Price Caps and Price Floors in Climate Policy

- A Quantitative Assessment -

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IEA Day, Poznan, 9 December 2008

Introduction

- Climate change is a long-term issue fraught with uncertainties
  - Should not delay action, but…
  - Cost benefit analysis difficult
- Price caps reduce cost uncertainty
  - May help get more countries on board
  - May allow for more ambitious policies
  - Shift uncertainty to the side of emissions
    - How bad is this?

Purposes of the study

- **Calculate expected costs of target levels**
  - **Calibrating a model with IPCC AR4, *World Energy Outlook* and *Energy Technology Perspectives***
  - **Uncertainty analysed with Monte Carlo simulations**
- **Assess price caps and price floors**
  - **How they change expected costs and outcomes – emissions, concentrations and temperature change**
- **Quantify the possible 'strengthening of targets'**
  - **Find which combination of targets, price caps & floors entail the same expected costs than a 'certain' target**

The ACTC Model

- A global aggregate model of economy and energy-related CO_2 emissions
- Halving global emissions by 2050
  - From either 1990 or 2005 levels
  - G8 leaders agreed to 'consider seriously' (2007) and 'share that goal with all UNFCCC Parties' (2008)
- Four ten-year periods considered
- Optimal pathway to 2050 on best-guess values
  - with 5% discount rate
- Abatement cost curves from IEA work
- Temperature change committed by 2050

BaU CO_2 emissions

IPCC, energy-related and industrial CO_2 emissions

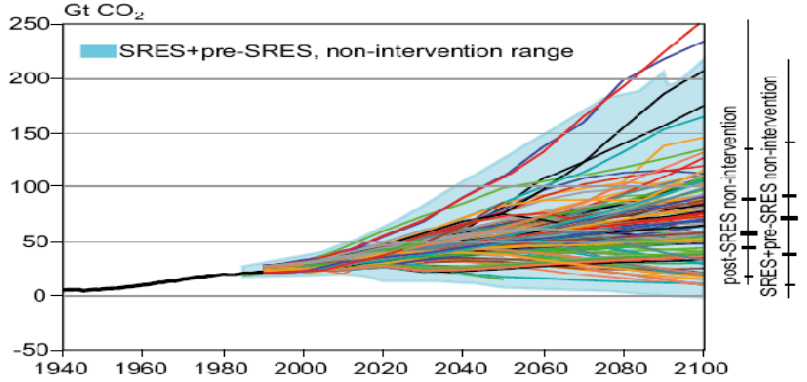
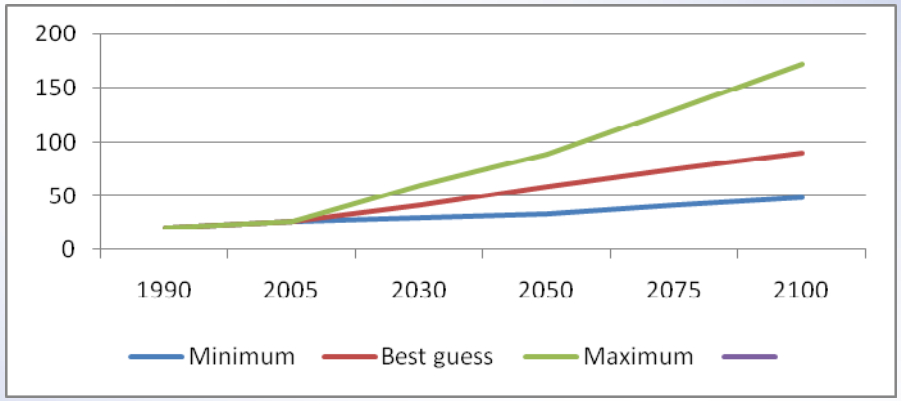


Figure TS.7: *Comparison of the SRES and pre-SRES energy-related and industrial CO_2 emission scenarios in the literature with the post-SRES scenarios [Figure 3.8].*

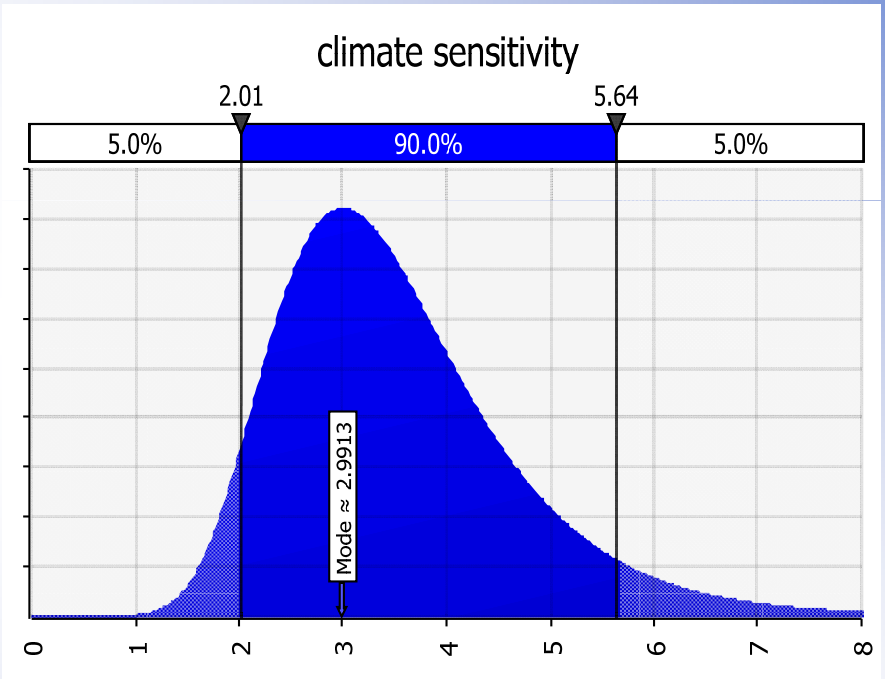
Note: Two vertical bars on the right extend from the minimum to maximum of the distribution of scenarios and indicate the 5th, 25th, 50th, 75th and the 95th percentiles of the distributions by 2100.

