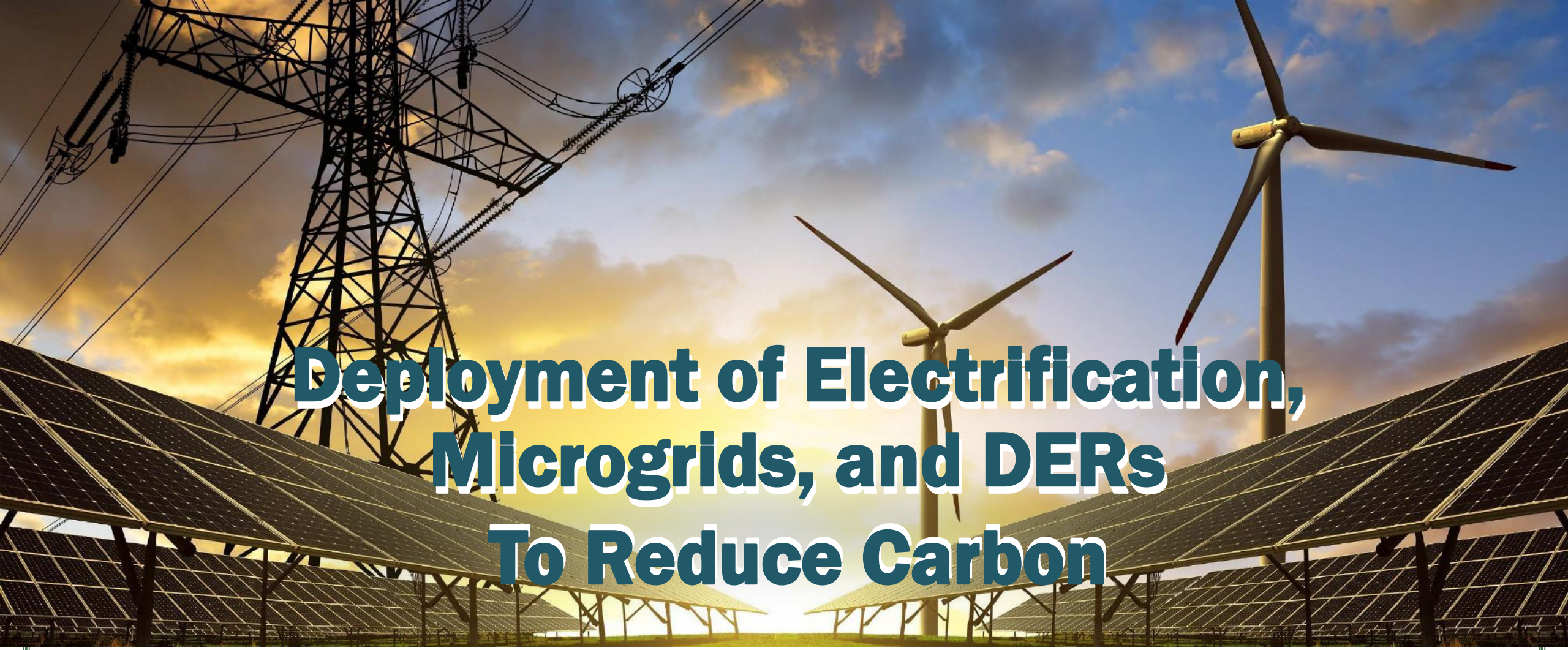

Deployment of Electrification, Microgrids, and DERs To Reduce Carbon

Greater Philadelphia Association of Energy Engineers
September 29, 2020

David Smith – Burns Engineering, Inc.
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Burns

Overview – Burns Engineering

Burns

- Specialized engineering services for complex power systems, utilities, on- site power solutions
- 60-year history of electrical
- engineering excellence
- 200 technical professionals
- Ranked #12 Electrical Design firms

EC&M TOP 40

- 10 offices nationwide
  - Philadelphia
  - New York
  - New Jersey
  - Los Angeles
  - Washington D.C.
  - St. Louis
  - Orlando
  - Tampa
  - Dallas
  - Denver

Energy & Utilities

Burns Experience

- Resilient & Sustainable Energy, Infrastructure, & Microgrid Projects
  - 545MW Combined
  - Technologies:
    - Solar
    - CHP
    - Fuel Cells
    - Batteries
    - Interconnections
    - Microturbines
    - Industrial Turbines
  - Largest Microgrid: 120MW TransitGrid for NJ Transit
  - Customers Include:
    - DOD
    - Atlanta Airport
    - Port Authority of NY & NJ
    - GlaxoSmithKline
    - IKEA
    - Lehigh University
    - New York Power Authority
    - Pittsburgh Int'l Airport
    - Lawrence Berkeley Lab
    - City of Philadelphia
    - NYU

Resilient & Sustainable Energy, Infrastructure, and Microgrid Projects	PROJECT TYPE/PHASE				FACILITY TYPES & INFRASTRUCTURE INCLUDED IN PROJECT											MW	PROJECT TECHNOLOGY TYPES & SCOPE						
	Energy, Carbon and/or Utility Plan	Feasibility Assess/	Prelim Design	30%-100% Design	Built or planned	Airports	Campus/Higher Ed	Comm'l/ Industrial	Community/ Mixed	Fleet/EV	Hospital	K-12	Military	Rail/ Transport	Elect Utility	Water/Wastewater	Megawatts (MW)	Solar PV	Battery Storage	Cogeneration (CHP)	Standby Generator	Fuel Cells	Efficiency	Interconnection
Project Name & Customer Type	5	52	21	14	7	10	9	8	5	3	2	5	3	5	8	545	15	17	17	19	4	9	25
Campuses/Higher Ed																							
University of Pennsylvania	1															-							
Philadelphia Navy Yard Mixed Campus*	1	5	4	4		1	1			1		2		3		20	•	•	•	•	•	•	•
Swarthmore College		1	1													4				•			•
Lehigh University	1															5			•				
Temple University		1	1	1		1										16				•			•
Manhattan College		1	1			1										1			•			•	•
The College of New Jersey**	1		1	1												10			•				
Santa Fe Community College		1	1	1		1										2	•	•					•
Mississippi State Univeristy		1	1	1		1										0.3			•				•
Duke Farms		1				1	1		1							1	•	•					•
Airports																							
JFK International Fuel Farm		1			1		1									13				•			•
JFK International		5			1											110	•	•	•	•	•	•	
Denver International	1	1			1											50	•	•		•	•	•	•
Pittburgh International		1		1	1											20	•			•			•
Atlanta Hartsfield-Jackson Int'l		1			1											45	•	•		•			
Commercial																							
GlaxoSmithKline (2 sites)		2					2									5			•	•			•
IKEA (3 stores)		3					1									3	•	•	•				
Arkema Chemical		1	1				1									1.2			•			•	•
Bellevue Hotel		1	1				1									1.1			•				•
Community/Mixed Customers																							
NY State Prize (8 unique projects)		8	2			2		6		0	1		1		2	37	•	•	•	•	•	•	•
NJ Town Microgrids (2 unique projects)		2				1	1	2	2		1					8	•	•		•			•
Brookville Smart Energy Depot		1							1							2	•	•		•			•
SEPTA Midvale Bus Depot		1							1							13							•
NYU Winthrop Hospital		1	1							1						9		•	•	•		•	•
Bellevue Medical Center		1	1							1						4		•	•	•		•	•
Military/Department of Defense																							
Camp Smith Army Nat. Guard		1				1						1				1			•	•		•	•
Joint Base Andrews		1			1							1				2		•		•			
Dyess Air Force Base			1	1	1							1				18		•		•			•
Rail/Transportation/Utility																							
NJ Transit "TransitGrid"		1	1	1									1			120	•	•	•				•
Pennsylvania Turnpike		1	1	1									1			3	•		•				
Confidential Investor-Owned Utility		1	1	1										1		2	•	•		•			•
Water/ Wastewater																							
Philadelphia Gas Works		1	1	1											1	8.6			•				•
NYC Dept of Env. Protection (5 plants)		5												1	5	10	•	•		•			•

