District Energy:

Private Multi-User Microgrids
A Case Study in Innovation

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District Energy Microgrids: Key Benefits

Reliability & Resilience:

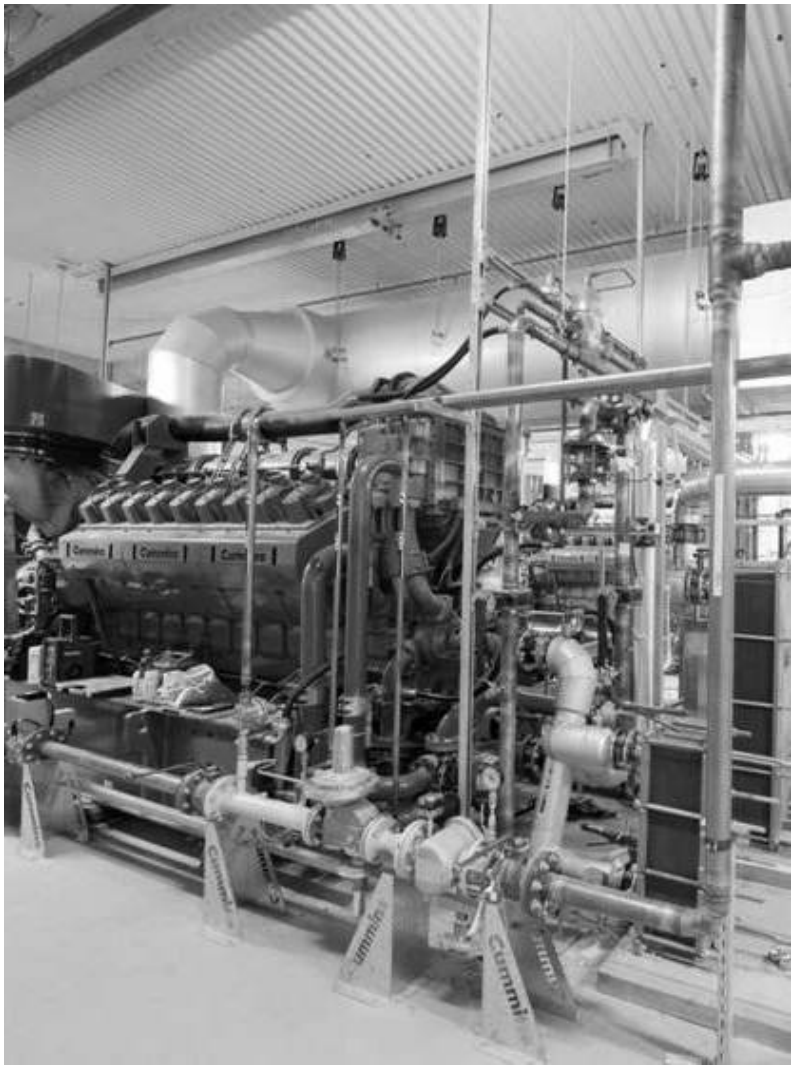
- Disaster Hardening
- Redundancy
- Power Quality

Environmental Sustainability:

- Lower CO2 Footprint
- Integration of RE
- Efficiency Platform

Financial Benefits:

