Study Committee C1

Power System Development and Economics

Paper 11033_2022

Long-Term Demand Forecast For Oman Electricity Transmission System Master Plan (2020-2040)

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Motivation

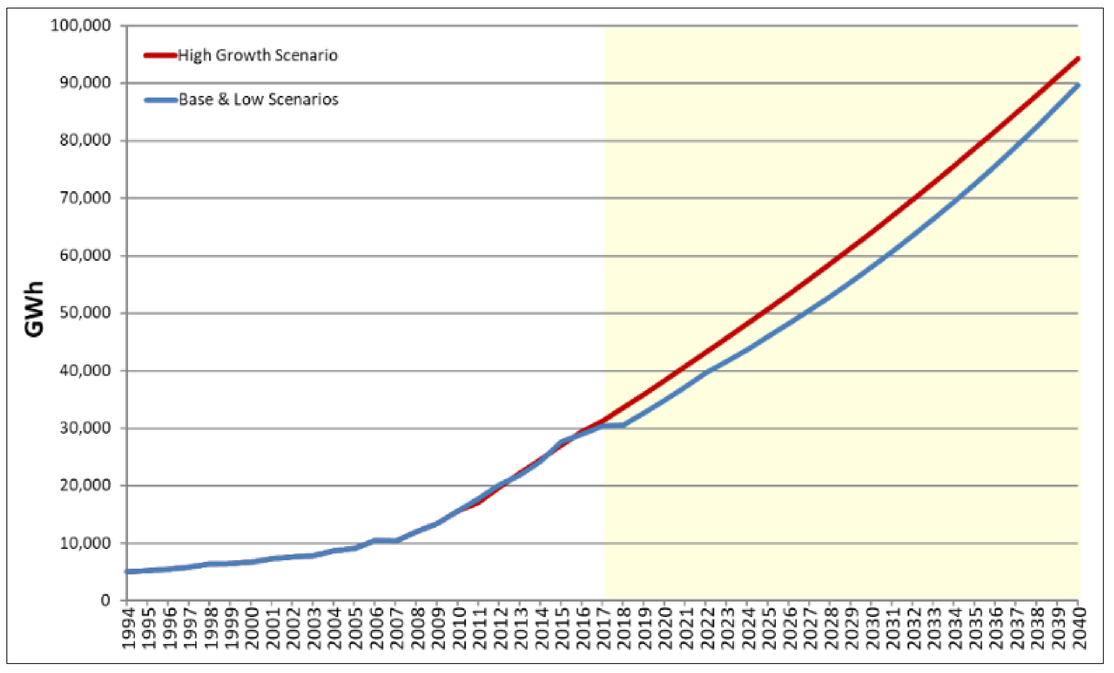
- OETC is responsible for the planning of the transmission network, at medium terms OETC prepare Five-Year Annual Transmission Capability Statement. On other hand, long-term vision for the development of the transmission network is required to evaluate decisions on capital expenditures for the expansion of the power generation and network infrastructure which will give a clear road map for investments in the transmission network.
- The objective is to present the methodology, approach and results of the demand forecast analysis used in Oman Electricity Transmission Master Plan (2020-2040). Oman Electricity Transmission Company analyse the challenges and review the existing load demand forecast for Oman until 2040.

Method/Approach

- When talking about load forecasts, it is possible to identify different targets: the forecasts of electrical load or electrical energy consumed or produced can be made by several different entities. Furthermore, the forecasts are used for a range of purposes, from real-time operation of the power system, to determining the required long-term generation, transmission and distribution development plans.
- After the review of historical trends of energy and peak demand, the initial load forecast model was defined in line with the traditional approach used in power system planning by OETC, based on a combination of Top-down and Bottom-up methods.
- The main result of the two approaches is the estimation of the annual energy that is the main variable that describes the energy trends of the country because it considers the evolution over the whole year and therefore it is not heavily affected from special events. On the other hand, it should be highlighted that the peak can depend each year on conditions (temperatures, Ramadan, etc.). Therefore, the estimation of the peak load starts from the energy and applying appropriate load factors to it. The load forecast must also consider new Additional Variables such as Bulk load, the Cost-Reflective Tariffs (CRT), together with the potential development of distributed renewables and electric vehicles.

Top-down approach

- Among the several methodologies to perform the long-term forecast, the most used and quoted in the literature is the econometric approach. The degree of detail of the modelling depends on the availability of different economic indicators that may impact the overall consumption of electricity. By this reason, the Top-down model selected was the econometric approach having in mind the availability of the aggregated Gross Domestic Product (GDP); the GDP by category or economic activity and the availability of the total population, the population by Wilayat and considering the division of the population between Omani and Expats.
- The forecast was performed for the Base Scenario and for the High Scenario Figure below shows the historical values and the forecast of the Energy Consumption in different scenarios.



