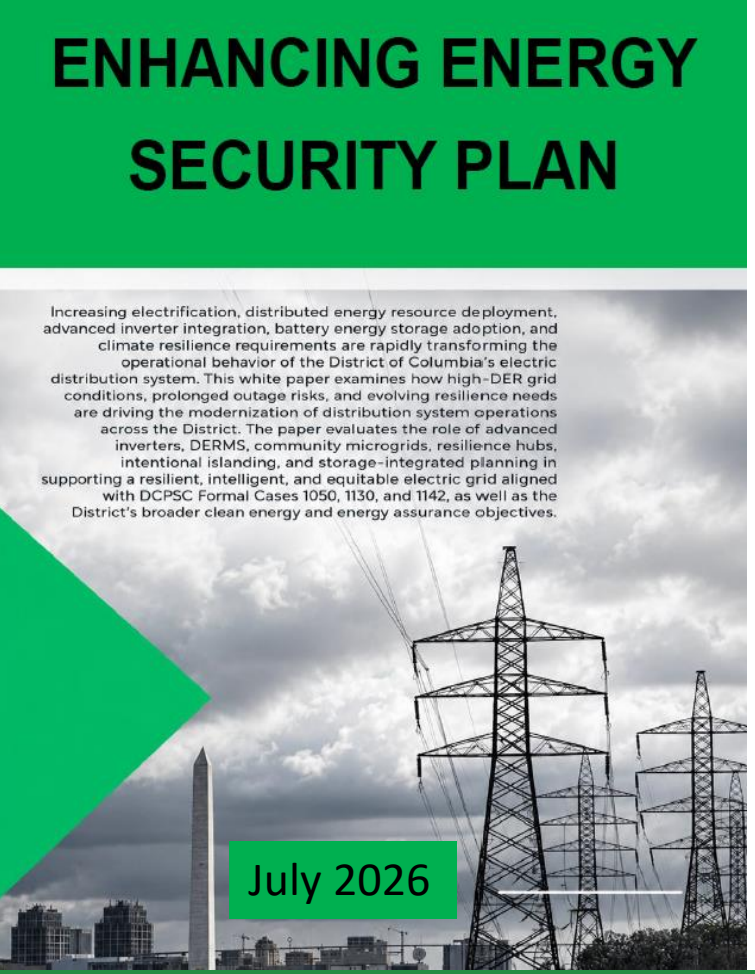

Enhancing Energy Security in the District of Columbia

Advanced Inverters, DERMS, Energy Storage, and Distribution System Modernization for

72-Hour Urban Grid Resilience

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DEPARTMENT OF ENERGY & ENVIRONMENT
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MURIEL BOWSER, MAYOR

Executive Summary

The District of Columbia's electric distribution infrastructure is undergoing rapid transformation driven by electrification, renewable energy deployment, transportation modernization, and increasing digitalization. Existing Energy Security Plan (ESP) frameworks were built around centralized restoration models, architectures increasingly misaligned with modern distributed energy environments.

This white paper proposes a ***Distribution-Level Energy Security Framework*** designed to sustain critical services during prolonged outage conditions lasting ***72 hours or longer***, integrating advanced inverters, battery storage, DERMS coordination, resilience hubs, feeder segmentation, and cybersecurity governance into a unified modernization strategy.

Framework Alignment

- District Energy Security Plan
- Clean Energy DC
- Climate Ready DC
- DCPSC FC No. 1050, 1130 & 1142
- Sustainable DC

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DC as a National Resilience Model

The District of Columbia is uniquely positioned to become a **nationally significant benchmark** for urban distribution-level resilience modernization — combining dense infrastructure, ambitious climate objectives, rapidly evolving DER environments, and critical federal continuity requirements.

What DC Can Model Nationally

Few frameworks nationally address operational integration of inverter-based distributed infrastructure into distribution-level continuity strategies. DC can close this gap.

