

Sustainability as a Paradigm of Energy Policy

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Abstract. The overall energy concept will be the priority matter in the agendas of the various governments in the coming years. The economic prosperity and development of knowledge of nations inevitably depends on energy. For that reason, it is important that institutions establish policies that promote energy sustainability of countries. But their different energy and territorial situation complicate obtaining a suitable model of indicators which could be used to build policies on energy to promote a sustainable development. In short, in this article the fundamental premises are determined to define a indicators model for energy sustainability of countries. Similarly other subsystems about sustainable development are defined. A starting model for the definition of energy policies has been set to take into account all the variables and their relationships.

Key words

Energy, sustainability, policy, technology

1. Introduction

Before addressing the concept of energy sustainability, sustainable economy or sustainable development should be defined. There are multiple meanings, literature and authors that describe the many nuances of the definition (Pezzey, 1997), (Neumayer, 2003) or (Ciegis, 2009). This term was first used in the Brundtland Report, presented at the World Commission on Environment and Development United Nations in 1987 (The World Commission on environment and Development, 1987), and the conceptual definition is: "satisfy the needs of energy of the present generation without compromising the ability of future generations to satisfy their own needs". Therefore, one of the fundamental premises of sustainable development as discussed below, will be decoupled that dependency, and consequently, the variation of the dimensions does not influence the development and evolution of contiguous. It is widely recognized that sustainable development consists of three closely related dimensions: environment, economy and society (Munasinghe, 1992) and (Ghosh, 2008). Any change in one dimension significantly affects the other two (Lior, 2010) and moreover, they are closely interrelated. Therefore, one of the basic tenets of sustainable development as, discussed below, will be to decouple that dependency, so the variation in one

dimension would not influence the development and evolution of the adjacent. For suitable explanation of these three dimensions a Venn diagram is used. This method uses a graphical representation to argue logically the produces. But the problem will be more complicated by incorporating the energy subsystem and traditionalist conceptions and definitions of sustainable development, (included in Romero, 2014). The role of natural value is the main problem to be solved, according to the operational conceptualization of sustainable development based in values (Neumayer, 2003). This method aims to protect various types of values such as: monetary, human, social and natural. Those are the tools to meet all human needs. Therefore, the natural value is the source of the two main schools of knowledge: the strong paradigm of sustainability: proposing the natural principal as a limit to growth; and weak sustainability paradigm: proposing permeability between the different principals, even the natural. A representation of sustainable development using the strong paradigm is shown in Figure 1, in which the absolute limits of nature prevents development of society and economic activity based on those limits are recognized. This paradigm, as shown below, cannot develop the conceptualization proposed in this paper.

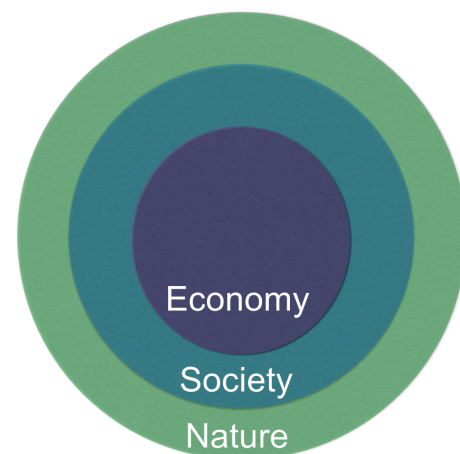


Fig. 1. Dimensions of sustainable development as the paradigm of strong sustainability.

The following diagram will be more adequate to represent the relationship between the three dimensions, see Figure

2. In this diagram it has been taken into account a weak paradigm of sustainable development.

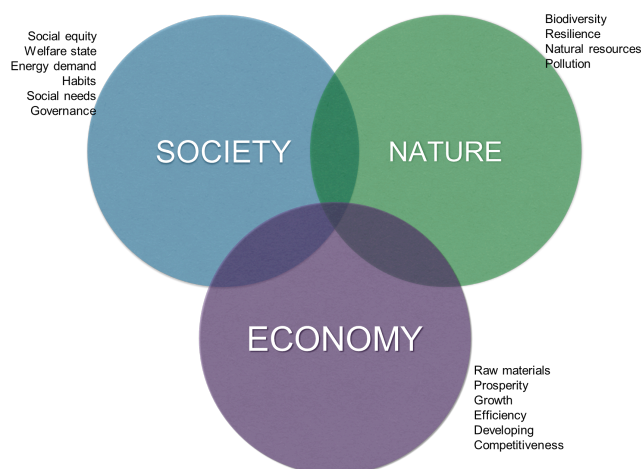


Fig. 2. Dimensions of sustainable development as the paradigm of weak sustainability.

