Stabilizing Long-Term Temperature: The Issues of Uncertainty, Timing, Costs and Technology

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Issues

1. What is the range and likelihood of temperature change over the 21st century in the absence of climate policy?

2. What is the impact of technological expectations on the least-cost emission pathways for stabilizing global-mean temperature?

3. What is the impact of technological expectations on the near-term price of carbon?

4. What is the potential value of a technology rich energy future?

5. Why focus on stabilizing temperature rather than concentrations?

MERGE

- An intertemporal CGE Model
- 9 geopolitical regions
- 150 year time horizon
- Bottom-up representation of energy sector
- Learning-by-doing (LBD)
- Top-down representation of rest of economy
- Multiple greenhouse gases
- Aerosol cooling
- Tradeoff among gases based on relative prices, not GWPs
- Climate module calibrated with MAGICC

Electricity Generation Technologies

Identification/ Examples	Availability - Pessimistic Technology Scenario	Availability - Optimistic Technology Scenario
Hydroelectric, geothermal and other renewables	yes	yes
Existing nuclear and fossil	yes	yes
Advanced combined cycle	yes	yes
New coal without CO2 recovery	yes	yes
Fuel cells with capture and sequestration	no	yes
Integrated gasification and combined cycle with capture and sequestration	no	yes
Carbon-free technologies; costs do not decline with LBD	yes	yes
Carbon-free technologies; costs decline with LBD	no	yes

Nonelectric Energy Supplies

Description	Availability - Pessimistic Technology Scenario	Availability - Optimistic Technology Scenario
Coal-direct uses	yes	yes
Oil	yes	yes
Gas	yes	yes
Coal-based synthetic fuels	yes	yes
Renewables	yes	yes
Carbon-free technologies; costs do not decline with LBD	yes	yes
Carbon-free technologies; costs decline with LBD	no	yes

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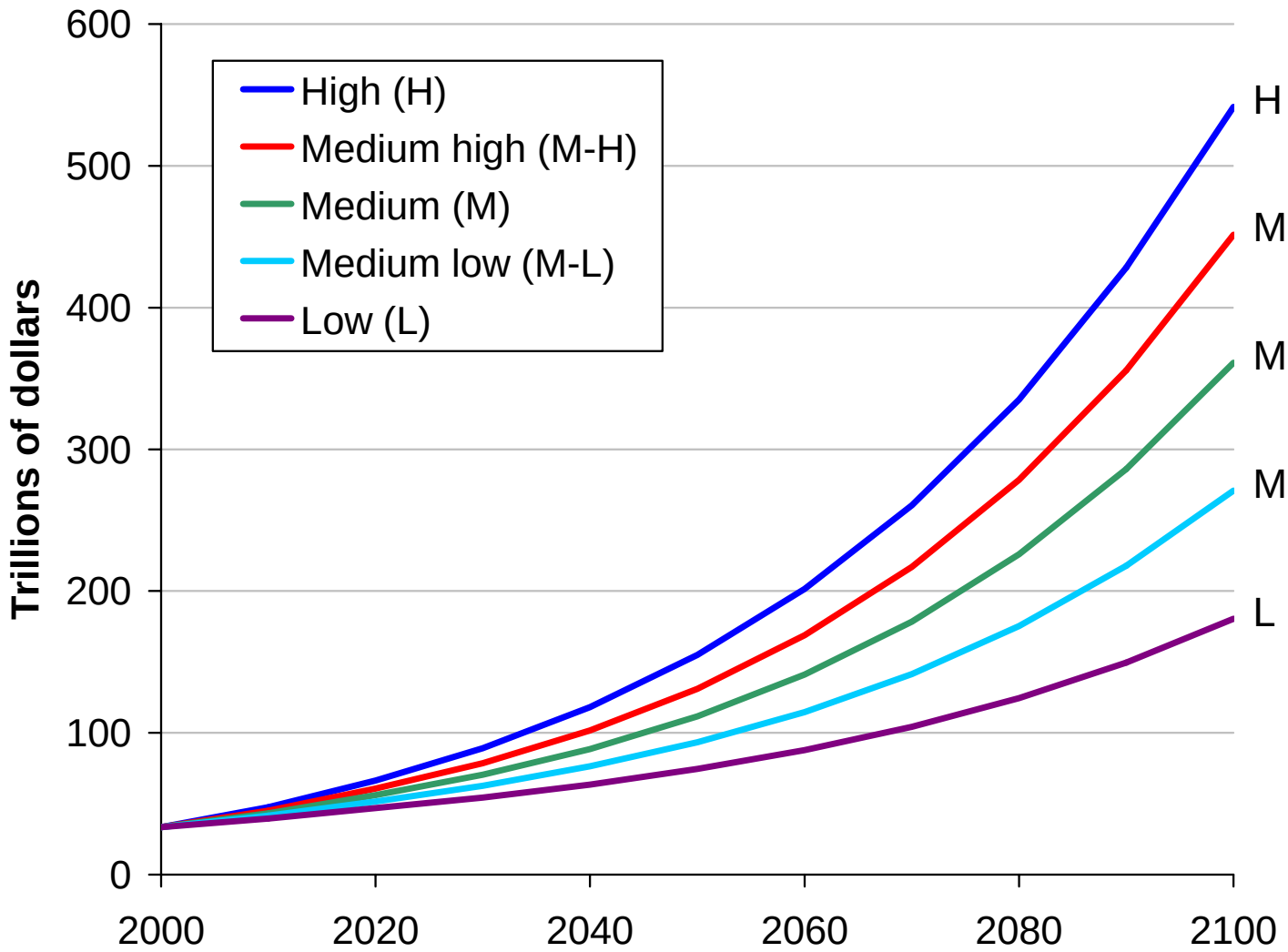
Three Uncertainties