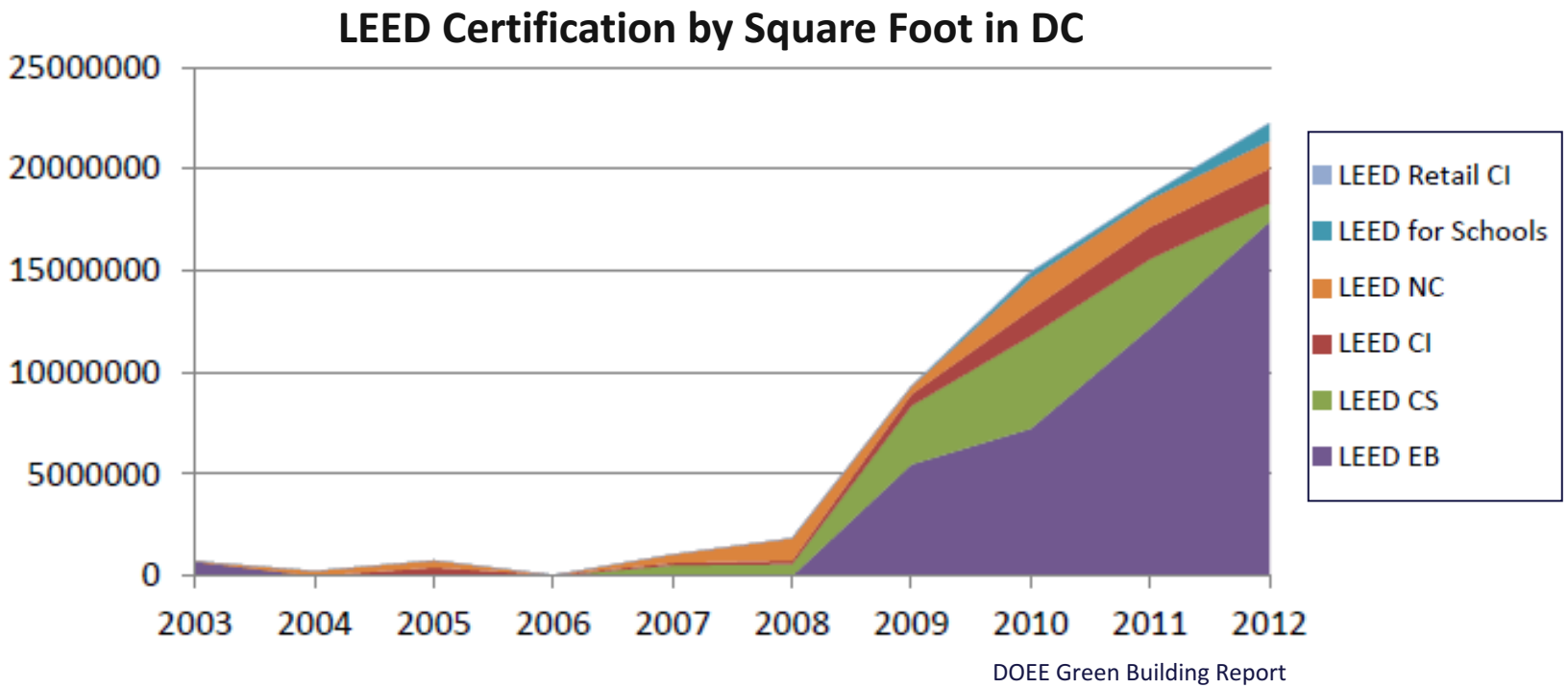
- Reduced Capital Costs
- New Revenue Streams
- Transforms Costs to Assets



Financial Benefits: Marketing & Leadership

- Build resilient and more profitable developments
  - Those that only offer generic grid power may be left behind

- Analogy: LEED used to be risky but potentially forward-thinking
  - Now if you're not LEED, you can't compete in the Class A market



DOEE Green Building Report

Case Study: Microgrid vs. Central Systems

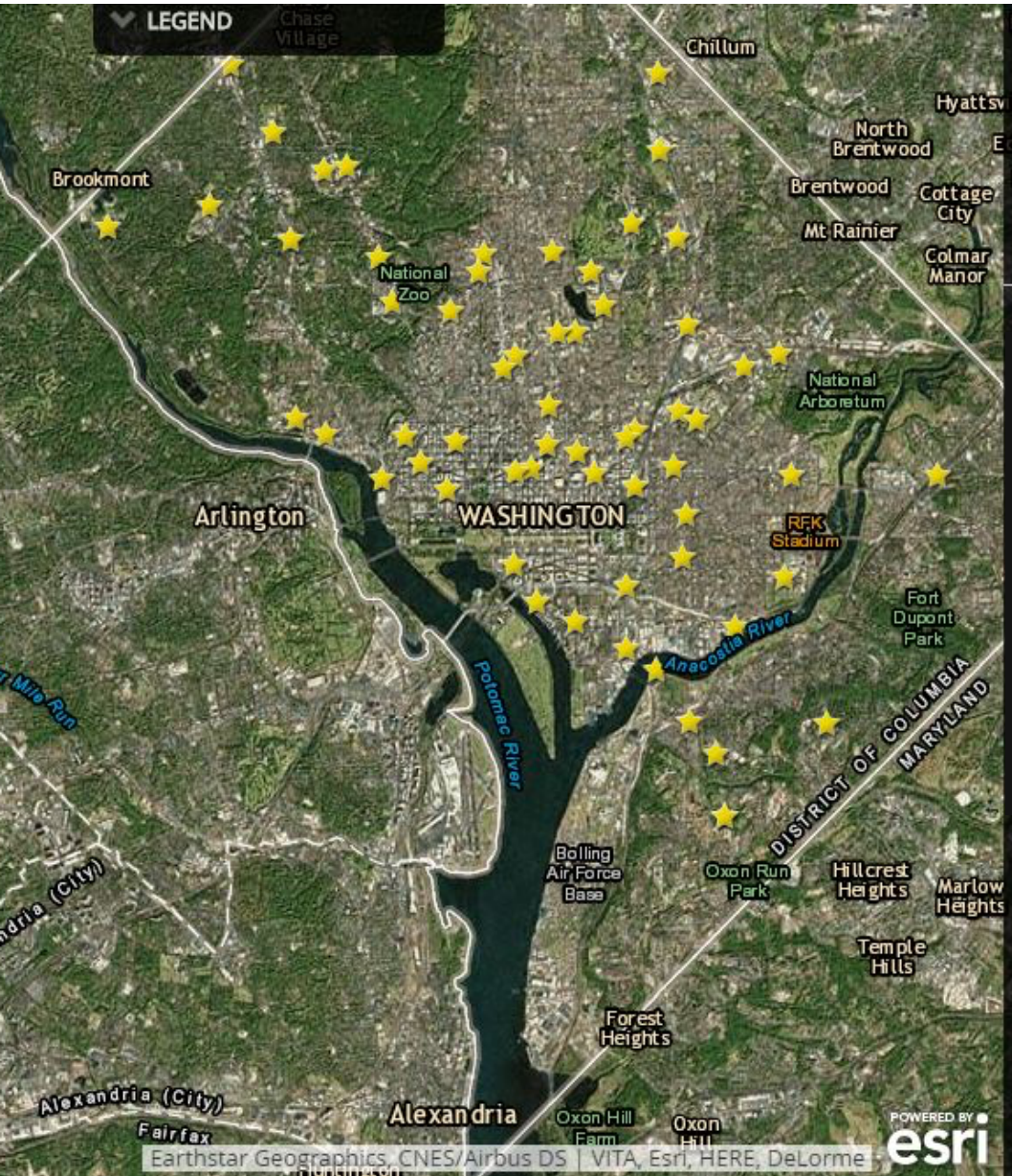
Lower First-Cost, Extra Space:

