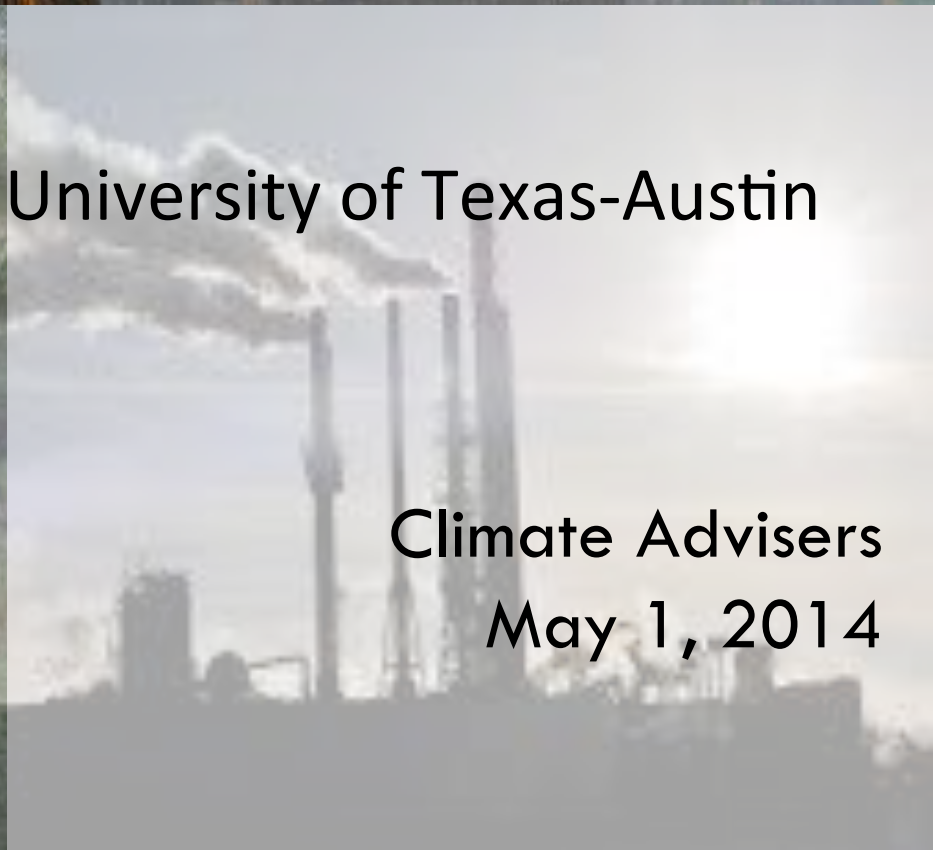

University of Texas-Austin

Climate Advisers

May 1, 2014

blogs.utexas.edu/mecc/

Agenda

- Overview
- Sector Presentations
  - Short-Lived Climate Forcers
  - Energy Production
  - LULUCF/Agriculture
- Country Presentations
  - China
  - India

