INTERFUEL COMPETITION MODEL FOR ELECTRICITY GENERATION IN VENEZUELA

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BACKGROUND

Electric Power Generation in Venezuela has become an important aspect of the national electricity system. Due to the high availability and variety of primary energy sources in Venezuela, the decision on the fuel used to generate electricity has to be accompanied by a technical and economic feasibility study that help to select the most suitable option.

Competition among fuels for electricity generation depends on the type of market in which are the fuels related. Markets vary depending on the final use of fuel, maturity, technological advances, prices of alternative fuels and the differential price between the domestic market and export.

It is envisaged that the growth of electricity generation capacity in the country will be based on thermal energy production, as the hydroelectric sector is limited and makes it difficult to increase capacity in this way. That is why the importance of having tools to conduct prospective studies in the field of electricity generation.

PDVSA Intevep has developed a model of interfuel competition in order to study the economic competitiveness of different fuels used in electricity generation and thus be able to support the strategies of energy policies and the rational use of the fuels.

AIMS

Main objective of this study is to show a model that allows determining the suitability of using a type of fossil fuel substitute for other, in those thermoelectric generating plants being planned across the country.

The specifics objects are:

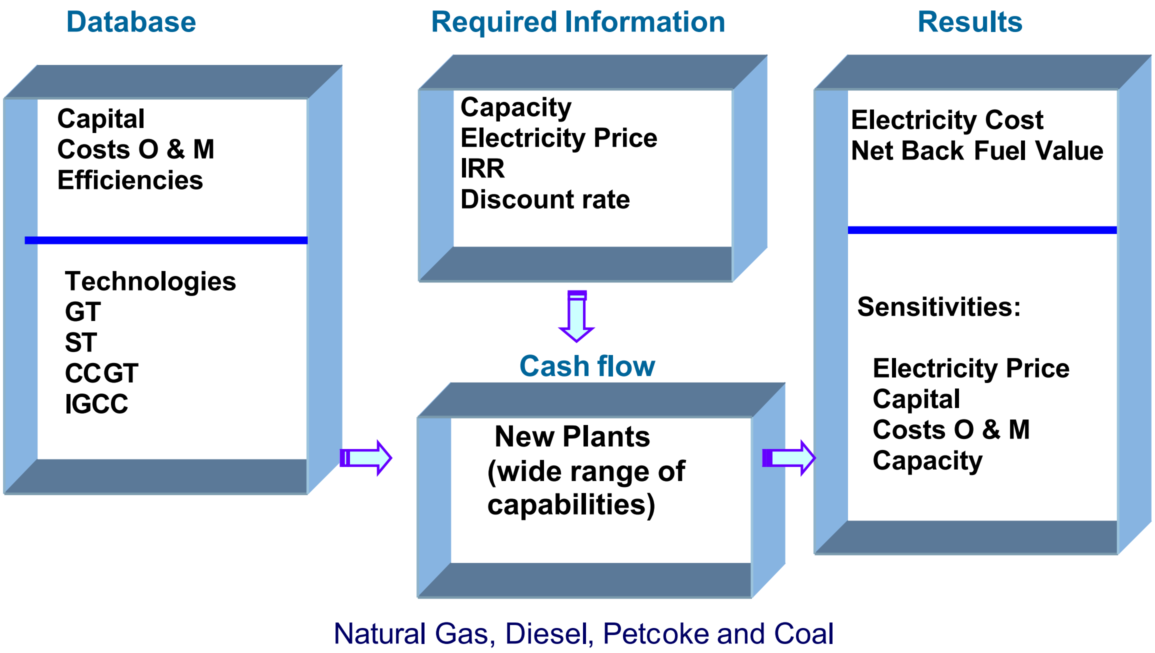
- Determine the cost of generation expressed in USD mils $/kWh, for the different scales of generation, technologies and fuels used.
- Evaluation of different technologies, scales and fuel power generation purposes.
- Determine the range of cost of electricity generation considering different fuels and technologies.
- Perform sensitivity to economic parameters such as investment, O & M costs related to the fuel cost.

