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103

Peru: Extending the Use of Natural Gas to Inland Provinces

April 2006

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Peru: Extending the Use of Natural Gas to Inland Provinces

Technical, Social, Environmental, and Economic Studies of Natural Gas Supply Projects within Peru: Ayacucho, Junín, Ica, and Cusco

April 2006

Energy Sector Management Assistance Program (ESMAP)

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Preface

The Peruvian Government Agency for the Promotion of Private Investment, ProInvestment, requested the technical–economic prefeasibility studies on the extension of trunklines from the main Camisea pipeline within Peru. The study provides the terms to be used for the natural gas transportation and distribution concession bids within four regions: Ayacucho, Junín, Ica, and Cusco. The prefeasibility study on the extension of trunklines to supply natural gas to the Ica, Ayacucho, and Junín regions was assigned to Consorcio R. García Consultores S.A., INTEC Engineering S.R.L. and ARCAN Ingeniería y Construcciones S.A. and financed by ESMAP as part of its workprogram on the diversification of energy supplies under the Energy Security Thematic Area of the 2005-2007 Business Plan. Similarly, the Canadian government funded the prefeasibility study on the extension of trunklines to supply natural gas to the Cusco Region, prepared by Canadian firms Colt Engineering/Stantec. The above-mentioned studies were completed in 2004. Subsequently, under the sponsorship of the Camisea Project contractors, Consorcio R. García Consultores & INTEC/ARCAN was requested to expand the study on the Cusco Region pipeline, and this was completed in the latter part of April 2005.

This consolidated report contains the final results and conclusions of these studies, which provide important considerations on the strategy and structuring of future concessions to supply gas to those regions. The study's results became useful tools for the government with its goal to grant concessions for gas supply services to the regions, which has the characteristics of a "Greenfield" project.[1] Technical, social, and environmental studies have served as the basis for the economic analysis of the project, making it possible to identify the savings to be generated for the population and the regions' economic activities (trade, industry, electricity generation, transport) from the use of natural gas. Finally, this led to the development of financial models, whose results, combined with those of previous studies, were useful in the design of the most appropriate strategy and approach to meet the goals of the country and of the regions.

The final report has been structured in five main chapters with an Executive Summary that includes the most significant conclusions and recommendations.

Chapter 1 summarizes the regions´ demand projections used for the Economic–Financial Prefeasibility Study, explaining the basic premises to quantify the potential demand for natural gas for the period under analysis (2005-2025).

Chapter 2, Cost of Supplying Natural Gas to the Regions, takes into account all costs involved in the provision of the service to supply natural gas for the regions (CAPEX, OPEX) including the costs incurred to make the connection for the users (internal installation and conversions) to be able to use the natural gas. This chapter presents the technical–environmental studies carried out with respect to the design of the main and secondary routes. It shows the methodology followed to quantify the different

[1] Frequently used term that identifies businesses, where, once the potential demand has been identified, one would need to start from zero to develop the required infrastructure to be able to commercially exploit the identified business.

costs of the supply chain; those which are unique to the laying and commercial exploitation of the natural gas trunklines and networks of these new businesses, plus others, which are exogenous to the behavior of the concessionaires, such as the cost of the natural gas flow and transportation through the Camisea trunk pipeline to the point where it connects with the new regional trunklines.

Chapter 3 details the results of economic and financial prefeasibility studies, as well as the methodology used in the economic studies to quantify the net economic benefits of the regional projects, the price assumptions, the valuation of the energy demand substitutable by natural gas (NG); and the criteria for the allocation of costs per sector (residential, businesses and small industries, vehicle natural gas, and large industrial customers). This methodology helped determine the benefits for each of the sectors that will be converted to natural gas. A subject, which is also important, is the sensitivity analysis with respect to the modifications of the critical variables that detected: positive effects (+) or negative effects (-) by case.

In addition, this chapter includes the results of the financial prefeasibility evaluation. This item summarizes the business cash flow, breaking it down by main trunklines, secondary trunklines, and distribution networks or integrated by region; revenues required from the business units for the financial sustainability of the natural gas supply services, composition of the service's costs (in CAPEX and OPEX) and temporary income and expense analysis. The financial section makes it possible to calculate the average rates by segment in the new concessions: (i) Main Regional Trunklines (MRT) and (ii) Distribution Trunklines and Networks (DLN). Finally, for each region to be supplied with natural gas, a comparison is made of the average natural gas cost to be paid by the final user, against the average cost of the energy currently being paid by all sectors.

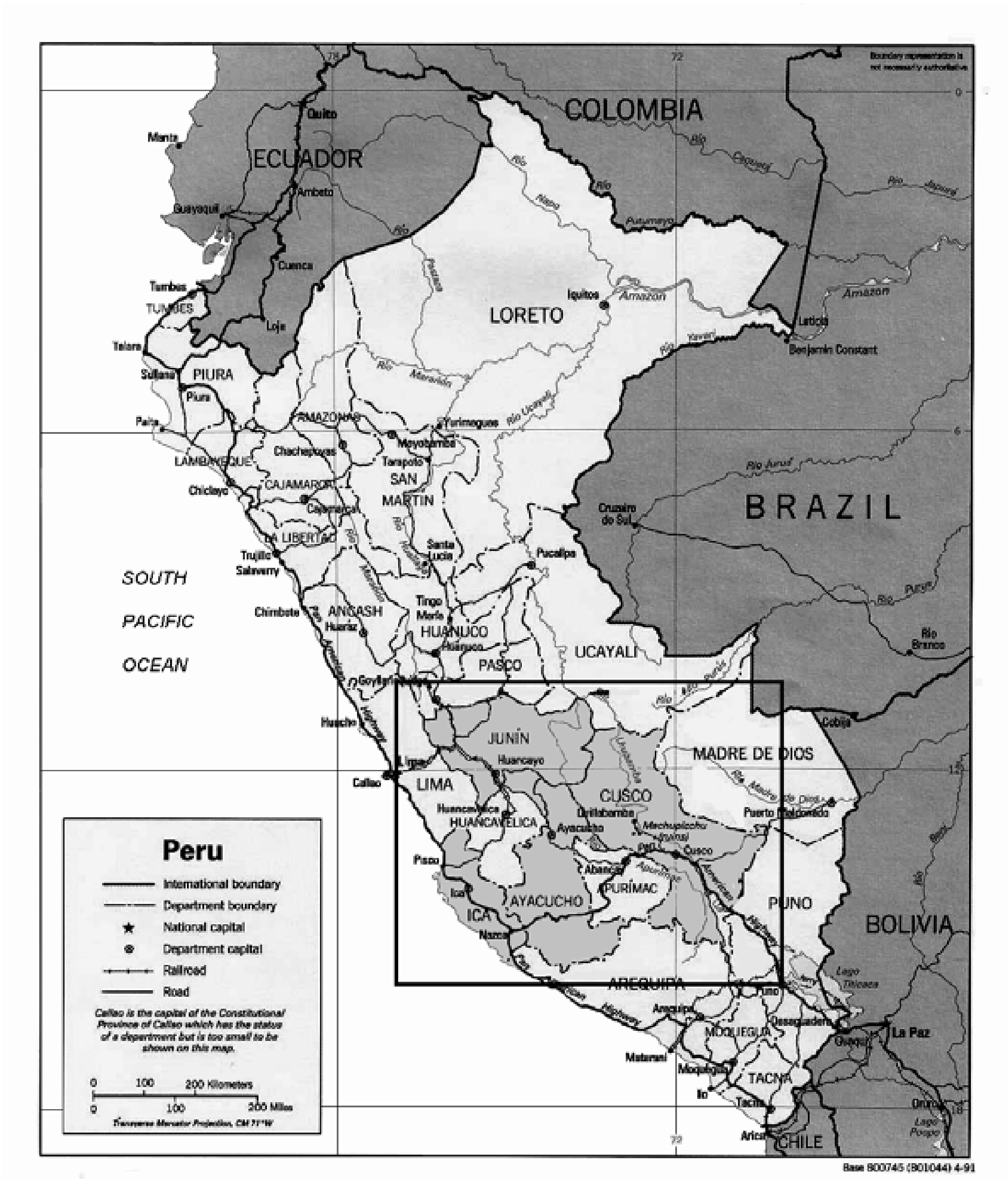
Chapters 4 and 5, based on the results obtained, provide proposals for the structuring of the services as well as considerations on the strategy to be followed for the granting of the services concession to the studied regions.

The foregoing summary confirms the technical and economic prefeasibility studies of the extension of the first trunklines of the Camisea Pipeline within Peru on the basis of the information provided as of April 2005. In addition in the following months of 2005 a series of project proposals have been made, which causes one to be rather optimistic about the possible achievement of the goal of extending the gas industry and in this way have most of the Peruvian people benefit from the Camisea gas reserves.

These proposals relate to possible export projects: (i) Repsol–YPF will have a decisive participation in the development of the exportation project of liquefied gas to Mexico and the United States; and (ii) the governments of Brazil, Argentina, Uruguay, Paraguay, and Chile have proposed to Peru, based on the natural gas reserves existing in the Camisea area, to develop the "Southern Cone's Power Ring," a project which, if carried out, would allow a quicker supply to southern Peru's departments such as Arequipa, Moquegua, Tacna, and so forth. This mega project starts with the laying of a pipeline toward the north of Chile from Pisco—the arrival point of the Camisea trunk pipeline on the Pacific coast—to Tocopilla in Chile.

Figure 1 shows the location of the regions involved in the study.

Figure 1: Relative Location of the Regions Considered in the Study



Acknowledgments

The Prefeasibility Studies on the extension of natural gas trunklines within Peru and this consolidated study have been possible thanks to ESMAP (the Energy Sector Management Assistance Program) and CIDA (Canadian International Development Agency).

The study concept and the specific terms of reference were prepared by Eleodoro Mayorga Alba, Task Manager, in close collaboration with Luis Ortigas, Paúl Sumar and Aníbal del Águila, Proinversión officials, and Efraín del Castillo, technical consultant. The officers of the regional governments played a very important role in gathering data and providing assistance to consultants; among them, the support of Hernán López, from the Junín Region, and Alejandro Contreras and Fernando Paliza from the Cusco Region was significant.

The consultancy team of R-G and Intec/Arcan included the following experts: Raúl García, Gustavo Carvalho, Pablo Gigovri, Daniel Rodríguez Villafañe, Julio Moreno, Florencia Ferrero and Eduardo Doria. The market studies were subcontracted by Macroconsult and CCR and were prepared by Gonzalo Tamayo, Ricardo de la Cruz, Horacio Acosta and Ana María Guzmán. The Stantec-Canada consulting team included Ian Morrison, Fernando Rodrigo and Lila Becerra Katz.

Alonso Zarzar (Latin America Social Development expert, World Bank) contributed with the preliminary data review of the route design and the environmental and social impacts and Michael Levitsky (Oil, Gas, and Mining Policy Division, World Bank) provided the review of the market and economic appraisal studies. The final report was reviewed by Dominique Lallement, Energy Adviser, ESMAP.

The consolidated report was prepared by Pedro Touzett and Jessica Pacheco (consultants). The English version was translated by Maricarmen Pizarro (Servicios Profesionales y Administrativos S.A.C. - SERPROADSAC). Esther Petrilli (Oil, Gas, and Mining Policy Division, World Bank) was responsible for the final editing. Marjorie K. Araya coordinated the publication and dissemination of the report.

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Abbreviations and Acronyms

Alt.	Alternative
BC	Base Case
BOOT	Build, Own, Operate and Transfer
BV	Block Valve
CAE	Discount Rates
CAPEX	Capital Expenditure
CCR	Corporation of Research Companies
CTT	Camisea Trunk Transport
DLN	Distribution Trunkline and Network
DN	Distribution Networks
DOE	"Department of Energy"
EIA	Environmental Impact Assessment
EPC	Engineering, Procurement and Construction Cost
FSU	Former Soviet Union
HP	High Pressure
Ind.	Industries
LP	Low Pressure
LPG	Liquefied Petroleum Gas
MEM	Ministry of Energy and Mines
LU	Large Users
MP	Medium Pressure
MRT	Main Regional Trunkline
NB	Net Benefit
NPV	Net Present Value
NG	Natural Gas
NGL	Natural Gas Liquids
NGLC	Natural Gas of Lima and Callao (S.A.)
NPFA	Non-Productive Fixed Assets
OECD	Organization for Economic Co-operation and Development
ON	Other Networks (Medium and Low Pressure)
OPEC	Organization of the Petroleum Exporting Countries
OPEX	Operating, Maintenance, Administration and Merchandizing Cost
OSINERG	Organization for the Supervision of Investments in Energy
PD	Point of Delivery
Resid.	Residential
S/.	Nuevos Soles

TGP	Transportadora de Gas del Perú S.A.
TS	Thermal Station
US$	US Dollars
VNG	Vehicle Natural Gas
WACC	Weighted Average Capital Cost
WTI	"West Texas Intermediate", intermediate grade crude price in Cushing, Oklahoma.

Units of Measure

bar	Bar
bar M	Manometric Pressure
bbl	Barrel
BTU	British Thermal Unit
f^3	Cubic Feet
g/cm^2	Gram per Square Centimeter
km	Kilometer
M	Thousand
m^3	Cubic Meter
m^3/hour	Cubic meter per hour
MM	Million
MMCFD	Million Cubic Feet per Day
MW	Mega Watts
MWh	Mega Watts per Hour
SDR	Standard Dimensional Rate
TCF	Trillion (1012) Cubic Feet

Monetary Equivalence

US$1	3.3 Nuevos Soles[2]

[2] The exchange rate has been stable since April 2004.

Executive Summary

1. Since the realization of stage one of the Camisea Project during August 2004, with the commercial commencement of the natural gas delivery services in Lima and Callao, and the production of LPG and condensates at the fractionation plant in Pisco, new opportunities are available for the development of projects and uses of natural gas in various activities which are likely to benefit the citizens of Peru. In the next few years, natural gas will undoubtedly be a highly significant component in the country's energy matrix.

2. Conscious of the availability of this energy element and of the success of stage one, the government has started technical–economic prefeasibility studies for stage two of the Camisea Project, which includes the extension of main and secondary pipelines to provide the natural gas supply service to four regions inside the country: Ayacucho, Junín, Ica–Pisco, and Cusco. Subsequently, these studies will support the planning of the natural gas transportation and distribution (supply) in said regions. According to the Peruvian legal framework and the regulations in force, these service concessions must be granted to private companies through open bids.

3. Each Prefeasibility Study was comprised of the following tasks: (i) market studies; (ii) socioeconomic diagnosis; (iii) environmental assessment; (iv) pipeline route evaluation; (v) basic engineering; (vi) conceptual development of distribution networks; (vii) economic prefeasibility; and (viii) preparation of proposed strategic plan for the concession of natural gas transportation and distribution in the aforementioned regions.

4. The R. García Consultores and Intec/Arcan consortium was responsible for completing the studies for the Ayacucho, Junín, and Ica regions, and for the expansion of the previous study carried out for the Cusco Region by Canadian firms Colt Engineering and Stantec. The recommendations from these studies will provide the participating authorities with points of view concerning the most adequate technical-economic action alternatives to accomplish the final objective, that is, natural gas penetration into the region's energy matrix which will bring about a greater level of regional development and well being for the population.

5. The conclusions and recommendations of the studies take into consideration the extrinsic and intrinsic context conditions of the project. The project's goal is to configure realistically the potential business units that are likely to be awarded in concessions to private operators. These conditions are comprised of: (i) the socioeconomic reality of regions and current and potential energy use; (ii) the current legislation governing natural gas, (iii) the framework of institutions at the national, regional, and district levels; (iv) the base infrastructure already in place and in operation in Camisea ("upstream"–"midstream") upon which the project's trunklines will be extended; (v) the characteristics of the areas crossed by the potential route of Camisea Trunk Transport pipeline (CTT) with respect to the extended pipelines and the relevant environmental restrictions; (vi) the project's supply costs compared to the economic benefits contributed; (vii) the financial requirements of the business units, and the

engineering and design of a combination of reasonable revenues and rates which will attract responsible users and investors to the regional supply systems.

6. The estimated investments in natural gas supply infrastructure to these four selected regions will be around US$414 million to satisfy a demand of as much as 70 MMCFD by 2007 and 214 MMCFD by 2025. This demand would represent 44.7 percent of the capacity of the main Camisea Pipeline and 33.7 percent of the projected demand for Lima by the year 2023,[3] which is proof of the importance of the project. The benefits to society for the next 20 years, quantified only with respect to savings of energy substitution, represent around US$416.6–505.6 million.

7. The demand analysis entailed the combination of fieldwork and surveys of potential users, as well as the use of economic and social statistics available in order to attain a socioeconomic diagnosis of the regions. The demand analysis and the technical–environmental analysis of the potential route of transportation and distribution pipelines formed the basis of the Economic Prefeasibility Analysis for the natural gas supply to the regions.

8. The diagnosis and analysis of the demand reveal that the sustainability and quick consolidation of the proposed natural gas distribution and transportation businesses will depend on whether users with significant consumption (large industrial customers) will find sufficient incentives to switch and use natural gas for their production processes and even propose new projects to expand their business. It has been noted that by 2025 in the Ica, Junín, and Cusco Regions, even within conservative scenarios, the demand for large customers will represent more than 90 percent. The Economic Prefeasibility Study supports this conclusion, including circumstances where substitute prices are lower than those in place as of the date of the study.

9. No less important than the above is the potential demand from natural gas thermal stations. As part of the main hypothesis, thermal plants of 150 MW for 2007–8 in the Ica region and one of 72 MW with an expansion of 50 MW for 2015 in the Cusco Region (Quillabamba) are included. This premise, incorporated into the projected gas demands of these regions, is in line with the provision made by the authorities in the sector in the sense that the generation of electrical power will be the main natural gas consumer in three of the scenarios managed within the MEM plans for the 2004–2027 period.[4]

10. The potential demand of the remaining sectors and/or potential use, such as residential and non-residential consumption, and the vehicle natural gas (VNG), is not significant with respect to the dimensioning of the pipelines to supply the regions,

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[3] 549.8 MMCFD according to the Economic Studies Office—OSINERG.

[4] See MEM, "Report Actualidad del Sector Eléctrico" *[Report on the Current Electricity Sector]*, August 2004. "El Gas Natural en el Market Eléctrico y sus Perspectivas" *[Natural Gas in the Electricity Market and its Perspectives]*, prepared by the General Electricity Bureau: (i) Hydrothermal Scenario: by the end of the period there would be an effective thermal generated power of 66%. This panorama would be possible based on an effective thermal-originated power of 40%; (ii) Thermal Scenario: if the entire growth of the future electric generation was from thermal sources, based on natural gas, by the year 2027 there would be an effective thermal-generated power of approximately 75%. In any of these scenarios, natural gas demand would be significant: 800 MMCFD or over 1000 MMCFD, respectively.

however, they have special importance in social terms and as far as the eventual direct benefits for the population are concerned. Although economic evaluations yield positive results when one incorporates the heating effect into residential consumption, certainly a need that is not satisfied at present, it will be necessary to apply business and rate tools (facilities in the financing of conversions and internal installations, subsidies, and so forth) given the low per capita income and restricted access to credit on the part of most of the users as specified in the corresponding section of the socioeconomic diagnosis. The studies conclude that in order to supply the markets with a new type of energy, major commercialization and educational efforts will be required, and economic, social and cultural barriers will need to be overcome.

11. The potential use of VNG is modest in the areas under study compared to the Lima market. However, its importance will depend on how intensive traffic becomes in the Lima–Ica section once dispensing outlets have been installed, unlike the case of Cusco, where the market will be restricted to Cusco City.

12. With respect to the natural gas demand by businesses and small industries, its importance is also minor, taking as a reference the current electricity users in the areas and the surveys conducted to determine the energy consumption patterns of these segments. In this sense, it will be necessary to deepen the evaluation of these markets, based on a detailed field study for a better quantification. However, the access to natural gas by homes, small and medium industries and businesses, will create jobs for skilled workers and should promote in general the political sustainability of large natural gas projects.

13. In the technical–environmental evaluations in the case of the Ayacucho, Junín, and Ica regions, different trunkline and route configuration alternatives were analyzed.

- The Ica market would be through any of the alternatives studied, with a Main Regional Trunkline (MRT) of 96 km and 10-inches in diameter.[5]
- In the case of the Junín market, natural gas could be supplied through two transportation alternatives. In Alternative 1, through the MRT: Lurín–Tarma–La Oroya—191 km of 12 inches, and 45 km of 8 inches, with or without the extension to the locality of Huancayo. In Alternative 2, the natural gas would be received with an MRT of 349 km of 10 inches and 31 km of 6 inches (with an interconnection in the CTT, at the Ayacucho diversion, 277 km from Camisea) supplying the localities of Huancayo, La Oroya, and Tarma. It is important to point out that the pipeline of Alternative 2 would get natural gas at the CTT, with more pressure with respect to the interconnection point in Lurín (732 km from Camisea).
- Finally, the trunkline, which would supply Ayacucho, differs in duct diameter, depending on the consideration given to either Alternative 1 (3 inches) or Alternative 2 (10 inches). The increased diameter for Alternative 2 is a result of the need to supply markets downstream from

[5] The trunkline could be extended to the Nazca–Marcona market with a 180 km duct and a 10-inch diameter, something that was not taken into consideration in the prefeasibility analysis.

Ayacucho, that is, the rest of the Central Sierra, for the pipeline that diverts from CTT to Ayacucho.

14. The technical–economic appraisal concludes that Alternative 2 is the most feasible for supplying natural gas to the Junín Region. According to the analysis, it is more reasonable to extend a main trunkline with a diversion in Ayacucho, which could supply the markets downstream from Huancayo, La Oroya, and Tarma. The technical and economic reasons are as follows: (i) a greater investment when considering the alternative of a trunkline with a diversion in Lurín, which entails significant engineering difficulties, (ii) the incremental investments in pumping units which would be required in the CTT of Camisea three years before compared to the requirements of Alternative 2 with a diversion in Ayacucho, (iii) a greater risk by depending on the delivery of natural gas at the final end of a system (732 km from the fields to Lurín) versus an intermediate point at a shorter distance from the fields (277 km).

15. In the case of the Cusco Region, several alternatives have been reviewed; based on this study it has been determined that the most feasible is the Main Regional Trunkline (MRT) to supply the different demand nodes of the project (Cusco and Cachimayo; Quillabamba; Combapata) which is interconnected at Kepashiato (km 126) to the main Camisea pipeline. In addition, a 37 km diversion to the Quillabamba market from km 88 is to be built; from this point the pipeline follows a route of 134 km up to Cachimayo and runs another 11 km to the City of the Cusco. Finally, to reach the Combapata market an expansion of 110 additional kilometers would be required. With this extension, the total pipeline route in the Cusco region would total 343 km from the CTT diversion. However, lacking demand, the economic feasibility of the Cusco project has not been demonstrated.

16. The business units are designed on the basis of a series of instruments and actions that are encapsulated into a type of service organization that mainly addresses the regulatory framework in force for the natural gas industry, the principle of sustainability and minimum scale economy of the supply, and the basic objectives of the project. In that sense, a strategic study was conducted, which included the service structure and its degree of integration / segmentation, the size of the businesses to be given in concession, the uniqueness of the business, type of rates, commercial structuring of the business, players' roles, and other aspects.

17. To guarantee the development of an incipient market and a reliable and safe penetration of natural gas, it is suggested to define businesses of a rather high magnitude. In order to attract major operators who could meet such objectives, the integration of the transport business and the distribution business into a single service unit is recommended. This could generate important savings in fixed service costs, since the amounts of the annual revenues (cost of service to be recovered by the concessionaire every year) are very low in the case of distribution, and alone would not attract major operators.

18. For the business units to be given in concession, the ownership should exclude any restrictions to the vertical–horizontal integration in the ownership in the concessions.

19. It is desirable to place at least two concession areas for tender, the first being the regions of Ica-Pisco and Ayacucho-Junín. Integrating these regions under the same service area is reasonable due to the advantages described in the Prefeasibility Study in terms of lower costs for Junín-Ayacucho users (Alternative 2).

20. The second area in concession is the Cusco Region, which as in the case of the two concessions of the previous point has the characteristics of a "Greenfield" project, that is, a business where it is necessary to identify the potential demand and develop the entire infrastructure required for the commercial exploitation of the business.

21. Table 1 shows the results of the economic appraisal: updated values revenues, the costs and the difference between them (NPV); in addition, it shows the extension of the MRTs and the trunklines and distribution networks, besides the estimated quantity of users of the natural gas supplying service.

Table 1: Economic Benefits of MRTs

	Current Values (US$million)				*Extension (km)*	
Regions	*Benefit (Revenues-Costs)*	*Revenues*	*Costs*	*Users*	*MRT*	*DLN*
Ayacucho, Junín, and Ica (Alt. 1)	339.4	822.9	483.5	59,732	354	691
Ayacucho, Junín, and Ica (Alt. 1-A)	340.5	899.1	558.6	99,360	460	1,061
Ayacucho, Junín, and Ica (Alt. 2)	415.9	899.1	483.2	99,360	476	1,069
Cusco + Cachimayo	89.7	199.5	109.8	37,665	233	362
Cusco + Cachimayo + Quillabamba	77.2	261.1	183.9	42,449	270	411

22. As can be observed in table 1, the pipeline route for Alternative 2 that will serve around 100,000 users in Ayacucho, Junín, and Ica Regions is the most profitable, with a NPV of US$416 million. For the Cusco Region, the economic appraisal indicates a NPV of US$90 million (for the city of Cusco and Cachimayo). However, if the pipeline were extended to Quillabamba (and Combapata, eventually) the additional investment for infrastructure would have to be financed through guaranteed incomes from the available proportional gas royalties, which will increase when natural gas is supplied to Cusco and the rest of the regions, rather than being paid by the existing users through higher rates.

23. The proposal is for the concessionaires to have exclusivity in the expansion and supply within their distribution area. This exclusivity implies not only the prohibition of a "physical bypass" (that is, the pipeline owned by large users, built to transport the natural gas bought by third parties, with a transportation system that goes up to their plant) with the user always having to pay for the transportation within the concessionaire's network in the area, but also exclusivity in the provision of the full service (resale of natural gas and CTT and use of the concessionaire's network) to the regulated lower consumption market (residential, commercial, small industries, and

VNG); in addition to having priority over third parties in the expansion within the area of concession.

24. With respect to the rate system, two positive conclusions arise from the Prefeasibility Reports in terms of searching for economic rationality and reinforcing the penetration of natural gas into the regions.

25. The first one consists of structuring the rates of CTT that the concessionaire resells to its customers, incorporating the distance factor instead of the present "sole postage stamp" system. The distance factor better reflects the "drivers" of transport costs and adequate incentives are provided for the localization of productive activities in the regions. Certainly, the further the point of delivery from the point of injection, the higher the cost of materials (pipe extensions and installation, pumping, among others) and of transportation of the natural gas volume with such infrastructure.

26. The second conclusion refers to distribution rates by High Pressure (HP). In this aspect the suggestion is to design rate sub-areas within the concession's geoGraph area, since in some cases (such as the Ayacucho and Junín pipeline) the localities are grouped in points at the end of the system, there being considerable distances throughout the route of the regional pipeline without any in between consumption. Designing rates by areas would have the advantage that, for localities very near the CTT point of delivery (PD) a much lower rate could be defined, substantially different from the rate of consumers located at the peak of the system, since the demand's gravity center is in the PD localities.

27. The capacity of some of the regional pipelines might exceed the aggregate consumption of the localities to be supplied initially in the area in order to make it possible to have an expansion of trunklines to more distant localities in the future, such as Marcona. For example, the leveled rate of the Ica–Pisco Region is reduced by more than half, if the government includes a guarantee equivalent to the revenues that would be generated by the Marcona demand if this occurred simultaneously with the Ica-Pisco demand.

28. The crude price in the international market has passed the US$65/bbl WTI mark and the world demand keeps growing. In Peru the impact of the increased prices of crude and other products at international levels has been almost totally transmitted to consumers. This situation helps the introduction of natural gas and to a certain point compensates for the small size markets within the considered regions. The interested companies, after reviewing the studies, may be able to decide the most efficient routes for the construction of the pipelines (including capital costs and operational costs required for an adequate management of social and environmental impacts) and the establishment of an adjusted timetable for the execution of works, and based on such information, prepare their offers for the bidding.

29. The strategy to open a bidding for the transport and distribution systems of natural gas was shaped after reviewing the demand of large industries and the price and costs hypothesis used in the economic calculations to insure the profitability of businesses given in concession. This revision took into consideration the guarantees required and the execution and operation conditions that should be offered as part of the

bid. This revision established that it was appropriate to grant in concession two integrated systems: (i) the Ica, Junín, and Ayacucho Regions and (ii) the Cusco Region.

30. The evaluation of the conditions that allow creating businesses, which will balance risks and ensure an adequate market, permits the conclusion that it is possible to call a bidding immediately for the supply of gas to the regions of Ica, Junín, and Ayacucho under a sole BOOT (build- own - operate -transfer) concession. Thus, the construction works would allow having complete gas transport and distribution systems in operation for the 2007 horizon.

31. Considering that the current Cusco demand includes only residential, businesses (tourism) and industrial (medium-sized and small companies) sectors, it is necessary that a minimum demand be guaranteed for the concessionaire, in such a way that natural gas will be able to compete with other energy alternatives. The lack of an industrial market of large customers makes it necessary to recommend that the gas demand of three projects be assured first—the thermal station of Quillabamba, the cement plant, and the conversion of the Cachimayo plant—before launching the bid. In this way, the guarantee of a demand sustained by the Gas Canon revenues would be reduced to a more manageable level. Although the Canon revenues are enough to maintain this guarantee, it is crucial to ensure a minimum demand to avoid reducing the Canon by almost 50 percent. Without a guaranteed demand for the projects mentioned, the region would have to guarantee the concessionaire almost its entire annual minimum-billing equivalent to US$20 million per year. With a guaranteed demand for these projects the guarantee is reduced to US$10 million; a guarantee which would tend to disappear in the following years with the endorsement of industrial projects in the region.

32. Finally, in the institutional aspect, it is important to have a clear definition of the roles to be played at the different levels of government involved in the implementation of the projects: national, regional, district. Government action is supposed to include natural gas as a vector energy in the regions, and at the same time, organize and encourage campaigns for the diffusion of the energy source in the domain of government areas (officials) and in society in general (chambers, builders, users, and so forth). The task of the successful bidders will benefit from good coordination between these authorities.

1

Projection of Natural Gas Demand in the Regions: Basic Premises for Demand Estimates

1.1 The projection of natural gas demand for each of the regions included in the study represents one of the key variables for conducting the Economic and Financial Prefeasibility Analysis. A greater penetration of this new source of energy in the regions' energy matrixes will obviously improve the results in terms of the cost of service and in terms of gains for the concessionaire and for society as a whole.

1.2 The period under analysis for demand projections included the period 2005–2025. Projections were made under three scenarios: Pessimistic (C-); Conservative (C); and Optimistic (C+).

1.3 In the case of the Ica region, the study included an estimate of the demand in the localities of Marcona and Nazca, as possible markets to supply in the future. The projections for these localities are shown for reference purposes and to design the regional trunkline from Humay to Ica.[6] In the case of the Cusco Region, a rather preliminary demand estimate included the locality of Combapata (Province of Canchis) as a possible market to supply in the future. This projection is included in the large customers sector also for reference purposes and to design the section of the regional trunkline that will be built eventually from Cusco to Combapata.[7]

1.4 The consumer sectors considered in the market study of the regions, which will be substituting energy (for example, LPG, kerosene, residual, electricity, and others) for natural gas, are listed below:

- Residential
- Business and Small Industry
- Vehicle Natural Gas (VNG)
- Large Customers (industries and electricity generation)

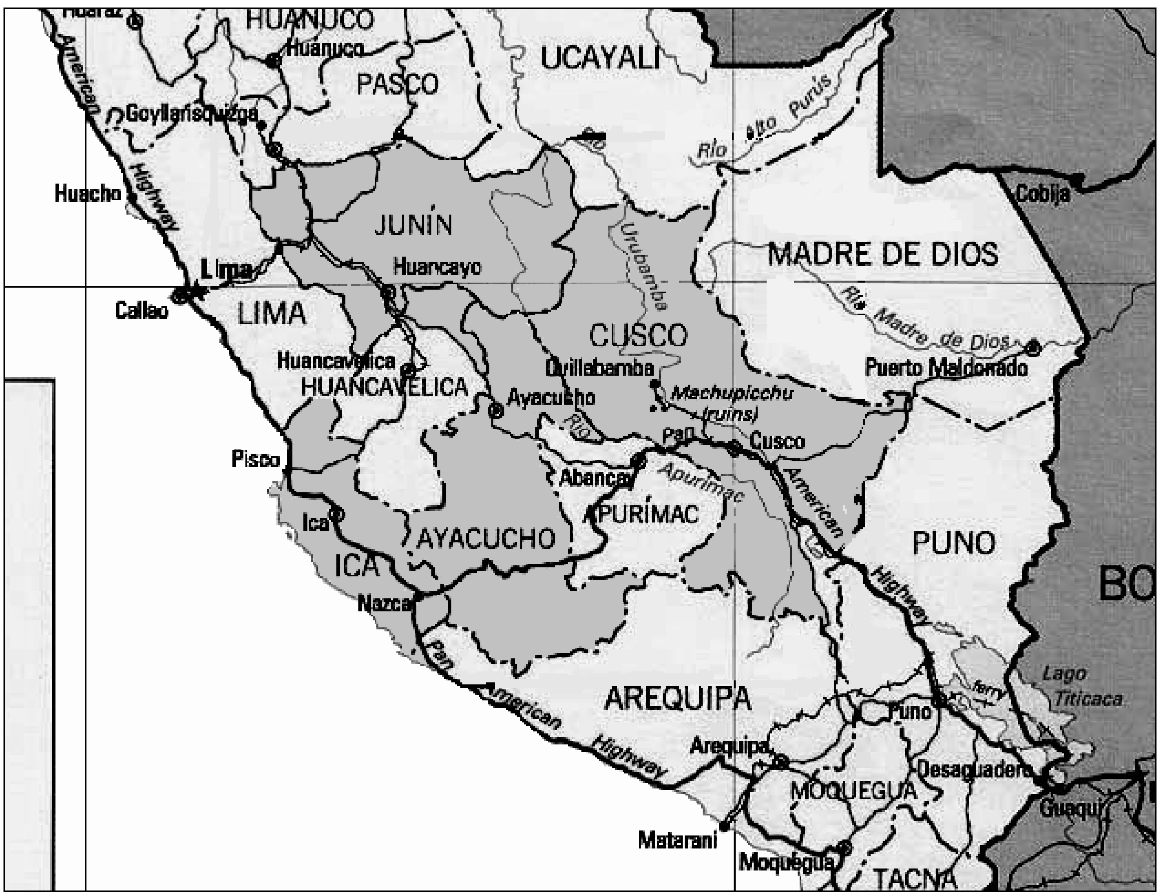
[6] As stated in the financial prefeasibility section, the calculation of the leveled rate for the Ica–Pisco region is reduced by US$0.10/MMBTU if the government includes a guarantee equivalent to the revenues to be generated by the Marcona demand if it occurred simultaneously with the Ica-Pisco demand.

[7] The calculation of the leveled rate for the Cusco Region is reduced by US$1.9/MMBTU if the government includes a guarantee equivalent to the revenues to be generated by the capacity demand of customers different from the Cachimayo and Cusco consumption.

1.5 The Demand Reports prepared by CCR-Macroconsult under a contract with R-G Consultores[8] formed the basis used for the projection of demand in the aforementioned sectors.

1.6 Estimates of consumption of large industrial customers were prepared based on a field study, which consisted of personal interviews with officials from the businesses visited. They revealed base information to quantify the demand of energy potentially convertible to natural gas, which is currently being used for their productive processes, and new industrial process projects planned, which would use natural gas; in the case of the Ica, Junín, and Ayacucho regions, this will occur shortly. This made it possible to design different demand projection scenarios in the sector, which are different for each industry, with respect to the speed of the conversion throughout time, and to the date of commencement of the new industrial projects with natural gas demand.

Figure 1.1: Regions and Localities under Study



1.7 The survey for the Ica and Junín regions took place in the month of July 2004, when the price of WTI crude was US$38/bbl. In the case of Cusco, the survey was conducted in the month of February 2005 when the price of WTI crude was US$50/bbl. The costs and benefits (for example, advantages related to storage and minor operational

[8] "Alternative estimate of residential natural gas demand for the areas of La Oroya-Tarma-Huancayo, Ica-Pisco-Marcona, and Ayacucho," incorporated into the Final Market Study Report. October 2004.

costs) were variables taken into account only in quality terms in the analysis and projection of the natural gas demand. Undoubtedly, the aggregate demand of natural gas will be on the basis of the price of crude and its byproducts, therefore sensitivity analyses were conducted on the economic valuations—Chapter 3.2.3—for different crude price scenarios. Subsequently, for general comparison purposes, the reference used in the economic price calculations of the energy sources was based on the assumption of US$40 per barrel of WTI crude.

1.8 With respect to the probable natural gas demand in electricity generation, the consulting firms CCR–Macroconsult take into consideration a scenario with a natural gas plant situated in the Ica Region, with a capacity of 150 MW. This has been incorporated into the projected natural gas demand for the region in two of the scenarios, as will be explained further below (Conservative and Optimist).[9] In addition, the consulting firms have considered a scenario with a natural gas thermal plant, situated in Quillabamba, with an effective power of 72 MW, plus an expansion of 50 MW by the year 2015, incorporated into the projected natural gas demand for the Cusco Region.

1.9 The demand of energy sources to be substituted for natural gas in the business and small industry sector has been estimated considering the universe of users that consume electricity. In the case of the Cusco Region, the entire universe of users not included in the survey conducted by CCR is considered potential natural gas consumers for the projects. In addition, for users with no electricity, the current average energy consumption per unit was used as base data for the substitution with natural gas (LPG, carbon, residual, and so forth) and a projection of potential demands was performed assuming a penetration factor in time, extrapolating later the composition of the number of businesses and small industries within the population universe.

1.10 Although in the CCR–Macronsult study, the consulting firm made estimates of the residential demand, R. García Consultores deemed it appropriate to use an alternative model to estimate the demand in this sector, incorporating the potential effect of the use of heating[10] especially in the mountain areas comprised in the Junín–Ayacucho and Cusco projects.

1.11 With respect to the VNG demand, projections[11] were performed, based on the number of vehicles in the regions, in addition to factors such as the relative location of the cities, predominant activity, closeness to other localities, traffic type and flow. In any case, it is worth clarifying that the VNG demand included in the economic–financial

[9] The selection of the commencement date of the new natural gas thermal station in the Ica region in 2007-8 responded to the following reasons: a) The growth of the electricity demand and the dispatch economic model conclude that it is necessary to have a new station during that period; b) ProInversión has stated its interest in promoting the entry of a new stations in Pisco as part of the concession strategy for the distribution of natural gas; c) Some operators are already inquiring into entry requirements.

[10] "Alternative estimate of residential natural gas demand for the areas of La Oroya–Tarma–Huancayo, Ica–Pisco–Marcona, and Ayacucho", incorporated into the Final Market Study Report. October 2004.

[11] "Estimate of the VNG" estimated into the Final Market Study Report. October 2004 for Junín and Ica and the Final Market Study Report. April 2005 for Cusco.

appraisal only incorporates the consumption projected for the number of vehicles in the localities considered to have potential for the development of VNG.[12]

Figure 1.2: Location of Main Industries in the Regions under Study

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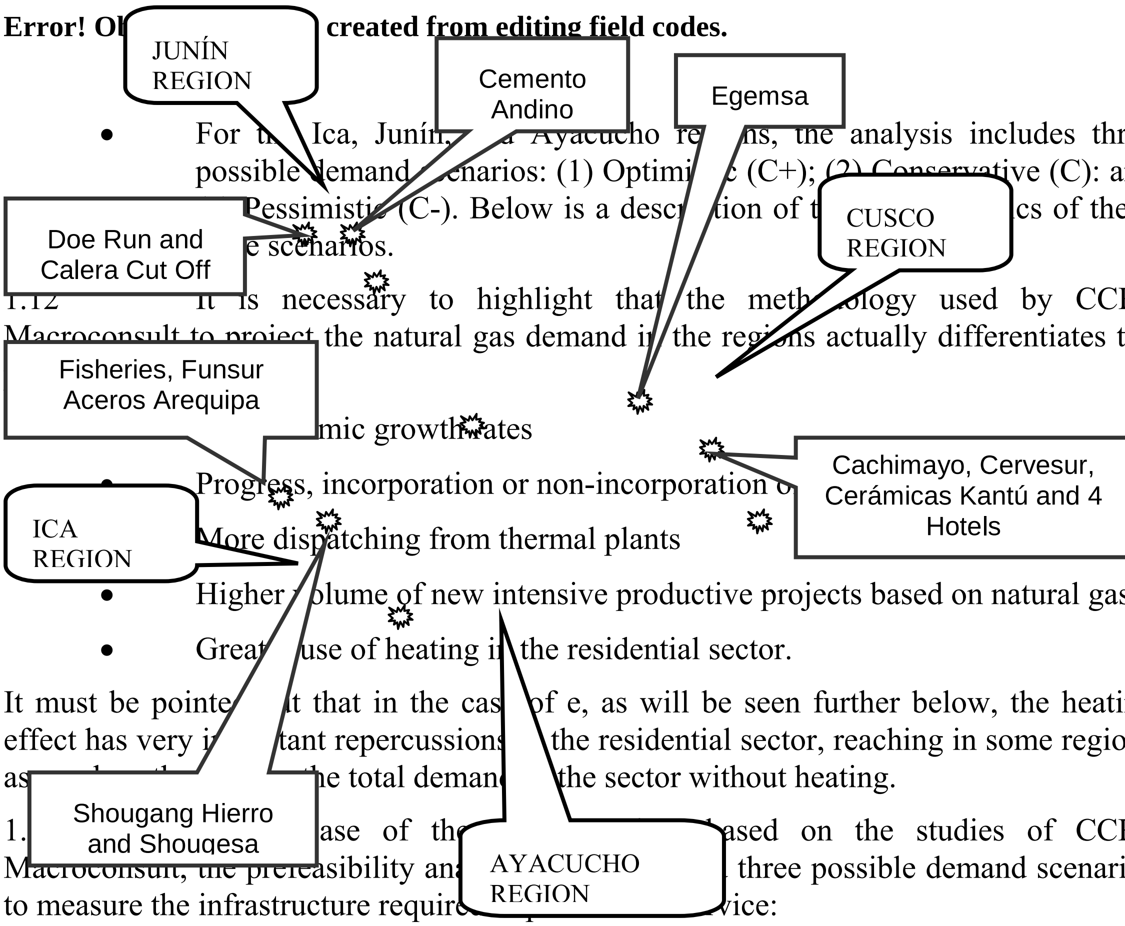


- For t… Ica, Junín, … Ayacucho re…ns, the analysis includes three possible demand scenarios: (1) Optimi…c (C+); (2) Conservative (C): and … Pessimistic (C-). Below is a descr…tion of t… cs of these …e scenarios.

1.12 It is necessary to highlight that the meth…ology used by CCR–Macroconsult to project the natural gas demand in the regions actually differentiates the … mic growth rates

- Progress, incorporation or non-incorporation o…
- More dispatching from thermal plants
- Higher volume of new intensive productive projects based on natural gas,
- Great… use of heating in the residential sector.

It must be pointe… t that in the cas… of e, as will be seen further below, the heating effect has very i… tant repercussions … the residential sector, reaching in some regions as … the total deman… the sector without heating.

1. … ase of th… ased on the studies of CCR–Macroconsult, the prefeasibility an… three possible demand scenarios to measure the infrastructure require… vice:

- Scenario I: Cusco and Cachimayo
- Scenario II: Cusco, Cachimayo, and Quillabamba
- Scenario III: Cusco, Cachimayo, Quillabamba, and Combapata

Results

Projections of Natural Gas Consumption

1.14 According to the assumptions made in the previous section, below are demand estimates for the Junín, Ica, and Ayacucho regions, for the conservative scenario, and for three specific times during the period under analysis: (i) Start (2007) (ii) Middle (2015) and (iii) End of Period (2025).

[12] Localities considered: Huancayo, Ica, Pisco, and Cusco.

1.15 In the Ica and Junín regions, large customer demand represents 93 percent and 90 percent, respectively, of the projected demand in conservative scenarios for those regions, taking as a reference the year 2025. Furthermore, in the Ica Region, the demand for electricity will represent 35 percent of the total demand from large customers. However, no potential consumption from large customers has been identified in the Ayacucho Region. The demand from this region is comprised of consumption from residential customers, businesses, and small industries.

1.16 Concerning the VNG market, it would be most important in the Junín Region (with Huancayo as its main hub) although it will be available in Ica as well. For VNG estimates, only the consumption of vehicles from each area of influence has been considered. The potential consumption of regions will be higher as long as the vehicle transit between these two markets and the Lima Region, which comprises around 65 percent of the total vehicles, is considered.

Table 1.1: Demand Scenarios for the Ica, Junín, and Ayacucho Regions

Type of User	*Criteria*	*Scenarios*		
		C+	*C*	*C-*
Main Customers	Investment Projects	Direct Reduced Iron : 20 MMCFD	Direct Reduced Iron : 15 MMCFD	There is no Direct Reduced Iron plant
		Factor of Shougesa Plant: 50–30%	Factor of Shougesa Plant: 40–70%	Factor of Shougesa Plant: 30–70%
		Start-up of New TS in Pisco: 2007	Start-up of New TS in Pisco: 2007	New TS is not located in Pisco
	Growth rates	Long-term rates plus 0.5%	Long-term rates	Long-term rates minus 1%
Businesses and Small Industries	Growth of the area	Long term GDP rates plus 0.5%	Long-term GDP rates[b]	Long-term GDP rates minus 1%
Residential	Heating effect	With heating effect in 100% of connected users	With heating effect in % of connected users	Without heating effect
VNG	% number of vehicles using gasoline	Sole penetration scenario		

[a] The growth of the NG demand of main customers is basically explained by the annual sequence of the years when the conversion of operational systems to NG was started. For 2005 only the consumption of Funsur y Aceros Arequipa (situated in the Pisco area) is available, amounting to 2 MMCFD. Assuming that the NG will get to Ica, Pisco and Marcona in 2006, the NG demand will be 31 MMCFD taking into consideration a conservative scenario. Between 2006 and 2010, the potential demand continues to grow, at rates higher than 30 percent and then slows down reaching average annual rates of 3 percent between the years 2010 and 2020.

[b] The growth of the NG demand for businesses and small industries is determined by the GDP pattern for the geoGraph area, the year when the NG reaches the areas under study and the market penetration pace.

Table 1.2: Scenarios of Demand and Possible Infrastructure for the Cusco Region (Infrastructure Amount: III >II >I)

Demand	*Infrastructure Scenario*		
	I	*II*	*III*
Cusco + Cachimayo (D1)	D1	D1	D1
		+	+
Quillabamba (D2)		D2	D2
			+
Combapata (D3)			D3

1.17 The inclusion of the heating effect in the residential sector causes a very significant increase in the total demand of said sector for all regions. Taking the year 2025 as a reference, it can be observed that the residential demand with heating represents 227 percent of the "base" residential demand.

1.18 Tables 1.3 to 1.7 show the natural gas demand for the Junín, Ica, and Ayacucho regions; in the three proposed scenarios and for years 2007, 2015 and 2025.

Table 1.3: Projection of Demand by Consumer Sector in Conservative Scenario Junín Region

Sector			*2007*	*2015*	*2025*
Large users		Consumption in MMCFD	18.4	35.2	47.3
		% of Total (Resid. Base)	97	90	90
Businesses and small industries		Consumption in MMCFD	0.1	1.4	2.1
		% of Total (Resid. Base)	1	3	4
VNG		Consumption in MMCFD	0.3	1.9	2.4
		% of Total (Resid. Base)	2	5	5
Residential	Base	Consumption in MMCFD	0.1	0.6	0.9
		% of Total (Resid. Base)	1	2	2
	ΔHeating	Consumption in MMCFD	0.4	1.9	2.7
		% of Total (Resid. ΔHeating)	2	5	5
Total (considering the residential demand Base)			19.0	39.1	52.7
Total (considering the residential demand with heating)			19.2	40.3	54.5

Table 1.4: Projection of Demand by Consumer Sector in Conservative Scenario Ica Region (excluding Nazca/Marcona)

Sector			*2007*	*2015*	*2025*
Large users		Consumption in MMCFD	15.1	44.0	58.6
		% of Total (Resid. Base)	97	93	93
Businesses and small industries		Consumption in MMCFD	2.0	2.0	3.0
		% of Total (Resid. Base)	1	4	5
VNG		Consumption in MMCFD	0.1	0.8	0.1
		% of Total (Resid. Base)	–	–	–
Residential	Base	Consumption in MMCFD	0.2	0.5	0.6
		% of Total (Resid. Base)	1	1	1
	ΔHeating	Consumption in MMCFD	0.2	0.6	0.9
		% of Total (Resid. ΔHeating)	1	1	1
Total (considering the residential demand Base)			15.6	47.2	63.3
Total (considering the residential demand with heating)			15.7	47.4	63.5

Table 1.5: Projection of Demand by Consumer Sector in Conservative Scenario Ayacucho Region

Sector			*2007*	*2015*	*2025*
Large users		Consumption in MMCFD	0.0	0.0	0.0
		% of Total (Resid. Base)	–	–	–
Businesses and small industries		Consumption in MMCFD	0.0	0.4	0.6
		% of Total (Resid. Base)	41	69	70
VNG		Consumption in MMCFD	0.0	0.0	0.0
		% of Total (Resid. Base)	–	–	–
Residential	Base	Consumption in MMCFD	0.0	0.2	0.3
		% of Total (Resid. Base)	59	31	30
	ΔHeating	Consumption in MMCFD	0.1	0.4	0.5
		% of Total (Resid. ΔHeating)	75	49	48
Total (considering the residential demand Base)			0.1	0.6	0.9
Total (considering the residential demand with heating)			0.1	0.8	1.1

Table 1.6: Projection of Total Demand by Consumer Sector in Conservative Scenario—Ica, Junín, and Ayacucho Regions

Sector			*2007*	*2015*	*2025*
Large users		Consumption in MMCFD	33.5	79.1	106.0
		% of Total (Resid. Base)	97	91	91
Businesses and small industries		Consumption in MMCFD	0.3	3.7	5.6
		% of Total (Resid. Base)	1	4	5
VNG		Consumption in MMCFD	0.4	2.7	3.4
		% of Total (Resid. Base)	1	3	3
Residential	Base	Consumption in MMCFD	0.3	1.3	1.8
		% of Total (Resid. Base)	1	1	2
	ΔHeating	Consumption in MMCFD	0.7	2.9	4.1
		% of Total (Resid. ΔHeating)	2	3	3
Total (considering the residential demand Base)			34.6	86.9	11.8
Total (considering the residential demand with heating)			35.0	88.5	119.2

1.19 The project for the laying of natural gas trunklines to the localities included in the Economic–Financial Prefeasibility Analysis (excluding Nazca and Marcona) will make it possible to supply, by the horizon year (2025) an average annual demand of approximately 120 MMCFD in the conservative scenario. For the same year, it can be noted that the Ica Region will constitute 53 percent of the total demand of the regions, followed by the Junín Region, which will account for 46 percent. In addition, it should be observed that the optimist and pessimist demand scenarios are between 20 percent above and 40 percent below, respectively, of the level projected for the conservative scenario. The scenarios also show the natural gas demand projected for the localities of Nazca and Marcona,[13] which is basically comprised of two large industrial customers.

Table 1.7: Projection of Total Demand in All Scenarios Ica, Junín, and Ayacucho Regions (in MMCFD)

Region	*2007*			*2015*			*2025*		
	C-	*C*	*C+*	*C-*	*C*	*C+*	*C-*	*C*	*C+*
La Oroya	7.3	7.5	7.7	19.2	21.5	22.8	23.5	28.9	32.2
Tarma	10.6	11.0	11.2	12.6	14.2	15.2	15.5	19.1	21.4
Huancayo	0.5	0.7	1.1	3.5	4.7	6.2	4.8	6.4	8.7
Sub-total Junín Region	*18.4*	*19.2*	*19.9*	*35.4*	*40.3*	*44.2*	*43.8*	*54.5*	*62.3*
Pisco	14.9	15.3	27.6	17.1	45.8	53.8	19.2	61.3	74.7
Ica	0.3	0.4	1.4	1.4	1.6	4.6	1.9	2.2	6.4
Sub-total Ica Region	*15.2*	*15.7*	*29.0*	*18.5*	*47.4*	*58.4*	*21.1*	*63.5*	*81.1*
Ayacucho	0.1	0.1	0.2	0.5	0.8	1.1	0.8	1.1	1.6
Sub-total Ayacucho Region	*0.1*	*0.1*	*0.2*	*0.5*	*0.8*	*1.1*	*0.8*	*1.1*	*1.6*
Total	*33.6*	*35.0*	*49.1*	*54.4*	*88.5*	*103.7*	*65.7*	*119.2*	*145.0*
Marcona	17.5	20.1	22.5	20.1	25.2	29.5	23.8	30.9	34.8
Nazca	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4
Total	*51.3*	*55.2*	*71.7*	*74.7*	*113.9*	*133.4*	*89.8*	*150.4*	*180.1*

1.20 For the case of the Cusco Region, Table 1.13 shows natural gas demand estimates for the localities of Cusco, Quillabamba, Cachimayo, and Combapata, and for three specific times of the period under analysis: (i) Start (2007) (ii) Middle (2015) and (iii) End of Period (2025). The projection to 2007 assumes that important investment decisions were made to make these projects possible. A relevant factor is that in the localities of the region, the large customers' demand represents between 98 percent and 90 percent of the projected demand of the conservative scenario for those regions, taking years 2007 and 2025 as a reference, respectively. In addition, it must be highlighted that in the locality of Quillabamba, the demand for electricity generation represents almost 100 percent of the total demand from that locality.

[13] As explained above, the demand of these districts was not included in the subsequent analysis.

Table 1.8: Projection of Demand by Consumer Sector in Conservative Scenario Localities of Nazca and Marconaco

		Sector	*2007*	*2015*	*2025*
Large users		Consumption in MMCFD	20.1	25.0	30.7
		% of Total (Resid. Base)	99	99	98
Businesses and small industries		Consumption in MMCFD	0.1	0.3	0.4
		% of Total (Resid. Base)	0	1	1
VNG		Consumption in MMCFD	0.0	0.0	0.0
		% of Total (Resid. Base)	0	0	0
Residential	Base	Consumption in MMCFD	0.0	0.1	0.1
		% of Total (Resid. Base)	0	0	0
	ΔHeating	Consumption in MMCFD	0.0	0.1	0.1
		% of Total (resid. Δ Heating)	0	0	0
Total (considering the residential demand Base)			20.2	25.4	31.2
Total (considering the residential demand with heating)			20.2	25.4	31.2

1.21 In the locality of Cusco, since there are no industrial consumers, consumption by business and small industry customers is more relevant, followed by residential consumption. The heating purposes of natural gas will be very important for residential consumption in the Ayacucho, Junín, and Ica regions, since its inclusion would triple the original demand of natural gas by the sector in the Cusco region.

