

# EPRI-IEA Workshop on Clean Energy and Electrification

## Session 4: Electrification of Industry

November 30, 2016

Allen Dennis

Sr. Program Manager



# Agenda



- Overview of EPRI
- EPRI's Participating Utilities
- Future Industrial Growth Markets
- Emerging Electric Technologies
- EPRI's Need to Collaborate With Vendors
- Final Thoughts

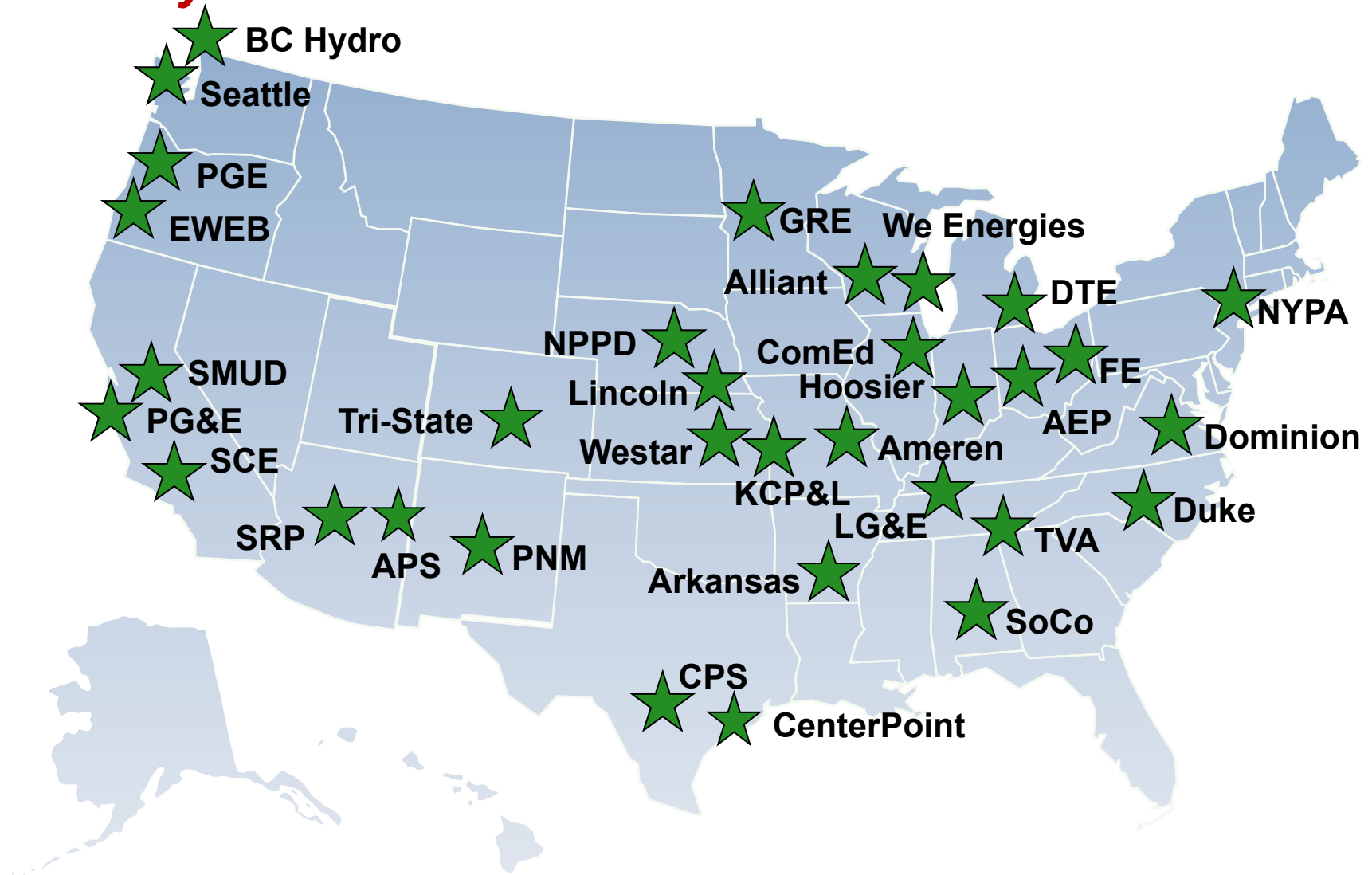
# What is Electrification?

