Integrated Distribution System & Grid Modernization Planning

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Newport Consulting

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Distribution Grid Planning

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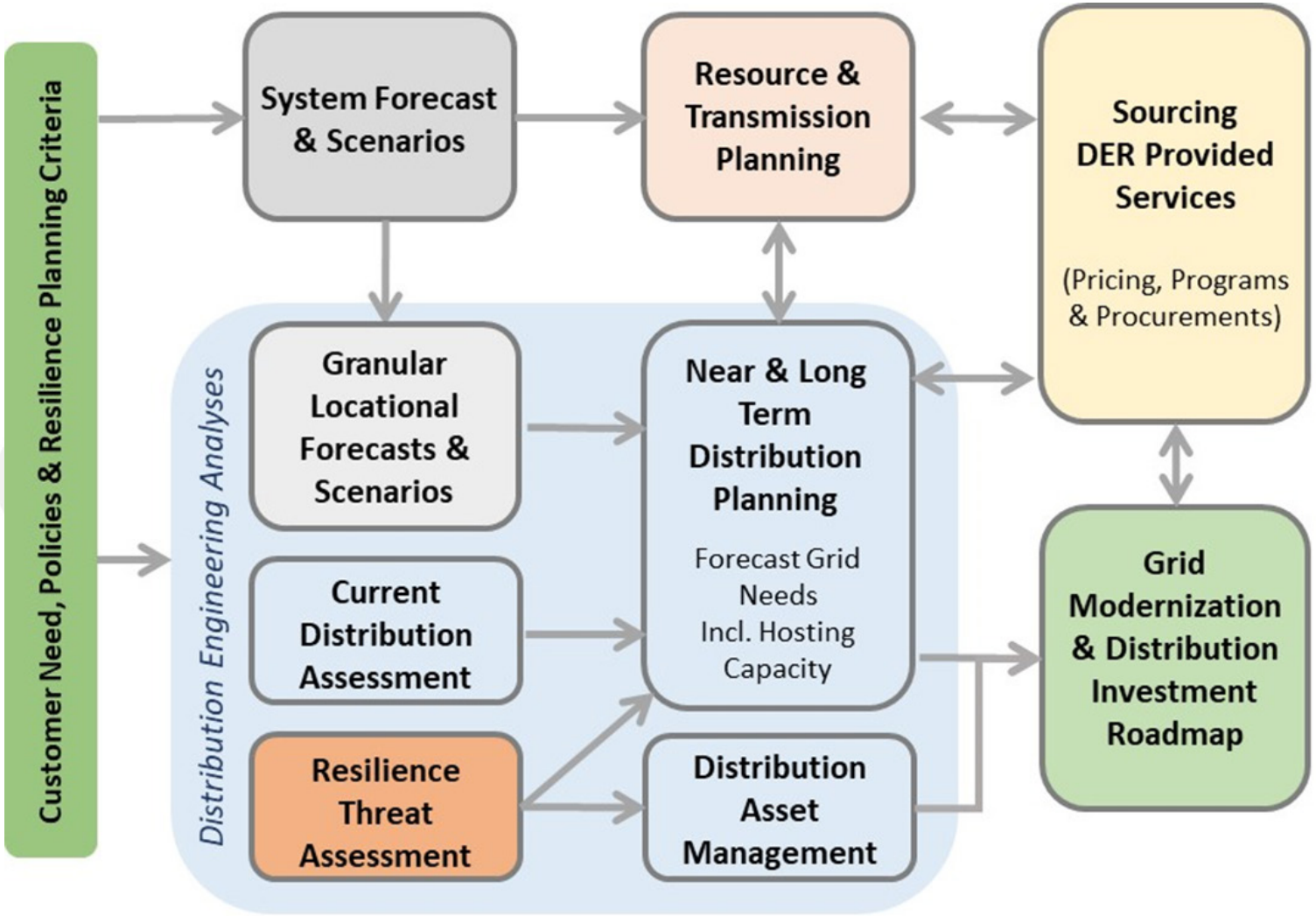
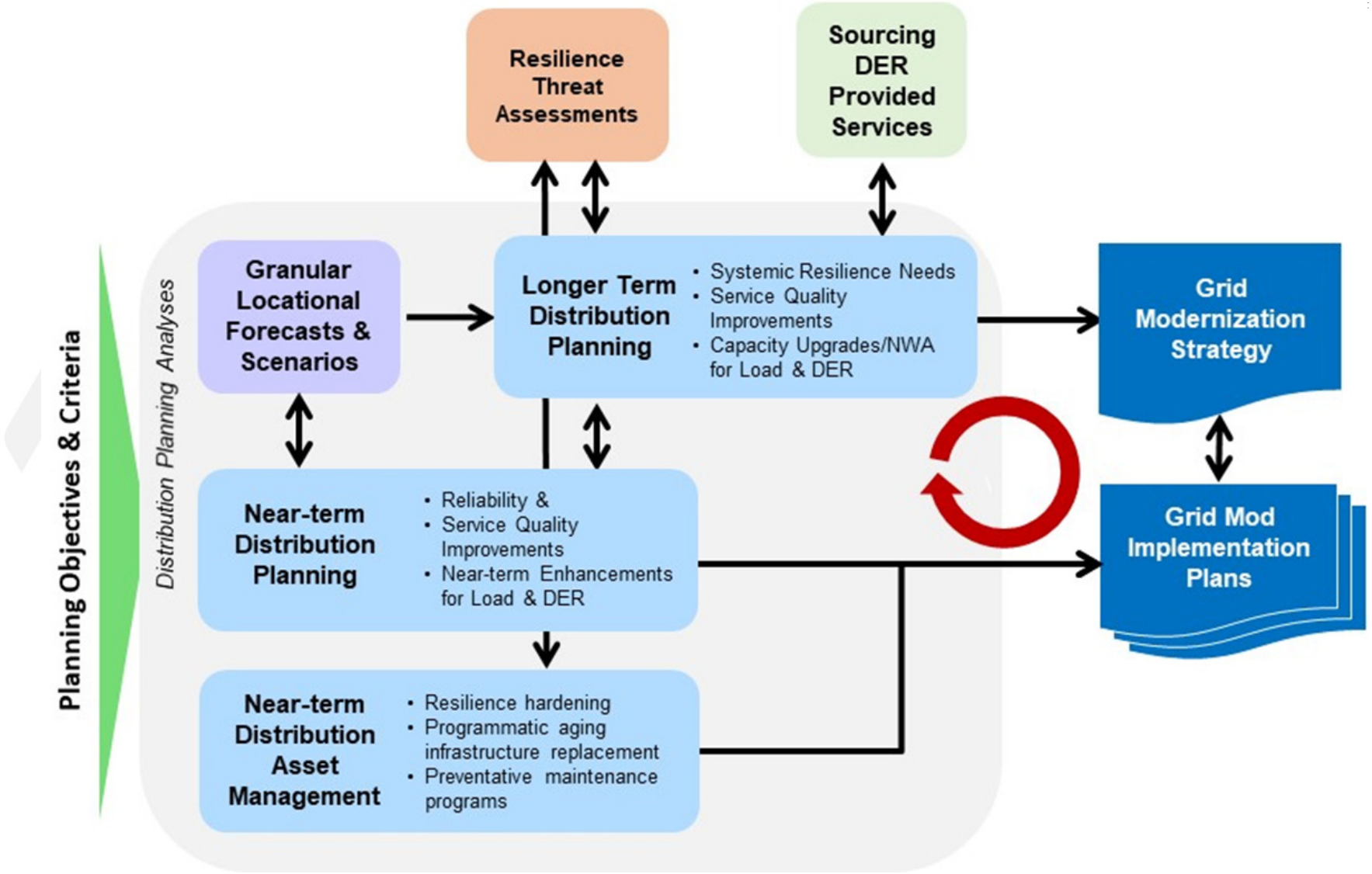
Distribution planning across the U.S. addresses unique areas of focus regarding planning considerations often within these three areas to meet customer needs

