

# **Sustainable development: Challenges for Sugar Mills**

**Maximiliano Arroyo Ulloa**

Industrial Engineering Department  
Santo Toribio of Mogrovejo Catholic University  
Chiclayo, Peru  
[marroyo@usat.edu.pe](mailto:marroyo@usat.edu.pe)

**Maira Arroyo Lujan**

Management Department  
Decorlux SAC Enterprises  
Lima, Peru  
[maira.arroyo@decorlux.com.pe](mailto:maira.arroyo@decorlux.com.pe)

**Javier Beltran Reyes**

Bussiness Intelligence Department  
Comercio Group  
Lima, Peru  
[Javier.beltran@comercio.com.pe](mailto:Javier.beltran@comercio.com.pe)

## **Abstract**

Development and well-being is associated with energy or technology. But development goes further, involving social development policies based on the resources available in the region: industries and natural resources. This research analyzes current situation for determining the sustainable development of the sugar mills at the north region based upon three priorities for mounting a power portfolio in a middle-long term toward an energy economy based on solar resources. The program emphasized the use of local renewable resources as a challenge and an opportunity for small-middle power plants in order to facilitate entry into the energetic market in the middle-long term of new technologies for the regional development.

## **Keywords**

Sustainable development, energy, management, policy.

## **1. Introduction**

The term paradigm is used to denominate elements that follow some design or model. A modern use of this word refers to the filters that impose our brain, for example: superstitions, concepts and the experiences that give us a way to view the things. It's possible to say that they are mental pre-concepts which is a barrier for new types of developments, for example vision of the technology and innovation. The paradigm of the sustainable development constitutes an alternative to the civilization crisis. Is not only to promote a technological and social reconfiguration but also a cultural reorientation to take full advantage of the technology, processes and achieving efficient industries (Simsek and Seashore 1994). In this sense, technology and innovation play a key role in sustainable development that looks for the maximization of the human well-being for today's generations without declining the well-being of the future generations. However, our socio-economic system does not provide adequate drivers for innovation and technological change.

Peru needs increasing supplies of energy to sustain the rapid growing economies as the population demand. Solving the energy supply and demand should be made in the best way through implementation of energy efficiency systems. It could be possible translating research results into technological proposal that enable energy renewable resources to be used more productively. A massive expansion of renewable energy is only achievable if supported by research,

strong promotional policies, and financial incentives. As a country signed of Kyoto Protocol has the responsibility to contribute with sustainable proposals to reduce the global warming. The covid-19 pandemic has shown that are necessary to made changes in the country's development goals and new trends on energy systems make necessary to create a sustainable structure in energy supply and use (linked to social-economic development), and this mean increasing use of renewable energy sources by substituting fossil fuels. At this point, the national progress in its diffusion and deployment is slow, for this reason it's necessary to decentralize the development of renewable energy system, especially at the north regions, where regional industries have the potential to save enough money by creating an active market linking local renewable energetic resources with energy management.

Lambayeque region located at the north of Peru seem to be on the right track making progress in the field of renewable energy systems providing funding, subsidies, and rural handwork. Organizational and personal experiences in renewable energy technologies have proven to be competitive in particular in remote areas. The dissemination of these renewable energy technologies however faces some barriers which could be minimized by sugarcane sector through an integral supply sugarcane model where are including all small farmer. This is a way to access to credit on a small scale. And in this way improving the living conditions of low-income people and contributing to sustainable development.

Lambayeque is an agricultural region characterized by sugarcane and rice production and where a new energy scenario could have a positive impact to extend the land base available for agricultural activities and to create new market for small rural farmers. Lambayeque has significant areas of agricultural land that could be dedicated to bioenergy production without pressure to food production on the remaining land.

## **2. Literature review**

The vulnerability of modern world is an important issue to our humanity. For this reason, it's of great importance to understand the state of system (enterprise, country, process, etc.) which may lead to the hazardous degeneration of any life support systems (United Nations 2002). The sustainable development goals aim to achieve ending poverty and protecting resources for next generation (Kates et al. 2012) but at the same time it's necessary to know the concept of sustainable agriculture because seeks integrate environment-economy- social factor which come to determinate real and relevance development policies (Rose et al. 2019).

It's necessary to review industrial policies under the sustainable development goals so that it allows to consider the social factor as a first strategy by achievement environment and economy (Sachs and Reid 2006). Industrial development policies must be dynamics according to the regional interest to reduce uncertainties in policymakers (Hezri and Hasan 2004) and precision in decision making. In developing countries, social reality forces to the governments to prioritize decisions. For this reason, the first thing is the socio - economic factor and then environmental problems. But from a strategic point of view, a change in paradigms of economic management can bring at the same time social and environment benefits: decentralized jobs, (Kemmler and Spreng 2007).