ACTC Model, energy-related CO_2 emissions



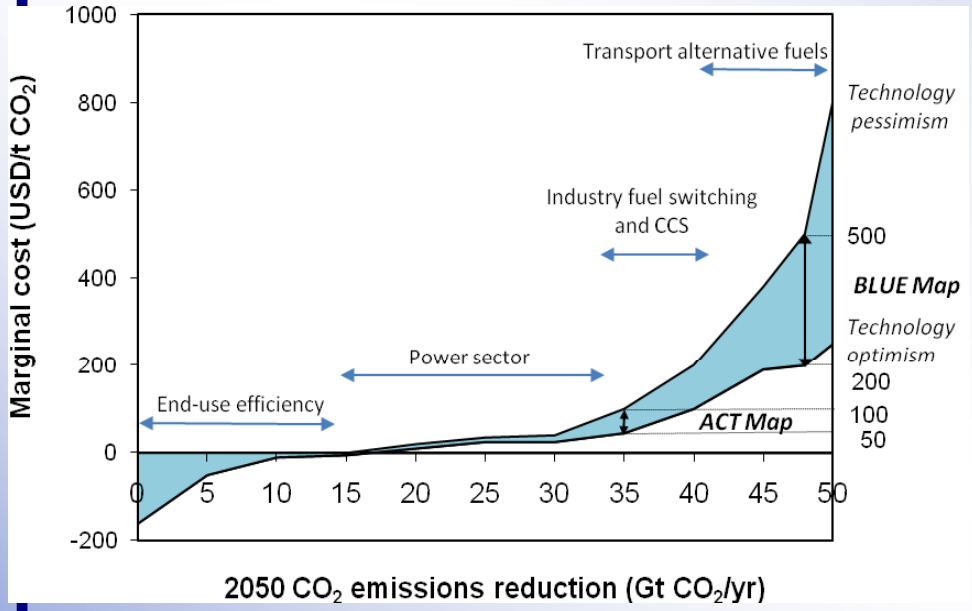
Temperature Change

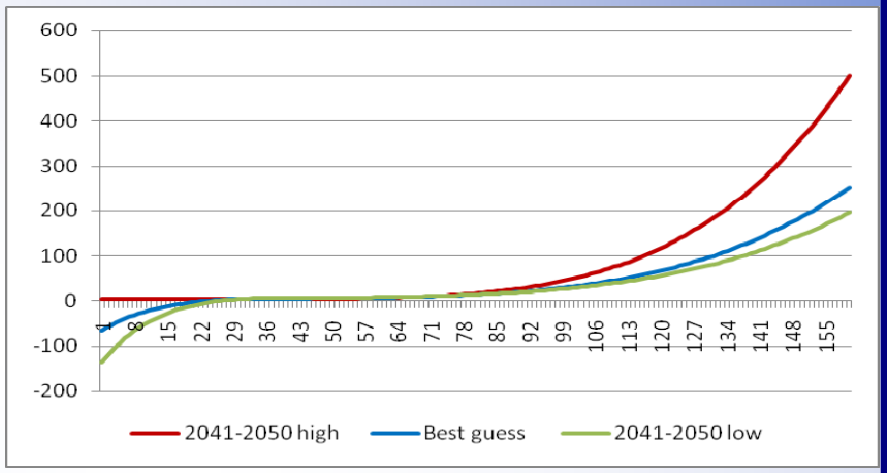
- Committed by 2050
- 60% of the emitted CO_2 remains in the atmosphere
- *C* atmospheric CO_2 concentration (in ppm), 275 ppm pre-industrial CO_2 concentration, *s* Earth climate sensitivity (in °C), temperature change committed by 2050, relative to pre-industrial:



