Appraising aluminium smelters in small island developing states

J. Ram
The University of the West Indies, St. Augustine, Trinidad and Tobago

Abstract

Trinidad and Tobago are the most southerly of the Caribbean islands located just 11 kilometres (7 miles) off of the north east Venezuelan coast. The country has been engaged in the international oil market for over a century utilizing its hydrocarbon resources to boost economic development. Most of the country's foreign exchange earnings come from the export of oil and gas and related down stream industries such as methanol, iron and steel and ammonia. The thrust to monetize the gas reserves continues in Trinidad and Tobago and the government has recently signed agreements for the construction of two aluminium smelters. However, concerns have been raised that aluminium smelting could have negative environmental and social consequences for a small island developing state. The economic question is how should a small island developing country balance the need for further economic development with its concern for ecosystem conservation and possible alternative livelihoods in the future? What are the true benefits and costs of aluminium smelting to a small island developing state? Are the possible environmental costs minimal or significant? Should aluminium smelting be powered by electricity generated by natural gas, a non-renewable resource? What is the user cost associated with an aluminium smelter using natural gas as its power supply. What are the valuation techniques necessary to analyse such a policy?
Keywords: appraisal aluminium smelting, user costs, small island states.

1 Introduction

The republic of Trinidad and Tobago (T&T) is located 12 kilometres off the north east coast of Venezuela and is the most southerly of the islands comprising the Caribbean archipelago. The population of T&T is approximately 1.3 million

www.witpress.com, ISSN 1743-3541 (on-line)
doi:10.2495/SDP070351

and the latest national income data states that per capita GDP is US$16,700 (purchasing power parity). The economy of T&T is heavily dependent on the export of hydrocarbons resources such as petroleum and natural gas or products derived from these resources such as methanol, urea, and ammonia.

Trinidad and Tobago has been relatively successful in attracting foreign direct investment to its oil and gas industry. Foreign companies are active in exploration and production as well in downstream activities. Since the 1970s the government has had an active policy to monetise its gas reserves by either setting up key industries such as methanol, ammonia and iron and steel plants at its Point Lisas industrial estate situated on the west coast of Trinidad. During the setting up of this estate, the government was the risk taker, providing the infrastructure and the capital for the initial industries. However, most of the industrial plants at the Point Lisas industrial estate are now owned and operated by private companies (mainly foreign). The government has tended to provide concessionary gas prices, as well as tax holidays to encourage foreign investment. Most new industrial development in the oil and gas sector is financed by private capital, with the government of Trinidad and Tobago having equity stake in some key industries or providing the necessary infrastructure for the developments. Diversification of the oil and gas downstream industry is a prerogative of the government, and it is now attempting to enter the aluminium smelting industry, using inexpensive natural gas to provide the vast energy needs for aluminium smelting. This paper examines the case of investment appraisal for a small island economy with reference to aluminium smelting and the possible environmental impacts of this industrial process in a densely populated island.

2 Proposed aluminium smelters

The government of Trinidad and Tobago has signalled its intention to facilitate the construction of two aluminium smelters in Trinidad. The first smelter if built, will be located at the Union industrial estate, and will have a capacity of 125,000 mt per year.

The second smelter, will be built at a new proposed industrial estate, located in Chatham/Cap-de-Ville on the south-west peninsular of Trinidad and Tobago and will produce 240,000 mt per year of aluminium products per year.

3 Investment Appraisal of an aluminium smelter in Trinidad and Tobago

Trinidad and Tobago is considered a developing country and therefore its government welcomes investment that should add to the country’s national income. However, the country is at a stage in its gas monetisation to start implementing proper investment appraisal of new projects to ascertain the true costs and benefits to the economy. This investment appraisal should account for all costs including environmental, social and opportunity costs of the project as well as the true benefits. Where as before the country was at a stage along its development path to ignore all the costs of similar projects in the name of development, now with greater affluence, knowledge and capacity constraints it is becoming imperative for the government to analyse projects in totality. This section therefore tries to ascertain the possible positive and negative impacts of an aluminium smelter in a small island developing state. However, it should be noted that monetary estimates of the impacts have not been included in this paper, although possible valuation techniques to estimates these impacts are alluded to later in the paper.

What therefore should be included in an analysis of an aluminium plant in a country like Trinidad and Tobago? To answer this question it is therefore important to review all the possible impacts and then try to choose which impacts are important for a country like Trinidad and Tobago at its current stage of development.

4 Activities and possible impacts

Two aluminium smelters are proposed for Trinidad and Tobago. For this paper, the proposed smelter to be built in Chatham/Cap-de-Ville on the south-west peninsula of Trinidad will be analysed.

