Policy Brief

REDUCING WEIGHTED AVERAGE COST OF GENERATION IN PAKISTAN THROUGH TIME OF USE (TOU) PRICING MODELS OF FLEXIBLE ELECTRIC LOADS

Naveed Arshad

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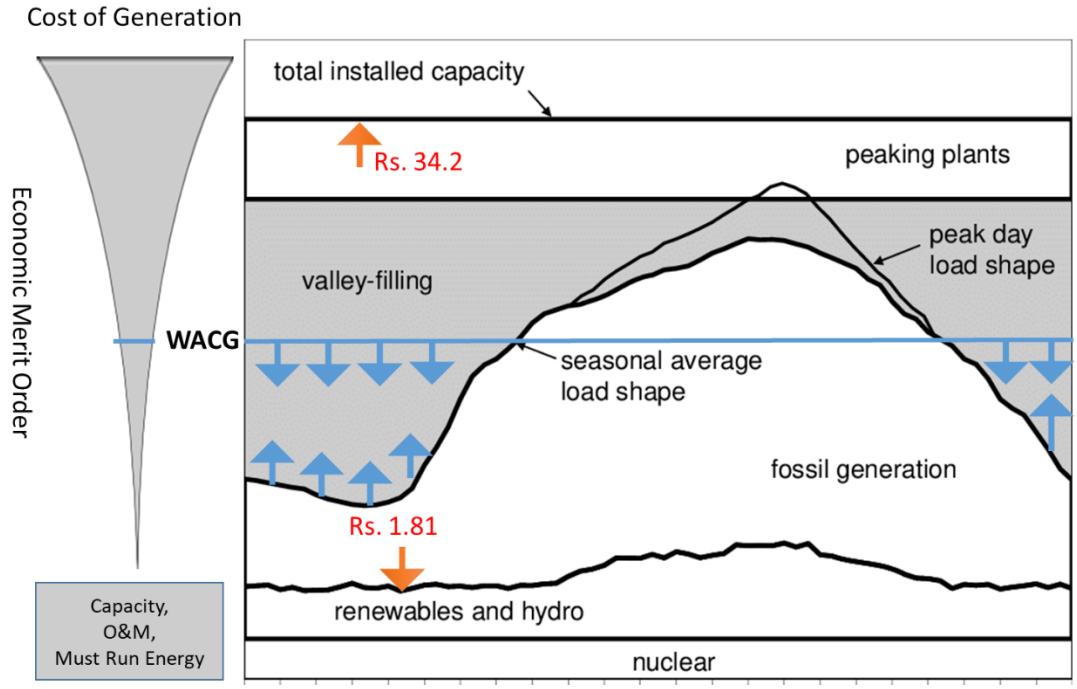
INTRODUCTION

Pakistan has been accumulating substantial circular debt in various sectors. This includes 2300 billion of circular debt of the power sector, 1300 billion circular debt of the petroleum sector, and 320 billion circular debt of the RLNG sector. This colossal cumulative circular debt is paralyzing the economic prosperity of the country. Since the power sector depends on petroleum and the RLNG sector for its fuel requirements, it indirectly impacts the circular debt in these two sectors.

One of the significant reasons for circular debt in the power sector is the surplus generation capacity. This surplus generation capacity results in capacity payments that are due whether we generate electricity or not. Moreover, Pakistan has significant daily and seasonal variations in the demand, accounting for vast surplus capacity during off-peak times. For example, the country's peak load touches 24,500 MW in summers only for few hours but comes down to less than 8,000 MW in winters. The average load in 2020 was around 17000 MW against an installed capacity of 36,000 MW. Due to this significant variation in peak loads and the addition of many new generation plants, the annual Weighted Average Cost of Generation (WACG) has increased drastically over the last few years. For example, in 2015, the WACG was Rs 7.2, which climbed to Rs 12.3 in 2020. Please note that WACG is generation cost only and does not include transmission, distribution, cross-subsidy, taxes, and other surcharges that a consumer pays.