Industries have directly impact in the quality of the resident's life, offering a real possibility of development to the rural families, creating better conditions for its integration with the current world globalization. A sustainable industrial processing chain help to minimize investment costs, support social-economic development of rural areas, attract private investors, apply clean technologies and protect the environment. One problem for energy development is the low knowledge about clean energy and in consequences grows the paradigm that investment in new technologies to reduce poverty and to mitigate environmental are not commercial (Shah et al. 2011).

## **3. Methodology**

Peru is interested on electricity market reform to increase efficiency and attract investment. This energetic national policy linked to natural gas has reduced the promotion of projects based on renewable resources. Natural gas is a fossil source and price instability is a risk that we should to face in the next years. What can the central government offer to the sustainable energy development of Lambayeque region? It can offer availability of the renewable feedstock; environmental policies; and saving CO<sub>2</sub>. This research analyzes for determining the sustainable development of the sugar mills at the north region based upon three priorities (Table 1) for mounting a power portfolio in a middle-long term toward an energy economy based on solar resources. The program emphasized the use of local renewable resources as a challenge and an opportunity for small-middle power plants in order to facilitate entry into the energetic market in the middle-long term of new technologies for the regional development:

Table 1. Priorities actions

| Dimensions          | Priorities                            | Actions                                                                                                                                                                                                    |
|---------------------|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Micro level         | Promoting regional renewable sources. | Every region has an enormous potential that need to be calculated and exploited in a sustainable way increasing the country capacity for supplying future demand.                                          |
| Micro – Macro level | Implementing renewable energy system  | Maintaining, improving and expanding renewable energy application based on renewable fuel diversity by helping to protect small-middle economy and consumers from prices fluctuations, and fuel shortages. |
| Macro Level         | Favoring long-term solutions          | Economic expansion is not possible without the addition of new sustainable generating capacity.                                                                                                            |

In a micro level, the program was focused in the implementation of motivation, transfer of know-how, capacity building, and legal framework for new actors in the market offering renewable energy solutions. Information provided to the regional government. In a macro level the program involved concrete and quantitative policy targets, based on an analysis of technologies, potentials, market, and barriers through the integration of resources and cost assessment.

The priorities were carried out considering the dynamics of sustainable development. Sustainable development is dynamic in terms of space - time and must be constantly redefined due to the context and resources (Nijkamp and Sosteman 1990). In this sense, dynamic of the well-being (Wt) must be made balanced and compatible between socio-economic (w1) and environmental system (w2). Each factor considers relative weights (a, b):

$$Wt = aw_1 + bw_2 \quad a: \text{production, demand, resource exploitation, etc.}$$

$$b: \text{renewable resources, waste, substitution, water, air, etc.}$$

Environmental system is the main supplier of the raw material necessary for economic growth, which depends on a constant supply of raw material (Hediger, 2006), and considering that the sustainable development (SD) must not decrease over time, well-being must remain positive over time ( $dW / dt \geq 0$ ):

$$\begin{matrix} dW_1 \geq 0 & \delta & dW_2 \geq 0 & (\text{weak sustainability}) \\ dW_1 \geq 0 & i & dW_2 \geq 0 & (\text{strong sustainability}) \end{matrix}$$

#### 4. Results

A solar economy could be built on large members of decentralized system, all networked so that their output (electricity) could be fed into the power grid as and when necessary. These mean opportunities for renewable energy technologies linked to micro, medium and middle enterprises. Peru is a country with great potential for renewable energy use for a number of very good reasons: high levels of solar radiation, wind energy in several regions, and a great biomass potential.

Planned increases in generation capacity over the coming years are expected to result in valuable reliability coverage. Integration of renewable sources in new electricity systems can play a role in improving power reliability and quality, as well as allowing a transition towards new technologies using common regional planning and operational systems based on a large share of both renewable and other distributed energy sources (Mendoza et.al. 2004). Currently there are a growth interest for drying crops employing both direct exposure to sunlight and the use of heated air; solar hot water for small industrial enterprises; and solar/wind water-pumping for crops irrigations system. The cost of current technologies for renewable energy sources is, in most cases, beyond the reach of small-middle enterprise. A combination of biomass, wind, and sun are forms of renewable energy connected to sustainability that could be able to meet one half of the North Peruvian energy needs.

