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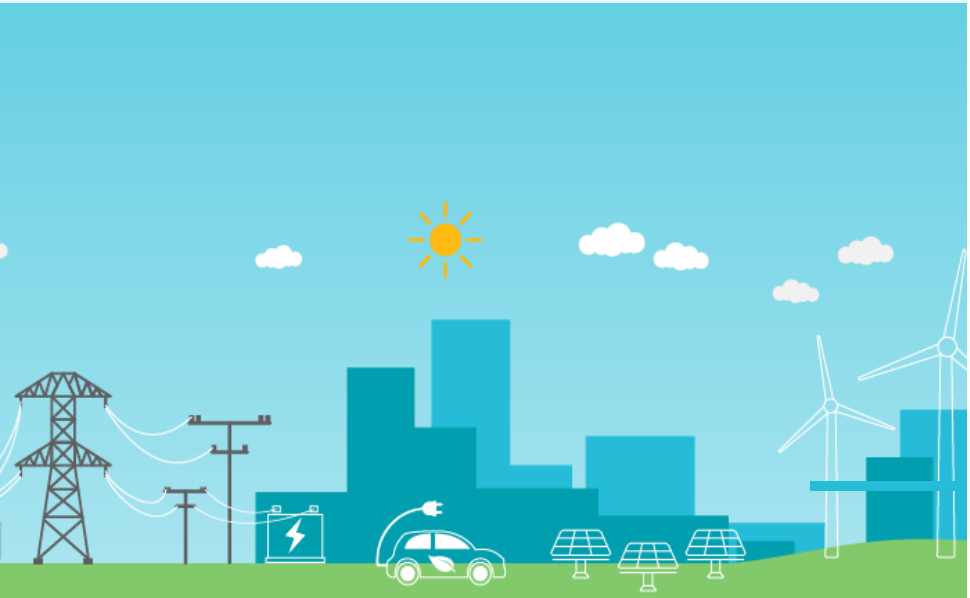


DON'T STOP BELIEVIN'

THE SCOTTMADDEN ENERGY INDUSTRY UPDATE

Energy Indu
Update—D
Stop Belie

A Special Edition for
Supply Chain Con

January 21, 201

Efficient Electrification

The Electric Industry Sees a Growt Opportunity

Efficient Electrification

What Is Electrification?

Electrification: The process of **switching** from the **combustion of f** based fuel (i.e., natural gas or propane) to **electricity** to provide a co service

Transportation

- Light-duty vehicles
- Transit/school buses
- Heavy-duty trucks

Residential

- Air-source and ground-source heat pumps
- Variable-capacity ducted heat pumps

Commercial

- Variable refrigerant flow heat pumps
- Variable-capacity rooftop heat pumps
- Heat pump water heaters

- Inf dry
- UV
- Ind tre
- Ind

Efficient Electrification: Electrifying the end use of energy—**where efficient** to do so—for the **benefit of customers**, the **environment**,

Efficient Electrification

Electrification Stakeholder Groups

Environmental Groups

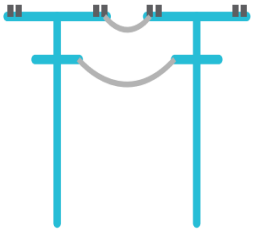
End Users

L

Gove

Expected Outcomes

- Growth in electric load
- Decrease in GHG emissions
- Decrease in local air pollution



Electric Utilities

Ga

Efficient Electrification

Recent Electrification Studies

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Electrification Futures Study: Scenarios of Electric Technology Adoption and Power Consumption for the United States

EPRI
ELECTRIC POWER RESEARCH INSTITUTE

U.S. National Electrification Assessment

AGA
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As

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Efficient Electrification

Electrification Opportunities by Sector

The electrification of the transportation sector is wide having the largest potential increase in electricity usa

