



ELECTRIC POWER  
RESEARCH INSTITUTE

# The Outer Limits of Electrification

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Principal Technical Executive



June 19, 2019

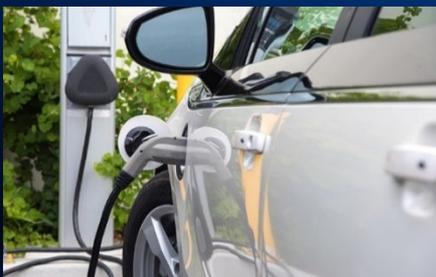


[www.epri.com](http://www.epri.com)

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# Efficient Electrification – “Sustainable” Opportunities



**Electric Vehicles**



**Airport/Port Electrification**



**Infrared Heating**



**Advanced Manufacturing**



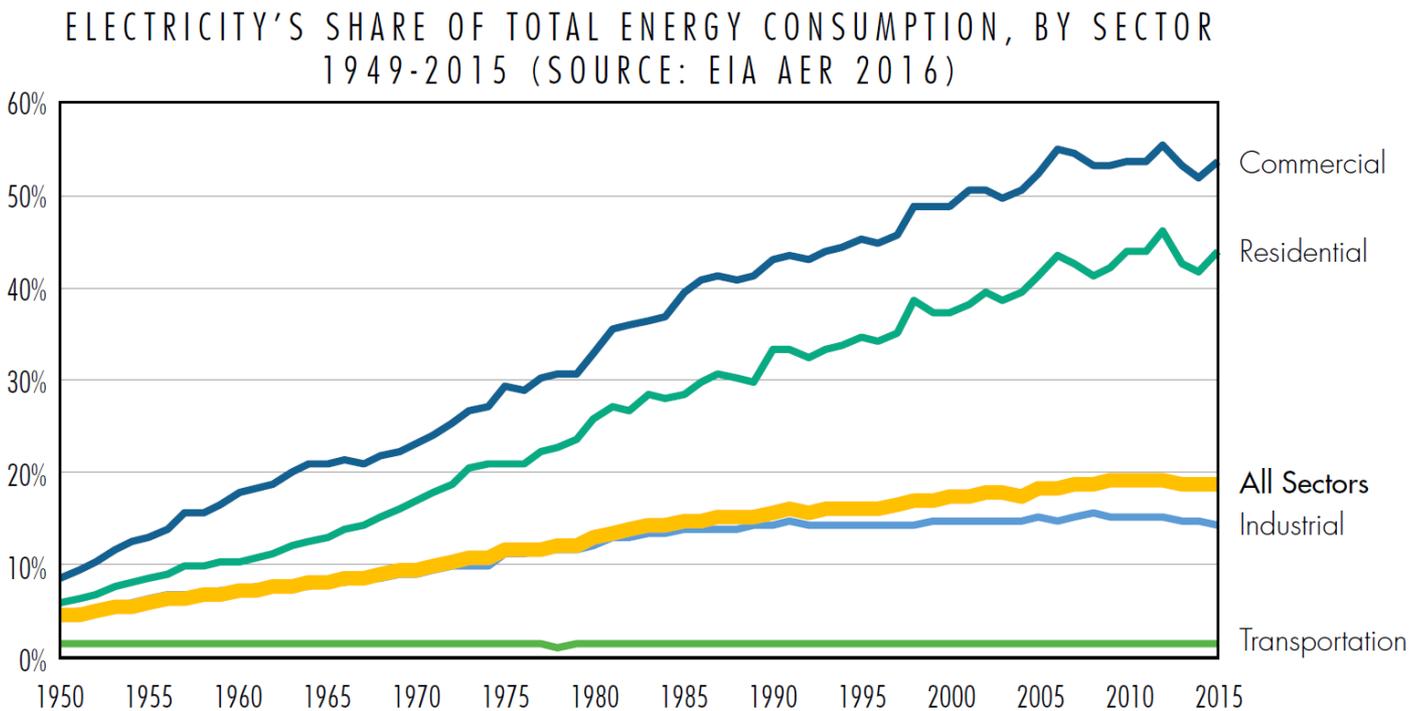
**Indoor Agriculture**



**Hybrid Residential Heating**

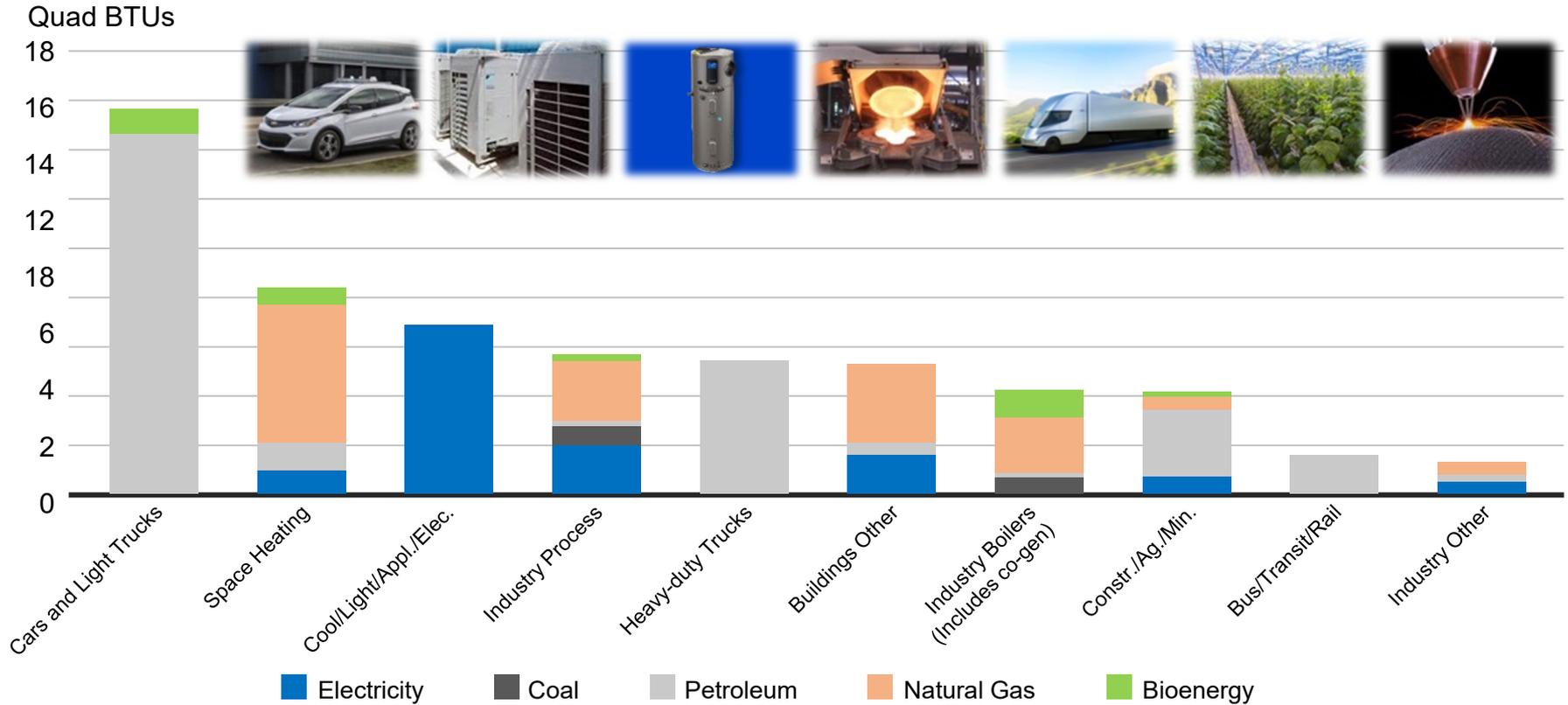
***Improve Productivity, Reduce Emissions, Reduce Cost,  
Deliver Other Non-Energy Benefits, and Give Customers Control***

