Integrating Non-Wires Alternatives into Utility Planning

2023 EPRI Research Guide

Non-Wires Alternatives (NWAs) are increasingly being considered by distribution and transmission planners as a means for economically addressing identified grid constraints. Their rising popularity is due to technological advancements, falling costs (including for distributed energy resource [DER] technologies like battery energy storage and solar PV, as well as other flexible resources that provide energy efficiency and demand response benefits, such as smart thermostats and controllable water heaters), and supporting regulatory directives and government initiatives. In fact, regulators in several jurisdictions[1] are now mandating that utilities evaluate the viability of DER-based alternatives prior to conducting any major grid reinforcements. But while NWAs present opportunities for distribution and transmission planners, they have a significant impact on the complexity of the planning process and pose new challenges to associated analytics, tools, and business processes.

In this research guide, NWAs, also termed Non-Wires Solutions (NWS), are defined as utility-driven solutions (e.g., solar PV, storage, PV+storage, co-generation, demand response, energy efficiency, etc.) to identified constraints on the electric power system that defer or eliminate the need for traditional system upgrades. While the focus of this guide's content is on DER-based NWAs, other solutions such as novel grid software and control can also be considered as alternatives to conventional upgrades. NWA approaches can be pursued at the distribution or transmission level, though this guide focuses on research surrounding distribution-connected NWAs.

Recognizing these challenges, EPRI has been advancing the utility industry's awareness of NWAs for many years. This novel body of research seeks to equip utilities and other stakeholders with an understanding of key NWA concepts and applications. EPRI's work considers all facets of NWAs in planning (see Figure 1). It encompasses methods for performing techno-economic analysis, guidance on technologies, and case studies of real-world demonstrations and emerging utility practices. This document builds upon a first edition guide, published in 2020 (3002018655), and provides an update of EPRI's research on NWAs. Included is a latest listing of recent EPRI deliverables (see Table 1) that can serve as a quick reference across various topical research activities. The focus of this canon of research is on the holistic incorporation of DER-based NWAs into the planning space. EPRI is also actively conducting research on many other aspects related to NWAs, including cost modeling, system integration, power quality impacts, as well as communication and metering requirements. Additionally, a growing library of research is assessing opportunities for leveraging DER for grid services, which has overlap with and distinctions from NWAs (see 3002027231). But while these important topical areas can all inform planning decisions, this document emphasizes research that directly relates to planning approaches and methods.

