Laboratório Nacional de Ciência e Tecnologia do Bioetanol

CNPEM

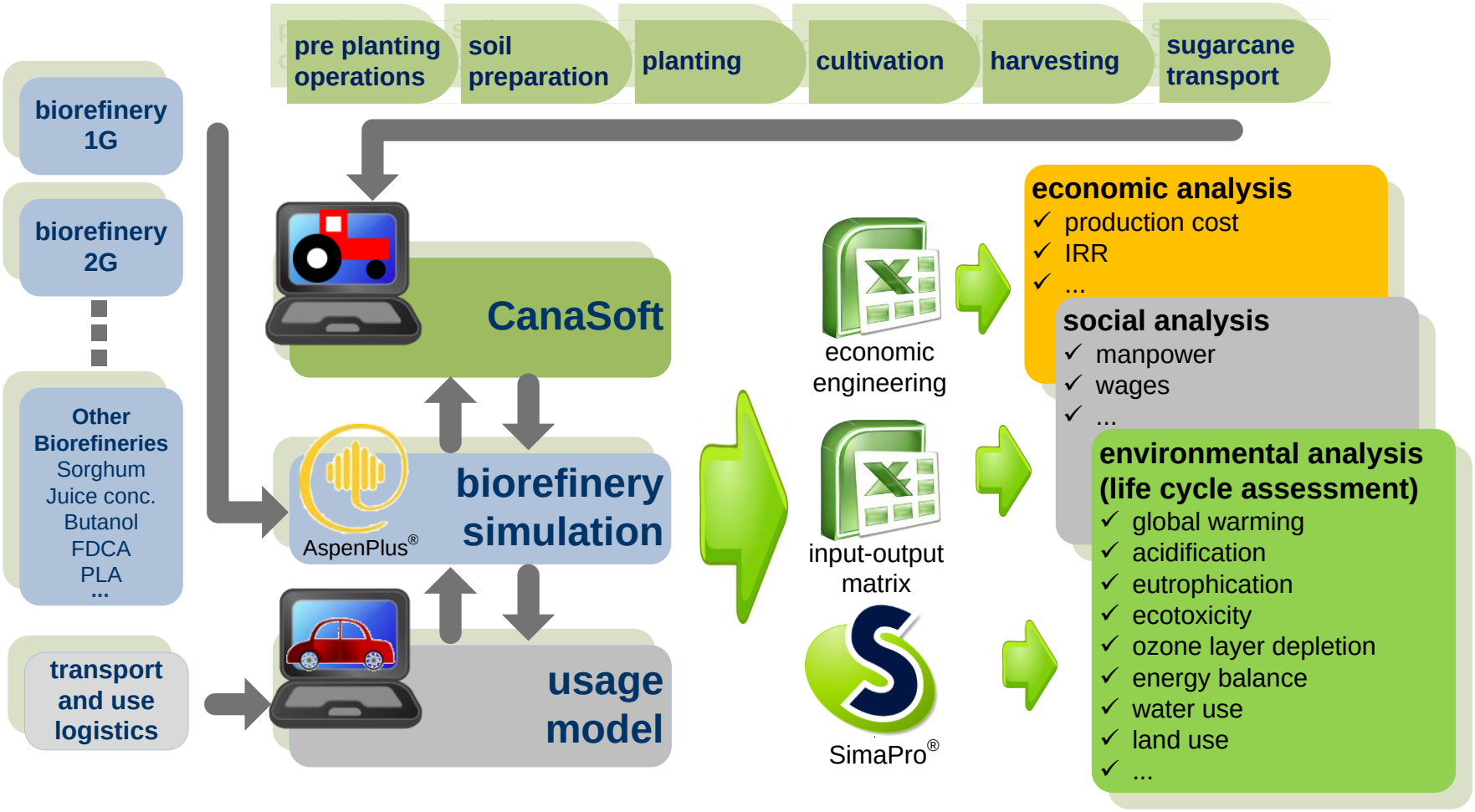
Assessment of Different Biofuels Production Chain Alternatives Using the Virtual Sugarcane Biorefinery

Laboratório Nacional de Ciência e Tecnologia do Bioetanol – CTBE

Centro Nacional de Pesquisa em Energia e Materiais - CNPEM

August 2014

Virtual Sugarcane Biorefinery



CanaSoft

Input data

- **Scenario description**
  - **Agricultural operatons**
    - Tractors and Implements
  - **Transport**
    - Trucks
  - **Inputs**
    - Fertilizers
    - Agrochemicals
  - **Irrigation**
    - Vinasse application
    - Irrigation systems
  - **General**
    - Emission factors
    - Investment data

Results

CanaSoft
Biorrefinaria Virtual de Cana-de-Açúcar

- **Economic**
  - Production costs
  - Data for financial analysis
- **Environmental**
  - Life Cycle Inventory
- **Social**
  - Data for Input-Output analysis

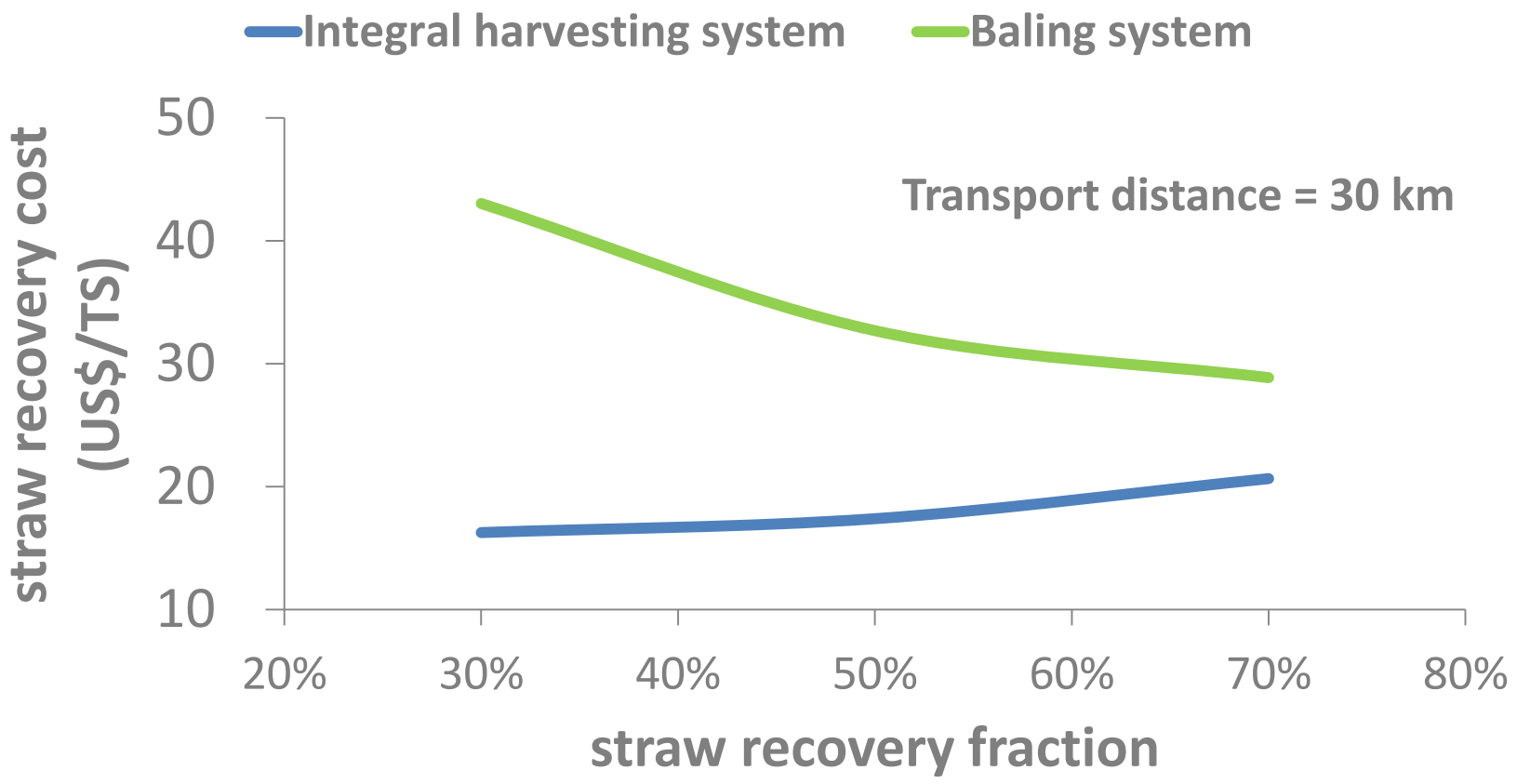
entrance | initial_eng | scenario_descript | economic_results | LCI | LCIA | emission factors | operations | machinery | transport | trucks | inputs | fertilizers

