Adapting Coal for the 21st Century

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Hudson Strategic Energy Advisors LLC

Mission: Advise clients on low-carbon energy technology, finance, and policy

Practice:

- Carbon market architecture: Int'l, US, RGGI, WCI
- Advanced fossil fuel technologies and projects
- Carbon capture and storage policy
- Carbon Investment strategy

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Why Coal?

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Energy Security: Fossil Fuels Remain Abundant

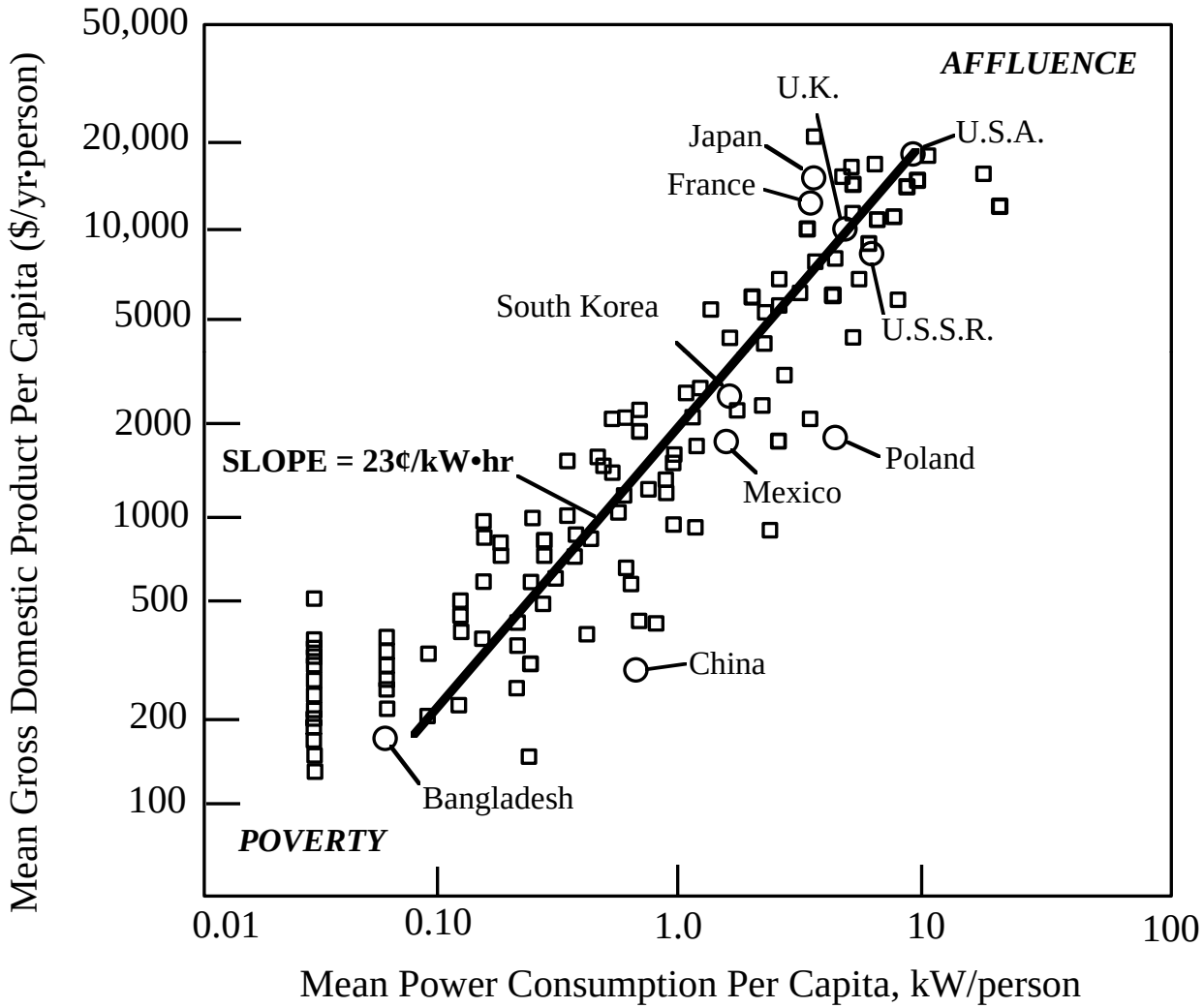
Table 9 Aggregation of global fossil energy sources—all occurrences, in Gtoe[a]

	Consumption					
	1860–1994	1994	Reserves	Resources[b]	Resource base[c]	Additional occurrences
Oil						
Conventional	103	3.21	150	145	295	
Unconventional	6	0.16	183	336	519	1,824
Natural gas						
Conventional[d]	48	1.87	141	279	420	
Unconventional	—	—	192	258	450	387
Clathrates	—	—	—	—	—	18,759
Coal	134	2.16	1,003	2,397	⇨ 3,400	2,846
Total fossil occurrences	291	7.40	1,669	3,415	⇨ 5,084	23,815

[a]Sources: Historial consumption (46). Reserves, resources, and occurrences, see Tables 2–8.
— = negligible volumes.
[b]Reserves to be discovered or resources developed to resources.
[c]Resource base is the sum of reserves and resources.
[d]Includes natural gas liquids.