$$\Delta T = s * LOG(C/275)/LOG2$$

Abatement Costs





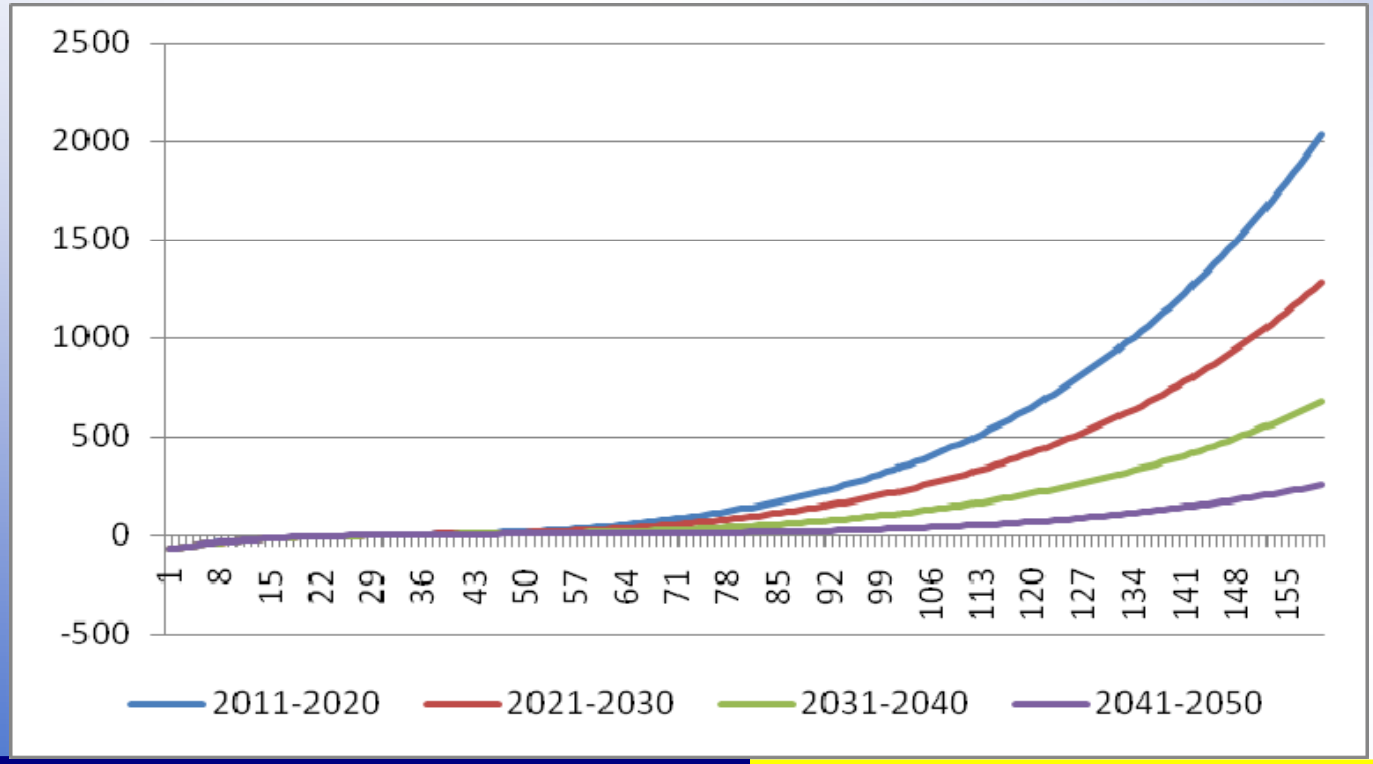
ETP 2008

ACTC Model

Changing scales from 50 Gt CO_2/y to 160 CO_2/10y by 2050: yearly to ten-year reductions – but realised during one of the four periods (capital turnover) and piled-up from one period to the next – then further adjusted as the model reveals uneven amounts of abatement per 10-y period

Technical progress

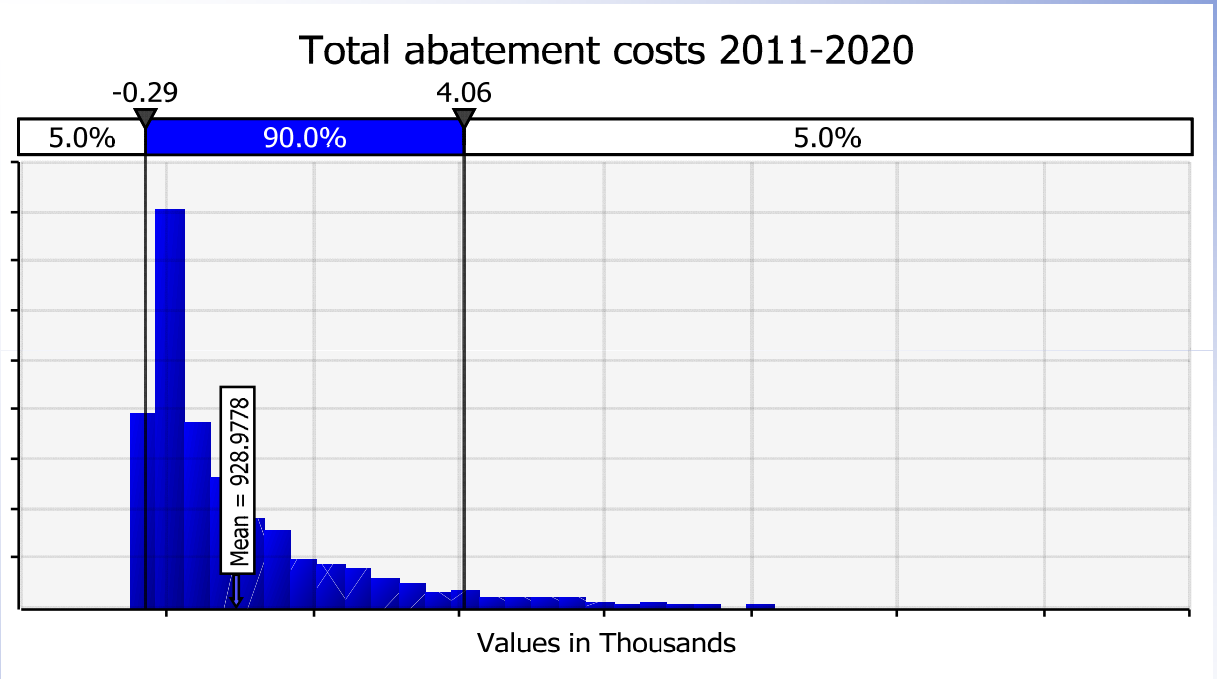
- Reduces costs over time
- Adjusted on IPCC AR4 abatement potentials
  - (only best guess values shown)



Selecting targets

	2011-2020	2021-2030	2031-2040	2041-2050		Total
Reference 2005	95%	83.5%	74.5%	50%		
Cap ($Gt\ CO_2$/10y)	258	234	206	136		834
MAC (US$/t CO_2)	67	101	158	252		
TAC (bn $)	350	1 119	3 002	6 575		2 754 (npv)

