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The Social Energy: Contexts for Its Assessment

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Abstract

The recognition that interdisciplinary approaches must be integrated in any planning that concerns science and technology has shifted from theoretical perspectives to practical implementation. The once distant worlds of Engineering and Social Sciences must cross their boundaries if they are to contribute to the transition toward a carbon-neutral energy supply. The objective of this chapter is to explicitly state the connection of the social dimension with engineering applications (such as the OTEC technology) by developing basic elements of social analysis and explaining the conceptual and practical framework of instruments and practices like the social impact assessment. The chapter will mention the holistic perspective of the Sustainable Development Goals (SDGs), and the general debate of integrating the social sciences and humanities in environmental change research.

Keywords: social dimension, interdiscipline, social impact assessment, Sustainable Development Goals

1. Introduction

Imagine, as an engineer, a day in the university. Once you have found your classroom and taken a seat, the professor starts to write in the chalkboard: Joseph Fourier. So far, nothing strange. You recall your thermal engineering lessons and therefore the transport equations where the surname Fourier became familiar for the first time. You grab your pen as the professor starts to talk.

-Lets recapitulate our last theme. We saw the important role Fourier played in...

You write in your notebook “Fourier’s important role in...”

...in the public commissions on insurance and social statistics in France, as the director of Recherches statistiques sur la ville de Paris et le département de la Seine between 1826 and 1829.

What a confusion! For sure you have mistakenly entered a Social Science class. As you prepare to leave the room, the professor goes on.

-Remember how Laplace established calculations of the probability that a quantity lay within certain limits? Well, Fourier took that principle—first used in the analysis

of the voting procedures of some juries in Europe—and extended its application to mass social phenomena. Just as Laplace found profoundly terrifying that the judicial system of his country executed people with a 30% chance of error, Fourier was committed to a sociopolitical project (the Science Morale of the XIX century), where a comprehensive theory about the way humans relate to each other was the goal.

Mathematics, physics, law, statistics, society, politics... All in one. Why? How come? Returning your notebook to the bench where you sat initially, you decide to stay.

By no means this chapter will talk about Fourier's biography nor Laplace's. An excellent book about the history of probability is available [1]. Instead, some of the main ideas regarding what is expected to be a social analysis (in the context of renewable energy transition) will be exposed, using an imaginary conversation between an Engineering student (ES) and a professor (P). The title refers to “social energy” as a guiding analogy to the physical one. The metaphor (in the sense of an equivalence resulting in work or heat) helps to suggest an intrinsic force that operates within societies, fundamentally, in a moral realm: not what is the case (as in Natural Sciences) but what should or should not be the case. This social guidance, translated in the scenario formulated by Sustainable Development Goals, points to a radical proposal: “While science and technology will undoubtedly play a key role in sustainability transitions, how societies choose to construct and pursue visions of sustainability will be an intensely social, political and cultural process” [2].

As the text develops, it will be mentioned how the notion of interdisciplinarity made its way through the actual perspectives of fully understanding society and nature, followed by some considerations about the stages and characteristics of project planning. At this point, a brief consideration about the interaction between theory and practice will be given in order to make sense about the role that social analysis is supposed to play in engineering applications such as OTEC technology. The Social Impact Assessment tool will be presented in an historical and actual context. Finally, all these themes will find a closure within the Sustainable Development Goals—based in scientific diagnosis and coordinated social management—which blueprint solutions to challenges facing poverty, inequality, environmental degradation and prosperity.

2. The social energy

-[ES] Professor, why does the majority of the scientists of the past knew about everything? I did not have a clue that Fourier, for example, contributed to social statistics.

-[P] That's an interesting question. Imagine that in Ancient Greece one of the most perdurable traditions was that of verbal arguing. It was a form of combat between two people who dispute the strongest knowledge about something. The rules were simple: the questioning challenged his opponent by asking a question that presented two options to solve a contradiction. As the interrogate chose one (the thesis of the argument), he bet for the truth of it. The purpose of the questioning was to find a way to contradict that thesis by developing a demonstration. If he manages to show a unitary relation in the chain of arguments, the conclusion was irrefutable. This is the birth of logic as a discipline: a progressive discursive refinement. Now picture practicing debates for centuries... as demonstrating a proposition meant to find a bridge (concept) to unify arguments, naturally that bridge needed to be more abstract than the proposition at stake. So the search for concepts, each time more abstract than the preceding ones, leaded to distinguish the most evanescent

abstractions ever thought by Occidental civilization. Philosophy appears relying on these cultural phenomena as an investigation of abstract concepts, mainly in the form of a written treatise [3]. That's the reason why Philosophy, as a discursive refinement, coordinate in the past the highest levels of abstraction of every other specific investigation. Many factors lead to the progressive separation of Natural Sciences, but for sure biographies such as Laplace's or Fourier's remind us of subjacent connections that may bring together apparently different things.

