Science Based Targets & Electric Power Sector Decarbonization

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Introduction

Background

- Many companies have or are considering greenhouse gas reduction targets
  - Environmental organizations creating methodologies they want applied
- Companies also asked to evaluate the impacts of efforts to manage climate
- Technically challenging activities, with issues and uncertainties relevant to all
- EPRI project developing technical resources for informed public dialogue & decisions

Presentation outline

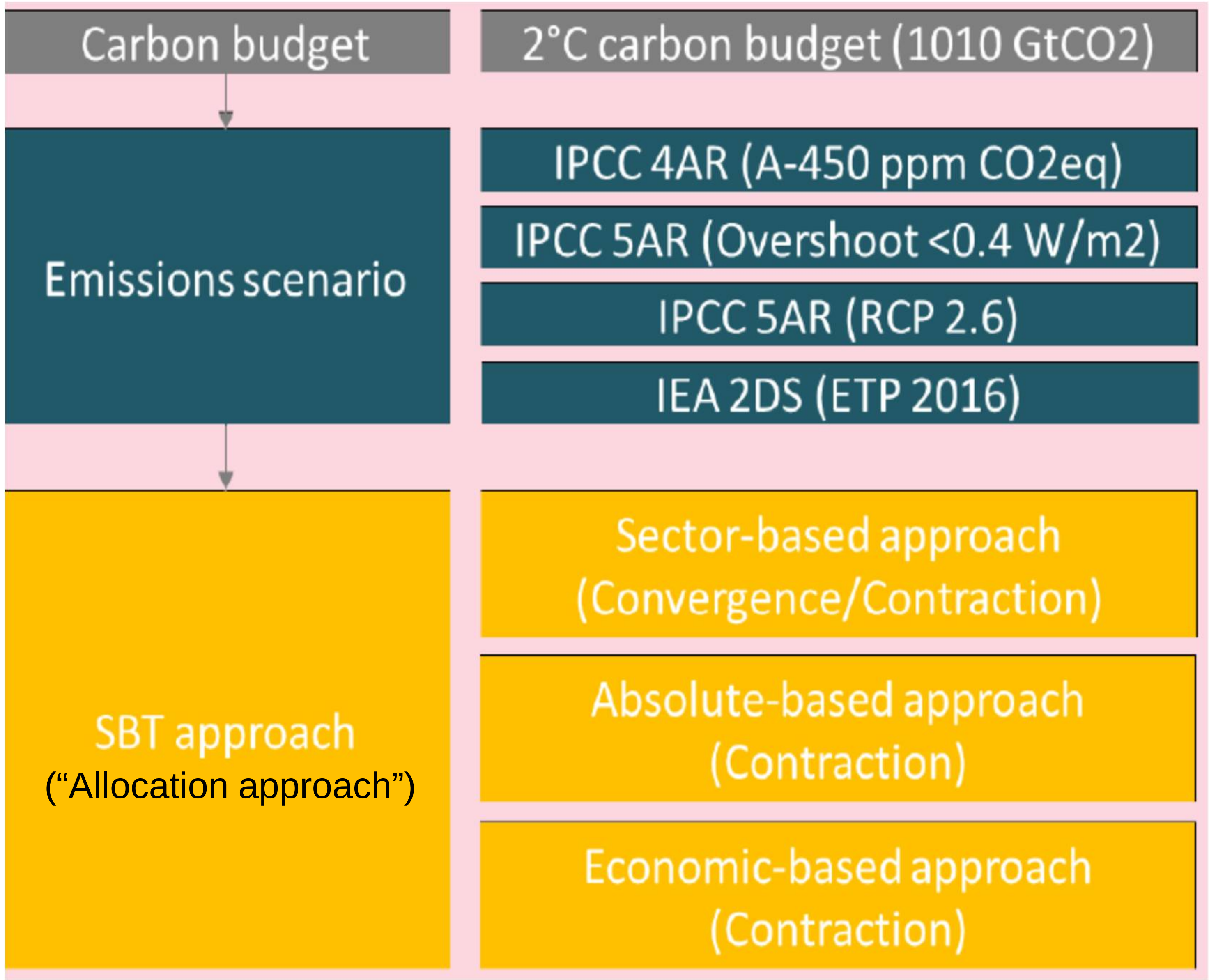
- The Science Based Target Initiative (SBTi) methodology
- Technical issues for companies to consider
- Insights for company emissions reduction goal setting

Main Elements of the SBTi Methodology

SBTi is an initiative of CDP (formerly Carbon Disclosure Project), World Resources Institute (WRI), World Wide Fund for Nature (WWF), UN Global Compact (UNGC).

"SBT": "…GHG emissions reduction targets are considered 'science-based' if they are in line with the level of decarbonization required to keep global temperature increase within 2°C of pre-industrial levels."

- sciencebasedtargets.org



Source: SBTi Manual

SBTi Main Elements

1. 2˚C goal
2. Carbon budget
3. Emissions scenario
4. Company emissions reduction allocation

SBTi Allocation Approaches

1. Absolute emissions contraction
2. Climate Stabilization Intensity Targets (CSI)
3. Context-based Carbon Metric (CSO)
4. Corporate Finance Approach to Climate-stabilizing Targets (C-FACT)
5. Greenhouse Gas Emissions per Value Added (GEVA)
6. Sectoral Decarbonization Approach (SDA)
7. 3% Solution (US only)

Most apply a uniform target (reduction, growth rate, intensity) across regions, sectors, or companies based on global results

Source: SBTi Manual

Table 8-1. Summary of SBT methods.