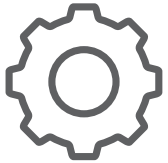
Residential

21 Quads Total
14 Quads Electricity

Commercial

18 Quads Total
14 Quads Electricity

Industrial



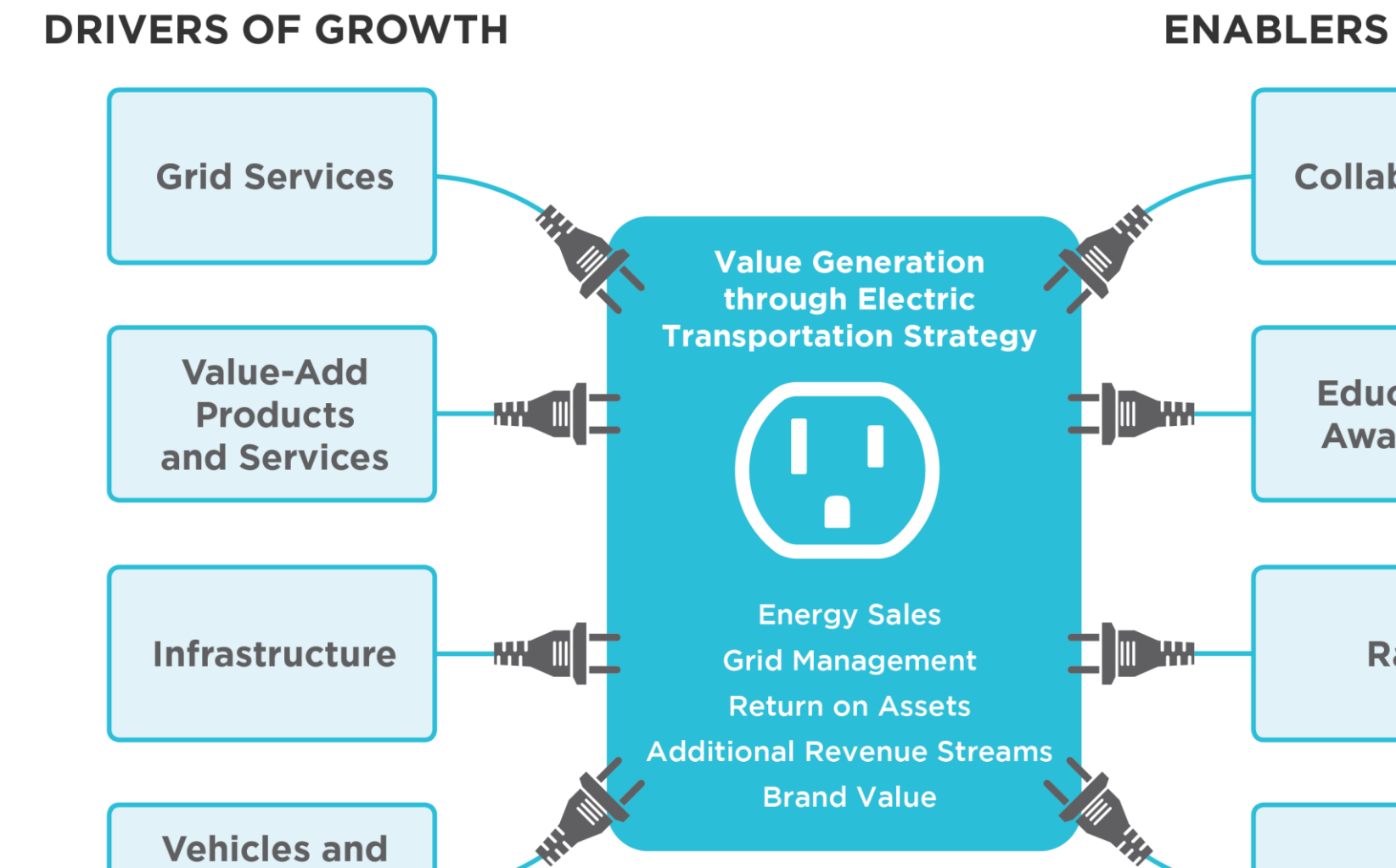
31 Quads Total

Transportation

28 Quads Total

Efficient Electrification

Drivers/Enablers of Electric Vehicle Growth

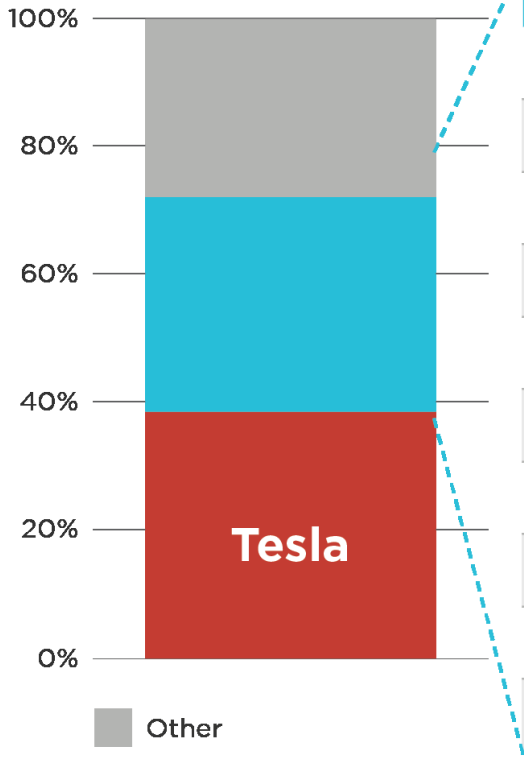


Efficient Electrification

U.S. Electric PEV Forecast

The United States hit a total of one million PEVs in Oc

2018 PEV Sales by Type (% of Total)



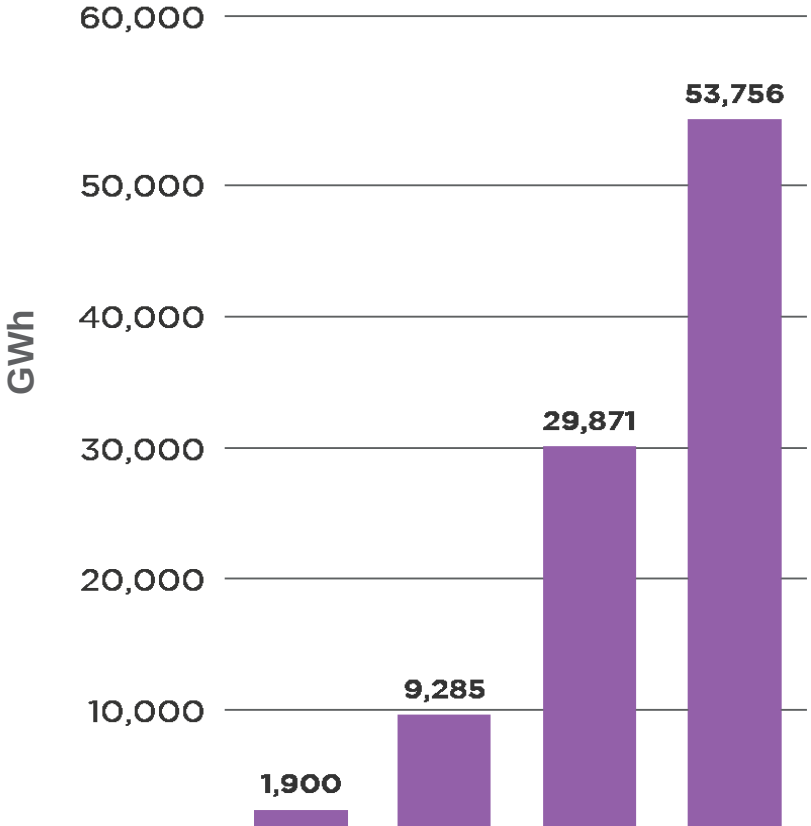
Top 10 (2018 Sales) PEVs Available under $40,0

