

Grid Modernization Investment Economics

Fredrich (Fritz) Kahrl, 3rdRail Inc.

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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

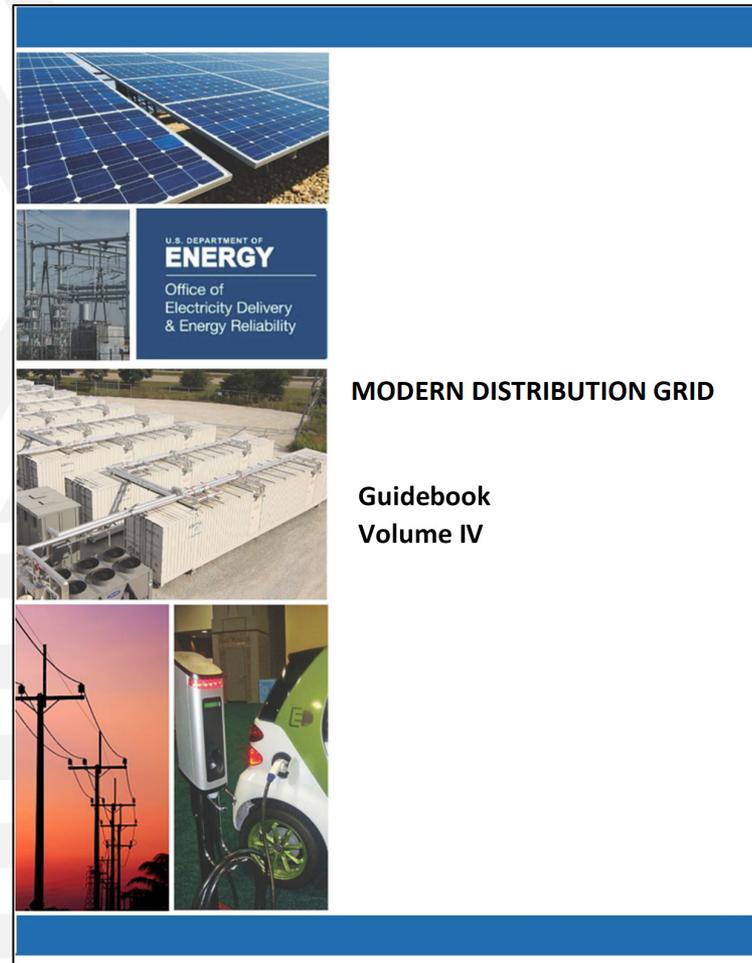
Uncertainty

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

DOE's Modern Distribution Grid Guidebook: Grid Modernization Investment Economics