Information	Absolute Emissions Contraction	CSI	Context-Based Metric (CSO)	C-FACT	GEVA	SDA	3% Solution
Base Year	Flexible	Flexible	2005	Flexible, prefers 2009	Flexible, prefers 2010	Flexible, from 2010 onward	Flexible (2005-2010)
Target Year	Flexible	Flexible through 2050	Flexible through 2050	Flexible through 2050	Flexible through 2050	Flexible through 2050	2020
Emissions scenario	Flexible	Flexible, although IPCC Fourth Assessment Report used in current implementation	Flexible	Flexible, although IPCC Fourth Assessment Report used in current implementation		IEA 2DS	Based on proprietary cost abatement curves
Level of sector differentiation	None	None	None	None	None	Sectoral	Sectoral (designed for companies with substantial U.S. emissions)
Allocation Mechanism	Contraction (absolute)	Contraction (intensity)	Contraction (intensity)	Contraction (absolute)	Contraction (intensity)	Convergence (for homogeneous sectors)	Contraction (absolute)
						Contraction (for heterogeneous sectors)	
Input Data – Base year	• Absolute emissions, scope 1+2+3 if desired	• Combined scope 1 and 2 intensity • Gross Profit	• Scope 1 and 2 absolute and intensity emissions (separately) • Gross Profit, Revenue, Physical Activity	• Absolute scope 1, scope 2, or scope 1+2+3 if desired • Gross Profit, Revenue	• Either intensity or absolute scope 1, scope 2, or scope 1+2 • Gross Profit	• Scope 1 and 2 absolute emissions (separately) • Physical Activity; Gross Profit	• Scope 1 and 2 absolute emissions
Input Data – Target year	• Growth Projection (specified by method scenario)	• Growth Projection (As projected by company) • Gross Profit/Margin	• Growth Projection (As projected by company) • Gross Profit/Margin Target (as determined by company)	• Growth Projection (As projected by company) • Gross Profit/Margin Target	• Growth Projection (specified by method scenario)	• Growth Projection (as projected by company and only for homogeneous sectors)	• Growth Projection (As projected by company) – requires change in market share
Target Year Outputs	Absolute reduction, scope 1+2+3 if desired	Combined scope 1 and 2 intensity	Scope 1 and 2 absolute and intensity emissions (separately)	Presents intensity and absolute reductions	Intensity target or absolute target	Scope 1 and 2 absolute emissions and intensity (separately)	Scope 1 and 2 absolute emissions

Sectoral Decarbonization Approach (SDA)

- Documentation (2015)
- SDA Spreadsheet Tool
  - Latest version v8.1
  - Uses International Energy Agency (IEA) ETP 2016 scenario data

SDA Allocation of Carbon Budget to Sectors

A 2011-2050 carbon budget created for each **large global sector** based on IEA ETP 2DS scenario emissions (net non-included sectors)

Source: SDA (2015)

TABLE 1. SECTORAL CO_2 BUDGETS FOR SDA AND RCP 2.6, 2011-50

	Sector	Subsector	Cumulative CO_2 emissions 2011–50 ($GtCO_2$)
SDA	Power Generation	N/A	300
	Industry	Iron & Steel	112
		Cement	89
		Aluminum	11
		Pulp & Paper	8
		Chemicals & petrochemicals	78
		Other industry	51
	Transport Services	Passenger transport - Air	36
		Passenger transport – Light road	93
		Passenger transport – Heavy road	15
		Passenger transport - Rail	1
		Other transport	91
	Services / Commercial Buildings	Trade / Retail	32
		Finance	
		Real estate	
		Public administration	
		Health	
		Food and lodging	
		Education	
		Other commercial ser-vices	
	Non-included sectors*	N/A	138
	Total cumulative emissions		**1,055**
RCP 2.6	Fossil fuels and industry	N/A	979
	Land use change*	N/A	104
	Total cumulative emissions		**1,083**

Power Sector SDA – Sample Results*

Company inputs

base year, target year, base year activity (MWh), target year activity (MWh), base year scope 1 emissions (tCO_2e)

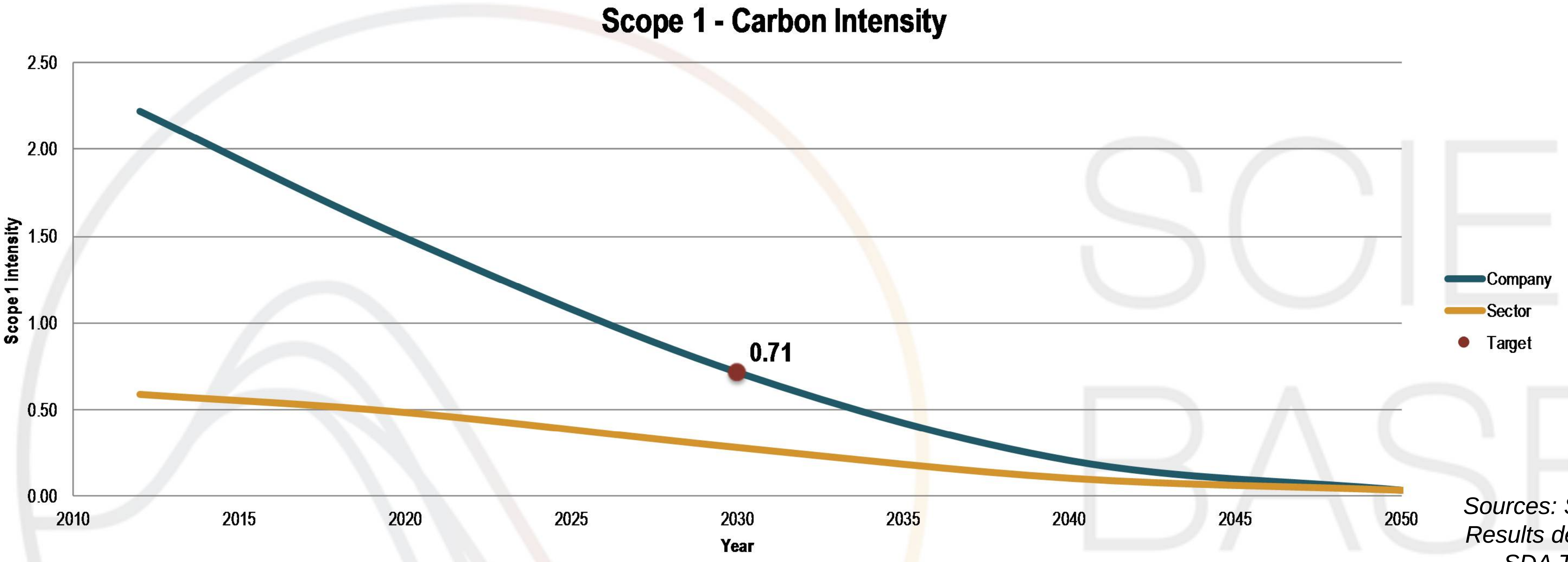
IEA ETP 2DS scenario inputs

global power sector activity pathway (MWh), global power sector emissions pathway (tCO_2e)

