TEP Greenhouse Gas Reduction Goal

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Outline

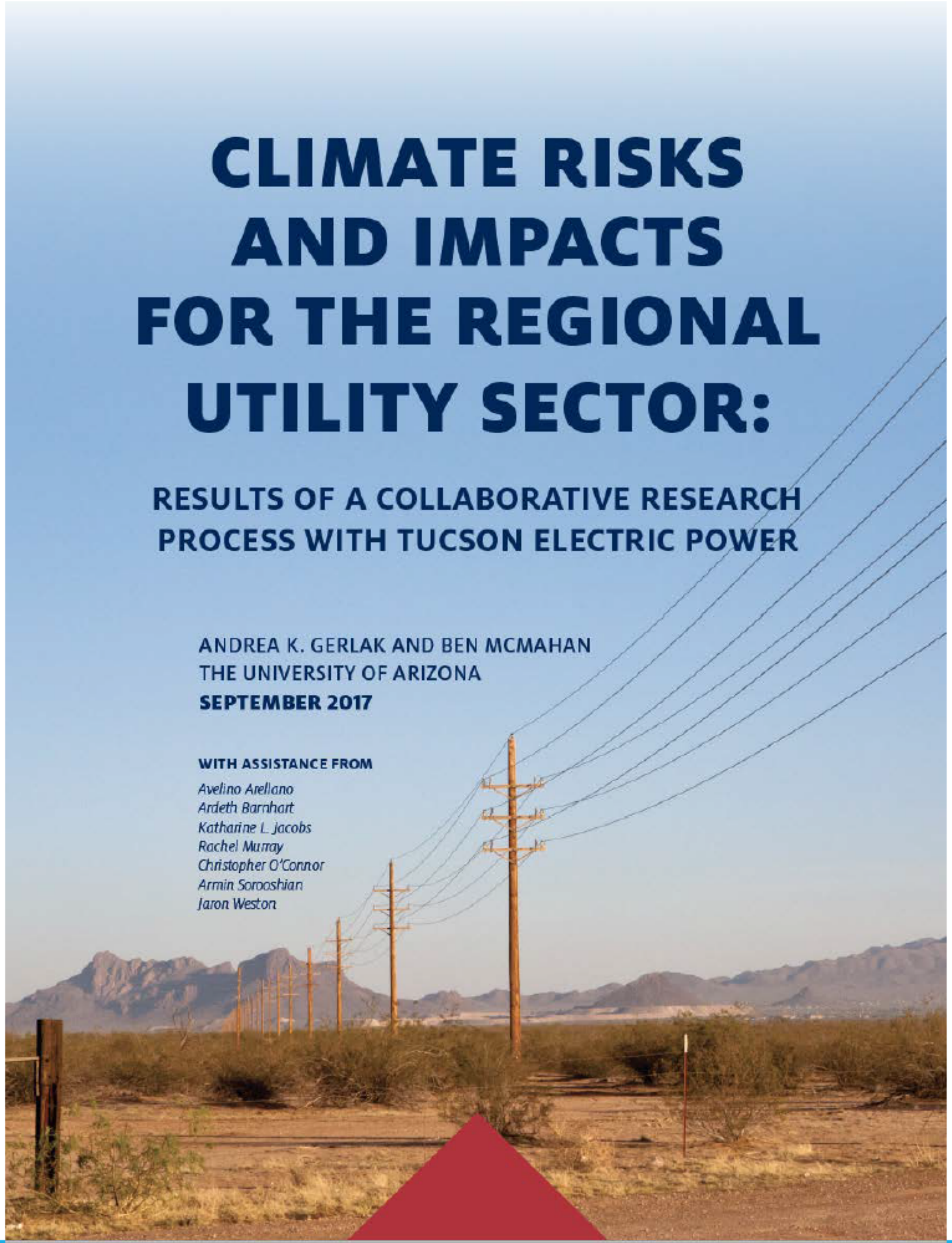
(1) Background and Context

(2) TEP Greenhouse Gas Reduction Goal Planning Report

(3) Scenarios for Carbon Reduction: Risks and Opportunities

PART I: BACKGROUND AND CONTEXT

ARIZONA BUSINESS RESILIENCE INITIATIVE (ABRI)