Team

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Blog Site

Blog Site

- http://blogs.utexas.edu/mecc/

- 5 sector papers
- 7 country papers (forthcoming)
- Videos

Intuitions

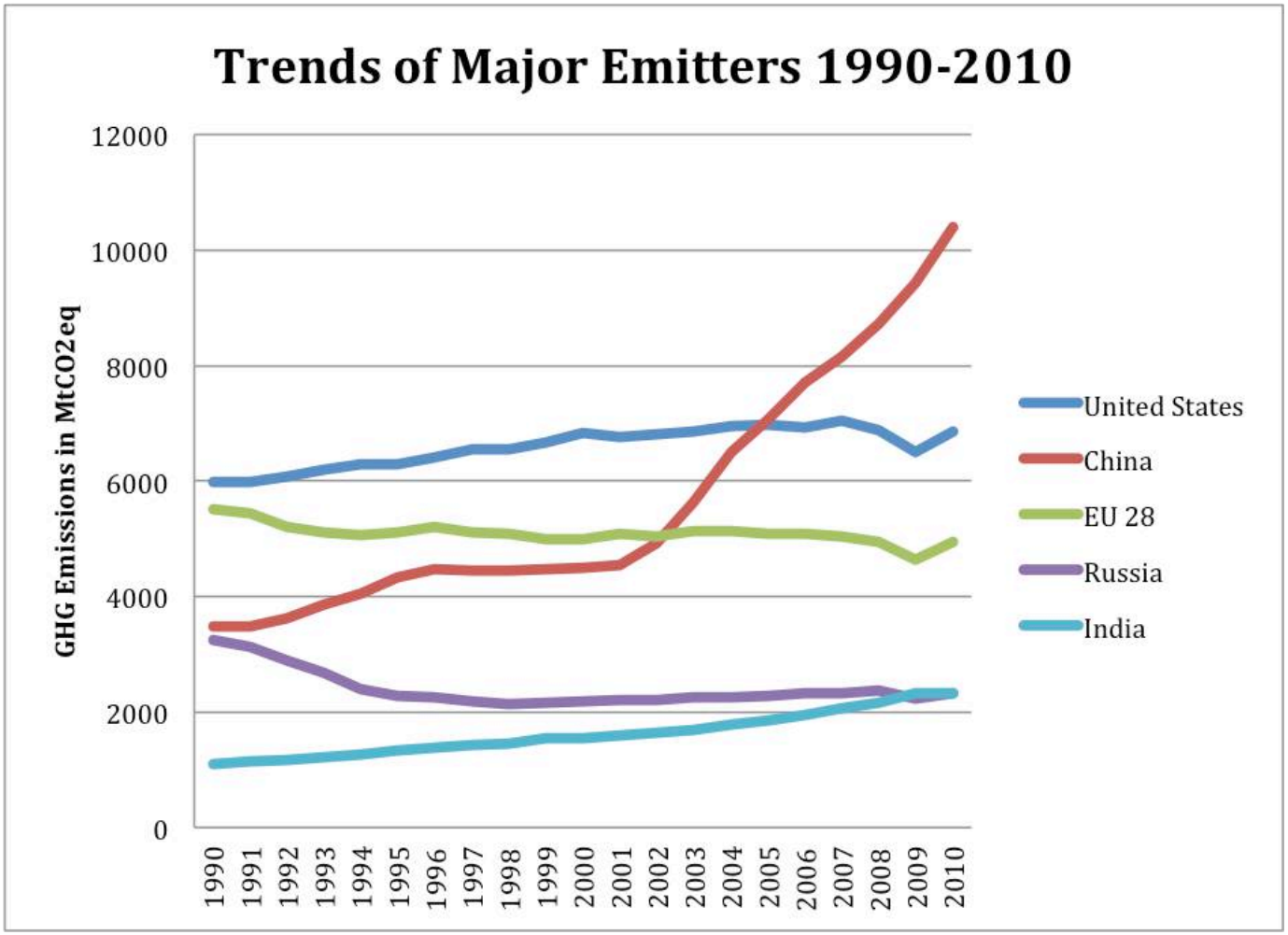
- GHG emissions are concentrated in particular countries
- Key sectors/areas drive those emissions and possible emissions reductions
- Domestic conditions may shape the prospects for realizing those reductions

Major Economies

- Top 14 political actors responsible for ¾ of GHGs

Rank	CAIT 2010 All Gases		% of TOTAL
		MtCO2eq	
1	China	10,385.54	23.32%
2	United States	6,866.92	15.42%
3	EU 28	4,944.80	11.10%
4	India	2,326.19	5.22%
5	Russian Federation	2,326.10	5.22%
6	Japan	1,298.89	2.92%
7	Brazil	1,162.62	2.61%
8	Indonesia	823.41	1.85%
9	Iran	727.00	1.63%
10	Canada	726.63	1.63%
11	Mexico	688.25	1.55%
12	Korea, Rep. (South)	678.32	1.52%
13	Australia	587.53	1.32%
14	South Africa	559.65	1.26%

A handful of countries really matter



EDGAR

Sectors

- Emissions and reduction opportunities are concentrated in specific sectors/areas
  - Energy production
  - Transport
  - Land-use and agriculture
  - Short-lived gases
  - Efficiency

Electricity Generation

- Top 6 political actors responsible for ¾ of GHGs in electricity generation
- Sector 39.42% overall of total GHG emissions

Rank	Country	Public electricity and heat production	% of Total Sector
		MtCO2	
1	China	3,482.28	28.52%
2	United States	2,185.05	17.89%
3	EU 28	1,439.10	11.78%
4	Russian Federation	899.81	7.37%
5	India	818.78	6.70%
6	Japan	499.34	4.09%