- Income growth
- Climate sensitivity
- Temperature lag

Potential Gross World Product



	Annual Rate of Growth (%/year)	Probability
H	2.8	5%
M-H	2.6	20%
M	2.4	50%
M-L	2.1	20%
L	1.7	5%

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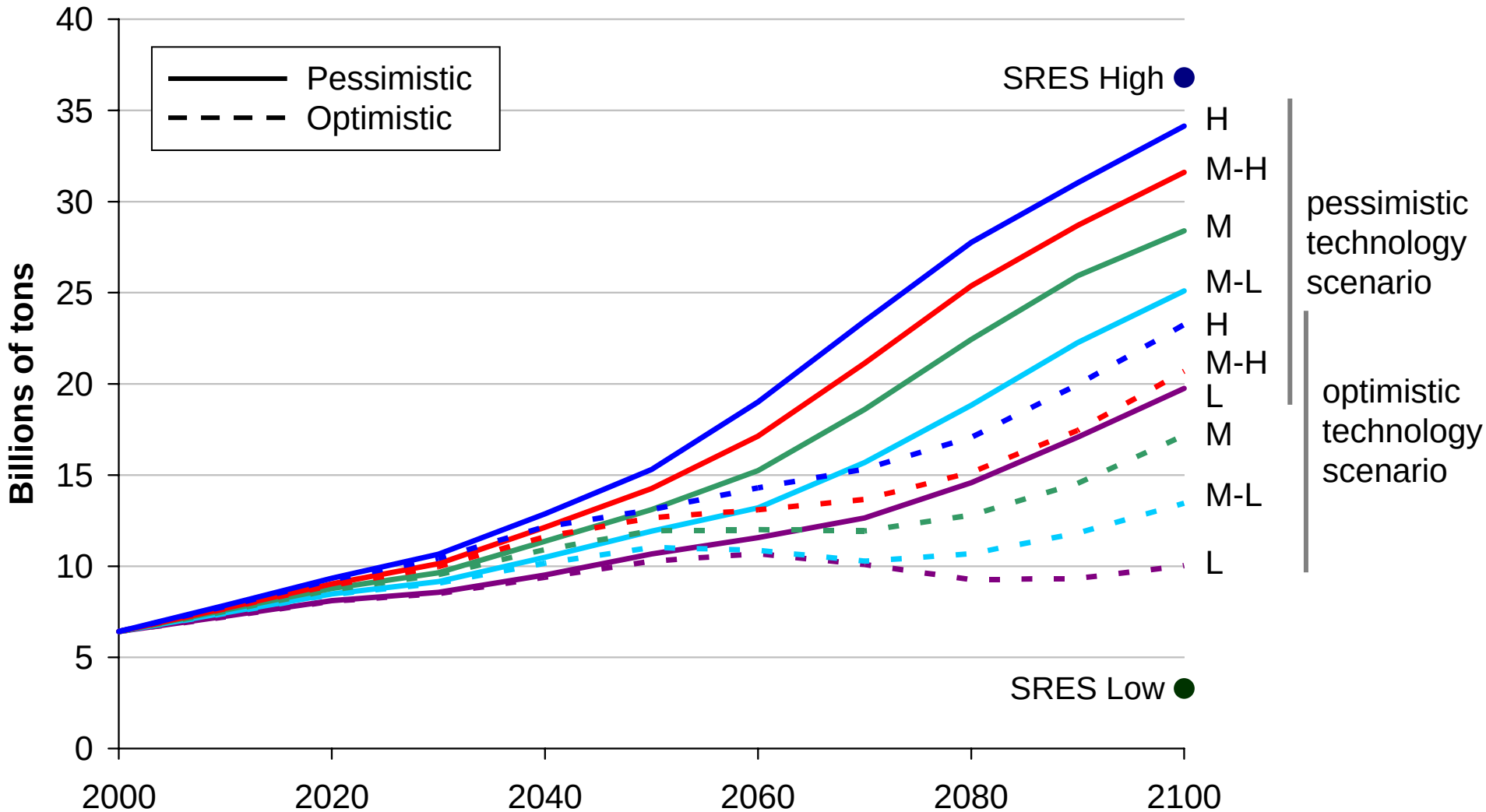
Carbon Emissions Baseline