Straw recovery systems

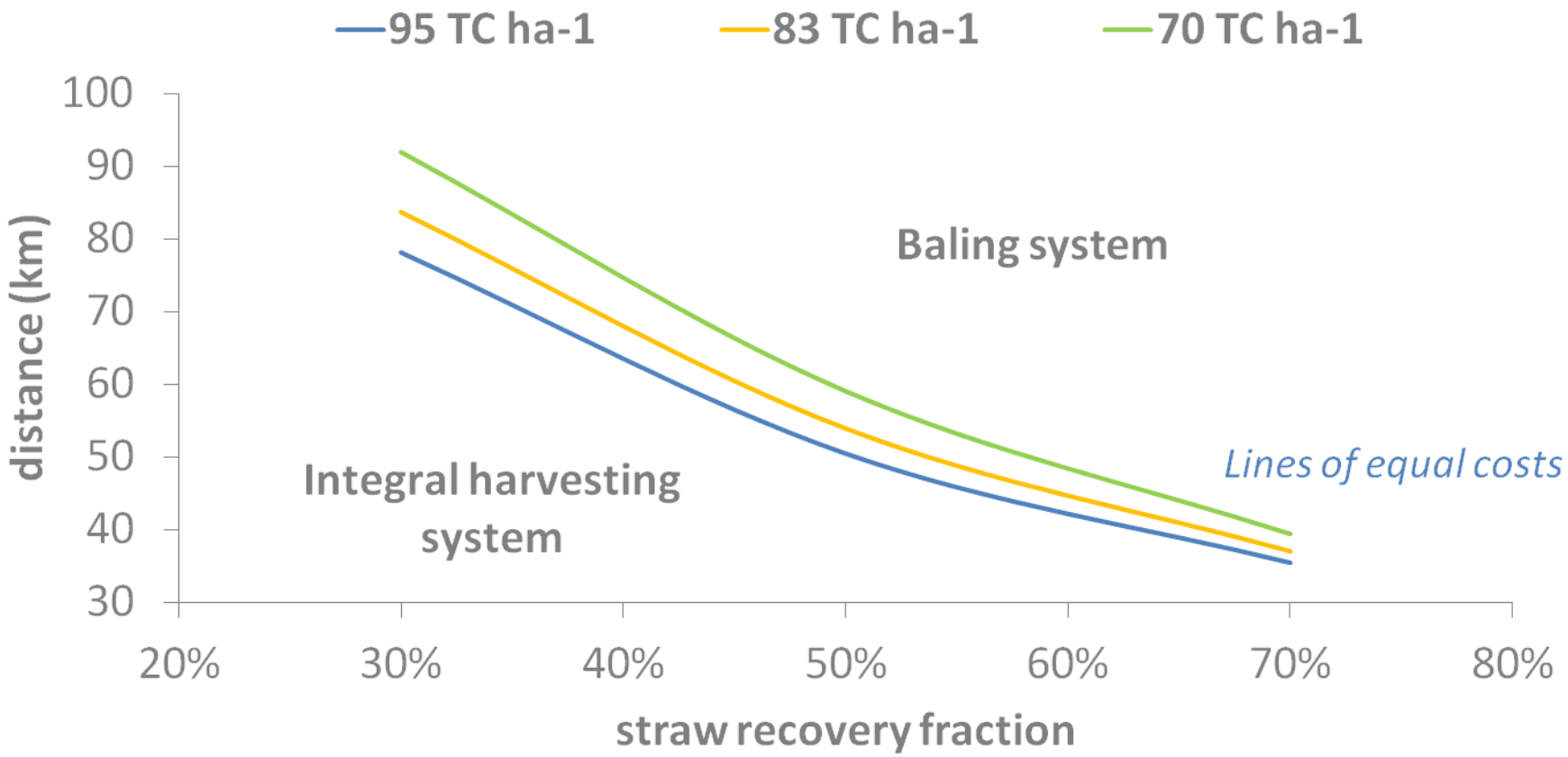
integral harvesting system

baling system

Straw recovery systems

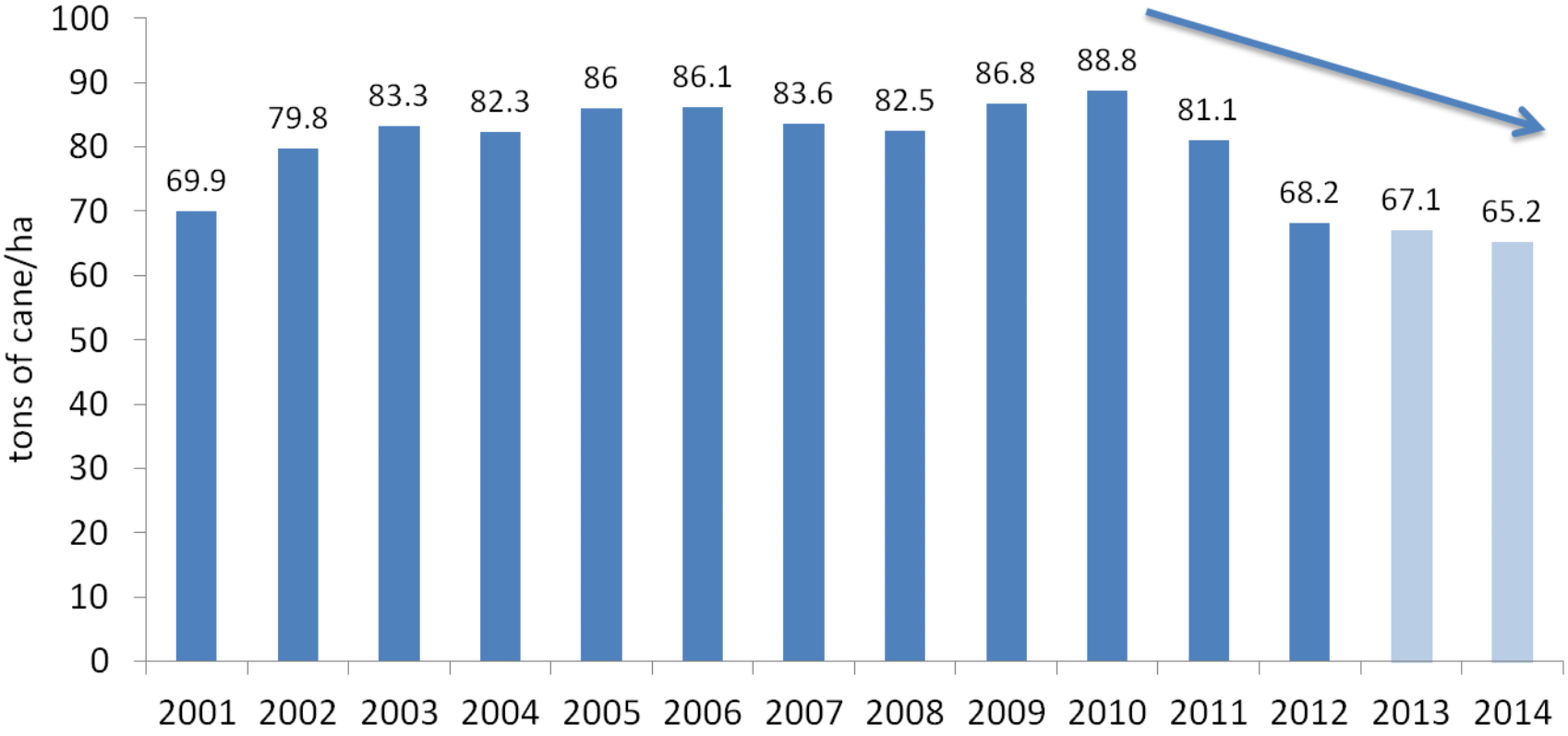


Straw recovery systems



Introduction of mechanization

(in Center-South region)



