EPRI Social Cost of Carbon Webcast Series

Today – Applying the Social Cost of Carbon: Technical Considerations

September 5, 2017

EPRI SCC Webcast Series

- July 25, 2017
  - *Understanding the Social Cost of Carbon: A Model Diagnostic and Inter-Comparison Study*
- August 16, 2017
  - *Social Cost of Carbon Pricing of Power Sector CO_2: Accounting for Leakage and Other Social Implications from Subnational Policies*
- September 5, 2017
  - *Applying the Social Cost of Carbon: Technical Considerations*

Publications and slides available at http://eea.epri.com ("Research" tab, "Integrated Assessment"). For information: Steven Rose, srose@epri.com.

Applying the Social Cost of Carbon: Technical Considerations

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Energy and Environmental Analysis Research Group

Webcast
September 5, 2017

Important to Evaluate Social Cost of Carbon Application

- Most commentary (public & scientific) related to the social cost of carbon (SCC) is on estimation of the SCC, not its use
- Surprising, given that we are most interested in the potential consequences of climate change and their management, not the SCC (a metric)
- Conceptual and methodological issues to consider in climate benefits and cost-benefit calculations
- **Study Objective**: Develop intimate understanding of how the SCC is being used, and should be used, that informs public dialogue and future application

The Social Cost of Carbon: An Important Metric & Issue

- **Social Cost of Carbon (SCC)** is an important metric
  - An estimate of damages to society from a unit of CO_2
  - An estimate of the benefits of avoiding a unit of CO_2
- SCCs increasingly **being considered & used** to value greenhouse gas emissions
  - Federal, state, local, and other decisions-makers
- **US Government (USG) legally obligated to value CO_2**
  - Obama: USG developed SCC values used.
  - Trump: Unknown. Withdrew SCC estimates.
- **Lack of technical information & understanding** needed for proper evaluation and discourse
  - Led to detailed EPRI assessment of SCC modeling (1st EPRI SCC webcast)
  - And now, EPRI analysis of SCC application

Table ES-1: Social Cost of CO_2, 2010 – 2050 (in 2007 dollars per metric ton of CO_2)

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2010	10	**31**	50	86
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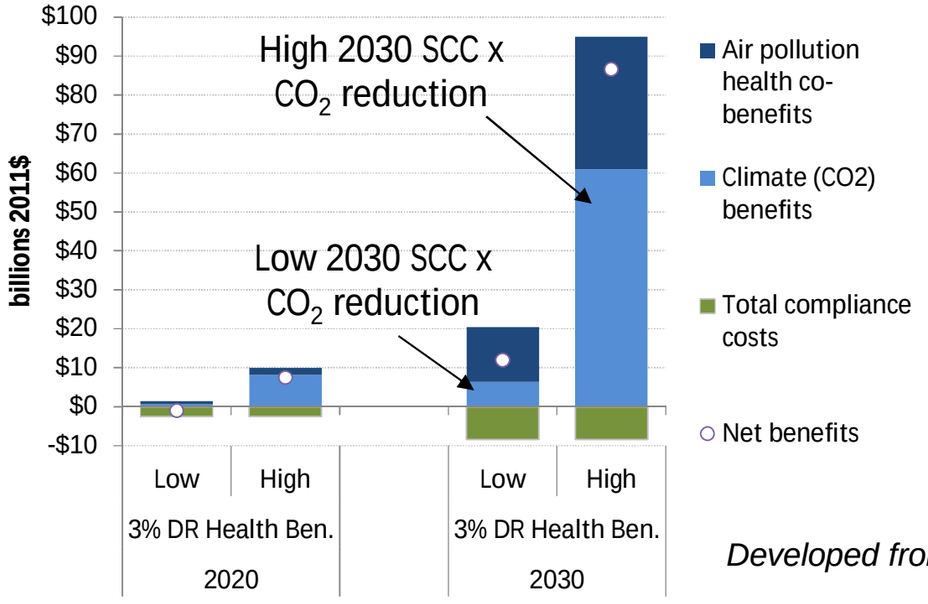
US Government (2015, 2016)

Estimated 2020 and 2030 range of estimated benefits, costs, and net benefits for EPA's Clean Power Plan (Rate Based Approach)



Developed from EPA RIA

This Study

- Investigates SCC use to understand and evaluate the state of the art for application
- Identifies specific issues and opportunities for improving existing and future CO_2 reduction benefit and cost-benefit analyses
- Initial report 2016. Updating with new applications.
  - **Issues and insights continue to be relevant.**

Methodology

1. Catalogue types of SCC applications
2. Develop an inventory of federal regulatory applications
3. Characterize appropriate use—conceptually and mechanically
4. Evaluate applications, identifying issues and opportunities for improvement

Applying the Social Cost of Carbon: Technical Considerations

http://eea.epri.com (“Research,” “Integrated Assessment”)

Types of SCC Applications

Application type	Examples	Global emissions implications	SCCs used
Federal regulatory	DOT (NHTSA) vehicle efficiency standards, EPA Clean Power Plan, DOE small motor efficiency standard, DOE microwave efficiency standard (1, 2, 3, 4)	Incremental	USG
Federal non-regulatory	CEQ NEPA reviews, BLM coal mine permitting (5, 6)	Incremental	USG
State	Minnesota, Maine (7, 8)	Incremental	USG considered
Local (e.g., city)	Austin, TX (9)	Incremental	Custom
Value of technology	Technology SCC pricing (10)	Incremental	USG and other
Non-U.S. regulatory	Canada, United Kingdom (U.K.) (11, 12)	Incremental	Canada – USG UK – Custom
Federal climate goal evaluation	U.S. proposed legislative GHG cap and trade policy (12)	Non-incremental	USG
Global climate goal evaluation	Tol (2009) (13)	Non-incremental	Custom