# Electricity Use Has Grown Faster than Total Energy for More than A Century... What Will Happen Next? Or Could Happen?



**Historic growth driven by efficiency, convenience, safety, and low cost**

# End Use (Final) Energy Use By Sector, 2016



• Excludes upstream and midstream energy use, e.g., power generation, oil and gas extraction, refining, and pipelines.  
Adapted from Energy Information Administration

# EPRI's U.S. National Electrification Assessment (USNEA)

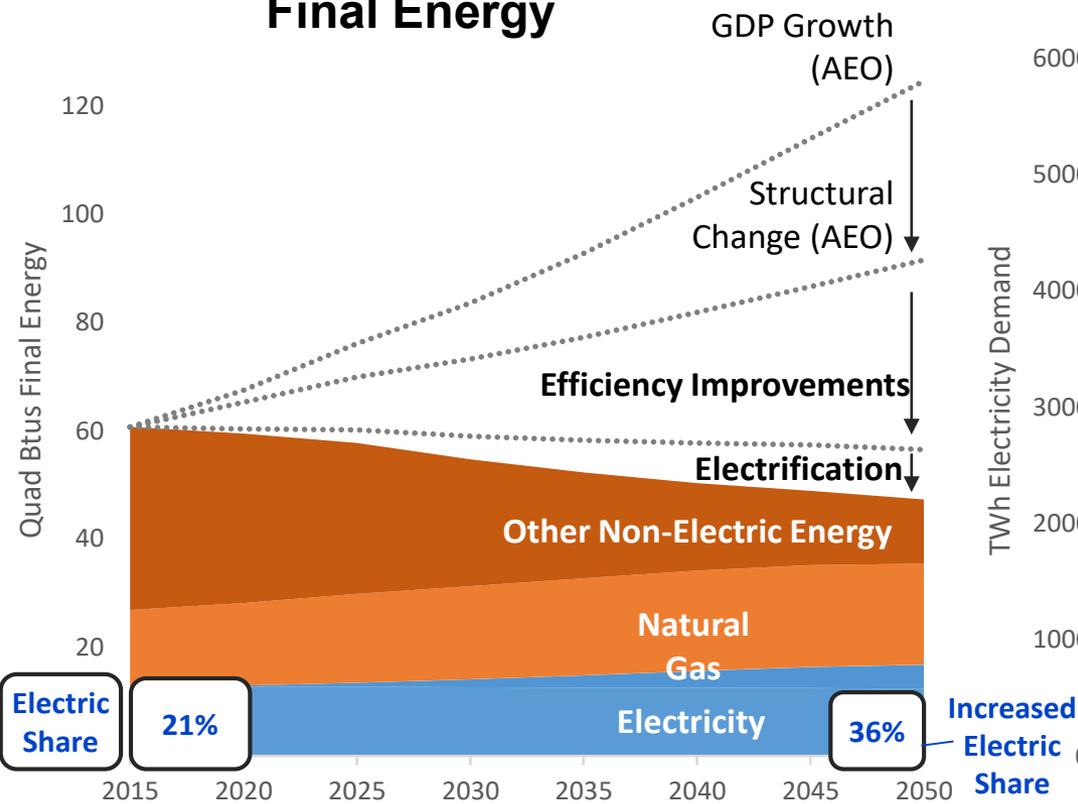


- Economy-wide assessment:
  - Residential
  - Commercial
  - Industrial
  - Transport
- Customers have broad technology choices and control
- Customer choices integrated with detailed electricity supply model