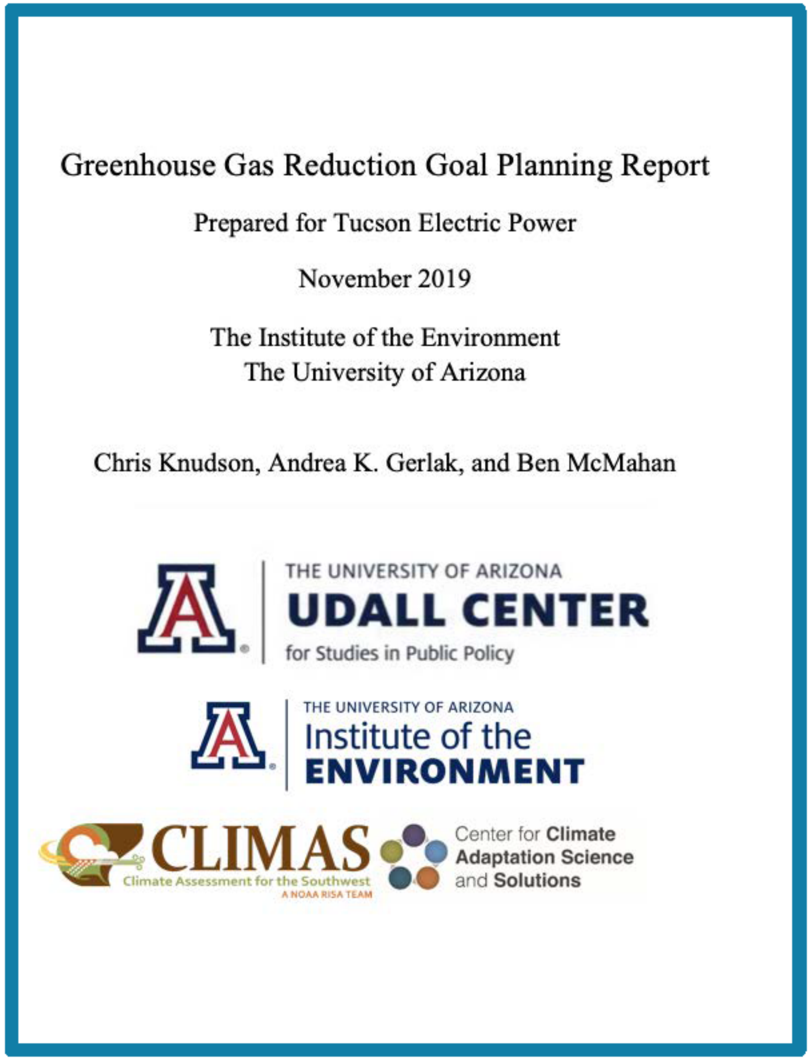


	Qualitative Risk Assessment						
	Description of Key Risk/Cost and/or Benefit	Timescale & Intensity: Short	Medium	Long	Confidence	Intervention Potential (TEP)	Adaptation or Analysis Action
Wildfire	Fuel Load - Proximity to Critical Infrastructure	MED	HIGH	HIGH	MED	HIGH	Modeling of fire risk and fuel load (right of way), fuel load redu parternships
	Fire Risk - Proximity to Critical Infrastructure	MED	HIGH	HIGH	MED	LOW	Fire models in relation to transmission infrastructure, potential
	Buffel Grass Infestation	MED	HIGH	HIGH	HIGH	HIGH	Modeling of buffel grass distribution, proximity to critical infras intervention/treatment to reduct BG
	Debris Flow & Post-Fire Flooding	LOW	LOW	LOW	LOW	LOW	Modeling of post-fire flooding risk, when critical infrastructure threatened
	Smoke & Ash	LOW	LOW	LOW	LOW	LOW	Smoke/plume and fire models in relation to transmission infras arc (soot)
Heat & Climate	Increased Peak (daily) Load/Demand	LOW	MED	HIGH	HIGH	HIGH	Peak daily load modeling given changing climate (general warm demographic growth. Assess role of nighttime lows increasing
	Infrastructure Wear (O&M Costs)	LOW	MED	MED	MED	HIGH	Assess role that warming termperatures play in infrastructure
	Transmission Efficiency	LOW	MED	MED	LOW	MED	Assess role that warming termperatures play in transmission ef significant enough to affect peak daily load during extreme hea
	Rolling Outages (regional demand spikes, other causes)	LOW	MED	HIGH	MED	MED	
	Increased Revenue	LOW	MED	HIGH	HIGH	MED	
	Reduced Capacity Factor	LOW	MED	HIGH	HIGH	MED	
	Changing Temporality of Demand (Seasonal)	LOW	MED	HIGH	MED	HIGH	Adapt portfolio to provide for additional generating capacity du seasons (late spring/early summer, late early fall) as temperatu
Water	Debris Flow & Post-Fire Flooding	LOW	LOW	LOW	LOW	LOW	
	Regional Drought & Water Restrictions (e.g. 1075')	MED	HIGH	HIGH	MED	MED	
	Springerville Plant						
	Water Availability - Competition over Water Resources (PHX Basin)	LOW	MED	HIGH	HIGH	MED	
	Water Availability - Tucson Basin	LOW	LOW	LOW	HIGH	MED	Limited need, current plans allow for sufficient water resources
	Water Availability - Limited Water Resources (4 corners)	LOW	MED	HIGH	HIGH	MED	Contribute to regional drought plans that reflect short and inte projections on both water availability (1075, streamflow, other
Air Smoke & Ash	Increased Dust & Erosion	LOW	MED	HIGH	HIGH	LOW	
	Increased NO.x and O3 (Phoenix Basin)	LOW	MED	HIGH	MED	LOW	
	Smoke & Ash	LOW	LOW	LOW	LOW	LOW	
	Increased GHG Emissions/Methane (Regionally)	MED	MED	HIGH	HIGH	HIGH	
		LOW	MED	HIGH	LOW	LOW	
					MED	MED	
					HIGH	HIGH	

PART II: TEP GREENHOUSE GAS REDUCTION GOAL PLANNING REPORT

STATE OF THE CLIMATE SCIENCE

EXAMINATION OF SCIENCE BASED GHG EMISSION REDUCTION TARGETS FOR UTILITIES


Greenhouse Gas Reduction Goal Planning Report

Prepared for Tucson Electric Power

November 2019

The Institute of the Environment
The University of Arizona

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THE UNIVERSITY OF ARIZONA
UDALL CENTER
for Studies in Public Policy

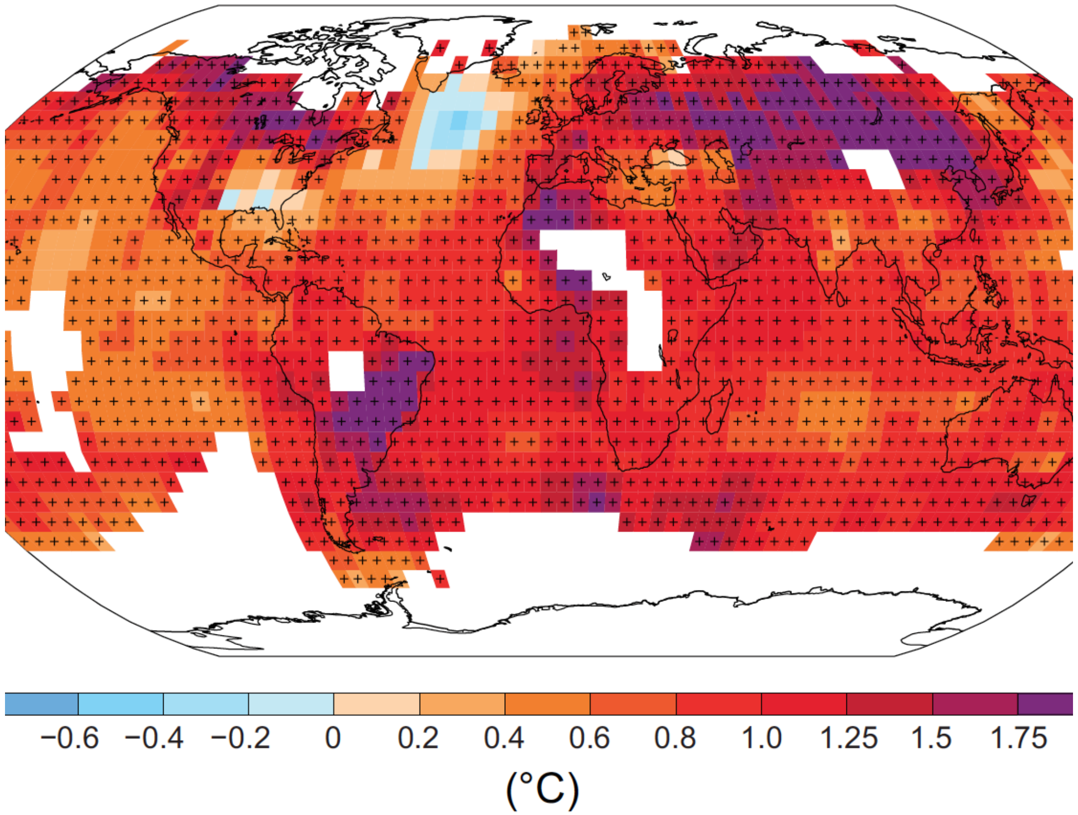
THE UNIVERSITY OF ARIZONA
Institute of the
ENVIRONMENT

CLIMAS
Climate Assessment for the Southwest
A NOAA RISA TEAM

Center for Climate
Adaptation Science
and Solutions

- State of the Climate Science
- Examination of science based GHG emission reduction targets for utilities

State of the Climate Science



From the period 1880-2012, the global average temperature increase of both the land and ocean has been **0.85°C**.

Since pre-industrial times, **CO_2 concentrations have increased by 40%**.

Warming of the climate system is "**unequivocal**" and many of the changes to the system have been "**unprecedented** over decades to millennia".

Human activity has been the **dominant cause** of global warming since the mid-20th century.

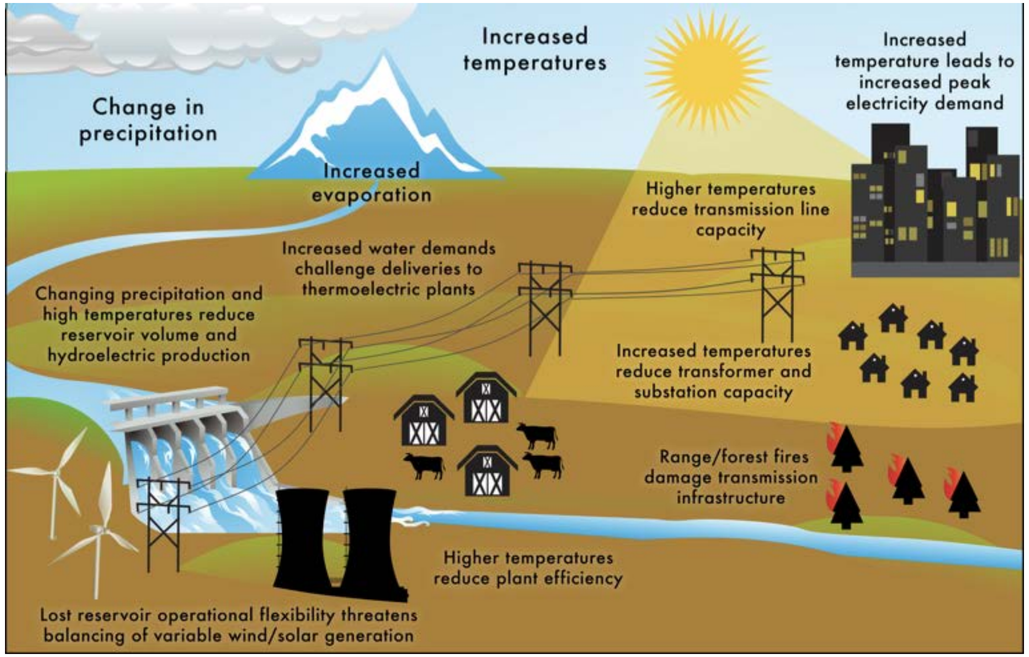
UArizona Climate Science Expertise

There will be **widespread impacts** even under 1.5°C warming.

