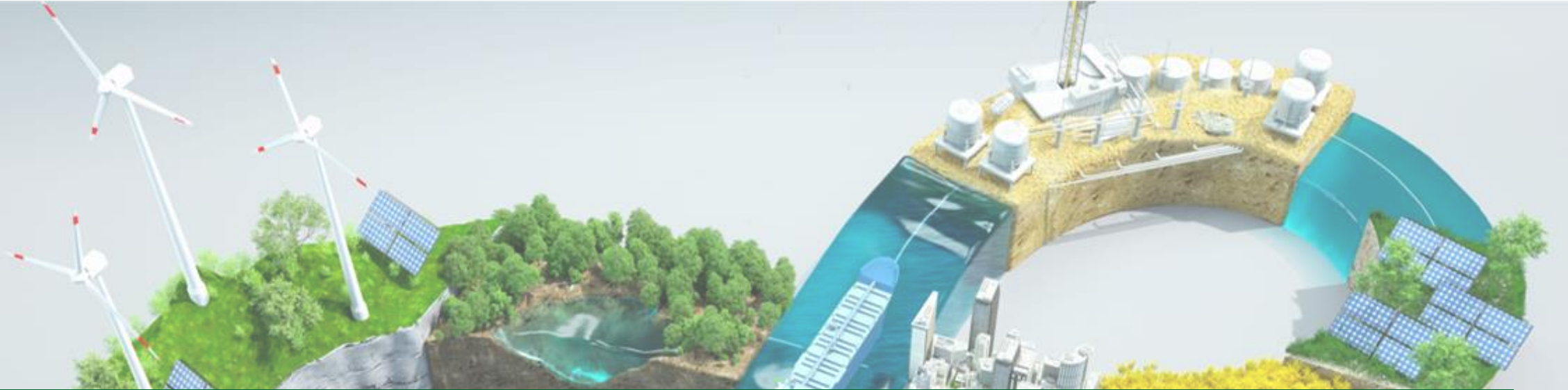




U.S. DEPARTMENT OF
ENERGY



Pathways to Commercial Liftoff: Innovative Grid Deployment

May 2024



Agenda

- Liftoff scope
- Opportunity at stake
- Current state of deployment
- Path to liftoff
- Key actions for and resources to support deployment

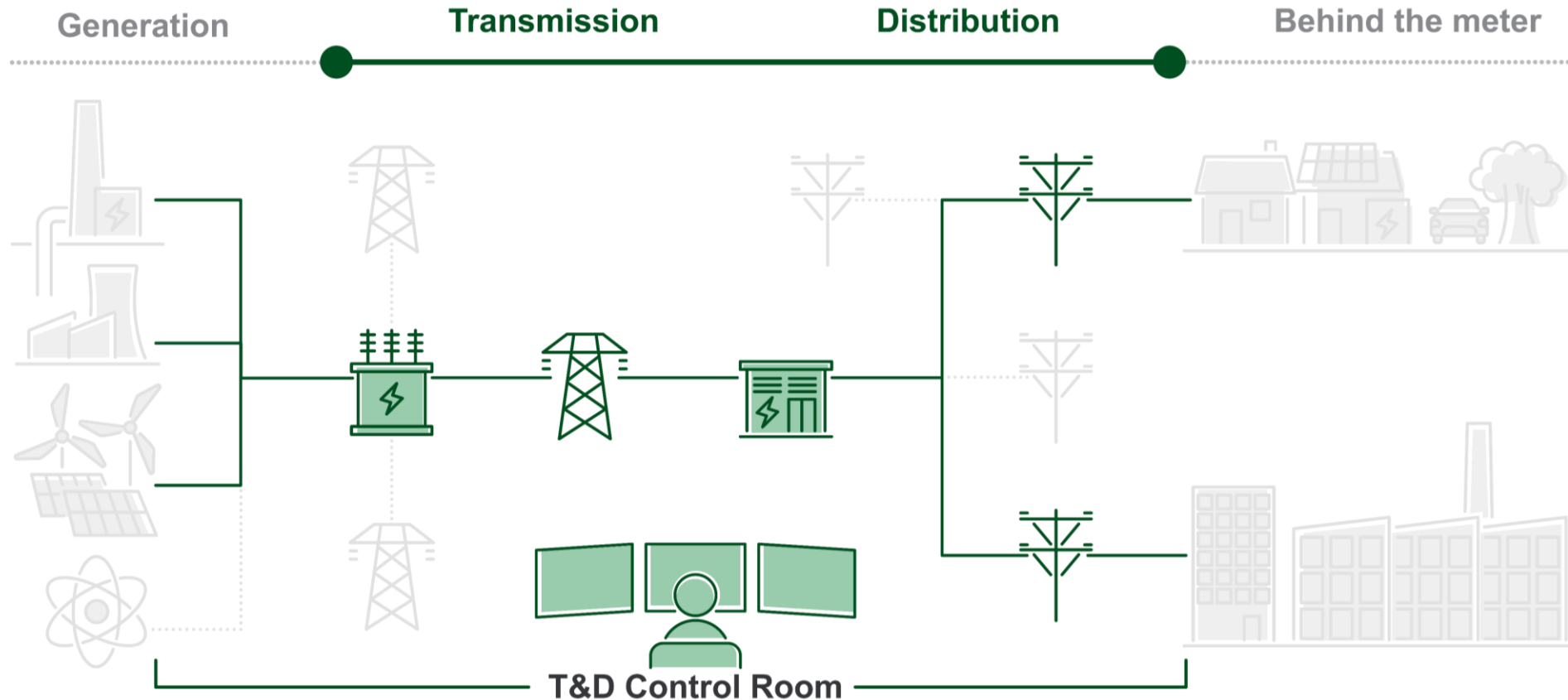
Key messages

- Multiple advanced grid solutions are available today to quickly and cost-effectively get **more capacity out of the existing transmission and distribution system** – supporting upwards of 20-100 GW of additional peak demand – while advancing **grid reliability, resilience, affordability, and sustainability**.
- These **advanced grid solutions are already being used today** – yet **deployment at scale and associated industry know-how is lagging** due to a lack of sufficient incentives and prioritization.
- Achieving liftoff and deployment at scale requires **proactive investment approaches** with greater **technology information sharing and integration in grid planning** along with **policy and regulatory signals and reforms** to give industry sufficient incentive to invest.
- Policymakers, regulators, and utilities can **better evaluate and therefore strategically deploy these advanced grid solutions today** – leveraging federal funding and resources – to address grid hotspots in the near-term while modernizing the grid for the long-term.

Disclaimer

- DOE is only communicating public and non-privileged information during this webinar.
- DOE will not be discussing the details of any specific program opportunity in this webinar (e.g., Request for Information, Notice of Intent, Funding Opportunity Announcement)