Brand	Model	PEV Type	Vehicle Sales (2018)	PEV Market Share (2018)	Starti MSR
Toyota	Prius Prime	PHEV	27,595	7.6%	$27,300
Honda	Clarity PHEV	PHEV	18,602	5.1%	$33,400
Chevrolet	Volt	PHEV	18,306	5.1%	$34,095
Chevrolet	Bolt EV	BEV	18,019	5.0%	$37,495
Nissan	Leaf	BEV	14,715	4.1%	$29,990
Ford	Fusion Energi	PHEV	8,074	2.2%	$33,400
Chrysler	Pacifica Hybrid	PHEV	7,062	2.0%	$39,995
Mitsubishi	Outlander PHEV	PHEV	4,166	1.2%	$34,595
Kia	Niro PHEV	PHEV	3,389	0.9%	$27,900
Audi	A3 e-tron	PHEV	2,597	0.7%	$39,500

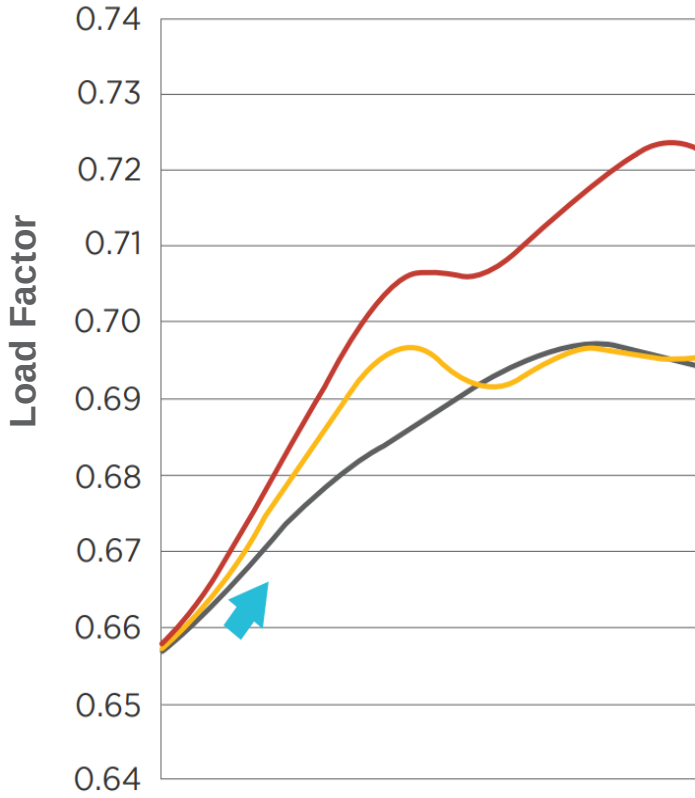
Efficient Electrification

Electric Grid Impacts

PEV Consumption (GWh) (2017 Actual and 2020–2030 Projected)



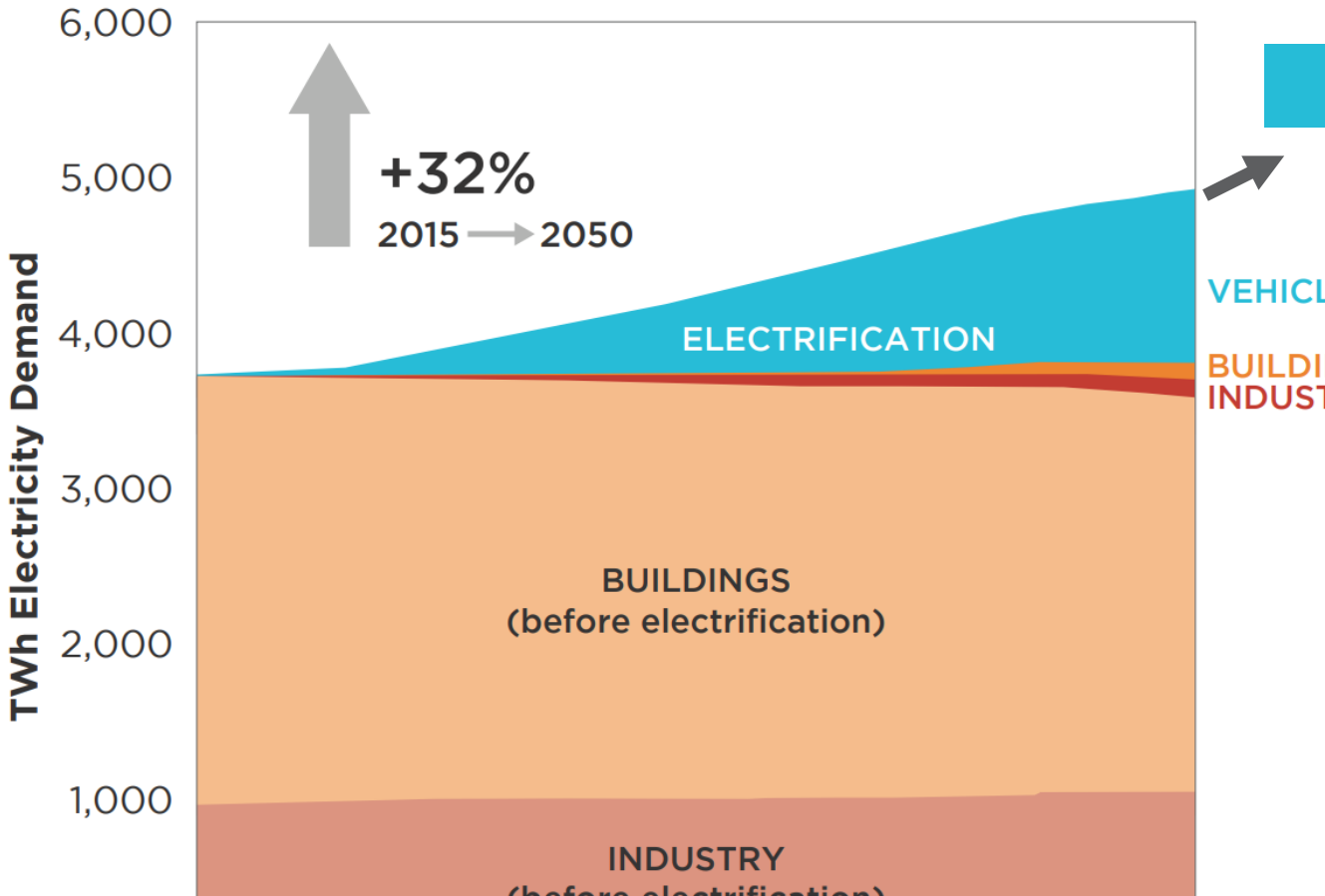
Load Factor Estimates f Electrification Scena (2017 to 2050)



