90 years +3
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INDÚSTRIAS DE BASE

Paulo Augusto Soares
paulo.soares2@dedini.com.br

EMISSIONS MITITIGATION ON SUGARCANE MILL

STRATEGIES AND ACTIVITIES

Bio-energy and CCS (BECCS): Options for Brazil

June 13th, 2013

HOW MUCH BIOENERGY FROM SUGARCANE?

1 T CLEAN SUGARCANE ≅ 1,2 T INTEGRAL SUGARCANE

≅

1,2 OIL BARRELS

1 T-FIELD
1718 x 10^3 KCAL

JUICE TOTAL SUGAR 153 KG	608 x 10^3 KCAL
BAGASSE (50% MOISTURE) 276 KG	598 x 10^3 KCAL
STRAW (*) (15% MOISTURE) 165 KG	512 x 10^3 KCAL
	1718 x 10^3 KCAL

1 OIL BARREL
1386 x 10^3 KCAL

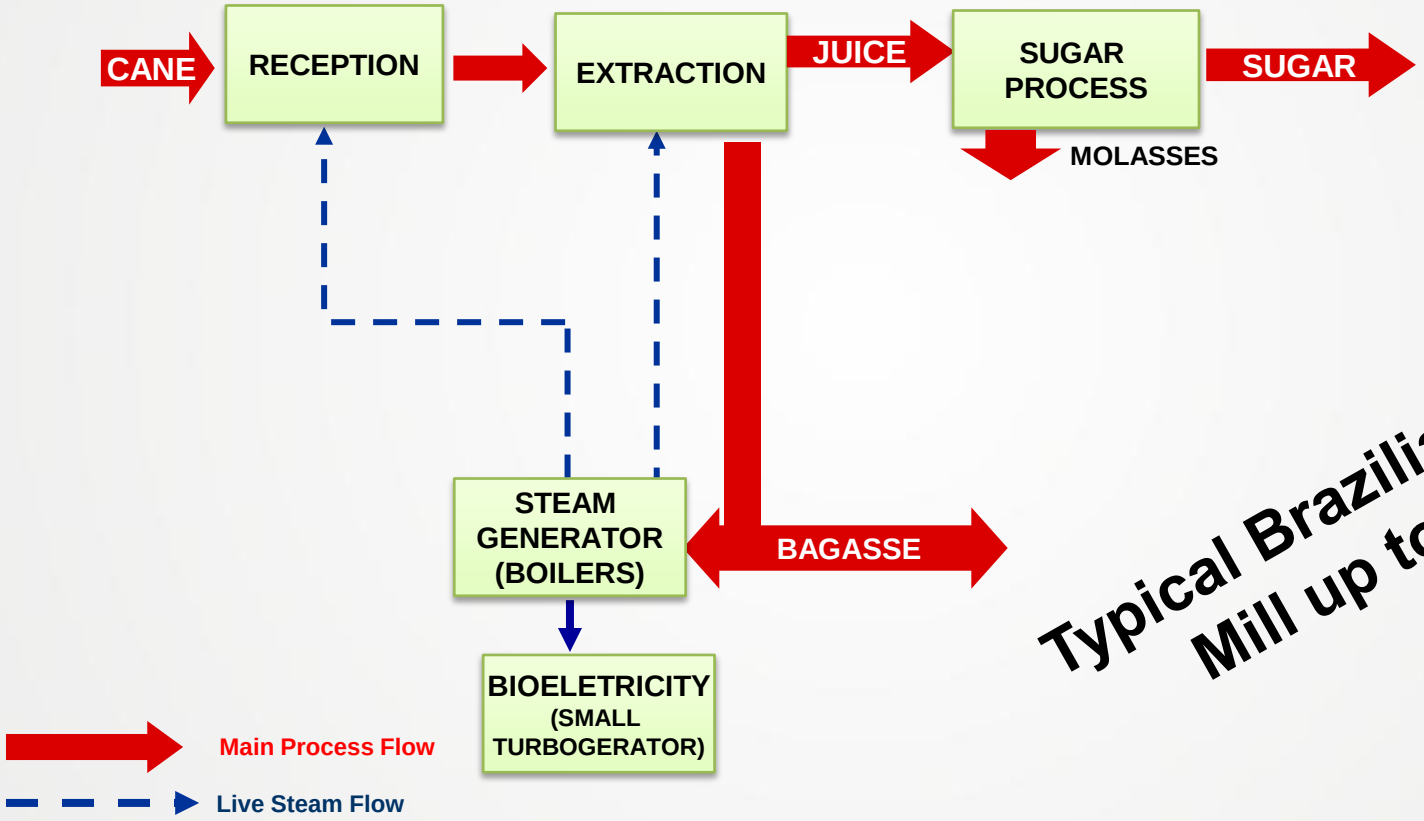
SUGAR CANE IS PURE ENERGY			SEASON 2008/09	SEASON 2010/11
	1/3 AS SUGAR FROM JUICE	SUGAR: THE CHEAPEST FOOD (IN KCAL) IN THE WORLD BIOETHANOL: CLEAN AND RENEWABLE LIQUID ENERGY	648.000 b/d	770.000 b/d
	1/3 FROM BAGASSE	CLEAN AND RENEWABLE ELECTRICITY (may be advanced cellulosic bio-fuel in future)	648.000 b/d	770.000 b/d
	1/3 FROM STRAW (*)	CLEAN AND RENEWABLE ELECTRICITY (may be advanced cellulosic bio-fuel in future)	648.000 b/d	770.000 b/d
		TOTAL	1.944.000	2.310.000

