Innovative Solutions and Approaches Taken by North American Utilities in Leveraging Benefits of DERs and Grid Modernization

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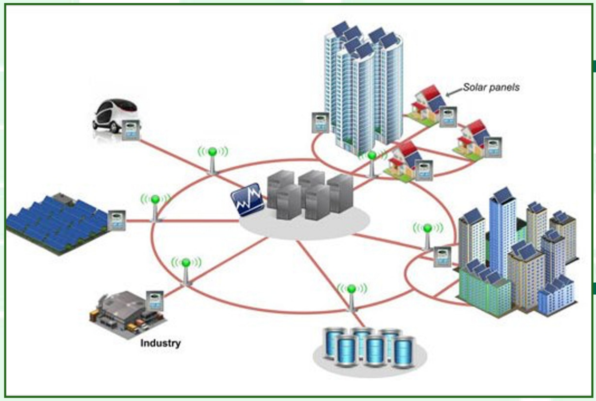
Outline:

- Background and Motivation
- NWA versus Conventional Wire-based Solutions
- Implementation and Evaluation Approach
- Performance-based Verification and Correction
- Conclusions

Non-Wires Alternatives (NWA):

- Solutions that are formulated on the promises of introducing optimized ways of using existing infrastructure to defer the upgrade or improve reliability;
- Building on the two following trends of the electric utility industry:

Growing penetration of renewable and distributed energy resources (DER)

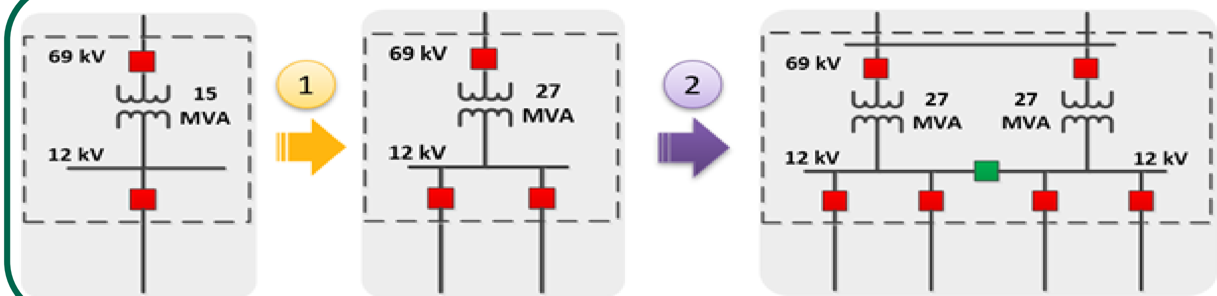


Greater focus on digitization and further automation of the grid control and operation schemes

Example: Traditional vs NWA Solution

System Problems:
- load growth
- reliability of serving customer with one feeder

Traditional Solution



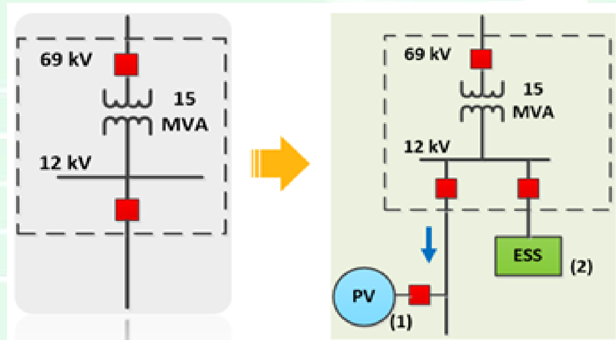
1 Adding a second feeder and upgrading the substation transformer.

2 Adding a new transformer to split the load.

NWA Solution

✓ A combination of DER and distributed controls locally incorporated at feeder, community and customer levels.

✓ The solar plus energy storage systems will be able to serve loads during a few hours of peak demand per year to avoid or delay any expansion projects.