Innovative Grid Deployment Liftoff scope



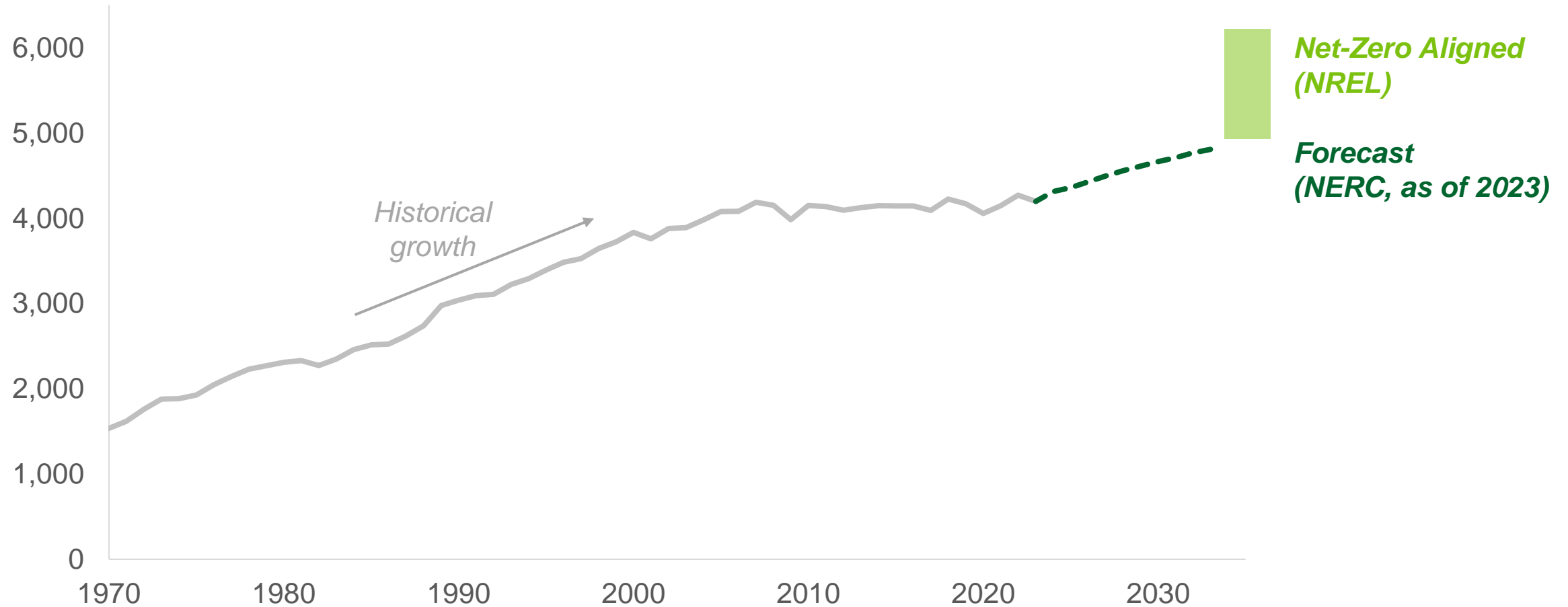
Liftoff Scope

✓ Transmission and distribution system

✓ Existing rights-of-way infrastructure

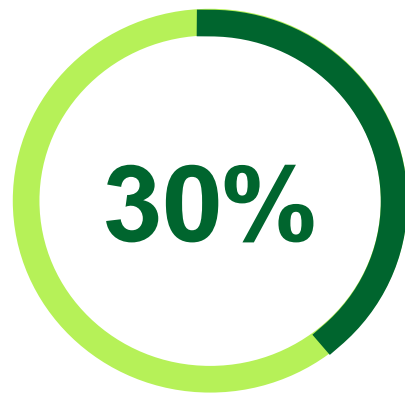
✓ Commercially-available, advanced grid solutions

Electricity Demand (TWh)

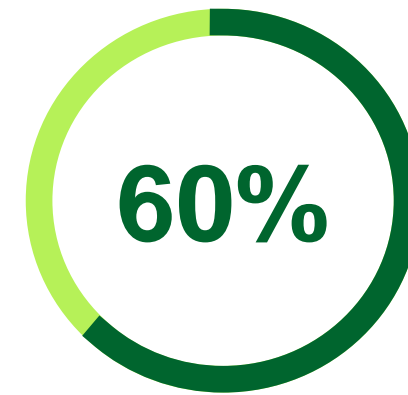


Data source: NERC *Electricity Supply and Demand Data* (2023); EIA, *Monthly Energy Review*; NREL *Pathways to 100% Clean Electricity* (2022).
Note that electricity demand here includes transmission losses and direct use.

Portion of lines estimated to be at or near end of life



Transmission



Distribution

Significant external pressures stress the grid



Utility Dive
Sept 2023

“Record 13% of Eastern Interconnect capacity failed in Winter Storm Elliott: FERC, NERC”

**News Service
of Florida**
Oct 2022

“FPL to seek \$1.1 billion from customers to cover Hurricane Ian costs”

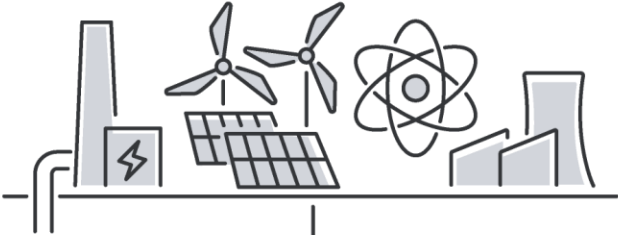
CBS News
Aug 2021

“PG&E briefly shut off power to 48,000 residents as wildfires continue to threaten California's power grid”

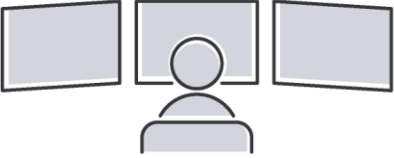
USA Today
Dec 2022

“Attacks on power substations are growing. Why is the electric grid so hard to protect?”

