Siemens Digital Grid Leadership Opening Presentation

Farel Becker Director of Digital Grid Marketing

Tuesday, April 30, 2018

Digital Grid Customer Summit Safety Moment Announcement

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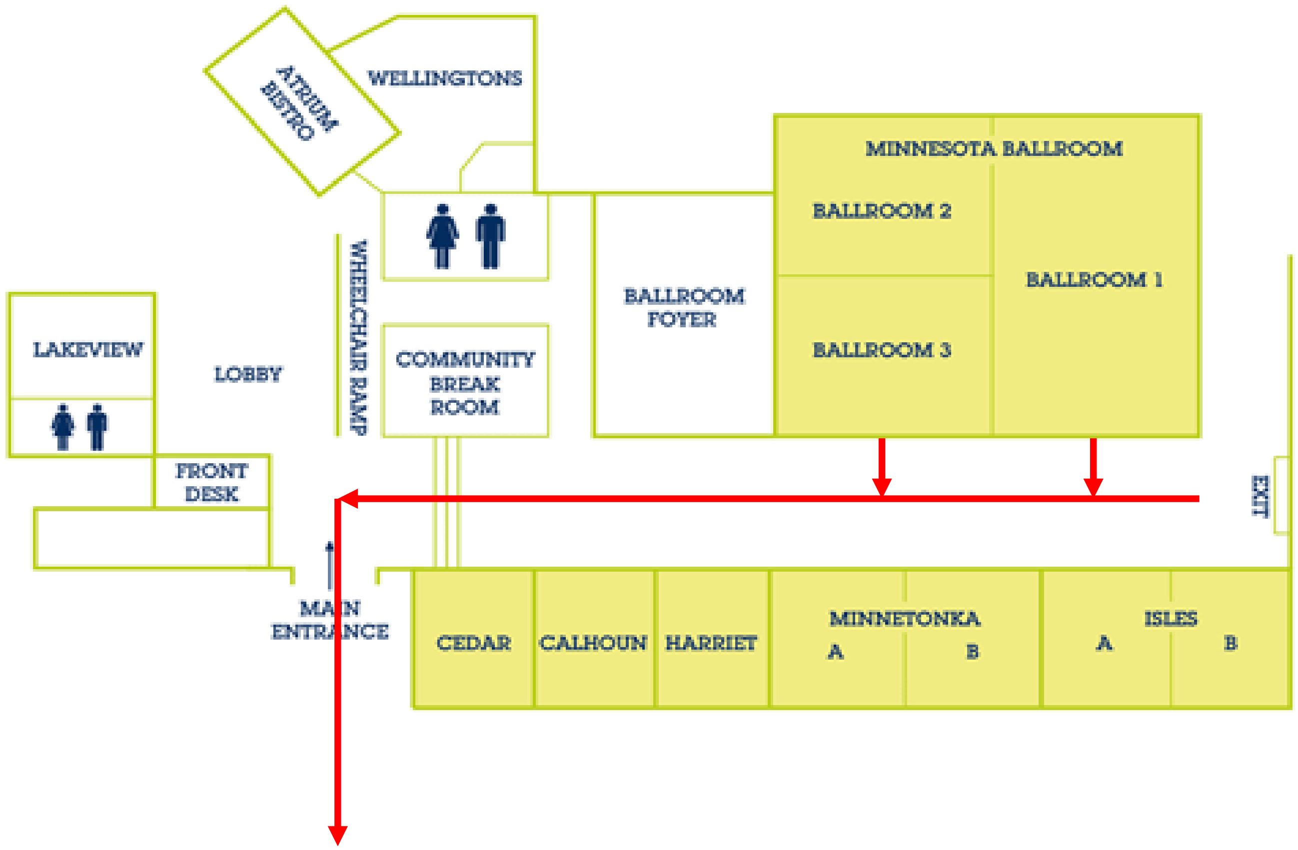

Move away from the building for emergency vehicles

Please Download the Digital Grid Customer Summit App

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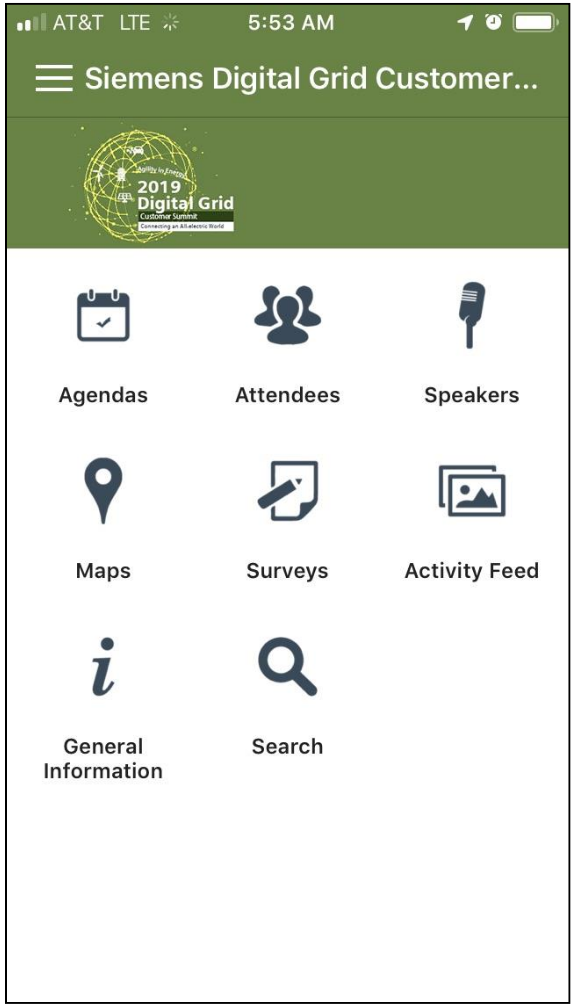
- Your guide to all activities
- A convenient place to keep your notes
- A survey to provide Siemens with back
- Your place to ask questions for the panel session at the end



Agenda

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8:00-8:05 am:	Welcome and Agenda Review *Farel Becker-Head of Digital Grid Marketing*
8:05-9:00 am:	Siemens Smart Infrastructure *Ruth Gratzke-Head of Products and Systems Sales*
9:00-9:45 am:	Grid Modernization–a Long-term view *Michael Schneider-Head of Digital Grid Software Product House and Consulting.*
9:45-10:00 am:	Break
10:00-10:45 am:	Modernizing the Puerto Rico Grid *Scott Hulett-Head of PTI Consulting*
10:45-11:30 am:	Grid Innovation *John DeBoer-Head of Siemens Future Grid*
11:30 am-12:00 pm:	Panel discussion on Grid Modernization *Jim Taylor-Head of Business Solutions and Strategy*

7:00 am-8:00 am	**Breakfast and Registration**	
8:00 am-8:05 am	**Welcome and Agenda Review**	**Farel Becker** *Head of Digital Grid Marketing*
8:05 am-9:00 am	**Siemens Leadership Presentation** **Topic: Siemens Smart Infrastructure Division**	**Ruth Gratzke** *Head of Siemens Infrastructure Products and Systems Sales*
9:00 am-9:45 am	**Executive Keynote** **Topic: Grid Modernization—A long-term View**	**Michael Schneider** *Head of Digital Grid Software Product House & Consulting*
9:45 am-10:00 am	**Break**	
10:00 am-10:45 am	**Industry Presentation** **Topic: Modernizing the Puerto Rico Power Grid**	**Scott Helutt** *Head of PTI Consulting*
10:45 am-11:30 am	**Innovative Presentation** **Topic: Grid Innovation—A Look Ahead**	**John DeBoer** *Head of Siemens Future Grid*
1:00 pm-5:00 pm	**PSS® User Technical Conference** **Meet us in Ballroom 2-3** • What's new in the PSS® Portfolio • Introduction to PSS® CAPE • Introduction to the Harmonics Module • MUST Add-on Module • PSS® core product enhancements *see detailed agenda for abstracts and timing	**SECA** • User interface working group • PI interfaces/uses • Staffing structure and training
5:30 pm-9:00 pm	**Siemens Sponsored Evening Outing: Wabasha Street Caves** Food, Games, Music, Fun *Transportation will be provided*	

Evening Event-Dinner Theater

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What: Wabasha Street Caves-
Murder Mystery Theater

Where: 215 Wabasha St S
Saint Paul, MN

When: Bus departs at 5:30 pm
from the hotel lobby

Description: Lots of fun and laughs

Recommended dress: Business Casual-
bring a jacket or a sweater

Smart Infrastructure Business Update

Ruth Gratzke
Head, Product and System Sales
Smart Infrastructure

Global megatrends shaping future markets

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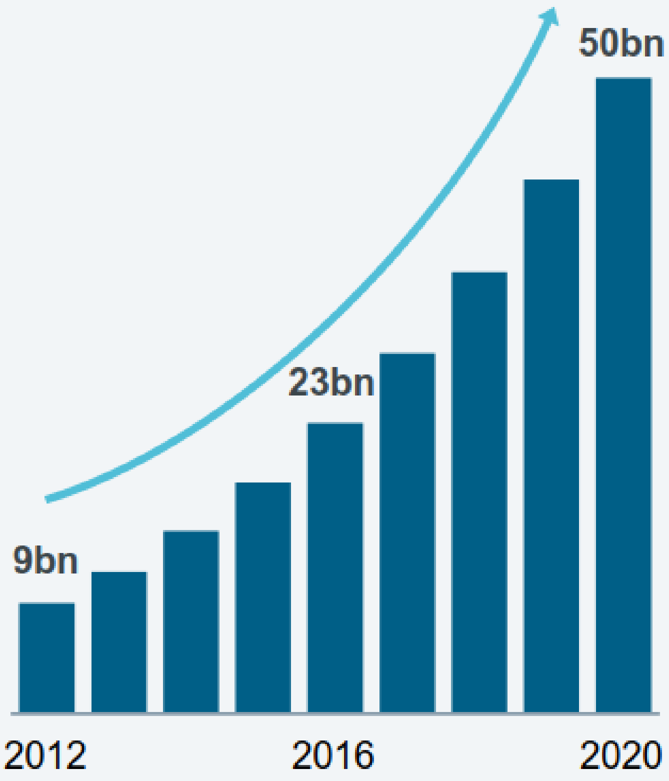
Demographic Change

>20% of global population **over the age of 60 in 2050**

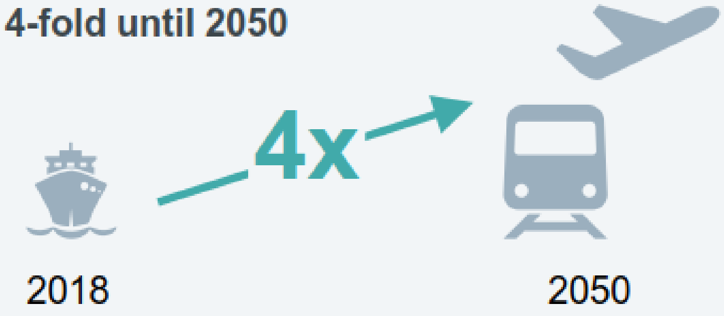
Digitalization

50bn IoT devices connected by 2020



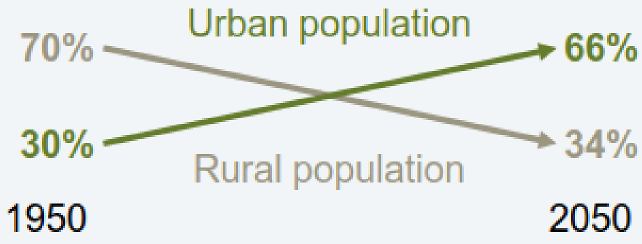
Globalization

Global trade will increase **4-fold until 2050**



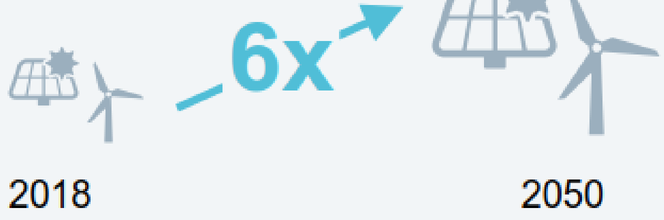
Urbanization

~70% of global population will **live in cities by 2050**



Climate Change

Solar & wind power generation will **increase six-fold until 2050 strongly driving electrification**



Rapid transition from utilities to industrial sector and "prosumers"

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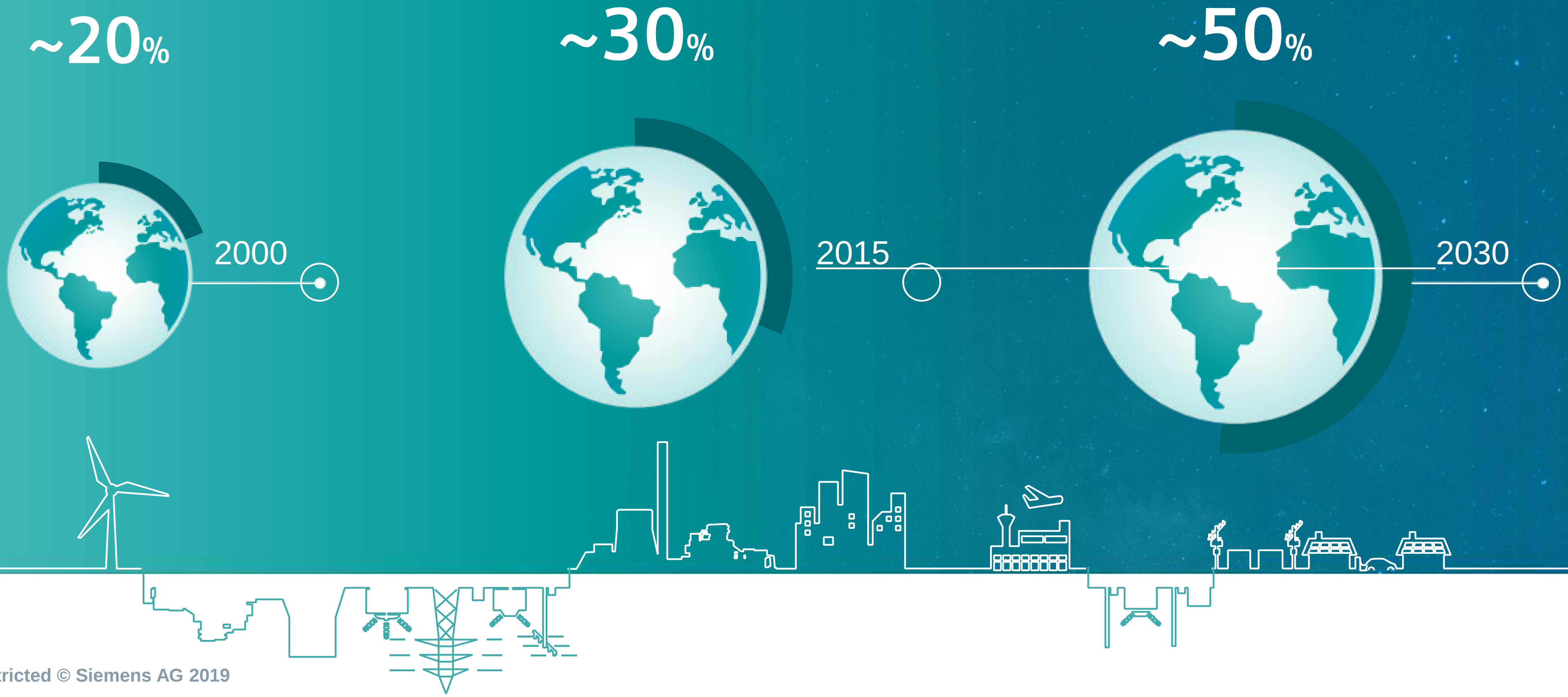
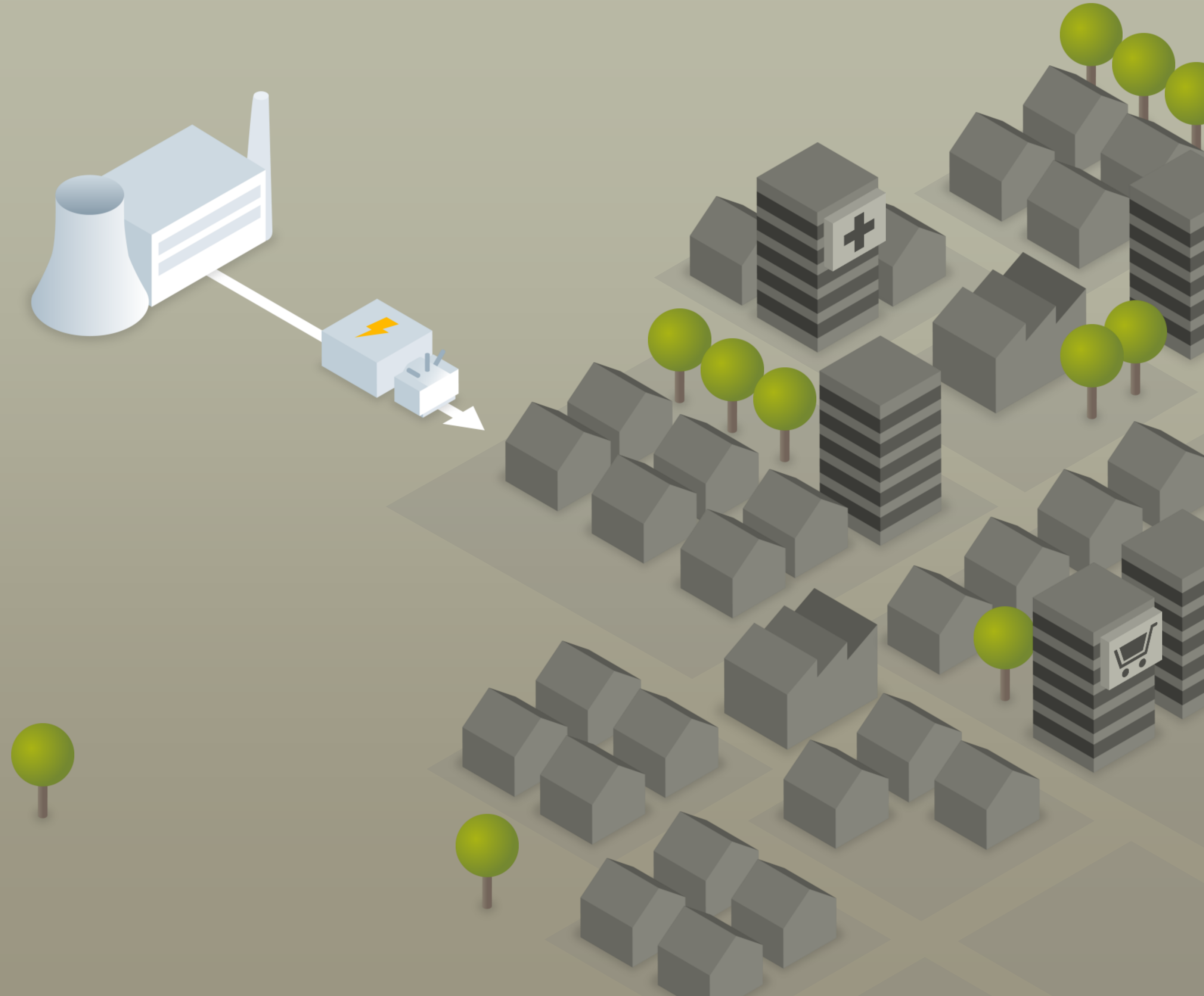
Total power generated from renewable energy sources or distributed small sale power facilities



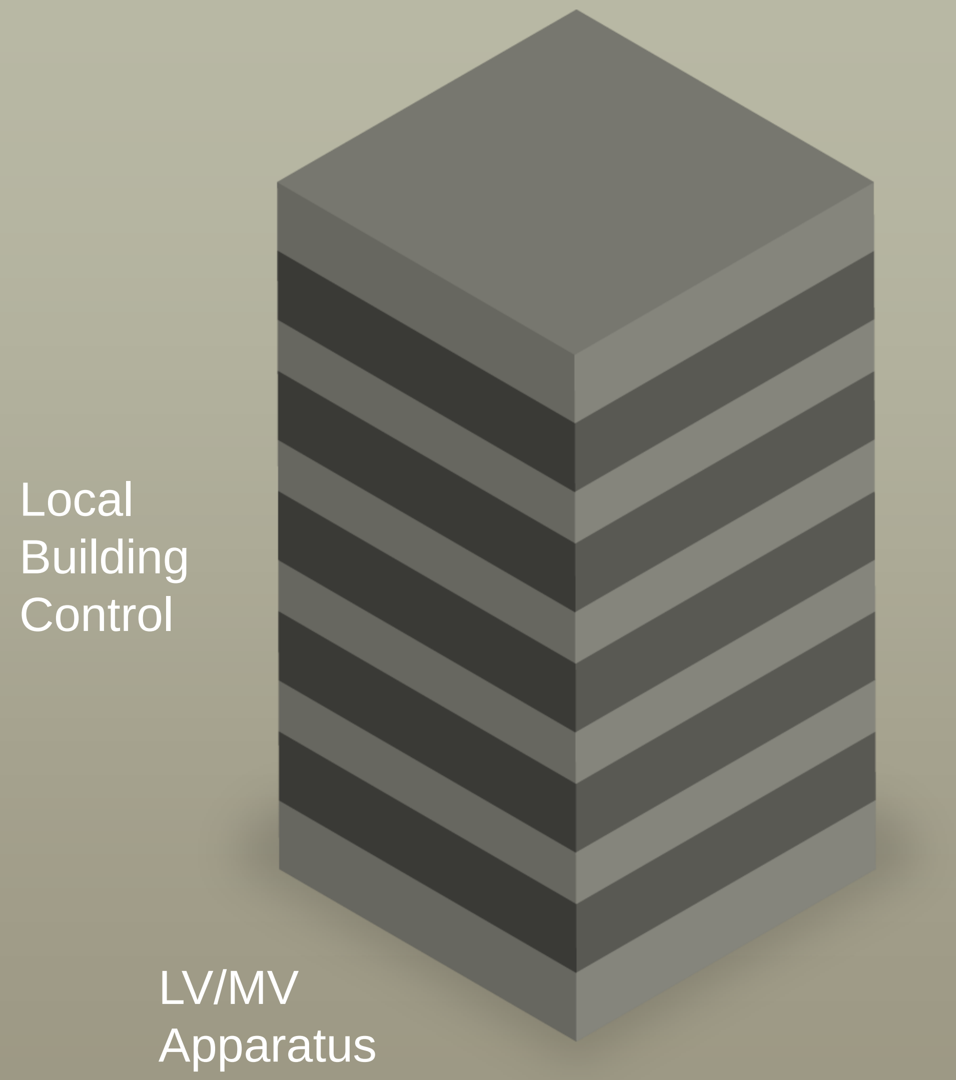
The future of grids, buildings, and industry

From a single, one-directional, centralized power source…

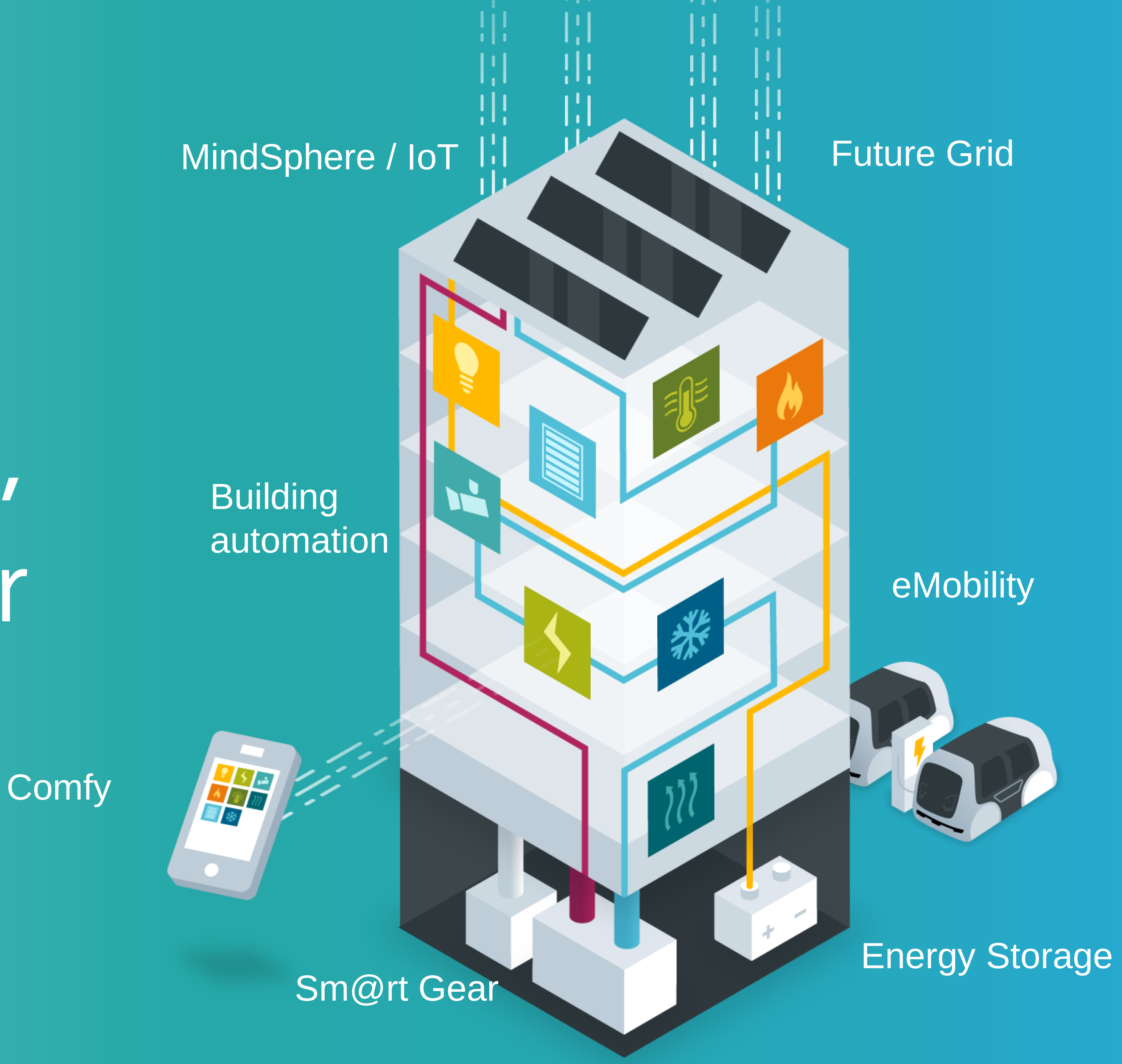


...to decentralized power generation

From passive, stand-alone consumers of energy…



… to interactive, smart buildings, generating their own energy



The Future is:

