# EVALUATION REPORT

## Terminal Evaluation

## Promoting the Development of Biogas Energy amongst Select Small- and Medium-Sized Agro-Industries

UNIDO Project ID: 100181 and 100179 (PPG)

GEF ID: 5335

4 December 2019

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**Annexes**

## List of acronyms

| | |
|---|---|
| AOP | Annual Operational Plan |
| CARP | Project Regional Advisory Committees (Comités Asesores Regionales del Proyecto) |
| CER | Renewable Energy Centre (Centro de Energías Renovables) |
| CIFES | Centre for Innovation and Promotion of Sustainable Energy (Centro para la Innovación y Fomento de las Energías Sustentables) |
| CORFO | Corporación de Fomento |
| GHG | Greenhouse Gas |
| EQ | Evaluation Question |
| FIA | Foundation for Agricultural Innovation (Fundación para la Innovación Agraria) |
| INE | Instituto Nacional de Estadísticas |
| INIA | Institute of Agriculture Research (Instituto de Investigaciones Agropecuarias) |
| INN | National Standards Institute (Instituto Nacional de Normalización) |
| IPPU | Industrial Process and Products Use |
| LULUCF | Land Use and Land Use Change and Forestry |
| MTR | Mid-term Review |
| NAMA | Nationally Appropriate Mitigation Actions |
| NCh | Chilean Standard of the INN (Norma Chilena) |
| NPV | Net Present Value |
| NCRE | Non-conventional renewable energy |
| PMU | Project Management Unit |
| PPG | Project Preparation Grant |
| REP | Responsibility Extended to the Producer (Responsabilidad Extendida al Productor) |
| SC | Steering Committee |
| SEC | Superintendent for Electricity and Fuels (Superintendencia de Electricidad y Combustibles) |
| SERCOTEC | Technical Cooperation Service (Servicio de Cooperación Técnica) |
| TA | Technical Assistance |
| TE | Terminal Evaluation |
| ToC | Theory of Change |
| ToR | Terms of Reference |
| USACH | Universidad de Santiago de Chile |

# Executive summary

## Evaluation purpose and methodology

The field visit of the Terminal Evaluation (TE) of the UNIDO project "Promoting the Development of Biogas Energy amongst Select Small- and Medium-Sized Agro-Industries" implemented in Chile was conducted in June 2019. As indicated in the Terms of Reference included in Annex I, the TE aims at assessing the project performance in terms of relevance, effectiveness, efficiency, sustainability and progress to impact, as well as at developing a series of findings, lessons and recommendations for enhancing the design of new and implementation of ongoing projects by UNIDO.

The TE has been carried out following the methodology set in the Evaluation Matrix included in Annex II that contains 15 evaluation questions (EQ) under which the overall performance of the project is assessed. The EQ are linked to the evaluation criteria and the questions mentioned in the ToR of the TE. For answering the EQ, two main methods have been adopted: the review of documents produced by the project, as well as other relevant documents of the sector, and the interview of the stakeholders involved in the project and related to the sector. The list of documents reviewed is available in Annex III while the list of stakeholders interviewed is included in Annex IV. There have been no constraints in conducting the TE. The needed documents for conducting the assignment have been made available and the vast majority of stakeholders could be interviewed during the field phase.

## Key findings

The key findings of the project are detailed in chapters 2, 3, 4 and 5. The main impact of the project has been to provide evidence and real figures on the efficiency of existing biogas plants in Southern Chile and to determine the feasibility of expanding such technology to dairy agro-industries. The project responded to the need of the Ministry of Energy to determine the feasibility of installing biogas plants in dairy agro-industries. Based on international figures, it was initially estimated that there was potential for the development of biogas plants in farms of 100-500 cows in the Regions of Los Lagos and Los Ríos in Southern Chile, which present a high concentration of dairy farms. The design was adequately formulated around three relevant components: policy and information, capacity and skills development, and project portfolio and investment. The logframe was adequately formulated but the design relied on the co-financing for implementing the feasible biogas plants that would be identified. The project lacked alternative strategies for implementation in case the assumption on the potential feasibility did not hold true and the co-financing was not made available for implementing the feasible projects.

Further to the pre-feasibility and feasibility studies conducted, and the monitoring of existing biogas plants, the project concluded that the installation of biogas plants in farms of 100-500 cows is economically feasible in few cases and in farms with more than 500 cows the feasibility prospects increase. The project adequately assessed the installation of biogas plants under different scenarios (e.g. individual and collective biogas plants), incorporating additional businesses (e.g. the commercialization of the digestate) and expanding the assessment to bigger farms and farms located in less rainy areas in order to have a full understanding of the viability. Systematically, the different studies yielded negative economic viability results and the efficiency of the biogas plants turned out to be lower than anticipated. It was found that the quantity and quality of the cow manure that would be used as input for the biogas plants resulted in generating less biogas than expected. The studies concluded that biogas plants in dairy agro-industries in Southern Chile could be feasible in farms with a higher number of cows than the ones initially targeted, or in farms located in central Chile with less rain and higher solid percentage of cow manure. Out of more than 50 farms assessed, just four presented positive feasibility results. To date none of these farms have installed biogas plants, because the feasibility studies were finalised by the end of the project, without sufficient time for linking up with potential co-financing sources, and the planned funds for implementing the few feasible projects have not been made available. The public tender for financing the biogas plants was not launched and the Financial Component of the NAMA Facility faces a significant delay and will start only in 2020. Consequently, there is no contribution yet to the objective of reducing the Green-House Gas (GHG) emissions through the viable projects identified. Through the co-financing however, four biogas plants are under development and will contribute to this objective, although these plants are being installed in other sectors than the one targeted. It is unlikely that the four feasible projects identified will be

implemented because the investment cost of biogas plants is too high for the farmers assuming the totality of the cost, especially further to the approval of the new regulation on safety on biogas plants, which has increased the total cost. Funds at regional level may be available for co-financing the investment but their contribution would be marginal compared to the total investment cost needed.

The initially planned 36 months implementation period turned out to be unrealistic and an extension was granted, as recommended by the Mid-term Review. Despite the delays during implementation, most of the planned activities were executed at the planned cost. UNIDO and the National counterparts have performed well in implementing the project. There has been continued support, good follow up and availability of the needed resources when needed. Although female farmers have been involved in the project and their role highlighted, the project did not have a gender strategy, even though it seems that the willingness of farmers to adopt technologies that imply environmental benefits may have a gender dimension.

The planned outputs have been produced with good quality in general. The project has been effective in the policy development component, reaching the planned outcomes in terms of biogas regulations and norms produced. The project has also thoroughly assessed the feasibility of installing biogas plants in the targeted agro-industries and, despite the negative feasibility results, it has been demonstrated that biogas plants will lead to significant positive environmental benefits. The installation of biogas plants would reduce considerably the GHG emissions of the agro-industries compared to the business as usual situation. The manure cow management practices observed in several farms indicate potential negative environmental impacts, related mostly to water pollution. The installation of biogas plants could be one of the possible solutions to improve the management of cow manure in the small agro-industries targeted and it would eliminate the negative environmental impacts derived from the actual practices.

The project has generated valuable information and knowledge in the biogas sector and has kept stakeholders timely informed on progress and on the results of the studies developed. The project has also been actively present in events and has been effective in raising awareness on biogas and in sharing the knowledge generated. Due to Government changes during project implementation, not all stakeholders in the relevant institutions are aware yet on the knowledge generated. The documents are adequately available in the web site of the Ministry of Energy, but they have not been summarised and transformed to adapt the content into the specific needs of the potential users. Awareness has been raised through the trainings, seminars and workshops conducted, and skills have been developed albeit reaching few of the existing biogas plants operators; developing the skills of biogas plant operators could have been relevant taking into account the frequent operation and maintenance problems that current biogas plants in the targeted agro-industries face. The project has however contributed to increasing slightly the number of certified biogas installers in the country.

The summary of achievements compared to the intended outcomes is detailed in the Project Results Framework that is included in Annex V:

| **Intended outcomes in Project Results Framework** | **Actual outcomes as of June 2019** |
|---|---|
| **Objective:** To reduce GHG emissions by promoting investment and market development of biogas energy technologies in small- and medium-sized agro-industries | No GHG emissions have been reduced yet as a consequence of biogas plants installed in small- and medium-sized agro-industries. Under the co-financing, four ongoing biogas plants are being developed although in other sectors than the targeted one. |
| **Outcome 1:** Policies targeting the development of biogas-based electricity and heat generation in agro-industries have been strengthened | A new regulation regarding the safety of biogas plants was adopted in February 2017 and new biogas plants in Chile follow the regulation. Two standards on anaerobic plants design and operation (NCh3381) and on the quality of digestate commercialization (NCh3375) have been published. |
| **Outcome 2:** Adequate design, installation and operation practices for biogas energy plants in the agro-industrial sector have been adopted due to improved capacities of developers, suppliers and technicians | Awareness has been raised on biogas and on the requisites of the new regulation. Technicians have a better understanding on biogas development. The workshops carried out have allowed exchanging experiences among biogas practitioners. |
| **Outcome 3:** Biogas energy has been adopted by select agro-industries | Four feasible projects of biogas plants have been identified but none of them has been implemented yet, due to the production of the feasibility studies by |

| | |
|---|---|
| | the end of the project and the lack of co-financing to cover the investment cost. |

The location of the Regional Coordinator at Consorcio Lechero was appropriate for reaching out to the beneficiaries and for networking with relevant stakeholders, although this position was not sufficiently exploited for further involving the industries and interacting directly with the dairy associations part of Consorcio Lechero in the project.

While biogas development is progressing slowly in Chile, other non-conventional renewable energies, mainly solar and wind, are advancing more than intended. As a consequence, in 2017 the percentage of electricity supplied coming from NCRE significantly exceeded the target set for that year. Few biogas plants are however still being implemented in the country, although these developments take place in other sectors than the targeted one.

## Conclusions, recommendations and lessons

The conclusions, recommendations and lessons learned are explained in chapter 6. The table below summarises the main conclusions with its associated recommendations.

| Conclusions | Recommendations |
|---|---|
| The installation of biogas plants in dairy agro-industries of 100-500 cows in Southern Chile is rarely economically feasible. While this message has been widely known during the project, not all stakeholders are aware that biogas plants can be a valid solution for solving environmental problems detected in the farms. The installation of biogas plants implies a significant reduction of GHG emissions. | Synthesize the relevant conclusions of the studies produced, tailor the information according to the users' need and disseminate succinct information to each of the target groups |
| The information produced by the project is adequately organised and accessible but not adapted to the needs of each of the potential users. | |
| The implementation of biogas plants cannot be seen as mere independent energy supply solutions, but rather as a part of the agro-industries' business with the additional environmental benefits it implies. This perspective shifts the focus of the project from the energy sector to the agriculture and environmental sectors. | Agree on implementing the measures foreseen in the Action Plan related to coordinating actions at central and regional level between the Ministries of Energy and the Ministries of Agriculture and Environment to address the environmental problems in the targeted dairy agro-industries that can be solved with biogas plants. |
| While the legislative framework in the energy sector is favourable for NCRE development, there are gaps in the agriculture and environmental sector that do not help solving the environmental problems detected. | |

Other conclusions can be drawn also in order to extract lessons for future interventions, as summarised below:

| Conclusions | Lessons learned |
|---|---|
| The feasibility of biogas plants depends on multiple factors related to the specific context of the project. The project was designed based on international reference figures of potential biogas production which resulted in assuming that a vast majority of feasible projects would be identified and implemented in 3 years, financed by the co-financing. These assumptions did not hold true. | It is unrealistic to develop pre-feasibility and feasibility studies, as well as implement the projects in just 3 years.<br>For ensuring the availability of funds for investment, not all the investment should rely on external funds, as this depends on factors project cannot control. |
| It was assumed that a significant number of feasible projects would be identified and that farmers would be willing to adopt the technology with the co-financing provided. The project had however not assessed the motivations and attitudes of beneficiaries towards the new technology promoted. | The adoption of new techniques implies behavioural changes in the target group and it is necessary to know better the characteristics of the beneficiaries in terms of attitudes and willingness to adopt the new technologies. Awareness raising and education are in general necessary for promoting new technologies, but methodologies to study, select and involve the beneficiaries are equally important to pursue the intended behavioural change. The gender dimension should not be forgotten as a factor determining the different attitudes towards the technology. |
| The coordination mechanisms of the project have been established at central and regional level, which are useful for articulating actions and linking up with regional funds that could co-finance the biogas plants. The meetings have ceased once the project ended. | Basing the necessary multi-stakeholder dialogue on existing coordination mechanisms may ensure its continuity beyond the project's implementation period, which is necessary for broadening the adoption of new technologies in the long term. |

| Conclusions | Lessons learned |
|---|---|
| The results achieved in the second component (capacity development and technical skills) are more modest and concern mostly raising awareness on biogas plants. The lack of a capacity development strategy has reduced the effectiveness and sustainability of this component. | Skills development of new technologies are essential for ensuring their implementation and maintenance. Sound capacity development strategies need to be developed in order to focus the skills development to the right target group. Training institutions that would adopt the curriculum developed and that could continue once the project ends should be involved during project implementation. Consequently the identification of training institutions should consider not only their experience and capacity to coordinate different skills development programmes but mostly the likelihood of integrating new training modules into their existing programmes. |

## Project ratings

The evaluation criteria have been rated according to UNIDO's six-point rating system: Highly Satisfactory (HS), Satisfactory (S), Moderately Satisfactory (MS), Moderately Unsatisfactory (MU), Unsatisfactory (U) and Highly Unsatisfactory (HU). The summary of the rating is detailed below:

| Criterion | Rating |
|---|---|
| **Impact** | MS |
| **Project Design** | |
| • Overall Design | MS |
| • Logframe | S |
| **Project performance** | |
| • Relevance | MS |
| • Effectiveness | MS |
| • Efficiency | MS |
| • Sustainability of benefits | MU |
| **Cross-cutting performance criteria** | |
| • Gender mainstreaming | MU |
| • M&E | S |
| • Results-based management | S |
| **Performance of partners** | |
| • UNIDO | S |
| • National counterparts | S |
| **Overall rating** | **MS** |

# 1 Introduction

1. An independent Terminal Evaluation (TE) of the UNIDO project in Chile entitled "**Promoting the Development of Biogas Energy amongst Select Small- and Medium-Sized Agro-Industries"** was included as part of the project design in 2012. In line with the Terms of Reference of the TE included in Annex I and following UNIDO Evaluation Policy and GEF Monitoring & Evaluation Policy, this TE has been carried out during the period June-August 2019 by an independent international consultant (Mr. Iosu Arizkorreta).

2. The Biogas Project ("Proyecto Biogás Lechero") was launched in Chile in November 2014 by UNIDO and executed by the Centro de Energías Renovables (CER) first and then by the Ministry of Energy, together with INIA, the Institute for Agriculture Research. The Biogas Project was completed in July 2019, over a period of 52 months.

## 1.1 Evaluation objectives and scope

3. The purpose of this TE is to assess the mentioned project in order to help UNIDO improve the performance and results of ongoing and future programmes and projects. The TE covers the whole duration of the project from its start in November 2014 to the completion in July 2019. The evaluation has two specific objectives:
   - Assess the project performance in terms of relevance, effectiveness, efficiency, sustainability and progress to impact.
   - Develop a series of findings, lessons and recommendations for enhancing the design of new and implementation of ongoing projects by UNIDO.

4. In terms of scope, the TE assessed to which extent the project achieved its objectives and outcomes. It analysed the quality of the services provided by the Project Management Unit (PMU), the implementation of the planned activities and to what extent the results achieved are likely to be sustained.