**Applying efficient electric technologies as an alternative to existing technologies, while increasing customer benefit.**



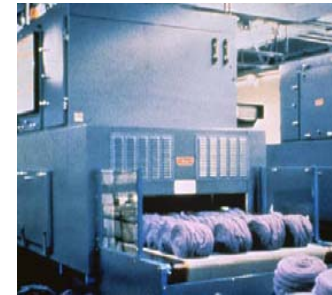
# Electrification Participants

**32 Utility Members**



# Metrics for Valuing Electrification

Metric Options	Benefit		
	Customer	Utility	Society
<b>Economic Efficiency</b> <i>-- It costs less</i>	✓	✓	✓
<b>Economic Development</b> <i>-- Jobs creation</i> <i>-- Development of community assets</i>			✓
<b>Energy Efficiency</b> <i>-- Uses fewer BTUs overall</i>	✓	✓	✓
<b>Environment</b> <i>--Emissions reduction, CO2 savings, water savings, etc.</i>	✓	✓	✓
<b>Plant Productivity Improvements</b> <i>-- Plant output increases</i> <i>-- Reduction in energy intensity</i> <i>-- Improved product quality</i>	✓		✓
<b>Worker Safety Improvements</b> <i>--Reduced loss time accidents and fatalities</i>	✓		✓



**Electric Process Heating**



**Heat Pumps**



**Electric Lift Trucks**

# Transition to Cleaner Electricity Generation ~2030



**Renewables**



**Distributed Energy Resources**



**Ultra Supercritical**

**Renewable Growth will be Global;**  
**Pace and Scale of Nuclear, Coal and Natural Gas Growth will vary from Region to Region**

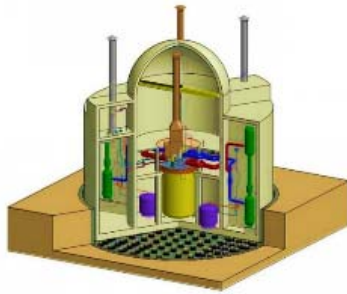


**Natural Gas**



**Nuclear**

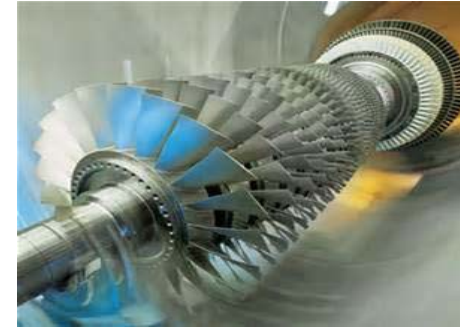
# Pathway of Cleaner Electricity/Energy Generation ~ 2050



**Generation IV Nuclear**  
(co-production – electricity, hydrogen steam)

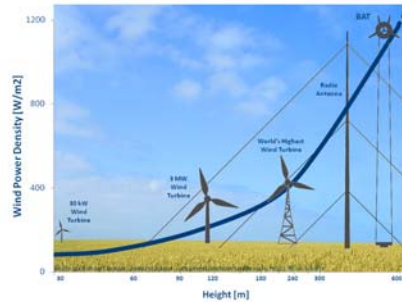


**Large-Scale Storage**

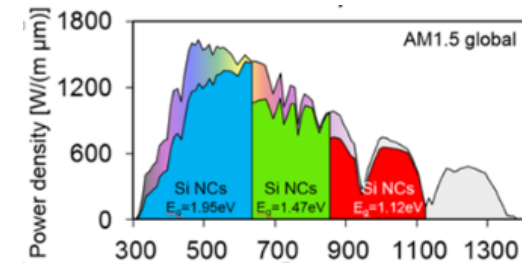


**Advanced Power Cycles**  
e.g. Supercritical CO2 Cycle

**Technology Innovation in the next decade will be Key to Ensure all Options for Cleaner Energy Production are Available in the Long Term**