Large Generators



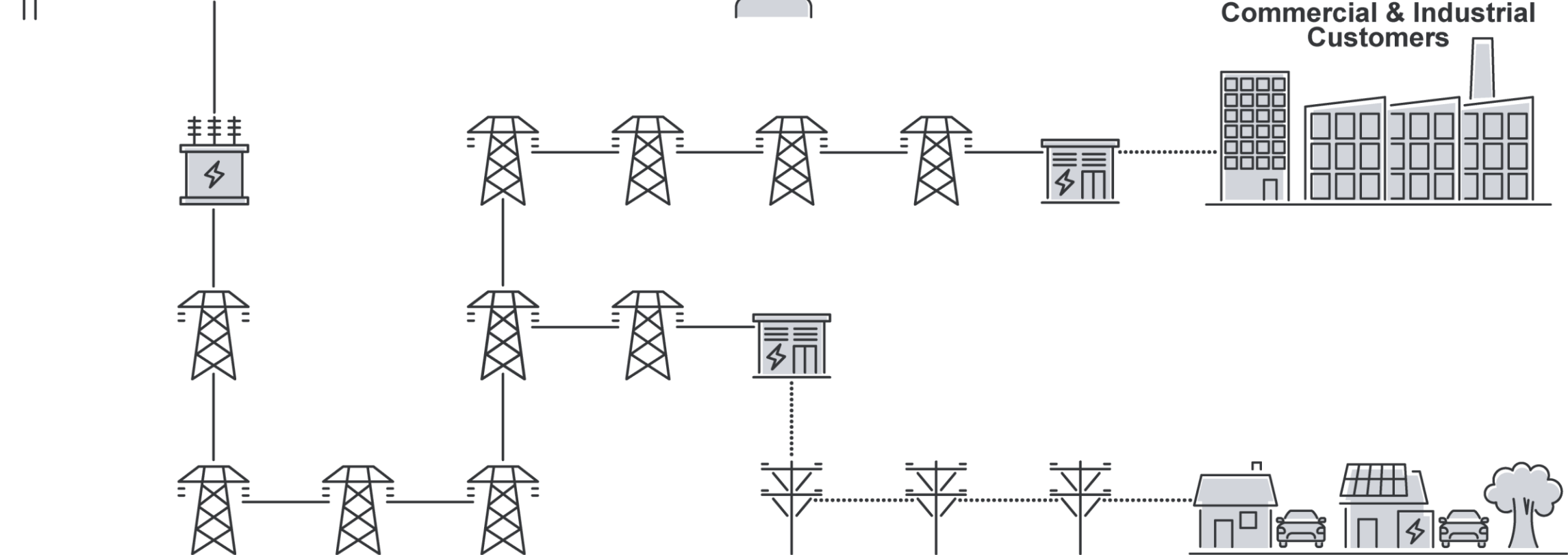
Control Room

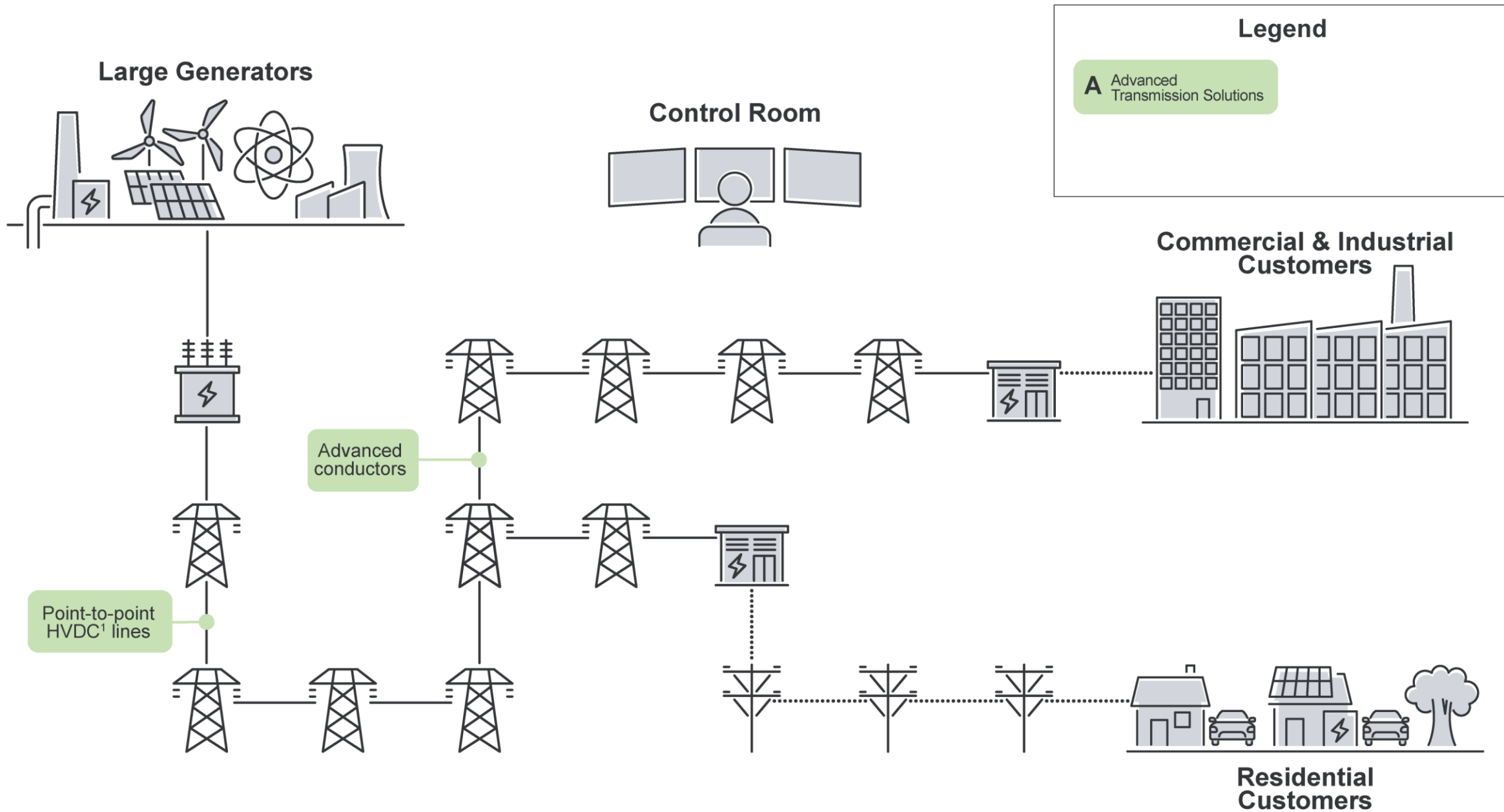


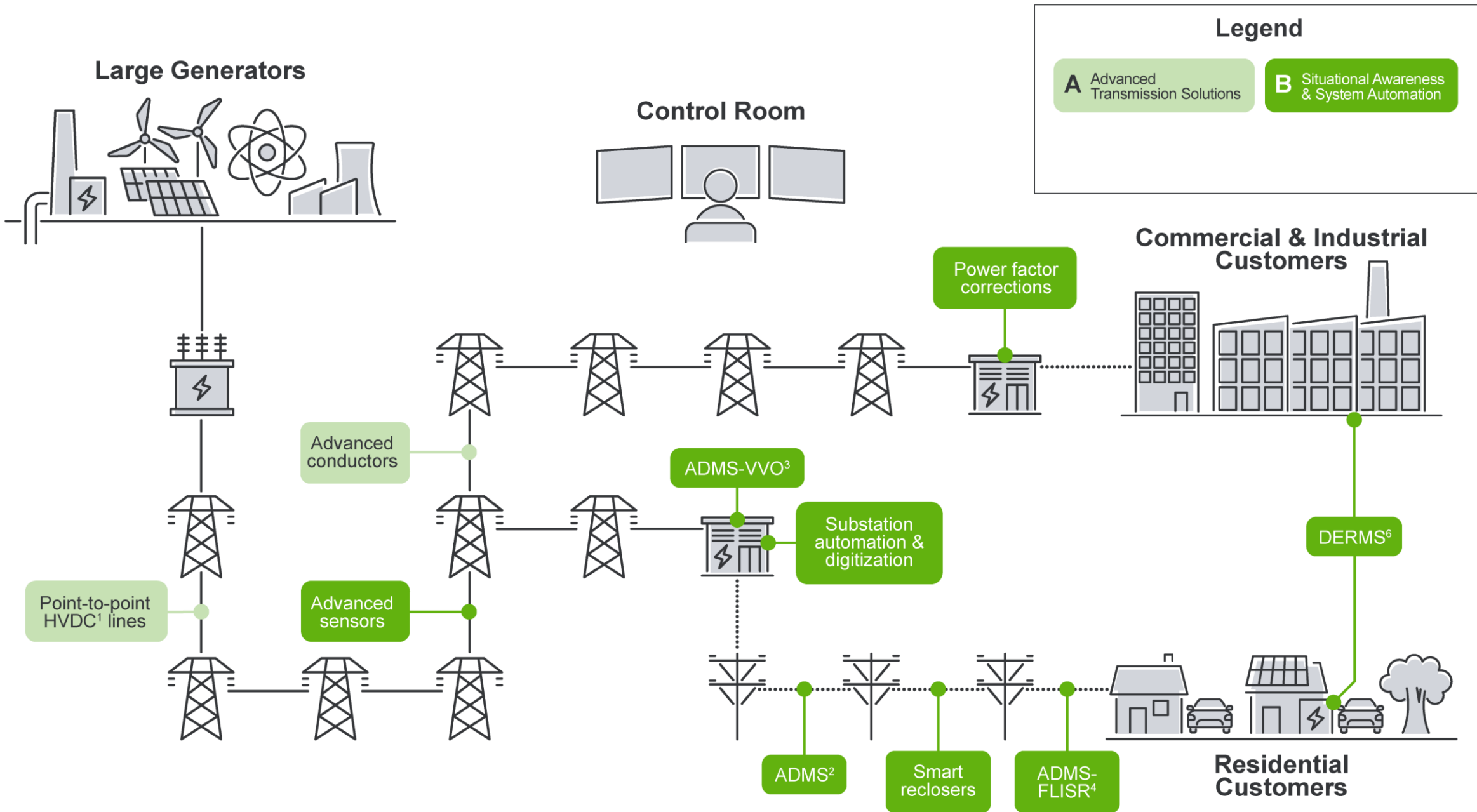
Commercial & Industrial Customers

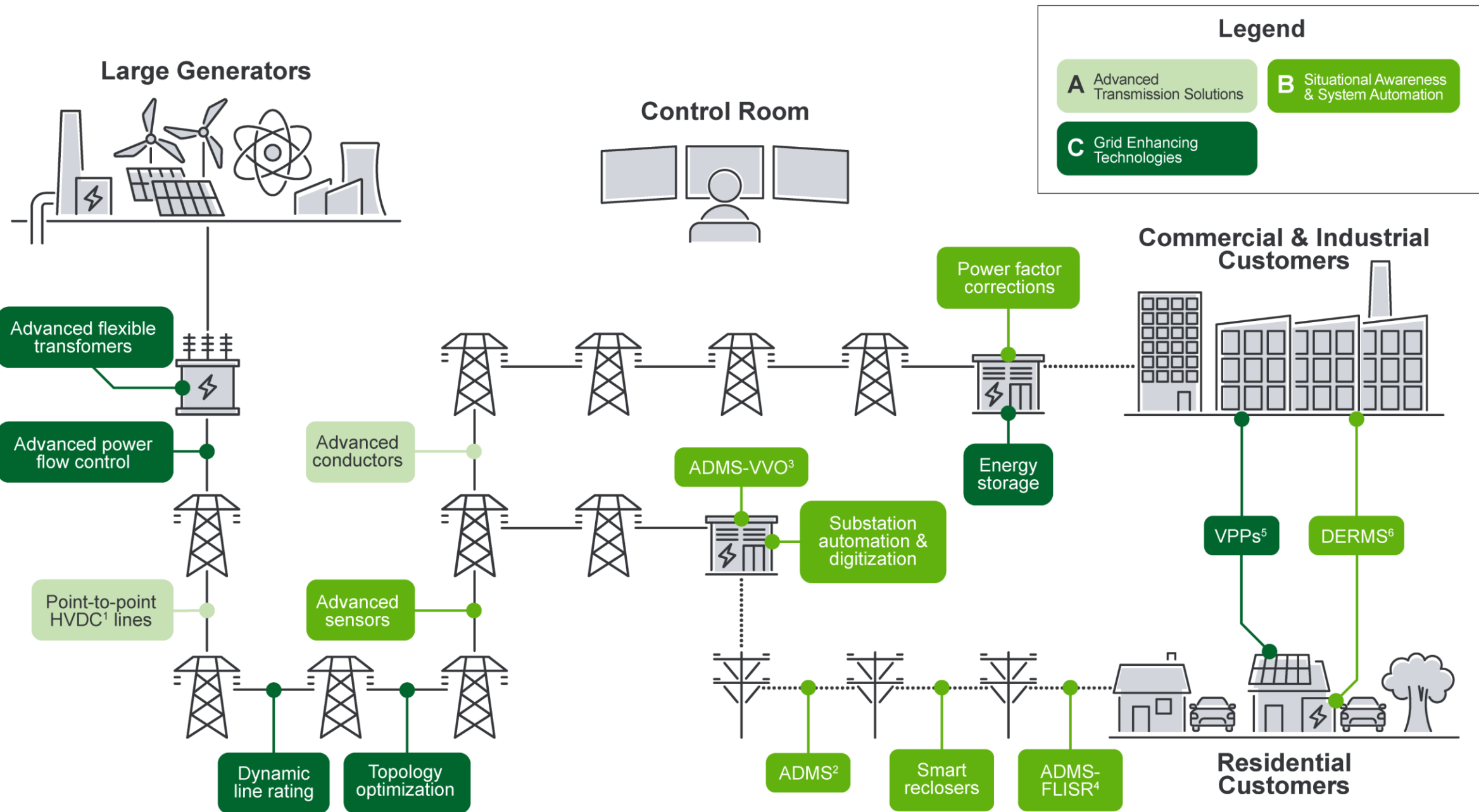


Residential Customers

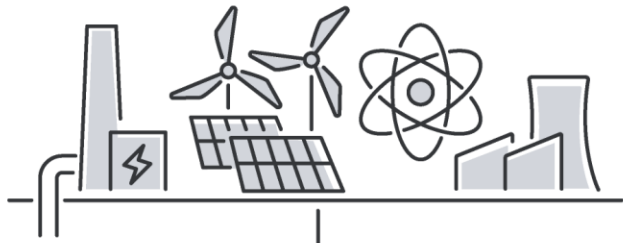








Large Generators



Control Room

- Alternate timing & synchronization
- Data management systems
- Communications technologies
- System digitization & visualization

Legend

- A** Advanced Transmission Solutions
- B** Situational Awareness & System Automation
- C** Grid Enhancing Technologies
- D** Foundational Systems

Advanced flexible transformers

Advanced power flow control

Point-to-point HVDC¹ lines

Advanced conductors

Advanced sensors

Dynamic line rating

Topology optimization

ADMS-VVO³

Substation automation & digitization

Power factor corrections

Energy storage

Commercial & Industrial Customers



VPPs⁵

DERMS⁶



Residential Customers

ADMS²

Smart reclosers

ADMS-FLISR⁴

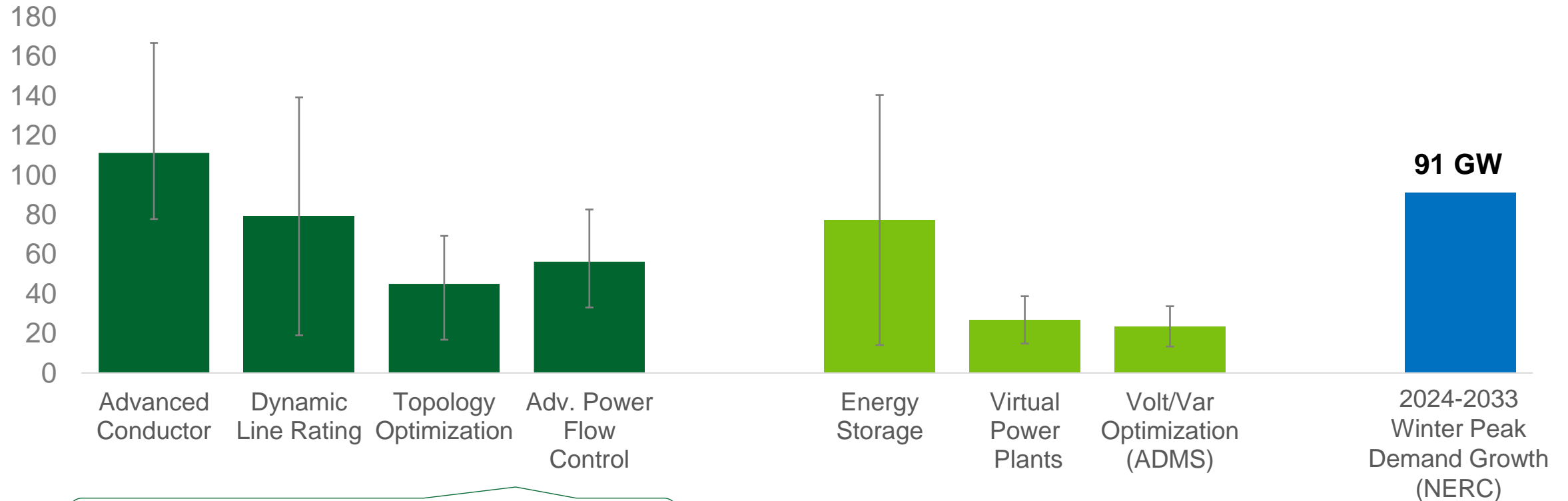
¹ High Voltage Direct Current
² Advanced Distribution Management Systems
³ Volt/VAR Optimization
⁴ Fault Location, Isolation, Service Restoration
⁵ Virtual Power Plants
⁶ Distributed Energy Resource Management Systems

Estimated effective transmission capacity unlocked from bulk system investments

Estimated T&D capacity relief from non-wires investments

Expected 10-year peak demand growth

System Increase (GW)



HVDC is a critical part of the transmission solution set – while it has more limited use cases on existing ROW infrastructure, there are strong opportunities for new build corridors not captured here

Represents estimated full potential of deploying at scale in technically and economically feasible locations on the existing grid (as of 2023)
