Environmental Certification for Biofuels

The Inmetro LCA Collaboration

Introduction

Biofuels and the Environment

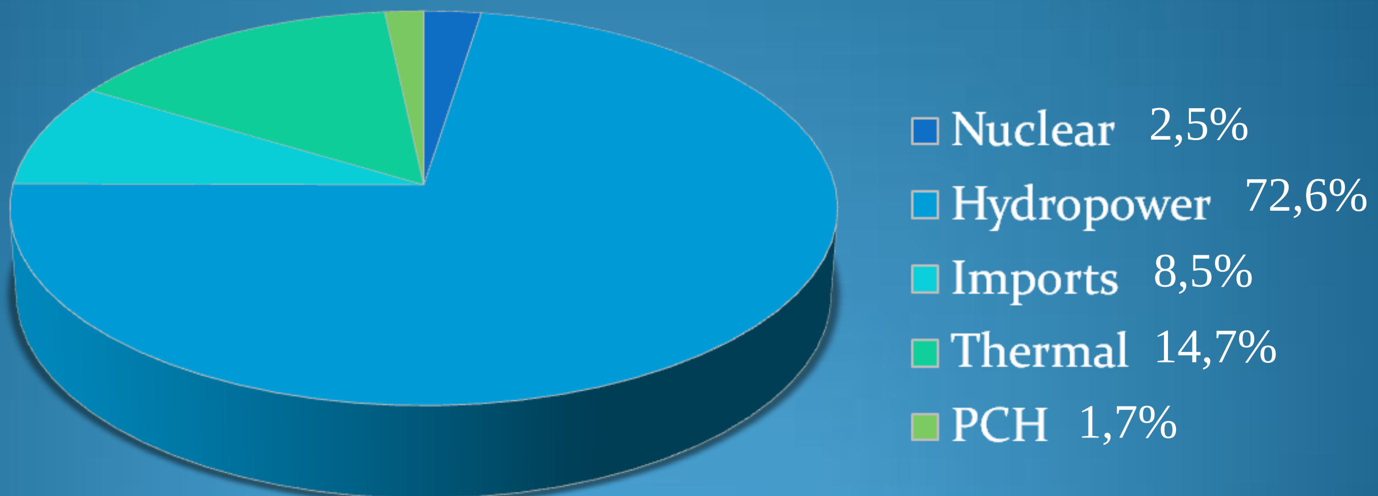
- Currently, the default fuels worldwide are from fossil origin. Lately, with the tighter regulations and with the increase in environmental awareness, this has been questioned.
- With new technologies and enhanced methods, the scientific community has been finding ways to replace fossil fuels with cleaner fuels, such as ethanol and biodiesel.
- The establishment of "new fuels" worldwide needs to be closely monitored in order to ensure that it will have a beneficial effect.

