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Grid Modernization, the Feeder and Substation of the Future, and Utilizing Advanced Metering Infrastructure (AMI) as a Foundational Component of a Grid Modernization Roadmap

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2022 CIGRE Grid of the Future Symposium
Chicago, IL
Nov. 8, 2022

Grid Modernization Drivers

Aging infrastructure

Evolving expectations

Of customers regarding reliability, resilience, and power quality

Stresses and requirements

Imposed on the existing grid by the adoption of new technologies, such as DER and electrification

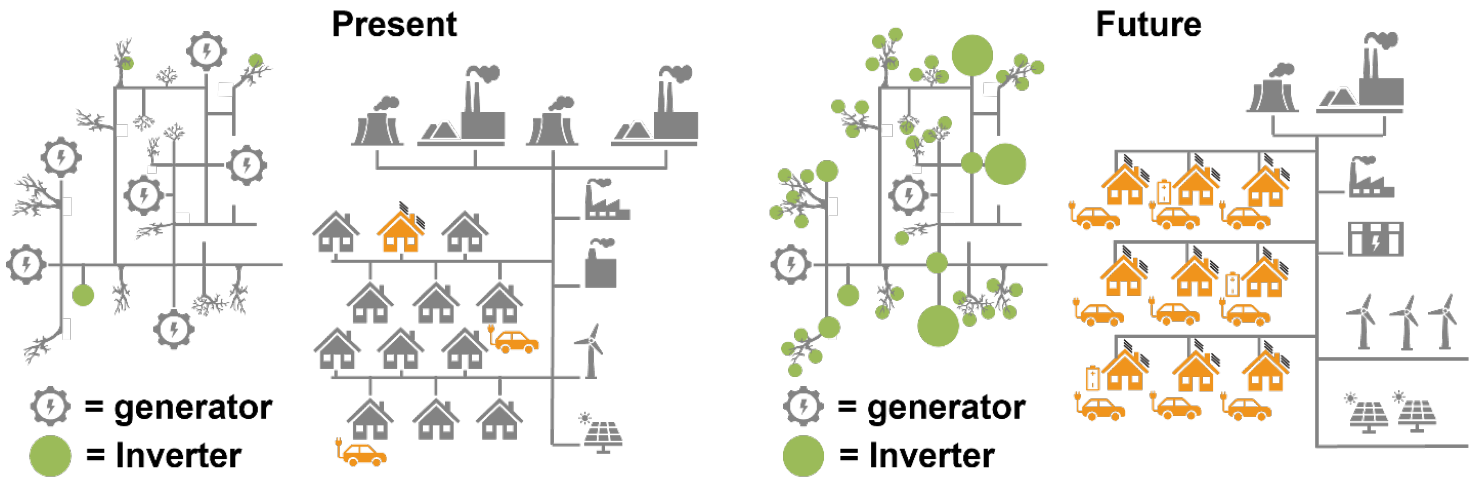
Evolving challenges

To severe weather impacts (e.g., more frequent and more severe storms and catastrophic events, such as hurricanes and wildfires)

Man-made impacts

From events (e.g., cyberattacks, sabotage, terrorism, etc.).

Grid Modernization Features



Improved reliability for everyday operations.

Increased sustainability through energy-efficiency, demand response, and renewable resources.

Superior flexibility to respond to the variability and uncertainty of conditions at one or more timescales, including a range of energy futures.