## 1.2 Overview of the Project Context

5. In 2015 the Government of Chile approved the Energy Policy 2050, structured around four pillars (security and supply quality, energy as driver of development, energy compatible with the environment and, efficiency and energy education), and aiming at increasing the share of renewable energy. Agro-industries could contribute to this objective and may benefit from biomass waste biogas systems based on anaerobic digestion of animal manure and other organic waste. The number of biogas plants in the country has increased, from 26 in 2012, to 57 in 2016, 107 in 2017 and 144 in 2019. In 2017 just 16% of the biogas plants installed in Chile were in the dairy agro-industrial sector and in general there are problems in the operation of the plants installed in the targeted agro-industries, since just around 60%-70% of the plants operate as expected[1].

6. The installed capacity in the country has increased from 20,375 MW in 2015 to 23,315 MW in 2017 and non-conventional renewable energies (NCRE)[2] have significantly increased their share in the capacity installed: while when the project started in 2014 the capacity installed from NCRE was 1,352 MW, in 2018 it was 4,857 MW. This growth corresponds mostly to the development of wind and solar energy that in 2018 comprised 81% of the capacity installed in NCRE. In 2018, 53% of the total capacity installed corresponds to thermoelectricity, 26% to conventional hydroelectricity and 21% to NCRE[3].

7. The regulatory and market conditions are positive for NCRE development. There have been three different Governments in the country since the project was designed in 2012: the first government of President Piñera (March 2010-March 2014) during which the project was designed, the second government of President Bachelet (March 2014-March 2018) during which most of the activities

[1] Data from CER (2012), INIA (2017) and the Ministry of Energy (2017 and 2019).
[2] The Second National Communication for Chile defines NCRE as wind energy, small scale hydro power (plants up to 20 MW), biomass, biogas, geothermal energy, solar and tidal energy.
[3] Anuario Estadístico de Energía 2018, Comisión Nacional de Energía

of the project were implemented, and the second government of President Piñera (since March 2018). Relevant legislation has been introduced to develop NCRE, such as the Net Billing Law (Law 20.571), approved in 2013 for small generators with capacities up to 100 kW. All governments have promoted the development of NCRE albeit refusing to establish public subsidies to promote their implementation.

8. The Government has introduced targets to the electric companies related to the share of electricity supplied coming from NCRE. Due to the surge in the wind and solar energy production, in 2017 the percentage of electricity supplied coming from NCRE significantly exceeded the target set for that year.

9. In 2016 the total Greenhouse Gas (GHG) emissions in Chile reached 111 million $tCO_2eq$, which represents an increase of 114% compared to 1990 and of 7% since 2013[4]. The main sectors that contributed in 2016 to the GHG emissions were energy (78% of the total, including fuel for transport), agriculture (10.6%), Industrial Process and Products Use (IPPU – 6.2% of the total) and waste (5.2%). All these sectors are increasing their GHG emissions except agriculture, which shows a decrease in the emissions compared to the 1990 and 2013 levels. The decrease in GHG emissions in the agriculture sector is mainly due to the reduction in the number of cows and sheep in the country in the last decade, even though the pig and poultry population has increased and the use of fertilizers has continued to grow. The Land Use and Land Use Change and Forestry (LULUCF) sector consistently absorbs $CO_2$ and has a climate change mitigation potential. The fires that occurred in the last years have however reduced the $CO_2$ absorption capacity of the sector. The total emissions are dominated by $CO_2$ (78.7%), followed by $CH_4$ (12.5%) and $N_2O$ (6%). The country is committed to reducing emissions by 30% by 2030 compared to 2007 level.

10. There is no specific legislation for the dairy sector and its industrial and productive activity is subject to the general industrial legislation. The health and environmental legislation applicable to industries focuses on treating the wastes produced in the production process. In the dairy sector the livestock effluent (e.g. cow manure) is used as nutrient directly applied to meadows and crops. There are regulations linked to the possible air and odour pollution derived from livestock effluents.

11. According to the figures of the National Institute of Statistics (INE – Instituto Nacional de Estadísticas), in 2017 the X and XIV regions targeted by the project concentrated 45% of the cattle in the country for milk and meat production. The dairy industry of Chile is concentrated in these two regions, which in 2015 concentrated 83% of the cattle used for dairy production in the country (56% in the X Region and 27% in the XIV Region). Most of the dairy agro-industries are grouped in associations, such as Fedeleche, Aproleche, Aproval, Saval and Sago. Consorcio Lechero, based in Osorno (Region X) is a platform for coordinating stakeholders in the dairy sector. The main companies in the dairy sector are Colún (which concentrates 27% of the total production), Soprole (24%), Nestlé (18%) and Watts (12%); these companies do not have specific projects on cow manure management and/or biogas plants development in the fields of their producers. Some companies have however plants for managing the liquid industrial wastes, mainly related to cheese production.

## 1.3 Overview of the Project

12. The key objective of the project is to reduce GHG emissions by promoting investment and market development of biogas energy technologies in selected agro-industries in Chile. The expected outcomes are:

    a. Policies and information targeting the development of biogas-based electricity and heat generation in agro-industries have been strengthened.

    b. Adequate design, installation and operation practices for biogas energy plants in the agro-industrial sector have been adopted due to improved capacities of developers, suppliers and technicians.

    c. Biogas energy has been adopted by select agro-industries.

[4] Tercer Informe Bienal de Actualización de Chile sobre Cambio Climático, Ministerio de Medio Ambiente 2018.

The project implementation started in November 2014 and has been finalised in July 2019 (the initial project end date was September 2017).

13. The general approved information on the project is presented in the following table 1:

**Table 1.** General approved information on the project

| | |
|---|---|
| **Project title** | Promoting the Development of Biogas Energy amongst Select Small- and Medium-Sized Agro-Industries |
| **GEF ID number** | 5335 |
| **UNIDO ID (SAP Number)** | 100181 |
| **Region** | LAC |
| **Country(ies)** | Chile |
| **GEF Focal area and operational program:** | Climate Change<br>CCM-3 |
| **Co-implementing agency(ies)** | - |
| **GEF agencies (implementing agency)** | UNIDO |
| **Project executing partners** | Renewable Energy Centre (CER) at time of MSP approval, Ministry of Energy after government changes |
| **Project size (FSP, MSP, EA)** | MSP |
| **Project CEO endorsement/Approval date** | 4 September 2014 (date of MSP approval) |
| **Project implementation start date (PAD issuance date)** | 6 November 2014 |
| **Original expected implementation end date (indicated in CEO endorsement/Approval** | 6 November 2017 |
| **Revised expected implementation date (if any)** | 31 July 2019 |
| **Project duration** | 52 months |
| **GEF grant (USD)** | 1,715,151 |
| **GEF PPG (USD) (if any)** | 50,000 (excluding project agency fee) |
| **Co-financing (USD) at CEO endorsement** | 16,444,500 |
| **Total project cost (USD) (GEF grant + co-financing at CEO endorsement)** | 18,159,651 |
| **Agency fee (USD)** | 162,939 |

14. UNIDO is the implementing agency for the project. The Executing Agency at the time of the MSP approval was the CER, an agency of the Ministry of Energy serving as information and guidance for the public and private sectors, as well as academia. In November 2014, the CER became CIFES (Centre for Innovation and Promotion of Sustainable Energy), which was the Executing Agency responsible for implementation at the time of project approval, through a designated National Project Coordinator. CIFES operated in coordination with CORFO[5] (Corporación de Fomento) and the Ministry of Energy. In May 2016, the Ministry of Energy announced that CIFES as such would cease to exist and that all international projects led by CIFES, with the exception of solar power related initiatives, would be transferred to the Ministry of Energy. The National Project Director initially appointed by the CER was transferred to the Ministry of Energy and retained his functions. Since July 2016 the Ministry of Energy is in charge of the implementation of the project.

15. The project established a Steering Committee (SC) as its highest decision-making organ, which planned to meet on a bi-annual basis. The SC included representatives from UNIDO, the Ministry of Energy, Ministry of Environment, Ministry of Agriculture (through ODEPA, the Bureau for Studies and Agriculture Policies – Oficina de Estudios y Políticas Agrarias), GEF Focal Point, and the National Project Coordinator, the latter only as Secretary to the SC.

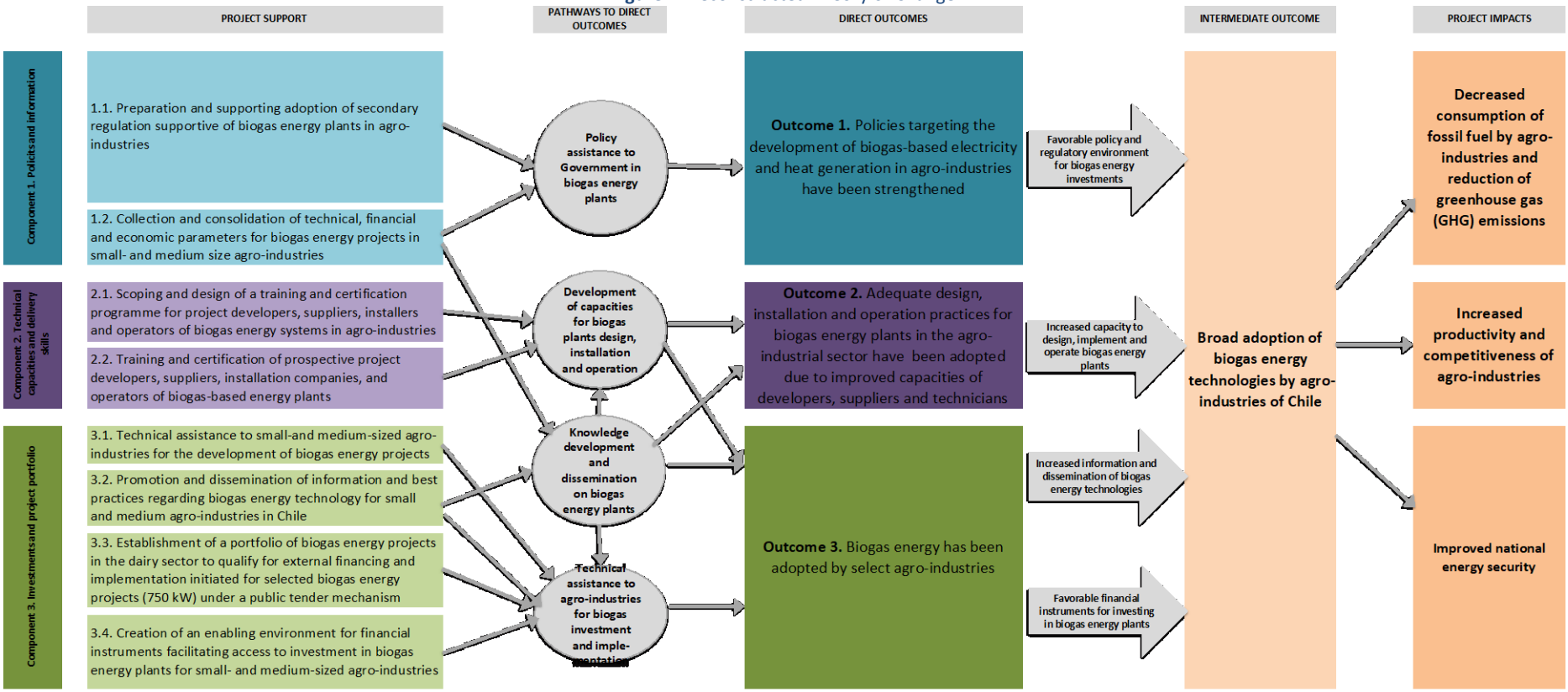
16. The Project Management Unit (PMU) was responsible for the day-to-day management and coordination. It was staffed by the National Project Coordinator and a Regional Coordinator, based in the offices of Consorcio Lechero in Osorno (X Region).

[5] CORFO, founded in 1939, is the public agency in charge of promoting economic development focusing on the national production of goods and services.

## 1.4 Theory of Change

17. The next page includes the reconstructed Theory of Change (ToC) based on the project results framework.

**Figure 1.** Reconstructed Theory of Change




**Assumptions:**
1) Sustained government commitment to strengthen regulatory framework andapproval of the proposed regulation by National Congress
2) Adequate coordination between involved authorities and sector stakeholders
3) Sector stakeholders are willing to share information
4) Installed biogas systems yield realistic data on project design, cost and performance
5) Interest of stakeholders in training on biogas technology and of women's associations to be consulted
6) Baseline activities provide a solid institutional context
7) Call for proposals on biogas proceed as expected
8) Sufficient expert support is available
9) Agreements between Government, NAMA Facility and lending institutions

**Assumptions:**
1) Sustained government commitment to strengthen regulatory framework and interest in biogas market development
2) Demonstrated economic, social and environmental benefits of decentralized (biogas) power generation compared to baseline situation
3) Proposed projects are able to attract adequate financing

**Targeted agro-industries:** Medium-sized (100 to 500 cows) dairy farms of Los Rios and Los Lagos regions

## 1.5 Evaluation Methodology

18. The TE has been carried out following the methodology set in the Evaluation Matrix (see Annex II). The Evaluation Matrix contains 15 evaluation questions (EQ) that help assessing the overall performance of the project and drawing lessons for future interventions. The EQs are linked to the questions indicated in the ToR and the evaluation criteria of relevance, quality of design, efficiency, effectiveness, impact, sustainability, gender mainstreaming, role of partners and added-value elements. Sub-questions are listed for each of the EQs, and the evaluation tools and data sources for each of the questions is detailed in the Evaluation Matrix. The Evaluation Matrix included in Annex II details the list of the EQs, with its sub-questions, as well as the evaluation tools and main evidence source.

19. For answering the EQs, the evaluation methodology is based on the review of documents and on interviewing key stakeholders who have been involved during project implementation or that are related to biogas development in Chile. The list of documents reviewed is detailed in Annex III and they correspond to documents produced by the project (e.g. progress reports, feasibility studies, workplans) and other stakeholders (e.g. Energy Policy). The main documents have been made available for the TE and they allowed preparing adequately the field mission. Few documents were missing before the field mission started (minutes of regional working groups, report of the Regional Workshop I, final report of the use of digestate) and they were made available shortly after the start of the field mission. The stakeholders interviewed concern those involved in the project (project management unit, national policy-makers, target groups, beneficiaries), as well as other stakeholders involved in the biogas sector (donors, industries, other related projects) even though they have not been involved directly in the project. The list of stakeholders met during the TE is in Annex IV. The information collected through these two methods has been recorded and organised according to the EQs and sub-questions.

20. The TE comprised a desk phase for reviewing the documents and preparing the agenda of the field phase. The field phase was conducted from 17 to 28 June in Chile where the stakeholders listed in Annex IV were met. On 27 June, the last Steering Committee of the project was held, and the TE communicated the preliminary conclusions and recommendation. Following the field phase the TE report was drafted.

## 1.6 Limitations of the Evaluation

21. There were no significant limitations for carrying out the TE. The needed documents were made available for the analysis and most of the planned meetings could take place. The main stakeholders could also be met, although it was challenging to get feedback from the universe of around 800 agro-industries targeted by the project in the X and XIV regions. The TE was not intended however to get feedback from all these agro-industries and a sample of farmers were interviewed (both physically and by phone) to get an idea on the effects of the project. The information collected was sufficient for that assessment. On the other hand, the vast majority of the institutional stakeholders could be met. The few exceptions were for instance the Ministry of Environment, which could not be met since the representative was out of the country during the field visit. This however did not hamper getting the needed information and answering the EQs.

# 2 Project's contribution to Development Results – Effectiveness and Impact

## 2.1 Project's achieved results and overall effectiveness

**EQ7.** What have been the project's key results outputs and to what extent they correspond to the planned ones?

22. Most of the planned outputs have been delivered, even though later than expected in some cases. The outputs present in general good quality and stakeholders have a positive impression on this contribution. The detail of outputs produced compared to the initial plan is included in Annex V.

