Interdisciplinary Practices for the History of Solar Engineering in Chile

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Chapter 16
Interdisciplinary Practices for the History of Solar Engineering in Chile

Barbara Kirsi Silva, Cecilia Ibarra, and Mauricio Osses

Abstract This paper seeks to question some intersections between history and engineering, through the history of solar energy in Chile. In this analysis we give importance to the humanity in every innovation as well as acknowledging the importance of practices' temporalities. The historical research of solar energy's practices was done in collaboration between engineers in the field and historians. By addressing the contemporary history of solar engineering in Chile, we aim to discuss the connection between different scales, as well as the intersections of transitions and coexistence between different technologies. This will lead us to reflect on the philosophical possibilities of interdisciplinary work, and on the relationship between narratives of the past and imagination of the future.

Keywords History of technology · Solar energy · Interdisciplinary practices · Engineering and temporality

16.1 Introduction

Solar energy is a technology widely available in current times. Some devices in public spaces use solar energy; in some urban areas it is possible to see houses with solar technology; and in rural locations every now and then we can find solar

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photovoltaic fields. Certainly, solar energy has integrated discourses addressing the need for clean energies. The demand is evident: the concerning global climatic crisis.

A crisis is broadly defined as a particular time in which humans (individually or collectively) experience intense difficulties or dangers. Moreover, a crisis is usually associated with a 'new sense of time which both indicated and intensified the end of an epoch' (Koselleck & Richter, 2006, 358). Whichever conceptualization we may chose, we understand a crisis in a specific—yet not determined, time frame. Therefore, the very concept of crisis embeds the factor of temporality. Societies and individuals are related in an inalienable way to time. Moreover, this relationship with time is intertwined with the duality of continuity and change, which intersects practices and processes. Scientific and technological products are not 'immune' to the binary motion of continuity and change. On the contrary, if a teleological philosophical perspective might suggest a linear development towards progress (Allen, 2016), the history of science and technology shows that its shape throughout time is far more complex.

If we were to study solar energy in Chile, two definitions were crucial: the first one was solar energy development did not begin because of the current environmental crisis but has a longer history. The second one was that if we wanted to understand transformations and permanence in solar energy, and for them to have an influence in current discussions of the future, then we had to go back in time and address its temporality in depth, beyond the 'oral tradition' or statements repeated once and again, which might have been accurate or not.

In this paper, we will address our work in reconstructing history of solar energy in Chile throughout interdisciplinary discussions. By putting the history of solar energy in perspective, we could draw its development connecting a local, national and global scale, far beyond center-periphery narratives (Kaps & Komlosy, 2013). This multi-scale standpoint allows understanding the diversity of meanings of solar technology, to different actors (Fritzsche & Oks, 2018). Furthermore, historical comprehension integrates the coexistence of different technologies and what it meant for diverse actors in solar development.

These elements allow us to propose the intersection of history and engineering, produced within a collaborative and interdisciplinary method, as a contribution to philosophy of engineering. The result of these collaborative and interdisciplinary historical research transformed the narrative of the past of solar energy in Chile and may influence the imagination on the role of solar energy in sociotechnical imagined futures. Therefore, we propose to ask how time—or more broadly a temporal perspective, could contribute to reflecting on philosophy and engineering.

16.2 Time, Temporality and Solar Engineering

At first sight, history is the discipline that studies the past. We ask questions to a certain past, trying to understand processes that are gone and will never come back. These questions though are constructed within our present. In other words, it is our present what inspires which questions we are going to formulate to the past; and which approaches, interests, focuses are we going to use in designing the research to cope with those questions. Classic historians such as Bloch (2001, 18) or Benedetto Croce (quoted in Collingwood, 1996, 198), among many others, have stated the idea that history is indeed a discipline of the present.

However, this does not imply we should embrace some sort of 'presentism'. In the concept of François Hartog (2020), current societies are embedded in a ubiquitous present, as we are focused on immediate responses to immediate needs, which erode our connections to the past. This 'regime of urgency' then, should not replace the crucial relationship between past and present in which we situate history. Current times indicate the urgency to deal with climate change (IPCC 2018 et al., 2019) and strengthening an environmental responsibility as an inescapable and undeniable need. One of the many actions is to promote the use of clean energies, and solar energy is obviously one of them.

