

Solar energy and the Energy Institute of the National University of Engineering (1962-1969)

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Abstract. This article examines one of the first institutional initiatives that promoted the study of solar energy in Peru. For this purpose, the case of the Energy Institute, a unit attached to the Faculty of Mechanical and Electrical Engineering (FIME) of the National University of Engineering, is analyzed during the 1960s. The Institute concentrated its efforts on the location of the regions with the highest solar incidence and in the development of devices that could use successfully this kind of energy. Through the hermeneutic analysis of journals, bulletins, theses, interviews and the use of specialized bibliography, we build a historical account in which the role of the Institute and its exponents for the promotion and research of solar energy is highlighted. With this objective, the article is divided into three sections, the first one details the context in which there was a greater awareness of the role that energy played in national development. Secondly, the changes that FIME went through and that allowed for the creation of the Energy Institute are described. Finally, the works undertaken by the Institute in the field of solar energy and the profile they take over time are exposed.

1. Introduction

In the 1960s, there was a greater awareness, in different academic, professional, political and industrial sectors, about the role played by energy in the Peruvian social and economic development. A particular context formed in this decade, involving two complementary and fundamental sectors of the economy - industry and energy - proved the importance and limitations of the national energy sector. On one hand, the complicated panorama that surrounded the oil industry (low production, the failure of exploration and drilling of new deposits, the inability to meet domestic demand, the problem with the International Petroleum Company, etc.), put at risk the supply of the main source of energy that the country had. This situation showed the energy dependence in which the national productive system had run aground and, also, the limited capacity of the industrial sector to exploit other energy sources. On the other hand, the active participation of the State in the promotion of industrial activity and in the urbanization process, generating a series of demands that revolved around the administration of the use of energy. In this complex scenario, there was a significant increase in demand for greater government intervention in the energy sector, as well as the need to have qualified professionals capable of conducting an efficient deployment of national energy potentials in favor of industrialization and national progress.

In general, this was a period in which the energy problem was intensively and widely discussed. It is important to point out that different state authorities, engineers, scientists, economists, businessmen and other agents with direct interference in the industry and energy sector dedicated themselves to study of



the energy issue. After long and intense debates frequently organized for the analysis of the Peruvian energy reality, the aforementioned agents agreed on the need to create a specialized national corps for the study and recording of energy resources. The main objectives were to identify the all kinds of energy resources that the Peruvian territory had, investigate its potential from different sciences, encourage its rational use, plan its future sustainability and, based on what was described above, establish a national energy policy capable to guide national development.

Following the previous objectives, the use of the different energy resources of the country was promoted. Even though, the attention of public authorities was focused on the promotion and exploitation of conventional energies, usually oil was overshadowed by resources such as coal, hydropower and natural gas, the "unconventional" energies, such as nuclear, wind and solar energies, were not left aside. It should be noted that the inclusion in this last set of "renewable energies" was a discovery for the time. The novelty was that this kind of energy were considered, despite their limitations, as alternative means that could provide useful resources for social development, especially in rural areas of the country. This led them to be introduced into sophisticated spaces where they were studied in all their complexity based on rational criteria. The knowledge produced served to promote the development of technologies that could use them in an efficient and simple way. The case that better exemplifies what it is described previously is the solar energy, since, unlike the other renewable resources, it has a more ample and lasting study.

This article analyzes one of the first institutional initiatives that promoted the use of solar energy through its research and technological development. For this purpose, the Institute of Energy is taken as a case study, as it is one of the first research centers in Peru in to take care of the study of renewable energies. The period of study covers the years of 1962 and 1969, time of existence of the mentioned organism. Since the deployment of the Energy Institute is closely linked to the course of the FIME and the UNI, and these with the requirements of the Peruvian State and society, the first section of point two of this paper describes the changes that the mentioned faculty went through to meet the demands of the productive and energy sector. We believe that this particular context allowed the creation of the Energy Institute. The second section of point 2 is entirely dedicated to analyze the Institute of Energy and solar energy. This describes the particular way in which its members and some mechanical engineers addressed the study and use of solar energy. It highlights the effort to locate the regions of the country with the highest solar radiation and the development of devices that could use this energy efficiently and easily.