EDGAR 2008

Transport

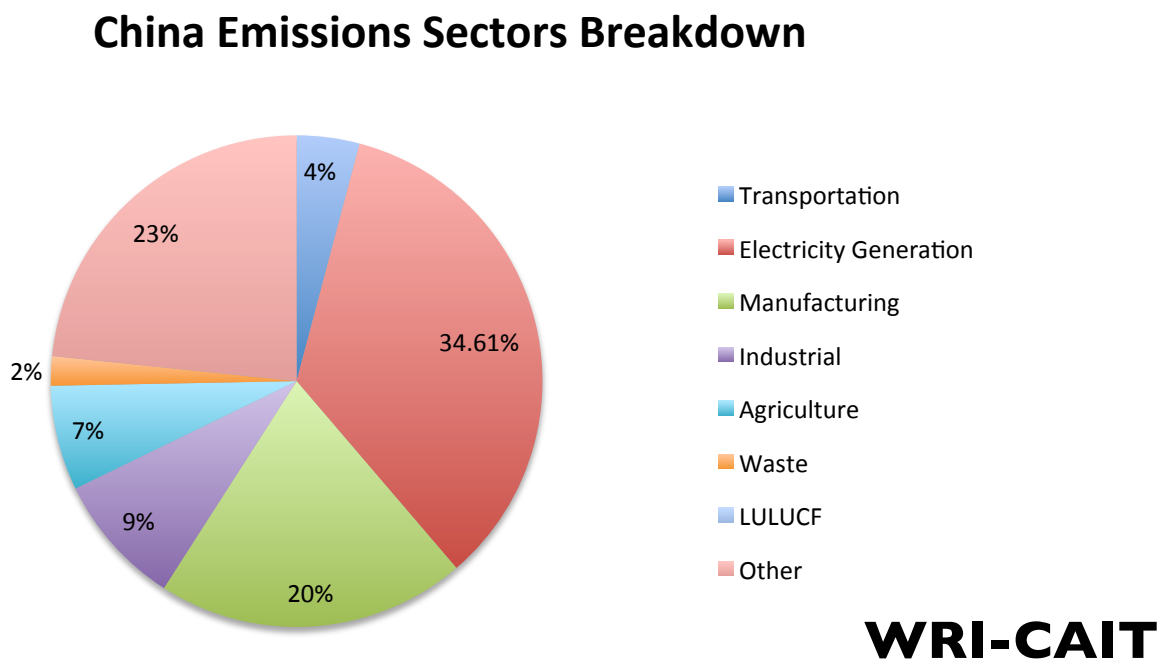
- Top 9 political actors responsible for ¾ of GHGs in transport
- Sector 17.61% overall of total GHG emissions

EDGAR 2008			
Rank	**Country**	**Transportation**	**% of Total Sector**
		MtCO2	
1	United States	1,710.95	31.36%
2	EU 28	981.36	17.99%
3	China	415.28	7.61%
4	Russian Federation	233.43	4.28%
5	Japan	221.43	4.06%
6	Canada	162.29	2.97%
7	Brazil	153.97	2.82%
8	Mexico	145.15	2.66%
9	India	125.22	2.30%