1.22 The VNG market will be more important in the locality of Cusco (the main city in the region).

Table 1.9: Projection of Demand by Consumer Sector—City of Cusco

		Sector	*2007*	*2015*	*2025*
Large users		Consumption in MMCFD	0.3	0.4	0.5
		% of Total (Resid. Base)	50	13	13
Businesses and small industries		Consumption in MMCFD	0.1	1.4	2.1
		% of Total (Resid. Base)	19	54	56
VNG		Consumption in MMCFD	0.1	0.4	0.5
		% of Total (Resid. Base)	10	14	13
Residential	Base	Consumption in MMCFD	0.1	0.4	0.5
		% of Total (Resid. Base)	20	18	18
	ΔHeating	Consumption in MMCFD	0.3	1.4	2.0
		% of Total (resid. Δ Heating)	42	39	39
Total (considering the residential demand Base)			0.5	2.6	3.7
Total (considering the residential demand with heating)			0.7	3.5	5.0

Table 1.10: Projection of Demand by Consumer Sector—Cachimayo

Sector			*2007*	*2015*	*2025*
Large users		Consumption in MMCFD	5.8	7.3	9.9
		% of Total (Resid. Base)	100	100	100
Businesses and small industries		Consumption in MMCFD	0.0	0.0	0.0
		% of Total (Resid. Base)	0	0	0
VNG		Consumption in MMCFD	0.0	0.0	0.0
		% of Total (Resid. Base)	0	0	0
Residential	Base	Consumption in MMCFD	0.0	0.0	0.0
		% of Total (Resid. Base)	0	0	0
	ΔHeating	Consumption in MMCFD	0.0	0.0	0.0
		% of Total (resid. Δ Heating)	0	0	0
Total (considering the residential demand Base)			5.8	7.3	9.9
Total (considering the residential demand with heating)			5.8	7.3	9.9

Table 1.11: Projection of Demand by Consumer Sector—Quillabamba

Sector			*2007*	*2015*	*2025*
Large users		Consumption in MMCFD	8.2	16.6	22.1
		% of Total (Resid. Base)	100	99	99
Businesses and small industries		Consumption in MMCFD	0.0	0.1	0.1
		% of Total (Resid. Base)	0	0	1
VNG		Consumption in MMCFD	0.0	0.0	0.0
		% of Total (Resid. Base)	0	0	0
Residential	Base	Consumption in MMCFD	0.0	0.1	0.1
		% of Total (Resid. Base)	0	0	0
	ΔHeating	Consumption in MMCFD	0.0	0.1	0.1
		% of Total (resid. Δ Heating)	0	0	0
Total (considering the residential demand Base)			8.2	16.7	22.3
Total (considering the residential demand with heating)			8.2	16.7	22.3

1.23 For the localities included in the Economic-Financial Prefeasibility Analysis for the Cusco Region (excluding Combapata) the pipeline would make it possible to supply by the horizon year (2025) an average annual demand of approximately 37.2 MMCFD in the CCR-Macroconsult conservative scenario. For that same year, it could be observed that the Quillabamba consumption represents 60 percent of the total demand for the localities, followed by Cachimayo with 26 percent and finally Cusco, which accounts for 14 percent of the regions.

Table 1.12: Projection of Total Demand by Consumer Sector in Scenario II Cusco Region (Cusco, Cachimayo, and Quillabamba)

Sector			2007	2015	2025
Large users		Consumption in MMCFD	14.3	24.3	32.5
		% of Total (Resid. Base)	98	91	90
Businesses and small industries		Consumption in MMCFD	0.1	1.5	2.2
		% of Total (Resid. Base)	1	6	6
VNG		Consumption in MMCFD	0.1	0.4	0.5
		% of Total (Resid. Base)	0	1	1
Residential	Base	Consumption in MMCFD	0.1	0.5	0.8
		% of Total (Resid. Base)	0	2	2
	ΔHeating	Consumption in MMCFD	0.3	1.4	2.1
		% of Total (resid. Δ Heating)	2	5	6
Total (considering the residential demand Base)			14.5	26.7	35.9
Total (considering the residential demand with heating)			14.8	27.6	37.2

1.24 Table 1.13 shows projected total demand, including expected consumption for the area of Combapata, which includes demand from large industrial projects that are not yet completed. The demand from these districts was not included in the subsequent analysis.

Table 1.13: Projection of Total Demand per Consumer Sector—Cusco Region (Cusco, Cachimayo, Quillabamba, and Combapata)

Sector			2007	2015	2025
Large users		Consumption in MMCFD	14.3	43.5	59.3
		% of Total (Resid. Base)	98	95	95
Businesses and small industries		Consumption in MMCFD	0.1	1.5	2.2
		% of Total (Resid. Base)	1	3	4
VNG		Consumption in MMCFD	0.1	0.4	0.5
		% of Total (Resid. Base)	0	1	1
Residential	Base	Consumption in MMCFD	0.1	0.5	0.8
		% of Total (Resid. Base)	1	1	1
	ΔHeating	Consumption in MMCFD	0.3	1.4	2.1
		% of Total (resid. Δ Heating)	2	3	3
Total (considering the residential demand Base)			14.5	45.9	62.8
Total (considering the residential demand with heating)			14.8	46.8	64

1.25 Table 1.14 summarizes the natural gas volumes projected for the three scenarios to supply the demand of the Cusco Region.

Table 1.14: Projection of Total Demand in the Three Supply Scenarios Cusco Region (in MMCFD)

Demand Scenarios	*2007*	*2015*	*2025*
Cusco + Cachimayo	6.5	10.9	14.9
Cusco + Cachimayo + Quillabamba	14.8	27.6	37.2
Cusco + Cachimayo + Quillabamba + Combapata	14.8	46.8	64.0

1.26 *Projections of Natural Gas Users*: Projected users by consumer sector and by region are shown in Table 1.16. The users connected in the residential sector arise from the household penetration scenario determined in the final Demand Report.[14] VNG user projections come from the projected gas stations of the different localities.[15] The estimates of users for the remaining consumer categories arise from the CCR–Macroconsult Demand Study.

Conclusions of Projected Demand for the Regions

1.27 The current and potential demand for natural gas in the regions is explained, above all, by the large industrial customers and their new and substitution projects. These customers are only 24 in total, of which 11 belong to Cusco. Industrial customers represent approximately 90 percent of the total consumption of the regions under analysis for the year 2025. There are three important factors, which must be highlighted with respect to the sector's projected demand:

- High prices of alternative/competing energy sources are a positive factor or "driver," which will boost natural gas demand. An exception to this is Cachimay–Cusco industry, where the nitrates plant will switch to electricity, which has a price that is not directly linked to that of crude oil.
- Natural gas demand projected for this sector will be influenced by any risks which may occur by time lag or delays in conversions or in the building of new projects.
- The projected large customers demand in the Cusco Region will be strongly dependent on a single user (Cachimayo Nitrates), which concentrates two-thirds of the Cusco node's demand (Cusco + Cachimayo).

1.28 If the new natural gas power station project to be located in the Ica Region materializes, it will have a significant influence on the region's demand (35 percent of the total). In addition, the new natural gas power station project to be located in Quillabamba would also have an important influence on the region's demand (35 percent of the total Cusco + Cachimayo + Quillabamba, to the 2015 horizon).

[14] "Alternative estimate of residential natural gas demand for the areas of La Oroya-Tarma-Huancayo, Ica-Pisco-Marcona, and Ayacucho", incorporated into the Final Market Study Report. October 2004.

[15] "Estimated VNG Demand," prepared by R. Garcia Consultores, October 2004.

1.29 The potential use of VNG is modest compared with the Lima market, which accounts for 65 percent of the total number of vehicles in the country. In any case, its potential will depend on the increase of VNG and traffic between Lima and those regions within the Lima–Ica section. The cities of Huancayo and Cusco have the potential to be a captive market.

1.30 The importance of the demand in the businesses and small industries sector has very little influence on the total, in spite of the many tourism-related activities in the City of Cusco, although they require a careful field study for better quantification.

1.31 The residential sector's demand, although not so significant in terms of volumes in the total, incorporates an important number of people (customers connected) into the service (over 100,000 in the case of the Ica, Junín, and Ayacucho regions, and more than 40,000 in the Cusco Region, by 2025) representing a substantial improvement in the standard of living, as society can consume a cheaper source of energy, even when consuming needs which are not currently being met (that is heating in the highlands region).

Table 1.15: Projection of Users by Region and Consumer Sector—Cusco Region

Sector	*2007*	*2015*	*2025*
Residential	6,533	28,413	40,903
Business and small industries	78	1,045	1,532
Large users	11	11	11
VNG	0	3	3
Total Region	6,622	29,472	42,449

Table 1.16: Projection of Users by Region and Consumer Sector
Ica, Junín, Ayacucho Regions and Localities of Marcona and Nazca

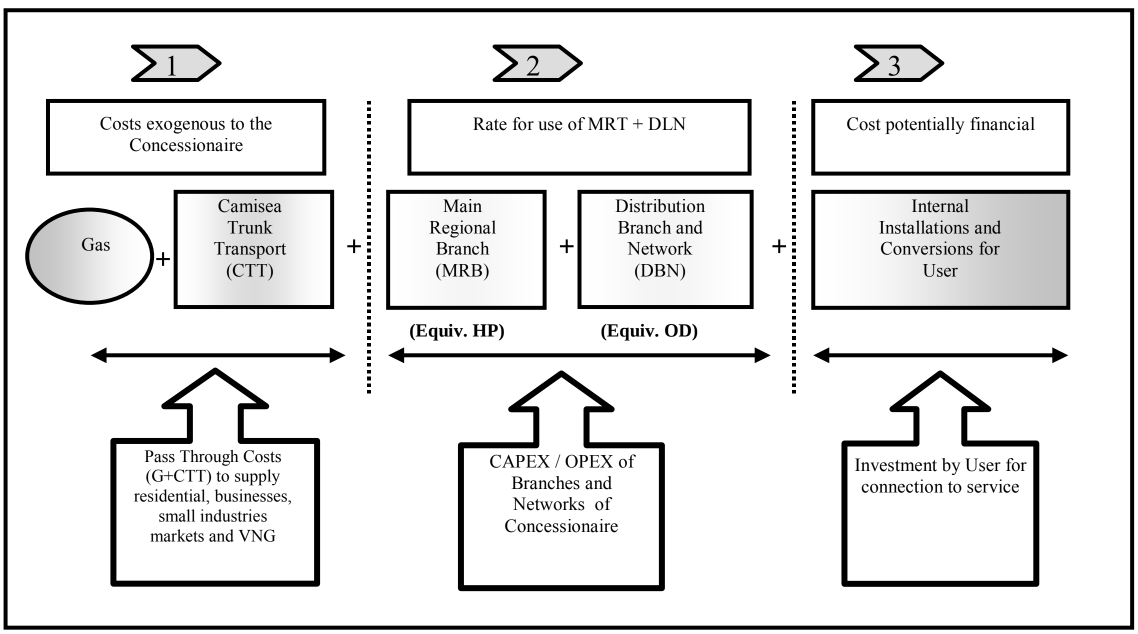
Region	*Consumer sector*	*2007*	*2015*	*2025*
Junín	Residential	7,819	34,010	48,959
	Businesses and small industries	27	332	498
	Large users	3	3	3
	VNG	2	9	12
	Total Region	7,851	34,353	49,472
Ica	Residential	8,687	24,934	34,684
	Businesses and small industries	63	634	961
	Large users	10	11	11
	VNG	1	5	5
	Total Region	8,761	25,584	35,661
Ayacucho	Residential	2,208	9,602	13,823
	Businesses and small industries	29	269	403
	Large users	0	0	0
	VNG	0	0	0
	Total Region	2,237	9,871	14,226
Total	Residential	18,714	68,546	97,466
	Businesses and small industries	119	1,235	1,862
	Large users	13	14	14
	VNG	3	14	17
	Total Region	18,849	69,809	99,359
Marcona and Nazca	Residential	1,077	3,092	4,301
	Businesses and small industries	83	140	182
	Large users	2	2	2
	VNG	0	0	0
	Total Region	1,162	3,233	4,484
Grand total (Ica, Junín, Ayacucho, Marcona, Nazca)	Residential	19,791	71,638	101,767
	Businesses and small industries	202	1 374	2 044
	Large users	15	16	16
	VNG	3	14	17
	Total Region	20,011	73,042	103,843

2

Cost of Supplying Natural Gas to the Regions Structure of Cost of Supply to Final User

2.1 The cost of supplying natural gas to the regions is equal to the addition of the costs of every activity or segment along the value chain from the wellhead up to the delivery of the natural gas to the final consumer (residential, businesses, small industries, VNG, large customers). Figure 2.1 depicts the structure of the natural gas delivery service in the regions. The economic and financial evaluation of the new businesses to be given concessions to provide natural gas delivery service is based on this structure.

Figure 2.1: Composition of Costs for the Supply of Natural Gas within Peru



2.2 Synthetically, the cost of service of the new regional concessions will be comprised of investment (CAPEX) and operational costs, as well as of maintenance, administrative and merchandising (OPEX) costs associated with the provision of the natural gas supply service (Stage 2).

- CAPEX: the companies will be responsible for the execution of investments in the infrastructure of the Main Regional Trunklines (MRT) and Distribution Trunklines and Networks (DLN).
- OPEX: the concessionaires for the commercial exploitation of their businesses will assume operational and maintenance costs of trunklines, plus administrative and merchandising costs to deliver the natural gas to the final user.

2.3 Figure 2.1 shows costs under Stage 1 which are exogenous to the behavior of the new concessionaires in the regions. Among these costs there are the natural gas price at the wellhead and its transportation to the point of interconnection of the new regional trunklines with the Camisea Trunk Transport (CTT). Under a procedure known as "pass-through," the cost of natural gas and the approved transportation rates will be passed on by the concessionaire to the users. These users are those who will be buying the service from the new concessionaires as a package, including: natural gas price, CTT rate, and the rates for the use of MRT and DLN.[16]

2.4 To complete the cost of service to be assumed by the final natural gas user, it is necessary to add the costs (Stage 3) to be directly assumed by each of the consumers in order to gain access to the service. These costs include investments in internal installations, process conversions, and natural gas driven devices.

Technical Design of Regional Natural Gas Supply Projects

Main Regional Trunklines (MRT)

2.5 In the respective Technical Study[17] the tentative route of the regional trunklines for the supply of the localities under study were analyzed from a point of view of design,[18] construction, preliminary environmental impact, and hydraulic studies. This identified the tentative route of the regional trunkline for the Ica and Cusco Regions and two alternative designs for the supply of the Ayacucho, Junín, and Ica regions, identified as Alternatives 1 and 2.

2.6 Figures 2.2 and 2.3 identify the tentative routes (Alternatives 1 and 2, respectively) following the main trunklines to supply Ayacucho and Junín, which will connect with the Camisea CTT at different diversion points along it; and Figure 2.4 schematically presents the Main Regional Trunkline (MRT) to supply the different

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[16] In the case of Cusco it comprises all categories except large customers who would buy the natural gas and assume transportation costs at their own account.

[17] *Reports of Design Bases and Hydraulic Studies of the Extension of Natural Gas Pipelines within Peru, October 2004*, and *Reports of Design Bases and Hydraulic Studies of the Extension of Natural Gas Pipelines within Peru*, April 2005.

[18] The technical design of the MRT (lengths and diameters) arises from the results contained in the Hydraulic Studies prepared by Intec-Arcan, where main branches were configured according to the projected flows for the period 2005-2025, considering: (i) The Market Study for the Ayacucho, Junín, Ica and Cusco Regions. (ii) The demands furnished by Proinvestment for Limas and Cusco Regions. (iii) The pressures guaranteed in the CTT that must be satisfied in time (furnished by Proinvestment).

demand nodes of the Cusco Region demand (Cusco + Cachimayo; Quillabamba; Combapata).

Figure 2.2: MRT Route for Alternative 1—Junín and Ayacucho Regions

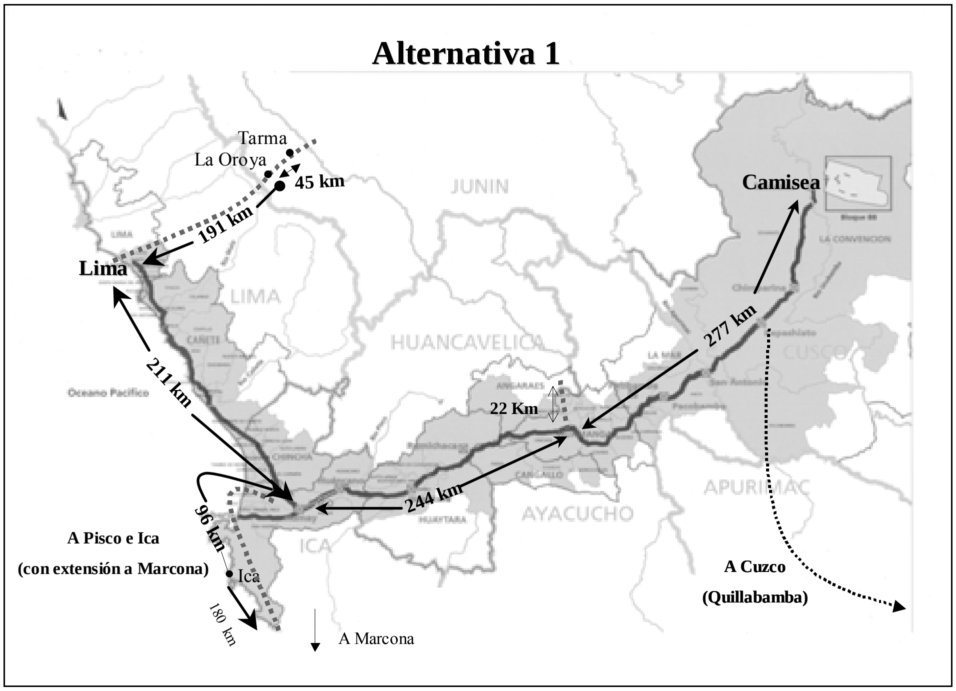


Figure 2.3 MRT Route for Alternative 2
Junín and Ayacucho Regions

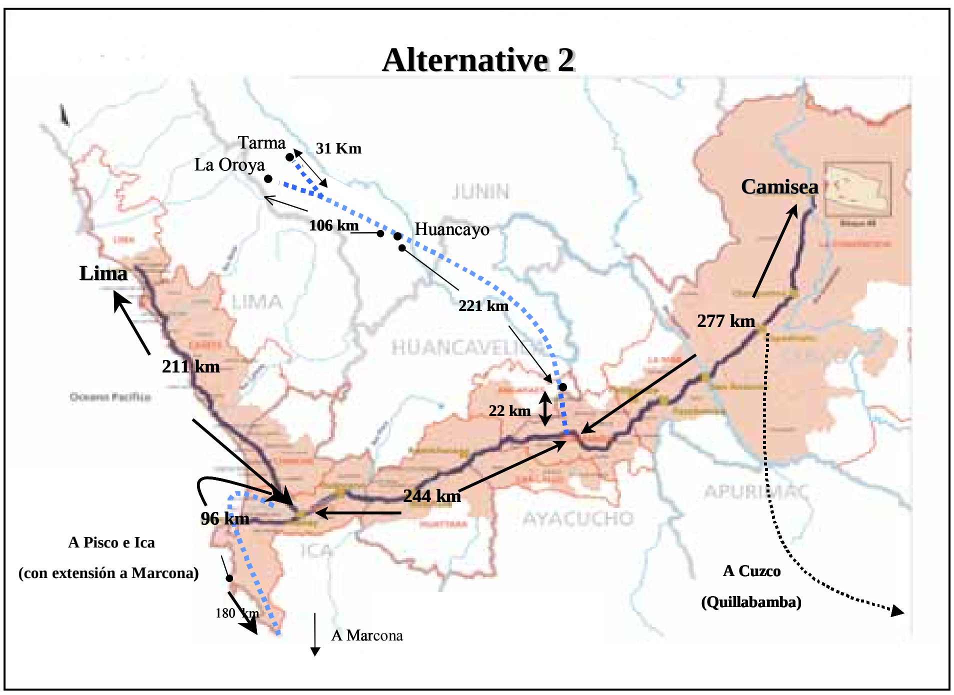
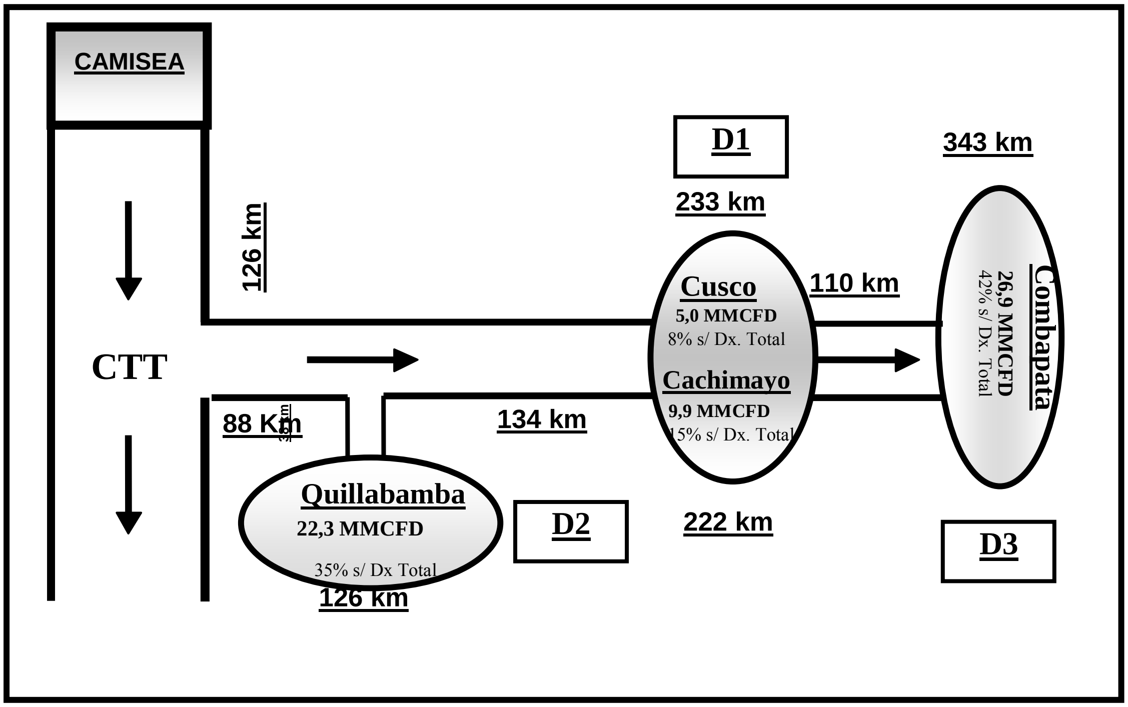


Figure 2.4: MRT Route Scheme—Cusco Region



2.7 Figure 2.4 is a detailed configuration of the MRT by region, taking into consideration the above-mentioned alternatives for Junín and Ayacucho and the routes identified for Ica and Cusco.

MRT—Ica Region

Description of Pipeline Route

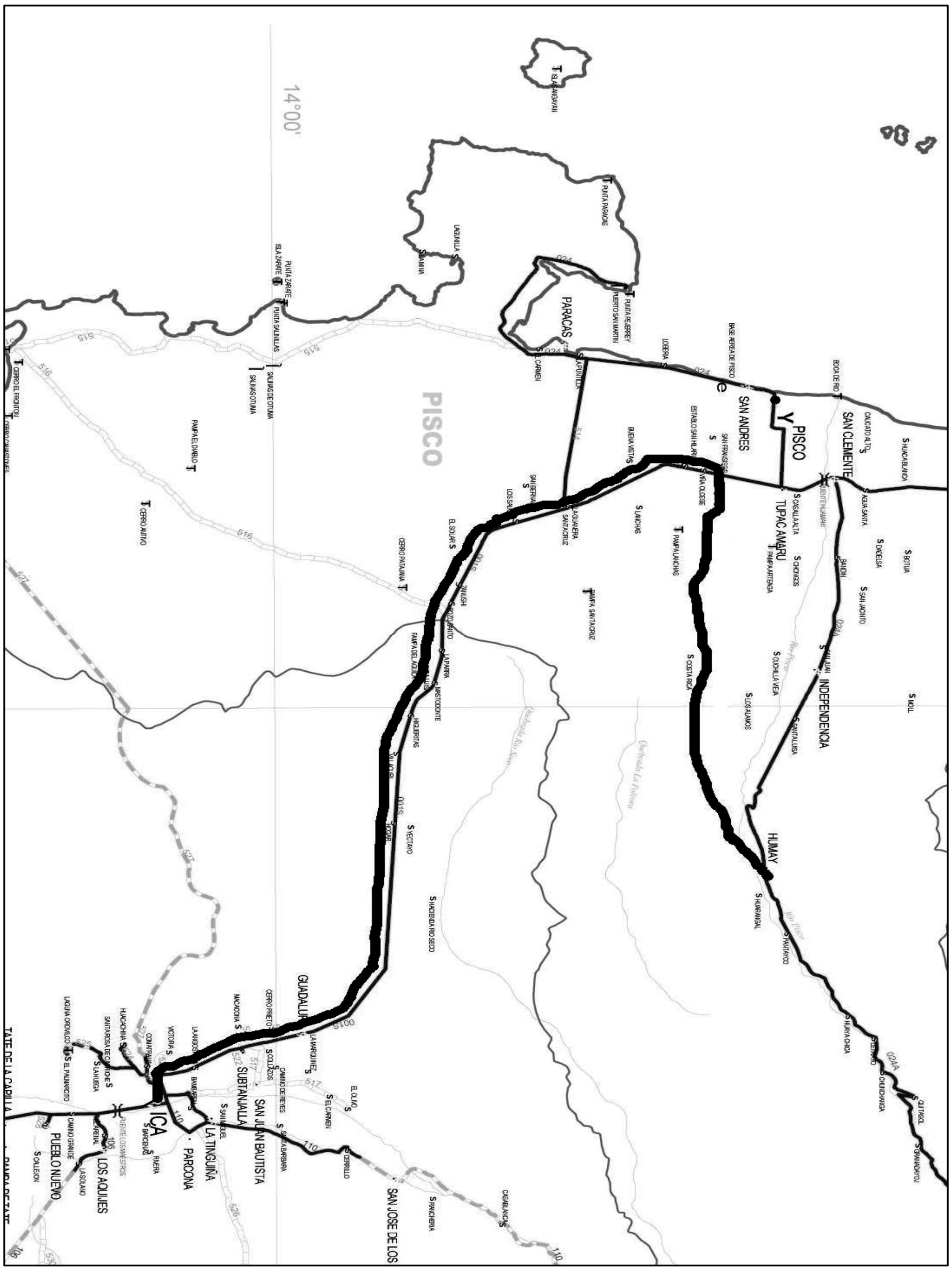
2.8 The market in the Ica Region would be supplied by a 96 km. long and 10–inch diameter MRT,[19] in either of the routes considered (Alternatives 1 or 2). For the evaluation of this section it was considered advisable to take advantage of a 30 km survey line (construction area) of an existing gas pipeline, with a starting point in the Scraper Trap of the Camisea Gas Pipeline as far as the intersection with the South Pan-American Highway.

2.9 The corridor created by this trunkline would go as far as the area near the steel industries located over the South Pan-American Highway in the Pisco area. This area was considered to be the most suitable for the installation of the Pisco City Gate, whereas the route would continue toward Ica, running parallel to the South Pan-American Highway along the right of way.

[19] "Bases for theDesign Nº 81041030-00-000-MDG-1002 Rev. A", Plans of Drawing, Scala 1:25000 (amount: 7) and Typical Plans (amount: 8) October 2004. The trunkline could have an extension to the market of Nazca-Marcona with a pipe of 180 km and a diameter of 10", aspects not considered in the analysis of prefeasibility performed. However, it may be noticed that the section of gas pipe from Humay until Ica includes the projected demand of the Nazca-Marcona market capacity.

2.10 This area is a desert with thick sand and shifting sand dunes, which could complicate the construction of the ditches due to the unstable nature of the slopes. Figure 2.5 shows the MRT Route for the Ica Region.

Figure 2.5: MRT Route for the Ica Region



Preliminary Environmental Study

2.11 This study contains the preliminary environmental and social analysis of the areas affected by the above-mentioned routes, based on the determination of critical environmental sites and the communities likely to be affected, in order to establish how viable the project is.

2.12 The first stage of the process included analyzing the cartoGraph material in order to evaluate possible alternatives. TopoGraph aero-photogrametric maps digitalized in 3D were obtained from the National GeoGraph System (NGI) on a scale of 1:100,000. There followed a 20-day working campaign on the site, expedited via contacts with regional governments. This campaign involved visits to each of the areas covered by the study, where the environmental, technical, and economic conditions that ensured the feasibility of the project were evaluated The analysis of the micro routes required to enhance the main routes will be analyzed during a second stage.

2.13 At relevant points, UTM geoGraph coordinates were taken with a Global Positioning System (GPS) to establish the correlation between the evaluated areas and the NGI maps.

2.14 Taken into consideration as part of the environmental conditions were the presence of archeological remains, potential risks of erosion, landslides, the existence of endemism in the wildlife, species in danger of extinction, population settlements, the degree of anthropoid disturbances, use of soil, and so forth

2.15 With this information, an analysis of the weighted aptitude of the route was made, based on relevant aspects and their environmental sensitivity. Then the most acceptable strips were studied in more detail and a photoGraph survey was conducted along the route of the strips that were considered more useful for the implementation of the project.

2.16 Table 2.1 shows the results obtained for the Ica Region.[20]

Hydraulic Study

2.17 The global hydraulic study of the transport system[21] revealed that natural gas could be supplied to the Ica Region until 2007, although the supply would not reach Pisco and Ica (which are considered separately) until subsequent years.

2.18 By 2007, the pressure values will largely exceed the minimum pressure guaranteed not only for the City Gate in Lurín, but also for all the other diversion points situated over the Camisea-Lima gas pipeline.

2.19 The supply of natural gas will continue to be viable until approximately 2010 (it must be stressed that the entire transport system is being analyzed) by which time all the established pressure and volumes will be complied with in all the cities in the system except Lima, where a 38 bar pressure will be achieved in the Lurín City Gate, which is slightly lower than the 40 bar pressure to be guaranteed in that point.

[20] "Preliminary Environmental Study No. 81041030-00-000-IAG-1001 Rev A", October 2004.

[21] "Hydraulic Study No. 81041030-00-000-RTZ-1001 Rev. A", October 2004.

Table 2.1: Weighted Grading of Environmental Aspects—Ica Region[22]

	Environmental Aspects	*Weighting*	*Grading (%)*	*Quantification (%)*
1.	Geology	5	100	5.00
2.	Soils	5	70	3.50
3.	Surface hydrology	9	100	9.00
4.	Vegetation	9	90	8.10
5.	Wildlife	6	95	5.70
6.	Ecosystems	11	95	10.45
7.	Preservation Areas	11	100	11.00
8.	Climate	2	100	2.00
9.	Agriculture	4	90	3.60
10.	Afforestation	3	80	2.40
11.	Mineral resources	3	100	3.00
12.	Settlements	11	70	7.70
13.	Transport	5	80	4.00
14.	Recreational. educational and religious areas	5	90	4.50
15.	Archaeology - Paleontology	11	100	11.00
GRAND TOTAL		**100**		**90.95**[b]

2.20 The above-mentioned analysis revealed that in order to comply with the minimum guaranteed pressure in the Lurín City Gate, the pressure in Humay must be raised so that the values are much higher than the 65 bar minimum guaranteed pressure in that point.

Investment Estimate

2.21 Based on the studies of the route, the preliminary environmental impact, the hydraulic study, and the technical–constructive feasibility analysis, estimates were made of the industrial cost of building the MRT in the Ica Region, considering a tentative work period of 140 consecutive days, including contingencies.

[22] For the interpretation of the data shown in table 2.1, the following should be considered:

a Grading of Environmental Aspects	Environmental Sensitivity	b Global Grading (Total)	Environmental Viability of the Project
80 to 100%	Low	80 to 100%	Viable
60 to 80%	Average	60 to 80%	Viable but requires further analysis of unfavorable variables.
Less than 60%	High	Less than 60%	Not viable

Table 2.2: Investment Estimate—Ica Region

Item	*Amount in US$*
Direct labor	1,805,087
Indirect labor	178,123
Materials and surface installations	10,412,288
Equipment	1,579,800
Overheads	1,067,380
Total Industrial Cost	15,042,678

Relevant Aspects

2.22 The selected route proved viable in terms of its environmental aspects, design, and technical–constructive feasibility, the following being the most prominent aspects:

- The route runs parallel to existing corridors such as the Pan-American Highway, the existing gas pipeline, and internal roads; therefore no new disturbances are created.
- New access roads will not be necessary during the construction and operating stages.
- Since the route follows the road circuit practically all the way, very few property owners are likely to be affected; as the corridor has already been disturbed. Potential wildlife endemism areas will not be affected.
- Private farms will experience virtually no interference in. No protected natural areas will be intercepted, nor any cultural or heritage sites. There was no evidence of any archaeological or paleontological sites.
- It is worth pointing out that the MRT could be extended to the Nazca–Marcona market via a 180 km long and 10-inch diameter gas pipeline. Although this had not been considered in the prefeasibility study, the design of the section of the pipeline from Humay to Ica includes the projected demand of the Nazca and Marcona markets.
- The majority of the evaluated route has a low environmental sensitivity rate. However, the presence of specific cases should not be discarded, such as the populations affected during the construction of the works. The risk of accidents tends to increase in urban areas and the lack of information could cause some conflicts. At the same time, however, the creation of jobs for local workers and the recovery of business opportunities during the construction stage will be a positive impact.
- Furthermore, this project will create an opportunity for gaining access to cleaner and more economic sources of energy like natural gas and will boost the growth of new industrial areas.

MRT—Junín Region—Alternative 1

Description of the Pipeline Route

2.23 The Junín market could receive natural gas through the MRT known as Lurín–La Oroya–Tarma with a total length of 236 km: 191 km at 12 inches, 31 km at 10 inches and 14 km at 6 inches.[23] This MRT was designed to satisfy the Huancayo demand, but it does not include the pipes to feed that locality.

- In the first section of the pipeline route the possibility of installing the future trunkline parallel to the existing one that runs from the Lurín "City Gate" to the crossing of the Evitamiento highway with the Lima–La Oroya railroad was considered to use the easement area or right of way, but the work of assembling the pipes in this area is highly complex.
- To continue with the route toward La Oroya, from the crossing of the aforesaid Evitamiento road and the railroad, the first section will use the physical space available from the property given in concession by the railroad company. This type of work was already tried by another construction company toward the Ventanillas sector. The works in this sector must be coordinated with personnel from the railroad company when the construction is to be carried out. The limited space existing between the railroad tracks and the urban construction's municipal line cause certain places to have some degree of complexity for pipe assembly works, as the task has to be done as an urban assembly work, with restricted progress and adequate protection on matters related to safety, due to the closeness of the railroad tracks. This section goes in the same manner until the point at km 77+700, where it is advisable, due to the prevailing conditions, to adopt mechanical protection for the pipe or larger cover, which could tentatively be at least 1.5 meters. The crossings appearing along this section are the conventional type; in other words, open, or with the use of drilling equipment (tunnels) with consideration also to be given to the possible existence of rock when crossing to a depth of two or more meters.
- Because of the limitation of the existing space for continuous assembly in the area near Los Ángeles (point at km 67+800), the pipeline route crosses the railroads twice; the places tentatively selected allow for such a situation, continuing from then on, with the assembly line on the northern side of the railroad. Having passed the localities of La Cantuta and Chosica, the pipeline continues along the asphalt and the road shoulder, which can be seen starting at km 77+800 and stretching for approximately 400 meters. This situation is caused by the scarce space available in the area.

[23] "Design Bases No. 81041030-00-000-MDG-1001 Rev. A," Route Blueprints Scale 1:25000 (quantity: 13) and Typical blueprints (quantity: 8), October 2004.

- From the point at km 81+300 to the point at km 114+000, the route follows the space existing between the Rimac River and the Central Highway, continuing through a dirt road and then over one of the banks of the Rimac River. In this area, to give further safety to the installation, it would be advised to provide an external mechanical protection to the pipe, such as concrete lining. The extra time required to carry out this work should be considered. The section of the route where it is estimated that the pipe must be reinforced with concrete starts at the point at km 85+000, to the point at km 91+150, approximately.
- From the point at km 91+850 to the point at km 94+900 of the route, it is estimated that the assembly of the pipe must be done in the vicinity of the chain of ditches and from the point at km 95+350 to the point at km 113+800, through the Rimac river valley.
- Continuing the route toward La Oroya to the point at km 190+900, where the La Oroya regulation and measuring station shall be built, there is a series of villages, settlements, and communities generally located on both sides of and near the Central Highway, and the Rímac River. These include, for example, Matucana, Huaripampa, Cacachaqui, Ocatapa, Tamboraque, and so forth. In addition, the Rímac river shores host recreational zones as well as a small, cultivated area. On the way to La Oroya, higher altitudes are encountered and the valley becomes narrower; at this point the sites of mining companies and the corresponding towns can be seen. The conditions of the route in this section are very peculiar, given the complexity of the land, crossing sectors where pipes must be installed near asphalt and water routes, which need to be crossed several times, and where—in general—the soil is rocky, in crossings as well as on the river bed, featuring unstable slopes as well. In many sectors, pipes will have to be lined with concrete for certain parts with a counterweight, while in others, pipes shall have adequate mechanical protection when being placed in ditches, which must be done using pneumatic drilling equipment or controlled blasting. These cases must consider the transport of fine material for the covering. In this section, this type of work must be done practically on a constant basis due to the existence of rock in ditches and fine material for the covering of the piping.
- From the point at km 130+200, to the point at km 140+700, the lack of physical space means that the pipeline route parallel to the Central Highway has to be diverted to the hill's slope, continuing on its upper surface (crest). Once the sector has been dealt with, through this deviation, the route returns to the Central Highway.
- Further ahead, in points at km 147+100 and km 161+100, two areas cross geological faults, where, at the detailed engineering stage, specific geological studies must be done, to make it possible to determine the desirable location of the route and the consequential procedure for the installation of the piping, taking into account—in particular—the

existence in the area of slopes with a high risk of sliding and extremely sensitive to erosion.

- *La Oroya Sector*: This urban area is embedded between hills with very vertical slopes and unstable rock. Houses are built along both sides of the river and over the gradients of the surrounding slopes. Consequently, the installation of the pipes going through the urban nucleus entails serious complications, and due to safety reasons its execution is highly improbable. Therefore, in order to prevent the inconveniences of this pipeline route within the city, it is advisable to access the city with low pressure, setting up the pressure measuring and regulation station on its outskirts.

- *La Oroya-Tarma Sector:* From the point at km 190+900, approximately, the route continues to the City of Tarma through the high peaks located north of La Oroya. The geography of the land in this sector is more favorable for the pipeline installation compared to the previous sectors, where construction can be accomplished using conventional methods and equipment. Most of the pipeline route is developed over soft slopes filled with natural pastures, passing near some populated communities.

- In the vicinity of Tarma, flower growing and horticulture are the most developed activities, to which effect the land has been modified to comprise the so–called intensive crop terraces. These areas need to be given special consideration in the construction process, particularly during its recomposition.

- A diversion to an important customer, the cement company, Cemento Andino, has been considered at km 222+140. The route was reviewed even though it is out of the original scope. The terrain leading to this point has characteristics similar to those described in the previous paragraph. Figure 2.6 shows the MRT Route for the Junín Region, Alternative 1.

Preliminary Environmental Study

2.24 Given the environmental differences between the Lurín–La Oroya section with respect to the La Oroya–Tarma section, it was decided to make two separate tables depicting their weighting effect,[24] using the methodology previously explained.

[24] "Preliminary Environmental Study No. 81041030-00-000-IAG-1001 Rev. A," October 2004.

Figure 2.6: MRT Route for the Junín Region—Alternative 1

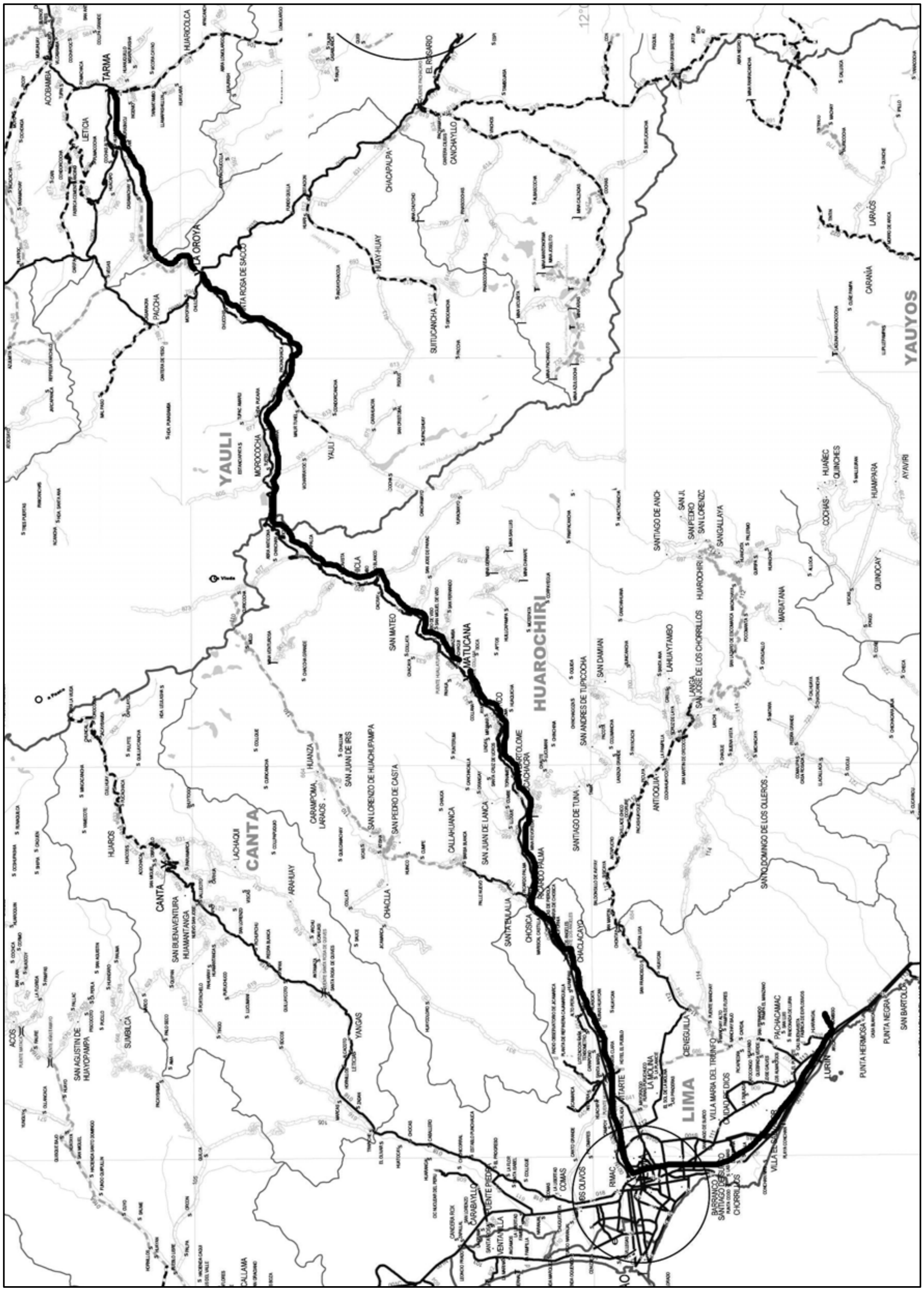


Table 2.3: Weighted Grading of Environmental Aspects for the Lurín–La Oroya Section

	Environmental Aspects	*Weighting*	*Grading*[a] *(%)*	*Quantification (%)*
1.	Geology	8	70	5.6
2.	Soils	9	60	5.4
3.	Surface hydrology	8	60	4.8
4.	Vegetation	7	70	4.9
5.	Wildlife	6	90	5.4
6.	Ecosystems	6	90	5.4
7.	Preservation areas	9	100	9.0
8.	Climate	2	100	2.0
9.	Agriculture	5	70	3.5
10.	Afforestation	3	80	2.4
11.	Mineral resources	3	90	2.7
12.	Settlements	11	60	6.6
13.	Transport	7	60	4.2
14.	Recreational. educational and religious areas	5	80	4.0
15.	Archaeology—Paleontology	11	100	11.0
GRAND TOTAL		**100**		**76.9**[b]

Table 2.4: Weighted Grading of Environmental Aspects for the La Oroya–Tarma Section[25]

	Environmental Aspects	*Weighting*	*Grading*[a] (%)	*Quantification (%)*
1.	Geology	5	90	4.50
2.	Soils	5	60	3.00
3.	Surface hydrology	8	90	7.20
4.	Vegetation	9	70	6.30
5.	Wildlife	6	90	5.40
6.	Ecosystems	11	90	9.90
7.	Preservation areas	11	100	11.00
8.	Climate	2	100	2.00
9.	Agriculture	5	70	3.50
10.	Afforestation	3	95	2.85
11.	Mineral resources	3	95	2.85
12.	Settlements	11	85	9.35
13.	Transportation	5	90	4.50
14.	Recreational. educational and religious areas	5	90	4.50
15.	Archaeology—Paleontology	11	100	11.00
GRAND TOTAL		**100**		**87.85**[b]

[25] For the interpretation of the data shown in tables 2.3 and 2.4, the information in footnote number 22 should be considered:

Hydraulic Study

2.25 The global hydraulic study of the transportation system[26] reveals that natural gas supply could be achieved only in the year 2007, when the pressure values exceed the minimum pressure to be guaranteed not only at the Lurín "City Gate" but also at the rest of the diversion points situated on the Camisea–Lima Pipeline.

2.26 The natural gas supply will continue to be viable up to the year 2010, even with the inconvenience of having to restrict the City of Lima's flow to a value equivalent to those of the years 2007 and 2008, in order to give the localities of La Oroya and Tarma a pressure of approximately 20 bar, which is considered reasonable for local industrial supply and for future extensions of this distribution trunkline.

2.27 In addition, the system's viability would continue up to the year 2010 even if the City of Lima's flow is restricted to the 2008 level, but the difference from the previous case is that the pressure values in La Oroya and Tarma are significantly reduced to allow the local industrial supply and future extensions of this trunkline. As a result of all of the above is that starting 2010, it would not be possible to supply the required flows, since this would prevent satisfying the 40 bar minimum pressure to be guaranteed at the "City Gate" of Lurín.

Investment Estimate

2.28 Based on the studies on the pipeline route, such as the preliminary environmental impact study, the hydraulic study, and the technical-construction feasibility analysis, the estimated industrial cost for the construction of the trunkline, considering a tentative work term of 320 continuous days, including unforeseen expenses, is as follows:

Table 2.5: Investment Estimate—Junín Region

Item	*US$ amount*
Direct labor	7,653,873
Indirect labor	403,467
Materials and surface installations	29,062,336
Equipment	8,410,340
Overheads	8,277,290
Total Industrial cost	**53,807,306**

Relevant Aspects

2.29 **The Lurín–La Oroya section** features a great variety of environmental and social situations, which were considered for the environmental feasibility analysis. The route is environmentally viable but requires a deeper analysis of the more unfavorable variables:

[26] "Hydraulic Study No. 81041030-00-00-RTZ-1001 Rev. A," October 2004.

- The need to have for blasting along the pipeline route, as well as the importance of geological faults in the area being crossed.
- Soils sliding and erosion are risks, which are significant in certain cases, so adequate retention structures should be considered, as may be applicable in each case. However, the predominance of rock substrate along a major portion of the route will require quarries for the extraction of fine material, which must be analyzed in future studies.
- The works to be performed on the Rímac River are worth further study, since a good portion of them will be performed on the rocky bed of the river or on its banks.
- In the case of settlements, it will be necessary to perform a more detailed analysis in the urban areas, urban perimeter areas, mining settlements, and so forth found along the pipeline route.
- The logistics for the construction stage are important in this section, given the complexity of the roads, the reduced valley space, and the need to transport all types of materials. Roads and transportation require particular study and coordination to be able to minimize the effects during the construction stage since the Central Highway is the main road joining Lima, the Highlands, and the Central Jungle, one of Peru's richest regions.
- Since it has been largely changed by anthropic activity, the section used for this route prevents an adverse effect on native wildlife and flora, or on natural protected areas.
- An alternative whereby the existing Lima–Callao pipeline could be used should be analyzed since this would avoid constructing a new parallel pipeline in one of the most complex areas, such as the urban and urban perimeter areas of the City of Lima. In this way, the construction works would begin at the crossing of Evitamiento Road and the Central Railway.

2.30 **The La Oroya–Tarma section** appears to be a viable project with a generally low environmental sensitivity; however, specific cases should not be disregarded in future studies in the vicinity of Tarma, such as the soils, natural vegetation, and agriculture. This section leads to a mining region where the possibility of having natural gas as an energy source would lead to important changes in its development. One of the main environmental problems in the entire region is the high level of pollution, chiefly in the area of La Oroya; thus, natural gas would be well accepted.

2.31 Given the construction and environmental complexity detected, the possibility of an analysis of alternative routes to La Oroya other than those considered as Alternative 1 should not be ruled out.

MRT—Ayacucho Region—Alternative 1

Description of the Pipeline Route

2.32 The trunkline feeding the ***Ayacucho Region***[27] differs in diameter depending on whether Alternative 1 (3 inch) or Alternative 2 (10 inch) is considered. The difference in diameters is the result of determining that Alternative 1 is only meant to feed the City of Ayacucho, while in Alternative 2 it is necessary to supply markets located downstream from that city (Huancayo, La Oroya, Tarma), which generate the need to increase the piping section to 10 inches.

2.33 The pipeline route starting point is in the area of Block Valve BV 277, located in the point at km 277 of the Camisea Pipeline to Lima, taking the straightest possible route toward the City of Ayacucho following the high level curves and going over the Cerro Santa Trinidad peak, until it runs into a track known as "Camino de Herradura" (bridle path) and continuing through that trail up to the area considered the most appropriate for the installation of the Ayacucho "City Gate".

2.34 The length of the route evaluated is approximately 22 km and the terrain appears with no apparent rocky formation, with relatively soft slopes and scarce special crosses. In the area there are places, which are usually not very populated; for example, Uchuypampa, noticing the existence of roads, which would be useful as access during the construction stage.

Preliminary Environmental Study

2.35 Table 2.6 shows the results obtained for the Ayacucho Region:[28]

Hydraulic Study

2.36 According to the transport system's global hydraulic study,[29] natural gas supply is possible until the year 2025, when the pressure values easily exceed the minimum pressure to guarantee not only in Lurín "City Gate" but also in the rest of the diversion points located on the Camisea Pipeline to Lima.

2.37 The hydraulic analysis also reveals that in order to meet the minimum pressure to be guaranteed at Lurín "City Gate", the pressure at Block Valve BV 277 located on the Camisea Pipeline should be at values much higher than the minimum pressure of 45 bars to be guaranteed at that point.

Investment Estimate

2.38 Based on the studies of the pipeline route, the preliminary environmental impact, hydraulic study and the technical–constructive feasibility analysis, an estimate has been performed of the industrial cost involved in the construction of the trunkline considering a tentative work term of 25 consecutive days, including unforeseen elements:

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[27] "Design Bases Nº 81041030-00-000-MDG-1002 Rev. A," Route Blueprints Scale 1:25000 (quantity: 2) and Typical blueprints (quantity: 8) October 2004.

[28] "Preliminary Environmental Study No. 81041030-00-000-IAG-1002 Rev A", October 2004.

[29] "Hydraulic Study No. 81041030-00-000-RTZ-1001 Rev. A," October 2004.

Table 2.6: Weighted Grading of Environmental Aspects—Ayacucho Region[30]

	Environmental Aspects	*Weighting*	*Grading* [a] *(%)*	*Quantification (%)*
1.	Geology	5	95	4.75
2.	Soils	5	60	3.00
3.	Surface hydrology	8	90	7.20
4.	Vegetation	9	60	5.40
5.	Wildlife	6	90	5.40
6.	Ecosystems	11	90	9.90
7.	Preservation areas	11	100	11.00
8.	Climate	2	100	2.00
9.	Agriculture	6	90	5.40
10.	Afforestation	3	95	2.85
11.	Mineral resources	2	100	2.00
12.	Settlements	11	90	9.90
13.	Transport	5	95	4.75
14.	Recreational. educational and religious areas	5	100	5.00
15.	Archaeology - Paleontology	11	90	9.90
GRAND TOTAL		**100**		**88.45** [b]

Table 2.7: Investment Estimate—Ayacucho Region

Item	*US$ Amount*
Direct labor	259,167
Indirect labor	13,993
Materials and surface installations	963,374
Equipment	225,700
Overheads	278,613
Total Industrial Cost	**1,740,847**

Relevant Aspects

2.39 For the pipeline that would supply the City of Ayacucho, the following relevant aspects were established:

- The section under analysis was environmentally viable with environmental sensitivity being, in general, low. However, specific cases, such as the

[30] For the interpretation of the data shown in table 2.6, please see footnote number 22.

presence of soil erosion and natural vegetation should be taken into account in futures studies.

- The soils have a risk of erosion, and therefore consideration should be given to the building of adequate berms and/or retention structures as well as the suitability of revegetation. However, the pipeline route was designed in such a manner that it avoids deep gorges in order to reduce the movement of soils and therefore the risk of erosion.
- It is important to point out in this section the presence of trails or roads, which, albeit not in good condition, allow access to practically the entire route. This is significant, since there will be no need to open up new roads for logistics during the construction and operational stages.
- The main economic activity of the people of Ayacucho is farming and livestocking. However, in most cases it is just subsistence; and at times, it does not generate sufficient income so economic activities are diversified; in many cases, there is temporary migration in search for job sources. The area's products are sold at local markets and rural fairs which are not enough for merchandizing outside the region. The possibility of having natural gas could be attractive for industries to settle in the area and for developing small businesses, which could start producing a regional economic change.
- The population with possibilities of accessing natural gas must first convert their system in order to be able to use it. However, the benefit would be substantial for the family economy, since it represents a less costly resource, opening possibilities for a better quality of life. Furthermore, tourism as a sector with development potential, could offer better services with the new energy source.

2.40 Table 2.10 provides a summary of the main characteristics evaluated of the MRT considered in Alternative 1.

MRT—Junín, Ayacucho and Ica Regions—Alternative 2

Description of the Pipeline Route

2.41 Natural gas supply for both regions is feasible through an MRT with a length of 380 km: 349 km at 10 inches and 31 km at 6 inches (with interconnection in a CTT spot located at the point at km 277 coming from Camisea) supplying the localities of Ayacucho, Huancayo, La Oroya, and Tarma.[31]

- The first section of the 22 km route coincides with the description of the pipeline route performed for the Ayacucho Region. From the Ayacucho "City Gate", the route is crossed by several secondary roads, the paved road to Huanta and the Huatata River, at the convergence with the Alameda River. Then, the route follows the high peaks of the Uma Orcco

[31] "Design Bases Nº 810411112-00-000-MDG-0001 Rev. A," Route Blueprints Scale 1:25000 (quantity: 21) and Typical blueprints (quantity: 8) October 2004.

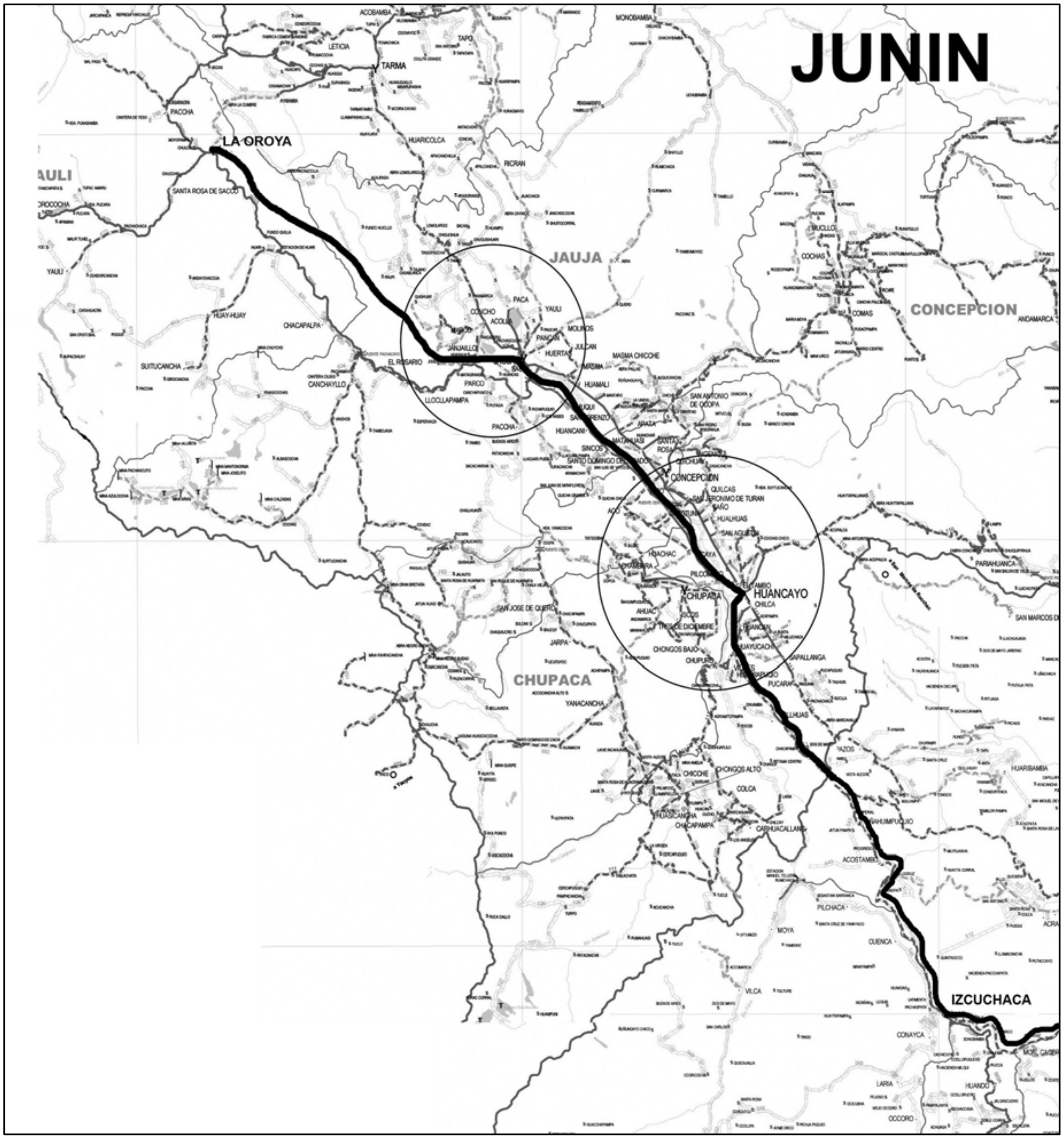
hill, until the locality of Compañía. Subsequently, the section chosen would be located between the Cachi river valley and the secondary road running parallel to it, until reaching the area of the Cangari Rural Estate; from here to the Iribamba Rural Estate, the situation is the same.