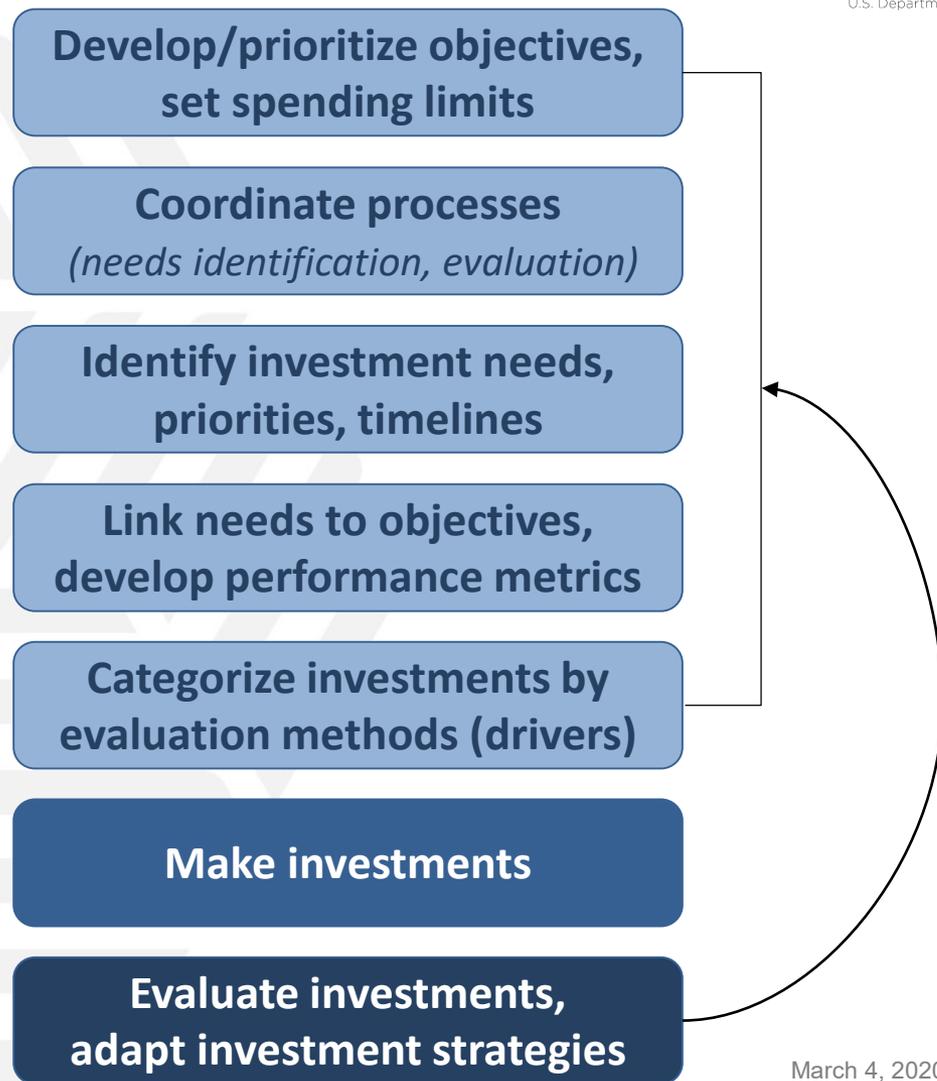
- ▶ Volume IV includes an economic evaluation framework for grid modernization investments
 - Aims to inform approaches to evaluating economics of grid modernization investments and strategies for prioritizing investments
- ▶ No textbook approach — multiple reasonable paths to achieving the same broad goals

U.S. Department of Energy. *Modern Distribution Grid Volume IV: Guidebook*. Forthcoming.



Economic evaluation framework

- Framework has three basic stages:



Prioritizing objectives

- ▶ Different jurisdictions will identify and emphasize different objectives for modernizing distribution grids
- ▶ Priorities will shape economic evaluation frameworks

Priority objective	Customer choice	Distributed energy resource integration	Reliability and resilience
Investment priority	Advanced metering infrastructure that enables full retail competition	Monitoring, sensing, and control systems that enable higher DER penetration	Feeder upgrades, distribution automation, outage management systems that reduce outages and improve response time
Example priority investments and functionality	Communications network, data management, advanced meters	Communications network, ADMS, GIS, VVO	Communications network, ADMS, GIS, OMS, FLISR