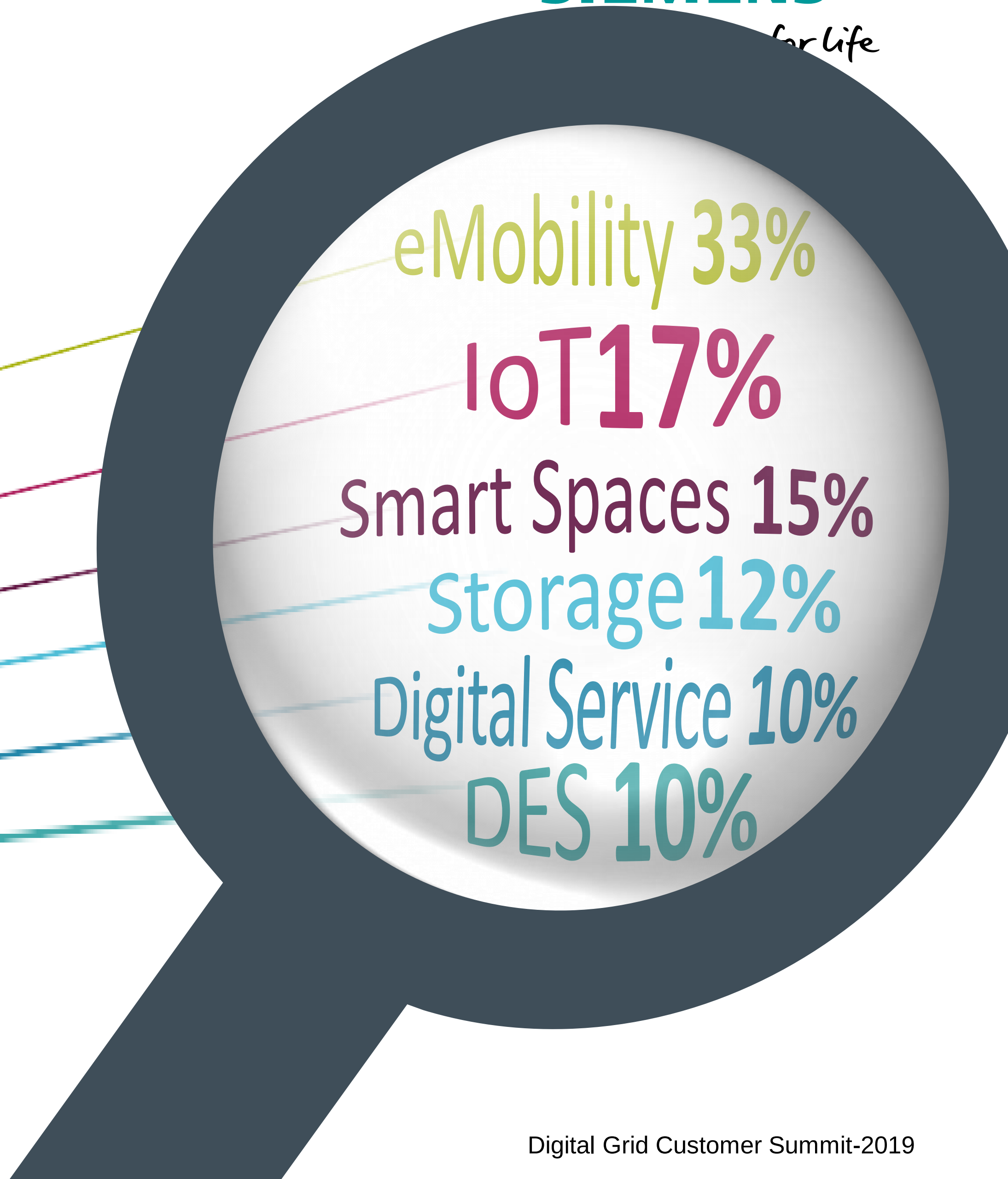
Smart power +

Smart grids +

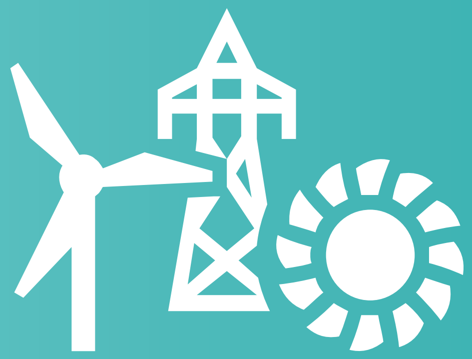
Smart buildings

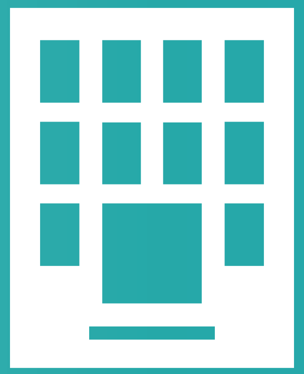
The analysts' perspective:

significant growth projected in emerging technologies



Our organization is adapting, but our face to the customer remains unchanged





Vision 2020

- Power and Gas
- Building Technologies
- Energy Management
- Digital Factory
- Process Industries and Drives
- Power Systems Sales

Vision 2020+

- **Power and Gas**
- **Smart Infrastructure**
- **Digital Industries**
- Power Systems Sales

Siemens has invested and is continuing to do so

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Digital Services

- Data-driven services
- Digitally enhanced services

Technology

- Critical environments
- Storage
- Renewables

Digital Twin

- For simulation, testing and design
- For operation

eMeter A Siemens Business
PSS DG, Dec 2011

J2 INNOVATIONS A Siemens Company
PSS BP, May 2018

enlighted A Siemens Company
RSS SSP, May 2018

SIEMENS Comfy
RSS SSP, June 2018

FLUENCE A Siemens and AES Company
PSS DS, January 2018

Russelectric A Siemens Business
PSS LP, March 2019

KACO new energy.
PSS DS, March 2019

electrocon international incorporated
PSS DG, October 2018

Leading technologies that addresses real customer issues - reducing wildfire ignition risk with Fusesaver™

- Ultra-fast circuit breaker with O-C-O functionality
- Reaction time of less than half a cycle from detection to fault clearance
- Protects lateral line fuses from transient faults (80%)
- Onboard event history and remote control capabilities
- Lightweight: less than 12 lbs.
- Improves network reliability; reduces SAIFI and SAIDI penalties
- ROI of less than two years
- Reduces operating costs with fewer maintenance callouts.

Analysts recognize Siemens as top player in grid automation and control

NAVIGANT RESEARCH

[April 26, 2019] Siemens named a leading DERMS provider, recognized for:

- Vision
- Go-to-Market
- Technology
- Quality and Reliability

Gartner®

[January 24, 2019] For the fifth year, Siemens Meter Data Management positioned in the 2018 Leaders Quadrant for:

- Ability to Execute
- Completeness of Vision

Beyond Digital Grid, Siemens provides products and solutions to the majority of US Investor Owned Utilities

~20 of the top IOUs have spent >$10M with us over FY15-17

Energy IP – meter data management
Consolidated Edison, USA (New York)

Challenge

- Use power consumption information to improve grid reliability and reduce outages, empower customer engagement and facilitate the integration of renewable energy resources onto the grid.

Solution

- Siemens EnergyIP software will manage nearly five million meters by 2022.

Benefits

- First US energy provider capable of recording and processing meter date in near real-time – delivered every 15 minutes
- Supports NY REV* strategy
- Improved uptime for NYC subway system, managed by the city's Mass Transit Authority
- Improved outage management and mitigation
- Integration with gas sensors to mitigate leaks from gas meters

*Reforming the Energy Vision (REV)

Energy IP – demand management
New Brunswick Power, Canada

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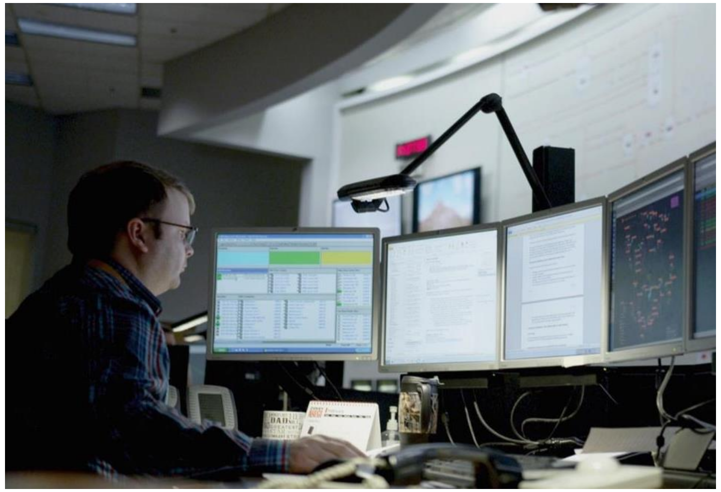

Solution

- Decentralized generation and consumer load bundled on a virtual platform
- Used as a flexible single power plant

Challenge

- NB Power needs to balance load and various renewable generation using demand response and virtual power plant applications
- Anticipate future needs to manage Distributed Energy Resources (DERs) connecting to their grid.

Planned Benefits

- Integration of local DER into the entire grid
- Integration of number of commercial microgrids to balance generation and load
- Incorporate real-time demand response into the active grid model

Spectrum Power Microgrid Management System
Blue Lake Rancheria (Blue Lake, California)

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Challenge

Establish an onsite solution to intelligently manage power to increase stability of power, secure critical facilities and reduce carbon footprint.

Solution

Siemens Microgrid Management System will power the entire 100-acre Native American reservation, including government offices, a casino, a hotel and the Red Cross safety shelter.

Benefits

- 7 days of uninterrupted electric power during a grid outage
- > 40% renewable energy generation produced annually
- Reduces annual consumption from the grid by 680 MWh
- 25% energy cost savings annually
- Reduces greenhouse gas emissions by at least 195 metric tons CO_2

What should we do differently to better serve you?

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Agility in Energy
2019 Digital Grid
Customer Summit
Connecting an All-electric World

Executive Keynote
Grid Modernization – A Long-term View

Michael Schneider-Head of Siemens Digital Grid Software Product House and Consulting

Tuesday, April 30, 2019

50

Years

Power Technologies International (PTI)

>45

Years

Siemens Grid Control in operation in the US

25

Years

Control Data Corporation Energy Management at Siemens

The Energy Revolution: Big Picture

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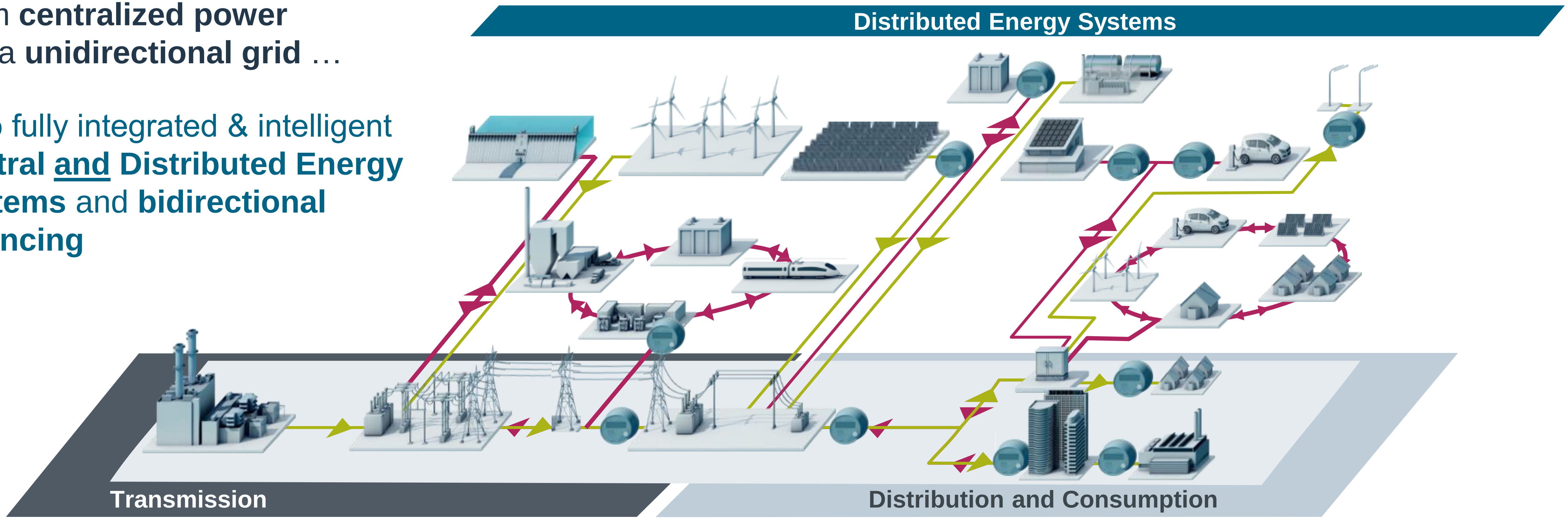
From **centralized power**
and a **unidirectional grid** …

… to fully integrated & intelligent
Central and Distributed Energy Systems and **bidirectional balancing**



1 Changing generation mix	**2** Generation capacity additions	**3** Distance from source to load	**4** Decentralization (public/private)	**5** Refurbishment/ upgrades

Electricity Grids are undergoing massive change: Integration of renewable Energy is the key driver…

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…while the importance of Electrical Energy as universally applicable compares to no other energy carrier

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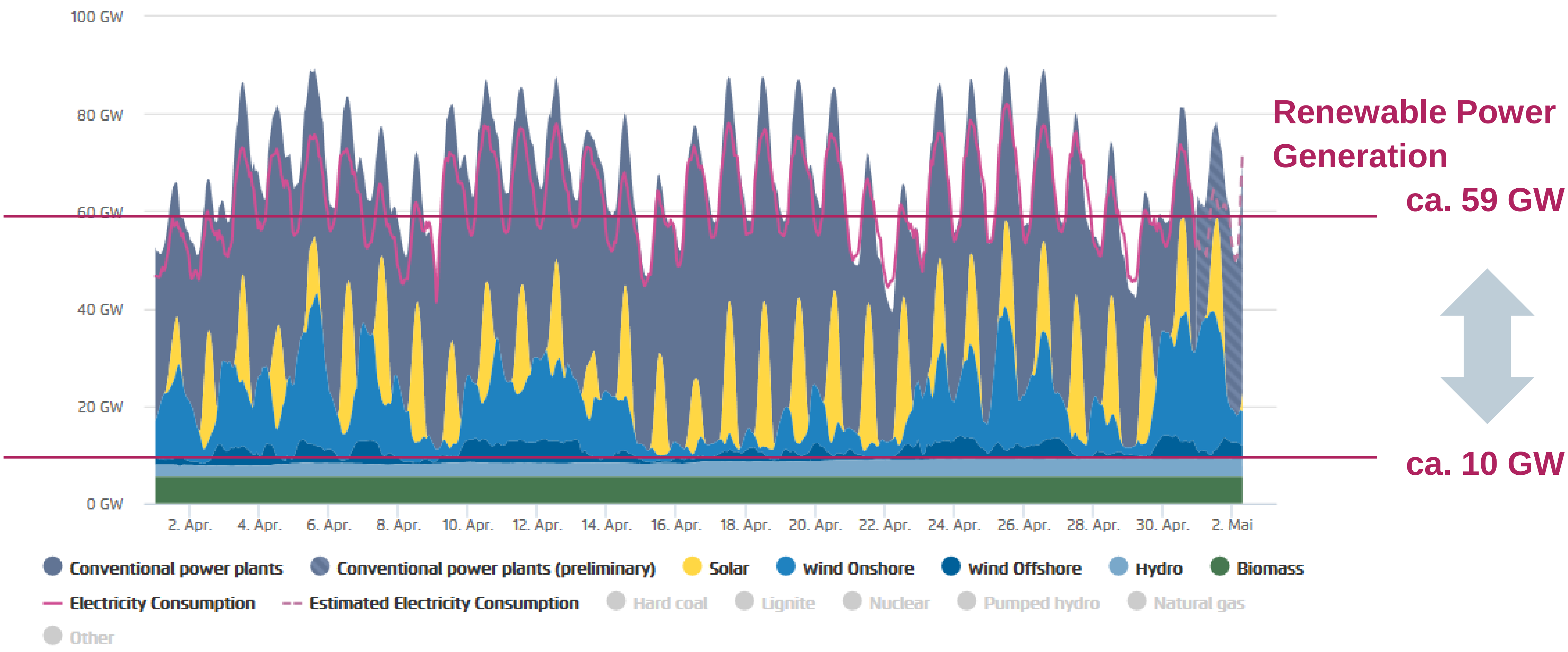
Electrified **tracks** account for nearly 1/3 of total tracks globally

100 million **e-cars** on the road expected until 2030

Efficient **heat pumps**: 4 kWh heat with 1 kWh electric power

Germany: Power Generation and Electricity Load (April 2018)



Source: https://www.agora-energiewende.de/en/topics/-agothem-/Produkt/produkt/76/Agorameter/

Germany: Regional renewable distribution is challenging

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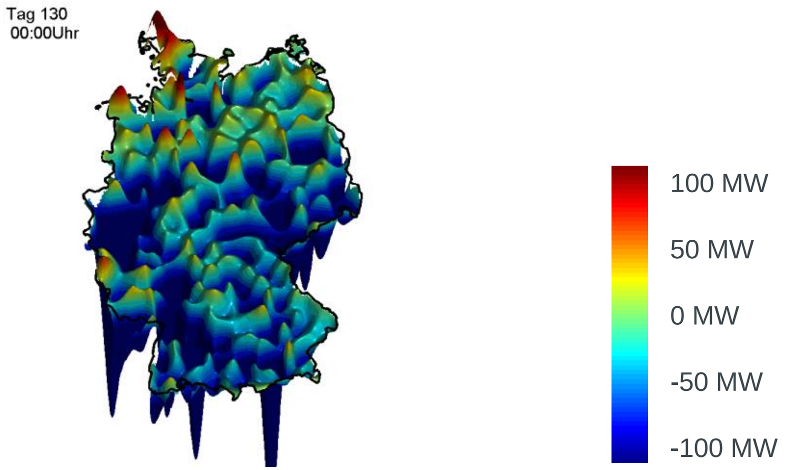
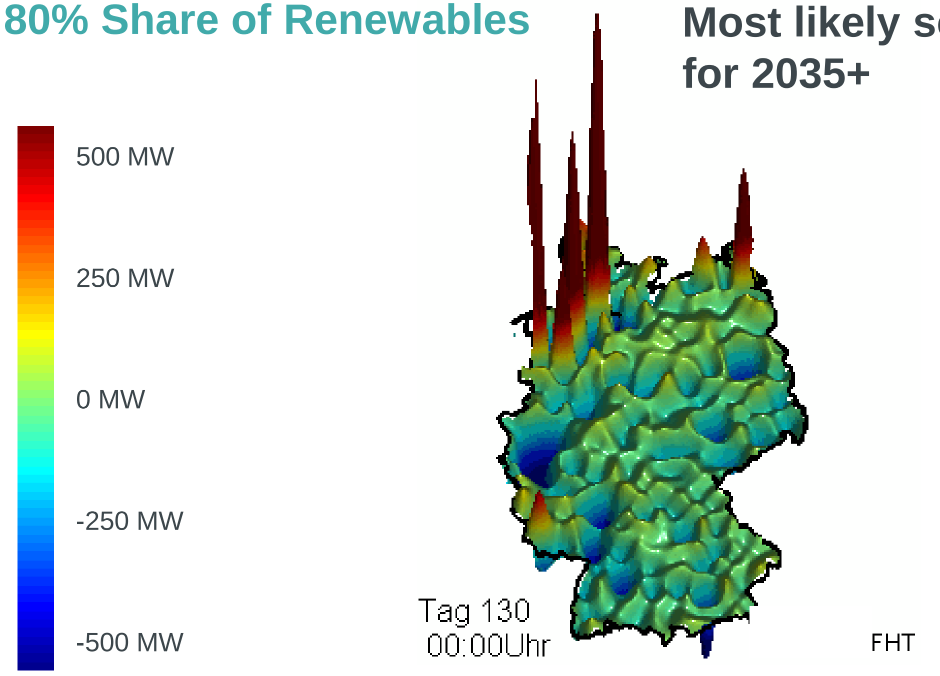
40% Share of Renewables

Most likely scenario for 2024



80% Share of Renewables

Most likely scenario for 2035+



Past
Generation follows consumption

Today
Generation and consumption: gap

In the future
Generation and consumption decoupled

Source: German Power Network Development Plan

Grid modernization secures sustaining business success

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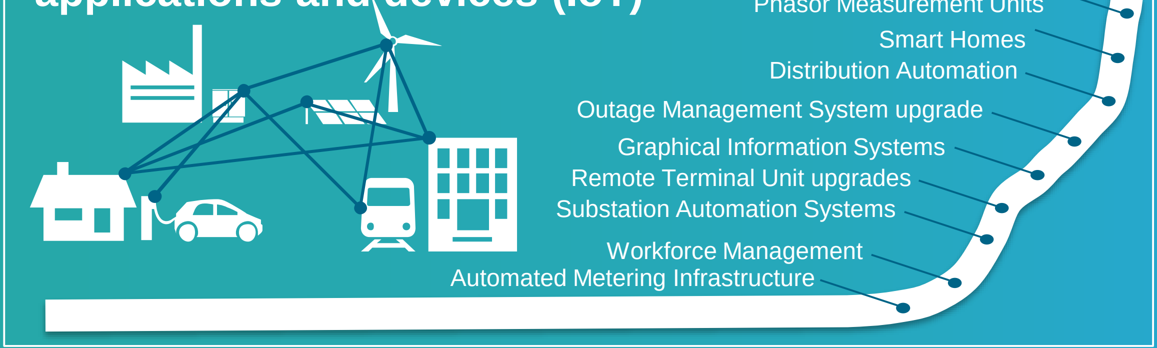
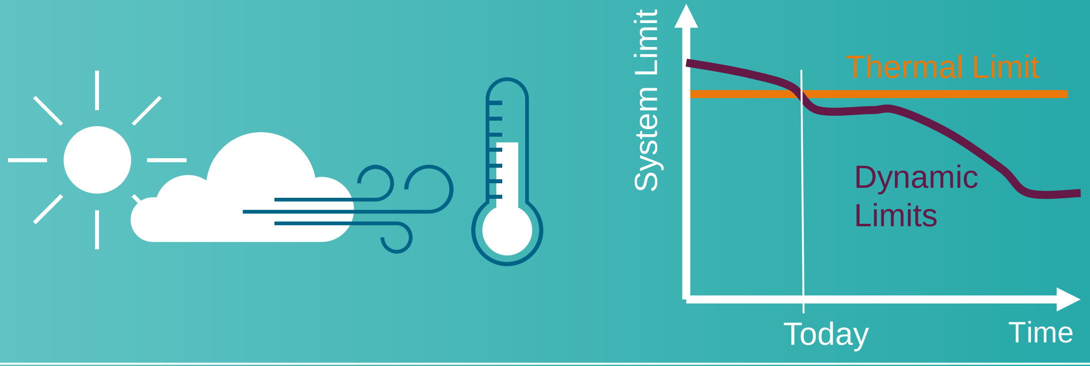
Manage increasing renewable and decentralized generation, make use of flexibilities

Deal with increasing data volume and increasing complex interconnection of enterprise SW applications and devices (IoT)



Exhaust the physical limits of the energy system (thermal / dynamic)



Benefit from the transformation of Business Models with focus on the customer

Siemens Digital Grid Software & Consulting:

For a safe, reliable, future-proof and efficient grid infrastructure

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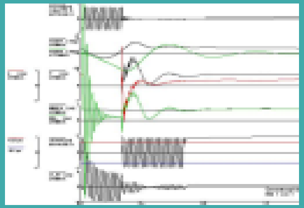
Consulting

Energy infrastructure strategy and process consulting

Energy Business Advisory



Grid design, planning, optimization and operational support

Power System Consulting

Software

PSS™ and SIGUARD™ grid planning and simulation

Grid Simulation

Spectrum Power™ grid operations and control

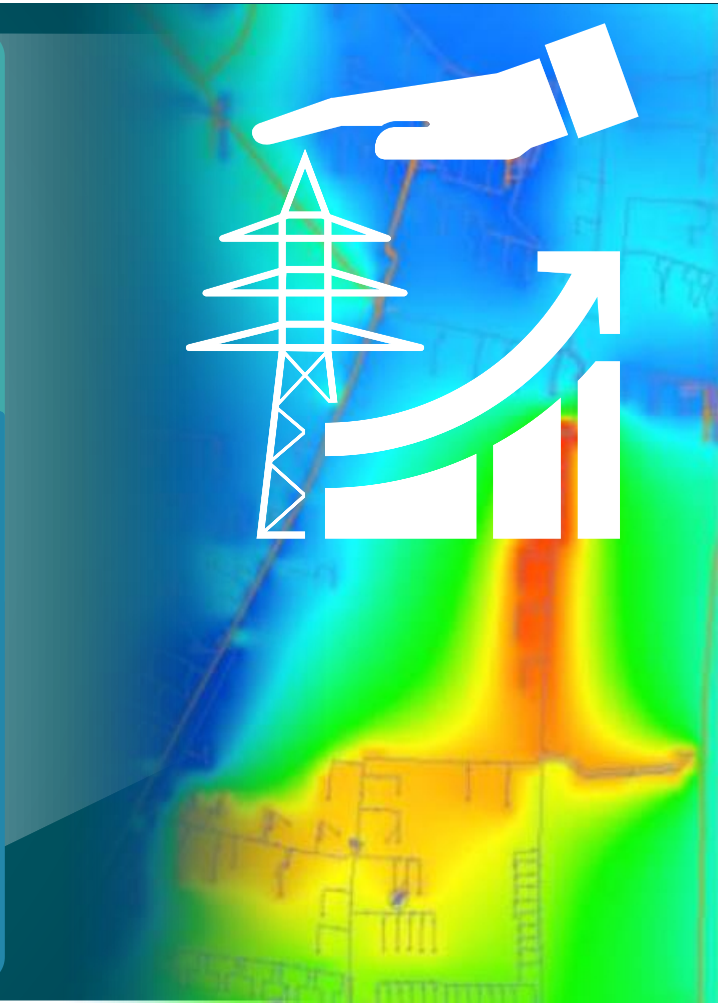
Grid Control

EnergyIP™ business applications and analytics

Grid Applications

Managed Applications and Services

Combining Grid Software applications with cloud infrastructure, IT environment and application management, customer service desk and data management, including end-to-end services



Trust in the trusted—the SW&C experts know what it means that huge parts of global power supply depend on our products

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- In-depth understanding of our customers' business resulting from decades of experience
- Partnering with customers to make changes and optimizations smooth and non-disruptive
- Strictly following most stringent EHS, cyber security, data safety and data integrity requirements

We care – with decades of experience in the domain

~70%
of global electrical power supply flows through grids designed with our digital simulation software

Driving grid digitalization in
>90
countries

>500
R&D engineers in 17 development centers

>1,000
Grid control systems in operation

>30 Consulting offices

Siemens Digital Grid Software & Consulting: Global collaboration — and the US is our #1 market

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~30%
of global market in the US

~30%
of SW R&D spend in the US

100%
committment to the SPARC-process (US and EU)

Driving the digitalization: Software trends and developments

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- EnergyIP™
- PSS™
- Spectrum Power™

The EnergyIP™ Portfolio –
Evolving functional and IT-landscape

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Functional Priorities

- Best in Class Meter2Cash Capabilities
- Enabling Customer Choice
- Balancing Supply and Demand
- Grid Operations and Optimization

IT Drivers

- Total Cost of Ownership
- Hybrid Deployment Models
- Device Management
- End to End Cyber-security

Meter Operators

EnergyIP Metering Solutions

- Meter Data Management
- Front End Processor
- Advanced Device Management
- Low Voltage Outage Management
- Energy Engage

EnergyIP Prepay
Prepaid Energy Solution

EnergyIP Analytics
Analytics Suite

DSO TSO

EnergyIP Assetguard

EnergyIP SDM
Substation Device Management

EnergyIP MTM
Market Transaction Mgmt.