METHODS

The model was developed using a spreadsheet program and performs the economic evaluation of generation projects based on different types of plants and fuels: Simple Cycle Gas/Diesel Turbine (GT), Steam Turbine (ST) using gasoil, coal or petcoke, Combined Cycle Gas Turbines (CCGT), Combined Cycle Integrated Gasification (IGCC) of coal and petcoke.

The model is designed to conduct assessments of thermo-electric plants of 200, 300 and 500 MW. Also, it was verified that the investment and operating cost include the emission control systems evaluated for each scheme. The model has an updated database up to 2010 consisting of investment, operation and maintenance cost and efficiencies, among others.

The fuels used are natural gas, diesel, coal and petcoke.



Source: González (2001, Amended page.12)

Figure 1 Calculation model developed

ECONOMIC BASES

The economic assumptions used in the study are the following:

- Base year of study: 2010
- Location: Venezuela
- Currency: USD
- Capital and maintenance cost: The amount of investment for each capacity.
- CAPEX and OPEX values are updated for year 2010.

- Thermal Efficiency: The thermal efficiency values for cycles GT, CCGT, ST and IGCC were determined based on information available at Kehlhof et al (1999).
- Utilization factor: 0.85.
- Location factor Venezuela / U SCG: 1.3
- Cash flow in constant currency terms
- Internal Rate of Return (IRR): 15%
- Discount rate: 10%

RESULTS

The model can plot the cost of generating electricity in mils USD$/kWh and fuel cost in USD$/MMBtu for the different technologies options considering an internal rate of return of 15%, using mathematics correlations for each technology. The result is called Interfuel Competition Map. The plot can be done for differents capacities.

To illustrate the use and calculation capabilities of the model, some examples are shown. Considering an internal rate of return of 15%, utilization factor of 85% to generate 500 MW of power, the chart of electricity cost in milsUSD/kWh against fuel cost in USD/MMBtu for the different options of electricity generation, is obtained as shown in Figure 1.

The follow plots shows that generation cycles operating with natural gas offer the lowest cost of electricity using gas turbine, followed by combined cycle gas turbine and generation using coal and petcoke.

The Figure 2 shows that the best technology of generation is using Gas Turbine considering the electricity price until 40 mils USD/KWh, the cost structure of this technology is the most suitable for this prices range.

The technologies CCGT (Combine Cycle Gas Turbine) and Gas Turbine are the best option to produce electricity for the range between 40 to 100 milsUSD/kWh. Moreover, the break even point is achieved when the fuel cost is around 7 USD/MMBtu, the point where the total revenue is sufficient to cover the total cost of the electricity.

In the case of technologies such as Steam Coke Turbine, Steam Gas Turbine and IGCC (Integrate Gasification Combine Cycle), the price of the electricity is between 100 and 180 milsUSD/kWh due to the cost structure of this technology mainly the high investment cost. The electricity price must be high to obtain profitability with these generation options.

