GEF-6 REQUEST FOR PROJECT ENDORSEMENT/APPROVAL

PROJECT TYPE: Full-sized Project
TYPE OF TRUST FUND:GEF Trust Fund

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PART I: PROJECT INFORMATION

Project Title: Biogas applications for the Brazilian agro-industry			
Country(ies):	Brazil	GEF Project ID:[1]	9057
GEF Agency(ies):	UNIDO	GEF Agency Project ID:	150014
Other Executing Partner(s):	Ministry of Science, Technology, Innovation and Communication (MCTIC), Ministry of Mines and Energy (MME), Itaipu Binacional and CI Biogas-ER	Submission Date:	04/19/2017
GEF Focal Area (s):	Climate Change	Project Duration (Months)	60
Integrated Approach Pilot	IAP-Cities ☐ IAP-Commodities ☐ IAP-Food Security ☐	Corporate Program: SGP ☐	
Name of Parent Program	N/A	Agency Fee ($)	665,000

A. FOCAL AREA STRATEGY FRAMEWORK AND OTHER PROGRAM STRATEGIES[2]

Focal Area Objectives/Programs	Focal Area Outcomes	Trust Fund	(in $) GEF Project Financing	(in $) Co-financing
CCM-1 Program 1	Outcome A. Accelerated adoption of innovative technologies and management practices for GHG emission reduction and carbon sequestration.	GEFTF	6,091,153	52,511,503
	Outcome B. Policy, planning and regulatory frameworks foster accelerated low GHG development and emissions mitigation.	GEFTF	908,847	5,880,567
	Total project costs		7,000,000	58,392,070

B. PROJECT DESCRIPTION SUMMARY

Project Objective: To reduce GHG emissions and dependence on fossil fuels through the promotion of biogas-based energy and mobility solutions within agro-industrial value chains in Southern Brazil and strengthening of national biogas technology supply chains.

Project Components/ Programs	Financing Type[3]	Project Outcomes	Project Outputs	Trust Fund	(in $) GEF Project Financing	(in $) Confirmed Co-financing
1. Policy framework and information	TA	1.1 Enhanced inter-ministerial coordination and implementation of policies, regulation and instruments to promote the adoption of biogas and biomethane energy systems based on	1.1.1 Establishment of an inter-ministerial coordinating unit on biogas and biomethane market development receiving support from the Project. 1.1.2 Updating and detailing of federal and state policies and	GEFTF	860,000	5,800,000

[1] Project ID number remains the same as the assigned PIF number.
[2] When completing Table A, refer to the excerpts on GEF 6 Results Frameworks for GETF, LDCF and SCCF and CBIT programming directions.
[3] Financing type can be either investment or technical assistance.

		agroindustrial organic waste.	programmes, and regulatory and financial instruments to facilitate biogas and biomethane market development based on agroindustrial organic waste. 1.1.3 Integration of biogas and biomethane into federal and state-level energy and agriculture sector programmes. 1.1.4 Design of an MRV system for tracking of GHG emission reductions from anaerobic digestion in agro-industries.			
		1.2 Information on biogas and biomethane technology and market development updated, consolidated and made accessible to public and private stakeholders.	1.2.1 Collection, validation and publication of technical, legal, economic, and other relevant information for biogas market development based on agroindustrial organic waste. 1.2.2 Operationalization of a Biogas Information Platform (BIP) to update, manage and disseminate validated information to stakeholders.	GEFTF	835,000	3,470,000
2. Biogas and biomethane technology and value chain	TA	2.1 Strengthening of the biogas and biomethane value chain by promotion of cost-effective, standardized technologies, consolidation of market strategies and business models, and transfer of know-how and skills to project developers and other stakeholders.	2.1.1 Validation of biogas and biomethane business models for agroindustries, including associative biogas production schemes. 2.1.2 Preparation of recommendations and guidelines for standardization of technical designs, feedstock, equipment, and operational procedures for biogas production schemes. 2.1.3 Adaptation of equipment, components and processes for biogas and biomethane production to local socio-economic and technical conditions ("tropicalization"). 2.1.4 Implementation of	GEFTF	2,525,000	14,924,070

			training, capacity building and promotional activities for biogas producers, project developers and other stakeholders. 2.1.5 Development and approval of market introduction strategies and business models for biogas-based electricity and biomethane by electricity and gas companies in Southern Brazil.			
3. Demonstration and optimization of biogas projects	Inv	3.1 Demonstration and optimization of the technical and economic feasibility of biogas and biomethane production and utilization based on agroindustrial organic waste.	3.1.1 Verification and implementation of demonstration pilots for biogas production and utilization based on agroindustrial organic waste in Southern Brazil. 3.1.2 Investment and technical services to ensure operational performance and sustainability of the installed demonstration pilots.	GEFTF	1,950,000	32,170,000
	TA		3.1.3 Monitoring of operational aspects and performance of established pilots, including systematization of lessons learned and recommendations for enhancement.	GEFTF	220,000	1,000,000
4. Monitoring and Evaluation	TA	4.1 Monitoring plan prepared and implemented.	4.1.1 Monitoring of project progress and compliance with UNIDO and GEF guidelines and safeguards on social (including gender) and environmental impact. 4.1.2 Implementation of Mid-term Review. 4.1.3 Implementation of independent Terminal Evaluation.	GEFTF	280,000	228,000
			Subtotal		6,670,000	57,592,070
			Project Management Cost (PMC)[4]	GEFTF	330,000	800,000
			Total project costs		7,000,000	58,392,070

[4] For GEF Project Financing up to $2 million, PMC could be up to10% of the subtotal; above $2 million, PMC could be up to 5% of the subtotal. PMC should be charged proportionately to focal areas based on focal area project financing amount in Table D below.

C. CONFIRMED SOURCES OF CO-FINANCING FOR THE PROJECT BY NAME AND BY TYPE

Please include evidence for co-financing for the project with this form.

Sources of Co-financing	Name of Co-financier	Type of Cofinancing	Amount ($)
Recipient Government	Federal Ministry of Science, Technology, Innovation and Communication (MCTIC)	Grants	700,000.00
Recipient Government	Federal Ministry of Science, Technology, Innovation and Communication (MCTIC)	In-kind	1,300,000.00
Recipient Government	Federal Ministry of Mines and Energy (MME)	In-kind	2,237,064.84
Recipient Government	Federal Ministry of Environment (MMA)	In-kind	1,101,425.00
Recipient Government	Federal Ministry of Agriculture, Livestock and Food Supply (MAPA)	Loans	9,000,000.00
Others	Itaipu Binacional	Grants	18,500,000.00
Others	Itaipu Technology Park Foundation (FPTI)	Grants	559,052.56[5]
Recipient Government	Companhia Paranaense de Gás (Compagas)	In-kind	500,301.00
Recipient Government	Companhia de Gás do Estado do Rio Grande do Sul (Sulgás)	Equity	2,225,967.50[6]
Recipient Government	Companhia Paranaense de Energia (COPEL) – Entre Rios	Grants	5,467,298.13[7,8]
Recipient Government	Banco do Brasil	Equity	1,589,976.79[9]
Private Sector	Cooperativa Agroindustrial Lar	Equity	1,112,983.75[10]
Private Sector	GEO Energética	In-kind	10,000,000.00
Recipient Government	Empresa Brasileira de Pesquisa Agropecuária (Embrapa)	In-kind	2,770,000.00
CSO	Associação Brasileira de Biogás e Biometano (Abiogás)	In-kind	100,000.00
Others	Fundação Getúlio Vargas (FGV)	Equity	1,000,000.00
GEF Agency	UNIDO	In-kind	100,000.00
GEF Agency	UNIDO	Grants	128,000.00
Total Co-financing			58,392,069.57

D. TRUST FUND RESOURCES REQUESTED BY AGENCY(IES), COUNTRY(IES), FOCAL AREA AND THE PROGRAMMING OF FUNDS

GEF Agency	Trust Fund	Country Name/Global	Focal Area	Programming of Funds	(in $)		
					GEF Project Financing (a)	Agency Fee [a)] (b)[2]	Total (c)=a+b
UNIDO	GEF TF	Brazil	Climate Change	N/A	7,000,000	665,000	7,665,000
Total Grant Resources					7,000,000	665,000	7,665,000

a) Refer to the Fee Policy for GEF Partner Agencies

[5] Orignal value in co-financing letter is BRL 1,758,052.58. Exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017
[6] Orignal value in co-financing letter is BRL 7,000,000.00. Exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017
[7] Orignal value in co-financing letter is BRL 17,193,012.43. Exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017
[8] Please note that COPEL has made additional co-financing available through its programme Gera Rural, which focuses on hybrid RE systems (including biogas). Details to be found in Annex P.
[9] Orignal value in co-financing letter is BRL 5,000,000.00. Exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017
[10] Orignal value in co-financing letter is BRL 3,500,000.00. Exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017

E. PROJECT'S TARGET CONTRIBUTIONS TO GLOBAL ENVIRONMENTAL BENEFITS[11]

Provide the expected project targets as appropriate.

Corporate Results	Replenishment Targets	Project Targets
1. Maintain globally significant biodiversity and the ecosystem goods and services that it provides to society	Improved management of landscapes and seascapes covering 300 million hectares	*hectares*
2. Sustainable land management in production systems (agriculture, rangelands, and forest landscapes)	120 million hectares under sustainable land management	*hectares*
3. Promotion of collective management of transboundary water systems and implementation of the full range of policy, legal, and institutional reforms and investments contributing to sustainable use and maintenance of ecosystem services	Water-food-ecosystems security and conjunctive management of surface and groundwater in at least 10 freshwater basins;	*Number of freshwater basins*
	20% of globally over-exploited fisheries (by volume) moved to more sustainable levels	*Percent of fisheries, by volume*
4. Support to transformational shifts towards a low-emission and resilient development path	750 million tons of CO_{2e} mitigated (include both direct and indirect)	*Direct emissions: 535,000t CO_2e Indirect emissions: 2,300,000t CO_2e Total: 2,835,000 t CO_2e* metric tons
5. Increase in phase-out, disposal and reduction of releases of POPs, ODS, mercury and other chemicals of global concern	Disposal of 80,000 tons of POPs (PCB, obsolete pesticides)	*metric tons*
	Reduction of 1000 tons of Mercury	*metric tons*
	Phase-out of 303.44 tons of ODP (HCFC)	*ODP tons*
6. Enhance capacity of countries to implement MEAs (multilateral environmental agreements) and mainstream into national and sub-national policy, planning financial and legal frameworks	Development and sectoral planning frameworks integrate measurable targets drawn from the MEAs in at least 10 countries	*Number of Countries:*
	Functional environmental information systems are established to support decision-making in at least 10 countries	*Number of Countries:*

F. DOES THE PROJECT INCLUDE A "NON-GRANT" INSTRUMENT? No

(If non-grant instruments are used, provide an indicative calendar of expected reflows to your Agency and to the GEF/LDCF/SCCF/CBIT Trust Fund) in Annex D.

[11] Update the applicable indicators provided at PIF stage. Progress in programming against these targets for the projects per the *Corporate Results Framework* in the *GEF-6 Programming Directions*, will be aggregated and reported during mid-term and at the conclusion of the replenishment period.

PART II: PROJECT JUSTIFICATION

A. DESCRIBE ANY CHANGES IN ALIGNMENT WITH THE PROJECT DESIGN WITH THE ORIGINAL PIF[12]

1. Work carried out during the PPG phase was aimed at complementing information and validating the assumptions underlying the Project Identification Form (PIF), as well as engagement with project counterparts. After an inception workshop (December 2015), contracted consultancies and activities took place in the period January – December 2016. Some adjustments were made to the original project strategy outlined in the PIF in order to respond to changes in Project context and approach, and to adequately address the identified barriers and needs. Please refer to the below table for an overview of changes incurred between the project design and the original PIF. As a result, the impact and cost-effectiveness of the Project is substantially increased compared to the original proposal. Targeted overall GHG emission reductions are lower than at PIF stage due to a more accurate calculation of expected global environmental benefits.

Changes in Project's Strategic Results Framework between PIF and CEO ER			
Components at PIF stage	**Outputs - location at PIF stage**	**Outputs - location at CEO Endorsement**	**Comments / Rational for changes**
1. Strengthening of the policy and institutional framework.	1.1.1 Assessment of the policy framework for biogas utilization by agro-industries including climate change, environmental protection, agricultural and industrial policy.	1.1.1 Establishment of an inter-ministerial coordinating unit on biogas and biomethane market development receiving support from the Project.	The original output has been eliminated as such assessment was largely completed during the PPG phase. New output addresses the identified need for coordination and stronger ownership of the biogas agenda at the federal level.
	1.1.2 Recommendations (incl. proposals for secondary regulation) to streamline the policy framework towards greater uptake of biogas solutions prepared, validated and submitted to the government for adoption.	1.1.2 Updating and detailing of federal and state policies and programmes, and regulatory and financial instruments to facilitate biogas and biomethane market development based on agroindustrial organic waste	Output has been rephrased to encompass a wider array of policy instruments.
	1.1.3 Exploitation of synergies with initiatives and mechanisms supportive to the national priority of implementing results-based financing for climate change mitigation activities in Brazil.	1.1.3 Integration of biogas and biomethane into federal and state-level energy and agriculture sector programmes.	Scope of the output is narrowed to support for anaerobic digestion and biogas in the federal and state level programmes in the energy and agricultural sector.
2. Strengthening of the biogas technology base and supply chain.	2.1.1 Biogas Innovation Centre (BIC) with viable business plan established and operational.	1.2.2 Operationalization of a Biogas Information Platform (BIP) to update, manage and disseminate validated information to stakeholders.	Rephrased to clarify the scope of the envisaged body addressing the need for consolidated information among stakeholders as identified during the PPG phase. Besides a lack of availability and quality of information, a lack of a tradition of information sharing was also noted.
	2.1.2 Information on the energy and nutrient potential of agroindustrial wastes and residues in the targeted region	1.2.1 Collection, validation and publication of technical, legal, economic, and other relevant information for biogas market	The outputs 2.1.2 and 2.1.3 have been restructured into 1.2.1 and 2.1.1. Business development has been

[12] For questions A.1 –A.7 in Part II, if there are no changes since PIF , no need to respond, please enter "NA" after the respective question.

	has been validated and completed.	development based on agroindustrial organic waste.	expanded to the market demand side, addressed by new output 2.1.5.
	2.1.3 Studies into agroindustrial production processes, potential business models for biogas and organizational structures for biogas initiatives undertaken as input for project developers and end-users.	2.1.1 Validation of biogas and biomethane business models for agroindustries, including associative biogas production schemes.	
		2.1.5 Development and approval of market introduction strategies and business models for biogas-based electricity and biomethane by electricity and gas companies in Southern Brazil.	
	2.1.4 Analyses carried out for the adaptation of international biogas technology (designs) to fit local technical, production, economic, financial, and environmental requirements.	2.1.2 Preparation of recommendations and guidelines for standardization of technical designs, feedstock, equipment, and operational procedures for biogas production schemes.	This output has been integrated into the new output 2.1.3. A new output 2.1.2 has been added to address the prioritized need for more standardization of biogas and biomethane technology and designs.
	2.1.5 Existing capacity/skills/number of prospective biogas project developers and other supply chain actors enhanced through the provision of training and targeted information.	2.1.4 Implementation of training, capacity building and promotional activities for biogas producers, project developers and other stakeholders.	The output has been rephrased: the scope has been broadened to market actors rather than the supply chain alone.
	2.1.6 Product development of biogas equipment (prototypes and testing thereof), development of industrial production facilities, transfer of technology (patents, licenses), etc. undertaken.	2.1.3 Adaptation of equipment, components and processes for biogas and biomethane production to local socio-economic and technical conditions ("tropicalization").	The purpose of this output has been shifted from developing a technology chain (e.g. mobility) to adaptation of technology to Brazilian circumstances with a view on achieving capex and opex reductions.
3. Demonstration of a biogas-based system for rural areas.	3.1.1. Pre-feasibility studies updated, followed by selection of pilot site.	3.1.1 Verification and implementation of demonstration pilots for biogas production and utilization based on agroindustrial organic waste in Southern Brazil.	The outputs 3.1.1, 3.1.2 and 3.1.3 are included in new output 3.1.1.
	3.1.2 Detailed feasibility study (including environmental and social assessments) for the biogas-based system carried out.		
	3.1.3 Detailed technical studies, operational plans, business model and ownership constellation developed.		
	3.1.4. Development and application of a tailored MRV mechanism including monitoring on operational aspects.	1.1.4 Design of an MRV system for tracking of GHG emission reductions from anaerobic digestion in agro-industries.	This output has been rephrased to focus solely on the development of a sector-specific MRV system for monitoring GHG emission reductions and as such is included under Component 1. Monitoring of pilot system operation is covered by new output 3.1.3.
	3.1.5 One demonstration biogas system (tentatively: local mobility) installed and made	3.1.1 Verification and implementation of demonstration pilots for biogas production and utilization based on agroindustrial	Output 3.1.5 has been divided into initial investment in selected biogas and biomethane pilot systems (new output 3.1.1); system optimization (new output

	operational.	organic waste in Southern Brazil. 3.1.2 Investment and technical services to ensure operational performance and sustainability of the installed demonstration pilots. 3.1.3 Monitoring of operational aspects and performance of established pilots, including systematization of lessons learned and recommendations for enhancement.	3.1.2) and monitoring (3.1.3).
4. Monitoring and Evaluation.	4.1.1 A monitoring plan (incl. ESSP and gender aspects) has been established and agreed upon.	4.1.1 Monitoring of project progress and compliance with UNIDO and GEF guidelines and safeguards on social (including gender) and environmental impact.	Rephrased to better reflect the actual activities to be carried out by the Project Management Unit (PMU). It is understood that a monitoring plan will be the basis for successfully monitoring project progress and compliance.
	4.1.2 Project progress on defined indicators and compliance with UNIDO and GEF guidelines has been monitored.	4.1.2 Implementation of Mid-term Review.	The original output 4.1.2 is covered by 4.1.1. Mid-term review and final evaluation have been separated into independent outputs as they constitute separate undertakings.
	4.1.3 Project progress report(s) are carried out, including mid-term and final evaluation.	4.1.3 Implementation of independent Terminal Evaluation.	The Mid-term review is covered by output 4.1.2. This output focuses solely on the independent terminal evaluation.

A.1. *Project Description*. Elaborate on: 1) the global environmental and/or adaptation problems, root causes and barriers that need to be addressed; 2) the baseline scenario or any associated baseline projects, 3) the proposed alternative scenario, GEF focal area[13] strategies, with a brief description of expected outcomes and components of the project, 4) incremental/additional cost reasoning and expected contributions from the baseline, the GEFTF, LDCF, SCCF, CBIT and co-financing; 5) global environmental benefits (GEFTF) and/or adaptation benefits (LDCF/SCCF); and 6) innovativeness, sustainability and potential for scaling up.

(1) The global environmental and/or adaptation problems, root causes and barriers that need to be addressed.

2. About half of cumulative anthropogenic greenhouse gas (GHG) emissions between 1750 and 2010 have occurred in the last 40 years, accelerating the pace of global warming. There is growing awareness that "the climate is moving out of the envelope of natural variability" and as such, the threat of irreversible climate change presents a significant global challenge to humanity and the biosphere in the 21st century.14 The Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) has agreed that actions must be taken to keep global temperature rise below 2 degrees Celsius (2°C) above the pre-industrial level; this would require a substantial reduction in annual GHG emissions.
3. Brazil is one of the largest countries in the world with an area of nearly 8.6 million km2 and a population of 200 million people.15 The Federative Republic of Brazil is divided into 26 states, 5,570 municipalities and the Federal District where the capital Brasilia is located. The Southeast region, encompassing the states of Rio de Janeiro, Sao Paolo, Minas Gerais and Espirito Santo, is the country's most populous region, with about 42% of total inhabitants. The average urbanization rate is high (84.4%, 2010), especially in the Southeast (92.9%).16 Brazil's economy is

[13] For biodiversity projects, in addition to explaining the project's consistency with the biodiversity focal area strategy, objectives and programs, please also describe which Aichi Target(s) the project will directly contribute to achieving..

[14] Source: GEF-6 Programming Directions Final, p.49 (extract from GEF Assembly Document GEF/A.5/07/Rev.01, May 22, 2014).

[15] The total population of Brazil is estimated at 200 million (2012). Source: IBGE, 2012.

[16] Source: Third National Communication. Ministry of Science, Technology and Innovation, Secretariat of Policies and Programs of Research and Development, General Coordination of Global Climate Change, Brasília, 2016. (Executive Summary, p.25)

characterized by a diversified industrial infrastructure, the export of equipment and machinery (including aircraft and motor vehicles), a well-developed domestic market, and commodity supply (e.g. coffee, cocoa, soybeans, corn; minerals) to the world markets. Brazil has internationally renowned universities and highly qualified research and technological facilities. The economy ranks seventh in the world, with a GDP of US$ 2,530 billion in 2012 (purchase power parity). Industry accounts for 25% of national production, agriculture for approximately 6% and services nearly 69% (2010).

4. Brazil is also one of the most important repositories of the world's forests and biodiversity, including the Amazon Rainforest. Brazil's development path is critical for preserving these repositories and for controlling national GHG emissions within established limits. Brazil has played a leading role in global environmental discussions since the Rio Summit in 1992 and was the first signatory to the UNFCCC.[17] According to Brazil's Third National Communication (TNC, 2016)[18], total net CO_2 emissions in 2010 ascended to 739,671 Gg. The attribution per sector being as follows: energy (47.1%), land use, land-use change and forestry (LULUCF, 42.0%), waste (0%) and industrial processes (10.9%). Methane (CH_4) could be reduced by 9.2% between 2005 (18,397 Gg CH_4) and 2010 (16,668 Gg CH_4).
5. Methane emissions predominantly stem from the agricultural sector (74.4%), followed by the waste sector (14.8%), LULUCF (6.8%), energy (3.8%) and industrial processes (0.3%). Note that total net CO_2 emissions were significantly lower than in 2005 (2,156,607 Gg), which was the peak year for emissions due to land-use change (1,790,368 Gg). Emissions in the energy sector and industry grew by around 20% over the period 2005-2010. The dominant source in agriculture is enteric fermentation (66.9%), mainly by beef cattle. Manure management accounts for 3.6% (cattle: 16%; pigs: 1.3%; poultry: 0.7%). Industrial and domestic effluents (waste water) account for 6.8%.19
6. Brazil's National Policy on Climate Change (PNMC), adopted in December 2008, established voluntary commitment to cut projected GHG emissions between 36.1% and 38.9% by 2020. The PNMC further defines actions and measures aimed at mitigation and adaptation to climate change. Federal Law No. 12,187 (December 29, 2009) provides the principles, objectives, guidelines and implementation mechanisms of the PNMC. This Law is a milestone since its creates a legal basis for actions already being implemented by the Federal Government and for developing further policies by the Federal, state and local Governments. The Brazilian Climate Change Fund (Fundo Clima) was created by Law No. 12,144 (December 9, 2009) to financially support mitigation and adaptation action using resources from oil royalties.
7. Departing from the PNMC, Federal Decree 7,390 (2010) provided for the creation of sectoral emission reduction plans defining actions, indicators and targets to reduce emissions and mechanisms to verify compliance. Biogas technology, based on the process of anaerobic digestion of organic matter, is a valuable asset for achieving the objectives of the sectoral plans for the agricultural sector and the energy sector by: (1) reduction of sector GHG releases (CH4) by bio-chemical conversion of organic waste and effluents; (2) production of a renewable energy source (biogas) that can be used for heat and electricity generation, and for transport, thereby offsetting fossil fuels; and (3) effective treatment of effluents and waste in compliance with environmental regulation and best practices, which is a key condition for production upscaling and long-term sustainability.
8. In 2015, Brazil's intended Nationally Determined Contributions (INDC) reconfirmed this commitment by setting a national target of 37% below 2005 levels, to be attained in 2025.[20] Sectoral emission reduction plans have been made for several sectors, including the electricity sector (the Ten-Year Energy Expansion Plan, PDE), agriculture (the Low-Carbon Agriculture plan, ABC), and the iron and steel sector[21], among others.

[17] Brazil signed the UNFCCC on 4 June, 1992, followed by its ratification by on 28 February 1994. The Convention entered into force for Brazil on May 29, 1994 (90 days after its ratification by the National Congress).

[18] TNC, Vol III, Chapter II – Summary of Anthropogenic Emissions by Sources and Removals by Sinks of Greenhouse Gases. MCTI, Brasilia, 2016.

[19] Please refer to the Third National Communication, Vol III, p. 56-61 for more information on the emission totals in CO_2 equivalents and the discussion on the GWP (Global Warming Potential) metrics. Note that applying the GWP-SAR (1995), with 1 CH_4 = 21 CO_2eq, total emissions by the energy sector (371,086 Gg CO_2eq) and agriculture (407,067 Gg CO_2eq) would be of the same order.

[20] Source: Brazil INDC 2015, http://www4.unfccc.int/submissions/INDC/Published%20Documents/Brazil/1 /BRAZIL%20iNDC% 20english%20FINAL.pdf.

[21] Targeted by the GEF-5 project "Production of sustainable, renewable biomass-based charcoal for the iron and steel industry in Brazil", GEF ID 4817, implemented by UNDP.

Barriers that need to be addressed

9. An exhaustive assessment of the barriers affecting market development for biogas in Brazil was performed under the PROBIOGAS programme (2015)[22]. This analysis was complemented through consultancies and work groups set up during the PPG phase and the findings largely confirmed by ABiogás in the PNBB. The main barriers are: (a) policy and regulation; (b) access to technology; (c) availability and access to information; (d) business models; and (e) finance.

(a) Policy and regulation:

10. PROBIOGAS identified the lack of specific policies for biogas as a key barrier for its development. The complexity of biogas and biomethane (compared to other renewables) is noted, which urges for creating synergies between traditional sectors (such as energy production and organic waste control) and policy integration in two dimenstions, i.e. horizontally between sectors and vertically between the three levels of government. In its PNBB, ABiogás highlights the historical absence of the State to implement regulation and standards for biogas and biomethane and the lack of an overarching policy framework. In recent years, recognition of the strategic importance of biogas is developing but supportive policies and incentives, specifically addressing biogas and biomethane are still incipient. MME's recently launched RenovaBio pursues promoting biofuel market development based on the principle of creating a level playing field for producers differentiated according to specific technologies and sources, which would open up investment opportunities for biogas.[23]
11. Another barrier is the need for articulation of the biomethane value chain (from production to commercialization) and regulation of the actors involved. In fact, a market model for biomethane production could draw to a large extent on the experiences with the promotion of decentralized electricity generation. A key condition for such a market to function is to have guaranteed access for biomethane producers to the gas network.

(b) Access to technology:

12. The implementation of pilot projects demands for a systematic approach, including thorough analysis of experiences and sharing thereof with stakeholders. Currently, this is not taking place in Brazil: doubts persist about the maturity of business approaches, the effectiveness of technical solutions, reliability of components, operational performance, among other aspects. It must be noted that earlier biogas experiences in Brazil – specifically the dissemination of small-scale anaerobic digesters for rural energy supply in the 1970s and 1980s, and the systems installed under the Clean Development Mechanism (CDM) – were soon abandoned due to technical and operational issues, and the collapse of the carbon market.
13. Possible reasons for project failure include: (i) immature designs and engineering; (ii) more demanding user involvement and skills than anticipated; (iii) benefits not meeting expectations; and (iv) lack of effective technical support. In all cases, the approach towards biogas technology was opportunistic and focused on generating short-term benefits, rather than developing a strategic asset to strengthen core business development. In the absence of such commitment, existing installations were not systematically monitored, experiences were not deeply analyzed, and lessons learned were used for follow-up.

(c) Availability and access to information:

14. The diversity of potential markets and business models increases the complexity and efforts required to develop biogas energy projects. Most existing installations were motivated by a need for treatment of effluents and residues, at a minimum capital expenditure. Interest from agroindustries in biogas production has developed only recently driven by considerations of energy costs and a need for compliance with environmental regulation. Several categories of information barriers were found:
15. Information about the legal aspects of biogas production and commercialization. There is a lack of clarity for all stakeholders concerning the legal status of biogas installations and obtained products (biogas, biomethane, bio-fertilizer).

[22] Report "Barreiras e Propostas de Solucoes para o Mercado de Biogas no Brasil", prepared by Consorcio AKUT / Rotaria do Brasil in collaboration with Methanum for the Ministry of Cities and PROBIOGAS, July 2015.

[23] See: "RenovaBio – Diretrizes Estrategica, Poposta Submetida a Consulta Publica", published for public consultation by the Federal Government (MME, MAPA, ANP, EPE), p.4. Available at: www.mme.gov.br (Jan 2017).

16. There is a lack of information on technologies and substrates for effective biogas production. Specifically, stakeholders report a lack of information in Brazil about appropriate biogas technologies and substrates for biogas production.

(d) Business models:

17. Capital and operational expenditures for biogas projects in Brazil are high. Contributing factors include: (i) small market characterized by low demand and lack of competition between providers; (ii) lack of domestic manufacturers and suppliers; (iii) capital-intensive foreign equipment not tailored to Brazilian conditions; (iv) high import duties on foreign equipment; (v) ineffective O&M strategies due to lack of operational experience; (vi) high transaction costs during project development and procurement; and (vii) compliance with high quality standards for commercialization of biogas products (biomethane). The weak financial feasibility of biogas projects not only inhibits upscaling of investment but is also an impediment for technology transfer from abroad and for building a domestic biogas technology base and industry.
18. Meanwhile, the incipient demand for biogas-based energy carriers (biogas, electricity and biomethane) translates into uncertain project revenue streams. There are few opportunities for long-term contracts with third parties at a price level that allows financial closure.
19. There is no open market for commercialization of biomethane to third parties as a substitute for natural gas. The gas market is organized through concessionaries which act as a regional monopolist for gas distribution and commercialization. Forcibly, surplus biomethane must be sold to this company.
20. Energy self-supply options include biogas combustion for process heat, which can be extended to co-generation and tri-generation. Different to typical cogeneration systems, biogas plants are not dimensioned in function of a given heat demand but rather to process a determined effluent stream. The application of the biogas for energy purposes primarily depends on opportunity costs (including the cost of capital for investment). Local electricity generation is valued given its flexibility to drive a variety of energy end-uses; in addition, engine and generator technology is widely understood and accepted. Low-grade heat applications are less relevant in a warm country. Cooling applications based on biogas would be a niche market but have never been demonstrated.

(e) Finance:

21. A number of financing windows exist, which are applicable to biogas; however, these are not specifically geared to the peculiarities of biogas projects and prospective loan takers. Currently family farmers wanting to invest in renewable energy projects only have a limited array of financing options to choose from. Among them the credit line for “Investment in Renewable Energy and Environmental Sustainability” (PRONAF – ECO) from PRONAF. Another credit line is PRONAF – Agroindustries, which provides loan capital for the construction, modernization, expansion and refurbishment of agroindustrial installations, including the integration of renewable energy projects. The payback periods are ten years; interest rates and grace periods are 2.5% and 5 years (ECO), respectively 5.5% and 3 years (Agroindustries).
22. A constraint frequently mentioned by stakeholders involves the need for collateral and/or guarantees. The incorporation of a biogas plant into a company’s balance sheet may work for larger companies but not for smaller (and potentially undercapitalized) family farms. Equity may be used, if available, but would usually be oriented towards core business activities. Biogas installations operated by public entities (such as landfill or sewage facilities) also face financing constraints, as secure public revenues (such as taxes imposed by a municipality for waste collection and other public services) are not accepted to secure finance. Project finance, as commonly applied to renewable energy technologies, is not feasible if revenues are not secured under a long-term PPA. Note that the ANEEL auction system for electricity generators does not offer a fixed feed-in tariff but variable revenues based on a complex calculation. It should be noted that ABiogás has proposed some amendments to this calculation in the PNBB.[24]

(2) The baseline scenario or any associated baseline projects.

Energy sector

23. The Brazilian energy mix is characterized by a high share of renewable energy sources, predominantly ethanol (used for transport), large and small hydropower systems (electricity), and sugar-cane bagasse (for heat and

[24] See: ABiogás PNBB, p. 47-51.

electricity). This situation is the result of national policy formulated in the 1970s and 1980s in an attempt to reduce vulnerability to global oil price markets. Brazil's natural resources in terms of land area, hydrological resources, biomass, and more recently, oil and gas, have been a key asset to achieve this objective. In line with the increase in population and GDP, final energy consumption grew from 102,934 ktoe in 1990 to 196,168 ktoe (2010), and fossil fuels consumption increased from 72,207 ktoe (1990) to 143,831 ktoe (2010). There is a trend towards an increased use of renewable energy sources and higher-quality fossil fuels, at the expense of heavier hydrocarbons including coal, lignite, fuel oil, and charcoal.[25]

24. Brazil's electricity sector is dominated by renewable energy sources (79.3%), primarily hydropower (71%), biomass (8%) and wind energy (1%), as depicted in the below figure. Fossil fuels make up 21% of total generation including natural gas (11%) and oil products (4%).[26] The figures also make evident the traditional focus on large-scale, centralized energy supply systems. However, there is growing awareness that Brazil's continental dimensions are an impediment for bringing centrally produced energy (both electricity and natural gas) to all consumers outside the demand centers in a cost-effective manner. This is also the case in Southern Brazil, where, for example, the gas distribution network is located mainly along the coast.