The Modernization Imperative

As distributed energy penetration increases across the U.S., urban electric systems require segmented operating capability, coordinated dispatch, and decentralized resilience architectures.

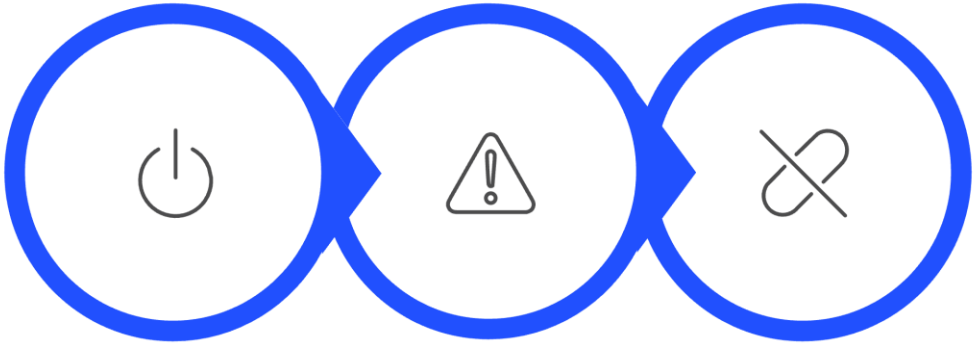
Next Steps for DOEE

Initiate feeder survivability assessments, advance FC No. 1050 inverter standards, pilot resilience hub storage deployments, and establish the DERMS governance framework by 2026.

The modernization pathway outlined in this framework positions DC to strengthen local resilience while establishing a replicable model for advanced urban grid security planning nationwide.

The 72-Hour Resilience Framework

The 72-hour benchmark reflects the most operationally critical window after major disruptions — the period during which fuel logistics, telecommunications, and centralized restoration capability experience the greatest degradation. Federal emergency preparedness exercises consistently validate this threshold.



The framework prioritizes healthcare systems, emergency response, telecommunications, water and wastewater, resilience hubs, government continuity facilities, affordable housing, and vulnerable population centers throughout each operational state.

Critical Infrastructure Priority Targets

Healthcare Systems

Hospitals and emergency medical facilities require uninterrupted power for life-safety operations — the highest priority tier across all framework conditions.

Emergency Telecommunications

Communications infrastructure must sustain 48-hour minimum continuity to coordinate emergency response operations throughout the District.

Water & Wastewater

Water infrastructure continuity protects public health and emergency response capacity during prolonged outage conditions.

Government Continuity

Federal and District government operations, including public safety, require sustained priority continuity access during emergency conditions.

Resilience Hubs & Housing

Affordable housing developments and community resilience hubs serve as sheltering anchors for vulnerable populations during prolonged emergencies.

The Problem: Critical Gaps in Current Planning

Diesel Dependency

Many critical facilities rely heavily on diesel backup systems with finite runtime, fuel delivery constraints, and limited scalability during extended emergencies.

Feeder Architecture Gaps

Existing feeder configurations were not designed for sustained localized continuity independent from broader centralized restoration timelines.

DER Integration Failures

Distributed solar and storage assets lack sufficient telemetry integration, leaving them unavailable during outages despite installed operational capability.

No Standardized Metrics

Planning frameworks lack standardized methodologies to evaluate outage sustainment capability, communications survivability, and infrastructure dependency risk.

Quantitative Resilience Metrics & Operational Targets

Measurable operational indicators are essential for guiding modernization priorities, resilience investment strategies, and emergency operational sequencing. The table below summarizes the proposed performance targets for DC's distribution-level energy security planning.

