

Grid Modernization Planning and Investment Economics

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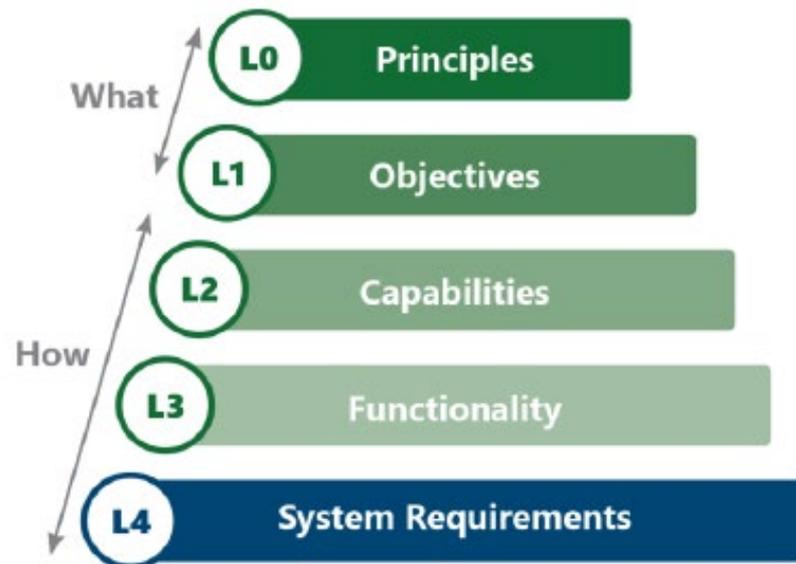
**Integrated Distribution System Planning Training
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Grid Modernization Planning

Paul De Martini, Newport Consulting

Grid Architecture Approach

- ▶ **Grid modernization planning starts with objectives & capabilities needed**
- ▶ **Scale and scope of needs require a holistic architectural approach.**
- ▶ **Resist temptation to start with technology choices**



Grid Mod Strategy & Planning Process

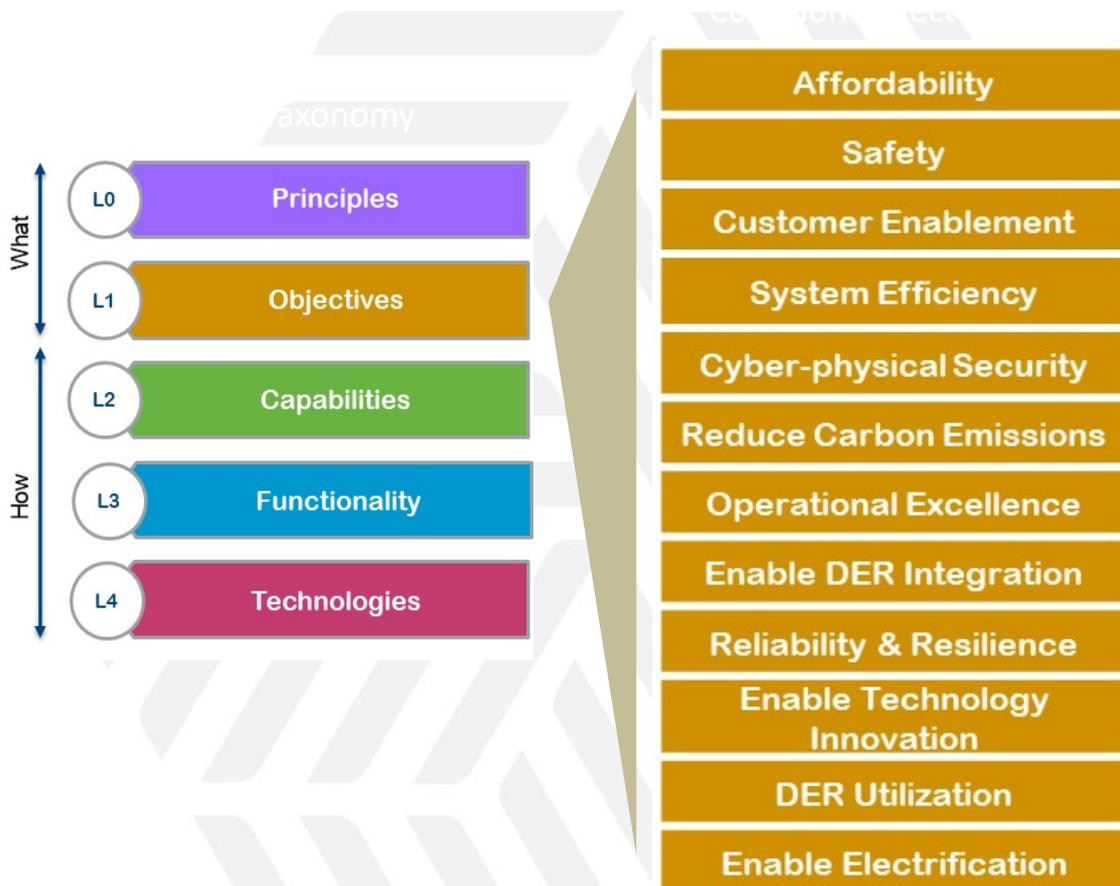
What, Why, How, When & How Much



DSPx Guidebook, Vol. 4, 2020

While encouraged, it is not essential to start with a grid mod strategy. But, a clear set of objectives is necessary to develop and assess implementation plans.