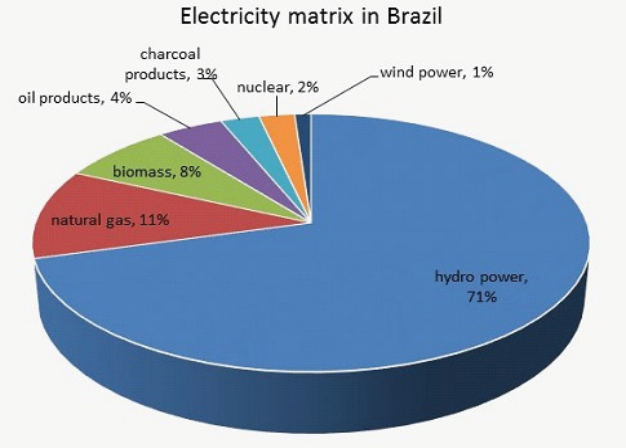


Figure 1: Electricity production in Brazil according to primary source. Source: MME, 2015

25. The cornerstone for Brazil's energy policy is the National Energy Policy (Law 9.478), enacted in 1997, which created the National Agency of Oil, Gas and Biofuels (ANP). The National Electricity Agency (ANEEL) was established one year later by Decree 2,665 (1998). In 2002, support for (non-conventional) renewable energy-based electricity generation was initiated under the Alternative Electricity Sources Incentive Program (PROINFA) programme, set out by Article 3 of Federal Law 10.438 (2002) issued by the Ministry of Mines and Energy (MME).
26. In 2003 and 2004, the Government created a new framework for the national electricity sector, through the enactment of Law 10,847 and 10,848, and Decree 5,163. This framework foresaw in the establishment of an institution responsible for long-term energy planning, the Empresa de Pesquisa Energetica (EPE) which overviews supply security in the electricity market through the Electricity Sector Monitoring Commission (CMSE[27]), including the activity of the Mercado Atacadista de Energia Eletrica[28] (MAE) and the Electric Energy Commercialization Chamber[29] (CCEE).
27. The Regulated Electricity Market[30] (ACR) is made up of concessionaries, which distribute and commercialize electric energy to the (captive) group of regulated consumers. The concessionaries have own generation capacity

[25] Source: Brazil's Third National Communication, Vol III, p.66-67.
[26] Source: Ministry of Mines and Energy, 2015.
[27] CMSE = Comite de Monitoramento do Setor Eletrico.
[28] Electric Energy Wholesale Market.
[29] CCEE = Camara de Comercializacao de Energia Eletrica.
[30] ACR = Ambiente de Contratacao Regulado.

that is complemented by acquiring electricity under a public auction system. In the Unregulated Electricity Market[31] (ACL), electricity generators (including independent power producers, self-suppliers, energy traders and importers) establish bilateral contracts with (unregulated) consumers. Prices in the non-regulated market tend to be 10-30% below ACR levels. In principle, sales of biogas-based electricity through the CCEE can be either to the concessionaries (ACR) or directly to large energy consumers (ACL). Since March 2016, a minimum capacity of 5 MW has been established to enter the CCEE. Smaller power plants are classified as mini-generation (75 kW – 5 MW) which are subject to the ACR but can benefit from the net metering modality introduced by ANEEL regulation RN 482 (2012).

28. The net metering concept is based on energy credits, allowing electricity consumers to inject electricity from small generators into the distribution grid and utilize this at a later moment.[32] ANEEL regulation RN 687 (2015) modifies some aspects of RN 482 and issues technical regulation for distributed generation, including: (i) extension of the validity of energy credits from 36 to 60 months; (ii) utilization of energy credits across multiple connection points owned by the same user (within the same distribution area); (iii) creation of "shared generation" modality, allowing a group of users to form a consortium or cooperative, feed electricity into the distribution grid and consume it at a later moment (with the benefit to reduce energy costs); (iv) extension of the capacity range for mini-generation from 100 kW – 1 MW to 75 kW - 5 MW (3 MW for small hydro); and (v) lowering of the range for micro-generation to maximum 75 kW. The new rules entered into force 1 March 2016.

Biogas in Brazil

29. The use of natural gas in Brazil is largely limited to the larger cities and the coastal regions where piped transport infrastructure is in place. Biogas, being a small-scale and distributed energy source, can be used to complement the large-scale energy networks by providing modern energy forms in areas where grid electricity and natural gas supplies is weak, intermittent, or not available at all. Anaerobic digester technology fits into decentralized development models and is instrumental for adaptation strategies aimed at reducing the exposure of the agroindustrial sector, energy sector, and farmer communities, to the effects of global climate change.
30. The use of biogas cuts across various sectors. In this context, the 5-year PROBIOGAS programme should be recalled, initiated by the Ministry of Cities, through its National Environmental Sanitation Secretariat (SNSA) with supported from the German Government and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.[33] The programme seeks to contribute to the expansion of biogas energy with a focus on urban waste and the sewage sector. PROBIOGAS addressed some of the barriers related to biogas in Brazil but also pointed out the challenges to exploit the great potential for biogas production in agroindustries, industry and the sugar cane sector, as well as the deficits for urban waste and wastewater treatment in Brazil.[34]
31. Nowadays, anaerobic digester technology is acknowledged as one the most efficient and feasible technologies for organic waste treatment, reducing their environmental impact at same time that the biogas produces renewable energy and mitigates GHG emission.[35] Given Brazil's huge dimensions, climate conditions and economic activities, it represents a large potential for biomass production and the sustainable generation of thermal energy products such as biogas and biomethane. The biogas market can be characterized as incipient and, in spite of

[31] ACL = Ambiente de Contratacao Livre.
[32] RN 482 applies to generators using alternative energy sources and for small distributed energy generation.
[33] PROBIOGAS was set up by the Brazilian and German Government to cooperate on biogas for energy promotion. It is a 5-year initiative (2013-2017) with a budget of € 10 million (GIZ) and € 150 million credit implemented by the German Kreditanstalt für Wiederaufbau (KfW). The federal ministries composing the Steering Committee are: Ministry of Cities (MCIDADE), Ministry of Mines and Energy (MME), Ministry of Science, Technology, Innovation and Communication (MCTIC), Ministry of Environment (MMA), Ministry of Industry and Commerce (MCID), and Ministry of Agriculture (MAPA). Please refer to the PROBIOGAS website for more information: http://www.cidades.gov.br/saneamento-cidades/probiogas.
[34] See report: "Barreiras e Propostas de Solucoes para o Mercado de Biogas no Brasil – Probiogas", Consorcio AKUT / Rotaria do Brasil in cooperation with Methanum, PROBIOGAS – Ministry of Cities, July 2015.
[35] The International Energy Agency (IEA) Task Force 37 has several publications and country reports See, for example: "Biogas handbook: Science, production and application", edited by A. Wellinger, J. Murphy and D. Baxter, Woodhead Publishing Series in Energy No. 52, February 2013 (http://www.iea-biogas.net/biogas-handbook.html). A brief overview of the status of biogas in Brazil is provided in the Country Reports Summary 2015, available at: http://www.iea-biogas.net/.

Brazil's industrial capacity, a national value chain serving the biogas market has not yet developed and operational experiences with biogas are limited.

32. Small rural digesters processing livestock residues were promoted during the 70's and 80's, typically focusing household energy needs, representing the first cycle of this technology. Larger digesters were introduced under the Clean Development Mechanism at landfills and wastewater plants, flaring the biogas produced. PROBIOGAS supported the use of biogas for energy purposes from urban waste, resulting in a substantial number of operational biogas systems delivering electricity to the national grid; similarly, a number of private industries have ventured into biogas production, such as Geo Energética (Londrina, PR), based on sugar cane vinasse for now, and Amidonaria Navegantes (Assis Chateaubriand, PR), processing manipueira. Associative or "condominium" production models, as, for example, supported by Itaipu Binacional and CIBiogas, involve simple biodigesters for animal manure linked to a central generator feeding into the distribution grid as in Granja Colombari (São Miguel do Iguaçu, PR).
33. Based on data from the National Institute for Geography and Statistics (IBGE)[36], the biogas production potential is estimated at 296,597 million m^3 biogas per year, equivalent to an energy volume of 424,134 GWh. Animal breeding makes up 3.2% of this total, comparable to the waste sector (3.3%). The largest potential is found in agroindustries (93.5%), specifically the beer breweries (90.1%). Biogas represents 14% of Brazil's total energy potential based on agricultural and industrial residues, the majority being non-woody biomass waste from the sugar cane, corn, soy and cassava sectors (2,615,360 GWh/yr, or 96% of total if combusted for electricity generation).
34. ANEEL's Database on Electricity Generation (BIG)[37] provides information about all authorized power plants under construction and in operation in the country; this database is continuously updated but does not cover micro-generation systems. The biogas plants registered in the BIG account for only 26 out of 4.477 power plants (0.58%) installed in the country and an installed capacity of 87 MW (0.06%) (on a total of 143 GW). Nearly all capacity (83.7MW) is accrued by 14 biogas plants installed at landfills, which demonstrates the incipient stage of biogas energy production in agroindustries. In fact, detailed information on the technology and operational performance of these biogas plants seems not publicly available.

[36] IBGE = Instituto Brasileiro de Geografia e Estatística.
[37] BIG = Banco de Informações de Geração.

BIOMASS AND BIOGAS POTENTIAL FOR INDUSTRIAL AND AGROINDUSTRIAL RESIDUES IN BRAZIL							
SECTOR		FEEDSTOCK	ANNUAL PRODUCTION (TON/YR)		BIOGAS PRODUCTION POTENTIAL (M3/YR)	ENERGY POTENTIAL (GWH/YR)	
			PRODUCTION	RESIDUES			(%)
NON-WOODY BIOMASS	Sugar cane		701,890,694	379,020,986	-	1,684,538	86%
	Corn (milho)		58,350,097	82,857,135	-	407,381	
	Soy		65,319,827	91,447,758	-	370,871	
	Cassava		24,893,634	34,851,088	-	152,570	
SUBTOTAL NON-WOODY BIOMASS BRAZIL						2,615,360	
ANIMAL BREEDING	Aviculture	Chicken manure	1,032,038,992 (head)	154,805,849 (kg/day)	2,825,206,741	4,040.05	14%
	Dairy livestock	Cow manure	38,795,902 (head)	91,170,370 (kg/day)	2,628,897,610	3,759.32	
	Pork farming	Pork manure	22,803,519 (head)	285,043,987 (kg/day)	3,953,560,107	5,653.59	
INDUSTRY AND AGROINDUSTRY	Alcohol and Sugar	Vinasse	27,808,591 (m^3)	333,703,092 (m^3)	3,170,179,374	4,533.40	
	Biodiesel	Glycerol	2,717,483 (m^3)	271,748 (m^3)	67,937,087	97.15	
	Starch factories	Manipueira	519,671	171,491	703,115	1.01	
	Dairy factories (cheese)	Whey	867,100	7,803,900 (m^3)	88,769,363	126.94	
	Citrics	Yellow water	18,012,560	5,403,768 (m^3)	114,613,919	163.70	
	Paper mills	Paper and cellulose	24,078,000	3,900,636,000 (m^3)	3,578,833,530	5,117.73	
	Beer breweries		14,137,049,858 (m^3)	n/a	267,271,219,338	382,198.00	
	Slaughterhouses and meat packers	Bovine	11,862,879	154,217,427 (m^3)	1,323,185,524	1,892.16	
		Pork	3,027,803	39,361,438 (m^3)	340,476,442	486.88	
		Chicken	12,759,628	165,875,163 (m^3)	1,310,413,785	1,873.89	
MUNICIPAL WASTE AND EFFLUENTS	Municipal Solid Waste		59,109,898	n/a	5,910,989,798	8,452.72	
	Waste water plants		9,398,066,253 (m^3)	n/a	357,126,518	510.69	
	Maintenance and pruning		n/a	20,887,745	3,655,355,463	5,227.16	
	Central market residues (CEASAs)		n/a	n/a	n/a	n/a	
SUBTOTAL BIOGAS BRAZIL					296,597,467,714	424,134	
GRAND TOTAL						3,039,494	100%

Table 1: Biomass and biogas potential from industrial and agro-industrial residues in Brazil. Source: SENAI/PR publication "Oportunidades da Cadeia Produtiva de Biogas para o Estado do Parana", 2016 [9].

35. Compared to the use of biomass for energy production, biogas is still in its infancy.[38] Although its most common application is to drive a stationary gas engine for electricity self-supply or interconnection to the distribution grid, alternative uses include process heat production for grain drying on farms, for example; sludge drying in Sewage Treatment Plants (STPs); poultry farm heating; gas lighting; slurry treatment; purification to produce biomethane vehicle fuel; among others. The Biogas Map, compiled by CIBiogas with support from PROBIOGAS, is presumably the most comprehensive database on biogas in Brazil. This database containing 151 elements allows for a characterization of biogas systems per sector (and associated waste type) in terms of penetration rate (number of plants per sector) as shown in the Table below.

CLASSIFICATION OF BIOGAS PLANTS BY BIOGAS END-USE				
BIOGAS END-USE	NUMBER OF PLANTS		BIOGAS PRODUCTION	
	[-]	[%]	[m^3/day]	[%]
Electricity	54	36%	797,269	34%
electricity and other	37	25%	913,560	40%
thermal uses	50	33%	448,862	19%
Biomethane	5	3%	134,900	6%
mechanical power	5	3%	14,720	1%
TOTAL	151	100%	2,309,311	100%

Table 2: Classification of biogas plants by biogas end-use. Data based on Biogas Map (CIBiogas), elaboration by R. Leme [14].

36. Another relevant figure is the average plant capacity (biogas volume produced per day) per sector (see Table below). Here, large differences can be seen. Applications in agro-industries are typically 5-10 times smaller than biogas systems based on landfill gas (86,000 m3/day); intermediate sizes include sewage systems and vinasse (10,000 – 25,000 m3/day). Manure-based systems typically produce less than 10,000 m3/day.

CLASSIFICATION OF BIOGAS PLANTS BY SECTOR AND WASTE TYPE				
SECTOR AND WASTE TYPE		NUMBER OF PLANTS		AVERAGE PLANT SIZE
		[-]	[%]	[m^3/day]
AGRO-INDUSTRIES	pig manure	61	40%	4,359
	co-digestion	13	9%	17,595
	Vinasse	3	2%	24,987
	cattle manure	7	4%	881
	chicken manure	2	2%	575
	slaughterhouse waste	2	1%	2,050
	dairy farm manure	1	1%	1,000
URBAN WASTE	Landfill	15	10%	86,134
	Sewage	9	6%	10,072
INDUSTRIES	food and beverage	38	25%	9,069
TOTAL		151	100%	

Table 3: Classification of biogas plants by agro-industry and waste type. Data based on Biogas Map (CIBiogas) and work by R. Leme [14].

37. In spite of their potential, biogas and biomethane have only been embraced recently by national energy policy. Neither biogas nor biomethane appear in the National Energy Balance (BEN) 2015[39], the Analysis of the Biofuels Sector 2015, or the Statistical Yearbook of Electricity 2015. They are only mentioned in Technical Note 13 (2014), issued by the national agency Energy Research Agency (EPE)[40], which acknowledges their relevance for addressing the limitations of conventional large-scale electricity generation and distribution systems. In December 2016, MME launched the RenovaBio programme with the aim of promoting the expansion and production of

[38] Biomass is an important energy source for electricity and heat production, notably the use of sugar cane bagasse with 388 interconnected cogeneration plants with a total capacity of 10.0 GW (6.9% of installed capacity)
[39] BEN = Balanço Energético Nacional.
[40] EPE = Empresa de Pesquisa Energética.

biofuels in Brazil. Besides securing the competitiveness and credibility, amongst others, of biofuels in the national energy matrix, the programme also intends to contribute to Brazil meeting its GHG emission reduction target of 43% by 2030, which was set at COP21 in Paris. With this recent launch of RenovaBio, biogas and biomethane are now being considered together with other, more traditional biofuels such as ethanol and biodiesel.

38. Biogas can be upgraded to biomethane by purification of the gas and removal of the CO_2. In January 2015, the National Oil Agency (ANP) enacted Resolution No. 8 setting formal specifications in accordance with Technical Regulation 1/2015 for biomethane produced in Brazil. The resolution seeks full compatibility of biomethane with systems for natural gas transport, distribution and utilization. Biomethane can be injected as "green gas" into the gas distribution (piping), allowing low-cost transport over long distances but also be compressed and transported in cylinders (CNG[41]). Users can be the residential sector, gas-fired power plants, and gas filling stations for road vehicles. In 2014, natural gas consumption in Brazil ascended to 72.7 million m^3, which is slightly lower than national production (82.9 million m^3). Since gas imports from Bolivia will likely fall short to meet future demand, biomethane can contribute to energy security and reducing dependence on imported fuels.
39. Some financial incentives are in place for consumers of biogas-based electricity. Since 2007, consumers sourcing at least 50% of the electricity from biogas plants, specifically: landfills, anaerobic digestion of vegetal and animal residues, organic MSW and sewage sludge, are eligible for a discount up to 100% of the electricity tariff.[42] Electricity sector legislation stipulates that the agents in the electricity market (concessionaries, generators, transmission and distribution companies) disburse a percentage of their operational earnings into the Sectoral Energy Fund[43]. Several electricity companies have submitted proposals for biogas-based electricity production under this programme, specifically under the Strategic Call[44] 14 issued by ANEEL (2012), which is still open.
40. Heat production from biogas has a higher energy efficiency than electricity generation (typically 85% vs. 35%, respectively). Heat applications in agriculture and livestock businesses include warming of poultry farms, preparation of animal food, drying of grains, wood, seeds, etc. Combined heat and electricity generation is also possible (co-generation), allowing the highest attainable efficiency with potential cash revenues from electricity sales. A legal impediment is the monopoly of the state gas concessionary to install and operate gas ducts, hence biogas distribution at present is limited to self-supply within a private property or a consortium. Another niche application is small-scale biomethane production for on-site mobility, which offers the highest financial return per unit energy produced. However, commercialization of surplus biomethane must be through the state gas companies, which is a major constraint for upscaling of (private) biogas upgrading.
41. Certain advances in the regulatory framework are made to incorporate biogas (and other small renewables) into the formal energy sector and generate revenues for project owners. In particular biogas installations in larger agrobusinesses and in waste and sewage facilities fit into the mini-generation range (75 kW – 5 MW). Payments offered for biogas-based electricity and gas are still too low for financial closure, presumably with the exception of some large installations selling electricity under the ANEEL auctions. Law project PLS No.433 was proposed in the Senate by senator Cássio Cunha Lima (2015) aimed at amending PROINFA by setting a mandatory minimum share of 15% non-conventional renewable energy technologies, including biogas, for the Brazilian electricity matrix by 2025. However, the political unrest and government changes in 2015/2016 have stalled many legislative processes.
42. There are a reasonable number of national companies developing and implementing biogas projects. The Brazilian industry is relatively new in this field, offering only a modest range of products and models. Covered lagoon type digesters are well developed, associated to pioneer company Sansuy in cooperation with UNESP. Today its horizontal digesters are made in several sizes, using one or two layers of plastic (HDPE or PVC coated polyester), flexible and resistant, and supplied with the required piping and accessories. In 2013, Sansuy launched a plastic digester dedicated to cassava starch industries, whose wastewater is highly pollutant due to cyanate compounds and can be treated by anaerobic digestion.
43. Other national companies supplying the biogas market include BGS, which offers equipment for monitoring digestion and using biogas (burners, stoves, generator sets). Brasmetano supplies stirrers, mixers, screens, filters,

[41] CNG = Compressed Natural Gas.
[42] Segunda Resolucão Normativa 271 ANEEL, 2007.
[43] The Fundo Setorial de Energia (CT-Energ), which is funded through a levy of 0.3-0.4% imposed on the invoiced revenues made by electricity generation, transmission and distribution oncessionaries.
[44] The so-called Chamada 14.

slurry pumps for large digesters, as well as products for using and treating biogas. Ecometano designs projects and feasibility studies for farmers and agroindustries in Brazil with a focus on the waste and sugar cane sector (vinasse treatment). Many foreign companies supplying generator sets and auxiliary component are active in Brazil. An important advantage of national suppliers is their more convenient position to provide after-sales services and maintenance, which is essential for intensively used energy systems. National manufacturing has a cost benefit compared to imported equipment, which is subject to high import duties in Brazil. A list of national companies involved in biogas was compiled by the German-Brazilian Trade Chamber in 2015.[45]

Biogas for agroindustries in Southern Brazil

44. The Project will primarily focus on medium- and small-size agroindustries in the Southern states (Paraná, Santa Catarina, and Rio Grande do Sul). This selection has been made due to the fact that the region is set to become one of the leading protein producing regions of the country in the coming years, entailing various environmental stresses. There is thus a compelling demand for anaerobic digestion of animal manure in the region, especially pig manure. Moreover, agroindustries, including private farmers and cooperatives, in these states acknowledge the potential of biogas for electricity and heat self-supply, as well as its potential as a vehicle fuel. Electricity companies and (state) gas concessionaires in the states have demonstrated interest in the use of biomethane as a substitute for natural gas, as well as in biogas for distributed electricity generation.

Figure 2: Map of Southern states of Brazil (Source: Economist)

45. Livestock breeding (cattle, poultry and pigs) is one the main economic activities in the three Southern states of Brazil: Paraná (PR), Santa Catarina (SC), and Rio Grande do Sul (RS). In 2013, Paraná, the fifth state in Brazil in terms of GDP, was the largest poultry producer in the country (31.1%) followed by Santa Catarina (16.6%), Rio Grande do Sul (14.5%) and Sao Paulo (10.9%). Santa Catarina is the largest pig farming state (24.8%), followed by Rio Grande do Sul (18.0%) and Paraná (14.2%).[46] Other biogas sources relevant for Paraná include sugar-cane vinasse (1.9%), paper mills and cellulose (5.4%), slaughterhouses and meat packers (5.9%), and breweries (66.3%).
46. Brazil has set a goal to double animal protein production over the period 2014-2024, which is hard to achieve if environmental externalities are not mitigated.[47] The National Policy on Solid Wastes, established by Law 12.305

[45] See: report "Zielmarketanalyse: Biogas Brasilien – Energetische Nutzung von Abfällen und Abwässern, mit Profilen der Marktakteure", Deutsch-Brasilianische Industrie- und Handelskammer, Rio de Janeiro, 2 December 2015, p.54 (www.export-erneurbare.de).
[46] In 2012, the number of animals grown in Parana was estimated as follows: poultry 233 million; pigs 5.5 million; and dairy cows: 1.6 million. For the whole of Brazil, these figures ascend to: poultry 1.03 billion; pigs 38.8 million; and dairy cows: 22.8 million.
[47] As formulated by the Programa Mais Carne, launched 18 February 2014 by the Ministry of Agriculture, Livestock and Supply (MAPA). Source: http://www.brasil.gov.br/economia-e-emprego/2014/02/ministerio-da-agricultura-lanca-plano-mais-pecuaria.

(2010) provides the policy framework for controlling effluent control. It pursues the improved management of solid wastes in Brazil, including those generated from agricultural and poultry farming and processing activities. Among other elements, the policy foresees in the adoption, development, and improvement of clean technologies, including anaerobic digester technology, as a way to minimize environmental impacts. However, enforcement of environmental control in practice is still weak in Brazil.

47. Effective effluent treatment and systemic changes in the regional productive systems are necessary to achieve this goal as well as being a key condition for sustained economic growth in the Southern states. Treatment of manure and other organic effluents by anaerobic digester technology can assist in closing nutrient and water cycles and facilitate the integrated production of fodder and animals. Although environmental regulation has been poorly enforced up to now, stakeholders are aware of the unsustainability of current production schemes. Paraná has adopted most federal policies and enacted guidelines for implementing the Low-Carbon Agriculture (ABC) Programme (state Law 17,441/2012). This law requires animal waste to be treated allowing the generation of certified emission reductions. The law further promotes collaboration between state agricultural and environmental agencies and universities, federal entities and financiers.
48. Meanwhile, Paraná has been a net importer of energy over the last decades, obliging the energy companies COPEL and COMPAGAS to import gas, electricity and transport fuel from elsewhere in Brazil.[48] Local biogas production can help mitigate this energy deficit by making use of a locally available biomass to deliver biogas, electricity, or biomethane. Moreover, decentralized renewables such as biogas are an asset for extending the electricity and gas service to more sparsely inhabited areas –especially the natural gas grid is limited to the main urban areas. The energy companies in all three states have demonstrated interest in using biogas (and other renewables) to increase coverage and improve the service.[49]
49. An improved energy supply would contribute to social equity and welfare outside the urban centres. In Paraná, only 14 of the 399 municipalities received gas supplies from state concessionary COMPAGAS. Seven of these are served by compressed natural gas (GNC) distributed by road transport, and seven municipalities[50] (including the main urban centres) are connected to the the piped gas infrastructure. The company envisages extending the piping network around the capital Curitiba[51] but also considers the use of biomethane. In May 2016, COMPAGAS entered into an agreement with CIBiogas to jointly develop biogas and biomethane projects in Paraná.[52]
50. A recent publication (2015) supported by CIBiogas[53] outlines the potential and opportunities for biogas technology in Paraná. The annual biogas energy potential from poultry, dairy cows and pig farms was estimated at 1,846,560 GWh/yr. For state-level policy and planning purposes, assessments were performed for the ten subregions defined within Paraná state. The available biogas energy would be sufficient to meet the electricity demand of over 700,000 people in Paraná[54]. In September 2016, a map of biomass resources became also available for the state of Rio Grande do Sul, compiled by the state gas company (SULGAS), the state Secretariat of Mines and Energy, and the Universidade Integrada do Vale do Taquarí (UNIVATES).[55]
51. The three states have advanced in regulation of renewable energies and waste treatment during the recent period. Among other instruments, the Paraná Programme for Renewable Energy was established by State Decree 11,671/2014 with the objective to promote production and consumption of renewable energy by small industries

[48] Source: "Oportunidades da Cadeia Produtiva de Biogas para o Estado do Paraná¨, SENAI/PR, ISBN 978-85-5520-015-1, Curitiba (PR), Brazil (2016), p.94.
[49] For more information refer to the websites of COMPAGAS (PR): www.compagas.com.br; SULGAS (RS): www.sulgas.rs.gov.br; SCGAS (SC): www.scgas.com.br.
[50] Including the capital Curitiba and con-urbanized towns (Sao Jose dos Pinhais, Campo Largo, Araucaria) and Balsa Nova, Palmeira and Ponta Grossa. Source: "Oportunidades da Cadeia Produtiva de Biogas para o Estado do Paraná¨, SENAI/PR, ISBN 978-85-5520-015-1, Curitiba (PR), Brazil (2016), p.96-98.
[51] Including the municipalities Quatro Barras, Colombo, Pinhais, Campina Grande do Sul, Castro, Carambei, Sao Mateus do Sul, and Lapa. The investment would amount to R$ 84.2 million, to be executed before 2019.
[52] See: http://www.compagas.com.br/index.php/noticias-rodape/462-compagas-e-cibiogas-assinam-termo-para-conducao-de-projetos-de-biogas-e-biometano-no-parana.
[53] Report: Oportunidades da Cadeia Produtiva de Biogas para o Estado do Parana, FIEP-SENAI-PR, with support from CIBiogas and PROBIOGAS, Curitiba, 2016, p. 30 ff.
[54] At an estimated average electricity demand of 217 kWh/month. The number of people served (about 700,000) is equivalent to the combined population of the towns Londrina and Paranaguá in Paraná and roughly 6.5% of the total population of the state of Parana (about 11 million).
[55] Atlas das biomassas do Rio Grande do Sul para produção de biogás e biometano / Odorico Konrad et al. - Lajeado : Ed. da Univates, 2016. ISBN 978-85-8167-166-6.

prioritizing regions with lower human development indices. The Decree explicitly mentions biogas. The Programme stipulates the creation of a financing line for renewable energy projects by the Regional Development Bank for the Far South (BRDE), which was launched in 2015.

52. In 2016, the Rio Grande do Sul enacted a state Policy on Biomethane (State Law 4,864/2016). This extensive policy acknowledges the potential benefits of biogas and biomethane for local development. It seeks economic valorization of organic waste and reduction of GHG, proposes mechanisms for fostering the biomethane value chain in RS, and aims to secure biomethane purchases by the state concessionary SULGAS. Paraná and Santa Catarina have similar law projects under development.[56] These initiatives demonstrate a general understanding at state level of the systemic importance of organic waste treatment and valorization, and the role of local energy production including biogas and biomethane.

Biogas in agricultural policies and programmes

53. Brazil has invested in the sustainability of its agricultural sector. By means of research and technological development, the country has an important role in global food production. Production capacity has intensified from 1.2 t/ha to 3.4 t/ha over the last 35 years. The Low-Carbon Agriculture (ABC) Plan was established in 2011 as a government instrument to increase the area under sustainable agricultural practices. The ABC Plan aims to control and reduce GHG emissions by the agricultural sector, which represent 35% of the total.[57]
54. The objectives of the ABC Plan include, among others: (a) to ensure continuous and sustained improvement of management practices in Brazilian agriculture that can reduce GHG emissions and; (b) to encourage the adoption of sustainable production systems such as Crop-Livestock-Forestry Integration (CLFi); (c) to encourage animal manure treatment for the generation of biogas and organic compound; and (d) to reduce the deforestation resulting from the expansion of livestock farming and other factors.
55. The ABC Plan observes that Brazil produces about 180 million tons of stabled waste and effluents from pigs, cattle and poultry farming per year. Anaerobic digestion has been identified as the key technology for processing this waste stream and producing biogas and bio-fertilizer. The Plan acknowledges the following benefits: (i) mitigation of environmental impacts compared to the business-as-usual scenario (no treatment); (ii) reduced emissions of methane and other GHG gases; (iii) increased supply of biogas; (iv) increased energy supply; (v) production of bio-fertilizers (liquid and solid); (vi) reduction in the use of synthetic fertilizers; (vii) reduced production costs; and (viii) provision of new income sources for farmers. The ABC plan commits a GHG emission reduction of 6.9 M ton CO_{2eq} from the treatment of 4.4 million m^3 of manure over the program period until 2020 (see table below for further details).

GHG COMMITMENTS UNDER THE FEDERAL LOW-CARBON AGRICULTURE PROGRAMME (ABC PLAN)		
TECHNOLOGICAL PROCESS	COMMITMENT (INCREASE AREA/USE)	MITIGATION POTENTIAL (MTON CO2eq)
Recovery of degraded pasture lands	15 million ha	83 – 104
Integrated Farming-Livestock-Forestry	4 million ha	18 – 22
No tilling practices	8 million ha	16 – 20
Biological nitrogen fixation	5.5 million ha	10
Planted forests	3 million ha	-
Animal waste treatment	4.4 million m^3	6.9
TOTAL		133.9 – 162.9

*Table 4:*GHG Commitments defined under MAPA's Low-Carbon Agriculture Programme.
Source: Third National Communication of Brazil to the UNFCCC, Vol. II, p.50 (Table 1.5) (2015).

[56] Note that there is a dispute whether or not states have the competence to legislate about biogas and biomethane. The State of Parana was working on a draft bill on biogas, but it was considered unconstitutional by the Commission of Justice and Constitution and thus rejected by Parana's house of representatives. The state of Santa Catarina is currently discussing a Draft Bill on agro-energy which encompasses biogas. See: Annex K.

[57] Brazil's Third National Communication, Vol. III, p.44.

56. The ABC Plan has nationwide coverage, and the formal participation of states and municipalities is encouraged. The Ministry of Agriculture, Livestock and Supply (MAPA) is responsible for coordinating the Plan through a National Executive Committee, linked to the Interministerial Committee on Climate Change. State Managing Groups[58] (GGE) were created at the state level for the decentralization of the ABC Plan.[59] Civil society organizations have also been concerned with the issue of growing GHG emissions from this sector. In May 2013 the ABC Observatory was launched, which is an initiative aimed at engaging society in the debate on low carbon agriculture coordinated by the Center for Studies on Agribusiness of the Getulio Vargas Foundation.[60]

Baseline project

57. The baseline project consists of a set of federal and state policies and programmes, and initiatives by energy and agricultural sector organizations and enterprises aimed at pushing forward biogas and biomethane energy production and utilization in Brazil. Given the federal structure of the country, with decentralized public agencies and replicated, autonomous government structures in the provinces, the number of sector, initiatives and stakeholders involved is substantial. The set of initiatives and activities by various public and private entities encompasses: (A) the federal government; (B) Itaipu Binacional and CIBiogas; (C) electricity and gas companies in the prioritized three states (Paraná, Santa Catarina and Rio Grande do Sul); (D) the sector organizations ABiogás and FAEP; and (E) research agencies and universities. All of which directly contribute to the objectives of the proposed Project.

(A) Federal Government

Ministry of Science, Technology, Innovation and Communication (MCTIC)

58. Traditionally the Ministry of Science, Technology, Innovation and Communication (MCTIC) has had a strong emphasis on research for the biofuel markets, specifically ethanol and biodiesel. With the publication of the ANP specification in January 2015, that allows biomethane produced from agroindustrial residues to be fed into the gas network and used as a vehicle fuel, the focus of MCTIC has also shifted towards the inclusion of biogas and biomethane. In fact, due to the heightened interest in this sector demonstrated by the inclusion in the RenovaBio programme as well as the work being undertaken by other actors such as CIBiogas, MCTIC is currently structuring a program to support biofuels, in which biogas and biomethane are listed as priorities, through its innovation agency, the Funding Authority for Studies and Projects (FINEP). The programme will encompass credit lines focused on financing the entire production chain. The expectation is that there will be financing lines for small, medium-sized and large enterprises, with different rates according to the size of each project. These lines of credit will be continuous and will be available over a period of 10 years. Project submissions shall be accepted on a rolling basis and the programme is expected to kick off during Q2, 2017 with an initial focus on ethanol.

Ministry of Mines and Energy (MME)[61]

59. Planning of the energy system is carried out under the guidelines of the Ministry of Mines and Energy (MME), through decennial studies reviewed on an annual basis, the so-called Ten-Year Energy Expansion Plan (PDE). The plan consists of defining a reference scenario for the implementation of new facilities in the infrastructure of energy supply. Decree No. 7,390/2010, in its Article 3, considers the PDE as the sectoral plan on mitigation and adaptation to climate change for the energy sector. According to Article 5 of this Decree, emissions projections from the energy sector would for 2020 be 868 Mton CO2eq under the baseline scenario. The adoption of the actions established in the PDE will reduce emissions by 234 Mton CO_2eq.
60. The 20-Year PROINFA programme, launched by MME in 2002, initiated support for non-hydropower renewable energy electricity generation in Brazil. The programme, which is ongoing, aims at the inclusion of 3.300 MW renewables into the Brazilian electricity grid by 2022, by imposing a mandatory 10% share of biomass, wind, and small hydropower. Under Brazil's power auction model, construction and operating concessions have been awarded to bidders offering the lowest annual revenue since 2005 (CGEE, 2012). By the end of 2011, a total of

[58] GGE = Grupos Gestores Estaduais,
[59] Each Managing Group is coordinated by the representative of the respective State Secretariat of Agriculture, with the main participation of MAPA, the State Secretariat for the Environment, the Brazilian Agricultural Research Corporation (Embrapa), State Organizations of Agricultural Research (OEPAs), and official banks as well as with the integration of representatives of the civil society (productive sector, workers, universities, research centers, cooperatives, Agriculture Federation, NGOs etc.).
[60] For more information: http://www.observatorioabc.com.br/
[61] Source: TNC, Vol. II.

119 undertakings have been implemented, with 41 wind energy plants, 59 SHPs and 19 biomass-fired power plants (ELETROBRAS, 2015).

61. The Biofuel Law 12.490 (2011) gives extensive support to the incorporation of sugar-cane bagasse for electricity production and to the development of biofuel technology and production (biodiesel). This law sets a framework for: (i) promoting biomass-based electricity generation and the use of byproducts from biofuel production for energy production; (ii) attracting investment capital for a biofuel transport and storage infrastructure; (iii) strengthening Brazil's position in the international biofuel markets; (iv) promoting research and technology development in the field of renewable energies; and (v) mitigation of energy and transport sector GHG emissions by the use of biofuels.

