

TECHNOLOGIES DRIVERS THAT ARE IMPACTING THE UTILITY BUSINESS MODEL

DISTRIBUTED ENERGY RESOURCES

JAN VRINS
GLOBAL ENERGY
PRACTICE LEAD



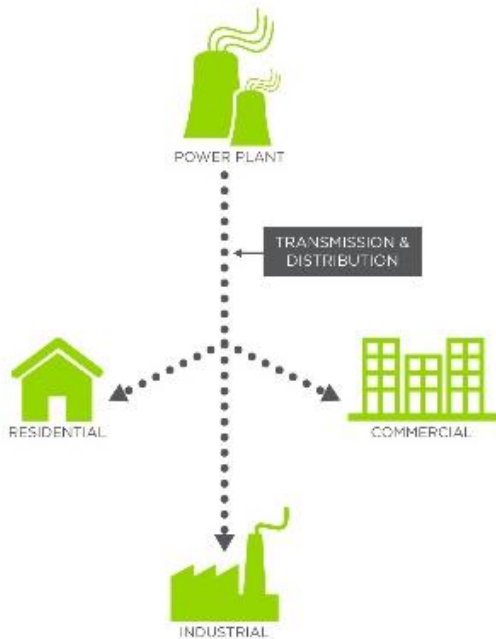
MIDWESTERN GOVERNORS ASSOCIATION
JUNE 15TH, 2016

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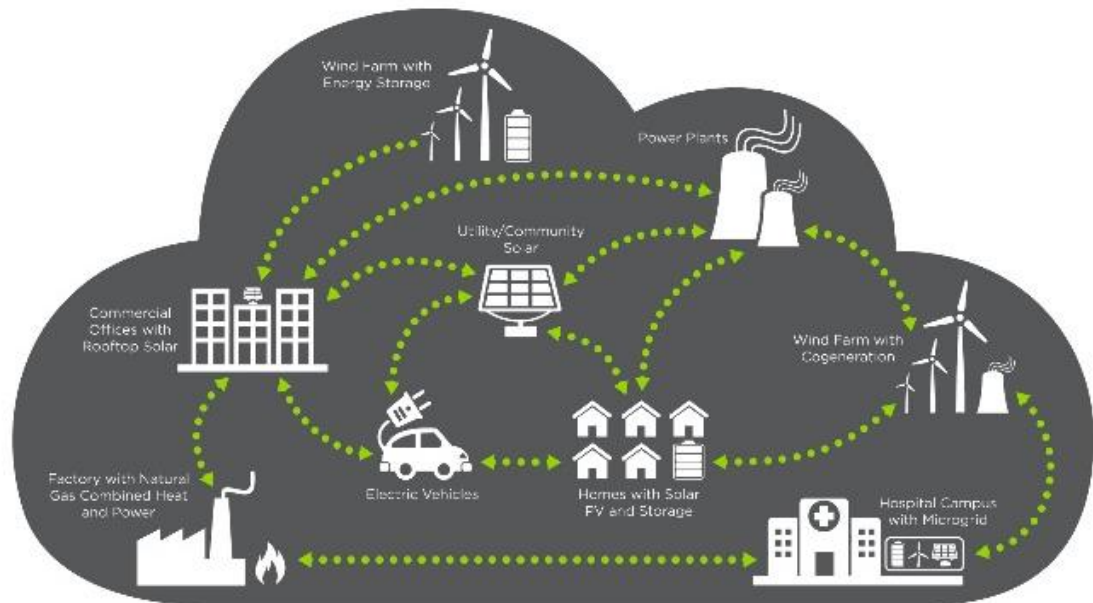
ENERGY INDUSTRY TRANSFORMATION

THE ENERGY CLOUD¹

TODAY - Traditional Power Grid
Central, One-Way Power System



EMERGING - The Energy Cloud
Distributed, Two-Way Power Flows

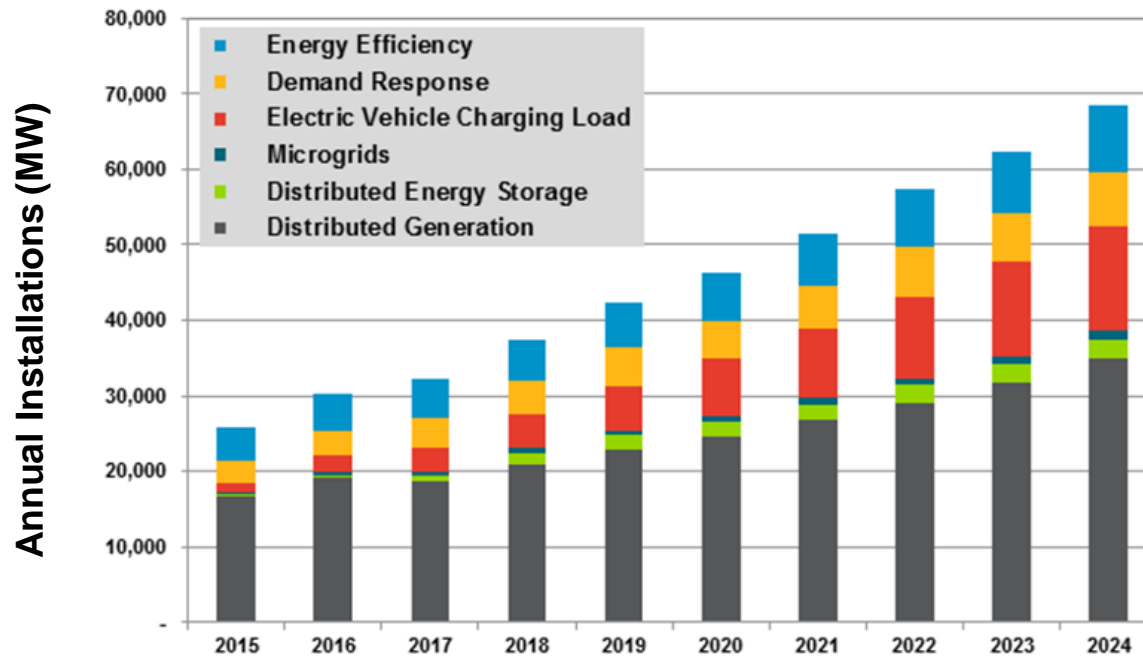


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¹ The Energy Cloud - Emerging Opportunities on the Decentralized Grid ([white paper](#))

ACROSS THE US, WE FORECAST STRONG DER PENETRATION GROWTH OVER THE NEXT DECADE

US DER Forecast*



*Source: Navigant Research *Distributed Energy Resources Global Forecast, Q4 2015*

