Anyone with a set of 'solar tools' and an interest in hot water systems is welcome to participate in the Task, with work expected to continue through 2025. To get involved, please contact the Task Organizers, Robert Taylor of the University of New South Wales – Sydney (Robert.Taylor@unsw.edu.au) and He Tao of the China Academy of Building Research and Chinese SHC Executive Committee member (iac@vip.sina.com).

Low Carbon, High Comfort Integrated Lighting

A spotlight on our lighting work will continue now that a new proposal for a follow-on Task to the recently completed Task 61 on Integrated Solutions for Daylighting and Electric Lighting got the blessing from the IEA SHC Executive Committee. The Task Definition Phase will begin in the new year, building on the work of five earlier SHC Tasks. The proposed Task will work to identify and support lighting (electric and façade: daylighting and passive solar) in the context of decarbonization and energy efficiency and aligned with the new integrative understanding of humans' light needs. So what does this exactly mean? The project's overarching work areas, which will be discussed during the Task Definition Phase, are the carbon footprint of the lighting value chain, "renegotiating" the role of daylighting as it relates to buildings facades and in the urban context, and digitalization.

Interested in getting in on the ground floor to help define this project? Then now is the time to contact the Task Organizer, Jan de Boer, jdb@ibp.fhg.de. The first workshop is planned for February/March 2022. The success of the Task will depend on the work of a group of experts with very diverse skill sets – architects, lighting designers, LCA software developers, energy consultants, lighting and lighting control specialists, facility managers, psychologists/experts for non-visual effects, and lighting industry and manufacturing professionals.

OPINION

The Real Climate Strikers

Trade unions, which facilitate collaboration between employees to achieve strategic common employment-related goals, have a complex relationship with the solar sector that can be difficult to untangle. In this article, Dr. Richard Hall, a Vice Chair of the IEA Solar Heating and Cooling Programme (IEA SHC), delves into this relationship to assess whether the IEA SHC Programme should be engaging more with trade unions, and if so, on what issues.

Solar trade associations are considered key stakeholders in the IEA SHC Programme, facilitating collaboration between solar companies to achieve strategic common business-related goals. On the other hand, trade unions (also known as labor unions), which are key stakeholders in the wider energy sector and clearly engaged in climate change politics, are not considered key stakeholders. Trade unions can be important market actors, either accelerating or decelerating solar deployment. I've been wondering, therefore, why the relationship between the IEA SHC Programme and the trade associations is such a given, and yet the IEA SHC's relationship with trade unions is more challenging and difficult to define.

"Trade unions can be important market actors, either accelerating or decelerating solar deployment."

Where Is the Solar Trade Union?

Part of the answer probably lies in the fact that there are no 'solar trade unions' to talk directly with, or at least, not at the scale of their trade association counterparts. That is not to say there is no union activity in the solar sector. The United Solar Plant Workers Union in South Africa is, for example, currently fighting the unfair dismissal of workers from a CSP plant. And the BlueGreen Alliance in the US, which brings together labor unions and environmental organizations, is working to maintain high-quality jobs in the clean energy transition.

But there appears to be a lack of clear unionization, with solar jobs spread beyond a single location or profession. A civil servant working in the solar sector may belong to a civil service union, an installer may belong to a builder's union, and someone working in mineral extraction may belong to a mineworker's union. If solar jobs were more concentrated in one place, then this would likely promote stronger union activity. In China, there is a large concentration of solar workers within a socialist market economy, but in this case, it could be argued that the function of the trade union is largely built into the State itself.

Given the lack of a single point of contact, I believe the best way for the IEA SHC to start engaging more with trade unions is to find potential intersection points between trade union activity and the solar sector. I'd like to look now at where these intersection points can be found.

The Middle Class and Affordable Solar

The first intersection point I want to explore is between workers' wages and their ability to afford solar energy. When talking about the American Jobs Plan, US President Biden recently said that "unions built the middle class," and as part of the Build Back Better plan, one of the key elements of their climate change program is to deliver rebates to support families shifting to clean energy. Whilst it is not the responsibility of the IEA SHC to support the development of a moderately prosperous society, we do work on developing and evaluating policies that are designed to make solar energy more affordable (rebates, grants, and tariffs). The IEA SHC does therefore have an interest in understanding the relationship between workers' wages and solar energy rebates.

When we talk about affordable clean energy (the United Nations Sustainable Development Goal 7), a lot of the focus is on innovation to make the technology cheaper for the consumer, which is clearly very important. However, affordability will also depend upon worker wages and the amount of disposable

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income available to them. Data from UK deployment shows that consumers of microgeneration technologies (heat pumps and solar panels) are generally professionals and homeowners; in other words, the middle class. So when considering rebate-style solar deployment policies, innovation to reduce the capital cost is one element, but another consideration is the disposable income of the population. When it comes to making solar affordable by raising the income of the workers, trade unions are likely to be keen to engage; to the mutual benefit of all stakeholders.

The Real Climate Strikers

The second intersection point I want to explore is worker rights in the solar energy sector. Today the concept of a 'Climate Strike,' defined as "a form of public protest intended to draw attention to climate change and the need for urgent action" (OED), is more commonly associated with the School Strike for Climate movement. But there have been in the past climate strikes in the trade union sense, involving a collective work stoppage, a go-slow, picketing, or workplace occupation, with the purpose of resolving climate-related labor disputes.

One example of a climate strike in the wind energy sector occurred in 2009, when the workers at the Vestas wind turbine manufacturer occupied the factory on the Isle of Wight to prevent the factory from closing (there were around 500 workers on the site). In this climate strike, workers were clearly aiming to protect their jobs. But many of the workers had been attracted to the job "because of the desire to produce green technologies for green energy" (Hampton 2016, p.158), and it could therefore be argued that they were choosing to work in and support the renewable energy sector.

Another famous example of a climate strike comes from the 'Green Bans', a movement that took place in Australia in the 1970s. The Green Bans, led by Jack Mundey of the Builders Labourers Federation (BLF), were work bans on building developments that the union deemed to be neither socially useful nor of an ecologically benign nature. For a few years, the Green Bans prevented the development of billions of Australian dollars' worth of unsustainable construction projects and ultimately led to pro-environmental planning reforms (green buildings). One of the guiding principles of the Green Bans was that "workers have a right to insist that their labor not to be used in harmful ways" (Burgmann and Burgmann, 2017). Given the popularity of the school climate strikes, will future workers only apply for jobs within companies they consider to be clean?

Offshoring Jobs for A Better Environment

This leads me to the final intersection point I want to explore, which is around the geographical location of solar energy jobs. This is an area where we do see some conflict between trade unions and the solar sector. One of the classic criticisms of trade unions from environmentalists is that unions act to prevent the transition to clean energy by actively protecting jobs in the fossil fuel sector. But given the current geographic distribution of jobs in the solar sector, it's understandable that major unions are wary of the potential 'spatial misalignment' of jobs that could result when a State transitions from fossil fuels to solar (Nilsen, 2021; IRENA & ILO, 2021).

There are solutions to this classic 'jobs vs. environment dilemma,' and in many OECD countries, we are seeing strong strategic alliances between trade unions and environmentalists develop (Soder, Niedermoser, & Theine, 2018). For the purposes of the IEA SHC Programme, the solutions originating from these new alliances will result in the redirection of innovation spending, and thus, we must be conscious of how this redirection of funding may impact the Programme.

It's Helpful Not to Be Hated

Whilst the relationship between trade unions and the solar sector is difficult to unpack, and irrespective of whether the IEA SHC Programme does or does not consider trade unions key stakeholders, there are some interesting points at which we intersect. Whether that be on the issue of clean energy affordability and workers' wages, the use of climate strikes to accelerate progress on climate change, or pragmatic solutions to the jobs vs. environment dilemma. These intersection points can offer real benefits to both parties and those they represent.

Ultimately, if solar energy is going to lead the transition away from fossil fuel generation, then, as Machiavelli wrote, it's helpful not to be hated and despised by the people. If the solar sector's solution to the problem of climate change results in fewer union jobs with lower wages (compared with the oil and gas sector), then trade unions are unlikely to be supportive of our plans. But if our solution includes a comprehensive plan for secure, well-paid jobs, then there are many areas where trade unions can support workers to make the smooth transition into the solar energy sector.

Further Reading

Nilsen, E. (2021) Why major unions are wary of the move to wind and solar jobs. Vox Media, LLC.

IRENA & ILO (2021) Renewable Energy and Jobs: Annual Review 2021.

Soder, M., Niedermoser, K. and Theine, H. (2018) 'Beyond growth: new alliances for socio-ecological transformation in Austria', Globalizations, 15(4), pp. 520–535. doi:10.1080/14747731.2018.1454680.

Burgmann, M. and Burgmann, V. (2017) Green bans red union: the saving of a city.

Hampton, P.S. (2016) Workers and trade unions for climate solidarity: tackling climate change in a neoliberal world. Routledge.