Biofuels vs. Fossil Fuels

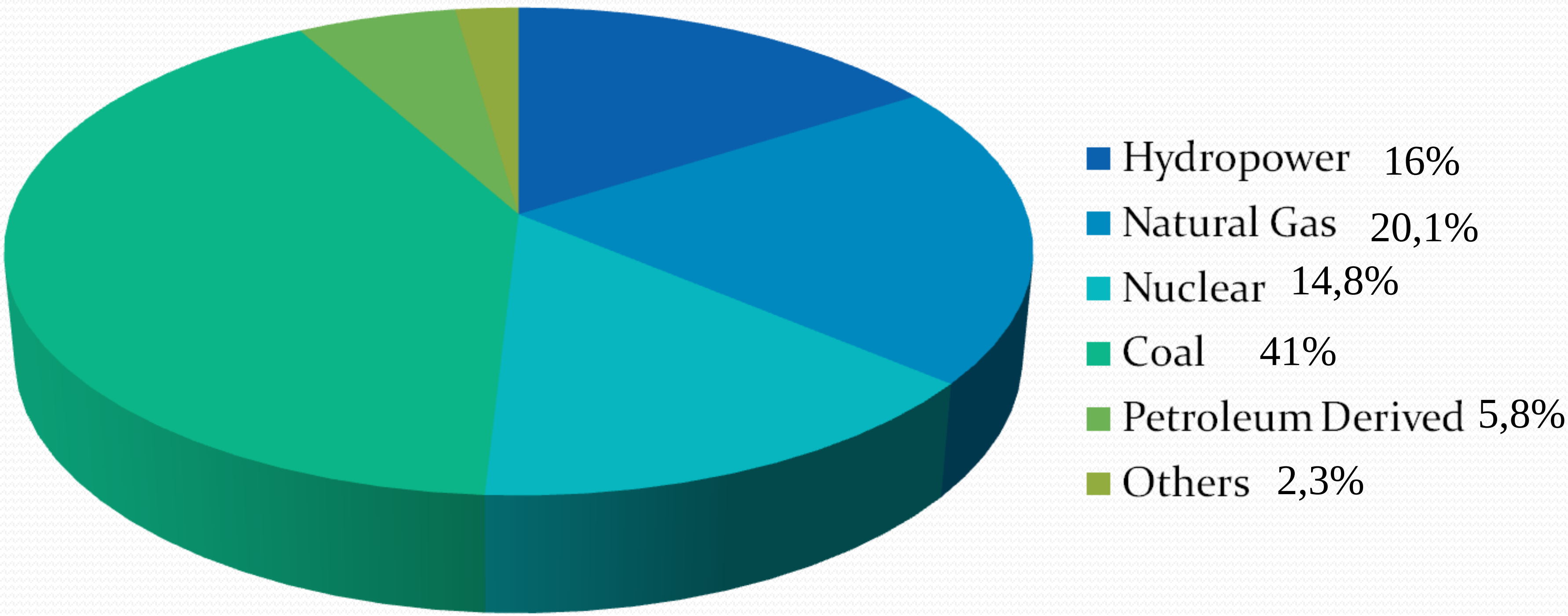
- Main difference is due to photosynthesis, which draws CO_2 from the atmosphere to produce biomass. CO_2 emitted from biofuels was already removed from the atmosphere during the crop growing >>> Neutral Emissions.
- Fossil fuels, on the other hand, use limited supplies, and aside from being finite, the process draws carbon (eg. from oil reservoirs and coal seams) and transfers it to the atmosphere, affecting the carbon cycle.

Brazil has a clean energy matrix

Brazilian Electric Energy by Primary Source of Generation (2007, BEN 2008)



World Electric Energy by Primary Source of Generation (2006, BEN 2008)



Objective

- Inmetro has been working to elaborate a questionnaire / worksheet model (as inspired by Michael Wang´s GREET 1.8b) for Brazilian producers, in order to construct a database for its different regions.
- The goal is to gather information from reliable sources (such as ANP, CTC, Embrapa, agricultural schools, ethanol producers, etc.) in order to come up with a standard methodology for the LCA Inventory associated with the ethanol production, not only for Brazil, but also for other potential producers.
- The ultimate achievement would be to have the producers themselves using this methodology, in order to rate and improve their processes.

Model Characteristics

- The model LCA Inventory should be:
  - Open
  - User friendly
  - Based on measurements
  - Verifiable
  - Periodically Updated

The final outcome of the application of the methodology would be a Biofuel Quality Seal (presenting environmental indicators such as, for example: GHGs emissions and Energy Balance). Other indicators may be introduced later in the certification process. Evolution of the application may result in a full LCA.

What is LCA?

Life Cycle Assessment (LCA, also known as **life cycle analysis**, **ecobalance**, and **cradle-to-grave analysis**)

A Protocol which may be used to compare the environmental performance of products and processes.

LCA for Environmental Certification

In our LCA application we focus on the GHG inventory and energy consumption – impacts on the mitigation power of biofuels with respect to Climate Change.

