

# **An Economic Evaluation of Peru's Liquefied Natural Gas Export Policy**

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## **Highlights**

- ❖ Peru's Liquefied Natural Gas project is creating an economic loss to the country; analyses results are robust for all scenarios considered.
- ❖ The present value of the cost of replacing exported energy far exceeds tax revenue.
- ❖ Projects cannot be approved based on the immediately benefits without considering the potential opportunity costs

## **Abstract**

Peru's Camisea gas fields hold nearly 90% of the country's natural gas reserves. In the 1990s, the government prioritized Camisea gas for domestic consumption. The revocation of this policy in the 2000s allowed private developers to export 40% of Camisea's proven reserves, equivalent to one third of Peru's total. This USD 3.9 billion liquefied natural gas (LNG) export project boasts the largest single foreign direct investment in Peru's history. A major component of the financing was granted by international financial institutions on economic grounds. While the project was expected to yield a substantial return to private investors, it is clear that the export of one third of Peru's total proven natural gas reserves is not in line with its long-term interests. We undertake cost-benefit analyses for a series of scenarios, starting with the project's formative stage in the mid-2000s, and then in 2012, two years after it began its commercial operation. In all cases, Peru does not have sufficient reserves to warrant export, and the economic costs far exceed the benefits. This project should not have been approved by the government, nor should the loans have been granted by international financial institutions.

**JFL Classification:** Q38; D61

**Keywords:** Peru; Camisea gas fields; LNG export; cost-benefit analysis, energy trade

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We wish to express thanks to Robin Boadway and participants of a public-economics seminar at Queen's University for their comments. The collaboration and assistance of Aaron Goldzimer, Farai Kanonda and Pradip Ghimire during the early stages of this study is greatly appreciated. The usual disclaimer applies.

## **An Economic Evaluation of Peru's Liquefied Natural Gas (LNG) Export Policy**

### **1. INTRODUCTION**

In the second half of the 2000s, Peru faced a decision on whether to conserve its natural gas reserves in the Camisea gas fields for future domestic consumption, or to implement a project for exporting liquefied natural gas (LNG). Named Peru LNG (PLNG), the project consists of the construction of a natural gas liquefaction plant, a marine loading terminal and a gas pipeline that connects to the Camisea gas fields, which contain over 90% of Peru's proven natural gas reserves. The total investment was estimated to be USD 3.9 billion, making PLNG the largest single private investment in Peru's history.

During the late 1990s, the foreign company that had discovered the Camisea fields proposed a similar project. This was rejected by President Alberto Fujimori, who favoured domestic consumption. In the 2000s, during Ollanta Toledo's presidency, the government approved a project for the export of LNG, despite opposition from civil society. The concern was that Peru's gas reserves might be insufficient to simultaneously satisfy the export commitment and long-term domestic needs. Proponents of the project claimed it would generate millions of dollars in tax revenues, and stimulate economic activity from domestic procurement and local employment. The purpose of this cost-benefit analysis (CBA) is to evaluate the claims of both sides in order to shed light on the policy question. The findings unequivocally support the opposition's argument. Peru may revert to being an energy net importer as early as the mid-2030s.

The economics of PLNG touch on several strands of research in the literature. Hotelling (1931) predicts how a mining firm would choose an extraction path that takes into account the Hotelling rent of the underground resource. The Hotelling rent, however, includes only the firm's opportunity cost in terms of future revenues forgone, and the societal opportunity cost is not internalized. As such, Hotelling-inspired theoretical models (Herfindahl, 1967; Ozkan and Ozkan, 2013) that yield (constrained) optimality under various circumstances can only be understood with reference to the firm, but what is optimal for the firm is not necessarily optimal for society. When the distinction between private and social optimality is recognized, the optimal extraction problem is often framed in the context of environmental externalities (Chakravorty et al., 2008) or non-competitive market structure (Daubanes 2011), and rarely of competing claims for the usage of a resource. The issue involved in PLNG comes closest to those described in Im et al. (2006) or Roumasset and Wada (2012) that feature multiple sources of demand, although these models involve solving a single optimization problem, from the social planner's perspective. PLNG and the many real-life situations it presents suggest an approach to the problem in the principal-agent framework that requires optimization of both the private investor and social planner perspectives.

Peru's experience with LNG export foreshadowed a situation that currently confronts many countries, as cost-reducing shipping and drilling technological advancements and the explosive growth of the Asian energy markets have created a global dash for LNG development. Currently, two LNG projects are underway in the Russian Far East (OGJ, 2013a); six projects in the USA and three in Canada have received government approval (Doshi, 2013; OGJ, 2013e), with several

more pending approval (OGJ, 2012a; OGJ, 2012b; OGJ, 2013b); an ambitious floating LNG terminal was announced in Australia (Oil Drum, 2011). Beyond the resource-rich regions, similar private initiatives have been brought forward in countries with recent gas discoveries, but which are not conventionally associated with natural gas production. These include Cyprus (OGJ, 2013d), Ghana (OGJ, 2011), Mozambique (OGJ, 2012c), and Israel (OGJ, 2013c), to name but a few.

The LNG opportunity has sparked national debate in the countries concerned, especially in the USA and Israel. Balancing export commitment with domestic needs is at the core of the debate. Governments are called upon to design suitable LNG export strategies. While the legislative panel review in USA is ongoing, the Water and Energy Ministry of Israel recommended a 40/60 split between export and domestic market (OGJ, 2013c). In Malaysia and Indonesia, dwindling petroleum supply, compounded by increasing domestic gas demand, will necessitate a revision of LNG export policies.<sup>1</sup> Hence, the findings in this study are relevant to policy makers in the process of reviewing private LNG export projects.

The findings neither support the energy independence argument nor deny the energy trade surplus argument, these being positions that are often taken by the two sides of the LNG debate. The economic viability of LNG export is rather project- and country-specific, depending on the specific terms of the projects and the amount of available resources. However, the paper does set out an explicit evaluation criterion that gives adequate attention to the economic benefits and the true opportunity costs of an LNG project for the host country.

## **2. A HISTORY OF THE CAMISEA PROJECT**

### **2.1 History of Camisea I**

Discovered by Royal Dutch Shell (Shell) in 1983, the Camisea gas fields in the Peruvian Amazon were heralded as one of the most important natural gas reserves in Latin America. The Camisea fields consist of two major deposits, Block 88 and Block 56. Throughout the 1990s Shell negotiated with the Peruvian government for the commercial exploitation of Camisea gas. This project eventually fell through in 1998 owing to a number of disagreements. Fundamentally, whereas Shell intended gas exportation, the government gave priority to domestic consumption. Their conflicting preferences were responses to the same phenomenon, namely that Peru had traditionally relied on hydropower and imported petroleum products to meet its energy needs, while the natural gas market remained underdeveloped. For Shell, gas exportation could mitigate demand risk. However, the goal of the government was to improve Peru's hydrocarbon trade deficit by substituting imported petroleum products with Camisea gas in the energy matrix.<sup>2</sup>

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<sup>1</sup>Indonesia has reached a paradoxical juncture where LNG is simultaneously exported to Japan and imported from USA (Kennedy, 2013).

<sup>2</sup> The possibility of supplying the domestic market had been explored, but no agreement could be reached on the price and quantity of gas to be sold domestically. See Banco Wiese Sudameris (2002), The Economist (1998) and Accion Ciudadana Camisea's webpage for details about the Camisea project during this early phase.

Upon Shell's withdrawal, the government organized an international tender for the three components of the Camisea project: 1) gas extraction and processing near the Camisea fields; 2) gas transportation in a pipeline across the Andes; and 3) the distribution network around the capital, Lima. To conserve Camisea gas for domestic use, laws were passed to proscribe gas exportation unless the proven gas reserves could meet the total projected domestic demand for the next 20 years.<sup>3</sup> The Ministry of Energy and Mines (MEM) was to review annually Peru's proven gas reserves and domestic needs for the next 20 years. If in any one year the total projected demand exceeded the proven reserves, gas producers must suspend supplying gas to exporters until the following year's evaluation. The prospect of abrupt interruption in feed gas was sufficient to deter private investment in gas export projects.