*Multiple projects for smart grid, resilience, electric capacity and distributed energy, from planning through construction

**Burns was selected to create a Carbon Neutral Plan but the project has been delayed due to COVID; the CHP project was for controls and major equipment renewal

Beneficial / Strategic Electrification as Overarching Trend

Burns

Beneficial electrification *(or strategic electrification) is a term for replacing direct fossil fuel use (e.g., propane, heating oil, gasoline) with electricity in a way that reduces overall emissions and energy costs.*

There are many opportunities across the residential, commercial and public sectors, and throughout transportation systems and infrastructure. This can include switching to an electric vehicle or an electric heating system – as long as the end-user and the environment both benefit.

Drivers – Resilience – Power Grid Threat Vectors

Burns

- Grid Failures
- Climate Change
- Cyber Threats
- Pandemic

Drivers – Resilience – Pandemics and Natural Disasters

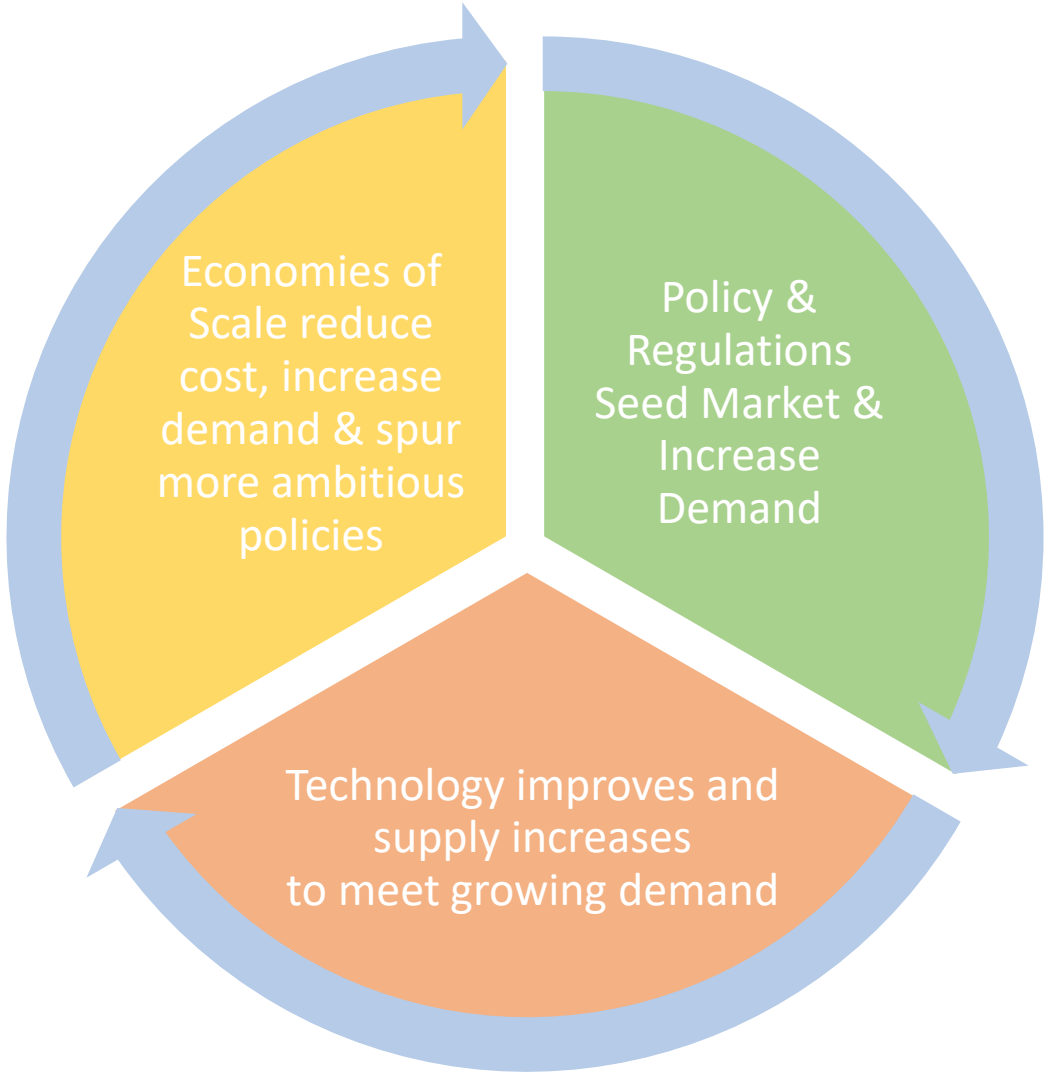
Burns

- Full Hospital Backup – “Open for Business”
- COVID-19 Heightens Need for Hospital Resilience
- Surge Events Convert Entire Hospitals to Critical Care
- Safe Reliable Operation of Grid Threatened During Pandemic

Drivers – Economics, Regulations/ Legislation & Market Demand

Burns

A virtuous cycle: policy changes and improved regulation increase demand, drive technology advances, cause economies of scale and put more ambitious goals within reach



Drivers – Economics
The Greener Cheaper Grid

- Coal and natural gas plant closures
- Large (“utility-scale”) off-site solar PV systems
  - Stanford University – 70MW PV in Mojave Desert
  - Swarthmore – Partnering with other universities
  - City of Philadelphia – 70MW
  - Cincinnati – 100MW

– Xcel Energy Colorado
  - 2018 Auction: 3.6 cents/kWh PV+Storage

- Portugal: 1.3 cents/kWh (PV)

