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The Role of Technology Development in Accelerating U.S. Mercury and Carbon Dioxide Emission Reductions

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- **Non-profit environmental think tank founded in 1985 by state governors to find a market-based solution to acid rain**
- **Applying similar approaches to ozone, greenhouse gases, and air toxics at state, regional, national, international levels**
- **Leader in OTAG process, EU GHG trading system design, and international climate change negotiations**
- **Sponsor power sector and economy-wide modeling to support policy design**

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CCAP Air Quality Dialogue

- **A stakeholder policy dialogue on alternative designs of power sector three-pollutant (3P) and four-pollutant (4P) legislative programs**
- **ICF conducted an IPM modeling analysis of 3P and 4P incentive and/or cap and trade programs**
- **Stakeholders agreed on model assumptions and options for analysis**
- **Goal was to understand possible middle-ground, second-best solutions**

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Some Caveats

- Not speaking for the environmental community
- Recommendations based on analysis conducted within multi-stakeholder Air Quality Dialogue
- Not commenting on the legality of EPA's Mercury Rule
- Technology ideas expressed in this presentation were discussed in the context of a larger policy package and may not be supported independently by some groups

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Technology Key to Industry Acceptance of Emissions Caps

- **Perceived availability of technologies with cost and performance certainty reduces resistance to new emissions caps**
- **Less resistance to NO_x, SO_2 caps at "efficient" levels of control b/c high degree of certainty on control technology performance and cost**
- **More experience w/advanced Hg and CO_2 control technologies (or low-emitting generating technologies) is expected to build confidence in, reduce costs of technology, and lower resistance to new requirements**

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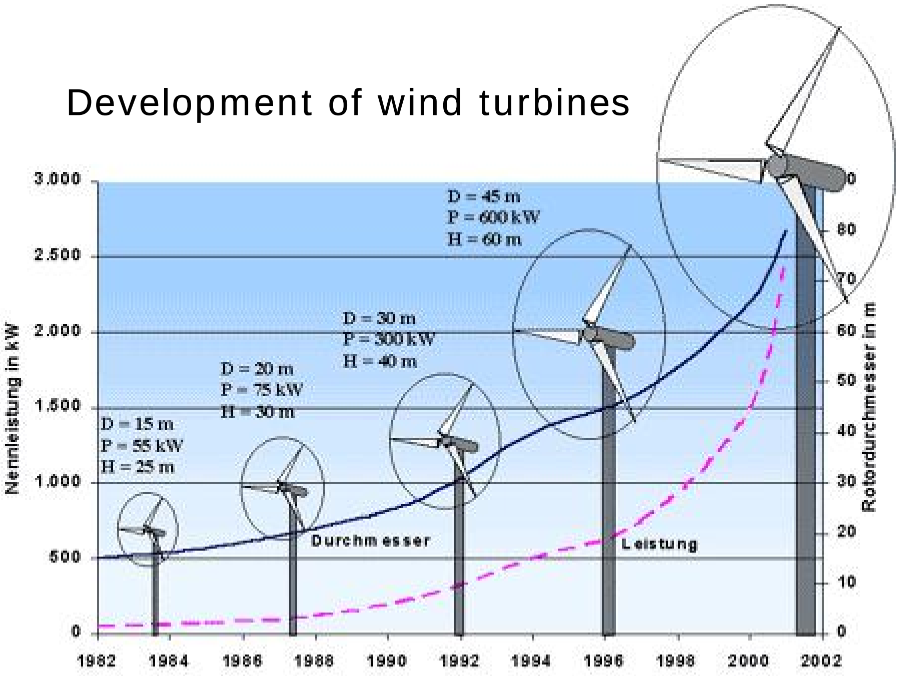
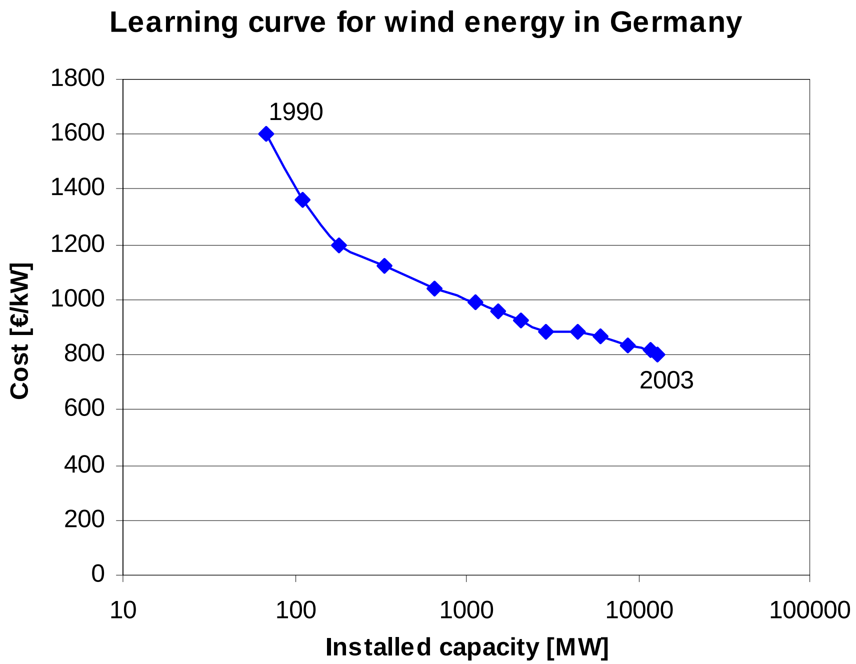
Development of wind technology





