DEDINI

INDÚSTRIAS DE BASE

1st BRAZIL-U.S. BIOFUELS SHORT COURSE

DESIGNING COMPLETE MILLS TOWARDS A BIOREFINERY, OR...

DSM – DEDINI SUSTAINABLE MILL!!!

USD – USINA SUSTENTÁVEL DEDINI!!!

SÃO PAULO, 05th AUGUST, 2009

JOSÉ LUIZ OLIVÉRIO

SENIOR TECHNOLOGY AND DEVELOPMENT VICE PRESIDENT

DEDINI S/A INDÚSTRIAS DE BASE

DEDINI
INDÚSTRIAS DE BASE

FACTORY DESIGN – HOW TO DO IT

- INPUT INFORMATION: SUGARCANE SPECIFICATIONS; PRODUCTS; CAPACITY; DURATION OF THE CROP; EFFECTIVE WORKING DAYS; LOCATION AND ACCESS; SITE CONDITIONS; CODES, STANDARDS AND LEGISLATION; LOCAL INFRASTRUCTURE AND WATER AVAILABILITY; ETC.
- BALANCES: MASS/PRODUCTS; STEAM; WATER; UTILITIES.
- PFD – PROCESS FLOW DIAGRAM: PRODUCT.
- P&ID – PROCESS AND INSTRUMENTATION DIAGRAM.
- EQUIPMENT DEFINITIONS AND QUANTIFICATION.
- GENERAL LAYOUT OF THE PLANT: LAND UTILIZATION/ BUILDINGS/ ROAD SYSTEM.
- DETAILED INDUSTRIAL LAYOUT.
- LAYOUT OF AUXILIARY/SERVICES SECTORS.
- CIVIL WORKS DESIGN.
- ELECTRICAL DESIGN.
- PIPING DESIGN: WATER, STEAM, PRODUCTS.
- CONTROL AND INSTRUMENTATION DESIGN.
- EFFLUENTS PROJECT AND RESIDUES.
- LEGAL PROJECTS.

THIS CHECK-LIST CAN BE USED IN FACTORY DESIGN OF DIFFERENT KINDS AND CONCEPTS, FROM TRADITIONAL TO MOST ADVANCED PROJECTS.

THIS PRESENTATION IS RELATED TO THE RECENT EVOLUTION AND THE FUTURE TRENDS OF THE CONCEPTUAL DESIGN OF THE FACTORY.

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INDÚSTRIAS DE BASE

PRELIMINARY CONCEPTS TO THIS PRESENTATION

FOR ALMOST 500 YEARS, SUGARCANE HAS BEEN CONSIDERED ALMOST ONLY AS A RAW MATERIAL FOR SUGAR PRODUCTION, AND MORE RECENTLY, IN BRAZIL, FOR ETHANOL PRODUCTION.

THE RECENT AND SPECTACULAR WORLD INTEREST IN ETHANOL DERIVES FROM ITS ENVIRONMENTAL QUALITIES AND BECAUSE IT IS PRODUCED FROM RENEWABLE FEEDSTOCK.

FURTHERMORE, FOR ECONOMICAL REASONS AND CONSIDERING TECHNOLOGICAL DEVELOPMENT, THE WORLD IS SEARCHING FOR NEW AND CLEAN ENERGY SOURCES.

SUGARCANE, AS A BIOMASS AND RENEWABLE RAW MATERIAL FOR BIOFUELS AND BIOENERGY PRODUCTION, EVALUATED FROM THE ENVIRONMENTAL AND ENERGY POINT OF VIEW, REACHES A NEW AND HIGHER DIMENSION.

CONSIDERING THE GROWING TREND TO SUSTAINED DEVELOPMENT, SUGARCANE WILL GENERATE A NEW CYCLE OF NEW BUSINESSES.

THIS PRESENTATION HAS THE OBJECTIVE TO SHOW HOW DEDINI SEES THAT EVOLUTION, CONSIDERING THE TECHNOLOGICAL POINT OF VIEW, AND HOW THIS EVOLUTION WILL INFLUENCE AND MODIFY THE FACTORY AND THE FACTORY SYSTEM DESIGN OF THE FUTURE, THAT MEANS,

THE NEAR PAST, PRESENT AND THE UPCOMING SUGARCANE MILL, TOWARDS A BIOREFINERY.

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DESIGNING COMPLETE MILLS TOWARDS A BIOREFINERY, OR…
DSM – DEDINI SUSTAINABLE MILL!!!

TRADITIONAL MILL DESIGN

NEW TRENDS IN TRADITIONAL MILL DESIGN

DESIGNING THE BREAKTHROUGH MILL

DSM - DEDINI SUSTAINABLE MILL

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Sugar and Ethanol

SINCE 1920

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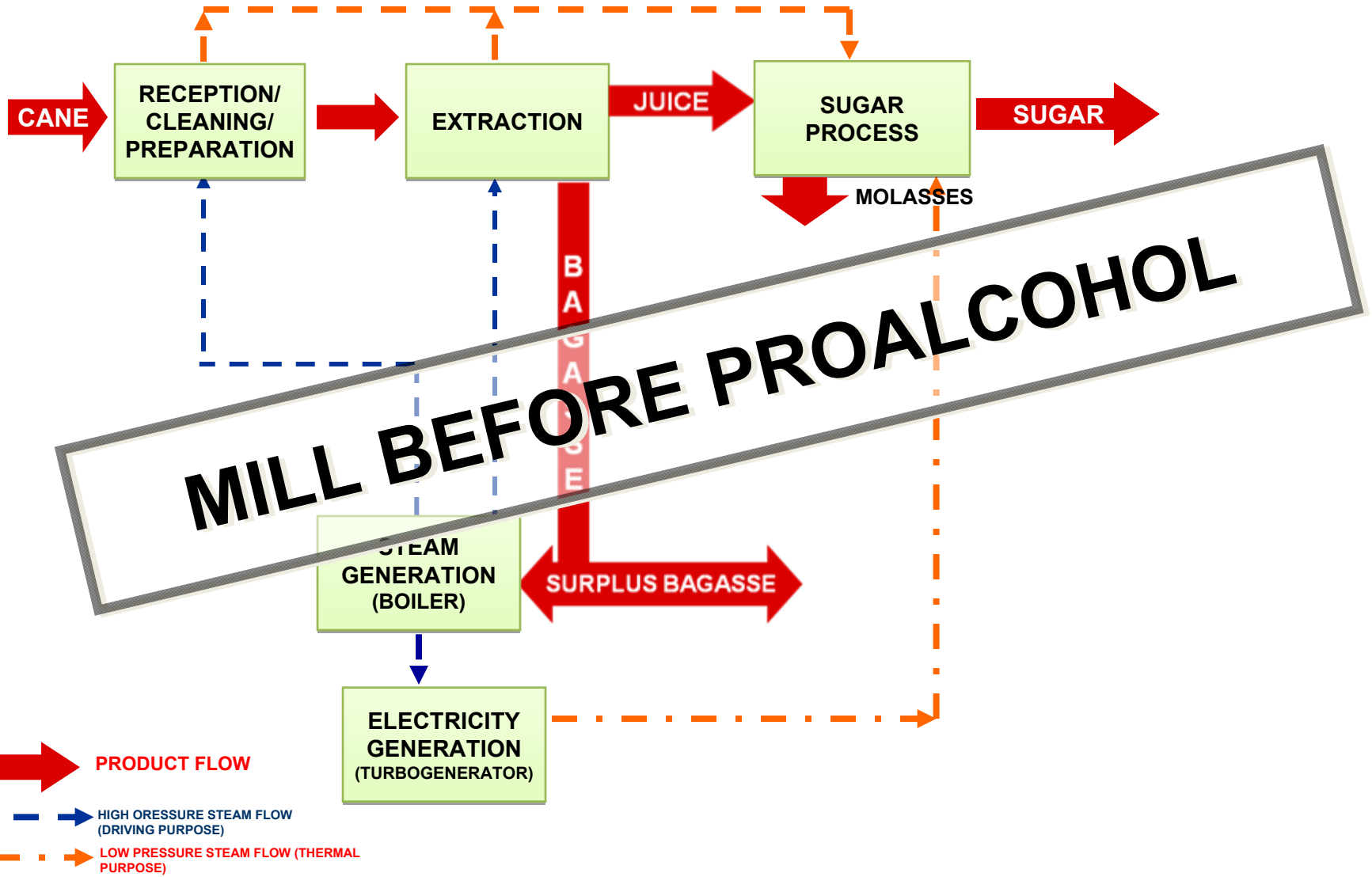
INDÚSTRIAS DE BASE

TRADITIONAL TECHNOLOGY AND PRODUCTION PROCESS: SUGAR AND SURPLUS ENERGY

PRODUCTION FLOWCHART – SUGAR AND SURPLUS BAGASSE



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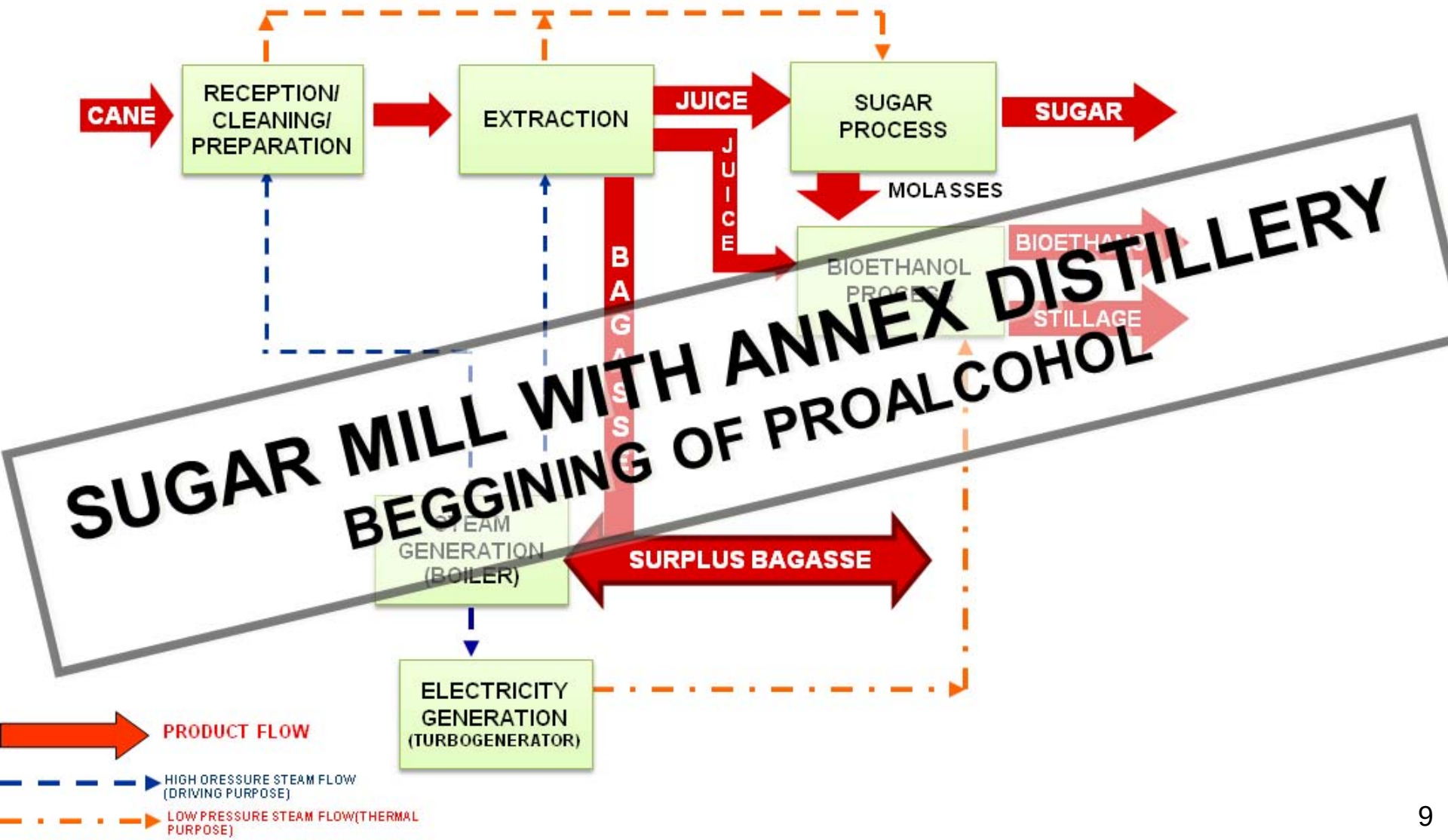
TRADITIONAL TECHNOLOGY AND PRODUCTION PROCESS: SUGAR, BIOETHANOL AND SURPLUS ENERGY

PRODUCTION FLOWCHART – SUGAR, BIOETHANOL AND SURPLUS BAGASSE



SUGAR MILL WITH ANNEX DISTILLERY
BEGGINING OF PROALCOHOL

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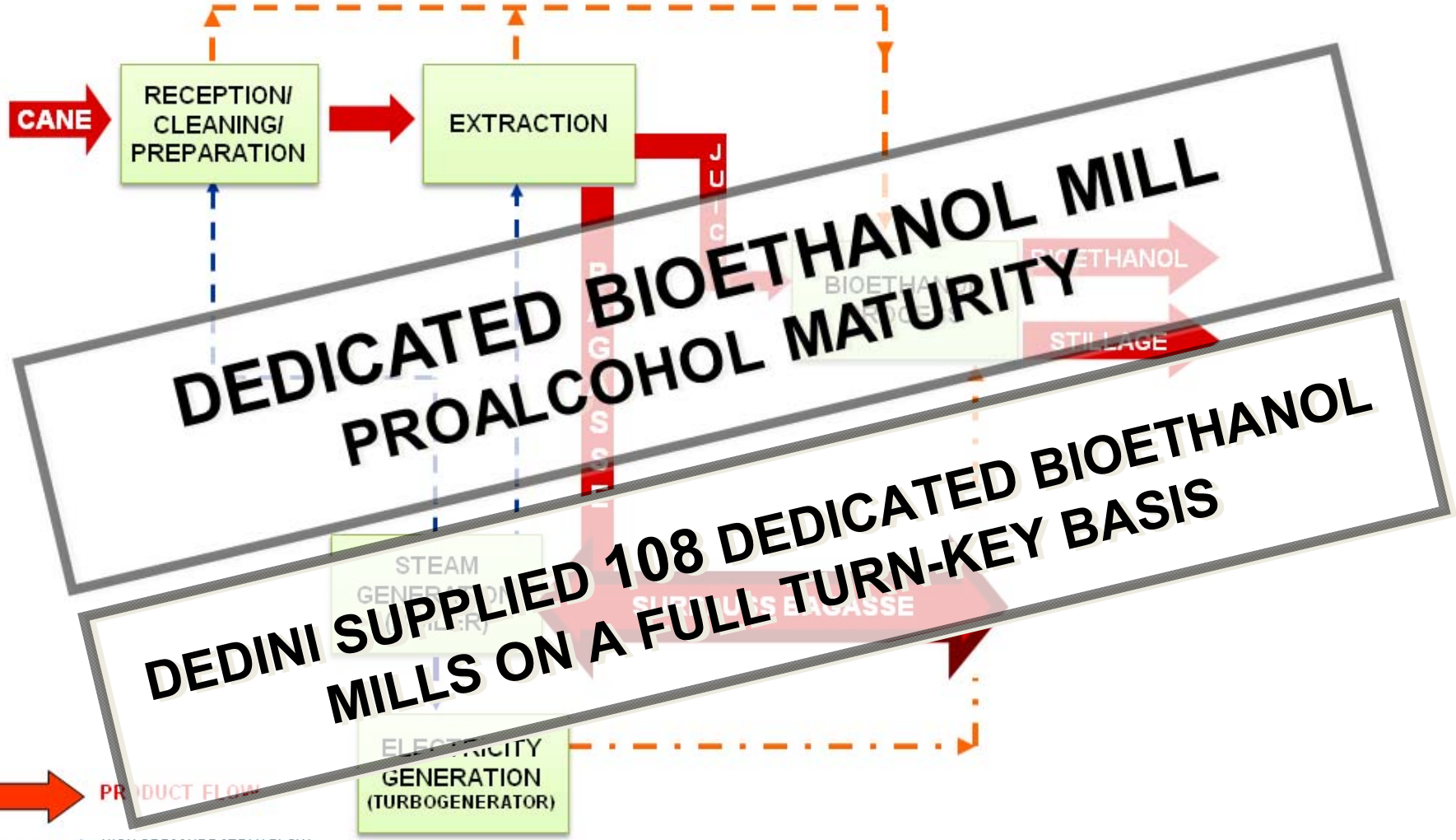
INDÚSTRIAS DE BASE

