Alternatives of Financing for New Nuclear Reactors in Mexico

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Abstract. Nuclear power deployment requires an extensive capital investment that in many cases prevents the addition of new units for single private companies. The deployment of a single unit of 1000 MWe with the current economical cost requires around 5 billion US dollars assuming no delays or unforeseen problems. In Mexico the electricity is produced by the government utility "Comision Federal de Electridad" with 47 GWe of installed capacity thereby it can afford this kind of investment. Here we assess two financing scenarios for deployment of a single nuclear reactor unit, in the first one the utility will use their own resources and in the second the nuclear power plant will be built using international and national credits, comparisons of these two scenarios are presented.

1. INTRODUCTION

In Mexico, the electric power sector remains largely under state control, due to some changes to Mexico´s Electricity Law[1] now the Private companies (PIE´S) are allowed to generate electricity for areas not considered "public service." They include generating electricity for export and generating electricity for public service during an emergency. Self- or co-generators and small producers may generate electricity for their own use, and independent power producers are permitted to sell excess power to the Federal Electricity Commission (CFE) under long term contracts. However Nuclear Power generation remains under state control.

At any rate any new nuclear power deployment will be done by the government trough CFE therefore it is necessary to assess the investment cost of any new power plant and the scenarios that could be considered to finance this deployment.

New reactors designs have incorporated the recent technology developments to reduce the amount of equipment inside the reactor building. Along with that, new more efficient construction techniques have produce a cost reduction for building new nuclear plants.

The new modularization techniques for construction allow many construction activities to proceed in parallel. This technique reduces the plant construction calendar time, which saves the interest during construction cost and reduces the risks associated with plant financing.

The so called Generation III reactors are the most recent reactor development, it includes two types of reactor, those that are an evolution of their predecessors, like the Advance Boiling Water Reactor (ABWR) from General Electric, the European Pressurized Reactor (EPR) from AREVA and the Advance CANDU Reactor 1000 (ACR1000) from AECL.

The second class correspond to the ones that use passive safety systems, among these are the Advance Pressurized 1000 (AP1000) from Westinghouse and the Economical Simplified Boiling Water Reactor (ESBWR) from General Electric.

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As an example of the new construction techniques, the recent ABWR in Japan (Shika 2) took less than 5 years from first concrete to commercial operation proving that it is possible to build new generation reactors in a timely schedule. Here we will assume that the reactor will be build according to schedule and no delay will be considered.

2. INVESTMENT COST

Currently, AREVA, AECL, General Electric and Westinghouse have claimed in public documents that the overnight-cost for nuclear kW can be between 2500 and 3500 US dollars [1]. The output power for the so-called Generation III reactors is between 1100 and 1600 MW, therefore we will use a medium value of 1350 MW as guiding parameter to evaluate the nuclear option. The maintenance and operation costs used here will be the ones reported by the OECD [3]. Table I shows all the characteristics of the Electricity nuclear power generating system considered.

Table 1. General characteristics of the nuclear power plant

Lifetime (years)	Capacity Factor (%)	Power Output (MW)	Construction Time (years)	Overnight Cost (US$/kW)	Fuel Cost US$/MWh	O&M Cost US$/MWh
40	90	1350	5	2500-3500	6.80	7.83

Table 2 shows the levelized cost for the assumptions given in Table I along with the respective total investment in present worth money, assuming a 5%, 8% and 10% discount rate. The total investment includes the interest generated during construction. From here, it can be seen that for the more expensive case (with an overnight cost of 3500 US$/kW) and a discount rate of 10% the investment cost is around 4716 US$/kW in present worth (US$ at July 2008) and the levelized generating cost will be 72.34 US$/MWh.

Table 2. Levelized electricity generating cost

	Levelized Cost US$/MWh			Investment Cost US$ Millions			Investment no interest US$ Millions
Discount Rate	5%	8%	10%	5%	8%	10%	
Overnight Cost US$/kW							
2500	36.63	47.98	55.95	4028.57	4334.59	4547.82	3375
3000	40.97	54.57	64.14	4834.28	5201.51	5457.39	4050
3500	45.31	61.17	72.34	5639.99	6068.43	6366.95	4725

3. FINANCING ASPECTS

There are not official plans to build new Nuclear Power Plants (NPPs) in Mexico; however studies about de economical feasibility of nuclear reactor of Generation III are taking place since 2003. In Mexico, there is not competition into electricity markets, the selling of the electricity to all users have to be through the government utility CFE, which determine the sell price for all kind of consumers. The electricity generation is primarily a government-sector business.

Financing plays a very important role for the deployment of new nuclear reactors units in any country and Mexico is not the exception. According to Mexican Constitution in the 25, 27 and 28 articles the public sector will have in an exclusive way the construction of new NPP, which have to be financing with a 100% Government's budget. This will be made through CFE.