Solar and wind energy. A market for solar and wind applications is related to the geographical position with potentials of solar irradiation that reach the 6.5 kwh/m<sup>2</sup>/daily and the wind average velocity is around 9 m/s. Probably there is no significant direct use of solar energy other than agriculture and electricity generation in very small units, mainly

through photovoltaic system. The solar energy production is only 0.5% of total energy produced in Peru. The production from wind resources is very low in Peru, but exist three wind power plants (more than 100 MW).

**Biomass.** The unsustainable and inefficiently use of firewood and bagasse have put into a serious risk the environment in many regions, leading to deforestation, soil erosion, and reducing soil fertility. During 2017-2018 the north region has produced about 4.5 million of tons of residues from agricultural crops: sugarcane, rice, fruits, corn, etc. (Canales 2018). The most obvious opportunity is biomass through agricultural and agro-industrial residues that could be used as a biomass fuel source in modern plants to produce electricity. Sugarcane and residues can be used to produce significant quantities of surplus electricity in sugar mills located in Lambayeque; corn residues in Piura, Cajamarca and San Martin; or fruits and rice residues in almost all north regions. In this sense, it's necessary the use of agricultural residues in order to achieve efficient energetic systems and at the same time to improve the regional environment-economy. Among crop residues, rice and sugarcane waste (bagasse and barbojo) is very interesting as a renewable energy source because it is produced in abundance, and at the same time crop fields are located in the Lambayeque region, where electricity is 100% produced on thermal systems and residual biomass is about 715256 tons.

It's time to change paradigm in sugarcane mills where sugar must be a by-product and energy the core product (Mendoza et al. 2003). Now, a half of the bagasse is used for electricity cogeneration and selling it to the national grid. Lambayeque has ideal conditions of soil, climate, land and low labor cost for sugarcane cultivation. Figure 1 shows the regional concentration of the most representative crops: sugarcane. There are 14000 Ha from rice crop, and 31500 Ha from sugarcane. The Lambayeque region energy future is linked to biomass applications due to the enormous potential of agricultural residues (low cost). Whenever agricultural or forestry residues are used as a fuel for self-generation, under low efficiency thermal conditions. Competitive sugarcane mills are those that have added to the commercialization of sugar the sale of ethanol and electricity (Fernandes et al. 2017). Local biomass resources (bagasse, rice straw, rice husk, barbojo, etc.) have an important role in the development of the urban and rural economy in terms of the application of new technologies: jobs opportunities for harvesting and manufacturing processes.

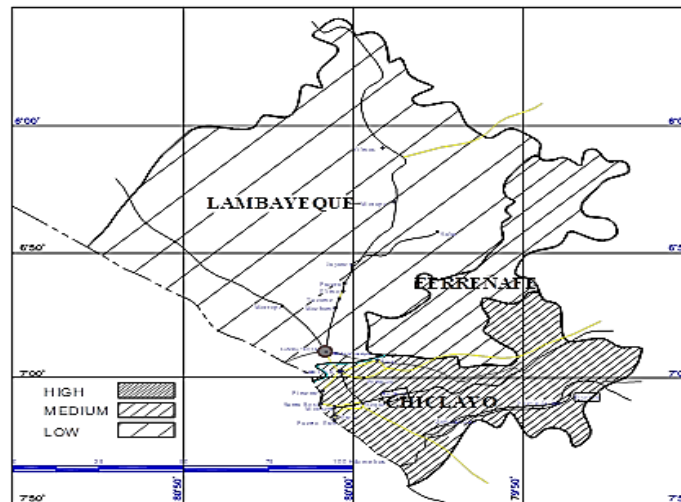


Figure 1. Sugar cane concentration

Crops residues offer a reliable opportunity for development of new and existing enterprises. Micro - small enterprises can offer job opportunities for unskilled workers in harvesting and residues transport, bio-fertilization and biogas production, etc., because the labor involved in growing, harvesting and collecting crop residues must be done locally. We have determined and analyzed the quantities of harvested sugarcane biomass that it's possible to obtain in manual green harvesting (without burning sugarcane fields). As a result, barbojo (trash, stalk, foil, etc.) obtained is more economical than mechanized harvesting, and barbojo has a major energetic value than bagasse. Manual harvesting labor could support the development of small enterprises.

The commitment of government authorities within a framework of growth and sustainable economic development, requires increased productivity based on innovation, greater access to basic services in rural areas, sustainable management of local resources, applied research and increased private investment. As Figure 2 shows, commitment

requires a process of constant evaluation and monitoring of economic activities for the benefit of both parties: industry - local economy.

