Urban Ingenuity's New

Microgrid Extension Service

for Washington DC

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DEPARTMENT OF ENERGY & ENVIRONMENT

Background: Agricultural Extension Service

National Statistics:

13,000 employees

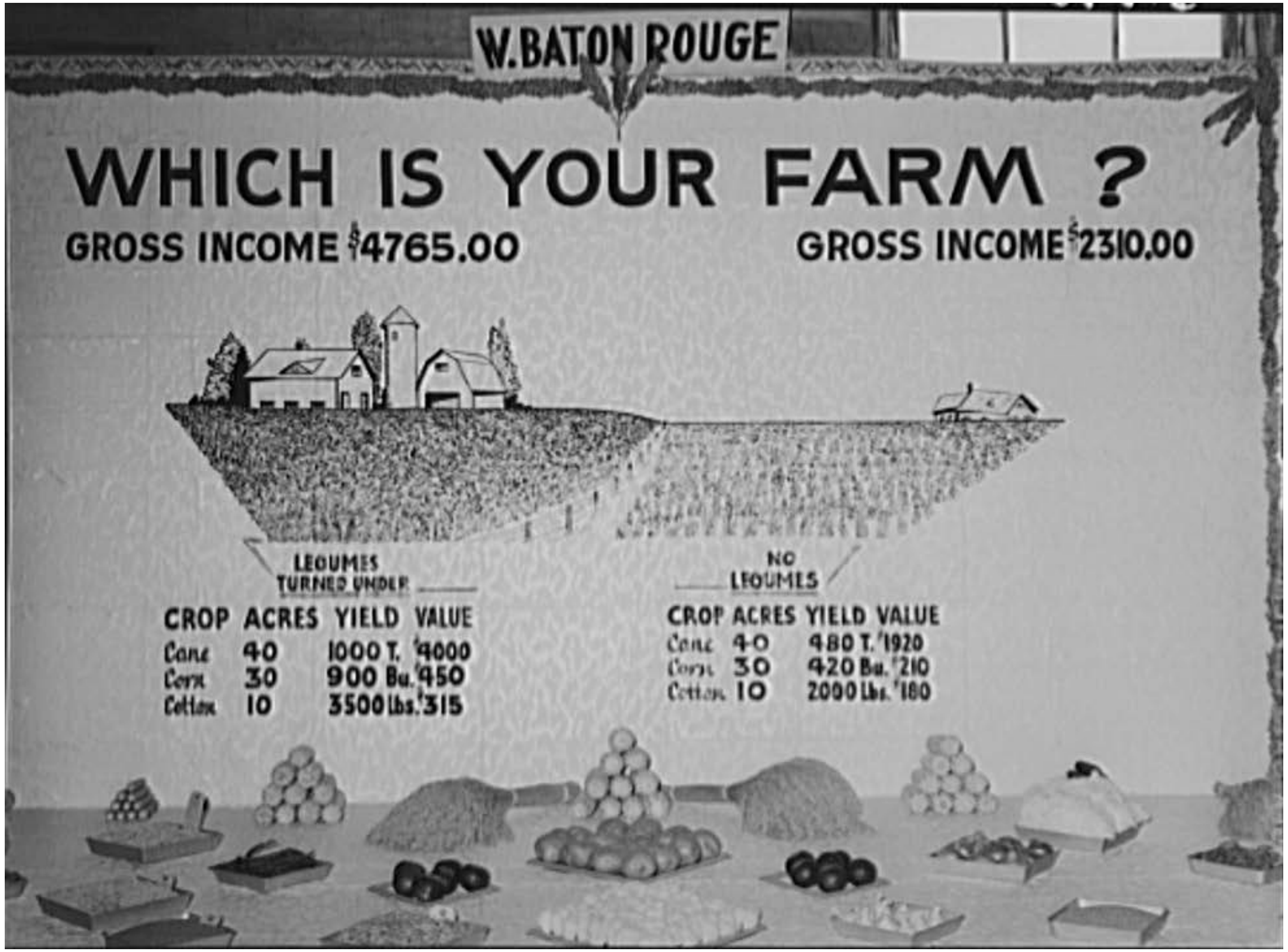
3 million volunteers

$3 billion annual funding

(Federal, states & counties)