Tool outputs company target year carbon intensity (tCO_2e/MWh)

$$CI_y = d^*p_y{}^*m_y + SI_{2050}$$

- Company carbon intensity (CI) in target year y lower if…
- Company base year CI closer to 2050 sector CI
- Company target year closer to 2050
- Expect growth in company share of global sector output
- Lower 2050 sector CI (from global scenario)



Sources: SDA (2015); Results derived using SDA Tool v8.1

*Inputs for results above: base & target yrs = 2012 & 2030; base & target yrs activity = 45 & 90 TWh; base yr scope 1 emissions = 100 $MtCO_2$

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Technical Issues for Companies to Consider

- What 2˚C represents?
- Our understanding of the relationships between global average temperature and…
  - Carbon budgets?
  - Global emissions pathways?
  - Sub-global emissions (sector, country, country-sector, company)?
- Non-climate related uncertainties?
- Comparison of target setting alternatives?
  - E.g., cost (to companies, customers, society), environmental effectiveness
- Robust strategies for companies?

SBTi Main Elements

1. 2˚C goal
2. Carbon budget
3. Emissions scenario
4. Company emissions reduction allocation

What 2˚C Represents?

- **2˚C is a policy ambition**, not a scientific threshold (e.g., damages not infinite > 2˚C)
  - And, Paris Agreement country emissions reduction pledges are voluntary with their implementation uncertain
- **Limiting warming to 2˚C is extremely challenging** – geophysically, technologically, economically, politically
- **For companies, uncertainty about whether the world will be able to follow global pathways for limiting warming to 2˚C and the specific policies that will be implemented**

Regional Costs for Increasingly Ambitious Emissions Reduction Goals
(Reductions in Discounted Average Per Capita Consumption through 2100)

	US	EU	Other G20	China	India	Other Countries	Max ˚C
S1							6.9 (3.8-9.6)
S2	0.2%	0.3%	0.3%	1.4%	0.1%	-0.2%	6.0 (3.4-8.3)
S3	0.3%	0.4%	0.6%	2.3%	0.0%	-0.5%	5.4 (3.0-7.4)
S4	0.5%	0.7%	1.1%	4.8%	-0.1%	-0.7%	5.0 (2.8-7.0)
S5	0.5%	0.7%	1.0%	4.8%	0.8%	-0.6%	3.8 (2.2-5.3)
S6	0.5%	0.7%	1.0%	4.9%	2.0%	0.2%	2.7 (1.6-3.8)
S7	0.5%	0.8%	1.0%	5.1%	4.3%	2.1%	2.3 (1.4-3.1)
S8	2.1%	2.2%	5.2%	12.3%	14.1%	6.5%	2.0 (1.3-2.6)

Regional costs increase at an increasing rate

Source: Rose et al (2017)

2˚C Attainability? Model Feasibility, Policy Objectives, and Technology

e.g., Energy Modeling Forum 27th Study on the Role of Technology in Achieving Climate Objectives

models producing scenario / # models that tried

	FullTech	LowEI	NoCCS	NucOff	LimSW	LimBio	Conv	EERE	LimTech
Baseline	13/13	13/13		11/11	11/11	13/13	13/13	13/13	11/11
550 ppm	13/13	13/13	12/12	11/11	11/11	13/13	13/13	12/12	6/9
450 ppm	10/11	9/10	4/11	9/10	9/10	9/11	8/11	6/11	0/10

Greatest fraction of model infeasibilities occurred with CCS constrained (fossil & biomass CCS)

Source: Krey et al. (2014)

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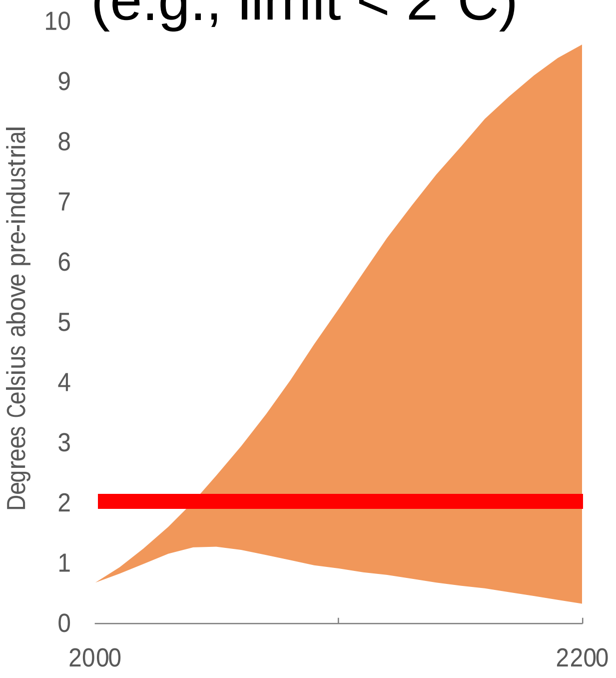
Global Climate Goals and the Relationship to Companies

Climate goals
(e.g., limit < 2˚C)