Task 61

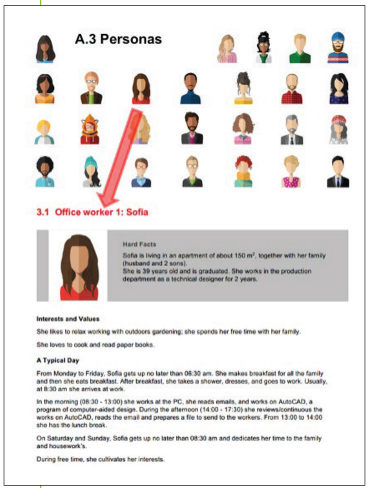
The Best From Both Worlds: Integrated Solutions For Daylight and Electric Lighting

The IEA SHC Programme has worked on different lighting aspects over the years. The first SHC Tasks looked solely into the benefits of efficient daylight usage then shifted to a broader focus beginning with SHC Task 50: Advanced Lighting Solutions for Retrofitting Buildings, which addressed lighting retrofits. The most recent lighting project, IEA SHC Task 61: Integrated Solutions for Daylighting and Electric Lighting, a collaborative project with IEA EBC, looked specifically at the interfaces of electric lighting and daylighting. Up until now, both were often treated as different trades in practice and research – although people work and live in one encompassing lighting environment. This said, the success of highly energy-efficient lighting designs hinges on more than technological ingenuity. Other key make-or-break factors are smart control strategies and the interaction of lighting users with the built environment. These "other" factors were analyzed over the last three and half years by 55 experts from 37 research institutes, universities, and businesses in 17 countries. This article summarizes the key accomplishments and conclusions of SHC Task 61/EBC Annex 77: Integrated Solutions for Daylighting and Electric Lighting.

Improving the Understanding of Human Lighting Requirements as Targets for Integrated Lighting Design

A key component of this Task was to examine how people impact lighting use, which in the end, resulted in a new way of describing user impact on lighting use. Task experts began with the question, **What light (radiation) do users actually need?** To begin to answer this question, Task participants conducted a comprehensive literature overview of more than 100 articles from which 28 criteria in four main categories on the perception of light, visual comfort, psychological aspects of lighting, and non-image forming aspects were analyzed. Based on this work, electric lighting and daylighting can now be more easily compared and optimized.

Next, the Task participants identified typical user groups for a number of building types and analyzed their lighting-related behavior. The researchers' aim was to paint a picture of different user personas as opposed to illustrating behavior only by numbers and statistics. Each Persona was embedded in a narrative describing the behavior of a group of individuals within a distinct setting. An example is a typical office worker, who was even given a name and an identity, whose workday is described in terms of what she is doing, the light sources (e.g., computer screens), and the software programs she uses. The report, Personas, detailing a total of 26 Persona to design lighting systems based on a more holistic view of a user's impact, that is, their lighting needs and behavior, will soon be posted online.


A.3 Personas

3.1 Office worker 1: Sofia

Hard Facts

Sofia is living in an apartment of about 150 m², together with her family (husband and 2 sons).
She is 39 years old and is graduated. She works in the production department as a technical designer for 2 years.

Interests and Values

She likes to relax working with outdoors gardening; she spends her free time with her family.

She loves to cook and read paper books.

A Typical Day

From Monday to Friday, Sofia gets up no later than 06:30 am. She makes breakfast for all the family and then she eats breakfast. After breakfast, she takes a shower, dresses, and goes to work. Usually, at 8:30 am she arrives at work.

In the morning (08:30 - 13:00) she works at the PC, she reads emails, and works on AutoCAD, a program of computer-aided design. During the afternoon (14:00 - 17:30) she reviews/continuous the works on AutoCAD, reads the email and prepares a file to send to the workers. From 13:00 to 14:00 she has the lunch break.

On Saturday and Sunday, Sofia gets up no later than 08:30 am and dedicates her time to the family and housework's.

During free time, she cultivates her interests.

▲ **The typical office worker is one of 26 Personas.** (Source: IEA SHC/EBC Task 61 Report, Personas)

Controls are the Key Technology to Implement Integrated Lighting Solutions

Another major aim of SHC Task 61 was to identify promising lighting control solutions for integrating lighting – solutions that could minimize the electricity demand and better meet the needs of users and facility managers. The question asked to start this work was, **What drives practitioners?** The first step in this process was to undertake an extensive survey among more than 100 professionals, most of them facility managers, to try to understand what influences their decision to implement and use lighting control systems.

From the large number of solutions available on the market, Task experts chose 16 specific lighting control protocols – some wired and some wireless – and analyzed their potential and barriers before giving recommendations on how to smartly adjust them for high comfort and good

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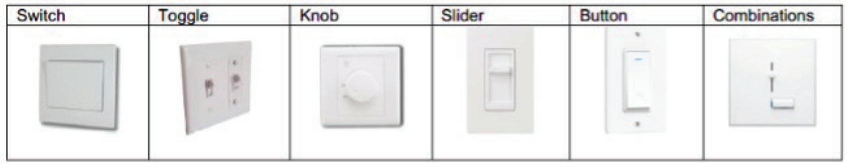
energy performance. This in-depth analysis of user interfaces shows the need for well-designed, simple-to-understand front-end interfaces.

Looking at R&D pipelines shows that challenges for new systems lie in the multi-criterial optimization of lighting needs and other building needs, such as solar gain protection. Bringing the electric lighting and daylighting control systems directly to the workplace (to the computer screen) gives the user direct control. In this Task, three new approaches from leading European brands were examined and discussed in the soon to be published report, Review of New Systems and Trends.

Throughout the Task, the participants also looked at standardizing market implementation, which is vital for the widespread and proper use of integrated controls. For example, a review showed that the two areas – control of daylight and control of electric lighting – are still treated separately but desperately need a comprehensive standard for integrated controls. You can read the details in the soon to be published report, Standardization Issues Related to Lighting and Daylighting Control Systems.



▲ **Variety of user interfaces investigated: from analog to fully digital embedded devices.** (Source: IEA SHC/EBC Task 61 Report, User Interfaces)

New Design Processes Help Bring Integrated Lighting Solutions onto Designers' Desktops

Planning and design processes have a long-lasting impact on a building's energy usage and performance. Therefore, they are of utmost importance, so for this work, the question to answer was, How to plan integrated lighting? To begin, Task participants collected and discussed typical workflows, which provided detailed insights into planning integrated lighting. Then, the workflow and application of 12 software tools were compared in three state-of-the-art buildings in Austria, Germany, and China.

Another relatively future-proof aspect of Task 61 is in the field of photometric modeling to simulate facades and the sky. The façade modeling work included:

- A summary of the current state-of-the-art in the field of characterization of daylighting and shading systems by bidirectional scattering distribution functions (BSDFs). You can read more in the soon to be published report, Analysis and Evaluation of BSDF Characterization of Daylighting Systems.
- A White Paper, BSDF Generation Procedures for Daylighting Systems, to trigger standardization.

▼ **Conventional lighting controls detect and regulate horizontal illuminance levels (upper left picture), but the user comfort is predominantly in the vertical field of vision (upper right picture). Workplace orientated sensor controlling both daylighting and electric lighting (lower picture).** (Source: IEA SHC/EBC Task 61 Report, Standardization Issues Related to Lighting and Daylighting Control Systems ©Fraunhofer IBP)

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Daylight and Electric Lighting *from page 9*

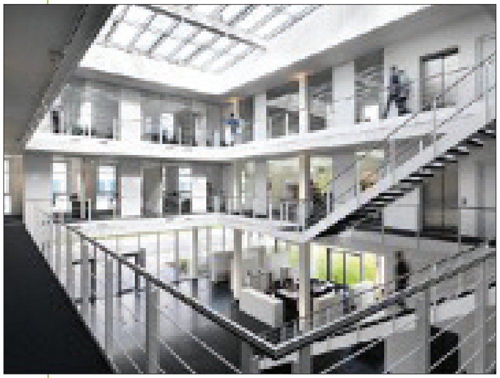
- An extensive round-robin test in six labs showed high data assessment and post-processing quality, which means that complex fenestration systems can be practically planned with high confidence.

Applying new data models to simulate the sky is a big step forward. So far, daylight simulation tools have featured only monochromatic models. In this Task, spectral sky measurements and existing models were reviewed and merged into a simplified model for practical applications. This research can be applied to extend classical monochromatic sky models to support color-dependent design processes and improve the understanding and modeling of daylight's non-visual effects in the built environment. The Task report, Spectral Sky Models for Advanced Daylight Solutions, summarizes the existing color models and discusses their use in three different simulation tools (LARK, ALFA, and RADIANCE).

