

Potential Role of Sugar Mills in the Peruvian Development

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Abstract

This paper gives some preliminary results of systems analysis for ethanol production and utilization options as residue from sugar mills. Analyses are carried out for all production-chain, with a particular interest in scenarios in a middle and large time, where ethanol and hydrogen from biomass resources seem very promising. Peru has a great opportunity for using renewable sources biofuel in the public transport, energy demand in micro – small enterprises, specially converting traditional crops, like sugarcane, into ethanol to be blended with gasoline or used directly in internal combustion engines. Ethanol and sugarcane residues have the potential to reduce our greenhouse gas emissions from fossil fuels and the same time to diversifying and to give dynamical to the bioenergy sector. We have identified a market niche in the public transport in Lambayeque, a small town at the north of Peru, where existing more than 30000 mototaxis (motorcycles adapted for transport of persons and loads) an economic way for public transport based upon gasoline. 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. These positive impacts in the dynamics of the rural economy could have a substantial role in reducing the traditional exodus to urban areas and could create more favorable conditions for investment in rural infrastructure, health, and education.

Keywords

Biomass, renewable resources, ethanol, energy, development.

1. Introduction

Motorized transport is essentially based on the internal combustion engine: the engine burns a mixture of air and fuel to produce energy that powers the vehicle. Reducing the amount of pollution per kilometers of travel consists in using cleaner fuels, and burning fuels more efficiently. Growing transportation problems, including gasoline prices and carbon dioxide emissions, are forcing urban governments to consider implementing better public transportation initiatives in an effort to reduce the impact of the declining oil economy on our environment and financial markets., but research and development of renewable energy sources will require increased funding commitments from

municipalities already struggling to overcome their congestion and pollution problems (Mendoza et al. 2003). And not always there is an answer.

In a short-middle term, northwest regions of Peru could soon become a generator of jobs and local well-being, thanks to the big market for renewable energy ethanol. According to a USDA Foreign Agricultural Service report, during 2019 Peruvian ethanol production was 180 million liters but consumption is 200 million liters. Peru's feedstock for ethanol production is sugarcane but is insufficient to supply for sugar production and ethanol market (consumption and export). The Law for Regulation for the Commercialization of Biofuels decree that all gasoline sold in Peru was required to contain at least 7.8 percent ethanol (Gasper 2019).

But, is it a real opportunity for ethanol and sugarcane residues?

The province of Lima consumption was about 65 percent of the country's ethanol and gasoline but in recent year public transport are turned to liquefied natural gas (LNG) and liquefied petroleum gas (LPG). In this way the opportunities for a real growth market for ethanol is uncertainly (Canales 2019). At this point it's necessary to change the market to another region where ethanol is produced.

Table 1. Ethanol production in Peru

Item	2016	2017	2018	2019
Production (million liters)	205	165	140	180
Consumption (million liters)	180	185	194	200
Imports (million liters)	113	112	173	140
Exports (million liters)	113	91	108	130
Refineries (number)	2	2	2	2
Capacity (million liters)	350	350	350	350
Capacity use (%)	58.6	47.1	40.0	51.4
Sugarcane as a feedstock (1000 MT)	2575	1750	2250	2414

At the north of Peru are located two refineries: Coazucar with about 6500 hectares of sugarcane and Caña Brava with 8000 hectares. The second one has a capacity production of 127 million liters/year instead Coazucar could produce sugar or ethanol according to the market demand. Probably, the existence of a sea wharf makes Piura more attractive than Lambayeque.

But the most important detail is the know-how acquired by Lambayeque throughout the years by sugarcane processing, and the installed infrastructure. Lambayeque located next to Piura has an enormous potential for producing ethanol from sugarcane and other sources if sugarcane factories decides to improve production and changing market strategies. Demand for ethanol is expected to continue to surge as Americans automakers deliver on promises to manufacture more cars that can run on the fuel. But, ethanol demand will continue to rise, as along as oil process remain relatively high and changing Peruvian government attitudes by sustainable local transport. These two regions could have the opportunity to be an ethanol hub, and producing 500 million gallons by year, and generating employment in rural areas, decrease dependence on imported fuel, and lower carbon emissions (EY 2019).

2. Methodology

This research is both exploratory and analytical as it explores the potential production of ethanol and the recovery of sugarcane' residues through analyzing the current situation and the regional development policies. Through literature review, the research identifies and utilizes data about currently ethanol production and consumption and the capacity production or potential of sugar mills to became the core of the regional development at the north in Peru.