23. In the first component (Policy and Information), the main outputs produced are as follows:

    - Regulation of safety for biogas installation validated by the Superintendent for Electricity and Fuels (SEC).
    - Publication by the National Standards Institute (INN – Instituto Nacional de Normalización) of the Technical Standards regulating the quality of the digestate for commercialization (NCh3375) and the design and operation of biogas plants (NCh3381).
    - Manual for the design, construction, operation maintenance and control of biogas facilities.

    Workshops and multi-stakeholder discussions were organised for drafting the regulation for safety of biogas installation, as well as for the technical standards on the quality of digestate commercialization and on the design and operation of anaerobic plants (output 1.1). Under output 1.2, a baseline study on biogas projects in the dairy sector was also conducted in 2016, which concluded that the development of biogas plants in the dairy agro-industries was still incipient, that the potential of biogas generation in the two targeted regions based on international figures was estimated to be of 283,913 MWh/year, and that the GHG emissions of manure cow management could be reduced by 82% with the installation of biogas plants. Several barriers were identified for promoting the technology (this aspect is further explained in chapter 2.2. Impact). Project summaries of the 14 existing biogas plants in dairy agro-industries of the two targeted regions were produced, noting the weak penetration of this technology among the dairy agro-industries, the fact that half of them were not operational and the lack of information in the agro-industries on both cow manure and biogas production. A study was also produced aimed at identifying the gaps for existing biogas plants in order to be registered in the SEC and fulfil the regulation on safety for biogas plants. It was found that most owners of biogas plants (74 were identified in 2015 across the country in all sectors), as well as developers of the plants, were not aware of the existing biogas norms and of the register established by SEC. In general, the activities related to outputs 1.1 and 1.2 were produced timely and output 1.1 was instrumental in producing the subsequent regulation for the safety of biogas installation.

24. Under component 2 (technical capacity and delivery skills), different training programmes and workshops were designed by different institutions responsible for each of the training proposed (output 2.1). The workshops and seminars were necessary to raise awareness on biogas. A technological tour to Costa Rica and Mexico was organised by Consorcio Lechero and 12 farmers participated. Initially, it was planned that INIA would conduct all the training courses, but since INIA did not have the means and experience to conduct trainings to all the target groups (i.e. from operators of the biogas plants, to installers of biogas plants, to decision-makers), it was appropriately decided to implement the trainings through other organisations. The project aimed at training 75 biogas professionals and at certifying 50 biogas professionals, but these targets were not met. 73 people were trained in the biogas plant operators training course, but just 30 (8 of which women) completed successfully the training. On the other hand, the participants to that training were professionals, but not the actual operators of existing biogas plants in dairy farms. 20 people participated in the biogas specialist training course, but just 9 finalised it (of which one woman). From the training courses in which sex-disaggregation information is available, it can be concluded that the percentage of women trained that completed the training course was above

the target of 10%. The details of the trainings and workshops conducted are described in the table below (the figures in brackets correspond to the number of women out of the total indicated).

**Table 2.** Trainings, workshops and seminars carried out by the project

| Training | Institution | Date & location | Duration | People trained | |
|---|---|---|---|---|---|
| | | | | Total participants | Finalised / approved |
| **Workshops and seminars** | | | | | |
| Technological Tour Redbiolac | Canales | November 2015 (Santiago) | 3 days | 10 (unknown) | 10 (unknown) |
| Technological Tour | Consorcio Lechero | September 2016 (Costa Rica and Mexico) | 1 week | 12 (2) | 12 (2) |
| Seminar for the dissemination of the technological tour | Consorcio Lechero | October 2016 | 1 day | 115 (unknown) | 115 (unknown) |
| Regional Workshop: Regulation on biogas plants safety | Consorcio Lechero | October 2016 | Half day | 15 (6) | 15 (6) |
| Regional Meeting: Regulation on biogas plants safety | Consorcio Lechero | November 2016 | 1 day | 21 (7) | 21 (7) |
| International seminars | INIA | June 2017 (Valdivia) | Meeting: 1 day | 16 (7) | 16 (7) |
| | | | Seminar: 1 day | 105 (41) | 105 (41) |
| | | December 2018 (Puerto Montt) | 1 day | 48 (21) | 48 (21) |
| Regional workshops | INIA | June 2017 (INIA Remehue) | 1 day | 32 (15) | 32 (15) |
| | | October 2017 (Paillaco) | 1 day | 30 (14) | 30 (14) |
| | | May 2018 (Purranque) | 1 day | 20 (6) | 20 (6) |
| **Trainings** | | | | | |
| Biogas specialist | AS&D | October 2016 (Osorno) | 28 hours | 20 (3) | 9 (1) |
| Training of trainers | U Adolfo Ibáñez/IBBK | May-June 2018 (Santiago) | 1 week | 30 (9) | 30 (9) |
| Biogas plant operators | USACH | Aug-Oct 2018 (Santiago) | 110 hours[6] | 37 (5) | 10 (2) |
| | | Aug-Oct 2018 (Osorno) | | 22 (6) | 14 (5) |
| | | July-October (Valdivia) | | 14 (2) | 6 (1) |
| Decision-makers training | AS&D | December 2018 (Valdivia) | 2 days | 9 (4) | 23 (unknown) |
| | | December 2018 (Pto Montt) | 2 days | 5 (2) | |
| | | December 2018 (Santiago) | 2 days | 20 (10) | |

25. The quality of the training courses varies, although most of the courses were positively considered by participants (e.g. training of trainers). According to the questionnaires sent to participants after the training course, few training courses were poorly evaluated by participants; among them was the biogas plant operator training course. The training of biogas specialists carried out by the project in Osorno in 2016 was one of the five training courses developed by SEC in the country in the period 2014-2017. The training of trainers was appropriate in order to ensure the sustainability of the capacity development and the course was based on Chile Valora's professional profile for biogas plant operators.

26. The interest of stakeholders in participating in the training courses and workshops decreased during project implementation and in general not all participants completed the training courses. For instance, the three regional workshops organised in order to disseminate knowledge on biogas plants indicate a progressive decrease in the number of participants. The participants to the regional workshops ranged from farmers with or without biogas plants, to beneficiaries of the pre-feasibility studies, to representatives from Universities. In the training to decision-makers, 184 invitations were sent and 74 signed up to the different training courses. Just 49 of the decision-makers that signed up complied with the criteria and were inscribed. Finally, just 34 people participated in the course but only 23 attended the 2-day training course. On the other hand, it was more difficult to involve decision-makers from the targeted regions than those from the capital: out of the 34 participants, 20 came from Santiago.

27. In component 3 (investment and project portfolio), the TA to beneficiaries has been provided from May 2015 to April 2019, the report on legal and regulatory framework was delivered and 20 summaries on biogas plants were produced (output 3.1). The study on 20 farms already yielded some light with respect to the feasibility of implementing biogas plants: the feasibility was considered positive in 14 of the 20 farms if biogas generation is combined with the

[6] Each of the training courses was designed for 110 hours, 70 of which corresponded to e-learning and 40 hours were presential.

commercialization of the digestate and just in one farm the installation of the biogas plant could be economically viable without the commercialization of the digestate. The $CO_2$ calculator and the monitoring guide were also produced (output 3.2). The main planned output of this component corresponded to the identification of feasible biogas projects that would lead to their financing through public funds (output 3.3). In this respect, the project was active in producing 53 pre-feasibility studies divided in five different lots that were carried out by four consulting companies. Contrary to the initial assumption of the project, the installation of biogas plants would be economical feasible in few of the agro-industries studied.

**Table 3.** Summary of pre-feasibility studies conducted

| Lot | Company | Scope | Results |
|---|---|---|---|
| 1 | AS&D | 5 farms with existing biogas plants in the X Region, each with 160 to 350 cows | Lower than expected biogas production (20-25% of manure cow used as input); not all bio-digestors operate correctly. None of the plants is registered at SEC. Owners of the plants do not look only for economic profitability, but for environmental benefits as well. The needed investment for improving the efficiency of the plants is not economically viable. |
| 2 | EBP | 3 associative projects for 2 and 3 farms in the X and XIV Region (each with 155 to 783 cows) | Collective biogas plants are not feasible economically, due to high investment cost and long distance and transport cost between the farms.<br>Biogas plants would reduce GHG emissions between 78% to 98% compared to business as usual scenario. |
| 3 | EBP | 15 farms in the X and XIV Region (each with 110 to 650 cows) | Biogas plants are in general economically not feasible and just 2 farms show positive results (payback < 20 years).<br>Manure cow collected is not optimal for biogas production.<br>Biogas plants would reduce GHG emissions between 83% to 96% compared to business as usual scenario. |
| 4 | Biotecsur | 15 farms in the X Region (each with 90 to 358 cows) | 3 of the farms could be economically feasible (payback within 20 years). The management of manure cow in 10 of the f15 arms assessed could have negative environmental impacts. |
| 5 | TTA | 15 farms in the X and XIV Region (each with 320 to 1,000 cows) | 10 projects have a payback within 20 years but none of the projects has a positive Net Present Value (NPV) if 100% of the investment is to be paid by the farmers. Few farms have waterproof wells for manure disposal. |

28. After the initial indications of the 20 farms assessed by INIA that economic feasibility could be more difficult than expected, the project expanded its initial scope in the pre-feasibility studies to collective biogas plants and few farms with more than 500 cows were also assessed, as indicated in the table above. However, few cases of the 53 farms assessed in pre-feasibility studies indicated potential viability. Five farms studied in the pre-feasibility studies were assessed in the feasibility study, together with four dairy agro-industries outside the targeted regions; these farms had more than 500 cows and/or higher periods of cattle housing. Instead of the 20 feasibility studies initially planned, 9 studies were conducted by the company TTA with the results summarised in the following table.

**Table 4.** Summary of the feasibility studies carried out

| Farm | Type of biodigestor | % of manure collected | Number of cows | $m^3$ biogas produced / year | Investment (USD)[7] | Pay-back (years) |
|---|---|---|---|---|---|---|
| Tronador (*) | Covered lagoon | 29.76% | 1,185 | 151,029 | 577,000 | 8.15 |
| Las Mercedes (*) | Complete mix | 96.37% | 794 | 380,255 | 834,000 | 7.47 |
| Las Tórtolas | Complete mix | 37.56% | 303 | 76,729 | 462,800 | 16.44 |
| San Jorge | Covered lagoon | 40.92% | 500 | 170,291 | 488,000 | 9.90 |
| La Engorda | Covered lagoon | 39.89% | 478 | 53,540 | 334,500 | 11.96 |

[7] The investment cost indicated in USD is an approximative figure from the original cost calculated in Chilean Pesos (CLP); the exchange rate used is 1 USD = 700 CLP.

| Farm | Type of biodigestor | % of manure collected | Number of cows | m³ biogas produced / year | Investment (USD)[7] | Pay-back (years) |
|---|---|---|---|---|---|---|
| La Gruta | Complete mix | 40.65% | 500 | 111,678 | 483,800 | 12.43 |
| La Rotunda (*) | Covered lagoon | 42.67% | 880 | 124,384 | 550,300 | 7.59 |
| Santa Elena | Covered lagoon | 85.11% | 400 | 41,583 | 1,411,500 | > 20 |
| Santa Amalia (*) | Complete mix | 31.50% | 1,200 | 573,999 | 844,700 | 4.43 |

29. Four of the 9 projects assessed presented positive economic results in the feasibility studies (indicated with an asterisk in the table above): Tronador, Las Mercedes, La Rotunda and Santa Amalia. There is no correlation between the type of biodigestor proposed (covered lagoon or complete mix) and the feasibility obtained. None of the projects that yielded positive feasibility results has been implemented yet. The Government did not launch the planned public tender to finance the feasible projects. A tender was launched by the Foundation for Agricultural Innovation (FIA – Fundación para la Innovación Agraria) with resources from the Ministry of Energy in 2013-2014, i.e. before the present project started, directed to NCRE projects. Two biogas projects in the dairy sector were selected.

30. Regarding the development of an enabling environment for the financing of biogas projects (output 3.4) there has not been much progress, mainly due to the fact that the initiatives in which the project relied, i.e. the NAMA financial component, has suffered significant delays; it is expected that the financial component of NAMA will only start in 2020. Nevertheless, the project developed a searcher on financing instruments for biogas projects that is available at the web site of the Ministry of Energy. There is still private investment in the biogas sector in the country, even though progress is slow compared to other renewable energies. The Chilean private company Schwager has four biogas projects under development, but none of them in the dairy sector.

**EQ8.** What is the likelihood of the planned outcomes being achieved?

31. The level of achievement of the outcomes according to the logframe indicators is detailed in Annex V. Outcome 1 (Policies targeting the development of biogas-based electricity and heat generation) has been achieved as intended. The policy gap identified was the lack of a regulation for ensuring the safety of biogas plants installation and that regulation was adopted in February 2017. Additionally, two standards on anaerobic plants design and operation (NCh3381) and on the quality of digestate commercialization (NCh3375) were issued by the INN in February 2015 and 2016, respectively. The implementation of the regulation on biogas installation safety was necessary in order to have a framework for biogas development that would ensure the safety in the installation and operation of the plants. The regulation is detailed and it has defined standards, which also suppose an increase in the investment needed for developing new biogas plants, compared to the previous situation. The study produced for identifying the gaps for existing biogas plants in order to be inscribed in the SEC found that the cost for raising the standards of the existing biogas plants to the requisites of the new regulation could be considerable in some cases[8]. While this regulation was necessary, the development of biogas plants may be hampered in some cases due to the increase in the investment needed.

32. The intended contribution to outcome 2 (adequate design, installation and operation practices for biogas energy plants in the agro-industrial sector have been adopted due to increased capacity of developers, suppliers and technicians) has been lower than expected. The main contribution of the project has been to sensitise and raise awareness on biogas plants development in the dairy sector. It is estimated that more than 200 people have participated in the different workshops and seminars that have been organised. But there has not been a tangible effect in increasing the capacity of biogas plants operators in order to overcome the problems they face in the operation and maintenance of the plants: the 20 people trained that completed the course aimed at biogas plants operators were University students and professionals, but not the farm workers that operate the existing biogas plants. The biogas specialist training course contributed to the

[8] Five cases were studied with costs of biogas plants spanning from USD 11,500 to USD 640,000, with the % of cost of investment vs cost for eliminating the gap ranging from 149% in the former and 4% in the latter.

programme developed by SEC. Just 17 installers of biogas plants are certified in the country by SEC, and one of them was certified after completing the training course implemented by the project (in which 9 participants, out of the 20 enrolled, successfully completed the training course). There are few companies in the country that design and build biogas plants and they have been involved in the project activities. This has allowed the designers and builders of biogas plants acquiring additional knowledge. On the other hand, the workshops and seminars implemented have allowed sharing the experience of these companies in implementing and eventually operating biogas plants.

33. The negative results of most of the feasibility studies carried out, as well as their late delivery, just few months before the project needed to be finalised, has resulted in outcome 3 (biogas energy has been adopted by select agro-industries) not being achieved yet. The reduced number of dairy agro-industries where biogas plants would result economically feasible and the high investment costs suggest that probably there will not be a development of this technology in the targeted dairy agro-industries. The four agro-industries with positive results in the feasibility study indicate an investment cost between USD 550,000 to USD 850,000. Even though the pay-back may be short in some cases, the investment is significant taking into account that there are no specific government subsidies for the development of biogas plants. Although co-financing may be obtained from public sources, it would be small and would cover a marginal part of the total necessary investment cost.