TRADITIONAL TECHNOLOGY AND PRODUCTION PROCESS: BIOETHANOL AND SURPLUS ENERGY

PRODUCTION FLOWCHART – BIOETHANOL AND SURPLUS BAGASSE

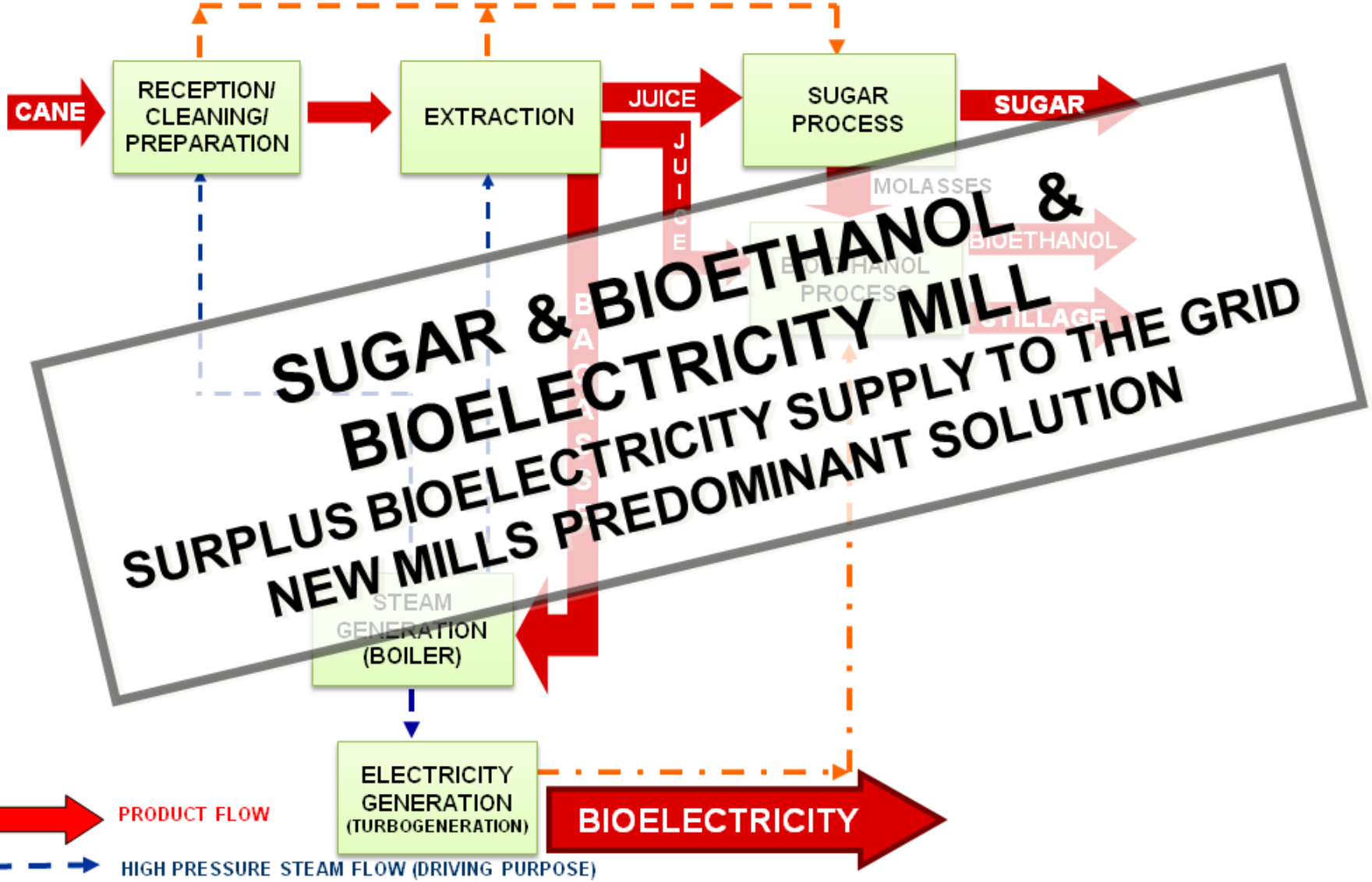


DEDICATED BIOETHANOL MILL
PROALCOHOL MATURITY

DEDINI SUPPLIED 108 DEDICATED BIOETHANOL MILLS ON A FULL TURN-KEY BASIS

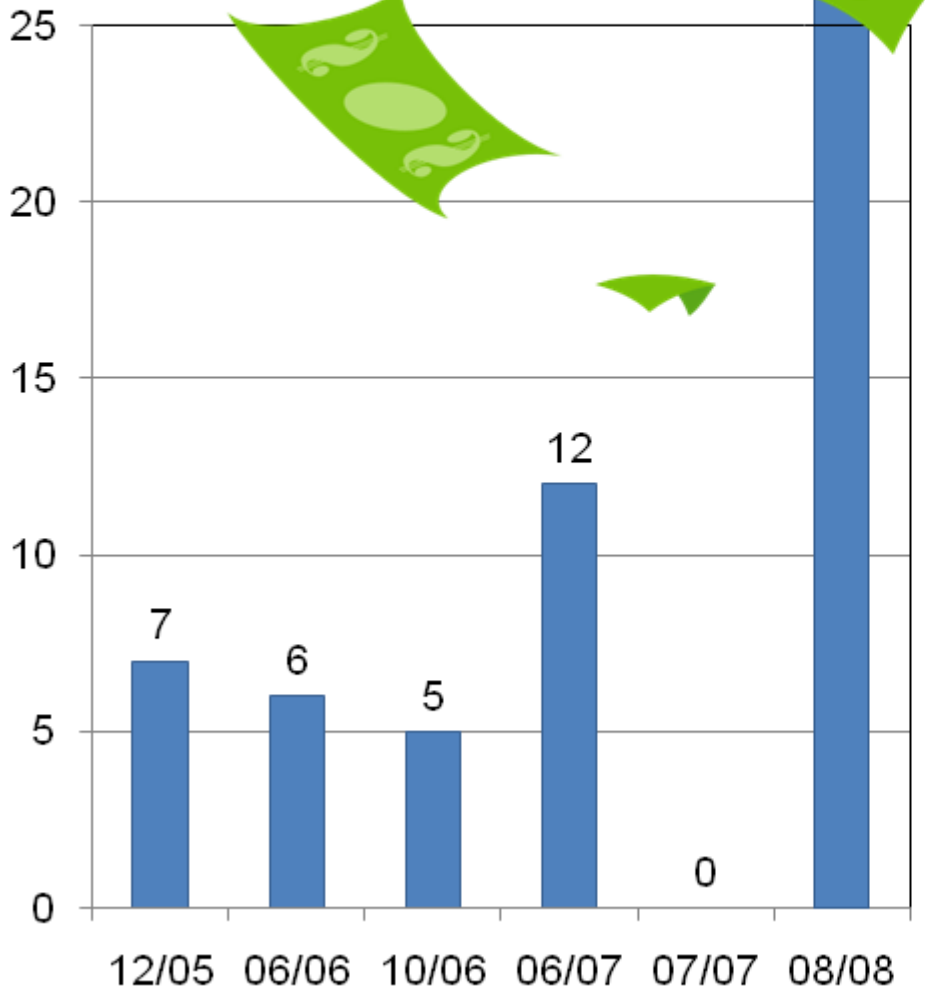
TRADITIONAL TECHNOLOGY AND PRODUCTION PROCESS: SUGAR, BIOETHANOL AND SURPLUS ENERGY

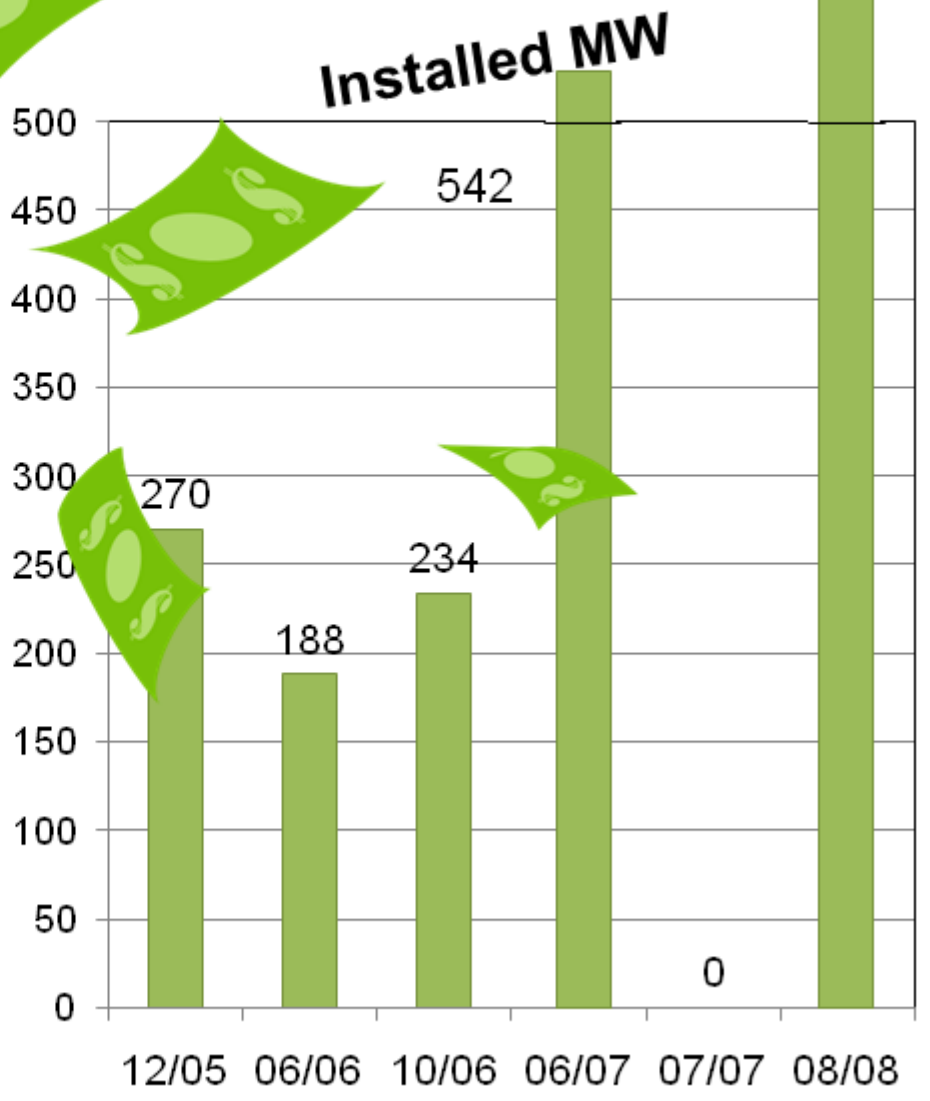
PRODUCTION FLOWCHART – SUGAR, BIOETHANOL AND SURPLUS BIOELECTRICITY



BIOELECTRICITY: A NEW BUSINESS IN SUGARCANE SECTOR

BIOELECTRICITY AUCTIONS: A GROWING INTEREST OF THE SUGARCANE MILLS





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DESIGNING COMPLETE MILLS TOWARDS A BIOREFINERY, OR...
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TRADITIONAL MILL DESIGN

NEW TRENDS IN TRADITIONAL MILL DESIGN

DESIGNING THE BREAKTHROUGH MILL

DSM - DEDINI SUSTAINABLE MILL

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TECHNOLOGICAL EVOLUTION IN SUGARCANE AGRIBUSINESS

IMPACT OF TECHNOLOGY

INCREMENTAL INNOVATIONS

DISRUPTIVE INNOVATIONS (BREAKTHROUGH)

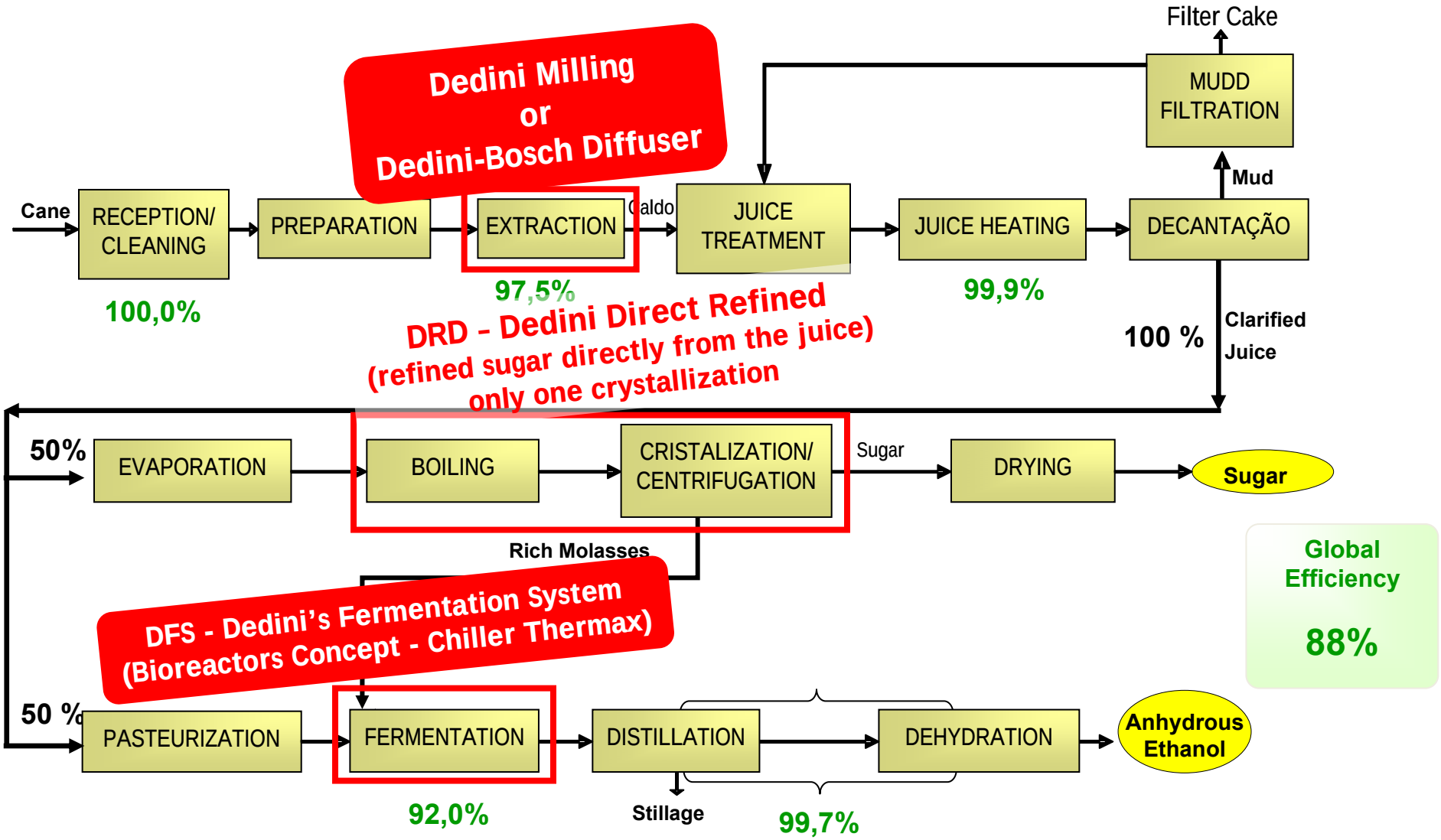
TECHNOLOGICAL HIERARCHY

1st GENERATION TECHNOLOGY

2nd GENERATION TECHNOLOGY

3rd GENERATION TECHNOLOGY

EFFICIENCIES DIAGRAM – SUGAR & ETHANOL PROCESSES INCREMENTAL INNOVATIONS



MAXIMUM ETHANOL PRODUCTION

MAXIMUM ETHANOL PRODUCTION

JUICE EXTRACTION – MAXIMIZE EXTRACTION YIELD

DEDINI MCD-01 1st MILLING UNIT 56”x100”
(1.422 x 2.540 mm) ASSEMBLED

6 MILLING TANDEM 56”x100” AT U.S. SUGAR
ELECTRO-HYDRAULIC DRIVE

U.S.SUGAR - BIGGEST CRUSHING CAPACITY IN THE WORLD
IN A SINGLE MILLING TANDEM: 28.000 TCD (TON CANE / DAY)

MAXIMUM ETHANOL PRODUCTION

JUICE EXTRACTION – MAXIMIZE EXTRACTION YIELD

DEDINI-BOSCH MODULAR CHAINLESS DIFFUSER

EXPANDABLE | NO CHAINS | LOWER MAINTENANCE | LIGHTER SOLUTION

THE 1st IN OPERATION IN BRAZIL AND THE 1st COMMERCIAL IN THE WORLD

SEPTEMBER/08 – NOROESTE MILL – 12.000 TCD (→ 15.000 TCD)

MAXIMUM ETHANOL PRODUCTION

BIOETHANOL PROCESS – MAXIMIZE FERMENTATION YIELD

DFS – DEDINI FERMENTATION SYSTEM – BATCH / CONTINUOUS - BIOREACTORS CONCEPT + COLD WATER FLOW UTILIZATION AT THE MILL INTEGRATING THERMAX CHILLER

DEMONSTRATION PLANT AT USINA BOM RETIRO, GRUPO COSAN

MAXIMUM SURPLUS ENERGY PRODUCTION
INCREMENTAL INNOVATIONS

OBJECTIVE:

MAXIMUM SURPLUS ENERGY

(=)

MAXIMUM UTILIZATION OF AVAILABLE ENERGY AT THE MILL

(-)

MINIMUM INTERNAL ENERGY CONSUMPTION AT THE MILL

MAXIMUM SURPLUS ENERGY PRODUCTION

BIOETHANOL PROCESS – MINIMIZE ENERGY CONSUMPTION

JUICE TREATMENT
AND CONCENTRATION

FERMENTATION/ DISTILLATION

MAXIMUM SURPLUS ENERGY PRODUCTION

BIOETHANOL PROCESS – MINIMIZE ENERGY CONSUMPTION

DEDINI-SIEMENS SPLIT FEED DISTILLATION (PARTIAL) AT LAGINHA MILL

MAXIMUM SURPLUS ENERGY PRODUCTION

BIOETHANOL PROCESS – MINIMIZE ENERGY CONSUMPTION

SIFTEK SYSTEM INSTALLED IN CANADA

DEDINI-VAPERMA MEMBRANE SYSTEM APPLIED TO DISTILLATION TECHNOLOGY

TECHNOLOGY BEING INTRODUCED IN BRAZIL – DEMONSTRATION PLANT AT COSTA PINTO MILL – COSAN GROUP

MAXIMUM SURPLUS ENERGY PRODUCTION

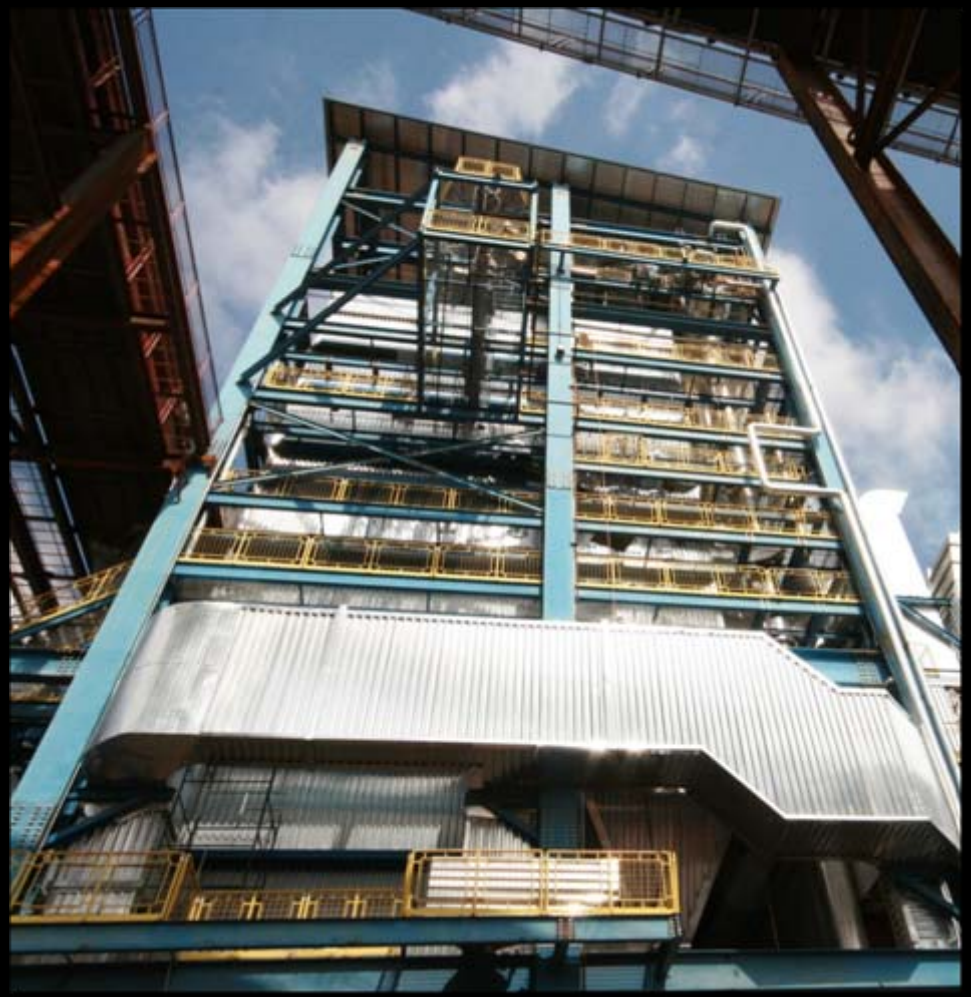
BIODIGESTION PROCESS – MAXIMIZE AVAILABLE ENERGY UTILIZATION

DEDINI METHAX PLANT – AT SÃO JOÃO MILL – S. J. BOA VISTA
BIOGAS/BIOMETHANE PRODUCTION VIA STILLAGE BIODIGESTION

BIOGAS/BIOMETHANE UTILIZATION AS A BOILER FUEL

MAXIMUM SURPLUS ENERGY PRODUCTION

STEAM PRODUCTION – MAXIMIZE AVAILABLE ENERGY UTILIZATION



DEDINI MULTIFUEL BOILER – BAGASSE, STRAW AND BIOGAS UTILIZATION AS FUELS UP TO 400 T STEAM/H – 120 ATA – 540°C – 89% POWER EFFICIENCY (LHV)