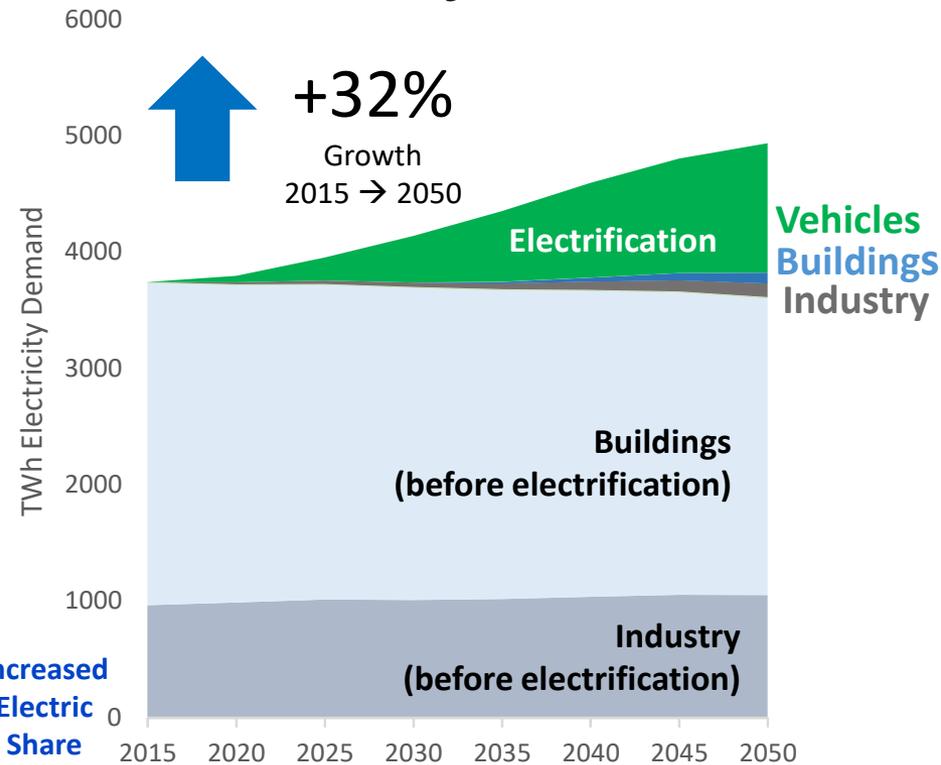
For more information on EPRI's Efficient Electrification Initiative:  
<https://www.epri.com/#/pages/sa/efficient-electrification?lang=en-US>