Negative emissions will be **necessary to keep to 1.5°C** by 2100.

- IPCC Fifth Assessment Report
- Fourth National Climate Assessment
- Special Report: Global Warming of 1.5 ºC

Projected impacts for the U.S. Southwest



Using the higher emission scenarios, there will be up to a **4.8°C increase** in annual average temperatures in the Southwest by the end of the century.

Under all the emission scenarios, there are concerns about economic losses and social vulnerabilities.

Source: National Climate Assessment

Paris Agreement and 1.5°C target

Countries pledged to keep global average temperature below 2°C, with a **target of 1.5 °C** above pre-industrial levels.

Key to this are **Nationally Determined Contributions (NDCs)**, the plans that countries make to mitigate climate change and adapt to its impacts.

National emission reduction targets

In response to the Paris Agreement, the US established its NDC in late 2015.

*"The United States intends to achieve an economy-wide target of reducing its greenhouse gas emissions by **26%-28% below its 2005 level in 2025** and to make best efforts to reduce its emissions by 28%."*

The NDC was to be followed by "deep, economy-wide" transformations to achieve **80% reductions under 2005 emissions by 2050**.

Examine science-based GHG emission reduction targets for utilities

A reduction target is "**science-based**" if it is in line with the level of decarbonization necessary to **limit warming to 1.5 C** or **well below 2°C** compared to pre-industrial levels.

SCIENCE BASED TARGETS

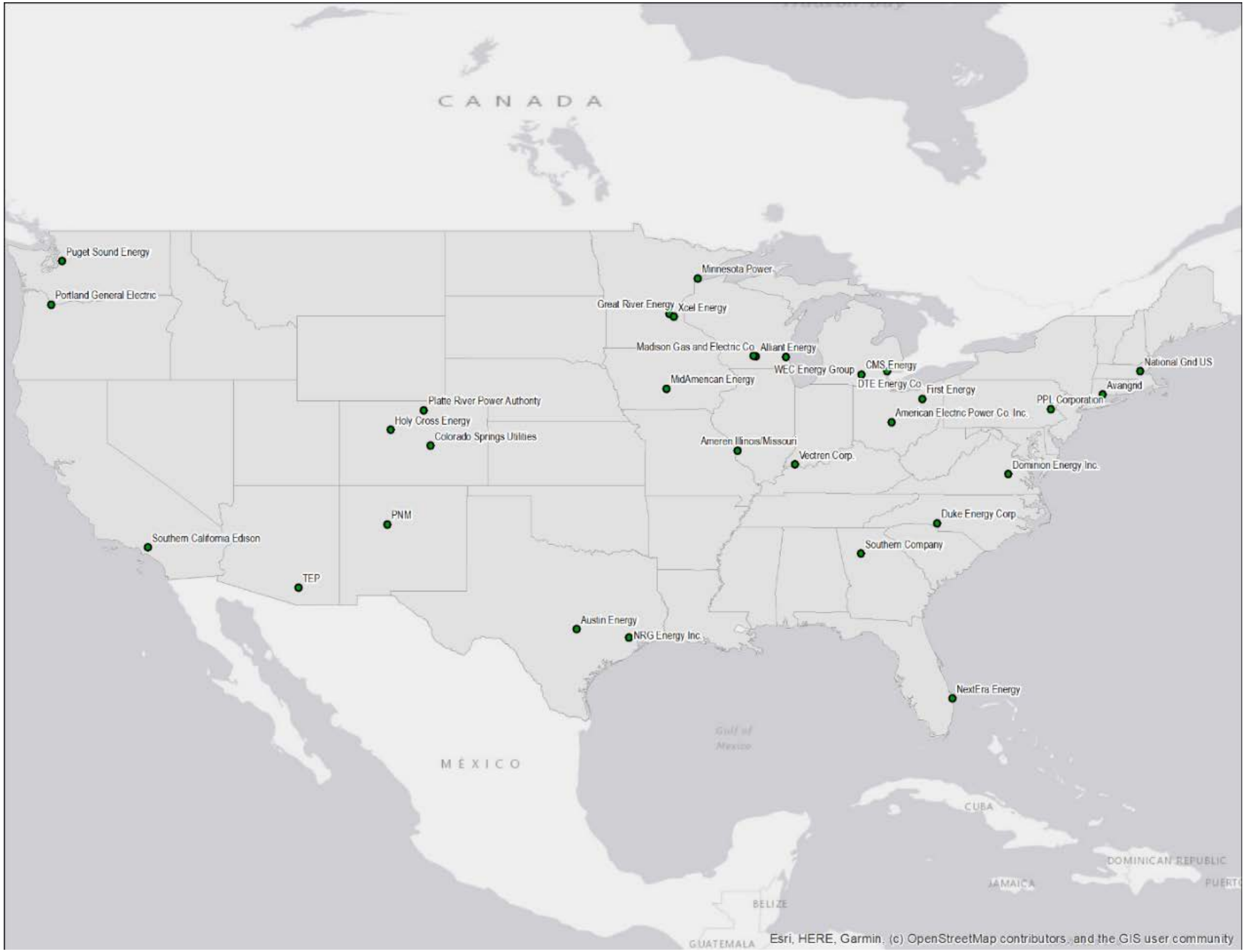
DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

CDP DISCLOSURE INSIGHT ACTION

UN GLOBAL COMPACT

WORLD RESOURCES INSTITUTE

WWF



29 US energy utilities

represent utilities with targets that state a specific percentage reduction in carbon emissions, compared to a baseline, by a future date

represent a diversity of sizes, locations, and energy mixes in their generating portfolios

Appendix 1: Table of US utilities with carbon emissions targets, and their characteristics

Utility name	Headquarters	Baseline	Emissions reduction (final %)	Emissions target date (final)	Non-carbon emissions target	Utility ownership	Capacity (MW)	Energy portfolio
Alliant Energy	Madison, Wisconsin	2005	80%	2050	Renewables 30% of energy mix (2030) Eliminate all coal from energy mix (2050)	Investor-owned	5,500	2017 Portfolio: Coal 33% Renewable 16% Natural Gas 44% Oil 1% Nuclear 6%
Ameren Illinois/Missouri	St. Louis, Missouri	2005	80%	2050	N/A	Investor-owned	10,250	2017 Portfolio: Coal 75% Renewable 4% Natural Gas 1% Nuclear 20%
American Electric Power Co. Inc.	Columbus, Ohio	2000	80%	2050	N/A	Investor-owned	24,000	2017 Portfolio: Coal 47% Renewable (hydro, wind, solar) 13% Natural Gas 27% Nuclear 7% Other 6%
Austin Energy	Austin, Texas	N/A	N/A	N/A	Renewables 55% of energy mix (2025) Renewables 65% of energy mix (2027)	Cooperative	3,000	2017 Portfolio: Coal 28.2% Renewable 36.4% Natural Gas & Oil 12.9% Nuclear 23.5%
Avangrid	Orange, Connecticut	2015	100%	2035	N/A	Investor-owned	7,000	2017 Portfolio: Wind 80% Natural Gas 11% Cogeneration 9%

Motivations for GHG reduction goals

Government regulation

- Emissions reduction targets (local, state, federal)
- Mandatory cap and trade (e.g. RGGI in Northeast US)