We are, at first, excluding any other environmental impacts.

Objective – To compare the Brazilian sugarcane ethanol versus petroleum fuels for the light duty vehicles fleet.

Brazilian Sugarcane

- Leading edge technology
    - (Pro-Álcool - 1980s)
- Leading sugarcane production (followed by India and China)
    - (8,2 MHa of cane fields)
- Leading ethanol efficiency
    - (Superior to corn, beet, etc.)
- One of the most efficient photosynthesizers in nature

LCA Applied to the Sugar Cane Ethanol

- First Effort: Quantification of the Use of Energy and the Emissions of GHGs (CH_4, N_2O and CO_2)
- The most relevant phases in the production of the sugar cane ethanol are:
  - Sugar Cane Planting
  - Handling the Sugar Cane Culture
  - Sugar Cane Harvesting
  - Distillation
  - Transport to the Large Distributors
  - Transport to the Small Distributors

LCA Applied to the Sugar Cane Ethanol

Use of Energy and Green House Gases Emissions

Inventory Items

- First Stage – Planting the Sugar Cane:
  - Farming Equipment and Trucks
  - Diesel Oil
  - Manual Labor
  - Herbicides
  - Soil ph Corrector
  - Nitrogen
  - Phosphate
  - Potassium
  - Plant Seeds
  - Transport of the Farming Implements

LCA Applied to the Sugar Cane Ethanol

Use of Energy and Green House Gases Emissions Inventory Items

- Second Stage – Culture Handling:
  - Farming Equipment
  - Diesel Oil
  - Manual Labor
  - Pesticides
  - Use of “Vinhaça”

Sugarcane Harvesting

Traditional (60%):

Manual labor, cane field burning

Trabalhador carrega cana em Alagoas.
Foto: Sérgio Vignes / Observatório Social

Sugarcane Harvesting

Mechanized (40%):

Automated machinery

Social implications - a single mechanized harvester is equivalent to 80 men's work

LCA Applied to the Sugar Cane Ethanol
Use of Energy and Green House Gases Emissions
Inventory Items

- Third Stage – Harvesting:
  - Farming Equipment and Trucks
  - Diesel Oil
  - Manual Labor
  - Transport of the Sugar Cane to the Distilleries
  - Emissions from Residues
    - Burning in the Manual Harvesting
    - Soil Mineralization in the Mechanized Harvesting

Distilleries

LCA Applied to the Sugar Cane Ethanol

Use of Energy and Green House Gases Emissions

Inventory Items

- Fourth Stage – Distillation of the Ethanol:
  - Use of Construction Materials in the Plant:
    - Structural light steel
    - Equipment light steel
    - Stainless steel
    - Concrete
  - Rectification to 99.5% (reduction in water content)
  - Chemical Reagents
  - Diesel Oil
  - Manual Labor
  - Energy (external use versus bagasse use)

Distribution

Production | Large Distributors | Small Distributors | Consumer

LCA Applied to the Sugar Cane Ethanol

Use of Energy and Green House Gases Emissions Inventory

- Fifth Stage – Distribution:
  - First Evaluation – Transport from Distilleries to Large Distributors.
  - Use of production and consumption data (distribution by states – will lead to average results) produced a distribution profile for the country observing smaller distance routes.
  - Estimation of the number of necessary trips (for 40.000 liters trucks) for transporting the production in these routes.
  - The average consumption for the trucks (going full and returning empty) was estimated to be 4 km / liter of diesel.
  - Estimation of the diesel consumption in the process.
  - Employing energy and emission factors for the use of diesel in the trucks for estimating the use of energy and the GHGs emissions.