EDGAR 2008

Sectors within Countries

- Some sectors are dominant sources of emissions within countries

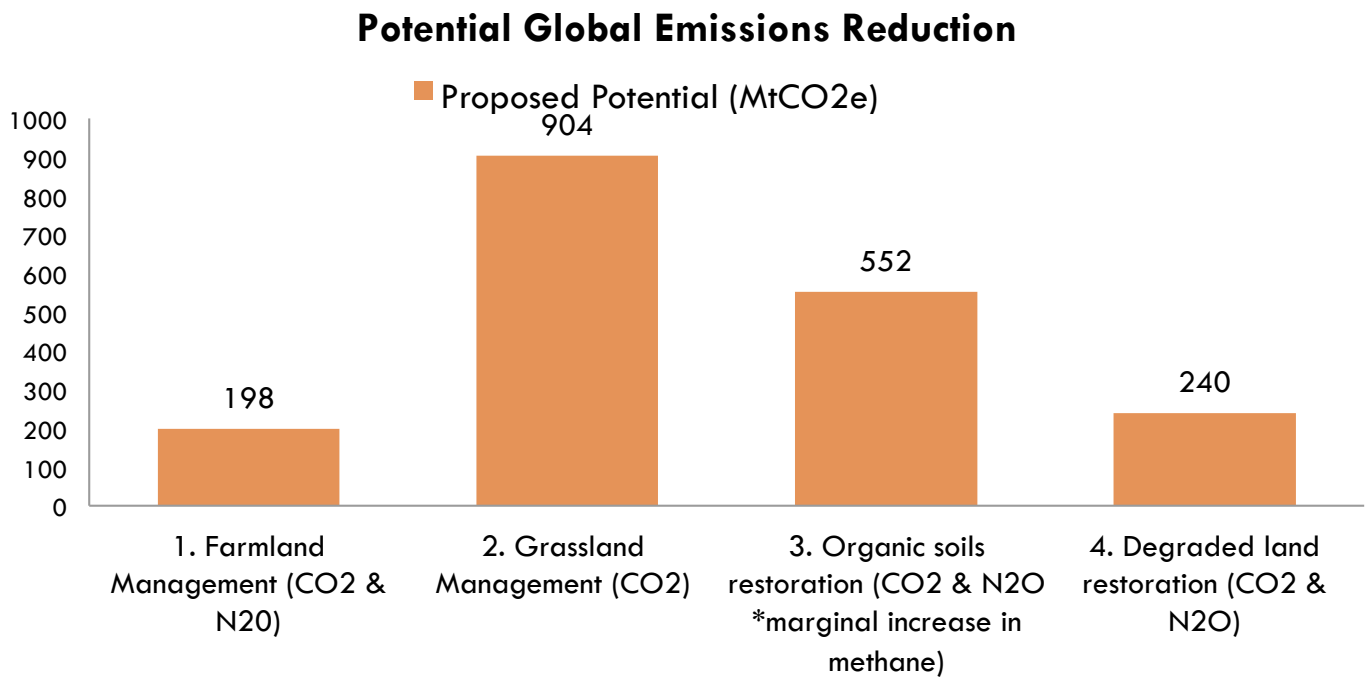


Research Questions

- Where are the best opportunities for large-scale emissions reductions?
  - Focus on key countries
  - Focus on key sectors
  - Focus on key sectors within countries

Methods

- Theoretically possible emissions reductions are much harder to achieve because of implementation challenges