-[ES] That's true! I'm working in team that is developing a technology to convert the gradient of temperature in the ocean into energy. There are biologists, physicists, engineers, chemists and... some social science guys. Anyway, we are all trying to perform the best out of our specific knowledge, but there are times when problems call for an interaction. I mean, the other day the biologist asked for information about the pipes. It seems that an ecological disturbance can happen if you mix water of different densities.

-[P] Well, Oceanography is an excellent example of what is called nowadays interdisciplinary. In 1902 the International Council for the Study of the Sea recognized that a sharp line should never be drawn between the disciplines that embraces all studies pertaining to the sea [4]. If we extend this criterion to the activity of the whole group of scientists in their particular subjects, we may see a wide-ranging and complex structures of interdependencies.¹ But due to the accumulation of novel phenomena, a task of arrange and restate the results of different sciences needs to be done; in other words, "interdisciplinary inquiry requires understanding the manifold logical dependencies to which the regularities of different individual sciences give rise" [6]. Can you explain a bit why the biologist asked for that information to the engineers?

-[ES] Well, it's part of the requirements of the project. I mean, each scientist contributes in their own area of expertise, but we are told about the caring of the environment... it's like the final filter. Now that I think about it, no matter how good your engineering calculus are done, a project may be completely rejected! Why is not enough the precision of the sciences?

-[P] We may need to recapitulate what led us to this situation. Since the XVIII century, the progress of sciences was meant to transform in moral progress of people: living better in community. The advances of science and technology were associated with reflection about freedom because of their practical consequences, such as improvement in hygienic conditions or material innovations. The question is how under these ideals are we now in a situation of environmental degradation and extended poverty all over the world? This is called the unintended consequences of development. For sure the precision that you talk about had led to reinforcement, through machines, of the normal performance of the human organism, but that has not result—paradoxically—in having control of the direction of the technical path we invented! That's why, nowadays, if we are not to repeat that historical process, we must take into consideration a wider connection of things involved. We are in the crossroad of figuring out if the means (the results of science and technology)

¹ Another useful distinction of terms is given by Spangenberg [5]: "I distinguish here between multidisciplinary (several disciplines working parallel, with limited interaction, on a shared object of interest), interdisciplinarity (researchers from different disciplines working together in a way that their results can be integrated) and 'transdisciplinarity'. Transdisciplinarity is a demanding form of knowledge integration and it is dependent on reflectivity. It requires a non-idealized perception of the objects of research, a reflection on the specific limitations of the disciplinary construction of reality" (p. 277).

will determine the objectives, or objectives must be sketched first to apply just the necessary means. So precision in Natural Sciences is important but not in the same way or appliance to a social context.

2.1 The social object

This imaginary conversation is leading to our theme: how to analyze the social? Or even, what is “the social”? The mention of the historical passage about Fourier is relevant because it is the episode where a strange combination of scientific knowledge resulted in the consideration of social phenomena as something to do with behaviors, numbers, tendencies, and specific approaches: the study of people and their social relationships. Collections of data about populations (such as registers of property and use of land) are found since 1600. But the XIX century depicts a scenario where numbers about suicides per year were available and interpreted as an indicator of the quality of life. The second element was the debate if the notion of laws (such as Newton’s) could be found in societies. Finally, a particular interpretation of probability (as a proposition about the stability of mass phenomena and the incorporation of the “law of errors” of observational astronomy) takes place in measuring the population characteristics [1]. For the purpose of this chapter, let us keep in mind two main ideas that remain about (a certain type of) analysis of society:

- a. Governments obtain data from the population (e.g., criminality rates) in order to change the conditions that underlie certain social phenomena.
- b. Knowing something is equivalent of measuring something.