DEDINI AT™ SINGLE DRUM BOILER – 100 ATA - COSAN GROUP

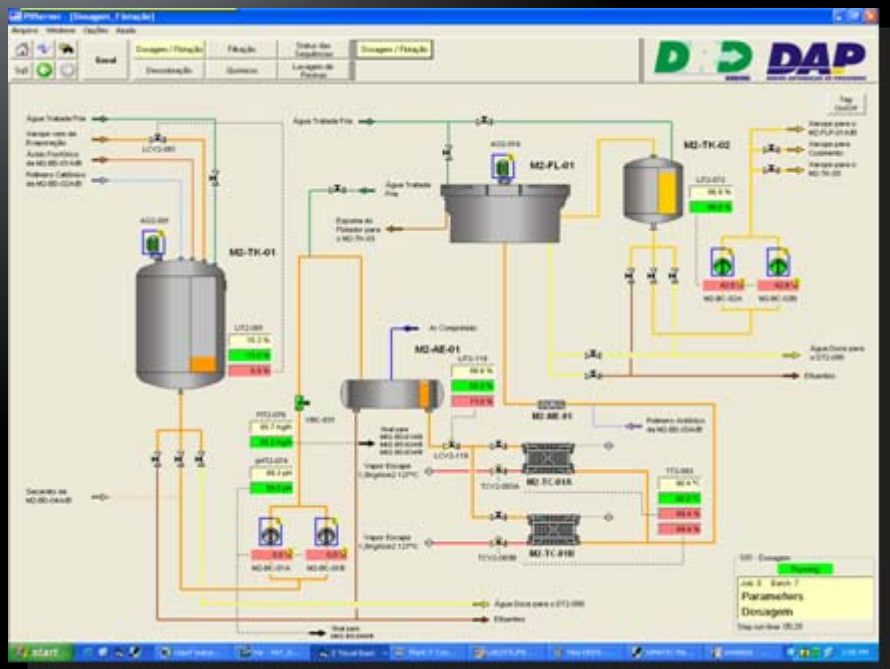
NEW TRENDS IN TRADITIONAL SUGARCANE MILL TECHNOLOGY

FACTORY DESIGN CUSTOMIZED ACCORDING TO THE INVESTOR OBJECTIVE

- MAXIMUM BIOETHANOL PRODUCTION MILL
- MAXIMUM SUGAR PRODUCTION MILL
- FLEXIBLE MAXIMUM SUGAR / BIOETHANOL MILL
- MAXIMUM ENERGY PRODUCTION MILL

NEW TRENDS IN TRADITIONAL SUGARCANE MILL TECHNOLOGY

DEDINI AUTOMAÇÃO DE PROCESSOS



DEDINI TOTAL MILL AUTOMATION CONTROL
(M E S LEVEL)

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DEDINI'S CONTRIBUTION TO SUGARCANE INDUSTRY

RESULTS OF INDUSTRIAL TECHNOLOGICAL EVOLUTION IN THE SUGAR & BIOETHANOL SECTOR – ~~2007~~

	DEDINI PRODUCTS	BEGINNING PROALCOHOL	TODAY 2008
▪ CRUSHING CAPACITY (TCD) - 6X78"	DH1 / MCD01	5,500	15.000 ~~14,000~~
▪ FERMENTATION TIME (H)	BATCH/CONT. FERM	24	6 - 8
▪ BEER ETHANOL CONTENT (ºGL)	FERMENTATION PLANT	6.5	> 9.0
▪ EXTRACTION YIELD (%SUGAR) - 6 MILL UNITS	DH1/ MCD01 / Mod. Diffuser	93	98 ~~97~~
▪ FERMENTATION YIELD (%)	BATCH/CONT. FERM. / DFS	80	92 ~~90~~
▪ DISTILLATION YIELD (%)	DESTILTECH	98	99.7
▪ TOTAL YIELD (LITER HYDR. BIOETH./TON CANE)	DEDINI TECHNOLOGY	66	87 ~~86~~
▪ TOTAL STEAM CONSUMP. (KG S/TON CANE)	DEDINI TECHNOLOGY	600	320 ~~380~~
▪ STEAM CONSUMPTION - HYDR. (KG S/LITER)	DESTILTECH/ Split Feed	3.4	1,6 ~~2.0~~
▪ STEAM CONSUMP. - ANHYDR. (KG S/LITER)	DESTILTECH (+) MOLECULAR SIEVE / Split Feed + Membrane	4.5	2,0 ~~2.7~~
▪ BOILER – EFFICIENCY (% LHV)	AZ/ AT/ SINGLE DRUM	66	89
PRESSURE (ATA) / TEMPERATURE (ºC)		21 / 300	120/ 540
▪ SURPLUS BAGASSE (%) - BIOETHANOL MILL	DEDINI TECHNOLOGY	UP TO 8	UP TO 78
▪ BIOMETHANE FROM STILLAGE (NM^3/LITER BIOETH.)	METHAX	-	0.1
▪ STILLAGE PRODUCTION (L STILLAGE/L BIOET)	BIOSTIL/CONCENTRATION	13	0,8

DEDINI'S CONTRIBUTION TO THE SUGARCANE INDUSTRY

DEDINI'S NUMBERS – SUGAR AND ETHANOL

- **BIOETHANOL SUPPLIES**

  - **BIOETHANOL DISTILLERIES** 864

  - **COMPLETE BIOETHANOL MILLS (TURN KEY) - BRAZIL** 108

- **ETHANOL/SUGAR PLANTS ABROAD:** 29

  VENEZUELA/ECUADOR/URUGUAY/MEXICO/HAITI/PAKISTAN/ETHIOPIA/GUATEMALA

  ARGENTINA/PERU/COSTA RICA/PARAGUAY/VIRGIN ISLAND/BOLIVIA/JAMAICA/SUDAN

• CRUSHING MILLS	2.595
• BOILERS	1.255
• COGENERATION PLANTS (TK)	114

WORLD'S GREATEST SALES VOLUME

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TRADITIONAL MILL DESIGN

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INDÚSTRIAS DE BASE

SUGARCANE – THE AGRIENERGY VIEW

SUGARCANE ENERGY FOCUSED VISION

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 FROM SUGAR JUICE	SUGAR: THE CHEAPEST FOOD (IN KCAL) IN THE WORLD BIOETHANOL: CLEAN AND RENEWABLE ENERGY	648.000 b/d	770.000 b/d
	1/3 FROM BAGASSE	CLEAN AND RENEWABLE ENERGY	648.000 b/d	770.000 b/d
	1/3 FROM STRAW	CLEAN AND RENEWABLE ENERGY	648.000 b/d	770.000 b/d
		TOTAL	1.944.000	2.310.000
		ENERGY EQUIVALENCE – BARRELS OIL/DAY		

(*) STRAW = TOPS, LEAVES, STRAW

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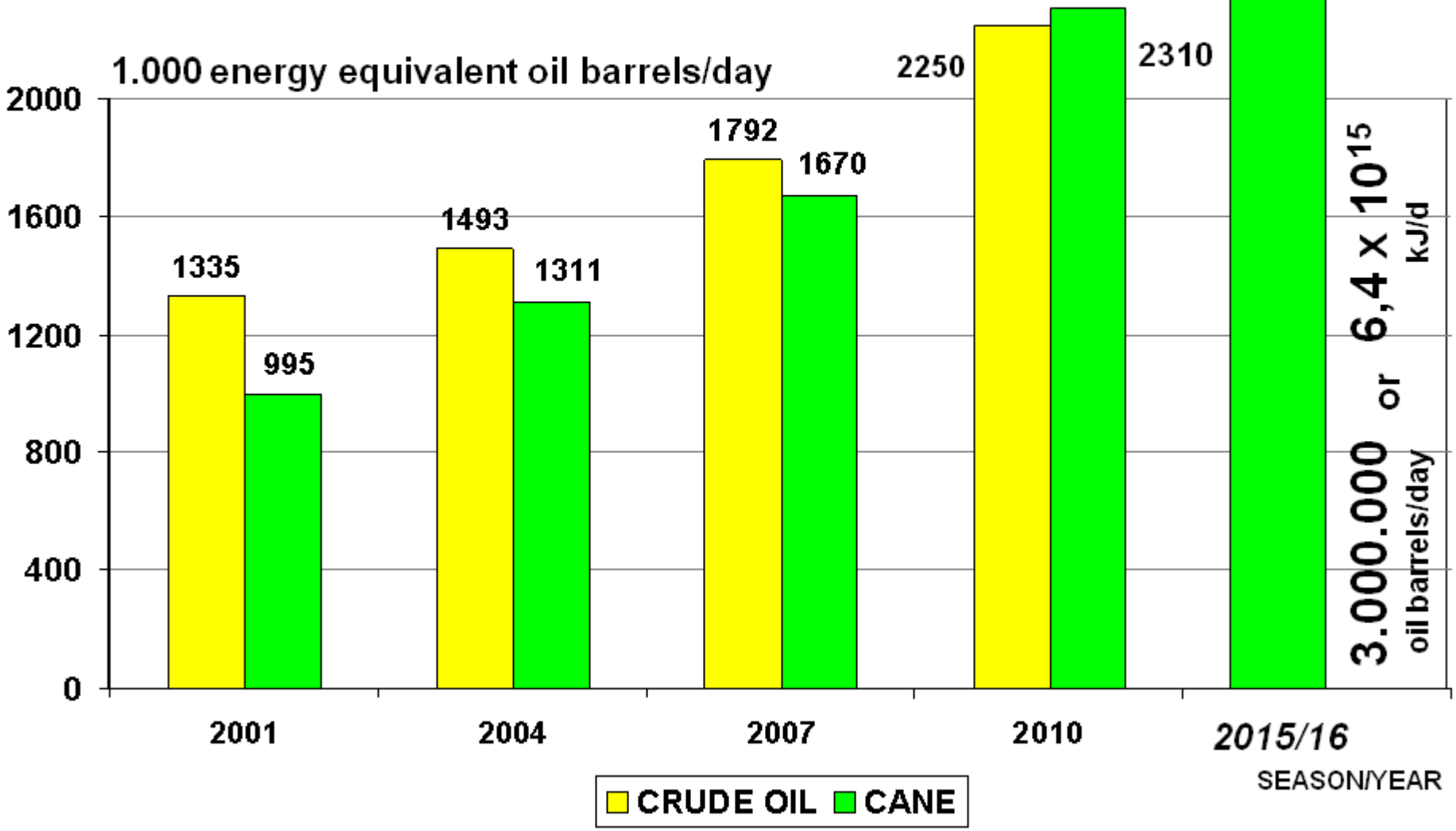
SUGARCANE – THE AGRIENERGY VIEW

CRUDE OIL PRODUCED IN BRAZIL – ENERGY – DAILY AVERAGE

BRAZILIAN SUGARCANE ENERGY – DAILY AVERAGE OIL BARREL EQUIVALENT



SOURCE: ANP

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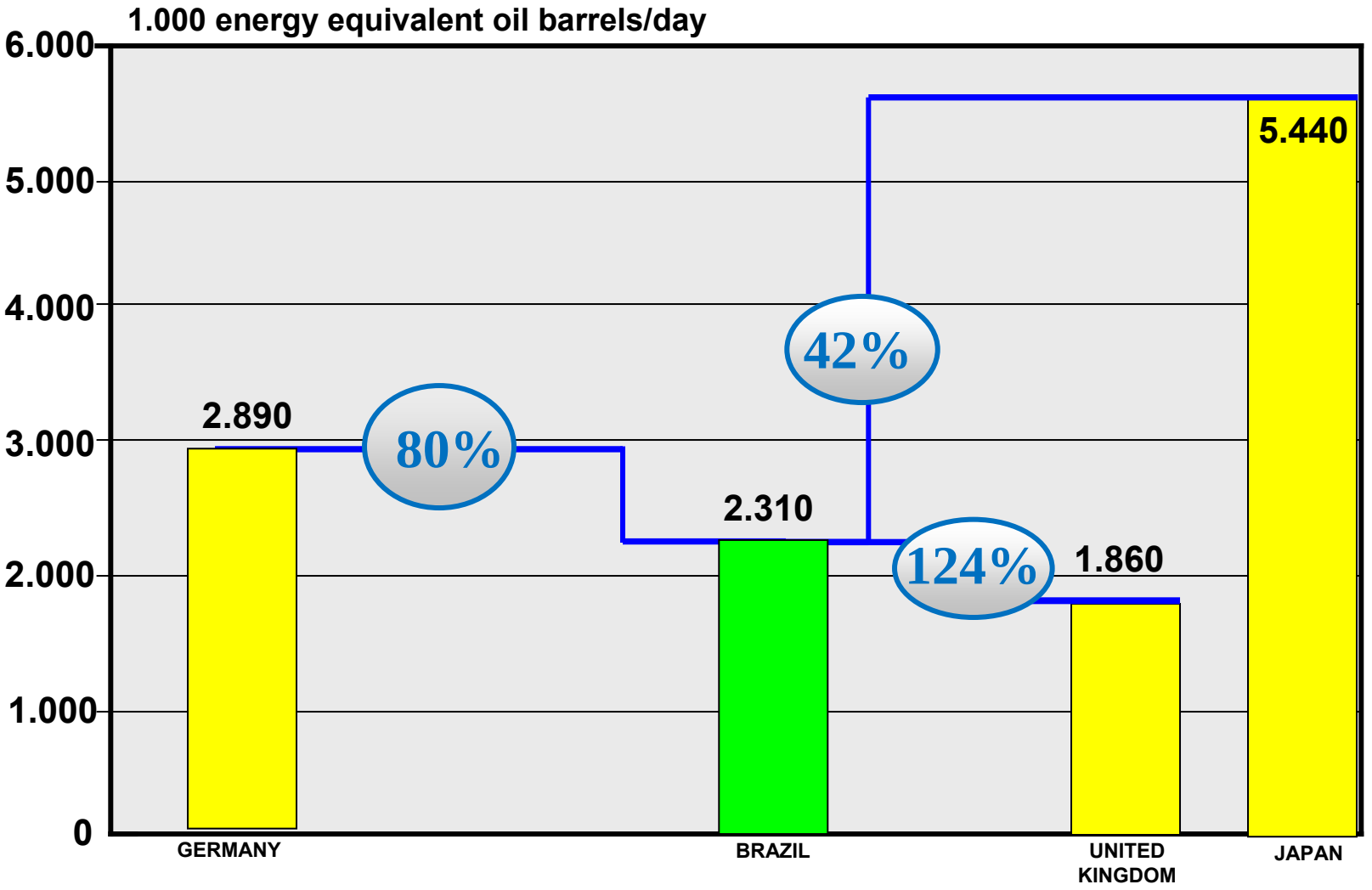
SUGARCANE – THE AGRIENERGY VIEW

BRAZILIAN SUGARCANE - TOTAL ENERGY CONTENT

SUGARCANE ENERGY VIEW – COMPARATIVE - 2010



SOURCE: EIA

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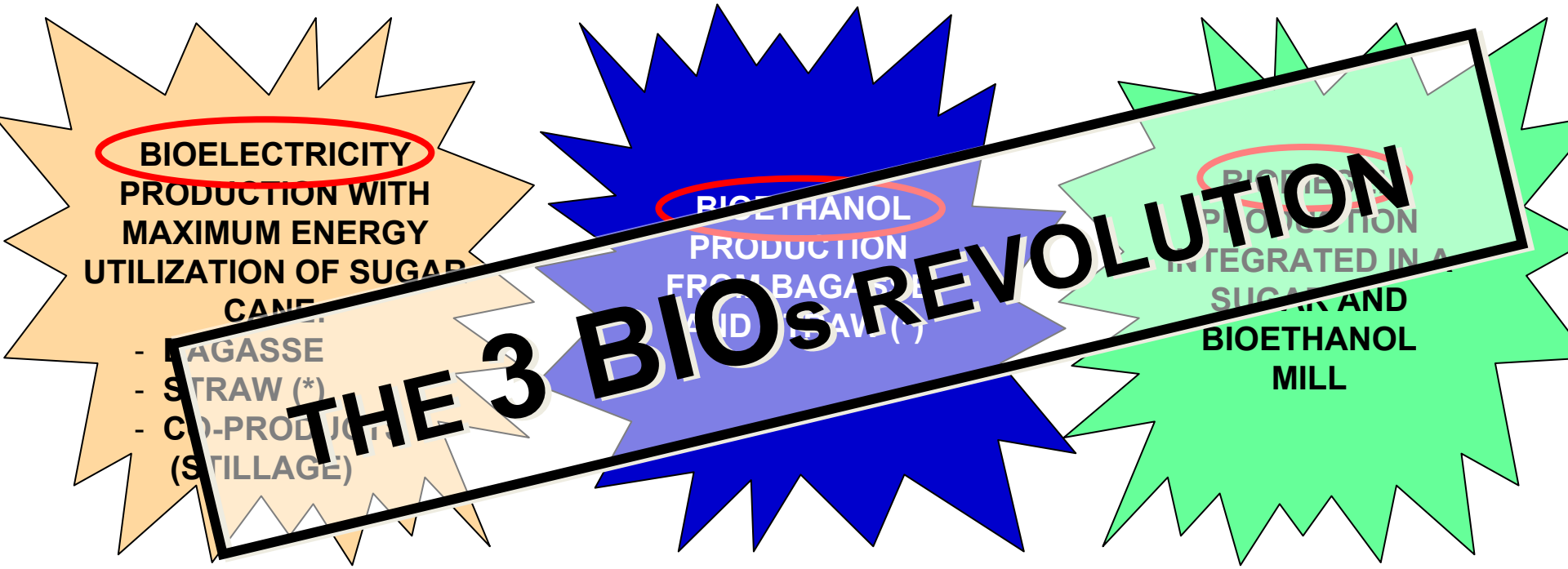
DEDINI'S NEW VISION ON SUGARCANE INDUSTRY

TECHNOLOGICAL EVOLUTION WILL BE FOCUSED ON MAXIMUM UTILIZATION OF SUGARCANE

HIGH IMPACT UPCOMING TECHNOLOGIES DERIVED FROM AN ENERGY FOCUSED VISION

SEVERAL NEW DEVELOPMENTS ARE ON TRACK

3 OUTSTANDING UPCOMING TECHNOLOGIES ARE SELECTED DUE TO THE REVOLUTIONARY IMPACT FOR THE SECTOR



(*) STRAW = TOPS, LEAVES, STRAW → 1/3 OF SUGARCANE'S ENERGY

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INDÚSTRIAS DE BASE

TECHNOLOGICAL EVOLUTION IN SUGARCANE AGRIBUSINESS

IMPACT OF TECHNOLOGY

INCREMENTAL INNOVATIONS

DISRUPTIVE INNOVATIONS (BREAKTHROUGH)

