Forest Residues and Unused Species in Bioenergy Production

Conversa Creativa S.C.
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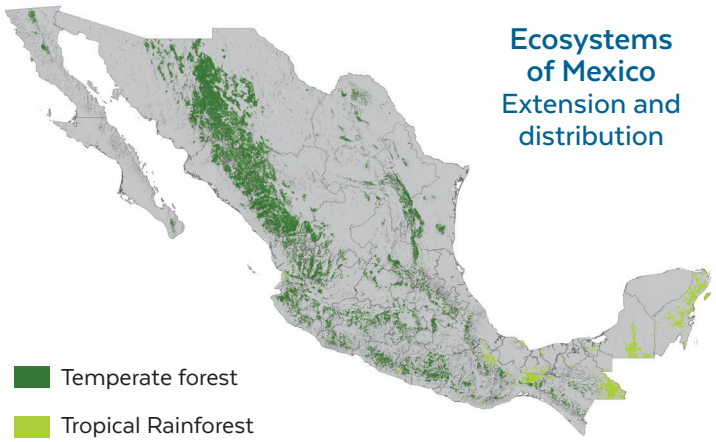
Between 2005 and 2015[2] the use of renewable energies and biomass in Mexico increased by 1.84% to provide 7.85% of Mexico's total energy matrix (649 Petajoules), from this biomass provides 4.35%. The remaining energy is produced with coal, hydrocarbons and nuclear fuels. However, bioenergy has the potential to increase its participation from 4.35% to 38% of total national primary energy production[3], becoming a strategic factor in mitigating climate change and promoting economic development in the rural sector. Recent studies indicate that the largest potential biomass for energy production in Mexico can be found in temperate forests and tropical rain forests because crop and agro-industry residues already have established uses and markets.[4] Both ecosystems cover considerable areas and are widely distributed throughout the country (temperate forest 16.5% and tropical rain forest 8%, CONABIO, 2012). Important volumes of primary materials for energy production purposes can be obtained in forest species without market demand, as well as residues from silvicultural practices, forest harvesting and industrialization.



This document intends to contribute to the knowledge and recognition of the scale of forest resources that are currently underused and could be harnessed for energy production, which would result in social, environmental and economic benefits for the country. We have systematized some of the data available regarding the proportion and origin of forest biomass with potential energy use into visual applications. This document is based on research revealing the panorama of potential for bioenergy in the forestry sector.[5] See the electronic version of this document at: www.conversamexico.com/knowlegde.html

Wood energy refers to forests as being a source of energy in addition to only supplying wood. Different levels of technological sophistication are required to harness this energy, from the direct burning of wood, compacting biomass into pellets or briquettes, to the production of electricity from biomass using gasification, pyrolysis and other technologies. Forest biomass is the principal source of primary energy in developing countries and has a high cultural value – specifically firewood and charcoal, which are used domestically and for artisanal or microenterprises. However, this biomass is burned using inefficient combustion processes without systematic attention being paid to maintaining balance in the forest.[6] Modern and efficient use of forest biomass means that the same resources can generate more energy with reduced environmental impact.

Heat and electricity production at a residential or industrial level can be more efficient, consume fewer resources and imply lower costs for users. To achieve this it is necessary to promote biomass conditioning processes (drying and densification) and the diversified, integral and sustainable use of forests. In Mexico harnessing the energy in forests is at an early stage, with ample potential for development, which would require public and private involvement.

Technification, types of fuels and energy uses.

Between the Forest and Residues

In the following diagram the arrows indicate the origin and destination of forest biomass around the world. In the center of the diagram we can see the intermediate products of the process and by-products without apparent use. Sixty percent of the total volume of wood in managed forests is extracted for a range of uses; the remaining 40% is waste, which stays on site in the form of unharvested trees, waste from the extraction process and waste from silvicultural practices to maintain the forest's health. Of the 60% harvested, half is sold as logs or