1 Examples in the U.S. include the states of New York and California.

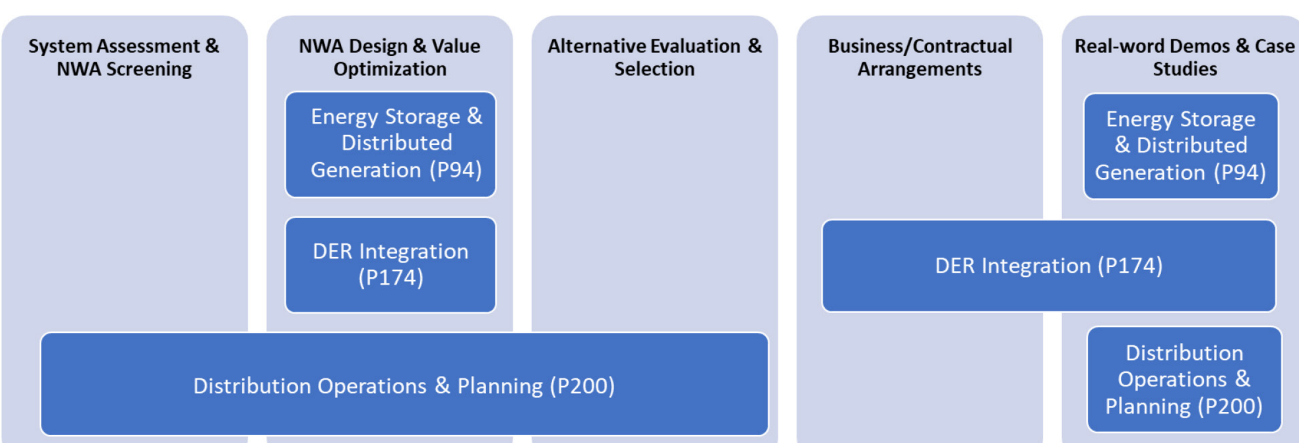

Figure 1. Coverage of NWAs in planning by EPRI Research Program

Table 1. *Selected EPRI Research on NWAs*

			Scope of Report						Technical Areas of Focus						
			Grid Domain		DER(s) Considered as NWA				Systems Needs Assessment and NWA Screening	NWA Design and Value Optimization			Alternative Evaluation and Selection[1]	Business Practices and Contractual Arrangements	Real-World Demos and Case Studies
Year	**Report ID**	**Title**	**D**	**T**	**EE/DR**	**PV**	**ES**	**Other**		**Siting**	**Sizing**	**Value Stacking**			
2009	1017896	Screening Demand Response as a Transmission Resource		●	●				●				●		
2011	1024586	Use of Energy Storage to Increase Transmission Capacity		●			●			●	●		●		●
2013	3002001186	Use of Large-Scale Energy Storage for Transmission System Support: Energy Storage as Black-Start Resource		●			●				●				●
2014	3002003229	The Evolving Load Profile and Impact on Assets and Reliability	●		●	●	●	●	●		●				
2016	3002008212	Examining the Effects of Storage as Mitigation to Distributed PV Impacts on Distribution	●				●			●	●		●		●
2016	3002008410	Time and Locational Value of DER: Methods and Applications	●		●	●	●	●					●		●
2016	3002008213	Comparing the Cost-Benefit of Guided vs. Unguided PV Deployment on Distribution	●			●				●			●		●
2017	3002010272	A Systematic Framework for Analyzing DER and Energy Storage	●				●			●	●	●	●		●
2018	3002013327	Guidance on DER as Non-Wires Alternatives	●		●	●	●	●						●	●
2018	3002013415	Automated Scenario Planning: Time-Series Requirements and Selection	●		●	●	●	●	●						
2018	3002010997	Incorporating DER Into Distribution Planning	●		●	●	●	●							
2019	3002015284	Quantifying the Locational Value of DERs	●			●				●	●		●		●
2019	3002015767	Outsourcing NWAs to 3rd Party Providers	●		●	●	●	●						●	
2019	3002015235	Guidance and Recommendations on Performing Time-Based Simulation in Distribution Planning	●		●	●	●	●	●						
2019	3002015232	Guidance on Integrating Energy Storage into Distribution Planning: Using Energy Storage as a NWA for Distribution Capacity	●				●			●	●	●	●		

[1] Cost-benefit analysis comparing alternatives is included in this step.

Table 1 (continued). *Selected EPRI Research on NWAs*

			Scope of Report						Technical Areas of Focus						
			Grid Domain		DER(s) Considered as NWA				Systems Needs Assessment and NWA Screening	NWA Design and Value Optimization			Alternative Evaluation and Selection[1]	Business Practices and Contractual Arrangements	Real-World Demos and Case Studies
Year	Report ID	Title	D	T	EE/DR	PV	ES	Other		Siting	Sizing	Value Stacking			
2019	3002016883	Transmission Planning Considerations for Energy Storage: Site Specific Use-Cases and Long-Term Planning Methods		●			●				●				
2019	3002015278	Method for Optimizing Traditional and NWAs Across A Multi-Year Planning Horizon	●		●	●	●	●					●		●
2019	3002015230	Reliability and Lifetime Estimates of DER-based Planning Alternatives: PV Systems, Energy Storage, and Inverters	●			●	●	●	●				●		
2019	3002015219	Modernizing Distribution Planning: Benchmarking Practices and Processes as they Evolve	●		●	●	●	●	●						
2019	3002015279	Application of Optimization Methods in Designing Distribution Planning Alternatives: Novel Approach for Designing Solar Plus Storage for Overload Mitigation	●			●	●	●			●	●			
2019	3002016457	Energy Storage Valuation 2019: Functions, Methods, Tools, Lessons Learned, and Examples	●	●		●	●				●	●	●		
2019	3002014764	Distribution-Connected Energy Storage Valuation and Impact Analysis in Southern California: Impact Analysis	●			●	●				●	●	●		
2020	3002018820	Screening of Non-Wires Alternatives in Distribution Planning	●		●	●	●	●	●						
2020	3002018968	Assessing NWA Impact on System Reliability	●				●		●	●	●		●		
2020	3002018646	A Streamlined Method for Quantifying the Time & Locational Value of DER	●			●				●	●		●		●
2020	3002014064	Energy Storage Analysis Supplemental Project Report Finding, Designing, and Operating Projects (2018-2020)	●	●			●			●	●	●	●		●
2020	3002019874	Modernizing Distribution Planning: Drivers and Future Vision	●			●	●		●	●	●	●	●		