TECHNOLOGICAL HIERARCHY

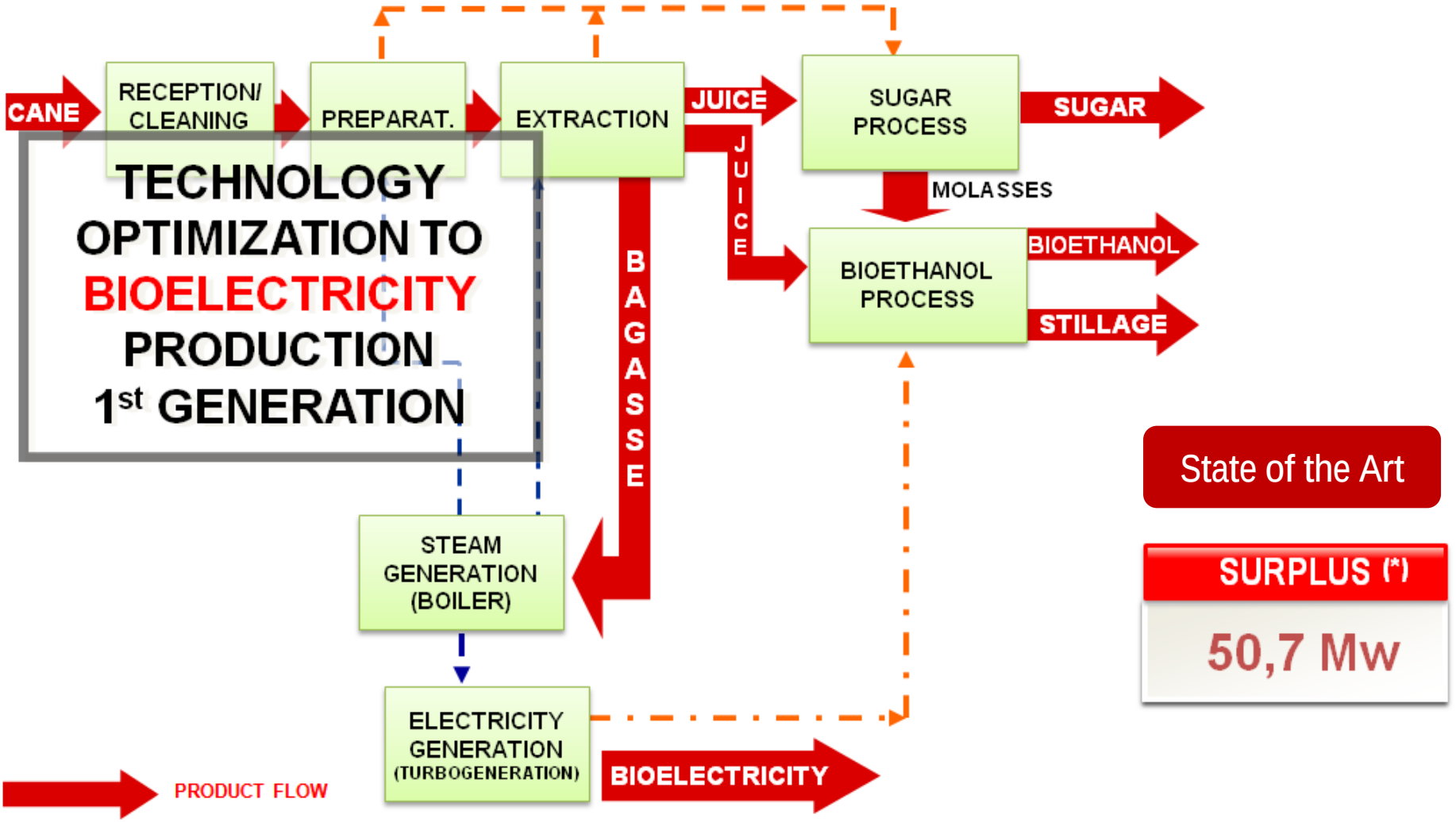
1st GENERATION TECHNOLOGY

2nd GENERATION TECHNOLOGY

3rd GENERATION TECHNOLOGY

BIOELECTRICITY TRADITIONAL PRODUCTION TECHNOLOGY

PRODUCTION FLOWCHART – SUGAR, BIOETHANOL AND SURPLUS BIOELECTRICITY



TECHNOLOGY OPTIMIZATION TO BIOELECTRICITY PRODUCTION 1st GENERATION

State of the Art

SURPLUS (*)

50,7 Mw

(*) REFERENCE: 12.000 TCD ≅ 2 MM TCC

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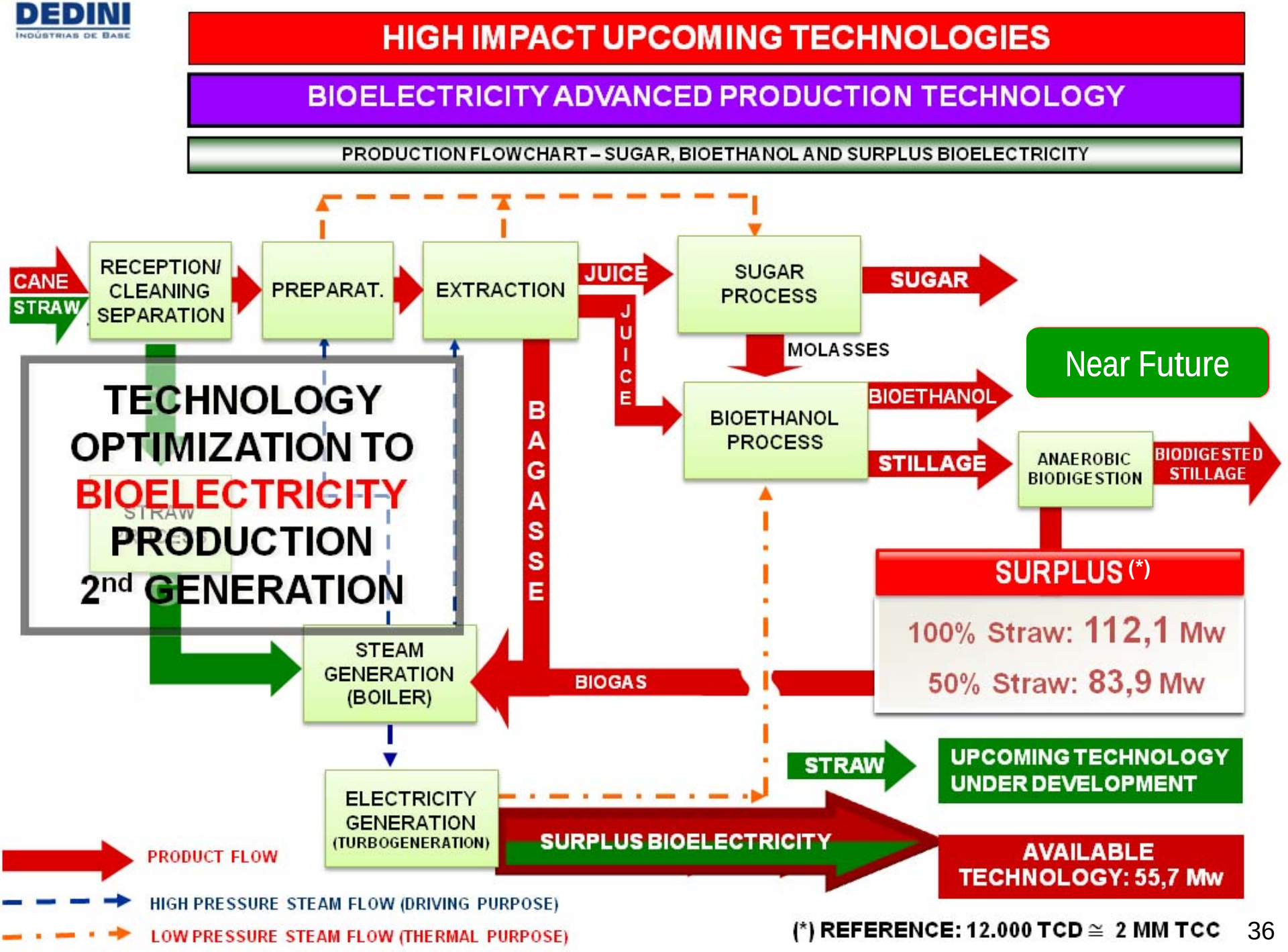
HIGH IMPACT UPCOMING TECHNOLOGIES

BIOELECTRICITY ADVANCED PRODUCTION TECHNOLOGY

PRODUCTION FLOWCHART – SUGAR, BIOETHANOL AND SURPLUS BIOELECTRICITY



(*) REFERENCE: 12.000 TCD ≅ 2 MM TCC

MAXIMUM SURPLUS ENERGY PRODUCTION

Integral (billets + straw) Cane Harvesting

Integral Cane Unloading in a Cane Feed Table

Straw Separation and Cleaning System

Rotary Screen

Straw Chopping

Straw Conveyor

Boiler

SYSTEM AND EQUIPMENT FOR STRAW UTILIZATION AS A FUEL, SUCH AS: INTEGRAL SUGARCANE CLEANING SYSTEM AND STRAW SEPARATION, HANDLING SYSTEM, STRAW CLEANING AND SAND SEPARATION, CHOPPING AND BOILER FEEDING.

DEDINI STRAW PROCESS - TECHNOLOGY UNDER DEVELOPMENT

Surplus: 100% Straw = 112,1 Mw / 50% Straw = 83,9 Mw

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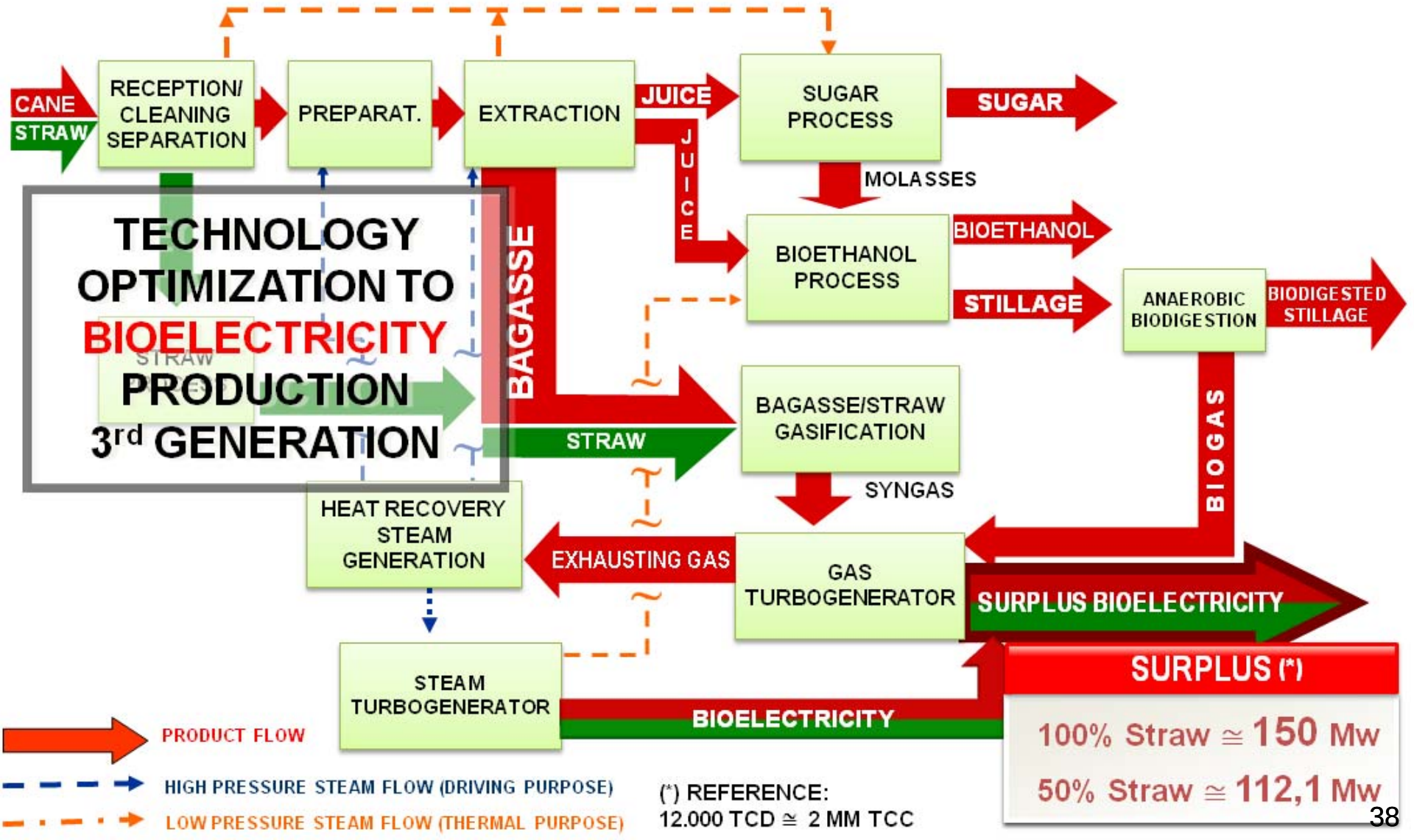
INDÚSTRIAS DE BASE

HIGH IMPACT UPCOMING TECHNOLOGIES – THE NEW GENERATION

SUPER ADVANCED BIOELECTRICITY PRODUCTION TECHNOLOGY

PRODUCTION FLOWCHART – SUGAR, BIOETHANOL AND (SURPLUS BIOELECTRICITY)^2



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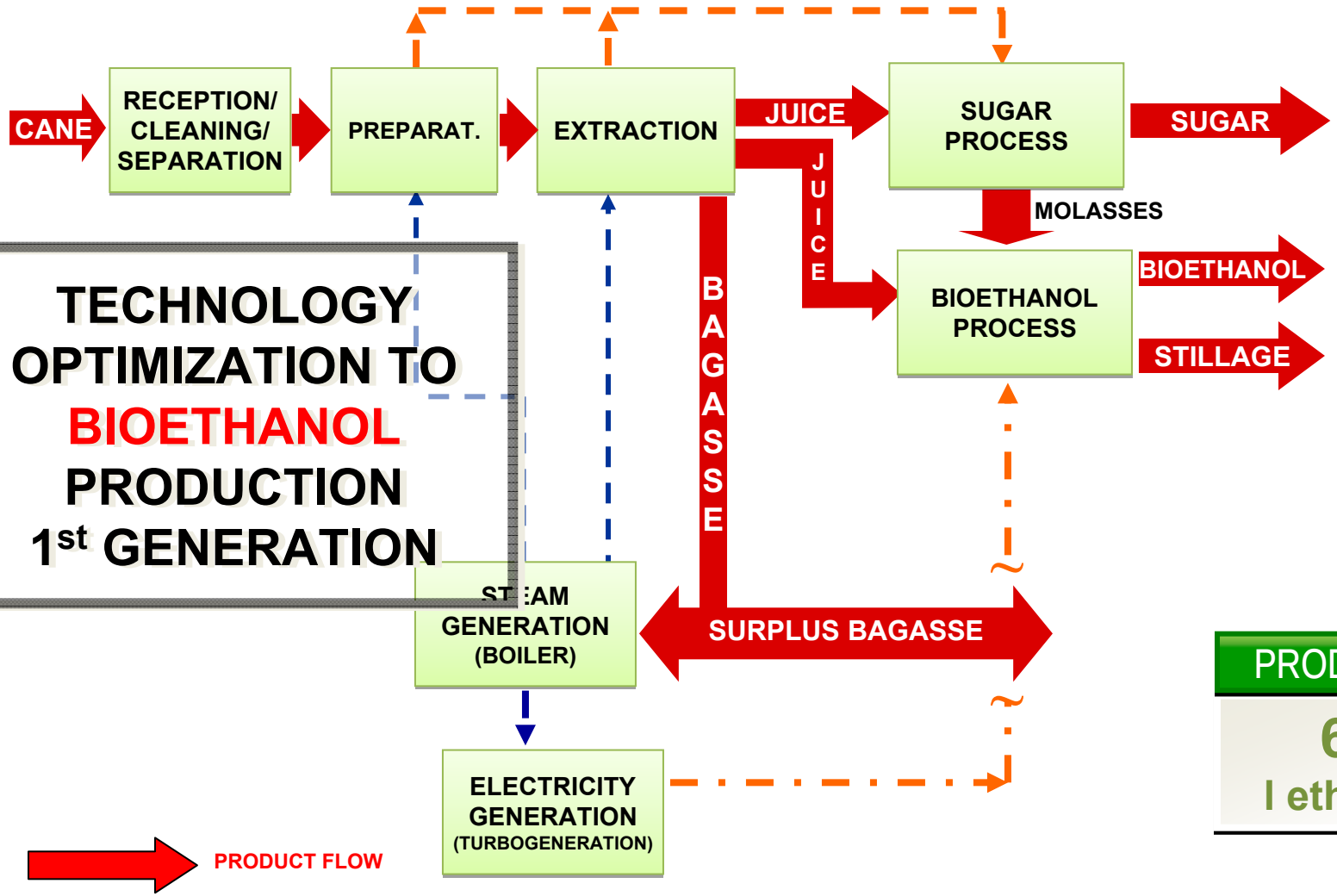
TRADITIONAL TECHNOLOGY AND PRODUCTION PROCESS: SUGAR, BIOETHANOL AND SURPLUS ENERGY

PRODUCTION FLOWCHART – SUGAR, BIOETHANOL AND SURPLUS BAGASSE



PRODUCTIVITY

6.400

l eth/ha cane

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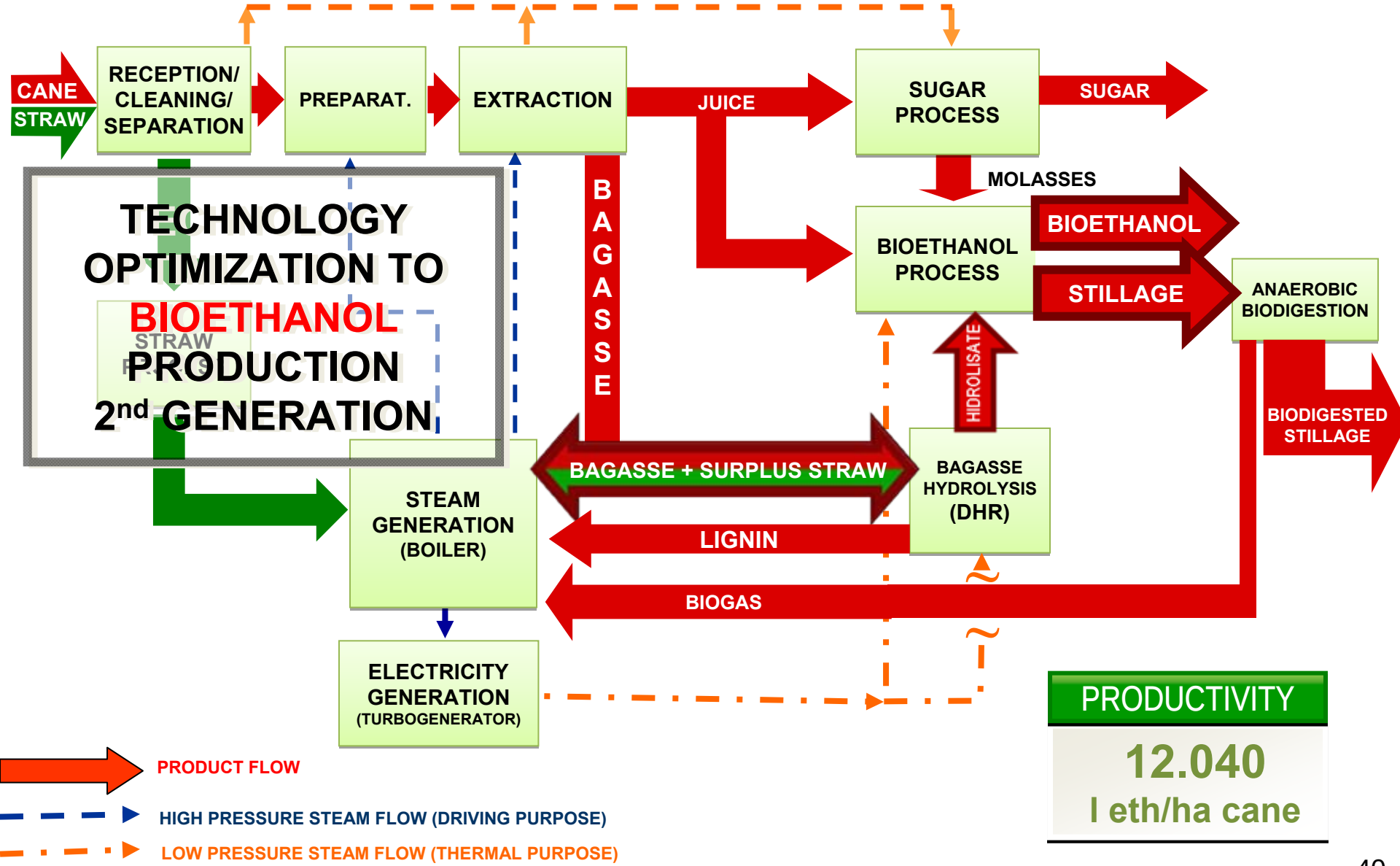
INDÚSTRIAS DE BASE