## 2.2 Project's impact / Gaps in documentation and other limitations

**EQ1.** To what extent is the project contributing to the long-term objectives?

34. The lack of implementation for the time being of the few feasible viable projects that have been identified results in no contribution to the reduction of GHG emissions in the targeted agro-industries. The main contribution of the project has been to obtain real data on biogas plants in Southern Chile through the monitoring and feasibility assessment of biogas development in the dairy sector in the Chilean context. In this sense, the project has provided the answer that was sought in the beginning: real data on biogas production and on the efficiency of existing biogas plants has been obtained. It has been concluded that biogas plants could be economically viable in few farms of 100-500 cows in the X and XIV Regions and feasibility could take place in farms with higher number of cows and/or in farms in less rainy regions of the country. The project design assumed that the development of biogas plants would be viable in a large number of dairy farms and therefore the technology would be adopted broadly with the consequent reduction of GHG emissions. The project has concluded after several studies carried out that this assumption does not hold true.

35. In 2016 the GHG emissions in the agriculture sector amounted to 11.8 million $tCO_2eq$, which represents 10.6% of the total GHG emissions. The share of the agriculture sector in the GHG emissions has decreased since 1990, mainly due to the continuous decrease in the number of cows and sheep in the country (and in spite of the increase of swine, poultry and use of nitrogen fertilizers). The data produced by the project indicate that the implementation of biogas plants would reduce the GHG emissions of the dairy farms around 70% to 90% in most of the cases compared to the business as usual scenario. But the negative economic results of the feasibility studies imply that the initially estimated reduction of around 2.9 million $tCO_2eq$ in 20 years after installing biogas plants in the 800-targeted dairy farms would not be possible. In a considerably lower number of agro-industries where the investment is economically feasible or where owners have environmental objectives beyond the pure economic analysis there can be a contribution to GHG reduction. If biogas plants were installed in the four farms that yielded positive results in the feasibility studies, the GHG emissions reduction would be 57,415 $tCO_2eq$ in 20 years. While the farms studied have not yet contributed to GHG reduction, the four ongoing biogas projects that Schwager is actually implementing in the winery, waste treatment and cheese sector and that are part of the co-financing will reduce 850,000 $tCO_2eq$ in 20 years.

36. The Government is committed to reducing the GHG emissions by 30% in 2030 with respect to the 2007 level. The development of the solar and wind energy concentrates now the main efforts of the Ministry of Energy in the promotion of NCRE. Biogas development is progressing in Chile, albeit

slowly, and not in the targeted agro-industries. The project adequately reacted after the initial negative conclusions of the pre-feasibility studies to expand the feasibility studies to some dairy farms with a higher number of cows, with higher cow housing practices, or in farms located in Central Chile with less rain, in order to find a niche for biogas development. As demonstrated, biogas has more potential in other sectors and the main barrier for its development in the dairy farms is the high investment cost, taking into account that there are no subsidies for its development.

37. The studies conducted indicate a pattern of environmental risks associated to the management of the cow manure in the dairy farms assessed. The cow manure is frequently used as nutrient directly applied to meadows and crops without any treatment. In some cases detected in the pre-feasibility and feasibility studies, this practice happens too close to living areas. The cow manure collected is disposed in wells, which are not always waterproof and therefore risk polluting aquifers and rivers. These wells usually release bad odour and the use of manure as fertilizer may further increase odour pollution in the neighbourhood. The implementation of biogas plants is one of the possible solutions to improve the management of cow manure. This technology should not be seen just from an energy point of view, as its implementation can result in positive environmental benefits and a substantial reduction in GHG emissions.

**EQ2.** To what extent has the project helped put in place the conditions likely to address the drivers, overcome the barriers and contribute to the long-term objectives?

38. The studies carried out indicated the difficulties in spreading the technology due to the high investment cost and negative economic feasibility in most of the cases. The project was designed based on international references on efficiency and assuming an average production of 0.5-0.9 $m^3CH_4$/cow/day, while the results of the studies indicate values in Southern Chile below that average, ranging from 0.15 to 0.79 $m^3CH_4$/cow/day. The main factors that result in the lower than expected efficiency of the biogas plants and therefore in their negative feasibility are as follows:

    a) The pasture practices in most of the dairy farms of the targeted regions imply that cows are housed around 4 hours per day and therefore just around 25% of the manure would be collected as input for the biogas plants.

    b) The low content of dry material in the cow manure[9], due to the large quantity of water in the manure (stemming from the cleaning of the facilities and from the rain) and due to the cows' diet, which is normally based on grass from the meadows.

    c) Cold temperatures in winter decrease the anaerobic process of the biogas plants. This moreover demands isolation and heating, and consequently higher investment costs for an efficient functioning.

39. Due to the lower than expected efficiency of the biogas plants, in most of the cases studied the biogas produced in the targeted agro-industries would cover partially the internal electricity and heating demand of the farms, and there would be rarely a surplus to sell electricity to the grid. The baseline study conducted found that few agro-industries in the targeted regions know their production costs[10]. According to the answers of the beneficiaries interviewed during the TE field visit, the electricity cost of the targeted dairy farms is around 2% to 5% of the total operation costs. Therefore, the implementation of biogas plants would reduce the cost of the electricity bill but it would not impact significantly on improving the competitiveness of the targeted agro-industries.

40. The legal framework in the energy sector does not hinder biogas development. The lack of regulation and norms in the agriculture and environment sector for managing more sustainably the cow manure does not however help changing the above-mentioned current practices that can

[9] According to INIA the dry material in cow manure in Southern Chile is just 3.9% with almost 50% of cow manure having just 2% of dry material.

[10] According to the baseline study, 31% of the dairy agro-industries of the XIV Region know their production costs and has a register of these costs, while in the X Region 26% of the dairy agro-industries know their production costs and just 21% has a register of these costs.

impact negatively the environment. The project has identified this aspect and has moreover produced substantial and precise information with respect to the development of biogas plants in the dairy sector. The negative results of the pre-feasibility studies and the frequent problems in the operation and maintenance of the existing biogas plants in dairy agro-industries have however installed the narrative that biogas plants are not an appropriate solution for energy generation and that they imply significant problems in the operations. While this is partially true, the details of the research carried out have not been effectively communicated to date in order to nuance this narrative. There is economic viability of biogas plants in the targeted agro-industries, albeit in few cases. There are examples of existing biogas plants that function. The current practices in the cow manure management in the dairy farms imply in many cases potential environmental damages that could be avoided with the implementation of biogas plants. The knowledge generated by the project has not been yet adapted, summarised and communicated to each of the target groups in order to provide the detailed picture of the conclusions of the project.

41. The activities of the project have helped to better understand the barriers for biogas development in the dairy sector. The few companies that design and build the small biogas plants have been involved in the project and they have gained experience and better understanding on the functioning, efficiency and feasibility of biogas plants. These companies are now developing bigger biogas plants with higher standards in compliance with the new safety regulation and mostly in other sectors. Being implemented by the Ministry of Energy, the project has mostly been regarded from the energy perspective, while during implementation the environmental aspect has emerged as the main benefit of biogas plants. The project has adequately involved the Ministry of Agriculture and the Ministry of Environment that could consider the development of biogas plants from this perspective. An Action Plan has been produced for these stakeholders taking action on certain aspects once the project is finalised.

42. Despite the weak economic feasibility of biogas plants in the dairy farms of 100-500 cows, few farmers would be still interested in the development motivated by environmental convictions. Since the initial assumption was that most biogas plants would be economically feasible, the project did not develop methods for selecting beneficiaries based on their motivation, conviction, and financial capacity for investing in the implementation of biogas plants. Such a selection of the target group could have perhaps led to few plants being implemented and/or to showcasing the biogas plants as an environmental solution.

# 3 Project's quality and performance

## 3.1 Design

**EQ3.** To what extent was the project design adequate to develop biogas energy for dairy agro-industries in Chile and what lessons can be drawn for future designs?

43. The project design was adequately built around three necessary components: 1) the development of the biogas policy framework, 2) skills and capacity building on biogas, and 3) the identification and implementation of feasible biogas projects. The design responded to the policy and skills development needs, the latter especially with respect to the operation of biogas plants where it was detected that poor maintenance resulted in some cases in the abandonment of the plants. The assumption based on international criteria was that biogas plants would be feasible and that the project would result in a portfolio of biogas projects to be financed. The design did not include an alternative plan in case this assumption did not hold true and few cases of feasibility were found. In such a case, a deeper analysis of the motivations and willingness of farmers to adopt and implement biogas plants would have been necessary, in order to ensure that a number of cases could have more chances of being implemented. On the other hand, it was too optimistic to intend to implement the three components of the project in the initially planned 3-year execution period.

44. The design relied on the co-financing for achieving the outcome related to the implementation of biogas plants that would result in a reduction of GHG emissions. The risk of relying on external funds for achieving the objective was not sufficiently assessed. The commitment of the Government of Chile to support the research was ensured during the whole implementation. But the commitment to launch a public tender for financing the biogas projects varied. During the design phase a public tender on NCRE was launched. Once the project started, a new Government took office and finally a third Government was in place once the feasibility studies were concluded. The negative results of the pre-feasibility and feasibility studies hampered fulfilling the commitment of launching the planned public tender to finance the feasible biogas projects detected. The political cycles and their influence in the availability of the funds for the public tender, as well as the consistent policy of Chilean governments to avoid subsidies, were not sufficiently considered in the design. The reliance on other external funds, such as the NAMA, for further financing biogas projects was also a risk, considering that the NAMA Financial is still not operational.

45. The choice of INIA for conducting the capacity development component and its incorporation in the project document as executing partner upon request of the government counterpart was appropriate from an administrative point of view, since this would save time used in the procurement of different contracts with several entities. While INIA is a relevant institution for conducting research and organising related trainings and workshops, the skills development objectives set in the project exceeded the capacity and area of responsibility of INIA. The project adequately reacted to this and contracts with other training institutions where established. This, among other aspects, delayed implementation. Although capacity development objectives and indicators were established in the design, no comprehensive strategy was developed to detail how these objectives would be achieved with the different trainings and workshops.

**EQ4.** To what extent the logframe contains a clear and logic results-chain and SMART indicators?

46. The logframe of the project is well structured with a logical link between outputs and outcomes. The indicators proposed both at output and at outcome level are valid and allow measuring progress and achievements. All the indicators have baseline and target values. The values of the indicators during implementation can easily be obtained and therefore these indicators are appropriate for measuring the results defined. Annual Operation Plans (AOP) have been developed by the project, with detailed activities and sub-activities under each of the outputs defined in the logframe. Indicators have also been defined for each of the activities of the AOP and these are linked with the ones of the logframe.

47. While the indicators allow measuring the progress and the achievement of the results, in some cases the same indicator is repeated both at output and outcome level. For instance, the indicator "number of biogas professionals trained" is both in output 2.2 and in outcome 2; the indicator "number of biogas projects that started operations" appears in output 3.3 and in outcome 3. The duplication of indicators at different levels of the logic of intervention hampers differentiating the levels of achievement with its corresponding indicators. For instance, while "number of biogas professionals trained" is optimal at output level, at outcome level a more appropriate indicator would have been "number of biogas operators applying the skills gained in the trainings".

## 3.2 Relevance

**EQ5.** To what extent does the project respond to the needs of the target groups?

48. The project responded to the need of the Ministry of Energy to promote NCRE, diversify the sources of energy and assess whether biogas was a viable NCRE for the dairy agro-industries. When the project was designed there was no sufficient information in this respect and the intervention adequately responds to the need to answer that question. The successful development of solar and wind energy in the country after the design of the project has however diversified the energy matrix and helped achieve the expected target of NCRE supply. The data obtained by the project has given the necessary information for decision-makers for biogas development in the targeted agro-industries.

49. Initially the project was hosted by CER, which was dissolved, and the project was transferred to the Ministry of Energy, where it has been embedded within and fully aligned with the policies of the Government. Adequately, the project involved in the Steering Committee not just the Ministry of Energy, but also the Ministry of Agriculture and the Ministry of Environment. The involvement of these other ministries is relevant, not only to promote the adoption the technology, but also to consider the environmental and production implications derived from the implementation of biogas plants.

50. The target groups selected are relevant. Around 83% of the cows used in the dairy sector are concentrated in the two regions targeted and farms between 100-500 cows constitute around a third of the total[11]. There was no assessment before the project started on the interest of the dairy farmers in adopting biogas plants. The beneficiaries that have been contacted by the project for conducting the different studies indicate mostly an economic motivation in the biogas plants, as they will reduce the operation costs, while few expressed additionally environmental motivations. It seems that few farmers would adopt the technology if there is no financial support from external sources and the interest of farmers in biogas plants may have waned during project implementation. As mentioned, the number of participants to the different seminars and workshops decreased slightly during implementation. For selecting the pre-feasibility studies, the project aimed at having 100 expressions of interest from the agro-industries targeted and 80 were received.

51. The project adequately considers the involvement of Consorcio Lechero, an organisation that aims at articulating dairy producers, the industry, service and research companies for improving the competitiveness and sustainability of the sector. The Regional Coordinator of the project was based at Consorcio Lechero, which was instrumental in order to reach out to stakeholders and disseminate information. The linkage of Consorcio Lechero with sector associations and the industry was however not sufficiently used by the project to further involve these stakeholders. The attitude of sector associations and the industry towards biogas implementation in the producers' farms was not sufficiently assessed. Their support in developing standards on sustainable and environmentally-friendly production in the targeted agro-industries could have raised funds for co-financing the biogas plants and/or it could have helped motivating and sensitising farmers to adopt the technology.

52. There is interest also among biogas professionals in developing biogas standards and skills, and the project has adequately contributed to that. The trainings and seminars proposed are an

[11] Project Document, Annex J.

opportunity for professionals in the sector to exchange ideas and learn on how to improve the current practices and the incipient sector under development.

**EQ6.** Is the project a relevant solution to promote the investment and growth of the biogas technology market in dairy agro-industries?

53. The project was adequately conceived to assess the feasibility of biogas technology for dairy agro-industries. Sufficient budget was allocated to assess the pre-feasibility and feasibility of biogas plants in dairy agro-industries in order to obtain evidence-based data. When the project was designed there were over 100 biogas plants in Chile, although some presented deficiencies in their design and there was no precise information on the viability of biogas projects. On the other hand, there was a lack of clarity on the investment needed and on the cost of biogas plants operation and maintenance. The detailed analysis on the functioning of current plants and the feasibility of new plants would therefore yield light on these aspects. The existence of a critical mass of dairy agro-industries in the X and XIV Regions was appropriate for promoting the adoption of biogas plants and succeeding in implementing a number of projects.

54. The Ministry of Energy has been committed to implementing the project, although the interest in biogas has understandably decreased once the results of the feasibility were known. The interest of industries and sector associations in implementing biogas plants in dairy agro-industries was not assessed during the design phase.

55. The project was designed based on international average figures on the viability of biogas plants, which indicated a potential for expanding the technology in the agro-industry sector. In order to get exact figures on the application of biogas, the project included relevant activities apart from the feasibility studies, such as the monitoring of existing biogas plants.

56. The project included coordination mechanisms at central and regional level to share the results with relevant stakeholders. This is relevant in order to ensure the scaling up of the technology in case it turns to be feasible. The Steering Committee at central level and the CARP at regional level are valid multi-stakeholder coordination mechanisms. These mechanisms were moreover planned to provide strategic guidance to the project. The participation of the industry was however not foreseen and they were however not linked to existing mechanisms that could ensure the continuation of the discussions once the project will finalise.

