ECREEE
Towards Sustainable Energy

GBEP
Global Bioenergy Partnership

ECOWAS/GBEP 5th Bioenergy Week

&

Study Tour for Capacity Building

"Addressing food and energy security through sustainable biomass value chains"

Ghana, Accra, 22-24 June 2017

Session 3: RESOURCES ASSESSMENT, OPTIONS AND STRATEGIES

WATER RESOURCES

Prof Suani Coelho

GRUPO DE PESQUISA EM BIOENERGIA
Universidade de São Paulo | Instituto de Energia e Ambiente

Research Centre for Gas Innovation
cleaner energy for a sustainable future

GRUPO DE PESQUISA EM **BIOENERGIA**

Universidade de São Paulo | Instituto de Energia e Ambiente

SINCE 1996
www.iee.usp.br/gbio

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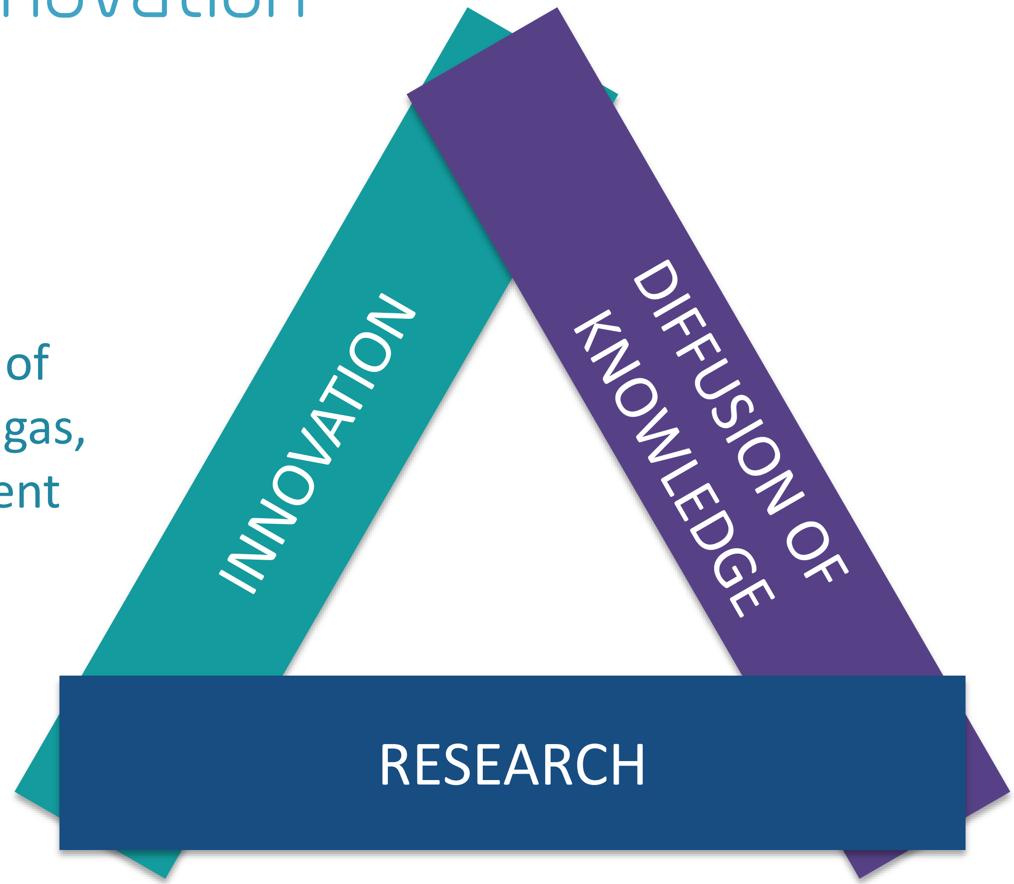
Summary

- Presentation of RCGI- Research Center on Gas Innovation – FAPESP/SHELL
- Water Quantity
  - Water consumption on ethanol from sugarcane
    - Progress on efficiency
    - **Use of vinasse for fertirrigation – reduction on cane irrigation in some countries**
- Water Quality
  - Bioenergy from vinasse and from urban and rural residues (large x small scale)
  - Synergies – increasing energy access x environmental sustainability
- Challenges – lack of funds, lack of policies, ...
- Brazilian experience – how utilities are obliged to invest on renewable energy R&D projects

