



Analyze status of biofuels production and use in non-IEA countries/emerging economies

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Latin America		Raw materials
	Brazil	Sugarcane; Corn; Bagasse; Soy oil
	Argentina	Corn; Molasses
	Colombia	Sugarcane; Crude Palm Oil
	Guatemala	Sugarcane; Crude Palm Oil
Africa		
	South Africa	Soya; Canola; Sunflower; Sugarcane; Sugar beet
	Nigeria	Sugarcane, cassava, plant seed and waste materials.
Asia		
	India	Sugarcane, Sugar beet, Sweet Sorghum, Corn, Cassava, Algae.
	China	Kernals; Cassava; Sweet Sorghum; Cellulosic Biomass
	Thailand	Sugarcane; Cassava; Molasses
	Malaysia	Crude Palm Oil
Europe		
	Russia	Fuel pellets, rapeseeds, and rapeseed oil

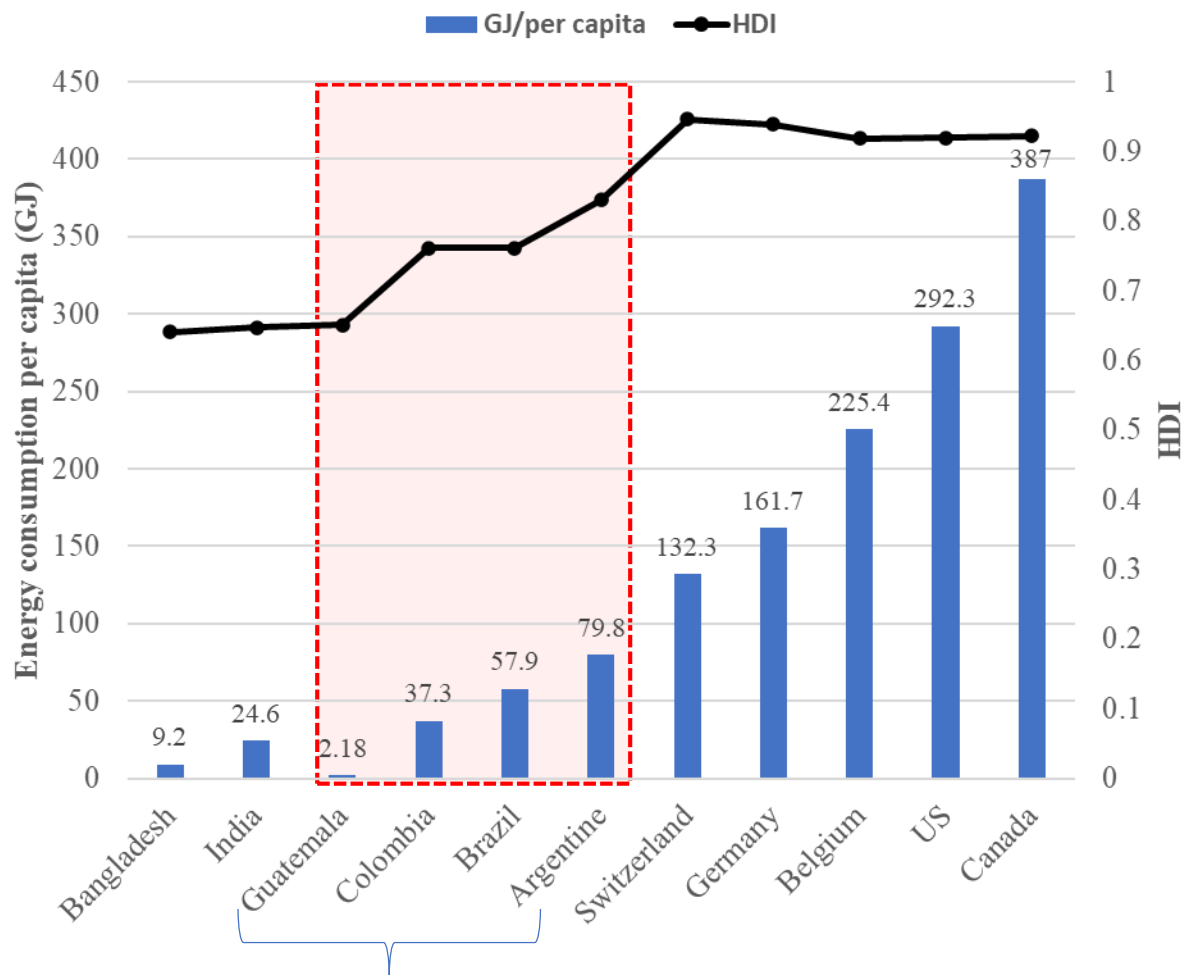
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Specific objectives:

1. Selection of the countries that are considered as emerging economies with a large population and in average lower energy consumption compared to developed countries.
2. Identification of official data source for each country in terms of energy production, energy demand as well as the production of biofuels.
3. Database construction of relevant data (*energy matrix, feedstock availability, the energy expenditure of production, net energy content, energy conversion efficiency, among others*).
4. Identification of possible raw-materials and conversion technologies.
5. Evolve the analysis including sustainability (*Energy and Exergy-based performance indicators*).
6. Evaluate how incentives can alter sustainability and process (*using Renovabio as a case study, sugarcane biorefinery concept*).

On-going steps

1. Database development	<i>In progress</i>
2. Update and expansion of the database of the energy matrix, including feedstock production and use for energy in each of the selected countries	<i>DONE</i>
3. Identification of possible raw-materials and conversion technologies in each of the selected countries • Meetings with biofuels experts	<i>DONE</i>
4. Evaluation of incentives using the Renovabio program as a case study	<i>In progress</i>
5. Generation of periodic reports and scientific papers	<i>In progress</i>



need for economic growth

↪ Increase of CO₂ emissions

↪ Large-scale electrification unfeasible

Energy matrix
↑ share of renewables

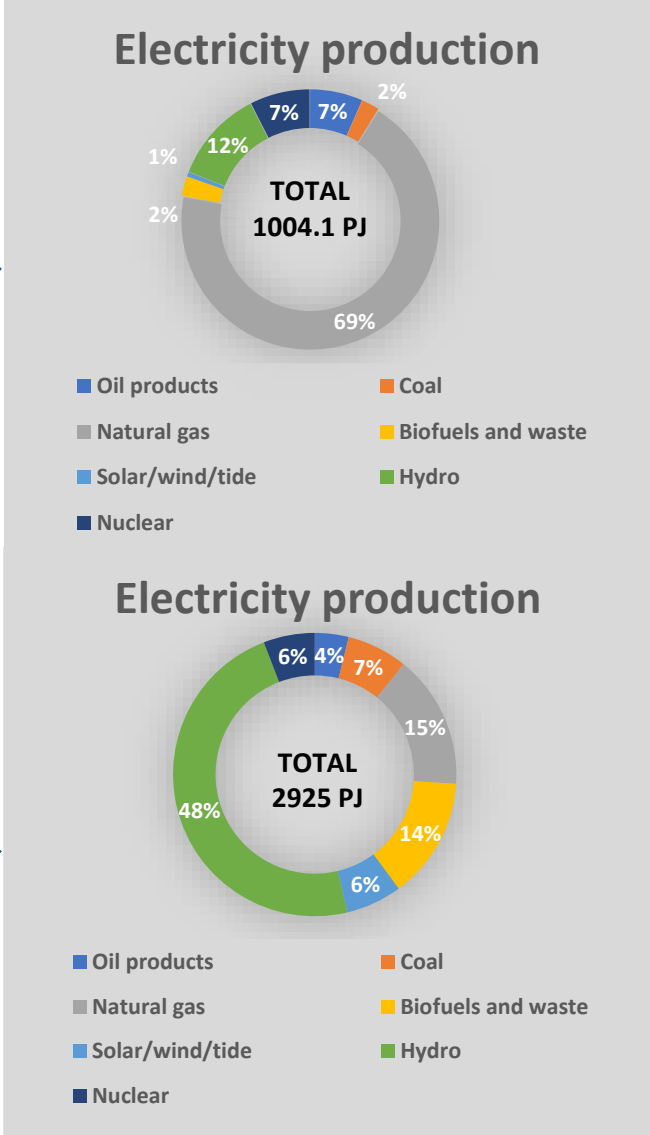
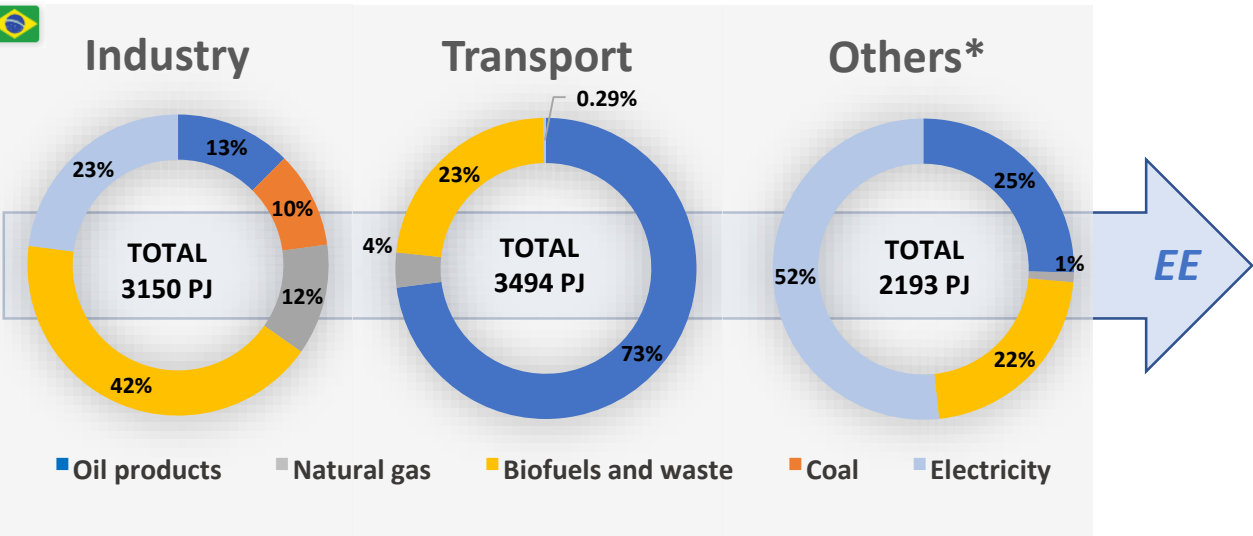
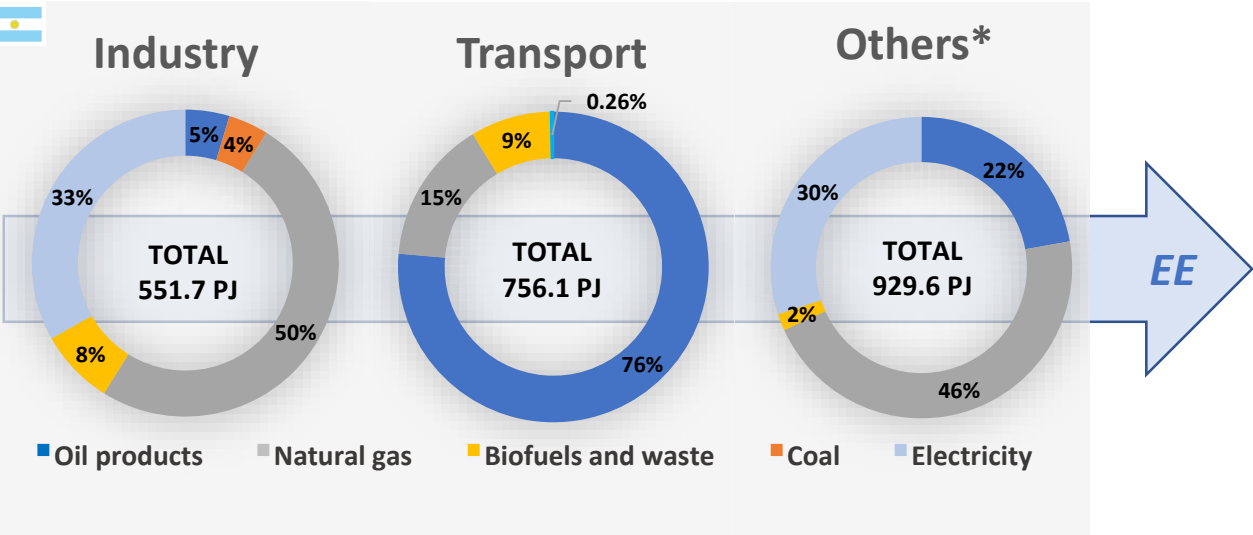
Biofuels