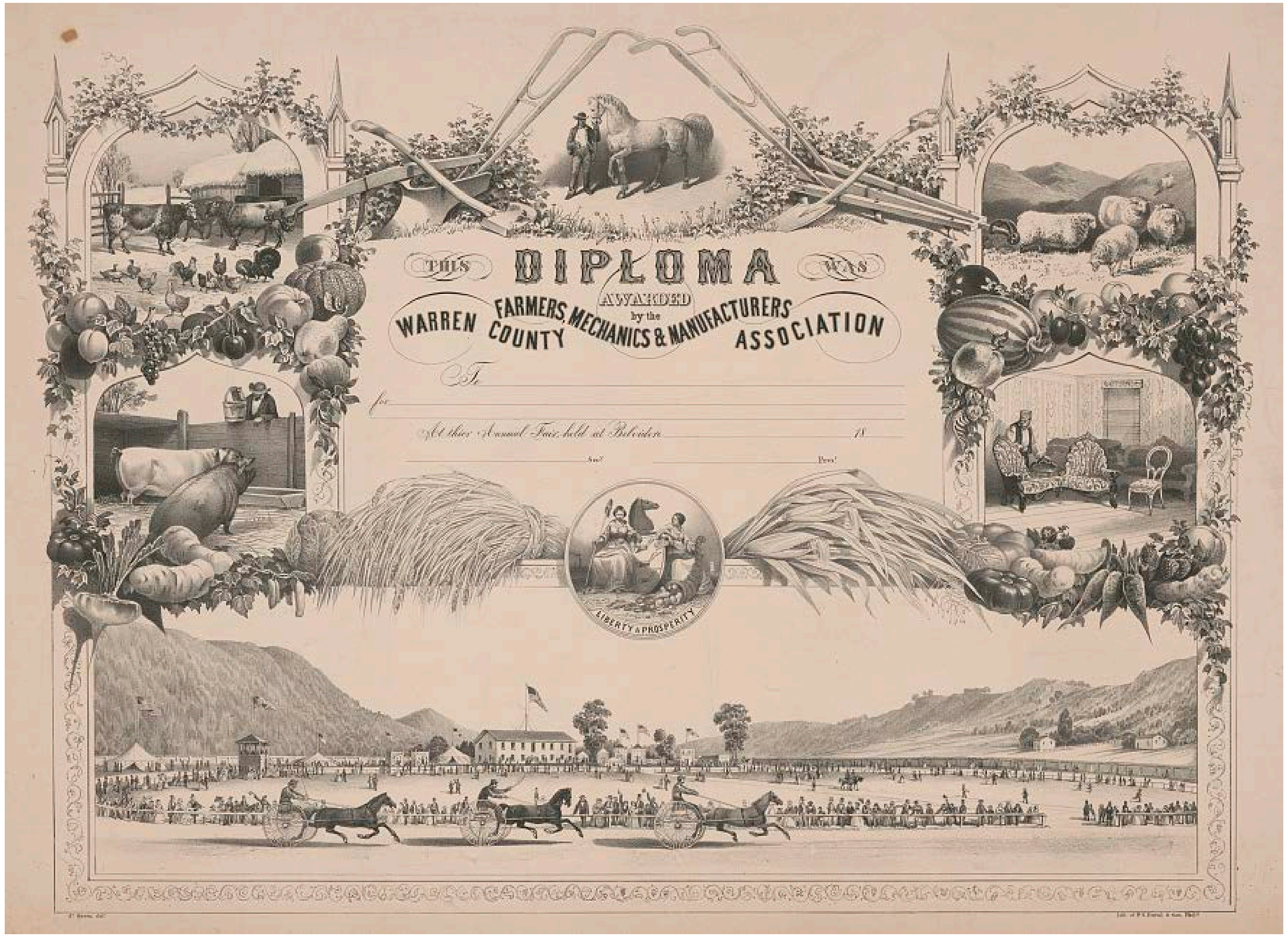
~50% IRR

~30:1 B/C ratio



Origins: Agricultural Extension Service

- 1809 – First agricultural fair, Columbia Agricultural Society
- 1862 and 1890 – Land grant colleges for disseminating agricultural research
- 1914 – Full Federal-state Cooperative Extension Service, every state and DC



