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A brief from the **Energy Security Studies Program**

Daily Electricity Demand

Key Terms

Daily Demand Curve • Peak Load • Load Following • Intermediate Load • Base Load • Reserve Margin

Introduction

Every light that turns on, each air conditioner that kicks in, and every factory that begins production contributes to the ever-changing demand for electricity. It is the responsibility of grid operators to continuously match supply and demand second by second, map fluctuations, track predictable patterns, and respond to unforeseen events. The **daily demand curve** reflects this continuous matching of supply and demand for electricity generation over a twenty-four-hour period. This is a complex operation, and it requires a portfolio of resources and technologies with distinct characteristics.

Electricity Supply and Demand

Changes in electricity demand are influenced by several factors to which power providers must instantly respond: time of day, day of week, temperature, geography, and seasons. Figure 1 illustrates how demand varies over the course of the day. Any imbalance in matching supply and demand in real time can have serious implications, jeopardizing overall grid stability.

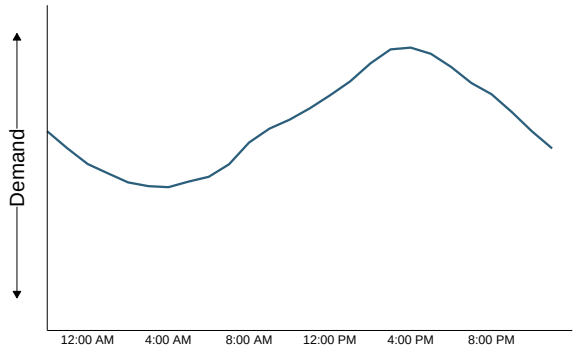

Figure 1: Daily Electricity Patterns

If supply falls below demand, during unexpected spikes, the system risks shortages or brownouts, interrupting essential services and compromising safety. If supply exceeds demand, this may trigger an electrical surge, leading to widespread blackout. For instance, Virginia grid operators had to act rapidly when sixty data centers went offline at once, creating a situation where supply was poised to far exceed demand (McLaughlin, 2025). This unexpected disruption highlights the critical need for real-time monitoring of the grid.

Load Following

Adjusting electricity output to match fluctuating demand is known as **load following**. Load refers to the amount of electricity needed to power the grid at any specific moment. Utility operators categorize the daily electricity demand into three general load levels: **base**, **intermediate**, and **peak loads** (Figure 2). These indicate the variation between the minimum and maximum power re-

quired to support essential operations. **Base load** refers to the minimum electricity load required throughout the day; such as household appliances, heating and cooling systems, hospitals, industrial processes, data centers, and other critical infrastructure. As the day progresses, demand increases, peaks, and then decreases. Intermediate load is described as the demand between base load and peak load, requiring flexibility and responsiveness. Peak load refers to the maximum demand required during the day.

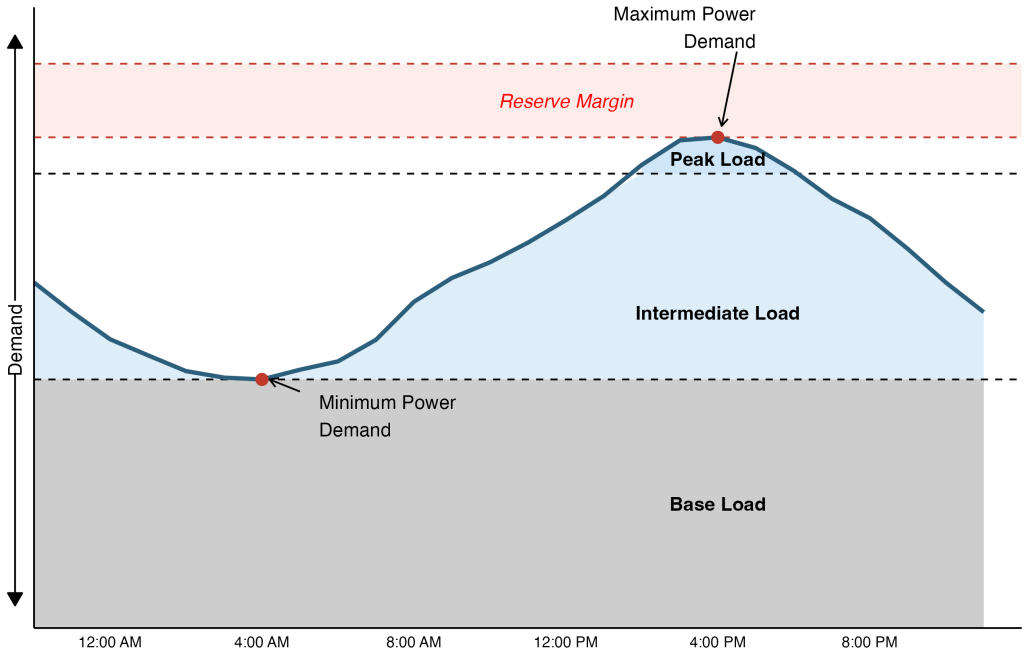

Figure 2: Daily Electricity Demand by Load Levels

However, unforeseen events occur. For example, when power demand spikes beyond its projected peak load or when a power plant must be taken offline unexpectedly. Reserve margins provide grid operators with additional generating capacity to match supply and demand. These reserves serve as backup power ready to be deployed. They are also needed for when power plants undergo routine maintenance.