Preliminary Model Results

- Obtained with data from EMBRAPA (2009)
- Test case

Energy flows and GHG emissions in Sugarcane Sowing

Sugarcane Planting

Worksheet Output

	kg. CO_2Eq./ ha.yr	
Machinery	75.5	11%
Diesel	37.9	5%
Labour	7.4	1%
Herbicides	106.1	15%
Lime	275.3	38%
Nitrogen	34.6	5%
Phosphorus	2.7	0.4%
Potassium	28.2	4%
Seeds	21.0	3%
Cane transport	114.0	16%
Transport of consumables	15.3	2%

717.9 kg. CO_2 eq./ha.yr

30.4% Emissions

Sugarcane Sowing

63% Energy

8962.6 MJ/ha.yr

	MJ/ha.yr	
Machinery	794.5	9%
Diesel	511.5	6%
Labour	100.4	1%
Herbicides	1445.3	16%
Lime	480.8	5%
Nitrogen	3061.8	34%
Phosphorus	51	1%
Potassium	488.9	5%
Seeds	286.3	3%
Cane Transport	1536.2	17%
Transpor of consumables	206	2%

Energy flows and GHG emissions in Plantation Handling

Sugarcane Handling

Worksheet Output

	kg. CO_2Eq./ ha.yr	
Machinery	15.1	3%
Diesel	5.9	1%
Labour	7.4	1%
Insecticides	6.4	1%
Vinasse disposal	151.1	30%
Soil emissions	322.4	63%