- ***Eliminate*** centralized **boilers & chillers**
- ***Eliminate*** rooftop **cooling towers** & condenser water treatment
- ***Eliminate*** **standby generators** & fuel-oil systems
- ***Reduce*** sub-contracting & **construction management** overhead
- ***Reduce*** **commissioning** time & expense
- ***Smaller*** total **space requirements**

✓ ***Capital Cost Reduction: $5/sf***

✓ ***Operating Cost Reduction: $0.60/sf/yr***

Washington DC: Project Identification



A story map

Edit ×

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District Energy:
A Visualization of Microgrid Potential in Washington, D.C.

Fix issues in your story ×

Sites by Ward:

- Ward 1: 8
- Ward 2: 12
- Ward 3: 8
- Ward 4: 3
- Ward 5: 17
- Ward 6: 19
- Ward 7: 7
- Ward 8: 8

Data Sources:

Zoning PUD Map
Filed Campus Plans
DMPED "Real Estate Projects"
DMPED New Communities
All 9 current BIDs & NCPC Great Streets programs
All EPA Title V permits
Chapter 2 Air Quality Permits *(Existing & Permit Gen >500kW)*
MWCOG Dist. Energy Inventory *(EPA eGrid & ICF CHP database)*

ENERGY smart

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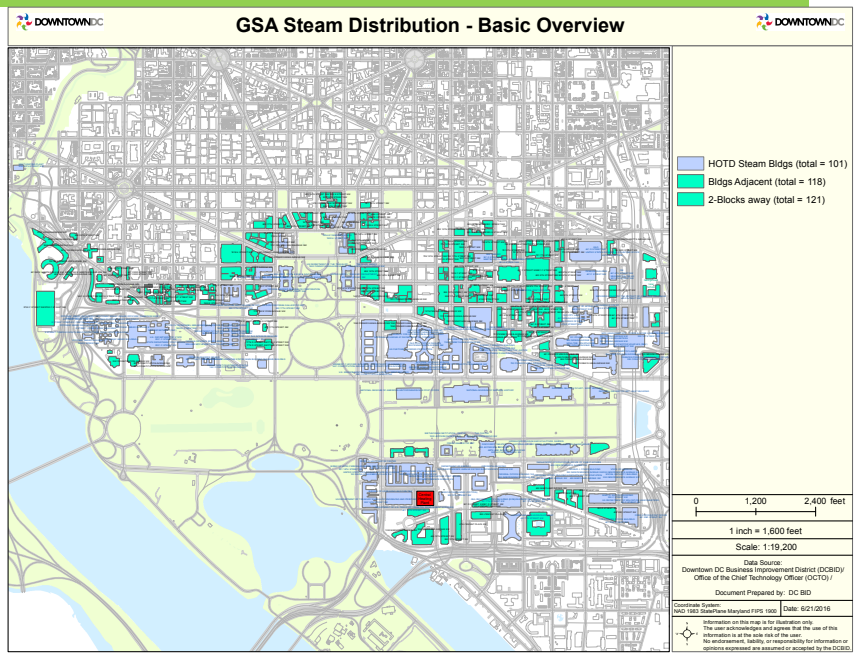
Three year grant from DOEE to assess microgrid feasibility in Washington DC

- Site screening tools
- Policy support
- Microgrid “Extension Services”

Additional work for New York City Mayor’s Office of Recovery & Resilience, US GSA, Metropolitan Washington COG

- Optimization of St. Elizabeth’s plans
- Microgrid RFP for Walter Reed
- Market potential for GSA HOTD plant
- Evaluating 10 microgrid sites in NYC



