



**CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006**

CONTENTS

- A. General description of project activity
- B. Application of a baseline and monitoring methodology
- C. Duration of the project activity / crediting period
- D. Environmental impacts
- E. Stakeholders' comments

Annexes

- Annex 1: Contact information on participants in the project activity
- Annex 2: Information regarding public funding
- Annex 3: Baseline information
- Annex 4: Monitoring plan

**SECTION A. General description of project activity****A.1 Title of the project activity:**

Conversion of existing open cycle gas turbine to combined cycle at the Central Termica Patagonia power station, Comodoro Rivadavia, Argentina

Version 1

Date of completion: 29/09/2006

A.2. Description of the project activity:

The project activity will convert two turbines currently operating in open cycle mode to combined cycle operation at the Energia del Sur (EDS) Central Termica Patagonia power station in Comodoro Rivadavia, Argentina. This will involve the installation of two heat recovery steam generators (HRSGs) that utilise the waste heat from the gas turbine to raise steam. The steam will be used to generate electricity using a steam turbine. The plant consists of two gas turbines (PATATG01 and PATATG02) currently operating in open cycle mode. The project will result in approximately 73% efficiency increase of the plant which will allow for additional electricity generation. In order to fully harness the capacity of the new steam turbine the project will also include gas over-firing in the steam turbine with a consequent increase of the total fossil fuel combustion at the project site. The project will not involve any upgrade or modification to the existing gas turbines that would impact their technical operating life.

The EDS generating plant was commissioned in 1995. The plant was temporarily taken offline from 2002 until 2004. Re-commissioning of the units began in November 2004 and both units are now fully operational.



Figure 1: Central Termica Patagonia power plant

The Comodoro plant consists of two frame 6 General Electric MS 6001B gas turbines currently operating in open cycle mode with 77MW of net installed capacity. Once operating in combined cycle mode the total installed capacity will be 134MW. Of the additional 57MW effective capacity, 38MW will be generating electricity without the use of additional fossil fuels (additional capacity of the steam turbine), with waste heat being the only generating source of steam. The remaining 19MW will be generated by over firing in the HRSGs. Figure 1 shows the Central Termica Patagonia at Comodoro Rivadavia.



The proposed project will supply electricity to the Patagonia Electricity Grid (Mercado Electrico Mayorista del Sistema Patagonico or MEMSP), which comprises approximately 5% of the total electricity generation in Argentina. The Patagonia grid has been essentially isolated from the main national grid of Argentina (the Mercado Electrico Mayorista, MEM) until 2006 and historical data of electricity interchange between the two grids indicate negligible electricity transfers between the MEM and the MEMSP in the past. However, as of March 2006 the two grids are connected through the 500 kV line linking Choele Choe/500kV and Pto Mandry/500kV substations and as such the entire Argentinean grid is the system boundary for the project.

Argentina is characterised by the third-largest power market in Latin America, relying mostly on hydropower and natural gas to fuel its electricity sector. Argentina has the third-largest natural gas reserves in South America, after Venezuela and Bolivia, amounting to an estimated 21 trillion cubic feet (Tcf) in 2005¹. In December 2005, the country had approximately 24 GW of installed generation capacity, of which 55% was fossil fuel based (mainly gas), 41% hydroelectric and the remainder nuclear². The total power generated amounted to approximately 94,000 GWh. Electricity demand has steadily grown since 1991, though the economic collapse and financial crisis of 1999-2001 caused a temporary decline in both electricity generation and consumption (demand reached a negative value of -2% in 2002). At the same time natural gas production has increased steadily over the last decade, making Argentina the largest producer in Latin America. When Argentina experienced a severe energy crisis in 2004, the natural gas industry was at the centre of it. Government imposed caps on natural gas prices led to a surge in natural gas usage, exceeding the country's gas supply.

The abundance in natural gas availability in the recent past together with the natural gas pricing strategies of the government have allowed the Argentinean thermal power sector to develop without much attention devolved to generation efficiency. The majority of thermal plants in Argentina are gas turbines operating in open cycle configuration and thus characterised by fairly low efficiency. The proposed project will utilise the waste heat from the two gas turbines to generate additional electricity, thus improving the efficiency of electricity production at the site and harnessing a natural resource which is currently in decline (natural gas production began to decline following the 2002 economic crisis; this trend continued also during 2003-04³).

Typically the dispatch of power —according to the least-cost dispatch— sees both nuclear and hydro plants run first (they are only limited by repairs, water access, etc.) followed by the cheapest thermal plants and then the most expensive (oil and coal). As such, marginal power plants are typically thermal units characterized by the lowest efficiency. The efficiency improvement due to the proposed project's investment will lower the emission factor for the electricity generated at the Central Termica Patagonia plant when compared to existing open cycle operation at the site. It is expected that the power plant conversion to combined cycle will be able to deliver in the order of 167,491 tonnes of CO₂ equivalent per year over the crediting period. The amount of GHG savings claimable by the project is estimated using the baseline methodology and monitoring plan which make up this project design document.

¹ EIA (Jan, 2005) “*Argentina Country Analysis Brief*” available online at www.eia.doe.gov

² Source: CAMMESA statistics available on <http://memnet2.cammesa.com/inicio.nsf/marcomemnet>.

³ EIA (Jan, 2005) “*Argentina Country Analysis Brief*” available online at www.eia.doe.gov

**Contribution of the project to sustainable development:**

The aim of the project is to deliver clean and sustainably generated electricity to the Argentinean grid. Specifically, the proposed project activities will generate an additional 38 MW of electricity without any additional use of fossil fuels and associated CO₂ emissions. Indeed, Argentina continues to endure slow economic growth, although electricity demand has grown by approximately 6.7% per year between 2003 and 2006, stabilising itself to 5.8% at the beginning of 2006, a trend that is expected to continue⁴. Therefore the proposed project will contribute to sustainable development by efficiently generating electricity, for which there is a growing demand in the country.

Despite the proposed CCGT conversion not being the first in Argentina, the technology employed is still relatively young in the country (there is only one other example of CCGT conversion in Patagonia), therefore the project will contribute to sustainable development by transferring skills and technology associated with combined cycle gas turbines. The CCGT project will also increase the skilled workforce required at the generating station. Further, The CCGT will result in training of local workers, including the recruitment of students from the National University of Patagonia. Specifically, the proposed project will create 6 permanent jobs and 500 temporary positions of which approximately 98% will be comprised of residents in the Comodoro Rivadavia area.

Additionally, the project will make a better use of the natural gas resources of Argentina through the efficiency gains achieved. This is particularly significant in the case of Argentina where there is currently a shortage of gas. The UIA (Argentine Industrial Union) has expressed its fears with regards to energy provision in the forthcoming years, specifically related to the future of gas and electricity supply.

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Party involved wishes to be considered as project participant (Yes/No)
Argentina (Host)	Energia del Sur S.A. (EDS) (Project owner)	No

() In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.*

Argentina is a party to the Kyoto Protocol which was ratified on 28 September 2001.

The project proponent is Energia del Sur, SA (EDS). EDS owns the Central Termica Patagonia plant. EDS is one of the largest companies involved in thermal power generation in the Patagonia region of Argentina. EDS is owned by Patagonia Energy Limited, which in turn, is owned by two shareholders; Rurelec PLC, and Basic Energy Limited.

⁴ Exhibit A: Conversion to CCGT: Operating Result Evaluation (2006).

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:



Figure 2: The project location in Argentina

The location of the project activity will be the Central Termica Patagonia power station in Patagonia. The project address is:

Energía del Sur S.A.
Central Termica Patagonia
Ruta 39, Km. 12, Ciudadela
Comodoro Rivadavia
Chubut,
Argentina

Figure 2 shows the map of the location of the plant in Argentina.

A.4.1.1. Host Party(ies):

Argentina

A.4.1.2. Region/State/Province etc.:

Chubut

A.4.1.3. City/Town/Community etc.:

Comodoro Rivadavia

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

The EDS power plant is located at km 12 of the Ruta N° 39 in the northern part of the municipal area of Comodoro Rivadavia in the Chubut Province, Southern Argentina. The GPS co-ordinates of the project site are:

45° 47.609 Latitude South;
67° 30.872 Longitude West.

Figure 3 shows the location of the project in the Chubut province in Patagonia.



Figure 3: Location of the Comodoro power plant

A.4.2. Category(ies) of project activity:

Energy Industries (non-renewable sources)

A.4.3. Technology to be employed by the project activity:

The existing plant at the project site consists of two General Electric MS 6001B gas turbines currently operating in open cycle mode. The two gas turbines currently have a combined net installed capacity of 77 MW (2 x 38.5 MW). The proposed project will convert the two gas turbines to combined cycle operation through the addition of the following equipment (see Figure 4 for details of the plant flowchart and Table 1 for the technical characteristics of the plant):

- Two Heat Recovery Steam Generators (HRSGs), one per gas turbine;
- One condensing non-reheat steam turbine (ST);
- One air-cooled condenser;
- One main transformer and one 132 KV breaker to connect to the electricity grid.

Table 1: Technical Characteristics of Energia del Sur Power Plant

TECHNICAL CHARACTERISTICS OF ENERGÍA DEL SUR THERMAL POWER PLANT	
Installed capacity (Effective)	136.4 MW
Gas turbine	77 MW (2x38.5 MW)
Steam turbine	59.4 MW
Heat rate	CC: 1880 kCal/kWh (45.7%) TG: 2760 kCal/kWh (31.2%)
Availability	95%
Combined Cycle – Commissioning date	Nov. 2007

The technology to be employed uses the waste heat from the existing gas turbines to generate the additional capacity. Hot exhaust gases from the two combustion gas turbines will pass to two heat recovery steam generators (HRSGs) where thermal energy is harnessed to generate steam. To increase the amount of steam generated, each HRSG inlet duct will be equipped with a duct burner which fires additional natural gas (this supplementary firing⁵ corresponds to an additional 19 MW capacity). A single steam turbine (ST) will receive high-pressure steam from the HRSGs contributing an additional 38 MW capacity to the plant. The total final capacity of the power plant will be 134MW. Steam is then exhausted to a condenser where it is air-cooled. This will result in two main environmental benefits:

- CO₂ emission reduction per unit of generated power; and
- Reduction of local pollutants such as NO_x which contribute to smog formation.

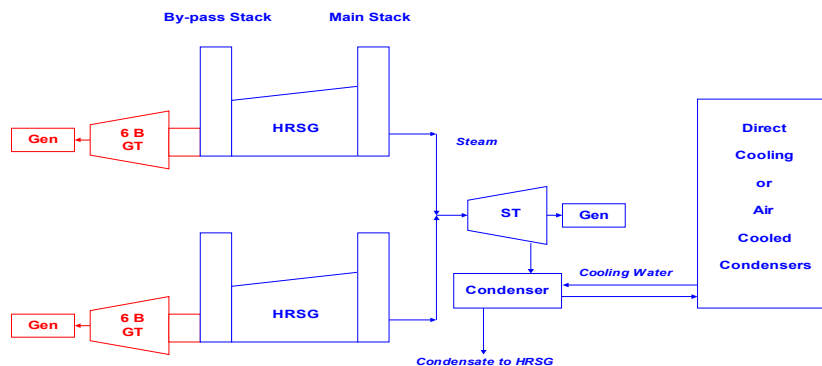


Figure 4: Schematic diagram of the Combined Cycle system

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

The crediting period chosen for the proposed combined cycle conversion project is renewable, 7 years, renewable twice. The total emission reductions due to the project are estimated to be approximately **1,172,437 tCO₂** over the first 7 years of the crediting period. The calculated average annual emission reductions achievable through the proposed project are conservative estimates based on an estimated grid

⁵ ‘Supplementary firing’ describes the incorporation of a gas burner to add heat to the HRSGs to supplement that from the gas turbines, the HRSG cannot operate without the heat input from the gas turbine in this case.



emission factor of 0.53 tCO₂/MWh. This factor was calculated according to the selected consolidated baseline methodology ACM0007 and ACM0002. Annual emissions reductions were then estimated using projected power generated by the combined cycle steam turbine. The actual CERs will be calculated ex-post following the fulfilment of the project monitoring activities.

Annual estimates of emissions reductions over the first crediting period (7 years) are given in the table below:

Year	Estimated emission reductions (tonnes CO ₂)
2007 (2 months)	27,915
2008	167,491
2009	167,491
2010	167,491
2011	167,491
2012	167,491
2013	167,491
2014 (10 months)	139,576
Total (tonnes CO₂)	1,172,437
Number of crediting years	7
Annual average over crediting period (tonnes CO₂)	167,491

A.4.5. Public funding of the project activity:

There is no public funding for the project activity



**SECTION B. Application of a baseline and monitoring methodology****B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:**

The approved consolidated methodology **ACM0007**: “**Baseline methodology** for conversion from single to combined cycle power generation” Version 01 and **ACM0007**: “**Consolidated monitoring methodology** for conversion from single cycle to combined cycle power generation” are used for the Comodoro combined cycle conversion project⁶.

B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

The ACM0007 baseline and monitoring methodology is applicable if the following conditions are met:

1. *When project developers utilize previously-unused waste heat from a power plant, with a single-cycle capacity, and utilize the heat to produce steam for another turbine – thus making the system combined-cycle;*

The Comodoro project will install two heat recovery steam generating boilers to utilise the waste heat from the existing open-cycle gas turbines to raise steam and thus to generate additional electricity.

2. *When waste heat generated on site is not utilized for any other purpose on-site;*

Currently there is no practical use for the heat generated on site, which is dispersed through two outlet stacks.