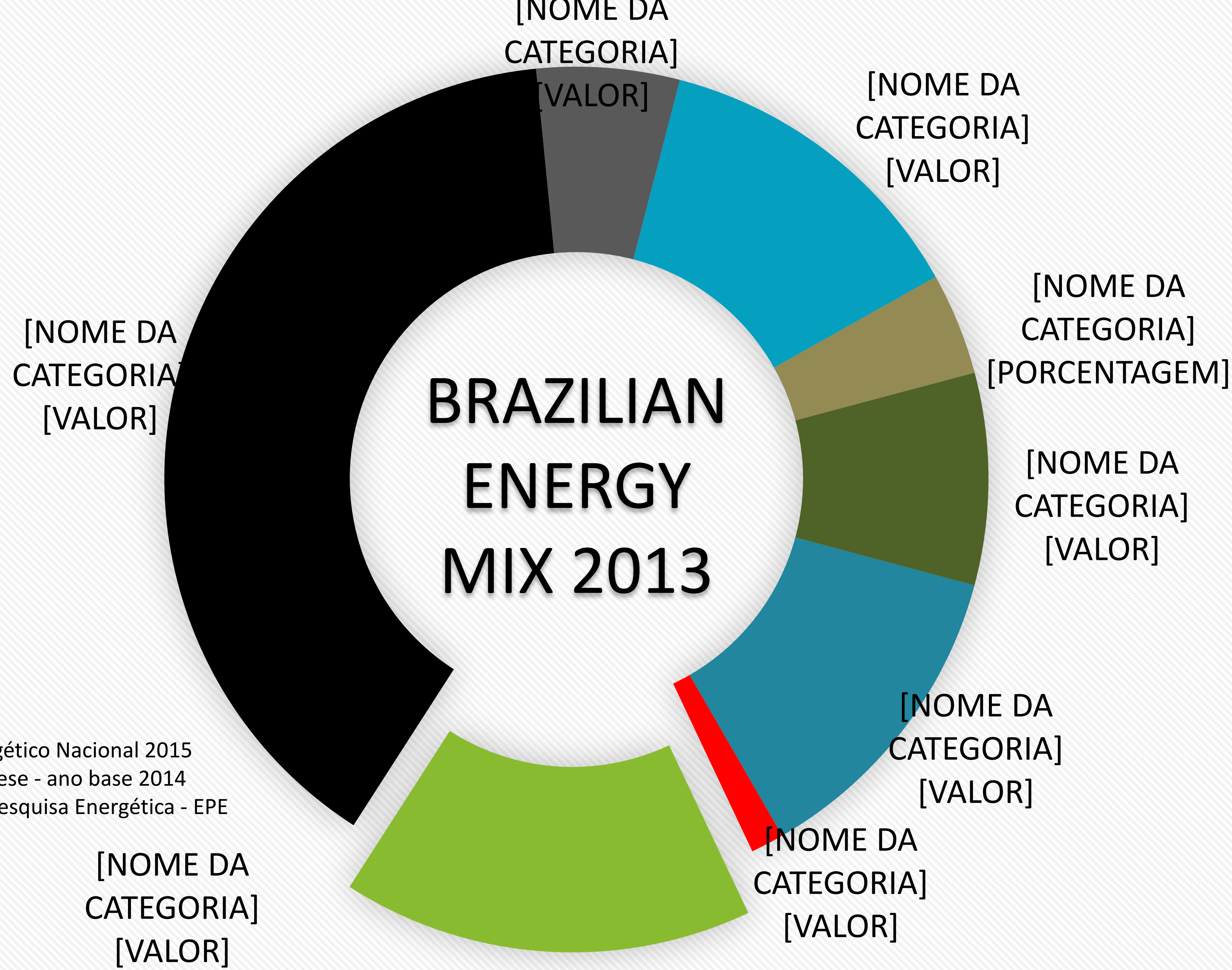
Research Centre for Gas Innovation

Cleaner energy for a sustainable future

A centre for advanced studies of the sustainable use of natural gas, biogas, hydrogen and abatement of CO_2 emissions