Bioenergy



Economic growth
and lower emissions

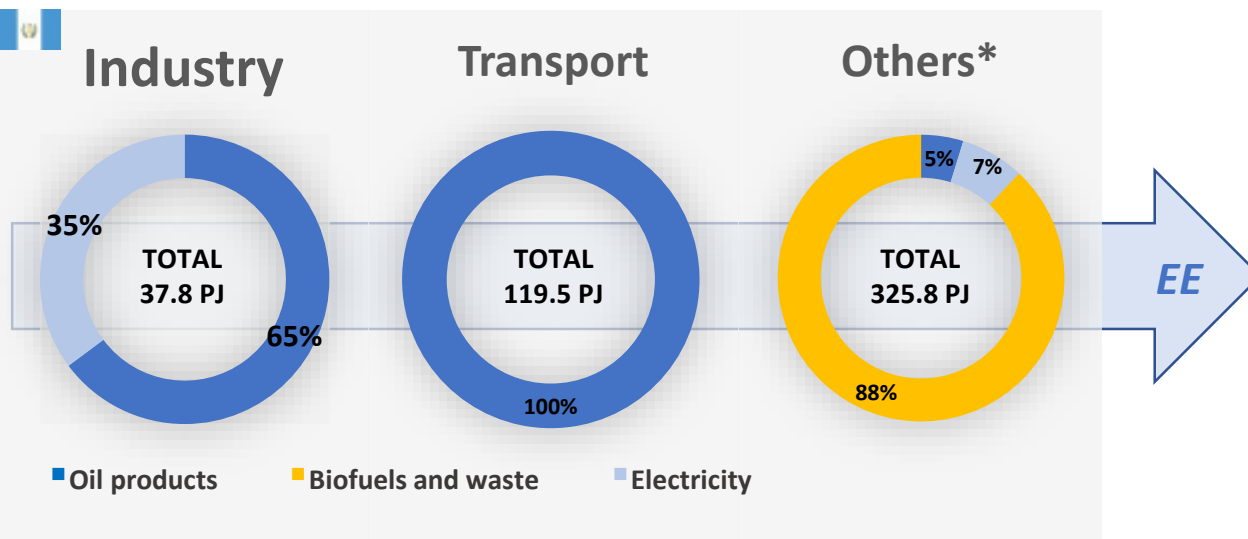
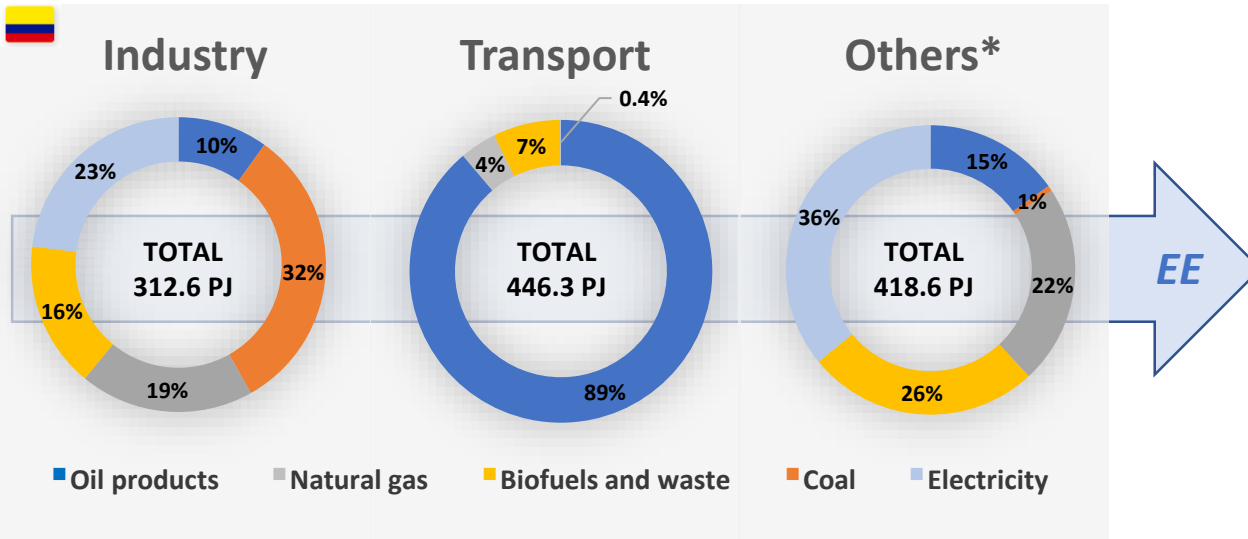
Energy matrix | Consumption by sectors



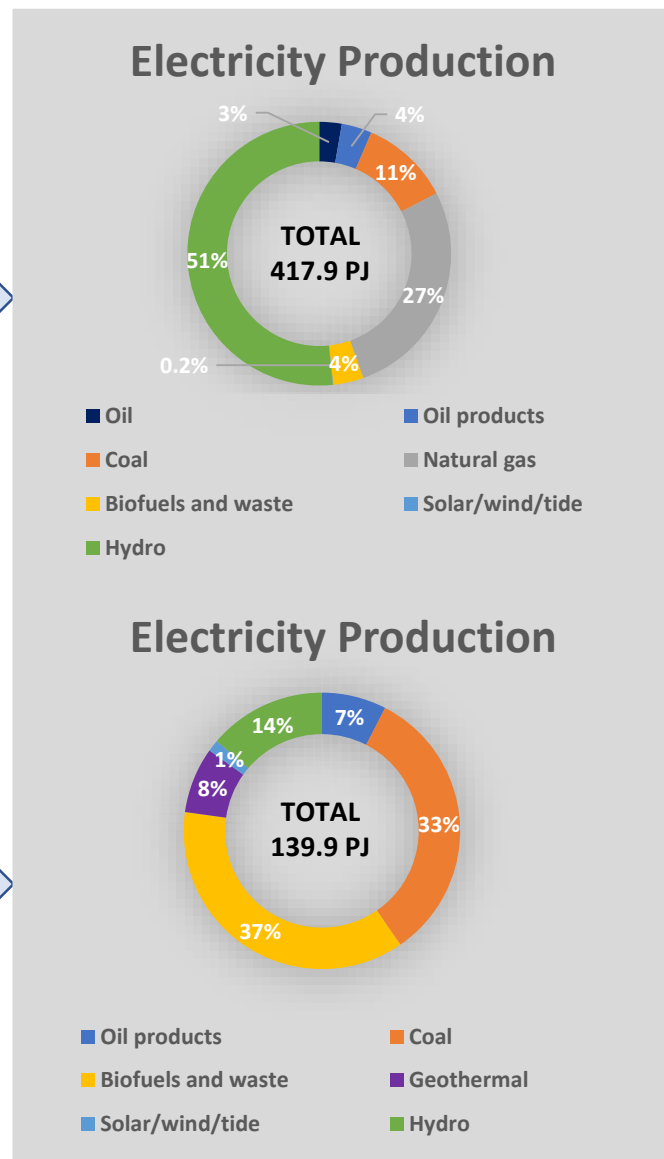
*residential, commerce and public sectors

Source: IEA, 2018.