One might think it is this urgent need which leads us to question our past regarding solar energy, even in a far away, underdeveloped country such as Chile. And this is indeed true, together with local effervescence for the topic (Rojas et al., 2019). The presence and need for solar energy today inspire the questions we can make to solar energy's past. However, even if this is the case in working with history's temporalities, this should not cloud our understanding that the past has an experience independent of what is happening in our present.

We can find experiences of uses of solar energy in Chile from 1870s onwards. But this does not mean we can set a continuous teleological history of this development for about 150 years. The experiences of solar energy we found in history were not necessarily related to this environmental crisis or to the need of clean energy. However, that historical trajectory can contribute to understanding the complexity of time-based relations, its different silhouettes and traces.

Technology—and in this regard, engineering, plays a decisive role in moving forward the horizon of what is possible. The future is challenged and shaped by engineers and scientists' imagination when dealing with concrete world conditions (Pirtle et al., 2021). Nonetheless, imagination is also intersected by the narratives we have of the past (McKittrick, 2015) and by socio technical imaginaries, which can be understood as shared visions of desirable futures which could be achieved by technological change (Jasanoff & Kim, 2015). Understanding this statement implies leaving behind the static distinction between philosophy and engineering drawn upon 'the life of the mind and the life of the action' (Pitt, 2013, 92). If the future can be imagined, we should embrace the idea that 'technology combines the physical world with the social, the objective with the subjective, the machine with the man' (Pool, 1997, 15).

In history, we understand facts and processes were not always meant to be as they were. There is no script for history, therefore, it is human decision making (individually and collectively) what shapes history. And also, humans are those who built narratives of the past. Future was not written; it was imagined by humans, including engineers, and the past can show us how this 'blank canvas' became a story to tell.

When adding historical perspective, it becomes clear how human intention shaped the possibility of obtaining energy from the sun, beyond receiving sunlight. Past motivation was not environmental crisis, but industrial and domestic endeavors. Obtaining fresh water, cooking and drying food, heating water, and even generating electric power were among the technical experiments dealing with solar energy. At the same time, scientific drives such as measuring radiation and understanding its variations intersected human interest in working with solar energy.

Therefore, both engineering and history deal with what is and was possible, and what actually happened or could happen, in this case, when working with solar energy. By bringing together this articulation of time and possibilities, these disciplines reflect on the human condition and on human imagination. As such, to work with history and engineering is to unveil the humanity in every innovation as well as to acknowledge the importance of practices' temporalities.

When the time came for accelerating the development of clean energies, solar energy already had a long history in the country (Osses et al., 2019). Not always known, not always conscious, but it was there. It was time that articulated its course, far more complex than a continuous linear trajectory moving for increasing progress. Similarly, in different moments and processes of its history, solar energy connected local, national and global scales. Radiation was used in particular places in the country, but solar energy knowledge moved throughout communities, universities, public policies, as well as in international academic communities and diverse experiences around the world.

Beyond instrumentalism proposing that science provides tools to navigate the world more than uncovering its 'fundamental truths' (Stanford, 2016), the experience of solar energy showed that providing such tools is a complex exercise of intertwining science, society, and temporality.

16.3 The Historical Path of Solar Energy in Chile

Chile's Atacama Desert has been shown to have the highest long-term solar irradiance of any place on Earth, offering unique conditions for solar energy development. This has attracted worldwide attention since the 1900s, fostering technological development in the region through a variety of applications and experimentation, such as desalination, solar ponds, water heating, radiation measurements, cooking stoves, photovoltaic cells, and solar energy storage systems. These projects used both local capacities together with an early and active international collaboration.

The first recorded references of solar energy technological development in Chile appeared in 1872, in the Atacama Desert. Engineer Charles Wilson built the first distilling plant known as Las Salinas, with a production capacity of 20 thousand liters of water per day, being operative until 1910. This productivity was explained both by the solar radiation harvested, and by the Atacama Desert cold wind, which managed to maintain the glass' outside temperature sufficiently cold. The existence of Las Salinas was known in the northern hemisphere, at least, since 1883, 11 years after it was built, thanks to publications in London, New York, Oklahoma and Madrid. Dr. Maria Telkes in the United States recovered this experience in the 1950s (Telkes, 1955) and gave information about its existence to engineer Julio Hirschmann, from the Technical University Federico Santa María at Valparaíso, Chile (UTFSM, by its acronym in Spanish). From that moment on, Las Salinas became an icon for those initiated in solar energy technologies.