The former is mainly a political claim that will be treated further. The latter certainly is a very strong tool, but we want to add some nuances to avoid the interpretation that without numbers there is no knowledge at all. Here are some broad considerations that distinguish society as an object of study [7]:

1. Society is immersed in historical contexts; it does not pertain to experimental systems of controlled conditions.
2. Partial relations in a society can be depicted by isolated magnitudes, but contexts of major complexity with interdependencies escape that treatment.
3. Investigation about society works within notions of comprehension, reference to values, and the co-elaboration of sense.
4. The social structure can be represented with variables such as demographic composition, social stratification, power positions, ways of production, and network of communications.
5. A theory of social action is meant to explain social processes in the dimension of historical processes.
6. An example of a type of reasoning (functional) about the social dimension could look like: If we examine a community, we recognize a social structure > the people (social units) are connected by a defined set of social relations > the continuity of the social structure is not destroyed by changes in the unities > the continuity of the structure is maintained by social life processes > these processes consist in the activities and interactions of individual human beings and

groups they form > a recurrent practice with a specific function (e.g., punishment) contributes to the maintenance of the social structure.

The main distinction to observe is the fact that the society can be an object (of investigation), just of different kind than the objects in Natural Sciences. Certainly the treatment of social mass phenomena in terms of quantifiable magnitudes—as Fourier’s example—was the resultant of many other political needs of the time: statistical analysis of debt, annuities, life insurance rates, etc. This, all together, opened the possibility to interpret numbers about society as indicators and for information and planning in a broad way.

-[ES] So we are in an undesirable situation: scarcity of resources and humanitarian crisis. I kind of get what engineering can do for solving the problem. For example, OTEC technology could supply clean energy for coastal communities as well as fresh water. In that way the problem of energy supplying, water and reducing CO₂ emissions get solved... but I’m not sure exactly what a social analysis contribution would look like.

-[P] In Sociology, there are three traditions: one that tries to develop the categories of social action; the second is an analytic theory of action, which tries to clarify the structure of the activities meant to achieve a purpose (teleology); and the third, the theory of the speech acts, that departs from the processes of understanding between people [7]. All these knowledge is technical, because it develops a specialized language and, in one way or another, it produces information that may be traduced into technical recommendations. That is the level where empirical regularities—such as the ones of social statistics—can contribute, but there is a deeper level of analysis where an interpretation of the significance of social processes must be the outcome. Anyway, in the intersection of knowledge that we talk about earlier, it was in 1969 when the Special Committee on Problems of the Environment (SCOPE) took as its main investigation man’s impact on natural ecosystems.² In 1971 the United Nations Educational, Scientific and Cultural Organization (UNESCO) devised its Man and the Biosphere (MAB) program where methods of data collection were meant to develop; 3 years later a convention was made to give a specific task to the contribution of Social Sciences; the main thesis was that man is simultaneously part of the environment and—with his awareness and capacity for deliberate action—responsible for its stewardship. Thus, man should not be seen merely as an “actor” on the environmental “stage.” The “man in the biosphere” aspect should be stressed, and a systemic, holistic view taken on the interrelationships between man and other components of the biosphere [8].

So you stated the practical contribution of engineering in solving problems—which is true—but how could engineering help to solve the 500 environmental and social conflicts around the world concerning projects on electricity? [9].

-[ES] Well, but that is not part of engineering!

² The guiding question was: “In what qualitative ways and by how much quantitatively is the global environment of man being adversely affected by the technological revolution begun during the 19th century? The growth of population and the per capita capability of modification and exploitation of the environment are accelerating at such rapid rates that unforeseen and often unwanted side effects are continually arising. How serious are the consequences of these *for the future life of man on earth?*” [8]. SCOPE was the first environmental organization to focus attention on human influence.

-[P] You are right... but the conflicts remain as part of the reality of the world. This is where an interpretation of the significance of social processes take place: you may have the best OTEC prototype of the world but the people that is meant to receive the benefits of that material innovation is communicating something else, something that need to be attended before technical considerations. Here is an example. You may think that marine protected areas are intrinsically good because they help conservation and fisheries management. Somehow a protected area is a result of technical advises regarding environment, biodiversity, flows of energy, etc. But what about fishing and harvesting livelihoods? Studies have suggested [10] that such implementations may lead to negative experiences of the local communities such as results of marginal employment, monetary benefits from tourism for a select elite, reduce access to the area, and lack of development of social, cultural and financial assets. So there is a problematic relationship between the intention of solving or improving life conditions (as is the goal of engineering) and local communities, that eventually may lead in undermining the success of renewable energies.

-[ES] I get it. So Social Sciences can be used for avoiding a conflict?