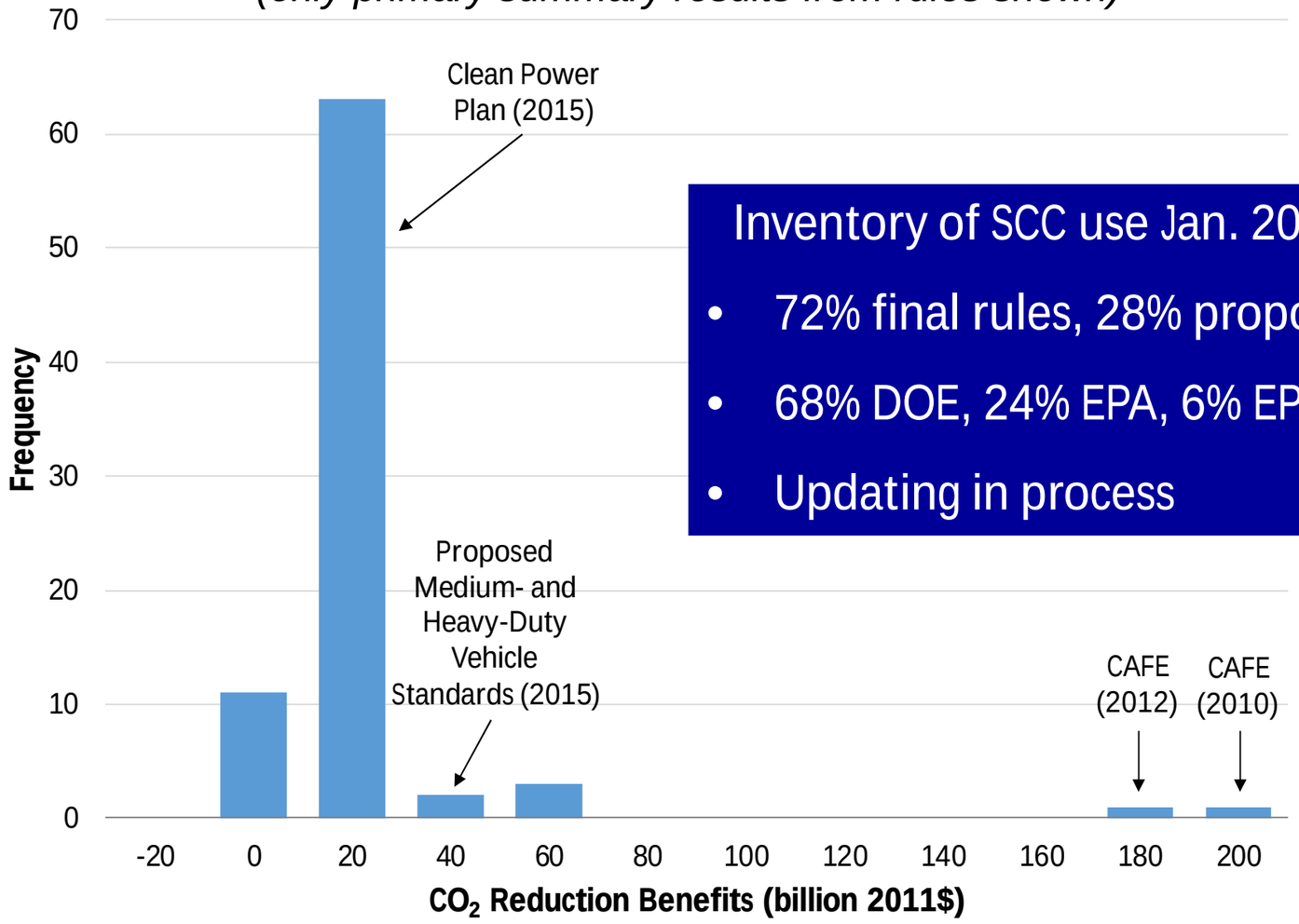
"Incremental" = policy with relatively small expected effect on global emissions

"USG SCCs" = federal Interagency Working Group values

Inventory of U.S. Federal Regulatory SCC Applications

Histogram of Estimated CO_2 Reduction Benefits from U.S. Federal Regulations Jan. 2008 – Mar. 2016

(only primary summary results from rules shown)