 Range represents potential outcomes based on technology impact (e.g., DLR can increase effective capacity between ~5-40%)
 See full report for source and assumption information.

Individual technology value proposition

Advanced Grid Solutions		T&D capacity impact	Affordability	Reliability	Resilience	Sustainability
Advanced Transmission Technologies	Advanced Conductors	High	Medium	High	High	High
	Point-to-Point HVDC systems	High	Medium	High	High	High
Situational Awareness and System Automation Solutions	Advanced Sensors	Low	Medium	High	High	High
	Power Factor Correction	Medium	High	Medium	Low	High
	Smart Reclosers	Low	Low	High	Medium	Low
	Substation Automation & Digitization	Low	Low	High	High	Low
	ADMS <i>Base ADMS (D-SCADA, OMS)</i>	Low	Low	Medium	Medium	Low
	ADMS <i>System efficiency: VVO</i>	High	High	Low	Low	High
	ADMS <i>DER integration: DERMS</i>	High	Low	Low	Low	High
	ADMS <i>Reliability: FLISR</i>	Low	Low	High	High	Low
Grid-Enhancing Technologies and Applications	Dynamic Line Ratings (DLR)	High	High	Medium	Low	High
	Adv. Power Flow Control (PFC)	High	High	Medium	Low	High
	Topology Optimization	High	High	High	Medium	High
	Energy Storage	High	Medium	High	High	High
	Advanced Flexible Transformers	Low	Low	High	Low	Low
	Virtual Power Plants (VPPs)	High	Medium	Low	Low	High

Low	Moderate	Significant	Primary
Indirect, limited impact	Direct, moderate impact	Direct, operationally significant impact	Direct, primary impact

Note: Foundational technologies are excluded since they have limited direct impact on outcomes. Benefits representative of relative impact for a specific technology (within each row) and not for comparison between technologies (between rows).