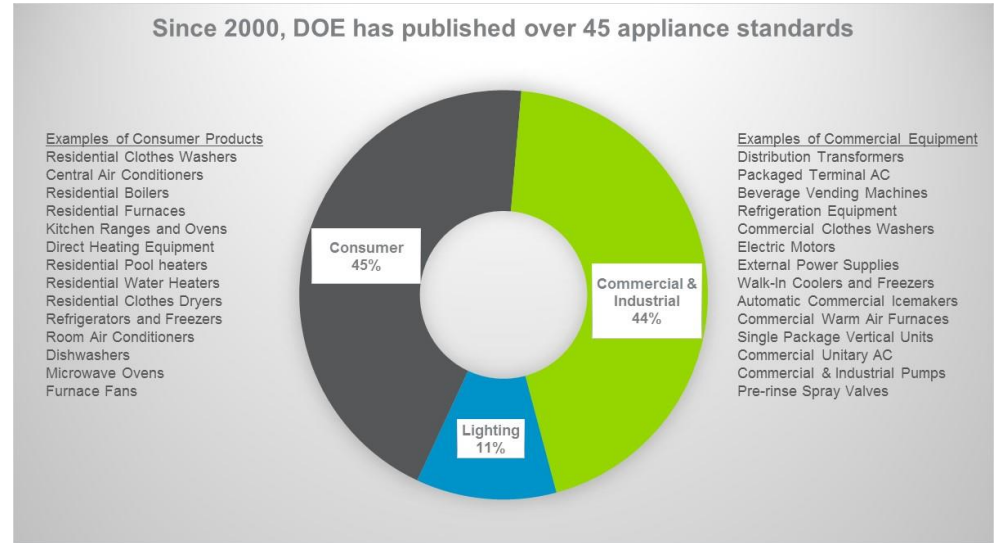
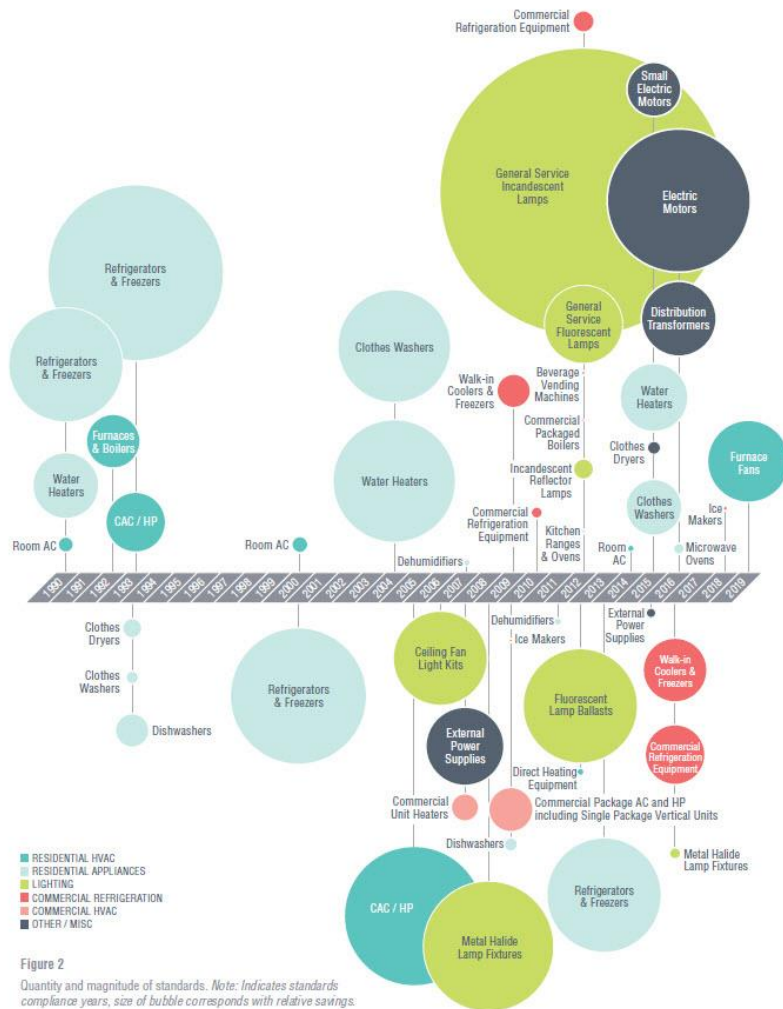
Drivers

- Declining System Costs
- Supporting Policies and Incentives
- New Business Models
- Reliability Concerns
- Product Availability
- Access to Financing

Observations

- This year, DER deployments will reach 30 GW in the US. According to EIA, central generation net capacity additions (new generation additions minus retirements) are estimated at 19.7 GW in 2016. This means that DER is already growing significantly faster than central generation.
- On a 5-year basis (2015-2019), DER in the US is growing almost 3 times faster than central generation (168 GW vs. 57 GW).

1. ENERGY EFFICIENCY : THE IMPACT OF DOE RULEMAKING ON LOAD GROWTH WILL BE SIGNIFICANT



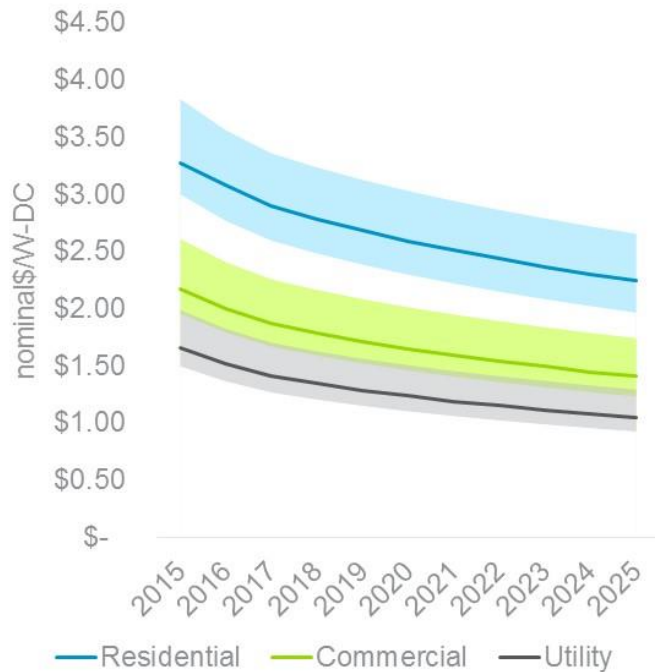
Energy Efficiency savings from DOE rules issued since 2000

- 100 quads of energy savings¹
- Equivalent to eliminating all U.S. residential energy consumption for 4 years

¹energy savings based on rules issued since 2000 over a period of 30 years after they were issued

2. DISTRIBUTED GENERATION: RESIDENTIAL AND COMMERCIAL SOLAR PV CONTINUES TO GROW

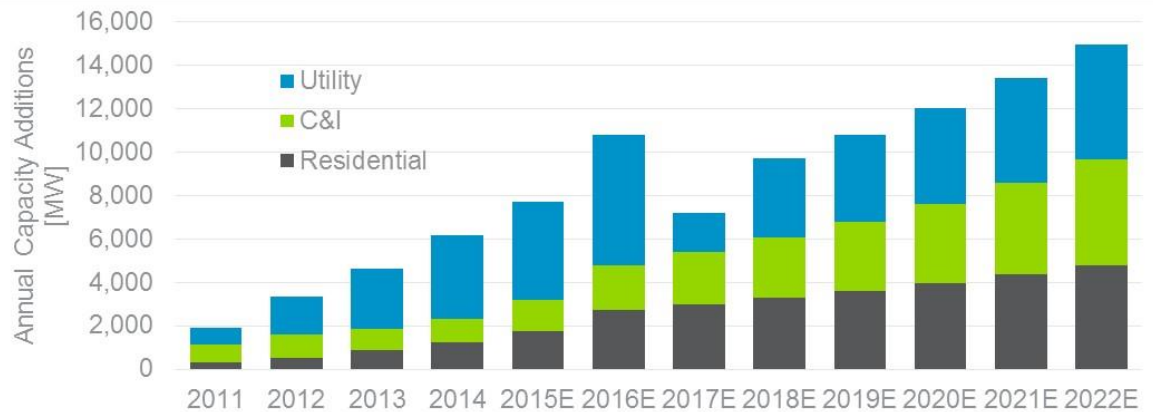
Solar PV Cost Reduction Scenarios



Source: Navigant, January 2016

- Solar PV Cost (installed) will continue to decline.
- The 5 year extension of the 30% federal investment tax credit (ITC) will drive continual market growth.
- Utility and Community scale solar most cost effective, but residential and commercial will continue to grow.