McKinsey Climate Desk

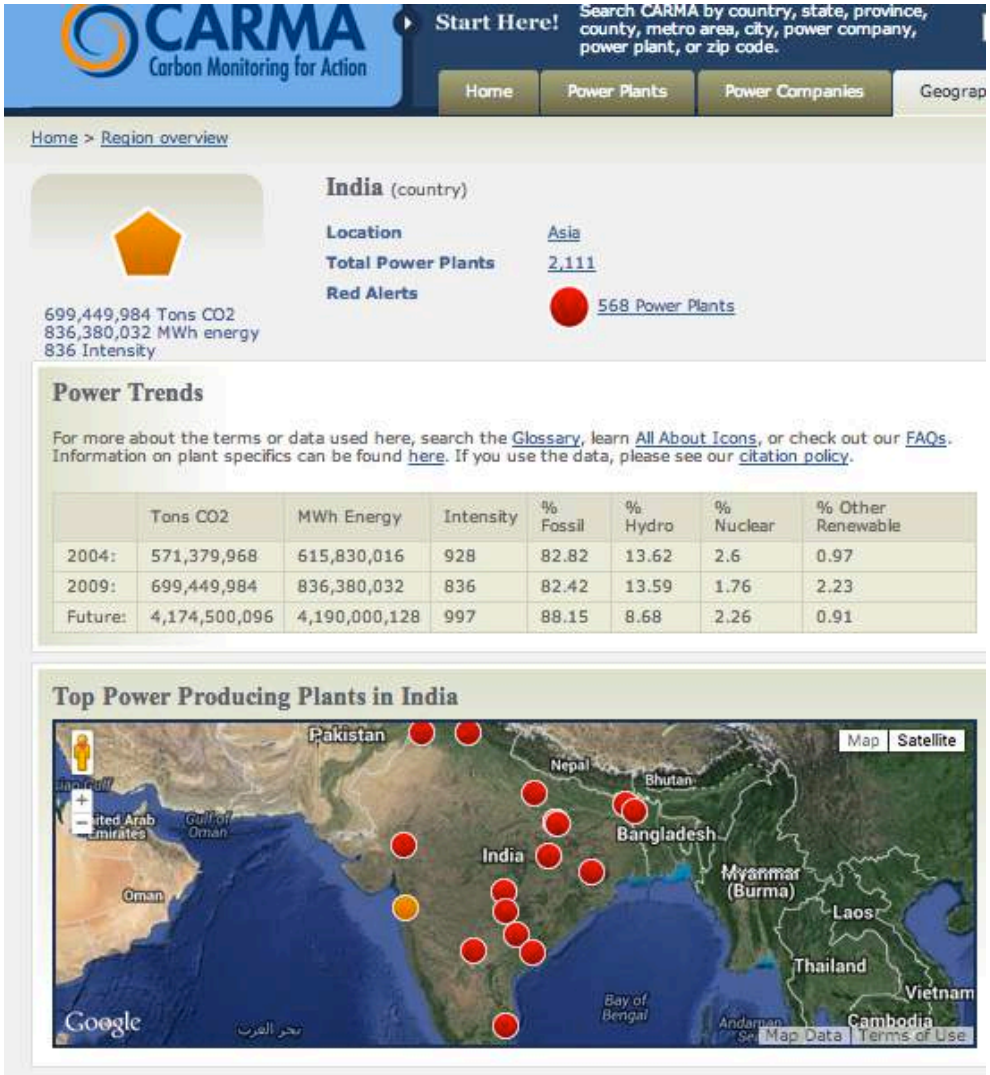
Domestic Implementation Challenges

- Degree of concentration of emissions
  - Diffuse sources of emissions harder to control b/c of collective action problems
- Power balance between center, local, private
- Preferences

Sectoral Conclusions

- Some areas depend on behavior change of too many actors and are hard areas for advancement
  - Cook stoves
  - Small farmer agriculture
  - Ruminant digestion
- Other sectors tend to be more concentrated and provide better handles for large-scale change
  - Power sector
  - Industry

India Power Sector



- 19 power companies with 15+ plants produced 52% of India's power sector emissions in 2009*

* Doesn't include top 2 companies with largest number of plants

Country Report Key Conclusions

- Emphasize co-benefits
  - Climate is the co-benefit
  - More important motivations for China/India
    - Air quality
    - Energy security
    - Political stability

Country Conclusions

- Coal dominant in China/India
  - Too many coal plants in China
    - (CCS, Fuel Switching, Renewables)
    - Local motivations, experience main barriers
  - India too many inefficient coal plants
    - (HELE, Renewables)
    - Motivation, fragmentation, financing main barriers

Next Steps

- India paper
- Additional country studies – China
- Implications for international negotiations

Industry/Manufacturing

- Top 8 responsible for ¾ industry (6.87%)
- Top 9 responsible ¾ manufacturing (19.82%)

	Total Industrial Processes	% total sector	% of country
	MtCO2		
China	878.50	41.28%	8.73%
EU 28	240.58	11.30%	4.54%
United States	149.20	7.01%	2.16%
Russian Federation	94.85	4.46%	3.64%
India	92.70	4.36%	3.81%
Japan	71.31	3.35%	5.13%
Korea, Republic of	41.66	1.96%	7.00%
Brazil	37.90	1.78%	2.56%

EDGAR 2008

CAIT 2008		
Country	Manufacturing	% of Total Sector
	MtCO2eq	
China	2,167.88	36.47%
United States of America	633.08	10.65%
EU 28	611.45	10.29%
India	279.82	4.71%
Japan	247.46	4.16%
Russian Federation	229.53	3.86%
Indonesia	131.03	2.20%
Iran	113.29	1.91%
Brazil	108.32	1.82%

LULUCF

- 7-9 actors responsible for ¾ of emissions
- Between 16.8% and 8.71% of total emissions

EDGAR 2008		
	Forest fires, forest fires post-burn decay, and peat fires and decay of peatland	% of Total Sector
	MtCO2	
Indonesia	1,293.51	24.86%
Congo_the Democratic Republic of the	935.34	17.97%
Brazil	445.66	8.56%
Central African Republic	347.35	6.67%
Myanmar	227.16	4.36%
Guinea	201.18	3.87%
Russian Federation	161.15	3.10%
Cote d'Ivoire	135.34	2.60%
Cambodia	122.59	2.36%
Bolivia	93.24	1.79%

