IMPACT OF INVESTMENT TAX CREDITS IN THE DEVELOPMENT OF A CSP INDUSTRY IN CHILE

Fernando Hentzschel [1], Rodrigo García[1] and Rodrigo A. Escobar[2]

[1] Centro de Energías Renovables, CORFO- Ministerio de. Energía, Santiago (Chile)

[2] Pontificia Universidad Católica de Chile, Santiago (Chile)

1. Introduction

Chile is located in the west coast of the southern half of South America. The country is a narrow strip of land that stretches about 4300 km, with an average width of about 170 km. Chile shares borders with Argentina and Bolivia to the east and with Peru to the north. The Pacific Ocean forms the entire western border of Chile, which has a coastline stretching more than 6400 km. Geographically Chile may be divided into three macro zones: in the north, the Atacama Desert stands as the driest place on Earth, with characteristic sandy and rocky terrain; a central valley, where most of Chile's population lives and where productive lands are located, having a mild climate; and continuing south, a barely populated system of islands, fiords, and low mountains with a tough, cool, and damp climate is found. This diversity of geographical features and climates makes endowed with a wide range of natural resources, and through the production, addition of value and exports of such resources it has emerged as a successful economy.

In the last decades, Chile has experienced a steady economic growth, resulting from sound economic policies maintained consistently since the 1980s. This development has allowed Chile to increase the quality of life of its inhabitants, reducing poverty rates by over half, and tripling its GDP in just two decades. A consequence of this progress has been the increase in the overall energy consumption, both in the industrial and residential sectors. In order to provide the energy needed to meet the rising demand, conventional sources have been used throughout the years, especially imported oil, coal and gas (Fig. 1**Error! Reference source not found.**), making it a growing net importer of energy. Renewable energy sources in use by the country comprise mostly hydroelectricity and wood-based biomass. In the best case, renewable energy sources only account for 28% of primary energy consumption, while non-renewable sources account for the other 72%. As also shown in Fig. 1, in terms of power generation, renewable contribution is small and it mainly comes from. So, due to the reliance on imported fuels that the energy matrix has, renewable energy sources are an alternative to diversify the energy matrix with local resources. Remarkably, by December 2010 the installed capacity of not conventional renewable energy (NCRE) in Chile was only 452MW, which represents 3% of the country's total installed capacity.

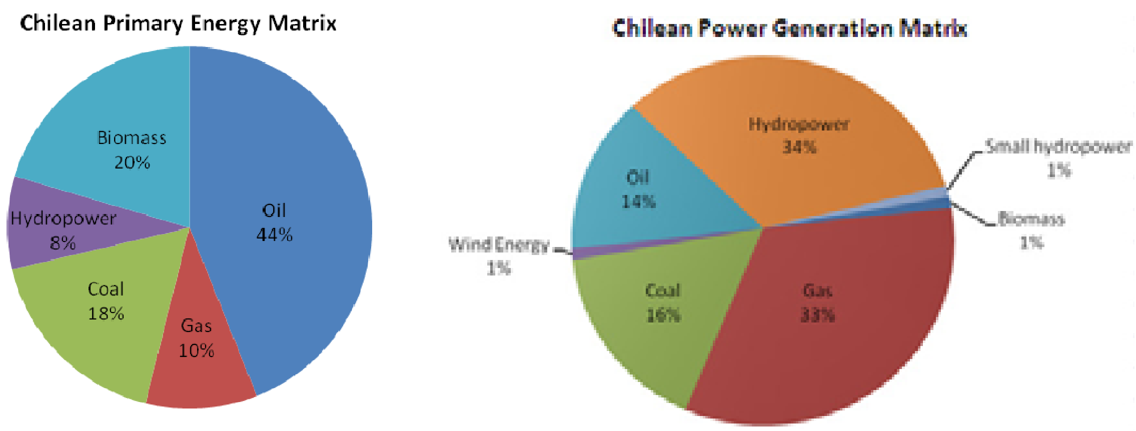

Fig. 1: Chilean Primary Energy and Power Generation Mix

In addition, the incorporation of renewable energy sources to the matrix goes in line with the Chilean energy policy, which is based on the main objectives of achieving competitive energy prices and ensuring energy security supply while being environmentally friendly. With these objectives established, the current government has set as a goal that by 2020, 20% of the power generation in the country must come from renewable energy sources. It is expected that this ambitious target will boost the renewables industry by accelerating its deployment and development, including the solar energy sector.