U.S. Annual Capacity Additions (MW)



(Source: Navigant, January 2016)

2. DISTRIBUTED GENERATIONIT IS HAPPENING NOW CUSTOMER CHOICE

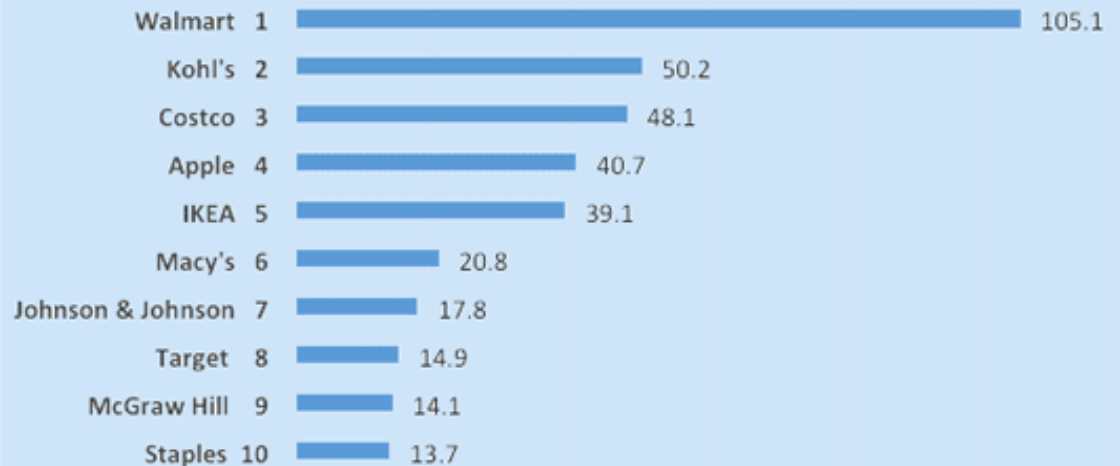


Whole Foods Market Inc. is embracing solar power. The Texas-based grocery chain has signed agreements with SolarCity and NRG Energy Inc. to install rooftop solar units at up to 100 stores and distribution centers in 9 states.



Fact: Since 2012, top U.S. companies have ramped up their solar capacity by more than 100 percent.

Top 10 Companies Installing Solar (MW)



3. DEMAND RESPONSE: TECHNOLOGY IS ENABLING DR RESOURCES TO RESPOND MORE LIKE GENERATION

Availability

- 24/7, year-round availability
- Dispatch-able dozens or hundreds of times per year

Speed of Response

- Spinning reserves (<10 min.)
- Frequency response/ Regulation services

Performance

- Ramp-up *and* down
- ISO-qualifying precision of delivered megawatts
- Real-time visibility from control room
- Improved customer experience

MARKET ANALYSIS

Authors
Stuart Schare is a Managing Director of Energy at Navigant Consulting Inc. Brett Feldman serves as Senior Research Analyst at Navigant Consulting.

POWER Engineering
the magazine of power generation

119 YEARS

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A New Era of Demand Response

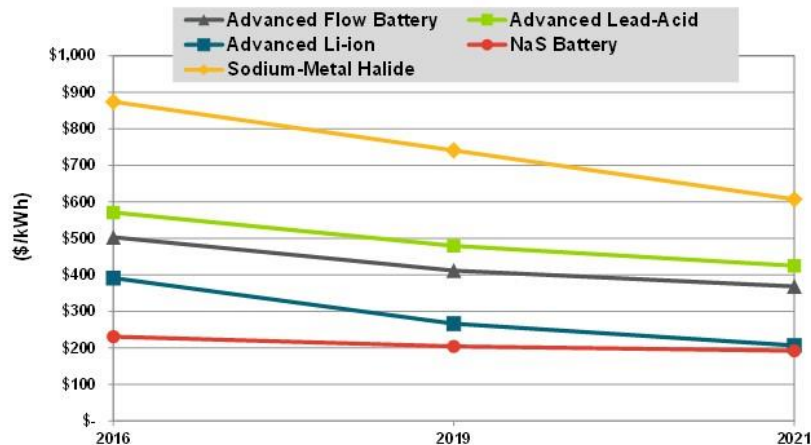
Blurring the Lines between Generation and Demand-Side Resources

BY STUART SCHARE AND BRETT FELDMAN

4. DISTRIBUTED STORAGE: COMMERCIAL & INDUSTRIAL

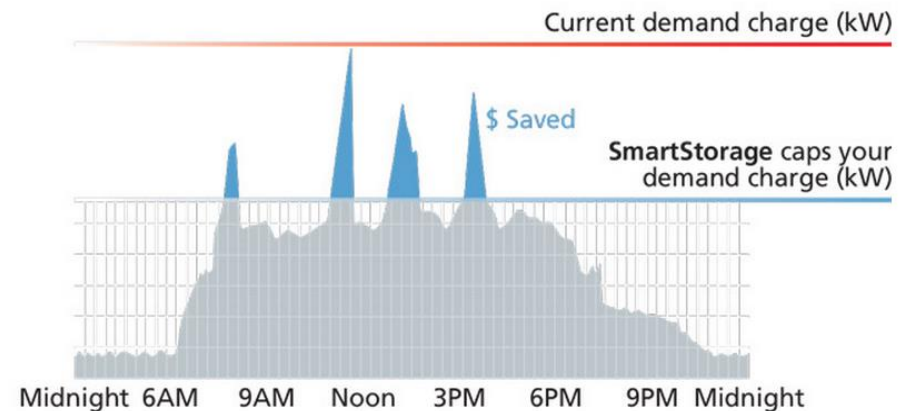
- Business case based around reduction of demand charges and energy cost mgmt.
- Vendors are now offering third party financing.
 - No money down installation
 - Shared savings model
 - Minimal risk or involvement required of customers
- Leading vendors include: Stem, Green Charge Networks, Coda Energy, Sharp

Battery Pack Forecasts, World Wide Pricing



Source: Navigant, January 2016

Reduction of Demand Charge

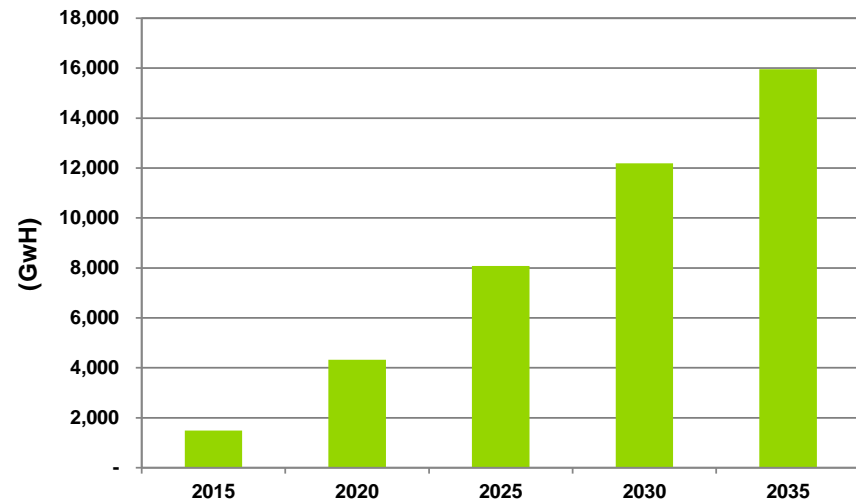


Source: Sharp

5. ELECTRIC VEHICLES : ALTHOUGH EARLY, ADOPTION WILL CONTINUE

- Electric Vehicles are large opportunity for utility load growth
- Workplace and home charging can be timed to grid requirements (peak load)
- Investments in charging infrastructure is beneficial for utilities
- EV adoption rates differs greatly by region and will depend on:
 - Regulations
 - Gasoline prices & battery costs
 - Range & recharge time
 - Charging infrastructure
 - Electric resale rules
 - Consumer preferences