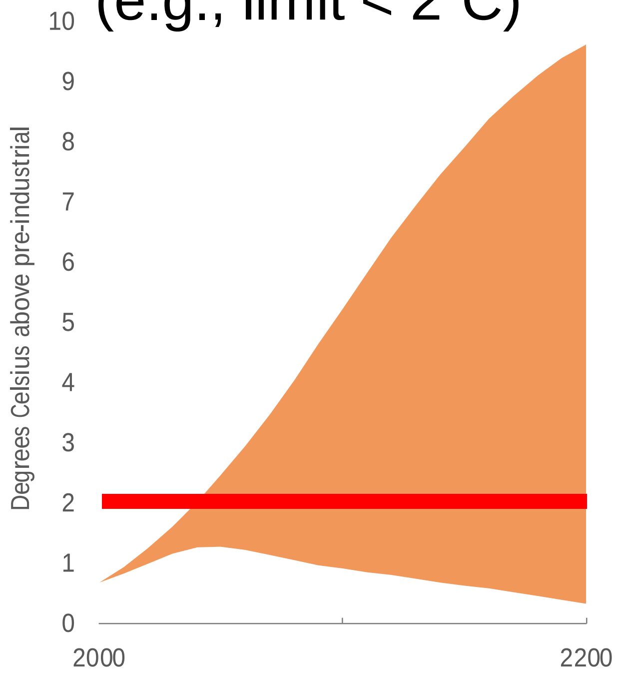
?

Company

Global Climate Goals and the Relationship to Companies

Significant pieces between global temperature and a company

Climate goals
(e.g., limit < 2˚C)



Potential global GHG pathways

Potential sector GHG pathways

Potential national & subnational GHG pathways

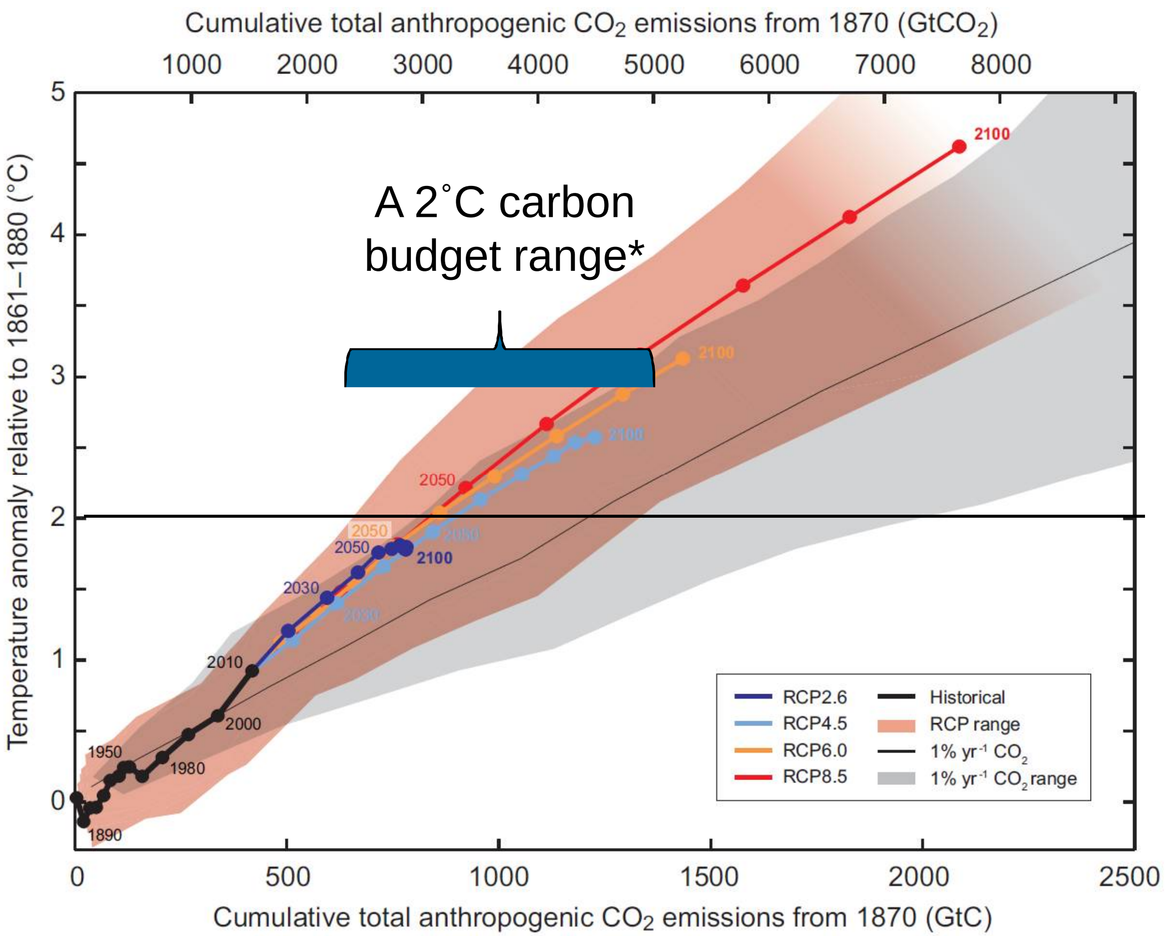
Company

Potential energy systems and electric sectors?

Pieces, factors connecting them, underlying them, and uncertainties critical

The Relationship Between Temperatures and Carbon Budgets

- A range of 2050 carbon budgets are consistent with a global average temperature outcome
  - SBTs based on a single 2011 onward carbon budget of 1010 $GtCO_2$ (1055 $GtCO_2$ in SDA)
- Also, new literature suggests that current budget estimates may be too small



IPCC WGI (2013)

IPCC scenarios category (CO_2eq concentration in 2100, ppm)		2011-2050 CO_2 budgets in scenarios ($GtCO_2$)**	Probability of staying below 2˚C	Probability of staying below 3˚C
1	430-480	550-1300	63-88%	97-99%
2	480-530	860-1600	39-68%	90-97%
3	530-580	1070-1780	16-46%	81-92%
4	580-650	1260-1640	7-26%	65-86%
5	650-720	1310-1750	5-12%	57-74%
6	720-1000	1570-1940	0-3%	17-45%
7	> 1000	1840-2310	0%	2-8%