To request the resources CFE, in accordance with the article 4th and 9th of the Law of the Public Service of Electricity (Ley del Servicio Público de Energía Eléctrica, LSPEE), performs annually the planning for the following 10 years, in order to assure the service of electricity with the minimal global cost. The planning is made identifying the options for expansion of the generation systems and transmission that allow satisfying the future demand of electricity at a suitable level of reliability and quality.

The Program of Works and Investment of the Electrical Sector (Programa de Obras e Inversiones del Sector Eléctrico, POISE) is the result of a process of planning that includes the necessary programs of work for generation, transmission and distribution, to satisfy the growth of consumption and demand of electricity, as well as the corresponding investment programs.

The projects that are selected for the expansion program are those that minimize the sum of the costs of investment and operation during the period of planning. These studies are made based in the technical and economic analysis of several alternatives using mathematical models for simulation and optimization.

The CFE incorporates the projects identified in the previous steps, into a projects briefcase to be constructed including the approximate totals of investment and the construction programs. CFE sends the project briefcase to the Secretary of Energy (Secretaría de Energía, SENER) for his review. Once SENER approves them, sends the projects to the Secretary of Treasury and Public Credit (SHCP) for his authorization.

In case the report of SENER and SHCP is favorable, the resources needed by the recognized projects are included in the Government´s Budget (Presupuesto de Egresos de la Federación, PEF) and sent to the Congress. If the Congress approves the budget assigned for each of the projects that appear in the PEF, it authorizes the SHCP to include them in the budget. The SHCP sends the authorization and program the schedule of the resources of the projects to the SENER and this one to CFE.

Two financing alternatives can be used to support such project: the first one is that the utility provide from its own resources the capital for the investment; and the second one through international and national credits to support the nuclear project.

To be a loan candidate the viability of the nuclear project must be demonstrated, it implies among other things to have a qualified national infrastructure. Also, the utility must have an international credit record in good status by the international qualifying companies.

In February 2002, Standard and Poor's granted the “Investment Grade” to Mexico with a qualification of BBB. In March 2000, Moody's granted the “Investment Grade” to Mexico (Baa). In January 2002, Fitch-IBCA granted the “Investment Grade” to Mexico (BBB).

The financial agencies give a credit qualification that serves as reference to the decisions of saving and/or investment on a global scale. What the agencies qualify is the capacity and the desire of an issuer of sovereign debt to pay the loans of a periodic way (principal and interest). When a sovereign debt receives the “Investment Grade” it means that the agency does not have doubt that the country in question will pay his debt commitments.

The “Investment Grade” was granted to the sovereign debt of Mexico, owed principally to the parameters of liquidity and payment capacity that the Mexican government has showed in the previous years.
CFE has a favorable credit record on the financial local market, since the commercial banking has granted loans in several occasions and under favorable conditions and in 2003 issued bonds in the Mexican Stock Exchange (BMV) with excellent results. In the “Report of Works of CFE, June 2006-May 2007 ” it is mentioned that the company hired loans for long term (10 to 30 years) with the

following banks: IXE Banco S.A., BBVA Bancomer S.A., HSBC México, S.A., Instituto de Crédito Oficial de España (ICO). Also issue a bond for 30 years maturity in the international markets with Goldman and Sachs.

In the international financial markets CFE had credit lines with the following banks: Societé Génerále, Santander Central Hispano, BNP Paribas (Suiza), BBVA, S.A. MILAN BRANCH, Japan Bank for International Cooperation (JBIC).

CFE has a good relation with the financial markets (local and international), every time it has fulfilled his financial obligations in time and form, so the possibilities of obtaining new financing would be high, therefore exist the possibility to build new nuclear reactors in Mexico. Here we will assess both alternatives to deploy new nuclear power plant: by getting financing or by using its own resources.

4. DEPLOYMENT BY USING THEIR OWN RESOURCES

In this case CFE will provide, after getting the corresponding approval, the total amount of the resources to build the new nuclear power plant. Here the opportunity cost of the money will be of an 8%.

Using the data from Table II, the total investment without interest to deploy 1350 MWe of nuclear power is shown there. By including the cost of opportunity and using the investment curve [4] the total investment will be for each overnight cost considered the ones given for an 8% discount rate.

The annual expending from the nuclear power plant will be 259,978,797.00 US$. This amount is composed as follows: 96,192,154.00 are fuel, 115,274,598.00 are O&M and 48,512,045.00 will be used for a special dismantling fund and the backend of the fuel cycle. This annual expending is in present worth and will last for the whole lifetime of the power plant, 40 years.