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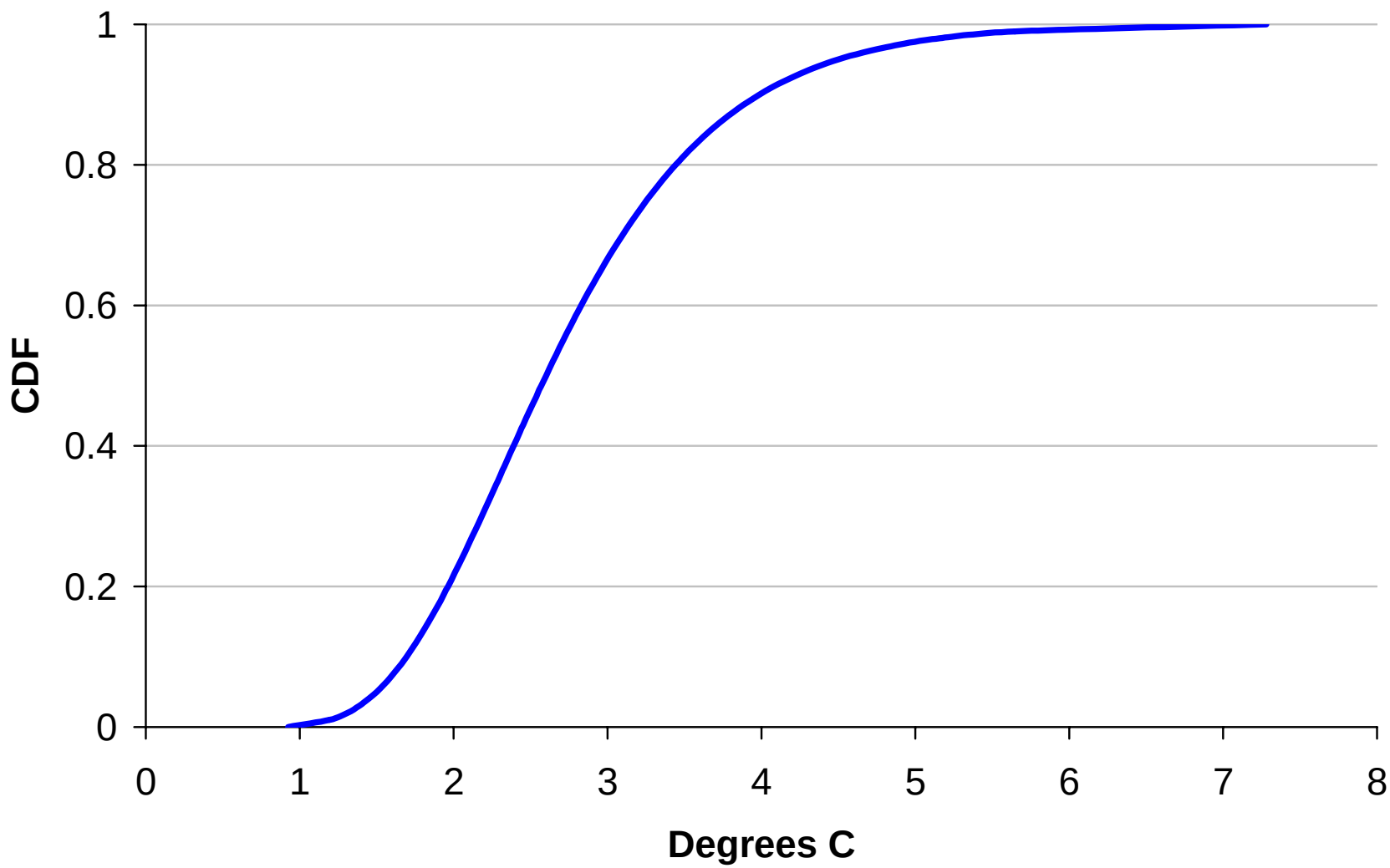
Climate Sensitivity