FAPESP

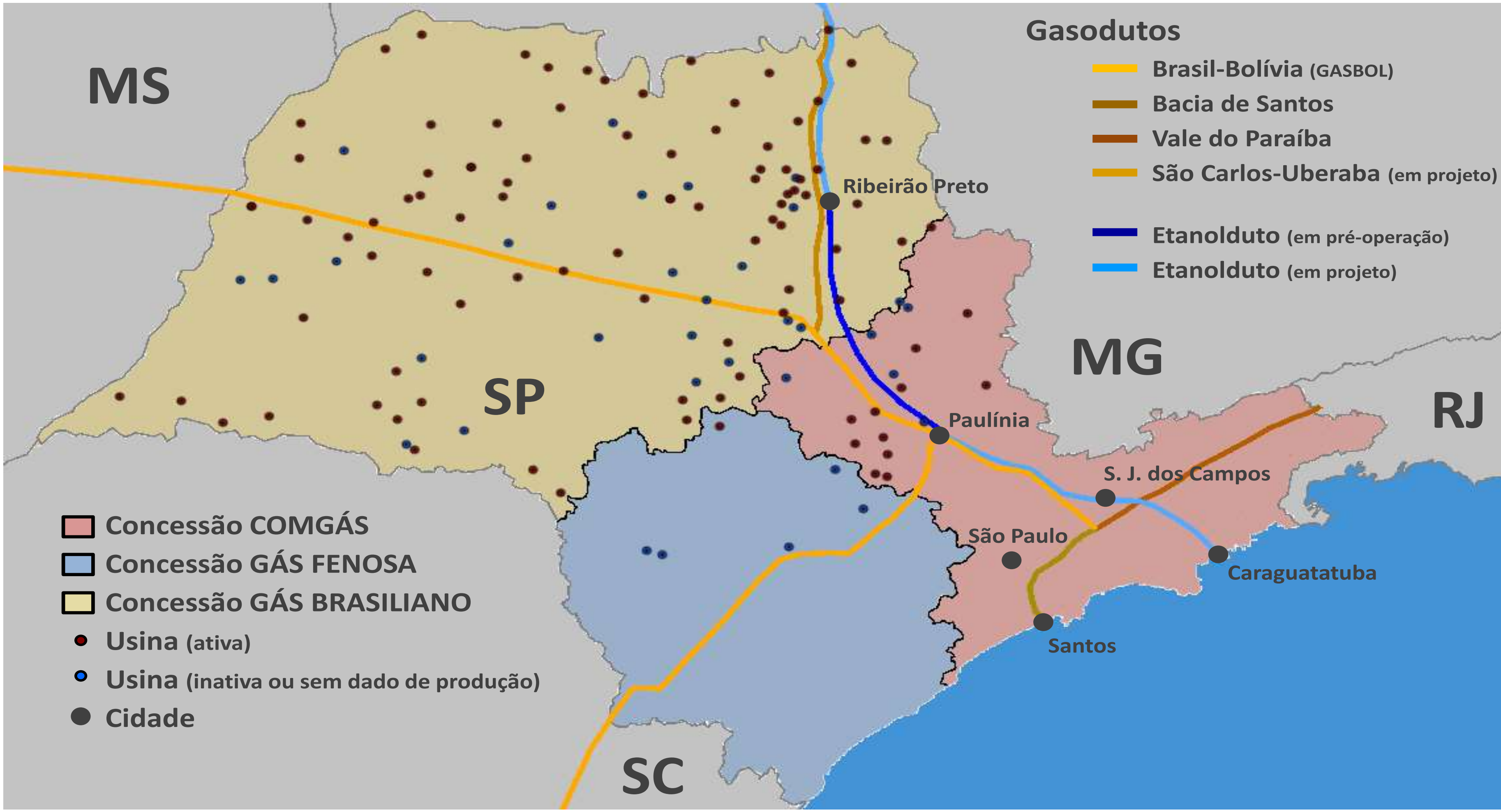


Balanço Energético Nacional 2015
Relatório Síntese - ano base 2014
Empresa de Pesquisa Energética - EPE

RCGI – PROJECT 27 – Biogas Perspectives for São Paulo State

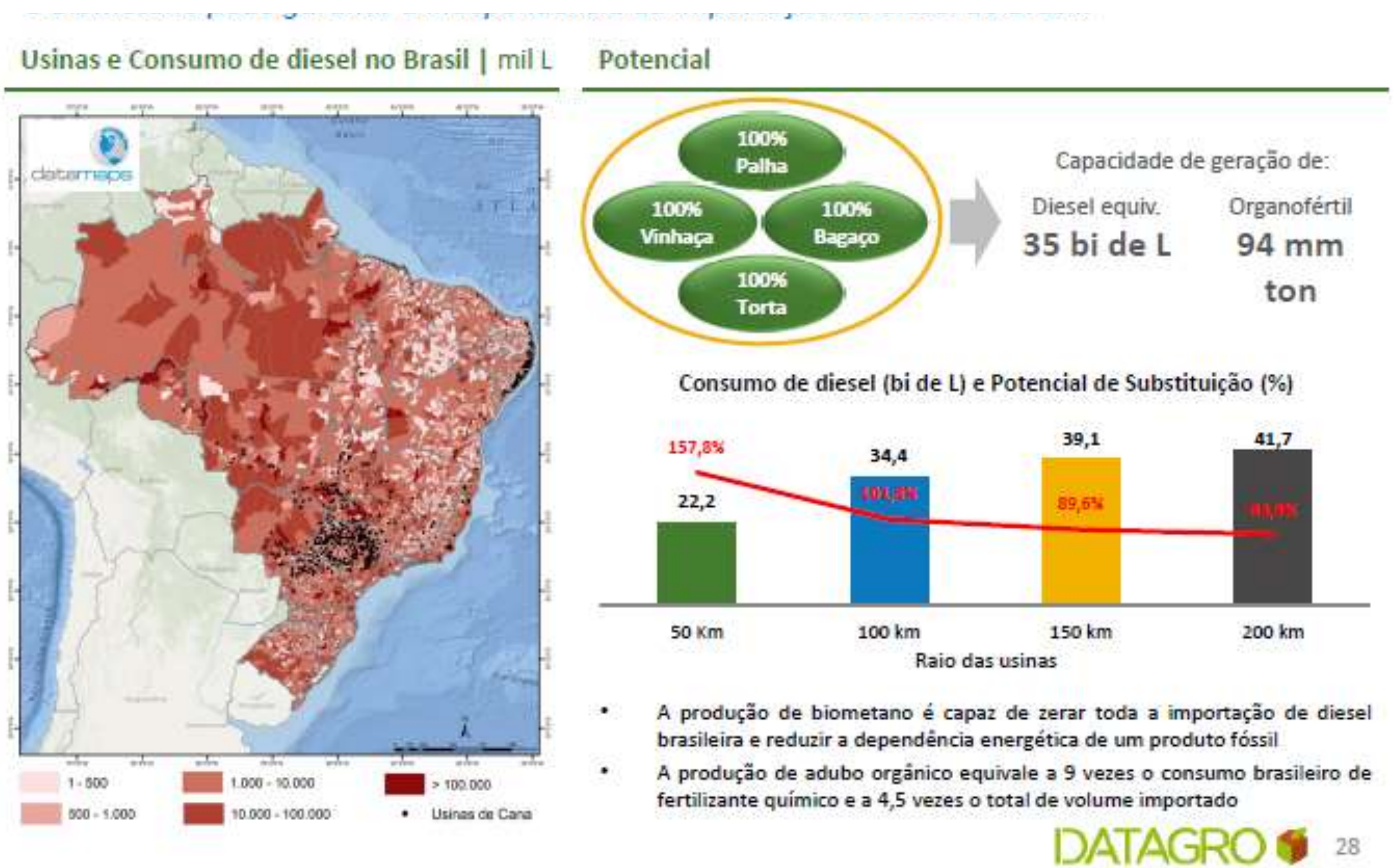
- Roadmaps
  - Biogas production technologies
  - Biogas purification – Biomethane
- Proposals to improve current legislation in Brazil and São Paulo
- Geo-referenced biogas mapping for São Paulo State

