Global Environment Facility (GEF)

United Nations Development Programme (UNDP)

Ministry of Environment and Sustainable Development (MAyDS)

TERMINAL EVALUATION – Report

Sustainable Business Models for Biogas Production from Organic Municipal Solid Waste

UNDP # PIMS 5345
GEF ID # 5734

ARGENTINA
GEF-5; GEF Climate Change Mitigation; CC1-Promote the demonstration, deployment, and transfer of innovative low-carbon technologies

Evaluation timeframe: July 2016 – June 2022

FINAL version

19 June 2022

Disclaimer

Please note that the analysis and recommendations of this evaluation report do not necessarily reflect the views of the United Nations Development Programme, its Executive Board or the United Nations Member States. This publication reflects the views of its authors.

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The authors wish to thank UNDP Argentina, MAyDS, the Project Team and the stakeholders met during the evaluation mission for the assistance and information provided.

ABBREVIATIONS AND ACRONYMS

AWP	Annual Work Plan
CDM	Clean Development Mechanism
CEAMSE	*Coordinación Ecológica Área Metropolitana Sociedad del Estado*
CEO	Chief Executive Officer
CEO ER	CEO Endorsement Request
CH_4	Methane
CO	Country Office
CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide (equivalent in global warming potential)
COVID	Corona virus disease
DOC	Degradable organic carbon
EA	GEF Executing Agency (UNDP Implementing Partner)
EE	Energy efficiency
EoP	End of project
FAO	Food and Agrioculture Organization
GEF	Global Environment Facility
GIRSU	Integrated Urban Waste Management (*Gestión Integral de Residuos Sólidos Urbanos*)
GHG	Greenhouse gas
GWh	Gigwatt-hour (= 1 billion Watt-hour)
GWP	Global warming potential
IA	GEF Implementing Agency
IADB	Inter-American Development Bank
INTA	National Institute for Agriculture and Livestock Technology *(Instituto Nacional de Tecnología Agropecuaria)*
INTI	National Institute for Industrial Technology *(Instituto Nacional de Tecnología Industrial)*
IRR	Internal rate of return
JSC	Joint Stock Company
$ktCO_2$	Kiloton of CO_2
kW	Kilowatt
kWh	Kilowatt-hour
LFG	Landfill gas
MAGyP	Ministry of Agriculture, Livestock and Fisheries *(Ministerio de Agricultura, Ganadería y Pesca);*
MAyDS	Ministry of Environment and Sustainable Development (Ministerio de Ambiente y Desarrollo Sostenible)
M&E	Monitoring and evaluation
MRECIC	Ministry of Foreign Affairs, International Trade and Worship (*Ministerio de Relaciones Exteriores, Comercio Internacional y Culto)*
MSW	Municipal solid waste
MW	Megawatt (= 1 million Watt)
MWh	Megawatt-hour
NPD	National Project Director
NPV	Net present value
OECD	Organisation for Economic Cooperation and Development
PIF	Project Identification Form
PIR	Project Implementation Review
PM	Project Manager
PMU	Project Management Unit (Project Team)
RE	Renewable energy
RTA	Regional Technical Advisor
SDG	Sustainable Development Goal
tCO2	Ton of CO2
TE	Terminal Evaluation
ToR	Terms of Reference
tCO_2	Ton of carbon dioxide
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme
USD	United States dollar
WB	World Bank

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EXECUTIVE SUMMARY

Project Title:	**Sustainable Business Models for Biogas Production from Organic Municipal Solid Waste**			
GEF Project ID:	5734		*at endorsement (USD)*	*at completion (USD)*
UNDP PIMS ID:	5345	*GEF financing:*	2,779,849	2,779,849*)
Country:	Argentina	*IA/EA own:*	150,000	145,784
Region:	Latin America	*Government:*	12,595,000	12,620,540
Focal Area:	Climate Change Mitigation	*Other:*		
FA Objectives, (OP/SP):	CC1-Promote the demonstration, deployment, and transfer of innovative low-carbon technologies	*Total co-financing:*	6,629,394	6,698,773
Executing Agency:	Ministry of Environment and Sustainable Development (MAyDS)	*Total project Cost:*	15,374,850	15,400,390*)
CEO Endorsement	26 July 2016	*ProDoc Signature (date project began):*		23 Jan 2017
		Operational closing date	*Proposed:* 31 Dec 2020	*Actual:* 30 June 2022

*) Including expected expenditures in 2022

Background and description of the Project

After municipal solid waste (MSW) is collected and recycled, it is transported to the disposal sites. To accomplish better waste separation and recycling and a shift from open dumpsites to managed sanitary landfills, the National Integral MSW Program (GIRSU in its Spanish acronym) has been operating supported by the national budget and development partners, such as World Bank and Inter-American Development Bank (IADB). It was realised that shifting from dumpsites to landfills does not remedy or even make worse the release of so-called landfill gas (LFG). Landfill gas is composed roughly of 45-60% methane (CH_4), 40-60% carbon dioxide (CO_2) and a small amount of non-methane organic compounds that are produced from the decomposition of the organic content of the MSW from anaerobic bacteria. Methane is a potent greenhouse gas 28 times more effective than CO_2 at trapping heat in the atmosphere[1]. From an environmental and (as it is explosive) a safety viewpoint, sanitary landfill sites should capture the LFG and burnt it (flaring).

However, there is no financial benefit in just the recovery of the gas. The international markets for carbon trade (on which the methane emission avoided could be traded, such as the Clean Development Mechanism) have collapsed. An additional benefit is utilising the recovered LFG (that is half of the heating value of natural gas) for electricity generation (on-site or to sell to the power grid) or for thermal applications. Some LFG facilities operate at the large landfills near the major urban centers, such as Buenos Aires generating and selling power to the grid, usually helped by favorable feed-in tariffs (as part of the country's renewable energy programmes.

Most of Argentina's towns and communities will have small or medium-sized LFG facilities and the economics of scale works against the viability of sales to the grid, while they often lack the financial resources and infrastructure of the large urban waste companies. Thus, while encouraged to move from open dumps to managed landfills, local government or waste companies will not see a business case for only LFG recovery. About three-quarters of landfills investigated in a recent study, do not actively capture landfill gas. To remedy this situation, the project "Sustainable Business Models for Biogas Production from Organic Municipal Solid Waste" was formulated and presented to the Global Environmental Facility (GEF) for co-financing. The Project envisages demonstrating the potential of biogas (including landfill gas) for energy generation from organic municipal solid waste at medium-sized urban centers in Argentina. The project aims to develop and optimize effective business models for energy production as part of

[1] Please note that the GWP attributed to methane has been changing over time. Older reports use the value of "21" as appeared in 2nd IPCC Assessment Report (AR). The Fourth AR gives a value of"24", the Fourth AR (2007) of "25", the Fifth AR (2014) of "28"and the Sixth AR (2021) of 27.2 (non-fossil origin) and 29.8 (fossil origin). As emission reductions of pilot projects refer to the period 2014-2021, the value of "28" is used in this report for reasons of comparability.

integrated waste management under the national GIRSU program. Three to four small-scale LFG energy systems will be procured and demonstrated in selected municipalities.

The **objective** has been to introduce biogas technologies for energy generation as part of the National Strategy for Integrated Urban Waste Management (GIRSU) to be achieved through the following main **outcomes:**

1. MSW-based biogas energy technologies are incorporated in the national GIRSU programme for deployment in municipal and regional waste plants
2. Demonstration biogas energy technologies using MSW feedstock are procured and fully operational

The strategy to achieve these outcomes has consisted of:

- Dissemination of the benefits of this technology, especially in environmental and social terms, so that a range of public and private stakeholders as well as beneficiaries are made aware of the issue.
- Strengthen the legal-regulatory framework for the development of landfill gas and biomethanation at national, provincial, and local levels.
- Institutional strategies to improve coordination and synergies between the different actors in various and at various levels (federal, local).
- Promote the development of the industries that produce the components, equipment and inputs required for the installation, operation and maintenance of biogas plants and capacity building of local municipalities, institutions waste companies or communities to operate and maintain LFG plants.
- Promotion and demonstration of landfill gas recovery and utilisation for energy purposes through the application of various instruments such as non-monetary benefits, loans, investments for the construction of new works,
- Training of human resources in the installation and operation of technologies.
- operation of the technologies.
- Promotion of research and development strategy articulating projects with universities, research bodies and industry, universities, research bodies and industry, seeking technological innovations to add value to the entire biogas production chain.

The project started in January 2017 with the signature of the Project Document and was scheduled to end by July 2020 but was extended until June 2022.

Achievements – summary

Outcome indicators and outputs	**Achievement**	
Outcome 1 - MSW-based biogas energy technologies are incorporated in the national GIRSU programme for deployment in municipal and regional waste plants		*Evaluation rating:* S
Indicators and end-of-project (EoP) target:		
A) Achieved direct GHG emission reductions by pilot biogas energy plants and replication (ton CO_2eq/yr); *Target:* 13,400 tCO_2 per year	The 08 pilot projects, once fully operational, will give a combined GHG emission reduction due to: ▪ Methane release into the atmosphere avoided (the gas is recovered and flared or otherwise utilised). Releasing gas from landfills is the case in 74% of cases; baseline). It is assumed that 50% of the gas is recovered in practice; thus, avoiding the leaking of this amount of CH_4 into the atmosphere has substantial impact (1,362 $ktCO_2$.eq per year ▪ Avoided grid electricity (with grid emission factor of 0.486 tCO_2 per MWh). As total generation capacity is fairly small, the reduction due to power generation is small (0.86 $ktCO_2$ per year). ▪ Over the assumed period of 10 years, the cumulative reduction (methane avoided and grid electricity avoided is 13,635 $ktCO_2$	
B) Policy and regulatory framework for MSW-based biogas energy supported; *Target:* 05	The "Technical standard for agricultural application of digestate from anaerobic digestion plants" was adopted in 2018. A model for municipal regulations was developed. The project is currently working with other areas of government on the development of a national "Minimum Standards Act" for the use of biogas generated from MSW.	

Outcome indicators and outputs	Achievement
C) Number of public-private partnerships exploiting MSW-based biogas established *Target: 0*3	The ProDoc mentions a "range of business models for biogas energy generation based on MSW" will be delivered, but up to present there is no clear business model that ensures the technical and viable (commercial) operation of MSW biogas energy systems. However, in the last two years two public-private partnerships have been developed: • Escobar: cooperation of municipality with the local Mercado Frutihortícola de la Comunidad Boliviana de Escobar • Fachinal: cooperation between the provincial government (Misiones), the municipality and the local company (AESA Misiones SA) that manages the landfill site • Tapalqué: municipality and the site (in which part of the energy is used on-site and revenue of energy sold to the grid going to the municipality).
D) Number of people served by the electricity produced by pilot biogas energy plants and replication *Target:* 21,000	Based on the 8 pilots, about 25,000 people, once fully in operation
Outputs of Outcome 1:	
1.1. Optimization of business and management models for MSW biogas energy generation systems operated by municipalities or private concessionaires in the framework of the national GIRSU program. 1.2. Enhancement of technical, management and coordination capacities of the GIRSU program to support the effective deployment of MSW-based biogas energy technologies 1.3. Short-term studies supportive of MSW-biogas project and policy development addressing identified legal, technical, social, environmental and operational issues 1.4. Design and presentation of proposals to enhance the regulatory framework for MSW biogas in coordination with the relevant authorities and ministries	In close cooperation with GIRSU, the project has supported biogas on MSW landfills in several municipalities (Gualeguaychú, Tucumán, Escobar, Rafaela, Tapalqué, Fachinal) as part of the landfills under the GIRSU programme. The works have been awarded for design or are under construction (see Box 9). The new landfills will include biogas capture systems, which will generate electricity once the landfill is sufficiently mature. There has been close cooperation between the MSW Biogas and GIRSU programme, which now has incorporated gas infrastructure as part of the technical specifications for new landfill projects. Several consultancies and studies were conducted: • *Assessment of the potential for capture and energy use of the methane generated* (in selected landfills, INTI, 2019-20) • *Barriers, issues and controversies to the implementation of biodigestion technology applied to MSW* (by HYTSA, 2020) • *Social and environmental evaluation of biodigestion technology in its different phases of generation, operation, dissemination and training* (by Desarrollos y Gestión Sustentable SRL; 2020) • *Design and presentation of proposals to promote the regulatory framework for biogas in Argentina* • *Technical, operational and economic evaluation of biodigestion technology applied to MSW* (by Cleanergy Renovables SA; 2020) • *Incorporation of biodigestion technology in national programmes* (by HYTSA, Dec 2020)
Outcome 2 - Increased use and deployment of locally-produced high-quality LED lighting technologies	*Evaluation rating:* S
Indicators and end-of-project (EoP) target:	
E) Installed electricity generating capacity of MSW-based biogas pilot projects *Target:* 540 kW	The combined capacity of the Project-supported pilots is 230 kW
F) Annual volume of electric energy produced by biogas pilots *Target:* 4,010 MWh per year	If all pilots are completed and running, the expected power generation is 1,770 MWh per year. The actual power generation is minimal given the fact that most biogas (recovery and) utilisation at landfills has only recently been installed. It should be noted that the installed generation capacity is often less than what is maximum possible, reflecting investment budget limitations (smaller generator) and limited on-site energy needs. On the other hand, the biogas can also be used for thermal application (which was not chosen as a target)

Outcome indicators and outputs	Achievement
G) Financing mobilized for investment in MSW-based biogas energy systems *Target:* USD 10 million	The grant co-financing realised corresponds with the landfill activities of GIRSU (supported with IADB grant) with an investment of USD 12.44 million. It should be noted that MAyDS had prepared a proposal for biodigesters in 5 fruit and vegetable markets and is preparing a pipeline of several landfills that will be equipped with gas recovery (with existing and new IADB funding for GIRSU; see *Section 4.4*).
H) Number of people trained and employed for MSW-based biogas energy generation *Target:* 40 m and 40 f	Realised: a, 56 men and 57 women from the various pilots were trained (by July 2022), with training of the people from the Overa Pozo pilot still pending (based on the project's *Informe de Cierre).*
Outputs:	
2.1 Execution of functional design and feasibility studies for shortlisted MSW biogas generation projects 2.2 Feasibility studies, detailed engineering, and formalization of responsibilities of project partners for MSW biogas generation projects 2.3 Procurement of MSW-based energy generation pilot projects demonstrating different energy uses and business models	During the first years of the project, no significant advance was made towards the development of pilots. Economic-financial pre-feasibility studies were carried out by INTI in 2019 for biogas extraction and electricity generation in 13 sites related to the RenovAr program. As explained in the previous section, none of these were or could be submitted due to their small size, viability issue, lack of investment, or influenced by external factors. Rather than pursuing viability goals by selling to the grid, the new Project Team that took over in 2020 has focused on the new options linked to the self-supply use of gas to solve the problem of insufficient or unreliable energy supply in locations far from the main networks and supporting financially a number of smaller pilot projects. The waste-to-energy pilots can be grouped into three categories, according to their level of social impact: • Biodigesters for small native people communities (10-40 families) • Biodigesters for markets or small rural producers • Biodigester for landfills in small and medium-sized towns for which biogas is used on-site or delivered to the (local) electricity grid. Currently (May 2022), most of the pilots the provision, installation and commissioning of the equipment have been carried out or are being finalised: SDP 02/2020 Biodigesters at technical and agricultural schools SDP 03/2020 Biodigester in the Mercado Concentrador de frutas y verduras: Comunidad Boliviana SDP 01/21 Biogas collection and use plant at the landfill Predio Ecoparque Gualeguaychú SDP 02/2021 Biogas capture and utilization in Fachinal landfill SDP 03/2021 Biodigestion Pilot Plant for the use of biogas in the Environmental Complex of Rafaela SDP 04/2021 Biodigesters in Salta indigenous communities SDP 05/2021 Use of biogas in sewage treatment plant SDP 06/2021 Biogas recovery and utilization in Overa Pozo landfill

Project design issues and external factors that have influenced project implementation

The achievement of the results (and the longer-term sustainability thereof) has been influenced by the way the Project was formulated and designed, the way the project was implemented by the various project partners and the occurrence and impact of external factors. The project design has suffered from too high expectations with respect to achieving a special agreement with the Argentinian renewable energy programmes for generating and selling electricity to the national market operator. Even large LFG facilities receive higher feed-in tariffs than utility-scale solar or wind energy. It was not realistic to assume that small and medium LFG facilities in small towns or communities would approach the economics of scale to reach viability as their large counterparts. The Project waited quite a long time, until 2019, in addressing the issue and re-orient LFG to local benefits and circumstances.

Admittedly, the Project's implementation was hampered by frequent changes in the national government (2015, 2019), and the government institutional setup (2015, 2018, 2019) with consequences for the composition of the Directive

Board, for project management and the project team. In 2019 the Project was in dire straits in terms of achievements and delivery rate. Fortunately, a new management and project team has been able to provide a new focus, strengthened integration with the GIRSU team (also under the National Directorate for Urban Solid Waste of MAyDS), selected and support several pilot LFG pilot activities in municipal landfills, local communities and fruit and vegetable market, and commissioned several studies on background status of landfills and LFG (at the national and provincial level), technical options and issues with biogas utilisation, remaining obstacles and barriers for wider-scale LFG application, as well as necessary regulations.

Summary of ratings

1. Monitoring and Evaluation	*rating*	2. IA& EA Execution	*rating*
M&E design at entry	MS	Quality of UNDP Implementation	S
M&E Plan Implementation	S	Quality of Execution - Executing Agency	MS
Overall quality of M&E	*MS*	*Overall quality of Implementation / Execution:*	*S*
3. Assessment of Outcomes	***rating***	**4. Sustainability**	***rating***
Relevance	R	Financial resources:	ML
Effectiveness	S	Socio-economic & stakeholder capacity	L
Efficiency	MS	Institutional framework and governance:	L
Overall Project Outcome Rating	*S*	Environmental:	L
5. Design logic	MU	*Overall likelihood of sustainability:*	ML

Ratings for Outcomes, Effectiveness, Efficiency, M&E, IA&EA Execution

6: Highly Satisfactory (HS): no shortcomings
5: Satisfactory (S): minor shortcomings
4: Moderately Satisfactory (MS)
3. Moderately Unsatisfactory (MU): significant shortcomings
2. Unsatisfactory (U): major problems
1. Highly Unsatisfactory (HU): severe problems

Additional ratings where relevant:
Not Applicable (N/A)
Unable to Assess (U/A)

Sustainability ratings:

4. Likely (L): negligible risks to sustainability
3. Moderately Likely (ML): moderate risks
2. Moderately Unlikely (MU): significant risks
1. Unlikely (U): severe risks

Relevance ratings
2. Relevant (R)
1. Not Relevant (NR)

Impact Ratings:
3. Significant (S)
2. Minimal (M)
1. Negligible (N)

Note:
Regarding 'execution', it is difficult to provide a rating, which should distinguish between the period 2017-2019 (rated as 'U') and 2020-221 (rated as 'HS'). The rating presented is the average of the two, giving a 'MS' rating. The rating "Design logic" has been added by the Evaluator

Conclusion and recommendation

On a small and medium scale, LFG is still much in a demonstration phase. The UNDP/GEF MSW project has demonstrated the potential of biogas (including landfill gas) for energy generation from organic municipal solid waste for medium-sized urban centres in Argentina. However, in view of the initial delay in project implementation, the Project has only effectively operated in the past two or three years, a time which is too short to develop the market to the next deployment phase. While the Project has pushed for energy production as part of integrated waste management under the national GIRSU programme, there is a need for experimenting with and optimize effective business models for the wider-scale deployment of the LFG recovery and utilisation.

The main **recommendation** is to formulate and implement a successor programme that builds on the demonstration of LFG utilisation and small and medium-scale applications, as pioneered by the MSW Biogas project, and focuses on business and financing models for a wider-scale deployment (in municipal landfills, vegetable and fruit markets and community applications). Such a new program would address remaining financial-economic, technical, and regulatory barriers (see Section 4.4) and fill a niche between the World Bank project on *basurales* and the continuation of the GIRSU programmes

1. INTRODUCTION

1.1 Purpose of the Terminal Evaluation and objectives

1.1.1 Background

Argentina is a net importer of energy in the form of crude oil, diesel oil and natural gas. Renewable sources are increasing their share in the national energy matrix, mainly as a result of two active policies: a) the mandatory admixture of bioethanol and biodiesel in gasoline and diesel oil, and b) a public bidding system (RenovAr) opening the electricity market to renewable sources of electricity.

The country is the third-largest country, population-wise, in South America (45.2 million in 2020). About 93% of the inhabitants live in urban areas. About 99.8% of the municipal solid waste (MSW) is collected and about 65% ends up in sanitary landfills. Reducing the amount of waste flowing into landfills has been declared a priority in the national Integral MSW Management (GIRSU) Strategy. The organic fraction of the waste eventually decays in the landfill generating large amounts of methane that contribute to global warming. According to the Fourth Biennial Updater (to UNFCCC), greenhouse gas emissions were 365,890 kiloton CO_2-eq in 2018 (of which 16,432 ktCO_2 from waste (and 9,639 ktCO_2 solid waste). Apart from a climate change mitigation measure and as a public health strategy, the use of the biogas generated by this flow is seen as an opportunity to recover economic value as thermal energy or electricity[2].

1.1.2 Purpose of the Terminal Evaluation (TE)

With the MSW Biogas project ending, a Terminal Evaluation (TE) needs to be undertaken in accordance with the UNDP and GEF Monitoring and Evaluation (M&E) policies and procedures. The TE must be carried out by an independent consultant, i.e., not previously involved in project design or implementation. In a competitive process, the expert Mr Johannes (Jan) van den Akker was chosen as the expert to carry out the assignment, hereafter referred to as the 'Evaluator'.