CCAP Recommendation #1

- Legislative or regulatory approaches should include a ***technology incentive pool*** to spread the risks of technology development and help build confidence in the performance and cost of advanced mercury control technologies

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"Technology Incentive Pool" for Mercury

- Dialogue evaluated "Technology Incentive Pool" to encourage early experience with advanced Hg control technology
    - » Allocates 10% of the allowances from Phase I target to early adopters of advanced Hg technologies (ACI) pre-Phase I
- Modeling shows 31 GW of ACI in 2010 w/Technology Incentive Pool in contrast to 21 GW in 2010 without the incentive pool option*
- Increase in the system costs is minimal (1%, or $400 million over 2005-2030)

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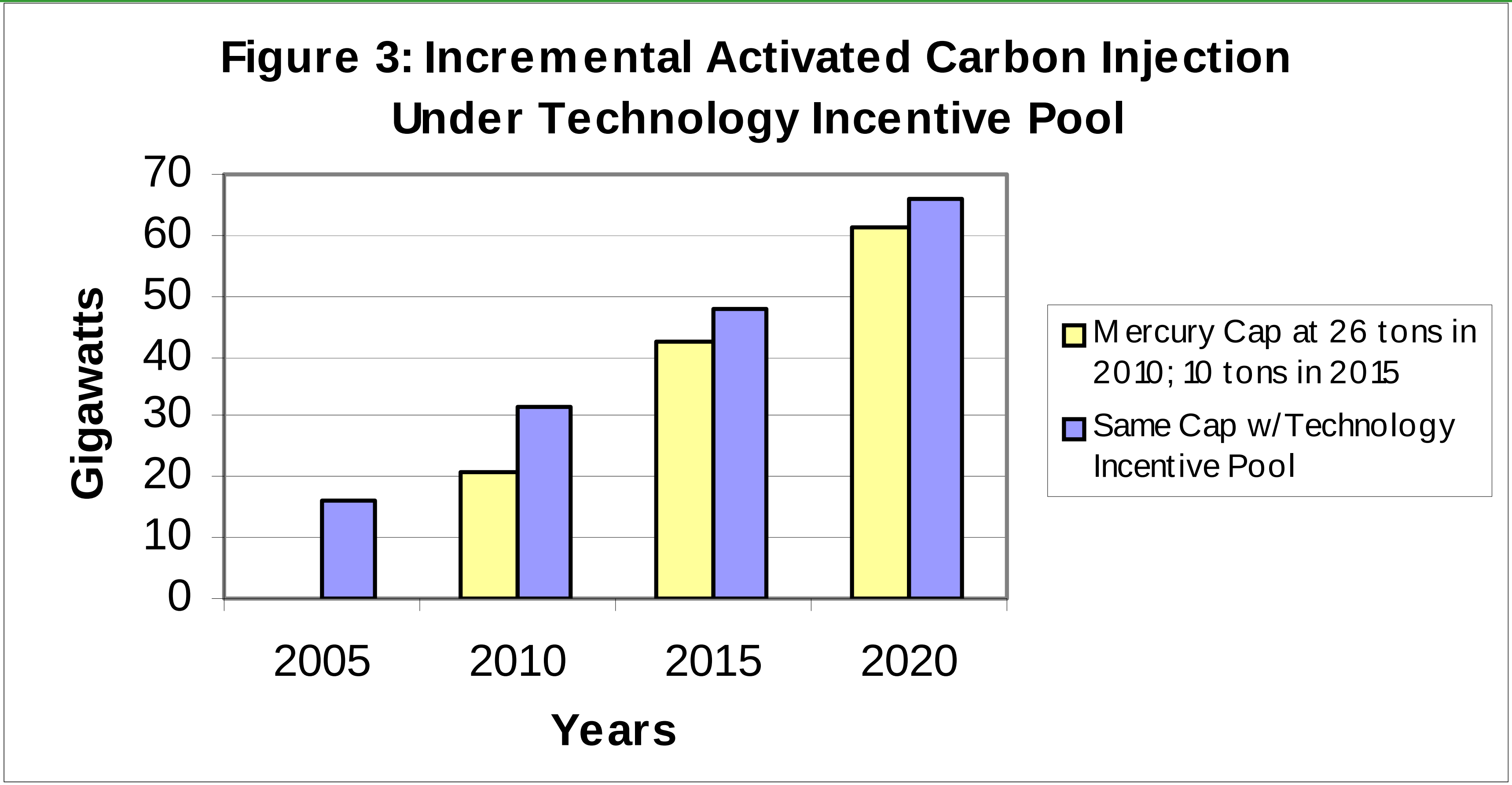
* Comparison case assumes Hg is capped at 10 tons in 2015.

"Technology Incentive Pool" Achieves Early Mercury Technology



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Design and Implementation of a Mercury "Technology Incentive Pool"

- Tons could be awarded by:
  - » reverse auction – lowest bidders win
  - » First come, first served
  - » Pro rata sharing of 2.6 ton pool