In 2000 a group of international companies won all components of the tender under the guise of three nominally independent consortiums. Consorcio Camisea was awarded the right to extract natural gas from Block 88 for 40 years. Transportadora de Gas del Peru (TGP) was awarded the transportation concession, with a 33-year term. Although gas export was not explicitly ruled out, a clause was inserted in Block 88's licence agreement, similar to that in the aforementioned executive order.<sup>4</sup> The extraction right for the adjacent Block 56 was not assigned at that time.<sup>5</sup> Construction began in 2001, and in late 2004 gas from Block 88 reached Lima. Collectively, this phase of the Camisea project was dubbed 'Camisea I'.

## 2.2 History of Camisea II

In 2003, several key consortium members formed another consortium, PLNG, to execute Camisea II. PLNG was to build a natural gas liquefaction plant at a coastal site that turned natural gas into liquid. The project also required a feedstock pipeline that tapped into the main pipeline operated by TGP, and marine loading and docking facilities for the LNG to be loaded to tankers for export. The total investment cost for PLNG was expected to be 3.47 billion USD; 43.4% of the investment was funded by equity and the balance by loans from international financial institutions. If financing costs were included, the total investment cost amounted to 3.97 billion USD (IFC, 2008a). PLNG boasts the largest foreign direct investment in the history of Peru.

The LNG plant's feed gas would come from Block 56 and Block 88 of the Camisea fields. PLNG concluded an 18-year gas-supply agreement with the sister company, Consorcio Camisea.

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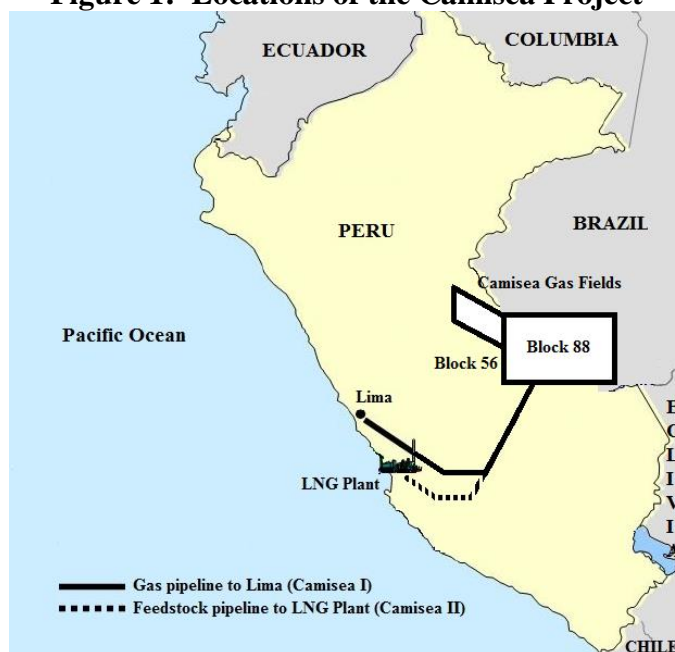
<sup>3</sup> Congress §Law N° 27133, Article 4, and Executive Order N° 040-99-EM, Section 2.1.

<sup>4</sup> Section 5.11 of the Block 88 License Agreement reads: "The export of natural gas [...] can be made as long as the supply of the domestic market for the following twenty (20) years is guaranteed, according to forecasted natural gas demand [...] as published annually in the Reference Plan of Hydrocarbons of the Ministry of Energy and Mines." (MEM, 2000).

<sup>5</sup> In 2006, the Toledo administration granted Consorcio Camisea Block 56's extraction right without putting it out to tender, for which it was heavily criticized. The government had created a situation that precluded competition between gas companies. Given the geographical proximity of Blocks 88 and 56, and the fact that that gas reserves in Block 56 were insufficient to justify building an independent pipeline, gas output from the two blocks would share the same pipeline. However, the gas transportation concession contract allowed Consorcio Camisea to have exclusive use of the pipeline for 10 years. Consorcio Camisea exercised a *de facto* stranglehold on the marketing of gas in Block 56, since no other company could use the pipeline without its consent (Gamboa et al., 2008). Hence, no other developer would bid for Block 56's exploitation right, even if it were put to open tender.

Commencing June 2010, PLNG would receive a daily gas delivery volume of 620 million cubic feet (MCF). This implied a commitment of 4.20 trillion cubic feet (TCF) of natural gas, or one third of the country’s proven reserves, over the contract period. Since Block 56’s gas deposit was insufficient to fulfil the contract obligation, natural gas would be partly sourced from Block 88. Figure 1 illustrates the locations of the Camisea project.

**Figure 1: Locations of the Camisea Project**



While serving as Peru’s president from 2001 to 2006, Alejandro Toledo was instrumental in dismantling the gas export restriction. Previously, export had to cease if MEM’s yearly evaluation found the total proven reserves insufficient to meet the domestic demand for the following 20 years. Toledo annulled Fujimori’s executive order. Gas reserves were now considered sufficient if, “on the date of signing the contract for the sale of natural gas for export”, there was enough to supply the domestic market for 20 years (Executive Order N° 050-2005-EM). Once contracts were signed, gas export could continue regardless of unforeseen changes in domestic demand.

Since its inception, the Camisea project has met with opposition from conservation groups concerned about its adverse impact on the Amazon forests and the lives of the aboriginal peoples. When PLNG emerged, these groups were joined by those who – echoing Fujimori – held that Camisea gas should be restricted to domestic use.

To placate opposition, Consorcio Camisea upgraded its proven reserves estimate for Camisea from 10.9 to 13.4 TCF in early 2008 (IFC, 2008a), and further to 14.1 TCF in early 2009 (Gestión, 2009a). However, two independent assessments did not substantiate the upgrade announcements (GCA, 2009a; GCA, 2009b; NSAI, 2010).<sup>6</sup> In explaining the discrepancy

<sup>6</sup> One of the consulting companies, Gaffney, Cline and Associates, was hired by the Camisea operators. Its reserves estimate was 8.80 TCF.

(Gestión, 2009b), Consorcio Camisea gave hints as to how its estimate had been derived. Hydrocarbon deposits are classified along two dimensions, certainty and commercial recoverability. A comparison between how Consorcio Camisea defined reserves and the industry standards (SPE, 2007) suggests that 3.1 TCF of its last estimate of 14.1 TCF should really be classified as resources, or gas deposits that did not meet the criteria of reserves, much less proven reserves. There are indications that gas deposits were misclassified.<sup>7</sup>

### **2.3 Involvement of Inter-American Development Bank (IDB) and International Finance Corporation (IFC) in Camisea II**

Opponents of Camisea II attempted to block PLNG from obtaining financing from international financial institutions, a strategy employed by the conservation groups during Camisea I.<sup>8</sup> Despite its previous modest success, the strategy failed. In December 2007 IDB approved a direct loan of 400 million USD and a syndicated loan of 400 million USD, together accounting for one third of PLNG's total borrowings. While conceding adverse environmental impacts,<sup>9</sup> IDB approved the loans on economic grounds: "PLNG will spend approximately 1 billion USD on local salaries and goods and services [...] Additionally and as a result of the project, the Peruvian government will receive an average of 200 million per year in incremental royalties and 150 million in additional income taxes over the first 20 years [...] The entire project is expected to yield 4.8 billion in net present value terms in cumulative economic benefits" (IDB, 2006). In addition, IDB claimed the project "represents a major step in the country's efforts to develop its energy sector and achieve oil and gas *self-sufficiency*" [emphasis added] (IDB, 2007). There is a question about how long Peru can remain energy self-sufficient by the end of the project's life, with one third of its proven reserves being exported.

Following IDB's lending decision, in February 2008 IFC approved a loan of 300 million USD, the largest IFC transaction in Latin America (PLNG, 2009). Although the amount was only 40% of IDB's loan, IFC's role was no less vital by virtue of its stature among development finance institutions. IFC also highlighted the economic benefits of tax revenues, job creation and local procurement (IFC, 2008b).