The evaluation has assessed the performance of the MSW Biogas project based on expectations set out in the Project Results Framework (logical framework), which provides performance and impact indicators for project implementation along with their corresponding means of verification. The evaluation has covered the criteria of relevance, effectiveness, efficiency, sustainability, and impact. The Evaluator assessed the key financial aspects of the project, including the extent of co-financing planned and realized. It assessed the extent to which the project was successfully mainstreamed with other UNDP priorities, including improved governance, and gender. The Evaluator also looked at the extent to which the project is achieving impacts or progressing towards the achievement of (intended or unintended) impacts.

1.2 Scope and methodology

Evaluation criteria

The terminal evaluation is based on the OECD-DAC[3] criteria of *relevance, effectiveness, efficiency, sustainability, and impact*. The rating has taken place according to the evaluation criteria using the rating scales recommended in the UNDP *Guidance for Conducting Terminal Evaluation of UNDP-supported, GEF-financed Projects* (2012)[4], as given in

[2] *Biennial Update Report* (2021), *Waste Management Country Report: Argentina,* Holland Circular Sport (2021)

[3] Organisation for Economic Cooperation and Development (OECD) – Development Assistance Committee (DAC)

[4] Other guidelines consulted are those presented in the UNDP *Handbook on Planning, Monitoring and Evaluating for Development Results*, *Updated Guidance on Evaluation* (2012), the UNDP Discussion Paper: *Innovations in Monitoring & Evaluating Results* (2013) and the GEF *Review of Outcomes to Impacts (ROTI) Handbook* (2009). Regarding gender aspects, the evaluation refers to the *Guide to Gender Mainstreaming in UNDP Supported GEF Financed Projects* (2016).

Box 1 Rating and rating scales for evaluation criteria in UNDP/GEF projects

1. Monitoring and Evaluation	*rating*	2. IA& EA Execution	*rating*
M&E design at entry		Quality of UNDP Implementation	
M&E Plan Implementation		Quality of Execution - Executing Agency	
Overall quality of M&E		*Overall quality of Implementation / Execution:*	
3. Assessment of Outcomes	**rating**	**4. Sustainability**	**rating**
Relevance		Financial resources:	
Effectiveness		Socio-political:	
Efficiency		Institutional framework and governance:	
Overall Project Outcome Rating		Environmental:	
		Overall likelihood of sustainability:	

Ratings for Outcomes, Effectiveness, Efficiency, M&E, IA&EA Execution

6: Highly Satisfactory (HS): no shortcomings
5: Satisfactory (S): minor shortcomings
4: Moderately Satisfactory (MS)
3. Moderately Unsatisfactory (MU): significant shortcomings
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Additional ratings where relevant:
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Sustainability ratings:

4. Likely (L): negligible risks to sustainability
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1. Unlikely (U): severe risks

Relevance ratings
2. Relevant (R)
1. Not Relevant (NR)

Impact Ratings:
3. Significant (S)
2. Minimal (M)
1. Negligible (N)

Box 1. Evaluation conclusions related to the project's achievements and shortfalls (comprehensive and balanced statements which highlight the strengths, weaknesses, and results of the project, based on the OECD-DAC criteria:

- Relevance: How does the project relate to the main objectives of the GEF focal area, and to the environment and development priorities at the local, regional, and national levels?
- Effectiveness: To what extent have the expected outcomes and objectives of the project been achieved?
- Efficiency: Was the project implemented efficiently and cost-effectively, in line with international and national norms and standards?
- Sustainability: To what extent are there financial, institutional, social-economic, and/or environmental risks to sustaining long-term project results?
- Impacts: Are there indications that the project has contributed to, or enabled progress toward, reduced environmental or other impacts?

The ratings in this report have been determined based on the project progress reporting and the analysis the Evaluator carried out of the available information and based on stakeholder interviews. Information collection and analysis were guided by a checklist and evaluative questions for use in collecting primary information. All tools were designed to address the key questions (grouped according to the before-mentioned OECD-DAC criteria) that were part of the Inception Report of the evaluation assignment. *Annex D* contains the matrix of evaluative questions.

Approach

The TE has been based on the following *sources of information*:

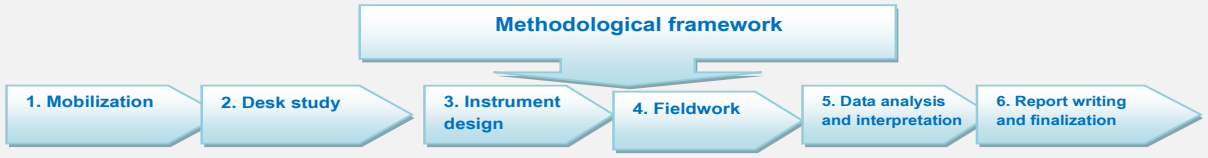
- Desk review of progress reports and project documents (listed in *Annex C*),
  - CEO Endorsement Request (CEO ER) and annexes; annual progress reports (PIRs, project implementation reviews); other progress reporting and PowerPoints; draft Project final report
  - Overview of budget expenditures and realized co-financing; annual work plans
  - Project technical reports and description of outputs;
  - Government or counterparts' websites

- National policy documents on (renewable energy; biogas) as well as other relevant reports, PowerPoint presentations, and documents from counterpart organizations.

- An evaluation mission of 10 working days (from 23 May to 03 June 2022) to meet UNDP, the Project Team, and Project Director and to hold interviews with project partners and beneficiaries in and outside Buenos Aires (see the mission itinerary in Annex B). The meetings and interviews helped the reviewers to obtain in-depth information on impressions and experiences and to explore opinions about the Project and their understanding and identify opportunities
- A presentation of the initial findings was made at the end of the evaluation mission (on 02 June 2022).

Regarding *data analysis and methods for analysis*, many relevant reports and documents were collected (where possible before the mission). The review of project and background documents (listed in *Annex C*) provided the basic facts and information for developing the terminal evaluation report, giving a basic insight into progress (targets vs. values achieved) and reasons for under- and over-achievements were explored.
The evaluation mission served to verify these basic facts, get missing data and learn the opinions of stakeholders. The mission conducted key informant interviews with the representatives of different partners and stakeholders, such as (i)

Box 2 Evaluation method and approach



UNDP, (ii) Ministry of Environment (project team, GIRSU team) and other government entities, as well as (iii) pilot project beneficiaries (schools, fruit and vegetable product markets, landfills) and (iv) technology suppliers. Triangulation (of the interviews with document analysis) has allowed validation of information through cross verification from two or more sources. In appraising the result-wise effectiveness of the program's major interventions, the Evaluator thoroughly assessed targets against progress. The Evaluator used information provided by the Project Team[5] and later cross-checked this with the documents and interview statements. Along with collecting information, evaluators reviewed data from the Project Implementation Reviews (PIRs) and other project-related documents. The above-mentioned processes and methods helped to gather plenty of evidence about the outcomes of the project. A draft report was shared with the MAyDS-based Project Team and UNDP in the agreed format and the report was finalized after incorporating feedback and suggestions.

1.3 Structure of the TE report

This report consists of the report body, executive summary, and annexes. The body of this report is structured around the following chapters: it starts with an introduction to the objectives, scope, and methodology of the terminal evaluation (*Section 1*), a description of the project context and a summary of project facts (such as start date, duration, the context in which the project started), its objectives and stakeholders (*Section 2*).

The assessment and formulation of the "findings" have been guided by the questions of the "evaluative matrix", of which a final draft was formulated at the inception stage of the assignment (see *Annex D*)[6]. The report follows the outline for terminal evaluations of UNDP/GEF projects[7] but has split the suggested chapter on "Findings" into three parts for practical reasons due to the chapter size and to permit a more reader-friendly presentation of the information. Findings on relevance and design are in *Section 3*. An overview of progress regarding the achievement of outcomes and outputs is given in *Section 4*, which is followed by a presentation of findings regarding replication effects and sustainability. Findings on project implementation and monitoring are presented in *Section 5*. The report ends with conclusions, recommendations, and lessons learned from the project.

[5] PowerPoints, PIR, quarterly progress reports, minutes of meeting.
[6] See the *Inception Report* of the Terminal Evaluation (May 2022)
[7] See Annex F, 'Evaluation Report Outline' in the UNDP *Guidance for Conducting Terminal Evaluations* (2012)

In development projects, 'results' are the describable or measurable development change resulting from a cause-and-effect relationship. These results include project outputs, short- to medium-term outcomes, and longer-term impacts, (including global environmental and development benefits).

The achievement of the results and the longer-term sustainability thereof is influenced by the:

- way project was formulated and designed (discussed in *Section 3*);
- way the project was implemented by the various project partners (discussed in *Section 5*);
- occurrence and impact of internal and external risks (discussed in *Section 5*).

Annexes at the end of the report include the Terms of Reference (*Annex A*), Itinerary, field visit details people interviewed and results (*Annex B*), List of documents collected and bibliography (*Annex C*), Evaluative questions and methodology (*Annex D*), Consultant Code of Conduct form *(Annex E),* About the evaluator *(Annex F)*. The Audit Trial *(Annex G)* is available in a separate file.

2. PROJECT DESCRIPTION AND BACKGROUND

2.1 Context and problems that the project sought to address

Argentina's total primary energy mix is dominated by natural gas (55%) and oil (33%), with bioenergy contributing 5%, and hydropower and nuclear another 3% each. Argentina has the second largest reserve of shale gas and the fourth largest reserve of shale oil worldwide. In 2019, the country produced 500,000 barrels per day (bpd) of oil, of which 89,000 bpd was exported, but the country remains a net importer of oil products[8].

The power supply was about 145 terawatt-hours (TWh) in 2019, produced from natural gas (65%), hydropower (17%), followed by nuclear 7%, wind (6%), landfill gas and biogas (2%), solar (1%) and others (coal, oil) with about 39 TWh of power imported. Energy consumption was 129 TWh in 2019. Total electricity coverage in Argentina was close to 100%. The installed capacity in 2020 was 42.0 gigawatt (GW), of which 25.4 GW thermal and 13.8 GW renewable (10.4 GW large hydro, 3.4 GW solar and wind, with 22 and 29 kilowatts of landfill and biogas, respectively)[9].

A set of public policies have boosted utility-scale projects in variable renewables, taking advantage of its rich solar and wind resources, including Genren[10] (2009-2010 and RenovAr, launched in 2016 by the Government). The first RenovAr rounds (numbers 1, 1.5 and 2), allowed RE generation capacity to expand by about 4,466 MW in 147 projects (mostly wind, 2466 MW; solar 1732 MW, biomass/biogas, 203 MW)[11] with about USD 7 billion of investment. This helped to increase the share of non-hydro RE in power generation from less than 2% to 8% by 2019/2020. Round 3 (Miniren) was launched in 2018, awarding 203 MW in 2020 to 33 projects[12], mobilizing USD 319 million. The macroeconomic turbulence in Argentina in 2018-19[13] caused the projects awarded under the Round 3 of the RenovAr program to face serious difficulties in obtaining the necessary financing for their development and several projects of the original 259 MW awarded failed to sign the signing deadline in 2020.

Total installed power could reach 50 GW in 2025. Law 26.190, with the amendments introduced by Law 27.191, establishes the objective of achieving a contribution from renewable energy sources of 12% (in addition to large-scale hydro) by 31 December 2019, rising to 20% by 2025 (or about 10 GW). While the figures reached by RenovAr are below the Law's ambitious objective, they did present a change in a trend toward more renewables in the power mix.

Agriculture is an important sector in Argentina. Agriculture provides about 5.3-7% of GDP. The country is one of the world's major agricultural producers, ranking among the top producers in most of the following, exporters of beef, citrus fruit, grapes, honey, maize, sorghum, soybeans, squash, sunflower seeds, wheat, and yerba mate. For example, in 2018/19, Argentina was the third largest producer of soy in the world, with 37.7 million tons produced (behind only the US and Brazil), the 4th largest producer of maize in the world and the 4th largest exporter of beef[14]. Agricultural activities are responsible for the generation of a high amount of agriculture residues and by-products.

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8 https://www.iea.org/countries/argentina

9 www.cammesa.com (accessed 2021), not including off-grid installed capacity nor distributed generation (small biogas/biomass facilities, rooftop solar panels, etc.)

10 The first tender under the Genren Program was launched in 2009, in which 32 projects were awarded reaching a total of 895 MW. A second phase was launched in 2020 (26 projects, 1200 MW). Source: *Renewable Energy Situation in Argentina* (Min. de Relaciones Exteriores y Culto; 2012)

11 Of which 37 biogas projects (65 MW0 and 3 MSW biogas projects (13 MW). Feed-in tariff offered in the power purchase agreements were an average USD 54.72/MWh, ranging from USD 50.07/MWh for wind and USD 50.35/MWh for solar to USD 129.2 for MSW biogas and USD 159.7/MWh for biogas, respectively. Source: RenovAr webpage

12 Weighted average contracted prices were wind USD 58.04/MWh (128.7 MW capacity awarded), solar PV USD 57.58/MWh (96.9 MW), biogas USD 158.57/MWh (15.7 MW), biomass (SD 106.15/MWh) and small hydro USD 103.44/MWh (7.4 MW). Source: https://www.renewablesnow.com/news/argentina-finalises-renovar-3-round-5-projects-locked-out-of-ppas-684911/ and https://www.argentina.gob.ar/sites/default/files/20190805_adjudicaciondeproyectos.pdf

13 GDP dropped from an average USD 606 billion over 2013-2017 to a low USD 389 in 2020 but increased again to USD 489 in 2021. Sources: www.statistics.com

14 http://www.fao.org/faostat/en/#data/QL/

Thus, Argentina presents a considerable potential for biogas production and utilization (for electricity and heat generation). According to a study undertaken by INTI/FAO in 2016, there were about approximately 105 biodigester plants of various sizes, technology levels, utilization and application purposes, of which 38% were in agroindustry, 33% livestock and farming residues, and 28% urban residue (solid residues and sewage). Most of the plants are for the treatment of residues and if used for energy generation (56%) most biogas is used for thermal applications[15].

In 2018 Argentina produced almost 14 million tons of municipal solid waste (MSW, *residuos sólidos urbanos* in Spanish), or around 0.86 kilograms per person per day. Some 10% was recycled, about 65% goes to sanitary landfills and the remainder is improperly disposed of and ends up in (open) dumpsites (*basurales* in Spanish). Landfills are mainly concentrated around the bigger population centers. In other regions, only part of the MSW ends up in sanitary landfills; for example, in Mesopotamia in the northeast, this share is 15% only. *Basurales* may partly meet the conditions of a sanitary landfill or not at all but in general form a source of contamination and causes health risks and damages to the environment.

A sanitary landfill *(relleno sanitario* in Spanish) is a method of final disposal of waste, which is basically a depression in the ground covered by an inner membrane. The inner membrane is usually plastic covered with clay. The core idea is to isolate the waste from the rest of the environment until a point when it is no longer considered a risk, health-wise and ecologically. This implies that the waste is completely degraded biologically, chemically and physically. A plumbing network is attached to be able to take care of leachates from the waste. The waste is put in waste soil layers to help the process of decomposition go more rapidly. When the sanitary landfill is full, it is covered with clay.

At the national level, Argentina has a General Environmental Law (Law 25.675) and a Management of Industrial and Services Waste Law (25.612). In addition, there is the Law on the Management of Domestic Waste (Law 25.916). The Argentine government developed the National Strategy for the Integrated Management of Urban Solid Waste (ENGIRSU) in 2004 for the timespan 2005-2025. Important elements of the Strategy include:

- Reduction, separation and maximize valorization, according to the R5 principle (reduce, recover, re-use, repair, recycle) and minimize disposal;
- Disposal in a sustainable manner (in sanitary landfills) and closure of open dumpsites;
- Master plans of solid waste management developed and operational in each province (regionalization);
- Implementation of projects that include integrated solid waste management promoting social inclusion of waste pickers[16]

The City of Buenos Aires passed a "Zero Waste Law" in 2005 that aims to reduce the amount of waste by 75% in 2017, later revised to 80% in 2030. Initially, the Law also prohibited waste incineration, but this provision was taken out in 2018[17]. As a part of the green city plan, a number of *puntos verdes* (green points) were installed around the city. The idea is for residents to be able to bring their garbage to separate it there. There are possibilities to separate glass, cardboard, paper, metal and plastic

About 50% of the waste in Argentina is organic. There are a number of technologies for its processing, depending on the volume, moisture content, site of generation, etc. One way of treatment is through aerobic composting. There are several plants for the biological transformation of waste through aerobic composting in different locations, such as the plant operated by Tecsan Ingenieria Ambiental S.A., in the Norte III Complex in Buenos Aires.

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15 *Relevamiento de Plantas de Biogás en Argentina* (INTI, 2016)

16 Traditionally, waste collection for recycling in Argentina has been dominated by the workers in the informal sector (also referred to as *cartoneros*). There have been initiatives to integrate the waste pickers in a more formal system of recycling, but not all waste pickers are interested to join in. At present, approximately one third has a formal contract and sells the recyclables to cooperatives of waste pickers. Each cooperative was given a particular zone of the city to be responsible for. Source: *Challenges in Solid Waste Management in Buenos Aires,* A. Nillsson (2016; KTH)

17 At first glance, the size of the metropolitan area of Buenos Aires and its waste output (15 million people and almost 18,000 tons a day) appear to justify research into the possibility incineration plants. However, to date, there is no such plant in Argentina. Recycling complemented with renewable energy has clearly less impact on the climate and the economy. It might be better environmentally to skip the incineration step completely, or to postpone it until recycling system are optimally functioning. Source: *Waste Management Country Report; Argentina* (2021), Holland Circular Hotspot

When MSW is first deposited in a landfill, it undergoes an aerobic (with oxygen) decomposition stage when little methane is generated. Then, typically within a year, anaerobic conditions are established and methane-producing bacteria begin to decompose the waste and generate methane (which reaches its peak level after 3-5 years). The actual LFG production and composition (about half is CO_2 and half methane) depends on a number of factors, such as the composition (the higher the organic content the better) and age of the waste, presence of oxygen (CH_4 is only produced when no oxygen is present), moisture content and temperature.

Landfill gas is composed roughly of 45-60% methane (CH_4), 40-60% carbon dioxide (CO_2) and a small amount of non-methane organic compounds. Methane is a potent greenhouse gas 28 to 34 times more effective than CO_2 at trapping heat in the atmosphere[18]. According to the latest UNFCCC report, greenhouse gas emissions from waste were 4.5% in 2018 (and 2.65% from solid waste[19]). Methane is not only a potent greenhouse gas and is also explosive. From an environmental and safety viewpoint, sanitary landfill sites should capture the LFG and flare it, or even better, utilize the gas for electricity generation, thermal application, or to convert as fuel (see Box 3). Using the recovered methane as a fuel for heating or power generation gives an additional GHG emission reduction impact (if replacing fossil fuels).

Apart from a climate change mitigation measure and as a public health strategy, the use of the biogas generated by this flow is seen as an opportunity to recover economic value as thermal energy or electricity. The MSW-to-energy route in a viable business model was not considered yet technically or financially proven in small and medium towns, as hindered by a number of barriers at the time of formulation of the Project.

a) Defective political framework for small-scale renewable energy projects (< 500 kW) to sell power to the wholesale market (run by the utility CAMMESA[20]) and gaps in regulations referring to grid access, net power measurement, security, transportation and end-use of digested biomass;
b) Inadequate coordination between authorities and stakeholders.
c) Limited knowledge of the biogas-to-energy technologies in the urban waste treatment sector and landfills are usually not designed or optimized for landfill gas extraction
d) Lack of 'practical experience with viable business models for energy generation from MSW-based biogas. Experience is important as digesters require a stable flow of biomass, of known composition, free of bactericides and heavy metals, regulated moisture, and pH;

Since the separate treatment of organic waste demands more investment and increases the operational costs of already existing or future waste management systems, their owners or operators want to be sure that the new revenues or the savings, obtained from energy generation will compensate for the additional expenditures, and will be both financially sound and free of risk. This may not be the case for small-scale systems with different economies of scale than large systems (see footnote 38 on page 38).

A defective or unreliable technical performance of biogas-to-energy systems may sharply reduce the interest of public and private operators of municipal waste systems, who logically tend to prefer the old, fool-proof and problem-free alternatives that they can manage with their own human and local resources, i.e., burning the biogas in torches. In short, defective performance and/or negative cash flows are non-acceptable risks, both for the municipal administrations and the private operators of MSW systems

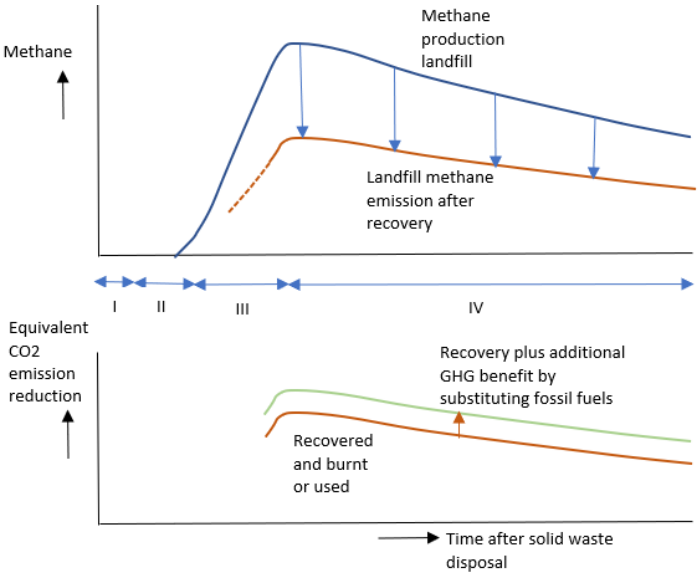
[18] Over a 100-year period; see, for example the Fourth and Fifth Assessment Report of IPCC (Intergvovernmental Panel on Climate Change) mention GWPs of 25 and 28, respectively, while the Sixth gives values of 28-36.