Commercial & Industrial

EnergyIP DEOP
Distributed Energy Optimization

EnergyIP EEA
Energy Efficiency Analytics

Integrated Utilities, Aggregators

EnergyIP DEMS
Demand Response& Virtual Power Plants

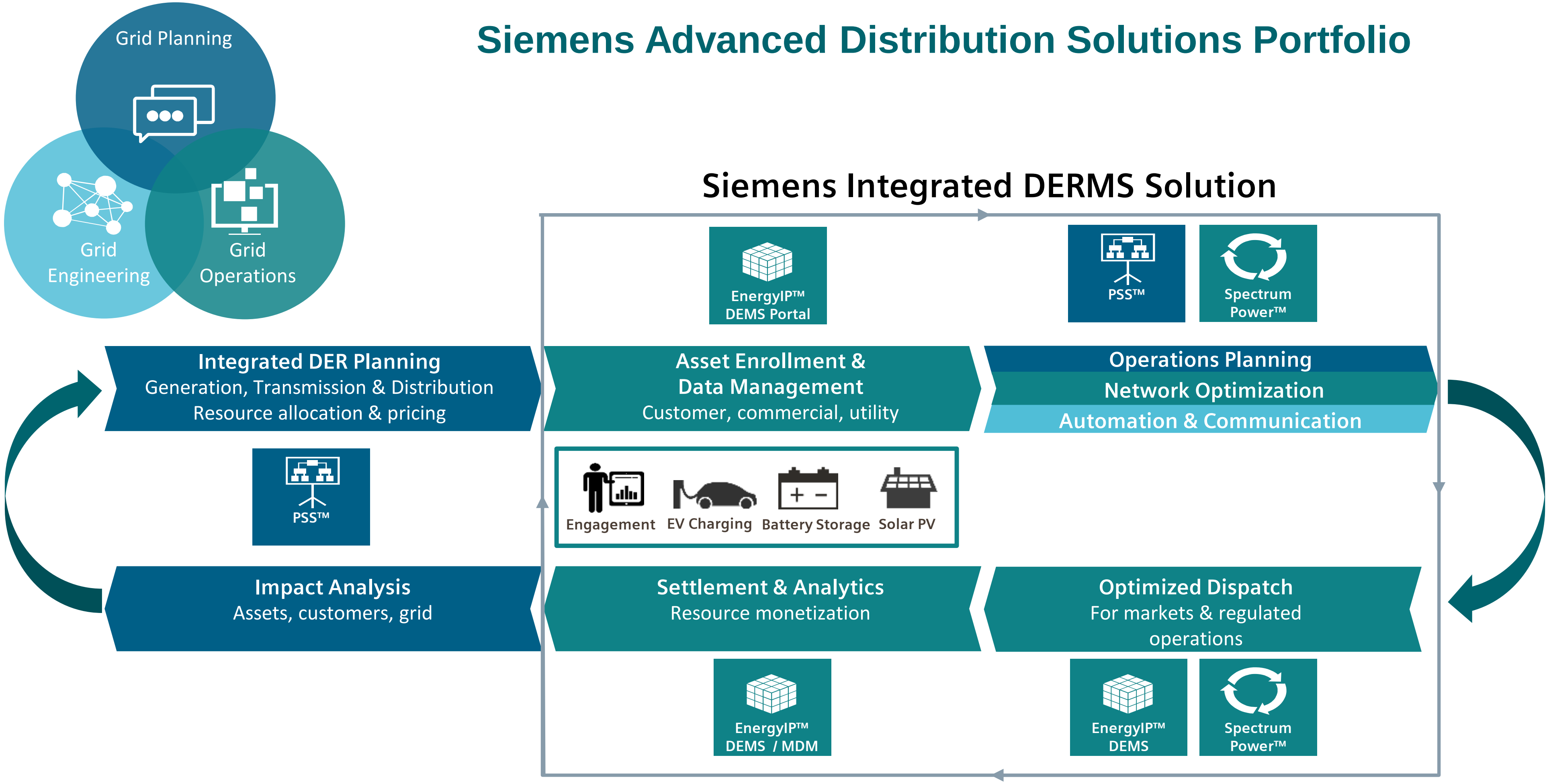
EMobility Solutions

EnergyIP E-Car OC

Mindsphere powered by EnergyIP

DERMS for Utilities: Plan, enable & optimally manage DERs

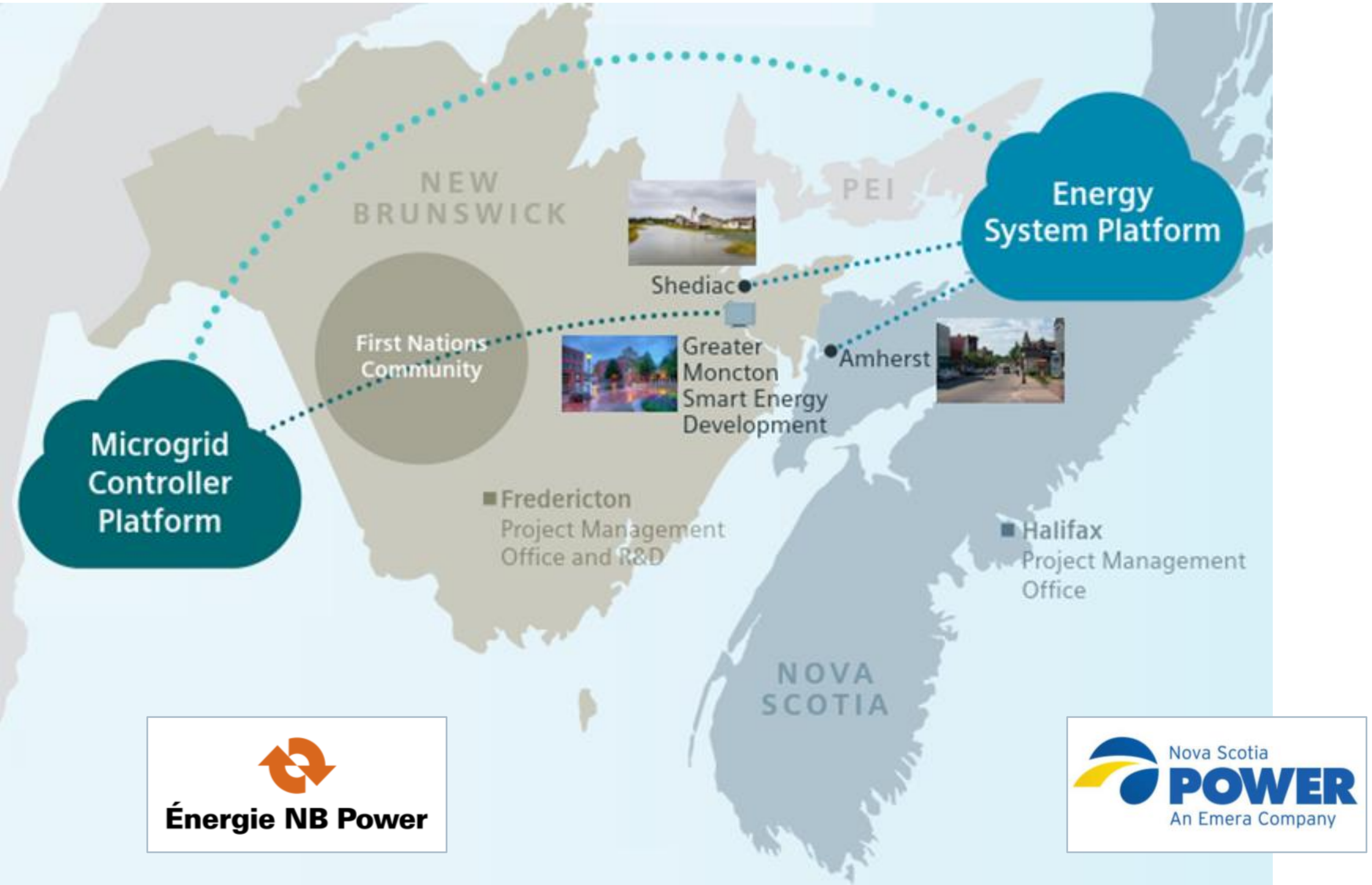
Siemens Advanced Distribution Solutions Portfolio



Managing Distributed Energy Resources:

- Leverages DER for both the economic and operational benefits
- End to end DER lifecycle support
- Packaged solution made up of existing products, pre-configured to work together
- Reduces costs
- Supports creation of new value streams

Smart Grid Atlantic: Two cloud-based platforms developed and deployed in four communities



NB Power
Agility in demand management

Solution
10 year strategy developed by PTI and smart grid based on our EnergyIP™ IoT platform to sustainably boost efficiency

Benefit
Reduce peak demand by 185 MW/year avoiding one replacement power plant

The PSS™ Portfolio—a step towards grid modernization
Strengthening capabilities and harmonizing data silos

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Our promise:
Enabling utilities to master their technical and business challenges to efficiently plan and operate the energy systems of today and tomorrow.

PSS™E
- Simulation & analysis software optimized for transmission network and operations planning

PSS™SINCAL
- Simulation & analysis software optimized for distribution and industrial planning

PSS™CAPE
- Computer-Aided Protection Engineering software enabling highly-detailed protection simulation

SIGUARD™
- Grid security solutions comprised of Phasor Data Processor and Dynamic Security Assessment

PSS™MOD
- Enterprise data management and exchange for PSS™E data

PSS™ODMS
- CIM-based transmission network modeling & analysis

- **New portfolio elements:** **PSS™CAPE** – enabling customers to protect their grid.
- **New alliances:** **Siemens-Bentley** OpenUtilities (powered by PSS) to prepare utilities for DER integration.
- **One grid, one data model:** Focus on data interoperability across the planning and operations solutions and the **Electrical Digital Twin**

One grid one data model: The Electrical Digital Twin integrates over the entire lifecycle

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MindSphere connects the virtual with the real world—for infrastructure and buildings

Powered by MindSphere

Digital System Twin	Digital Construction Twin	Digital Performance Twin
Modeling and simulation for planning and protection of energy systems and power grids	2D/3D engineering, construction workflows and as-built models of system and grid assets	Realtime monitoring, optimization and control for operations, asset mgmt. and maintenance
PSS™ Simulation SW Suite	Bentley	**Control Center, MG Automation, Protection**

Electrical Digital Twin application Testimonial: Transmission Network Model Management at AEP

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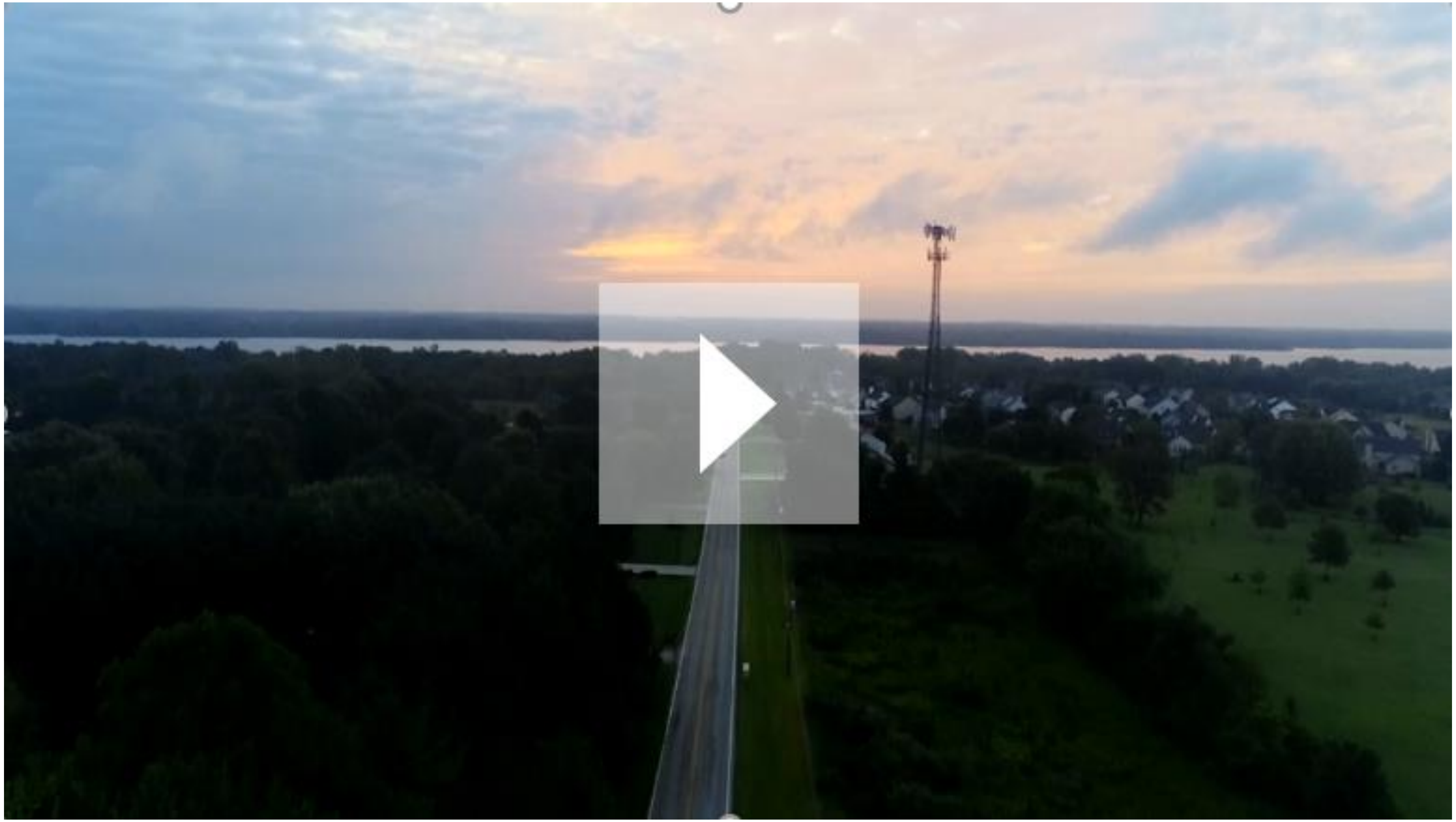


Electrical Digital Twin application example: Transmission Network Model Management at AEP

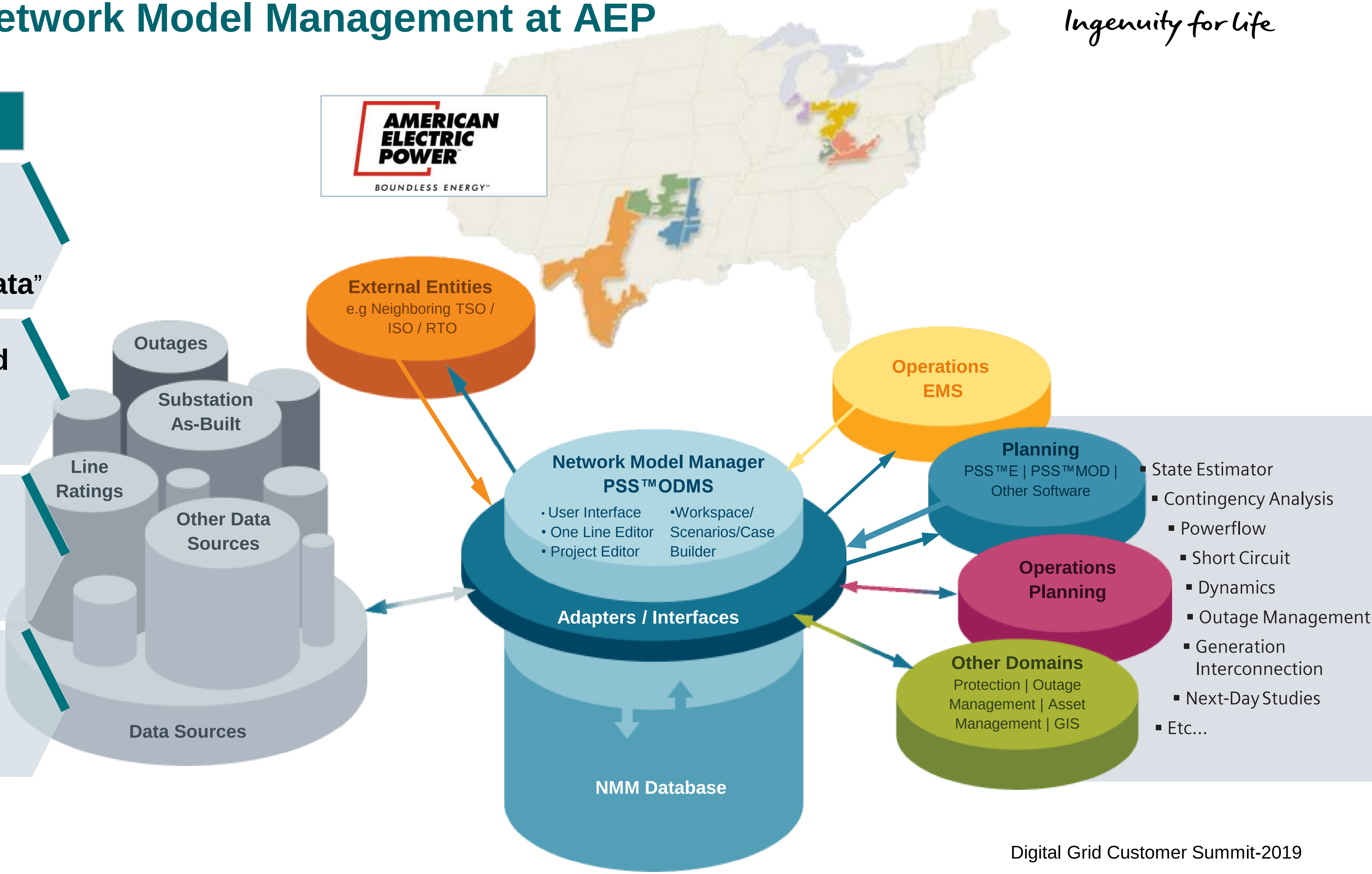
The solution will…

"…give AEP an advantage in a competitive business environment by enhancing the company's ability to **exploit data**"

"…greatly **reduce the time and costs** associated with manual model coordination efforts"

"…**accelerate** the ability to capture value"

"…improve the ability to **manage growth** in the number and mix of transmission projects"



Electrical Digital Twin application example: Fact-based investment decisions for grid modernization at Fingrid

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Jussi Jyrinsalo
Senior Vice President,
Grid Services and Planning,
Fingrid

"We can calculate for a future as far away as 25 years."

Reduced effort

80 % data collection and verification / 20% advanced analysis turns into 20/80 %

Improved investment planning

with "single source of truth", 25 years in the future

Integration of clean power

with a cost-efficient grid

Improved grid reliability

>99,9996% through cross-functional workflows and data management

FINGRID

Basis for modernization investment decisions of ~ €1.0bn by 2025

Spectrum Power™
The future is with Spectrum Power 7 and 5

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Spectrum Power 7
Support of Linux
Mainly for the
market segments of


Transmission


Distribution


Energy market


Infrastructure

Global applications connectable to both platforms
Common standards like CIM, IEC 61970
Common innovative Service oriented architecture SOA

Spectrum Power 5
Support of Windows
mainly for the
market segments of


Multi-utilities


Municipalities


Industry & infrastructure


Generation

- **Shaping reliable, efficient and sustainable energy grids**
- **Reducing total cost of ownership**

Sacramento Municipal Utility District: EMS Replacement with Spectrum Power 7

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A True Win-Win Scenario

- Siemens and SMUD Partnership
  - SMUD-Reduced total cost of implementation SMUD-Minimizes cost and reduces scheduling impacts to implement Energy Imbalance Market (EIM)
  - Siemens-Improved OPS platform, project planning and deployment process

Spectrum Power 7 incl. IFS/ICCP, UI, AGC, IMM/MAGE, TNA, OTS HIS, SCADA

Recent Successes:

- March 15 2019-First USA utility operational with Spectrum Power 7
- Met ability to implement EIM-April 3rd 2019

California ISO:
EMS and EMMS Upgrades

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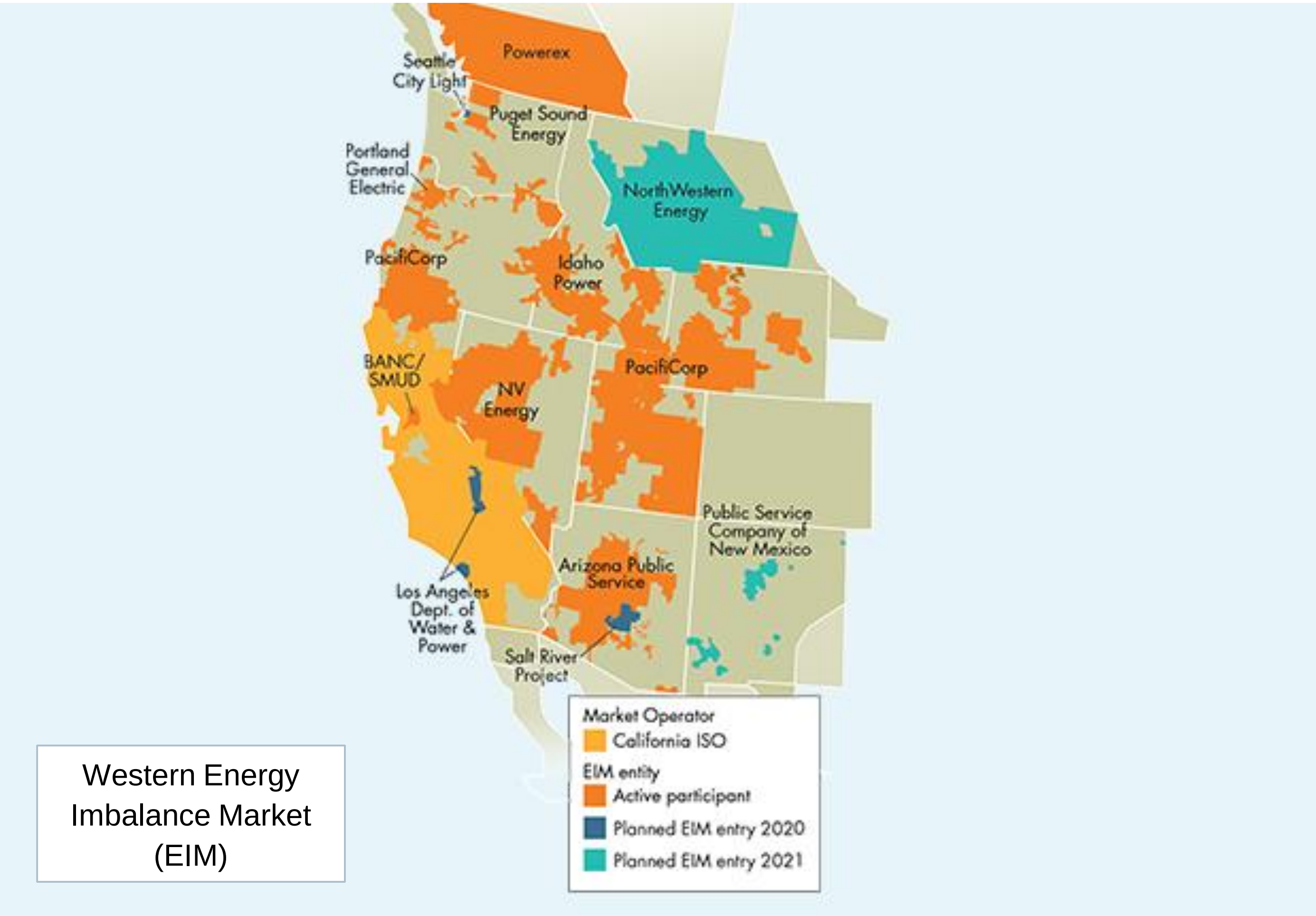

Upgrade of the Information Model Management System (EMMS)

- Modern Architecture with Spectrum Power 7 and Linus OS
- New Graphical Editor Development
- Development of automatic One line Generator

EMS ABB replacement project (SCADA, AGC, ICCP, IFS, PI, OTS):

- Advanced, Alarming
- Peer to Peer Multi-site EMS deployed at two locations.
- Web Services for all EMS, EMMS and EMNA interfaces via JBOSS/Fuse.
- Big data repository-Data Access Layer (DAL)
- CAISO EMS model includes full WEC

Recent Successes:

- April 1st Parallel operation
- Proceeding with availability testing

Trust in the trusted—Spectrum Power™ 7 is being rolled out globally … > 100 systems, > 25 systems in operation