Since IDB's project appraisal report on PLNG is not publicly available, it is unclear whether or not IDB gave sufficient consideration to the popular belief that export might occur at the expense of domestic needs. IFC's appraisal report did mention gas reserves sufficiency as a risk factor: "[c]oncerns have been raised by CSOs [civil society organizations] and other parties that Peru may not have sufficient reserves to supply both Peru LNG, and meet forecasts for domestic gas demand beyond 20 years". However, the report fell short of providing a mitigation strategy, merely suggesting that "the rising domestic demand for gas from Peru's expanding economy as

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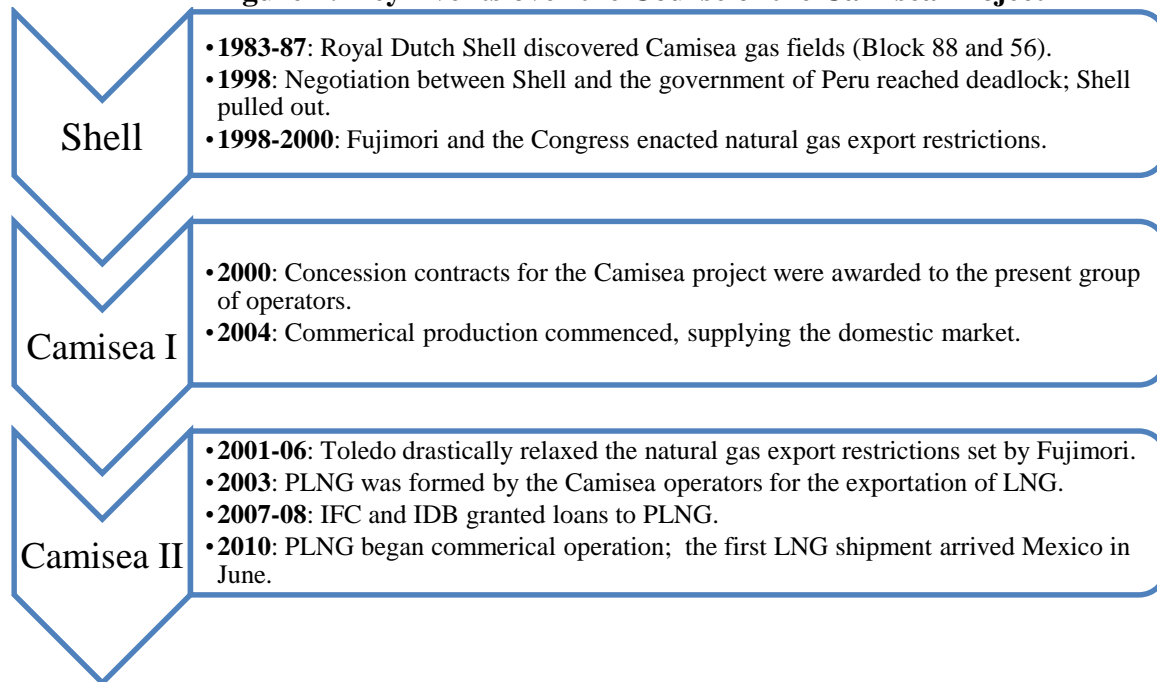
<sup>7</sup> In 2012 additional gas reserves were discovered in the Camisea fields and confirmed by the government. As of December 2012, Peru registered a proven reserve of 15.38 TCF; see Section 4.2.1. Prior to 2012, proven reserve estimates increased modestly from 11.82 to 12.70 TCF between 2007 and 2011.

<sup>8</sup> See Vences (2006) for details.

<sup>9</sup> Adverse environmental impacts are in fact presented as an "additionality" that *justifies* IDB's involvement: "[t]he Bank's participation in this project contributes significantly to the environmental and social management plans and systems of the companies, especially in terms of investments in community development and environmental protection" (IDB, 2007).

well as export requirements for the Project will be met from a combination of the expansion of current resources and future gas finds in Peru” (IFC, 2008a).

**Figure 2: Key Events over the Course of the Camisea Project**



Both IDB and IFC highlighted the immediate benefits the project would bring to Peru’s economy as a justification for their loans to PLNG. However, it is contrary to the fundamentals of economics that a decision be made based solely on what will be gained, without taking into account what could be lost – that is, without taking into account the opportunity costs. With PLNG, the most significant opportunity cost is that of acquiring an alternative energy resource to replace the exported gas. While the question of reserves adequacy was muted in IFC’s appraisal, it was clearly voiced in the public discourse. Jenkins (2007) conducted a preliminary study of the project that pointed out the dangers of the project creating an economic loss to Peru; a summary report was circulated on the internet and made available to both international financial institutions. Jenkins’ study was also cited in an open letter to IFC, signed by a dozen international non-governmental organizations (NGOs) that opposed the project (Amazon Watch, 2008).

### 3. CBA ANALYSIS

#### 3.1 Theoretical Underpinning

The CBA is undertaken from the perspective of Peru. Within Peru there are several major stakeholder groups, namely 1) the government; 2) domestic consumers of natural gas; 3) domestic contractors and the part of the labour force employed by the LNG project; and 4) the local population that live within the project’s area of influence. Since the consortium members

that own and operate the Camisea project will remit profits abroad, the companies' after-tax financial performance is not a consideration in this analysis. The relationship between the economic costs and economic benefits of the LNG project, as well as the evaluation criteria, can be illuminated with several mathematical equations.

Let  $R_t^D$  and  $CIT_t^D$  represent the royalties and the corporate income taxes (CIT) collected by the government at time  $t$ , for the natural gas that is supplied to the domestic market denoted by the superscript  $D$ . Likewise, let  $R_t^E$  and  $CIT_t^E$  represent the royalties and the CIT associated with the LNG project, denoted by the superscript  $E$ . Royalties are collected from Consorcio Camisea, the licensed gas producer, whether the gas are sold domestically or abroad. CIT are paid not just by PLNG, but also by Consorcio Camisea and TGP.

Use  $A_t$  to denote the benefits of domestic procurement and job creation;  $B_t$  to denote the benefits that Peruvian gas users will generate from receiving Camisea gas; and  $C_t$  to denote the adverse socio-environmental impacts. Let  $P_t^G$  and  $Q_t^G$  denote the unit price and volume of Camisea gas sold domestically, and let  $P_t^I$  and  $Q_t^I$  denote the unit price and barrels of oil imported to replace the exported gas. Suppose PLNG's project life is  $T$  years. Since natural gas is a non-renewable resource, its depletion is inevitable. Let  $T'$  represents such a date, where  $T' > T$ .

During the project life, the government will receive tax revenues ( $R_t^E$  and  $CIT_t^E$ ), and the difference between  $A_t$  and  $C_t$  is the benefits to society. Until natural gas depletes at date  $T'$ , Peruvian customers enjoy the benefits of its usage ( $B_t$ ), at a cost ( $P_t^G Q_t^G$ ) paid to the Camisea gas producers. After  $T'$ , it is assumed that Peru will resume importing petroleum products for its energy needs, as was the case before Camisea I.<sup>10</sup> At a discount rate of  $\beta$ , the present value of the economic resource flow to Peru in the with-project scenario (denoted by  $\Pi'$ ) can be summarized by the following equation:

$$\begin{aligned} \Pi' = & \underbrace{\sum_{t=0}^{T'} \beta^t (R_t^E + CIT_t^E + A_t - C_t)}_{\text{Collective benefits to Peru, from the LNG project}} + \underbrace{\sum_{t=0}^{T'} \beta^t (B_t - P_t^G Q_t^G)}_{\text{Benefits to domestic gas users, from domestic sales}} + \underbrace{\sum_{t=0}^{T'} \beta^t (R_t^D + CIT_t^D)}_{\text{Benefits to the government, from domestic sales}} \\ & - \underbrace{\sum_{t=T'+1}^{\infty} \beta^t P_t^I Q_t^I}_{\text{Costs to Peru, from oil imports, after gas depletion at } T'} \end{aligned} \quad (1)$$

As noted, the Camisea project is foreign-owned, and all financial profits will be remitted abroad. Since companies' after-tax profitability does not affect Peru's net proceeds from the LNG project, it does not enter into the equation. By the same token, the companies will defray all costs associated with bringing the Camisea gas to domestic users' doorsteps. For Peru, the resource cost of Camisea gas exactly equals the final price that domestic customers paid to the companies.