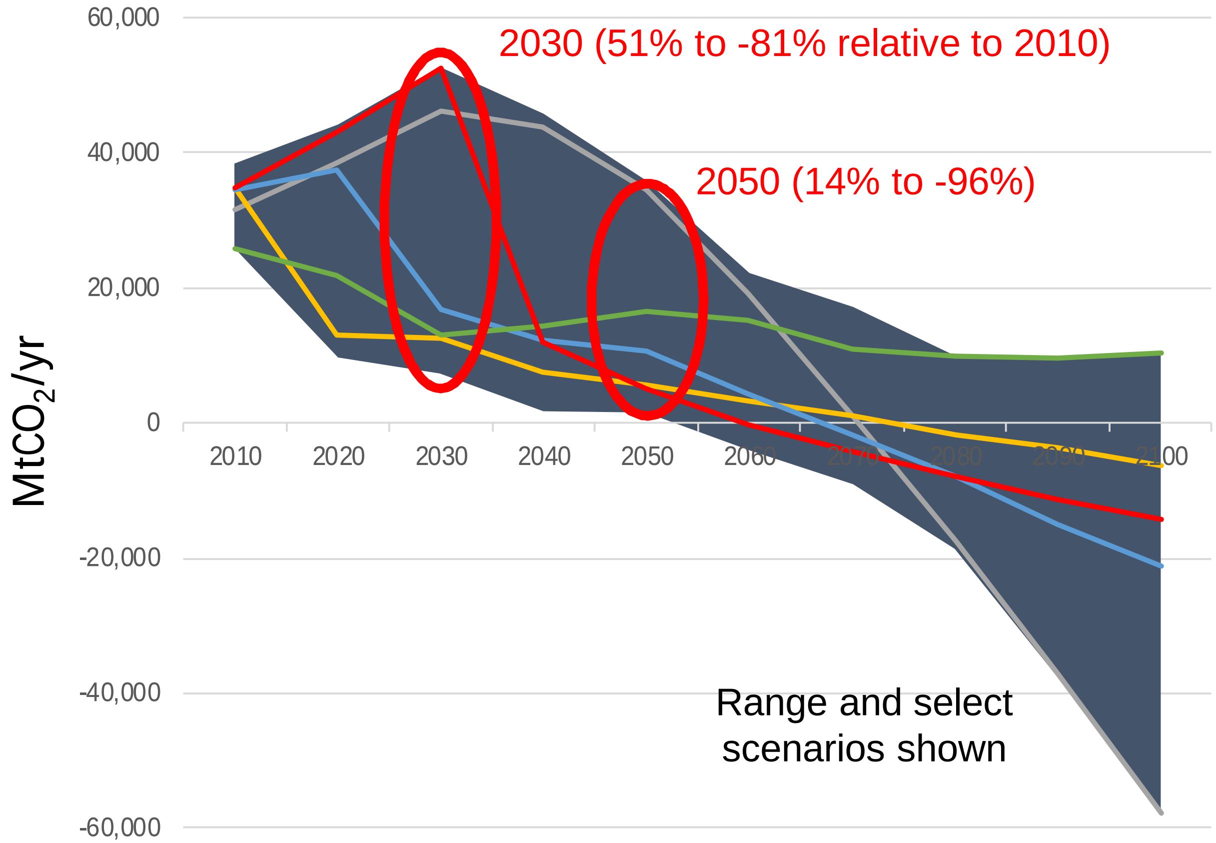
Developed from IPCC WGIII (2014)

* IPCC adjusted for an assumed level of non-CO_2 forcing. 2011 onward budgets would net out pre-2011 emissions of 1630-2150 (avg. 1890) $GtCO_2$.
** 10-90th percentile range shown. Will be revised to reflect full range.

The Relationship Between Temperatures and Global Emissions

- A range of pathways and 2030 & 2050 reductions consistent with a global temperature goal
- Scenario ensembles provide ranges, not distributions (not amenable to statistics). Full uncertainty larger.
  - Emissions scenarios are not requirements
  - SBT uses particular global emissions scenario result that is treated as a prescription/requirement

Global CO_2 Pathways Consistent with 40+% Chance < 2˚C (IPCC Cat 1 & 2)



Change in Emissions from 2010

Category		2030	2050	n*
1	Max	36%	-30%	122
	Min	-81%	-96%	
2	Max	51%	14%	294
	Min	-69%	-90%	
3	Max	76%	16%	232
	Min	-40%	-70%	
4	Max	52%	52%	147
	Min	-21%	-67%	
5	Max	38%	43%	60
	Min	-6%	-40%	
6	Max	60%	101%	149
	Min	-5%	-4%	
7	Max	95%	175%	167
	Min	18%	40%	

Developed from IPCC WGIII (2014)

* Some 2050 horizon scenarios compatible with more than one category

The Relationship Between Temperatures and Electric Sector Emissions

2050 IPCC category 1 & 2 emissions changes from 2010

	Global CO_2	Global Elec CO_2	Global Elec CO_2 w/o negative emissions
Max	14%	-2%	-13%
Min	-96%	-163%	-100%
n	408	373	55

Negative emissions generation being deployed. Represents subsidy payments to operators. Depends on acceptability of negative emissions technologies and policy design (global & economy-wide here).

Many models can't find solutions for achieving very low emissions pathways without a negative emissions technology

Developed from IPCC WGIII (2014)

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The Relationship Between Temperatures and Electric Sector Emissions

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n	408	373	55

Category 1 & 2 2010-2050 carbon budgets ($GtCO_2$)