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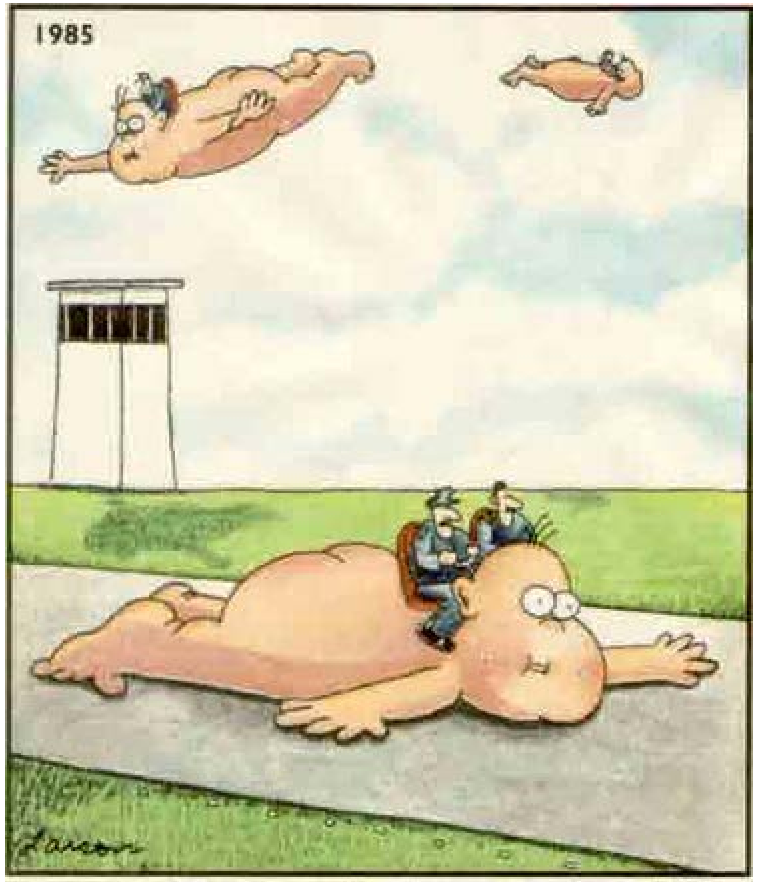
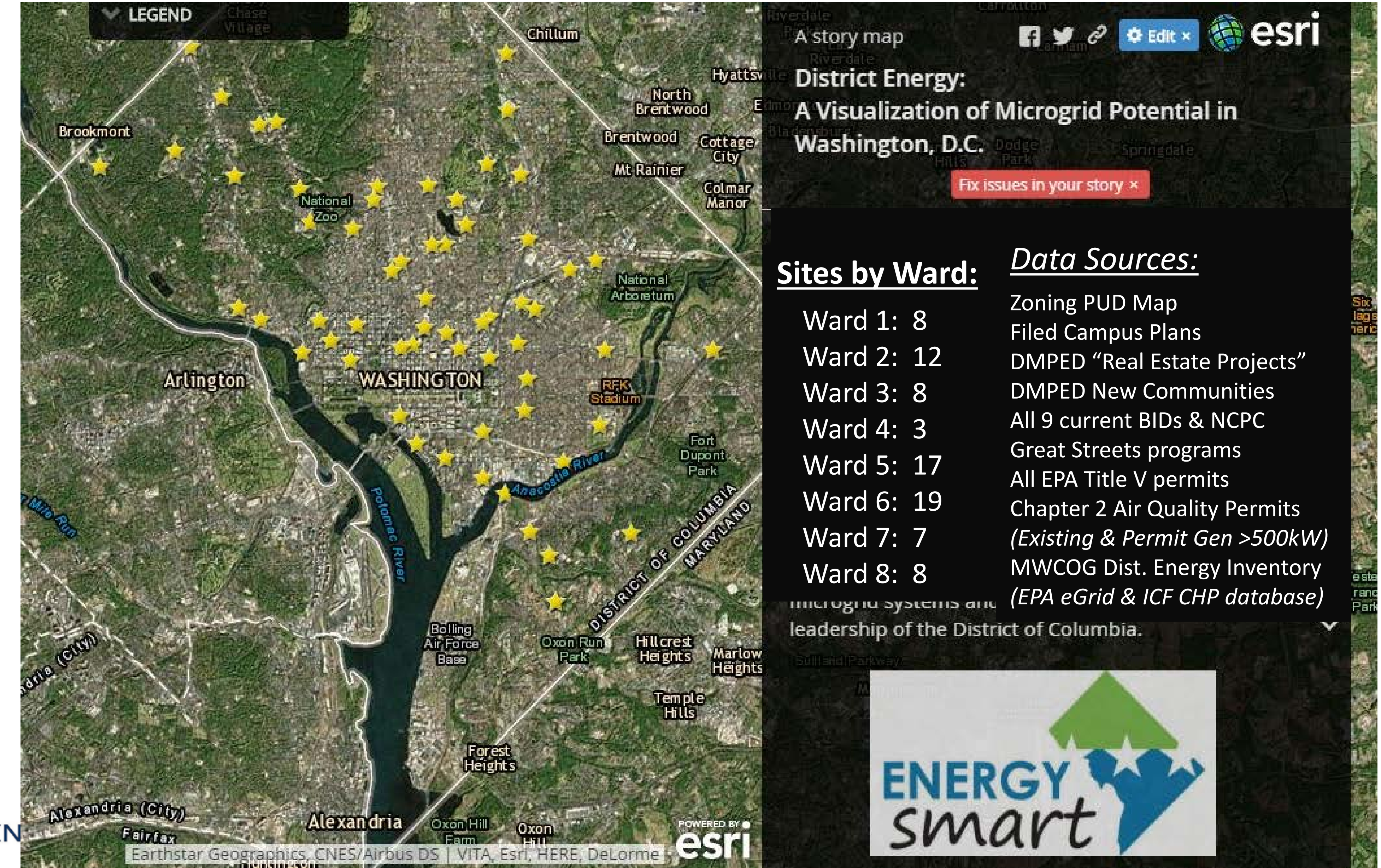
Microgrid Extension Service: Pilot Year