[19] Biennial Update Report, total GHG emissions of 365,890 tCO_2 in 2018, of which energy sector 59.7% and waste 4.5%. Emission from waste and soid waste in 2012 were similar, 4.5% and 2.7%, respectively (Third National Communication)

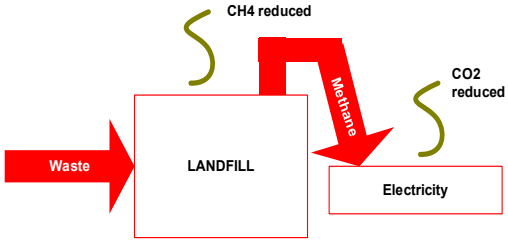
[20] Private and state-owned companies carry out generation in a competitive, mostly liberalized electricity market. CAMMESA (*Compañía Administradora del Mercado Mayorista Eléctrico*) is the administrator of the wholesale electricity market.

Box 3 Landfill and biomethanation

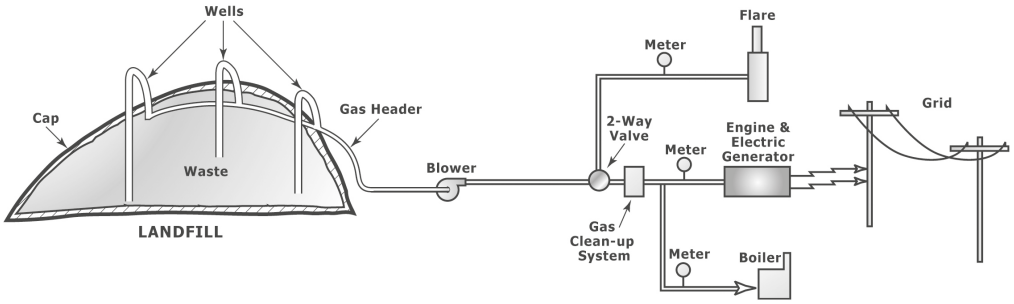
Landfill gas (LFG) is created from the decomposition of organic matter in a municipal solid waste (MSW) landfill. In a first phase after disposal of the solid waste, in which aerobic bacteria (bacteria that live only in the presence of oxygen) consume oxygen while breaking down the long molecular chains of complex carbohydrates, proteins, and lipids that comprise organic waste. The primary by-product of this process is carbon dioxide. After the oxygen is depleted, anaerobic bacteria (that do not use oxygen) convert compounds created by aerobic bacteria into acetic, lactic and formic acids and alcohols such as methanol and ethanol. As the acids mix with the moisture present in the landfill and nitrogen is consumed, carbon dioxide and hydrogen are produced. The first two phase takes about half a year. In a third phase, anaerobic bacteria consume the organic acids produced in Phase II and form acetate, an organic acid. This process causes the landfill to become a more neutral environment in which methane-producing bacteria are established by consuming the carbon dioxide and acetate.



Phase III takes 3 months to 3 years. After 3 to 5 years, a stable Phase 4 is reached with a relative constant LFG production that consist about 50-55% of methane (CH_4), 45-50% of carbon dioxide (CO_2), non-methane organic compounds and other gases (sulfides). The phase IV lasts 20 years or longer. Capturing and using LFG helps to reduce odors and other hazards associated with LFG emission. Methane's ability to trap heat in the atmosphere, which is called its "global warming Potential (GWP)," is at least 26 times larger than that of CO_2.



Instead of allowing LFG to escape into the air, landfill owners and operators, are increasingly capturing the gas to be flared or for other uses. With half of the LFG being methane, LFG has a heating value of approximately half that of natural gas and can often be used in place of conventional fossil fuels (coal, petroleum products and natural gas) in electricity generation or thermal applications. It can also be upgraded to pipeline-quality gas that can be used directly or processed into an alternative vehicle fuel. Methane offers a unique opportunity to mitigate climate change and simultaneously increase available energy supply. LFG production depends on the volume and type of waste (particularly its organic content) and landfill conditions (especially moisture). The gas is extracted from landfills using a series of wells and a blower (or vacuum) system. This system directs the collected gas to a central point where it can be flared, processed and treated, depending on the ultimate use for the gas.



The production of biogas under controlled conditions is often referred to as *biomethanation* and called *anaerobic digestion*. Biomethanation (BM) may have relevance in treating waste from several sectors, not only municipal solid waste (MSW) but also, sewage waste water treatment and livestock and agricultural residues (crop residues, animal manure, slaughterhouses, and waste from sugar, starch, and other agro industries).

In **wastewater treatment** is usually based on various systems, including aerobic (presence of oxygen) and/or anaerobic (absence of oxygen), in two main steps: (1) sedimentation and primary treatment in sedimentation ponds, septic tanks, simple biogas digesters or deep anaerobic ponds, followed by (2) secondary treatment (anaerobic in filters or septic tanks or aerobic/anaerobic treatment in constructed wetlands or ponds. Large-scale urban and industrial treatment methods include the activated sludge process, the fluidised bed reactor, aerated or chemical flocculation and all kinds of controlled re-circulation of wastewater. Large-scale urban and industrial treatment methods include the activated sludge process, the fluidised bed reactor, aerated or chemical flocculation and all kinds of controlled re-circulation of wastewater. In an anaerobic the sewage is brought in contact with a 'sludge blanket' where organic bacteria reduce the organic content by means of anaerobic fermentation. The reactor yields two final products in the form of sludge and treated wastewater. Given appropriate post-treatment steps, these can be re-used as fertiliser or soil conditioner.

2.2 Project description and strategy

2.2.1 Objective, outcomes, and indicators

To address the issue the Argentina biogas generation project "Sustainable Business Models for Biogas Production from Organic Municipal Solid Waste" was formulated, sometimes referred to as 'ProBiogas", but hereafter in this report referred to as the "MSW Biogas project" (as not to confuse with biogas activities in other sectors) or as the "Project". The Project Document was signed on 31 January 2017[21] and was to be implemented from 2017 to 2020 for four years but was extended until 30 June 2022.

The **objective** is to introduce biogas technologies for energy generation as part of the National Strategy for Integrated Municipal Solid Waste Management *(Estrategia Nacional para la Gestión Integral de Residuos Sólidos Urbanos, ENGIRSU).* The main source of financing is the Global Environmental Facility (GEF) with a USD 2,779,849 contribution, which is supplemented with co-financing by the United Nations Development Programme (UNDP) and government co-financing of USD 10,135,000. UNDP has been the GEF Implementing Agency and the Ministry of Environment and Sustainable Development has been the national GEF Executing Partner under UNDP's National Implementation Modality (NIM).

Box 4 Summary of the project objective, outcomes, and outputs

Project objective:	**Indicators (description with EoP target)**
To introduce biogas technologies for energy generation as part of the National Strategy for integrated municipal waste management	1. Achieved direct GHG emission reductions by pilot biogas energy plants and replication (13.4 ktCO_2/yr) 2. Framework of regulations and policies supported for energy generation from biogas of MSW (05) 3. Number of public-private partnerships established exploiting MSW-based biogas (03) 4. Number of people served by the electricity produced by pilot biogas energy plants and replication (21,000)

Outcome	**Indicators:**
1. MSW-based biogas energy technologies are incorporated in the national GIRSU program for deployment in municipal and regional waste plants	5. Number of municipalities with MSW-based biogas energy projects covered by the GIRSU program (04) 6. Number of programs and policies MSW-based biogas as a relevant option (04) 7. Number of policy and regulatory proposals developed and adopted (05)
2. Demonstration biogas energy technologies using MSW feedstock are procured and fully operational.	8. Installed electricity generating capacity of MSW-based biogas pilot projects (0.54 MW) 9. Annual volume of electric energy produced by biogas pilots 4010 (MWh/yr) 10. Financing mobilized for investment in MSW-based biogas energy systems (USD 10 million) 11. Number of people trained and employed for MSW-based biogas energy generation (40 m/40 f)
3. The Monitoring & Evaluation plan for the Project has been implemented	12. Mid-term review (01); and follow-up on recommendations to enhance project effectiveness and sustainability 13. Terminal Evaluation document (01)

The GEF budget and committed co-financing as approved by GEF is given below.

[21] The concept (PIF) was approved on 30 April 2014 and the project approved for implementation in July 2016

Box 5 Approved GEF budget and committed co-financing

Sources of Co-financing	GEF budget (USD)		Co-financing (USD)
	Approved 2016	Budget revision D 2020	
Component 1	975,000	779,463	1,850,000
Component 2	1,610,000	1,805,627	10,650,000
Comp. 3 (M&E)	100,000	99,909	40,000
Project management	94,849	94,849	250,000
Total	2,779,849	2,779,849	12,745,000

Note: co-financing: grant/cash MAyDS, USD 10,135,000, in-kind USD 2,460,000, cash UNDP USD 150,000

2.3 Project partners and stakeholders

2.3.1 Main project partners and project implementation arrangement

The Project has been implemented by the Ministry of Environment and Sustainable Development (MAyDS)[22]. A Directive Board (*Comité Directivo*) was set up in 2017, chaired by MAyDS, with a representative from the Ministry of Foreign Affairs (MRECIC)[23] and UNDP. The Directive Board is responsible for the approval of the pluriannual workplan, monitoring its development, approval of budgetary annual and substantive revisions, and approval of financial and technical reports. The role of project assurance has been exercised by the UNDP staff responsible for the project, based in the UNDP Country Office (CO)[24] and the Regional Technical Advisor (RTA) based in the UNDP Panama Regional Hub[25].

2.3.2 Stakeholders

Box 6 below gives a description of the main stakeholders involved and the nature of their involvement in the MSW Biogas project.

Box 6 List of project stakeholders

Stakeholder	Description
Ministry of the Environment and Sustainable Development (*Ministerio de Ambiente y Desarrollo Sostenible*; MAyDS)	MAyDS oversees the government's policy on environmental issues and promotes sustainable development. In 2015, the then Secretariat (since 1991 under various ministries was elevated by president Macri elevated to the ministerial level in his first cabinet, but the decision was reversed in 2018 and placed under the General Secretariat of the Presidency. In 2019. MAyDS regained its status in the cabinet of president Alberto Fernández. • The MSW project, as well as the GIRSU program, fall under the responsibility of MAyDS's Secretariat of Environmental Control and Surveillance (*Secretaría de Control y Monitoreo Ambiental*) - National Waste Direction (*Dirección Nacional de Residuos*) • Climate change mitigation is the responsibility of Secretariat of Climate Change, Sustainable Development and Innovation (*Secretaría de Cambio Climático, Desarrollo Sostenible e Innovación*) - National Climate Change Directorate (*Dirección Nacional de Cambio Climático*)

[22] Ministerio de Ambiente y Desarrollo Sostenible

[23] Ministerio de Relaciones Exterirores, Comercio Exterior y Culto (MRECIC). Its *Secretaría de Coordinación y Planificación Exterior* is responsible for the coordination of coordination of the implementation of programs and projects of the United Nations Development Programme (UNDP) and the United Nations Office for Project Services (UNOPS).

[24] Ms. Carolina Robles (project responsible), guided by Ms. Maria Di Paola (Environment and Sustainable Development)

[25] Ms. Ludmila Diniz

Ministry of Foreign Affairs, International Trade and Worship (*Ministerio de Relaciones Exteriores, Comercio Internacional y Culto*; MRECIC	MRECIC deals with the foreign relations of Argentina, foreign policy, international development, international trade, diaspora, and matters dealing with Mercosur. • UNDP projects in Argentina fall under the responsibility of the *Secretaría de Coordinación y Planificación Exterior - Dirección de Proyectos de Implementación Nacional*
Ministry of Economy (*Ministerio de Economía*)	The Ministry is the country's state treasury and manages economic policy • In 2015, the then Secretariat of Energy (under the Planning ministry) was elevated to the rank of Ministry of Energy, but was downgraded again to Secretariat in 2018 and is now under the Ministry of Economy. The Secretariat covers electricity and hydrocarbon fuels, while a Sub-Secretariat deals with renewable energy technologies, including the use of landfill gas and biogas for energy.
Ministry of Agriculture, Livestock and Fisheries (*Ministerio de Agricultura, Ganadería y Pesca*; MAGyP	MAGyP oversees production, commerce and health regulations in the agricultural, livestock and fishing industries. In 2010, it launched the "Project for the Promotion of Energy from Biomass (ProBiomasa), with FAO support, on biomass resources from forestry and agriculture, covering relevant bioenergy technologies, including biogas production.
Municipalities and waste companies	The municipalities are in charge of the management of Municipal Solid Waste (MSW) in their jurisdiction. This means they are responsible for collecting and disposing of the waste, for setting the rules and levying the waste fees. They also take care of the operation and maintenance of the waste management infrastructure (waste is collected by the municipalities or by subcontracted waste management companies). They can stimulate methane recovery and utilization in their jurisdiction
Provincial authorities	Their potential role is promoting projects, enacting positive provincial regulations, providing clear rules, incentives, and simplifying bureaucracy, as well as in securing project guarantees.
Institutes and universities	A number of institutes have been involved in research and consultancy services on biomethanation, landfills and waste management: • INTI - National Institute for Industrial Technology (*Instituto Nacional de Tecnología Industrial)* • INTA - National Institute for Agriculture and Livestock Technology *(Instituto Nacional de Tecnología Agropecuaria)* Some universities are involved in waste or energy, such as UNSAM (Universidad de San Martín), UTN (Universidad Tecnológica Nacional) and University iSalud.
Consejo Federal de Medio Ambiente (COFEMA)	COFEMA has a Commission that works on solid waste management. Its potential role is in prioritizing the development of biogas technologies in the framework of sustainable MSW treatment, encouraging a cross-sectoral approach, and in promoting regionalization based on the participation of various provinces.
Educational, social, political, religious institutions, service co-operatives, communities	These can become active figures in the development and promotion of projects as well as benefitting from the waste-to-energy projects
National and international financial institutions	The entities can provide funding for projects or inputs and favorable interest rates and repayment terms

3. FINDINGS: PROJECT DESIGN AND STRATEGY

Next in this report follows an overview of the evaluation findings. Due to the size of the main text on findings, it has been divided into three chapters that cover a) project design and relevance, b) project results, impacts and sustainability, and c) project implementation. The findings are based on several evaluative criteria and questions (originally formulated in the Inception report and slightly re-formulated). Here, the reader can make a link between what was asked and the findings. The questions in the orange-coloured boxes in this and subsequent Sections are taken from the Evaluative matrix (*Annex D*).

Section 3 looks first at the project relevance and country drivenness (at project design), and its links with national goals and development. Second, it looks at the design logic (in the framework of outcomes and objectives to reach the objective) and how the design framework was formulated, including the definition of indicators and target values for outcomes and outputs.

3.1 Relevance and design

- Have project outcomes been contributing to national development priorities and plans and taking into account national realities?
- Consistency with the GEF focal areas in Climate Change/operational program strategies of the GEF CC and with the UN and UNDP country programming in Argentina
- Relevance of the project's objectives, outcomes and outputs to the different target groups of the interventions.

Country priorities and relevance

Bioenergy development is firmly embedded in national legislation and sector legislation and plans:

- National Law 26.093 (2006) - *Regime for the Regulation and Promotion of Biofuel Production and its Sustainable Use*) - was put into effect for a term of 15 years. Biogas was included as part of the biofuels that are to be promoted.
- National Law 26.190 (2006) - *Regime for National Stimulation for the Use of Renewable Energy Sources directed to Electric Energy Generation*. This Law establishes that in ten years 8% of the energy would be provided for consumption to originate from renewable sources. In fact, it is a norm that laid a basis for creating incentive programs for the generation of electric energy from renewable energy sources, such as GENREN and RenovAr.
- National Law 27.191 (2016) - *New Law on Renewable Energy Sources for Electric Energy Generation* and Regulation Decree 531 (2016). The law provides instruments directed to the diversification of the national energy matrix, the expansion of the installed power in short periods, the reduction of energy generation costs, the predictability of costs in the mid and long runs, and to contribute to mitigating climate change. This new Law determined that in 2017 the country was to be provided with 8% of its electricity generation originating from renewable energy and the Regulation aims at elevating this percentage to 20% by 2025
- National Law 27.424 - *Regime for the Promotion of the Distributed Generation of Renewable Energy* - and its regulatory Decree is aimed at decentralizing electric power generation (from a large group of small sources) thus allowing for self-consumption and injection of the surplus into the network.

The municipalities oversee the management of municipal solid waste (MSW) in their jurisdiction. This means they are responsible for collecting and disposing of the waste, setting the rules and levying the waste fees. They also take care of the operation and maintenance of the waste management infrastructure. Investments in integrated urban solid waste management in the main urban centers (Buenos Aires, Córdoba, Rosario, Salta, etc.) are financed mainly with municipal funds; in the other urban centers, with federal resources (MAyDS, MINTUR, other). The City of Buenos Aires (CABA) has issued the so-called Zero Waste Law. The principal aim is to reduce the amount of waste ending up in landfills by 80%

reduction in 203. In and around Buenos Aires metropolitan area, landfill gas capture is used to produce electricity in several landfill sites[26], generating 25 MW de electricity.

The FAO-supported Project for the Promotion of Biomass-derived Energy (ProBiomasa) aims at enhancing the production of biomass-derived energy at the local, provincial, and national levels in order to ensure that society is provided with a steadily growing supply of renewable, clean, reliable, and competitive energy while opening new opportunities for the development of the agriculture, livestock, forestry and agroindustry sectors in the country. The program aims at lifting a total of 1,889 kilotons of waste per year into useful by-products for energy generation, (estimated for the year 2016) to a total of 12,515,637 tons of waste (in 2030) for conversion into dry or wet biomass residues by thermochemical (combustion, gasification, other) or chemical processes (such as anaerobic digestion). Regarding the latter, ProBiomasa focuses on the livestock and agricultural sector and does not cover municipal solid waste[27].

In 2004, the Argentinean government developed a National Strategy for Integrated MSW Management, ENGIRSU, for the period 2005 to 2025[28]. Integrated waste management refers to the comprehensive approach followed by the program to the reduction and recycling of MSW, composting, efficient collection, and the construction of adequate sanitary landfill sites as centers for final disposal, thereby offering complete solutions. The operation of the landfill sites and the waste collection and recycling service is assumed either by the local municipality itself or by a concessionary (a private company).

Implementation of GIRSU has been supported by IADB loans of USD 150 million (AR-L1151) and AR-L1868 (focusing on smaller municipalities with tourism potential) to help improve the operational capacity and management of operators, to facilitate an increase in recovery and recycling rates and improvement in the quality of collection and final disposal services and for the formalization and inclusion waste collectors. The GIRSU Program has been operational in Argentina since 2007 and will continue with a new loan recently approved by IADB (AR-O0018) of USD 300 million. Although, MAyDS acknowledges the relevance of biogas technology for the treatment of the organic fraction of municipal solid waste, the technology was not included as such in the GIRSU concept. The value-added of the UNDP/GEF MSW Biogas project has been the integration of MSW-based biogas energy systems into the concept of the GIRSU Program, while at the same time, taking advantage of the institutional capacity of the latter, including its capacity to organize stakeholders, concentrate available know-how, and attract investment capital.

The technical capacity in the field of anaerobic digestors for biogas production is fairly well developed in Argentina. The National Institute for Industrial Technology (INTI) and the National Institute for Agricultural and Livestock Technology (INTA) have research groups and programs targeting the development and implementation of biomethanation. According to a study undertaken by INTI/FAO in 2016, there were about approximately 105 biodigester plants of various sizes, technology levels, utilization and application purposes, of which 38% were in agroindustry, 33% in livestock and farming residues, and 28% urban residues (solid waste and sewage).

Systems for landfill gas capture and flaring were installed at larger landfill sites by project developers to produce and commercialize certified carbon credits under the CDM mechanism[29]. After this market collapsed, many of these installations fell into decay with some notable exceptions. For example, the huge landfill site of the public waste company CEAMSE[30] at the Complejo Industrial Norte III near Buenos Aires absorbs a daily stream of 17,000 tons of MSW generated by the capital and surrounding urbanizations (Buenos Aires City and Province). This landfill was sanitized under the CDM mechanism to stop the leakage of the stored methane into the atmosphere. Thereafter, with financial support from Genren and other national programs, waste-to-energy biogas plants were put into operation, Central San

[26] Metropolitan Buenos Aires covers the city and adjacent urban areas in the Province of Buenos Aires. It should be noted that the City of Buenos Aires (*Ciudad Autónoma de Buenos Aires,* CABA*)* is not part of the Province of Buenos Aires

[27] See the website of UTF/ARG/020/ARG - *Proyecto para la promoción de la energía derivada de biomasa*, /www.probiomasa.gob.ar

[28] ENGIRSU was supported by the World Bank Project "National Urban Solid Waste Management" P089926 loan with USD 40 million loan (BIRF 7362-AR). The loan financed the construction of appropriate infrastructure for MSW management in 31 municipalities by closing of existing open dumps and building sanitized landfills and strengthening of institutional and management capacity. Social components targeted the inclusion of traditional, informal waste pickers and their families

[29] Biogas from landfill sites was exploited by private project developers under the Clean Development Mechanism (CDM) by flaring the captured biogas and producing certified carbon credits for CH_4 emission reductions.

[30] *Coordinación Ecológica Área Metropolitana Sociedad del Estado*

Miguel (10 MW) and San Martín (5 MW). With the plants in the Complejo Ambiental Ensenada and Complejo González Catán, CEAMSE operates a total of 25 MW, avoiding the emission of 1.5 million tons of $CO_{2\text{-eq.}}$ annually[31], which is planned to be expanded to 35 MW in the near future[32].