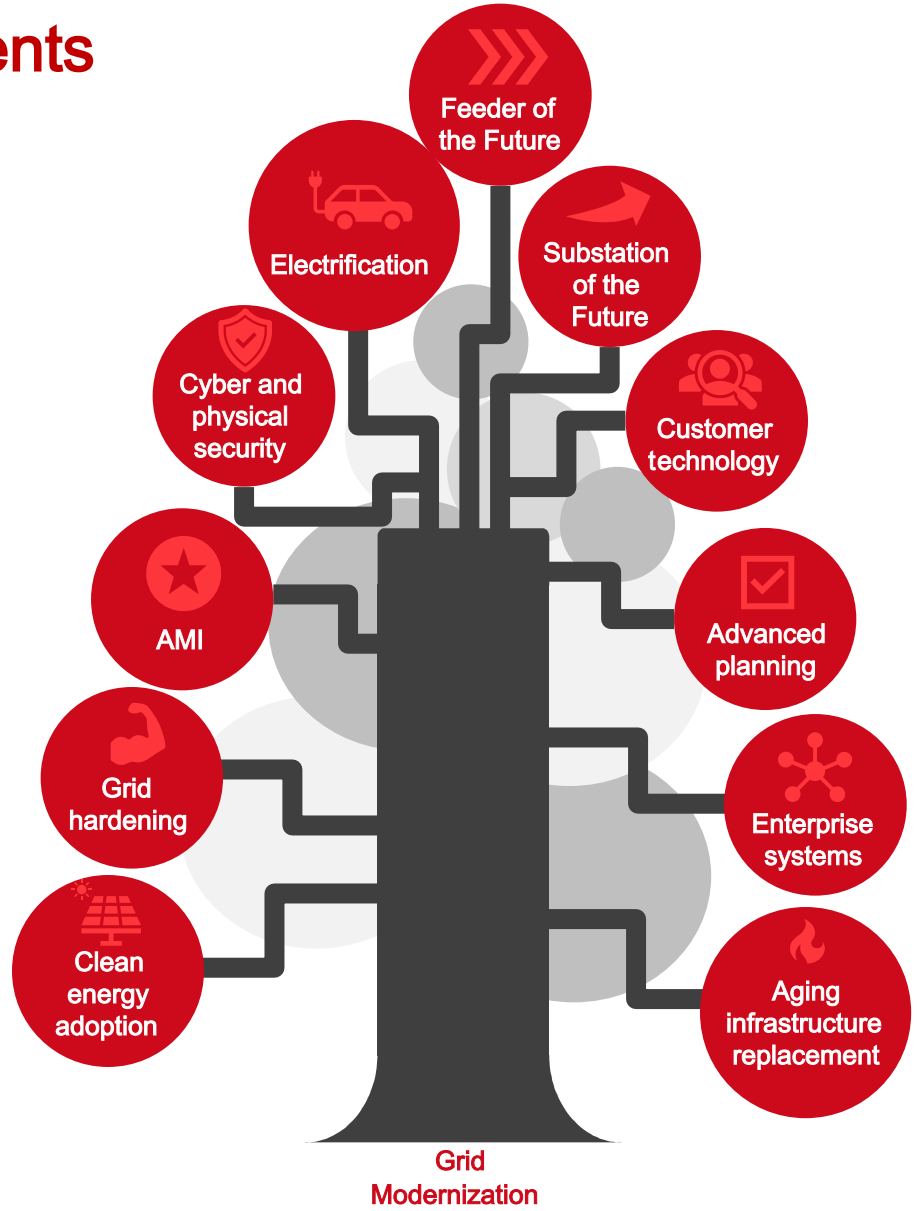
Enhanced physical and cyber security from an increasing and evolving number of threats.

Long-term affordability to maintain economic prosperity.