This power plant will produce 10,359.92 MWh per year, assuming the cheapest average cost in Mexico of the electricity selling to be 87.07 US$/kWh, then there will be an income of 902,082,817.00 US$.

Construction will last the first five years. In this time there will be only expending given by the investment program. After that there will be income by the selling of electricity and expending by nuclear power operation activities that comprise O&M and fuel.

From the previous amounts and the nuclear power plant building investment schedule the Figure 1 can be done to show the operative cumulative cash flow that this type of project will produce, the operative cash flow will be 642,104,020.00 US$ per year starting in year 1 for the whole life of the power plant. As can be seen in Figure 1 the investment is recovered between 7 and 10 years depending on the overnight cost that was considered.

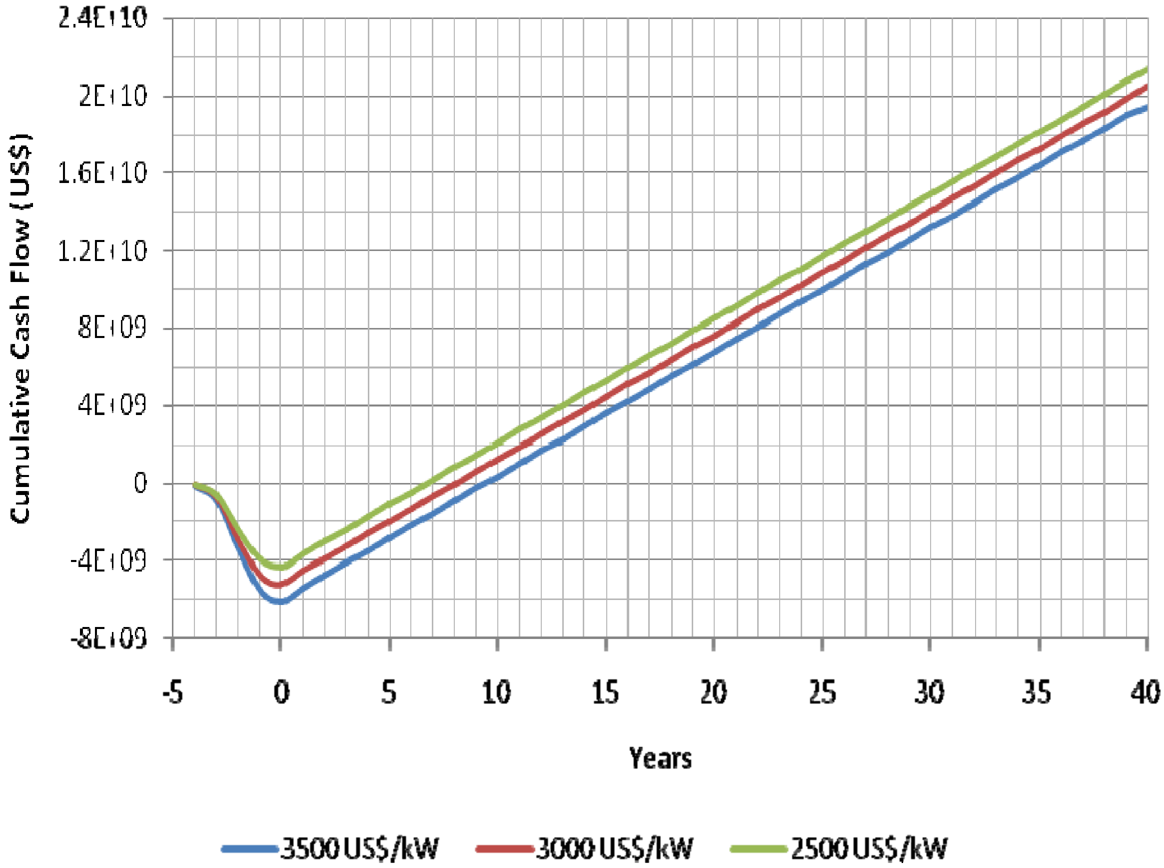

Fig. 1. Cumulative cash flow for an own resources deployment for different overnight cost

5. DEPLOYMENT BY USING CREDIT RESOURCES

For this alternative, there will be two sources of financing, one from international credit institutions that will contribute with an 85% of the lump sum and the second will be a national credit institution that will afford the other 15%. Discount rates considered in this case are as follows: for the international credit according to the global market is 8%, and for the national credit a 12% discount rate is used.

In this case the national scheme used is one called Financing Public Infrastructure (in Spanish Obra Pública Financiada), where the national credit institutions will support the civil works and the international credit institutions will support the Nuclear and generator islands.

Under this scheme the credit institutions or the reactor vendors through the credit support will finance the nuclear power plant construction up to be in commercial operation. In that moment the utility will start to pay the credit according to the payment schedule.

