# Decarbonization – 2030 and beyond

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*EPRI's 22nd Energy and Climate Research Seminar*
*Washington, DC*

***May 16, 2019***

# ENERGY & CLIMATE RESEARCH SEMINAR

I. *Scientific Research Drivers*

II. Decarbon-ization

III. Actions and Initiatives

# EPRI - Independent – Objective – Technically Based

## BORN IN A BLACKOUT

Founded in 1972 as an independent, nonprofit center for public interest energy and environmental research

New York City, The Great Northeast Blackout, 1965

## EPRI'S VALUE

To provide value to the public, our members, and the electricity sector

**THOUGHT LEADERSHIP**

**INDUSTRY EXPERTISE**

**COLLABORATIVE MODEL**

## OUR MEMBERS…

- 450+ participants in more than 30 countries
- EPRI members generate approximately 90% of the electricity in the United States
- International funding – nearly 25% of EPRI's research, development, and demonstrations
- $415M Annual funding

# EPRI Global Research Areas

## Power Delivery & Utilization

Transmission, Distribution, and Substations

## Power Delivery & Utilization

Distributed Energy Resources and the Customer

## Nuclear

## Generation

## Energy and Environment

## Technology Innovation

# The Integrated Energy Network


**Source:**
**EPRI 3002009917**
**February 2017**

## …Best Serves the Customer

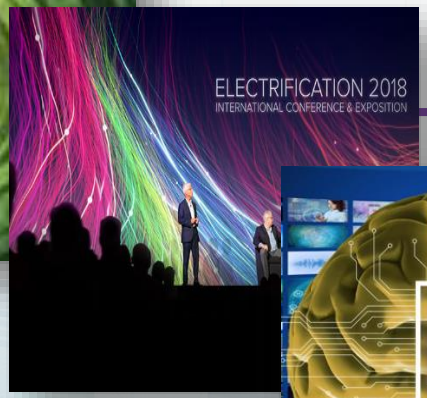
***Integration of Interdependent Energy Resources is Enabled by Advances in Digitization, Information and Communication Technologies***

