Coordinated GT&D Planning and Investment Prioritization - An Introduction to our Industry Needs

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Agenda

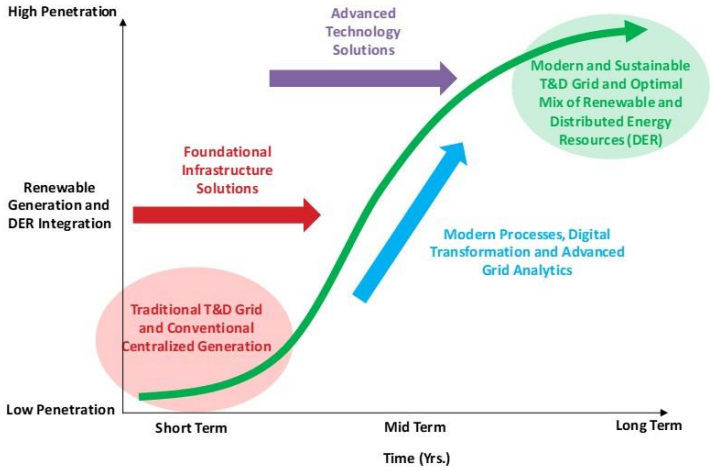
1. **Introduction to Generation, Transmission, and Distribution (GT&D) Planning**
    - Sample Case Study
    - Drivers of Convergence
    - Key Premise
    - Evaluation Approach: G,T,D impact and level of maturity
2. **Sample Areas of Coordination and Convergence**
    - Integrated T&D Planning
    - Integrated T&D Operations
3. **Coordinated GT&D Planning and Investment Prioritization**

INTRODUCTION TO GENERATION, TRANSMISSION, AND DISTRIBUTION (GT&D) PLANNING

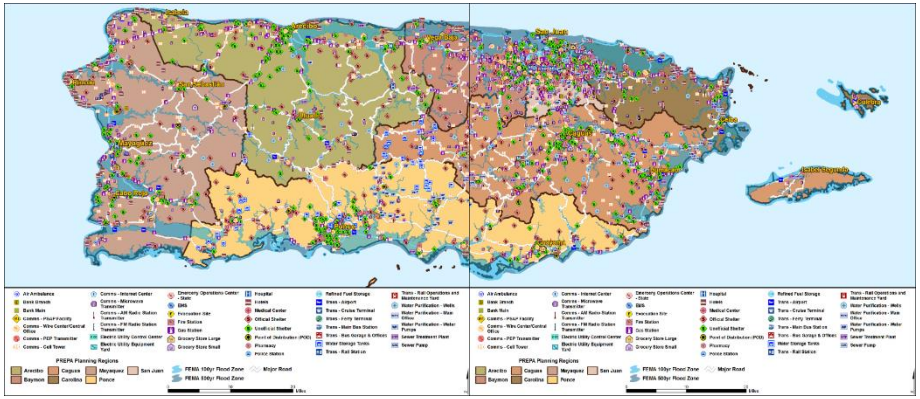
- Sample Case Study
- Drivers of Convergence
- Premise
- Evaluation Approach

Sample Case Study: Puerto Rico

- Hurricane Maria devastated the island creating a need for significant infrastructure investment
- Policy objectives to shift to more renewable generation and distributed energy resources to support renewable portfolio standards (RPS) and improve grid resilience
- New planning paradigm is required to achieve improved reliability and safety, increased resilience, reduced prices, and lowered carbon emissions



Microgrid Locations Benefitting Community Resilience



Source: Sandia National Labs

Coordination across GT&D planning and operations to guide investment prioritization is necessary to meet policy objectives and customer needs

Policy and Strategic Objectives are Driving Planning Convergence

Policy & Strategic Objectives

- Decarbonization
- Financial Sustainability
- Resilience
- Reliability
- Safety

Policies & Plans

- Renewable Portfolio Standards
- Electrification
- Integrated Resource Plans (IRPs)
- General Rate Cases
- Risk Mitigation Plans
- Grid Modernization Plans

Related Analyses (Examples)

- Value of DER
- Load & DER[1] Forecasting
- Protection, Automation, & Control
- Non-Wires Alternatives (NWA)
- Hosting Capacity
- Reliability
- Asset Management

Each of these types of analysis has the potential to impact each planning domain.