NWA Challenges

Regulatory Environment

No comprehensive mechanism for analyzing NWA solutions is established for:

- Cost recovery
- Procurement (contracting mechanism)
- Funds for the projects

Utility Operational Space Limitations

Not enough expertise and capabilities on the NWA solutions to effectively :

- Plan
- Procure
- Implement
- Operate and Maintain

NWA Solutions

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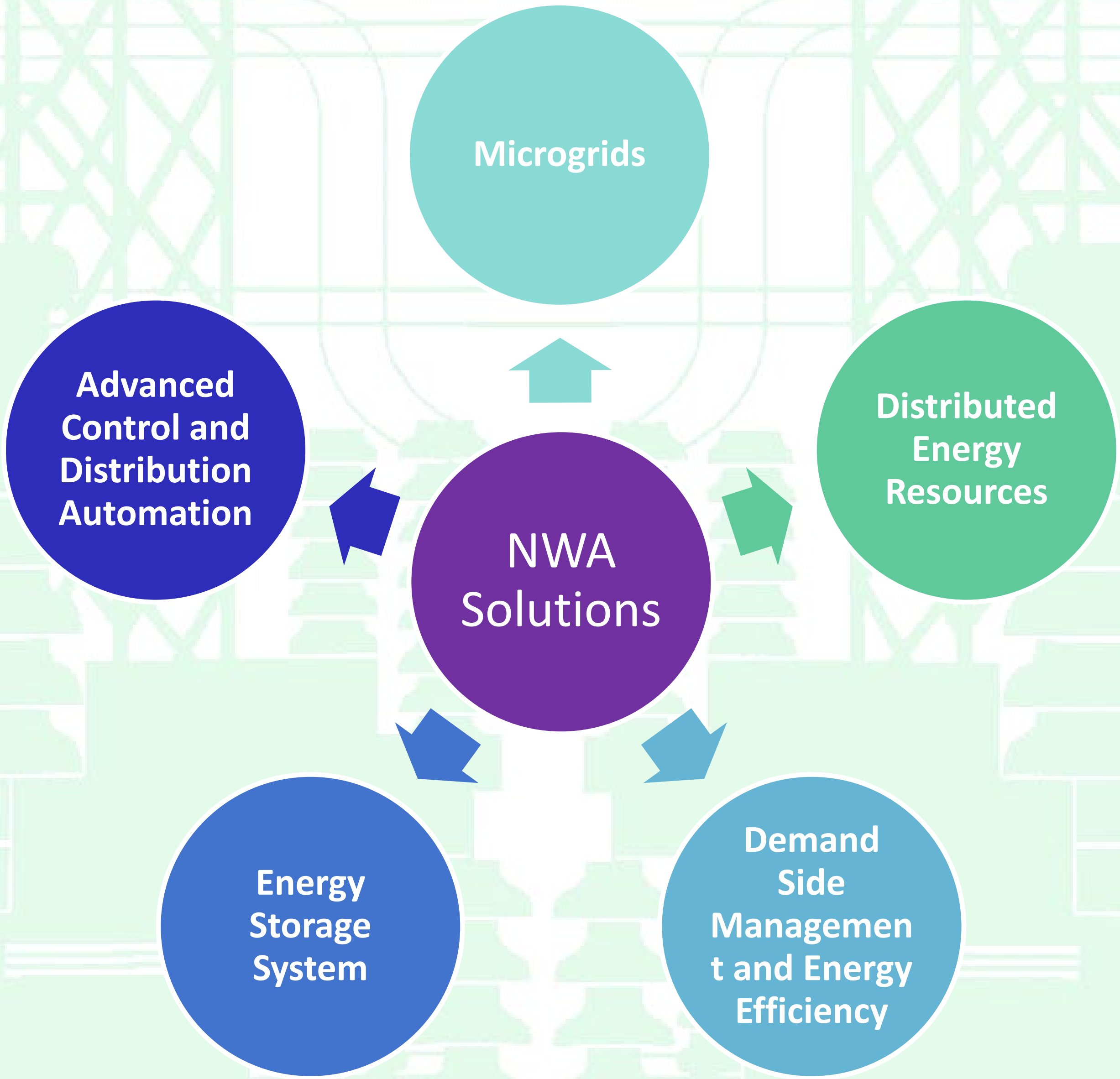
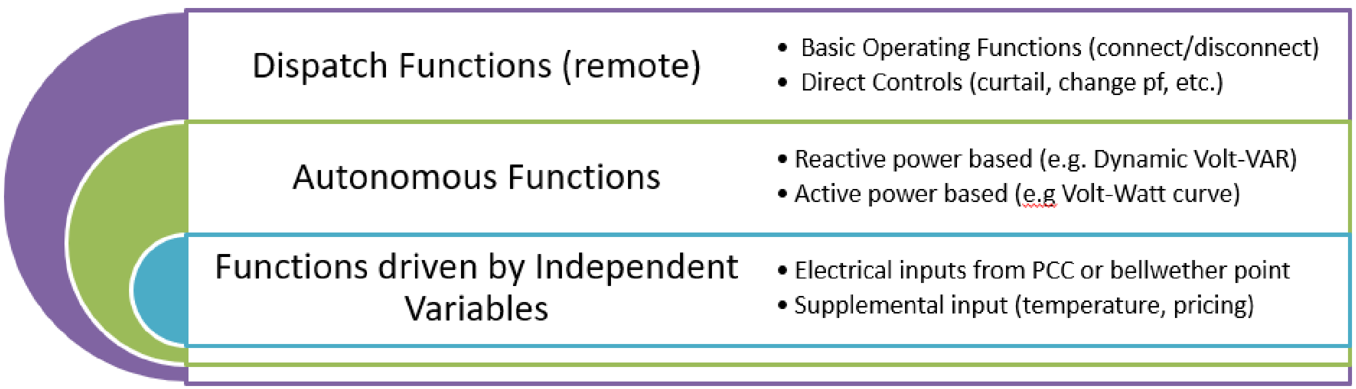