Road Transportation Electricity Consumption, U.S. : 2015-2035



(Source: Navigant Research)

(Source: Navigant Research)

IMPLICATIONS FOR UTILITIES *STRATEGY AND BUSINESS MODELS*



Customer Choice and Technology drive regulatory changes, new entrants and business models.

Rate design must integrate DER to fairly compensate utilities and DER owners/operators for the value they provide

More fluid, incentive-oriented frameworks needed to support innovation and modernization and operations investments

Incumbent utilities can adapt to DER trends and incorporate into Integrated Resource Planning and Operations, and have to do so without disrupting current model (safe, reliable, affordable power)

IMPLICATIONS FOR UTILITIES

EXAMPLES OF CURRENT DER BUSINESS MODELS

Utility	DER	Program
Arizona Public Service	Solar PV	Pilot program where they own and rate base residential PV systems that are grid-tied; participating customers are on specific feeders and receive \$30/month for hosting the PV system.
Detroit Edison	Solar PV	Community solar program in which DTE owns and operates the PV systems and offers their customers subscriptions to the projects.
Exelon	Microgrids	Exelon is developing microgrids across its territory. ComEd is moving forward with 6 microgrids in Northern Illinois.
San Diego Gas and Electric	Energy Storage	Proposed a plan for customers – on targeted feeders - to own energy storage, but SDG&E has ability to dispatch systems during peak events.

IMPLICATIONS FOR UTILITIES

DER STRATEGY AND BUSINESS MODEL DECISIONS

There is broad variance among utilities planning for a transition to the Energy Cloud. They can select from a variety of DER business models for development and ownership.

Assess	Strategize	Pilot	Implement	Integrate (iDER)
Model		Selection Rationale		
1. Integrate, develop, and own DER		Utility has DER integration experience and has no difficulty with designing, integrating, and controlling with in-house resources.		
2. Develop and own DER		Utility has the in house capability to handle permitting, site selection, financing, and interconnection.		
3. Purchase a turnkey solution		Due to DER specific knowledge, it may be more economical to have a third party handle the project development and site preparation tasks.		
4. Contract services		Due to the regulatory environment, utility contracts services from 3 rd Parties.		

CONTACTS

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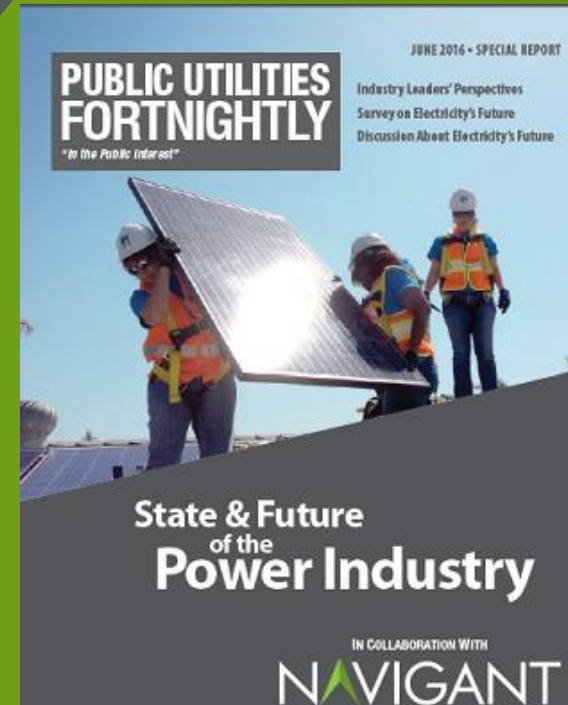
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Navigant Energy Practice

<http://www.navigant.com/industries/energy>

Navigant Research

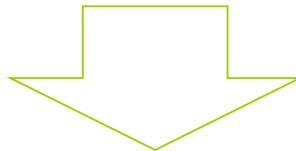
<http://www.navigantresearch.com/research>



MEGA TRENDS THAT DRIVE ENERGY INDUSTRY TRANSFORMATION

The following mega trends¹ underpin the industry transformation:

1. Greater customer choice and demand for more (sustainable) energy options.
2. Increased policies and regulations to reduce carbon emissions.
3. Shifting power-generating sources.
4. Search for shareholder value: new ventures and increased M&A.
5. Regionalization of Energy.
6. Merging of mega industries around growth opportunities.
7. Replacement of old infrastructure and transition toward an increasingly decentralized and smarter power grid architecture (the energy cloud - DER).



¹ Take Control of Your Future: [Megatrends](#) in the Utilities Industry

The Energy Industry transformation includes a wide range of strategic, operational, technological, commercial, environmental, and regulatory changes that are transforming the traditional strategies and business models.

UNDERSTANDING THE DISRUPTION - TIPPING POINTS

The potential for disruption can be assessed by observing five key dimensions affecting the utility business: 1) customers; 2) regulation and policy; 3) business models, 4) technology and 5) operations.

Dimension	CLEAN	DISTRIBUTED	INTELLIGENT
Customers	<ul style="list-style-type: none"> • Rise of Community Choice Aggregation (CCA) • Demand for solar/wind • Sustainability programs 	<ul style="list-style-type: none"> • Self-generation/storage • Security/reliability • Cost savings 	<ul style="list-style-type: none"> • Data access control • Transactive energy • Multiple communication channels
Regulation and Policy	<ul style="list-style-type: none"> • Renewable Portfolio Standards. • Clean Power Plan (EPA 111[d]) • Paris Accord 	<ul style="list-style-type: none"> • Self-generation incentives • Net Energy Metering • Feed-in Tariffs (FITs) 	<ul style="list-style-type: none"> • Smart grid infrastructure investment • Standardization
Business Models	<ul style="list-style-type: none"> • Utility-scale renewables • Green pricing • Community aggregation 	<ul style="list-style-type: none"> • DER investment • DSM/EE spend • Energy services 	<ul style="list-style-type: none"> • Network orchestrator • Variable rate design • Performance-based incentives
Technology	<ul style="list-style-type: none"> • Solar/wind adoption • Cost decline • Pairing: solar + storage 	<ul style="list-style-type: none"> • Distribution automation • AMI • DER 	<ul style="list-style-type: none"> • IT / data analytics • Sensors / telecommunications • Open vendor platforms
Operations	<ul style="list-style-type: none"> • Integrated G,T&D planning • Renewables integration • Load balancing 	<ul style="list-style-type: none"> • Distribution automation • Volt/VAR • Distr. VPP aggregation and dispatching 	<ul style="list-style-type: none"> • Customer engagement (e.g., BYOT) • Cybersecurity as a foundation • Data visualization & controls