H. Rogner, 1997

Economic development requires energy



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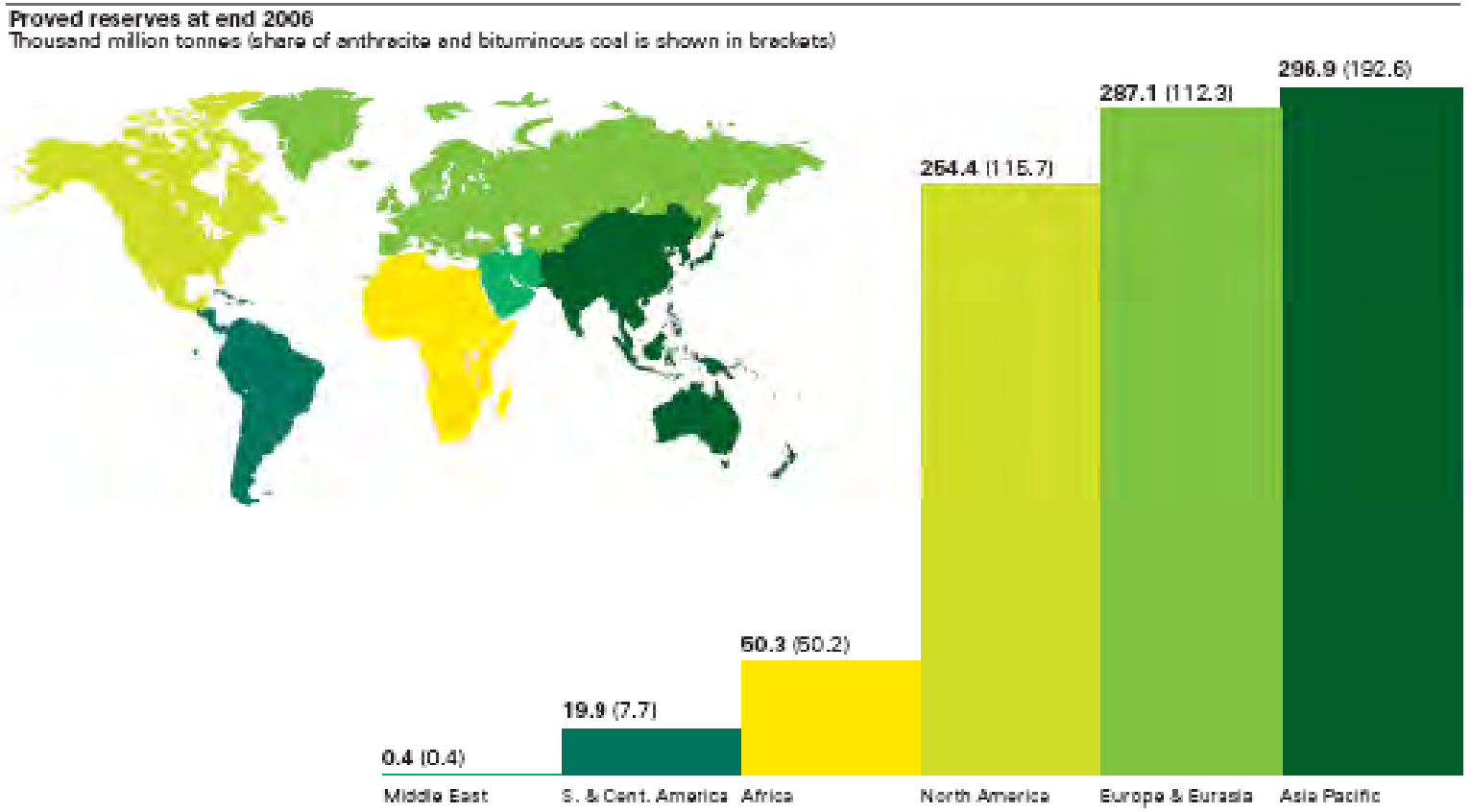
Coal can power industrializing Asia, Europe, and North America



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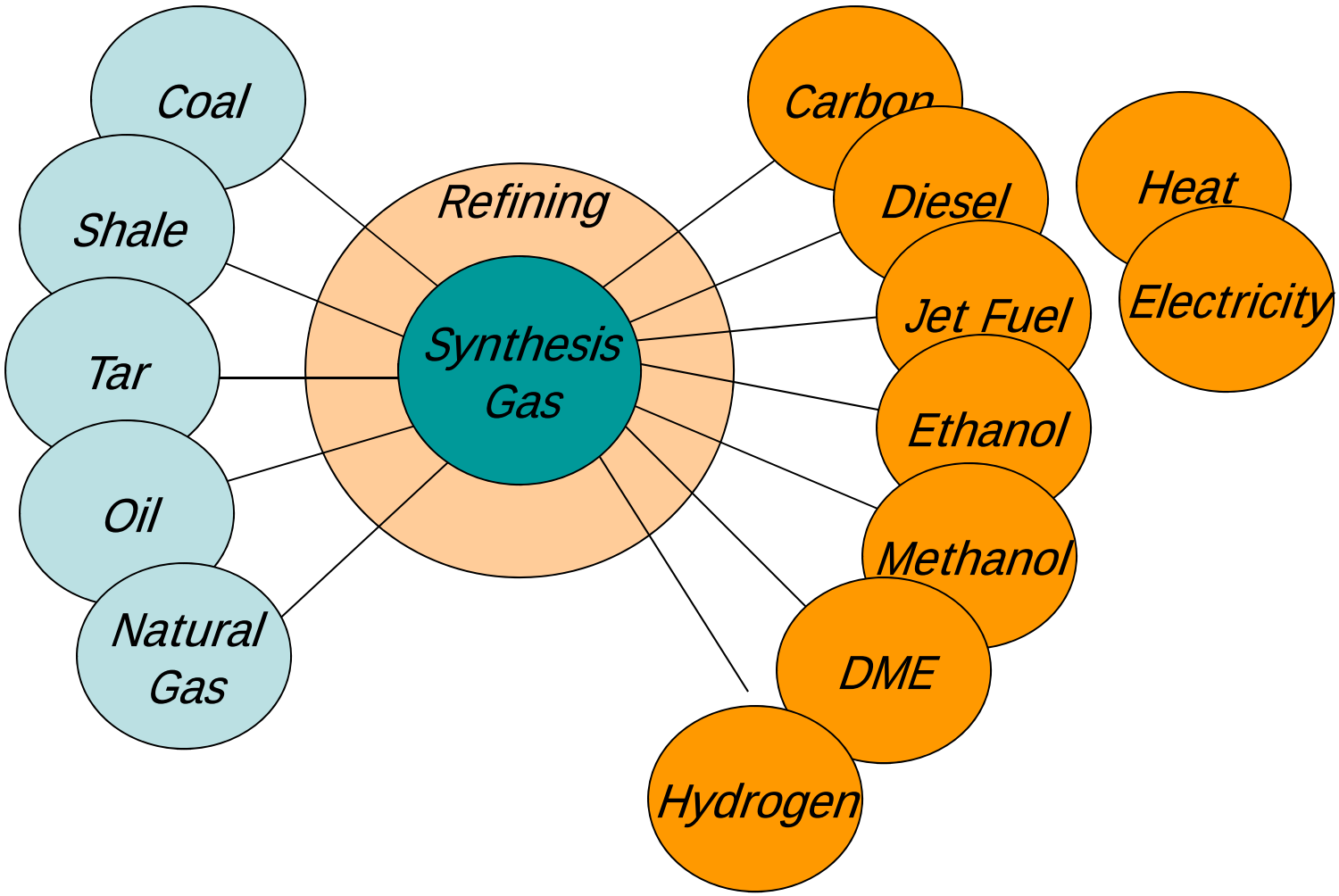
Fossil fuels are fungible