Microgrids
Advanced Control and Distribution Automation
Distributed Energy Resources
NWA Solutions
Energy Storage System
Demand Side Managemen t and Energy Efficiency

Distributed Energy Resources (DERs)

DER refers to various generation and energy storage technologies with primary sources that are non-bulk power sources

- ✓ The local generation of electricity increases energy efficiency and enhances grid reliability and resiliency
- ✓ DER can provide grid supporting services such as voltage and reactive power management of the grid
- ✓ DER standardization in recent years is enabling Smart Inverter Functions for grid support and ancillary services as added values



- ✓ Smart inverter functions ensure remote communications, monitoring and control of IBRs by utilities in a coordinated fashion with the rest of the grid

Energy Storage Systems

✓ Addressing a wide range of reliability and capacity enhancement services

✓ Addressing the overloading issue that is constrained to parts of the system or a certain timeframe during peak seasonal demand

- deploying ESS at a substation or along a feeder can be more efficient, more economic and offering faster in-service time.

Example

The Arizona Public Services Punkin Center Battery ESS

✓ deferring installation of 20 miles of lines for serving feeder loads during peak-time.

✓ The ESS based NWA option was evaluated as the least-cost option to serve load growth in the rural, remote community of Punkin Center, AZ.

✓ In addition to feeder-level capacity upgrade deferral, the ESS can provide other services such as energy and ancillary market participation, if required.

Microgrids for Reliability

A cluster of DER and loads that are operated in a controlled fashion and can operate in parallel or isolated from an area electric power system

- ✓ The distinguishing feature versus DERs:
  - The ability to supply local customers within a defined electric boundary independent of the main grid (island mode)
- ✓ Applications:
  - ✓ Provide reliability/resiliency services during planned or unplanned outages in the system.
  - ✓ Load management, power quality enhancement for critical facilities and increasing renewable content for fuel saving and emission reduction.

Example:

Illinois Commerce Commission (ICC) approved the Bronzeville Community Microgrid, a $25M project that demonstrates a shared utility multi-customer microgrid business model in the U.S.

Demand Side Management and Energy Efficiency

Demand side management refers to the changes in the behavior and pattern of the electricity consumption and usage monitoring, on the customer side to manage peak-demand or unforeseen events - in response to time-based rates or incentive payments for lower electricity usage during high wholesale market prices

- ✓ Customers are encouraged to reduce or curtail their electricity consumption during the high demand hours or emergency occurrences

Example: Brooklyn Queens Demand Management ("BQDM") program

BQDM is the most famous and successfully implemented demand response and energy efficiency-based NWA project.