The three dimensions of a sustainable development are:

- The society (represents social equity, the welfare state, energy demand, habits and social needs, the government and regulation, and ultimately all actions aimed at reducing inequalities between peoples);
- The nature (where emissions are included, waste, environmental degradation, resilience, biodiversity, natural resources, anything that will jeopardize the environmental balance for future generations)
- The economy (the production of raw materials, prosperity, growth, efficiency and optimization of processes, stability, economic development that will meet the needs of the population).

Intersections that are represented in the Venn diagram define areas containing variables in common to two or even all three dimensions of sustainable development. From an economist point of view, making use of advances in technology and applying the concept of efficiency through policies of governments and institutions to promote their implementation, a dissociation of the dimensions of sustainable development is achieved. That is, it is able to reduce the negative impact on the whole, of any change in one of them, what drives exponentially the possibilities of human development. You can illustrate the problem of dissociation between the three dimensions reducing the problem to a more operational level. In general, the increase of industrial production (economy), using the same level of technology and resources, means to increase emissions and waste (nature). But if we incorporate a new technology to produce more with fewer resources and we also reduce pollutant emissions and waste generated during the process, or even the technology allows recovery and recycling of such waste, we achieve a decoupling between the two dimensions: economy and nature. For instance increasing production to meet social needs will not produce an increase in environmental degradation; therefore we are getting a sustainable outcome. In the building field, for example,

the electricity consumption by the home user (society) involves consumption of primary energy needed to generate that electricity (coal, nuclear, renewable...) which produces emissions (Nature) that will be greater the more power is demanded. Therefore, if some policies that encourage saving measures and energy efficiency in building construction are applied, and if modern technologies that respect the environment in the process of generating electricity are used, finally we will ultimately reduce energy consumption and therefore the dissociation between society and nature areas. This will be obtained with public awareness policies, with a change of habits in energy consumption by users.

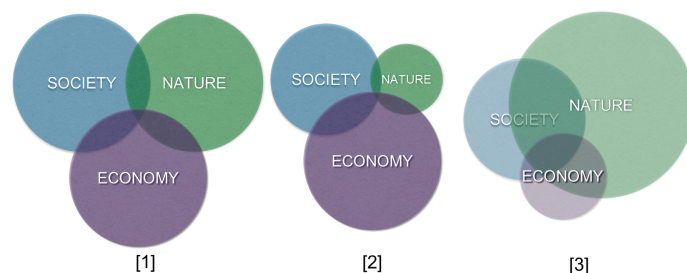


Fig. 3. Venn diagram for the three pillars of sustainable development. Source: (IUCN - The World Conservation Union, 2004) IUCN Programme 2005-2008: Many Voices, One Earth and authors.

As shown in Figure 3, the different socio-political humanity to explain their level of commitment to sustainable development based on the relative size of the three-dimensional models. So, a purely capitalist model, as shown in [2], would be used if the size of the economy and the competitiveness becomes more relevant to the environmental or social area. Social counterpoint would be given by [3] using a model in which an ecological thought would transcend social and economic growth. Finally, it should be explained a model in which the social dimension acquired greater relevance, and competitiveness would give a way to competitiveness (competitiveness through cooperation).

2. Transverse forces: technology and policy.

Therefore, you must define a model taking into account these transverse forces, and establishing a second layer to those subsystems that in aggregate support sustainable development. The problem is complex to solve it globally, but is crucial to define a model of indicators to evaluate the direction in which to establish appropriate policies. Finally, it is important to emphasize the concepts of global and local sustainability (Naredo, 1996) when the study area is established. As it approaches the transverse forces will be different taking the global Earth or considering a reference scale more premises for processes, decisions or smaller and limited in space and time subsystems. This argument will be taken into account in the definition of the three premises of energy sustainability in point 4. To sum up, institutional policies and regulations (Vera, 2005) as well as science and (Robles, 2011) technology must be

considered as transverse forces to the three dimensions of sustainable development for their relevance and influence.

Mayer researches in Sustainability (Mayer, 2008) allow us to state that a system with certain dimensions, as a general rule, will be sustainable if it is sustainable each and every one of the dimensions. Scientific and practical application through technology innovation and knowledge could become a valuable tool for humanity because this drives and manages it. But the social, economic and cultural inequalities between nations become complex analysis using any technology as a global concept (Fernandez-Baldor, 2012). It is the term "appropriate technology", popularized by Schumacher.