The main international credit assumptions are:

- Payment credit period: 15 years.
- 30 payments, each one every 6 months (does not include any payment during construction).
- Grace period: 6 months after commercial operation.
- Annual discount rate in dollars: 8%.

The main national credit assumptions are:

- Payment credit period: 5 years.

- 10 payments, each one every 6 months (does not include any payment during construction).
- First payment: at start up of comercial operation.
- Discount rate in dollars: 12%.

Using again the information about the expending and income and the payment of the loans, international and international, the cumulative cash flow can be calculate, which is shown in Figure 2. It considers the three different overnight cost used in this study.

To have a positive cash flow is mandatory to the approval of a project under this financing scheme. It is achieved for the 2500 US$/kW and 3000 US$/kW overnight costs considered in this study. Therefore under this two overnight cost scenarios the nuclear power plant deployment will be feasible.

For the 3500 US$/kW overnight cost there is a small negative cash flow (15,009,082.00 US$ per year) during the first five years, after that time the national debt is already paid and the cash flow start to be positive. Although, it still can be a suitable candidate but could be subject to other constraints.

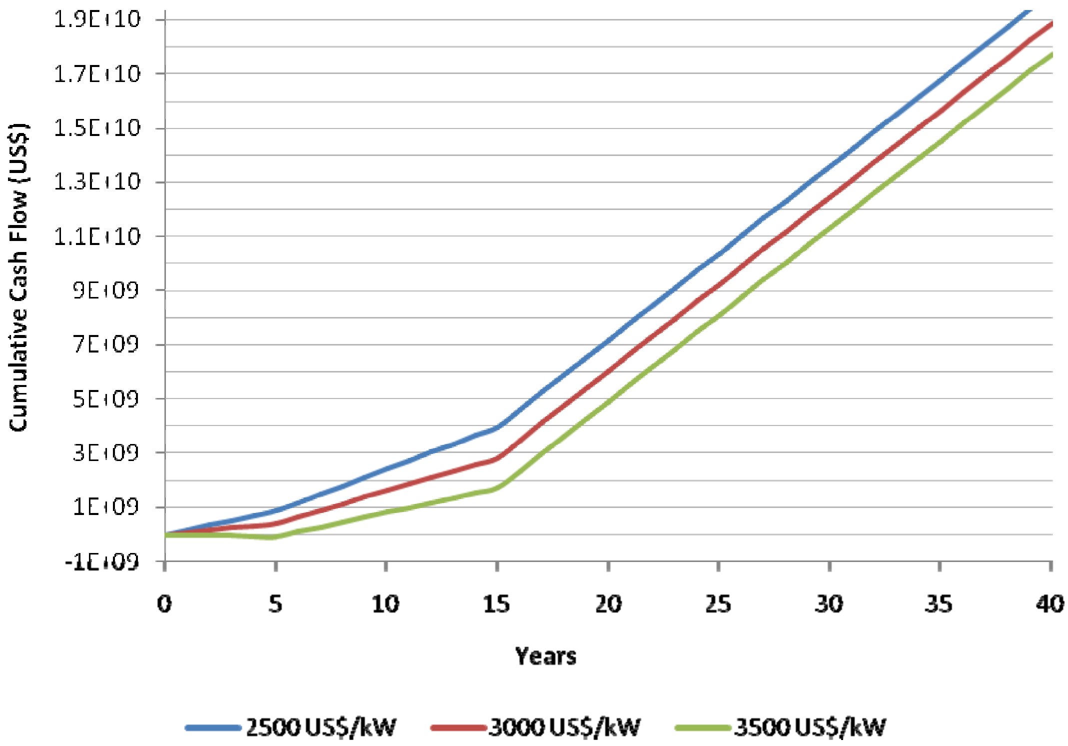

Fig. 2. Cumulative cash flow from credit resources for different overnight cost

4. DISCUSSION

A diversification strategy can give greater protection against the volatility prices of primary fuels. It also eliminates the international dependence to only one natural gas provider among other benefits.

In Mexico several studies already consider nuclear energy an option to be considered as part of the electricity expansion, it makes a viable option from several different points of views. It can help to reduce or mitigate carbon emissions helping to alleviate climate change and also is already a competitive economical option in the long run.

Laguna Verde already has proven the adequate use of nuclear power providing with almost 5% per year in the last 10 years of the total annual electricity generation. In 2008 it only represented 2.7% of the total installed capacity but due its better practices and with capacity factors around 90% it provided 4.7% of the total electricity generation. It shows that it is a mature technology that has been absorbed by the Mexican engineers.

However, in particular in Mexico the use of nuclear power is a President decision that involves a lot of political constraints. Therefore, for us it is very important to convince all the political actors to proceed in a near future with new deployments of nuclear power in Mexico.

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