- ✓ Uses primarily energy efficiency and customer-sited distributed generation in the form of combined heat and power, fuel cells, and rooftop solar PV systems to achieve more than 50 MWs of peak demand reduction.
- ✓ Additional value propositions and energy saving are also justified with incorporating coordinated voltage and reactive power optimization (VVO), and deployment of utility scale ESS.
- ✓ The total projected program cost for this NWA has been about $200 million, which in contrast, is significantly lower than cost of adding a substation and transmission feeders for achieving same level of 50 MW demand management, which was estimated more than $1 billion.

Advanced Controls & Distribution Automation

- ✓ The integrated and automated controls through centralized DMS approaches or localized feeder automation schemes for alleviating the reliability concerns and deferring capital upgrade investments
- ✓ Enabling fast restoration and rearrangement of feeders' topologies to ensure continuity of supply to customers in a reliable way (self healing)
- ✓ Enabling utilities to incorporate DERs in the overall day-to-day forecast and energy balancing (curtail or generate) when approaching feeder limits, or to manage reactive power and voltages to reduce demand

Example: ComEd DG rebate program

To increase DER penetration and to utilize the benefits of smart inverters, ComEd is providing a rebate of $250 per kW of nameplate generating capacity to retail customers.

- ✓ Motivation: provisions for future DER penetration and lack of controllable grid-supporting infrastructure for use during deviations from normal operating voltage and frequency conditions.
- ✓ The DG Rebate program was strongly justified on the fact that it takes away investments from traditional infrastructure and instead funds NWA projects through Smart Inverters while also encouraging higher DER penetration, equipped with adverse impact mitigation approached, without the need to expand present infrastructure.