1 We would like to thank Grecia Ruiz López, a Forest Engineering student at the Universidad de la Sierra Juárez in Oaxaca, for her help with this publication.
2 This is most recent report provided by SENER in the Energy Information System: http://sie.energia.gob.mx/ The percentage refers to the production of primary energy according to the National Balance.
3 Bioenergy in the energy transition strategy. REMBIO http://www.conuee.gob.mx/pdfs/BIO.pdf
4 The primary uses of crop, food and drink processing residues include: animal feed, reincorporation into the soil, filling automotive parts, and to a lesser extent the production of biogas and composts.
5 Research consulted includes projects carried out by the FAO, the National Research Institute of Forestry, Agriculture and Livestock (Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, INIFAP) and the National Forestry Commission (Comisión Nacional Forestal, CONAFOR), as well as information regarding the productivity of the Mexican forestry sector reported by the National Institute of Statistics and Geography (Instituto Nacional de Estadística y Geografía, INEGI) and the Ministry of Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales, SEMARNAT).
6 There has been a significant effort to improve wood burning processes in many countries by promoting wood-saving or ecological stoves, primarily through government subsidy programs.

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Bioenergy in Temperate Forest

The proportion of residues produced harvesting temperate forests is lower than for tropical rainforests. However, the Pinus genus has the highest availability, production volume and national and international demand. In other words, there is a larger proportion of wood waste in rain forests but temperate forests have bigger stocks and production. These natural and market generated dynamics mean that more residues of broad leaf species, such as oak, are generated. Mexico has not promoted the use of this species; there are limited forest companies with the knowledge or technology to do so. This species is suitable for wood energy use because there is a large unused supply as a result of the difficulties marketing the authorized volumes in the wood market and because the tree's structure generates a low sawmill coefficient. At every stage of the forest harvest and industrialization process quantities of biomass with no current use are generated, and they are generally wasted. They could have an energy use; this potential is indicated using the "forest bioenergy" symbol in the following diagrams.

Forest bioenergy

Temperate Forest

Total forest production (2014):
5.7 million m³r

Pine: 4.7 million m³r
Oak: 0.5 million m³r

Source: prepared by the authors on the basis of information from (CONAFOR, CONACYT, INIFAP, 2011)

Physicochemical characteristics compared by species		
Renewable energy potential		
2,728.80 11,425.40	Tcal TJoule	334.90 1,402.40
Mass density		
0.374 - 0.565	kg/m³	0.552 - 0.597
7.890 - 9.071	Moisture %	7.386 - 8.263
Calorific value		
4,136.58 - 4,766.67 17.31 - 19.95	kcal/kg MJ/kg	4,300.98 - 4,641.39 18.00 - 19.43