Efficient Electrification

Load Growth through Transportation Electri

Reference Scenario Projections for U.S. Electricity



Electrification

Key Takeaways

Efficient Electrification:
The Electric Industry Sees a Growth Opportu

1. Electrification may provide significant load growth

2. Transportation has the highest potential for electrification

3. Grid investment may be needed to support significant growth of PEVs

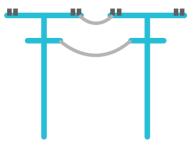
Gas and Power Infrastructu
Development

Challenges and Opportunities

Infrastructure Development

Tailwinds Abating

DRIVING FACTORS



Reliability Needs

Increasing Renewables

Retirements

Convergence of Electric and Gas

RESTRAINING F

Grass Roots Opposition

Pipeline Contracting Rules

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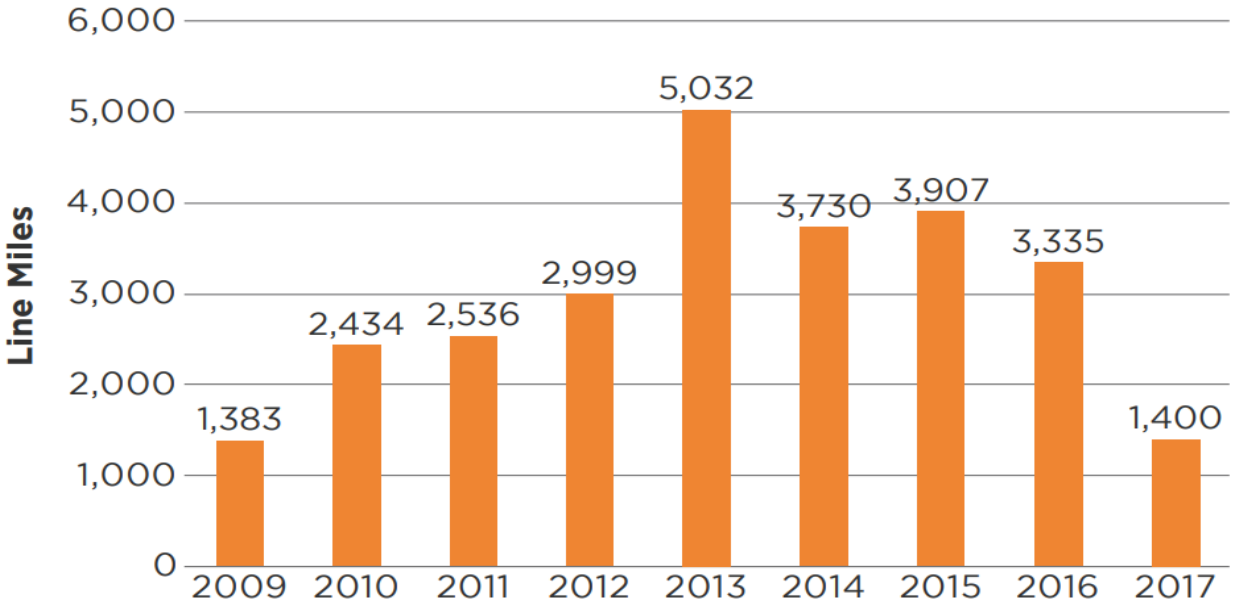
Infrastructure Development

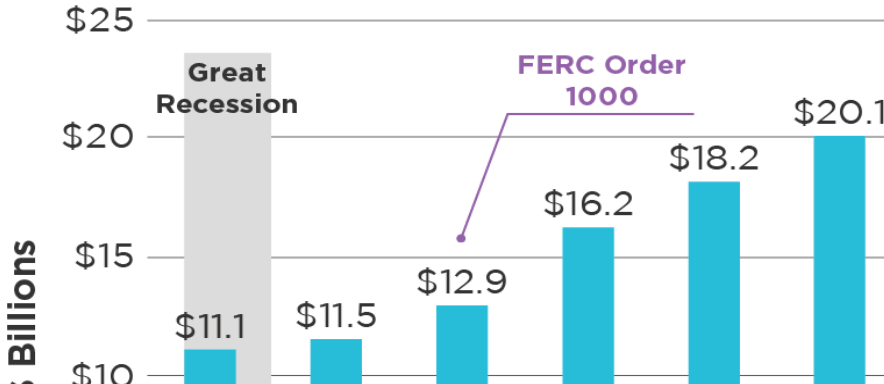
Power Transmission Investment – Current S