Photo by Andreas Gücklhorn

Cities, Counties and States – Committed to 100% Clean Power

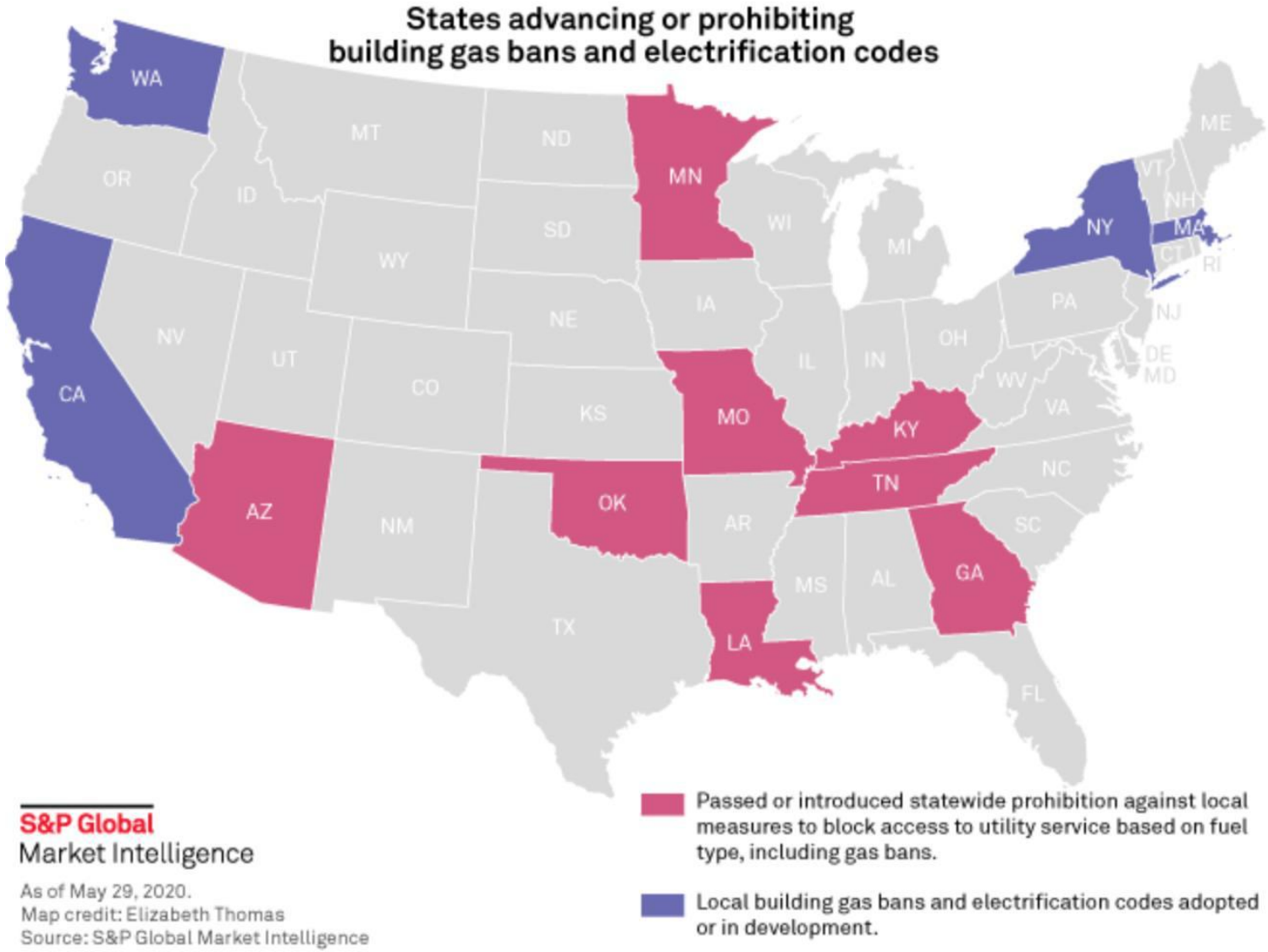
Burns

- Over 160 cities, more than ten counties, and eight states across the U.S. have goals to power their communities with 100% clean, renewable energy. These commitments—formalized in resolutions, climate action plans, renewable portfolio standards, and other policies—are the product of leadership from coalitions of civic champions, frontline activists, and Ready For 100 organizers nationwide.

In total over 100 million people now live in a community with an official 100% renewable electricity target.

Regulatory Policy and Legislation – Carbon – Natural Gas Bans or Electrification Codes

Burns



Regulatory Policy and Legislation - Storage

Burns

- Storage
  - Federal Energy Regulatory Commission's Order 841, directing regional transmiss-ion organizations (RTOs) and independent system operators (ISOs) to remove barriers to energy storage from participating in energy, capacity, and ancillary service markets

State Energy Storage Targets as of April 2020

State	Goal / Target / Mandate	Follow-through	Other components
California **2010 bill** **2013 regulation**	1,325 MW by 2020 (Target)	Required solicitations, programmatic support, progress reporting	Carve-outs by segment (Tx-connected, Dx-connected, BTM)
Oregon **2015 bill**	Minimum 10 MWh, up to 1% peak load by 2020 (Mandate)	Legal mandate, utility plan required, planning reforms	
Massachusetts **2016 bill** **2017 regulation** **2018 bill**	200 MWh by 2020, 1,000 MWh by 2025 (Target)	Utility plan required, programmatic support	Denotes target in MWh
New York **2017 bill** **2018 regulation** **2019 bill**	1,500 MW by 2025, 3,000 MW by 2030 (Target)	Legal mandate, progress reporting, programmatic support	
New Jersey **2018 bill**	600 MW by 2021, 2,000 MW by 2030 (Goal)	Goal	
Nevada **2017 bill** **2020 regulation**	1,000 MW by 2030 (Target)	Utility plan required, planning reforms	Biennial interim targets
Virginia **2020 bill**	3,100 MW by 2035 (Mandate)	Legal mandate, other measures TBD	Requirement of >35% procured from 3rd parties; interim targets TBD

Regulatory Policy, Legislation and Carbon Commitments
Non-Wires Alternatives and Grid Optimization

Burns

- New York
- New Jersey
- Maine
- Massachusetts
- Washington DC
- California
- Connecticut
- Maryland

Regulatory Policy & Legislation – EV Mandates

Burns

- California
  - 50% of all trucks sold in the state to be zero-emissions by 2035
- New York City
  - 5,700 buses will be zero-emission electric by 2040
- Los Angeles
  - 2,300 buses to electric by 2030
- Chicago
  - 1800 bus fleet, 100% by 2040
- NJ Transit
  - 2000 bus fleet, 100% of new buses electric by 2032
- Seattle King County Metro
  - 2200 buses, 100% goal by 2040 at latest