3. Results

The environmental and public transport issue is very complex problem and its associated to the culture of cities and towns. The research has reviewed regional development policies and competitiveness strategies to be implemented in the coming years, concluding that the main factors have not been considered. If inaction is maintained to face the problem, it will cause that micro – small enterprise disappears in the dynamics of markets or reduce their profits, at the same time this situation is generating a negative environmental impact, specifically due to the transport sector and the lack of recovery strategies for waste from the main industrial activity in the region: sugar production.

As we can see in figure 1, there are other problems related to the use of fossil fuels that will have an economic impact in the coming years.

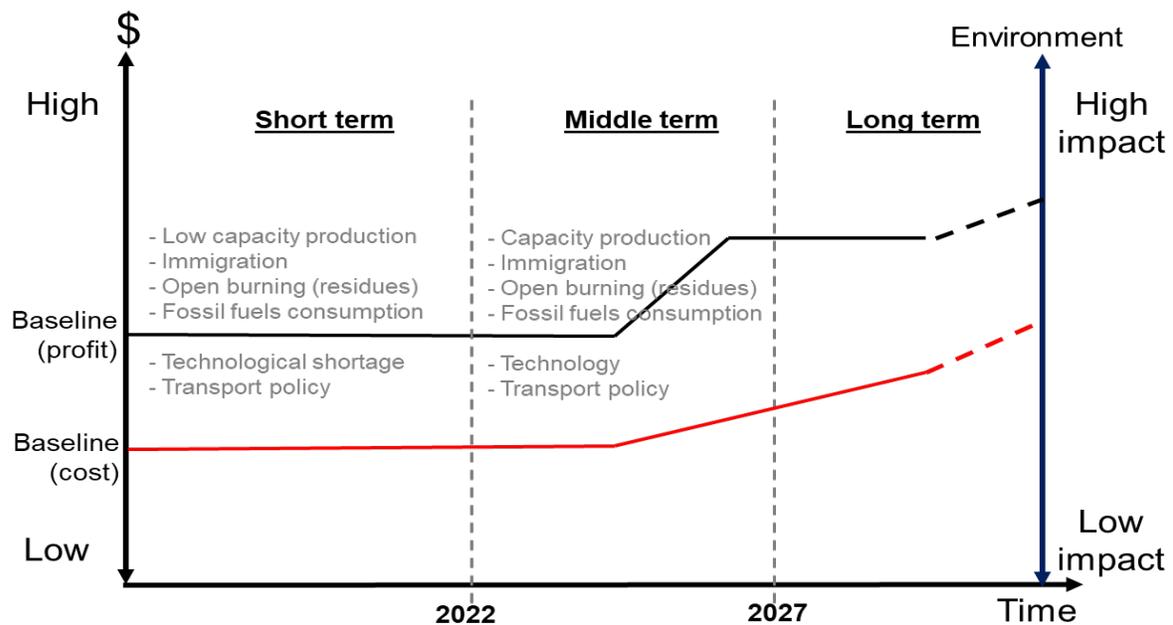


Figure 1. Environmental impact related to policy and economic activities

3.1. Transport and environment in Lambayeque

The main objective of the government’s initiative is to enhance the economic productivity and the quality of life in regions. Lambayeque needs urgently to resolve environmental problems due to public transport through improving mobility and accessibility for the urban population by establishing an efficient, reliable, cleaner and safer mass rapid transit system. In Lambayeque, the transport sector is a significant contributor to deteriorating ambient air quality. Table 2 show the strong growth in transport volume. This reflects the increasing of transport intensity, combining with an informal development of urban polices.

Table 2. Vehicular trends in Lambayeque

Region	Number of vehicles including some mototaxis (unit)			
Year	2015	2016	2017	2018
Lambayeque	38315	39314	40888	42288

In addition, there are more than 5000 mototaxis not registered. At the end of 2018, about 30000 mototaxis will be circulating for public cheap services Transport volumes are forecast to continue to grow without environmental

regulations or incentives for clean vehicles. One of the most visible signs of urban air pollution is the black smoke coming out of the tailpipes of public transport, especially from diesel buses, old taxis, and mototaxis. Urban transit mototaxis are high usage vehicles that operate in heavily congested areas, and blending substituting fossil fuels for ethanol is one way of reducing emissions of fine particles. One option for effectively eliminating black smoke is to use a clean fuel or an element oxygenate for fossil fuel (Duy 2019). Mototaxis units have grown steadily over the past decade by almost 100% leading to an overall increase of pollutants.

The table 3 shows the growth in emissions of acidifying substances (NO_x, NMVOCs) and ozone precursors (NO_x). Without emission standards for road vehicles, especially mototaxis, emissions will be far above the level the last two years. According to the World Health Organization, air pollution increase risk of development respiratory symptoms and exacerbation of allergic reactions. A report of the Peruvian Minister of Health about north regions show that in the last five years the respiratory problems (e.g. asthma) have increased from 15%.