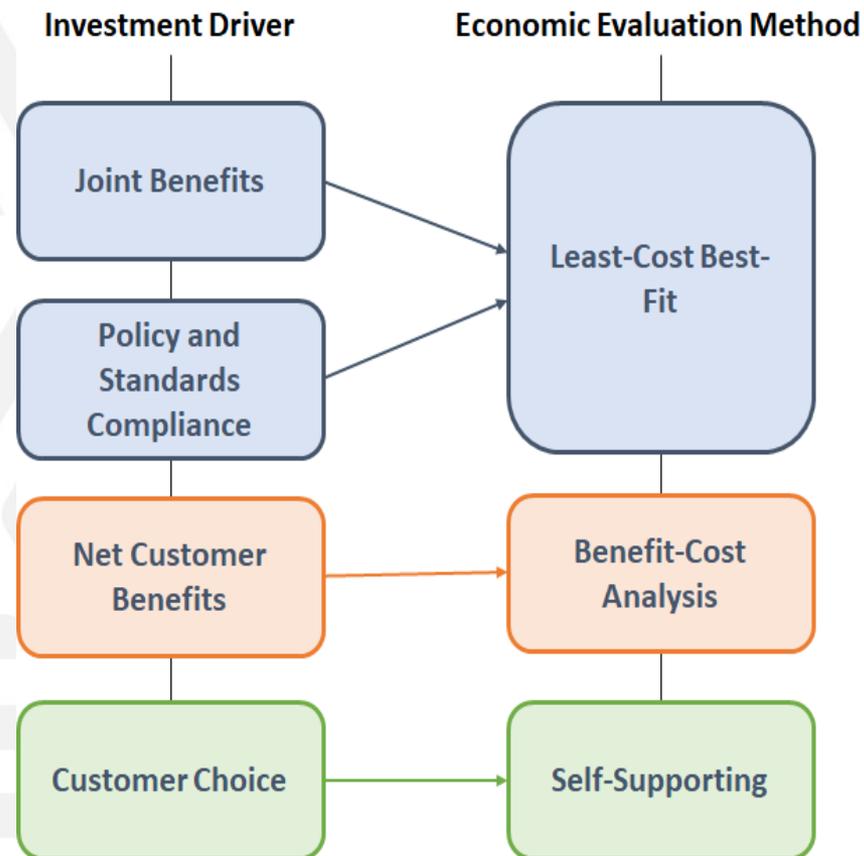
Coordinating processes

- ▶ Grid modernization involves a large number of processes
- ▶ Coordination among processes:
 - Enables holistic approach to investment
 - Ensures consistency between investments and long-term objectives
 - Avoids double counting