**High Altitude/Power Wind**



**Gen III Photovoltaic (PV)**

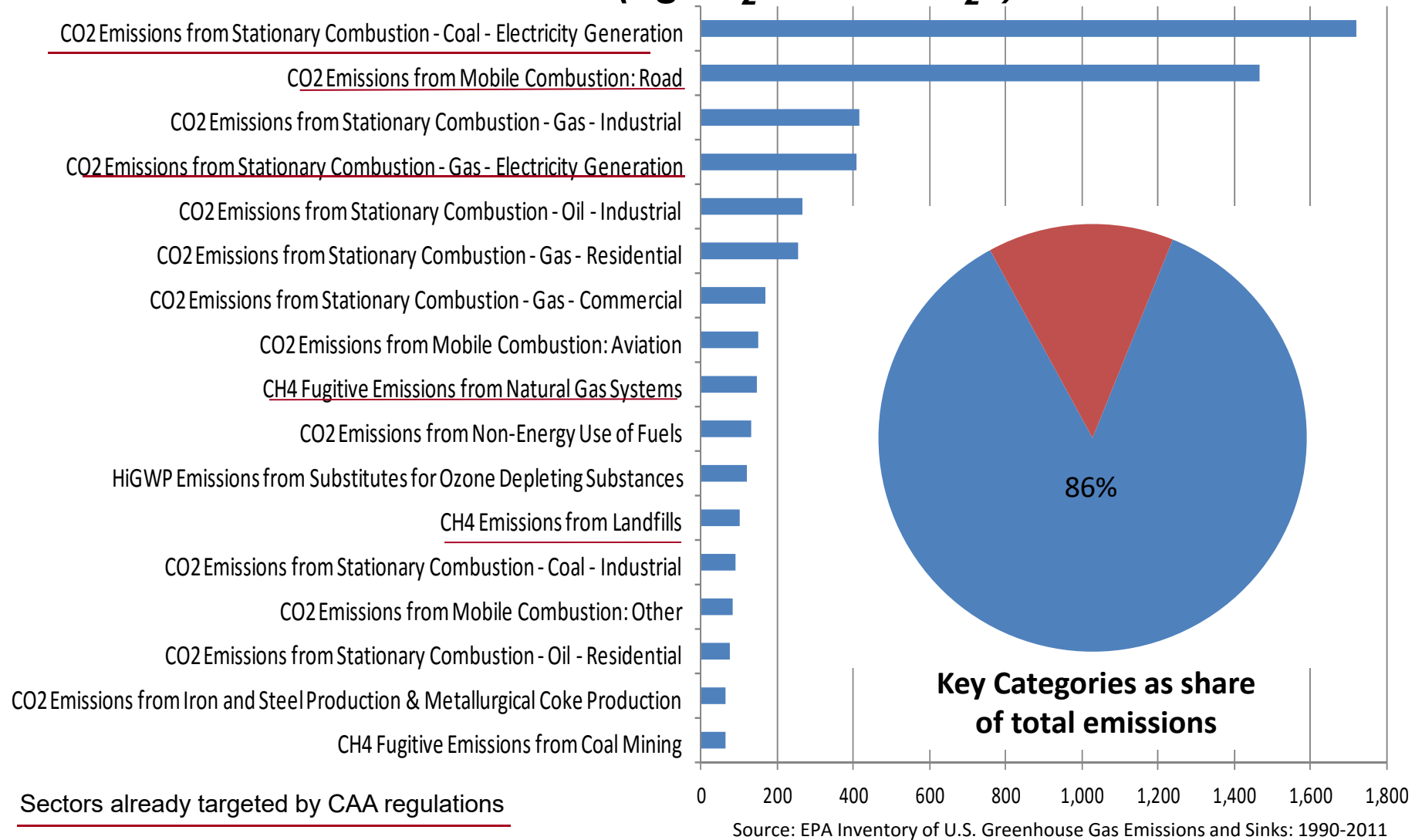
Source: Carbon Capture Image – htcco2systems.com; Gen IV Image – KAERI





# Opportunities for Carbon Reductions

## Key Categories from the EPA GHG Inventory by Economic Sector (TgCO<sub>2</sub>e or MTCO<sub>2</sub>e) in 2011



# Current issues facing utilities

- Technologies are changing quickly
- Electric utilities are experiencing lower energy sales
- Emission reductions are in the forefront of many community and stakeholder groups
- Utilities have significantly reduced their technical staffs
- Utility customer satisfaction scores are suffering



# Collaboration With Vendors Is The Key

## Vendor Areas of Focus:

- Available business cases, that include financial analyses
- Typical targeted customers
- Typical installation and operating cost of equipment
- Quantification of non-energy benefits, including emissions benefits
- Available technology training materials
- Understanding barriers for adoption
- Financing/leasing arrangements available
- Typical installation timeframe
- Marketing/promotion approaches



# Targeted Industrial Electric Technologies

## Process Industries

- 1 - **Electrochemical Synthesis**
- 2 - **Electrolytic Separation**
- 3 - **Freeze Concentration**
- 4 - **Industrial Process Heat Pumps**
- 5 - **Membrane Processes**
- 6 - **Electric Boilers**
- 7 - **Pulsed Power**

## Materials Production

- 8 - **Direct Arc Melting**
- 9 - **Electro galvanization**
- 10 - **Electrolytic Reduction**
- 11 - **Electroslag Processing**
- 12 - **Resistance Heating And Melting**
- 13 - **Induction Melting**
- 14 - **Ladle Refining**
- 15 - **Plasma Processing**
- 16 - **Vacuum Melting**