Figure 1 shows electricity load variation across time. Electricity cannot be stored at a large scale; it has to be consumed the moment it is produced. Therefore, many power plants together fulfill the load requirements. Must-run plants like nuclear, wind, solar and run-of-river hydro are the first ones to meet the load requirements. If the load increases fossil fuel-based plants or reservoir-based hydel generation with low marginal cost and high dispatchability are operated next. As the load increases, more plants adds into the mix based on their economic merit order which is also a factor of marginal cost. In Figure 1, the first fossil-fuel based plant can produce a unit of electricity at Rs 1.81 per kWh while the last available plant costs almost Rs 34.2 per kWh. The average of all plants' operational costs determines the WACG.

Figure 1: A Typical Day Load Profile and Cost of Generation based on Economic Merit Order



To reduce the WACG, electric utilities strive to reduce their peak loads as much as possible. Because not only does it results in higher generation costs but it also creates a situation where unutilized capacity adds further financial burden. In Figure 1, the more the grey area is the more is the WACG. For easier understanding, we call the load hours above the WACG line as peak hours and those below the WACG line as off-peak hours. Any new load that is added in off-peak hours reduces the WACG. Similarly, any new load in the peak hours increases the WACG.

In Pakistan, we follow a 'take or pay' regime in our generation sector. In this regime, a fixed capacity payment is due whether we generate electricity or not. Due to energizing of many new generation plants, the capacity payment component in generation cost has increased from Rs. 2.7 in 2015 to Rs. 6.3 in 2020. Therefore, for Pakistan's electricity sector to become sustainable, we need to shape our energy load as flat as possible.

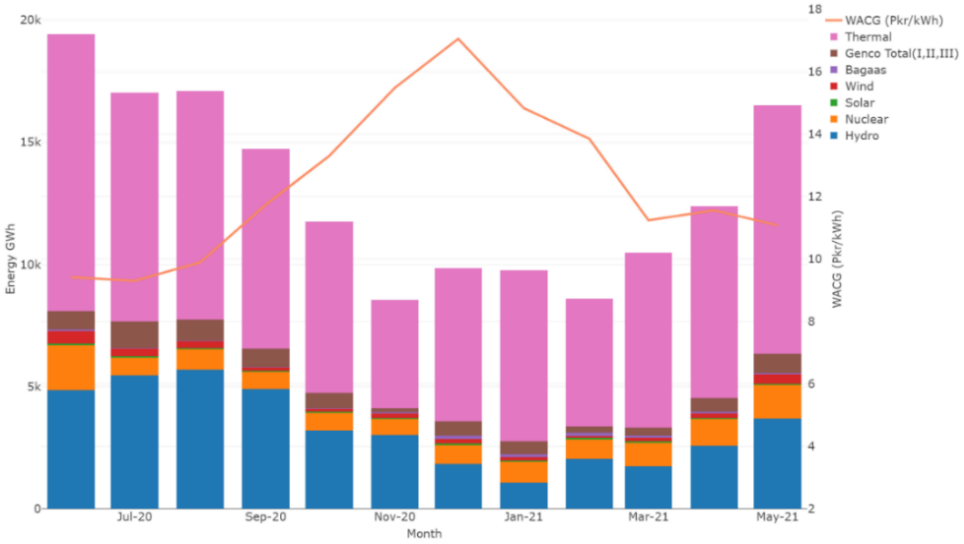
In this policy brief, we present a technical and financial analysis of the impact of shifting loads from peak hours to off-peak hours. In our analysis, we have gathered authentic data from various sources like NEPRA[1], CPPA[2], NTDC[3], NPCC[4], PITC[5] and other relevant stakeholders. We have developed a software tool that automatically performs the financial calculations based on the generation plants and their marginal costs. We have shared our findings with the Ministry of Energy (Power Division) and the Board of Directors of CPPA.