Utility Carbon Commitments

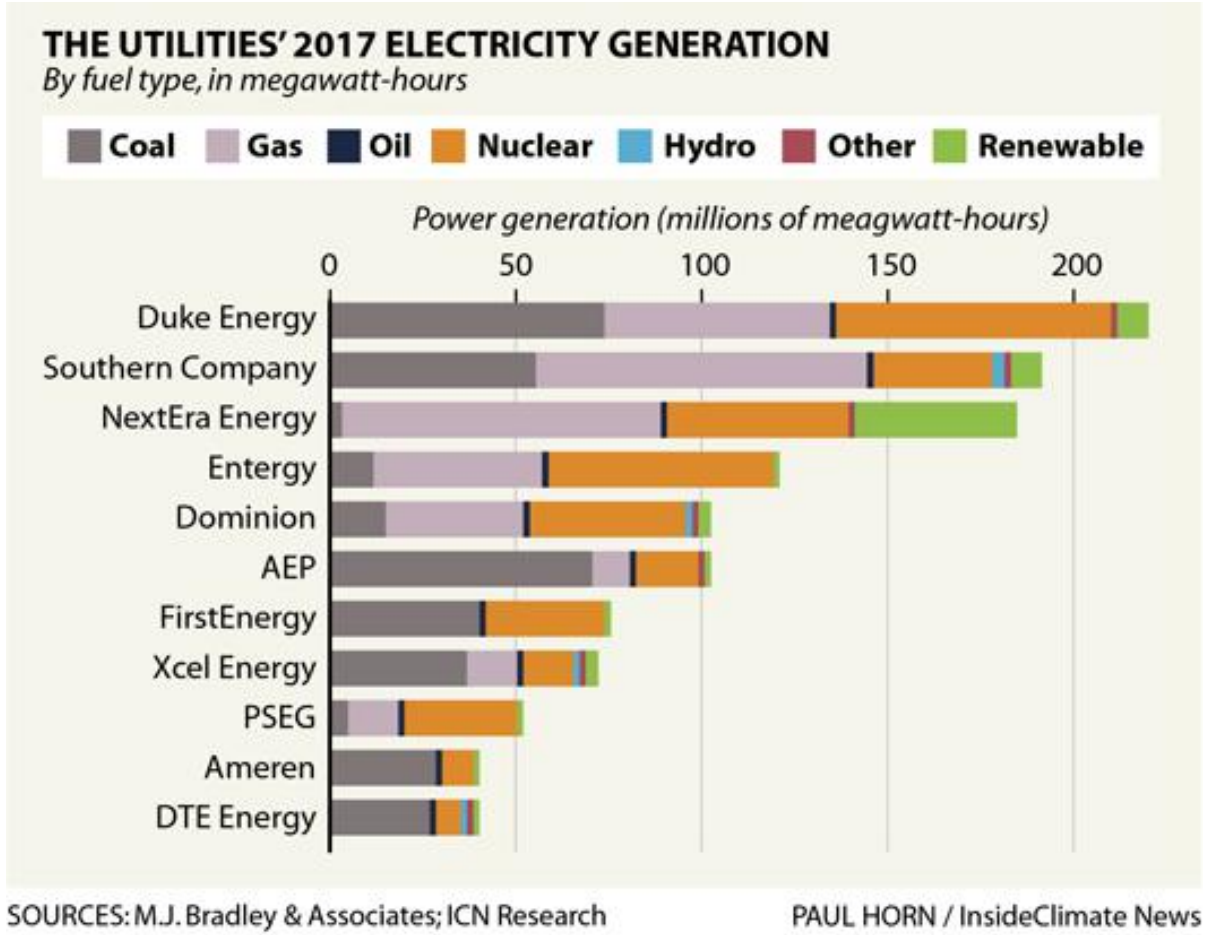
Burns

Utilities' Emissions-Cutting Plans

Most of the United States' largest utility holding companies have announced plans for deep cuts in their carbon emissions. Their electricity generation mix shows how far they have to go.

COMPANY	PLAN	PLAN RELEASE
Duke Energy	Net zero by 2050	Sept. 2019
Southern Company	"Low to no carbon" by 2050	April 2019
NextEra Energy	40 percent (from 2005 levels) by 2025	June 2019
Entergy	50 percent (from 2000 levels) by 2030	April 2019
Dominion	80 percent (from 2005 levels) by 2050	Dec. 2018
AEP	80 percent (from 2000 levels) by 2050	Feb. 2018
FirstEnergy	90 percent (from 2005 levels) by 2045	Dec. 2015
Xcel Energy	Net zero by 2050	Dec. 2018
PSEG	80 percent (from 2005 levels) by 2046 with "a vision" of net zero by 2050	July 2019
Ameren	80 percent (from 2005 levels) by 2050	Sept. 2017
DTE Energy	Net zero by 2050	Sept. 2019

Note: Two of the largest — Exelon and Berkshire Hathaway Energy — have not issued plans.