Forecasted Energy Consumption Scenarios in GWh

Bottom-up approach

- The aim of the Bottom-up approach is to validate the Top-Down model and to provide a more comprehensive overview of the Energy Consumption in Oman in the different areas. The Bottom-up approach analyses in detail the historical electricity consumption of the different economic sectors (residential, industrial, commercial, rural, desalination, etc.) present in a specific area, considering the singularity of bulk projects (e.g. refineries, malls, industrial areas) that typically do not strictly follow the socio-economic trends. Thus, the demand of the different areas of Oman is constructed building together the different consumption components.

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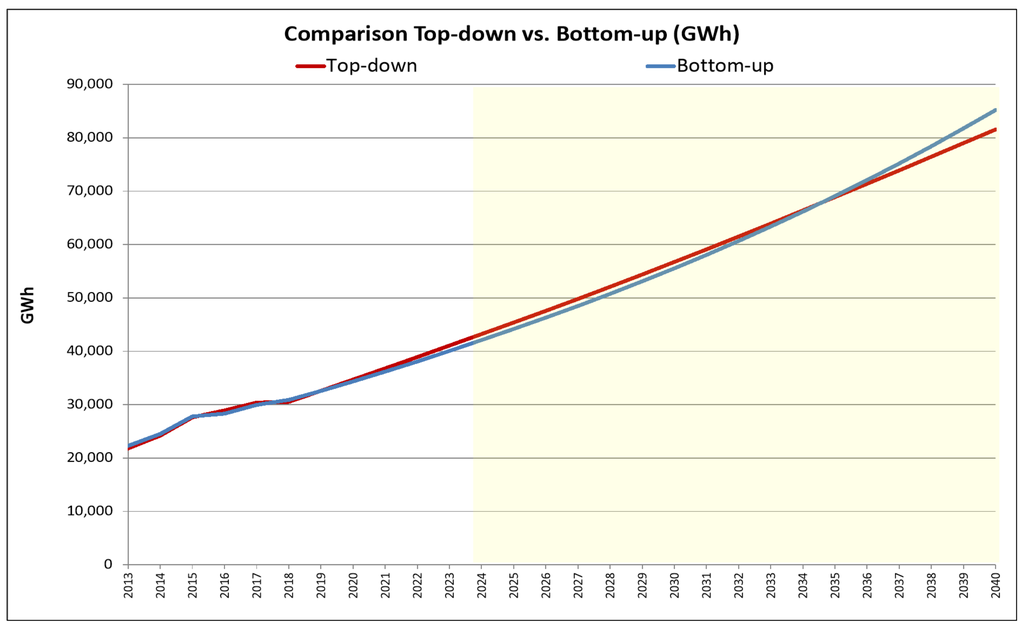
Comparison of Top-Down and Bottom-Up Approaches

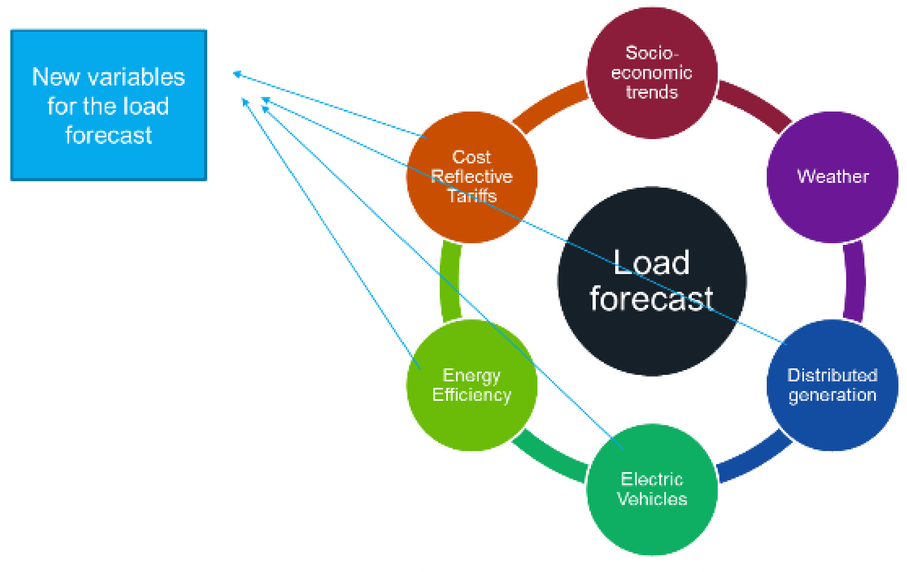
- The Top-down approach was performed considering the main macro-economic variables that were verified to have an influence in the energy consumption of the Sultanate. Considering that this is a long-term forecast, the macroeconomic approach was chosen, and several analyses were conducted on the data and the historical time series. The results are the Energy Consumption for the MIS and Dhofar System at Grid Stations levels, without considering the transmission losses and auxiliary consumption of the generation power plants.
- The Bottom-up approach, instead, starts from the detailed analysis of the historical electricity consumption of each Area or Region considering the singularity of every area and capturing their sensitivity the different set of variables available. Each Region or Area has different explanatory variables for the energy consumption. Therefore, there is a wide variety of variables influencing the energy consumption in each region, from the total GDPs, the sectorial GDPs, population and any combination of those variables. Hence, the results of the two different approaches were compared and the result will provide the final load forecast. Figure below shows the comparison between Top-down and Bottom-up Approaches in GWh