# EPRI – 2019 Cross-EPRI Topics

## SHARED INTEGRATED GRID

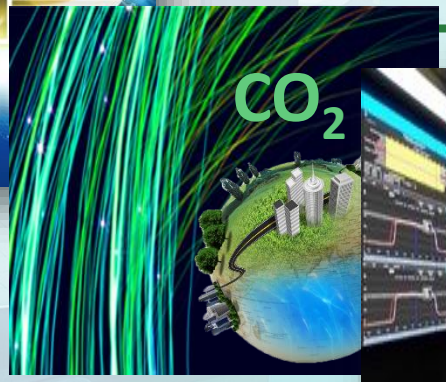
## CUSTOMER AND GRID RESILIENCE

## CYBER SECURITY




## EFFICIENT ELECTRIFICATION


## ARTIFICIAL INTELLIGENCE AND DATA ANALYTICS




## PROJECT 2X

## ADVANCED DISTRIBUTION PLANNING AND OPERATIONS



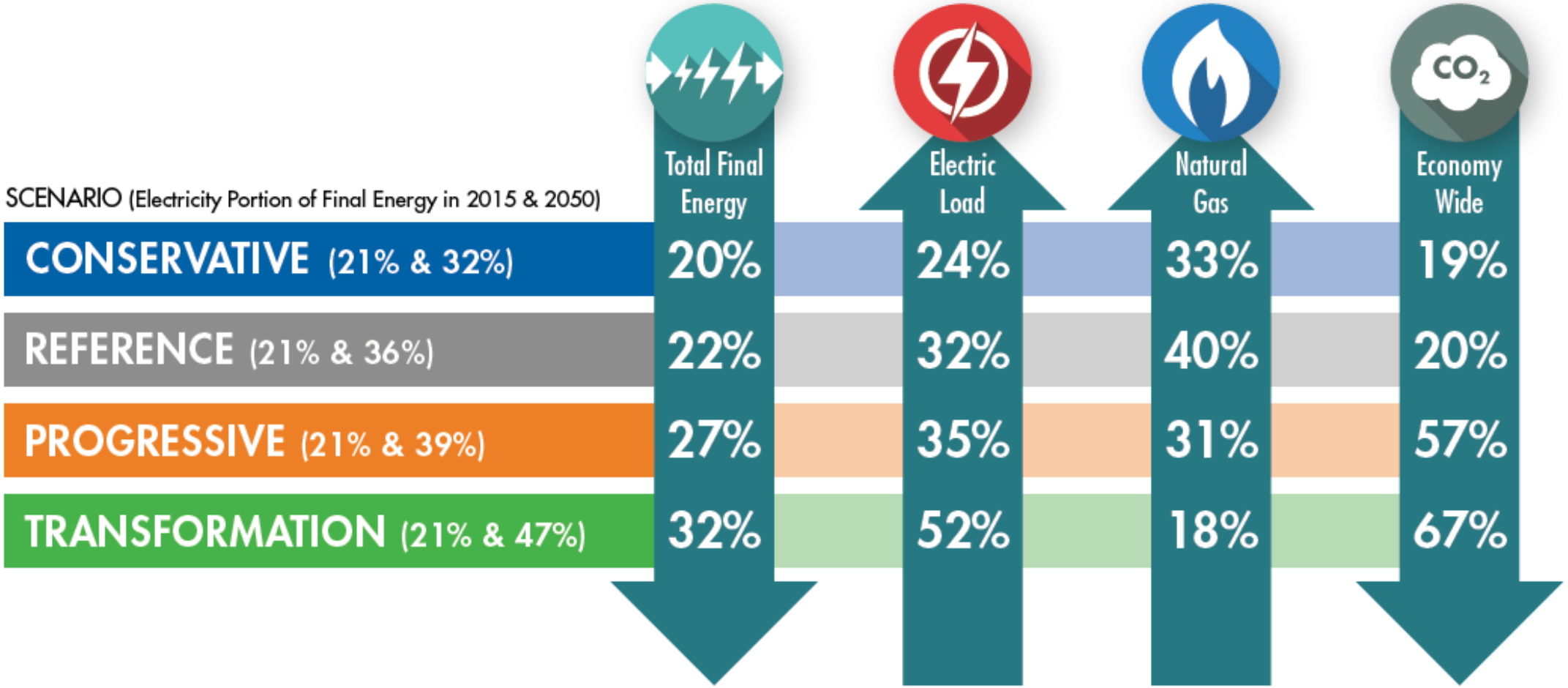

# EFFICIENT ELECTRIFICATION

# U.S. National Electrification Assessment (USNEA)


- **Economy-wide assessment:**
  - **Residential, commercial, industrial and transport**
- **Customers have broad technology choices and control**
- **Customer decisions integrated with detailed electricity supply mode**

For more information on EPRI's Efficient Electrification Initiative:
https://www.epri.com/#/pages/sa/efficientelectrification

# Customer Choice Assessments - Results




## U.S. National Electrification Assessment (USNEA) – Results 2015-2050

# Key Take Away Messages from U.S. National Electrification Assessment

| | |
|---|---|
| **Electrification Trend Continues** | Driven by technological change and consumer choice, further bolstered by policy |
| **Efficiency Increases Emissions Decrease** | Efficient electrification + end-use efficiency lead to falling final energy use |
| **Natural Gas Use Grows** | Remains a key fuel for end-use and electric generation |
| **System Impacts** | Changing load shapes and new flexible loads create challenges and opportunities |

