Saudi Arabia’s Growing Demand for Electricity: Some Strategic Recommendations

Yasir Abdulkarim Alturki1 and Abdel-Aty Edris2

1. Electrical Engineering Department, King Saud University, Riyadh 11421, Saudi Arabia
2. IEEE Fellow, Sr Manager, Exponent, Inc., California 94025, USA

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Abstract: Demand for electricity in Saudi Arabia is growing at a significant annual rate of nearly 8%. It is expected that, by 2030, the demand will increase to about 120 GW per year, approximately three times the 2010 load. Satisfying this demand will require a significant investment in the power grid at an estimated cost, over the next 10 years, of SAR (Saudi Arabia Riyal) 500 billion. Existing power plants rely on oil and natural gas, it is anticipated that meeting the demand in 2030 will consume 3 million barrels of oil each day, which significantly impacting the economy by reducing the country’s income from oil exports, which is a hot button for Saudi decision makers. This paper reviews the responses of various countries in meeting their loads, and therefore, draws recommendations for some resources that should, and should not, be considered best-candidate options for Saudi Arabia economically, technically and environmentally. The discussion primarily examines renewable and nuclear resources.

Key words: Load growth, nuclear power, renewable, Saudi Arabia.

1. Introduction

Demand for electricity in Saudi Arabia is growing at a significant annual rate of approximately 8%. It is expected that, the demand for 2030 will be about 120 GW (Fig. 1) (ECRA (Electricity and Co-generation Regulatory Authority) of Saudi Arabia) [1, 2]. Meeting this demand requires a significant investment in new power plants as well as an upgrade using advanced transmission technologies, the goal of which is to increase transmission capacity. The estimated investment over the next ten years is expected to be more than SAR (Saudi Arabia Riyal) 50 billion [3]. Based on the current electricity generation, which relies solely on oil and natural gas, by year 2030, this amounts to a consumption of approximately 3 million barrels of oil each day [1, 2]. Because oil exports are the country’s primary source of revenue, the increase in oil consumption in order to meet the ever-growing demand for electricity will have significant negative ramifications for the Saudi Arabian economy for generations to come. There is a real and urgent need for strategic and comprehensive planning to adopt alternative sources of energy.

This paper looks globally at energy resources which should be considered best-fit alternatives for meeting Saudi Arabia’s growing demand, examining in particular nuclear and renewable energy resources despite no official plan or approved regulations for using renewable energy having been announced to date. The findings are substantiated by economic, technical and environmental factors. The paper concludes with strategic recommendations.

2. Nuclear Energy

Nuclear energy as a resource for generating and meeting the demand for electricity is widely considered one of the basic options. Construction of nuclear power plants began more than seven decades ago and nuclear
energy was particularly attractive in the 1970s, primarily as a direct result of the oil embargo crises and the resultant dramatic spikes in oil prices. The attractiveness of nuclear energy was then, and continues to be, the relatively low running costs in spite of the high capital outlay for a nuclear power plant, and the lack of CO2 emissions. Another key factor is the appeal of moving away from the reliance on imported fuel. For example, Europe currently imports about 50% of its energy needs, this is expected to reach 70% by 2030 [4].

Moderating this move towards increasing the number of nuclear power plants, however, has been the ongoing debate about the safety of nuclear power and the potential dangers, it poses to humans and to the environment. In some industrial countries, the debate has gone as far as conducting national referenda soliciting “Yes” or “No” votes on nuclear power generation. The referenda have included such issues as reducing the time nuclear power plants are in operation, asking whether the plants should be immediately shut down, or considering should the country set a date for dismantling all existing nuclear power plants. Germany is a case in point where a decision was made to divest itself of all nuclear power plants by 2020. The debate and subsequent outcomes were logical reactions to several nuclear catastrophes: Three Mile Island in the US in 1979, Chernobyl in the former Soviet Union in 1986, and the catastrophic and devastating Fukushima nuclear reactor accident in Japan in 2011 due to a major earth quake. Examining Fig. 2 [5] presents a parallel between high oil prices in the 1970s and the increase in demand for the installation of nuclear power plants. Likewise, one notes the number of new reactors coming online and the output capacity of nuclear power plants dropped with the events at Three Mile Island and Chernobyl. These accidents continue to contribute to a strong public opposition causing significant cost increases in the construction of nuclear power plants as a result of legal costs and litigation. The insurance costs have also been a factor in the cost increases.

Fig. 1  Electricity demand forecast (GW) in 2030 (source: ECRA).