Potential for Biomethane injection into NG pipelines
Ethanol mills x gas pipelines (Sao Paulo)

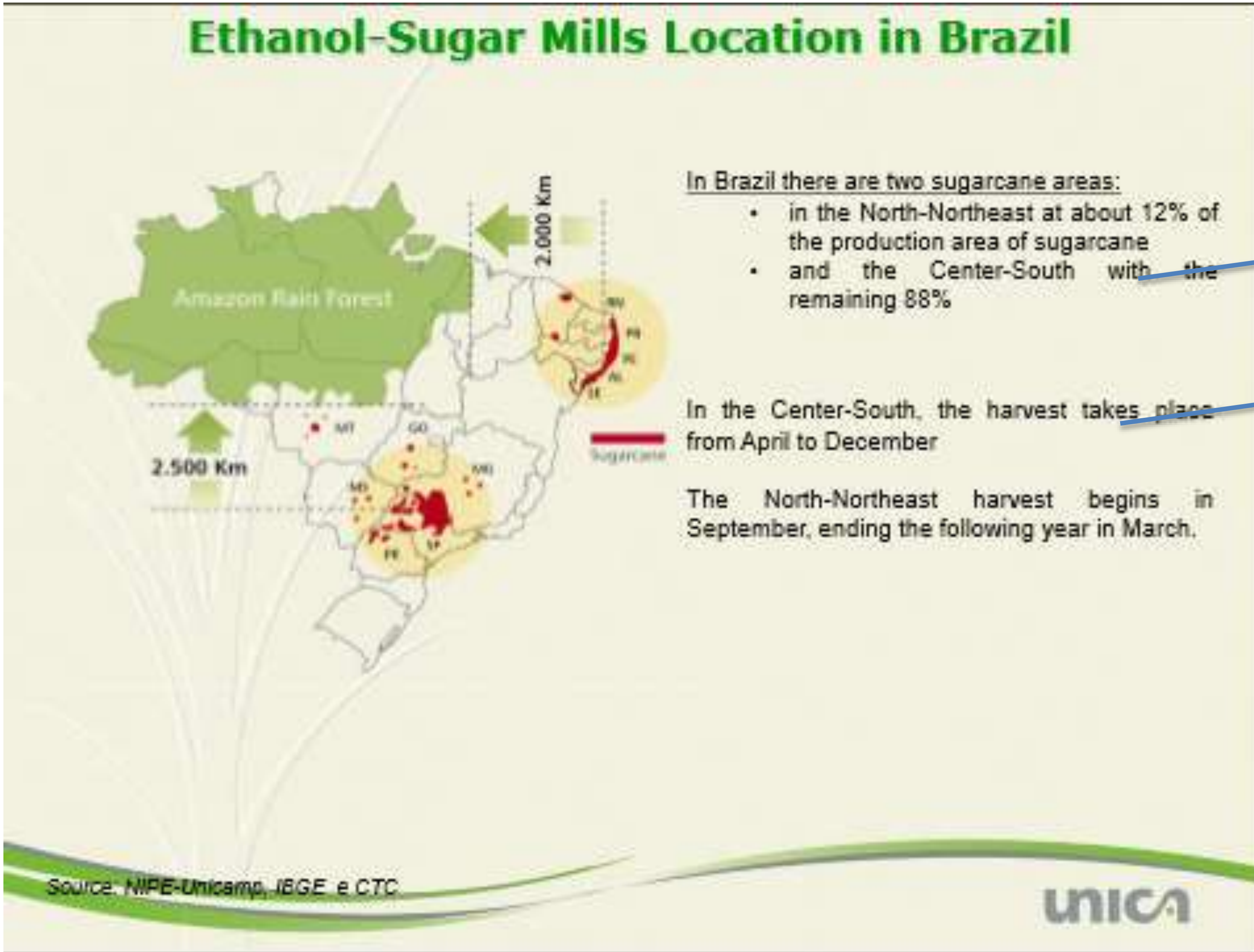


Biomethane & Independence on diesel imports

Possible replacement of 59.7% of diesel consumption in SP



Source: Nastari, P. (2016). Workshop on Perspectives