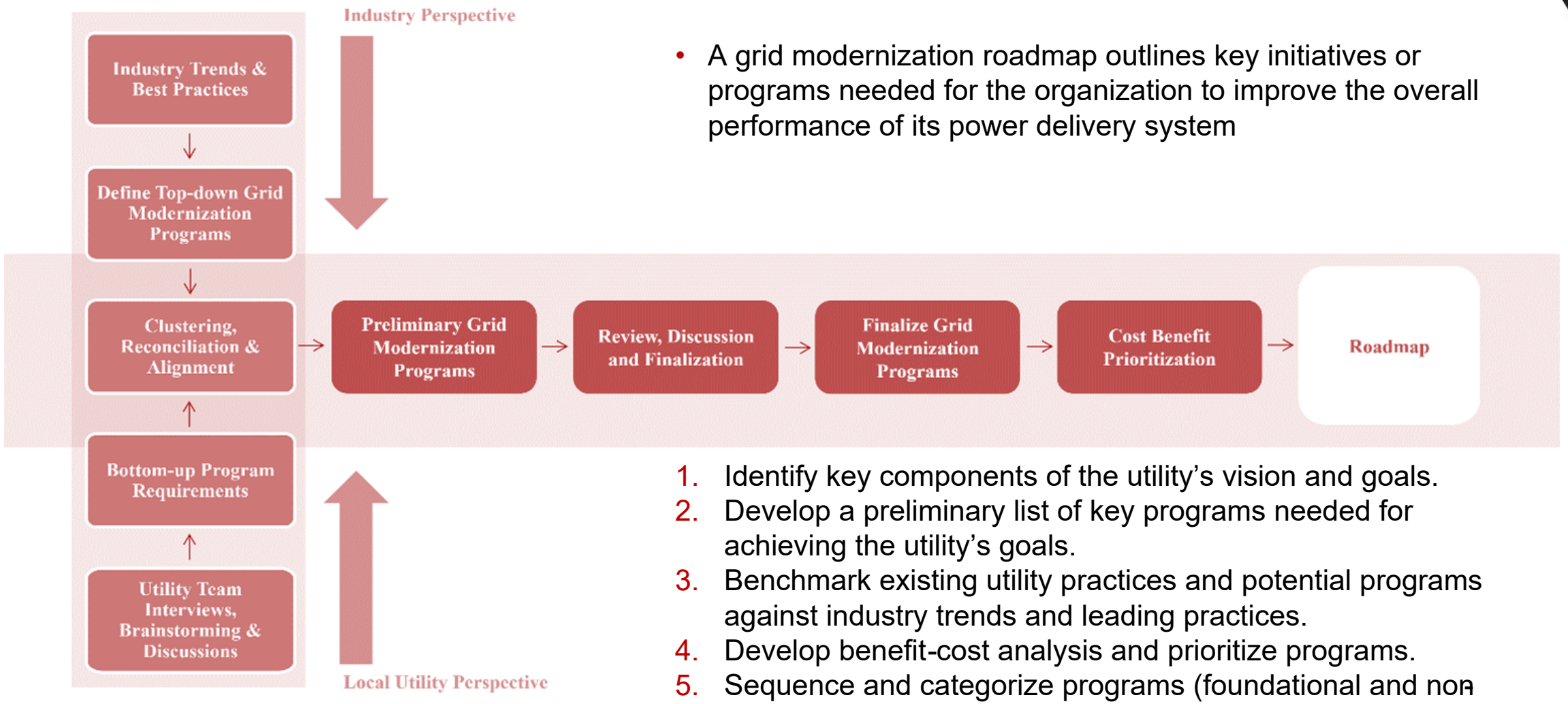
Greater resilience for hazards of all types.

Grid Modernization Strategic Components

- Grid modernization leverages industry's best practices and considers emerging technologies to set the basis for transforming and preparing for the future according to the utility's vision and goals
- A grid modernization strategy involves multiple components intended to address key drivers and enable selected features and capabilities of a modern grid
- This presentation focuses on three of them:
  - Feeder of the Future
  - Substation of the Future
  - Advanced Metering Infrastructure