Source: S&P Global Market Intelligence; ScottMadden analysis

Complete Transmission by Ye (2009–2 (in Line M

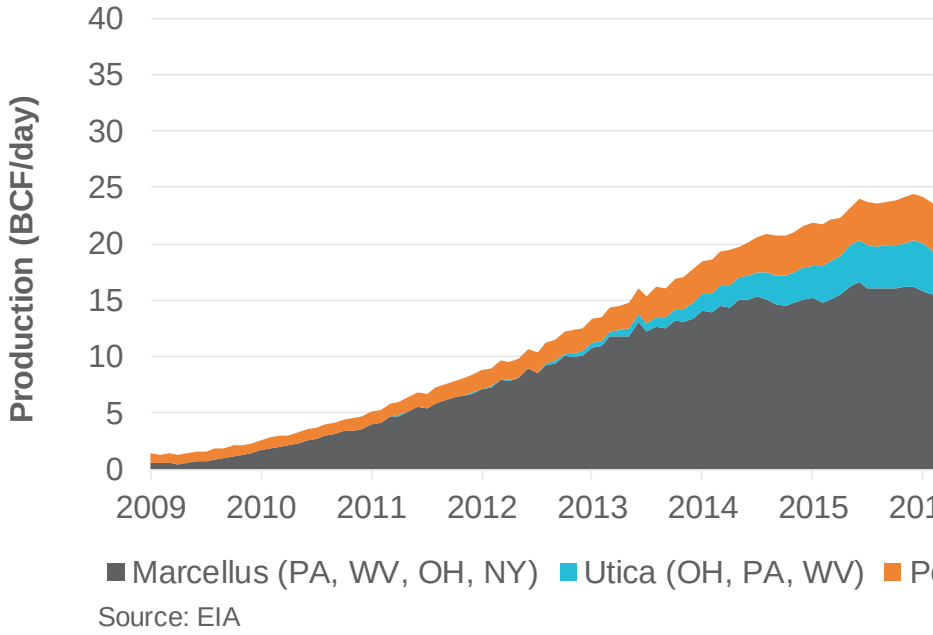
Construction Expenditures for Transmission by Investor-Owned Utilities (2009–2016) (Real 2016$B)



Infrastructure Development

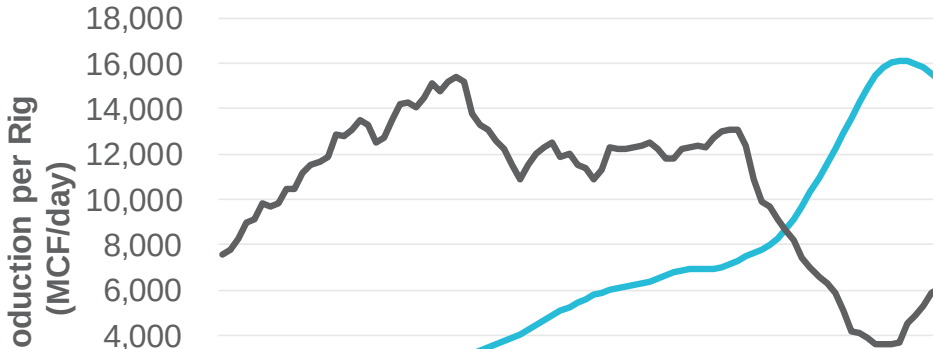
Marcellus and Utica Shale Production

Dry Shale Gas Production (Sept. 2009–Sept. 2018)



Source: EIA

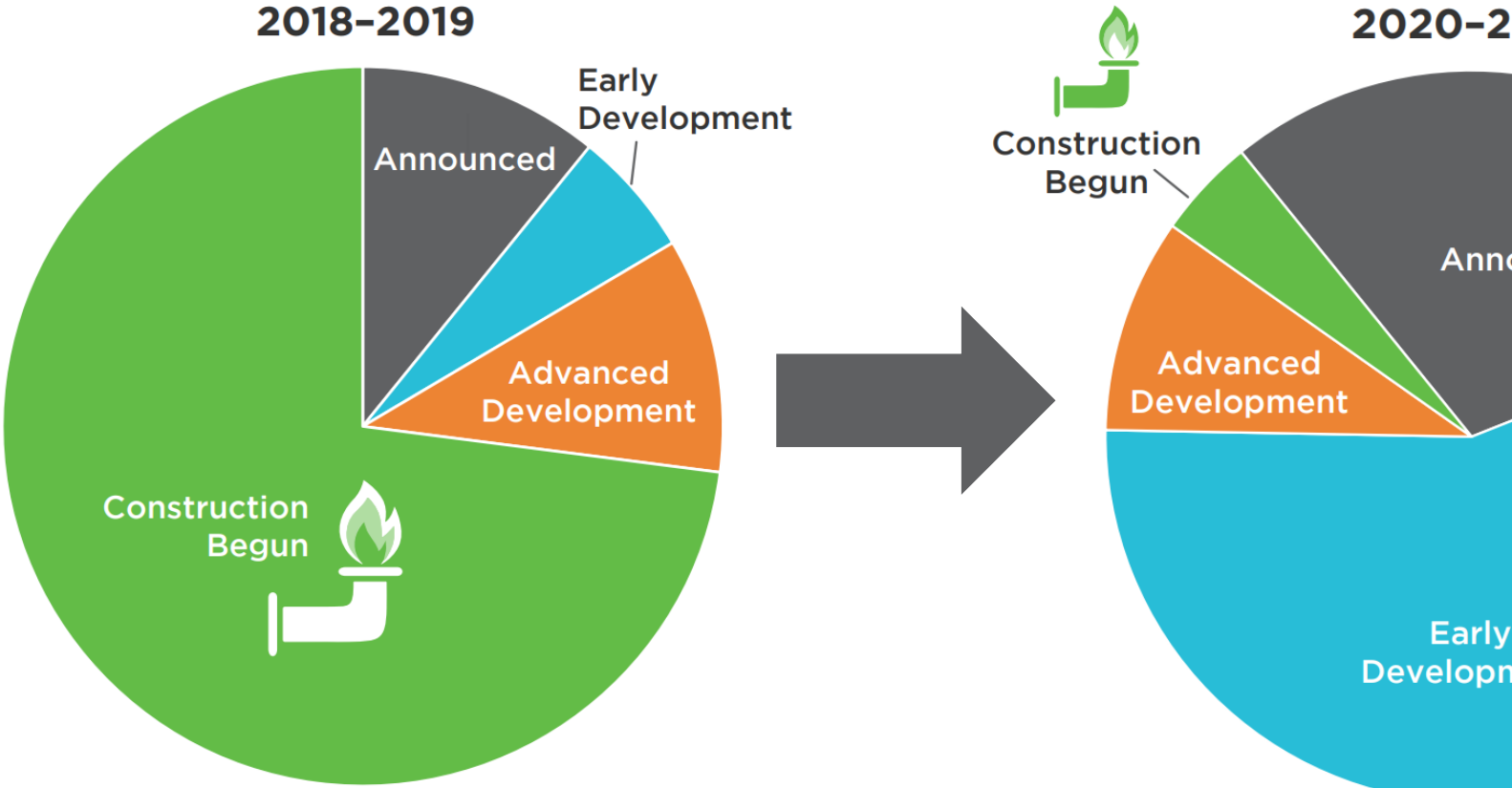
Appalachia Region Rig Count and Rig Production (Aug. 2009–Aug. 2018)