of the biomethane contribution to increase NG offer. September 14, 2016. GBIO/RCGI/USP



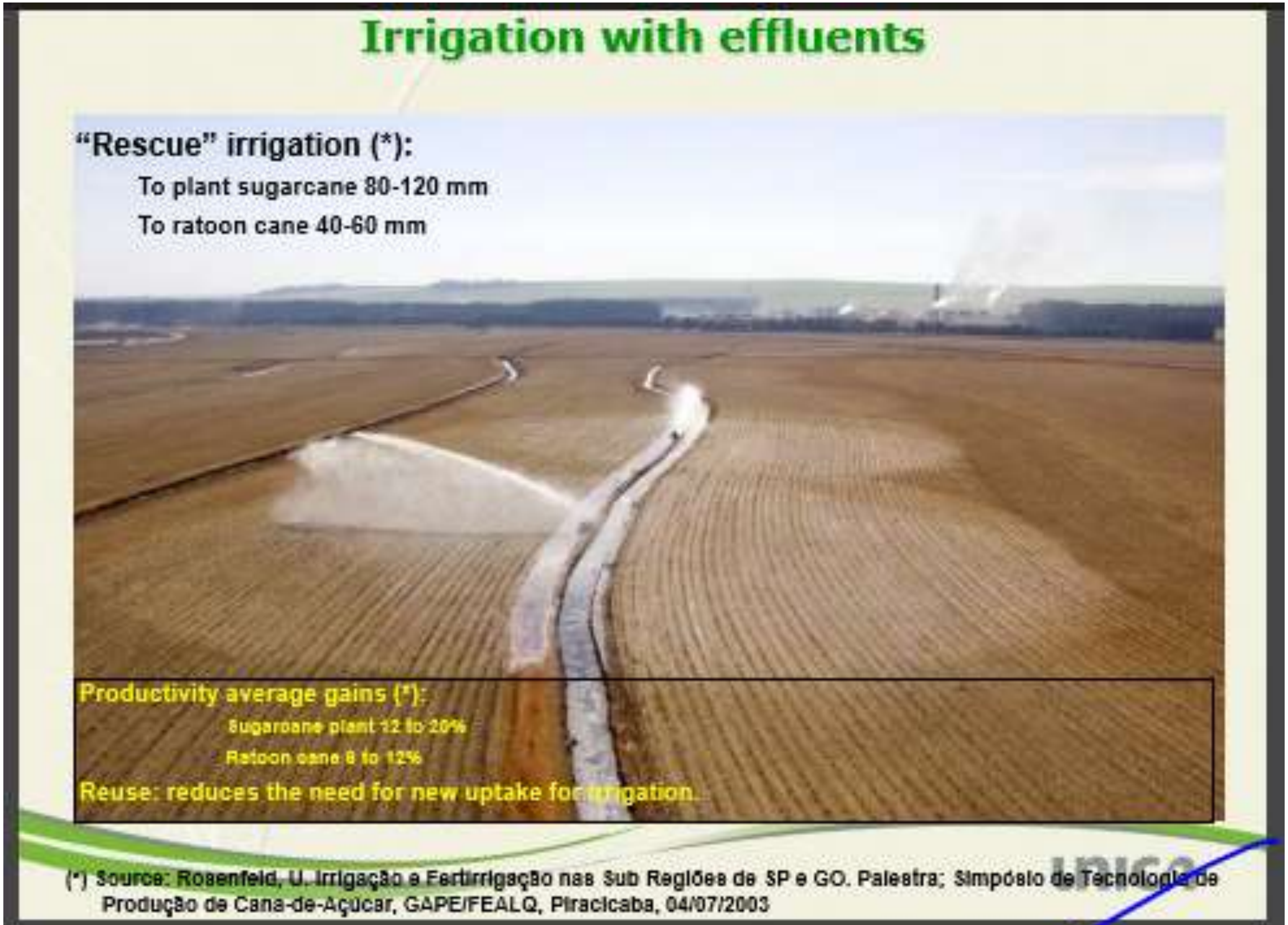
2015/16 season

N-Northeast :
49 MM t cane
1.9 billion L ethanol

Center-South:
617 MM t cane
No irrigation
Ferti-irrigation w/ vinasse
28.2 billion L ethanol