observed sugarcane agricultural yields

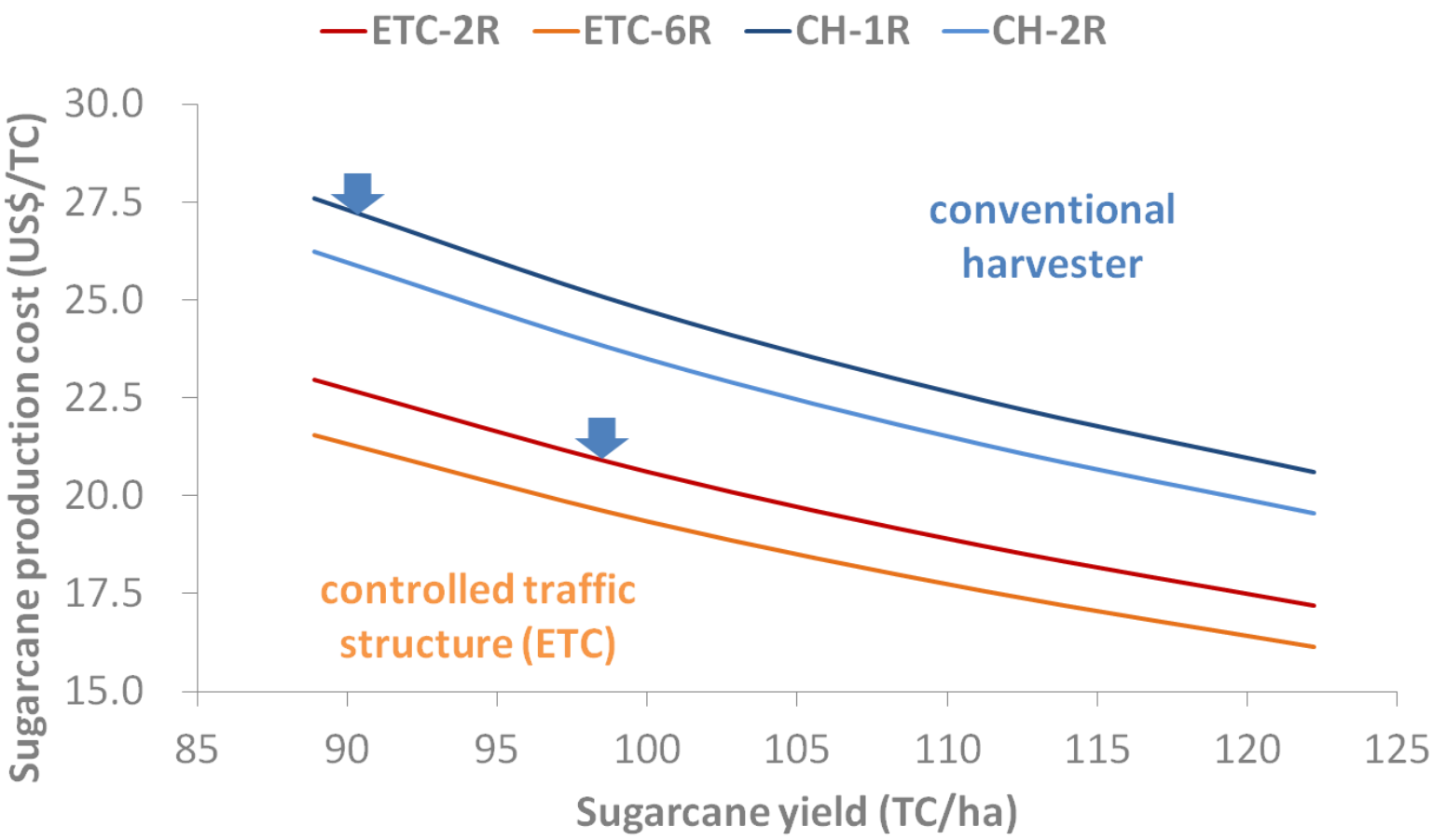
Source: IDEA

Controlled Traffic Structure - ETC

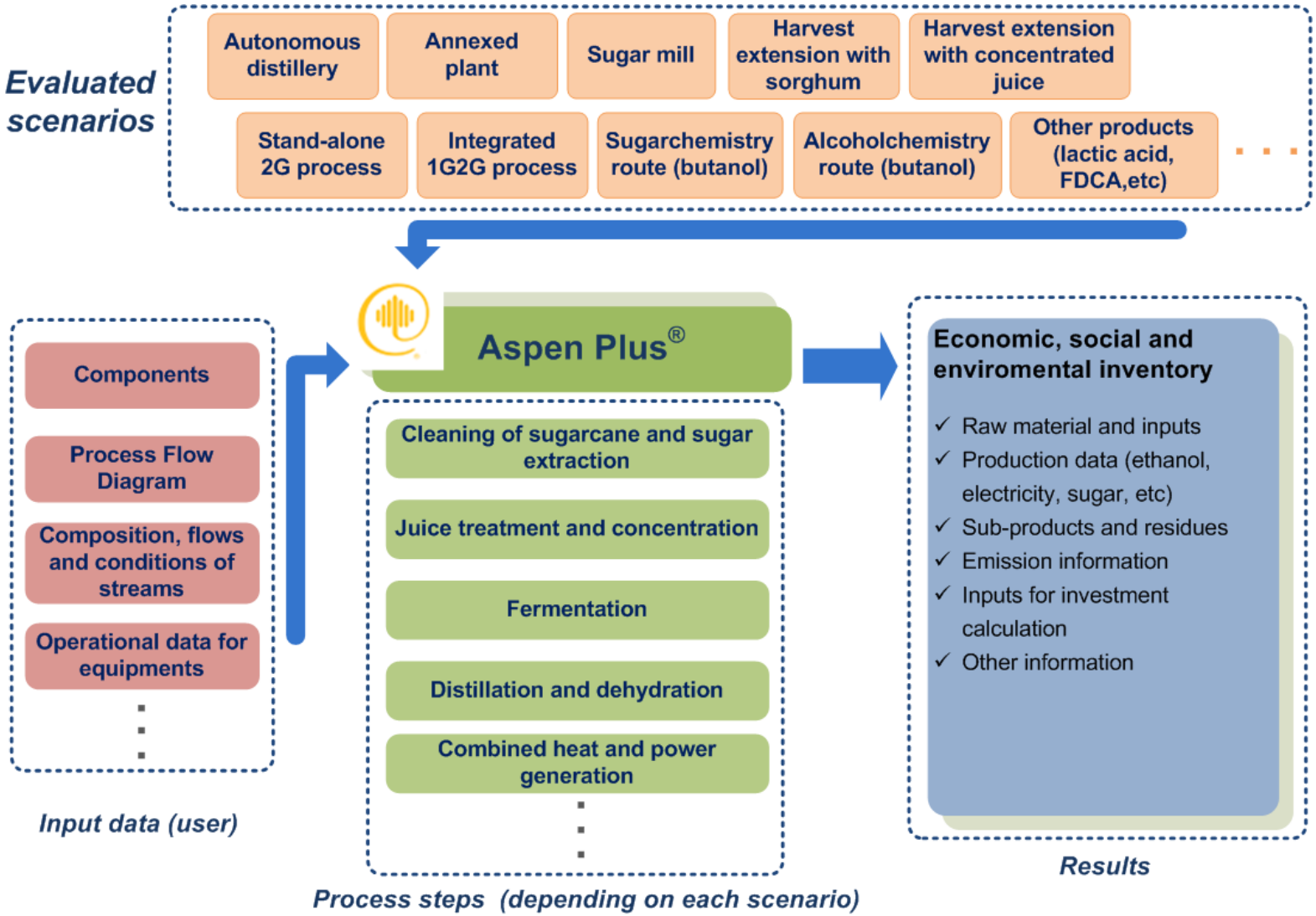
(harvesting and planting)

conventional harvester		controlled traffic structure (ETC)	
CH-1R	CH-2R	ETC-2R	ETC-6R
			