Infrastructure Development

Introduction to Gas Pipelines

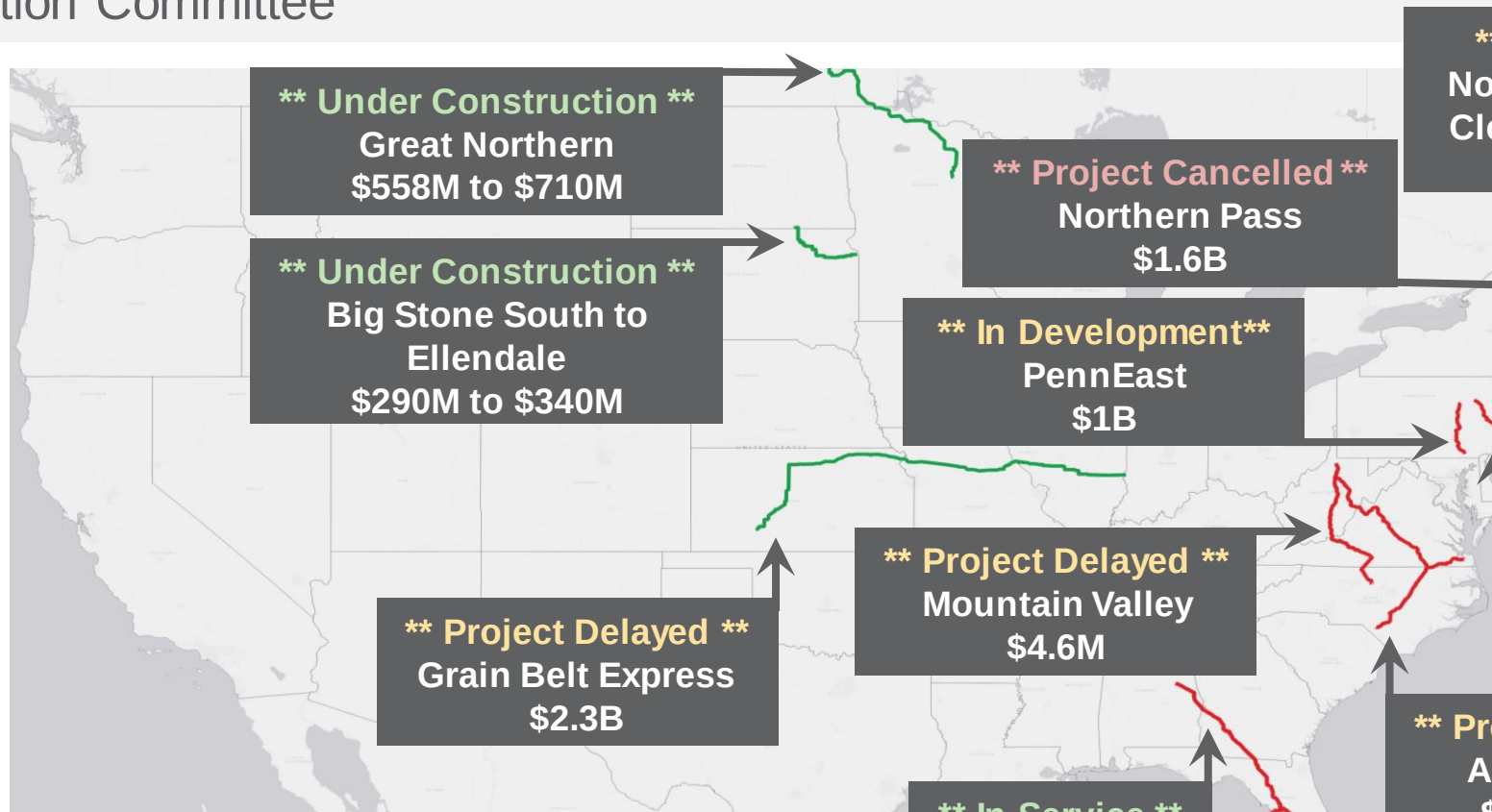
U.S. Gas Pipeline Development Projects (by Expected Year in Service)



Infrastructure Development

Infrastructure Projects

"…a new **antiestablishment movement** …has energized a new gen
stand in front of the bulldozers and coal trucks." – Scott Parkin of
Action Committee