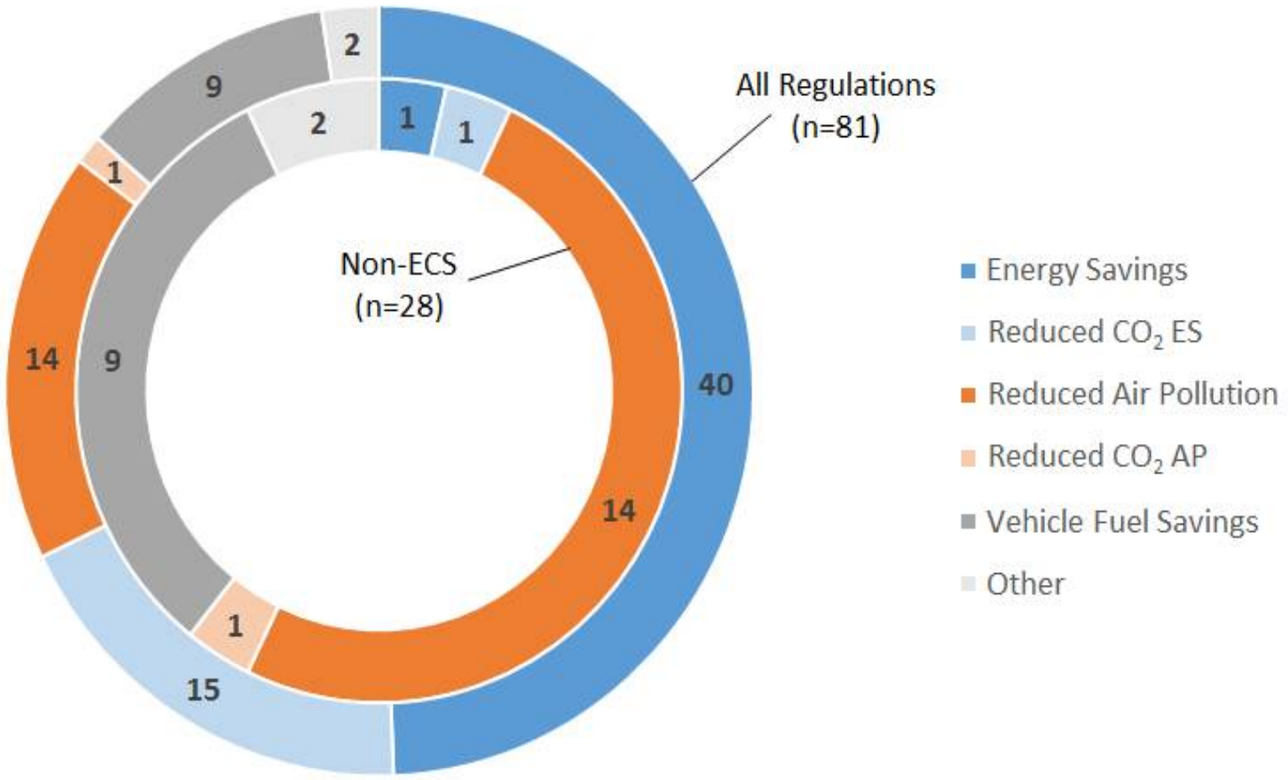


Inventory of SCC use Jan. 2008 – Mar. 2016

- 72% final rules, 28% proposed
- 68% DOE, 24% EPA, 6% EPA/DOT, 2% DOT
- Updating in process

The Role of CO_2 Reduction Benefits in Federal Rules Uncertain

Primary benefits in U.S. Federal Rules (based on RIA "primary summary" values)

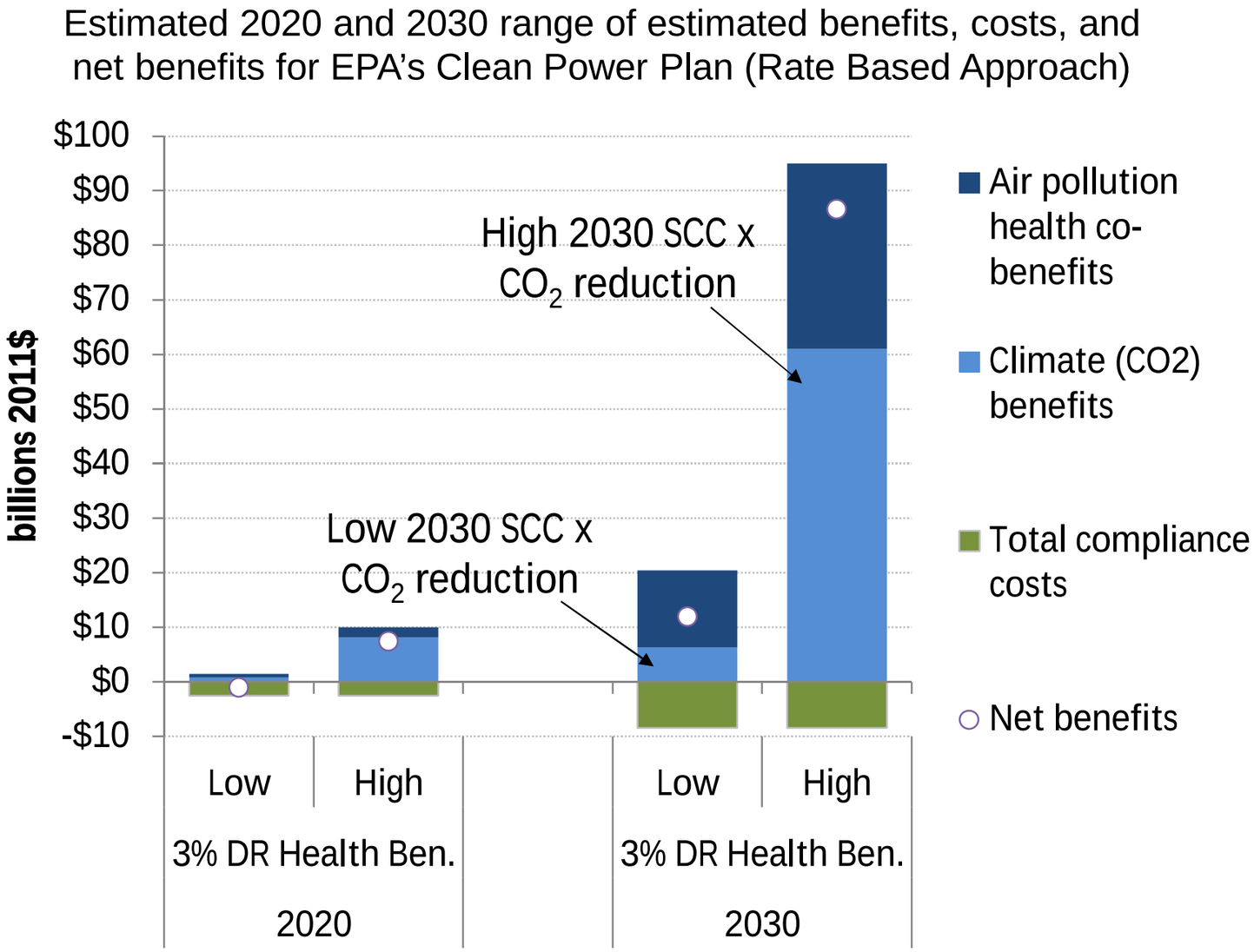


ECS = Energy Conservation Standards (DOE)

- RIA "primary summary" results suggest **climate benefits not the main driver** for most rules
- **However, caution about drawing conclusions!!**
- **More than primary summary results in RIAs** – CO_2 benefits can be minority to majority of benefits
- Most importantly, **we identify issues that need to be addressed** to properly assess CO_2 reduction and net benefits