Integrated Distribution Planning



Adapted from P. De Martini, *Integrated Distribution Planning*, ICF

Distribution Planning for a Modern Grid



Architecture Manages Complexity

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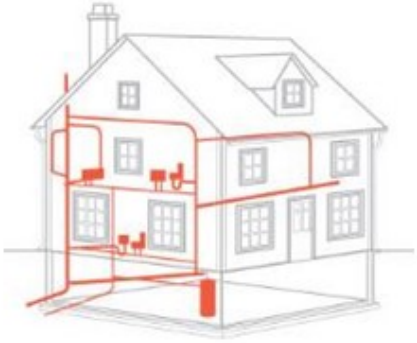
The engineering issues associated with the scale and scope of customer choice, and envisioned in policy objectives for grid modernization, requires a holistic architectural approach.



So, pick-up a pencil

Before trying to hang windows

Resist temptation to start with technology choices

Grid Mod Strategy & Planning Process

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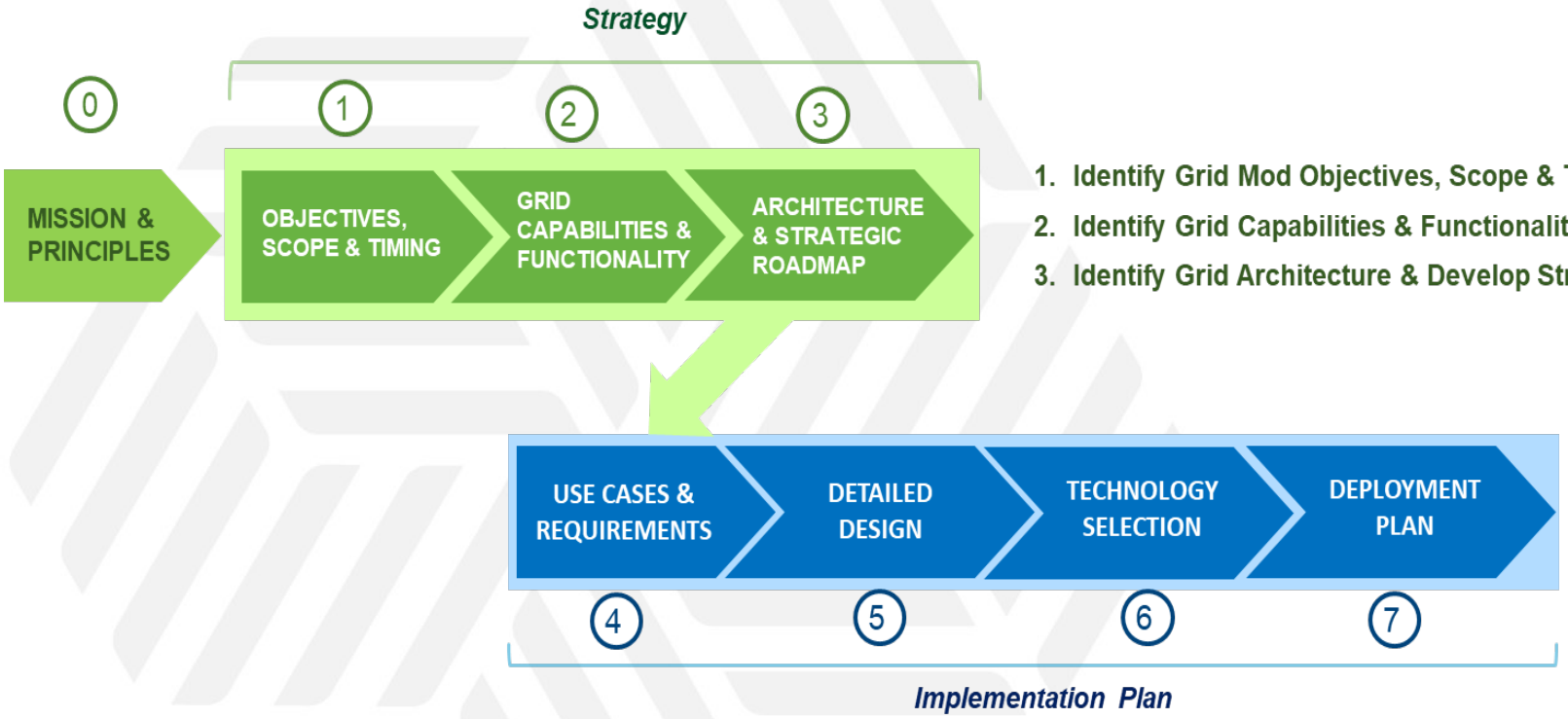
What, Why, How, When & How Much



1. Identify Grid Mod Objectives, Scope & Timing
2. Identify Grid Capabilities & Functionality Needed
3. Identify Grid Architecture & Develop Strategic Roadmap

4. Develop Functional Use Cases to Identify Detailed Business & Technical Requirements
5. Develop Detailed Architecture & Design
6. Technology Assessment & Selection
7. Develop Deployment Plan & Cost Effectiveness Assessment

Grid Modernization

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

New
Existing

		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/locational value realization