- From the Iribamba Rural Estate to the locality of Mayocc, the section runs over Route 3, through the Huarpa river valley, and partly through the mountain peak. From Mayocc to Huancayo, there are two possible route alternatives, one around the area of the cities of Churcampa and Pampas, a section which has been checked throughout its length, and which is not recommendable, both due to its longer length and the problems and cost involved in the assembly, which would be much higher than those of the other alternative, which runs through the area known as the Mantaro valley. For the above reasons, from Mayocc, located some 53.5 km from the "City Gate," to the City of Izcuchaca, 104.5 km away from Mayocc, a large part of the section is located by the service road of Route 3S, with a possibility of being paved.
- From Izcuchaca to the Huancayo "City Gate," the route continues through the mountain peak and then by a secondary road which was left after Road 3S was paved. This paved road goes from Huancayo to Izcuchaca for approximately 65 km. This trail crosses cultivated sectors, which could be affected in the construction stage, which is why consideration should be given to the immediate remediation of the area. Following the direction of this trail, which must be widened during the construction stage, the pipeline route follows the area near Chupuro, and crosses the Mantaro River. It goes along the river's valley and through parallel streets arriving at Huancayo "City Gate", with an accumulated distance of approximately 221.5 km. From this point, the corridor is located within the route's service road going toward the City of Jauja, on the western side of the Mantaro River.
- The route and the river cross each other at Stuart Bridge The route then climbs and follows along the hills to the vicinity of La Oroya at a distance of approximately 327 km from Ayacucho. A tentative spot was selected in this sector for the location of La Oroya "City Gate", 3.4 km away from the Doe Run ore processing plant.
- The pipeline route then continues toward Cemento Andino factory, a final section of 23 km, which should not provide major complications in construction, other than those normal for this type of work.

2.42 Figure 2.7 shows the MRT Route for the Junín and Ayacucho Regions, divided into two sections:

Figure 2.7: MRT Route for Alternative 2—Junín and Ayacucho Regions (Ayacucho–Mayoc–Izcuchaca Section)

Figure 2.8: MRT Route for Alternative 2—Junín and Ayacucho Regions (Izcuchaca–Huancayo–La Oroya Section)



Preliminary Environmental Study

2.43 Table 2.8 shows the results obtained for the Junín and Ayacucho Regions:[32]

Table 2.8: Weighted Grading of Environmental Aspects Junín and Ayacucho Regions (Alternative 2)[33]

	Environmental Aspects	*Weighting*	*Grading [a] (%)*	*Quantification (%)*
1.	Geology	5	95	4.75
2.	Soils	5	60	3.00
3.	Surface hydrology	8	75	6.00
4.	Vegetation	9	60	5.40
5.	Wildlife	6	90	5.40
6.	Ecosystems	11	90	9.90
7.	Preservation areas	11	100	11.00
8.	Climate	2	100	2.00
9.	Agriculture	6	70	4.20
10.	Afforestation	3	90	2.70
11.	Mineral resources	2	95	1.90
12.	Settlements	11	75	8.25
13.	Transport	5	70	3.50
14.	Recreational. educational and religious areas	5	95	4.75
15.	Archaeology—Paleontology	11	100	11.00
GRAND TOTAL		**100**		**83.75[b]**

Hydraulic Study

2.44 The global hydraulic study of the transport system[34] reveals that the natural gas can be supplied up to the year 2007, when the pressure values widely exceed the minimum pressure to be guaranteed not only at the Lurín "City Gate" but also at the rest of the diversion points situated on the Camisea–Lima Pipeline. The provision of natural gas will continue to be viable until "almost" the year 2010 when there is a pressure of 38 bars at the Lurín "City Gate," value which is slightly lower than the 40 bars pressure to be guaranteed at this point.

2.45 An analysis of the above paragraphs shows that in order to meet the minimum pressure to guarantee the pressure at BV 277at the Lurín "City Gate" located

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[32] "Preliminary Environmental Study Nº 81041030-00-000-IAG-1002 Rev. A," October 2004.

[33] Please see footnote number 22.

[34] "Hydraulic Study Nº 81041030-00-000-RTZ-1001 Rev. A," October 2004.

on the Camisea Pipeline should be at values much higher than the minimum pressure of 45 bars to be guaranteed at that point.

Investment Estimate

2.46 Based on the studies on the route, such as the preliminary environmental impact study, the hydraulic study, and the technical-construction feasibility analysis, the estimated industrial cost for the construction of the trunkline, considering a tentative work term of 300 continuous days, including unforeseen elements, is as follows:

Table 2.9: Estimate of the Investment—Junín and Ayacucho Regions (Alternative 2)

Item	*US$ Amount*
Direct labor	5,502,253
Indirect labor	357,888
Materials and surface installations	37,158,015
Equipment	3,536,422
Overheads	11,196,190
Total Industrial Cost	**57,750,768**

Relevant Aspects

2.47 The Ayacucho–Huancayo–La Oroya–Tarma trunkline features environmental and social situations, such as the following:

- The need to have blasts or detonations, especially in the section corresponding to the extension of the Mantaro canyon road, would require further analysis.
- Although part of the route goes through existing roads, there are places, which are environmentally sensible or critical with respect to the risk of erosion. A major part of the route goes through an area with semi-arid characteristics, but rain falls during a short period of the year; this, added to the characteristics of the terrain and to the type of soil, raises the level of erosion risk and slides. The specific EIA (Environmental Impact Assessment) must specify adequate retention structures to be used in each case.
- Water bodies cross the section throughout the route; some of them are rather important, such as the Cachi–Huarpa and Mantaro rivers, as well as other minor rivers. However, their use in agricultural irrigation is significant; thus, it will be necessary not to interrupt the water flow. However, any changes made to riverbeds can cause alterations in behavior, and this can lead to the start of erosion on some of the banks, possibly affecting cultivation terraces. Therefore, all works to be performed on riverbeds and river crosses, must be subject to a specific study.

- Although efforts were made to use existing trails as to minimize the need to open up the road and consequently reduce the effect on natural vegetation, there will still be an impact. The vegetation to be affected shows a certain degree of deterioration, either because of overgrazing or the effect of road berms; however, it serves to retain the soils. The natural recovery of the affected vegetation for most of the section will be very slow, due to the aforementioned climate conditions.
- The construction stage will generate positive as well as negative impacts on the settlements involved, and this is why a more detailed analysis needs to be performed in the specific EIA. Construction activities within populated settlements must include all the required safety measures, and there must be an excellent level of communication with the inhabitants. Because of the type of soil existing in a large part of the route, with fine features (lime and clay) suspended particles could flourish during the construction stage, a situation that must be controlled, especially in populated areas.
- The route could affect cultivated land, as well as the various common irrigation canals in the area.
- The logistic analysis of the construction stage will be important due to the complexity of the roads and the limited space in part of the route.
- Roads and transport need to have particular studies and coordination to lessen the impact during the construction stage. The section between Mayocc and Izcuchaca would be partially interrupted.
- The corridor used for this route, since it is quite changed by anthropic activity, prevents an impact over endemic wildlife or flora, as well as protected natural areas.
- The route goes through one of the most productive areas in the Central Highlands, which is quite rich in non-metal minerals; thus, natural gas would bring new possibilities for regional development. In the Junín Region there are mining and farming development projects; and the presence of natural gas could facilitate their execution.
- In addition, the existing mining industries first need to convert their systems to be able to use natural gas to benefit substantially by using a less expensive and cleaner energy source. Air pollution is a very serious local problem. Thus, there are companies, which have already committed to making the expected switch.

2.48 Tables 2.10 and 2.11 summarize the main characteristics of the MRT evaluated for Alternatives 1 and 2. A comparative analysis shows that Alternative 2 is the most appropriate from the environmental, hydraulic, economic, and technical–constructive feasibility points of view.

Table 2.10: Alternative 1 Summary (trunkline to Huancayo not included)

Main Characteristics	*Junín Region Turín–La Oroya–Tarma Trunkline*	*Ica Region Humay–Pisco–Ica Trunkline*	*Ayacucho Region Camisea BV 277–Ayacucho Trunkline*
Final year with natural gas supply	2007	2010	2025
Length (km)	236	96	22
Diameter (inches)	12–10–6	10	3
Distance from Camisea to diversion (km)	732	521	277
Hydraulic behavior versus transport system	Critical to divert from Lurín (system's extreme node)	Semi-critical since it derives from Humay, which is far from Camisea	Acceptable because it diverts closer to Camisea
Environmental sensitivity	Low and Medium	Low	Low
Construction complexity	Medium and High	Low	Low and Medium
Future localities	Huancayo	Nazca and Marcona	---------
Industrial cost (US$)	53,807,306	15,042,678	1,740,847
Total Industrial Cost of Alternative 1 (US$)	**70,590,831**		

MRT—Cusco Region

Description of the route

2.49 The proposed route was based on the analysis of the alternatives submitted by the Canadian consulting firms Colt and Stantec, which prepared the trunkline extension study for the Cusco Region and which was subsequently extended by the Consortium R.García Consultores & INTEC/ARCAN. From the work of the Canadian companies, the red route and the blue route, thus named by Colt, were cited as being the routes with greatest possibilities. Both routes were analyzed and partly covered and some sectors were found to be conflictive and occasionally restrictive. After this verification in situ and consulting with archaeologists, an analysis of the Stantec alternatives, called "segments", was performed. The route, which was finally chosen preliminarily, is made up, with certain variations, of a combination of Colt "routes" and some Stantec "segments". The future concessionaire shall establish the definite route.

2.50 The evaluation made at this stage details the most relevant peculiarities of the route and an estimate of the conditions for the laying of the pipeline.[35] The first

[35] "Design Bases Nº 810411112-00-000-MDG-0001 Rev. A," April 2005.

section under analysis goes from the City of Cusco to the locality of Yanamayo. The second section under analysis goes from the point of connection to the Camisea pipeline, in the locality of Kepashiato, up to Yanamayo, and the third section under analysis goes from Quellouno to the city of Quillabamba.

Table 2.11: Alternative 2 Summary (trunkline to Huancayo included)

Main characteristics	*Junín Region and Ayacucho* *Camisea BV 277–Ayacucho–Huancayo–La Oroya–Tarma Trunkline*	*Ica Region* *Humay–Pisco–Ica Trunkline*
Final year with natural gas supply	2010	2010
Length (km)	380	96
Diameter (inches)	10–6	10
Distance from Camisea to diversion (km)	277	521
Hydraulic behavior versus the transport system	Acceptable because it diverts closer to Camisea	Semi-critical because it diverts at Humay, which is far from Camisea
Environmental sensitivity	Low	Low
Construction complexity	Low and Medium	Low
Future localities taken into account	-----	Nazca and Marcona
Industrial cost (US$)	57,750,768	15,042,678
Total industrial cost of Alternative 1 (US$)	**72,793,446**	

- ***Cusco–Yanamayo Section***—The route starts at the Cusco “City Gate”, located in the vicinity of the City of Cusco, in a neighborhood bordering on the District of Santiago. The location of the “City Gate” was determined after consideration was given to the tentative design of the distribution network into the city and the distance to it, within the safety margins applicable to this type of installations.
- From the place selected for the “City Gate”, the route runs through the peak of the area’s existing hills, going toward Poroy, and proceeding parallel to the existing high tension lines. This is how it crosses the route joining Cusco and Cachimayo, going to the north of the Chuspioc gorge, and running parallel thereto, to cross areas where agricultural exploitation is going on, to the crossing of the Cusco-Machu Picchu railway and the route joining Cachimayo and Cusco.
- The route is located west of the town of Cachimayo, avoiding houses and recreational areas, with consideration to the location of the diversion and of the “City Gate” in the vicinity of the YURA S.A. Nitrate Plant, going

toward the north between the route to Chincheros and the route to Abancay. In that area, the route has another railroad crossing, nearing the high tension lines going in the direction of the Sacred Valley. It continues north going up to Pampas de Piura–Maras, parallel to the high tension line, forking out in the area of the small rural settlements, and then returns to run parallel to the aforementioned power line.

- In this place, two different geoGraphal areas can be identified, the first one being up high, located near Cusco, with no rocky terrain and not requiring blasting or special equipment. The second area is a typical valley area, without major construction complications, with scarce soil movement and adequate access.
- After passing the locality of Maras, the route runs through a high valley without any significant changes in the type of terrain, save for the crossing of some gorges, which are not so deep and with no apparent rock content. When the route runs down to the Sacred Valley, which is intersected by the Urubamba River, the sharpest gradients have been avoided, to minimize construction impediments as well as to reduce the visual impact from the valley. In this sector the terrain has meteorized rocky outcrops, in addition to loose soils, which is why the necessary measures must be adopted prior to the construction stage to ensure the execution of retention means and soil erosion control steps.
- The crossing with the Urubamba River has been located in a sector which is broad, with low banks, where the approximate width of the bed is 30 m, taking into account that, at times, it has a considerable volume of water.
- Leaving the Urubamba river valley, the route keeps going up toward the base of the hill, avoiding the Tayta Chapel ruins as well as existing houses. The route continues up through a mountain strip located east of the Ollantaytambo Archaeological Park area, following a path which does not allow vehicles, but where there is a bridle trail, which would make it possible to build the route through the peaks, to then go down to the Patacancha valley. This route location avoids the protected archaeological areas of Ollantaytambo, Pumamarca, and others. Furthermore, this mountain area has soils with rocky type alternate material, with easily eroding clayish soils. Also noticeable is the existence of certain minor settlements located on the valley's slopes. It must be taken into account that in this section, with an approximate length of 13 km, there are no access roads, which is why rolling equipment used to haul construction material and equipment must go over the road built for the assembly of the pipeline.
- Once the Patacancha valley has been reached, the route continues by the side of the Ocororuyoc gorge, without offering any problems for construction, and there are cultivated fields on the slopes. The type of soil

in this area does not feature rocky outcrops; but does have some surface water filtering and small gorges, which do not make construction difficult.

- The route continues going up to the area of Panticalla, a natural water dividing line and the end of the Ocororuyoc valley, at an altitude of approximately 4,500 meters, going down to the Yanamayo valley, an affluent to the Ocobamba River, using a very steep slope with evidence of solid rock, which will require blasting and the use of heavy equipment to move the soil and open up the assembly road. It continues by crossing to the western bank of the gorge and going through the valley until reaching the settlement of Puncuyoc, where part of the section is located through the existing road which must be widened, also modifying curve radiuses, so that it will facilitate the works and transport. The soil is clayish in this area, and there is no evidence of rocks, or of the need to provide erosion control protection.
- When reaching the settlement of Yanamayo, the existing houses are avoided, going up the hill and returning to the road, until reaching the end, which is also where the section's vehicle traffic ends. This is where the works of the company building the route are located, but no tasks are performed until the rainy season ends in the area (month of April). From this point, the route goes down to the Ocobamba river valley, which is where the High Jungle begins, following the existing bridle trail.
- ***Kepashiato–Yanamayo Section***—In this section the route starts at the diversion indicated by TGP, identified by the Block Valve existing at the point of km 123+600 of the Camisea Pipeline, situated in the vicinity of the locality of Kepashiato. Departing from this valve, the route runs parallel to the Camisea Pipeline, going south, through a length of some 100 meters, where it changes to an easterly direction. The separation, measurement, and regulation system prescribed by TGP will be installed in this area and then the boosting scraper trap will be placed. From this point on the route, running along the Cumpirusato river, is located parallel to the road to the locality of Materiato. The settlement of Kepashiato is surrounded by the hill's base, a jungle type place where bananas are grown on some of the parcels.
- The route then goes up to Cerro Abra, then down and crosses the Cushireni, with a width of approximately 100 meters, near the settlement of Kiteni. This populated area is avoided by bordering the base of the hill, after which it continues following the Urubamba River parallel to the road, through a short section. In order to avoid a broken up and closed area in this stretch of the road the route goes up the Siberia hill's slope, to the crossing of the Cirialo river, with a width of approximately 100 meters.
- Once the populated area has been left behind, the route again runs parallel to the road to then continue next to a power line, partly by the base of the hill and partly parallel to the road, near the Coribeni river and once it has

crossed it, continues by the existing terraces, then goes up to the Manataroquichayoc hill. It continues up high through the Sanganato hill, from where it comes down in the vicinity of the locality of Rosalía, which is avoided, to then run parallel to the road until reaching and crossing the Vilcanota River with a width of approximately 350 meters. Along this section the vegetation is the upper jungle and jungle type, alternating with cultivated parcels, mainly located in the proximity of the roads and vicinity of populated areas. The topoGraphal features cause the sector to be surrounded by many a gorge and some rocky bed rivers. In some sectors there are solid rock outcrops, while the soil is normally reddish and clayish. For several kilometers, the route in this section runs parallel to the existing road, toward the vicinity of the locality of Quellouno.

- Once the Vilcanota River has been crossed, at the point of Km 88+200, there is the diversion valve of the pipeline going to Quillabamba and the boosting "Scraper" Trap. It would be feasible to take advantage of the tentative installation area of the intermediate pipeline, the "Scraper" Trap by continuing toward Cusco. The route continues in the direction of Cusco, crossing the Tumasmojo hill at the lowest point, to run following the Yanatile river route, parallel to the road until reaching the locality of La Oroya, where it goes up to the peak of the Santa Rosa hill. It then continues through the Munaypata and Chinganillagrande hills to later go down by the slope of the Negrohuarcuna hill, where it again starts running parallel to the road, following the route of the Ocobamba River, to the settlement of Yanamayo.
- ***Quellouno–Quillabamba Section***—The route toward the City of Quillabamba starts at the diversion point located at the point of km 88+200, after crossing the Vilcanota River, where the pipeline's Boosting Trap is situated in the city of the same name. From here on, in general terms, the route is located on the southeastern bank of the Vilcanota river valley, running parallel to the highway and to the roads joining this sector's settlements until it reaches the City of Quillabamba. From the aforementioned diversion valve, the route runs parallel to the highway; and in some cases, right over the highway, crossing sectors with rocky sectors where explosives will have to be used. In other sectors of the section, there are soils with clastos and clay, with some coinciding cultivated parcels. The existing settlements are avoided by making alternative diversions, such as the case of Cocabambilla, where the route is located on the base of the San Miguel hill, to then take the road again.
- When reaching Echarate, the settlement existing between this city and the Huacayoc River is avoided. This sector corresponds to an alternate natural vegetation area with cultivated parcels growing bananas, papayas, and so forth, with an unleveled terrain highly sensitive to erosion and destabilization. Finally, the route runs upwards to fix itself on the hill

slopes, partly accompanied by the existing high-tension line, until reaching the vicinity of the City of Quillabamba.

- The route has a length of approximately 37 km and it ends at the "City Gate" located in the area of the city, where access is accomplished. This has been selected as the best spot for this location since it meets the necessary conditions due to the adequate access to the installation of the receiving Scraper Trap and the corresponding separation, measurement, and regulation station.

2.51 Figure 2.9 shows the MRT Route for the Cusco Region.

Preliminary Environmental Study

2.52 According to the preliminary environmental study, the route was selected considering the existence of a land access road, where archaeological parks or protected natural areas would not be impacted and the natural ecosystems have already been modified. However, for its location, the search was for places where soil movement was minimal, trying to avoid unnecessary slope cuts.

2.53 Table 2.10 shows the results obtained for the Kepashiato–Cusco section.

Hydraulic Study

2.54 According to the results obtained in the Hydraulic Study[36] it has been determined that a diameter of 12 inches is the best for the Camisea–Cusco trunk pipeline, while a diameter of 6 inches is suitable for the diversion pipeline to Quillabamba. Based on these values, a study has been made of the variation of pressure in each supply point for each year of projected demand to 2025.

2.55 Considering the above-mentioned studies and taking into account the border conditions imposed, it was determined that the best diameters are 12 inches, with a thickness of 8.74 mm, for the Camisea–Cachimayo–Cusco trunk pipeline; and of 6 inches with a thickness of 6.35 mm, for the diversion pipeline to the City of Quillabamba. The indicated thicknesses meet the requirements for the route in Class 3. These diameters allow the transport of natural gas under the conditions specified to the year 2025 for the cities of Quillabamba, Cachimayo and Cusco, including the future expansion to the City of Combapata, as well as an additional "safety" flow at the end of the pipeline.

[36] "Hydraulic Study No. 81041112-00-000-RTZ-002 Rev. A," April 2005, point no. 6.

Figure 2.9: MRT Route Alternative 2—Cusco Region

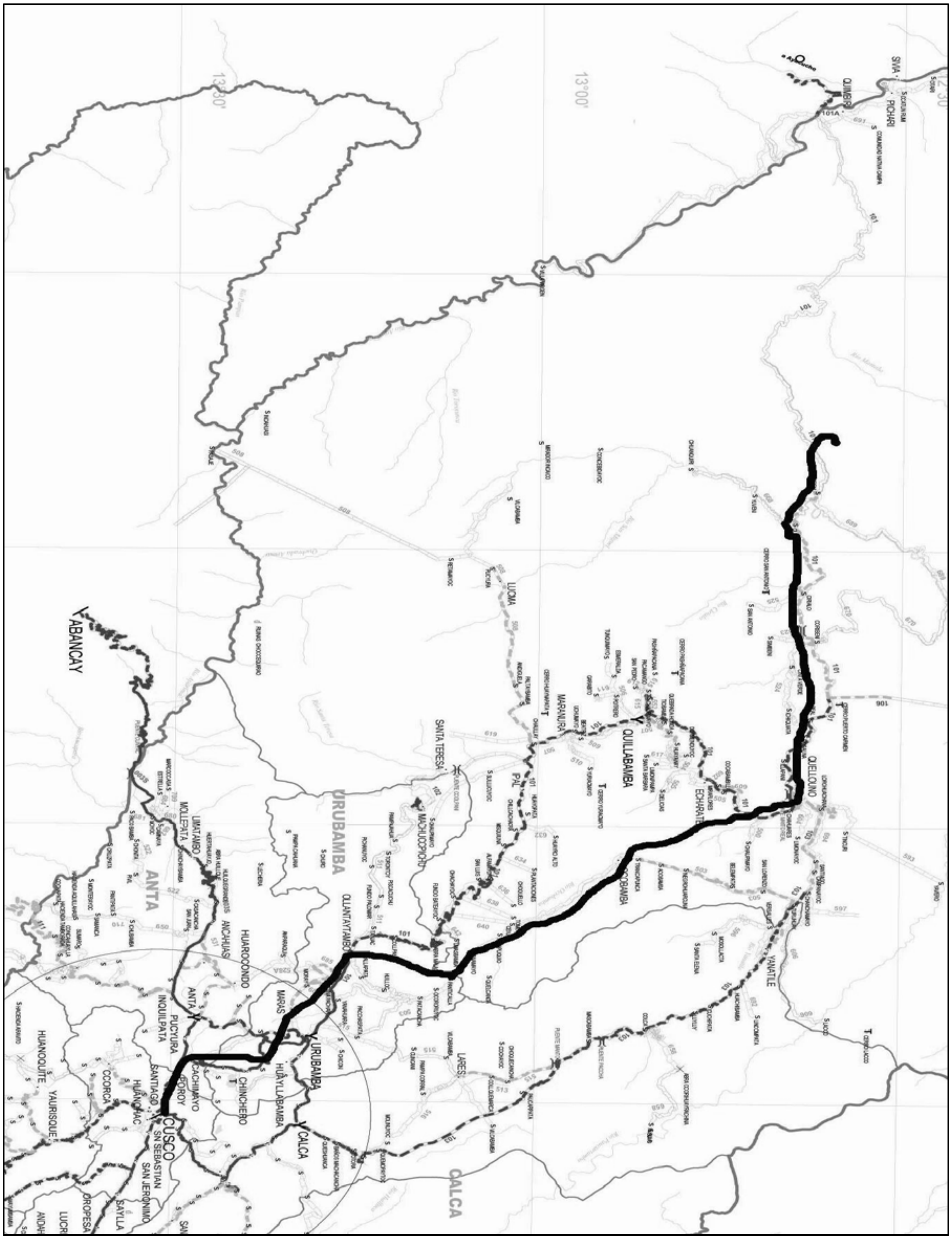


Table 2.12: Weighted Grading of Environmental Aspects for the Kepashiato–Cusco Section[37]

	Environmental Aspects	*Weighting*	*Grading [a] (%)*	*Quantification (%)*
1.	Geology	5	90	4.50
2.	Soils	6	60	3.60
3.	Surface hydrology	8	75	6.00
4.	Vegetation	9	60	5.40
5.	Wildlife	5	90	4.50
6.	Ecosystems	11	90	9.90
7.	Preservation areas	11	100	11.00
8.	Climate	2	98	1.96
9.	Agriculture	6	60	3.60
10.	Afforestation	3	60	1.80
11.	Mineral resources	2	100	2.00
12.	Settlements	11	55	6.05
13.	Transport	5	80	4.00
14.	Recreational, educational and religious areas	5	90	4.50
15.	Archaeology–Paleontology	11	90	9.90
GRAND TOTAL		**100**		**78.71[b]**

2.56 In addition, other scenarios were modeled for the dimensioning of the MRT infrastructure for different demand flow alternatives. Two cases were evaluated in this regard:

- Maximum demand to the year 2025 without Combapata and without the 20 MMCFD reserves, which requires a pipeline with a nominal diameter of 10 inches; the conclusion is that this diameter is acceptable and that it will allow certain future expansions.
- Maximum demand to the year 2025 without Quillabamba, Combapata, nor the 20 MMCFD of reserve, requiring an 8–inch pipeline; the conclusion is that this diameter is not adequate, due to the limitations for future expansions.

Relevant Aspects

Environmental

- The proposed route is environmentally viable with an environmental sensitivity, which is medium in some cases and high in others, which implies that future studies must go deeper into such specific aspects.

[37] Please refer to footnote number 20 when interpreting the data in the table 2.12.

- The soils have some important risks of erosion. In the jungle and upper jungle sector, for example, there is a high risk of slips.
- Due to the topoGraphal characteristics, the route will cross rivers, many gorges, and water filtering spots.
- The crossing of the Urubamba River, at Yanahuara, involves the so-called Sacred Valley. Although the route has been fixed in such manner as to lower the landscape impact, this impact will remain, since the tourist route to Ollantaytambo runs parallel to the river, a mere few meters away.
- Vegetation is one of the aspects affected by this project, with the most important sectors being those corresponding to the high Andean area and to the jungle and upper jungle area. Between Kepashiato and Yanamayo, the impact will be on the part which is jungle and upper jungle, however this type of vegetation and forest resource have already been modified, due to the proximity of human activities. In the high Andean area, between Yanamayo and Yanahuara, the vegetation to be impacted would be the high altitude pastures.
- Between Cusco, and Yanahuara the farming activity will be the most affected, because practically all the soils are used under the cultivation parcels system.
- The proposed route calls for the existence of trails or paths, some of which are not in good condition, but they allow access to almost the entire route. This is significant for the logistics at the construction stage since the need to open up new roads to access the pipeline's assembly road will be minimal.
- The section between Yanahuara and Patacancha, presently lacks a road for vehicle traffic. In this sector, the same pipeline's assembly road must be used for the transport of heavy equipment.
- With respect to wildlife, while the route runs through populated areas used for human activities, it is probable that in certain areas, principally in the area of the jungle and upper jungle, the presence of local wildlife species may be affected.
- From the social point of view, both positive as well as negative impacts are expected on the settlements involved, thus, a more detailed analysis will be required in the specific EIA. It will be good to have social work teams in such communities.
- Construction activities will generate a positive impact, however, even though it is on a temporary basis. They will use local labor as well as local goods and services, which will generate an economic reactivation. What is expected is that the government's final objective with this project will be sustained economic reactivation; and consequently, an improvement in the quality of life of the people.

- Having natural gas in Cusco would allow it to offer better international tourism services, which is the region's main economic activity, and it could act as an attraction for the development of small entrepreneurs who could produce a regional economic change.
- The same would be the case in Quillabamba where there could be a possibility of industrializing the products generated in the jungle and upper jungle, such as coffee, cocoa, and so forth, attaching added value to them and increasing work sources.
- Having natural gas in Cusco, however, would open up possibilities of extending its reach to localities such as Combapata, where there are projects prepared by the regional government with a view to future industrial settlements.

Technical—Constructive

- The land is suitable for the construction of pipelines. The Kepashiato–Quellouno–Yanahuara section is the most difficult for construction, while the Yanahuara–Cusco section presents normal construction difficulty.
- For the construction stage there are sufficient access roads, which must be reconditioned for the arrival of work equipment and material.
- In general, the execution of special works (river crossings, roads, and so forth) is limited.
- Isolated sections with rock in the mountain area will require the use of explosives, both at the road opening stage, as well as during assembly and ditching.
- The works' logistics between Kepashiato and Yanahuara will be affected by the geoGraphal location of the place with respect to the existing supply points.

Distribution Trunklines and Networks (DLN)

2.57 The plan is to take natural gas supply to the different localities of the regions under study, through local distribution systems, consisting of pipes of different diameters and pressures, which will depend on the type of users to be supplied through the natural gas supply service. Figure 2.5 shows a scheme of the configuration that these systems would provide for the natural gas supply service at the final consumption markets level.

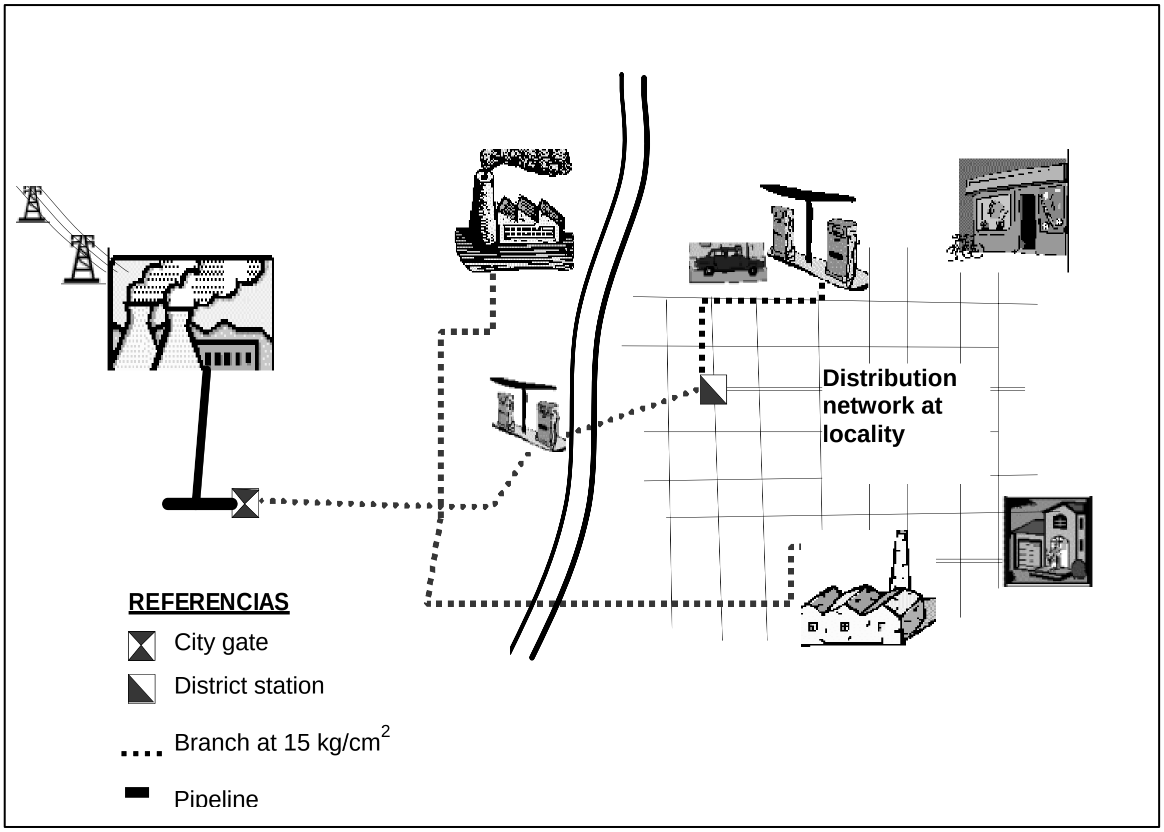
2.58 The design of the medium pressure distribution trunklines, at 15 bars in the different localities to be supplied with natural gas in the Ayacucho, Junín, Ica and Cusco regions (20 bars in Quillabamba[38]) is the result of assumptions made on maximum time patterns of consumption per consumer sector[39] (residential, commercial and small

[38] To guarantee a minimum of 17.5 bars at the entrance to the electricity generation center.

[39] "Final Network Design Concept Report," October 2004, for the Ayacucho, Junin, and Ica Regions; and "Final Network Design Concept Report." April 2005, for the Cusco Region.

industries, VNG, and large customers). The plan was to generate configurations that will minimize investment, feeding industries, district stations, and gas stations, among others.

Figure 2.10: Scheme of DLN Configuration for the Local Natural Gas Supply



2.59 The following figures show the medium-pressure distribution systems (MP) by locality. The nodes of each section can be identified with the respective diameter of the pipe to be installed. In that sense, pipelines have been identified in a broad range of 3 inches to 10 inches, depending on the distances to be covered and the characteristics of the demands to meet by locality.

Figure 2.11: Distribution Systems (MP)—La Oroya (Alternative 1)

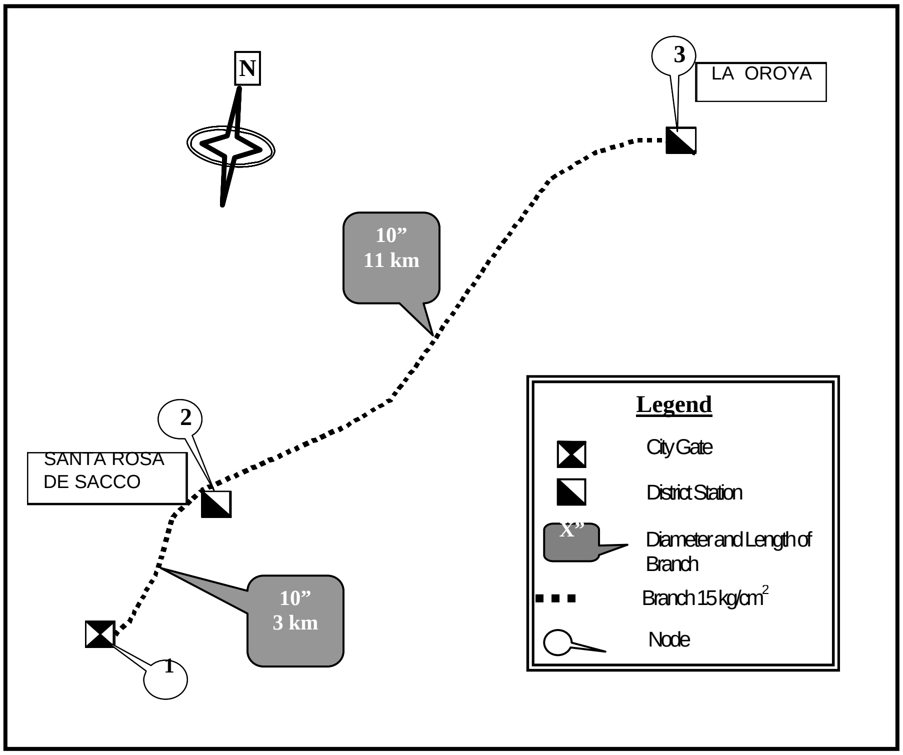


Figure 2.12: Distribution Systems (MP)—La Oroya (Alternative 2)

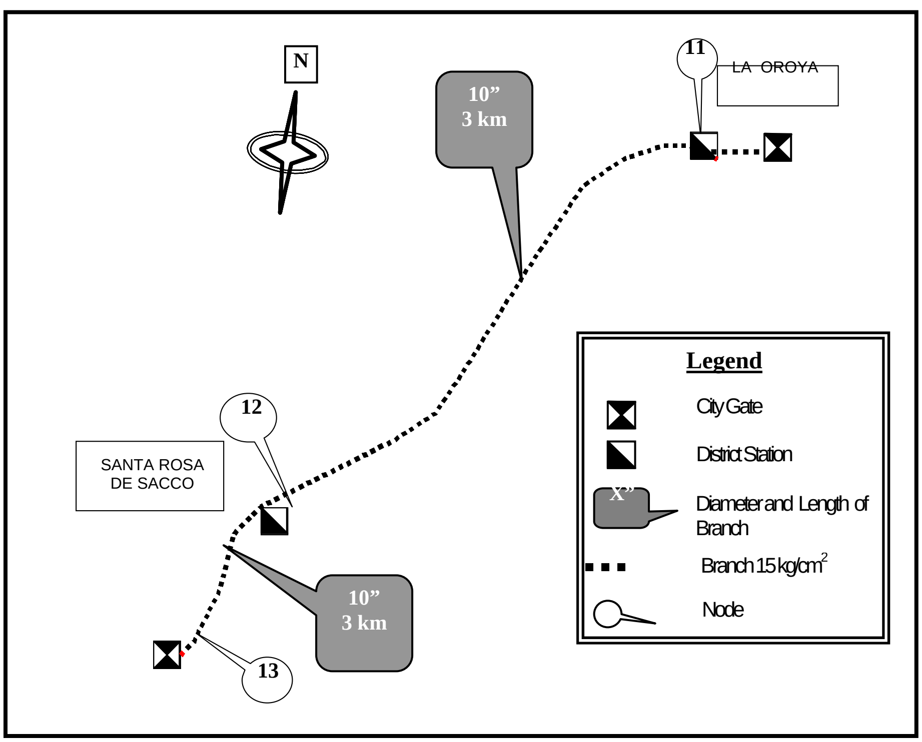


Figure 2.13: Distribution Systems (MP)—Tarma

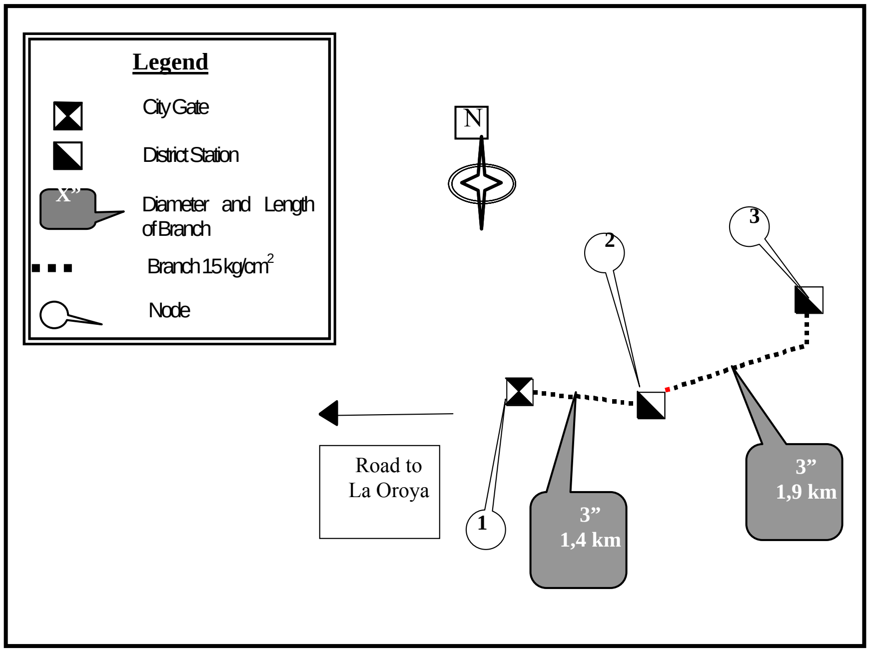


Figure 2.14: Distribution Systems (MP)—Huancayo (Alternative 2)

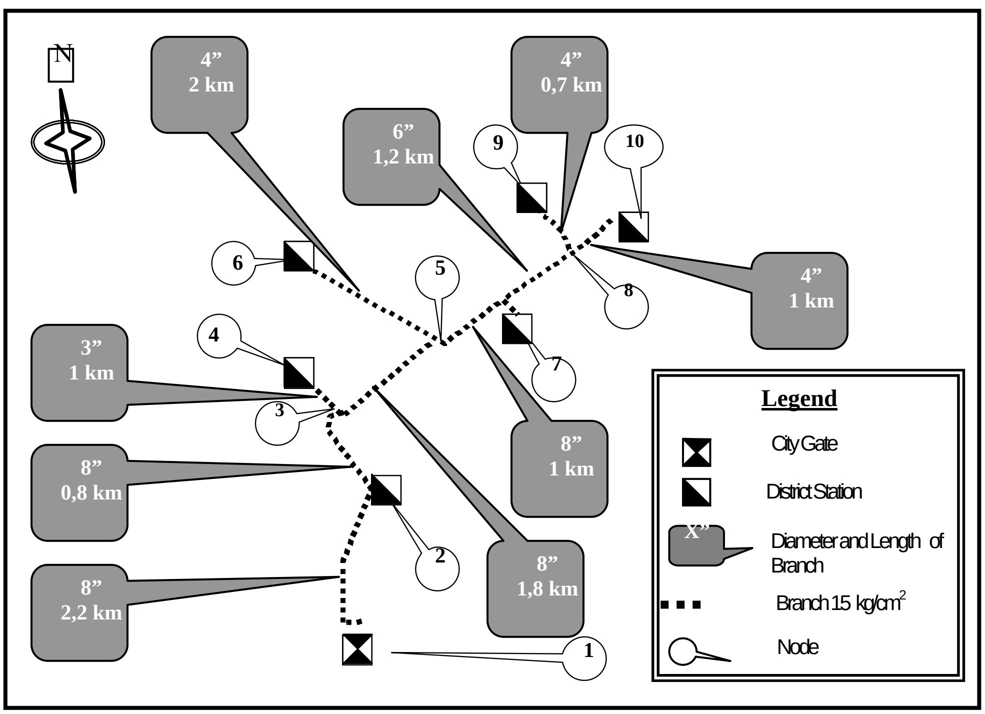


Figure 2.15: Distribution Systems (MP)—Ica

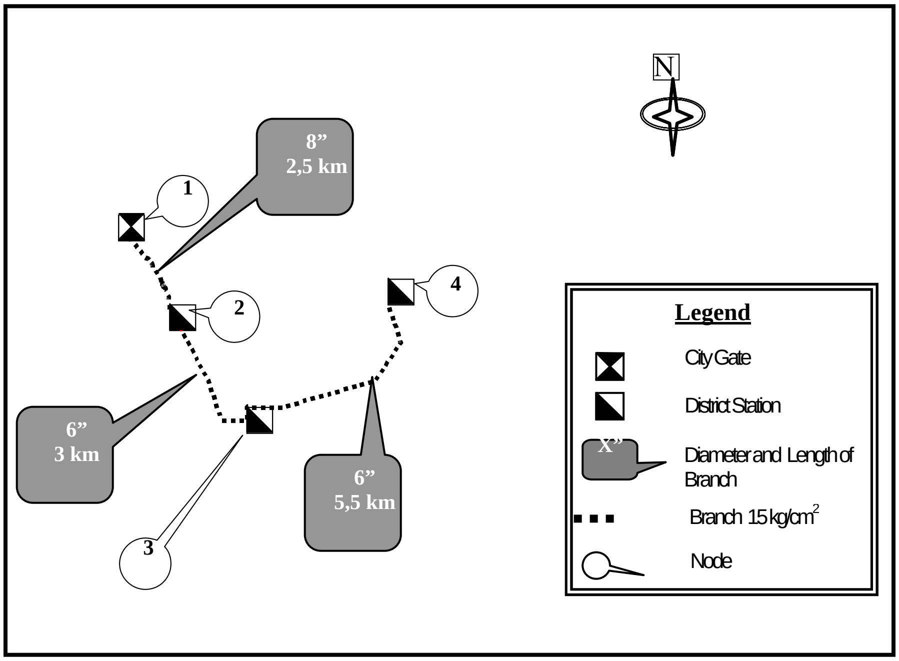


Figure 2.16: Distribution Systems (MP)—Pisco

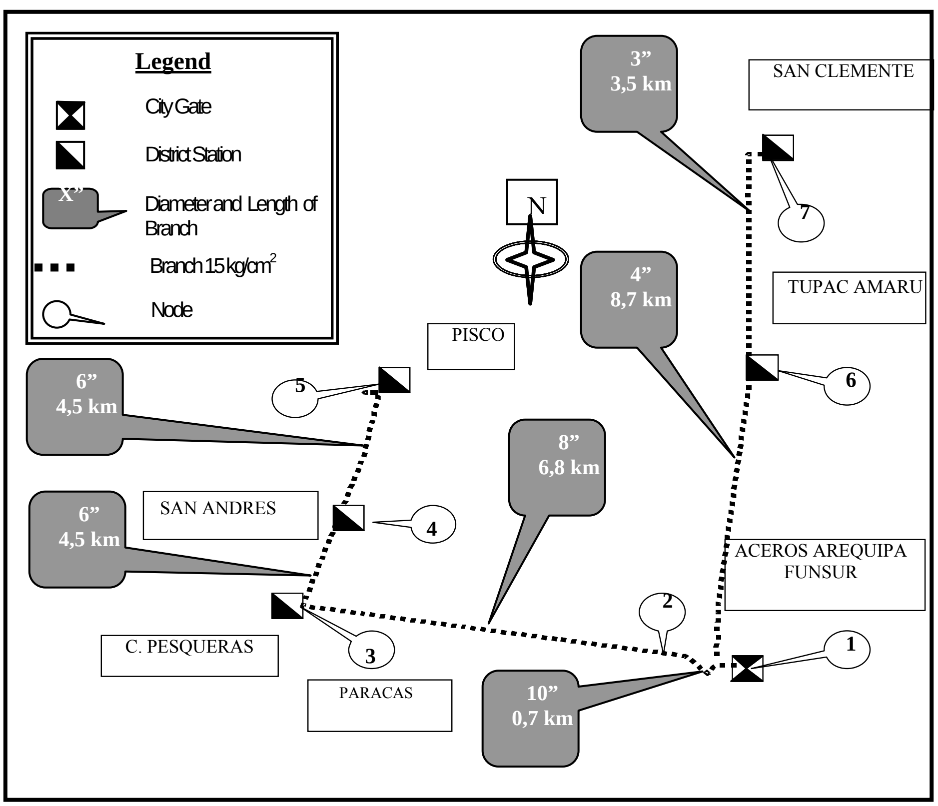


Figure 2.17: Distribution Systems (MP)—Ayacucho

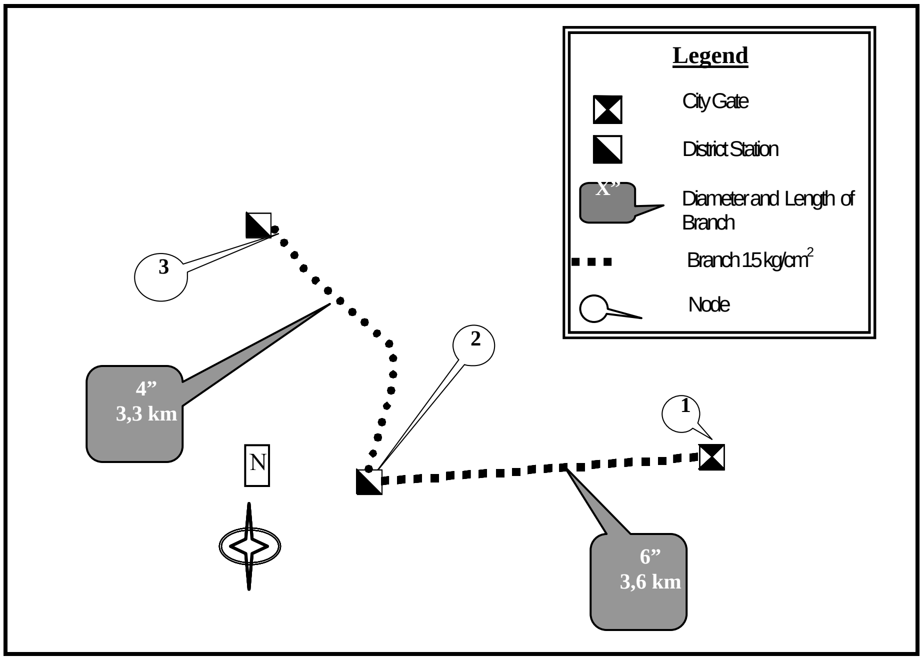


Figure 2.18: Distribution Systems (MP)—Cusco and Cachimayo

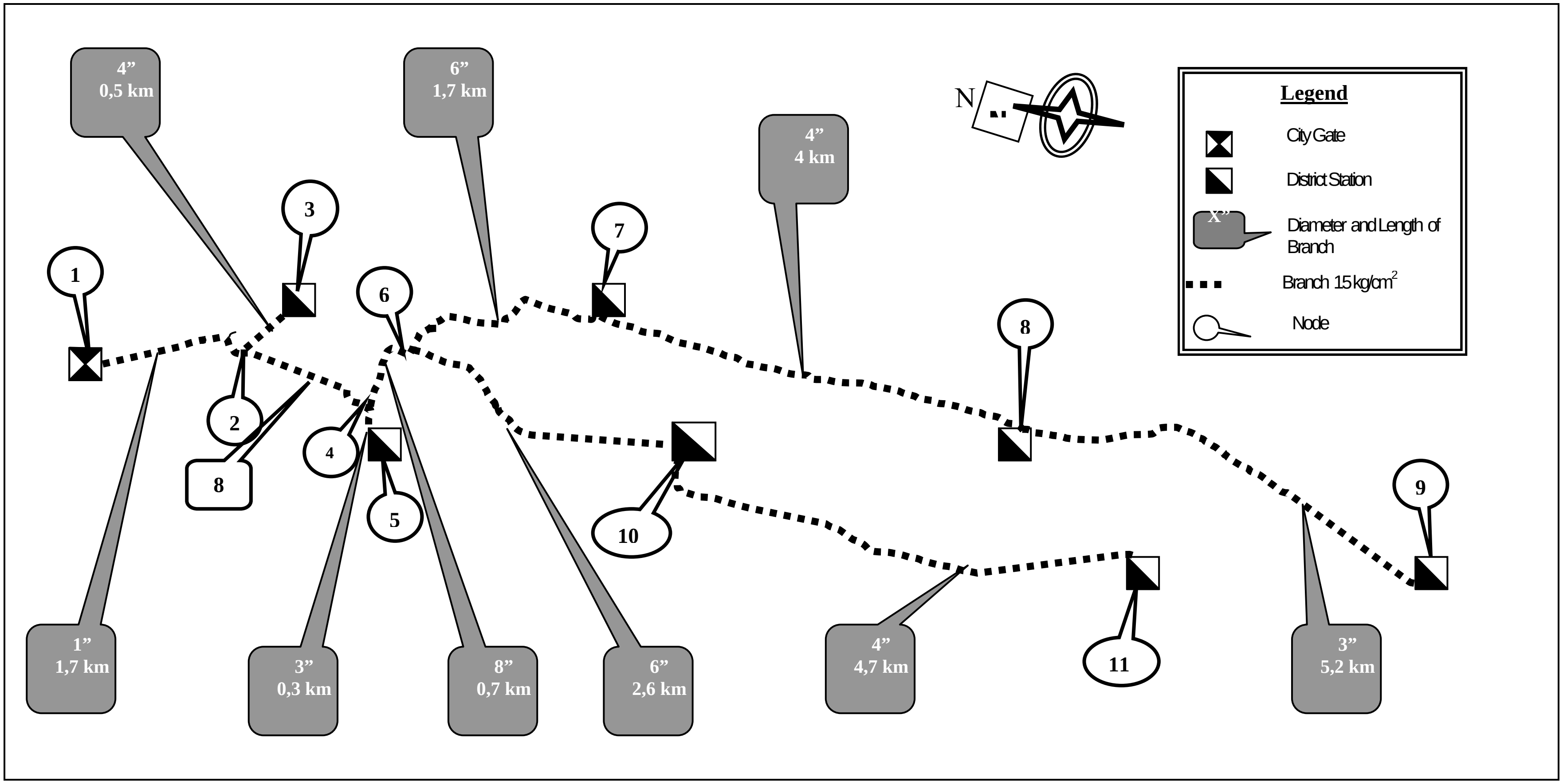
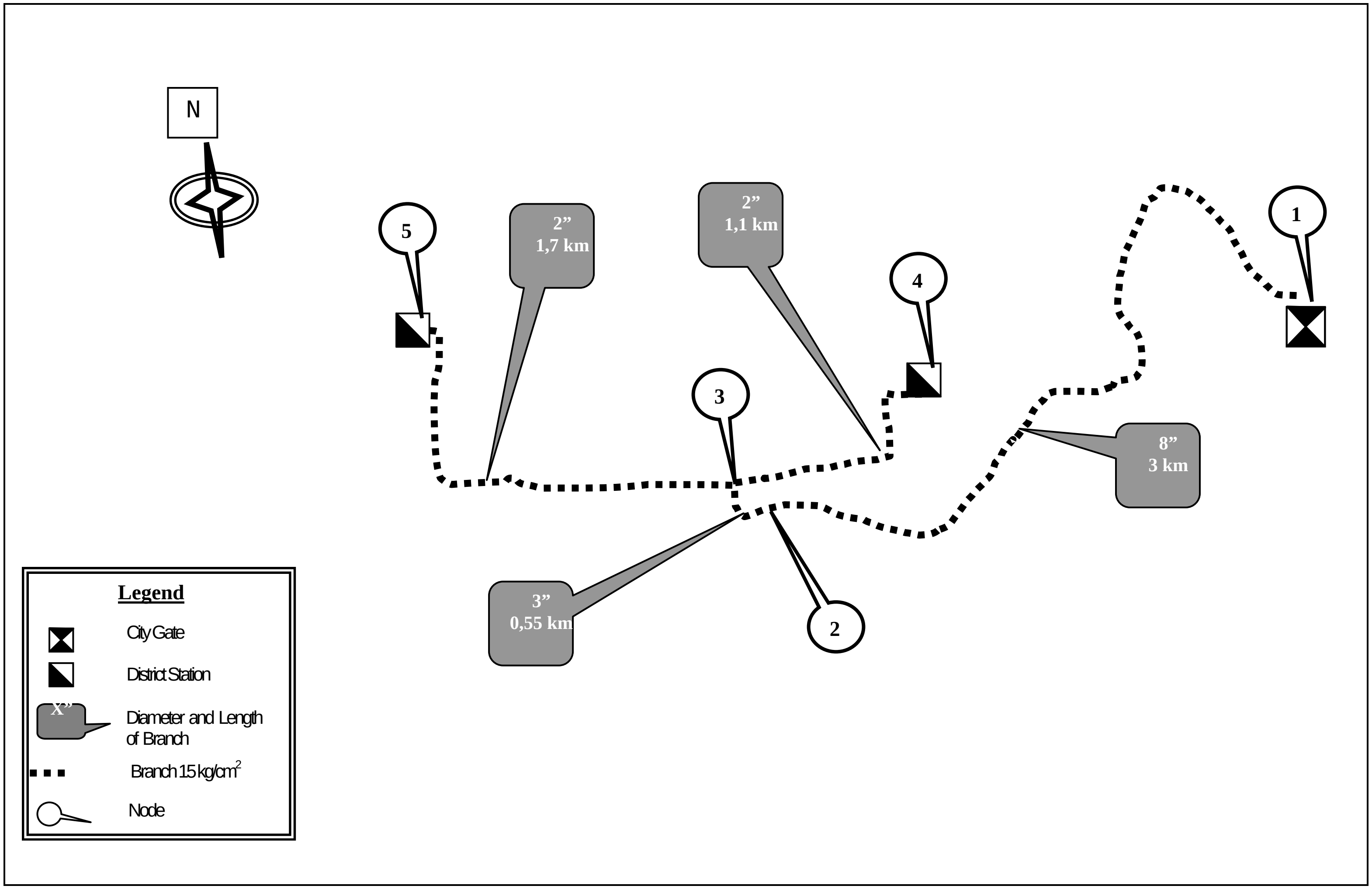


Figure 2.19: Distribution Systems (MP)—Quillabamba



Distribution Trunklines and Networks (DLN)

2.60 The plan is to take natural gas supply to the different localities of the regions under study, through local distribution systems, consisting of pipes of different diameters and pressures, which will depend on the type of users to be supplied through the natural gas supply service. Figure 2.5 shows a scheme of the configuration that these systems would provide for the natural gas supply service at the final consumption markets level.