- Portion of tons could be set aside for particular plant characteristics and coals (e.g. PC burning subbituminous coals) to insure demos on all configurations
- Incentive pool could be added to multi-pollutant bill
  - Hg Early Action Reduction Credits were included in S.131, the Clear Skies Act of 2005

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Comparison of CCAP Tech Incentive Pool and Senate version

- Senate version did not set aside share of original allocation pool for techs – leakage from cap
- Allowances given to all reductions carried out early via tech – no limits, no process for selecting winners
- Senate incentive level may not have been high enough to cover cost differential – might only reward "free riders"
- Reverse auction method preferable

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Small Increases in 3P Compliance Costs Under Tougher Hg Caps

Table 2: Comparison of Three-Pollutant (3P) Scenario Costs and Cumulative Mercury-reductions

	NPV of Incremental 3P (billion 1999$)	Percent Change		Cumulative Hg Redux by 2022 (tons)	% Hg change from CSA
		From CSA	From Ref Case		
REFERENCE CASE	53.8				
CSA (26 tons in 2010; 15 tons in 2018)	60.5		12.5%	358	
Case 3 (10 t ons in 2018)	63.6	5.1%	18.2%	387	8%
Case 1 (10 tons in 2015)	66.6	10.1%	23.8%	431	20%
Case 4 (7.5 tons in 2015)	70.1	15.9%	30.3%	459	28%