# Efficient Electrification: Reference Scenario

## Final Energy

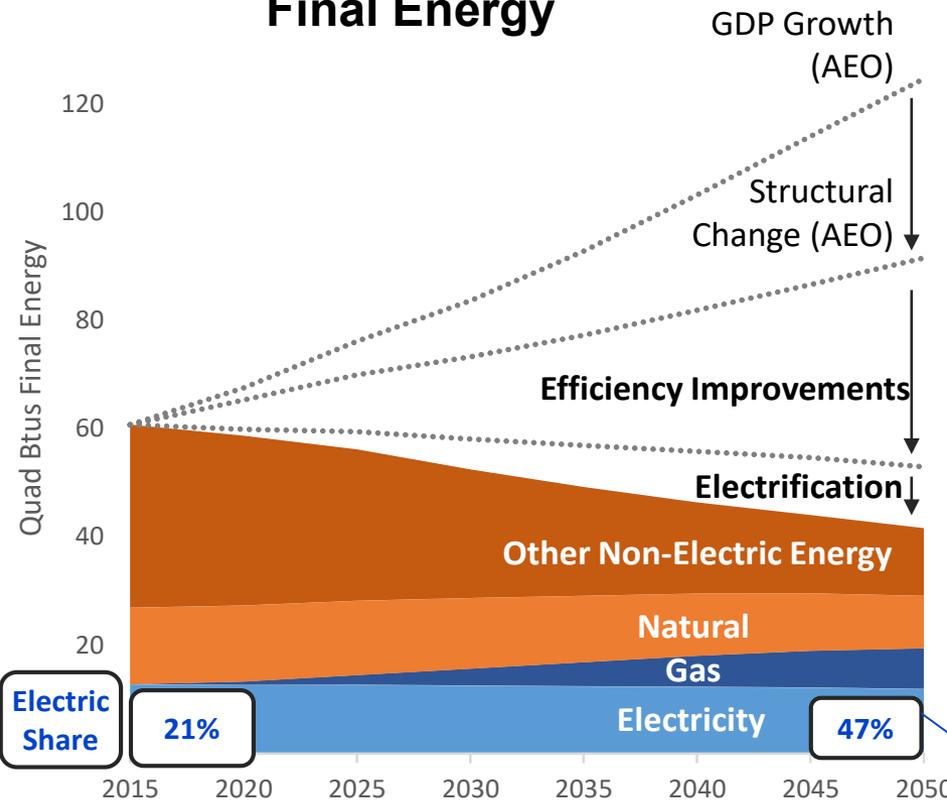


## Electricity Generation

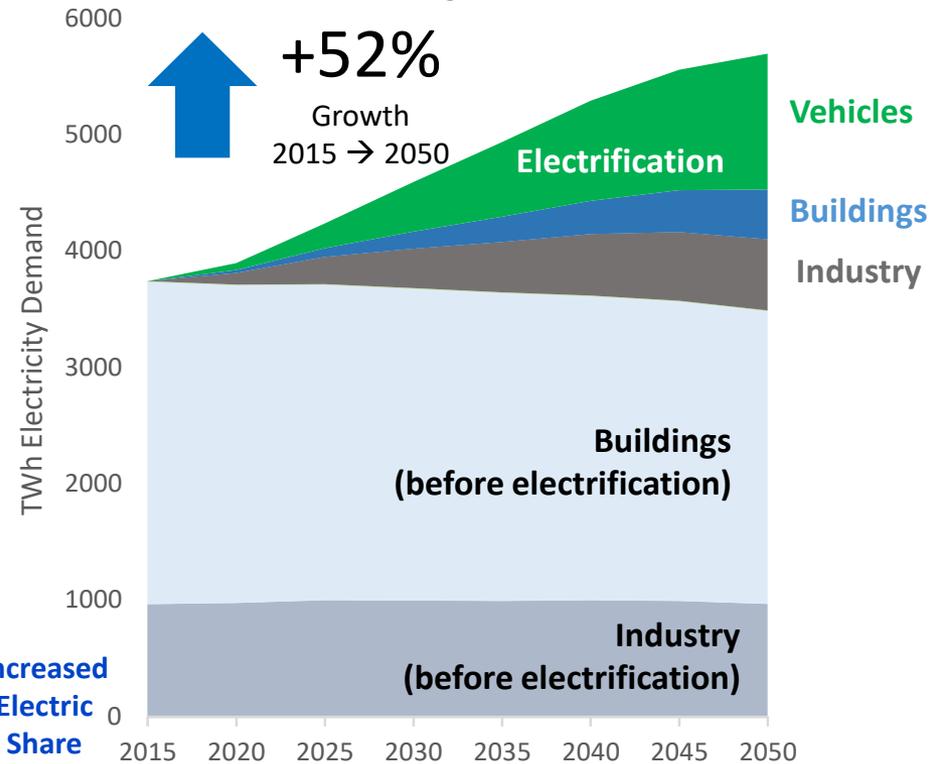


# Efficient Electrification: Transformation (tight carbon target)

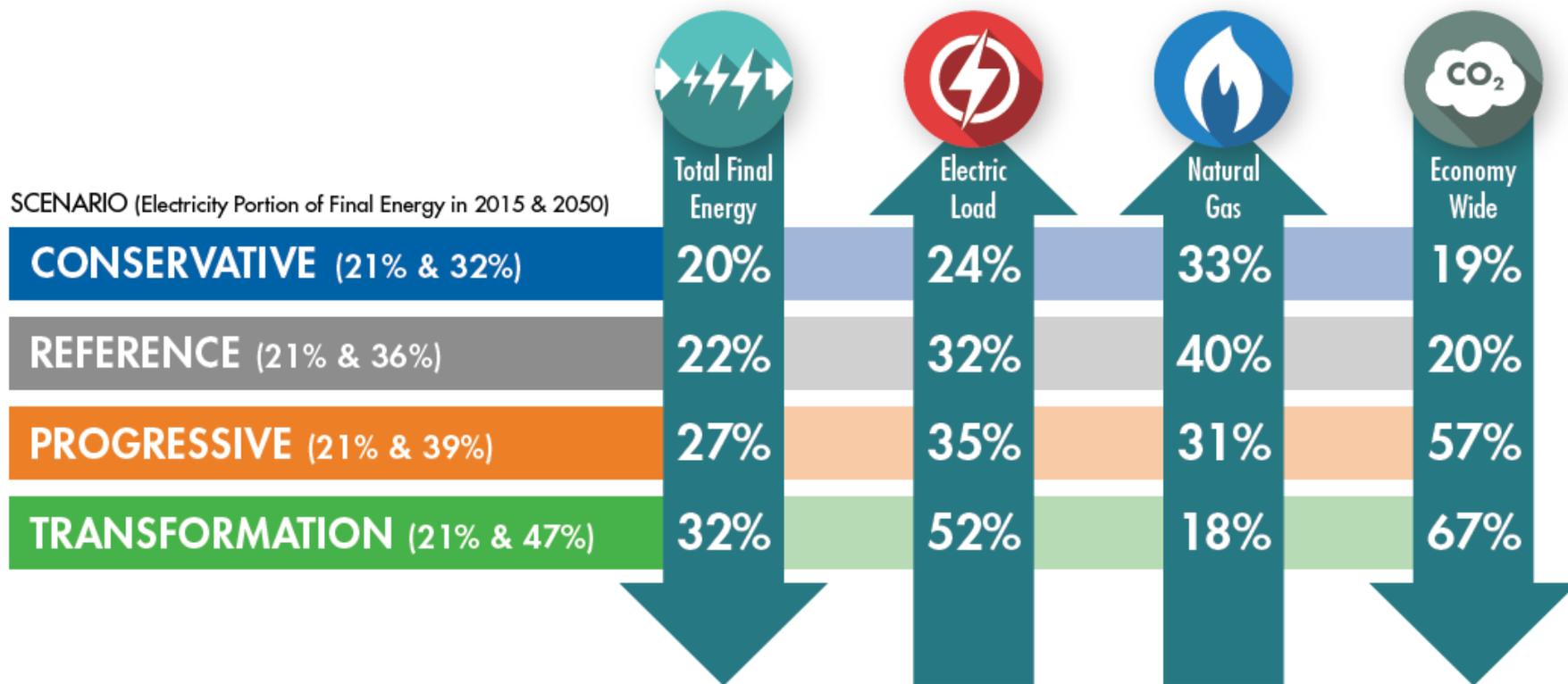