KEY FINDINGS

[1] National Electric Power Regulatory Authority
[2] Central Power Purchasing Agency
[3] National Transmission and Despatch Company
[4] National Power Control Centre
[5] Power Information Technology Company

- The WACG in the power sector is highly dependent on the season and nature of the fuel used in the generation plants. For example, while we have a high load in Summers, the WACG is low because of cheaper hydro and other renewable resources. However, in winters the WACG is much high because of dependency on imported fuel base sources of generation. For instance, in July 2020 the WACG was Rs 8.86 while in January 2021 the WACG was 14.46. Figure 2 shows the variation in WACG across the year 2020-21.

Figure 2:Monthly Energy Consumption and variation in respective monthly WACG



- By shifting only 5% of load from peak to off-peak hours the country can save around Rs 6.5 billion with 2020-21 fuel costs. Of course the savings will amplify with the high fuel prices. Not only we have these direct savings we may be able to retire a number of expensive generation plants that may not be needed due to a reduction in peak load. Moreover, all these savings will also save foreign exchange reserves. Finally, as these plants are also the most polluting, we will reduce the overall emissions from the power sector.

- The water reservoirs of Tarbela, Mangla, and others are a source of cheaper energy and provide many other critical benefits. These reservoirs provide stability in the electric grid because of their extremely fast ramping time. With more solar and wind resources, their role will amplify as they require backup power sources due to their variability and intermittency.

- Until now, our power sector has been using fixed tariffs with some time-of-use (ToU) tariffs based on fixed peak and off-peak hours. However, the electricity load patterns are changing due to distributed generation, electric vehicles, and other disruptive technologies. Therefore, it is critical to reassess the tariff design and create a win-win situation for the power sector and consumers.

- The tariff and other financial calculations of the power sector in Pakistan are based on monthly figures. However, we can do fine tuned financial calculations based on hourly information availability. This provides much better optimization and will improve the bottom line of the power sector. Pakistan is opening its electricity market in 2022. With high granularity of information, the market will open many more opportunities for prospective investors and consumers.

RECOMMENDATIONS

Based on the findings of this study, literature review, and the collected data and analyses, the following recommendations should be considered in order to improve the financial bottomline of the power sector:

- **Smart Metering**

  To regulate peak load and for many similar interventions, smart meters must be placed for demand side management and to monitor the load at any given time interval. Smart meters keep a real-time record of electricity consumption and communicate the electricity usage information to the distribution company. PITC already has developed a smart metering platform that any DISCO can use. Although the cost of smart meter is a bit high ($100-300) but for bulk and large consumers this may not be a challenge. For smaller consumers the load flexibility may determine if the DISCO should invest in installing smart meter. For flexible loads like water pumping, tubewells and some commercial and industrial loads the resulting benefits will outweight the cost of smart meters.

  During peak periods like summers, higher tariffs may be offered to the consumers to recuce their demand in lieu of lower tariff in off-peak hours. These price signals will minimize electricity generation costs by lowering the peak demand at selected time intervals. Around fifty thousand smart meters are installed at MEPCO and PESCO. These smart meters may be used for any pilot project.

- **Incentivized Tariff**

  Once the smart meters are installed, several tariff-based interventions are possible. For example, in 2021, the Government of Pakistan offered winter electricity package with lower tariffs to improve the load factor through utilizing idle generation capacity. However, we believe that this may not be the most optimal strategy as if the load adds to the peak load then WACG will increase due to higher imported fuel-based generation. Instead, tariffs based on peak and off-peak hours may provide much better financial savings for both the power sector and the consumers. As peak and off-peak hours change almost monthly, one needs a careful analysis of when to offer an incentive. Using our tariff modeling tool one may perform as many scenarios as possible to evaluate the impact of a given load pattern.

- **New Flexible Loads**

  After incorporating major industrial and bulk consumers, a range of newly identified flexible loads can be further added to the new tariff schemes. This effort will include the addition of flexible municipal loads such as tube wells, water pumps, etc. Through the usage of smart meters, flexible loads will get dynamic tariff rates via communication protocols of smart meters. The introduction of such tariffs will help both municipalities and DISCOs by lowering their peak demand and increasing their load factor.