3. *Where the project activity does not increase the lifetime of the existing gas turbine during the crediting period (i.e. this methodology is applicable up to the end of the lifetime of existing gas turbine, if shorter than crediting period);*

The project will utilise the exhaust heat of the existing gas turbines but will not involve any upgrade or modification to the turbines themselves that would impact their technical operating life.

4. *Where project developers have access to appropriate data to estimate the combined margin emission factor, as described in ACM0002 “Consolidated baseline methodology for grid-connected electricity.*

The electricity grid in Argentina is centrally despatched by the Wholesale Electric Market Management Company (CAMMESA). Data related to the power exported to the grid from each generating plant over the year is available from CAMMESA.

The Comodoro combined cycle conversion project meets all the above applicability criteria and therefore ACM0007 is selected as an applicable and appropriate methodology for the determination of the project’s baseline.

⁶ The consolidated methodology ACM0007 is available on the UNFCCC-CDM website at http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_ACM_GR5DZKC3ZP817LEFCOQNBETEAD51F6

**B.3. Description of the sources and gases included in the project boundary**

The included sources of GHG emissions included in the calculations are shown in the table below.

	Source	Gas	Included/ Excluded	Comments
Baseline	Open cycle fuel use	CO ₂	Included	Main emission source
		CH ₄	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N ₂ O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Grid electricity generation	CO ₂	Included	Main emission source
		CH ₄	Excluded	Excluded for simplification. This is conservative
		N ₂ O	Excluded	Excluded for simplification. This is conservative
Project Activity	Project fuel use	CO ₂	Included	Main emission source
		CH ₄	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N ₂ O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Closed cycle steam turbine fuel use	CO ₂	Included	Main emission source
		CH ₄	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N ₂ O	Excluded	Excluded for simplification. This emission source is assumed to be very small.

The Baseline methodology, ACM0007 refers to the methodology ACM0002⁷ for the purposes of estimating the combined margin emission factor of the grid on which the project is operating. The physical project boundary consists of the Central Termica power plant and the plants connected to the grid. The Central Termica Patagonia plant has been historically connected to an isolated grid in southern Argentina referred to as the Patagonic System (the Mercado Eléctrico Mayorista Sistema Patagonico). This system has operated largely in isolation from the larger Argentinean interconnected grid, the MEM, because the two grids were originally connected via a 132 KV line which constrained electricity transfers between Patagonia and the rest of Argentina.

However, as of March 2006 the two grids are officially connected from Puerto Madryn to Choele Choe further north through the addition of a 500 KV high tension transmission line (details of the new transmission line are shown in Figure 5. Therefore the two systems are considered as a single grid, as they will operate as one in terms of marginal costs. Figure 6 shows a schematic of the entire Argentinean grid. For the purpose of this PDD the entire Argentina grid, with its connected plants, will be considered as the project electricity system on the grounds of increasing electricity traffic on the 500 kV line.

⁷ UNFCCC “Consolidated baseline methodology for grid-connected electricity generation from renewable sources” Version 06.

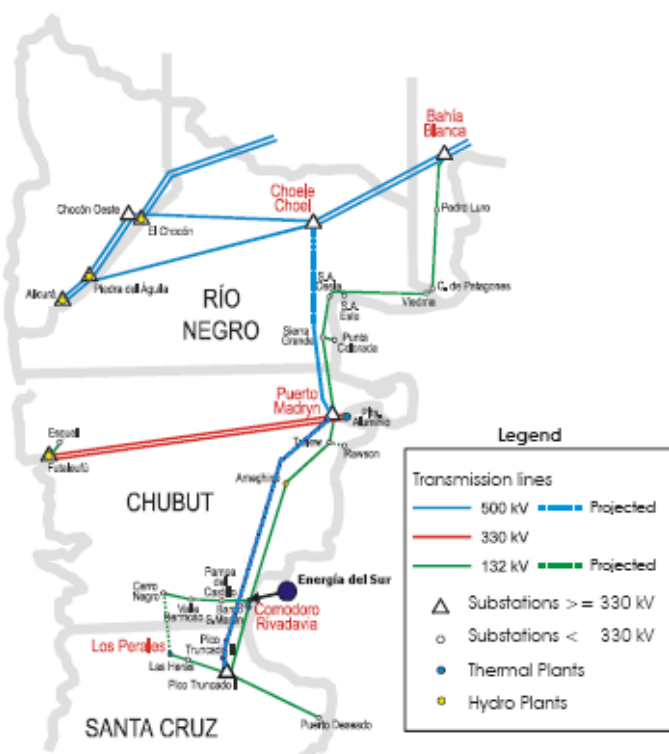


Figure 5: The Patagonic system transmission network with the new 500 kV transmission line

As shown in Table 2, since the transmission capacity between Patagonia and the rest of Argentina was upgraded in March 2006, the movement of electricity from MEM into Patagonia has been negligible, compared to the electricity exports from Patagonia into Argentina which amounted to an increasing proportion of the total power generated in MEMSP throughout the first three months of the new link's operation. This gradual increase in exported power is expected to continue throughout the project's lifetime, given that the main areas of power demand are in the northern regions of Argentina.

Table 2: Electricity transfers between MEM and MESP since March 2006

	Mar-06 MWh	Apr-06 MWh	May-06 MWh	Jun-06 MWh
Import/Export*	-18,249.7	-43,701.7	-55,375.1	-93,168.5
Total generation MEMSP	410,158.3	448,795.2	482,463.2	N/A
Exports to MEM as % of MEMSP total generation	4.45%	9.74%	11.48%	
Total generation MEM	8,450,427.6	7,858,528.7	8,217,437.7	N/A
Imports from MEMSP as % of MEM total generation	0.22%	0.56%	0.67%	

Notes: * A negative sign indicates power exported from MEMSP to MEM

Source: SMEC (Sistema de Medición Comercial)

Furthermore the demand in the Patagonia system has the peculiar characteristic that a sole agent, ALUAR, represents approximately 65% of the total energy demand in the region⁸. This agent has a practically constant consumption of about 476 MW (330MW until the first semester in 1999), and is partly self-supplied with its own generation (GT and CC types). In the past unusual high growth rates in energy demand in MEMSP were related to the expansion of ALUAR's plant. The characteristic described above implies that the global growth rate of the system's demand is strongly influenced by the evolution of ALUAR's demand, as well as by the demand traded by this agent in the Patagonia system, a value sensitive to ALUAR's auto-generation policy. The non-industrial demand has shown an annual constant growth rate of 5.4%, the same value as that indicated by CAMMESA in its latest seasonal programming.

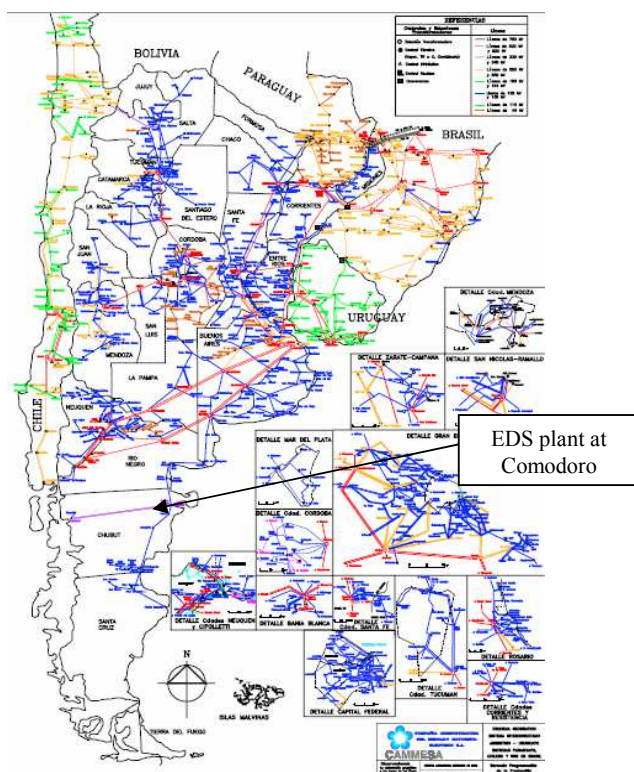


Figure 6: Schematic diagram of the Argentinean Interconnected System

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

ACM0007 is only applicable to projects where it can be demonstrated that the baseline scenario is the continuation of current practice (i.e. in the absence of the proposed project electricity to meet the demand in the grid system will be generated by:

⁸ Exhibit A: Conversion to CCGT: Operating Result Evaluation (2006).



1. the continued operation of the existing gas turbines in open cycle;
2. the operation of existing grid-connected power plants; and
3. the addition of new generation sources to the grid).

The ACM0007 baseline methodology requires all plausible alternative options to the project activity to be identified and a detailed barrier analysis to be performed on each option according to the steps highlighted in the “*Tool for the demonstration and assessment of additionality*”⁹. The option with the fewest barriers is taken to be the baseline scenario. These steps are followed below.

1) Identification of alternatives to the project activity consistent with current laws and regulations

Under the current circumstances of the Argentinean power sector there are three plausible alternatives to the project activity capable of delivering similar outputs and services, available to Energía del Sur, these are:

1. No project activity undertaken (continuation of current practice).

Under this scenario power to meet the grid demand is generated and supplied by the existing gas turbines at the site running in open cycle configuration, by other existing grid-connected power plants, and by the addition of new generation sources to the grid.

2. Investment in a new fossil fuel power plant of annual output equivalent to the proposed project.

Under this scenario the project developer would invest in a new open cycle gas turbine of power output equivalent to the proposed steam turbine in order to increase the power generation of the Central Patagonia power station.

3. The proposed project activity NOT undertaken as a CDM project activity.

Under this scenario EDS would commission a steam turbine of the same capacity to operate in a closed cycle configuration without the support of the CDM.

4. Commercial renewable power plant of equivalent capacity to the proposed project NOT undertaken as a CDM activity.

Since grid connected hydropower is the only renewable technology to be firmly established in the Argentinean power sector, this alternative refers to hydropower plant of equivalent output.

2) Conduct a barrier test analysis:

A detailed barrier analysis is performed in Section B5. Table 3 below presents the summary of the results of the barrier analysis conducted considering the following types of barriers:

- Investment barriers;
- Technological barriers;

⁹ The “Tool for the demonstration and assessment of additionality (version 2)” (28 Nov 2005) is available online at http://cdm.unfccc.int/methodologies/PAmethodologies/AdditionalityTools/Additionality_tool.pdf.



- Barriers due to prevailing practice.

Table 3: Results of the barrier analysis

Barriers	Scenario 1: Continuation of current practice	Scenario 2: Investment in a new fossil fuel power plant of equivalent output to proposed project	Scenario 3: The proposed project activity NOT undertaken as a CDM	Scenario 4: Renewable power plant of equivalent output
Current laws and regulations	N/A	N/A	• There is no regulation that requires upgrading existing OCGT to operate in closed cycle.	N/A
Investment Barriers	N/A	Intermediate barriers • Attracting investment and/or raising capital for new fossil fuel plants of any type is difficult in Argentina as low electricity prices have deterred investment in this sector since the economic. • Because of the overall lack of capacity in Argentina, the cheapest generation plants (HFO and diesel reciprocating engines) will most likely be targeted as investments.	Significant barriers • In Argentina it is difficult attracting investment and/or raising capital for a new CCGT system as low electricity prices has deterred investment in this sector since the economic collapse. • CCGT investments are particularly difficult because the low electricity tariffs act unfavourably for efficient plants. • Without the additional revenue from CER sales the project debt for an OCGT investment would be difficult to recover.	Intermediate barriers • Despite hydropower is the only renewable source of energy for which there is comparable technical know-how in Argentina, with limited available hydropower resources to be developed in the area, the economic return of an hydropower plant of similar capacity is less attractive. • The capital costs of installing renewable technologies like hydroelectric or wind generation units are much higher than thermal equipment generation costs.
Technological Barriers	N/A	No barriers • The capacity necessary to design fossil fuel reciprocating engines exists within Argentina.	Significant barriers • The capacity and skills necessary to do the design and process engineering work for CCGT conversion is very new to Argentina	Intermediate barriers • There are no suitable exploitable hydropower resources available in the area. • The project developer does not have technical experience in the development of hydropower plants.



Prevailing Practice	N/A	Intermediate level of barriers - There have not been any new electricity generating plants commissioned in Argentina since 2002, and there is currently no incentive for increasing efficiency (e.g., conversion to CCGT). - The current growing problem in Argentina with gas supply will lead in the near future to the commissioning of new HFO and Diesel reciprocating engines to meet power demand.	Significant barriers - Due to difficult economic conditions in Argentina there is little incentive to convert plants to CCGT operation. Indeed, under the current energy payment system to generators, efficient plants receive unfavourable returns. - Overall in Argentina there are thirteen CCGT plants, including one in Patagonia, the latest of which was brought on line in 2002. CCGT plants are NOT prevailing practice in Argentina.	N/A
---------------------	-----	--	--	-----

3) Justify the selection of baseline scenario

The scenario with the least barriers is **Scenario 1**: Continuation of current practice. As shown in the summary table above and as described in more detail in Section B5, it is clear that one or more of the barriers identified in the barrier analysis affect the project scenario as well as all of the other alternative scenarios apart from Scenario 1, which is therefore chosen as the baseline scenario. As such this project meets the requirements of the baseline methodology for the purpose of determining both the baseline and project emissions.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

The consolidated tool for the demonstration and assessment of additionality is applied in ACM0007. The tool provides a set of steps to demonstrate and assess additionality. These steps, with reference to the Comodoro project, are illustrated in the following paragraphs.