HIGH IMPACT UPCOMING TECHNOLOGIES

BIOETHANOL ADVANCED PRODUCTION TECHNOLOGY – BIOETHANOL FROM CELLULOSICS



PRODUCTIVITY

12.040

l eth/ha cane

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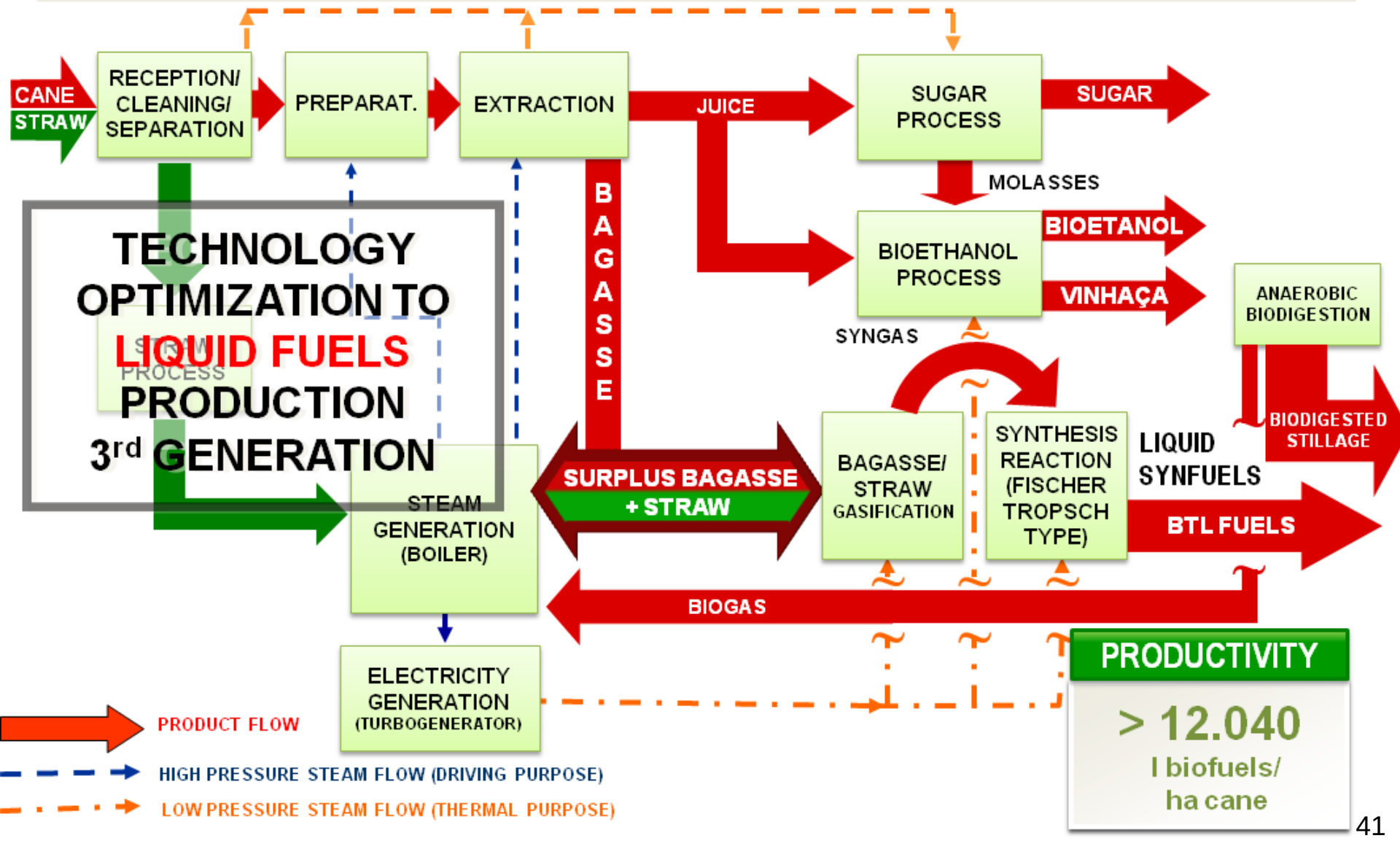
HIGH IMPACT UPCOMING TECHNOLOGIES – THE NEW GENERATION

BTL TECHNOLOGIES – BIOMASS TO LIQUID

PRODUCTION FLOWCHART – SUGAR, BIOETHANOL AND OTHER BIOPRODUCTS



PRODUCTIVITY

> 12.040

l biofuels/ ha cane

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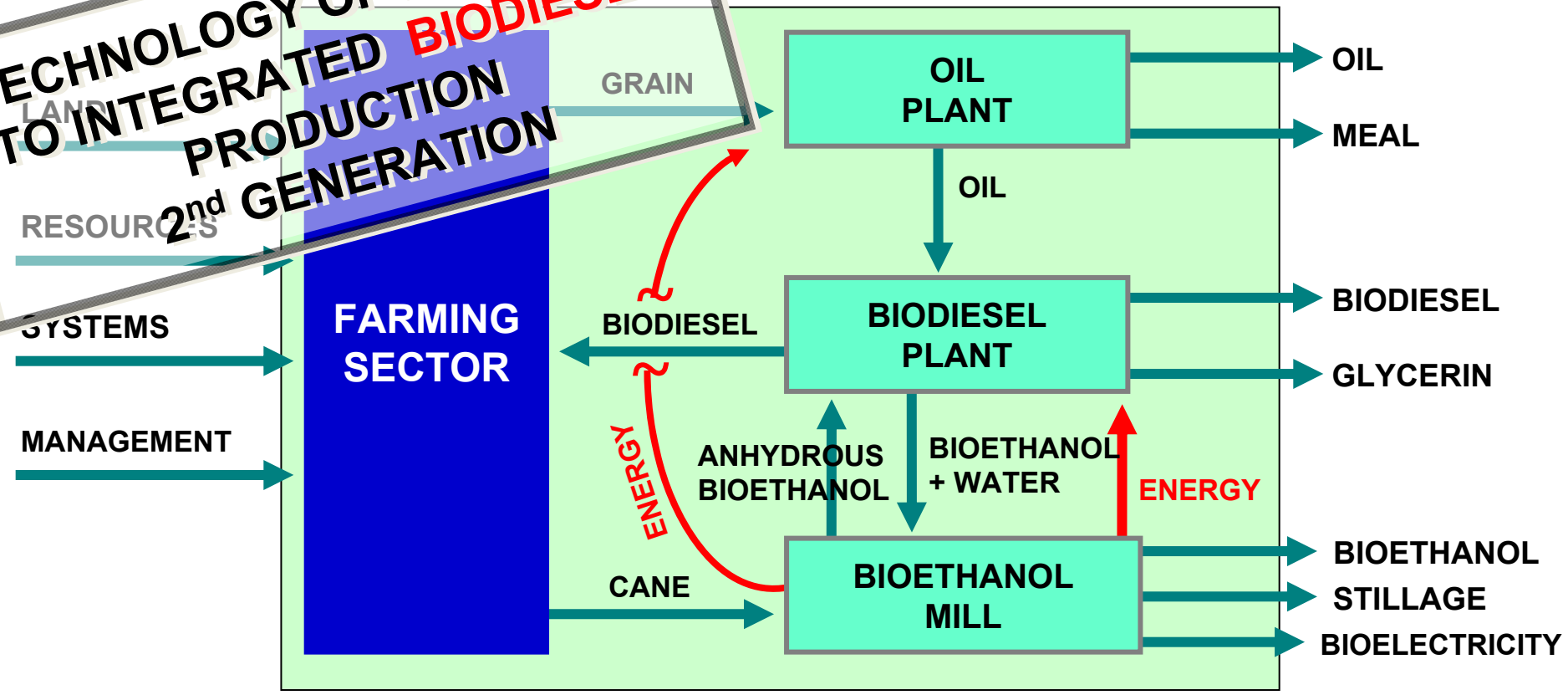
INDÚSTRIAS DE BASE

HIGH IMPACT UPCOMING TECHNOLOGIES

THE BIOETHANOL ↔ BIODIESEL INTEGRATION

2ND STAGE: FARMING AND INDUSTRIAL INTEGRATION

TECHNOLOGY OPTIMIZATION TO INTEGRATED BIODIESEL PRODUCTION 2nd GENERATION



AVAILABLE TECHNOLOGY

State of the Art

Bioethanol, Bioelectricity, Biodiesel

The 3 BIOs Mill

Dedini's State of Art Mill is a product in continuous development

DEDINI
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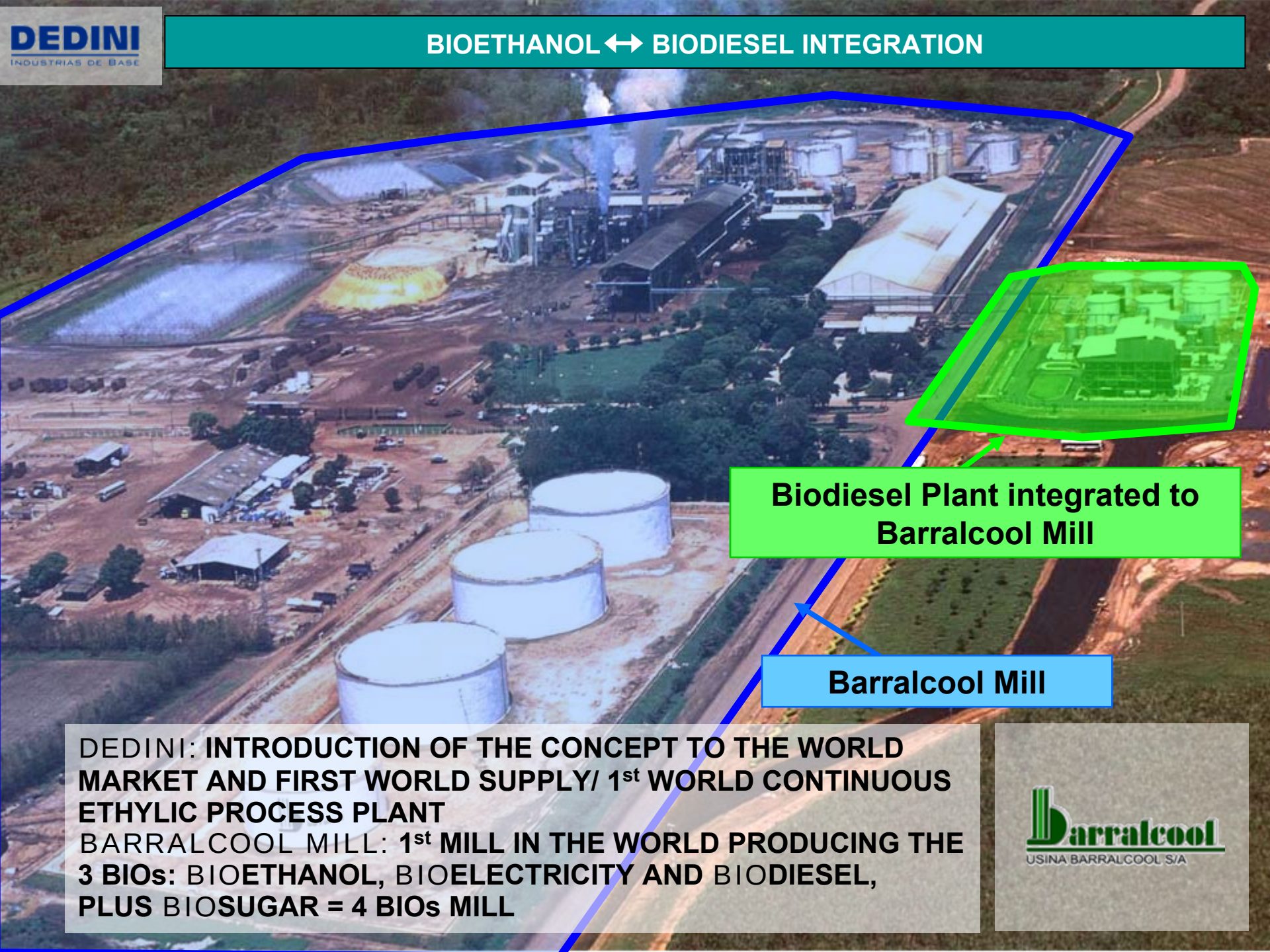
BIOETHANOL ↔ BIODIESEL INTEGRATION



DEDINI: **INTRODUCTION OF THE CONCEPT TO THE WORLD MARKET AND FIRST WORLD SUPPLY/ 1st WORLD CONTINUOUS ETHYLIC PROCESS PLANT**

BARRALCOOL MILL: **1st MILL IN THE WORLD PRODUCING THE 3 BIOs:** BIO**ETHANOL,** BIO**ELECTRICITY AND** BIO**DIESEL, PLUS** BIO**SUGAR = 4 BIOs MILL**

Barralcool
USINA BARRALCOOL S/A


Barralcool
USINA BARRALCOOL S/A
DEDINI
INDÚSTRIAS DE BASE
INAUGURATION: 21/NOV/ 2006
BRAZILIAN PRESIDENT LULA
MATO GROSSO GOVERNOR MAGGI
BARRALCOL PRESIDENT J. PETRONI

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INTRODUCTION TO HYDROLYSIS PROCESS

THE TREE STAGES OF THE BIOETHANOL PRODUCTION PROCESS FROM CELLULOSIC MATERIALS

HYDROLYSIS (SACCHARIFICATION → **PROCESS THAT INTRODUCES WATER TO CELLULOSE AND HEMICELLULOSE, TRANSFORMING THEM INTO HEXOSE AND PENTOSE SUGARS**

(+)

FERMENTATION → **PROCESS THAT TRANSFORMS SUGARS INTO BIOETHANOL**

(+)

DISTILLATION → **PROCESS THAT SEPARATES ETHANOL FROM THE OTHER COMPONENTS OF THE BEER (MAINLY WATER)**

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INTRODUCTION TO HYDROLYSIS PROCESS

THE TREE STAGES OF THE BIOETHANOL PRODUCTION PROCESS FROM CELLULOSIC MATERIALS

HYDROLYSIS (SACCHARIFICATION → THERE ARE SEVERAL KNOWN HYDROLYSIS PROCESSES, BUT THEY DON'T PRESENT ECONOMIC FEASIBILITY

(+)

FERMENTATION → **FERMENTATION PROCESS**

MASH PREPARATION (TREATMENT OF THE HYDROLYSED LIQUOR)	TECHNICAL AND ECONOMIC FEASIBILITY NEEDS IMPROVEMENT
C6 - HEXOSE (GLUCOSE)	TECHNICAL AND ECONOMIC FEASIBILITY
C5 - PENTOSE (XILOSE)	UNDER DEVELOPMENT

(+)

DISTILLATION → ECONOMIC AND TECHNICAL FEASIBILITY

TO BIOETHANOL PRODUCTION FROM CELLULOSIC MATERIALS, THE ECONOMIC UNFEASIBILITY DERIVES FROM THE HYDROLYSIS STAGE.

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INTRODUCTION TO HYDROLYSIS PROCESS

HYDROLYSIS MAY BE APPLIED TO ANY CELLULOSIC MATERIAL: FORESTRY RESIDUES, WOOD, GRASSES, AGRICULTURAL RESIDUES, THAT ARE RAW MATERIAL FOR HYDROLYSIS.

NECESSARY CONDITION FOR THE RAW MATERIAL	**AVAILABILITY**
	LOW COST/PRICE

IN BRAZIL, THE MOST SUITABLE RAW MATERIAL IS SUGARCANE BAGASSE	**ALREADY PREPARED BY THE MILLS**
	AVAILABLE IN LARGE QUANTITIES
	MINIMUM COST OR ZERO COST
	AVAILABLE AT THE PLACE WHERE USED

IN NEAR FUTURE, CANE STRAW (MEANING TOPS, LEAVES AN STRAW) MAY BE RAW MATERIAL OR, BEING USED AS BOILER FUEL, RELEASE BAGASSE FOR HYDROLYSIS