62. The earlier mentioned RenovaBio programme encompasses four lines of action: (a) platform for dialogue with the private sector about the role of biofuels in Brazil's energy matrix; (ii) economic, financial and environmental sustainability; (iii) framework for commercialization of biofuels; and (iv) support for new types of biofuels.[62] For the first time biogas and biomethane are included among the sources of biofuels along with biodiesel, ethanol and biokerosene. In this context, the Biofuture Platform presented at COP22 is also to be mentioned; it has been created to boost the use of biofuels in Brazil and in the international market.[63]

Ministry of Agriculture, Livestock and Supply (MAPA)

63. The Ministry of Agriculture, Livestock and Supply (MAPA) is responsible for the development of the large agricultural sector in Brazil, as well as for national food security. It also plays a pivotal role for the development of biofuels and for promoting low-GHG emission practices, the latter being pursued through the Low-Carbon Agriculture Plan (2011). The ABC Plan commits a GHG emission reduction of 6.9 M ton CO2eq from the treatment of 4.4 million m^3 of manure over the program period until 2020.

64. A credit line was established action under the ABC Program by Resolution No. 3,896 of the Bank of Brazil on August 17, 2010, which is open for rural producers including individuals, legal entities and their cooperatives. Interest rates range from 4.5% and 5.0% and up to 15 years for amortization.[64] By December 2014, 32,310 contracts had been approved, with a total disbursement of USD 3.18 billion[65] to structuring projects recommended by the ABC Plan countrywide. The budget for the ABC Plan amounts to USD 0.70 billion[66] (2017).

65. Furthermore, already in 1994, the National Programme for Strengthening Family Farming (PRONAF)[67] was created with the understanding that the majority of agricultural businesses in Brazil are small-scale family farms. While initially endowed with a credit line of USD 31.8 million[68], the capital mobilized through PRONAF has grown to USD 4.64 billion[69] in the current harvest year (2016/17). The objective of PRONAF is to allow family farms to access investment capital and become more efficient and competitive. PRONAF received a major boost under the former governments, which assigned it to the Ministry of Agrarian Development (MDA), which since 2016 no longer exists as such. According to MDA figures, family farming attained annual productivity increases of 3.8% over the last decade.

66. Biogas is an eligible technology under the ABC Plan and PRONAF. The Bank of Brazil reports expenditures on animal manure treatment under the ABC Plan of about USD 10.49 million[70] during the last 5 year period, and expects to implement credits of the order of USD 1.59 million[71] in manure treatment technology in 2017.

Ministry of Environment (MMA)

67. The Ministry of Environment (MMA) has been responsible for the elaboration of Brazil's Nationally Determined Contribution (NDC) under the Paris Agreement. The NDC of Brazil commits the country to reducing greenhouse gas emissions by 37% below 2005 levels by 2025 with a subsequent indicative contribution of reducing greenhouse gas emissions by 43% below 2005 levels in 2030. To this end, the country intends to increase the share

[62] Source: http://www.mme.gov.br/web/guest/pagina-inicial/outras-noticas/-/asset_publisher/32hLrOzMKwWb/content/mme-lanca-renovabio-e-marca-reabertura-do-dialogo-com-o-setor-sucroenergetico.
[63] See: http://www.brazilgovnews.gov.br/news/2016/11/brazil-launches-platform-to-boost-biofuel-market
[64] More information available at: http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Programas_e_Fundos/abc.html.
[65] Original value is BRL 10 billion. Exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017
[66] Orignal value is BRL 2.2 billion. Exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017
[67] PRONAF = Programa Nacional de Fortalecimento da Agricultura Familiar.
[68] Orignal value is BRL 100 million. Exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017
[69] Orignal value is BRL 14.6 billion. Exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017
[70] Orignal value is BRL 33 million. Exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017
[71] Orignal value is BRL 5 million. Exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017

of sustainable bioenergy in its energy matrix to approximately 18% by 2030, to restore and reforest 12 million hectares of forests, as well as to achieve an estimated 45% share of renewable energy in the composition of the energy matrix in 2030. The share of sustainable bioenergy encompasses also biogas and biomethane.

Ministry of Development, Industry and Foreign Trade (MDIC)

68. The Ministry of Development, Industry and Foreign Trade (MDIC) is responsible for the development policy on industry, trade and services; intellectual property and technology transfer; metrology, standardization and industrial quality; foreign trade policy; regulation and implementation of programs and activities related to foreign trade; assess and apply trade remedies; and, participation in international trade negotiations. MDIC participated in the inter-ministerial meetings that were part of PROBIOGÁS and intends to continue its engagement in the promotion of biogas / biomethane for industries. It will form part of the inter-ministerial coordinating unit to be set up.

Ministry of Cities MCIDADES/SNSA) - PROBIOGAS Programme

69. The PROBIOGAS Brazilian-German technical cooperation project, coordinated by the Ministry of Cities and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), encompassed a network of partnerships in the governmental, academic and business spheres. To achieve its objective, PROBIOGAS focused on four main action lines during its project lifetime (2013-2017): (a) Survey on biogas potential, dissemination of basic information and improvement of framework conditions; (b) Capacity development: Support for professional training and capacitation of institutions and relevant agents for the consolidation of the theme in Brazil; (c) Academic and business partnerships: Support for the development of academic and business partnerships between Brazil and Germany; and (d) Good practice and reference projects: Technical support for potential reference projects for the sector.

(B) Itaipu Binacional and CIBiogas

Itaipu Binacional

70. Besides operating one of the largest hydropower plants in the world, Itaipu Binacional is committed to sustainable development and the promotion of renewable energy. Moreover, it is an important driver for economic development in the Southern part of Brazil, especially for Paraná. A direct interest to engage with biogas technology was the need for reverting eutrophication from agroindustrial effluents, which affected the Itaipu dam reservoir. In order to address this need, a biogas study centre and a laboratory was set up in 2008; CIBiogas was formally constituted in 2013.

71. Over time, Itaipu Binacional has invested significantly to: (i) set up CIBiogas facilities and build human capacity; (ii) register and formally accredit the laboratory (with INMETRO); (iii) execute programmes with partners (such as ongoing involvement in BiogasFert); (iv) support initial biogas projects in the Southwestern part of Paraná, such as in the Entre Rios municipality, and the "Agri-energy Cooperative for Family Farming" project, among others.[72] In 2015, the company acquired 30 Fiat light cars to operate with biomethane, which is initially drawn from the Haacke Farm near Santa Helena. Early 2017, a small biomethane production plant will become operational at the Itaipu premises. Baseline funding provided by Itaipu Binacional amounts to US$ 18.5 million over the period 2015-2018 and covers committed expenditures to ongoing programmes and activities, as well as the in-kind value of CIBiogas facilities and field projects (Entre Rios, amongst others).

International Center on Renewable Energy - Biogas (CIBiogas)

72. The International Center on Renewable Energy Biogás (CIBiogas) was established to promote sustainable development of the biogas value chain. CIBiogas has its headquarters in the Itaipu Technology Park (PTI), in Foz do Iguaçu. It has a qualified Biogas Laboratory accredited by the National Metrology Institute (INMETRO) and ISO 17025, which is used to evaluate the biogas production potential from different substrates and support biogas projects. CIBiogas has set up a map of existing and planned biogas installation in Brazil with support from the PROBIOGAS programme, which is accessible online.[73]

73. CIBiogas has been implementing small-scale biogas and biomethane projects since 2013. One pioneer experience (2006) is the pig breeding farm Granja Colombari in São Miguel do Iguaçu (PR), which uses biogas from animal manure to drive a generator supplying electricity to COPEL's distribution grid. The farm holds 5,000 pigs

[72] See also: https://www.itaipu.gov.br/tecnologia/itaipu-e-energias-renovaveis.
[73] See: https://cibiogas.org/biogasmap.

producing 45m^3 of liquid effluent daily, which is processed by two covered-lagoon digesters in batch configuration. The current production capacity is 750 m^3 biogas per day and about 1,000 kWh electricity per day. This farm served as a model for other plants, such as the Haacke farm dedicated to poultry and cattle breeding. Part of the biogas is used for electricity self-supply and part is fed into a biomethane upgrading unit with a capacity of 50 m^3 biogas per hour based on pressure swing adsorption technology. The obtained biomethane is compressed to 250 bar and stored in cylinders for utilization within 60 vehicles of the fleet of Itaipu Binacional.

74. In addition, the Agroenergy Condomium for Family Agriculture of Sanga Ajuricaba, in the municipality of Marechal Cândido Rondon (PR) should be mentioned. This project demonstrates an associative business model, which connects 33 small pig and dairy farms – each equipped with a simple anaerobic digester – by a 25.5 km low-pressure biogas pipeline. Up until now, the biogas has been used as a fuel for household stoves and for grain drying. The collected remaining biogas drives a 100kVA generator, set which was initially conceived for electricity self-supply. Since 2014, the condominium operates interconnected to the COPEL distribution grid.[74] The next table gives an overview of biogas plants producing electricity as developed by CIBiogas:

BIOGAS PLANTS IMPLEMENTED WITH SUPPORT FROM CIBIOGAS (2016)[75]					
PLANT NAME	START YEAR	FEEDSTOCK	BIOGAS PRODUCTION	PROCESSED EFFLUENT VOLUME	ENERGY PRODUCTION
			M^3/DAY	M^3/DAY	kWh/day
Granja S. Pedro Colombari	2006	pig manure	750	40-60	1,000
Condominio Ajuricaba	2009	cattle and pig manure	821	48	350
LAR Cooperativa Industrial	2009	poultry slaughterhouse residues	1,700	960	biogas used as fuel
Fazenda Iguacu - Starmilk	2009	cattle manure	1,440	200	1,500
Pig farm Itaipulandia	2009	pig manure	1,450	140	1,800
Amidonaria Horizonte	2010	cassava starch wastewater	10,800	1,470	biogas used as fuel in boiler
Amidonaria Navegantes	2011	cassava starch wastewater	20,000	570-1,620	biogas used as fuel in boiler
Amidonaria San Jose	2012	cassava starch wastewater	15,000	1,800	biogas used as fuel in boiler
Pig farm Serranopolis	2012	pig manure	1,000	140	1,400
Granja Haacke	2013	poultry manure	1,000	100	n/a

Table 5: List of biogas plants implemented with support from Itaipu Binacional and CIBiogas. Compiled by L. Horta, 2016 [13].

Itaipu Technological Park Foundation (FPTI)

75. In 2003, the Itaipu Technological Park (PTI) evolved from the village and training centers put in place for the construction of the Itaipu Binacional Hydropower plant. Installed in the buildings formerly occupied by the workers, the present PTI acts as a regional centre for research, education, technology development, and entrepreneurship. Educational programmes cover vocational training, and academic graduate and post-graduate levels. The PTI community engages approx. 2,000 people, including staff, trainees, researchers and teachers. Partnerships with public and private entities are a key element of PTI's strategy for implementing educational and R&D programmes. Entrepreneurs can take benefit from these programmes, with PTI providing specific support for business start-ups (incubator concept). In 2006, the PTI Foundation (FPTI) was created for managing the Itaipu Technological Park.[76]

[74] IEA bioenergy working group Task 37 provides a detailed description of the Ajuricaba project, available for download at: http://www.iea-biogas.net/files/daten-redaktion/download/case-studies/brazil_web_Final.pdf.
[75] For information about biogas installations developed with support from CIBiogas, please consult: https://cibiogas.org/uds/.
[76] For more information, please refer to: https://www.pti.org.br/.

76. FPTI has funded staff costs for CIBiogas since 2013, which amount to USD 369,645[77] over the last 3-year period. It has further absorbed operational costs related to the facilities used by CIBiogas, up to USD 189,408[78], adding to a total of USD 559,053[79].

(C) Electricity and gas companies in the prioritized states

Companhia Paranáense de Energia (COPEL)

77. COPEL, established in 1954 is active in the fields of electric power generation, transmission and distribution, as well as in telecommunications. It is the largest enterprise in Paraná. Among its assets are power plants, transmission lines, substations and electricity distribution networks; it further owns a modern optical telecommunications networks that covers all cities of Paraná. As an average, each year about 70,000 new connections are established, covering practically 100% of urban households and 90% in the rural areas. COPEL actively engages in research and development of biogas-based solutions, not only through its support of the Entre Rios project but also through a large-scale, 5-year programme to investigate the possibilities of hybrid RE solutions that include biogas together with wind and/or solar ('GERA Rural').

Companhia Paranáense de Gás (COMPAGAS)

78. The Companhia Paranáense de Gás (COMPAGAS) is responsible for the distribution of natural gas in Paraná, serving customers in the residential, commercial and industrial sectors; as well as natural gas for vehicle fuel. Its business strategy is focused on expansion of the gas network by investing in long-distance connections with the objective to increase coverage and capacity, and supply more regions and municipalities of Paraná state with natural gas. In addition, COMPAGAS is also interested in creating decentralized gas grids that support communities further away from the main city (Curitiba), including on the basis of biomethane.

Companhia de Gás do Estado do Rio Grande do Sul (SULGAS)

79. The Companhia de Gás do Estado do Rio Grande do Sul (SULGAS) is the enterprise responsible for the commercialization and distribution of ducted natural gas in the state. It is a mixed-capital society established in 1993, the shareholders being the Rio Grande do Sul State and PETROBRAS Gás S/A – Gaspetro. Once the gas line connecting Bolivia and Brazil has been completed, commercialization of natural gas started in the year 2000. At present, SULGAS has only been engaging in R&D activities with regards to biomethane. They are involved in a pilot project producing 1000m3 of purified biomethane per day together with Ecocitrus and Janus & Perger. The proejc tis used to generate data to facilitate commercial uptake of similar installations at a later stage. SULGAS also plans to hold a public call for biomethane in the near future.

(D) Sector organizations

Brazilian Association of Biogas and Biomethane (ABIOGÁS)

80. The Brazilian Association of Biogas and Biomethane (ABiogás) is a non-governmental, not-for-profit organization, which associates industries and institutions involved in biogas and biomethane development. ABiogás promotes the interests of national and international companies that are part of the biogas and biomethane value chain, by promoting the use of these energies and their integration into Brazil's energy mix. It organizes seminars, workshops and congresses targeting selected sectors (such as agroindustries), to give exposure to new technical developments and applications, and to attract the attention of policy makers and investors.[80]

81. Late 2015, ABiogás prepared a proposal for a national policy on biogas and biomethane, the PNBB, which was submitted as a discussion paper to the Ministry of Mines and Energy (MME) early 2016. The PNBB includes a series of specific proposals to enhance existing legislation and procedures, including: the creation of an inter-ministerial committee; tax simplification, tax incentives, regular public bids for energy acquisition; better adequation on existing financing lines; biogas project finance; creation of a guarantee fund for biogas projects; simplification on environmental licensing for biogas projects.

[77] Orignal value is BRL 1,162,386. Exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017
[78] Orignal value is BRL 595,666. Exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017
[79] Orignal value is BRL 1,758,052.58. Exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017
[80] See: http://www.abiogas.org.br/eventos

Agriculture Federation of the Paraná State (FAEP)

82. FAEP was founded to represent the interests of rural producers and affiliated trade unions with the aim of contributing to the creation of prosperity among the sectors it represents. It operates in several areas and provides assistance to rural producers with regards to issues of concern, focusing on the social, economic and political development of the rural producer in Paraná. Activities encompass information provision, services, studies and projects, and training. In this way, the study and development of alternative solutions to the issues related to agricultural activities, with a view to improving the quality of life and generating employment and income for the sector are promoted and the adoption of rules, standards and training aimed at raising the productivity indexes of agriculture and livestock, by improving working methods and marketing processes, are enhanced. FAEP entertains 11 technical committees, focusing on different agricultural sub-sectors and also has one focusing on the environment.
83. Anaerobic generation has attracted the interest of the top management of FAEP as a viable solution for an integrated approach to effluent management and sanitation on farms. Furthermore, the added co-benefits of energy security and bio-fertilisers are highly valued, especially for the drier and economically weaker agricultural areas, where soils have often been overexploited. In order to foster knowledge and awareness of this technology among the farmers, four study tours to Austria, Germany and Italy are being organised from May 2017 onwards.

(E) Research agencies and universities

Brazilian Agricultural Research Corporation (EMBRAPA)

84. The Brazilian Agricultural Research Corporation (EMBRAPA) is the leading R&D institution in agriculture, livestock and agroindustry in Brazil. It has been a prominent factor to explain the development of the Brazilian agriculture since the 1980s. Among the several Embrapa's research centers, the most active in anaerobic digestion is the EMBRAPA Swine and Poultry Research Center in Concordia (SC). Other research centers involved with anaerobic digesters are the EMBRAPA Suinos e Aves (Swine and Poultry) Research Center in Sete Lagoas (MG) and the EMBRAPA Dairy Cattle Center in Juiz de Fora (MG).[81]
85. The project BiogasFert started in 2013 in support of MAPA's ABC Plan[82]. The project is led by EMBRAPA Swines and Poultry Research in Concordia and has set up a network of laboratories and technology institutes to develop biogas and biofertilizer technologies for different agricultural and livestock production systems. The virtual library of EMBRAPA offers for download publications related to biogas production and biofertilizer utilization, most of them focusing on units at household or farm level, for processing manure from cattle, swine and poultry.

Universities and research institutes

86. Research undertaken at Brazilian universities often responds to the priorities set forth by funding bodies such as the sectorial strategic programmes, for example, ANEEL's Strategic Program 2015 calling for R&D in the field of power generation from landfill and municipal solid waste. Universities involved in biogas include:
    - University of Campinas (Unicamp),
    - University of São Paulo (USP),
    - Universidade do Oeste do Paraná (UNIOESTE),
    - Federal University of Paraná (UFPR),
    - Federal Technological University of Paraná (UTFPR),
    - Federal University of Santa Catarina (UFSC).
    - Faculdade de Ciências Agrárias e Veterinárias (Campus Jaboticabal, Universidade Estadual Paulista (UNESP);
    - Universidade Estadual de Maringá (UEM);
    - Universidade Federal de Lavras (UFLA);
    - Latin America Federal Integration University (UNILA),
    - Universidade Federal Rural do Rio de Janeiro;

[81] For background information please consult: Embrapa's experience with swine manure anaerobic digestion, by Kunz, A.; Biogas purification, by Pergher, G.D.; Digesters for swine manure treatment, by Konzen, E.A. and Biodigester effluents and their impact as soil fertilizer, by Seganfredo, M.A. (Embrapa Suínos e Aves, 2006).

[82] For more information, see: http://www.cnpsa.embrapa.br/biogasfert/.

- Escola Superior de Agricultura Luiz de Queiroz da Universidade de São Paulo (ESALQ/USP);
- Universidade Federal da Grande Dourados UFGD; and
- Universidade Integrada do Vale do Taquarí (RS).

87. Other institutions occasionally develop activities or projects on biogas production, such as the agricultural extension state agencies (EMATER83) and state agricultural research institutes, such as the Instituto Agronômico do Paraná (IAPAR), Empresa de Pesquisa Agropecuária de Minas Gerais (EPAMIG) and Instituto Agronômico de Campinas (IAC) and Instituto de Zootecnia (IZ) in São Paulo.

Gaps related to the baseline project

88. Several gaps have been identified with regards to the baseline project. These have been detailed below. Gaps relate specifically to (a) policy and regulation; (b) access to technology; (c) availability and access to information; (d) business models; (e) finance.

(a) Policy and and regulation:

89. Advances in direct regulation for biogas include the technical specification of biomethane (ANP 8/2015), eligibility of biogas under ANEEL Strategic Call 14 (2012); and the inclusion of biogas under ANEEL auction "A-3" for 2017; indirectly biogas benefits from the recent net metering framework (ANEEL RN 482/2012). Notwithstanding, stakeholders consulted agree about the need to establish a comprehensive regulatory framework, including the removal of impediments created by existing legislation, which in effect requires a more holistic, inter-sectoral approach. With a view on electricity generation, there is scope for fine-tuning of the conditions and payment modalities under the auction system to the profile of biogas-based power plants.
90. Worthwhile mentioning are the implications of the state monopolies as established in Art. 177 of the Federal Constitution and the Gas Law, which regulates activities such as the transport and storage of piped natural gas. Current gas legislation does not acknowledge the very different origin and socio-economic characteristics of biomethane, for which the monopolized model is counterproductive.[84] This barrier can be addressed by narrowing down the scope of existing natural gas legislation and issuing complementary regulation for biomethane, the latter being the mandate of ANP under Art.8-XVI of the Petroleum Law 9.478 (1997).
91. A key condition for a biomethane market to function is to have guaranteed access for biomethane producers to the gas network. A second condition is the possibility for gas network operators to switch between natural gas and biomethane, assuming the latter complies with the technical specifications as defined in ANP resolution 8/2015. Draft regulation for (operational) switching between both sources has been prepared by ANP. ABiogás recommends the creation of state-level bodies (representing prospective biomethane producers and gas distribution companies) to assess the capacity of the distribution grid for biomethane injection.
92. Regulatory barriers also exist related to the transport of manure and digestate across farm properties as well as waste transport across municipalities, both of which are not regulated at the moment. Specific regulation is also lacking concerning installation safety, certification of designs and materials, and environmental licensing.

(b) Access to technology:

93. It is assumed that available biogas technologies – especially for smaller and medium-sized operations – are not well matched to the specific circumstances in Brazil and would required adaptation in terms of processes, materials, and cost profile ("tropicalization"). The requirements will vary according to region, substrates and project scale. However, detailed assessments at system, component, and equipment level have not been made; by consequence, specific proposals for tropicalization are not available. A survey of the technical and operational aspects of the (modest number of) existing biogas projects in Brazil would provide more insight.[85] Sharing of information and experiences is key condition underpinning such analysis.
94. Stakeholders further mention a lack of national enterprises with a proven track record in the operation of biogas plants and the commercialization of obtained products. Stakeholders are hesitant whether success stories from abroad would be replicable under local conditions. This can be explained from the incipient status of the biogas market in Brazil. While such experience exists among specialized foreign companies, the lack of immediate market

[83] EMATER = Empresa de Assistência Técnica e Extensão Rural

[84] Note that, as a consequence of this monopoly, holders of low-pressure ducted networks for biogas must pay royalties to the state gas company, even if these networks are located on-farm and funded by the owner.

[85] Note that a systematic survey of biogas systems was recently produced by INTI in Argentina. See: http://www.probiomasa.gob.ar/_pdf/Relevamiento%20Biodigestores%20VF%20PROBIOMASA.pdf.

prospects inhibits these from entering the country and assuming upfront costs and risks. By consequence, the process of technology transfer to Brazilian companies and other market actors does hardly develop, notwithstanding demonstrated interest from national companies and other countries.[86]

(c) Availability and access to information:

95. The outreach of information and knowledge about business approaches, the commercialization of biogas and related products, cost aspects, financing, and other aspects of biogas plants, is inadequate. Existing incentives and financing instruments are insufficiently promoted among biogas producers and project developers. Due to a lack of awareness and practical information, available financing windows for biogas R&D are poorly exploited.[87]
96. There is an asymmetry in terms of access to information. Farmers cannot verify if information is accurate and reliable and are hesitant to accept advices offered by providers and energy professionals as these may not be independent and objective. Information issues are further caused by the difficult access to information (if existent), and a general culture of not sharing information and experiences. By consequence, business opportunities are not recognized, project development costs are elevated and perceived risks are high which in turn, increases capital costs and undermines profitability.

(d) Business models:

97. In the absence of a more supportive policy framework and established demand markets, current business projects are largely ad-hoc, with smaller biogas projects more focused on energy self-supply. Larger projects (such as those based on sugarcane vinasse) can deliver to the electricity market. The sugarcane sector also has the benefit of a long history of energy generation; it can draw on internal know-how (reducing project development and transaction costs) and benefits from economies of scale.
98. Business models based on electricity sales to third-parties include bilateral contracts with non-regulated consumers (Ambiente de Comercialização Livre - ACL). In order to be financially attractive for a consumer, ACL prices should be below those on the regulated market (Ambiente de Comercialização Regulada - ACR). In 2014 this was not the case however, as ACR prices were as low as 169 R$/MWh[88], compared to ACL prices in the range of 200-250 R$/MWh[89]. Since current cost prices for biogas electricity are above ACR prices (for long-term contracts under the auction schemes), biogas is unlikely to compete. As such, the most viable business opportunities are either self-supply (thereby avoiding the costs of grid electricity) or, delivery to the ACR under auctions dedicated to specific renewable energy sources, such as biogas.[90] Under such a bidding process, biogas projects would compete in terms of generating costs, triggered by setting (progressive) benchmarks. Barriers to this model are: (i) the low actual benchmark values (Valor de Referência - VR) under the auctions, which are out of reach of biogas; and (ii) the weak position of biogas projects to warrant energy supply under a long-term contract.[91]
99. Electricity self-supply becomes especially attractive in case of high energy tariffs (either for grid electricity, piped or compressed natural gas, or vehicle fuel). For electricity, the net metering system adds flexibility to the self-supply modality by temporarily storage of energy into the grid, from which it can be retrieved later. ANEEL Resolution 482 (2012) provides the legal basis for this mechanism. Self-suppliers must be connected to the distribution grid and are presently limited to 1 MW. Storage and retrieval of electricity is based on a system of energy credits, which expire after 60 months.
100. Regional gas companies in Paraná (COMPAGAS), Santa Catarina (SCGAS) and Rio Grande do Sul (SULGAS) have demonstrated interest in sourcing biomethane for two reasons: (i) the opportunity to incorporate a renewable energy source, thereby diversifying supply and reducing sector GHG emissions; and (ii) to take benefit from local

[86] For example, a business mission was held by the German-Brazilian Trade Chamber to Rio Grande do Sul and Rio de Janeiro from 24-28 October 2016. Another match-making event was held in Sao Paulo in November 2016 under the EU Programme Low Carbon Business Action in Brazil.

[87] For example Call 14 issued by ANEEL (2012); credit lines managed by BNDES, Fomento Paraná.

[88] USD 53.74/MWh at today's prices (exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017).

[89] USD 79.50/MWh at today's prices (exchange rate used from http://www.xe.com/currencyconverter/ on 16 April 2017).

[90] Note that the auction system is based on average prices. If biogas-based electricity was used to avoid peak diesel power with estimated generating costs of R$ 650 per MWh (about 230 USD/MWh), the sector could substantially reduce costs. Note that total installed diesel capacity in Brazil is about 8.5 GW.

[91] For a detailed description of the auction model refer to, for example the: "Zielmarketanalyse: Biogas Brasilien – Energetische Nutzung von Abfällen und Abwässern, mit Profilen der Marktakteure", Deutsch-Brasilianische Industrie- und Handelskammer, Rio de Janeiro, 2 December 2015, p.54 (www.export-erneurbare.de).

biomethane production to expand the consumer base, specifically by compressed gas delivery in areas not covered by the natural gas pipe infrastructure.

101. Business models into this direction require synergies between the supply side (agroindustry) and demand (gas companies) under which a range of ownership, financing and O&M modalities may emerge (joint-ventures, equipment lease, specialized maintenance services). Joint-ventures may lead to benefits including increased technological level, economies of scale, long-term supply agreements, and improved access to capital and tax benefits, among others. Under this model, the biogas producers would be price taker, with price levels largely being determined by the natural gas markets. Monetarization of avoided externalities would allow for a higher price to be paid for biomethane[92]. Compared to electricity production in a stationary gas engine, purification of biomethane to meet ANP standards requires additional investment. Other cost factors include the compressor station (for filling the gas cylinders) and the transport infrastructure.

102. As a general appraisal, biogas self-supply business models tend to be based on low-cost technology to cover energy needs with a high value, including back-up power for critical business operations, such as (electrical) ventilation of pig and poultry farms. A metric to assess the value of biogas electricity in such cases could be the cost of unserved energy calculated for the national grid.

(e) Finance:

103. Complex tax regulation is an impediment for many investors to benefit from existing instruments and exemptions; this barrier affects small companies more than large ones, as these usually can draw on more extensive knowledge and counseling. The tax regime varies from state to state. ABiogás presents an overview of the applicable tax basis and opportunities to introduce benefits for biogas and biomethane installations (taxable assets) and the products they deliver (energy, fertilizer, services), which are subject to earning taxes and value-added tax (VAT). Similar to components for wind turbines in Brazil, tax exemptions can be introduced for materials and components for biogas technology, such as gas engines.[93]

104. Moreover, there is a lack of awareness and specific knowledge in the financial sector, including federal entities such as the BNDES, FINEP, Caixa Econômica Federal, to properly evaluate technical and financial aspects of biogas projects. Better streamlining of financial instruments and the establishment of specific windows for project categories (such as biogas) would help concentrating the know-how and human resources skilled for addressing them.

Problem statement

105. The development problem associated with the utilization of biomass residues and organic waste in agroindustries is formulated as follows: *"The introduction of biogas technologies for energy self-supply and sales of electricity and biomethane to energy market agents, is hampered by a range of barriers related to policy and regulation, technology, business models, and access to consolidated information."* This problem leads to a series of social, economic, environmental and public health externalities including the production and release of the greenhouse gases CO_2 and CH_4 into the atmosphere, contributing to global warming.

(3) The proposed alternative scenario, GEF focal area[94] strategies, with a brief description of expected outcomes and components of the project.

Development objective

106. The objective of the Project has been formulated as follows "To reduce GHG emissions and dependence on fossil fuels through the promotion of biogas-based energy and mobility solutions within agro-industrial value chains in Southern Brazil and strengthening of national biogas technology supply chains."

Long-term solution

107. The proposed solution is oriented towards: (i) enhanced coordination between key sectors to improve ownership of the biogas subject at the federal level (agriculture, energy and environment); (ii) preparation and adoption of

[92] Such as branded by SULGAS (RS) as Gas Natural Verde (GNVerde).
[93] For a more exhaustive overview of tax aspects of biogas installations in Brazil, see ABiogás PNBB, p.35-42.
[94] For biodiversity projects, in addition to explaining the project's consistency with the biodiversity focal area strategy, objectives and programs, please also describe which Aichi Target(s) the project will directly contribute to achieving.

policy instruments in the field of energy markets, agriculture, environment, fiscal policy and incentives; and technical regulation targeting compliance with safety and environmental standards; (iii) validation and dissemination of information to key stakeholders, covering data on biogas potential, biogas and biomethane technologies, validated business models, and other information relevant to project developers; (iv) increase interest among investors in biogas and biomethane technologies by demonstration of high-potential business cases and facilitating market upscaling.

108. The Project is aligned with GEF-6 CCM-1 Program 1 by timely development, demonstration and deployment of mitigation options (renewable energy technologies); by accelerating market uptake through the design and implementation of supportive policies and mechanisms; and by enhancing articulation between stakeholders and increasing technical capacity levels and know-how. Obtained greenhouse gas reductions extend to the replacement of fossil fuels by the national energy sector, as well as the avoidance of CH4 from effluents produced by agroindustries, primarily pig farms.

Project strategy

109. The Project "Biogas applications for the Brazilian agro-industry (GEF Project ID 9057)" will pursue its objective through the following components:

1. Policy framework and information.
2. Biogas and biomethane technology and value chain.
3. Demonstration and optimization of biogas projects. And:
4. Monitoring and evaluation.

110. The estimated total project budget is US$ 65,392,070, including a grant of US$ 7,000,000 that is sought from the GEF to cover incremental costs. The proposed GEF-funded activities will trigger market development for biogas-based renewable energy technologies compared to the baseline scenario. GEF-funded activities will further create investment opportunities, thereby mobilizing capital resources from third parties.

Project components

111. The envisaged Project outcomes and outputs are described in the following paragraphs. Please refer to the Strategic Results Framework for the proposed progress indicators and targets.

COMPONENT 1. POLICY FRAMEWORK AND INFORMATION

112. The objective of this component is to streamline and complement policies and regulation to accelerate the market for biogas and biomethane in Brazil. Key government stakeholders at the national level include MCTIC, MME, MAPA, MMA, MDIC and MCIDADES; other stakeholders include Itaipu Binacional, CIBiogas and ABiogás. This component aims to accelerate the implementation of a supportive regulatory framework at the federal level. Besides the electricity market, the Project aims to strengthen the policy framework for decentralized biomethane production and distribution. Specific regulation will cover safety, sanitary and environmental aspects of biogas installations, including transport of organic substances.

113. This component aims to facilitate access to finance by project owners by adjusting existing financial instruments. Existing financing instruments need to the tailored to the needs and characteristics of (smaller and medium-sized) agrobusinesses and be actively promoted. Proposals into this direction have been prepared by ABiogás and included in the PNBB. Since tax regimes vary from state to state, a practical approach will be followed targeting the three Southern states of PR, SC and RS. The Project will further advocate for more rewarding prices for biogas-based electricity and biomethane sold to energy market agents. The internalization or avoidance of environmental externalities (including GHG emissions) by agroindustries would justify such a price premium. The RenovaBio programme can provide an entry point for discussions at the federal level. As part of the Project's exit strategy, this component aims to anchor supportive, specific regulation and incentives for biogas into sectoral plans programmes at the federal level and in the targeted states.

114. In addition, this component will facilitate the generation, validation and consolidation of information on biogas and biomethane technology and market development, making it accessible to public and private stakeholders alike. The aim being a significant contribution to the strengthening of national biogas technology supply chains.

Outcome 1.1: Enhanced inter-ministerial coordination and implementation of policies, regulation and instruments to promote the adoption of biogas and biomethane energy systems based on agroindustrial organic waste (GEF US$ 860,000; co-finance US$ 5,800,000).

115. Outputs under this outcome are to be lead and sustained by MCTIC and MME with the support of the other involved authorities.

Output 1.1.1 Establishment of an inter-ministerial coordinating unit on biogas policy and technology development receiving tailored expertise from the Project (GEF US$ 190,000; co-finance US$ 1,000,000).

116. This output aims to foster coordination between key authorities in the field of biogas and biomethane policy at the federal level, including energy (MME), agriculture (MAPA), environment (MMA), technology and innovation (MCTIC), industries (MDIC) and cities (MCIDADES). The output is aligned with recommendations made by the PROBIOGAS programme and the PNBB to coordinate the policy development process at both the strategic and regulatory – more technical – levels, in the understanding that effective biogas policy should pursue energy sector objectives as well as promote the interests of the agricultural sector, in particular the producers of biomass feedstock. Relevant elements for shaping the agenda of the coordinating unit include the RenovaBio programme, law project PLS 433, draft bill 6559/2013 (MDA) and the ABiogás National Biogas and Biomethane Plan (PNBB), among others.

117. This output will facilitate the implementation of high-level working sessions (with participation of the key ministries) with the direct objective to structure the policy-making process and push forward the development of specific policy, technical regulation and incentives, according to the needs and priorities established.

118. The identified activities are the following:

1.1.1.1 Definition and approval of the mandate and procedures for inter-ministerial coordinating unit by participating ministries.