Key Takeaways

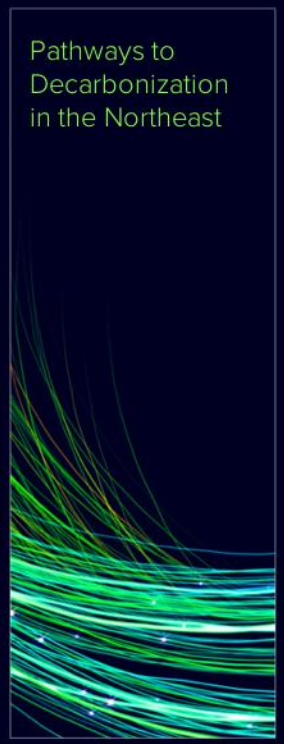





# EPRI Electrification Events in 2019 - 2020

U.S. SYMPOSIUM SERIES

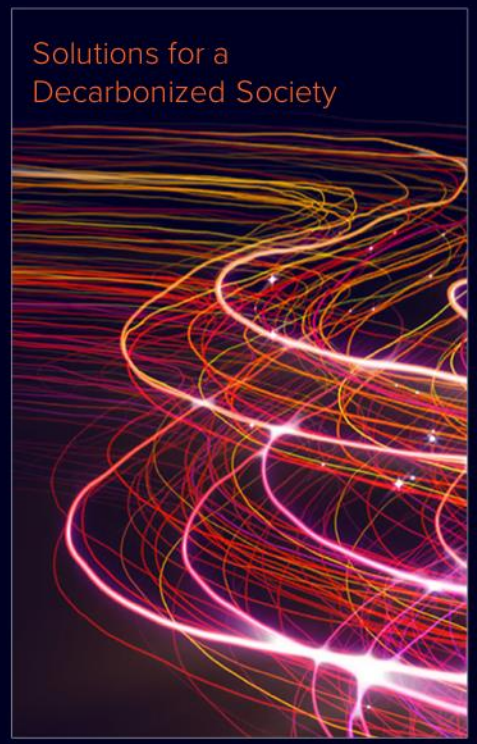

July 11-12, 2019
Berkeley, California




August 27-29, 2019
Brooklyn, New York


October 2-3, 2019
San Antonio, Texas

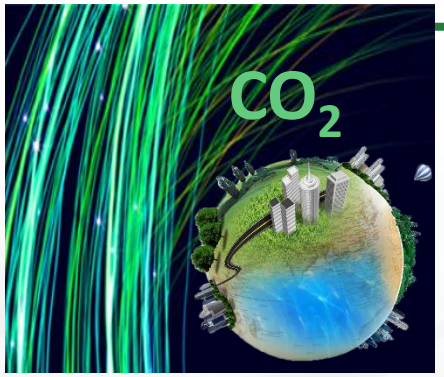
EUROPE 2019
INTERNATIONAL SUMMIT




October 16-17, 2019
Paris, France

2020 INTERNATIONAL
CONFERENCE & EXPOSITION


