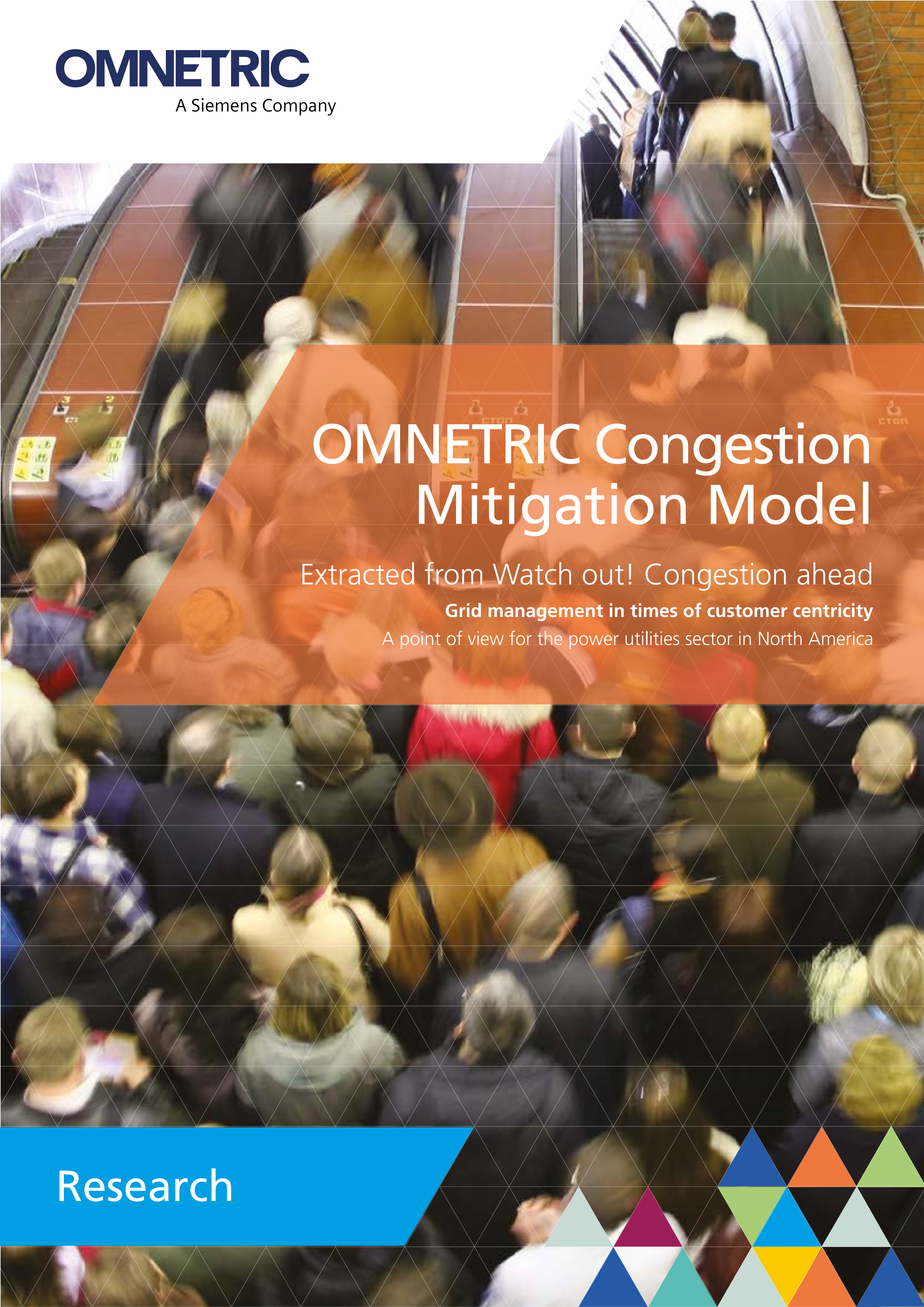
OMNETRIC
A Siemens Company



OMNETRIC Congestion Mitigation Model

Extracted from Watch out! Congestion ahead

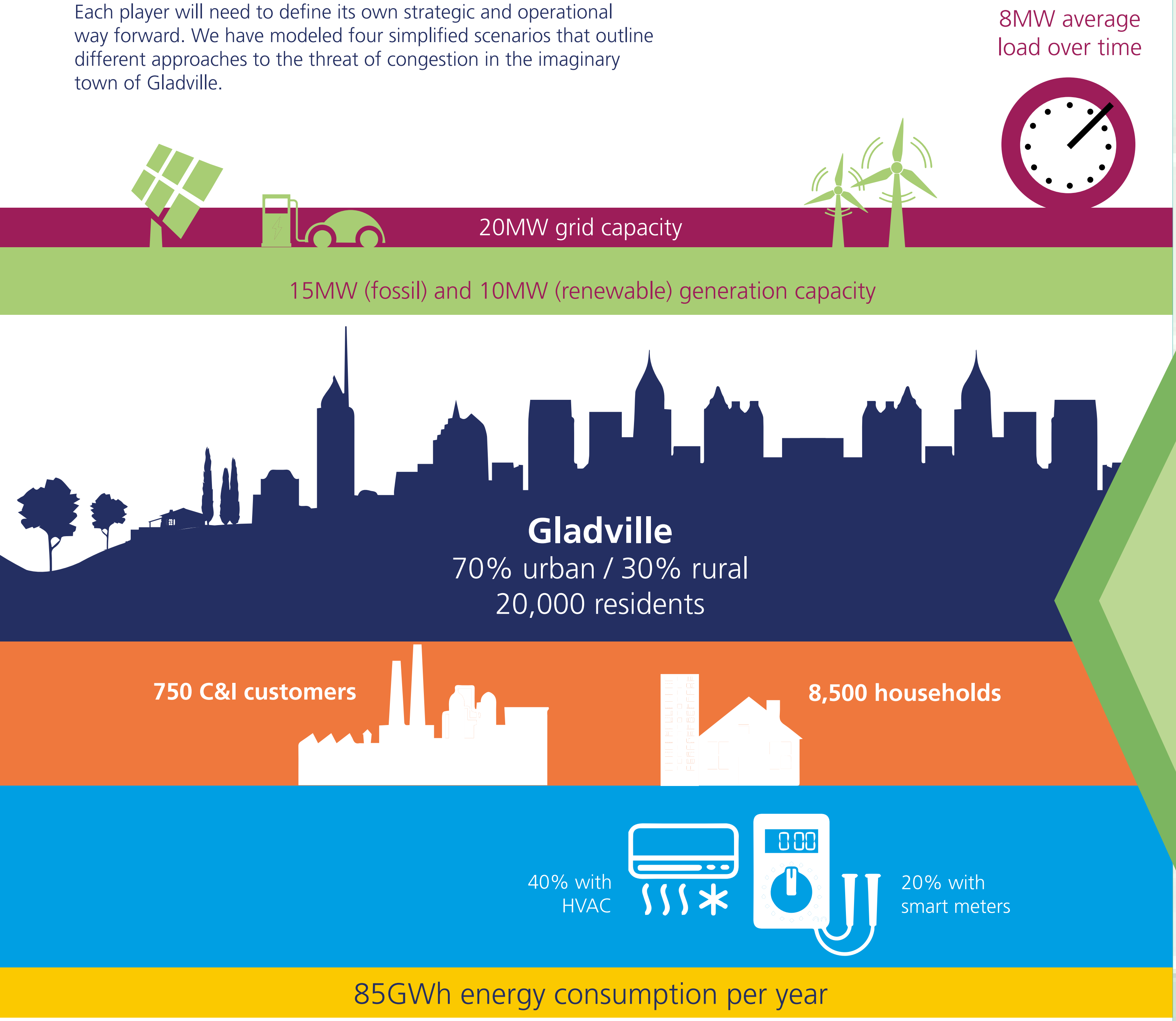
Grid management in times of customer centricity

A point of view for the power utilities sector in North America

Research

OMNETRIC Congestion Mitigation Model

How do utilities deal with congestion? There is no single solution. Each player will need to define its own strategic and operational way forward. We have modeled four simplified scenarios that outline different approaches to the threat of congestion in the imaginary town of Gladville.



Gladville has historically been a bedroom community for Big Metro City. Recently, Gladville was also voted as #5 in the "Top 10 Small Towns to Live in the US" and is seeing rapid growth. Furthermore, with its proximity to three major universities and a major metro airport, Gladville has made the short list of cities identified by online retailer Mega River, Inc., as a potential site for a second hub.