Step 0: Preliminary screening of projects based on the starting date of the project activity

The proposed project does not wish to have the crediting period start prior to the registration of their project activity.

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

Step 1 includes two components: Sub-step 1a requires the identification of alternatives available to the project participants, and Sub-step 1b requires these alternatives to be assessed to determine whether they meet all legal and regulatory requirements.

***Sub-step 1a. Define alternatives to the project activity***

Under the current circumstances of the Argentinean power sector, the plausible alternatives available to the project developer as stated in Section B.4 are as follows:

Scenario 1: Continuation of current practice

Scenario 2: Investment in a new fossil fuel power plant of equivalent output to proposed project

Scenario 3: The proposed project activity NOT undertaken as a CDM project activity

Scenario 4: Implementation of a renewable power plant of equivalent output.

Sub-step 1b. Enforcement of applicable laws and regulations

The first test to run on the alternative scenarios consists in proving that they are in compliance with all applicable legal and regulatory requirements.

Scenario 1 is clearly consistent with prevailing laws and regulations. There is no regulation in Argentina to prevent the continuation of current practice and there are no specific laws that require upgrading existing OCGT to operate in closed cycle or to utilise wasted heat on the premises where it is generated; indeed, there are many plants in Argentina that are operating in open cycle mode.

Scenario 2: There is no regulation that specifies what type of fossil fuel must be used for new generation additions. Hence, any power plant using fossil fuel would be in compliance with current regulations.

Scenario 3 is also consistent with prevailing laws and regulations since the project was proposed and was duly awarded to the project developer under the current laws and regulations governing the Argentinean power sector. There is no legal requirement to register projects such as this under the CDM. Further, Argentina has no regulation in place that requires the utilisation of waste heat on the premises where it is generated.

Scenario 4 is also in compliance with all relevant rules and regulations that govern the generation of hydroelectric power.

Alternatives to the project activity can be clearly identified. The alternatives also clearly meet all regulatory and legal requirements of the Argentinean electricity sector.

Step 2. Investment Analysis

In order to demonstrate the additionality of the proposed CDM project activity, a full investment analysis is not undertaken; nonetheless elements of it are incorporated in Sub-step 3a in the section regarding *Investment Barriers*.

Step 3. Barrier Analysis

The following barrier analysis highlights the barriers that have been identified to be hurdles to the development of the proposed CDM project activity. These barriers also apply to Scenarios 2, 3 and 4 identified in Step 1, hence leaving the “current practice - no project” option as the only available alternative and, as such, the baseline scenario for the project.



Sub-step 3a: Identify barriers that would prevent implementation of type of the proposed project activity

(a) Investment Barriers

There are a range of barriers which affected the development of the project related to the investment conditions, these include:

Low energy tariffs: In 2001 Argentina endured a major economic crisis which resulted in the devaluation of the peso from 1 to 1 parity against the US dollar to 4 to 1 over a matter of months. As a result, the government converted energy tariffs to Argentinean pesos (\$PPAD) regardless of whether a project's debt was to be paid in dollars. In addition the government has implemented modifications to the regulatory framework so as to mitigate the impact of the crisis on the price of energy and the operation of the wholesale electricity market in the short term. The Energy Secretariat passed a series of resolutions in order to avoid a strong increase in the price of energy:

- A Price of Available Capacity was set at 12\$/MW in hours when capacity payment happens. In Argentine pesos, this represents a 20% increase on the value before the crisis, but a 60% reduction compared to the previous value (2001 year) nominated in US dollars.
- A maximum energy price was set at 120\$/MWh (40 US\$/MWh).
- The price of energy is set assuming that all power plants use natural gas and have transmission availability, regardless of what actually occurs. Thus, energy prices do not reflect the marginal cost of the system, and are often significantly lower.

The immediate effect of these measures was that, as expected, energy prices did not raise significantly as a result of the devaluation of the Argentine currency and the negative impact on the electric power tariffs paid by demand was avoided. Nonetheless these measures resulted in immediate financial problems for many generating companies as they had financed their investments through debt in US dollars. Also, as a consequence, energy revenues were suddenly cut by up to 60%.

In the years since 2001 the cost of energy has increased slightly though the government maintains control over these prices. Indeed, the energy tariffs are among the lowest in South America (see Figure 7). In a recent study commissioned by Capex S.A., it was estimated that the payback price for an investment into a combined cycle system is approximately USD \$29 per MWh, though during the past 4 years the energy tariff price has never reached this level¹⁰. If the resolution of the Energy Secretariat remains in force, energy prices will practically not change, remaining around 20 US\$/MWh, with variations between 15 US\$/MWh and 25 US\$/MWh according to the month of the year¹¹. This means that the expansion of generation plants by private investors in response to price signals in the spot market would not be possible.

¹⁰ Project Design Document, Agua del Cajon Thermal Power Plant – Open to Combined Cycle Conversion, Version 01, 20 October 2005.

¹¹ Exhibit A: Conversion to CCGT: Operating Result Evaluation (2006).

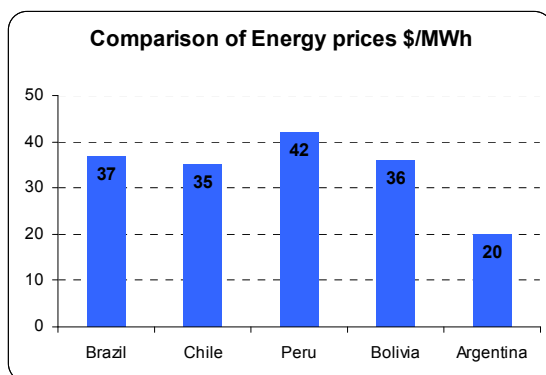


Figure 7: Comparison of energy prices among various South American countries (2005 data; AGEERA)

Project scenario and Scenario 3: Under these conditions there is no incentive whatsoever for investment in new generating plants in Argentina because low energy tariffs do not allow for profit. Without the CDM this type of efficiency improvement project could not occur because the low energy tariffs prevent companies to repay debt.

Government imposed retention of marginal profits: In addition to imposing caps on energy tariffs, in 2003 the Argentinean Government approved a resolution (406/2003)¹² which states that from the date of it coming into force generating companies should be paid for their variable operating costs but their marginal profit on spot transactions would be withheld by CAMMESA for payment at a future date. The spot price should be based on the operating costs of the most inefficient plant on the grid, however it has been artificially frozen by the government since the economic crisis in 2001, and thus, is no longer a reflection of the marginal cost. CAMMESA pays operating costs according to a formula as stated in *Subsection d* of the resolution. For all but the most inefficient plants, the operating costs (according to *Subsection d*) are considerably lower than the spot price for electricity. Of this margin between the costs per MWh paid out to operators and the spot price, only 35% of this marginal profit is paid back to generating companies. This 35% of the margin is paid back in arrears, months after the original sale. The remaining proportion of the marginal profit is not paid to generating companies, but is retained in a trust fund (FONINVEMEM, "Fondo Para Inversiones Necesarias que Permitan Incrementar la Oferta de Energía Eléctrica en el Mercado Eléctrico Mayorista"), which the government intends to use to invest in new generation (both expansion of existing and construction of new plants). Major companies with significant debt therefore receive insufficient payment to cover their fixed costs.

Project scenario and Scenario 3: The fact that the government retains 65% of the variable profit from generating companies does not attract foreign investors nor does it inspire confidence in the system. There has not been any investment in the electricity generating sector in Argentina in the past 4 years, despite growth in electricity consumption and demand. The development of a technology relatively new for Argentina like CCGT would be the least attractive option for a developer unless some of the financial barriers are mitigated by the additional revenue stream of carbon credits. Therefore this represents a significant barrier to the proposed project in the absence of the CDM.

¹² Source: ENRE; Ente Nacional Regulador de la Electricidad, Annual Report 2003



Scenario 4: The lack of viable hydro resources in the area of Comodoro (see the Technology Barriers section below) contribute in making the investment in a large size hydropower plant a non financially attractive alternative to the proposed project. Furthermore, the retention of marginal profit does represent an intermediate barrier to the development of new hydro power plants.

Disincentive for efficiency: The marginal cost system in Argentina actually provides a strong disincentive for efficiency as the price per MWh that is paid to more efficient plants is lower than that to inefficient plants. That is, an efficient producer will obtain a margin between its variable costs and the most expensive plant at a given time, however, at this time 65% of that margin is not paid out to generating companies.

Project scenario and Scenario 3: This is a significant barrier to the development of CCGT systems as the conversion makes the generating system far more efficient than the starting OCGT.

Further decrease in energy tariffs: The proposed project activity is in the region of Chubut, in the south of Argentina. Prior to March 2006 this plant was operating on an isolated grid (MEMSP) which benefited from higher spot prices for electricity¹³. However, as of March 2006 the two systems are connected and thus the marginal costs will be driven down as a result. This provides an added barrier for companies wishing to invest in generation in the southern regions of Argentina, whatever the chosen technology; therefore Scenarios 2, 3 and 4 as well as the project scenario are all affected by the foreseeable reduction in energy prices.

Difficulty of raising debt: International Banks are reluctant to provide debt for projects in the power sector due to the risks associated with the economic instability in Argentina. In Argentina there is only one local bank (Banco Nacion) that is willing to directly provide finance for this type of project. In their screening process to grant debt to a project they require a government recommendation. In all cases the debt finance is associated with complicated conditions and high interest rates (10 – 15%). Indeed, there have not been any investments in power generation in Argentina since 2002. Existing companies within Argentina are unable to invest in new power plants because they are unable to secure new debt as they remain heavily burdened by pre-existing debt which has become difficult to repay due to the devaluation of the peso against the dollar (followed by low revenues in the energy generation sector associated with low electricity tariffs). In addition foreign companies and banks are not interested in investing in Argentinean power generation plants because the tariffs are too low to repay debt and to make a profit.

Project scenario and Scenario 3: There is a clear difficulty of raising debt (even on a recourse basis) for any kind of project due to the banks' reluctance to take Argentina counterparty risk. Also finance banks are not willing to finance projects in Argentina unless the projects' return is enhanced by carbon financing; therefore the CDM incentive will help mitigate this by providing an additional revenue stream from the sale of CERs. This will reduce the overall risk of the project revenues and should reduce the overall risk profile of the project. Furthermore, if the additional revenue stream from the sale of CERs is recognised by debt providers, it will increase the Debt Service Coverage Ratio (DSCR) of the project. Indeed, the potential revenue from CERs has been noted in all solicitations for debt equity. CDM revenue for the Comodoro CCGT conversion (estimated at circa US \$1 million per year) will contribute significantly to the recovery of debt.

Scenario 4: Due to the current combination of generation units in both MEM and MESP, the resulting price in the wholesale market doesn't allow for additional investments to be financially attractive. When

¹³ Source: CAMMESA



the prices are too low, the private sector is not willing to invest in getting new equipment on line. This, combined with the difficulties in raising debt highlighted above contribute in making the capital costs of installing renewable technologies like hydroelectric or wind generation units much higher than traditional thermal equipment generation costs.

(b) Technology Barriers

For an electricity market with a load factor like the one in Argentina it is not practical to operate with a high participation of combined cycles in the supply without new investments in state-of-the-art generation equipment. Such equipment is less efficient in environmental terms and it is necessary to meet the daily demand peaks. Those combined cycles already installed and the ones that will be installed in the future have very little operational flexibility. Indeed it could be said that combined cycles, nuclear power plants and most hydropower plants are built to operate at full capacity all the time, with scarce capability of adjusting power. In conclusion, from a technology point of view, in the Argentinean electricity market the most plausible alternative is to either keep the old equipment running or to install more flexible, not so efficient equipment, like open cycle gas turbo generators.

Project scenario and Scenario 3: There are significant technology barriers to the development of CCGT plants. All equipment required for combined cycle systems is foreign and not manufactured in Argentina. Furthermore, despite the presence of a number of CCGT plants in Argentina, the design engineering expertise needed to set up combined cycle systems still has to be imported from abroad.

Scenario 4: Grid-connected hydropower is the only renewable technology option which could provide a technically plausible alternative to the project. Due to the limited availability of usable hydropower resources in the area of Comodoro there is no potential for the development of large size hydropower plants. There are limited resources in the Cordillera, but, under the current conditions of the energy sector, these resources are not economically viable. Furthermore, Energia del Sur does not have experience in developing and running hydropower plants.

(c) Prevailing Practice Barriers

There is a growing concern about gas shortages due to lack of investment in gas exploration of reserves. This was well illustrated in May 2004, when Argentina cut gas exports to Chile by 50%, and again in January 2005 when Argentina further reduced the gas exports due to increased domestic demand for natural gas, which resulted in a strained relationship with Chile, which used to import gas from Argentina. This shortage is particularly problematic because currently the Argentinean grid has an installed capacity of approximately 22,000 MW. At peak demand the country currently requires 16,700 MW of this capacity. This represents a dangerously small reserve margin. This is exacerbated during times of drought when many large hydro plants run at 20% - 30% capacity. Also, during cold winters heat requirements outweigh the electricity requirement thus diverting gas away from turbine generating plants.

Further, there are frequent reductions in this generation due to malfunction of aging and poorly maintained plants. Therefore, this energy reserve margin has potential to become even more constrained, and result in severe energy shortages in the future. Indeed, the consumption of electricity is growing at a much faster rate than the gross domestic product. There have not been any new electricity generating plants commissioned since the year 2002, as a consequence there is urgent need for growth in the electricity generation sector, despite the lack of incentives to support this growth or the required investments.