Impacted Planning Processes

- Generation
- Transmission
- Distribution

Resource-Focus ⟷ **T&D Infrastructure-Focus**

[1]Distributed Energy Resource (DER)

Changes Impacting Planning and Operation Paradigms

1 Technology, Climate, and Business Transformation:

T	Mechanical	Digital
	Large Centralized	Distributed
	Uni-Directional	Bi-Directional
	Dispatchable	Intermittent
	High Cap Factor	Low Cap Factor
C	Predictable	Uncertain
	1 in 100-year Events	Every year Events
B	IT Secure	Cyber Intrusion
	Franchise Model	Merchant Model

2 Create Planning and Operational Challenges:

- Need to interconnect large amounts of MWs
- D hosting capacity and T deliverability
- IBR interconnection limits and standards
- Flexibility to counter increased uncertainty
- NWA planning criteria, tools, and expertise
- DER visibility and controllability
- Aging infrastructure
- Resilience goals
- Utility investment incentives

3 Requiring New Skills, Tools, and Techniques:

- Granular time-series analysis
- Granular spatiotemporal forecasting (load and DER)
- Asset condition assessments
- Risk analysis
- Probabilistic planning
- Participatory and transparent planning process
- Financial analysis
- Utility incentives and rate-making
- DERMS[1] / ADMS[2] / AMI[3] / Volt-VAR / DA[4] infrastructure
- Scalable communication
- Protection system for grids with high IBR penetration
- Vulnerability analysis

4 To Achieve Goals:

- Safety
- Reliability
- Affordability
- Capacity
- Sustainability
- Resilience
- Security
- Customer Engagement

[1]Distributed Energy Resource Management System (DERMS). [2]Advanced Distribution Management System (ADMS)
[3]Advanced Metering Infrastructure (AMI) [4]Distribution Automation (DA)

Key Premise and Implications

Key Premise

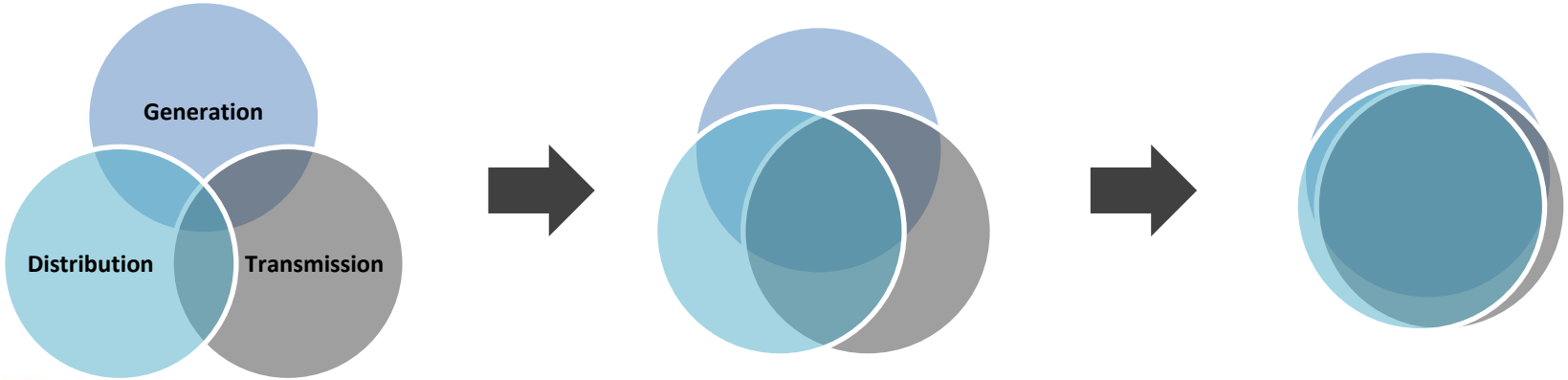
There are no siloed investments; investments inherently touch each planning domain (as well as operations)

- ***Direct Impact:*** e.g., distribution line reconductor increases hosting capacity, which supports RPS and potential transmission NWAs
- ***Indirect Impact:*** e.g., increase in distribution line reconductors with insulated conductor to reduce wildfire exposure, reduce budgets for 4 to 12 kV conversions which limits hosting capacity

Planning Implications

- Investments should be valued similarly across each planning domain
- Investments are increasingly interchangeable across each planning domain
- Operational short-term forecasting requirements are converging with long-term planning requirements