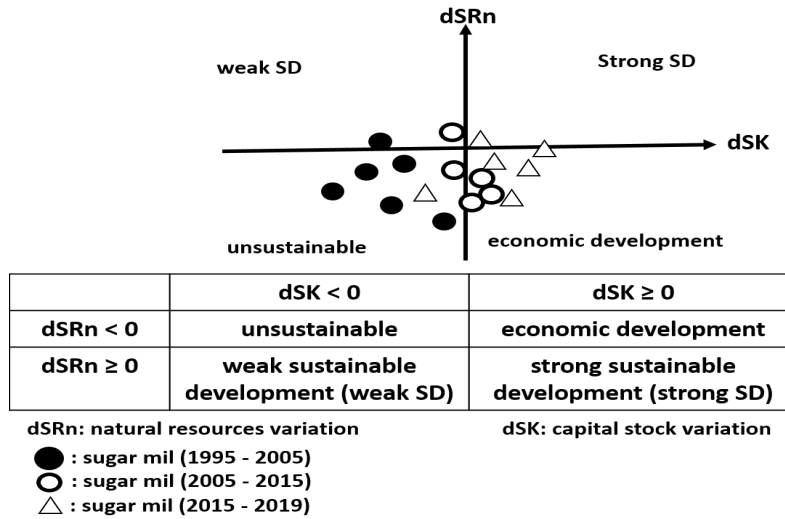


Figure 2. Sugar mills vs sustainable development (Adapted from Van Pelt, 1993)

Figure 2 have showed the relationship industry- sustainable development. The original data for social economy were mainly taken from the Statistical Regional Yearbook of Lambayeque 2017. Figure 3 show how concentrate sugarcane activities in Chiclayo results in a low poverty level (53.40% to 62.50%). Instead, critical index of low development is located where lands have the more favorable conditions. It means that is necessary decentralized sugar sector and optimizing internal infrastructure. These positive changes in the dynamics of the rural economy could have a substantial role in reducing the traditional exodus to urban areas and could create more adequate conditions for investment in rural infrastructure, health, and education.

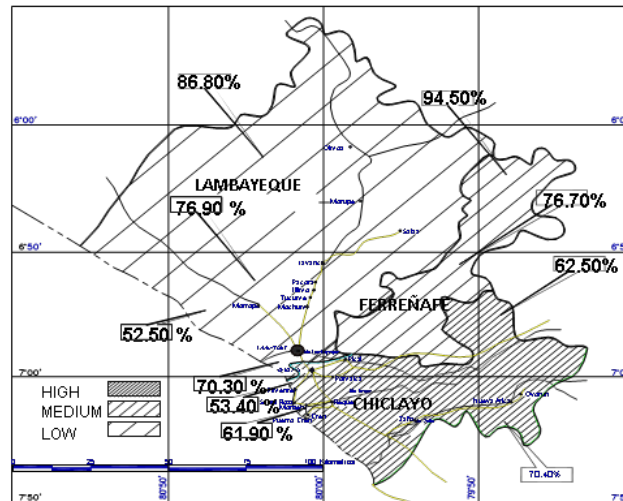


Figure 3. Sugar cane concentration related to poverty level

It has become clear that industry does not contribute much to the development of target communities if it is delivered to isolated areas in an isolated manner, so industry contribute effectively to rural development only if its integrated in productivity chains. Social aspect of the Lambayeque region is an important factor to define the quality of the region and the industrial development policy. Beside the adverse effect of the industries on the environment, there may be another driving force for the social changes: new jobs, new investment and new infrastructure.

Renewable energy technologies could be associated to a productivity chains and provide local benefits if government implement policies for decentralized generation specially where there is a high poverty level, especially in Ferreñafe:

Table 2. Opportunities for rural communities in Lambayeque

| Technology         | Time | Ferreñafe: communities    |                           |                           |
|--------------------|------|---------------------------|---------------------------|---------------------------|
|                    |      | Inkawasi                  | Uyurpampa                 | Riopampa                  |
| Small wind turbine | ST   | water pum/irrigation      | water pum/irrigation      | water pum/irrigation      |
|                    | MT   | industrial dryer systems  | household lighting        | irrigation and lighting   |
|                    | LT   | carbon footprint projects | public lighting           | public lighting           |
| Biomass            | ST   | briquettes                | briquettes                | briquettes                |
|                    | MT   | biogas/biofuels           | biogas/biofuels           | biogas/biofuels           |
|                    | LT   | carbon footprint projects | carbon footprint projects | carbon footprint projects |
| Solar thermal      | ST   | -----                     | -----                     | -----                     |
|                    | MT   | solar dryer               | water heater              | water heater              |
|                    | LT   | carbon footprint projects | carbon footprint projects | carbon footprint projects |