-[P] Beyond that, because the intersection between renewable energy projects and the society should not be seen as a calculus to avoid conflicts, but as a scenario where new technologies fit human needs. And as you can guess, a human need is not merely access to energy but living in an integral context of wellbeing regarding health, prosperity, peace, and justice. In such an environment, technical innovations can be well received; without, hardly any innovation could substitute bonds within people, people with their institutions and people with nature.

The call for interdisciplinarity is a call for understanding better the complexity of today's world. Certainly, engineering plays a major role in the implementation of material improvements, but when negative experiences in the interaction technology-society start to proliferate, it is time to pose new questions. As society is the basis of our human reality, questions aiming at comprehension, values, and sense must be addressed. Social Sciences have theorized regarding all those topics. But as Plato once said, there is nothing more practical than theory. At any time in history, abstractions about society have found in daily life a correspondence and a feedback. We will see in the next section, how some of the general considerations about social analysis have landed in specific practical tools that concern the energy transition.

3. Social impact assessment tool

In this section, a brief critical history of the origin of the SIA and an interesting cycle of applications and reflections experienced by the practitioners of that tool during the 1970s and 1980s will be shown. Having in mind some critical perspectives and, indeed, actual debates regarding social impacts, the SIA will be presented in the framework of the International Association for Impact Assessment (IAIA) as a compilation of best practices. Finally, some specific tools for addressing socio-economic variables will be presented.

3.1 A brief (critical) history

The history of Social Impact Assessment (SIA) begins in the 1970s, at the same time that new environmental legislation came into action via the National Environmental Policy Act (NEPA) in the United States of America. Measuring the

effects of technological developments within parameters of quality of human life became relevant in the context where diagnosis of environmental degradation and complex processes of decision making were more and more intertwined. This was first appointed by the Environmental Impact Statement (EIS), concerning alterations in the biophysical environment and, only when social and economic impacts were “clearly interrelated,” they were included in an EIS. This subject was ambiguous at the time, and became clearer as specific cases were treated. Here are two examples:

1. In 1983, the US Council of Environmental Quality required the Nuclear Regulatory Commission to prepare an EIS before restarting operations of a nuclear reactor at Three Mile Island. Some citizens argued that the psychological health of people of the area could be in jeopardy, but the US Supreme Court (*Metropolitan Edison Co. v. People Against Nuclear Energy*, 460 U.S. 766, 103 S. Ct. 1556 [1983]) did not find a close causal connection between the act of restarting the reactor and an increase in mental health problems. Although this was not solved in favor of a “social cause,” it is the first antecedent of a SIA-related litigation.
2. In 1985, the Department of the Interior prepared an EIS on an affected area that involved the largest federal coal lease ever held. The Northern Cheyenne Tribe, inhabitants of that territory, sued the Department of the Interior for not including in their EIS likely social, cultural, and economic impacts of the project. They succeeded. A judge voided the sale of over 350 million tons of Federal coal (with a market price of 4 billion dollars) and rebuked the Department of the Interior for failing to deliver a meaningful analysis of impacts on certain groups of residents within the affected area of Federal coal with a market price of 4 billion dollars [11].

These precedents are relevant because it is in the context of interpretation and application of new legislation that the society and its different groups (private sector, indigenous groups, academia, government, etc.) make sense of their future interaction regarding construction projects. A unique, centralized, and unquestionable decision of industrial development—just for the sake of industrial development as an autonomous process of prosperity—would be no longer viable. Assuring that fundamental social structures are not torn apart while promoting material improvements is the goal of a Social Impact Assessment. So it is a contribution to broader policy considerations.

The discussion of what is a benefit or a damage in the social realm is a complex problem, a problem that may show a partial solution in a sense, but reveals negative consequences in another. For example, economic benefits of growth show results in solving some rural poverty and urban crises. A general indicator of employment may give signs of increase, but analyzing long-term effects can reveal, for example, concentration in less-skilled job categories, almost no decrease in local unemployment rate, and no influence on local youth to stay in their communities [11].