Objectives Drive Grid Mod Planning



PUC Ohio example:

- **A Strong Grid:** A distribution grid that is reliable and resilient, optimized and efficient and planned in a manner that recognizes the necessity of a changing architectural paradigm.
- **The Grid as a Platform:** A modern grid that serves as a secure open access platform—firm in concept and as uniform across our utilities as possible—that allows for varied and constantly evolving applications to seamlessly interface with the platform.
- **A Robust Marketplace:** A marketplace that allows for innovative products and services to arise organically and be delivered seamlessly to customers by the entities of their choosing.
- **The Customer's Way:** An enhanced experience of the customer's choosing on the application side, whether for reasons arising from financial, convenience, control, environmental, or any other chosen consideration.

Note: The 'safe, reliable, and affordable' components were included in the mission statement, which was incorporated into the principles of the PowerForward Roadmap.

Grid Modernization Capabilities

Customer Needs & Policy drive grid capabilities and corresponding enabling business functionality and technology

		Objectives		
		Safety & Operational Efficiency	Reliability & Resilience	DER Integration & Utilization
Capabilities	Market Operations	●	●	●
	Grid Operations	●	●	●
	Planning	●	●	●

This analysis helps to identify the core platform functions and related technologies as well as the applications linked to specific policies/customer needs/location value realization

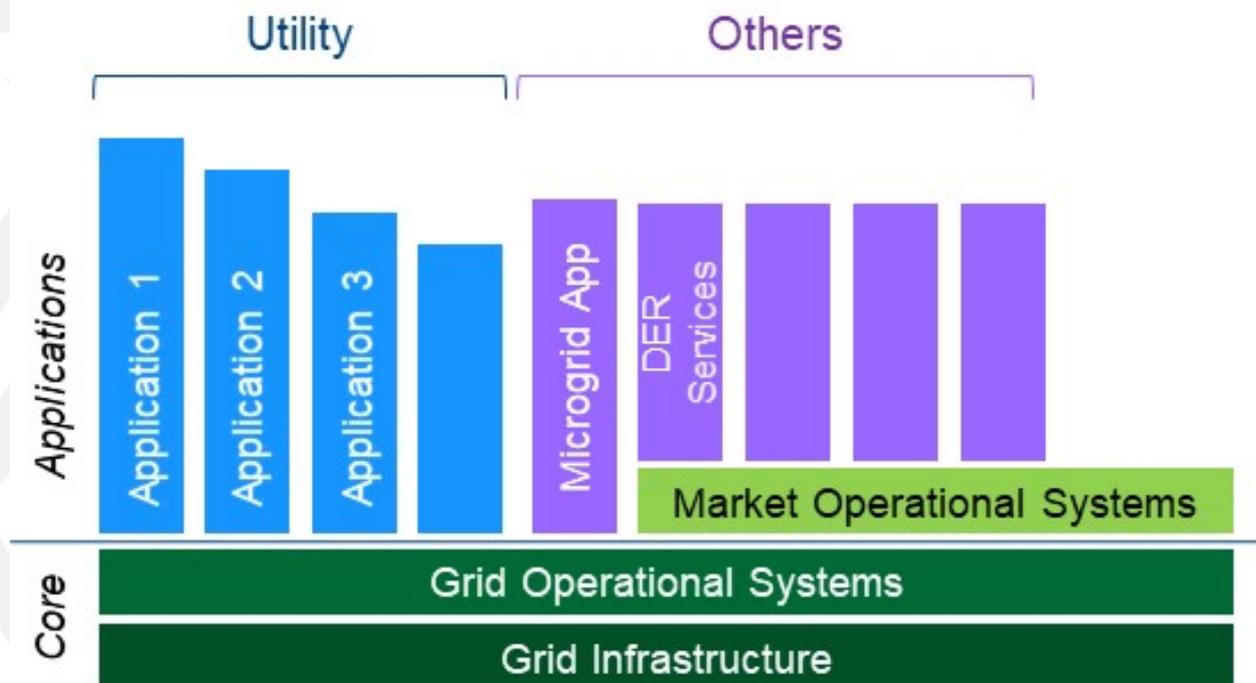
Taxonomy Example

Objective	Capability	Function	Technology
<p>Reliability improvement by reducing customer unplanned outage durations</p> <p>Achieve 2nd Quartile CAIDI Performance by 2025</p>	Improve outage identification and customer service restoration	<p>Fault Identification</p> <p>Fault Location</p> <p>Fault Isolation</p> <p>Service restoration</p>	<p>Fault Current Indicators</p> <p>Outage Notification from Meters</p> <p>Outage Management System</p> <p>Geospatial Information System</p> <p>Distribution Management System and/or SCADA</p> <p>Automated Switches</p> <p>Work Management System</p>