## Final Energy



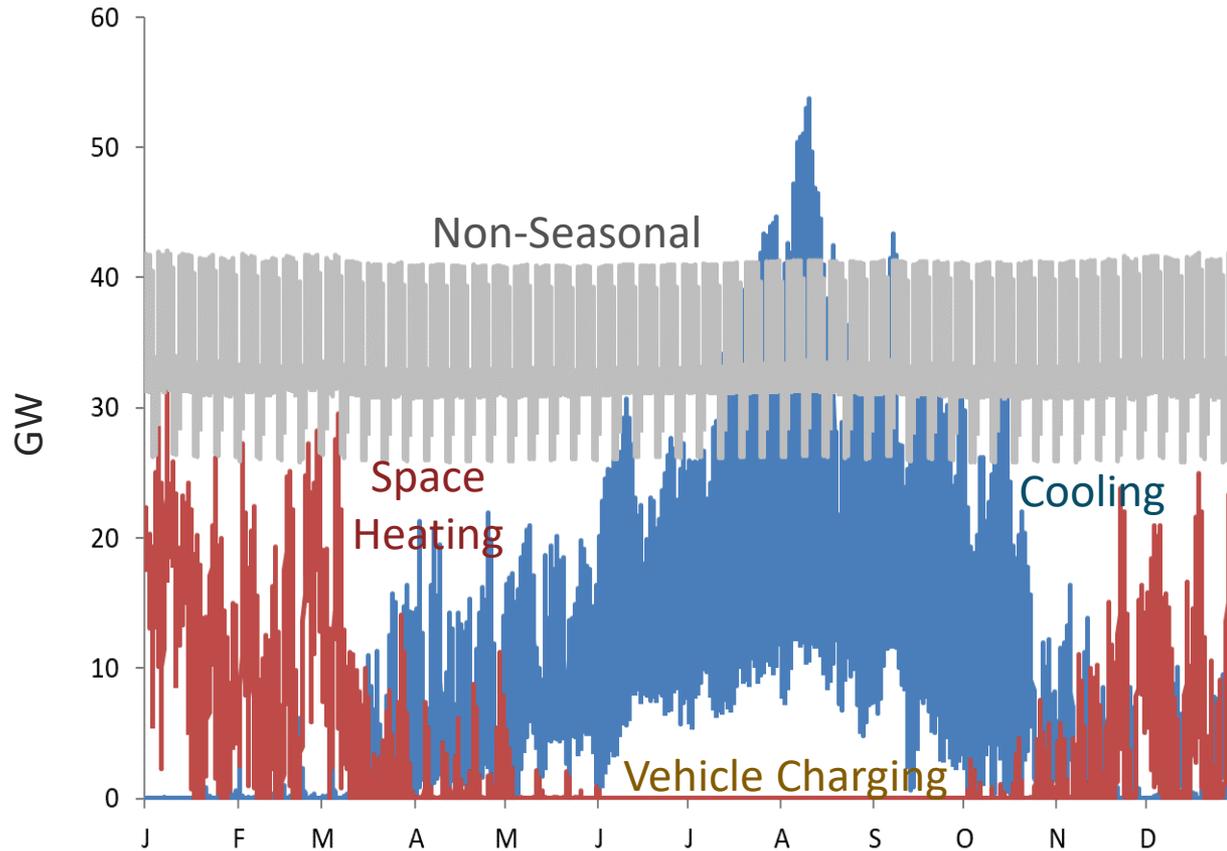
## Electricity Generation



# U.S. National Electrification Assessment (USNEA) – Results

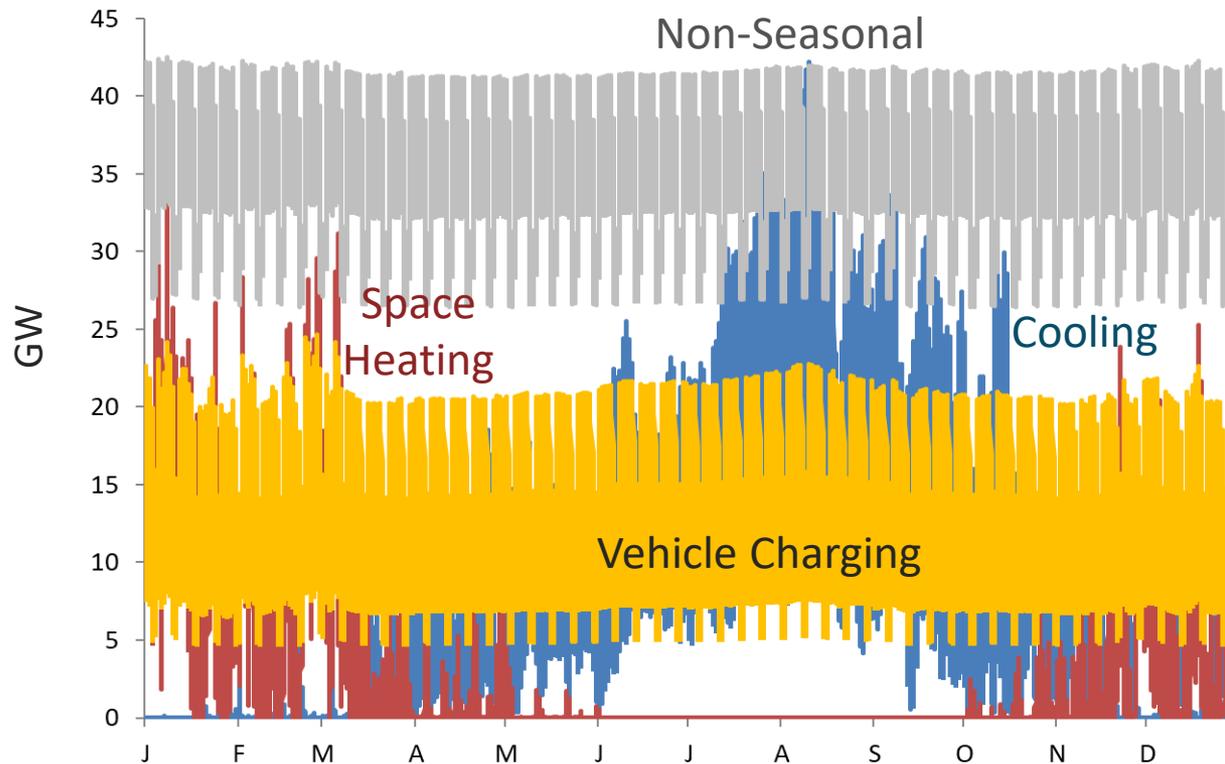


# Texas 2015 Load Profiles by End-Use



How Will Sectoral Loads Change Over Time?