ST: short time    MT: middle time    LT: long time

## 5. Conclusions

The notion of sustainability as the measure for the ability of the society to secure and not compromise the ability of future generation to have quality of the life at least the same as our generation (United Nations 2015). Mutual interaction between industrial sector and it surrounding is immanent for any life support system that take material resources from the surrounding and disposal residual to the environment.

A change in the industrial development policies of the region is necessary and urgent. The excessive concentration of economic activities as rice and sugarcane leaves out the opportunity to integrated social, economic and environmental factors. Through time, sugar mills and sustainable development, have not been integrated and it have made difficult an improvement in social factor. Figure 2 showed that two sugar mills have made a small advance in the interaction with natural resources, but a greater participation is still necessary by coordinating the relationship between sustainable development (SD) and economic growth (Table 3).

Table 3. Decentralized sugar mills: impact and opportunities

| Province of | Sugar mills concentration | Poverty Level |         | SD potential | Impact / opportunities (decentralized sugar mills activities)                                                                                                            |
|-------------|---------------------------|---------------|---------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|             |                           | Minimum       | Maximo  |              |                                                                                                                                                                          |
| Chiclayo    | 100 %                     | 53.40 %       | 62.50 % | Low          | Severe salinization of soils (39834 hectares). Deforestation. Water scarcity (deficit 15.465 to 44.70%)                                                                  |
| Lambayeque  | 0 %                       | 52.50 %       | 86.80 % | High         | Diversification of energy sources based on sugarcane waste and developing of micro and small enterprises. Reducing carbon footprint projects.<br>New jobs opportunities. |
| Ferreñafe   | 0 %                       | 76.70 %       | 94.50 % | High         |                                                                                                                                                                          |

Sugar mills occupies a central position in the development of Lambayeque region, and shifting policies is necessary to improve social-environment conditions. This implies that decentralization of sugar mills activities should be challenged. It has already been demonstrated that economic growth doesn't always in regions where the standard of living is still comparatively low, because environmental, energy and social factor has a higher cost in the well-being equation (Haapenen and Tapio 2016).

Sugar mill have an important participation in regional Gross Domestic Product, but it doesn't mean that they contribute to the sustainable development. Despite the concentration of sugar mills in Chiclayo (Figure 3), poverty levels are still around 60% which means that it has grown economically at the expense of the environment, natural resources and society (Gaspar, Cardoso and Fuinhas 2017).

Sugar mills have shown that it is possible to respond to the growing energy demand, the reduction of pollution and to promote competitive micro-small enterprise, but it's necessary to establish in regional development policies that energy is a factor that could leads to improve the well-being in all the Lambayeque region (Mendoza, Arroyo and Jimenez 2007). Sugar mills have the technology, resources and infrastructure, but they must consider and following new development policies to allow for improved comparisons in the next year. This is the challenge.

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## Biographies

**Maximiliano Arroyo Ulloa.** Industrial engineer. Professor in the Department of Industrial Engineering at the Santo Toribio of Mogrovejo Catholic University, Chiclayo, Peru. He earned Master in Human Talent Management from North Private University, Peru and PhD in Energetic and Environment Technologies for Development from La Sapienza University, Rome, Italy. Research interests include lean manufacturing, optimization, reliability, scheduling, manufacturing, and industry 4.0. Member of the Lean Manufacturing Institute.

**Maira Arroyo Lujan.** Bachelor degree in Management and Marketing. Specialist in Digital Marketing and Graphic Design. She has been recognized as a professional management consultant with over 8 years of experience in working with closely-held businesses. He has taught courses in digital marketing, entrepreneurship, management and corporate entrepreneurship. Executive Director of MAXiMA Enterprise Consulting.

**Javier Beltrán Reyes.** Systems Engineer. Master in Commercial Management and Marketing Direction. Specialist in Big Data, Business Intelligence. Developer of SQL server. .net Senior analyst in international and national enterprise. Supervisor in supply chain management. Analyzer in customer intelligence. He has been recognized as a professional management consultant with over 15 years of experience in working with closely-held businesses. He has taught courses in entrepreneurship, management and corporate entrepreneurship and innovation for engineers.