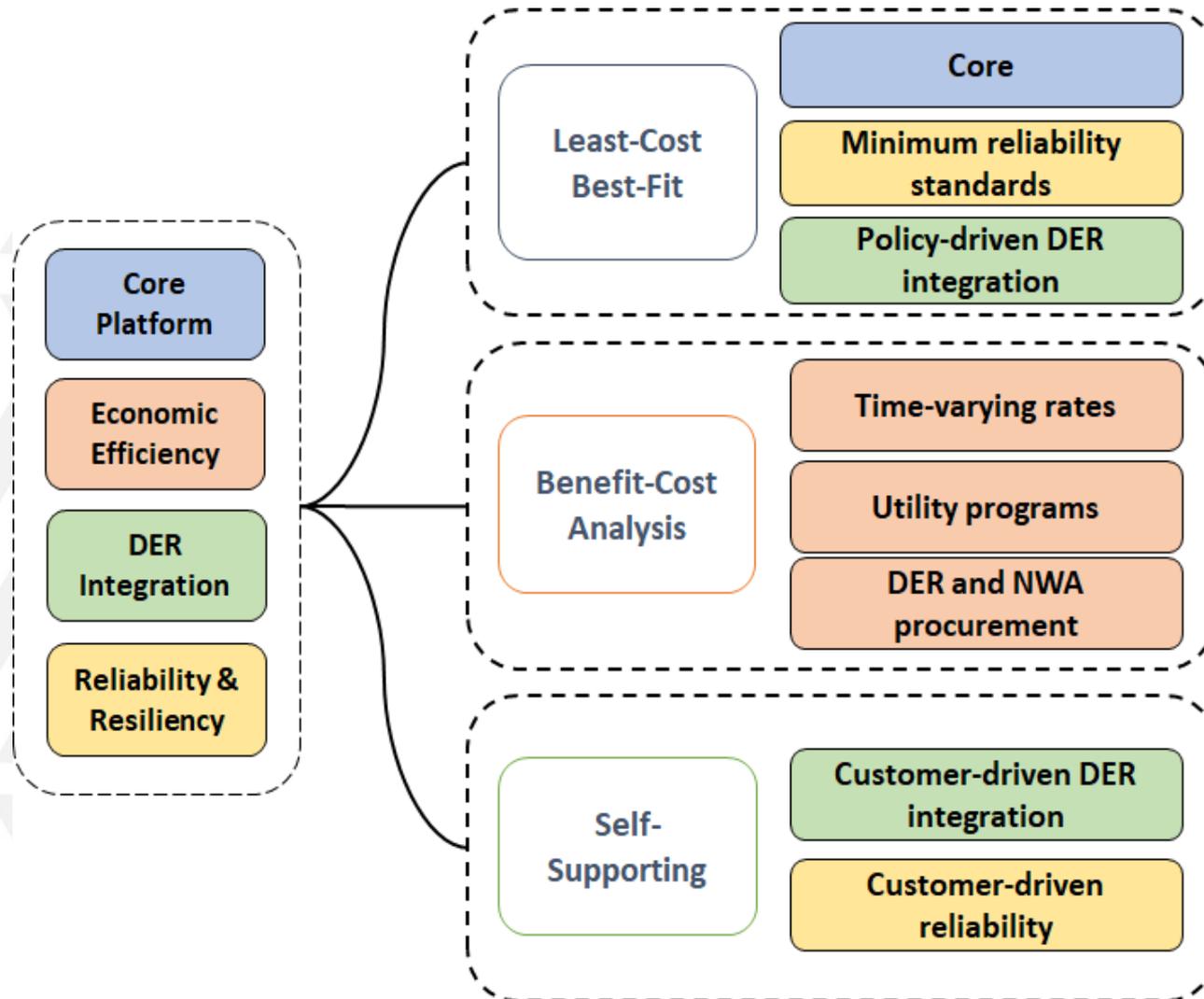


Targeting economic evaluation

- ▶ **