Continuing the Task work on modeling, participants worked on an integrated energy rating level, developing a new hourly-based rating method for the energy demand

	Applies to Software + = yes, o = partly, -- = no												
	AGi32	ElumTools	DALEC	DIALux	DIAL+	DIVA-for-Rhino	FENER	GB SWARE Dali	Ladybug / Honeybee	PKPM	Radiance	RELUX	Remarks / explanations
DAYLIGHTING													
Point-in-time simulation	+	+	--	+	+	+	+	+	+	+	+	+	
Climate-based annual simulation	--	--	+	--	+	+	+	--	+	+	+	--	
Illuminance values	+	+	+	+	+	+	+	+	+	+	+	+	
Luminance values	+	+	+	+	+	+	--	+	+	+	+	+	
Daylight factor values	+	+	--	+	+	+	+	+	+	+	+	+	
Daylight autonomy (DA, cDA, sDA)	--	--	+	--	+	+	+	+	+	+	o[11]	o[12]	11: calculation from annual illuminance values (post processing) 12: calculation of daylight autonomy depending on daylight factor for the sensor
Glare calculations (DGP, DGI, …)	--	--	--	--	--	+	+	+	+	+	+	--	
CIE sky models	+	+	o[3]	+	+	+	--	+	+	+	+	+	3: diffuse part modeled as CIE uniform sky
Perez sky model	+	+	--	--	+	+	+	+	+	+	+	--	
Sensible to orientation	+	+	+	+	+	+	+	+	+	+	+	+	
Consideration of daylight systems as geometry	+	+	--	+	+	+	+	+	o[9]	o[10]	+	+	9,10: partly considered; model complexity and calculation accuracy depend on the settings of the engine (Radiance)
Import of daylighting systems as BSDF data	--	--	+[3]	+[4]	--	--	+	+	+	--	+	+[12]	3: XML import in Klems format in next release 4: import of DDLS and ODLS format; includes measured BSDF data 12: import available in Radiance format
Data base of daylight systems	--	--	+	+	--	--	+	+	--	+	--	+	
Consideration of outdoor obstructions	+	+	o[3]	o[4]	+	+	+	+	+	+	+	+	3: horizontal obstruction or overhang possible as exterior shading 4: reflection of outdoor surfaces not considered

Bartenbach R&D office in Aldrans, Austria



DIAL Corporation Building in Lüdenscheid, Germany

CABR NZEB in Beijing, China

▲ **Detailed analysis of design workflows in three buildings. Comparison of 12 software tools used in designing integrated lighting solutions with respect to daylight. Other criteria were Algorithms / Engines, Electric Lighting, and Control Systems.** (Source: IEA SHC/EBC Task 61 Report, *Workflows and Software for the Design of Integrated Lighting Solutions*)

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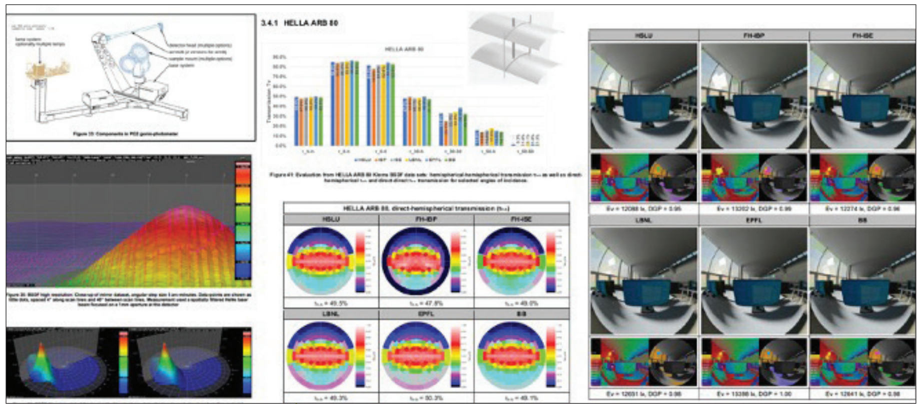
of integrated lighting solutions, which is closely aligned with building automation and control system (BACS) structures and definitions. This new approach allows for an integrated workflow in lighting design and commissioning installations while avoiding future double specifications. The method is being implemented in ISO Standard 10916: Calculation of the impact of daylight utilization on the net and final energy demand for lighting. In addition, core functionalities will be included in a simple web-based tool and the well-known freeware lighting software environment DIALux Evo in early 2022, which has 700,000+ users worldwide – bringing the new rating capability directly onto the desktops of designers.

Another Task work area focused on using VR systems in building design practice. Four case studies highlight the capabilities of VR-based presentations of integrated lighting scenarios. This approach holds enormous potential for the future as it allows for a more realistic, intrinsic understanding of lighting concepts. A VR decision guide will be available on the Task website in early 2022.

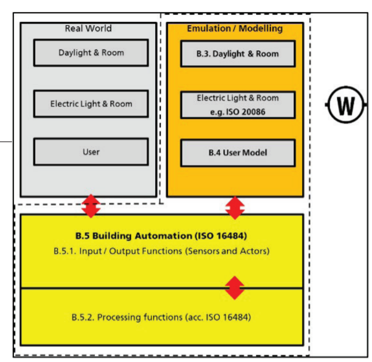
25 Field Study Assessments Show What Is Working and What Is Not

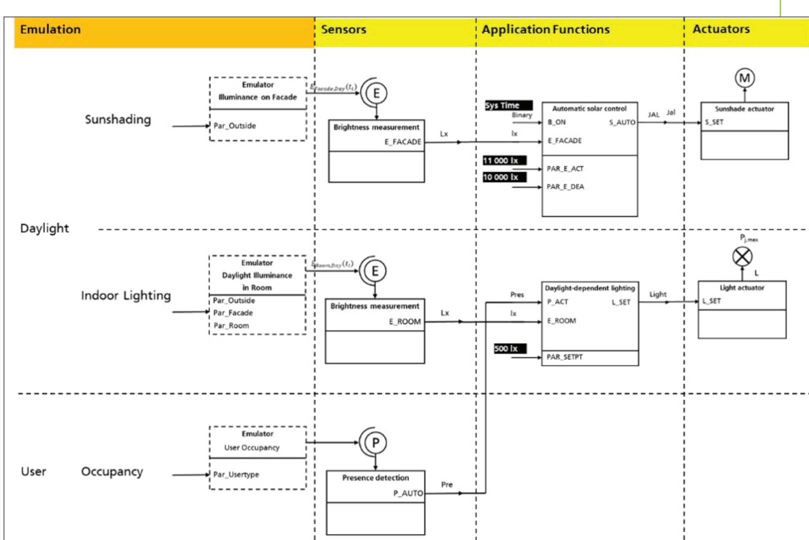
In the end, practice beats theory. Experiences from 25 case studies (office, retail, sport/recreation, health, residential) from 12 countries were collected and cross analyzed, verifying, and in parts, showing drawbacks in applied integrated approaches. To have the appropriate tools at hand, a new monitoring framework had to be developed to properly assess the performance of lighting solutions. This protocol covers the assessment of energy use (electrical lighting



▲ **Round robin test on the characterization of sun shading and daylighting systems performed for two typical samples with data and software from 6 labs.** (Source: IEA SHC/EBC Task 61 Report, Analysis and Evaluation of BSDF Characterization of Daylighting Systems)

▲ **Spectral sky scanner at daylight measuring site at the Technische Universität Berlin.** (Source: IEA SHC/EBC Task 61 Report, *Spectral Sky Models for Advanced Daylight Solutions*)





New hourly-based rating method for the energy demand of integrated lighting solutions, closely aligned with building automation and control system (BACS) structures and definitions. (Source: IEA SHC/EBC Task 61 Report, Hourly Rating Method for the Energy Demand of Integrated Lighting Solutions, to be published)

continued on page 12

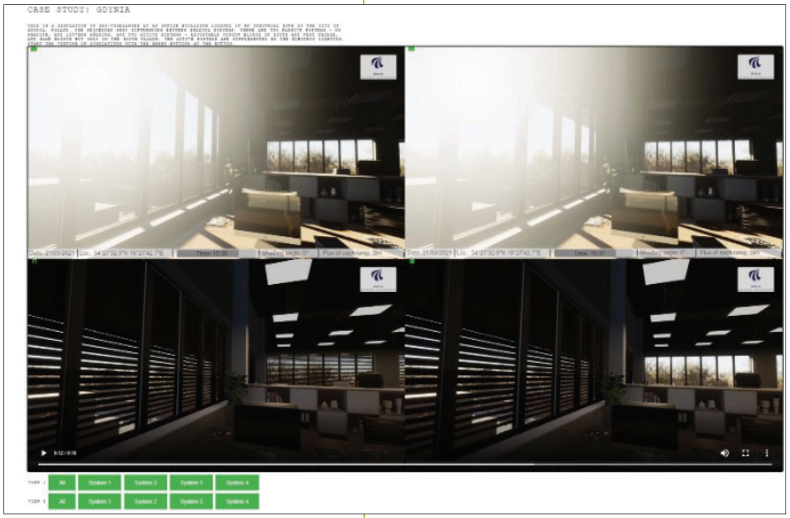
Daylight and Electric Lighting *from page 11*

systems), visual effects (Indoor lighting environment/photometry), non-visual effects (circadian potential), and the user (subjective/surveys and observations). Its application helped extract lessons learned from the case studies, which are documented in four-page Fact Sheets targeting a professional audience. What the case studies showed was that:

- The energy demand for lighting can drastically be reduced thanks to the combined effect of more efficient light sources, advances in controls, and raised awareness about the integration of daylighting and electric lighting. Annual lighting energy use as low as 3-4 kWh/m^{2}a is now possible but still far from the standard in ordinary projects. Recommissioning, monitoring, and validation are central to achieving the energy results.
- Integrative lighting (often also referred to as 'human-centric lighting.' aiming at eliciting human circadian response) is driving lighting technology innovation, and wider implementation is expected as knowledge expands in the field of non-visual requirements for lighting. Electric lighting will be able to support non-visual requirements when daylight is insufficient.
- In practice, integrative lighting is hardly integrated with daylighting. Up to today, there has been a lack of tools and knowledge for designers to implement daylight in integrative lighting schemes.
- Integrative lighting may result in significant energy rebounds because it is often designed without regard to daylight. As a result, electric lighting loads increase to reach appropriate lighting levels for users during the day despite daylight being sufficiently available means – more delivered lumens and lower luminous efficacies, thus jeopardizing energy performance.
- Daylighting integration is of utmost importance for achieving quality beyond energy saving as underscored by occupant satisfaction being, for example, strongly linked to having a view of the outdoors.
- Integrated design is facing new challenges, so questions about comfort and health need to be answered now. There needs to be a shift to designing for user needs rather than for the physical space.