1 row	2 rows	2 rows	6 rows
conventional tillage		reduced tillage	

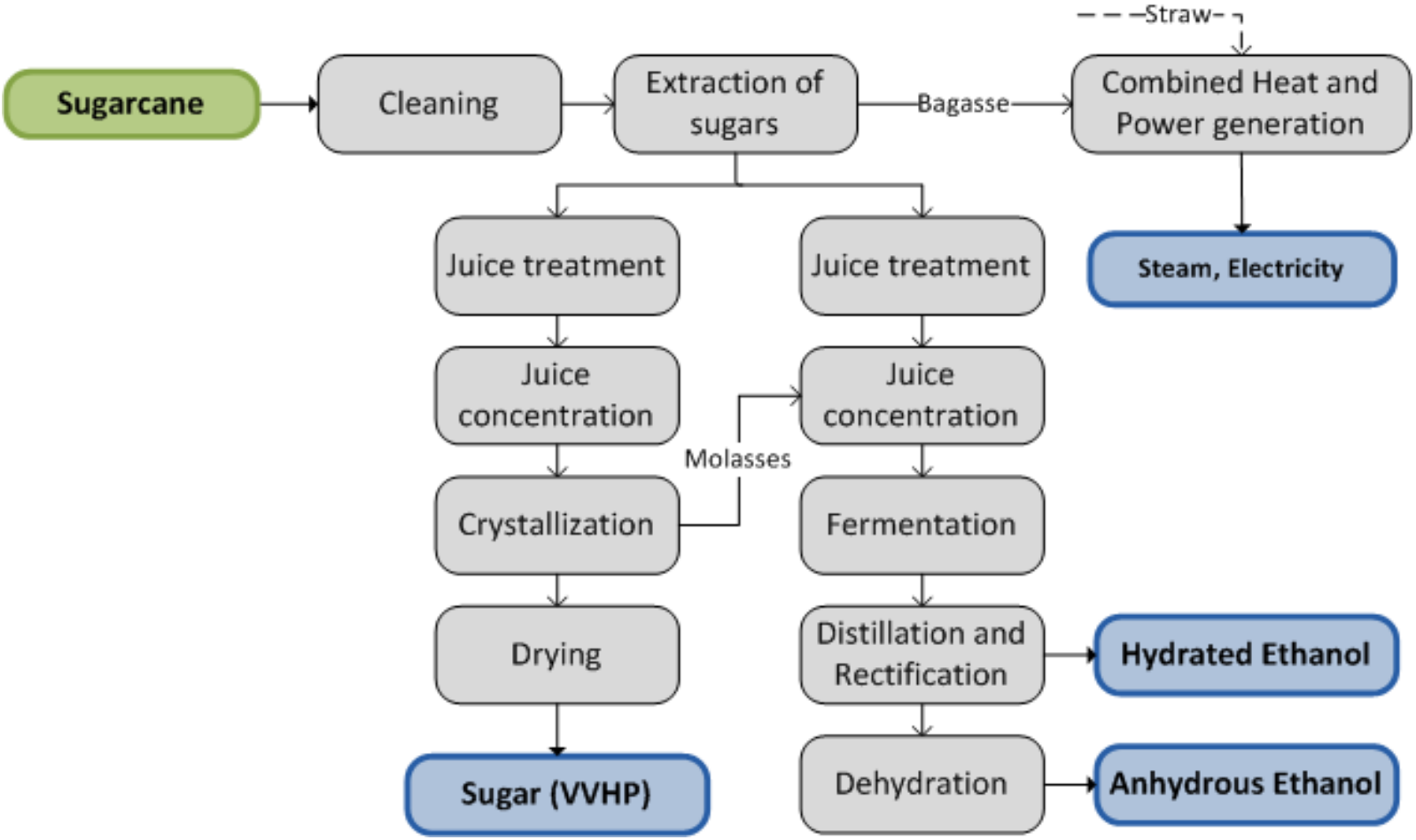
Economic assessment of ETC



Biorefinery simulation



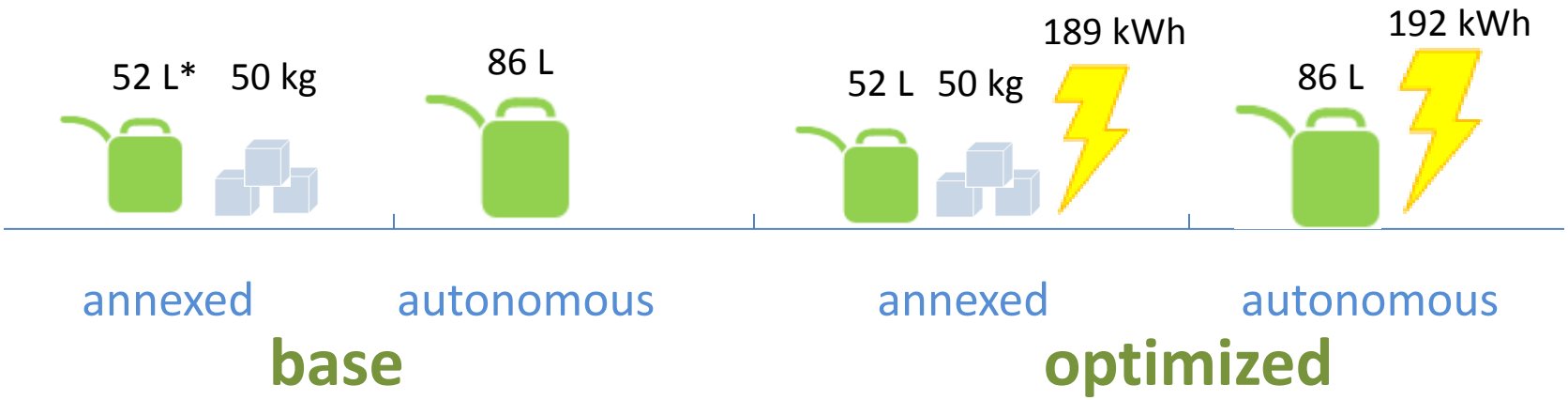
1G annexed plant



1G – technical parameters

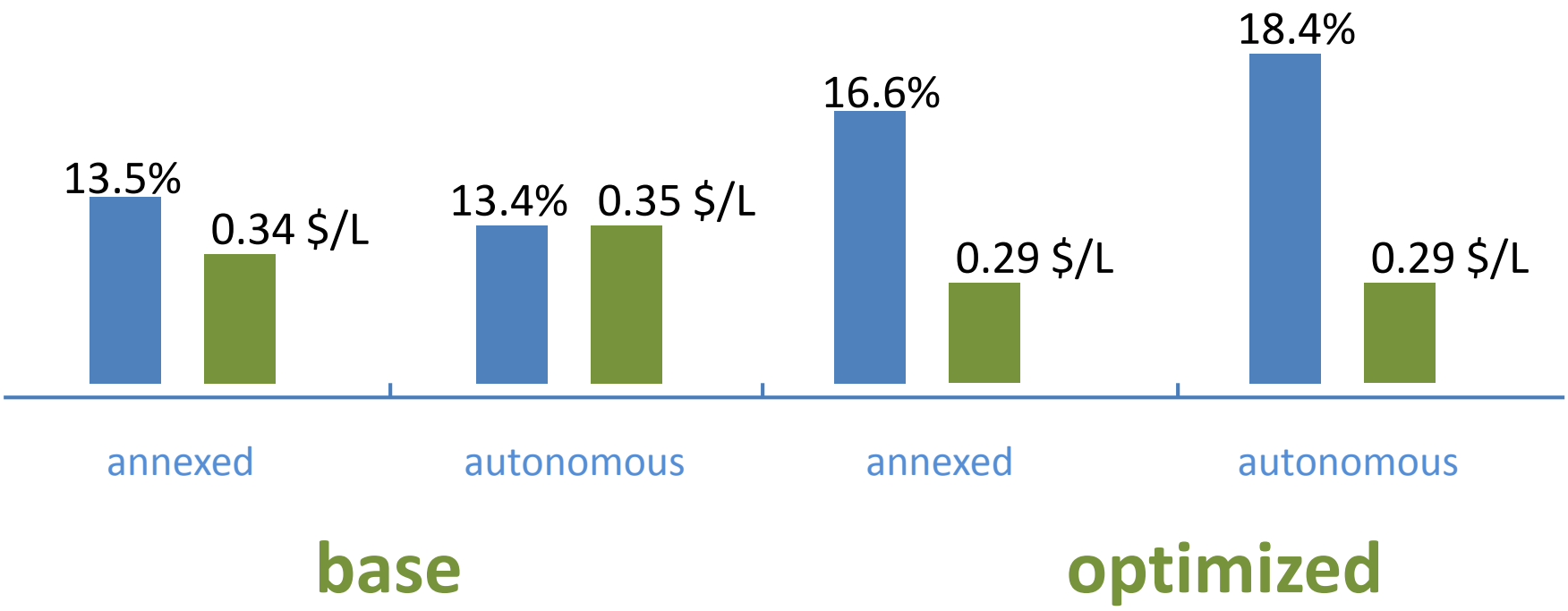
parameter	base	optimized
boiler pressure	22 bar	90 bar
surplus bagasse	sold	fuel
surplus electricity	no	yes
drivers	direct	electric
use of straw (50%)	no	yes
steam consumption	value from simulation	20 % reduction