Project scenario and Scenario 3: Prevailing practice in Argentina is notably not the development of CCGT systems. Prior to 2002 there were several CCGT plants commissioned, however current economic conditions are significantly different and thus, prevailing practice is better based on the present situation. There are 13 CCGT plants in Argentina (see Table 4), but all were commissioned prior to the economic crisis in Argentina. It should also be noted that in the Patagonia region, where the proposed project activity is located, there is only one CCGT plant in existence.

Table 4: Combined cycle plants installed in Argentina

Power Plant	Capacity (MW)	Installation date
Genelba	674	Jan 1997
Buenos Aires	322	Feb 1997
Luján de Cuyo	285	Feb 1998
Costanera	851	Oct 1998
Tucumán	447	Oct 1998
Dock Sud	773	Jan 1999
Puerto	786	Jan 1999
AES Paraná	845	Jan 2000
Agua del Cajón	677	Jan 2000
Alto Valle	N/A	Jan 2001
San Miguel	382	May 2001
Modesto Maranzana	447	Oct 2002

Sub-step 3b: Show that the identified barriers would not prevent the implementation of at least one of the alternatives

(a) Investment Barriers (as described in Sub-Step 3a)

Low energy tariffs

Scenario 1: Low energy tariffs do not represent a barrier to the continuation of current practice. Although they are not ideal, already established power plants are able to continue current practice as there is demand for generated power.

Scenario 2: Low energy tariffs do represent a barrier to all new development of power generating plants. However, this situation does indirectly encourage the development of cheaper power generation using alternative fossil fuels such as heavy fuel oil and diesel.

Government imposed retention of marginal profits

Scenario 1: Relative investment costs of developing OCGT and reciprocating engine thermal power plants are lower than for any other technology. Local capital markets (debt and equity) are familiar with the costs and risks of power sector investments and capital will likely start flowing into reliable and rewarding investments in new conventional power additions under the current situation of high electricity demand across the economy. The retention of marginal profit only represents a limited barrier to the continuation of current practice because it only impacts on new investments and not on the existing power plants.



Scenario 2: The retention of marginal profit does represent an intermediate barrier to the development of power plants using fossil fuels other than gas. However, because the energy demand in Argentina is increasing, the cheapest power plants are most likely to be developed, and the government is likely to use this retained marginal profit to invest in these power plants itself.

Disincentive for efficiency

Scenario 1: This does not represent a barrier to the continuation of current practice as open cycle systems are not the most efficient systems on the dispatch.

Scenario 2: This is not a barrier to the development of alternative fossil fuel power plants as the most likely alternative would be heavy fuel oil reciprocating engines¹⁴, which have very low efficiency.

Difficulty of raising debt

Scenario 1: Relative investment costs of developing OCGT and reciprocating engine thermal power plants are lower than for any other technology. Local capital markets (debt and equity) are familiar with the costs and risks of power sector investments and capital will likely continue to flow into reliable conventional power additions under the current climate of sustained rises in electricity demand; therefore this does not represent a barrier to the continuation of current practice.

Scenario 2: Raising capital for power projects in Argentina is very difficult as investment funds targeting Latin America will not consider Argentina because of country risk. This represents only an intermediate barrier to the development of power plants using alternative fossil fuels because less expensive generation options are likely to attract more investment.

(b) Technology Barriers (as described in Sub-Step 3a)

Scenario 1: The power sectors of Patagonia and of Argentina as a whole show a wide range of technological applications of natural gas and fossil fuels for power supply. As such the technology know-how for the design, manufacturing, installation and operation of conventional thermal power is widely available in Argentina. Thus there are not deemed to be any technology barriers to the continuation of current practice.

Scenario 2: As specified for Scenario 1 the power sector of Argentina shows a wide range of technological applications of fossil fuels for power supply. As such there are no recognised technological barriers to the further development of this sector given that the technological expertise exists in Argentina as well as much of the necessary equipment to develop generators using fossil fuels different from natural gas.

(c) Prevailing Practice Barriers (as described in Sub-Step 3a)

Scenario 1: There have not been any thermal generation plants commissioned in Argentina since 2002; therefore the prevailing practice since that time is the continuation of current practice, due to a slow down in both the development and investment in the power generation sector.

¹⁴ FUNDELEC; Foundation for Electricity Development



Scenario 2: Given the current economic situation in Argentina and the state of the power sector, it is likely that as electricity shortages continue the most economical electricity generation will be developed, which is diesel or fuel oil reciprocating engines.

To summarise, **Scenario 2** is not a viable alternative option due to the financial barriers identified in Sub-Step 3a. Similarly, **Scenario 4:** the investment in a commercial hydropower plant of equivalent output to the proposed project is discarded on grounds of both financial and technological barriers as highlighted in the barrier analysis above. **Scenario 3**, identified in Step 1 as the investment in a CCGT equivalent to the proposed project activity, but without registering it as a CDM project activity, is affected by all the barriers that affect the project scenario and cannot be considered the baseline for the project.

In conclusion, it is possible to assume that the only alternative option available is the no project/current practice option (**Scenario 1**). As such the provision by the Argentinean grid of an amount of electricity equivalent to the project output will be taken as baseline for the Comodoro CCGT project. The project scenario is the conversion of the two MS 6001B OCGTs by the addition of one HRSG and one steam turbine connected to the grid. In the baseline scenario this power would be generated largely from other thermal OCGT plants or reciprocating engines.

Step 4. Common Practice Analysis

The common practice step requires reviewing whether the proposed technology has already diffused in the relevant sector and region.

Sub-step 4a: Analyse other activities similar to the proposed project activity

Between 1997 and 2000 several natural gas combined cycle turbines were installed in Argentina, as a consequence of deregulation of the MEM, the wholesale electricity market, when power dispatch was based on lowest generation costs, thus favouring the installation of efficient equipment. The main reason for the installation of CCGTs prior to 2000 (the last one was commissioned in 2002) was related to competitiveness in the market. The electricity market has completely derailed since 2001, and is associated with extremely low and frozen electricity tariffs as explained in Step 3. It is important to note, also, that the current electricity market system in Argentina could not survive by incorporating capacity additions to the most efficient technology (such as CCGT) since the variable costs of these power plants would become equal to the marginal price—which determines the price paid to generators—and would thus leave generating companies with insufficient revenue to compensate investments.

Sub-step 4b: Discuss any similar options that are occurring

Presently there are no other CCGT conversions occurring in Argentina due to the barriers listed above. Given the present conditions of the Argentinean power sector and all the barriers identified in Step 3, if new capacity was to be added it is most likely to be the reinstatement of existing older/offline power plants. Indeed, if a crisis in energy supply does ensue (as it is predicted) the most likely addition of *new* capacity would be reciprocating engines using heavy fuel oil as these are cheaper to construct, and they do not require gas, the supply of which is currently constrained.

Step 5. Impact of CDM Registration

The use of the CDM in this project to overcome the barriers identified above was decided at an early stage in the project's planning. As a result the CDM played an important role in the decision making process to



proceed with the CCGT conversion at the Energia del Sur plant in Comodoro Rivadavia. There is a range of evidence to support this:

- Rurelec approached consultants in October 2005 to advise on undertaking the CCGT conversion as a CDM project activity; a PIN was drafted to assess the potential CER benefits;
- The eligibility assessment and PDD development started in October 2005, prior to financial closure of the project;
- Rurelec and Energia del Sur minutes of Board meetings dated from February 2006¹⁵ clearly state that the decision to proceed with the CCGT conversion is subject to the project meeting the criteria of the CDM and that the CDM incentive is a crucial factor in the decision making to proceed with the project; and
- Various official communications from banks clearly state that any debt raised for the purpose of the CCGT conversion is contingent to the project gaining CDM status, including a loan application to the Standard Bank.

The planned registration of the Comodoro project with the CDM has had a number of benefits, including:

- The CDM incentive has helped mitigating the investment barriers by providing an additional revenue stream from the sale of carbon credits. A CER purchase agreement with an organisation from an Annex I country will diversify the income of the project to sources external to Argentina and had the effect of reducing the overall risk profile of the project.
- The additional revenue from carbon credits contributes to increase the IRR and NPV of the project. The results of the calculations of the impact of CERs on IRR are presented in Table 5 and are based on the following assumptions:
 - price of carbon set at 10 US\$/tCO₂;
 - volume of CERs approximated to 150,000 tCO₂/yr to be conservative;
 - 7 years crediting period starting in November 2007.

Table 5: Impact of Carbon Finance on the project's IRR

1. CCGT conversion without CDM incentive	2. CCGT conversion project with CDM incentive
IRR	IRR
0.3%	20.90%

Clearly the CDM incentive has a large impact on the project's IRR. The increase in IRR makes the project a more attractive option to Rurelec, and although it would probably still not be attractive to a third party investment fund, this is sufficient for Rurelec to proceed with the project.

- The additional revenue stream stemming from the CDM registration will help mitigating the exchange rate risks. A CER purchase agreement paid in US\$ (or other stable currency) will mitigate the exchange rate risk and hence decrease the risk profile of the project from the perspective of foreign lenders.

¹⁵ Exhibit B - Acta de Directorio



- The CDM incentive contributed to the business case to implement the CCGT conversion project that resulted in the involvement of Rurelec in the project. Rurelec has extensive experience in designing, building and operating CCGTs around the world and without the CDM incentive it would not have invested in the Comodoro project. As a consequence the necessary skills and technology to implement a CCGT project would not have been imported into Argentina, and the Comodoro conversion would not take place.

Conclusions

The proposed project faces many barriers: low energy tariffs in Argentina mean that the project will have very poor returns without the CDM incentive. Further, securing debt for project in Argentina is exceedingly problematic due to economic difficulties in the country. The CDM has a significant impact on the project finance and makes the project a reasonable investment opportunity for EDS (see Table 5). Furthermore, Rurelec, the UK project partner has identified the CDM as a critical issue, and therefore without the CDM Rurelec would not be interested in implementing the project. Using the tool to demonstrate additionality clearly shows that the project scenario is different from the baseline scenario.

Using the ACM0007 (with reference to ACM0002) baseline methodology, the baseline scenario in this project would be the continuation of current practice. Therefore, in the absence of the project, the additional 38 MW of installed capacity resulting from combined cycle operation would be replaced by existing power generation on the grid. Indeed, according to ACM0002, the project will be displacing plants with the least merit order. The project will generate 38 MW of installed capacity without any additional fossil fuel consumption, thus, the project emissions are expected to be less than the baseline emissions.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

ACM0007 requires the emission reduction (ER_y) by the project activity to be calculated as the difference between the baseline emissions (BE_y), project emissions (PE_y) and emissions due to leakage (L_y).

$$ER_y = BE_y - PE_y - L_y$$

Determination of the project activity emissions (PE_y)

Project emissions in tonnes of CO_2 include emissions from use of fossil fuel to operate the gas turbine ($PEGT_y$) and supplementary fossil fuel used in order to operate the steam turbine ($PEST_y$).

$$PE_y (tCO_2) = PEGT_y + PEST_y = COEF_i * FGT_{i,y} + COEF_i * FST_{i,y}$$

Where $FGT_{i,y}$ is the amount of natural gas (m^3) consumed annually by the project and $FST_{i,y}$ (m^3) is the amount of supplementary natural gas consumed in the HRSGs to operate the steam turbine by the project in year y.

$COEF_i$ is the CO_2 emission coefficient of natural gas (tCO_2 / m^3), taking into account the carbon content of the fuel used by the project during the year. For Argentina the specific GHG coefficient of gas is



available from the 2nd National Communication and has been used for the calculations as specified in Section B.6.2.

Determination of the baseline emissions (BE_y)

The baseline scenario for the proposed project as outlined in ACM0007 is that power to meet the grid demand would be generated and supplied by the existing gas turbines at the site running in open cycle configuration, by other existing grid-connected power plants, and by the addition of new generation sources to the grid. Hence the baseline emissions are calculated as the sum of emissions of the current power plant operating in open cycle mode and the emissions that would be generated by the grid (existing and future plants) if it was generating an amount of power equal to that generated by the proposed project operating in closed cycle mode. As such the baseline emissions are calculated as follows:

$$BE_y(tCO_2) = (EF_{OC} * OG_y) + (EF_{grid,y} * CG_y)$$

Where EF_{OC} and $EF_{grid,y}$ (tCO_2 / MWh) are respectively the emission factor for the plant operating in open cycle mode and the combined margin emission factor of the grid; OG and CG (MWh) are respectively the electricity generated by the open cycle and the electricity generated from the use of waste heat and over-firing.

Step 1: Estimating OG_y

In order to estimate the annual electricity generation by the plant in open cycle mode (OG_y) the following equation is applied:

$$OG_y(MWh) = PLF * OC * T$$

Where PLF is the plant load factor expressed as a fraction; OC (MW) is the net capacity of the open cycle plant; and T is the operating hours during the year.

Two options are given for the calculation of PLF : either ex-ante, using historical data for the OCGT, or ex-post utilising actual data from the project (including both gas and steam turbine). The option that gives a conservative estimate of the baseline emissions will be chosen by the project developer during monitoring.

Option 1

$$PLF = \frac{HG_{OC,x}}{OC_x * 8760}$$

Where $HG_{OC,x}$ (MWh) is the average annual electricity generated by the power plant operating in open cycle mode based on x years of generation records previous to start of the project and OC_x (MW) is the net historic capacity of the OCGT.