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Effects of Tighter Phase 2 Hg Cap Levels & Timing

- **Costs of incrementally more stringent cap levels and timing about 5% of incremental 3P cost for each tightening evaluated**
- **Cumulative Hg benefits increase 8-12% with each incremental change evaluated**
- **Tightening the timing and size of cap has very limited impact on wholesale electricity prices (-1.5% to +2.1% depending on the scenario)**
- **If measured against mercury only costs, the percentage increases would be considerably higher**

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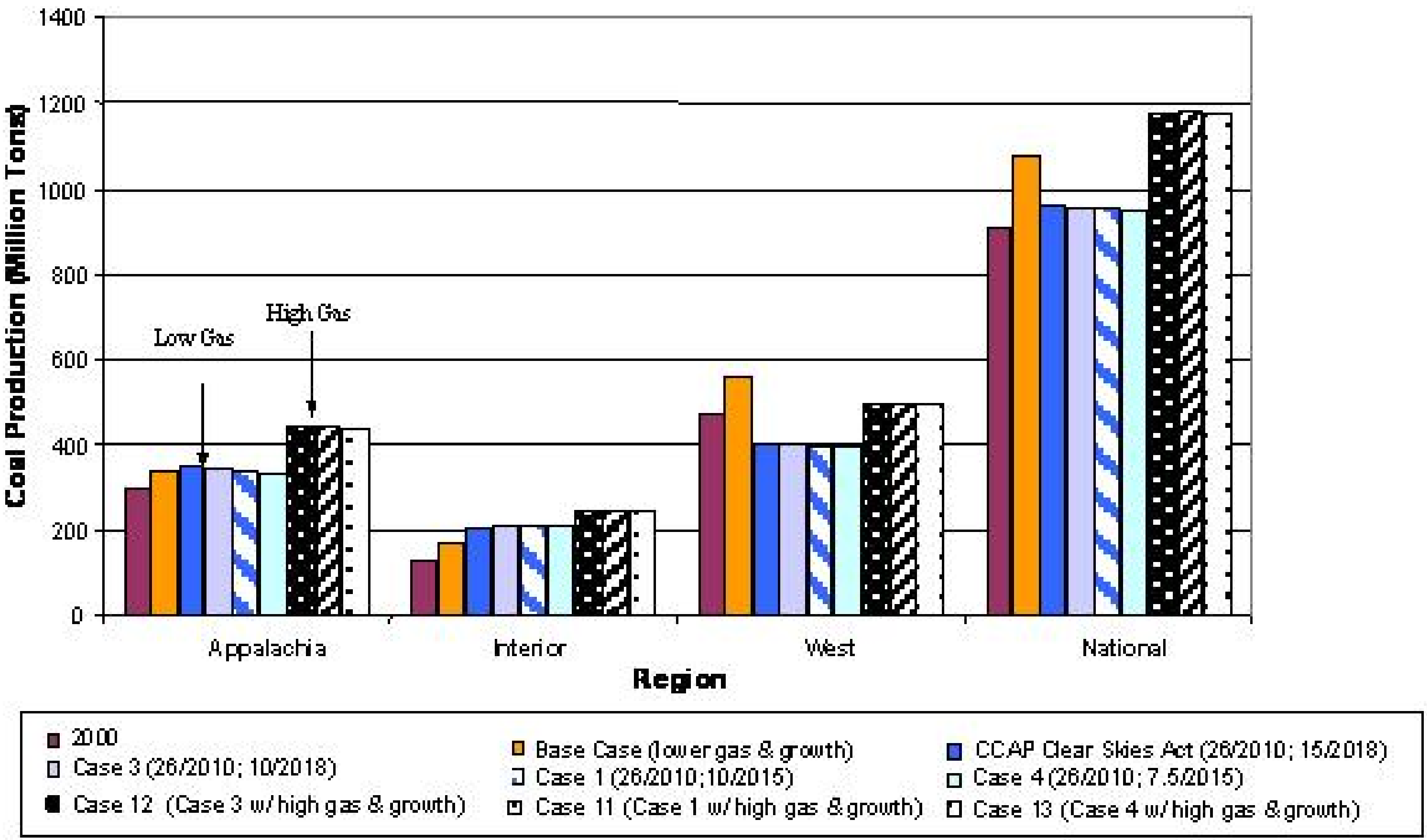
Effect on Coal Markets of Tighter Hg Caps and Timing