In the project's absence, reserves depletion will occur at date  $T''$ , with  $T'' > T'$ . The economic resource flow to Peru in the without-project scenario (denoted by  $\Pi''$ ) becomes

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<sup>10</sup> Alternative energy solutions, including hydropower and natural gas imports, are explored, but none appears to be attractive on economic grounds. See Section 4.1.2.



$$\Pi'' = \underbrace{\sum_{t=0}^{T''} \beta^t (B_t - P_t^G Q_t^G)}_{\text{Benefits to domestic gas users, from domestic sales}} + \underbrace{\sum_{t=0}^{T''} \beta^t (R_t^D + CIT_t^D)}_{\text{Benefits to domestic gas users, from domestic sales}} - \underbrace{\sum_{t=T''+1}^{\infty} \beta^t P_t^I Q_t^I}_{\text{Costs to Peru, from oil imports, after gas depletion at } T''} \quad (2)$$

Equation (2) is similar to Equation (1), except that Peru no longer receives royalties and CIT from operations associated with the LNG project, and that the reserves depletion date is extended to  $T''$ .

More realistically, as PLNG crowds out supply to the domestic market, domestic gas users consume less gas but pay more on a per-unit basis, since the increased scarcity exerts an upward pressure on gas price. The result is a lower net benefit to domestic gas users ( $B_t - P_t^G Q_t^G$ ) in the with-project scenario. While the project's impact on the tax revenues from domestic sales ( $R_t^D$  and  $CIT_t^D$ ) during the project life is ambiguous, it is evident from a mathematical relation that the overall net economic benefits from domestic sales are reduced owing to crowding out, although the magnitude is difficult to quantify.<sup>11</sup> For simplicity, the crowding-out effect is assumed away. Between time 0 and  $T$ , Peruvian industries receive the same quantity of gas at the same price in both scenarios, but the total amount of gas available to domestic customers will last longer, until  $T''$  without the project. This simplification makes the project appear more favourable economically.

In performing an economic analysis, it is imperative to capture only the incremental difference between the with-project and without-project scenarios. Define the incremental difference ( $\Delta$ ) as the with-project resource flow ( $\Pi'$ ) minus the without-project resource flow ( $\Pi''$ ):

$$\begin{aligned} \Delta &= \Pi' - \Pi'' \\ &= \sum_{t=0}^{T'} \beta^t (R_t^E + CIT_t^E + A_t - C_t) - \sum_{t=T'+1}^{T''} \beta^t (R_t^D + CIT_t^D) - \sum_{t=T'+1}^{T''} \beta^t (B_t - P_t^G Q_t^G) \\ &\quad - \sum_{t=T'+1}^{T''} \beta^t P_t^I Q_t^I. \end{aligned} \quad (3)$$

The first term is the discounted sum of royalties and CIT associated with the LNG project, and this represents the incremental benefits. IDB and IFC emphasized this first term in their analysis, but attached little importance to the socio-environmental costs ( $C_t$ ) and the opportunity costs (the rest of the terms).

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<sup>11</sup> Suppose the benefit per unit of gas consumption is  $B$ , or  $B_t = B Q_t^G$ . For any positive quantity consumed it must be the case that  $B \geq P_t^G$ . Royalties and CIT are increasing with the quantity supplied and price. Suppose  $R_t^D = \tau_R P_t^G Q_t^G$  and  $CIT_t^D = \tau_{CIT} P_t^G Q_t^G$ , where  $\tau_R$  and  $\tau_{CIT}$  represent the respective tax rates whose sum must be less than unity. In each period the net benefit of domestic sales is  $\pi_t = (B_t - P_t^G Q_t^G) + (R_t^D + CIT_t^D) = B Q_t^G - P_t^G Q_t^G (1 - \tau_R - \tau_{CIT})$ . Given that price is decreasing with the quantity supplied ( $\frac{\partial P_t^G}{\partial Q_t^G} < 0$ ), it is obvious that the derivative with respect to the quantity supplied is positive ( $\frac{\partial \pi_t}{\partial Q_t^G} > 0$ ). In other words, the larger the quantity supplied, the greater is the net benefit of domestic sales. It can also be verified that crowding out reduces the welfare of domestic gas users, and has an ambiguous effect on tax revenues.

A vigorous analysis should weigh the first term against the rest of the terms in Equation (3). The LNG project is economically viable if and only if the sum is a positive number. However, there are challenges in performing a CBA based on Equation (3). First, the benefits of domestic procurement and employment ( $A_t$ ) cannot be determined without first computing their economic values, which is information intensive. It can be expected that the true economic surplus of such items will be a small fraction of what the private investors bore as financial costs, after netting the opportunity costs of the resources Peru used in providing the goods, services and local labour. Secondly, the impact on Peruvian consumers ( $B_t$ ) is difficult to quantify. The question rests on the type of user, and whether a substitute is available. Lastly, monetarizing the socio-environmental impacts ( $C_t$ ) is either controversial or challenging, if not both, as in the case of aboriginal interests. Given the information constraints, these variables need to be dropped. In all likelihood, incorporating these missing variables would only weigh against the LNG project. Equation (3') defines the incremental benefits and costs that will be captured in the CBA analysis:

$$\Delta = \sum_{t=0}^T \beta^t (R_t^E + CIT_t^E) - \sum_{t=T'+1}^{T''} \beta^t (R_t^D + CIT_t^D) - \sum_{t=T'+1}^{T''} \beta^t (P_t^I Q_t^I - P_t^G Q_t^G) \quad (3')$$

To recapitulate, the first term refers to the additional tax revenues generated by the LNG project. Had Camisea gas not been exported, taxes could still be collected from their domestic sales at a later date. The second term represents the taxes forgone. Domestic consumers must pay for the use of energy with or without the project. In the first case the payment will be made to foreign oil companies, and in the second to Consorcio Camisea and TGP. The last term represents the additional costs of energy incurred by Peru as a result of accelerated gas depletion.

### 3.2 Elements of the CBA Model

To determine the first term in Equation (3'), which represents the total tax revenues paid to the government, a detailed financial model was constructed for PLNG. Its first component is an investment schedule that indicates the amount of capital expenditures incurred during the construction phase, followed by a tax depreciation schedule to determine depreciation allowances. Second, a loan schedule computes loan disbursements as well as interests and principal repayments over the tenor of the loans. The third component forecasts PLNG's operating revenues, and fixed and variable operating costs, based on the sales agreement made with PLNG's sole client, Repsol Comercializadora de Gas S.A. (Repsol CG), and on the gas purchase and gas transport agreements with Consorcio Camisea and TGP. The difference between operating revenues and operating costs gives earnings before interest, taxes, depreciation and amortization (EBITDA). Lastly, an income tax statement is constructed to determine CIT liabilities by netting depreciation allowances, interest payments, loss carry-forward and other deductible items. Along the way, royalties are calculated and the second-order benefits of CIT contributions from Consorcio Camisea and TGP are approximated.<sup>12</sup>

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<sup>12</sup> Similar financial models were constructed for Consorcio Camisea and TGP. Although the companies produce and transport gas for both PLNG and the domestic market, the consolidated financial statements do not distinguish the two types of sales. There is insufficient information to isolate the cost of goods sold and other operating costs associated with the portion of sales to PLNG. Therefore the CIT liabilities for Consorcio Camisea and TGP must be imputed.

$R_t^D$  and  $CIT_t^D$  in the second term of Equation (3') can be calculated in essentially the same way as for  $R_t^E$  and the portion of  $CIT_t^E$  paid by Consorcio Camisea and TGP.<sup>13</sup> Once the financial models for Consorcio Camisea and TGP have been built, the computation of  $R_t^D$  and  $CIT_t^D$  is relatively straightforward, for a given gas price forecast and a given counterfactual quantity of natural gas that could be supplied to the domestic market.

The final term in Equation (3') is a function of a number of factors, including future energy prices ( $P_t^G$  and  $P_t^I$ ), future gas demand and its oil equivalence ( $Q_t^G$  and  $Q_t^I$ ), and the size of the proven gas reserves. The larger the reserves, the later the oil import date, and thus the lower the present value of the opportunity costs. The first step in deriving a numerical value for this final term is to determine the expected date of reserves depletion. This is achieved by comparing the total available gas reserves with the forecasted cumulative demand in each scenario. Once  $T'$  and  $T''$  are known, the second step is to convert the forecasted gas demand for each period ( $Q_t^G$ ) into barrels of oil ( $Q_t^I$ ) using energy equivalence.<sup>14</sup> Multiplying the quantity of gas or oil equivalence demanded by the respective price forecasts ( $P_t^G$  and  $P_t^I$ ) gives the cost of energy for each source. The difference between the products is the additional costs of energy incurred in substituting petroleum products for gas.