However, up to now the penetration of solar electricity in the country has been slowed down by its perceived high costs and returns on investment that are lower than what investors expect in a deregulated electricity market as the Chilean. However, the electricity costs produced from fossil fuels in Chile are among the highest within the region and have displayed a tendency to increase during the last decades, which constitutes a comparative advantage for renewable energy as the high electricity costs are expected to make competition for renewable feasible sooner.

Here we present the results of a technical-economical analysis which considers radiation levels and investment costs plus an investment tax credit in order to create a market penetration scenario for CSP technologies in northern Chile. The analysis takes a 50 MW CSP plant model for which hourly simulations of electricity production are performed. Electricity market sale prices are used for characterizing sales incomes. A 30-year lifecycle financial analysis is performed which allows the analyzing the effects of applying the investment tax credit. The analysis presents a base case without the investment tax credits, and shows how much a developer could benefit from its application. The market penetration scenario allows predicting the total expenses for the Chilean state if achieving a CSP-produced quota is desired.

2. Chilean Framework for solar energy technology

Over the past 30 years, Chile's energy policy has been founded on the premise that the best way to meet the demand for electricity at affordable prices is to rely on competition among private utilities, regulating natural monopolies and limiting the role of the State in any business decision. In 1982, Chile was a pioneer in the privatization of the electricity market. Since then, the average cost of technology and technical reliability were the only variables taken into account in decisions on capacity expansion, above and not considering other variables such as diversification of the generation matrix (which could limit the emissions of greenhouse gases by achieving equilibrium between fossil-produced electricity and renewable sources), improving local technology development, or the creation of skilled jobs (Pueyo et al, 2011).

The assumption that competitive markets offer the security of supply was included in this approach to the mainly private utility market. However, the heavy reliance on imported fossil fuels created periods of severe power shortages during the last two decades, with the consequent rise in prices of electricity, as shown in Fig. 2, which shows the evolution of prices of electricity sold in northern Chile (average market prices) as reported by the CNE (National Energy Commission) by August 1, 2011. Here you can see that although in the long run has been strong fluctuations (last year have fluctuated between 60 and 93 clp/kWh), the price has tended to stabilize at around 66 clp/kWh, equivalent to approximately $ 0.13/kWh or 0.1 € / kWh.