- **Tightening the mercury cap has marginal impacts on regional coal markets**
  - » Interior coal production rises slightly (1-3%)
  - » Appalachian and western coal production declines slightly (2-4% and within 1%, respectively)
- **National coal production is higher than 2000 levels in all cases and varies only slightly between cases**

Figure 4: Coal Production Under Different Three-Pollutant Policy Cases (Low or High Gas Prices) in 2020 Versus Coal Production in 2000



Hg/3P Conclusions

- Technology incentive pool before Phase I could encourage ACI early at low add'l cost, potentially reducing Phase 2 costs
- Significant portion of Tech pool probably needs to be targeted to subbituminous/lignite
- Costs of incrementally more stringent cap levels and timing about 5% of incremental 3P cost for each tightening

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Policy Implications of Hg/3P Modeling (CCAP View)

- Possible win-win areas on multi-pollutant design:
  - » Phase I cap w/ some portion allocated to “technology incentive pool” would encourage experience w/advanced technology, reducing current disagreements on ACI feasibility
  - » Trade off easy (e.g., 34 ton) Phase 1 cap for tougher and earlier Phase 2 cap – cost of moving to a 10 ton cap in 2015 is roughly equal to the savings from moving from 26 to 34 ton phase I target, going to 7.5 ton cap adds another 6%

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CCAP Recommendation #2

- Legislative approaches should include ***incentives for IGCC with carbon capture and sequestration***, whether with or without a cap. Such incentives can help reduce carbon dioxide emissions while preserving coal-fired power generation.