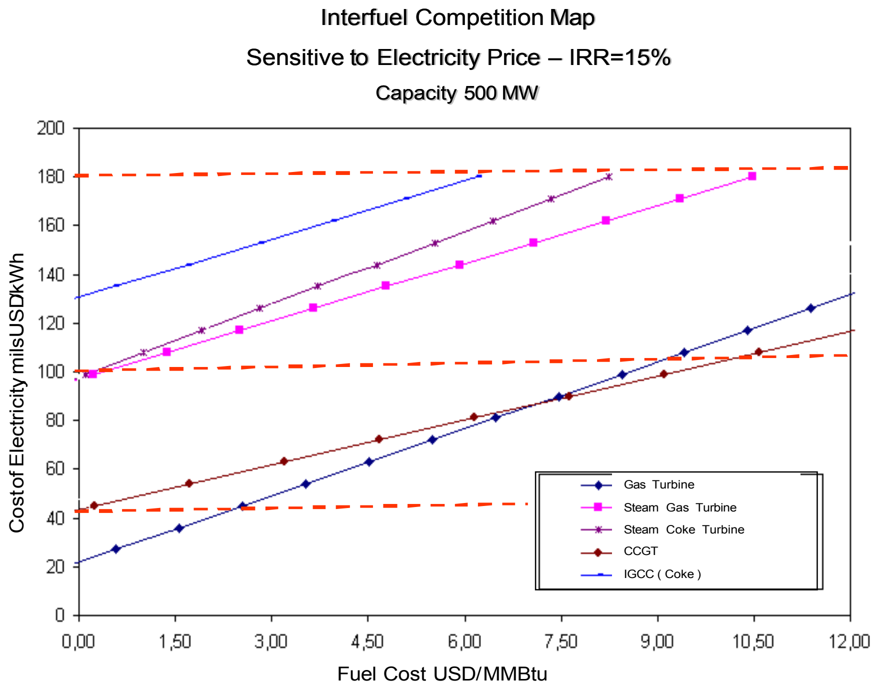


Figure 2 Inter Fuel Competition Map

Considering the case of Venezuelan electricity price of 30 milsUSD/kWh and all the economics basis, the minimum fuel price (Natural Gas) using gas turbine should be around 0,7 USD/MMBtu to obtain profitability in the project, as is show in the Figure 3.

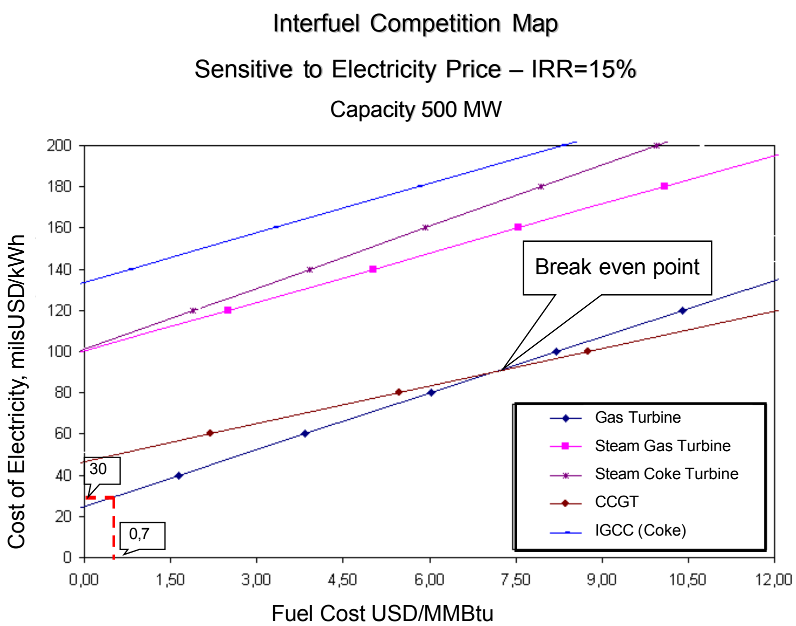


Figure 3 Inter Fuel Competition Map and Break Even Point

The sensitivity to the investment and O&M costs are also calculated (see Figure 4 and 5). In this case (Venezuelan electricity price) neither investment nor O&M costs are profitable for any technology different than Gas Turbine in a range of fuel net back from 0 to 3 USD/MMBtu.