André Elia Neto
Environmental and Water Resources Consultant

Workshop on "Examples of Positive Bioenergy and Water Relationships"
Royal Swedish Academy of Agriculture and Science (KSLA)
Stockholm, 25-26 August 2015



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Water use in sugarcane ethanol production

- **Agricultural phase:** most of the sugarcane produced in Brazil does not need irrigation.
- **Industrial phase – Progress in efficiency**

  - Reduction on water use (catchment):

    1997: 5 m3 /t sugarcane

    2015 – maximum of 0.85 m3/tc - mandatory in Sao Paulo State

    Results from GBEP Indicators Project for Brazil

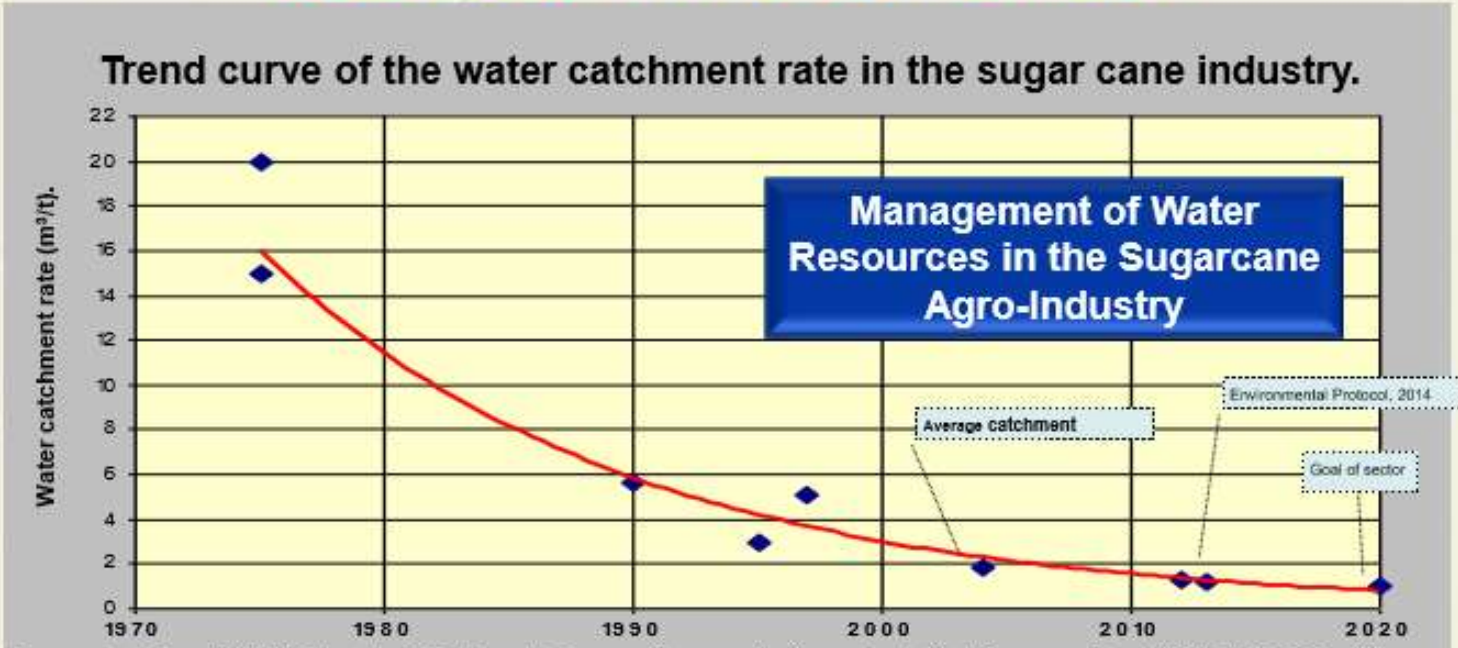
    Some mills less than 0.7 m3/tc

  - Sugarcane dry cleaning process (no water)

  - Mechanical harvesting of green cane – little need for cleaning

Source: Coelho, S.