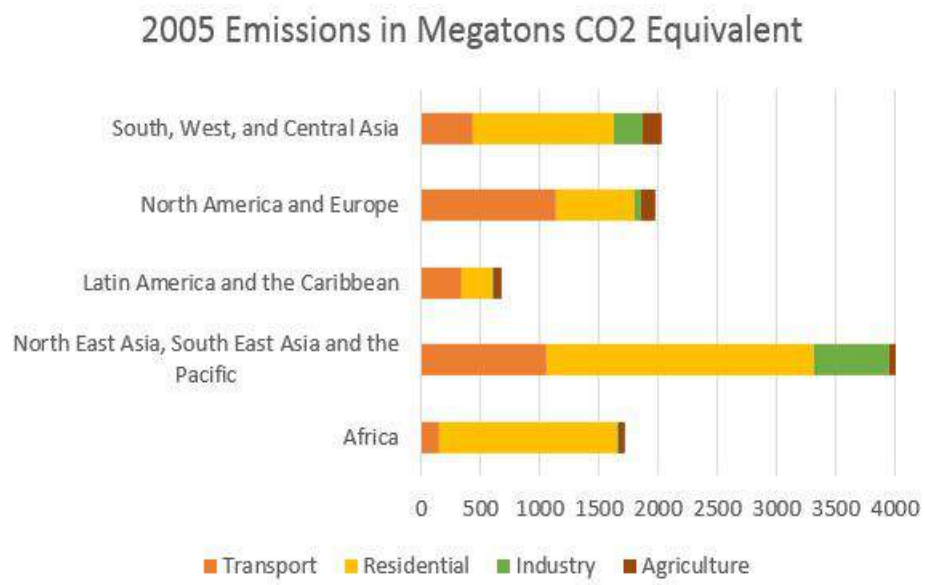
CAIT 2008		
	Land Use and Forestry (Net Forest Conversion)	% of Total Sector
	MtCO2e	
Brazil	973.58	37.26%
Indonesia	346.61	13.26%
Nigeria	180.22	6.90%
Australia	149.07	5.71%
Congo, Dem. Rep.	145.01	5.55%
Venezuela	124.65	4.77%
Cameroon	108.90	4.17%

Agriculture

- Ag - 22 countries, ¾ emissions
- Roughly 16% of emissions

CAIT 2008		
	Agriculture	% of Total Sector
China	694.18	11.73%
Brazil	613.00	10.36%
European Union 28	494.97	8.36%
United States	448.93	7.59%
India	347.11	5.86%
Indonesia	242.81	4.10%
Russian Federation	157.04	2.65%
Congo, Dem. Rep.	151.78	2.56%
Argentina	142.84	2.41%
Myanmar	129.64	2.19%
Sudan	121.46	2.05%
Pakistan	119.19	2.01%
Angola	104.44	1.76%
Australia	97.48	1.65%
Nigeria	94.77	1.60%
Ethiopia	88.93	1.50%
Vietnam	75.40	1.27%
Colombia	74.87	1.27%
Canada	64.93	1.10%
Central African Republic	60.16	1.02%
Thailand	59.52	1.01%
Mexico	58.98	1.00%