IMPLICATIONS FOR UTILITIES

PATHS FORWARD ARE DIFFERENT

Maturity Level	Description
Level 5	Fully mature iDER Business (full set of value added DER products and services, significant revenue, fully integrated into IRP, Markets and Operations)
Level 4	Managed iDER at scale (full implementation, DER at scale, fully integrated into in IRP, Markets and Operations, limited value added DER products and services)
Level 3	Integrated pilot DER (piloting, DER at scale, initial integration of some DER in IRP, Markets and Operations)
Level 2	Fragmented DER at scale (planning, DER at scale, not integrated)
Level 1	Limited DER (Inactive, no significant DER at scale, not integrated)

Utility Grid Reform (going from maturity level 4 to 5)

One example utility, that operates in what could be characterized as a Grid Reform state i.e. aggressive renewable and distributed policies, has taken a decidedly Energy Cloud mindset. Anticipating a more networked grid, this utility has begun developing new services – integrating EV charging with demand response, offering bring your own device programs to customers, etc. – to serve an integrated, ‘plug-and-play’ electricity system that it believes will enhance the value of individual assets across the network. With the goal of shifting away from the traditional ratepayer model, this utility is taking steps to provide customers maximum flexibility and choice in how they use energy in order to maximize value across the network. To accomplish this, this utility has proactively built collaborative partnerships with technology providers.

Utility Business as Usual (going from maturity level 1 to 2)

One example utility in a state representative of BAU, stayed the course on investing in traditional generation assets and was reluctant to even pursue AMI investments. However, disappointing load growth and increased federal regulations targeting fossil generation of late, have begun undermining long-standing assumptions, causing management to re-evaluate priorities. This includes surveying DER opportunities and contemplating shifting investments toward distribution automation assets and services. The questions remain whether these efforts will be too little, too late, as their customers increasingly become targets for third-party providers of energy services.

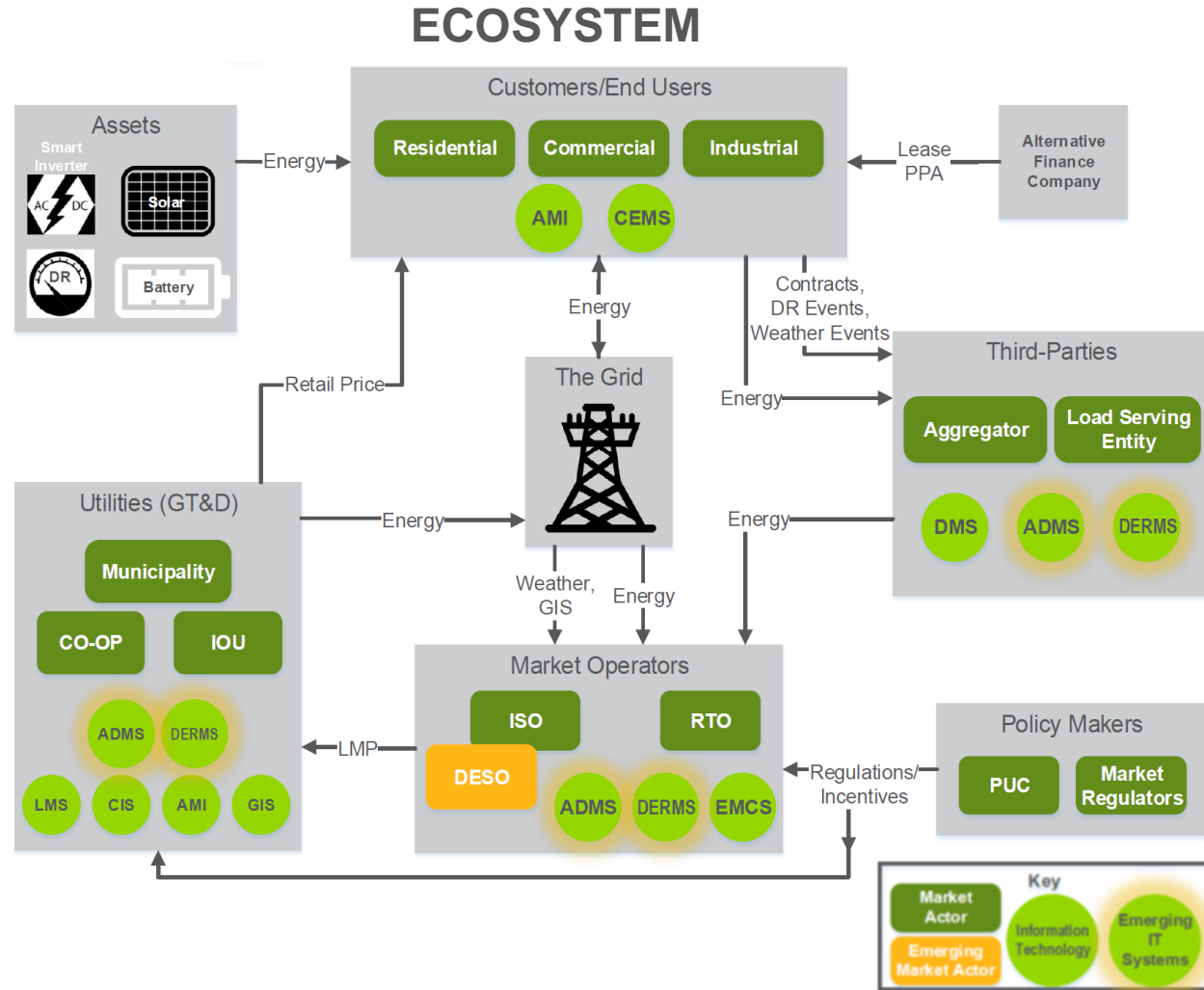
IMPLICATIONS FOR THE PARTICIPANTS

ECOSYSTEM WILL EVOLVE TO ACCOMMODATE DER PENETRATION.

- Basic power products for Residential and C&I
 - Safe
 - Reliable
 - Affordable
- Individualized Energy Products and Services
 - S/R/A
 - Clean
 - Distributed
 - Intelligent



- Regulation
- Governance
- Strategy
- Business models
- Processes/systems
- Standards