508.2 kg. CO_2 eq./ha.yr

21.5% Emissions

Plantation Handling

8% Energy

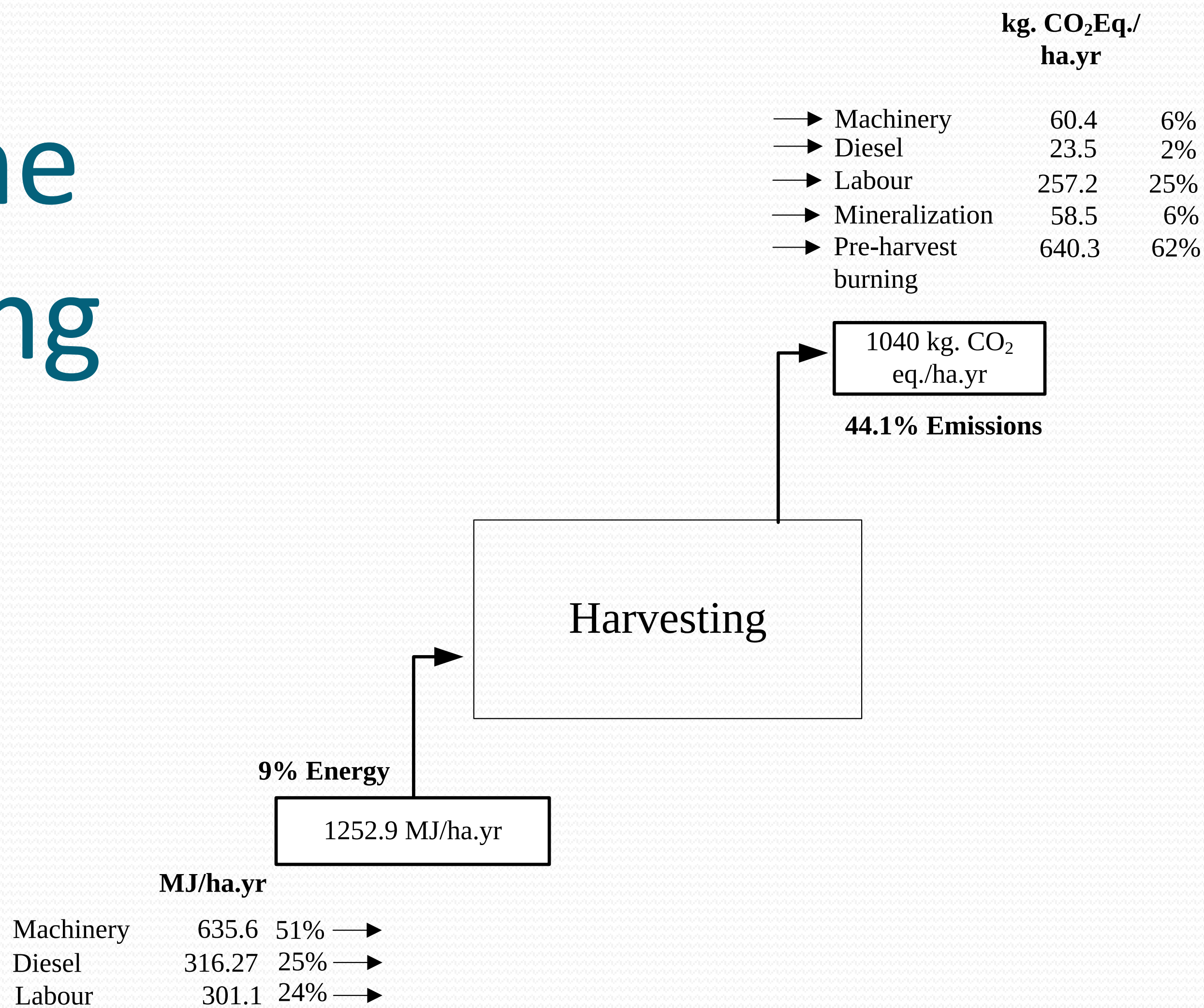
1080.8 MJ/ha.yr

	MJ/ha.yr	
Machinery	159	15%
Diesel	79.1	7%
Labour	100	9%
Insecticides	87.3	8%
Vinasse disposal	655	61%

Energy flows and GHG emissions in Harvesting

Sugarcane Harvesting

Worksheet Output



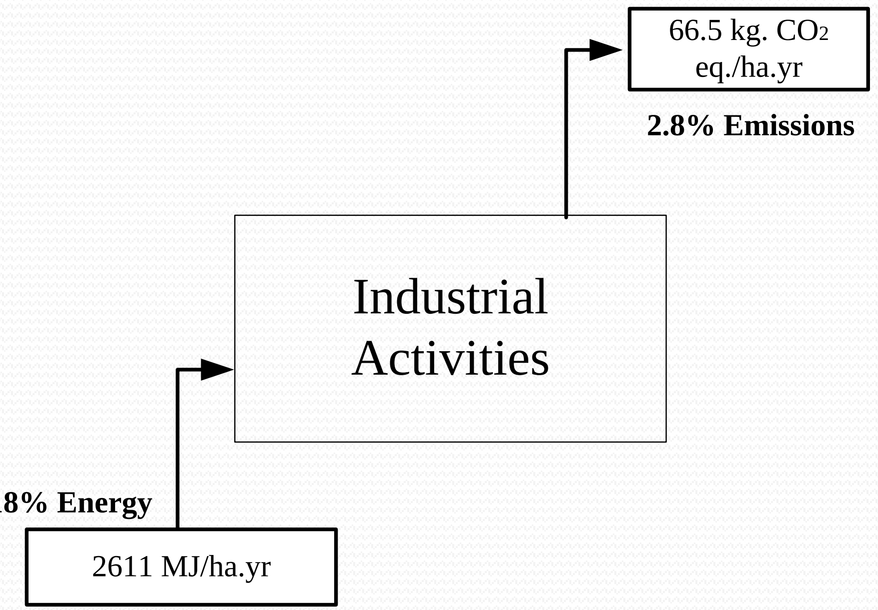
Energy flows and GHG emissions in Industrial Activities

Distilleries

Worksheet

Output

	kg. CO_2Eq./ ha.yr	
Structural mild steel	29.7	45%
Stainless steel	6.4	10%
Cement	5.8	9%
Mild steel in light equipment	24.5	37%