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The Climate challenge to coal

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U.S. Milestones Toward Carbon Constraints

- U.S. Supreme Court certifies CO2 as a "pollutant" under Clean Air Act.

- RGGI states adopt rules to auction permits for 2008

- CA imposes 1,100 lbs/KWh performance standard

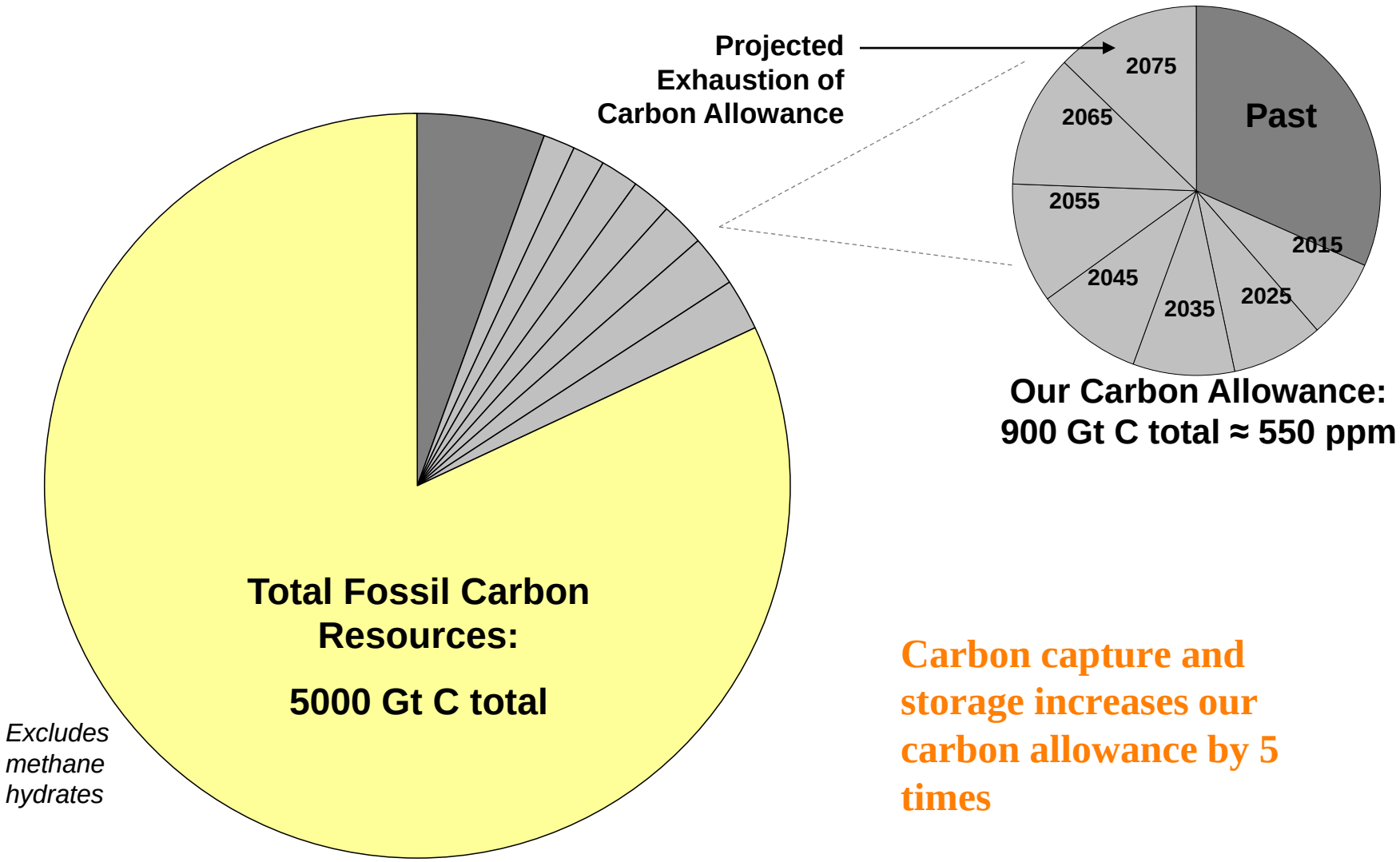
- Lieberman-Warner outlines proposed US climate policy

- NARUC issues suggested guidelines for US CO2 cap and trade

- Federal Ninth Circuit rejects U.S. emissions rules for light trucks as "insufficiently measuring the expected costs of carbon dioxide emissions"