Distribution Grid as a Platform

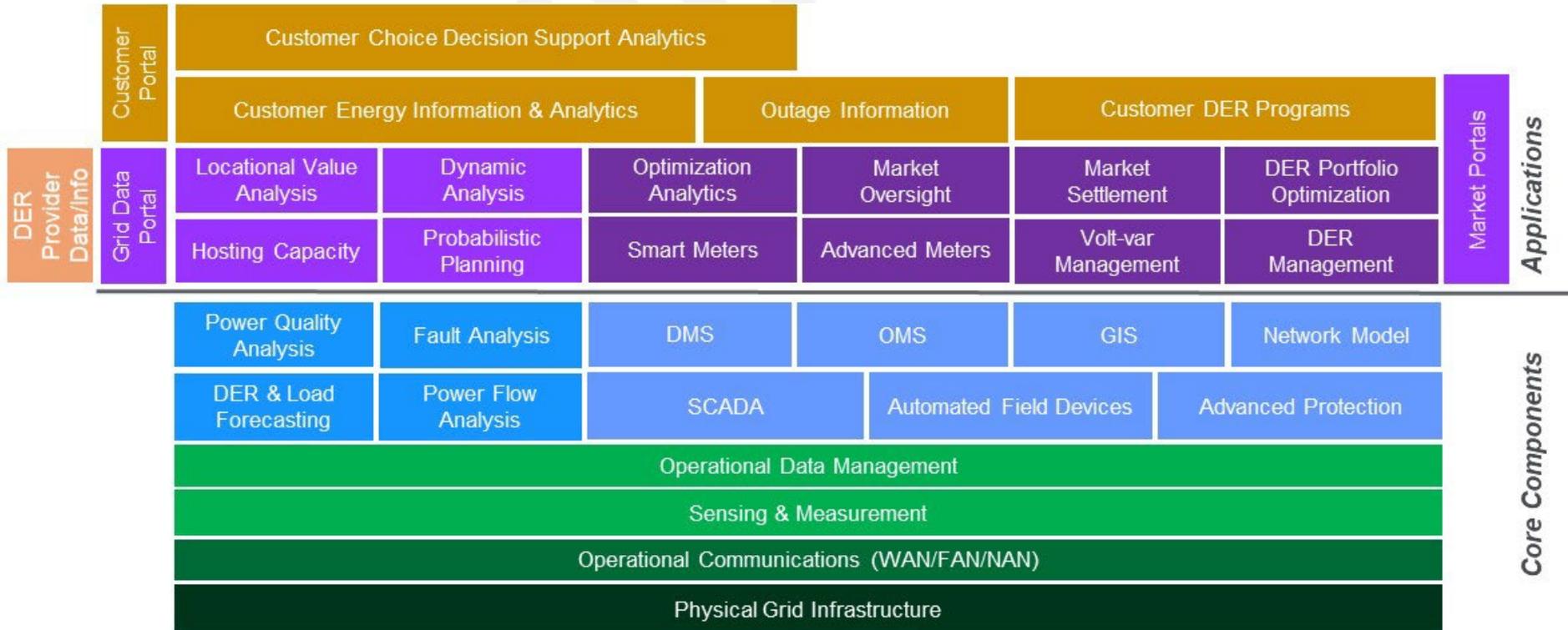
The Grid as a Platform: A modern grid that serves as a secure open access platform—firm in concept and as uniform across our utilities as possible—that allows for varied and constantly evolving applications to seamlessly interface with the platform.