CO_2 Benefits Could be Minority to Majority of Benefits

E.g., Clean Power Plan RIA



Developed from EPA RIA

Appropriate SCC Application

Conceptually

- SCC_t = The net present value of global climate change impacts from one additional net global metric ton of carbon dioxide emitted to the atmosphere at a particular point in time
  - SCC is a **marginal value** (cost or benefit) of CO_2
  - SCC depends on the **projected reference condition**
  - SCC values one unit change in **net global** CO_2
- Proper use:
  - SCC is an appropriate metric for valuing incremental changes in global CO_2 emissions
  - Estimated CO_2 changes should be estimates of global net changes in CO_2

Mechanically

- Two contexts—calculating CO_2 reduction benefits and policy net benefits

Net Present Value CO_2 Reduction Benefits

$$= \sum_t \frac{1}{(1+i)^t} (Net\ global\ CO_2\ Reduction_t * SCC_t)$$

Net Present Value Net Benefits

= *NPV Benefits – NPV Compliance Costs*

= *NPV CO_2 Reduction Benefits*

+ NPV Other Benefits

- NPV Compliance Costs

- Challenges: combining calculations from different analyses, value streams over time, discounting

Key Issues Identified in SCC Applications

- **Consistency between estimated benefits and costs**
  - Inconsistency in reference socioeconomic and emissions assumptions
  - Inconsistency in the treatment of uncertainty across calculations
  - Inconsistency in the type of values compared (levelized vs. annual)

Inconsistency in Reference Assumptions & Uncertainty

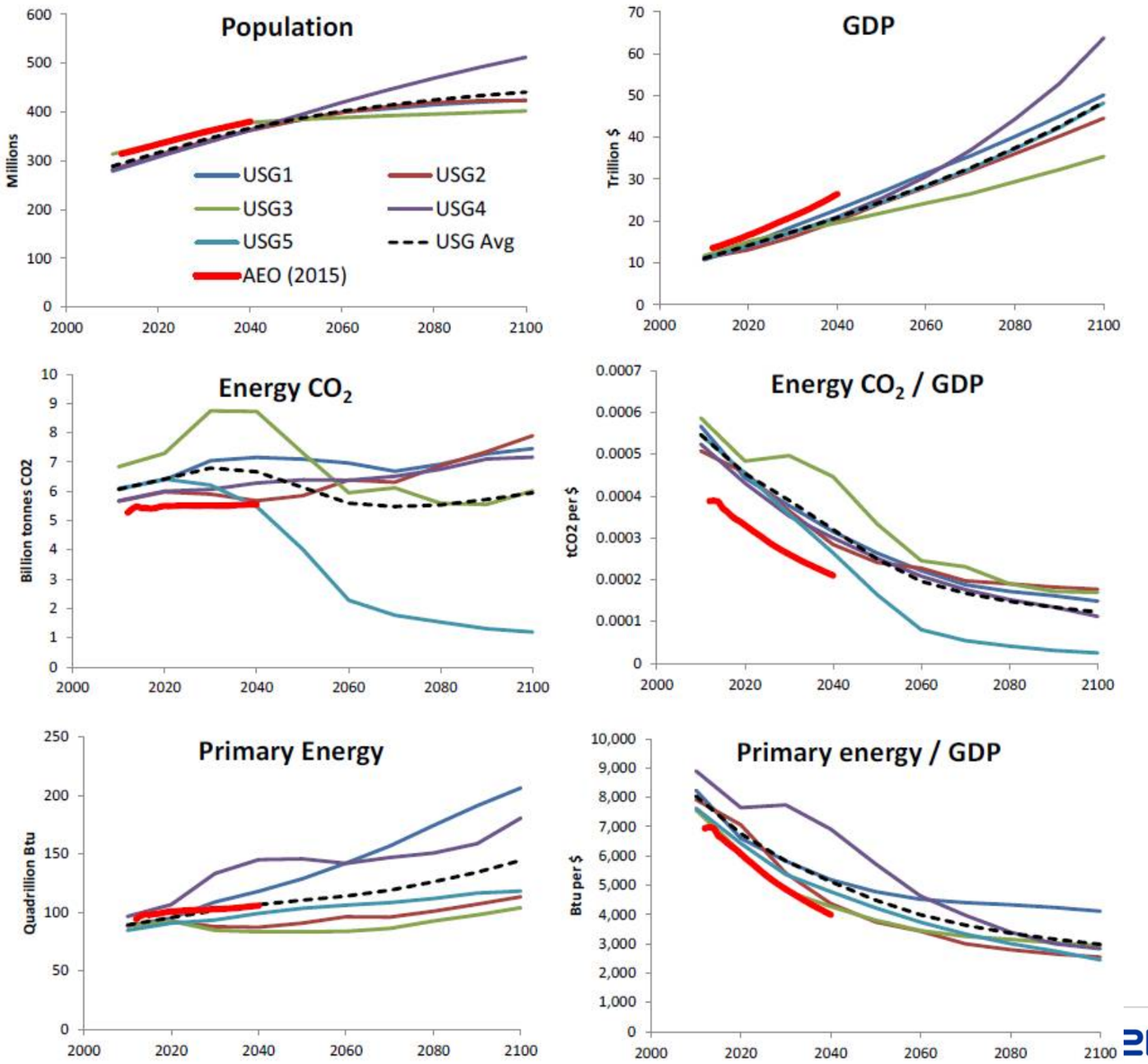
Two types of inconsistency:

(1) Future represented

(2) Treatment of uncertainty

Comparing Clean Power Plan CO_2 reductions & compliance cost reference assumptions (AEO 2015) with SCC assumptions (USG)