Two other desalination plants followed, Sierra Gorda and Domeyko, which operated supplying drinking water in the area for several decades. Juan Oliveira owned Sierra Gorda desalination plant, located 50 kilometers east of Las Salinas. This second solar industry was active between 1886 and 1894. The distiller of Sierra Gorda apparently had a supply of 40 thousand deciliters for every 24 hours (Hirschmann, 1964). This would have made it twice as productive as Las Salinas.

All desalination plants built between 1872 and 1907 disappeared without written register of their design process or the cessation of operations, which, due to their size, should have involved administrative procedures. Engineers drove these developments motivated by providing water to the community and the flourishing nitrate industry, in the middle of the driest desert in the world and a region known for its intense seismic activity. Technically they correspond to passive solar systems; the concept 'solar energy' was not yet used, but rather 'evaporation' and 'atmospheric agents'.

Later, in 1918 the Smithsonian Astrophysical Observatory, led by Samuel Langley, installed a solar station in Calama, northern Chile. The Calama-Monte Montezuma station was the longest operating facility of the Smithsonian program, measuring radiation continuously between 1923 and 1947, that is, over a period of 25 years, under the direction of researcher Dr. C. G. Abbot. The main objective of this observatory was to rigorously measure changes in the solar constant, with the least possible disturbances of particles, clouds or water vapor in the atmosphere (Hoyt, 1979).

As far as our research could tell, these initiatives were not linked to each other. However, the work of these pioneers, with large-scale industrial applications, and the Smithsonian Institute, with experimental measurements, was taken up again by the universities in the 1950s: Universidad del Norte with Carlos Espinosa, Universidad de Chile with German Frick and UTFSM with Julio Hirschmann. In a collaborative work, they reactivated the development of passive applications, such as solar evaporation ponds and desalination. Hirschmann founded the Solar Energy Laboratory in 1961, where in 1970 the National Solarimetric Archive was inaugurated in the presence of delegates of the Regional Associations of the World Meteorological Organization of the United Nations (Hirschmann, 1973). Records of up to 80 stations were received here, spread along Chile, from Parinacota to Antarctica, including Mataveri station on Easter Island. In this way, local solar stations connected to the international community that was researching the field.

Examples of historical development in solar engineering (Fig. 16.1).

Fig. 16.1 From left to right: Solar distillation plant at Domeyko, c.1908 (Telkes, 1955); Evaporation pond at Coya, 1959 (Hirschmann, 1961); Experimental distillation plant at Quillagua, 1974 (Hirschmann, 1975)

16.4 Networks of Solar Development in Chile

When Chilean engineers took their first steps into solar energy science and technology in the late 1950s, they looked back at Wilson desalination plants, despite it had not been operative for decades, and it even had been practically forgotten. Julio Hirschmann wrote about Domeyko and Sierra Gorda and contributed into making Wilson's work an inspiration for solar work in technology and innovation in Chile (Hirschmann, 1964). Hirschmann gave a central place to water desalination in his solar laboratory, giving continuity to this technology. Providing access to clean water to the population in the north of the country was a problem then, as it is today.

The late 1950s were the years of organization of networks of scientists and engineers around solar energy in Chile and abroad. The Chilean Solar Committee was founded in 1957 with participation of government officials and academics from different universities; its main objectives were related to the solution of the problems of water and energy provision for the country. Chile lacks fossil fuels reserves and energy security was a concern. The 1960s saw the development of a network of collaboration around measuring solar radiation and experimenting with technology. Work was concentrated in universities, with teams connected to peers in the country and abroad. Chilean engineers joined the international association from its beginnings and took part in the United Nations conferences for the development of renewable energies. The solar community was one of the first groups alerting on the phenomena of climate change.