You can learn more about this Task's work and find all the reports by visiting https://task61.iea-shc.org/.

▲ **Core functionalities of the new hourly-based rating method for the energy demand of integrated lighting solutions implemented into the software DIALux Evo. It encompasses an energy tachometer that ranks the current design to an optimal theoretical design, indicating designer potentials for improvement.**



▲ **Screenshot of the VR-Decision guide software shows a lighting scene's views in different technical configurations from various positions within the space. The software mimics glare and will be available on the Task website in early 2022.**

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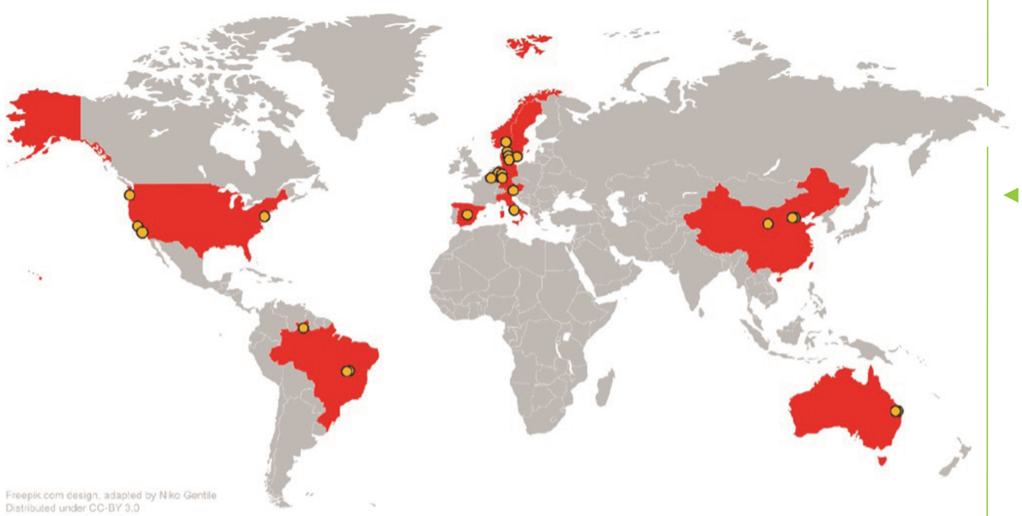
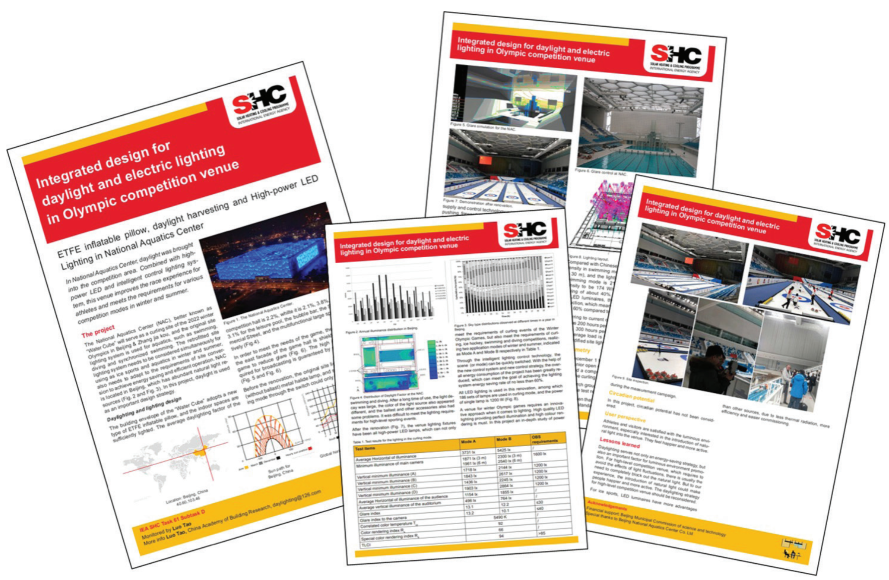
Daylight and Electric Lighting *from page 12*



Locations of the 25 case studies covering different latitudes and longitudes. (Source: IEA SHC/EBC Task 61 Report, *Integrating Daylighting and Lighting in Practice*)



Fact Sheets for each of the 25 studies representing different building types and technologies. (Source: IEA SHC/EBC Task 61 Report, *Integrating Daylighting and Lighting in Practice*)

This article was contributed by the SHC Task 61 Operating Agent, Jan de Boer of Fraunhofer Institute for Building Physics, Germany; Barbara Matusiak of Norwegian University of Science and Technology and leader of Subtask A; Marc Fontoynont of BUILD, Denmark and leader of Subtask B; David Geisler-Moroder of Bartenback GmbH, Austria and leader of Subtask C; and co-leaders of Subtask D Werner Osterhaus of Aarhus University, Denmark and Niko Gentile of Lund University, Sweden.

INTERVIEW

Task 61

Integrated Solutions for Daylighting and Electric Lighting

The SHC Programme finalized its work on Integrated Solutions for Daylighting and Electric Lighting (SHC Task 61/EBC Annex 77) in November. To learn first-hand about the Task's impact on lighting, we asked Jan de Boer, the Task Operating Agent, to share some of his thoughts on this 3.5-year project.

Why was a project like this needed?

Jan de Boer (Jan): The IEA SHC Programme took on this project for a couple of reasons. First, a focus purely on LEDs for optimizing lighting efficiency is not enough. Second, the potential in the fast-moving field of improving lighting controls and daylight integration was not being adequately addressed. And third, electric lighting and daylighting are typically dealt with by two separate communities and market sectors. The opportunity, and need, we saw was a project focused on integrating these two areas at the research and the industry levels. Lighting solutions and performance depend to quite a significant extent on regional aspects, like daylight availability, cultural appreciations of light, and technological standards. So, what better means to address these topics than by tapping into the broad international IEA SHC network of member countries and experts.

What is the current status of the technology?

Jan: The transition to a LED market is basically done – products are highly efficient, spectra are improved, and costs have dropped. As a result, mercury-based fluorescent lamps are starting to be banned through regulations. In terms of product development, there are now products for lighting controls and integrating non-lighting features into fixtures, for example, for indoor navigation, both of which are seeing prices drop. On the daylight and glazing side, glass parameters are very much dominated by the thermal side; nevertheless, today's 2- or 3-pane glazing units are optimized for high visual transmission and good color rendering. As for sun shading and glare protection, satisfactory solutions are available for some but far for all relevant applications.

Is there one result that surprised you?

Jan: Yes, it is how low we can now get the end energy with correctly installed installations. Down to 4 kWh/m²a end energy for lighting is possible for office situations, as demonstrated in our field studies. Nevertheless, all the bits and pieces of a lighting concept have to work together in an optimal way, which means it is still far from being the standard. But it does set a benchmark.

Do you have a Task success story from an end-user or industry to share?

Jan: An actively participating sun protection manufacturer has recognized the immense relevance and added value of integration with the artificial lighting industry. Building on this, stronger collaboration with the lighting industry is being sought, and joint developments on integrated systems implemented.

What is the future of the technology – new developments, markets, policies, etc.?

Jan: Lighting is not just one technology delivering one service like a radiator delivering heat. Lighting has to be designed specifically for the multi-criteria user needs, that is, for what people are doing and in which context. The importance of this is underlined by the fact that humans acquire 80-90% of their information via their eyes. That said, knowledge on the non-visual perception of light (radiation perceived) also is critical, and this area is still growing and will need to be better integrated into design processes, standards, and lighting controls. For example, controls managing workplace light directly in the field of vision is an upcoming area. With regard to façade technology, a big disruptive step might be on the brink in the field of switchable glazing systems. Micro-optics will offer new design options that are more resource-efficient for LED luminaires and façade applications.

What were the benefits of running this as an IEA SHC Task?

Jan: By going via the IEA SHC research platform, access was granted to a very well-established network of experts, each of course linked to their national research agendas but contributing to the bigger picture of the Task's work plan. Because of this, Task experts and countries benefitted from sharing knowledge – IEA SHC served as a big multiplier. The longevity of the Programme is a strong "plus," particularly for this Task as some experts go back to earlier Tasks (Tasks 21, 31, 50). That means more than 20 years of IEA SHC Task experience for some experts. This level of experience is quite unique in today's fast-changing world. And it is hard to go wrong by bringing research and practice together in a good way. The Programme offers a well-established infrastructure to support the Task's management, organization, and dissemination of results. The IEA SHC definitely is a brand that opens doors and attracts attention, for example, for workshops and other public events.