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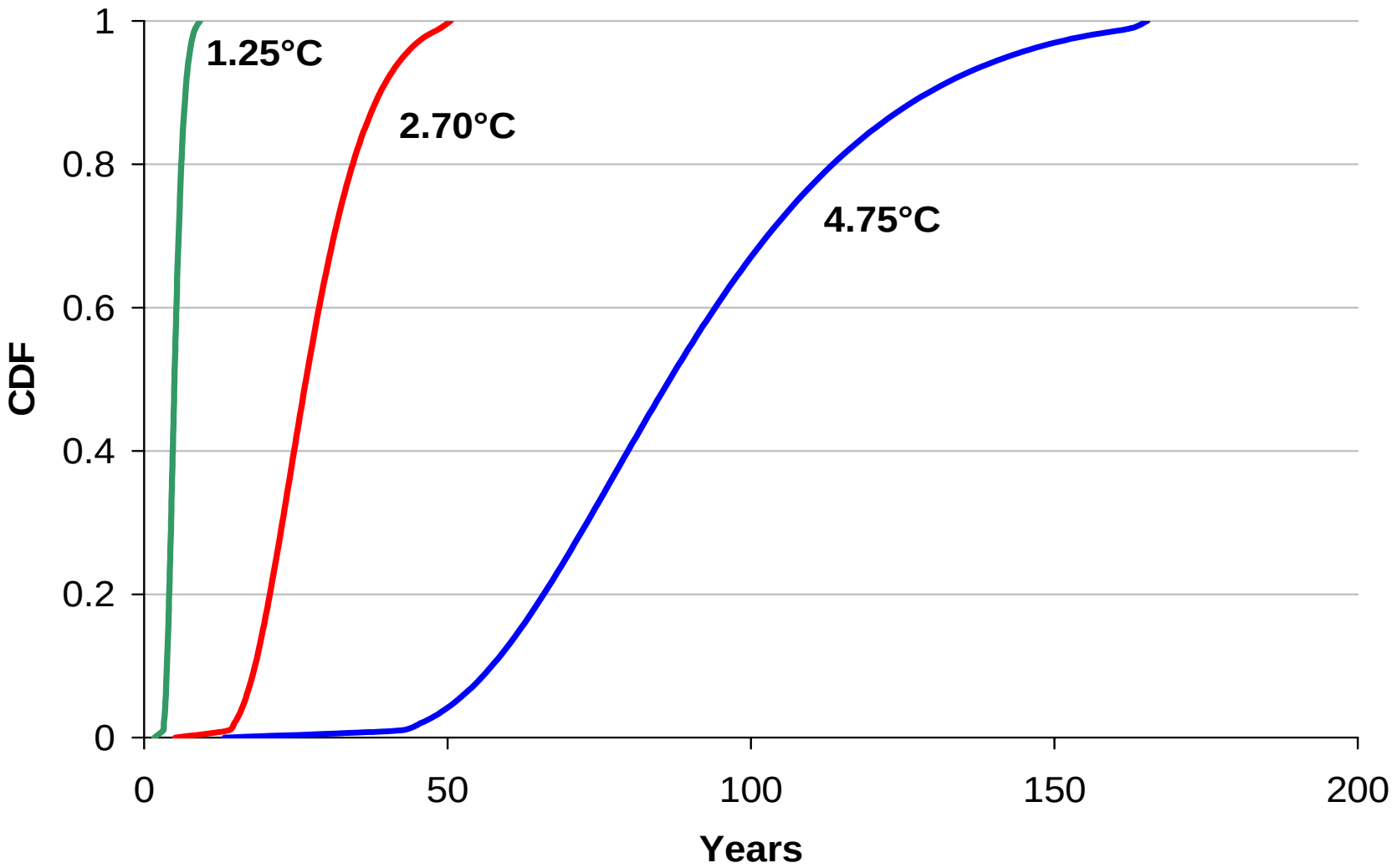
Response Time for Alternative Climate Sensitivities