- Supported by DC government
  - Dept of Energy & Environment
- FY2017 budget: < 1 FTE
- Empowered to assist any of ~100 microgrid candidates in DC
- Leveraging existing tools:
  - DC-wide site survey
  - Expert-system site assessment
  - Hourly load models
  - Cash-flow financial models
- Integrated with ongoing policy support



"Fuel ... check. Lights ... check. Oil pressure ... check. We've got clearance. OK, Jack—let's get this baby off the ground."

Washington DC: Project Identification



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)

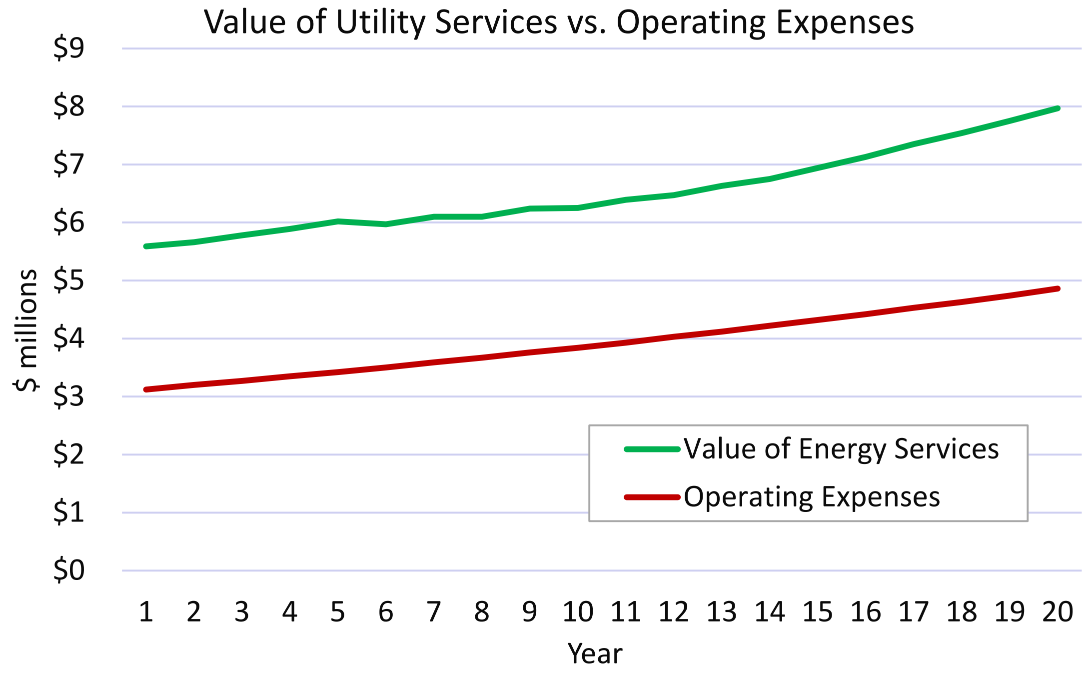
Market Uptake for Extension Service

Differentiated Offerings to Match Project Maturity / Sophistication

- Outreach via public events and webinars
  - Attended or viewed by thousands of people, plus collateral / web
- Microgrid “Help Line”
  - No 800 number (yet)
  - Scores of calls and emails – majority from government agencies
- Screening Analysis
  - Residential, Universities, Public lands, Real Estate developers
  - Thousands of residents / students / acres
- In-Depth Analysis
  - Hospital complex – 1650 beds plus outpatient services
  - University campus with adjoining mixed-use development – 4M sf
  - Steam district conversion – potential to reach 56 M sf