Grid Modernization Roadmap

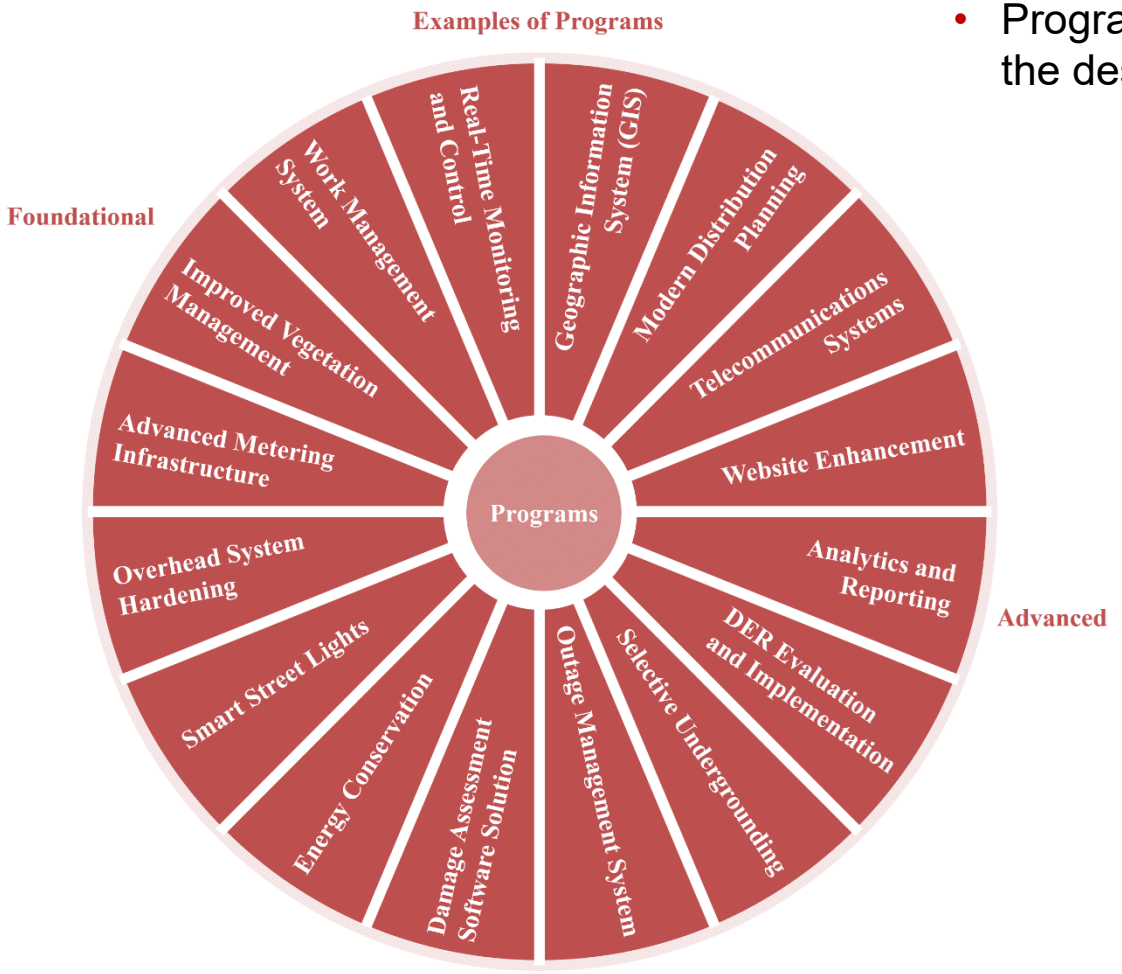


- A grid modernization roadmap outlines key initiatives or programs needed for the organization to improve the overall performance of its power delivery system

1. Identify key components of the utility's vision and goals.
2. Develop a preliminary list of key programs needed for achieving the utility's goals.
3. Benchmark existing utility practices and potential programs against industry trends and leading practices.
4. Develop benefit-cost analysis and prioritize programs.
5. Sequence and categorize programs (foundational and non-foundational)