Precisely, in the history of SIA, there are cycles of understanding it as a tool. In the period 1970–1975, there was a strong tendency to develop guidelines, in which the American Sociological Association played an important role in using Social Sciences frameworks to clarify human–environment aspects in general terms. Later on, from 1975 to 1980, there was a bloom of application of SIA in a context of development of massive projects and energy development; procedural guidance was needed and all sorts of manuals were published with “all the information necessary

to conduct a SIA” [11]. Finally, during 1981–1986 there was a reflection of what was known about social impacts, having empirical evidence accumulated during years. General problematic dichotomies were pointed out, such as: quantitative methods/qualitative methods, account of attitudes/non-attitudes, need for original data/use of publicly data, and use of many metrics/combining all impacts on a single metric. Some agreements of that epoch were:

1. It is inappropriate to limit a SIA to available data.
2. SIAs should not be limited to variables that are easily quantified and/or politically convenient to a certain group or person.
3. The summary to decision-makers should provide relevant information for judgment, even though it is expressed in many metrics; combining incommensurable metrics in favor of a simplistic “overall figure” should be avoided.

This brief and selective historical context has a purpose. Nowadays, there is a lot of material regarding procedural guidance on how to conduct a SIA. Reflections of the recent past should not be forgotten. The debate is still open between alternatives and the debate is still open within perspectives: help communities cope with (a certain type of) development or help developers learn about the livelihoods of non-urbanized communities. Are social scientists seen as internal proponents for community interests or as workers in favor of the developers’ projects? Is it possible to identify a pro- or an anti-development bias in the SIA according to its legal structure? Should impacts be publicly revealed or maintained inside a private communicative sphere? Should social impacts be considered only during a project development or should they take into account long-term social problems (e.g., the erosion of a community’s economic base) as well as changes in national policies? Should planning stay within the limits of *ceteris paribus* conditions or should other strategies be adopted for dealing with uncertainties?

3.2 The social impact assessment of the IAIA

The International Association of Impact Assessments (IAIA) in its *Guidance for assessing and managing the social impacts of projects* defines a Social Impact Assessment as “the processes of analyzing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions” [12]. It is emphasized that a SIA is not a product but a process of management that needs to be implemented at the same time of the conception and design of a project. Nowadays, social impacts are considered as modifications in people’s way of life, culture, community, political system, environment, health and well-being, personal and property rights, and fears and aspirations.

Because all of these components belong to the intimate way of life of a community, a SIA must include participatory processes that, ideally, foment bonds of solidarity. Some of the key concepts relevant to a SIA stated by IAIA are:

3.2.1 Social License to Operate

As development nowadays is more than just meeting the regulatory requirements, leading corporations are encouraged to meet expectations of the local

impacted communities as well as of governments and international ONG's. This term is mainly a language of business driving strategies to avoid reputational harm and, in the worst scenarios, strikes, protests, sabotages, and legal actions.

3.2.2 Free, Prior, and Informed Consent (FPIC)

Communication between a project developer and a local community must avoid coercion or manipulation of information (in favor of stakeholders). Consent must be sought before any technical intervention in the inhabited territory and complete information must be given to the parts explicitly stating the possible benefits and negative aspects of the project. The idea of self-determination of a community implies the possibility of saying no to a project. Reaching a consent means communities have a real option to say no or yes to a certain project.

3.2.3 Human rights-based approach

This measure is in line with the political philosophy of democratic regimes where human rights are at the core element of actions. Also, the demand for accountability and transparency, fostering empowerment, ensuring meaningful participation of right-holders, and guaranteeing non-discriminatory engagement, prioritizing vulnerable groups has become a clear mandate for any perspective of development.

3.2.4 Non-technical risks

Risks concerning managerial, legal, social, and political issues must not be minimized in contrast with physical, structural, and engineering risks.

3.2.5 Shared value

Considering not only conventional economic needs but societal needs is what gives meaning to the shared value. It is a way of re-considering the role of a company beyond profit and engaging with society benefits at the same time.

Within all these key concepts, IAIA guide suggests that there are four phases in a SIA, which are:

1. Understand the issues
2. Predict, analyze, and assess the likely impact pathways
3. Develop and implement strategies
4. Design and implement monitoring programs

For a deeper view on these subjects, IAIA guide is offered for free as a digital document. The considerations that concern this chapter are for introductory purposes in understanding some particularities of integrating social issues in engineering projects.

-[P] New regulations concerning social impacts, as you may see, try to encompass and preserve a delicate equilibrium. One that is similar to that of the physical environment, with balances and subtle ties that if not attended can lead to disastrous consequences.

-[ES] I see... at least the same rigor and seriousness of a physical balance of flows is needed in the social realm. I know, I know, with its own concepts and procedures, but at the same level of importance. So I wonder how some of these procedures operate in coastal environments...