Other Enabling Systems and Technology

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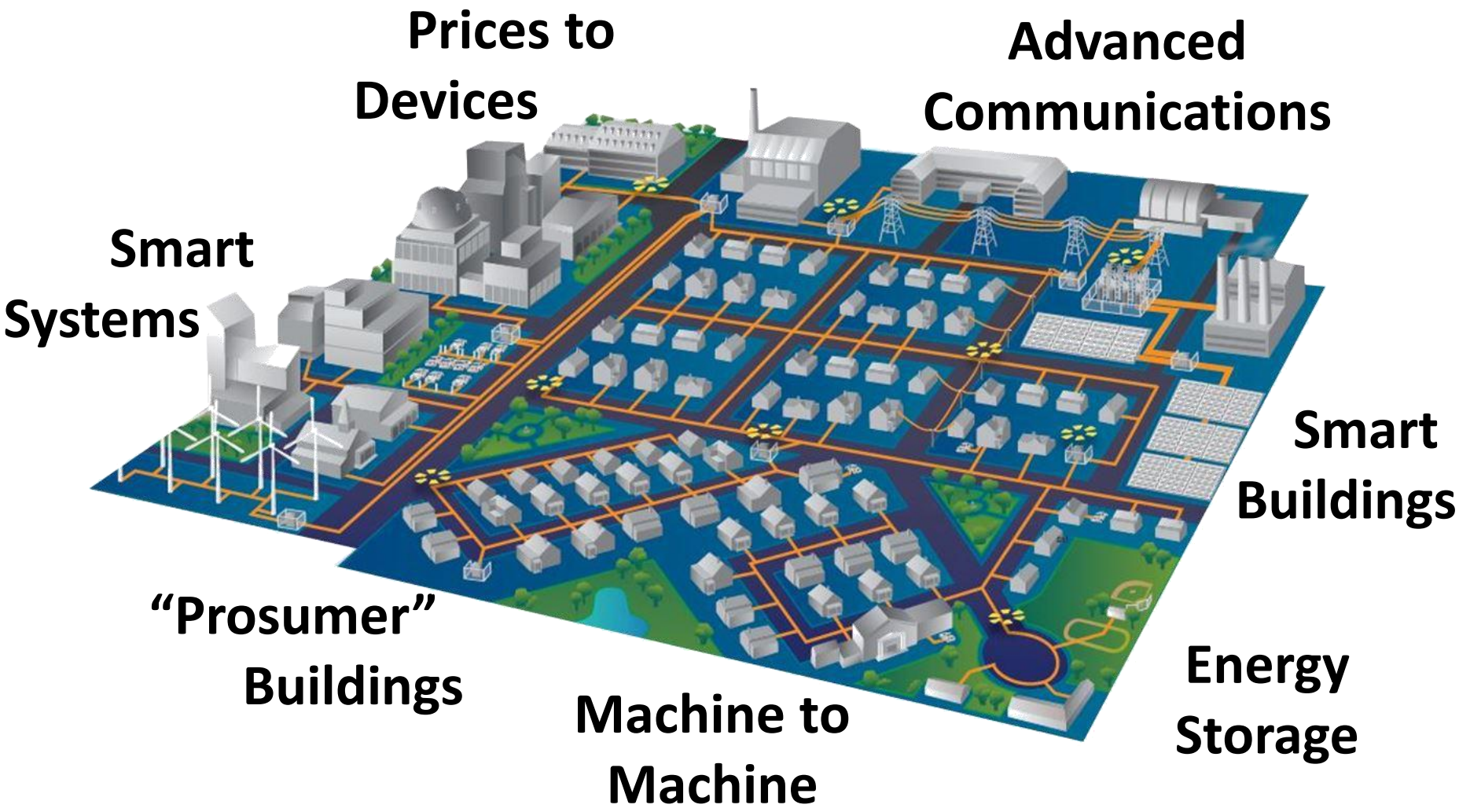
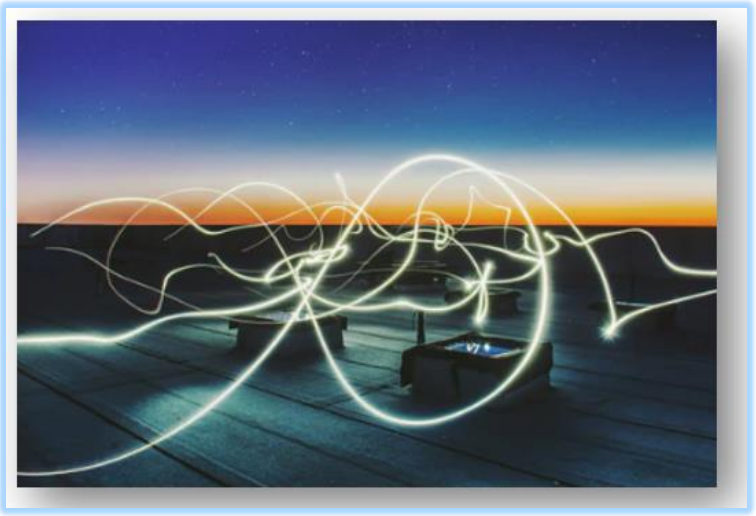


Microgrids – Optimized Resilience

Burns

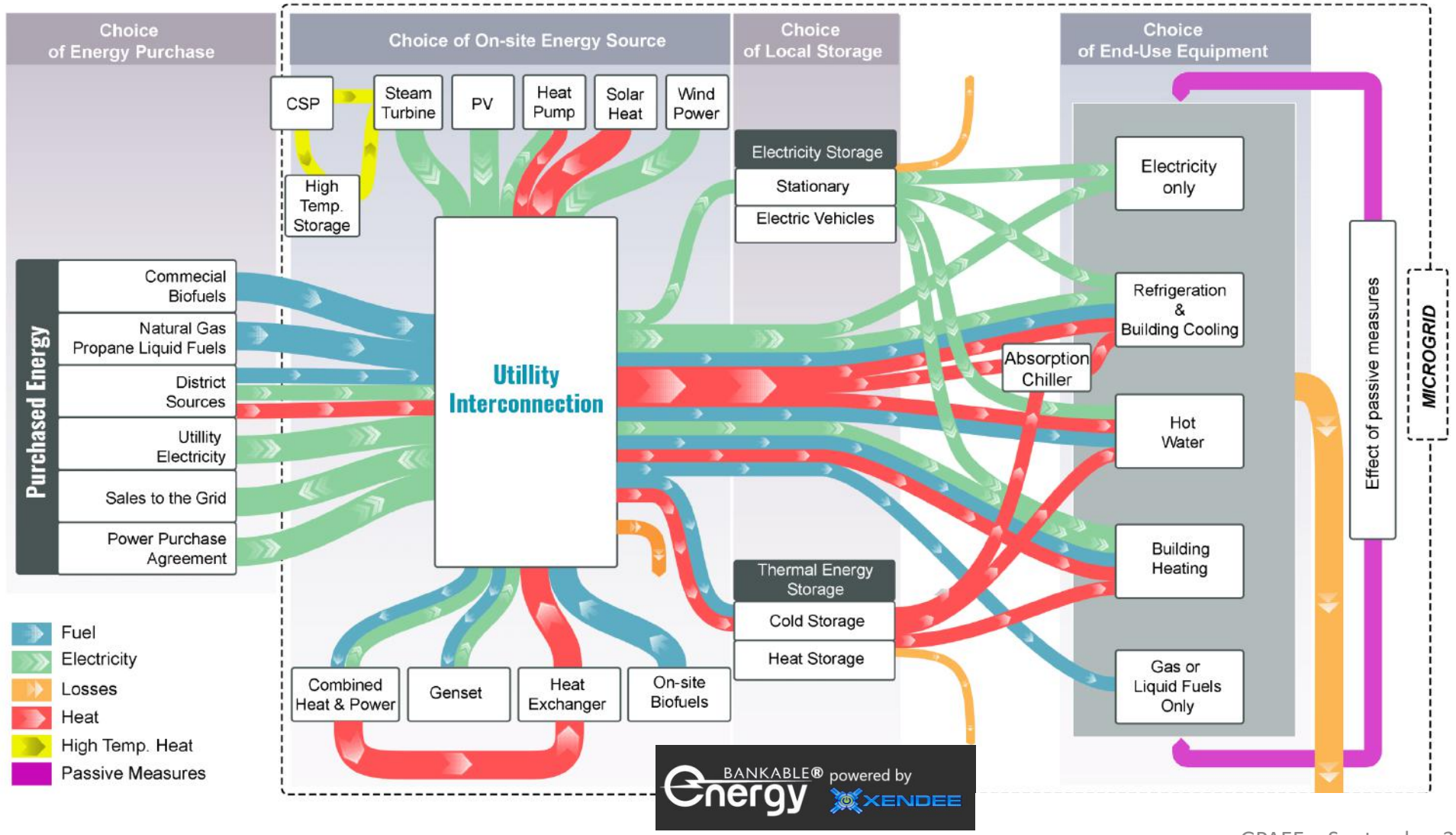
- Business as usual: deploy more diesel backup generation
- Alternative approach:
  - Microgrids as strategic platform for electrification/decarbonization
  - Monetize hybrid energy resources:
    - on-site generation
    - battery storage
    - smart buildings & systems
    - energy markets
  - Resilience with a payback?