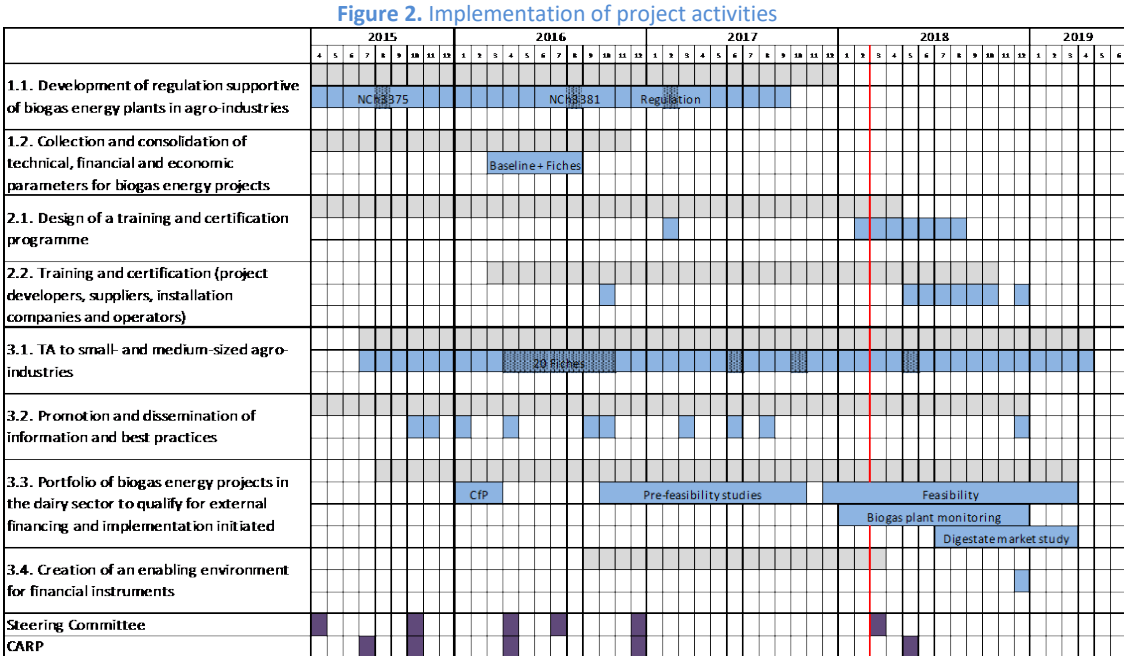
## 3.3 Efficiency

**EQ9.** To what extent were activities implemented within the original budget and timeframe?

57. Most of the planned activities have been implemented although in general there have been delays in executing them (see Figure 2 below with the comparison of activities implemented in blue compared to activities planned in grey). Instead of the planned implementation period of 36 months, the project has been executed over 52 months. The project started in November 2014, the PMU was established in December 2014 when the Project Coordinator was recruited and the effective implementation of the project´s activities began in March 2015. While activities under the first component (policy and information) were implemented according to the plan, delays happened in the second (technical capacities and delivery skills) and third (investment and project portfolio) components. The delays in the second component stem from the necessary rearrangement to identify different institutions for the trainings, once it was realised that INIA could not carry out all the planned activities, and from the finalisation of the pre-feasibility studies. The delays in the third component are related to the late launch of the call for proposals to beneficiaries interested in conducting pre-feasibility studies in their fields, and to the time taken to conduct these studies. The completion of the 53 pre-feasibility studies divided in five lots took one year while the 9 feasibility studies were finalised almost in a year and a half. The pre-feasibility studies took longer than expected also because farmers did not deliver the key analytical information to consultants on time. Due to the longer than expected time for conducting the studies the results were available just by the end of the project, without sufficient time for consolidating the information and promoting the investment of the few feasible projects identified.

58. The sequence of the activities implemented is not the most logical; ideally it would have been preferable to start earlier with the feasibility studies and with awareness-raising activities, and then have sufficient time to ensure the financing of the feasible projects and to implement the training programme.

**Figure 2.** Implementation of project activities




59. Few of the planned activities have not been implemented and this did not have a significant effect on the overall project implementation. For instance, the consultancy on the materials to use in biogas plants was not implemented, since no tenderer submitted a bid; as a consequence, the regulation for the safety of biogas plants did not include details on the materials to be used, although it mentions characteristics the materials need to fulfil, which is considered sufficient. Less than expected activities were also carried out in output 3.4 related to creating an enabling environment for financial instruments. The negative results of the feasibility studies and the delays in launching the NAMA financial component limited actions in this field. A search engine of financing instruments for biogas projects was however developed and is available at the web site of the Ministry of Energy.

60. The planned human resources have been made available for implementing the project, both from the GEF grant and from the Government. The activities have been implemented within the planned costs (see table 5 below) and the GEF grant budget has been consumed as planned. In general there has not been a major deviation in the execution compared to the planned budget. The co-financing provided has been lower than expected, mainly because the planned tender for the biogas projects has not been launched.

**Table 5.** Overview of planned and executed budget (in USD)

| | Budget lines | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|
| | 1100 – Staff&Intern consultants | 1500 – Local travel | 1700 – Nat. Consult/ Staff | 2100 – Contractual services | 3000 – Train/Study/ Fellowship | 5100 – Other direct costs | |
| **1. C1: Policy and information** | | | | | | | |
| Planned budget | 100 | 2,336 | 22,173 | 73,833 | 0 | (52) | **98,391** |
| Executed budget | 15 | 2,336 | 22,314 | 73,783 | 0 | (193) | **107,590** |
| % executed vs planned | 15.34% | 99.99% | 100.64% | 99.93% | - | - | 109.35% |
| **2. C2: Technical capacities & delivery skills** | | | | | | | |
| Planned budget | 0 | 1,884 | 14,745 | 142,859 | 69,367 | 228 | **229,082** |
| Executed budget | 0 | 1,810 | 14,975 | 142,729 | 69,366 | 59 | **250,689** |
| % executed vs planned | - | 96.10% | 101.56% | 99.91% | 100.00% | 25.92% | 109.43% |
| **3. C3: Investment and project portfolio** | | | | | | | |
| Planned budget | 35,253 | 11,109 | 277,104 | 827,319 | 0 | 2,741 | **1,153,527** |
| Executed budget | 35,253 | 11,095 | 276,766 | 827,365 | 0 | 2,703 | **1,262,734** |
| % executed vs planned | 100.00% | 99.87% | 99.88% | 100.01% | - | 98.61% | 109.47% |
| **4. Project Monitoring** | | | | | | | |

| | Budget lines | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|
| | 1100 – Staff&Intern consultants | 1500 – Local travel | 1700 – Nat. Consult/ Staff | 2100 – Contractual services | 3000 – Train/Study/ Fellowship | 5100 – Other direct costs | |
| Planned budget | 12,875 | 5,616 | 24,787 | 0 | 0 | (279) | **43,000** |
| Executed budget | 12,875 | 5,616 | 24,737 | 0 | 0 | (410) | **46,885** |
| % executed vs planned | 100.00% | 100.00% | 99.80% | - | - | - | 109.04% |
| **5. Project Management** | | | | | | | |
| Planned budget | 0 | 653 | 156,158 | 0 | 0 | 340 | **157,151** |
| Executed budget | 0 | 653 | 156,048 | 0 | 0 | 330 | **171,948** |
| % executed vs planned | - | 100.00% | 99.93% | - | - | 97.05% | 109.42% |
| **6. Terminal Evaluation** | | | | | | | |
| Planned budget | 19,000 | 3,000 | 10,000 | 0 | 0 | 2,000 | **34,000** |
| Executed budget | 18,487 | 1,049 | 7,040 | 0 | 0 | 1,166 | **30,377** |
| % | 97.30% | 34.96% | 70.40% | - | - | 58.29% | 89.35% |
| **7. TOTAL (1+2+3+4+5+6)** | | | | | | | |
| Planned budget | 67,228 | 24,598 | 504,968 | 1,044,012 | 69,637 | 4,979 | **1,715,151** |
| Executed budget | 66,630 | 22,558 | 501,880 | 1,043,877 | 69,366 | 3,654 | **1,707,966** |
| % | 99.11% | 91.71% | 99.39% | 99.99% | 100.00% | 73.39% | 99.58% |

**EQ10.** Has the project done the right things, with value for money?

61. The design of the project did not leave much room for alternative strategies in case the results of the pre-feasibility and feasibility studies turned out to be negative. The project team however was active to adapt the project to the changing circumstances and included new relevant activities. For instance, the monitoring of existing biogas plants to better understand their efficiency in the Chilean context, the development of an Action Plan upon finalisation of the project for partners to take action, or the market study of the digestate (in order to see whether selling the digestate would increase the feasibility of the biogas plants) were new relevant activities that were not initially planned. The market study of the digestate was particularly relevant, since in some cases the feasibility of biogas plants could turn positive if the digestate was commercialized. However, this study concluded that in general farms would not have always a surplus of digestate to commercialize. In cases where there was digestate to commercialize, the long distances and high travel costs hampered the viability of this business. The budget has been implemented according to the plan and the project team has appropriately used it to include new relevant activities oriented to the objective of the project.

62. The majority of the project budget was allocated to component 3 (investment and project portfolio), especially for the pre-feasibility and feasibility studies. The project team divided the 53 pre-feasibility studies in five different lots, not only for dividing the studies among different companies but also for assessing the pre-feasibility from different angles. As showed in table 4, one of the lots assessed the pre-feasibility of collective biogas plants for a number of agro-industries, while another lot studied existing biogas plants (and the investment needed for improving the efficiency of the plants). The division in different lots implied more coordination effort for the PMU, which appropriately was carried out. Analysing the pre-feasibility from different perspectives also provided additional information, such as the possibility of biogas development in different scenarios, which is relevant in view of the negative viability results yielded. The division in different lots and the coincidence in all of them on the negative viability conclusions are also relevant for confirming the conclusions. As mentioned before, the project was also flexible for expanding the study to other geographical areas and bigger dairy farms in view of the negative results of the pre-feasibility studies.

63. The governance mechanisms of the project, i.e. the SC and the CARP, were established and have met regularly in 2015 and 2016. From 2017 onwards however just one SC and CARP meeting was held, in order to introduce the project to representatives from the newly formed Government. The project has adequately filed and organised all the documents produced and it has regularly kept the members of the SC and CARP updated. These platforms served however more for transmitting information to stakeholders than for providing strategic guidance and for reflecting on the challenges for developing biogas plants in the dairy agro-industries. The meetings led sometimes to agreeing on follow-up actions that required further ad-hoc meetings with relevant

stakeholders. While information was promptly sent to stakeholders, the final data obtained have not been classified, summarised and tailored to the needs of each of the target groups (e.g. policy-makers, beneficiaries, agro-industries). This could be necessary for ensuring the understanding of the conclusions of the studies conducted and the implications for their respective responsibilities.

## 3.4 Sustainability

**EQ11.** To what extent the achieved results will sustain after the completion of the project?

64. Under component 1 (policy and information), the regulation on the safety of biogas plants and the two standards produced have been approved; these results will be sustained after the completion of the project. The SEC is responsible for enforcing the regulation and has a list of 17 certified biogas plants installers able to comply with the regulation. With the slow development of new biogas plants in the country, the number of certified installers may be sufficient for handling the process. Not all the existing biogas plants have been registered yet at SEC and as found during project implementation several farmers with biogas plants did not know the new safety regulation and the need to register their plants. The standards produced are norms of voluntary application and it is not mandatory to apply them.

65. The sustainability prospects of the results achieved under component 2 (technical capacity and delivery skills) are weak. Different trainings have been carried out by different institutions but it is unlikely that any of them will continue. The training developed by SEC on biogas plants installers could continue in future, but due to the slow progress of biogas plant development it is unlikely that further trainings will take place. It is also unlikely that the rest of the trainings implemented by the project will continue. The trainings developed by Universities (the biogas plant operators training course and the training of trainers of biogas operators) were implemented once during project implementation; the Universities have not included these courses in their curriculum and therefore it is unlikely that they will be replicated. The project has had no effect in developing a critical mass of skilled operators that can solve the operation and maintenance problems facing several biogas plants.

66. Under component 3 (investment and project portfolio) for the moment it is unlikely that the four feasible projects identified will be implemented. The interest of farmers to invest in biogas plants has probably decreased. The high investment needed and the lack of substantial co-financing that could complement the cost may hamper the development. Moreover, the operational cost of the biogas plants is frequently not considered by owners, which affects the functioning of the plant and explains also the number of biogas plants abandoned. The beneficiaries of the agro-industries that have been assessed in the pre-feasibility and feasibility studies have been informed on the results of the studies. Among the targeted agro-industries, beneficiaries have learned of the negative feasibility of biogas plants in their fields and without external financial support it is unlikely that the technology will be developed.

67. It is unlikely that public funds will be available specifically for co-financing biogas projects, since few are economically viable and the Government is in general reluctant to provide subsidies. The main support from the Ministry of Energy to NCRE is the call for proposals directed to public institutions to install solar panels[12]. Although not allocated for NCRE or biogas specifically, funds managed by the Regional Governments may be available and eligible for co-financing biogas plants. For instance, the Technical Cooperation Service (SERCOTEC – Servicio de Cooperación Técnica) of the Ministry of Economy is aimed at assisting small and medium enterprises for their development and has regionalised subsidies. Since 2019, renewable energies and energy efficiency is one of the eligible activities in the call for proposals, and the priorities and orientation of the calls are in general defined by Regional Governments. The financial amount of these grants is however minimal compared with the investment needed for installing a biogas plant. Therefore, the potential availability of these funds may not determine the decision of beneficiaries to build biogas plants in their agro-industries.

[12] Since the programme was launched in 2014, 62 call for proposals have been launched.

68. According to the baseline study, seven private banks in the country have financed renewable energy projects[13], mainly wind and small hydro-electric plants. Few bank institutions indicate their support to NCRE specifically in agriculture. Although small and medium agro-industries may not be attractive customers to bank institutions, there has not been much interaction between the project and these institutions to facilitate access to credit for the implementation of the biogas plants.

69. Although it is unlikely that biogas plants will be broadly adopted by the targeted agro-industries, the technology is slowly progressing in the country and biogas plants are under construction. This takes place however in other sectors (e.g. wine, waste management, dairy including cheese production) and not in the targeted dairy agro-industries. The project has gathered real data on biogas installation in Southern Chile and has contributed to clarifying the feasibility of such technology in the targeted agro-industries. This has allowed raising awareness on the strengths and weaknesses of the technology. Small biogas companies that have been involved in the project have learned and are adapting their design and operations. The knowledge generated remains however mostly within the circle of the people involved during implementation. A closure seminar was organised in December 2018 and relevant information was communicated to stakeholders. The information developed by the project is available in the web site of the Ministry of Energy, although it is not yet organised and tailored to the need of the different users.

**EQ12.** What risks exist and how they may affect the continuation of the results?

70. The main risk for the development of biogas plants in the targeted agro-industry is considering the technology just as an additional infrastructure that needs to be economically viable and not as part of the whole business with the positive implications it has. As most cases indicated the negative economic feasibility of installing biogas plants, most stakeholders have rejected this technology as a viable solution without paying attention on how the biogas plants could be a solution for the management of cow manure. Even though not profitable from an economic point of view, biogas plants have positive environmental externalities because they are a valid solution to address problems derived from the actual practices in the management of cow manure that can cause environmental problems. Their installation will moreover imply a considerable reduction in GHG emissions compared to the business as usual situation. The lack of regulation with respect to cow manure management hampers the consideration of such benefits by most of the targeted farmers.

71. The Law 20.920 of June 2016, called REP (Responsibility Extended to the Producer - Responsabilidad Extendida al Productor), establishes the framework for waste management, the responsibility of the producer and promotes recycling. Up to 2021, several targets are being set for recycling different products, namely tires, containers and packaging, lubricant oils, batteries and electronic devices. Manure cow is not yet in the list of waste to be included under this law, which may not facilitate considering biogas plants as valid solutions for improving waste management in the dairy agro-industries.

72. The coordination mechanisms established by the project, the SC and the CARP, have not continued once the project finalised. Although other multi-stakeholder mechanisms between these services exist for coordination, the continuation of the dialogue specifically on biogas has not continued. The project has adequately produced by the end of the project an Action Plan, which identifies actions to be considered and/or taken by different institutions in view of the project conclusions. Without further coordination in the sector, it would be difficult that the actions planned will be considered, implemented and followed-up by the different institutions.