Energy matrix | Consumption by sectors

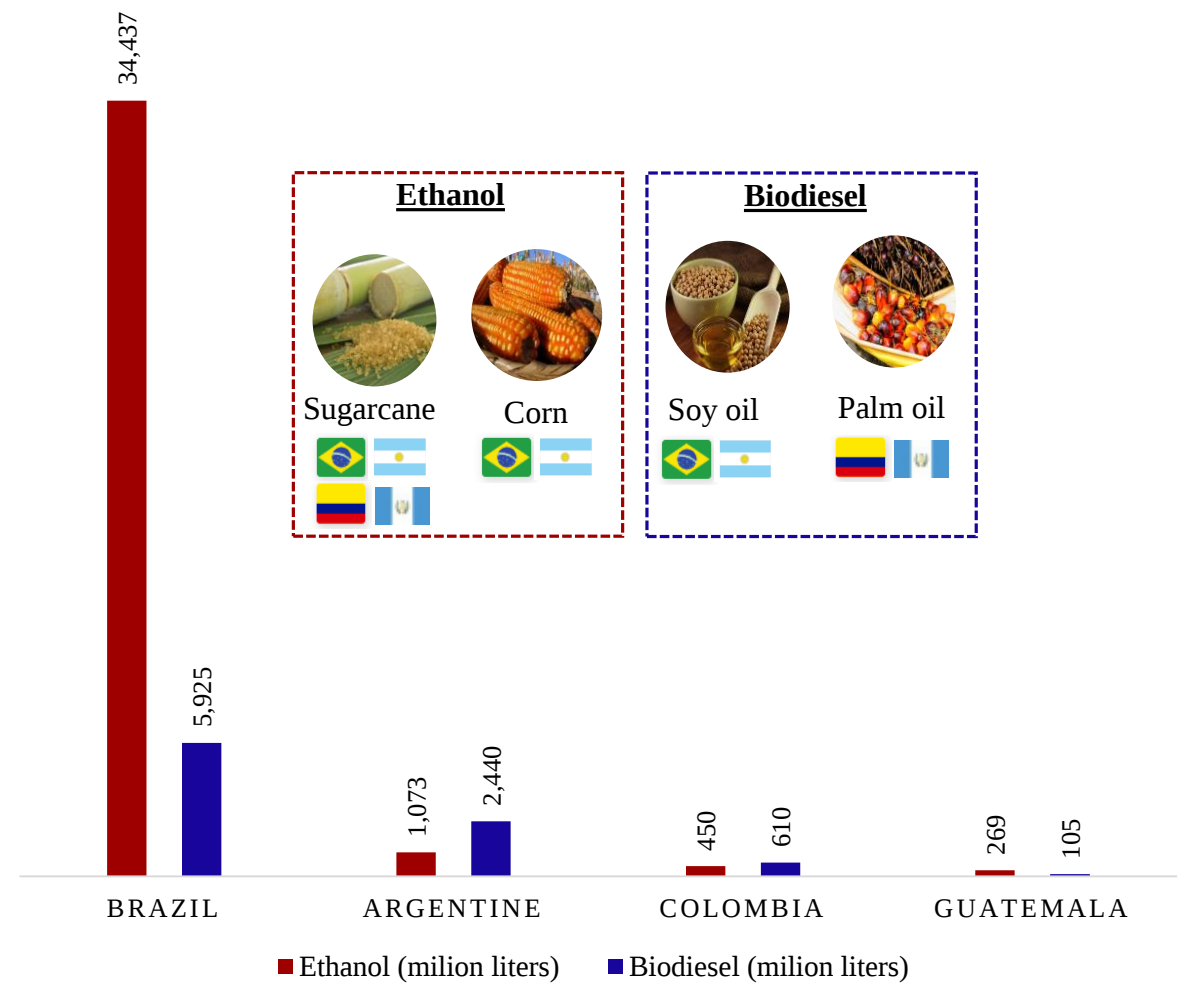


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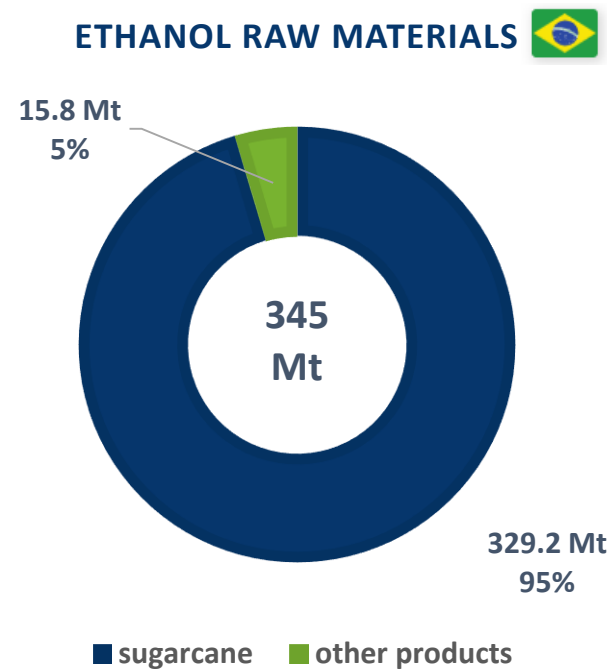


Source: IEA, 2018.

Liquid biofuels production| 2019



ANP, 2019; USDA, 2020.



Sugarcane-based ethanol pathway

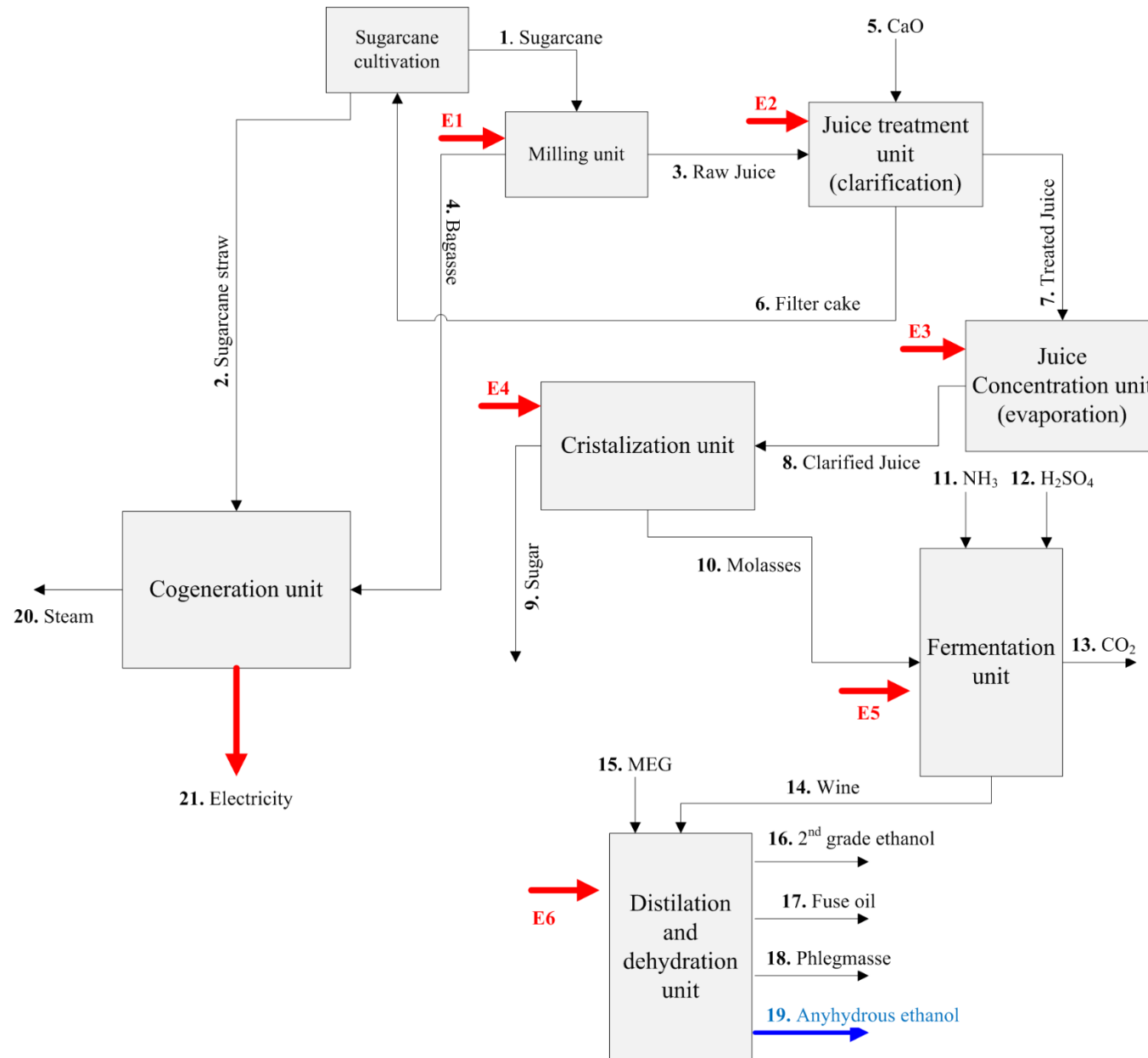


Table 1 | Cradle-to-gate emissions for selected countries.