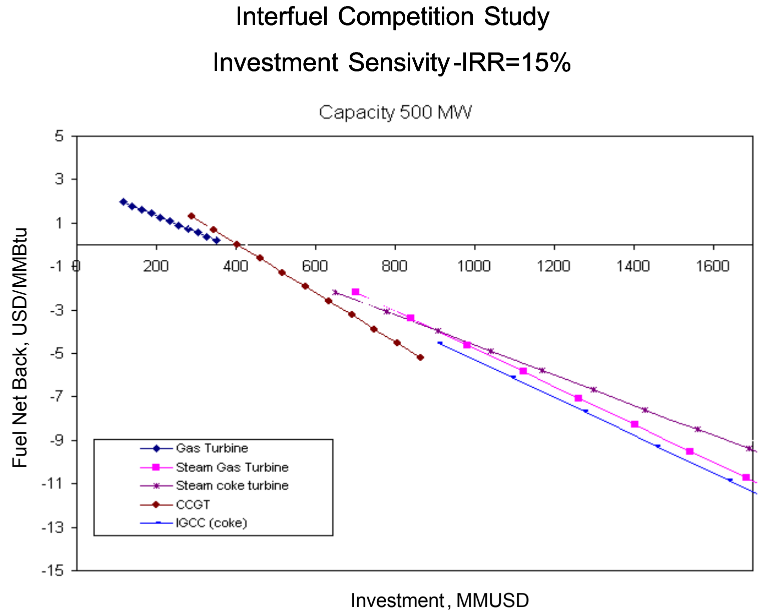


Figure 4 Plot of fuel Net Back (USD/ MMBtu) vs investment cost (MMUSD)

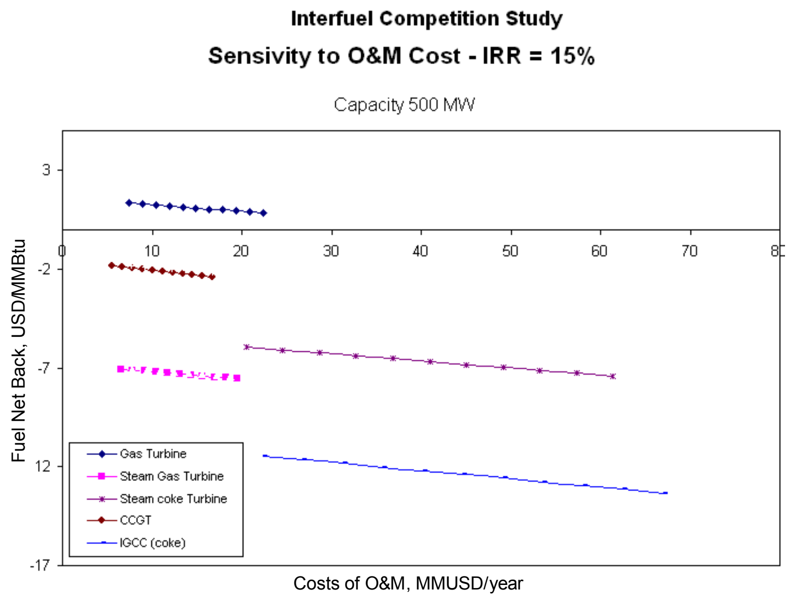


Figure 5 Plot of fuel Net Back USD/MMBtu for O & M cost MMUSD

SUMMARY

Venezuela has a huge available energy resources, the current proven reserves are 195 TCF of natural gas, and 296.500 MMMBP of oil and 1657 MMTM of coal. The use of different fuels should be considered in power generation. This will allow the definition and establishment of energy policies to meet domestic demand for electricity and the rational use of resources according to the energy demand. This will depend on the natural competition and fuel price differentials between the domestic and export prices.

In this sense, it has been developed a model to determine the competition of fuel for thermal power generation plant. The model involves different technological options for electricity generation and can determine the fuel net back value based on power generation price. It also generates parametric analysis to determine the sensitivity on the investment and O&M cost. Taking in account the economics bases that could be applied.

The application of the model was illustrated with an example considering an internal rate of return of 15%, utilization factor of 85% and electricity price of 30 milsUSD/KWh to generate 500 MW of power, resulting GT tech using natural gas as the best cost-efective option.

CONCLUSION

The devised model allowed the determination, for the Venezuelan case, that the current cost of electricity (30 milsUSD/KWh) is achieved if natural gas in GT for 500 MW is used. Others option of electricity generation such as CCGT (natural gas), ST (petcoke), ST (coal) and IGCC using petcoke/coal will increase the electricity price mainly due to the investment costs on these technologies. Additionally, this tool performs sensitivity studies with respect to Net Back value of the cost of fuel for capital and O&M cost for each generation scheme proposed.