Although successful, the CEAMSE paradigm cannot be considered a replicable business model for biogas exploitation from MSW in the rest of Argentina. The scale of the waste streams to landfills in the Buenos Aires metropolitan area is much larger than in the small to medium towns elsewhere (allowing generating capacity in the order of 0.2-1 MW maximum) and do not have access to the type of the institutional support and infrastructure a large company can offer. Because the majority of cities and municipalities in Argentina lack such institutional capacity and financial resources to sustainably organize their urban waste management was one reason for the creation of the GIRSU program.

Several barriers to waste-for-biogas are identified in the Project Document and the Mid-Term Review report:

- *Policy, institutional and regulation*

The policy framework focuses on power generation for the wholesale market in large-scale renewable energy projects with inadequate secondary regulations for small-scale projects regarding grid access, net power measurement, security, transportation and end-use of digested biomass, as well as inadequate coordination between authorities and stakeholders.

- *Information and technology demonstration in smaller-scale application*

While landfill gas technology is being applied in large-scale projects and can draw upon extensive expertise with anaerobic biodigesters used in agro-industries, experience with using MSW in small and medium-sized settings has been rather limited. The majority of municipalities and waste operators lack information about technical, legal, economic and financial aspects of biogas energy projects. There is a lack of reliable commercial providers of technology for small-scale anaerobic digestion.

- *Lack of viable business models and lack of funding for energy generation from MSW-based biogas*

Local governments, including municipalities, face severe budget restrictions and have very limited resources to invest in infrastructure. In fact, GIRSU program was born to circumvent this limitation and promote investment from the national level. MSW-based biogas systems represent a niche market that can be targeted directly by the GIRSU program, but their financing has not been integrated with GIRSU and needs to be negotiated with the multilateral banks that back the program. There is a need to find a viable business model for (small-scale) municipalities and waste operators, focusing on maximization of potential benefits and revenues, and rationalization of operation to minimize operational costs.

To address such barriers and challenges, the MSW Biogas project was designed to (a) address policy and regulatory issues at the federal and provincial levels, (b) strengthen institutional capacities by mobilizing specific biogas and energy sector expertise available towards the MSW sector, in particular, the GIRSU project team; (b) develop business models enabling the sustainable operation of MSW-based energy plants by small and medium-size towns; and (c) demonstrate MSW-based biogas energy technologies for a range of technologies, conditions and sizes.

<u>GEF and UNDP programming</u>

The project results framework in the ProDoc refers to the following results as defined in the Country Program 2014-2017 and UNDAF framework: “Output 1.4: Scaled up action on climate change adaptation and mitigation across sectors which is funded and implemented” under “Outcome 4: By 2020, the country will have reinforced the sustainable management of natural resources and implemented adaptation and mitigation policies with respect to climate change and man-made damage, using a gender and intercultural approach”.

The project falls within the GEF-5 program area “GEF Climate Change Mitigation; Strategic Program SP-1 “Promote the demonstration, deployment, and transfer of innovative low-carbon technologies” with Outcome 1.1, “Technologies successfully demonstrated, deployed, and transferred”, and Outcome 1.2 “Enabling policy environment and mechanisms created for technology transfer”, as well as “tons of $CO_{2\text{-eq}}$ avoided”.

[31] https://www.buenosaires.gob.ar/educacion/escuelas-verdes/recorre-el-complejo-ambiental-norte-iii/disposicion-final-de-los-residuos-solidos-urbanos/generacion-de-energia-electrica-partir-de-los-residuos

[32] https://www.carbono.news/energia/el-ceamse-pronto-podria-abastecer-de-electricidad-producida-por-biogas-a-500-000-personas/

Gender

Gender as such is not reflected in the results framework, because at the time of project conceptualization (2014), there were no clear guidelines on including gender-relevant indicators in the results framework[33]. The project design is not explicitly gender-sensitive. This does not mean that the Project has ignored gender issues during implementation, as will discussed in Section 5.

3.2 Conceptualization and results framework

- Were lessons from other relevant (UNDP and non-UNDP) properly incorporated in the project design? Were the partnership arrangements properly identified and the roles and responsibilities negotiated prior to project approval?
- Has the project's design (logframe) been adequate to address the problems at hand? Was the project internally coherent in its design (logical linkages between expected results and design (components, choice of partners; scope, use of resources)? Were any (major) amendments to the assumptions or targets been made or planned during the Project's implementation?

Originally, four projects were foreseen to be presented to the government's RenovAr programme (Mar del Plata[34], Olavarría, Las Heras and Tapalqué) with a combined power capacity of 540 kW and annual electricity production of 4,010 MWh per year. This translates into an emission reduction of 3,208 tCO_2-eq per year due to avoided fossil fuel power generation and 3,548 tCO_2-eq due to avoided methane leakage[35], or 6,756 tCO_2-eq annually (according to the Project Document, Annex D) or about 67 $ktCO_2$ over an assumed 10-year lifetime.

The project's first concept (the PIF) assumed that private biogas project developers would enter the biogas market under the Genren program, and the Project Document assumes the same under the RenovAr program. RenovAr had established a maximum price for solid waste biogas projects, even higher than for other renewable energy, like solar and wind, around USD 0.13-0.16/kWh[36] (RenovAr, rounds 1 to 3, see Section 3.1). But to be part of RenovAR, projects had to guarantee a potential of at least 0.5 MW, during 20 years, which is above the size of a MSW biogas plant in an average Argentinian town. The project proposed some regulatory recommendations to RenovAr in order to permit smaller generation projects from biogas (less than 0.5MW) could participate in the bids.

The project design has suffered from too high expectations with respect to achieving such a special agreement or a waiver to the RenovAr rules and concerning the viability of small-scale biogas-for-power systems that sell to electricity market operator CAMMESA. Even with feed-in tariffs as high as USD.0.16/kWh, it was still very questionable whether MSW biogas in small-medium towns would be viable, i.e., being able to cover both operational and capital expenditure, unless given additional investment subsidy (in addition to favorable feed-in tariffs). Studies carried out by INTI in 2019 indicate that only projects with a capacity above 0.5 MW, sustained for 15 years, could be profitable by selling electricity at USD 0.129/kW (see Box 7). Under such circumstances of expected negative cash flows, it was doubtful that operators (private or municipal) would build small landfill gas power generation systems.

Three years after the MSW Project's initiation, it became clear that pursuing the option of small landfill gas systems (below 0.5 kW) for the sale of electricity to the grid was a fruitless one. A new project team (established in 2020/19, see Section 5) chose to change course and focus on the benefits of on-site use of the electricity generation, especially in areas where grid electricity is not sufficiently or irregularly available. Thus, requests for proposals were issued in 2020-2021 for the pilots in 8 sites that were constructed during 2021-2022, as will be discussed in the next Section 4.

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33 The recent UNDP/GEF ProDoc template now includes a separate section dedicated to gender issues, while a detailed gender action plan needs to be annexed.

34 Later replaced in the quadruplet of pilots by Rafaela (Santa Fe)

35 It is assumed that 30% of the methane used for power generation would otherwise have leaked into the atmosphere. The ProDoc calculates that the annual generation of 4,010 MWh/yr avoids emissions in the national grid of 3,208 tCO_2/yr. To generate the 4,010 MWh a quantity of 1,123 tCH_4 needs to be burnt annually, of which is assumed that 30% would otherwise have ended up in the atmosphere (giving an avoided GHG leakage iof 3,548 tCO_2_eq per year. This is a very conservative estimate. With no incentive to capture gas, there will be no recovery at all and will neither be flared or used for energy in the baseline.

36 RenovAr has supported a few MSW biogas project: Ricardone (Sante Fe, 3.1 MW; Gonzalez Catan (Buenos Aires, 5 MW), Ensenada (Buenos Aires), 5 MW

Box 7 Data from INTI and other studies on electricity generation from landfill gas

		Cumulative over 20 years							
	Tons of waste generated	CH4 captured (in $ktCO_{2-eq}$)	Avoided emissions power generation (in $ktCO_{2-eq}$)	Total reduction ($ktCO_2$)	Energy generated (MWh)	kW max	kW min	Investment (USD)	Feasibility
Gualeguaychú (2023-2042)	2014-2022: 274,374	40.82	3.36	44.18	6,288	119	11	455,486	Under 230 USD/MWh NPV < 0
Mar del Plata (2022-2041)	2012-2030: (2 phases) 7,427,000	2,263.02	172.76	2,435.78	322,150	2000	1300	8,688,399	At USD 60-129/MWh, NPV = USD 0.62-14.32 million and IRR=6-21%
Bahía Blanca (2022-2041)	2005-2026: (3 phases) 3,073,127	933.20	80.76	1,013.96	150,964	1000	605	3,589,903	At USD 60-129/MWh, NPV = USD 0.92-- 7.45 million and IRR=8-26%
Rivadavia (2021-2040)	2011-2022 (2 phases) 2,277,540	774.85	70.11	844.96	130,747	1,100	500	3,405,423	At USD 60-129/MWh, NPV = USD 0.45-6.24 million and IRR=7-25%
Fachinal (2001-2026)	2001-2026 (3 phases) 2,717023	839.27	65.04	904.31	119,510	1000	270	3.155,181	At USD 60-129/MWh, NPV = USD 0.523-5.38 million and IRR=7-29%
Catamarca (2020-2041)	2013-2023 (2 phases) 689,941	149.96	13.51	163.48	23,604	234	77	689,941	At USD 105/MWh, NPV = USD 57,000 million and IRR=6%
Piedras Bl. Córdoba (2022-2041)	2011-2021 7,101,991	2,174.15	145.52	2,319.67	510,000	2000	1000	6,342,570	At USD 60-129/MWh, NPV = USD 1.36-12.66 million and IRR=9-30%
Trelew, Chubut (2021-2041)	2013-2027 (2 phases) 839,256	109.57	11,29	120.86	44,455	390	190	1,287,918	At USD 87/MWh, NPV = 0.37 million and IRR = 8%
Mendoza (small)		117.33	51.90	169.23	97,007	4381	1260	3,773,520	At USD 84-129/kWh, NPV = USD 0.36-3.34 million and IRR=8-22%
Mendoza (larger) (2020-2040)	2001-2009	194,89	86.21	281.10	161,135	4381	2810	7,676,500	At USD 84-129/kWh, NPV=USD 5.83-14.78 million; IRR=20-38%

Source: Data compiled from various INTI pre-feasibility reports of the above-mentioned sites, elaborated during 2019-2020. Only larger sites have a positive business case (with IRR > 20%) assuming that energy can be sold at USD 129/MWh as under the RenovAr program, but at prices USD 60-87/MWh IRR values are below 9%. Even at prices higher than USD 129 USD/MWh, the smallest sites had a negative IRR.

Methane gas production is calculated following a first order decay mode. In this model, the amount of decomposable DOC (degradable organic material) in the disposal site is calculated, taking account of the amount deposited each year and the amount remaining from previous years. This is used to calculate the amount of DOC decomposing to CH_4 and CO_2 each year. The amount of CH_4 generated from the decomposed DOCm and subtracts the CH_4 oxidised in the cover material to give the amount of CH4 emitted. The calculations assume that half of the CH_4 emitted is recovered.

Another study, *Barreras, Problemáticas y Controversias para la Implementación de la Tecnología de Biodigestión Aplicada a RSU* (by HYTSA SA) that can be divided in three groups according to waste disposal, biogas generation and energy use

	Waste (tons/day)	Biogas capture (thousands/m^3	Potential power (kWh/day; [incl. 97-194 own use)	Households potentially served
Low (4): S.Fernando, Ríio Cuarto, Villa Carlos Paz, Reconquista	110-270	36-59	74-118	-
Small (3): Bahía Blanca, Villa Dolores, Casilda	58-290	46-168	114-228	0 - 176
Medium (9): Ezeiza, Resistencia, Corrientes, Formosa, Palpalá, Caraguaytay, Confluencia, Santa Fe, Galvéz	300-500	230-379	382-929	252-992
High (10): Ensenada, Pureyddon, Catán, Córdoba,. Fachinal, Salta, Rafaela, Ricadone, Overo Pozo, Pacará	280-1100	373-976	1039-4240	1140-5462

Not including Norte III with 16,100 tons.day, 6182 thousand m^3 gas and can generate 10 MWh/day, after self-use sufficient to 13,500 households

3.3 Ratings for project design and relevance

Although the Terminal Evaluation must rate 'project design' (as evidenced by this Chapter 3), the UNDP/GEF rating scheme only provides the item "M&E at design" in the official rating table (see Box 1). 'Design' is one of the main factors, alongside 'implementation' and 'external factors' that determine the achievement of 'results'. Therefore, the Evaluator has the opinion that should have a separate place in the ratings table and has added the item "5. Design logic" to the categories of Box 1, as indicated in Box 8)

The Evaluator's rating is 'MU' which is based on the lack of results of the MSW Project in the period 2017-2019 (as described in Section 5) is partly based on faulty assumptions in the project design. The Project Document (on page 14) mentions that it is "highly questionable whether the current incentives will be sufficient for financial closure of small-scale renewable energy projects, including MSW-based biogas". While acknowledging the barrier, there is an implicit assumption that programs, such as RenovAr can be expanded (financed by the federal budget) to overcome this barrier by extending to small renewable energy projects at even higher feed-in tariffs than those offered to large MSW projects (which are already at the top range of the tariffs offered). In its design, the project has suffered from ambiguously situating the market development stage of small and medium-sized MSW gas projects as approaching the 'deployment' stages (see Box 19) as the large grid-connected landfill gas projects, while these were in the demonstration stage only.

Fortunately, the Project Team chose in 2020 to focus on demonstration first (by using the GEF budget for INV) by supporting several pilots; before the tackling the issue of trying to raise co-financing for a larger-scale deployment (which remained difficult with no clear viable business model).

Box 8 Evaluation ratings of project design and relevance

Evaluation item	Corresponding section	Rating
Design logic		
- Design logic and approach; assumptions and risks	Section 3.2	MU
- Formulation of the log-frame (outcomes/outputs; choice and values of indicators)	Section 3.2	S
Relevance	Section 3.1	R
M&E at design and entry	Section 4.1	MS

In the rating for 'design' of the MSW Biogas project, a six-point rating scheme is followed:

- Highly satisfactory (HS), no shortcomings
- Satisfactory (S), minor shortcomings
- Moderately satisfactory (MS), moderate shortcomings
- Moderately unsatisfactory (MU), significant shortcomings
- Unsatisfactory (U), major shortcomings
- Highly unsatisfactory (HU), severe shortcomings
- U/A = unable to assess.

Regarding '**relevance', the** rating is on a two-point scale with "R" meaning 'Relevant' and "NR" meaning 'not relevant'.

4. FINDINGS: RESULTS AND SUSTAINABILITY

4.1 Introduction

- To what extent have the expected outcomes and objectives of the project been achieved?
- What outputs and outcomes has the project achieved (both qualitative and quantitative results, comparing the expected and realized end-project value of progress indicators of each outcome/output with the baseline value)?
- Were objectives, outcomes and outputs achieved on time? How did the project contribute to GHG emissions reduction within the project implementation cycle and beyond?

Section 4.5 presents progress towards results. For each of the five project components, as mentioned in paragraph 1.2, this section assesses the progress in the implementation of the project's outcomes and outputs, following the 'project results framework' format and as reported by the Project Team in the annual UNDP/GEF Project Implementation Reports (PIRs) as well as information and documents by the Project Team to the Evaluators and interviews with stakeholders. Section 4.2 describes the progress achieved in outputs and activities for each Component/Outcome, following the outline of outcomes and outputs of Box 4. Section 4.2 tries to provide a quantitative and descriptive overview of the achievements of outputs and outcomes. Section 4.3 provides an assessment of results in terms of attainment of the outcomes and outcome indicators. The baseline and target values of the indicators are taken from the project's logical framework (as reported in the Inception Report and PIRs), while the achievements (i.e., indicator value at the Project's end, is compiled from the draft Final Report and other data provided made by the Project Team). This includes a review of the greenhouse gas emissions reduction. Section 4.4 discusses sustainability and replicability. Section 5.3 ends with a summary of the Evaluator's ratings towards results.

4.2 Progress in achieving outputs and outcomes

4.2.1 Outcome 1 MSW-based biogas energy technologies are incorporated in the national GIRSU programme for deployment in municipal and regional waste plants

Indicator with end-of-project (EoP) target	Actual value or status of the indicator
Number of municipalities with MSW-based biogas energy projects covered by the GIRSU program *Target:* 04.	In close cooperation with GIRSU, the project has supported biogas on MSW landfills in six municipalities. Furthermore, a pipeline has been prepared for landfills to include biogas recovery and utilisation
Number of programs and policies MSW-based biogas as a relevant option *Target:* 04	There has been close cooperation between the MSW Biogas and GIRSU programme, which now has incorporated gas recovery infrastructure as part of the technical specifications for new landfill projects. A new lot of 12 landfill projects will be prepared to include biogas utilisation.
Number of policy and regulatory proposals developed and adopted *Target* 6	• Resolution 19 - "Technical standard for agricultural application of digestate from anaerobic digestion plants" was adopted in 2018 • The project has supported several consultancies: • The project has promoted the formulation of a "Law of minimum budget for biogas utilisation"

Achievements

Output 1.1. Optimization of business and management models for MSW biogas energy generation systems operated by municipalities or private concessionaires in the framework of the national GIRSU program.

In close cooperation with GIRSU, the project has supported biogas on MSW landfills in a number of municipalities (Gualeguaychú, Tucumán, Escobar, Rafaela, Tapalqué, Fachinal) as part of the landfills under the GIRSU programme. The works have been awarded for design or are under construction (see Box 10). The new landfills will include biogas capture

systems, which will generate electricity once the landfill is sufficiently mature. The new projects not only consist of the construction of the landfill but include a "decreasing operation time" where the construction company operates the landfill for 1 or 2 years with a "soft landing" transition to the municipality. If the operation is successful, the tenure can be extended, if not, it can be reassigned to a new operator, removing the burden of operation from municipalities, usually not very well trained in this type of management.

Output 1.2. Enhancement of technical, management and coordination capacities of the GIRSU program to support the effective deployment of MSW-based biogas energy technologies

There has been close cooperation between the MSW Biogas and GIRSU programme, which now has incorporated gas infrastructure as part of the technical specifications for new landfill projects.

Output 1.3 Short-term studies supportive of MSW-biogas project and policy development addressing identified legal, technical, social, environmental, and operational issues

Output 1.4 Design and presentation of proposals to enhance the regulatory framework for MSW biogas in coordination with the relevant authorities and ministries.

Box 9 Summary of recent MSW Biogas project-commissioned consultancies

Barriers, issues and controversies for the implementation of biodigestion technology applied to MSW
(by HYTSA, Oct 2020)
The study gives an overview of the situation regarding sanitary landfills in the different provinces of Argentina, including number and status (construction, operational, closed), size, type of LFG management (none, capture, flaring, use of biogas). Another chapter reviews the legal-regulatory framework at federal and provincial level. The report assesses the potential biogas production in a number of sanitary landfills. The study ends with a review of existing barriers and challenges (technical, legal-policy, economic-financial) and possible mitigation measures. *Interesting is the overview of 90 landfills investigated all over Argentina indicating that in 61 gases are ventilated or otherwise escaping into the atmosphere; only in 6 cases the gas was captured and flared, in 9 cases de gas was captured and used for energy (with 14 unknown data).*

Social and environmental evaluation of biodigestion technology in its different phases of generation, operation, dissemination and training
(by Desarrollos y Gestión Sustentable SRL; Oct 2020)
An overview is given of institutional setup and legal-regulatory framework regarding environmental issues at federal and provincial level. The report gives an overview of elements of an environmental and social impact assessment (ESIA), of environmental and social management plans, community participation plans, and of capacity building plans.

Design and presentation of proposals to promote the regulatory framework for biogas in Argentina
The report starts with an overview the (larger) about 10 landfill gas projects (CEAMSE, others) that are currently active as well as relevant stakeholders. An overview is given on relevant regulations (MSW, renewable energy, biofuels, natural gas, distributed generation) and policy-regulatory requirements needed in these areas and for biogas in particular. The report ends with legal-regulatory guidelines for national and provincial, and municipal level and technical regulations for the design, operation, maintenance and monitoring of MSW biogas, as well as linking MSW biogas facilities to electric power or natural gas grids.

Technical, operational and economic evaluation of biodigestion technology applied to MSW
(by Cleanergy Renovables SA; Oct 2020)
The report presents scenarios of MSW production and potential energy generation (that can range from 512 to 3,475 kW).

Incorporation of biodigestion technology in national programmes
(by HYTSA, Dec 2020)
The report provides an overview of the national programs (such as RenovAr) and projects (such as ProBiomasa) in the area of renewable energy and of climate change mitigation as well as various sustainable energy program and in initiatives at the provincial level. The study describes the various biodigester technologies for use at domestic level and

Output 1.5 Integration of biogas produced from MSW in national policies, programs and financing instruments for renewable energy development, environmental protection, and climate change mitigation

The "Technical standard for agricultural application of digestate from anaerobic digestion plants" was adopted in 2018. A model for municipal regulations was developed. The project is currently working with other areas of government on the development of a national "Minimum Standards Act" for the use of biogas generated from MSW. The following consultancies have been supported by the Project (see Box 9)

- Guidelines for a "National Programme for Promotion and Development of MSW Biogas"
- Technical standard for domestic biodigesters
- Basis for standard municipal regulations for biodigesters (to help small communities more easily adopt the technology)
- Guidelines for biogas project baseline formulation and social-environmental evaluation.