Energy Resources and Technology

The grid relies on diverse energy resources and technologies, each having unique physical and operating characteristics to support fluctuating load. Nuclear, coal, and natural gas combined cycle power plants are core baseload technologies that provide firm power, which means their generating capacity is generally available. Renewable resources such as wind and solar are intermittent, as they are dependent on time of day, weather, and geographic location. However, because water can be stored and used to generate electricity on demand throughout the day, hydropower can serve as dispatchable renewable resource. While not inherently intermittent, hydropower availability is impacted by drought conditions and reservoir management. Natural gas combustion turbines (NGCT) are typically used during peak hours as they can be called on to quickly respond to sharp increases in demand. Figure 3 is a general illustration of where these resources fall within the daily electricity demand curve, with each resource playing a strategic role to match supply and demand.

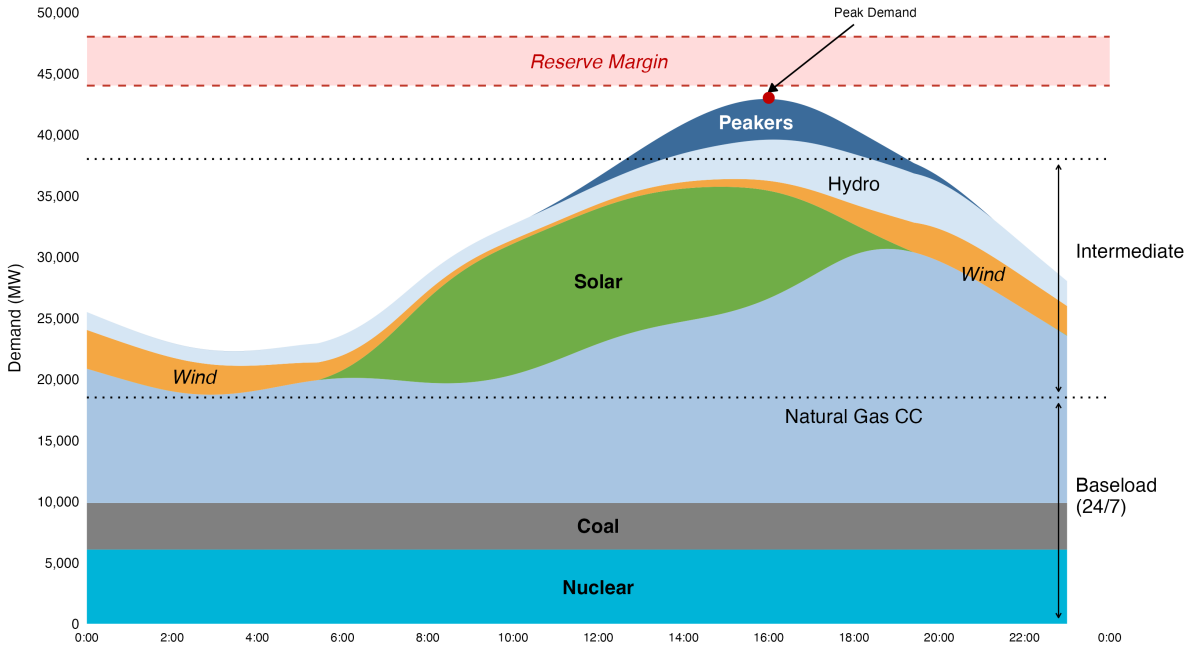

Figure 3: Energy Resources and Technologies in the Daily Demand Curve

Summary Point

Due to varying physical characteristics such as availability and flexibility, resource diversity is necessary for ensuring a reliable energy supply regardless of shifting demand patterns or external conditions. Similarly, the technologies that convert these resources into electricity vary in their operational characteristics, making technological diversity equally important.

Acknowledgements

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References

McLaughlin, T. (2025). Big tech's data center boom poses new risk to US grid operators. *Reuters*. https://www.reuters.com/technology/big-techs-data-center-boom-poses-new-risk-us-grid-operators-2025-03-19/