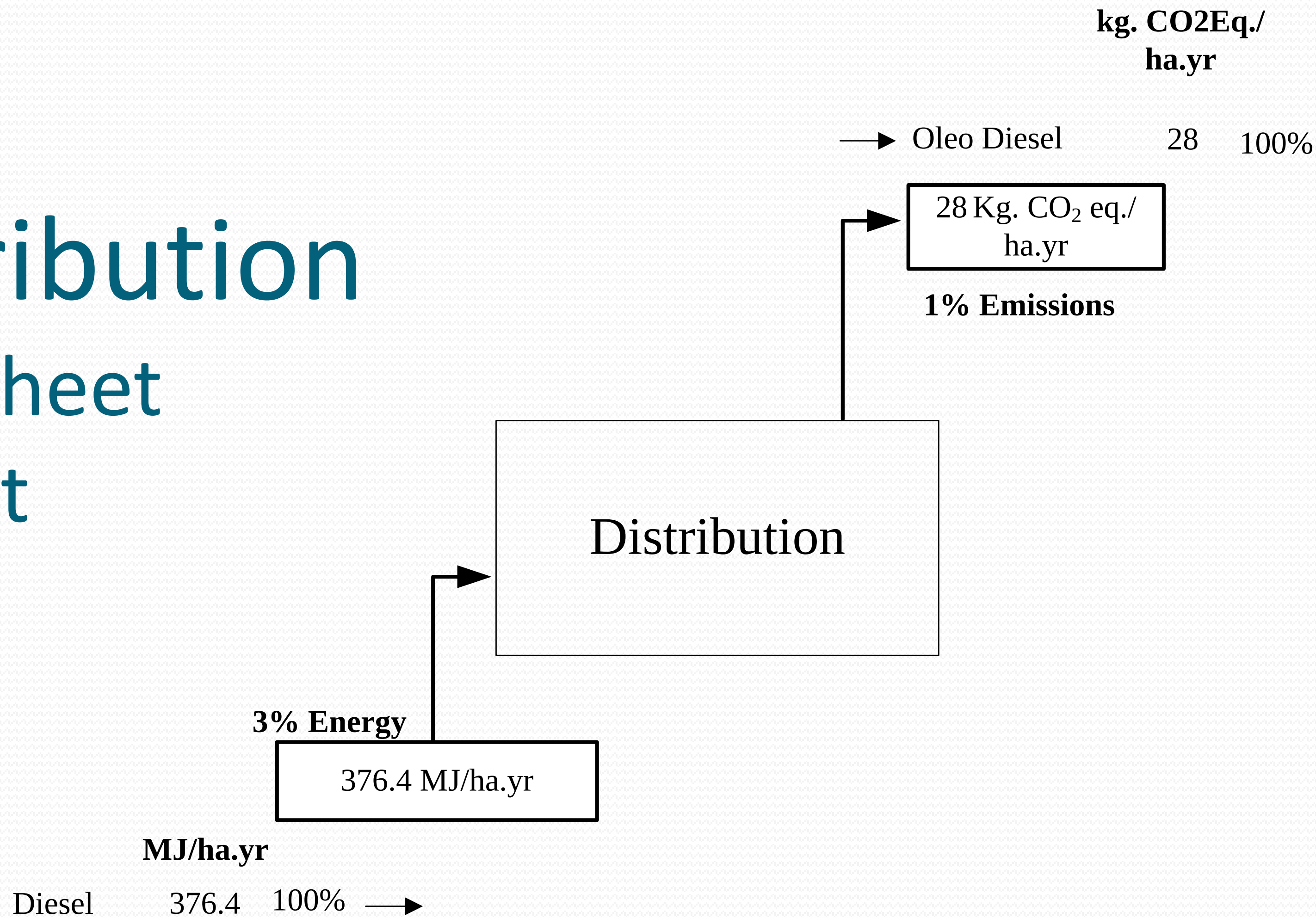
	MJ/ha.yr	
Structural mild steel	841.8	32%
Mild steel in light equipment	693.6	27%
Stainless steel	286.8	11%
Cement	75.94	3%
Rectification 95%	225.3	9%
Chemicals	487.6	19%