1.1.1.2 Technical, liaison and administrative support for coordinating unit by a project consultant.

1.1.1.3 Technical support for internal analysis and policy development by a project consultant.

Output 1.1.2 Updating and detailing of federal and state policies and programmes, and regulatory and financial instruments to facilitate biogas and biomethane market development based on agroindustrial organic waste (GEF US$ 420,000; co-finance US$ 1,000,000).

119. This output aims to complement the existing body of legislation and regulation and enhance consistency with overarching energy, agricultural and environmental policy (including climate change policy), focusing on: (i) biogas for energy self-supply in agroindustries; (ii) biomethane for mobility; (iii) biogas for distributed electricity generation, and (iv) biomethane for state gas markets. It will depart from existing regulation including ANP biogas resolution 8/2015, ANEEL resolutions 482 and 687, and the law projects mentioned under output 1.1.1. Relevant regulation at state level (Parana) includes: Decree 2101 (2003) on on-farm biofuels, Law 12.493 (1999) on waste reduction, and Law 17.441 (2012) on low-carbon agriculture. In Rio Grande do Sul: the biomethane law 14.864 (2016).

120. This output further addresses regulatory voids that affect the legal status and operation of biogas energy systems. Specific regulation is needed concerning technical specifications and safety aspects of biogas installations. As a minimum, regulation of biogas plants should cover the following aspects: (i) definitions and concepts; (ii) classification of installations (buildings, vessels and containment facilities, drainage and piping, charge and discharge, fire protection and control); (iii) zoning of risk areas; (iv) active and passive protection measures; containment measures; special measures for biogas storage; (v) fire hazard management and control. With respect to digestate, this output pursues to: (i) establish technical and environmental parameters to be met by digestate in function of the biomass feedstock used; (ii) define and regulate the procedures and technical measures related to transport and disposal of digestate; and (iii) incorporate and regulate the use of digestate as an organic fertilizer. In addition, this component can provide inputs for MAPA and state governments to foster local or national markets for organic fertilizer to replace mineral nutrients.

121. This output will improve existing financing instruments for biogas and biomethane production, thereby focussing on the specific needs and circumstances of small- and medium-scale agroindustries. In spite of recently enacted programmes, including the biomethane incentives programme in Rio Grande do Sul (Law 14.864), credit lines (BOB, BRDE), VAT exemptions (Parana, Decree 6080 (2012), capital costs for investment by (usually family-run) agrobusinesses remain high due to bank costs, required collateral and/or lack of economies of scale.

The establishment of a guarantee mechanism may represent an alternative to direct collateral from the borrower, as recommended by ABiogás in the PNBB.

122. Alternative financing options may also result from innovative arrangements between biogas producers and external buyers (gas and/or electricity market agents), in which part of the production chain is owned by the buyer (electricity generator and grid interconnection; biomethane plant, compressor station and CNG distribution vehicles). Other options include leasing arrangements and joint-ventures. Work into this direction can build upon initial experiences gathered in Parana and Rio Grande do Sul as promoted by CIBiogas, COPEL, SULGAS, and others.

123. The activities identified under this output include the following:

1.1.2.1 Development of proposals for adaptation of federal energy policy instruments, regulation and financial instruments to support biogas-based electricity generation.

1.1.2.2 Development of proposals for adaptation of federal and state gas sector regulation to foster the production and utilization of biomethane.

1.1.2.3 Design of proposals for environmental and sanitary regulation to facilitate biogas project and market development.

1.1.2.4 Design of one or more proposals for monetarization of the environmental benefits of anaerobic digester technology.

1.1.2.5 Design of proposals for adaptation of existing credit instruments to match the specific circumstances of small and medium-scale biogas and biomethane investments.

1.1.2.6 Study to explore the feasibility and structure of a financial guarantee mechanisms to support investments in biogas and biomethane energy projects.

Output 1.1.3 Integration of biogas and biomethane into federal and state-level energy and agriculture sector programmes (GEF US$ 150,000; co-finance US$ 2,800,000).

124. This output aims to anchor biogas and biomethane technologies into energy, agricultural and environmental sector policies and programmes. Government recognition of these renewable energy technologies has grown during the last years as demonstrated by policy projects (EPE Technical Note 13 (2014), law project PLS 433 (2015)), energy sector programmes including PROINFA (electricity) and – recently – RenovaBio, the agricultural programmes (ABC Plan, PRONAF), and the sectoral GHG mitigation plans. Notwithstanding, existing programmes still lack specific mechanisms and targets for effectively supporting the implementation of biogas and biomethane technologies by market actors. The programmes are not well matched to decentralized technologies such as biogas in terms of project scale and operational characteristics. There is also a lack of mechanisms for effective engagement of energy sector programmes with biomass producers (in particular family-run pig farms), which explains the need for coordination with the agricultural sector at federal and state level. Specific programmes state level include the Parana Programme for Renewable Energy (Decree 11.671 (2014), the Climate Change Policy (law 17.133 (2012)) and the Parana Low Carbon Agriculture (law 17.441 (2012)).

125. This output aims to address these barriers and streamline support for biogas technology under these programmes. GEF financing is used for hiring of short-term consultancies (national and/or international) to provide expertise, perform reviews and issue recommendations for enhancement.

126. The envisaged activities under this output include:

1.1.3.1 Analysis of opportunities and mechanisms to promote biogas and biomethane production under energy and agricultural sector programmes (including RenovaBio, ABC Plan, PRONAF).

1.1.3.2 Technical support for formal incorporation of biogas and biomethane technology into sector programmes.

Output 1.1.4 Design of an MRV system for tracking of GHG emission reductions from anaerobic digestion in agro-industries (GEF US$ 100,000; co-finance US$ 1,000,000).

127. With a view to climate change policy, this output attempts to integrate biogas into sectoral GHG emission reduction plans. Monitoring, Reporting and Verification (MRV) procedures are essential for assessing the environmental services delivered by biogas systems in agroindustries, in particular the avoidance of methane releases from animal manure. This output will support the Ministry of Environment (MMA) to set up an MRV system targeting agroindustries. GEF funding will be available for functional design and specification of the system, development of relevant ICT modules, and embedding thereof into the designated institution(s). Funding will further cover training on the use of the system, including verification of input information.

128. The envisaged activities under this output include:

1.1.4.1 Design and implementation of a Monitoring, Reporting and Verification (MRV) system covering biogas and biomethane projects in agroindustries.

1.1.4.2 Training for the optimal use of the system.

Outcome 1.2: Information on biogas and biomethane technology and market development updated, consolidated and made accessible to public and private stakeholders (GEF US$ 835,000; co-finance US$ 3,470,000).

129. Outputs under this outcome are to be initially lead by the Project. However, it is envisaged that the BIP will be hosted by an existing agency in the field of bioenergy that can provide institutional support and long-term sustainability.

Output 1.2.1 Collection, validation and publication of technical, legal, economic, and other relevant information for biogas market development based on agroindustrial organic waste (GEF US$ 535,000; co-finance US$ 2,000,000).

130. This output will address the general lack of consolidated data and methodologies to assess the economic, financial and technical performance of biogas and biomethane projects, as identified during the PPG phase. It will complement baseline activities on mapping of biogas potential in selected states and agroindustrial sub-sectors including, as a minimum, the livestock sector (pig farming, cow farming and poultry) with a focus on the Southern states Paraná, Santa Catarina and Rio Grande do Sul. Process parameters, feedstock properties, conversion efficiencies and emission factors will be reviewed and validated to enable accurate predictions of biogas production per process type, as well as attainable GHG emission reductions. The information collected will be used as input for policy development, for orientation of technological innovation, and for the design of consolidated business models.

131. This output will assess technical and economic aspects of biogas production systems, including scenarios for transport of biomass feedstock (logistics). A survey will be conducted to determine investment and operating costs of installed biogas and biomethane systems in Brazil[95]; a comparison will be made with installations in other countries and relevant conclusions will be drawn. Peer review of deliverables and working methodologies will be considered, and would benefit from UNIDO's role in related programmes in countries in the region (Argentina, Uruguay, and Chile), where considerable know-how is being built.

132. This output encompasses the following activities:

1.2.1.1 Field research and analysis to collect and validate relevant information on biogas and biomethane.

1.2.1.2 Design and delivery of information packages and publications differentiated according to stakeholder type.

Output 1.2.2 Operationalization of a Biogas Information Platform (BIP) to update, manage and disseminate validated information to stakeholders (GEF US$ 300,000; co-finance US$ 1,470,000).

133. The purpose of this output is to establish a Biogas Information Platform (BIP) that assumes the following functions: (i) collection and validation of information on legal, technical, financial and operational aspects of biogas and biomethane plants; (ii) effective dissemination of such information to stakeholders, including local authorities, energy market agents and project developers; and (iii) to act as a clearinghouse for information, inquiries, experiences and proposals from and for sector stakeholders. This output responds to the identified barrier that information and know-how on biogas technology is currently scattered, difficult to access and poorly exchanged. For more information about the design process and stakeholder consultations carried out during the PPG phase, reference is made to Annex L.

134. It is envisaged that the BIP will be hosted by an existing agency in the field of bioenergy that can provide institutional support. Continuation of the platform after Project termination can be achieved by embedding into the host institute or a biogas network and cost recovery through membership fees and payment for delivered services. GEF funding during the first years of the platform will cover operational costs (staffing) to deliver information services to the target public. Among other functions, a help-desk will be implemented to address user's questions about all aspects of biogas project development.

135. Project funds will further be used to design and implement an internet-based (ICT) platform (database and user interface) to facilitate access to information. The BIP will be responsible for managing the platform and validating stored information, and continuous enhancement with calculators and other tools in support of biogas and biomethane project developers. Among other functions, the system is expected to provide up-to-date information for project developers on legal and regulatory aspects of biogas and biomethane installations; biogas production;

[95]Please note that it was not possible to gather this information during the PPG phase due to a lack of consolidation of available data as well as confidentiality constraints.

technologies; model contracts, business opportunities; financial incentives; and valorization of environmental benefits including GHG emission reductions.

136. The following activities have been identified under this output:

1.2.2.1 Verification of appropriate host institution for approval by the Project Steering Committee.

1.2.2.2 Administrative and technical support for BIP by a project consultant.

1.2.2.3 Design and implementation of an internet-based platform and database to facilitate access through updated information for stakeholders.

1.2.2.4 Provision of help-desk services to stakeholders.

1.2.2.5 Periodic monitoring of PIB's effectiveness by collection and analysis of user's feedback.

COMPONENT 2. BIOGAS AND BIOMETHANE TECHNOLOGY AND VALUE CHAIN

Outcome 2.1: Strengthening of the biogas and biomethane value chain by promotion of cost-effective, standardized technologies, consolidation of market strategies and business models, and transfer of know-how and skills to project developers and other stakeholders (GEF US$ 2,525,000; co-finance US$ 14,924,070).

137. This project component is designed to close identified gaps along the biogas and biomethane value chain in Brazil. Its specific objective is to strengthen the supply side of the biogas market by consolidating legal, economic, financial and institutional aspects of biogas production plants (output 2.1.1), and by making a contribution to the adaptation of biogas technology to local conditions which will translate into reduced investment and operational costs and increased plant performance and reliability (output 2.1.3). Instrumental to this objective are the development and adoption of technical standards and guidelines for biogas and biomethane production plants (output 2.1.2) and the transfer of know-how and skills to biomass owners, project developers and plant operators (output 2.1.4). In this regard, cooperations with universities and research institutions will be promoted; particularly, train-the-trainer concepts are to be encouraged to assure long-term sustainability. With respect to technology adaptation ("tropicalization"), this component will engage with current network initiatives including BiogasFert, sector associations (ABiogás), CIBiogas and other stakeholders to prioritize the technological challenges and define a work programme for "tropicalization". Following Project closure, it is expected that the activities initiated are continued by these lead entities. A selection of proposals will be prioritized and submitted to the Steering Committee for financial support from the Project.

138. During the PPG phase a series of initiatives by energy companies focused on sourcing of biogas-based electricity and biomethane to expand their customer base, increase reliability of the energy service and reduce their GHG footprint was identified; warranting further support (output 2.1.5). This output aims to accelerate the market pull for biogas and biomethane by assisting the energy sector to: (i) design intelligent market introduction strategies; (ii) explore joint ventures with agro-industries (with potential benefits in terms of access to finance and fiscal benefits and enhanced project management and operation schemes); and (iii) increase know-how with respect to scalability and logistics of biomethane production and transport. These inputs will enable energy companies and biogas producers to enhance their value proposition, which is critical in a market characterized by low prices. It is expected that activities under this output are not only lead by the various regional market actors but are also to be incorporated and followed up in their long-term planning.

Output 2.1.1 Validation of biogas and biomethane business models for agroindustries, including associative biogas production schemes (GEF US$ 170,000; co-finance US$ 650,000).

139. This output will deliver consolidated business models for ownership and operation of biogas and biomethane energy systems covering the legal, management and operational aspects thereof, among others. The objective is to provide off-the-shelf solutions for project structuring by market parties (project developers, biomass owners, energy companies), which is particularly relevant given the incipient status of the market, the typically small scale[96] of the energy projects considered, and the lack of experience with such projects by the agricultural sector. The availability of proven arrangements and contracts will increase trust by stakeholders and reduce transaction costs. This output will draw upon the experiences from pioneer projects by CIBiogas and Itaipu Binacional, COPEL, SULGAS and others.

140. Given their complexity, this output will make a detailed assessment of the roles and responsibilities of the actors involved in associative biogas production schemes, such as the "condominium" model promoted by

[96] Please note that under Brazilian market conditions, this would entail a maximum size of between 1-5MW.

CIBiogas and Itaipu Binacional. This encompasses an analysis of current experiences with digester operation by individual farmers and its impact of project performance. Other aspects to be reviewed include maintenance and repair services. Although farmers can assume some tasks of biogas operation, a rational approach based on cost-effectiveness and minimization of operational risks is essential to ensure uninterrupted system operation; which is a prerequisite for biogas producers selling energy (electricity or biomethane) to the energy companies. A controlled, predictable energy production adds value and enables biogas producers to negotiate a higher price.

141. The following activities are envisaged under this output:

2.1.1.1 Survey of existing existing biogas projects in agroindustries including the collection of technical, financial and operational information.

2.1.1.2 Review and consolidation of project evaluation methodologies, for approval by project partners and peer reviewers.

2.1.1.3 Preparation of detailed case studies of existing biogas and biomethane projects in agroindustries (including associative production models) and identification of boundary conditions, opportunities and constraints.

Output 2.1.2 Preparation of recommendations and guidelines for standardization of technical designs, feedstock, equipment, and operational procedures for biogas production schemes (GEF US$ 280,000; co-finance US$ 674,070).

142. The lack of standardized biogas system designs, operating parameters including feedstock composition, components and equipment, and operational procedures is a major barrier leading to sub-optimal, ad-hoc solutions with reduced performance, cost-effectiveness and maintenance characteristics. The lack of standards is also a serious impediment for component suppliers to enter the market.

143. This project output will depart from an inventory of currently used technologies, equipment and practices in biogas plants in Brazil. It will further draw on experiences and technical standards in use in other countries. In dialogue with the sector and considering specific needs for local standards (see output 2.1.3), a work list of technical issues will be drafted for further development. The immediate objective of this output is to define and promote voluntary standards and best practices; sector stakeholders will be engaged during the complete development cycle. If feasible and considered appropriate, the Project will seek formalization of specific standards through the designated authorities in Brazil, including INMETRO. The BIP will play a pivotal role in disseminating the results of this output.

144. The activities identified under this output are the following:

2.1.2.1 Inventory and analysis of current practices and technologies for biogas and biomethane production by agroindustries in Brazil.

2.1.2.2 Preparation of recommendations and guidelines for standardization of technical designs, equipment, feedstock, processes and operational procedures.

2.1.2.3 Stakeholder consultation of recommendations and guidelines and prioritization in function of identified needs and benefits.

Output 2.1.3 Adaptation of equipment, components and processes for biogas and biomethane production to local socio-economic and technical conditions ("tropicalization") (GEF US$ 1,570,000; co-finance US$ 9,500,000).

145. This output will prioritize opportunities for adaptation of biogas and biomethane technologies to the specific conditions and market circumstances of Brazil and generate detailed proposals to start innovation into this direction. Activities under this output will be focused on – but not limited to – the context of industries in the Southern states of Brazil. Opportunities for adaptation exist with respect to anaerobic digester designs and processes; integration into agroindustrial core business activities; selection of construction materials; cost reduction; process operation; and control systems and strategies including online monitoring. With respect to biomethane production, the following should be mentioned: scalability and system sizing; biogas collection and purification; and biomethane storage, transport and logistics. Another field of adaptation includes the availability of appliances for efficient energy end-use. This output will draw upon the experiences being gained by pioneer installations, such as the Itaipu mobility pilot, CIBiogas demonstration pilots, SULGAS mobility pilots, etc.

146. The following table provides a list of identified technological challenges for biogas and biomethane development in Brazil, with a focus on smaller systems in the range of 500 – 20,000 m^3 biogas per day as relevant for the context of Southern Brazil (pig farming, dairy farming, cassava starch, meat processing (slaughterhouses),

etc.). The listed challenges, which were identified by national consultancies and expert consultations undertaken during the PPG phase, are complementary to baseline work such as carried out under the BiogasFert programme.

CHALLENGES FOR BIOGAS TECHNOLOGY DEVELOPMENT FOR BRAZILIAN MARKET	
PRIORITIZED CHALLENGES	
	Anaerobic digester designs and concepts
	Integration of manure and digestate production in overall farm management
	Standardization of components
	Cost reduction of anaerobic digester systems
	Opportunities for cost reduction of biomethane technology
	Low-capacity gas engines range and microturbines
	Biogas boilers
OTHER RELEVANT CHALLENGES	
	System and anaerobic digester sizing
	Materials for anaerobic digester, piping, valves
	Methane leakage control systems
	Biogas burners
	Process control systems
	Operational procedures and personnel safety
	Sizing of biofertilizer production systems
	Sizing of biogas upgrading plant for biomethane production
	Mobile biogas upgrading
	Issues with intellectual or industrial property right (patents etc).

Table 6: Challenges for biogas and biomethane technology development in the Brazilian market. Based on stakeholder consultations carried out during the PPG phase.

147. The concepts and designs produced under this output will be available for third parties to initiate (public or proprietary) technology and product development processes. The concepts can be used for underpinning partnerships between national companies and foreign technology suppliers. GEF funds under this output can also be used for scoping of innovation opportunities in support of Brazilian companies and partnerships, on the condition that results are public. This modality will reduce initial financial risks and upfront costs for companies interested in entering the biogas and biomethane market.

148. The activities pursued under this output include:

2.1.3.1 Preparation of conceptual designs and proposals for technological and process innovation and adaptation of biogas and biomethane technologies to local circumstances and market demands.

2.1.3.2 Prioritization of proposals and definition of an innovation and adaptation work programme, to be approved and evaluated annually by the Project Steering Committee.

2.1.3.3 Establishment of partnerships between national and foreign companies for supplying technology, components and integrated systems to the Brazilian biogas and biomethane market.

2.1.3.4 Adaptation of biogas and biomethane designs, equipment and components in accordance with established work programme.

Output 2.1.4 Implementation of training, capacity building and promotional activities for biogas producers, project developers and other stakeholders (GEF US$ 230,000; co-finance US$ 800,000).

149. This output will design and implement training activities for biogas producers, project developers and other stakeholders. Relevant topics include: (i) process monitoring and operation; (ii) arrangements for sourcing of biomass feedstock, including co-digestion; (iii) monitoring of feedstock composition for anaerobic digestion plants; (iv) control and optimization of process parameters for anaerobic digestion plants; (v) safety of biogas installations; and (vi) planning and execution of maintenance and repair activities. Project funds will be used to

hire one or more specialized companies or institutions to implement the requested services. The training material developed under this output will include manuals and tutorials for future reference and post-project training. Cooperation with local universities and national research bodies wil be emphasised as will train-the-trainer concepts.

150. This output further aims to increase awareness and understanding of biogas and biomethane technology and investment projects. Envisaged activities include workshops and events targeting policy makers, officers from electricity distribution companies and cooperatives, electricity system regulators, environmental authorities, sector organizations, financial sector, civil society organizations, and others, on specific aspects of biogas projects, such as: (i) social and environmental impact, (ii) applicable regulation and permitting procedures; (iii) project development cycle; (iv) project finance; and (v) socio-economic benefits and opportunities. GEF funding will be used for the organization and hosting of events and workshops, promotional material, local travel, and sundries.

151. The following activities are proposed under this output:

2.1.4.1 Design of training programme on technology and operation of biogas and biomethane systems in coordination with agroindustry sector organizations and other stakeholders in Southern Brazil.

2.1.4.2 Production of material for on-distance learning and presential education.

2.1.4.3 Implementation of training and capacity building activities for agroindustries in Southern Brazil.

2.1.4.4 Implementation of promotional events to exchange know-how and experiences with biogas and biomethane technology among agroindustries and other stakeholders.

Output 2.1.5 Development and approval of market introduction strategies and business models for biogas-based electricity and biomethane by electricity and gas companies in Southern Brazil (GEF US$ 275,000; co-finance US$ 3,300,000).

152. This output will engage closely with the demand side of the biogas market, specifically the electricity distribution companies and the (state) gas companies in PR, SC and RS. Several of these companies have biogas and biomethane pilots running and are interested in further developing the market. Examples of these initiatives are a biomethane waste collection truck operated during the 2014 World Football Championship (SULGAS); the Ecocitrus biomethane project with Cooperativa Vale (SULGAS); distributed electricity generation with the Municipality of Entre Rios (COPEL) and Itapiranga (ELETROSUL), among others. However, a comprehensive view on the market and corporative strategies and action plans are still lacking. There is a lack of methodologies and tools to evaluate scenarios for decentralized biomethane production, compression and transport and optimize costs and logistics, necessary for strengthening the value proposition for biogas-based energy. GEF funding under this output will cover the cost of expert consultancies and specialized services.

153. The activities proposed under this component are as follows:

2.1.5.1 Review of scenarios and options for biogas and biomethane market introduction strategies and business models for electricity and gas companies.

2.1.5.2 Consultations to discuss strategies and business models with companies, agroindustries and other stakeholders.

2.1.5.3 Optimization of biogas-based electricity and biomethane commercialization schemes through the analysis of relevant scenarios and technical and financial parameters.

2.1.5.4 Finalization of strategies and business models for approval by electricity and gas companies.

COMPONENT 3. DEMONSTRATION AND OPTIMIZATION OF BIOGAS PROJECTS

Outcome 3.1: Demonstration and optimization of the technical and economic feasibility of biogas and biomethane production and utilization based on agroindustrial organic waste (GEF US$ 2,170,000; co-finance US$ 33,170,000).

154. This outcome encompasses the verification and implementation of biogas and biomethane demonstration pilots. Envisagedly, the demonstration pilots will cover the following business models: (1) distributed electricity generation; (2) biomethane production and distribution; (3) energy self-supply for heat, electricity and mobility. The pilots will serve as a test bench for the business models, institutional arrangements, financing concepts, environmental guidelines and technical standards developed under the Project and will provide valuable experiences for the refinement thereof.

155. Output 3.1.1 entails the verification and specification of the pilots and procurement of engineering services, equipment, civil works, electrical systems and auxiliary systems. Procurement will take place primarily under responsibility of the respective project owners. GEF funds will be used to finance designs and systems that go

beyond the business-as-usual designs, thereby mitigating the increased upfront investment costs. GEF resources will further be used to ensure the technical and financial sustainability of the demonstration projects and optimize system performance when possible such as extended warrantees, improvement of process control and management, corrective action to ensure compliance with environmental regulation, if needed; investment to enhance energy end-use and/or energy efficiency, and to increase project revenues.

156. A technical committee will be established to make a selection from initiatives seeking support from the Project based on agreed criteria. The committee will also review proposals for enhancement and optimization, to be submitted to the Project Steering Committee for approval. The pilot projects will be systematically monitored to determine the needs for improvement to ensure project sustainability (output 3.1.3). The findings and lessons extracted from the demonstration pilots will be prepared for sharing with stakeholders including the UNIDO and GEF community.

157. In the end-of-project situation, the installed pilots are expected to perform satisfactorily in a commercial business context. Assurance of long-term viability shall rest with the respective (national) owners.

Output 3.1.1 Verification and implementation of demonstration pilots for biogas production and utilization based on agroindustrial organic waste in Southern Brazil (GEF US$ 1,000,000; co-finance US$ 31,170,000).

158. This project output encompasses the verification of the biogas and biomethane pilots to be implemented and demonstrated under the Project. A list of potential demonstration pilots has been identified during the PPG phase (please see Annex M for details). This will be further refined based on project status during project implementation. The list includes pilot projects such as Entre Rios do Oeste and Sao Roque, which focus on associative biogas models and for which pre-feasibility studies have been conducted (see Annex N) and co-financing has been made available. It should be noted that this list is not exclusive and that the intent is to explore not only on-farm opportunities but also utilise potentials in processing industries (e.g. slaughterhouses, cassava starch, etc.). Procurement of the systems will take place under responsibility of the respective project owners, who will attract the necessary investment capital to this purpose (cofinance). GEF funds will be used to finance incremental costs of the investments. The Project will provide guidance during the final stages of the project development phase and ensure compliance with social and environmental safeguards (quality assurance). A mechanism will be set up to select the initiatives that will receive direct technical assistance and financial back-up from the Project (see output 3.1.2).

159. The Project will provide technical assistance for drafting the tender documents for engineering services and procurement of equipment, civil works, electrical systems and auxiliary systems for the selected biogas and biomethane demonstration pilots. Contractors shall include a training programme for operators in their offers, as well as extensive after-sales services and provisions for technical failure or malfunction.

160. Envisagedly, the demonstration pilots will cover the following business models: (1) distributed electricity generation; (2) biomethane production and distribution; (3) energy self-supply for heat, electricity and mobility. Where appropriate, the projects will deliver to the regional electricity and gas companies under a power purchase agreement or equivalent contract. As and if appropriate, joint-venture and/or leasing arrangements will be pursued to strengthen roles and financing capabilities. The demonstration projects will provide an opportunity for the application of technical standards, regulation, and incentives developed under the Project. They will further serve as a test bench for the envisaged environmental guidelines and provide valuable experiences for the refinement thereof.

161. The key activities identified under this output are:

3.1.1.1 Establishment of a shortlist of biogas projects in agroindustries for verification of demonstration pilots according to pre-established criteria.

3.1.1.2 Selection of final demonstration pilots by a technical committee representing key stakeholders, to be submitted to the Project Steering Committee for final approval.

3.1.1.3 Implementation of demonstration pilots by investments in civil works (co-financing only) and equipment.

Output 3.1.2 Investment and technical services to ensure operational performance and sustainability of the installed demonstration pilots (GEF US$ 950,000; co-finance US$ 1,000,000).

162. The purpose of this output is to ensure the technical and financial sustainability of the implemented demonstration projects and optimize system performance when possible. The demonstration pilots will be monitored on technical and performance aspects, including critical issues for project sustainability (see output

3.1.3). Based on these inputs, the Project will prepare proposals for technical enhancement in coordination with the respective project owners. The aforementioned proposals, including a financial budget will be reviewed by a technical committee and submitted to the Project Steering Committee for approval.

163. GEF resources under this output can be used to cover the costs of beyond business-as-usual services, maintenance and technical support; for example, for management and processing of digestate, storage and handling of biomass feedstock; improvement of process control systems; improved logistics of biomethane distribution; additional measures for compliance with environmental requirements (noise, emissions), etc.

164. As such, this output offers flexibility for system optimization under the Project, enabling the extraction of operational experiences and lessons learned.

165. The key activities foreseen under this output are:

3.1.2.1 Identification and contracting of extended services to ensure performance and sustainability (including extended equipment warranties).

3.1.2.2 Identification, specification and implementation of additional equipment, control systems, civil works, among others, to ensure operational performance and sustainability of established pilots.

Output 3.1.3 Monitoring of operational aspects and performance of established pilots, including systematization of lessons learned and recommendations for enhancement (GEF US$ 220,000; co-finance US$ 1,000,000).

166. This project output will set up a mechanism for monitoring of the technical performance and operational parameters of the biogas energy systems installed under Output 3.2.2. Events will be recorded and analyzed, and made available for stakeholders. To this purpose, project owners and the Project will make agreements detailing provisions for sharing of information, respecting confidentiality of critical information for the project owners where necessary. Lessons learned will be used as input for future project development and technical regulation and will also be shared with key stakeholders.

167. The activities proposed under this output include:

3.1.3.1 Determination of indicators and technical parameters to be measured for performance monitoring, and establishment of a measurement programme.

3.1.3.2 Implementation of monitoring activities, including periodic analysis of results and identification of corrective actions as and if needed.

3.1.3.3 Systematization of experiences and lessons learned from demonstration pilots and recommendations for enhancement.

COMPONENT 4. MONITORING AND EVALUATION

Outcome 4.1: Monitoring plan prepared and implemented (GEF US$ 280,000; co-finance US$ 228,000).

168. Monitoring of project progress is essential for the adequate and timely delivery of results. This component covers project monitoring and oversight by the Project Management Unit (PMU) in close coordination with the Executing Partner(s) and the other partners represented in the PSC, as well as the mid-term review and terminal evaluation of the Project.

Output 4.1.1 Monitoring of project progress and compliance with UNIDO and GEF guidelines and safeguards on social (including gender) and environmental impact (GEF US$ 125,000; co-finance US$ 160,000).

169. This output covers backstopping to review project progress and compliance with UNIDO guidelines, best practices and safeguards concerning social, economic, environmental, and human development. Special attention will be given to identify opportunities to strengthen the position of women. Relevant project activities, specifically related to training, communication with civil society groups, and bioenergy usage involving small and medium agroindustries will be reviewed on gender-specific issues and opportunities. Activities to be implemented shall include: (i) measurement and validation of project progress and identification of key issues; (ii) follow-up upon environmental issues, including preservation of natural resources (forests, soils and aquifers); gender aspects; and human development aspects; as well as (iii) regular monitoring and site visits by the PMU.

Output 4.1.2 Implementation of Mid-term Review (GEF US$ 55,000; co-finance US$ 34,000).

170. This project output consists of the mid-term review. The mid-term review will be carried out after the second PIR. The mid-term review will be carried out by the PMU with the support of an independent international as well as national consultant contracted by UNIDO.

Output 4.1.3 Implementation of independent Terminal Evaluation (GEF US$ 100,000; co-finance US$ 34,000).

171. This project output consists of the independent GEF terminal evaluation to be carried out by independent consultants. The GEF terminal evaluation will be implemented in the last three months before operational project termination. It will be carried out by independent international and national consultants contracted by UNIDO.

(4) Incremental/additional cost reasoning and expected contributions from the baseline, the GEFTF, LDCF, SCCF, and co-financing.

172. The development problem described in the PIF remains valid but has been put into the current context for bioenergy in Brazil. Bioenergy policy development in Brazil is taking place as part of the baseline scenario; the Project will help keep biogas and biomethane on the political agenda, which is especially relevant given the recent political and institutional changes in the federal government. The Ministry of Science, Technology, Innovation and Communication (MCTIC) is the leading entity for the Project. The Project will provide continuity to the results of PROBIOGAS and ensure inter-institutional coordination between MCTIC, MME, MAPA, MMA, MDIC and MCIDADES (output 1.1.1). MME and ABiogás are key partners in furthering this policy process.

173. The Project will provide expert knowledge for developing specific regulation and for fine-tuning of financial instruments to the needs of the biogas market. The Project further aims to integrate biogas and biomethane production and utilization into energy sector and agricultural sector programmes and plans (mainstreaming) and to set-up an MRV system for tracking of GHG reductions (outputs 1.1.2-1.1.4). Baseline contributions by the project partners cover, among others: (a) policy making processes by federal ministries, legislative bodies and agencies; (b) technical analysis and advice for the design of specific regulation, by sector agencies and specialists; (c) hosting, communication and logistical support to the Project; (d) revision and updating of sectoral plans, regulatory instruments, financial instruments and tributary regulation; and (e) government communication with involved sectors and the general public.

174. During the PPG phase, substantial weaknesses in terms of availability and quality of information on wet biomass resources, applicable biogas technologies and processes, real-life investment and operational costs, business models and best practices were found. There is also a lack of tradition of sharing information and of articulation between technology institutes, the manufacturing industry, and biogas project developers. The Project aims to close these gaps by complementing and validating information and by making this accessible through a Biogas Information Platform (BIP), while fostering the exchange of know-how and experiences among stakeholders. This platform will link to current thematic networks such as BiogasFert which are more constrained to a specific audience (outputs 1.2.1 and 1.2.2). Baseline contributions include information and studies by sector agencies and institutions, including Itaipu Binacional and CIBiogas, and the hosting of the BIP.

175. During the PPG phase, it was observed that innovation processes are diffuse and, given the incipient market, a champion (host) entity to lead the biogas innovation agenda could not be identified. The Project will therefore pursue a more holistic approach towards strengthening the biogas and biomethane value chain including a technology component aimed at standardization, adaptation to local circumstances, and cost reduction (outcome 2.1). Aspects along the value chain addressed by the project include: business models (output 2.1.1), standardization of technologies and materials (2.1.2), adaptation of technology (2.1.3), training of business skills (2.1.4), and value propositions by optimization of market strategies (2.1.5).

176. The Project aims to integrate the current initiatives by market actors from the biogas supply side (agroindustries) and the biogas and biomethane demand side (electricity and gas companies). GEF resources are critical for closing the identified gaps by addressing issues that are considered high-risk by individual stakeholders, or that are beyond their mandate. The Project will bring in know-how and business approaches from other regions in Brazil and from other countries (both North-South and South-South). With a view to technology adaptation and the development of more cost-effective biogas solutions, the Project will provide funding for implementing a test and engineering programme of equipment, components and biogas plant processes subject to an established work plan to be approved by the PSC (output 2.1.3).

177. Without the leading role of the Project, individual actors will unlikely close the technology gap in the near future. In-kind and cash baseline contributions include investment by energy companies and suppliers in technology development; market studies and corporate business plans; co-organization of training events and promotional events; participation in technical work groups; participation in field surveys, meetings, and work

groups. The Project will further make an attempt to mobilize additional bilateral funding by promoting partnerships between national and foreign industries.

178. The Project will demonstrate one or more biogas and/or biomethane pilots in Southern Brazil based on high-potential business cases. Besides biomethane use for mobility and on-farm traction, the PPG phase revealed the incipient, but growing interest from energy companies to source biogas-based electricity and biomethane. To this purpose, several energy companies, CIBiogas, agroindustrial companies and cooperatives have entered into agreements to develop biogas energy projects in Parana, Santa Catarina and Rio Grande do Sul (3.1.1). The Project adds value to the baseline by providing technical assistance and co-investment to secure the operational performance and sustainability of installed systems in accordance with social and environmental safeguards (3.1.2); by systematic monitoring and optimization of system operation; by promoting integration of anaerobic digester technology into core agrobusiness operations; and by systemizing and sharing of experiences and lessons learned. Such an integrated approach to biogas project development will unlikely take place under the baseline scenario (3.1.3). Substantial co-financing is provided by project partners through investment in biogas and biomethane project installations, project development and operations.