Table 1 (continued). *Selected EPRI Research on NWAs*

			Scope of Report						Technical Areas of Focus						
			Grid Domain		DER(s) Considered as NWA				Systems Needs Assessment and NWA Screening	NWA Design and Value Optimization			Alternative Evaluation and Selection[1]	Business Practices and Contractual Arrangements	Real-World Demos and Case Studies
Year	**Report ID**	**Title**	**D**	**T**	**EE/DR**	**PV**	**ES**	**Other**		**Siting**	**Sizing**	**Value Stacking**			
2020	3002018827	Distribution Scenario Planning: Scenario Creation, Multi-year Assessment, and Result Processing Methods	●				●		●		●				
2020	3002017649	Controllable Water Heater Load Simulator: Demand Response Emulation and Distributed Energy Resources Integration Tool	●		●	●	●	●	●			●			
2020	3002019189	A Quick Guide to the Cost-Benefit Analysis Module for the DER Valuation Estimation Tool	●			●	●	●		●	●	●	●		
2021	3002021681	Screening of NWAs in Distribution Planning: Integration of NWA Screening Criteria, Methods, and Resource Characterizations	●		●	●	●		●						
2021	3002021616	Assessing System Reliability Impacts with NWAs: Guidance on Assessing NWAs as Grid Hardening Resources	●			●	●		●	●	●		●		●
2021	3002023006	Modernizing Distribution Planning: Collaborative Report on System Study Cases and Prototype Tool Advancements	●		●	●	●		●	●	●		●		●
2021	3002022345	Modernizing Distribution Planning: Economic Cost-Benefit Assessment for Distribution Operations and Planning	●		●	●	●		●	●	●		●		
2022	3002025636	Application of Energy Storage to Support Distribution Operations	●				●								●
2022	3002024486	Overview and User Guide: DRIVE "DER Grid Deferral Value" Module (NWA screening tool)	●			●	●	●	●	●	●	●	●		
2022	3002025662	Distribution Planning Evolution: Developing a Modern Distribution Planning Platform	●			●	●		●	●	●	●	●		
2022	3002024485	A Streamlined Method for Quantifying the Time and Locational Value of PV+Energy Storage on the Distribution Grid	●			●	●		●	●	●	●	●		

Table 1 (continued). *Selected EPRI Research on NWAs*

			Scope of Report						Technical Areas of Focus						
			Grid Domain		DER(s) Considered as NWA				Systems Needs Assessment and NWA Screening	NWA Design and Value Optimization			Alternative Evaluation and Selection[1]	Business Practices and Contractual Arrangements	Real-World Demos and Case Studies
Year	Report ID	Title	D	T	EE/DR	PV	ES	Other		Siting	Sizing	Value Stacking			
2022	3002025461	Automated Distribution Assessment and Planning Tools (ADAPT) v2.0.2.1	●		●	●	●		●	●	●		●		
2022	3002023142	Advanced Distribution Planning Process: A Roadmap to the Data You Need and Why	●		●	●	●		●	●	●		●		
2023	3002027231	Distribution Services Provided by DER: 2023 EPRI Research Guide	●		●	●	●	●	●			●		●	●
2023	3002027698	Utility Strategies and Lessons Learned from NWA Projects: Workshop Proceedings	●		●	●	●		●	●	●	●	●	●	●

Overview of Research Areas and Activities

Technology Adequacy

EPRI's research has considered the suitability of a range of DER technologies to defer, mitigate, or eliminate traditional "wire" solutions in the distribution and transmission domains. Recent efforts have focused on the adequacy of solar PV and energy storage technologies. Considerations to determine whether a DER technology, or a mix of technologies – potentially in combination with traditional "wire" solutions – can adequately meet the requirements of a specific NWA opportunity include resource availability, output variability, controllability, sustainability of response, reliability, and resource lifetime.

Technology Adequacy is among the areas identified by EPRI for continued research. Ongoing EPRI work includes the development of methodologies for evaluating PV capacity contributions to reduce peak load. Other gaps include the need to further evaluate behind-the-meter, customer-owned DER and flexible loads as potential building blocks for NWA solutions. Specific research topics include modeling and evaluation approaches, portfolio acquisition strategies, DER aggregation and management schemes, communications and controls requirements for aggregated DER groups, and performance verification metrics.