April 6-9, 2020
Charlotte, North Carolina



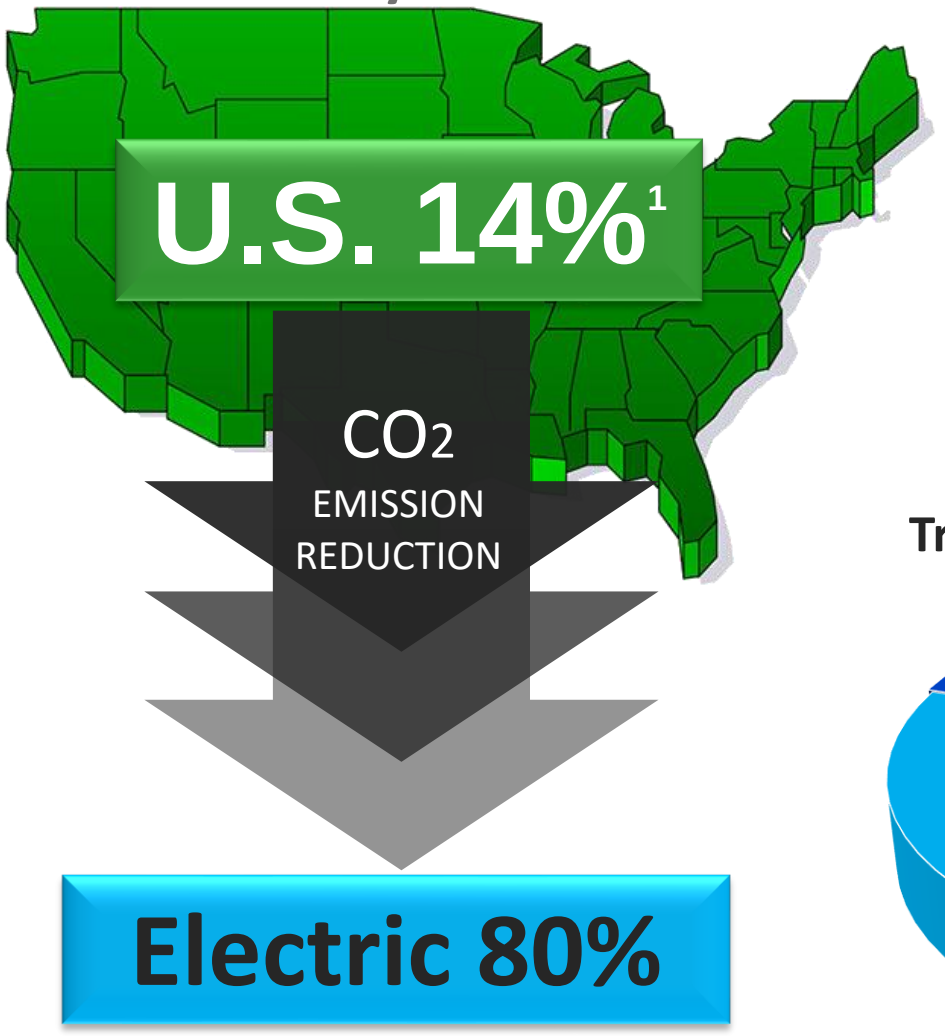


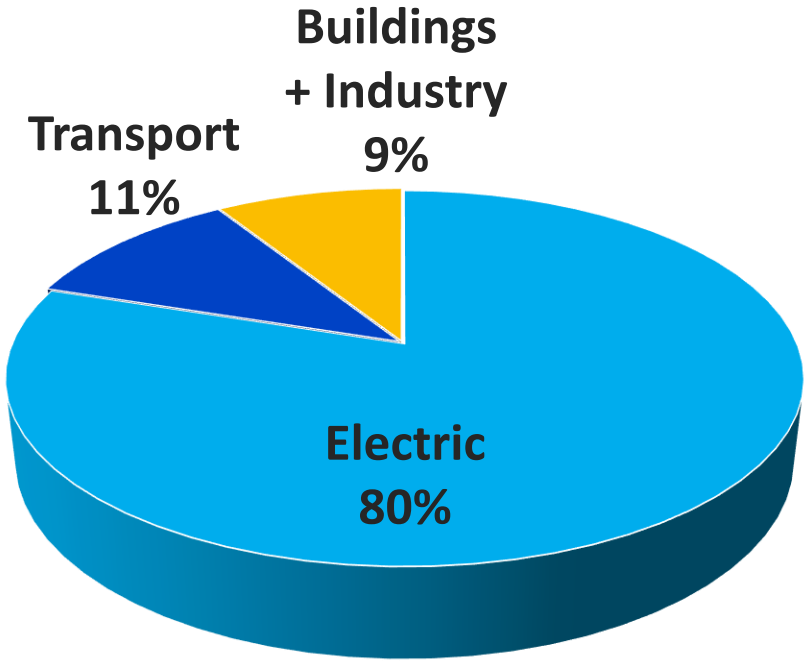

# Accelerating Decarbonization: PROJECT 2X (U.S.)

***Accelerating the drive towards a cleaner energy future affordably and reliably.***

# Global and U.S. Carbon Emissions 2005-2017

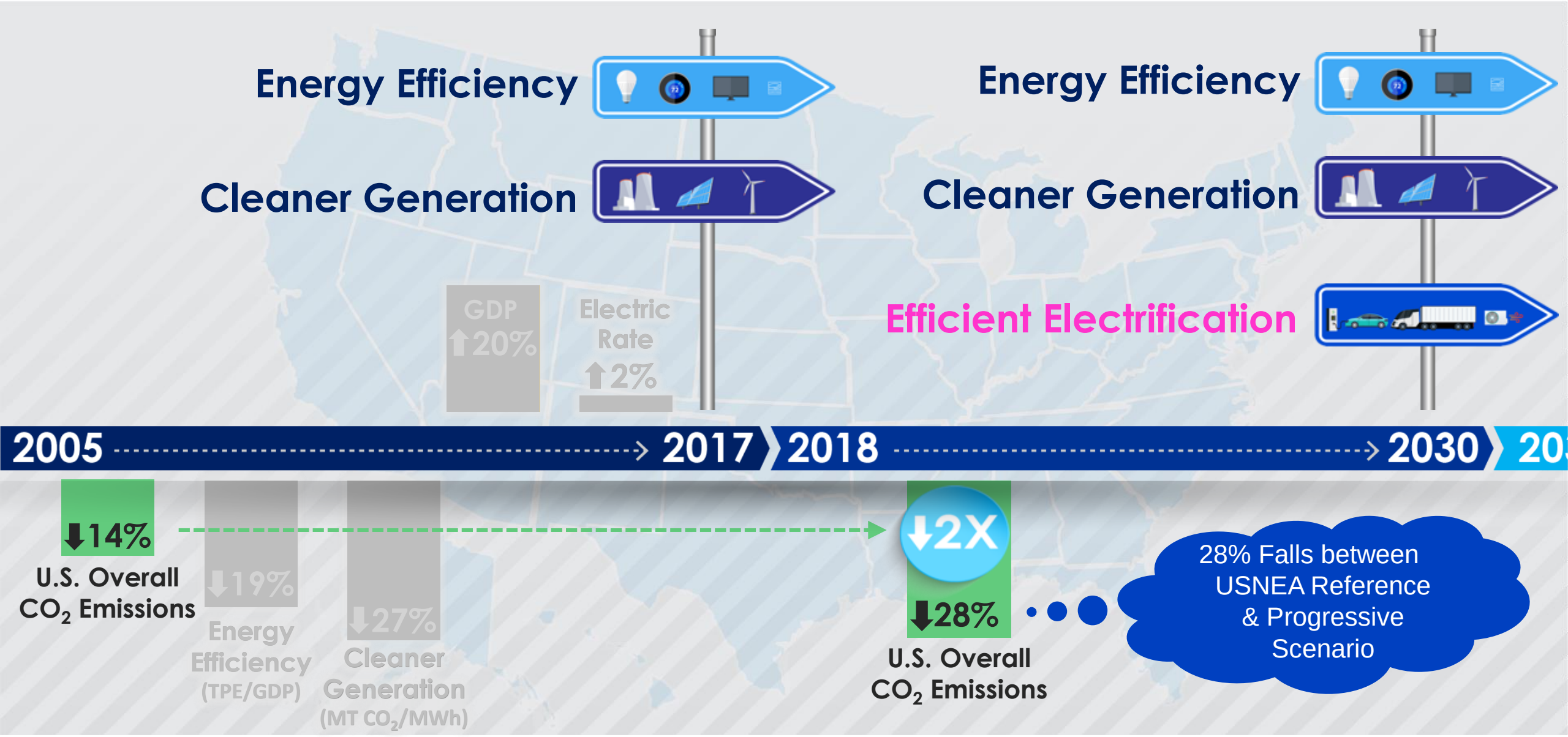
## US $CO_2$ Economy-Wide Reduction


[1] EIA Monthly Energy Review, Feb 2019