4.1 Activities

Many of the possible impacts are related to the activities associated with the construction and operation of the smelter.

While it is envisioned that the aluminium smelter will be built within an industrial estate, there will however be several construction activities associated with the smelter. These include:

- clearing and grading of required construction land (200 hectares)
- piling to ensure soil stability;
- casting of foundations;
- construction of drainage and retention pond;
- construction of infrastructure;
- construction of smelting facilities;
- construction of associated ancillary systems (cooling towers, anode plant and casting house);
- construction of a power plant;
- construction of sewage treatment plant;
- construction of administration buildings and parking facilities.

Where the Cap-de-Ville smelter will be located a new port will also have to be established, and this will require several activities:

- land stabilisation along the coast;
- land reclamation;

- dredging of approach channel;
- construction of port facilities;
- construction of fuel storage tanks; and
- construction of administration buildings and parking facilities.

The proposed smelter is expected to produce 240,000 metric tonnes (mt) of billet and forge stock per year. To produce the expected output, the smelter will require 341,000 mt of alumina per year. The proposed operator and builder, ALCOA, will source the alumina from its other existing alumina facilities. Table 1 shows the materials and quantities required for the smelting process.

Table 1: Materials and quantities required for smelting process.

Process Material	MT per day
Alumina	1,868
Calcined Pet Coke	10,274
Pitch	1,500
Aluminium Fluorides	255

Source: Certificate of Environmental Clearance (CEC) application, Alcoa Inc.

4.2 Possible adverse impacts

There are possible adverse impacts related to each of the activities highlighted above during construction and operation of the smelter.

4.2.1 Environmental and health impacts

It is possible that during the construction and operation of the proposed smelter that there will be negative environmental impacts. During construction, several environmental impacts are possible including reduced air quality from construction vehicle emissions, loss of wild life, loss of plant life and soil contamination. The environmental impacts during operation will also range from air quality impacts, noise impacts and ecological impacts. Details on the possible quantities of emissions or ecological losses are difficult to ascertain. However, Table 2 gives the type and sources of air pollution that may be emitted during the operational phase of the smelter.

There are possible health impacts associated with the operation of aluminium smelters. The extent of the health impacts will however depend on the concentrations of the emissions. It is possible that there will be short and long term impacts. The proposed site for the smelter is a major aquifer that supplies water for the south west peninsular of Trinidad. It is possible that water discharges from the smelter can be a major source of pollution for the aquifer. Climatic conditions also mean that run-off from the smelter might be high during the rainy season from June to December of each year.

Table 2: Type and sources of air pollution that may be emitted during the operational phase of the smelter (Kg/MT unless otherwise stated).

Parameter Source	Total Flourides	SO2	POM	PAH	PM10	PFC as CO_2	CO_2	NOx
Pot Room emissions	0.35kg/MT Al	25.2kg/ MT Al	N/A	0.52kg/MT Al	0.12kg /MT Al	183kg/ MT Al	1660 kg/ MT Al	.106kg/MT Al
Anode baking furnace	0.01	2.59	0.09	N/A	0.005 grains/ dscf	N/A	430 *	0.018
Anode production dry coke scrubber	N/A	N/A	0.01	N/A	0.03	N/A	N/A	N/A
Cast House	N/A	0.028 kg/MM scf natural gas	N/A	N/A	0.03	N/A	353	25.3 Kg/MM scf/natural gas
Material Handling dust collectors	0.005 grains/dscf	N/A	N/A	N/A	0.005 grains/ dscf	N/A	N/A	N/A

Source: Certificate of Environmental Clearance (CEC) application, Alcoa Inc.
*Baked Carbon.

4.2.2 Social Impacts

Where the aluminium smelter's proposed site will be; in the vicinity of the communities of Chatham, Cap-de-Ville and Cedros, these communities have already expressed concerns about expected emissions from the proposed smelter. The communities are generally against the building and operation of such a plant. Discontent over the proposed smelter is not only limited to local residents. A recent newspaper survey also identified that a majority of the Trinidad and Tobago population are also against the construction of the smelter (Trinidad Guardian ICM Poll).

The proposed site also currently has several residential buildings. Therefore, families will have to be relocated to allow construction of the industrial estate. Where the port is proposed, there is currently a beach that is used for recreation and religious activities. If the port is established these activities will have to cease.

The village of Cedros and most other communities along the south-west peninsular of Trinidad are primarily fishing communities. The construction and operation of the proposed port will restrict access to fishing grounds, which might have an impact on the traditional livelihood of these communities.