2.61 The distribution pipes infrastructure is complemented by the distribution networks to be developed based on the district stations. They will be built of polyethylene pipe with an SDR dimensional relation (external diameter / thickness) of 11, suitable to operate at a work pressure of 4 bars (LP at 4 bars). These pipes will supply users with the lowest consumption units (residential and business sectors). Finally, the distribution system of the concessionaires is completed with the services of intakes to the different types of users.

2.62 The assumptions and conditions used in the design of the distribution networks for the Ayacucho, Junín, and Ica Regions are as follows:

- High-density polyethylene pipe with SDR of 11.
- It has been anticipated that for the level of pressure used at the networks (4 bars) and given the consumption, which could be experienced in each locality, the average diameter of these pipes will be 63 millimeters.
- In the mountain region, a 9-meter long distribution network per user.
- In the coastal region, an 11.3 meter long distribution network per user.
- The supply to the locality of Paracas in the Ica Region is made through a 4-inch polyethylene pipeline (PE) of 4 inches in Low Pressure.
- As can be observed in the case of La Oroya, the system's configuration differs, depending on whether Alternative 1 or Alternative 2 is used:
    - For Alternative 1, where the supply is produced in Lurín, the pipeline needed will be MP–10 inches, to supply Doe Run, a large customer located at the end of the system.
    - For Alternative 2, since the same industry is located at the start of the system; and therefore, consumption volumes are lower downstream, what is needed is an MP branch of a smaller diameter (4 inches).

2.63 In addition, the assumptions and conditions used in the design of the distribution networks for the Cusco Region are shown below:

- Medium density polyethylene pipe with SDR of 11.
- Maximum operating pressure of 4 bars M.
- Simple or double design depending on the municipal configuration (pipes on one sidewalk, on both, or on the road or street).

- Length of distribution network assigned for each user of 9 meters.
- Length considered for the front of a block of 113 meters.
- Transport capacity defined:
  - Domestic users: 0.6 m^3/ hour.
    - Commercial users: 1 m^3/hour.
    - Industries: as per consumption condition.

2.64 The following must be considered for the historical center of Cusco:

- Not damage the walls built by the Incas, by installing cabinets for the natural gas services, since they are in a preservation category impeding their breakage.
- For safety reasons, the consumption pressures could not exceed 22 g/cm^2.
- The plan calls for the laying of main pipes, which would operate at 4 bars M, plus secondary, pipes at 22 g/cm^2, diverting from the latter, the service to be provided to the users.[40] Regulation points of 4 bars M to 22 g/cm^2 will be distributed depending on the configuration of the network, with consideration to the location and type of user (every two or more blocks). This method of construction would make it possible to go into the properties at consumption pressure, installing natural gas pipes in a manner similar to that being used currently with the water supply. The unit of measure could be installed in the vicinity of the entry point of the pipe, inside the properties.

Premises and Assumptions for the Valuation of Cost of Natural Gas Supply Service

CAPEX in Main Regional Branch (MRT)

2.65 Based on the evaluations made (study of routes, hydraulic studies, and technical–constructive evaluation) an estimate was made of the total cost involved in installing the MRT. The valuation of these costs is made on the basis of the so-called industrial cost of the works, better known as the engineering, procurement, and construction cost (EPC2) which includes the following items:

- Direct labor
- Indirect labor
- Materials and surface installations

[40] It is envisaged that the low pressure network in this zone will be 0.25 bar. In this case the cost to the consumers for 20% of the users in the district – estimated for the historic section of Cusco – will be multiplied by 3; it is also assumed that the pipeline diameters will be 110 mm (3 inches).

- Equipment
- Overheads

2.66 The industrial cost per branch was budgeted and incorporated into the studies of routes and design bases prepared by Intec/Arcan, both for Ayacucho, Junín, and Ica, as well as for Cusco. For this cost, it was necessary to estimate the costs known as soft costs, which include the following items:[41]

- Taxes on gross wages (5 percent of the cost of wages)
- Import of pipes and other materials (10 percent of FOB value)
- Works insurance (1 percent of EPC)
- Municipal taxes (US$ 3,000/km).
- EIA expenses (Coast–Highlands): US$6,800–13,500/km.
- Right of Way (US$5,000/km).
- Contingencies (5 percent of total CAPEX).

2.67 It must be noted that the projects' budget takes into account an analysis of unit prices based on the information available from local suppliers and on an inquiry into details available from previous works executed by similar companies;[42] however, it is important to point out that values are relative and subject to adjustments during a deeper and more detailed analysis. Nevertheless, the values obtained provide a quite accurate preliminary idea of the total cost to take into consideration.

2.68 For the Ayacucho, Junín and Ica Regions, Tables 2.13 and 2.14 project the cost of investment in MRT for each alternative route (Alternatives 1 and 2, respectively). The total CAPEX associated (EPC + Soft Costs) to each alternative is, without including the extension to Nazca and Marcona (which is shown only for reference purposes) as follows:

- Alternative 1: US$87.0 million
- Alternative 2: US$92.7 million

However, it is worth highlighting that through Alternative 2, Huancayo is being supplied, because in order for the two alternatives to be comparable in terms of markets to supply, it will be necessary to add to Alternative 1, the cost of the branch from La Oroya to Huancayo. This cost has been estimated in a pipeline of 106 km and 10 inches in diameter, which ends up in an investment increase for Alternative 1, in the amount of US$22 million.

[41] Estimated parameters according to private sources in Peru.

[42] "Cost Details of the RRP (for the region and RRD (for the locality)" R. Garcia Consultores & Intec/Arcan, October 2004 (Ayacucho, Junin, and Ica Regions) and May 2005 (Cusco Region).

Table 2.13: MRT Investment Costs by Section and Region—Ayacucho, Junín, and Ica Regions (Alternative 1)

Section / System	*million US$*
Lurín–La Oroya	57.6
La Oroya–Tarma	8.2
Total System Junín	*65.9*
Humay–Pisco	6.3
Pisco–Ica	12.3
Ica–Marcona	35.2
Total System Ica	*53.8*
Ayacucho Diversion	*2.5*
Total CAPEX (with extension to Nazca – Marcona)	**122.1**
Total CAPEX (without extension to Nazca – Marcona)	**87.0**

Table 2.14: MRT Investment Costs by Section and Region—Ayacucho, Junín, and Ica Regions (Alternative 2)

Section / System	*million US$*
Ayacucho–Huancayo	41.9
Huancayo–La Oroya	22.2
La Oroya–Tarma	4.5
Total System Junín	*68.6*
Humay–Pisco	6.3
Pisco–Ica	12.3
Ica–Marcona	35.2
Total System Ica	*53.8*
Ayacucho Diversion	*5.5*
Total CAPEX (with extension to Nazca – Marcona)	*127.9*
Total CAPEX (without extension to Nazca – Marcona)	*92.7*

2.69 For the Cusco Region, a construction cost of the MT was estimated for each one of the three alternatives to supply natural gas considered in the study. The results are three different evaluations depending on the following diameters required for the pipeline:

- Cusco + Cachimayo: 8-inch pipeline.
- Cusco + Cachimayo + Quillabamba: 10-inch pipeline.
- Cusco + Cachimayo + Quillabamba + Combapata: 12-inch pipeline.

2.70 The estimated investment for these alternatives has been quantified by Arcan with a tolerance of +/- 20 percent and costs are presented in the form of probability of occurrence, considering that they vary depending on the supply and demand in each category. Table 2.15 shows the cost of investment in MRT for each infrastructure scenario (D1; D1+ D2; D1+ D2 + D3).

Table 2.15: MRT Investment Costs by Demand Scenario—Cusco Region (in US$ million)

CAPEX Requirement	*Demand*		
	D1	*D2*	*D3*
	Cusco + Cachimayo	*Cusco + Cachimayo + Quillabamba*	*Cusco + Cachimayo + Combapata*
CAPEX D1	67.8		
	+		
Incremental CAPEX (D2 – D1)	21.2		
CAPEX D1 + D2	=	89.0	
		+	
Incremental CAPEX (D3 – D2)		38.9	
CAPEX D1 + D2 + D3		=	127.9

CAPEX in Distribution Branches and Networks (DLN)

2.71 In the case of the valuation of the CAPEX for medium pressure branches (15 bars in Ayacucho, Junín, Ica, and Cusco; and 20 bars in Quillabamba) the basis is the configuration previously shown. Unit costs in distribution branches and networks have been applied by OSINERG in the rates review of other networks in Lima and El Callao.[43]

2.72 The following are total costs for investment in infrastructure of the medium pressure distribution systems (MP) in the localities supplied by the MRT, for the Ayacucho, Junín, Ica, and Cusco Regions.

[43] OSINERG Resolution No. 097-2004-OS/CD adopted final tariffs for other natural gas distribution lines in Lima and Callao for the period August 2004–July 2005, Lima, 20/05/2004.

Table 2.16: Investment in MP Distribution Branches by Region—Ayacucho, Junín, and Ica Regions (Alternative 1)

System	*M US$*
La Oroya	2,785
Tarma	1,601
Total Junín Region	*4,386*
Pisco	3, 714
Ica	1,594
Total Ica Region	*5,309*
Total Ayacucho Region	*868*
Total CAPEX	**10,563**

Table 2.17: Investment in MP Distribution Branches by Region—Ayacucho, Junín, and Ica Regions (Alternative 2)

System	*M US$*
La Oroya	2,614
Tarma	1,601
Huancayo	1,781
Total Junín Region	*5,996*
Pisco	3,714
Ica	1,594
Total Ica Region	*5,309*
Total Ayacucho Region	*868*
Total CAPEX	**12,172**

Table 2.18: Investment in MP Distribution Branches by Locality—Cusco Region (in US$ million)

CAPEX Requirement	*Demand*	
	D1	*D2*
	Cusco + Cachimayo	*Cusco + Cachimayo + Quillabamba*
CAPEX D1	2.9	
	+	
Incremental CAPEX (D2 – D1)	0.9	
CAPEX D1 + D2	=	*3.7*

2.73 Investment in Low Pressure (LP) networks will depend on the number of users connected during the period. Considering, both the length of LP pipe per user previously presented for the coastal and mountain regions, and the unit costs for PD networks at 4 bars of 2 inches, total CAPEX in LP networks has been valued for each of the localities. In addition, the cost of intakes will depend on the type of users connected (residential, businesses, VNG, large customers) and on the total number of connections throughout time. Taking as the basis the unit costs in intakes per type of customer according to OSINERG (for the case of residential, businesses and small industry and VNG) and private sources (for the case of large customers) the cost of investment has been estimated in intakes of the service.

2.74 Table 2.19 shows the total investment in LP infrastructure and intakes required by the project for the Ayacucho, Junín, and Ica Regions in the conservative demand and user penetration scenario. It must be pointed out that this scenario will be the base case for economic and financial evaluations. Table 2.20 shows the total investment in LP infrastructure and intakes for the Cusco Region, considering Infrastructure II scenario, in other words, Cusco, Cachimayo, and Quillabamba.

2.75 These investments relate to costs to be incurred by the concessionaires in addition to those described so far (piping, "City Gate" installations, pressure regulating stations, and so forth). The NPFA[44] include all assets which are also required to provide the service, for example: land, buildings, vehicles, accessories, computer systems, and others; which have been valued according to international benchmarks. It has been estimated that these investments represent 5 percent of investment in MRT and DLN infrastructure. The investment amounts corresponding to this item are shown in table 2.19, totaled up by region.

[44] Abbreviation used by OSINERG to identify this type of investment.

Table 2.19: Investment in LP Distribution Networks and Intakes by Region—Ayacucho, Junín, and Ica Regions

Distribution System	*Ref. No. of Users by Year 2025*	*In US$ M*			
		LP	*Intakes*	*Sub-total*	*Total*
La Oroya	3,682	785	815	1,600	
Tarma	6,162	1,314	1,391	2,705	
Huancayo	39,628	8,452	12,192	20,643	
Total Junín					*24,949*
Pisco	10,834	2,885	2,618	5,503	
Ica	24,828	6,620	5,921	12,542	
Total Ica					*18,045*
Ayacucho	*14,226*	*3,035*	*3,371*	*6,406*	*6,406*
Total	**99,360**	**23,092**	**26,307**	**49,400**	**49,400**

Table 2.20: Investment in LP Distribution Networks and Intakes by Locality Cusco Region

Distribution System	*Ref. No. of Users by Year 2025*	*In US$ M*		
		LP	*Intakes*	*Total*
Cusco	37,663	11,899	9,701	*21,600*
Quillabamba	4,784	1,17	3,544	*4,561*
Cachimayo	2	0	2,400	*2,400*
Total	**42,449**	**12,916**	**15,645**	**28,561**

CAPEX in Non-Productive Fixed Assets (NPFA)

Investment Requirements for Working Capital

2.76 In providing the service, the concessionaires will have to deal with costs associated with the stock of materials and the financial monetary capital necessary to fund the time lag existing between the time when natural gas and CTT transport expenses are incurred and when the earnings from their billing are actually obtained. The following criteria has been considered as benchmarks for the valuation of these costs:

- Stock of materials: 2 percent of the annual OPEX value
- Monetary Capital: For MRT, 12.5 percent of the annual increase in OPEX; and for DLN: 20 day lag between the time when gas and CTT expenses

are incurred and when the revenues deriving from billing final users are received.

2.77 These investment requirements are incorporated into the cash flows of the businesses whenever the financial prefeasibility of each unit to be given in concession is analyzed.

OPEX of the Concessionaire's Service

2.78 The valuation of the OPEX of the service provided for the MRT and DLN is obtained by applying the references used by OSINERG in the rate study for Lima and El Callao, as referred to above.[45] The OPEX of the MRT are valued taking into account a cost per length of branch with US$10,627/km of extension of branch. The OPEX of the DLN depends on two main factors: (i) the length of the distribution branches and networks; and, (ii) the number of users provided the service. For the valuation of the OPEX in the Distribution Networks (DN) business for the period under analysis, consideration has been given to these two factors: (i) evolution of km of MP and LP networks, as stated previously, (ii) the user penetration scenario of the so-called Base Case.

CAPEX for which the user is responsible in internal installations and conversions

2.79 It has already been indicated that for the connection to the service and subsequent start of the natural gas consumption, users must make investments in internal installations and conversions. Considering the conservative user penetration scenario in the Ayacucho, Junín, and Ica Regions, the amounts of investment are shown in Table 2.21.

Total Valuation of CAPEX and OPEX by Region and Alternative

2.80 Tables 2.23 to 2.26 contain the global results of the costs of supply (CAPEX and OPEX) by region, as well as technical aspects of the branches such as lengths of the pipes laid and users supplied for all systems. Also identified are the amounts of investment in branches and networks carried out at the start of the project (Year 0) and those performed gradually in the rest of the period under analysis (1–20). It can be appreciated that investment in MRT and DLN of LP is made at the start. The investment in LP networks, intakes and internal installations, on the other hand, is made as the different types of users are incorporated into the service system.

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[45] OSINERG Resolution No. 097-2004-OS/CD.

Table 2.21: Investment in Internal Installations and Conversions by Region Ayacucho, Junín and Ica Regions (in US$ thousands)

Distribution System	*Investment in Internal Installations and Conversions*
La Oroya	3,941
Tarma	2,042
Huancayo	14,649
Total Junín Region	*20,631*
Pisco	10,075
Ica	6,150
Total Ica Region	*16,225*
Ayacucho Region	*2,449*
Total CAPEX	**39,305**

Table 2.22: Investment in Internal Installations and Conversions by Locality Cusco Region (in thousands US$)

Distribution System	*Investment in Internal Installation and Conversions*
Cusco	7,734
Quillabamba	689
Cachimayo	2,500
Total CAPEX	**10,923**

Table 2.23: CAPEX AND OPEX Total—Ica Region (does not include Main Ica–Marcona Branch or the Nazca / Marcona Distribution System, in US$ million)

CAPEX	*Configuration*	*Total Period*	*2005 (Year 0)*	*2006–25 (Rest)*
1. Main Regional Branches	96 km	18.6	18.6	
2. Distribution Branches and Networks	442 km	14.8	6.8	8.1
MP Networks	(39 km)		(5.3)	(8.1)
LP Networks	(403 km)		(1.5)	-
Sub-total CAPEX Costs - Branches and Networks		33.5	25.4	8.1
3. Intake System	35,662 users	8.5	1.3	7.3
4. Internal Installations/Conversions		16.2	7.1	9.2
CAPEX Sub-total Costs - Access to Service		24.8	8.3	16.5
5. Investments in Non-Productive Fixed Assets		1.7	1.3	0.4
	TOTAL	***59.9***	***35.0***	***24.9***
			58%	42%
OPEX		*2007*	*2025*	*Average (2006 –25)*
Branches and Networks System	**TOTAL**	**2.1**	**2.3**	**2.1**

2.81 Table 2.22 shows investments in internal installations and conversions to be made by the users of the Cusco Region to use the natural gas supply service, to which effect, Infrastructure II Scenario (Cusco, Cachimayo, Quillabamba) was considered.

Table 2.24: Total CAPEX and OPEX—Ayacucho Region (in US$ million)

CAPEX	*Configuration*	*Total Period*	*2005 (Year 0)*	*2006–25 (Rest)*
1. Main Regional Branches	22 km	2.5	2.5	
2. Distribution Branches and Networks	136 km	3.9		3.9
MP Networks	(7 km)			
LP Networks	(129 km)			
Sub-total CAPEX Costs - Branches and Networks		6.4	2.5	3.9
3. Intake System	14,226 users	3.4		3.4
4. Internal Installations/Conversions		2.4		2.4
Sub-total CAPEX Costs - Access to Service		5.8		5.8
5. Investments in Non-Productive Fixed Assets		0.3	0.1	0.2
	TOTAL	***12.5***	***2.6***	***9.9***
			21%	79%
OPEX		*2007*	*2025*	*Average (2006 –25)*
Branches and Networks System	**TOTAL**	**0.5**	**0.7**	**0.6**

Table 2.25: Total CAPEX and OPEX—Junín Region, Alternative 1

CAPEX	*Configuration*	*Total Period*	*2005 (Year 0)*	*2006–25 (Rest)*
1. Main Regional Branches	236 km	65.9	65.9	
2. Distribution Branches and Networks	113 km	6.5		6.5
MP Networks	(24 km)			
LP Networks	(89 km)			
Sub-total CAPEX Costs - Branches and Networks		72.4	65.9	6.5
3. Intake System	9,844 users	2.2		2.2
4. Internal Installations/Conversions		6.0		6.0
Sub-total CAPEX Costs - Access to Service		8.2		8.2
5. Investments in Non-Productive Fixed Assets		3.6	3.3	0.3
	TOTAL	***84.2***	***69.2***	***15.0***
			82%	18%
OPEX		*2007*	*2025*	*Average (2006 –25)*
Branches and Networks System	**TOTAL**	**2.7**	**2.9**	**2.8**

Table 2.26: Total CAPEX and OPEX—Junín Region, Alternative 2

CAPEX	*Configuration*	*Total Period*	*2005 (Year 0)*	*2006–25 (Rest)*
1. Main Regional Branches	380 km	71.6	71.6	
2. Distribution Branches and Networks	492 km	16.5		16.5
MP Networks	(45 km)			
LP Networks	(447 km)			
Sub-total CAPEX Costs - Branches and Networks		88.1	71.6	16.5
3. Intake System	49,472 users	14.4		14.4
4. Internal Installations/Conversions		20.6		20.6
Sub-total CAPEX Costs - Access to Service		35.0		35.0
5. Investments in Non-Productive Fixed Assets		4.4	3.6	0.8
	TOTAL	***127.6***	***75.2***	***52.4***
			59%	41%
OPEX		*2007*	*2025*	*Average (2006–25)*
Branches and Networks System	**TOTAL**	**4.8**	**5.5**	**5.1**

2.82 In order to facilitate the comparison of the routes Alternatives 1 and 2 of the Ayacucho, Junín, and Ica Regions, with regard to investment amounts required and markets to be served with natural gas supply, the cost of supply of the first alternative has been increased by the cost of the extension of the MRT La Oroya–Huancayo (Junín Region) and investments in DLN and internal installations in the locality of Huancayo. Thus, Alternative 1 has been conditioned and identified as Alternative 1–A. Tables 2.27, 2.28, and 2.29 show the total results (CAPEX and OPEX) for Alternatives 1, 1–A and 2, respectively.

Table 2.27: Total CAPEX and OPEX—Ayacucho, Junín, and Ica Regions, Alternative 1 (in US$ million)

CAPEX	*Configuration*	*Total Period*	*2005 (Year 0)*	*2006 –25 (Rest)*
1. Main Regional Branches	354 km	87.0	87.0	
2. Distribution Branches and Networks	691 km	25.2	6.8	18.4
MP Networks	(70 km)		(5.3)	(5.3)
LP Networks	(620 km)		(1.5)	(13.2)
Sub-total CAPEX Costs - Branches and Networks		112.2	93.7	18.4
3. Intake System	59,732 users	14.1	1.3	12.9
4. Internal Installations/Conversions		24.7	7.1	17.6
Sub-total CAPEX Costs - Access to Service		38.8	8.3	30.5
5. Investments in Non-Productive Fixed Assets		5.6	4.7	0.9
	TOTAL	***156.6***	***106.7***	***49.8***
			68%	32%
OPEX		*2007*	*2025*	*Average (2006 –25)*
Branches and Networks System	**TOTAL**	**7.3**	**7.8**	**7.4**

Table 2.28: Total CAPEX and OPEX—Ayacucho, Junín, and Ica Regions, Alternative 1–A (in US$ million)

CAPEX	*Configuration*	*Total Period*	*2005 (Year 0)*	*2006 –25 (Rest)*
1. Main Regional Branches	460 km	109.1	109.1	
2. Distribution Branches and Networks	1,061 km	35.4	6.8	28.7
MP Networks	(82 km)		(5.3)	(7.0)
LP Networks	(978 km)		(1.5)	(21.6)
Sub-total CAPEX Costs - Branches and Networks		144.6	115.9	28.7
3. Intake System	99,360 users	26.3	1.3	25.1
4. Internal Installations/Conversions		39.3	7.1	32.3
Sub-total CAPEX Costs - Access to Service		65.6	8.3	57.3
5. Investments in Non-Productive Fixed Assets		7.2	5.8	1.4
	TOTAL	***217.4***	***130.0***	***87.4***
			60%	40%
OPEX		*2007*	*2025*	*Average (2006 –25)*
Branches and Networks System	**TOTAL**	**8.0**	**9.1**	**8.4**

Table 2.29: Total CAPEX and OPEX—Ayacucho, Junín, and Ica Regions, Alternative 2 (in US$ million)

CAPEX	*Configuration*	*Total Period*	*2005 (Year 0)*	*2006 –25 (Rest)*
1. Main Regional Branches	476 km	92.7	92.7	
2. Distribution Branches and Networks	1.,069 km	35.3	6.8	28.5
MP Networks	(91 km)		(5.3)	(6.9)
LP Networks	(978 km)		(1.5)	(21.6)
Sub-total CAPEX Costs - Branches and Networks		127.9	99.5	28.5
3. Intake System	99,360 users	26.3	1.3	25.1
4. Internal Installations/Conversions		39.3	7.1	32.3
Sub-total CAPEX Costs - Access to Service		65.6	8.3	57.3
5. Investments in Non-Productive Fixed Assets		6.4	5.0	1.4
	TOTAL	***199.9***	***112.7***	***87.2***
			56%	44%
OPEX		*2007*	*2025*	*Average (2006 –25)*
Branches and Networks System	***TOTAL***	***9.3***	***10.4***	***9.7***

2.83 Table 2.30 shows the characteristics differentiating Alternatives 1 and 2, which have been explained in detail thus far. It is concluded is that although the Lurín–La Oroya–Tarma branch is to supply the Junín Region with an implicit lower cost of investment, compared to the Ayacucho–Huancayo–La Oroya-Tarma diversion branch, the following needs to be pointed out:

- It is necessary to add in the first alternative the incremental investment to include the Huancayo market, and this makes this alternative's investment higher.
- Under Alternative 1, prior incremental investments will be needed on the Camisea trunk pipeline (three years prior than that of Alternative 2).
- The fact that Alternative 1 starts at a point, which is further from Camisea, makes the supply to the Junín Region more critical, since, with regard to the hydraulic behavior versus the transport system, it is less risky to take the natural gas, which is closer to the fields.

Table 2.30: Branch Comparison by Alternative for Supply to the Junín Region

Item	*Alternative 1*		*Alternative 2*
	Lurín–La Oroya–Tarma Section		*Camisea BV277—Ayacucho–Huancayo–La Oroya–Tarma Section*
	Without extension to Huancayo	*With extension to Huancayo*	
Final year with natural gas supply	2007		2010
Length (km)	236	342	380
Diameters (inches)	12–10–6		10–6
Distance from Camisea to diversion (km)	732	838	278
Hydraulic behavior versus the transport system	Critical since it derives from Lurín (system's extreme node)		Acceptable since it is a point which is closer to Camisea
Industrial cost (millionUS$)	53.8	71.3	57.8

2.84 Tables 2.31, 2.32, and 2.33 present the Total CAPEX and OPEX for the three demand scenarios considered for the Cusco Region:

Table 2.31: Total CAPEX and OPEX—Cusco Region, Scenario I: Cusco–Cachimayo (in US$ million)

CAPEX	*Configuration*	*Total Period*	*2005 (Year 0)*	*2006 –25 (Rest)*
1. Main Regional Branches (8-inch)	233 km	67.8	67.8	-
2. Distribution Branches and Networks	362 km	14.8	4.7	10.0
MP Networks	(23 km)		(2.9)	-
LP Networks	(339 km)		(1.8)	(10.0)
Sub-total CAPEX Costs - Branches and Networks		82.6	72.5	10.0
3. Intake System	37,665 users	12.1	3.9	8.2
4. Internal Installations/Conversions		10.2	3.3	6.9
Sub-total CAPEX Costs - Access to Service		22.3	7.3	15.1
5. Investments in Non-Productive Fixed Assets		4.1	3.6	0.5
	TOTAL	***109.0***	***83.4***	***25.6***
			70%	24%
OPEX		*2007*	*2025*	*Average (2006 –25)*
Branches and Networks System	**TOTAL**	**3.3**	**3.7**	**3.6**

Table 2.32: Total CAPEX and OPEX—Cusco Region, Scenario II: Cusco–Cachimayo–Quillambamba (in US$ million)

CAPEX	*Configuration*	*Total Period*	*2005 (Year 0)*	*2006 –25 (Rest)*
1. Main Regional Branches (8-inch)	270 km	89.0	89.0	-
2. Distribution Branches and Networks	411 km	16.7	5.8	10.9
MP Networks	(29 km)		(3.7)	-
LP Networks	(382 km)		(2.0)	(10.9)
Sub-total CAPEX Costs - Branches and Networks		105.7	94.8	10.9
3. Intake System	42,449 users	15.6	6.5	9.2
4. Internal Installations/Conversions		10.9	3.4	7.5
Sub-total CAPEX Costs - Access to Service		26.6	9.9	16.7
5. Investments in Non-Productive Fixed Assets		5.3	4.7	0.5
	TOTAL	***137.6***	***109.4***	***28.1***
			80%	20%
OPEX		*2007*	*2025*	*Average (2006 –25)*
Branches and Networks System	***TOTAL***	***3.8***	***4.3***	***4.1***

Table 2.33: Total CAPEX and OPEX—Cusco Region, Scenario III: Cusco–Cachimayo–Quillambamba–Combapata (in US$ million)

CAPEX	*Configuration*	*Total Period*	*2005 (Year 0)*	*2006 –25 (Rest)*
1. Main Regional Branches (8 inch)	380 km	128.0	128.0	
Kepashiato–Quillabamba–Cachimayo–Cusco	(270 km)		(95.6)	
Cusco–Combapata	(110 km)		(32.4)	
2. Distribution Branches and Networks	411 km	16.7	5.8	10.9
MP Networks	(29 km)		(3.7)	
LP Networks	(382 km)		(2.0)	(10.9)
Sub-total CAPEX Costs - Branches and Networks		144.6	133.7	10.9
3. Intake System	42,449 users	15.6	6.5	9.2
4. Internal Installations/Conversions		10.9	3.4	7.5
Sub-total CAPEX Costs - Access to Service		26.6	9.9	16.7
5. Investments in Non-Productive Fixed Assets		7.2	6.7	0.5
	TOTAL	***178.4***	***150.3***	***28.1***
			84%	16%
OPEX		*2007*	*2025*	*Average (2006 –25)*
Branches and Networks System	**TOTAL**	**5.0**	**5.5**	**5.3**

Comparison of Investment Costs between the Ayacucho, Junín, Ica, and Cusco Regions

2.85 Table 2.34 shows investment costs broken down for the Ayacucho, Junín, Ica, and Cusco regions, with details of costs for the three demand scenarios of the Regions such as Ica, Junín, and Ayacucho, with higher forecasts of natural gas demand for the year 2025 (63.5 MMCFD and 55.6 MMCF, respectively) have an implicit lower cost of investment per capacity unit, versus the case of the Cusco Region.

Table 2.34: Total CAPEX AND OPEX—Ayacucho, Junín, Ica, and Cusco Regions (in US$ million)

Item		*Junín + Ayacucho*	*Ica*	*Cusco Region*		
				Cusco + Cachimayo + Quillabamba + Combapata	*Cusco + Cachimayo + Quillabamba*	*Cusco + Cachimayo*
CAPEX MRT + NPFA	million US$	78.1	56.8	135.2	94.3	71.9
CAPEX DLN + Intakes	million US$	38.2	23.4	32.3	32.3	26.9
Internal Installations + Conversions	million US$	23.1	16.2	10.9	10.9	10.2
Total CAPEX	million US$	139.4	96.4	178.4	137.6	109.0
OPEX MRT + DLN	million US$	5.7	2.1	5.3	4.1	3.6
Demand (2025)	millionCFD	55.6	63.5	64.1	37.2	14.9
Total CAPEX / Demand	**US$/CFD**	2.51	*1.52*	*2.78*	*3.7*	*7.32*
Users	No.	63,698	35,662	42,450	42,447	37,663

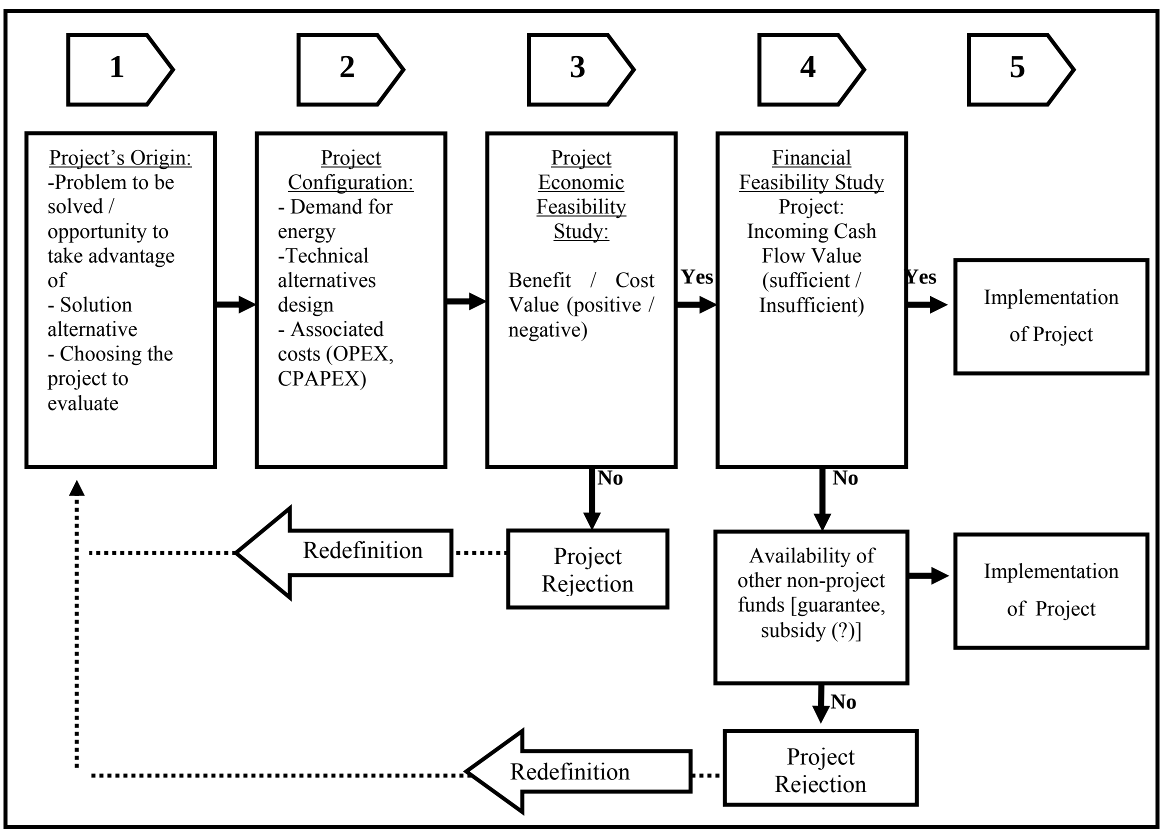
3

Economic and Financial Prefeasibility Analysis of the Projects: Evaluation Methodology

Evaluation Methodology

3.1 The projects for the provision of natural gas to the regions are under analysis from the economic and financial points of view following a staged methodology shown below. Under this methodology, projects pass different analyses or tests to decide on their implementation.

Figure 3.1: Stages for Preparation and Analysis of Economic and Financial Feasibility of Projects



3.2 So far, coverage has been given to Stage 1 (Origin of the Project) and Stage 2 (Configuration of the Project). This chapter will deal with Stages 3 (Economic Evaluation) and Stage 4 (Financial Evaluation), which, once successfully addressed, lead into Stage 5 (Implementation of Projects).

3.3 The economic evaluation—shown in Figure 3.2—compares the economic benefits and costs generated by projects to supply natural gas to the different regions. The benefits are represented by the economic value of the energy sources to be replaced by the different sectors, as well as by environmental benefits estimated to be brought about by the arrival of the natural gas. The benefit is calculated as the current value of the demand for energy sources to be replaced in the period, multiplied by the respective economic prices of the energy sources.[46] It should be noted that the valuation of the revenues does not include the additional amount generated by the fluids (ethane, propane, butane, and gasoline) which can be extracted and sold since the natural gas is produced to be sold in the "downstream" market in the form of dry natural gas.[47] The economic value is then compared to the economic costs, which will be required to supply the new energy source, stated in current value. The costs include all of the chain's costs explained in Chapter 2 to the final consumer (natural gas, transport, CAPEX and OPEX of MRT and DLN, CAPEX of internal installations, and conversions of final users). The valuation of the net economic benefits, as usual, does not include any form of taxes or other transfers between sectors of the economy.

3.4 Whenever the benefits exceed the costs, the following financial evaluation stage is started; otherwise, the project needs to be rejected and redefined from Stage 1.

3.5 It is worth noting that in addition to the economic evaluation analysis, a different analysis was performed to value the potential monetary savings of consumers when they substitute more expensive energy sources with natural gas. This analysis is called "substitution suitability" and it takes into account, for the valuation of revenues, the current prices of the energy sources to be substituted. This analysis was only performed for the Cusco Region, since on the date of preparation of the study for this region, there were more frequent increases in the oil prices (April 2005); although this was not the case for the Ayacucho, Junín, and Ica Regions, where the analysis could not be justified, because the economic prices were practically the actual prices paid by the user, excluding taxes[48] (October 2004).

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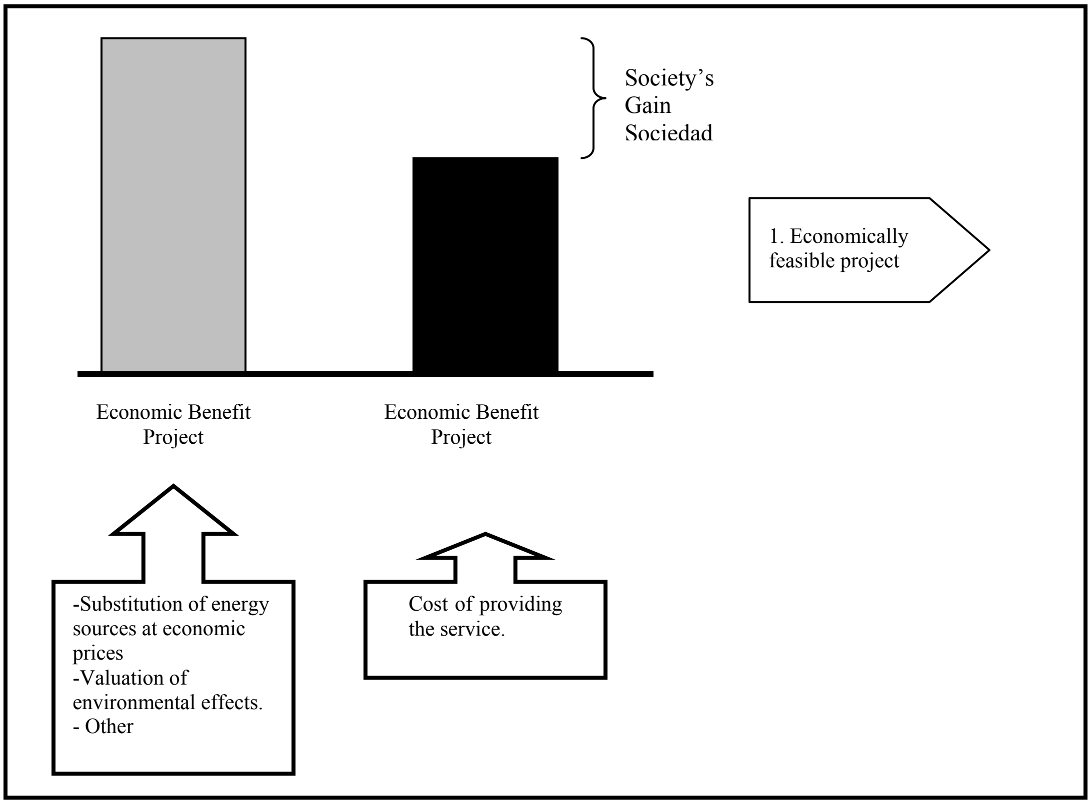
[46] It shows the savings in energy that this project brings to the economy.

[47] Mostly methane.

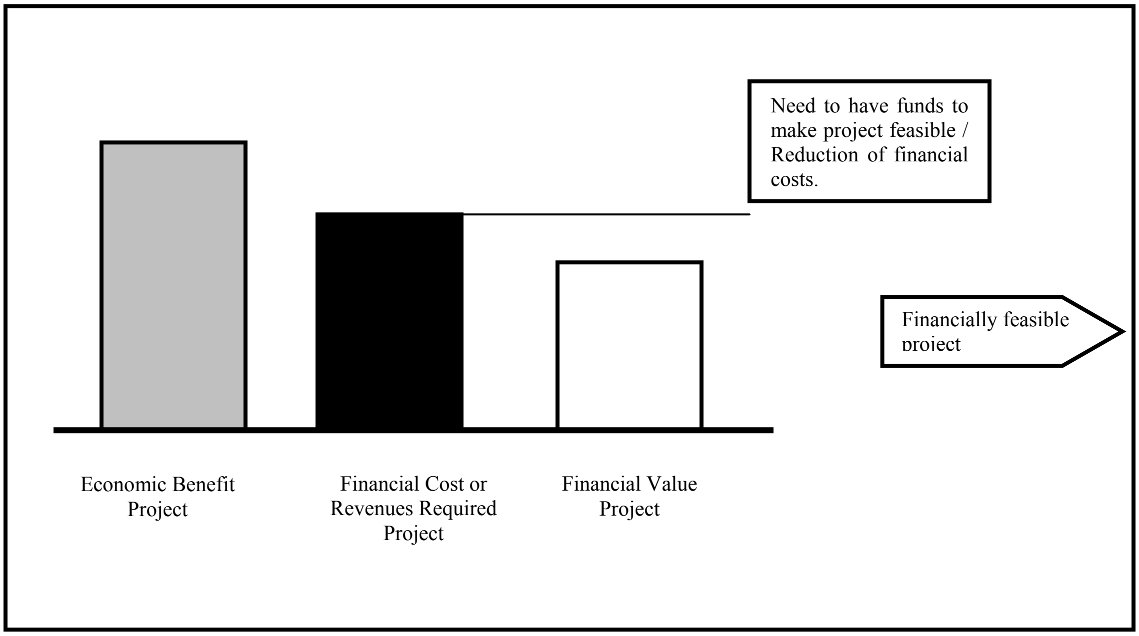
[48] See "Prices of other Energy sources to be Replaced by Natural Gas" page 94.

Figure 3.2: Economic Prefeasibility of the Project



3.6 In the financial evaluation, the objective is to make the projects to supply natural gas to the regions sustainable for the concessionaire. This means that providing the service should encompass an income or rate or a combination of both to permit the recovery of all financial costs, plus other costs beyond the control of the concessionaire (natural gas, CTT) and all the CAPEX and OPEX of the main and secondary trunklines to the final user, plus a reasonable compensation. In the event that—due to social, market, or other reasons—the government decides to impose a rate which is lower than the cost to provide the service, there must be funds which are not generated by the project itself, known as off-project funds, so the provision of the service is sustainable in financial terms. Figure 3.3 features a scheme of the analysis performed in financial terms, and it can be observed that in the event that it is not possible to adequately structure the business from the financial point of view, for the concessionaire, it will be necessary to redefine the project and in that case, return to Stage 1, creating a new supply project to be implemented, which will be the reevaluated.

Figure 3.3: Financial Prefeasibility of the Project



Economic Prefeasibility of the Projects and Suitability of Substitution

3.7 The calculation for the prefeasibility analysis of the projects, which includes the analysis of suitability of substitution for the user for the Cusco Region only and the economic evaluation for all regions, was made according to the so-called base case for the project of the Ayacucho, Junín, and Ica Regions, while in the case of the project of the Cusco Region, consideration was given to Scenarios I and II for the dimensioning of the MRT to supply Cusco–Cachimayo (8-inch pipeline) and Cusco–Cachimayo–Quillabamba (10-inch pipeline) respectively. The assumptions for these scenarios will be explained in detail further down. Additionally, as will be seen below, sensitivity exercises were conducted to identify the main critical variables of the projects for the supply of natural gas to the different regions. In the methodological annex shown in Exhibit 1 the development of the formulae used for the calculations of the economic evaluations is included.

3.8 For the specific calculation of the economic benefits by region, the prefeasibility analysis was specifically conducted for each consumer sector by region in order to identify the sectoral composition of the economic benefits of the projects under analysis.

Analysis and Information Assumptions for Calculations

Valuation of the Revenues

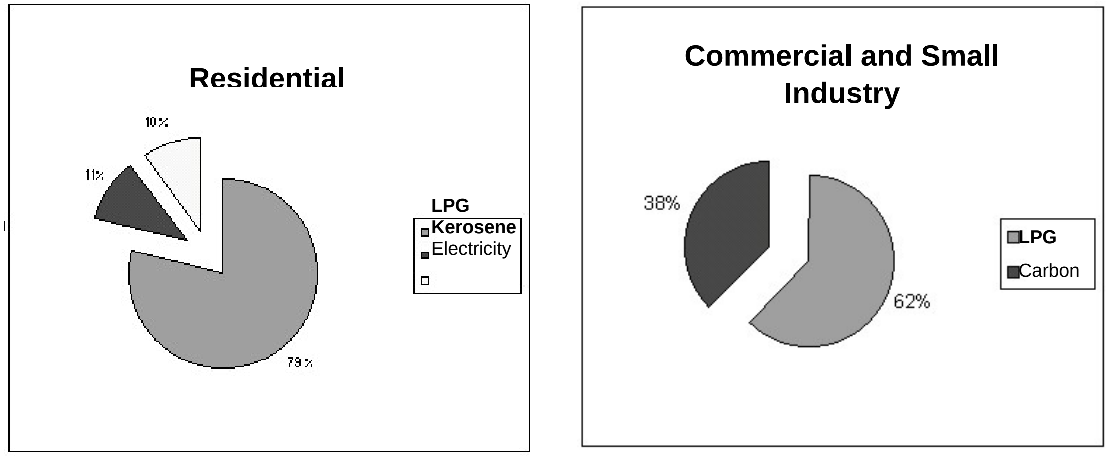
A) Composition of Basic Consumption of Energy Sources to be Replaced by NG, by Sector

3.9 According to the data resulting from the surveys made by the CRC–Macroconsult, which formed the basis for the preparation of the market studies, a design of the composition of the basic energy sources to be replaced by natural gas was made by consumer sector. The results are shown in Graphs 3.1–3.4, for each of the regions under analysis.

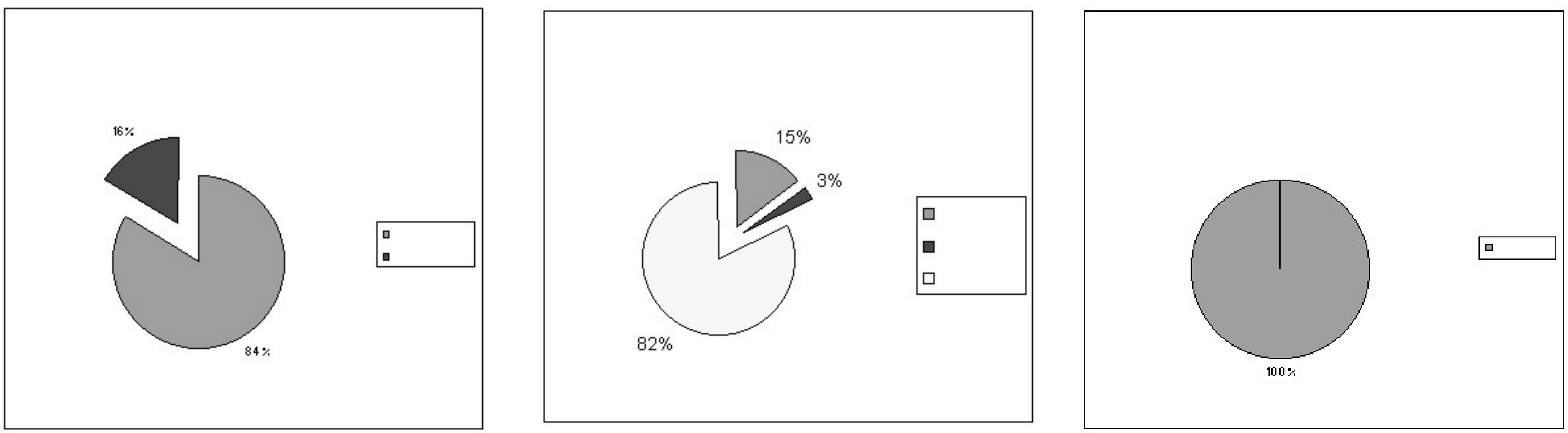
3.10 The main fuel to be replaced in the residential sector will be LPG, followed, with less volume, by kerosene, lumber, and electricity.[49] In the commercial and small industries sector, the most relevant will be residual, followed by LPG. In the large customers sector, the main energy sources to be replaced are residual and carbon, principally. In the motor vehicles sector, which does not form part of the Graph, the fuel to be replaced will be gasoline.

[49] The nitrates division of the Yura company located in Cachimayo in the Cusco Region would replace this power station.

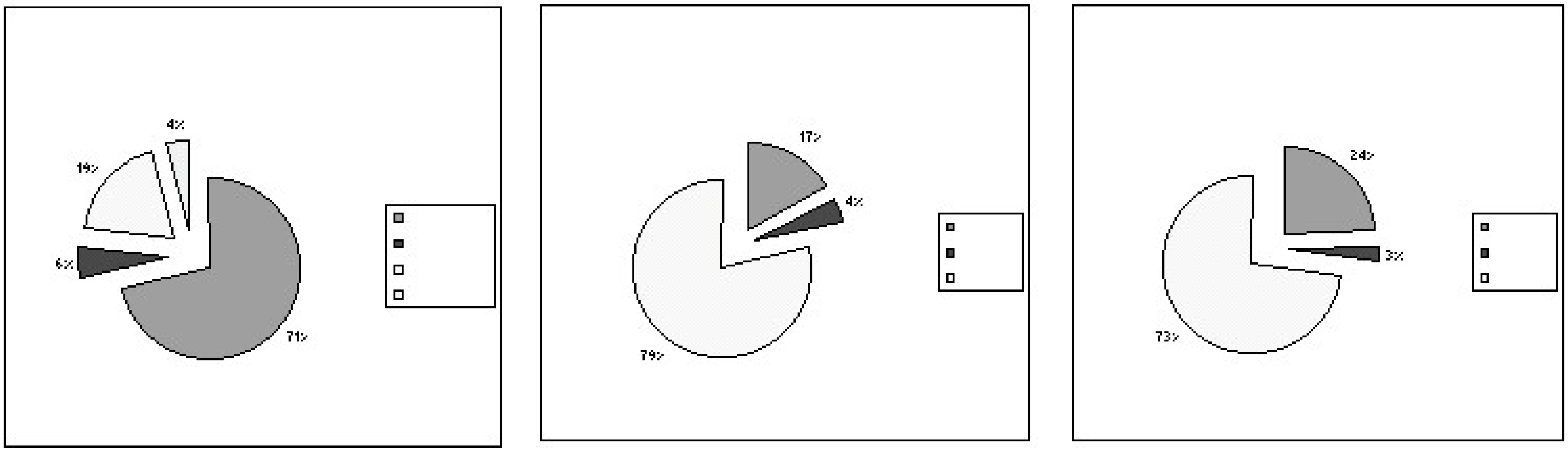
Graph 3.1: Consumption of Energy Sources Potentially Replaceable by Natural Gas—Ayacucho Region



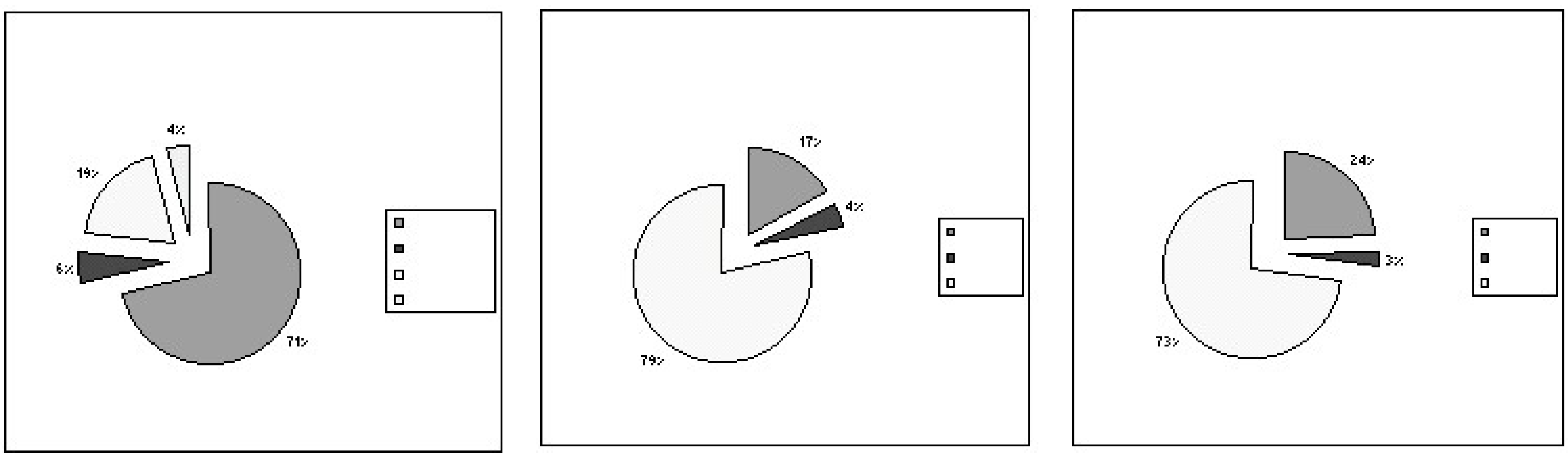
Graph 3.2: Consumption of Energy Sources Potentially Replaceable by Natural Gas—Ica Region



Graph 3.3: Consumption of Energy Sources Potentially Replaceable by Natural Gas—Junín Region



Graph 3.4: Consumption of Energy Sources Potentially Replaceable by Natural Gas—Cusco Region



B) Valuation of the Economic Benefit of the Natural Gas Thermal Station in Quillabamba

3.11 In the case of Quillabamba, a city situated in the Cusco Region, the potential natural gas demand is explained almost entirely by a thermal generation project. For the valuation of the benefit which electricity generation could contribute, the calculation of the "Net Back Value" (NBV) of natural gas delivered at the new thermal station is made. This NBV results from calculating the difference in current values for a 20-year period of the revenues to be generated by the thermal station at the energy bar price at the Machupichu node minus the cost of capital and operational cost of the station for a reasonable plant use factor[50] during the period under consideration. The NBV must be interpreted as the maximum value of natural gas to be used in the thermal station. For the benefit of the station to be positive in the analysis, the NBV must be greater than the cost of supplying natural gas delivered at the station (natural gas price + Main Camisea Pipeline Transport + Costs MRT-DLN).[51]

C) Prices of the Energy Sources to be Replaced by Natural Gas

3.12 The prices of the energy sources to be replaced differ depending on the analysis performed:

- *Substitution prices for the user:* current prices excluding VAT (value added tax).
- *Economic Prices:* Petroperú prices of energy sources excluding taxes, amended as per the price values published by OSINERG under the name "Reference Prices of Petroleum Byproducts." These prices are considered an adequate proxy of the economic prices, since the methodology used by the entity for its reference price calculations uses estimates of import or export parity prices. For the study of the Ayacucho, Junín and Ica Regions, the parity prices correspond, to the prices in force for July 2004 and for the study of the Cusco Region, to the prices in force for March 2005, with the implicit WTI crude oil price at the time being US$38/bbl and US$54/bbl, respectively. Due to this difference, assuming a conservative general position, US$40/bbl was taken as the reference price for the estimates in the scenarios or base cases of the two reports for the period under analysis (2005–2025). The simulation exercises made, as shown further below, were conducted reflecting the rising trend in crude oil prices. See Table 3.2 with sensitivity values for the prices of the energy sources in several WTI scenarios.

3.13 As was indicated at the beginning of this section the user substitution suitability analysis was only performed for the case of the Cusco Region due to the rise in the international prices of crude at the time when the study was prepared for this region (April 2005); this not being the case for the Ayacucho, Junín, and Ica Regions (October

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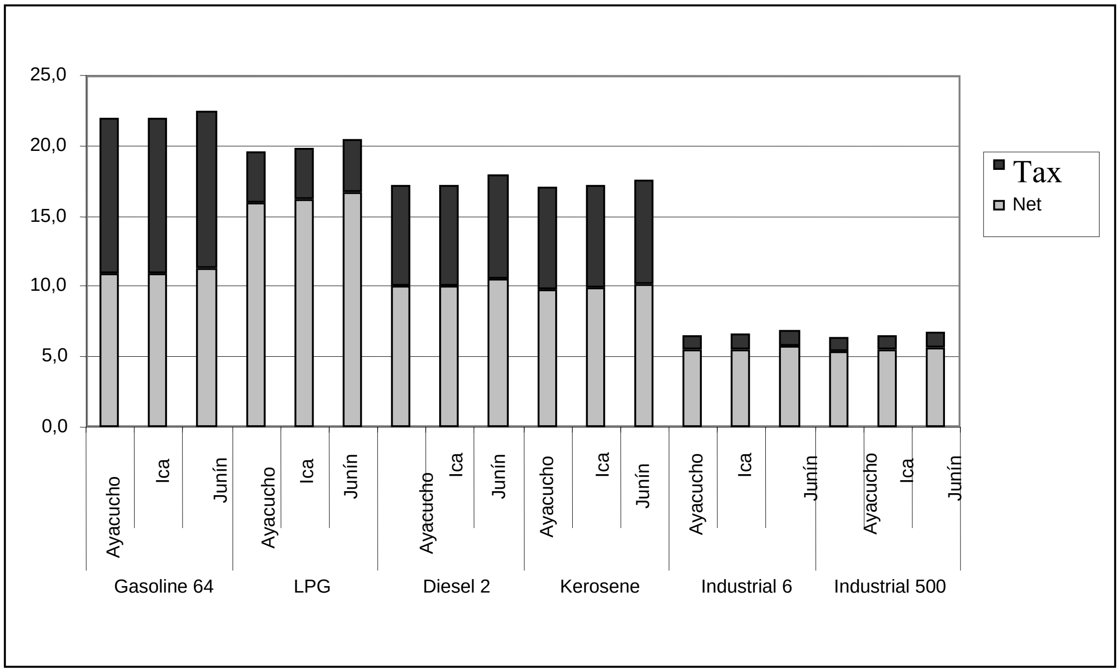
[50] For this exercise a factor of plant use capacity of 60 percent was used.
[51] See Annex 1, paragraph A.3.