An Exelon Company

Utility of the Future

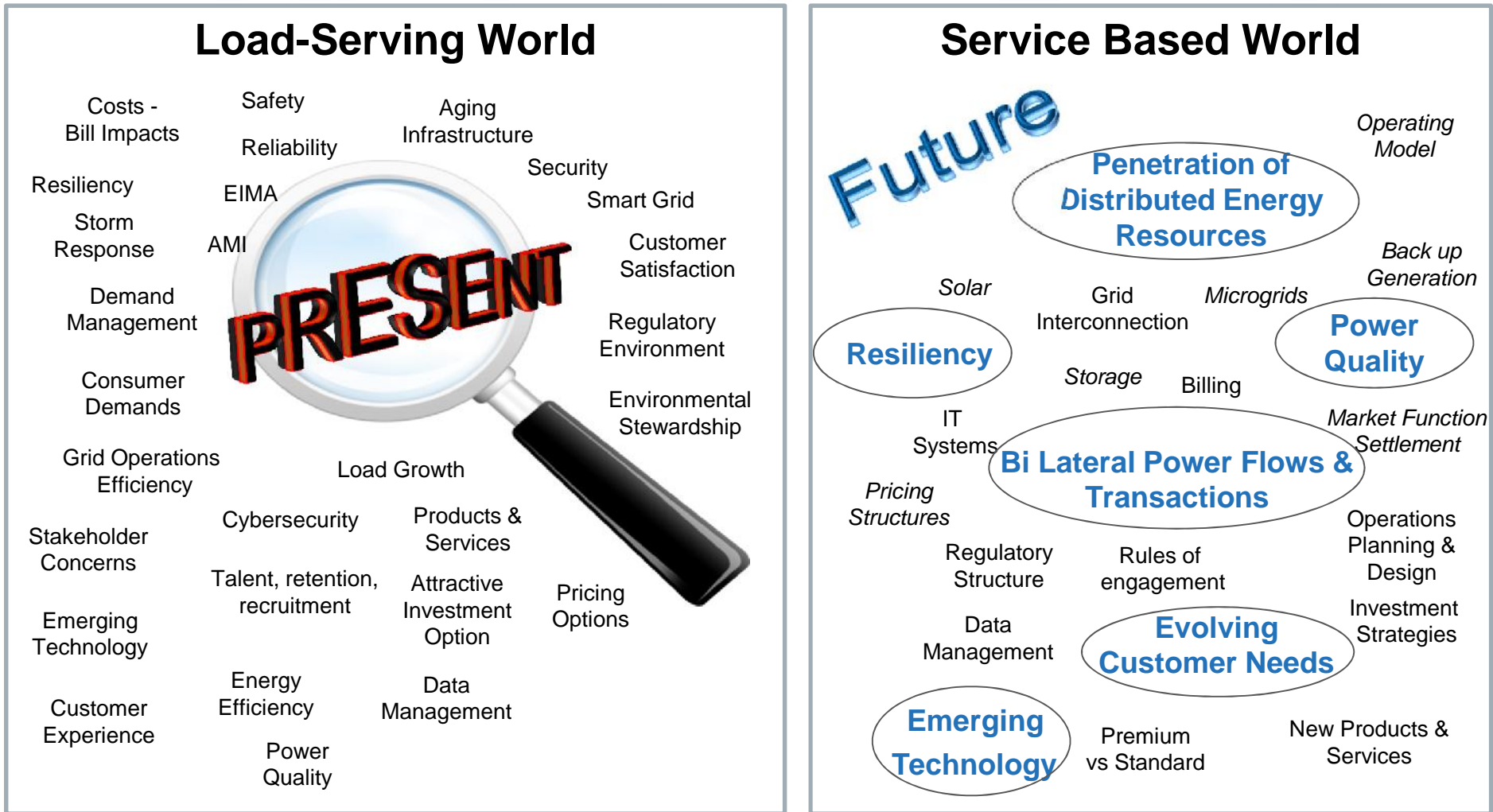
Manuel Avendaño, Ph.D.

Manager – Emerging Technology

Midwestern Governors Association

June 15, 2016

Electric Utility Industry Transforming Rapidly



Changes in the electric utility industry will require us to reevaluate our strategy for regulatory recovery, our business and operating models, and the way we interface with our customers.

ComEd's Customer Driven UoF Strategy

1 Target by customer type.

2

Focus offerings to customer wants and needs.

3

Align to and exceed expectations through supreme experience.

Residential Customers

- Budget Constrained Multi-Unit Renters
- Affluent Single Family Home Owners
- Energy Tech Enthusiasts
- Disengaged Customers

- Comfort and ease through integrated IT, lighting, HVAC, and smart appliance systems
- On-demand access to products and services
- Economically and environmentally friendly transportation options
- Increased disposable income

- Energy marketplace
- Peak time savings and DR programs
- Smart thermostats
- Small-scale storage for CEMI customers
- Public EV charging

C&I Customers

- 24 Hour Power Users
- Retail Big Box
- Small and Medium Businesses
- Critical Users
- Office Buildings and Complexes
- Energy Super Users
- Supersized Infrastructure

- Efficient and flexible operations
- Innovative tools and processes
- High product/service quality
- Digital capabilities to enhance business management and the user experience

- C&I portal
- Microgrids
- Premium power
- Next generation energy efficiency programs

Municipal Customers

- City of Chicago
- Forward Looking
- Cost Conscious

- Street lights, water, garbage disposal
- Police, fire and health emergency services
- Disaster mitigation and relief
- Fiscal responsibility
- Quality of life assurance to citizens

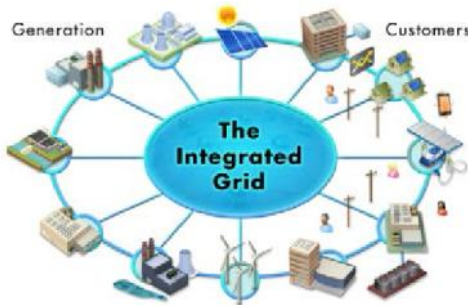
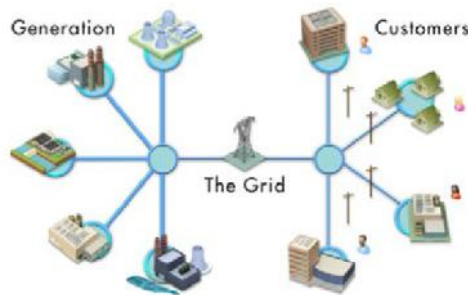
- Municipal portal
- Open data platform
- Smart streetlights
- Non-AMI metering



Transitioning From a One-Size-Fits-All System to Providing Customized Solutions

ComEd's role is evolving to meet the growing interest among customers in having more choice and personalized services.

Grid Operations



Guiding Principles

- 1 ComEd must adapt from the historical utility model by increasing investments to address aging grid infrastructure in a digital economy requires greater dependency on electricity by both businesses and individuals.
- 2 ComEd will continue to build, maintain, and operate the grid to provide reliability, security and resiliency at reasonable cost, while investing in foundational automation technologies to move from a smart grid to a “smart cities” concept – where efficiencies derived from the grid can accommodate new, cleaner technologies ranging from smart streetlights to distributed generation.
- 3 ComEd will leverage its core competencies and expertise to play a role in owning, operating, and managing an integrated grid in a new world where choices for central generation and local distributed generation expand to better serve the customer.

Customer Lens

Load-Serving World



Service-Based World



The Three Networks of the Utility of the Future

5

Increasing integration of the three networks to achieve holistic offerings that do the job for our customers



ComEd's electricity delivery network of 105,000 miles of T&D power lines and over 1,300 substations.

- *Today*, ComEd's physical network is the legacy of traditional T&D infrastructure that is designed, constructed, and serviced to meet the present and future needs of our 3.8 million customers.
- *Tomorrow*, ComEd's physical network will be enhanced by innovative grid edge technologies (microgrids, battery storage, smart infrastructure) to optimize our existing assets while unlocking grid flexibility (e.g. multi-directional power flow) and new value streams for our customers.

Physical Network



ComEd's communication network layered between the social and physical networks enables the transmission of data and information.

- *Today*, ComEd's communication network is comprised of systems to support core utility functions (customer billing and grid operations).
- *Tomorrow*, ComEd's communication network will evolve to include the collection and transmission of data to optimize grid planning and operations. This enables non-traditional service offerings that enhance security, resiliency and liveability of our communities and facilitate drawing insights from business intelligence and data analytics and new service offerings to our customers.

Digital Network



ComEd's direct relationship with every resident, business, and municipality in northern Illinois, as well as residents interacting with each other.