Systems Needs Assessment and NWA Screening

Per Figure 2, NWAs introduce new complexities and challenges into every step of the planning process. Consequently, EPRI research is developing guidance on how to integrate NWAs into the utility planner's toolbox. Insights encompass advancements in the system assessment capabilities that are needed to characterize system impacts and inform the design and assessment of DER-based NWAs that introduce new temporal aspects beyond those of traditional passive solutions.

In conjunction with these efforts, EPRI R&D is also developing new methods and tools that automate planning studies and analytics in each step of the planning process. These activities are intended to support the effective and efficient evaluation of NWAs. Additionally, EPRI continues to actively research NWA screening methods and practices to help determine whether the technical and economic viability of the solutions warrant further examination in the next stage of the planning process.

NWA Design and Value Optimization

NWAs offer a multitude of new capabilities and options to address system upgrade and expansion needs. However, designing these novel solutions requires consideration of additional aspects beyond those for traditional wires solutions. The application of less streamlined methods compared to more conventional solutions is also necessary. Key NWA design and optimization considerations include:

- DER siting, including considerations on spatial limitations, the location and complexity of network constraint(s), and the general influence of circuit configuration.
- DER sizing to meet the system needs at hand and successfully defer, mitigate, or eliminate conventional upgrades that would be otherwise required. This topic has been particularly explored in the context of NWA solutions that leverage battery energy storage systems (BESS). The research is increasingly shifting to evaluating and identifying NWA solutions consisting of portfolios of DER, potentially combined with traditional solutions.
- Value stacking approaches that enable DER to "stack" incremental value and revenue streams by delivering other grid services in addition to those provided to meet NWA requirements. Additional services may comprise those provided to the wholesale market, distribution grid, transmission system and/or end-users. This topic has been particularly examined in the context of BESS deployments.

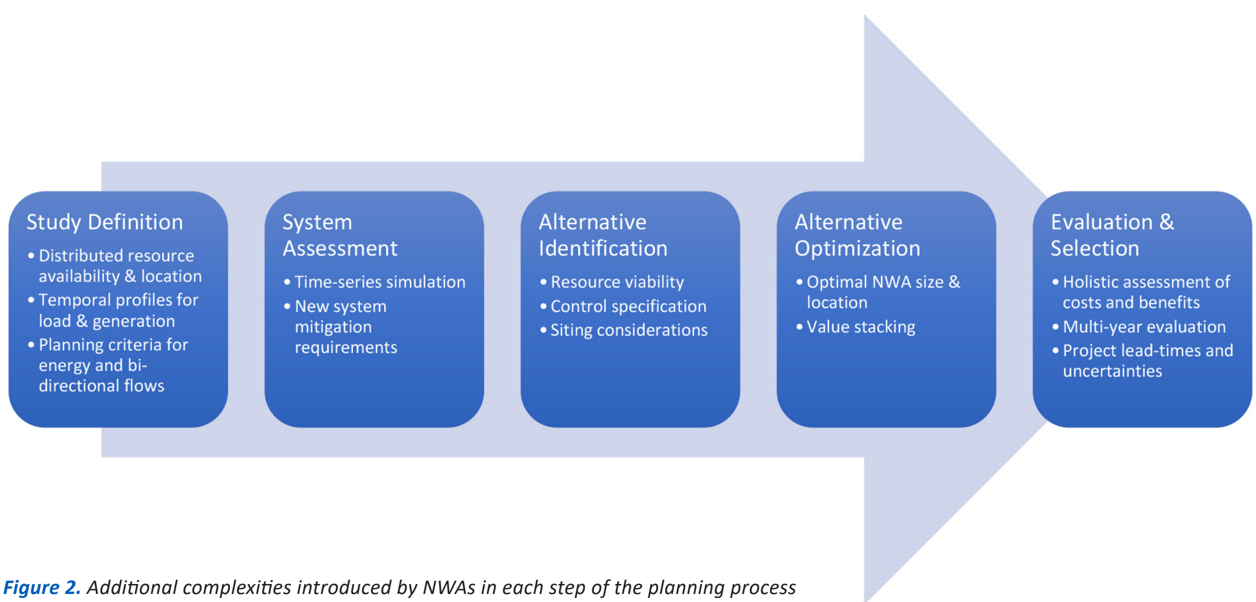

Figure 2. *Additional complexities introduced by NWAs in each step of the planning process*