3.3 An outline for coastal contexts

Relationships between people and the ocean can shape the sense of place, personal identity, and a broad array of leisure, recreation, and work opportunities [13]. Increasingly, oceans are being used to meet resource needs. Marine energy development may play an important role in the redistribution of ownership rights in the marine environment changing the distribution of the current economic activities [14].

In this section, we identify the socioeconomic elements that may shape the public acceptance or perceptions related to marine renewable energy projects.

3.3.1 Public engagement

Support for renewable energy often stems from environmental concerns and ethical obligations related with fossil fuel generation and climate change consequences. Offshore renewable energy developments are often opposed due to concerns about the cumulative impacts of arrays of devices on landscapes and marine life. Also, the opposition may be based on a desire to keep the ocean free of industrial development to keep it intact [15]. However, public consultation can identify a timeline of the transformations of the territory. Yet, Social Sciences remain underutilized in energy policy, especially in a marine context [16]. Thus, creating alliances between stakeholders and the population could set the path to achieve agreements to promote sustainable development and design appropriate projects.

3.3.2 Disruptions of the landscape

Natural environments provide a wide variety of ecosystem services, which classify in (a) supporting services, (b) provision services, (c) regulating services, and (d) cultural services, this one is related to the spiritual attachment of the population or appreciation of the landscape. This service has a strong influence on the well-being of the communities, so the impact of visual disturbance is one of the aspects for opposing to a renewable energy project.

3.3.3 Changes in the economic activities of the area

Traditional maritime sectors are not always spatially compatible with the development of new maritime industries. In coastal zones, fishery is one of the main economic activities of the community. Possible restrictions and negative influence over the fish stocks are among the concerns in this area. Also, competition between different sectors for alternative uses of sea space can lead to sub-optimal economic development, which can cause conflicts between sectors and the rejection of the population and industries [17, 18]. While developers often meet only statutory requirements to acquire legal rights to occupy the sea space and exploit marine energy resources, they must also balance this with the rights and prerogatives of other sea users. There is little precedent regarding this subject due to minority of success in commercial developments. It would be useful to develop some guidance [19].

3.3.4 Energy supply

One of the targets of marine renewable energy is to establish a supply chain for the coastal communities to sustain the economic activities. The presence of Marine Renewable Energy (MRE) devices can address the current and future power needs of remote communities [20]. The expansion of the grid represents an increase in the cost of the projects, so developers are responsible for providing precise information of the range of the potential supply of the technologies and the percentage of the benefited population. Increased access to energy will improve the conditions of the communities such as: housing conditions, economical activities, services, etc. Energy access is variable and associated with local context. The access to this basic service may have positive repercussions and this could change the perception of the population regarding the modifications in the environment as a result of the establishment of an MRE extraction device.

3.3.5 Marine spatial planning (MSP)

The coastal zone is a particular area due to its inherent ecotone characteristics; coastal ecosystem has already experienced major changes due to human activities, triggering spatial conflict of uses and demands that are increasingly growing [21]. The issue manifests in the lack of mechanisms for monitoring, regulating, and legislating marine space. The marine spatial planning (MSP) is a multidisciplinary instrument for the promotion of sustainable development in the coastal and marine space. It seeks an active society participation in the consultation phase with the purpose of identifying the socio-environmental problem [22]. Identifying the problems related to the different anthropogenic activities that are carried out in the coastal zone to assess its impact and determine if it is necessary to carry out an order to avoid conflicts between sectors is fundamental. Thus, the combination of ecological and human data in management instruments is particularly valuable in visualizing overlapping interest to achieve communication channels [20, 21, 23].

4. The Sustainable Development Goals

-[ES] Professor, you mentioned earlier how Fourier was committed to a sociopolitical project of his time, right? I guess that was his motivation for his technical work. Is there something similar today?

-[P] In a certain way there is. Have you heard about Sustainable Development? It is a political attempt, by all 193 member States of the United Nations, to impulse and prosperity, peace and partnership among people and promote caring for the planet. As geopolitical scenarios get more complicated, and the unintended consequences of development shows that poverty, inequality, violence and environmental degradation is the general case of the world, Sustainable Development rises as a pathway to prevent disastrous consequences. That's probably why Human Rights have climbed into such a determinant position even in front of development projects that involve great amounts of money, material resources and innovative technology... without a societal support, there are no pillars that could support development.