per tonne of sugarcane:



** Hydrated ethanol*

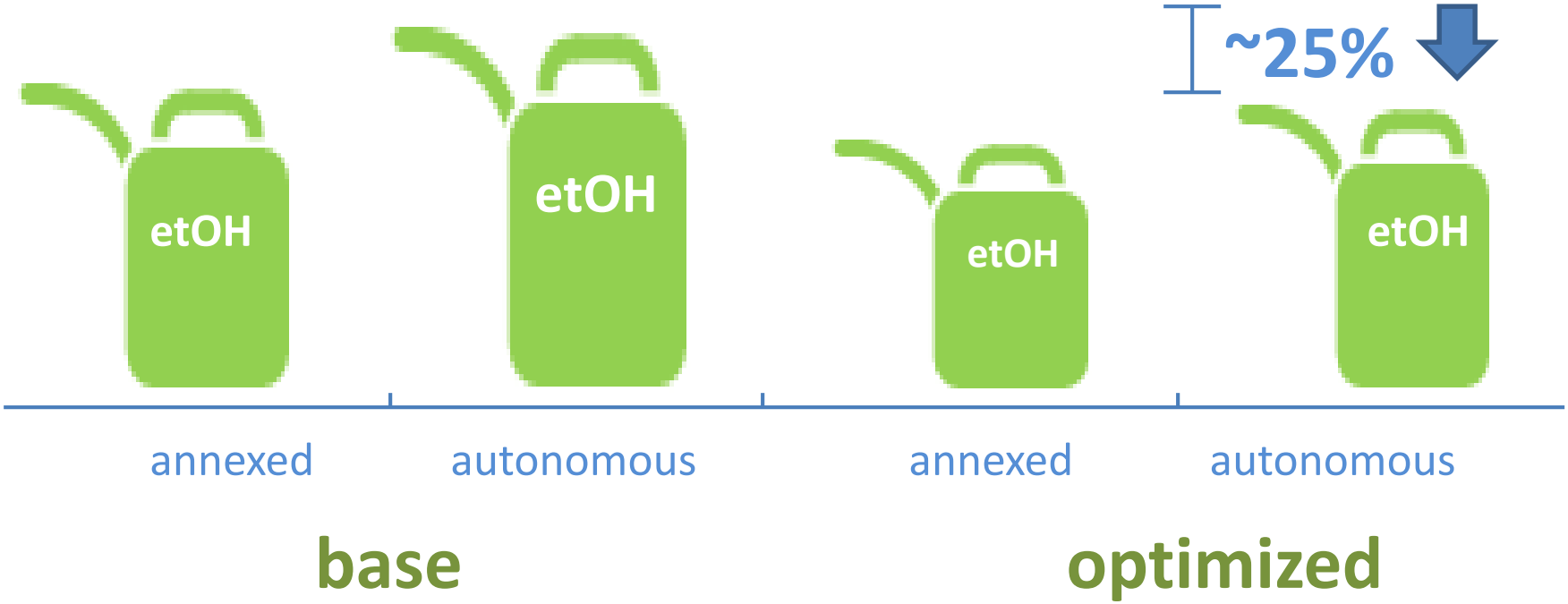
Economic assessment



Source: Cavalett et al., 2011. Environmental and economic assessment of bioethanol, sugar and bioelectricity production from sugarcane. Chemical Engineering Transactions

Environmental assessment

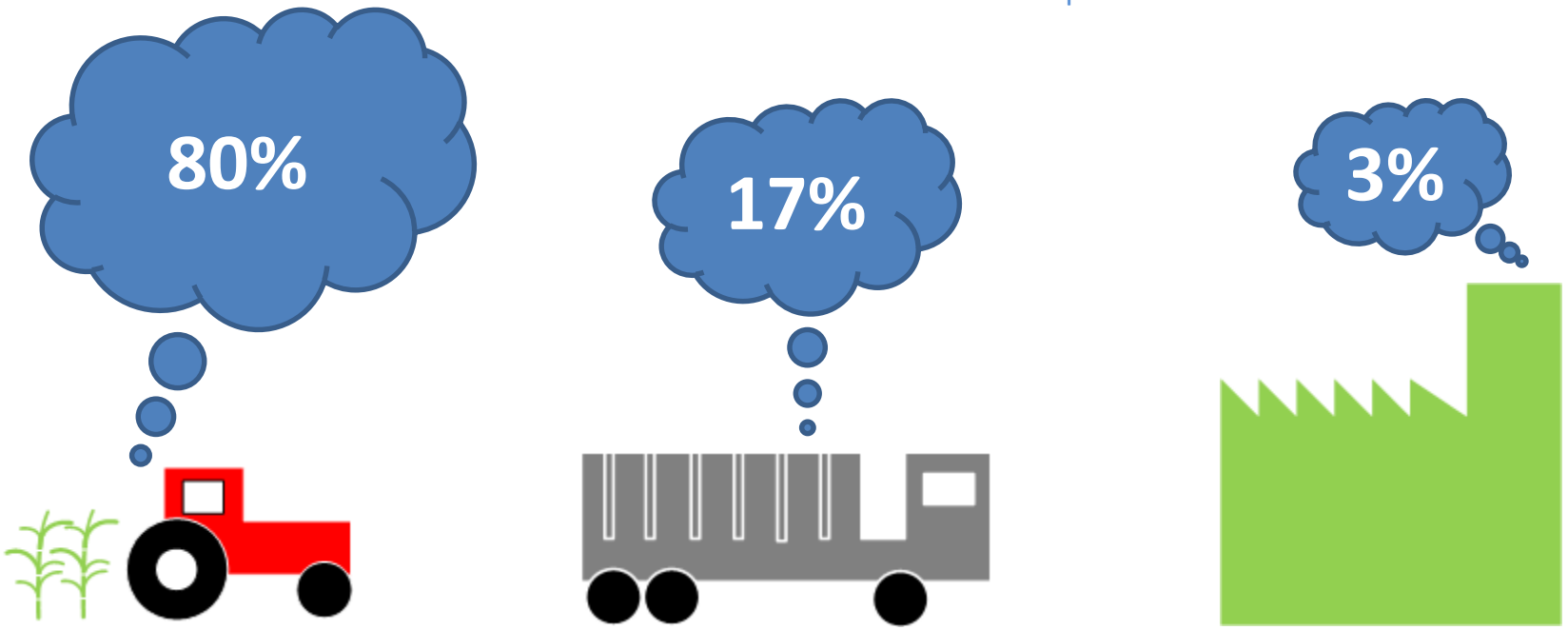
(per L of ethanol)