Declining cost of alternative energies

- Cost of natural gas and renewables has approached cost of coal

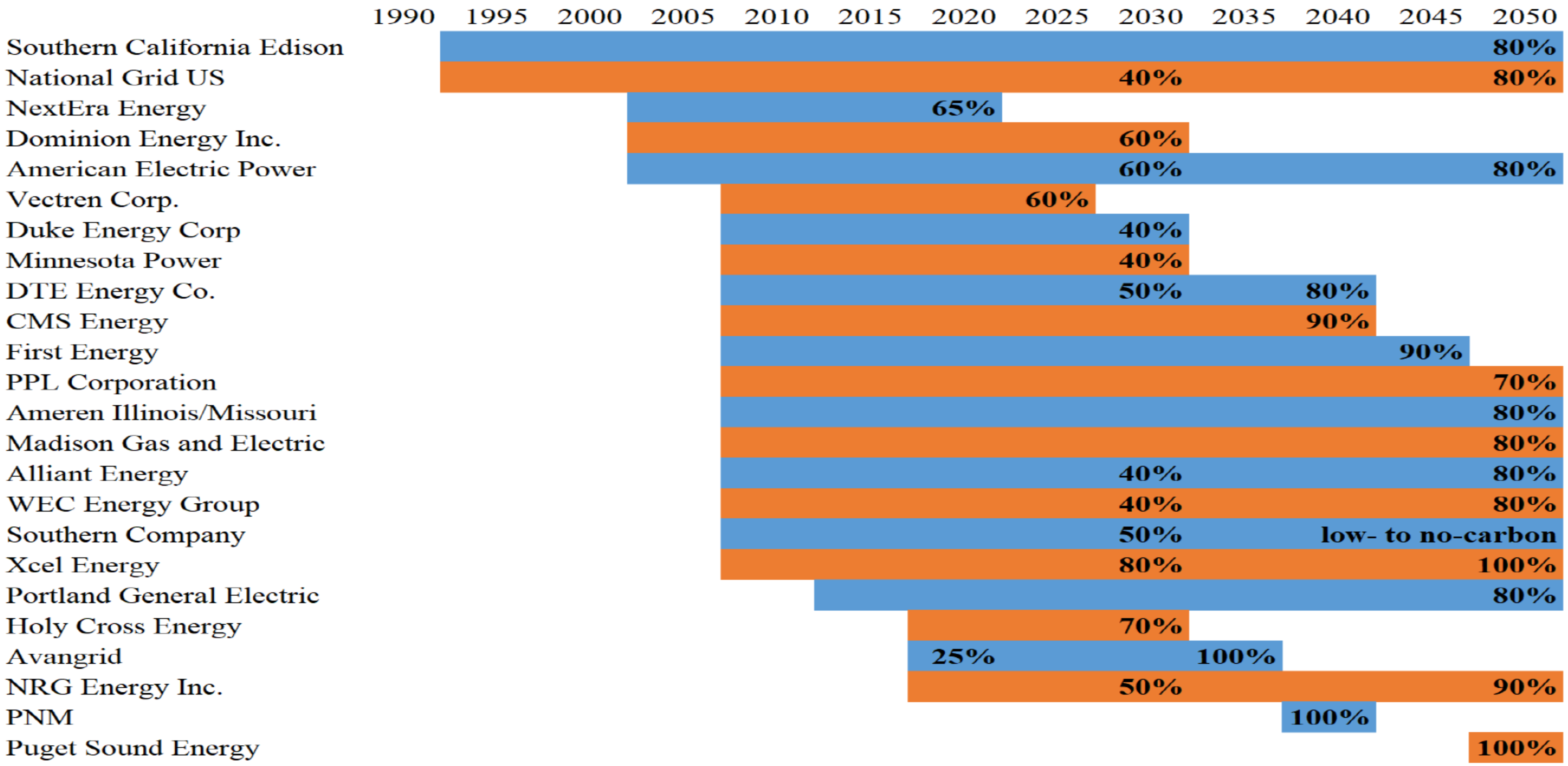
Investor pressure

- Pension funds have been asking utilities to accelerate their work in reducing carbon emissions

Image

- Opportunity for utilities to position themselves as leaders in sustainable energy

Select U.S. utilities' emissions reductions targets



What can we learn from this?

Most investor-owned utilities frame targets as a % reduction below a baseline before an end date.

Diversity of targets makes comparisons difficult.

The **anchor among all the targets** is the extension to the **US's NDC**: "80% reductions under 2005 emissions by 2050".

Size/energy mix typology

	Small	Large
Low carbon	25% of all utilities Alliant Energy, Avangrid, CMS Energy, Portland General Electric, Puget Sound Energy, Xcel Energy	29% of all utilities Dominion Energy Inc., Duke Energy Corp, National Grid US, NextEra Energy, NRG Energy Inc., Southern California Edison, Southern Company
High carbon	33% of all utilities First Energy, Holy Cross Energy, Madison Gas and Electric Co., Minnesota Power, PNM, PPL Corporation, Vectren Corp., WEC Energy Group	13% of all utilities American Electric Power Co. Inc., Ameren Illinois/Missouri, DTE Energy Co.

Table 3. Four-part typology of utility size (energy capacity) and use of coal (energy mix).

Situating TEP in the landscape of targets

	Small/Low-Carbon	Small/High-Carbon	Large/Low-Carbon	Large/High-Carbon
Low Target Level	-Alliant Energy -Portland General Electric	-Holy Cross Energy -Madison Gas and Electric Co. -Minnesota Power -PPL Corp. -WEC Energy Group	-Duke Energy -NRG Energy -Southern Company	-Ameren Illinois/Missouri
Medium Target Level		-Vectren Corp.	-Dominion Energy Inc. -National Grid -NextEra Energy -Southern California Edison	-American Electric Power -DTE Energy
High Target Level	-Avangrid -CMS Energy -Puget Sound Energy -Xcel Energy	-First Energy -PNM		

Table 5. Correspondence of level of reduction targets with the 4 utility types: Small/Low-Carbon, Small/High-Carbon, Large/Low-Carbon, and Large/High-Carbon.

TEP as a Small/High-carbon utility, which has the greatest proportion of Low targets among its members:

- 50% of the targets are Low target, compared to 43% for Large/Low-Carbon, 33% for Large/High-Carbon, and 20% for Small/Low-carbon

TEP has the opportunity to set both a high targeted level of carbon reduction and an easily comparable target.

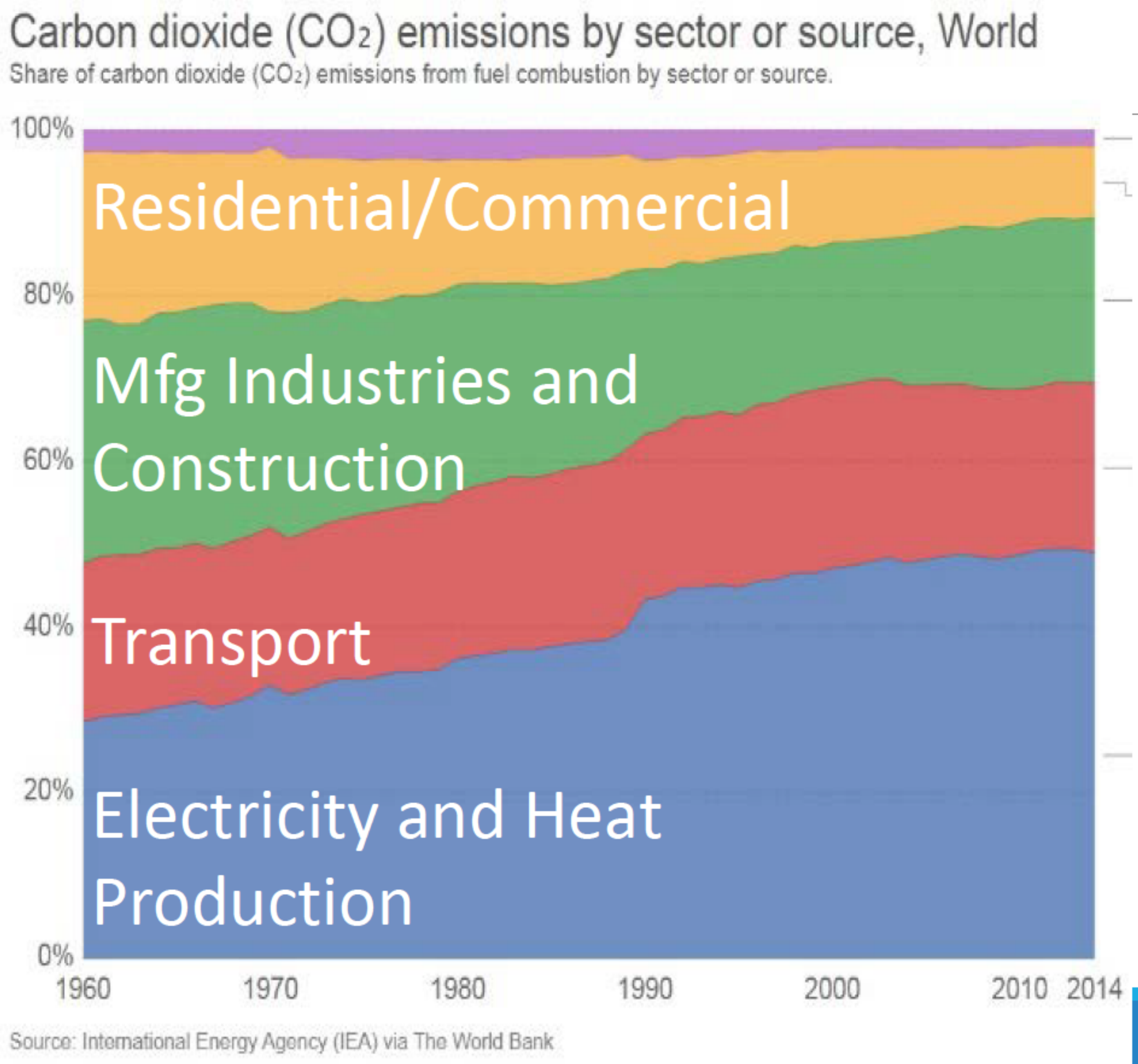
TEP could set a target with a 2005 baseline—which recognizes the industry norm—but that also sets a higher percentage goal than 80% reductions and/or sets a date earlier than 2050.