Comparison of Top-down and Bottom-up Approaches in GWh

Effect of Additional Variables

- The Top-down and Bottom-up approaches discussed previous have been carried out in line with traditional practices, which correlate the energy consumption to socio-economic trends. However, the power sector is facing a series of innovations that can impact the energy and peak demand in the future. Therefore, it is necessary to include such new variables in the forecast for the next years, analysing them in detail one by one.
- Figure below reports such new variables to be included in the forecast, namely: Cost Reflective Tariffs, Energy efficiency programs and Electric Vehicles and Generation installed in the distribution networks



New variables included in the OETC forecast

Load Forecast Scenarios

- In order to get final load forecast from 2020 to 2040 the Top-down model, the additional explanatory variables, and the assumptions about the evolution of the scenarios (e.g. GDP, population, CRT implementation, EV penetration, Bulk Loads, etc.) are combined. For both MIS and Dhofar System, three forecast scenarios have been developed, called:
- Scenario 1
- Scenario 2
- Scenario 3

Scenario 1

Scenario 1	
Variable	**Assumption**
GDP-Population	Base scenario of the Top-down model
CRT extension to other categories	Staring after 2030, with a gradual implementation 20% additional each year in 5 years
EE	50% of the target proposed by JICA. To be implemented between 2025 and 2040. Starting from 5% in 2025 and then increasing linearly (around 6%/year)
Rooftop PV	100 MW per year starting from 2025
EV	5% of new annual registration between 2025 and 2029, then 10% up to 2039 and 20% in 2040

Scenario 2

Scenario 2	
Variable	**Assumption**
GDP-Population	Base scenario of the Top-down model
CRT extension to other categories	Staring after 2030, with a gradual implementation 20% additional each year in 5 years
EE	Not considered
Rooftop PV	Not considered
EV	Not considered

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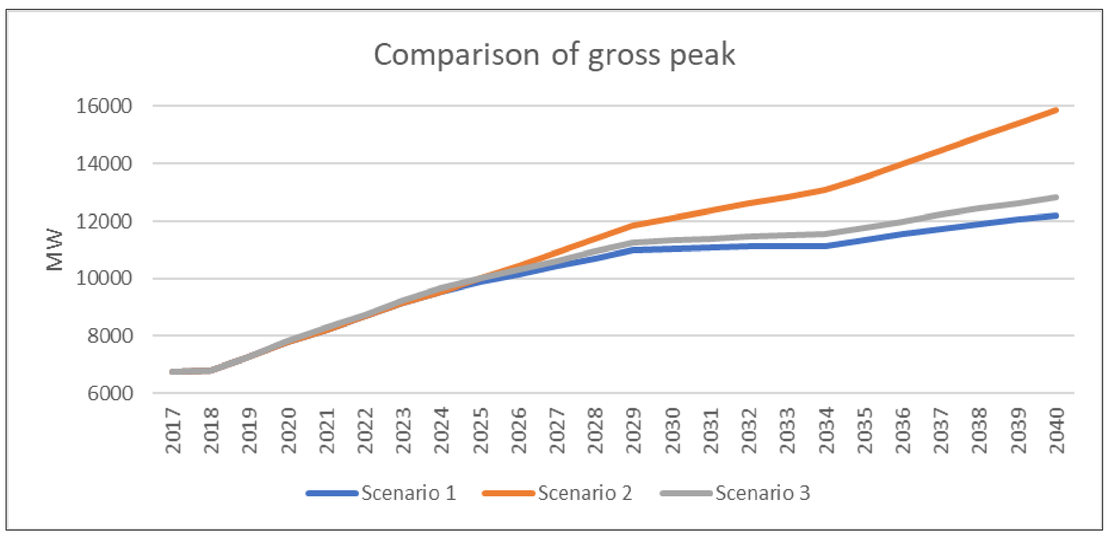
Scenario 3