Option 2

$$PLF = \frac{PG_y}{PC * 8760}$$

Where PG_y (MWh) is the actual electricity generated by the project in year y and PC (MW) is the net installed capacity of the project (both gas turbine and steam turbine).

**Step 2: Estimating EF_{OC}**

The emission factor for the open cycle generation in the baseline is given by historical performance of the plant when operated in open cycle using data for 5 most recent years¹⁶ previous to the start of the project. The emission factor is calculated as follows:

$$EF_{OC} = \frac{FC_{HIST}}{HG_{OC,x}} * COEF_{i,HIST}$$

Where FC_{HIST} (m^3) is the historical annual average fuel consumption, $HG_{OC,x}$ (MWh) is the net annual generation from the operation of the power plant in open cycle mode based on x years of generation¹⁷ previous to the commencement of the project and $COEF_{i,HIST}$ is the historical GHG coefficient for natural gas used for operating the open cycle turbine. The historical CO_2 emission coefficient $COEF_{i,HIST}$ for gas is obtained as:

$$COEF_{i,HIST} = NCV_{i,HIST} * EF_{CO_2,i,HIST} * OXID_i$$

where $NCV_{i,HIST}$ is the net calorific value (GJ/m^3) of the natural gas consumed over the historical period, $OXID_i$ (%) is the oxidation factor of natural gas, $EF_{CO_2,i,HIST}$ is the CO_2 emission factor per unit of energy of natural gas over the historical period.

Step 3: Estimating CG_y

In order to estimate the annual electricity generation attributable to waste heat use in the steam turbine the following equation is applied:

$$CG_y (MWh) = PG_y - OG_y$$

where PG_y (MWh) is the electricity generated by the project. This will be calculated ex-post.

Step 4: Determine the emission factor for the grid

The baseline emission factor for grid connected electricity is calculated as a combined margin. An operating margin OM and a build margin BM are calculated for the grid; these are then averaged applying appropriate weights to derive the combined grid margin.

The OM is calculated as follows:

$$EF_{OM,Dispatch Data, y} = \frac{E_{OM,y}}{PG_y}$$

¹⁶ HIST = 5 years. If five years data is not available, then data for the most number of complete years available should be used, with a minimum of one full year.

¹⁷ x = 5 years. If five years data is not available then data for the most number of complete years available should be used, with a minimum of **three** full years.



Where PG_y (MWh) is the annual generation of the project; and $E_{OM,y}$ (tCO_2) are the annual emissions associated with the operating margin.

$E_{OM,y}$ is calculated as:

$$E_{OM,y} = \sum_h (PG_h * EF_{DD,h})$$

where PG_h (MWh) is the generation of the project in each hour h ; and $EF_{DD,h}$ (tCO_2/MWh) is the hourly generation-weighted average emissions per electricity unit of a set of power plants ' n '. According to ACM0007 the group ' n ' of power plants is the set power plants in the top $x\%$ of grid system dispatch order during hour h . $x\%$ is equal to the greater of either:

- 10%; or
- the project generation during hour h expressed as a percentage of the total grid generation for that hour.

In the case of Argentina on average the 10% of the total power dispatched on the grid each hour is well above what the project generation can be for the same hour, therefore 10% is always chosen for the calculations. $EF_{DD,h}$ is calculated as:

$$EF_{DD,h} = \frac{\sum_{i,n} F_{i,n,h} * COEF_{i,n}}{\sum_n GEN_{n,h}}$$

Where $F_{i,n,h}$ (in volume units) is the amount of fuel i consumed by the set of power plants n that dispatch power during hour h ; $COEF_{i,n}$ ($tCO_2/volume\ unit$) is the CO_2 emission coefficient of fuel i used and $GEN_{n,h}$ (MWh) is the electricity delivered to the grid by the sources ' n ' during the hour h .

The volume of fuel used by the power plants is not available, hence it is back calculated using the heat rate or energy efficiency $\eta_{i,n}$ ($kCal/kWh$) for plant n dispatching power when using fuel i as published by CAMMESA. The efficiencies declared are usually smaller than the real ones; therefore they represent a conservative assumption. The following equation is used:

$$F_{i,n,h} = GEN_{n,h} * \eta_{i,n} * (1/ NCV_{i,n})$$

where $NCV_{i,n}$ is the net calorific value (energy content per mass or volume unit) of fuel i as from the Cammesa Annual Report for 2004¹⁸.

To determine the set of plants ' n ', CAMMESA provides: a) the grid system dispatch order of operation for each power plant of the system; and b) the amount of power GEN_h (MWh) that is dispatched from all plants in the system during each hour that the project activity is operating. At each hour h , each plant's generation is stacked using the merit order. The set of plants ' n ' consists of those plants at the margin, i.e.: having the least merit (most expensive to dispatch), whose combined generation ($\sum GEN_h$) comprises

¹⁸ Cammesa Informe Anual; 2004 available on <http://memnet2.cammesa.com/inicio.nsf/marcomemnet>



10% of total generation from all plants during that hour. Any plant falling in part capacity within the 10% is included in the top 10% list.

The BM emission factor ($EF_{BM,y}$) is the generation-weighted average emission factor (tCO_2/MWh) of a sample of power plants m calculated as follows:

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} * COEF_{i,m}}{\sum_m GEN_{m,y}}$$

where $F_{i,m,y}$, $COEF_{i,m}$ and $GEN_{m,y}$ are analogous to the variables described for the operating margin above for a sample of new build plants m , excluding power plants registered as CDM project activities.

The sample group m consists of either the five power plants that have been built most recently, or the most recent capacity additions in the electricity system that comprise 20% of the system generation. Energia del Sur will use from these two options the sample group that comprises the larger annual generation every year. For the crediting period, $EF_{BM,y}$ will be updated annually ex post for the year in which actual project generation and associated emissions reductions occur

The project developer will assess every year which one of the two options gives a sample group m that comprises the larger annual generation. In 2005 the sample group of power plants comprising 20% of total system generation comprised the larger annual generation. The sample group m based on most recent data can be found in Annex 3.

The combined margin is calculated as the weighted average of OM and BM using the standard weighting suggested by ACM0002:

$$EF_{grid,y} = w_{OM} * EF_{OM,y} + w_{BM} * EF_{BM,y} = 1/2 (EF_{OM,y} + EF_{BM,y})$$

Determination of the Leakage (L_y)

Overall the project activity will decrease the volume of gas consumed per unit of electricity produced in Argentina. It could therefore have positive leakage affects on fugitive emissions of gas. However as described in the methodology ACM0007 the impact of gas consumption on the volume of fugitive emissions is not measurable or attributable to the project. Therefore such positive leakage is not considered by this project. With regards to the increased usage of gas it is not expected that there will be any CH_4 leakage associated to its production, transportation and usage.

Also, in accordance with the methodology, leakage from emissions produced during the construction of the project is not considered as such emissions are not measurable and not considered significant in the project context when compared to the baseline. The project developer will not claim any credit for the project on account of reducing these emissions below the level of the baseline scenario.

As a consequence leakage is zero.

**B.6.2. Data and parameters that are available at validation:**

Data / Parameter:	OC
Data unit:	MW
Description:	Net capacity of the gas turbine in the open cycle operations
Source of data used:	Licence of the GT
Value applied:	77 MW
Justification of the choice of data:	This value is available from generation licences and is only recorded once when the baseline is set.
Any comment:	

Data / Parameter:	OXID_{GAS} & OXID_{HIST, GAS}
Data unit:	% or fraction
Description:	oxidation factor for natural gas
Source of data used:	TABLE 1.4, “2006 IPCC Guidelines for National Greenhouse Gas Inventories”
Value applied:	1
Justification of the choice of data:	Data available internationally. Specific data for Argentina are not available
Any comment:	

Data / Parameter:	OXID_{GAS OIL} & OXID_{HIST, GAS OIL}
Data unit:	% or fraction
Description:	oxidation factor for gas oil
Source of data used:	TABLE 1.4, “2006 IPCC Guidelines for National Greenhouse Gas Inventories”
Value applied:	1
Justification of the choice of data:	Data available internationally. Specific data for Argentina are not available
Any comment:	

Data / Parameter:	OXID_{FUEL OIL} & OXID_{HIST, FUEL OIL}
Data unit:	% or fraction
Description:	oxidation factor for fuel oil
Source of data used:	TABLE 1.4, “2006 IPCC Guidelines for National Greenhouse Gas Inventories”
Value applied:	1
Justification of the choice of data:	Data available internationally. Specific data for Argentina are not available
Any comment:	

Data / Parameter:	OXID_{COAL} & OXID_{HIST, COAL}
Data unit:	% or fraction
Description:	oxidation factor for coal
Source of data used:	TABLE 1.4, “2006 IPCC Guidelines for National Greenhouse Gas Inventories”
Value applied:	1
Justification of the choice of data:	Data available internationally. Specific data for Argentina are not available



choice of data :	
Any comment:	

Data / Parameter:	COEF_{GAS}
Data unit:	tCO ₂ /m ³
Description:	GHG coefficient for gas
Source of data used:	Argentina 2 nd National Communication
Value applied:	0.00195
Justification of the choice of data:	Data specific to Argentina
Any comment:	ACM0007 suggests that this parameter is calculated. Given that a specific value for Argentina is available, this option was chosen over the calculation from IPCC data

Data / Parameter:	COEF_{GAS OIL}
Data unit:	tCO ₂ /t
Description:	GHG coefficient for gas oil
Source of data used:	Argentina 2 nd National Communication
Value applied:	3.16
Justification of the choice of data:	Data specific to Argentina
Any comment:	ACM0007 suggests that this parameter is calculated. Given that a specific value for Argentina is available, this option was chosen over the calculation from IPCC data

Data / Parameter:	COEF_{FUEL OIL}
Data unit:	tCO ₂ /t
Description:	GHG coefficient for fuel oil
Source of data used:	Argentina 2 nd National Communication
Value applied:	3.17
Justification of the choice of data:	Data specific to Argentina
Any comment:	ACM0007 suggests that this parameter is calculated. Given that a specific value for Argentina is available, this option was chosen over the calculation from IPCC data

Data / Parameter:	COEF_{COAL}
Data unit:	tCO ₂ /t
Description:	GHG coefficient for coal
Source of data used:	Argentina 2 nd National Communication
Value applied:	2.58
Justification of the choice of data:	Data specific to Argentina
Any comment:	ACM0007 suggests that this parameter is calculated. Given that a specific value for Argentina is available, this option was chosen over the calculation from IPCC data



Data / Parameter:	NCV_{GAS}
Data unit:	GJ/m ³
Description:	Net Calorific Value for gas
Source of data used:	Cammesa Informe Anual; 2004
Value applied:	0.0352
Justification of the choice of data:	Data specific to Argentina
Any comment:	The value used in the OM calculations is then turned into kcal/m ³

Data / Parameter:	NCV_{GAS OIL}
Data unit:	GJ/t
Description:	Net Calorific Value for gas oil
Source of data used:	Cammesa Informe Anual; 2004
Value applied:	43.54
Justification of the choice of data:	Data specific to Argentinean fuels
Any comment:	The value used in the OM calculations is then turned into kcal/t

Data / Parameter:	NCV_{FUEL OIL}
Data unit:	GJ/t
Description:	Net Calorific Value for fuel oil
Source of data used:	Cammesa Informe Anual; 2004
Value applied:	41.03
Justification of the choice of data:	Data specific to Argentinean fuels
Any comment:	The value used in the OM calculations is then turned into kcal/t

Data / Parameter:	NCV_{COAL}
Data unit:	GJ/t
Description:	Net Calorific Value for coal
Source of data used:	Cammesa Informe Anual; 2004
Value applied:	22.61
Justification of the choice of data:	Data specific to Argentinean fuels
Any comment:	The value used in the OM calculations is then turned into kcal/t

Data / Parameter:	w_{OM}
Data unit:	fraction
Description:	weighting
Source of data used:	ACM0002
Value applied:	0.5
Justification of the choice of data:	Default weighting for the operating margin taken from ACM0002.
Any comment:	



Data / Parameter:	W_{BM}
Data unit:	fraction
Description:	weighting
Source of data used:	ACM0002
Value applied:	0.5
Justification of the choice of data:	Default weighting for the build margin taken from ACM0002.
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

Emissions from the project activity (PE_y) are calculated for year 2005 using the following equation:

$$PE_y = PEGT_y + PEST_y = (COEF_{GAS} * FGT_{GAS,y}) + (COEF_{GAS} * FST_{GAS,y})$$

The calculation of project emissions is based on:

- 2005 historical data for PEGT; and
- EDS estimates for gas consumption in the steam turbine based on forward calculations for PEST.

$$FGT_{GAS,y} = 181,264,526 \text{ m}^3$$

$$FST_{GAS,y} = 45,333,662 \text{ m}^3$$

$$COEF_{i,y} = 1.95 \text{ kgCO}_2/\text{m}^3$$

$$PE_y = 353,466 + 88,400 = 441,866 \text{ tCO}_2 \text{ eq p.a.}$$

There is no leakage involved in this project activity.

$$L_y = 0$$

The baseline emissions (BE_y) were estimated using a grid emission factor calculated applying the following steps:

Step 1: Estimating OG_y

$$OG_y = PLF * OC * T = 566,450 \text{ MWh}$$

Where the plant load factor $PLF = 84\%$ was calculated using historical data as per Option 1 described in Section B.6.1. For the calculations of CERs during monitoring, PLF will be calculated both ex-post and ex ante and the most conservative value will be used. OC is 77 MW and T used was 8760. During the project monitoring T will reflect the actual hours of operation of the project.