Considering uncertainties



Global 'straight' target for 2011-2020: 95% of 2005 emissions. Simulations reveal higher total expected costs under uncertainty: USD 929 bn *vs.* USD 350 bn under "best-guess" scenario

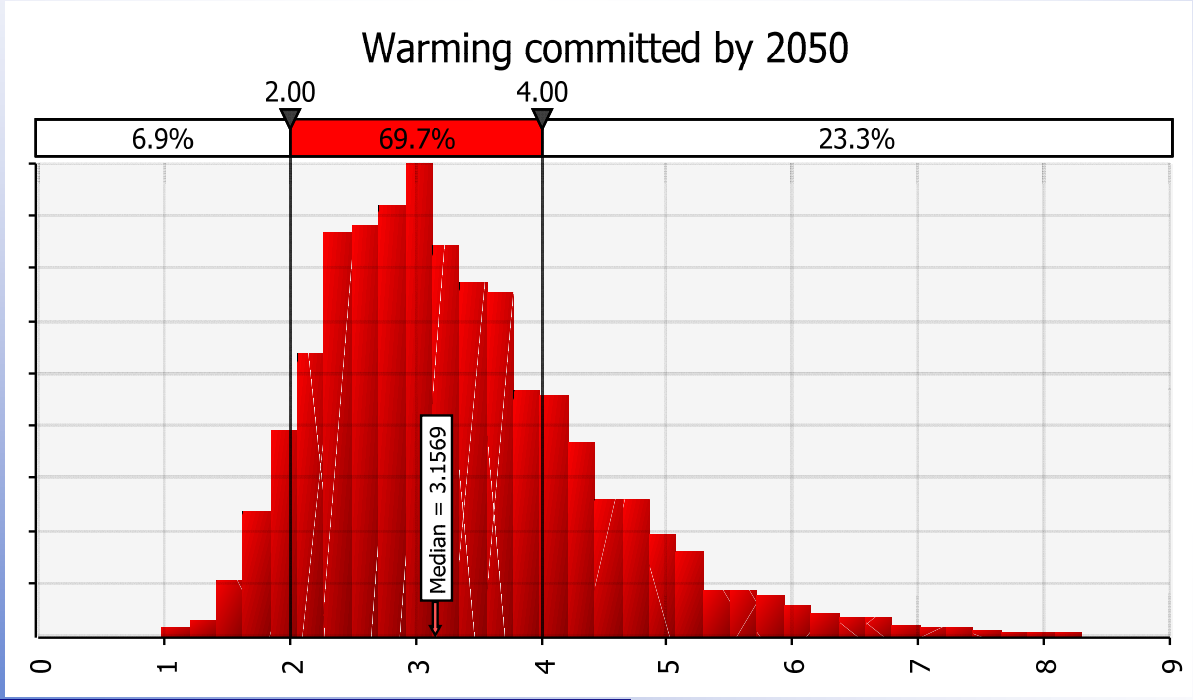
Considering uncertainties

halving emissions from 2005 levels

		2011-2020	2021-2030	2031-2040	2041-2050	Total (npv)
MAC (USD/t CO_2)	Best guess	67	101	158	252	
	Mean	92	181	288	504	
TAC (USD bn)	Best guess	350	1 119	3 002	6 575	**2 754**
	Mean	929	3 729	8 307	18 179	**7 885**
TAC in % WGP	Best guess	0.04%	0.10%	0.20%	0.33%	
	Mean	0,11%	0.30%	0.50%	0.80%	

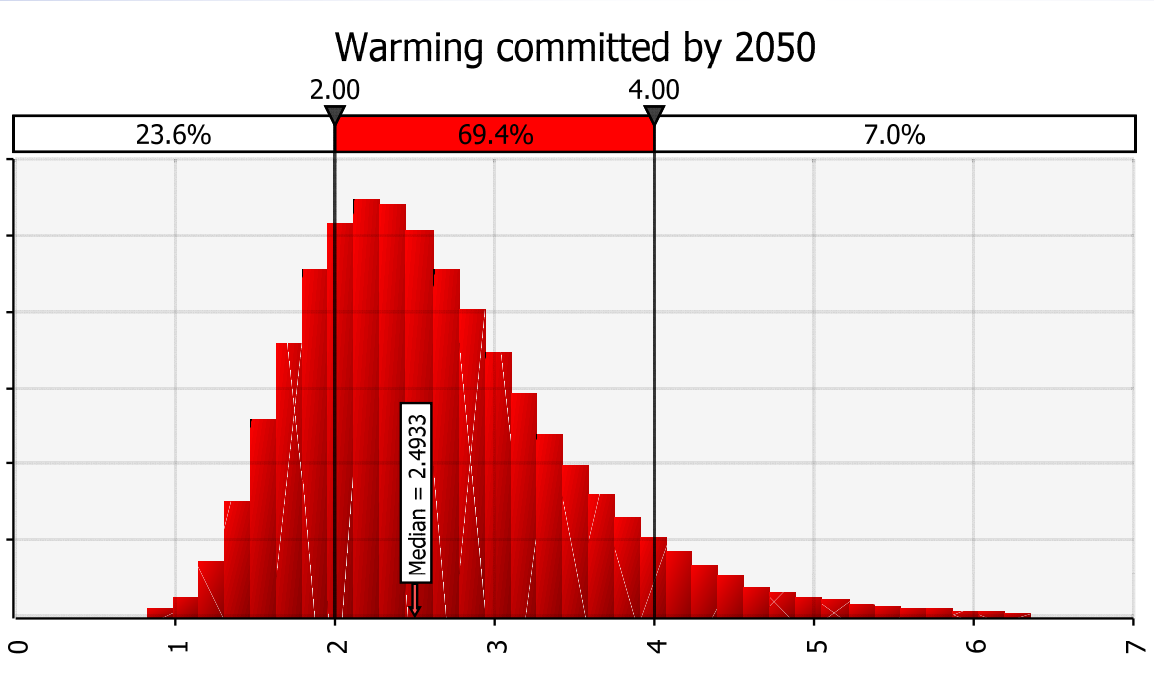
No policy case: 2050

- CO_2 concentration 499 – 579 ppm
- Committed temperature change 3.16°C
  - And still rapidly increasing…