Fig. 2  Accidents at Three Mile Island (1979, first dotted line—1, 1’) and Chernobyl (1986, second dotted line—2, 2’) and the drop in reactor construction and capacity of nuclear power plants world-wide.
Regardless of the ongoing safety and environmental concerns of using nuclear power plants, some countries, nevertheless, continue to use nuclear power plants as an attractive option for meeting their respective base load demands, such as France and other countries as shown in Fig. 3. Note the US was the biggest investor in nuclear power until the period following the 1979 Three Mile Island accident, the rest of the world continued investing even after 1979. European countries such as the UK, France, Germany, Spain and Russia continued building nuclear power plants until after 1986, the year of the Chernobyl disaster. France, the UK and some Asian countries continued constructing nuclear facilities even after Chernobyl [5].

The 2011 disaster at Fukushima caused many changes related to nuclear power plants in Japan as well as around the world. Japan stopped issuing licenses for new plants and announced its intention to cease its dependence on nuclear power, eliminating 54 nuclear power plants by 2040 [6]. In Europe, Germany announced a phasing out of nuclear power plants with the goal of being completed by 2022—marking a historic shift in the industrialized countries [7]. Italy cancelled its plans to build new nuclear power plants, and Switzerland is planning to close all nuclear plants by 2034 [8]. On the other side of the Atlantic, due to concerns over the storage of nuclear waste, the US announced a temporary hold on issuing licenses for new plants and on renewing licenses for

Fig. 3  Chronological record of plant construction and the corresponding capacity (source: IAEA (International Atomic Energy Agency), “Nuclear Reactors in the World”, referenced data series No. 2, April 2006).
existing facilities in 2012 [9]. Belgium [10] also decided to phase out all its nuclear power plants provided that there is no shortfall in meeting demand. Fig. 4 shows the number of nuclear power plants under construction in 2011 in various countries worldwide [11].

As previously mentioned, along with the benefit of not producing CO₂, the costs of running a nuclear facility are moderate. While these benefits have been significant factors in advocating for the use of nuclear power, the initial investment in a nuclear power plant is high. Since the life span of a nuclear plant is only about 40 years researchers in the US are studying the possibility of extending the lifespan of nuclear power plants to 80 years. Regardless of its lifespan, however, at midlife, a nuclear plant will need major maintenance that will cost up to $1 billion [12].

3. Renewable Energy Resources

Renewable energy resources are now being considered as alternatives to carbon fuel-based energy resources, i.e., coal, oil and gas. The driving force behind this move has been very much environmental and aimed at reducing CO₂ production. For many countries, the viability of renewable energy resources has become an option for meeting their energy demands allowing them to move away from their dependence on imported oil and gas. Over the next two decades, renewable energy resources are expected to become an increasing percentage of electricity production. Fig. 5 [13] shows, by 2050, about 21% of electricity generation will be from renewable energy resources.

Although adopting renewable energy is expensive, particularly solar energy, renewable energy resources will play an increasingly important role in the coming years in electricity generation for power systems around the world. The changes will have a significant impact on the operations of power system operators: dispatch and ramping capabilities of existing conventional power plants will need to increase along with the increased levels of penetration of renewable energy resources. Furthermore, there will be a need for deployment of large-scale energy-storage systems to manage the variability and intermittency of renewable energy.

![Fig. 4 Number of nuclear power plants under construction worldwide as of March 2011.](image)

![Fig. 5 PRISM (parameter-elevation relationships on independent slopes model) data indicating 21% renewable energy by 2050.](image)
4. Important Considerations for Saudi Arabia

Followings are some points that Saudi Arabia should keep in mind when considering various options in responding to the growing demand for electricity over the next 20 years:

- Countries that are currently relying on nuclear power for electricity generation are faced with a significant challenge: decommissioning nuclear plants due to the justified and growing fears of environmental safety concerns. The estimated cost to decommission a plant is about USD 300-400 million [14]. Even though the running costs of nuclear plants are quite low compared to other types of power generation, their short life spans coupled with their high decommissioning costs minimize their financial appeal;

- Another significant challenge is the overreliance on nuclear power to reduce dependence on imported fuels. For example, in 2009, Europe imported 83.5% of its oil needs and 64.2% of its natural gas needs [15], so, the pressure was on to reduce this reliance;

- At the same time, however, because reducing CO₂ emissions is a driving factor in the move toward clean energy, European nations are now tasked with finding an acceptable alternative to nuclear energy;

- As seen in Fig. 4, even prior to the Fukushima disaster, the general trend in the construction of nuclear power plants was declining—most notably after the two previous disasters. Consequently, based on the history of these two events, it is logical to anticipate the Fukushima disaster that would have had a marked impact on the increasing difficulty of building new nuclear power plants. The increasing difficulty coming in the form, for example, of higher capital outlays, the greater need for safety assurances, or mounting public opposition. The same challenges hold true for efforts to extend the life of existing plants;