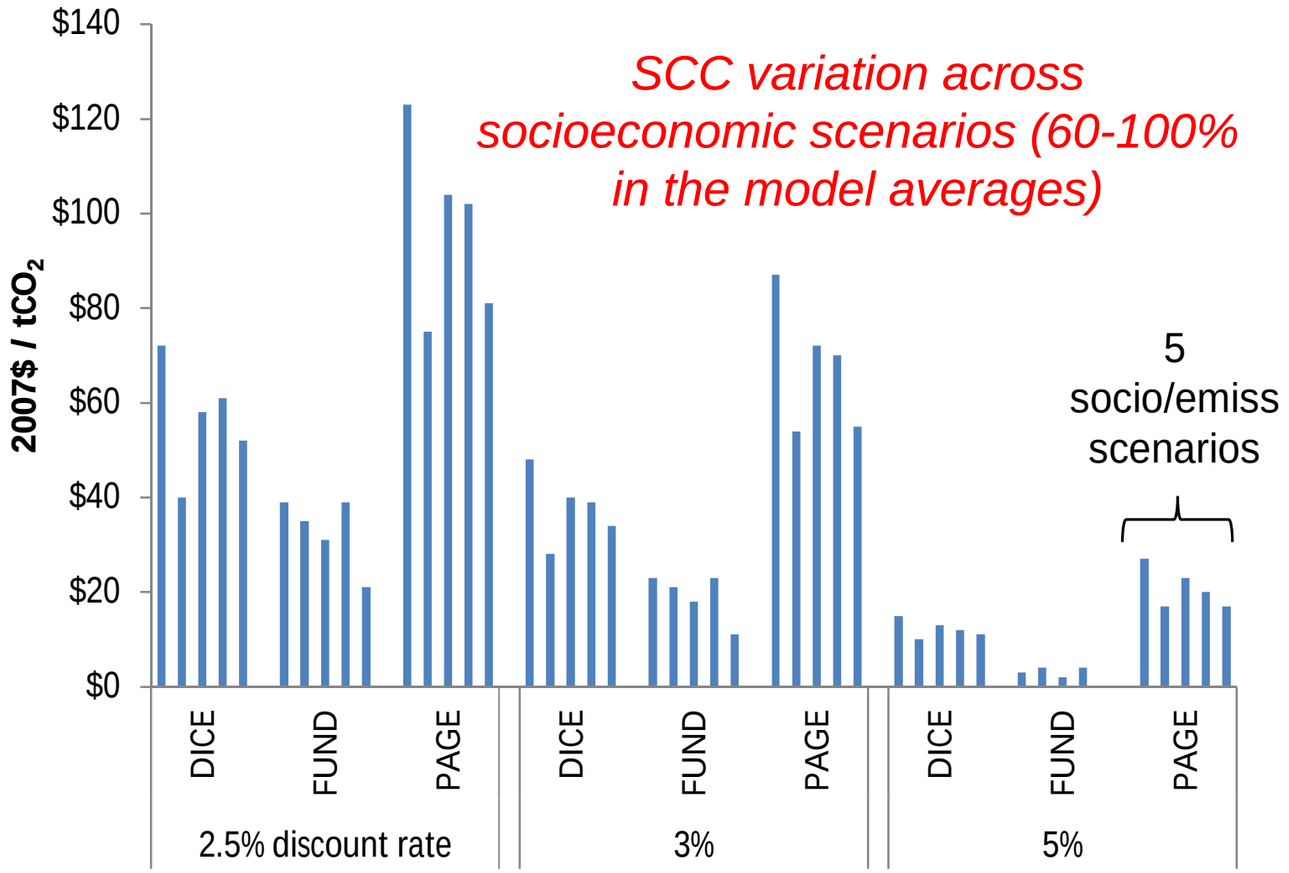
U.S. socioeconomic and CO_2 emissions assumptions



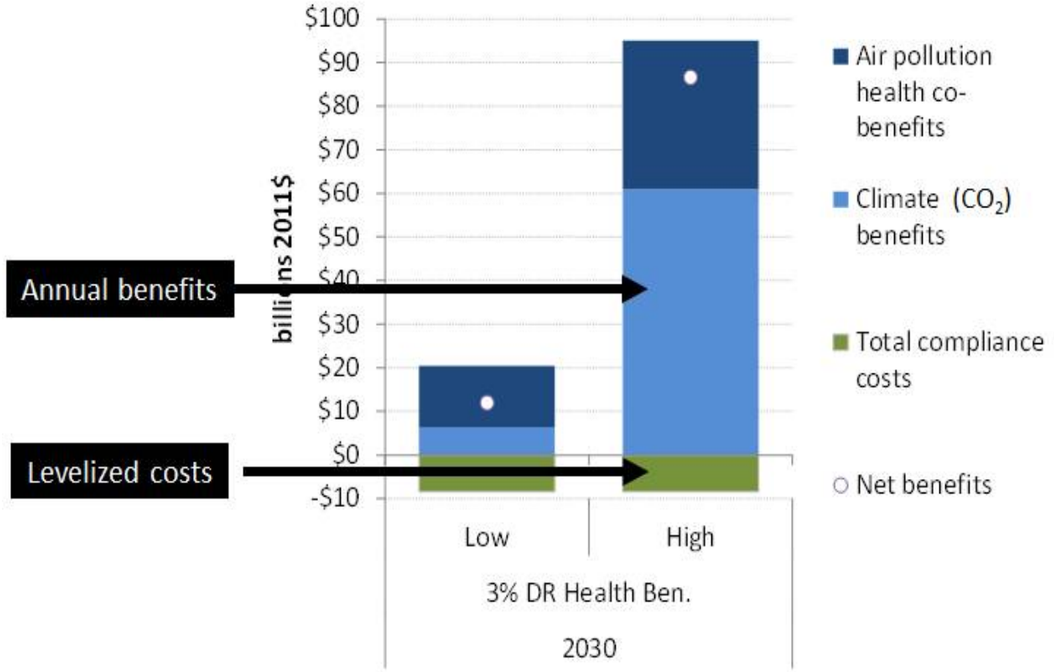
Inconsistency in Reference Assumptions & Uncertainty

Socioeconomic/emissions assumptions matter for the SCC. May matter for other cost-benefit calculations also.