Half of 2005 level by 2050

- Discounted abatement costs USD 7 885 bn
- CO_2 concentration 462 ppm
- Committed temperature change 2.49°C



Straight targets. The uncertainty reflects the uncertain equilibrium climate sensitivity

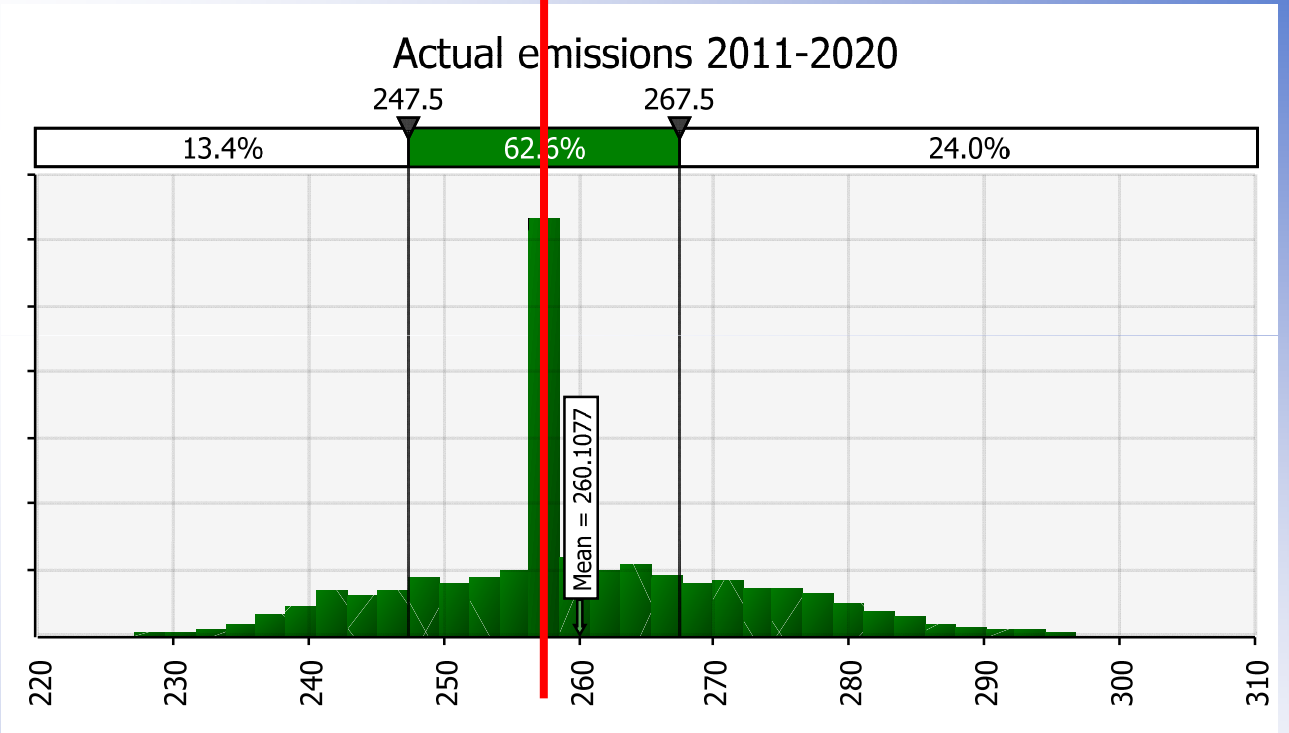
Price caps and floors

- **Price cap: a price paid at the end of the compliance period for emissions beyond the target, defined from the outset**