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Transmission

- PGCIL * India
- XM * Colombia
- EETC Egypt
- COES * Peru
- APS * US
- NEGK Kyrgyzstan
- CenterPoint US (Phase 1)
- SOMELEC Mauritania
- DynaGrid CC GER (research)
- CAISO* US
- TPC ADDC Taiwan
- ONEE* Moroc
- SMUD * US
- CENACE * Mexico
- EPSO Armenia
- ENDE* Bolilvia
- GSE Georgia
- NEA Nepal
- RE International Peru
- PGCIL WREMC India
- CFE GRTNO Mexico

Distribution / ADMS

- CFE (x2) Mexico
- PT PLN (Persero) Bangka Beliting - Idn
- Union Fenosa D. Spain
- GEDIZ Turkey
- Linz Netz AG Austria
- EVN Austria
- Jeddah LDC SEC, KSA
- KCETAS Turkey
- EVN SPC Vietnam
- CARUNA * Finland
- ADDC U.A.E.
- Makkah LDC SEC KSA
- Salzburg Netz AG AT (research)
- EPM Columbia
- SCDA (AT) Seestadt Aspern
- VANGÖLÜ Turkey
- Osmangazi Turkey
- EP BiH
- Torosolar Turkey
- Enercal New Caledonia
- Neoenergia Brazil
- Netz OÖ Austria
- Germany
- India
- Copel Brazil
- Norway
- Norway
- Finland

MicroGrid

- NREL,CPS, Duke Energy US
- Blue Lake Rancheria US
- ComEd US
- Algonquin collage Canada

Research
*** Multi-Site System**

Generation

- Colombia
- Chile
- Sweden
- UAE
- Norway
- Ukraine

EMM

- PEMC Philippines
- CAISO US
- XM Colombia

in operation

Future of Grid Control: Example DynaGrid

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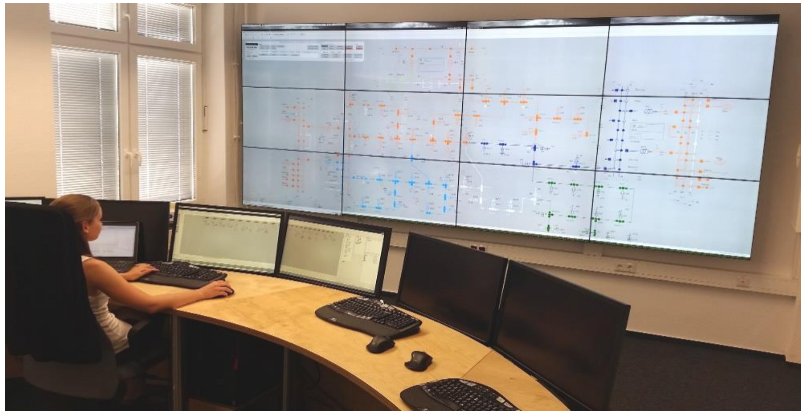
Innovation project with all German TSOs



amprion
50hertz
Fraunhofer IFF
TECHNISCHE UNIVERSITÄT ILMENAU
SIEMENS
OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG
RUB
Fraunhofer IOSB Institutsteil Angewandte Systemtechnik AST
TRANSNET BW
TenneT

From static towards a dynamic grid

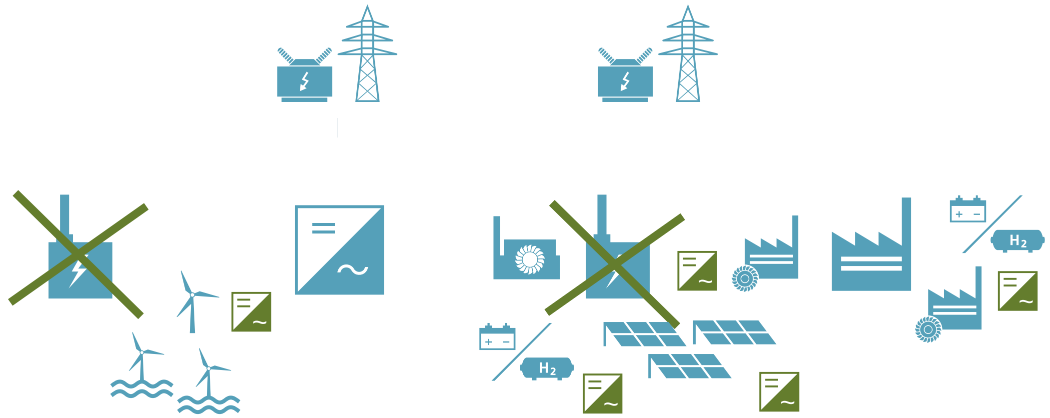
Dynamic Control center

Data stream | Dynamic Security | “Auto-assist”

SPECTRUM 7

Digital Substation

Primary Equipment



- Integration of measurements (PMU) & advanced simulation
- Dynamic System stability challenges mastered
- Coordinated operation of hybrid AC/DC networks
- Self-healing & “Auto-Assist” workflows

Electrical Digital Twin use case example: Dynamic contingency analysis in operations

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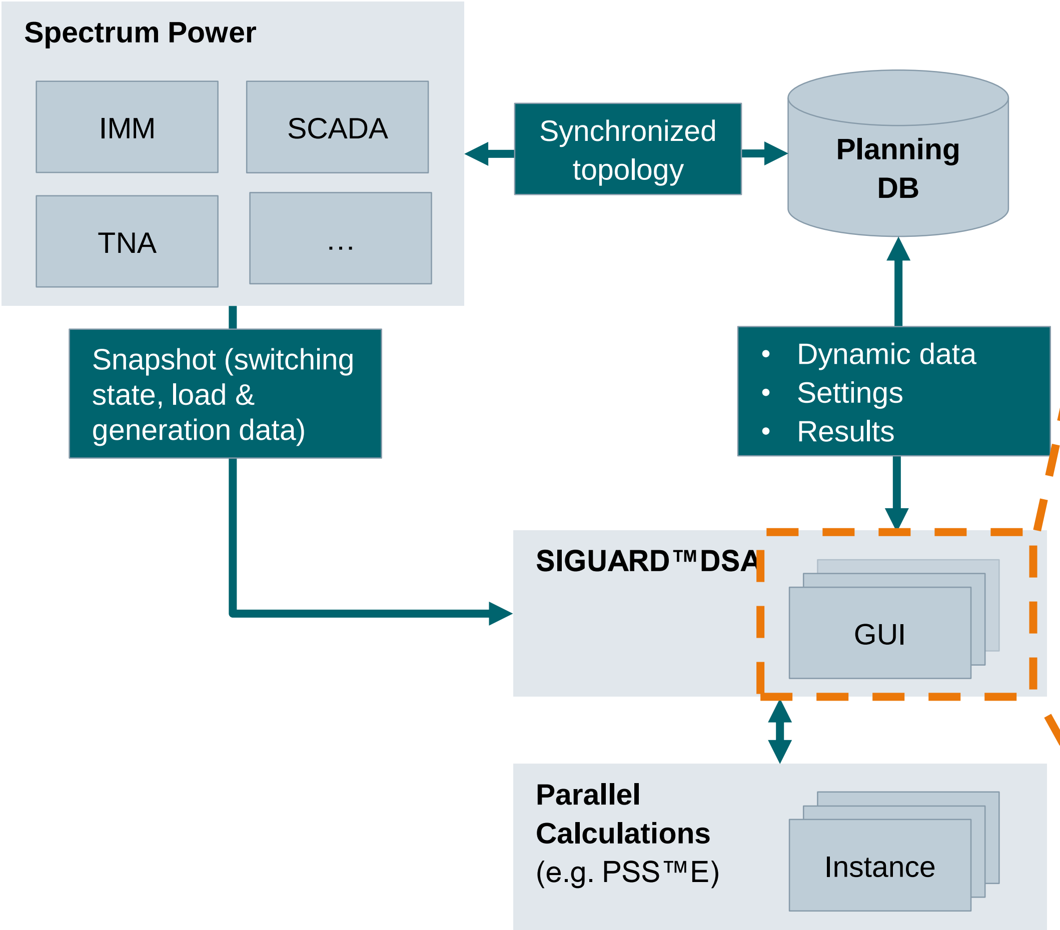
Based on synchronized topology data from planning and operations, SIGUARD™DSA allows for dynamic contingency analysis in operations …



… for which a GUI is used reg. parameter settings and displaying results

DSA: Dynamic Security Assessment IMM: Integrated Model Management TNA: Transmission Network Analysis GUI: Graphical User Interface

AEP Co-creation Process
Underground Network Analytics

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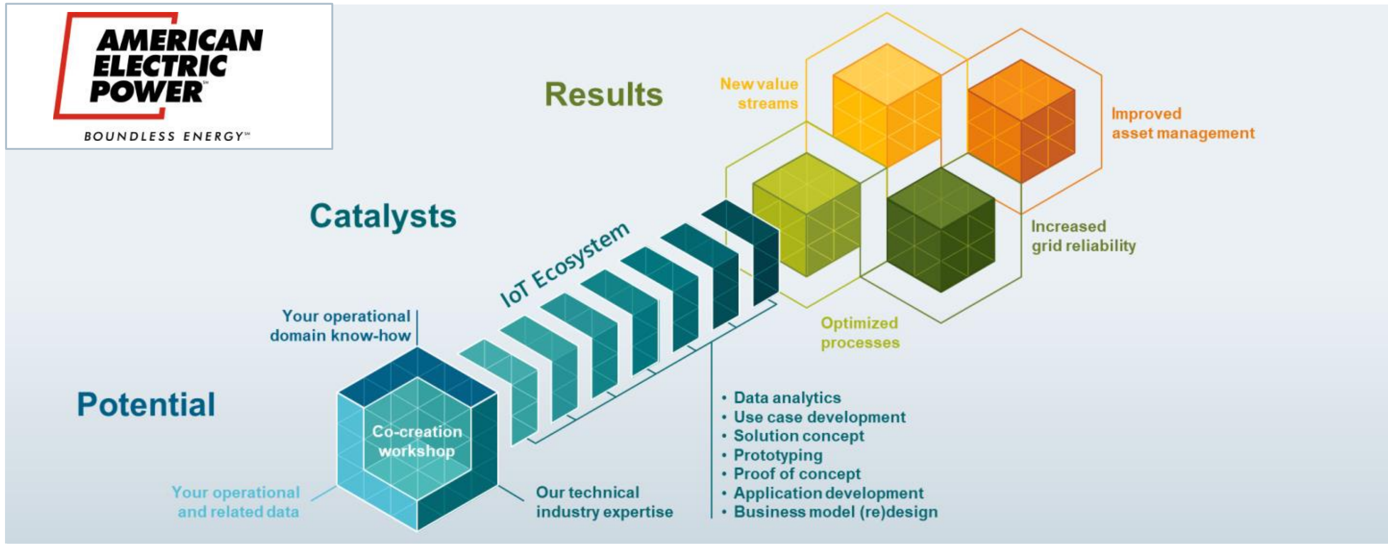

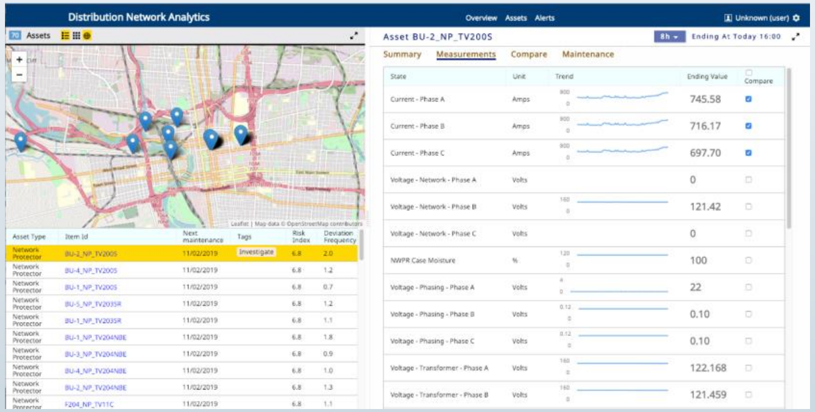

Market requirements
Achieving efficient, reliable, and sustainable power supply while:
- Taking advantage of digitally enabled solutions
- Exploiting value from flood of "new" data

Solution - Unlock the potential of energy data
Developing data-based strategies that create added value – in business models, applications, solutions, and services.

Customer benefit - Turning data and expertise into value
Customer and Siemens domain experts explore and co-create innovative digital use-cases and solutions – with the clear aim of turning data into value by:
- Optimized processes
- Increased asset life time and maximized availability of assets
- New value streams
- Increase grid resilience and reduced downtimes

Ongoing dramatic changes of the energy system

- Grid modernization is the answer
- Digitalization is the key enabler

Cross-functional Approach and Partnership

Strong installed base & domain know how of Siemens

Modernizing the Puerto Rico Power Grid

PREPA Integrated Resource Planning

Scott Hulett
Head of PTI Consulting

Tuesday, April 30, 2019

PREPA Historical Context, Modernization Challenges

Large Public Power Utilities
PREPA's U.S. Peer Group Comparison

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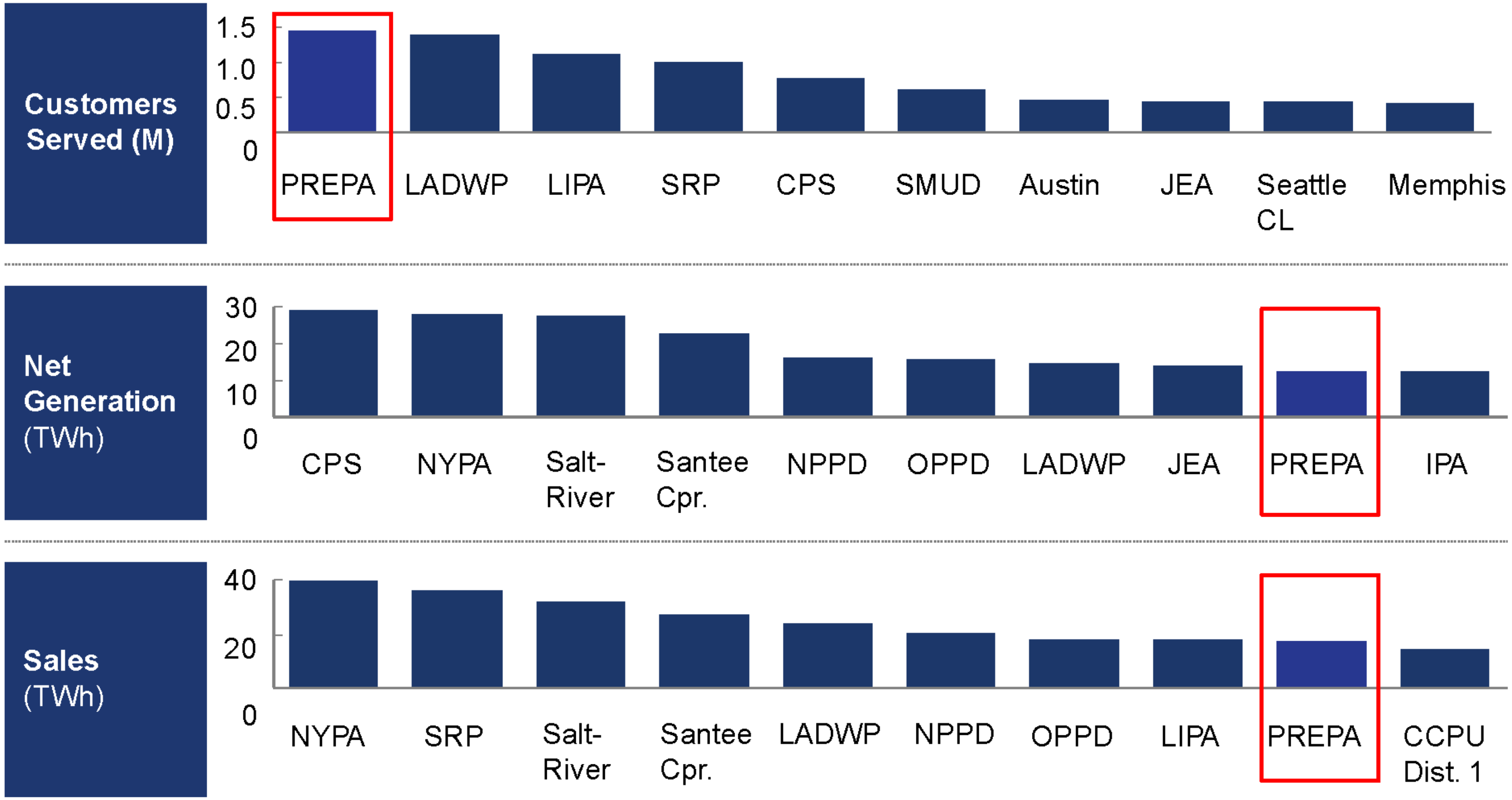

SOURCE: PREPA, as of June 30, 2016, based on unaudited results APPA. "U.S. Electric Utility Industry Statistics, 2014". 2016-2017 Annual Directory & Statistical Report

PREPA is the Vertically Integrated, Sole Provider of Energy in Puerto Rico

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Key statistics on PREPA

- **PREPA serves ~1.5M** customers and has **~6,000** employees

- For FY2017, PREPA had total revenues of **$3.4B,** total assets of **$9.4B,** and total liabilities of **$11.4B**

- Overview of generation system:
  - Generating Capacity: **6,085 MW (PREPA 4,892 MW; IPP 1,193 MW)**
  - **45%** of generation is from oil, compared with national average of **4%**
  - **31** major generating units in **20** facilities; older than national average
  - **4%** of generation capacity from renewables, vs. national average of 15%
  - Plants average ~**40 years** old[1]

- Overview of transmission and distribution system
  - Transmission Lines: **2,416 miles (230 kV / 115 kV)**
  - Distribution Lines: **30,675 miles (38 kV, 13 kV, 8 kV, 4kV)**
  - 38 kV substations: **283**
  - 115 kV substations: **51**

1 PREPA-owned plants excluding renewables

SOURCE: PREPA and Puerto Rico Energy Resiliency Working Group report

PREPA Fiscal Plan: Documented Historic Challenges (Before Hurricanes Irma and Maria)

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Generation	▪ **Frequent power plant outages** (12 times more often than mainland US average) ▪ High dependence on **fuel oil and inability to diversify fuel mix** (<4% from renewables and 45% oil, relative to industry average of 4% oil) ▪ Principal generation located far from demand centers with a **poorly maintained** T&D infrastructure
Transmission and distribution	▪ **T&D infrastructure that has not been adequately maintained,** further contributing to outages, losses, poor quality ▪ The **$2.5 billion** estimated expenditure need identified by PREPA in the 4-28-2017 Certified Fiscal Plan (pre-Maria) for **repair and maintenance** prior to the hurricanes is no longer sufficient and does not address necessary **resiliency and hardening;** post-hurricane T&D expenditure could exceed $13B ▪ **Highly vulnerable** to catastrophic events impacting delivery of electric service
Collections and customer service	▪ Relatively high level of **technical losses and theft** (17.3% of energy lost in FY 2016 was higher than industry average; source: PREPA Planning and Research Directorate) ▪ Disorganized and ineffective **customer service infrastructure** ▪ **Inconsistent and unreliable** IT system for remote, reliable, and timely collections, and service ▪ **High vulnerability** to damage from disasters immediately impacting collections, revenue, and service

SOURCE: Puerto Rico Electric Power Authority Fiscal Plan - August 1, 2018

PREPA Fiscal Plan: Documented Historic Challenges (Before Hurricanes Irma and Maria)

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Organizational	▪ Lack of **institutionalized processes and procedures** ▪ **Outdated systems** and information technology ▪ Above-market benefits in **collective bargaining agreements** with evergreen provisions ▪ **Underfunded pension obligations** (over $3.6B) ▪ Significant losses of experienced personnel
Environmental and Safety Compliance	▪ **Safety system and record dramatically below industry standards** ▪ **History of environmental non-compliance** ▪ Inability to execute PREPA's **strategic environmental compliance plan**, including timely compliance with MATS (Mercury and Air Toxic Standards) EPA emission limits
Operating Environment	▪ **PREPA's static business model** has not adopted changes in a rapidly changing and innovative industry ▪ Legal requirements to provide power to certain customers at **subsidized rates** ▪ **Poor quality** of electric service has impacted business and investment climate ▪ The prolonged and ongoing recession has led to a significant **drop in energy sales** ▪ Poor credit rating leading **to lack of market access** and the inability to invest in needed capital expenditure projects
Post-Irma and Maria Challenges	▪ **Accelerated migration** of population ▪ **Accelerated demand reductions** ▪ **Greater possibility** of distributed generation and inside fence generation ▪ **Dramatic economic contraction and job losses** ▪ **Deeper distrust** in state-monopoly as sole provider of electricity

SOURCE: Puerto Rico Electric Power Authority Fiscal Plan - August 1, 2018

2017 Grid Resiliency Rebuild Assessment
Puerto Rico Energy Resiliency Working Group (ERWG)

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- Immediately following Hurricane Maria, PREPA set out to review and assess damage to the system and began emergency restoration
- Damage assessment and emergency restoration efforts were supported by NYPA, ConEd, and USACE. Further damage assessment and resiliency rebuild estimates were developed by The Puerto Rico Energy Resiliency Working Group, comprised of the following members:
  - New York Power Authority, Puerto Rico Electric Power Authority, Puerto Rico Energy Commission, Consolidated Edison NY, Edison International, Electric Power Research Institute, Long Island Power Authority, Smart Electric Power Alliance, U.S. Department of Energy, Brookhaven National Laboratory, and the Public Service Enterprise Group
- The Puerto Rico Resiliency Working Group estimate for the cost to rebuild with minimum resiliency to withstand extreme Category 4 storms and sufficient design margin to ensure high survivability for Category 5 events are summarized below
- Absent substantial federal funding for the rebuilding effort, the Energy Resiliency Working Group recommendations cannot be implemented

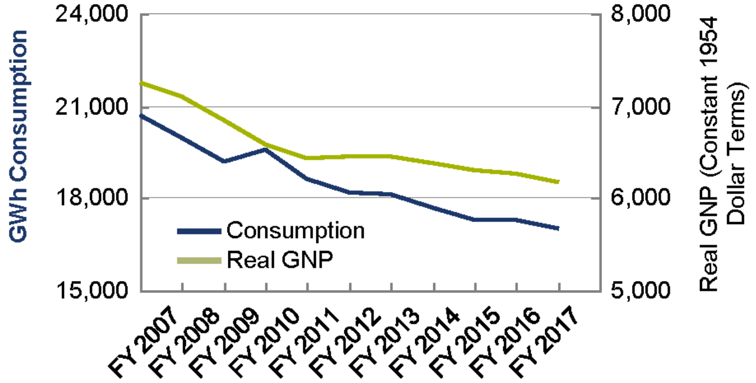
- The ERWG Grid Resiliency Report was part of the Government's formal request for supplemental Federal assistance
- Although Puerto Rico anticipates significantly more Federal Disaster Relief Assistance, out of the $17.6B for Federal Disaster Relief for the Rebuild of the Electric Grid, the Puerto Rico Government currently estimates that $13.7B of federal assistance would be available for repairs and improvements of the electric system.
- As of March 2018, FEMA has allocated $1.953 billion to USACE to execute the Mission Assignment for power grid restoration

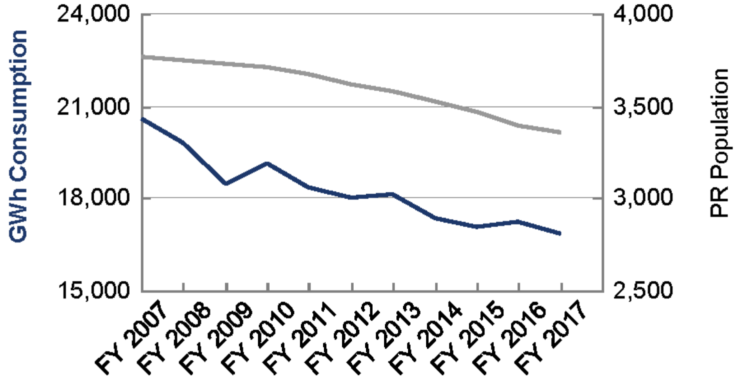
Rebuild Recommendations[1]	Total (millions)
Overhead Distribution (includes 38kV)	$5,268
Underground Distribution	$35
Transmission - Overhead	$4,299
Transmission - Underground	$601
Substations - 38kV	$856
Substations - 115kv & 230kV	$812
System Operations	$482
Distributed Energy Resources	$1,455
Generation	$3,115
Fuel Infrastructure	$683
Total Estimated Cost	**$17,606**

1 Note: Each line item includes a 30% scope confidence escalator. Final cost estimates require multiple engineering studies and an updated IRP.
SOURCE: Puerto Rico Energy Resiliency Working Group report, November 2017, USACE

Puerto Rico Macroeconomic Trends
PREPA Operations Impact Statement
(Before Hurricanes Irma and Maria)

As the economy deteriorated, population declined, and disruptive technologies emerged, demand dropped 18% from 2007 to 2017



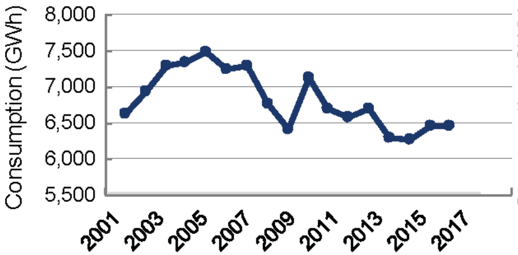


13% loss in demand in the residential sector since 2005 peak

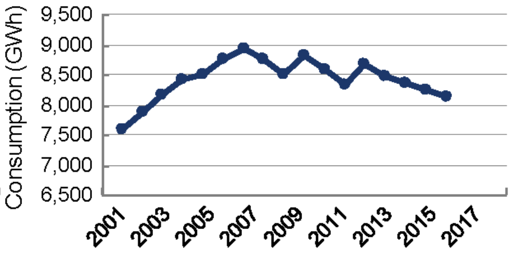
10% loss in demand in the commercial sector since 2007 peak

48% loss in demand in the key industrial sector since 2006 peak

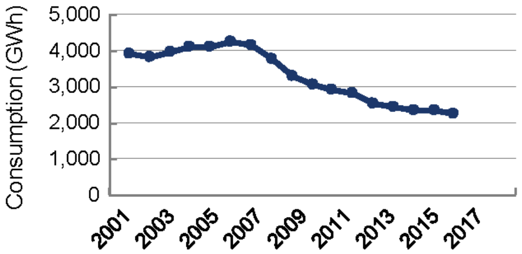
Residential[1]



Commercial



Industrial

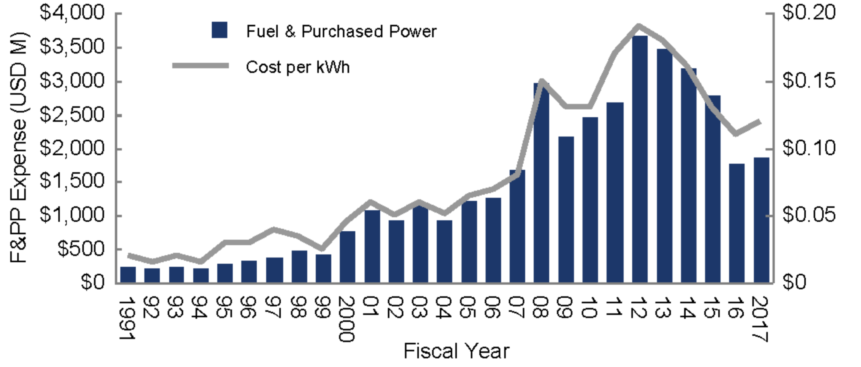


NOTE: here and elsewhere in the document, Fiscal Year begins in July of the previous calendar year

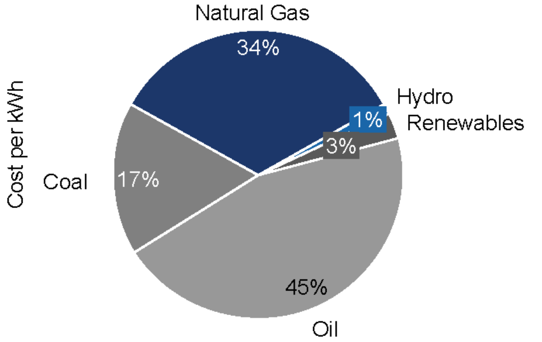
SOURCE: PREPA's rate records from 2000-2017

PREPA Fuel & Power Purchase Dependencies
High Cost Increases Over Three Decades

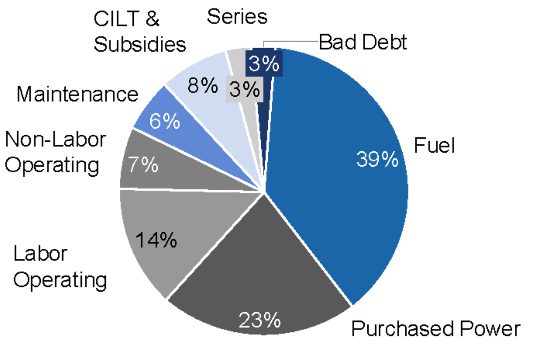
Fuel and Purchased Power is the predominant cost and most volatile rate component for PREPA. Reducing dependence on refined fuel oil for power generation has long been a top priority for PREPA and though progress has been made, oil remains the main source of energy.