Average 2020 USG SCCs by discount rate, model and socio/emissions scenario



Inconsistency in the Type of Values Compared – Levelized vs. Annual



Why is this problematic?

Levelized cost reflects discounted stream of values. Annual benefit value does not. **Cannot compare!!**

And, potentially misleading with different conclusions depending on comparison year. **Both invalid!**

Need to compare net present values!!

Key Issues Identified in SCC Applications

- **Consistency between estimated benefits and costs**
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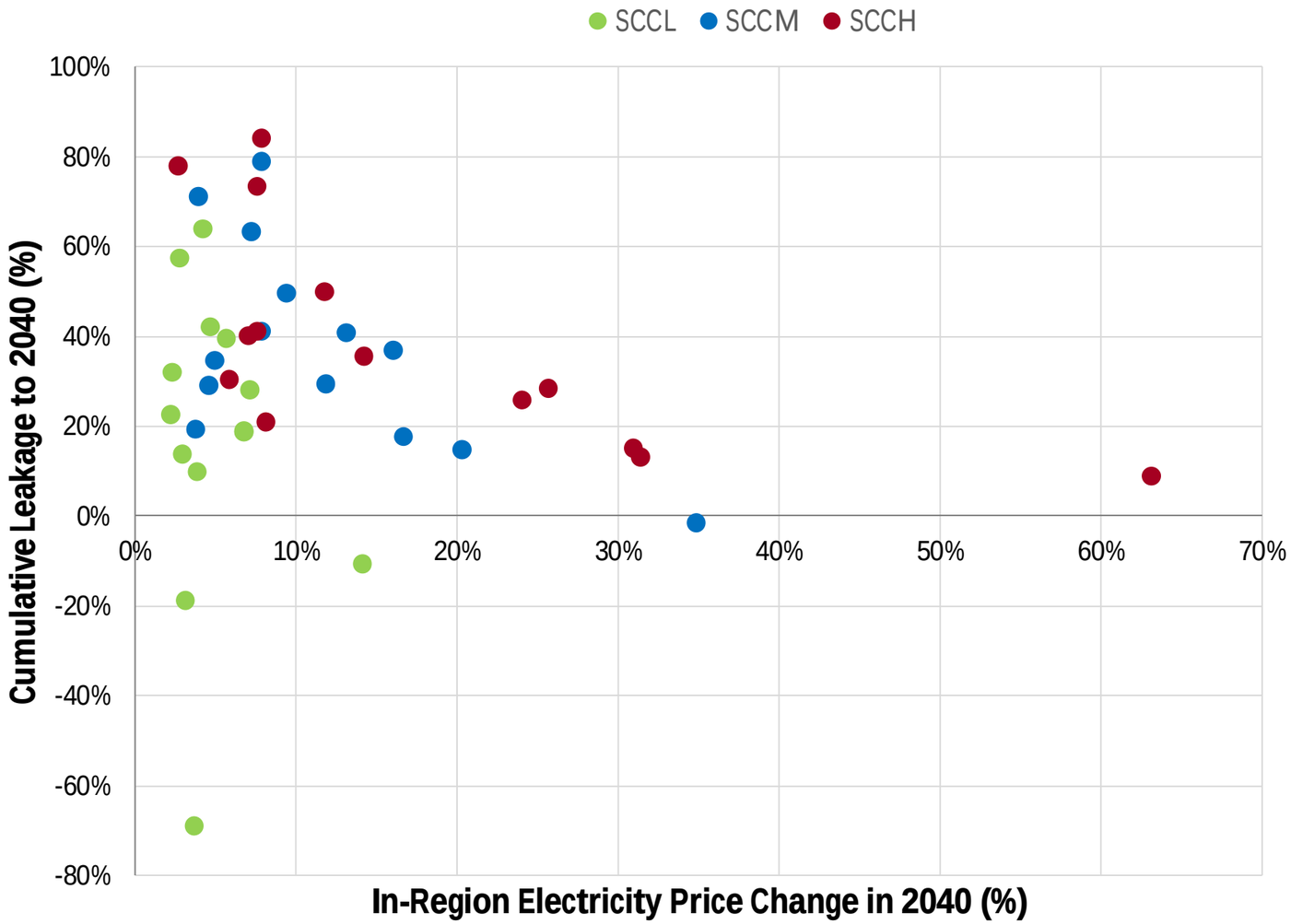
- **Estimating net global CO_2 changes**
  - SCC is the value of a net incremental change in **GLOBAL** CO_2
  - Regulations do not typically estimate CO_2 changes beyond the regulated segment (i.e., leakage)
  - x% positive leakage = x% lower CO_2 benefits

Need to Estimate Net Global CO_2 Changes

- Do we need to revise CO_2 benefits estimates?
- Yes, if there is expected to be significant CO_2 leakage beyond the regulated segment
- X% leakage = X% lower CO_2 benefits!

E.g., Estimated CO_2 leakage and electricity prices changes with subnational SCC pricing of power sector CO_2



Bistline and Rose (2017)

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  - Regulations do not typically estimate CO_2 changes beyond the regulated segment (i.e., leakage)
  - x% positive leakage = x% lower CO_2 benefits
- **Use of multiple SCC values**
  - Which SCC should be used (and corresponding benefits estimate)?
  - In one rule, across rules, across agencies?

Which SCC Should be Used?

Example range of CO_2 reduction benefits using the four USG SCC trajectories (CPP)

	Rate-Based Approach		
	2020	2025	2030
Climate Benefits [b]			
5% discount rate	$0.80	$3.1	$6.4
3% discount rate	$2.8	$10	$20
2.5% discount rate	$4.1	$15	$29
95th percentile at 3% discount rate	$8.2	$31	$61

Order of magnitude difference in estimated climate benefits. Which one to use?