(*) STRAW = TOPS, LEAVES, STRAW

ENERGY EQUIVALENCE – BARRELS OIL/DAY

TECHNOLOGY EVOLUTION

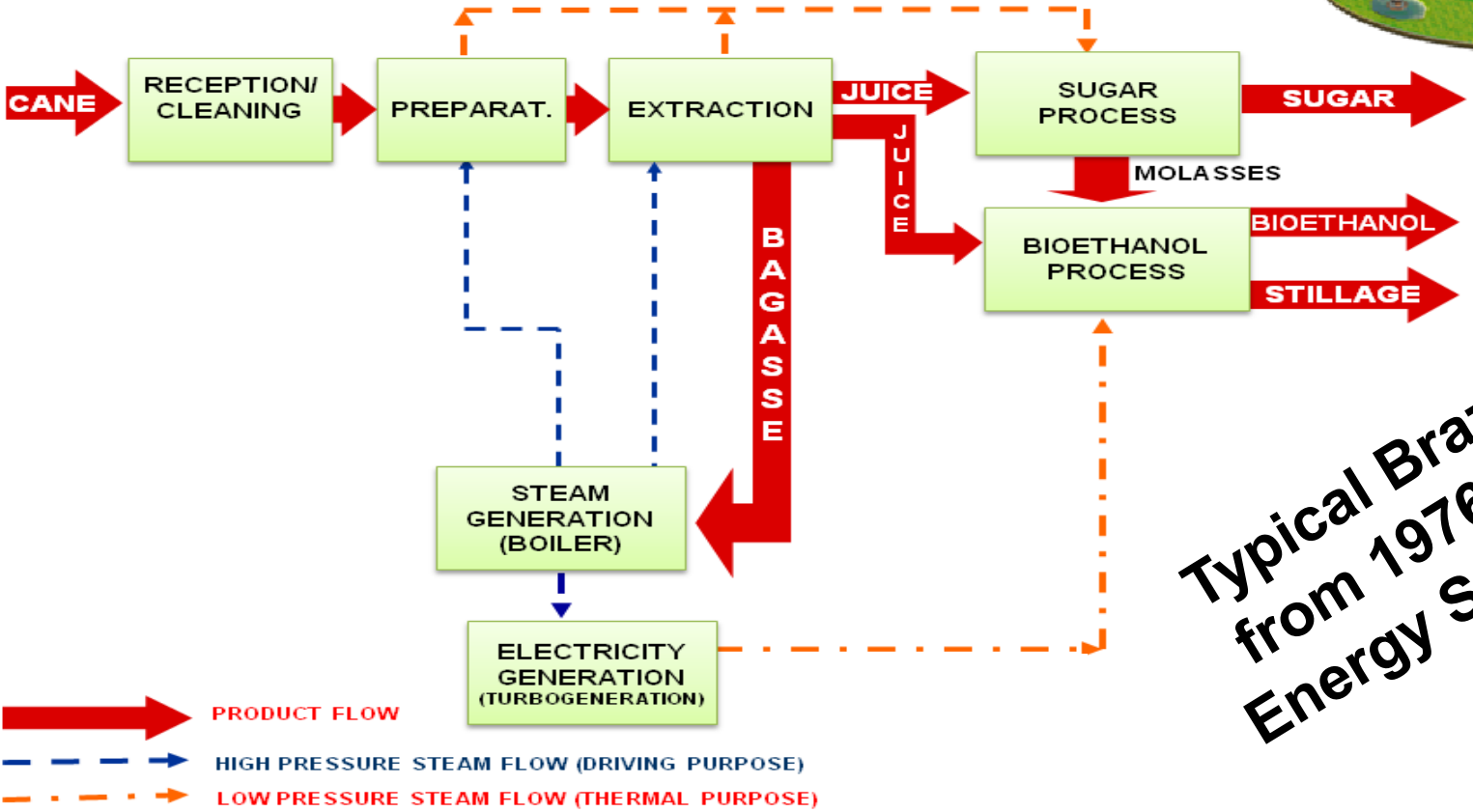
Typical Sugar Process



Typical Brazilian Sugar Mill up to 1976

TECHNOLOGY EVOLUTION

The Typical Mill Process



Typical Brazilian Mill from 1976 to 2000 – Energy Self Sufficient

TECHNOLOGY EVOLUTION: LAST PROJECTS

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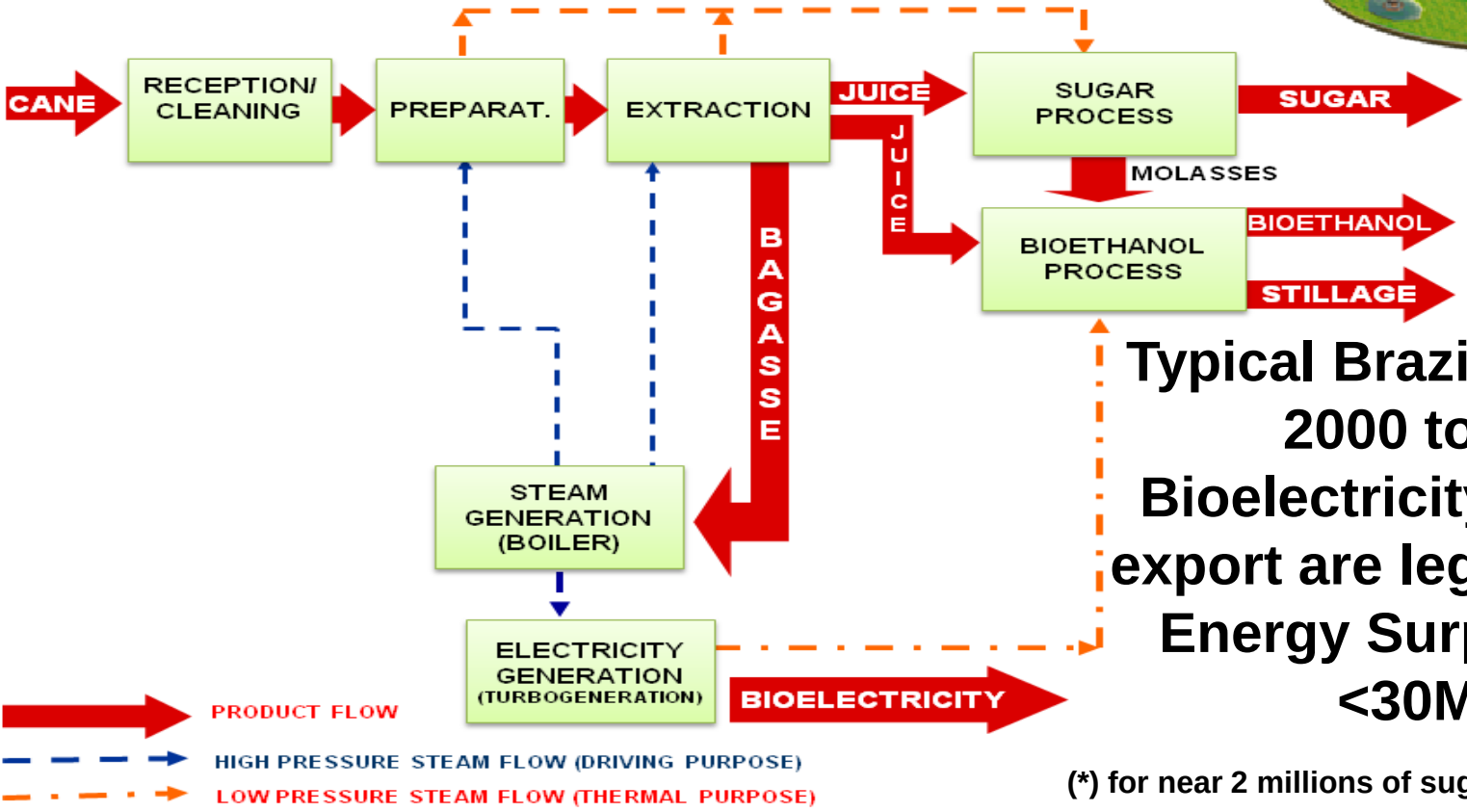
The Typical Mill Process