[13] The seven private banks are Banco Bice, Banco Consorcio, Banco de Chile, Banco Santander, Banco Bilbao Vizcaya Argentaria, Rabobank and DnB.

## 3.5 Gender mainstreaming

**EQ13.** Did the project design adequately consider the gender dimension and if so, has it been appropriately implemented?

73. The gender dimension is present in some of the indicators of the logframe, e.g. percentage of women trained, women associations be consulted or the production of a gender-mainstreamed Manual on biogas. It was not planned to have a gender strategy for the project and the approach adopted does not allow deepening this aspect. For instance, the Manual on biogas produced does not have any gender consideration. Without a gender strategy it is not possible to determine the different attitudes and behaviours women and men may have with respect to the technology proposed. Most of the data related to the participants to trainings and workshops are sex-disaggregated (see table 2). According to the figures available, the target of 10% of women participating in the training courses probably exceeded: in the three trainings were sex-disaggregated information is available[14], 18 women out of a total of 59 succeeded in completing the course, i.e. 30% of the total. Although tracking the participation of women associations in project activities may be relevant, as proposed in one of the logframe indicators, there is no evidence that women associations were involved in the discussions of the biogas plants safety regulation.

74. From the interviews held with beneficiaries and other stakeholders, it seems that women in the dairy agro-industries targeted may tend to have higher environmental concerns than men. This attitude may increase women's willingness in adopting biogas plants, as they can solve environmental problems. Due to the lack of a gender study, such conclusions cannot be drawn yet, but it would have been probably wise to consider the different attitudes of beneficiaries to the technology promoted from this angle, in order to identify farmers that would not look just to the economic feasibility results when deciding the investment of a biogas plant.

[14] Training courses on Biogas specialist, training of trainers and biogas operators.

# 4 Performance of partners

**EQ15.** What has been the quality of implementation (delivery) and execution (administrative and financial management) of the GEF agencies and the project executing entities in discharging their expected roles and responsibilities?

76. The planned human resources from UNIDO and the Ministry of Energy have been timely in place for executing the project. UNIDO has carried out a close follow up of the intervention with regular visits to the country by the Project Management and frequent contacts with the implementing partners. Despite the change of the Executing Agency (from the CER, to CIFES and then to the Ministry of Energy), the National Project Director was the same during the implementation of the project. The GEF financial resources have been made available as planned and they have been correctly used.

77. It was envisaged that the Government of Chile will make available the necessary financial resources that will support the development and scaling up of new biogas projects, also with the support of the NAMA Facility. The planned co-financing for the public tender has not been provided by the Government. This commitment was made during the first Piñera Government and a tender on NCRE was launched, under which two biogas projects were funded, mainly aimed at assessing the functioning of the Net Billing Law in biogas plants. These two biogas plants financed are no longer working, one due to a fire that destroyed the plant and the other due to problems in the operation and maintenance. During project implementation under the second Bachelet Government, no funds were allocated for launching a tender for biogas projects, as the feasibility of the cases studied yielded negative conclusions and the development of solar and wind energy projects took off. The delays in implementing the NAMA Financial component, planned to start in 2020, has also affected the project, which could have received earlier support for financing the few feasible cases assessed.

78. Among the co-financing foreseen, it was planned that the project would trigger investment in the biogas sector by the private company Schwager up to USD 11.2 million. Actually, four biogas projects are under development by Schwager, as indicated in the table below:

**Table 6.** Investment portfolio of Schwager in biogas

| Sector | Period | $M^3$ of biogas generated during period | tCO2eq reduced during period |
|---|---|---|---|
| Landfill | 2019-2038 | 144,000,000 | 725,892 |
| Dairy (cheese) | 2014-2033 | 16,060,000 | 19,506 |
| Dairy (cheese) | 2012-2031 | 29,930,000 | 21,642 |
| Wine | 2020-2039 | 550,000,000 | 91,563 |
| **Total** | | **739,990,000** | **858,604** |

79. The project has supported the multi-stakeholder dialogue as a means to coordinate the intervention and disseminate the information produced. Following the implementation of the project, there has not been an active commitment of the partners to continue the discussion in the coordination groups established in order to address the problems identified during the implementation of the project, which are more related to the agriculture and environmental sector (management of cow manure and the potential for reducing GHG emissions with biogas plants) than the energy sector. This approach implies shifting the focus of the project from the traditional energy angle to an environmental one. There has been however interest and commitment of some stakeholders to continue taking action in certain aspects defined in the Action Plan produced by the end of the project.

# 5 Factors facilitating or limiting the achievement of results

**EQ14.** What is the quality of the M&E system implemented and to what extent it has helped drawing lessons and improving implementation?

80. The project has put in place an adequate M&E system to track progress and measure the logframe indicators. The POAs included indicators linked to the ones of the logframe and they have been measured and monitored during implementation. The continuous contact between the PMU, the Ministry of Energy and UNIDO has facilitated the discussions and has helped taking decisions during implementation. This has been essential for adequately orientating the project in view of the negative results obtained from the pre-feasibility and feasibility studies.

81. A good system has been established for organising and filing the documents produced, so that the material is accessible to users. A wealth of documents has been produced and a final report will consolidate and summarise the main conclusions of the different studies. Few of the stakeholders interviewed admit having used the tools produced, such as the Manual on biogas or the biogas calculator. The information produced is available in a significant number of reports, but it is not yet tailored to the needs of each of the potential users.

82. A Mid-term Review (MTR) was conducted in June 2016. At that time the pre-feasibility studies had not started and the main conclusion of the MTR was the lack of sufficient time for implementing the planned activities. Consequently, the implementation period was extended. If the MTR had been implemented once the results of the pre-feasibility studies were finalised, other relevant recommendations could have been suggested, especially aimed at proposing alternative strategies in view of the negative economic viability of biogas plants in the targeted agro-industries.

83. The project involved the key stakeholders needed for the implementation of the planned activities but there was no strategy for further incorporating other key stakeholders that could be instrumental in the broad adoption of the proposed technology. For instance, the links between Consorcio Lechero and the industries and dairy associations were not sufficiently exploited in order to further involve these stakeholders. The establishment of such relationships could have helped in further involving the industries and in raising awareness on the need to change certain practices, reduce the risk of environmental damages and promote a climate neutral and sustainable production among the beneficiaries. This could have further helped beneficiaries in viewing biogas plants installation not only from the economic point of view.

## 5.1 Overarching assessment and rating table

According to UNIDO Independent Evaluation Division, a six-point rating system has been developed to assess the project in each of the different evaluation criteria. The rating spans from 1 (highly unsatisfactory) to 6 (highly satisfactory), depending on the level of achievement compared to the expectations. The rating system is as follows:

- Score 6 – Highly Satisfactory (HS)
- Score 5 – Satisfactory (S)
- Score 4 – Moderately Satisfactory (MS)
- Score 3 – Moderately Unsatisfactory (MU)
- Score 2 – Unsatisfactory (U)
- Score 1 – Highly Unsatisfactory (HU)

The rating of the present project according to the evaluation criteria set is described in the following table.

**Table 7.** Summarised assessment of the findings and rating

| Criterion | Summarized assessment of the findings | Rating |
|---|---|---|
| Impact | The main impact of the project has been to provide real data on the functioning of existing biogas plants and on the viability of their development in dairy agro-industries, although all the knowledge generated is not yet widely known and adapted to the users' needs. The feasibility of biogas plants in the dairy agro-industries of 100-500 cows has been thoroughly assessed. Out of the cases studied, few resulted economically feasible and to date no biogas plant has been implemented. Therefore, there is no direct contribution to GHG emissions reduction yet; biogas plants are however being developed as part of the co-financing in other sectors and in this way contributing to GHG reductions. | MS |
| Project Design | | |
| • Overall Design | The project was adequately designed with three relevant components but it relied on external funds for financing the feasible biogas plants, which is a risk. The design provided for strategies in Capacity development although a comprehensive development capacity plan was not produced . Communication strategies are missing in the design. | MS |
| • Logframe | The logframe is adequately formulated and valid indicators with baseline and targets are set. POAs are adequately linked to the logframe logic and indicators. | S |
| Project performance | | |
| • Relevance | The project responds to the need of the Ministry of Energy to determine the viability of biogas plants. It is relevant that the TA was provided from Consorcio Lechero although this position was not sufficiently used to further involve the industrial associations in the process. | MS |
| • Effectiveness | The planned outputs have been produced with good quality in general, although delayed. The planned regulations have been approved and a substantial number of cases have been assessed to determine the feasibility of biogas plants. The capacity development activities conducted have contributed to raising awareness on biogas, but have not had significant effect in increasing the capacity of biogas operators. There has been no biogas project implemented further to the feasibility studies conducted. | MS |
| • Efficiency | Most of the planned activities have been implemented at the planned cost, although more time than intended was needed. The sequence for the implementation of activities did not leave time for consolidating results. | MS |
| • Sustainability of benefits | Future biogas plants will be designed and built according to the new regulation and standards approved. It is unlikely that the few feasible projects identified will be financed in the short-term. The information produced by the project is filed and available at the web site of the Ministry of Energy, but not yet adapted to the needs of different audiences. It is unlikely that the training courses conducted will continue. | MU |
| Cross-cutting performance criteria | | |
| • Gender mainstreaming | Few gender considerations are included in the design but the project lacks a gender strategy, even though it seems that the willingness to adopt biogas technologies in the targeted agro-industries might have a gender dimension. | MU |
| • M&E | The project has developed a good M&E system that has allowed monitoring the intervention and including new relevant activities. | S |
| • Results-based management | The project has been implemented oriented towards the achievement of the targets set in its three components. | S |
| Performance of partners | | |
| • UNIDO | UNIDO has followed up closely the project implementation and has actively participated in the discussions. | S |
| • National counterparts | The national counterparts have provided the needed human and material resources for implementing the project. The planned public tender for financing the feasible biogas projects was however not launched, as few feasible projects were found. | S |
| **Overall rating** | | **MS** |

# 6 Conclusions, recommendations and lessons learned

## 6.1 Conclusions

**Conclusion 1:** The project has provided the needed data for understanding the functioning of current biogas plants and it has clarified the feasibility of biogas plants in dairy agro-industries. Contrary to the expectations, less than intended projects are economically feasible and the few feasible projects identified have not been implemented yet. Therefore, the project has contributed to generate the needed knowledge but not to the direct reduction of GHG emissions from the selected biogas energy projects (750 kW) envisaged originally. The assessments carried out have demonstrated however that the implementation of biogas plants will reduce significantly the GHG emissions of the agro-industries compared to the business as usual scenario.

**Conclusion 2:** Out of the assessment carried out, the development of biogas plants in agro-industries of 100-500 cows in Southern Chile is economically feasible in few cases, but their implementation would imply significant environmental benefits. Feasibility prospects increase in farms with more than 500 cows. The studies carried out have detected practices in the dairy agro-industries that reduce the efficiency of the biogas plants and the quantity of biogas the plants can generate, which would serve in most cases just for the agro-industries' self-consumption and would not leave excess for selling to the grid. A general loose management of cow manure in several agro-industries has also been observed in the studies, which can have negative environmental consequences. The installation of biogas plants is one of the possible solutions to address these environmental problems. This perspective changes the perspective of the project, from the initial energy point of view to an environmental consideration.

**Conclusion 3:** In the first component of the project (policy and information) the expected results have been achieved. The project has contributed to the development of the regulation on safety of biogas plants and to the norms on digestate quality and on the design and operation of biogas plants. The introduction of the new safety regulations for biogas plants has improved the standards but also increased the investment cost. The training course on biogas plants installers was aligned with the training programme of SEC.

**Conclusion 4:** Although the project reached a significant number of people through the trainings, seminars and workshops carried out, the results achieved in the second component (capacity development and technical skills) concern mostly raising awareness on biogas plants. Several trainings and workshops have been implemented with mixed results. While relevant information has been disseminated, the project has not achieved to develop the skills of a critical mass of biogas plants operators that could address the problems in the operation and maintenance detected in many of the existing plants. The lack of a capacity development strategy has reduced the effectiveness and sustainability of this component.

**Conclusion 5:** Contrary to the initial assumption, few feasible projects have been identified in the third component (project portfolio and investment): out of 9 projects assessed (after 53 pre-feasibility studies), just 4 turned to be feasible. The project adequately expanded the feasibility studies outside the scope initial determined in order to increase the likelihood of finding feasible biogas plants. Dairy agro-industries with higher number of cows and/or farms in Central Chile in less rainy regions were incorporated to the study. Additional studies were carried out to have a better understanding of the potential feasibility, for instance including the commercialization of the digestate or considering collective biogas plants. The results of the studies have been produced by the end of the project and it is unlikely that the planned public tender that will finance the implementation of these projects will be launched by the Ministry of Energy.

**Conclusion 6:** Since the project started there has been a considerable development of NRCE in Chile, mostly solar and wind energy. The share of NCRE in the energy produced has already achieved the target set. In a slower progress, biogas plants are still being installed in the country, although not in the dairy agro-industries targeted by the project. Under the co-financing, biogas plants are being implemented in other sectors.

**Conclusion 7:** The project was adequately designed around three relevant components related to policy development, capacity strengthening and project identification and investment. The logic was adequately formulated in the logframe and the POAs were linked with the logframe. The achievement

of the project objective was based on the assumption of a significant number of feasible projects and on the availability of external funds (public tender and NAMA Facility). The design did not foresee alternative activities in case the feasibility turned out to be negative and the co-financing was not available.

**Conclusion 8:** It was expected that a significant number of feasible projects would be identified and that farmers would be willing to adopt the technology with the co-financing provided. The selection of beneficiaries responded to the interest they expressed in assessing their farms, without further assessing their profiles (e.g. gender, commitment to environmental objectives) that could have better shown the willingness to install the biogas plants beyond the initial criterion of economic feasibility.

**Conclusion 9:** The PMU has adequately implemented and monitored the project. To the extent of what it was possible, new relevant activities were introduced and the target group was expanded in order to orientate the project towards an economically feasible scenario. The sequence of activities could have been improved, since the results of the studies have been produced by the end of the project without having sufficient time to consolidate the information and looking for financing solutions for the few feasible cases that were identified.

**Conclusion 10:** The coordination mechanisms of the project (the Steering Committee and the CARPs) have been established with the participation of different institutions. These mechanisms are useful for articulating actions and linking up with regional funds that could co-finance the biogas plants. The SC and the CARPs have been active mostly during 2015-2016 and the meetings have finalised once the project ended. Consequently, there is no multi-stakeholder mechanism now to discuss specifically on biogas. Even though the mechanisms had a strategic character, in practice they served more as a platform for disseminating project's information.

**Conclusion 11:** The project has generated valuable information in the different studies conducted and has disseminated adequately the reports to the members of the SC and CARPs. As members of these mechanisms have changed, actually few people know the conclusions of the different studies in detail and the narrative of non-feasibility of biogas in the targeted agro-industries is installed among farmers and policy-makers. The nuances of this information based on the data gathered and the studies carried out is however not largely known. Without adapting the studies and analysis produced to the language and specific needs of each of the different users and making it accessible, it is unlikely that the public will learn the details of the studies produced.

**Conclusion 12:** It is unlikely that there will be development of biogas plants in the targeted agro-industries, due to the high investment cost, the lack of compensation mechanisms derived from the positive environmental externalities and the lack of norms and regulations on the management of cow manure. The law REP does not foresee to regulate wastes related to the targeted agro-industries in the medium-future. There are no specific subsidies for developing this kind of technology although there are instruments that could co-finance renewable energies and energy efficiency; the co-financing of these instruments would be however marginal compared to the total cost needed for installing biogas plants.