2004) when the economic prices were practically the actual prices paid by the user, excluding taxes, that is to say, using the OSINERG calculation method.

3.14 The following charts show the prices with and without taxes for: LPG, gasoline, kerosene, diesel, and industrial residual (in the case of the Cusco Region, these prices were used for the analysis of substitution suitability for the user). Also shown are main energy price assumptions by sector.

Graph 3.5: Average Price of Energy Sources to be Replaced by Natural Gas for the Ayacucho, Junín, and Ica Regions, in effect as of July 2004 (in US$/ MMBTU)



Graph 3.6: Average Price of Energy Sources to be Replaced by Natural Gas for the Cusco Region, in effect as of March 2005 (in US$/ MMBTU)

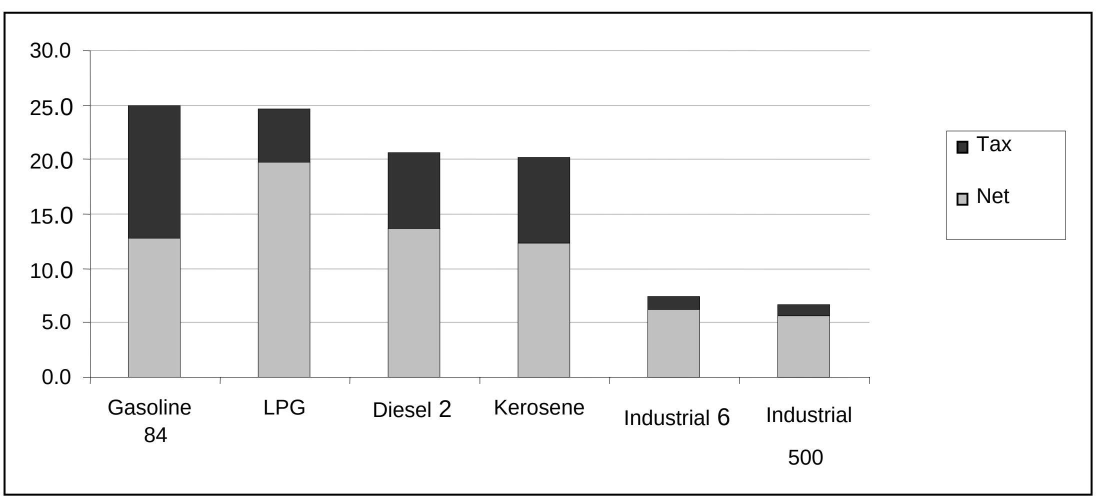


Table 3.1: Energy Price Assumptions

Sector	*Assumptions*[a]
Large users	1) Average prices of fuel: LPG, kerosene, diesel and residue, by locality. 2) In the case of some companies implicit fuel prices were used (Source: CCR Surveys)
Businesses and small industries	1) Average fuel prices: LPG, kerosene and residue, by locality. 2) For the price of carbon, the reference value is the purchase price of the mineral for Large Users (LU) from the closest area, plus 20 percent, as “proxy” of discounts made to LU for volume. (Source: CCR).
VNG	1) Average prices of 84 Gasoline by locality.
Residential	1) Average prices of fuel: LPG and kerosene, by locality. 2) For the regions of Ayacucho and Ica – Pisco the reference values are the prices of the Pisco Plant, for Junín Region: prices of the Pasco Plant (Source: Petroperú) 2) Electricity price (excluding VAT) according to typical consumption (*Source:* GART) 3) Lumber was not given an economic value.

[a] The prices of fuel are those in effect on the date of preparation of the reports, that is to say, as of July 2004 for the Ayacucho, Junín, and Ica Regions, and as of March 2005 for the Cusco Region. Source: Petroperú.

3.15 The economic prices of energy sources to be replaced by natural gas for different WTI price scenarios used in the economic evaluation analysis are also shown. Table 3.2 shows that the prices of gasoline and diesel are the prices that go up and down the most compared to the price of other byproducts.

D) Weighted Average Prices by Consumer Sector by Region

3.16 Based on the assumptions explained in the preceding points, it was possible to establish the average prices per equivalent heat unit (US$/MMBTU) paid on average by the different sectors evaluated by the energy sources to be replaced by natural gas.

3.17 Table 3.3 shows prices as of March 2005 for the Cusco Region, which are used as the basis for the analysis of substitution suitability for the user.

Table 3.2: Economic Prices of Energy Sources to be Replaced by Natural Gas (Sensitivity of Crude Prices as of July 2004)

Energy Source	*WTI Crude Price (US $/bbl)*				
	26	*31*	*40*	*46*	*54*
	Price (US$/MMBTU) and Variation (%) with respect to July 2004				
LPG	13.8	14.9	17.9	18.6	20.3
	-23%	*-17%*	*0%*	*4%*	*13%*
Gasoline	9.2	10.7	14.3	14.1	17.0
	-35%	*-25%*	*0%*	*-1%*	*20%*
Kerosene	9.7	9.6	12.8	13.9	16.6
	-24%	*-25%*	*0%*	*9%*	*30%*
Diesel 2	7.5	8.4	11.1	12.4	15.3
	-32%	*-24%*	*0%*	*12%*	*38%*
Residual 6	4.4	5.3	5.8	5.9	6.6
	-24%	*-8%*	*0%*	*2%*	*15%*
Residual 500	4.3	5.3	5.5	5.5	6.1
	-22%	*-4%*	*0%*	*-1%*	*11%*
Electricity	10.8	11.0	11.4	11.8	11.8
	-5%	*-3%*	*0%*	*3%*	*3%*

Table 3.3: Current Prices (excluding VAT) of Energy Source Substitutes Cusco Region (US$/MMBTU)

Energy Source Sector		*Energy source to be replaced*								*Weighted Average Price*
		LPG	*Kerosene*	*Electricity.*	*Lumber*	*Gasoline*	*Diesel 2*	*Carbon*	*Residual 500*	
Residential	Price	21.3	17.8	31.7	-	-	-	-	-	22.2
	% Use	71	6	19	4					
Businesses and Small Industries	Price	21.3					18.2	4.7		11.6
	% Use	16					32	53		
VNG	Price					21.8				21.8
	% Use					100				
LU	Price	18.1		6.0			18.2		6.1	6.4
	% Use	1		94			2		3	
Kantu	Price	12.8								12.8
	% Use	100								
Hotels	Price	20.1					18.2			18.7
	% Use	30					70			
Cervesur	Price						18.2		6.1	7.9
	% Use						15		85	
Cachimayo Nitrates	Price			6.0						6.0
	% Use			100						

3.18 Tables 3.4 to 3.8 show the economic prices of energy sources to be replaced by natural gas for all regions.

Table 3.4: Economic Prices of Energy Sources to be Replaced for the Ica–Pisco Region (US$/MMBTU)

Energy Source Sector		*Energy source to be replaced*								*Weighted Average Price*
		LPG	*Kerosene*	*Electricity.*	*Lumber*	*Gasoline*	*Diesel 2*	*Carbon*	*Residual 500*	
Residential	Price	17.1	12.2	29.2						19.0
	% Use	84	0	16						
Businesses and Small Industries	Price	17.1						4.7	5.4	7.1
	% Use								82	
VNG	Price					13.6				13.6
	% Use					100				
LU	Price		12.2						5.4	5.4
	% Use		0						100	
Fisheries	Price								5.4	5.4
	% Use								100%	
Acers Arequipa	Price		12.2						5.4	5.4
	% Use		0						100	
Funsur	Price								5.4	5.4
	% Use								100	

Table 3.5: Economic Prices of Energy Sources to be Replaced for the Junín Region—Alternative I (US$/MMBTU)

Energy Source Sector		*Energy source to be replaced*								*Weighted Average Price*
		LPG	*Kerosene*	*Electricity.*	*Lumber*	*Gasoline*	*Diesel 2*	*Carbon*	*Residual 500*	
Residential	Price	17.1	12.2	30.8	-					16.4
	% Use	80	11	4	4					
Businesses and small industries	Price	17.1						3.7		10.7
	% Use	52						48		
VNG	Price									
	% Use									
LU	Price	17.1				13.6	10.5	3.5	5.4	5.2
	% Use	1				0	3	24	72	
Doe Run	Price	17.1				13.6	10.5		5.4	5.9
	% Use	2				1	6		92	
Calera Cut Off	Price								5.4	5.4
	% Use								100	
Cemento Andino	Price							3.5	5.4	4.3
	% Use							60	40	

Table 3.6: Economic Prices of Energy Sources to be Replaced for the Junín Region—Alternative II (US$/MMBTU)

Energy Source Sector		*Energy source to be replaced*								*Weighted Average Price*
		LPG	*Kerosene*	*Electricity.*	*Lumber*	*Gasoline*	*Diesel 2*	*Carbon*	*Residual 500*	
Residential	Price	17.1	12.2	30.3	-					16.4
	% Use	78	9	7	7					
Businesses and small industries	Price	17.1						3.7	5.4	7.2
	% Use	17						4	79	
VNG	Price					13.6				13.6
	% Use					100				
LU	Price	17.1				13.6	10.5	3.5	5.4	5.2
	% Use	1				0	3	24	72	
Doe Run	Price	17.1				13.6	10.5		5.4	5.9
	% Use	2				1	6		92	
Calera Cut Off	Price								5.4	5.4
	% Use								100	
Cemento Andino	Price							3.5	5.4	4.3
	% Use							60	40	

Table 3.7: Economic Prices of Energy Sources to be Replaced for the Ayacucho Region (US$/MMBTU)

Energy Source Sector		*Energy source to be replaced*								*Weighted Average Price*
		LPG	*Kerosene*	*Electricity.*	*Lumber*	*Gasoline*	*Diesel 2*	*Carbon*	*Residual 500*	
Residential	Price	17.1	12.2	30.6						17.9
	% Use	79	11	10						
Businesses and small industries	Price	17.1						4.7		12.4
	% Use	63						38		

Table 3.8: Economic Prices of Energy Sources to be Replaced for the Cusco Region (US$/MMBTU)

Energy Source Sector		*Energy source to be replaced*								*Weighted Average Price*
		LPG	*Kerosene*	*Electricity.*	*Lumber*	*Gasoline*	*Diesel 2*	*Carbon*	*Residual 500*	
Residential	Price	17.9	12.8	31.7	-					19.5
	% Use	71	6	19	4					
Businesses and small industries	Price	17.9					11.1	4.7		8.8
	% Use	16					32	53		
VNG	Price					14.3				14.3
	% Use					100				
LU	Price	17.9		11.4			11.1		5.5	11.3
	% Use	1		94			2		3	
Kantu	Price	17.9								17.9
	% Use	100								
Hotels	Price	17.9					11.1			13.1
	% Use	30					70			
Cervesur	Price						11.1		5.5	6.3
	% Use						15		85	
Cachimayo Nitrates	Price			11.4						11.4
	% Use			100						

E) Natural Gas Demand by Consumer Sector

3.19 The conservative scenario demand projections have been considered for the case of the Ayacucho, Junín, and Ica Regions, and Scenarios II and I for the Cusco Region, taking into account all user categories. Electricity generation has not been included in the exercise as a use to be replaced.

Valuation of the Economic Costs of Supply

A) Costs of Supply

3.20 Following are all economic costs related to the provision of the service to supply natural gas to the final users identified in Figure 2.1:

- Total costs to provide the service: natural gas, CTT transport, MRTs, DLNs, and Services Intakes.
- Costs of internal installation and conversion of the user are included in the cost of supply, which were not subtracted from the revenue valuation.[52]

3.21 Following are some clarifications with respect to the natural gas and transport cost values assumed:

- *Cost of natural gas:* does not strictly carry its economic cost represented by the production cost, but rather, due to the effect of the respective analysis, a cost of US$1.0 /MMBTU is assumed, and it is increased to US$1.8/MMBTU in the sensitivity exercise.[53] In the case of the Cusco Region, in order to analyze the substitution suitability of the user and of economic evaluation, a referential cost was assumed in the amount of US$1.0/MMBTU.
- *Transport cost:* in the analysis of substitution suitability of the user a transport cost equal to the current cost is assumed for the CTT, which obviously does not represent a strict economic cost for this segment, since the rate is postal rather than by distance. This is why the economic analysis uses a referential estimated rate by distance. This concept of the distance factor in transport is explained further down, and its determination is detailed in the Methodological Appendix.

[52] It must be clarified that this report addresses the conversion to natural gas by all users; it must be taken into account that operational costs with natural gas are far lower compared to other fuels. For large users of residue and lumber, there are significant savings in equipment maintenance, warehousing, and fuel management. For businesses and small industries these types of savings would also apply. Within the residential consumption of LPG, it must be pointed out that natural gas avoids transport problems and having to store LPG cylinders (which occupy space and are difficult to deliver to isolated households). These aspects were not quantified as savings in the economic valuation, which undoubtedly increases the positive results reached.

[53] This price range reflects the amount negotiated for the Camisea project: US$1.0 /MMBTU for the initial contracts and US$1.8 /MMBTU for the contracts following the bidding. The price changing from US$1.0 to US$1.8 /MMBTU is only a transfer of revenues within the economy, and therefore it is not a loss for the company. What is meant to be shown with the sensitivity is what the user would not save if a higher price were taken into consideration.

B) Allocation of Costs by Consumer Sector

3.22 Since the impact of the natural gas supply to the different sectors of consumer users (residential, commercial and small industry, VNG, large customers) has been economically evaluated, it was necessary to perform a prior allocation of supply costs between the different types of customers. Table 3.9 identifies the criteria used to allocate the various types of costs (medium pressure, low pressure, intakes, operational costs, and so forth) between the different customer categories. They follow cost responsibility economic criteria.

Table 3.9: Supply Cost Allocation Criteria by Consumer Sector

Type of Cost	*Customer Category*				*Cost Allocation Criteria*
	Resid.	*Com. and Small Ind.*	*VNG*	*LU*	
(1) Main Regional Trunkline Cost	X	X	X	X	Allocation by volume and by customer category
(2) Investments in Exclusive Fixed Assets (HP)	-	-	-	X	Specific allocation by customer
(3) Investments in Combined Fixed Assets (MP)	X	X	X	X	Allocation by percent share in the demand
(4) Investments in Combined Fixed Assets (LP)	X	X	-	-	Specific allocation by customer
(5) Investments in Non-Productive Fixed Assets	X	X	X	X	5% value (2)+(3)+(4) by customer category
(6) Operational and Maintenance Cost	X	X	X	X	By number of users and by network km
(7) Costs of Intakes	X	X	X	X	Specific allocation by customer
(8) Internal Installation and Conversion Costs	X	X	X	X	Specific allocation by customer

C) Base Case Parameters

3.23 Having explained the assumptions used for the calculations, table 3.10 provides a summary of the basic parameters defining the so-called Base Case or Base Scenario for the regions under study:

Table 3.10: Definition of Base Case for the Ayacucho, Junín, and Ica Regions

Variable	*Criteria*
A) Demand of the Project:	
Demand Sectors	Conservative scenario
Residential demand	Conservative scenario / percent users without heating
B) Costs of Supply:	
Cost of natural gas	Reference Price: US$ 1.0 /MMBTU
Cost of Camisea Trunk Transport	Cost at Distance Rate: US$ 0.47/MMBTU for Ayacucho and Alternative 2 for Junín; US$ 1.16/MMBTU for Ica and Alternatives 1 and 1-A for Junín
MRT Cost (CAPEX–OPEX–Other)	Reference assumptions as per Point 2.3.1
Internal Installation and Conversion Costs	Reference assumption as per Point 2.3.2
C) Prices of the energy sources to be replaced:	
Residential, commercial and small and large industries sector prices	WTI Economic Prices US$ 40/bbl

C) Prices of the energy sources to be replaced:

Residential, commercial and small and large industries sector prices WTI Economic Prices US$40/bbl

Table 3.11: Definition of Base Case for the Cusco Region

Variable	*Analysis*	
	User Suitability	*Economic Evaluation*
A) Project Demand		
Demand Sectors		
Residential demand	Scenario without heating	
B) Supply Costs :		
Cost of natural gas	Reference price: US$ 1.0/MMBTU	
Cost of Camisea Trunk Transport—Rest of users	Postal Rate: US$1.21/MMBTU	Rate by Distance: US$0.22/MMBTU
Cost of Camisea Trunk Transport—Generators	Postal Rate: US$0.85/MMBTU	Rate by Distance: US$0.22/MMBTU
MRT Cost (CAPEX–OPEX–Other)	Reference assumptions as per Point 2.3.1	
Internal installation and conversion costs	Reference assumptions as per Point 2.3.2	
C) Prices of the energy sources to be replaced:		
Residential, commercial, and small and large industries sector prices	Fuel prices excluding IGV in effect as of March 2005 (*Source:* Petroperú)	Economic Prices WTI US$40/bbl

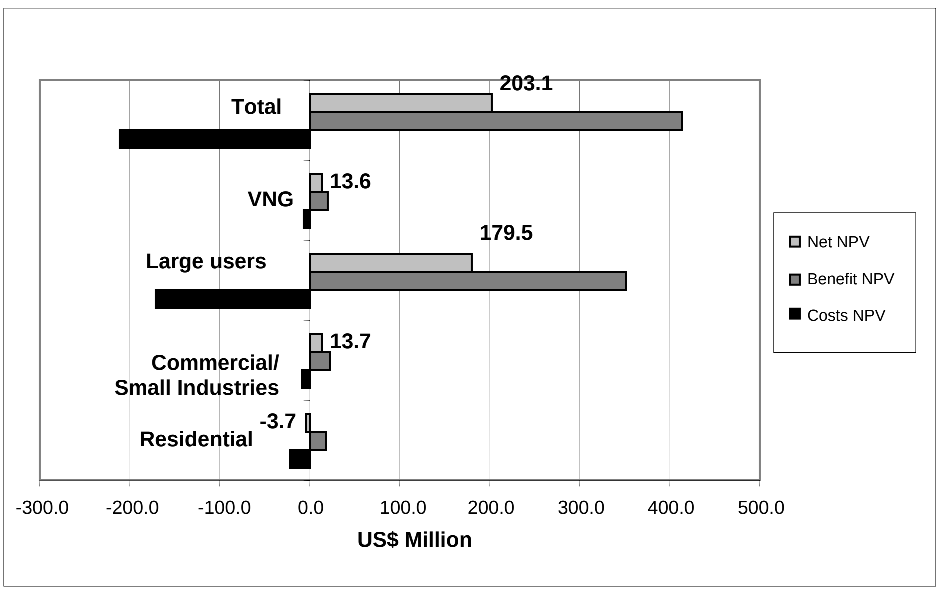
3.24 Based on the calculation algorithms presented in the Methodological Annex[54] and on the assumptions and basic premises described in Section 3.2.1, calculations were performed for the viability analysis of the regional projects; taking into account the base case for the study of the Ayacucho, Junín, and Ica Regions, and Infrastructure Scenarios I and II of the study for the Cusco Region (Cusco + Cachimayo and Cusco + Cachimayo + Quillabamba, respectively).

3.25 To express the revenue and cost variables of the valuation in current terms, consideration was given to a discount rate of 12 percent per year[55] and the Net Present Values (NPV) were calculated for a 20-year period.

Ayacucho, Junín, and Ica Regions

3.26 The results of the economic evaluation of the base case (revenues, costs, benefits) are shown below: (1) by region and by consumer category; (2) by alternative and by consumer sector; (3) for the total of the regions, as per alternative.

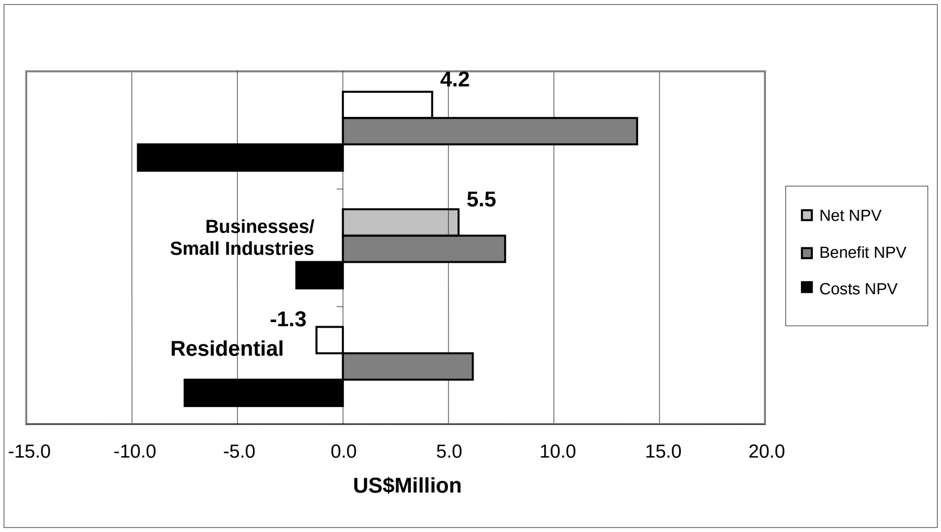
Graph 3.7: Economic Benefit Evaluation by Consumer Sector Ica–Pisco Region (US$ million)



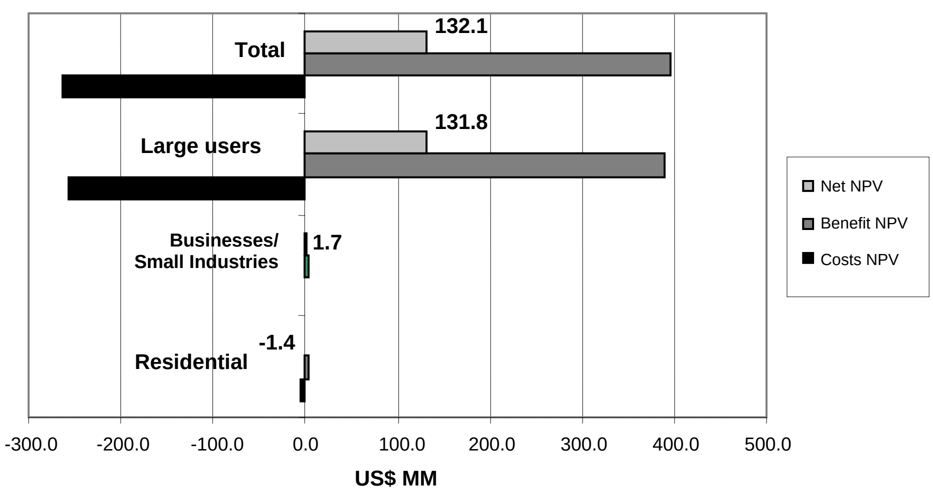
[54] Points A.3 and A.2.

[55] No estimated social discount rate for natural gas projects in Peru was available for this study.

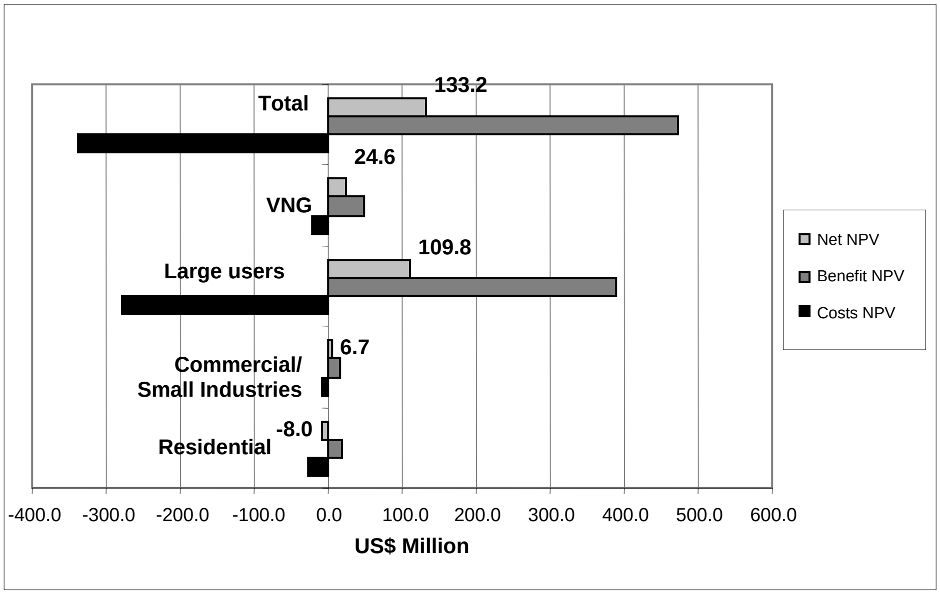
Graph 3.8: Economic Benefit Evaluation by Consumer Sector Ayacucho Region (US$ million)



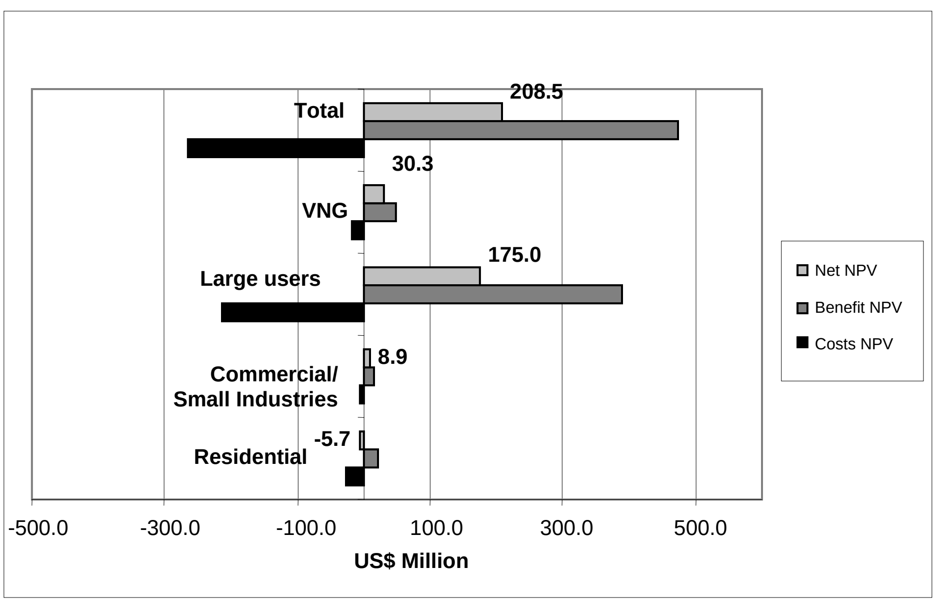
Graph 3.9: Economic Benefit Evaluation by Consumer Sector—Junín Region, Alternative 1 (US$million)



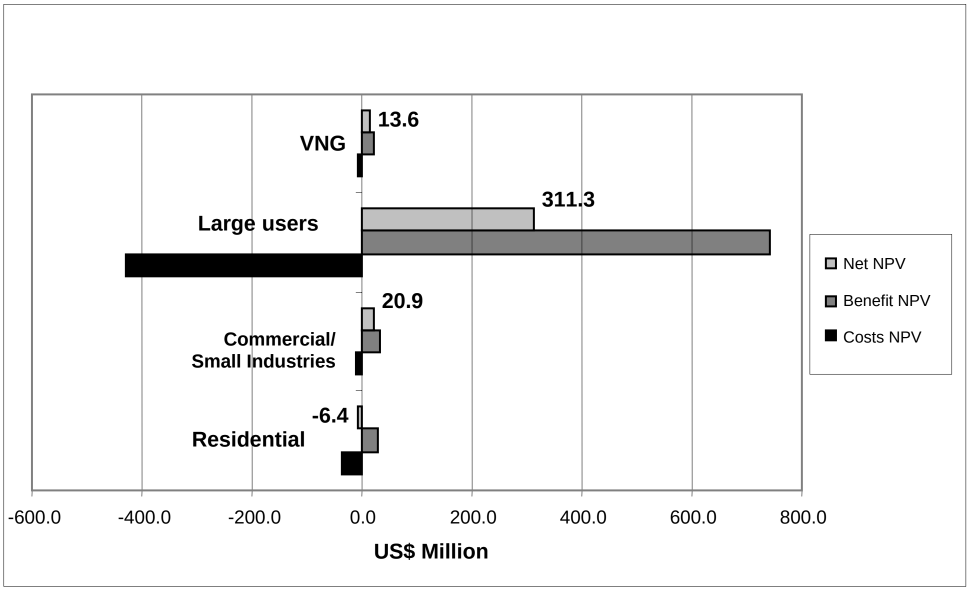
Graph 3.10: Economic Benefit Evaluation by Consumer Sector—Junín Region Alternative 1–A (US$ million)



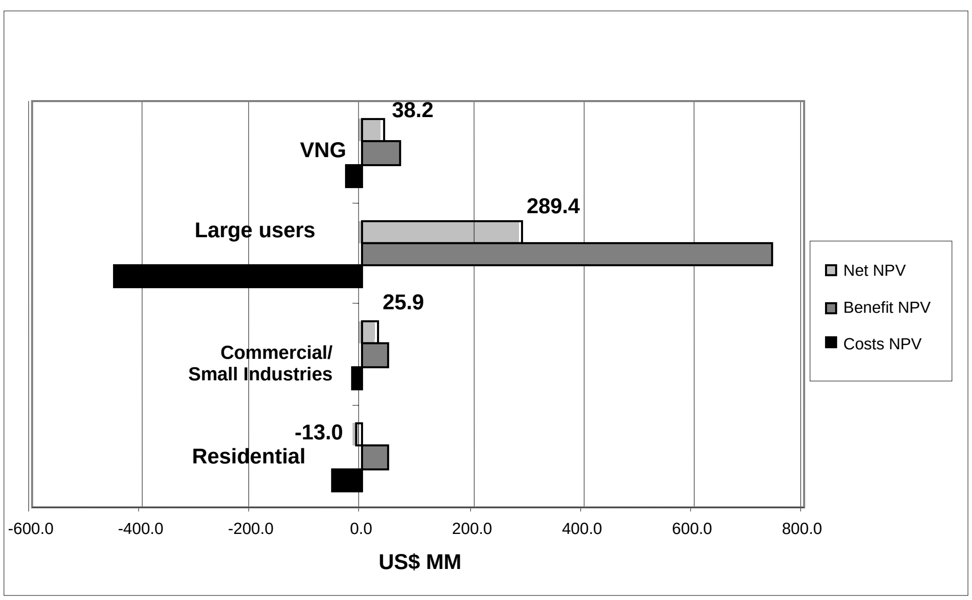
Graph 3.11: Economic Benefit Evaluation by Consumer Sector—Junín Region, Alternative 2 (US$ million)



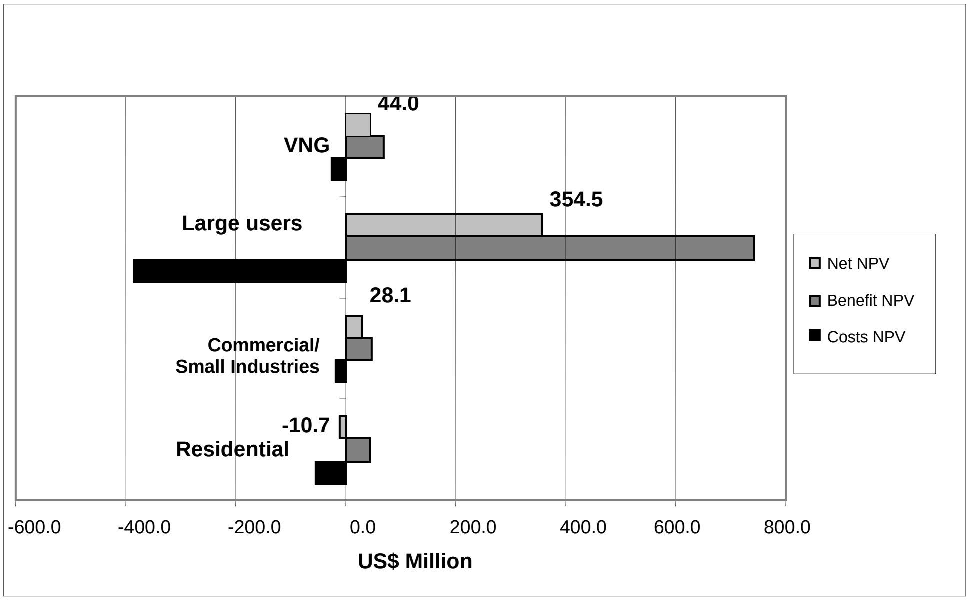
Graph 3.12: Economic Benefit Evaluation by Consumer Sector—Total Ayacucho, Junín, and Ica Regions, Alternative 1 (US$ million)



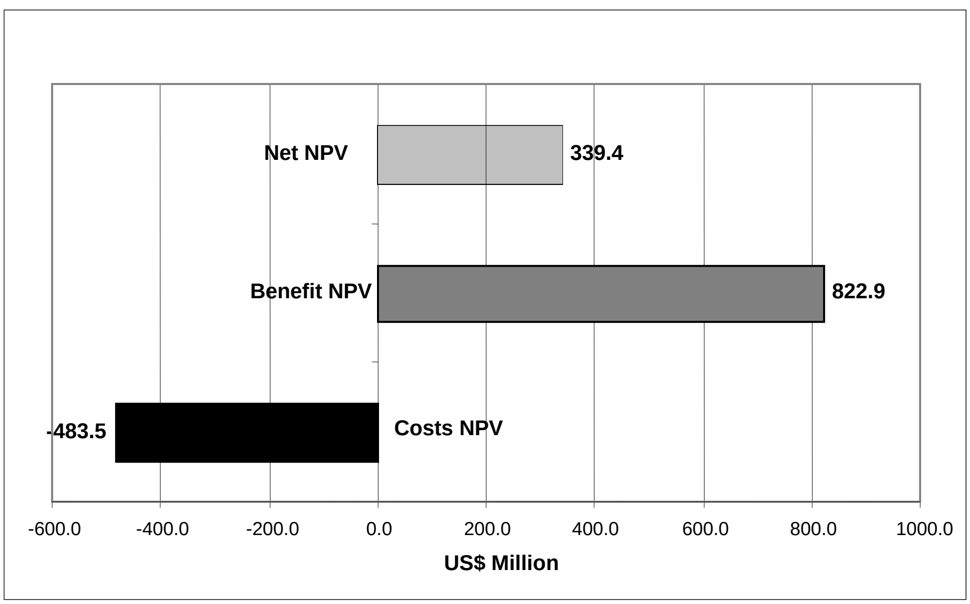
Graph 3.13: Economic Benefit Evaluation by Consumer Sector—Total Ayacucho, Junín, and Ica Regions, Alternative 1–A (US$ million)



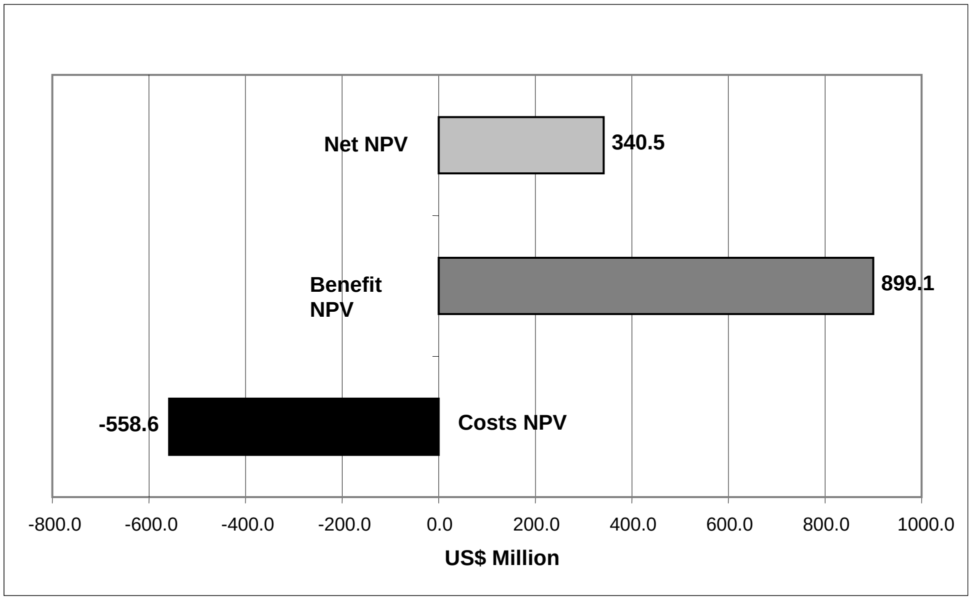
Graph 3.14: Economic Benefit Evaluation by Consumer Sector—Total Ayacucho, Junín, and Ica Regions, Alternative 2 (US$ million)



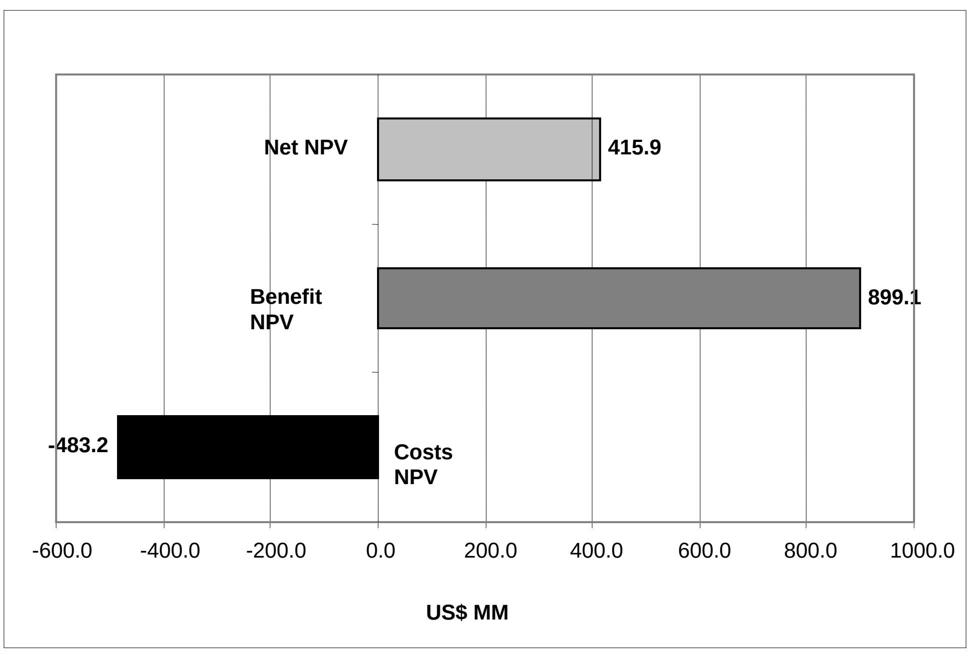
Graph 3.15: Economic Benefit Evaluation Total Consumer Sectors—Ayacucho, Junín, and Ica Regions, Alternative 1 (US$ million)



Graph 3.16: Economic Benefit Evaluation Total Consumer Sectors Ayacucho, Junín, and Ica Regions, Alternative 1–A (US$ million)



Graph 3.17: Economic Benefit Evaluation Total Consumer Sectors—Ayacucho, Junín, and Ica Regions, Alternative 2 (US$ million)



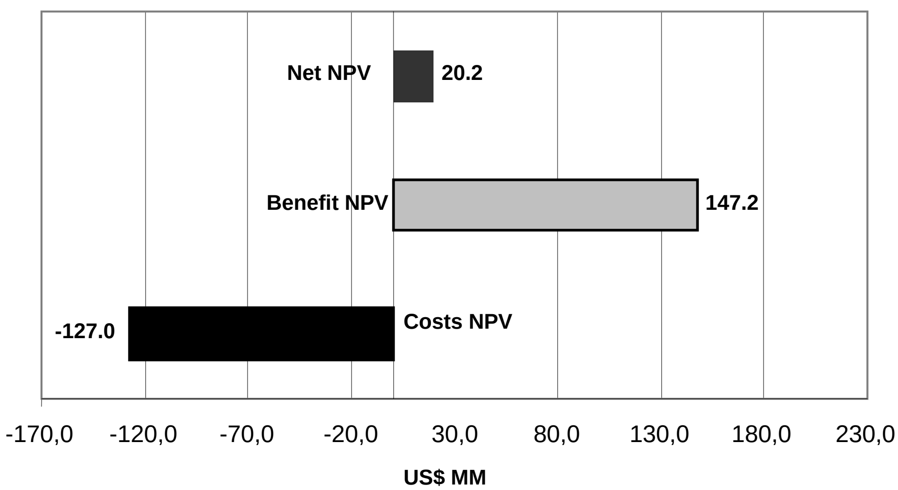
Cusco Region

3.27 The results of the economic evaluation (revenues, costs, benefits) for infrastructure scenarios I and II are shown below: (1) by type of analysis (user/economic suitability); (2) by scenario alternatives (I and II); and (3) by consumer sector (residential, commercial, VNG, and large customers).

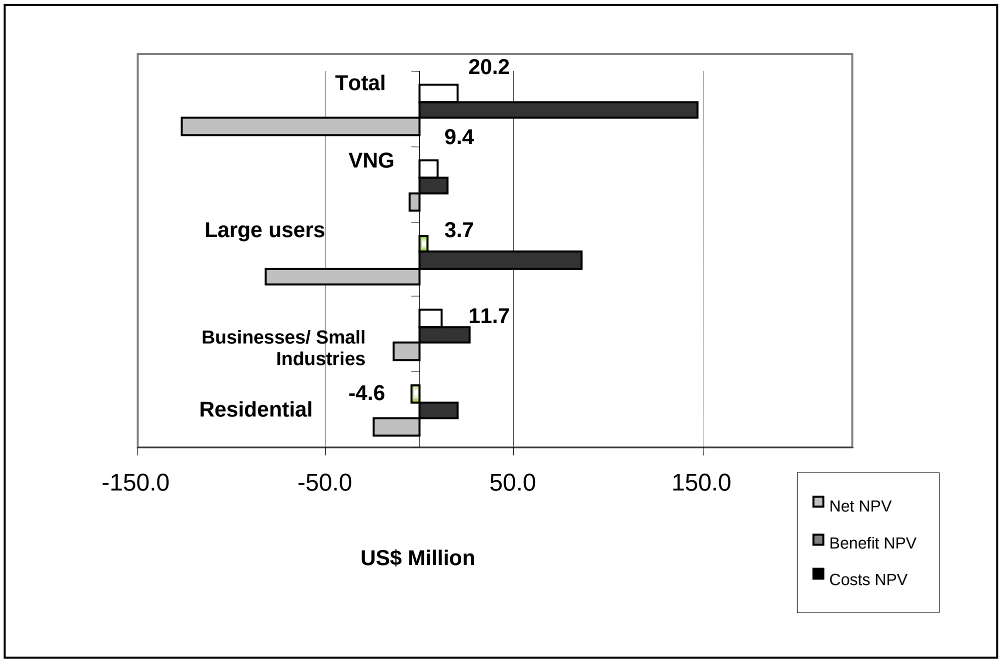
A) Evaluation of Scenario I: Cusco and Cachimayo

3.28 The net benefit of this project is positive both for the user suitability analysis (US$20.2 million) as well as for the economic evaluation (US$89.7 million). The difference between the two analyses is basically explained by the greater opportunity value (maximum value willing to be paid) given to electric energy (US$38/MWh) in the economic analysis compared to the price paid by the main large industry in Cachimayo (US$20/MWh, as of March 2005) which is the value used to evaluate user suitability. This can be appreciated by comparing Graphs 3.19 and 3.21 with respect to the valuation of the large customers sector.

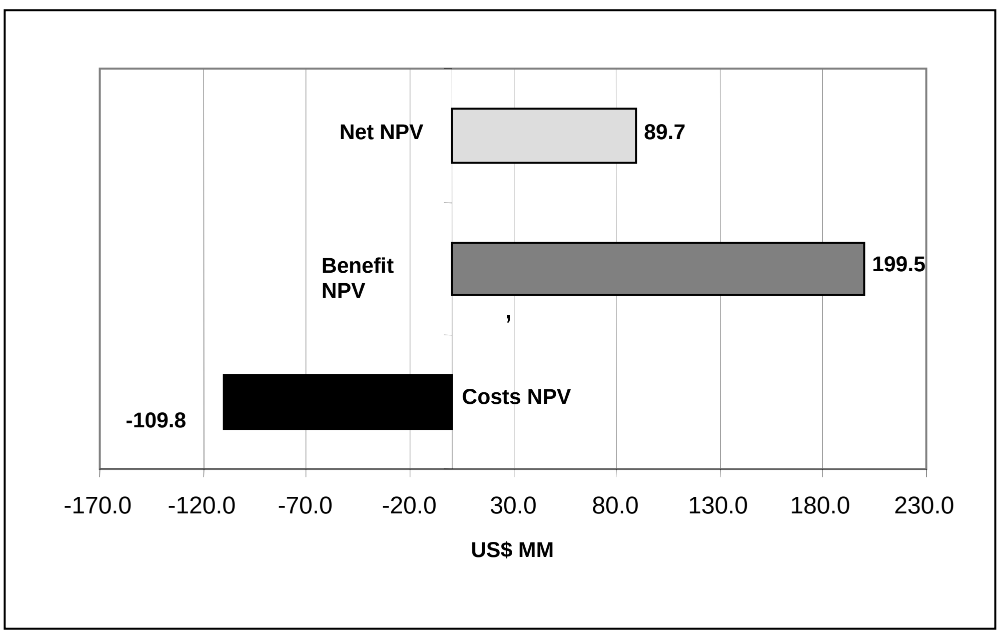
Graph 3.18: Evaluation of the Benefit of Substitution of Energy Sources Total Consumer Sectors (with market prices and costs as of March 2005) Cusco Region Scenario I (Cusco + Cachimayo)



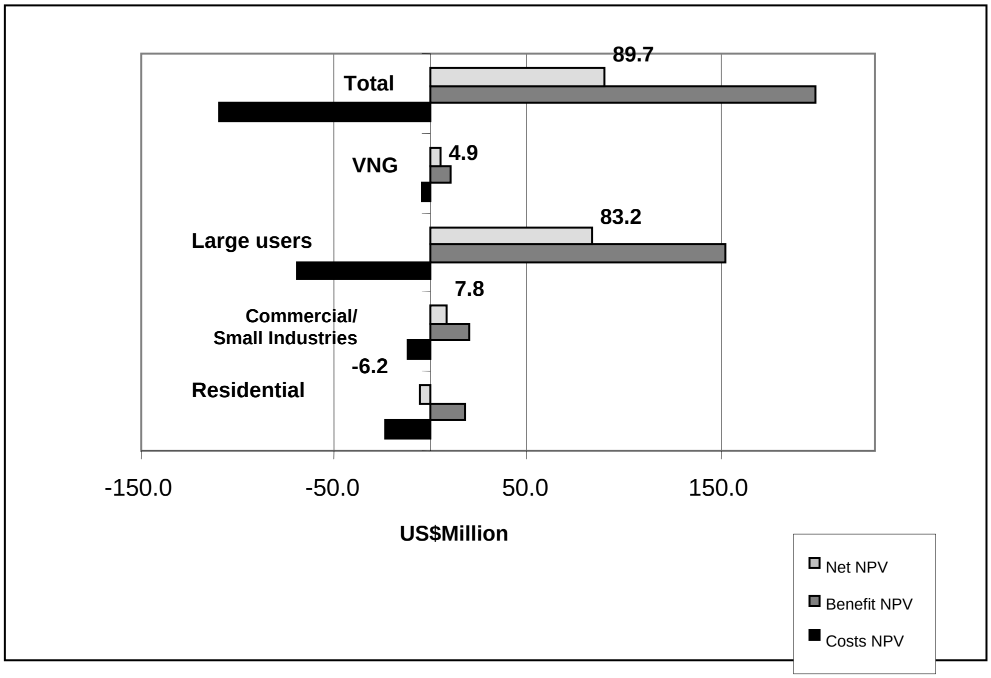
Graph 3.19: Evaluation of the Benefit of Substitution of Energy Sources by Consumer Sector (with market prices and costs as of March 2005)—Cusco Region Scenario I (Cusco + Cachimayo)



Graph 3.20: Economic Benefit Evaluation Total Consumer Sectors Cusco Region—Scenario I (Cusco + Cachimayo)



Graph 3.21: Economic Benefit Evaluation by Consumer Sector Cusco Region—Scenario I (Cusco + Cachimayo)

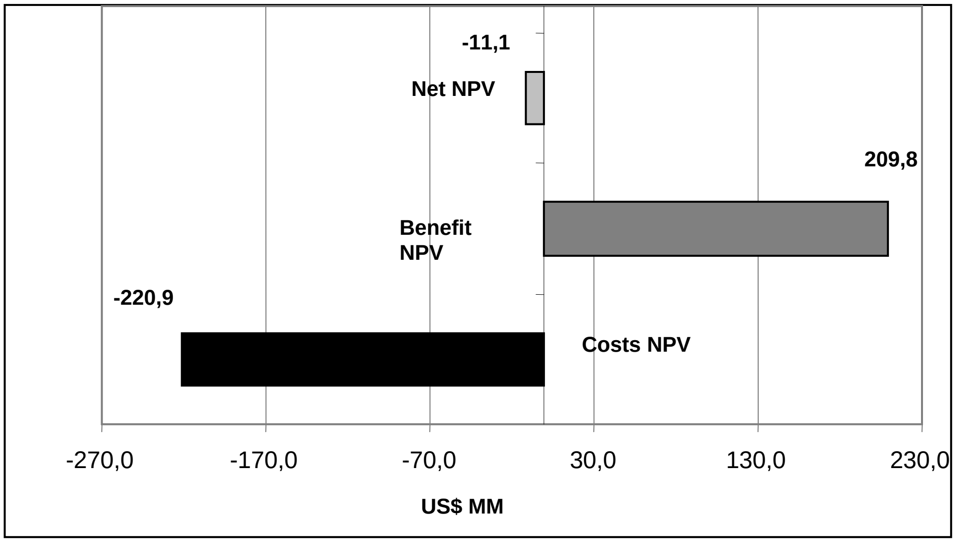


B) Evaluation of Scenario II: Cusco, Cachimayo, and Quillabamba

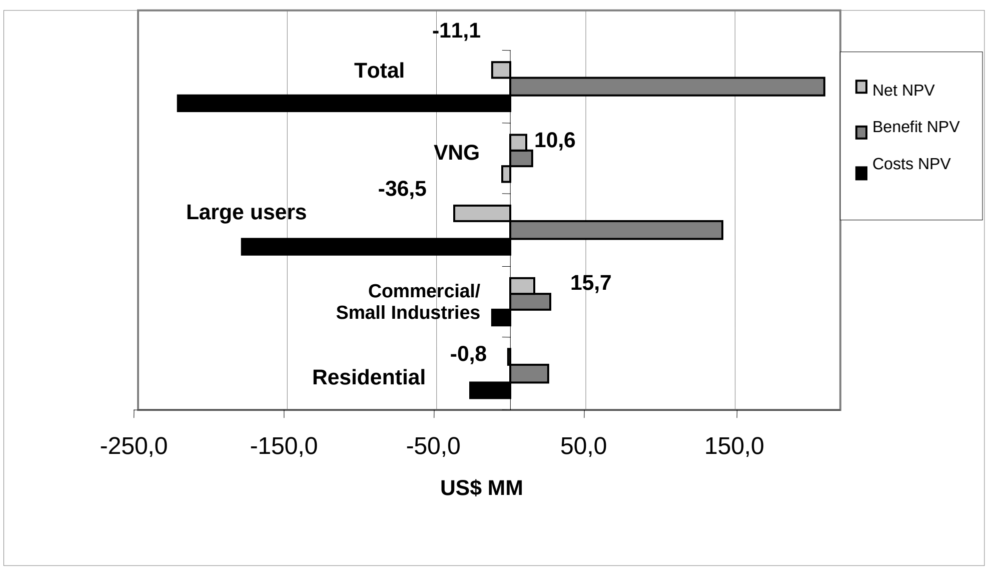
3.29 The evaluation of the project which adds the Quillabamba consumption to the Cusco and Cachimayo demand, yields a negative net benefit value in the user suitability analysis; this being a result of the opportunity value of the natural gas to be burned at the thermal station (price that the thermal station would be willing to pay for the natural gas or "Net Back Value" of the natural gas delivered at the station) is lower than the cost of natural gas supply charged to the station (price of natural gas, trunk transport, and main and secondary trunklines transport). That negative value of the project's net benefit explains almost the entire negative valuation of the large customers sector.

3.30 The economic analysis of Scenario II compared to the results of Scenario I demonstrates that the additional consumption of natural gas in Quillabamba has a negative impact (US$-12.5 million) over the positive economic value of the project in Scenario I.

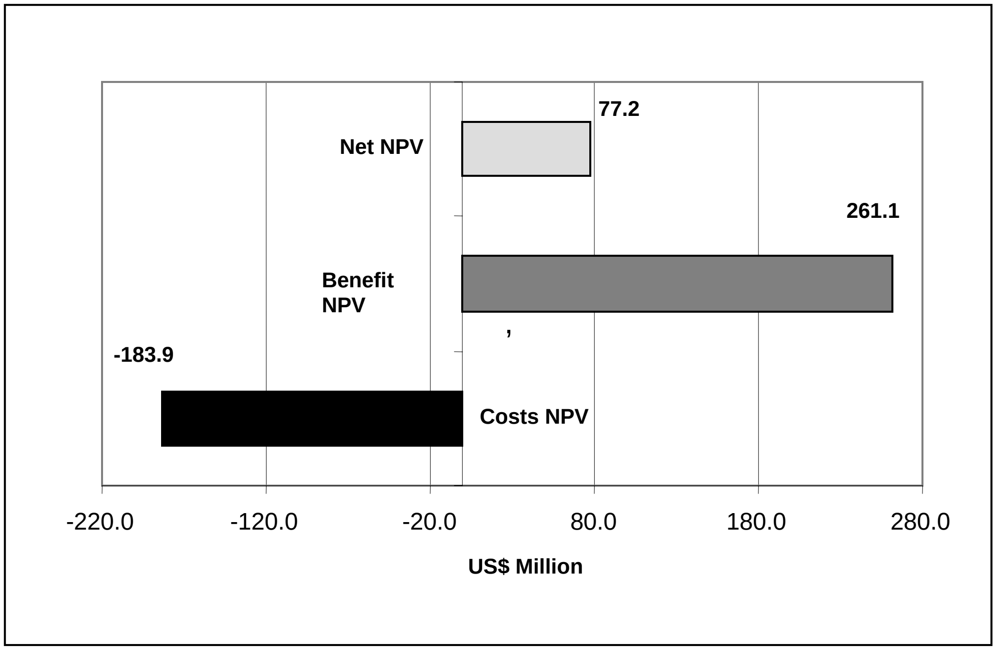
Graph 3.22: Evaluation of the Benefit of Substitution of Energy Sources Total Consumer Sectors (with market prices and costs as of March 2005) Cusco Region—Scenario II (Cusco + Cachimayo + Quillabamba)



Graph 3.23: Evaluation of the Benefit of Substitution of Energy Sources by Consumer Sector (with market prices and costs as of March 2005) Cusco Region—Scenario II (Cusco + Cachimayo + Quillabamba)



Graph 3.24: Economic Benefit Evaluation Total Consumer Sectors Scenario II (Cusco + Cachimayo + Quillabamba)

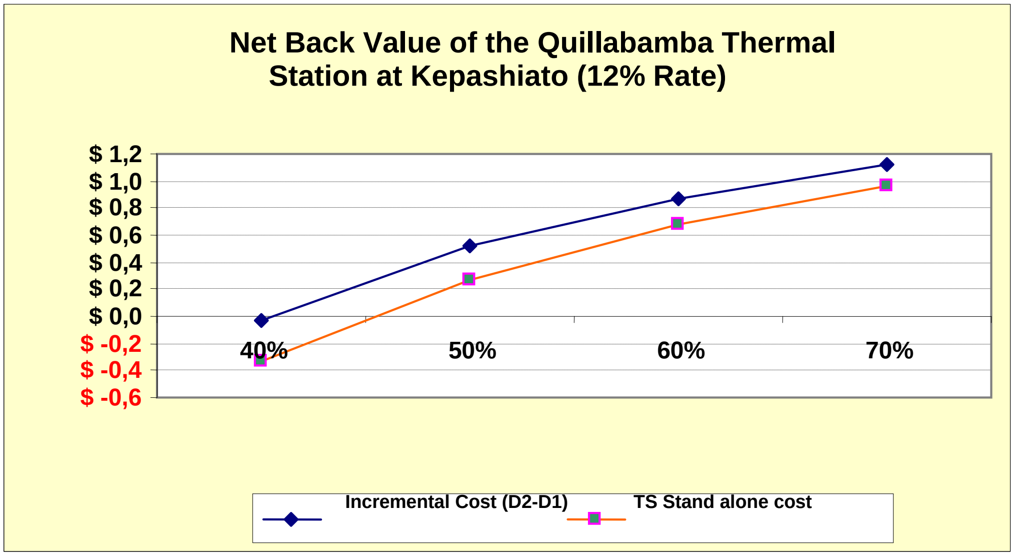


3.31 To be able to explain the consequences of introducing to the economic analysis the demand of the Quillabamba thermal station, the Graph 3.25 will reveal the maximum value that the station would be willing to pay for the natural gas from the diversion at Kepashiato[56] for different percentages of its use. The conclusion could be that, in order for the thermal station to be viable, it must take natural gas at Kepashiato at a price of US$0.7–0.9/MMBTU for a use factor of 60 percent.[57] That value includes the price of the natural gas "commodity" plus the transport cost through the main Camisea pipeline. This means that this lower value, compared to that used in the exercise (Price NG = 1 + CTT = 0.22 in US$/MMBTU) demonstrates why introducing the thermal station's demand makes the project's value drop.