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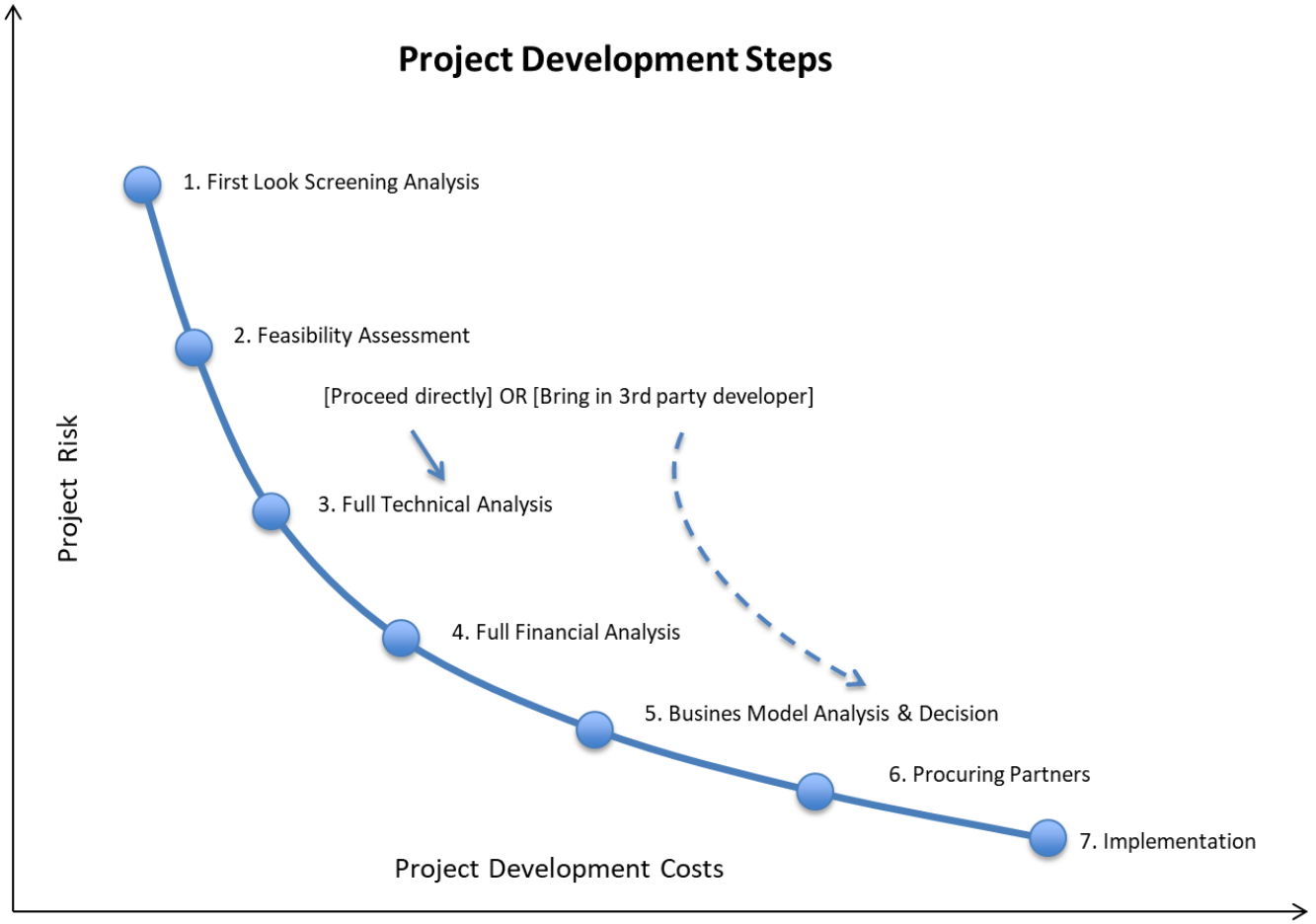
Risk vs. Development Cost Trade-Off

- Project risk declines with continued investment in analysis and development
- Earliest stages can often be accomplished with limited investment



