Use of bioenergy in Mexico

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Introduction

Bioenergy is of high interest as it could supply 40% of primary energy consumption in Mexico

A potential production of 3,569 PJ/year

The **Energy Reform** (2013) allowed the creation of a fund to strengthen renewable energy sources (4.7% of GDP based on the year 2013)

10% science, technology and renewable energy sources projects – 10% postgraduate formation

Alemán-Nava et al (2014) Renew Sustain Energy Rev

Introduction

Four main legal instruments are expected to promote renewable energy in Mexico:

- The recent **Energy Reform** approved by the Congress of the Union
- The **General Law for Climate Change** adopted in May 2012 (35% of energy generated in the country should come from renewable sources by 2024)
- The **law of Promotion and Development of Bioenergy** in order to achieve energy diversification and sustainable development in the production of energy
- The **law for the Use of Renewable Energy and Finance of the Energy Transition** (recently modified and approved)

REEEP (2007); DOF (2008); Rangel-Hernández et al (2011) Int J Energy Environ Eng; Camara de Diputados (2008)

Introduction

Global energy consumption in 2011 was estimated at 471.8 exajoules (EJ)

78.2%	Fossil fuels
2.8%	Nuclear power
19%	Renewable energy

Renewable energy

9.7%	Modern renewable sources: hydropower, wind, solar, geothermal and biofuels
9.3%	Traditional biomass (used primarily for cooking and heating in rural areas)

SENER (2011) National Energy Balance.

Introduction

Mexico produced 219.5 million tons of oil-equivalent energy during 2011

88.7% Fossil fuels,
6.9% Renewable sources,
3.17% Charcoal and the remaining
1.3% Nuclear sources

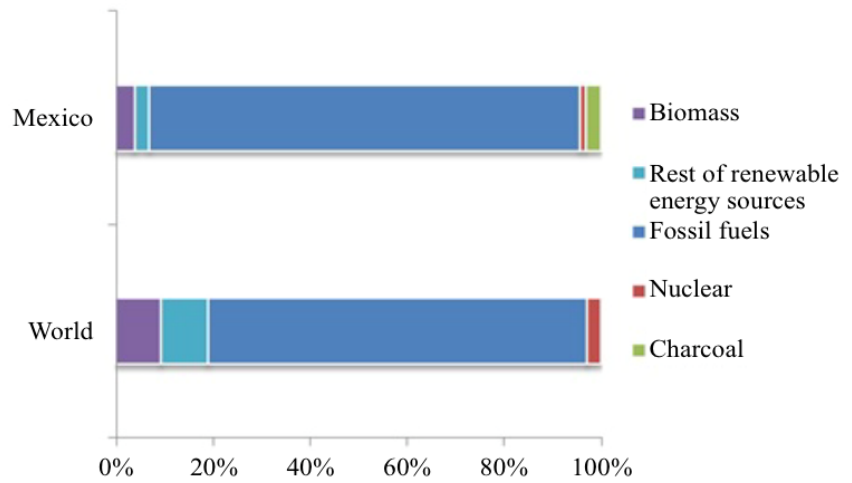

Figure 1: Energy share of global and Mexico final energy consumption in 2011.

Introduction

Biomass as a primary source of bioenergy has decreased in Mexico;

15.3% in 1965 → only 5.3% in 2005

Mainly because firewood is used by rural communities in the country for cooking and heating purposes.

Rural population has decreased from almost 50% in 1960 to 21% in 2013

Masera O (1993) Patterns Resour Use; INEGI (2009); The World Bank (2014)

Bioenergy potential in Mexico

Mexico was ranked sixth, as crude oil producer, and eighteenth as natural gas producer in 2009

However, there is a lack of investment to increase refining capacity.

Studies have shown that bioenergy may reach up to 16.17% of Mexico's total energy supply for electricity generation, transportation and rural residential sectors by 2030

Islas et al. (2007) Energy 32; Valdez Vazquez et al. (2010) Renew Sustain Energy Rev

Bioenergy potential in Mexico

Mexico is the third largest country in Latin American and the Caribbean in terms of cropland area

Mexico had 75.3 million tons of dry matter from crop residues that potentially could be transformed into bioenergy in 2006

The Mexican Ministry of Energy estimated that the potential energy per year in 2030 would be 85,500-119,498 MW from biomass

The potential of bioenergy in the global energy system was about 17%-36% of primary energy consumption in the world in 2008 according to the WBGU

ECLAC (2008); ProMéxico. Energías Renovables (2013)

Bioenergy potential in Mexico

The energy potential of the main sources of bioenergy available in Mexico was equivalent to 3,569 PJ/year, or 42% of the country's primary energy consumption in 2008.