Electrification & Resilience Modeling

Burns

- Bankable Energy's "XENDEE" modeling software



Driver – Enabling Technologies - Microgrids

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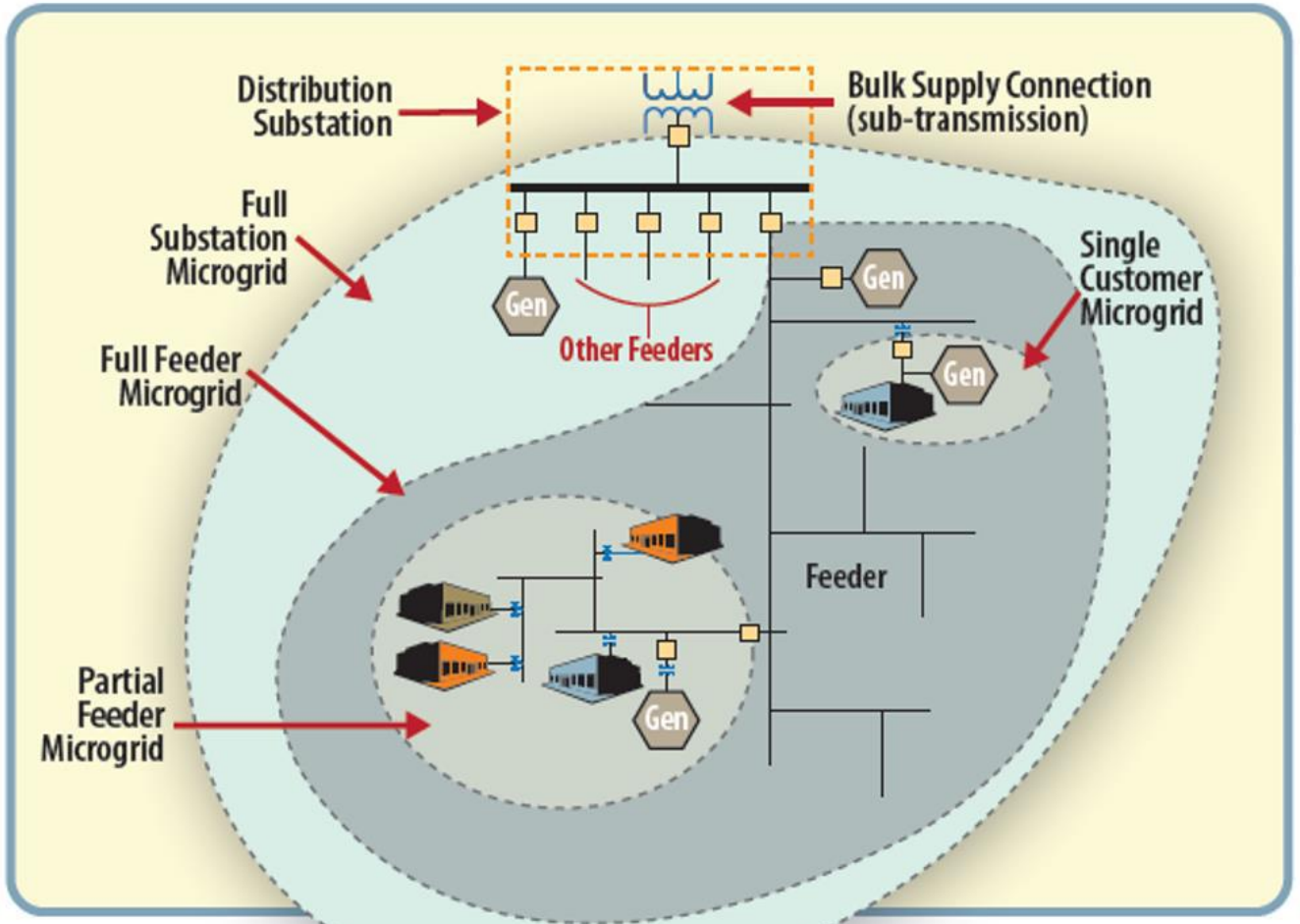
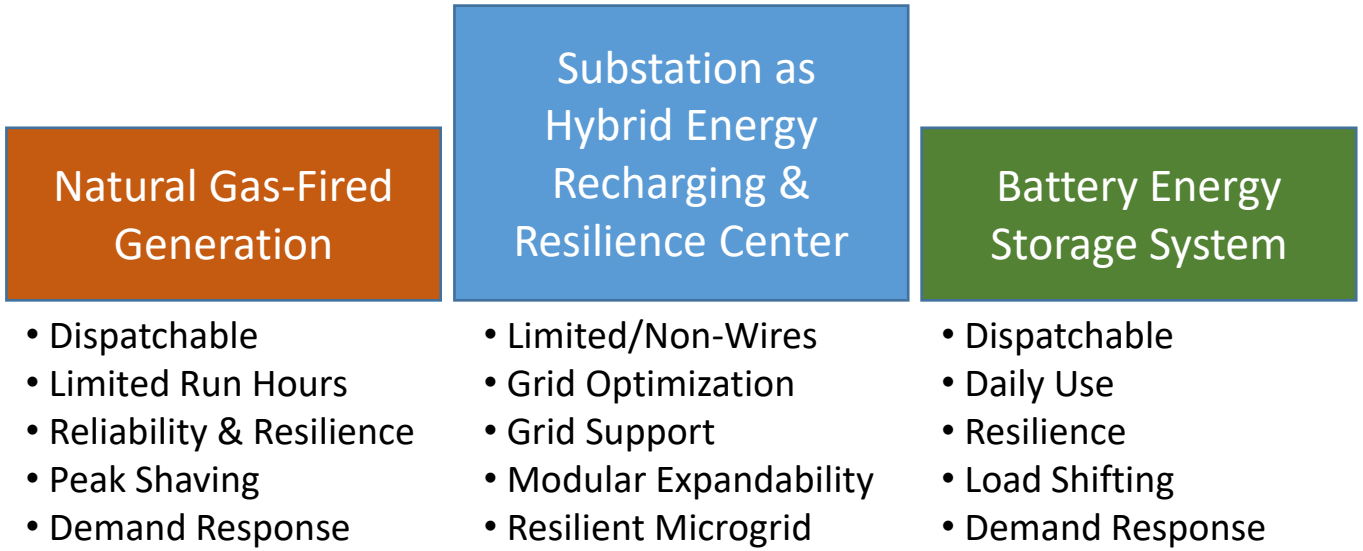


Source: Sandia National Labs Energy Surety Microgrid TM
http://energy.sandia.gov/?page_id=819

Hybrid Energy Resource Center

Burns

- Hybrid Energy Recharging & Resilience Center Concept
  - Addresses Power Reliability, Resilience, Quantity and Quality
  - Innovative Hybrid Ownership Models
  - Modular, Scalable, Future Proofed



Philadelphia Navy Yard – Hybrid Energy Resource Center PV+BESS+Natural Gas Engines

