

Economic Comparison of Nuclear and Gas Power in Saudi Arabia

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1. Introduction

Saudi Arabia is endowed with a sizeable reserves of natural gas. In spite of the large amount of natural gas reserve, the natural gas production in the country remains limited. However, the country has a plan to expand the extraction of natural gas to supply energy to the power sector. This means a greater role is to be given to gas power in generating electricity in Saudi Arabia. Saudi Arabia plans to increase electricity generating capacity to 120 GW by 2032 to meet the rapidly increasing demand for electricity. Saudi Arabia has a plan to introduce nuclear power to diversity energy mix in electricity sector. This study tries to investigate on the economics of nuclear power against gas power in Saudi Arabia.

2. Electricity generation by fuel type with fuel prices in Saudi Arabia

Almost all power generation has been made by using oil and gas. It is noted that solar(PV) started to make electricity from 2012, but the generation amount is quite limited. The share of it, out of total electricity generation, is only less than 0.05% in 2017. The graph shows that the share of gas is on the increasing trend in recent years, reaching more than 60% out of total electricity generation.

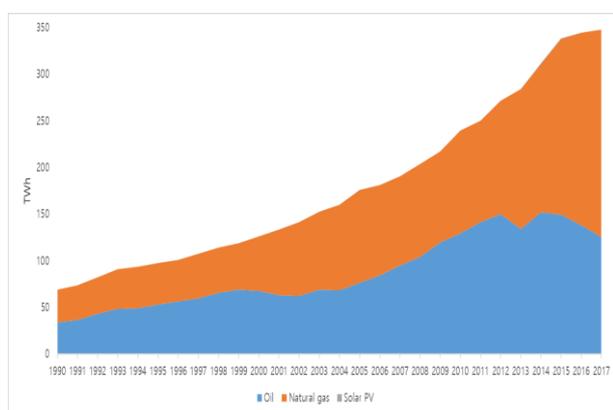


Fig 1. Electricity generation by fuel type in Saudi Arabia

Table 1. Administered fuel prices for utilities in Saudi Arabia

	Prices in 2015	Prices in 2016
Natural gas	0.75\$/MMBTU	1.25\$/MMBTU
Crude oil	4.24\$/bbl	6.35\$/bbl

Source: KAPSARC analysis, Council of Ministers Resolution No.55, Electricity & Co-generation Regulatory Authority(ECRA)

Fuel prices in Saudi Arabia is shown in Table 1. Fuel prices are heavily subsidized so that the regulated fuel prices selling for utilities are quite low. The increases in fuel prices in 2016 were great in terms of increasing rate. Natural gas price was increased by 67% and crude oil price by 50%. It is called an energy price reform. But they are being still remained quite low compared to the international market prices.

3. How to perform economic comparison between nuclear and gas power

Fuel price is one of decisive factors affecting economics of electricity power. It is well known that economic analysis should be made based on the true cost. What is true cost? Economics says that true cost of an item is the opportunity cost of it and the opportunity cost of an item is what you give up to get that item. When it comes to electricity power generation, the value of the fuel consumed to make electricity is the opportunity cost of the fuel. The value of the fuel should be evaluated not by the regulated fuel price but by the international price of the fuel.

In this study, LCOE (Levelized Cost of Electricity) is used to compare economics between nuclear and gas power. Given the international prices of gas, the competitive (breakeven) figures of overnight cost of nuclear power are calculated by applying LCOE method.

$$LCOE = \frac{\sum \left[\left(Capital_t + O \& M_t + Fuel_t \right) * (1 + r)^{-t} \right]}{\sum MWh(1 + r)^{-t}}$$

MWh: the annual electricity generation amount, assumed to be constant over the whole generation years

r: discount factor

Capital_t: total capital construction cost in year t

O&M_t: operation and maintenance costs in year t

Fuel_t: fuel costs in year t

4. Economic comparison of nuclear and gas power

4.1 Input data to the calculation of LCOE

Input data for the LCOE calculation are based on the median case in IEA/NEA(2015), which are listed in table 2.

Table 2. Input data for calculating LCOEs of Nuclear power and CCGT

	Nuclear Power	CCGT
Overnight cost	1,807~6,215 \$/KWe	1,014 \$/KWe
Construction period	7 years	2 years

Discount rate	5%	5%
Fixed O&M cost	68,800 \$/MWe	29,435 \$/MWe
Variable O&M cost	6.9\$/MWh	2.7\$/MWh
Fuel cost	9.33\$/MWh	5.5~14.4 \$/MMBtu
Thermal efficiency	-	59%

Note: Overnight cost of nuclear and gas price are listed in the range

As seen in Table 2, overnight cost of nuclear power is widely ranged from 1,807 to 6,215. A wide range is also found in the natural gas prices depending on the region where natural gas is used.

4.2 Breakeven Point analysis for the nuclear overnight cost vs. CCGT natural gas price

When the regulated price for natural gas is used, there is no way to make nuclear power competitive with CCGT. It is found that even though the overnight cost of nuclear power is assumed to be zero, the LCOE of nuclear power is higher than that of CCGT under the regulated gas price. As indicated in the above section, the regulated price is not appropriate to the economic analysis. From this perspective, the overnight costs of nuclear power are calculated for making a breakeven LCOE between the nuclear power and the CCGT given the various probable gas prices in the international market. The breakeven point analysis is done because a great deal of uncertainty is involved in the overnight costs of nuclear power and the natural gas prices.

Table 3. The breakeven overnight costs of nuclear power against CCGT given natural gas prices

Overnight cost of nuclear power (\$/kWe)	Natural gas price (\$/MMBTU)
3000	7.0
3500	7.8
4000	8.7
4500	9.6
5000	10.5

The breakeven overnight costs of nuclear power in Table 3 are quite subject to the input data in Table 1. It is noted that the breakeven overnight costs of nuclear power become lower as the lower discount rate, the lower thermal efficiency of CCGT, and the higher overnight cost of CCGT are applied. In addition, considering the carbon price would have the competitive overnight cost of nuclear power become smaller.

5. Conclusions

The quite low level of the regulated price of natural gas in Saudi Arabia leads to very low level of LCOE for CCGT. However, the true LCOE of CCGT should be based not on the regulated price but on the international market price, because much higher value of natural gas would be realized if the natural gas is exported rather than being used for domestic purposes. The competitive level of overnight costs of nuclear power are found in the range of 3000 and 5000 \$/kWe given the probable spectrum of natural gas prices in the international market. Of course, the competitive overnight costs of nuclear power depend on the other variables affecting economics of both nuclear power and CCGT.

The released natural gas obtained by replacing CCGT with nuclear power could be exported or added to the energy reserve. The real value of energy reserve is said to be greater than the international market price, because expanding energy reserve provides the country with energy security. The valuation of the energy reserve is suggested to be a promising study area.

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