### 3.3 Data Source and PLNG Operations

The parameters that populate the model were taken from a collection of publicly available information. Primary sources include 1) publications by Peru's MEM containing estimates on the size of gas reserves and domestic gas demand forecasts; 2) the original concession contracts for Blocks 56 and 88; 3) company credit reports and audited financial statements (PLNG, Consorcio Camisea and TGP) published by credit rating agencies;<sup>15</sup> 4) IFC's project appraisal report on PLNG; 5) publications by the Energy Information Agency (EIA) of USA that give energy price forecasts. The primary information was crosschecked and, to the extent possible, verified with secondary sources. To save space, the derivation of various financial parameters is documented elsewhere.<sup>16</sup> Here it suffices to highlight some key aspects of PLNG's operations.

PLNG has a project life of 20 years, including two years of construction starting in 2008. The capital investment was 3.47 billion USD, of which 2.25 billion USD was debt-financed. Financing was sourced from IDB (800 million), IFC (300 million), several export-import banks (950 million) and local bonds.

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<sup>13</sup> Sales to PLNG and sales to the domestic market are subject to different royalty tax regimes. Both regimes are modelled to capture the royalty collected from the LNG project ( $R_t^E$ ), and the future royalty forgone ( $R_t^D$ ).

<sup>14</sup> To give a stylized example, given that one BCF of gas contains 1,089,000 MMBtu of energy and each barrel of oil contains 5.98 MMBtu (self-derivation based on Beychok (2012)), it takes about 182,000 barrels of oil to replace one BCF of gas. In the actual conversion, care was taken to adjust how the way gas is consumed by domestic users affects the oil equivalence.

<sup>15</sup> The rating agencies are Apoyo and Associates (AAI, associated with Fitch Ratings), Equilibrium Clasificadora de Riesgo (ECR, associated with Moody's Ratings) and Pacific Credit Rating (PCR). The credit reports for the past two years are available from the company websites: [www.aai.com.pe](http://www.aai.com.pe); [www.equilibrium.com.pe](http://www.equilibrium.com.pe); [www.ratingspcr.com](http://www.ratingspcr.com).

<sup>16</sup> The documentation will be uploaded to John Deutsch International's website, under the title "Annex to An Economic Evaluation of Peru's Liquefied Natural Gas Export Policy".

PLNG will acquire in total 4.20 TCF of natural gas from the Camisea fields. Its liquefaction plant has an annual production capacity for LNG equivalent to 218 trillion British thermal units (TBTU).<sup>17</sup> The entire LNG output is sold to Repsol CG under an 18-year LNG sales agreement.

Since PLNG's gas sales price is a function of the price Repsol CG receives in overseas markets, it is necessary to describe how the latter disposes of the LNG. Repsol CG is contracted to sell two thirds of the LNG to Mexico, and the rest to Asian and European markets on an ad hoc basis. Sales to Mexico are indexed to Henry Hub. Repsol CG will receive 90% of the Henry Hub price, minus 3 US cents per MMBtu.<sup>18</sup> Sales to other markets are determined by the spot price. It is assumed in this study that Repsol CG will sell the remaining one third of the LNG in Asia, where gas prices have been the highest.

The feed gas cost and gas transport fee paid to Consorcio Camisea and TGP, as well as royalties, are functions of the LNG price in overseas markets (what Repsol CG receives). Royalties are determined following a particularly elaborate scheme. PeruPetro, a state-owned enterprise tasked with negotiating oil and gas projects on the government's behalf, regularly reports the overseas price and royalty payment for each LNG shipment. Given an overseas price, the model's royalty estimate closely matches that in PeruPetro's reports (PeruPetro, 2013). This gives confidence that the royalty payment is modelled precisely, which is important as this constitutes the most significant source of benefits for Peru.

#### **4. CBA RESULTS**

The CBA analysis was conducted for three scenarios that vary in energy price forecasts, size of gas reserves, and domestic demand forecasts. It is more convenient to discuss this set of parameters separately for each scenario.

For all scenarios, an economic discount rate of 8% is applied to discount the stream of economic benefits and costs. Peru's Ministry of Economy and Finance (MEF) issued a set of guidelines, the National Public Investment System (SNIP), for evaluating all public investment projects. It recommends a real discount rate of 10% (SNIP, 2012), implying that the next best alternative use of public funds will generate an economic benefit of 10%. However, it is felt that the discount rate appropriate for this study needs a downward adjustment, in view of a study by Munilla (2010) that investigated how the Camisea project's tax revenues were distributed and managed by the various recipients. Between 2004 and 2010, 16% of the tax revenue was allocated to the national government, 64% to the sub-national governments and the balance of 20% to a national defence fund, which is treated as an expense of current consumption. If under ordinary circumstances

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<sup>17</sup> To be technically precise, the LNG plant has a nominal capacity of 4.4 million metric tons per annum (MMTA), as it is an industry practice to express LNG output in weight unit. For the purpose of this paper, gas quantity is more conveniently expressed either in units of energy (Btu) or volume (cubic feet), depending on the context. Energy units are preferable for gauging the monetary value of the gas, since gas prices are quoted in USD per million British thermal units (USD/MMBtu). Volume unit is preferable when comparing gas quantity with the country's available reserves, which is given in cubic feet. While all three measures are convertible, this paper drops the weight unit to avoid adding to the confusion.

<sup>18</sup> To give a numerical example, if the Henry Hub price is 1 USD/MMBtu, Repsol CG will receive 88 US cents for the LNG that is shipped to Mexico.

such funds would reduce the need for government borrowing, they would generate an economic return of 10% to the economy. If, instead, 80% is available to reduce the government’s capital market borrowing, then the rate of return on these incomes would be reduced to 8%. The discount rate of equal value is chosen in recognition of MEF guidelines for public project evaluation and the particularity of the formula that directs the distribution of tax revenues from PLNG.

## 4.1 Scenario 1

### 4.1.1 Overview

Scenario 1 uses only information that was available around late 2007. The purpose is to evaluate the project using as much information as was available to decision makers at around the time of the loans approval. Although IDB and IFC did not incorporate reserves depletions into their analysis, the issue was clearly voiced in the public discussion. Key parameters are extracted from known studies on PLNG commissioned or conducted by IDB or IFC. As such, this part of the CBA analysis does not enjoy the benefit of hindsight.

It is useful to describe the economic situation in late 2007. The natural gas market outlook was then positive. IFC’s gas price forecasts ranged between 6 and 7 USD/MMBtu at Henry Hub, and between 8 and 9 USD/MMBtu in Asia (IFC, 2008a).<sup>19</sup> This study takes the upper limits for a more optimistic estimation of the tax revenues. As per Pluspetrol, the operator of the Camisea fields with 27% interest in Consorcio Camisea, gas for the domestic market is priced at 4 USD/MMBtu for sales to the petrochemical industry, and 1.59–2.7 USD/MMBtu for sales to other domestic customers (GCA, 2009b).<sup>20</sup> Lastly, the long-term price forecast for crude oil was 50 USD/barrel (IFC, 2008a), to which are added the costs of refining, marketing and distribution to derive a final consumer price of approximately 61 USD/barrel.<sup>21</sup> In real terms, the future cost of Camisea gas to be paid by domestic consumers ( $P_t^G$ ) is assumed to remain between 1.59 and 4 USD/MMBtu depending on the consumer types,<sup>22</sup> and the future cost of refined oil ( $P_t^O$ ) to be 61 USD/MMBtu in accordance with the World Bank forecast.

Peru’s MEM certified the country’s total proven reserves to be 11.8 TCF (MEM, 2008). Table 1 provides a breakdown of reserves by block and reserves category. The Camisea fields hold the majority of Peru’s total reserves by any standard.

**Table 1: Peru’s 2007 Reserves Estimates by Reserve Category (TCF)**

Natural gas fields	Proven <sup>a</sup>	Probable <sup>b</sup>	Proven and Probable <sup>c</sup>
Camisea			
Block 56	2.94	1.18	3.53
Block 88	8.21	2.70	9.56

<sup>19</sup> Unless otherwise stated, all prices are at the 2008 level, and all rates are in real terms.