# Project 2X –Economy-Wide Transition to Cleaner Energy Future



# 4 Waves of Energy Efficiency

## 1st Wave (~1970s)

- DOE codes and standards
- Energy Star program

## 2nd Wave (~1990s)

- Utility energy efficiency programs
- ~$6B per year to accelerate adoption

## 3rd Wave (~2006)

- Micro efficiency leading to macro efficiency
- Example – iPhone LED/OLED screen leads to hyper-efficient large-screen TVs

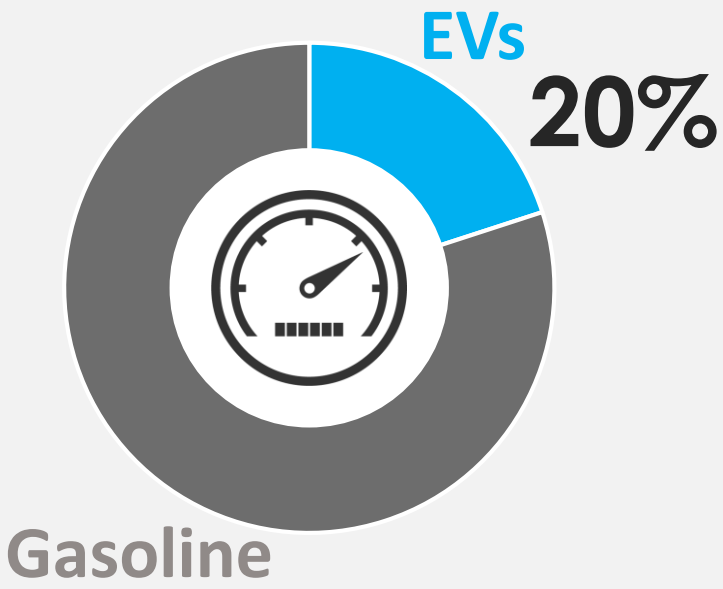
## 4th Wave (Now)