At the beginning of the 1970s the conditions for solar development changed dramatically. The price of fossil fuels rose, and Chile entered in a process of installment of neoliberal structure, with an open market economy and a subsidiary role for the State. Under market rules, solar energy achieved some growth in competitive areas such as passive solar applications (for example, water heating for residential use). The association continued to gather the solar community, conformed mainly by engineers from universities and the emergent private sector. The State rolled back as collaborator and funding agency for solar endeavors. There were few exceptions, such as the initiative of the public copper mining company, CODELCO, which implemented a solar technology plan aimed at reducing its energy costs (Román & Ibarra, 2019).

The emergent local market for solar technology shrunk in 1990s, with low prices for fossil fuels. Solar activity diminished; academics could maintain some activity supported by the international cooperation. By the mid 1990s the local association disappeared. The hard times of solar energy in Chile had one exception: the development of the so-called 'Socially adapted solar technologies', a Latin American movement for technological innovation of low cost and simple design, implementing ingenious applications to solve the needs of vulnerable population, and aided by international collaboration (e.g. Serrano, 1988). The global solar association made its case for influencing energy policy based on environmental concerns and some countries undertook policies, which allowed investing in solar energy, taking a very different path from Chile (Mills, 2005).

At the beginning of the new century, the Chilean State has had a role in fostering solar science and technology with energy policy favoring renewable energy and funding in the area. The surviving engineers from the solar community had a role in pushing policy makers and rebuilding local capacity.

In this great resurgence of renewable energies worldwide and in Chile, it is interesting to contrast recent emblematic projects with the first facilities. For example, the largest solar thermal concentration plant in Latin America, Cerro Dominador, is located only 80 km away from the location where Las Salinas desalination plant was built 150 years ago.

16.5 The Process of Reconstructing Solar Energy's History

The historical path presented in the previous section was neither obvious nor mandatory. Reconstructing it while understanding what was going on needed a dialogue between different disciplines, using a public history approach (Silva, 2018). The project included historical research, dialogue and collaborative work between solar scientists, engineers, technicians, historians, and science and technology researchers. Engineers working on history, social scientists and historians working on engineering was a new and challenging task for all of us. But very soon we realized knowledge and its applications need this dialogue, as solar energy did—and still does.

The project aimed at reconstructing the history of solar energy in Chile. Initially the goal was the collaborative production of a peer-reviewed book (Osses et al., 2019), and later it included also the production of a documentary based on the interviews held during the research phase, a photographic archive, a webpage and an interactive timeline[1] presented at the World Solar Congress (WSC) held in Santiago, Chile, in November 2019. It was the first time WSC took place in South America since it launched in 1957. In one way or another, it was the book that brought

[1] Documentary, photographic archive and time line available at the Project website (https://historiaytecnologia.cl/sol/)

together all these different initiatives to reconstruct and communicate solar energy's history in the country.

Twelve people participated in the book writing, three editors and nine co-authors, they belong to four universities and have different 'solar trajectories'. They were invited by the editors in a process that began at the end of 2017. The editors embarked in this book motivated by curiosity and admiration of the fragments they already knew on Chilean solar engineering. These stories were mostly unknown and not available for new entrants in the field. Engineering students choosing to do their final project on solar energy did not have a reference to learn from the local history; they could only refer to recent information on the media and on the websites of universities and enterprises currently working in the field. We believe earlier contributions to local science and technology must be made visible, valued by the new generation and recognized by engineering students. Acknowledging previous experiences is not only 'anecdotal' but sets technology within a wider time frame. This allows future experts to understand the relevance of individual convictions as well as understanding oneself within a local and global society. History shows so clearly this is not a relationship that began in the so-called 'Information era' but is at the core of science and technology development, even decades ago, even in a far away, small country such as Chile.

To form the team was the first task of this project. The Chilean solar community of scientists and professionals who had worked or work today in solar energy is small enough for them to have heard of each other. Since history of solar science and technology in Chile was undocumented, the team decided to include as sources long interviews with actors related to the subject. We conducted 22 extensive interviews to engineers and technicians with long careers in solar energy in Chile, starting at least in the 1970s. The project team made the selection—based on their knowledge of the solar community and archival sources. All the interviews are complete and with very little editing on the project website. Other sources were the scarce academic literature on the history of the sector; academic literature on solar science and technology produced in Chile; private archives with minutes and reports of the national Solar Association and their conferences; and academic writings and reports related to specific solar projects.