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Taking Solar Neighborhood Tools to the Classroom

Solar neighborhoods are a piece in the puzzle in achieving net-zero energy districts and low-carbon cities. This is why the IEA SHC Task 63: Solar Neighborhood Planning participants are working on solar planning and economic strategies, simulation methods and tools, and case studies. One unique aspect of this project's work is holding "Fall School" for Ph.D. and Advanced Masters students.

Fall School 2021

Tackling the complexity of urban level energy simulations: Introduction to solar neighborhood simulation methods and tools

A virtual classroom brought 14 Ph.D. and Advanced Masters students from six universities in Canada, France, Italy, Norway, and Sweden together to heighten their knowledge of simulating and analyzing neighborhoods with the end goal of facilitating the design and implementation of solar strategies in urban areas. The students, taught by nine instructors from six institutions, worked together between September 30 to October 21.

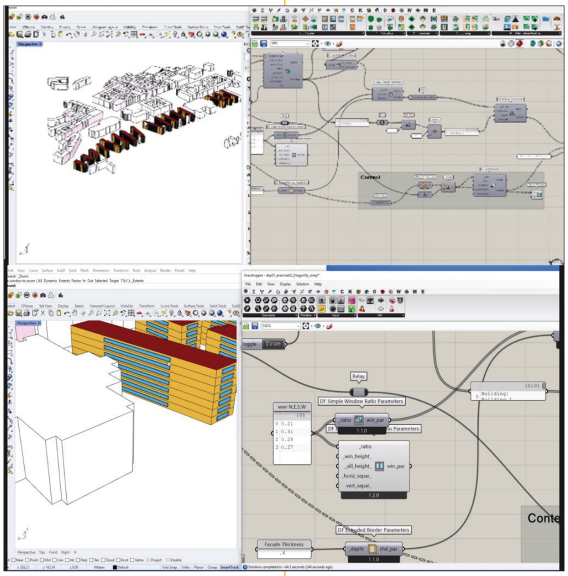

Figure 1. Examples of training materials from Day 1.

Optimizing energy efficiency and solar access and understanding the impact of various technologies is key if cities are to be sustainable and resilient. The process of simulating urban areas, however, is challenging and involves several degrees of complexity. For instance, urban level simulations need to include the building level (building envelope construction, building systems such as HVAC, equipment, etc.), an accurate representation of different building types and their designs, and the outdoor areas (open spaces, materials implemented, street layouts, etc.). Due to this complexity, different simulation tools are used simultaneously to achieve the desired analysis. Therefore, expertise in understanding and manipulating these tools (or chain of tools) is required for exploring various solar opportunities and technology implementation as well as passive design aspects while planning solar neighborhoods.

For this reason, the IEA SHC Task 63 team chose the topic of simulation tools for this year's Fall School. The course organizers focused on tools to estimate various key performance indicators such as the solar potential of buildings and sites, output of solar technologies such as integrated PV systems, daylight factors, and energy balances. The tools used by the students included GIS (Geographic Information Systems) and the visual programming environment Grasshopper.

The Coursework

The 2021 Fall School guided students through theoretical and practical topics. Below is a snapshot of the classroom days.

On Day 1, the instructors introduced the students to the fundamentals of modeling and an overview of the capabilities and limitations of existing tools and their potential application in the simulations. Next, basic geometry input/generation workflows were presented employing Rhinoceros - Grasshopper 3D environment. The instructors also demonstrated methods for obtaining basic geographic information using Grasshopper plugins (through OpenStreetMaps) and interoperability with urban scale modeling plugins. And lastly, the students were given a "survival kit" of resources for data input, learning, and problem-solving. Figure 1 shows examples of the training materials.

Day 2 focused on GIS modeling using different GIS tools (such as ArcGIS and QGIS-plugin UMEP (open source)). The students learned about the workflow to process solar radiation in an urban area and the

continued on page 16

visualization of the simulations, which is an essential step in the process of GIS modeling (Figure 2). At the end of the day, the students were asked to select one tool to practice estimating solar irradiation in different urban areas.

On Days 3 and 4, the students were given in-depth training on Grasshopper tools (ClimateStudio and Ladybug tools). These tools are used to perform climate analysis, solar analysis, and automated parametric design iterations. Over these two days, students had the opportunity to practice using the tools and applying local climate and solar potential to extract various performance criteria. Figure 3 presents some snapshots of the variety of tools presented during the training.

In addition to the hands-on training, the students were introduced to data processing methods that would allow them to handle a large amount of data. Various tools were introduced, such as MATLAB. To put what the students learned into practice, they were asked to practice simple coding to extract and plot specific data (such as cooling and heating loads).

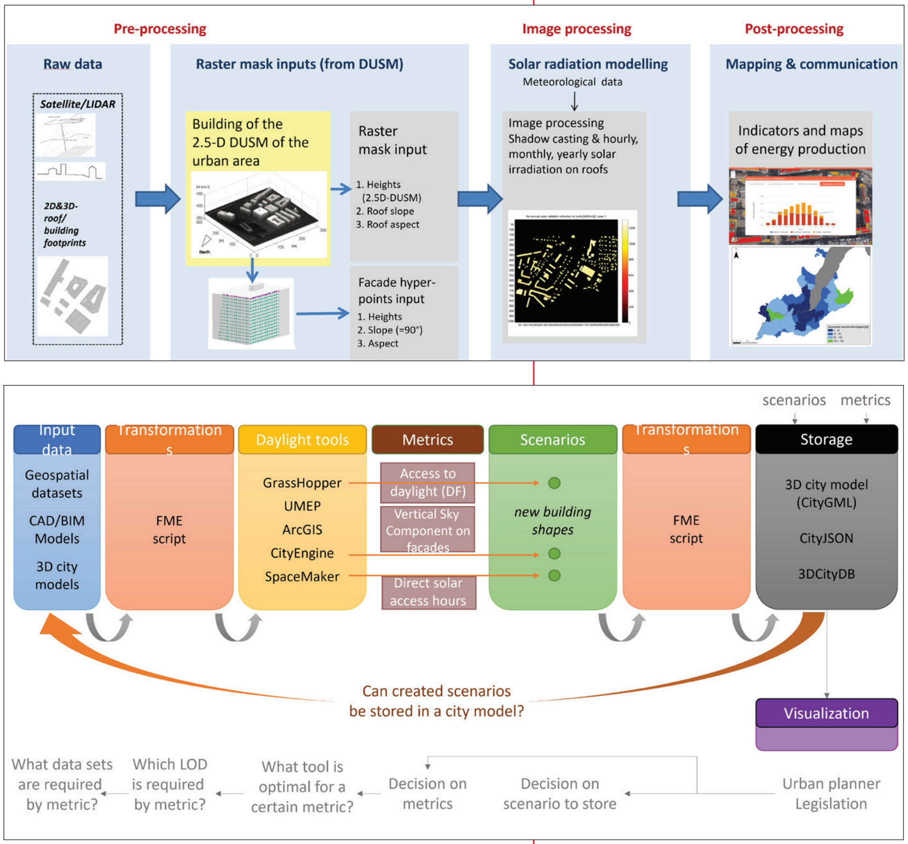

Figure 2. Methodologies employed in the application of GIS tools.

Day 5 was presentation day; the students demonstrated their new skill sets with creativity and curiosity in applying the methods and tools learned. For example, some students analyzed solar access of different neighborhood designs and their impact on design aspects, such as densification, including height of buildings and distance between them on solar radiation incident on roofs and facades (Figure 4a). While another group explored different methods for importing geographic data of existing neighborhoods into energy analysis and simulations tools. And other students focused on how to use GIS tools to study solar irradiation of the whole neighborhood (Figure 4b) and analyze the implication of specific building designs on solar access and shading on adjacent areas (Figure 4c).

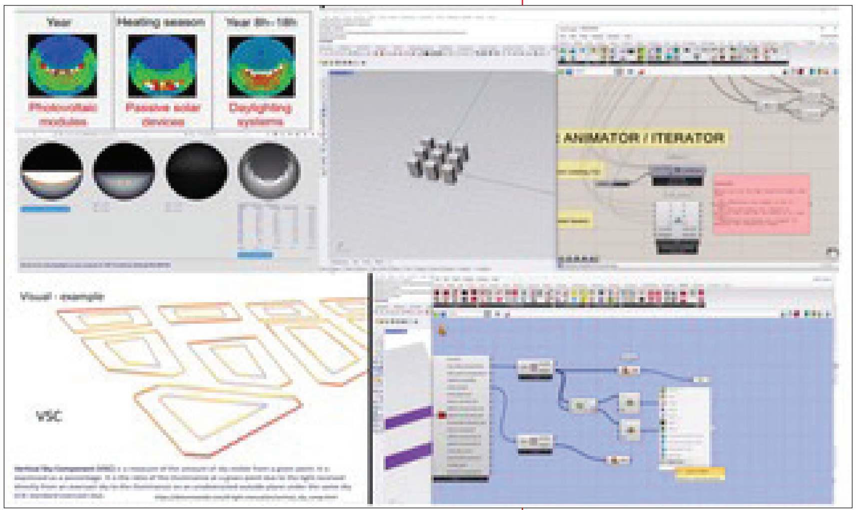

Figure 3. Examples of teaching and training material delivered on Day 3.