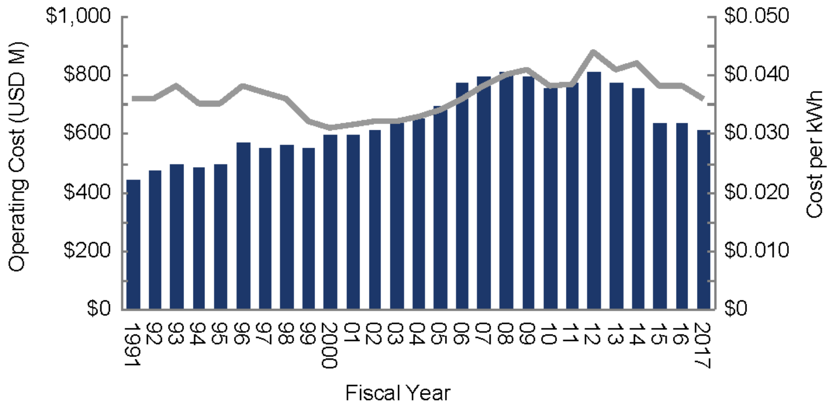


Breakdown of Fuel and PP by Generation Type



Operating Expense Breakdown





SOURCE: PREPA Planning & Finance

PREPA's Structural Debt Not Sustainable

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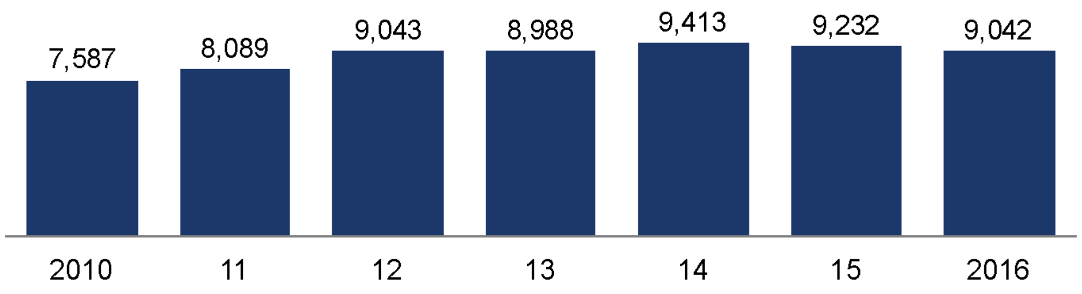
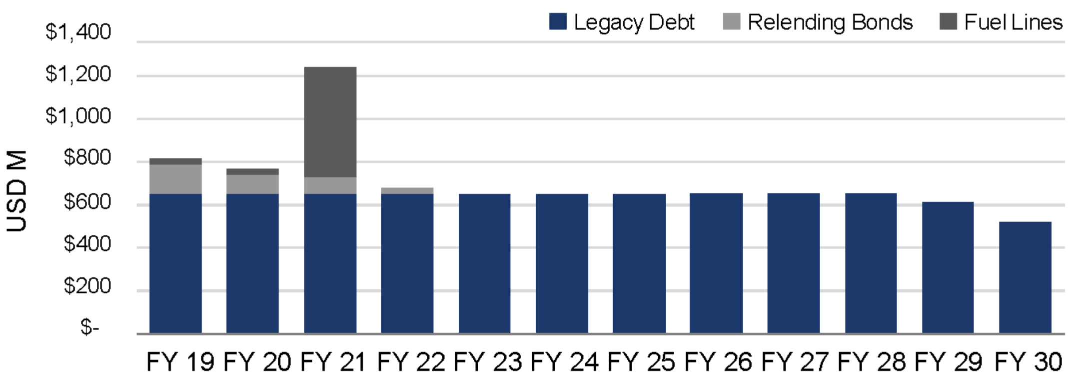
PREPA has had insufficient cash flows to service its debt and entered Title III in July 2017, with over $9B in debt to creditors

- As demand has fallen, financial performance has declined and PREPA has borrowed to fund operating expenses. By 2014, PREPA was overburdened with debt and had no access to additional liquidity
- PREPA had $9.25B outstanding debt as of 5/3/2017, with debt service obligations of $4.5bn over the next five years
- The estimated annual debt service obligation based on term out of all long-term financial liabilities at a 5% interest rate over 25 years was approximately $657 million per year

Debt Balance, USD M[1]



Status Quo Debt Service

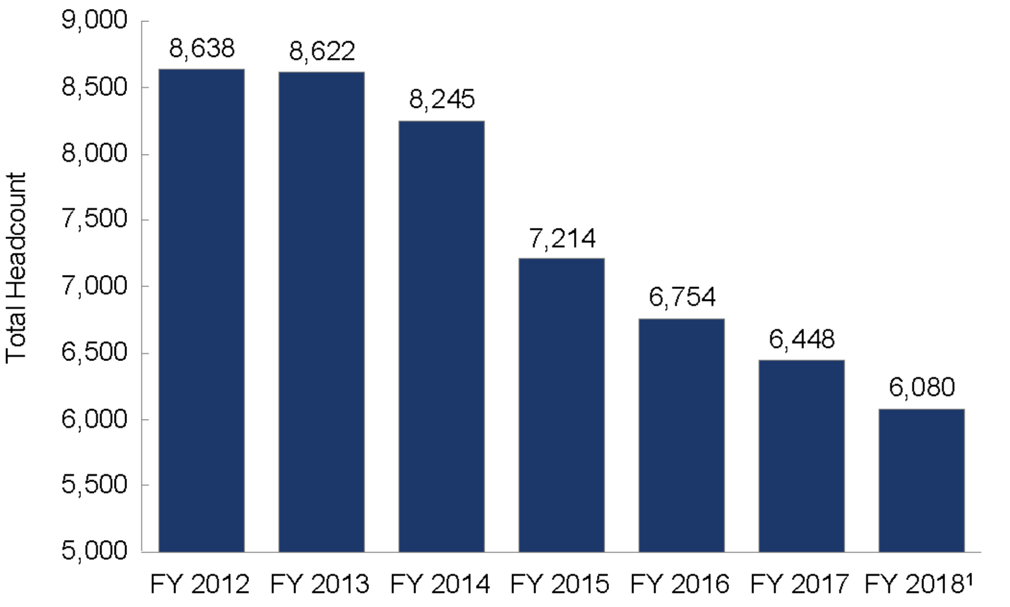


SOURCE: Puerto Rico Electric Power Authority Fiscal Plan - August 1, 2018

PREPA’s Declining Workforce

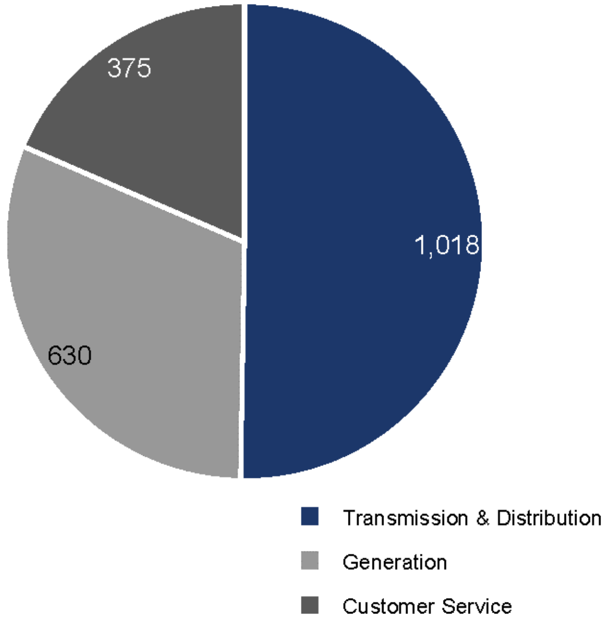
The loss of almost 30% of its workforce since 2012 has constrained PREPA's ability to respond to challenges

Annual employee headcount



- 6,080 as of May 2018
- PREPA’s headcount declined by 2,411 from FY 2012 to Dec 2017 – mostly due to retirement

Employee retirements from 2012-2017



- Of the 2,343 employees that retired between 2012 and 2017, 2,023 (86%) were from operations and 320 from administration

1 PREPA has 600 employees who are awaiting approval from the Employees Retirement System of PREPA SOURCE: PREPA Human Resources Directorate

PREPA's Reliability Metric Performance
(Before Hurricanes Irma and Maria)

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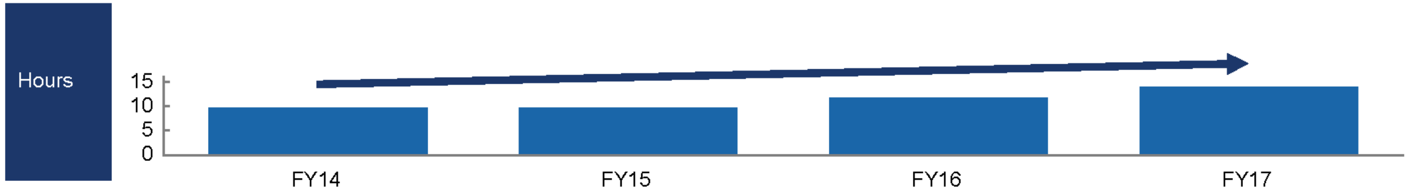
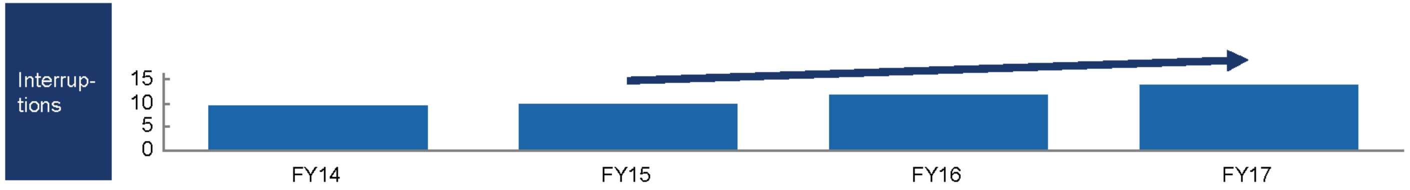
	FY17	2016 Utility Peer Group			Comparison of PREPA reliability to median North American Utility Peer Group reliability(1)
	PREPA[1]	Lower Quartile	Median[3]	Upper Quartile	
SAIDI	14.35	2.77	1.92	1.35	On average, PREPA customers do not have power for 14.4 hours
SAIFI	4.83	1.32	1.04	0.86	On average, PREPA customers lose power almost 5 times a year
CAIDI	2.97	2.10	1.84	1.57	On average, when PREPA customers lose power it takes 3 hours to restore

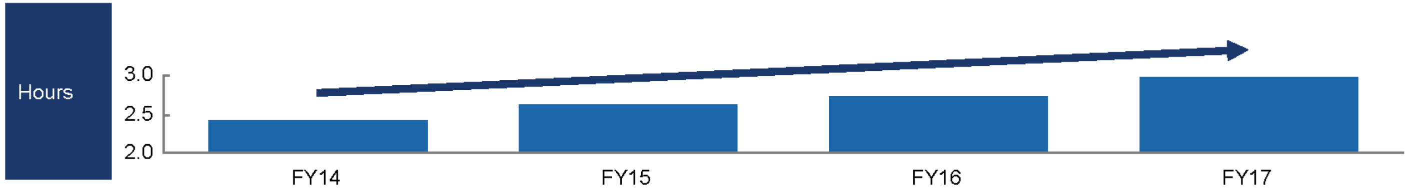
System Average Interruption Duration Index ("SAIDI")



System Average Interruption Frequency Index ("SAIFI")



Customer Average Interruption Duration Index ("CAIDI")



1 PREPA data LTM as of July 2017, SAIDI/CAIDI are measured in hours and SAIFI is measured in # of occurrences
2 FY 2017 data projected based on prior year performance for August through December to exclude the impact of the hurricanes
3 Source of SAIFI, SAIDI and CAIDI North American utility data is the IEEE Benchmark report:

PREPA's Fiscal Plan
Transformation Reliability and Resilience Targets

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Reliability

Potential metrics

Metric	PREPA (FY17)[1]	Low Quartile	Median	Upper Quartile
SAIFI (total # of annual customer interruptions/total # of customers served)	4.83	1.32	1.04	0.86
SAIDI (sum of all customer interruptions duration in hours per year/total # of customers served)	14.35	2.77	1.92	1.35
CAIDI (SAIDI/SAIFI)	2.97	2.10	1.84	1.57

Actions

- **Maintenance:** Maintain adequate level of maintenance capex given new grid in order to reduce both O&M costs and interruptions
- **System operations:** Upgrades including monitoring and automation technology to identify issues requiring action and enable automated responses during interruptions
- **Other** (O&M): Institute predictive maintenance programs

Resilience

Description

- Grid resiliency equal to mainland US hurricane-prone utilities: (e.g., resilience targets suggested by Sandia National Labs after Superstorm Sandy)
- Economic analysis of additional resiliency built into critical parts of system sufficient to deliver power during large storms and capital investment consistent with mainland US utilities

Targets

1 or fewer outage-days per customer

0 critical services without power more than 48 hours

$4-5B in targeted resilience investments

Actions

- **T&D upgrades:** Harden existing infrastructure assets, relocate or underground subset of assets
- **Microgrids:** Develop microgrid capabilities for critical infrastructure
- **Other** (generation): Build out distributed generation fleet less reliant on N-S transmission loops

1 Based on PREPA figures reported in 2017 compared to 2016 North American utility peer group (per IEEE benchmark report)
SOURCE: PREPA, North American utility data is the IEEE benchmark report

PREPA’s Fiscal Plan:
End State Structures for Transformation

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T&D Concession

- Delivery and retail utility functions provided by single private concessionaire using publicly-owned wires and retail service assets subject to conditions and rate and performance regulation
- Concession awarded via competitive process
- Concessionaire must make and fund necessary investments not otherwise publicly funded; title to all assets remains public
- Concessionaire receives retail rate revenues set generally under established rate standards
  - Rates recover prudent operating and supply costs
  - Rates include return of/on cost of new investments
  - Potential return on value of other assets and recovery of unrecovered investment costs at end of concession term linked to investment obligation
  - Performance on metrics and incentives can also affect rates and revenues
- IRP and Renewable Portfolio Standard (RPS)
- CPCNs for major investments not authorized by statute, franchise, investment plan, or IRP

Generation sale

- New franchises created for one or more privately owned generation companies
- Generation franchises create right to operate utility scale generation and sell to delivery utility
- Franchisees can acquire useful generation assets now owned by PREPA under Title III process
- CPCNs for major new investments not authorized by statute, franchise, investment plan, or IRP including new competitive utility-scale generation
- Energy sales can occur through negotiated contracts (PPOAs) subject to market power test and backup regulation
- Migration to other market structures (e.g., periodic auctions) possible if and as future market develops
- IRP, objective performance standards, reserve requirements, and Renewable Portfolio Standard regulations apply
- Regulation of subsequent purchases / sales / reorganizations under traditional standards

Industry end structure may take various other forms (e.g., vertically-integrated utility) based on industry participant feedback during market sounding

SOURCE: Puerto Rico Electric Power Authority Fiscal Plan - August 1, 2018

Integrated Resource Planning, Enabling Grid Modernization

Integrated Resource Planning (IRP)
Situational Awareness

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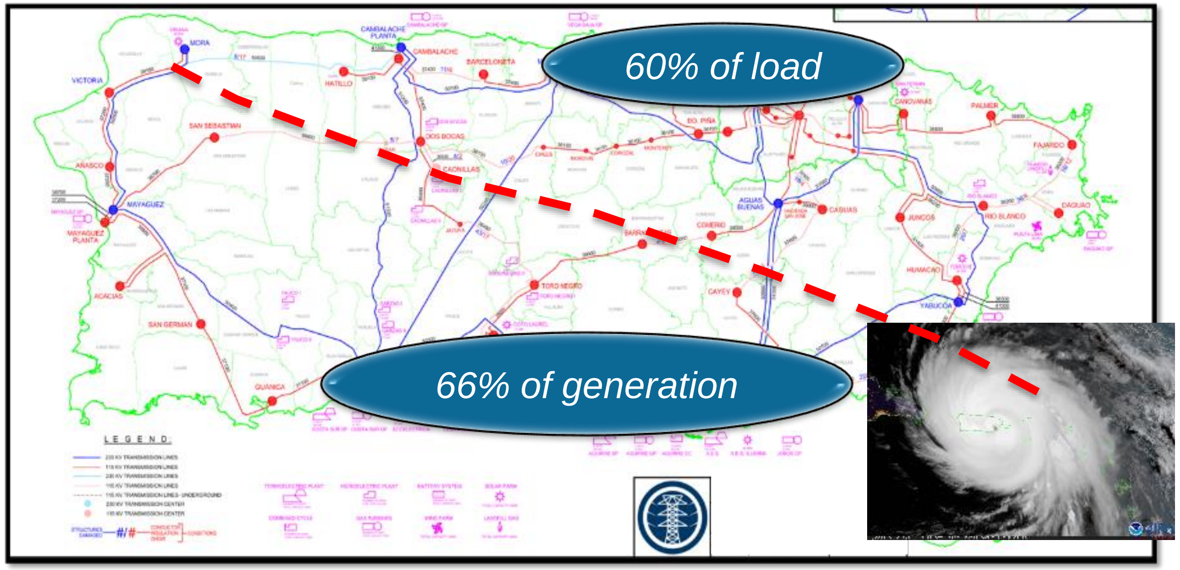

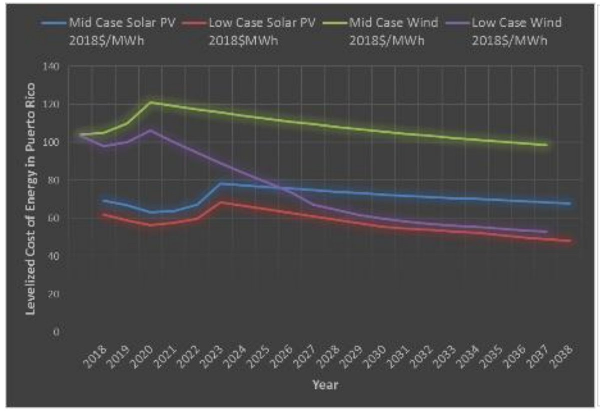

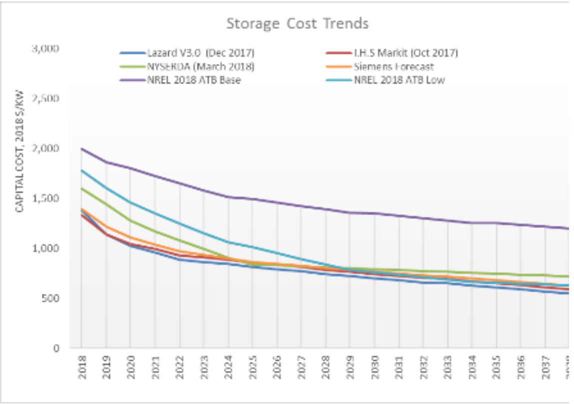

- A reliable electrical grid is the backbone of any city or community. Even more essential, is the inherent geographical isolation faced by an island community.
- ***Traditional grid designs that focused on economics have resulted in systems especially vulnerable to major atmospheric events.***
- Puerto Rico's electric power system was no exception and experienced massive devastation caused by hurricanes Irma and Maria.
- ***Resiliency, Reliability and Economics are the new paradigms for the design of a new electrical grid.***
- The steep drop in the cost of renewables and energy storage offers a rare and powerful opportunity to redesign the power system, to increase resiliency, reliability and economics while utilizing clean energy.

Modernizing Grid Architecture Requires Integrated Planning Processes

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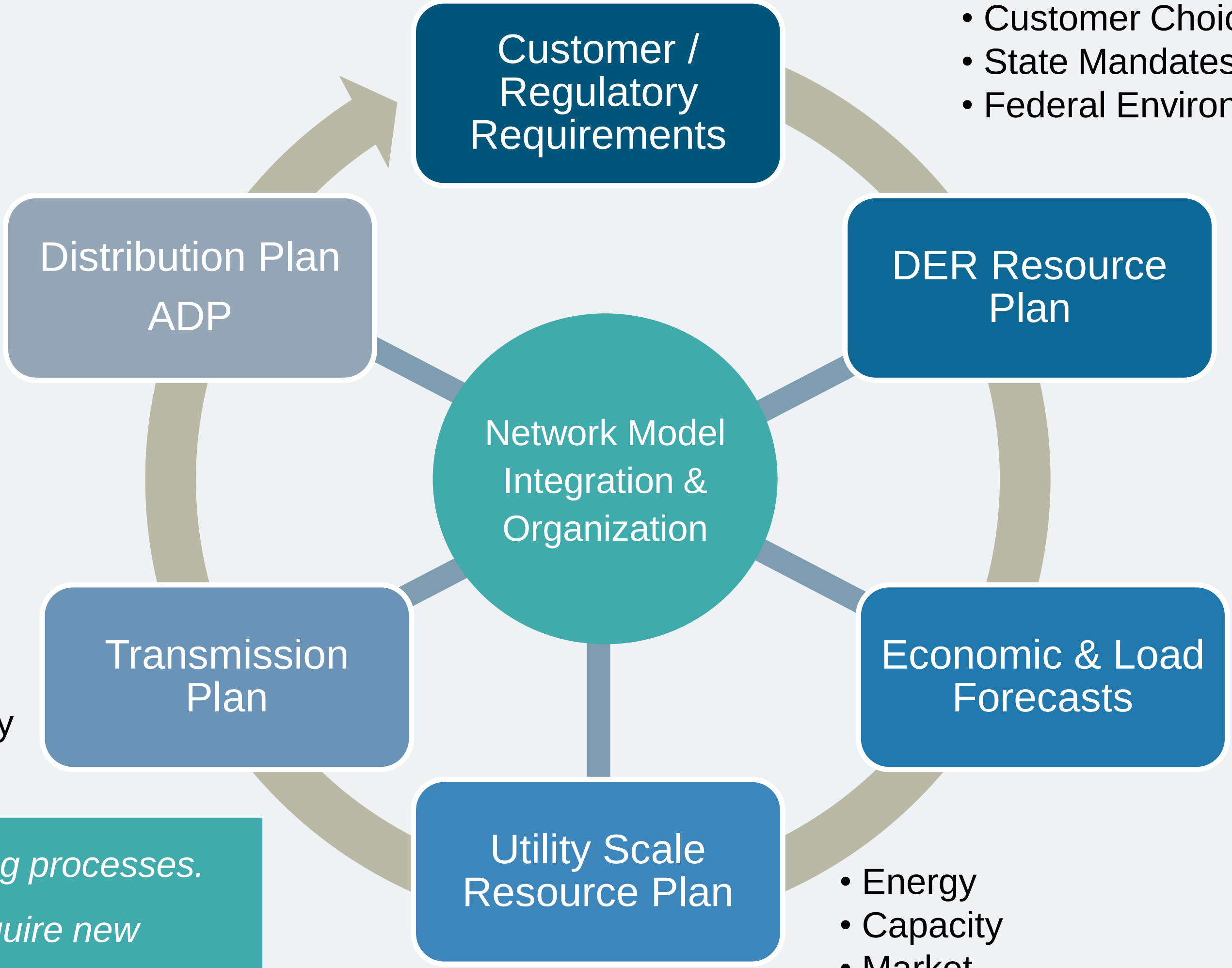
- Customer Choice
- State Mandates
- Federal Environmental Regulation

- Asset Replacement
- Loading
- Overloads
- Voltage Violations



- Solar
- Energy Storage
- Demand Response
- Energy Efficiency

- Congestion
- Capacity
- Contingency

- Load Forecast
- DER Resource Effects
- EV Forecast

- Energy
- Capacity
- Market
- Renewables

Classic grid design follows classic planning processes.