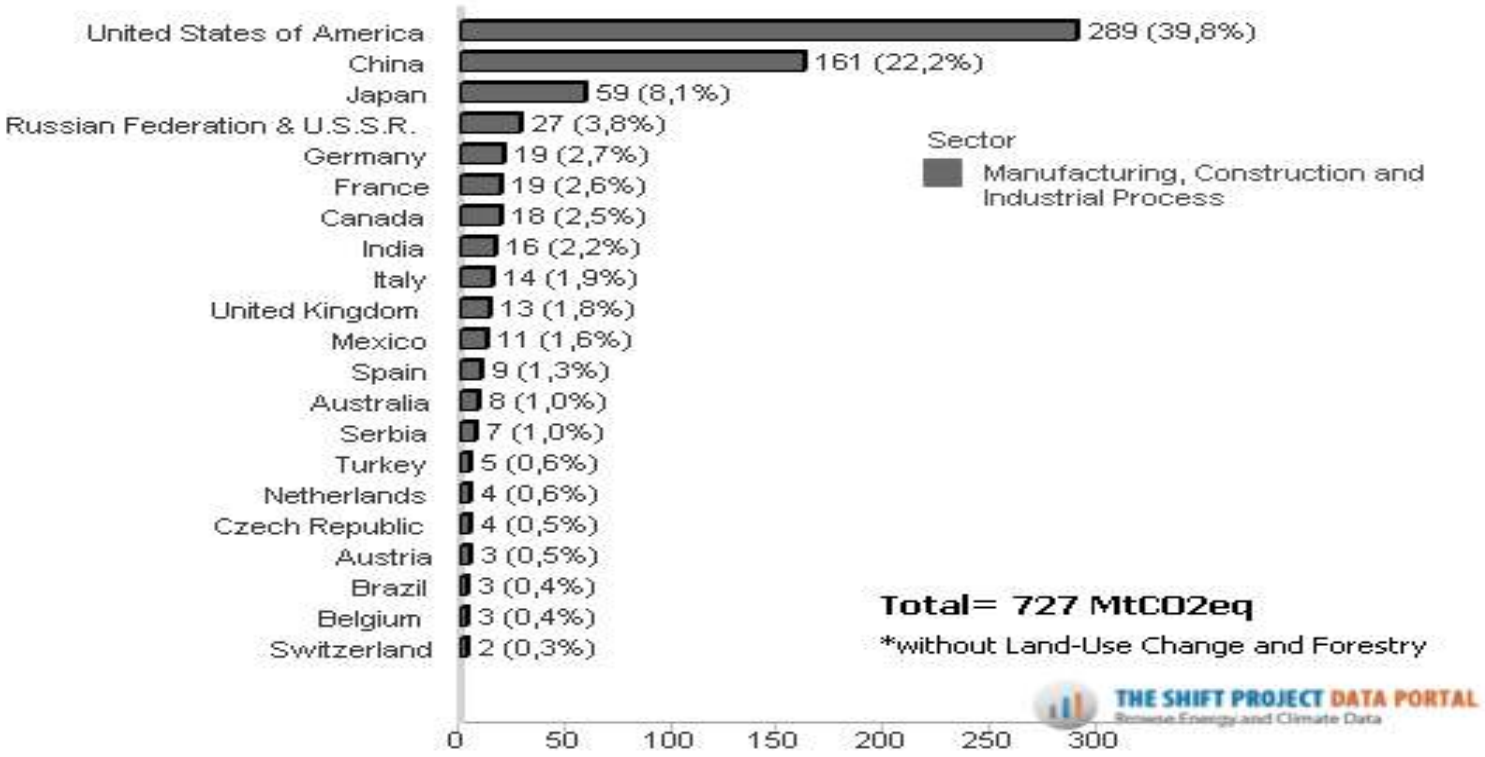
Black Carbon



- UNEP 2011

HFCs

- 5 actors, ¾ emissions



Methane

- 17 actors, ¾ emissions

China	1642257.6	0.218526248
India	621479.7	0.082696909
Russian Federation	533546	0.070996052
European Union	524786.6	0.069830486
United States	524688.1	0.069817379
Brazil	443288.9	0.058986033
Indonesia	218929.1	0.029131699
Pakistan	155236.3	0.020656446
Australia	122548.9	0.016306913
Mexico	115858	0.015416591
Iran, Islamic Rep.	115333.9	0.015346852
Vietnam	111337.5	0.014815073
Canada	104499.8	0.013905218
Thailand	104410.5	0.013893335
Bangladesh	103079.7	0.013716253
Sudan	94638.7	0.012593055
Nigeria	88021.4	0.011712527

IEA 2010

Short-Lived Climate Forcers:

Black Carbon, Methane, HFCs

blogs.utexas.edu/
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Cherie Saulter, Jesse Libra, Miyako Yerick