Looking Forward to 2022

Caroline Hachem-Vermette, the course coordinator, notes, "The 2021 Fall School was a productive event that gave students the opportunity to understand and practice the principles underlying successful simulations and analysis of solar neighborhoods. When designing and planning neighborhoods, a number of simulation tools might be needed to deal with the complexities, so a methodology to work

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Solar Tools to the Classroom *from page 16*

with these tools is extremely important." Fall School 2021 made this its central theme, highlighting the workflow used in different simulations and the need for flexibility. These simulation and analysis methodologies for urban areas are typically not covered in regular university or college courses. And in building simulation courses, the same tool is used by everyone to achieve a well-determined outcome.

All the participants, students and teachers, benefited from this unique international collaboration. Relationships have been built that will undoubtedly lead to future professional and academic cooperation.

As for IEA SHC Task 63: Solar Neighborhood Planning, the hope is that this program and its methodology will be used to create teaching materials or a condensed course for architects and planners.

This article was contributed by C. Hachem-Vermette, IEA SHC 63 Subtask A Leader, Ph.D., Associate Prof, University of Calgary (Canada).

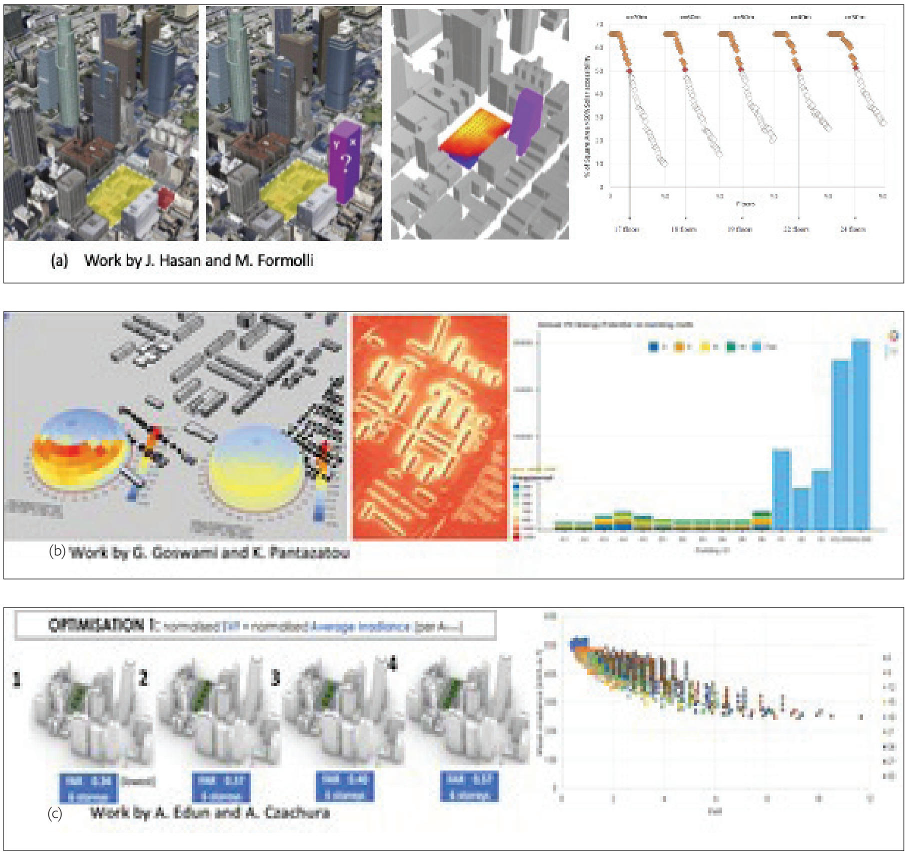
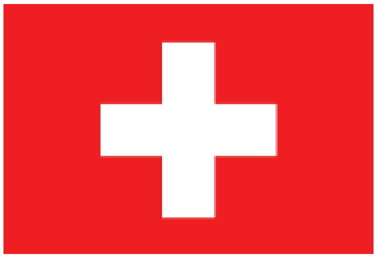


Figure 4. Examples of student work.

COUNTRY HIGHLIGHT

The Role of Solar in Switzerland's Energy Transition



Swiss Energy Policy

Switzerland ratified the Paris Agreement on 6 October 2017, setting a commitment to reduce emissions 50% by 2030 from 1990 levels, with partial emissions reductions from abroad. As an indicative target for 2050, the Swiss government decided in August 2019 that Switzerland should aim for net zero greenhouse gas emissions by 2050. The net zero target is also the subject of a popular 2019 initiative, the "Glacier Initiative." In response, the government has made a direct counter-proposal, and both the initiative and the counter-proposal are currently under discussion in Parliament.

The national legal basis for implementing climate goals in Switzerland is the CO_2 Act. In June 2021, the Swiss electorate rejected a revised version of the CO_2 Act. After analyzing the reasons for rejection of the new law, the government concluded that it was not a general 'no' to climate policy, but that it was mainly concerns about rising costs, in particular the possible increase in the price of transport fuels, that led to the rejection. The Swiss government, therefore, wants to send a draft of a new CO_2 Act into public consultation before the end of 2021 and submit it to Parliament next year. This draft should stick to the reduction target of 50% by 2030.

Future climate policy will be based on a mix of instruments. For example, Switzerland already has a CO_2 levy on thermal fossil fuels, such as heating oil and natural gas. This levy should be supplemented with effective incentives and targeted financial support measures to enable the population to reduce CO_2 emissions in everyday life and support the ongoing efforts of the various industries.

It is expected that the actual energy and climate policy will significantly increase the electricity demand for electromobility and heating (heat pumps). And, this will challenge the 2017 energy law that stipulates a gradual phase-out of nuclear energy, which today covers about 35% of the country's electricity demand. The targets, therefore, can only be achieved by reducing electricity demand in other areas and expanding the use of hydropower and renewable energy sources such as PV, wind, and geothermal energy use.

Total Energy Use

The Swiss Overall Energy Statistics is an annually updated document reporting on the final energy consumption of all energy carriers used in Switzerland. In 2020, Switzerland's final energy consumption fell by 10.6% compared to 2019. The main reasons for this are the COVID-19 pandemic and the warmer weather conditions compared to the previous year.

During the two COVID-19 lockdowns, distance traveled and vehicle movements in passenger transport decreased, as well as industrial production and gross domestic product (real GDP -2.9%). Warmer weather conditions compared to the previous year also brought down energy consumption: the number of heating degree days, an important indicator of energy consumption for heating, decreased by 4.4%. In contrast, other factors that determine the long-term growth trend in energy consumption increased slightly in 2020: the permanent resident population (+0.7%), the

LOOKING TO 2050, SOLAR THERMAL HAS A PLACE IN THE ENERGY MIX THAT INCLUDES APPLICATIONS NOT ONLY FOR DOMESTIC HOT WATER PREPARATION BUT ALSO FOR GEOTHERMAL, ICE STORAGE REGENERATION, AND SOLAR DISTRICT HEATING.

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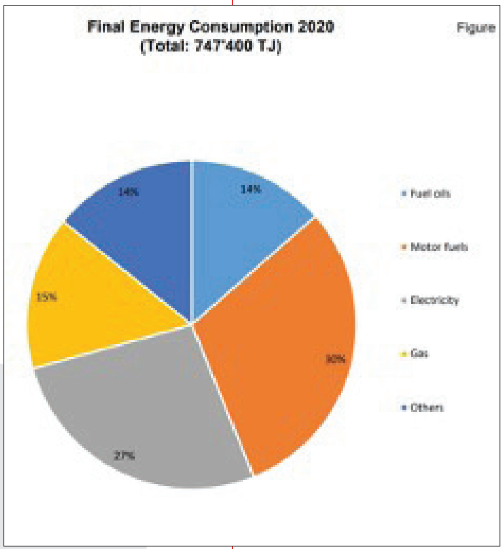
number of motor vehicles (+1.3%), and the housing stock (increase; detailed figures are not yet available). Efficiency gains and substitution effects, meanwhile, tended to stem the growth in energy consumption.

The warm weather conditions did not affect all renewable energy sources for heating purposes equally. The consumption of energy wood decreased by 3.5%, as did district heating consumption (-2.2%). However, the use of solar heat and ambient heat with heat pumps increased (solar: +0.8%; ambient heat: +3.6%). These energy sources represent 11.0% of total final energy consumption (energy wood: 5.3%, ambient temperature: 2.5%, district heating: 2.8%, solar thermal: 0.4%).

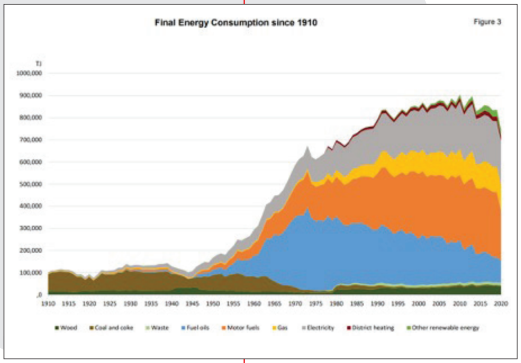
You can find more detailed market figures here.