What do they represent? Current SCC range not a representation of uncertainty.

Guidance needed.

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US Government (2015, 2016)

NAS notional alternative for improved SCC uncertainty communication

	Discount Rate								
	5.0%			3.0%			2.5%		
Year	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High
2020	—	—	—	—	—	—	—	—	—
2025	—	—	—	—	—	—	—	—	—
…									
2050	—	—	—	—	—	—	—	—	—

Source: National Academies of Sciences, Engineering, and Medicine. (2016)

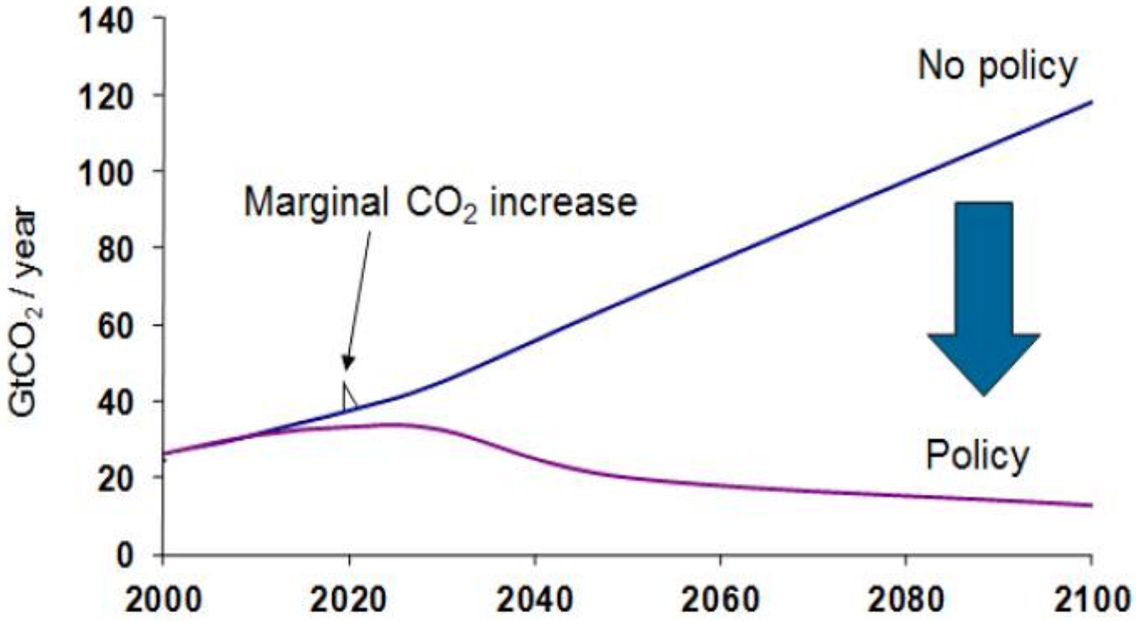
Key Issues Identified in SCC Applications (continued)

- **Pricing the CO_2 externality more than once**
  - Across policies, risk of pricing CO_2 twice (or more) – upstream & downstream.
  - **More than once = excess cost to society**
    - E.g., coal mine permitting / Public Utility Commission externalities pricing / Clean Power Plan
    - E.g., low-carbon subsidy / regional emissions cap / Clean Power Plan
  - Coordination (agency, jurisdiction) needed to insure CO_2 valued once to avoid excess costs on society
- **Valuing non-CO_2 GHGs**
  - Until last year, changes in non-CO_2 GHGs typically not valued. Now USG developed SC-CH_4 and SC-N_2O estimates.
  - Social costs of non-CO_2 GHGs differ from the SCC, and global damage trade-offs between GHGs differ from Global Warming Potential trade-offs
  - IMPORTANT: Many issues with current USG SCC modeling and application also relevant for non-CO_2 estimates
- **SCCs and overall climate objectives (global, national)**
  - Tempting to apply SCCs to evaluate or help set global and domestic climate policy goals
  - However, SCCs conceptually inappropriate for these applications
  - A different concept & framework needed

Can SCCs Inform Global Climate Policy Goals?

- No! Need a different concept and framework!
- **Interested in evaluating transitions** from higher to lower climate futures—changing climate and society
- **Marginal benefits changing** – value of X^{th} ton of CO_2 reduced will not equal value of 1^{st} ton reduced
  - Shape of climate damage function important
- **SCCs**
  - Based on a particular assumed socioeconomic and climate future
  - Also, USG SCCs based on an amalgamation of futures
- **Marginal costs also changing** – rise with the level of emissions reduction ambition
- **Bottom line**:
  - Evaluating climate strategies requires a framework for consistent modeling of endogenous marginal benefits & costs
  - Also, need better understanding of damages