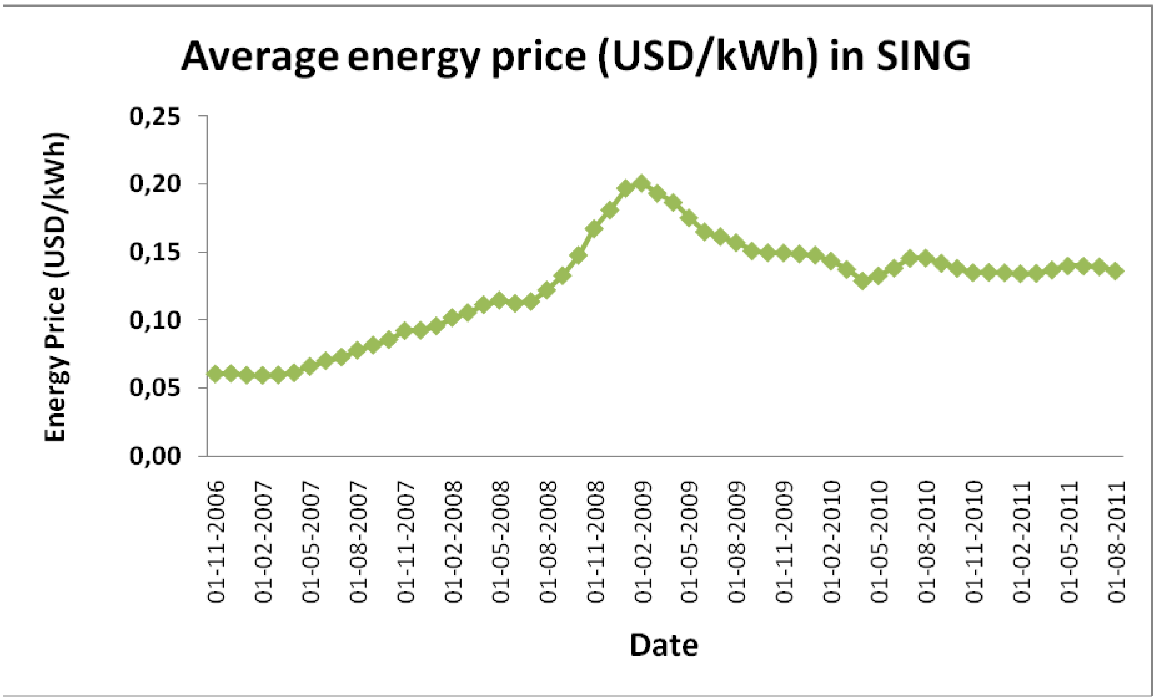

Fig. 2: Average market price in the SING, determined from the prices of contracts (PPA) reported to the CNE four months later. The figure shows which is stabilized in the last year around 0.13 USD/kWh (~ 0.1 €/kWh, ~65 $/kWh).

The great potential of solar energy in Chile has not been used since the long-term planning capacity to incorporate renewable energy is not easily compatible with the current electric model that best fits the short-term decisions for release through the order of merit. In the last five years, the regulatory conditions for the development of the renewable energy in Chile have improved. This has been done through new laws, including the creation of instruments for direct support (investment credit and subsidies for pre-investment studies); availability of better information on renewable energy resources; and the recognition that diversifying the energy sources is one of the central objectives of current energy policy. Thus, the regulatory framework has been improved over the years, maintaining the original objective of minimizing the overall cost of electricity to all consumers. The main changes include a policy to encourage demand for renewable energy in Chile (demand pull). Law No. 20,257 entered into force on April 1, 2008, requires companies that sell electricity directly to consumers to incorporate a renewable energy quota of 5% on sales of electricity. This percentage is required to gradually increase in order to reach 10% by 2024. Companies that fail to meet this quota are subject to fines. Finally, some institutional developments that favor renewable energy have been the creation of the Ministry of Energy and the Renewable Energy Center (REC) in 2009. The latter is an entity that seeks to play a role in accelerating investment in renewable energy and to become a center of knowledge and technology transfer.

2.2. Solar energy potential in Chile

Even as the quality of solar radiation data in Chile is not the best and considerable effort is being put into solving this issue, the conditions in northern Chile are considered to be very favorable for the application of solar energy conversion technologies, as stated by Ortega et al. (2010). In fact, as seen in Fig. 3, northern Chile has one of the highest intensities of solar radiation in the world, with clear skies during most of the year, which would allow solar field size per MW to be smaller than in other countries where CSP technologies have developed, thus resulting in investment costs reductions.

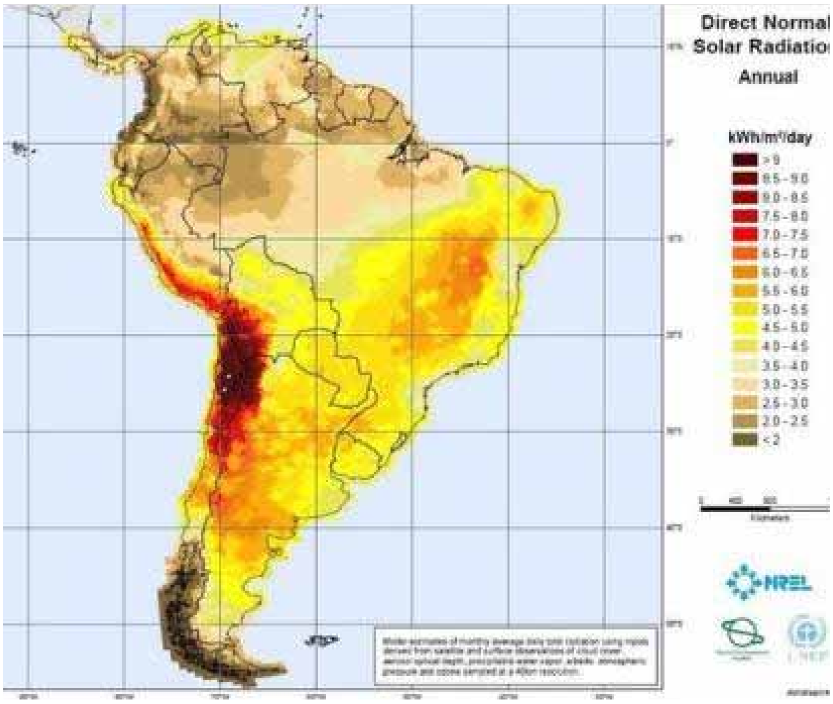

Fig. 3: NREL solar resource assessment in South America. In northern Chile can appreciate the DNI> 8.5 kWh/m2/day.(NREL, SWERA project: swera.unep.net).