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



Targeting economic evaluation: Example of less detailed categorization

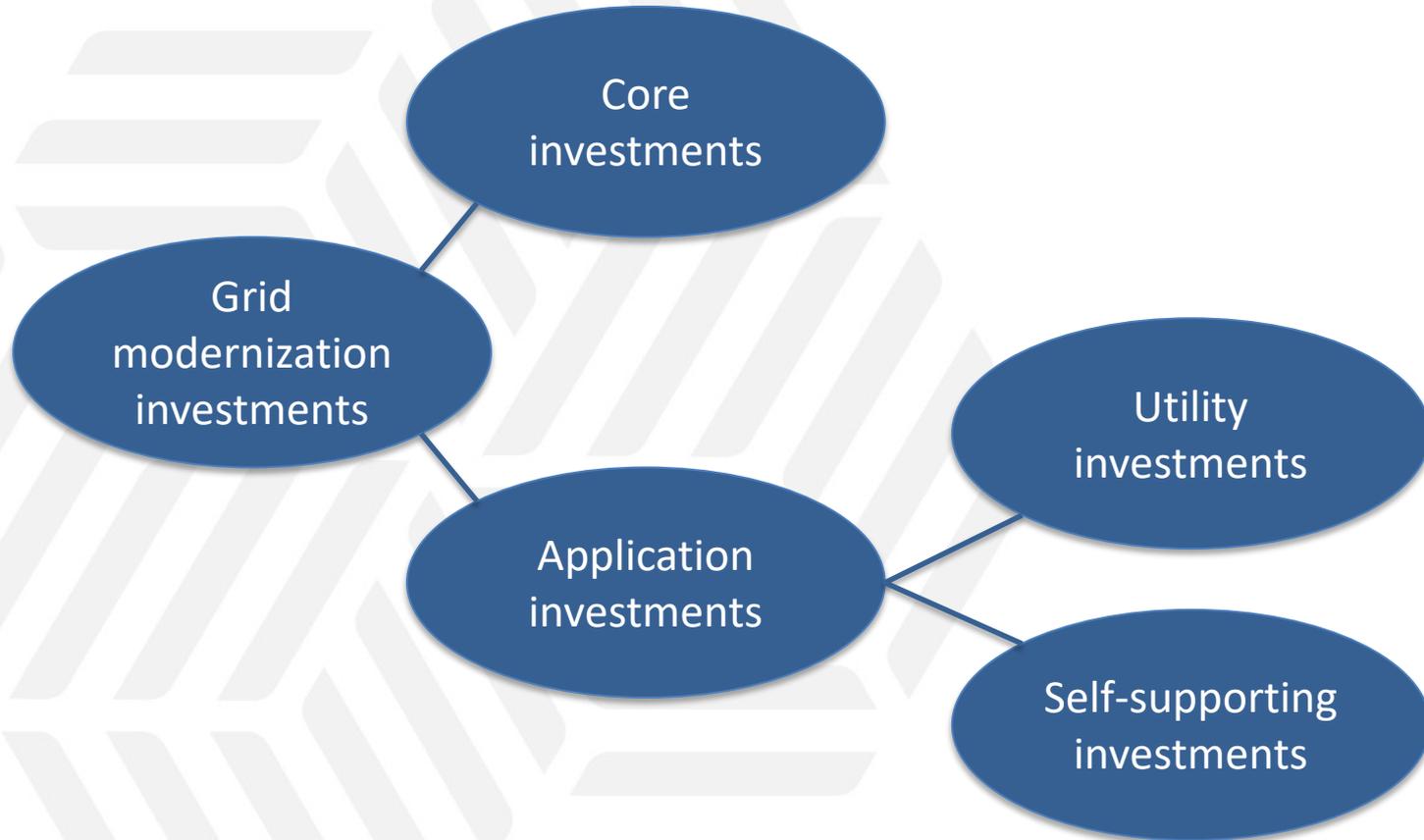
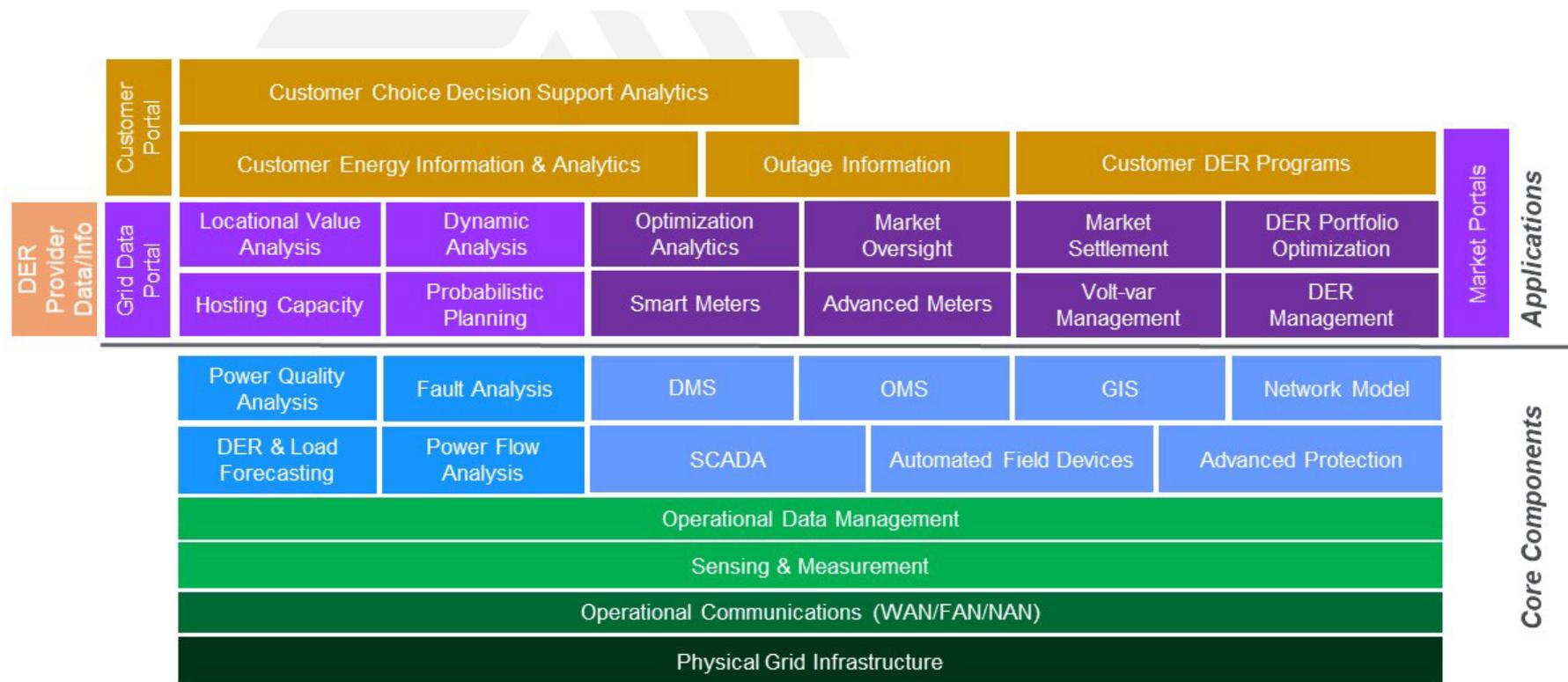