2. Development

The National Engineering University (UNI) throughout its history played an outstanding role in the Peruvian's material development, as the main training corps of qualified technical professionals in the different branches of engineering, science and architecture. From its conception and creation as Special School of Civil Constructions and Mining in 1876, the UNI was closely linked to the requirements and objectives that the State and the Peruvian society were drawn in its search for national progress. The opening of new specialties, the reforms of their curricula, the modifications of the teaching process, the acquisition of modern instruments and laboratories, among others [1], were some of those changes that show the renewing spirit of the UNI according to the Peruvian demands.

The UNI was no stranger to the energetic problems generated by the industrialization process, the low oil production and social demands in the 1960s. Its entry to the energy debate was parallel to an intense renovation and expansion of its guidelines. Although the UNI had acquired its legal status as a university in 1955, thus abandoning its status as a school, it was only until 1960s, as the historian and philosopher José Ignacio López Soria points out, when "his real transformation into a university occurs" [2]. The transformation was based on the cultivation of scientific and technological knowledge, the understanding of economic processes and the approach the world of art and culture. Under the rectorships of Mario Samamé Boggio (1960-1965) and Santiago Agurto Calvo (1966-1970), the UNI faced the new challenges of development.

2.1 *The Faculty of Mechanical and Electrical Engineering*

One of those university spaces that was subject to enormous changes due to the context initially described, was the Faculty of Mechanics and Electricity. Since its creation, in 1903, as an Electrical Engineers Section, until the 1940s, it went through a series of reforms mainly linked to external demands. The changes began to be particularly important at the end of the 50s and especially in the 60s, when the industrialization process required the presence of an agent that could direct and sustain its development from the field of technical and professional operations. For studying the "conversion of energy from one form to another, the design of all types of machinery, the instrumentation and control of all types of physical processes and the control of man over machines" [3] mechanical engineer became that desired agent. For the highest authority of the university, the rector Mario Samamé Boggio, this kind of professional was the best one to direct, prosecute and make "industrial development a reality" [4].

The growing machination of the national industry broadened the scope of the mechanical engineers who, just like in the past, began to be sued in sectors such as mining, oil, fishing, agriculture, textiles, transport, the sugar industry, the chemical, among others. Similarly, the energy problems that revolved around the supply of oil and its derivatives, opened a field of action in which the mechanical engineer for his training could actively participate. If previously the specialty with the highest labor demand was civil engineering, now, in the 60s, it would be mechanical engineering. Given the incipient state of the mechanical engineering faculties of the country, especially those located in the provinces, the Faculty of Mechanics and Electricity of the UNI, due to its long tradition in the field, became the space that covered the concerns that emerged from the industrial and energy sector. Its renovation was an essential fact. Thus, in the first half of the 1960s, the Faculty of Mechanics and Electricity experienced major changes in its curricula. The result was the establishment of four departments (Mechanical Engineering of Energy, Production, Electrical and Electronics) in which the students of the last two years could complete their studies by specializing in the area that best suits them [2].

Another of the most outstanding reforms was the opening of institutes dedicated exclusively to research and the development of technologies, in the field of mechanics, electricity and energy. With the idea that these would serve as spaces for complementary training for students and professional specialization for graduates, as postgraduate courses, four research institutes were created. The Energy Institute stands out among its peers for engaging in unprecedented work up to that point: the rational study of the national energy reality. The sample that the university authorities had assimilated the requirements of the industry and the social demands was reflected in the particular attention they paid to the issue of machines and energy. Although, due to the nature of the Faculty, these were topics that crossed all the curriculum, the opening of spaces that housed them showed the relevance they had acquired. As you can see, and here we only focus on the subject of our interest, a favorable environment was being formed in the classrooms and dependencies of the FIME for the study of energy. This time, not only would their physical and applicative virtues be studied, as had traditionally happened, but they would be studied in relation to socio-economic reality and in order to use it for national development.