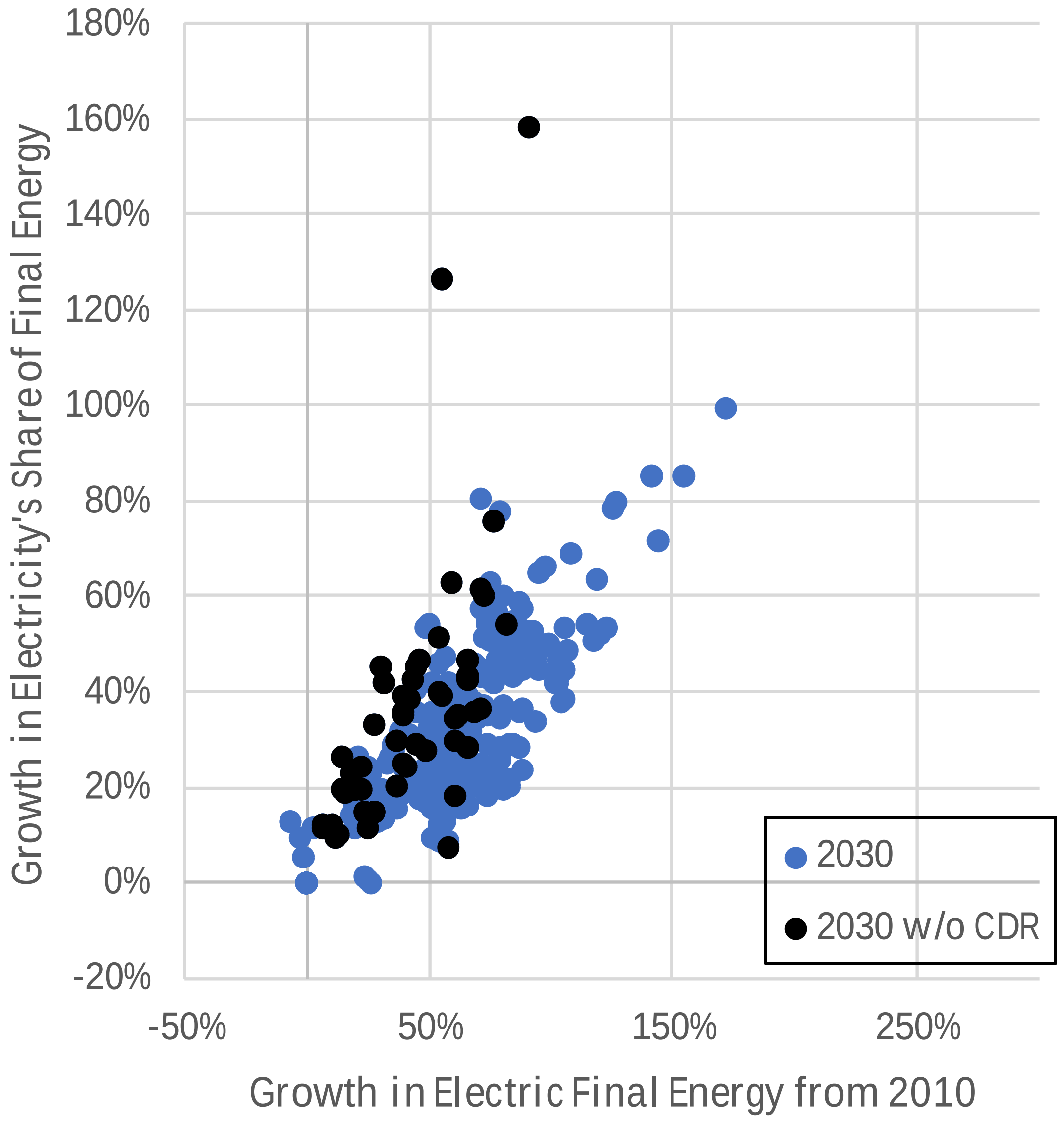
	Global CO_2 budget	Global Elec CO_2 budget	Global Elec CO_2 w/o negative emissions budget
Min	465	94	144
Max	1692	642	512
n	408	373	55