Additional benefits

- ✓ **Quick to deploy**

 - ~1-3 years for a utility's first deployment

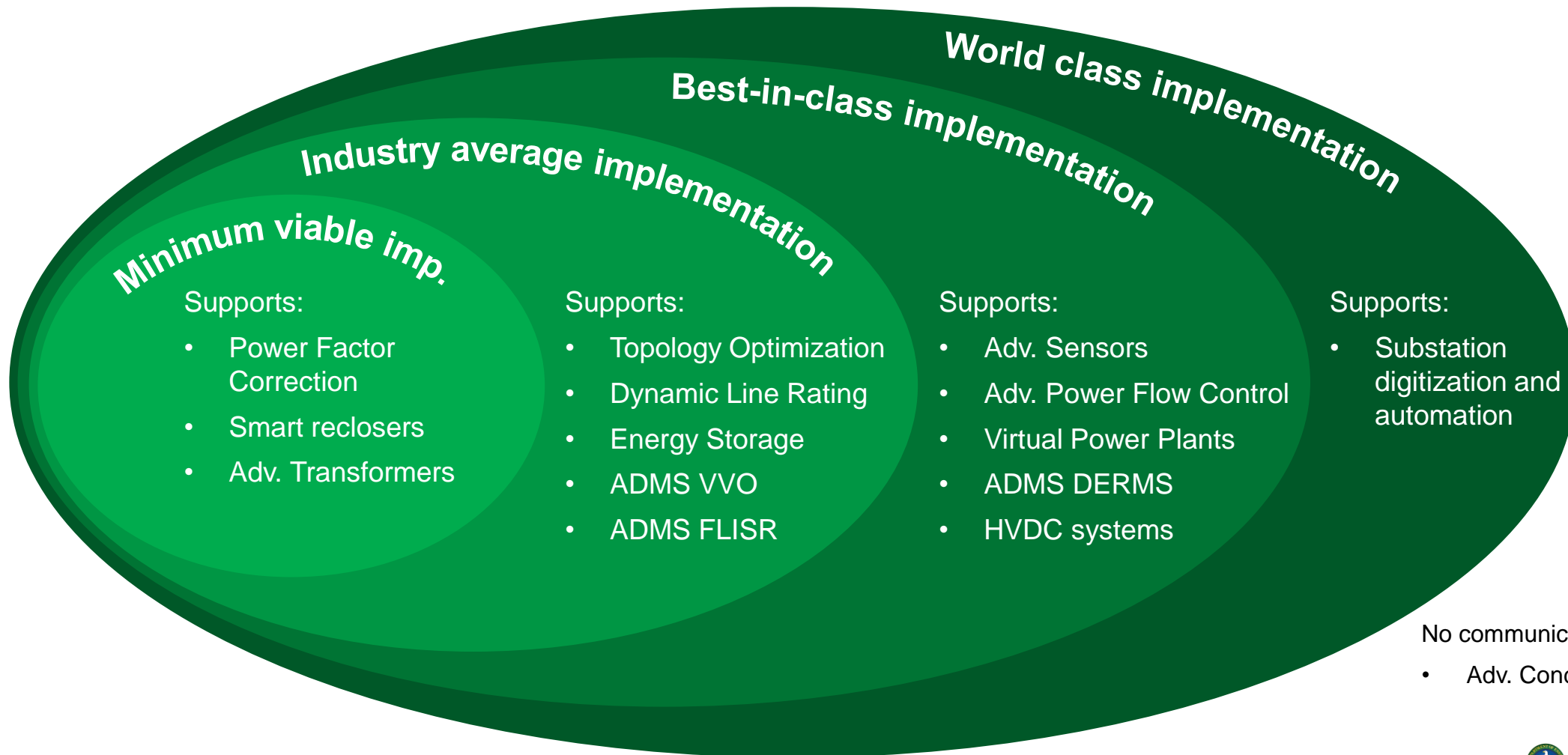
 - <6-12 months rapid scale up for subsequent deployments

- ✓ **Low cost**

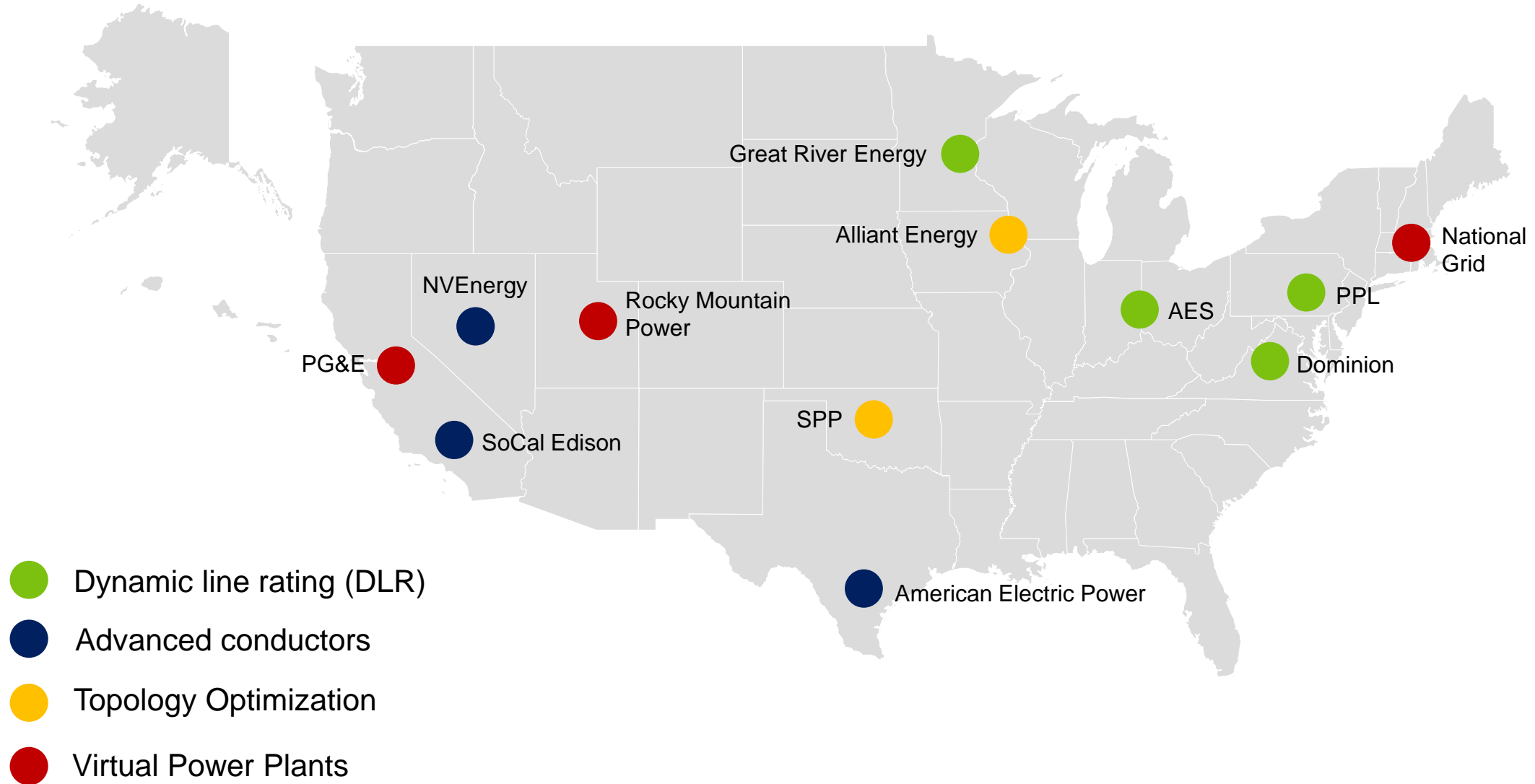
 - Example:* Grid-Enhancing Technologies like dynamic line rating and advanced power flow control are often <5-25% cost of conventional alternatives