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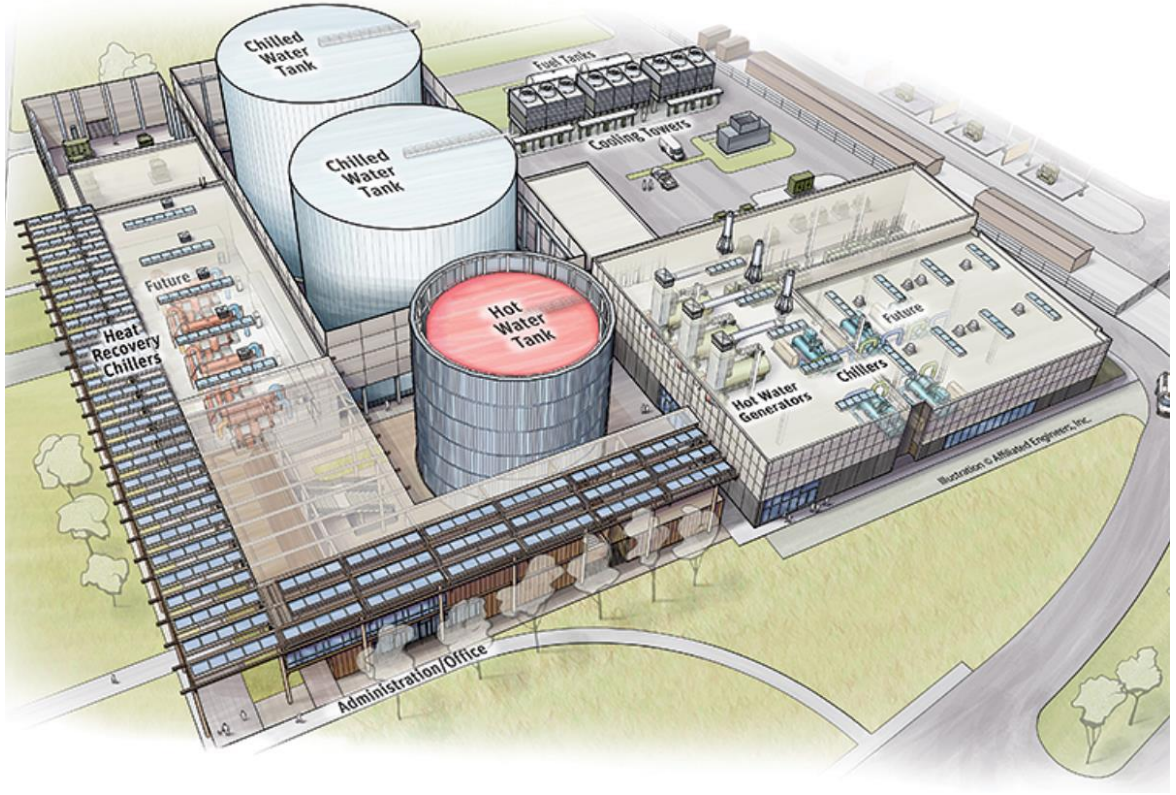
- BESS
  - Peak Capacity: 6.4MW
  - Energy Rating: 15MWH
  - Installed in 3 containers
  - Substation Connections: Two
  - Voltage: 13.2kV
  - Completion: Summer 2021
  - Contract Duration: 10 Years
  - Est. Capital Cost: $5 million
  - Delivered via Third-party / PPA
- Solar PV
  - 300kW – Community Solar
- Reciprocating Engines
  - 4 x 2MW Simple Cycle Natural Gas Recips

Hybrid Energy Resource Center – Campus Electrification

Burns

- Heat Recovery Chillers
- Hot Water Generators
- Thermal Storage
- Solar PV



"…reduced energy use by 50% and dropped its green-house gas emissions by 68%"

Beneficial Electrification: Where

Government, Campuses, Fleets & Airports

Government Electrification & Resilience Efforts

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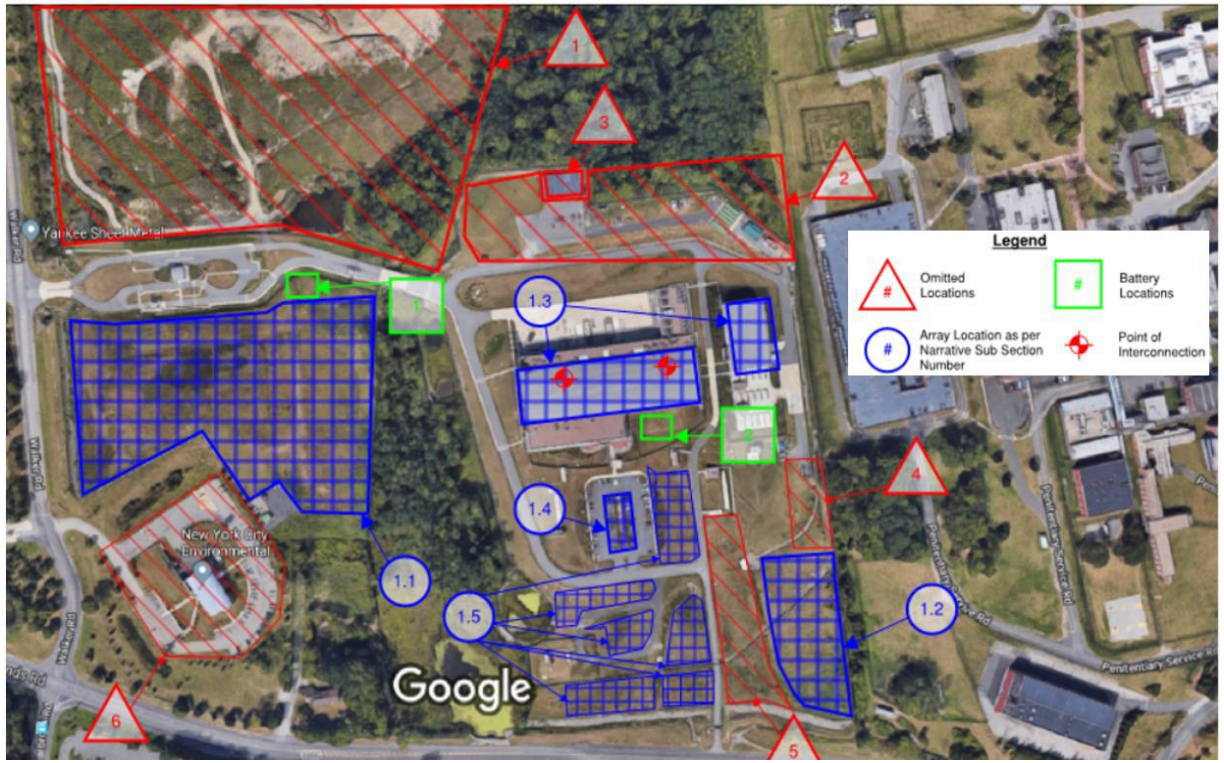
- Department of Defense (REPO)
- Infrastructure (Water/Wastewater, Rail Transit)
- Fleets
- Community Microgrids
  - New York Prize
  - NJ Town Center Microgrids
  - Connecticut
  - Massachusetts
- State-Owned Healthcare