- **Price floor: reserve (minimum) prices in periodic auctioning**

Price cap & floor in 2011-2020

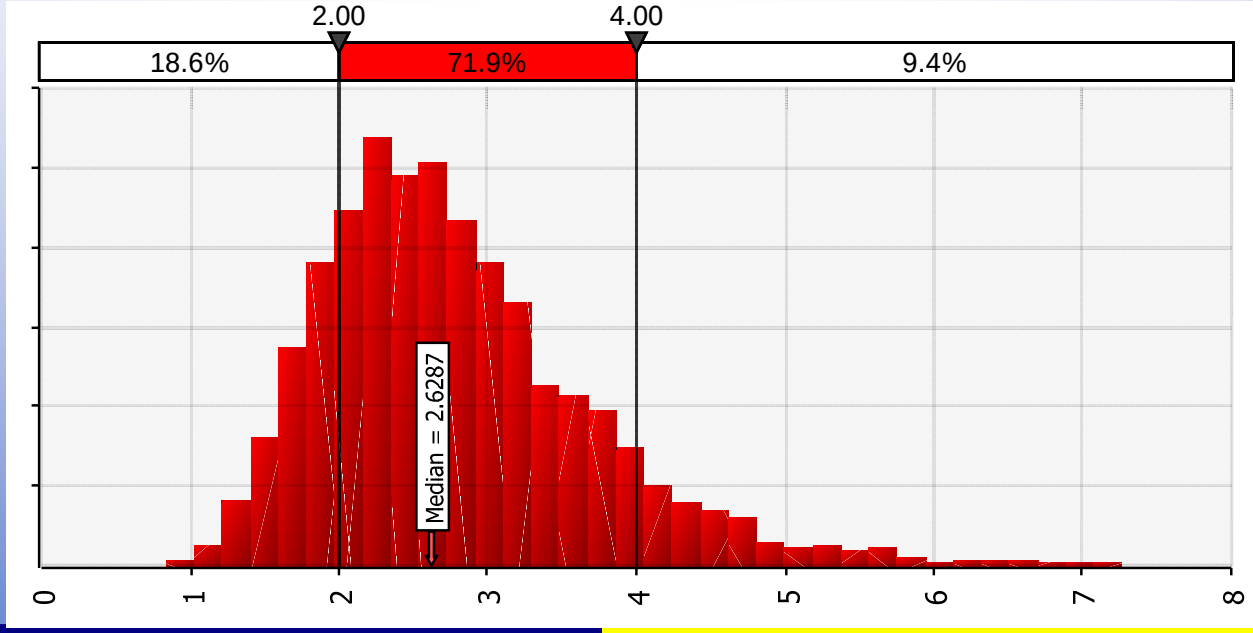
- *Target 95% of 2005 emissions (257.835 Gt CO_2 in 10 years)*



- **With a price cap at USD 80 and a price floor at USD 40 expected costs are down from USD 929 to 297 bn**
- **Mean emissions exceed target by 0.4 Gt CO_2**

Half 2005 level with low price caps
(USD 40 by 2011 to USD 80 by 2041)

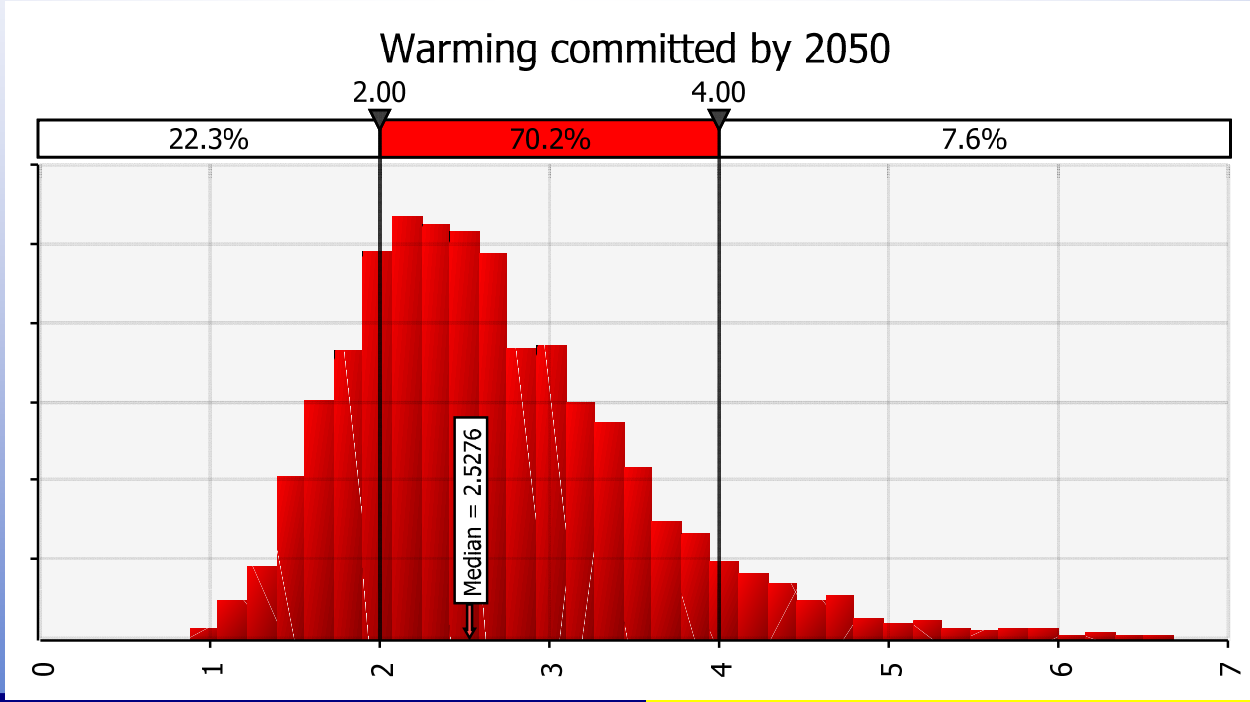
- Discounted abatement costs USD 645 bn
- CO_2 concentration 462 – 521 ppm
- Committed temperature change 2.63°C



Half 2005 levels w. caps & floors

($ 80 by 2011 to $ 260 by 2041, floors 1/2)