4.2.3 Impacts that impose opportunity costs

A possible major cost of the proposed aluminium smelter is the opportunity cost of natural gas that will be used to power the smelter. The most recent estimate of natural gas reserves to production ratio (r/p) of Trinidad and Tobago is 19 years [6]. The gas required to power the plant could reduce the r/p ratio significantly.

Natural gas is required to produce electricity for the proposed aluminium smelter's electrolysis process. It is proposed that a 580 MW power plant be constructed for the smelter. It is estimated that approximately 1.4 million m^3 of natural gas per day would be required to fuel the power plant. In 2005, the US price of natural gas was is approximately US$8.79 per million Btu. However, the government of Trinidad and Tobago has promised that there will be a subsidised cost of gas for the aluminium smelter. Details of the extent of the subsidy are unknown. The opportunity cost of gas going to power the smelter should also be included in the cost of the project. This opportunity cost should include the lost values had the gas been sold at market prices or at its highest value as well as the reduction in r/p or user costs that will result from construction and operation of the plant.

It is therefore possible that the proposed aluminium smelter could result in lost natural gas royalties and rents for the government of Trinidad and Tobago. While some of these lost rents might be recovered through other revenues, such as taxes from the smelter, these lost rents or opportunity costs should be included in any proper invest appraisal of the project.

Calculating user costs for energy resources such as oil and gas are generally found by solving the equations that refer to the depletion of the country's reserves and the cost of new technology needed to satisfy the nation's energy demand once those reserves are exhausted. However, since Trinidad and Tobago is an open economy, Trinidad and Tobago's oil and gas reserves are not only used for local energy demand but more importantly are also used for foreign exchange earnings. Given the open nature of Trinidad and Tobago's economy, the economy would not prosper without these foreign exchange earnings. These lost or foregone foreign exchange earnings are not only the lost earnings from hydrocarbon products, but from potentially higher value added industries (e.g. information technology), for which there will be no locally supplied oil ad gas energy. This is the true opportunity cost of not having the resource for use later on.

Future economic value or as is conventionally called the back stop technology should include a factor for the opportunity cost of a depleted resource. To determine the true user cost of depleting oil and gas in Trinidad and Tobago.

$$MUC = P^T{}_B - MC^T{}_G/(1+r)^T \tag{1}$$

where:
MUC = marginal user cost
$MC^T{}_G$ = marginal production cost of gas in year T
r = discount rate
$P^T{}_B$ = price of 'backstop technology' which substitutes for existing gas or oil in year T

Since this paper only attempts to provide a qualitative argument about what should be included in an investment appraisal for a small island state, no user costs have been estimated for the proposed aluminium smelter. However, Ram [5] estimated the user cost of gas used in a liquefied natural gas train in Trinidad and Tobago and found that the user costs of this facility ranged from US$ 0.35 to 0.61 /mmbtu.

Included in opportunity costs are the damage costs associated with green house gas (GHG) emissions such as CO_2. Trinidad and Tobago is a small island state and a relatively small emitter of GHGs. However, small island states are most vulnerable to the damage costs associated with global warming. Apportioned damage/opportunity development costs from GHG emissions should be attributed to the smelter. Thus since global warming might provide unique development challenges for small island states, the damage costs associated with the plant (which may be small) should be included as opportunity costs.

5 Benefits of the project

In financial terms the main benefits of the proposed aluminium smelter are employment, government tax revenues, and possible local content for the construction and operation of the plant. This paper does not attempt to quantify any of the costs and benefits of the smelter in financial terms but rather tries to provide a qualitative justification for what items should be included in an investment appraisal of an aluminium smelter in Trinidad and Tobago; a small island developing state.

6 Those impacts that should be included in a proper appraisal

The above sections have shown that there are many possible negative impacts from constructing and aluminium smelter. There are however, possible financial benefits for a small country like Trinidad and Tobago.

It was argued above, that Trinidad and Tobago is well advanced in the monetisation of its natural gas reserves. Natural gas industries are well developed in Trinidad and Tobago. Incomes have been rising and knowledge of negative impacts associated with natural gas industries have also been growing in Trinidad and Tobago. It might therefore be reasonable to assume that some negative impacts of such industrialisation that were ignored early in development should now be included in appraisal analysis. However, Trinidad and Tobago is not a developed country and a significant percentage of the population still lives below the poverty line. According to the United Nations Development Programme (UNDP), 39% of the population lived on below US$2 per day during the period 1990 – 2003. Given these obvious constraints, what impacts are important to balance the economic, social and ecological priorities for a small island state? Investment appraisal in Trinidad and Tobago must acknowledge the current state of development of and the possible natural gas user costs, associated with any new industrial project. Economic/environmental investment appraisal for a small island state must balance current and future economic growth. This will depend on the future vision for the economy and the possibility to maintain the environment of the islands for possible future economic activities and generations.