- Connected systems (Internet of Things)
- Machine learning/AI energy management

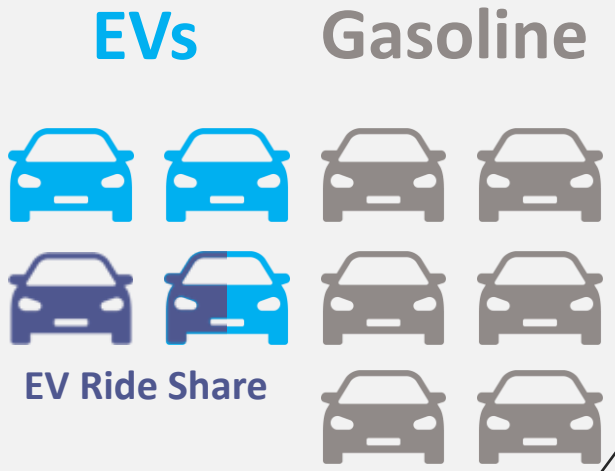
# Key to Lower Carbon: Light-Duty EVs Drive Rapid Transport $CO_2$ Reduction[1]

## 2030

### 2030 Vehicle Miles Traveled




### 2030 U.S. Electric Vehicle Share of New Car Sales Ratio




**4/10**

## Aggressive Deployment of EVs

### 2030 U.S. Electric Vehicle Share of New Car Sales

| | |
|---|---|
| NREL – Mid | 58% |
| EPRI Updated Reference | 40% |
| Bloomberg NEF | 35% |
| EEI (Consensus) | 22% |
| EIA 2019 | 9% |

[1]EPRI USNEA Updated Reference Scenario)

# Annual Household Comparison

Household with 2 Gasoline Vehicles

**Household Energy Expenses:**

Gasoline | Electricity | Natural Gas | Other

**Average Energy Bill:**
$4,528/year

**Average CO2 Emissions:**
18 $tCO_2$/year

Household with 1 Gasoline Vehicle and 1 Electric Vehicle

**Average Energy Bill:**
$4,113/year
10%

**Average CO2 Emissions:**
15 $tCO_2$/year
17%

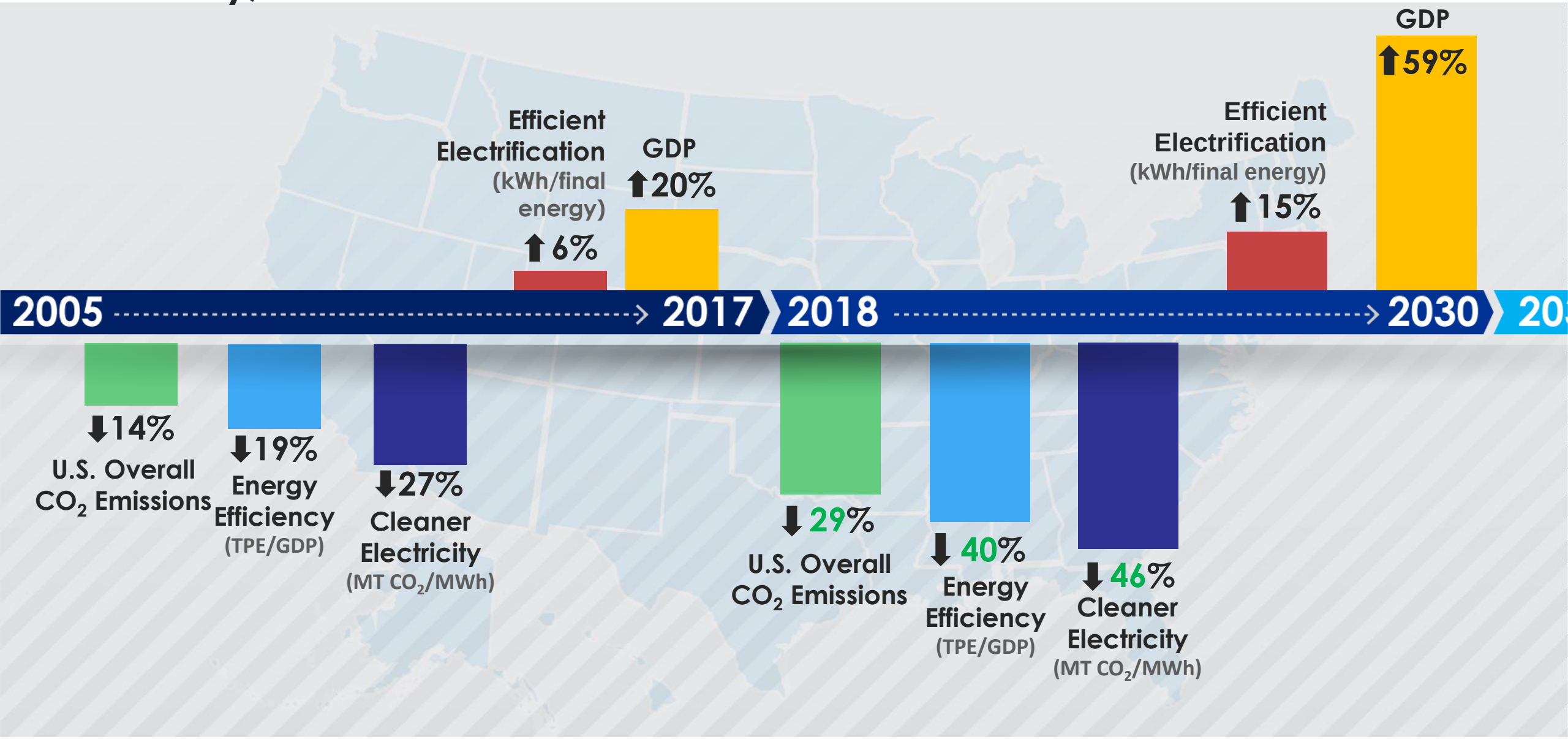
**Average Energy Bill:**
$3,571/year
21%