PART III: SCENARIOS FOR CARBON REDUCTION: RISKS & OPPORTUNITIES

IDENTIFYING PLAUSIBLE SCENARIOS FOR CARBON REDUCTION

EVALUATING AND SYNTHESIZING IMPLICATIONS OF SCENARIOS

Science Based Targets Initiative



Sectoral Decarbonization Approach:

GHG reduction target is “**science-based**” if it is in line with the level of decarbonization necessary to **limit warming to 1.5 C** or **well below 2°C** compared to pre-industrial levels.

SCIENCE BASED TARGETS

DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

Source: International Energy Agency & The World Bank

Electric Power Research Institute

4 insights for creating emissions reductions targets

1. Use individual perspectives to identify the **relevant uncertainties** and define the **company-specific context**;
2. Base climate strategies on **scientific understanding of climate goals** and the companies' relationship to these goals;
3. Choose a cost-effective target, **which will differ across companies**; and
4. Robust strategies are those that are **flexible and that make sense in different future contexts**.

UArizona Research & Impacts
Connecting Science & Decision Making

SBTs – 5 to 15 years plus long-term targets (e.g. 2050)

- Shorter term targets - more tangible/real data and information for decision making
- Long term targets complicated by emergent technologies and pricing (e.g. CCS/CDR, Batteries/Storage, Renewables)

Plausible Scenarios for Carbon Reduction

- Data from TEP (Portfolios) and UArizona sectoral expertise
- Empirically – what would we say with best available data

Evaluating and Synthesizing Implications of Scenarios

- UA Team: Climate Impacts and Adaptation, Weather and Solar Forecasting, Economics, Water Resource Management, Transportation, & Policy and Decision Making

GHG Reduction Scenarios and Impacts

1) Factors that affect load

- Demographic growth
- PEV penetration
- Use per Customer (efficiency)