- The impact of the events at Three Mile Island and Chernobyl along with the disaster at Fukushima, in spite of its compliance with the highest technical and safety standards, led General Electric, which is one of the world’s largest manufacturers of nuclear power equipment, to conclude that the use of nuclear power plants is an option that is no longer viable, neither from an economic nor an environmental perspective [16]. The former chairman of the U.S. Nuclear Regulatory Commission who was chairman of the commission at the time of the Fukushima disaster posits the nuclear industry in the US is “Going Away” [17];

- A demand-side management study by ECRA revealed that it is feasible to save approximately SAR 50 billion over the next 10 years [2];

- Investing in the development of a program for the efficient use of electricity will result in a reduction in the growth rate of current and future power demands. On point, there have been successful implementations of such programs in many countries, particularly in the US where spending on energy efficiency programs was approximately USD 5.9 billion in 2011 [18];

- The total investment in energy efficiency and related programs in the US in 2010 was USD 47 billion [19]. Furthermore, the U.S. EIA (Energy Information Administration) estimated a new power station in 2020 would cost approximately four times the 2009 cost of having invested in energy efficiency programs [20];

- It would be an imprudent move for Saudi Arabia to consider investing in the construction of nuclear power plants to meet its growing demand for electricity. This conclusion is supported by the following:

  - There is currently an ongoing worldwide debate about moving away from a reliance on nuclear power;
  - Countries are opting to decommission existing...
nuclear power plants in the near future;
- Building nuclear power plants is costly;
- It is highly likely research and development of nuclear technology will not continue, making the ongoing operations and maintenance of nuclear power plants difficult to guarantee;
- Choosing renewable energy is visionary.

• As shown in Fig. 5, renewable energy is expected to generate a large percentage of the world’s needs for electricity. This shift towards renewable energy resources will prompt increased investment in the research and development of related renewable energy technology, thus resulting in lowering the initial capital outlay. It would, therefore, be an astute and strategic move for Saudi Arabia to invest in harnessing renewable energy, particularly solar energy.

5. Strategic Recommendations to Meet Growing Electricity Demands

From the above analysis and perspectives, the followings are strategic recommendations to meet the growing demand for electricity in Saudi Arabia for the upcoming 10 years of load growth.

Invest in and implement energy-efficiency programs and load-management technology. The investment will result in a reduction in the current load level and allow for better management of load forecasts, the goals of which are a significant reduction in electricity consumption—there could be up to a 50% reduction in consumption based on the results of a study conducted by the JICA (Japan International Cooperation Agency) for the Saudi Arabian Ministry of Water & Electricity [21]. The study found that, homes with good insulation could save up to 50% of their electricity consumption for meeting its air conditioning needs compared to homes without insulation. The study concluded that, investing in energy efficiency is economically feasible and desirable—especially when oil prices are high. This conclusion is also supported by the ACEEE (American Council for an Energy-Efficient Economy) which found building new power generation plants is more expensive than investing in energy efficiency programs [22, 23];

- ECRA conducted a study on demand-side management that concluded up to SAR 50 billion could be saved over the next 10 years by avoiding the need to build a new 3,200 MW power station [2];
- Partner with companies that have proven track records in successfully designing, manufacturing, and building solar energy stations. This would be a particularly attractive option for the country due to its financially liquidity;
- With financial support from the government, promote the harnessing of solar energy in residential areas. This will not only result in the creation of new jobs, but also reduce peak loads. Furthermore, harnessing solar energy in residential areas will result in engaging consumers in the optimal use of electricity as it will make them calculate the solar energy produced by their panels and consumed or sold to the grid. People tend to reduce their energy consumption when they know more about their detailed use of home electricity [24];
- Encourage and facilitate the establishment of civic and cooperative companies that will invest in building renewable-energy power plants based on the experience of and knowledge in other countries;
- Avoid building large solar power stations integrated into the electric grid. Building large solar power stations is likely to require long-term contractual commitments with the investor that could prove costly for the Saudi economy and will increase the challenges to the restructuring plan, which is being implemented in its first stages, the electricity sector faces.

6. Conclusions

The paper presents factors that should be taken into consideration when Saudi Arabia is debating which resources for power generation ought to be considered
best-fit candidates for the country, economically, technically and environmentally. The paper concludes with strategic recommendations based on an analysis of the practical challenges to the current status of meeting electricity demands in various countries around the world. For Saudi Arabia, to consider investing in building nuclear power plants to meet the growing electricity demands would not be the right move for the Kingdom. This is supported by several factors: ongoing debate regarding moving away from relying on nuclear power plants, decisions worldwide to decommission existing nuclear power plants in the near future, and other feasible options being available. For example, there is significant potential for energy savings by investing in energy-efficiency and demand-side management programs, both of which would decrease the required investments in generation expansion needed to meet demand growth. Moreover, the adoption of solar energy technologies is a strategic and beneficial solution for the Saudi electricity sector.

References