Modern Distribution Grid (DSPx) Taxonomy Flow

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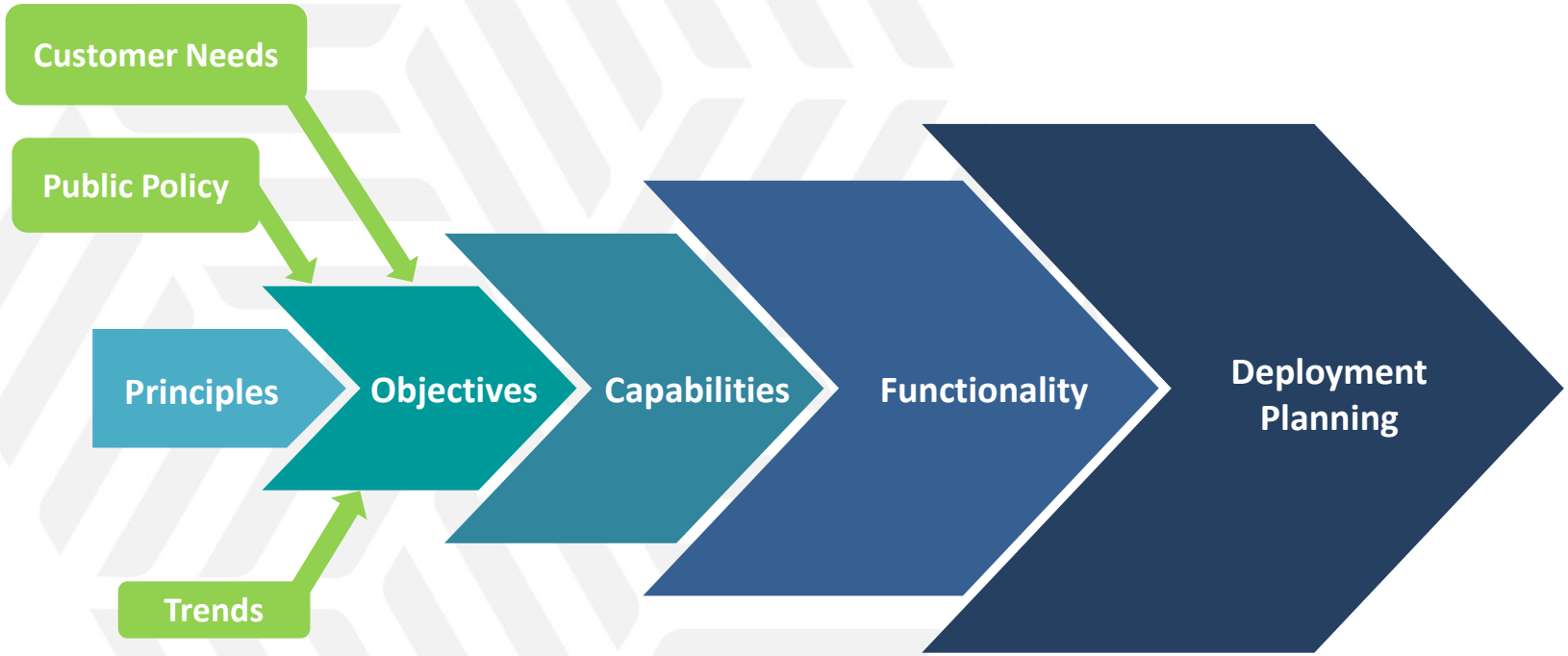
Customer needs, public policy & trends shape grid mod objectives that align to organizational mission & grid mod principles



Mission Examples

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Ohio

"The PUCO was created to assure Ohioans adequate, safe and reliable public utility services at a fair price. More recently, the PUCO gained responsibility for facilitating competitive utility choices for Ohio consumers."

Missouri

"We will:

- ***ensure that Missourians receive safe and reliable utility services at just, reasonable and affordable rates;***
- ***support economic development through either traditional rate of return regulation or competition, as required by law;***
- ***establish standards so that competition will maintain or improve the quality of services provided to Missourians;***
- ***provide the public the information they need to make educated utility choices;***
- ***provide an efficient regulatory process that is responsive to all parties, and perform our duties ethically and professionally."***

Grid Mod Principles Example

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Hawaii *(Adopted by HECO & PUC)*

- ***Enable greater customer engagement, empowerment, and options for utilizing and providing energy services.***
- ***Maintain and enhance the safety, security, reliability, and resiliency of the electric grid, at fair and reasonable costs, consistent with the state's energy policy goals.***
- ***Facilitate comprehensive, coordinated, transparent, and integrated grid planning across distribution, transmission, and resource planning.***
- ***Move toward the creation of efficient, cost-effective, accessible grid platforms for new products, new services, and opportunities for adoption of new distributed technologies.***
- ***Ensure optimized utilization of resources and electricity grid assets to minimize total system costs for the benefit of all customers.***
- ***Determine fair cost allocation and fair compensation for electric grid services and benefits provided to and by customers and other non-utility service providers.***

DSPx Taxonomy & Objectives

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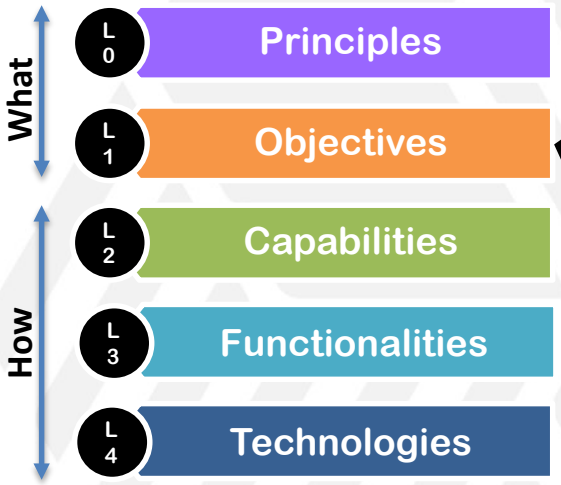
Taxonomy Provides a Structured Method to Trace Objectives to Functionality



Affordability	Operational Excellence
Safety	Enable DER Integration
Customer Enablement	Reliability & Resilience
System Efficiency	Enable Technology Innovation
Cyber-physical Security	DER Utilization
Reduce Carbon Emissions	Enable Electrification

Sample Relationship Maps

Objectives to Capabilities to Functionality Maps Enable Traceability

	CAPABILITIES	OBJECTIVES: Safety	Affordability	Reliability	Resilience	Technology Innovation	Customer Enablement	System Efficiency	Cyber-physical Security	Emissions Reduction	Operational Excellence	DER Integration	DER Utilization
2.1.1	Scalability		•	•	•	•	•	•			•	•	
2.1.2	Impact Resistance and Impact Resiliency	•		•	•				•				
2.1.3	Open and Interoperable		•	•		•	•	•			•	•	•
2.1.4	Accommodate Tech Innovation	•	•	•	•	•	•	•	•	•	•	•	•
2.1.5	Convergence with other Critical Infrastructure		•	•	•		•	•			•		
2.1.6	Accommodate New Business Models		•			•	•			•	•	•	•
2.1.7	Transparency	•	•	•		•	•	•				•	•
2.2.1	Operational Risk Management	•	•	•	•			•	•		•		
2.2.2	Situational Awareness	•	•	•	•			•	•		•	•	•
2.2.3	Controllability and Dynamic Stability			•				•		•			
2.2.4	Management of DER and Load Stochasticity		•		•			•		•	•	•	