- *Today*, ComEd's social interactions are comprised of everyday transactions such as reading meters, providing customer service and billing.
- *Tomorrow*, ComEd's social interactions will be guided by personalized information and insights, as well as customers providing services or information that can be used by the broader community.

Social Network

Next Generation Energy Plan

The Next Generation Energy Plan (NGEP) is a comprehensive energy solution that will drive Illinois' clean energy future while saving and creating jobs and strengthening the state's economy and infrastructure. The plan doubles energy efficiency, jumpstarts solar energy in Illinois, provides \$1B in low-income assistance, and secures the future of the state's nuclear plants.



Nearly double energy efficiency programs to create **\$4.1 billion in energy savings**, or the equivalent of taking **18 million cars off the road**.



Jumpstart solar energy in Illinois with rebates and more than **\$140 million per year** in new funding for solar development.



Provide **\$1 billion** of funding for low-income assistance, mostly through energy efficiency.

<p>CREATES \$4.1 BILLION IN ENERGY SAVINGS. THE EQUIVALENT OF TAKING 18 MILLION CARS OFF THE ROAD</p>	<p>SUPPORTS \$1 BILLION IN FUNDING FOR LOW-INCOME COMMUNITIES</p>
<p>STRENGTHENS ILLINOIS' NATIONAL CLEAN ENERGY LEADERSHIP BY CREATING AN INNOVATIVE ZERO EMISSION STANDARD</p>	<p>SAVES AND CREATES THOUSANDS OF CLEAN ENERGY JOBS</p>



Introduce a **Zero Emission Standard**, keeping the state's at-risk, zero-carbon nuclear facilities operating, saving 4,200 jobs, preventing large increases in electric rates, preserving over \$1.2 billion in economic activity annually, and preventing a dramatic increase in carbon emissions.



Reduce the fixed customer charge for energy delivery by 50% and create equitable rates, **giving customers more control over their bills**.



Strengthen and expand the **Renewable Portfolio Standard** to provide stable, predictable funding for renewable development.



Create **thousands of new clean energy jobs** through energy efficiency programs, energy innovation, and renewable energy.



Enhance the **reliability and security** of the power grid.

No Regret Investments to Build Utility of the Future

Smart Cities



Smart Cities Pilots

Analyze and pilot initiatives to further the development of smart city infrastructure for advanced monitoring, control and planning

Advanced Grid Infrastructure



Microgrids

Analyze and pilot initiatives to further the development of microgrid technologies and integration with the larger distribution system.



Energy Storage

Investigate and pilot potential of energy storage for T&D deferral, reliability, renewables integration, and behind-the-meter applications



Superconductor

Deployment plan of high temperature superconductor technology to build a superconducting cable system that will strengthen Chicago's electric grid, providing a new level of reliability and add unparalleled redundancy to the heart of the financial and business district of Chicago.



Power Quality & Premium Power

Development of an offering targeted to C&I customers to reduce risk of outages, ensure consistency of power delivery, and diversify the suite of products, services and information available to optimize energy consumption of C&I end-users

BI/DA Infrastructure



Asset Intelligence & Data Monitoring

Deployment of modern monitoring, protection and switching devices and voltage regulation/control assets



Deployment of OT/IT Infrastructure

Cost-effective identification and replacement of deteriorated or outdated OT/IT infrastructure, including control center infrastructure, full DMS/OMS functionality, communications systems, IT and enterprise systems



Grid Analytics

Procurement, customization, development, implementation, review, and update of several grid analytics applications and tools to be used in T&D infrastructure planning, operations, and engineering analysis, including applications pertaining to DER management, Distribution State Estimation, Phase Balancing and bidirectional power flow analysis

- Intelligent substations
- Underground cable replacement
- Pole replacement
- Advanced Metering Infrastructure
- Manhole refurbishments
- Storm hardening
- Wood pole remediation
- Distribution Automation

Foundational Initiatives



GRIP Program Expansion

Further investment in the three categories of the existing GRIP program: RTEP/Supplemental Transmission, Transmission Improvements and Distribution Improvements



Post EIMA Initiatives

Continue infrastructure, training and smart grid improvements of the EIMA program while preparing ComEd's grid for emergent challenges such as higher reliability and resiliency expectations



People

Develop and acquire big data analytical skills, market function and design skills. Maintenance and planning programs, EP/OCC Ops



Processes

Enhance ComEd's existing processes by integrating existing and new IT systems, and leveraging data from OT/IT infrastructures to address data integrity issues

Analytics & Insights	
	<p>Creating high performance and modular IT architecture and solutions that will bear extensive multi-directional data traffic and computing capability, while maximizing easy integration into both existing and more swiftly evolving new platforms.</p> <ul style="list-style-type: none"> Analytics Platform Residential Meter Usage Data (RMUD) Access Channel Analytics Use Case
People Strategy	
	<p>Identifying required skill sets and needs of the "employees of the future" to develop, train, and tap full value of existing talent, and to strategically attract and acquire the full range of diverse talents necessary to bring value to customers of future.</p> <ul style="list-style-type: none"> Customer Operations People Strategy <ul style="list-style-type: none"> Recruiting and Selection On-boarding Employee Engagement <ul style="list-style-type: none"> Performance Management and Development Succession Planning
IT Systems	
	<p>Creating high performance and modular IT architecture and solutions that will bear extensive multi-directional data traffic and computing capability, while maximizing easy integration into both existing and more swiftly evolving new platforms.</p> <ul style="list-style-type: none"> CIS North Star Project Interval Data Services / External Data Exchanges MDM Phasing Project AMI EDE Roadmap CIS Pluggable Architecture Data Abstraction Layer
Choice and Control	
	<p>Fundamentally pivoting from a "one-size-fits-all" service strategy to a suite of offerings that offer customers analytics/insight-driven choices, and selections that, in turn, genuinely empower the customer to easily take actions that are meaningful to him/her in the channel of choice.</p> <ul style="list-style-type: none"> Bidgely Pilot Smart Meter Connected Devices Pilot Nest and Xfinity Thermostat Pilots Residential Real Time Pricing (RRTP) Program Peak Time Savings (PTS) Program Energy Management and Efficiency Programs Pre-Payment Pilot Study Energy Strategy for Businesses Pilot Retrocommissioning Opportunity Expansion LED Streetlight Incentive Program Commercial & Industrial Web Portal (Managed Accounts)
Personalization	
	<p>Customized, personal, and data driven offerings and services that are based on customer preferences and insights, and are directly relevant to the customer.</p> <ul style="list-style-type: none"> My Account Usage Integration Project Preference Center Build-out BTM Marketplace Beta Appointment Scheduling and Order Status Tool Channel Analytics Use Case Mobile App Redesign Energy Concierge Service Program Unique Building Energy Efficiency Pilot Optimize Your Operations for Businesses
Transaction Freedom	
	<p>Acknowledging, enabling, and extending faster, more barrier-free, and easier customer-to-utility, customer-to-customer, customer-to-group, and other newly developing bilateral and multi-party transactions and interactions involving energy.</p> <ul style="list-style-type: none"> Green Button Connect My Data C&I and Residential Automate POG-Net Metering Billing

Initiative Status

■ = In-flight

■ = In planning or discussion

Microgrid Pilot Program

The goal of the pilot program is to protect critical infrastructure required to operate in the event of catastrophic incident that impacts the electric grid.