Possible impacts to be included are listed in the following categories:

- Population Impacts
- Impacts that impose opportunity costs
- Impacts that hinder sustainable development

6.1 Population impacts

Impacts that might have negative consequences for populations within the vicinity of the project should be included in the investment appraisal. These will include air emissions surface and ground water contamination that might have negative health impacts for the population. In a conventional investment appraisal, the impacts should be confined to the residents within the vicinity of the project. However, since Trinidad and Tobago is a small densely populated state it is possible that impacts could affect large portions of the population because of proximity e.g. if water drawn from an aquifer close to the proposed smelter is used to supply water to communities in other parts of the country. If this water is contaminated the impacts will stretch beyond the immediate vicinity of the plant. This scenario is possible in a small island state because of small land mass. It is therefore proposed that concentric circles are drawn on a map surrounding the proposed plant. Each circle with radii increasing as we move away from the plant represents populations living at increasing equal distances from the project. Possible impacts and their affect on populations within each circle should therefore be mapped. Depending on the possible impacts and proportion of population affected these impacts should be included in an investment appraisal. Therefore contamination of a fishery near to the plant which supplies fish to populations living as far as 100 km away should be included in the analysis. The impacts should not only be confined to livelihoods of nearby fisher-folk, but also include values for lost consumer surplus of far away populations. It might also be possible to weight the impacts as they become more removed from the vicinity of the proposed project.

6.2 Impacts that impose opportunity costs

Trinidad and Tobago is a unique case, in that it has been monetizing its gas reserves for three decades. Its reserve to production ratio has been declining and without significant new discoveries of natural gas any new project will reduce the r/p ratio further and impose opportunity and user costs on the population. New projects will therefore impose user costs that projects in the early stages of gas development would not have imposed because of the higher r/p ratios then. Natural gas user costs as discussed above should therefore be included in the analysis to determine the true costs of the project.

6.3 Impacts that hinder sustainable development

The impacts of this category are related to opportunity costs and focus on what future development, social and environmental costs are being imposed by the current period project. We should therefore always ask the following question: will these impacts hinder the opportunities of future development and generations? If the answer is yes then the impact should be included. For example if the project will cause negative environmental impacts that will limit future ecological use values or possible new industries reliant on ecosystem survival such as eco-tourism then these impacts should be included even if the costs are deemed minimal for current generations. Thus if the felling of trees in a relatively unused forest is needed for the project, the costs of this should not be limited to current use values but also to the “sustainable development costs” for future generations. This is an important criterion for a small island state like Trinidad and Tobago where the opportunities for development can be limited by space and population parameters. Due to space limitations any development that has negative impacts and might hinder possible future developments because of negative environmental or health impacts should be carefully scrutinised.

6.4 Valuing impacts

This paper has not attempted to place values on the possible impacts of the project. However, once impacts to be included have been chosen based on the categories set out above values should be placed on the impacts to get benefit cost ratios associated with the project. Each valuation technique such as contingent valuation or travel cost has its merits, but can be costly. One possible technique that might be easier to administer is an estimate of damage costs of the possible impacts. However, this technique would need to have a future component, which would allow valuing impacts that might have sustainable development implications.

7 Conclusion

Independent investment appraisal in small island developing state must account for many costs that might be ignored in larger countries because population density is higher and other industries and livelihoods are likely to be impacted upon, due to proximity effects. Appraising the construction of an aluminium smelter in a small island state means that many costs must be included but these must be balanced with the need for government revenues and development objectives, which the construction of an aluminium smelter might help alleviate. Social impacts and environmental impacts should be included based on population and livelihood impacts. However, valuation techniques tailored for small island states should be devised to help accurately quantify the impacts. Opportunity costs should also be included as these could represent a significant proportion of costs.

References

[1] Dasgupta, A. and Pearce, D. (1972) Cost-Benefit Analysis: Theory and Practice, Basingstoke: Macmillan.

[2] El Serafy, S. and Lutzs, E. (1989), ‘Environmental and Natural Resource Accounting’ in Schramm, G. and Warford, J.J. (Eds) Environmental

Management and Economic Development, Washington: John Hopkins University Press.
[3] Julius, DeAnne and Mashayeki, A. (1990) The Economics of Natural Gas: Pricing Planning and |Policy, OUP.
[4] Pearce D., (1985), Trinidad and Tobago Energy Assessment – Natural Gas pricing, Report to Energy Department, World Bank.
[5] Ram J. (2005), Rates of Return: Can Natural Resources Sustain Wealth? In *A Reader in Caribbean Economy* edited by Dennis Pantin, Ian Randle publishers.
[6] BP, Statistical Review 2006.