Typical Brazilian Mill from 2000 to NOW– Bioelectricity surplus for export are legally possible. Energy Surplus usually <30MW (*)

(*) for near 2 millions of sugarcane tones per crop

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TECHNOLOGY EVOLUTION: NOW

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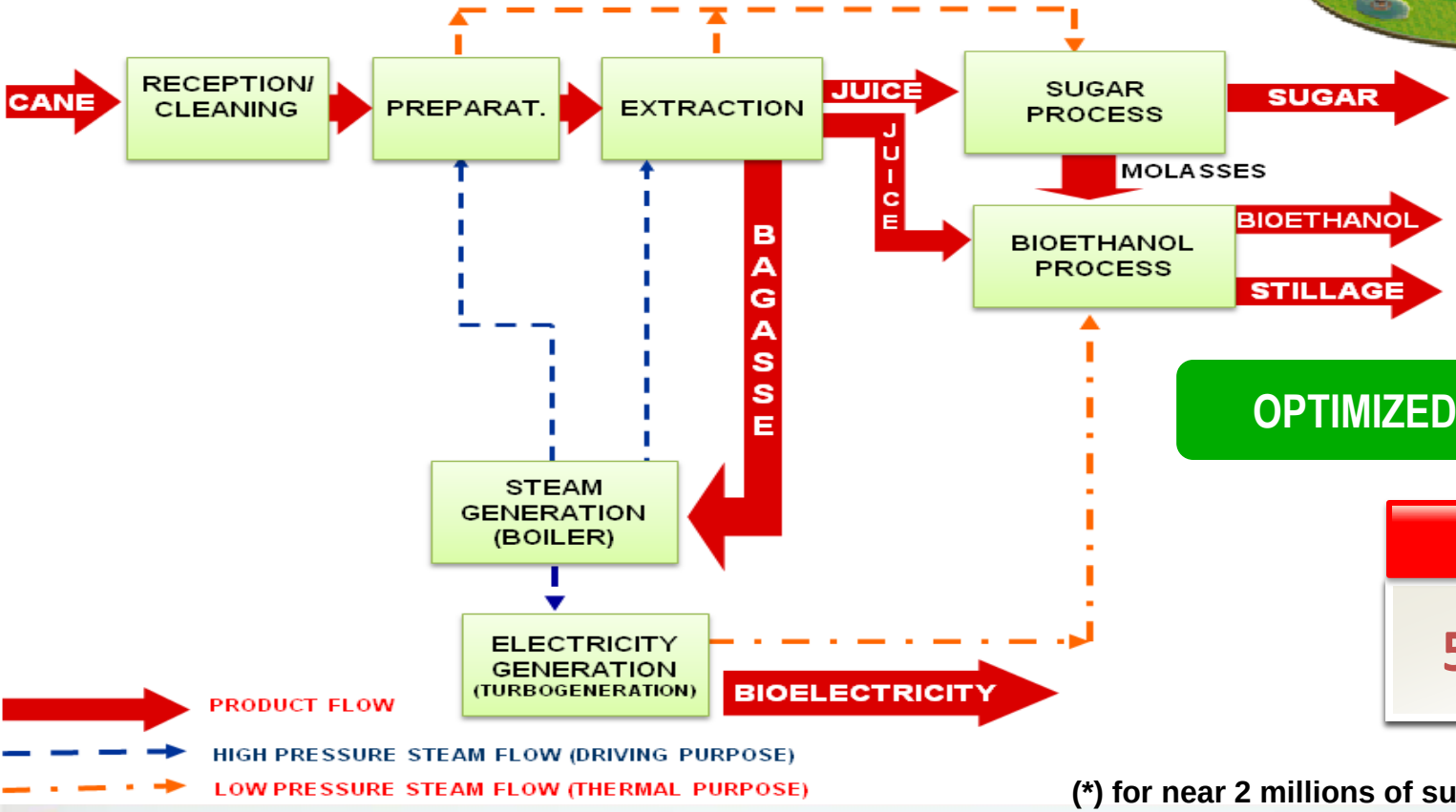
The Typical Mill Process



OPTIMIZED MILL NOW

SURPLUS

50,7 MW(*)

(*) for near 2 millions of sugarcane tones per crop

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NEW PLANT DESIGN STRACTEGY

ALL NEWS PLANTS WILL BE CUSTOMIZED ACCORDING CLIENT SPECIFICATIONS AND NEEDS.

NO STANDARD PLANT DESIGN CONCEPT

ACTUAL SUSTAINABLE PRINCIPLES WILL BE INCLUDE IN ALL NEW MILL PLANT DESIGN.

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TECHNOLOGY EVOLUTION: STATE OF ART

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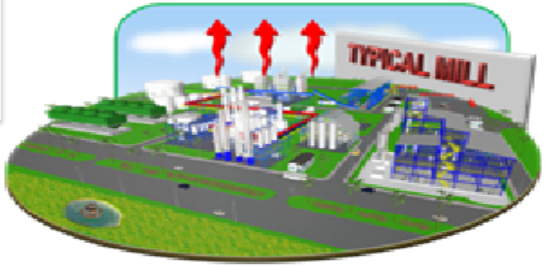
The Typical Mill Process



NEW RAW MATERIAL

CANE

RECEPTION/ CLEANING

PREPARAT.