Resiliency, Security & Safety:

- Improved physical and cyber security
- Increased resiliency through localized system control and operations

Reliability & Power Quality:

- Reduced interruptions
- Shorter outages
- Enhanced power quality

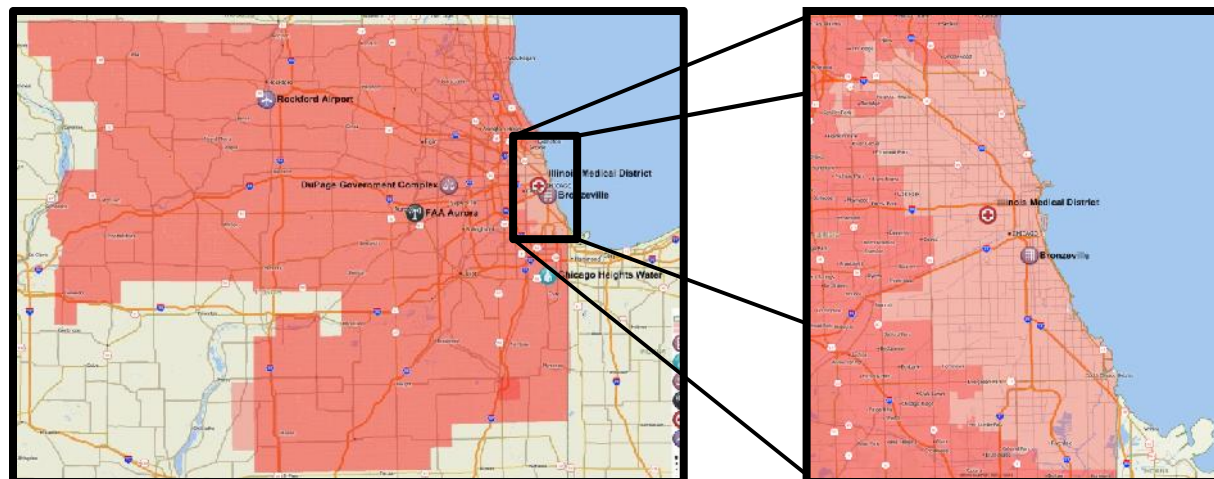


Economic:

- Greater system efficiency
- Deferred or avoided capacity investments
- Create new jobs

Environmental:

- Reduced CO2 and other harmful emissions
- Increases sustainable generation resources
- Reduced system losses



Privileged and confidential – prepared at the request of counsel in anticipation of litigation

Bronzeville – Testbed for Community of Future

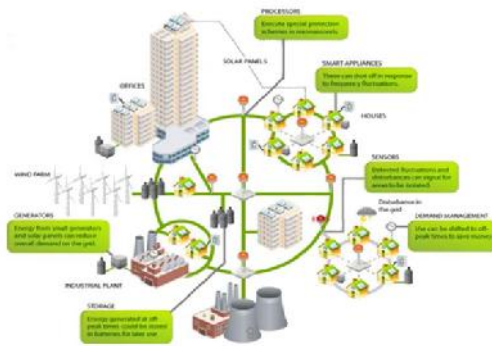
An ideal candidate to serve as an innovation test bed to align emerging energy products and services to mounting customer expectations, as well as a pioneer ComEd's initiative to effectively deploy and manage DERs in a way that optimizes rather than constrains the grid and maximizes value to customers and shareholders.

Evolution of Bronzeville to Integrated Community of the Future

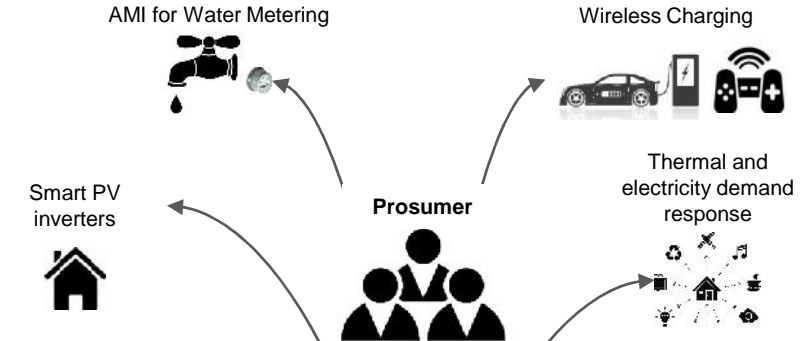
Dense urban community with distribution system built with legacy equipment



Resilient and reliable microgrid



Community of the future led by customer insights and optimized with advanced grid technologies/DERs



Microgrid Controller: In 2014, ComEd was awarded with the Department of Energy grant to develop a microgrid master controller with applications to the Bronzeville Community Microgrid. The master controller will be capable of multiple microgrids together as microgrid clusters.

The customers of Bronzeville are...

- 10 MW of load **
- \$33,000 median household income
- Diverse Community
- 62,000 utility customers of which >90% are residential
- Home to the Illinois Institute of Technology; Department of Homeland Security; Chicago Police Department Headquarters
- Diverse population of customers and load profiles



- Technologies/offerings to be tested:**
- Smart inverters
 - Energy storage
 - Wireless charging
 - Transactive Energy
 - Smart EV Charging
 - Smart street lighting
 - AMI for water metering
 - Service package
 - Smart thermostat control
 - Select low-income energy management devices and education
 - EV to thermostat pairing

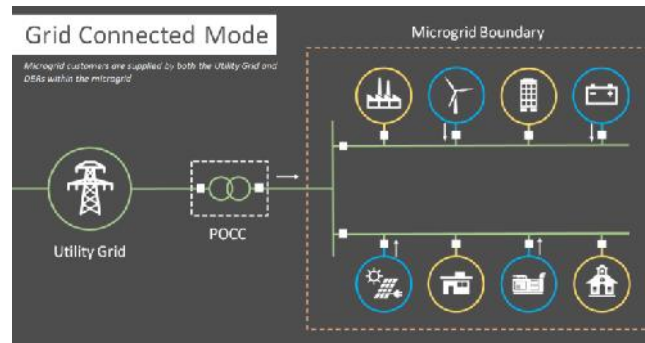
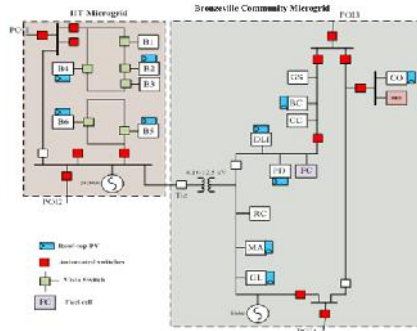
- Developed Data Analytics Tools**
- Resiliency metrics
 - Microgrid optimization tool - Secured a patent
 - Hosting capacity - On patent process
 - Distribution State Estimation

ComEd's Enables Ecosystem with Open Data, Analytics & Customer Management Platforms



Microgrid Controller

The DOE awarded approximately \$1.2 million to ComEd and its partners to develop and test a commercial-grade microgrid controller capable of managing two or more clustered microgrids.



SHINES/MISST

The DOE awarded \$4 M to ComEd to utilize smart inverters for solar PV and battery storage systems. Proposed MISST project will deploy high power solar PV and a high-power Battery Energy Storage System (BESS) in the Bronzeville Community Microgrid (BCM).



- Further develop and refine Utility of the Future Business and Operating model
- Identify and pursue most appropriate Legislative and Regulatory pathway to enable U of F strategy and preserves optionality
- Leverage learnings from existing and future customer and grid operations partnerships, pilots and initiatives
- Continue monitoring U.S. legislative and Regulatory proceedings, emerging technologies and consumer trends