— Public Utility Commission of Ohio



Distribution System Platform

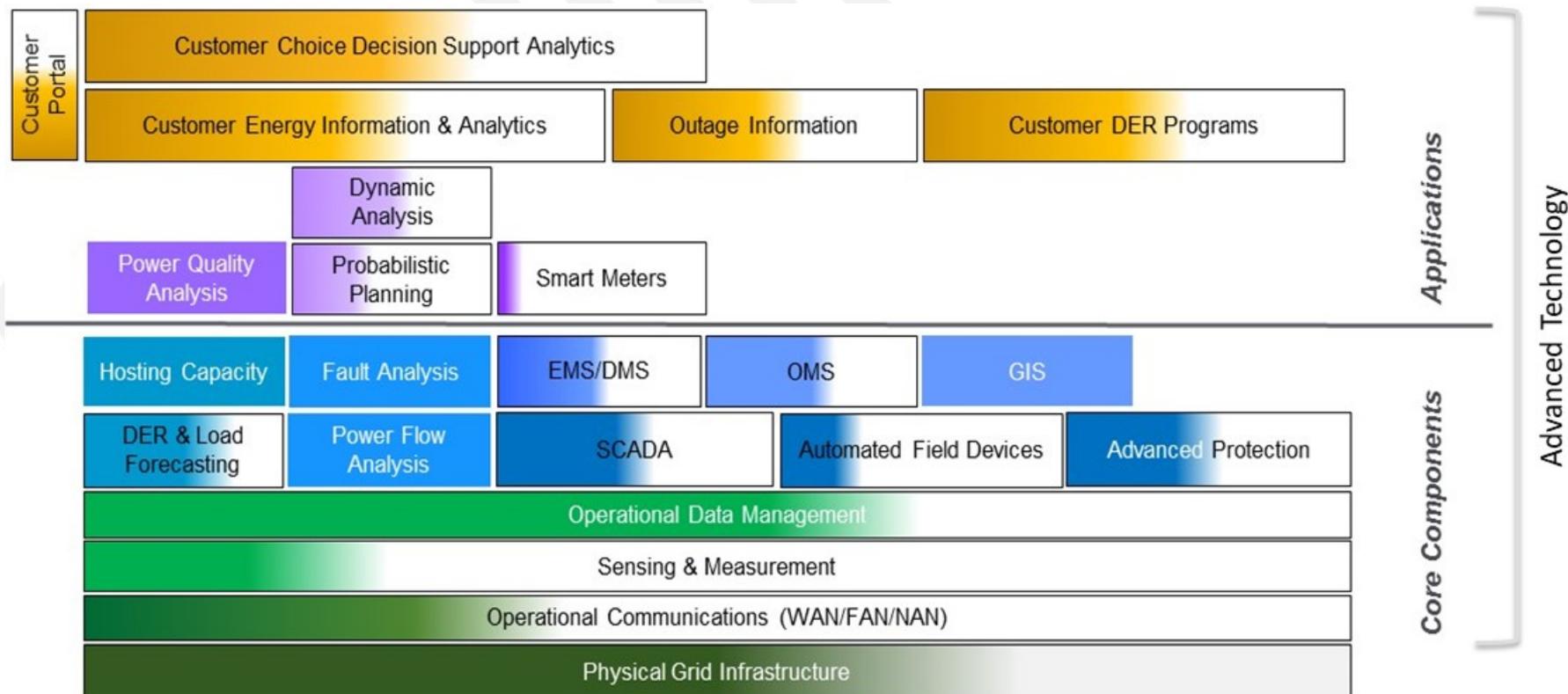
Logical layering of core components that enable specific applications



Green - Core Cyber-physical layer
 Blue - Core Planning & Operational systems
 Purple - Applications for Planning, Grid & Market Operations
 Gold - Applications for Customer Engagement with Grid Technologies
 Orange - DER Provider Application

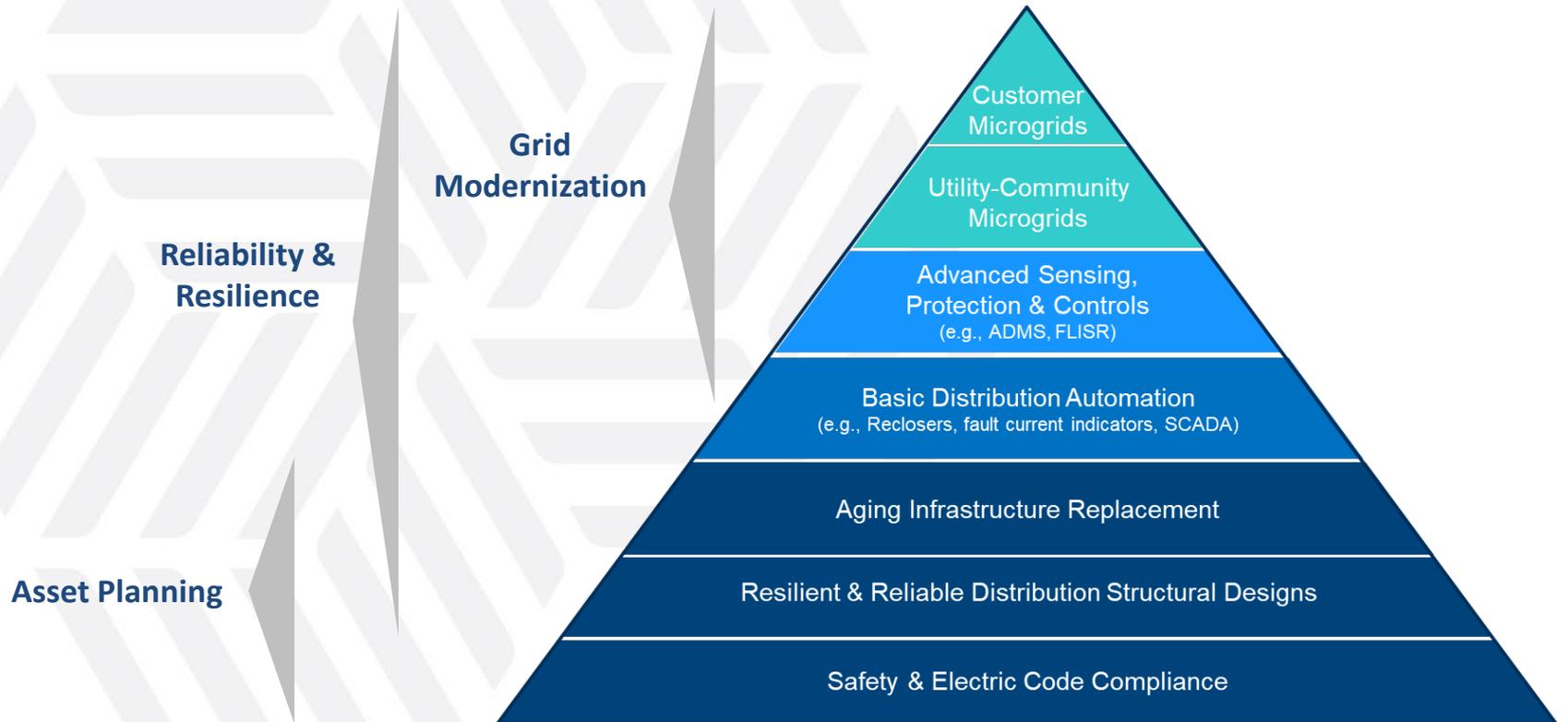
Identify Starting Point for Grid Investment