Emerging grid architectural paradigms require new integrated planning processes and tools.

IRP Design
Pillars and Implications

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- **Resiliency:** The system has to be able to prepare, manage and timely recover from extreme weather events like hurricane Maria.
- **Financially Viable:** The plan has to minimize the cost of supply and drastically reduce the dependence on imported fuels.
- **Sustainable:** The Puerto Rico electric system has to transition from one centered on fossil fuels to one in which renewable resources play a central role.
- **Customer-Centric:** Consumer participation via energy efficiency, customer side energy resources (distributed generation) and demand response have a predominant role in the energy matrix of Puerto Rico.
- **Economic Growth Engine:** Promote and support the economy of Puerto Rico. Encourages participation of consumer and third parties

Integrated Resource Plan (IRP) to be focused on distributed resources.

Generation Resource Selection:

- **Critical loads** to be served by local thermal resources; full coverage right after the event.
- **Priority loads** to be served by a combination of local thermal resources, utility scale and customer owned renewable (PV) and storage as assigned by the IRP.
- **Balance of loads** to be served by a combination of local and remote economic resources; on grid isolated mode some level of rotating load shed accepted.

Pre-planned grid segmentation and hardening or undergrounding of selected transmission and distribution facilities.

Customer participation via energy efficiency, demand response and distributed generation.

Tactical Objectives

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An implementable IRP is…

Flexible: The IRP is not a strict prescription of actions over its timeframe, but rather a road map with short term actions and off-ramps to deal with an uncertain future.

The short term actions have actual projects which are always the best option, called **no-regret projects** in our discussion, and preparatory actions that will ensure that we create and maintain the alternatives necessary for adapting to an uncertain future.

The medium and long term actions have directional value;
they show were we should go as a compass.

In the long run IRP has to have the flexibility of sails and not rails.

Tactical Objectives

SIEMENS
Ingenuity for life

An implementable IRP is…

Practical: The plan must be implementable and account for physical limitations on a number of projects that can be carried out in parallel, without compromising the reliability of the system and the ability to manage them.

Pragmatic: While forward looking and based on the use of new technologies such as storage, the technical risks must be managed and the adoption measured, particularly as we are moving towards a drastic departure from the way the system is being operated.

The IRP will change the system but it must be done prudently.

Design Concepts
Customer Initiatives

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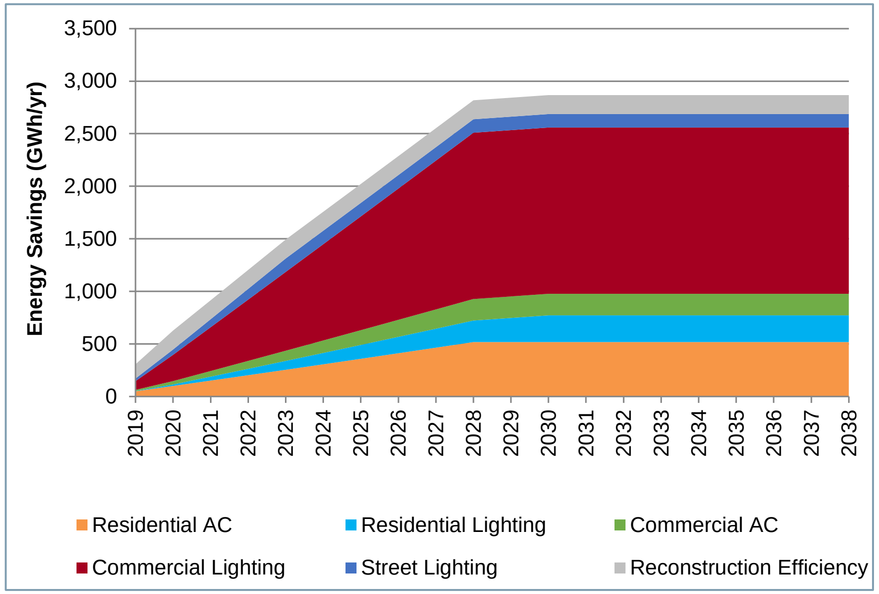
The IRP includes a number of customers initiatives:

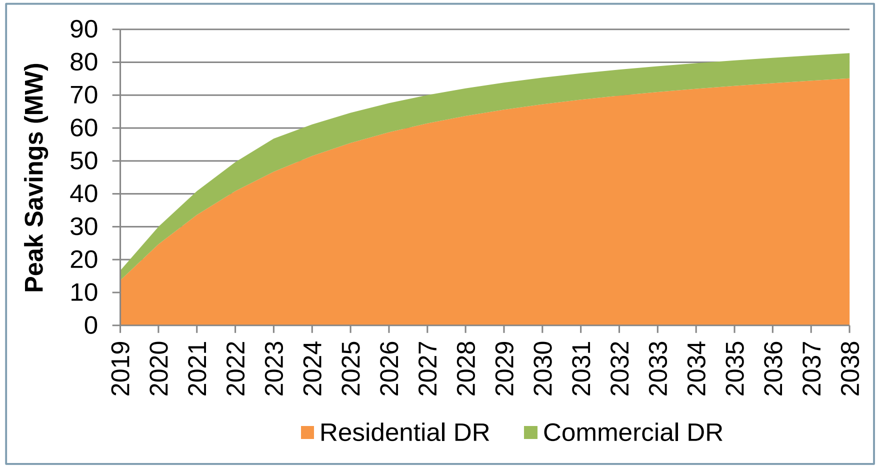
Energy Efficiency

- This is one of the most sustainable and high return alternatives to supply; maintain the comfort and services but consume less.
- 2% year on year gains for 10 years considered and initiatives identified.
- Detailed implementation studies need to be carried out anchored on Puerto Rico customer base reality.

Demand Response

- Load can help provide reserves, reducing the need to dispatch and even build expensive peaking generation.
- The impact on loads is minimal as they are called upon only during emergencies.
- Over 3% of the peak demand (10% of the planning reserve margin) can be supplied from this source.





Design Concepts
Customer Initiatives

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The IRP includes a number of customers initiatives:

Rooftop Solar & Combined Heat and Power (CHP)

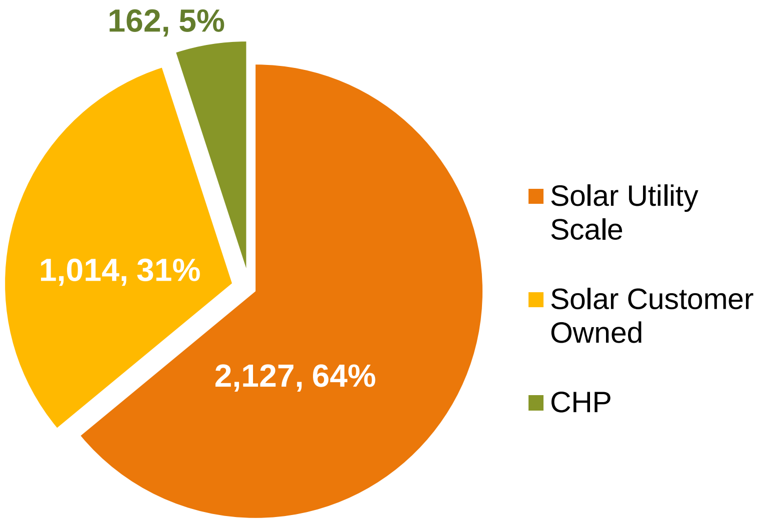
- Customer owned rooftop solar is an important element of the IRP resources.
- The IRP is NOT prescriptive in the actual amount to be integrated, if more than forecasted are connected then less will be required from the utility scale PV. Virtual power plants composed of rooftop solar, operated in an integrated manner, could replace an equivalent utility scale plant.
- Customer owned storage can also support the integration of PV, and if customer installs, then less will be required at the utility scale.

Combined Heat and Power (CHP)

- CHP is efficient way to provide cooling / steam and electric energy, but requires capital investments from industrial / commercial customers, thus conservative assumptions on integration were made. However as before if more is installed then less thermal generation is required.

Now resources are not fringe; they must be properly implemented and be able to support the grid (IEEE 1547).

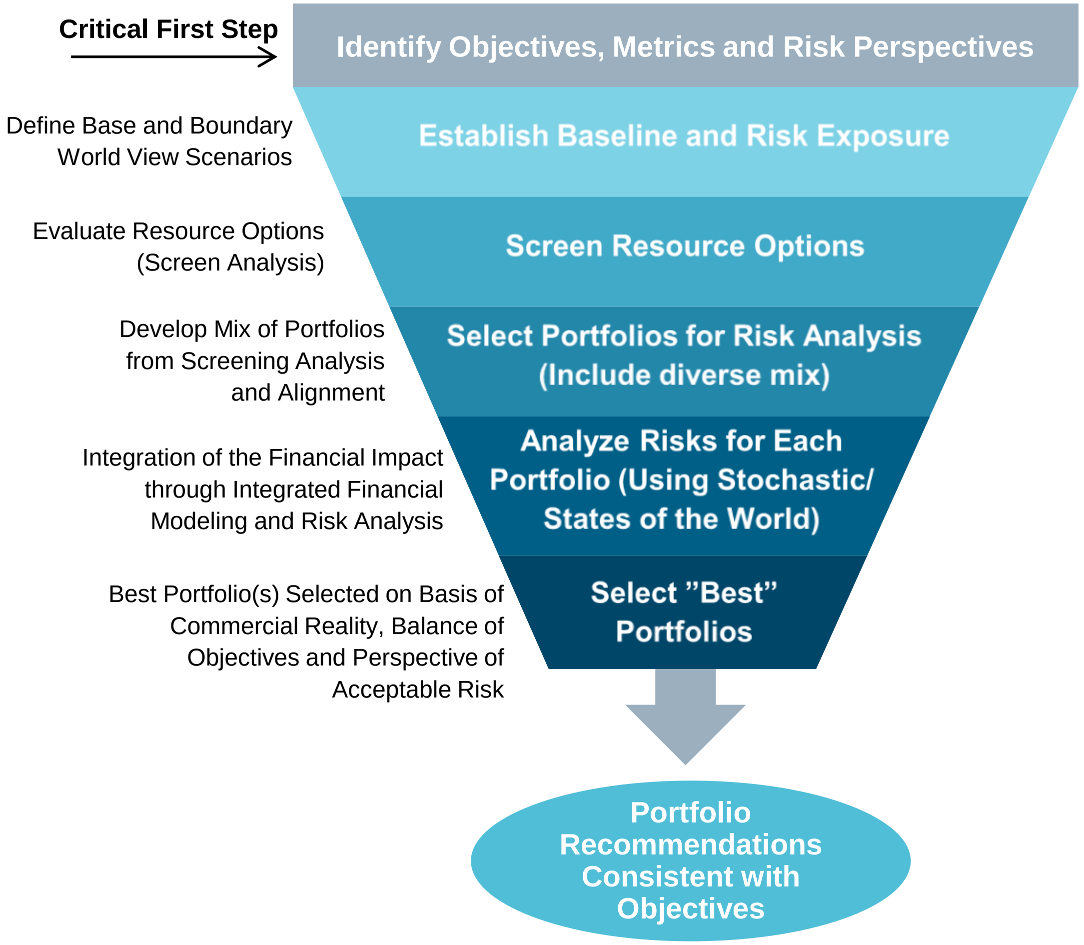
ESM 50% 2038 Renewable and CHP Mix MW, %



Distribution to be reinforced allowing this penetration.

Design Concepts
Long Term Capacity Expansion Plan

- To replace PREPA's ageing generating fleet, complement the customer owned generation and provide supply side resources to the MiniGrids and Puerto Rico in general, long-term capacity expansion (LTCE) plans are produced.
- These LTCE plans provide the information necessary to design our ***road map*** to achieve the overarching goal of creating an economic, reliable and resilient power system for Puerto Rico, complete with short term decisions and the off-ramps to deal with uncertainties.
- Next we will focus on this aspect of the IRP starting with ***strategies and scenarios*** moving to results and the action plan.



Puerto Rico
IRP Development

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- A series of long-term capacity expansion (LTCE) plans based on five defined scenarios regarding access to new natural gas and renewables resources.
- Each scenario is run at various load sensitivities, as well as three strategies for grid design:
  - **Strategy One:** System is fully centralized, with no limitations on resource location.
  - **Strategy Two:** System is highly distributed, with at least 80% of peak demand covered by localized capacity.
  - **Strategy Three:** System is moderately distributed, with at least 50% of peak demand covered by localized capacity.
- The IRP approval process is running concurrently with the transformation.

5 scenarios assessed x 3 strategies x 3 load levels = 45 LTCEs

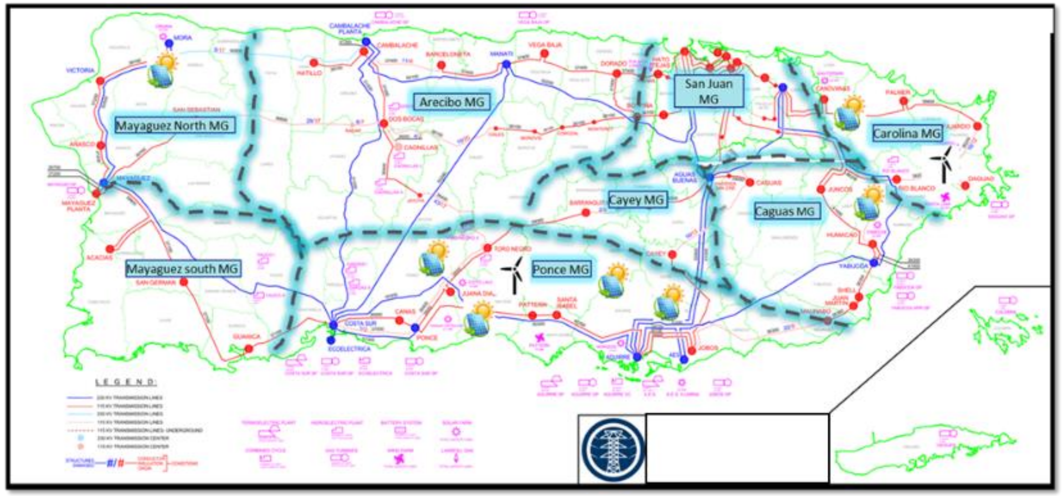
Scenario	New Gas				Renewable & Storage	
	AOGP	Land-based LNG at San Juan	Ship-based LNG at Yabucoa	Ship-based LNG at Mayaguez	Costs	Availability
1	No	No	No	No	Reference	Reference
2	No	Yes	No	No	Reference	Reference
3	No	Yes	Yes	Yes	Low	High
4	No	Yes	Yes	Yes	Reference	Reference
5	Yes	Yes	Yes	Yes	Reference	Reference

6 sensitives to assess impact on selected base cases

Sensitivity	Solar / BESS		Energy Efficiency	PPO As	Gas	
	Low Cost	High Cost	Low EE	Economic Retirement of AES and EcoEléctrica	Ship-based LNG at San Juan	High Gas Prices
1	◆					
2			◆			
3				◆		
4					◆	
5						◆
6		◆				

Results and Action Plan

IRP Study Results
Transmission



Minigrids T&D design based on:

- Backbone 115 kV and 38 kV underground or hardened for rapid reconfiguration.
- Generation and critical loads reconnected to the backbone via underground or hardened facilities
- Conversion to GIS of critical T&D substations
- Undergrounding of feeders serving critical loads.

To provide resiliency the system is organized into independent electrical **islands** into which the system can be divided following a catastrophic event; **the Minigrids.**

- Eight Minigrids identified considering the vulnerability of the transmission system and the practical possibilities to reinforce it.
- Minigrids designed to supply critical loads such as hospitals, police stations, fire departments, etc. during the event or shortly after by connecting loads to thermal generation with underground facilities.
- Minigrids complemented with microgrids for loads that cannot be effectively served by the Minigrid.
- Each Minigrid normally operates economically by interconnection with the rest of the electric power system, but can operate independently in the event of grid failure.

Eight Minigrids Serving
Ten Areas for Puerto Rico

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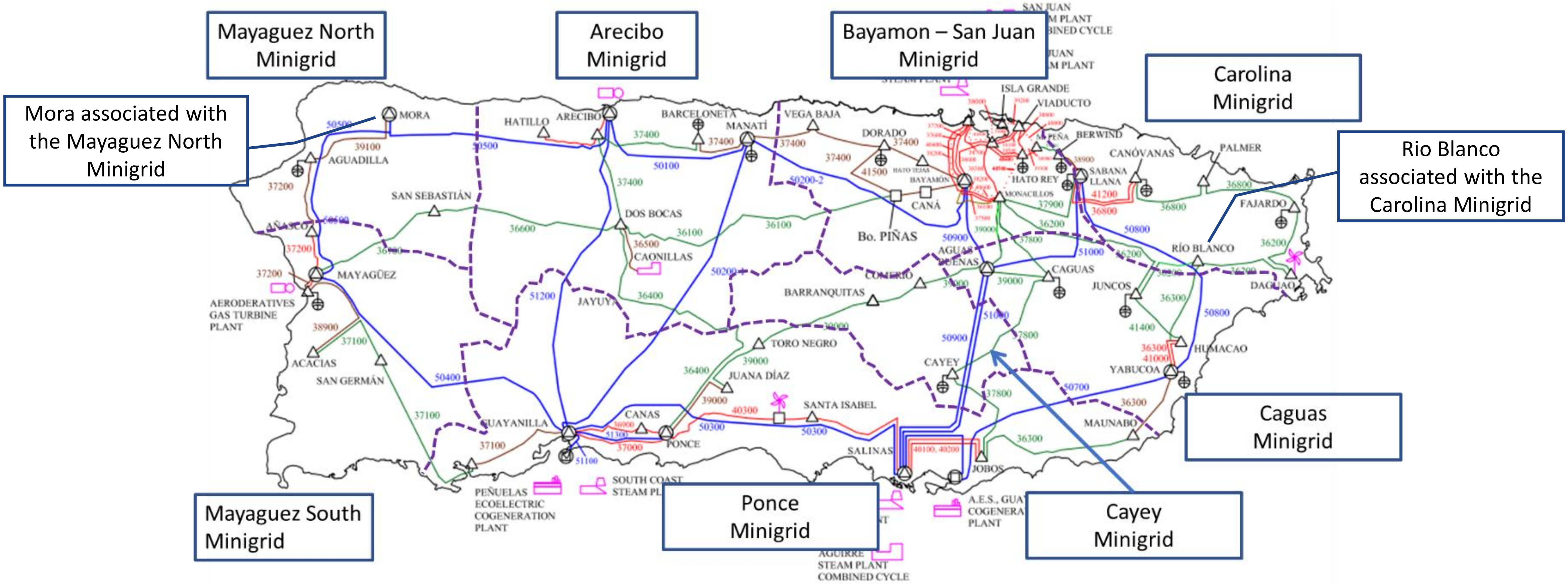

- Infrastructure expected to ride through a major event or at most a few hours interruption; targeted <10 days to repair & restore after a major event
- Infrastructure targeted <30 days to repair & restore after a major event
- 230kV infrastructure subject to >1 month long-term repair & restoration requirements after a major event
- Other infrastructure subject to >1 month long-term repair & restoration after a major event

Minigrids Design

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The design of the Minigrids (and microgrids) consist of two overarching activities:

Local Generation Resource Selection

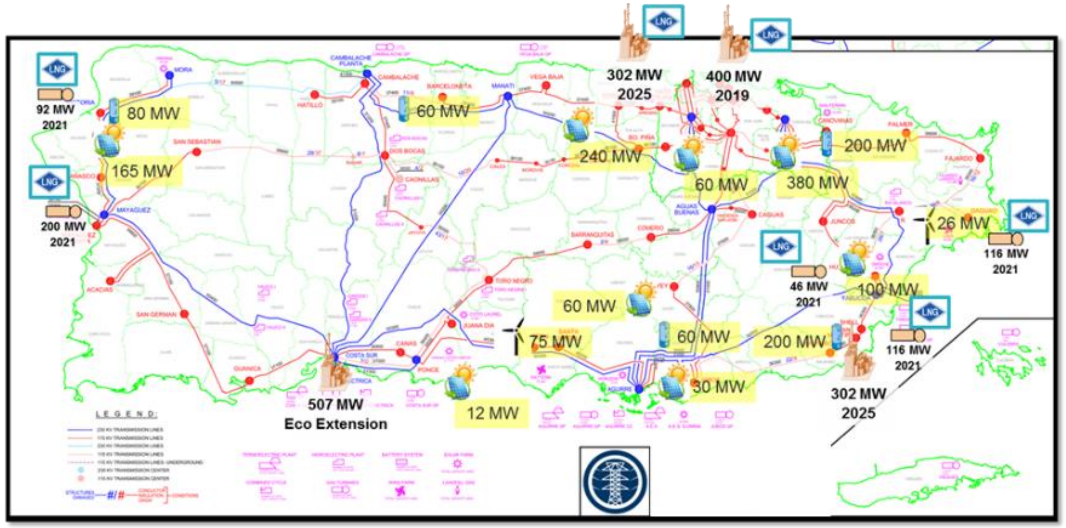
- The critical loads must be able to be served by thermal resources only; full coverage right after the event.
- Priority loads to be served by a combination of thermal resources and PV + Storage.
- Balance of loads to be served by a combination of thermal resources and PV + Storage and on grid isolated mode some level of load shed is accepted.
- Microgrid ideally should be covered by reciprocating engines assigned by the LTCE to the region. PV + Storage can complement.

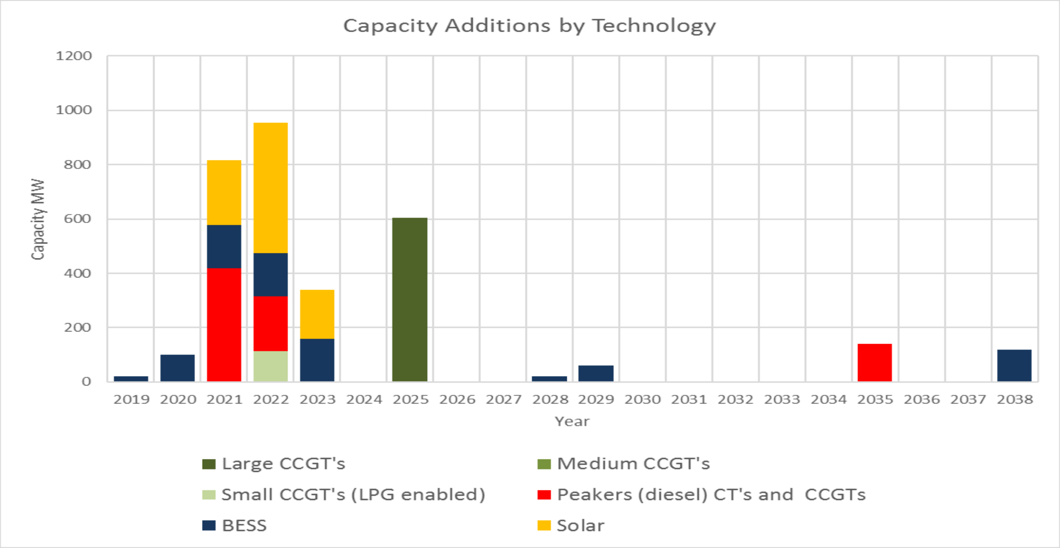
We present next the results for Scenario 4 Strategy 2: -80% minimum reserves.

Transmission / Distribution Design

- Hardening / new underground facilities to create a Minigrid backbone which the generation is connected to and loads are served from.
- Building underground facilities for interconnection of critical loads.
- New underground reliable facilities for the interconnection of Minigrids and faster consolidation.
- Extension of the Minigrid backbone to areas of high reliability and resiliency.
- Hardening of the existing infrastructure as complementary to the above.