Objectives to Capabilities to Functionality Maps Enable Traceability

CAPABILITIES		FUNCTIONALITIES: 3.1 DISTRIBUTION SYSTEM PLANNING										
		1	2	3	4	5	6	7	8	9	10	11
		Short and Long-term Demand and DER Forecasting	Short-term Distribution Planning	Long-term Distribution Planning	Interconnection Process	Reliability and Resiliency Criteria	Locational Value Analysis	Integrated Resource, Transmission, and Distribution Planning	Distribution System Information Sharing	Planning Analytics	Hosting Capacity Analysis	EV Readiness
2.1.1	Scalability	•		•	•	•		•	•			
2.1.2	Impact Resistance and Impact Resiliency	•	•	•	•	•					•	•
2.1.3	Open and Interoperable				•				•			•
2.1.4	Accommodate Tech Innovation	•	•	•	•		•	•	•	•	•	•
2.1.5	Convergence with other Critical Infrastructure	•	•	•		•	•	•	•	•		•
2.1.6	Accommodate New Business Models	•	•	•			•	•	•		•	
2.1.7	Transparency	•	•	•	•	•	•	•	•		•	
2.2.1	Operational Risk Management	•	•	•	•	•	•	•		•	•	•
2.2.2	Situational Awareness	•	•	•	•	•	•	•		•	•	•
2.2.3	Controllability and Dynamic Stability	•			•	•	•			•		•
2.2.4	Management of DER and Load Stochasticity	•	•	•	•		•	•		•	•	
2.2.5	Contingency Management		•	•	•	•	•	•		•		
2.2.6	Security		•	•	•	•						
2.2.7	Public and Workforce Safety		•	•	•	•						

Taxonomy Example

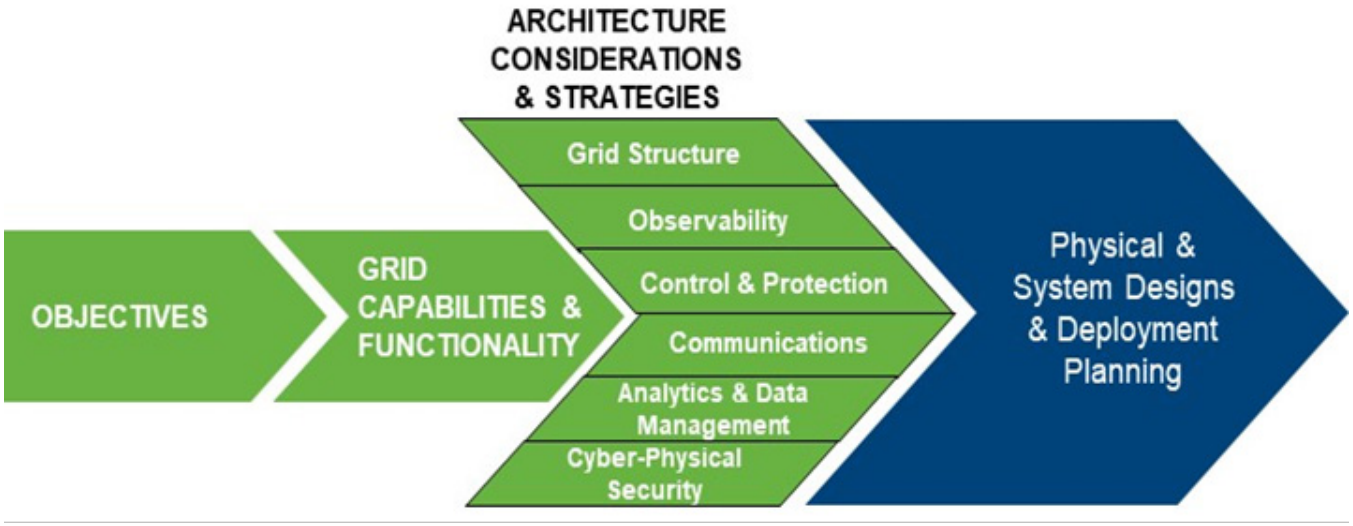
Objective	Capability	Function	Technology
Customer Choice through information access for small business & residential customers to support decision making by 2020	Provide online customer access to relevant & timely information	Remote meter data collection & verification Customer data management Energy management & DER purchase analysis	Customer Portal Customer Analytic Tools Greenbutton Smart Meter Telecommunications Meter Data Management System Customer Info System Data Warehouse

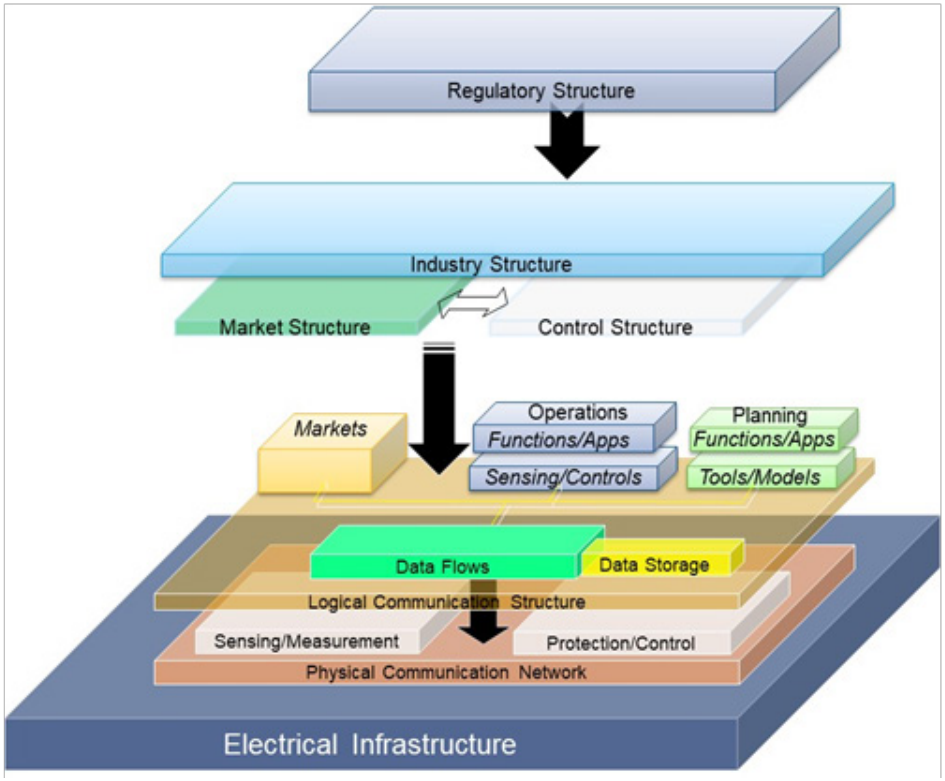
Taxonomy Example

Objective	Capability	Function	Technology
Reliability improvement by reducing customer unplanned outage durations Achieve 1st Quartile CAIDI Performance by 2020	Improve outage identification and customer service restoration	Fault Identification Fault Location Fault Isolation Service restoration	Fault Current Indicators Outage Notification from Meters Outage Management System Geospatial Information System Distribution Management System and/or SCADA Automated Switches Work Management System