Source: Cavalett et al., 2012. Environmental and economic assessment of sugarcane first generation biorefineries in Brazil. Clean Techn Environ Policy

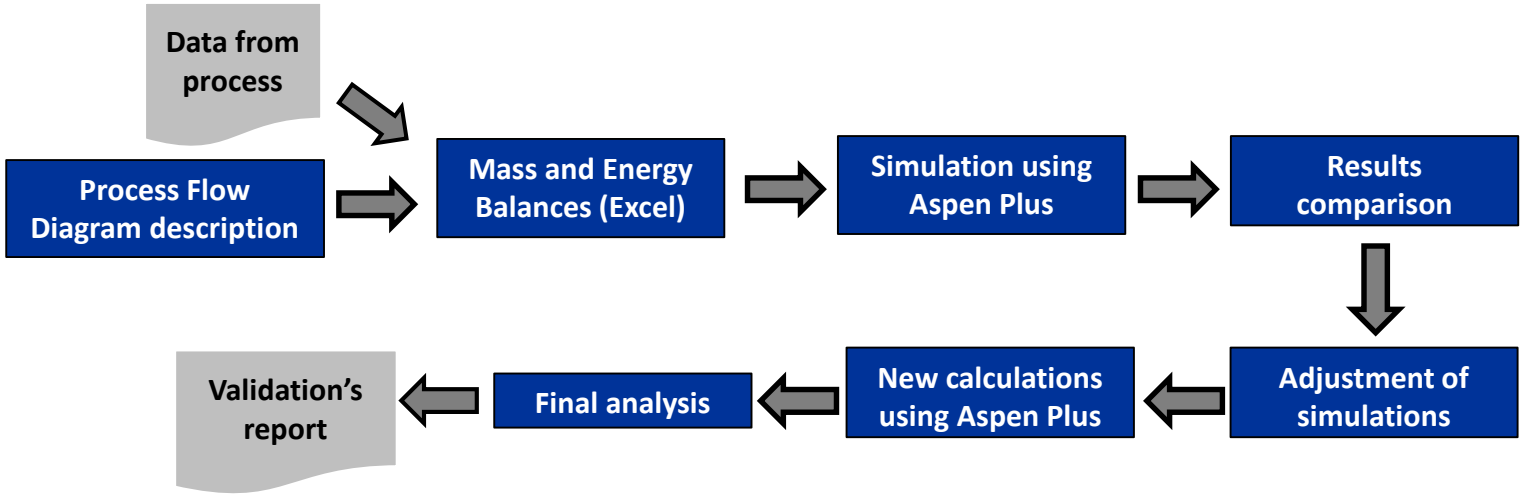
Environmental impacts

(global warming potential in CO_{2eq} per L of 1G ethanol)

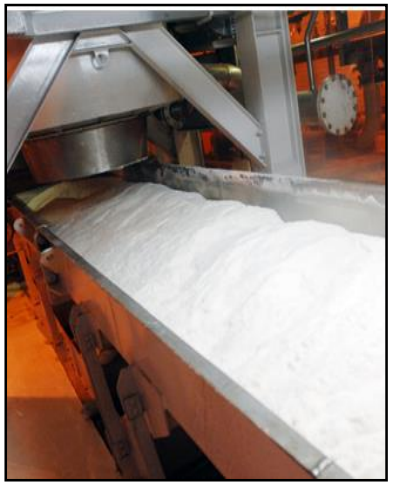


Source: Cavalett et al., 2012. Environmental and economic assessment of sugarcane first generation biorefineries in Brazil. Clean Techn Environ Policy

Validation of VSB



Processing capacity: 3 million tons of sugarcane/year
Products: crystal sugar, anhydrous and hydrated ethanol and power cogeneration



Validation Results

Main streams

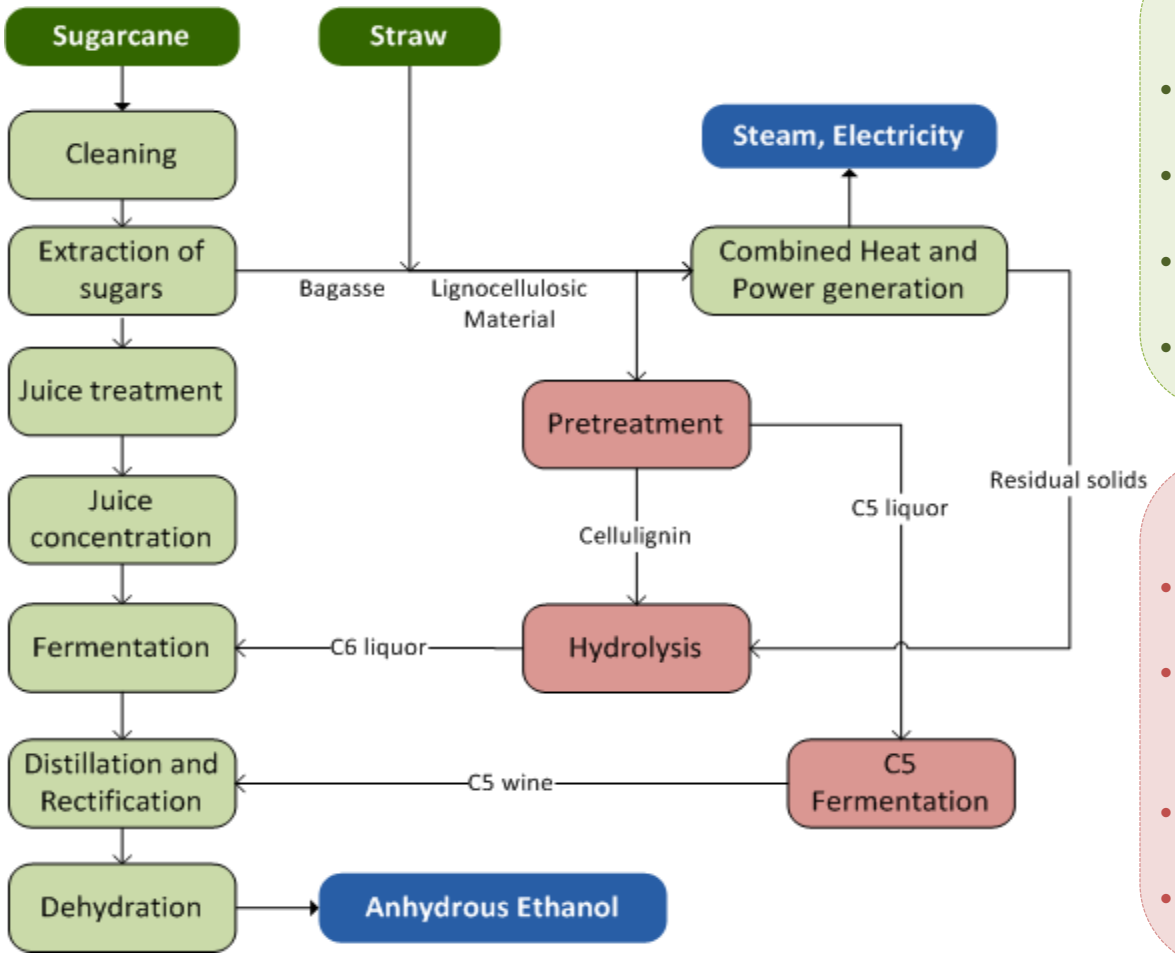
Product	Unit	Bulletin	Aspen	Deviation
Sugar	t/h	64.44	66.15	2.6%
Hydrated ethanol	m^3/h	15.46	15.59	0.88%
Anhydrous ethanol	m^3/h	25.03	24.88	-0.63%

Yield (TRS based)	Bulletin	Aspen	Deviation
Total	89.9%	91.3%	1.5%
Sugar House	91.5%	93.8%	2.5%
Distillery	86.6%	87.1%	0.62%

Validation of process parameters and simulation results with differences lower than 5%

Validating 1G increases confidence in methodology and process considerations to evaluate other routes/technologies