In the same geographical area that has the best solar resource (north of Chile) are concentrated major centers of energy consumption (both electrical and thermal demand), resulting from the multiple mining activities within the region. Given the above, Chile could have CSP plants closely located to points of consumption, thus avoiding transmission lines cost and energy losses. The existence of industrial mining activities located in the same area, with their auxiliary service providers and road infrastructure greatly facilitate the installation of CSP facilities, as well as local manufacture of plant components. The energy demand of the Northern Interconnected System (SING) is essentially constant (mining facilities operate 24 hours, seven days a week), while the power generation mix is mostly based on coal power plants. Given this, the possibility of having continuous solar power supply, as allowed by CSP technologies that include thermal storage, offer a unique opportunity to provide base capacity without emissions of greenhouse gases. Finally, Chile is the largest exporter of thermal storage salts currently in development for CSP plants, and it is thought that finding similar niches in auxiliary services that this industry requires is completely feasible. In this sense, social and economic impacts of developing a CSP industry (such as GDP growth, employment generation, human capital formation, productive clusters, among others) is yet another benefit worth considering, especially when assessing the net cost to the state and the benefits of CSP penetration.

2.3. Barriers for solar energy in Chile

Even in the context that it is possible to find ample opportunities for the penetration of solar generation technologies in northern Chile, some barriers can also be found, such as the capacity of electric transmission system is limited, so power projects above 350 MW should also consider expanding the capacity of the respective transmission lines in their projects. Also, solar generation technologies are still relatively high in terms of investment, and thus not necessarily allows for profitability of CSP technologies in a competitive deregulated market context as the Chilean.

Therefore, it is thought that a business model that helps to accelerate the recovery of the relatively high investment costs without changing the deregulated electricity market trade could bring the viability of this technology in the Chilean electricity market. An example of such a mechanism is an Investment Tax Credit (ITC), the analysis of which is the main objective of this paper.

3. The Investment Tax Credit model

A support mechanism such as an investment tax credit (ITC) gives favorable tax treatment to those parties that decide to invest in renewable energy projects at specific locations, by providing a partial tax write-off or credit to investors. Chile has previously implemented investment tax credits to help promote other industries in its northern and southern extreme regions, a mechanism that has not been widely used to promote renewable, as it is not industry-specific but rather aims to promote investment in general.

In particular for northern Chile, what is called "Ley Arica" or Law 19.420 establishes a tax credit for industries that deploy in the extreme north of the country in order to foster investment and thus promote the economic activity in an underdeveloped region. The main features of the "Ley Arica" are as follows

- Credit Amount: The amount of credit reaches 30% of the value of physical assets to fixed assets, which corresponds to construction machinery and equipment. It must be property subject to depreciation, have a life time over three years, and an investments major larger than USD167.000.
- Deduction period: The credit is deducted from the first category tax, and the unused credit can be imputed in the following year.
- Restrictions: The "Ley Arica" operates only with respect to investments that run until December 31, 2011, with the credit attributable to 2034.

Currently the so-called "Ley Arica" is only valid until the end of the year 2011; there are ongoing discussions in the Chilean Senate about this topic, and a recently announced presidential message has promoted the extension of the validity of this law to hold investments until 2025, thereby allowing for an additional period of 14 years, that will allow companies to benefit from this law by allocate the credits generated until 2045 thus giving the benefit a total period of 33 years.

It is thought that the application of this mechanism could result in a sustainable business model for CSP developers to use in order to enable rapid market penetration by means of enhanced financial returns; although its merits are evident on paper, so far no detailed analysis of this mechanism has been performed regarding its financial consequences for both industry and state.

4. Evaluation Assumptions

In an effort to assess the impacts of this proposed support mechanism both to increase the returns to investment and the respective costs and benefits that the extension of this law would mean for the state, a technical-economical assessment was performed for a reference plant of 50MW capacity, of the parabolic trough technology with a thermal energy storage system. The analysis was performed for both optimistic and pessimistic scenarios.