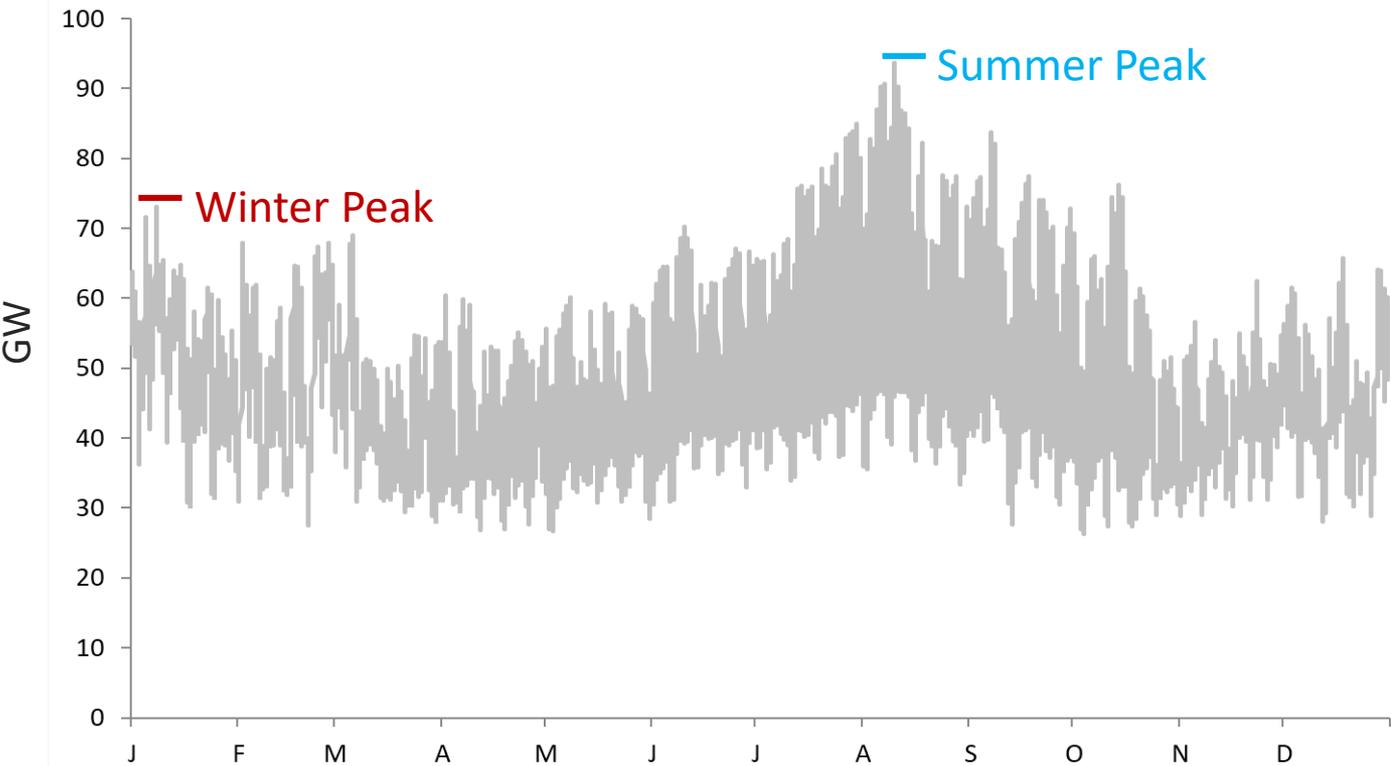
# Texas 2050 Reference Reflects Efficiency and Electrification Gains



## Vehicle Charging Emerges

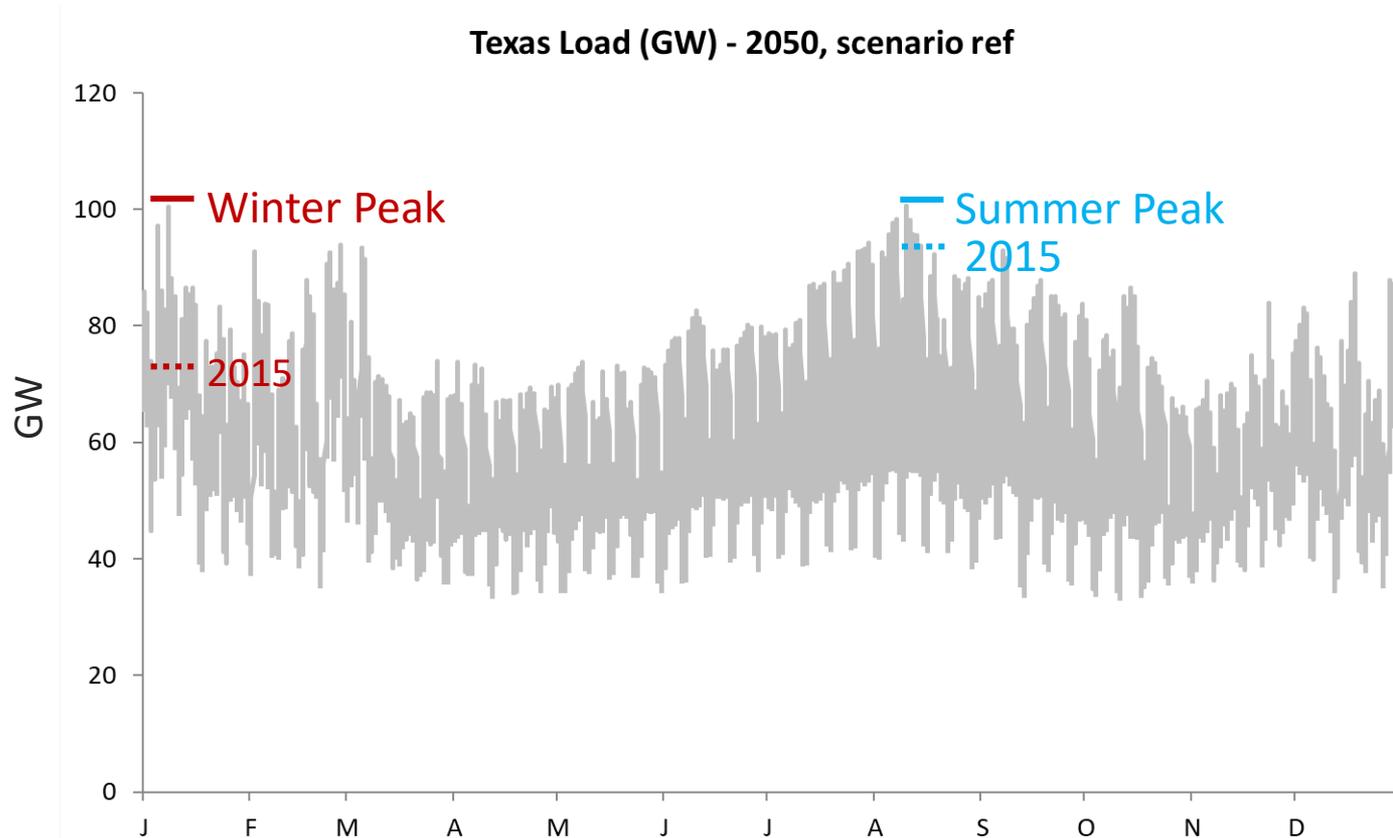
Efficiency Gains Offset Increased Cooling and Non-Seasonal Demands

# Texas 2015 Aggregate Load Profile



How Will Aggregate Load Change Over Time?