179. Bearing in mind that the GEF allocation of resources for this project is US$ 7,000,000, the cost-effectiveness is estimated at US$ 13 / ton CO_2eq, considering only the direct GHG benefits over the initiative's lifetime (535,000 tons CO_2eq). If the indirect GHG benefits (total 2,300,000 tons CO_2eq), which are based on the overall biogas potential in the three states, are included, the cost-effectiveness improves to approximately US$ 2.5 / ton CO_2eq.

(5) Global environmental benefits (GEFTF) and/or adaptation benefits (LDCF/SCCF).

180. The global environmental benefits of the Project are associated with (i) the implementation of biogas plants for electricity and heat generation, thereby off-setting grid electricity and fossil fuel (natural gas); (ii) the avoidance of methane releases into the atmosphere as a result of anaerobic digestion of effluents combined with biogas capture and utilization; and (iii) market development of biogas based electricity generating capacity. The following overview (based on the GEF Manual)[97] summarizes the methodology used:

[97] GEF/C.33/Inf.18, April 16, 2008, page 3.

Type of GHG emission reduction	Direct (A)	Indirect (B, C)	
Component of GEF intervention that can cause this type of GHG emission reduction	Direct implementation of RE technologies	The Project does not establish a direct replication mechanism. GHG benefits obtained from leveraged investments are considered as effects of market transformation.	Market transformation
Logframe (SRF) level	Outputs 3.1-3.3	n/a	Medium-term impact after project termination (10 years)
Quantification method	Direct evaluation of the environmental benefits over lifetime of an assumed portfolio of biogas systems. Avoided methane releases by anaerobic digestion, are estimated in accordance with approved CDM methodologies.	n/a	Top-bottom approach based on expected market development of biogas technologies for electricity and heat generation in Brazil.
Quality of Assessment	Based on expected performance of bioenergy systems in Brazil. Error range is estimated at +/-50%.	n/a	Based on: (i) assumption that 16.6 MW electricity generation capacity based on wet biomass is being added annually; (ii) CO2-intensity of electricity generation sector in Brazil is 0.3020 tCO_2/MWh: (iii) average availability of 80%; (iv) other effects (displaced fossil energy for thermal uses, solid biofuels, avoided methane releases) are not considered.

Direct GHG benefits

181. The combined emission reductions as a result of: (i) avoided methane releases from open lagoons; and (ii) replaced fossil fuel (diesel) for heating, would translate into total GHG emission reductions of 53,527 ton CO2eq/yr. Please see Annex I for detailed calculations. In practice, some installations will seek electricity generation and biomethane production on a smaller scale, as these generate the highest monetary revenues. Since the carbon-intensity of Brazil's electricity sector is low (0.3020 kg CO2eq/kWh), there is no GHG benefit compared to local heat production by combustion. The performance of compressed biomethane (bio-CNG) is also slightly below that of direct heat, as diesel fuel is the baseline in both case; but biomethane requires energy inputs for compression and distribution. Over a 10-year economic lifetime of the investments, the direct GHG emission reductions are estimated at: **535 kton CO2eq (0.54 Mton CO2eq).**

Indirect GHG benefits

182. To estimate the indirect GHG emission reductions, it is assumed in the following that biogas plants will supply electricity to the distribution grid, which is the most straightforward option to generate a financial benefit for the project owner. Since GHG benefits of replacing grid electricity are approximately equal to those of direct heat

production (combustion of the biogas for process heat), the estimated GHG reduction is therefore valid for combinations of distributed electricity generation, heat production and combinations thereof (co-generation).

183. To estimate the development potential for biogas energy systems, reference is made to the combined biogas potential for poultry, dairy farms, pig farms and cassava starch production in Parana, which is 1,291,806,203 m3 biogas per year. The related average annual energy production is 639,444 MWh/yr (please see Annex I for further details). The associated GHG emission reductions are thus 193,112 ton CO2eq/yr. Assuming a GEF causality factor of 40%, the GHG reductions attributable to the Project would be 77,245 ton CO2eq/yr. Finally, over a 10-year period, the total attributable indirect GHG reductions are estimated at 772,450 ton CO2eq (0.77 Mton CO2eq).

184. With some differences in the composition of biogas feedstock, the total GHG benefits for the combined states of Parana, Santa Catarina and Rio Grande do Sul will be about three times this value, about **2.3 Mton CO2eq**.

185. Based on these assumptions and input data, the direct GHG emission reductions are estimated at **535 kton CO2eq**. The indirect GHG reductions as a result of market transformation are of the order of **2.3 Mton CO2eq** over a 10-year impact horizon.

Other environmental benefits

186. Through the treatment and utilization of biomass waste and residues, the promoted biogas technologies will contribute to the preservation of soils and aquifers in the impact zones of agroindustries that release organic effluents directly into the environment under the baseline scenario. This is typically the case in pig farming, feedlots, dairy farms, as well as sugar-cane vinasse and cassave (manipueira). The retention of minerals such as phosphates and the reduction of the chemical oxygen demand of the effluent are critical measures to revert hypertrophication, thereby promoting recovery of life forms and habitats in the areas affected.

(6) Innovativeness, sustainability and potential for scaling up.

187. The Project is innovative as it aims to strengthen Brazils's energy sector by building upon drivers within agribusinesses to increase competitiveness and manage the organic residues and waste from production processes. Specifically, these drivers are: (i) social drivers related to inclusive and sustainable industrial development in Paraná and other Southern states; (ii) environmental drivers focused on reducing local contamination and preservation of soils and aquifers, as well as global emission reductions; (iii) energy security and energy access considerations by the individual businesses focused on securing critical operations; (iv) opportunities for agrobusinesses to reduce operational costs; and (v) opportunities for agrobusinesse for valorization of sector-own biomass to become energy generators.

188. Following a bottom-up approach, the Project will link up with federal and state policy to develop and implement supportive regulation. While the Brazilian energy sector is traditionally focused on large-scale, centralized power generation, the Project will exploit opportunities for distributed generation of electricity and biomethane including utilization of the latter for vehicle transport (mobility). It will further foster the utilization of biogas to meet on-farm thermal energy demands, thereby offsetting diesel and fuelwood. The incorporation of these modalities into national energy policy is instrumental for not only diversifying Brazil's electricity matrix and facilitating cost-effective access to energy, including outside demand centres, but also for operationalizing the low-emission agriculture programme (ABC Plan).

189. Another innovative aspect is the technical support modality for pursued demonstration pilots, covering up-front project development costs and leaving capital expenditures to the respective businesses. This approach will avoid a range of issues related to confidentiality of information and expectedly increases the effectiveness of GEF resources dedicated to demonstration and the extraction of operational experiences. The approach also integrates the selection of demonstration pilots with project portfolio development, enabling a faster uptake of post-project investment for replication; thus actively contributing to the development of a mature and competitive market that promotes sustainability and inclusiveness.

190. The Project pursues sustainability of the identified outcomes by building upon critical baseline conditions and inputs, including: (i) inter-ministerial coordination between the Ministries of Mines and Energy (MME), Agriculture (MAPA), Environment (MMA), Science, Technology, Innovation and Communication (MCTIC), the Ministry of Industry, Foreign Trade and Services (MDIC) and the Ministry of Cities (MCIDADES), facilitating engagement with key sector agencies and stakeholders; (ii) integration of biogas and biomethane into national energy planning and state development plans; (iii) implementation of supportive regulation for biogas-based

electricity generation and biomethane production at federal and state level; (iv) streamlining of the Project with federal and state programmes such as the ABC Plan; (v) exploitation of existing synergies between stakeholders at state level to accelerate the development of a project portfolio for replication, specifically with gas and electricity distribution companies (at the demand side) and agricultural cooperatives and family farms (at the supply side); as well as, (vi) exploitation of synergies with stakeholders in the region, fostering an enabling environment across countries. All of these outputs are covered within Components 1 and 2 of the Project.

191. The potential for up-scaling of biogas and biomethane investments in Brazil is very substantial. The market for anaerobic digestion of wet biomass residues and effluents just in Paraná state is of the order of 150 MW (electricity) considering only the poultry, pig farming, dairy farming and cassava starch subsectors. In the Southern states, this potential approaches 0.5 GW. Other agroindustrial sectors including sugar cane vinasse and beer breweries. The potential for thermal energy self-supply or and biomethane is of a similar magnitude. For an overview of the biogas potential in Brazil, please refer to Table 1. Initial steps facilitating future upscaling are covered though outputs of Component 3 and are supported by a range of capacity building activities pursued by the Project.

A.2. Child Project? If this is a child project under a program, describe how the components contribute to the overall program impact.
N/A

A.3. Stakeholders. Identify key stakeholders and elaborate on how the key stakeholders engagement is incorporated in the preparation and implementation of the project. Do they include civil society organizations (yes ☒ /no☐)? and indigenous peoples (yes ☐ /no☒)? [98]

192. The institutional framework for biogas and biomethane in Brazil is complex, fragmented, and characterized by a large number of actors at the three levels of the federation (national, provincial, and municipal). The mandates and roles of the most relevant stakeholders are outlined in the next table. Additional stakeholders the Project is likely to engage with are outlined in Annex E. To this can be added the national capacities on biogas that exist within universities, as well as private businesses with specific expertise and products. Below a non-exhaustive list of key project partners:

PROJECT PARTNERS FOR BIOGAS AND BIOMETHANE DEVELOPMENT IN BRAZIL		
TYPE	NAME	MANDATE AND ROLE IN THE PROJECT
NATIONAL GOVERNMENT – CENTRALIZED AND DECENTRALIZED INSTITUTIONS	Ministry of Science, Technology and Innovation and Communication (MCTIC)	MCTIC is the line ministry for the Project and one of the executing partners. It has a policy making role in the field of science technology, innovation and research. Furthermore, the Ministry coordinates and supervises science, technology and innovation activities in Brazil. For the purposes of providing perenniality and accessibility to the results of the National Anthropogenic Emissions Inventory by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol, the Ministry developed the National Emissions Registry System (SIRENE). MCTIC will chair the Project Steering Committee (PSC). It has committed co-financing resources to the Project to an amount of USD 2,000,000, of which USD 700,000 is in cash and the rest in-kind.
	Ministry of Mines and Energy (MME)	MME is one of the overall executing partners of the project. It was established in 1960 under Law No. 3.782 and reconstituted in 1992 (Law 8.422). MME's competences include geology, mineral and energy resources, hydraulic energy, mining and metallurgy, oil exploration, fuels and electricity, and nuclear energy, setting out policies and funding energy related research.. The Ministry presently holds four secretariats: (i) Oil, natural gas and biofuels (SPG); Geology, Mining and transformation of minerals (SGM); Electric energy (SEE); and Energy planning and development (SPE). Decentralized public entities linked to MME and relevant to this Project are: ANEEL, Eletrobras, EPE, ANP, and Petrobras. MME has committed co-financing resources to the Project to an amount of USD

[98] *As per the GEF-6 Corporate Results Framework in the GEF Programming Directions and GEF-6 Gender Core Indicators in the Gender Equality Action Plan, provide information on these specific indicators on stakeholders (including civil society organization and indigenous peoples) and gender.*

		2,237,065 (in-kind). The Ministry will be a member of the PSC and provide high-level orientation for shaping the Project strategy and key components in coordination with the other PSC members.
	Ministry of Agriculture, Livestock and Supply (MAPA)	MAPA is among the oldest institutions in Brazil, founded in 1860 under Jaime II. In 1930 its competence became focused on agriculture, in recent years amended with agricultural reform (1992) and food supply security (1996), taking its current name since 2001. MAPA is responsible for public policy promoting agriculture and livestock production, agrobusiness development and regulation of services in the sector. The sector encompasses small, medium-size and large-scale producers covering suppliers of equipment, technology and services, production systems, processing and transformation of produce and the distribution towards the final markets. With a view on reconciling sustainable development and competitiveness, MAPA aims to secure food supplies for the Brazilian population while exporting surplus, thereby contributing the national economy and strengthening Brazil's position on the global markets. MAPA will be member of the PSC and prominent in providing inputs to the selection of demonstration pilots. Co-financing to the amount of USD 9,000,000 in loans has been made available.
	Ministry of Environment (MMA)	MMA was created in 1985 under Decree No.91.145, taking its current name in 1999. Its responsibilities include national environmental policy; programmes targeting the Amazon region; policies related to Brazil's hydrological resources; protection, conservation, and sustainable exploitation of ecosystems, biodiversity and forests; politics fostering integration of environmental and productive systems; strategies to improve quality of the environment and sustainable exploitation of natural resources; economic and ecological zoning. Environmental monitoring is one of its key attributions, including monitoring, reporting and verification of GHG emissions. Alongside MCTIC, MMA is the key ministries within the federal government in charge of the design and implementation of national climate change policies in alignment with international conventions including the UNFCCC. MMA will be member of the PSC and prominent in providing technical inputs to the MRV system to be set up. In-kind co-financing to the amount of USD 1,101,425 has been made available.
	Ministry of Development, Industry and Foreign Trade (MDIC)	MDIC was established in 1999 with the overall goal of to formulate, implementing and evaluating public policies in order to promote competitiveness, foreign trade, investment, business innovation and consumer welfare. It is responsible for the development policy on industry, trade and services; intellectual property and technology transfer; metrology, standardization and industrial quality; foreign trade policy; regulation and implementation of programs and activities related to foreign trade; assess and apply trade remedies; and, participation in international trade negotiations. To accomplish its goals, the MDIC acts through four Secretariats: Secretariat of Industrial Development and Competitiveness (SDCI); Secretariat of Foreign Trade (SECEX); Secretariat of Trade and Services (SCS); Secretariat of Innovation and New Business (SINN). The National Institute of Metrology, Quality and Technology (INMETRO) is linked to the Ministry as are private non-profit organizations that receive resources from the Ministry for public interest actions such as the Brazilian Industrial Development Agency (ABDI). MDIC participated in the inter-ministerial meetings that were part of PROBIOGÁS and intends to continue its engagement in the promotion of biogas / biomethane for industries. It will form part of the inter-ministerial coordinating unit to be set up.
	Ministry of Cities (MCIDADES)	MCIDADES was created on January 1, 2003, from Provisional Measure 103/2003, converted into Law No. 10,683 of May 28, 2003. The Ministry of Cities is responsible for: a) urban development policy ; B) sectoral policies for housing, environmental sanitation, urban transport and transit; C) promotion, in articulation with the various spheres of government, with the private sector and non-governmental organizations, of actions and programs of urbanization, housing, basic sanitation and environmental, urban transport, transit and urban

		development; D) subsidy policy for popular housing, sanitation and urban transport; E) planning, regulation, regulation and management of the application of resources in urban development policies, urbanization, housing, basic and environmental sanitation, urban transport and transit; and F) Participation in the formulation of general guidelines for the conservation of urban water systems, as well as for the adoption of river basins as basic units of planning and management of sanitation. Being the lead ministry for PROBIOGÁS, the Project counts with the sharing of experiences and knowledge gathered during the implementation of this programme. The Ministry will form part of the inter-ministerial coordinating unit to be set up.
OTHER ENTITIES	Itaipu Binacional	Itaipu Binacional is one of the overall executing partners of the project (together with CIBiogas). Besides operating one of the largest hydropower plants in the world, this entity actively invests in the promotion of renewable energy, directly financing CIBiogás-ER and the Itaipu Technological Park Foundation (FITP). In addition to engaging in the biogas sector, it also supports the development of electric solutions for all vehicle classes. The existing know-how in the field of mobility as well as existing infrastructure will be utilized by the Biogas Information Platform (BIP) within the framework of the proposed Project. Moreover, Itaipu Binacional is one of the PSC members and actively supports the Project with co-financing to the value of USD 18,500,000.
	CIBiogas	Together with Itaipu Binacional, the International Centre of Renewable Energy - Biogas (CIBiogás-ER) is legally constituted by an association of 16 institutions and its mission is to develop biogas as a technically and economically viable energy product in Brazil, considering economic, environmental and social aspects. CIBiogas undertakes research into existing biogas potential as well as undertaking monitoring, laboratory testing and teaching of operators. It maintains several demonstration pilots. Furthermore, CIBiogas will be a member of the PSC as well as being expected to directly execute some Project outputs.
	Itaipu Technological Park Foundation (FPTI)	FPTI acts as a regional centre for research, education, technology development, and entrepreneurship. Educational programmes cover vocational training, and academic graduate and post-graduate levels. The FPTI community engages approx. 2,000 people, including staff, trainees, researchers and teachers. Partnerships with public and private entities are a key element of PTI's strategy for implementing educational and R&D programmes. Entrepreneurs can take benefit from these programmes, with PTI providing specific support for business start-ups (incubator concept). FPTI has funded staff costs for CIBiogas since 2013 and will support the Project with USD 559,052.56 in co-financing.
REGIONAL GAS AND ELECTRICITY COMPANIES	Companhia de Gás do Estado do Rio Grande do Sul (SULGAS)	SULGAS is the enterprise responsible for the commercialization and distribution of ducted natural gas in the state. It is a mixed-capital society established in 1993, the shareholders being the Rio Grande do Sul State and PETROBRAS Gás S/A – Gaspetro. Once the gas line connecting Bolivia and Brazil has been completed, it started commercialization of natural gas in the year 2000. Active interaction during Project implementation will be pursued to enhance demand for a market pull; SULGAS has committed itself with co-financing to the amount of USD 2,225,967.50 (equity).
	Companhia Paranáense de Gás (COMPAGAS)	COMPAGAS is responsible for the distribution of natural gas in Paraná, serving customers in the residential, commercial and industrial sectors; as well as natural gas for vehicle fuel. Its business strategy is focused on expansion of the gas network by investing in long-distance connections with the objective to increase coverage and capacity, and supply more regions and municipalities of Paraná state with natural gas. COMPAGAS has actively committed itself to the Project with co-financing of USD 500,301 (in kind).
	Companhia de Gás de Santa Catarina (SCGAS)	Santa Catarina has had natural gas as an energy source since April 2000, which benefits 29 municipalities. More than 1 million m3/ day are transported by the SCGAS network – a mixed-economy company, which is responsible for the distribution of piped natural gas in the State. The network is 500 km long – the

		third largest in Brazil – and covers the North of the State, the Itajaí Valley, Greater Florianópolis and the Southern Region, supplying industries and gas stations. Active interaction during Project implementation will be pursued to enhance demand for a market pull.
	Companhia Paranáense de Energia (COPEL)	COPEL, established in 1954 is active in the fields of electric power generation, transmission and distribution, as well as in telecommunications. It is the largest enterprise in Paraná. Among its assets are power plants, transmission lines, substations and electricity distribution networks; it further owns a modern optical telecommunications networks that covers all cities of Paraná. As an average, each year about 70,000 new connections are established, covering practically 100% of urban households and 90% in the rural areas. COPEL has been actively investing in research and development of biogas / biomethane; amongst others, through support of the Entre Rios do Oeste project (co-financing commitment of USD 5,467,298.13) as well as Gera Rural (see also Annex P).
	ELETROSUL	ELETROSUL is a mixed-capital, public company founded in 1968 governed by Decree No.64.395. It is assigned to MME, its operations being controlled by ELETROBRAS. ELETROSUL is active in power generation, transmission and commercialization, as well as in telecommunication. The company is based in Florianópolis, the capital of Santa Catarina and is active in several states. Active interaction during Project implementation will be pursued to enhance demand for a market pull.
	Companhia Estadual de Energia Elétrica (CEEE)	Created in 1943, CEEE was the precursor of the companies that today make up the CEEE Group. Following corporate restructuring of CEEE, which took place in 2006, three entities were created: the State Electric Power Company - CEEE-Par; the State Electric Power Generation and Transmission Company - CEEE-GT; and, the State Electric Power Distribution Company - CEEE-D. The group produces approximately 18% of the hydroelectric power generated in the State of Rio Grande do Sul, has more than 6,000 km of power transmission lines in the State and distributes electricity to one third of the Rio Grande market through 72,138 km of urban and rural networks located in 72 municipalities, providing electricity to about 4 million people. It also operates in programs to combat energy wastage and rural electrification, as well as various social, cultural and environmental projects. Electrobrás holds a 32.5% stake in the distribution arm of CEEE. Active interaction during Project implementation will be pursued to enhance demand for a market pull.
POTENTIAL BENEFICIARIES / PILOT PROJECT DEVELOPERS	Cooperativa LAR (PR)	LAR agroindustrial cooperative company is based traditionally in Paraná and Santa Catarina. It distributes agroindustrial products under its own brand. LAR has a network of several supermarkets and gas stations, has over eight thousand associates and about five thousand employees. The Sao Roque biogas project being pursued by LAR is one of the potential demonstration pilots. As such, LAR has committed USD 1,112,983.75 in co-financing.
	Entre Rios do Oeste	The Entre Rios de Oeste is a municipality in Paraná, in which a biogas project that utilizes swine manure is being developed. The project is actively being supported by COPEL and CIBiogas and constitutes another potential demonstration pilot.
	GEO Energética	GEO Energética is a 100% Brazilian company that, after ten years of research, has developed a unique and innovative biotechnological process for biogas production from reusing agro-industry waste. Its focus has mainly been on biogas production from sugar-alcohol industry waste, with an industrial-scale operation in Paraná. However, the company is also looking into alternative waste streams. As such, they have committed USD 10 million in co-financing to the Project for supporting the development of at least one viable installation utilizing agro-waste. The biogas produced may be used for generating electricity as a renewable source, or in the making of biomethane, to replace diesel.
FINANCIAL SECTOR	Bank of Brazil (BDB)	BDB was founded in early 19th century and is one the largest banking institutions in Latin America. It is a mixed-capital society with the federal Union (State of

		Brazil) being the majority shareholder with about 70% of the shares. The Bank of Brazil implements several financial instruments created by the Government for investment in agricultural innovation, including anaerobic digestion, biogas and biomethane technology. For 2017, BDB has committed USD 1,589,976.79 in co-financing to the Project.
RELEVANT SECTOR ORGANIZATIONS AND FOUNDATIONS (CSOS)	Brazilian Association of Biogas and Biomethane (ABIOGÁS)	Abiogás is a non-governmental not-for-profit organization, which brings together industries and institutions involved in biogas and biomethane development. In 2015, it presented a proposal for a national policy on biogas and biomethane, the PNBB. The proposal includes the creation of an inter-ministerial committee; tax simplification; tax incentives, regular public bids for energy acquisition; better adequation on existing financing lines; biogas project finance; creation of a guarantee fund for biogas projects; simplification on environmental licensing for biogas activities with the DBFZ in Leipzig projects. As the most prominent sector organization for biogas and biomethane in Brazil, Abiogás will be actively supporting Project efforts (co-financing commitment of USD 100,000).
	Agriculture Federation of the Paraná State (FAEP)	Besides promoting research, disseminating information to improve productivity and conditions of the agricultural industry in Paraná. FAEP represents the interest of rural producers in economic, social and environmental issues and has voiced a keen interest in furthering the uptake of biogas / biomethane solutions in Paraná, including with the support of the Project.
RESEARCH AND OTHER ORGANISATIONS	Brazilian Agricultural Research Corporation (EMBRAPA)	EMBRAPA is the leading R&D institution in agriculture, livestock and agroindustry and has been one prominent factor to explain the development of the Brazilian agriculture since the 1980s. Among EMBRAPA's research centers, the most active in anaerobic digestion is the Swine and Poultry Research Center in Concordia, Santa Catarina. EMBRAPA is the host organization for the BIOGASFERT programme. It will support the Project actively, having made USD 2,770,000 available in co-financing.
	Fundação Getulio Vargas (FGV)	FGV is a Brazilian higher education institution founded on December 20, 1944. It offers regular courses in economics, business administration, law, social sciences and information technology management. It has stated an active interest in supporting the Project's objective and in this respect, has made available USD 1,000,000 in co-financing.
	Austrian Development Agency (ADA)	As the operational unit of Austrian Development Cooperation, ADA executes bilateral development programmes and projects on behalf of the Federal Government of Austria. It maintains 13 field offices and has supported about 3,500 projects worth EUR 1 billion in the last ten years. With a focus on supporting sustainable development in its partner countries in Africa, Asia, Central America, South-Eastern and Eastern Europe and the Caribbean, it cooperates here with public institutions, CSOs and enterprises. It is currently supporting a project on knowledge exchange between Brazilian and European companies, universities, research institutions, customers and beneficiaries related to the biogas and biomethane chain. The project is being undertaken by CIBiogas and Spirit Design.

Table 7: Project partners for biogas and biomethane development in Brazil.

193. A basic stakeholder engagement plan has been included as part of the Environmental and Social Management Plan (ESMP) and will be refined during the Project (see also Annex G).

A.4. Gender Equality and Women's Empowerment. Elaborate on how gender equality and women's empowerment issues are mainstreamed into the project implementation and monitoring, taking into account the differences, needs, roles and priorities of women and men. In addition, 1) did the project conduct a gender analysis during project preparation (yes ☒ /no☐)?; 2) did the project incorporate a gender responsive project results framework, including

sex-disaggregated indicators (yes ☒ /no☐)?; and 3) what is the share of women and men direct beneficiaries (women X%, men X%)? [99]

194. UNIDO recognizes that gender equality, empowerment of women and access to sustainable energy are interrelated and have a positive impact on economic growth and inclusive industrial development, which are key drivers of poverty alleviation and social progress. [100] The Project aims to demonstrate good practices in mainstreaming gender aspects wherever possible, and to avoid negative impacts on people in general, including due to their gender. Although the Project was not found to focus on women's empowerment, gender dimensions will be considered throughout the whole project cycle. Please also see the preliminary gender analyses conducted (Annex H). Opportunities to include gender dimensions into the design of project activities mainly extend to: (i) capacity building and training activities, by promoting equal participation of women and men in training activities, both at managerial and technical levels, as participants and trainers; and (ii) design and selection of demonstration pilots, to ensure that socio-economic benefits are delivered in an equitable and inclusive manner. In addition, a gender-sensitive monitoring plan will be developed.

195. It must be noted that the targeted industry sectors (energy, agrobusiness) are typically male-dominated. Due to diverging needs and rights regarding energy consumption and production, women and men are expected to be affected differently by clean energy interventions. Structural changes in this respect involve long-term social and cultural processes that stretch well beyond the time horizon of the Project. Notwithstanding, the Project will promote awareness among key stakeholders about the relevance of gender equality for development and the guiding principle (shared by the Government of Brazil, UNIDO and the GEF) that both women and men must have equal opportunities to access, participate in, and benefit from the Project. Gender-sensitive recruitment will be practiced at all levels where possible, especially in selection of project staff. Gender-responsive Terms of Reference will be used to mainstream gender into subcontracted activities and services. The Project will strive at a gender ratio of 50% (women) : 50% (men) with respect to staff and contracted (individual) services.

196. Direct beneficiaries of the Project are: (a) energy consumers served by the national electricity grid; users (at state level) of compressed natural gas including for vehicle mobility; local consumers (including self-suppliers) of electricity and fuels for heat and mobility; (b) plant operators; project developers and managers; and (c) to a lesser extent, policy makers and public agencies. In principle, male and female users equally benefit from biogas-based grid electricity. Sex-disaggregated information about other beneficiary groups targeted by the Project (apart from the ones mentioned above) could not be retrieved; such data does not seem to be available.

197. The absence of a quantitative gender baseline is an impediment for defining targets for gender equality in the Project. The Project will therefore regularly perform gender analyses and specifically, establish a gender baseline for the demonstration pilots as part of the selection process. Efforts will be made to collect sex-disaggregated data. This will enable: (i) both men and women staff to participate in and benefit from the Project; (ii) understanding on the specific roles of both genders in the production processes (both internal and outsourced business activities); (iii) the design of training and capacity building activities in a targeted manner; and (iv) to balance the total project portfolio in terms of gender benefits. Tentatively, the Project will aims at a share of at least 40% female participants in training activities. Sex-disaggregated indicators have been provided in the results framework.

198. Special attention will be given to potential gender issues resulting from informal labor and the effect of environmental externalities. Although assumed to be of less relevance for the type and scale of agribusinesses targeted by the Project, the recollection and transport of agricultural residues is often gender-biased. Land tenure issues may play a role affecting the rights of women. Weak enforcement of effluent control may contaminate soils and aquifers, affecting health and livelihoods of neighboring rural settlements, where women, children and elderly typically make up the larger share of the population. The envisaged gender screening is aimed at identifying such situations and proposing corrective actions.

199. Both the mid-term review as well as the terminal evaluation will take the gender dimension into account in the assessment to be conducted.

[99] Same as footnote 8 above.

[100] See: UNIDO Policy on Gender Equality and the Empowerment of Women (2015).

A.5 Risk. Elaborate on indicated risks, including climate change, potential social and environmental risks that might prevent the project objectives from being achieved, and, if possible, the proposed measures that address these risks at the time of project implementation.(table format acceptable):

Risk	Likelihood	Impact	Mitigation actions
1. Delay to implement improvements to the policy and regulatory framework would impede biogas and biomethane market development.	Medium	Medium	The Government of Brazil (GoB) is increasingly committed to the incorporation of decentralized energy sources into the national energy system. The development of a biogas and biomethane value chain is key for the adequate treatment of agro-industrial effluents and residues, and urban waste streams and wastewater. The Project builds upon the GOB/GIZ PROBIOGAS programme implemented by the Ministry of Cities (MCIDADES), which set up an inter-ministerial working group to coordinate biogas and biomethane policy and regulation among the various sectors: technology and innovation (MCTIC); energy (MME); environment (MMA); industry (MDIC) and agriculture (MAPA). Awareness and specific knowledge about biogas and biomethane in the federal government is still limited and scattered. Moreover, policy development processes are lengthy due to the federal organization of Brazil and some uncertainties in terms of competences of involved legislative entities. As such, amendments to the regulatory framework may not materialize as swiftly as hoped. The Project will therefore make an effort to keep biogas technology on the political agenda at the highest level, while meanwhile pursuing tangible results by a practical approach to enhance existing legislation where possible and required, including financial incentives and tax benefits.
2. The executing entities would lack managerial and technical capacities to implement the Project.	Low	Medium	Part of the project will be executed with the support of national executing entities, specifically CIBiogas, as well as national research institutions and universities (see section A.3. for a list of project stakeholders as well as paragraphs 84-87). With the aim of building national capacities, MCTIC has requested UNIDO to provide technical and administrative assistance in the execution of the Project. The here identified risk is thus controlled through this arrangement as well as by continuous high-level oversight by UNIDO.
3. Lack of confidence in biogas technology would lead to agroindustries refraining from implementing biogas projects.	Low	High	While this is issue has not been systematically investigated, the PPG phase found a considerable number of investment in biogas technology and the apparent reliable operation of these plants. This observation particularly holds true for large, high-end systems. Examples are urban biogas plants processing wastewater (more than ten systems in operation) and, in Paraná, cassava starch effluent (Amidonaria Navegantes) and sugar cane vinasse treatment (Geo Energética). There is also co-investment from the demand side, as demonstrated by COPEL (biogas-based electricity), SULGAS (biomethane), and Itaipu (biomethane for mobility), among others. The main challenges are system scale, and return on the investment. Smaller installations still lack consolidated “off-the-shelf” plant designs, as is the case with the associative (condomium) business model. Moreover, capital opportunity costs for farmers are high; by consequence, farmers would prefer alternative investments under a rational business approach (typically upscaling of core business activities). However, farmers (in Paraná) show great interest in biogas technology as an option for reducing energy costs and increasing energy security as well as to reduce the environmental footprint of their business activities. The Project aims to reduce capital and operating costs for this group of producers while

Risk	Likelihood	Impact	Mitigation actions
			increasing technical maturity and introducing standardized designs and materials.
4. Lack of adequate technological support would undermine the success of proposed biogas demonstration pilots.	Low	High	Given the incipient market, a comprehensive value chain for biogas and biomethane production has not yet developed. It must be noted that anaerobic digester systems operate embedded into the core business process and require a certain level of active management. Large companies including sugar mills often have in-house know-how for designing and operating energy systems; note that outsourcing of energy activities, for example through an ESCO model, is poorly developed in Brazil. Smaller farmers would require training to operate biogas systems and are likely to need stand-by technical support, which implies a major cost. The condominia in Paraná receive operational support from CIBiogas, but a sustainable support model targeting the small farmers has not yet emerged. The Project will address this weakness by systematically monitoring system operations and performance and working towards an efficient and cost-effective operational model.
5. Bioenergy projects would be considered not feasible due to a lack of feasible business models, adequate revenues, and high operational and financial risks.	Medium	Medium	This risk is inherent to biogas development in many countries. From the project site, it can be mitigated by ensuring system reliability and performance and by optimization of project designs and cost parameters. A systemic problem is the lack of monetarization of delivered social and environmental benefits (avoided externalities such as pollution, GHG emissions and nuisance). In the absence of strict enforcement of environmental regulation (effluent control), the economic value of biodigester technology is not acknowledged. Meanwhile, the produced biogas, electricity and biomethane can generate revenues by replacing baseline fuel options; biofertilizer may provide additional income, but several market barriers must be addressed. The Project aims to strengthen biogas business models from various angles: (a) cost reduction and system optimization; (b) advocating for adequate pay-back prices for electricity and biomethane; (c) recognition of the economic value of biogas technology; (d) recognition of its strategic value for decentralized biomethane and electricity production, and for further expansion of the agroindustrial sector (including animal farming).
6. Implementation of project activities and pilot systems would be affected by inflation and currency risks.	Medium	Low	The exchange rate of the real with the US dollar is subject to substantial fluctuations (approx 20% increase compared to the USD between 1 Jan 2016 and 1 Jan 2017). The euro to USD rate also varies considerably. The impact of these fluctuations on the Project budget is uncertain, but may lead to a reduced value of Project resources to purchase foreign equipment and services. Meanwhile, the prices for national procurement are subject to inflation on the internal market. This risk is mitigated by conservative budgetting of goods and services.
7. Social and gender issues with bioenergy systems would hamper replication and/or exacerbate social and gender inequalities.	Low	Medium	Social and gender issues directly caused by the Project have not been identified, or can be mitigated by following promoting the participation of women in training activities, project management and contracted services and consultancies. Indirect effects may occur in the influence areas of the demonstration pilots. Note that the targeted sectors (energy, agroindustry) are typically male-dominated. Special attention will be given to potential gender issues resulting from environmental externalities and informal labor. Family-run farms typically have determined roles for men and women, which vary according to the scale of the farm. Land tenure

Risk	Likelihood	Impact	Mitigation actions
			issues may play a role affecting rights of women. Weak enforcement of effluent control may contaminate soils and aquifers affecting health and livelihoods of neighboring rural settlements, where women, children and elderly typically make up the larger share of the population. The envisaged gender screening is aimed at identifying such situations, proposing corrective actions and raising red flags if necessary.
8 Environmental factors, including the effects of global climate change, would cause bioenergy projects being delayed or abandoned.	Low	Low	The effects of climate change are felt worldwide. Brazil's TNC reports (summary p.47) that the Itajaí Valley witnessed prolonged heavy rains resulting in extensive flooding and multiple landslides in November 2008. About 1.5 million people in Santa Catarina were directly affected, 69,000 people were displaced, 120 lives were lost and a state of emergency was declared. Roads were blocked, electricity service collapsed and part of the gas pipeline coming Bolivia- Brazil was damaged, suspending supply for part of the state of Santa Catarina and the entire state of Rio Grande do Sul. The likeliness that proposed demonstration pilots be affected by natural hazards is small, but cannot be ignored. Most structural risks and changes in ambient parameters can be controlled by adequate system design and the use of appropriate materials and constructions. The Project shall review existing construction practices to ensure that proper risk probability assessments are being made. Water shortages associated with climate change are unlikely to affect the Project as the technology does not rely on water as a resource as such. However, water shortages may affect (the expansion of) farming practices; adaptive measures are expected to be taken to minimize any expected impacts.