4.1 Breakdown of costs

Based on standard costs of such plants, we made two scenarios, one pessimistic (CSP2) and another optimistic (CSP1), which consider the wide availability of solar resource and raw materials plus the proximity to centers of energy demand. Table 1 shows the cost considerations implicit in each scenario, both for investment and for the maintenance and operation of the plant.

Tab. 1: Main cost considerations

Project	CSP 1	CSP 2
Capacity (MW)	50	50
Plant capacity factor	47%	60%
Investment Costs (USD/W)	5,84	7,08
Total investment (MM USD)	292	354
O&M Fixed (USD/kW)	70	136
O&M Variable (US¢/kWh)	0,85	1,99

4.2 Financing assumptions

The main assumptions taken for this reference financing conditions are as follows:

- Financing: 20% own capital and 80% of 15-year finance, interest rate of 7%;
- Internal Rate of Return: 10%;
- CAPEX affected by the tax benefit (Arica Law): 75%;
- Plants built within the province of Arica (30% tax credit);
- Project Life: 30 years;
- Depreciation: accelerated to 5 years.

5. Results

5.1. Impact on energy price

The economic evaluation aims to determine the levelized cost of electricity (LCOE) for both scenarios (optimistic and pessimistic), both under the law Arica and absence of it, in order to establish a base case for comparison of its profits. The economic evaluation considered the NREL's CREST (Renewable energy cost of spreadsheet tool), which used to determine costs and cash flows. This tool allows you to select two types of payment of the tax benefit: "Carried forward" or "As generated". As an investment project of this nature will have to take operating losses during the early years and positive income will not materialize within 7 to 10 years, the difference between two types of payment can model two different types of investors:

• Those without pre-project business operations (hereinafter "enterprise SOC")

• Those with pre-project business operations (hereinafter "enterprise COC").

Since the "Ley Arica" is a tax credit attributable to taxes that are later payable by the company, the fundamental difference is that the SOC may not use company credit until after 7 to 10 years when it starts to rent, since before that any taxes will not be counted against those who charge the credit. Conversely, a company may use credit COC from the first year of project operations, attributable to its global taxes, which go beyond the project. Undoubtedly, the type of company will determine the real benefit that the law will have on the energy price; here only the case of companies who do best COC uses of this type of benefit will be evaluated and presented. Table Nº2 shows, for both scenarios, the resulting LCOE for companies COC.

Tab. 2: LCOE for both scenarios with a COC company

Proyecto	CSP 1	CSP 2
LCOE without ITC, COC (US$/MWh)	160,1	180,2
LCOE with ITC, COC (US$/MWh)	124,1	145,5
ITC effect	22,49%	19,26%
Utilized amount (Ley Arica), (USD)	65.700.000	79.605.000
Percentage of ITC utilized (Ley Arica)	100,0%	99,9%

The impact of the tax benefit is reasonably noticeable on LCOE, which was predictable, given that the "Ley Arica" lowers considerably the annual net outflows during the first years of operation of the plant.

Table 3 shows the percentage difference between the LCOE of each project against an energy price of 130 USD/MWh, plus the eventual income from bonds to reduce emissions to a conservative value (~12 US$/MWh depending of the SING emission factor). These percentages represent the prices that are competitive in the Chilean electricity market.

Tab. 3: Percentage difference between the LCOE of each project against an energy price

Proyecto	CSP 1	CSP 2
Average market price in the SING (USD/MWh)	130	130
Emission reducing (USD/MWh)	12	12
Percentage difference without ITC, SOC	-20%	-34%
Percentage difference with ITC, SOC	-17%	-32%
Percentage difference without ITC, COC	-13%	-27%
Percentage difference with ITC, COC	13%	-2%

It is noted that in the case of the company SOC, the "Ley Arica", is not enough to provide competitive projects; however, in the case of the COC business, it shows the effectiveness of the ITC, as the LCOE is reduced to be very similar to the sales price of energy in the CSP 2 scenario, while being lower for the CSP 1 scenario.