Model parameters:

1. *The utility is a regulated local distribution company focused on distribution of electricity to the end customer. It is the single source of supply in its service territory and does not have the charter to provide deregulated value-added services. The utility does not have any additional ways to drive economic benefit such as special tariff packages or flexibility services. Therefore, the distribution utility needs to be incentivized to operate efficiently through its distribution rates.*

2. *The utility's regulatory ratemaking process allows it to recover all capex and O&M expenditure associated with enabling integration of customer or third-party energy resources under the various scenarios described. It also allows for recovery of lost energy revenue from integrating customer-side resources via a lost revenue adjustment mechanism. This does not automatically mean that customers will have to pay for grid upgrades in all cases, because the rate increase could be mitigated by competitive market mechanisms. However, in this simplified model, we have assumed a favorable regulatory environment, wherein the utility is able to maintain cost and revenue neutrality for infrastructure investments and the reliable integration of third party energy resources.*

Here comes trouble! Congestion ahead

Gladville's current generation capacity of 25MW connected to its distribution network will almost double over the course of the next three years.

5MW of rooftop solar capacity will be added to the grid in year one thanks to an incentive program.

15MW of solar capacity will be added to the grid via an investor-owned solar farm to be installed over three years, adding 5MW of additional capacity per year.

The utility serving Gladville realizes that the increased local generation may help mitigate some of the demand growth, but that the current grid set-up will not be able to cope with the impact of these developments. The utility is evaluating four options to master the congestion threat:

- **Infrastructure enhancements**
- **Battery storage integration**
- **Demand response program**
- **Distributed energy resource management system (DERMS)**

Model parameters:

3. *The financial implications for the distribution utility were calculated over a time span of ten years. This reflects an average, market-compliant scope for investments and business case calculations, considering the projected life of inverters and battery systems. The ten-year approach may be conservative for certain classes of utility assets, but caps the benefit streams to realistic timeframes and simplifies the modeling for the out-years (when additional investments may be needed to address increased demand and equipment end-of-life).*

4. *The model incorporates a multitude of further key assumptions (e.g. regarding cost structures, technological feasibility and market acceptance) that are based upon data from well established, market-leading sources like EPRI and NREL.*

Four options to master the congestion threat

1 Infrastructure enhancements

In this scenario, infrastructure reinforcement is the only action taken by the utility. This includes traditional capacity upgrades such as transformers, but also increased monitoring capability and circuit modifications via smart switches and voltage regulation.

Benefits

- All costs are completely recovered via rate relief and while there are no incremental financial benefits to the utility, it remains revenue neutral.
- The utility can maintain or improve its reliability metrics even in the context of increased demand and increased generation on the distribution network.
- This initiative represents business as usual for the utility because the processes and action plans are in place and optimally tailored to the utility's specific situation.

Challenges

- This solution does not yield any financial benefit beyond cost recovery.
- In high density residential areas or areas with underground networks, where infrastructure enhancements are more complicated and cost-intensive, this scenario could be less attractive financially and in terms of customer perception.
- While seemingly straightforward, this solution will necessitate a multitude of adjustments to the grid and its future management, to enable remote monitoring and operation.

2 Battery storage integration

In this scenario, the utility adds 1MW / 4MWh of battery storage in year one. By charging the battery during periods of excess generation and discharging during periods of peak demand, the utility is able to smooth out its demand curve and mitigate against "duck curve" effects.

Benefits

- Financial benefit over ten years is in the region of $1.5M. This translates to a yield of $7K per MW of DER capacity added to the grid (from renewables and storage) per year.
- The utility can measure and quantify improvements in reliability metrics and confirm that the battery storage provides equivalent or better reliability than its benchmark.
- Battery discharge can be used to alleviate peak demand and periods of congestion, thereby representing a more dynamic solution than traditional infrastructure enhancements. Thanks to the increased flexibility in grid management, the utility benefits from avoided capacity charges as well as avoided distribution infrastructure and system capacity operations and maintenance (O&M), which accumulate to just over $1M over the course of the ten years (discounted).
- Costs associated with battery storage and ongoing O&M are continuously decreasing over time, improving the solution viability.

Challenges

- The battery storage solution incurs almost double capital expenditure investments compared to the infrastructure enhancements route, but ongoing O&M costs are lower.
- The industry does not have extensive experience with the technical, performance and financial characteristics of battery storage over time.
- Examples of utility-scale storage in the US to date are limited and it is difficult to determine whether regulation would currently fully support recovery of all battery costs via rate relief.

3 Demand response program

The utility implements a demand response program for commercial and industrial and residential customers together with the same infrastructure enhancements as described in the first scenario.