DECREASE WATER CATCHMENT



Source: adapted from ELIA NETO, A. et al., 2009 – Manual de Conservação e reuso de Água na Agroindústria Sucroenergética . UNICA, FIESP, CTC e ANA

- The water catchment, which had been 15-20 m3 per ton of cane about four decades ago, has been minimized with the closing of the water systems to reuse.
- On average, the water catchment for industry, is about 2 m3 / ton of cane (data from 2005)
- The self imposed target is 1 m3 per ton of cane

Water quality (1/2) – ethanol mills

1. Water quality in ethanol sector

   a) No water discharge

   b) Vinasse (by-product from ethanol distillation, 8-12 L/L of ethanol)

   – Current use: fertirrigation

   – Current trends: vinasse biodigestion - energy production

Vinasse anaerobic digestion for energy conversion

GEO ENERGETICA MILL – PARANA STATE

Filter cake, tops and leaves, vinasse
2012 – Start-up - 4 MW
Expansion – 16 MW
http://www.geoenergetica.com.br/perfil.php

Water quality (2/2) – Synergies of energy production x environmental sustainability

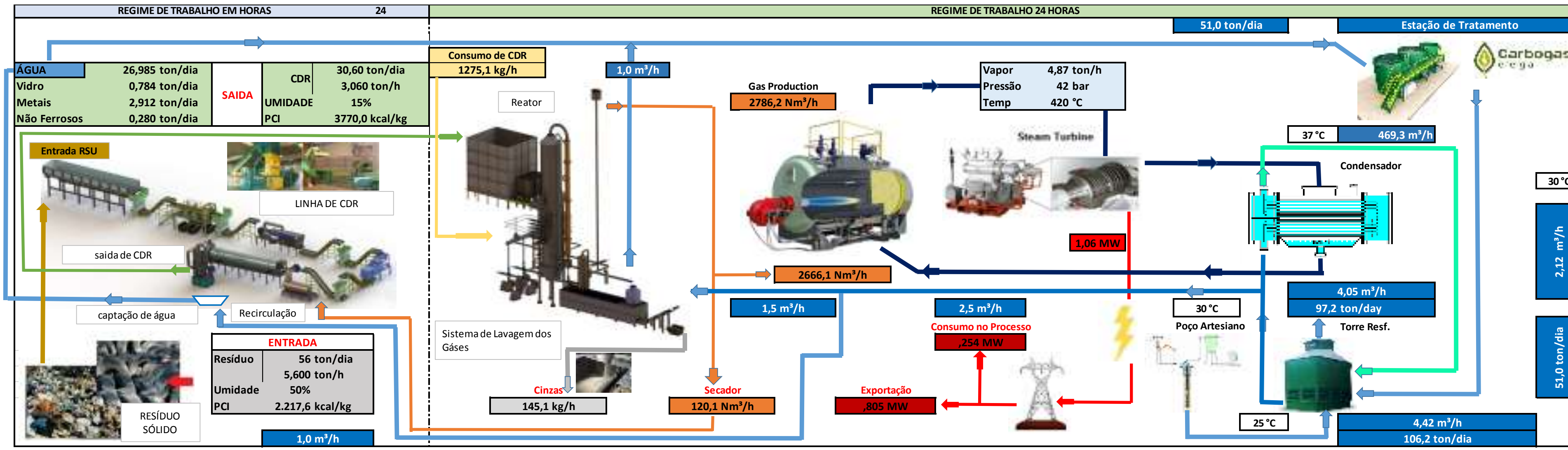
2. Urban residues – MSW – case study
   - Furnas Electric Co. (Minas Gerais State)
   - 35 municipalities around the lake (touristic region)
   - Inadequate disposal of MSW
   - Possible water contamination with slurry from the waste

Water quality (2/2) – Synergies of energy production x environmental sustainability

2. Urban residues (cont.)
   - Furnas Electric Co. (Minas Gerais State)
   - Waste to energy plant – Municipality of Boa Esperança – 40,401 inhabitants
     - 1 MWe – MSW gasification plant (syngas to power)
     - Brazilian technology – CARBOGAS fluidized bed gasifier

http://www.diariodocomercio.com.br/noticia.php?tit=furnas_investe_r_32_milhoes_em_usina_de_residuos&id=180486

BRAZILIAN TECHNOLOGY
MSW or biomass
Small Scale Fluidized Bed Gasification Plant



- MSW: 55 ton/day
- Net power generated: 1.06 MW
- Power surplus to export: 0.805 MW
- Area: 7,800 m²

- MSW LHV: 2,217 kcal/kg
- RDF LHV: 3,770 kcal/kg (refuse derived fuel)
- Syngas LHV: 1,294 kcal/Nm³