Output 1.6 Promotion and exchange of experiences on MSW biogas technology in Argentina with other countries in the region through seminars, workshops, field visits and publications

The PIR (2018) mentions that the project participated in several coordination spaces related to biogas, including a meeting on climate change. It has participated in inter-institutional meetings to develop a regulation on digestate with numerous stakeholders (INTA, INTI, private companies). The final report (*Informe Annual de Proyecto;* draft, May 2022) mentions that the project team presented at the International Congress on Environmental, Cultural, Economic and Social Sustainability in Spain.

4.2.2 Outcome 2 *Demonstration biogas energy technologies using MSW feedstock are procured and fully operational.*

Indicator with end-of-project target	**Actual value or status of the indicator**
Installed electricity generating capacity of MSW-based biogas pilot projects *Target:* 540 kW	The combined capacity of the Project-supported pilots is 230 kW (see Box 12)
Annual volume of electric energy produced by biogas pilots *Target:* 4,010 MWh per year	If all are completed, the expected power generation is 1,770 MWh per year. The actual power generation is minimal given the fact that most biogas (recovery and) utilisation at landfills has only recently been installed. It should be noted that the installed generation capacity is often less than what is maximum possible, reflecting investment budget limitations (smaller generator) and limited on-site energy needs. On the other hand, the biogas can also be used for thermal application (which was not chosen as a target)
Financing mobilized for investment in MSW-based biogas energy systems *Target:* USD 10 million	The grant co-financing realised corresponds with the landfill activities of GIRSU (supported with IADB grant) with an investment of USD 12.44 million. It should be noted that MAyDS had prepared a proposal for biodigesters in 5 fruit and vegetable markets and is preparing a pipeline of several landfills that will be equipped with gas recovery (with existing and new IADB funding for GIRSU; see *Section 4.4*).
Number of people trained and employed for MSW-based biogas energy generation *Target:* 40 m and 40 f	Realised: According to the project team, 56 men and 57 women from the various pilots were trained (by July 2022), with training of the people from the Overa Pozo pilot still pending. One of the major training activities will be the installation of biodigesters in technical colleges and community colleges (SDP 02/2020). Here, the Project has not limited to "install and leave the digesters there", but has supported whole process of installation, assembly and operation is done in direct collaboration with the students. This will allow for real hands-on experience, and lead to a real understanding of the technology to be implemented.

Box 10 Support by the MSW Project provided to landfill gas pilots

		Characteristics
SDP 02/2020 Biodigesters at technical and agricultural schools	Provision, installation and commissioning of prefabricated biodigesters to five technical and agricultural schools in Prov. Buenos Aires to treat the waste produced by the schools and to generate electricity by means of a generator adapted for biogas: • Secondary agric. school, Mun. Amirante Brown • Educational centre, Mun. Luján • Agricultural school, Mercedes, B.Aires • Agric. School, Quilmes • Technical school, San Fernando	2 ton of MSW per day 20 kW generator (4 kW each) Investment: USD 129,250 Beneficiaries: 1,650 (300 students and 150 teachers) Energy used on-site (e.g. greenhouse lighting, school) and use of biogas. Educational purposes. The company DEISA SA provided on-site training to teachers and students who will be in charge of the operation and monitoring of the biodigestion plant. Eight people were trained per school (18 males and 22 females in total)
SDP 03/2020 Biodigester in the *Mercado Concentrador de frutas y verduras*: Comunidad Boliviana	Location: Escobar (Prov. Buenos Aires). Provision, installation and commissioning of biodigester. Market waste before was delivered to CEAMSE but is now collected generating the triple benefit of sound waste management, biofertilizer and energy generation. Waste is gathered in containers that are emptied in the digestor (usable volume of 120 m^{3j}	4 tons of market a day" 10 kW generator (adapted for biogas), functioning 8 hours a day Investment: USD 226,200. Beneficiaries: 1500 members + 15000 clients Electricity is used to power about 32 lighting points of 50 W. The company that was awarded the project carried out all the training through two modalities, theoretical and practical, both presential and virtual. 12 people (8 male, 4 female) were trained
SDP 01/21 Biogas collection and use plant at the landfill *Predio Ecoparque* Gualeguaychú	Location: Gualeguaychú, Prov. Entre Ríos Provision, installation and commissioning of the biogas facility at the landfill. Established in 2014, it will reach an optimum generation level of biogas by 2021. Under construction.	115 tons of MSW per day. 60 kW generator (continuous operation) Investment: USD 409,861 Beneficiaries: 50
SDP 02/2021 Biogas capture and utilization in Fachinal landfill	Location: Fachinal, Prov. Misiones Provision, installation and commissioning of a system to capture and use the gas generated by the landfill. Although with a potential of about 600 kW, a 60 kW generator was installed (by DEISA). Under construction	480 tons of MSW a day. The landfill cells in 3 to 4 cells is extracted and part is utilized in a 60 kW generator for local grid connection (continuous operation) Investment: USD 415,460 Beneficiaries:1990 inhabitants of Fachinal
SDP 03/2021 Biodigestion Pilot Plant for the use of biogas in the Environmental Complex of Rafaela	Location: Rafaela, Prov. Santa Fe. Start-up of the Biodigestion Pilot Plant for the use of biogas. Construction started in 2018 (with 80% MAyDS and 20% municipal funds) bu met delays. The MSW Project supported finalization with additional funds.	1.3 tons of waste 15 kW generator (continuous operation) Investment: USD 128,800 Beneficiaries: 150
SDP 04/2021 Biodigesters in Salta indigenous communities	Location: a) Comunidad Kolla del Desierto (Las Pircas), b) Comunidad Guaraní La Colonia Fiscal 8 (Prov. Salta). About 15 families each. Biogas is used for energy (thermal or electricity) and substrate as fertilizer	1 ton of waste a day (2 projects) 2*6 kW generators (working 1 hour/day for powering 1.5 HP pump) Investment: USD 125,000 Beneficiaries: 150
SDP 05/2021 Use of biogas in sewage treatment plant	Location: Tapalqué. Provision, installation and commissioning of the facility. One kg of DQO generates about 0.35 m^3 biogas. Under construction	3 kW generator (for local grid connection) Investment: USD 142,680 Beneficiaries: 6,830
SDP 06/2021 Biogas recovery and utilization in Overa Pozo landfill	Location: Overa Pozo, Tucumán Provision, installation and commissioning of the biogas facility at the landfill. Biogas used for electricity generation for on-site lighting. Under construction.	1044 tons of waste a day 50 kW generator Beneficiaries: 150

Achievements, demonstration projects

Output 2.1 *Execution of functional design and feasibility studies for shortlisted MSW biogas generation projects*
Output 2.2 *Feasibility studies, detailed engineering, and formalization of responsibilities of project partners for MSW biogas generation projects*
Output 2.3 *Procurement of MSW-based energy generation pilot projects demonstrating different energy uses and business models*

During the first years of the project, no significant advance was made towards the development of pilots. Economic-financial pre-feasibility studies were carried out by INTI in 2019 for biogas extraction and electricity generation in 13 sites in relation to the RenovAr program. As explained in the previous section, none of these were or could be submitted due to their small size, viability issue, lack of investment, or influenced by external factors.

Rather than pursuing viability goals by selling to the grid, the new Project Team that took over in 2020 has focused on the new options linked to the self-supply use of gas to solve the problem of insufficient or unreliable energy supply in locations far from the trunk networks and supporting financially several smaller pilot projects.

The waste-to-energy pilots can be grouped into three categories, according to their level of social impact:

- Biodigesters for small native people communities (10-40 families)
- Biodigesters for markets or small rural producers
- Biodigester for landfills in small and medium-sized towns for which biogas is used on-site or delivered to the (local) electricity grid.

During 2020-21, basic studies of different landfill gas pilots were carried out, followed by a bidding process for all of the proposed pilot projects Due to the COVID-19 pandemic, the target dates could not be met. Currently (May 2022), at most of the pilots the provision, installation and commissioning of the equipment have been carried out or are being finalized. A list of waste-to-energy pilots supported by the MSW Biogas Project with a short description and status is given in Box 10. Some landfills were established some years ago and are producing landfill gas a sufficient amount to be extracted and used. In new landfills, it will take several years for the biogas production to reach peak levels to be used for energy generation (see Box 3).

4.3 Progress towards the objective and impacts

- How did the project contribute to GHG emissions reduction within the project implementation cycle and beyond?
- What are impacts on SDGs?
- Has the project had any impact on gender equality and economic empowerment for women and other marginalized groups? Was it intended to?

The table in Box 11 provides an overview of progress against the indicators reported in the project's results framework and subsequent PIRs.

Box 11 Progress towards results (objective and indicators)

Indicator with end-of-project (EoP) target	Actual value or status of the indicator
Achieved direct GHG emission reductions by pilot biogas energy plants and replication (ton CO_2eq/yr); *Target:* 13,400 tCO_2 per year	The 08 pilot projects, once fully operational, will give a combined GHG emission reduction due to: ▪ Avoided methane release into the atmosphere (the gas is recovered and flared or otherwise utilised). Releasing gas from landfills is the case in 74% of cases; see Box 9) In the calculation of Box 12 it is assumed that 50% of the gas is recovered in

	practice; thus, avoiding the leaking of this amount of CH_4 into the atmosphere has a substantial impact (1,362 $ktCO_2$.eq per year) ▪ Avoided grid electricity (with EF of 0.486 tCO_2 per MWh). As total generation capacity is fairly small, the reduction due to power generation is small (0.86 $ktCO_2$ per year). Over the assumed period of 10 years, the cumulative reduction (methane avoided and grid electricity avoided is 13,635 $ktCO_2$
Policy and regulatory framework for MSW-based biogas energy supported; *Target:* 05	The "Technical standard for agricultural application of digestate from anaerobic digestion plants" was adopted in 2018. A model for municipal regulations was developed. The project is currently working with other areas of government on the development of a national "Minimum Standards Act" for the use of biogas generated from MSW.
Number of public-private partnerships exploiting MSW-based biogas established *Target: 0*3	The ProDoc mentions a "range of business models for biogas energy generation based on MSW" will be delivered, but up to present there is no clear business model that ensures the technical and viable (commercial) operation of MSW biogas energy systems. However, in the last two years two public-private partnerships have been developed: • Escobar: municipality with the local Mercado Campesino de la Comunidad Boliviana • Fachinal: cooperation between the provincial government (Misiones), the municipality and the local company (AESA Misiones SA) that manages the landfill site • Tapalqué: municipality and the site (in which part of the energy is used on-site and revenue of energy sold to the grid going to the municipality).
Number of people served by the electricity produced by pilot biogas energy plants and replication *Target:* 21,000	Based on the 8 pilots, about 25,000 people, once fully in operation (based on the data in Box 10)

Global environmental impacts

For the purpose of estimating greenhouse gas emission reduction, an analysis has been carried out of the expected equivalent direct GHG emission reduction, based on a) avoided release of CH_4 into the atmosphere (captured and or flared or utilised as a source of energy), and b) the avoided use of electricity generated by fossil fuels. The data obtained is based on the 08 pilots supported by the MSW Biogas project (Box 10). The indirect GHG emission reduction can be estimated, based on the expected replication of the pilots. The results of the analysis are presented and explained in Box 12).

Gender and social

A part of the new focus on smaller biodigesters has been to serve small native people communities, such as in the Salta province. Meetings were held with local officers and later with community actors to understand how introducing biogas could improve everyday activities. This resulted in the pilot project with two biodigesters, one for a 'Wichi' and one for a 'Guarani' community for water provision and lighting. The two communities have the advantage of having a much higher level of women's participation than in other cases. It is also hoped that they will serve as success stories that can be expanded to communities that are less receptive or where women are largely marginalised from productive activities and are almost exclusively involved in child-rearing. A key element has been training aimed at women. This will empower the women with energetic management, giving them a new role in their household and community and hopefully will break some dynamics established.

One of the first steps of this new administration under President Fernández was to set minimum participation of 50% in all the consultancies hired by the program, and the gender perspective will be included in all the products resulting from this program.

The ProDoc's SES (Environmental and Social Screening) mentions that gender inequality would be increased along the waste-to-energy value chain, for example, by affecting the position of traditional female waste pickers and transporters. While this is a laudable goal, waste transport or recycling is strictly speaking outside the scope of the waste-for-energy project. In any case, gender aspects as part of waste management are monitored as part of the GIRSU program and the IADB interventions in that area.

Box 12 Greenhouse gas emission reduction estimates

Direct greenhouse gas emissions are, in GEF definition, the results of GEF-supported or co-financed investments (INV) that take place or are initiated during the period of project implementation. In the case of MW Biogas Project these are the eight pilot activities, listed in Box 10. An estimate has been made based on the daily MSW disposal figures given by a) calculating the amount of methane recovered (and assumed to be flared or utilized for energy so that the gas is converted in CO_2) and the amount of methane used to generate electricity (avoiding the use of grid electricity).

For a quick estimate the following equation is used to calculate the methane (CH_4) emissions (IPCC default)

$$CO_2\ equivalent\ of\ methane\ emission\ \left(\frac{ton}{day}\right) = MSW * MCF * DOC * DOC_F * F * \frac{16}{12} * (1 - OX) * GWP$$

MSW: MSW deposed in landfill (ton/day)
MCF: methane correction factor = 0.9 (assuming well-managed landfill)
DOC: degradable carbon fraction (in kgC per kgMSW) = 0.35
DOC_F fraction of DOC dissimilated = 0.77
F: fraction of methane (CH_4) in the landfill gas (LFG) = 0.5
16/12 conversion of C into CH_4
OX: oxidation factor = 0.1
GWP: global warming potential CH_4 relative to CO_2 = 28 (see footnote in Executive Summary)

The method gives a first approximation and cannot be easily compared with the first-order decay method (IPCC) used by INTI in its assessment of land fill sites (see Box 7). Typically, the default method gives higher emission estimates as it does not consider the time factor of diminishing LFG production over time. From the equation follows that 1 ton of MSW generates 4.2 ton of CO_2-eq. If it is assumed, in practice, only half of the gas (50%) is recovered i.e., not released into the atmosphere, the avoided methane emissions are 2.15 ton of CO_2-eq. It should be noted that not capturing methane is the baseline, following the findings of recent study that mentions that of 76 landfills investigated, about 74% do not capture LFG.

The effect of utilization of the captured methane is calculated by assuming that the energy generated is replacing the equivalent grid electricity, assuming a grid emission factor of 0.486 kgCO_2 per kWh. In general, it can be noted that the amount of methane produced is much higher than can potentially be used for energy, which is determined by the size of the generator (relatively low in the case of larger-sized projects). If all the methane gas captured could or would be used for power generation, the maximum generation could be about 200 GWh per year with a corresponding GHG emission reduction of 98,000 tCO_2 per year. However, the choice for size of the generator is in practice limited by investment funding availability, anticipated use of electricity (on-site or local grid) and anticipating declining methane production over time.

	Salta	Escobar	Gualeguay	Fachinal	Tucumán	Escuelas	Tapalque	Rafaela	TOTAL
MSW (ton per day)	1	4	115	480	1044	2		1.3	
CH_4 captured (t$CO_{2\text{-eq}}$ per year)	826	3,305	95,023	396,618	862,643	1,653	1,570	1,033	1,362,671
Generator capacity (kW)	12	10	60	60	50	20	3	15	230
Hours of operation (hrs/yr)	2920	2920	8760	8760	8760	8760	8760	2920	
Energy generated (MWh/yr)	35.0	29.2	525.6	525.6	438	58.4	26.28	131.4	1,769.5
Emissions avoided (tCO_2-eq/yr)	17	14	255	255	213	28	13	64	860
Total GHG reduction (per year)	843	3,319	95,278	396,873	862,857	1,681	1,583	1,097	1,363,531
Lifetime reduction (tCO_2-eq)	8,433	33,193	952,785	3,968,732	8,628,565	16,810	15,826	10,967	13,635,310

Assumed lifetime is 10 years. The GHG emission reduction for the wastewater facility at Tapalqué is based on:

$$CO_2\ equivalent\ of\ methane\ emission\ \left(\frac{kg}{day}\right) = EF * P * BOD * 365 * GWP * MCF$$

EF: emission factor (kg CH_4 per kg BOD)
P: number of inhabitants (= 8000)
BOD: 0.04 kg per person per day
MCF: methane correction factor: 0.8
GWP: methane: 28

This gives the methane emission avoided equivalent to 1,570 tCO_2 per year

Indirect emission reductions follow from the replication of the LFG capture and utilization pilots. In this respect, it is worthwhile mentioning that a new lot of 12 landfill projects identified in the GIRSU program will include biogas utilization for energy as a start. Assuming a replication factor (RF) of three (03) gives estimated lifetime **indirect emission reduction** of 40,906 kilotons of CO_2–equivalent.

Sustainable Development Goals

The project document (ProDoc) does not explicitly refer to the SDGs, maybe because it was not a requirement to do so at the time of ProDoc formulation. However, this Evaluation can confirm that the project addresses several SDGs both directly as well as indirectly, as indicated in Box 13.

Box 13 Sustainable Development Goals with relevance to the Project

Sustainable Development Goals	Linkage with energy
2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture	• Restoring soils through the recycling of nutrients, organic matter, and carbon • Increasing crop yields through use of nutrient-rich digestate biofertiliser • Recirculating phosphorus, which is essential for the growth of plants but limited in supply
3. Ensure healthy lives and promote well-being for all	• Treating and recycling sewage and organic wastes to reduce odours and the spread of diseases
5. Achieve gender equality and empower all women and girls	• Basic energy services are required for women-led rural enterprises and activities • Ensure that all men and women have equal rights to economic resources, basic services, ownership and control
6. Ensure availability and sustainable management of water and sanitation for all	• Energy is needed to supply clean water to rural communities • Stabilising and recycling biosolids through AD to allow them to be applied back to land • Reducing the carbon loading of wastewater to reduce impact on water bodies
7. Ensure access to affordable, reliable, sustainable, and modern energy for all	• Reducing dependence on fossil-fuel-based energy sources by replacing with biogas • Capturing waste heat from co-generating units linked to biogas plants • Utilising locally produced wastes and crops to generate energy for rural and remote communities and storing biogas to produce energy when required
9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	• Resilient infrastructure and public-private partnerships are required to ensure access to energy for all • Generating short-term construction employment and long-term equipment manufacturing and maintenance employment • Encouraging growth of micro-enterprises by providing reliable electricity that can be stored and used when needed, i.e., baseload energy • Improving the self-sufficiency and sustainability of industries by extracting the energy from their own effluents and using it for the self-generation of electricity and/or heat • Collaboration between industries and agriculture for mutual benefit
11. Make cities and human settlements inclusive, safe, resilient and sustainable	• Preventing spread of diseases through collection and proper management of organic waste • Improving sanitation and hygiene through decentralised and local treatment of biosolids • Stabilising the sludge from wastewater treatment to protect the marine environment and urban air quality • Improving urban air quality by substituting fossil fuel with biomethane in vehicles • Improving urban air quality by substituting solid fuel for domestic cooking and heating with biogas • Reducing greenhouse gas emissions by using biogas-based renewable energy in buildings, homes and industry
12. Ensure sustainable consumption and production patterns	• Renewable energies are a key part of a future in which there is sustainable consumption.
13. Take urgent action to combat climate change and its impacts	• Reducing carbon dioxide emissions by replacing fossil-fuel-based energy sources with biogas and commercial fertilisers with digestate biofertiliser • Reduction of methane and nitrous oxide emissions from livestock manures • Reduction of methane and generation of renewable energy from food and other organic wastes • Capturing emissions from landfills • Reducing deforestation by replacing solid-biomass-based domestic fuels with biogas
15. Sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss	• Recirculating nutrients and organic matter in organic wastes through anaearobic digestion (AD) and returning them to the soil in the form of digestate biofertiliser

Compiled from *2030 Agenda for Sustainable Development* (UN, 2015) and *How to achieve sustainable development through biogas,* Factsheet 3, World Biogas Association

4.4 Sustainability and replication

- What impact has the project had on policy, legal and institutional frameworks? To what extent are there financial, institutional, social-economic, and/or environmental risks to sustaining long-term project results? How sustainable (or likely to be sustainable) are the outputs and outcomes? Is there an exit strategy that is well planned? What could be done to strengthen exit strategies and ensure sustainability of interventions?
- To what extent will the stakeholders sustain the project?

Sustainability is generally considered to be the likelihood of continued benefits after the project ends. Consequently, the assessment of sustainability considers the risks that are likely to affect the continuation of project outcomes. Many risks are in one way or another related to the "barriers" mentioned in the Project Document). The occurrence of the "risks" and failure to implement risk mitigation, implies that it will be more difficult to lower corresponding "barriers" substantially, thus negatively affecting the likeliness of "sustainability" of the project's interventions. The critical "assumption" then is that the "internal risks" (i.e., risks that can be mitigated or managed by Project management), and 'external risks' have a low incidence and/or impacts, in such a way that sustainability remains (moderately) likely. The quality of adaptive management (mentioned in Section 5.1) is determined by the mitigation response of Project management to these external and internal risk factors as these manifests themselves more intensely and/or more frequently than expected.

Four main areas are considered in this section and then rated as to the likelihood and extent that risks will impede sustainability.