Table 8: Assessment of project risks and proposed mitigation measures.

A.6. Institutional Arrangement and Coordination. Describe the institutional arrangement for project implementation. Elaborate on the planned coordination with other relevant GEF-financed projects and other initiatives.

Management arrangements

200. The Project will establish a Project Steering Committee (PSC) as the highest decision-making authority, the preliminary composition of which is as follows:

- Representative of MCTIC (lead ministry);
- Representative of MME;
- Representative of Itaipu Binacional;
- Representative of CIBiogas;
- Representative of MMA;
- Representative of UNIDO;
- Project Management Expert;
- National Policy Expert.

201. The Steering Committee will be headed by an annually rotating Chair. Eligible institutions for the Chair are the national counterparts i.e. the Ministry of Science, Technology, Innovation and Communication (MCTIC), the Ministry of Mines and Energy (MME), Itaipu Binacional and CIBiogas. Initially the PSC will be headed by the National Project Director (NPD), who will be nominated by the lead ministry MCTIC. The NPD will be responsible for assuring that the Project is represented on the national level and that all communications are channelled correctly between the relevant (governmental) actors. The PSC will be convoked twice a year; either in Brasilia or Foz de Iguacu. If considered necessary, MCTIC, MME, Itaipu Binacional, CIBiogas and/or UNIDO can request extraordinary meetings of the Steering Committee. This project document shall guide the overall work of the Project Steering Committee, in particular, the budgeted work plan as per Annex F.

202. The responsibilities of the Steering Committee include, amongst others:
- Coordinating and managing the overall project activities at a macro level.
- Facilitating coordination of project activities across institutions.
- Reviewing project activities and their adherence to the work plan set forth in the project document, in line with the GEF regulations on major and minor amendments.
- Reviewing and commenting on each year's proposed work plan and budget.
- Requesting and reviewing financial and progress reports.
- Taking decisions on the issues brought to its notice by UNIDO and other cooperating institutions and advice regarding efficient and timely execution of the project.
- Initiating remedial action to remove impediments in the progress of project activities that were not envisaged earlier.

203. UNIDO's role in the PSC is to provide supervision and technical support. UNIDO will fulfil this responsibility by appointing a Project Manager and mobilizing services of its other technical, administrative and financial branches at UNIDO Headquarters and at the UNIDO Office in Brasilia, Brazil. The UNIDO Project Manager (PM) will facilitate the work of the Project Management Unit (PMU) in coordinating and networking with other related initiatives and institutions in the country and region.

204. The PSC will conduct its activities fully in line with the GEF and UNIDO rules and regulations (particularly GEF Council Documents C.39.09 and C.39.03/Inf.3). All decision-making processes will consider gender dimensions through efforts to achieve gender representation also in Steering Committee meetings.

205. In addition, a Technical Advisory Committee (TAC) with representatives from sector stakeholders (including, for example, representatives from MAPA, MDIC, EMBRAPA, Abiogás, etc.) may be set up to provide support to the Project, specifically the Project Management Unit (PMU).

206. For daily management and coordination of project activities, a project management unit (PMU) will be set up by UNIDO. The PMU will be responsible for the project at local level and will be the main point of contact for stakeholders. The PMU will include as a minimum the Project Management Expert (PME) and a Project Assistant (PA). It will be actively supported by a National Policy Expert (NPE), who will be primarily responsible for coordinating activities related to Component 1 and will act as the main focal point for government institutions.The PMU in close consultation with the NPE will also be responsible for elaborating the annual work plans. The PME will be responsible for the day-to-day management of the Project activities, including overall technical aspects of the project, the facilitation of contracting, close coordination with other experts including the NPE, and monitoring activities. S/he will be supported by the PA as well as technical staff. PMU members will be national consultants (Brazil) and will be based in the offices CIBiogas in Foz do Iguacu. The NPE will be based in the UNIDO office in Brasilia[101]. The PMU with the support of the NPE will be responsible for coordinating the communication and dissemination of the Project results, lessons learned and success stories that are important for the sustainable and future development of the involved market sectors in Brazil.

207. GEF Implementing Agency for the Project will be UNIDO. The counterparts will be the Ministry of Science, Technology, Innovation and Communication (MCTIC) – as lead ministry – and the Ministry of Mines and Energy (MME) as well as Itaipu Binacional and CIBiogas-ER. During the PPG phase, the lead ministry MCTIC requested UNIDO to provide technical and administrative execution support to the Project (please see Annex O for details). The International Centre on Renewable Energy – Biogas (CIBiogas – ER) will be the main technical execution agency at national level. CIBiogas – ER is legally constituted by an association of 16 institutions and its mission is to develop biogas as a technically and economically viable energy product in Brazil, considering economic, environmental and social aspects. Currently, the Centre is undertaking research into existing biogas potential as well as undertaking monitoring, laboratory testing and teaching of operators. As such CIBiogas will execute part of the Project and UNIDO will support execution. Hence, UNIDO will enter into an agreement with CIBiogas covering the execution of specific Project outputs, according to a detailed work plan and operational manual to be developed. Similar agreements may be entered into with other entities (e.g. for capacity building).

208. The following figure shows schematically how the counterparts and stakeholders relate with each other:

[101] In line with Brazilian law, which does not allow for internationally contracted personnel to be hosted in a ministry.

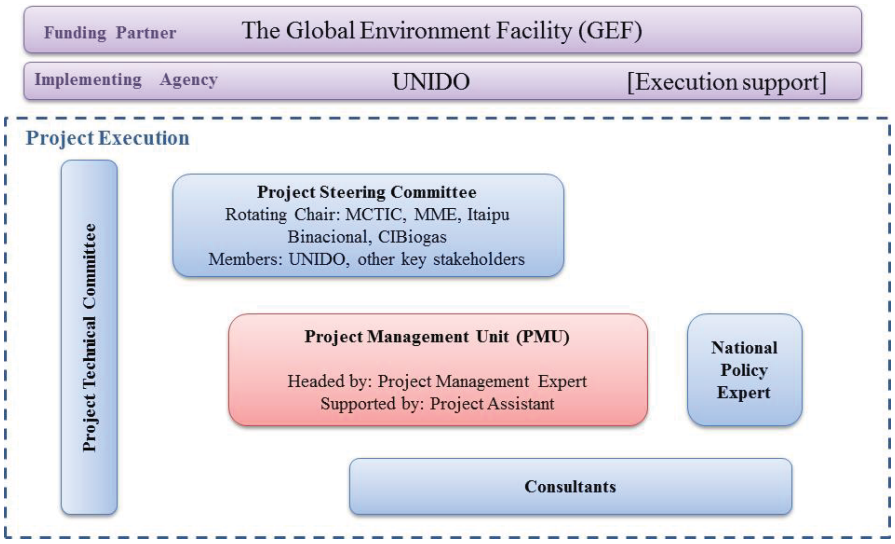


Figure 3: Management arrangements for Project execution and implementation

209. With regards to procurement, full or partial title and ownership of equipment purchased under the Project may be transferred to national counterparts and/or project beneficiaries during the project implementation as deemed appropriate by the UNIDO Project Manager in consultation with project stakeholders.

Reporting

210. UNIDO will establish regular reporting lines between the PMU, UNIDOs technical and administrative support teams and UNIDO's oversight team in order to assure that segregation of duties is maintained. The PMU – as the Secretariat to the PSC – is also required to regularly report to the PSC on technical as well as financial matters.

Coordination

211. The Project has been aligned with the priorities and sector policies in the field of renewable energy development and climate change mitigation as set forth by the Government. The Project will closely coordinate with similar UNIDO-GEF initiatives in the region. However, other GEF initiatives in Brazil are mainly related to biodiversity. No specific elements requiring coordination have been identified.

Additional Information not well elaborated at PIF Stage:

A.7 *Benefits.* Describe the socioeconomic benefits to be delivered by the project at the national and local levels. How do these benefits translate in supporting the achievement of global environment benefits (GEF Trust Fund) or adaptation benefits (LDCF/SCCF)?

Socio-economic benefits at national level

212. The proposed Project fits into national policies to enhance sector productivity and competitiveness, preserve natural resources, protect the local and global environment and diversify the country's energy mix by increasing the share of renewable energy. The Project is expected to deliver tangible socio-economic benefits for Brazils's energy and agroindustry sectors, as well as for individual businesses and the men, women and their families involved. Socio-economic benefits at national level are obtained as a result of avoided imports of fossil fuels for electricity generation and heat applications (specifically imported natural gas). Distributed biogas systems, as well as other grid-connected renewable energy plants can displace thermal-based power plants and improve the utilization rate of the transmission network, thereby postponing public investments in infrastructure. The direct replacement of diesel-based electricity represents very substantial savings of public expenditures given its high marginal costs during peak hours. Moreover, diversification of Brazil's energy mix enables a more economical operation of the national electricity system in function of fuel market prices and improves the country's position for negotiating long-term contracts with foreign suppliers. The electricity produced by biogas systems will

expectedly benefit energy consumers (men and women) at the end of the Project by replacing fossil-fuel based electricity.

213. Biogas provides an opportunity for agroindustrial "prosumers" to cut operational expenditures and become more competitive. Biogas technologies enable effluent management and treatment to reduce environmental impact. Especially export-oriented businesses increasingly need to comply with market demands for responsibly produced commodities and therefore seek opportunities to reduce their GHG footprint. Proactive companies view this challenge as an opportunity to add value to their products and strengthen business competitiveness and innovation capacity. The design and operation of biogas plants within agroindustrial businesses requires qualified human resources, which add value to a company and the sector as a whole.

Socio-economic benefits at local level

214. The Project contributes to the development of a professional biogas and biomethane sector able to design, implement and operate energy systems and equipment, including the provision of adequate after-sales services. This entails high-quality jobs in the field of engineering, agronomy, consultancy and project development with increased value creation, thereby offering opportunities for local professionals to attain higher incomes and sustain the development of human capital in the country and, particularly, in the Southern states. While data on numbers of jobs created varies with biogas systems normally requiring less human resources than, for example, biomass systems, it can be conservatively assumed, on the basis of experience with similar types of projects, that around 1-2 jobs new jobs per biogas system will be generated[102]. Gender will be mainstreamed throughout project implementation. It is expected that social and economic benefits from the implementation of biogas technologies will be shared equally by male and female workers in the respective sectors. Direct creation of jobs is an important opportunity that will benefit both men and women.

A.8 *Knowledge Management.* Elaborate on the knowledge management approach for the project, including, if any, plans for the project to learn from other relevant projects and initiatives (e.g. participate in trainings, conferences, stakeholder exchanges, virtual networks, project twinning) and plans for the project to assess and document in a user-friendly form (e.g. lessons learned briefs, engaging websites, guidebooks based on experience) and share these experiences and expertise (e.g. participate in community of practices, organize seminars, trainings and conferences) with relevant stakeholders.

215. Access to and management of knowledge on agro-industrial waste streams, specifically in the Southern states of Brazil, as well as appropriate biogas technologies has been acknowledged as one of the key barriers for biogas market development in Brazil. The pursued Biogas Information Platform (BIP) will collect, update, manage and disseminate validated, relevant information by drawing upon existing data and analysis from different sources and new inputs generated by the Project (Outputs 1.2.1 and 1.2.2). Specifically viable business models for various end-uses will be analysed (Outputs 2.1.1 and 2.1.5). Furthermore, the envisaged demonstration pilots will expectedly generate a wealth of new data and insights to expand the body of knowledge on biogas in Brazil (Outputs 3.1.1 and 3.1.2). Moreover, operational experiences will be systemized (Output 3.1.3).

216. During the PPG phase, a lack of a culture of sharing of information has been found to exist in Brazil. Sharing of knowledge and promotion are thus subject of Outputs 1.1.1 and 2.1.4 involving, on the one hand, representatives from relevant ministries and, on the other hand, policy makers, officers from electricity distribution companies and cooperatives, electricity system regulators, environmental authorities, sector organizations, financial sector, civil society organizations, and others. The inter-ministerial sessions shall help structure the policy development process at both the strategic and regulatory – more technical – levels. For the latter group, planned activities include events, workshops and promotional material on specific aspects of biogas projects including, amongst others, social and environmental impact, applicable regulation and permitting procedures and the project development cycle. The consolidation of gathered knowledge and experiences within the Biogas Information Platform (BIP) is an important element of the Project's exit strategy. Output 2.1.4 also covers capacity building and training for biogas produces, project developers and other stakeholders. Relevant topics include, amongst others, process monitoring and operation, safety of biogas installations, and planning and execution of maintenance and repair activities.

[102] See also Environmental and Energy Studies Institute (EESI). Fact Sheet: Jobs in Renewable Energy and Energy Efficiency (2015). November 6, 2015.

217. All knowledge management activities will be gender mainstreamed. This includes integration of gender dimensions into publications, for instance, through the presentation of sex-disaggregated data, gender-energy nexus theory, gender sensitive language, photos showing both women and men and the avoidance of stereotypes. In addition, it will be assured that women, men and youth have access to and benefit from the knowledge created.

218. Finally, UNIDO will ensure that relevant information and lessons learned will be collected as input for the Mid-term Review and Terminal Evaluation. UNIDO will further promote the exchange of experiences and technical information and know-how between related GEF projects in the region, including biogas initiatives in Uruguay (GEF ID 4890), Chile (GEF ID 5335) and Argentina (GEF ID 9053). These projects will also provide useful orientation for the design of national policy and regulation, specifically concerning safety of biogas installations, standards for composition and innocuity of digestate, guidelines for environmental protection, financial incentive schemes, and others.

B. DESCRIPTION OF THE CONSISTENCY OF THE PROJECT WITH:

B.1 *Consistency with National Priorities.* Describe the consistency of the project with national strategies and plans or reports and assessements under relevant conventions such as NAPAs, NAPs, ASGM NAPs, MIAs, NBSAPs, NCs, TNAs, NCSAs, NIPs, PRSPs, NPFE, BURs, INDCs, etc.:

219. The Second National Communication to the UNFCCC (2010) stresses the envisaged growth of renewable energy sources in Brazil's energy mix including the "modern use of biomass" based on agricultural and forest residues, solid waste, and the development of liquid biofuels for transportation. The Third national communication makes reference to the use of biomass for domestic electricity supply (7.6% in 2013) based on sugarcane bagasse, besides the use of charcoal, agro-industrial and forest waste and biogas.

220. Brazil's National Climate Change Policy (PNMC) established the voluntary commitment to cut projected emissions between 36.1% and 38.9% by 2020. Federal Decree 7,390 (2010) provides for the creation of sectoral emission reduction plans defining actions, indicators and targets to reduce emissions and mechanisms to verify compliance. Brazil's intended Nationally Determined Contributions (INDC) in 2015 reconfirms this commitment, setting a national target of 37% below 2005 levels, to be attained in 2025.[103]

221. Sectoral emission reduction plans have been made for several sectors, including the electricity sector (the Ten-Year Energy Expansion Plan, PDE), agriculture (the Low-Carbon Agriculture plan, ABC), and the iron and steel sector[104], among others. The National Ten-Year Plan for Energy Expansion, which is updated annually, foresees an increase of energy consumption with a 5.3% growth rate in its version for 2020 (PDE 2020). Targets set in the INDC for the energy sector include an estimated 45% of renewables by 2030 and expansion of non-hydro renewable energy sources to 28-33% by 2030. For the electricity sector, a share of at least 66% hydropower is foreseen, and 23% for other renewables (wind, biomass and solar).[105] MAPA's Low-Carbon Agriculture (ABC) Plan was established in 2011 as a government instrument to increase the area under sustainable agricultural practices. The objectives of the ABC Plan include, among others: (a) to ensure continuous and sustained improvement of management practices in Brazilian agriculture that can reduce GHG emissions and; (b) to encourage the adoption of sustainable production systems such as Crop-Livestock-Forestry Integration (CLFi); (c) to encourage animal manure treatment for the generation of biogas and organic compound; and (d) to reduce the deforestation resulting from the expansion of livestock farming and other factors. The Project is also supportive to the MAPA Programa Mais, which aims to double animal meat production in Brazil by increasing the livestock density from 1.3 to 2.6 head/ha, enabling a total production of 13.6 million ton meat at an area of 113.8 million ha.

222. Biogas and biomethane are acknowledged by MME's RenovaBio programme (2016) which encompasses four lines of action: (a) platform for dialogue with the private sector about the role of biofuels in Brazil's energy matrix; (ii) economic, financial and environmental sustainability; (iii) framework for commercialization of biofuels; and (iv) support for new types of biofuels. In this context also the Biofuture Platform is mentioned, presented as part of

[103] Source: Brazil INDC 2015, http://www4.unfccc.int/submissions/INDC/Published%20Documents/Brazil/1 /BRAZIL%20iNDC%20english%20FINAL.pdf.

[104] Targeted by the GEF-5 project "Production of sustainable, renewable biomass-based charcoal for the iron and steel industry in Brazil", GEF ID 4817, implemented by UNDP.

[105] For a detailed description of Brazil's commitments for the energy sector as presented in the IDNC, see: Tolmasquim, M.T., R. Gorini, E. Matsumura, J. B. Soares, L. B. Oliveira, M. L. V. Lisboa, G. V. R. Faria, M. R. Conde, N. G. Moraes, R. A. M. Silva (2016), The Brazilian Commitment to Combating Climate Change: Energy Production and Use, Empresa de Pesquisa Energética-EPE, Rio de Janeiro, RJ, Brazil, 96 pp.

the COP22, created to boost the use of biofuels in Brazil and in the international market.[106] Both initiatives fit into national policy to increase the share of sustainable bioenergy in the Brazilian energy matrix to approximately 18% by 2030.

C. DESCRIBE THE BUDGETED M &E PLAN:

223. Project monitoring and evaluation (M&E) are conducted in accordance with established UNIDO and GEF procedures. The M&E activities are defined by Project Component 4. and the concrete activities for M&E that are specified and budgeted in the M&E plan (please refer to the table below). Monitoring will be based on indicators defined in the Strategic Results Framework (which indicates the means of verification), and the Annual Work Plans. Monitoring and Evaluation will make use of the GEF CCM Tracking Tool, which will be submitted to the GEF Secretariat three times during the duration of the project: at CEO Endorsement, at mid-term review, and at project closure.

224. UNIDO as the GEF Implementing Agency will involve the GEF Operational Focal Point and project partners at all stages of the project monitoring and evaluation activities in order to ensure the use of the evaluation results for further planning and implementation. According to the Monitoring and Evaluation policy of the GEF and UNIDO, follow-up studies like country portfolio evaluations and thematic evaluations can be initiated and conducted. All project partners and contractors are obliged to (i) make available studies, reports or other documentation related to the project and (ii) facilitate interviews with staff involved in the project activities.

Type of M&E activity	Responsible Parties	Feeds into	Time frame	GEF Grant Budget ($US)	GEF Grant Budget ($US)
Monitoring of project impact indicators (as per LogFrame)	UNIDO Project Manager (PM); Project Management Unit (PMU); Project Steering Committee (PSC); expert consultancy	Project management; Semi-annual progress report; Annual GEF PIR	Quarterly	50,000	60,000
Periodic progress reports	UNIDO Project Manager (PM); Project Management Unit (PMU); Project Steering Committee (PSC); expert consultancy	Project management; Semi-annual progress report; Annual GEF PIR	Quarterly	50,000	60,000
Measurement GEF Tracking Tool specific indicators	UNIDO Project Manager (PM); Project Management Unit (PMU); Project Steering Committee (PSC); expert consultancy	Mid-term Review and Terminal Evaluation Reports	Mid of project and at project completion	25,000	40,000
Mid-term review	UNIDO Project Manager (PM); Project Management Unit (PMU); expert consultancy	Project management	Mid of project	55,000	34,000
Independent terminal project evaluation	Independent evaluators managed by UNIDO ODG/EVA.	Terminal Evaluation Review (TER) conducted by UNIDO EVQ and/or GEF IEO	Project completion (at least one month prior to the end of the project and no later than six months after	100,000	34,000

[106] See: http://www.brazilgovnews.gov.br/news/2016/11/brazil-launches-platform-to-boost-biofuel-market.

Type of M&E activity	Responsible Parties	Feeds into	Time frame	GEF Grant Budget ($US)	GEF Grant Budget ($US)
			project completion)		
TOTAL indicative cost				**280,000**	**228,000**

Table 9: Project monitoring and evaluation plan

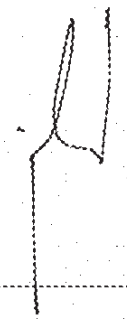
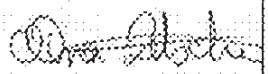
Legal Context

225. The Government of the Federative Republic of Brazil agrees to apply to the present project, mutatis mutandis, the provisions of the Revised Standard Technical Assistance Agreement between the United Nations and Specialized Agencies and the Government, signed on 29 December 1964 and entered into force on 5 May 1966.

PART III: CERTIFICATION BY GEF PARTNER AGENCY(IES)

A. GEF Agency(ies) certification

This request has been prepared in accordance with GEF policies[107] and procedures and meets the GEF criteria for CEO endorsement under GEF-6.

Agency Coordinator, Agency Name	Signature	Date (MM/dd/yyyy)	Project Contact Person	Telephone	Email Address
Mr. Philippe R. Scholtès, Managing Director, Programme Development and Technical Cooperation - PTC, UNIDO GEF Focal Point		04/19/2017	Ms. Nina Zetsche, Industrial Development Officer, PTC/ENE/RRE, UNIDO 	+43 (1) 26026 3569	n.zetsche@unido.org

[107] GEF policies encompass all managed trust funds, namely: GEFTF, LDCF, SCCF and CBIT

LIST OF ANNEXES

Annex A	Strategic Results Framework
Annex B	Responses to Project Reviews
Annex C	Status of Implementation of PPG Activities
Annex D	Calendar of Expected Reflows
Annex E	Other relevant stakeholders
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Annex G	Environmental and Social Management Plan
Annex H	Preliminary gender analysis for Brazil
Annex I	Estimation of GHG benefits
Annex J	Tracking Tool for Climate Change Mitigation Projects
Annex K	Existing policy and legal framework
Annex L	Summary and conclusions of preparatory work for BIC
Annex M	Potential demonstration pilots
Annex N	(Pre-)Feasibility studies
Annex O	Nomination for execution of project
Annex P	Additional project support
Annex Q	Background documentation

ANNEX A: PROJECT RESULTS FRAMEWORK (either copy and paste here the framework from the Agency document, or provide reference to the page in the project document where the framework could be found).

UNIDO/GEF Project: Biogas applications for the Brazilian agro-industry.					
Applicable GEF Strategic Objective and Program: CCM-1 program 1					
Applicable GEF Expected Outcomes: Outcome A. Accelerated adoption of innovative technologies and management practices for GHG emission reduction and carbon sequestration. Outcome B. Policy, planning and regulatory frameworks foster accelerated low GHG development and emissions mitigation.					
Applicable GEF Outcome Indicators: Indicator 1. Tons GHG reduced or avoided. Indicator 2. Volume of investment mobilized and leveraged by GEF projects for low GHG development.[108] Indicator 5. Degree of support for low GHG development in the policy, planning and regulatory framework.					
Project Objective	To reduce GHG emissions and dependence on fossil fuels through the promotion of energy solutions for productive uses, including biogas-based mobility, within agro-industrial value chains and by strengthening of national biogas technology supply chains.				
	Indicator	Baseline value	Target value (EOP)	Means of verification	Assumptions
	A (GEF Indicator 1). Total direct GHG emission reductions (ton CO_2eq); B (GEF Indicator 2). Volume of investment mobilized (US$); C (GEF Indicator 5) Degree of support for low GHG development in the policy, planning and regulatory framework. [109] D. Annual biogas production pilot plants (m3/yr); E. Number of new jobs created in biogas market (m; f).	A. No reductions (0 ton CO_2eq); B. No investment mobilized (US$ 0) C. Level "6" (Sub-sector and institutional plans reflect key policy targets and priority actions). D. No energy production (0 MWh/yr); E. No new jobs created (0m; 0f).	A. 535,000 ton CO_2eq. B. Investment mobilized (US$32,170,000). C. Level "8" (Strong policy and regulatory frameworks designed with incentive based mechanisms). D. 15.7 million MWh/yr; E. New jobs created (24m; 16f).		
Component 1.	Policy framework and information.				
	Indicator	Baseline value	Target value (EOP)	Means of verification	Assumptions
Outcome 1.1 Enhanced inter-ministerial coordination and implementation of policies, regulation and instruments to promote the adoption of biogas and biomethane energy systems based on agroindustrial organic waste.	(1.1) a) Number of biogas and biomethane policies and regulations enhanced (-); b) Funding earmarked for biogas investments under public programmes (US$/yr).	a) 0; b) 0 US$/yr	a) 3 policies and instruments; b) 10 M US$/yr	Official publications, project reports, interviews with federal and state authorities.	Sustained institutional and policy support from involved ministries and states. Project activities are implemented as expected.

[108] Disaggregated between public and private investments.
[109] Measured by a qualitative rating 1..10, according to GEF 6 Programming Directions, Annex II, p.83.

1.1.1 Establishment of an inter-ministerial coordinating unit on biogas and biomethane market development receiving support from the Project.	(1.1.1) Number of meetings held during project timespan (#/yr).	0 meetings/yr	3 meetings/yr	Project reports, official reports, interviews with key ministry staff.	Sustained institutional support by key ministries. Adequate political prioritization of biogas and biomethane at federal level.
1.1.2 Updating and detailing of federal and state policies and programmes, and regulatory and financial instruments to facilitate biogas and biomethane market development based on agroindustrial organic waste.	(1.1.2) a) Number of biogas policies and regulations enhanced (-); b) Number of financial instruments adapted to biogas (-).	a) 0 policies and regulatory instruments; b) 0 financial instruments	a) 3 policies and instruments; b) 1 financial instrument adapted.	Official publications, project reports	Sustained institutional and policy support from involved ministries and states. Project activities are implemented as expected.
1.1.3 Integration of biogas and biomethane into federal and state-level energy and agriculture sector programmes.	(1.1.3) Number of sector programmes and plans specifically promoting biogas and biomethane investments (-);	0 programmes	3 programmes	Official publications, project reports	Sustained institutional and policy support from involved ministries and states. Project activities are implemented as expected.
1.1.4 Design of an MRV system for tracking of GHG emission reductions from anaerobic digestion in agro-industries.	(1.1.4) Delivery of envisaged MRV systems for biogas plants.	Not implemented	MRV system implemented	Official publications, project reports	Sustained institutional and policy support from involved ministries and states. Project activities are implemented as expected.
Outcome 1.2 Information on biogas and biomethane technology and market development updated, consolidated and made accessible to public and private stakeholders.	(1.2) a) Number of information packages delivered (scale 0…4); b) Sustainable operation of Biogas Information Platform (BIP) (yes/no)	a) 0; b) no BIP in place	a) total of 10 packages delivered; b) BIP operational	Official publications, project reports, interviews with federal and state authorities.	Sustained institutional and policy support from involved ministries and states. Project activities are implemented as expected.
1.2.1 Collection, validation and publication of technical, legal, economic, and other relevant information for biogas market development based on agroindustrial organic waste.	(1.2.1) Number of information packages with validated information on biogas and biomethane delivered per year (#/yr).	0 packages/yr	2 packages/yr;	Project reports, sector reports, academic publications	Project activities are implemented as expected. Stakeholders and sector agencies are able and willing to share information and data.
1.2.2 Operationalization of a Biogas Information Platform (BIP) to update, manage and disseminate validated information to stakeholders.	(1.2.2) a) Status of Biogas Information Platform (BIP); b) Number of information requests to BIP (1/yr).	a) not implemented; b) 0 requests per year	a) implemented; b) 50 requests per year.	Project reports, sector reports, interviews	Project activities are implemented as expected. Stakeholders and sector agencies are able and willing to share information and data. Sector stakeholders are willing to

					maintain the BIP or pay for the services delivered.
Component 2.	Biogas and biomethane technology and value chain.				
	Indicator	Baseline value	Target value (EOP)	Means of verification	Assumptions
Outcome 2.1 Strengthening of the biogas and biomethane value chain by promotion of cost-effective, standardized technologies, consolidation of market strategies and business models, and transfer of know-how and skills to project developers and other stakeholders.	(2.1) a) Share of biogas projects implementing standardized technologies and best practices (%); b) Number of energy sector companies delivering biogas-based electricity and biomethane (-);	a) 0%; b) 0	a) 67%; b) 3 companies	project reports, sector information	Sustained interest by national and foreign stakeholders, including businesses, in biogas and biomethane development. Encouraging business environment in Brazil.
2.1.1 Validation of biogas and biomethane business models for agroindustries, including associative biogas production schemes.	(2.1.1) Delivery status of reports	No reports delivered	Reports delivered	Project reports, sector information	Baseline information is available and made accessible to the Project. Project activities are implemented as expected.
2.1.2 Preparation of recommendations and guidelines for standardization of technical designs, feedstock, equipment, and operational procedures for biogas production schemes.	(2.1.2) Delivery status of recommendations and guidelines (yes/no).	Recommendations not delivered	Recommendations delivered	Project reports, sector information	Sustained interest by key stakeholders in biogas and biomethane development.
2.1.3 Adaptation of equipment, components and processes for biogas and biomethane production to local socio-economic and technical conditions (“tropicalization”).	(2.1.3) a) Number of produced proposals and concepts for technology adaptation (-); b) Percentage of technological issues and components successfully improved (%); c) Number of industry partnerships in biogas and biomethane technology established (-).	a) 0; b) 0%; c) 0	a) 8 (sex-disaggregated data to be recorded); b) 67%; c) 5 partnerships	Project reports; interviews with proponents; PSC minutes; sector reports	Sustained interest by national and foreign stakeholders, including businesses, in biogas and biomethane development. Project activities are implemented as expected.
2.1.4 Implementation of training, capacity building and promotional activities for biogas producers, project developers and other stakeholders.	(2.1.4) a) Annual number of training events held (#/yr); b) Number of biogas professionals trained per year (m;f, #/yr).	a) 0; b) 0m, 0f per year	b) 1 event/yr; c) 30m; 20f per year	project reports, sector information	Sustained interest by key stakeholders in biogas and biomethane development.
2.1.5 Development and approval of market introduction strategies and	(2.1.5) Number of market introduction strategy documents	No strategies (0)	At least 3 strategies and action plans	Project reports, sector information, corporate	Sustained interest by key stakeholders in

business models for biogas-based electricity and biomethane by electricity and gas companies in Southern Brazil.	and action plans (-).		delivered	business reports;	biogas and biomethane development. Project activities are implemented as expected.
Component 3.	Demonstration and optimization of biogas projects.				
	Indicator	Baseline value	Target value (EOP)	Means of verification	Assumptions
Outcome 3.1 Demonstration and optimization of the technical and economic feasibility of biogas and biomethane production and utilization based on agroindustrial organic waste.	(3.1) a) Technical performance level (monitored biogas production / projected biogas production), per project; b) Operational cost coverage rate (%) (financial revenues / operational costs), per project; c) Number of people (m, f) benefitting directly from delivered investments (-; m/f).	a) Not defined; b) Not defined; c) 0m; 0f.	a) >80% level, per pilot project b) 100% coverage, per pilot project; c) 120 m; 80 f.	Project reports, interviews with stakeholders; project monitoring data; sector reports	Sustained interest by regional authorities and key stakeholders in bioenergy development. Project activities are implemented as expected.
3.1.1 Verification and implementation of demonstration pilots for biogas production and utilization based on agroindustrial organic waste in Southern Brazil.	(3.1.1) a) Number of projects approved (-); b) Investment by project partners in pilot project installations (US$)	a) 0 pilot projects; b) US$ 0	a) 4 pilot projects; b) US$32,170,000.	Project report, interviews with stakeholders, model contracts and protocols	Project activities are implemented as expected. Sustained interest by key stakeholders in biogas development.
3.1.2 Investment and technical services to ensure operational performance and sustainability of the installed demonstration pilots.	(3.1.2) a) Average time between project delivery and satisfactory operation (months, per pilot project); b) Additional investment needed for satisfactory project operation (% of initial CAPEX).	a) 0; b) Not defined	a) < 18 months; b) < 20% (average).	Project reports; project monitoring data; interviews with stakeholders	Project activities are implemented as expected.
3.1.3 Monitoring of operational aspects and performance of established pilots, including systematization of lessons learned and recommendations for enhancement.	(3.1.3) a) Annual production of biogas (m3/yr, per pilot project); b) Unscheduled down-time per year (hour/yr, per pilot project); c) Delivery status of report with lessons learned and recommendations (yes/no).	a) 0 m3 biogas /yr; b) Not defined; c) No report delivered.	b) 15.7 m3 biogas/ yr (total); b) <100 hours/yr, per pilot; c) Report delivered.	Project reports; field inspections; project monitoring data; interviews with stakeholders	Project activities are implemented as expected. Sustained interest by key stakeholders in biogas development.

ANNEX B: RESPONSES TO PROJECT REVIEWS (from GEF Secretariat and GEF Agencies, and Responses to Comments from Council at work program inclusion and the Convention Secretariat and STAP at PIF).