Appropriate technology, as transverse force, can be a source of dissociation of the dimensions of sustainable development. This introduces us to a new paradigm. A technological system, i.e., a set of technologies and their social, economic and environmental implications, can be characterized through its interaction with society, nature and the economy as the foundation of all prosperity and development of mankind. To understand technology as a transverse force to the three dimensions, it should be ignored the debate over whether to condemn or praise the development and use of science and technology as it can be cause massive damage to the environment, or development and prosperity for civilizations but, in itself, we must understand it as objective and neutral: there should be no interest or subjective factors in its content, and its effects and consequences depend on the use made of it humanity.

The path of a sustainable system can be affected by disasters and unexpected and unforeseeable circumstances. The unpredictable nature of disasters any of their origin, we cannot be forecasted and cannot be get by therefore we must discard the transverse force in the study, although it will always be present.

We think that setting limits to sustainable development can only remain unchanged if the time and space dimensions remain unchanged. From the moment that the system evolves in the space-time dimension new limits can be established. Moreover, a proper management of technology from humanity will allow energy sustainability beyond the limitations of nature. This would reflect a new vision of thought set about creating limits to growth (Meadows, 1972).

Finally, the policy as transverse force will affect forcefully about the social, economic and environmental dimensions of sustainable development (Vera, 2005). This Policy involves: managing the governance of nations, cooperation between governments to unify the energy and environmental policies, agreements reached at the summits on energy and climate, strategic energy plans the ability to obtain and analyze indicators, matching capacity investments, education, research or development etc. In conclusion, the political management is remarkable and very important aspect that must transcend the three dimensions, described above, and take a leading role in the model.

3. Subsystems in sustainable development. Contextualization of energy sustainability.

Before addressing the conceptualization of sustainable energy, it should be done a reflection about the sustainable development and the need to recognize the existence of other subsystems that are a source of partial sustainability (Naredo, 1996). Moreover, it is needed an efficiently manage for sustainable development and finally a complete separation of the three dimensions.

It is widely recognized that factors such as population growth and population migration, impact significantly on food demand, and therefore produce a higher impact on water resources. These resources will have a significant influence on production and economic growth, health and society. This will effect on environment and will promote a climate change. In earlier civilizations water management has been a priority for economic and social development issue, and now also plays a key problem in many regions. All this leads to the requirement for a sustainable water management and water resources. Water management should be an additional subsystem in the contextualization of energy sustainability, despite it will not be analysed in this work.

The demographic changes, the rural exodus and urbanization and outsourcing cities are a manageable paradigm. According to UN surveys, 54% of the world's population lives in urban areas and is expected to reach 66% by 2050 (United Nations, 2014) therefore, the territorial and urban management must also be conceived as a subsystem sustainable development.

Finally, the atmospheric environment is a subsystem contextualized in the model. It impacts significantly on human development, the economy and in society and their activity produces pollution that contributes significantly on the environment.

Therefore, the above four subsystems: energy management, territoriality, air quality and water resources management, create an interrelated model. This model will be possible if all sustainable development and each of the subsystems are sustainable (Figure 4).

This paper is an approach to the study of energy management as a subsystem of sustainable development. It is necessary to be clarified that is closely related to the other subsystems and sometimes variables can be considered shared by those subsystems.

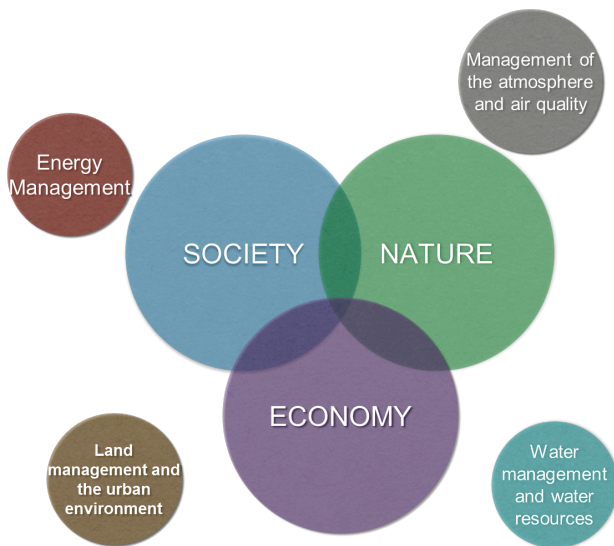


Fig. 4. Contextualization of energy sustainability.