Country	Biofuels	Raw material	Functional Unit (FU)	CO2 eq (kg/FU)	Ref.
Argentina	E1G	Sugarcane	1 kg EtOH	22.5	Amores et al. (2013)
	Biodiesel	Soybean	1 km driven a 28-t truck	4	Panichelli et al. (2008)
Brazil	E1G	Sugarcane	1 MJ EtOH	0.00626	Capaz et al. (2009)
	Biodiesel	Soybean	1 MJ Biodiesel	0.0243	Bonomi et al. (2019)
Colombia	E1G	Sugarcane	1 MJ Bioetanol	0.06 (Kg CO2eq/v.km)	MME, 2012
	Biodiesel	Palm oil	1 MJ Biodiesel	0.08 (Kg CO2eq/v.km)	MME, 2012
Guatemala	E1G	Sugarcane	1 t de etanol	1.82 Pt	Garcia-Zamora, 2010
	Biodiesel	Palm oil	-	-	N/A

Additional info's | Blending mixture gasoline and ethanol per country

Ethanol



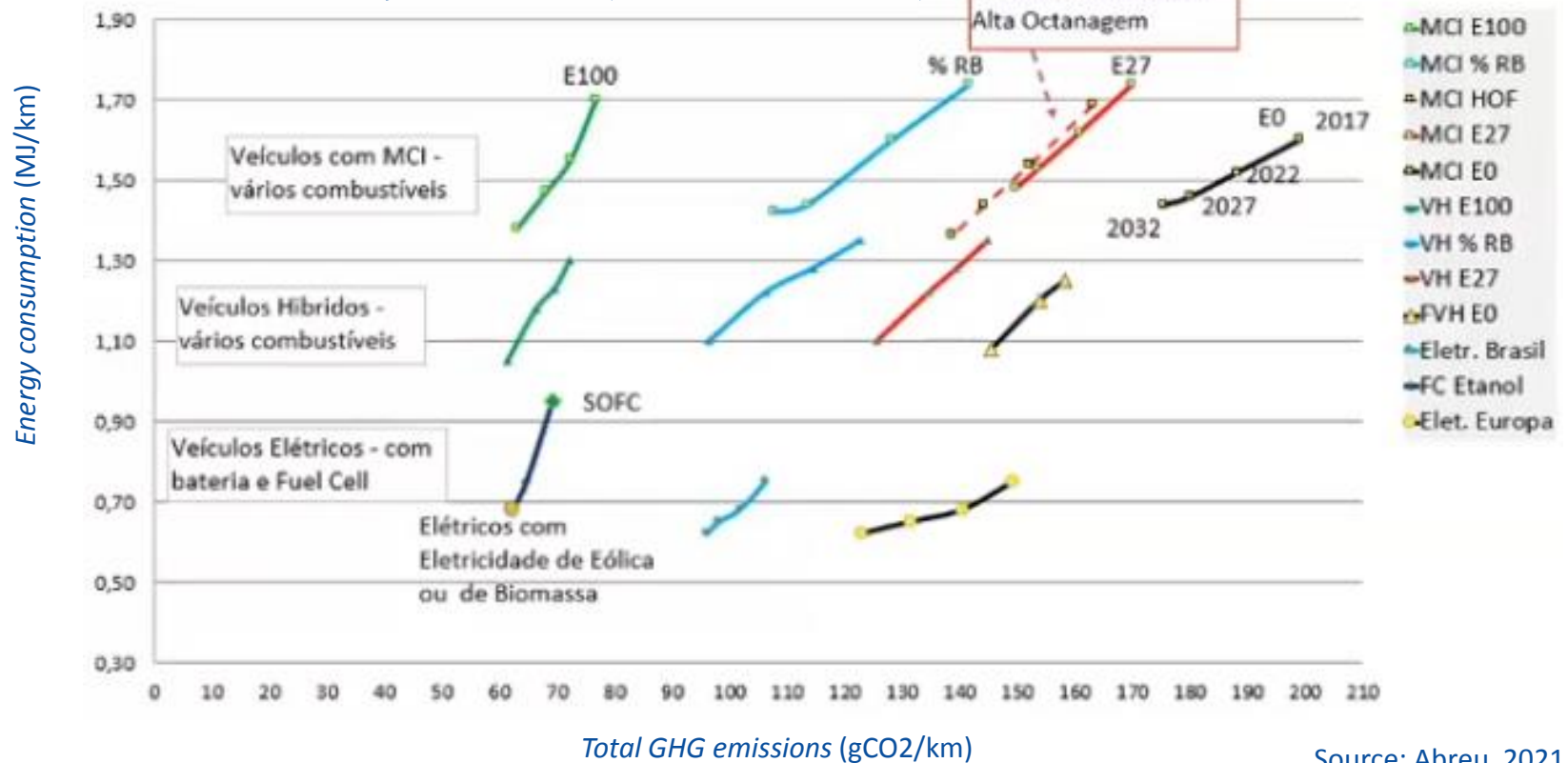
E27 E12 E10 **E10**

Biodiesel



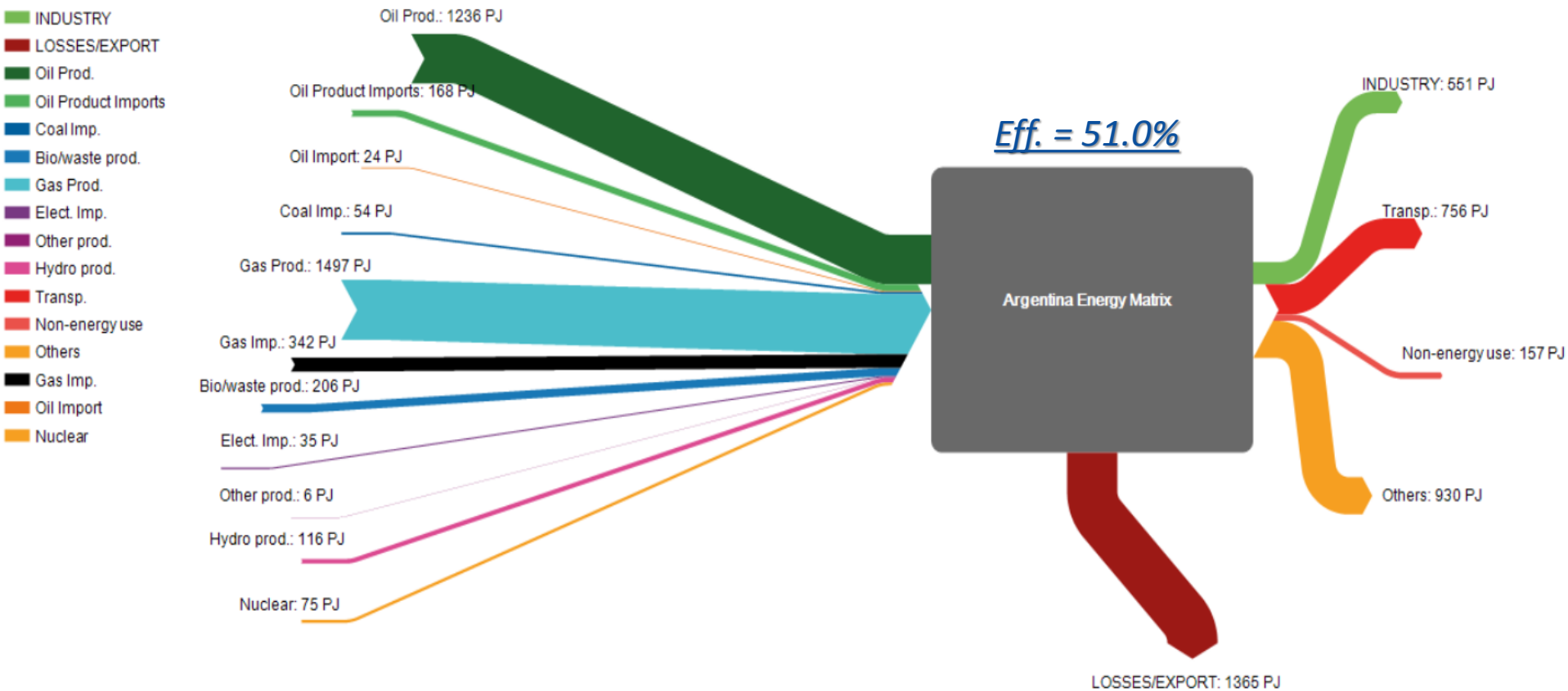
B13 B10 B12 **B2**

Life Cycle GHG (well-to-wheel)

