ECONOMIC CONSULTING ASSOCIATES

Viewpoint

Coping with load shedding when forecasting power demand

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Conventional load forecasting techniques start from the premise that the current demand of customers connected to the power grid is accurately reflected by their levels of electricity consumption. Unfortunately, in many developing countries load shedding is the norm rather than the exception, driving a wedge between demand and consumption.

This Viewpoint discusses approaches to dealing with load shedding when making long-term load forecasts to be used for planning purposes.

The problem

Forecasting future load is the critical first step in electricity systems planning; it provides the starting point for generation, transmission and distribution planning. An accurate forecast helps avoid underinvestment, causing a lack of electricity supply, as well as preventing costly overinvestment.

The various forecasting methodologies are well documented, but planners attempting to apply these to developing countries are typically faced with a combination of difficulties:

- Lack of quality data complicates attempts to identify historical relationships and obscures understanding of the current electricity system.
- Structural changes caused by improvements in technology and rapidly changing consumer tastes and business practices mean that the past is not always a reliable guide to the future.
- When load shedding is present, the current level of demand cannot be observed from utility sales data.

This last issue of load shedding has been overlooked to a surprising extent in the conventional practical guides on load forecasting, despite the frequency of this problem in developing economies[1]. In this Viewpoint we go some way towards correcting this and offer a few practical solutions.

Standard forecasting approaches

One of the most widely used load forecasting approaches is econometric modelling, using economic output as an independent variable to predict energy demand. A simple way to do this is to estimate with pooled time series data, but if a long enough time series is available then a cointegration approach can provide greater accuracy[2].

When data availability is limited, econometric modelling will not yield accurate results and a more *ad-hoc* modelling approach can be employed. This method typically forecasts industrial demand to rise with economic output at a rate set by the estimated energy intensity of each industry, and residential demand to rise with the number of electrified households and the rate of increase of consumption per household.

Load shedding presents problems for both the econometric and the ad-hoc approaches because it causes electricity sales to be lower than the actual demand for electricity, resulting in an underestimate of future demand. Below we set out a few ways in which the aforementioned difficulties can be surmounted.

A micro level approach

One way to tackle this problem is to use bottom-up methods which forecast consumption patterns by using micro level data on appliances used by businesses and households and predicting how

[1] See for example World Bank: 'Assessing the Accuracy of Electricity Demand Forecasts in Developing Countries'

[2] World Bank: 'Forecasting Electricity Demand: An Aid for Practitioners'

use and ownership of appliances will change over time without taking account of supply constraints which customers may face in practice. This side-steps the requirement for accurate macro level data, but there is the caveat that the good quality micro level data may be difficult to obtain.

Good judgement by the modeller is essential here as careful use of assumptions is required in order to ensure that total demand is accurately determined. A key problem is that it is very difficult to predict how use of appliances will change over time, subject as it is to the vagaries of changing tastes and emerging technologies. These changes may be especially relevant in a developing economy.

An energy consumption approach

A forward-looking solution is to set targets for access to the grid and combine these with assumed energy consumption per household and per business. This approach may be appropriate where planners want to work backwards from a goal that is seen as desirable and achievable in order to see what investments are needed to accomplish that goal. The modelling challenge of load shedding is resolved because it is assumed that load shedding is gradually eliminated between the present day and the target date.

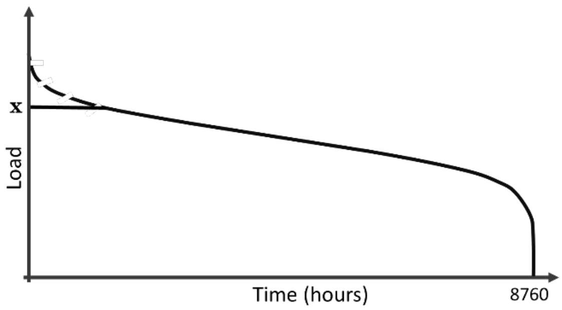
Here great care is needed to ensure targets are realistic as the target level of consumption can dramatically affect the implied investment needs. One study estimated capacity needs in sub-Saharan Africa in a 'moderate access' scenario as more than five times greater in 2030 than the amount predicted by a GDP regression approach[3].

Estimating the amount of suppressed demand from a load duration curve

A third way to address the problem is to attempt to directly estimate the amount of demand which is suppressed by load shedding. Typically, demand is suppressed only for the periods of time when it reaches its highest levels and generation capacity is insufficient to keep up. Looking at the load duration curve, which plots demand for every hour of the year in order of decreasing magnitude, it is the left-most part which shows the hours at which demand is the highest, and this will appear truncated when load shedding is present (truncated at x in the diagram below).

If the truncated area is small, we may be able to make a rough estimate of the suppressed demand, by extrapolating the rest of the curve using as a guide comparison to load duration curves from countries without load shedding.

Load duration curve with load shedding



Designing for uncertainty

From a practical standpoint, the key tenets to be observed when making a load forecast should be adaptability to changing circumstances; recognition of uncertainty; and integration with the rest of the electricity planning process. Each of these becomes even more critical when load shedding imposes additional uncertainty.

Regular updates to the forecast as new information becomes available has an important role to play in increasing forecast accuracy, especially for longer forecast horizons. New information can also help identify the extent of load shedding: as generation capacity increases over time, insight can be gleaned either through the persistence of load shedding, despite the increase in generation capacity, or through its decline in frequency.

The inherent uncertainty in predicting the factors that contribute to future demand can be handled by providing scenarios which encompass the likely range of outcomes that may emerge. Generation capacity can be designed with an option to scale up - the degree of flexibility needed can be informed by the scenario results. Engaging key stakeholders at an early stage can help with this – for example, working with land authorities allows banking of land that can later be utilised for solar farms or other forms of generation.

[3] Bazilian et al., 2013. Energy access scenarios to 2030 for the power sector in sub-Saharan Africa. *Utilities Policy*, 20(1), 1-16.

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