Table 3. Mototaxis emissions of air pollutants

Mototaxis	Polluting Agents by gasoline (year)						
	Demand (1 * 1000)	CO (Mg)	NO _x (Mg)	N ₂ O (Mg)	CO ₂ (Mg)	CH ₄ (Mg)	NMVOC (Mg)
2015	61118.65	15646.37	1173.47	1173.47	1955.79	39.11	103.46
2016	67544.15	17291.30	1296.84	1296.84	2161.40	43.22	114.33
2017	71322.20	18258.48	1369.38	1369.38	2282.30	45.64	120.73
2018	74610.47	19100.28	1432.52	1432.52	2387.53	47.75	126.30

3.2. Shifting to clean fuel

Basically, new transport technology is based on friendly environmental fuels. At present, talking about conventional gasoline is almost impossible to think a fuel that wholesale price is higher than gasoline, and for this reason ethanol to become competitive must to reduce substantially its production cost. Substantial cost reductions may be possible in two ways; using cellulose-based feedstock and getting the maximum use of sugar mill sector. Cellulose feedstock include agricultural wastes, woods, and grasses. In this case, Lambayeque is an agricultural region where rice straw (burning after harvesting) and bagasse are the principal waste that can be collected at relatively low cost and contributing to improve environmental issues.

The first problem with transport in Peru is related to division between vehicle technology and fuel quality standards. It's necessary to begin a transition to alternative fuel and new technology in public transport because the units in used have reached a significant age and need to be replaced. Producing ethanol from sugarcane means an opportunity for rice farmer to change to cane crops (if irrigation technology is implemented) or producing ethanol from rice straw.

3.3 Regional development strategies

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.

The crops residues are related to the reliable opportunity for development of new and existing enterprises. Small enterprises have begun to offer job opportunities for unskilled workers in harvesting and residues transport, bio-fertilization and low biogas production, etc., because the labor involved in growing, harvesting and collecting crop residues have been done locally.

Lambayeque 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 (Murton 2019). 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 biofuel production without pressure to food production on the remaining land. It is necessary decentralized sugar sector and optimizing internal infrastructure and taking advantage from the non-irrigated desert lands through modern irrigation technology. Currently actions are not enough to increase opportunities jobs. These positive changes in the dynamics of the rural economy have begun to have a substantial role in reducing the traditional exodus to urban areas and could create more favorable conditions for investment in rural infrastructure, health, and education (Rose 2020).

In table 4 we can see the ethanol production potential that could be possible to reach in Lambayeque if a technological development and economy of scale effects in transport is facility by investment and sustainable energy policies from government. Under these premises, emissions under 50 g/km can be reached. It's time to think in the sugar mills as energy sales centers where sugar is a by-product as well as the bagasse that could be 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.

Table 4. Ethanol production in Lambayeque

Ethanol Production (l/year) * 1000	
Sugar Cane	242550.00
Rice Straw	35129.77
Total	277679.77

There are 14000 Ha from rice crop, and 31500 Ha from sugarcane. The Lambayeque energy future is linked to biomass applications due to the enormous potential of agricultural residues. Whenever agricultural or forestry residues are used as a fuel, this is only done for self-generation, under low efficiency thermal conditions. For example, few sugar mills are characterized by maintaining the same technical criteria basic for the primary treatment of the raw materials as 30-40 years ago. The crisis of these sugar mills results from lack of technological innovation and high costs of fossil fuels. Sugarcane mills that are competitive in today's global market are those which have an integrated approach to their business: else from sugar they produce and sell bagasse, alcohol and power (Fabiola 2019).

In long term, local biomass resources (bagasse, rice straw, rice husk, barbojo, etc.) will 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. Biomass as renewable resources is very interesting for substituting fossil fuel. And in a sustainable future scenario, hydrogen production from thermo-chemical biomass conversion is possible. Cost about hydrogen production by biomass gasification is 10 to 13 USD/GJ range (if residues cost of 16 to 45 USD/t) (NREL 2011), but in the Peruvian case the cost of biomass residues is 5 to 8 USD/t. Some years ago, researchers from Italian and Peruvian universities have made an analysis about implementation of gasification system instead of traditional boilers where bagasse is burned inefficiently. Preliminary results encourage continuing research in all life cycle of sugarcane.

Research has 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. However, the first step has been expanding cane crop in the region for ethanol production.