Comments	Response	Reference in documents
Comments from the GEF Council		
United States: welcomes this project concept and thinks that, once implemented, it could provide significant GHG reductions. As the project is further developed into a full PPG, we urge UNIDO to consider the following points, along with the technical comments provided by the STAP.		
1. In the PIF, the timeline of expected impact is not clearly defined. Greater clarity and definition concerning the feedstock, beyond the classification as agricultural waste, may be useful to determine the range of global environmental benefits that can be expected. Additionally, the project may be strengthened by consideration of international policies that could affect the supply chain of agri-industrial waste. We recommend therefore, that these be factored into the feasibility study.	During the PPG phase, limitations with regards to available data on feedstocks were encountered. Hence the range of environmental global benefits could not be elaborated in great detail. However, this is foressen to take place during Project implementation. Considerations of international policies that could affect supply chains will be factored into feasibility studies to be undertaken.	Para 130
2. The private sector classification could be strengthened by including private farming entities. To strengthen the proposal, we encourage UNIDO to explore how previous investments have included farmers and landowners and what the results of their inclusion were. Working with these groups could potentially strengthen cost reasoning for the feedstock.	The final Project design implies an increased engagement with the private sector both at the energy demand side (electricity and gas companies) and the biogas production side. The project portfolio in Paraná presented in the document includes cooperatives, private livestock farmers, and processing facilities. In this context, it must be noted that many cooperatives members are actually small-scale landowners. The PPG did not retrieve quantified information about the opportunity costs of feedstock in the targeted subsectors (manure, cassava starch, slaughterhouse wastewater). Individual farmers still view organic effluents primarily as an environmental externality, their treatment implying a cost. Legal restrictions on waste transport are also an impediment for regional biomass markets to develop, alongside logistical barriers poor awareness of waste as a resource, and the low degree of communication between farmers. Larger agro-businesses including cooperatives are taking a more holistic perspective to sector development including aspects such as resource efficiency, water management and conservation, nutrient cycles, etc. There is a process of intensification of meat and crop production which urges for increased competitiveness while controlling and reducing environmental externalities. Boundary conditions are also set	Para 44, 190

	by national policy to replace fossil fuels and reduce dependence on imported fertilizers. The Project envisages working closely with private farmers and cooperatives (such as Cooperativa LAR) and state sector entities to promote a paradigm shift towards a more competitive and sustainable agroindustrial (specifically: livestock) sector fully supportive to the goals of Brazil's ABC Programme. Financing programmes exist targeting family farmers (PRONAF) and larger businesses (ABC Programme); loans are channelled through the national (development) banks. The PPG phase did not retrieve disaggregated information relating capital demands to farm sizes but as a qualitative appraisal, access for smaller agrobusinesses is more difficult as collateral requirements are usually very demanding in Brazil.	Para 192 Para 65 Para 53-56
3. We support STAP's observation that UNIDO should incorporate detailed assessments of other plants (including previous GEF investments) to develop a set of "lessons learned" that can be applied in this project. Given that there are a variety of plants (anaerobic digesters and ancillary equipment) operating successfully we are concerned about the $10.5 M proposed for research and development efforts. There does not appear to be a clear need for new equipment in such a mature and well-developed market. Additionally, it is our understanding that GEF funds are not meant to fund research and development activities.	It is noted that all stakeholders confirm the need for adaptation of globally available technology to the specific circumstances in Brazil. This observation is made for larger biogas plants in the sugar cane sector and for small associative biogas production systems in animal farming. Reference is made to the revised approach to technology development in the final Project design. Instead of developing and demonstrating a specific value chain (such as mobility as tentatively proposed in the PIF), the present approach is to test the claimed hypothesis that "tropicalization" of biogas technology would lead to more robust processes and reduced capital and operational costs. While such benefits are likely, the Project aims to adapt and improve technological systems, components and processes according to a pre-established list of priorities. The Project will strongly draw upon baseline work in Brazil, including the BiogasFert network, and make an effort to engage the national manufacturing industry where possible. Activities carried out during the PPG phase ran into serious limitations to access information about operational performance and lessons learned of existing biogas installations. There is no tradition of sharing this type of information in Brazil; moreover, confidentiality agreements are common for accessing even basic data. Other initiatives, notably PROBIOGAS, experienced similar issues and by consequence, a survey of existing biogas plants in Brazil has not been made so far. The proponents believe that this barrier has adversely affects the process of technology development and the success rate of individual biogas plants, given that peer reviews would lead to better structuring of pilot initiatives, enforce systematic monitoring and follow-up to implement improvement, and consolidation of data and methodologies for sharing results and proposals. The PPG team found substantial deficiencies in this respect; these lessons learned have been included in the final Project design.	Para 137 Para 174
4. The viability of the investment and the ability of this project to achieve	The envisaged biogas plants will operate embedded in existing agroindustries (farms), hence their operation must be	Para 154-167

global environmental benefits will require a robust operation and management plan and monitoring and evaluation framework. We expect that these will be fully developed prior to GEF CEO endorsement.	efficient and deliver tangible benefits for the owner. Project component 3. has been designed with a focus on ensuring technical sustainability and performance in a business environment. Monitoring of operational aspects is used for tracking of avoided GHG emissions and for identifying corrective measures and opportunities for improvement and performance optimization. Technical assistance and co-investment can be provided by the Project, based on a review of proposals by a technical committee and approval by the Project Steering Committee. By following a structured approach, sharing of information and collective learning - presently a barrier - will expectedly be encouraged.	
Comments from the GEF Secretariat at Work Plan Inclusion		
(no remaining comments)		
Comments from STAP		
1. The objective of this project is to stimulate biogas plant development nationally. It aims to demonstrate a medium to large scale plant (up to 3000 m3 biogas per day), which is planned. However, the design and size will be defined after a feasibility study. The barriers and threats are defined, however, few references are used and no assessment is planned of existing plants that are referred to under Section 2. The problem of barriers to deployment is clear.	Please refer to the table in the Project document, Part II-A for the changes between the final Project design and the PIF. Feasibility and engineering studies have been carried out by CIBiogas for a number of the biogas projects proposed as pilots (using baseline funding). A comprehensive survey of existing biogas plants in Brazil has not taken place as yet (see also response to US comment 3 above).	Part II-A
2. Outcomes on technical know-how and business models should closely liaise with Germany (already mentioned at the top of page 9), Denmark, the UK, etc. all have considerable experience with large-scale community based biogas projects using multi-feedstocks.	This is acknowledged. The Project will depart from business modalities and technical designs and parameters as used in the mentioned countries. Among other technical challenges, foreign expertise with respect to co-digestion will be brought into the Project. Notwithstanding, it must be noted that the business and technical environment in Brazil deviates greatly from Europe. Amendments to sector regulation must obey Brazilian law and business modalities; also there are major differences with respect to the organization, scale and capital-intensiveness of the agricultural sector.	Para 147 Para 17, 94
3. On-farm biogas plants usually fail due to lack of attention and maintenance. For this reason, a biogas plant needs to be large enough to warrant at least one full-time operator. The scale of the proposed demonstration plant as indicated in the PIF should be sufficient for this. Feedstocks will need to be brought to the central site. This issue has not been evaluated, nor whether back-loading of the nutrient effluent is possible.	Reference is made to the overview of (potential) biogas pilot projects, which vary in scale, ownership arrangements, feedstock and energy end-use. Note that one initiative involves biogas collection and transport, while another one concentrates the feedstock. We fully subscribe the importance of maintenance and skilled operation for performance and sustainability. Note that detailed lessons learned from existing biogas plants in Brazil are not available. A systematic evaluation of farmer skills and operational issues under the associative biogas production model (CIBiogas condominium model) has not taken place, hence this aspect has been flagged as a potential risk. In response, the Project will build operator	A5. Risks

	skills in the pilots pursued. It will further critically review the roles and responsibilities of project participants for a variety of business models. The Project will strive at integrating biofertilizer production into biogas business development; GEF funding, however, will be focused on energy generation, moreover given the strong baseline support for biofertilizer technology through the EMBRAPA BiogasFert programme.	Para 140
4. This is a 5 year project. This should allow time for detailed assessments of other plants (in Brazil and elsewhere), the selection of the design and site, construction and MRV.	We believe that a 5-year time horizon is adequate for the project. Government interest in MRV is increasing and has been addressed in the Project design (Output 1.1.4). Sharing of information, being culturally driven, will likely remain a challenge during Project implementation; improvements are expected once benefits become more visible to stakeholders and a common agenda is developing.	Para 127-128
5. The sum of the outputs is likely to contribute to the outcomes identified in this project proposal. However, it is not clear why US$11.5M on product equipment development and testing of prototypes is needed since there are many plants operating successfully of varying designs of anaerobic digesters and ancillary equipment using agro-industrial wastes as feedstocks.	Please refer to the answer to US comment 3 above.	
a) Who is going to undertake the R&D on product development?	a) At PIF stage, it was envisaged to detail one or more (product-oriented) R&D proposals in partnership with national industries and technological institutes. This proved more difficult than expected; hence, such partnerships did not develop. According to the Project proponents, the main reason is the incipient market size and lack of (technical) standards which refrains the manufacturing industry from developing new products tailored to this market. Existing large biogas projects are based on standard national components complemented with imported equipment, and often imply a substantial amount of in-house engineering. The supply chain is highly fragmented and lacks a clear champion. It is further noted that technological institutions tend to be more focused on upstream R&D rather than product development. This is often mentioned by private industries as a systemic barrier for innovation in Brazil. Without a clear counterpart, product development under the GEF project would lack ownership and not lead to sustainable results. The original approach to work directly with supply chain industries has therefore been revised thoroughly.	Para 142-143 Para 175
b) The proposed Biogas Innovation Centre (BIC) is planned, but who will it employ, and what will be the facilities for constructing and testing plant equipment? Providing information to encourage wide deployment is a good role for this plant, but it cannot be pre-assumed that there will be a need to	b) As described in the Project document, biogas is a research topic in a substantial number of R&D institutes and universities; accredited biogas laboratories are being implemented with support from BiogasFert serving the ABC Plan; and in Parana, CIBiogas was established in 2013.	Para 84-87 Part II A.2

develop new equipment in a mature and well-developed market.	The role and scope of work of a dedicated BIC was scrutinized during the PPG phase by a specialized international consultant, involving representatives from the biogas field. It was concluded that a new BIC would be redundant and likely lack sustainability. However, a biogas and biomethane technology programme was considered highly opportune, precisely to provide orientation to the market; the Project itself, through a technical committee, would then temporarily fulfil the role of a champion. While presently premature, institutionalization of this biogas technology programme, for example as a "BIC" within a host agency, will be considered. The Project will further seek synergies with parallel programmes and initiatives, such as business incubators (for example at Itaipu Technology Park), innovation programmes such as EMBRAPII, and bilateral activities promoting technology transfer (EU, Germany, Austria, among others).	Para 124-126
6. Component 4 relating to M&E is very general. STAP recommends that the project proponents develop specific indicators for monitoring and evaluating project impacts such as the volume of fossil fuels replaced by biogas production (also converted into GHG reductions); the amount of fossil fuel energy capacity retired from the grid; the amount of avoided GHG emissions with the increasing use of bio-based feedstocks/ waste; market development indicators as well as human capacity indicators.	Reference is made to the indicators proposed in the Strategic Results Framework, which covers the mentioned impacts. The Project further envisages the design and delivery of an MRV module to track GHG reductions from the addressed subsectors, in collaboration with the federal Ministry of Environment (MMA).	Annex A
7. In terms of baseline, the Government of Brazil has the goal of reducing agricultural emissions 38% lower than baseline. The national target for 4.4 M m3 of residues digested by 2020 which is presumably above current use. The number of biogas plants now operating is another baseline. However, there is no indication of the number of plants planned by a given timeline.	As described in the Project document, the most exhaustive inventory of existing biogas plants in Brazil is presumably the Biogas Map managed by CIBiogas, which contains about 150 projects. The energy generating capacity of this set of projects is dominated by a small number of large biogas plants in the waste sector (landfill and sewage). The proposed Project is aimed at a different sector (i.e. agroindustries) with a focus on smaller size projects. See also table par. 23 for typical sizes of biogas plants per (sub)sector. The Project aims to implement a set of pilot biogas plants under a variety of institutional arrangements (cooperative, associative, private). Especially the associative "condominium" models pursued by CIBiogas imply a substantial number of individual digesters. To allow some flexibility in terms of feedstock and digester size, the Project proposes to implement a portfolio of pilot projects with associated co-investment from the project partners and estimated (direct) GHG reductions. To provide some flexibility, the GHG estimate (Annex I) is based on an envelope under which the envisaged pilots will be developed. The time horizon for this envelope is the Project's lifetime (5-years). A useful indicator for assessing market growth of biogas	Para 35 Annex I

	(anaerobic digester capacity) can be the credits issued under agricultural programmes such as PRONAF and ABC. Current baseline investments in manure treatment technologies are of the order of R$ 5 million per year. The Project will make an effort to monitor mobilization of investment capital annually and report this in the PIR.	
7. In terms of incremental costs, the proposed incremental activities will potentially lead to the delivery of global environmental benefits including 3.57 Mt CO2-e mitigation in Table F. Section 5 of Component 2 shows this is 1.7 Mt over 20 year life of the proposed demonstration plant with vehicle fuelling facility and 1.87 indirect (consequential) emissions. These calculations are based on a "European state-of-the-art" plant but the scale (e g. m3 digester; ton feedstock/yr) is not given. 8.	Please refer to the provided GHG estimate for the digester sizes based on a portfolio of typical pilots to be developed under the Project.	Annex I
9. The project is not particularly innovative as this is a mature market. It will be unlikely to contribute to the scientific knowledge to help the GEF, though it is unclear if large-scale biogas plants have been supported in the past by the GEF.	As demonstrated in the Project document, the biogas value chain in Brazil is still poorly articulated; offered solutions are not well adapted to the local circumstances and business models are not consolidated. The PPG did not find evidence of GEF support to biogas development in Brazil in the past. To the opinion of the proponents, the final Project design is more innovative and robust than the PIF concept by: (a) integrating (mainstreaming) biogas development into agricultural support programmes (PRONAF, ABC Plan) and their corresponding financial instruments; (b) contributing to the momentum for biofuels and diversification of energy sources within MME (including the recent RenovaBio initiative); (c) pursuing biogas and biomethane market development not only from the biogas supply side (agroindustries) but also the demand side (electricity and gas companies); (d) pursuing technology development in function of the demand for more adapted solutions (“tropicalization”) and monitoring its impact in terms of reduced investment (CAPEX) and operational costs (OPEX). In general terms, the final Project design is more focused on influencing processes rather than delivering fixed, but probably not sustainable, outputs.	Para 11 Para 66 Para 10 Para 176 Para 145-148
10. The risks listed are valid and comprehensive and socio-economic issues are defined and supported by verifiable sources.	This is noted.	
11. It is not clear that the project taps relevant knowledge / learning from	Significant lessons for project design have been drawn from the recently approved GEF-5 project “Sustainable	

other projects. Several past GEF projects have supported biogas plants which is a mature technology. Will they be evaluated by project proponents to obtain lessons learned? An effort should be made to review past GEF biogas projects to learn from them. See The demonstration project in this PIF will be monitored; however, it is not clear how information will be disseminated, which would be helpful for sharing lessons for future initiatives.	Business Models for Biogas Production from Organic Municipal Solid Waste" (GEF ID 5345, UNDP) in Argentina, the parallel GEF-6 project in Argentina "Reducing Argentina's greenhouse gas emissions from the energy sector through the utilization of organic waste for energy generation in agriculture and agroindustries" (GEF ID 9053, UNIDO). Knowledge and experiences have also been drawn in from the UNIDO-implemented GEF-5 projects in Chile and Uruguay, which have a focus on biogas. UNIDO actively promotes the exchange of knowledge and experiences between these initiatives, as this is critical for accelerating the learning curve towards mature technological solutions and the review and adoption of best practices in the region.	
12a) Key question for biogas plants is who will undertake maintenance as biogas is corrosive? b) Also how will the co-product of effluent for soil nutrient amendment be exploited?	a) This issue has been acknowledged. Accessibility to desulphurization systems has been identified as a prioritized technological challenge, especially for biogas-based electricity generation. Work on business models under the Project will cover roles and responsibilities of project partners. b) Biofertilizer utilization should be an integrated part of biogas business models. Presently there is no strong drive in the livestock sector to recover nutrients. Please refer to the response to US comment 2 above.	Annex M Para 139-141
13) What innovative ideas are to be tested? Spending maybe US$1M on an extensive review of the 25 current plants operating in Brazil and elsewhere, and those that have failed, would be money better spent. Assessment of mixed feedstocks needs undertaking as part of the feasibility study.	This comment concerns the cost-effectiveness of the Project. The limitations impeding a full survey of anaerobic digester plants in Brazil have been outlined above. Note that lack of (documented) knowhow on co-digestion has been identified as a technological barrier.	Para 12
14) Planning the development of a biogas calculation tool would simply reinvent what has been widely done by many others. Funds can be saved by a simple literature review for such calculators. See for example, the following [list]:	This is acknowledged. The associated output has been reformulated towards the delivery of "information packages" tailored to specific needs of target groups. This output responds to the identified information barriers.	Annex A

ANNEX C: STATUS OF IMPLEMENTATION OF PROJECT PREPARATION ACTIVITIES AND THE USE OF FUNDS[110]

A. Provide detailed funding amount of the PPG activities financing status in the table below:

PPG Grant Approved at PIF: **USD 200,000**			
Project Preparation Activities Implemented	***GETF/LDCF/SCCF/CBIT Amount ($)***		
	Budgeted Amount	***Amount Spent Todate***	***Amount Committed***
Analysis of baseline situation and available capacities (policy framework, biogas supply chain, R, D,+I, technology transfer, institutional capacities)	52,000	44,309	7,691
Proposal for BIC	28,000	17,550	10,450
CEO Endorsement Request	120,000	64,130	55,870
Total	200,000	125,989	74,011

Activities conducted during the PPG phase include:

- Kick-off meeting with counterparts
- Contracting of national and international consultants to carry out research, analysis and stakeholder consultations on the following:
  - ➔ existing regulatory and policy framework,
  - ➔ biogas and biomethane supply chain in Brazil,
  - ➔ R, D + I in the Brazilian biogas and biomethane sector
  - ➔ opportunities and challenges for biogas and biomethane technology transfer
  - ➔ institutional capacities related to biogas and biomethane development in Brazil
- Convening of expert group to elaborate the business case for the envisaged center / network of excellence "Biogas of Innovation Center (BIC)",
- Validation meetings with key counterparts to finalize the CEO Endorsement Request

[110] If at CEO Endorsement, the PPG activities have not been completed and there is a balance of unspent fund, Agencies can continue to undertake the activities up to one year of project start. No later than one year from start of project implementation, Agencies should report this table to the GEF Secretariat on the completion of PPG activities and the amount spent for the activities. Agencies should also report closing of PPG to Trustee in its Quarterly Report.

ANNEX D: CALENDAR OF EXPECTED REFLOWS (if non-grant instrument is used**)**

Provide a calendar of expected reflows to the GEF/LDCF/SCCF/CBIT Trust Funds or to your Agency (and/or revolving fund that will be set up)

Not applicable as no reflows to the GEF Trust Fund are foreseen under this Project.

ANNEX E: OTHER RELEVANT STAKEHOLDERS

PROJECT PARTNERS FOR BIOGAS AND BIOMETHANE DEVELOPMENT IN BRAZIL		
TYPE	NAME	MANDATE AND ROLE IN THE PROJECT
NATIONAL GOVERNMENT – CENTRALIZED AND DECENTRALIZED INSTITUTIONS	Brazilian Innovation Agency (FINEP)	FINEP is a publicly owned company subordinated to MCTIC with the main aim to further the economic and social development of Brazil through the public promotion of science, technology and innovation in companies, universities, technological institutes and other public or private institutions. It is working closely with MCTIC to develop a 10 year programme that foresees the widespread dissemination of biogas and biomethane solutions, which will have direct linkages with the Project.
	ANEEL - National Electric Energy Agency	The National Electric Energy Agency (ANEEL) is the regulatory agency for electricity, supports research and development projects in the electricity sector. In 2012, it launched a strategic call for the execution of projects focusing on the analysis of technical and commercial arrangements for the insertion of biogas energy from waste and sewage into the Brazilian energy mix. It is anticipated that the proposed project will coordinate closely with ANEEL's R&D projects in the regulated biogas market, providing opportunities for sharing of information, training courses, technical assistance and the like.
	ANP - National Agency for Petroleum, Natural Gas and Biofuels	ANP is linked to the MME. Implemented in 1998 in response to Decree No. 2.455, it is the national regulatory body for activities in the fields of oil, natural gas and biofuels in Brazil in alignment with the Petroleum Law No. 9.478 (1997). ANP's instruments include ministry orders, technical standards and regulations. ANDP implements public calls and acts as a contract party on behalf of the federal Union with concessionaries involved in exploration, development and production of oil and natural gas. It further oversees and verifies activities of regulated industries, either directly or under agreement with other public entities.
	EPE - Energy Planning Company	The Energy Planning Company (EPE), which was created in 2004 to help the government plan its energy supply, is responsible for projecting energy supply and demand, supporting the government and power regulator ANEEL in implementing policies, as well as carrying out studies for new power projects to be offered at government auctions. In 2014, it published several technical notes directly relevant for the proposed project including ones that establish the theoretical biogas potential of agricultural waste streams and of organic municipal waste as well as analyzing the respective economic feasibility (Notes no. 15/14, 16/14, 17/14 and 18/14).
	National Institute of Metrology, Standardization and Industrial Quality (INMETRO)	INMETRO is an independent federal entity linked to MDIC. Together with the Council (CONMETRO) it constitutes the national system (SINMETRO) for Metrology, Standardization and Industrial Quality. INMETRO was created in 1973 under Law 5.966 with the broader objective to contribute to national industrial development by ensuring the quality of products and services delivered. Its competences include: implementation of national policies in the fields of quality assurance and metrology; verification of compliance with technical standards and legislation related to metrology; representation of Brazil in international activities related to metrology and quality assurance, and promotion of international exchange; promotion of quality assurance mechanisms within Brazilian enterprises; responsibility for the national accreditation system of calibration and test laboratories. INMETRO is a partner in this Project to ensure that biogas systems meet applicable standards, and to provide guidance for the development of biogas laboratory and their staff.
	PROBIOGÁS	The PROBIOGÁS Brazilian-German technical cooperation programme, coordinated by the Ministry of Cities (MCIDADES/SNSA) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), encompasses a network of partnerships in the governmental, academic and business spheres. To achieve its objective, PROBIOGÁS focuses on four main action lines during its lifetime (2013-2017): (a) Survey on biogas potential, dissemination of basic information and improvement of framework conditions; (b) Capacity development: Support for professional training and

		capacitation of institutions and relevant agents for the consolidation of the theme in Brazil; (c) Academic and business partnerships: Support the development of academic and business partnerships between Brazil and Germany; and (d) Good practice and reference projects: Technical support for potential reference projects for the sector.
FINANCIAL SECTOR	Regional Bank for the Development of the Far South (BRDE)	BRDE was founded on 15 June 1961 by the states Rio Grande do Sul, Santa Catarina and Paraná to foster economic development of the region. Since then, BRDE has provided financial support and technical assistance to initiatives aimed at increasing the competitiveness of businesses of all type in the region. The bank has been a catalyst to transform projects into a reality by providing long-term finance for investment. The BRDE is governed by procedures determined by CODESUL (the Council for Development and Integration of the South) under Constitutive Acts approved by the legislative bodies (assemblies) of the member states.
	National Bank for Economic and Social Development (BNDES)	Also known as the Brazilian Development Bank, BNDES is a federal public company associated with the Ministry of Development, Industry, and Trade. It is the main financing agent for development in Brazil. Since its foundation, in 1952, BNDES has played a fundamental role in stimulating the expansion of industry and infrastructure in the country. Over the course of the Bank's history, its operations have evolved in accordance with the Brazilian socio-economic challenges, and now they include support for exports, technological innovation, sustainable socio-environmental development and the modernization of public administration. The bank offers several financial support mechanisms to Brazilian companies of all sizes as well as public administration entities, enabling investments in all economic sectors. In any supported undertaking, from the analysis phase up to the monitoring, the BNDES emphasizes three factors it considers strategic: innovation, local development and socio-environmental development.
RELEVANT SECTOR ORGANIZATIONS AND FOUNDATIONS (CSOS)	Brazilian Association for Biogas and Methane (ABBM)	ABBM was created as a not-for-profit organization of biogas and biomethane stakeholders in 2014 in Rio Grande do Sul. ABBM emerged as the result of bilateral cooperation and Rostock University, Germany, and several national universities including UFRGS, UFSM, and UNIJUI, among others.
	Brazilian Association of Ducted Gas Distributers (ABEGAS)	ABEGAS is the association of the natural gas sector in Brazil. It represents the interests of the concession holders and fosters strategies to secure gas supplies and expand the distribution service. Its activities include the organization of seminars, workshops, courses and congresses in the field, specialized information and technical publications.
	Brazilian Association of Energy Commercializing Companies (ABRACEEL)	ABRACEEL aims to promote the energy market in Brazil from the perspective of free competition to foster efficiency and supply security. It covers the electricity, ethanol and natural gas markets. Its scope of work includes: the optimization of the legal and regulatory framework for the sector; market efficiency; consolidation of carbon credit markets; platform for discussion and dissemination of experiences and best practices in energy market development, both nationally and internationally.
RESEARCH AND OTHER ORGANISATIONS	Austrian Energy Agency (AEA)	AEA is the national centre of excellence for energy. New technologies, renewable energy, and energy efficiency are the focal points of the organization's scientific activities. The objectives of its work for the public and the private sector are the sustainable production and use of energy and energy supply security. Together with CIBiogas and Spirit Design, AEA has worked on a report for the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management on biomethane as a smart solution for rural Brazil, looking particularly at associative business models.
	National and international Universities	A range of Brazilian universities is undertaking research into biogas / biomethane. The Project will aim to engage these especially with regards to the Biogas Information Platform (BIP). Close cooperation with international research bodies such as the University of Natural Resources and Life Sciences (BOKU), Vienna, Austria and the Technical University of Vienna (TUWien), Vienna, Austria are also foreseen. As is cooperation with international research institutes such as the Deutsche Biomasseforschungszentrum (DBFZ).

ANNEX F ANNUAL BUDGET

PROJECT BUDGET							
Output Based Budget for the GEF Grant							
		GEF Grant Budget Component 1 (in USD)					
Component 1 - Policy framework and information	**Responsible Parties**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Output Total**
Output 1.1.1 Establishment of an inter-ministerial coordinating unit on biogas policy and technology development receiving tailored expertise from the Project	UNIDO Gov't counterparts	50,000	50,000	50,000	20,000	20,000	**190,000**
Output 1.1.2 Updating and detailing of federal and state policies and programmes, and regulatory and financial instruments to facilitate biogas and biomethane market development based on agroindustrial organic waste	UNIDO Gov't counterparts	90,000	90,000	90,000	90,000	60,000	**420,000**
Output 1.1.3 Integration of biogas and biomethane into federal and state-level energy and agriculture sector programmes	UNIDO Gov't counterparts	40,000	40,000	40,000	20,000	10,000	**150,000**
Output 1.1.4 Design of an MRV system for tracking of GHG emission reductions from anaerobic digestion in agro-industries	UNIDO Gov't counterparts	10,000	50,000	30,000	10,000	0	**100,000**
Output 1.2.1 Collection, validation and publication of technical, legal, economic, and other relevant information for biogas market development based on agroindustrial organic waste	UNIDO Gov't counterparts	135,000	200,000	150,000	50,000	0	**535,000**
Output 1.2.2 Operationalization of a Biogas Information Platform (BIP) to update, manage and disseminate validated information to stakeholders	UNIDO	30,000	100,000	100,000	40,000	30,000	**300,000**
	TOTAL Component 1	**355,000**	**530,000**	**460,000**	**230,000**	**120,000**	**1,695,000**

		GEF Grant Budget Component 2 (in USD)					
Component 2 - Biogas and biomethane technolgy and value chain.	**Responsible Parties**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Output Total**
Output 2.1.1 Validation of biogas and biomethane business models for agroindustries, including associative biogas production schemes	UNIDO	60,000	70,000	40,000	0	0	**170,000**
Output 2.1.2 Preparation of recommendations and guidelines for standardization of technical designs, feedstock, equipment, and operational procedures for biogas production schemes	UNIDO CIBiogas Gov't counterparts	50,000	70,000	70,000	60,000	30,000	**280,000**
Output 2.1.3 Adaptation of equipment, components and processes for biogas and biomethane production to local socio-economic and technical conditions ("tropicalization")	CIBiogas UNIDO	300,000	400,000	400,000	400,000	70,000	**1,570,000**
Output 2.1.4 Implementation of training, capacity building and promotional activities for biogas producers, project developers and other stakeholders	CIBiogas Research / Academia UNIDO	30,000	50,000	50,000	50,000	50,000	**230,000**
Output 2.1.5 Development and approval of market introduction strategies and business models for biogas-based electricity and biomethane by electricity and gas companies in Southern Brazil	CIBiogas Gas / Electricity companies UNIDO	60,000	60,000	70,000	70,000	15,000	**275,000**
TOTAL Component 2		**500,000**	**650,000**	**630,000**	**580,000**	**165,000**	**2,525,000**

		GEF Grant Budget Component 3 (in USD)					
Component 3 - Demonstration and optimization of biogas projects.	**Responsible Parties**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Output Total**
Output 3.1.1 Verification and implementation of demonstration pilots for biogas production and utilization based on agroindustrial organic waste in Southern Brazil	UNIDO CIBiogas Project owners	150,000	350,000	350,000	100,000	50,000	**1,000,000**
3.1.2 Investment and technical services to ensure operational performance and sustainability of the installed demonstration pilots	UNIDO CIBiogas Project owners	50,000	150,000	400,000	300,000	50,000	**950,000**
Output 3.1.3 Monitoring of operational aspects and performance of established pilots, including systematization of lessons learned and recommendations for enhancement	UNIDO Project owners	20,000	45,000	45,000	80,000	30,000	**220,000**
	TOTAL Component 3	**220,000**	**545,000**	**795,000**	**480,000**	**130,000**	**2,170,000**

		GEF Grant Budget Component 4 (in USD)					
Component 4 - Monitoring and Evaluation.	**Responsible Parties**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Output Total**
Output 4.1.1 - Monitoring of project progress and compliance with UNIDO and GEF guidelines and safeguards on social (including gender) and environmental impact	UNIDO	25,000	25,000	25,000	25,000	25,000	**125,000**
Output 4.1.2 - Implementation of Mid-term Review.	UNIDO	0	0	55,000	0	0	**55,000**
Output 4.1.3 - Implementation of independent Terminal Evaluation.	UNIDO	0	0	0	0	100,000	**100,000**
	TOTAL Component 4	**25,000**	**25,000**	**80,000**	**25,000**	**125,000**	**280,000**

		GEF Grant Budget Project Management Cost (in USD)					
Project Management Cost (PMC)	**Responsible Parties**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Output Total**
Project Management Expert (PME)	UNIDO	46,000	46,000	46,000	46,000	46,000	**230,000**
Project Assistant (PA)	UNIDO	20,000	20,000	20,000	20,000	20,000	**100,000**
TOTAL Project Management Cost		**66,000**	**66,000**	**66,000**	**66,000**	**66,000**	**330,000**

TOTAL Project Budget	**1,166,000**	**1,816,000**	**2,031,000**	**1,381,000**	**606,000**	**7,000,000**
	17%	**26%**	**29%**	**20%**	**8%**	**100%**

ANNEX G ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Separate file with file name “Annex G_Environmental and Social Management Plan.pdf”

ANNEX H PRELIMINARY GENDER ANALYSIS FOR BRAZIL

Separate file with file name “Annex H_Brazil_Biogas Agro-Industries Gender Analysis.pdf”

ANNEX I ESTIMATION OF GHG BENEFITS

The global environmental benefits of the Project are associated with (i) the implementation of biogas plants for electricity and heat generation, thereby off-setting grid electricity and fossil fuel (natural gas); (ii) the avoidance of methane releases into the atmosphere as a result of anaerobic digestion of effluents combined with biogas capture and utilization; and (iii) market development of biogas renewable energy based electricity generating capacity. The following table (based on the GEF Manual)[111] summarizes the methodology used:

Type of GHG emission reduction	**Direct (A)**	**Indirect (B, C)**	
Component of GEF intervention that can cause this type of GHG emission reduction	Direct implementation of RE technologies	The Project does not establish a direct replication mechanism. GHG benefits obtained from leveraged investments are considered as effects of market transformation.	Market transformation
Logframe (SRF) level	Outputs 3.1-3.3	n/a	Medium-term impact after project termination (10 years)
Quantification method	Direct evaluation of the environmental benefits over lifetime of an assumed portfolio of biogas systems. Avoided methane releases by anaerobic digestion, are estimated in accordance with approved CDM methodologies.	n/a	Top-bottom approach based on expected market development of biogas technologies for electricity and heat generation in Brazil.
Quality of Assessment	Based on expected performance of bioenergy systems in Brazil. Error range is estimated at +/-50%.	n/a	Based on: (i) assumption that 16.6 MW electricity generation capacity based on wet biomass is being added annually; (ii) CO2-intensity of electricity generation sector in Brazil is 0.3020 tCO_2/MWh: (iii) average availability of 80%; (iv) other effects (displaced fossil energy for thermal uses, solid biofuels, avoided methane releases) are not considered.

[111] GEF/C.33/Inf.18, April 16, 2008, page 3.

The following table presents the GHG reduction potential for the prioritized sectors as a result avoided methane releases (anaerobic digesters for wet biomass), substitution of diesel fuel for heating, grid electricity and vehicle transport. The presented figures are per unit of agro-industrial residues from the considered business.

The following references and input data are used:

- Global Warming Potential of methane: 21 (1 kg CH_4 is equivalent to 21 kg CO_{2eq});
- GHG emission factor interconnected electricity system in Brazil: 0.3020 kg CO2eq/kWh (IGES database);
- GHG emission factor diesel: 2.94 kg CO2eq/l; density: 0.785 kg/l; energy density 35.8 MJ/l;
- GHG emission factor CNG: 3.07 kg CO2eq/kg; density: 0.168 kg/l; energy density 9.0 MJ/l;
- GHG emission factor bio-CNG: 1.04 kg CO2eq/kg; density: 0.168 kg/l; energy density 9.0 MJ/l;
- Average range light diesel car: 11 km/l. Source: ”GEF/STAP Manual for Calculating Greenhouse Gas Benefits of Global Environment Facility, Transportation Projects”, p. 10; http://www.unep.org/stap/calculatingghgbenefits;
- Data from: CDM Project 0399 PDD: “3 MW Poultry Litter Based Power Generation Project, Hyderabad”;
- Data from: CDM Project 3633 PDD: “A project of biogas production from waste water of tapioca starch plant to substitute the use of bunker oil at Udornthani Province, Thailand”;
- Data from: ”Biogas from poultry waste – a case”, Nijhuis Water Technology BV, Th. Bijman, Dorset Symposium June 2014.