Advanced grid solutions share dependencies on foundational technologies

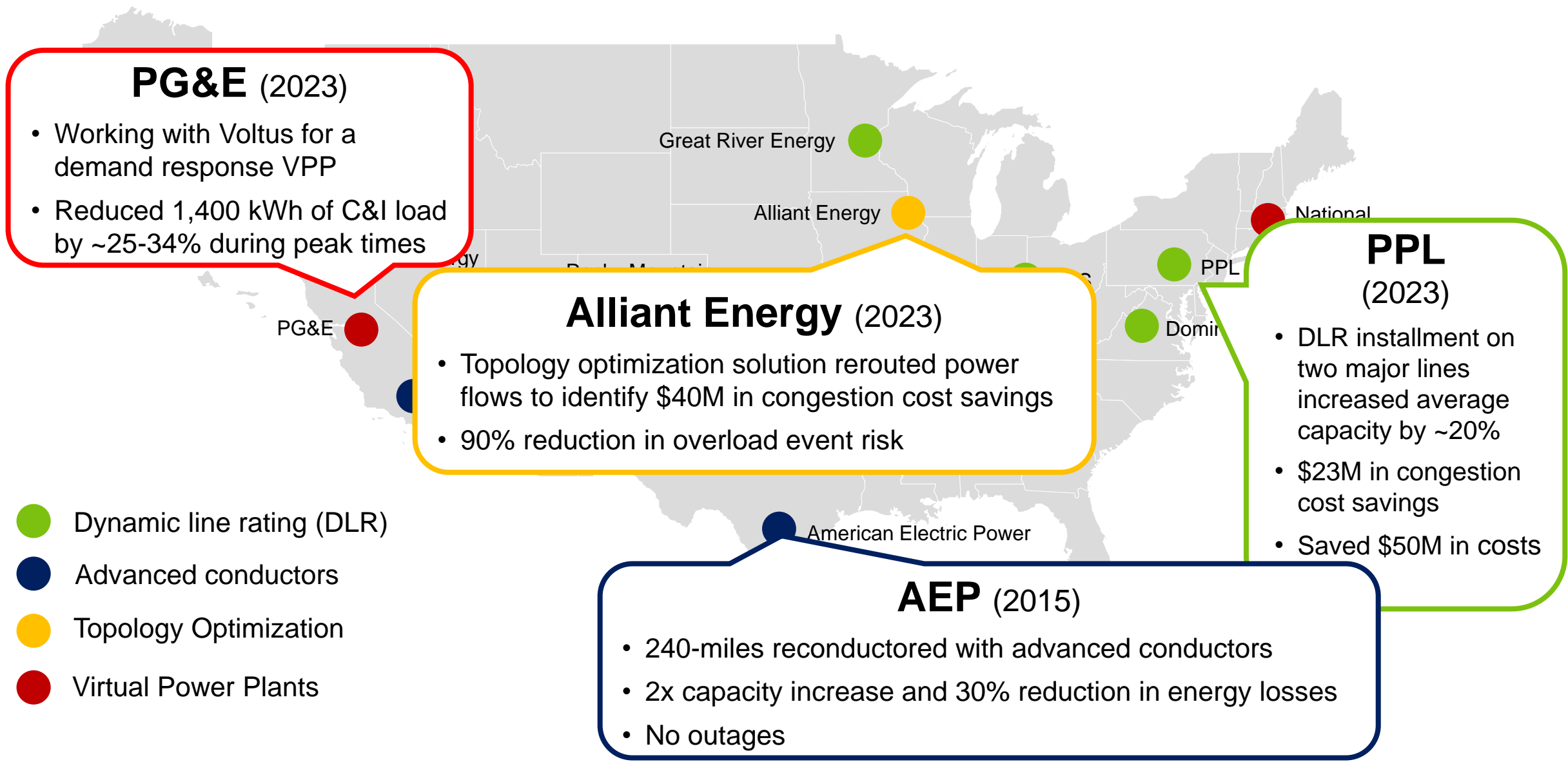
Example: Communications Foundational Technology



EXAMPLE DEPLOYMENTS.
NOT EXHAUSTIVE.



EXAMPLE DEPLOYMENTS.
NOT EXHAUSTIVE.



Sources: Alliant Energy, *Alliant Energy – NewGrid Topology Optimization Pilot* (2023); AEP / CTC Global, *American Electric Power Doubles Capacity, Saves Time and Money*; PPL, *Dynamic Line Ratings Operations Integration* (2022); PG&E, *Voltus – Load Impact Protocols* (2023)

Key drivers of advanced grid solution investments to date



Legislative and regulatory actions

(e.g., FERC orders, state policy planning requirements and incentives, regulatory grid modernization planning requirements)



External pressures

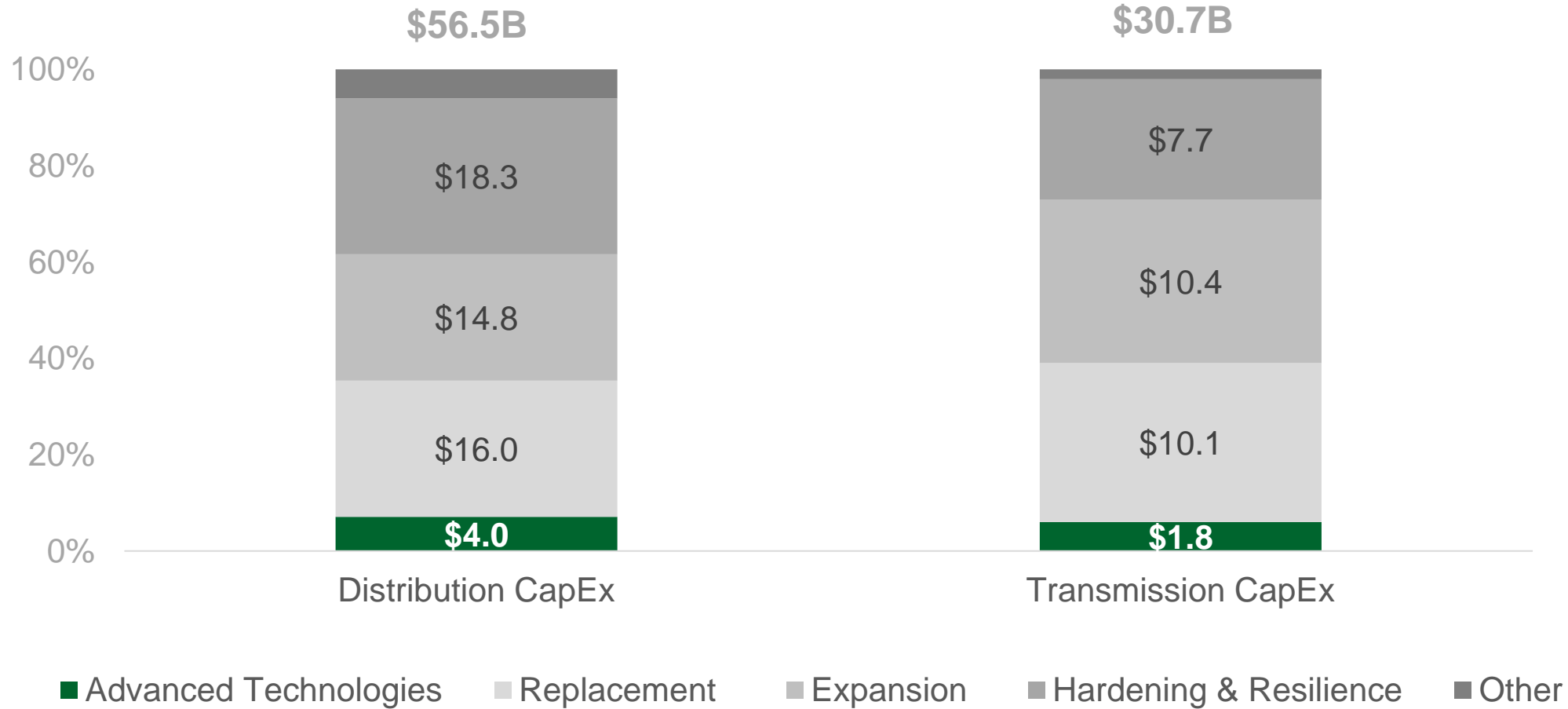
(e.g., severe weather, demand growth, distributed energy resource growth)



Federal funding and resources

(e.g., Grid Deployment Office GRIP program, Loan Programs Office low-cost loans)

Transmission and distribution capital expenditure in 2023 (\$B)