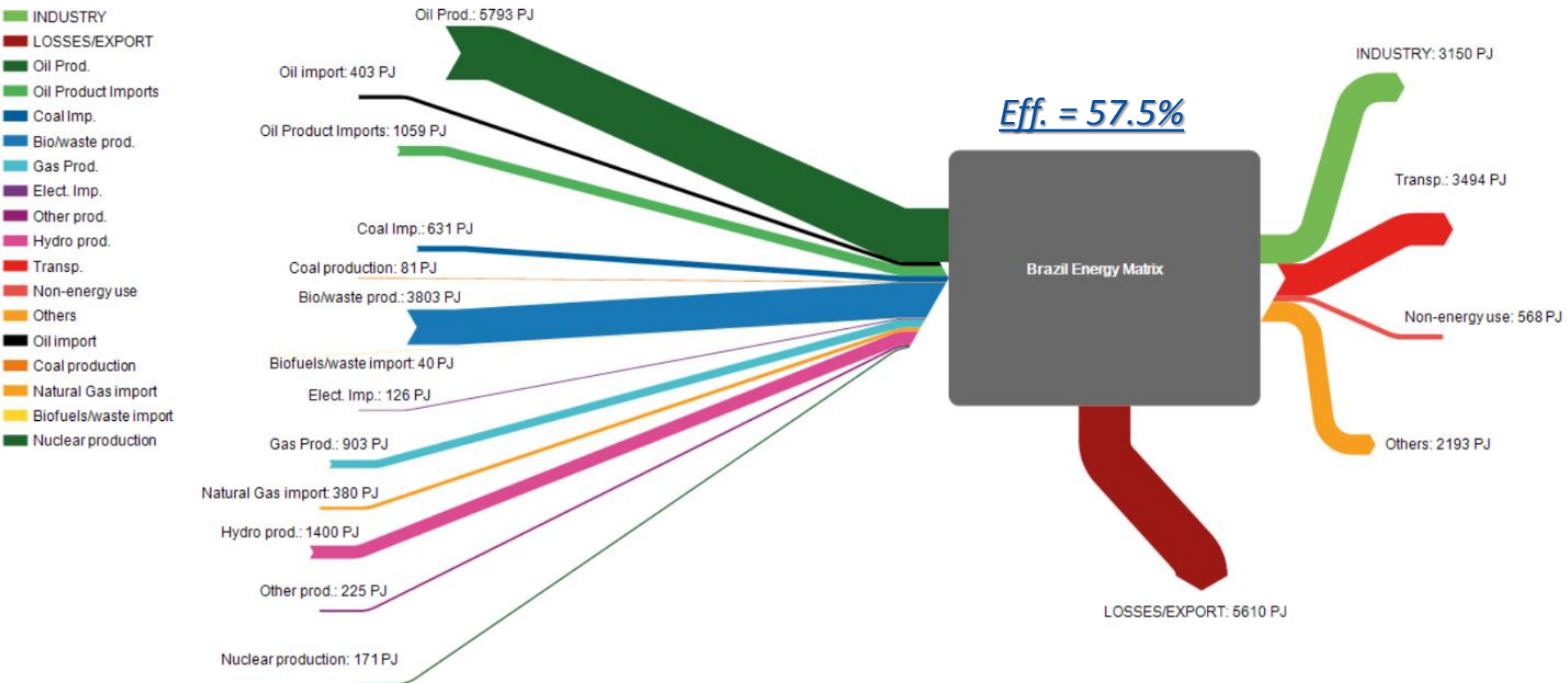


Source: Abreu, 2021

Argentina Mix

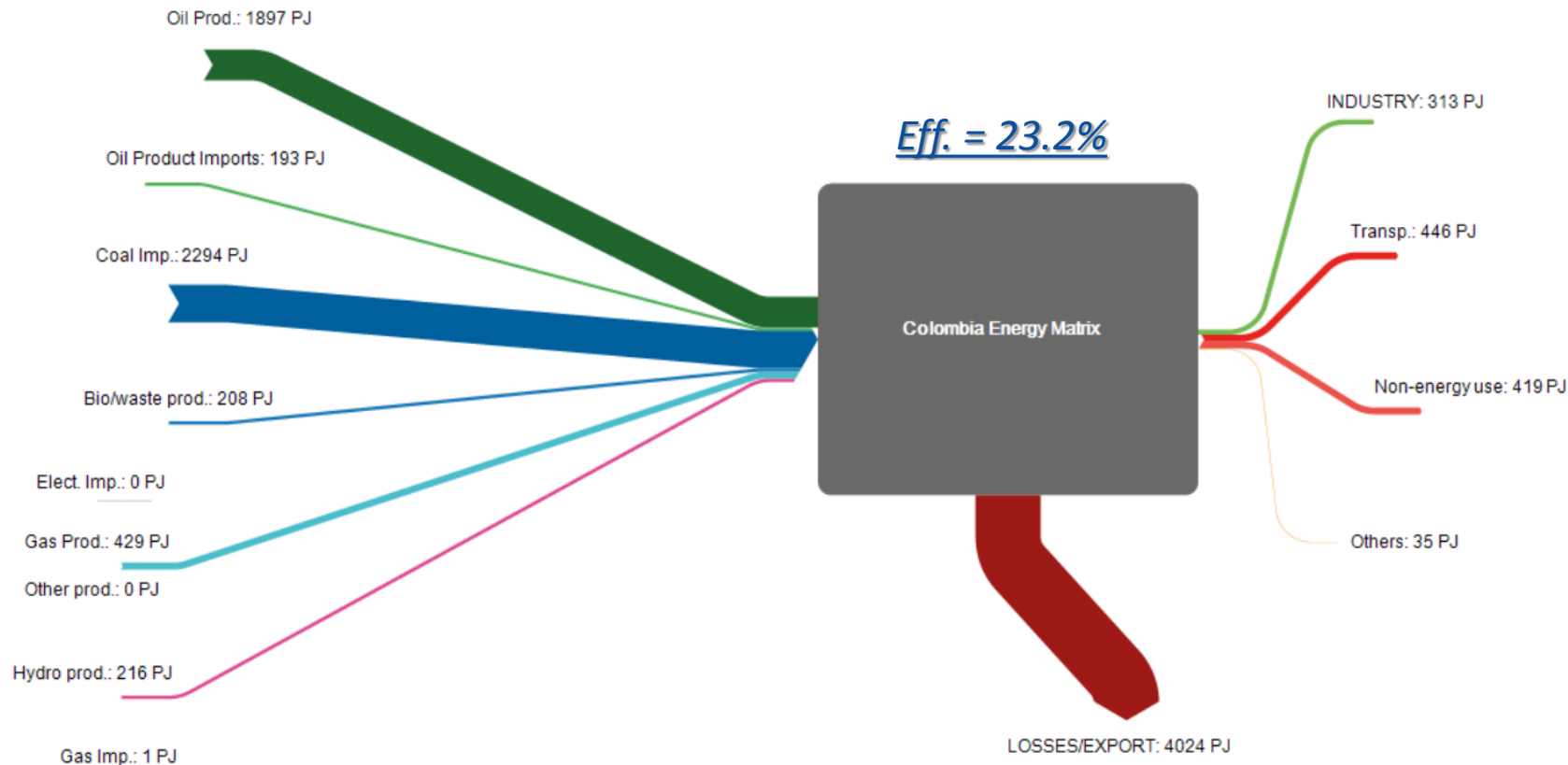


Brazil Mix

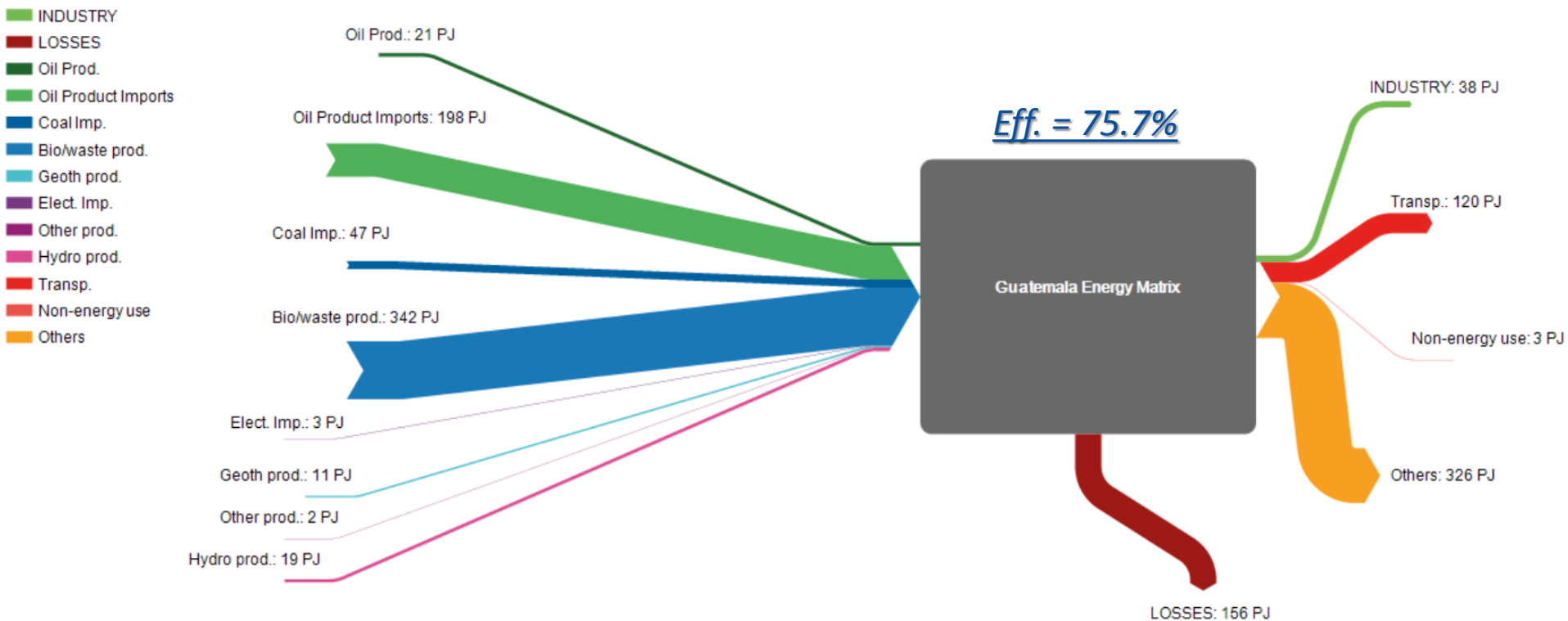


Colombia Mix

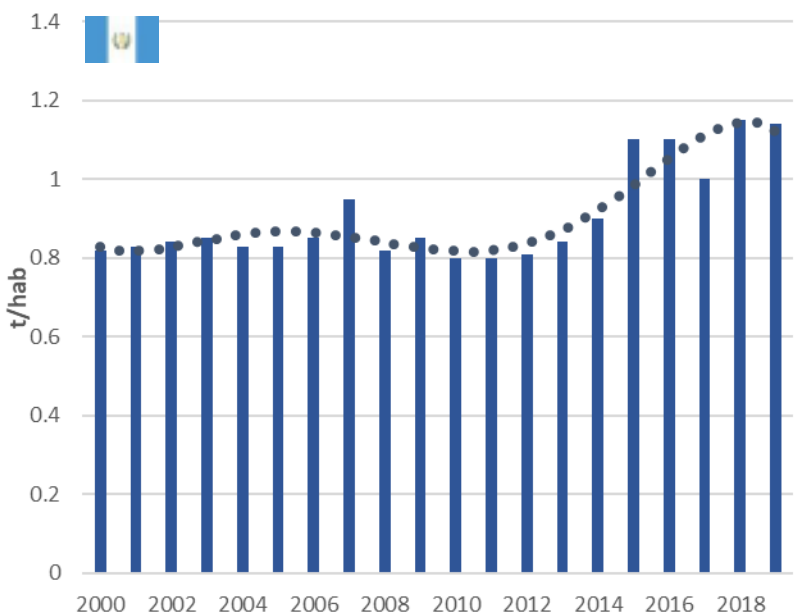
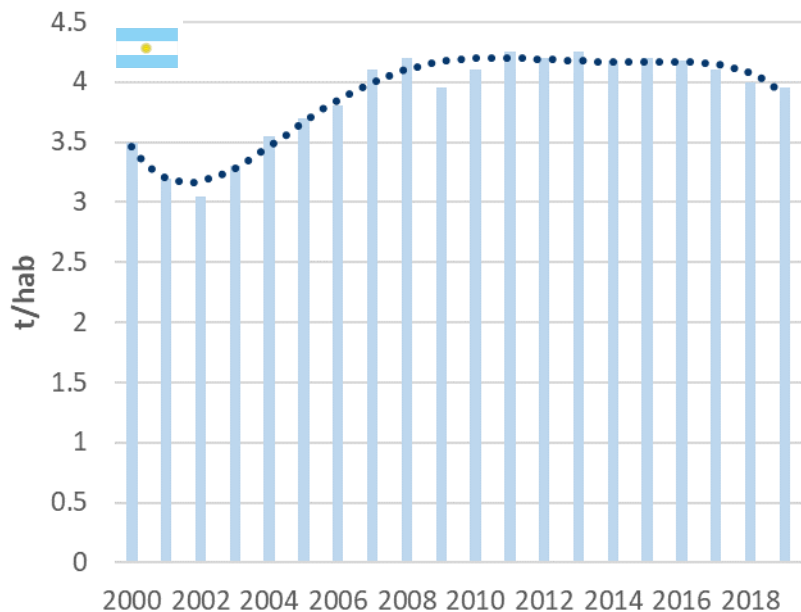