3.2. Impact on local economy

This section examines the impact that a CSP project developed under "Ley Arica" could have on the local economy in terms of direct and indirect jobs produced, both at the construction and the operation stages. To this end we use the JEDI tool ("*Jobs and Economics Development Impact Model*") of NREL, which determines the number of jobs by type and by stage as well as the income they receive both workers and the local economy. JEDI considers different types of outlets as the economic framework of the geographical area concerned so as various parameters of economic development (including industrial production local capacity v/s need to import raw materials) depending on the state you choose. In that sense, we are currently conducting a second analysis considering the specific economic conditions to the region of Arica; however, for this first approach, we considered as a reference the District of Columbia (DC) that does have not an industrial and manufacturing activity specified in CSP, unlike for example the state of California, where this industry is highly developed, so it is expected that the project's impact on the local economy may be smaller, yet more like what might be expected in the region of Arica in Chile.

Table 4 shows the results of this analysis, illustrating the impact of each project during the construction phase, during the operation stage (for each of the 30 years of the project) and finally the percentage impact of the tax credit in the community for each project for the total time of the project (construction plus operation). One can see that all projects have a fairly high impact on the local economy.

6. Conclusions

The solar conditions in northern Chile are considered to be very favorable for the application of solar energy conversion technologies. In fact, the availability of suitable terrain, high radiation levels, and large electricity and heat demand have sparked interest into the different alternatives that could be used in order to promote the development of a CSP industry. Additionally, northern Chile is characterized by a high, nearly constant electricity demand due to mining industry consumption, which is currently being satisfied by the operation of fossil thermoelectricity.

Despite these advantages, the penetration of these technologies in the Chilean electricity market has not been materialized, apparently because the high investment costs still do not allow utilities to achieve the expected profitability of investment projects in a deregulated market such as Chile. However, there are subsidies such as "Investment tax credits," that could be deployed in the extreme north of the country in order to foster investment and thus promote the economic activity in an underdeveloped region. This ITC, called “Ley Arica”, could provide a profitable business model CSP projects in this region through tax exemptions, increasing returns on investment projects, bringing it closer to competitive prices even in the context of deregulated Chile.

On the other hand, the economic impacts associated with the development of such projects in regions as Arica, are much higher than state costs that would involve implementation. But one should not forget that without these incentive mechanisms it is currently not feasible to implement CSP projects, so this reduction in taxes income, should not be understood as a reduction in public income, as without the ITC the CSP projects under discussion here will not materialize, and therefore will not generate income and profits subject to taxes.

7. References

Ortega, A., Escobar, R., Colle,S., Abreu S.L., 2010. The state of solar energy resource assessment in Chile. Renewable Energy. 35, 2514-2524.

Pueyo A., García R., Mendiluce M, Morales D., 2011 The role of technology transfer for the development of a local wind component industry in Chile, Energy Policy. 39, 4274-4283

Tab. 4: Resulting impact on the local economy

		CSP 1	CSP 2
Project development	Jobs	380	460
	Workers income (MM US$)	58,63	71,03
	Community income (MM US$)	69,52	84,23
Logistic	Jobs	219	265
	Workers income (MM US$)	19,97	24,20
	Community income (MM US$)	83,84	101,59
Indirect Jobs	Jobs	52	62
	Workers income (MM US$)	4,01	4,86
	Community income (MM US$)	10,20	12,36
TOTAL CONSTRUCTIO	Jobs	651	787
	Workers income (MM US$)	82,61	100,09
	Community income (MM US$)	163,56	198,18
Benefices/ ITC Costs (Construction)	Jobs	126%	126%
	Community income	249%	249%
	Total incomes	**375%**	**375%**
Operators	Jobs	23	23
	Workers income (MM US$)	2,19	5,02
	Community income (MM US$)	2,19	5,02
Logistic and local services	Jobs	12	28
	Workers income (MM US$)	1,02	2,31
	Community income (MM US$)	3,50	7,94
Indirect jobs	Jobs	4	6
	Workers income (MM US$)	0,28	0,48
	Community income (MM US$)	0,71	1,21
TOTAL OPERATION	Jobs	39	57
	Workers income (MM US$)	3,49	7,81
	Community income (MM US$)	6,40	14,17
Benefices/ ITC Costs (Annual Operation)	Workers income	5%	10%
	Community income	10%	18%
	Total incomes	15%	28%
Amount of credit (MM US$)		65,70	79,61
ITC Benefices (Total)	Workers income (MM US$)	82,61	100,09
	Community income (MM US$)	163,56	198,18
	Total incomes (MM US$)	**246,17**	**298,27**
Benefices/ ITC Costs (Total)	Workers income	285%	420%
	Community income	541%	783%
	Total incomes	**826%**	**1203%**