## 6.2 Recommendations

The main recommendations are related to:

- Synthesizing and disseminating the information produced based on the needs of the different target groups
- Hand over the information and coordinate actions between the Ministries of Energy and the Ministries of Agriculture and Environment to address the environmental problems in the targeted dairy agro-industries that can be solved with different solutions, one of them being the biogas plants.

The recommendations are detailed below and classified depending as short-term or medium-term, depending on when it is advised to implement them.

### 6.2.1 Short-term recommendations

**To the PMU/Ministry of Energy related to synthesizing and tailoring the information to the different audiences:**

**Recommendation 1:** Synthesize the information produced in the different studies and produce summaries of 1-2 pages directed to different audiences, for instance:

- Policy briefs to the Ministries of Agriculture, Environment and Energy on existing norms and policies and policy gaps identified, as well as on actions identified in the Action Plan directed to each of the institutions to consider the installation of biogas plants as a solution in the management of cow manure.
- Summary with the conclusions on the design, construction, operation and monitoring of biogas plants to display in the demonstration centre of INIA Remehue.
- Summary with the conclusions of biogas plants in dairy agro-industries for the sector associations and the industry.

**Recommendation 2:** Send to the beneficiaries of the four feasibility studies that showed positive feasibility prospects the information on possible sources of financing.

**To INIA related to incorporating the knowledge generated in its demonstration site:**

**Recommendation 3:** Expand the public information available at INIA Remehue on biogas plants based on the information generated and synthesised by the Project (see recommendation 1).

### 6.2.2 Medium-term recommendations

**To the Ministry of Energy related to the management of information and coordination between stakeholders**

**Recommendation 4:** Decide where and how the information contained in the website of the project will be maintained. It is recommended to maintain the information, together with the synthesis recommended in recommendation 1, on the website of the Ministry of Energy in a section dedicated to biogas.

**Recommendation 5:** Set up a meeting with representatives of the Ministry of Agriculture and Environment in order to:

- Inform on the conclusions of the studies, distribute the summaries recommended in recommendation 1 and explain where will be located the information generated by the Project.
- Explain the environmental problems identified in several dairy agro-industries and the fact that biogas plants can help to address these problems.
- Clarify the actions to be implemented by each stakeholder according to the Action Plan developed.

- Agree on a coordination mechanism between the services of each institution at regional level to ensure the continuity at regional level of the actions agreed.

**Recommendation 6:** Set up a meeting at regional level (regions X and XIV) with participation of the Regional Government, regional services of the Ministries of Agriculture, Energy and Environment, CORFO and other relevant actors in order to:

- Inform on the conclusions of the studies produced and distribute the summaries recommended in recommendation 1.
- Explain the location of the information generated by the Project.
- Explain the environmental problems identified in several dairy agro-industries and the fact that biogas plants can help to address these problems.
- Clarify the actions to be implemented by each stakeholder according to the Action Plan developed.
- Identify potential sources of financing at regional level for biogas plants.

### To the Ministry of Environment related to considering the practices of dairy agro-industries and their environmental implications

**Recommendation 7:** Analyse the Action Plan and consider actions to facilitate the development of models and norms that ensure a sustainable management of cow manure in dairy agro-industries. It is recommended to consider:

- The potential GHG emissions reduction through biogas plants installation and the incorporation of bio-digestors in the systems of emissions compensation.
- The relevance and priority of including cow manure among the wastes to target in the REP Law.

**Recommendation 8:** Guide the regional services of the Ministry of Environment with other regional services to define actions aimed at a sustainable management of cow manure.

### To the Ministry of Agriculture related to considering the practices of dairy agro-industries and their environmental implications

**Recommendation 9:** Analyse the Action Plan and consider actions to facilitate the development of models and norms that ensure a sustainable management of cow manure in dairy agro-industries. It is recommended to:

- Include the digestate from biogas plants as fertilizer in the norm on fertilizers actually under development, or in the norm on compost that will be updated.
- Develop models among farmers and the industries to promote incentives for sustainable production in the dairy agro-industries, from energy efficiency practices, to GHG emissions reduction, to the management of manure cow.

**Recommendation 10:** Guide the regional services of the Ministry of Agriculture with other regional services to define actions aimed at a sustainable management of cow manure.

### To UNIDO related to considering lessons of the present Project for designing future interventions

**Recommendation 11:** Include provisions in the design for:

- Assessing the different attitudes of the beneficiaries towards the technologies promoted by the Project in order to identify potential leaders and followers. This would facilitate the sequence in the selection of beneficiaries and broad adoption of the technologies. It can also determine whether gender plays a role in the adoption of the technology and therefore whether a gender strategy is needed.
- Developing and implementing a communication strategy aimed at interacting continuously with the stakeholders of the project.

**Recommendation 12:** For implementing capacity development activities aimed at developing technical skills, rely on training institutions that would adopt and continue with the training courses developed.

**Recommendation 13:** Base the coordination mechanisms of the project on existing multi-stakeholder mechanisms in order to ensure that the dialogue established will continue once the project will finalise.

## 6.3 Lessons learned

**Lesson 1:** In projects that include both assessing the feasibility of a technology and its implementation, it is wise to have more detailed information on the willingness of the beneficiaries to adopt the technology and to have a flexibility in the design for proposing new activities depending on the feasibility / non-feasibility scenario resulting from the studies that will be developed. The adoption of new techniques implies behavioural changes in the target group and for ensuring the achievement of such transition it is necessary to better know the characteristics of the beneficiaries in terms of attitudes and willingness to adopt the new technologies. The economic feasibility and the existence of funds for implementing the feasible projects may not be sufficient for some beneficiaries willing to adopt new techniques, while others may implement the technologies motivated by environmental convictions. Awareness raising and education are in general necessary for promoting new technologies, but methodologies to study, select and involve the beneficiaries are equally important to pursue the intended behavioural change.

**Lesson 2:** Assumptions are always made in the design regarding the feasibility / non-feasibility of the technology proposed. These assumptions need to be tested and assessed during implementation in order to adapt the design, if needed. For that purpose, the MTR is an essential exercise for testing the assumptions and revising eventually the design. The timing for carrying out the MTR should be carefully assessed, so that sufficient information is already produced by the project and the MTR can test the assumptions made, with a view of adapting the design, if necessary.

**Lesson 3:** The 3-years implementation period of projects that include the development of feasibility studies and the implementation of feasible projects is unrealistic. Almost two years were necessary in this project for carrying out the pre-feasibility and feasibility studies. The sequence of activities should be carefully designed, so that the results of the feasibility studies are available with sufficient time for being able to implement these projects.

**Lesson 4:** In projects promoting biogas plants it is necessary to involve different sectors, depending on the scope of the project, and not only the Ministry of Energy, since this technology depending on the sector and beneficiaries may have other implications. The conclusion of the present project is that biogas plants in dairy farms of 100-500 cows are in general non feasible economically in Chile and they may be rather an environmental solution rather than an energy supply one. In such cases, the focal sector of the project may shift from energy, as initially considered, to another one. This may determine the focal sector and institutional location of the project.

**Lesson 5:** As several sectors may be involved in biogas plants development, inter-institutional dialogue is necessary. Projects should therefore foresee coordination mechanisms for ensuring that representatives from the different sectors and institutions involved are present. Basing this dialogue on existing multi-stakeholder coordination mechanisms may ensure its continuity beyond the project's implementation period, which is necessary for broadening the adoption of new technologies.

**Lesson 6:** Skills development of new technologies are essential for ensuring their implementation and maintenance. Sound capacity development strategies need to be developed in order to focus the skills development to the right audience and carried out by training institutions that would adopt the curriculum developed and that could continue once the project ends.

## Annex I. Terms of Reference

## Annex II. Evaluation Matrix

| Evaluation criterion / dimension | Key Evaluation Question (EQ) | Sub-questions | Proposed evaluation tools | Main evidence sources |
|---|---|---|---|---|
| **A. Impact** | EQ1. To what extent is the project contributing to the long-term objectives? | • To what extent is the project contributing to the broad adoption of biogas energy technologies?<br>• Has the project contributed to the reduction of GHG?<br>• Has the project contributed to increased productivity and competitiveness of agro-industries?<br>• To what extent has the project contributed to improved national energy security? | • Document review<br>• Key informants' interview | • Project documentation<br>• Beneficiaries at industry level<br>• National policy makers |
| | EQ2. To what extent has the project helped put in place the conditions likely to address the drivers, overcome the barriers and contribute to the long-term objectives? | • What are the key drivers and barriers to achieve the long-term objectives?<br>• How well has the project managed the drivers and barriers to achieve the long-term objectives?<br>• What solutions has the project proposed to overcome the barriers? | • Document review<br>• Key informants' interview | • Project documentation<br>• Beneficiaries at industry level<br>• National policy makers |
| **B. Project Design / Overall design** | EQ3. To what extent was the project design adequate to develop biogas energy for dairy agro-industries in Chile and what lessons can be drawn for future designs? | • Was the project design based on a sound problem analysis?<br>• Do the solutions proposed solve the problems identified?<br>• Are the planned activities sufficient for providing the right solutions and can they be implemented in the given time frame and with the planned budget?<br>• Are risks and assumptions adequately addressed?<br>• What lessons can be drawn from the design of this project? | • Document review<br>• Key informants' interview<br>• Project performance document analysis | • Project documentation<br>• Country policies<br>• Beneficiaries at industry level<br>• National policy makers |
| **B. Project Design / Logframe** | EQ4. To what extent the logframe contains a clear and logic results-chain and SMART indicators? | • Are the proposed indicators adequate for measuring the results?<br>• Can the values of the proposed indicators be obtained?<br>• Are there baseline and targets associated to the indicators? | • Document review | • Project documentation |

| Evaluation criterion / dimension | Key Evaluation Question (EQ) | Sub-questions | Proposed evaluation tools | Main evidence sources |
|---|---|---|---|---|
| **C. Project Performance / Relevance** | EQ5. To what extent does the project respond to the needs of the target groups? | • Do the target groups (policy-makers, agro-industries, biogas professionals) support the project and do the project activities fulfil the needs of the target groups?<br>• Has the project been adapted to better respond to the needs of the target groups?<br>• To what extent is the project aligned (and has been adapted to) with the development and sector priorities of the country? | • Document review<br>• Key informants' interview<br>• Project performance document analysis | • Project documentation<br>• Country policies<br>• Beneficiaries at industry level<br>• National policy makers |
| | EQ6. Is the project a relevant solution to promote the investment and growth of the biogas technology market in dairy agro-industries? | • Are the different components of the project relevant for ensuring the broad adoption of biogas energy technologies?<br>• Are stakeholders committed to implement the project as designed?<br>• Is there a mechanism were the results of the project can be shared with relevant stakeholders to promote the investment and growth of biogas technology market? | • Document review<br>• Key informants' interview<br>• Project performance document analysis | • Project documentation<br>• Beneficiaries at industry level<br>• National policy makers |
| **C. Project Performance / Effectiveness** | EQ7. What have been the project's key results outputs and to what extent they correspond to the planned ones? | • What outputs have been achieved and to what extent they have been delivered as planned?<br>• What is the quality of the outputs provided?<br>• How stakeholders perceive the project outputs? | • Document review<br>• Key informants' interview<br>• Project performance document analysis | • Project documentation<br>• Beneficiaries at industry level<br>• National policy makers |
| | EQ8. What is the likelihood of the planned outcomes being achieved? | • How are outcomes being achieved following the outputs delivered?<br>• What barriers exist for the achievement of the outcomes and how the project is addressing them?<br>• How effectively has the project promoted biogas information and best practices?<br>• What lessons can be drawn on how the project could improve its effectiveness? | • Document review<br>• Key informants' interview<br>• Project performance document analysis | • Project documentation<br>• Beneficiaries at industry level<br>• National policy makers |
| **C. Project performance / Efficiency** | EQ9. To what extent were activities implemented within the original budget and timeframe? | • To what extent have activities been implemented according to the workplan? | • Document review<br>• Key informants' interview<br>• Project performance document analysis | • Project documentation<br>• Beneficiaries at industry level<br>• National policy makers |

| Evaluation criterion / dimension | Key Evaluation Question (EQ) | Sub-questions | Proposed evaluation tools | Main evidence sources |
|---|---|---|---|---|
| | | • To what extent have the non-executed activities or delayed activities affected the production of the planned outputs?<br>• What has been the final cost of the outputs? Has it remained within the planned costs? | | |
| | EQ10. Has the project done the right things, with value for money? | • What changes have happened during implementation? Were they oriented to improve the overall performance of the project?<br>• Has the budget been spent according to the planned budget lines and allocations?<br>• Was the TA provided to agro-industries value for money (help desk, studies and tools developed)? | • Document review<br>• Key informants' interview<br>• Project performance document analysis | • Project documentation<br>• Beneficiaries at industry level<br>• National policy makers |
| **C. Project performance / Sustainability of benefits** | EQ11. To what extent the achieved results will sustain after the completion of the project? | • Do the target groups have the necessary capacity for sustaining the results achieved?<br>• Have stakeholders taken the necessary measures (legal, institutional, financial) for ensuring the continuity of the results?<br>• Are the results affordable for the target groups?<br>• Is there political commitment to continue supporting the development of biogas in Chile? | • Document review<br>• Key informants' interview<br>• Project performance document analysis | • Project documentation<br>• Country policies<br>• Beneficiaries at industry level<br>• National policy makers |
| | EQ12. What risks exist and how they may affect the continuation of the results? | • Which are the risks (financial, socio-political, institutional and environmental) that can jeopardize the sustainability of the results?<br>• How would these risks affect the sustainability of the results?<br>• What measures are in place to address these risks? | • Document review<br>• Key informants' interview<br>• Project performance document analysis | • Project documentation<br>• Country policies<br>• Beneficiaries at industry level<br>• National policy makers |
| **D. Cross-cutting performance criteria / Gender mainstreaming** | EQ13. Did the project design adequately consider the gender dimension and if so, has it been appropriately implemented? | • To what extent is the project gender-sensitive?<br>• If relevant, does the project have a gender strategy?<br>• Is the gender dimension adequately addressed in project outputs (e.g. reports, surveys, training needs assessment)?<br>• Would the project performance improve if gender be considered differently than it has been? | • Document review<br>• Key informants' interview | • Project documentation<br>• Beneficiaries at industry level<br>• National policy makers |

| Evaluation criterion / dimension | Key Evaluation Question (EQ) | Sub-questions | Proposed evaluation tools | Main evidence sources |
|---|---|---|---|---|
| **D. Cross-cutting performance criteria / M&E design and implementation / Results-based Management (RBM)** | EQ14. What is the quality of the M&E system implemented and to what extent it has helped drawing lessons and improving implementation? | • What is the M&E system in place?<br>• To what extent it helps monitoring progress, assessing achievements and taking decisions during implementation?<br>• Is there a system for identifying best practices and drawing lessons? If so, how it has helped the project during implementation?<br>• What lessons can be drawn from the successful practices in designing, implementing and managing the project? | • Document review<br>• Key informants' interview | • Project documentation<br>• Beneficiaries at industry level<br>• National policy makers |
| **E. Performance of partners** | EQ15. What has been the quality of implementation (delivery) and execution (administrative and financial management) of the GEF agencies and the project executing entities in discharging their expected roles and responsibilities? | • To what extent have UNIDO and the Ministry of Energy made available timely the necessary resources for implementing the project?<br>• How well have the implementing partners executed the project (in terms of use of funds, procurement, contracting)?<br>• What support have other stakeholders (national counterparts, donors) provided for contributing to the project objectives? | • Document review<br>• Key informants' interview<br>• Project performance document analysis | • Project documentation<br>• Beneficiaries at industry level<br>• National policy makers |