Water quality (2/2) – Synergies of energy production x environmental sustainability

n	City	State	People	MSW (Kg/day)	Potential KW	Power MWh/day
1	Varginha	Minas Gerais	130.139	130.139	3.761	103,75
2	Lavras	Minas Gerais	98.172	98.172	2.837	78,27
3	Alfenas	Minas Gerais	77.618	77.618	2.243	61,88
4	Formiga	Minas Gerais	67.617	67.617	1.954	53,91
5	Três Pontas	Minas Gerais	56.156	56.156	1.623	44,77
6	Guaxupé	Minas Gerais	51.488	51.488	1.488	41,05
7	Campo Belo	Minas Gerais	53.656	53.656	1.551	42,78
8	Machado	Minas Gerais	40.760	40.760	1.178	32,50
9	Boa Esperança	Minas Gerais	40.018	40.018	1.157	31,90
10	Campos Gerais	Minas Gerais	28.683	28.683	829	22,87
11	Elói Mendes	Minas Gerais	26.759	26.759	773	21,33
12	Nepomuceno	Minas Gerais	26.725	26.725	772	21,31
13	Carmo do Rio Claro	Minas Gerais	21.206	21.206	613	16,91
14	Perdões	Minas Gerais	21.013	21.013	607	16,75
15	Muzambinho	Minas Gerais	21.007	21.007	607	16,75
16	Alpinópolis	Minas Gerais	19.391	19.391	560	15,46
17	Areado	Minas Gerais	14.503	14.503	419	11,56
18	Monte Belo	Minas Gerais	13.435	13.435	388	10,71
19	Guapé	Minas Gerais	14.349	14.349	415	11,44
20	Alterosa	Minas Gerais	14.306	14.306	413	11,41
21	Cabo Verde	Minas Gerais	14.262	14.262	412	11,37
22	Ilicínea	Minas Gerais	12.061	12.061	349	9,62
23	Cristais	Minas Gerais	12.046	12.046	348	9,60
24	Campo do Meio	Minas Gerais	11.831	11.831	342	9,43
25	Coqueiral	Minas Gerais	9.492	9.492	274	7,57
26	Pimenta	Minas Gerais	8.582	8.582	248	6,84
27	Capitólio	Minas Gerais	8.535	8.535	247	6,80
28	Serrania	Minas Gerais	7.778	7.778	225	6,20
29	São João Batista do Glória	Minas Gerais	7.241	7.241	209	5,77
30	São José da Barra	Minas Gerais	7.155	7.155	207	5,70
31	Divisa Nova	Minas Gerais	5.990	5.990	173	4,78
32	Cana Verde	Minas Gerais	5.739	5.739	166	4,58
33	Aguanil	Minas Gerais	4.293	4.293	124	3,42
34	Ribeirão Vermelho	Minas Gerais	3.990	3.990	115	3,18
35	Fama	Minas Gerais	2.419	2.419	70	1,93
	TOTAL		958.415	958.415	27.698	764

Energy potential from MSW in the municipalities

MSW (Kg/day)	Potential KW	Power MWh/day
958,000	27,698	764

Source: Estimates from J. Escobar, GBIO/USP, 2017)

Water quality (2/2) – Synergies of energy production x environmental sustainability

3. Rural residues (Parana State)
   - Small farmers – need for adequate disposal of animal waste
   - To avoid contamination of rivers and lakes
   - Itaipu Electric Co – Ajuricaba Basin
     - 21 farmers (5-swin and 16-cow producers)
     - Biodigestion plants (large and small)
     - Biogas cleaning (H2S)
     - Logistic: Biogas pipeline for the thermoelectric power plant

Source: Ajuricaba Project – Visit Suani Coelho (2017)

- **Biogas-cookstoves (Brazilian manufacturer - MULLER)**
- **Biogas for small scale electricity production – 80kW engine**
- **2017 - Tests with biomethane in light and heavy vehicles**

Source: Ajuricaba Project – Visit Suani Coelho (2017)

Last issue: a recent example from Kenya

Cogen for Africa Project – 2011
UNEP/GEF
AfDB

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Website: http://www.afrepren.org

Energy Security for Agro-industry - Kenya

Solar PV (Horticulture - Tambuzi, Kenya)

Biogas (PJ Dave Flowers, Kenya)

Kakira Sugar Ltd, Uganda

Ethanol plant

Ethanol plant with own vinasse/biogas-based cogeneration unit (0.4MW)

General challenges for syngas, biogas and biomethane projects

- Lack of policies for demonstration plants
- Lack of capacity building of agro-industries and farmers
- Lack of understanding the synergies between syngas/biogas plants and reduction on environmental impacts
- LACK OF FUNDS…

Brazilian experience with R&D projects for renewable energies

- Brazilian banks (e.g. BNDES) make investments (large plants)

- <u>New legislation (2000) for electric utilities: mandatory to apply 0.5 % of revenues on Research and Development Projects + 0.5% in energy efficiency projects (Federal Law 9,991/2000)</u>

  - Brazilian Regulatory Agency – ANEEL – in charge of the enforcement (www.aneel.gov.br)
  - Several projects already developed with such funds
  - Example – ITAIPU Project in Ajuricaba basin – USD 500,000 investment (21 farms)

- **RCGI-Project 27 – Policies proposals for Biogas and Biomethane improvements (injection into NG grid)**

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