EXTRACTION

JUICE

SUGAR PROCESS

SUGAR

MOLASSES

JUICE

BAGASSE

STRAW

UPCOMING TECHNOLOGY UNDER DEVELOPMENT

BIOETHANOL PROCESS

BIOETHANOL

STILLAGE

ANAEROBIC BIODIGESTION

BIODIGESTED STILLAGE

Near Future

AGRICULTURAL EMISSIONS REDUCTION

ENERGY OPTIMIZATION

STEAM GENERATION (BOILER)

BIOGAS

SURPLUS

ELECTRICITY GENERATION (TURBOGENERATION)

SURPLUS BIOELECTRICITY

100% Straw: 112,1 Mw

50% Straw: 83,9 Mw

PRODUCT FLOW

HIGH PRESSURE STEAM FLOW (DRIVING PURPOSE)

LOW PRESSURE STEAM FLOW (THERMAL PURPOSE)

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ALLOWABLE TECHNOLOGY

DEDINI Process Customization

How can a Mill contribute towards mitigating GHG emissions in agricultural and industrial sectors?

CANE → RECEPTION/ CLEANING → PREPARAT. → EXTRACTION → JUICE → SUGAR PROCESS → SUGAR

JUICE → BIOETHANOL PROCESS → BIOETHANOL

SUGAR PROCESS → MOLASSES → BIOETHANOL PROCESS

BIOETHANOL PROCESS → STILLAGE

EXTRACTION → BAGASSE → STEAM GENERATION (BOILER)

STEAM GENERATION (BOILER) → ELECTRICITY GENERATION (TURBOGENERATION) → BIOELECTRICITY

PROCESS INTEGRATION

ENERGY OPTIMIZATION

YIELD OPTIMIZATION

WATER RECYCLING

- **Energy Optimization**
  - Maximize Surplus Mw
- **Global Yield**
  - Maximize production - L bioeth./t cane
- **Direct Reduction**
  - Minimize CO_2 emissions in the process
- **"Avoided" Reduction**
  - Process CO_2 emis. replacing fossil emissions
- **Agricultural emissions reduction**
  - Minimize farming inputs that produces CO_2
  - Avoid/eliminate sugarcane burning

PRODUCT FLOW

HIGH PRESSURE STEAM FLOW (DRIVING PURPOSE)

LOW PRESSURE STEAM FLOW (THERMAL PURPOSE)

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Dedini Sustainable Mill

The Future Now

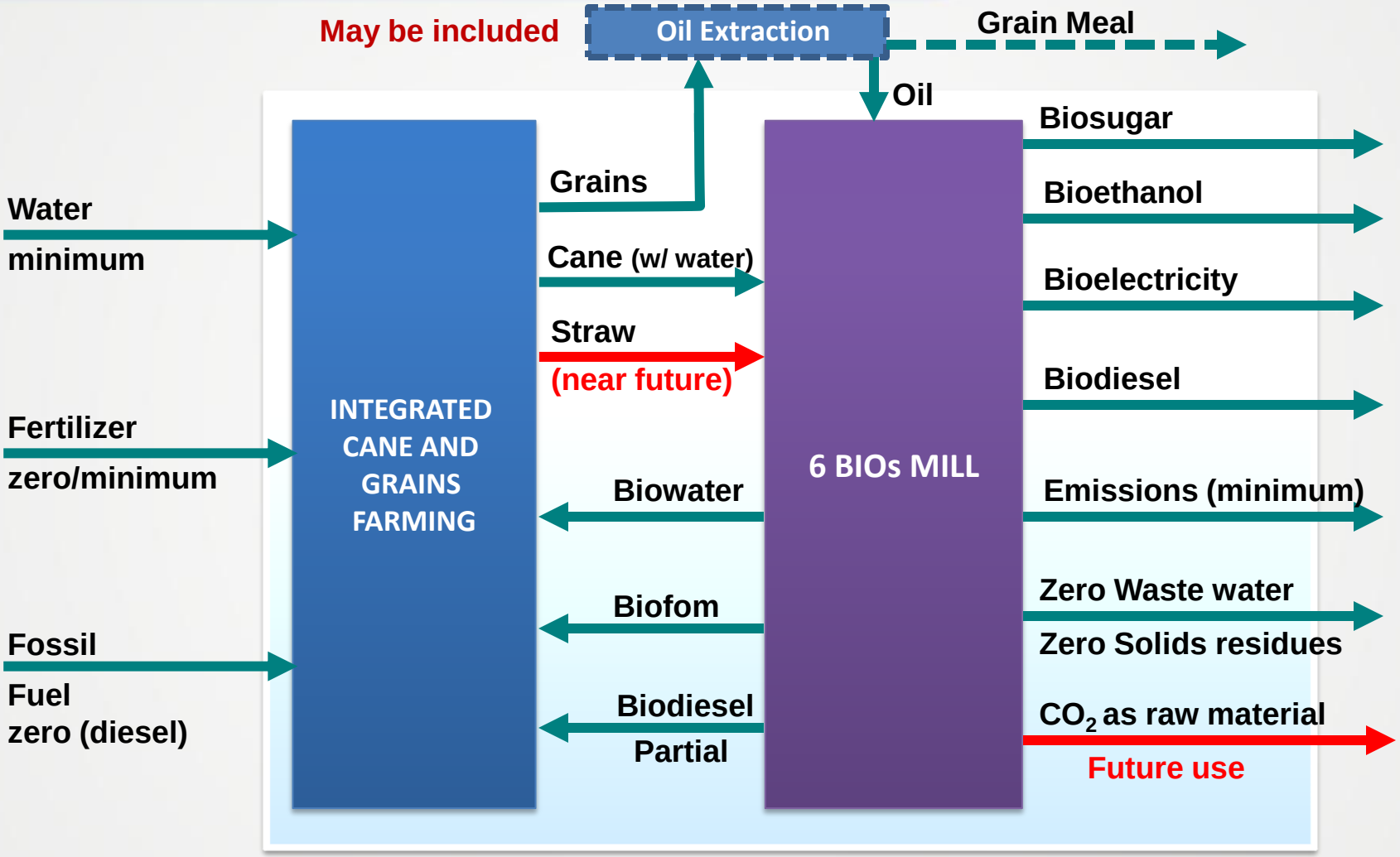
Zero Concept:

- ***Zero residues***
- ***Zero liquid effluents***
- ***Zero odors***
- ***Zero intake water***
- ***Minimal emissions***

The Bioethanol produced at DSM reduces 26% to 49% more GHG than traditional bioethanol Mill

THE 6 BIOs OF SUSTAINABILITY

INTEGRATION SCHEME WITH GRAINS

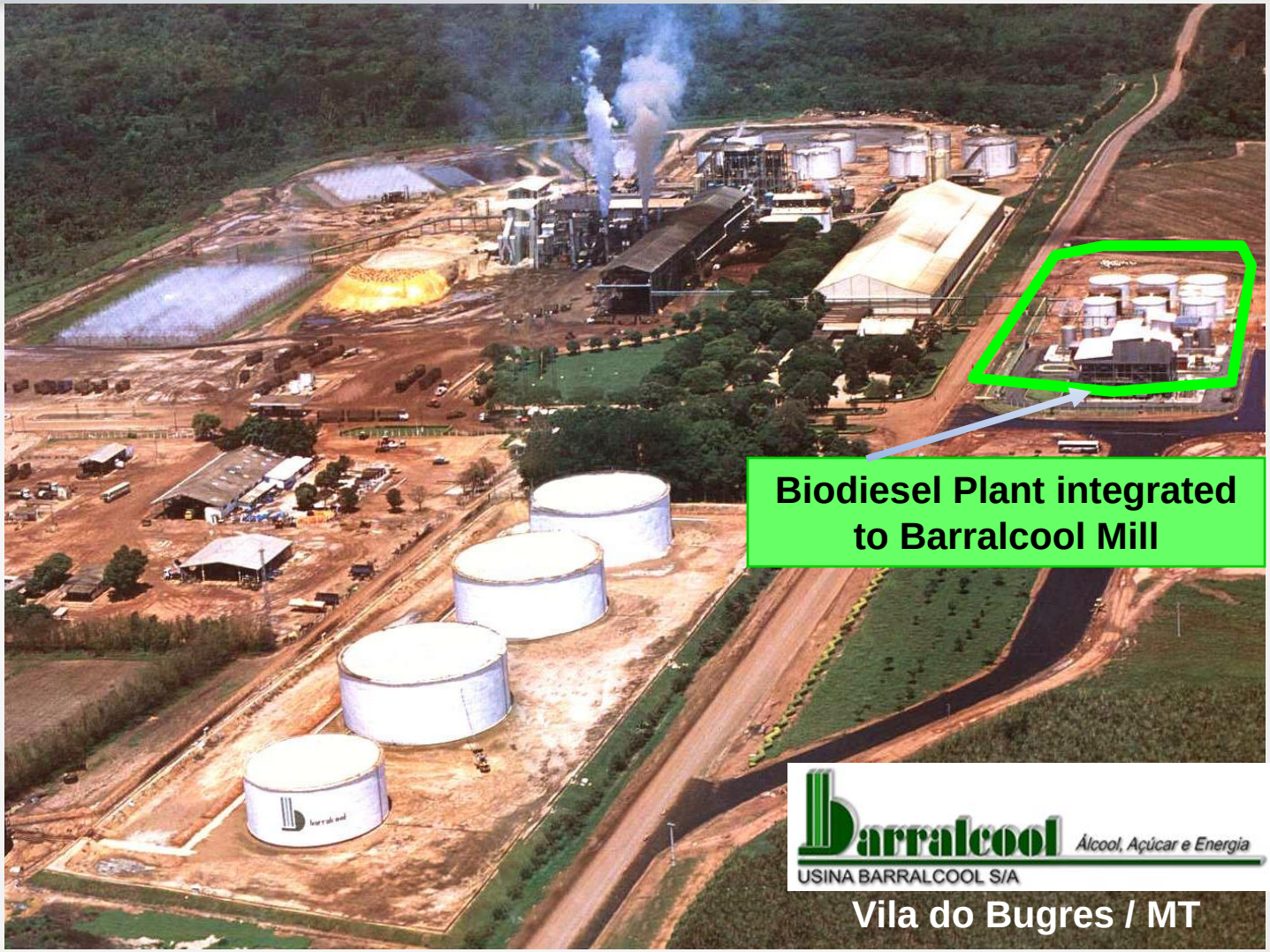


INTEGRATION REALITY

BIODIESEL Flex Plant Methilic & Ethilic Route

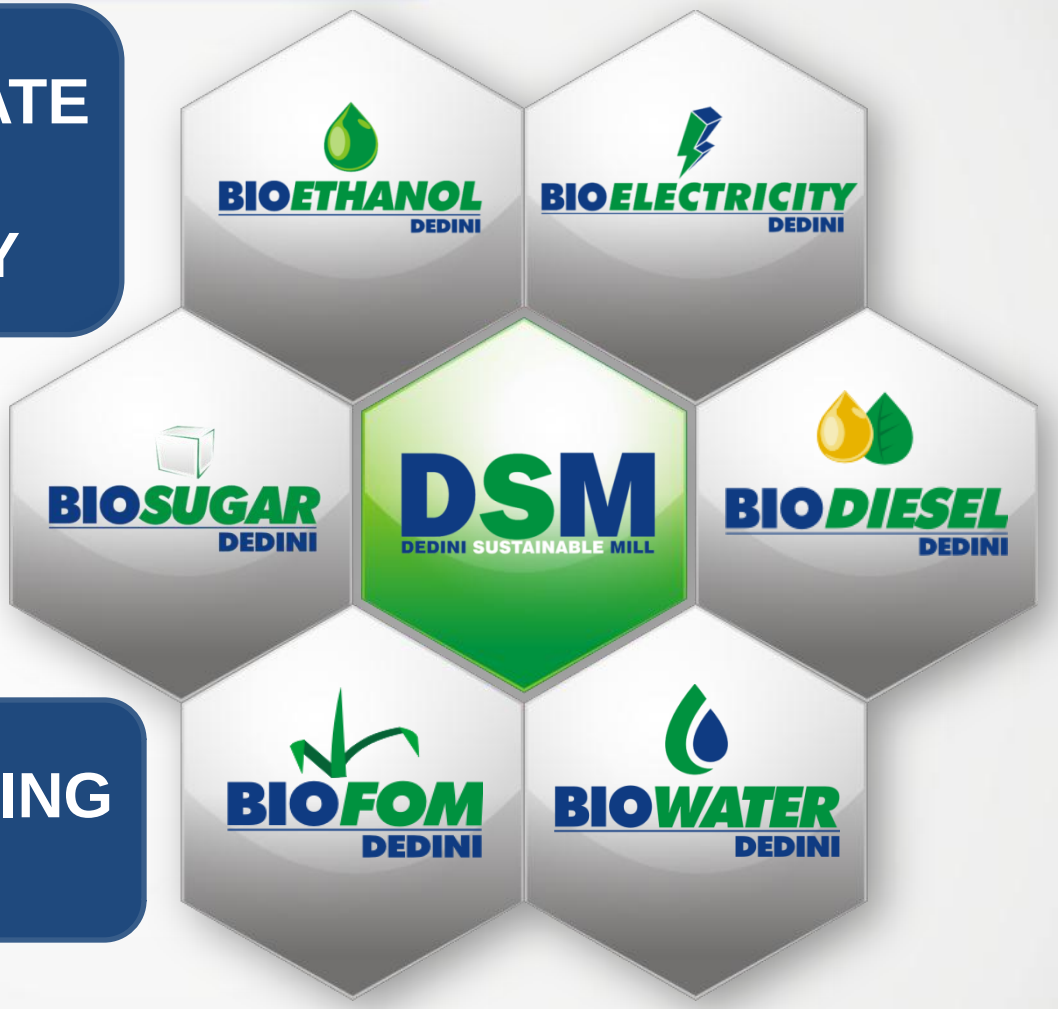
Tallow & Grain Oil as feed material

First Integrated Plant in the World - Startup in Nov. - 2006



RESEARCH & DEVELOPMENT

SUGAR CANE MILL: STATE OF ART GREEN TECHNOLOGY



CONTINUOUS UPGRADING TECHNOLOGY

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CO_2 MITIGATION

How can a Mill contribute towards mitigating GHG emissions in agricultural and industrial sectors?

CO2 REUSE OR CAPTURE ?

First Green Sodium Bicarbonate Industrial Plant – August, 2007

Coopcana – São Carlos do Ivaí /PR

CARBONATED BEVERAGES AS A REALITY IN BRAZIL NORTH EAST

Other possibilities are under feasibility study, as follow:
High Technology greenhouses;
Algae Plants;
others.

CARBON CREDITS – CHG REDUCTION

ETHANOL COMPLETE LIFE CYCLE – TRADICIONAL MILL

Base = 1000 liters of bioethanol

1) Cane Cultivation & Harvesting:*
Total emission:
2.961 kg CO_2

2) Cane Growing:
Absorption:
7.650 kg CO_2

3) Cane Processing:
Emission:
3.604 kg CO_2

4) Bioelectricity:
Avoided emission:
225 kg CO_2

5) Transporting:
Emission:
50 kg CO_2

6) Vehicles motor:
1.520 kg of CO_2.

Within a complete cycle, CO_2 emissions reduction by using ethanol replacing gasoline is

2,02 kg CO_2/l eth

FINAL BALANCE

Generated emissions:
(1+3+5+6): 8.135 kg CO_2

Reabsorbed + avoided emissions:
(2+4): 7.875 kg CO_2

Generated (-) reabsorbed/ avoided emissions