Energy flows and GHG emissions in Distribution

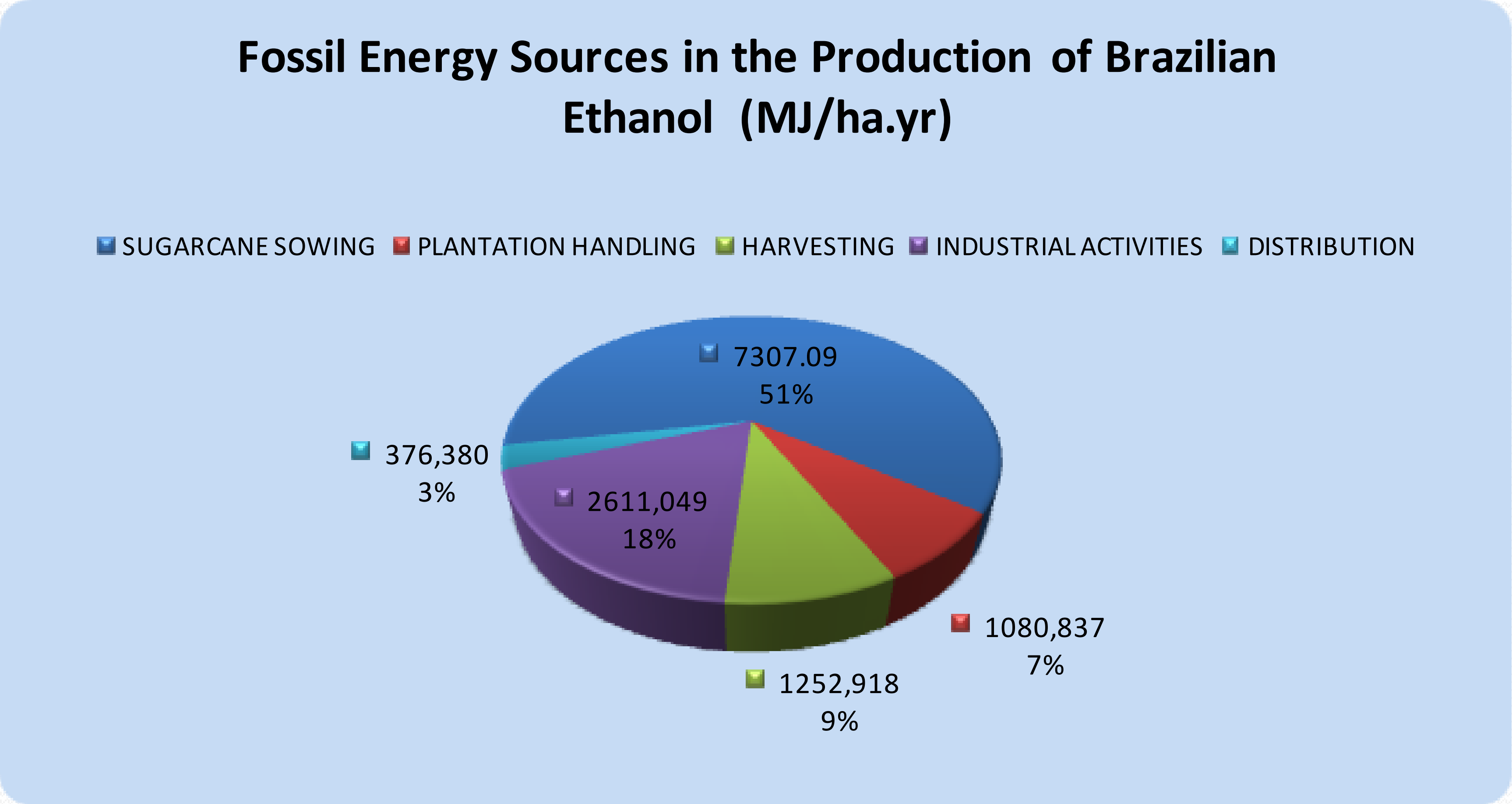
Distribution

Worksheet

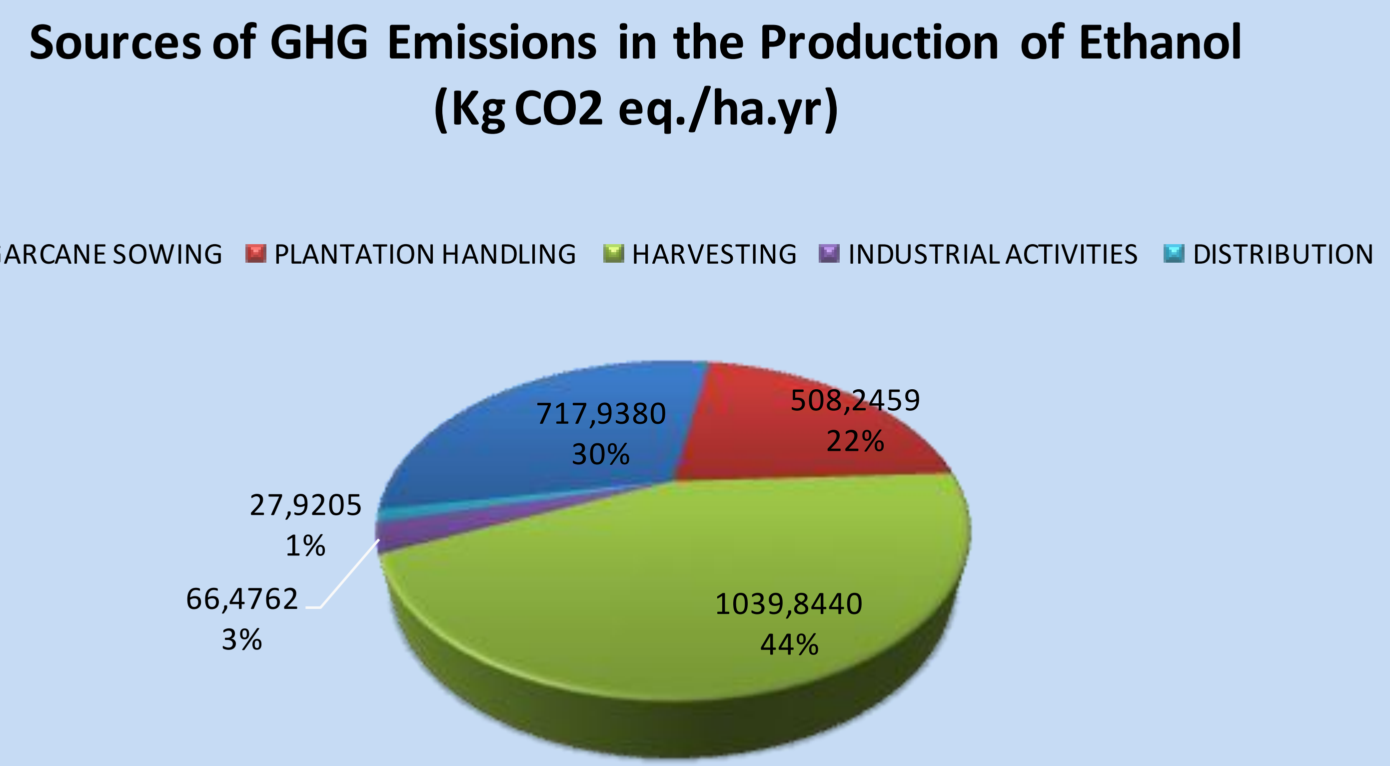
Output



Preliminary Results



Preliminary Results



Next

Field data will be collected for various installations, in different regions – will provide:

- Regional and technology dependent information – eg. study on the variability of the data
- Model optimization
  - eg. new items may be added to the inventory
  - eg. sensitivity analysis for a better definition of the scope – system boundaries

Thank you for the attention!

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