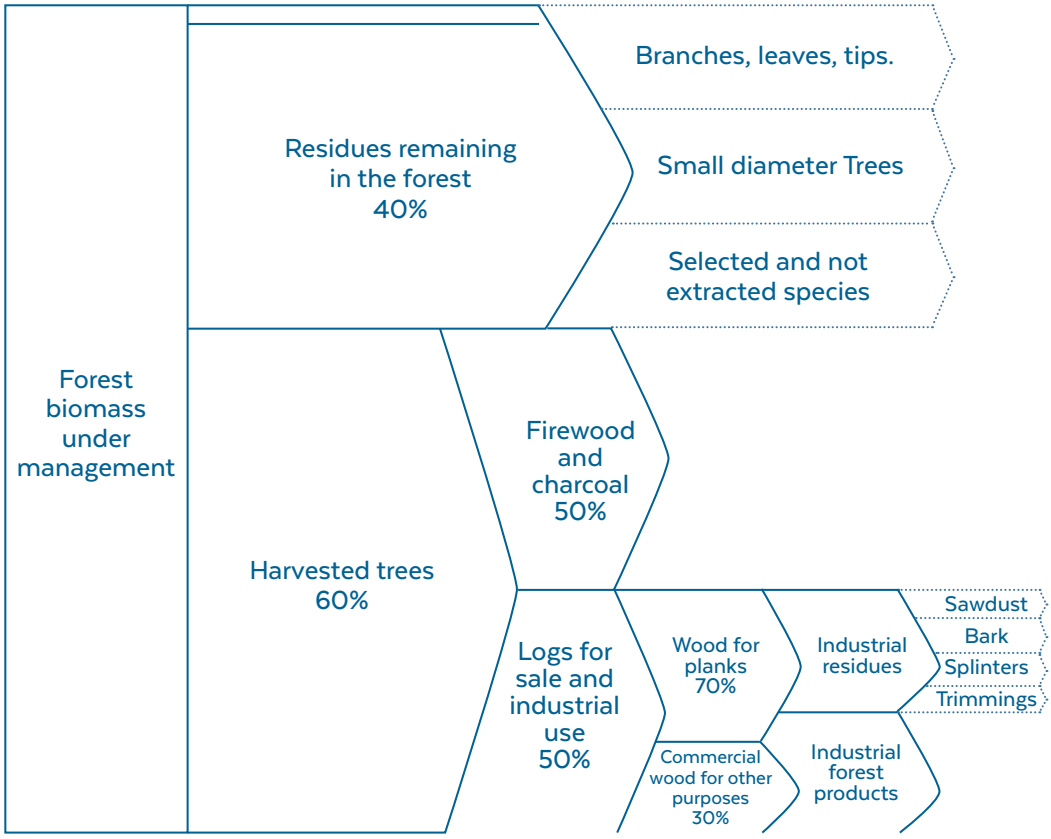
PINE

OAK

Only 2 out of every 10m^3 of harvested wood are transformed into a final product, such as lumber or scantling products (boards, studs, beams and sleepers). The remaining 8m^3 are residues that could have different uses, for example as biofuels. (CONAFOR, 2015a)

is transformed into boards and other products. The rest is turned into firewood and charcoal. Fifty percent of industrialized wood becomes sawdust and shavings. Forest companies close to industries requiring raw materials to make agglomerates and cellulose often sell this waste at low prices.[7] Recently this sector of the forest value chain has grown in Mexico.[8]

The quantity of waste that remains in the forest depends on silvicultural methods, forest species composition, extraction process and technologies, market demands and the skills of those who carry out the operations.



Source: prepared by the authors on the basis of information from (Rosillo, et al., 2007) (CONAFOR, CONACYT, INIFAP, 2011)

7 In Mexico's forest regions by-products or residues have symbolic prices between $1 and $200 p/m3, based on information from CONAFOR (2015b).
8 Between 2014 and 2016 five agglomerate manufacturing plants were opened in the states of Tabasco, Durango, Chihuahua and Jalisco.