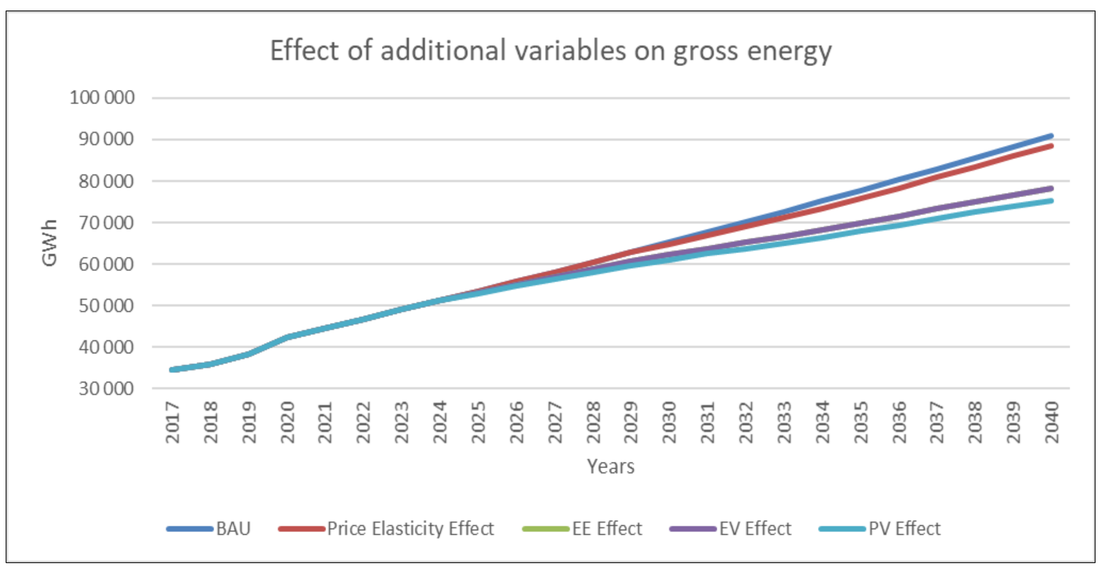
Scenario 3	
Variable	**Assumption**
GDP-Population	High scenario of the Top-down model
CRT extension to other categories	Staring after 2030, with a gradual implementation 20% additional each year in 5 years
EE	50% of the target proposed by JICA. To be implemented between 2025 and 2040. Starting from 5% in 2025 and then increasing linearly (around 6%/year)
Rooftop PV	100 MW per year starting from 2025
EV	5% of new annual registration between 2025 and 2029, then 10% up to 2039 and 20% in 2040