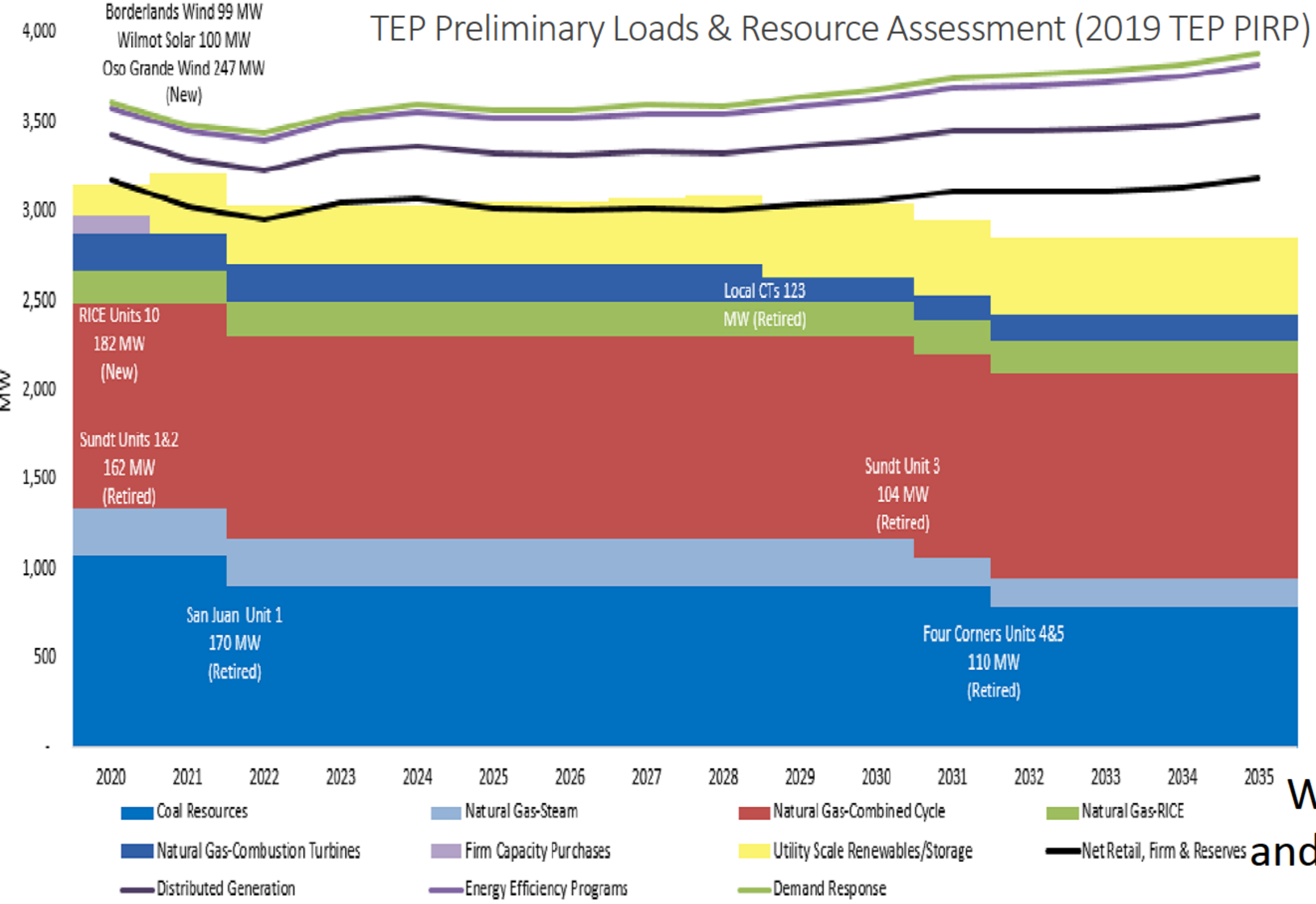
2) Ways to meet that load

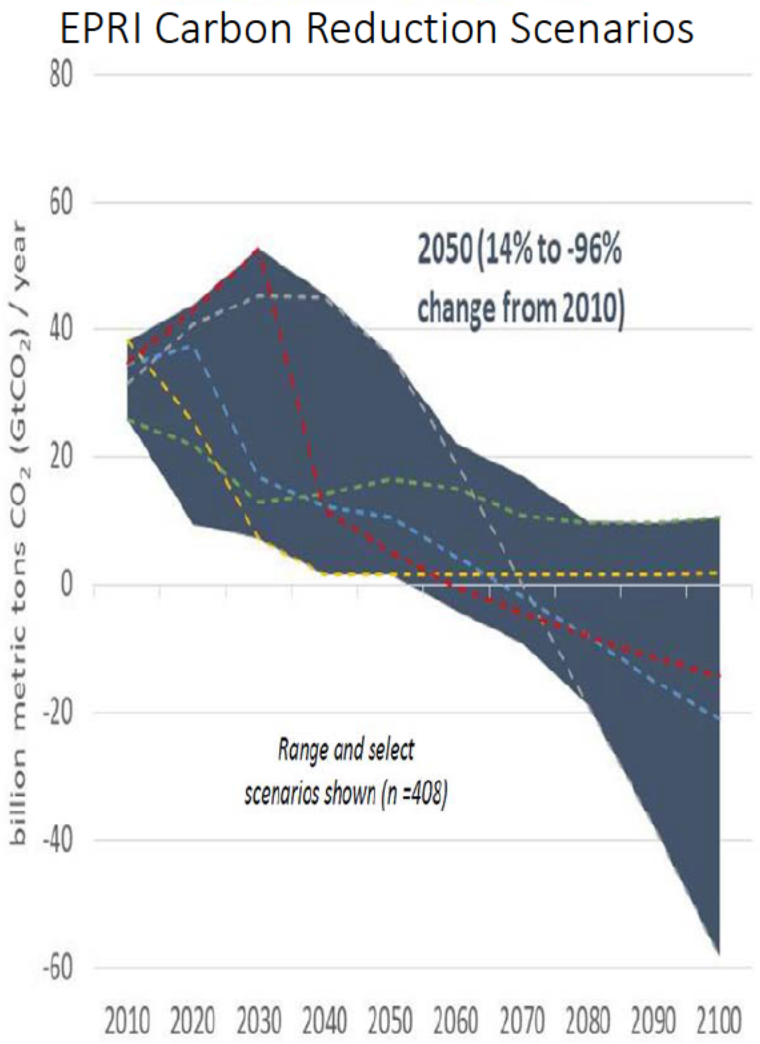
- Current portfolio
- Reduced/no coal portfolio
- Increased Renewables/Storage

3) Assess/quantify impacts of various options

- GHG reductions targets and/or cumulative emissions & timing
- Social cost of carbon, how changes affect customers, and other qual/quant/econ metrics
- Resulting percent renewables

- **Impacts (costs/benefits) – tradeoffs for different resource portfolio scenarios**

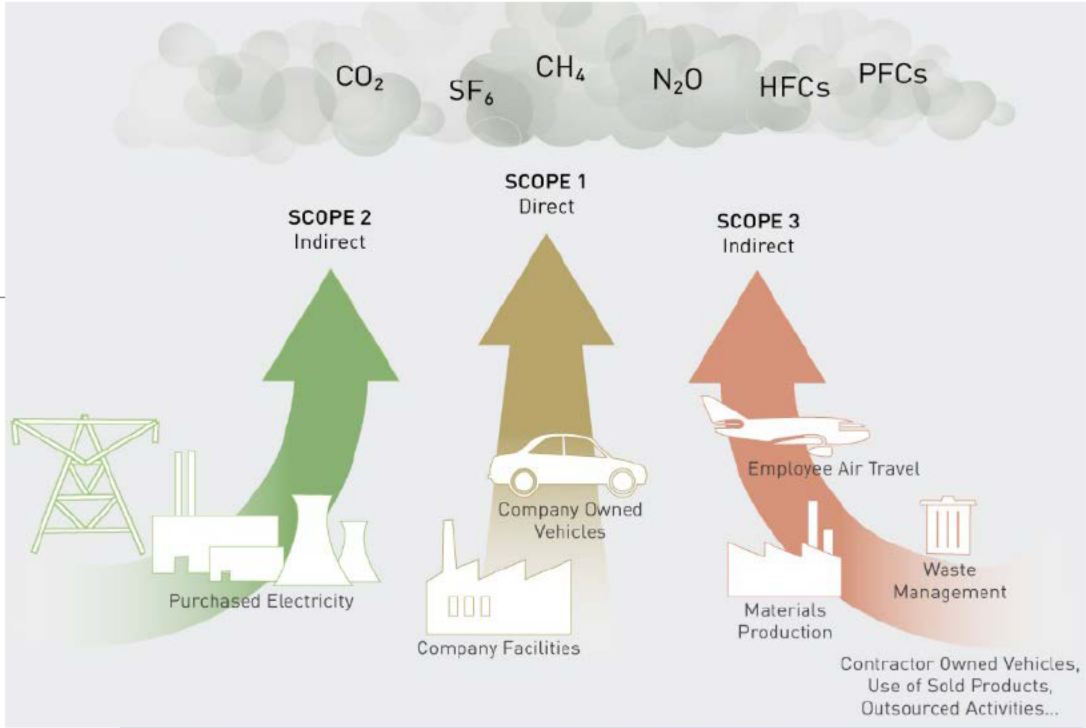




What portfolio will hit targets and meet demand? Implications?

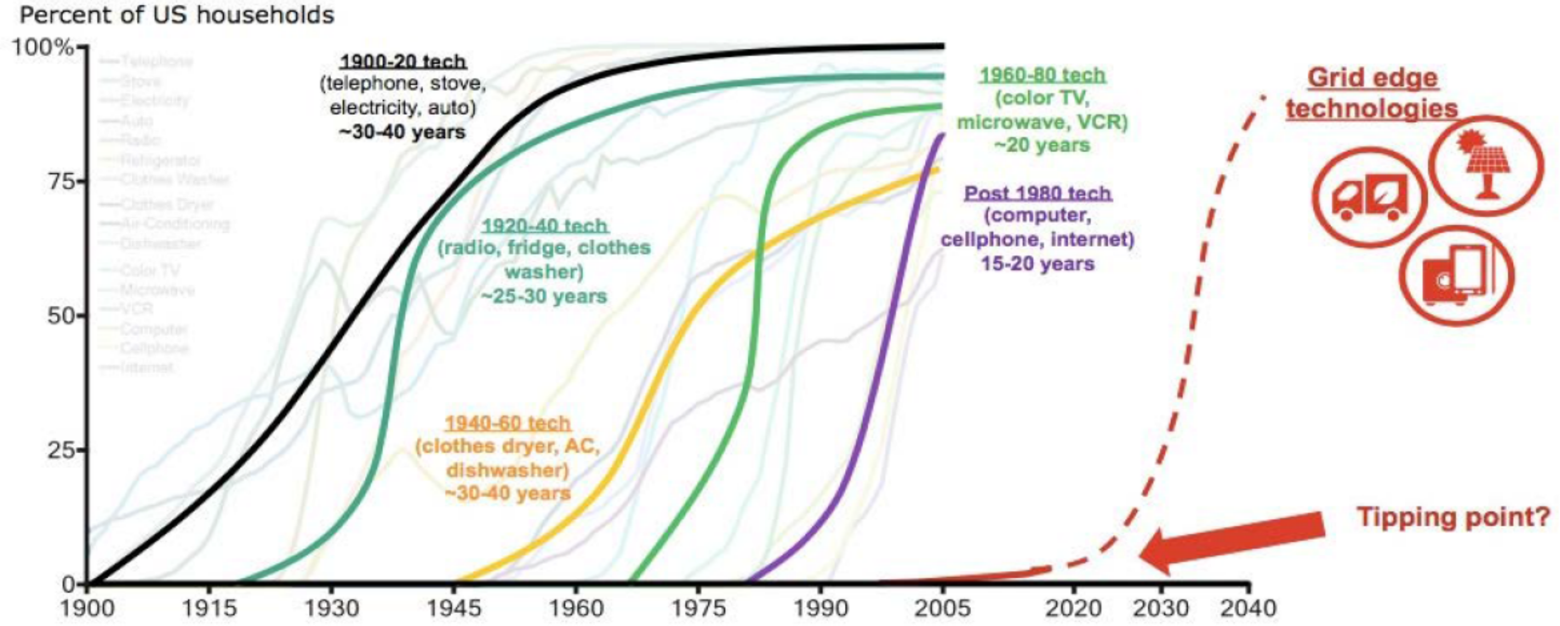
Sources: Tucson Electric Power 2019 PIRP (left)
Electric Power Research Institute (right)