SUGARCANE BAGASSE COMPOSITION	**NATURAL POLYMERS**	**CELLULOSE**
		HEMICELLULOSE
		LIGNIN

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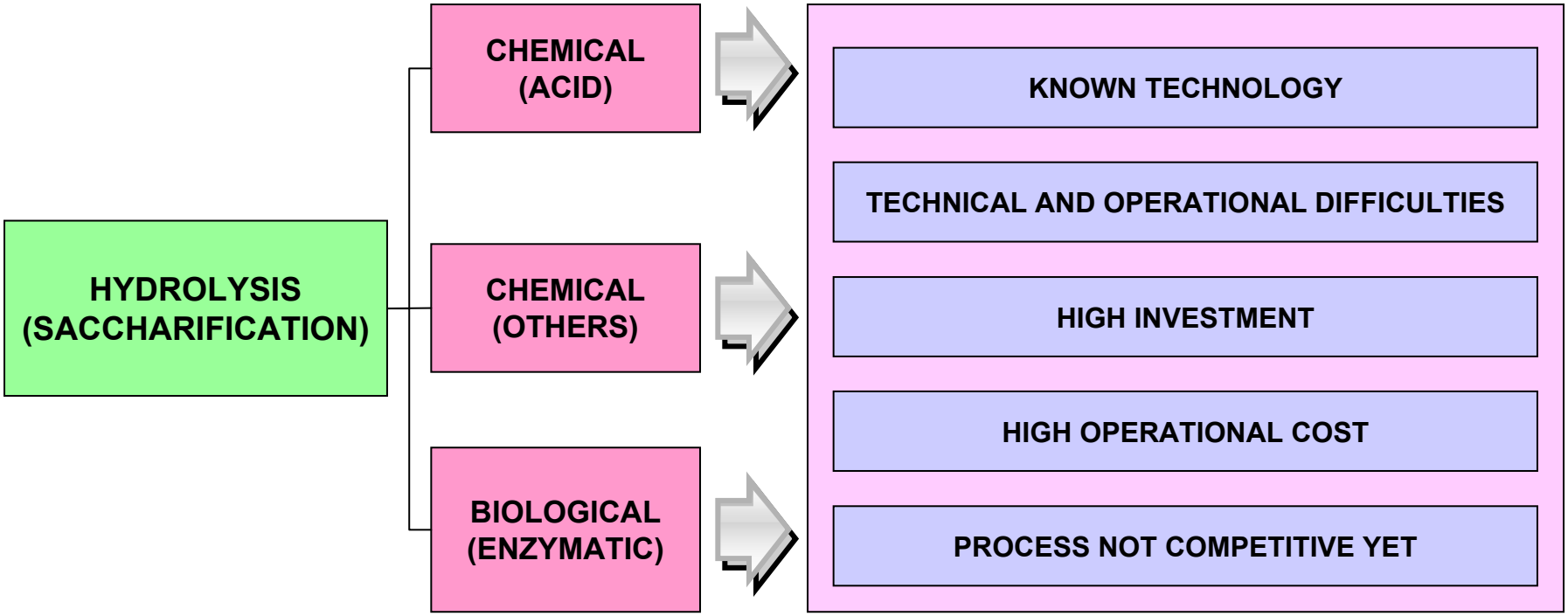
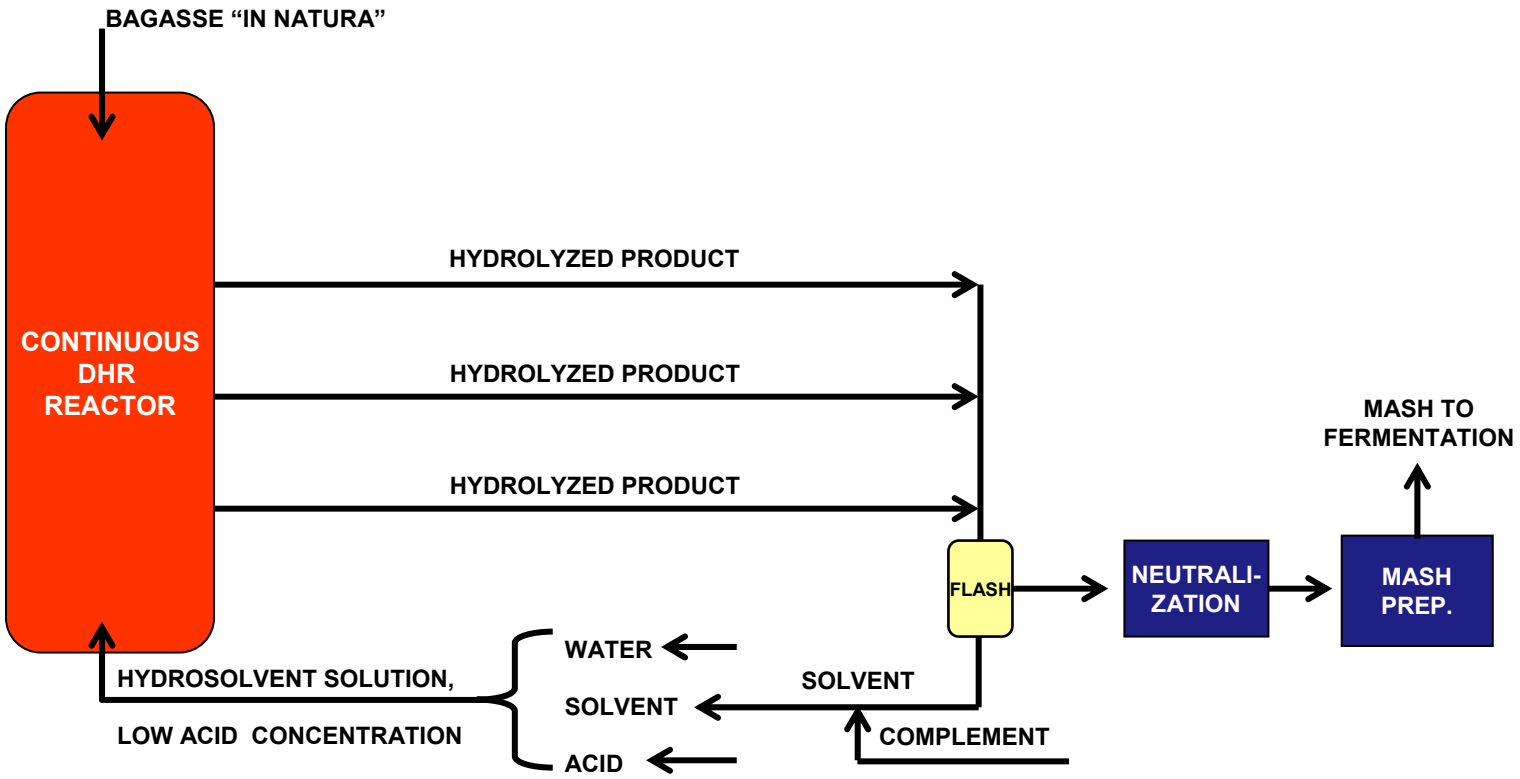
INTRODUCTION TO HYDROLYSIS PROCESS

HYDROLYSIS PROCESS: TECHNOLOGICAL ROUTES



WHAT IS DHR – DEDINI RAPID HYDROLYSIS TECHNOLOGY



DHR PROCESS	=	ORGANOSOLV PROCESS	+	CHEMICAL HYDROLYSIS WITH VERY DILUTED ACID

LIGNIN SOLVENTS – IN GREAT NUMBER (26 ANALYZED)

DEDINI TESTED SEVERAL SOLVENTS.
THE FINAL CHOICE WAS BIOETHANOL.

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DEVELOPMENT OF THE DHR-DEDINI RAPID HYDROLYSIS TECHNOLOGY

BIOETHANOL PRODUCTION FROM BAGASSE

DHR – "DEDINI HIDRÓLISE RÁPIDA" - RAPID HYDROLYSIS DEDINI: ENVOLVING HYDROLYSIS (+) FERMENTATION (+) DISTILLATION FOR THE BIOETHANOL PRODUCTION FROM BAGASSE.

DHR – PROCESS DEVELOPED BY DEDINI WITHIN THE 80's.
APPROVED AND FINANCED BY GOVERNMENTAL BRAZILIAN AGENCIES WITH FUNDS FROM THE WORLD BANK.

PATENTS ISSUED IN DIFFERENT COUNTRIES FROM ALL CONTINENTS.

DEDINI DEVELOPED AND OPERATED A PILOT PLANT OF 100 L BIOETHANOL/DAY, LATER TRANSFERED TO CTC-COPERSUCAR.

TECHNICAL COOPERATION AGREEMENT DEDINI - COPERSUCAR, SIGNED NOVEMBER/97.

A 5,000 L BIOETHANOL/DAY SEMI-INDUSTRIAL PLANT WAS INSTALLED IN NOVEMBER/2002 AT SÃO LUIZ SUGAR AND ETHANOL MILL, LOCATED IN PIRASSUNUNGA - SP, BRAZIL. PROJECT GATHERED DEDINI, COPERSUCAR AND FAPESP (STATE OF SÃO PAULO RESEARCH SUPPORT OFICIAL AGENCY)

THE SEMI-INDUSTRIAL PLANT OPERATED UNTIL 2007, IN ORDER TO CONCLUDE THE DEFINITION OF ENGINEERING PARAMETERS THAT WILL BE UTILIZED TO DEVELOP A FULL SCALE INDUSTRIAL PLANT. TODAY THE DHR PROCESS IS BEING ANALYZED LOOKING FOR IMPROVEMENTS

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DEVELOPMENT OF THE DHR - DEDINI RAPID HYDROLYSIS TECHNOLOGY

DHR PILOT AND LABORATORY

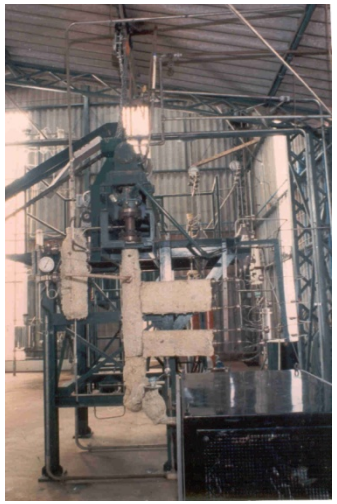
PILOT 100 L BIOETHANOL/DAY

SAMPLE: BAGASSE "IN NATURA", HYDROLYZED FROM THE REACTOR, HYDROLYZED FROM THE COLUMN OF SOLVENT RECUPERATION; DHR BIOETHANOL.

GENERAL VISION – DHR PILOT PLANT

BAGASSE FEEDING

DHR REACTOR



BIOETHANOL PRODUCTIVITY L HYD ETH / TON BAGASSE " IN NATURA" (50% MOISTURE)	
PILOT – ACTUAL (ONLY HEXOSE)	109
DHR PROCESS POTENTIAL (HEXOSE+PENTOSE)	180

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DEVELOPMENT OF THE DHR - DEDINI RAPID HYDROLYSIS TECHNOLOGY

MAIN RESULTS ACHIEVED – PILOT 100 L/ DAY

HYDROLYSIS YIELD IN TRS – TOTAL REDUCING SUGAR

AVERAGE- RUN	-	68,2%
STABLE PEAK – STABILITY CONDITION	-	88%

TRS CONCENTRATION IN HYDROLYZED PRODUCT: 10,9%

FERMENTATION YIELD (HEXOSE): 89%

STABLE AND CONTINUOUS OPERATION

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DEVELOPMENT OF THE DHR - DEDINI RAPID HYDROLYSIS TECHNOLOGY

THE SEMI INDUSTRIAL PLANT - 5,000 L/DAY – SÃO LUIZ MILL

BAGASSE: RAW MATERIAL FOR THE DHR
AND DHR HYDROLYSIS PLANT

REACTOR TOWER WITH
BAGASSE FEEDING SYSTEM

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DEVELOPMENT OF THE DHR - DEDINI RAPID HYDROLYSIS TECHNOLOGY

THE SEMI INDUSTRIAL PLANT - 5,000 L/DAY

REACTOR TOWER. DISTILLATION PRODUCTS RECOVERY EQUIPMENT: HYDROLYSED LIQUOR, RECOVERED SOLVENT (ETHANOL), LIGNIN, HYDROLYSED LIQUOR TREATMENT AND MIXING WITH TRADITIONAL MASH (FROM SYRUP/MOLASS)

FERMENTATION AND DISTILLATION: EXISTING FACILITIES BEING USED

How About the Future?


and How
About
the Future
of the
Future?

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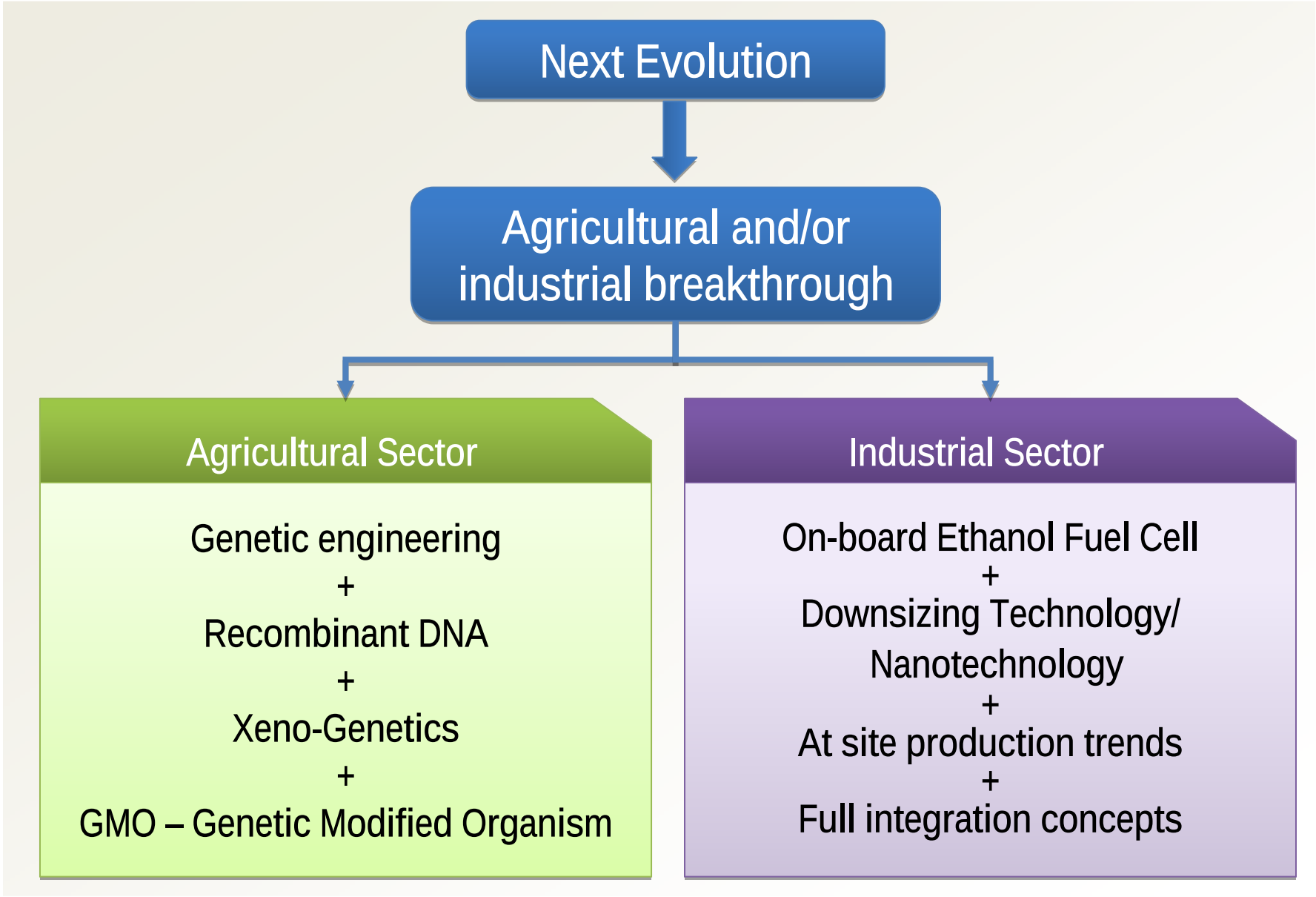
AND HOW ABOUT THE FUTURE OF THE FUTURE?



SUGARCANE AGRICULTURAL BREAKTHROUGH
THE FUTURE OF THE FUTURE

Electricity
Plug-in
Cane

Ethanol
Pump
Cane

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SUGARCANE INDUSTRIAL BREAKTHROUGH
THE FUTURE OF THE FUTURE

Direct Sugarcane Feeding in On-Board Ethanol Mill Vehicle

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DESIGNING COMPLETE MILLS TOWARDS A BIOREFINERY, OR...
DSM – DEDINI SUSTAINABLE MILL!!!

TRADITIONAL MILL DESIGN

NEW TRENDS IN TRADITIONAL MILL DESIGN

DESIGNING THE BREAKTHROUGH MILL

DSM - DEDINI SUSTAINABLE MILL

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SOME BIOREFINERY SOLUTIONS ALREADY SUPPLIED BY DEDINI

BIOMASS TO ANIMAL FEED: PIONEER SUPPLY OF THE FIRST BRAZILIAN BIOMASS TO ANIMAL FEED PLANT TO BIOTECNOLOGIA DO PARANÁ, VALE DO IVAÍ MILL AND ALLTECH JOINT VENTURE. PROCESS ENGINEERING FROM ALLTECH, TURN-KEY SUPPLY FROM DEDINI.
RAW MATERIAL: SUGARCANE JUICE
ANIMAL FEED : UPGRADED YEAST

XANTHAN GUM: PIONEER SUPPLY OF THE FIRST LATIN AMERICA XANTHAN GUM PLANT, TO POLICAM, CAMPO DOS GOITACAZES, RJ. DEDINI DELEVOPED A COMPLETE TURN-KEY SOLUTION USING PROCESS TECHNOLOGY DEVELOPED BY UNICAMP RESEARCHERS.
RAW MATERIAL: CANE SUGAR (IN OTHER COUNTRIES: CORN GLUCOSE)
PRODUCTION CAPACITY: 2.000 ANNUAL TON
XANTHAN GUM UTILIZATION: FOOD, OIL, CHEMICAL, PHARMACEUTICAL, COSMETIC INDUSTRY.

BIODIESEL: FIRST BRAZILIAN SALE OF A BIODIESEL PLANT USING FAT ACID FROM PALM OIL PRODUCTION TO AGROPALMA, BELÉM, PA. TECHNOLOGICAL FLEXIBLE ROUTE: METHYLIC OR ETHYLIC. TURN-KEY SUPPLY FROM A LAB-SCALE TECHNOLOGY DEVELOPED BY UFRJ (UNIV. FED. RJ)
PRODUCTION CAPACITY: 8.000 TON/YEAR

FIRST WORLD CONCEPTION/SUPPLY: BIODIESEL PLANT INTEGRATED TO SUGAR, ETHANOL AND BIOELECTRICITY MILL AND FIRST CONTINUOUS ETHYLIC BIODIESEL PLANT TO BARRALCOOL MILL, BARRA DO BUGRES, MT. BARRALCOOL MILL: 1st WORLD 4 BIOS MILL.
MULTI-FEED RAW MATERIAL: ANY VEGETABLE OIL/ANIMAL FAT.
CAPACITY: 50.000 TON/YEAR

FIRST WORLD COMPLETELY INTEGRATED 2 BIODIESEL MILLS, STARTING WITH THE RECEPTION OF THE GRAIN (MAINLY SOYA) UP TO THE FINAL PRODUCTION OF BIODIESEL. FIRST BRAZILIAN BIODIESEL PROJECTS DESIGNED TO EXPORT SURPLUS BIOELECTRICITY TO THE NATIONAL GRID. SUPPLIED TO AGRENCO BIOENERGIA, ALTO ARAGUAIA, MT, AND CAARAPÓ, MS
FUEL: ELEPHANT GRASS
CAPACITY: 100.000 TON/YEAR AND 200.000 TON/YEAR

DSM - DEDINI SUSTAINABLE MILL

SUSTAINED DEVELOPMENT

ECONOMIC

- DSM is competitive in a free market, without subsidies

ENVIRONMENTAL

- DSM solutions includes not to waste (also minimizing consumption), not to commit, not to pollute the environment and the natural resources, mainly air, water, energy, materials/raw materials, biodiversity, and generates minimum or zero emissions, effluents, residues, and odors.
- DSM attends the standards and regulations, reducing/ eliminating environmental impacts, and contributes to agricultural sustainability
- DSM contributes and makes it easier the management system ISO 14000

SOCIAL

- In DSM, the equipment, processes, materials, installations need to be located, to move, to operate, attending the standards and regulations, promoting and providing comfort, hygiene, safety and good health conditions
- The operator applies minimum physical effort considering ergonomic concepts providing a correct man-machine interaction
- DSM uses automation through integrated and intelligent software, MES level, linked and integrated to ERP System
- DSM contributes and makes it easier the management system SA-8000

Carbon Credits – GHG direct reduction by CO^2 emissions captured/reduced/avoided in a Traditional Mill

ETHANOL COMPLETE LIFE CYCLE

Ethanol brings environmental benefits from the moment sugarcane germinates in the field, absorbing the major portion of the carbon dioxide generated in ethanol production and consumption.

The data below refers to the CO_2 emissions for every 1000 liters of ethanol produced and consumed.

1) **Cane Cultivation & Harvesting:*** Tractors, harvesting machines and agricultural inputs release carbon dioxide (CO_2). Manual harvesting demands straw burning, which also generates such emissions.
Total emission: 2.961 kg CO_2

2) **Cane Growing:** Sugar cane is just like a natural "sponge", which absorbs great amounts of CO_2 while growing.
Absorption: 7.650 kg CO_2

The ethanol produced in Brazilian 2008/09 crop reached 27 billion liters. Consumed in motor vehicles, this volume of ethanol prevented the emissions of 53 million tons of carbon dioxide, meaning CO_2 absorption equivalent to a mature forest with 100 million trees.