BIOENERGY SYSTEMS – GREENHOUSE GAS REDUCTION POTENTIAL										
AGROINDUSTRY		ANAEROBIC DIGESTER			THERMAL POWER		ELECTRIC POWER		VEHICLE TRANSPORT[112]	
SECTOR		ENERGY DENSITY		GHG REDUCTION POTENTIAL (METHANE)	AVERAGE CAPACITY	GHG REDUCTION (THERMAL - LPG)	AVERAGE CAPACITY	GHG REDUCTION (ELECTRIC - GRID)	AVERAGE CAPACITY	GHG REDUCTION (LIGHT VEHICLE)
	(1/UNIT)			*(KG CO2EQ/UNIT)*	*(W/UNIT)*	*(KG CO2EQ/UNIT)*	*(W/UNIT)*	*(KG CO2EQ/UNIT)*	*(KM/UNIT)*	*(KG CO2EQ/UNIT)*
Feedlot	1/animal	105	m3 CH4/ yr	706	108	221	32.4	85.7	1,047	214
Dairy farm	1/animal	61		263	62.1	128	18.6	49.2	602	123
Pig farm	1/animal	64		453	65.6	135	19.7	52.1	636	130
Layer chicken farm	1 / animal	8.8		53.1	6	15.2	1.8	4.76	58	12
Cassava starch	1 / ton starch processed	14.2		129	13.3	31.6	3.99	10.6	129	26

The next table summarizes the direct GHG emission reductions for the proposed (tentative) demonstration pilots in the prioritized sectors. The indicated installed capacities refer to the use of biogas for electricity supply to the electricity distribution network.

BIOENERGY SYSTEMS - DIRECT GHG EMISSION REDUCTIONS DEMONSTRATION PILOTS								
AGROINDUSTRY			INSTALLED CAPACITY	ELECTRICITY PRODUCTION	GHG EMISSION REDUCTIONS			
SECTOR	PRODUCTION SCALE				METHANE	THERMAL	ELECTRIC – GRID	LIGHT TRANSPORT
	(UNITS)		*(KW)*	*(MWH/YR)*	*(TON CO2EQ/YR)*			
Feedlot	-	animals	-	-	-	-	-	-
Dairy farm	3,000	animals	55.8	391	789	384	146	369
Pig farm	40,000	animals	788	5,522	18,120	5,400	2,048	5,192
Layer chicken farm	140,000	animals	252	1,766	7,434	2,128	666	1,662
Cassava starch	120,000	ton per year	479	3,355	15,480	3,792	1,272	3,158
TOTAL			1,575	11,035	41,823	11,704	4,132	10,381

[112] A typical energy use of 3.11 MJ/km (0.864 kWh/km) has been estimated. Baseline emissions are 0.267 kg CO2eq/km (diesel) and 0.0631 kg CO2eq/km for bio-CNG alternative. The latter is due to the energy required for compression of biomethane to bio-CNG and the distribution chain.

BIOENERGY SYSTEMS – BIOGAS PRODUCTION								
AGROINDUSTRY SECTOR		ANAEROBIC DIGESTER ENERGY DENSITY		PRODUCTION SCALE		BIOGAS PRODUCTION		
	(1/UNIT)			*(UNITS)*		*(M3 CH4/YR)*	*(M3 CH4/DAY)*	*(M3 BIOGAS/DAY)*[113]
Feedlot	1/animal	105	m3 CH4/yr	-	animals	-	-	-
Dairy farm	1/animal	61		3,000	animals	183,000	501	836
Pig farm	1/animal	64		40,000	animals	2,560,000	7,014	11,690
Layer chicken farm	1 / animal	8.8		140,000	animals	1,232,000	3,375	5,626
Cassava starch	1 / ton starch processed	14.2		120,000	ton per year	1,704,000	4,468	7,781
TOTAL				Total gas production (M^3)		5,679,000	15,589	25,932
				Total energy production (MWh)		55,480	152	

The total biogas production (25,932 m3/day) is roughly one-third the capacity of an average landfill site (86,100 m3/day) and comparable to that of a vinasse biodigester plant (24,600 m3/day). The following table calculates the relative weight of each element into the total direct GHG reductions. It is assumed here that the biogas systems will be used for thermal energy.

BIOENERGY SYSTEMS – RELATIVE SHARE OF DEMONSTRATION PILOTS IN DIRECT GHG EMISSION REDUCTIONS – THERMAL USE									
AGROINDUSTRY			GHG EMISSION REDUCTIONS						
SECTOR	PRODUCTION SCALE		METHANE		THERMAL – LPG		TOTAL		
			(TON CO2EQ/YR)	*(%)*	*(TON CO2EQ/YR)*	*(%)*	*(TON CO2EQ/YR)*	*(%)*	
Feedlot	-	animals	-	-	-	-	-	-	
Dairy farm	3,000	animals	789	1%	384	1%	1,173	2%	
Pig farm	40,000	animals	18,120	34%	5,400	10%	23,520	44%	
Layer chicken farm	140,000	animals	7,434	14%	2,128	4%	9,562	18%	
Cassava starch	120,000	ton per year	15,480	29%	3,792	7%	19,272	36%	
TOTAL			41,823	78%	11,704	22%	53,527	100%	

[113]Approximate figure based on assumed 60% CH4 content.

Avoided methane releases represent about 4/5 (78%) of total GHG emission reductions averaged for all biogas pilots. For the chosen pilot sizes, the most substantial methane emission reductions are delivered by the pig farms (34% of total) and cassava starch factories (29% of total).

Direct GHG benefits

The combined emission reductions as a result of: (i) avoided methane releases from open lagoons; and (ii) replaced fossil fuel (diesel) for heating, would translate into total GHG emission reductions of 53,527 ton CO2eq/yr. In practice, some installations will seek electricity generation and biomethane production on a smaller scale, as these generate the highest monetary revenues. Since the carbon-intensity of Brazil's electricity sector is low (0.3020 kg CO2eq/kWh), there is no GHG benefit compared to local heat production by combustion. The performance of compressed biomethane (bio-CNG) is also slightly below that of direct heat, as diesel fuel is the baseline in both case; but biomethane requires energy inputs for compression and distribution. Over a 10-year economic lifetime of the investments, the direct GHG emission reductions are estimated at: 535 kton CO2eq (**0.54 Mton CO2eq**).

Total energy production

The methane produced per year (5,679,000 m^3/yr) will provide the equivalent of 55,480 MWh/yr thermal energy, or 6.33 MWh per hour. Assuming a conversion rate of 30% and an availability of 80%, the corresponding average electricity generating capacity would be 1.5 MW with a electricity production of 11,034 MWh per year. Over a 10-year lifetime, the energy production would be 554,800 MWh (total) and 110,340 MWh (electricity).

Indirect benefits

To estimate the indirect GHG emission reductions, it is assumed in the following that biogas plants will supply electricity to the distribution grid, which is the most straightforward option to generate a financial benefit for the project owner. Since GHG benefits of replacing grid electricity are approximately equal to those of direct heat production (combustion of the biogas for process heat), the estimated GHG reduction is therefore valid for combinations of distributed electricity generation, heat production and combinations thereof (co-generation).

It is noted that the average grid CO2-intensity factor (0.3020 kg CO2eq/kWh) is used here. Effectively, biogas-electricity would initially offset diesel-generated electricity; arguably, the much higher marginal CO2-intensity factor would apply up to a certain penetration level. Contrary to intermittent renewable energy technologies (wind and solar), the fact that biogas generators are controllable allows them to replace diesel systems effectively. The use of the average grid CO2-intensity factor provides therefore a conservative estimate.

For reference, a biogas production rate of 1,000,000 m3/yr is considered, equivalent to 2,740 m3/day. Assuming a caloric value of 21.6 MJ/m3 and an electric generator with a conversion efficiency of 30%, the annually produced electric energy E is:

E = 1,800 MWh/yr.

Assuming a capacity factor of 80%, the installed capacity would be:

P = E/(8,760*80%) = 0.26 MW.

To estimate the development potential for biogas energy systems, reference is made to the combined biogas potential for poultry, dairy farms, pig farms and cassava starch production in Parana, which is 1,291,806,203 m3 biogas per year, equivalent to 3,539,195 m3/day. Although the Project may influence biogas development in other agro-subsectors as well, this is ignored here.

Biomass and biogas potential for Industrial and Agroindustrial Residues in Paraná State					
Sector		Feedstock	Biogas production potential (m^3/yr)	Energy potential (Gwh/yr)	
					(%)
Non-woody biomass	Sugar cane		-	118,217	96%
	Corn (milho)		-	97,004	
	Soy		-	70,060	
	Cassava		-	23,342	
Subtotal Non-Woody Biomass Parana				308,623	
Animal breeding	Aviculture	Chicken manure	637,165,378	911.2	4%
	Dairy livestock	Cow manure	280,159,436	400.6	
	Pork farming	Pork manure	373,974,911	534.8	
Industry and agroindustry	Alcohol and Sugar	Vinasse	167,730,480	239.9	
	Biodiesel	Glycerol	3,002,771	4.29	
	Starch factories	Manipueira	506,478	0.72	
	Dairy factories (cheese)	wey (soro de leite)	774,774	1.11	
	Citrics	yellow water	5,810,781	8.31	
	Paper mills	paper and cellulose	468,646,155	670.2	
	Beer breweries		5,790,937,921	8,281	
	Slaugtherhouses and meat packers	Bovine	55,444,805	79,3	
		Pork	66,393,415	94.9	
		Chicken	396,783,234	567.4	
Municipal waste and effluents	Municipal Solid Waste		255,253,822	365.0	
	Waste water plants		19,779,046	28.3	
	Maintenance and pruning		200,139,537	286.2	
	Central market residues (CEASAs)		5,725,293	8.19	
Subtotal Biogas Parana				12,481	
GRAND TOTAL				321,104	100%

The equivalent electricity generation capacity would be:

P = 1,292 * 0.26 MW = 332 MW (Paraná).

The assumption is made that 50% of this potential is technically and economically feasible and will be developed in the 10-year period after project termination:

P = 50% * 322 = 166 MW.

Assuming a linear growth of installed capacity, 55% of this capacity will be online as an average over the considered period, which is:

$P_{average}$ = 55% * 166 MW = 91 MW.

The average annual energy production is:

E_{yr} = 91 * 8760 * 80% = 639,444 MWh/yr.

The associated GHG emission reductions G are:

G_{yr} = 639,444 * 0.3020 ton CO2eq/MWh = 193,112 ton CO2eq/yr.

Assuming a GEF causality factor of 40%, the GHG reductions attributable to the Project would be:

G = 77,245 ton CO2eq/yr.

Finally, over a 10-year period, the total attributable indirect GHG reductions are estimated at:

G = 772,450 ton CO2eq (0.77 Mton CO2eq).

With some differences in the composition of biogas feedstock, the total GHG benefits for the combined states of Parana, Santa Catarina and Rio Grande do Sul will be about three times this value, about **2.3 Mton CO2eq**.

ANNEX J TRACKING TOOL FOR CLIMATE CHANGE MITIGATION PROJECTS

Separate file with file name “Annex J_GEF-CCM-TrackingTool.xlsx”

ANNEX K EXISTING POLICY AND LEGAL FRAMEWORK

Document 1: POLICY, REGULATORY AND LEGAL FRAMEWORK APPLICABLE TO THE USE OF BIOGAS AND BIOMETHANE FROM AGRO-INDUSTRIAL WASTE FOR PRODUCTIVE USES AND MOBILITY by Raquel Rodrigues B. De Souza, July 2016

Separate file with file name “Annex K_a_Policy and regulatory (gap analysis).pdf” available.

Annexes to Document 1: Separate file with file name “Annex K_b_Annexes Policy and Reg.zip” available.

Document 2: POLICY AND REGULATORY FRAMEWORK APPLICABLE TO THE USE OF BIOGAS AND BIOMETHANE FROM AGRO-INDUSTRIAL WASTE FOR PRODUCTIVE USES AND MOBILITY (GAP ANALYSIS) by Raquel Rodrigues B. De Souza, July 2016

Separate file with file name “Annex K_c_Policy and regulatory (gap analysis).pdf” available.

ANNEX L SUMMARY AND CONCLUSIONS OF PREPARATORY WORK FOR BIC

The PPG carried out an extensive assessment of the viability of the Biogas Innovation Center (BIC) proposed in the PIF in terms of its appropriateness, sustainability and institutional set-up.[114] A specialized consultancy was hired during the second half of 2016 to address, amongst other, the following aspects: (i) identification of existing institutional capacities related to biogas and biomethane development in Brazil including relevant ongoing programmes and initiatives; (ii) identification of gaps and opportunities for the Biogas Innovation Centre (BIC) or a network of excellence; (iii) development of a business case for the envisaged BIC or network, including its unique selling points, mission and vision, business lines and activities, partnerships, organizational structure; and (iv) detailed business plan for the short-term (5-year) including staffing and funding requirements.

A UNIDO mission to Brazil was organized in July 2016 to gather the necessary information and elements. The mission observed a range of systemic and specific gaps and weaknesses in the Brazilian framework for (biogas) innovation. At the systemic level, there is a generally poor articulation of R, D & I activities between (public) technological institutions and the academic sector at one side and the (private sector) industries at the other side. Moreover, there are substantial redundancies in programming and institutional mandates and capacities across Brazilian states. Specifically for biogas, information needed for characterization of the value chain, including supply and demand, proved very hard to obtain or might simply not be available.

Following up on the mission, a work plan was devised to analyze the biogas and biomethane value chain in a systematic manner and engage directly with experts in this field in Brazil. An ad-hoc working group was created with participation of experts from EMBRAPA, CIBiogas, ABiogás, Probiogas and UNICAMP Campinas (SP) who met weekly through videoconference. This process allowed for the exchange of information and viewpoints with respect to biogas technology innovation. The experts reaffirmed the finding that the original BIC would have a great redundancy potential in the Brazilian context. A new agency would probably not be sustainable; moreover, it was deemed unlikely that baseline funding would materialize in the current economic situation. Instead, a structure that could operate throughout the biogas value chain and articulate the competencies of the different entities involved, was considered a valuable alternative to the BIC.

Prior to assessing such new structure, the working group attempted to generate a succinct description of the characteristics of the supply and demand of technological services directed to the biogas market (public and private), by entities providing the following services: (1) Technological assistance and consulting; (2) Tests and calibration; (3) R&D contracted by customer; (4) R&D co-financed; (5) Training; (6) Support for entrepreneurship. The following conclusions were drawn:

- The supply side is characterized by a lack of clarity and scope in terms of the services and specific customers that are served. One may conclude that suppliers of know-how and equipment are not driven by demand. The biogas market is, at best, a niche market for suppliers which is passively addressed.

- The demand for biogas technology services cannot be determined with sufficient detail. There is a lack of information and knowledge (also among the experts) to specify and quantify the market demand. Who seeks such services, what services are requested and at what stage of the biogas product cycle? Is it driven by national customers or international ones?

- Information about specific service requests is known by the individual suppliers (but may not be systematized). It is inferred that this market information is not shared; published studies on the demand for technological services in the biogas value chain apparently do not exist.

[114] For a detailed description, please refer to: "Biogas applications for the Brazilian agro-industry" (GEF ID 9057), Report International Expert biogas/biomethane, Luis Ferreira, November 2016.

The following tables summarize the findings of the supply and demand analysis for technological services, which make evident the mentioned information voids.

BIOGAS AND BIOMETHANE VALUE CHAIN ASSESSMENT – DEMAND SIDE						
Services directed to the biogas market	A. Number of entities (businesses or public agencies) supplying the market	B. Tipe of entities	C. Contract value (Reais)	D. Most requested services and corresponding life-cycle phase of the biogas activity (introduction,market growth, maturity, decline)	E. National or international procurement	Observations:
1. Technical assistance and consultancy	(1)	agroindustries and cooperatives (2) ; outsourced maintenance and operation of installations (2)	(1)	Services, public agencies, industries (1)	(3)	1. The initial assessment is characterized by a widespread lack of information about the volume of supplied services, identification of customers, type of requested services, life-cycle phase of biogas activity, origin of service requests. 2. Existing information is ultimately known by the individual service providers but not shared. It is inferred that published studies on the demand for technological services in the biogas value chain do not exist
2. Tests and metrological calibrations	(1)	(1)	(1)	(1)	(3)	
3. R&D contracted by customer	(1)	(1)	(1)	(1)	(3)	
4. R&D under shared-cost agreements or programmes	(1)	(1)	(1)	(1)	(3)	
5. Training	(1)	(1)	(1)	(1)	(3)	
6. Business development	(1)	(1)	(1)	(1)	(3)	
(1) Information not available or inaccurate (2) Interest with respect to technological development, but with other purposes than biogas value chain. (3) No specific procurement of one of the indicated services.						

BIOGAS AND BIOMETHANE VALUE CHAIN ASSESSMENT – SUPPLY SIDE							
Services directed to the biogas market	A.Supplier	B. Capital structure of supplier	C. Location (State, region)	D. Targeted clients	E. Overlap between suppliers	F. Applicable industrial property registers	Observations:
1. Technical assistance and consultancy	CiBiogás/ private companies / SENAI/Public and private universities / IPT	mostly 100% public	Paraná / Distributed over the whole country / S. Paulo	Services, public administration, industries (1)	(3)	(2)	Large spread in terms of targeted clients; insufficient information about the entry point in the biogas value chain.
2. Tests and metrological calibrations	SENAI / CTGás/ IPT / INT / Tecpar / LACTEC / IAPAR	mostly 100% public	Distributed over the whole country / Rio Grande do Norte/ S. Paulo/ Rio Janeiro/ Paraná	(2)	(3)	(2)	These services are critical for biogas development but are not yet tailored to the specific needs of the biogas market.
3. R&D contracted by customer	CiBiogás/ LACTEC/ IPT / Industry technology centers / UNIVATES	100% public; variable for industry R&D centers	Paraná /S. Paulo/ Rio Grande do Sul	(2)	(3)	(2)	Which are the key industry technology centres?
4. R&D under shared-cost agreements or programmes	EMBRAPA / Federal R&D institutes / Federal and State universities	100% public	Distributed over the whole country	(2)	(3)	(2)	Which are the key federal R&D institutes?
5. Training	Some universities (in the energy field) / CiBiogás/ IAPAR / EMBRAPA/ UNIVATES	100% public	S. Paulo/ Paraná / Santa Catarina/ Rio Grande do Sul	(2)	(3)	(2)	Each of these entities within their specialized fields as part of the biogas value chain.
6. Business development	SEBRAE/ ITAIPU Technology Park/ Other technology parks	100% public	Distributed over the whole country / Paraná	(2)	(3)	(2)	PTI might be most strongly focused on biogas.
(1) Generic information lacking statistical data (2) Information not available (3) Systemic overlaps exist (not further specified)							

BIOGAS AND BIOMETHANE VALUE CHAIN ASSESSMENT – LIST OF IDENTIFIED SUPPLIERS			
Acronym	Name	Biogas market focus	Location (State)
CiBiogás	Centro Internacional de Energias Renováveis - Biogás		Paraná
CT Gás	Centro de Tecnologias do Gás e Energias Renováveis	(1)	Rio Grande do Norte
EMBRAPA Suínos e Aves	Empresa Brasileira de Pesquisa Agropecuária - Suínos e Aves		Santa Catarina
INT	Instituto Nacional de Tecnologia	(1)	Rio de Janeiro
IPT	Instituto de Pesquisas Tecnologicas	(1)	São Paulo
IAPAR	Instituto Agronómico do Paraná		Paraná
Tecpar	Instituto de Tecnologia do Paraná	(1)	Paraná
LACTEC	Institutos Lactec	(1)	Paraná
	Centros tecnológicos – Indústria	(1)	several
UNIVATES	Centro Universitário UNIVATES		Rio Grande do Sul
	Federal R&D institutes		several
	Federal and State Universities		several
	Private Universities		
SEBRAE	Serviço Brasileiro de Apoio às Micro e Pequenas Empresas	(1)	several
PTI	ITAIPU Technology Park		Paraná
	Other technology parks	(1)	several
(1) Not focused on biogas but with potential to address the value chain			

The tables demonstrate the existence of relevant capacities in Brazil to deliver technological knowledge and support services to the biogas industry. The need to effectively articulate this capacity to serve demand is evident, which provides the rationale behind an instrument promoting such articulation in a focused manner and enabling further strengthening of the biogas supply chain and technology base in Brazil.

The working group agreed that the instrument "Technological Platform for Industrial Development of Biogas – PtDI Biogas"[115] could meet these characteristics. The proposed platform aims to create a partnership between stakeholders of the biogas value chain in order to align key elements of the Brazilian biogas ecosystem for the common purpose of the biogas industrial development. The general characteristics of PtDI-Biogas are as follows:

- Objectives and targets defined and to be fulfilled in 5 years;
- Structure based on working groups from stakeholders in the biogas industry;
- Hosted by a governmental agency, as a pilot project, during the GEF project;
- A general coordination unit funded by the GEF for 5 years; and
- Conversion after 5 years into a Public Private Partnership (PPP) or affine structure, with the purpose of attracting private capital (national and / or international).

A structure of 5 vertical and 2 horizontal working groups was proposed, supported by a permanent secretariat and general assembly. The PPG working group further suggested the assignment of the PtDI to the Brazilian Association for Industrial Development (ABDI) to ensure its insertion into the national framework for innovation policy and business development[116]. ABDI is ascribed to the Ministry of Development, Industry and International Trade (MDIC)[117].

Final Project Design

The final project design has adopted PPG proposal steps 1-4 (see above), specifically by introducing a Biogas Information Platform aimed at increasing articulation between stakeholders (output 1.2.2) and the establishment of a work programme for innovation governed by technical committees and the Project Steering Committee (output 2.1.3). Given the current absence of a champion taking full ownership of the biogas innovation agenda, the Project itself will assume this role. This explains the chosen governance structure under 2.1.3 enabling the PSC (including UNIDO) to ensure allocation of GEF funding in function of relevance and cost-effectiveness of the activities proposed.

For the same reason, a more flexible approach with respect to step 5 above is taken. Rather than pursuing full-fledged institutionalization, the Project will promote technology transfer and matchmaking between national and foreign industries on an ad-hoc basis. The benefits of such partnerships include a commercial view on the market potential of offered products and services, opportunities to mobilize external capital for product / technology development, and demonstration of modalities to handle intellectual property rights. Integration of the biogas innovation programme into a federal programme or entity (such as ABDI) however is not excluded.

[115] PtDI-Biogás = Plataforma Tecnológica para o Desenvolvimento Industrial do Biogás.
[116] See: http://www.abdi.com.br/
[117] MDIC = Ministério do Desenvolvimento, Indústria e Comércio Exterior.

ANNEX M POTENTIAL DEMONSTRATION PILOTS

The following section provides a brief description of seven biogas projects in Western Paraná which are developed by Itaipu Binacional and CIBiogas in partnership with private farmers and cooperatives. The associative production models in several cases further involve the local municipality. The projects are representative for the region in terms of subsector (livestock) and business organization (private, small farmers and cooperatives). The list of potential demonstration pilots has been compiled in close cooperation with the national counterparts, reflecting the most productive agro-industrial sectors in the region as well as experiences with biogas / biomethane solutions up until now.

Private farms

SELECTED PRIVATE BIOGAS PROJECTS			
Project Name	**1. Fazenda Iguaçu Starmilk**	**2. Haacke Farm**	**3. São Pedro Colombari**
Owner	Ibrahim Fayad	Nilson Haacke	Jose Carlos Colombari
Ownership biogas project	private	Private	Private
Project Type	Private biogas plant for effluent treatment 550 milk cows (stable)	Private biogas plant (covered lagoon) for 500 meat cattle and 84,000 poultry	Private biogas plant for effluent treatment 5,000 pigs
BIOGAS PRODUCTION			
Primary feedstock	dairy cattle manure	cattle and poultry manure	pig manure
Biogas potential	1,440 m^3/day	1,000 m^3/day	750 m^3/day
ENERGY END-USES			
electricity	330 kVA	112 kVA (self-supply)	100 kVA (self-supply) 1,000 kWh/day net metering (COPEL)
heat	-	-	-
biomethane	-	2,280 m^3 bio-CNG to Itaipu Binacional	-
mobility	-	biomethane for farm vehicle	-
INSTITUTIONAL ASPECTS AND FINANCING			
Asset ownership	Biodigester and generator owned by farmer	Biodigester system owned by farmer; Biomethane plant owned by Itaipu and operated by CIBiogas (rent paid for occupied space)	Biodigester and generator owned by farmer
Financing	Equity by farmer and credit (BNDES)	Biodigester: 100% equity by farmer Biomethane plant: 100% grant by Itaipu	100% equity farmer
CURRENT STATUS			
Current status	Farm is being modernized; digestate will be used for stable beds.	The biodigester plant will be expanded to treat a larger effluent volume; biomethane production will be increased to meet future demand by Itaipu	A biological H2S removal system is being tested to reduce concentration to acceptable levels for generator.
CHALLENGES			
technology	Energy recovery for biodigester heating (cogeneration)	Testing and evaluation of desulphurization technologies	Implementation of H2S removal technology by oxygen injection

SELECTED PRIVATE BIOGAS PROJECTS			
Project Name	**1. Fazenda Iguaçu Starmilk**	**2. Haacke Farm**	**3. São Pedro Colombari**
	Validation of suitability digestate for stable beds Testing of pre-treatment system (solids separation)	Availability of low-flux methane compressor pumps Improved efficiency of codigestion pig and poultry manure	Remote data collection for process monitoring Testing of pre-treatment system (solids separation) Codigestion of pig and cattle manure
business model	-	Development of a business model for biomethane	Development of business model fo electricity generation

Cooperative and associative models

SELECTED ASSOCIATIVE BIOGAS PROJECTS				
Project Name	**4. Entre Rios**	**5. Sao Roque**	**6. Toledo**	**7. Ajuricaba**
Owner / lead project developer	Municipality Entre Rios	Cooperativa LAR	Municipality Toledo	Condominio de Agroenergia para Agricultura Familiar
Ownership biogas project	present: municipality	biodigesters and biogas network: individual farmers; central gasometer, generator and biomethane plant: Cooperativa LAR	present: municipality	Cooperative of the biogas producers (COOPERBIOGAS)
Project Type	19 individual pig farmers; with individual biodigesters; connected by low-pressure biogas duct (25 km)	24 cooperative pig farmers with individual biodigesters; connected by low-pressure biogas duct (25 km)	17 individual pig farmers; manure transport to a central biodigester	33 pig and dairy cattle small farmers with individual biodigesters; connected by low-pressure biogas duct (25.5 km)
BIOGAS PRODUCTION				
Primary feedstock	pig manure	pig manure	pig manure	cattle and pig manure
Biogas potential	4,772 m^3/day	3,370 m^3/day	1,000 m^3/day	821 m^3/day
ENERGY END-USES				
electricity	480 kVA net metering (COPEL)	(95%)	net metering	104 kVA net metering (COPEL)
heat	-	-	-	present: grain drying (self-supply); future: sales of biogas to external client (COOPAGRIL) to replace fuelwood for process heating
biomethane	-	(5%)	(25%)	-
mobility	-	-	-	-
INSTITUTIONAL ASPECTS AND FINANCING				
Asset	to be defined	biodigesters: individual	Consortium of farmers and	present: all equipment

SELECTED ASSOCIATIVE BIOGAS PROJECTS				
Project Name	**4. Entre Rios**	**5. Sao Roque**	**6. Toledo**	**7. Ajuricaba**
ownership		farmers; network and generator: Cooperativa LAR	municipality.	belongs to ITAIPU future: transfer to municipality or cooperative[118]
Financing	100% grant/equity by COPEL under ANEEL Strategic Call 14	Equity is split between Cooperativa LAR and farmers; Likely to be complemented with BNDES loans (with whom LAR has standing agreements in other regions).	present: Multilateral funding (ADF, to be terminated) and Toledo municipality. future: campaign to attract new investors (farmers use assets at zero cost)	100% equity by Itaipu and Marechal Candido Rondon municipality; (farmers use assets at zero cost)
Operation	biodigesters: individual farmers; network and generator: to be defined	biodigesters: individual farmers; network and generator: Cooperativa LAR	central biodigester and generator: Toledo municipality; manure collection and transport to centralised plant: Toledo municipality[119]	biodigesters: individual farmers; network and generator: to be defined
CURRENT STATUS				
Current status	Grant approved	As of Jan. 2017, Cooperativa LAR has contracted a feasibility study	Engineering studies and technical designs completed. The municipality will issue a call for procurement of civil works and equipment in 2017.	Operational
CHALLENGES				
technology	Optimization of substrates for biodigesters System integration and technical and economic optimization of components and materials Monitoring and process control systems and strategies	Contamination effects of biogas due pipeline transport Testing of pre-treatment system (solids separation)	Contamination effects of biogas due pipeline transport Testing of pre-treatment system (solids separation) Validation of continuous stirred biodigester system for pig manure	Instrumentation and monitoring of biogas network Biogas cleaning for use in boilers Removal of moisture in biogas network
business model	Development of a technical and economic model for the condominium model	Validation of payment model for biogas producers Process control in an associative production model	Validation of payment model for biogas producers Process control in an associative production model	Operation and maintenance of biogas network Development of a technical and economic model for the condominium model

[118] Note: ITAIPU has made further funds available for investment but it is tied to the ownership structure being revised, i.e. responsibility has to be handed over.
[119] Note: It is not possible to obtain waste from surrounding municipalities due to Brazilian legislation.

ANNEX N (PRE-)FEASIBILITY STUDIES

Study conducted by CIBiogas for the Entre Rios do Oeste project, 2015

Separate file with file name “Annex N_a_Projeto Entre Rios do Oeste - 480 KW.pdf” available.

Study conducted by CIBiogas and SEBRAETEC for the Sao Roque project by Cooperativa Lar, 2016

Separate file with file name “Annex N_b_Coop. Lar - São Roque.pdf” available.

ANNEX O NOMINATION FOR EXECUTION OF PROJECT

Separate file with file name “Annex O_Carta Unido e CIBiogás Executores Assinada.pdf”.

ANNEX P ADDITIONAL PROJECT SUPPORT

Separate files with file names “Annex P_ Copel_Gera Rural_co-financing letter.pdf“ and “Annex P_Copel_Gera Rural_co-financing letter_eng” available.

ANNEX Q BACKGROUND DOCUMENTATION

The following documents can be consulted for additional background information:

(1) Third National Communication of Brazil to the UNFCCC, Vol. I-III. Ministry of Science, Technology and Innovation, Secretariat of Policies and Programs of Research and Development, General Coordination of Global Climate Change, Brasília, 2016 (2015).

(2) Federative Republic of Brazil - Intended Nationally Determined Contribution towards achieving the objective of the UNFCCC (2015).

(3) Balanco Energetico Nacional 2015, Relatorio Sintese, Ano Base 2014, Brasil Empresa de Pesquisa Energetica (EPE), Rio de Janeiro (2015).

(4) Plano Nacional de Agroenergia 2006-2011, Ministerio da Agricultura, Pecuaria e Abastecimento – Secretaria da Producao e Agroenergia, 2a edicao revisada, Embrapa Informacao Tecnologica, Brasilia, DF, 2006.

(5) RenovaBio – Diretrizes Estrategica, Poposta Submetida a Consulta Publica", Government of Brazil - MME, MAPA, ANP, EPE (January 2017)

(6) MCTI - Estimativas anuais de emissões de gases de efeito estufa no Brasil. Second edition (2014). Available at http://www.mct.gov.br/upd_blob/0235/235580.pdf.

(7) UNFCCC Country Brief 2014 – Brasil.

(8) Barreiras e Propostas de Solucoes para o Mercado de Biogas no Brasil – Probiogas, Consorcio AKUT / Rotaria do Brasil em cooperacao com Methanum, PROBIOGAS – Ministry of Cities (July 2015).

(9) Oportunidades da Cadeia Produtiva de Biogas para o Estado do Parana – Curitiba: SENAI/PR, ISBN 978-85-5520-015-1 (2016).

(10) Atlas das biomassas do Rio Grande do Sul para produção de biogás e biometano / Odorico Konrad et al. - Lajeado : Ed. da Univates, ISBN 978-85-8167-166-6 (2016).

(11) ABIOGAS – Proposta de Programa Nacional de Biogás e do Biometano (PNBB), version 1, G. Aragon (coordinator), Sao Paulo/SP (November 2015)

(12) Biogas / Biomethane Technology Transfer. Final report, by Gaston Aragon, 2016 (prepared for UNIDO during PPG phase using GEF funds)

(13) Biogas and biomethane sector from the R&D+I perspective and gaps/opportunities, by Luiz A. Horta Nogueira, November 2016 (prepared for UNIDO during PPG phase using GEF funds)

(14) Biogas and Biomethane Supply Chain and Existing Plants and Technologies in the Agro-Industry in Brazil. Identified Gaps and Recommendations for Strengthening of the Biogas / Biomethane Supply Chain, Including Opportunities for Technology Transfer and Adaptation of Technologies to Local Conditions, by Rodrigo Marcelo Leme, 2016 (prepared for UNIDO during PPG phase using GEF funds)

(15) Report International Expert (Biogas / Biomethane), by Luís Ferreira, November 2016 (prepared for UNIDO during PPG phase using GEF funds)

(16) Biowaste to Biogas, Fachverband Biogas e.V., Freising, Germany, May 2016 (www.biowaste-to-biogas.com).

(17) Zielmarktanalyse: Biogas Brasilien "Energetische Nutzung von Abfällen und Abwässern, mit Profilen der Marktakteure, Philipp-G. Hahn, Thiago Machado Bilek et al., Deutsch-Brasilianische Industrie und Handelskammer, Rio de Janeiro, Brazil, 15 Dec 2015 (www.export-erneuerbare.de)

(18) Factsheet AHK Geschäftsreise Brasilien Biogasmarkt in Rio Grande do Sul & Rio de Janeiro 24-28 Oktober 2016, Deutsch-Brasilianische Industrie und Handelskammer, Rio de Janeiro, Brazil, 3 Nov 2015

(19) Landwirtschaftliche Berufsgenossenschaft, Technische Information 4 – Sicherheitsregeln für Biogasanlangen, Herausgeber: Sozialversicherer für Landwirtschaft, Forsten und Gartenbau, Kassel, Germany, March 2016 (www.svlfg.de)

(20) IRENA Renewable Energy Technologies: Cost Analysis Series, Volume 1: Power Sector, Issue 1/5, Biomass for Power Generation, June 2012 (www.irena.org/publications/)

(21) Biogas handbook: Science, production and application, Edited by A. Wellinger, J. Murphy and D. Baxter, Woodhead Publishing Series in Energy No. 52, ISBN 0 85709 498 X, ISBN-13: 978 0 85709 498 8; February 2013; 512 pages.

(22) IEA Task Force 37 Bioenergy - Country Reports Summary 2015 (available at: http://www.iea-biogas.ne)