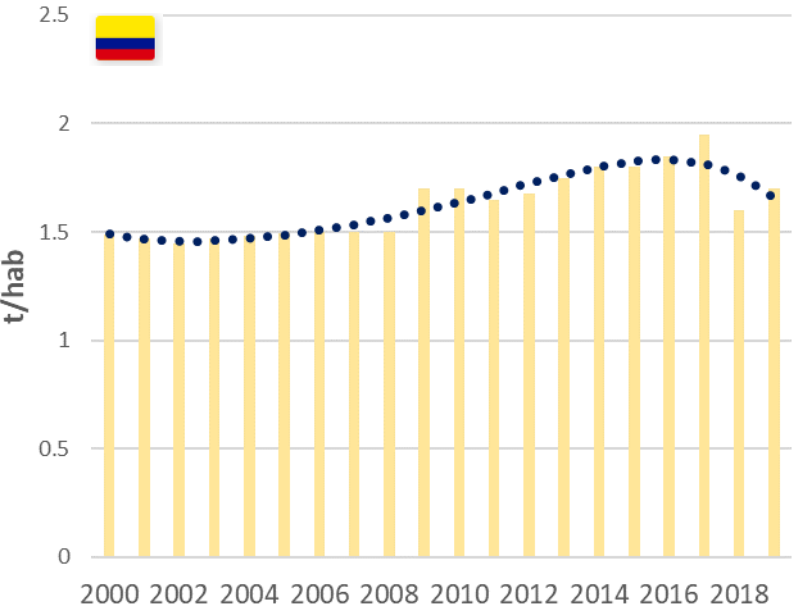
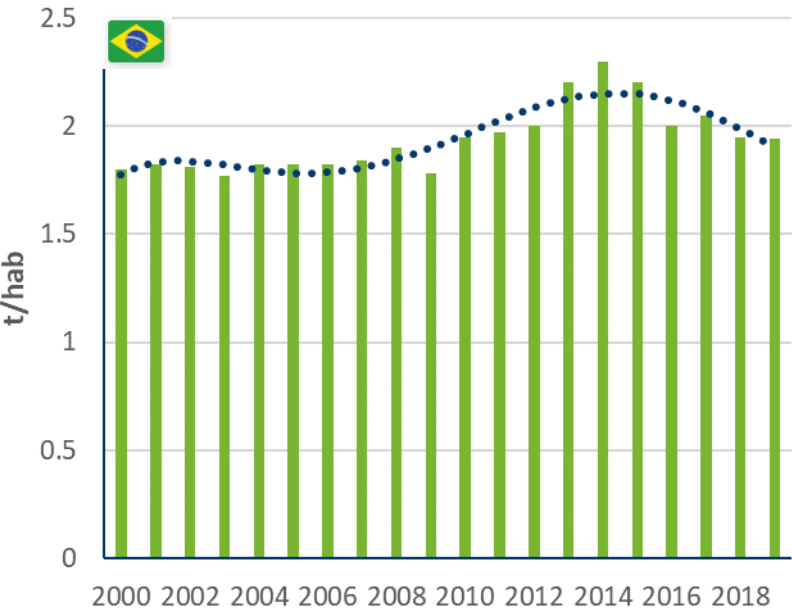
- INDUSTRY
- LOSSES/EXPORT
- Oil Prod.
- Oil Product Imports
- Coal Imp.
- Bio/waste prod.
- Gas Prod.
- Elect. Imp.
- Other prod.
- Hydro prod.
- Transp.
- Non-energy use
- Others
- Gas Imp.



