AMERICAN PUBLIC POWER ASSOCIATION
Powering Strong Communities

Peak Load Management Strategies for Public Power

As the demand for electricity grows, managing peak load effectively is crucial to ensuring the stability and sustainability of the electricity grid. Unmanaged load growth can strain infrastructure, increase operational costs, and undermine the reliability of electrical service. Traditional strategies for managing peak load have involved either building new transmission or distribution capacity or adding generation. Advances in grid and consumer technologies mean that public power utilities now have expanded options for managing peak load, including encouraging changes in usage patterns, designing new rates, and leveraging distributed energy resources.

Each strategy for managing peak load presents potential benefits and considerations for public power utilities.

Demand Management Strategies

Demand Response

Demand response, or DR, is when consumers adjust their electricity usage in response to signals from the utility. These signals can be price changes, financial incentives, or requests to reduce consumption during peak periods. DR programs can be automated or manual, involving residential, commercial, and industrial consumers.

Benefits
Helps utilities balance supply and demand, enhancing grid reliability.
Reduces the peak load, lowers operational costs.
Can defer investments in new infrastructure or additional power generation.
Provide consumers with opportunities to save on their electricity bills by shifting their usage to off-peak times or reducing usage during peak times.

Drawbacks and Considerations
Requires robust communication infrastructure and consumer participation.
Utilities must invest in technologies such as smart meters and control systems that allow utilities to measure and verify demand reductions made in response to a DR event.
Utilities must also have the capacity to provide timely and accurate price signals to program participants.
Consumer awareness and willingness to participate are critical, which may necessitate extensive outreach and education efforts.
If providing a financial incentive, it must be set at a level sufficient to motivate the desired consumer response.

Energy Efficiency

Energy efficiency involves reducing energy consumption through more efficient technologies and practices. Energy audits and retrofits are common approaches to identifying and implementing energy efficiency measures for consumers, which can include upgrading lighting, HVAC systems, insulation, and appliances. For public power utilities, energy efficiency efforts could include reducing line losses, conservation voltage reduction, transformer upgrades, and adding cap banks for power factor correction. Efficient use of the distribution system is a highly effective approach for managing peak load.

Benefits
Reduces overall electricity demand, leading to lower energy bills for consumers and reduced strain on the grid.
May limit or defer more costly investments in new generation or distribution infrastructure.

Drawbacks and Considerations
The initial cost of energy efficiency upgrades can be a barrier for some consumers. Utilities may need to provide incentives or financing options to encourage adoption.
Measuring and verifying energy savings can be challenging, requiring ongoing monitoring and evaluation.

Rate Design Strategies

Time-of-Use Pricing

Time-of-use, or TOU, pricing is a rate structure where electricity prices vary based on the time of day. Prices are higher during peak demand periods to incentivize consumers to shift their electricity usage to times when demand is lower.

Benefits
Helps flatten the demand curve, reducing peak load and operational costs for utilities.
Encourages consumers to use energy more efficiently and can lead to significant cost savings for those who can adjust their consumption patterns accordingly.

Drawbacks and Considerations
Requires advanced metering infrastructure to track and bill electricity usage based on time.
Some consumers may face bigger challenges in adjusting their usage, potentially leading to higher bills.
Effective communication and education are essential to help consumers understand and benefit from TOU pricing.
As TOU pricing is meant to encourage changes in consumer behavior, pricing structures must be carefully designed to maximize effectiveness.

Peak Demand Charges

Peak demand charges are imposed on consumers who either use electricity during utility peak demand periods or are charged additional fees periodically (e.g., monthly) based on their highest electricity usage during a defined interval. These charges are designed to incentivize consumers to reduce their peak demand and distribute their usage more evenly throughout the day.

Benefits
Can reduce the overall peak load on the grid.
Helps defer investments in new infrastructure and enhances grid reliability.
Consumers can reduce electricity costs by managing their peak usage.