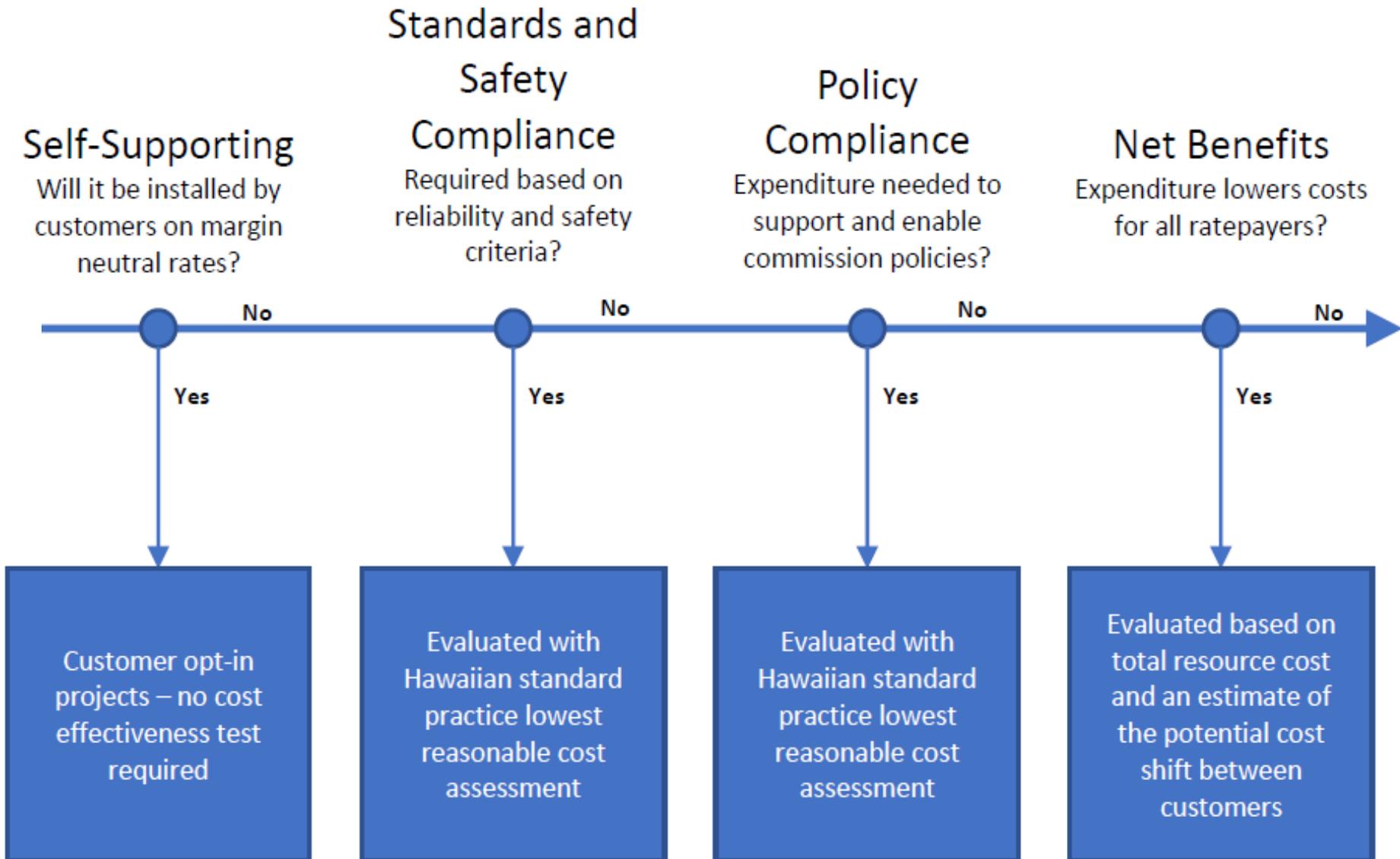
Illustration of core investments



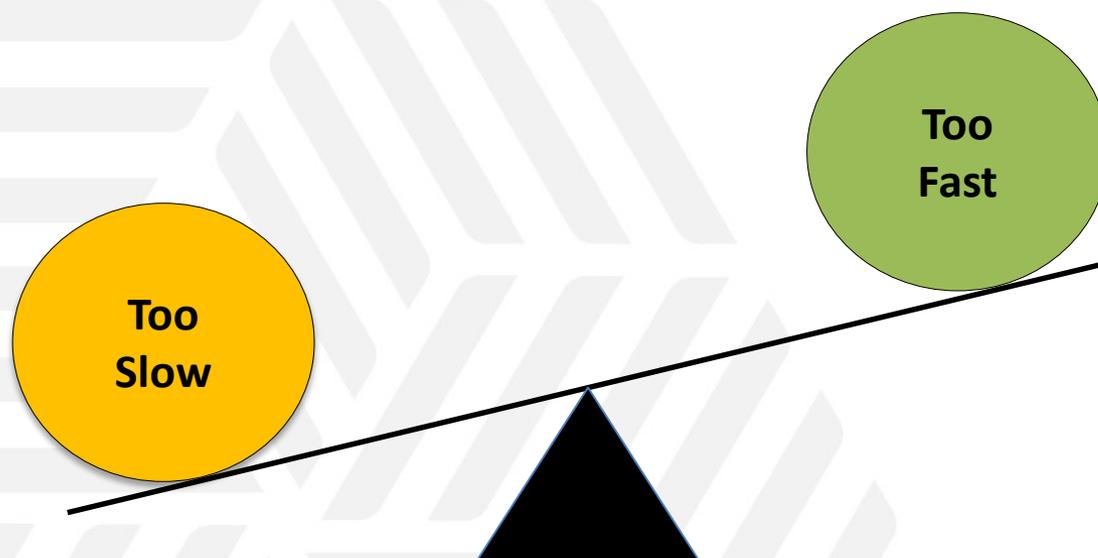
Green - Core Cyber-physical layer
 Blue - Core Planning & Operational systems
 Purple - Applications for Planning, Grid & Market Operations
 Gold - Applications for Customer Engagement with Grid Technologies
 Orange - DER Provider Application

Source: U.S. Department of Energy-Office of Electricity Delivery and Energy Reliability, 2017. *Modern Distribution Grid, Volume III: Decision Guide*. Available online at: <https://gridarchitecture.pnnl.gov/media/Modern-Distribution-Grid-Volume-III.pdf>