[56] This estimate is equal to the difference between total revenues from operations and investment costs, operational costs, and costs of principal and secondary trunklines from the deviation in Kepashiato to the electricity generation plant.

[57] This is the average use factor for the period 2007–2025 taken by Macroconsult-CCR to estimate the future natural gas demand at the terminal generation plan projected for Quillabamba.

Graph 3.25: Willingness to Pay for Natural Gas in the Quillabamba Thermal Station



3.32 Another way to look at this issue is by comparing the "Net Back Value" of the natural gas at the station, against the cost of supplying the station (natural gas price + CTT + MRT Transport and DLN) for several alternatives (incremental cost or "stand alone cost"; CTT rate with or without a distance). It is noted that the maximum value, which the station can pay, is US$0.8/MMBTU for a usage factor of 60 percent, which is lower than the value of the natural gas supplied to the station in any of the proposed alternatives.

Table 3.12: Feasibility Analysis for the Quillabamba Thermal Station

Item	*Branch w/ Incremental Cost*		*Branch w/Stand Alone Cost*		*Net Back Value Gas at TS (1)*
	Without Distance in CTT	*With Distance in CTT*	*Without Distance in CTT*	*With distance in CTT*	
Natural gas price	1.00	1.00	1.00	1.00	
CTT	0.85	0.22	0.85	0.22	
MRT+ DLN	0.93	0.93	1.12	1.12	
Final Average Rate	*2.78*	*2.15*	*2.97*	*2.34*	*1.80*
Ratio NG Rate vs. NBU Gas at TS (%)	*154*	*119*	*165*	*130*	

(1) (Bar Energy Price – CAPEX/OPEX Station); usage factor Thermal Station 60 percent

Sensitivity Analysis

3.33 In order to identify the critical variables with a greater impact, positive or negative, on the economic evaluations made, exercises were conducted to simulate changes in some of the variables of the economic model adopted for the base cases and estimating the impact of such changes on the NPV of the economic benefits of regional projects. Table 3.13 shows the variables modified with respect to the base case, in order to perform the sensitivity analysis planned.

Table 3.13: Sensitivity Analysis on the Base Case
Ayacucho, Junín, and Ica Regions

Analysis to Conduct	*Assumptions*
Reference: Base Case	Scenario: Conservative (Ayacucho, Junín, and Ica) and Scenario I (Cusco + Cachimayo) Energy prices: WTI= US$ 40/bbl Residential demand: without heating Gas transport price: rate according to distance Discount rate: 12 percent
1. Sensitivity versus the variation of prices of energy sources to be replaced:	Crude price: US$54/bbl
2. Sensitivity versus the variation of projected demand:	Residential demand with heating
3. Sensitivity versus the variation of the price of gas:	Gas price equal to US$1.8/MMBTU
4. Sensitivity versus the variation of gas transport rates:	Postal rate
5. Sensitivity versus the variation of project discount rates	Discount Rates at 15 percent per year

3.34 Table 3.14 shows the economic benefits resulting from the sensitivity analysis performed for the Ayacucho, Junín and Ica regions. Table 3.15 shows the results for the Cusco region.

Table 3.14: Results of Sensitivity Analysis—Ayacucho, Junín, and Ica Regions

Analysis Conducted	*Sensitivity and Economic Evaluation*			
	Alternative I		*Alternative II*	
	NPV Base Case US$ 340.5 million		*NPV Base Case US$ 415.9 million*	
	NPV (million US$)	*Effect on BC*	*NPV (million US$)*	*Effect on BC*
1. Increase in prices of energy sources to be substituted:	418.9	+78.4	494.3	+78.4
2. Increase in the projected demand:	386.2	+45.7	463.5	+47.6
3. Increase in the price of gas:	216.0	-124.5	291.4	-124.5
4. Variation of gas transport cost:	339.2	-1.3	357.3	-58.6
5. Increase in the project's discount rate	259.8	-80.7	319.4	-96.5

Table 3.15: Results of Sensitivity Analysis—Cusco Region

Analysis Conducted	*Sensitivity and Economic Evaluation NPV Base Case (Scenario I) US$89.7 million*	
	NPV (million US$)	*Effect on BC*
1. Increase in prices of energy sources to be substituted:	103.8	+14.1
2. Increase in the projected demand:	119.4	+29.7
3. Increase in the price of gas:	75.8	-13.9
4. Variation of gas transport cost:	72.5	-17.2
5. Increase in the project's discount rate	69.1	-20.6

Main Conclusions of the Economic Analysis

Ayacucho, Junín, and Ica Regions

3.35 The net benefits of Alternatives 1, 1–A, and 2 yield positive and significant values:

- Alternative 1: US$339.4 million
- Alternative 1-A: US$340.5 million
- Alternative 2: US$415.9 million

They are explained by the surplus in the valuation of the large industrial customers:

- Alternative 1: US$311.3 million (91.7 percent)
- Alternative 1-A: US$289.4 million (85 percent)
- Alternative 2: US$354.5 million (85.2 percent)

3.36 The valuations in the residential segments are highly sensitive to the heating effect, and this is why there is a very positive effect, if in addition to using natural gas to cook and heat up water, it is used for heating.

- Alternative 1–A: US$45.7 million and US$-13.2 million, with heating and without heating, respectively.
- Alternative 2: US$47.6 million and US$-10.7 million, with heating and without heating, respectively.

3.37 The valuations in segments such as businesses, small industries and VNG are positive, although less significant than in the large industries:

- VNG: US$13.6 million; US$38.2 million and US$44 million for Alternatives 1, 1–A, and 2, respectively.

- Businesses and small industries: US$20.9 million; US$25.9 million, and US$28.1 million for Alternatives 1, 1-A, and 2, respectively.

3.38 The net benefits of Alternatives 1 and 2 are very similar if the following is not taken into consideration:

- Incremental costs of expansion in the Camisea Trunk Transport (CTT)
- Anticipation of investments in Alternative 1 with respect to Alternative 2 (differential of three years)
- The provision of natural gas to Huancayo, which is not included in Alternative 1 (this is why, to make them comparable, Alternative 1-A includes the extension and provision to Huancayo)
- Rates driven by distance "driver" parameters, which will favor the trunklines with CTT points of delivery near Camisea in Alternative 2 (see Table 3.14 -Sensitivity Analysis in Case 4)

3.39 The sensitivity analysis conducted on the base case shows:

- With a scenario of crude prices at US$54/bbl for the 2005–2025 period, the benefits would increase by US$78.4 million both in the case of Alternative 1-A as well as Alternative 2.
- The effect of considering a higher natural gas price for all the regions is negative; however, the NPV of the economic benefits remain positive, being US$216 million and US$291.4 million for Alternatives 1–A and 2, respectively.

3.40 Discount rates is another critical variable in the economic valuations of projects: thus, a 3 percent annual increase also has a negative impact on the net benefits; however, the project's total value continues to be profitable, US$259.8 million and US$319.4 million for Alternatives 1-A and 2, respectively.

Cusco Region

3.41 The net benefit of extending natural gas trunklines to Cusco and Cachimayo is positive and it amounts to US$89.7 million.

3.42 The valuations in the residential segment, just as in the case of the Ayacucho, Junín, and Ica Regions, are highly sensitive to the heating effect, and this is why there is a positive effect if natural gas is used to cook and heat up water, as well as for heating, increasing the NPV to US$119.4.

3.43 In the small industries and commercial segments, the benefits are positive but not very significant.

3.44 The benefits of substitution for the industrial segments yield positive values in Scenario I, without the thermal station in Quillabamba, although not so significant since the Cachimayo industry is facing a low electric energy cost to be replaced by natural gas. In Scenario II, where the supply to the thermal station is included, the net benefit of substitution turns negative.

3.45 In Scenario I, the economic benefit of the large industry sector is very significant, since the opportunity value of electric energy (US$38/MWh) is almost twice as high as the current cost paid by the main large companies in Cachimayo (US$20 /MWh). The effect of introducing the thermal station in the analysis gives a negative effect (US$-12.5 million) on the positive economic value of the project in Scenario I.

3.46 The "Net Back Value" of the natural gas delivered at the thermal station or the price that the thermal station would be willing to pay for the natural gas it would burn is lower than the cost of supply of natural gas to the station (price of natural gas, trunk transport, and transport at main and secondary trunklines).

3.47 The sensitivity analysis made on the base case shows that:

- An increase of 3 percentage points in the discount rates (12 percent to 15 percent) reduces the valuation by US$20.6 million.
- The effect of the variation in the price of crude, of US$40/bbl to US$54/bbl is an increase in the value of the project by US$14 million.

Financial Prefeasibility of the Projects

3.48 The financial analysis of the Ayacucho, Junín, and Ica project was made on the variables of demands and costs of the so-called base case, whereas for the Cusco Region, the financial analysis considered two scenarios for the recovery of investment costs (CAPEX) and operational costs (OPEX) of the MRT and DLN infrastructures to supply the natural gas demand in Cusco and Cachimayo only:

Case I: The total cost required for the business units to recover 100 percent with rates to natural gas users. In this case, the dimensioning of the MRT infrastructure corresponds to the 8-inch pipeline, which—as stated—is the type required to satisfy the demand of the Cusco–Cachimayo node.

Case II: The total cost required for the business units to recover with rates to natural gas users, plus funds from outside the projects (subsidies, guarantees, and so forth). In this case the pipeline size is 10 inches (in spite of identifying as the only demand the one that corresponds to Cusco and Cachimayo) with the aim of designing a more flexible infrastructure and be able to allow for possible increasing demands in the future, which have not been included at this time.

Assumptions and Peculiarities for the Financial Analysis

3.49 As detailed in the Methodological Annex, average rates were calculated (MRT and DLN) by segment and by region supplied, that is to say, leveled rates. The methodology used for the cash flow, which is also explained in the annex, was used, considering the following:

- A 20-year evaluation period;
- A pre-tax capital cost rate of 12 percent per year;
- Linear depreciation of the CAPEX for a period of 30 years;

- MRT and DLN demand and costs corresponding to the conservative scenario for the case of the Ayacucho, Junín, and Ica regions, and to Scenario I (Cusco and Cachimayo) for the Cusco Region.
- Revenues required recovering all costs of trunklines and networks (CAPEX, OPEX, working capital, and other) including the cost of service intakes.

3.50 The "outputs" generated by the financial model for each of the regions analyzed included the following:

- Calculations of the revenues required for the segmented businesses: (1) main regional trunklines, (2) distribution trunklines and networks; and (3) business units integrating the segments (1) and (2).
- Temporary structure of income and expenses by segment and by region, identifying the point of inflection of the negative flow of income and expenses of the projects.
- Average rates for the use of the MRTs, and for DLNs.
- Details of the cost of providing the service to supply natural gas in the MRT and DLN segments by CAPEX and OPEX.
- Comparison of the costs involved in the provision of natural gas, including all costs of the chain (gas, CTT, MRT, DLN) versus the average cost of the energy sources to be replaced, by region.

Annual Rates and Revenues Required

3.51 Using the cash flow methodology for each MRT and DLN segment, a calculation was made of the revenues required to recover the CAPEX and OPEX costs involved in providing the service to supply natural gas. For each region, the results of the following are first shown:

- Average or leveled rates
- Average annual revenues required
- Composition of the cost of providing the service, with CAPEX and OPEX details
- NPV of the total costs to recover with the average rate.

3.52 This is then applied, taking both segments—natural gas transport and distribution—as a single integrated business for the region. In the case of the MRT businesses, what is more important is the initial cost of investment in trunklines, rather than the cost of maintenance for the rest of the period. On the other hand, in the DLN, costs are distributed throughout the entire period (in addition to the initial investment in the MP trunklines) since the investments and CAPEX flow will grow directly with the incorporation of users into the system.

Calculation of the Revenues Required Combining Rate and Out-of-Project Funds—Cusco Region

3.53 Because the project for the extension of trunklines to the Cusco Region includes the potential supply to other localities (Combapata, for example) it is recommended that the part of the infrastructure that would serve those potential supplies is financed with funds other than the gas tariffs, in order to avoid significant increases in the tariff levels. Therefore, in order to make financially feasible laying a 10-inch pipeline for the supply to Cusco and Cachimayo, the following assumptions were made:

3.54 The rate of MRT transport cost to satisfy the demand for Cusco and Cachimayo ("rate revenues of the business") would include only a part of the total investment, which considers the relative share of the capacity demand of Cusco/Cachimayo in the total capacity demand of the pipeline for the year 2025. For this case, the rate recovers a CAPEX of US$32 million plus the operational costs of the business.

3.55 Complementarily, the revenues contributed by the non-budgeted funds, derive from the difference between the revenues required to recover the total costs (CAPEX and OPEX) of the 10-inch pipeline and what is recovered through the rate revenues of the business explained in the preceding point.

Results of Financial Analysis

3.56 The main data obtained in the financial analysis concerning the business to be given in concession is shown in Table 3.16, for each region. Exhibit 2 displays the cash flow for the various alternatives and scenarios under study.

Ica Region

- The annual revenues generated by the two segments (MRT + DLN) are very similar, as a result of the MRT not extending very far away.
- The rates for the use of MRT and DLN are US$0.25 /MMBTU and US$0.23 /MMBTU, respectively.
- The average annual revenues are approximately US$8.9 million integrating both segments.

Table 3.16: Results of the Financial Evaluation

Region	*Costs*			*Average Annual Revenues (US$ million)*	*MRT Rate (US$/MMBTU)*
	NPV (US$ million)	*CAPEX (%)*	*OPEX (%)*		
ICA					
MRT Segment	27	71	29	4.0	0.2
DLN Segment	24	68	32	4.40	0.23
Integrated system (MTB+DLN)	1	70	30	8.90	0.49
JUNÍN (Alt. 1)					
MRT Segment	86	78	22	14.90	1.12
DLN Segment	10	83	17	1.80	0.13
Integrated system (MTB+DLN)	96	79	21	16.70	1.2
JUNÍN (Alt. 1 with extension to Huancayo)					
MTB Segment	117	77	23	20.0	1.37
DLN Segment	29	72	28	.60	0.3
Integrated system (MTB+DLN)	146	76	24	26.10	1.72
JUNÍN (Alt. 2)					
MTB Segment	101	72	28	17.70	1.19
DLN Segment	2	66	34	4.70	0.29
Integrated system (MTB+DLN)	126	71	29	22.30	1.49
AYACUCHO					
MTB Segment	4	9	41	0.80	3.16
DLN Segment	7	64	36	1.40	4.86
Integrated system (MTB+DLN)	11	62	38	2.30	8.03
JUNÍN (Alt.2) and AYACUCHO					
MTB Segment	106	72	28	18.50	1.22
DLN Segment	31	66	34	6.10	0.36
Integrated system (MTB+DLN)	137	70	30	24.60	1.59
ICA, JUNÍN (Alt.2) and AYACUCHO					
MTB Segment	133	72	28	23.00	1.47
DLN Segment	55	67	33	10.50	0.59
Integrated system (MTB+DLN)	188	70	30	33.50	2.08
CUSCO AND CACHIMAYO (8-inch)					
MTB Segment	77	79	21	12.30	3.25
DLN Segment	25	72	28	3.90	1.04
Integrated system (MRT + DLN)	102	77	23	16.20	4.28
CUSCO AND CACHIMAYO (10-inch)					
MTB Segment	91	79	21	15.10[a]	1.90
DLN Segment	25	72	28	3.90	1.04
Integrated system (MTB+DLN)	116	80	20	19.00[b]	2.93

[a] Only 50 percent are rate-related revenues.

[b] Only 60 percent are rate-related revenues.

Junín Region

- For Alternative 1, the annual revenues generated by the MRT segment are much higher than those of the DLN segment, as a consequence that the MRTs have an important and longer extension compared to the Ica Region.
- MRT and DLN use rates are US$1.12 /MMBTU and US$0.13 /MMBTU, respectively.
- Average annual revenues are approximately US$16.7 million with the integration of both segments.
- In Alternative 2, the annual revenues generated by the MRT and DLN segments are higher than those of Alternative 1.
- Although MRT and DLN use rates are higher: US$1.19 /MMBTU and US$0.29/MMBTU, respectively, it must be pointed out that Alternative 2 incorporates the cost of MRT and DLN extension to supply the locality of Huancayo.
- Average annual revenues for this alternative are approximately US$22.3 million, integrating both segments.
- In comparing Alternatives 1 and 2 in the Junín region, adding in Alternative 1 the incremental costs of the MRT for the La Oroya–Huancayo section and the DLN costs in Huancayo, but also adding the Huancayo's demand, the conclusion is that the MRT and DLN use rates are higher than Alternative 2 for Junín: US$1.37 /MMBTU and US$0.35 /MMBTU, respectively; and that the average annual revenues are approximately US$26.1 million integrating both segments.

Ayacucho Region

- The financial sustainability of the project requires, given the low level of gas demand in the region (explained by categories of customers with low consumption per capita) that MRT and DLN use rates are higher than those in the regions analyzed so far: US$3.16 /MMBTU and US$4.86 /MMBTU, respectively. When both segments are integrated, there would be an average annual business of US$2.3 million.
- The alternative to structure the service comprised of the Junín (Alternative 2) and Ayacucho regions could improve the position of the Ayacucho's users, by offering a service at a lower cost, without affecting the Junín customers too much. The results of such integration are as follows:
    - If the same concessionaire supplied the regions, the average MRT and DLN rates would be US$1.22/MMBTU and US$0.39/MMBTU, respectively.
    - The average annual revenues of the concessionaire would be US$24.6 million.

- Another alternative was also proposed, to integrate the Ica, Junín, (Alternative 2) and Ayacucho businesses, and this would generate a more profitable venture for the concessionaire, with average annual revenues of approximately US$33.5 million.

Cusco Region

- *Case 1:* Supply to Cusco + Cachimayo with 8-inch pipeline (100 percent rate-related revenues)
  - The annual revenues generated by the MRT segment are much higher than those of the DLN segment (three times as high) as a result of the fact that the Main Regional Trunkline has an important extension.
  - MRT and DLN use rates are US$3.25/MMBTU and US$1.04/MMBTU, respectively.
  - Average annual revenues are approximately US$16.21 million, with the integration of both segments.
- *Case 2:* Supply to Cusco + Cachimayo with 10-inch pipeline (rate-related revenues + non-rate related funds).
  - MRT use rates drop from US$3.25/MMBTU to US$1.9/MMBTU due to the effect of the decrease in the cost base to be charged to the project when non-rate revenues are used.
  - The average annual revenues are approximately US$19 million with the integration of both segments. These annual revenues are comprised of rate revenues for the MRT and DLN businesses, plus an amount for an annual guarantee, which covers the total costs of the service. This amount is known as a non-rate related fund.[58]
  - The updated value of the non-rate related funds required to recover all of this pipeline's costs (CAPEX and OPEX) is US$45.8 million, revenues which must be guaranteed based on a greater availability of the region's Gas Canon.

Comparison of Costs of Provision of Natural Gas versus the Average Cost of the Energy Sources to be Replaced

3.57 Once the average rates corresponding to the MRT and DLN segments have been calculated for each region, it is possible to put together the value chain of the average cost to supply the gas to the final user. To this effect, the hypothesis of the base case has been considered. For the purposes of conducting an analysis of the reasonableness of the cost to the user, it is useful to compare that value with the average

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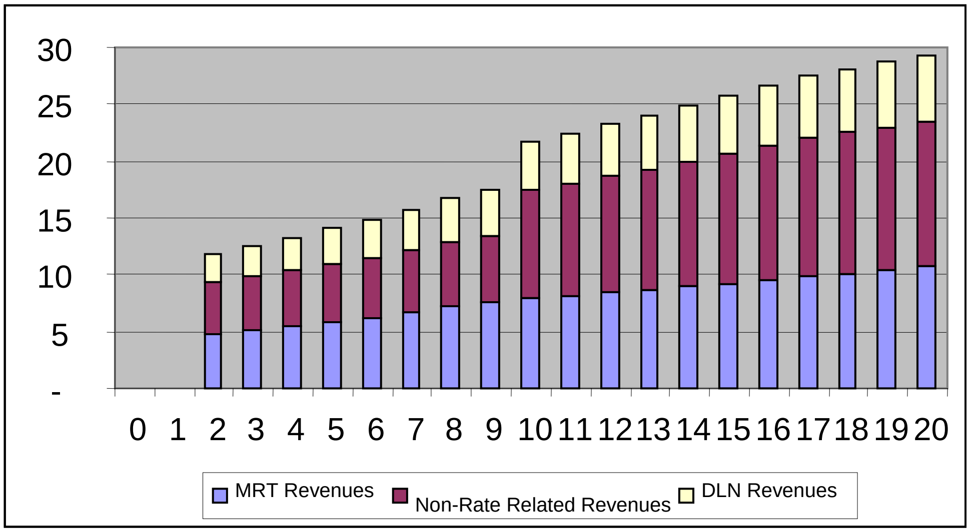
[58] See "Calculation of the entrance required with a combination of tariff and 'extraproject funds'—Cusco Region," page 137.

cost of the substitute. The cost of the substitute is stated by net of conversion and internal installation costs, so it can be comparable to the cost of supply of the natural gas.

Graph 3.26: Evolution of the Composition of Revenues from the Integrated System—Cusco + Cachimayo System (10-inch) (In US$ Million)



3.58 Table 3.17 depicts the exercise for the Ica Region; the average cost of the natural gas would be between 42 percent and 55 percent lower than the average cost of the substitute energy source. It should be noted that this does not mean that all consumers will obtain savings; actually, there could be consumers for which the cost of natural gas is higher than the substitute.

Table 3.17: Cost Comparison of NG versus Energy Sources Supply Services Ica Region in US$/MMBTU)

Item	*Provision with Natural Gas*	*Average Cost of Substitutes*[a]
Cost of natural gas	1.00	
CTT	1.16	
MRT	0.25	
DLN	0.23	
Average final rate	2.65	5.90
Ratio NG rate vs. substitute	45%	

[/a] Net costs of internal installation and conversion, July 2004.

3.59 In the Junín Region, for Alternative 1 (with and without extension to Huancayo) and Alternative 2, other possible cases may have been put forth; for example, it could be justifiable from the economic point of view for the transport cost in Alternative 2 to be recalculated, since the structure of the rate will depend on the distance factor, thus the transport cost to the user will be in accordance with the distance run by the pipeline.

3.60 If the following formula is observed, the rule determining that the transport cost must be compensated by a rate varying on the basis of the distance from the point of injection to the point of intersection of the concessionaire and with the Camisea Trunk Transport can be appreciated. If such a rate reduction is not taken into consideration regarding the transport of the CTT with the distance factor, the average cost of the service, considering Alternative 1—with and without extension to Huancayo—and Alternative 2, would be in the following ranges (in the sequence of the alternatives) with respect to the average cost of the substitute and depending on the cost of the natural gas considered:

- Cost of US$1.0/MMBTU: <26-35-31%>

3.61 Finally, if the distance effect is incorporated into the CTT rate, there are higher differences for the two cases in the cost of natural gas considered, versus the average cost of the substitute:

- Cost of US$1.0 /MMBTU: <-44%>

Table 3.18: Natural Gas versus Energy Sources Supply Service Cost Comparison Junín Region (in US$/MMBTU)

Item	*Provision with NG*				*Sust. Avg. Cost.*[a]
	Without distance in CTT			*Without distance in CTT*	
	Alternative 1		Alternative 2	Alternative 2	
	Without extension to Huancayo	With extension to Huancayo			
Cost of gas	1.00	1.00	1.00	1.0	
CTT	1.16	1.16	0.47	0.47	
MRT	1.12	1.37	1.19	1.19	
DLN	0.13	0.35	0.29	0.29	
Average final rate	3.41	3.88	2.95	2.95	5.25
Ratio NG rate versus substitute (%)	65	74	56	56	

/a Net internal installation and conversion costs, July 2004.

3.62 In the Ayacucho Region, following the same analysis, it can be appreciated that the average cost of natural gas provision is between -20 percent and -31 percent lower than the average cost of the substitute.

3.63 For the Cusco Region it can also be justified from the economic point of view for the transport cost to be recalculated, since the structure of the rate will depend on the distance factor, thus the transport cost to the user will be in accordance with the distance run by the pipeline. Table 3.20 shows the exercise for both cases (1 and 2) being presented.

Table 3.19: Natural Gas versus Energy Sources Supply Service Cost Comparison Ayacucho Region (in US$/MMBTU)

Item	*Provision with Natural gas*		*Substitutes Average Cost*[a]
	Without distance in CTT	*With distance in CTT*	
	Alternative 1	*Alternative 2*	
Cost of gas	1.0	1.0	
CTT	1.16	0.47	
MRT	3.16	3.16	
DLN	4.86	4.86	
Average final rate	10.19	9.49	13.70
Ratio NG versus substitute rate (%)	74	69	

/a Net Internal Installation and Conversion Costs, July 2004.

Table 3.20: Natural Gas versus Energy Sources Supply Service Cost Comparison Cusco Region

Item	*CASE 1 Supply Cusco + Cachimayo (MRT=8-inch)*		*CASE 2 Supply Cusco + Cachimayo + Ext. Section (MRT=10-inch)*[/a]	
	Without distance in CTT	*With distance in CTT*	*Without distance in CTT*	*With distance in CTT*
Cost of natural gas	1.00	1.00	1.00	1.00
CTT	1.21	0.22	1.21	0.22
MRT	3.25	3.25	1.90	1.90
DLN	1.04	1.04	1.04	1.04
Average final rate	*6.50*	*5.50*	*5.15*	*4.16*
	Substitute Cost by Sector [b]			
	Residential	*Businesses and small industries.*	*VNG*	*LU*
	21.3	11.6	20.6	6.2

a /a MRT rates with guarantee

/b Net Internal Installation and Conversion Costs, May 2005.

Considerations to the Incorporation of Residential Users

3.64 The considerations are as follows:

- Residential consumption has a low level of economic yield, as shown in the prefeasibility analysis.
- Connection goals cannot hide that the cost of internal installation and conversion (US$125) represents approximately 10 times the current LPG expense.

3.65 Tables 3.21–3.23 show, in Nuevos Soles, the cost of an average monthly billing for the different regions, adding all the costs of the chain, including internal installation and conversion,[59] considering a scenario with the heating effect and another scenario, without this effect. The following are certain implications of this analysis:

- Soft financing (since one payment installment in 10 years represents 15 percent of the expense in LPG per month) to attract residential customers is an essential element of the business policy.
- The calculations of the rates assigning the cost of the network to the residential users practically lead to a NG expense equal to that of the LPG, including the installment.
- The heating effect makes it possible to reduce the network unit cost, allowing a greater use of energy.
- In order to reach reasonable connection goals, it is recommended that a recalculation be made of the rate structure with a certain rebalancing of costs between industrial users and the rest of users.

Conclusions of the Financial Prefeasibility Analysis

3.66 The integrated businesses by region or area of concession have a more interesting magnitude than those, which are separate businesses (in ranges and averages) with the exception of Ayacucho. Average annual revenues of concessions of the integrated businesses will be:

- Ica Region: US$8.9 million
- Junín Region (Alt1–Alt2): US$(16.7–22.3) million
- Ayacucho Region: US$2.3 million
- Cusco Region (Case 1–Case 2): US$(16.2–19) million

3.67 Businesses separated by locality or region (without including the Main Regional Trunklines) do not provide significant revenues in general (ranges and averages).

[59] In the exercise for the calculation of the position (quota) by concept of internal installation and conversion, the investment is financed to the user by 10 years to an annual rate of 12 percent.

Table 3.21: Cost of NG Supply to Residential Sector (US$/MMBTU; Soles / Month) Scenario with the Heating Effect

Monthly Consumption / *Item*	*Ica*	*Ayacucho*		*Junín 1*	*Junín 2*	
	22	*34*		*42*	*48*	
	Without CTT dist	*Without CTT dist*	*With CTT dist*	*With CTT dist*	*Without CTT dist*	*With CTT dist*
Cost of gas	1.8	1.8	1.8	1.8	1.8	1.8
CTT	1.2	1.2	0.5	1.2	1.2	0.5
MRT	0.3	3.2	3.2	1.1	1.2	1.2
DLN	12.5	7.6	7.6	5.9	5.0	5.0
Average final resid. rate	*15.7*	*13.7*	*13.0*	*10.0*	*9.2*	*8.5*
Internal installation + conversion	2.0	1.3	1.3	1.1	0.9	0.9
Total resid. cost	*17.8*	*15.0*	*14.3*	*11.1*	*10.1*	*9.4*
Cost in S/. per month	*49.7*	*65.9*	*62.9*	*60.0*	*62.3*	*58.1*

Table 3.22: Cost of NG Supply to Residential Sector (US$/MMBTU; Soles / Month) Scenario without the Heating Effect for the Ayacucho, Junín, and Ica Regions

Monthly Consumption (m^3) / *Item*	*Ica*	*Ayacucho*		*Junín 1*	*Junín 2*	
	16	*16*		*16*	*16*	
	Without CTT dist	*Without CTT dist*	*With CTT dist*	*With CTT dist*	*Without CTT dist*	*With CTT dist*
Cost of gas	1.8	1.8	1.8	1.8	1.8	1.8
CTT	1.2	1.2	0.5	1.2	1.2	0.5
MTB	0.3	4.4	4.4	1.1	1.3	1.3
DLN	16.8	16.0	16.0	15.3	14.7	14.7
Average final resid. rate	*20.0*	*23.4*	*22.7*	*19.4*	*19.0*	*18.3*
Internal installation + conversion	2.8	2.8	2.8	2.8	2.8	2.8
Total resid. cost	*22.8*	*26.1*	*25.4*	*22.1*	*21.7*	*21.0*
Cost in S/.per month	*47.3*	*54.3*	*52.9*	*46.0*	*45.1*	*43.7*

Table 3.23: Cost of NG Supply to the Residential Sector (Cusco Region—Case MRT 10-inch) (US$/MMBTU, Soles / Month)

Item \ *Monthly consumption (m^3)*	*With heating 48*		*Without heating 16*	
	Without CTT distance	*With CTT distance*	*Without CTT distance*	*With CTT distance*
Cost of gas	1.0	1.0	1.0	1.0
CTT	1.2	0.2	1.2	0.2
MRT	1.9	1.9	2.0	2.0
DLN	6.2	6.2	17.6	17.6
Average final resid. rate	*10.3*	*9.3*	*21.8*	*20.8*
Internal installation + conversion	0.9	0.9	2.0	2.0
Total resid. cost	*11.2*	*10.2*	*23.8*	*22.8*
Cost in S/.per month.	*65.2*	*56.4*	*46.3*	*44.4*

3.68 The residential business is not very significant and the distribution margin could double if the heating effect is not included (similar to the problem experienced in Lima).

3.69 In the case of the Cusco region, if the network is changed (from 8 inch to 10 inch) for the temporary supply to a station in Quillabamba (or to another with a similar consumption magnitude) funds would need to be contributed, at such a level that the MRT rate would only finance 50 percent of the service cost. At present, the contribution of funds amounts to US$45.8 million.

3.70 In the regulation scheme assumed, the prohibition of the physical "by pass" has been proposed; that is to say, large customers must always pay the distributor a toll for the network (DLN). It should be noted that this is the way the system works in the sole region under concession at present, which is in Lima and El Callao. This will undoubtedly make the average charge of the DLN network lower than if the consumption of these large customers is not included. Furthermore, it is assumed that all large customers buy gas on their own. A sensitivity analysis shows how the DLN rate increases whenever the demand of the large customers is not included (Ica: from US$0.23/MMBTU to US$3.94/MMBTU, Junín Alternative 2: from US$0.29/MMBTU to US$2.44/MMBTU).

3.71 For all regions, the average cost to supply the gas in the base case provides a savings with respect to the average annual cost in energy sources to be replaced for each region (in percentage, considering a cost of gas of US$1.0/MMBTU):

- Ica: 55 percent
- Junín (Alternative.1–Alternative 2): 35–44 percent

- Ayacucho: 26–31 percent
- Cusco and Cachimayo (Case 1 and Case2): (56–63 percent) and (65–72 percent)

4

Proposals for Structuring the Natural Gas Supply Service

Need for a Strategic Plan

4.1 This chapter identifies the tools of the strategic plan to give in concession to the business units for the transport and distribution of natural gas (NG) in the regions as a result of the extensions of the Camisea Trunk Transport (CTT). The recommendations with respect to the strategy are based on the conclusions incorporated in the modules developed in the previous stages: (i) technical-environmental studies of Main Regional Trunklines (MRT) and Distribution Trunklines and Networks (DLN); (ii) market studies; and (iii) economic–financial studies.

4.2 The provision of the service in the regions will require the development of an important infrastructure to be built and operated by the concessionaire of the private sector to reach the consumer, that is: (i) construction of infrastructure; (ii) its operation and maintenance; (iii) expansion of the systems to new markets or futures users; (iv) introduction and commercialization of services; and (v) service to new and future customers. Since this is a main capital–intensive industry, with heavy investment requirements, and a certainly incipient market, there will be a need to add rationality, trust, and stability in the game rules to be defined by the authority.

4.3 The strategy developed is a reference framework for decision making by the authorities of the central government and regional governments in their acts, to achieve the regional penetration of NG. Several of the issues presenting themselves as distinctive elements of the strategic plan are put forth in terms of action alternatives, to allow for a more open and flexible discussion of aspects relating to the organization of the provision of the NG service proposed in the regions.

Pillars of the Strategy

4.4 The market, technical, environmental, and economic studies developed so far for the projects to supply NG to the regions of Ayacucho, Junín, and Ica, indicate that they are positive in terms of prefeasibility. The project to supply NG to the Cusco Region is also viable, provided the development premises of the demand are complied with, and a minimum consumption guarantee is provided.

4.5 Once this stage has been reached, the Peruvian government, through ProInvestment, may then start its search for the best tools needed to create a reasonable framework or environment for the development of a market which is incipient but with significant potential and effects on the welfare of society. This, in turn, leads to the establishment of a series of guidelines for the organization of the service to supply NG in the quest to accomplish the social objectives and for the penetration of the natural gas in the regions at the lowest cost possible.

4.6 The tools to be proposed to attract private capital to these businesses will require the definition of:

- *Objectives:* which may be accomplished through a path that will reinforce the realization of subsequent stages of the project; minimizing any inconveniences, which may cause a redefinition of the structuring and reorganization of the project's activities.
- *Context conditions adequately diagnosed:* This corresponds to the socioeconomic diagnosis, the demand study, the environmental pre-impact studies, costs studies, and economic and financial prefeasibility studies, and the analysis of institutional and regulatory conditions applicable to the natural gas supply businesses.
- *Effective and efficient instruments to reach such objectives:* organization of the supply service; obligations of the concessionaire; rate methodology; form and degree of participation of the various government institutions; advertisement and education in the use of natural gas; among others.

4.7 The reference framework taken into account in the definition of the strategic plan described in this report for the concession of the regional NG projects, is based on the study of the context conditions; that is to say:

- Take advantage of the experience gathered from the Camisea Project.
- Extract the benefits of a more competitive resource available.
- Have respect for the activity's regulatory framework with the purpose of securing its feasibility and sustainability in the long term.
- Consider the socioeconomic reality of the regions, evaluating viable alternatives for the concession of the service businesses.
- Identify any environmental restrictions and obstacles in the implementation of the projects.

4.8 Certainly, the projects pursue the final objectives with an impact on the current socioeconomic reality of the regions. These objectives are listed below:

- Availability of the NG resource with a reduction in the energy dependence and cost of the energy source
- *Regional development:* new productive undertakings, and growth of the current productive base

- Improvement in the quality of life (satisfaction of heating needs, impact on the environment, and economic welfare)
- Greater effectiveness in the interaction of the public and private roles for the general welfare (central government, regional governments, NGOs, service providers, and users)

4.9 As a matter of example, to present the positive effects of the projects, below is a summary of the impacts studied in the previous stages of this report:

- *Energy source cost savings:* approximately US$257.2–US$275.7 million for the Ayacucho, Junín, and Ica Regions and US$89.7 million for the Cusco Region.
- *Employment:* 1,300–1,400 direct jobs in the construction stage only for the project of the Ayacucho, Junín, and Ica Regions.
- *Connection of users:* 45,000 (2010) for the project of the Ayacucho, Junín, and Ica Regions, and over 15,000 (2010) for the Cusco Region.
- *Possibility of development of new industries.*
- *Environmental benefits.*

4.10 Reaching those objectives require the definition of an *adequate organization for the provision of the natural gas supply service* for the long-term sustainability to the industry. This will include the definition of the roles of agents, scope of the supply activities, and definition of levels and structure of rates, among others.

4.11 The actions supporting the strategy may be seen in Figure 4.1. Based on determined context conditions (socioeconomic reality; minimum judicial–regulatory conditions to attract capital to the industry, environmental requirements, among others) the objectives can be reached with the aid of a series of instruments and actions which are encapsulated in the term “organization of the provision of the service” including among others: the roles of the agents, type of concession, rate model, and size of the business to be given in concession.

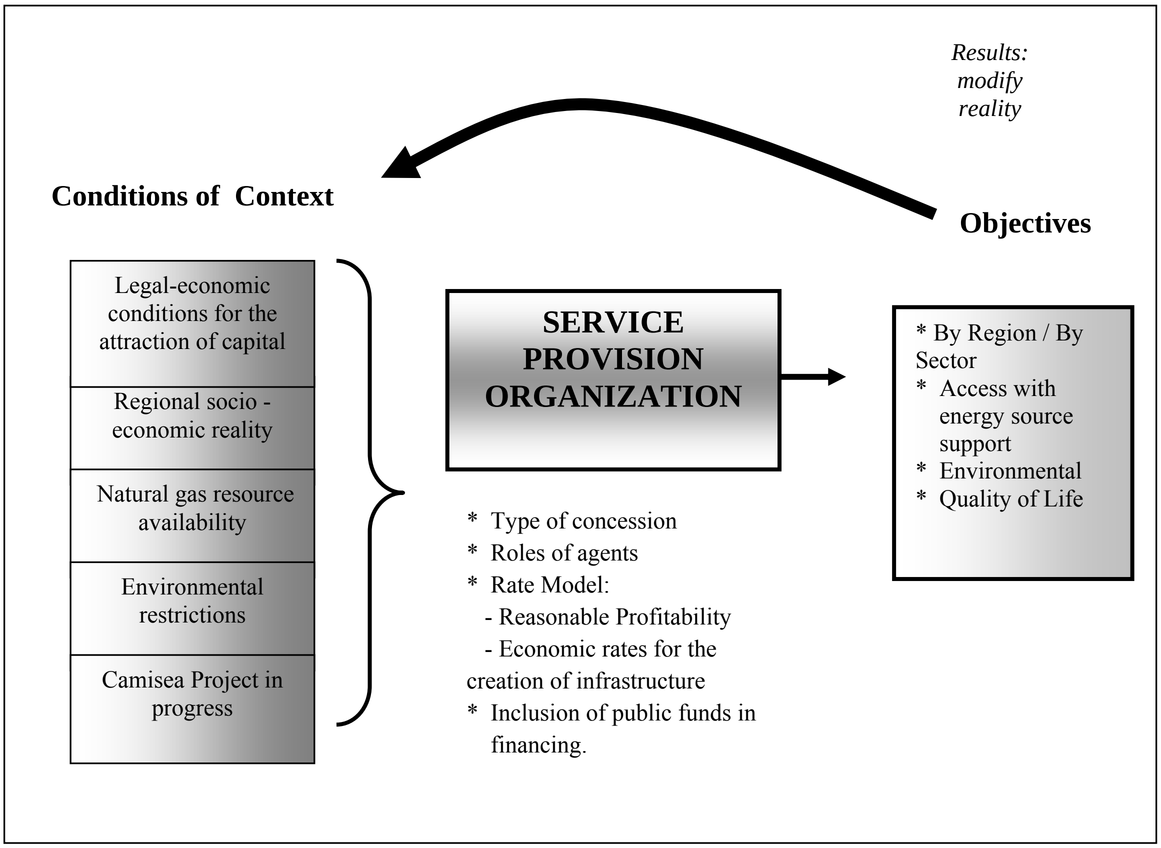
4.12 It must be noted that reaching certain regional development objectives, while at the same time securing competitive conditions for natural gas supply and contributing to the economic development of the region, may not be objectives, which are fully complementary. The implementation of some projects seeking the development of a certain sector of the region may require the use of cross-subsidies from one segment of users to another; which finally translates into a cost overrun in the rest of the activities or the need to redistribute funds sacrificing some alternative.

Context Conditions: Socioeconomic Reality, Environmental Restrictions, Judicial and Institutional Conditions

Socioeconomic Context

4.13 The studies conducted by the consulting firm—field and office studies—made it possible to identify key factors to be taken into account in the socioeconomic context, which become the first element to consider in the design of the strategic plan.

Figure 4.1: Conditions for the Penetration of Natural Gas into the Regions



4.14 In *general terms* the conclusion is that:

- A high percentage of the population in the cities earn revenues below 800 Nuevo Soles per month (75 percent in the case of Tarma and between 50 percent and 60 percent in Ayacucho, Oroya, and Huancayo; 30 percent in Ica and Pisco; 54 percent in Cusco); and in that sense, their socioeconomic development index is lower than that of Lima, where natural gas distribution started just this year and where the forecast for anticipated residential and business user connections is modest, with 55,162 customers connected by the fifth year of the project, 90,865 by the tenth year, and 116,708 by the fifteenth year.

- The average expenditure in electric energy is relatively low: 60–74 Nuevos Soles per month per household, and in LPG for cooking between 40 and 51 Nuevos Soles per month (1.2 to 1.4 cylinders of LPG per month); this is influenced by the socioeconomic level of the population and climate-related and cultural aspects.
- Since there is no mass natural gas consumption culture in Peru, the result to be obtained in Lima throughout the initial five years will be important.
- Demand projections in the scenarios considered depend on the realization of conversions and implementation of major projects (13 large potential users in the localities of La Oroya, Tarma, and Pisco and 11 large potential users in Cusco). The demand of the large industries or major projects represents, approximately, 90 percent of the total demand, and in some cases they are sufficient to justify the economic viability of the extension projects.
- In the particular case of the Cusco Region, the bulk of the demand depends on a few important users, and only one of them, the Cachimayo ammonium nitrate plant, accounts for 48 percent of the demand in Scenario I (Cusco + Cachimayo) provided there is substitution of the electric energy consumed by natural gas. Going to the rest of the scenarios, where demand notably grows based on new projects which do not derive from industries already installed in the region, requires significant investments in infrastructure and also, that projects finally materialize (Quillabamba station and the production of direct reduced iron in Combapata). The latter projects are exclusive, in other words, they can materialize in other areas besides the Cusco Region. In the case of direct reduced iron, an alternative would be for the undertaking to take place in Ica–Pisco, whereas in the case of the thermal station, the provision of the network is in competition with several other places.
- The demand of the business and small industrial sector is not significant, and it requires a very careful field study for better quantification.

4.15 The sector analysis leads to the following considerations over the potential of NG in the regions under analysis:

Residential Sector

- The low income observed in the population is normally associated with problems in accessing bank loans, which implies the needed definition of: (i) a policy for the financing of connections and conversions; (ii) an active role on the part of the concessionaire via business and rate tools.
- The type of housing, normally independent, is precarious, and this limits the number of connections and appliances, which could be installed, with care to minimum safety levels.
- The destination of the natural gas for heating could appreciably lower the unit costs of the service, but requires important investments by the user in

internal installations (additional consumption intakes) and of appliances; and it may possibly take long to manifest itself throughout time, because of a change in customs and the investments required.

- The general share of the residential sector in the total demand of the regions, with the exception of the cities of Ayacucho and Cusco, where there is a more interesting potential demand, is not significant in general (the residential demand implies 2 or 3 percent of the total demand, depending on whether it is the base residential scenario or with heating). However, this aspect has an important political and social impact. The population getting direct access to it will appreciate its advantages, in addition to the economic benefits, in relation to the fuel being substituted, and at the same time favorable conditions will be created for a better acceptance of this resource in Peru and a well-balanced regional development; getting to those far away regions through which the main Camisea pipeline goes through, that is, the regions under analysis.

Industrial–Business Sector

- The importance of the small industries and businesses sectors has a scarce impact on the total demand in the regions. As indicated in previous paragraphs, the large industries and the major projects are the relevant explanation of the current and potential demand.
- The main demand of the regions is of an industrial origin.
- Not withstanding the surveys conducted in the main demand centers, and the scarce information available in the regions with respect to establishments of consumption and their location, it will be necessary for the future concessionaire to conduct a detailed study to identify these activities and their potential.

Electricity Sector

- The large industrial consumption is the chief explanation for the demand, but the conversion and installation of new stations would help make the natural gas infrastructure viable. Nonetheless, it is necessary to consider adequately positive and negative aspects in the thermo-electric development to boost the gas demand in the regions.
- The future growth of the demand for electricity generation in Peru will be mainly with natural gas. Of the projected demand for the Camisea gas for distribution in the cities of Lima and El Callao[60] (549.8 MMCFD) toward the year 2023, the consumption of electricity generation will represent approximately 84 percent.
- The price of natural gas for electricity generation in original contracts (Camisea) which was less than for the rest of uses could also be applied to those with a potential demand in the areas under analysis.

[60] "The Natural Gas Industry in Peru," Working Paper No. 1, OSINERG, August 2004.

- The competition for the location of a station, possibly on the coast, near Ica, with a 150 MW capacity; the potential consumption of natural gas of an open cycle station of that type would be 12 MMCFD by 2008 (year of the start of operation) representing 44 percent of the demand of large users in the Ica Region.
- Reduction of congestion problems in transmission to the largest consumption center: Lima.
- With the exception of Shougesa, the benefits of the conversion to natural gas for the rest of the stations require specific studies of all small industries with a capacity of less than 7 MW (+/-) as indicated in the market study.

Vehicle Natural Gas

- As pointed out in the market studies, its potential use in the regions is modest. This is different from the potential market in Lima, with 65 percent of motor vehicles in the country, which does not depend on the peripheral development of VNG stations. An example of the scarce potential in some regions is the case of Ayacucho, where the number of vehicles is barely 5,000, which is only 0.4 percent of the total number of motor vehicles in the country.[61]
- The results can be summarized as follows:
  - In some cases the local viability is scant, due to the limited number of potential vehicles to be converted (Tarma, Ayacucho, and Cachimayo, for example);
  - It depends on a configuration of stations distributed between the cities along the routes in order to raise user valuation of the advantages of the conversion;
  - Its development over time will take long to occur, due to the economic development of the regions.

Judicial and Institutional Context

4.16 A second element to consider in the definition of the strategy has to do with the identification of the key factors in the judicial–institutional context:

- The roles and the interaction of the various government institutions: central government, regional and district governments, in their areas of competence
- The decentralization process and the facilitation of government services (permits, information, and so forth)

[61] "Natural Gas Industry in Peru," Working Paper No. 1, OSINERG, August 2004.

- The peculiarities of the project and its fitting within the current regulatory framework applicable to the provision of the service to supply NG

4.17 The decentralization process becomes a critical point for the planning of the works, even though it is the government's mission to promote local sustainable development, and as part of it, sponsor the local economies. This process is at the start phase; thus, authorities at the regional, provincial, and district levels are facing times of changes and uncertainty. There is lack of clarity in the assignment of functions and in the linking nature of the concerted development plans and participative budgets, as well as a weakness in the mechanisms for dealing with the local and regional governments.

4.18 To generate facilitating or proactive processes for the various stages of the works, local government officials may not be appropriate to interpret and affect the intervention of their respective governments with regard to the policy that converts natural gas as a strategic axis, as well as to their competencies and jurisdictions. Coordinated action of the different players will be required for the project implementation to meet its objectives in line with what has been stated in the preceding paragraphs.

Availability of the Natural Gas Resources and Implementation of the Camisea Project

4.19 It is obvious that the discovery of natural gas in the area of Camisea drove the transformation of the energy source sector in Peru. With proven reserves in two of its main fields, Cashiriari and San Martín, 8.7 x 1012 f^3 (TCF) of natural gas and 545 million bbl of liquids, the magnitude of natural gas in the Camisea field is equivalent to 16 times the size of the Aguaytía field. This demonstrates that the natural gas discovered in Camisea will be the most important basis for the development of the natural gas industry in the country.[62]

4.20 The Camisea Project began during the year 2000 with the awarding of the following businesses: (i) exploitation, separation, and fractionation of hydrocarbons; and (ii) transport and distribution of gas, to private consortiums. Since then, the Camisea Project has become a substantial incentive of the economic activity, as a result of the substantial investments necessary to exploit its reserves, the operational expenses produced around the three segments of the project ("upstream", transport, distribution) and the generation of wealth sources by projects to be materialized both in the industrial and business sectors and that of consumers. To date, the actual investment executed under the license agreement for the exploitation of Block 88 was US$730 million; whereas the construction of pipelines to transport natural gas and liquids was US$710 million.

4.21 The construction stage of the project demanded an important proportion of the total investments assumed by each of the consortiums involved; an amount on the order of US$1,440 million in the phase prior to the beginning of commercial exploitation, which occurred in early August 2004, with the inauguration of: the natural gas plant in

[62] According to L. Espinoza (OSINERG, 2000) the dry gas section of Camisea which could be used in a combined-cycle station would produce the equivalent of the energy generated in 110 years by the Mantaro hydroelectric complex (approximately 1 000 MW).

the production field of Las Malvinas; the Lurín "City Gate" (Lima), and the fractionation plant of natural gas liquids in Pisco.

4.22 Camisea and the Peruvian electricity sector depend on each other. Undoubtedly, the latter has made possible the development of the project due to the fundamental support given by the Guaranty Fund to the investment needed for its development. But at the same time, the Camisea natural gas provides the electricity sector with the reality of a competitive source of supply. According to the Bulletin of the General Electricity Bureau of the Ministry of Energy and Mines (September 2004) the incorporation of the Camisea Project in the calculation of rates from four years ago, has generated a major positive impact which is reflected in the reduction of rates, otherwise, they would have increased by more than 30 percent.

4.23 The penetration of natural gas in the electricity sector will imply moving the stations, which use the most expensive fuel and the emergence of more technologically efficient stations, such as the combined–cycle type, allowing for a supply at a lower cost for the final users of the electrical service. Termoeléctrica Ventanilla (ETEVENSA) is planning to commission two of its generators (GT3 and GT4) with 155 MW each, using natural gas. From 2006, in a second stage, the committed power will be an additional 383 MW in simple and combined cycles.

4.24 Having overcome the first stage, with the implementation of the natural gas production and the Camisea Trunk Pipeline, the projects for regional pipelines and for distribution trunklines and networks in the Ica, Junín, and Ayacucho Regions and in the Cusco Region will have a major influence on the project seen in a comprehensive way, since the projected demand of the regions by the year 2025 would represent 26.5 percent of the guaranteed capacity of the CTT and 2.7 percent of the Lima's demand by 2023.

Environmental Restrictions

4.25 The strategic studies such as the Environmental Impact Assessment and the Social Impact Study developed for natural gas distribution networks within the cities of Peru, which were analyzed in this report, make it possible to state in all cases that the availability of the natural gas resource is a strategic opportunity to strengthen and contribute to the sustainability of the socioeconomic development of regions and cities. This availability becomes, in some cities, a unique possibility to encourage and anticipate a change in the current socioeconomic inertia, promoting real strategic opportunities because of its effect on growth and productivity rates.

4.26 The availability of natural gas will have a very positive impact on the strengthening of the regional, provincial, and district strategic planning, bringing and providing sustainability to the change process being conducted with much effort in the transformation aimed at development. The natural resources and the environment have established themselves as a strategic opportunity of the regions and cities under study. Their conservation imposes the need to identify the critical aspects from the environmental and social points of view, in order to carry out the proposed projects.

4.27 The strategic studies of social and environmental impacts made it possible to see the need to deepen and aim efforts at the identification and conservation of monuments, historic and archaeological heritage, parks and green areas, protected areas under some conservation category, land with gradients and/or land which can suffer erosion, as well as rivers and gorges which cross cities. Other specific restrictions are mandatory due to possible interference with service networks, such as water, sewerage, electric energy or telephone, which are underground, as well as the quality of construction of housing and buildings.

4.28 The strategic socioeconomic benefits provided by energy sources, as a vector of development, must be complemented by those environmental benefits associated with improvements in the quality of life of the population, both due to the access to natural gas as a fuel and the reduction in contamination by fixed sources and mobile sources, which become important in urban environments under study, and which turn the project into a benefit for regions, cities, and districts, resulting in an environmental impact totally compatible with the objectives proposed.

Supply Service Organization

Instruments Facilitating Project Implementation

4.29 Among the most relevant aspects for the structuring and organization of the activity related to the supply of NG are: (i) The characteristics of transport, distribution, and commercialization activities (High Pressure [HP] and Other Networks [ON]) (ii) Physical scope of the service provision; (iii) Distribution area/s to be considered; (iv) Peculiarities of the regions and project; (v) Level of integration of the property and of the service activities; (vi) Priorities and exclusivities (temporary, of specific markets, physical) for the provision of the service; (vii) Rates (levels and structures);
(viii) Economic–financial viability of the projects; (ix) Integration of the project of regions being analyzed with: a) the concession already existing in Lima; and b) the concession of the service in the Cusco Region and other regions which may potentially use the infrastructure of the Camisea pipeline.

Starting Point

4.30 The implementation of the projects must be done in harmony with the current regulatory regime applicable to the industry, environmental requirements and the promotional peculiarities required for these projects, always under the premise that this is a business to develop (*"Greenfield"*). The basic guidelines proposed with respect to the aforementioned points are as follows:

The applicable regulations:

- Apply the regulations in force in Peru, except for matters requiring adaptation due to: (i) the peculiarity of the concession/s; (ii) the promotional nature regarding the development of the projects in the regions.

For the penetration of the natural gas in each region:

- Clearly define the roles of the regional governments and their interaction with other authorities.
- Conduct advertising campaigns on the benefits of using NG.
- Finance the connections through the rates charged to consumers.
- Facilitate finance lines for the conversions of users; including them in the bills, and eventually in the rates.
- Structure rates per segment.
- Prepare an investment plan with connection obligations for users.

For the supply at the lowest cost:

- Define businesses of a rather large magnitude (to attract major operators who could guarantee the development of the market and the reliable and safe provision of the service);
- List the risks of the "Greenfield" (market exclusiveness—temporary and physical—that will ensure that the effective discount rates to be applied for potential entries are low);
- Initial contracts for large users with promotional discounts, as was done at the time with the Camisea Concession, which will have the benefit of: (i) anticipating consumption throughout time; (ii) providing an isonomic treatment in reference to the Lima consumers.
- Use guarantees against revenues flow of the concessionaire in a manner similar to that of the Camisea Concession and alternatively or in addition, consideration to direct subsidies for the creation of infrastructure. Note that markets are to be developed for each of the regions and that part of the infrastructure of the HP pipelines to be connected to Camisea will serve the markets of some regions, such as the case of Marcona, which will require extensions of pipelines from Pisco and that the delivery capacity from this region must be sufficient to cater to this demand.

4.31 The role of the regional governments, which is essential to achieve the objective of deeper penetration, will occur at two points, through important activities (i) the concession of the services; (ii) during the period of the concession. The following action lines are suggested:

The concession of the services:

- Provide potential project developers the information required from the municipalities and other regional organizations (number and type of establishments, city maps, and so forth); coordinating and centralizing—without bureaucracy—the response time on such requests.
- Organize seminars to publicize the project and the advantages of natural gas.