The search for new alternatives, the recognition and registration, the evaluation of its potential, the projection in time and the rational and programmed use of the conventional and unconventional energy resources of the country, along with its effort to train specialists in the branch, were some of the tasks imposed by the Energy Institute, under the direction of the illustrious engineer Roberto Heredia Zavala. Likewise, this interest in the study of energy was shared by students and mechanical engineers not attached to the Institute, which shows that favorable environment that the FIME had fostered. With this projection, the Institute and the mechanical engineers were not only providing an answer to the energy question, but they were doing it in an unprecedented way until that moment, since they took into account resources scarcely used in the country, such as unconventional energies. From this broad group of energies, the special attention given to solar energy should be underlined.

If solar energy became the object of study and development in the engineering field, it was due to its intrinsic characteristics, its relative ease to be transformed into useful energy and, especially, because of the problematic context that involved it. The engineers pointed out that solar energy was

“everywhere” and in “immense quantities” and, therefore, could be harnessed through “simple and easy to build” devices or technologies that would transform it into useful energies (heat, mechanical, electrical) for social development. These virtues found fertile ground for their development as a result of the energy problem that Peruvian society was going through in the 1960s, due to low oil production and increased demand. While engineers still did not show that exaggerated concern about the shortage of oil, which would later characterize them in the 1970s following the international crisis of hydrocarbons, they considered that solar energy could be an “additional” source for local consumption. In another words, they were aware that this renewable source would not be able to replace traditional energies, but they did trust that it would at least be applied in spaces that lacked, due to their geographical and meteorological conditions, basic services (lighting, heating, etc.). In short, due to its intrinsic characteristics, solar energy was estimated by mechanical engineers as a viable alternative, although limited by technology, for the social development of certain regions of the country.

The incipient development of solar energy investigations in Peru forced that at this stage the efforts be directed to overcome fundamental obstacles for its study and application. The work of the Energy Institute and the mechanical engineers of the FIME were aimed at covering those gaps that were so necessary for their progress and, in that way, they laid the foundations on which subsequent researches on the field would be erected. For all the above, we can describe this stage as “exploratory” and “formative”, since, as we will see in the next section, it began to focus on the evaluation of the possibilities of solar energy development (identification of regions with greater solar radiation, and recognition and theoretical development of technologies that could take advantage of it) and to train the specialist that could lead its development.

2.2. *The Institute of Energy, mechanical engineers and solar energy*

The Energy Institute was created on April 6, 1962 and aimed at the study of national energy reality. For its development, research groups were organized led by teachers and integrated by students from the last two years of study and graduates [5], who would go through a process of training in the field of energy through specialized courses, lectures delivered by recognized national and foreign specialists and research trips inside the country.

One of these research groups was the so-called “National Solar Energy Task Force” which, according to the engineer Azi Wolfenson, was the one that “introduced the national interest in solar energy for the first time in Peru” [5]. This statement was not exaggerated, since, until the year of creation of the Energy Institute, the advances in solar energy research in Peru were reduced to informative studies and to the empirical manufacture of solar devices. On the one hand, there were reports such as those prepared by the FIME engineers or the Ministry of Public Works and Development, in the 50s, which were characterized by their desire to “know” and “arouse interest” in the solar energy applications. That is to say, more than studies of applicative cases they were informative that showed the range of applications that solar energy could have in Peru. On the other hand, according to the testimonies of the time since the 1930s, solar devices manufactured by hand for water heating were already used, such as the famous solar heaters of the city of Arequipa. Despite the significance of these advances, the study and application of solar energy was in a state of incipient development. One of the contributions of the Energy Institute was to train specialists who could in a rational way undertake studies and develop technologies for the use of solar energy.