Benefits

- Financial benefit over ten years is in the region of $3M–twice that of the battery storage integration route. This translates to a yield of $14K per MW of DER capacity (from renewables and demand response) added to the grid per year.
- The utility can measure and quantify improvements in reliability and confirm that the demand response provides equivalent or better reliability than its historic benchmark.
- The utility and rate payers realize the benefits of deferred capital expenditure for distribution grid upgrades, and avoided capacity charges, infrastructure and O&M expense that may otherwise be needed to meet the projected demand
- Environmental and societal benefits result from reducing the energy and demand footprint.
- This approach adds 2MW of additional capacity.
- The costs associated with demand response programs can be recovered in many regulatory environments via adjusted rates, whereas cost recovery for storage is currently less clear. As such, this option could feel a safer bet than the storage solution.

Challenges

- Because the behavioral programs involved in a demand response solution affect load, this solution not only includes the cost of the demand response program, but also the cost of infrastructure enhancements (as in the first scenario).
- Demand response programs require new skillsets to establish and manage an incentive-based grid management mechanism.
- A key success factor is the utility's ability to promote the demand response program to the different target groups and engage them over time. This calls for an open and informed dialogue between the utility and its customers.

4 Distributed Energy Resource Management System

The utility implements a distributed energy resource management system (DERMS) as the core platform to manage the different grid assets and information. This option incorporates a demand response program for commercial and industrial and residential customers, and infrastructure enhancements in the form of battery storage.

Benefits

- The financial benefit over ten years is in the region of $4.5M–50% more than the demand response route and three times more than the battery storage integration route. This translates to a yield of $20K per MW of DER capacity (from renewable generation, storage and demand response) added to the grid per year.
- The utility can quantify the benefits of congestion avoidance in terms of its typical reliability and quality-of-service benchmarks in the context of increased demand.
- A DERMS hedges against capacity charge increases and serves as a distribution system investment deferral strategy that may equate to 10% additional incremental benefits compared to the infrastructure enhancements route.
- The only major infrastructure reinforcement measure is the addition of 1MW / 4MWh of battery storage.
- This approach incorporates the same demand response program as the previous solution that adds 2MW of additional capacity.
- The operational experience gained in battery storage management and demand response program execution provide a foundation for future flexibility.

Challenges

- The upfront investment exceeds the other alternatives. However, the average yearly cost for the DERMS approach runs at almost the same level as the other scenarios over time.
- This is the most far-reaching transformation in terms of design and implementation. The requirements for each hardware and software element must be determined in the context of the full system to ensure optimal interplay and efficiency.
- DERMS represents a new area of expertise for many utilities, and demands that they design and implement their system in a highly collaborative way, drawing on the inputs of business, engineering and technical teams.

Summary

Our simplified modeling shows that utilities can take a number of approaches to mitigating congestion, and that these approaches can also deliver financial benefit.

The model shows that the most convincing solution in economic terms is the implementation of a DERMS. This approach optimally leverages the potential of software-, behavior- and asset-driven actions to offer the flexibility required for increased capacity and resilience.

Nevertheless, all scenarios represent viable options to improve grid capacity, optimize grid management and counter congestion.

The model does not factor in the scarcity of resources (e.g. investment, personnel) and lack of experience with new technologies that could impact the feasibility and success of the DERMS route. Indeed, implementing a DERMS could call for a multi-stage approach with pilot projects to determine the optimal combination of asset-, behavior- and software actions.

All scenarios assume that the utility can fully recover capital expenditure, and operational expenditure associated with infrastructure improvements, enablement of DERs and demand response programs. Additionally, it is assumed that regulatory policy allows for a lost revenue recovery mechanism for enablement of demand response and third party DER integration. See the "Modeling parameters" footnote on pages 11 and 12 for additional information.

Executive sponsor
Craig Cavanaugh
CEO—North America, OMNETRIC
craig.cavanaugh@omentric.com

For more information
Sachin Gupta
Senior Sales Director—North America, OMNETRIC ,
responsible for distributed energy resource management
sgupta@omnetric.com

OMNETRIC

OMNETRIC is dedicated to helping energy providers reap the benefits of the digital energy system by integrating their energy operations with IT to support their business goals.

Our global team of engineering, IT, security and data experts brings extensive industry experience to help customers discover and exploit data intelligence to capitalize on industry change, and realize new business models.

Helping customers since 2014, we are an inventive, technology services company. For more, visit www.omnetric.com.

OMNETRIC is a Siemens company.