- multiple coal power plants cancelled

550ppm of CO2 Imposes a Carbon Allowance



Carbon capture and storage increases our carbon allowance by 5 times

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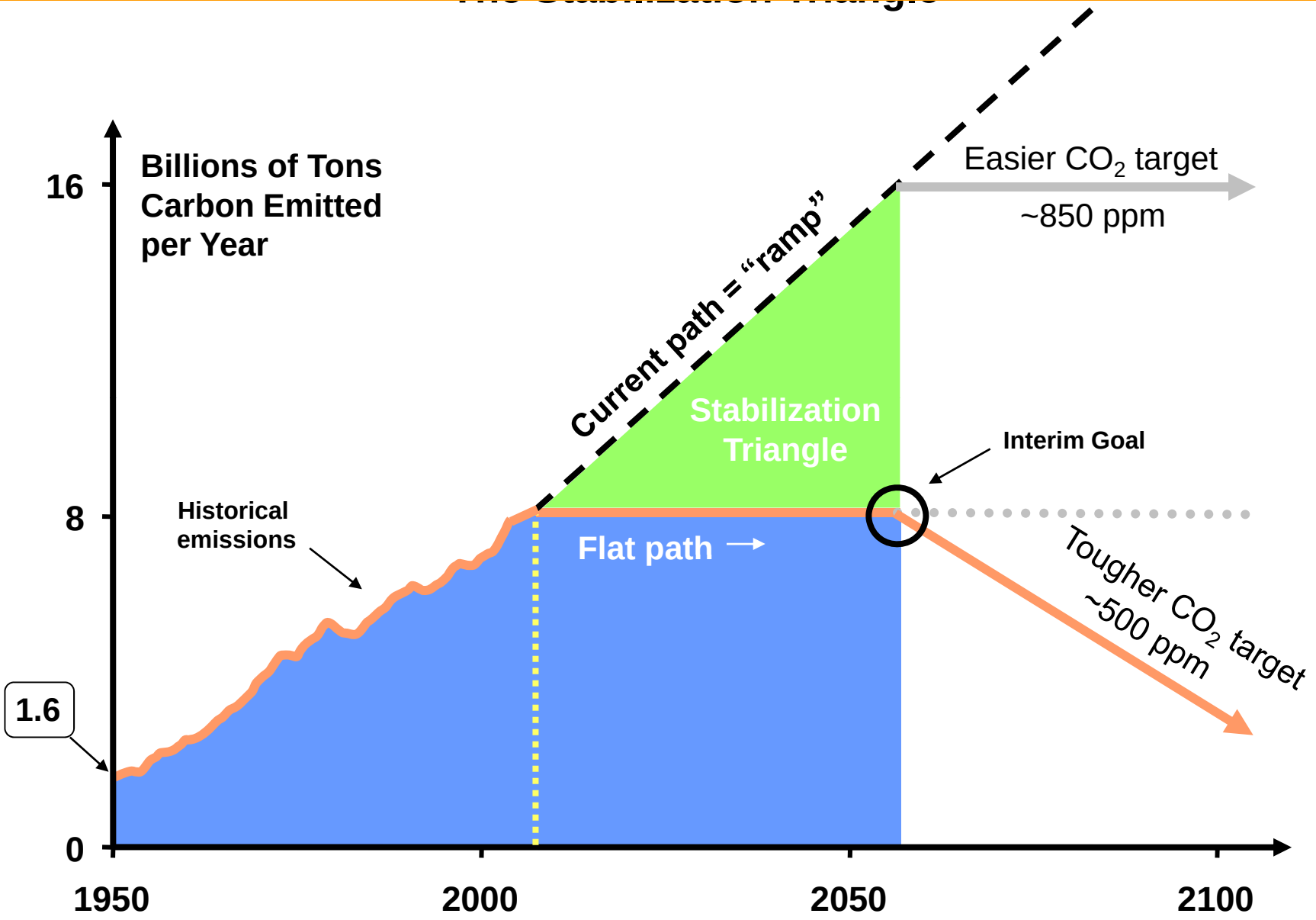
The Stabilization Triangle



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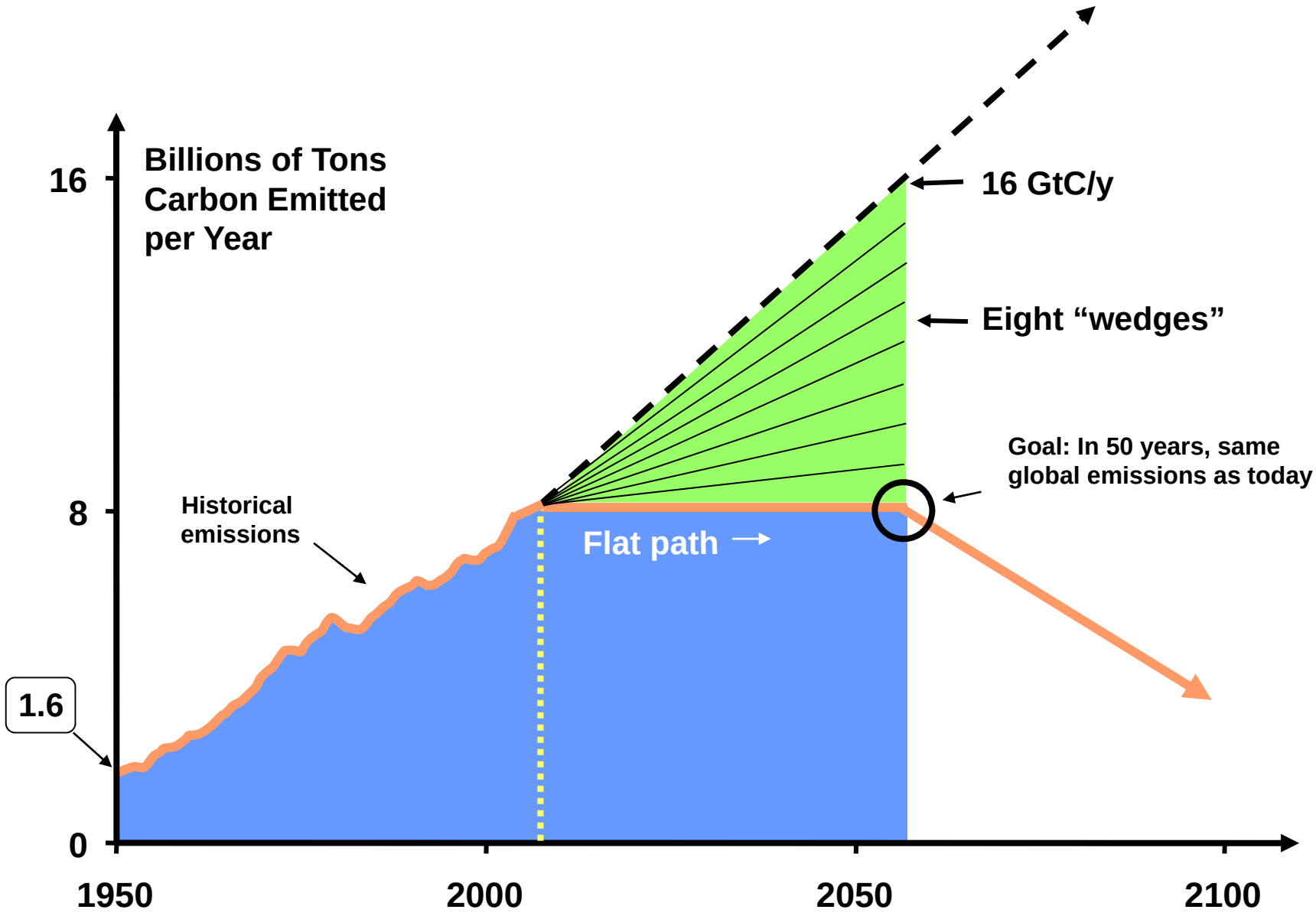
Stabilization Wedges