The reports and thesis presented to the FIME by members of the Solar Energy Group and non-attached engineers show the challenges they had to face as pioneers in the study and development of solar energy. One of the main problems they identified was related to the very nature of this energy. Although this could be “found everywhere” and in “immense quantities”, as noted above, its use depended on a series of geographical and meteorological conditions that determined its state and, therefore, its potential. This meant that in order to make use of solar energy, the areas with the highest solar radiation index had to be identified before. But how much progress had been made in this task? According to a specialist in the field, these were very limited, due to the lack of accurate and prolonged

statistical data of solar radiation [6]. Against this background, mechanical engineers went on to study the national territory with the clear objective of developing a solar map.

One of the first efforts came from mechanical engineer Benami Grobman, who, in 1960, made a solar map attached to a study that evaluated the possibilities of application of solar energy in Peru [7]. Later, in 1972, the engineer César Kadono, as part of a thoughtful work, which started from the elaboration of a “general method for the construction of maps of general energy distribution” [8], produce first and most sophisticated Peruvian solar map. Kadono located on the map the regions of the Peruvian territory with greater “intensity and permanence of solar radiation” with the aim of facilitating its use by specialists. According to their relevance, these regions were: Arequipa, Puno, Huancayo, Ayacucho, the north coast, Ancash, Ica, Moquegua and Tacna [9]. The recognition of these regions soon outlined the character that solar energy research would have in the Faculty of Mechanical and Electrical Engineering and, later, in the UNI.

Although much of the regions mentioned belonged to the Peruvian coast, engineers paid more attention to rural areas. The reasons for this choice can be found in the potentials and deficiencies that these spaces presented. On the one hand, as the young engineer Adolfo Vargas said, the rural environment was the most “promising” for the use of the solar source because, due to its location at great heights, they were “the first to receive the sun's rays, they count with clear sky, [is]free of moisture and air pollution typical of coastal cities” [6]. On the other hand, the low presence and use of conventional resources in the rural environment - which can be explained by the characteristics described above - made it impossible for it to have services (electricity, transportation, food, etc.) so necessary for its progress. According to the perception of the technical professionals, this absence had stopped the development of the regions of the interior of the country, to the point of turning it into “underdeveloped areas” or “fossilized” in a historical stage already overcome [6, 7]. Consequently, in these regions “stagnant” in time, but favored with unconventional resources intrinsic to them, solar energy became a means that enabled their social development.

In this decade, as in the later ones, the idea that solar energy could open a path for the social development of the rural environment was strengthened. The rational use of this resource through its photothermal conversion, according to scholars, could improve people's like quality and, in that course, transform their most harmful habits. Vargas Pacheco pointed out that the heating of water by means of devices that use solar energy, generated positive “transformations” in the habits of its users, since, by passing the water from the thaws to a state accessible for human consumption, the inhabitants they could use it recurrently in their daily food and hygiene activities, which was beneficial for their health [6]. In short, more than an economic purpose, the use of solar energy had at this stage a social purpose with a clear projection to rural regions lacking basic services.

This way of conceiving the use of solar energy had an impact on the choice of devices to be used. The studies carried out in this field and in this decade by the Solar Energy Group and mechanical engineers were characterized by having an “exploratory” character or, using the term given by Federico Coz Pancorbo, “of theoretical analysis”. Solar heaters, solar seawater distillers, solar cookers, solar dehydrators, among other devices, were widely described highlighting each of its peculiarities, the dynamics of its operations and the spaces in which they could be used. The primary intention was to show the variety of options that existed to transform and harness solar energy, so the use of specialized bibliography (books, magazines, minutes, etc.) prevailed over direct experimentation with the devices.

As part of these studies, the specialists pointed out the requirements that solar devices developed in rural areas should meet. According to them, their installation and operation “should not acquire specialized personnel because in these villages it will be difficult to dispose of them”, “the cost of investment and operation should be minimal” and, where possible, should be feasible to “build in the same area, with personal and own resources” [6]. The aforementioned devices fit the demands set forth, but for reasons that will be discussed below, preference was given to solar water heaters and, to a lesser extent, to solar seawater distillers.