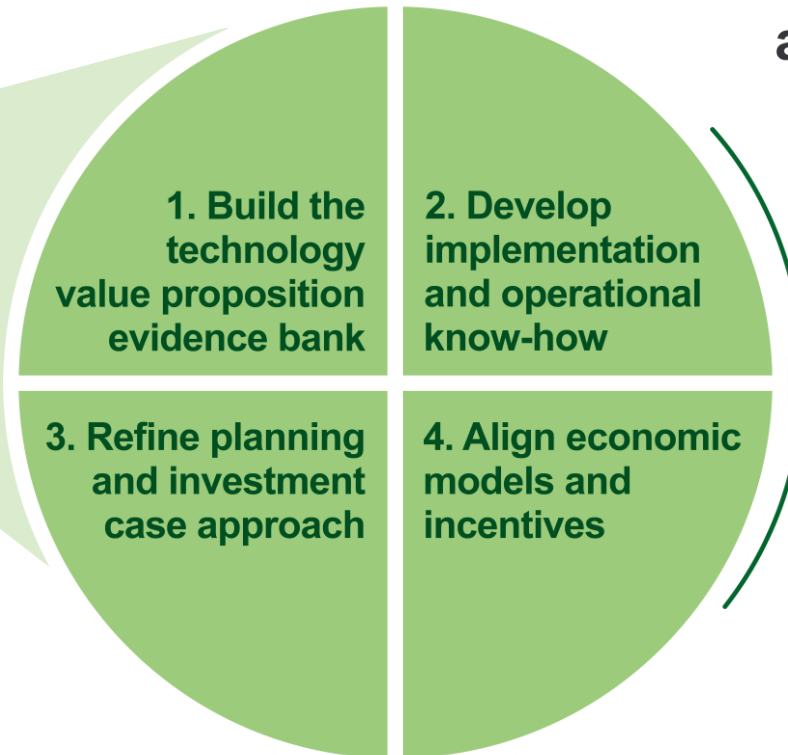
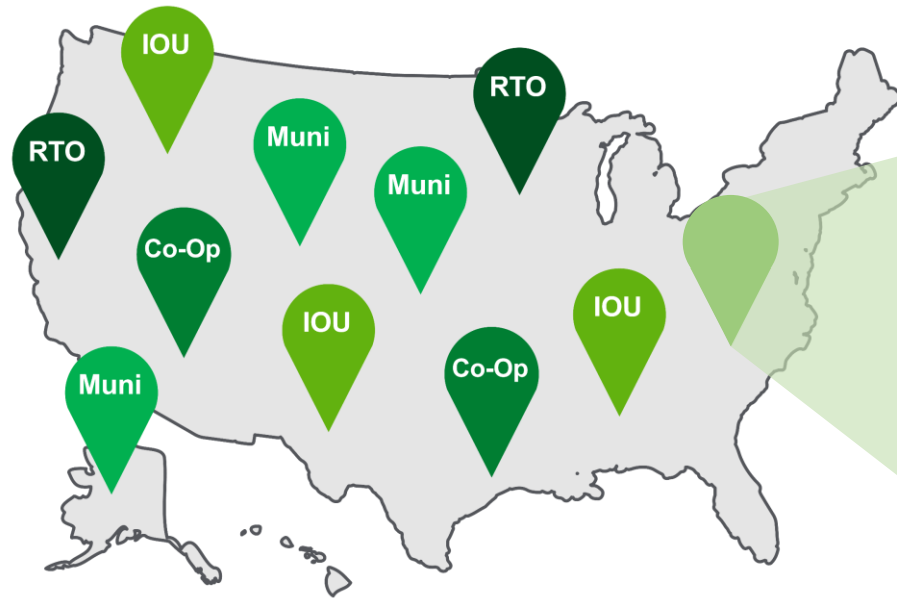
Source: EEI (2024)

Liftoff will be achieved when these advanced grid solutions become a **core part of utilities and regulators' planning and operational toolkit**

Achieving Liftoff within 3-5 years

Deploy no regrets solutions today...

...that simultaneously address four priorities for liftoff to de-risk adoption at scale



Liftoff priorities

6-12 large, in-field deployments

completed for each solution individually or in combination that holistically address Liftoff priorities across a diverse set of grid contexts



Priority 1: Build and transparently share the bank of industry evidence of the technology value proposition

Example opportunities:

- **Comprehensive and transparent case studies** from deployments – documenting benefits, costs, and operational impacts
- **Resource library/center of excellence** for advanced grid solutions
- **Multi-stakeholder convenings, workshops, and/or working groups** to share deployment experiences

Example efforts

Energy Systems Integration Group Grid-Enhancing Technologies User Group

Industry-led working group to share information and discuss best practices, challenges, and benefits

Idaho National Laboratory's Transmission Optimization with Grid-Enhancing Technologies (TOGETs) project

Technology analysis, reviews, and case studies (e.g., Advanced Conductor Scan Report, GETs case studies)

European Network of Transmission System Operators (ENTSO-E) Technopedia

Publicly accessible library of resources in Europe covering variety of grid technologies and applications



Priority 2: Develop implementation and operational know how

Example opportunities:

- Standardized and interoperable technical **specifications**
- Installation, inspection, and operational **checklists, guidance and best practices**
- **Workforce development partnerships** and training programs

Example efforts

Electric Power Research Institute (EPRI) advanced conductor testing and guidance

Technical reviews and guidance on selection and inspection of advanced conductors

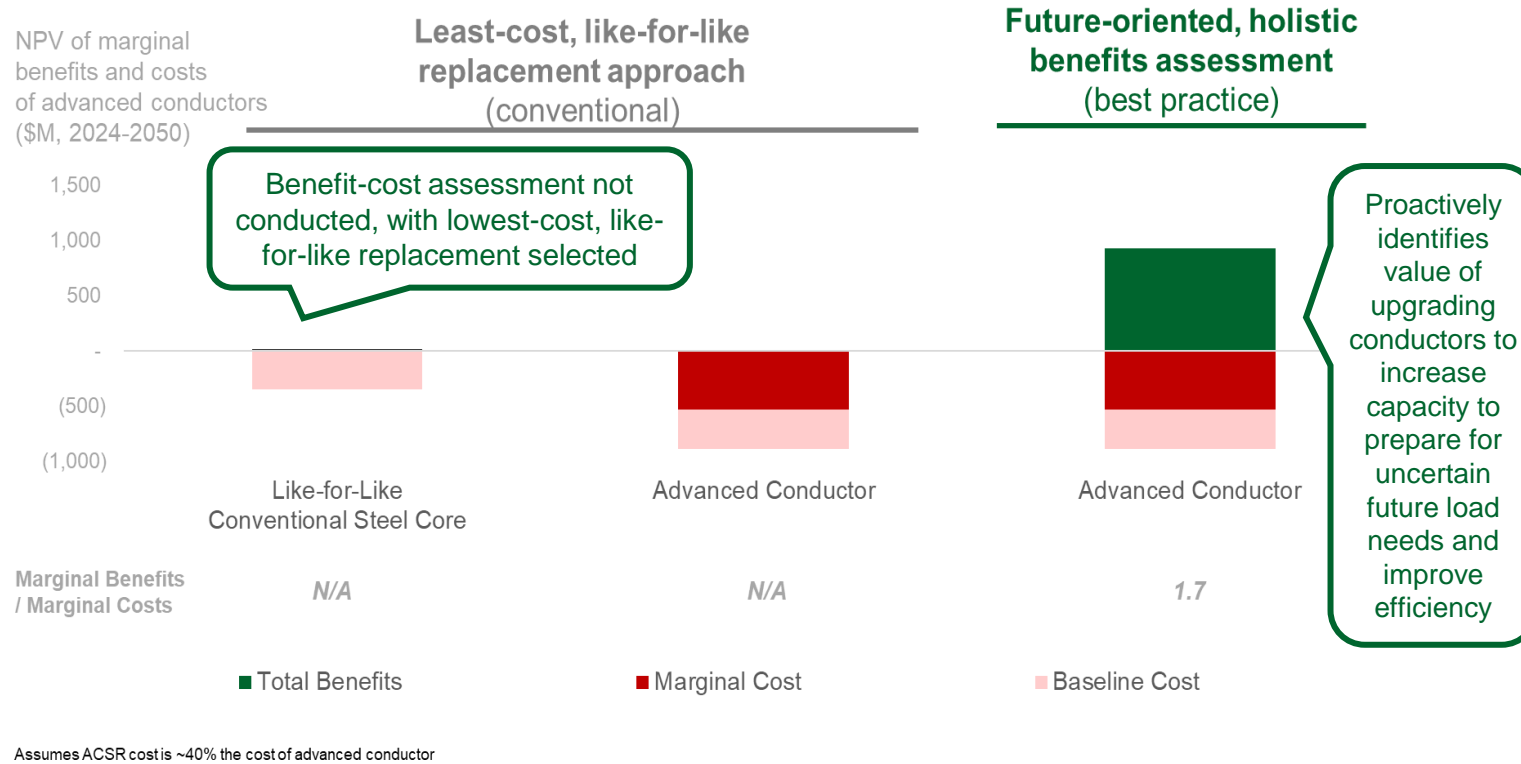
Idaho National Laboratory's Transmission Optimization with Grid-Enhancing Technologies (TOGETs) project