# Texas 2050 Aggregate Load Profile



Winter Peak Grows to Match Summer Peak

# Electrification is not a Given: Opportunities and Challenges Ahead



**Technology Improvement:  
Cost + Performance**



**Policy and Market Design:  
An Economy-wide View**



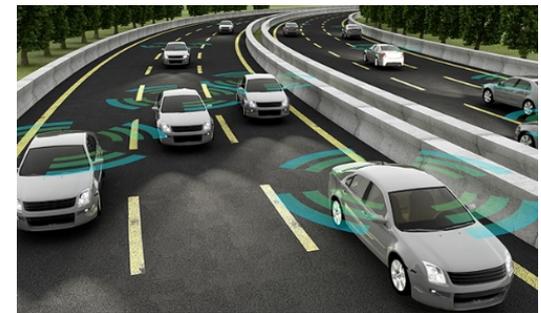
**Infrastructure  
Investment**



**Analyzing Customer  
Choice**



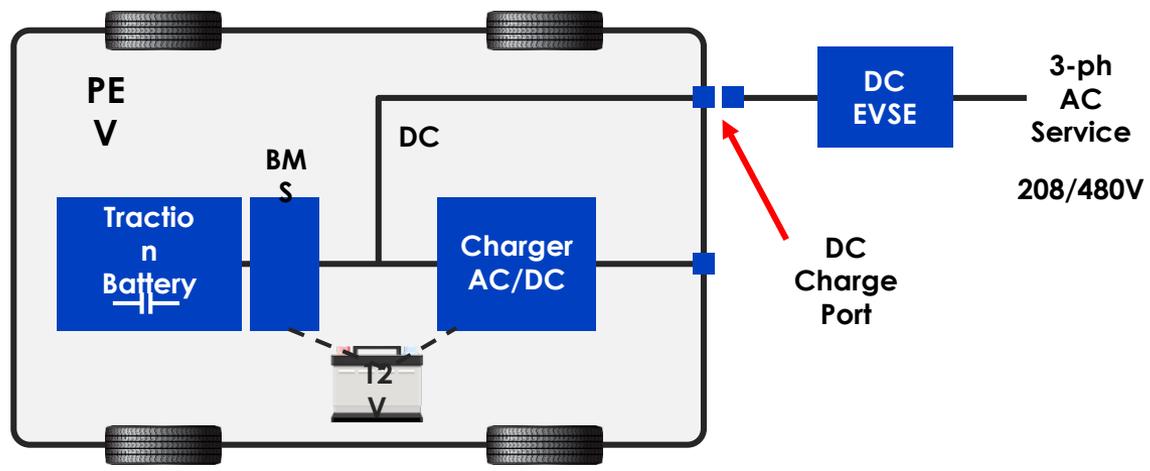
**Overcoming Non-  
Economic Barriers**



**Fundamental New Options:  
Autonomous/Shared Mobility**

# Informing Standards: Incompatible DC Charging Plugs Hamper EV Deployment

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
# EV models with DCFC	1	1	3	3	6	7	8	11	13	19	29	48	50



Name	Charge Port	Used By
SAE Combo Coupler System (CCS)		GM, Ford, Chrysler, Honda, KIA, Hyundai, BMW, Mercedes, Porsche, Audi
CHAdEMO		Nissan, Mitsubishi
Tesla		Tesla

**EPRI's Roles.** Convene Infrastructure Working Council.

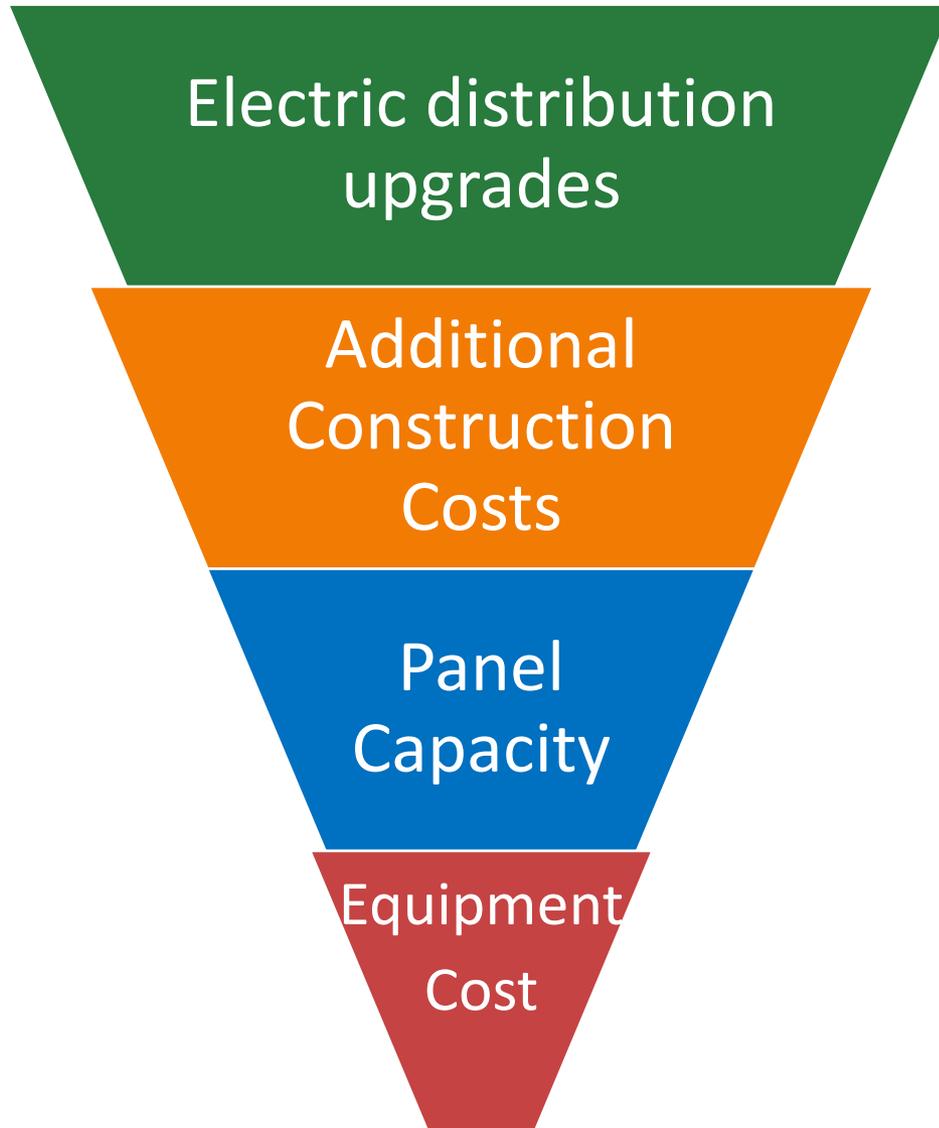
# Exploring Grid Technologies: Emerging DC Fast Charging Technology