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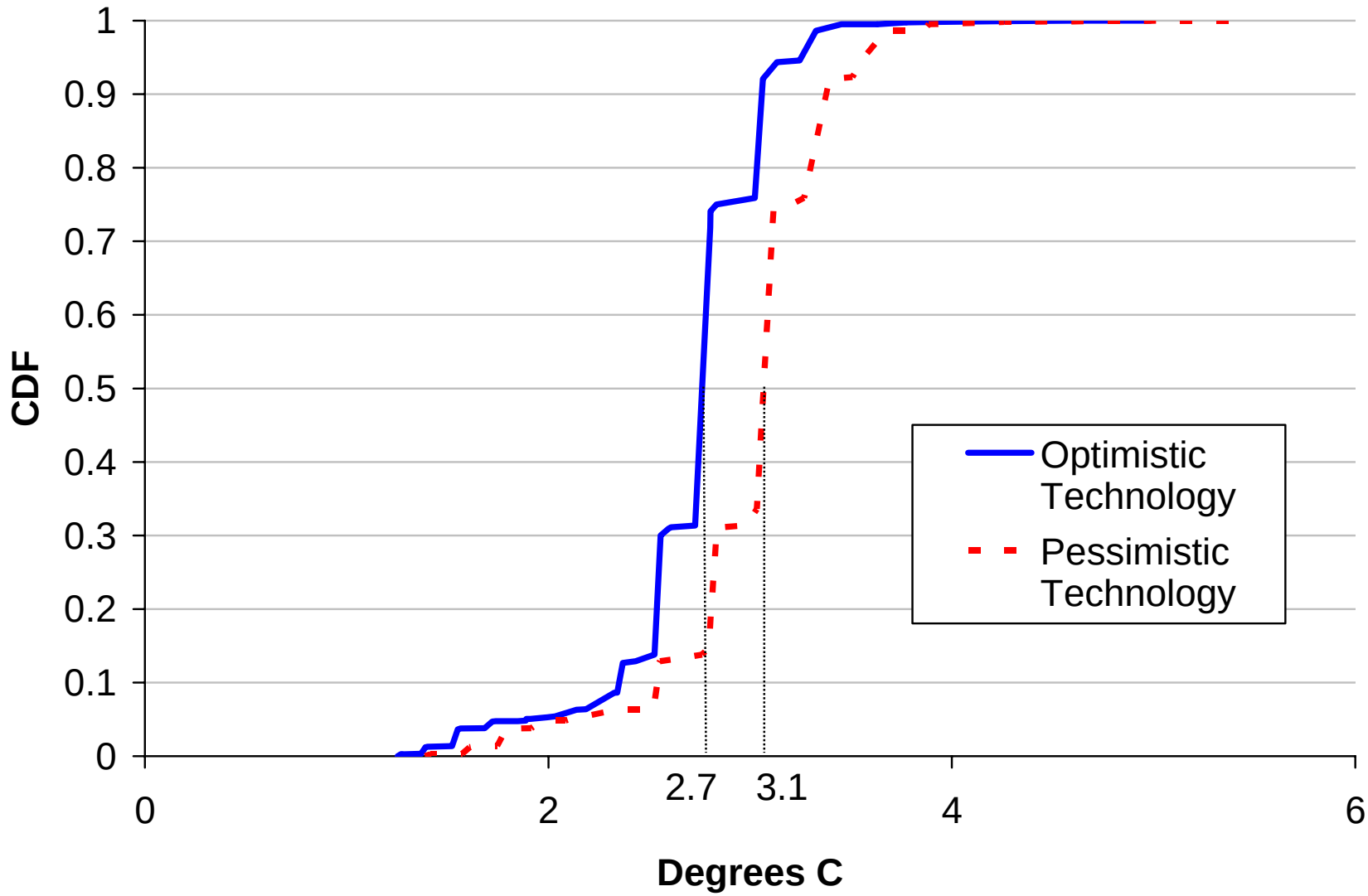
Temperature Increase During 21st Century In the Absence of Mitigation Policy



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Percentage Reduction from the CO2 Emissions Baseline (percent/year) for a 2 ° C Cap on Temperature Change