260 kg CO_2

Emissions with equivalent use of gasoline:
2.280 kg CO_2

TOTAL RELATIVE REDUCTION: (2280 – 260) /1000 = 2,02 kg CO_2/ liter of bioethanol or 89% mitigation to gasoline

(*) Considering 50% mechanical harvesting and 50% manual harvesting.

Source: UNICA web site

Source: Professor Isaias Macedo, UNICAMP; Joaquim Seabra, Doctoral Thesis UNICAMP 2008.

DSM MITIGATION

GGH MITIGATION CALCULATED BASED ON BRAZILIAN GASOLINE (E18-25)

Technology	Description	Mitigation %	Status
Tradicional	Única –Macedo/Seabra 2008	**89**	**allowable**
USD	DSM 2008 with biodiesel integration	**112**	**allowable**
USD Plus	DSM 2010 with 50% of straw	**132**	**Piooner plant**
USD Plus 2	DSM 2010 with 100% of straw	**188**	**Next future**
USD Plus 3	DSM with Fermentation CO2 reuse/capture	**220**	**Potential**
USD Plus 4	USD + CO2 capture + combined cycle	**241**	**Potential**

LAND AVAILABILITY

Authorized areas for sugarcane expansion is 64.7 millions hectares or 7.5% of total land area. Currently 1.1% is used and 1.5% is expected in 2021.

NO FOOD COMPETITION

Millions of hectares (2010)		% Total Land	% In Use Area
BRAZIL TOTAL AREA	**851**		
Preserved Area + free for agriculture (71)	182		
Land in Actual Use (agriculture)	260	30.5%	100%
Pasture	200	23.5%	77%
Crop Land (Food + others)	50.5	5.9%	19.4%
Sugar Cane (Ethanol + Sugar + other)	9.5	1.1%	3.6%
Sugar Cane for ETHANOL	**4,6**	**0.5%**	**1.7%**
Cane Expansion over Pastures up to 2021	**3.5**	**0.4% (*)**	**1.7%(*)**
Permanent Protected + Others Natives	349	**(*) - % over Pasture**	
Other Use Area(38) + city/road/lake(22)	60		

NO INFLUENCE IN SENSITIVE OR PRESERVED BIOMES

Source: UNICA, October/2012, Geraldine Kutas / IBGE and CONAB – Adapted by Dedini.