Grid Modernization Programs

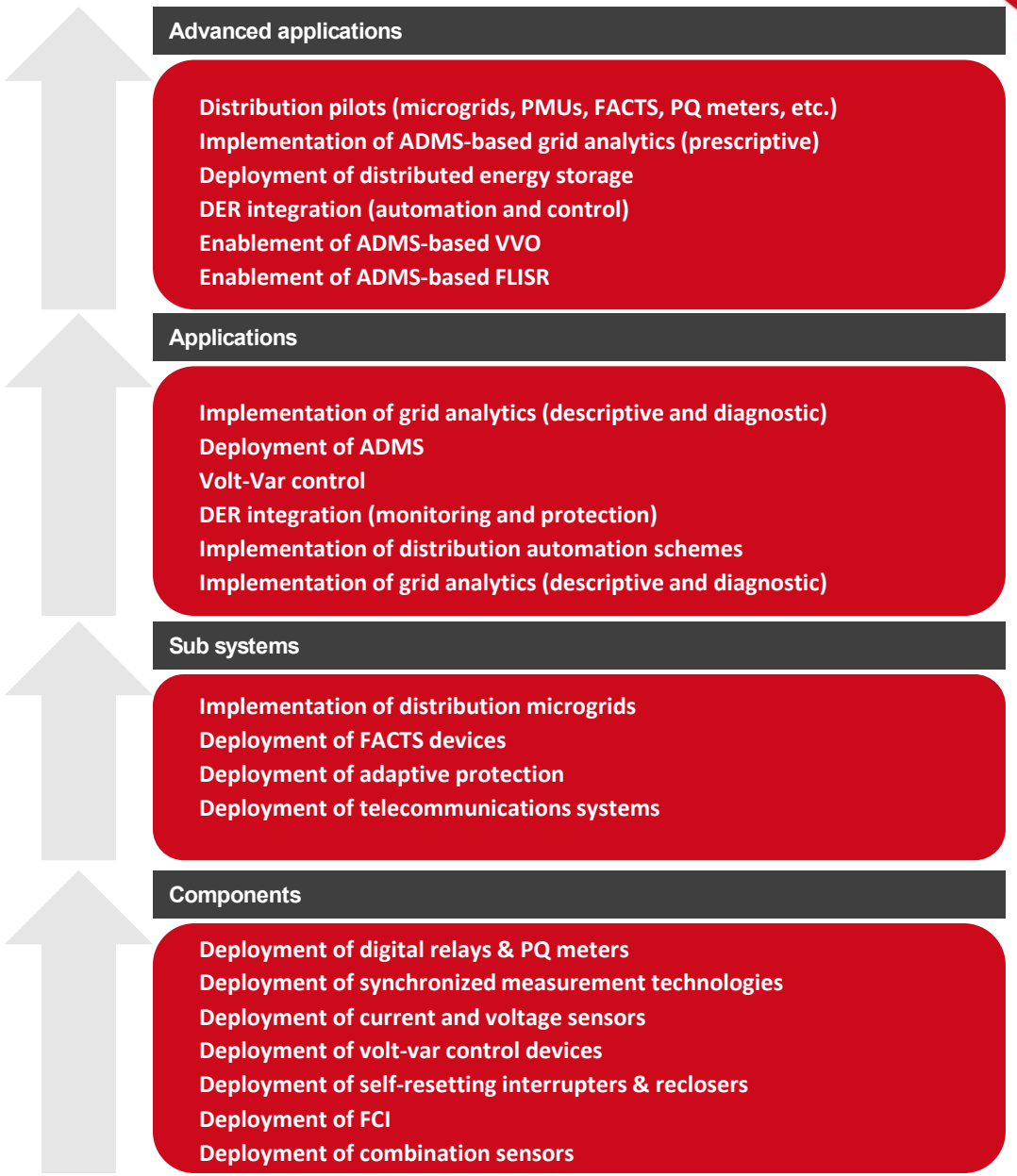
- A grid modernization roadmap consists of a prioritized portfolio of programs.
- Programs are projects or initiatives that can be implemented to realize the desired functionality, capability, or other specific utility goals.



Feeder of the Future – Programs

The Feeder of the Future component of a grid modernization strategy is intended to modernize the power delivery infrastructure to:

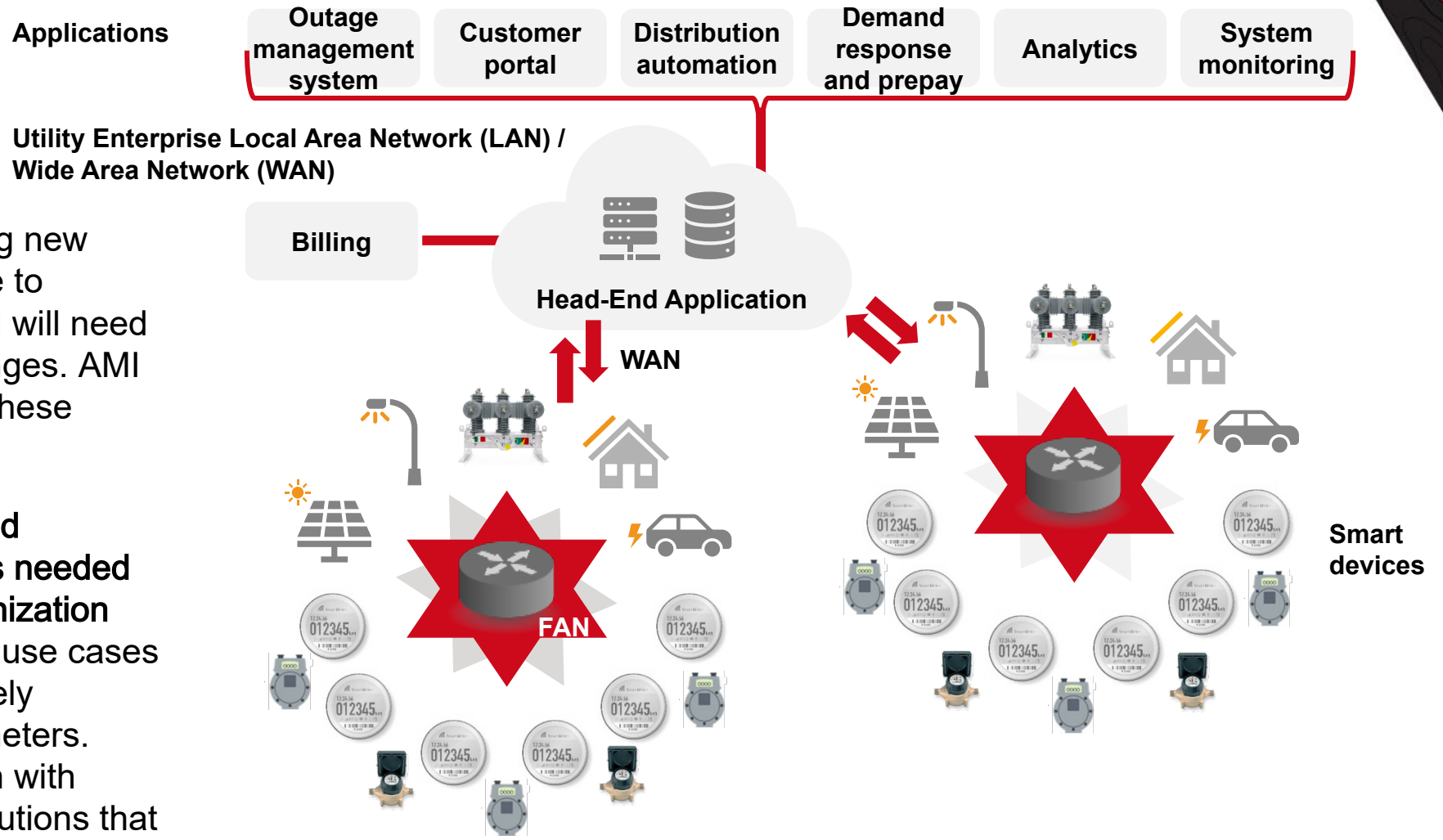
- **Prepare or "future proof" the distribution grid** , to the extent possible, for the adoption of DER (e.g., distributed generation, distributed energy storage, etc.), electrification and emerging technologies
- **Enable the required capabilities** to meet the utility's strategic objectives and regulatory requirements, such as reliability and resilience improvement (e.g., harden the grid against major weather events), decarbonization (e.g., adoption of DER and electric vehicles), and climate change preparedness