Architectural Strategy

1. Outline key system considerations from an understanding of grid technology, emerging trends and systemic issues
2. Define architectural strategies from an understanding of grid structure concepts
3. Apply strategies to key considerations in the design of new and modified grid systems

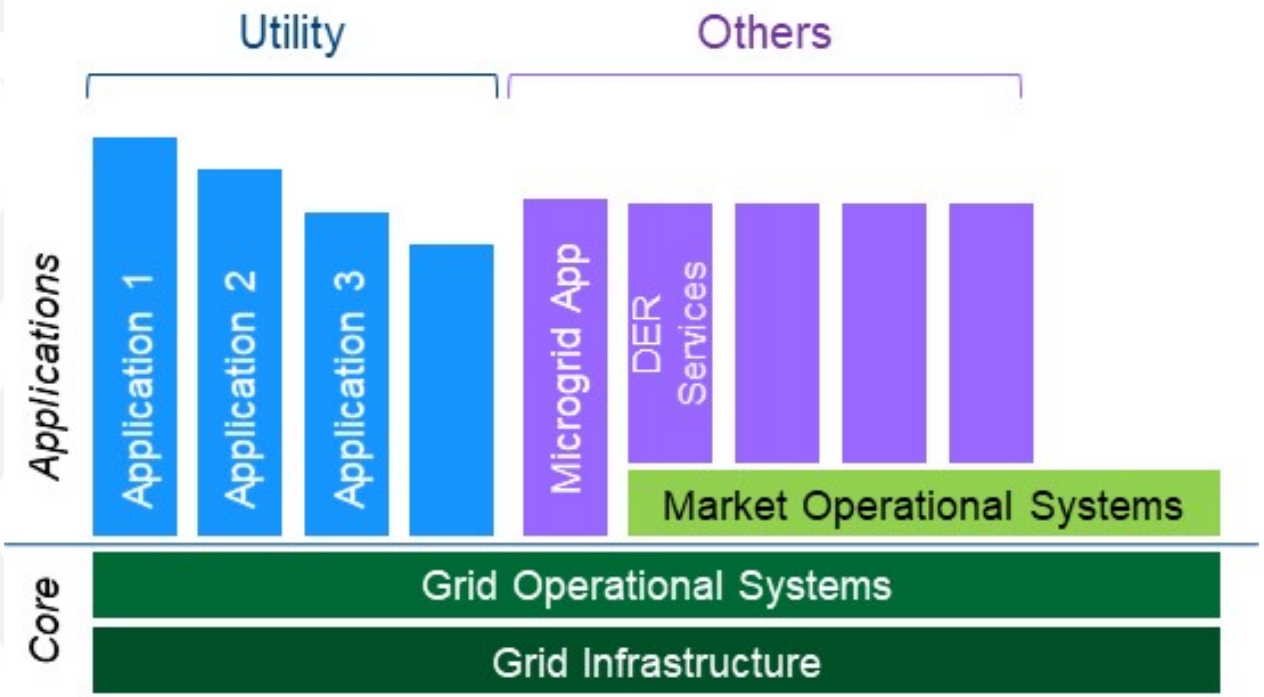




Distribution Grid as a Platform

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



Source: P. De Martini

Distribution System Platform

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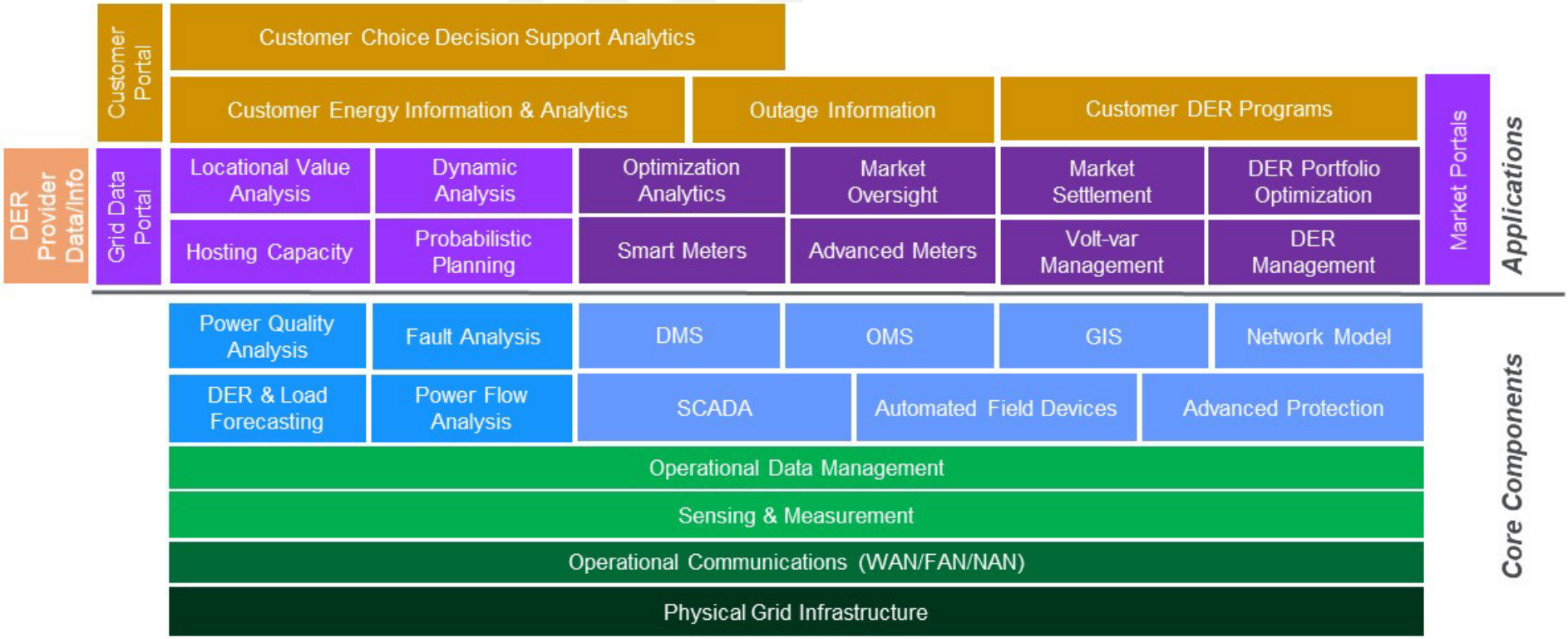
Logical layering of core components that enable specific applications



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

Source: U.S. Department of Energy-Office of Electricity Delivery and Energy Reliability, 2017. *Modern Distribution Grid, Volume III: Decision Guide*.