- Local energy storage with EV DC fast charging infrastructure could:
  - help to reduce T&D infrastructure cost
  - provide grid services as well
  - provide customer resiliency service
  - decrease customer operational cost (rates)
  - be situated in disadvantaged customer locations to encourage adoption of EV
  - augment grid solutions to increase PV hosting and voltage/var, resiliency, etc.
- [Energy Storage Paired with Electric Vehicle DC Fast Charging: Demonstration and Analysis in Hawaii](#)
  - 12 kWh battery coupled to 23 kW limited DC fast charger



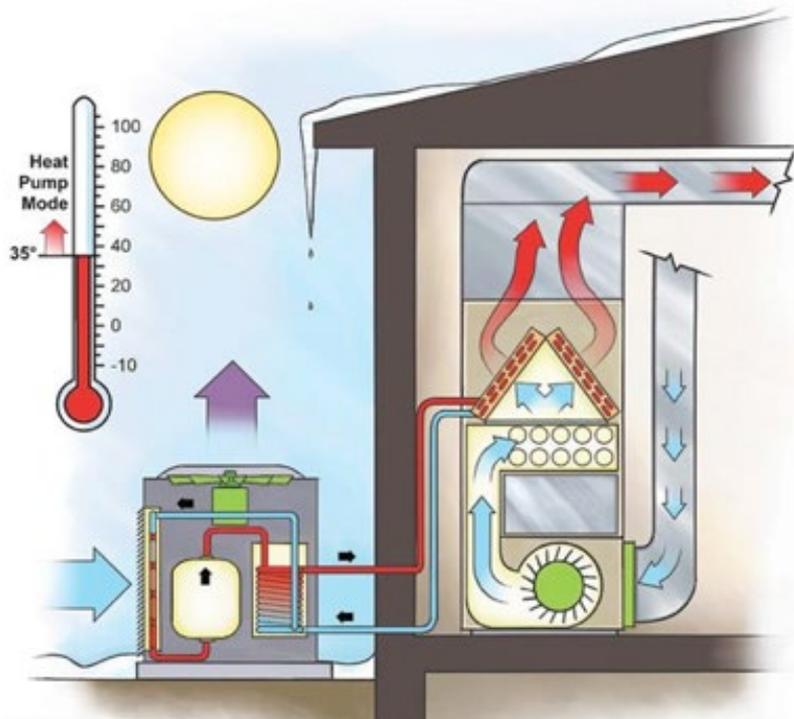
**EPRI's Role.** Model cost/benefit and nationwide test DC fast charging and storage integration project.

# Demonstration Projects to Understand Cost and Benefits: Addressing Retrofit Challenges – The Cost Stack



- Opportunity to integrate EV programs with building electrification programs
  - Do any panel or distribution upgrades once
- If customer upgrades can be rate based, do it once and get buildings “Electrification Ready”

# Developing New End-Use Capabilities: Next-Generation Hybrid Heating System



## Opportunity for Innovation

**Efficiency:** Adds combination mode, can utilize heat pump concurrently with gas/electric backup.

**Resiliency:** Next-gen system with optimized DC fan/solenoid and small energy storage can provide heating during power outage.

**Flexibility:** Current system lacks integrated smart connectivity to automate flexible operation based on cost/emissions/other criteria. Next-gen system enables demand response across electric and gas systems.

*Opportunity for EPRI to work with manufacturers to develop more efficient, resilient and flexible hybrid heating system of the future*

# Informing Electrification Program Design: Electrification Benefit/Cost Assessment Objectives

COMPLETED

- Critically assess standard energy efficiency cost-effectiveness tests; identify gaps to electrification analysis

COMPLETED

- Design robust cost-effectiveness framework: **Total Value Test**

COMPLETED

- Apply framework to initial set of use cases

Drafted;  
Under Review

- Publish report (Summer 2019)

2019 Q2-Q4

- Promulgate framework to stakeholders

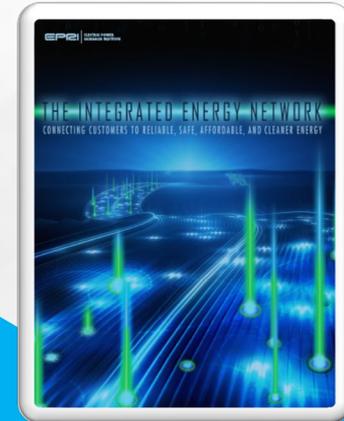
2019 Q2-Q4

- Build database of use cases

## Initial Use Cases



# Development of an Integrated Energy Network ... Smart. Connected. Increasingly Electrified ....



Source:  
EPRI 3002009917  
February 2017

## ...to Best Serve the Customer

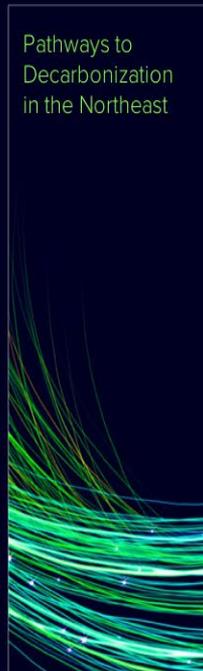
*Integration of Interdependent Energy Resources Enabled by Advances in Digitization, Information and Communication Technologies*

# Communication: Bringing Together Many Perspectives

## U.S. SYMPOSIUM SERIES



July 11-12, 2019  
Berkeley, California



August 27-29, 2019  
Brooklyn, New York



October 2-3, 2019  
San Antonio, Texas



## EUROPE 2019 INTERNATIONAL SUMMIT



October 16-17, 2019  
Paris, France



## 2020 INTERNATIONAL CONFERENCE & EXPOSITION



April 6-9, 2020  
Charlotte, North Carolina



# Together...Shaping the Future of Electricity