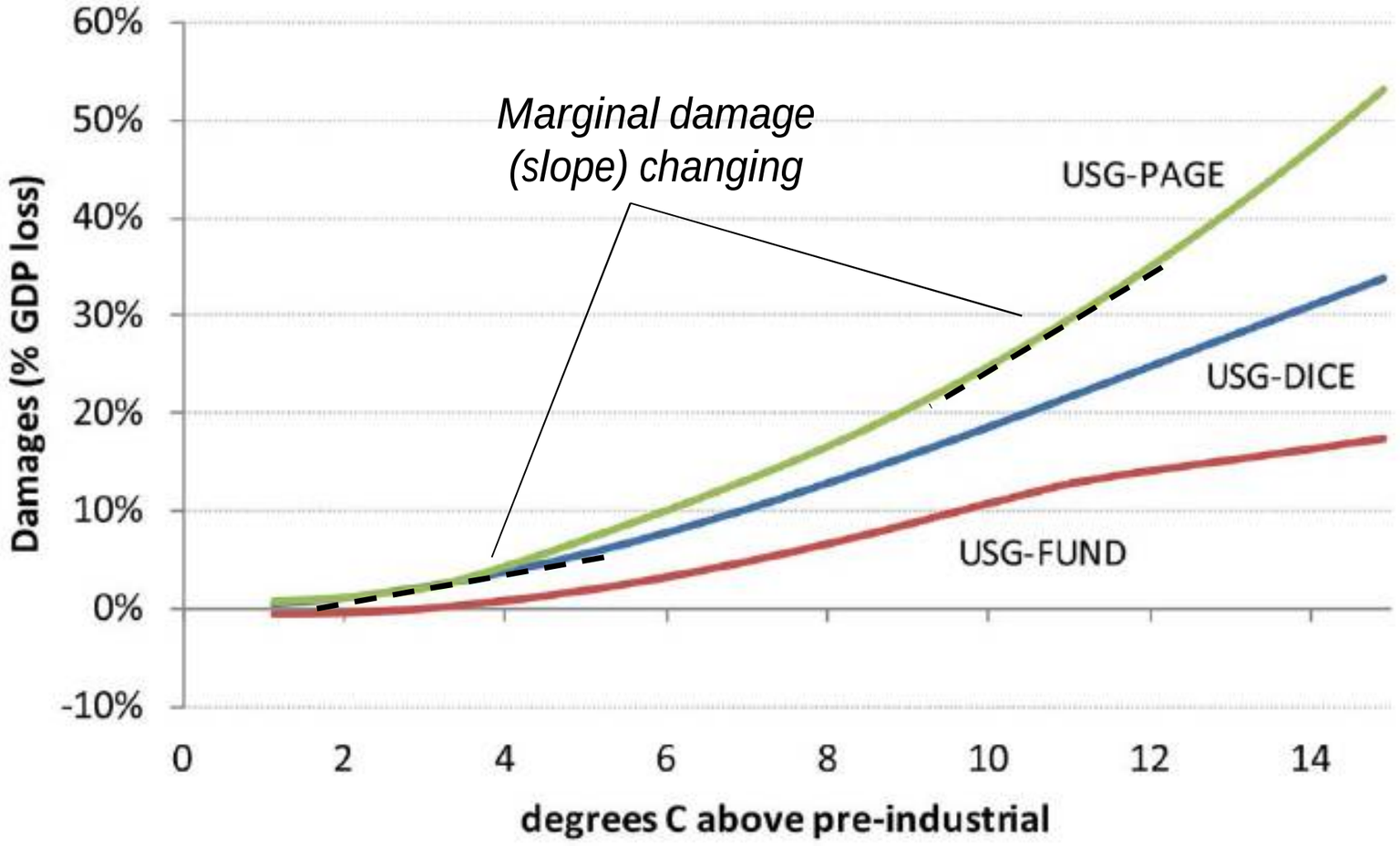
Illustration of a non-incremental shift in global CO_2 emissions



Marginal Damages are Not Constant

E.g., Implied damage functions behind USG SCC modeling

Global damage functions based on default damage parameterization results from a technical assessment of USG SCC damage component modeling



Developed from Rose et al (2017, 2014)

Application Issues Identified Not Isolated Instances

Application	Benefit & cost consistency?	Estimating net global CO_2 change?	Multiple SCC value guidance?	Valuing non-CO_2 GHGs?
Passenger and light duty truck vehicle efficiency standards	No	No*	Partially, standards based on 3% discount rate average SCC	No, monetized CO_2eq emissions for illustrative purposes but not in net benefits
Clean Power Plan	No	No	No	No
New Source CO_2 Performance Standard (111(b))	No	No	No	No
NRDC analysis of potential existing source CO_2 performance standard	No	No	No	No
Cooling water intake regulations	No**	No	No	No
Cost-benefit analysis of U.S. climate legislative proposal (Holladay and Schwartz, 2009)	No	No	No	Yes, but CO_2eq

SCC estimation issues also relevant

** RIA does estimate emissions reductions for reduced fuel consumption, including imports, but not market driven changes in international consumption*

*** Only reference assumption inconsistency*

Concluding Remarks

- Reviewing and improving SCC use is as important as improving SCC estimation
- This study identifies fundamental issues to address to improve the reliability of CO_2 reduction benefit and net benefit calculations, insights, and conclusions
- Application guidance is needed to avoid these issues and facilitate consistent application and improved decision-making
- SCC estimation issues, of course, still also need to be addressed

Thank you for joining us today!

We hope you have enjoyed the webcast series.
Stay tuned for future related research and insights.

Questions/information: Steven Rose, srose@epri.com.

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Resources

- Bistline and Rose (2017). Social Cost of Carbon Pricing of Power Sector CO_2: Accounting for Leakage and Other Social Implications from Subnational Policies, Discussion Paper, EPRI Report 3002011658.
- National Academies of Sciences, Engineering, and Medicine (2017). *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide*. Committee on Assessing Approaches to Updating the Social Cost of Carbon, Board on Environmental Change and Society, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press. doi: 10.17226/24651.
- Rose and Bistline (2016), Applying the Social Cost of Carbon: Technical Considerations, EPRI Report 3002004659.
- Rose, et al. (2017), "Understanding the Social Cost of Carbon: A Model Diagnostic and Inter-Comparison Study," *Climate Change Economics* 8(2).
- Rose, et al. (2014), Understanding the Social Cost of Carbon: A Technical Assessment, EPRI Report 3002004657.
- USG Interagency Working Group on Social Cost of Carbon (2016). *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866*, August.
- USG Interagency Working Group on Social Cost of Carbon (2015). *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866*, July.

Inconsistency in the Type of Values Compared – Levelized vs. Annual

Levelized costs cannot be compared to annual benefit values.

Comparing can be potentially misleading with different conclusions depending on comparison year. **Both invalid!**

Need to compare net present values!!