The device that occupied the attention of the Solar Power Group and the engineers was the solar water heater. Its brief design, the simplicity of its operation and, especially, the long experience it had

in the topic. It is just necessary to remember the case of the heaters of the city of Arequipa, helped its positioning against other devices of equal relevance. Engineer Alfonso Pareja already said it when evaluating the possibilities of development of solar energy: "solar water heaters have [...] great application in Peru and their use has been proven feasible" [7]. The interest in this device soon became a detailed exposition of its elements (parts, typologies, etc.), its operating dynamics (behavior, efficiency, etc.) and design proposals. In this line we can find the works of Alfonso Pareja Findelberg (1963), Adolfo Vargas Pacheco (1967) and Juan Jesús Meza (1970).

Similarly, solar seawater distillers began to be described in the works of the engineers. In a country like Peru, whose extensive coastal region stands out for having an arid subtropical climate and being crossed by rivers that at certain times of the year decreased its flow, the distiller was presented as a viable option for the supply of drinking water in areas that lacked of this resource. In this field we can highlight the studies carried out by the engineers Isaías Flit Stern (1966) and Alfredo Oliveros Donohue (1968). As technical secretary of the National Solar Energy Working Group attached to the Ministry of Agriculture, the first of them led a feasibility study to convert seawater into drinking water that unfortunately could not be published. On the other hand, thanks to the support of the Energy Institute and the Office of Research and Development of the Ministry of the Navy, Oliveros designed a program for an analog computer that evaluated the operation parameters of solar desalination plants.

Of the elements that were part of the solar device, the collector was the most relevant for the role it played in its operating dynamics. Through a set of overlapping parts (cover, absorption plate, insulators, etc.) the collector "intercepted" the sun's radiant solar energy and transformed it as efficiently as possible into thermal energy that was then transferred to the water [10]. That is, it was the medium that allowed the heating of fluids and gases at low (less than 100 ° C) or high temperature (greater than 100 ° C). Studies published in this period were concerned with describing collectors individually and integrated to the dynamics of solar devices. Although these works did not pass the theoretical expository order, we must highlight the repeated request of the authors to overcome this stage and direct their efforts to the design, construction and experimentation of collectors and, in general, of solar devices. Overcoming the theory and foreign schemes through the construction of devices that could take advantage of the material and natural resources of the local environment became one of the challenges that engineers had to face in this and subsequent decades.

3. Conclusions

The Energy Institute represented a turning point in the study of solar energy. Far from continuing with the isolated works of informative cutting and "empirical" applications, the Institute strived to train professionals specialized in the solar field, in general of energy research, who could undertake rational studies and develop technologies applicable to the local environment. Unfortunately, the incipient development of this field of study forced the Solar Energy Group and other engineers not assigned to it to deal with primary aspects, such as the recognition of regions with greater solar radiation and the identification of appropriate technologies to take advantage of it. According to their research, the country's rural areas were the most likely to use solar energy. In addition, they identified the solar water heater and, to a lesser extent, brackish water solar distillers. Before the keen eyes of the members of the Group and the engineers, the use of solar energy through the indicated devices enabled the social development of rural regions, that is, the use of solar energy could serve as a means to improve the quality of life of the inhabitants rooted in areas lacking traditional energy resources. This way of conceiving the use of energy gave the studies carried out in this period as in the subsequent ones in the UNI its own personality.

The untimely closure of the Energy Institute, in 1969, interrupted the gradual development of research in the solar field, to the point that they could not overcome the theoretical and reach the field of experimentation and design of solar devices. This does not discredit what was done by the Solar Energy Group of the Energy Institute and mechanical engineers, since in their role as pioneers they were able to fill the gaps that existed in the solar field facilitating their study and development. In addition, it should be noted that the experiences and professional relationships that were developed within the

Institute of Energy and, in general, in the FIME, around solar and renewable energies, subsequently enabled the continuation of work in public and University.

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