Now, a 7.8% biofuel blending scheme is being promoted by the government's environmental office, but refiners and automakers are already questioning whether such blends would damage the fuel systems of Peruvian old vehicle fleet. Methane (CNG) and propane (LPG) are now established in Lima but will be almost impossible (at least in the next 20 years) to take the all the country to a gas energy system. Geographical, economic and cultural factor made difficult a large scale from gas because it could not be fully competitive.

4. Conclusion

Peruvian producers enjoying preferred access to the United States will be able to export more under a special agreement to meet increasing demand caused by the market expansion and policy energy (Pacheco 2019). Taking advantage of these new opportunities will demand significant improvement in productivity and output. There is growing interest in substituting conventional fuel with much cleaner fuels because ambient concentrations of particulate matter are higher than standard. In this case, the local government needs to adopt policies to encourage the switch to ethanol (Fernandes 2019). Policies might include taxes for fossil fuels and establishing emissions standards for public transport. But will be necessary beginning in house trying to improvement transport and environmental situation. Increasing production and rehabilitant sugar mills will have a great socio-economic impact in all the communities from Lambayeque.

A new approach in the development strategies of the region offers the possibility of being able to reduce the environmental impact, improve the enterprises' economy and the creation of jobs (Gaspar et al. 2020). In the middle term, cost reduction due to increased production and better use of waste, as well as a shift towards fuels less polluting like ethanol, it will open the doors or be the bridge to a solar economy (Figure 2).

Figure 2.

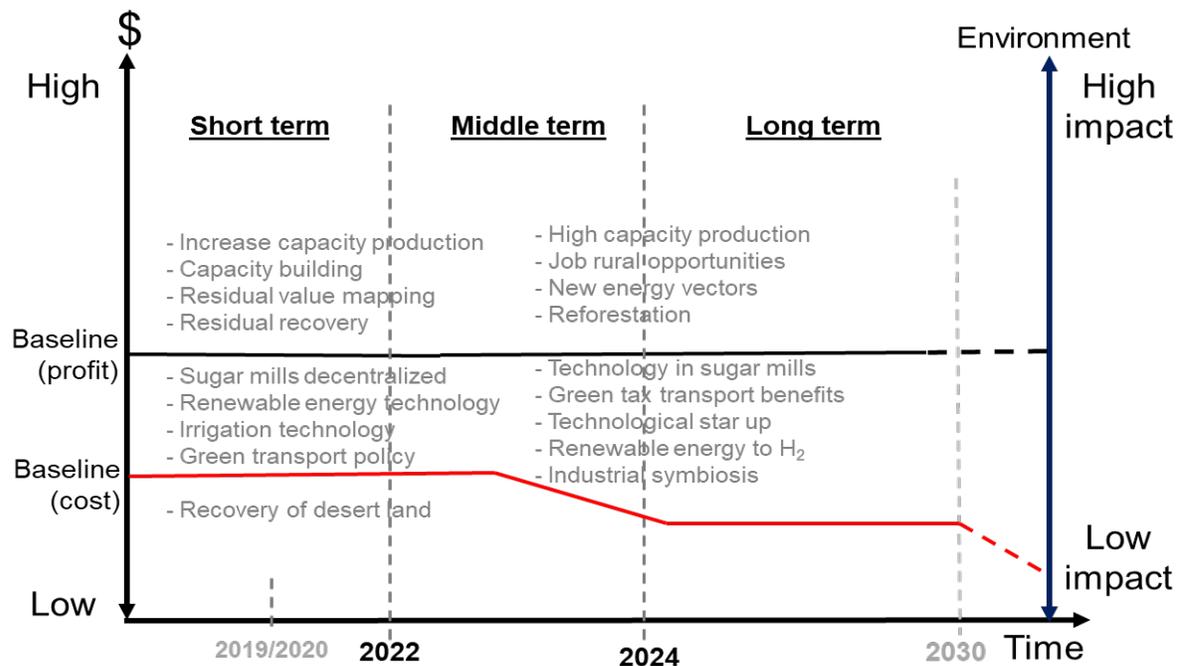


Figure 2. Integrating sugarcane's by-product into policy development

Sugar mills are ready for ethanol production to be blended in transport sector and selling out the remaining. Then, implementing green harvesting, gasifier and integrating rice husk and other non-biomass renewable resources could be promising a new sustainable energy system. We are called developing country, but we don't need to do the same technological path from developed countries. Peru's challenge is adapting technology to local energy resources. It has become clear that electricity does not contribute much to the development of target communities if it is delivered

to isolated areas in an isolated manner, so electricity will contribute effectively to rural development only if its delivery is bundled with that of other infrastructure services as a productivity chains.

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