This graphic is a summary illustration of a more complete assessment documented in narrative and tables to enable a gap analysis against objectives and identified capabilities & functionalities.



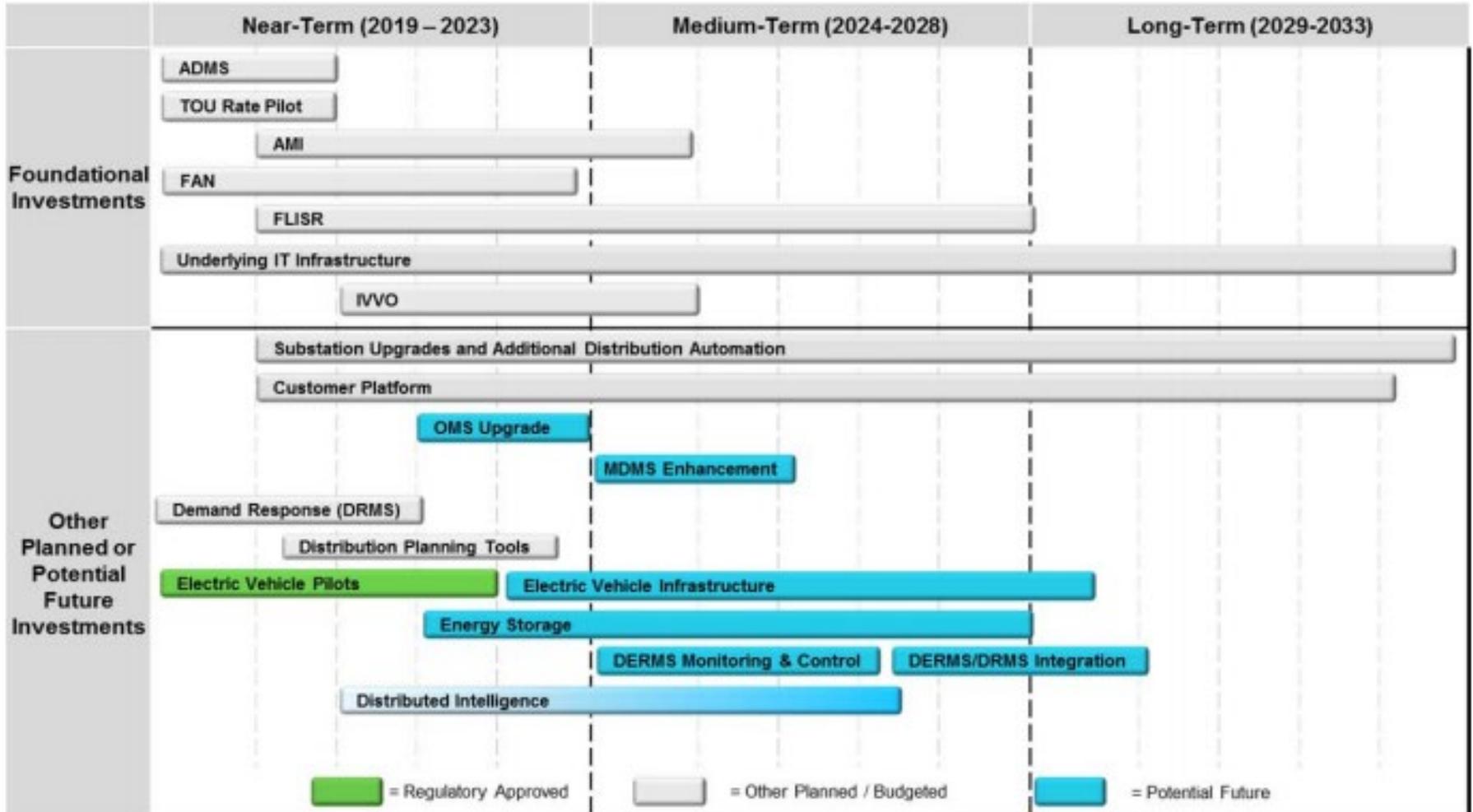
Distribution & Modernization Investment Categories

Grid Modernization technologies layer on top of & integrate with foundational physical grid infrastructure.