Planning and operational studies in partnerships with industry



Priority 3: Refine planning and investment case approaches

Scenario: Replacing aging transmission conductor lines



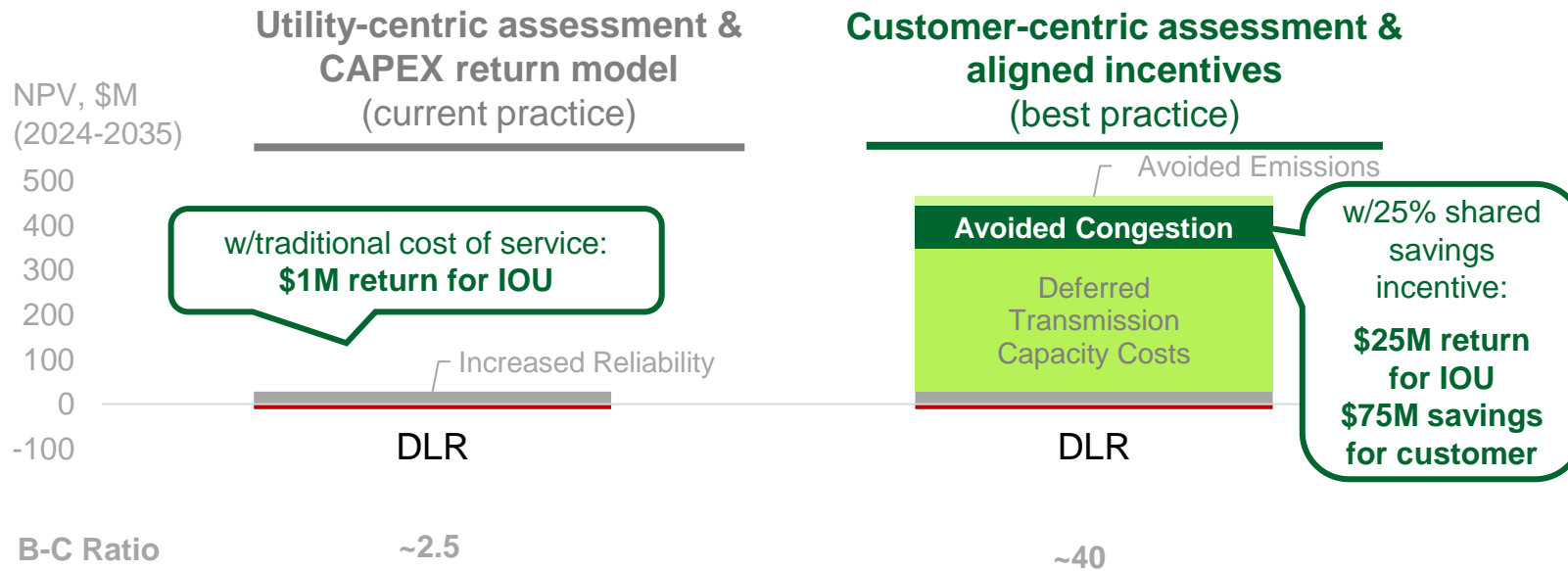
Example opportunities:

- **Longer-term planning horizons (10+ years)**
- **Integrated planning processes** (e.g., Integrated Distribution System Planning, capacity expansion and asset replacement integration)
- **Comprehensive investment case approaches** to consider technologies in strategic bundles and value the holistic suite of benefits (e.g., energy efficiency, equity, decarbonization)



Priority 4: Align economic models and incentives

Scenario: Evaluating dynamic line rating (DLR) to address congested transmission lines



Scenario inputs:

- Congestion costs = \$100M
- DLR deployment cost = \$10M
- 25% shared savings incentive

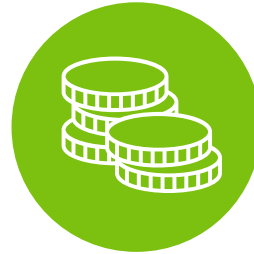
Example opportunities:

- **Performance-based regulation (PBR)**, such as:
 - Performance Incentive Mechanisms (PIMs)
 - Shared savings incentives
- **New cost allocation methods** (e.g., data centers pay for grid upgrades)
- **Cost recovery for innovation funds** for testing and scaling innovative solutions

Advanced grid solutions could be deployed without increasing costs to ratepayers



Use existing replacement investments to **proactively upgrade assets** with advanced grid solutions



Develop new **cost allocation** mechanisms



Leverage **federal funding** resources

Priority actions key grid stakeholders can start taking today



Grid Operators

(IOUs, co-ops, public power, RTO/ISOs)

- **Evaluate and deploy no regrets solutions** to address grid hotspots today
- **Develop grid modernization strategies** using emerging best practices



Regulators & Governance Boards

(PUCs, FERC, councils, boards, Tribal authorities)

- **Require grid operators to consider advanced grid solutions** in planning
- **Align utility incentive structures** and develop cost recovery mechanisms



Policymakers

(legislators, governors, state energy offices)

- **Support enabling legislation and collaborate with regulators** to integrate advanced solutions in current processes
- **Coordinate multi-stakeholder collaborations**



Solutions Providers

(tech. providers, engineering firms, consultants)

- **Integrate advanced grid solutions into core services** and articulate benefits
- **Share performance risk** for proven but sub-scale solutions



Associations & Labor Orgs

(industry, regulatory, utility, labor)

- **Develop enabling industry tools** (e.g., playbooks, briefs, best practices)
- **Drive and expand collaborations** between industry stakeholders



Community Groups & Intervenors

(community groups, consumer advocates, NGOs)

- **Engage in regulatory dockets and rate cases**
- **Engage with policymakers and regulators** on supportive policy actions

Leverage federal funding and technical assistance resources

Example DOE resources to support deployments

(not exhaustive)

Category	Program	Description
Direct Funding Support	Grid Resilience and Innovation Partnerships (GRIP) Program	\$10.5B in grant funding for grid investments, including for advanced grid solutions and applications.
	Grid Resilience State and Tribal Formula Grants	\$2.3B in formula grants for grid resilience against extreme weather
Loans and Financing	Transmission Facilitation Program	\$2.5B in commercial support for qualified transmission projects
	Energy Infrastructure Reinvestment Loan Program (1706)	Loan guarantees for projects repurposing existing energy infrastructure that has ceased operations or enable operating energy infrastructure to reduce emissions
Technical Assistance	Grid Resilience Assistance	Technical and other assistance to support state, Indian tribe, territory, and industry needs to support grid resilience
	State Technical Assistance Program	Technical assistance for state regulators and policymakers
Deployment tools and resources	Example: Technology analyses	Variety of technology reviews and assessments, including from National Labs (e.g., Advanced Conductor Scan Report , Reconductoring Economic and Financial Analysis (REFA) (full tool forthcoming))
	Example: System planning resources	Resources on grid modernization planning best practices, Integrated Distribution System Planning approaches, and other planning support (e.g., Integrated Distribution System Planning)

RECAP: Key messages

- Multiple advanced grid solutions are available today to quickly and cost-effectively get **more capacity out of the existing transmission and distribution system** – supporting upwards of 20-100 GW of additional peak demand – while advancing **grid reliability, resilience, affordability, and sustainability**.
- These **advanced grid solutions are already being used today** – yet **deployment at scale and associated industry know-how is lagging** due to a lack of sufficient incentives and prioritization.
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Thank you!

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Feedback is welcome at **liftoff@hq.energy.gov**