**Average CO2 Emissions:**
12 $tCO_2$/year
34%

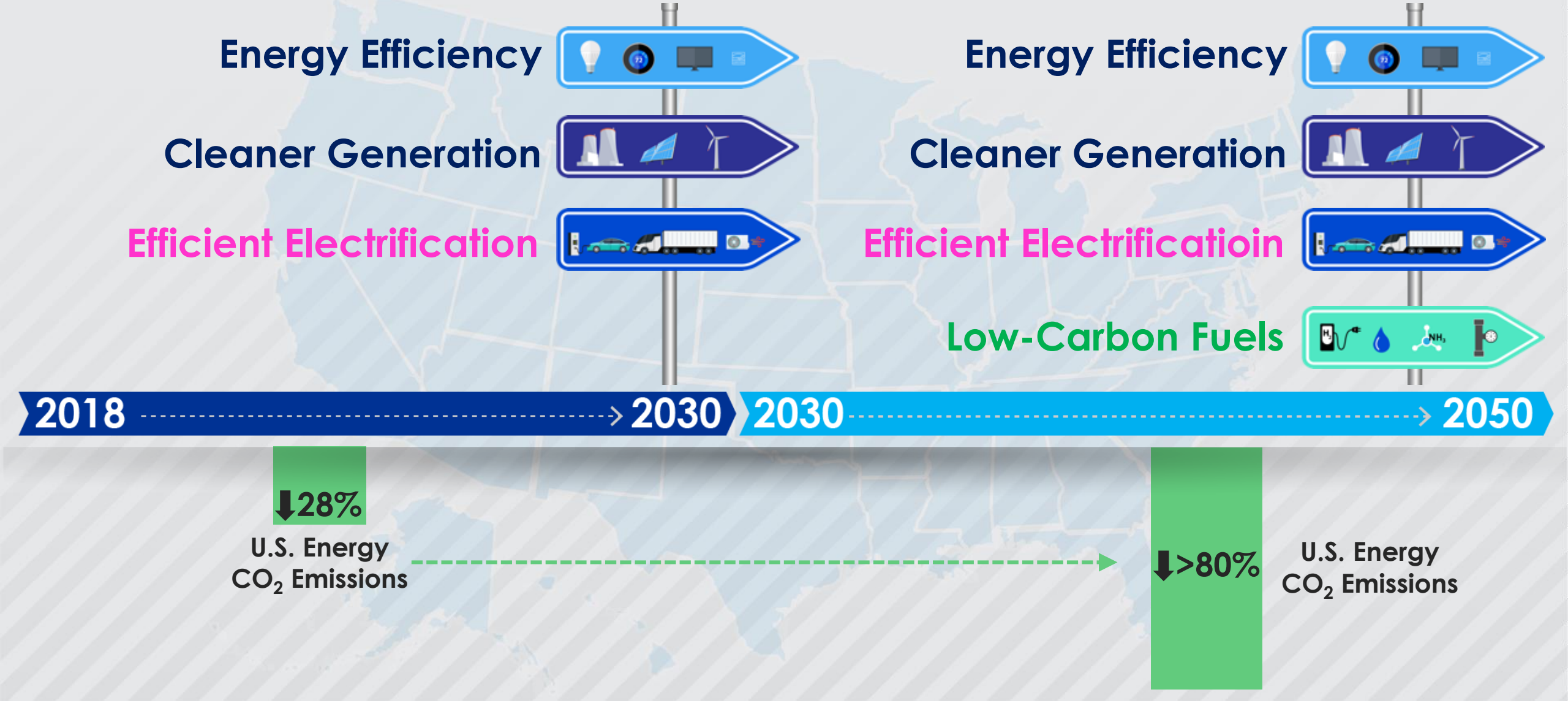
Household with 2 Electric Vehicles

? Purchase Price

# Pathway to 2X: Dialing in All "Three": Efficiency, Clean Generation & Electrification



# Beyond 2030



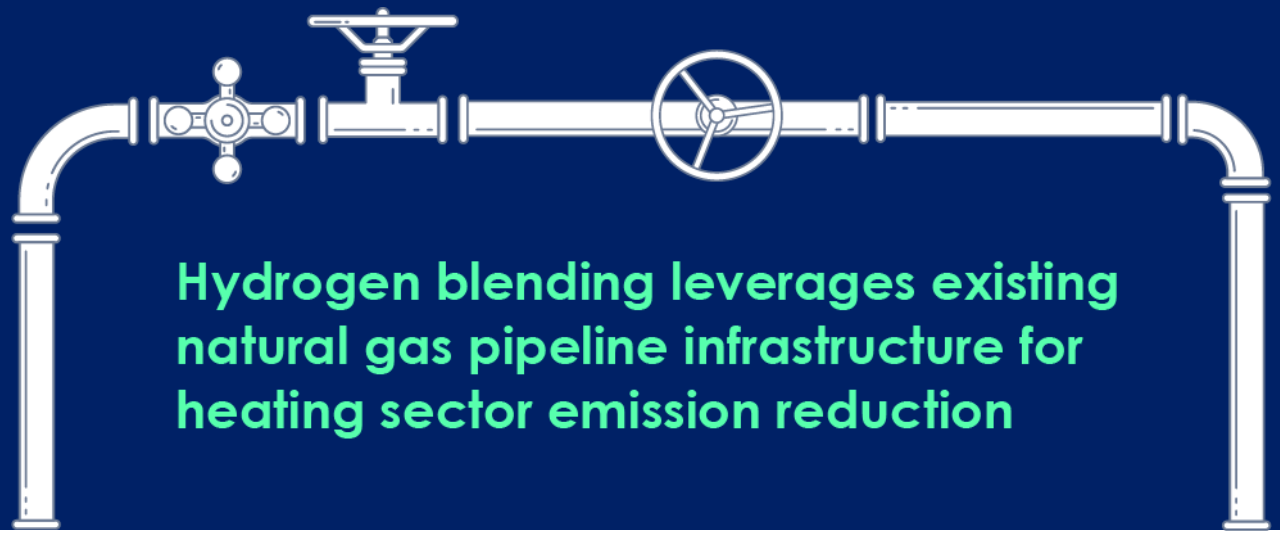
# Additional Key Technologies in A Very Low-Carbon 2050

## Zero-Carbon Electric Generation

- Carbon Capture & Storage
- Advanced Nuclear

## Low Carbon Fuels:

cleaner electricity → cleaner energy carriers ($H_2$, $NH_3$) → heavy duty transportation, heating, & industry



Hydrogen blending leverages existing natural gas pipeline infrastructure for heating sector emission reduction

# Key Takeaways from Accelerating Decarbonization: U.S. Project 2X

| | |
|---|---|
| **Cleaner Electricity** | Natural gas, renewables and nuclear key in the near team. Longer term advanced renewables, advanced nuclear, CCS and advanced grid, enable efficiency, affordable and reliable operation. |
| **Energy Efficiency** | 4th wave of energy efficiency + continuation of prior "waves", drives further carbon emissions reduction |
| **Efficient Electrification** | Electric transport dominates the next decade, continued electrification opportunities in buildings and industry are important paths to deeper emissions reductions. |
| **Low Carbon Fuels** | Near zero/low-carbon fuels and generation are needed for further reductions toward 2050 |

Key Takeaways

# Together...Shaping the Future of Electricity