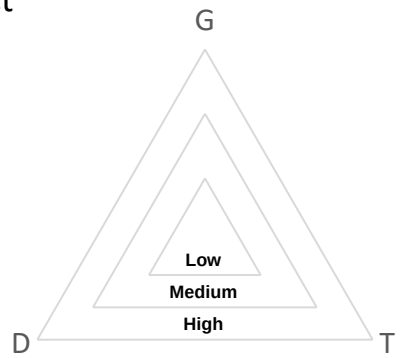
Legacy Perspective | **Current State** | **Future Trend**



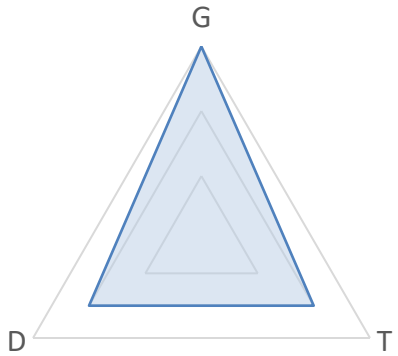
Approach for Evaluating Planning Domains

Each topic is scored on the following scale to identify the extent to which each planning domain is impacted:

1. Low Impact
2. Medium Impact
3. High Impact



The IRP example below shows a primary impact to Generation Planning and secondary impacts to Transmission and Distribution Planning.

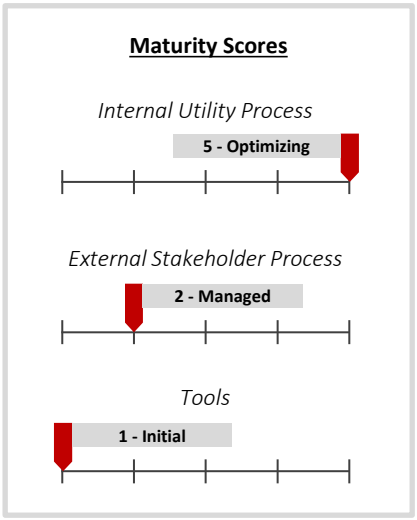


Integrated Resource Planning

Approach for Evaluating Maturity

Capability Maturity Model

- Standard model used to assess governmental contractors' abilities to implement software projects



Level 1: Initial / Chaotic

- Processes are typically undocumented or ad hoc
- Confidence level of results is often unknown

Level 2: Managed / Repeatable

- Some aspects of the process, including results, might be repeatable
- Minimal documentation

Level 3: Defined / Developmental

- The process is a standard business process with some documentation
- The process can be validated for some scenarios

Level 4: Quantitatively Managed / Capable

- Achievement of objectives is verifiable through quantitative metrics
- Process is adaptable to new projects and scenarios

Level 5: Optimizing / Efficient

- Focus on continuous process improvement using metrics and statistics

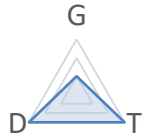
SAMPLE AREAS OF COORDINATION AND CONVERGENCE

- Integrated T&D Planning
- Integrated T&D Operations

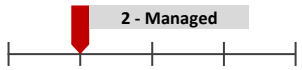
Integrated T&D Planning

Integrated T&D planning is necessary to account for the impacts of high-penetration DERs on the transmission system and to ensure that the grid has proper capacity to implement IRPs.

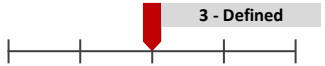
	Current State	Gaps
Processes	• Composite load modeling for transmission analysis • Snapshot analysis (few operating points) • Non-wire efficacy analysis not standardized • System-wide reliability standard	• T transients or contingencies not modeled in D analysis • D reconfiguration and load transfers not modeled in T studies • Time-series analysis of all operating modes stemming from alignment of load and renewable profiles • Analysis of value of DER in D grids • Analysis based on localized reliability needs
Tools	• Separate T&D models • Separate T&D tools (e.g., CYME, PSSE)	• NWA solution siting, sizing, and economics • Integrated analysis of T&D grids • Value of DER analysis • Probabilistic analysis tool to assess risk of delivery interruptions • T hosting capacity for invertor-based resources