Integrated 1G and 2G ethanol production



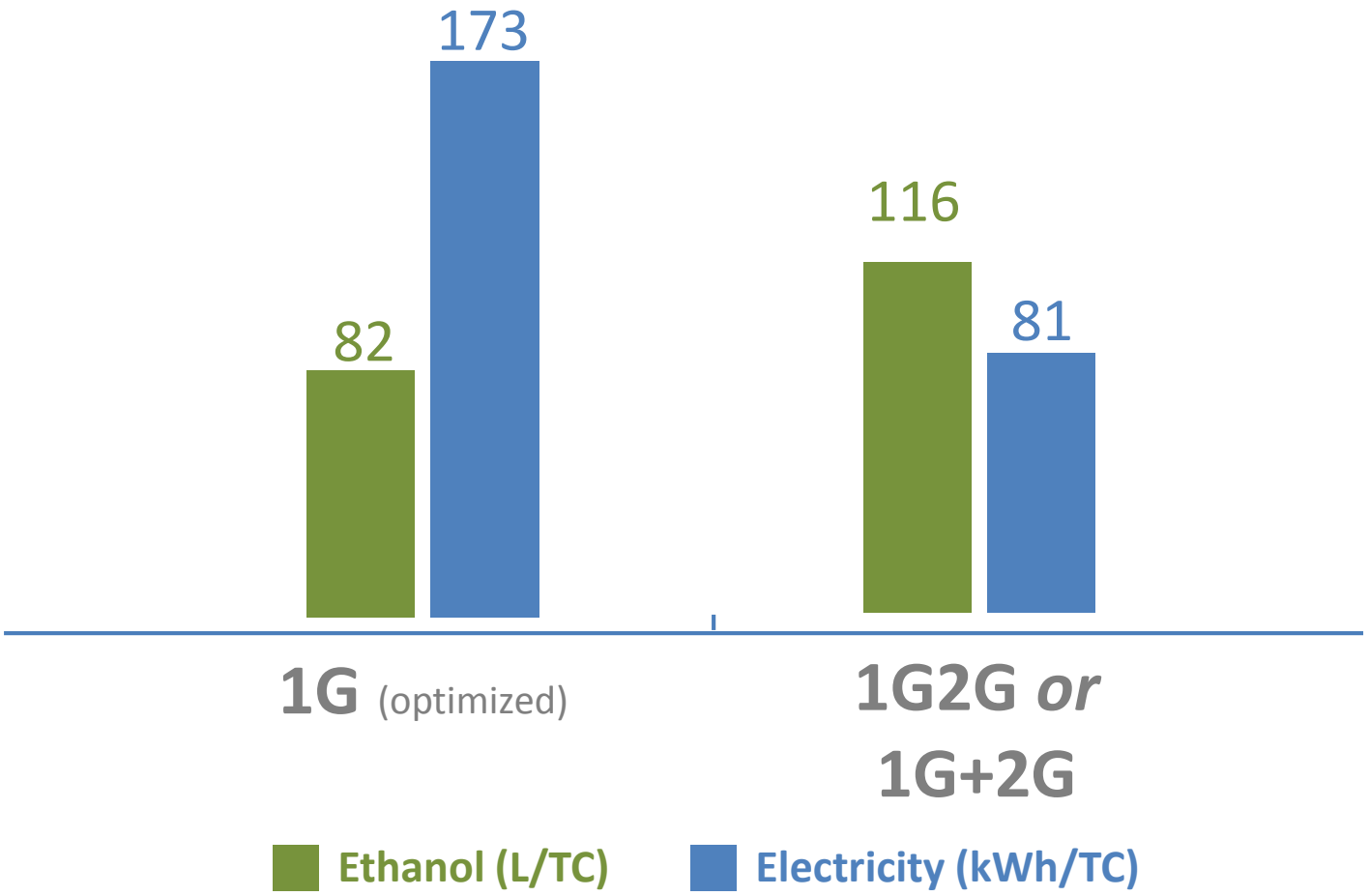
1G optimization parameters

- Straw use (50%)
- Molecular sieves for dehydration
- 65 bar boilers
- 20% reduction on steam demand

2G parameters

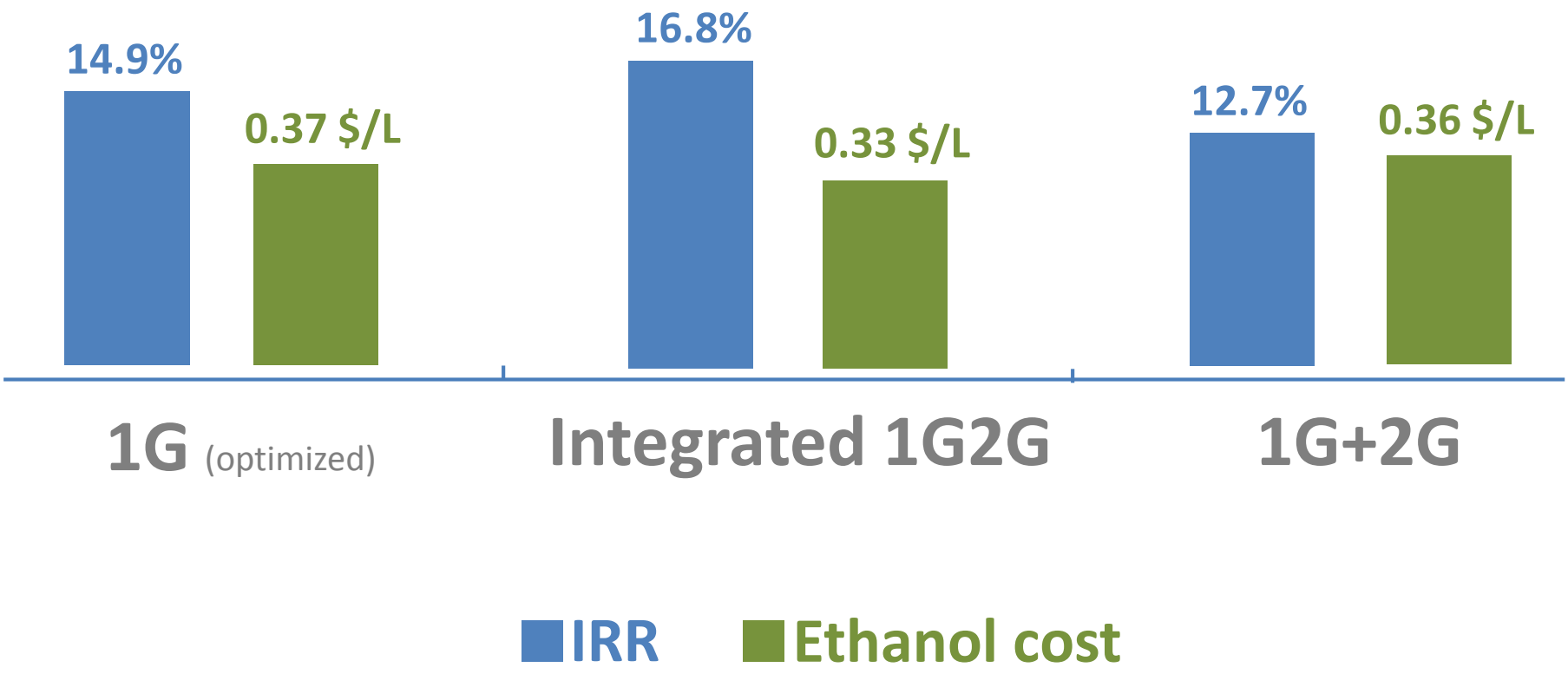
- Acid catalyzed steam explosion
- Hydrolysis: 48h, 15% solids, 10 FPU/g pretreated material
- C5 conversion to ethanol: 80%
- C6 conversion to ethanol: 90%