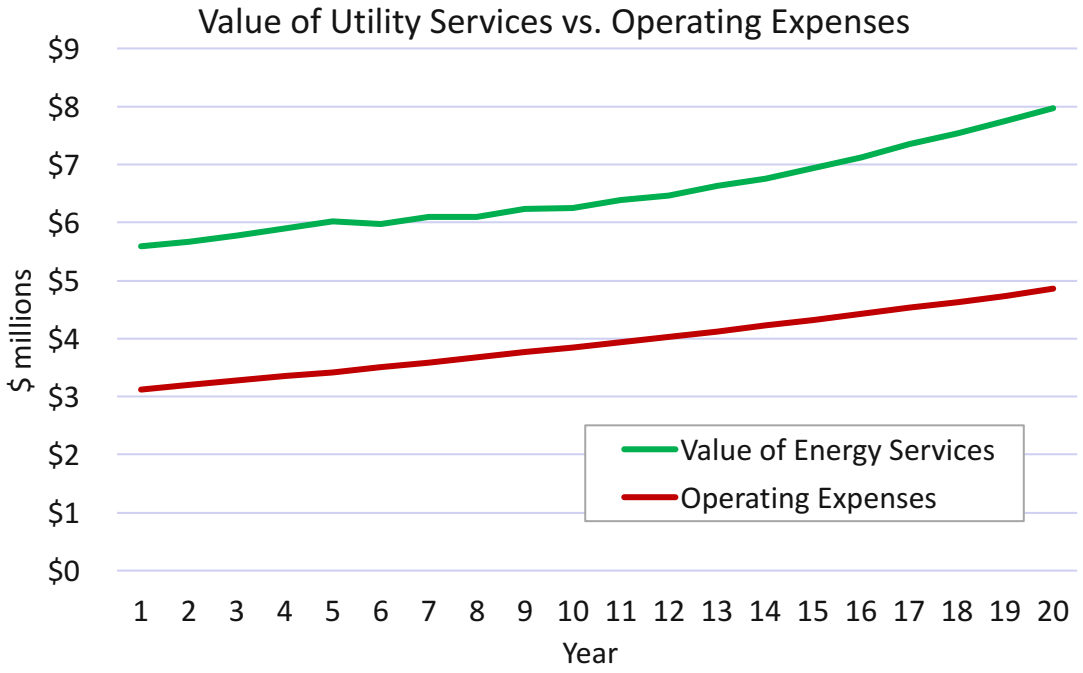
Project Development Risks

Owner Concerns	Structuring Solutions
Emerging Regulatory Framework	Open PSC Cases & Pilot Projects, Contractual Solutions
Capping Performance Risk	Performance Guarantees
Preserving the Upside	Shared Savings Agreements & Aligned Incentives
Guaranteeing Market Pricing	Contractual Agreements & Benchmarking
“Future Proofing”	Grid as Framework for Ongoing Improvement

Key Finding: Questions are solvable & benefits are real.

Phase I: Core Microgrid Design

- **Site Profile**: 100 acre campus-style development with single site-owner, existing distribution infrastructure
- **Project Conceptual Design**: 4 MW CHP, 1.5 MW solar PV, controls and automation
- **Project Cost**: $18 M
- **Conclusion**: A viable microgrid is possible, with value of benefits consistently exceeds operating costs



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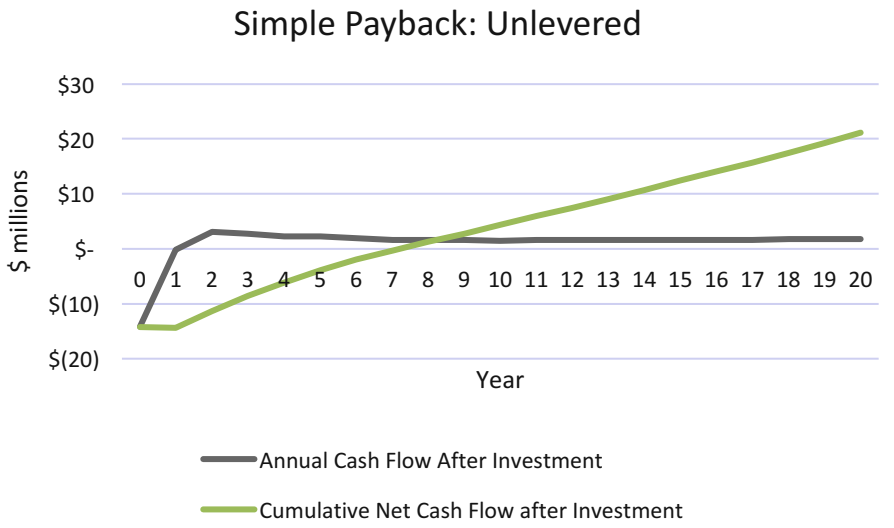
Phase I: Is it Economically Viable?