Solar + Storage – New York Power Authority (NYPA)

Burns

- Five Water and Wastewater Treatment Plants (NYC Metro)
- Technical and Financial Feasibility
  - 17 Arrays (ground, roof, canopy)
  - 6.5MW
- Evaluated feeder capacity, and PV & storage sizing for maximum deployment
- Assessed interconnection
- Identified storage siting options
- Reviewed flood plain, structural and civil issues



Beneficial Electrification: Where

Government, ***Campuses***, *Fleets* & Airports

- Main considerations
  - Campuses want to wean off fossil fuels
  - Requires electric heating of buildings
  - Grid electricity is getting greener
  - Greener is getting more affordable
- Hard, but not impossible
- Long-term transition for most campuses
- Energy planning in disrupted world
- Major capital investment for infrastructure renewal

Campus Electrification

Implications for Electric Infrastructure

Photo by American Public Power Association

- Large scale electrification requires reinforcing, modernizing and increasing the capacity electric distribution equipment & grid
  - New switchgear, transformers, circuits, feeders etc.
- Perhaps 1-30MW additional supply
- Power reliability and resilience become important considerations
  - New risk posed by power outages
- Growth of air-conditioning
- Electric vehicle charging will add load on top of building heating

Beneficial Electrification: Where

Government, Campuses, ***Fleets*** & Airports

Electrifying Fleets

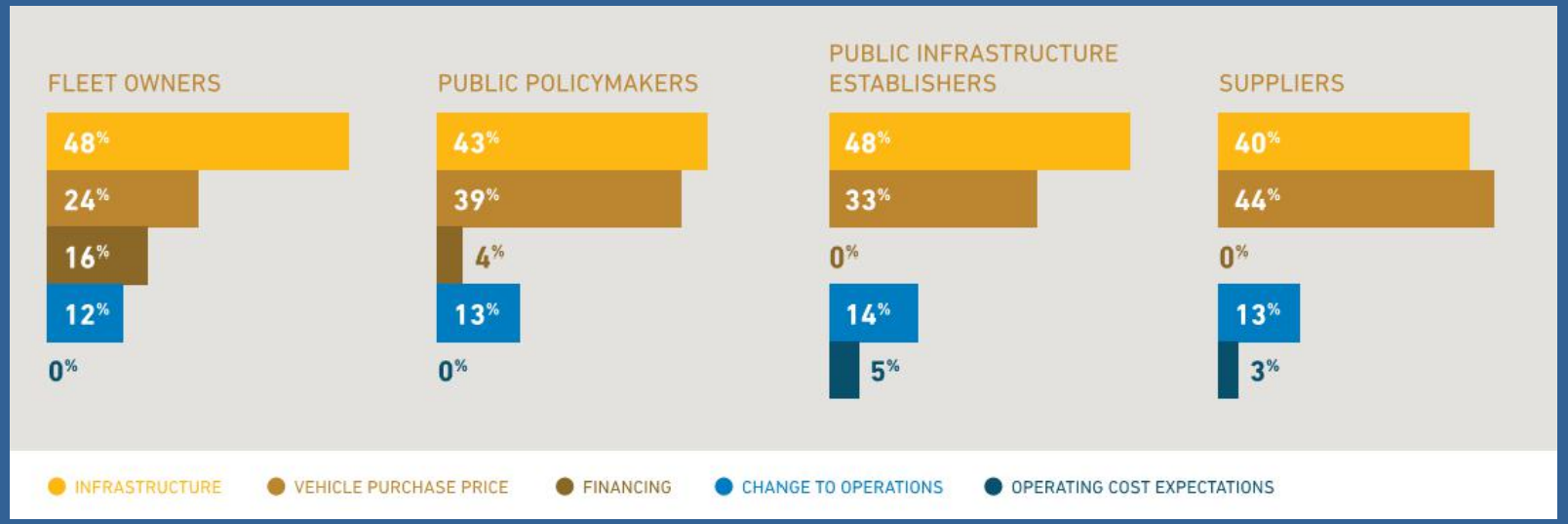
- Cities and states have a sense of urgency – transportation contributes approximately 28% of carbon emissions in US
- Technology improvements and corresponding cost declines foretells inevitable massive shift away from fossil fuels
- Fleet electrification requires reinforcing, modernizing and increasing electric distribution equipment & infrastructure

Electrifying Fleets

- Perhaps 1-20MW additional supply
- Phasing is challenging – need flexible, future proofed plan
- Power reliability and resilience become critical considerations
  - Buses don’t run if the power is out for very long
  - Can be very localized risk

Barriers to Fleet Electrification

- Infrastructure ranks as biggest barrier as viewed by Fleet Owners, Policy Makers, Infrastructure Establishers and Suppliers
- Operating Cost is of least concern



Research Report by Mortenson

Beneficial Electrification: Where

Government, Campuses, Fleets & ***Airports***

Airports and Resilient Microgrids

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Pittsburgh International Airport
CHP Resilience & Microgrid Project Support

- 3rd-Party On-site Power and a Resilient Microgrid
- RFI/RFQ Process to Identify Viable Solution Providers
- RFP for the construction of on-site energy systems

Denver International Airport
Energy Master Planning & Microgrid Feasibility

- Energy Master Plan
- Microgrid Feasibility Assessment & Prelim Design
- 50 MW of solar, 10 MW of battery storage, and 20 MW of natural gas engines

Atlanta Hartsfield-Jackson Airport
Microgrid Feasibility and Preliminary Design

- Assessing Energy Reliability and Resilience
- Distributed Energy & Generation
- Preliminary Assessment of a Full Airport Microgrid

Denver International

- "HERC" & Full Airport Microgrid
  - **Solar PV** = zero carbon energy
  - **Battery Storage** = maximize solar, grid services, load shifting and microgrid stability
  - **Fuel Cells** = low carbon, base-load generation
  - **Natural Gas Engines** = demand response, peak shaving, responsive & flexible assets for maximum resilience

Innovative Business Models

Burns

- Abundance of private capital
- Long-term investment opportunities
  - ESCO performance contracts
  - Power Purchase Agreements
  - Concession approach:
    - Ohio State getting $1b up front + $150m
    - 20- 50-year financing
- Leverage private expertise and OPM ("other people's money")
- Shift risk

Photo by Sharon McCutcheon

Innovative Business Models

Burns

- Players in this market:
  - AlphaStruxure
  - Compass Energy Platform
  - Amply
  - Engie
  - Clearway Energy

- Notable P3 Projects
  - Ohio State
  - JFK Terminal 1

Photo by Sharon McCutcheon

Conclusion and Q&A

Burns

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