Solar Heating Today

In the context of the Swiss energy scenarios, solar thermal energy use is seen as a means to reduce the energy demand of buildings. The challenge is that solar thermal systems are still seen to be relatively expensive in terms of system costs. Evacuated collectors continue to hold a small market share, while unglazed collector installations have increased, primarily due to a few big projects, mainly in combination with charging an ice storage. Heat pumps are beginning to overtake solar thermal's market shares.

Unfortunately, the Swiss solar thermal market has seen a decline in installations over the last 10 years after a peak of 160,000 m^2 installations in 2009. In 2020 about 29,000 m^2 were sold in Switzerland. In contrast, the PV market is at its highest level ever with a market grow of 48% in 2020 compared to 2019. It is obvious that homeowners are tending to invest more and more in PV and less in solar thermal applications.



In terms of systems installed, single-family homes dominate the market, with a slight trend to small collector areas – 70% on single-family houses and 27% on multi-family houses, totaling 97% of the market share. The majority (56%) of these systems are combi systems, 35% are domestic hot water systems, and only a small percentage are systems for other applications, such as process heat.

But looking to 2050, solar thermal has a place in the energy mix that includes applications not only for domestic hot water preparation but also for geothermal, ice storage regeneration, and solar district heating, as spotlighted in the research work below.

An 800 m^2 plant with evacuated flat-plate collectors for the return flow boost of the Geneva district heating network. At operating temperatures of 80 - 85 °C, the system achieves an excellent solar yield of 625 kWh/m^{2}a. (Source: Magali Girardin / SIG)

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Swiss Research Highlights

▲ **Experimental ice storage heat exchanger using flat plat collectors in stainless steel.**

Solar thermal energy in the context of the Swiss overall energy supply in 2050

The brand-new study "SolTherm2050" analyzes the energy policy significance of solar thermal energy in Switzerland for the next 30 years. Based on the energy system model, "Swiss Energyscope" of ETH, domestic hot water preheating, geothermal probe/ice storage regeneration, and solar district heating achieve a techno-economic potential of 5 - 10 TWh/a or 2 - 4 % of the overall energy consumption. By conserving scarce resources such as wood, biogas, waste, and geothermal energy, solar thermal energy results in annual savings of 200 - 400 million CHF (2 - 4 %). Furthermore, the report shows which incentives are needed to develop these potentials. (Researchers: HSLU, SPF, ETH, EBP, Swissolar)

Solar thermal potentials for district heating networks

According to the "SolCAD" study, 40% of Switzerland's 1,100 district heating networks would be suitable for solar thermal integration. In order to assess the suitability, many international projects, especially Danish ones, were studied. In the case of wood-fired systems, solar thermal energy helps to avoid harmful emissions thanks to fewer burner starts. On the basis of two existing heating networks with up to 1,200 m2 collector area and 250 m3 storage volume, dimensioning rules for such networks were simulated, validated, and optimized. (Researchers: CREM, EPFL, HES-SO, Martigny)

With "BigStoreDH," the dimensioning and operation of different size storages and the replacement of fossil backups are investigated. Based on the district heating supply of Basel and Zurich, which aim to reach "net zero" by 2040, technologies, transformation strategies, and opportunities for sector coupling are investigated. (Involved: SPF, VFS, IWB, energie360, Verenum, WV Buttisholz).

Ice storage for heating and cooling

In the projects "Big-Ice" and "SlurryStore," concepts and technologies are developed to use the latent heat of the water/ice phase change. Ice storage in combination with PVT and heat pumps is an interesting alternative to geothermal probes. Buildings with cooling demands use the store for low-cost cold storage in the spring. SPF has developed simple rules of thumb for sizing. Processes for the production of slurry ice help to increase storage capacities and minimize the equipment and costs. In the "Ice-Grid" project, the planning and intelligent control of area and energy grids is being investigated, with a focus on sector coupling and relieving the load on the power grids in winter. (Involved: SPF, EW Rapperswil-Jona)

Function control and yield monitoring of solar thermal systems

The system data transmitted via LoRaWAN is compared in real-time to current weather data. The device developed in the "LoCoSol" ("Low-Cost Monitoring") project can be retrofitted at low cost. Self-learning algorithms analyze the behavior of the plant, warning in case of malfunctions to avoid a gradual drop in yield. Losses due to gravity circulation can also be detected with high reliability. Hardware and software are planned to be commercially available in about one year. (Researchers: FHNW, EZS)

Hybrid seasonal storage for 100% solar homes

Thanks to custom-tailored PCMs, inexpensive commercial rainwater storage tanks can be used as modular seasonal storage units for single-family and multi-family homes and retrofitted at low cost.

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Switzerland *from page 20*

In the "HyTES" project, encapsulated PCMs based on salt hydrates are adapted to the supply temperature of the building and managed via conventional heat exchangers. The charging via PV and heat pump allows high flexibility and self-sufficiency in summer and winter and relieves the power grid. (Involved: HSLU, COWA, energy4me)

Inexpensive components and systems

With "TriSolHP," the yields from irradiation and ambient heat are optimized over the year for unglazed PVT modules with the aid of cooling fins on the back. The functional matching of the heat pump to the PVT energy roof makes it possible to dispense with a backup storage system in moderate climates, or to efficiently regenerate geothermal probes or ice storage systems in colder regions and achieve high levels of self-sufficiency, also in winter. (Involved: HEIG-VD, UNIGE, Energie-Solaire/Soltop)

▲ **SPF's dual-axis trackers for solar collector testing in Rapperswil/Switzerland. The people in the picture are visitors at a 2020 open house day. (This will be the venue for the IEA SHC Executive Committee meeting in June 2022.)**

In the "PVT-COPRAS" project, glazed PVT modules are optimized for simultaneous high heat and electricity yields by combining several overheating protection mechanisms. On the one hand, the electricity production reduces the stagnation temperature; on the other hand, the electricity can be used for household and energy technology. A combination with the above-mentioned hybrid storage system, which is optimally charged only up to a certain temperature level, is conceivable. (Researchers: SPF)

The SPF Institute for Solar Technology

The dedicated solar institute, SPF Institute for Solar Technology, supports industrial partners to turn their ideas into innovative market products and to test their newly developed products. In (international) cooperative research projects, SPF contributes its highly recognized expertise and research infrastructure in the field of sustainable, renewable, and efficient energy systems.

SPF is the Swiss testing laboratory for solar energy and heating appliances and for durability, optical and thermal properties of building materials - accredited according to ISO 17025 to guarantee the highest level of professional expertise and confidentiality.

Currently, 50 employees engage in Research and Development and Component and System Testing of innovative energy technologies with a general focus on energy efficiency and renewable energy technologies and a particular focus on solar thermal and solar electrical energy (Solar Thermal, PV, Heat Pumps and Solar Energy, Energy Storage, Systems and Grids, Industrial Process Heat and Cold, and Efficient Buildings and Systems).

This article was contributed by Swiss Executive Committee members Andreas Eckmanns and Stephan A. Mathez, and Andreas Häberle (SPF).

INTERVIEW

Task 59

Renovating Historic Buildings Towards Zero Energy

In November, the IEA SHC Programme finalized its work on Renovating Historic Buildings Towards Zero Energy (SHC Task 59/EBC Annex 76). To learn first-hand about the Task's impact on historic buildings, we asked Alexandra Troi, the Task Operating Agent, to share some of her thoughts on this multi-year project.

Why is a project like this needed?

Alexandra Troi (Alexandra): Buildings matter in that they take up about a 40% share of the total energy consumption in Europe. So, we're talking about the single largest sector of energy use. If 25% of buildings were constructed before 1948 (in the UK, Spain, and France this percentage is even higher), we absolutely have to consider them when it comes to the energy retrofit of historic buildings. There are a lot of interesting solutions for strengthening the solar position in the future renewable energy mix. And, this is one area.

What is the current status of the technology?

Alexandra: There are many solutions to retrofit historical buildings, and projects are most successful if in a comprehensive manner include bringing down the demand with all kinds of solar – from solar thermal, photovoltaics, and passive solar to daylight. People just often don't know. That's why we started collecting best practice examples in our HiBERatlas (www.hiberatlas.com) to show how historic buildings can be renovated to achieve high levels of energy efficiency while respecting and protecting their heritage significance.

Is there one outcome that surprised you?

Alexandra: I was totally surprised about the variety of solar solutions that we came across. From building-integrated photovoltaics, such as solar shingles designed to look like and function as conventional roofing materials while also producing electricity to non-reflective solar modules for places where you need to visually hide them, we had them all. Overall, we found 37 different solar solutions for retrofitting historical buildings all over Europe.

Do you have a Task success story from an end-user or industry to share?

Alexandra: More than one since we worked on 69 case studies ranging from very old buildings (including a church) to younger ones, from city dwellings to farmhouses. But when Julia Ludwar, from the one Bavarian federal state office for the preservation of historical monuments, told me that she uses the HiBERatlas to advise building owners, I knew that all of our hard work was totally worth it.

How has the Task's work supported capacity and skill building?