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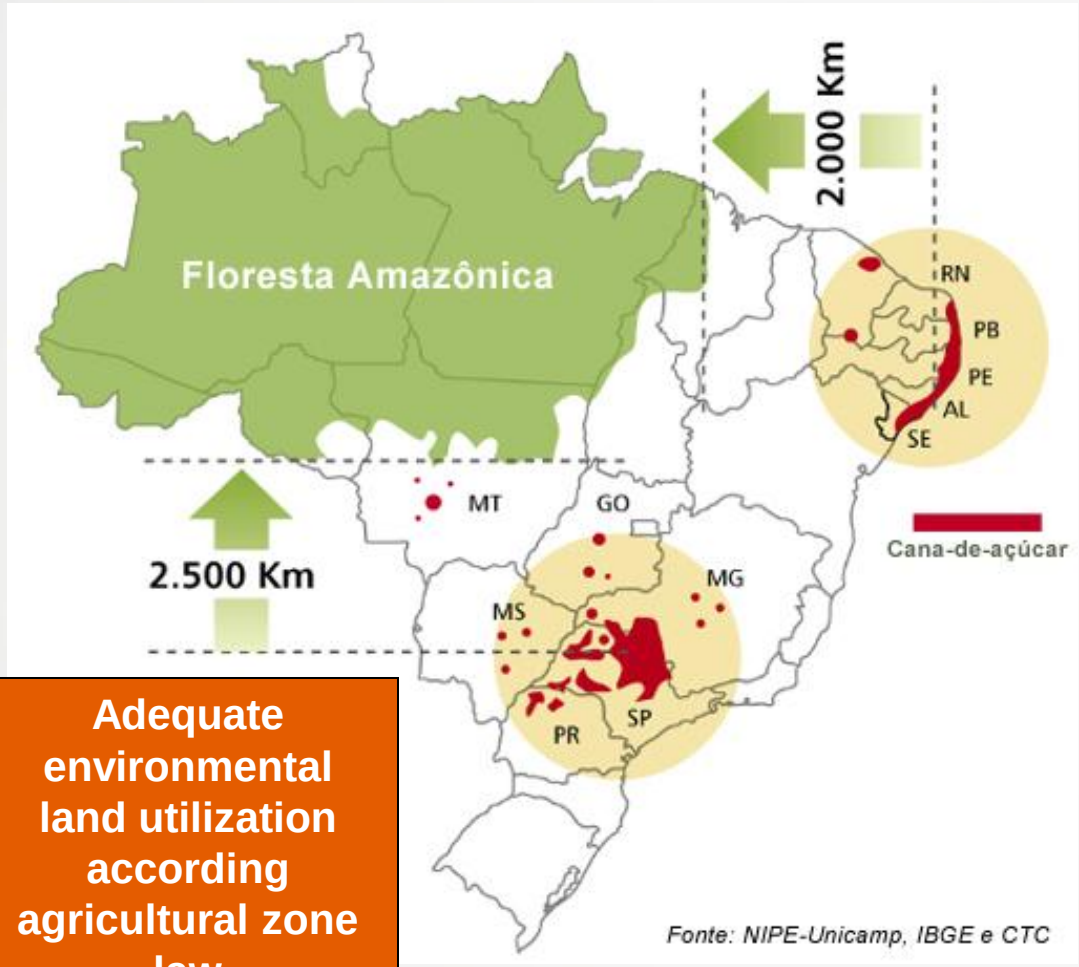
AGRICULTURAL AND FORESTRY IMPACTS



PROTECTED AREAS – AS: AMAZON FOREST, PANTANAL, etc. –

ARE NOT USED AS LAND AREA OR AGRICULTURE.

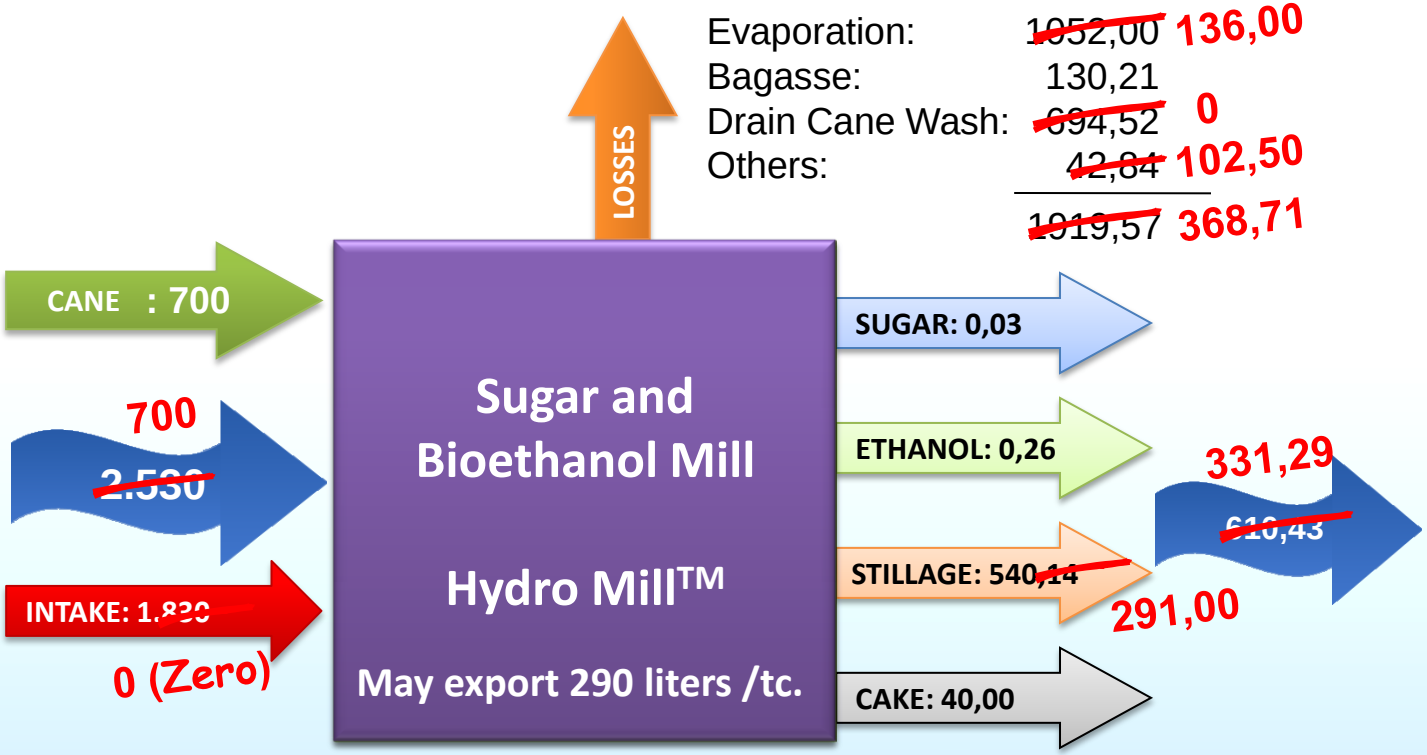
Sugar Cane cultivation with increasing productivity was done for centuries using the same land area.