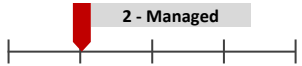
Internal Utility Process Maturity



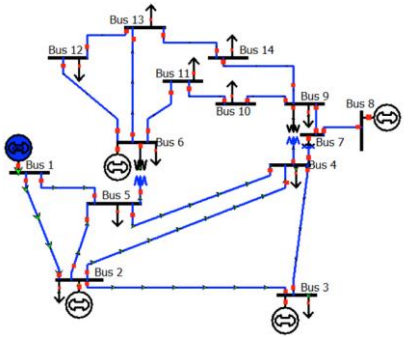
External Stakeholder Process Maturity

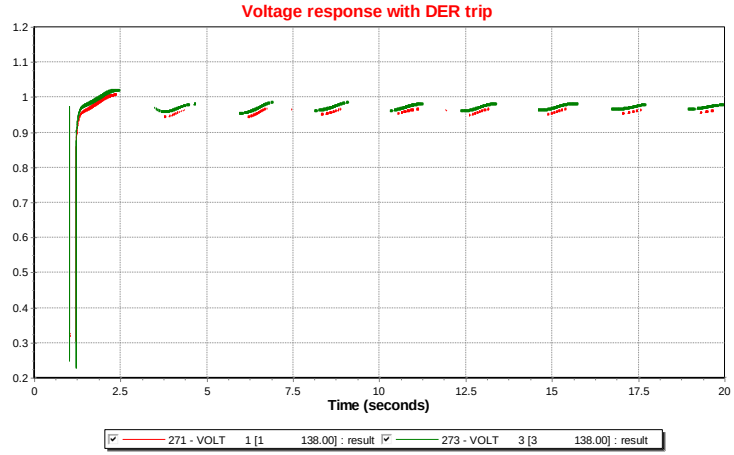


Tools



T&D Co-Simulation





Transmission Network

3ϕ voltage

3ϕ PQ

Interface:
Boundary of Convergence (coupling point)

INTERFACE

3ϕ voltage

3ϕ PQ

Distribution Network

3ϕ voltage

3ϕ PQ

Distribution Network

3ϕ voltage

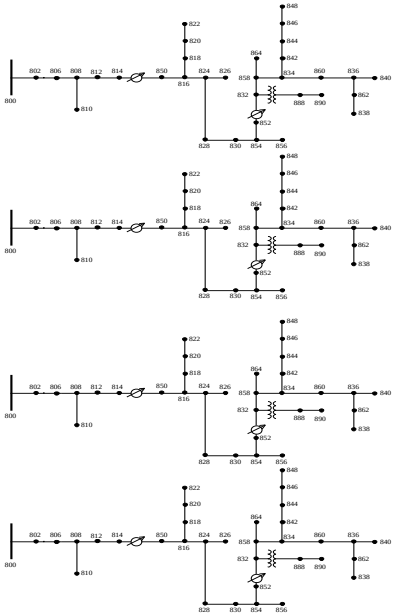
3ϕ PQ

Distribution Network

3ϕ voltage

3ϕ PQ

Distribution Network

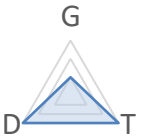


The computational requirements of the dynamic co-simulation of T&D systems are challenging and require research and optimization to become practical.

Integrated T&D Operations

As T&D operations become more interdependent with high levels of DERs, the industry needs to develop a long-term roadmap for the T-D interface.

	Current State	Gaps
Processes	• No clear direction among the stakeholders on how to evolve T-D interface • Coordination framework is being discussed among ISO, utility (DO[1]), and DER providers.	• Focus on "technology solutions" to address immediate concerns (but not long-term objectives) • DO is not in the loop on DER wholesale market transactions • Multi-use DERs may receive conflicting dispatches/signals from DO and ISO
Tools	• Vendors are focusing on offerings in distribution systems • Vendors respond to near-term client needs rather than a long-term solution that involves integrated T&D operations.	• Longer-term arrangements should be automated to deal with high levels of DER • Distribution grid real-time visibility • Real-time forecasting of DER impact at each T-D substation • Coordination procedures between ISO, DO, and DER regarding wholesale DER schedules and dispatches • Dispatch priority related multiple usages of DER



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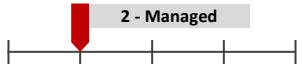

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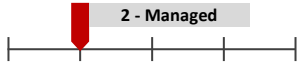

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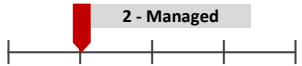

[1] Distribution Owner (DO)

Distribution Owner (DO)