Implementation and Evaluation Approach

Implementation Approach

Step 1 – Identify Alternative Solutions

- Evaluate DER services along with traditional approaches

Step 2 – Determine Least Cost / Best Fit

- Identify least cost / best fit portfolio of solutions

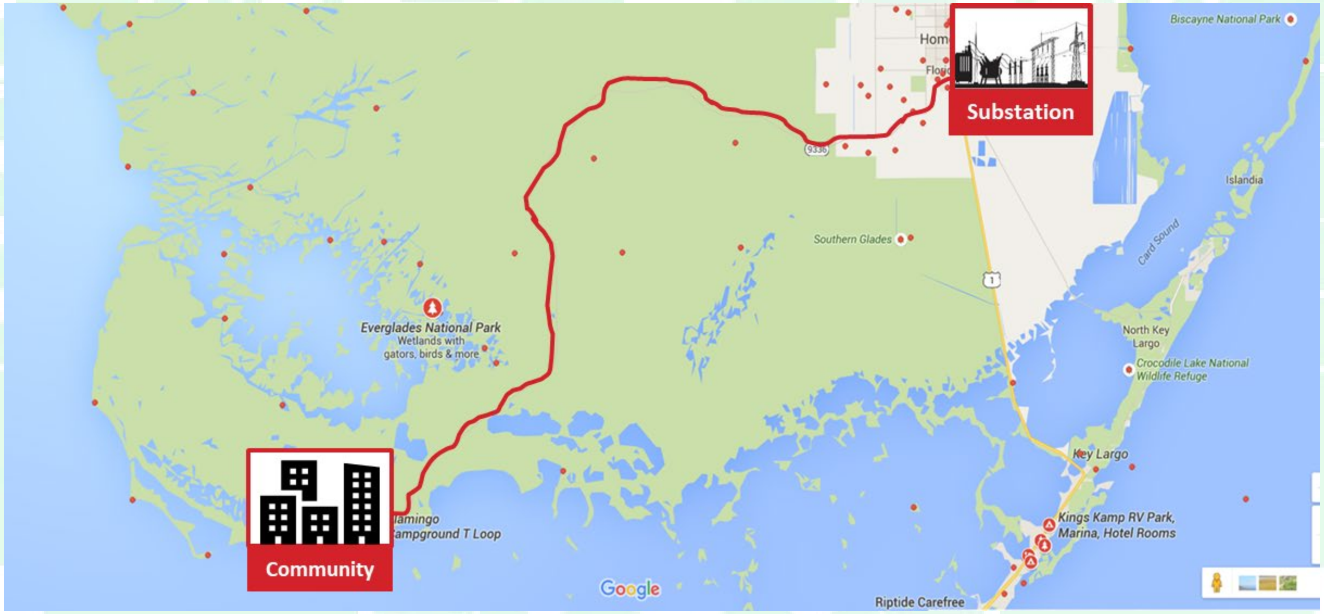
Step 3 – Deploy and Monitor Performance

- Procure services, monitor and verify the services and adjust portfolio as needed

Case Study: Energy Storage based Microgrid Solution for NWA

Problem Statement: A rural town located in the middle of a natural forest and served by a very long radial distribution feeder about 50 miles. The community experiencing multiple extended power outages per year (with durations in range of 40 to 85 minutes)

The utility was mandated to implement a mitigation solution. All possible solutions (traditional and nontraditional) were identified and evaluated for the least cost / best fit solution



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Case Study: Energy Storage based Microgrid Solution for NWA

Solution: Based on the Benefit-Cost Analysis, the utility proceeded with NWA solution of installing a Battery Energy Storage System as part of a Microgrid.

Step 1: Identify all Solutions		Step 2: Least cost/ Best fit
Traditional Solution 1	Add a new distribution feeder & implement faulted circuit indicators	Capital cost: ~ $12m O&M cost: ~ $100k
Traditional Solution 2	Use backup diesel generator	Capital cost: ~ $250k O&M cost: ~ $50k Emission and permitting concern
NWA Solution	Use Energy Storage System in a Microgrid	Capital cost: ~ $2m O&M cost: ~ $60k

Performance-based Verification and Correction

Performance-based Verification and Correction Approach

Purpose: To evaluate and track the NWA solution performance throughout the operational stage of a project and taking correctional actions to ensure meeting the grid needs and the cost-effectiveness of the solution

Procurement

- Key Performance Indices (KPIs) Identification
- RFP Preparation and Vendor Evaluation based on KPIs
- Contract terms and performance guarantees based on KPIs

Implementation

- Test plan development based on the KPIs
- Third-party acceptance and performance testing
- Correctional actions in commissioning stage

Operation

- Monitoring and tracking of the performance based on KPIs
- Correctional actions in operation stage

Sample Key Performance Indices (KPIs)

NWA Technology	Sample KPIs
Energy Storage Systems	Success rate (for targeted applications such as peak shaving, demand management) Deferred capacity increase or overload prevention State of Health (SOH) Energy efficiency (%) Number of full and partial cycles Cumulative charge/discharge (kWh) Annual throughput (%)
Microgrids	Success rate (for targeted applications such as islanding, load serving, peak shaving, etc.) Carbon emission reduction SAIFI reduction SAIDI reduction
Distributed Energy Resource	Production ratio Plant availability Firm capacity Voltage profile enhancement
Demand Response and Energy Efficiency	Customer participation percentage Success rate
Advanced controls and distribution automation schemes	Success rate (for targeted applications such as grid-connected support, energy management, etc.) Energy loss reduction and efficiency improvement

Key components of developing a successful NWA project

Identification of value streams and NWA valuation

Designing compensation methods, including:

- Benefit distribution among rate payers,
- Timeframe methods are applied,
- Certainty of effectiveness and acceptance by customers

Establishing performance requirements and measurements and verifications (M&V) to assess outcome and quantify benefits, penalties, etc.,

Operation considerations for enabling stacked benefits such as reliability and market applications

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Conclusions

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NWA will become key components of planning portfolio for addressing distribution system needs in a modernized grid

- ✓ NWA offers various benefits to the utilities, ratepayers and society in general; the most evident of all, is the economic savings of infrastructure upgrade deferral for utilities

- ✓ NWA solutions incorporate automation, monitoring and control elements which leads to a more interactive energy exchange with the grid. This leads to a more efficient and flexible customer-side energy behavior and eventually cost savings for the ratepayers

THANKS

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