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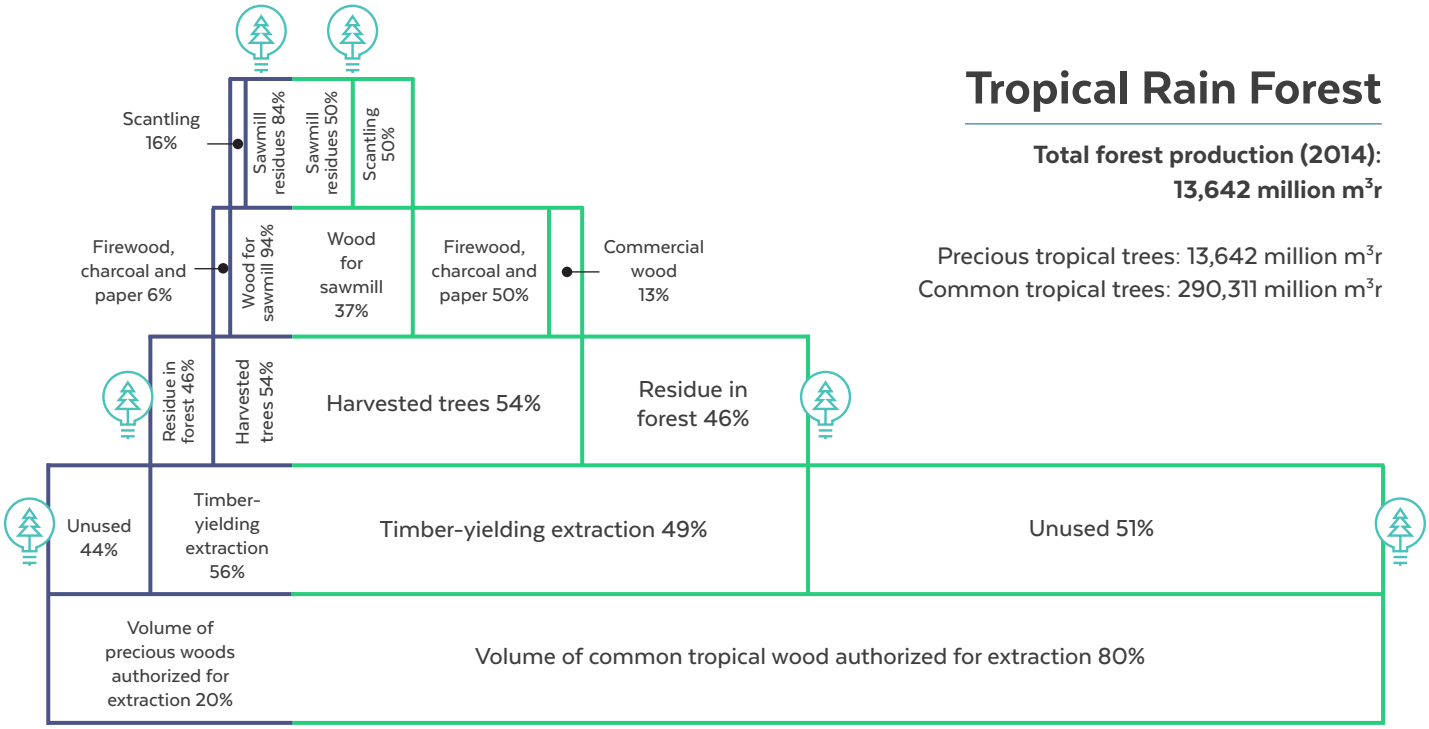
Bioenergy in the Tropical Rain Forest

Tropical species grow with more branches and with curved stems, which naturally generates a large volume of residual biomass in the forest and in the sawmill. Mexican rain forests are incredibly heterogeneous in terms of species;[9] this increases the underuse of the authorized volume for extraction because there is only market demand for particular species. For example, sapodilla, Terminalia amazonia and Spondis mombin are common species in the rain forest with the highest market demand; and in terms of precious woods there are the highly valued mahogany and cedar.



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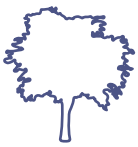

PRECIOUS TROPICAL TREES (Cedar y Mahogany)

Physicochemical characteristics compared by species		
Renewable energy potential		
166.30 723.04	Tcal TJoule	2,287.93 9,947.52
Mass density		
0.420 - 0.463	kg/m³	0.301 - 0.975
10.7	Moisture %	10.7
Calorific value		
4,316.00 - 4,585.65 18.07 - 19.19	kcal/kg MJ/kg	3,917.80 - 4,808.70 16.40 - 20.13

COMMON TROPICAL TREES

Harvesting species that currently have no market demand can also have an impact on the production and conservation of forests because cutting only certain species puts at risk the biodiversity of the ecosystem where they are extracted. The production of energy using residual forest biomass promotes a more integral vision of how forests can be managed.

To harness wood energy it is necessary to explore technical and economic alternatives to promote the integral management of forest ecosystems. The social, environmental and economic impact of this development will be reflected in increased opportunities for income generation, especially for ejidatarios and comuneros, owners of the Mexican forests. The value chains created based on energy use will also provide a means of local development.

9 Mexican rain forests have high numbers and limited use for species such as Tzalam (Lysiloma bahamensis), Ramón (Brosimum alicastrum), Ya'axnik (Vitex gaumeri), Chacá (Bursera simaruba), Jabín (Piscidia communis), Chechén Negro (Metopium brounei), Machiche (Lonchocarpus castilloi), Cencerro (Sweetia panamensis), Zapotillo, (Pouteria uniloculoris) Amapola (Pseudobombax ellipticum), Pimientillo Grueso (Licaria peckii), Sac Chacá (Dendropanax aroboreus) and Tinto (Haematoxilum campechianum)