Sample Products: Core Design

- **Site Profile**: 100 acre campus-style development with single site-owner, existing distribution infrastructure
- **Project Conceptual Design**: 4 MW CHP recip engines, >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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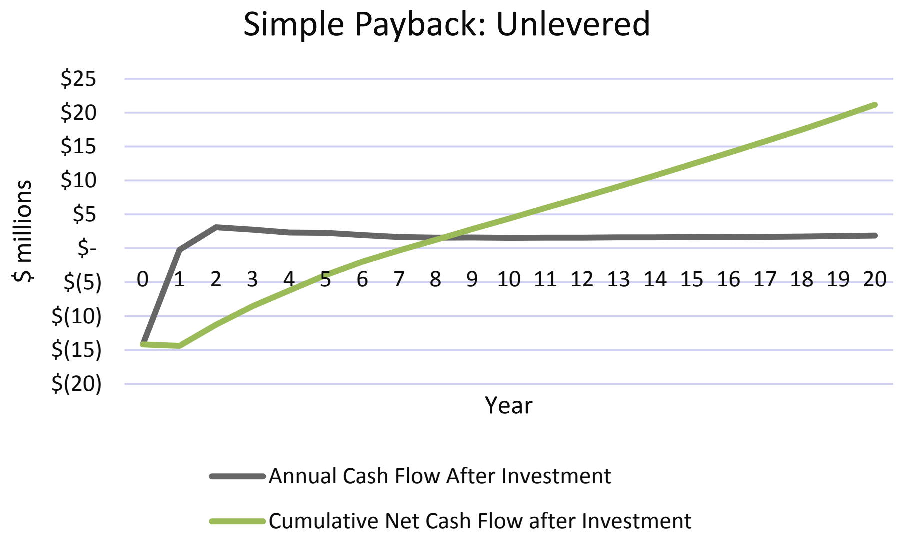
Sample Products: Economic Viability

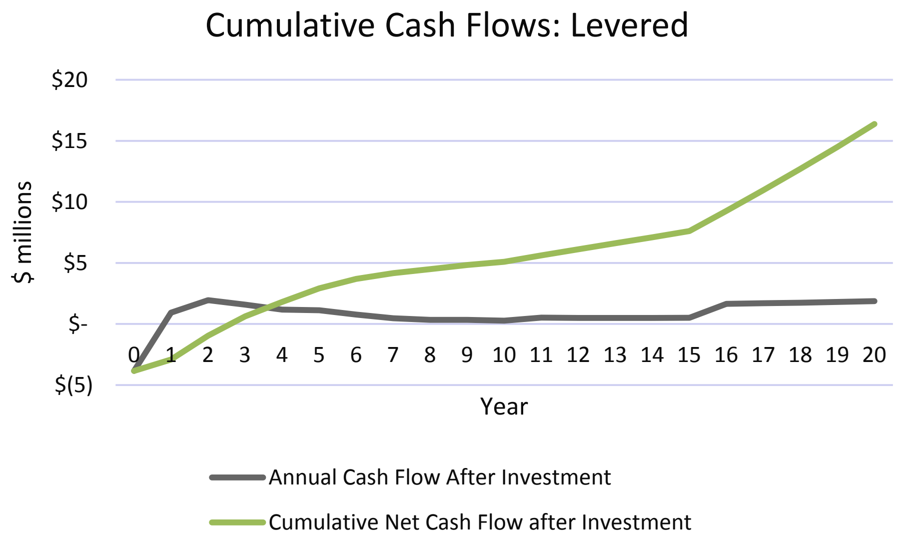
Unlevered

- 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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Sample Products: Optimization Pathways

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

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), publicly-owned

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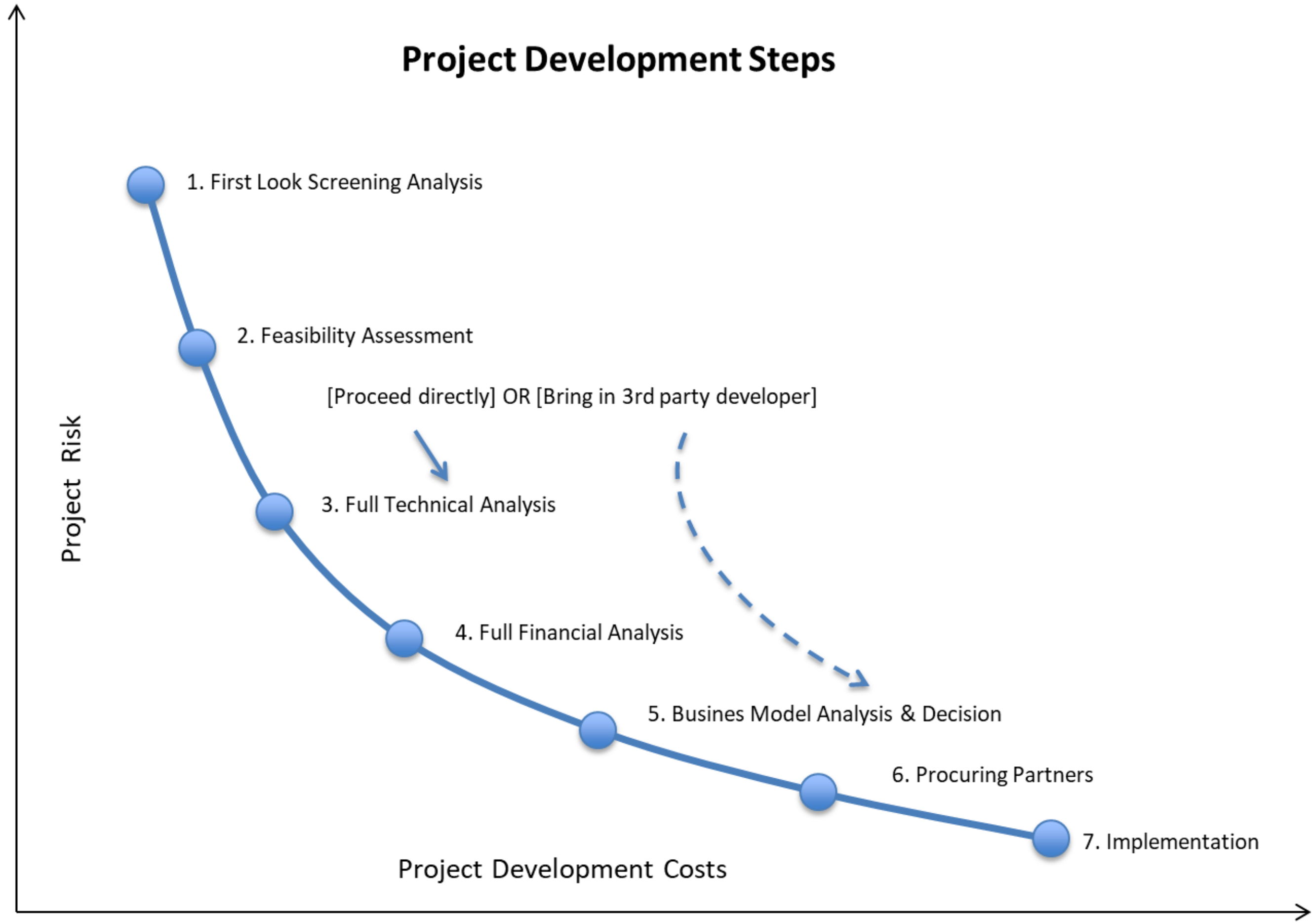
Risk vs. Development Cost Trade-Off