	Pessimistic Technology Scenario			Optimistic Technology Scenario		
	5th percentile	50th percentile	95th percentile	5th percentile	50th percentile	95th percentile
2010	0	5	20	0	3	19
2020	1	9	37	0	7	40
2030	1	19	53	0	19	60

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Price of Carbon ($/ton) with a 2 ° C Cap on Temperature Change

	Pessimistic Technology Scenario			Optimistic Technology Scenario		
	5th percentile	50th percentile	95th percentile	5th percentile	50th percentile	95th percentile
2010	2	36	212	0	22	176
2020	4	62	355	0	37	255
2030	6	106	637	0	64	409

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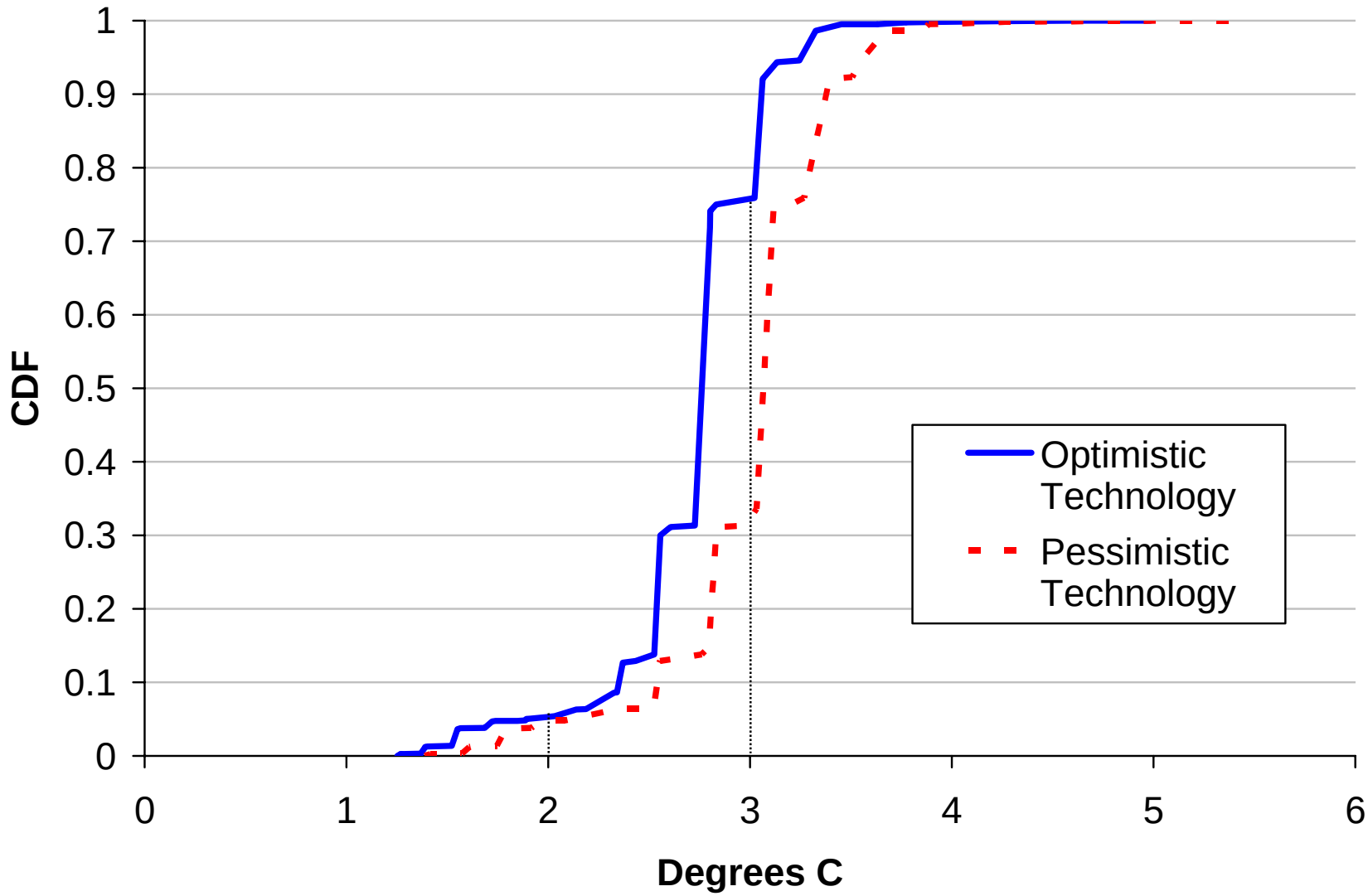