4. Premises of energy sustainability.

Entrepreneurs and policymakers and other stakeholders in the energy sector need reliable sources as dynamic as in the energy sector matter. They need agile and also accurate information to be able to do informed decisions in the short and medium term. Therefore, treatment of the information and making it available to agents in order to enabling them to define business strategies, growth policies, and moreover regulations must be focused on the real needs of information in the sector. But which variables are more proportionate? which more accurate definition of sustainable energy that can be used to define these variables? It is not an easy task because of the number of interconnections of the sector of energy to other areas such as: political, social, economic, infrastructure, ... Therefore also the dissociation between the three dimensions of sustainable development could only be conceived by the weak sustainability paradigm in the conceptualization of sustainable development.

A starting point should be the three fundamental premises:

- First premise lies in the use of the paradigm of weak sustainability (Norton, 1992) as the only way to taking the transverse force of technology that allows expanding the boundaries of natural capital. On the other hand when it is included a strong paradigm of sustainable development it is not possible to do a forecast because nature capital is explained as a limited capital. Therefore also the dissociation between the three dimensions of sustainable development could only be understood by the weak sustainability paradigm in the conceptualization of sustainable development.
- Second premise is that sustainable energy underlies sustainable development and should be considered separately. Then, energy sustainability is at a different layer defined by the three dimensions of sustainable development: economy, environment and social equity. A sustainable development will be not possible without

sustainable energy to allow such development. At the same time, as explained in point 3 other subsystems will exist around the three dimensions of sustainable development.

- The third premise is to question the appropriateness of indicators to different economic, energy, territorial and social situations in different countries, that is to say, not all indicators will be most suitable for analysis of the energy situation in the various nations taking into account the concept of local sustainability (Naredo, 1996).

Given the importance of this last premise, several examples are given below. The first two premises have been explained in the initial points.

In the third premise subsystem water sustainability and sustainable water management; are strongly linked to the three pillars of sustainable development: society, nature and the economy. Global demand for water is strongly influenced by population growth, feeding and behavior patterns of different cultures, energy policy and production sectors of the countries. It is very interesting to compare the situation of countries like Spain and the United Kingdom studying hydrographic data. The first has on its terrain a relief with a peninsular average altitude of 660 meters, completely different to the UK, where most of the territory does not exceed 200 meters. That different configuration, can obtain water resources for Spain through reservoirs (about 56,000 hm³) much higher than the UK. Where Spain has an average rainfall of 636 m³ /year in the United Kingdom is 1220 m³ / year. But nevertheless, these differences are not reflected in the water stress that demonstrates the two countries, which is similar (United Nations Educational, Scientific and Cultural Organization - UNESCO, 2015). However, the same indicator may be irrelevant as the analysis is performed in one country or another.

For example, a region such as Western Europe, where there is a great dependence on foreign energy and an important contribution from power sector in the final energy available, it should be assessed indicators that have nothing to do with those needed for the Central African region, whose electrical dependence is much lower. Somalia, a country in which agriculture accounts for 60.2 % of GDP is in a completely different UK energy situation where agriculture represents about 1 % of GDP. Therefore, we should not talk so much about energy sustainability indicators except models of sustainability indicators that will be appropriate for different situations of countries. From the definition and analysis of these indicators, the most suitable policies could be developed by different nations for the development of sustainable energy.

5. Conceptualization of energy sustainability

There are different models proposed for the definition of energy sustainability that they are briefly described below.

The World Energy Council has developed the concept of "Energy Trilemma" based on three dimensions: energy security, energy equity and environmental sustainability, which bring together 22 kinds of indicators of data collected worldwide to obtain an Energy Sustainability Index. This index reports the degree of compliance of countries related to these three dimensions. The World Energy Council define the use of these three variables for a definition of energy sustainability:

- Security of supply: an indicator of the effective management of primary energy supply, reliability of energy infrastructure, and the ability of the agents involved in the sector to ensure the demand meet from now to the future.
- Energy Equity: The degree of guarantee of accessibility and affordability of energy supply to the entire population of any country.
- Environmental sustainability: the degree of efficient supply and energy demand as well as the degree of development of energy from renewable sources and other sources of low-carbon consumption.