## Annex III. Lists of documents reviewed

**Project Design Documents:**

- Project Document
- Logframe

**Workplans:**

- Workplans 2015-2017 and 2017-2019

**Overall project progress, monitoring and evaluation reports:**

- 2018 and 2017 PIR
- 2018 and 2017 Progress Progress Update
- Independent Mid-Term Review (2016)

**Project thematic reports, studies and publications:**

Related to output 1.1:

- Survey on laws, norms and regulations of biogas development in the dairy sector: "Consulta de normas, reglamentos y otros aspectos legales necesarios para el desarrollo de la industria del biogás en el sector lechero en Chile" (May 2015)
- "Estudio de análisis de brechas para el registro de biodigestores bajo la normativa vigente y en desarrollo" (Schwager Energy S.A., November 2016)
- "Guía para el diseño, construcción, operación, mantenimiento, seguimiento y control de plantas de biogas de pequeña y mediana escala enfocadas al sector lechero en Chile" (September 2017)

Related to output 1.2:

- 12 biogas project fiches
- Baseline study: "Estudio actualizado de línea de base del proyecto" (November 2016)
- 20 biogas potential project fiches

Related to output 2.1:

- Training results and brainstorming: "Programa de Fomento al Biogás – Brainstorming the Capacitaciones – Febrero 2017"
- Contents of training modules 1, 2, 3, 4 and 5 of "Plan Formativo para Operadores e plantas de Biogás"

Related to output 2.2:

- Training reports and participants list of the following training courses: "Capacitación de Especialistas Biogás" (INIA, Osorno, October 2016), "Train the Trainers" (IBBK Biogás, November 2017), "Taller de capacitación para tomadores de decision en material de biogas" (AS&D, November 2018)
- Progress reports no.1 (April 2018), no.2 (August 2018) and Final Report (December 2018) of the Training Programme designed by Universidad de Santiago (activity 2.1.2)

Related to output 3.1:

- "Fortalecimiento del marco regulatorio, capacidades técnicas y cartera de proyectos para el desarrollo de una industria local de biogás en el sector lechero", Progress Report (INIA, November 2016), Reports of the TA workshops II and III (October 2017 and June 2018)
- Final Report "Critical review of Biogas calculator for the dairy sector in Chile", Jaime Martí Herrero (December 2017)

Related to output 3.2:

- "Reporte de Usabilidad (Manual de Plataforma) – Calculadora de Biogás" and "Manual de Usuario CMS – Calculadora Biogás", aeurus (May 2018)
- Final Report of Study Tours: "Encuentro RedBiolac 2015" (Puerto Montt, December 2015), "Gira de prospección de tecnologías en biodigestión anaeróbica de residuos de la agroindustria de Costa Rica y México" (January 2017)

- "Seminario internacional, taller y gira técnica – Desafíos y oportunidades para el desarrollo de la industria del biogas", INIA (July 2017) and Report of the Workshop Closure "Situación actual y perspectivas futuras del biogás en la producción ganadera en Chile", INIA (January 2019)
- Publications in agricultural magazines (7) and energy magazines (6)
- Final Report "Monitoreo de parámetros técnicos de la producción de biogás en plantas de digestión anaeróbica en Chile", INIA (March 2019)
- "Guía para el monitoreo de parámetros técnicos de producción de biogas en plantas de digestión anaeróbica en predios lecheros en el Sur de Chile"
- "Plan de Acción – Avanzando en mecanismos que promuevan el uso de la digestion anaeróbica y faciliten el acceso a la inversion en plantas de biogás para pequeñas y medianas agroindustrias", Rubiksustentabilidad (2019)

Related to output 3.3:

- Prefeasibility studies of 53 projects: blocs 1 (AS&D Consultores), 2 and 3 (EBP), 4 (Biotecsur) and 5 (Trama Medioambiental)
- Feasibility studies of 9 projects "Estudios de Factibilidad para proyectos de energía a biogás en el sector lechero", Trama TecnoAmbiental (February 2019)
- "Proyectos de biogas para la industria lechera en el sur de Chile – Análisis de la situación actual, conceptos de soluciones y modelos de negocio", Hans Friedman (October 2016)

Related to output 3.4:

- Final Report "Consultoría para la organización conjunta de una serie de eventos en torno a la temática de Economía Circular", Innodriven (January 2018)
- Final Report "Estimación de la reducción de emisiones GEI de proyectos actuales y potenciales que utilicen tecnología del biogás en Chile a través de una herramienta de gestión para su utilidad y replicabilidad en el tiempo", ImplementaSur (January 2019)
- "Guía didáctica para el registro de plantas de biogás en Chile" (September 2016)

**Coordination and Technical Committee minutes:**

- Project Steering Committee meetings 1 (March 2015), 2 (October 2015), 3 (April 2016), 4 (July 2016), 5 (December 2016), 6 (July 2016), 7 (March 2018).
- Review of the Technical Norm 3375 on digestate quality requirements; minutes of meetings 1 (December 2014), 2 (January 2015) and 3 (January 2015).

**Project presentation:**

- Presentation "Programa GEF de Fomento al Biogás – Promoviendo el desarrollo de la energía a biogas en pequeñas y medianas agorindustrias seleccionadas" (May 2018)
- Presentation "Propuesta de Reglamento de Seguridad para Plantas de Biogás" and workshop "Registro de Plantas de Biogás" (Osorno, November 2016)

**Laws, regulations, policies and norms:**

- "Energía 2050 – Política Energética de Chile". Ministry of Energy
- Regulation: "Reglamento de Seguridad de las Plantas de Biogás" (February 2017)

**Communication material**

- Project brochure (activity 1.2.4)
- Video

**Other:**

- "Las Energías Renovables No Convencionales en el Mercado Eléctrico Chileno (Edición 2018)". GIZ / Ministry of Energy
- Biogás de Residuos Agropecuarios en la Región de los Ríos – Aspectos generals, experiencias y potencial de producción. INDAP
- Manual de manejo y utilización de purines de lechería. Consorcio Lechero
- Guia de Planificación para proyectos de biogás en Chile. GIZ
- Biogas – The trade magazine of the biogas sector (Autumn 2017).

## Annex IV. List of stakeholders consulted

**Ministry of Energy (Executing Agency):**

1. Christian Malabrán, Project Director, Ministry of Energy
2. Gabriel Prudencio, Head of Renewable Energy Division, Ministry of Energy
3. Christian Santana, Former Head of Renewable Energy Division, Ministry of Energy
4. Marcel Silva, Sustainable Energy Division, Ministry of Energy

**UNIDO and PMU:**

5. Nina Zetsche, Project Manager, UNIDO
6. Javier Obach, Project Coordinator, UNIDO
7. Marianela Rosas, Regional Project Coordinator, UNIDO

**Stakeholders member of the SC:**

8. Miguel Stutzin, GEF Focal Point, Ministry of Environment, member of the SC
9. Daniel Barrera, ODEPA, Ministry of Agriculture

**Stakeholders involved in the implementation of the project:**

10. Francisco Salazar, INIA Remehue
11. Natalie Jones, Consorcio Lechero
12. Karin Von Osten, ex-Superintendencia de Electricidad y Combustibles (SEC)

**Stakeholders at regional level involved in the CARPs:**

13. Vicente Barrientos, Seremi Agricultura
14. Carolina Iturriaga, Regional Service of the Ministry of Environment in the X Region
15. Jean Paul Pinaud, Regional Service of the Ministry of Environment in the XIV Region
16. Moira Henzi, Director of the Regional Service of the Ministry of Agriculture in the XIV Region
17. Felipe Porflit, Director of the Regional Service of the Ministry of Energy in the XIV Region (by phone)
18. Jorge Balboa, Regional Government X Region
19. Nadine Campbell, CORFO X Region

**Beneficiary farmers from agro-industries**

20. Resi Reinecke, agro-industry
21. Carlos Neumann, agro-industry
22. Jaime Amthauer, agro-industry (by phone)
23. Alejandro Astete, agro-industry (by phone)
24. Patricia Prüssing, agro-industry (by phone)
25. Catie Konrad, agro-industry (by phone)

**Stakeholders from companies that design/build biogas plants:**

26. Mario Avila, Biotecsur
27. Josefa Gutiérrez, Schwager Biogás
28. Jean François Bradfer, ADS Consultores

**Other stakeholders:**

29. Ignacio Jofré Serrano, GIZ/NAMA Facility
30. Tomás García Huidobro, Fundación Innovación Agraria
31. Michel Junod, Director, Aproleche

**Stakeholders contacted but not available:**

1. Angelina Espinoza, ODEPA
2. Carolina Urmeneta, Ministry of Environment
3. Rocío Fonseca, CORFO
4. Matías Errázuriz, Genera Austral
5. Claudia Pavón, Universidad Adolfo Ibáñez

## Annex V. Updated Project Results Framework

| | | | | |
|---|---|---|---|---|
| **UNIDO/GEF Project:** CHILE – Promoting the Development of Biogas Energy Amongst Select Small- and Medium-Sized Agro-Industries | | | | |
| **Applicable GEF Strategic Objective and Program:** CCM Objective 3 "Promote investment in renewable energy technologies" | | | | |
| **Applicable GEF Expected Outcomes:** CCM-3 "Favourable policy and regulatory environment created for renewable energy investments"; "Investment in renewable energy increased" | | | | |
| **Applicable GEF Outcome Indicators:** CCM-3 "RE policy and regulation in place"; "Electricity and heat produced from renewable resources" | | | | |
| | **Indicator** | **Baseline** | **Target** | **Value end of project** |
| **Project Objective** | **To reduce GHG emissions by promoting investment and market development of biogas energy technologies in small- and medium-sized agro-industries** | | | |
| **Component 1** | **Policy and Information** | | | |
| **Outcome 1.** Policies targeting the development of biogas-based electricity and heat generation in agro-industries have been strengthened | a) Extent to which RE policies and regulations are adopted and enforced (score 0 to 5) | No regulation in place (level 1) | Regulation adopted but not enforced (level 4) | Regulation on the safety of biogas plants adopted and enforced (level 5). Standards on the quality of the digestate and on the design and construction of biogas plants produced. |
| | b) % of policies and regulations in which women associations have been consulted | No women's associations have been specifically consulted | Women's associations have been consulted | 3 women participated in the meetings held to discuss the regulation and the standards, but no women association have been specifically consulted |
| **Output 1.1.** Preparation and supporting adoption of secondary regulation supportive of biogas energy plants in agro-industries | a) Regulation for digestate quality and transport | No regulation in place (level 0) | Regulation discussed, submitted for approval and adopted (level 4) | The National Standards Institute (INN) has published technical standards regulating the quality of digestate for commercialization (NCh3375) |
| | b) Regulation for safety of biogas installation | No regulation in place (level 0) | Regulation discussed, submitted for approval and adopted (level 4) | The Superintendent for Electricity and Fuels (SEC) has validated the regulation for security in biogas installation and sent it to the Ministry of Energy for approval |
| **Output 1.2.** Collection and consolidation of technical, financial and economic parameters for biogas energy projects in small- and medium-sized agro-industries | Detailed set of consolidated parameters for biogas in Chile | No consolidated data set available for biogas in Chile | Consolidated data set | Baseline, project summaries and report on digestate produced |
| **Component 2** | **Technical capacity and delivery skills** | | | |
| **Outcome 2.** Adequate design, installation and operation practices for biogas energy plants in the agro-industrial sector have been adopted due to improved capacity of developers, suppliers and technicians | Number of biogas professionals trained | No biogas professionals trained | 75 biogas professionals trained | 9 people (1 women) finalised the training on biogas specialist and 20 (8 women) the biogas operators training course. 30 people (9 women) completed the training of trainers and 23 the decision-making training course |
| **Output 2.1.** Scoping and design of a training and certification programme for project developers, suppliers, installers and operators of biogas energy systems in agro-industries | Report with training programme, which considers specific incentives and facilities for female participants | No training programme designed | Training programme designed | Training programme for biogas operators designed by USACH |
| **Output 2.2.** Training and certification of prospective project developers, suppliers, installation companies and operators of biogas-based energy plants | a) Number of biogas professionals trained | No biogas professionals trained (0) | 75 biogas professionals trained (at least 10% women) | 9 people (1 women) finalised the training on biogas specialist and 20 (8 women) the biogas operators training course. 30 people (9 women) completed the training of trainers and 23 the decision-making training course |

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| | b) Number of biogas professionals certified | No biogas professionals certified (0) | 50 biogas professionals certified | One of the 9 people that completed the training of biogas specialist is certified by SEC as biogas installer. The 20 biogas operators trained have a University certificate |
| **Component 3** | **Investment and project portfolio** | | | |
| **Outcome 3.** Biogas energy has been adopted by select agro-industries | a) Number of biogas projects started operations | No biogas projects started operations (0) | A total of 750 kW projects started operations | 0 |
| | b) Number of jobs created | No biogas related jobs created (0) | At least 10 biogas related jobs (including temporary) created | 0 |
| | c) Private investment capital leveraged (USD) | USD 0 | USD 11 million | Four biogas projects under implementation by Schwager in other sectors. |
| **Output 3.1.** Technical assistance to small- and medium-sized agro-industries for the development of biogas energy projects | a) Permanent help desk (or task force) on biogas within CER | Generic support on NCREs by CER | Helpdesk (or task force) on biogas established completing baseline situation | The project web site allows interacting with the target groups. The Regional Coordinator of the project in place at Consorcio Lechero |
| | b) Number of biogas projects assisted during pre-investment phase | Project portfolio under tenders until 2013 | At least 20 projects supported | 20 case studies based on the project summaries developed |
| **Output 3.2.** Promotion and dissemination of information and best practices regarding biogas energy technology for small- and medium-sized agro-industries in Chile | a) Gender mainstreamed publication on biogas in dairy sector with best practices and key parameter | No specific publication | Gender mainstreamed publication on biogas with best practices and key parameters | 250 copies of Biogas Guide, biogas calculator, 7 publications in agricultural magazines, 6 publications in energy magazines |
| | b) Gender mainstreamed promotional material (brochures website) available | No material developed (0) | Gender mainstreamed promotional material developed and distributed | Project logo, merchandising material, project web site |
| | c) Presence of project on business fairs and events | Isolated activities by sector stakeholders (0) | Presence of project in at least 3 events | Presence of project in 8 events |
| **Output 3.3.** Establishment of a portfolio of biogas energy projects in the dairy sector to qualify for external financing and implementation initiated for selected biogas energy projects (750 kW) under a public tender mechanism | a) Number of projects with feasibility and technical studies | No studies (0) | 20 projects with feasibility and technical studies completed | 53 pre-feasibility studies and 9 feasibility studies carried out |
| | b) Number of projects legally structured and with permits in place | No projects legally structured, and no permits obtained (0) | 20 projects legally structured and with permits in place | Zero. Out of the 9 feasibility studies conducted, 4 yielded positive NVP and farmers were discouraged to participate in financing biogas plants without government subsidies |
| | c) Biogas projects approved under CER tender | Nonviable proposals received under earlier tenders (0) | A total of 750 kW biogas projects approved under CER tender | No biogas projects approved. The 4 projects with positive NVP would yield 837 kW of gross power that could be transformed into 251 kW of electric power. |
| | d) Biogas projects started operations | No biogas projects started operations (0) | A total of 750 kW projects started operations | No biogas projects started operations. |
| 3.4. Creation of an enabling environment for financial instruments facilitating access to investment in biogas energy plants for small-and medium-sized agro-industries | a) Number of biogas energy projects in small- and medium-sized enterprises accessing existing technology specific financial instruments | No biogas projects accessing technology specific subsidies and financing windows (0) | 5 projects have submitted business plans to access existing technology specific financial instruments | No biogas projects have submitted business plans |
| | b) Private investment capital leveraged | None (USD 0) | At least USD 11 million | Four biogas projects under implementation by Schwager in other sectors. |