In 2015, the United Nations (UN) adopted the Agenda 2030 for Sustainable Development along with 17 Sustainable Development Goals (SDGs), which allow countries to concentrate their efforts toward common objectives. With regard to the energy sector, the UN included the Sustainable Development Goal 7 (SDG7), which

aims at ensuring access to “affordable, reliable, sustainable and modern energy for all” [24]. Even though SDG7 stands as a goal in itself, it is of particular relevance because of its interrelation with the rest of the SDGs. In this sense, it is important to remember that energy is crucial for ensuring access to clean water and sanitation, health services, education, food, transportation, communications, and security, among others [22].

The SDGs are based on a holistic perspective of sustainable development that takes into account social, environmental, and economic concerns. In this sense, the SDGs recognize that the best way for addressing the most pressing challenges of the twenty-first century is through strategies that build economic growth and address the current social needs while at the same time they address climate change and focus on environmental protection [25]. With this perspective, the SDGs can be understood as goals that are interlinked and interrelated. This means that it is not possible to address one goal without also advancing in other goals.

With SDG7, the UN recognizes that energy is central for addressing every major challenge in the world today, from climate change to ending poverty, and indicates that access to energy for all is essential for sustainable development [26]. However, the UN points out that providing access to energy for all should be done through clean and sustainable sources of energy: “ensure access to affordable, reliable, sustainable and modern energy for all” [24], which can be expected to have an impact on the rest of the goals. In this sense, SDG7 can be considered as an enabling factor for addressing the rest of the SDGs [27].

To begin with, SDG7 aims to guarantee universal access to affordable, reliable, and modern energy services for all. This is crucial for vulnerable people around the world in order to be able to meet their basic needs and get access to basic services such as health care, education, information, adequate and safe housing, and access to drinking water and sanitation services (see **Figure 1**) [26]. Furthermore, energy is a fundamental input for daily activities such as lighting and electronic appliances whether they are for cooking, cleaning, leisure, or security [26].

One of the most pressing challenges in the world is to increase the access to clean cooking fuels and technologies. In 2017, only 61% of the global population had access to clean cooking fuels and technologies, which meant that the other 39%, almost 3 billion people, relied on inefficient and polluting cooking systems [24]. The use of wood, charcoal, and dung as fuel for cooking or for heating results in a constant interaction with smoke that includes a variety of pollutants and

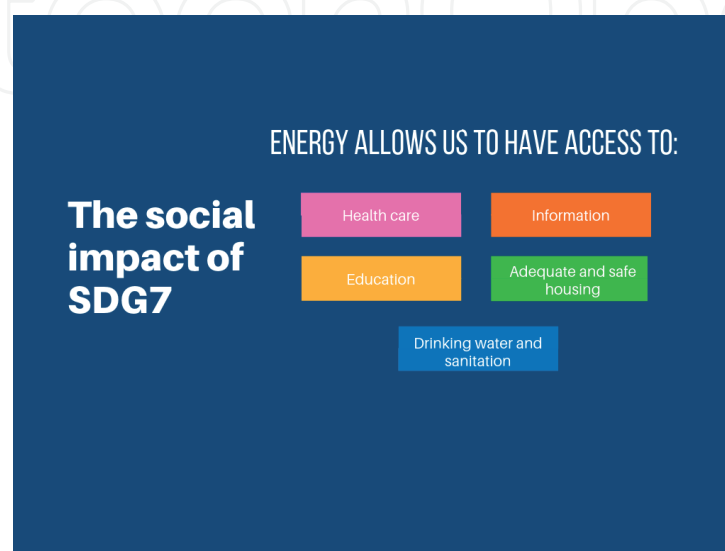


Figure 1. Energy allows us to meet our basic needs and have access to basic services. Note: Graphic created by the authors.



Figure 2.
Social benefits of sustainable energy. Note: Graphic created by the authors.

translates into adverse health effects [26]. Likewise, increasing the access to clean and sustainable energy is particularly relevant for communities that are faced with extreme temperatures and need to use energy either in cooling or on heating systems [28].

The same can be said with regard to the transportation sector, which represents approximately 19% of the global use of energy and emits 23% of all the energy-related CO₂ emissions [28]. Whether it is by planes, buses, cars, trains, or ships, most of our modes of transportation still depend on fossil fuels and emit dangerous pollutants into the atmosphere that include greenhouse gases and particles that produce adverse health effects and have a negative environmental impact.