IRP Study Results
Generation

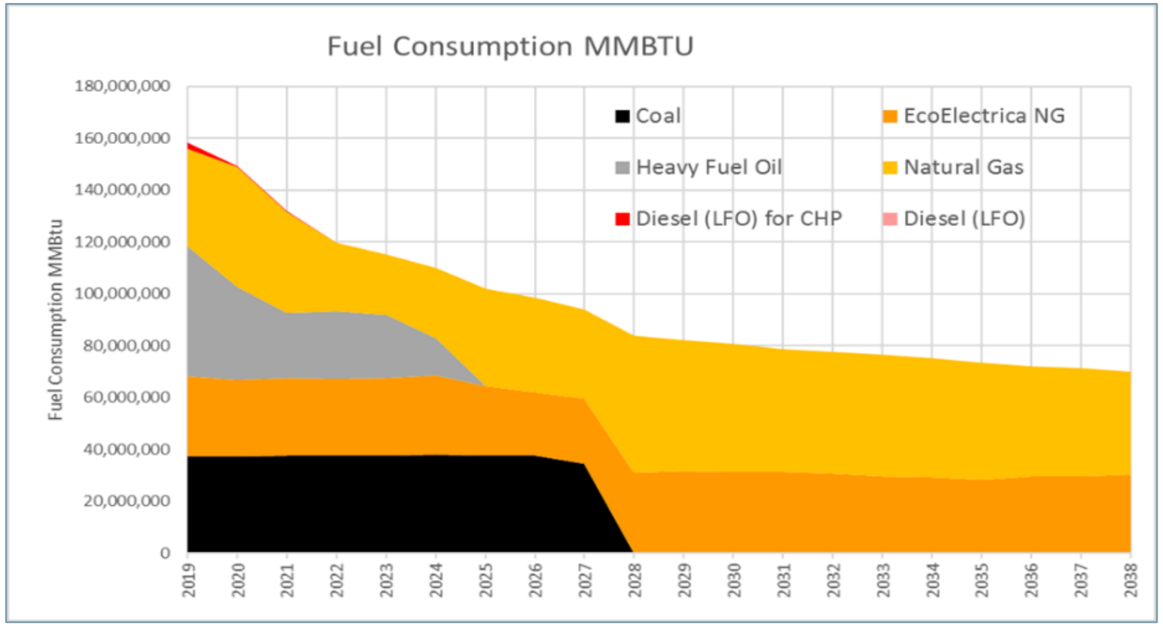




No Regret Decisions

- Maximize the rate of installation of renewable generation for the first four years (2019 to 2022) of the plan; 900 to 1200 MW.
- Install between 440 MW to 900 MW of Battery Energy Storage in the first four years of the plan (depending on renewable installation rate achieved).
- Develop a land-based LNG in the north and supply a new 302 MW CCGT and the existing San Juan 5&6 CCGT
- Convert existing San Juan 5&6 Combined Cycle (CC) to burn natural gas
- A new 300 MW CCGT at Costa Sur or extend a renegotiated contract with EcoEléctrica
- Retire the majority of the old and expensive power plants in the initial five years

IRP Study Results
Generation



Fuel Consumption

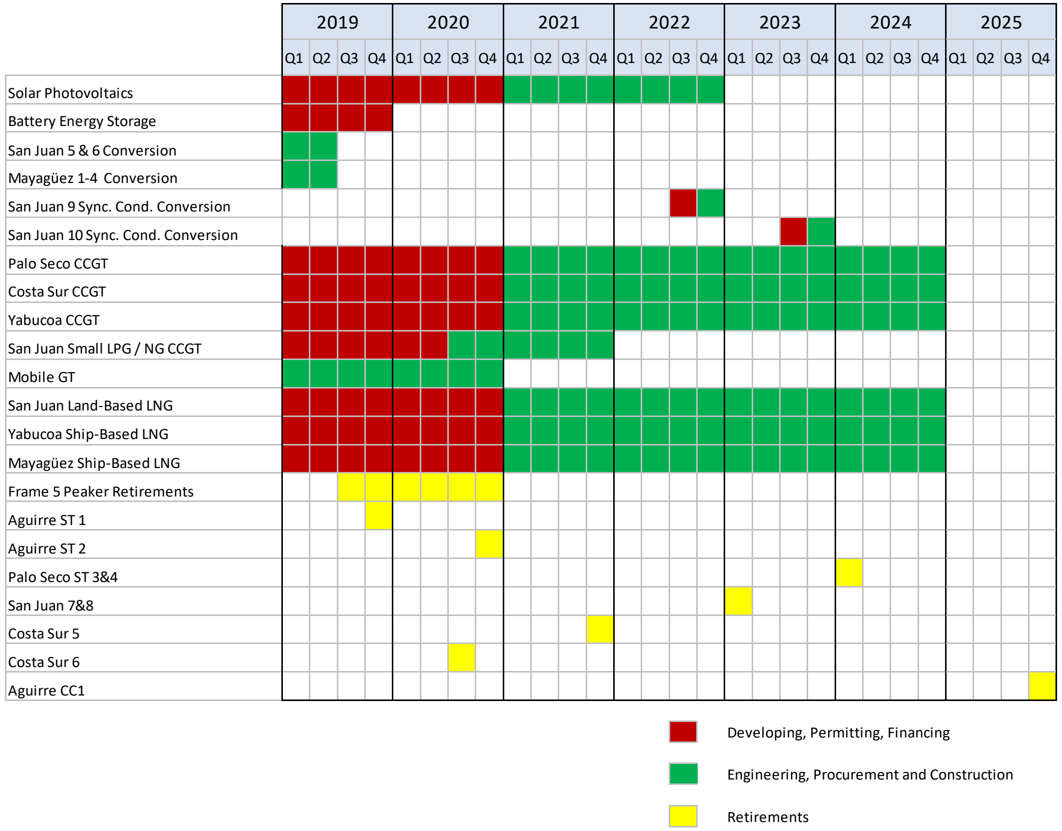
In line with the change in the energy supply matrix, there is a sharp drop in fuel consumption and associated costs with the implementation of the plan. Fuel consumption declines by 44% by 2038.

Minimum Regret / Hedging Decisions

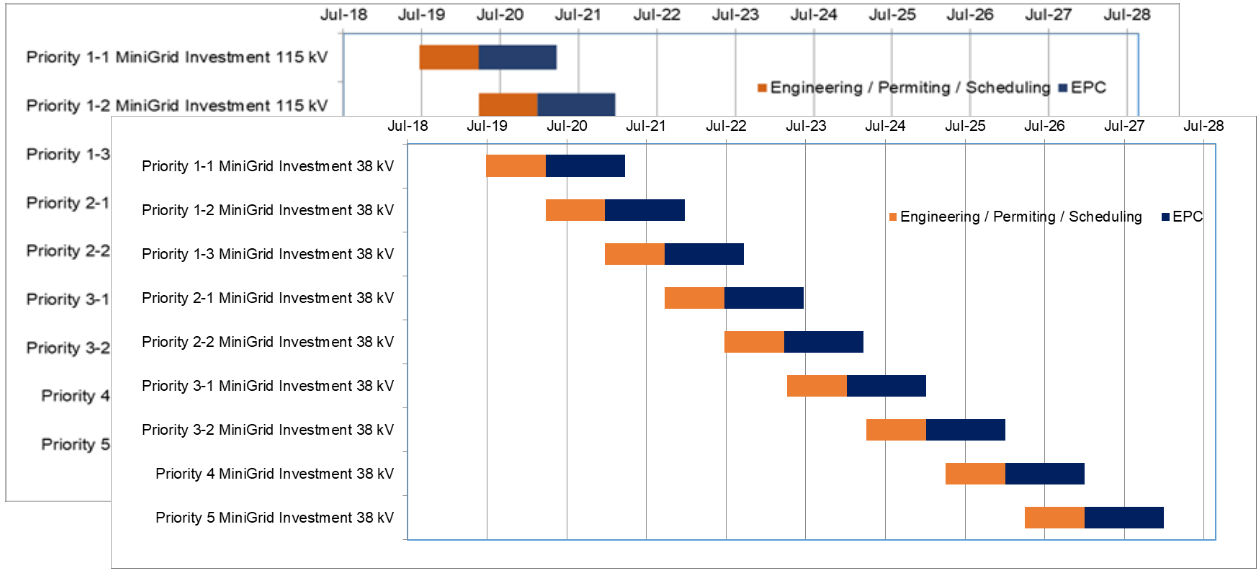
- Install a new 300 MW CCGT in the south or extend a renegotiated contract with EcoEléctrica (existing plant)
- Develop a Ship-Based LNG terminal in the west (Mayagüez) and supply the existing 4x50 MW Aeros and possibly a new 300 MW CCGT depending on load and the development of other CCGTs.
- Develop a Ship-Based LNG terminal in the east (Yabucoa) with a new 300 MW CCGT.
- Monitor Renewable (PV) and storage prices as well as integration technologies
  - With low renewable prices and high adoption, lower costs of supply can be achieved.
  - Volumes are very high and may stretch the ability to operate the system, but technology is improving fast
  - Keep flexibility and be able to change our course.

IRP Action Plan
High Level Timelines were developed as part of the action plan

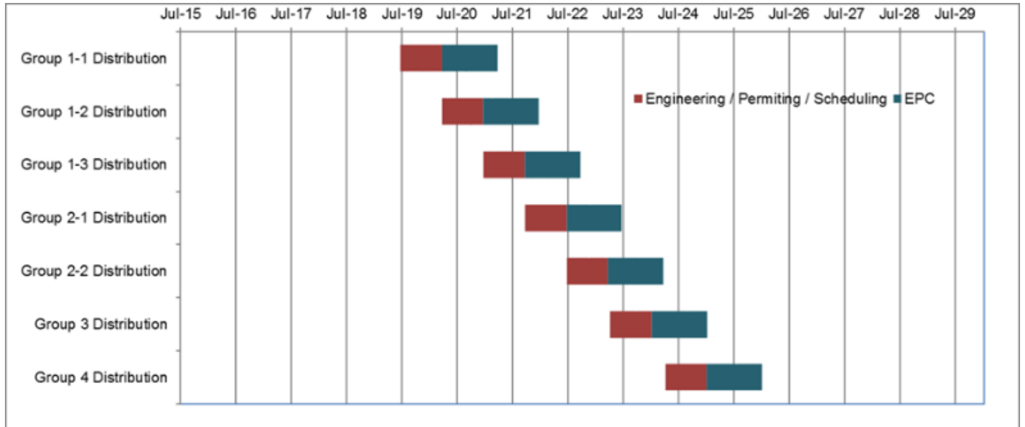
Generation



Transmission



Distribution



Benefits to Puerto Rico

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1. Resilient system able to minimize impact of major hurricanes
2. Reduction in cost of electricity supply with a reliable, efficient and economic power system
3. Elimination of hazardous emissions from power plants and CO_2 emissions over time
4. Stable and predictable electricity rates with a drastic reduction of price shocks due to the volatility of imported fuel prices
5. Consumer participation; elimination of unnecessary investments and wasteful consumption via energy efficiency and Demand Response.

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Siemens Digital Grid Leadership Presentation

John DeBoer Head of Siemens Future Grid

Tuesday, April 30, 2018

Agility in Energy
2019 Digital Grid
Customer Summit
Connecting an All-electric World

 usa.siemens.com/digitalgrid

The eMobility Accelerator

siemens.com/emobility-ecosystem

Megatrends that are changing our world

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By 2050, nearly **70%** of the world population will live in cities; today it's **54%**.

Source: United Nations, World Urbanization Prospects. The 2014 Revision, New York, veröffentlicht 2015

At the UN Climate Conference in Paris in 2015, almost all nations of the world agreed to limit anthropogenic global warming to well under **2º centigrade**.

Source: Earth System Research Laboratory, NOAA, 5. Oktober, 2017

By 2020, the global volume of data will soar to **44 zettabytes**, and **50 billion** devices will be connected.

Source: IDC, The Digital Universe of Opportunities: Rich Data and the Increasing Value of the Internet of Things, April 2014

In the time span of **20 years**, global export volume has more than quadrupled.

Source: Statista, 2017

75%

of energy consumed in cities

33%

for transportation

The Mobility Sector is Under Complete Disruption

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Electric

Decentralized
Makes customers active parts of the system, though requires significant coordination

Digitalized
Allows for open, real-time, automated communication and operation of the energy system

Clean and renewable
Critical to long-term decarbonization goal. Mindset shift in society of developed countries

Autonomous
System takes over driving completely for all street types, speed zones, and environment conditions

Shared
Increases the overall use of the mobility assets based on customers' needs

On-demand
Journeys start when and from where the user needs them and get more flexible driven by digitalization

A New Acceleration Pattern Has Emerged

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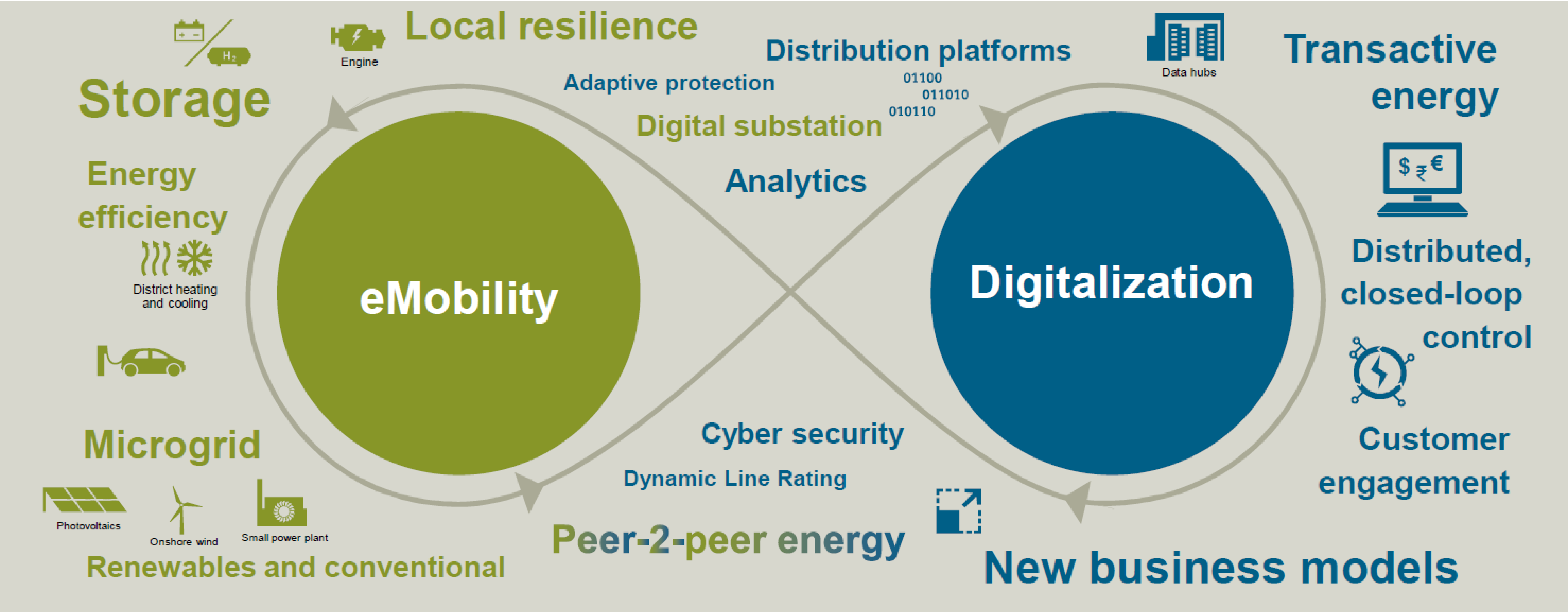

Are You Ready for Your First Chinese Electric Car?

eMobility Is changing Now

Private Transportation

Public Transportation

Fleet

Renewable

Electrical Infrastructure
(plug-to-grid)

Spending

If It Moves People or Goods…It is Electrifying <u>Today</u>

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Rivian - Amazon invests $700 Million comes out 2020 Located in Detroit

Amazon converting 100's of vehicles to EV in 2019

*Daimler Delivers Freightliner Electric Truck to **Penske** in 2019*

Tesla Truck & Semi-Truck

Learning from Our First 100,000 Charging Installations Around the World

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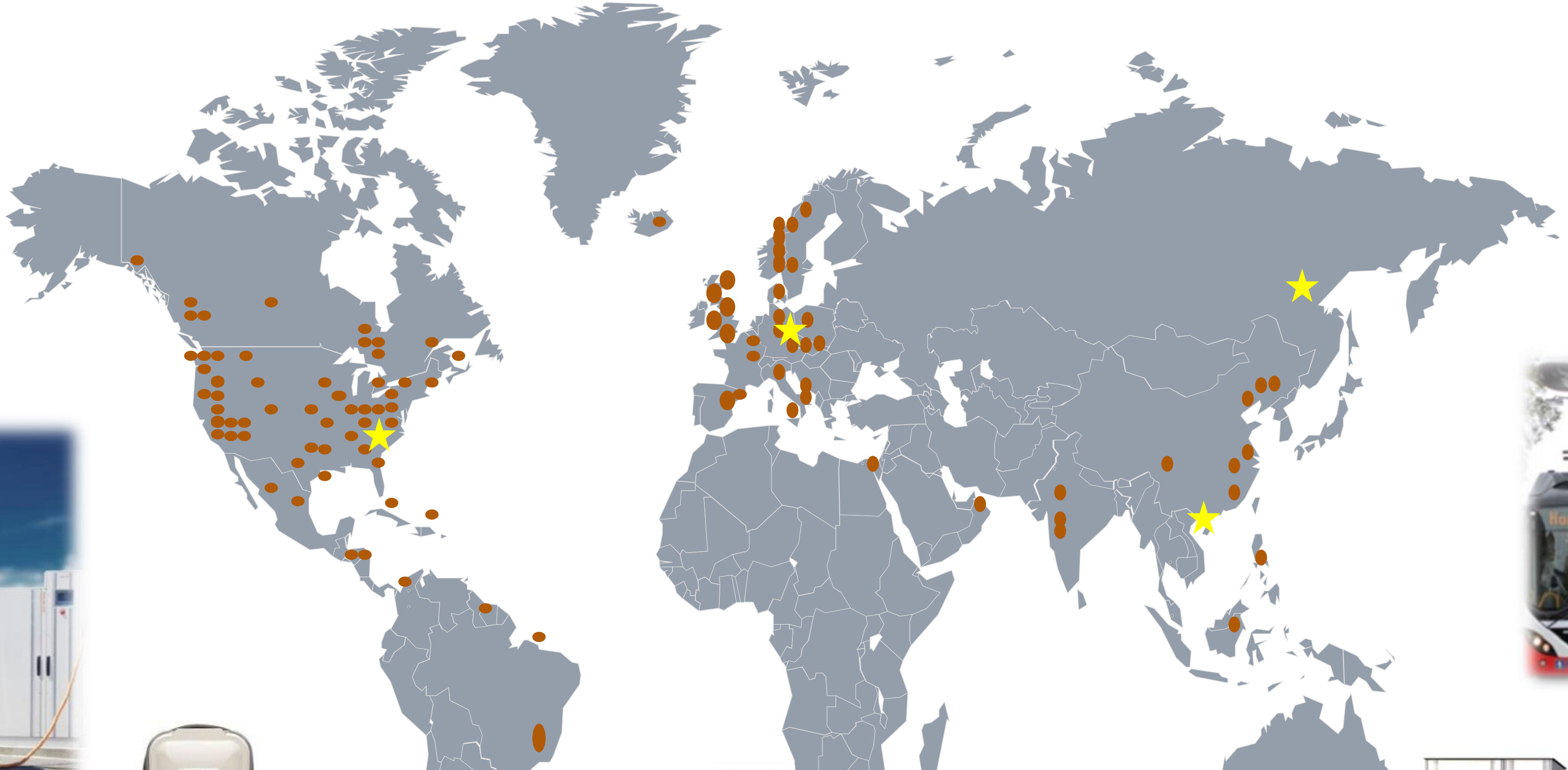
Level 1 & 2 Applications



Make-Ready Gear

Battery Storage

DC Charging

Life as an American EV Owner in 2018

Infrastructure is Extremely Limited in the United States

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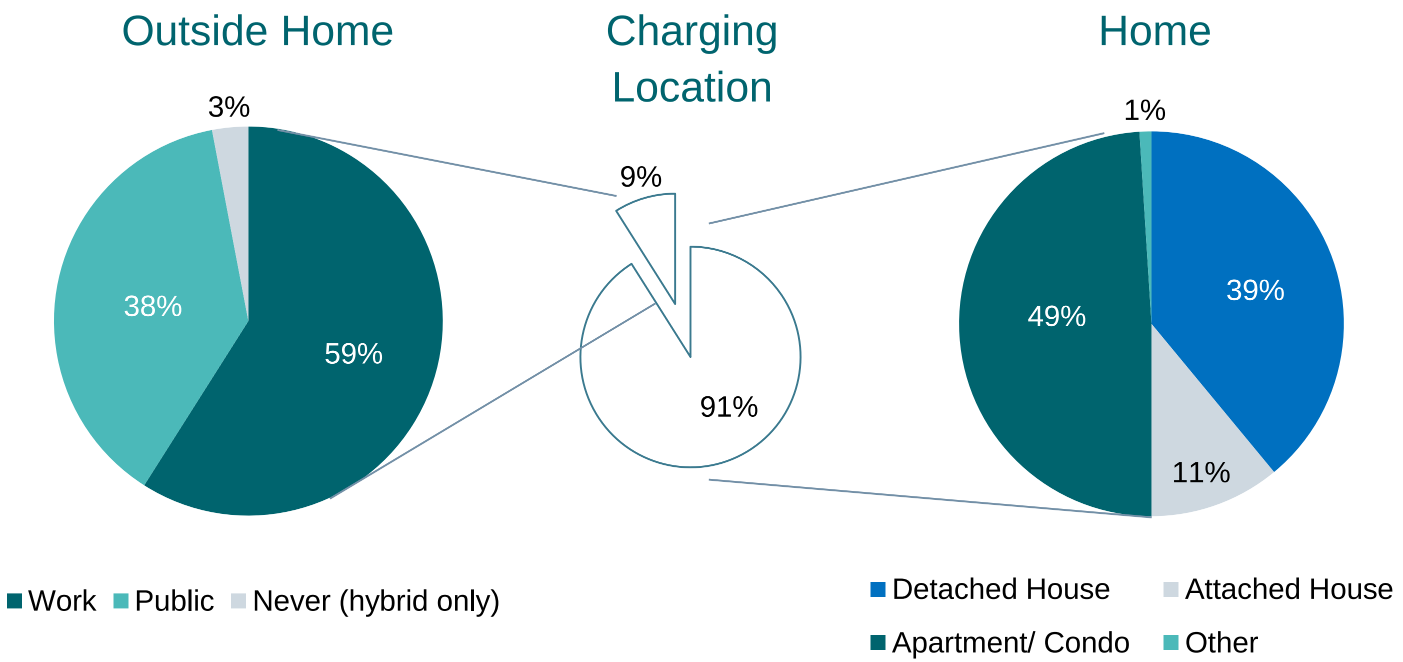
Retail Charging Preference



Source: Clean Energy Financing Advisory Council: Electric Vehicle Charging Stations, January 26, 2017

PEV buyers desire home charging—must consider additional cost in buying decision

- Larger BEV batteries require at least Level 2 chargers to fully recharge overnight

Not all home types well-suited to charging

Public domain full of proprietary technologies / readers

And While Experience Doesn't Match Our Expectations Yet

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The Transformation is Happening Now

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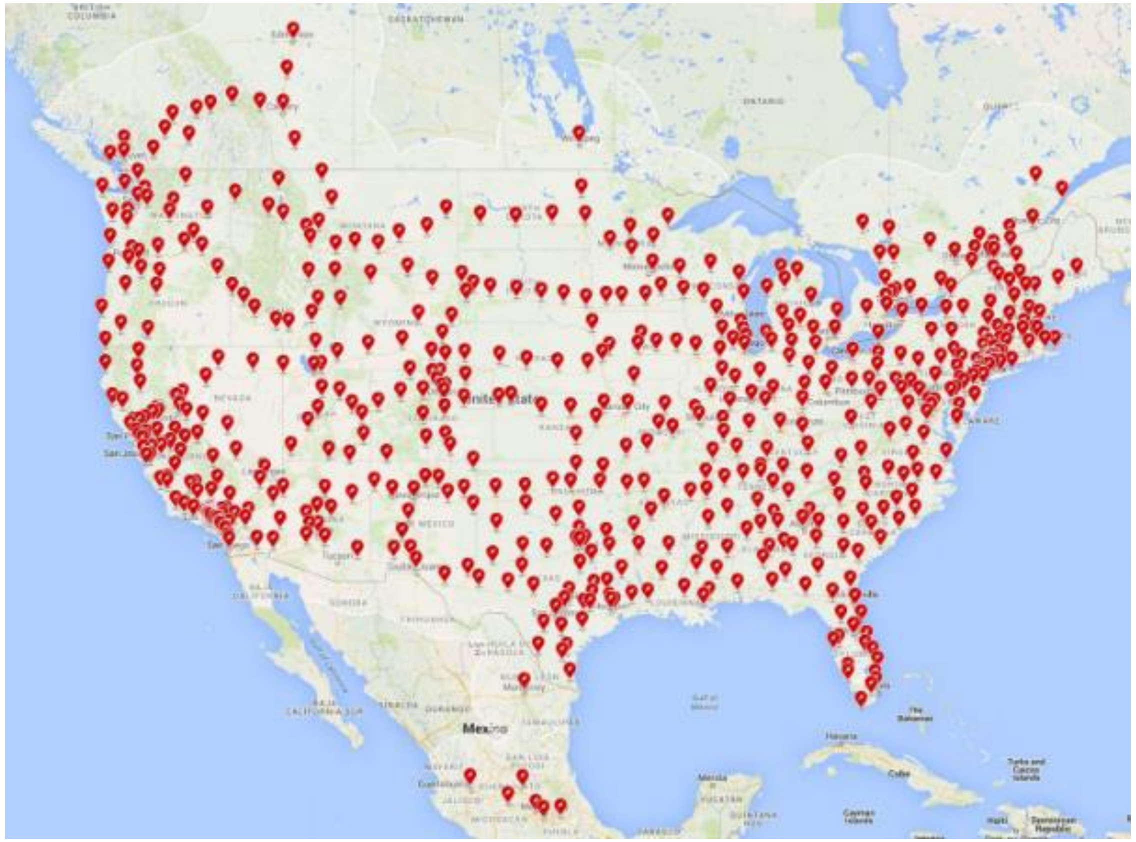
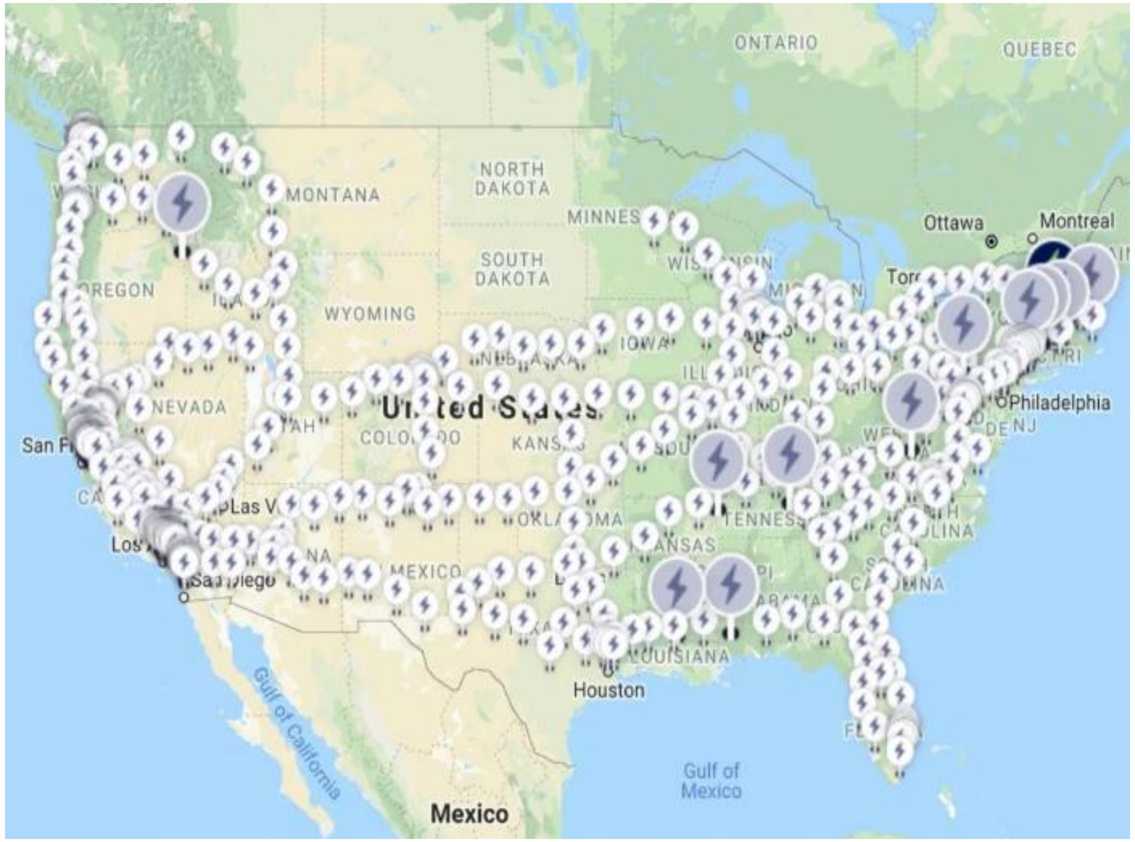
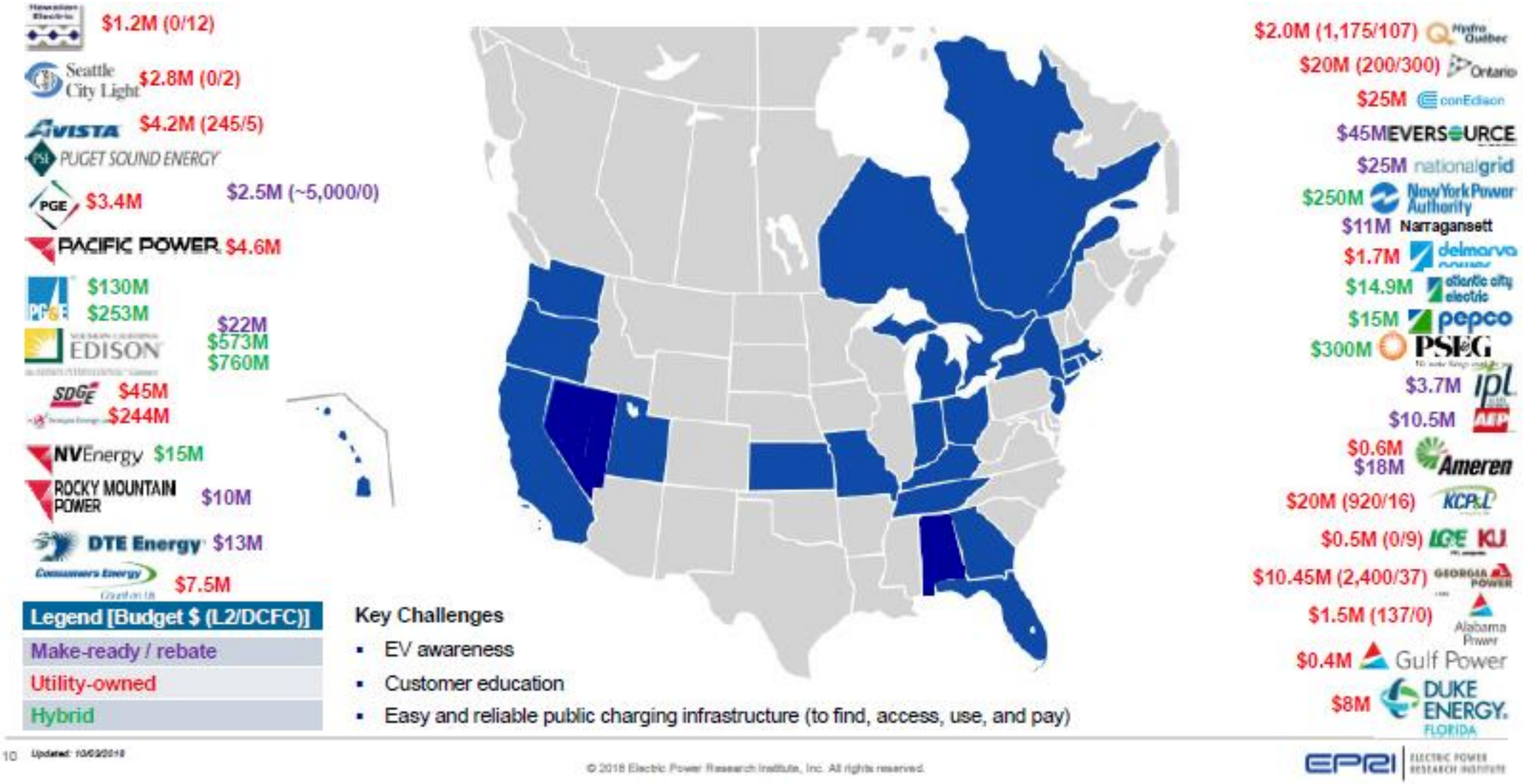