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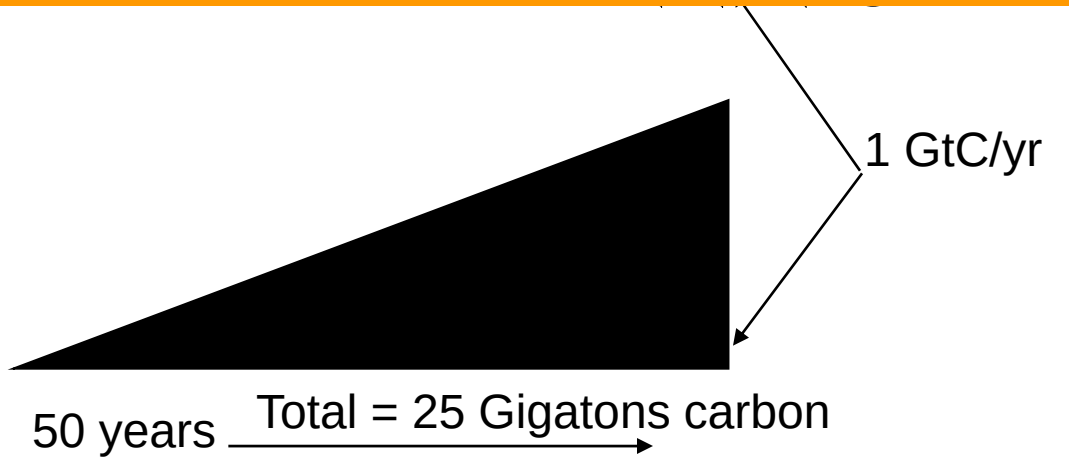
The Energy "Wedge"



A "wedge" is a strategy to reduce carbon emissions that grows over 50 years from zero to 1.0 GtC/yr.

- Triple the world's nuclear electricity capacity by 2055

- Double current natural gas supply by 2055

- Implement CCS at 800 GW coal electric or 1600 GW natural gas electric plants

- Replace all the world's incandescent bulbs with CFL's (1/4 of one wedge)

- Increase current wind capacity by 30 times

- Increase current solar capacity by 700 times

- With current practices, plant all India with biofuels

Carbon capture and storage

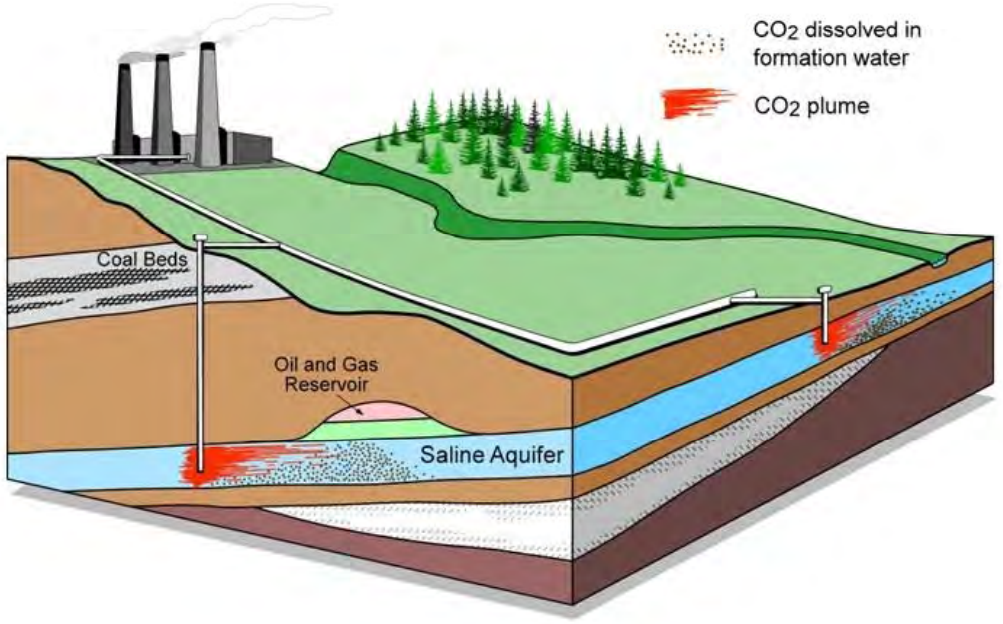
"Carbon capture and storage is the critical enabling technology for continued coal use."

- MIT "The Future of Coal"

MAGNITUDE OF CARBON CAPTURE AND STORAGE

Implement CCS at

- **800 GW coal electric plants or**
- **1600 GW natural gas electric plants**



U.S. SPENDS $500 BILLION ON RETAIL ELECTRICITY

Graphic courtesy of Alberta Geological Survey

THERE ARE CURRENTLY THREE STORAGE PROJECTS THAT EACH INJECT 1 MILLION TONS OF CO_2 PER YEAR – BY 2055 NEED 3500.