- Cooperate in the training of officials.
- Include natural gas as an energy source of development in the plans of the regions.
- Facilitate access to premises or records in coordination with the municipal governments.

During the period of the concession:

- Facilitate permits for right of way and construction.
- Sign cooperation agreements with the distribution Concessionaire.
- Organize seminars to spread the advantages of the natural gas.
- Cooperate with training plans for the interested parties of the system (installers, builders, users, officials, and so forth).

Business to be Developed and Definition of the Type Concession

4.32 The structure of the businesses to provide services to supply NG presented in this chapter should be a guide for the government so that concession of services is granted through efficient and effective criteria. Below is a description of the key aspects in the structuring of such instruments:

Structuring the Supply Service Activity

4.33 The distribution concession should include the assets and the provision of the integrated transport activity through high pressure and medium/low pressure network, including the activities of commercialization to users. To this effect, see Figure 2.1 in Chapter 2.

- Transport by the HP network: this includes the Main Regional Trunklines (MRT) of over 15 bar
- Other networks: include the distribution trunklines and networks, consigned as DLN, consisting of the MP trunklines (15 bar) and low pressure distribution networks.

4.34 As indicated in the economic–financial prefeasibility section, the separation of the business relating to the distribution of the supply trunklines to the districts and industries would have the following disadvantages:

- The businesses are too small. In this sense, as a way of example one should note the average annual revenues of the business units of Alternative 2 of the Junín Region, in a segmented way: (i) MRT, US$17.7 million; (ii) DLN, US$4.7 million;
- There can be savings in major fixed costs, with regard to operations, commercialization, and administration, by integrating—at least in each region—these activities; and taking into account that the size of the market to serve would not justify other savings either, which could be obtained from the specialization of functions.

4.35 From this point of view, concerning the technical characteristics of the businesses to be given in concession, they would be similar to those of the current supply of NG in the Lima and El Callao region (with assets making up a main HP network, which in the case of the regions would include the regional pipelines, and secondary networks of medium and low pressure); and the distributor performing the tasks of transporting the natural gas from the points of connection with the Camisea pipeline to the "City Gate" and then its distribution and commercialization to the final user.

Degree of Integration of the Property and Other Businesses to be Developed by the Concessionaire

4.36 In line with the lack of restrictions for the integrating activities in the concession, it is also proposed to maintain the lack of restrictions for the integration of the property in the concession, both vertical as well as horizontal.

4.37 The government must evaluate the suitability of current operators' participation in the businesses to be given in concession. From the regulatory point of view—with the difficulties in obtaining accurate information on the service cost—it would be good for new operators and companies to come in, different from the current ones, to afford the possibility of comparing the performance, which would enrich the regulatory task. However, a restriction of that kind must be in line with the true possibilities of getting sufficient firms—quality companies—to compete in order to gain access to the business.

4.38 Permit the undertaking, by the concessionaires, of activities which, in principle, could be subject to market competitiveness, such as those related to:

- The provision and maintenance of internal installations
- The sale of gas-run domestic appliances
- The financing of such services and sales in an independent way or included in the services billing
- The provision of other services such as the periodic review of the installations or appliances

The undertaking of these activities by the same entity, the concessionaire, but without this being on an exclusive basis, would save on costs related to market development and the construction activities for the laying of networks during the commercial stage. Taking advantage of the concessionaire approaching the customer may be positive in order to use the synergy between operational and commercial activities.

Physical Environment for the Provision of the Distribution Service

4.39 It is suggested for the distribution concessions to comprise a marked geoGraphal area, including one or several regions and districts. To that effect, the government must evaluate the suitability of what apparently surfaces from the prefeasibility studies. The existence of at least three geoGraphal areas: a) the Ica–Pisco Region; b) a region , which would include Junín and Ayacucho; c) another separate in the Cusco Region.

4.40 The Prefeasibility Study of the Ayacucho, Junín, and Ica Regions denotes the suitability of the supply alternative known as Alternative 2, through the trunkline which, going from the interconnection with the Camisea pipeline, can supply the districts of Ayacucho–Huancayo–Tarma and La Oroya. Not only are the costs of the service markedly reduced by sharing the use of the same infrastructure, but, in addition, there are gains as far as the safety of the supply to Lima in the near future is concerned; as well as in terms of lower pipeline expansion costs when the demand increases. To define the final strategy. it would be useful to analyze carefully if the Ica Region, which yields the best economic and financing results, is added to Alternative 2.

4.41 The level of integration of the operation should occur without restrictions for one or several operators from all the distribution areas. This is related to the aforementioned aspects associated with comparison suitability, which ought to be evaluated by the government.

Degree of Exclusivity and Priority in the Provision of the Service

4.42 *Extension of the Trunklines and Networks:* It is proposed that the concessionaire have exclusivity in the extension and supply within its area of concession, including the localities or users not forming part of the projected investments plan.

4.43 For works, which are not included in the concession list, the following alternatives could be put forth in favor of the concessionaire:

- Priority with respect to the eventual supply to a locality by a sub-distributor
- Exclusivity (with obligation of investment provided this is compensated at the authorized profitability rate)
- Temporary nature of the priority, as is the case in Lima and El Callao for example, where the time of "priority" is limited to 12 years).

4.44 *Exclusivity for the Transport by Network:* An important aspect to take into consideration is the absence of a physical "bypass" to the HP network and ON for any type of user (including large customers). Allowing the physical bypass without limits to the distributor, once the distribution systems were bid and delivered for exploitation to the concessionaires, may carry a huge risk for the business, since there is the possibility of unnecessary duplication of assets and a possible increase of the service cost for users who remain connected to the distributor's network, as a result of ceasing to use the network by a given number of users.

4.45 Degree of Exclusivity for the Supply of Markets of Each Type of User:

- It is suggested that the concessionaire have exclusivity to cater to residential users, business, small industries, and VNG in their area of distribution.
- Allow the commercial "bypass" for independent consumers only, which means that they must always pay the concessionaire the respective transport tariff included in the "bundled" service.

- Concerning the definition of an independent consumer, it is suggested to keep the floor of 1 MMCF of the distribution regulations.
- Since there are few large customers, it would be appropriate for them to contract for the natural gas directly with the producer and to arrange the transport with the carrier of the main pipeline, with the advantage of obtaining access to promotional natural gas prices (initial contracts, similar to the Camisea concession process). In the event that the purchase of natural gas and transport is carried out by the distributor for resale to these users, the possibility must be provided for the distributor to return to the producer and to the carrier of the main pipeline, the amount of natural gas and of transport contracted directly by the independent consumer.

Toll for the Use of the Network

4.46 Distribution tolls (MRT and DLN) must be structured in the following manner, depending on the type of market to supply:

- *Regulated Market:* with a toll for the use of the concessionaire's infrastructure, which will be included in the final rate of the regulated user (residential user, businesses and small industries, VNG);
- *Independent Consumer Market:* with a toll for the use of the concessionaire's infrastructure, separate for the large customers of the area of concession, which may acquire natural gas and the trunk transport (CTT) directly without the brokerage of the distributor.

Interface with the Trunk Transport from Camisea (CTT)

4.47 With respect to the Operation and Maintenance (O&M) of the MRT it is proposed that the following alternatives be evaluated: (i) Payment for an O&M service to the operator of the CTT; (ii) O&M by the concessionaire of extensions.

Extensions and Expansions of Trunklines and Networks

4.48 An evaluation should be made of the suitability to include the plan of mandatory investments of extensions and connections to trunklines and networks in the bid list, similar to the Camisea bidding process. Said plan should contain at least:

- The minimum supply capacities in each district, specifying the points of connection with the Camisea Pipeline
- Minimum supply capacities for the potential independent users
- Number of connections, which must be performed to connect residential and business users in a given period of time.

4.49 *Regulatory Treatment and Financing of Expansions and Extensions:* For the extensions and expansions, which were not included in the plan of mandatory investments and which treatment could be performed when there are rate reviews.

4.50 *Expansions upstream from the connection with the CTT (over the Camisea transport)*: The adjustment in the transport rate from Camisea depending on the coverage of the benefit (and provided it satisfies the economic prefeasibility study) may be:

- "Roll-in," if it benefits the users of all the regions served through the CTT.
- Incremental, if the benefits can be assigned to users of the region only.

4.51 *Expansions and Extensions in the Area of Concession (HP and LP):* The adjustment in the distribution rate should correspond to criteria similar to those indicated before.

Regulatory Treatment and Financing of Network Connections by Users

4.52 In view of the low level of income in the regions and the consequential problems in accessing credit at reasonable cost terms, the following is necessary:

- The inclusion of the costs of the intake in the rate
- The financing of the internal connections and its inclusion in the billings
- A preferential rate and terms for the financing of connections
- Service rates

4.53 It is proposed to apply the NGLC Rate Regime (Natural Gas of Lima and El Callao S.A.) with some peculiarities:

Rates for Trunk Transport to the Point of Delivery (PD) to the Distributor (point of connection with the Regional Pipeline): In the prefeasibility report, two alternatives were evaluated for the calculation of the transport rates:

- Without consideration to the distance, defining one postal rate or "postage stamp" for CTT Transport (same as transport in Lima–Callao).
- With reflection of the distance factor in the transport rate (by area).

4.54 The structuring of the transport rate, with respect to the distance factor, as indicated in said report, more adequately reflects the "drivers" of the costs of service provision and, consequently, suffers from the inefficiencies introduced by a postal rate scheme in transport. To begin with, adequate incentives are provided for the localization of the production activity; and regional development objectives are met for the areas near the sources of supply; regions, which also have a low socioeconomic development index, as outlined above.

Distribution Rates by HP (from the Camisea Transport Trunk PD to the district "City Gate") in the Distribution Areas

4.55 Consider the definition of sub-areas within the geoGraphal area of concession of the distribution service, for cases where the distance from the Trunk Transport PD to the district station of the locality is important (for example, Ica Region–Pisco versus Marcona; Ayacucho–Junín Integrated Regions: Ayacucho versus Tarma, Cusco Region, Cusco City versus Quillabamba). In this case, it is suggested that the distribution margin (HP) be structured by "clusters" in the regions, since: (i) localities are grouped at given points; (ii) considerable distances occur in the route without any kind of consumption being registered; (iii) some localities are very far from the center of gravity of the pipeline's demand.

Economic Viability of the Concession and Comparison of Alternatives

Economic Rates and Regional Development

4.56 The comparison of supply alternatives for each region must take into consideration the economic costs in the entire system (including those of eventual expansions of the trunk transport). In that sense, the methodology for rate calculation (whether or not it includes the distance "driver") guides the election of the alternatives as explained above:

- The transport rate by distance in the Camisea trunk would favor the connections of the trunklines to the main pipeline, which are near the area of production (Ayacucho–Tarma trunkline versus Lurín–Tarma trunkline) as opposed to the current Malvinas–Lima/Callao postal rate.
- It is also important for the election of alternatives to take into account this aspect, since the economic valuations obtained in the prefeasibility report support that position.

4.57 The distribution concession areas can admit rate sub-areas, something that is justified by principles, which are similar to the previous ones, in order not to penalize potential activities and consumption in those districts:

(a) There is a significant distance between some of the centers of consumption supplied by the same HP trunkline, which connects the Camisea trunk pipeline with the localities to be supplied.

(b) The levels of consumption of the localities could have a very different significance in the consumption structure and therefore, in the determination of the rate.

In both cases, a) and b) a single distribution margin for the entire geoGraphal concession area could be discriminating and unnecessarily discourage regional development. For example, supplying the entire locality of Ayacucho through Alternative 2 and determining a rate by distance through the trunkline which supplies the region, would represent a much lower rate for that locality and not substantially different for Huancayo–Oroya–Tarma, since the center of gravity of the demand is placed in these latter localities.

4.58 For eventual subsidy schemes (or guaranteed entry) to support regional development, consideration should be given to:

- The consumption of the regions along the route will contribute to the reduction of the guarantee of the Main Camisea–Lima Pipeline; and in that sense, it would mean anticipated savings, which could be put to use to consider a certain guaranteed entry scheme for some of the distributors.
- The current transport rates (through the trunk pipeline) exceed the rates by distance to the future areas to be served (up to the point of delivery to the

area of distribution) and consequently constitute an extra cost for these regions, something that should be eliminated. If the government decides to maintain the postal rate, consideration could be given to an eventual subsidy in the final rate so that the user may receive the service at its economic cost.

- The capacity of some of the regional pipelines must exceed the aggregate consumption of the localities to be supplied in the area, in order to make it possible in the future, to extend trunklines to localities, which are farther away. This is the case of Marcona, for example.

5

Strategy to Call a Bidding

5.1 This chapter contains the definition of the strategy to call a bidding for natural gas transportation and distribution systems for the four regions selected, using the conclusions and recommendations of the studies presented in the preceding chapters.[63]

5.2 This task starts with a review of natural gas demand by the large industries, which must be sufficient to match the billing numbers required by the concessionaire to recover the investments made into transportation and distribution of natural gas to the different customers of the cities under consideration, plus the necessary costs to operate these systems efficiently and to maintain earning power in the global business at about 10 percent.

5.3 The interested companies, after reviewing studies, will be able to decide on the most efficient route (including capital and operational costs necessary for the adequate management of socio-environmental impacts) and set an adjusted implementation schedule to prepare their bids and to participate in the bidding.

5.4 The first step to secure the economy of the pipeline extension projects is to verify the projected natural gas consumption by the large industrial customers, which in practice, are the ones which will be generating the most important demand; in other words, the "anchor" to the projects under study. The following step will be the re-valuation of the hypothesis of the price and costs used in the economic calculations, and finally, the estimate of the type of implementation and operational guarantees and conditions to be offered as part of the bidding.

Re-evaluation of Natural Gas Demand

5.5 In the case of the Ica Region, the most prominent industrial customer is Aceros Arequipa, a company which has asked Pluspetrol and TGP to supply natural gas as soon as possible, through a temporary agreement, from the condensates fractionation facilities of the current Camisea Project located in Paracas, very close to its installations. In general the analysis demonstrates that supply to the Ica Region is, in all scenarios, a profitable project.

[63] The calculations made by Proinversión and the Latin investment bank Capital Pacific have been used for this document.

5.6 In the case of the Junín Region, although Doe Run and Calera Cut Off have confirmed their intention to buy natural gas rather shortly, the other important industrial customer, Cemento Andino, uses carbon to feed its production installations, with the inconvenience that the price of domestic carbon is lower than the natural gas supply price. In the analysis made by the R. Garcia and Intec/Arcan consultants, no differentiation was made between domestic carbon and imported carbon prices, assuming, for the base case (which considers a WTI crude oil price of US$40/bbl) an average carbon cost of US$3.50 to US$3.70/MMBTU. The difference is substantial since Cemento Andino can buy domestic carbon for US$2.91/MMBTU, while natural gas would be available at an estimated price of US$3.70/MMBTU, assuming that the entire production capacity of this company converts to natural gas.

5.7 A revision of transportation and distribution rates with a lower demand would make the new price of natural gas delivered to the user's installations go up by almost US$5/MMBTU, a level where natural gas cannot compete with imported carbon either, which price is US$4.26/MMBTU.[64] Likewise, as can be evidenced in the table 5.1, with lower demand and a new price, it would be difficult for natural gas to compete with alternative energy sources in the residential, business, and small industrial markets as well.

5.8 It should be noted that in this table, the cost of natural gas at wellhead is US$1.00/MMBTU, and the rate for the use of the TGP gas pipeline is only US$0.83/MMBTU. The following section discusses the validity of these changes in the prices of natural gas and in the transportation rates.

5.9 In the case of Ayacucho, the lack of industrial customers requires that the concession of this region's pipeline, if possible, be incorporated into another region's concession bidding. The adoption of Alternative 2 route to reach the Junín market, the price of natural gas at wellhead of US$1.00/MMBTU and the change in regulation for transportation rates in pipelines from the "postage stamp" fee to a distance-based fee, will facilitate a bid to build the distribution system as part of the bidding to supply natural gas to Junín.

5.10 In the case of the Cusco region, the current demand from the industrial sector is quite low. It is necessary to review the assumption regarding the dates when the initial natural gas demand will be met, which come from the following industrial projects: the conversion of the Cachimayo Nitrate Plant, Quillabamba Cement Plant, and Thermoelectric Plant, as well as the coverage of the residential natural gas distribution systems; that is, the first cities to be served and the minimum number of connections to be implemented in each of them. Unlike other regions, Cusco is privileged to have a very significant Gas Canon, which continues to grow. While there are industrial customers in Ica and Junín, in Cusco the demand required to achieve minimum billing will certainly have to be guaranteed with part of the funds deriving from the Canon.

[64] Price of the used coal in the plant to May 20, 2005 = USS120/metric ton.

Table 5.1: Natural Gas Adjusted Price—Junín and Ayacucho Regions (in US$/MMBTU)

Item	*Industries*	*Businesses and Small Industries*	*Residential*	***Final Price for Industry***
Natural Gas				
Cost at wellhead	1.00	1.00	1.00	
TGP transport	0.83	0.83	0.83	
MRT	2.87	2.87	2.87	
DLN	0.24	5.84	5.84	
Delivered to User Price	***4.94***	***10.54***	***10.54***	
Intake		0.13	3.22	
Internal Installation and Conversion		0.34	2.63	
- Doe Run	0.17			***5.11***
- Calera Cut Off	0.15			***5.09***
- Cemento Andino	0.13			***5.07***
Final price to Consumer		***11.01***	***16.39***	
Alternative Energy Sources				
LPG	17.9	17.9-16.7	17.9-16.7	
Domestic carbon	2.91	3.7-4.7		
Imported carbon	4.26			
Diesel 2	15.1			
Residual	5.80	5.80		

Prices do not include VAT but they do include the Gas Tax and Excise Tax
Prices to Consumer in force as of July 17, 2005
Price of WTI Crude US$40/bbl and of imported ground carbon US$120/MT FOB Plant

Table 5.2: Natural Gas Demand in the Cusco Region (in MMCFD)

Users	*2007 Year 2*	*2009 Year 4*	*2010 Year 5*	*2015 Year 10*	*2020 Year 15*	*2025 Year 20*
1. Total Demand	*14.49*	*15.76*	*16.45*	*26.33*	*31.23*	*35.42*
1.1 Large Users	14.26	15.23	15.74	24.30	28.74	32.45
Cervesur	0.17	0.18	0.18	0.21	0.25	0.29
Hotels	0.07	0.07	0.08	0.10	0.12	0.15
Cerámicas Kantu	0.03	0.04	0.04	0.04	0.05	0.06
Cachimayo	4.20	4.46	4.59	5.32	6.17	7.15
Cement Plant	1.60	1.70	1.75	2.03	2.35	2.72
Thermal Station	8.19	8.79	9.11	16.60	19.81	22.08
1.2 Businesses and small Industries	0.11	0.26	0.39	1.50	1.82	2.20
1.3 Residential	0.12	0.26	0.32	0.53	0.67	0.77
2. Number of Users	*6,622*	*14,174*	*17,370*	*29,469*	*36,873*	*42,446*

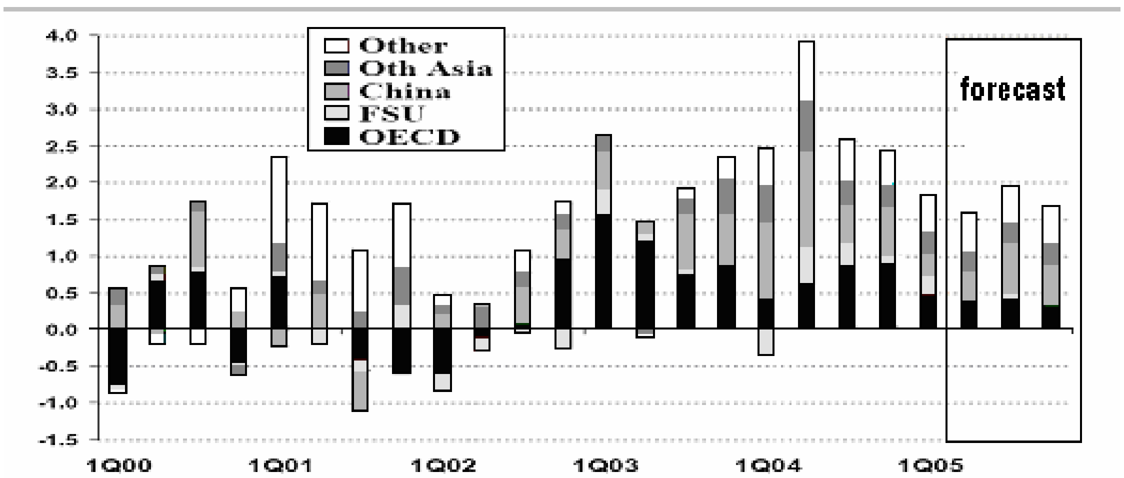
International Prices of Crude Oil, Natural Gas at Wellhead and the Energy Sources to be Replaced

5.11 Throughout this year, the press has been writing on a daily basis about the rapid escalation of oil prices in the international market. Nominal WTI crude oil prices have gone over the US$65/bbl mark. However, if the inflation element is not considered in actual US Dollars, it has yet to beat the all time record posted in 1979–1980. What is of concern is that, at the time, it was certain that once the crisis was over, and with Iran back into the market, the prices would go down. It is not certain that could happen today; and prices are probably not going to come down in the short term.

5.12 In order to analyze crude oil prices, one needs to examine the fundamentals of the market. On the demand side, there are three main facts: first, imports from China, India, and other developing countries have increased more than expected; second, energy efficiency has not increased due to a lack of incentives, and actual prices in the 1980s and 1990s have obviously dropped; and finally, the contribution of substitute energy sources such as natural gas, hydroelectricity, and carbon or nuclear energy have developed slowly while demand for petroleum is still on the rise.

5.13 Looking at what has become apparent between the year 2000 and now, it can be appreciated in Graph 5.1 that as from the end of 2002, economic growth has increased both in the undeveloped and developing countries, causing a significant demand for petroleum. It is worth mentioning the peak experienced in the first quarter of 2004 when consumption rose with respect to the first quarter of last year by 4 million barrels per day. The chart also depicts the impressive growth of demand in China, India, and in the consumption of other Asian countries and developing countries as well.

Graph 5.1: World Oil Demand (differences in Millions of Barrels / Day)



5.14 The petroleum products with the widest demand are medium distillates, such as diesel, kerosene, and jet-fuel. This trend, which is observed in many developing countries, is the result of price and tax-related policies, which favor diesel over the other fuels, most notably over gasoline. In the international market, the price of diesel, especially low sulfur diesel, has increased more rapidly than that of crude and the other products. Furthermore, the difference between the price of light and heavy crude has considerably increased, as well as refinery margins, which for many years have stayed rather low. At present there are better conditions to carry out investments than in the past, which caused expansions and modernization work at refineries to be postponed.

5.15 Another notable change is the advancement of technology. As in the case of other industries, the petroleum industry has benefited from the technology information development, data treatment, new materials, and so forth, to the point that it is possible today to drill at a lower cost and more precisely, and extract a higher percentage of the reserves "in situ." The industry has been able to have access to deeper marine areas and to operate in fragile environments, significantly reducing its impact on the environment. However, in the last decade, the discoveries have not been able to offset the extraction of conventional oil reserves. The contribution of new producing countries that are not members of the Organization of Petroleum Exporting Countries (OPEC) without considering the decrease in production in many countries does not counterbalance the demand rise worldwide. Some experts consider that conventional oil production is reaching its peak and that in the future there will not be any other choice but to produce non-conventional petroleum, liquefy natural gas, or produce bio-fuels, something that will demand a greater level of investment.

5.16 In this decade, although technology has improved, the political risk seems to have increased. Without going into a discussion about sociopolitical causes, it is sufficient to watch the number of countries that, with a significant level of reserves (Iraq, Venezuela, Indonesia, Bolivia, Ecuador, and so forth) produce below their potential level. Because of the political risk, the investments, which could mobilize new reserves and increase production, are not happening, and the companies that would make them, are asking for higher rates of return.

5.17 If the problems to increase energy production and efficiency persist, the balance by the year 2010, in view of the trends observed, show that the dependence on the OPEC cartel will continue to increase. In a market of nearly 90 million barrels per day, a reserve capacity of 1 to 2 million is insufficient. This is why the high volatility conditions in prices persist and will continue to have an impact on the economy of the sector's projects. Futures markets confirm that the agents have confined this situation and the prices for the next 24 months have started to be higher than the current price of the barrel. It is possible that the "contango" situation observed since June 2005 will continue for some time.

5.18 Although it is considered that between now and the year 2010 it will be difficult for substantial changes to occur, it is possible that after that date, there may be an increase in production and/or a reduction in consumption. Both actions are compatible and they respond to the high prices incentive. However, prices alone are not enough. In the case of production, political risk must be reduced and in the case of the demand what is needed is the issuing of more radical preservation policies. One piece of good news from the last Group of Eight summit was the recognition by the Bush Administration of how serious a problem global warming really is. However, it is recognition without much of an impact if it is not accompanied by a gradual adjustment in the level of demand for fossil fuels; an adjustment which will probably permit a sustained increase in the price of natural gas.

Table 5.3: Supply and Demand of Oil by the Year 2010 (in Millions of Barrels / Day)

Producers and Consumers	*2000*	*2004*	*2005*	*2007*	*2010*	*2000-04* %/year	*2004-10* %/year
OECD	44.1	45.6	46.2	46.9	48.0	0.9	0.8
FSU	3.6	3.8	3.9	4.1	4.3	1.7	2.0
China	4.5	6.4	7.0	7.9	9.1	9.2	6.0
Other	24.5	26.8	27.5	29.0	31.3	2.3	2.4
Total Demand	*76.7*	*82.7*	*84.6*	*87.8*	*92.7*	*1.9*	*1.9*
OECD	18.3	17.2	17.0	17.4	17.2	-1.1	0.0
FSU	7.9	11.1	11.6	12.9	14.0	3.2	2.9
Other	22.5	25.0	25.9	27.2	29.1	2.5	4.1
OPEC Crude	28.0	19.1	30.2	30.4	32.5	1.1	3.4
Total Supply	*76.7*	*82.4*	*84.7*	*87.9*	*92.8*	*5.7*	*10.4*
OPEC Capacity	31.0	30.9	31.6	33.7	35.4	-0.2	4.5
Reserve Capacity	3.1	1.8	1.4	3.3	2.9	-1.3	1.1

5.19 As far as energy demand is concerned, it has to be recognized that there are flagrant differences in consumption habits and that price alone is not going to change them, evidencing a more or less elastic demand. Today, the highest monthly expense of an owner of a four-wheel drive vehicle—a Ford Explorer or a Chevrolet Tahoe—which runs an average of 1,500 kilometers/month—compared to someone who owns a Honda automobile, is US$17.50. For the average American, the difference is not sufficient to change his appetite for power, or to persuade him to change vehicle model and get a more economical one next time he buys. The difference between the consumption of an American and an average Chinese is ten to one. What is also of concern is that the shortage of development models with low energy content causes the oil demand of China and of other developing countries to run the unavoidable risk of increasing.

5.20 This oil price scenario in the international market forces a revaluation of the assumption under which substitute fuel and natural gas prices in the market and at wellhead have been proposed.

5.21 With respect to the substitute fuels, it is worth noting that Peru is the only country in the South American region, which has maintained a pricing policy to avoid subsidies. The impact of the rising crude prices and of products at the international level has been almost entirely passed on to consumers; there have only been reductions in the excise tax in order to cushion the escalation. Thus, for example, in April 2005, diesel in Peru was amongst the most expensive in the region:

Table 5.4: Price of Diesel (in US$/gallon—April 2005)

Country	*Price*
Venezuela	0.11
Ecuador	1.00
Colombia	1.55
Bolivia	1.75
Argentina	1.85
Paraguay	2.00
Brazil	2.50
Chile	2.65
Uruguay	2.80
Peru	3.00

5.22 This situation facilitates the introduction of natural gas and more or less offsets the small size of the markets of the regions under consideration. Furthermore, as part of the contractual agreements signed in December 2004 for the development of the San Martín and Cashiriari fields, the consortium led by Pluspetrol agreed to consider a price of US$1.00/MMBTU for natural gas at wellhead for consumers in the Cusco Region, a price which should be adjusted with the same formula applicable to the price of natural gas for the rest of the country.[65] To encourage the industrialization and decentralization process, ProInversion has been negotiating with the producing consortium to maintain this price for the entire production sold in regional markets.

5.23 In relation to the fuels, which can be used in thermal stations, the outlook of refined product prices on the rise to continue for the rest of this decade makes natural gas become more valuable. This is complemented by its advantages in terms of fewer greenhouse gas emissions.

[65] Pt = Pa x adjustment factor. Where:

Adjustment factor = (0,5 * F01j / FO1a + 0,25 * FO2j / FO2a + 0,25 * FO3j / FO3a).

Pt = Precio Maximum realized at ouput fiscalization point readjusted, as applied to the new calendar year.

Pa = Maximum realized price at output fiscalization point on the date of subscription.

FO1= Fuel Oil N° 6 US Gulf Coast Waterbone (1 percent sulfur)
FO2= Fuel Oil N° 6 Rotterdam (1 percent sulfur)
FO3 = Fuel Oil N° 6 New York (3 percent sulfur)
FO1j, FO2j y FO3j are the arithmetic mean of each fuel oil price, calculated from daily prices published by "Platt's Oilgram Price report" for the four years prior to the calendar year. during the previous 120 months to the date of the subscription.

FO1a, FO2a y FO3a are the arithmetic mean of each fuel oil price, calculated from daily prices published by "Platt's Oilgram Price report" during the previous 120 months to the date of the subscription.

In those cases where the adjustment factor is less than one (1), the value of the adjustment factor considered is one (1).

The Pipelines Route, Environmental Impacts, Capital Costs, and Operational Costs

5.24 It is worth noting that the routes described in Chapter 2 are of an indicative nature and that they have been prepared with two essential purposes: (i) to confirm the technical prefeasibility and to identify the complexity of the environmental and social impacts which could occur, and (ii) to estimate the investments and the operational costs with an acceptable degree of precision[66] to be able to carry out the economic and financial analysis of the projects.

5.25 In that sense, the retained capital and operational costs are those found in table 5.5.

Table 5.5: CAPEX and OPEX of the Natural Gas Transport and Distribution System for the Regions of Ica (excluding Marcona) Ayacucho and Junín (Alternative 2)

Cost	*Amount US$ million*	*Table of Reference*
Transportation Network (DLN)	92.7	2.14
Medium Pressure Network	12.2	2.17
Low Pressure Network	49.4	2.19
Internal Systems and Conversions	39.3	2.21
Total CAPEX[a]	193.6	
	US$ million/year	
Operational Cost	9.7	2.29

[a] Does not include working Capital requirements

Table 5.6: CAPEX and OPEX of the Natural Gas Transport and Distribution System for the Cusco Region (excluding extension to Combapata)

Cost	*Amount US$ million*	*Table of Reference*
Transportation Network (DLN)	89.0	2.15
Medium Pressure Network	3.7	2.18
Low Pressure Network	28.6	2.20
Internal Systems and Conversions	10.9	2.22
Total CAPEX[a]	132.2	
	US$ million/year	
Operational Cost	4.1	2.32

[a] Does not include working capital requirements

5.26 The concessionaire will have to define the final route based on more detailed studies and much more detailed environmental and social impact evaluations.

[66] Approximately 20 percent.

The concessionaire will be responsible for making sure that the chosen route will allow for the most efficient operation at the lowest cost.

Adaptation of the Regulations Applicable to Natural Gas Transport and Distribution

5.27 The first adaptation to be considered deals with vertical integration. The search for competence and a better supervision of costs incurred in a natural gas transport and distribution system, just like an electric system, aims at prohibiting a vertical integration, forcing each stage of the supply chain to be handled by different companies. This principle, which forms part of most of the regulatory frameworks for these activities, must be adapted considering the size of the business being planned. It is very possible that the companies attracted are not well qualified for small systems such as the Ayacucho or even Ica markets by themselves, since such companies have administrative costs, which cannot be covered if they do not form part of projects of a given size. This is why there is a proposal for the integration of the transportation and distribution systems in the case of the proposed pipelines: Humay to Ica, Ayacucho to Tarma and Kepashiato to Cusco.

5.28 A second important adaptation would be the change of the rate system for the trunk pipeline operated by TGP. The current postage stamp system, according to which, all users of a line—regardless of the point from which the natural gas is taken—pay the same rate, must be changed for one which is based on the payment for distance concept, that is, users who are close to the fields would pay less than those who are farther away. Since Lima is the terminal point of the TGP pipeline, to maintain a postage stamp system would be equivalent to generating subsidies by the regions which are closer to the fields, in favor of the capital city; which is totally against all logical economic reasoning; and of route, against government's current decentralization policy.

5.29 In relation to this second adaptation, during the year 2005, ProInversion has started negotiations with TGP to ensure that the cash flow of this company as well as any additional costs generated by the regional market will be taken into account. Likewise, ProInversion has approached OSINERG, the government body that regulates the sector, requesting the respective change in the regulation of the rates applicable to the transportation of natural gas. It appears that in order to fairly facilitate the calculation of the rates, a system considering several areas is being adopted:

i. An initial section, from the beginning of the pipeline to km 126, applicable to the pipeline, which would serve the Cusco region, with a rate of US$0.40/MMBTU

ii. A second section, from km 126 to km 521, applicable to the Ica, Junín, and Ayacucho regions, with a rate of US$0.83/MMBTU

iii. Finally a third section, applicable to the rest of the consumers on the Pacific coast, including Lima, with a rate of US$1.18/MMBTU.

The First System to Bid On: Ica + Junín + Ayacucho Regions

5.30 Given the uncertainty explained in the case of the industrial customers of the pipeline to serve the Central Highlands region (La Oroya and Tarma), it seems appropriate to propose that a single concessionaire be asked to build and operate the service to supply natural gas to the Ica, Ayacucho, and Junín regions, in order to create a business with a guaranteed profitability, whereby whatever risk there may be—with respect to higher or lower natural gas consumption in substitution of carbon—can be offset by a guarantee from the industrial customers of the Ica Region.

5.31 This business would have to have a single rate for the transportation of natural gas applicable to the entire concession, but with distribution rates that will differentiate the various user categories. In this way the business would accomplish an initial sales figure estimated at US$7.6 million, which would increase to US$36 million in the first five years—especially if new industrial projects materialize; to which effect, an investment estimated at US$200 million would be required, to be recovered in about eight years.

5.32 For the Ica, Junín, and Ayacucho regions, the results of these decisions would make it possible to reach the following comparisons between the prices of natural gas and the prices of alternative energy sources at the consumer level, as shown in tables 5.7 and 5.8.

5.33 A final observation with respect to this concession would be to consider—in case of very advanced progress made on the Pisco to Tocopilla pipeline project—for the line to be sized taking into account the markets in southern Peru and northern Chile.

5.34 The invitation to bidding for the natural gas distribution and transportation services concession for these regions could take place immediately, including for that purpose, among others, the following conditions:

- To participate, bidders must have an operator with experience in natural gas distribution systems. Technical and financial prequalification criteria should be established to that effect, such as:
  - *Technical Criteria:* Number of residential users the bidder currently provides to.
  - *Financial Criteria:* Asset and equity levels.

5.35 The rates for the transportation and distribution within this concession must also be adapted to the distance principle rate to attract customers in the Ayacucho region.

- The prequalified operator must hold at least 25 percent of the concessionaire's company for a minimum of 10 years.
- The term of the concession is 30 years, renewable as per applicable law. The maximum term for the execution of the works and fitting of the regional pipelines up to the points of entry into each city ("city gates") for the concession covering the Ica–Ayacucho–Junín regions will be two years. The terms are counted from the date of approval of the

Environmental Impact Studies or six months from the closing date, whichever happens first.

- The concessionaire's obligations include:
  - Complying with the plan to expand the service to a given number of residential customers, as may be prescribed in the bases (approximately 38 percent access in the cities served)
  - Three years after the commissioning of the commercial operation, submission of a plan to connect the other cities (to be defined before the bidding) located within the concession area
  - Operation and maintenance of the system, as per technical and quality rules set forth in the regulations and in the agreement.
- Other obligations:
  - Compensation to the regulator, as per applicable law
  - Establishing a company domiciled in Peru, with a minimum capital of US$10 million per concession.
- The concessionaire's rights include:
  - The exploitation of the distribution service for residential customers, commercial customers, and large users.
  - The distribution concession shall be granted on an exclusive basis in the area of concession.
  - Capacity to participate in future concessions.
- The guarantees to be fixed prior to the bidding will include:
  - Validity, effectiveness, and compliance with the economic bid
  - Reconsideration and appeal of prequalification
  - Objection to the award
  - Performance bond with regard to the transportation and distribution agreements.

5.36 The predominant criteria for the award would be the lowest transportation rates offered through the regional pipelines.

Table 5.7: Comparison between the Price of Natural Gas and the Price of Substitute Energy Sources—Ica Region (in US$/MMBTU)

Energy sources	*Prices by Consumer Sector*[a]			
	Industrial	*Businesses and small Industries*	*Residential*	*Electricity Sector*
NATURAL GAS				
- Cost at wellhead	1.00	1.00	1.00	1.00
- TGP Transport	0.83	0.83	0.83	0.89[b]
- MRT	1.35	1.35	1.35	0.13
- DLN	0.19	1.47	5.65	0.00
Price to user	3.37	4.65	8.83	2.02
Intake		0.19	3.22	
Internal Inst. and Conversion	0.08	0.51	2.63	
Final Price to Consumer	3.45	5.34	14.69	2.02
ALTERNATIVE ENERGY SOURCES				
LPG		16.70	16.70	
Kerosene	14.50		14.50	
Imported carbon	4.70			
Diesel 2	15.10			
Residual	5.80	5.80		
Electricity			29.20	

[a] Price to consumer with a reference crude of US$40/bbl including taxes, except VAT.

[b] The chief proposal is closer to Lima and this is why a rate for the use of the TGP trunk pipeline of US$0.89/MMBTU has been assumed.

Table 5.8: Comparison between the Price of Natural Gas and the Price of the Substitute Energy Sources—Junín and Ayacucho Regions (in US$/MMBTU)

Energy Sources	*Prices per Consumer Sector* [a]			*Final price to Industrialist*
	Industrial	*Businesses and Small Industries*	*Residential*	
NATURAL GAS				
- Cost at wellhead	1.00	1,00	1,00	
- TGP Transport	0.83	0.83	0.83	
- MRT	1.35	1.35	1.35	
- DLN	0.51	2,01	5,65	
Price to user	3.69	5.18	8.83	
Intake		0.13	3.22	
Internal Inst. and Conversion		0.34	2.63	
> Doe Run	0.17			3.86
> Calera Cut Off	0.15			3.84
> Cemento Andino	0.13			3.82
Final Price to Consumer		5.65	14.69	
ALTERNATIVE ENERGY SOURCES				
LPG	17.90	17.9/16.7	17.9/16.7	
Domestic carbon	2.91	3.7/4.7		
Imported carbon	4.26			
Diesel 2	15.10			
Residual	5.80	5.80		

[a] Prices do not include VAT but they do include the Gas Tax and the Excise Tax.

Prices to Consumer in effect as of July 17, 2005.

WTI Crude Price US$ 40/bbl and imported ground carbon price US$120 /MT FOB Plant.

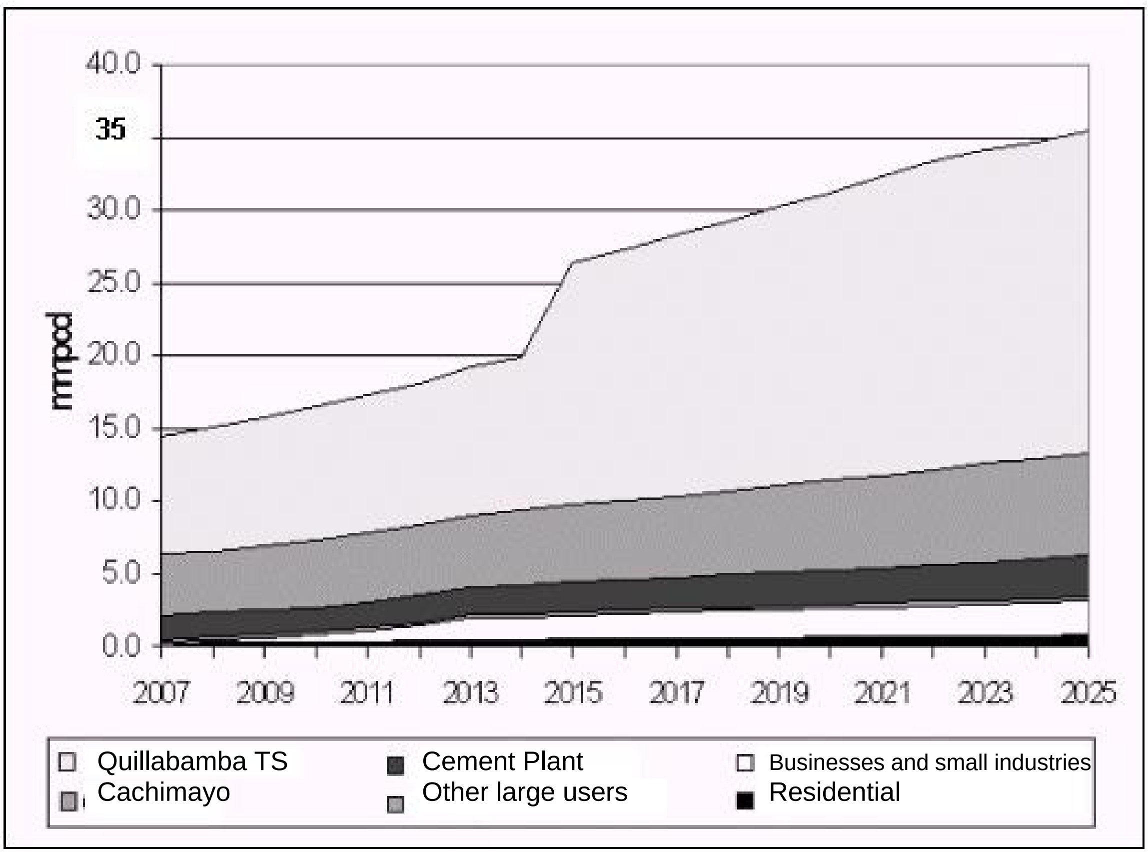
Second System to Bid On: Cusco Region

5.37 Although there are no industrial customers in the Cusco region, which can easily convert to natural gas, this region will continue receiving very significant sums of money for the Gas Canon because it is the region, which produces this resource. The Gas Canon Law prescribes that the Cusco region will receive 50 percent of the royalties and income tax paid by the operators of the natural gas fields found within this region. To this effect, during the first 12 months of operation, the Camisea Project in its initial magnitude, in other words, only serving the city of Lima's market, has generated approximately US$70 million for Cusco in terms of Canon, an amount which will keep on growing as the prices of natural gas and of condensates increase and/or when production volumes are increased, whether through sales within the country, or from NGL exports to the markets in Mexico and California or through the pipeline to northern Chile.

5.38 However, it is appropriate to note that the Canon is shared by the regional government (20 percent) the San Antonio de Abad University in Cusco (5 percent), and most of the provincial and district municipalities, especially those where the natural gas is found. Therefore, any decision to use the Canon to provide a subsidy or to guarantee the construction of the pipeline to Cusco must take this sharing into account.

5.39 As has been pointed out, Cusco's current demand does not include large industries; therefore, it is limited to the residential and industrial sectors (medium and small) as well as to the business sector (tourism).

Graph 5.2: Distribution of the Demand per User in the Cusco Region



5.40 Almost the entire demand shown in Graph 5.2 corresponds to projects such as the Quillabamba thermoelectric power generation plant, the cement plant, and the Cachimayo factory, following their conversion from electricity to natural gas.

5.41 However, the investments for the transportation of natural gas to Quillabamba and Cusco are significant, as they could amount to US$150 million if the working capital and capital costs are included. This is based on a transportation concession, which includes the construction of high-pressure pipelines in two trunklines:

- 10-inch Trunkline: 232.8 km from Kepashiato to Cusco
- 6-inch Trunkline: 37.5 km from Quelloundo to Quillabamba.

5.42 In order to evaluate the possibilities of natural gas access into the different markets of this region, it is appropriate to differentiate the case of the electricity sector, given that the Quillabamba plant must provide almost all of its production to the integrated system; the price of natural gas to be dispatched must be the same or lower than the price of the natural gas paid by the thermal stations in Lima; that is, approximately US$2.00/MMBTU. If the natural gas at wellhead has a price of US$1.00/MMBTU and transportation in the TGP trunk is US$0.40/MMBTU, to supply the Quillabamba TS, a regional distribution rate of US$0.60/MMBTU must be considered.

5.43 This will have implications in the transportation rate since non-electricity users must also have incentives to convert to natural gas; the final price of natural gas (including internal installation and conversion costs) must not exceed the price of the alternate energy sources:

- US$5.80/MMBTU for large users;
- US$5.80/MMBTU for businesses and small industrial users;
- US$15.20/MMBTU for residential users.[67]

5.44 Nonetheless, as shown in the table 5.9, the price of natural gas to the consumer (including intake and internal installation and conversion costs) is over and above the prices of alternative fuels. The influence of the high value, which would be the rate of transportation in the regional pipeline for the other consumers, creates problems for massive access to natural gas.

5.45 Since the other consumers cannot assume the full subsidy needed for the system—even if there is a demand from the thermoelectric plant, the cement plant, and Cachimayo—it will be necessary to establish what the subsidy derived from a different source would be, possibly from the Gas Canon.

5.46 An estimate of the required average annual billing of the concessionaire responsible for building this system, efficiently operate it, and obtain a 10 percent profit, is approximately US$20.12 million. With this guarantee, as shown in table 5.10, natural gas would have no problems competing with the alternative energy sources.

5.47 It is important to point out that at present, the possible natural gas billing in the Cusco region, without the aforementioned industrial projects, would barely reach US$1 million. Therefore, the materialization of these three projects is very important.

[67] Considering a reduction of taxes in the LPG price due to pressures resulting from the Bolivia high subsidies to this product and the change in the valuation of the product from an import parity to an export parity condition.

Table 5.9: Comparison between the Price of Natural Gas and the Price of the Substitute Energy Sources—Cusco Region (in US$/MMBTU)

Energy Source	*Prices by Consumer Sector*			
	Large Users	*Businesses and Small Industries*	*Residential*	*Thermal Station*
Natural gas				
- Cost of gas at wellhead	1.00	1.00	1.00	1.00
- TGP transport	0.40	0.40	0.40	0.40
- Distribution Rate	4.37	10.07	10.07	0.60
Price to user	**5.77**	**11.47**	**11.47**	**2.00**
Intake		0.19	3.49	
Rate + Intake		11.66	14.96	2.00
Internal Install. and Conversion		0.32	2.01	
Price to Consumer		**11.97**	**16.97**	**2.00**
ALTERNATIVE ENERGY SOURCES				
LPG	15.20	15.20	15.20	
Diesel 2	15.10			
Residual	5.80	5.80		

[a] Price does not include IGV, it includes Excise Tax where applicable. Implicit price of crude – US$ 40/bbl WTI

5.48 If these three projects are available before 2017, that is, in the assumption that firm commitments are made for the three projects in the next few months and a policy is in place for the promotion of the use of natural gas in the region; a scenario could occur whereby the amount of the actual subsidy to be contributed, thanks to the guarantee of the minimum demand, would decrease by the year 2017 to approximately US$10 million with the expectation that these payments—which would have to be guaranteed by the Canon one way or another—will gradually decrease as shown in Graph 5.4.

Table 5.10: Comparison between the Subsidized Price of Natural Gas and the Price of the Substitute Energy Sources—Cusco Region (in US$/MMBTU)

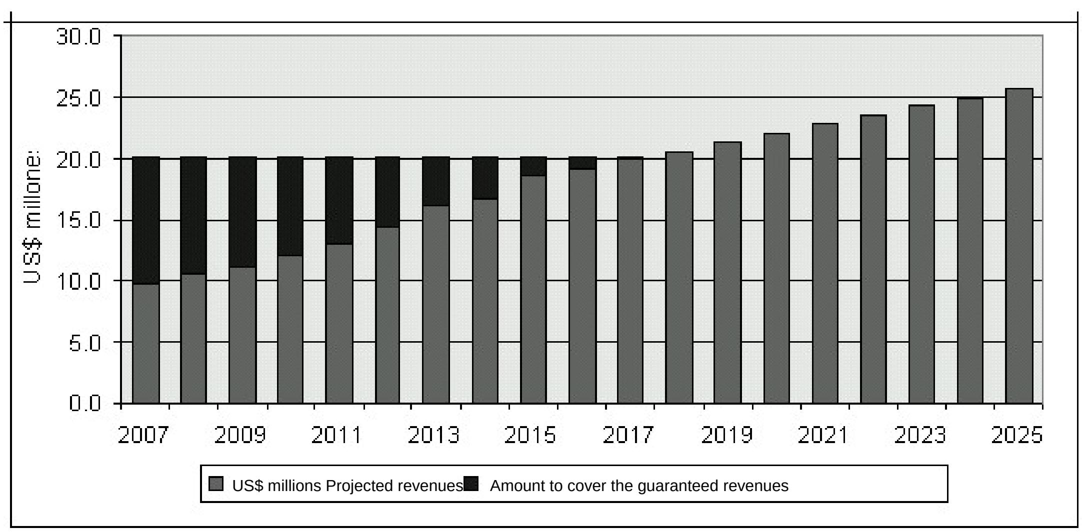
Energy Source	*Prices by Consumer Source*[a]			
	Large Users	*Businesses and Small Industries*	*Residential*	*Thermal Station*
Natural gas				
- Cost of gas at wellhead	1.00	1.00	1.00	1.00
- TGP Transport	0.40	0.40	0.40	0.40
- Distribution Rate	3.30	7.60	7.10	0.60
Price to user	**4.70**	**9.00**	**8.50**	**2.00**
Intake		0.19	3.49	
Rate + Intake		9.19	11.99	2.00
Internal Install. and Conversion		0.32	2.01	
Price to Consumer		**9.51**	**14.00**	**2.00**
ALTERNATIVE ENERGY SOURCES				
LPG	15.20	15.20	15.20	
Diesel 2	15.10			
Residual	5.80	5.80		

[a] Does not include VAT

Includes Excise Tax where applicable

Implicit price of crude – US$40/BBL WTI

Graph 5.3: Projection of the Amounts Guaranteed by the Canon for the Cusco Region Pipeline, 2007–2025 Period



5.49 If the projected demand is met, the amount to cover the projected revenues would be US$10.3 million in 2007 and it would drop as the demand grows, until it disappears in the year 2017. The amount of the guarantee will depend on the evolution of the natural gas demand, especially whether or not the use of natural gas grows (particularly in industrial projects).

5.50 Considering an optimistic scenario for the demand, if the current values of the cost of the subsidy are estimated, under these conditions and at a discount rate of 10 percent, the figure of only US$38.0 million would be achieved. This figure, compared to the Canon's value, is manageable, especially considering that the Canon itself will be increasing with the growth of natural gas consumption as a result of the undertaking of the project.

5.51 A calculation of the Gas Canon at different price levels, with a production assumption limited to the domestic market, shows that the current value of the region's Canon is high, and that, with respect to the required subsidy, it is merely 3.3 percent, with a very conservative oil prices scenario.

Table 5.11: Subsidy of the Price of Natural Gas in the Cusco Region as per Price of Crude

WTI Crude Price (US$/bbl)	*VPN Canon (US$ million)*	*Subsidy of Pipeline (%)*
30	1,150	3.3
40	1,447	2.6
50	1,745	2.2
60	2,040	1.9

5.52 Although, with respect to the entire Canon, the guarantee for the pipeline is a small (tolerable) fraction, prior to the bidding for the pipeline, it is very advisable to ensure the execution of the thermal plant, the conversion of the Cachimayo nitrates plant, and the cement plant.

5.53 The invitation for bidding of the service concession to transport and distribute natural gas to the Cusco region could wait a few months and take place under the same BOOT (build, own, operate, transfer) conditions as those indicated for the first bidding; that is to say:

- To participate, bidders must have an operator with experience in natural gas distribution systems. Technical and financial prequalification criteria should be established to that effect, such as:
    - *Technical Criteria:* Number of residential users the bidder currently services
    - *Financial Criteria:* Asset and equity levels.
- The prequalified operator must hold at least 25 percent of the concessionaire's company for a minimum of 10 years.

- The term of the concession is 30 years, renewable as per applicable law. The maximum term for the execution of the works and fitting of the regional pipelines up to the points of entry into each city ("city gates") for the concession covering the Ica–Ayacucho–Junín regions will be two years. The terms are counted from the approval date of the Environmental Impact Studies or six months from the closing date, whichever happens first.
- The concessionaire's obligations include:
  - Complying with the plan to expand the service to a given number of residential customers, as may be prescribed in the terms (approximately 38 percent access in the cities served)
  - Submitting a plan to connect the other cities (to be defined before the bidding) located within the concession area three years after the commissioning of the commercial operation
  - Operating and maintaining the system, as per technical and quality rules set forth regulations and in the agreement.
- Other obligations:
  - Compensating the regulator, as per applicable law
  - Establishing a company domiciled in Peru, with a minimum capital of US$10 million per concession.
- The concessionaire's rights include::
  - The exploitation of the distribution service for residential customers, commercial customers, and large users
  - The distribution concession will be granted on an exclusive basis in the area of concession
  - Capacity to participate in future concessions.
- The guarantees to be fixed prior to the bidding will include:
  - Validity, effectiveness, and compliance with the economic bid.
  - Reconsideration and appeal of prequalification.
  - Objection to the award.
  - Performance bond with regard to the transportation and distribution agreements.

5.54 The predominant criteria for the award would be the lowest transportation rates offered through the regional pipelines.

Annex 1

Methodological Appendix

A. Calculations Algorithm for Economic Analysis

A.1 Specification of the Discount Factor

The discount factor is used to express the future variables of revenues and costs at values from the start of the period under analysis and consequently, to standardize the treatment of these variables produced at different moments in time.

$$d = \frac{1}{1+r} \qquad [1]$$

where:

d = discount factor, and r = Economic Discount Rates representing the social rate of discount of the projects.

A.2 Calculation of Economic Benefits at Start Values for the Residential, Commercial, Transport, and Industrial sectors

For the purposes of the prefeasibility analysis, the following equation (2) denotes in generic form the manner in which the valuation is performed on the project's economic benefits for the residential, commercial and industrial sectors. Expressed in current values is the result of the difference between economic revenues and costs:

$$VPBeneficiosEcon = VPIEcon - VPCEcon \qquad [2]$$

The revenues will be defined in current values as:

$$VPIEcon = \sum_{j} \sum_{i=1}^{i=20} d^{i} (psustj_{i} \times qj_{i}) \qquad [3]$$

where:

VPIEcon= current value of the project's revenues

psustji = economic price of the energy source to be replaced in Consumer Sector j in effect in Period i

qji = total volume of natural gas in demand by Consumer Sector j in Period i

d = discount factor

i = year

j = customer category

The economic costs are expressed in current values as:

$$VPCEcon = \sum_{j} \sum_{i=1}^{i=20} d^{i} (pcgj_{i} + tccj_{i} + trrpj_{i}) qj_{i} + (capexrrdj_{i} + opexrrdj_{i}) + (capex\,\mathrm{int}\,yconvj_{i}) \qquad [4]$$

Where:

$pjcg$ = price of the economic cost of the natural gas assigned to Consumer Sector j in Period i

$tccj$ = rate of the economic transport cost of the Camisea trunk to interconnection point of the Concessionaire's trunkline with trunk assigned to Consumer Sector j in Period i

$tMRTj$ = average rate of transport cost by the MRT assigned to Consumer Sector j in Period i

$capexDLNj_{i}$ = cost of investment of the Distribution Trunklines and Networks assigned to Consumer Sector j in Period i

$opexDLNj_{i}$ = operational and maintenance cost of the Distribution Trunklines and Networks assigned to Consumer Sector j in Period i

$capexintyconvj_{i}$ = cost of investment in internal installation and in conversion of equipment corresponding to Consumer Sector j in Period i

qj_{i} = total volume of natural gas in demand by Consumer Sector j in Period i

d = discount factor

i = year

j = customer category

A.3 Calculation of Economic Benefits at Start Values for the Electricity Generation Sector

The following equation (5) describes, in a generic manner, the manner how the economic benefits of the electricity generation sector are valued. They are expressed in current values, resulting from the difference of economic revenues and costs:

$$VPBeneficiosEconGenEE = VPIEconGenEE - VPCEconGenEE \qquad [5]$$

The revenues will be defined in current values as:

$$VPIEconGenEE = \sum_{j} \sum_{i=1}^{i=20} d^{i} (pBEnergía \times qGenEE_{i}) - (capexCT_{i} + opexCT_{i}) \qquad [6]$$

Where:

$VPIEcon$ = current value of the electricity generation sector's revenues

$pbEnergía$ = price of the energy at the Cusco bar in force in the current period

$qGenEE_i$ = quantity of KWh generated in Period i (capacity of the station x 5256 hs-year x Factor Use of the station)

$capexCT_i$ = cost of investment of the thermal station in Period i

$opexCT_i$ = operational and maintenance cost of the thermal station in Period i (without cost of natural gas FOB station)

d = discount factor

i = year

The economic costs are expressed in current values as:

$$VPCEcon = \sum_{j} \sum_{i=1}^{i=20} d^{i}(pcgj_{i} + tccj_{i} + trrpj_{i})qj_{i} + (capexrrdj_{i} + opexrrdj_{i}) + (capex \text{ int } yconvj_{i})$$

$$VPCEcon = \sum_{j} \sum_{i=1}^{i=20} d^{i}(pcgGenEE + ttcGenEE_{i} + tRRPGenEE + tRRDGenEE_{i})xqgGenEE \quad [7]$$

Where:

$pcgGenEE_i$ = price of the natural gas assigned to Generation Sector EE in Period i

$CTTGenE_i$ = rate of the economic transport cost of the Camisea trunk to interconnection point of the Concessionaire's trunkline with trunk assigned to Generation Sector EE in Period i

tMRTGenEE = average rate of transport cost by the MRT assigned to Generation Sector EE in Period i

tDVNGenEE = average rate of transport cost by the MRT assigned to Generation Sector EE in Period i

qgGenEE = total volume of natural gas in demand by Generation Sector EE in Period i

d = discount factor

i = year

j = customer category

A.4 Brief Summary of Calculations for the Diversion of Rates by Distance

In strictly economic terms, the transport rate over the Camisea trunk pipeline should correspond to economic costs. This assumes that this cost will vary in direct reference to the demand of capacity and the distance of the run, factors which are responsible for the cost of the transport service. This is certainly an aspect to keep in mind, since benefits are being analyzed in economic terms.