Sequencing of Investments

Long-term strategic plan of distribution grid investments



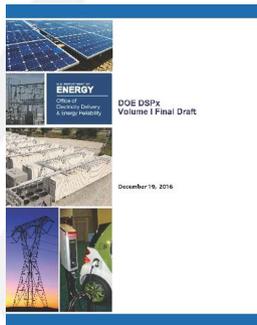
Thank You

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Joe Paladino, joseph.paladino@hq.doe.gov

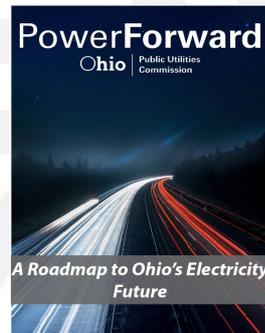
References:

Modern Distribution Grid Report



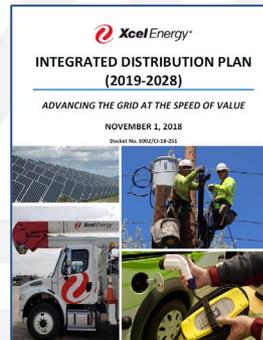
<https://gridarchitecture.pnnl.gov/modern-grid-distribution-project.aspx>

PUCO Grid Mod Roadmap



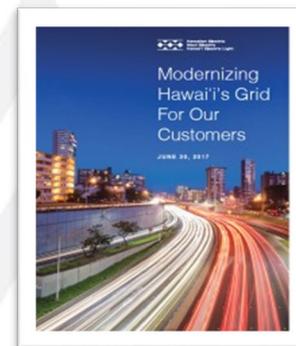
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Grid Modernization Strategy Using DSPx



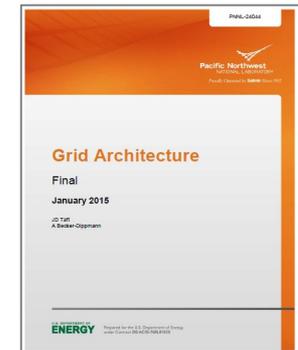
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Grid Modernization Strategy Using DSPx



www.hawaiielectric.com/gridmod

Grid Architecture



<http://gridarchitecture.pnnl.gov>

Grid Modernization Investment Economics

Fredrich (Fritz) Kahrl, 3rdRail Inc.

Grid modernization investment economics

- ▶ Consensus on the vision of a future information-rich, flexible, automated, secure, resilient distribution grid
- ▶ Less consensus on the focus and timing of investment to get there
- ▶ Economic evaluation of potential investments is a key hurdle



Why is economic evaluation of grid modernization investments complex and challenging?

Whole vs. Parts

Grid modernization will ideally be supported by a holistic vision and investment strategy, but component investments may support different objectives and have different evaluation methods

Resources vs. Grid

Grid modernization investments may support distribution-level resources, but resource and grid investments often have different evaluation methods

Joint & Inter- dependent Benefits

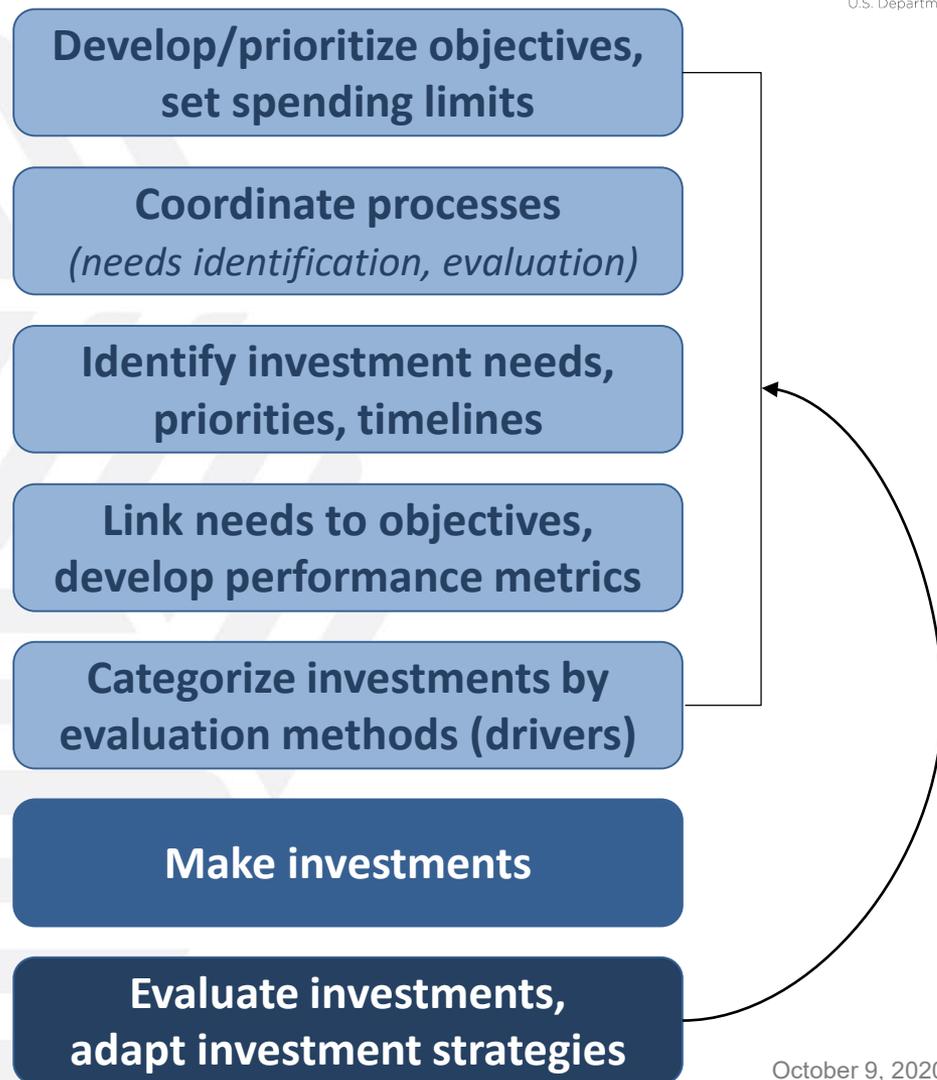
Grid modernization investments often have benefits that are hard to isolate and depend on other investments