Technical sustainability (likely)

Barriers to sustainability, identified in 2016	**Status at mid-term review**	**Current status and remaining barriers**
Technical sustainability: likely		
• Lack of practical experience with (small) biogas utilisation from MSW. • Limited knowledge of the biogas-to-energy technologies in the waste treatment sector. • Lack of reliable commercial providers of technology for small-scale bio digestion	• Big landfills generate power (CEAMSE). Some smaller MSW biogas units were evaluated (Cerrito, El Jote), apparently operating with good results. • Landfill design is not regularly optimized for the capture of biogas. Defective re-injection of lixiviates and other design characteristics limit the biogas extraction. • In the small-scale MSW biogas market, technology providers in the R&D&D sector, do not operate as commercial firms and do not give guarantees and after-sales services.	• Several big landfills generate power (a total of about 25-35 MW)[37] • Pilots supported in MSW project have just started or will start operations. It should be noted that landfill cells only produce sufficient gas after 3-5 years. A larger monitoring period is needed to assess the results (in terms of landfill degasification and utilisation of gas for energy) and to troubleshoot problems. • GIRSU has incorporated gas recovery infrastructure as part of the technical specifications for new landfill projects. A new lot of 12 landfill projects (supported by GIRSU) will include this (thus facilitating biogas utilisation for energy). The objective of this repository is to have a base always available with a set of projects ready to be built. To this end, 12 Environmental Centres will be built: 6 in the north of the country and 6 in the south. • Several commercial companies (DEISA, EVA, others) have provided services (incl.

[37] Of which five, supported by programmes (GenRen o RenovAr) and five other (El Jote-San Luís, Cerrito-Entre Ríos, Las Heras, Cipoletti and Tres Arroyas. Source: *Diseño y presentación de propuestas para propiciar el marco regulatorio del biogás en la República Argentina, Producto D* (2021)

Barriers to sustainability, identified in 2016	Status at mid-term review	Current status and remaining barriers
		one or two years of after-sales service) to the project-supported pilots.
Policy-regulatory sustainability: likely		
• Defective political framework for small-scale renewable energy projects. vacuums in the secondary regulation referring to grid access, net power measurement, security, transportation and end-use of digested biomass.	• Plants below 500 kWe are not allowed to sell power to the wholesale market (RenovAr). • The use of bio-digested solid and liquid effluents from MSW is not allowed by SENASA. Net power measurement is accepted by some power distribution companies.	• MSW biogas projects, because of their high cost, are unlikely to be attractive for the purpose of feeding energy into the grid. • The "Technical standard for agricultural application of digestate from anaerobic digestion plants" was adopted in 2018. • A model for municipal regulations was developed. The project is currently working with other areas of government on the development of a national "Minimum Standards Act" for the use of biogas generated from MSW. • Pending actions would be the approval by MAyDS, of regulations establishing technical and environmental criteria to be used in the different stages of GIRSU, especially with regard to the separation and recovery of waste, and the capture and use of biogas and biomethane.
Financial sustainability: moderately likely		
• Lack of viable business models for energy generation from MSW-based biogas • Lack of funding for small-scale energy projects	• No viable business models have been designed and tested. Feasibility studies by INTI in five landfills (plus the UNL study in Rafaela biodigestion) found positive business cases (IRR above 20%) only in large MSW sites. • Big projects for energy recovery from landfills can make profits and have access to private funding or bank loans. Small projects, with negative Net Present Value, are not bankable and need subsidies to be implemented.	• Smaller projects therefore must seek value added in using the energy on-site or support unreliable local grid supply, or for local thermal application) • Financial viability is improved if the gas recovery system is mandatory in new landfills and would be present already. Since the Municipalities are the local governments having most of the responsibilities for municipal waste management, they are the main institutions that make the decisions on the options opened to collect and use the landfill gas, or to give a separate treatment to the organic fraction of waste streams and to utilize biodigesters for energy generation. • Smaller the projects have lower economies of scale, in general. This will also be true for LFG projects. Thus, the investment cost per volume of gas generated or operating cost per volume of gas generated are higher than of large LFG projects. The economies of scale can improve by setting up larger projects[38], However, the budget for investments in municipalities for landfill development and

[38] The issue is mentioned in the Mid-Term Review report. For general information on 'economies of scale', see, for example, https://www.investopedia.com/terms/e/economiesofscale.asp

Barriers to sustainability, identified in 2016	Status at mid-term review	Current status and remaining barriers
		for energy generation from captured landfill gas will be limited. There is a need for a policy to provide municipalities with appropriate support and incentives.

Box 14 Replication and scaling up

There has been close cooperation between the MSW Biogas and GIRSU programme, which now has incorporated gas recovery infrastructure as part of the technical specifications for new landfill projects. With MAyDS's own resources the pilot with the fruit & vegetable markets will be replicated in other similar markets:"

Projects with MAyDS funding (Treasury)	Estimated amount (USD)
• *Centro Ambiental,* Avellanada	400,000
• *Mercado Concentrador,* Hipólito Irigoyen (San Fernando, Buenos Aires)	400,000
• *Mercado frutihortícola,* Berazategui, Buenos Aires	400,000
• *Mercado Concentrador,* San Juan, San Juan	400,000
• *Mercado* Mercafrut, San Miguel de Tucumán	400,000
Total	2,000,000

There has been close cooperation between the MSW Biogas and GIRSU program, which now has incorporated gas recovery infrastructure as part of the technical specifications for new landfill projects. A new portfolio of GIRSU landfill projects will be prepared to enable biogas utilization for energy.

Projects (design, construction, operation of works)	Amount (USD)	Company contracted	Date
IADB – Loan 3249/OC-AR			
• Environmental centre for the recovery and final disposal of solid waste, Formosa	5,996,284	EVA SA	2020-2024
• Regional environmental centre Concordia and clean-up of the Concordia open-air landfill site	6,444,255	EVA SA / Pietroboni	2021-2024
• Environmental management centre, Villa María, Córdoba	10,318,676	MILICIC	2021-2024
• Environmental centre Luján and clean-up of site	13,065,427	EVA SA	2021-2025
• Ecopark Chascomús, Buenos Aires	11,442,137	Transportes Malvinas	2022-2025
Next tranche – IADB			
• Alto Valle	28,224,585		
• Santiago de Estera, La Banda	26,686,750		
• Gral. Alvarado	8,547,207		

4.5 Ratings for achievement of Project outcomes and sustainability

Box 15 Evaluation ratings of progress towards results and sustainability

Evaluation item	Rating	Comment / correspondence with sections in the report
Relevance	R	See rating in Section 3.1
Efficiency	MS	See rating in Section 4.4
Effectiveness:	S	Chapter 5 (progress towards results)
• Outcome 1	S	Section 5.2.1. The Project has commissioned several studies, including surveys of experience with and implementation of LFG projects; pre-feasibility analysis of selected sites; information and recommendations for legal-regulatory frameworks (for federal and lower level of governments) and LFG-specific measures (minimum standards, use of substrate).
• Outcome 2	S	Section 5.2.2 The project has successfully supported demonstration setting up during 2020-2022 a number of project pilots at medium scale (Gualeguaychú, Tucumán, Fachinal) and small scale (Salta, Escobar, five schools in B.Aires prov, Tapalque, Rafaela)
• Attainment of the objective	S	Section 5.3. The MSW Project has managed to demonstrate the technical viability of small and medium-scale LFG investment but there is no clear business or financing model yet
Overall project outcome	HS	Overall project outcome rating is based on the above
Financial-economic	ML	GIRSU has incorporated gas infrastructure as part of the technical specifications for new landfill projects. A new lot of 12 landfill projects (supported by GIRSU) will include biogas utilisation for energy. No business model has come up that is not dependent on grant financing to supplement local sources of financing. However, the IADB tranche for GIRSU will support further landfill development, while a new World Bank activities with *basurales* will incorporate gas recovery and utilisation
Institutional	L	
Technical	L	
Likelihood of sustainability	ML	

In assessing the 'sustainability' of the Project, a simple rating scheme is used:

- Likely (L): negligible risks to sustainability;
- Moderately Likely (ML): moderate risks to sustainability;
- Moderately Unlikely (MU): significant risks to sustainability; and
- Unlikely (U): severe risks to sustainability.

- (HS) Highly Satisfactory: Project is on track to exceed its end-of-project targets, and is likely to achieve transformational change by project closure. The project can be presented as 'outstanding practice'; (S) Satisfactory: Project is on track to fully achieve its end-of-project targets by project closure. The project can be presented as 'good practice'; (MS) Moderately Satisfactory: Project is on track to achieve its end-of-project targets by project closure with minor shortcomings only; (MU) Moderately Unsatisfactory: Project is off track and is expected to partially achieve its end-of-project targets by project closure with significant shortcomings. Project results might be fully achieved by project closure if adaptive management is undertaken immediately; (U) Unsatisfactory: Project is off track and is not expected to achieve its end-of-project targets by project closure. Project results might be partially achieved by project closure if major adaptive management is undertaken immediately.

5. FINDINGS: PROJECT IMPLEMENTATION

This part of the Evaluation Report describes the assessment and rating of the quality of the execution by the GEF Implementing Agency (IA), UNDP, and the Implementing Partner, MAyDS. An assessment is made of the partnerships established and stakeholder interaction during implementation and the important role of adaptive management. The Evaluation Report presents an assessment and rating of the project monitoring and evaluation (M&E) at implementation. A special section is dedicated to the budget, expenditures, and co-financing of the MSW Biogas project.

5.1 Implementation and management

5.1.1 Management arrangements and adaptive management

- Was the project implemented (by IA) and executed (by EA) in an efficient way?
- Were there any unplanned effects? Which external factors have contributed or hindered the achievement of the expected results? Has the project proactively taken advantage of new opportunities?
- What have been management responses to issues and recommendations indicated in progress reports and Mid-Term review?
- Did UNDP and Project staff identify problems in a timely fashion and submit advice to the project team? If so, has the project practicing adaptive management e.g., (approve modifications in time)? If so, how effective were the adaptive management approaches practiced during the project?

Management arrangements

The Project has been implemented under the National Implementation Modality (NIM) with support from the UNDP Country Office (CO) in Argentina by the Ministry of Environment and Sustainable Development (MAyDS) through its *Dirección Nacional de Gestión Integral de Residuos* (DNGIR). The Directorate is responsible for executing all actions and programs regarding MSW. MAyDS has appointed a high-ranking official from the Secretariat of Control and Environmental Monitoring (of which DNGIR is part) as National Project Director. To be efficient, the same person in DNGIR responsible for GIRSU has also been responsible for the MSW Biogas Project).

A Project Steering Committee *(Comité Directivo)* was formed with the participation of representatives from MRECIC (Ministry of Foreign Affairs, International Trade and Worship - *Dirección de Proyectos de Implementación Nacional*), UNDP as well as representatives from the Ministry of the Environment and Sustainable Development (National Project Director; project manager in DNGIR for GIRSU and MSW Biogas; representative from the *Dirección Nacional de Cambio Climático*) and a representative from the Secretariat for Energy (Subsecretariat for Renewable Energy and Energy Efficiency).

External factors affecting project implementation and adaptive management

The following external factors have hindered the achievement of project results.

1) *Government changes; project staffing and macro-economic developments*

In 2015, a new government took office and inherited an economy with a complex scenario . In April 2016, the Macri administration introduced measures intended to tackle inflation and overblown public deficits. This was accompanied by some governmental restructuring about mid-term during the Macri administration. This reform generated changes in Ministry authorities and organizations that took time and impacted the activities and progress of the Project. For example, the former Secretariat of Environment and Sustainable Development became a Ministry in 2017. The Secretary's Solid Residues Unit became part of the Monitoring and Control Secretariat of the new MAyDS. These institutional (and accompanying personnel) changes took place in parallel to and affected the MSW Project inception throughout most of 2017. The project document was signed in December 2016 with an Inception workshop carried out in August 2017. Under Macri administration, economic recovery remained elusive with a monetary crisis emerging in

2018 with GDP shrinking, spiralling inflation and a severe devaluation of the peso[39]. As can be imagined, such macro-economic conditions (that have continued since) have had an impact on both federal and municipal finances and the role of programmes such as RenovAr.

Again, after the 2019 general elections, the party (that governed from 2001-2015) took office in December 2019 resulting in the replacement of the many authorities at the highest positions and staff in many institutional organizations. As in 2017, these changes brought a need to build coordination and communication strategies among the new responsible staff. For MSW Project, this implied new representatives in the project´s Steering Committee from the various ministries, while a new Project Team was appointed in 2019-20[40].

2) *COVID*

With activities of the pilot project development and accompanying awareness-creation and training starting in 2020, the project faced a serious setback in the form of COVID-19, declared a pandemic by the World Health Organisation in March 2020. The subsequent lockdown policies set in place after March 2020 in Argentina led to a slowdown some in site activities, such as the initiative to train agricultural and technical schools into building their own biodigester as well as training and awareness creation of pilot project stakeholders in general.

In response to the COVID-19, the team working on this project has adapted very quickly to the challenges of the lockdown. Project activities have been pursued by distant work modality and much of the procurement process adjusted to virtual modality. Communication was continued online through Google Meet video conferencing which has allowed to make up partly for the lack of staff present in the office. Similarly, it was necessary to work with local authorities and companies through virtual meetings, having to limit visits to the work sites. With respect to the latter, a big obstacle in the COVID period has been the restriction on travel as many of the pilots are outside Buenos Aires and required inspections to resolve issues at the pilots' location.

Following the Project's mid-term review recommendation as well as per mitigation measures under COVID 19 pandemic taken by governments, the Project requested an extension which was approved by the last quarter of 2020, which allowed the project team to speed up progress towards achieving the planned outcomes and outputs.

3) *Technology supply*

In terms of supply chains, suppliers have encountered difficulties in importing certain products needed for the realisation of projects, and have had to adjust the timing to the COVID situation. The continuing difficult economic situation will also negatively affect the import of technology and the realization of projects in general[41].

5.1.2 Monitoring and evaluation

- Was the information provided by the M&E system (annual work plans, PIRs, other) used to improve performance and to adapt to changing needs; Are there any annual work plans?
- What have been management responses to issues and recommendations indicated in progress reports and the Mid-Term review? How have the project management systems, including progress reporting, administrative and financial systems and monitoring and evaluation system been operating as effective management tools to aid in effective implementation and provide a sufficient basis for evaluating performance and decision making?

[39] Since the economic depression of 1998-2002, inflation has plagued the Argentinian economy. During 2010-2013, inflation was about 10% annually, increasing to 25% in 2017, 34% in 2018 and 53% in 2019. Dropping to 42% in 2020 it increased again to 48% in 20201. https://www.statista.com/statistics/316750/inflation-rate-in-argentina/. Exchange rates US dollar to Argentinian peso have been dropping since 2013 (1:5) to 1:15.9 in 2017 to 1:38.4 in 2019 and 1:91 in 2021. Source: Información Económica al Día: Dinero y Bancos, Ministerio de Economía). Dropping exchange rates to affect projects as cost of imported materials increase in terms of local currency value

[40] The project has had three different Project Directors (2016-2018, 2018-2019, 2019-present), three Officers responsibl;e fopr GIRSU and Biogas MSW (2016-2018, 2018-2019, 2019-present) and two Project Coordinators (2016-2019 and 2020-present)

[41] See preceding footnote

M&E: design at entry

At Inception, a total of USD 100,000 was allocated, about 3.5% of the total GEF budget, which should be enough given the Project's objectives. In the M&E plan as formulated in the project documentation, the performance of the Project is monitored and assessed according to the goals defined and agreed upon in the Project Document (according to the target values of the outcome indicators as defined in the Project's results framework) and according to the annual targets set in the Annual Work Plans (AWPs). The ProDoc also gives a 'standard-type' of M&E Plan of which the main elements are:

- Project Inception Workshop and Report
- Project Implementation Report (PIR)
- Project Steering Committee (PSC) meetings
- Mid-Term Review and Terminal Evaluation
- Learning and knowledge sharing: results from the Project to be disseminated within and beyond the project intervention zone through existing information-sharing networks and forums.

M&E implementation; reporting

An Inception Report was prepared as a deliverable of the Inception Workshop (October 2017). The annual Project Implementation Reviews (PIR) for 2018, 2019, 2020 and 2021 have been formulated (in English), while a draft project Completion Report (in Spanish) is under preparation. The PIRs indicate the delays in project implementation in the period 2017-2019 and give progress ratings as 'moderately unsatisfactory' and indicate the presence of high risks to project implementation.

The Mid-Term Review was carried out during August-October 2019 and concludes that by that time "overall progress towards project´s objective and outcomes is very little in general, and nil in some relevant aspects" with a 'highly unsatisfactory rating".

Thus, the monitoring and evaluation system gave clear warnings about the increasing arrears in the financial execution (as evidenced by the low budget disbursements; see Box 16) and the late delivery of products /outcomes during 2017-2019. This late delivery was influenced by the external factors discussed in Section 5.1.1, the over-optimistic project design assumption (discussed in Section 3, as well as hampering decision-making by the project management on the need for corrective action in the period until 2019 to address the late delivery issue.

These substantial delays in implementation were discussed in the second Directive Board session (July 2019) and internally by the implementing agency after the new project management and technical team were established in 2019-2020. Thereafter, two important adaptive management measures were taken:

- Speeding up activities, notably the tendering for design and implementation of biogas recovery and/or utilization in pilots (comprising all activities needed to implement each pilot project by a technically capable organization)
- Extension of the project implementation period to June 2022

Meetings of the *Comité Directivo* have been held annually, according to UNDP information. More frequent meetings in the early years might have benefited the project. Also, the frequent changes staff changes in the government ministries involved (see the discussion on page 40) led to frequent changes in the Directive Board composition and delays in decision-making.

5.2 Project finance and co-financing

- How efficient was the financial management of the project, including specific reference to cost-effectiveness of its interventions? If there was a difference in the level of expected co-financing and the co-financing actually realized, what were the reasons for the variance?

Given the description of the lengthy delays in project implementation, it is no surprise this is reflected in the annual and cumulative disbursement. The originally approved budget (A) was revised in 2020 (D). About 85% of the GEF budget has

been spent in the last two years (2021-22) of the Project. This is apparent in Component 2 (99% spent in 2021-22) but also in Component 1 (58%). It should be noted, that there has not been quick spending before the project's end, just for the sake of spending. The new Project Team has carefully, but speedily, disbursed the budget for the five consultancy assignments (see Box 9) and initiated and financially supported eight LFG pilot activities (see Box 10).

Box 16 UNDP/GEF budget and actual expenditures and co-financing data

Planned GEF (2017) budget "A"	Total	2017	2018	2019	2020		
Comp1	975,000	277,289	536,629	131,411	29,671		
Comp 2	1,610,000	457,888	886113	217,000	48,999		
M&E	100,000	21,750	17,250	17,000	44,000		
PM	94,849	19,849	25,000	25,000	25,000		
Total	2,779,849	776,776	1,464,992	390,411	147,670		
Planned GEF (2020) budget "D"	**Total**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Comp1	975,000	13,861	31,637	66,335	418,000	175,000	74,630
Comp 2	1,610,000	17	1,030	917	192,404	1,303,259	308,000
M&E	100,000	11,458	56	148	20,410	21,463	46,374
PM	94,849	13,179	40,642	29,990	6,519	4,519	0
Total	2,779,849	38,515	73,366	97,390	637,333	1,504,241	429,004
Expenditures (realised 2017-21, expected by July 2022)							
	Total	**2017**	**2018**	**2019**	**2020**	**2021**	**2022 '(est)**
Comp1	743,373	13,860	31,637	66,334	199,812	248,863	182,867
Comp 2	1,819,901	17	1,030	917		913,103	904,834
M&E	121,726	11,458	56	148	47		110,017
PM	94,849	13,179	40,642	29,990	2,388	830	7,820
Total	2,779,850	38,514	73,366	97,390	202,246	1,162,796	1,205,538

Expenditures on pilots	(in USD)
Total INV	*1,904,348*
Salta	134,626
Escobar	226,200
Gualeguaychú	409,860
Fachinal	415,460
Tucumán	350,000
5 escuelas	129,250
Tapalqué	128,952
Rafela	110,000

Source: Project documents; data provided by Project Team

Co-financing figures reported are as follows:

Name of Co-financier	Type of Co-financing	Co-financing amount confirmed at CEO Endorsement / Approval	Realized co-financing as of Jun 30, 2022
Ministry of Environment and Sustainable Development (MAyDS)	In kind	2,460,000	180,000
Ministry of Environment and Sustainable Development (MAyDS)	Grants	10,135,000	12,440,538
UNDP	Grants	150,000	145,784

The realized grant co-financing can be related to the expenditures up to 2022 of planned operations and ongoing design for methane recovery and utilization in GIRSU projects, financed by MASyD with own or IDB resources; see Box 14).

5.3 Stakeholder involvement

- How efficient are partnership arrangements for the project? Did stakeholders participated in the project management and decision-making have ownership over project outcomes and their further replication and scaling-up? Did the project efficiently utilize local capacity in its implementation?

Stakeholder involvement

Many stakeholders were identified, participated in the Inception Workshop, and made contributions in the form of recommendations for Project implementation at this event. These include the various policy formulation bodies dealing with climate change, renewable energy, and waste management, especially in MAyDS and the Foreign Affairs Ministry (MRECIC). Initially, the most directly and strongly interested stakeholders were four Municipalities (Rafaela, Tapalqué, Olivarria and Las Heras). Only in the first two cases, this did eventually result in letters of agreement, but after 2019 cooperation was extended to other municipalities (Gualeguaychú, Tucumán, Escobar, Rafaela, Tapalqué, Fachinal).

Communication

There has been a good level of communication and cooperation established with three National Programs (GIRSU, RenovAr and ProBiomasa), in particular the GIRSU project team and management. Regarding external communication, the Project has not a web page of its own, and its presence on the MAyDS website is limited to a sheet. The Project has produced interesting technical reports (see Box 7 and Box 9) but cannot be found easily (INTI report) or cannot be located and/or not made available yet (other technical reports).

It is understood that the Project will produce a 'publication' by the end of the Project. This should be widely publicised as part of a promotional campaign focussing on local authorities and waste management companies as well as other stakeholders (small communities, markets).