<sup>20</sup> Curiously, feed gas to PLNG is priced at 0.51 USD/MMBtu.

<sup>21</sup> Self-derivation based on the before-tax, gasoline price breakdown in USA (EIA, 2013a).

<sup>22</sup> Domestic gas prices are not subsidized and are thus the true costs paid by Peru to Consorcio Camisea. In addition, the gas transportation fee is around 0.66 USD/MMBtu (self-derivation based on credit agencies’ reports on TGP).

Subtotal	11.15	3.88	13.09
Others	0.67	2.95	2.15
Total	11.82	6.83	15.24

<sup>a</sup>Proven reserves have at least a 90% chance of being present.

<sup>b</sup>Probable reserves have at least a 50% chance of being present.

<sup>c</sup>100% of proven reserves plus 50% of probable reserves.

Source: MEM (2008)

In accordance with industry practices, MEM's reserves estimates are classified into three categories according to the probability of their being present: proven, probable and possible. Proven reserves have at least a 90% chance of being present and probable reserves have at least a 50% chance. Since possible reserves have a mere 10% chance of being present, they are not included as part of the total available reserves. To avoid supply interruption and gas shortfall penalties, it has been an industry practice to contract out only from proven reserves. In this study, the proven reserves are taken to be Peru's total available reserves in the base case, supplemented by a sub-scenario that augments the total available reserves by 50% of the probable reserves.

A year before loan approval, IDB commissioned a consulting firm, Apoyo Consultoria (Apoyo), to conduct a study on Camisea I. According to Apoyo (2007), Peru's cumulative domestic gas demand was expected to be 6.5 TCF over the period 2007–2033.<sup>23</sup> The composition of demand is 2% by residential users and natural gas vehicles, 15% by industries, 59% by power plants, and the remaining 23% by the petrochemical sector. For this study, demand past 2033 is assumed to grow at a constant rate of 2% per year.<sup>24</sup>

#### 4.1.2 CBA Results for Scenario 1

As will become apparent, Scenario 1 describes the most favourable macro-environment of all three scenarios. Table 2 summarizes the CBA results.

**Table 2: CBA Results Summary - Scenario 1 (2007 estimates)**

	Proven <sup>a</sup>	Proven and Probable <sup>b</sup>
Total available reserves (TCF)	11.8	15.2
<b>Financial analysis</b>		
Equity IRR (%)	12.8	12.8
Project IRR (%)	7.6	7.6
<b>Economic analysis</b>		
	million USD	million USD
ENPV @ 8% economic discount rate	<b>-3,199.9</b>	<b>-967.2</b>
<b>Immediate benefits (+)</b>		
CIT ( $CIT_t^E$ )	764.7	764.7
PLNG	66.6	66.6
Upstream suppliers	698.2	698.2
Royalty ( $R_t^E$ )	1,481.8	1,481.8
<b>Opportunity costs (-)</b>		

<sup>23</sup> Own derivation based on Apoyo (2007).

<sup>24</sup> For the period 2007–2033, the implied long-run average demand growth rate in Apoyo (2007) is 8%, which may not be sustained.

CIT forgone ( $CIT_t^D$ )	145.7	53.9
Royalty forgone ( $R_t^D$ )	294.1	171.5
Difference in energy costs <sup>c</sup> ( $P_t^I Q_t^I - P_t^G Q_t^G$ )	5,006.6	2,988.4

Earliest oil import date (year)		
With project	2036	2043
Without project	2045	2052
Million barrels of oil import during the interval	1,015.7	1,031.1

<sup>a</sup>Proven reserves have at least a 90% chance of being present

<sup>b</sup>100% of proven reserves plus 50% of probable reserves.

<sup>c</sup>Crude oil price at 50 USD/barrel, implying a final refined oil price of 61 USD/barrel.

IRR, internal rate of return; ENPV, economic net present value.

The model forecasts an equity internal rate of return (IRR) of 12.8%, and a project IRR of 7.6%, as compared to IFC's project IRR projection of 6.0% (IFC, 2008a).<sup>25</sup> The disparity is due to differences in several assumptions, mostly notably in natural gas price forecasts. The financial model can reproduce a project IRR of 6.6% if the full set of IFC assumptions is adopted. Similarity in the project IRR projections gives confidence that the current financial model is a fair approximation of the original.

From Peru's standpoint, the private return for foreign investors is immaterial. The economic viability of this project rests entirely on what Peru as a whole will receive. In this scenario, the government collects 1.48 billion USD of royalties plus 765 million USD of CIT, both in present value at an economic discount rate of 8% (in real terms). It is noteworthy that PLNG accounts for only 8.7% (66.6 million USD) of total CIT contributions. This is not surprising considering that PLNG's depreciation allowances – the sum of construction costs, financing costs and interest during construction – reached 3.83 billion USD. The total tax revenues amount to 2.25 billion USD in present value.

With the project, gas exhaustion is expected to occur in 2036. Without the project, gas depletion is deferred until 2045. During the nine-year interval, approximately 1,016 million barrels of refined oil are required to replace the exported gas. At 61 USD/barrel, the total cost of replacement oil amounts to 6.06 billion USD in present value. If, during the same interval, domestic consumers could buy the exported gas at the current contracted price, they need only pay 1.05 billion USD altogether for the gas itself and the transportation fee. Either way, Peru's energy needs would be satisfied, but importation of petroleum substitute imposes an additional cost of 5.00 billion USD on Peru. In addition, of the 1.05 billion paid to the Camisea operators, the government could collect another 440 million USD of royalties and CIT revenues that are now forgone. The economic benefits of royalties and CIT in the short and medium term are outstripped by the opportunity costs by 3.20 billion USD.

It may be argued that Peru will find alternative solutions to its energy problem without resorting to oil imports. Two possible solutions were explored, namely re-importation of natural gas, and hydropower, but neither seems to be economically attractive.

<sup>25</sup> The equity IRR is based on net income (after tax and financing), whereas the project IRR is the after-tax IRR for the whole project, before financing.

A supplementary CBA was conducted under the assumption that, instead of importing petroleum, Peru will re-import LNG. Equation (3') is still a valid evaluation criterion, except that the product  $P_t^I Q_t^I$  in the last term now represents the cost of importing LNG and must be re-estimated. Otherwise, the numerical estimates for other variables are the same as those in Table 2. Natural gas re-importation would call for the construction of a regasification terminal; the one built recently in Mexico to make use of Repsol CG's LNG is estimated to have cost 900 million USD (Samsung, 2012), plus operating and maintenance costs. At the forecasted long-term natural gas price of 7 USD/MMBtu at Henry Hub, the free on board (FOB) price of LNG (inclusive of liquefaction at the source country and shipping) for Peru should not be less than 8 USD/MMBtu. The 4.2 TCF of LNG alone would cost 3.17 billion USD in present value. When the construction costs of the regasification plant are included, the total cost of imported gas is around 3.67 billion USD as compared to the cost of Camisea gas for Peruvian gas users, estimated at 1.05 billion USD. This implies an additional energy cost of 2.25 billion USD. When the LNG project's tax revenues and the tax revenues forgone (440 million USD, as reported in Table 2) are all accounted for, the total opportunity costs amount to 2.65 billion USD. As the project would generate a gross benefit of 2.25 billion USD of tax revenues for Peru, the economic net present value (ENPV) in this case would be -438 million USD.

As for hydropower, it is a poor substitute for industries that rely on natural gas as a heating fuel or a chemical ingredient, constituting 38% of the total demand. This aside, it can be inferred from Apoyo's gas demand forecasts that, from 2030 onward, gas-fired power plants will produce upwards of 36,000 gigawatt-hour (GWh) of electricity each year.<sup>26</sup> With an average availability factor of 0.7, producing the equivalent amount of hydroelectricity would require no less than 5.87 GW of new installed hydropower capacity. To put this figure into perspective, Peru had 23 hydropower plants as of 2012, with a total installed capacity of 3.6 GW (MEM, 2012a). This implies an additional installed capacity of 160%. It is a challenge in itself to find suitable sites for the many new hydroplants, not to mention the monetary and environmental costs involved. Given that Peru has been harnessing hydropower as a major energy source for three decades, it is likely that hydroplants have already been constructed in the places that are the least expensive to build.<sup>27</sup> To count on hydropower replacing natural gas would impose great risks on Peru's future energy security.