Infrastructure Development

Early Generation Retirements

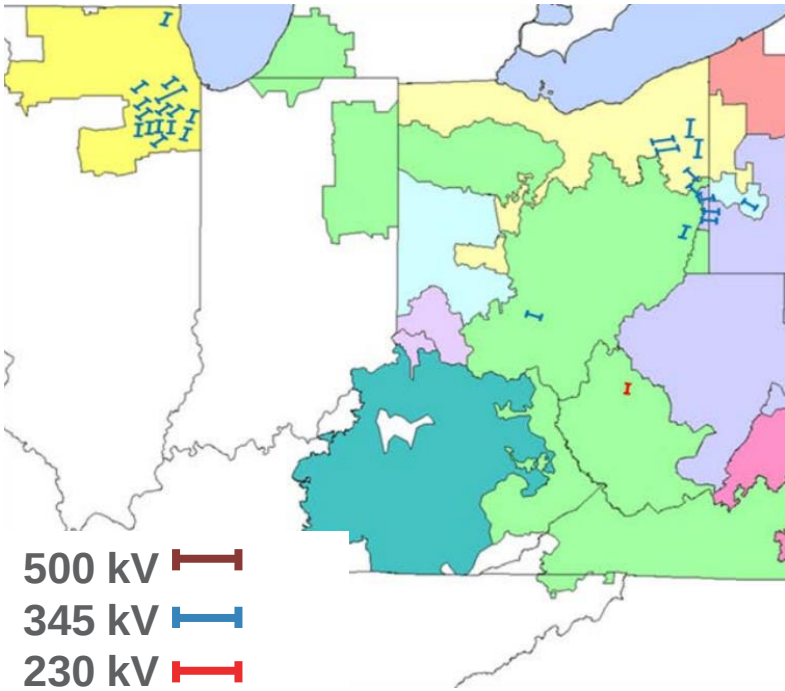
NERC Generation Retirement Scenario

"**Ensuring reliability** throughout a significant retirement transition **will likely include construction of new transmission and fuel infrastructure**." – NERC

Findings

- On a regional scale, significant replacement reserves are needed, requiring expedited queues
- Gas is expected to be the predominant replacement resource
- Large amounts of retirements may result in extensive transmission network upgrade requirements

Location of Thermal Viol
Studied Case Summe



Source: NERC

Infrastructure Development

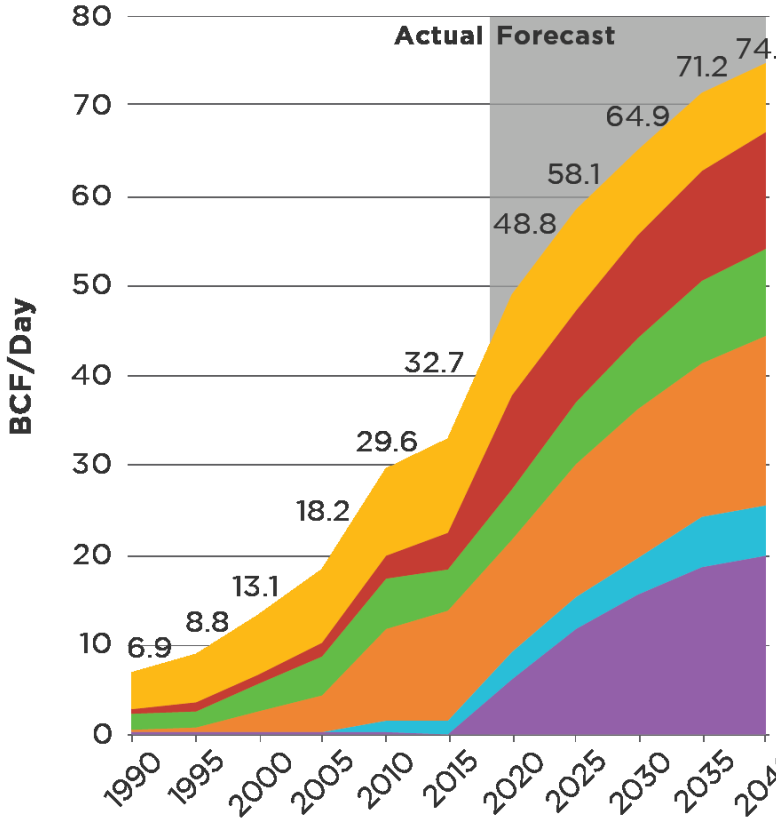
North America Poised to Lead

Cumulative Capacity Additions

2017	2019	2023
2.7 BCF/day	7.1 BCF/day	11 BCF/day

Additional 16 facilities totaling 27.3 BCF/day pending approval

Actual and Forecast LNG E
Region (BCF/Day



Infrastructure Development

Key Takeaways

Infrastructure Development: Challenges and Oppo

1. Infrastructure continues to move ahead but at slower pace
2. Challenges to siting and permitting will continue
3. Coal and nuclear retirements will drive transmission investment

Grid Modernization

States and Utilities Test the Waters

Grid Modernization

What Is Grid Modernization?

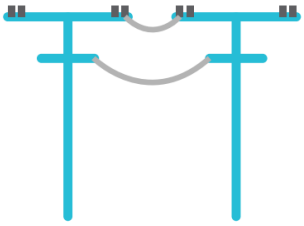
Grid Modernization: Investments—some of which may be considered
and/or DSP-enabling—that improve the **reliability, resiliency, efficie**
automation of the T&D system. Such investments can include the se
and communications networks that enable enhanced visibility and unc
the behavior of the network; technologies and equipment that **facilitat**
customer engagement regarding energy usage and alternatives; and
underlying systems, data management and analytics that facilitate situ
awareness, asset management, contingency and risk analysis, outage
and restoration. These necessary core investments underpin the requ
grid reliability and resiliency. They provide the basis for increased **ope**
flexibility, can enable efforts toward **achieving state policy goals**, s
integration of various types of DER, and are beneficial for any reso
– New York Joint Utilities

Grid Modernization Drivers

Customer Expectations

Technology Advances

D
Pene



Aging

Policy Drivers

Grid Modernization

Grid Modernization Technologies

Distribution Automation

Communicating sensors and switches that can operate autonomously or through centralized control systems

Tools and Analytics

Adva
technologi
big data a
enhance
making and
oper

Flexible Resources

Resources or management systems that enable the use of a more diverse and distributed mix of supply or services