Step 2: Estimating EF_{OC}

$$EF_{OC} = \frac{FC_{HIST}}{HG_{OC,x}} * COEF_{i,HIST} = 0.64 \text{ tCO}_2/\text{MWh}$$



Because the Central Termica Patagonia was offline for approximately 3 years (2002, 2003 and 2004), for the historical annual fuel consumption of the gas turbines in open cycle (FC_{HIST}) an average of 5 *non consecutive* years of operation was adopted: 1998, 1999, 2000, 2001, and 2005.

$$FC_{HIST} = 184,909,136 \text{ m}^3$$

Similarly, the historical generation of the gas turbines in open cycle has been calculated based on an average of the same 5 years of operation: 1998, 1999, 2000, 2001, and 2005.

$$HG_{OC,x} = 566,451 \text{ MWh}$$

$$COEF_{i,HIST} = NCV_{i,HIST} * EF_{CO2,i,HIST} * OXID_{i,HIST} = 0.00197 \text{ tCO}_2/\text{m}^3$$

Data	Value	Source
NCV_{GAS}	$3.52 \times 10^{-2} \text{ GJ/m}^3$	National Inventory of GHG of the Republic of Argentina
$OXID_{i,HIST}$	1	TABLE 1.4, “2006 IPCC Guidelines for National Greenhouse Gas Inventories”
$EF_{CO2,HIST}$	$0.056 \text{ tCO}_2/\text{GJ}$	Cammesa, Informe Anual (1999-2004)

Step 3: Estimating CG_y

For the calculations in this PDD, both PG_y and CG_y were estimated using a plant load factor for the CCGT of 93% as suggested in the independent energy market assessment prepared for Energia Del Sur by Mercados Energeticos S.A.¹⁹ while OG was calculated as explained above.

$$PG_y = 1,091,671 \text{ MWh}$$

$$OG_y = 566,451 \text{ MWh}$$

$$CG_y = 464,367 \text{ MWh}$$

Step 4: Determine the emission factor for the grid

The software program for the calculation of the grid's combined margin as per ACM0002 was run to estimate $EF_{OM,Dispatch Data}$ using grid dispatch data for the period 1st March 2006 – 18th August 2006. The selection of this period was dictated by the fact that since March 2006 the Patagonia system MEMSP has been connected to the main Argentinean grid (MEM) and as such the entire Argentinean distribution system is considered to be the project boundary. More details of the way the calculations were run are available in Annex 3.

$$EF_{OM,Dispatch Data, y} = \frac{E_{OM,y}}{PG_y}$$

$$PG_y = 1,091,671 \text{ MWh}$$

¹⁹ Exhibit A: Conversion to CCGT: Operating Result Evaluation (2006).



CDM – Executive Board

page 35

$$E_{OM,y} = \sum_h PG_h * EF_{DD,h}$$

$PG_h = 53$ MWh based on 93% expected load factor as described previously. During the monitoring activities PG_h will reflect real dispatched power ex-post. The monitoring programme will also calculate $EF_{OM,Dispatch Data, y}$ ex-post.

The program used to calculate the OM for the purpose of this PDD calculates for every hour an emission factor based on the units with least merit that are running on the grid (further details are available in Annex 3). The result from running the program with data from 01-03-06 to 18-08-06 was:

$$EF_{OM,Dispatch Data, y} = 0.652 \text{ tCO}_2/\text{MWh}$$

The BM emission factor ($EF_{BM,y}$) is the generation-weighted average emission factor (tCO_2/MWh) of a sample of power plants m . The plants included in the calculation of the build margin for the purpose of this PDD are reported in Table 6 below:

Table 6: Power plants included in the Build Margin

Year	Power plant	Type	Name of unit	Region	Installed Capacity (MW)	Electricity generation (MWh)	Natural gas (m3)	Gas oil (m3)	Fuel oil (t)	Emissions (tCO ₂)
2003	Pluspetrol Norte	GT	PPNOTG02	MEM	116	119,285	38,144,700	0	0	74,382
2002	Cacheuta Nueva	H		MEM	122	403,682	0	0	0	0
2002	Pluspetrol Norte	GT	PPNOTG01	MEM	116	52,988	16,989,900	0	0	33,130
2001	AES Paraná	CC	AESPTG01 AESPTG02 AESPTV01	MEM	845	4,182,647	816,913,870	15,740	0	1,634,016
2001	CT San Miguel de Tucumán*	CC	SMTUTG02 SMTUTV01	MEM	269	1,449,426	228,972,230	0	0	446,496
2000	Dock Sud	CC	DSUDTG07 DSUDTG08 DSUDTG09 DSUDTG10 DSUDTV11	MEM	794	3,821,614	723,367,660	3,663	0	1,420,117
2000	Electropatagonia C. Rivadavia	CC	CRIVTG27 CRIVTG28 CRIVTV25	MEMSP	63	275,845	103,859,000	0	0	202,525
1999	Puerto Nuevo	CC	PNUETV07 PNUETV08 PNUETV09	MEM	798	1,573,936	155,802,930	0	266,320	1,148,050
1999	Central Termica Tucumán**	CC	TUCUTG02 TUCUTV01	MEM	150	1,705,314	291,437,510	0	0	568,303
1999	Pichi Picun Leufú	H		MEM	255	1,177,263	0	0	0	0
1999	C. Comb. Costanera	CC	COSTTV01-07 COSTTG08 COSTTG09 COSTTV10	MEM	851	7,077,336	1,164,600,900	7,593	314,175	3,286,701

Notes: GT stands for gas turbine, H stands for hydro, CC for combined cycle.

The CC Agua del Cajon has applied for CDM status, therefore it is not included in the list of most recent plants, even if the investment happened in 2000.

The first unit of San Miguel de Tucuman was installed in 1995, while the first unit of Central Termica Tucuman was installed in 1996, therefore their contribution to the Build Margin is not considered.

$$EF_{BM,y} = 0.404 \text{ tCO}_2/\text{MWh}$$



The annual grid factor is calculated as the weighted average of the OM emission and the BM emission factor:

$$EF_{\text{grid},y} = w_{\text{OM}} * EF_{\text{OM},y} + w_{\text{BM}} * EF_{\text{BM},y} = 0.53 \text{ tCO}_2/\text{MWh}$$

Step 5: Calculate the baseline emissions BE_y

$$BE_y = (EF_{\text{OC}} \cdot OG_y) + (EF_{\text{CM},y} \cdot CG_y)$$

$$EF_{\text{OC}} = 0.64 \text{ tCO}_2/\text{MWh}$$

$$OG_y = 566,451 \text{ MWh}$$

$$EF_{\text{grid},y} = 0.53 \text{ tCO}_2/\text{MWh}$$

$$CG_y = 464,367 \text{ MWh}$$

$$BE_y = 609,357 \text{ tCO}_2$$

Therefore the Emission reductions of the project activity are:

$$ER_y = 167,491 \text{ tCO}_2\text{eq p.a}$$

B.6.4 Summary of the ex-ante estimation of emission reductions:

Year	Estimation of project activity emissions (tCO ₂ e)	Estimation of baseline emissions (tCO ₂ e)	Estimation of leakage (tCO ₂ e)	Estimation of overall emission reductions (tCO ₂ e)
2007 (2 months)	73,644	101,559	0	27,915
2008	441,866	609,357	0	167,491
2009	441,866	609,357	0	167,491
2010	441,866	609,357	0	167,491
2011	441,866	609,357	0	167,491
2012	441,866	609,357	0	167,491
2013	441,866	609,357	0	167,491
2014 (10 months)	368,222	507,797	0	139,576
Total	3,093,062	4,265,502	0	1,172,437

B.7 Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	PE_y
Data unit:	tCO ₂
Description:	Project Emissions
Source of data to be used:	Calculated as $PEGT_y + PEST_y$ using the variables described below
Value of data applied	441,866 tCO ₂



for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Parameter calculated
QA/QC procedures to be applied:	N/A
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	PEGT_y
Data unit:	tCO ₂
Description:	Project emissions from the use of fossil fuel to operate the gas turbine
Source of data to be used:	Parameter calculated
Value of data applied for the purpose of calculating expected emission reductions in section B.5	353,466 tCO ₂
Description of measurement methods and procedures to be applied:	Calculated as $(COEF_{GAS} * FGT_{GAS,y})$
QA/QC procedures to be applied:	N/A
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	PEST_y
Data unit:	tCO ₂
Description:	Project emissions from the use of fossil fuel to operate the steam turbine
Source of data to be used:	Parameter calculated
Value of data applied for the purpose of calculating expected emission reductions in section B.5	88,400 tCO ₂
Description of measurement methods and procedures to be applied:	Calculated as $(COEF_{GAS} * FGT_{GAS,y})$
QA/QC procedures to be applied:	N/A



Any comment:	Data shall be archived for 2 years following the end of the crediting period.
--------------	---

Data / Parameter:	FGT_{i,y}
Data unit:	m ³
Description:	Consumption of natural gas during the year for operating the gas turbines
Source of data to be used:	Meter reading
Value of data applied for the purpose of calculating expected emission reductions in section B.5	181,264,526 m ³
Description of measurement methods and procedures to be applied:	Data will be downloaded from meters and stored within the site's existing gas consumption control sheet. The project developer will monitor gas consumption for the existing gas turbines at Central Termica Patagonia
QA/QC procedures to be applied:	Fuel consumption data for the project will be based on meter readings and where appropriate reconciled to third party data such as gas invoicing
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	FST_{i,y}
Data unit:	m ³
Description:	Consumption of natural gas during the year for operating the steam turbine
Source of data to be used:	Meter reading
Value of data applied for the purpose of calculating expected emission reductions in section B.5	45,333,662 m ³
Description of measurement methods and procedures to be applied:	Data will be downloaded from meters and stored within the site's existing gas consumption control sheet. The project developer will monitor gas consumption for the HRSG at Central Termica Patagonia
QA/QC procedures to be applied:	Fuel consumption data for the project will be based on meter readings and where appropriate reconciled to third party data such as gas invoicing
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	BE_y
Data unit:	tCO ₂
Description:	Baseline emissions
Source of data to be used:	Parameter calculated
Value of data applied for the purpose of calculating expected	609,357 tCO ₂



emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Calculated as $(EF_{OC} \cdot OG_y) + (EF_{CM,y} \cdot CG_y)$
QA/QC procedures to be applied:	N/A
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	OG_y
Data unit:	MWh
Description:	Electricity generation attributable to open cycle operation
Source of data to be used:	Parameter calculated
Value of data applied for the purpose of calculating expected emission reductions in section B.5	566,451 MWh based on historical data
Description of measurement methods and procedures to be applied:	The parameter will be calculated as $(PLF * OC * T)$
QA/QC procedures to be applied:	N/A
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	PLF_y
Data unit:	%
Description:	Project load factor
Source of data to be used:	Parameter calculated
Value of data applied for the purpose of calculating expected emission reductions in section B.5	84% based on ex-ante historical data
Description of measurement methods and procedures to be applied:	Calculated either using ex-post or ex-ante data as specified in Section B.6.1. The value that provides the most conservative baseline will be chosen for the monitoring activities unless valid justification is given.
QA/QC procedures to be applied:	N/A
Any comment:	Data shall be archived for 2 years following the end of the crediting period.



Data / Parameter:	T
Data unit:	Hours
Description:	Plant operating hours
Source of data to be used:	Cammesa records of operation of units PATATG01, PATATG02 and PATTV0X at Comodoro
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8760
Description of measurement methods and procedures to be applied:	The operating hours of the project will be obtained from Cammesa records. The monitoring software program will generate this value as one of the outputs from the calculation of the grid operating margin
QA/QC procedures to be applied:	The operating hours of the project will be double checked against records of operation at the project site.
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	PG_y
Data unit:	MWh
Description:	Electricity generated by the project (OCGT and CCGT) during one year and exported to the grid
Source of data to be used:	Cammesa records of operation of units PATATG01, PATATG02 and PATATV0X at Comodoro
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,091,671 MWh based on forecasted 93% load factor for the project
Description of measurement methods and procedures to be applied:	The power generated by the project will be obtained from Cammesa records. The monitoring software program will generate this value as one of the outputs from the calculation of the grid operating margin
QA/QC procedures to be applied:	Electricity dispatch data from the project site will be recorded from meter readings and reconciled to the records of the central dispatch organisation. The historical data might not be corroborated.
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	PC
Data unit:	MW
Description:	Net installed capacity of the project
Source of data to be used:	Licence plate
Value of data applied for the purpose of calculating expected	134 MW



emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Parameter based on the expected capacity of equipment to be installed
QA/QC procedures to be applied:	Value of net installed capacity will be checked against data available from Cammesa
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	EF_{OC}
Data unit:	tCO ₂ /MWh
Description:	Emission factor for the open cycle gas turbine
Source of data to be used:	Parameter calculated
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.64 tCO ₂ /MWh
Description of measurement methods and procedures to be applied:	Parameter calculated based on the efficiency of the turbines from historical records of the fuel consumed per unit of electricity dispatched and on the emissions coefficient of fuel consumed
QA/QC procedures to be applied:	N/A
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	FC_{HIST}
Data unit:	m ³
Description:	Historical gas turbine fuel consumption
Source of data to be used:	Historical site records of meter readings
Value of data applied for the purpose of calculating expected emission reductions in section B.5	184,909,136 m ³
Description of measurement methods and procedures to be applied:	Fuel consumption data from the project site will be recorded from meter readings and reconciled to the records of fuel purchase invoices. The historical data might not be corroborated.
QA/QC procedures to be applied:	Historical site records of fuel consumed based on meter readings and where available checked to third party evidence such as invoices
Any comment:	Data shall be archived for 2 years following the end of the crediting period.