In other hand, the International Atomic Energy Agency - IAEA developed the ISED: Indicators for Sustainable Energy Development, in cooperation with other international organizations based in the conceptualization of four dimensions (Vera, 2005):

- The economic dimension: measuring usage patterns, production and supply of energy efficiency and energy intensity transformations, energy prices, taxes and fees, security of supply and diversity of the mix.
- The social dimension: measuring the impact of energy on social welfare, in terms of employment, poverty, education, culture, demographic transition, pollution and environmental health. It also describes the problems related to accessibility, affordability and the disparity between supply and demand of energy. This dimension highlights the difficulty of collecting appropriate data in developing countries.
- The environmental dimension: measuring the environmental impact of production, distribution and use of energy for consumers and users, industries and cities, considering a global, national or regional level.
- The institutional dimension. This dimension measures the degree of incidence of energy policies in a given state, the existence and effectiveness of national energy plans, the capacity for analysis and compilation of statistical data, and the adequacy and effectiveness of new investment in capacity, education or research and development. Therefore this indicator is particularly difficult to define.

According to studies from Romero (Romero, 2014), and based on researches from Neumayer (Neumayer, 2003), they claim that sustainable energy model will be the one that meets three key conditions for sustainability:

1. A model that enables non-decreasing level of welfare, including the four types of assets: economic, natural, social and human.
2. A model that ensures social equity between generations.
3. A model that respects the resilient limits of the medium.

In the previous different approaches, the three dimensions of sustainable development underlie the different conceptualizations of energy sustainability of different authors and organizations. But understanding the conceptualization of sustainable energy as a subsystem of sustainable development, is has to be located on a different layer, but adjacent to the location of the transverse forces that influence the dissociation of the dimensions that determine sustainable development of mankind. They are: technological and scientific developments on the one hand and regulatory and governance of political institutions on the other, as shown in Figure 5.

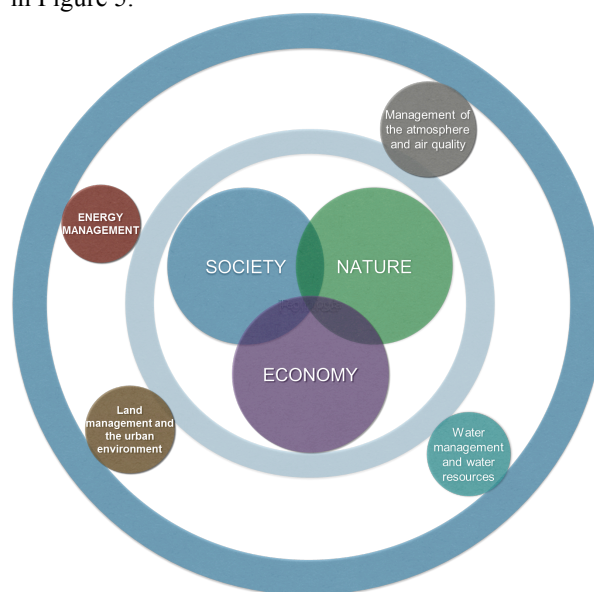


Fig. 5. Subsystems to consider sustainable development and transverse forces.

The technological and scientific developments could be understood within the social dimension of sustainable development. These variables but must acquire a distinct location in the analysis moving to the outer layer of sustainable development. Where from that layer, also explains the four subsystems:

- Energy Sustainability ,
- Territorial and Urban Sustainability ,
- Sustainability of Water Resources
- Sustainability in the atmosphere

Finally, surrounding the whole system, there are institutional policies and regulations and governance of nations. These must combine all areas by: promoting energy efficiency, defining tax and fiscal policies aimed at reducing pollution, establishing treaties and agreements international emissions trading, always involving all subsystems. This parameter will allow the success or failure of sustainable energy.

6. Conclusions

The model explained in this paper is based on the paradigm of sustainable development with the three dimensions established: nature, society and economy, with a significant influence of two transverse forces: on one hand "the policy": managing the governance and cooperation between governments, the strategies, the capacity for analysis of indicators, investment management, and on the other hand the "appropriate technology": defined by social, economic and cultural disparities between the various nations, therefore, analysis of technology becomes sterile as a global concept.

Therefore we must doubt about the suitability of a definition of valid universal indicators for all countries, as different economic, energy, territorial and social situations are different in all countries, that is to say, that not all indicators are suitable for analysis of the energy situation in the various nations.

Four subsystems around sustainable development can be taken into account: energy management, urban and land management, air protection and air quality management and water resources are established. These parameters together with the three dimensions of sustainable development create an interrelated model on which to build indicators. Moreover, the degree of development of these subsystems at the local level should discriminate those indicators that are not appropriate for carrying out any further analysis.

Finally, the model should be considered from the weak paradigm of sustainability, that is, from the absence of limits to sustainable development, considering that, a proper management of technology from humanity can create new subsystems that promote sustainable development beyond the limitations of nature.

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