Drawbacks and Considerations
Requires accurate measurement of peak usage, necessitating advanced metering systems.
Some consumers may face difficulties in reducing their peak demand, leading to higher charges.
Utilities need to ensure that the charges are clearly communicated and that consumers have access to tools and programs to help manage their usage.

Dynamic Pricing

Dynamic pricing involves electricity prices that change in real-time based on market conditions and grid demand. Prices can vary throughout the day, reflecting the actual cost of electricity production and delivery at any given time.

Benefits
Provides a strong financial incentive for consumers to adjust their usage, which can lead to significant reductions in peak load and operational costs for utilities.
Promotes efficient use of the grid.
Can more effectively integrate renewable energy sources.

Drawbacks and Considerations
Requires sophisticated metering and communication infrastructure.
Consumers must be willing and able to respond to price signals, which can be challenging without automation technologies.
Utilities need to provide clear information and support to help consumers understand and adapt to dynamic pricing.

Distributed Energy Resources

Energy Storage

Energy storage systems, such as batteries, accumulate electricity during periods of low demand and release it during peak periods. These systems can be deployed at various scales, from residential to utility-scale applications, and can store energy from various sources, including renewable generation.

Benefits
Helps balance supply and demand, reducing the need for peaking power plants and enhancing grid stability, helping to regulate energy prices.
Can provide backup power during outages and serve as a stabilizing resource when paired with intermittent renewable energy sources.

Drawbacks and Considerations
High upfront cost can be a barrier to widespread adoption. Utilities must consider the long-term benefits and potential revenue streams from storage to justify the investment.
As energy storage technologies evolve, utilities need to stay informed about advancements and best practices.

Vehicle-to-Grid Systems

Vehicle-to-grid, or V2G, systems support peak load management by enabling electric vehicles to discharge stored energy back to the grid during peak demand periods. V2G technology allows EV batteries to act as distributed energy storage resources, providing additional capacity to the grid when most needed.

Benefits
Can significantly reduce the strain on the grid during peak periods, enhance grid stability, and decrease reliance on costly peaking power plants.
Enhanced grid flexibility and reliability while providing EV owners with potential financial incentives for participating.
May allow utilities to defer investments in centralized energy storage systems.

Drawbacks and Considerations
Requires compatible EVs, charging infrastructure, and grid management systems.
The grid itself must be configured to allow for bidirectional energy flows in a manner that is safe, controlled, and properly metered.
The technology is still in its early stages; widespread adoption will take time. Utilities need to address regulatory, technical, and consumer acceptance challenges.

Virtual Power Plants

A virtual power plant, or VPP, is an aggregated network of centrally managed distributed energy resources, such as solar panels, batteries, and demand response assets like smart thermostats. VPPs operate as a single power plant, offering flexibility and reliability services to the grid.

Benefits
Enhance grid resilience by leveraging distributed resources to balance supply and demand.
Can reduce peak load, support renewable energy integration, and provide ancillary services.
Leverage underutilized assets.
May defer investments in new transmission, distribution, and generation capacity.

Drawbacks and Considerations
Coordinating and managing a diverse set of distributed resources can be complex.
Requires advanced software platforms and communication systems to operate effectively. While many VPPs utilize cloud-based computing systems to simplify implementation, cyber-physical security concerns may arise.
Regulatory frameworks and market structures must also evolve to accommodate the unique characteristics of VPPs, which may involve compensating utility customers for use of diverse assets.

More Resources for Public Power

The American Public Power Association has produced numerous resources that more fully explore many of the peak demand management strategies introduced in this technology brief. These include:

- Public Power Rate Design Case Studies
- Aligning Utility Rate Design with Grid-Edge Technologies
- A Refresher on Reducing Distribution System Loss

In addition, APPA Engage is an online space for the public power community to discuss important topics, share successes, ask questions, and connect with peers. APPA members interested in peak load management can request to join the Energy Innovation group or the Energy Transition Community group.