Column 2 of Table 2 presents results for a sub-scenario that adds 50% of the probable reserves to the total available reserves, now totalling 15.2 TCF. The economic outcome improves drastically.

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<sup>26</sup> The figure is derived by multiplying the public utilities' annual demand (MMCF) by the energy content of natural gas, known as higher heating value (MMBtu/MMCF), and then dividing the product by the heat rate for gas-fired plants. The heat rate is the amount of energy required to produce one kilowatt hour of electricity (Btu/kWh), which varies by energy source. As a side note, gas-fired plants are typically more efficient than fuel-oil-fired plants; the respective heat rates are 8,152 and 10,829 Btu/kWh (EIA, 2013b). The relative inefficiency of oil-fired plants increases the LNG project's opportunity costs as more barrels of replacement oil are required for the same amount of electricity produced by natural gas.

<sup>27</sup> Using a sample of 71 hydroelectric projects financed by World Bank from 1965 to 1986, Bacon and Besant-Jones (1998) estimated that on average hydropower projects experienced a cost overrun of 27%. It can be expected that the actual construction costs for the 5.87 GW installed capacity will negate the 2.25 billion USD tax revenues the project is supposed to bring.



Increasing the total available reserve defers the earliest with-project importation date to 2043, thereby reducing the present values of the opportunities costs from 5.45 to 3.21 billion USD. However, the ENPV remains negative at –967.2 million USD.

## 4.2 Scenario 2

### 4.2.1 Overview

The commercial operation of PLNG commenced in mid-2010, in the wake of the 2008 financial crisis. Scenario 2 gauges the economic contribution of PLNG to the Peruvian economy, given the evolving circumstances.

Three factors have had a major impact on the project outcome. First, the Henry Hub price of gas fell considerably since 2007 – from 6.5 to 3.5 USD/MMBtu – as shale gas extraction technology became economical, bringing an ample supply to the US market. EIA’s latest Henry Hub forecasts are bleak, with prices ranging from 3.2 to 5.7 USD/MMBtu (in 2012 prices) between 2013 and 2030 (EIA, 2012). Also in 2012 prices, the forecast is that the crude oil price will reach 82 USD/barrel by 2030, which implies a final refined oil price of 101 USD/barrel. In contrast, Asian LNG prices have risen sharply. In this analysis the gas price in Asia is taken to be 12 USD/MMBtu.

Second, Consorcio Camisea had twice upgraded the reserves estimate, from the initial 10.9 to 14.1 TCF in 2009. The upgraded figures were found to be exaggerated by two consulting companies that carried out independent assessments of Camisea’s gas reserves. There were no significant finds between 2008 and 2011, but in 2012 additional proven reserves in the Camisea fields were indeed confirmed by MEM. Consequently, Peru’s total proven reserves increased to 15.38 TCF as of December 2012. Probable reserves decreased moderately to 5.44 TCF. Since the projection period in the spreadsheet model starts from 2008, 1.2 TCF of gas is added to 2012’s proven reserves estimate to account for the volume extracted during the interval. Table 3 presents the quantity of gas that was actually in place in December 2007.

**Table 3: Peru’s Updated Reserves Estimates by Reserve Category as of 2007 (TCF)**

Natural gas fields	Proven <sup>a</sup>	Probable <sup>b</sup>	Proven and Probable <sup>c</sup>
Camisea			
Block 56	3.56	0.97	4.05
Block 88	12.02	1.64	12.84
Subtotal	15.58	2.61	16.89
Others	1.00	2.83	2.42
Total	16.57	5.44	19.29

<sup>a</sup>Proven reserves have at least a 90% chance of being present

<sup>b</sup>Probable reserves have at least a 50% chance of being present.

<sup>c</sup>100% of proven reserves plus 50% of probable reserves.

Source: self-derivation based on MEM (2013), inclusive of cumulative gas extraction between 2008 and 2012.

Third, after a decade of promotion, Peruvian industries are taking an active interest in reequipping their facilities to burn natural gas, only to find that the proven reserves are

inadequate for their needs. News of shortages emerged as early as June 2009, *before* the commercial operation of PLNG (La Republica, 2009), and domestic gas supply is being rationed. According to MEM's latest estimate, the total domestic demand from 2010 to 2040 is 15.8 TCF, compared with 6.3 TCF between 2007 and 2033 in Scenario 1.<sup>28</sup>

#### 4.2.2 CBA Results for Scenario 2

CBA results for the second scenario are summarized in Table 4.

	<b>Proven<sup>a</sup></b>	<b>Proven and Probable<sup>b</sup></b>
Total available reserves (TCF)	16.6	19.3
<b>Financial analysis</b>		
Equity IRR (%)	8.3	8.3
Project IRR (%)	5.4	5.4
<b>Economic analysis</b>		
	million USD	million USD
ENPV @ 8% economic discount rate	<b>-4,989.7</b>	<b>-3,481.2</b>
<b>Immediate benefits (+)</b>		
CIT ( $CIT_t^E$ )	773.1	773.1
PLNG	24.0	24.0
Upstream suppliers	749.1	749.1
Royalty ( $R_t^E$ )	1,765.4	1,765.4
<b>Opportunity costs (-)</b>		
CIT forgone ( $CIT_t^D$ )	171.8	131.7
Royalty forgone ( $R_t^D$ )	346.3	265.5
Difference in energy costs <sup>c</sup> ( $P_t^I Q_t^I - P_t^G Q_t^G$ )	7,010.0	5,622.5
<b>Earliest oil import date (year)</b>		
With project	2036	2040
Without project	2042	2045
Million barrels of oil import during the interval	970.1	1,003.0

<sup>a</sup>Proven reserves have at least a 90% chance of being present

<sup>b</sup>100% of proven reserves plus 50% of probable reserves.

<sup>c</sup>Crude oil price at 82 USD/barrel, implying a final refined oil price of 100 USD/barrel.  
IRR, internal rate of return; ENPV, economic net present value.

In this scenario, the equity IRR for PLNG drops to 8.3%. It comes as a surprise that royalty collection actually increases moderately by 283 million USD, from 1.48 to 1.77 billion, despite the ailing Henry Hub market. Further analysis traces this counterintuitive result to the risk-sharing structure embodied in the royalty regime. In essence, royalty is a convex function of overseas gas price, that is, royalty increases more (less) at the margin at a higher (lower) overseas price. Given the respective gas prices at Henry Hub and in Asia, the weighted royalty tax is 0.7076 USD/MMBtu in this scenario, and 0.6997 USD/MMBtu in the previous. Sales to the booming Asian markets thus make up for the losses at Henry Hub.

<sup>28</sup> Own derivation based on MEM (2012b).

Alongside 2012's new discovery that added 3.10 TCF of gas to the proven reserves, the forecasted domestic demand has grown by 150%. Gas depletion is expected to occur in 2036, as before, and the quantity of oil replacement (970 million barrels) is similar to that in Scenario 1 (1.02 billion barrels). Both observations indicate that domestic demand growth almost negates the economic gains, in terms of reducing reliance on oil imports, from new gas discovery. Nevertheless, additional energy costs rise from 5.00 to 7.01 billion USD owing to rising forecasted oil prices. Peru forgoes another 518 million USD of royalties and CIT from counterfactual sales to the domestic market. In summary, while the LNG project is expected to generate 2.54 billion USD of gross economic benefits, the economic costs total 7.53 billion USD. Peru will suffer a net economic loss of 4.99 billion USD.

### **4.3 Scenario 3**

#### **4.3.1 Overview**

The LNG project's short history is marked by episodic outbreaks of opposition at various levels of society. In July 2009, seven Peruvian departments pursued joint legal action against the federal government's approval of the project. In place of PLNG, they argued that natural gas transported through a South Andean pipeline could aid economic development in Southern Peru (La Jornada, 2009). Demonstrations against the project have been frequent, but in June 2010, several thousand protestors staged road blocks in the Cusco Region, where the Camisea fields are located, and were joined by several thousand more in Lima (La Jornada, 2010). In response to popular protest, former President Alan Garcia issued an executive order that set a minimum royalty for future LNG contracts (Executive Order N° 039-2010-EM). He also reinstated Fujimori's order that Camisea developers must guarantee domestic supply for 20 years at the time of LNG export (Executive Order N° 053-2010-EM).<sup>29</sup> Contract renegotiation was soon suspended as the current incumbent, president Ollanta Humala, dislodged Garcia from office.