Uncertainty

Grid modernization technologies are subject to significant uncertainty over costs, timing of need, technology maturity, deployment challenges, etc.

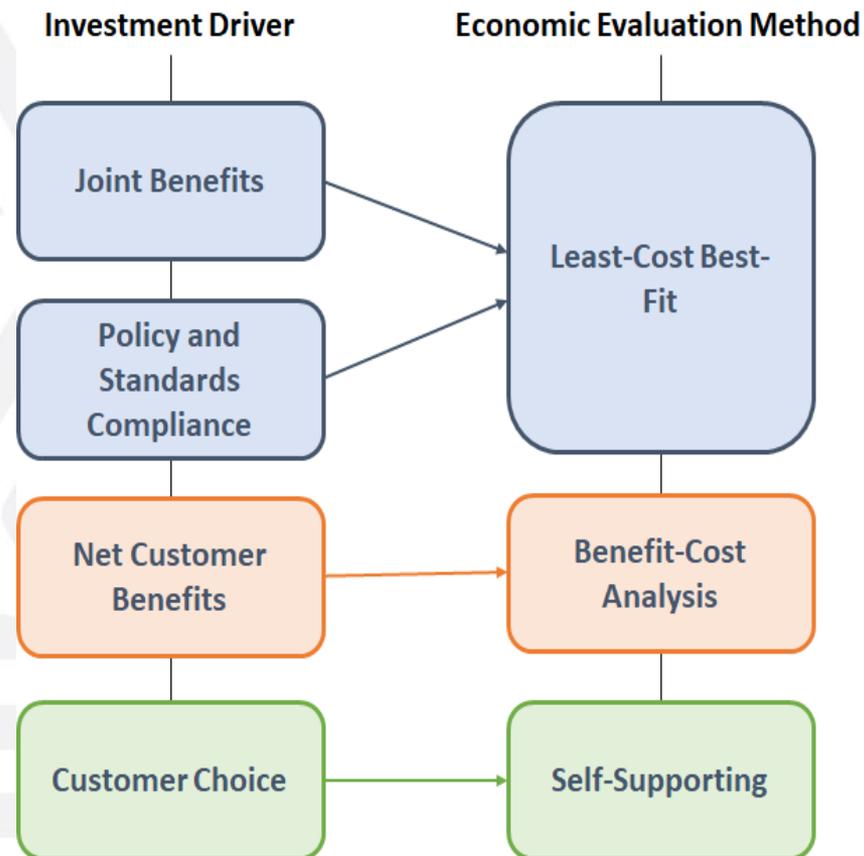
Economic evaluation framework

- Framework has three basic stages:

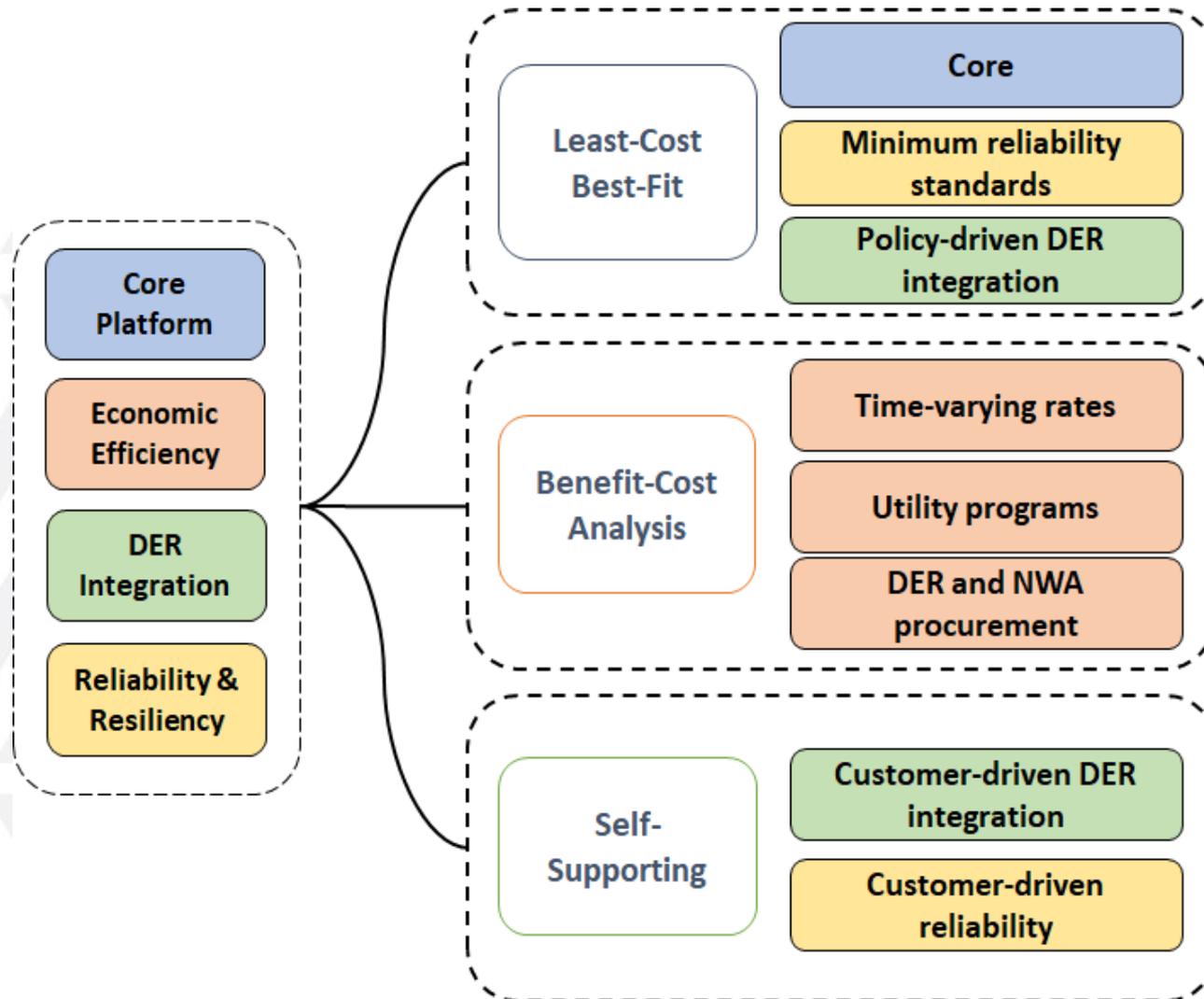


Targeting economic evaluation

- ▶ **Joint and interdependent benefits** — core platform investments that are needed to enable new capabilities and functions in the distribution grid
- ▶ **Standards compliance and policy mandates** — utility investments that are needed to comply with safety and reliability standards or to meet policy mandates for proactive investments to integrate DER
- ▶ **Net customer benefits** — utility investments from which some or all customers receive net benefits in the form of bill savings
- ▶ **Customer choice** — utility investments triggered by customer interconnection, opt-in utility programs, and customer-driven reliability improvements, paid for by individual customers



Targeting economic evaluation: Example of more detailed categorization



Summary

- ▶ Economic evaluation of grid modernization investments is complex and challenging.
- ▶ Clear objectives, robust and coordinated planning, and targeted evaluation of investments can help to address challenges.
- ▶ Targeted evaluation can be organized around different evaluation methods:
 - Least-cost best-fit — joint and interdependent benefits (core investments) and compliance with standards and policy mandates
 - Benefit-cost analysis — net customer benefits
 - Self-supporting — customer choice
- ▶ Planning, spending limits, pilots, and ex post performance assessment are all tools for incorporating risk into investment decision-making.
- ▶ Performance metrics are critical.

Questions states can ask

- ▶ Have clear modernization objectives been established in policy or regulation or proposed by the utility?
- ▶ Which objectives are supported by different grid mod investments?
- ▶ How should planning processes affected by grid mod be coordinated?
- ▶ What are the drivers of investments and how should they be evaluated?
- ▶ What is the pace and scope of change expected over the planning period and does the grid mod plan address the needs?
- ▶ What are reasonable levels of spending and rate impacts for grid modernization investments?
- ▶ What performance metrics should be used to evaluate investments?
- ▶ How should risk management be incorporated into investment prioritization and decision-making?
- ▶ Has a clear starting point for modernization been identified?
- ▶ Do grid mod plans incorporate flexibility needed for the uncertainty in needs and emergent grid technologies?

Resources for more information

- ▶ DOE's [Modern Distribution Grid](#) project
- ▶ Utility plans
 - [HECO's Modernizing Hawai'i's Grid For Our Customers](#)
 - [Xcel Energy's Integrated Distribution Plan](#)
- ▶ Public Utility Commission documents
 - California PUC, [Decision on Track 3 Policy Issues, Sub-Track 2](#) (Grid Modernization)
 - New Hampshire PUC, [Staff Recommendation on Grid Modernization](#)
 - Minnesota PUC, [Staff Report on Grid Modernization](#)

Thank you

Questions?
Insights?

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