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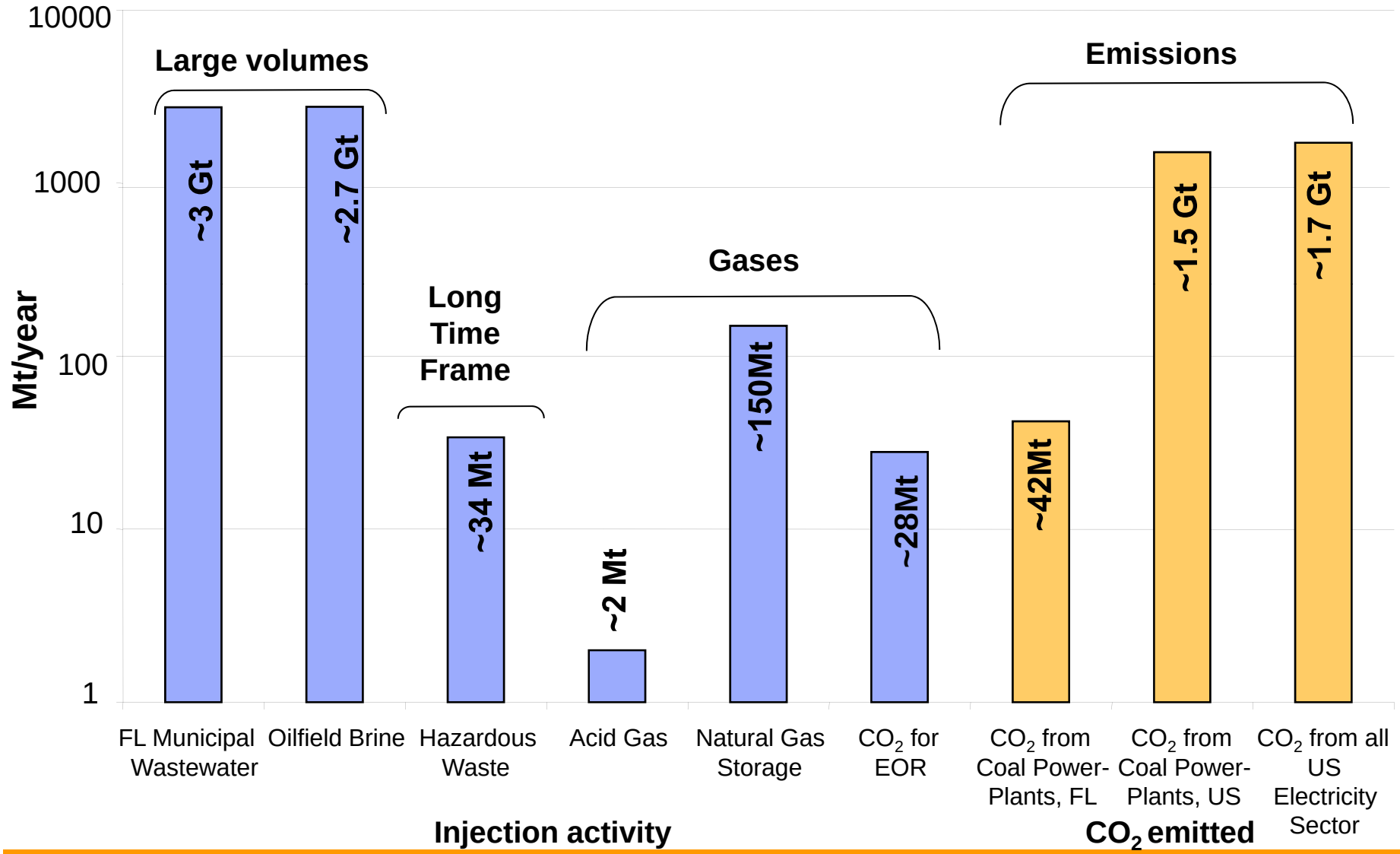
U.S. Injection activity Versus CO2 emissions



Sources: Wilson, Johnson, and Keith, 2003

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Coal's New Platform

- Long-term commitment to deployment of CCS with significant research spending and persuasive pathway
- CCS regulatory framework by 2009: jurisdiction, property rights, liability, (IOGCC)
- Regional carbon storage infrastructure partnerships to promote project deployment: geologic storage, post-combustion, pre-combustion
- Near-term commitment to high-efficiency plants
- Engagement with carbon policy: Support for cap and trade

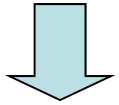
Energy Security and Environment: The Connection