In honouring his pledge to rectify Camisea II, Humala issued an executive order that earmarks Block 88 for domestic uses (Executive Order N° 008-2012-EM). Export gas can now be sourced only from Block 56. Renegotiation is likely to take time, as the Camisea developers offered 2.5 TCF of Block 88's proven reserves – the volume in Block 88 initially committed to the LNG project – to the lenders group as collateral that backed PLNG's financing (Gestión, 2011). Legal issues need to be resolved with international financing institutions before the Camisea developers can continue negotiation with the government. International financial institutions' involvement has the anticipated effect of mitigating policy risks for private investors, but creates obstacles to Peru correcting a past mistake.

Perhaps the Humala administration was unaware of the latest reserves estimates when issuing the executive order in mid-2012, but restricting gas export to what is available in Block 56 is unlikely to have a significant impact. Since Block 56 is estimated to hold 3.56 TCF of proven reserves, PLNG may still export 85% of the 4.2 TCF intended. Humala can conserve no more than 0.64 TCF of natural gas for Peru.

#### **4.3.2 CBA Results for Scenario 3**

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<sup>29</sup> See Section 2.2.

For completeness, a final CBA analysis was conducted to quantify how the executive order may help to reduce Peru’s economic loss. The renegotiation is assumed to bring no changes to the tax regime or to other terms in the licensing agreement. Energy price forecasts, domestic demand forecasts and reserves estimates are identical to Scenario 2. However, the exportable volume of natural gas is reduced from 4.2 to 3.56 TCF in the base case, and to 4.05 TCF in the sub-scenario. In this scenario, the ENPV improves from –4.99 billion to –4.36 billion USD in the base case, indicating a reduction in economic loss of 628 million USD. For the sub-scenario, the reduction in loss is negligible.

**Table 5: CBA Results Summary - Scenario 3 (2012 estimates)**

	Proven <sup>a</sup>	Proven and Probable <sup>b</sup>
Total available reserves (TCF)	16.6	19.3
<b>Financial analysis</b>		
Equity IRR (%)	7.6	8.3
Project IRR (%)	4.9	5.4
<b>Economic analysis</b>		
	million USD	million USD
ENPV @ 8% economic discount rate	<b>–4,361.3</b>	<b>–3,810.7</b>
<b>Immediate benefits (+)</b>		
CIT ( $CIT_t^E$ )	668.1	773.1
PLNG	0	24.0
Upstream suppliers	668.1	749.1
Royalty ( $R_t^E$ )	1,614.7	1,765.4
<b>Opportunity costs (–)</b>		
CIT forgone ( $CIT_t^D$ )	151.8	131.7
Royalty forgone ( $R_t^D$ )	306.1	265.5
Difference in energy costs <sup>c</sup> ( $P_t^I Q_t^I - P_t^G Q_t^G$ )	6,186.2	5,622.4
<b>Earliest oil import date (year)</b>		
With project	2037	2040
Without project	2042	2045
Million barrels of oil import during the interval	878.1	1,003.0

<sup>a</sup>Proven reserves have at least a 90% chance of being present

<sup>b</sup>100% of proven reserves plus 50% of probable reserves.

<sup>c</sup>Crude oil price at 82 USD/barrel, implying a final refined oil price of 101 USD/barrel.  
IRR, internal rate of return; ENPV, economic net present value.

## 5. SENSITIVITY ANALYSIS AND DISCUSSION

The analysis results in the previous section depend on the interaction of a set of variables. Since many parameter values cannot be determined with absolute certainty, sensitivity tests are conducted to test how changes in several critical variables influence the economic outcome. To save space, this section only reports the results from one such test for Scenario 2, which reflects the latest development. The sensitivity test is performed on the price of oil. The results are given in Table 6. As a reminder, the long-term prices of crude oil and refined oil are 82 and 101 USD/barrel respectively in Scenario 2. The ENPV in the base case is –4.99 billion USD, and

is –3.48 billion USD in the sub-scenario. The project is still economically unviable when the price of refined oil drops to 85 USD/barrel.

**Table 6: Sensitivity Analysis on ENPV in Scenario 2 (million USD)**

Crude oil (2012 prices)	Refined oil (2012 prices)	Proven <sup>a</sup>	Proven and Probable <sup>b</sup>
82	101	–4,989.7	–3,481.2
69	85	–3,690.3	–2,445.8
73	90	–4,098.1	–2,770.8
78	95	–4,505.8	–3,095.7
<b>82</b>	<b>101</b>	<b>–4,989.7</b>	<b>–3,481.2</b>
86	105	–5,321.4	–3,745.5
90	110	–5,729.2	–4,070.5
94	115	–6,137.0	–4,395.4
98	120	–6,544.8	–4,720.3

<sup>a</sup>Proven reserves have at least a 90% chance of being present

<sup>b</sup>100% of proven reserves plus 50% of probable reserves.

The crux of the problem is that Peru receives only a fraction of the LNG sales proceeds, but will pay a much higher price for petroleum substitutes than it would for Camisea gas, as is apparent from the following calculation. Table 7 reports the royalty fee for different gas price levels in the overseas markets. For the same overseas gas price, royalties from sales to Mexico are less than royalties from sales to Asia because the LNG to Mexico is priced at 3 US cents less than 90% of the Henry Hub price; recall Repsol CG’s LNG supply agreement with Mexico.

**Table 7: Royalty as a Function of Overseas Gas Price (USD/MMBtu)**

Gas price	Royalty		Gas price	Royalty	
	HH	Asia		HH	Asia
3.00	0.150	0.150	9.00	0.906	1.125
4.00	0.151	0.159	10.00	1.118	1.357
5.00	0.195	0.239	11.00	1.326	1.588
6.00	0.279	0.425	12.00	1.535	1.820
7.00	0.487	0.656	13.00	1.744	2.052
8.00	0.695	0.889	14.00	1.952	2.284

Even when the gas price reaches 14 USD/MMBtu, the government collects a maximum royalty of 2.28 USD/MMBtu. Based on the terms of the present gas purchase agreements, future Peruvian consumers will pay a weighted average cost of 2.32 USD/MMBtu for the Camisea gas, and another 0.66 USD/MMBtu for its transportation to Lima. In contrast, at the refined oil price of 85 USD/barrel, and given that each barrel of oil contains 5.98 MMBtu, oil replacement will cost 14.21 USD/MMBtu. On a per-MMBtu basis, oil replacement is 11.23 USD more expensive than Camisea gas. Peru collects no more than 2.28 USD of royalty but will pay no less than 11.23 USD extra to replace every MMBtu of Camisea gas exported.

## **6. CONCLUSION**

It may appear that natural gas that is left underground has little or no immediate value. Following the same logic, it may also appear that receiving some tax revenues from an LNG project that exports one third of Peru's gas reserves is better than conserving the natural gas and receiving nothing. If such is the basis of comparison, it is understandable why the government gave the green light to the project, and why development banks approved loans to PLNG. However, projects cannot be evaluated solely on the basis of their immediate gross benefits without regard to the potential opportunity costs. If only the gross benefits are considered, one might be impressed by the billions in royalties and CIT revenues generated for Peru. However, the billions of tax revenues are dwarfed by the billions more incurred on importing petroleum substitutes.

When Peru exhausts its natural gas resources, the private investors of the Camisea project will seek better opportunities in other countries. By that time, Peru will have followed in the footsteps of Indonesia, which, having exhausted much of its petroleum resources amidst growing domestic demand, lapsed from being a net oil exporter to become a net importer in 2004. Since then, the rising oil price has forced the Indonesian government to divert an increasing share of public funds to subsidise fuel (Ministry of Finance of Indonesia, 2010; The Economist, 2013). With or without subsidy, it will be the future generation of Peruvians that pay for the current generation's mistake. According to Scenario 2's estimate, PLNG will generate a rate of return on equity of 8.3%, which is marginally satisfactory in compensating for the capital investment and the risks involved. By lending to PLNG, IDB and IFC have done Peru a disservice, though ironically, to the benefit of none.

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