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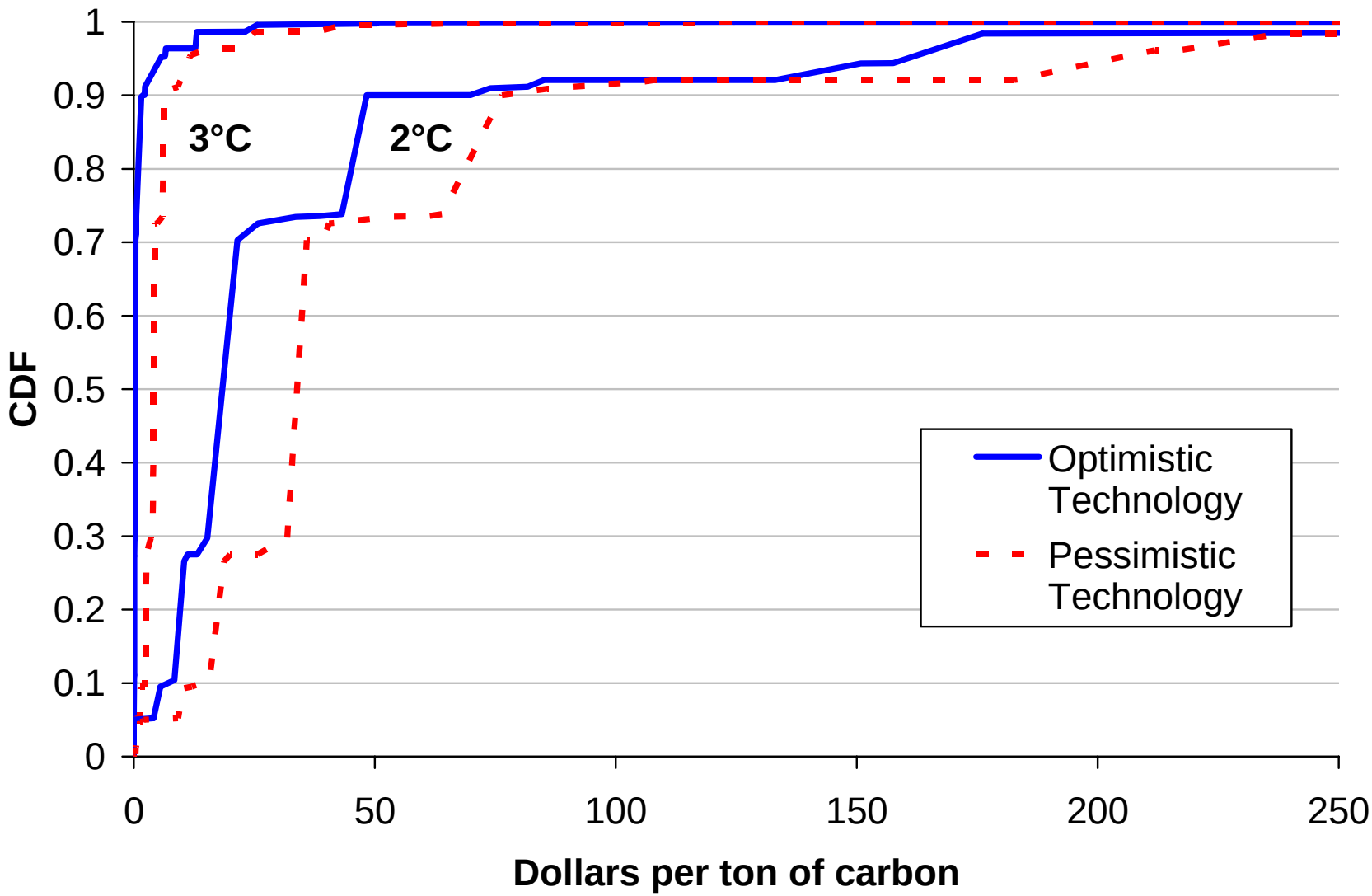
Carbon Price in 2010 with 2 ° and 3 ° C Temperature Caps