5.4 Ratings for project implementation

Box 17 Evaluation ratings of project implementation and execution

Evaluation item	Corresponding report section	Rating
Quality of UNDP implementation (adaptive management; finance)	5.2	S
Quality of execution (coordination; adaptive management; stakeholder involvement	5.1, 5.2, 5.3	MS
Overall UNDP implementation and implementing partner execution; Efficiency in achieving results		**MS**
M&E plan implementation	5.2	S

Regarding 'execution', it is difficult to provide a rating, which should distinguish between the period 2017-2019 (rated as 'U') and 2020-221 (rated as 'HS'). The rating presented is the average of the two, giving a 'MS' rating

- Highly satisfactory (HS), Implementation of all components, 1) management arrangements, work planning, reporting, project-level monitoring and evaluation, 2) stakeholder engagement and communications, 3) finance and co-finance, is leading to efficient and effective project implementation and adaptive management. The project can be presented as demonstrating "good practice".
- Satisfactory (S), implementation of most of the components has led to efficient and effective project implementation and adaptive management except for only a few components that are subject to remedial action
- Moderately satisfactory (MS), implementation of some of the components has led to efficient and effective project implementation and adaptive management, with some components requiring remedial action.
- Moderately unsatisfactory (MU), implementation is not leading to efficient and effective project implementation and adaptive management, with most components requiring remedial action.
- Unsatisfactory (U), implementation of most of the components is not leading to efficient and effective project implementation and adaptive management.
- Highly unsatisfactory (HU), implementation of none of the components is leading to efficient and effective project implementation and adaptive management.
- U/A = unable to assess.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 General conclusions

A summary of ratings and their motivation is given in Box 18. The achievement of the results (and the longer-term sustainability thereof) has been influenced by the way the Project was formulated and designed, the way the project was implemented by the various project partners and the occurrence and impact of external factors. The project design has suffered from too high expectations with respect to achieving a special agreement with the Argentinian renewable energy programmes for generating and selling electricity to the national market operator. Even large LFG facilities receive higher feed-in tariffs than utility-scale solar or wind energy. It was not realistic to assume that small and medium LFG facilities in small towns or communities would approach the economics of scale to reach viability as their large counterparts. The Project waited quite a long time, until 2019, in addressing the issue and re-orient LFG to local benefits and circumstances.

Admittedly, the Project's implementation was hampered by frequent changes in the national government (2015, 2019), and the government institutional setup (2015, 2018, 2019) with consequences for the composition of the Directive Board, for project management and the project team. In 2019 the Project was in dire straits in terms of achievements and delivery rate. Fortunately, a new management and project team has been able to provide a new focus, strengthened integration with the GIRSU team (also under the National Directorate for Urban Solid Waste of MAyDS), selected and support several pilot LFG pilot activities in municipal landfills, local communities and fruit and vegetable market, and commissioned several studies on background status of landfills and LFG (at the national and provincial level), technical options and issues with biogas utilisation, remaining obstacles and barriers for wider-scale LFG application, as well as necessary regulations.

Box 17 Summary of ratings

1. Monitoring and Evaluation	*rating*	2. IA& EA Execution	*rating*
M&E design at entry	MS	Quality of UNDP Implementation	S
M&E Plan Implementation	S	Quality of Execution - Executing Agency	MS
Overall quality of M&E	*MS*	*Overall quality of Implementation / Execution:*	*S*
3. Assessment of Outcomes	***rating***	**4. Sustainability**	***rating***
Relevance	R	Financial resources:	ML
Effectiveness	S	Socio-economic & stakeholder capacity	L
Efficiency	MS	Institutional framework and governance:	L
Overall Project Outcome Rating	*S*	Environmental:	L
5. Design logic	MU	*Overall likelihood of sustainability:*	ML

Ratings for Outcomes, Effectiveness, Efficiency, M&E, IA&EA Execution

6: Highly Satisfactory (HS): no shortcomings
5: Satisfactory (S): minor shortcomings
4: Moderately Satisfactory (MS)
3. Moderately Unsatisfactory (MU): significant shortcomings
2. Unsatisfactory (U): major problems
1. Highly Unsatisfactory (HU): severe problems

Additional ratings where relevant:
Not Applicable (N/A)
Unable to Assess (U/A)

Sustainability ratings:

4. Likely (L): negligible risks to sustainability
3. Moderately Likely (ML): moderate risks
2. Moderately Unlikely (MU): significant risks
1. Unlikely (U): severe risks

Relevance ratings
2. Relevant (R)
1. Not Relevant (NR)

Impact Ratings:
3. Significant (S)
2. Minimal (M)
1. Negligible (N)

The Evaluator judges the project to be **unsatisfactorily implemented with highly unsatisfactory results** in the period 2017-2019 and **highly satisfactorily implemented with satisfactory results** in the period 2020-2021

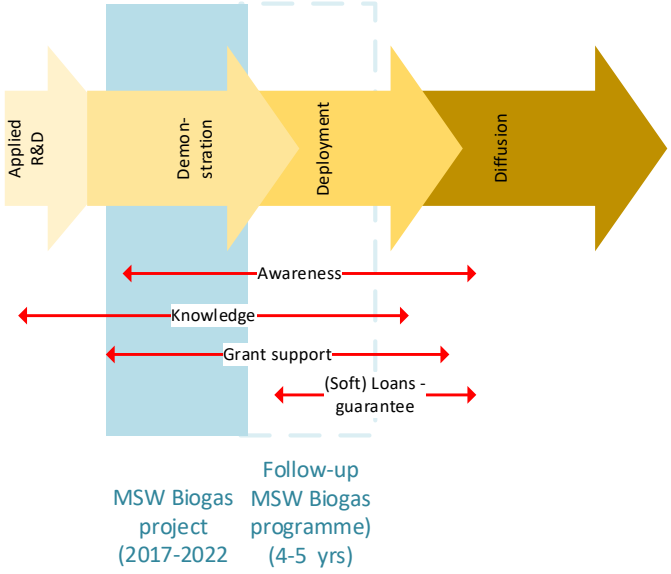
On a small and medium scale, LFG is still much in a demonstration phase. The UNDP/GEF MSW project has demonstrated the potential of biogas (including landfill gas) for energy generation from organic municipal solid waste for medium-sized urban centres in Argentina. However, in view of the initial delay in project implementation, the Project has only effectively operated in the past two or three years, a time which is too short to develop the market to the next deployment phase. While the Project has pushed for energy production as part of integrated waste management under the national GIRSU programme, there is a need for experimenting with and optimize effective business models for the wider-scale deployment of the LFG recovery and utilisation.

6.2 Recommendations

Follow-up activities

The intervention of the MSW Biogas project must be seen as part of the whole development and diffusion of the technology in the world. The use of landfill gas for energy has for long been the subject of R&D, followed by the demonstration of the first landfill gas plants, followed in recent years by the deployment of landfill-gas-for energy facilities towards commercial-scale diffusion. The global landfill gas (LFG) market is projected to grow from USD 3.40 billion in 2021 (of which half in North America, USD 1.25 million) to USD 5.21 billion in 2028 (with strong growth in Europe) at a CAGR of 6.3% in the forecast period, 2021-2028[42].

Box 19 Status of small and medium-scale LFG recovery and utilisation in the technology innovation process



In Argentina, several landfill sites near the major urban centers (such as Buenos Aires) have deployed landfill gas recovery and use for power generation with financial support from international programmes (CDM) and national programmes (Genren, RenovAr) operated by large waste management companies.

However, the MSW-for-energy had not been demonstrated at medium-scale in towns or small-scale in communities or markets (in the kilowatt range). The main actors (municipalities, waste companies) do not have the financial resources, infrastructure, technical knowledge, and economics of scale as, for example, CEAMSE operating facilities in the megawatt ranges. However, on a small and medium scale, LFG is still much in a demonstration phase. The UNDP/GEF MSW project has demonstrated the potential of biogas (including landfill gas) for energy generation from organic municipal solid waste for medium-sized urban centres in Argentina but the status is still not that of a pre-commercial deployment stage.

Given the initial delay in project implementation in the initial years, the Project has only effectively operated in the past two or three years, a time which is too short to develop the market to the next deployment phase. While the Project has pushed for energy production as part of integrated waste management under the national GIRSU programme, there is a need for experimenting with and optimising effective business models in further deployment of the LFG recovery

[42] https://www.fortunebusinessinsights.com/landfill-gas-market-105683

and utilisation. Third, there is a need to monitor the eight LFG pilots supported by the LFG project, which needs a substantial time as recently closed landfill cells only start producing gas in optimal quantities after 3 to 5 years. A fourth observation is that an effective project team has been established within the *Dirección Nacional de Residuos Sólidos* of MAyDS and should continue its operations not to lose the recently gained expertise and experience, so it can adequately advise the GIRSU program.

Main recommendation

Formulate and implement **a successor programme** that builds on the demonstration of LFG utilisation and small and medium-scale application, supported the UNDP/GEF MSW Biogas Project, and focuses on business and financing models for a wider-scale deployment in municipal landfills, vegetable and fruit markets and community applications. Such a new program would address remaining financial-economic, technical, and regulatory barriers (see *Section 4.4)* and fill a niche between the World Bank project on *basurales* and the continuation of the GIRSU programmes (with lending from IADB, EIB and others for landfills. The Evaluator suggests that UNDP explores options with the GEF Focal Point in Argentina to present a project concept for consideration by GEF under its new GEF-8 replenishment cycle.

Other recommendations

Some minor recommendations include (for MASyD):

- The Project will produce a 'publication' by the end of the Project. This should be widely publicised as part of a promotional campaign focussing on local authorities and waste management companies as well as other stakeholders (small communities, markets);
- Pilots supported in MSW project have just started or will start operations. It should be noted that landfill cells only produce sufficient gas after 3-5 years. A larger monitoring period is needed to assess the results (in terms of landfill degasification and utilisation of gas for energy) and to troubleshoot problems.

Regarding the evaluation ratings, the scheme would benefit from a clearer distinction between design, implementation, and results. In the mandatory scheme (see Box 1), the four categories do not relate in an unambiguous way with the OECD-DAC criteria (relevance, coherence, effectiveness, efficiency, impact, sustainability). For example, 'efficiency'; is a part of 'outcomes' but relates more to implementation, while effectiveness describes the achievement of outcomes. M&E is not an OECD criterion and is part of both design and implementation. Design (except for M&E design) is not rated at all, while nonetheless taking a whole chapter in the evaluation report's outline. Impact is an OECD criterion but does not have to be rated in the scheme of Box 1. The evaluator suggests (to UNDP/GEF) a more clear-cut definition of evaluation items, grouped into a) relevance; design (did the design's strategy address the relevant issues and did the outcomes-outputs-indicators of the logframe reflect adequately the strategy), coherence (with other interventions), b) effectiveness and impacts (achievement of impacts, objective, outcomes, and planned outputs), c) efficiency (in IA/UNDP implementation/execution), d) sustainability.

1. Relevance; coherence and design	***scale***	**3. Sustainability**	***scale***
- Design approach/strategy; risks	Six-point	Financial resources	Four-point
- Formulation of results framework		Socio-economic & stakeholder capacity	
- M&E design at entry		Institutional framework and governance	
Overall quality of design		Environmental	
Coherence	Two-point	*Overall likelihood of sustainability:*	
Relevance	Two-point		
2. Effectiveness and impacts	***scale***	**4. Efficiency**	***scale***
- Achievement of outcomes	Six-point	Quality of UNDP implementation	Six-point
- Achievement of objective		Quality of IA execution	
Overall Project results rating		M&E plan implementation	
Impacts	*Four-point*	*Overall quality of implementation/execution*	

6.3 Lessons learnt

1. An effective policy and regulatory framework with public budget allocation at the national and local levels is an important condition for the wider-scale deployment of LFG technology.

2. Small and medium-scale LFG-for-energy projects should seek the benefits of local use of captured LFG (for on-site use or boost local electricity grid, or thermal applications) and environmental and public health benefits, rather than competing with large renewable energy projects in selling energy to the main grid. It is important to assess effective and appropriate business and financing models that involve local government, waste companies, institutions, communities as well as national-level government entities.

3. GEF project design must be realistic in terms of the timeframe needed to develop markets for new technologies from demonstration to deployment in a pre-commercial, pioneering, market development phase to widespread diffusion in an expanding market, which may be double or triple the size of the implementation period of a typical GEF climate mitigation project (of 4-5 years). Trying to squeeze this lengthy market development into the typical timeframe of one GEF project can lead to over-optimistic assumptions on the impact of proposed market barrier removal activities

(Note: The TOR should retain enough flexibility for the evaluation team to determine the best methods and tools for collecting and analysing data. For example, the TOR might suggest using questionnaires, field visits and interviews, but the evaluation team should be able to revise the approach in consultation with the evaluation manager and key stakeholders. These changes in approach should be agreed and reflected clearly in the TE Inception Report.)

The final report must describe the full TE approach taken and the rationale for the approach making explicit the underlying assumptions, challenges, strengths and weaknesses about the methods and approach of the evaluation.

3. DETAILED SCOPE OF THE TE

The TE will assess project performance against expectations set out in the project's Logical Framework/Results Framework (see ToR Annex A). The TE will assess results according to the criteria outlined in the Guidance for TEs of UNDP-supported GEF-financed Projects http://web.undp.org/evaluation/documents/guidance/GEF/UNDP-GEF-TE-Guide.pdf). *(insert hyperlink). (The scope of the TE should detail and include aspects of the project to be covered by the TE, such as the time frame, and the primary issues of concern to users that the TE needs to address.*

The Findings section of the TE report will cover the topics listed below. A full outline of the TE report's content is provided in ToR Annex C.

The asterisk "(*)" indicates criteria for which a rating is required.

Findings

i. Project Design/Formulation

- National priorities and country driven-ness
- Theory of Change
- Gender equality and women's empowerment
- Social and Environmental Standards (Safeguards)
- Analysis of Results Framework: project logic and strategy, indicators
- Assumptions and Risks
- Lessons from other relevant projects (e.g. same focal area) incorporated into project design
- Planned stakeholder participation
- Linkages between project and other interventions within the sector
- Management arrangements

ii. Project Implementation

- Adaptive management (changes to the project design and project outputs during implementation)
- Actual stakeholder participation and partnership arrangements
- Project Finance and Co-finance
- Monitoring & Evaluation: design at entry (*), implementation (*), and overall assessment of M&E (*)
- Implementing Agency (UNDP) (*) and Executing Agency (*), overall project oversight/implementation and execution (*)
- Risk Management, including Social and Environmental Standards (Safeguards)

Terminal Evaluation Terms of Reference (ToR) Template for UNDP-supported GEF-financed projects

1. TE PURPOSE

The TE report will assess the achievement of project results against what was expected to be achieved, and draw lessons that can both improve the sustainability of benefits from this project, and aid in the overall enhancement of UNDP programming. The TE report promotes accountability and transparency, and assesses the extent of project accomplishments.

2. TE APPROACH & METHODOLOGY

The TE report must provide evidence-based information that is credible, reliable and useful.

The TE team/consultant will review all relevant sources of information including documents prepared during the preparation phase (i.e. PIF, UNDP Initiation Plan, UNDP Social and Environmental Screening Procedure/SESP) the Project Document, project reports including annual PIRs, project budget revisions, lesson learned reports, national strategic and legal documents, and any other materials/deliverables produced during the project implementation that the team/consultant considers useful for this evidence-based evaluation. The TE team/consultant will review the baseline and midterm GEF focal area Core Indicators/Tracking Tools submitted to the GEF at the CEO endorsement and midterm stages and the terminal Core Indicators/Tracking Tools that must be completed before the TE field mission begins.

The TE team is expected to follow a participatory and consultative approach ensuring close engagement with the Project Team, government counterparts (the GEF Operational Focal Point), Implementing Partners, the UNDP Country Office(s), the Regional Technical Advisor, direct beneficiaries and other stakeholders.

Engagement of stakeholders is vital to a successful TE. Stakeholder involvement should include interviews with stakeholders who have project responsibilities, including but not limited to sub national governments of Escobar and Tapalqué (Buenos Aires); Fachinal (Misiones), Gualeguachy (Entre Rios); Rafaela (Santa Fe); executing agencies, senior officials and task team/component leaders, key experts and consultants in the subject area, Project Board, project beneficiaries, academia, local government and CSOs, etc. Additionally, the TE team/consultant s expected to conduct field missions to Escobar, Tapalqué and Rafaela.

The specific design and methodology for the TE should emerge from consultations between the TE team/consultant and the above-mentioned parties regarding what is appropriate and feasible for meeting the TE purpose and objectives and answering the evaluation questions, given limitations of budget, time and data. The TE team must use gender-responsive methodologies and tools and ensure that gender equality and women's empowerment, as well as other cross-cutting issues and SDGs are incorporated into the TE report.

The final methodological approach including interview schedule, field visits and data to be used in the evaluation must be clearly outlined in the TE Inception Report and be fully discussed and agreed between UNDP, stakeholders and the TE team.

iii. Project Results

- Assess the achievement of outcomes against indicators by reporting on the level of progress for each objective and outcome indicator at the time of the TE and noting final achievements
- Relevance (*), Effectiveness (*), Efficiency (*) and overall project outcome (*)
- Sustainability: financial (*) , socio-political (*), institutional framework and governance (*), environmental (*), overall likelihood of sustainability (*)
- Country ownership
- Gender equality and women's empowerment
- Cross-cutting issues (poverty alleviation, improved governance, climate change mitigation and adaptation, disaster prevention and recovery, human rights, capacity development, South-South cooperation, knowledge management, volunteerism, etc., as relevant)
- GEF Additionality
- Catalytic Role / Replication Effect
- Progress to impact

Main Findings, Conclusions, Recommendations and Lessons Learned

- The TE team will include a summary of the main findings of the TE report. Findings should be presented as statements of fact that are based on analysis of the data.
- The section on conclusions will be written in light of the findings. Conclusions should be comprehensive and balanced statements that are well substantiated by evidence and logically connected to the TE findings. They should highlight the strengths, weaknesses and results of the project, respond to key evaluation questions and provide insights into the identification of and/or solutions to important problems or issues pertinent to project beneficiaries, UNDP and the GEF, including issues in relation to gender equality and women's empowerment.
- Recommendations should provide concrete, practical, feasible and targeted recommendations directed to the intended users of the evaluation about what actions to take and decisions to make. The recommendations should be specifically supported by the evidence and linked to the findings and conclusions around key questions addressed by the evaluation.
- The TE report should also include lessons that can be taken from the evaluation, including best practices in addressing issues relating to relevance, performance and success that can provide knowledge gained from the particular circumstance (programmatic and evaluation methods used, partnerships, financial leveraging, etc.) that are applicable to other GEF and UNDP interventions. When possible, the TE team should include examples of good practices in project design and implementation.
- It is important for the conclusions, recommendations and lessons learned of the TE report to incorporate gender equality and empowerment of women.

The TE report will include an Evaluation Ratings Table, as shown below:

ToR Table 2: Evaluation Ratings Table for *(project title)*

Monitoring & Evaluation (M&E)	Rating[2]
M&E design at entry	
M&E Plan Implementation	
Overall Quality of M&E	
Implementation & Execution	**Rating**
Quality of UNDP Implementation/Oversight	
Quality of Implementing Partner Execution	
Overall quality of Implementation/Execution	
Assessment of Outcomes	**Rating**
Relevance	
Effectiveness	
Efficiency	
Overall Project Outcome Rating	
Sustainability	**Rating**
Financial resources	
Socio-political/economic	
Institutional framework and governance	
Environmental	
Overall Likelihood of Sustainability	

4. TIMEFRAME

The total duration of the TE will be approximately *(average 25-35 working days)* over a time period of *(# of weeks)* starting on *(date)*. The tentative TE timeframe is as follows:

Timeframe	Activity
March 29th 2022	Application closes

[2] Outcomes, Effectiveness, Efficiency, M&E, Implementation/Oversight & Execution, Relevance are rated on a 6-point scale: 6=Highly Satisfactory (HS), 5=Satisfactory (S), 4=Moderately Satisfactory (MS), 3=Moderately Unsatisfactory (MU), 2=Unsatisfactory (U), 1=Highly Unsatisfactory (HU). Sustainability is rated on a 4-point scale: 4=Likely (L), 3=Moderately Likely (ML), 2=Moderately Unlikely (MU), 1=Unlikely (U)

April 1st 2022	Selection of TE team/consultant
First week after contract (IC) signature- Expected 11th-15th April week	Preparation period for TE team/consultant (handover of documentation)
Expected 18th -20th April week	Document review and preparation of TE Inception Report
April 22nd	Finalization and Validation of TE Inception Report; latest start of TE mission
Expected weeks 25th - 29th April ; 2nd to 6th May and 9th- 11th May.(recommended 7-15)	TE mission: stakeholder meetings, interviews, field visits, etc.
Expected May 16th	Mission wrap-up meeting & presentation of initial findings; earliest end of TE mission
Expected May 30th	Preparation of draft TE report
Expected May30th-June 3rd	Circulation of draft TE report for comments
Expected June 6th- June 10th	Incorporation of comments on draft TE report into Audit Trail & finalization of TE report
Expected June 6th- June 10th	Preparation and Issuance of Management Response
N/A	Concluding Stakeholder Workshop (optional)
Expected June 6th- June 10th	Expected date of full TE completion

Options for site visits should be provided in the TE Inception Report. Visits are expected to be done during the week *2nd to 6th May*

5. TE DELIVERABLES

#	Deliverable	Description	Timing	Responsibilities
1	TE Inception Report	TE team clarifies objectives, methodology and timing of the TE	No later than 2 weeks before the TE mission:	TE team submits Inception Report to Commissioning Unit and project management
2	Presentation	Initial Findings	End of TE mission:	TE team presents to Commissioning Unit and project management
3	Draft TE Report	Full draft report *(using guidelines on report content in ToR Annex C)* with annexes	Within 3 weeks of end of TE mission:	TE team submits to Commissioning Unit; reviewed by RTA, Project Coordinating Unit, GEF OFP
5	Final TE Report* + Audit Trail	Revised final report and TE Audit trail in which the TE details how all received comments have (and have not) been addressed in the final TE report *(See template in ToR Annex H)*	Within 1 week of receiving comments on draft report:	TE team submits both documents to the Commissioning Unit

*All final TE reports will be quality assessed by the UNDP Independent Evaluation Office (IEO). Details of the IEO's quality assessment of decentralized evaluations can be found in Section 6 of the UNDP Evaluation Guidelines.[3]

6. TE ARRANGEMENTS

The principal responsibility for managing the TE resides with the Commissioning Unit. The Commissioning Unit for this project's TE is *(in the case of single-country projects, the Commissioning Unit is the UNDP Country Office. In the case of regional projects and jointly-implemented projects, typically the principal responsibility for managing the TE resides with the country or agency or regional coordination body – please confirm with the RTA in the region – that is receiving the larger portion of GEF financing. For global projects, the Commissioning Unit can be the Nature, Climate and Energy Vertical Fund Directorate or the lead UNDP Country Office.)*

The Commissioning Unit will contract the evaluators and ensure the timely provision of per diems and travel arrangements within the country for the TE team. The Project Team will be responsible for liaising with the TE team to provide all relevant documents, set up stakeholder interviews, and arrange field visits.