15 GW of Public Charging Coming Online: 2017 - 2021

And 125+ Utilities are Further Closing the Gap



Cloud Ecosystem is Consolidating Under Open Standards …and Proprietary Systems are Breaking Down

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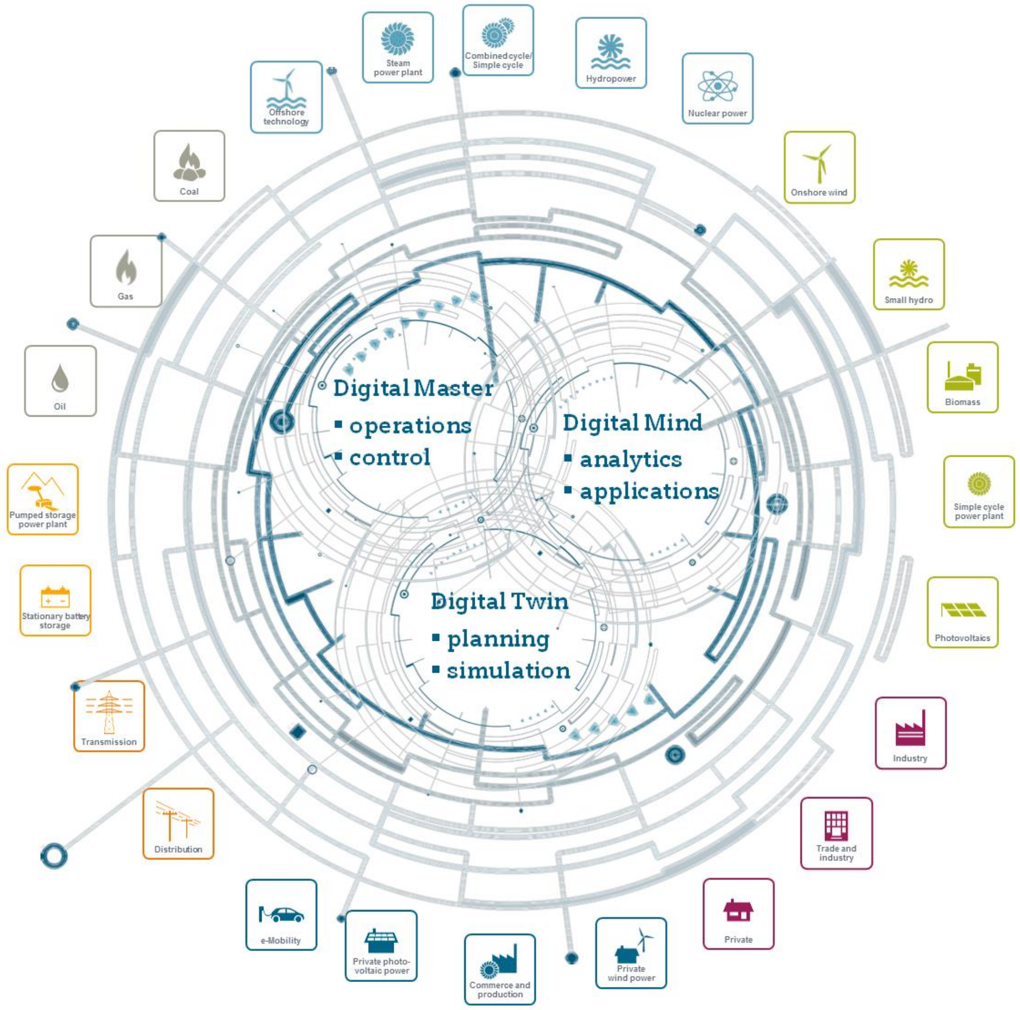

We are Dedicated to An Open Ecosystem of “Smart Charging Technologies”

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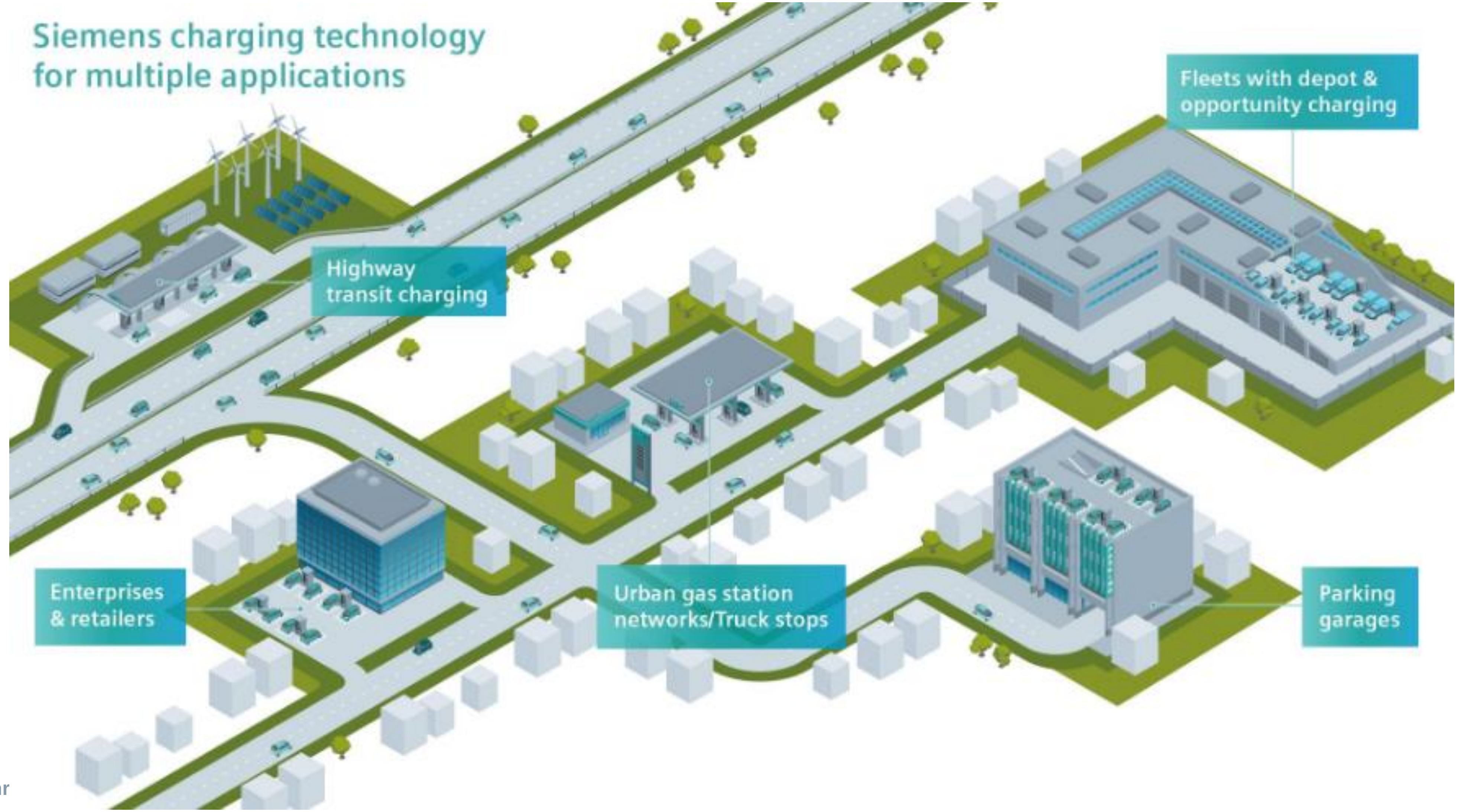

Unr

But What About the Bus?

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Depot today	Future e-Bus depot

Depot today	?????	Future e-Bus depot
0,4 MVA installed load		25 MVA peak load
~ 2 M T Diesel		~ 30 GWh electricity
No load management needed		Load management required
10kV grid access		110kV grid access

Data/Example: Depot at City of Hamburg

"Stalls, stops and breakdowns: Problems plague push for electric buses…" LA Times, March 2018

Load Growth: Sudden and Concentrated

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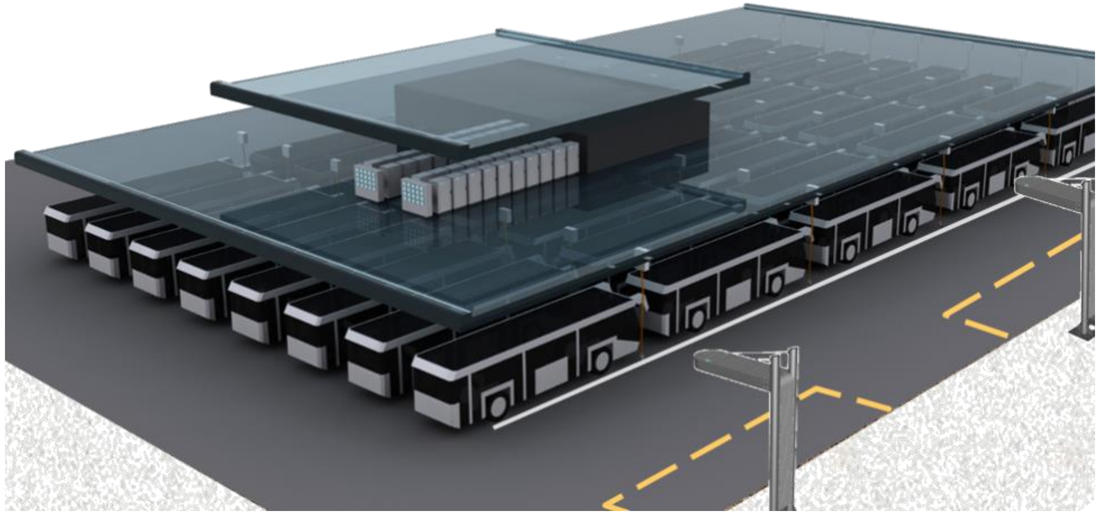
Vehicle Demand Accelerates (16,000 buses)

Charging Concentrates Rapidly (>10 MW / Site)



A Key Trend… The Integrated Charging Depot

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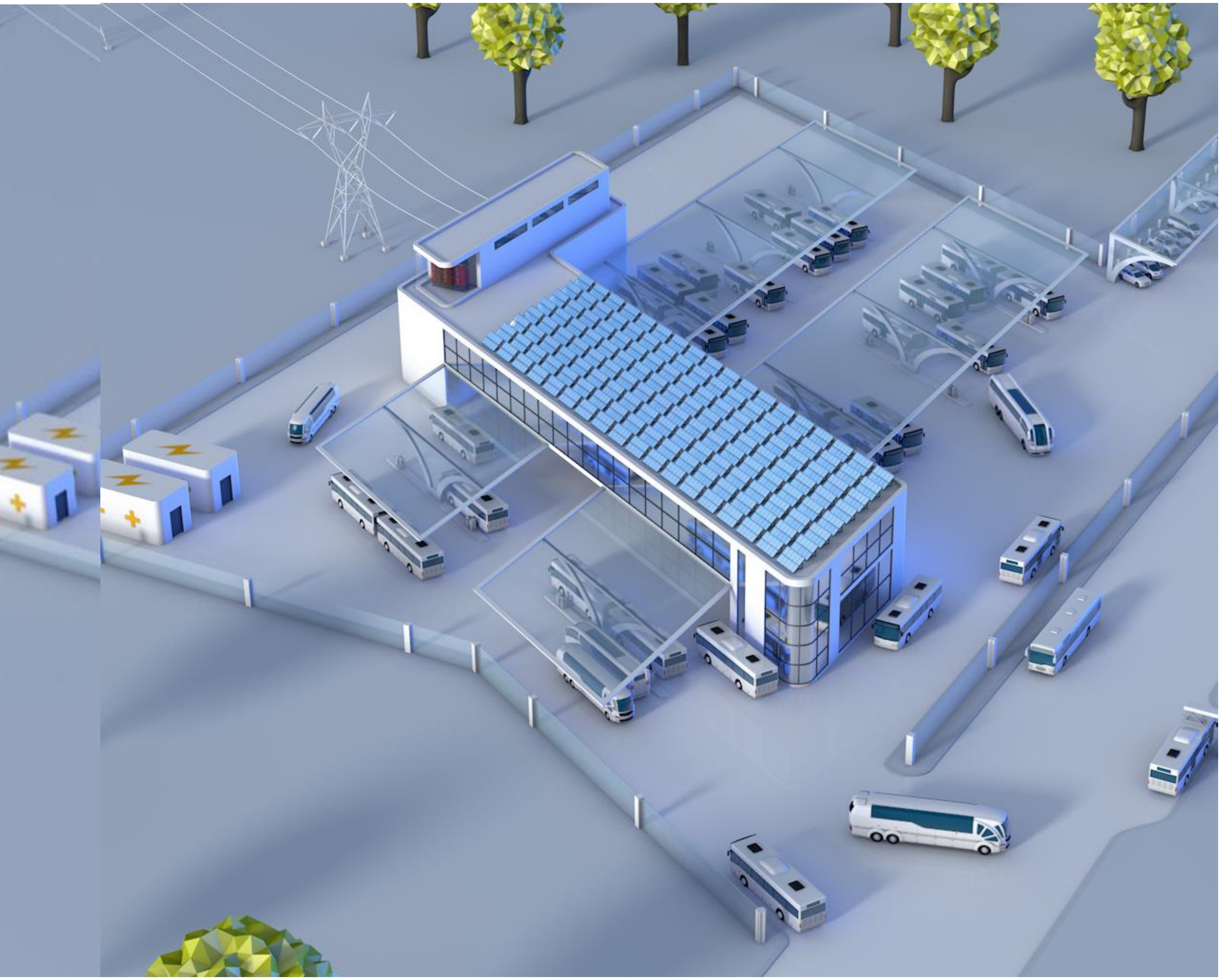


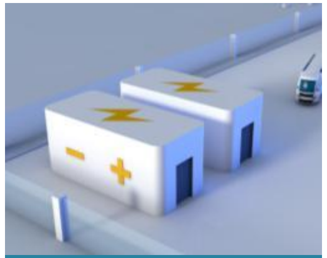
Chargers
Plug-in or roof-mounted

Indoor pantograph

Fast charging stations
outside

Integration of e-cars
service fleet

Renewable integration
& micro-grid



Modular storage
& second life

Monitoring & control SW

Siemens Is Helping the Movement Forward Today

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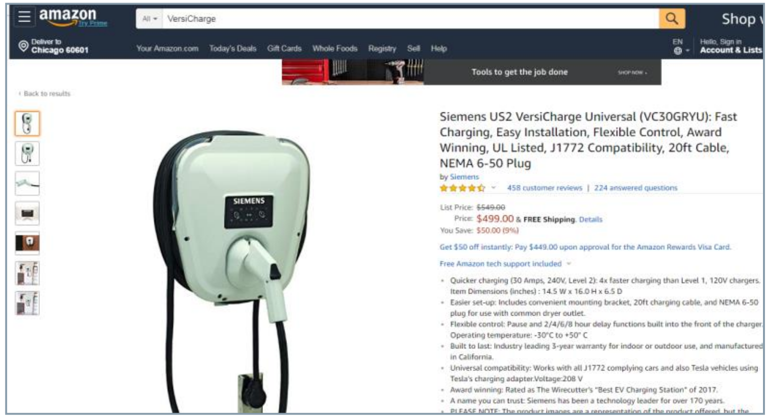
Bus Terminals

City Infrastructure

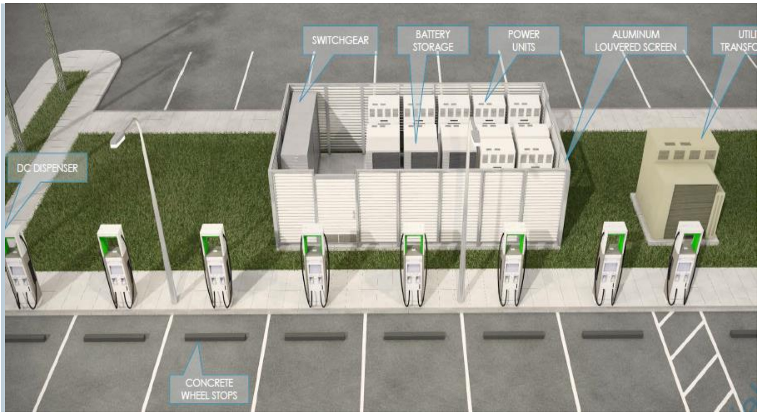
Online electrical commerce



Freight depots

Utility / Public Infrastructure

The Future of the Gas Station



Siemens has a Suite of Charging Products

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AC Chargers “Level 2” (L2)

- Name: **VersiCharge**
- Primarily car market
- Home, workplace, longer-term stop areas
- Around **7.2kW**
- Multiple hours to charge
- Built in US (California)

DC Fast Charger “Level 3” (L3)

- Name: TBD
- Primarily car market
- Gas stations, Highway Corridors, etc.
- **50kW** and **175kW (Q3)**
- Half hour to charge
- Built in US (California)

DC Heavy Duty Bus Multi- Plug

- Name: **Cascade**
- Bus and Truck Depot’s
- 60kW+ **150kW**
- Load balancing
- 1-4 hours to fully charge
- Built in US (North Carolina)

“Opportunity Charging” Bus Overhead

- Name: **MDHD Pantograph**
- “MDHD” (Medium/Heavy Duty) Overhead – top down
- On-route charging
- Around 300 - **600kW**
- Minutes to charge
- Built in US (Oregon)

As Well as Software and Services
...Open, Standards Based, and Flexible for Your Application

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Software …

OCPP

OCPP

OCPP

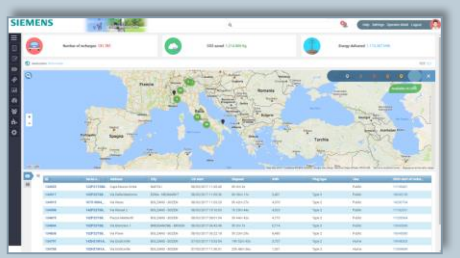
Siemens Remote Monitoring Platform

VersiCloud Commissioning, Monitoring and Control

External Commissioning and Monitoring Platforms

EVSE System SW

Siemens eCar Operation Center (OC)



- Network management platform
- Open standards based
- Reporting and control capabilities
- Three levels of service available (SaaS, EVSP, MS)

Network Management & Analytics SW

… and Services

Customer web interface and mobile applications

Status overview and reports

System Administration

Hotline

System Integration and Customization through Omnetric

Siemens eMobility ^{TM} North America …We're Here To Help

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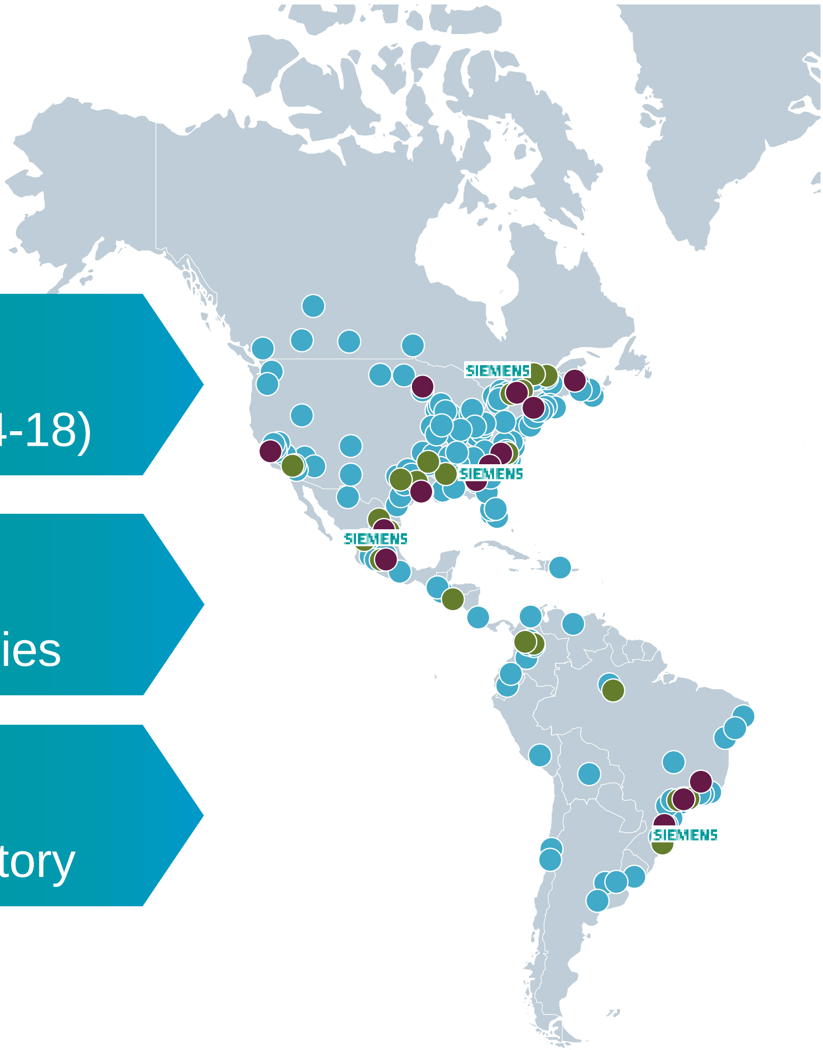

USA Highlights

40,000
Charging points (14-18)

6
Local Market Factories

100 Gb
7+ years of user history

eMobility ^{TM} USA Footprint

R&D

•AC Charging	Atlanta, GA
•DC Bus Charging,	Atlanta, GA
•Charging Software	Foster City, CA / Minneapolis, MN

Factory Footprint

•AC Charging	Los Angeles, CA Shanghai, China
•DC Charging	Raleigh, NC Portland, OR Portugal, Spain
• Make-ready Panels	Spartanburg, SC Grand Prairie, TX Pomona, CA

Solution Support

• Dedicated design and solution teams - nationwide

Let’s shape eMobility world together.

Thank you


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Questions?