COORDINATED GT&D PLANNING AND INVESTMENT PRIORITIZATION

Investment Planning Requirements

Policy & Strategic Objectives

- Decarbonization
- Financial Sustainability
- Resilience
- Reliability
- Safety

Policies & Plans

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Related Analyses (Examples)

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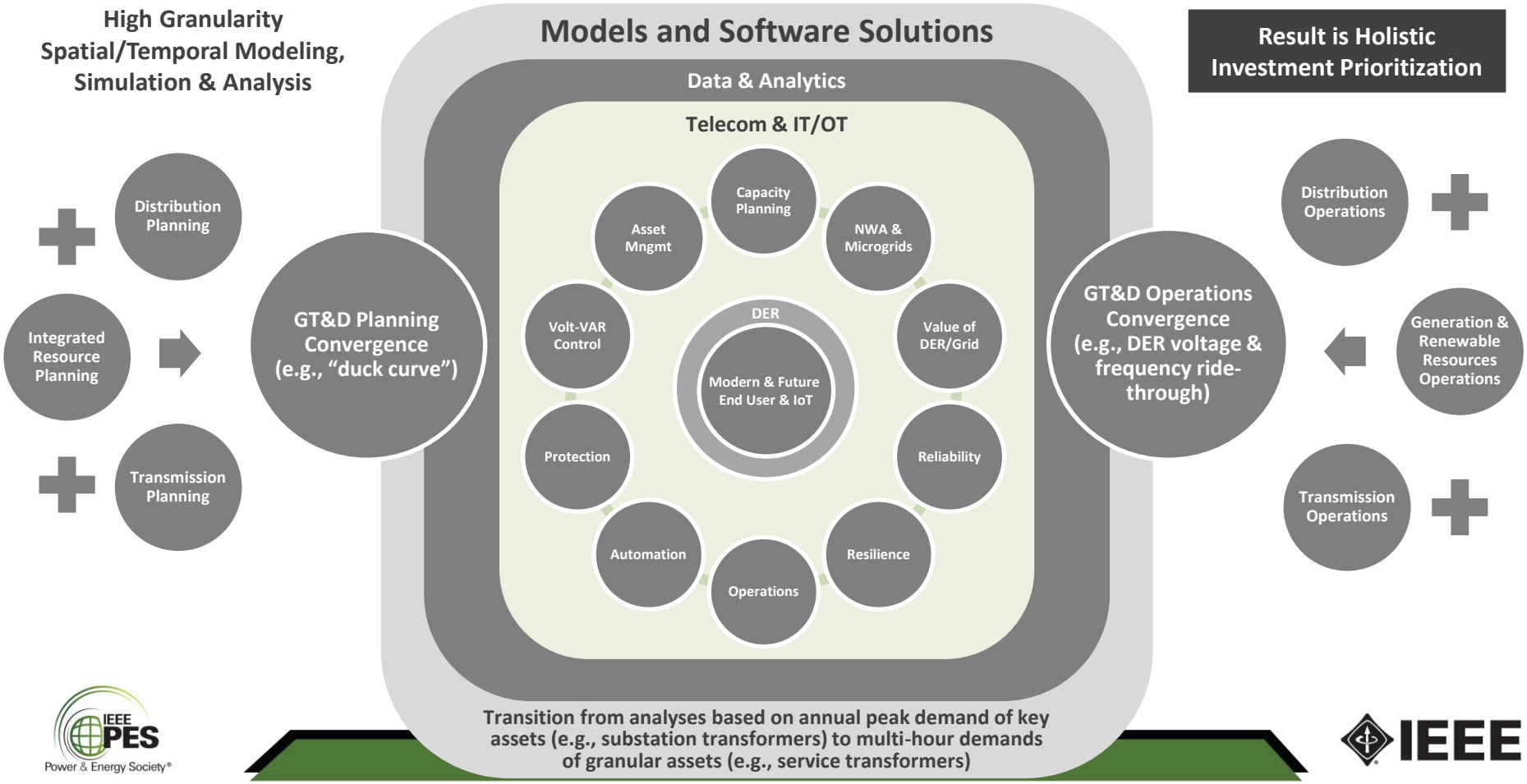
Proposed investments need to be valued across all planning domains equally to support optimal portfolio development.

Utility Investment Planning

- Executed Project 1
- Executed Project 2
- . . .
- Executed Project *n*

Modern Planning Process: GT&D Planning, Operations, & Investment Convergence



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QUESTIONS?