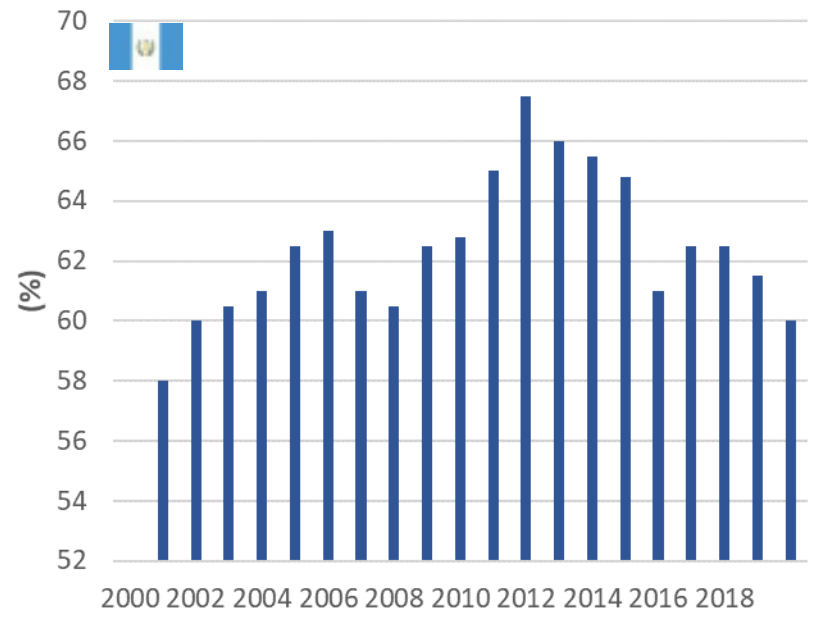
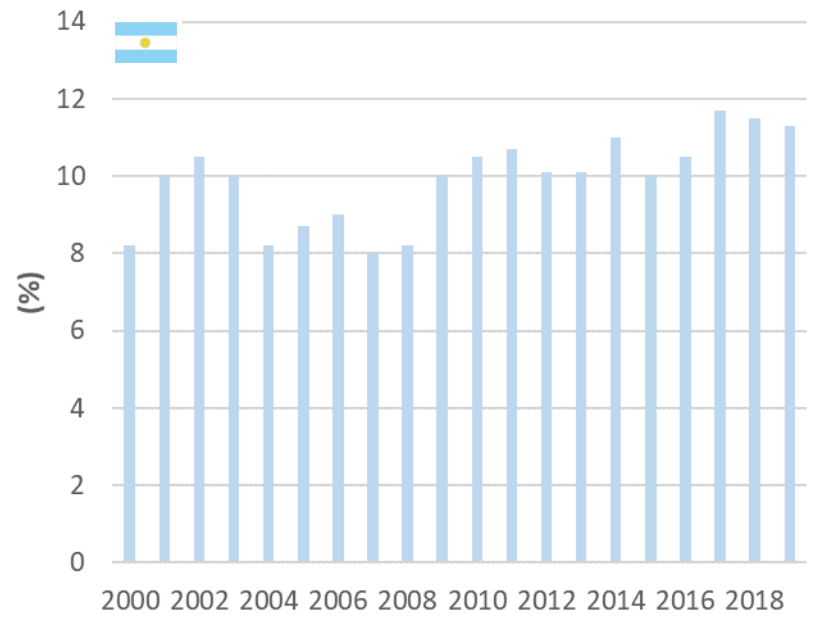
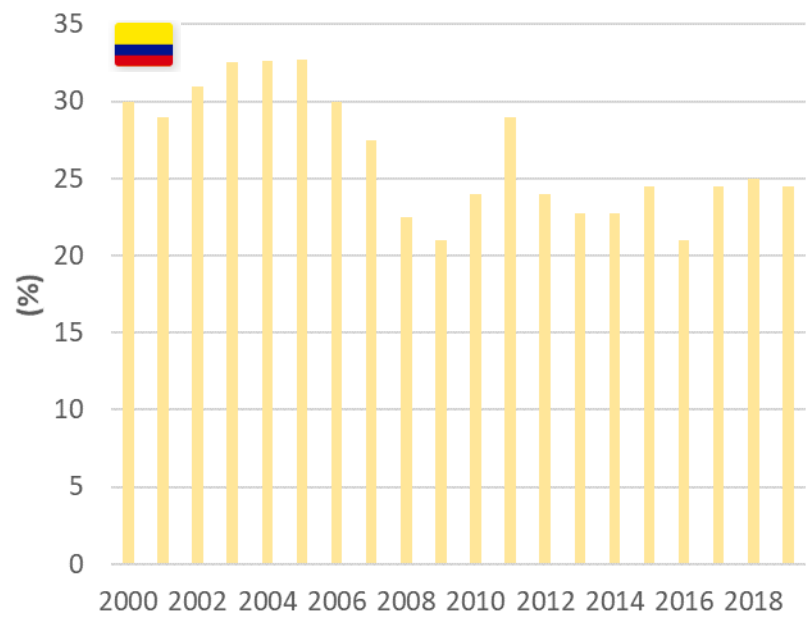
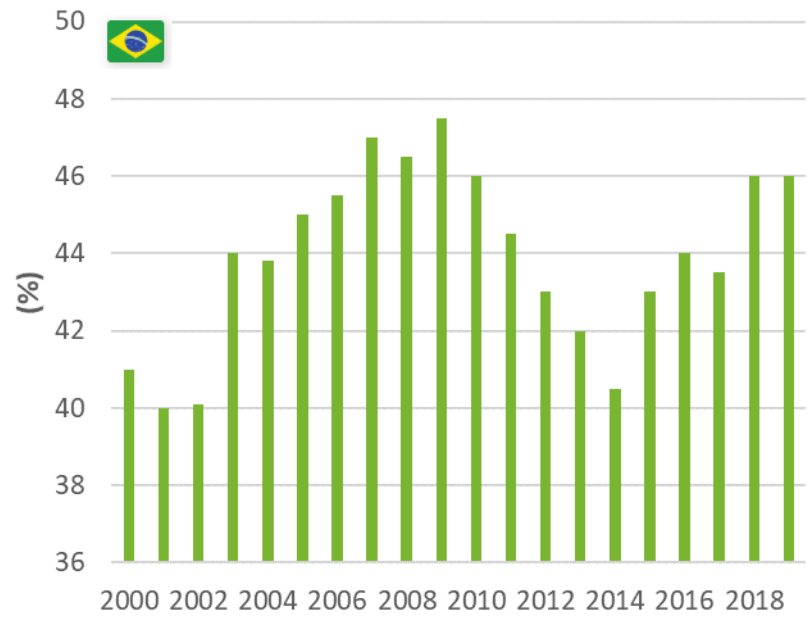
Guatemala Mix



Key performance indicators | CO₂ emissions per capita



Key performance indicators | Renewability index



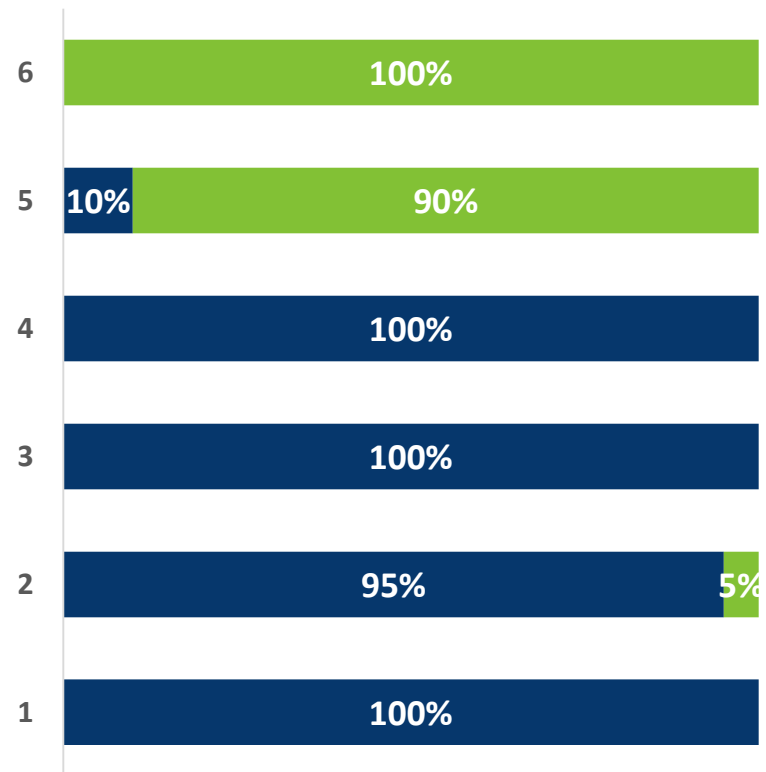
Project progress



1. Selection of the countries that are considered as emerging economies with a large population and in average lower energy consumption compared to developed countries;
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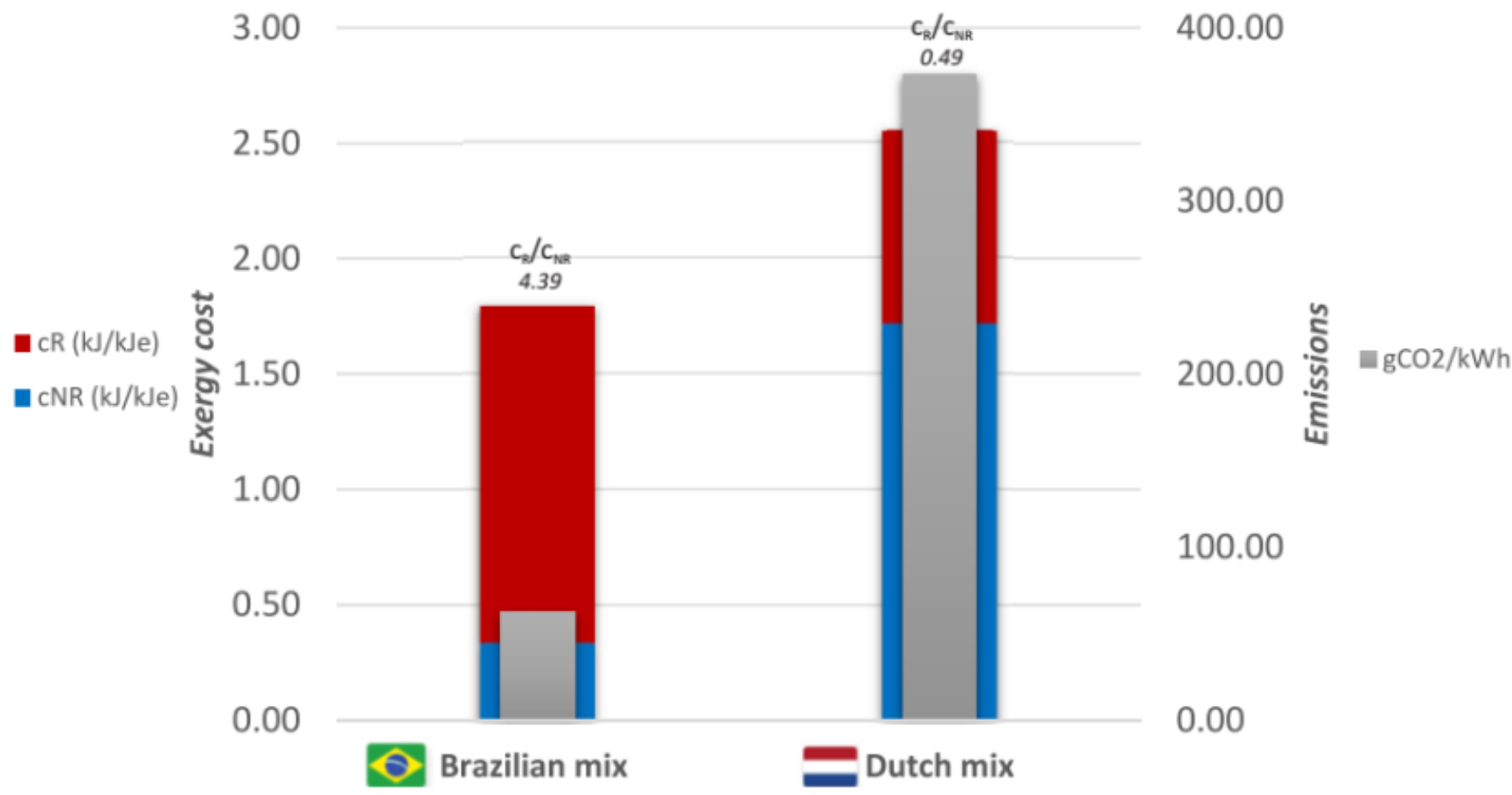
IEA PROJECT PROGRESS

■ Done ■ In Progress



WHERE WE WANT TO GO

COMPARISON BETWEEN THE DUTCH AND BRAZILIAN ELECTRICITY MIX IN TERMS OF THE TOTAL, RENEWABLE, AND NON-RENEWABLE UNIT EXERGY COSTS AND SPECIFIC CO2 EMISSIONS.