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



Potential Pitfalls

Ensuring an Extension Service that is Built to Last

- Underserved Communities:
  - Same as Agricultural Extension history – 1890 Morrill Act, 30 years to include black farmers, still separate-but-equal
  - Emphasize affordable housing and environmental justice – not just elite universities, luxury condos, trophy office buildings
- Independence & Ongoing Funding:
  - Time-limited grants only work for start-up
  - Need sustainable multi-year assistance for long lead-time projects
- Two-Way Ties to Academic Research
  - Pathways to translate innovation into action, while fostering the next generation of microgrid experts and entrepreneurs

Plans for Continuation & Expansion

- <u>Ongoing Funding Sources:</u>
  - Green Banks and revolving loan funds
  - FEMA – e.g. PDM (Pre-Disaster Mitigation) planning grants
  - Foundation support for resilience in vulnerable communities
- <u>Industry Outreach:</u>
  - Real Estate Developers and REITS
  - Affordable Housing
  - Need sustainable multi-year assistance for long lead-time projects
- <u>Jurisdictions Beyond DC:</u>
  - Match agricultural extension – but start with cites
  - Mayor’s office vs. Econ Development vs. Energy & Environment
  - Urban Sustainability Directors Network? DOE CHP TAPs?

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Extra Slides:

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)

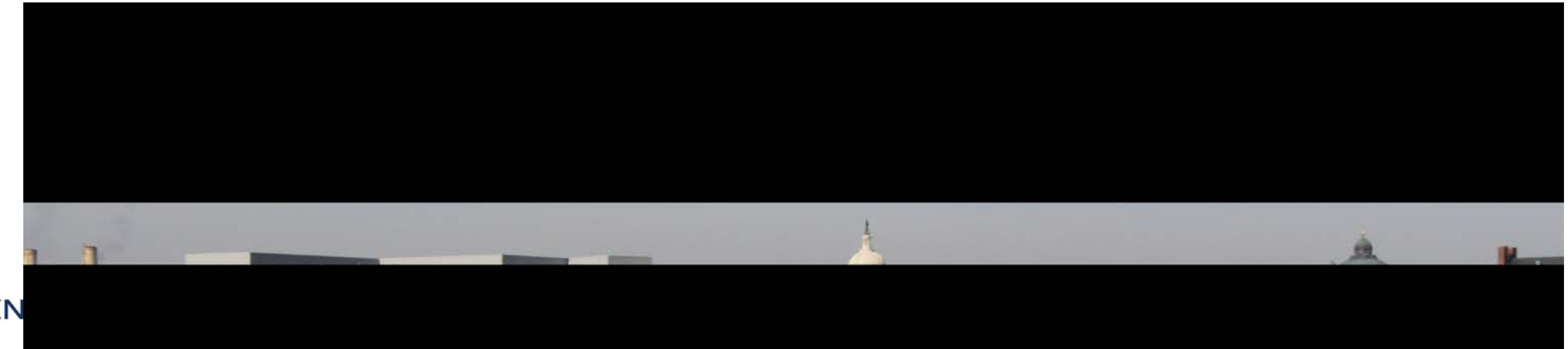
New World:

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

Spotlight Solar

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**



Microgrid Value Stacks

Energy Revenues & Incentives

Heating, Cooling, Electricity

- Credits & Incentives: *ITC, MACRS, SRECs*
- Grants, PACE, low-cost $$$

New Revenue Streams

1st Cost Savings, Design Opportunity

- Grid Sales, Real Options
- Reliability, Premium Power

Community Amenities

LEED Points, PEER, Marketing Gains

- CO2 & Green Impacts
- Resilient Neighbor-hoods

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.

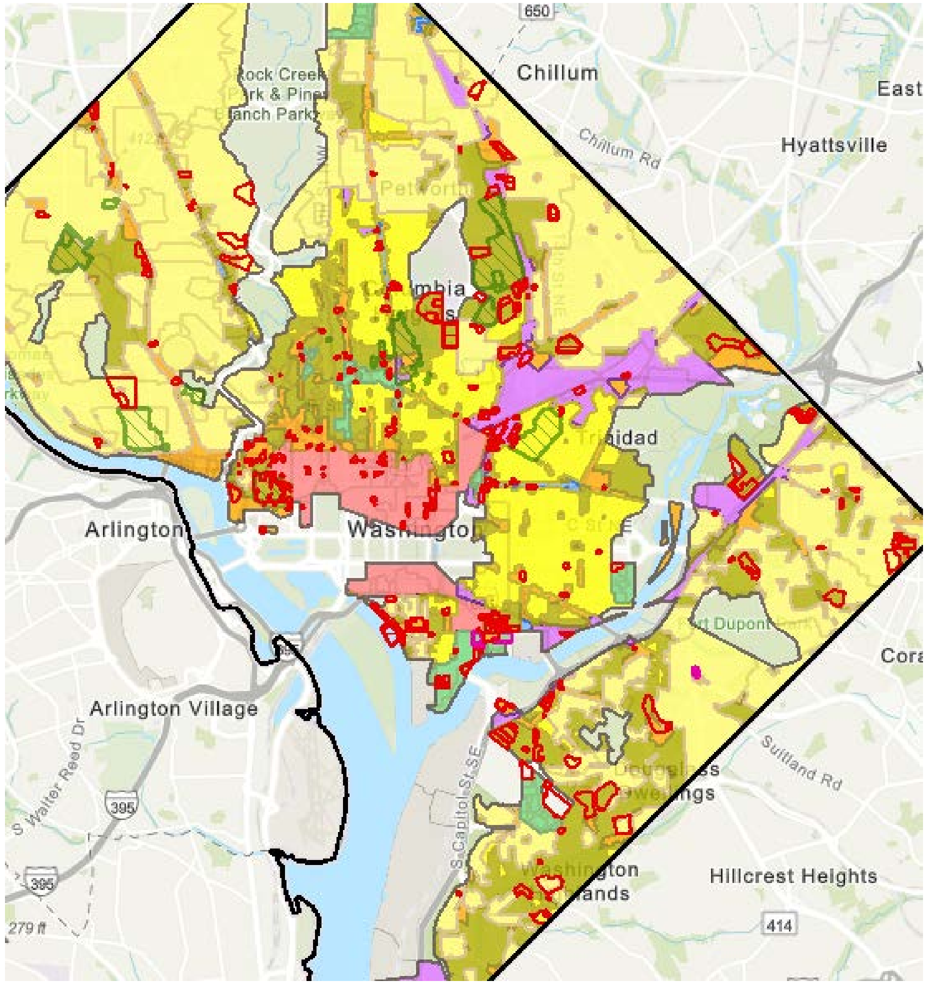