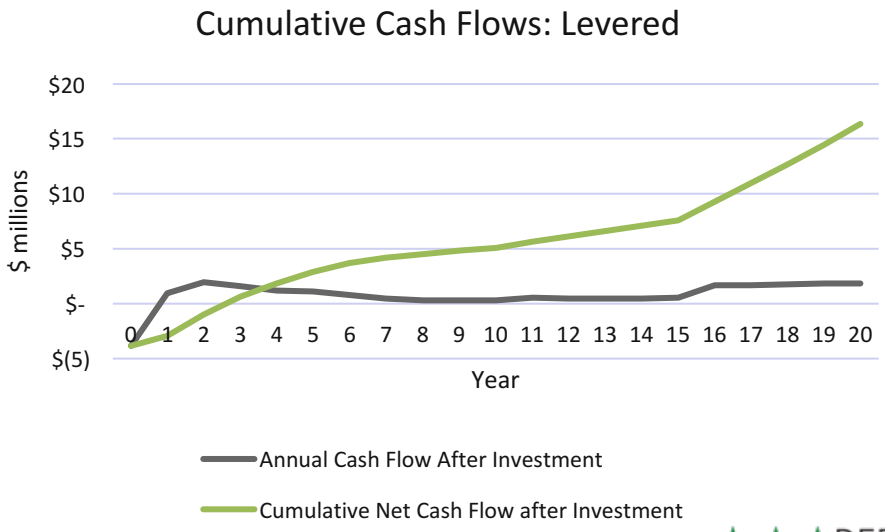
Unlevered

- NPV: $8 M
- IRR: 11% IRR
- 20-Year Net Cash Flow: $21 M
- Greater NPV & overall returns

Levered

- NPV: $7 M
- IRR: 29%
- 20-Year Net Cash Flow: $16 M
- Faster path to cash flow positive; higher IRR





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Phase III: Further Optimization

Optimizing Projects Yields More Significant Financial Returns

- Opportunities to optimize for lower cost, higher savings:
  - Chilled-water storage
  - Avoided costs of heating & cooling equipment
- Additional possible savings from:
  - Sales to wholesale markets
  - Ancillary services to Pepco grid
  - Serving surrounding loads
  - Accessing grants, incentives, creative financing

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Extra Slides:

Microgrid Value Stacks

Energy Revenues & Incentives	New Revenue Streams	Community Amenities
Heating, Cooling, Electricity	1st Cost Savings, Design Opportunity	LEED Points, PEER, Marketing Gains
Credits & Incentives: *ITC, MACRS, SRECs*	Grid Sales, Real Options	CO2 & Green Impacts
Grants, PACE, low-cost $$$	Reliability, Premium Power	Resilient Neighbor-hoods

A Typical Washington DC Microgrid

- **Loads:** One or more property owners (new, renovated, or existing buildings), roughly contiguous
- **CHP:** Co-generation fueled with natural gas, methane, or biomass
- **Solar PV:** Predominantly rooftop
- **Back-up generation:** Existing or new diesel / gas generators
- **Thermal distribution:** May include hot water, chilled water, steam, and thermal storage
- **Electric distribution**

Technical & Financial Analysis

Steps should be conducted in parallel.

Full Technical Analysis for Optimized Design

Deeper Design Diligence and Customization

Detailed design with solid cost estimates, integration with site planning, project phasing, and optimization based on 8760 load data.

Outcome: Optimized system design sufficient to resolve all technical concerns.

Full Financial Analysis for Optimized Design

Investment Grade Financial Modeling

Advanced revenue modeling integrated with an approach to organizing debt, equity, and financial structure, demonstrating sufficient returns to project partners.

Outcome: Financial model providing sufficient detail to solicit formal participation of capital partners.

Business Model Decision

Who will own and manage the project?

Choose an ownership model to allocate risks and corresponding returns.

Outcome: Structuring decision and key contractual agreements to memorialize.

	Host Site Owned	Third-Party Owned	
+	• Retain more control (best if host has substantial in-house expertise, or with substantial external resources)	• Mitigates risk and capital expenses	+
		• Gives away potential revenue streams	−
−	• Host takes on implementation and operations risk	• Should be managed with strong contracts to protect host	+/−

Other ownership models: Multi-stakeholder (shared ownership), publically-owned

Microgrid Business Models

Precedents & Innovations in Service Delivery Models

Commercial Structures	Precedents & Analogues
Municipally Owned Services	DC Water, Public Power
Energy Services Agreements (ESA)	Solar City PPA
Microgrid-as-a-Service with Price & Performance Guarantees	Energy performance contracting, Cloud Computing - Software-as-a-Service
Shared Infrastructure	Central parking structure
Microgrid operator hired by Home Owners Association (HOA)	Outsourced Contracts for Building Management, Landscaping, etc.