Data / Parameter:	HG_{OC,x}
Data unit:	MWh
Description:	Net annual electricity generated by the plant operating in open cycle
Source of data to be used:	Historical site records of meter readings
Value of data applied for the purpose of calculating expected emission reductions in section B.5	566,451 MWh
Description of measurement methods and procedures to be applied:	Electricity generation data from the project site will be recorded from meter readings and reconciled to the records of Cammesa.
QA/QC procedures to be applied:	Historical site records of dispatched electricity are based on meter readings and where available checked against Cammesa records. The historical data might not be corroborated.
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	CG_v
Data unit:	MWh
Description:	Electricity generation attributable to the use of waste heat
Source of data to be used:	Parameter calculated
Value of data applied for the purpose of calculating expected emission reductions in section B.5	464,357 MWh
Description of measurement methods and procedures to be applied:	The power generated by the project will be obtained from Cammesa records. The monitoring software program will generate this value as one of the outputs from the calculation of the grid operating margin
QA/QC procedures to be applied:	The parameter will be calculated, but it will also be checked against Cammesa records for power dispatched from PAPATVX
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	EF_{OM, Dispatch Data}
Data unit:	tCO ₂ /MWh
Description:	Emission factor associated with the grid operating margin
Source of data to be used:	Parameter calculated
Value of data applied for the purpose of calculating expected emission reductions in	0.652 tCO ₂ /MWh



CDM – Executive Board

page 43

section B.5	
Description of measurement methods and procedures to be applied:	Parameter calculated as $E_{OM,y} / PG_y$
QA/QC procedures to be applied:	N/A
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	$EF_{DD,h}$
Data unit:	tCO ₂ /MWh
Description:	Hourly emission factor for a set of power plants n in the top 10% of grid system dispatch order
Source of data to be used:	Parameter calculated by the software calculation program using Cammesa data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A
Description of measurement methods and procedures to be applied:	Parameter calculated as $\Sigma (GEN_{n,h} * \eta_{i,n} * (1/NCV_{i,n}) * COEF_{i,n}) / \Sigma GEN_{n,h}$
QA/QC procedures to be applied:	All the dispatch data necessary to calculate the emission factor associated with the OM will be obtained from the Cammesa website http://memnet2.cammesa.com/inicio.nsf/marcomemnet and used in the calculation software program to generate the grid's OM
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	$\eta_{i,n}$
Data unit:	Kcal/MWh
Description:	Efficiency of generation for a set of power plants n in the top 10% of grid system dispatch order
Source of data to be used:	Cammesa records for efficiency of generation for thermal power plants in the Argentinean grid
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A
Description of measurement methods and procedures to be applied:	All the dispatch data necessary to calculate the emission factor associated with the OM will be obtained from Cammesa
QA/QC procedures to	N/A



CDM – Executive Board

page 44

be applied:	
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	GEN_{n, h}
Data unit:	MWh
Description:	Power generated by a set of power plants <i>n</i> in the top 10% of grid system dispatch order
Source of data to be used:	Data available from the Cammesa dispatch records
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A
Description of measurement methods and procedures to be applied:	All the dispatch data necessary to calculate the emission factor associated with the OM will be obtained from the Cammesa website http://memnet2.cammesa.com/inicio.nsf/marcomemnet (Despacho de Generacion y Combustible) and used in the calculation software program to generate the grid's OM
QA/QC procedures to be applied:	N/A
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	EF_{BM, y}
Data unit:	tCO ₂ /MWh
Description:	Emission factor associated with the grid build margin
Source of data to be used:	Parameter calculated
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.404 tCO ₂ /MWh
Description of measurement methods and procedures to be applied:	Parameter calculated as $\Sigma (F_{i, m, y} * COEF_{i, m}) / \Sigma GEN_{m, y}$
QA/QC procedures to be applied:	N/A
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	F_{i, m, y}
Data unit:	Volume or mass unit
Description:	Annual amount of fuel used to generate power by a set of generating units <i>m</i> that comprise 20% of the Argentinean grid generation
Source of data to be	Cammesa records



used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A
Description of measurement methods and procedures to be applied:	Data available from Cammesa
QA/QC procedures to be applied:	N/A
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	GEN_{m, v}
Data unit:	MWh
Description:	Annual power generated by a set of generating units <i>m</i> that comprise 20% of the Argentinean grid generation
Source of data to be used:	Cammesa records
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A
Description of measurement methods and procedures to be applied:	Data available from Cammesa
QA/QC procedures to be applied:	N/A
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

Data / Parameter:	Plant commissioning
Data unit:	date
Description:	Date of plant commissioning
Source of data to be used:	Cammesa
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A
Description of measurement methods and procedures to be applied:	Date of commissioning is available from Cammesa and is used to identify the most recently built plants connected to the grid



applied:	
QA/QC procedures to be applied:	N/A
Any comment:	Data shall be archived for 2 years following the end of the crediting period.

B.7.2 Description of the monitoring plan:

The management and operational structure of Energia Del Sur is designed to ensure that electricity generation, export, and gas usage is tightly controlled, as all are used for accounting purposes. This tight operational and management structure will continue under the project. Energia Del Sur has also adopted an ISO 14001 integrated Environmental Management System. CDM monitoring activities will be included in the management system. The following key tasks will be carried out:

- Monitoring power generation from both the gas turbines and the steam turbine;
- Monitoring gas consumption;
- Monitoring all data necessary to recalculate the emissions attributable to the operation of the gas turbine in open cycle mode according to ACM0007;
- Monitoring all data necessary to calculate on an annual basis both the OM and BM of the Argentinean grid.

In order to complete the monitoring tasks above, EDS will continue to have access to Cammesa data relating to the output of all thermal plants connected to the Argentinean grid for every hour of the year, Cammesa also provides data on the efficiency of the thermal plant and the position within the dispatch order. These data will be input directly into the project monitoring programme from Cammesa sources. The responsibilities for carrying out these tasks within EDS have been reported in Table 7 below.

Table 7: Monitoring Responsibilities with Energia del Sur SA.

Monitoring Responsibilities	
Technical responsibility Mr. Jorge Ramos	Contact person: Jorge Ramos Address: Ruta 39 Km12 – Comodoro Rivadavia – Provincia de Chubut Phone/fax: 54 297 454 9045 E-mail: jorge.ramos@energiadelsursa.com.ar
Commercial responsibility Mr. Guillermo Ibañez	Contact person: Guillermo Ibañez Address: Calle 48 N° 667 – La Plata – Provincia de Buenos Aires Phone/fax: 54 221 482 0951 E-mail: guillermo.ibanez@energiadelsursa.com.ar
Responsibility for data acquisition (Continuous, monthly and yearly) Mr. Luis Sacaba	Contact person: Luis Sacaba Address: Ruta 39 Km12 – Comodoro Rivadavia Phone/fax: 54 297 454 9045 E-mail: luis.sacaba@energiadelsursa.com.ar
Responsibility for calculation of emission reductions (Monthly and yearly)	Contact person: Luis Sacaba Address: Ruta 39 Km12 – Comodoro Rivadavia



Mr. Luis Sacaba	Phone/fax: 54 297 454 9045 E-mail: luis.sacaba@energiadelsursa.com.ar
Responsibility for monitoring supervision (Continuous) Mr. Horacio Sanchez	Contact person: Horacio Sanchez Address: Ruta 39 Km12 – Comodoro Rivadavia Phone/fax: 54 297 454 9045 E-mail: horacio.@energiadelsursa.com.ar

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

Date of completion of Baseline study and monitoring methodology: 29/09/2006

Name of person/entity responsible for the application:

Ottavia Mazzoni
Energy for Sustainable Development (ESD) Ltd
Overmoor, Neston, Corsham,
Wiltshire, SN13 9TZ,
UK

Tel: +44 1225 812102 (switch)
Tel: +44 1225 816831 (direct)
Mobile: +44 7769691240
Fax: +44 1225 812103
Email: ottavia@esd.co.uk

ESD is not a project participant.

SECTION C. Duration of the project activity / crediting period**C.1 Duration of the project activity:****C.1.1. Starting date of the project activity:**

30/10/2007 expected commissioning date

C.1.2. Expected operational lifetime of the project activity:

25 years

C.2 Choice of the crediting period and related information:**C.2.1. Renewable crediting period****C.2.1.1. Starting date of the first crediting period:**



01/11/2007

C.2.1.2. Length of the first crediting period:

7 years 0 months

C.2.2. Fixed crediting period:**C.2.2.1. Starting date:**

N/A

C.2.2.2. Length:

N/A

SECTION D. Environmental impacts**D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:**

An Environmental Impact Assessment (EIA)²⁰ for the Comodoro CCGT conversion project was completed in April 2006 in accordance with the requirements of Article 30 of Law 5439. The outcome of the EIA was favourable and the project was not found to have significant and permanent environmental and social negative impacts overall.

The main negative impacts of the project will be on the soil and the atmosphere, mainly during the construction phase as summarised in the list below:

- Increased noise levels;
- Dust and particulates due to machinery action;
- Possible lubricants and oil spillages from machinery;
- Possible contamination of soil due to residues and effluents;
- The appearance of the project site will be modified.

The impacts are not deemed to be significant and will not require any changes in the proposed engineering of the project. This is mainly due to the fact that the construction of the new steam turbine and annexed operative units will be at the site of the existing Central Termica Patagonia. With regards to noise, once the plant is operational, it is expected that the noise level will be well below the maximum level of 90 dB as measured at one meter from the source in respect to the normative IRAM 4032. Furthermore, despite the overall increase in noise generation, it is expected that the noise at ground level will be considerably reduced compared to the current situation due to the increased height of the chimneys and the addition of the condensers.

²⁰ Exhibit C: Estudio de Impacto Ambiental – Comodoro Rivadavia; April 2006



The EIA also identified that the project will have some positive environmental and social impacts, mainly due to the higher efficiency of generation and the creation of local employment. Despite the fact that the direct social impacts are expected to be temporary (the majority of jobs created will be during the construction phase); they will nonetheless have a considerable positive effect in the region due to the current economic situation of unemployment and low employment. In addition to this, there will also be relevant indirect social benefits due to the more secure availability of electricity.

The relevant Argentinean authorities (Dirección General de Protección Ambiental) have granted EDS the go ahead to perform a public hearing (Audiencia pública) based on the results of the EIA. This is part of the formal approval process of the EIA.

Before undertaking the EIA, Energía del Sur commissioned a study²¹ to assess the environmental impacts of the gaseous emissions from the closed cycle plant in compliance with the requirements of Article 30 of Law 5439 and with the “*Resolución 13/97*” of the Argentinean regulatory body for electricity (Ente Nacional de Regulación de la Electricidad, ENRE). The evaluation was conducted following the procedures established by the “*Resolución 13/97*”, which indicate the calculation models to be used to quantify the expected impact on air quality due to the emissions from the power plant. In line with the fuel used, the expected emissions from Carbon Monoxide (CO) and Nitrous Oxides (NO_x) were assessed and subsequently compared to the guidelines contained in the “*Ordenanza 5594/95*” established by the municipality of Comodoro Rivadavia. Table 8 shows the maximum permitted emissions established by the “*Ordenanza 5594/95*”, while Table 9 shows the acceptable levels of pollutants established by the “*Ley Nacional 20284/73 de Contaminación Atmosférica*”.

Overall it is expected a positive impact on the gaseous emissions per unit of power generated due to the increased nominal capacity of the power plant.

Table 8: Maximum permitted emissions (Ord. 5594/95 Comodoro Rivadavia)

Contaminants	Maximum limit
CO	0.2% of volume in normal conditions
NO _x	0.55 kg/10 ⁶ Cal

Table 9: Guideline levels for air quality purposes (Ord. 5594/95 Comodoro Rivadavia)

Contaminants	Maximum concentration		
	1 hour	8 hours	24 hours
CO	57.3 mg/m ³	10.3 mg/m ³	-
NO _x	847 µg/ m ³	-	282 µg/ m ³

The application of the model to the Comodoro project gave the following results:

- **NO_x**: the expected pollutant maximum hourly concentration for both the HRSG units of the Central Patagonia will be approximately 50 µg/ m³, which is well below the guideline level for

²¹ Exhibit D: Modelado de Impacto Atmosférico por Instalación de Ciclo Combinado – Central Patagonia, Energía del Sur S.A. (February 2006)



NO_x as shown in Table 9. Furthermore, the expected emission is in compliance with the criteria established by the “*Resolución 13/97*” which require the calculated emissions to be below 50% the respective guideline level.

- **CO:** the results of the model show that the expected maximum concentration of CO is well below the guideline level and that the impact on air quality is within admissible levels.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

With regards to the gaseous emissions, the analysis of the expected environmental impacts of the project on the atmosphere is based on assumptions about the future emissions of gaseous contaminants from the combined cycle plant. The study recommends that the following measures are taken:

- After the completion of the installation works verify ex-post that the level of CO and NO_x emitted are within the limits established through the model used for the impact assessment;
- Once the combined cycle plant is operational proceed to establish a monitoring campaign specifically to assess the concentration of CO and NO_x in the plume downwind from the plant;
- Once the combined cycle plant is operational establish a program to monitor the air quality with regards to the concentration of CO and NO_x at least in four monitoring points at the perimeter of the plant and at least two control points critical for air quality.