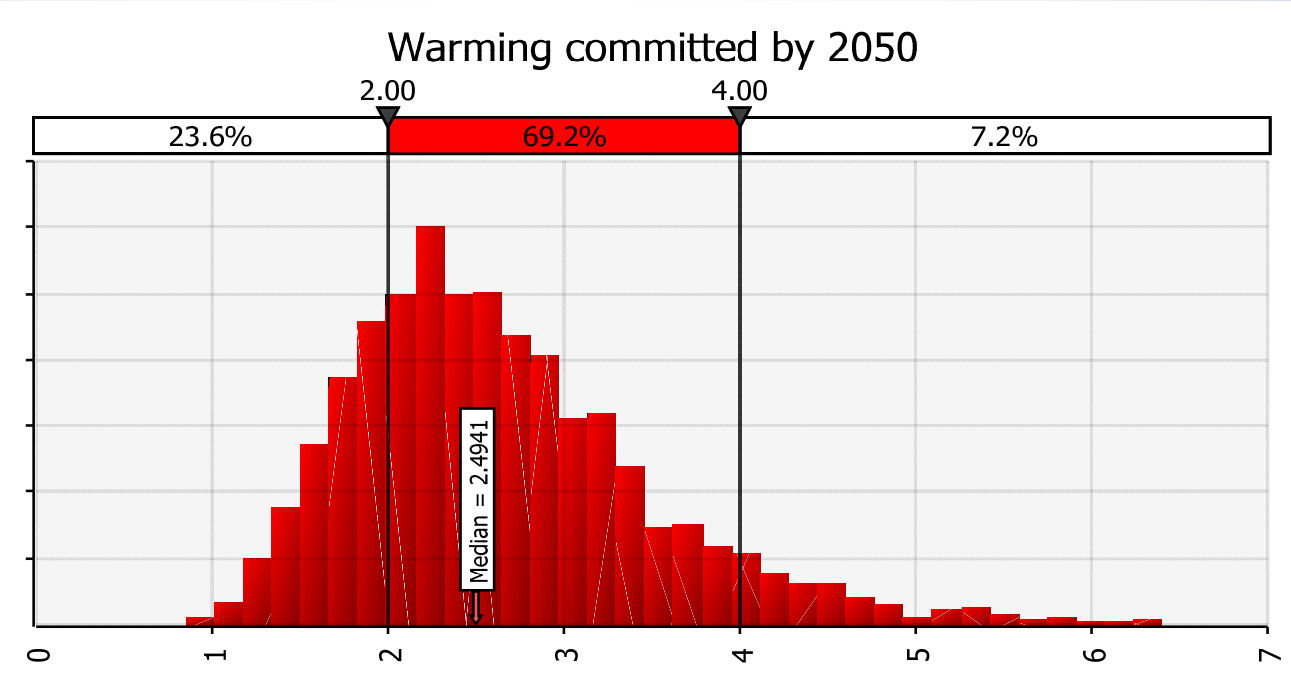
- Discounted abatement costs USD 2 354 bn
- CO_2 concentration 432-506 ppm
- Committed temperature change 2.53°C



Half 1990 levels w. caps & floors

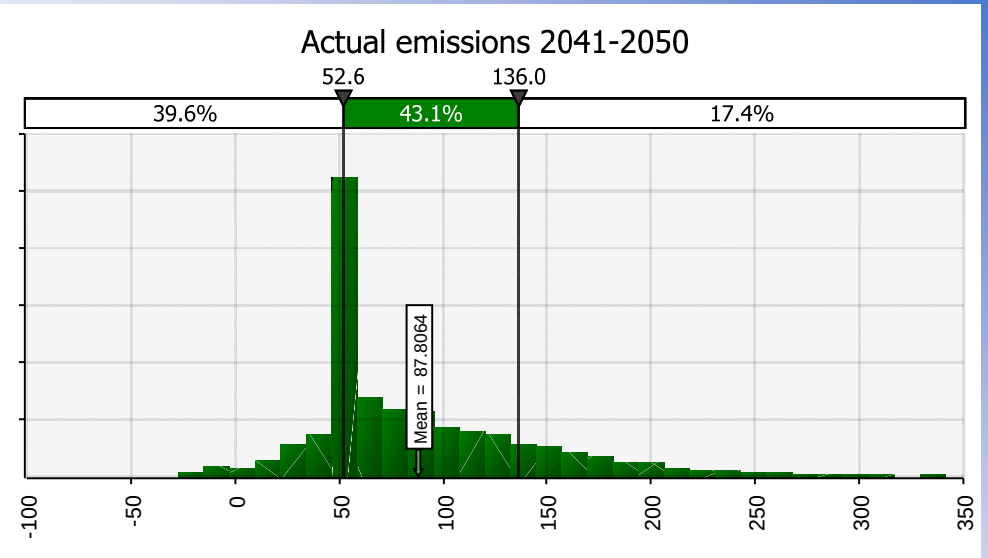
($ 110 by 2011 to $ 360 by 2041, floors 1/3)

- Discounted abatement costs USD 3 474 bn
- CO_2 concentration 436-501 ppm
- Committed temperature change 2.49°C