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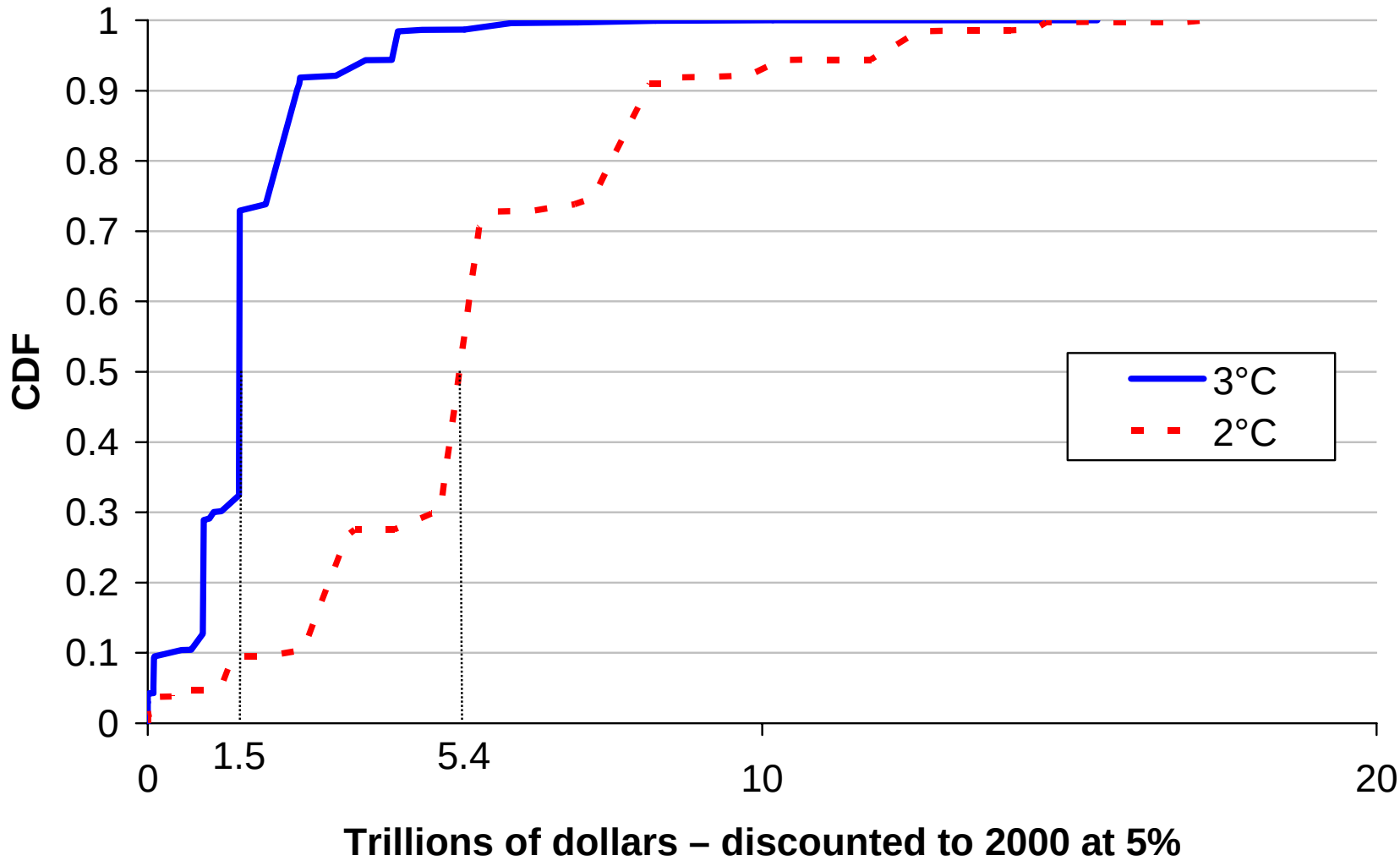
Difference in Consumption Losses (in $ trillions) for Two Technology Scenarios Under a 2 ° C Temperature Cap – discounted to 2000 at 5%

	5th percentile	50th percentile	95th percentile
Consumption losses under pessimistic scenario	1.0	8.0	30.0
Consumption losses under optimistic scenario	0.0	3.5	17.7
Difference in consumption losses	1.0	5.4	12.3

Gross Benefits Under Alternative Temperature Constraints



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Stabilization of Atmospheric CO2 Concentrations (PPMV) for Alternative Temperature Caps

		5th percentile	50th percentile	95th percentile
2°C	Pessimistic	417	472	743
	Optimistic	414	445	503
3°C	Pessimistic	535	574	669
	Optimistic	523	580	592

Causal Chain Between Human Activity and Damages