If engineers and historians were reconstructing the history of solar energy in Chile, and writing a collaborative book, soon it seemed this remarkable history needed a broader communication process. The material gathered during the research for the book gave us the idea of showing the results in different formats, for example, a 25-minute documentary based on the interviews and the interactive timeline displayed at the WSC. Following the theoretical approach of the research and the book, the final design of the timeline includes a parallel between world events and what was happening in Chile at the time, as well as a third line where the attendees could contribute with milestones that were not considered at first. The timeline format made visible and explicit that this process had many gaps, even oblivion. It also showed there was not a perfect coherence regarding a supposed progress making solar engineering increasingly extensive, reaching to present times.

A new stage in the development of solar energy in Chile can be observed in the last decade. The rapid growth of solar energy for electricity generation gathers general interest, policy attention and international notoriety. Competences develop in certain directions; there is always more than one path. Areas of expertise get stronger depending, for example, on funding and incentives. Also, their advancement depends on visions of the future and values, as carbon neutrality currently demands. During the 2 years of research, using public history methodologies, we observed tacit values in the local solar energy community which could be a compass for the future.

The shared values we identified were: passion, persistence, collaboration, and consciousness. We recognized passion for learning, inventing, discovering, and solving problems, and observed persistence in keeping in the field, working hard even when governments and markets seemed unsupportive, as it happened once and again in this history. Collaboration and solidarity with the local and international community were features displayed along the decades. And consciousness points towards the environment; the world solar community has been aware of climate change and environmental degradation for a long time. It has been also conscious of social needs, policy and governance issues.

This collective and historical exercise recognized the intentions of engineers and, at the same time, prompted them to be reflective and enrolled them into conversations about the role of solar energy in the past and the future. The current time of crisis calls for deeper changes which require dialogue and re-imagining the future. Conceptual shifts may come from the sort of conversations fostered in the process of revisiting the past. This process problematized sociotechnical imaginaries (Jasanoff & Kim, 2015) by showing a diversity of visions of desirable futures supported by solar technology in place at the same time.

The research agenda proposed by Pirtle et al. (2021) calls for a reimagined engineering in service of society, based on critical reflection from interdisciplinary approaches. Historical research can contribute to this purpose by providing a temporal perspective on values surrounding a given technology and options for technological development, which could remove, or at least question, ideas of linear technological progress.

16.6 Final Remarks. Time and Interdiscipline in Solar Energy

When reconstructing the history of solar energy between engineers and historians, we followed the collaborative practice at the core of the history of solar energy development. This disciplinary dialogue was crucial to put the past of solar energy in perspective; the horizon of understanding in which we analyzed solar engineering was deeper and wider. We could integrate culture, society, global scope, even ethical and epistemological considerations into the development of solar energy.

When working in historical perspective, philosophical considerations go beyond ethics and epistemology: it puts time and temporality as prisms to reflect on the articulation—or possible imbrication, between philosophy and engineering. Working on history of engineering with an interdisciplinary and collaborative approach allowed us to open possibilities when thinking of time.

For engineering, reflecting on time and temporality might be insightful, as this reflection could question not only the linearity of time, but the teleology of engineering itself. This questioning of time became evident when we analyzed the historical path of solar engineering in Chile, its networks and the process itself of reconstructing solar engineering's history, as described above.

Chronological time by which we organize society, measure projects, and plan developments is not the only temporality in which we coexist. Historical work can contribute to thinking of a multiple time, which embraces connections through epochs and places. Global networks do not only refer to relationships with people in different places of the world, but also connections through time. This does not shape a perfect line that is moving hygienically forwards, step after step, but messy, multiple and kaleidoscopic. Being aware of this condition of time might open possibilities for engineering to question what the future is and how it relates to innovation, progress or newness. Consciousness about the past's fragmentary nature might help in opening possibilities for imagining the future.

By historizing actors and contexts in the past of solar energy, we could understand how social and cultural conditions, as well as individual ambitions and interests intertwined to give shape to solar energy. Thus, it is not only engineering which could imagine the future. Historical research allows us to build comprehensive narratives of the past, and by transforming our narratives of the past, we can also change our possibilities of imagining the future.

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