With regards to the identified environmental impacts during the construction phase, the following measures were considered to reduce the negative impacts as part of a Plan of Environmental Management:

Work site

Access will only be allowed in the area of work. It will be obligatory to obey to the provisions for the safeguard of hygiene, security and the environment. The toilet services will be constructed according to the rules specified by Law 19587. The effluents will be treated before their disposal. The septic tanks will be built to ensure that the effluent does not contaminate ground water. The soil affected by oil spills or lubricants will be eliminated and disposed of in safe conditions for treatment. Once construction is completed all will be done to ensure that the site will be returned to its original state.

Construction phase

In compliance with the requirements from the Law 19587, Decree 351/79 and Decree 1338/96 a head of security will be in charge of all the tasks relevant to industrial security during the construction works.

Operational phase

The environmental protection plan during operation of the power plant will be incorporated within the Environmental Management System (EMS) of Energia del Sur, which will be revised to include the operation of the Steam turbine.

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

The project was presented to the public and local authorities by way of a public hearing which took place at the Council of Representatives of the City of Comodoro Rivadavia on Tuesday December 5th, 2006.

Invitation to participate in the hearing was made by way of full-page announcements in two local newspapers, the Diario Cronica and Diario Jornada Trelew, with the ads featuring on three consecutive days, the 24th, 25th, and 26th of October. Figure 8 shows a photograph from the public meeting.

Figure 8: Public Hearing at the Council of Representatives of the City of Comodoro Rivadavia



The hearing was chaired by Dr. Ariel Gamboa the Deputy Secretary of Environmental Management and Sustainable Development of the Ministry of Environment and Sustainable Development Control of the Province of Chubut, and Table 10 lists the participants in the meeting.

Table 10: Participants in the Public Hearing

Name	Position	Organisation
Licentiate Ricardo Lloyd Jones	Director of Sustainable Management of the Environmental Protection General Division, Undersecretariat of Natural Resources and Environment	Province of Chubut.
Engineer Beatriz Alicia Pérez	General Director of the Senguer-San Jorge Fields	Province of Chubut
Agricultural Engineer Miguel Murtagh	General Director of Environmental Impact Assessment of the Undersecretariat of Environment	Municipality of Comodoro Rivadavia
Technical Auditor Enrique Pritchard	Technical Direction of Supervision of the Undersecretariat of Environment	Municipality of Comodoro Rivadavia
Engineer Jorge Ramos	Power Plant Manager	Energía del Sur at Patagonia Power Plant



Licentiate María Eugenia Ivanissevich	Manager of Environmental Affairs	Energia del Sur SA
--	----------------------------------	--------------------

The public hearing was recorded and an official transcript was compiled.

Fifteen additional stakeholders were invited to participate in the consultation process by way of a survey. Participants included representatives from the following groups: the municipality and deliberating council of Comodoro Rivadavia, local unions, the project's gas and water suppliers, local residents, along with shareholders and employees of Energia del Sur.

E.2. Summary of the comments received:

1. Concerns were expressed about air quality at the site both during construction and operation of the project.
2. Questions were asked about how the noise level in the area will be affected by the combined cycle implementation.
3. Stakeholders asked how any hazardous waste from the cooling system would be managed.
4. Concern was expressed that some work on the project had commenced before the final environmental approval had been issued.
5. A number of individuals surveyed stated that the project would have positive impacts with regard to the creation of local employment and economic growth during the construction phase. As well, they also believed that during operation the project would have positive impacts on local air quality and visual aspects at the site.

E.3. Report on how due account was taken of any comments received:

>>

1. Measures will be taken to avoid the generation of dust, and other impacts on local air quality. Fortunately the prevailing winds are from the west which will also help to prevent impacts on the more urbanized area located to the south of the site. Overall it is important to note that the largest positive impact of the project will be the decrease in greenhouse gas emissions and particulate emissions per MW generated.
2. With regard to noise levels at the site, the health and safety of nearby residents and plant employees will be taken into account, in compliance with Hygiene and Safety Act and IRAM Standard 4062. The project is considering installing silencers, similar to the ones currently in operation at the plant, to ensure that noise levels at the site will not exceed 60-65 decibels. A reduction in noise levels will also be achieved through the chimneys being lifted to a height of between 23 and 27 meters.



3. In terms of hazardous wastes at the site, according to the Dangerous Waste Act, an analysis will be performed to categorise all wastes produced by the project, and disposal will be completed with a certified treatment company. As the cooling circuit is closed, only a small amount of waste (water with ethilenglycol) is generated, and this is emptied as part of the general maintenance processes, and disposed of under the current regulations on waste transportation. As regards sewage effluents and the purge water of the combined cycle system, after passing them through a small sewage effluent treatment plant, the company uses them for watering the site.
4. Finally, the only work that has been initiated at the site has been the establishment of minimum foundations required to receive the equipment that has been purchased by the company for the project. The company will not commence any work on the project while the approval is still pending, and all of the equipment will remain in containers until that time.

**Annex 1****CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

Organization:	Energía del Sur SA
Street/P.O.Box:	Ruta 39, Km. 12, Ciudadela
Building:	
City:	Comodoro Rivadavia
State/Region:	Chubut
Postfix/ZIP:	
Country:	Argentina
Telephone:	+54 (297) 454-9045
FAX:	
E-Mail:	Jorge.ramos@energiadelsur.com.ar
URL:	http://www.energiadelsursa.com.ar/
Represented by:	
Title:	Chief Engineer
Salutation:	Mr.
Last Name:	Ramos
Middle Name:	E.
First Name:	Jorge
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	



Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is available for the proposed project.

**Annex 3****BASELINE INFORMATION****Fuel emission factors**

Fuel	Emission Factor	Source
Natural gas	1.95 kgCO ₂ /m ³	2 nd National Communication of the Republic of Argentina to the UNFCCC
Fuel oil	3.17 kgCO ₂ /kg	
Gas oil	3.16 kgCO ₂ /kg	
Coal	2.58 kgCO ₂ /kg	

Fuel net calorific values

Fuel	NCV	Source
Natural gas	8,400 kcal/m ³	Standard NCV values for Argentinean fuels Cammesa Informe Annual; 2004
Fuel oil	9,800 kcal/kg	
Gas oil	10,400 kcal/kg	
Coal	5,400 kcal/kg	

Conversion factor 1kcal = 0.0041868 MJ

Oxidation factors

Fuel	Emission Factor	Source
Natural gas	1	TABLE 1.4, “2006 IPCC Guidelines for National Greenhouse Gas Inventories”
Oil and Oil products	1	
Coal	1	

Fuel density

Fuel	Emission Factor	Source
Fuel oil	825 kg/m ³	Cammesa Informe Annual; 2004
Gas oil	825 kg/m ³	

Operating margin calculations

The calculations of the OM are performed by a software program that was prepared on purpose. The program analyses the hourly dispatch data downloadable from the Cammesa website <http://memnet2.cammesa.com/inicio.nsf/marcomemnet> as specified in Annex 4 and calculates the grid operating margin for the monitoring year using the equations that have been described in Section B.6.

Build margin calculations

The capacity additions to both MEM and MEMSP are shown in the table below. The table includes the name of the power plants and the name of the units as they appear in the dispatch files of Cammesa, the



CDM – Executive Board

page 57

installed capacity, the type of generation, the cumulative power generated for 2005 and the total fuel consumption for the same year, by type of fuel²².

Total generation in Argentina in 2005 was 94,011 GWh, the 20% of which amounts to 18,802 GWh.

Year	Power plant	Type	Name of unit	Region	Installed Capacity (MW)	Electricity generation (MWh)	Natural gas (m3)	Gas oil (m3)	Fuel oil (t)	Emissions (tCO ₂)
2003	Pluspetrol Norte	GT	PPNOTG02	MEM	116	119,285	38,144,700	0	0	74,382
2002	Cacheuta Nueva	H		MEM	122	403,682	0	0	0	0
2002	Pluspetrol Norte	GT	PPNOTG01	MEM	116	52,988	16,989,900	0	0	33,130
2001	AES Paraná	CC	AESPTG01 AESPTG02 AESPTV01	MEM	845	4,182,647	816,913,870	15,740	0	1,634,016
2001	CT San Miguel de Tucumán*	CC	SMTUTG02 SMTUTV01	MEM	269	1,449,426	228,972,230	0	0	446,496
2000	Dock Sud	CC	DSUDTG07 DSUDTG08 DSUDTG09 DSUDTG10 DSUDTV11	MEM	794	3,821,614	723,367,660	3,663	0	1,420,117
2000	Electropatagonia C. Rivadavia	CC	CRIVTG27 CRIVTG28 CRIVTV25	MEMSP	63	275,845	103,859,000	0	0	202,525
1999	Puerto Nuevo	CC	PNUETV07 PNUETV08 PNUETV09	MEM	798	1,573,936	155,802,930	0	266,320	1,148,050
1999	Central Termica Tucumán**	CC	TUCUTG02 TUCUTV01	MEM	150	1,705,314	291,437,510	0	0	568,303
1999	Pichi Picun Leufú	H		MEM	255	1,177,263	0	0	0	0
1999	C. Comb. Costanera	CC	COSTTV01-07 COSTTG08 COSTTG09 COSTTV10	MEM	851	7,077,336	1,164,600,900	7,593	314,175	3,286,701
						21,839,337				8,813,720

* Unit SMTUTG01 was installed in 1995 and is not accounted in the BM

** Unit TUCUTG01 was installed in 1996 and is not accounted in the BM

Notes: GT stands for gas turbine, H stands for hydro, CC for combined cycle.

The CC Agua del Cajon has applied for CDM status, therefore it is not included in the list of most recent plants, even if the investment happened in 2000.

The cumulative generation for the 5 most recent power plants amounts to 6,208,028 MWh, which corresponds to 6.6% of the total generation in Argentina. Therefore the calculation of BM is based on the plants shown in the table above whose cumulative generation accounts for approximately 23% of the total generation.

²² Source: Cammesa 2005 power generation and fuel consumption summary tables.



Annex 4

MONITORING INFORMATION

Background

The electricity generation from EDS investment at the Central Termica Patagonia, comes from the installation of the new steam turbine **PATATV0X** (38MW) and from over firing of gas in the two HRSG units (additional 19MW). The generation of electricity in the steam turbine does not cause any additional GHG emissions, while over firing in the HRSGs does. Both instances will be accounted for in the calculations of total emission reduction arising from the investment.

The new investment from EDS will displace the generation of marginal generating units in the Argentinean electricity wholesale market and as a consequence of its higher efficiency will offset a certain amount of CO₂ emissions. The steps highlighted below are a guideline of how the GHG emission reductions arising from the project can be calculated using the monitoring program. The software program records, calculates and provides the archive for all data necessary to calculate the grid Operating margin. The operating margin is then entered into an excel workbook that allows calculating the build margin and the GHG emissions reductions due to the project over each verification period. This monitoring plan describes the usage of the program and of the workbook in day to day operations.

Source of data

The data used in these calculations comes from different sources, mainly CAMMESA, the Secretariat of energy, the Argentina Second National Communication to the UNFCCC, and IPCC. In all cases the most conservative approach is considered.

CAMMESA regulates the electricity market in Argentina by dispatching units according to their declared marginal cost. The cheaper unit is dispatched first. CAMMESA provides three reports for each hour of operation of the grid:

1) The generation dispatch reports provide for each hour of the year the power dispatch information for each unit in the Argentinean power system (MEM and MEMSP). CAMMESA provides the **Thermal Generation Dispatch Report**, and the **Hydroelectric Dispatch Report**. Both reports have the same three columns structure that shows:

- Column 1: the units dispatched for each hour at the spot price;
- Column 2: the units dispatched at operating cost. These units do not operate at full capacity, but if demand increases, more power can be dispatched from them; and
- Column 3: the units in reserve. These units are not operational, and are not included in the calculations.

2) The **fuel dispatch report** gives information about the kind of fuel or fuel mix used by each unit each hour of the day. This report does not include the amount of fuel consumed, which can be back calculated using the provided data of generation and efficiency of the units.

Steps to calculate the grid emission factor

For every hour during the monitoring year it is required to:

- 1) Obtain the total generation for that hour from all generating units in the grid;



- 2) State the most expensive 10% out of the total MW generated at that hour;
- 3) Estimate the emission factor for that 10%;
- 4) Calculate the CO₂ tonnes displaced by Energia del Sur project for that hour.

The values calculated for all the hours in the previous set of operations must be added up in order to obtain the total tonnes of CO₂ displaced by the project during the monitoring period.

Obtain the “Operating Margin” emission factor for the analyzed year by dividing the total tonnes of CO₂ produced during the year by the total power generated by the project.

Calculate the “Build Margin” using the following steps:

Select a set of power plants choosing the group that comprises the larger annual generation among the following two options:

- 1) the 5 power plants that have been build more recently (in the case of Argentina this is very unlikely to be the case); or
- 2) the most recent power plants whose cumulative generation comprises 20% of the entire system generation.

Then calculate the average annual emissions (tCO₂/MWh) of the set, dividing the emissions of the set (calculated as the efficiency times the generation times the fuel emission factor for each plant in the group) by the total power generated by the set in the monitoring period.

Once both OM and BM have been calculated, the grid combined margin is obtained using the chosen weights.