Regional Carbon Balance & PEV Penetration



Regional Carbon Emissions – Carbon Balance

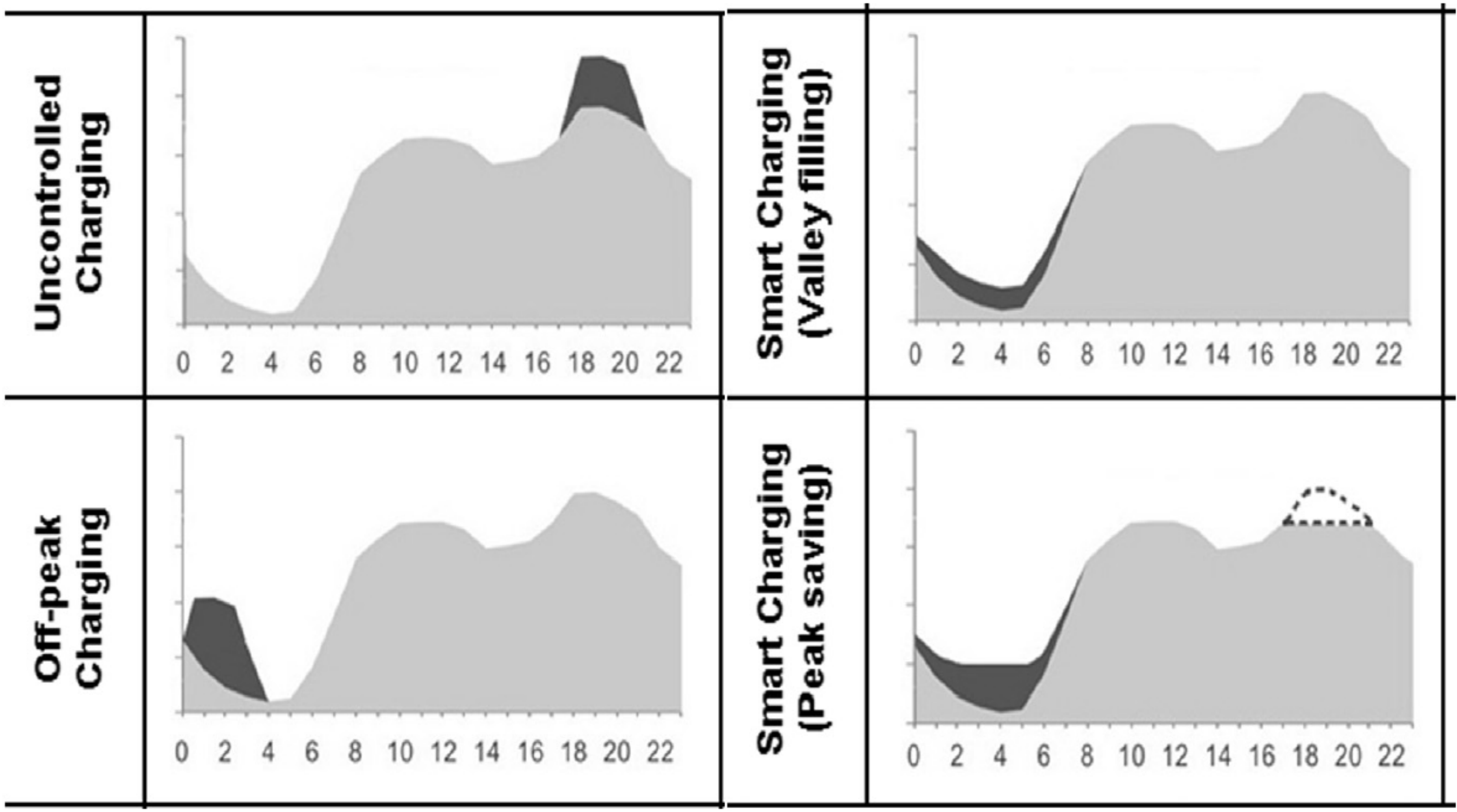
- Increased PEV penetration & net regional emissions vs. utility emissions - implications for GHG targets
- Assess/Quantify positive impacts associated with decreased CV use (local emissions, EPA attainment)
- Portfolio Decisions & Managing Existing Resources



PEVs, Renewables, Existing Resources Portfolio Decision Making

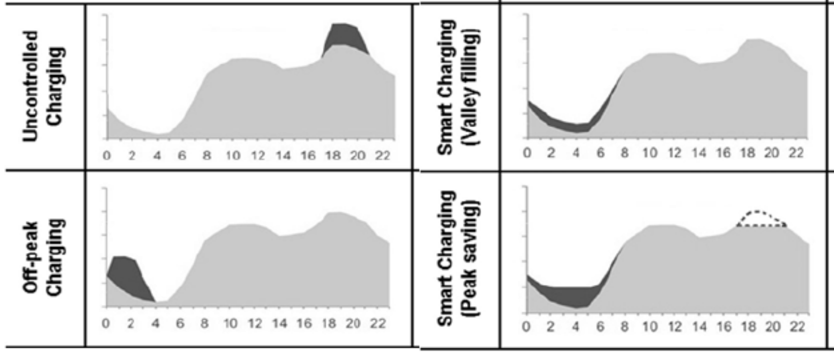
Planning for Increased Load, Anticipating Social/Political Context

- Implications for revenue (growth), and fuel source for increased load
- Implications for time of use, load management, and available resources