Metric Category	Proposed Target	Strategic Purpose
Tier 1 Feeder Continuity	≥72 Hours	Sustain critical infrastructure and life-safety operations
Tier 2 Feeder Continuity	24–48 Hours	Support community continuity and strategic service restoration
Telemetry Availability	≥95%	Maintain operational visibility and DER coordination
DER Dispatch Response	<5 Minutes	Enable rapid emergency dispatch and continuity support
DERMS Communication Latency	<2 Seconds	Support real-time distributed operational coordination
Battery Storage Availability	≥90% During Emergencies	Improve localized continuity and dispatch reliability
Resilience Hub Sustainment	48–72 Hours	Support community sheltering and continuity operations
Secure Communications Compliance	100% Encryption & Authentication	Protect operational integrity and interoperability

Feeder Survivability Classification

Three-Tier Framework

Feeders are classified by criticality and continuity requirements to enable targeted investment and emergency dispatch prioritization throughout the District's distribution network.

Spatial prioritization methodologies identify which feeders, infrastructure assets, and community continuity zones require enhanced survivability support during prolonged outage conditions.

Tier 1 - Critical Continuity Feeders

Hospitals, emergency communications, water infrastructure, and government continuity. Minimum **72-hour** sustainment target.

Tier 2 - Strategic Support Feeders

Community continuity, resilience hubs, emergency shelters, and affordable housing. **24–48 hour** sustainment target.

Tier 3 - Conventional Restoration Feeders

Standard distribution feeders prioritized for conventional centralized restoration after Tier 1 and Tier 2 continuity is established.

Advanced Inverters & IEEE 1547-2018 Integration

From Disconnect to Grid-Support

Historically, inverters were designed to disconnect during disturbances to prevent unintentional islanding. IEEE 1547-2018 compliant technologies fundamentally alter this paradigm, enabling inverters to actively **support** the grid during disturbances rather than abandoning it.

Key Grid-Support Functions

- Voltage & frequency ride-through
- Volt-VAR and Volt-Watt response
- Dynamic reactive power support
- Telemetry integration & remote configurability
- Grid-forming (GFM) islanding capability

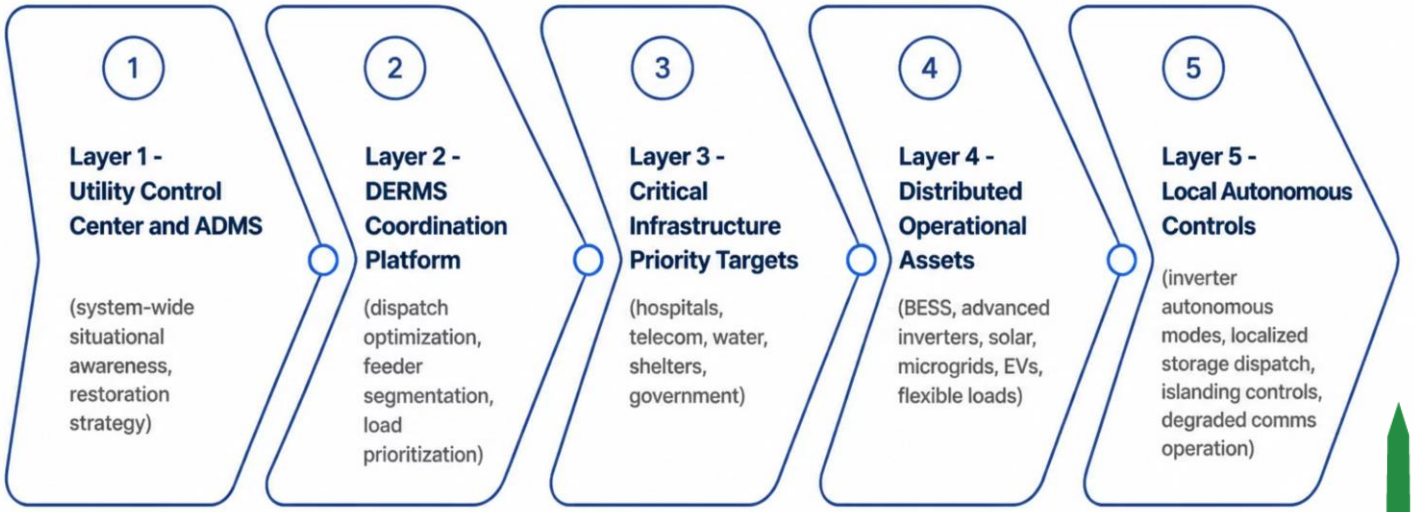
Protection Coordination Implications

Inverter-based systems provide fault currents of approximately **1.1–2 per unit** due to semiconductor thermal constraints, versus **3–7 per unit** for conventional synchronous generators. This distinction has significant implications for protection coordination and operational planning across modernized feeders.