Designing & Optimizing a Microgrid

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

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

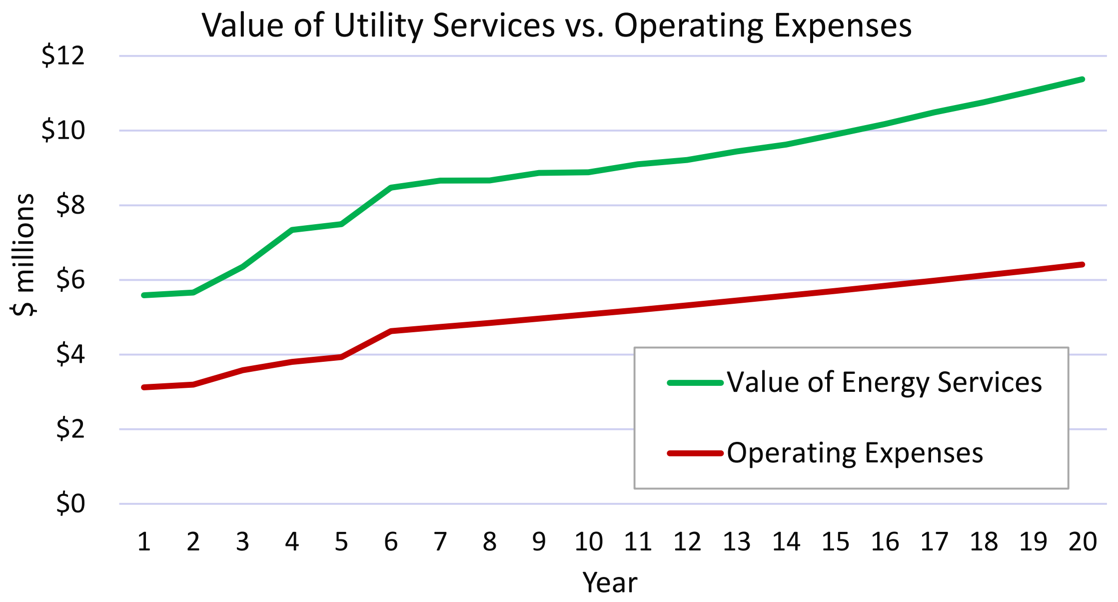
Investment Grade Financial Modeling

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.

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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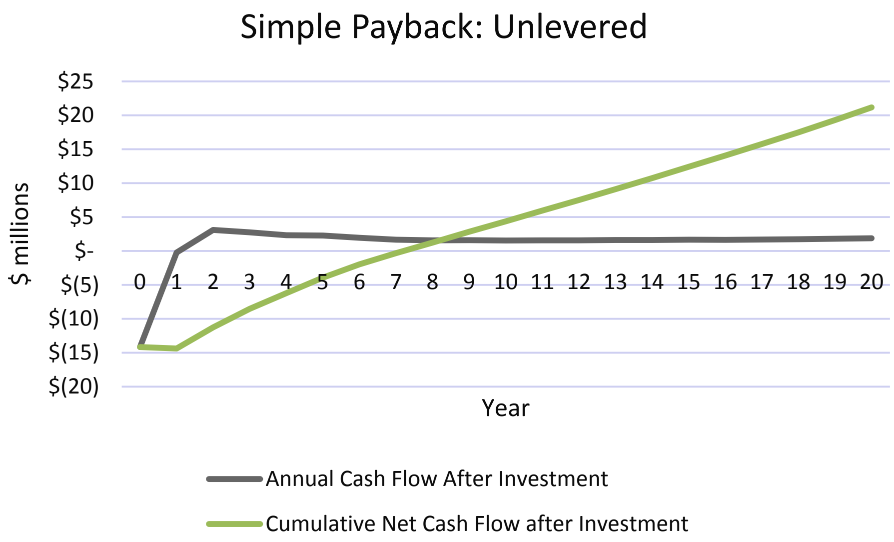
Phase II: Is it Economically Viable?

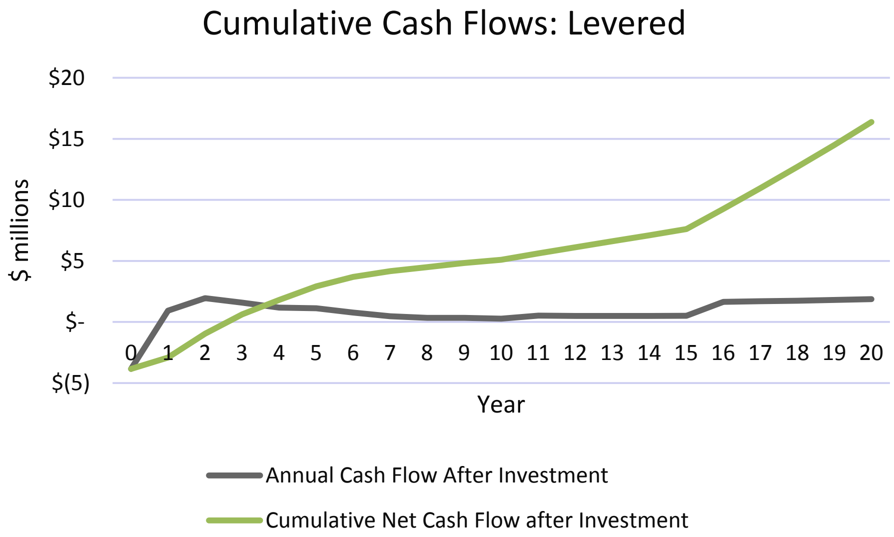
Unlevered

- 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





Gallaudet: Campus Microgrid Planning