3) **Cane Processing:** Both - fermentation and bagasse burning to generate energy for internal process utilization - release CO_2.
Emission: 3.604 kg CO_2

4) **Bioelectricity:** The use of bagasse to produce surplus bioelectricity/ bioenergy to supply to the grid avoids GHG emissions to the atmosphere.
Avoided emission: 225 kg CO_2

5) **Transporting:** Ethanol is transported to the gas stations by diesel trucks.
Emission: 50 kg CO_2

6) **Vehicles motor:** Ethanol burning produces **1.520 kg of CO_2.**

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

Source: UNICA website

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

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Carbon Credits – GHG direct reduction by CO^2 emissions captured/reduced/avoided in a Traditional Mill

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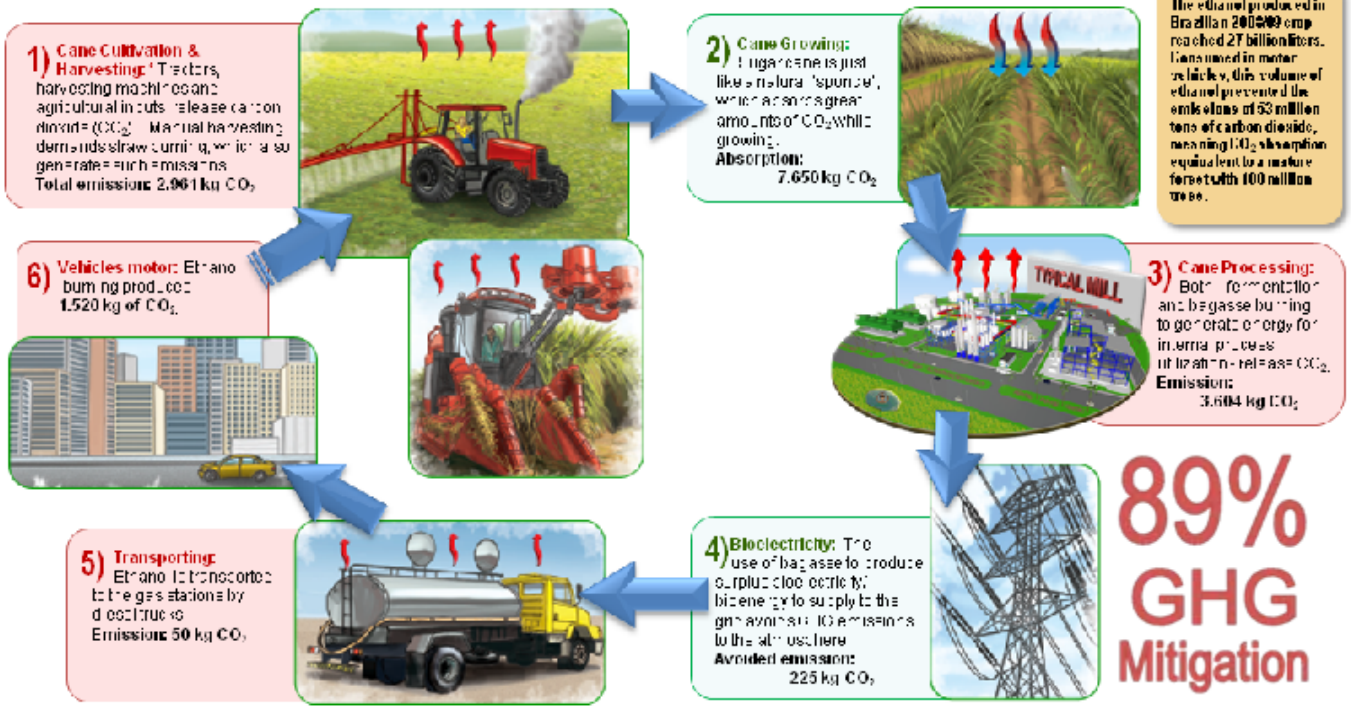

89% GHG Mitigation

Within a complete cycle, CO_2 emissions reduction by using ethanol replacing gasoline is (2,28 – 0,26)= 2,02 kg CO_2/ liter eth

FINAL BALANCE

Generated emissions:
(2.961 + 3.604 + 50 + 1.520):
8.135 kg CO_2

Reabsorbed + avoided emissions:
(7.650 + 225):
7.875 kg CO_2

Generated (-) reabsorbed/ avoided emissions
(8.135 – 7.875):
260 kg CO_2

Emissions with equivalent use of gasoline:
2.280 kg CO_2

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

Source: UNICA website

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

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

The Typical Mill Process

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

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

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

EXTRACTION → JUICE → BIOETHANOL PROCESS

SUGAR PROCESS → MOLASSES → BIOETHANOL PROCESS → BIOETHANOL

BIOETHANOL PROCESS → STILLAGE

ENERGY OPTIMIZATION

YIELD OPTIMIZATION

- **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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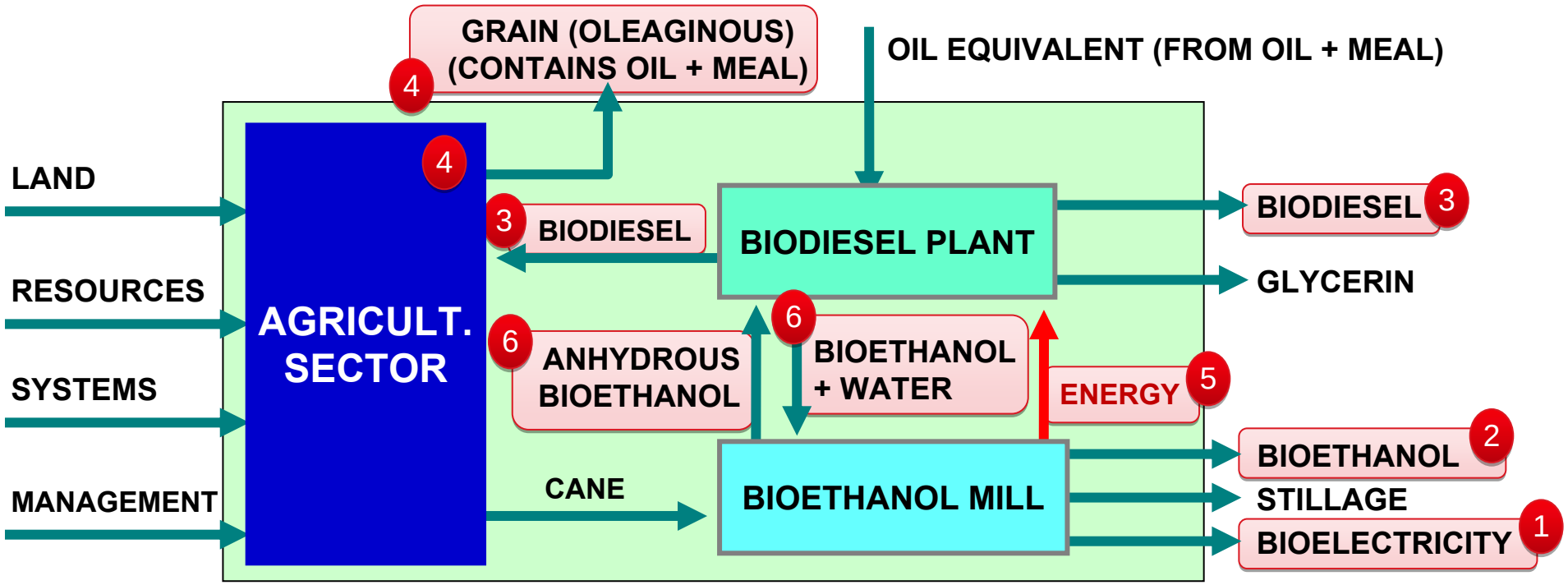
THE BIOETHANOL ↔ BIODIESEL INTEGRATION

1ST STAGE: PARTIAL INDUSTRY INTEGRATION

HOW A 3 BIOS MILL CONTRIBUTES TOWARDS MITIGATING CO_2 EMISSIONS IN AGRICULTURAL AND INDUSTRIAL SECTORS?

1. MAXIMIZING SURPLUS MW
2. MAXIMIZING YIELDS - L BIOETH/T CANE
3. BIODIESEL REPLACING DIESEL IN FARMING ACTIVITIES / IN THE MARKET
4. DOUBLE USE OF THE LAND
5. BIODIESEL PLANT USES BIOENERGY
6. ETHYLIC BIODIESEL, NOT METHYLIC / DEWATERING BIOETHANOL AT THE MILL



AVAILABLE TECHNOLOGY

STATE OF THE ART MILL – 3 BIOS MILL

SUSTAINABILITY WILL HAVE A BIG INFLUENCE IN SUGARCANE MILLS' CONCEPTION AND DESIGN IN A MEDIUM TERM FUTURE

(*) PLUS BIOSUGAR

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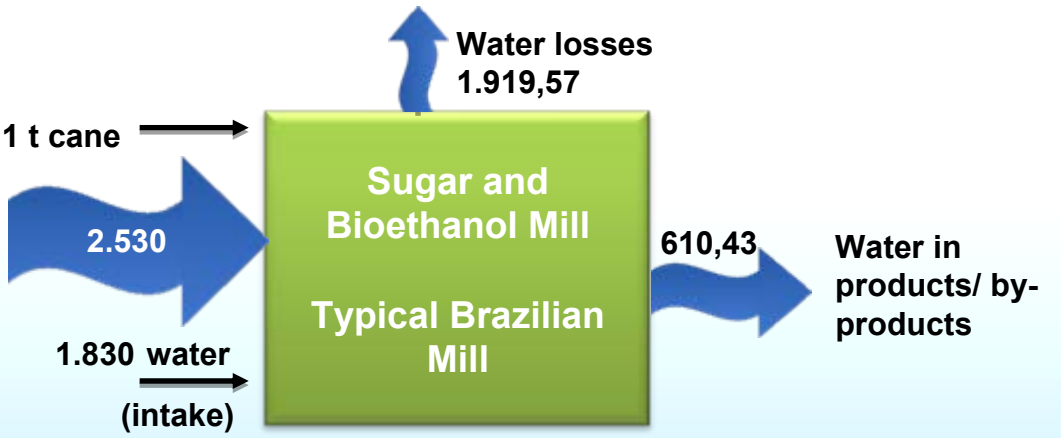
INDÚSTRIAS DE BASE

SUSTAINABILITY WILL HAVE A BIG INFLUENCE IN SUGARCANE MILLS CONCEPTION AND DESIGN

FOCUS: WATER CONSUMPTION

Sugarcane Composition – 1 ton.

Composition	Weight (kg)
Sugar	160
Fiber	125
Other Solids	15
Water	700
Total	**1.000**



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

- Current mills are big water wasters
- Future scenario reveals the water as a noble resource, and considering environmental constraints: conclusion is that water consumption must be minimized

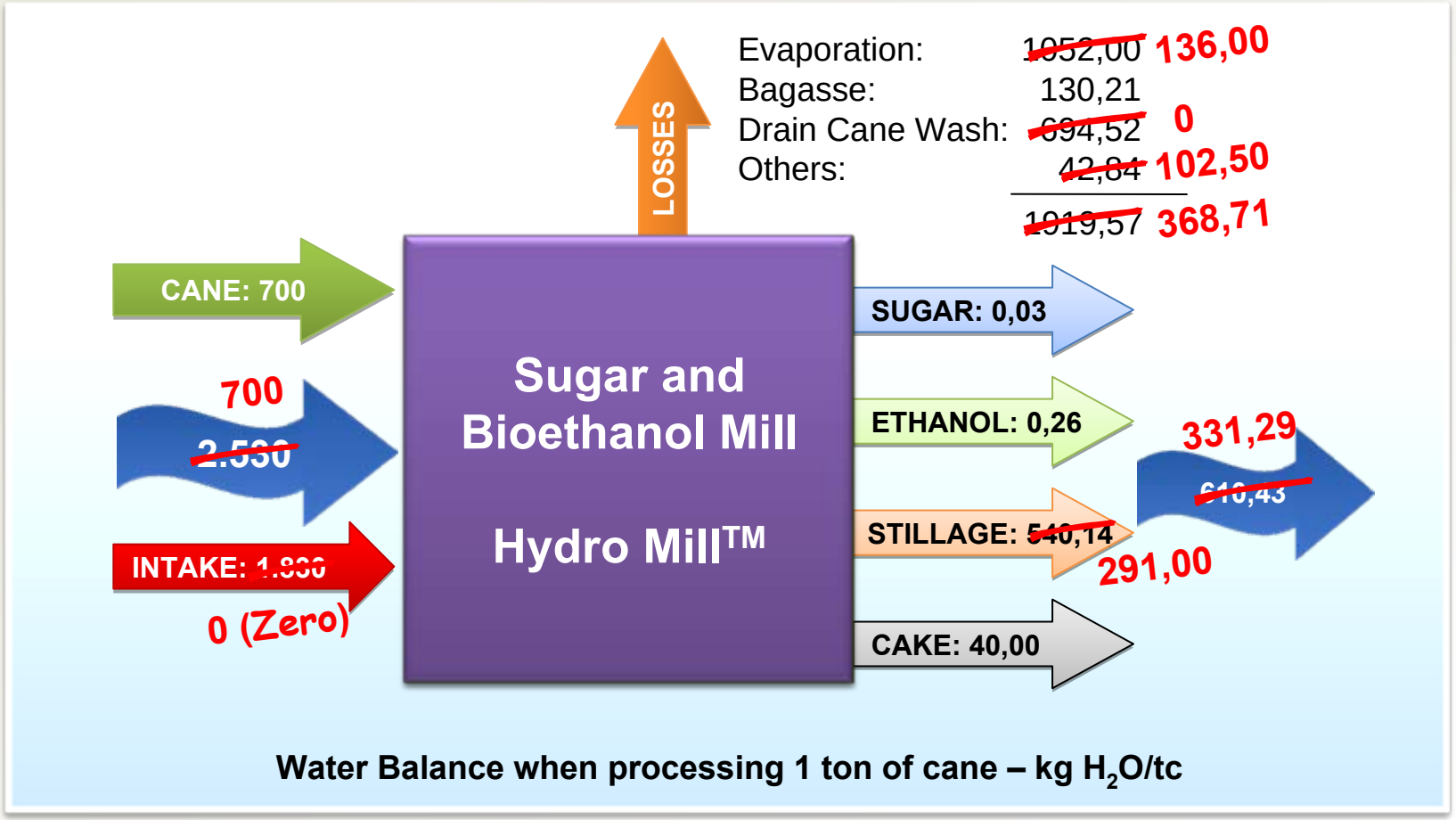
Conclusion: to develop Technological Projects reducing water consumption

And that, Dedini have made during ISSCT Workshop(1) and SIMTEC 2008(2) by introducing to the world market the Hydro Mill

(1) ISSCT Workshop - Piracicaba – 30/jun/08 - (2) SYMPOSIUM AND TECHNOLOGY EXHIBITION SIMTEC 2008 – Piracicaba – 04/jul/08

FOCUS: WATER CONSUMPTION

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

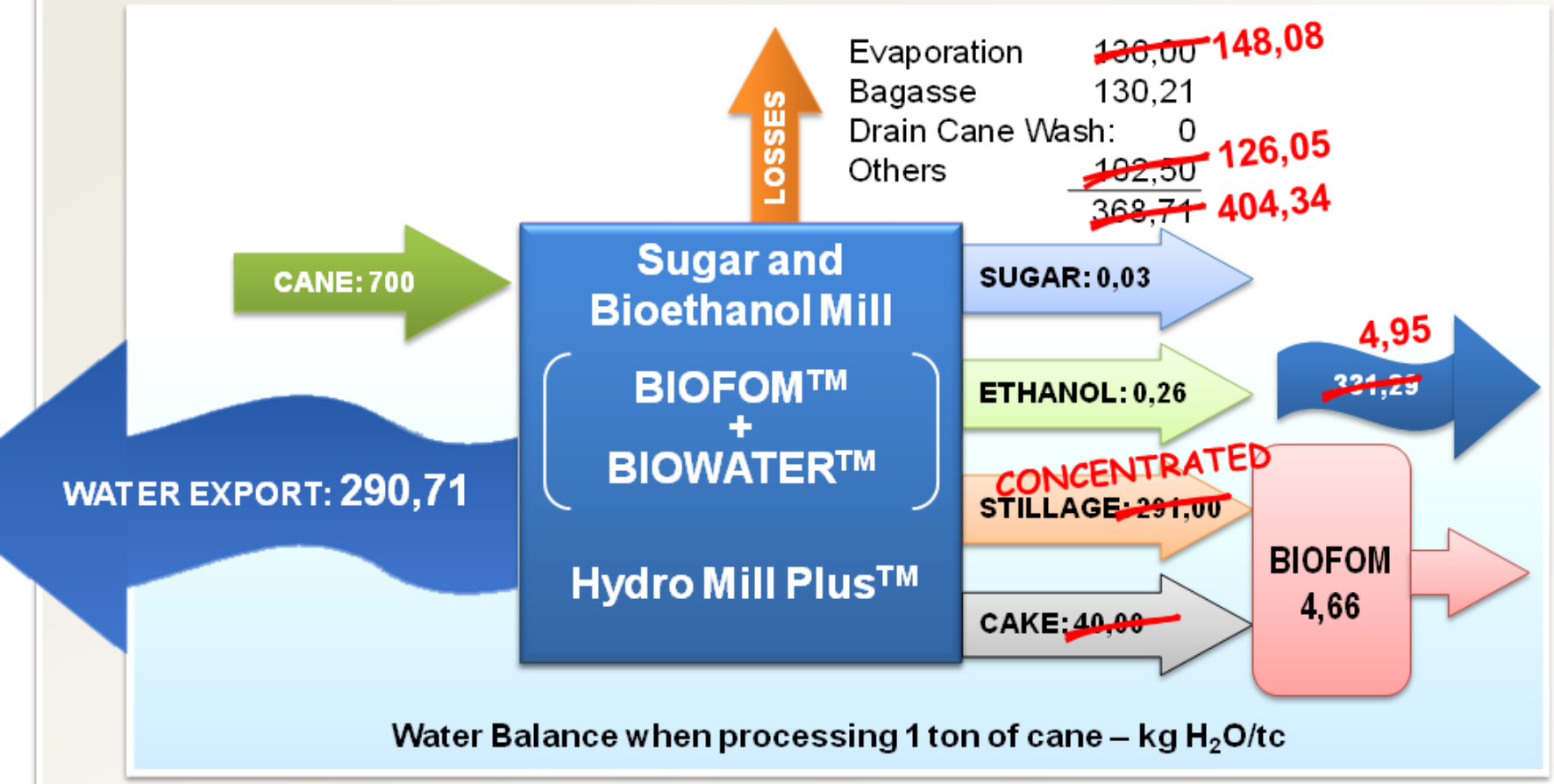


Water Balance when processing 1 ton of cane – kg H_2O/tc

HIGHER ENVIRONMENTAL SUSTAINABILITY INFLUENCE IN SUGARCANE MILLS DESIGN

FOCUS: WATER CONSUMPTION

Optimal Sugarcane Mill Design – The Hydro Mill Plus™ – the water exporter mill and Organo-Mineral Biofertilizer (BIOFOM™) producer mill



BIOFOM – Organo-Mineral Biofertilizer (Concentrated Stillage, Filter Cake, Boiler Ashes + Complementary Nutrients if necessary)