Substation of the Future – Programs

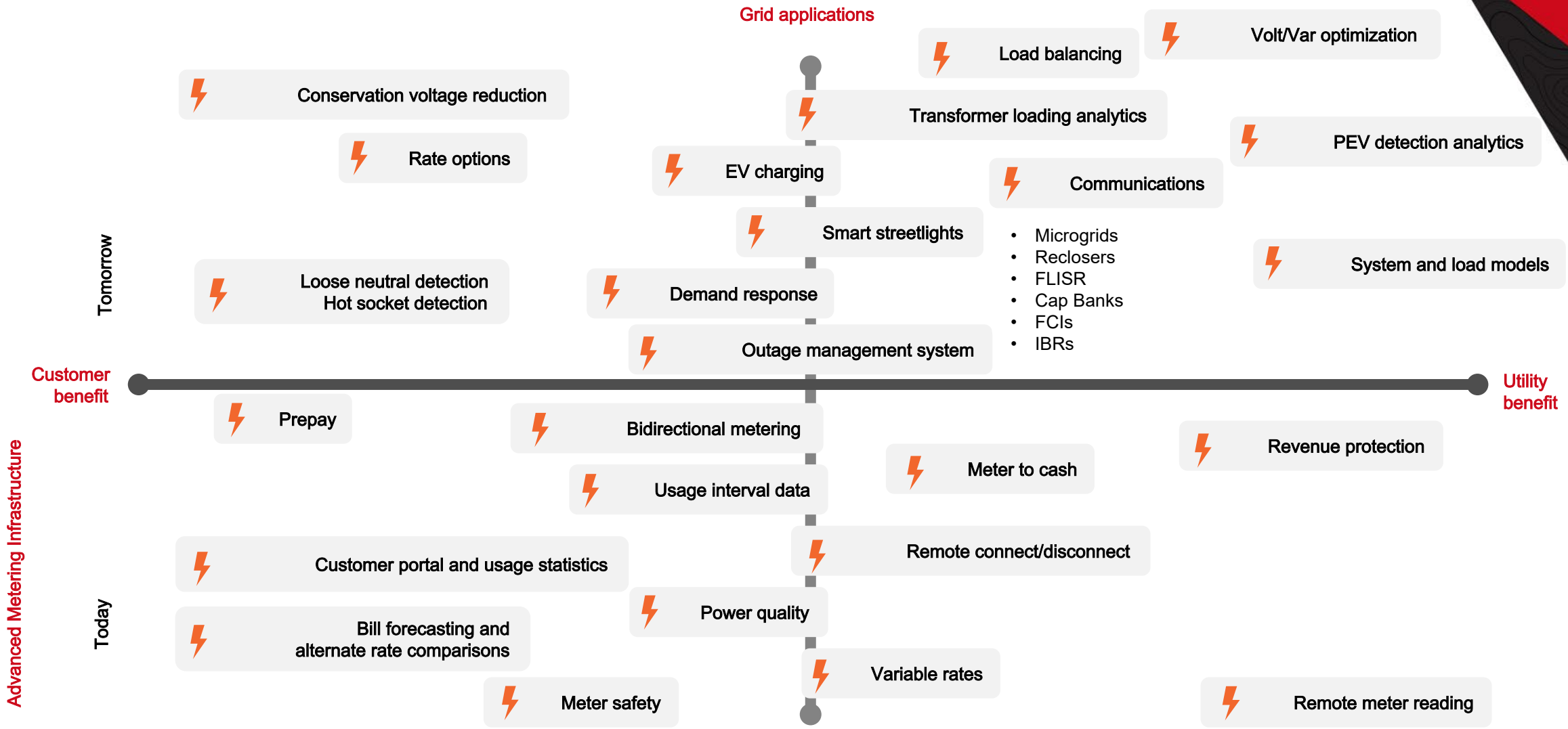
- There is an urgent need for substation modernization given the increasing importance of the interaction effects between transmission and distribution systems, such as reverse power flow through substation transformers as well as voltage fluctuations and protection coordination challenges caused by DER proliferation
- Additionally, transportation electrification integration is creating a growing need to monitor substation assets in real-time to understand how charging infrastructure impacts asset loading (e.g., substation transformers), power quality, and equipment operation (e.g., load tap changers)
- Technology evolution, such as the proliferation of intelligent electronic devices (IED), including microprocessor-based relays and power quality meters, can enable key new capabilities to plan and operate modern power delivery systems that were not available in traditional equipment (e.g., electromechanical relays)
- This can also allow implementing new concepts, such as substation-level microgrids and Virtual Power Plants (VPP) and intentionally islanding

Advanced Metering Infrastructure – Overview



- The distribution grid is facing new challenges that will continue to increase over time. The grid will need to adapt to meet these changes. AMI is one tool to help address these challenges
- **AMI enables many advanced applications and capabilities needed for a successful grid modernization program.** These benefits or use cases cannot be achieved by merely installing the network and meters. Many will require integration with ADMS or other software solutions that allow the data to be analyzed, visualized, and paired with other data

AMI and Grid Modernization – Advanced Grid Infrastructure



Conclusions

- As utilities continue to drive decarbonization initiatives, integration of renewables and DER, adoption of electric transportation, and climate change readiness, there will be an increasing need to understand and proactively manage distribution system assets to optimize operations, improve performance, and minimize (or prevent, to the extent possible) system disruptions
- Given the impacts on the distribution grid, it is important to include the Feeder of the Future and Substation of the Future concepts as part of an overall grid modernization plan.
  - The FoF concept involves the deployment of feeder devices, subsystems, and applications. Communications continues to be a major issue for the distribution grid to implement many of these features
  - The SoF concept enables advanced real-time monitoring, protection, automation and control capabilities, and therefore, depends on a reliable communications infrastructure
- To achieve communications across the distribution grid to connect the various components and enabling new applications, it is important to examine the use of the AMI network as a cost-effective solution. Conversations need to shift beyond the meter as a metering device to a component of an Advanced Grid Infrastructure (AGI) that addresses the needs of a modern grid

Thanks!