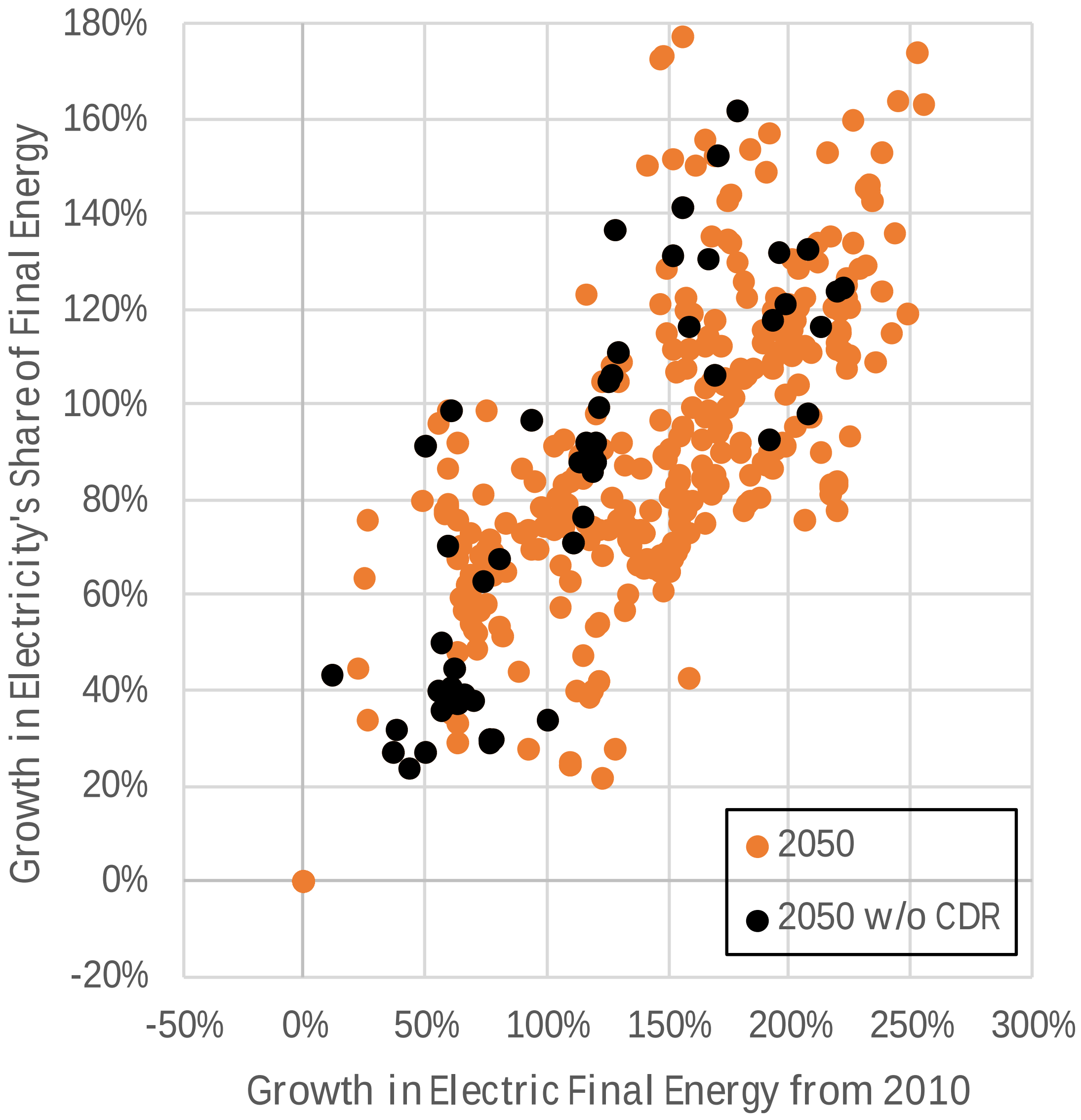
vs. SDA budget 300 $GtCO_2$

Developed from IPCC WGIII (2014)

Global Electrification Consistent with 40+% Chance < 2˚C (IPCC Cat 1&2)

With economy-wide policies and w/ and w/o negative emissions (CDR = carbon dioxide removal)





Without negative emissions technologies (CDR)…

Slower growth in global electricity consumption and final energy share.

But also increased possibility that staying below 2C unattainable (55 vs. 373 models able to find a solution)

Developed from IPCC WGIII (2014)

Policy Design Matters

- Will affect cost (to companies, customers, society), environmental effectiveness, and the cost-effective role of sectors and individual companies
- Represents another uncertainty for companies
- Most scenarios assume global action and economy-wide emissions caps (globally or regionally)
- However, real policy is unlikely to proceed that way. Various factors to consider…
    - Sector/emissions coverage
    - Eligible technologies
    - Policy instrument type
    - Offsets (uncovered emissions)
    - International partnerships
- SBTi advocates a particular policy instrument – company targets with uniform emissions objective (e.g., global sector emissions intensity)
    - And, constrains cost-effective coordination (e.g., precluding offsets, discouraging cooperation, creating a mixture of company approaches)

General Insights for Company Emissions Reduction Goal Setting

- The cost-effective emissions reduction target for a company will likely differ from what is cost-effective at the global, country, or sector level
- Companies should consider uncertainty, want flexibility, and strive for robust strategies
  - Uncertainty about limiting warming to 2˚C, temperature–emissions relationships, technologies, policy design, non-climate uncertainties (e.g., economic growth, energy markets)
  - A strategy is robust if it still makes sense in different future contexts
  - A strategy is more than a target (or range), it is an approach that recognizes uncertainty and can respond appropriately
- Given uncertainties…
  - It is likely difficult to identify a unique company-level target that is robust to all future possibilities
  - Therefore, a strategy with flexibility is needed to contain company, and therefore societal, costs
- Identifying robust technical insights helps inform robust decisions
  - e.g., future global emissions need to be lower than today to limit warming to < 2˚C, and a broad range is relevant

Thank you!

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Resources

- Fawcett, AA, LE Clarke, S Rausch, JP Weyant, 2014. Overview of EMF 24 Policy Scenarios. *The Energy Journal* 35 (Special Issue 1 – The EMF 24 Study on U.S. Technology and Climate Policy Strategies).
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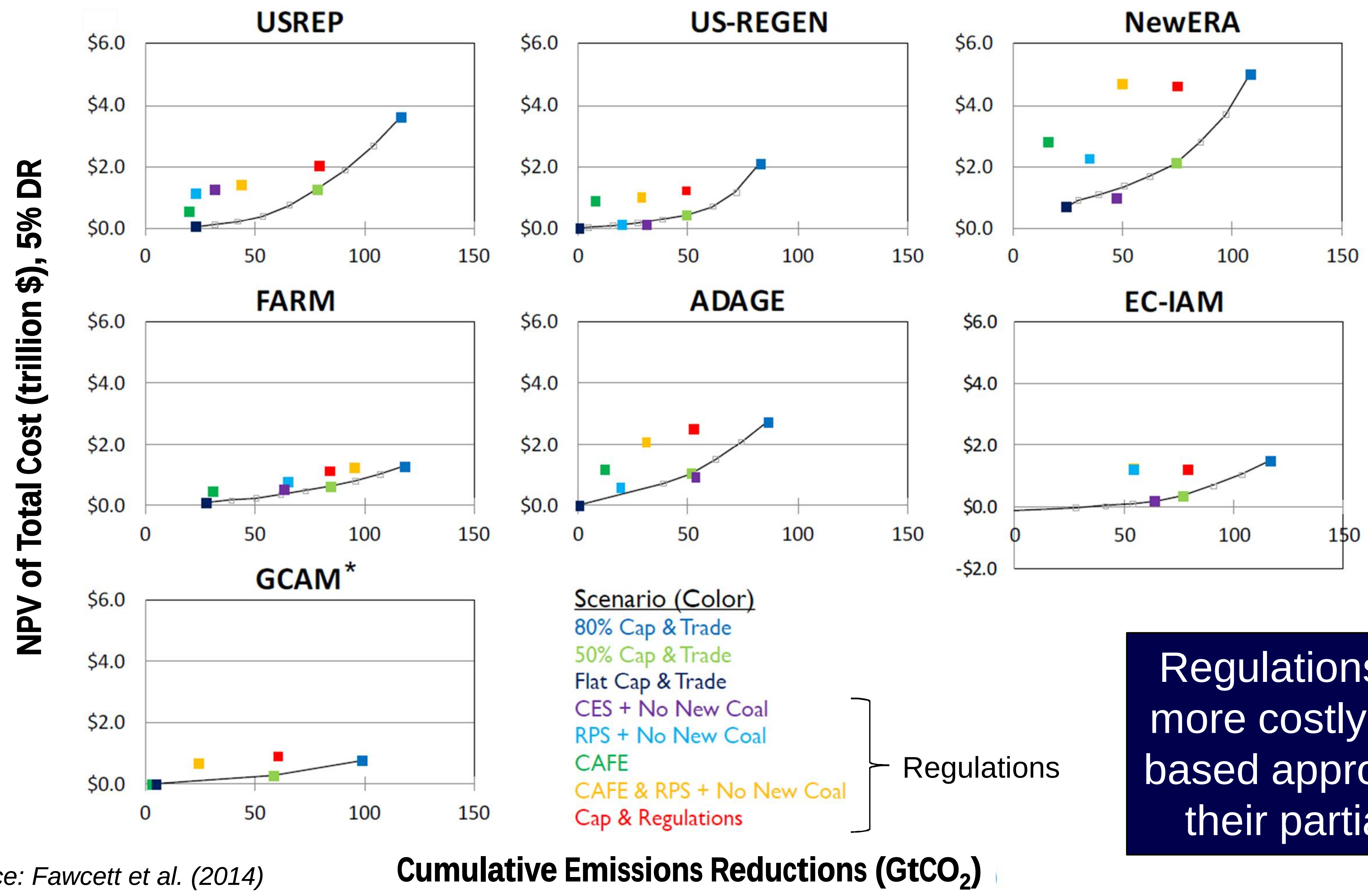
Policy Design Matters – e.g., Regulation vs. Cap & Trade