Identify Starting Point for Grid Investment

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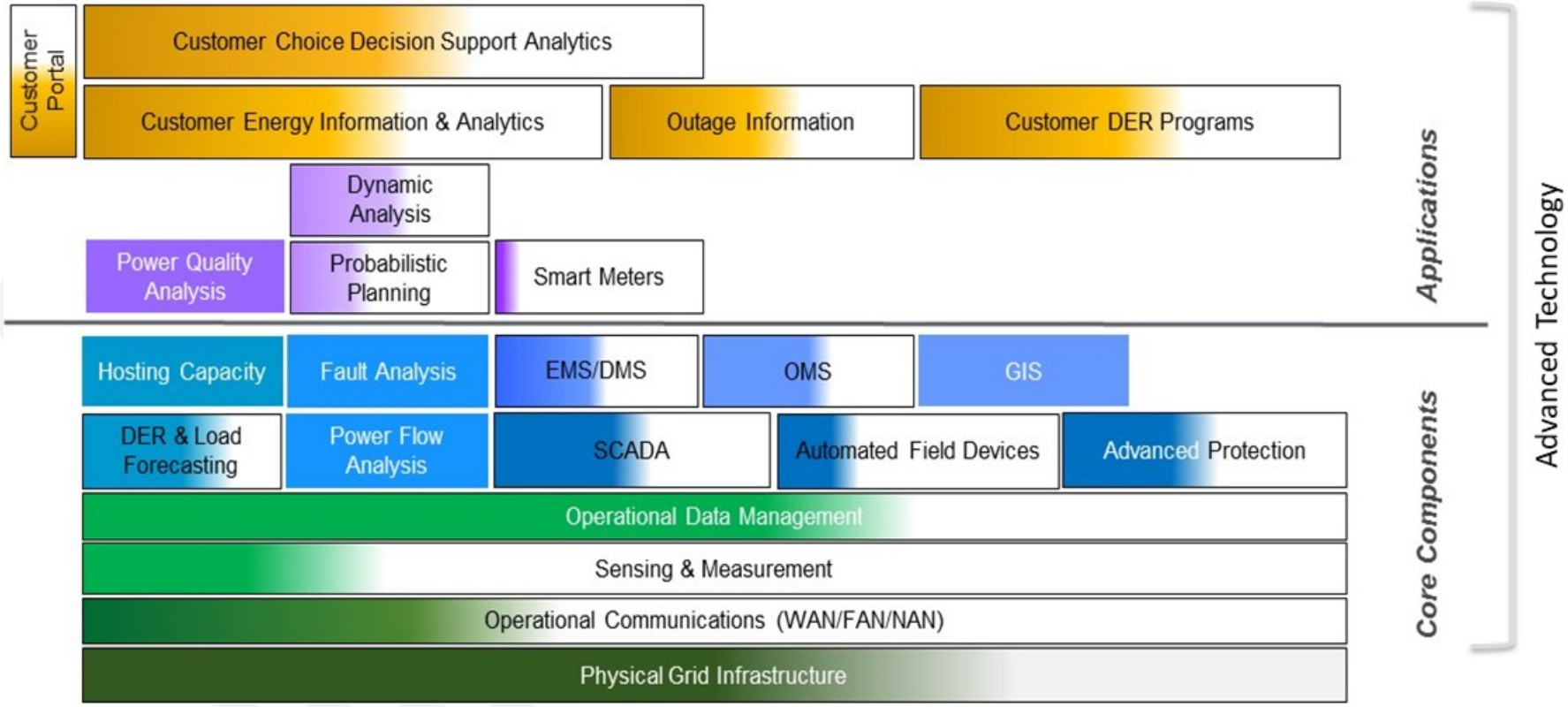
This graphic is a summary illustration of a more complete assessment documented in narrative and tables to enable a gap analysis against objectives and identified capabilities & functionalities.



Source: Hawaiian Electric 2017

Technology Implementation Decision Criteria

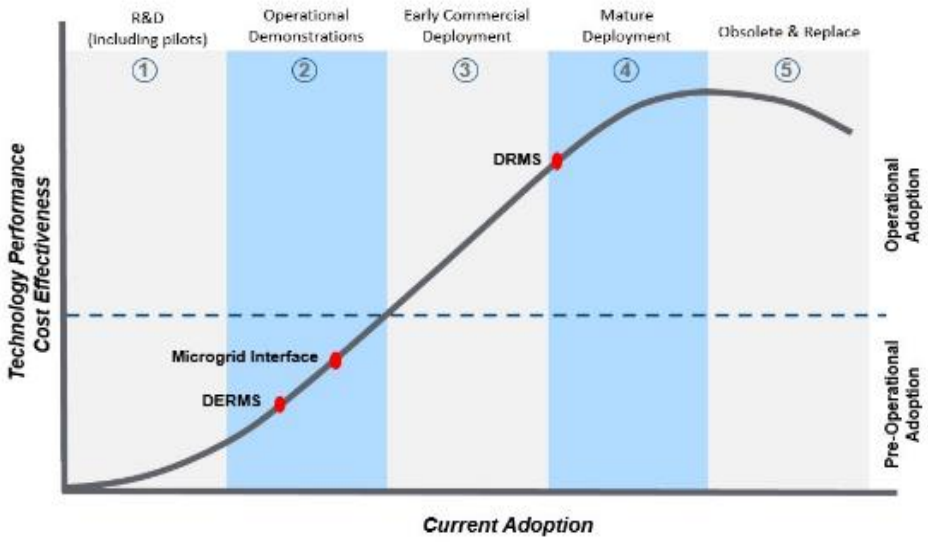
General framework for technology assessment within a stage gate sequence where the evaluation begins with conceptual screening on a set of these criteria and increasingly becomes more detailed and definitive in terms of the quantitative and qualitative assessment.

Source: P. De Martini

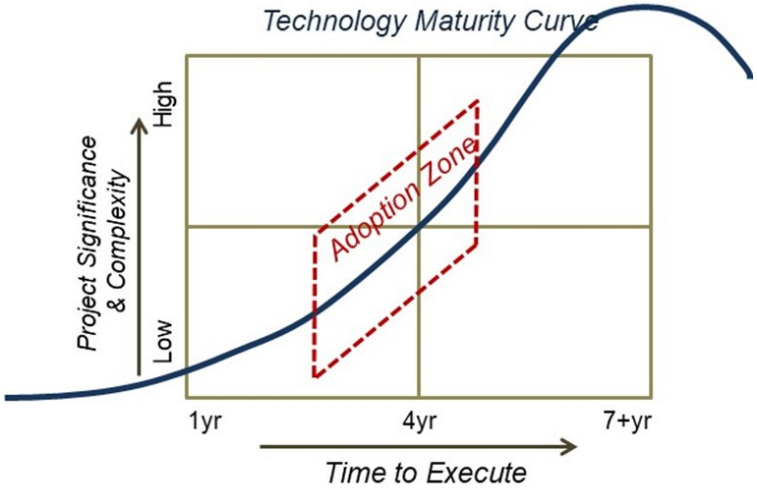
Technology Adoption Considerations

Deciding when to adopt grid technologies involves several factors: technology maturity, time to deploy, implementation complexity & functional criticality.