Tighter targets to 2050

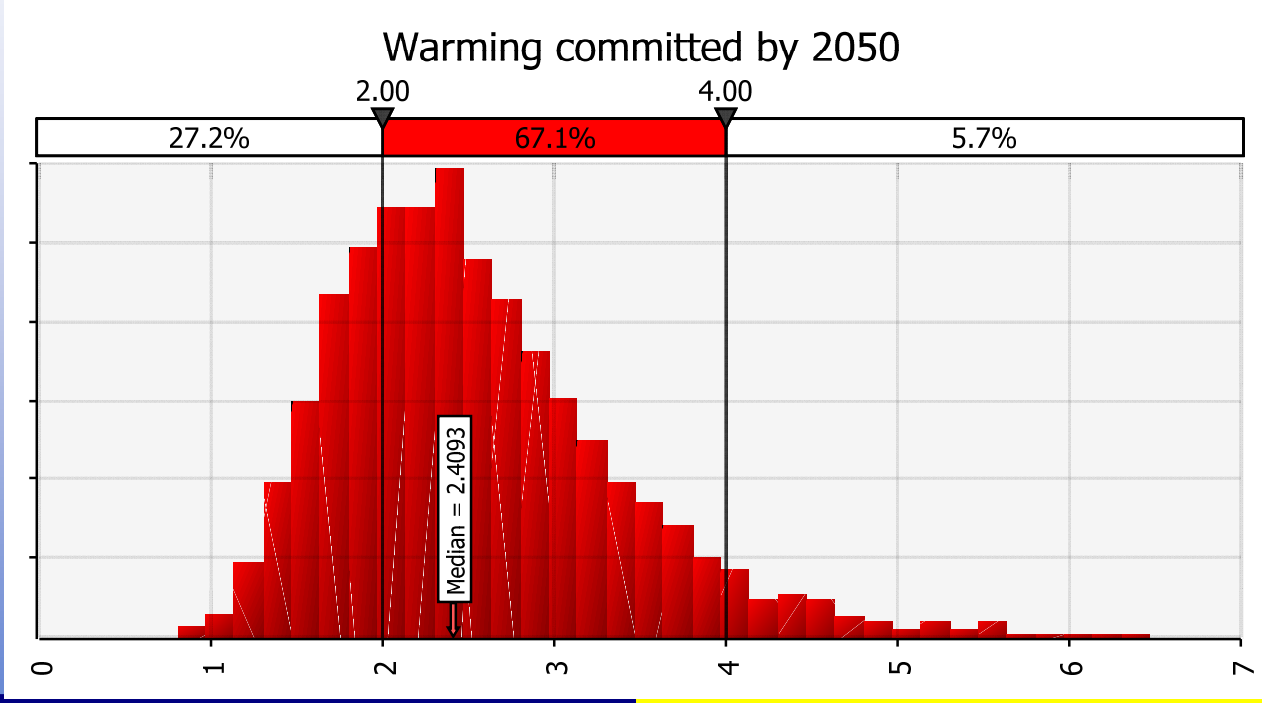
- ¼ of 1990 levels
- Targets: 24.5 t CO_2 by 2020, 20.4 by 2030, 15.2 by 2040, 5.26 by 2050



- Price caps set at USD 150, 240, 360, 600
- Price floors set at USD 50, 80, 120, 200
- Mean emissions: 8,8 Gt CO_2/y
- NPV abatement costs 2011-2050: USD 6 762 bn
  vs. 7 885 with straight targets 13.5 Gt CO_2

Tighter targets w. caps & floors
($ 150 by 2011 to $ 600 by 2041, floors 1/3)

- Discounted abatement costs USD 6 762 bn
- CO_2 concentration 430-494 ppm
- Committed temperature change 2.41°C



Policy	Target 2050 *Price caps* Price floors (2011 to 2050)	Abatement costs - npv *Min -Av.-Max* *in % WGP*	Concen-tration (ppm) by 2050 ppm Min ppm Max	Warming committed by 2050				
				Median	*%* Chances of not exceeding…			
				°C	*2°C*	*3°C*	*4°C*	*5°C*
No policy	-	-	***499*** ***579***	**3.16**	*6.9*	*43.2*	*76.7*	*91.9*
1: Half 2005 level	**13.6 Gt CO_2** No price cap	$ 7 885 bn *0–0.4–5.5*	***462***	**2.49**	*23.6*	*72.2*	*93*	*98.5*
2: Half 1990 level	**10.5 Gt CO_2** No price cap	$ 10 071 bn *0–0.6–9.9*	***457***	**2.44**	*25.8*	*74.4*	*93.8*	*98.8*
As 1 + low price caps	**13.6 Gt CO_2** *$40 to $100*	$ 645 bn *0–0.03–0.06*	***462*** ***521***	**2.63**	*18.6*	*67*	*91.6*	*97.7*
As 1 + price caps & floors	**13.6 Gt CO_2** *$80 to $260* $40 to $130	$ 2 292 bn *0–0.12–0.19*	***432*** ***506***	**2.53**	*22.3*	*70.3*	*92.4*	*98.3*
As 2 + price caps & floors	**10.5 Gt CO_2** *$110 to $360* $35 to $120	$ 3 456 bn *0–0.2–0.3*	***436*** ***501***	**2.49**	*24.1*	*71.9*	*93.2*	*98.6*
Tight target +price caps & floors	**5.26 Gt CO_2** *$150 to $600* $ 50 to $200	$ 6 762 bn *0–0.35–0.5*	***430*** ***494***	**2.41**	*27.4*	*75.8*	*94.4*	*98.8*

Some conclusions

- Price caps could significantly reduce cost uncertainty
- Price-driven variations in emissions have little influence on temperature changes
  - If price cap and price floor levels are commensurate with the ambition of the policy
  - Building up CO_2 concentrations smoothes emission changes
  - The uncertainty on climate sensivity by far exceeds the uncertainty on emission levels
- Tighter targets with price caps & price floors entail lesser economic risks and similar climate results
- Short term certainty on emissions may be less important than long term policy ambition

Additional remarks

- **Reduced expected abatement costs**
  - **Result from ‘where to’ flexibility**
  - **Not only from time flexibility**
- **Differences with Pizer’s work (2002)**
  - **Discount rate not uncertain in this study**
  - **No ’optimal’ abatement level sought for here**
  - **But ‘best use of a given amount of money’**
- **Cap and floor levels depend on scenario**
  - **Actual decisions beyond 2030 to be taken with better knowledge of emissions and costs**

INTERNATIONAL ENERGY AGENCY
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The report will be posted soon on our web site www.iea.org

France, Germany, and the Netherlands supported this work

Cédric Philibert
International Energy Agency

Future work

- Could extend the analysis to all greenhouse gases
- Could assess the impacts of reduced price volatility on investors' behaviour
- Could analyse concrete issues in implementing price caps and floors