7. TE TEAM COMPOSITION

An *independent evaluator* will conduct the TE – *one team leader (with experience and exposure to projects and evaluations in other regions)*

The team leader will *be responsible for the overall design and writing of the TE report, revise documents and visit locations assess emerging trends with respect to regulatory frameworks, budget allocations, capacity building and work with the Project Team in developing the TE, etc.)*

The evaluator(s) cannot have participated in the project preparation, formulation and/or implementation (including the writing of the project document), must not have conducted this project's Mid-Term Review and should not have a conflict of interest with the project's related activities.

Qualities:

Education

- Master's degree in *Environment, Climate or Energy* or other closely related field;

Experience

- Relevant experience with results-based management evaluation methodologies;
- Experience applying SMART indicators and reconstructing or validating baseline scenarios;
- Competence in adaptive management, as applied to Nature, Climate and Energy
- Experience in evaluating projects;
- Experience working in Latin America ;
- Experience in relevant technical areas for at least *10 years;*
- Demonstrated understanding of issues related to gender and; experience in gender responsive evaluation and analysis;
- Excellent communication skills;
- Demonstrable analytical skills;
- Project evaluation/review experience within United Nations system and/or the Global Environmental Facility projects will be considered an asset.

Language

- Fluency in written and spoken English
  Fluency in written and spoken Spanish

8. EVALUATOR ETHICS

The TE team will be held to the highest ethical standards and is required to sign a code of conduct upon acceptance of the assignment. This evaluation will be conducted in accordance with the principles outlined in the UNEG 'Ethical Guidelines for Evaluation'. The evaluator must safeguard the rights and confidentiality of information providers, interviewees and stakeholders through measures to ensure compliance with legal and other relevant codes governing collection of data and reporting on data. The evaluator must also ensure security of collected information before and after the evaluation and protocols to ensure anonymity and confidentiality of sources of information where that is expected. The information knowledge and data gathered in the evaluation process must also be solely used for the evaluation and not for other uses without the express authorization of UNDP and partners.

9. PAYMENT SCHEDULE

- 20% payment upon satisfactory delivery of the final TE Inception Report and approval by the Commissioning Unit- Around April 22nd in accordance to timeframe
- 40% payment upon satisfactory delivery of the draft TE report to the Commissioning Unit- Around May 30th in accordance to timeframe
- 40% payment upon satisfactory delivery of the final TE report and approval by the Commissioning Unit and RTA (via signatures on the TE Report Clearance Form) and delivery of completed TE Audit Trail- Around June 10th in accordance to timeframe

Criteria for issuing the final payment of 40%[4]:

- The final TE report includes all requirements outlined in the TE TOR and is in accordance with the TE guidance.
- The final TE report is clearly written, logically organized, and is specific for this project (i.e. text has not been cut & pasted from other TE reports).
- The Audit Trail includes responses to and justification for each comment listed.

10. TOR ANNEXES

(Add the following annexes to the final ToR)

- ToR Annex A: Project Logical/Results Framework
- ToR Annex B: Project Information Package to be reviewed by TE team
- ToR Annex C: Content of the TE report
- ToR Annex D: Evaluation Criteria Matrix template
- ToR Annex E: UNEG Code of Conduct for Evaluators
- ToR Annex F: TE Rating Scales
- ToR Annex G: TE Report Clearance Form
- ToR Annex H: TE Audit Trail

ANNEX B. ITINERARY, FIELD VISITS, PEOPLE INTERVIEWED AND RESULTS

Fecha	Actividad	Participantes	Topics discussed
Fin de semana	Llegada a Buenos Aires		
Lunes 23	Mañana 10-12 Briefing	Equipo de proyecto: Juan Persico- Clara Barragán, Walter Magnol PNUD: Carolina Robles	▪ Overview of Project implementation and results; issues in implementation; actions of new project team and responsible persons after 2019; Status of landfill gas/biogas pilot projects ▪ Organisation and agenda of the mission (incl. field visits)
	Tarde: revisar documentos		
Martes 24	Mañana: redacción informe		
	Tarde: Reunion GIRSU 14.30 hs. Reunión con proveedor	Carlos Silva (responsable MSW Project and GIRSU en MAyDS) GIRSU: Belen Cerezal; Paula Gonzalez PNUD: Carolina Robles Presencia de EVA SA (proveedor)	▪ Role of RenovAr (large versus *basurales* and small landfills); ▪ Cooperation of project teams of GIRSU and of then UNDP{/GEF project ▪ Relation of Biogas MSW with GIRSU (and role of IDB); Plans for future small-scale landfill gas recovery (linked with GIRSU) and sources of financing ▪ Role of technology providers
25 día feriado			
Jueves 26	Mañana 11.30 Reunion equipo Cancillería	Marta Carlevarino – Alejandro Puglisi Dirección de Proyectos de Implementación Nacional; Secr. de Coordinación y Planificación Exterior - MRECIC	▪ Role of *Cancillería* in Project governance (and of UNDP projects in general) ▪ Post-project sustainability and links with GIRSU
	Tarde: Redacción informe		
Viernes 27	Redacción del informe Revisar documentos		
Fin de semana	Redacción del informe Revisar documentos		
Lunes 30	Mañana: Visita biodigestor Escobar-Mercado concentrador	Carlos Silva (y equipo del biodigestor)	▪ Technical functioning of the biogas plant (works well) and maintenance; use of the gas Importance of providing the right feedstock
	Tarde: Redacción informe		
Martes 31	Mañana: Visita con equipo Almirante Brown-escuela	Coord Juan Persico (y equipo Almirante Brown)	▪ Technical functioning of the biogas plant (not operational; gas production issues to be sorted out) and maintenance; use of the gas and digestate substrate

Mié 01	Mañana: Reunión virtualhras) con equipo Gualeguaychu-Piloto relleno sanitario	Coord Juan Persico (y equipo Gualeguaychú, Ruben Martínez, Ma. de los Angeles Gómez)	▪ Status of the site development: (test phase: good gas production); installation of power generator; importation issues ▪ Future development plans (more landfill cells); Use of electricity (local)
	Tarde: Reunión con el Director Nac. de Proyecto	Dir Nacional - Sergio Federovisky (Secretario, Control y Monitoreo Ambiental, MAyDS)	▪ Importance of Biogas MSW project ▪ Importance of post-project activities for continuation of activities and fill gap between Biogas MSW and post-project /GIRSU activities
Jueves 02	Mañana: Preparar presentación		
	Tarde: 14.30 Presentación de los hallazgos preliminares	PNUD (oficina)	▪ Presentation and discussion of the main findings and recommendations
Viernes 03	Tarde: Redacción informe		
Sábado	Salida de Buenos Aires y regreso a Holanda		

ANNEX C. LIST OF DOCUMENTS COLLECTED AND REVIEWED

The following project reports/documents have been made available before the mission (starting 29 June)

- Informe sobre el Taller de Inicio
- UNDP Project Document;
- PIR (Project Implementation Review), 2018, 2019, 2020, 2021
- Meetings of the *Comité Directivo* (07/2019; 07/2017)
- *Informe de avance* 19-12-2019
- Overview of expenditures (ATLAS) and realized co-financing;
- Other materials produced by the projects, such as training manuals, info brochures, promotional videos and selected technical reports and products
- Technical reports and products (see Box 7 and Box 8 in the main text)
- Annual report 2022 *(Informe de cierre,* draft)

Although not a product of project activities, policy documents, research reports, articles, websites, and other sources of information will be consulted in support of the review on an as-needed basis, such as:

- Estrategia Nacional para la Gestión Integral de Residuos Sólidos Urbanos (ENGIRSU, 2005; SAySD)
- RenovAr (website MEM)
- ProBiomasa (website MAGyP)
- Third National Communication to UNFCCC (2015; SAySD)
- Fourth Biennial Update Report to UNFCCC (2021; MAyDS)
- Reports and data available at www.argentina.gob.ar/economia/energia
- LFG Energy Project Development Handbook (US Environmental Protection Agency, 2021)
- Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, Intergovernmental Panel for Climate Change (2006)
- Waste Management Country Report: Argentina; Holland Circular Hotspot, 2021
- Challenges in Solid Waste Management in Buenos Aires, by A. Nilsson; KTH, Sweden (2016)
- Sustainable Waste Management Challenges in Argentina, by Savino, A. & De Titto, E. (ARS/Isalud); 2019

ANNEX D. QUESTIONNAIRE AND EVALUATION MATRIX

Contents	Model evaluation criteria and/or questions	Indicator(s)	Means and sources of information	Sources of verification
1. Findings: Relevance and design • Relevance and country drivenness • Stakeholder involvement • Assessment of logframe and M&E design	**Relevance:** • Have project outcomes been contributing to national development priorities and plans and taking into account national realities? • Consistency with the GEF focal areas in Climate Change/operational program strategies of the GEF CC and with the UN and UNDP country programming in Argentina • Relevance of the project's objectives, outcomes and outputs to the different target groups of the interventions. **Design:** • Were lessons from other relevant projects (e.g. VEEPL) properly incorporated into the project design? Were the partnership arrangements properly been identified and the roles and responsibilities negotiated prior to project approval? • Has the project's design (logframe) been adequate to address the problems at hand? Was the project internally coherent in its design (logical linkages between expected results and design (components, choice of partners; scope, use of resources)? Do these address gender or social issues? Were any (major) amendments to the assumptions or targets made or planned during the Project's implementation?	**Relevance:** • Extent to which Project supports national energy priorities, policies and strategies • Coherency and complementarity with other national and donor programmes • Extent to GEF climate change focal area is incorporated • Degree to which the project supports aspirations and/or expectations of stakeholders **Design:** • Degree of involvement of government partners and other stakeholders in the Project design process • Number and type of performance measurement indicators (SMART indicators)	• Desk review of project design and technical documents; Documents from GEF; national policies and strategies; • Interviews with project staff management, project partners (incl. former staff), stakeholders (local and national government entities, private sector, universities/NGOs) and UNDP staff	• Interviews with project partners and stakeholders and analysis thereof • Document and report analysis
2. Findings: Results and effectiveness • Assessment of outcomes and outputs (cf. with baseline indicators) • Effectiveness • Global environmental and other impacts	**Results and effectiveness** • To what extent have the expected outcomes and objectives of the project been achieved? • What outputs and outcomes has the project achieved (both qualitative and quantitative results, comparing the expected and realized end-project value of progress indicators of each outcome/output with the baseline value)? • Were objectives, outcomes and outputs achieved on time? How did the project contribute to GHG emissions reduction within the project implementation cycle and beyond?	**Results and effectiveness:** • Level of achievement (as laid out in the logframe) • Achievement of outputs (qualitative, quantitative) and description of activities • Evidence of adaptive management and/or early application of lessons learned	• Desk review of project design and technical documents and other relevant docs • Interviews with project staff management, project partners (incl. former staff), stakeholders (local and national government entities, private sector,	• Interviews with project partners and stakeholders and analysis; • Document and report analysis • Check with publicly available information

Contents	Model evaluation criteria and/or questions	Indicator(s)	Means and sources of information	Sources of verification
	• Were there any unplanned effects? Which external factors have contributed or hindered the achievement of the expected results? Has the project proactively taken advantage of new opportunities?		universities/NGOs) and UNDP staff • Interviews with project experts (national and international)	
3. Findings: implementation, processes and efficiency • Management and administration; role of UNIDO • Monitoring and evaluation systems • Stakeholder engagement and communications • Budget, expenditures and co-financing; procurement	**Implementation and management** • Was the project implemented (by IA) and executed (by EA) in an efficient way? • How efficient was the financial management of the project, including specific reference to cost-effectiveness of its interventions? If there was a difference in the level of expected co-financing and the co-financing realized, what were the reasons for the variance? • How efficient are partnership arrangements for the project? Whether or not national stakeholders participated in project management and decision-making and have ownership for project outcomes and their further replication and scaling-up? Did the project efficiently utilize local capacity in implementation? • How have the project management systems, including progress reporting, administrative and financial systems and monitoring and evaluation system been operating as effective management tools aid in effective implementation and provide a sufficient basis for evaluating performance and decision making? In particular, was the information provided by the M&E system (annual work plans, PIRs, other) was used to improve performance and to adapt to changing needs; What have been management responses to issues and recommendations indicated in progress reports and Mid-Term Review? • Did UNDP and Project staff identify problems in a timely fashion and advice the project? If so, has the project practiced adaptive management e.g., (approve modifications in time)? If so, how effective was the adaptive management practiced under the project and lessons learnt?	**Implementation and management** • Extent to which project partners committed time and resources to the project • Extent of commitment of partners to take over project activities • Evidence of clear roles and responsibilities for operational and management structure **M&E** • Actual use of the M&E system to change or improve decision-making/adaptive management • Share of M&E in the budget • Quality and quantity of progress reports **Stakeholders and communications** • Extent to which project partners committed time and resources to the project • Extent of commitment of partners to take over project activities **Financial planning** • Extent to which inputs have been of suitable quality and available when required to allow the Project to achieve the expected results;	• Desk review of project design and technical documents (incl, PIRs; data on budget; other relevant docs; media coverage, official notices and press releases • Interviews with project staff management, project partners (incl. former staff), stakeholders (local and national government entities, private sector, universities/NGOs) and UNDP staff • Interviews with project experts (national and international)	• Interviews with project partners and stakeholders and analysis thereof • Document and report analysis
4. Findings: sustainability	**Sustainability**	**Sustainability**	• Desk review of project	• Interviews with

Contents	Model evaluation criteria and/or questions	Indicator(s)	Means and sources of information	Sources of verification
and impact • Risks and external factors • Replication	• To what extent are there financial, institutional, social-economic, and/or environmental risks to sustaining long-term project results? how sustainable (or likely to be sustainable) are the outputs and outcomes? • Are there any unaddressed barriers remaining? • Is there an exit strategy that is well planned? If not, what can be done to ensure the sustainability of interventions made? To what extent will the stakeholders sustain the project? **Impact** • How did the project contribute to GHG emissions reduction within the project implementation cycle and beyond? • What impact has the project had on policy, legal and institutional frameworks? What are impacts on SDGs? • Has the project had any impact on gender equality and economic empowerment for women and other marginalized groups? Was it intended to?	• Extent to which risks and assumptions are adequate and are reflected in the project documentation • Extent to which project is likely to be sustainable beyond the project; • Extent to which main stakeholders plan to provide sustainability to the project's results in the future, including commitment of financial resources	design and technical documents (incl, PIRs; other relevant docs) • Interviews with project staff management, project partners (incl. former staff), stakeholders (local and national government entities, private sector, universities/NGOs) and UNDP staff	project partners and stakeholders and analysis thereof • Document and report analysis* • Check with international practices and publicly available information
5. Conclusions and recommendations • Conclusions on the attainment of objectives and results • Lessons learned • Recommendations	• Evaluation conclusions related to the project's achievements and shortfalls (comprehensive and balanced statements which highlight the strengths, weaknesses and results of the project, including a summary of evaluation criteria[43]: o Relevance o Effectiveness o Efficiency o Sustainability o Impacts • What lessons have been learned from the project regarding the design, achievement of outcomes, effectiveness, efficiency for other similar activities in the future? • What recommendations, if any, can be made to follow up or reinforce benefits from the project; Proposals for future directions related to the main objectives	• Ratings of evaluation criteria • Lessons that have been learned regarding the achievement of outcomes and efficiency (implementation) • Recommendations for post-project and future actions	• Interviews with project staff and partners • Desk review of project docs and reports as well as external policy and other docs	• Interviews with project partners and stakeholders and analysis thereof • Document and report analysis

[43] Relevance: How does the project relate to the main objectives of the GEF focal area, and to the environment and development priorities at the local, regional and national levels? Effectiveness: To what extent have the expected outcomes and objectives of the project been achieved? Efficiency: Was the project implemented efficiently and cost-effectively, in line with international and national norms and standards? Sustainability: To what extent are there financial, institutional, social-economic, and/or environmental risks to sustaining long-term project results? Impacts: Are there indications that the project has contributed to, or enabled progress toward, reduced environmental or other impacts?

ANNEX E. CONSULTANT CODE OF CONDUCT FORM

Evaluators/reviewers:

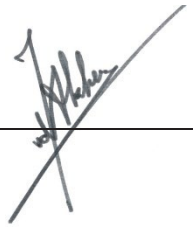
1. Must present information that is complete and fair in its assessment of strengths and weaknesses so that decisions or actions taken are well founded
2. Must disclose the full set of evaluation findings along with information on their limitations and have this accessible to all affected by the evaluation with expressed legal rights to receive results.
3. Should protect the anonymity and confidentiality of individual informants. They should provide maximum notice, minimize demands on time, and respect people's right not to engage. Evaluators must respect people's right to provide information in confidence, and must ensure that sensitive information cannot be traced to its source. Evaluators are not expected to evaluate individuals and must balance an evaluation of management functions with this general principle.
4. Sometimes uncover evidence of wrongdoing while conducting evaluations. Such cases must be reported discreetly to the appropriate investigative body. Evaluators should consult with other relevant oversight entities when there is any doubt about if and how issues should be reported.
5. Should be sensitive to beliefs, manners, and customs and act with integrity and honesty in their relations with all stakeholders. In line with the UN Universal Declaration of Human Rights, evaluators must be sensitive to and address issues of discrimination and gender equality. They should avoid offending the dignity and self-respect of those persons with whom they come in contact in the course of the evaluation. Knowing that evaluation might negatively affect the interests of some stakeholders, evaluators should conduct the evaluation and communicate its purpose and results in a way that clearly respects the stakeholders' dignity and self-worth.
6. Are responsible for their performance and their product(s). They are responsible for the clear, accurate and fair written and/or oral presentation of study limitations, findings, and recommendations.
7. Should reflect sound accounting procedures and be prudent in using the resources of the evaluation.

Evaluation/reviewer Consultant Agreement Form

Agreement to abide by the Code of Conduct for Evaluation in the UN System

Name of Consultant: J.H.A. VAN DEN AKKER (Team Leader)
Name of Consultancy Organization (where relevant): _____
I confirm that I have received and understood and will abide by the United Nations Code of Conduct for Evaluation.

Signed at Lima, Peru
Signature: _____



ANNEX F. ABOUT THE EVALUATOR

Mr. Jan van den Akker is a technology management scientist with a Master's degree from Eindhoven University of Technology (Netherlands), specializing in international development cooperation. He is an expert on sustainable energy policy and technologies. Mr. Van den Akker specializes in studies and analytical work, project design and development, project coordination and implementation, project monitoring and evaluation, knowledge management, capacity strengthening and public-private partnerships in the field of sustainable energy strategies, energy efficiency, energy technologies and supply, climate change and the Clean Development Mechanism. He has lived and worked abroad for over 7 years in Zambia, Mexico, and Thailand. In addition, has undertaken numerous short missions to about 50 countries in Africa, Latin America, and Asia & the Pacific.

In 2003/2004, he founded ASCENDIS, as an independent office, and has been providing consultancy on sustainable energy and climate change, specializing in development issues. ASCENDIS is based in Westerhoven, Netherlands, but offers services in Africa, Asia and the Pacific, Europe and Latin America & the Caribbean, often by associating itself with local freelance experts, professionals, and organizations. As a long-term expert with the United Nations system, Mr. Van den Akker has provided advice to governments and organizations on the design of investment and capacity building programs for UNEP, UNDP and UNIDO (mostly in GEF-funded activities), UNFCCC, European Commission and for NGOs/consultancy companies (e.g., Practical Action Consulting, Winrock, GFA, Sofreco) in the area of renewable energy, energy efficiency and sustainable transportation.

As an independent consultant, he has reviewed and evaluated about 40 GEF-funded sustainable energy projects and assisted in the design of 55 sustainable energy projects, mostly for UNDP, as well as evaluation for the European Union He worked as UNDP Regional Technical Advisor on climate change mitigation (in Eastern and Southern Africa) during 2007-2009 and as Key Expert in the European Union Technical Assistance Facility for Sustainable Energy for All (2015-16). He has also been involved in various advisory assignments (such as feasibility analysis of minigrids, energy efficiency, renewable energy) and analytical work (such as public-private partnerships in grid-connected renewables, climate finance and mitigation priorities, and just energy transition)

ANNEX G. AUDIT TRAIL

Annexed in a separate document