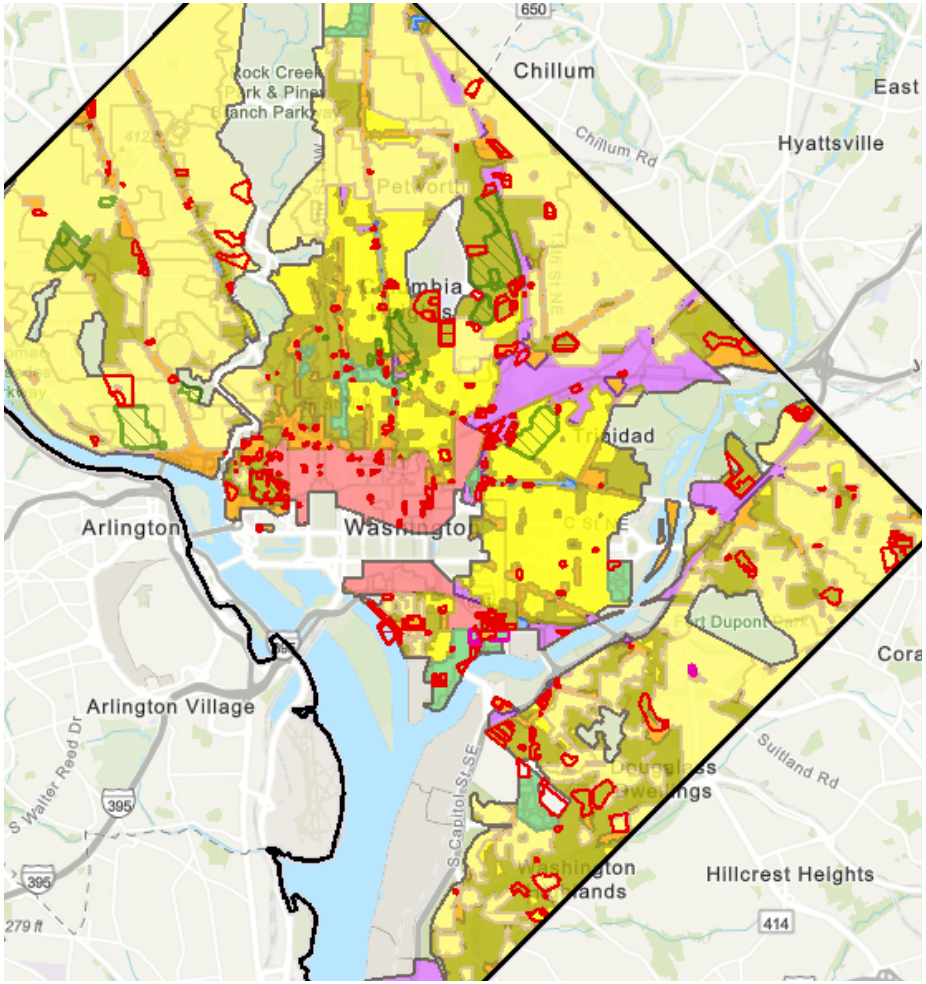
Designing & Optimizing a Microgrid

This case study provides a framework for understanding the economics of a microgrid in the District of Columbia.

Key lessons:

- Determine viability for a **core site**
- **Explore expansion** to serve neighboring loads on a marginal cost basis
- **Further optimization** to improve efficiency and economics

Note: Case study is based on actual analysis conducted for a District site-owner. Numbers have been simplified for illustrative purposes.



DC Office of Zoning

Phase I: Is it Economically Viable?

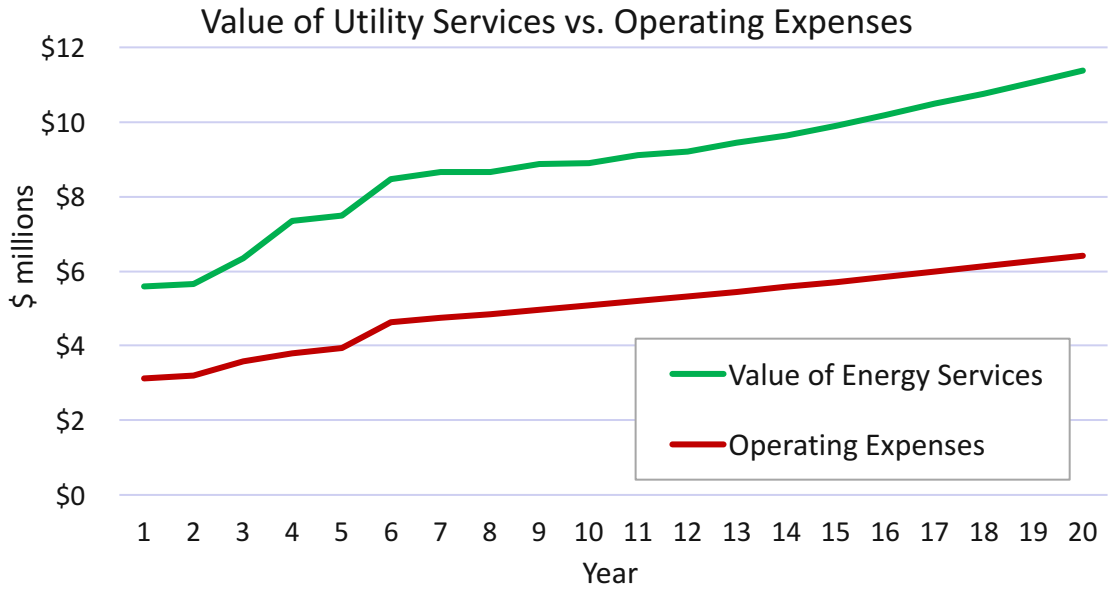
Financial Analysis Assumptions

Unlevered	
Leverage: Debt/Equity	100% Investment
Term of Debt	None
Commercial Interest Rate	None
Discount Rate (for NPV)	5% = Site Owner Cost of Capital