DC's Formal Case No. 1050 provides the regulatory foundation for advanced inverter integration, establishing modernized interconnection standards across the distribution system.

DERMS: The Operational Coordination Brain

Distributed Energy Resource Management Systems (DERMS) are the essential coordination layer for managing decentralized infrastructure at scale. As DER penetration increases, continuity capability becomes directly dependent upon real-time situational awareness and coordinated dispatch management



During prolonged outages or degraded communications, DERMS incorporates **fallback operational states,** predefined local control modes, segmented feeder autonomy, and localized storage dispatch logic; ensuring continuity
even when centralized coordination is constrained

Battery Energy Storage & Community Resilience

Battery energy storage systems (BESS) provide dual-mode operational value: optimizing normal grid operations while delivering dispatchable continuity capability during prolonged emergencies. Storage systems mitigate feeder congestion, reduce thermal overloads, support localized voltage regulation, defer infrastructure upgrades, and improve operational adaptability.

Priority Deployment Locations

- Healthcare facilities & hospitals
- Community resilience hubs & emergency shelters
- Affordable housing developments
- Telecommunications infrastructure nodes

Credits: Generated by AI
Existing District initiatives—such as the Ward 7 resilience hub projects and the St. Elizabeths microgrid—provide operational proof-of-concept for distributed resilience infrastructure.

Distribution System Modernization & Planning Evolution

Traditional planning approaches focused on thermal loading and conventional reliability metrics are increasingly insufficient for modern distribution environments characterized by bidirectional power flows, dynamic voltage conditions, and telemetry-dependent coordination.

Reverse Power Flow

High DER penetration introduces bidirectional flows requiring new feeder congestion management and dynamic voltage control strategies.

Feeder Segmentation

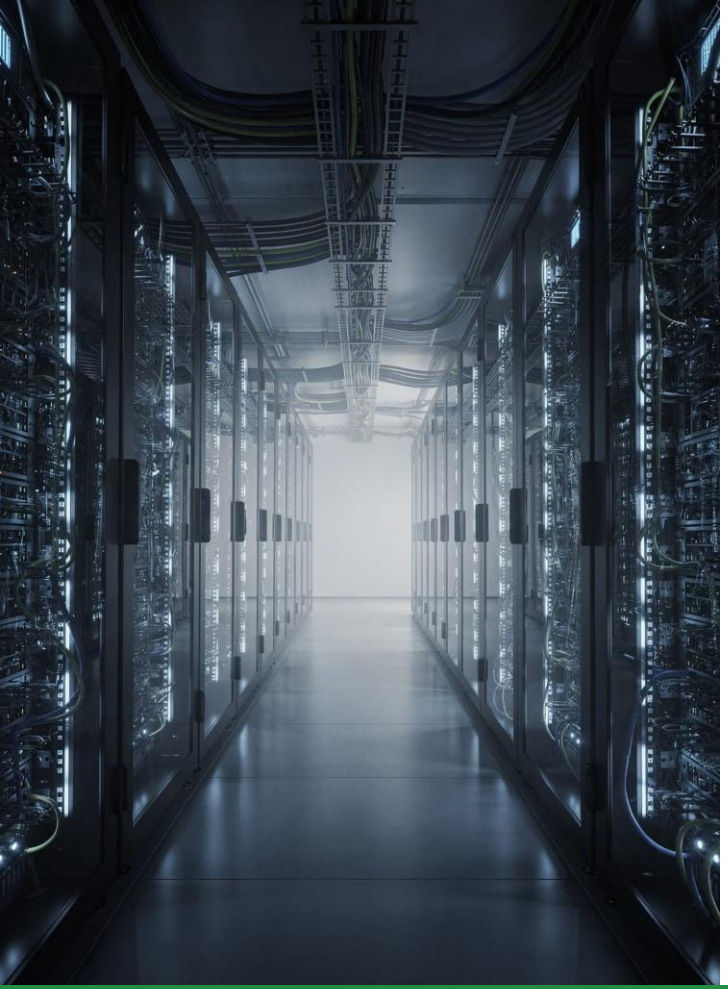
Automated sectionalization capability enables localized island operations during outages, sustaining critical services independently of broader restoration timelines.