The following is an explanation of the methodology used to calculate the 60 percent discount of the transport rate, Camisea–Ayacucho / Junín Diversion and an 80 percent of the Camisea–Kepashiato transport rate, product of the application of the aforementioned economic concept.

For the calculation of the rate by distance, the distance factor is computed by region crossed by the Camisea trunk pipeline, which weigh the distance run by the natural gas from the fields—in this case, Camisea—to the area of delivery of the natural gas to the area to be given in regional concession.

The rate by distance is given by the following expression [1]:

$$TDj\left[\frac{d_j}{D}\right]xTP \qquad [1]$$

Where:

TDj = rate by distance of the transport trunk for the Delivery Area j

dj = distance between the natural gas fields and Delivery Area j

D = average distance from the Camisea trunk pipeline

TP = postal rate of the transport trunk for any Delivery Area j

In turn, the average distance of the trunk pipeline, D, is expressed by the following equation [2]:

$$D = \frac{\sum_{i=1}^{i=\ddot{}20} d^i \left[\sum_j (dj_i \times qj_i)\right]}{\sum_{i=1}^{i=\ddot{}20} d^i \left[\sum_j (qj_i)\right]} \qquad [2]$$

With Discount Factor d being equal to:

$$d = \frac{1}{1+r} \qquad [3]$$

Where: r = 12 percent Discount Rates

Applying the algorithms of previously developed calculations ([1] and [2]), estimates were made of the distance factor, dj, for the Delivery Areas of the Camisea Trunk Pipeline; that is to say: Cusco, Ayacucho/Junín, Ica, and Lima (for Lima according to the data included for the fixing of the postal rate; for Cusco as per demand data forecasted for Cusco; for Ayacucho/Junín and Ica as per demand data projected for the conservative scenario in the other regions study[68]).

According to the application of the described methodology, the distance factor for the Ayacucho / Junín Delivery Area (Alternative 2) it is approximately 0.4 whereas for the Kepashiato Delivery Area, it is approximately 0.2.

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[68] Work prepared for Proinvestment: “Technical, Social, Environmental, and Economic Studies of Natural Gas Supply Projects to Ayacucho, Junín, and Ica”; Final Report, December 2004.

B. Calculations Algorithm for Financial Analysis

B.1 Specification of Discount Factor

The discount factor used to express the future variables of revenues and financial costs of the projects at the start of the period values is defined through the following equation:

$$d = \frac{1}{1+r} \qquad [1]$$

where:

d = discount factor

r = discount rates determined by the regulator, representing the official estimate of the weighted average cost of capital (WACC) before income tax (12 percent) or opportunity cost of the capital

In turn, the discount rates represent the maximum limit on return on investment, which the regulator is willing to accept for the rate calculation of the Main Regional Trunkline (MRT) and Distribution Trunklines and Networks (DLN).

B.2 Methodological Approach

B.2.1 Cash Flow (20-year cash flow)

The financial model calculates the average rates for the MRT and the DLN (independent or X variable) to match the current value of the revenues with the current value of the expenses, the investments, and the loss of value of the stock of capital (equation [2]).

In other terms, the project evaluation technique is used, so that the Net Present Value of the project is equal to zero, which means that the costs of the provision of the service are met, plus a profit equal to the opportunity cost of the capital.

In this sense, the evaluated "project" implies a flow of revenues (first equation member [2]) matching an expenditure: An initial investment represented by the value of the base rate (fixed assets) and the working capital, at the start (BT0 and WC0) for costs relating to operations, maintenance, administration and commercialization, investments and taxes, and a residual value of the base rate (depreciated fixed assets) and of the working capital at the end of the 20-year period (BT20 and WC20).

$$VPIs = BTs_0 + WCs_0 + \sum_{i=1}^{i=20} d^i (Os_i + Ks_i + \Delta WCs_i + Ts_i) - d^{20}(BTs_{20} + WCs_{20})$$

$$VPIs - BTs_0 - WCs_0 - \sum_{i=1}^{i=20} d^i (Os_i + Ks_i + \Delta WCs_i + Ts_i) + d^{20}(BTs_{20} + WCs_{20}) = 0 \qquad [2]$$

Where:

d = discount factor (equation [1])

VPIs = current value of the regulated revenues (equation [2]) corresponding to Segment s

BTsi = value of the base rate or assets at the end of year i of Segment s

WCsi = working capital at the end of year i of Segment s

Os = OPEX corresponding to Segment s

Ks = CAPEX corresponding to Segment s

ΔWCs = Variation of working capital of Segment s

Ts = Taxes (excluding income tax) of Segment s

s = type of segment: (i) Main Regional Trunklines (MRT) or, (ii) Distribution Trunklines and Networks (DLN)

i = year

B.2.2 Revenues Required by the Businesses under Concession to Recover Trunkline and Network Costs

For the purposes of the financial study the focus will be on the global level of revenues of the concessionaires by segment (MRT and DLN) rather than on the rate structure, this is why there will be a generic reference to all rate categories throughout the equation [3]:

$$VPIs = \sum_{i=1}^{i=20} d^{i}\left(ts_{i} \times qs_{i}\right) \qquad [3]$$

Where:

VPIs = current value of regulated revenues of the segment (MRT or DLN)

ts = average rate corresponding to segment s (independent variable to be determined by the model)

qs = total volume of natural gas sales in segment s

d = discount factor

i = year

B.2.3 Definition of Base Rate or Depreciated Fixed Assets of the Concessions

The base rate represents the value of the assets necessary for the provision of the concessionaire's service based on which, the capital return is calculated.

In the model, the base rate will be changed throughout the relevant period for the rate calculation, in two opposite ways: positively, due to the investments projected; and negatively, because of the loss of value as a result of the depreciation produced by the passing of time (equation [4]).

$$BTs_{i} = BTs_{i-1} + Ks_{i} - Ds_{i} \qquad [4]$$

Where : *BT* = value of the base rate of Segment s

Ks = CAPEX of Segment s (net investments of withdrawals or unencumbrances of replaced assets)

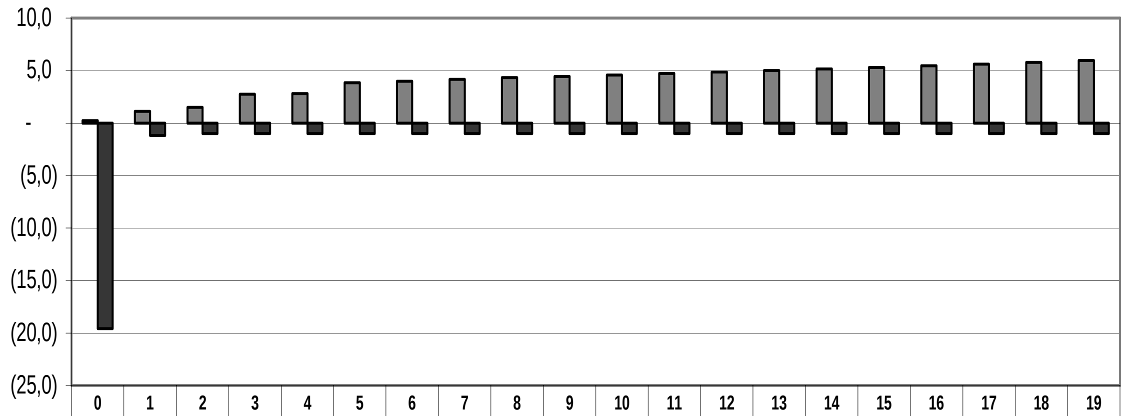
Ds = depreciation or amortization (lineal over 30 years) of the assets of Segment s

i = year

Annex 2

Financial Analysis of the Projects

Graph A2.1: Income and Expenditures (ICA Region)

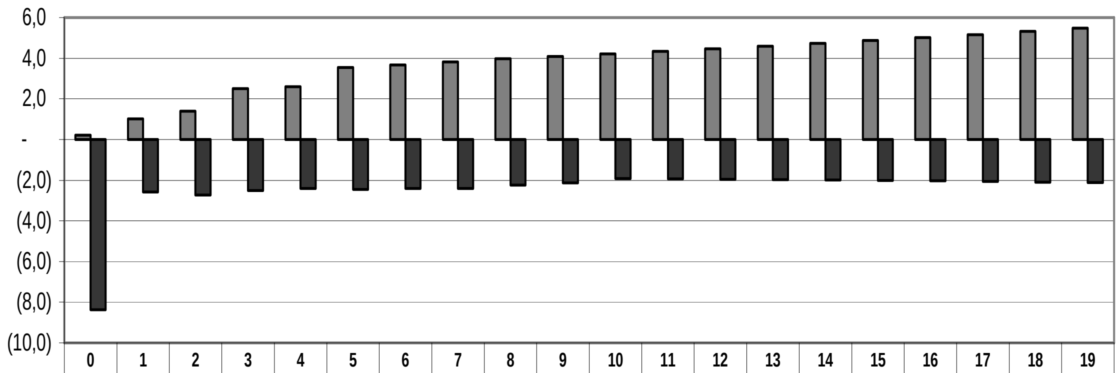


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	0,2	1,1	1,5	2,7	2,8	3,9	4,0	4,1	4,3	4,4	4,6	4,7	4,9	5,0	5,1	5,3	5,5	5,6	5,8	6,0
Salidas de Fondos	(19,6)	(1,2)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)	(1,0)

NPV (Costs)	**US$27 million**
CAPEX	**71%**
OPEX	**29%**
Avg Revenue	**US$4.5 million**
MRT Tariff	**US$ 0.25/MMBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.2: Income and Expenditures: DLN Segment (ICA Region)

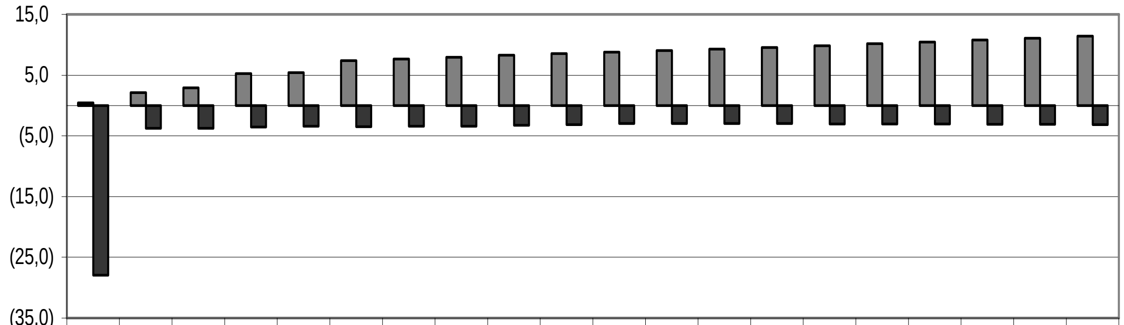


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	0,2	1,0	1,4	2,5	2,6	3,5	3,7	3,8	4,0	4,1	4,2	4,3	4,5	4,6	4,7	4,9	5,0	5,2	5,3	5,5
Salidas de Fondos	(8,4)	(2,6)	(2,7)	(2,5)	(2,4)	(2,5)	(2,4)	(2,4)	(2,2)	(2,1)	(1,9)	(1,9)	(1,9)	(2,0)	(2,0)	(2,0)	(2,0)	(2,1)	(2,1)	(2,1)

NPV (Costs)	**US$24 million**
CAPEX	**68%**
OPEX	**32%**
Avg. Revenue	**US$4.4 million**
DLN Tariff	**US$0.23/MMBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.3: Income and Expenditures—Integrated System (Ica Region)

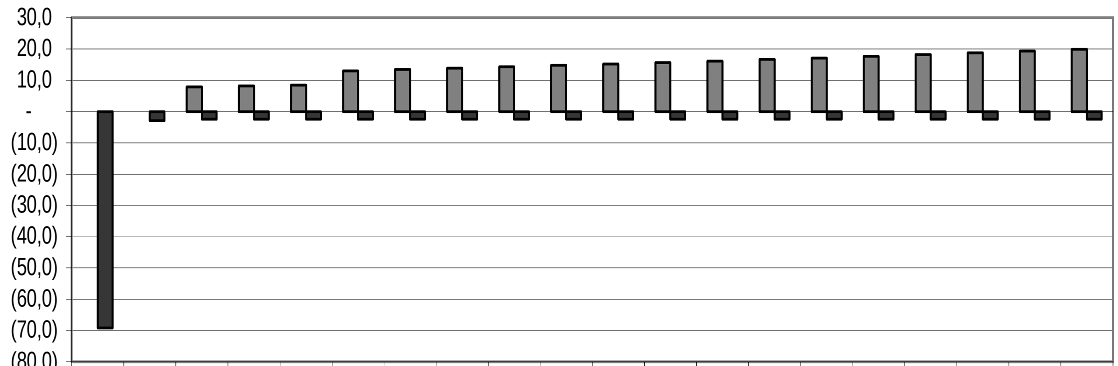


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	0,5	2,1	2,9	5,2	5,4	7,4	7,7	8,0	8,3	8,5	8,8	9,0	9,3	9,6	9,9	10,2	10,5	10,8	11,1	11,4
Salidas de Fondos	(27,9)	(3,7)	(3,7)	(3,5)	(3,4)	(3,5)	(3,4)	(3,4)	(3,3)	(3,2)	(2,9)	(3,0)	(3,0)	(3,0)	(3,0)	(3,0)	(3,1)	(3,1)	(3,1)	(3,1)

NPV (Costos)	**US$51 million**
CAPEX	**70%**
OPEX	**30%**
Avg. Revenue	**US$8.9 million**
Average Tariff	**US$0.49/MMBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.4: Income and Expenditures—MRT Segment (Junín Region, Alternative 1)

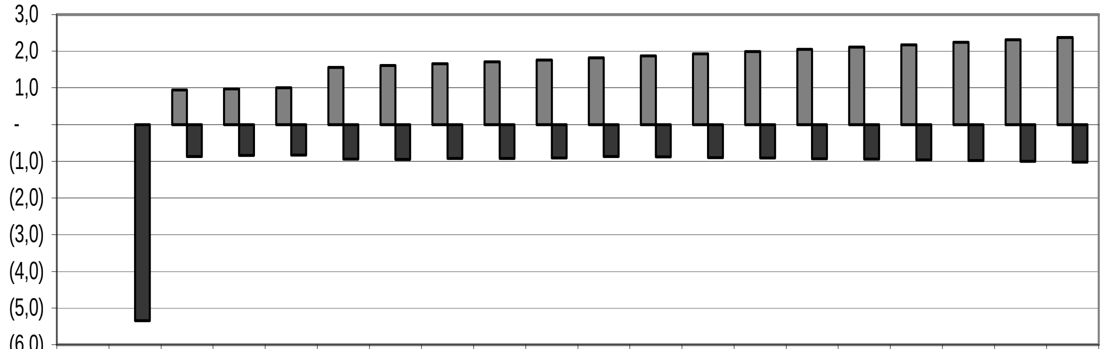


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	7,9	8,2	8,4	13,0	13,4	13,9	14,3	14,8	15,2	15,7	16,2	16,6	17,1	17,7	18,2	18,7	19,3	19,9
Salidas de Fondos	(69,2)	(2,9)	(2,5)	(2,5)	(2,5)	(2,5)	(2,5)	(2,5)	(2,5)	(2,5)	(2,5)	(2,5)	(2,5)	(2,5)	(2,5)	(2,5)	(2,5)	(2,5)	(2,5)	(2,5)

NPV (Costs)	**US$86 million**
CAPEX	**78%**
OPEX	**22%**
Avg. Revenue	**US$14.9 million**
MRT Tariff	**US$1.12/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.5: Income and Expenditures—DLN Segment (Junín Region, Alternative 1)

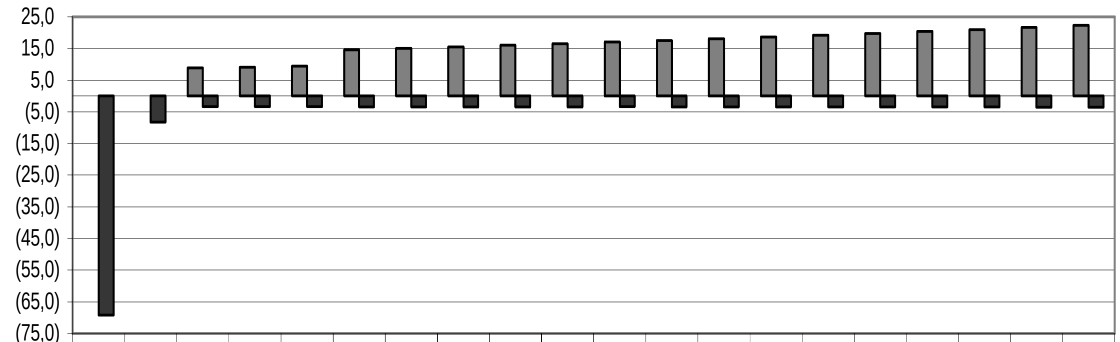


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	0,9	1,0	1,0	1,6	1,6	1,7	1,7	1,8	1,8	1,9	1,9	2,0	2,1	2,1	2,2	2,2	2,3	2,4
Salidas de Fondos	-	(5,3)	(0,9)	(0,8)	(0,8)	(0,9)	(0,9)	(0,9)	(0,9)	(0,9)	(0,9)	(0,9)	(0,9)	(0,9)	(0,9)	(0,9)	(1,0)	(1,0)	(1,0)	(1,0)

NPV (Costs)	**US$10 million**
CAPEX	**83%**
OPEX	**17%**
Avg. Revenue	**US$1.8 million**
DLN Tariff	**US$0.13/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.6: Income and Expenditures—Integrated System (Junín Region, Alternative 1)

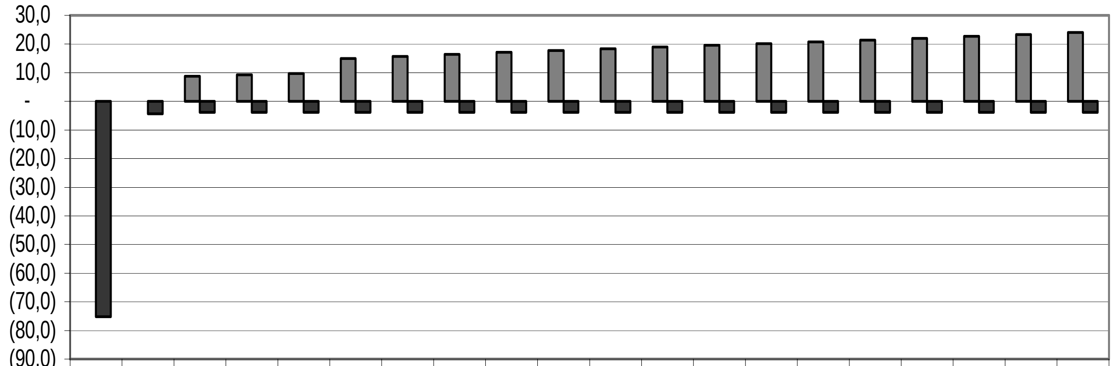


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	8,8	9,1	9,4	14,6	15,1	15,5	16,0	16,5	17,0	17,6	18,1	18,6	19,2	19,8	20,4	21,0	21,6	22,3
Salidas de Fondos	(69,2)	(8,2)	(3,4)	(3,3)	(3,3)	(3,5)	(3,5)	(3,4)	(3,4)	(3,4)	(3,4)	(3,4)	(3,4)	(3,4)	(3,4)	(3,5)	(3,5)	(3,5)	(3,5)	(3,5)

NPV (Costs)	**US$96 million**
CAPEX	**79%**
OPEX	**21%**
Avg. Revevnue	**US$16.7 mill.**
Combined Tariff	**US$1.25/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.7: Income and Expenditures—Integrated MRT (Junín Region, Alternative 2)

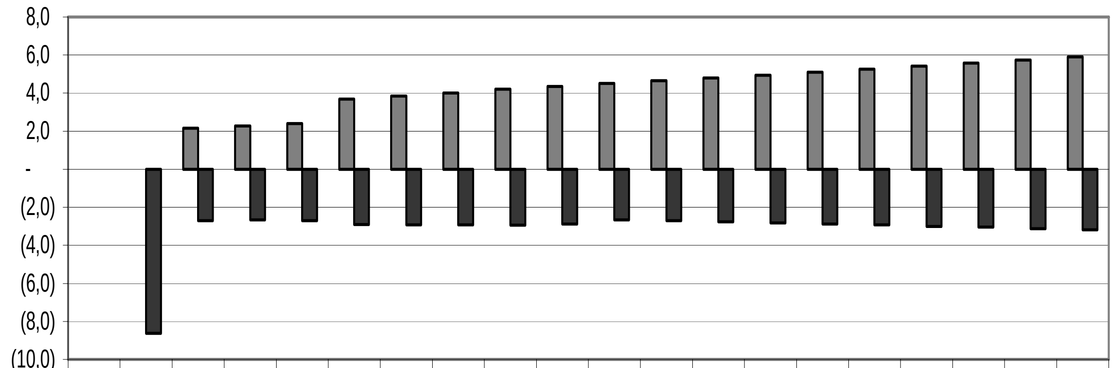


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	8,7	9,3	9,8	15,0	15,7	16,4	17,2	17,8	18,3	18,9	19,5	20,1	20,8	21,4	22,0	22,7	23,4	24,1
Salidas de Fondos	(75,2)	(4,4)	(3,8)	(3,8)	(3,8)	(3,8)	(3,8)	(3,8)	(3,8)	(3,8)	(3,8)	(3,8)	(3,8)	(3,8)	(3,8)	(3,8)	(3,8)	(3,8)	(3,8)	(3,8)

NPV (Costs)	**US$101 million**
CAPEX	**72%**
OPEX	**28%**
Avg. Revenue	**US$17.7 million**
MRT Tariff	**US$1.19/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.8: Income and Expenditures—DLN Segment (Junín Region, Alternative 2)

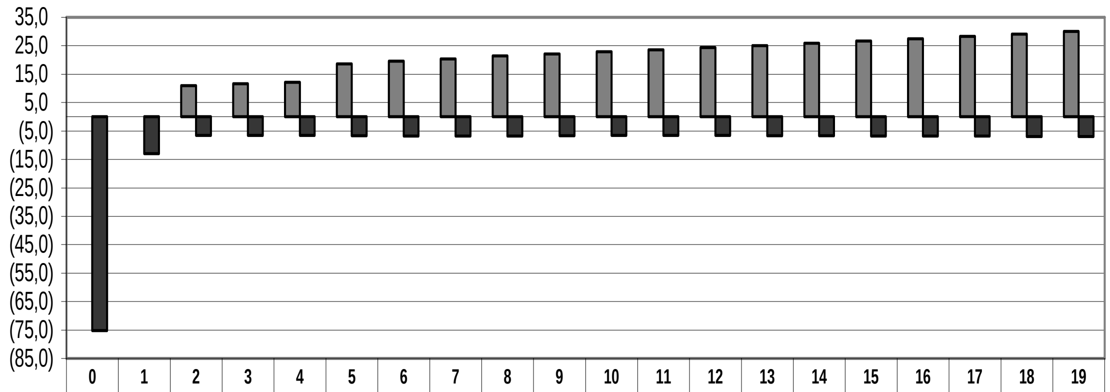


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	2,1	2,3	2,4	3,7	3,8	4,0	4,2	4,4	4,5	4,6	4,8	4,9	5,1	5,3	5,4	5,6	5,7	5,9
Salidas de Fondos	-	(8,6)	(2,7)	(2,7)	(2,7)	(2,9)	(2,9)	(2,9)	(2,9)	(2,9)	(2,7)	(2,7)	(2,8)	(2,8)	(2,9)	(2,9)	(3,0)	(3,1)	(3,1)	(3,2)

NPV (Costs)	**US$25 million**
CAPEX	**66%**
OPEX	**33%**
Avg. Revenue	**US$4.7 million**
DLN Tariff	**US$0.29/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.9: Income and Expenditures—Integrated System (Junín Region, Alternative 2)

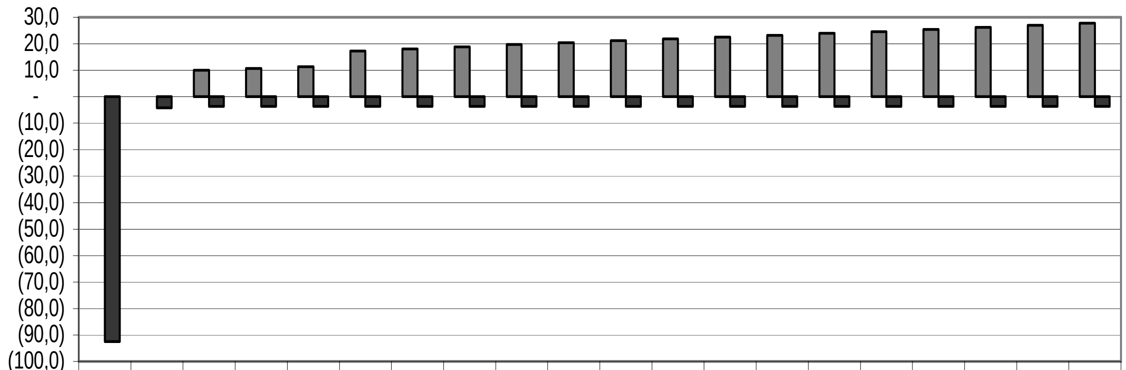


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	10,9	11,6	12,2	18,7	19,5	20,4	21,4	22,1	22,8	23,6	24,3	25,1	25,9	26,6	27,4	28,3	29,1	30,0
Salidas de Fondos	(75,2)	(13,0)	(6,5)	(6,5)	(6,5)	(6,7)	(6,7)	(6,7)	(6,7)	(6,7)	(6,5)	(6,5)	(6,6)	(6,6)	(6,7)	(6,7)	(6,8)	(6,9)	(6,9)	(7,0)

NPV (Costs)	**US$126 million**
CAPEX	**71%**
OPEX	**29%**
Avg. Revenue Unit Price	**US$22.3 million**
MRT Tariff	**US$1.49/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.10: Income and Expenditures—MRT Segment (Junín Region, Alternative 1 with an extension to Huancayo)

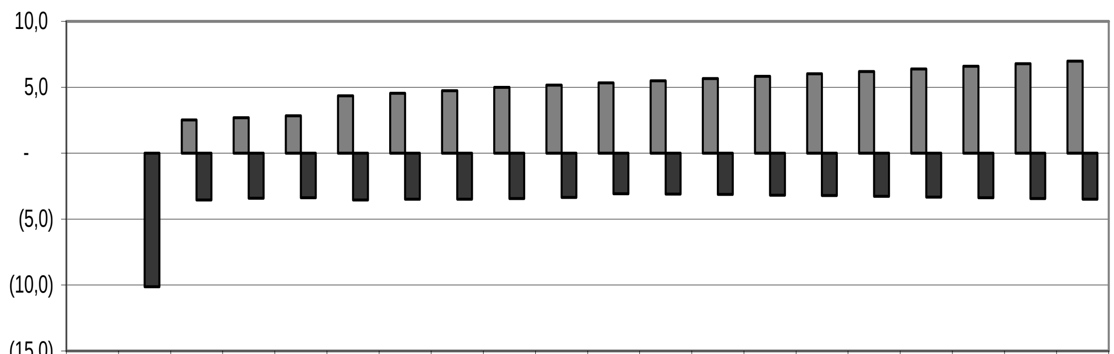


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	10,1	10,7	11,3	17,3	18,0	18,8	19,8	20,4	21,1	21,8	22,5	23,2	23,9	24,6	25,4	26,2	26,9	27,7
Salidas de Fondos	(92,4)	(4,2)	(3,6)	(3,6)	(3,6)	(3,6)	(3,6)	(3,6)	(3,6)	(3,6)	(3,6)	(3,6)	(3,6)	(3,6)	(3,6)	(3,6)	(3,6)	(3,6)	(3,6)	(3,6)

NPV (Costs)	**US$117 million**
CAPEX	**77%**
OPEX	**23%**
Avg. Revenue	**US$20.5 million**
MRT Tariff	**US$1.37/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.11: Income and Expenditures—DLN Segment (Junín Region, Alternative 1 with an extension to Huancayo)

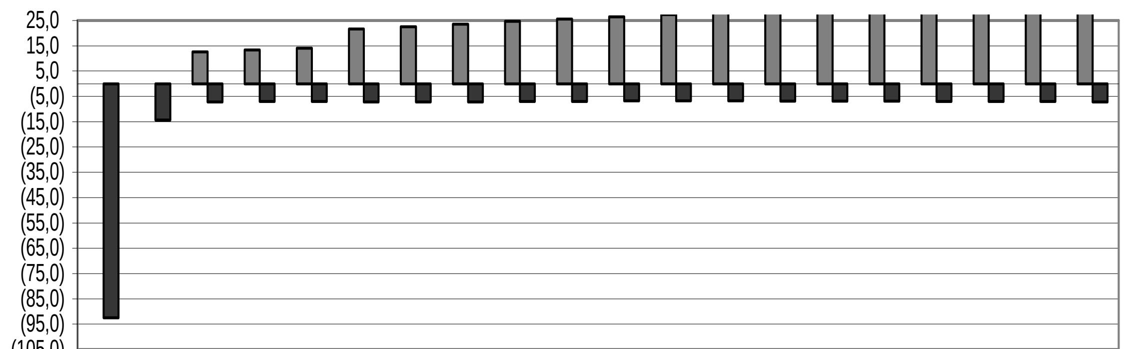


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	2,5	2,7	2,8	4,3	4,5	4,7	5,0	5,1	5,3	5,5	5,7	5,8	6,0	6,2	6,4	6,6	6,8	7,0
Salidas de Fondos	-	(10,1)	(3,5)	(3,4)	(3,4)	(3,5)	(3,5)	(3,5)	(3,4)	(3,3)	(3,1)	(3,1)	(3,1)	(3,2)	(3,2)	(3,3)	(3,3)	(3,4)	(3,4)	(3,5)

NPV (Costs)	**US$29 million**
CAPEX	**72%**
OPEX	**28%**
Avg. Revenue	**US$5.6 million**
DLN Tariff	**US$0.35/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.12: Income and Expenditures—Integrated Segment (Junín Region, Alternative 1 with an extension to Huancayo)

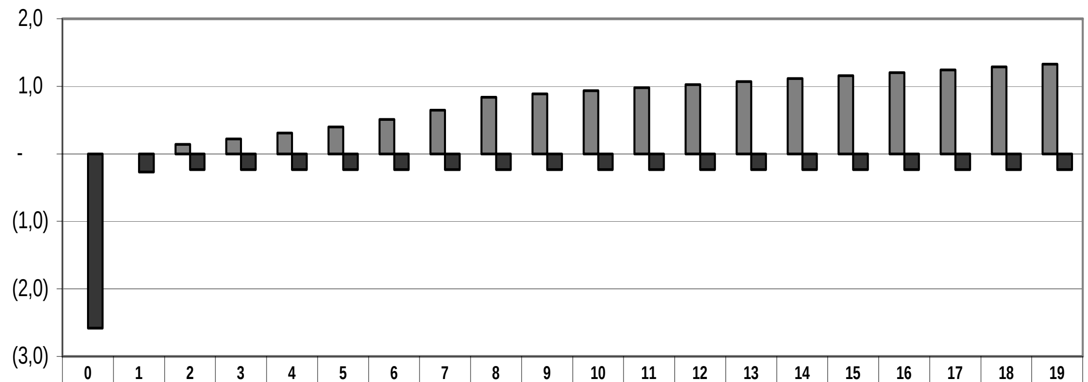


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	12,6	13,4	14,1	21,6	22,6	23,6	24,8	25,6	26,4	27,3	28,2	29,0	29,9	30,8	31,8	32,7	33,7	34,7
Salidas de Fondos	(92,4)	(14,3)	(7,2)	(7,1)	(7,0)	(7,2)	(7,1)	(7,1)	(7,1)	(7,0)	(6,7)	(6,7)	(6,8)	(6,8)	(6,9)	(6,9)	(7,0)	(7,0)	(7,1)	(7,1)

NPV (Costs)	**US$146 million**
CAPEX	**76%**
OPEX	**24%**
Avg. Revenue	**US$26.1 million**
CombinedTariff	**US$1.72/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.13: Income and Expenditures—MRT Segment (Ayacucho Region)

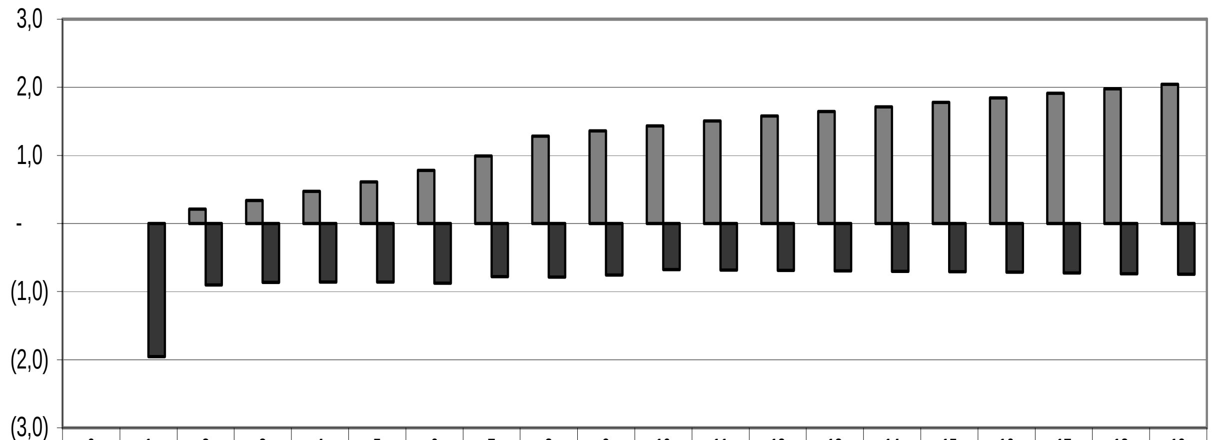


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	0,1	0,2	0,3	0,4	0,5	0,6	0,8	0,9	0,9	1,0	1,0	1,1	1,1	1,2	1,2	1,2	1,3	1,3
Salidas de Fondos	(2,6)	(0,3)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)	(0,2)

NPV (Costs)	**US$4 million**
CAPEX	**59%**
OPEX	**41%**
Avg. Revenue	**US$0.8 million**
MRT Tariff	**S$3.16/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.14: Income and Expenditures—DLN Segment (Ayacucho Region)

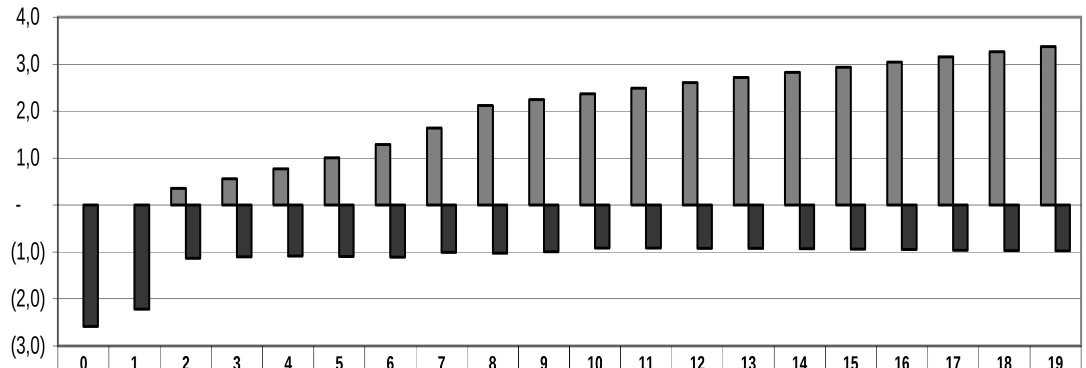


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	0,2	0,3	0,5	0,6	0,8	1,0	1,3	1,4	1,4	1,5	1,6	1,6	1,7	1,8	1,8	1,9	2,0	2,0
Salidas de Fondos	-	(2,0)	(0,9)	(0,9)	(0,9)	(0,9)	(0,9)	(0,8)	(0,8)	(0,8)	(0,7)	(0,7)	(0,7)	(0,7)	(0,7)	(0,7)	(0,7)	(0,7)	(0,7)	(0,7)

NPV (Costs)	**US$7 million**
CAPEX	**64%**
OPEX	**36%**
Avg. Revenue	**US$1.4 million**
Unit Price	
DLN Tariff	**US$4.86/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditure

Graph A2.15: Income and Expenditures—Integrated System (Ayacucho Region)

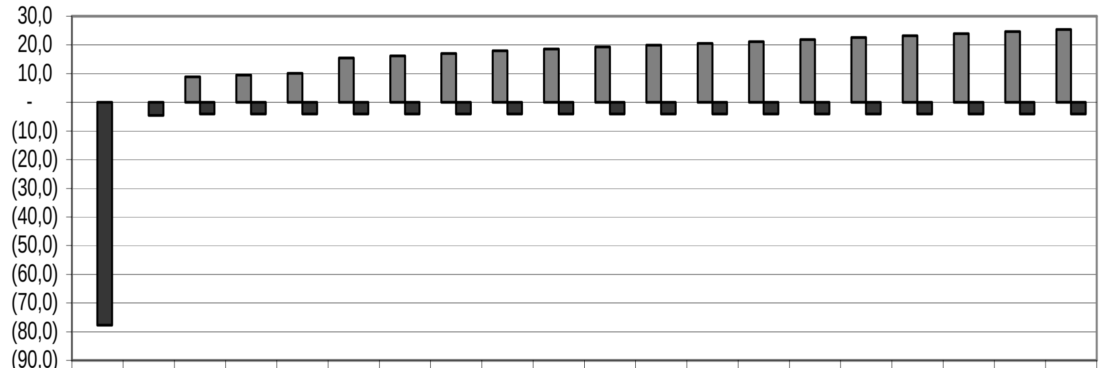


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	0,4	0,6	0,8	1,0	1,3	1,6	2,1	2,2	2,4	2,5	2,6	2,7	2,8	2,9	3,0	3,2	3,3	3,4
Salidas de Fondos	(2,6)	(2,2)	(1,1)	(1,1)	(1,1)	(1,1)	(1,1)	(1,0)	(1,0)	(1,0)	(0,9)	(0,9)	(0,9)	(0,9)	(0,9)	(0,9)	(0,9)	(1,0)	(1,0)	(1,0)

NPV (Costs)	**US$4.86 million**
CAPEX	**62%**
OPEX	**38%**
Avg. Revenue	**US$2.3 million**
Combined Tariff	**US$8.03/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.16: Income and Expenditures—MRT Segment (Junín / Ayacucho Region, Alternative 2)

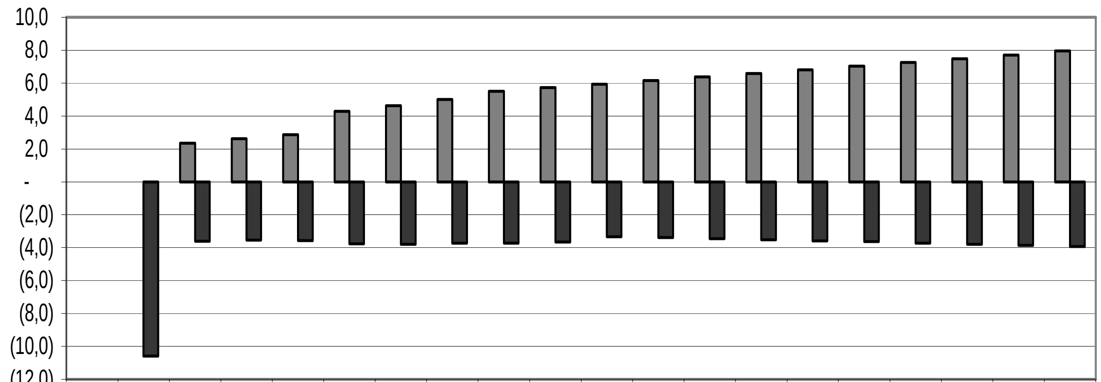


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	8,9	9,5	10,1	15,4	16,2	17,0	18,0	18,6	19,3	19,9	20,6	21,2	21,9	22,5	23,2	23,9	24,7	25,4
Salidas de Fondos	(77,7)	(4,6)	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)

NPV (Costs)	**US$106 million**
CAPEX	**72%**
OPEX	**28%**
Avg. Revenue	**US$18.5 million**
Unit Price	
MRT Tariff	**US$1.22/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.17: Income and Expenditures—DLN Segment (Junín / Ayacucho Region, Alternative 2)

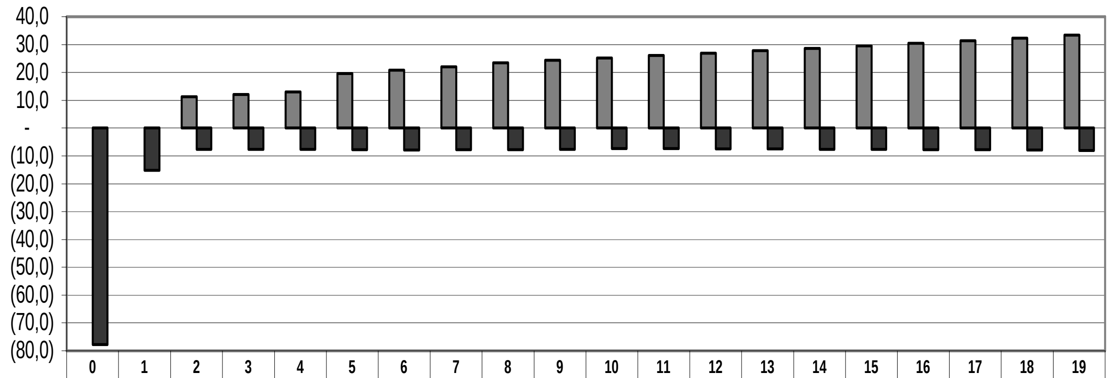


	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	2,4	2,6	2,9	4,3	4,6	5,0	5,5	5,7	5,9	6,2	6,4	6,6	6,8	7,0	7,3	7,5	7,7	8,0
Salidas de Fondos	-	(10,6)	(3,6)	(3,5)	(3,6)	(3,8)	(3,8)	(3,7)	(3,7)	(3,6)	(3,3)	(3,4)	(3,4)	(3,5)	(3,6)	(3,6)	(3,7)	(3,8)	(3,9)	(3,9)

NPV (Costs)	**US$31 million**
CAPEX	**66%**
OPEX	**24%**
Avg. Revenue	**US$6.1 million**
DLN Tariff	**US$0.36/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.18: Income and Expenditures—Integrated System (Junín / Ayacucho Region, Alternative 2)



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	11,2	12,1	13,0	19,7	20,8	22,0	23,5	24,4	25,2	26,1	26,9	27,8	28,7	29,6	30,5	31,4	32,4	33,4
Salidas de Fondos	(77,7)	(15,2)	(7,6)	(7,6)	(7,6)	(7,8)	(7,8)	(7,8)	(7,8)	(7,7)	(7,4)	(7,4)	(7,5)	(7,6)	(7,6)	(7,7)	(7,8)	(7,8)	(7,9)	(8,0)

NPV (Costs)	**US$137 million**
CAPEX	**70%**
OPEX	**20%**
Avg. Revenue	**US$24.6 million**
Combined Tariff	**US$1.59/MBTU**

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

Graph A2.19: Financial Evaluation—Cusco Region (Cusco and Cachimayo, 8-inches)

(A) MRT Project

NPV (Costs)	**US$77 million**
CAPEX	**79%**
OPEX	**21%**
Avg. Revenue	**US$3.5 million**
MRT Tariff	**US$1.59/MBTU**

+

(B) DLN Project

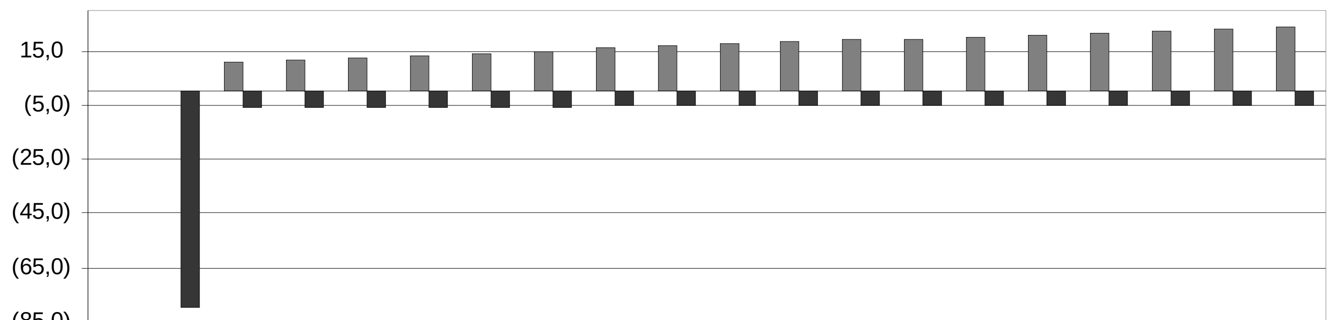
NPV (Costs)	**US$25 million**
CAPEX	**72%**
OPEX	**28%**
Avg. Revenue	**US$3.9 million**
DLN Tariff	**US$1.04/MBTU**

=

(C) Integrated Project

NPV (Costs)	**US$102 million**
CAPEX	**77%**
OPEX	**23%**
Avg. Revenue	**US$16.2 million**
Combined Tariff	**US$4.28/MBTU**

Ingresos y Salidas de Fondos -Sistema Integrado Cusco



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	10,7	11,5	12,3	13,1	14,1	15,1	16,5	17,1	17,7	18,3	19,0	19,6	20,2	20,9	21,5	22,2	22,9	23,6
Salidas de Fondos	-	(80,0	(6,0)	(5,7)	(5,5)	(5,4)	(5,4)	(5,5)	(5,1)	(5,0)	(5,0)	(4,7)	(4,8)	(4,8)	(4,8)	(4,8)	(4,8)	(4,9)	(4,9)	(4,9)

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

A2.20: Financial Evaluation—Cusco Region (Cusco and Cachimayo, 10-inches)

Ingresos de Fondos = Income
Salidas de Fondos = Expenditures

(A) MRT Project

NPV (Costs)	**US$91 million**
CAPEX	**79%**
OPEX	**21%**
Avg. Revenue	**US$15.1 million**
MRT Tariff	**US$1.90/MBTU**
Tariff Income	**50%**
Nonsales Revenue	50%

+

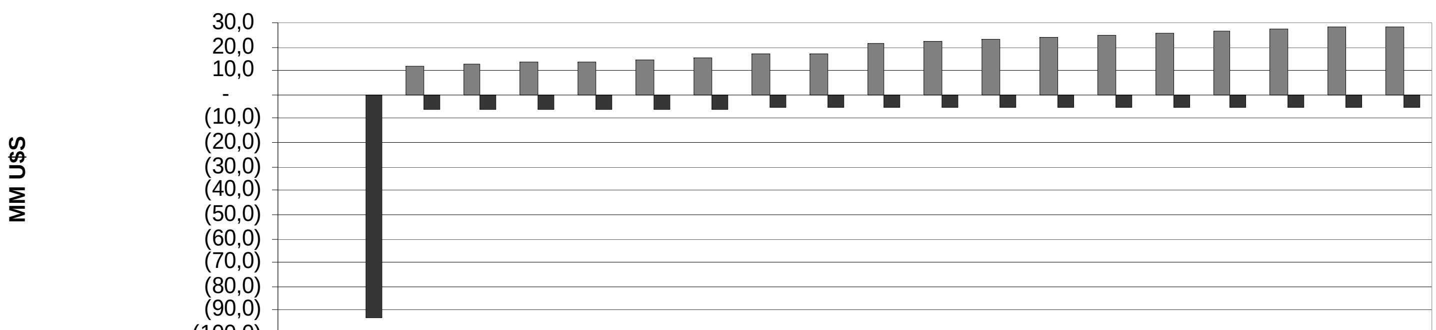
(B) DLN Project

Tarifa RRP	1,04 US$/MMBTU
NPV (Costs)	**US$25 million**
CAPEX	**72%**
OPEX	**28%**
Avg. Revenue	**US$3.9 million**
DLN Tariff	**US$1.04/MBTU**

=

(C) Integrated Project

NPV (Costs)	**US$116 million**
CAPEX	**80%**
OPEX	**20%**
Avg. Revenue	**US$19.0 million**
Combined Tariff	**US$2.94/MBTU**
Tariff Income	**60%**
Nonsales Revenue	40%



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ingresos de Fondos	-	-	11,9	12,6	13,3	14,0	14,8	15,7	16,8	17,5	21,7	22,5	23,3	24,1	24,9	25,7	26,6	27,5	28,1	28,7
Salidas de Fondos	-	(92,	(6,4)	(6,1)	(5,9)	(5,8)	(5,8)	(5,9)	(5,5)	(5,4)	(5,4)	(5,1)	(5,2)	(5,2)	(5,2)	(5,2)	(5,2)	(5,3)	(5,3)	(5,3)

Joint UNDP/World Bank

ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

LIST OF TECHNICAL PAPER SERIES

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	Nigerian LP Gas Sector Improvement Study	03/04	056/04
	Taxation and State Participation in Nigeria's Oil and Gas Sector	08/04	057/04
Regional	Second Steering Committee: The Road Ahead. Clean Air Initiative In Sub-Saharan African Cities. Paris, March 13-14, 2003.	12/03	045/03
	Lead Elimination from Gasoline in Sub-Saharan Africa. Sub-regional Conference of the West-Africa group. Dakar, Senegal March 26-27, 2002 (French only)	12/03	046/03
	1998-2002 Progress Report. The World Bank Clean Air Initiative in Sub-Saharan African Cities. Working Paper #10 (Clean Air Initiative/ESMAP)	02/02	048/04
	Landfill Gas Capture Opportunity in Sub Saharan Africa	06/05	074/05
	The Evolution of Enterprise Reform in Africa: From State-owned Enterprises to Private Participation in Infrastructure —and Back?	11/05	084/05
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	Alleviating Fuel Adulteration Practices in the Downstream Oil Sector in Senegal	09/05	079/05
South Africa	South Africa Workshop: People's Power Workshop.	12/04	064/04
Swaziland	Solar Electrification Program 2001—2010: Phase 1: 2001—2002 (Solar Energy in the Pilot Area)	12/01	019/01
Tanzania	Mini Hydropower Development Case Studies on the Malagarasi, Muhuwesi, and Kikuletwa Rivers Volumes I, II, and III	04/02	024/02
	Phase-Out of Leaded Gasoline in Oil Importing Countries of Sub-Saharan Africa: The Case of Tanzania - Action Plan.	12/03	039/03
Uganda	Report on the Uganda Power Sector Reform and Regulation Strategy Workshop	08/00	004/00
	WEST AFRICA (AFR)		
Regional	Market Development	12/01	017/01
	EAST ASIA AND PACIFIC (EAP)		
Cambodia	Efficiency Improvement for Commercialization of the Power Sector	10/02	031/02
	TA For Capacity Building of the Electricity Authority	09/05	076/05
China	Assessing Markets for Renewable Energy in Rural Areas of Northwestern China	08/00	003/00
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	Technology Assessment of Clean Coal Technologies for China Volume II—Environmental and Energy Efficiency Improvements for Non-power Uses of Coal	05/01	011/01
	Technology Assessment of Clean Coal Technologies for China Volume III—Environmental Compliance in the Energy Sector: Methodological Approach and Least-Cost Strategies	12/01	011/01
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Philippines	Rural Electrification Regulation Framework. (CD Only).	10/05	080/05
Thailand	DSM in Thailand: A Case Study	10/00	008/00
	Development of a Regional Power Market in the Greater Mekong Sub-Region (GMS)	12/01	015/01
Vietnam	Options for Renewable Energy in Vietnam	07/00	001/00
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	Vietnam's Petroleum Sector: Technical Assistance for the Revision of the Existing Legal and Regulatory Framework	03/04	053/04
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	Opportunities for Women in Renewable Energy Technology Use In Bangladesh, Phase I	04/04	055/04

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Macedonia	Elements of Energy and Environment Strategy in Macedonia	03/06	100/06
Poland	Poland (URE): Assistance for the Implementation of the New Tariff Regulatory System: Volume I, Economic Report, Volume II, Legal Report	03/06	101/06
Russia	Russia Pipeline Oil Spill Study	03/03	034/03
Uzbekistan	Energy Efficiency in Urban Water Utilities in Central Asia	10/05	082/05
	MIDDLE EASTERN AND NORTH AFRICA REGION (MENA)		
Regional	Roundtable on Opportunities and Challenges in the Water, Sanitation And Power Sectors in the Middle East and North Africa Region. Summary Proceedings, May 26-28, 2003. Beit Mary, Lebanon. (CD)	02/04	049/04
Morocco	Amélioration de d´Efficacité Energie: Environnement de la Zone Industrielle de Sidi Bernoussi, Casablanca	12/05	085/05
	LATIN AMERICA AND THE CARIBBEAN REGION (LCR)		
Brazil	Background Study for a National Rural Electrification Strategy: Aiming for Universal Access	03/05	066/05
	How do Peri-Urban Poor Meet their Energy Needs: A Case Study of Caju Shantytown, Rio de Janeiro	02/06	094/06
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Chile	Desafíos de la Electrificación Rural	10/05	082/05
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	Stimulating the Picohydropower Market for Low-Income Households in Ecuador	12/05	090/05
Guatemala	Evaluation of Improved Stove Programs: Final Report of Project Case Studies	12/04	060/04
Honduras	Remote Energy Systems and Rural Connectivity: Technical Assistance to the Aldeas Solares Program of Honduras	12/05	092/05
Mexico	Energy Policies and the Mexican Economy	01/04	047/04
	Technical Assistance for Long-Term Program for Renewable Energy Development	02/06	093/06
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	Bank Experience in Non-energy Projects with Rural Electrification Components: A Review of Integration Issues in LCR	02/04	052/04
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	Study on Investment and Private Sector Participation in Power Distribution in Latin America and the Caribbean Region	12/05	089/05

GLOBAL

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	Household Energy Use in Developing Countries: A Multicountry Study	10/03	042/03
	Knowledge Exchange: Online Consultation and Project Profile from South Asia Practitioners Workshop. Colombo, Sri Lanka, June 2-4, 2003	12/03	043/03
	Energy & Environmental Health: A Literature Review and Recommendations	03/04	050/04
	Petroleum Revenue Management Workshop	03/04	051/04
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	Renewable Energy Toolkit Needs Assessment	08/05	077/05

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	Crude Oil Prices Differentials and Differences in Oil Qualities: A Statistical Analysis	10/05	081/05
	Operating Utility DSM Programs in a Restructuring Electricity Sector	12/05	086/05
	Sector Reform and the Poor: Energy Use and Supply in Four: Countries: Botswana, Ghana, Honduras and Senegal	03/06	095/06