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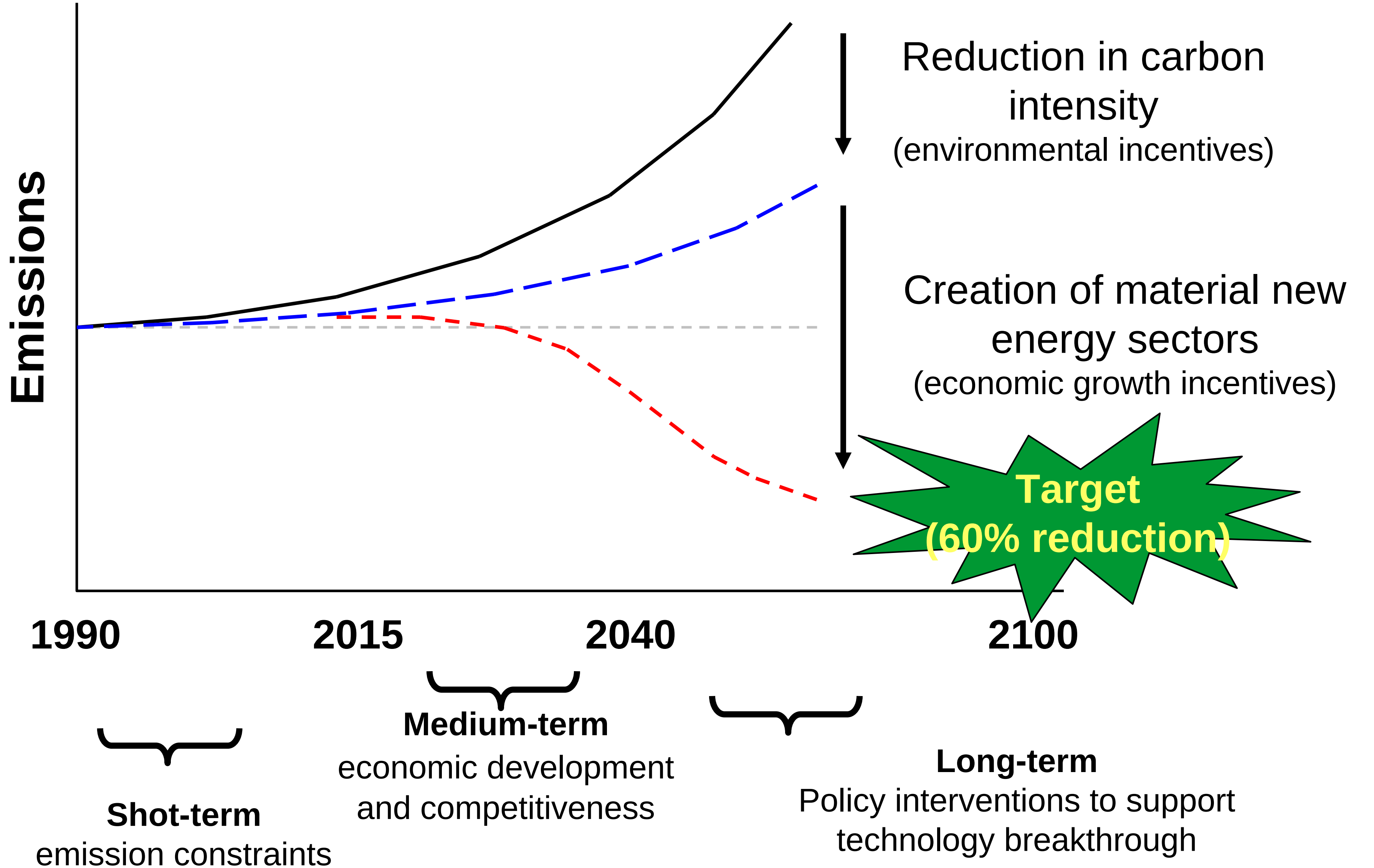
Need both **Mid-Term** and long-term solutions for climate



What is the scale of one 1Gtc wedge?

Business Sector	***1Gtc per year Wedge***	***Number of Wedges***
Fuel sw itching	1400 GW fueled by gas instead of coal	1
Coal plants w ith sequestration	700 1GW pow er plants	1-3
Geological sequestrations	3500 Sleipners or In Salahs, at 1MtCO2/year	1-3
Hydrogen fuel	1 billion H2 cars displace 30mpg gasoline/diesel vehicles	1
Energy efficiency improvements	Carbon intensity per $GNP drops 0.2% faster than in past	1-3
ICE efficiency	2 billion gasoline and diesel cars w ith 60mpg rather than 30mpg	1
Solar pv displaces coal	1000 X current capacitry, i.e. 5Mha	1
Wind displaces coal	70 X current capacity	1
Nuclear displaces coal	700 1GW plants, i.e. 1.5 X current capacity	1-3
Biofuel displaces petroleum	200Mha, grow ing @ 7.5tc/ha per year (= US agro land)	1
Re-forestation	700Mha, grow ing @ 2tc/ha per year	1

Source: Rob Socolow, Princeton

Chicken and Egg Problem

- Without technology solutions, hard to get strong reduction requirements; however, without strong reduction requirements, there is little incentive to develop technology solutions.
- Solution: Use incentives and a carbon cap together

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Key 4P Modeling Assumptions

- 3P Reference Case assumes:
  - » Phase 1 Hg control is 26 tons in 2010, Phase 2 Hg control is 10 tons in 2015
  - » EIA AEO 2003 assumptions on gas price and electricity demand
- Capital cost of IGCC = $1,248/kW
- Enhanced Oil Recovery (EOR) lowers sequestration costs by ~$10/ton CO2
- EOR is available in TX, CA, NM, LA & WY

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Selected 4P Scenarios Modeled