Technology Maturity Assessment



Technology Adoption Strategy



Source (above): U.S. Department of Energy-Office of Electricity, 2017. *Modern Distribution Grid, Volume II: Advanced Technology Maturity Assessment*.

Distribution & Modernization Investment Categories

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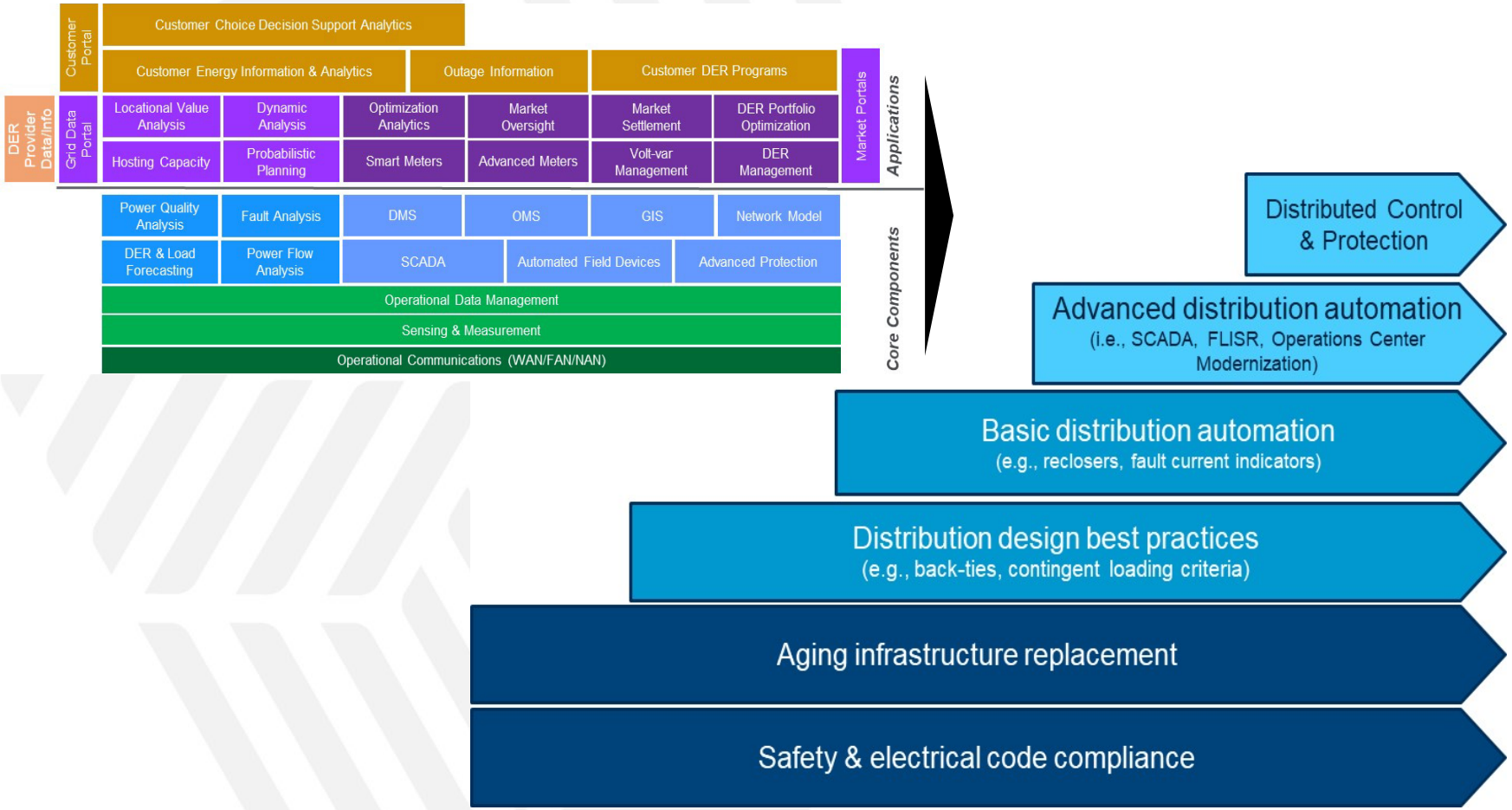
Grid Modernization technologies layer on top of & integrate with foundational physical grid infrastructure.