Technical results of 2G ethanol



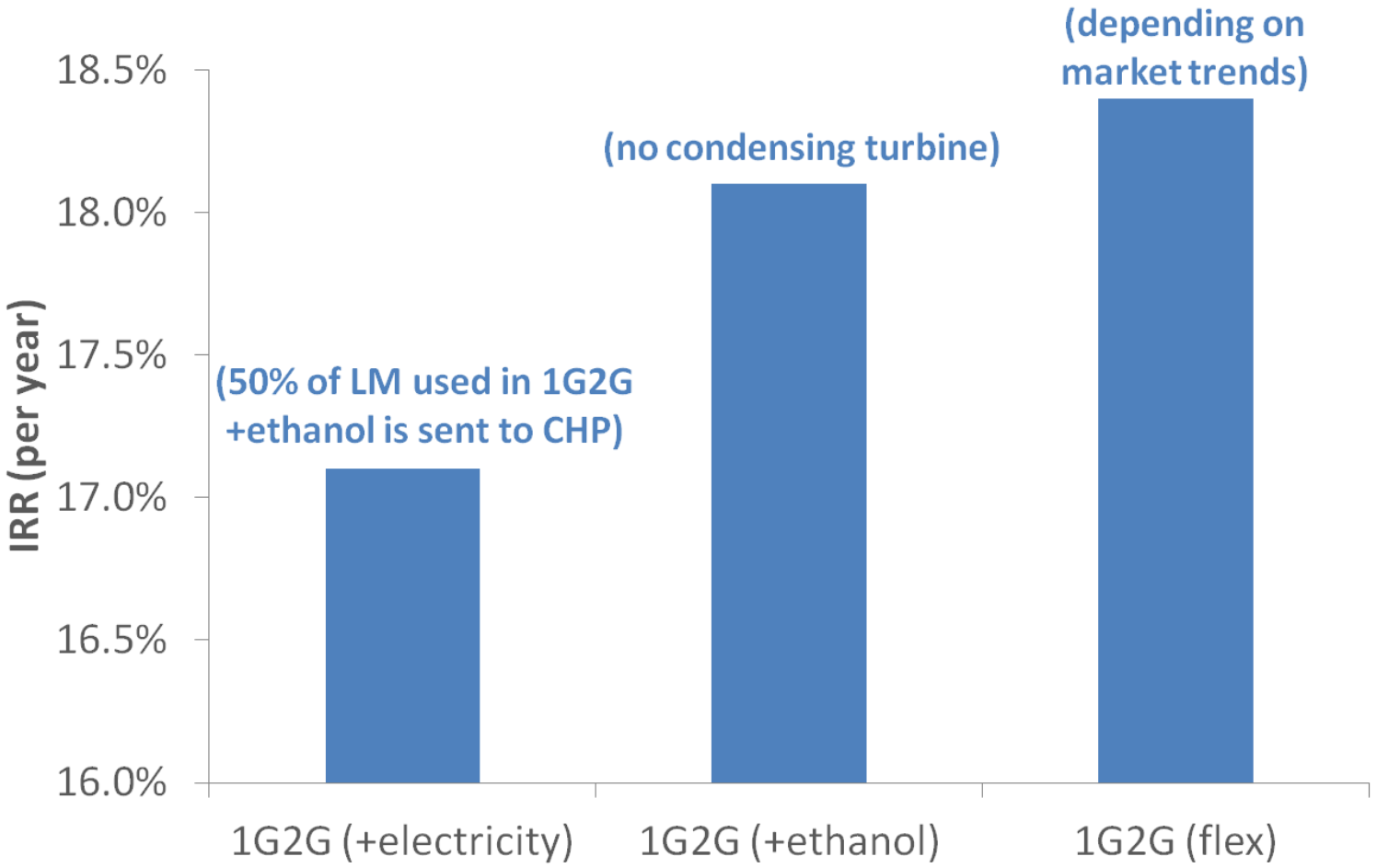
Dias et al., 2012. Integrated versus stand-alone second generation ethanol production from sugarcane bagasse and trash. Bioresource Technology

Economic assessment of 2G ethanol



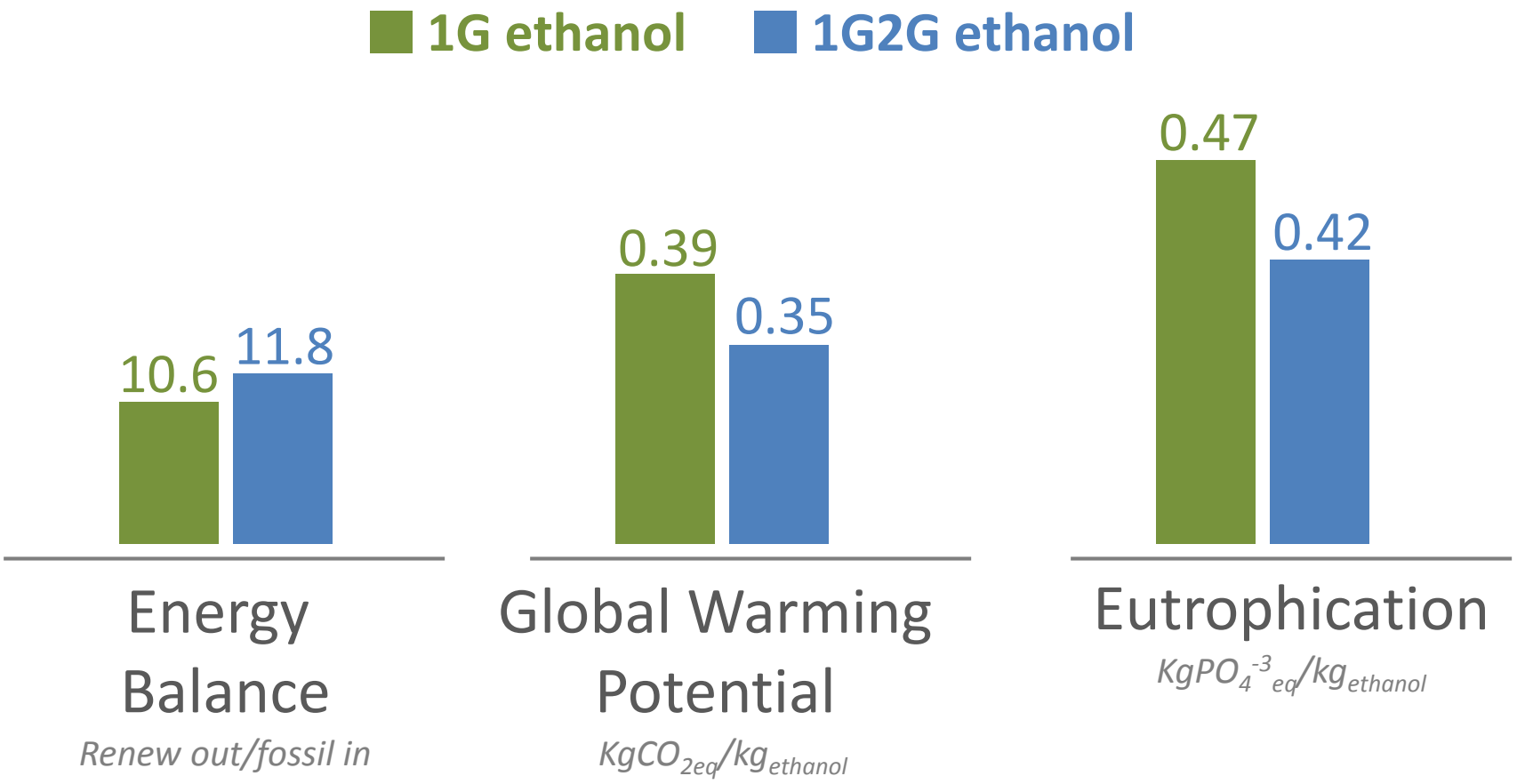
Dias et al., 2012. Integrated versus stand-alone second generation ethanol production from sugarcane bagasse and trash. Bioresource Technology

Flexibility ethanol 2G *vs* electricity



Source: Dias et al., 2013. Biorefineries for the production of first and second generation ethanol and electricity from sugarcane. Applied Energy

Environmental impacts 2G ethanol



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CNPEM

Technological Assessment Team for LACAf-1.3 Project

Antonio Bonomi	Coordination
Tassia Junqueira	Simulation of scenarios
Vera Gouveia	Simulation of scenarios
Mateus Chagas	Agricultural Model
Otávio Cavalett	Environmental impacts
Marcos Watanabe	Economic evaluation
Post-doctoral fellow	Simulation of scenarios

Obrigado!!

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