Politics Imposes Need for Low-carbon Technologies

- Efficiency
- Biofuels
- Gasification
- Carbon Capture and Storage

Opportunities for Advanced Coal Applications

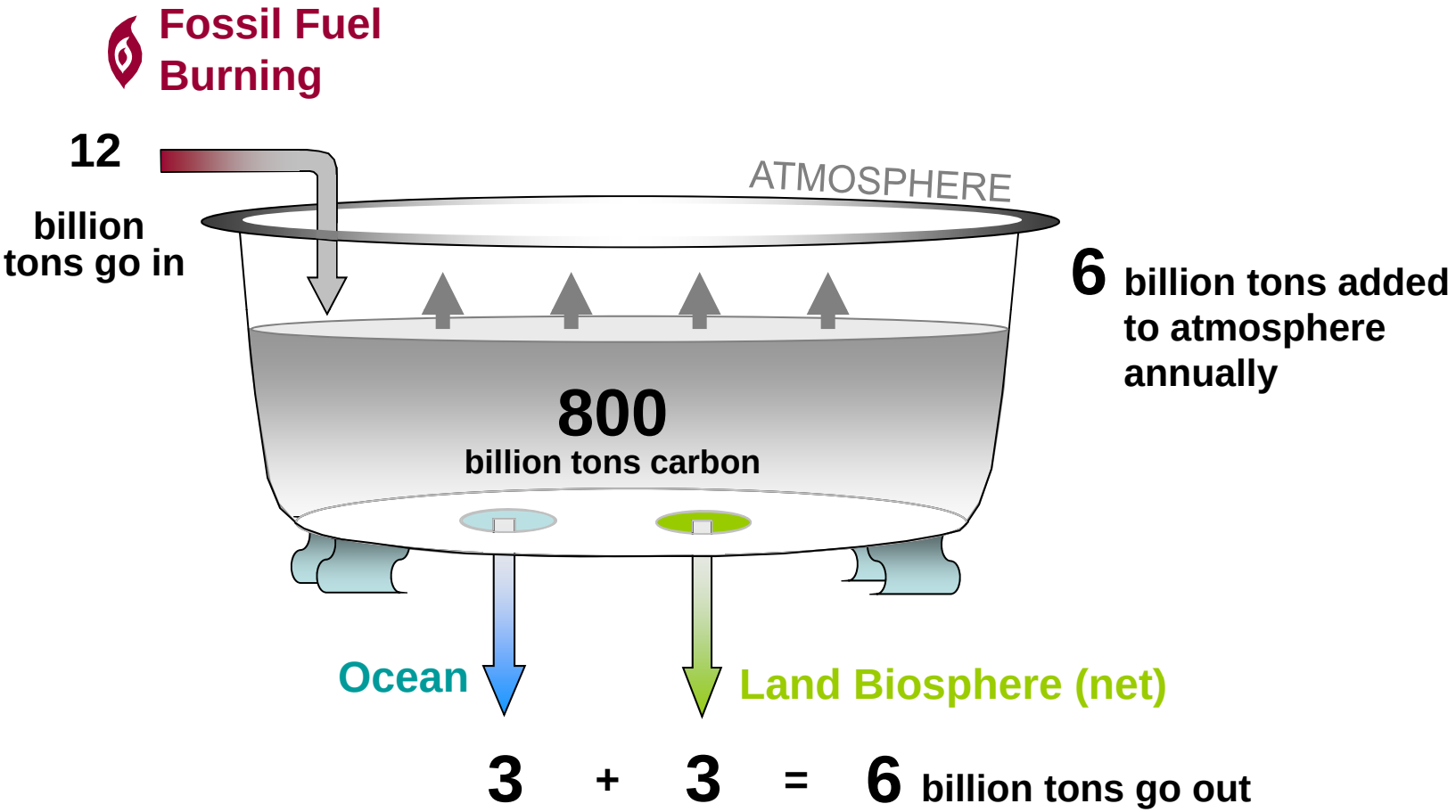
- Coal to Liquids
- Biomass Co-Firing
- Zero-Emission Coal Power Plants



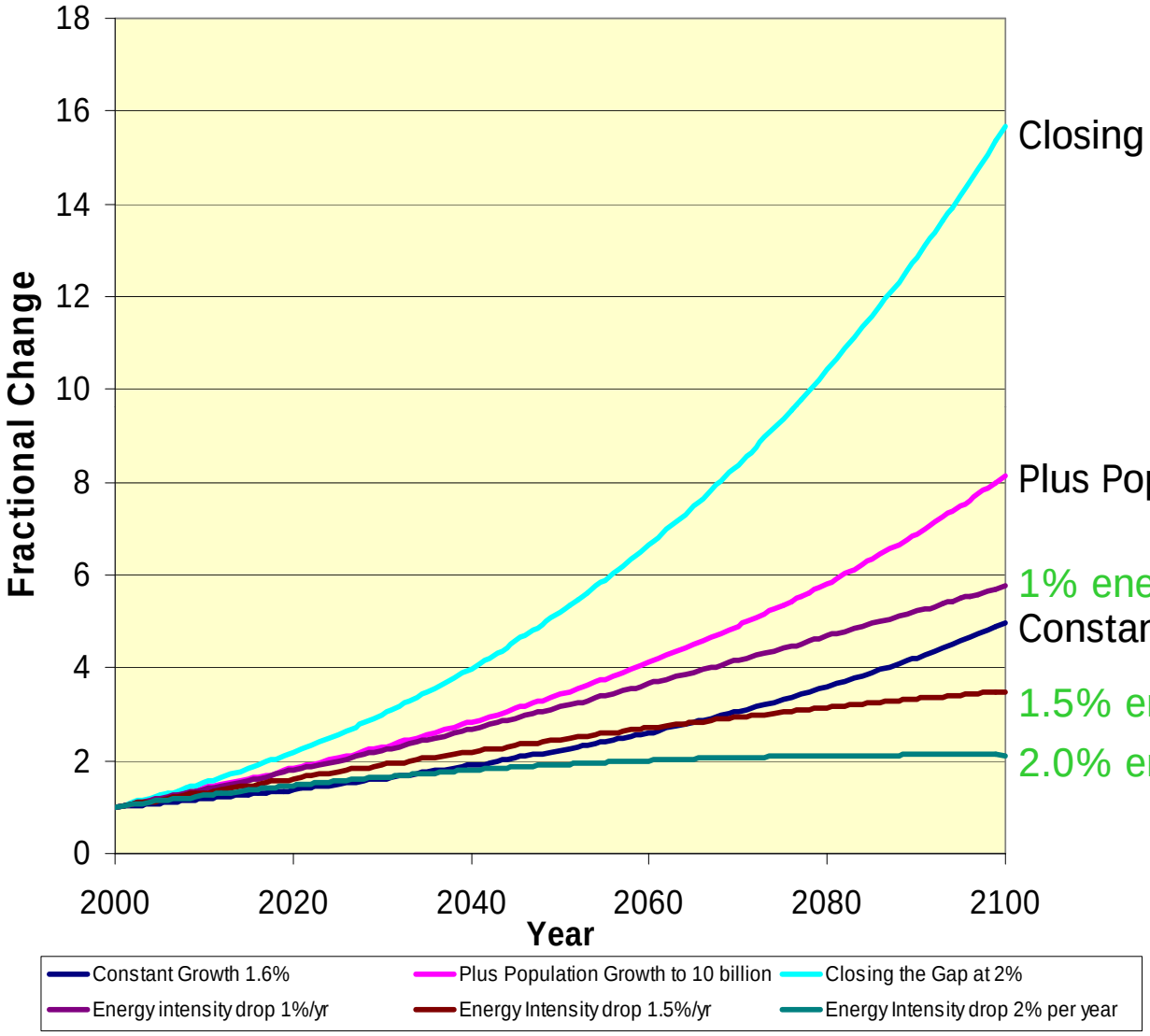
Lower Emissions and Reduced Oil Consumption