Alexandra: We did not only collect best practices, but we also elaborated a HiBERtool. Following a simple question and answer series, the building owner or technician can immediately find out which retrofit solution is the best for his historic building. The HiBERatlas and HiBERtool are not only centered on solar but include windows, walls, ventilation, and heating too.

We also developed a course for the Chamber of Architects of South Tyrol based on the best practice content of the HiBERatlas, and I offered an elective subject for the University of Coburg – to mention one specific example. Many university students have contributed to the success of this project by documenting farmhouses in South Tyrol and buildings in Germany. They learned a lot by interviewing architects, technicians, and building owners. Unfortunately, a lot had to be done online because travel was quite restricted over the past two years. But actually, all the Task experts were active in using the Task's results for increasing skills in their area!

What is the future of the technology – new developments, markets, policies, etc.?

Alexandra: I am confident that the demand for the energy retrofit of historic buildings will increase, also thanks to initiatives such as the New European Bauhaus. I believe that the timing for publishing our project results couldn't be better. The results can be used as guidelines on how to apply the European Standard in retrofitting historic buildings. For now, the European Standard is a bit abstract and not often used in practice - hopefully, that'll change soon too.

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What were the benefits of running this as an IEA SHC Task?

Alexandra: For over three years, 64 experts – architects and engineers to historical preservationists – from 13 countries put their expertise together. That alone is impressive and guarantees well-balanced project outcomes.

Will we see more work in this area in the IEA SHC Programme?

Alexandra: Topics abound. If we get the funding for a follow-up project, many of us will be in.

You can learn more about this Task's work and find all the reports, online tools, videos, touring exhibition details, and blog by visiting the Task's webpage and you can watch a webinar highlighting the Task's major outcomes.

Historic Building Energy Retrofit Tool

The web-based HiBERtool helps practitioners find the perfect solution for conserving historic buildings. The tool explains more than 150 retrofit measures, ranging from increasing a building's energy efficiency to providing solar energy on-site. With just a few clicks, users can get solutions tailored specifically to their needs. Page navigation is fairly intuitive, so reading a manual is unnecessary. All solutions come with a detailed description in a downloadable PDF.

How it works, the HiBERtool uses three major criteria to help you find solutions for your specific building needs: historic conservation value, living comfort and energy efficiency, and solar energy use.

The current version includes:

- 60 solutions for windows (box type, single and coupled windows)
- 40 solutions for walls (solid walls and (half) timber framing)
- 18 solutions for building ventilation
- 40 solar thermal and PV solutions (mainly building-integrated elements)

A complement to the HiBERtool is the HiBERatlas, an online database detailing 57 of Europe's retrofitted historic or listed buildings.

The tool's development was supported by two projects, IEA SHC Task 59: Renovating Historic Buildings Towards Zero Energy and Interreg Alpine Space ATLAS.

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Will we see more work in this area in the IEA SHC Programme?

Jan: As is often the case, answering questions in one project inevitably brings up new questions. Lighting requirements, technology, and design constraints all have to be addressed and optimized as a whole along the lighting value chain. And what that means is that we have to reorganize our understanding of efficient lighting in the context of the big global trends – decarbonization by means of digitalization on all levels. Therefore, I guess 'Yes' is the answer to this question. As a matter of fact, the Task 61 participants submitted a proposal for a new IEA SHC Task just last month. So, if you are interested in contributing to the Task definition work or learning more, you can email me at jan.deboer@ibp.fraunhofer.de.

SOLAR ACADEMY SHC

FOR HEATING & COOLING IN BUILDINGS & INDUSTRY

Training Workshop Explores Economic and Technical Aspects of Solar Cooling in Southern Africa

The IEA SHC Solar Academy and SOLTRAIN (Southern African Solar Thermal Training and Demonstration Initiative) hosted with the support of SACREEE and SANEDI a specialized course for professionals on Solar Cooling for Sunbelt Regions in November at Stellenbosch Institute for Advanced Study in South Africa. A total of 46 participants from 7 countries took part, with around 8 of them participating virtually.

Daniel Neyer, Manuel Ostheimer und Uli Jakob, all IEA SHC Task 65: Solar Cooling for the Sunbelt Regions experts, led the training over two days. Day 1 was dedicated to an overview of SHC Task 65's work, state-of-the-art and future trends of solar cooling, basic solar cooling functions, and finally, a look at several state-of-the-art products and systems, such as the HyCool technology.

On Day 2, the training turned to an economic and technical assessment of solar cooling systems, focusing on hybrid chillers for southern African applications. For the interactive portion, the trainers introduced in detail the tool T53E4 developed in IEA SHC Task 53: New Generation Solar Cooling & Heating and then put it to use to compare a hybrid solution to a standard vapor compression chiller solution. The case study relied on annual TRNSYS HVAC simulations with validated models. During this interactive session, the group discussed in detail the key technical and economic figures, load analyses, and specific design issues. The day then wrapped up with the compilation of a do's and don'ts list along with best practice examples.

As Uli Jakob, a course trainer and the SHC Task 65 Operating Agent, notes, "Another successful Solar Academy training by SHC Task 65 for the books." There was unanimous positive feedback from the participants who benefited immensely from the course and the in-depth discussions on hybrid chiller configurations for hot climates.

2022 WEBINARS

1 **Global Solar Certification**
March 2022

2 **Solar Heating and Cooling Markets and Industry Trends**
June 2022

3 **Task 65 Solar Cooling for the Sunbelt Regions**
October 2022

4 **Task 64 Solar Process Heat**
November 2022

YouTube

You can watch all the past webinars on our SHC YouTube channel

click here

Marketplace

The Solar Heating and Cooling Programme is not only making strides in R&D but also supporting the growth of the solar thermal sector. This section of the newsletter highlights the link between our R&D work and its practical impact on the world.

Solar Process Heat

Simulation Tools to Assess Yield

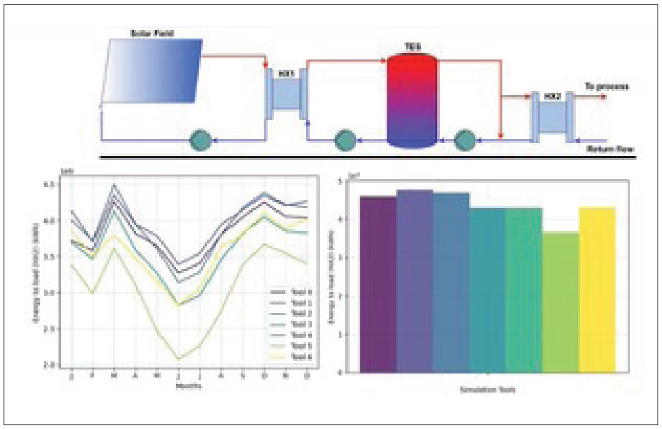
Solar process heat system yields are simulated during feasibility studies and have a decisive influence on the profitability of the project investment. The large number of simulation tools available means that results can differ significantly and possibly create a lack of trust by investors. This is why a group of IEA SHC Task 64/ SolarPACES Task IV: Solar Process Heat researchers, headed by Jose Cardemil, Associate Professor at Pontifical Catholic University of Chile, decided to evaluate several tools by analyzing their limitations and comparing their results.

The research team selected four operating plants as case studies to conduct yield assessments and identify the sources for the differences:

- Flat-plate collectors at a copper mine in Chile
- 1-Axis tracking flat-plate collectors at a paper mill in France
- Linear fresnel collectors in Spain
- Parabolic trough collectors at a dairy factory in Switzerland

The group also defined a standardized way to directly compare the yields from the different simulation tools. Nine tools were compared, including tools created by project developers, tools developed in the context of EU research projects, and several commercial simulation tools:

- NewHeat, France
- CEA, SHIP2Fair, France
- Polysun, SPF, Switzerland
- SAM, NREL, USA
- SHIPCal, Solatom, Spain
- Greenius, DLR, Germany
- Matlab, Polytechnische Universität Valencia, Spain
- SCILAB, Federal University of Paraná, Brazil
- TRNSYS, (CIMAV/México, USeville/Spain, LEPTEN/Brazil)



▲ **Chilean copper mine case study results from the nine simulation tools show smaller differences in the annual yields (right) but significant variations at the monthly level (left).**

A number of the reasons for the differences and uncertainties found in the case studies are:

- How the control scheme is considered
- How the heat exchanger is modeled
- How the position of the system is set (particularly critical for concentrating collectors)
- How the internal flows are modeled
- How thermal capacitances are considered

But one of the most significant impacts on the yield is how the storage is modeled. So the research team is planning to assess the impact of time steps considered for the simulation.

This work is on track to define a standardized way to simulate yields and publish guidelines on the method. The end goal of unifying the criteria for simulations will undoubtedly help reduce perceived risks for investors.

IEA SHC programme

The International Energy Agency was formed in 1974 within the framework of the Organization for Economic Cooperation and Development (OECD) to implement a program of international energy cooperation among its member countries, including collaborative research, development and demonstration projects in new energy technologies. The members of the IEA Solar Heating and Cooling Agreement have initiated a total of 68 R&D projects (known as Tasks) to advance solar technologies for buildings and industry. The overall Programme is managed by an Executive Committee while the individual Tasks are led by Operating Agents.

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SOLARUPDATE

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