## Materials Fabrication (Metals and Non-metals)

- 17 - **Electric Discharge Machining**
- 18 - **Electrochemical Machining**
- 19 - **Electrofinishing**
- 20 - **Electroforming**
- 21 - **Electron Beam Processing**
- 22 - **Flexible Manufacturing Systems/Automation**
- 23 - **Induction Heating**
- 24 - **Infrared Processing**
- 25 - **Laser Processing**
- 26 - **Microwave Heating And Drying**
- 27 - **Radio-Frequency Heating And Drying**
- 28 - **Ultraviolet Curing**
- 29 - **Acoustics/Ultrasound**
- 30 - **Industrial Process Measurement, Control, and Integration**
- 31 - **Cryogenics**

## Industrial Wastewater Treatment

- 32 - **Industrial Ozonation**
- 33 - **Industrial Reverse Osmosis**
- 34 - **Industrial Ultraviolet Disinfection**

# Current CO2 and Cost Effective Targeted Technologies



<b>Residential</b>	Heat pump technologies
<b>Commercial</b>	Variable capacity heat pumps
	Heat pump water heaters
	Forklifts (comm & ind applications)
	Truck stop electrification
	Commercial food service equipment
	Water ozonation
	Wastewater treatment
<b>Industrial</b>	Industrial Processes
	Pipeline compression
	Electric furnaces
	C&I heat recovery chiller

# Top Ten Industrial Growth Areas To Target Electric Technologies

Electrotechnology	Electricity Consumption (Million kWh)			5-Year Growth%	Primary Growth Drivers
	2015	2020	Growth		
Cryogenics	15,500	19,700	4,200	27%	Product Quality, Industry Growth (Industrial Gases)
Direct Arc Melting	32,600	36,300	3,700	11%	Steel Industry Growth, Productivity
Induction Heating	21,100	24,300	3,200	15%	Product Quality, Industry Growth (Metals Industries and Transportation Equipment)
Resistance Heating and Melting	37,300	40,200	2,900	8%	Industry Growth (Plastics, Mineral Products, Chemicals, other Manufacturing Industries)
Ultraviolet Curing	7,700	9,900	2,200	29%	Product Quality, Environment, Efficiency, Industry Growth (Printing and Curing)
Infrared Processing	5,900	7,900	2,000	34%	Product Quality, Fuel Switching, Industry Growth (Transportation, Plastics, Other)
Water Supply Reverse Osmosis (Desalination)	2,300	3,200	900	39%	Environmental Benefits/Requirements
Induction Melting	2,900	3,600	700	24%	Productivity, Industry Growth (Primary Metals)
Membrane Processes	2,200	2,800	600	27%	Industry Growth (Chemicals, Food), Fuel Switching, Product Quality
Electroslag, Vacuum and Plasma (Combined)	1,900	2,300	400	21%	Product Quality, Industry Growth (Primary Metals)
<b>TOTAL</b>	<b>129,400</b>	<b>150,200</b>	<b>20,800</b>	<b>16%</b>	

# Electrification Program Road Mapping

## Member Needs



## EPRI's Work Efforts

- |  |                                       |                                  |                                |                           |
|--|---------------------------------------|----------------------------------|--------------------------------|---------------------------|
| ➤ Knowledge Base Enhancements          | ➤ Target Technologies                 | ➤ Marketing Material Development | ➤ Customer Assessments         | ➤ E,M and V Development   |
| ➤ Analytics Expansion                  | ➤ Target Customers                    | ➤ Program Development            | ➤ Site Visits /Analyses        | ➤ Utility Working Groups  |
| ➤ Working Councils: Vendor Engagements | ➤ Determine Revenue/ Earnings Impacts | ➤ Training                       | ➤ Effective Targeted Marketing | ➤ Local Vendor Engagement |

# EPRI Industrial Center of Excellence (ICoE)

**This project provides practical resources enabling utilities to increase productivity of key industrial customers.**

- Industrial Productivity and Beneficial Application of Electricity
  - Online Resource Platform
  - Facility Assessments
  - Case Studies
  - Workshops and Training
  - TechBriefs, Application Guides, and other resources





# Final Thoughts

- Expand electric technologies to new and existing customers
- Technologies are changing quickly, important to stay current on technology adoptions
- Focus on markets that can execute quickly
- Reduce emission impacts/opportunities
- Develop/access strong technical resources





# Together...Shaping the Future of Electricity