At the same time, guaranteeing universal access to affordable, reliable, and modern energy services could have contributions to reducing poverty, violence, and inequalities [26]. For example, an increment in the hours of access to electricity per day in communities with limited access to energy can have effects such as a higher number of people engaged in productive activities, longer hours of public lighting, which can increase safety at night, and reduction of the amount of hours dedicated to securing access to water, food, and heating/cooling, activities that are mostly carried out by women in the vulnerable sectors of the population (see **Figure 2**) [24, 26].

It is important to point out that the energy sector is the major contributor to climate change, representing approximately 60% of the total greenhouse gas emissions [29]. Therefore, transitioning toward clean and sustainable energy sources can have a significant impact in mitigating the adverse effects of climate change.

5. Conclusions

Renewable energies are in the middle of an ongoing debate about the means and the ends. The use of energy, especially since the Industrial Revolution, has been a fulcrum of an unparalleled material innovation that adds, not substitutes, the mechanical forces of a human body. Engineering has shown the amazing power of machines, which can be seen as the concrete expression of the most profound physical-mathematical abstractions articulated in ingenious, solid, and complex artifacts. Challenges concerning technical difficulties in the physical realm are incentives to the human mind to solve certain problems that derive from a feedback from nature: if a material does not resist or if a device malfunctions in particular conditions, we learn something from experience. We are to modify things in our procedures to test again our creations against wind, soil, and water.

But what about the social realm? Certainly, the same profundity in thoughts and abstractions is found in political theories, moral codes, and various philosophies. Material innovation is interrelated with social processes as much as biological phenomena in the ocean is interrelated with physico-chemical reactions. Ideas about human order (what should be the path to follow) encourage certain material arrangements and, in a cycle, material arrangements can modify and give birth to other ideas about the direction of progress. Our feedback from that social nature, in our statistics, is not uplifting. Lessons learned from the Industrial Revolution teach us that merely material innovation is not enough for solving deep societal problems in the world.

The debate between means and ends puts on the table a redefinition of the learning cycle of knowledge: proceed to let the social realm guide the technical innovations. To evaluate what “human needs” means requires not a unique paradigm, but flexible plans for different contexts of our multicultural world. That is one of the goals for the Social Impact Assessment: keeping possible a real scenario of communication and choice between a development proposal (that involves intervention in an inhabitant territory) and the people living in that particular place. It is a tool wide enough to interpret it as solely a new restriction and warning for profit-making under stricter rules, or a new way of making business that even benefits the profit-making as the world markets incorporate the environmental-social schemes, or as a political project that will try to show how it would look like if social parameters are the guiding line of the continuous industrial development, now, under regulations of environmental and human rights protection.

From these three perspectives, there are as many nuances as contexts in the world. General guides as the one offered by IAIA are very valuable sources that gather many lessons learned since the appearance of the SIA in the 1970s. This chapter intended to be a wider introduction for those themes, not pretending to substitute them but to offer some basic and interesting points to think about for an engineering student. The first section, presented mainly as a dialogue, meant to put into consideration what interdisciplinarity is about, at least in its attempt to bring together Engineering and Social Sciences. Afterward, we presented what can be understood, in general terms, by a social analysis. Broad considerations about the social object were stated just as examples to visualize some specific categories that contrast the vocabulary often used in Natural Sciences.

The brief historical preface of the SIA as a tool had two purposes: to reach some valuable reflections that came into surface during the 1970s and 1980s, when Environmental Impact Assessment included social and economic impacts as well. The other purpose was to show the value of historical research (part of Social Sciences) as people may be misguided by the apparent novelty of tendencies that,

in fact, comes always from a historical process that has already clues of what is expected to be the result in the present.

From the general to the particular, we landed in a brief presentation of the SIA covering some fundamental perspectives and, later on, we gave a concrete example of a social assessment tool regarding marine environments. The last part concerning the SDG gives a closure to make sense why criteria about development are shifting from an apparent autonomous progress held by material innovations to the inter-linkage of objectives, both social and technical, to face extended worldwide poverty, inequities, and escalation of conflicts.

Social energy, as a metaphor of the relevance of our social structure, is making its way in the priorities of international agenda. For people acquainted with Social Sciences, these may be seen as something familiar and positive (yet, many adjustments are still needed [30]). People from other areas might perceive it as something strange and somehow imposing. Instead, it should be seen as an experiment, trying to take into consideration the feedback of history. It will be a long process of blending disciplines in which one may need wider perspectives to fully understand the phenomena at stake. Fourier or Laplace can give us clues of such a comprehension, and models for the engineering students of the future.

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