Adequate environmental land utilization according agricultural zone law

Recovery of 15 millions ha of degraded pastures in "Low Carbon Agricultural Plan" will reduce emissions.

WATER IMPACTS

New Factory Design – The Hydro Mill™ – The water self sufficient mill



Water Balance when processing 1 ton of cane – kg H_2O/tc

ETHANOL IN BRAZILIAN MARKET

THE BRAZILIAN ETHANOL EXPERIENCE

- ✓ Vehicles & engines made in Brazil operate on Brazilian Gasohol (E20 to E25), Ethanol (E100, dedicated vehicles) and blends (E20 to E100 in FFV – Flex Fuel Vehicles)
- ✓ Imported gasoline vehicles from almost 15 countries use Gasohol
- ✓ Small airplanes made in Brazil operate on Ethanol E100
- ✓ Other: buses (E95), boats (E100) and FFV motorcycles (E20 to E100)
- ✓ Power plants (E100 & blends)
- ✓ Alcohol chemical industry, bio-plastics, beverages, cosmetics, perfumery, pharmaceutical
- ✓ Ethylene Industrial production

Ethanol (E100) Vehicle - 1925

1st serial production of vehicles 100% ethanol (E100) - 1979

New Brazilian Flex Cars

Source: UNICA

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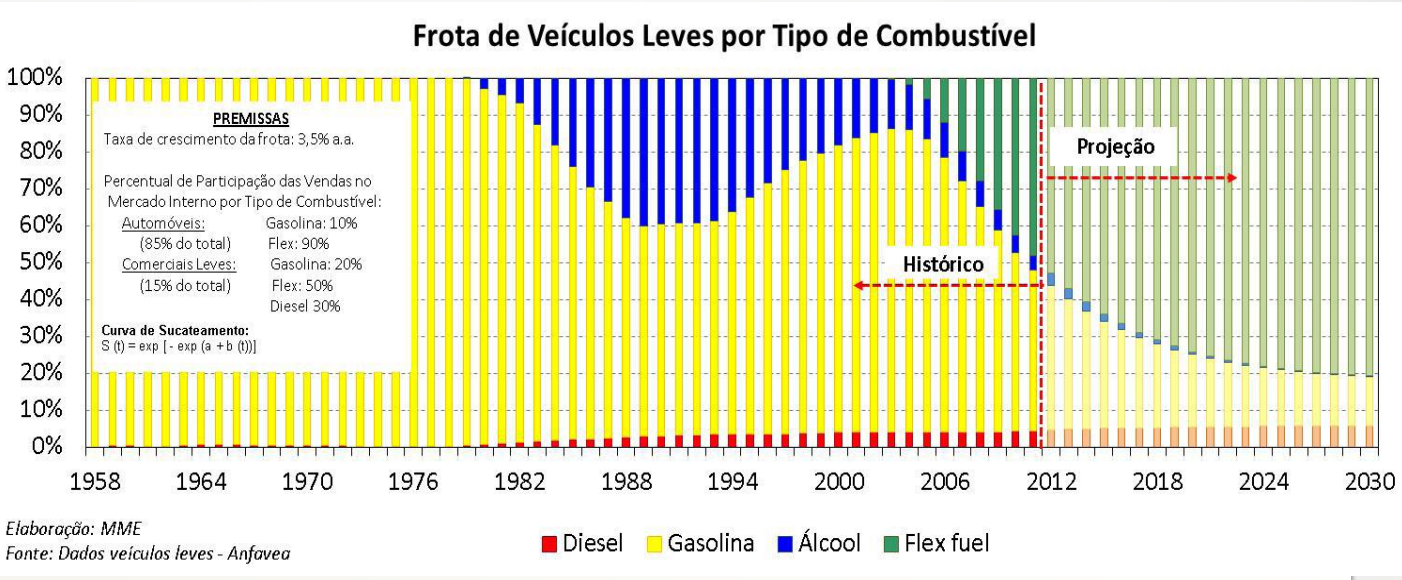
FLEX FUEL VEHICLES

FFV SPLIT BY FUEL TYPE: Today FFV near 53%.

1ST BRAZILIAN FLEX FUEL VEHICLE - FFV E20 TO E100 – 2003



In Brazil, there is no pure gasoline (E0), only gasohol (E20 to E25)

Flex Fuel can operate from E20 to E100

Source: Brazilian Energy Ministry - 2012

HIBRID VEHICLES

NO BRAZILIAN MARKET FOR HYBRID VEHICLES AT 2013

Grid power management, soft electrical house plug-in connection and batteries may be a bigger technical limitation for electric cars, as well the cost.

Why hybrid vehicles can not be Flex Fuel or Ethanol Fuel (E100)?

Tetra (Four) fuels vehicles was allowable: E0; E20, E100 and Natural Gas Engine

Performance of FFV engines are limited by gasoline quality (low octane index).

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CONCLUSION:

THE STRATEGY WILL BE DONE BY INCREMENTAL INOVATIONS FOLLOWING BY RUPTURE INOVATIONS, AS FOLLOW:

- incremental innovation in first generation plant design;
- Increase agricultural performance by precision techniques and/or sugarcane genetic modification;
- Increase raw material flexibility (sorghum/corn/others);
- Traditional Mill integration with others plants as: biochemical's, bio-fuels, elastomers, animal feed, fertilizer, etc.;
- Integration with cellulosic ethanol or others biomass raw material (as energetic forests);
- increase engine performance of light vehicles up to or near ethanol limit and introduce a new ethanol hybrid vehicles;
- Dual (diesel/bio-methane) engines for heavy trucks/equipments.

Proud of its Past
Focus on the **Present**
Building up the Future

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