Grid Edge Sensing

Sensors
smart de
provide
visibil
situational

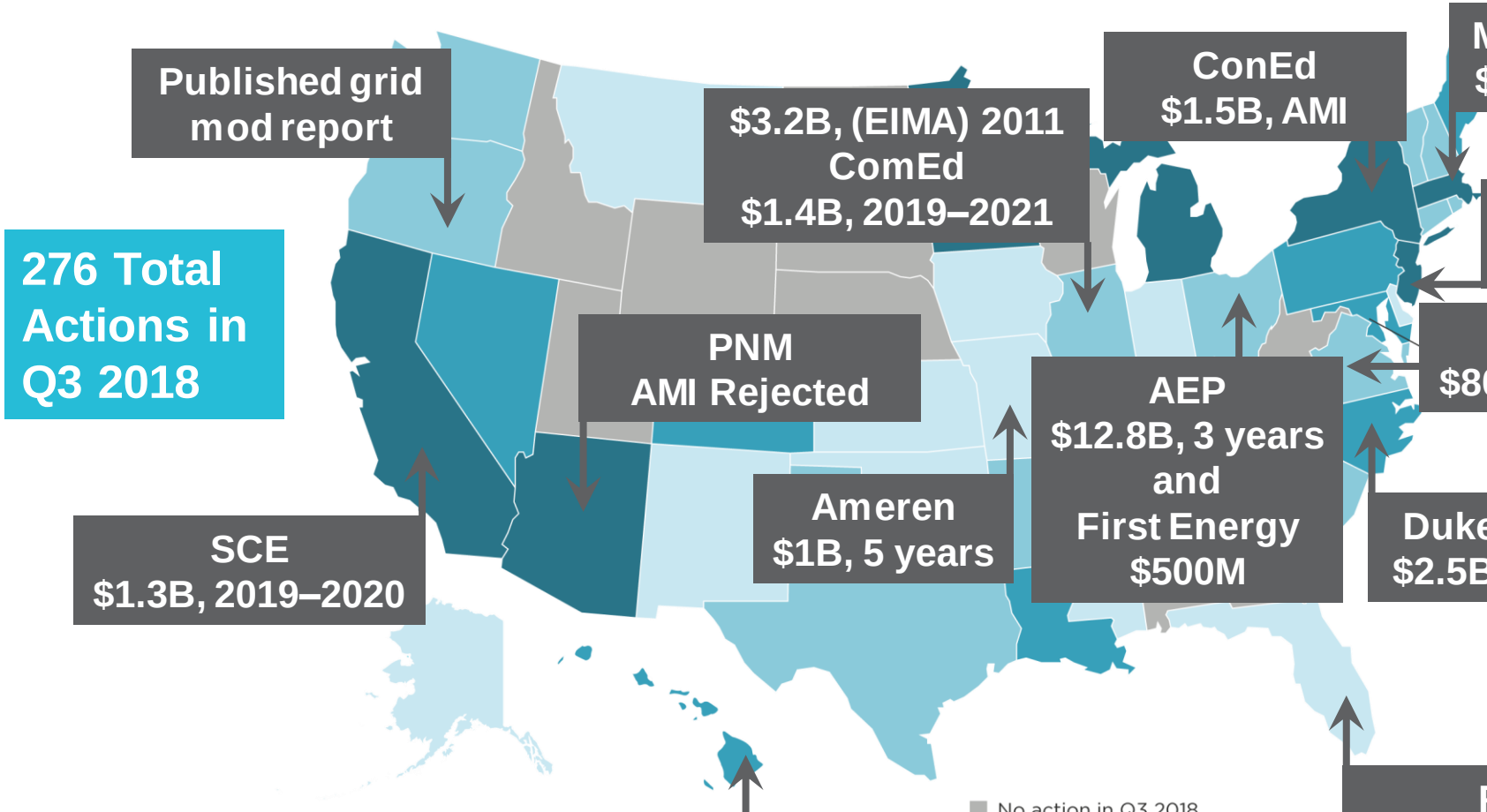
Foundational Systems and

IT and OT systems and equipmen
to enable current and future ca

Grid Modernization

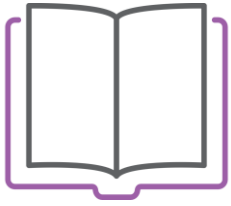
Latest News

Q3 2018 Legislative and Regulatory Action on Grid Mo



Grid Modernization

Paying for Investments



Rate Cases

Grid Modernization Riders

Legislat

Grid Modernization

Key Takeaways

Grid Modernization: States and Utilities Test the

1. A confluence of factors are driving grid modernization programs
2. Grid modernization is not just happening in NY and CA; it's all over the United States
3. Regulatory treatment and rate impacts matter

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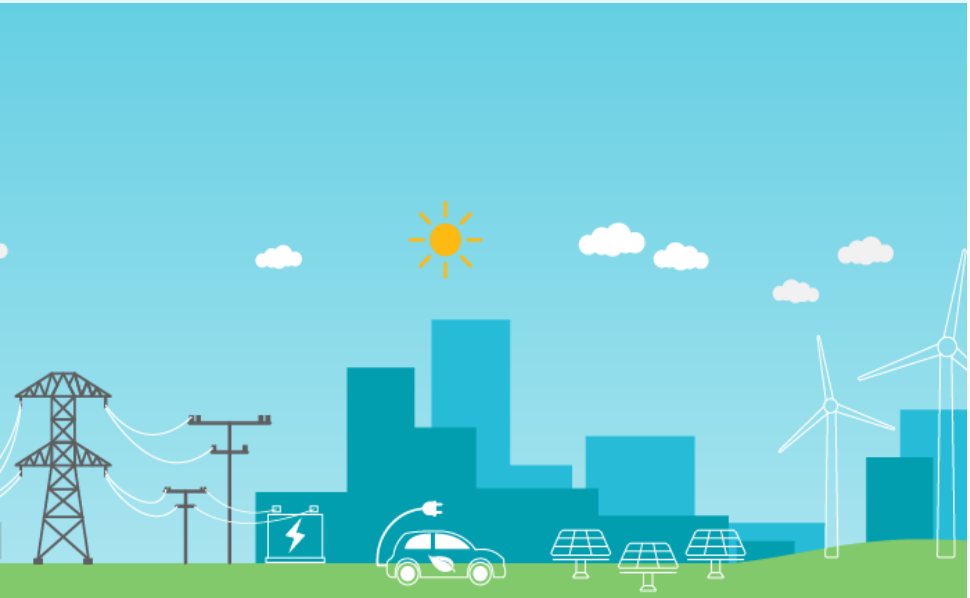

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