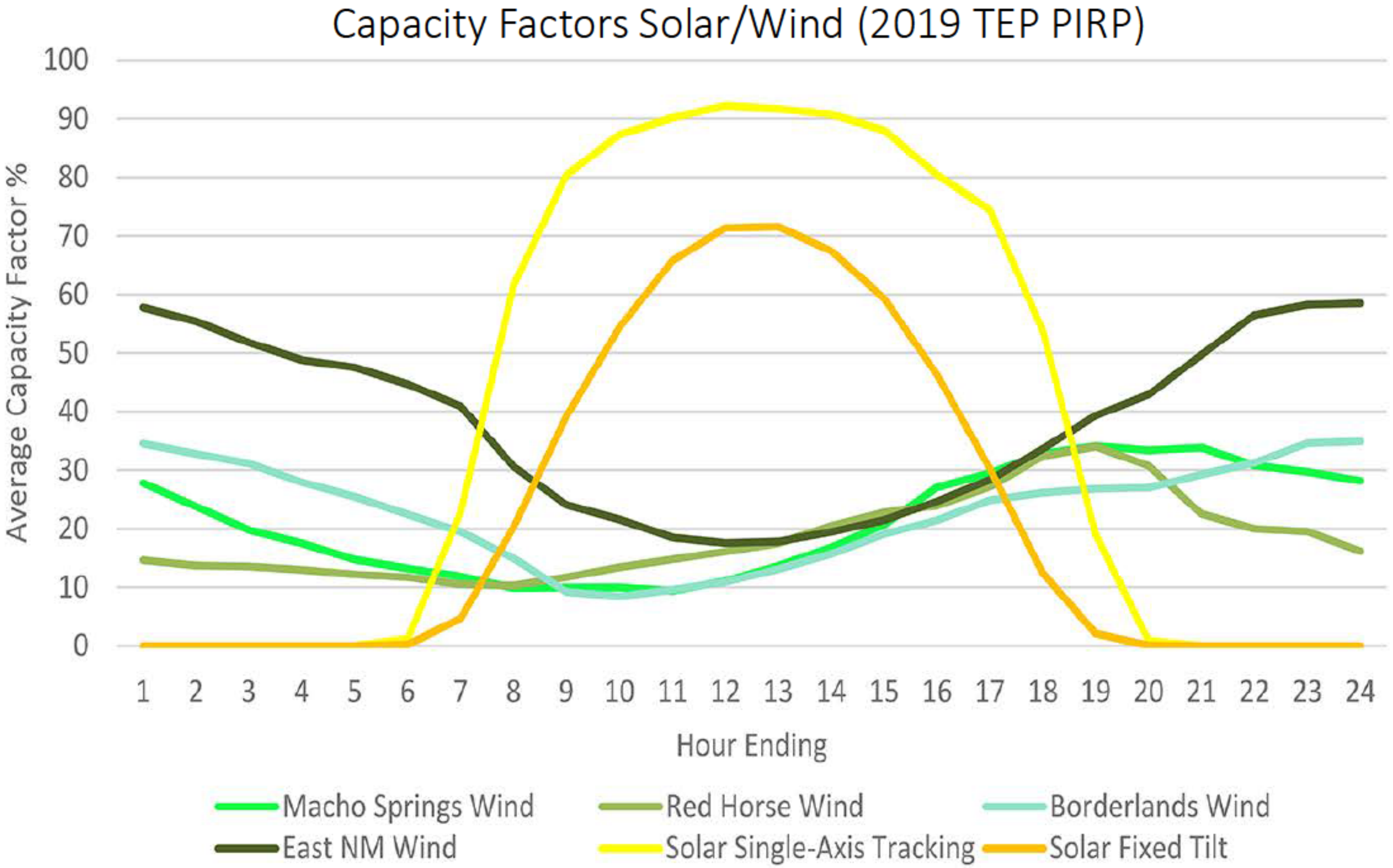
Garcia-Villalobos 2014

PEVs, Renewables, Existing Resources Portfolio Decision Making



Renewables Portfolio

- Smart/Coordinated Charging - Leveraging overlap to maximize efficiency
- Investments in low carbon resources to meet increased load
- Timing investments to minimize cost, maximize value



Source: Tucson Electric Power 2019 PIRP (bottom)

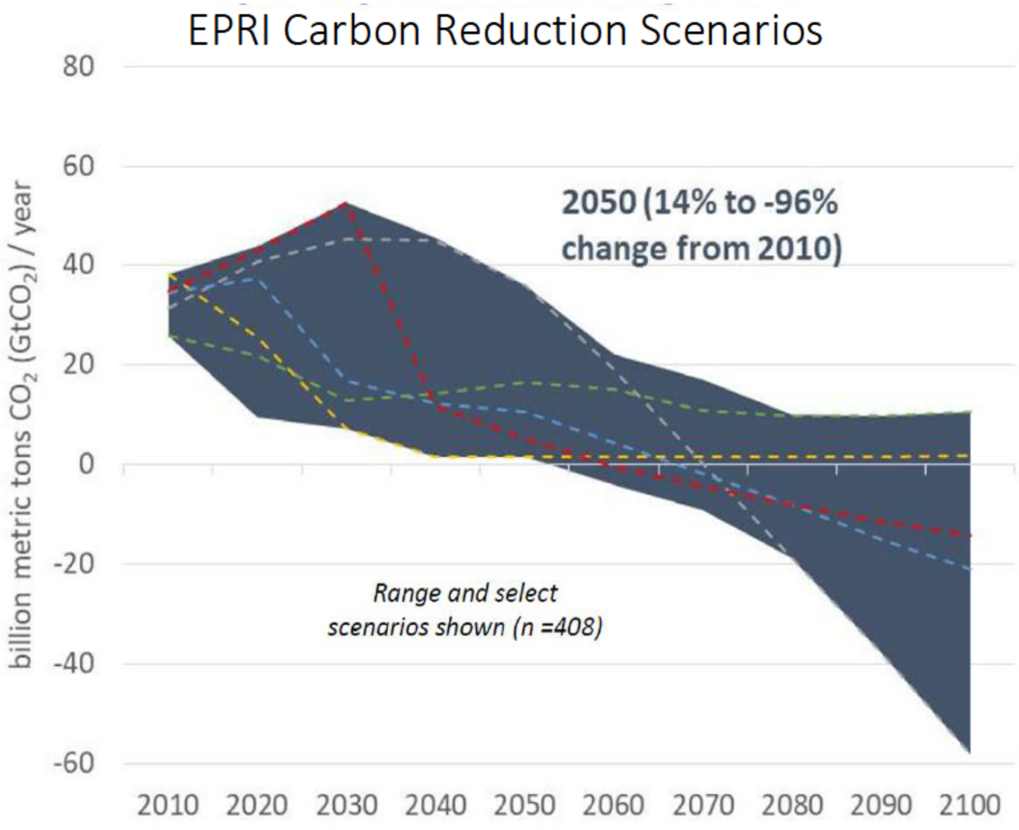
GHG Reduction - Costs/Benefits of Pathways

Cumulative Emissions vs. Reduction Targets

- Numerous scenarios may hit 2050 target but have different costs/implications based on qualitative factors or cumulative emissions
- Cumulative emissions as alternative metric to assess scenarios based on overall contribution

Percent renewables as outcome of scenario decisions – Emphasis on GHG reduction targets

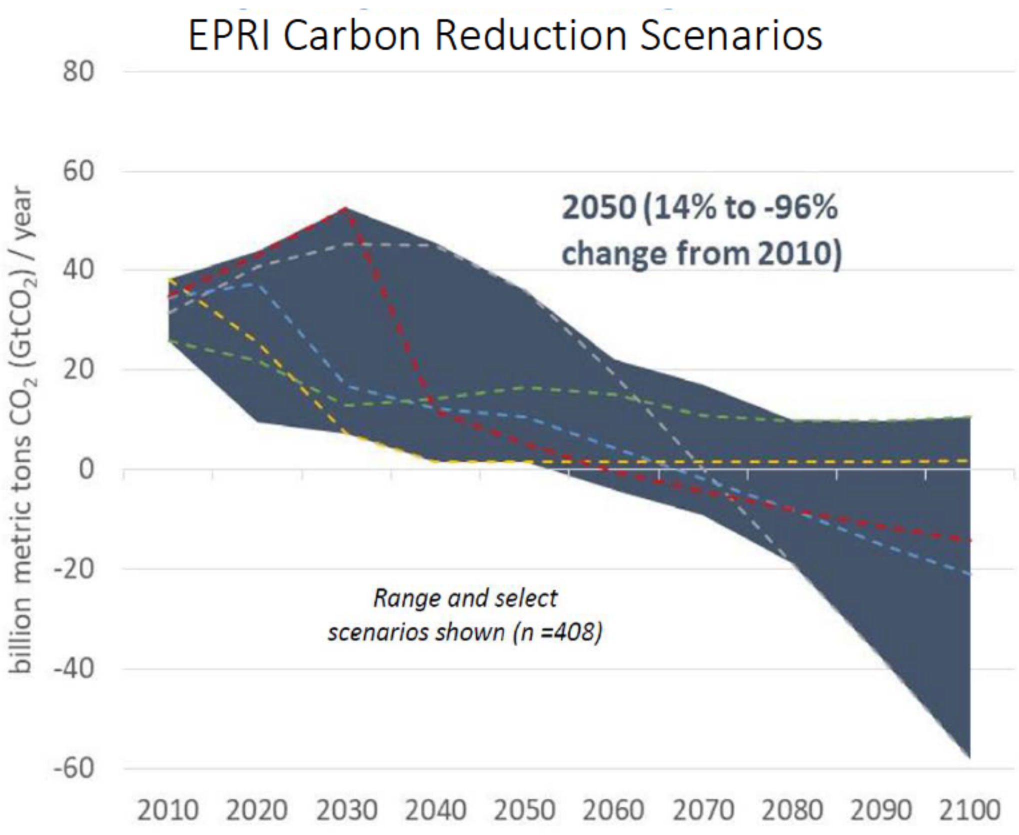
- I.e. scenario A results in X% renewables by 2050, not setting a target of X% by 2050.



GHG Reduction - Costs/Benefits of Pathways

What are costs/benefits of different pathways to GHG emissions reduction targets?

- Costs and tipping points - willingness to pay re: GHG targets, costs of earlier vs. later portfolio changes, etc.



Source: Electric Power Research Institute (top)

QUESTIONS AND COMMENTS

CLARIFICATIONS OR DETAILS?
WHAT ARE WE MISSING?

INPUT ON LOCAL/REGIONAL CONTEXT FOR SCENARIOS

EXPERTISE AND INSIGHT FROM STAKEHOLDER EXPERTISE