Using decision trees to aid categorization: Hawaii example



Managing risks



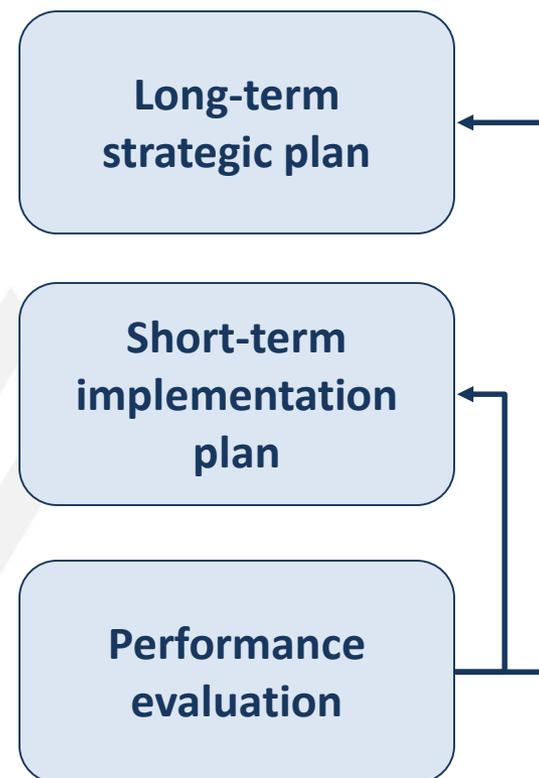
- ▶ Utilities may want to go fast, if regulators ensure cost recovery.
- ▶ DER providers and customers may want to go fast, but don't want to overpay.
- ▶ Customers may want more reliability, resilience, and clean energy but don't want bill shocks.
- ▶ Regulators may want modern grids, but worry about rate impacts and technology obsolescence.

Risk-based investment prioritization

- ▶ Tools for managing risk tradeoffs among stakeholders
 - **Long-term strategic planning** — establish investment priorities and sequencing; investment scoring vis-à-vis objectives is a useful approach
 - **Spending limits** — set limits on spending (or rate impacts) over a given time interval; use limits to guide investment decision-making
 - **Pilots** — use pilots to better understand technology benefits, costs, operational needs, organizational changes
 - **Ex post performance assessment** — assess investments relative to pre-determined performance metrics, prioritizing learning and adaptation
- ▶ **Walk-jog-run** approach in Vol III of DOE's *Modern Distribution Grid* provides useful framework for managing risk and uncertainty

Evaluating performance

- ▶ Important to set performance metrics in advance, link to long-term and short-term objectives
 - For instance, as part of long-term strategic and short-term implementation plans
- ▶ Metrics can cover both deployment and operation
- ▶ Particularly important for core investments
 - For example, how do we evaluate performance of an ADMS?
- ▶ Evaluation can correspond with planning/investment cycles



Example performance metrics

- ▶ Performance metrics will vary across jurisdictions, according to differing objectives and priorities

Example category	Example performance metrics
Deployment	Extent of planned deployment or number of installations
Customer satisfaction	Customer experience ratings, customer engagement metrics
Reliability	System-wide or targeted SAIDI, SAIFI, CAIDI, CAIFI
Resilience	Service interruptions and restoration time after extreme events
Safety	Emergency events and response times, accidents and injuries
Economic efficiency	Investment and operating cost savings
Network and data access	Interconnection times, data access times, developer satisfaction
Retail competition	Number of customers choosing a competitive retail option
Program or rate participation	Customers enrolled in EV and other time-of-use rates, utility programs

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 regulators can ask

- ▶ What are the objectives and priorities of grid modernization?
- ▶ Which objectives are supported by different grid modernization investments?
- ▶ How should the different planning processes affected by grid modernization be coordinated?
- ▶ What are the drivers of different investments and how should they be evaluated?
- ▶ 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?

Thank you

Questions?
Insights?

Fritz Kahrl
fkahrl@outlook.com