Levered	
Leverage: Debt/Equity	70% / 30%
Term of Debt	15 years
Commercial Interest Rate	7%
Discount Rate (for NPV)	7% = Commercial Rate

Phase II: Expansion Microgrid Design

- **Site Profile**: Parcels adjoining main site (independently owned) could opt in to the microgrid during a planned redevelopment.
- **Project Conceptual Design**: Additional 4 MW CHP, 600 kW solar PV, new distribution infrastructure.
- **Project Cost**: Additional $10 M ($28 M total)
- **Additional Concerns**: Determine if multi-user microgrid permissible from a legal / regulatory perspective.
- **Conclusion**: Later phases can be implemented on a marginal cost basis, improving the economics / energy efficiency of the larger system.



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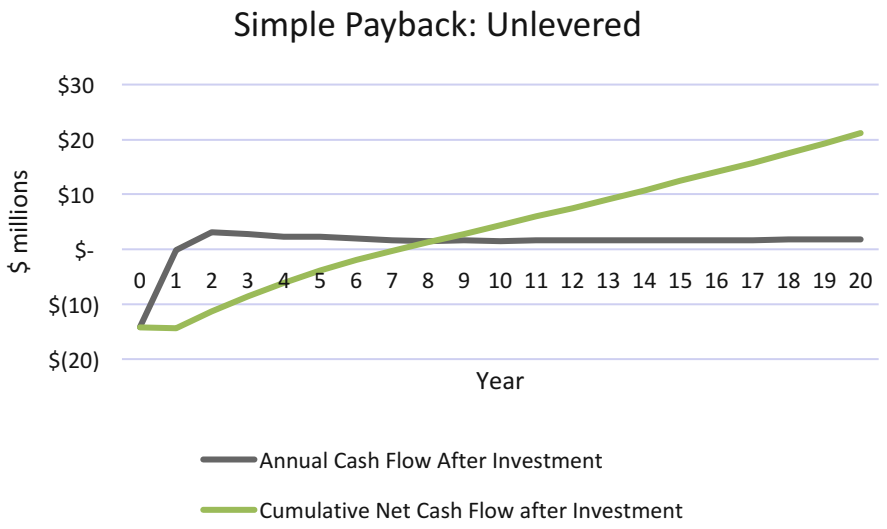
Phase II: Is it Economically Viable?

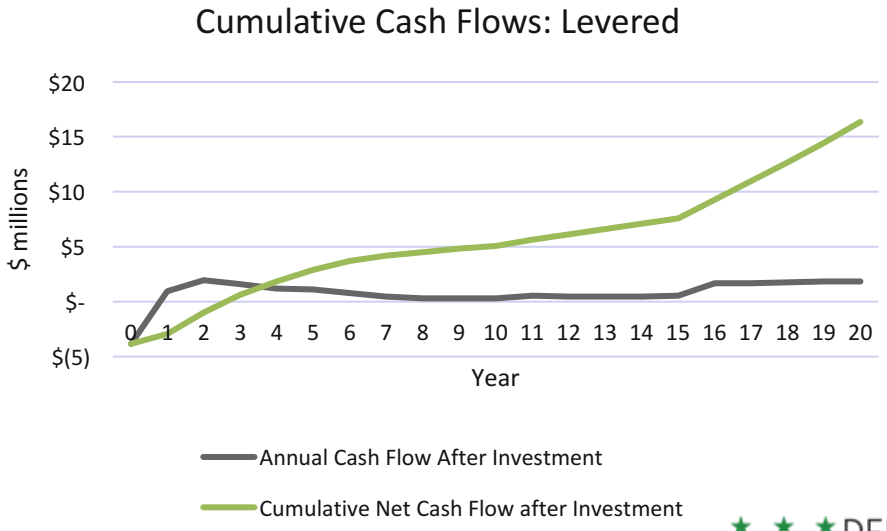
Unlevered

- NPV: $11 M
- IRR: 11% IRR
- 20-Year Net Cash Flow: $31 M
- Greater NPV & overall returns

Levered

- NPV: $8.5 M
- IRR: 25%
- 20-Year Net Cash Flow: $23 M
- Faster path to cash flow positive





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Old and New Paradigms

Old World:

- Utility has full control
- Buy brown power or buy RECs
- Rate increases year after year
- At risk: cyber-attacks, heat waves, 100-year storms, terrorism

Matthew D. Wilson (LtPowers)

New World:

- On-site resource = security & flexibility
- Smaller carbon footprint
- Lower energy costs, new revenues, and controllable costs
- Grid outages? What grid outages?

Spotlight Solar

Gallaudet: Campus Microgrid Planning