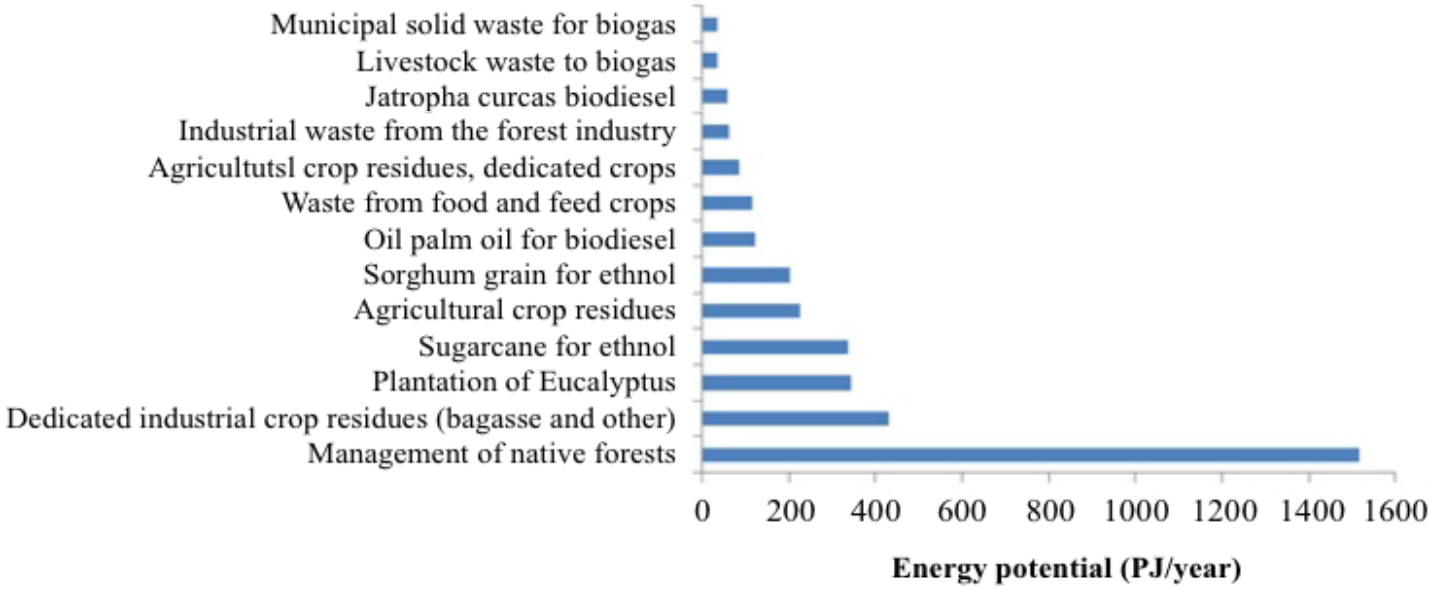

Figure 2: Biomass energy potential divided by sources in Mexico.

Johnson et al. (2009) México: estudiosobre la disminución de emisionesde carbono.

Bioenergy potential in Mexico

Society is concerned and it is important to excluded lands

a) Used for agriculture,
b) Covered by forests, jungles and other natural hedges,
c) Belong to conservation areas and
d) Non arable because they have a slope higher than 4-12%

REMBIO (2011)

Case Studies in México

There are several pathways that allow the use of biomass as a sustainable energy source

- Biogas
- Efficient wood stoves
- Efficient charcoal furnaces
- Biofuels

*Direct combustion, gasification, fermentation and anaerobic digestion

REMBIO (2011)

Biogas

Gaseous biofuels are classified according to their procurement processes

Biological, to generate biogas - or **thermochemical** to produce syngas (synthesis gas)

Biogas has many applications:

- as fuel in stoves and boilers;
- for domestic lighting and heating;
- to fuel internal combustion engines or gas turbines;
- generating power or electricity

REMBIO (2011)

Biogas

Mexico has relevant experience on biological methods for biogas production

Project	Location	Start date	Capacity	Source of energy
Biogas from landfill	Salinas Victoria, Nuevo León	2009	7.4 MW (2003), 12.72 MW (2007), 15.9 MW (2010)	Biogas from muynicipal waste
Biogas from swine waste	Cadereyta, Nuevo Leon	2005	65 kW	Pig farm manure
Biogas from wastewater treatment	León, Guanajuato	2008	2 plants of 55 kW	Cattle manure

Table 1: Projects for biogas production.

REMBIO (2011)

Biogas

Biogas from landfill

- Bioenergy Nuevo Leon, SA de CV (BENLESA)
- First project in Mexico and LA of biogas as renewable energy produced from a landfill.

Biogas from swine waste

- The Agricultural Development Corporation of Nuevo León (August 2006) on farm “El Chancho”, Cadereyta
- The first of three electricity generating plants using biogas.

Biogas from wastewater treatment

- As a need to reduce Biological Oxygen Demand (BOD) and energy cost of the aerobic phase of wastewater treatment plants from slaughterhouse “TIF 333”.

Efficient wood stoves

About 2 billion people worldwide rely on biomass for cooking and heating.

10% of primary energy in Mexico and contributes 46% to the residential sector energy

In Mexico, 89% of the **rural** population uses wood for cooking - **urban** areas firewood users represent 11% of the population

There are various projects developed in Mexico:

Project	Location	Start date	Size	Characteristics
Patsari stove	Michoacán and 15 more states	2003	105 cm×70 cm×27 cm	The exterior is made of brick which includes an optimized combustion chamber and tunnels to reduce the production of emissions.
Mexalitl stove	Nuevo Leon, Chihuahua, State of Mexico and Yucatan	2008	35 cm×70 cm	The exterior is made of concert with a combustion chamber of ceramic.
ONIL stove	Chiapas, Oaxaca, Veracruz, Puebla, Hidalgo, State of mexico, Queretaro and Guanajuato	2010	80 cm×54 cm×20 cm	Stove made from cement, sand and iron with a volume of 15 L.

Table 2: Projects for use of wood stoves.

Efficient wood stoves

Patsari stove

The Interdisciplinary Group for Appropriate Rural Technology A.C. in collaboration with the Center for Ecosystem Research (2003).

Patsari means “the one who keeps” in the Purépecha language

5 main components:

a) innovation and technology development;
b) dissemination of efficient stoves;
c) development of local small businesses;
d) monitoring and impact assessment;
e) strengthening the program.

Efficient wood stoves

Mexalit stove

- This stove has a weight of 76 kg, thus facilitating its distribution.
- Designed to reduce 50%-60% fuel consumption (vs traditional open stoves), and to improve combustion heat.

Onil stove

- Designed using the principles of combustion “Rocket elbow” developed by Dr. Larry Winiarski of Aprovecho Research Center, Oregon.
- There have been so far more than 16,720 stoves installed in 9 states of Mexico

Efficient charcoal furnaces

10 million urban households use charcoal in Mexico

Charcoal is produced mainly in traditional earth kilns with low transformation efficiency of coal burning

Harm to the health of producers by inhalation of toxic gases and exposure to high temperatures

Domestic consumption of charcoal reaches over 600 thousand ton/year

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Improved technologies offer an opportunity to reduce the consumption of wood in the manufacture of charcoal, mitigate greenhouse gas emissions