Silva-Ortiz et al. (2020)

Final Comments | take-home message

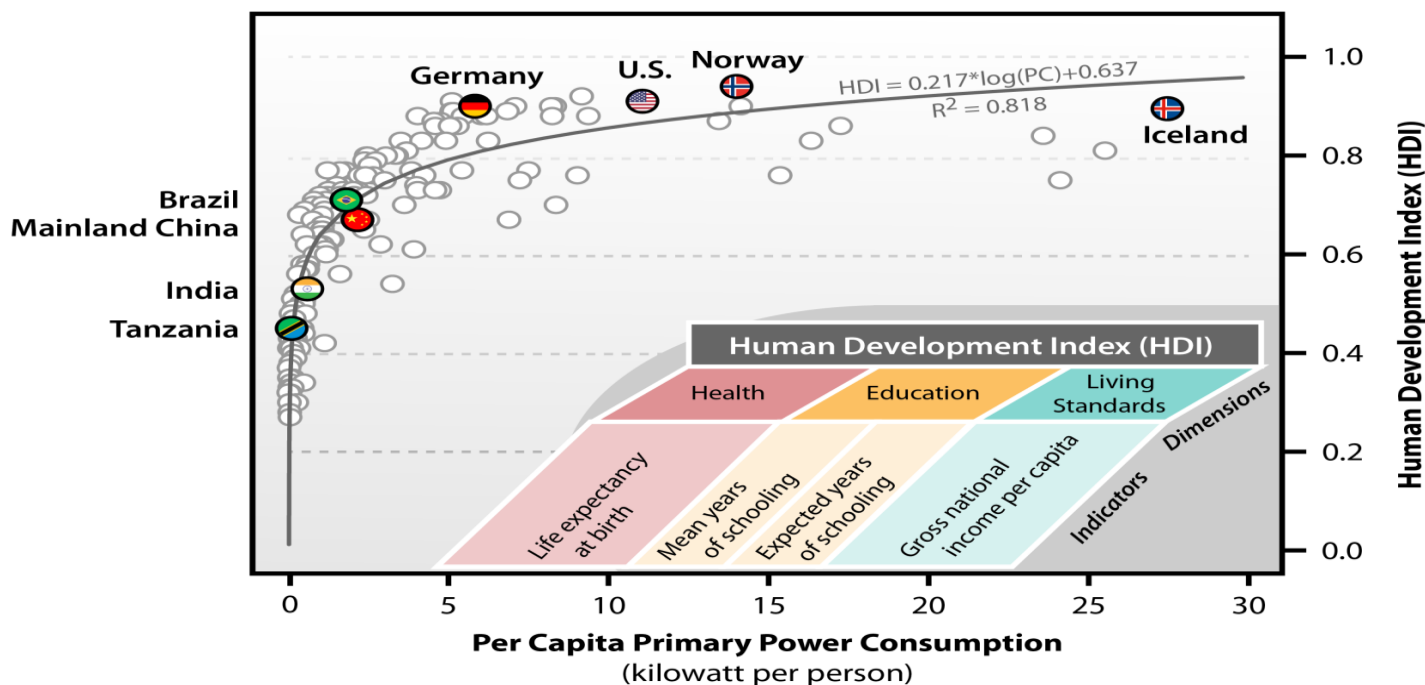
- Bioenergy has potential to be significant part of the energy matrix (biomass biofuels and biochemicals) for emerging economies focus on technological and social implications;
- Policy incentives mechanism assurance for biofuel production; Energy transition dilemmas and paradoxes (Guatemala case)
- The global pictures/geopolitics context for each country based on the energy plans (2050) shows the interest to increase the blending mixture of gasoline and ethanol into the main activities of the oil and natural gas industry to fund the energy transition.

Final Comments

Emerging countries are increasing their need for energy, and liquid biofuels have to be produced in such way the renewable electricity may also be generated;

Liquid biofuels appears to be a suitable approach for developing countries but the developed countries policy may be in other direction;

Bioenergy has potential to be significant part of the energy matrix, but it has to be in sustainable way using countries/regional resources with suitable and available technologies.



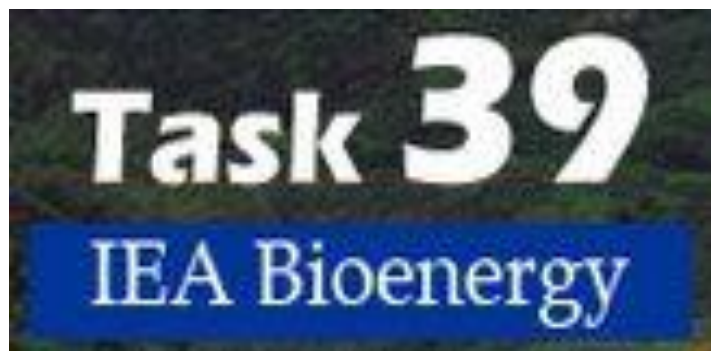
Thank you for your
attention!

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www.task39.ieabioenergy.com



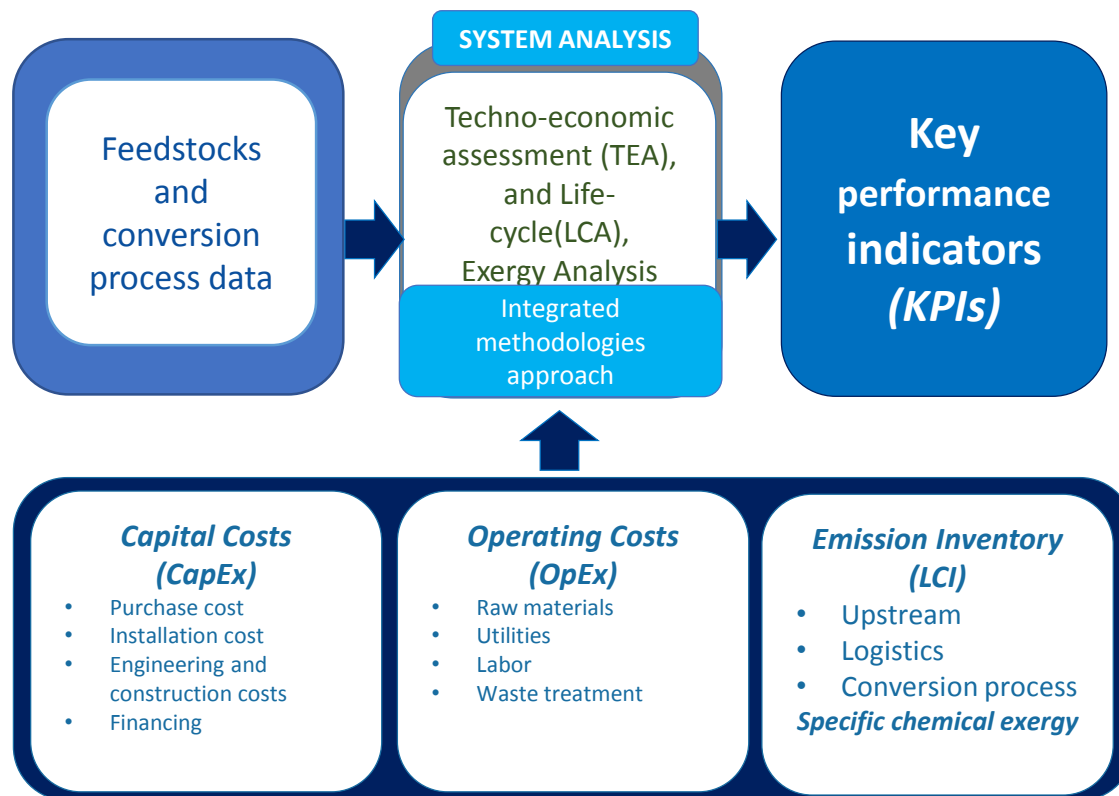
IEA Bioenergy

Technology Collaboration Programme

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Methodology

SCOPE: Developing Countries with large populations and high energy demand.



<i>PROCESS Feedstock</i>	Corn¹	Switchgrass¹	Sugar cane²
<i>Energy unit</i>	(GJ/ha.yr)	(GJ/ha.yr)	(GJ/ha.yr)
Crop production energy consumption	18.9	17.8	13.9 
Biomass Energy	149.5 ³	220.2	297.1 ⁴ 
Agricultural energy ratio	7.9	12.3	21.3 
Ethanol production energy consumption	47.9	10.2	3.4 

1- Source: ORNL, 2- Source: Copersucar/UNICAMP, 3-No credit for corn stover, 4- No credit for sugar cane leaves

How to evaluate if metabolic improvement is viable: Theoretical Photosynthesis Production Capacity (TPPC) compared to observed production

For sugar cane TPPC= 386 ton/hay and the observed production capacity is 85 ton/hay (Moore et. al, 2013, Souza Mendes et. al 2015)

For sugar cane ethanol - 9-14 liters renewable energy/liter fossil energy

Oil - Each unit of energy invested to produce oil in the 1940s yielded the equivalent of 110 energy units (1 to 100) Nowadays - depending upon the oil field 1-10
(Maciel Filho, 2014)