- **IGCC w/CCS Incentive Package**
  - Incentives for 17.5 GW IGCC+CCS, half w/credits for enhanced oil recovery, half without
  - Modeled by forcing desired level of IGCC+CCS generation; incentive was output
- **Cap at 2000 Levels in 2010 with IGCC Incentive Package**
  - Offsets used to meet 15% of compliance
  - 17.5 GW of IGCC+CCS, half with EOR credits
  - EOR availability capped

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Effect of IGCC Incentive Package

- IGCC + CCS package reduces emissions by 2 to 3% below projected levels at an incremental cost of $8.2 billion and an annual cost in 2010 of $750 – 870 M*
- If incentive program were added to the 3P bill modeled here, cost would increase by 11%
- IGCC + CCS package maintains coal consumption at levels > or = to 3P Reference Case and lowers wholesale electricity prices
- Incentives needed to encourage IGCC+CCS are low ($1.20-$4.30/MWH) where EOR is available, higher ($15.30-$28.30/MWH) where it is not**

*Costs reflect NPV from 2005 to 2030. 3P Reference Case = $71.3 billion. **For comparison, the federal tax credit for renewable energy is $17/MWh.

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Comparison of IGCC/CCS Incentives (Phase I) with Existing RE Incentives

	Cost per Year in 2010 ($millions)	Price per MWH	Capacity (GW)
RE	$328	$17	2.75
IGCC+CCS no EOR	$750-870	$15-28	4.75

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Effect of CO_2 Cap w/IGCC Incentives

- Results in an increase in emissions over current levels due to use of offsets but reduces emissions by 4 to 10% from what they would otherwise be in the absence of the cap.
- Costs $29.0 billion* and results in allowance costs of $3 to 5 per ton CO_2
- Results in higher coal consumption than 2000 levels, but less than 3P Reference Case
- Raises wholesale electricity prices by 5 to 8% from 3P Reference Case

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* Costs reflect NPV from 2005 to 2030;
3P Reference Case = $71.3 billion.

Effect of CO_2 Cap w/IGCC Incentives, cont.

- IGCC incentives come to $0.9 to 1.3 billion per year as modeled (with ½ EOR) in 2010 and 2015
  - » This is less than 10% of CO2 allowance value under modeled power sector scenario at the revised McCain-Lieberman Cap levels
  - » This comes to more than double the proposed value of tax incentives and direct subsidies for coal in the Energy Bill
- S. 131 NOx/Sox allowance incentives for IGCC would total approximately $80 million per year

* This is the cost of the incentive with a cap at 2000 levels in 2010. The cost varies depending on the level of the carbon cap.

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Design of CO_2 Control Measure: Including IGCC in a CO_2 Cap

Adding IGCC incentives to a cap program* results in:

- Slightly higher system costs (1-2%)
- Lower electricity prices
- Slightly more coal generation (4%)

*Note: These results are based on CO_2 cap runs that were not previously described. Runs capped CO_2 at 1990 levels by 2016 but allowed unlimited penetration of EOR.

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Conclusions (CCAP View)

- Affordable incentives can achieve real penetration of mercury and advanced coal technologies.
- Expected advantages include:
  - Greater certainty on technology performance
  - Lower costs for Hg control technologies and advanced coal generation technologies
  - Enhanced fuel diversity
- New legislative authority is needed to advance these issues – ideas were in play with S. 131, albeit at lower incentive levels.

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Conclusions (cont)

- Growing consensus that need to have both IGCC demos and sequestration demos – can be separate
- State CO2 cap & trade programs could provide first tests of IGCC/sequestration techs – Cal cap on load-serving entitities
- Proposed Frontier Line from Wyoming to Cal could be 6,000 MW sequesteration-ready IGCC w/ 6,000 MW wind

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For More Information

- See “Design of a Multipollutant Control Program: Stakeholder Analysis of Potential Policy Options,” available at www.ccap.org/pdf/2004-May--multipollutant-report.pdf
- Contact Ned Helme, Center for Clean Air Policy, at 202-408-9260 or nhelme@ccap.org

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