Sequencing of Investments

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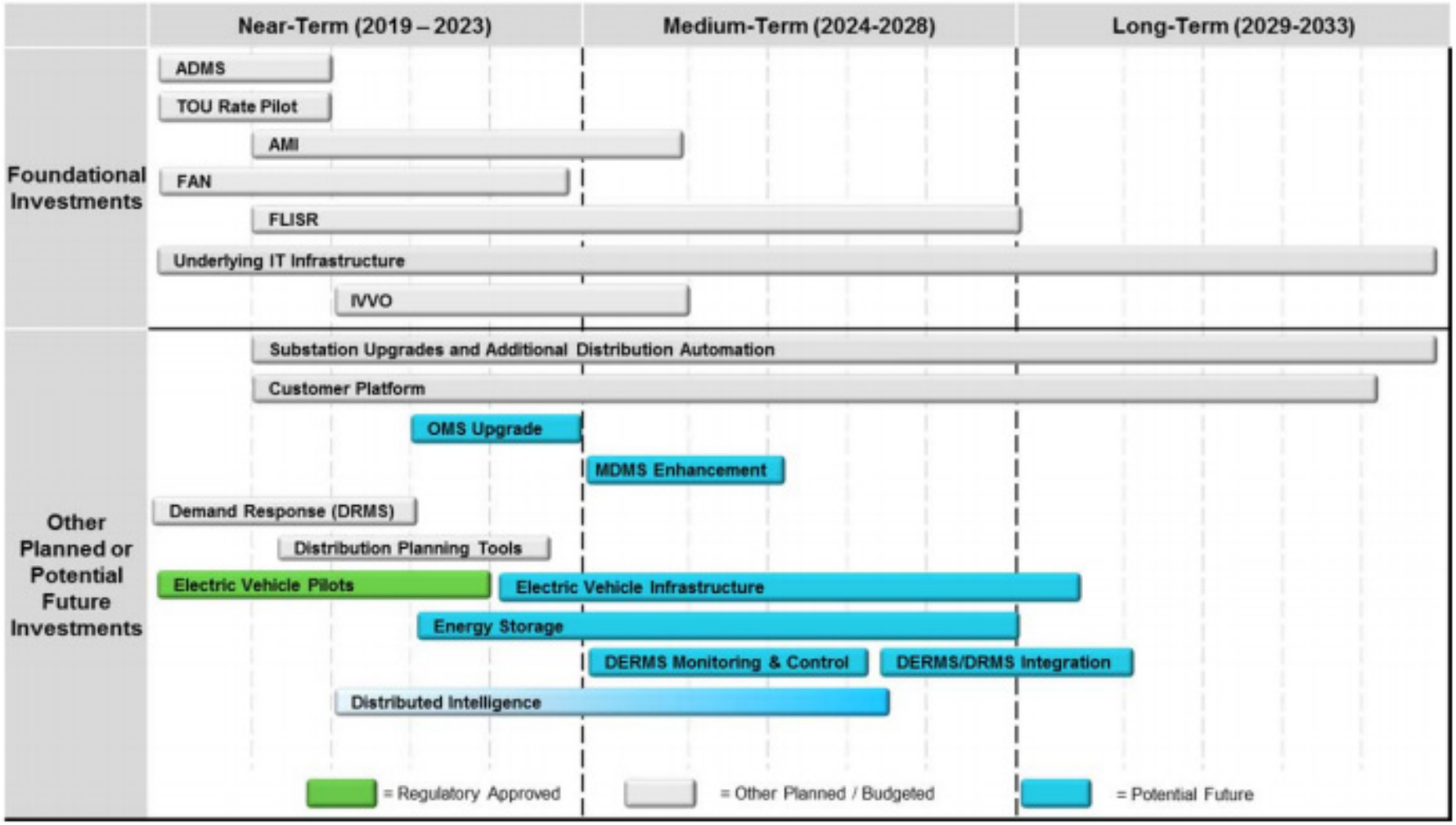
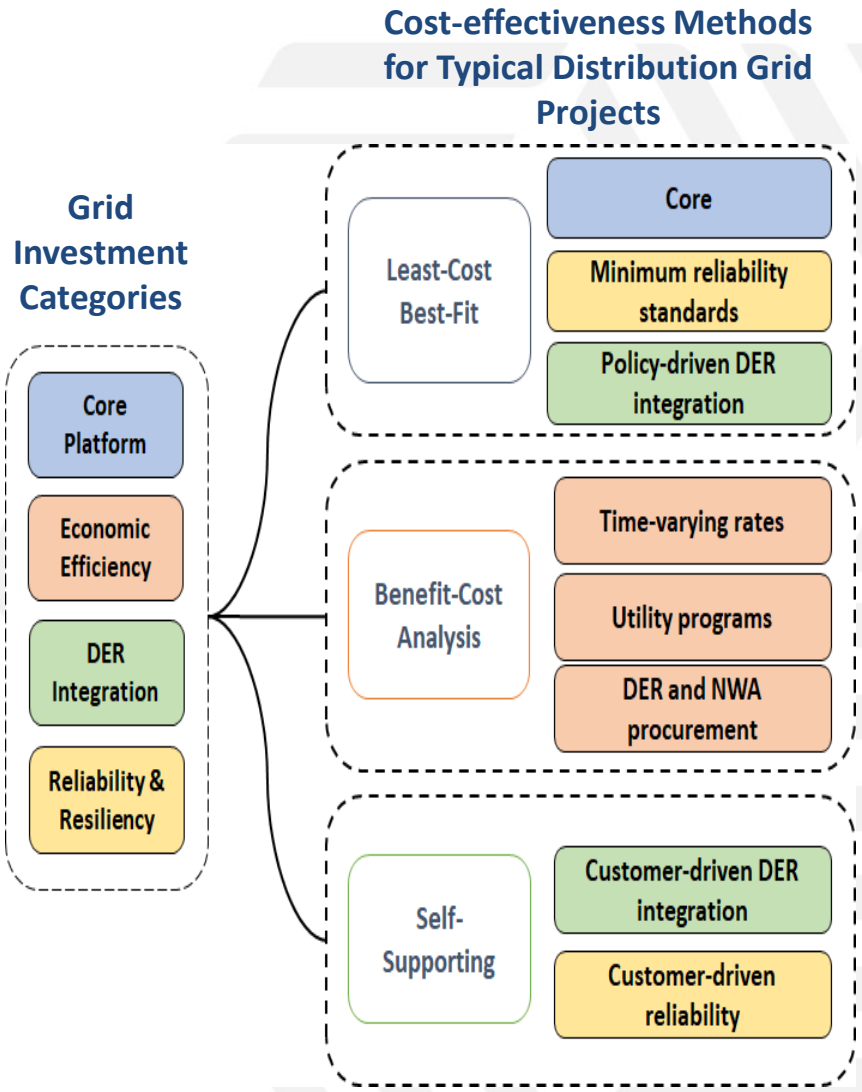
Long-term strategic plan of distribution grid investments



From Xcel Energy's 2019 Integrated Distribution Plan

Grid Investment Cost-Effectiveness Framework



Least-cost, best-fit for core grid platform and grid expenditures required to maintain safe, reliable, resilient operations as well as integrate distributed resources connected behind and in front of the customer meter that may be socialized across all customers.

Benefit-Cost Analysis for grid expenditures proposed to enable public policy and/or incremental system and societal benefits to be paid by all customers. Grid expenditures are the cost to implement the rate, program or NWA. Various methods for BCA may be used.

Customer Self-supporting costs for projects that only benefit a single or self-selected number of customers and do not require regulatory benefit-cost justification. For example, DER interconnection costs not socialized to all customers. Also, undergrounding wires at customers' request.

Thank You

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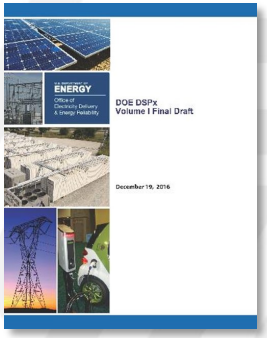
Contact:

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

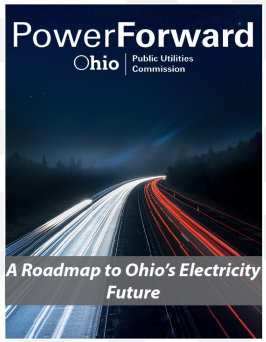
References & Examples:

Modern Distribution Grid Report



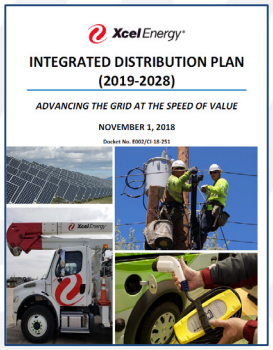
https://gridarchitecture.pnnl.gov/modern-grid-distribution-project.aspx

PUCO Grid Mod Roadmap



https://puco.maps.arcgis.com/apps/Cascade/index.html?appid=59a9cd1f405547c89e1066e9f195b0b1

Grid Modernization Strategy Using DSPx

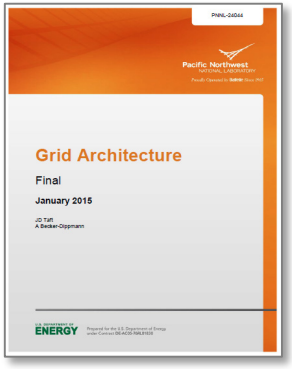


https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={E098D466-0000-C319-8EF6-08D47888D999}&documentTitle=201811-147534-01

Grid Modernization Strategy Using DSPx

www.hawaiianelectric.com/gridmod

Grid Architecture



http//gridarchitecture.pnnl.gov