NWA approaches that enable multi-use applications (MUAs) continue to receive industry attention. The goal is to capture secondary value streams beyond those achieved from meeting primary NWA requirements by delivering multiple grid services, either concurrently or at different times, in one or more grid domains. Ongoing research in this area focuses on compatibility and priority order between services, and potential cross-domain negative impacts between Transmission and Distribution. MUA scenarios can also include the use of mobile DER as NWAs; ongoing efforts aim to inform whether this approach may provide a cost-effective solution to planning uncertainties and help reduce the likelihood of stranded assets or overbuilt capacity.

Alternative Evaluation and Selection

The final step of the planning process (see Figure 2), is to evaluate the identified alternatives against a common standard that holistically considers all pertinent utility constraints, criteria, and objectives. This analysis serves as the basis for selecting the best alternative for deployment. Evaluations may be based on economic cost-benefit analysis and/or consider additional attributes, such as system reliability, solution esthetics, or potential safety risks.

Methods and tools that evaluate multi-year evaluations in alternative deployments are also being researched to fully assess deferment applications as well as the relatively short operational lifespans and potential modular deployment of NWAs. Activities include cost-benefit analysis approaches that compare a base case (traditional network reinforcements) to one or several change cases comprising various NWA solutions.

Business Practices and Contractual Arrangements

Recent EPRI research has also examined emerging utility business practices that source NWA solutions through third-party providers.

Contingency planning practices (see Figure 3) is another area that is being explored in the context of NWAs. The goal is to further understand whether traditional pro-active and corrective measures addressing unplanned equipment failures may need to be further expanded to address scenarios involving NWA underperformance.

Real-Word Demos, Case Studies, and Utility Lessons Learned

Commentaries of real-world NWA case studies, as well as techno-economic assessments considering actual circuits, are a final key component of EPRI's NWA research. EPRI will continue to actively inform its members and the public about key lessons learned from real-world NWA projects. Ongoing activities will involve tracking the proportion of technically and economically viable NWA opportunities that successfully convert to operating NWA solutions, as well as documenting challenges that may arise during the planning or execution phases. As practical experience with NWAs accrues, further data points on the reliability of NWA solutions (especially when operated by third party providers) are expected to emerge, as are opportunities for retrospective analysis.

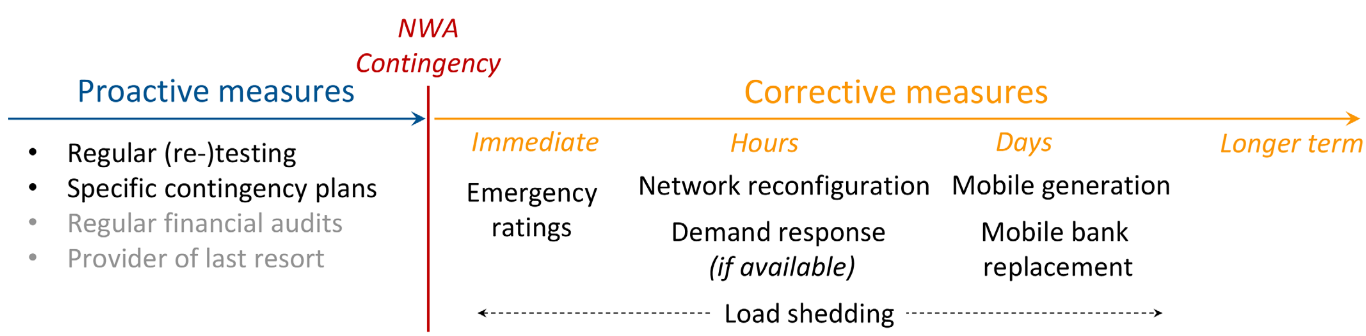

Figure 3. *Example contingency measures to consider when sourcing NWAs from third parties*

About EPRI

Founded in 1972, EPRI is the world's preeminent independent, non-profit energy research and development organization, with offices around the world. EPRI's trusted experts collaborate with more than 450 companies in 45 countries, driving innovation to ensure the public has clean, safe, reliable, affordable, and equitable access to electricity across the globe. Together, we are shaping the future of energy.

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