Comparison Between Scenario 1, Scenario 2 and Scenario 3

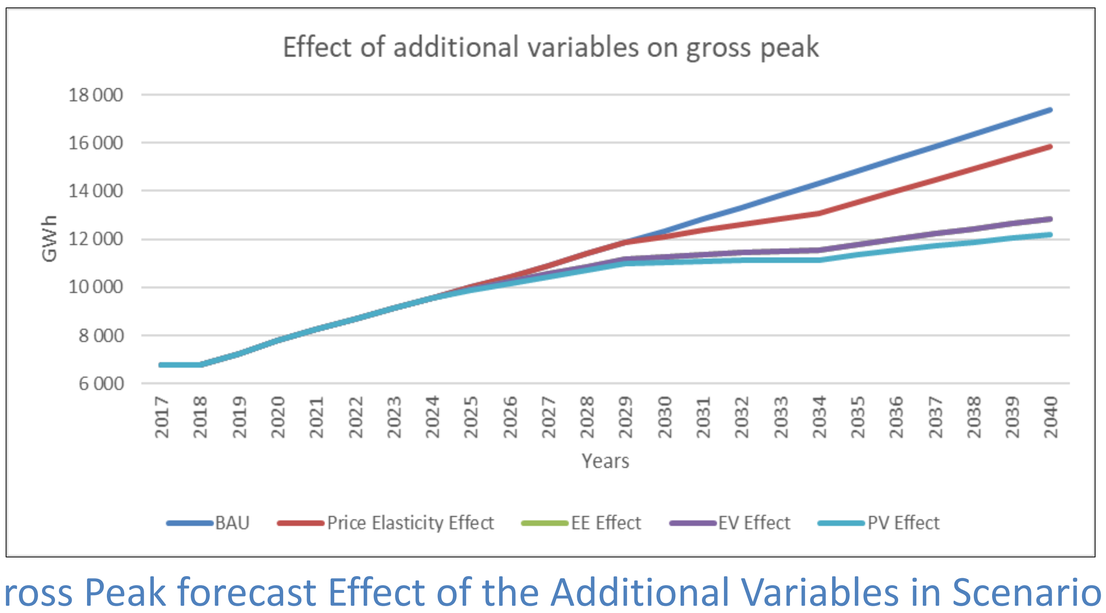


Gross Peak forecast in Scenario 1, Scenario 2 and Scenario 3

Decarbonization Initiatives Impact



Gross Energy forecast Effect of the Additional Variables in Scenario 1

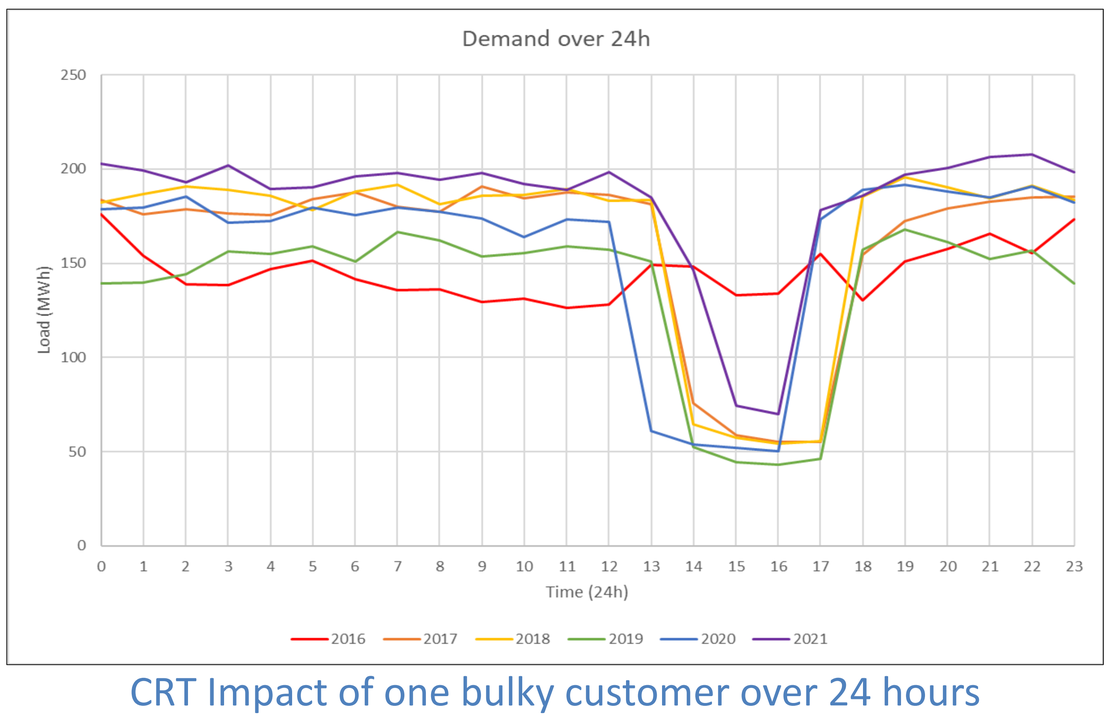


Gross Peak forecast Effect of the Additional Variables in Scenario 1

- From the graphs, the following can be observed:
- The effect of the price elasticity of demand is higher for the peak respect to the annual energy. It was observed that due to the structure of the CRT, the main effect of the CRT tariffs is on peak demand and not on energy.
- The EV effect is practically negligible. In fact, from the graph it is possible to observe that the purple curve related to the EV effect practically covers the green curve related to the Energy Efficiency programs.
- The main reduction in the energy consumption is due to the Energy Efficiency programs.
- Between the BAU scenario and the final curve of the forecast, named Baseline Scenario there is a reduction of 17% in Energy and 30% in Peak Demand.

Implementation of Demand Forecast Results and Conclusion

- The demand forecast is providing an excellent insight about the growing area and load density.
- To well plan the required transmission infrastructure and securing the right of way approval and plot acquisition.
- Optimize the system design to meet the long-term system demand, hence minimize re-doing more investment.
- Understanding the required project amount to support future investment financing.
- Different factors and variables will support understanding the impact and timely occurrence of the demand growth.



CRT Impact of one bulky customer over 24 hours