BIOFOM – ORGANO MINERAL BIOFERTILIZER

BIOFOM composition

COMPLEMENTARY NUTRIENTS

BIOFOM
DEDINI

BIOFOM Official Evaluation

AGRONOMIC EVALUATION OF BIOFOM, MADE BY ESALQ – "ESCOLA SUPERIOR DE AGRICULTURA LUIZ DE QUEIROZ" FROM "UNIVERSIDADE DE SÃO PAULO"
PLANT TEST: MAIZE - INTERNATIONAL CRITERIA AND METHODOLOGY UTILIZED

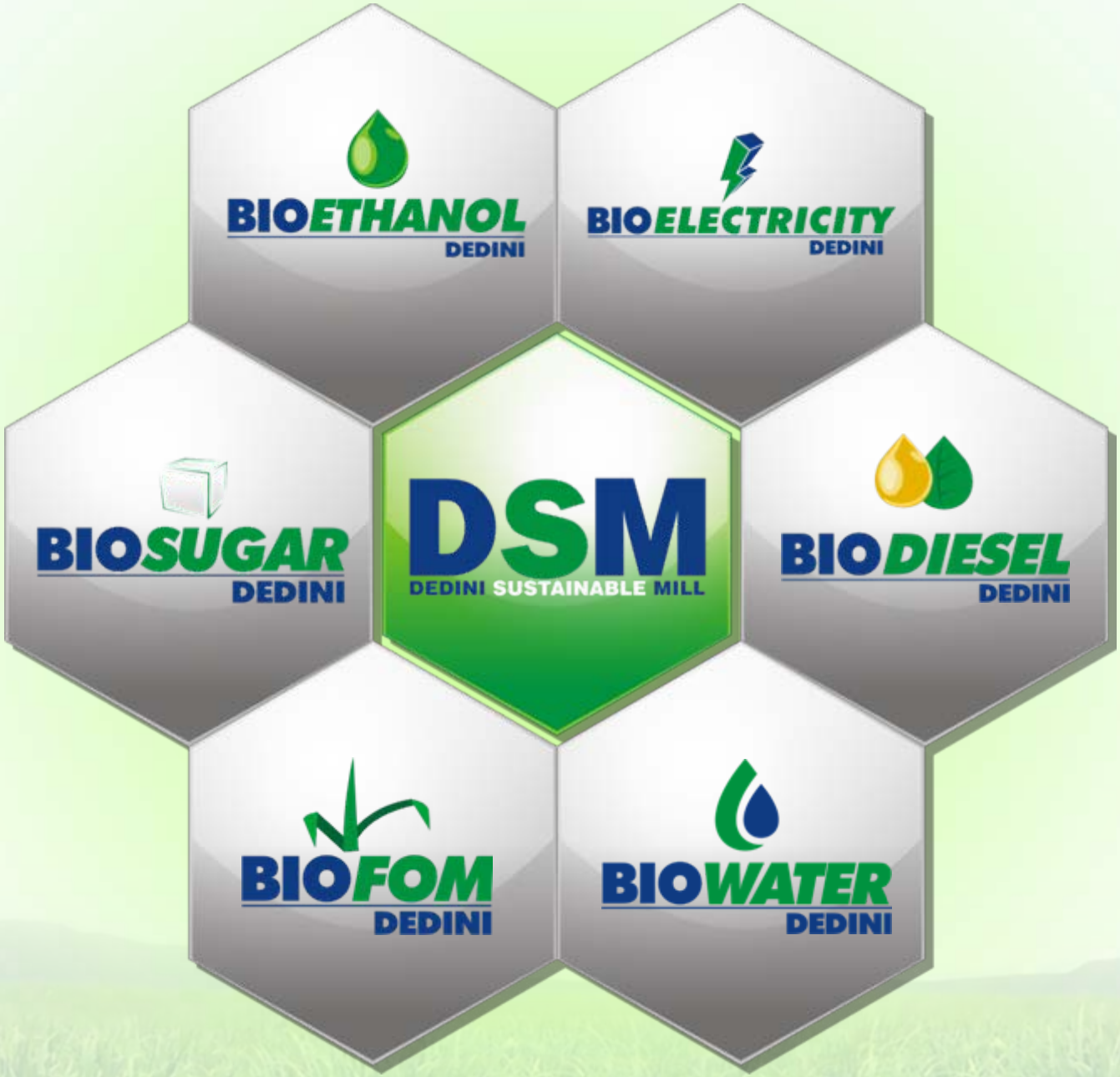
STATE OF THE ART MILL – 3 BIOS MILL

SUSTAINABILITY WILL HAVE A BIG INFLUENCE IN SUGARCANE MILLS' CONCEPTION AND DESIGN IN A MEDIUM TERM FUTURE

Biowater

Biofertilizer

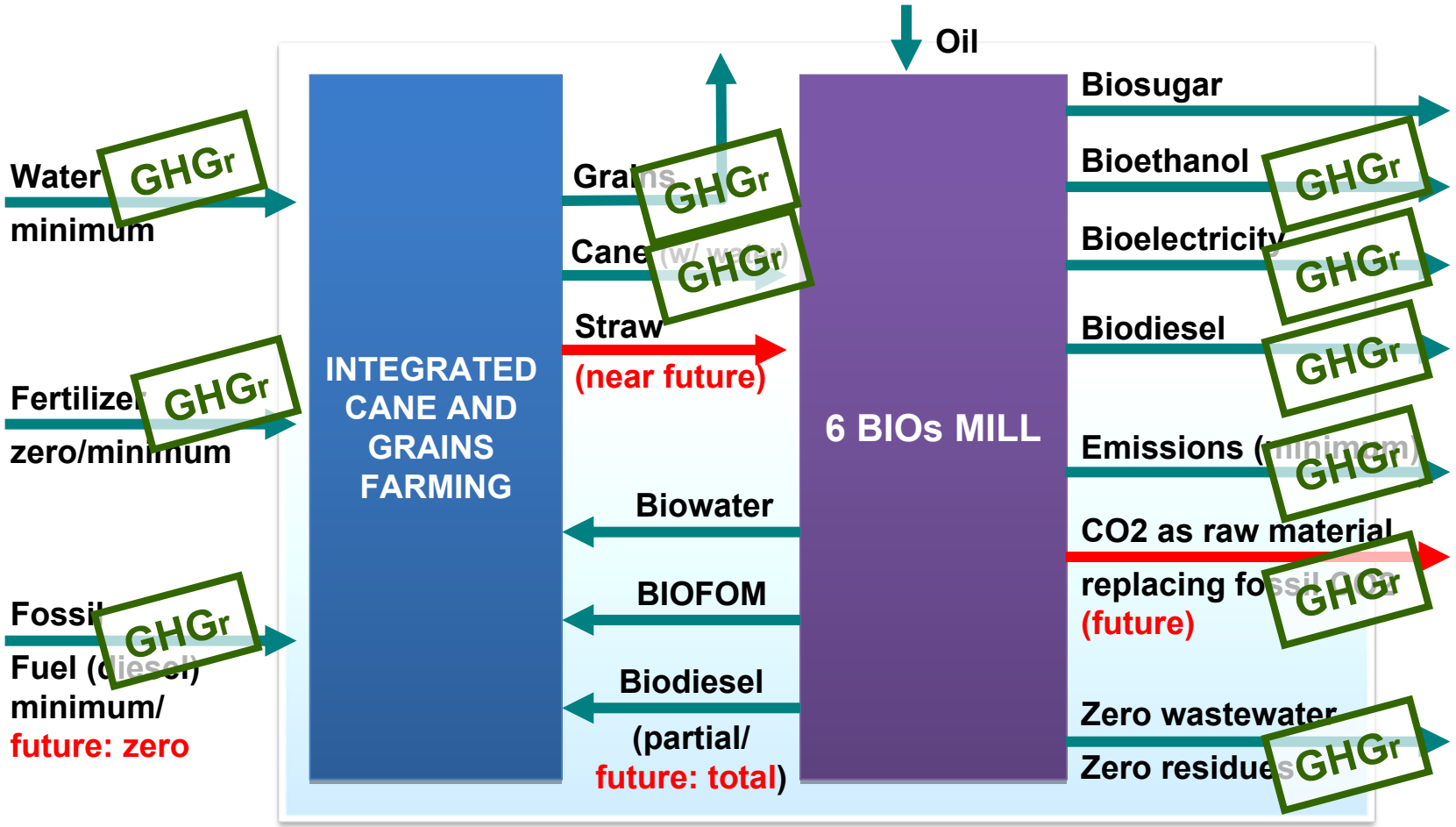
(*) PLUS BIOSUGAR


BIOETHANOL
DEDINI
BIOELECTRICITY
DEDINI
BIOSUGAR
DEDINI
DSM
DEDINI SUSTAINABLE MILL
BIODIESEL
DEDINI
BIOFOM
DEDINI
BIOWATER
DEDINI

DSM – Dedini Sustainable Mill is a product in continuous development

DEDINI SUSTAINABLE MILL

DSM – Dedini Sustainable Mill = Economic + Social + Environmental



DEDINI ECOMILL

GHGr Greenhouse Gases reduction

Carbon Credits – GHG direct reduction by CO^2 emissions captured/reduced/avoided in a ~~Traditional Mill~~ DSM – Dedini Sustainable Mill

DSM-1: Available Tecnology

ETHANOL COMPLETE LIFE CYCLE

DSM reduces CO^2 emissions

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

DSM reduces CO^2 emissions

4) **Biorefinery:** **Avoided emission:** ~~225~~ kg CO_2

DSM increases CO^2 avoided emissions

5) **Transporting:** **Emission:** 50 kg CO_2

6) **Vehicles motor:** 1.520 kg of CO_2.

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

2,56

112% Mit.

~~2,92~~ ~~2,02~~ kg CO2/l eth

~~89%~~ Mitigation

FINAL BALANCE

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

Reabsorbed + avoided emissions: (2+4): ~~7.675~~ kg CO_2

Generated (-) reabsorbed/ avoided emissions ~~-260~~ kg CO_2

Emissions with equivalent use of gasoline: 2.280 kg CO_2

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

Source: UNICA website

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

Carbon Credits – GHG direct reduction by CO^2 emissions captured/reduced/avoided in a ~~Traditional Mill~~ DSM – Dedini Sustainable Mill

DSM-1: Available Tecnology
+ 50% straw utilization as energy
= DSM-2: near future

ETHANOL COMPLETE L

DSM reduces CO^2 emissions

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

2) Cane Growing: Absorption: ~~4.620~~ kg CO_2

3,02p
132% Mit.

~~256~~
~~112% Mit.~~

~~4,02~~
kg CO2/l eth
~~89%~~ Mitigation

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

6) Vehicles motor: 1.520 kg of CO_2.

DSM reduces CO^2 emissions

3) Cane Processing: Emission: ~~3.604~~ kg CO_2

FINAL BALANCE

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DSM increases CO^2 avoided emissions

p: Preliminary, work in progress at Dedini

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

Source: UNICA website

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

THE ONE AND ONLY "GREEN" SODIUM BICARBONATE IN THE WORLD

- Designed Capacity: 50.000 t/crop
- Start-up: march/2004
- Process and Plant owner: Raudi Indústria e Comércio
- Allied Ethanol Mill: Coopcana – São Carlos do Ivaí – Paraná State – Brazil
- Plant Manufacturing/Supply: Dedini

(*) Source: Valor Econômico, 27/aug/07

SODIUM BICARBONATE PRODUCTION PLANT – $NaHCO_3$ INTEGRATED TO AN ETHANOL MILL

USES CO_2 FROM CANE SUGAR TO ETHANOL FERMENTATION PROCESS AS A RAW MATERIAL TO PRODUCE $NaHCO_3$

CARBON CREDITS METHODOLOGY HAS ONU APPROVAL(*)

CARBON CREDITS SOLD UNDER CONTRACT TO ABN AMRO LONDON(*)

Carbon Credits – GHG direct reduction by CO^2 emissions captured/reduced/avoided in a ~~Traditional Mill~~ DSM – Dedini Sustainable Mill

ETHANOL COMPLETE LIFE CYCLE

DSM reduces CO^2 emissions

>5,00 p
219% Mit.

3,02 p
132% Mit.

2,56
112% Mit.

2,02
kg CO2/l eth
89% Mitigation

DSM-1: Available Tecnology
+100% straw utilization as energy
+ Process CO2 capture/ replacing fossil
= DSM-Potential

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

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

6) **Vehicles motor:** **1.520 kg of CO_2.**

DSM reduces CO^2 emissions

3) Cane Processing: **Emission:** ~~3.604~~ kg CO_2

5) **Transporting:** **Emission:** **50 kg CO_2**

4) Bioelectricity: **Avoided emission:** ~~225~~ kg CO_2

DSM increases CO^2 avoided emissions

FINAL BALANCE

Generated emissions: (1+3+5+6): 8.~~135~~ kg CO_2

Reabsorbed + avoided emissions: (2+4): ~~7.675~~ kg CO_2

Generated (-) reabsorbed/ avoided emissions ~~260~~ kg CO_2

Emissions with equivalent use of gasoline: 2.280 kg CO_2

p: Preliminary, work in progress at Dedini

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

Source: UNICA website

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

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2) Cane Growing: Absorption: ~~1.6~~ kg C

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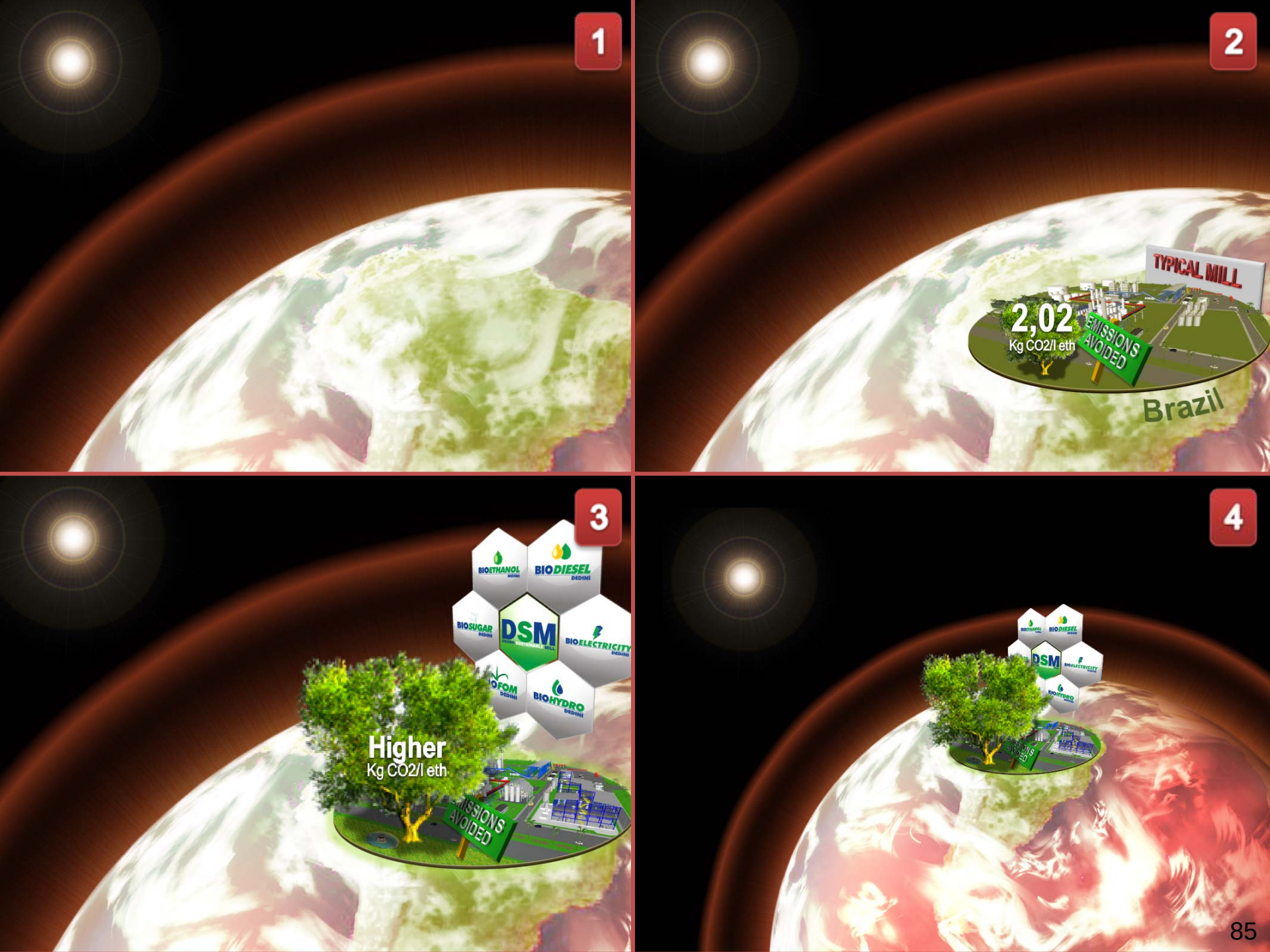
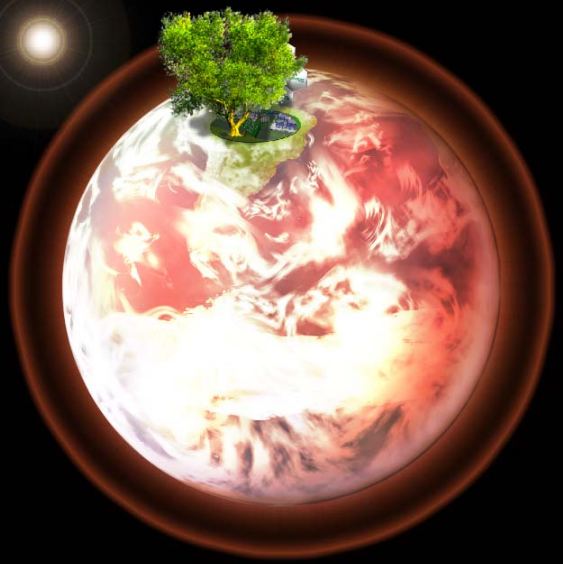

1
2
TYPICAL MILL
2,02
Kg CO2/l eth
EMISSIONS AVOIDED
Brazil
3
BIOETHANOL
BIODIESEL
BIOSUGAR
DSM
BIOELECTRICITY
BIOFOM
BIOHYDRO
Higher
Kg CO2/l eth
ISSIONS AVOIDED
4

5



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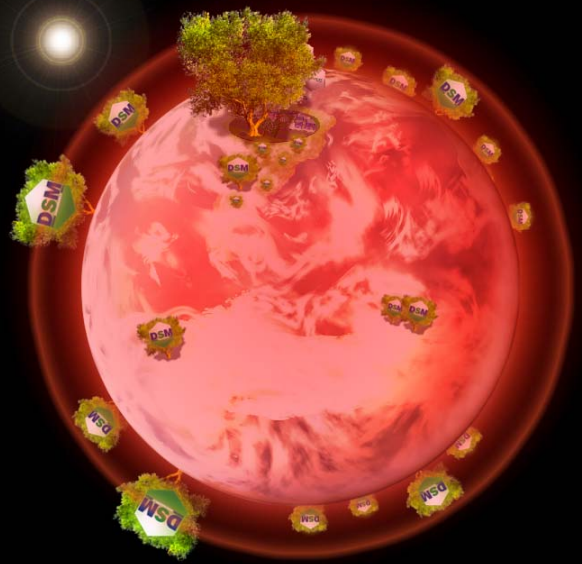

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Thank you for your attention.