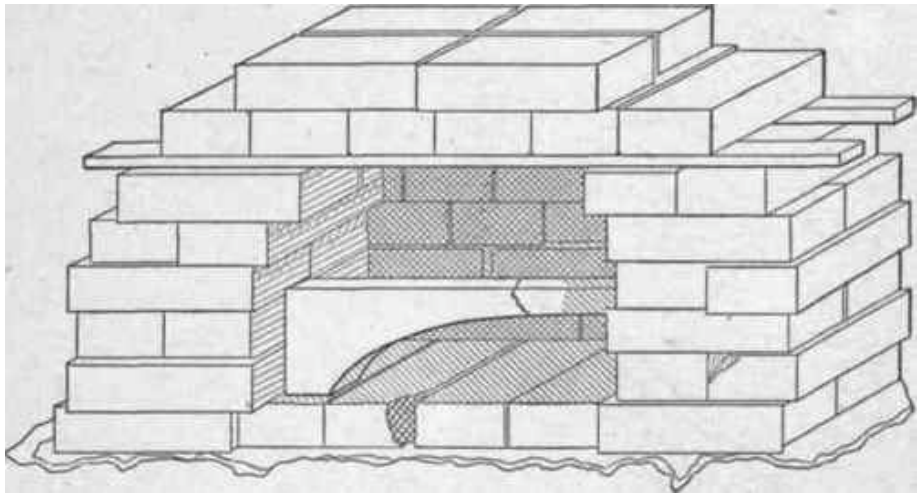
Efficient charcoal furnaces

Originally designed by the Technological Institute of Minas Gerais, Brazil.

Aim: improving the production process over traditional earth kilns

It started in Queretaro (2003) with a transferred technology known as “RaboQuente”

So far eight states are involved, ~30 projects, 60 furnaces and 100 direct beneficiaries.



Monteiro et al. (2000) Pap Do NAEA

Biofuels

- **Biodiesel**: a mixture of fatty acid esters with short chain alcohols,
- Resulting product from the reaction of vegetable oils / animal fats with methanol or ethanol at atmospheric pressure
- Produced from renewable sources
- It can replace petroleum diesel (B100), or be used in mixtures (B1,B5,B10)
- Biodiesel is expected to replace 7.8% of conventional diesel fuel consumption by 2031

Chisti (2007) Biotechnol Adv; Demirbas et al. (2008) Energy Convers Manag; Lozada et al. (2010) Renew Sustain Energy Rev

Biofuels

Bioenergetic Chiapas

- Program operated by the Institute for Agricultural Restructuring and Tropical Agriculture (IRPAT)
- It included the establishment of plantations, oil extraction and biodiesel production plants.
- The objective of the program was to establish 20,000 ha of pinion (Jatrophacurcas L.) by 2012 in more than 20 municipalities, which was partially achieved

Biocombustibles Internacionales S.A. de C.V

- First biodiesel production plant in Mexico, with a capacity of 1.5 million liters a month.
- Beef tallow and recycled vegetable oils as main raw materials
- Biodiesel produced is used by PEMEX Refining as an additive of ultra-low sulfur diesel

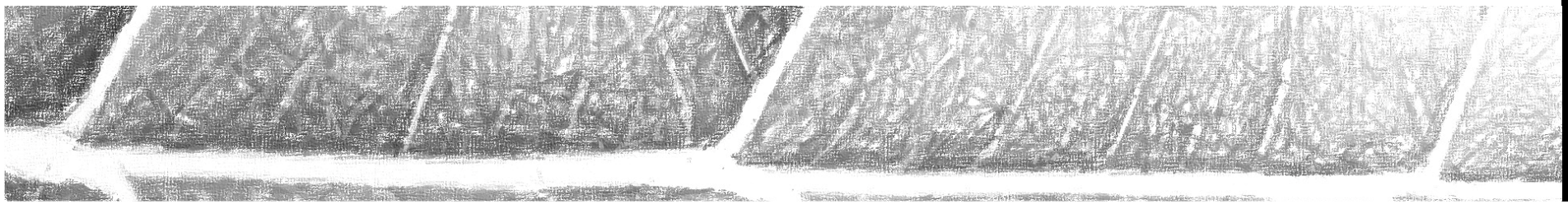
Biofuels

Biodiesel in Mexico would bring out several benefits:

- job creation,
- expansion of the facility to rural areas,
- development of rural economies,
- conservation of oil resources and
- development of multiple crops

Conclusions

- Energy policies in Mexico have strengthened the development of renewable sources of energy during the last years
- One of the most promising sources of renewable energy is biomass
- Biomass conversion technologies in Mexico rely mainly on biogas and biofuel production
- Three important wood stove types were developed in Mexico
- Mexico is a pioneer in the landfill biogas energy generation in Latino America
- Development of this kind of projects will allow the country to reduce gradually its dependence on fossil fuels.



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