Supplemental slides

Global Emissions Arithmetic 101



Potential Global Emissions increases



Closing the Gap

Plus Population Growth

1% energy intensity reduction

Constant growth

1.5% energy intensity reduction

2.0% energy intensity reduction

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Gasoline and CTL Under Carbon Constraints

Gasoline (b/d)	CO2 Cost/Ton	CO2 Emissions	Total CO2 Cost	CO2 Cost/Bbl
100,000	$12	27,000	$324,000	$3.24
100,000	$24	27,000	$648,000	$6.48

CTL (b/d)	CO2 Cost/Ton	CO2 Emissions	Total CO2 Cost	CO2 Cost/Bbl
100,000	$12	50,000	600,000	$6
100,000	$24	50,000	1,200,000	$12

PROPOSED BILLS WITH CAP AND TRADE SYSTEMS FOR GHG

Title and Sponsors	Reduction Target and Timeframe	Significant Aspects
Climate Stewardship and Innovation Act (S. 280) Lieberman (CT) and McCain (AZ)	Brings emissions to 2004 levels by 2012, to 1990 levels by 2020, to 22% below 1990 levels by 2030, and to 60% below 1990 levels by 2050.	Caps electric power, industrial, commercial, and transport sectors (economy wide). Includes provision for clean development mechanism by which US companies gain credit for emissions reductions they sponsor in developing countries. Provisions for expansion of nuclear power.
Global Warming Pollution Reduction Act (S.309) Sanders (VT) and Leahy (VT)	Stabilize global greenhouse gas concentrations below 450ppm; US reductions to 1990 levels by 2020 and 80% below that by 2050.	Economy wide caps. National renewable energy quotas and energy efficiency goals with credit trading programs.
Electric Utility Cap and Trade Act (S. 317) Feinstein (CA) and Carper (DE)	Caps current emissions through 2011, then at 2001 levels by 2012, thereafter cap lowers further 1% each year through 2020 subject to EPA review.	Power sector only. Specifies auctioning of credits (not allocation) and use of offsets. Establishes independent scientific panel to make recommendations to the EPA every 4 years on the reduction rate required.

Climate Stewardship Act (H.R. 620) Olver (MA) and Gilchrest (MD)	Emissions stabilize at current levels from 2012 to 2019, then are reduced 15% by 2020, 38% by 2030, 75% by 2050 (which equals 70% below 1990 levels).	Same as Lieberman/McCain except that offset credits may account for only 15% of emissions reductions and "early action" credits limited to 20% of cap. Does not contain Senate version's nuclear provisions.
Global Warming Reduction Act (S.485) Kerry (MA) and Snowe (ME)	Reduce emissions to 60% 1990 levels by 2050, through increasing annual reductions starting at 1.5% a year for the first 10 years.	Economy wide caps. National renewable energy quota of 20% by 2020. National renewable transport fuels standard.
Safe Climate Act (H.R. 1590) Waxman (CA)	Emissions freeze at 2009 levels in 2010. Beginning in 2011, emissions cut 2% per year, falling to 1990 levels by 2020. Beginning in 2021, annual emissions cuts of 5% per year falling to 80% below 1990 levels by 2050.	National renewable energy quota of 20% by 2020. Energy efficiency targets increase from 0.25% of electricity sales in 2010 to 1% of sales in 2012 and each year thereafter through 2020.
Clean Air Planning Act (S. 1177) Carper (DE)	Caps power plant emissions at today's levels in 2012, at 2001 levels in 2015. Thereafter, annual reductions to achieve 25% below 1990 levels by 2050.	Power sector only, offsets allowed, output based allocation system (not auctions), includes a new entrant reserve (carbon credits reserved for allocation to newly built installations).
Clean Air /Climate Change Act of 2007 (S. 1168) Alexander (TN) and Lieberman (CT)	Power plants emissions capped at 2.3 billion tons (2006 levels) in 2011, at 2.1 billion in 2015, 1.8 billion in 2020 (1990 levels), and 1.5 billion in 2025 and beyond (17% below 1990 levels).	Power sector only, allows offsets, includes new entrant reserve of no more than 5% of the year's allowances, includes emissions performance standard for plants built after 2015 (no more than 1100 lbs co2/mwh).

Clean Power Act (S. 1201) Sanders (VT)	Same as S. 1168 for CO2 and specifies that if no greenhouse gas bill has been passed by 2012 then emissions from power plants must be decreased by 3% each year.	Power sector only. CO2 performance standard for new plants, renewable energy quota of 20% by 2020. Energy efficiency targets with credit trading system to achieve gradual reduction of peak demand and overall electricity use.
Low Carbon Economy Act Bingaman (NM) and Specter (PA)	Reduction of greenhouse gases to 2006 levels by 2020 and to 1990 levels by 2030.	Limits cost of allowances to $12/ton CO2e in 2012, rising by 5% above inflation each year after that. Allowance allocation through 2017: 53% free, 24% auctioned, rest reserved for certain sectors and projects. Tariffs on goods from high emitting countries
America's Climate and Energy Security Act (S. 2191) Lieberman (CT and Warner (VA).	Cut US GHG emissions to 1990 levels by 2020, 65% below 1990 by 2050.	"Carbon market Efficiency Board" overseas market of allowances to prevent volatility, tariffs on goods from high emitting countries, allowance allocation: 51% auctioned in 2012 increasing to 100% in 2036. 20% of auction proceeds reserved for low-income consumers.