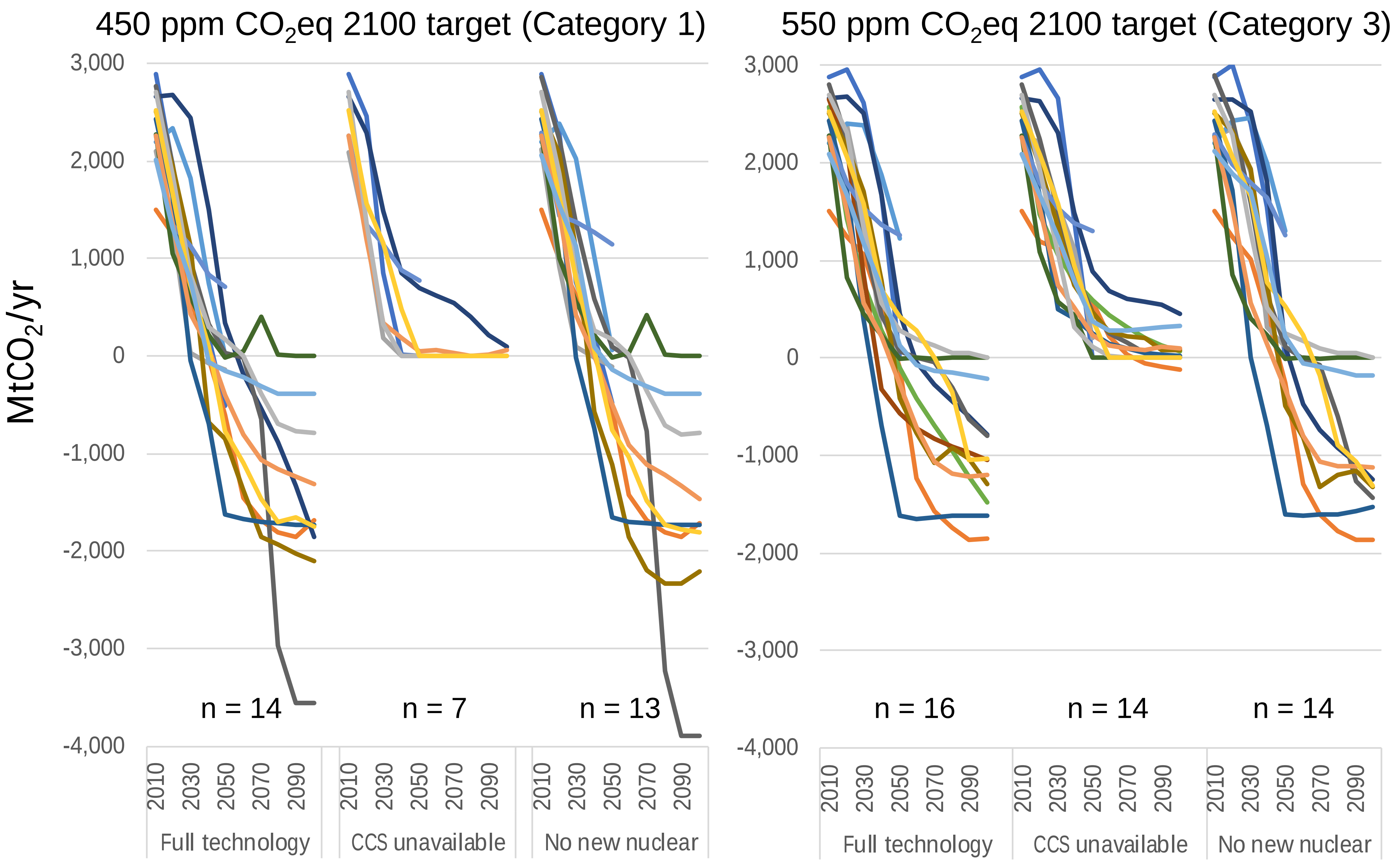


Regulations found to be more costly than market-based approaches due to their partial coverage

Source: Fawcett et al. (2014)

US Electric Sector CO_2 Pathways

e.g., Energy Modeling Forum 27th Study on the Role of Technology in Achieving Climate Objectives



Cost-effective US electric sector CO_2 pathway (and electrification) ranges and their viability will depend on:

- Available generation options
- The range of climate targets considered
- Policy design (global & economy-wide assumed in these results)

Source: Developed from EMF-27 study

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