Hosting Capacity Growth

ElectrifyDC analyses indicate local solar generation must increase significantly over two decades, implying deep dependence on advanced distribution coordination capability.

Operational Telemetry

Real-time telemetry integration across utility and customer-connected systems is essential for effective situational awareness and emergency dispatch management



Cybersecurity & Operational Governance

Why Cybersecurity Is a Resilience Issue

Operational continuity increasingly depends upon secure communications architectures and telemetry integrity — not just physical infrastructure. Modern distribution systems rely upon cloud coordination platforms, remote management technologies, and interoperability frameworks across thousands of distributed assets.

Key Governance Requirements

- Encrypted communications architectures (IEC 62351, TLS)
- Authentication protocols and certificate management
- IEEE 2030.5 & DNP3 Secure Authentication compliance
- Continuous cybersecurity monitoring and auditing

Critical Operational Risks

Unauthorized inverter configuration changes

Telemetry degradation and coordination failures

Communications disruption during outages

Cloud dependency risks affecting operational visibility

⚠ Cybersecurity governance must be integrated directly into resilience modernization strategies — not treated as a separate compliance function.

Economic Investment & Non-Wires Alternatives

Rethinking Infrastructure Investment

Advanced DERs, inverter functionality, and coordinated DERMS management can defer portions of traditional capital investment — feeder upgrades, substation expansion, and conventional capacity reinforcement — under certain operating conditions.

Investment Valuation Must Include:

- Avoided outage cost valuation
- Infrastructure deferral potential
- Operational flexibility benefits
- Continuity support capability
- Societal benefits for vulnerable populations

The Cost of Inaction

Prolonged electric service interruptions produce substantial economic losses: healthcare disruption, telecommunications failure, commercial interruption, transportation degradation, and constrained emergency response. Resilience investments at hospitals, resilience hubs, affordable housing, and public infrastructure deliver ***disproportionate societal returns*** during prolonged outage conditions.

Future utility planning frameworks should evaluate resilience-oriented ***non-wires alternatives (NWAs)*** - distributed assets providing local operational support without equivalent conventional infrastructure expansion costs.

Phased Implementation Roadmap

Achieving distribution-level resilience requires a phased, coordinated, and measurable modernization pathway — from strategic planning toward mature operational implementation across DC's urban electric system.

Phase 1 — Foundation (Years 1–2)

1

Develop resilience metrics and feeder survivability methodologies. Launch pilot resilience hub deployments. Establish advanced inverter operational standards, cybersecurity governance structures, and initial DERMS integration planning.

2

Phase 2 — Scaling (Years 3–5)

Expand DERMS platforms, distributed battery storage, resilience hub operations, telemetry integration, feeder segmentation capability, and interoperability standards across the distribution system.

Phase 3 — Maturity (Years 5–10)

3

Achieve advanced segmented operations, grid-forming operational capability, dynamic distributed dispatch, adaptive resilience planning, and integrated cyber-physical governance across the urban electric system.

Each phase builds upon the previous, progressively expanding governance maturity, operational coordination capability, interoperability evolution, and measurable resilience outcomes across DC's distribution infrastructure.