Short-Lived Climate Forcers

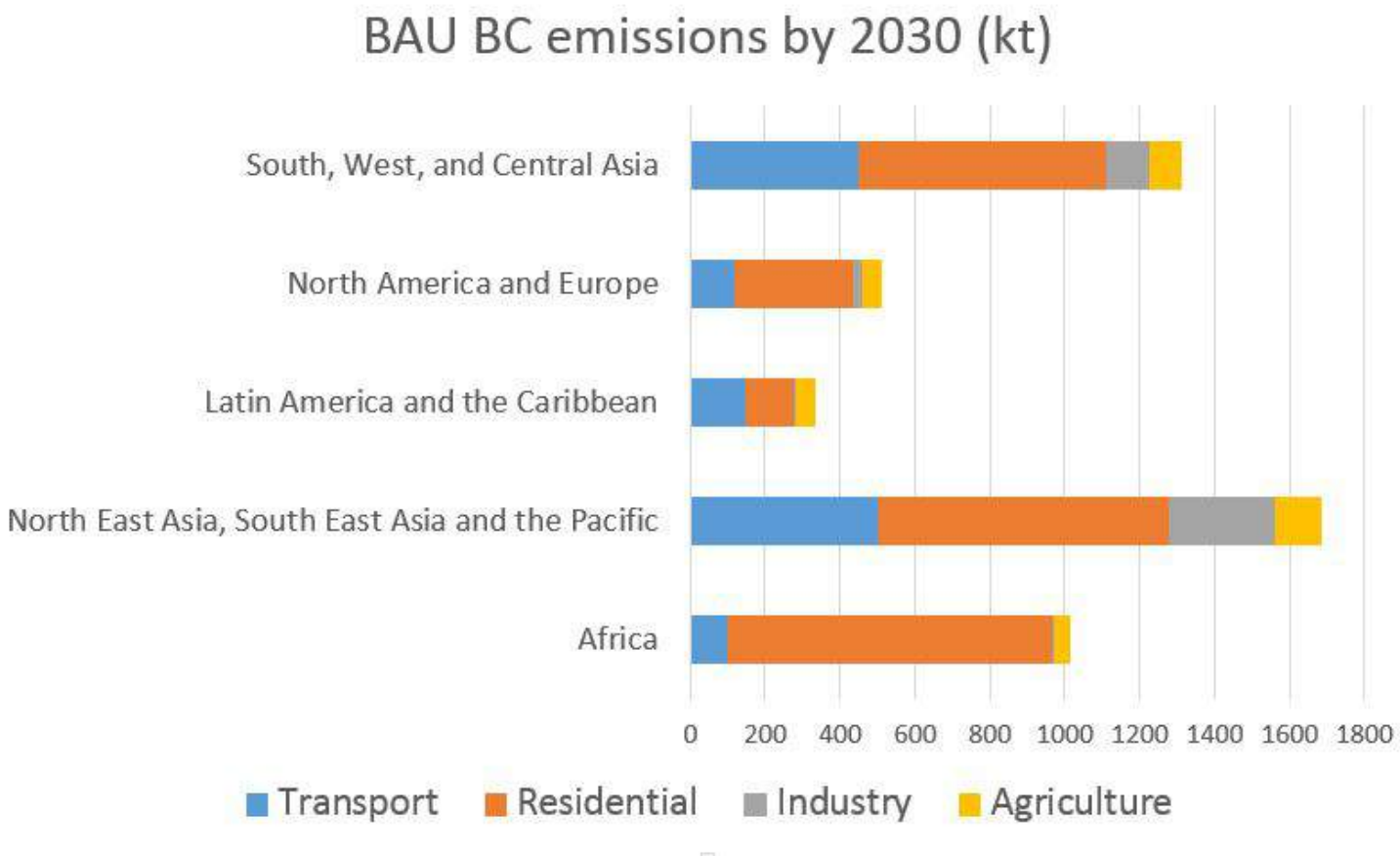
GAS	LIFESPANS	REDUCTIONS MtCO2e
BLACK CARBON	3-8 days	4,942 in 2030
METHANE	12 years	1,645 in 2030
HFCs	~13-222 years	76-134,000 in 2050 (cumulative)

Short-Lived Climate Forcers

BLACK CARBON	Dissemination and adoption of increased-efficiency biomass-burning cookstoves
	Adoption of diesel vehicle standards and installation of diesel retrofits
	Installation of coke dry quenching technology in coke production
METHANE	**Capture of ventilated associated gas during oil and gas production**
	Pre-mine degasification and capture of coal-mine methane
	Installation of anaerobic digestion systems
	Aeration of rice paddy fields
	Sorting and treatment of biodegradable municipal waste
HFCS	**Adoption of HFC amendment to Montreal protocol**
	Replacement of HFCs with CO2, ammonia, or hydrocarbon refrigeration

SLCF continued - Black Carbon

- Black Carbon Breakdown



UNEP 2011

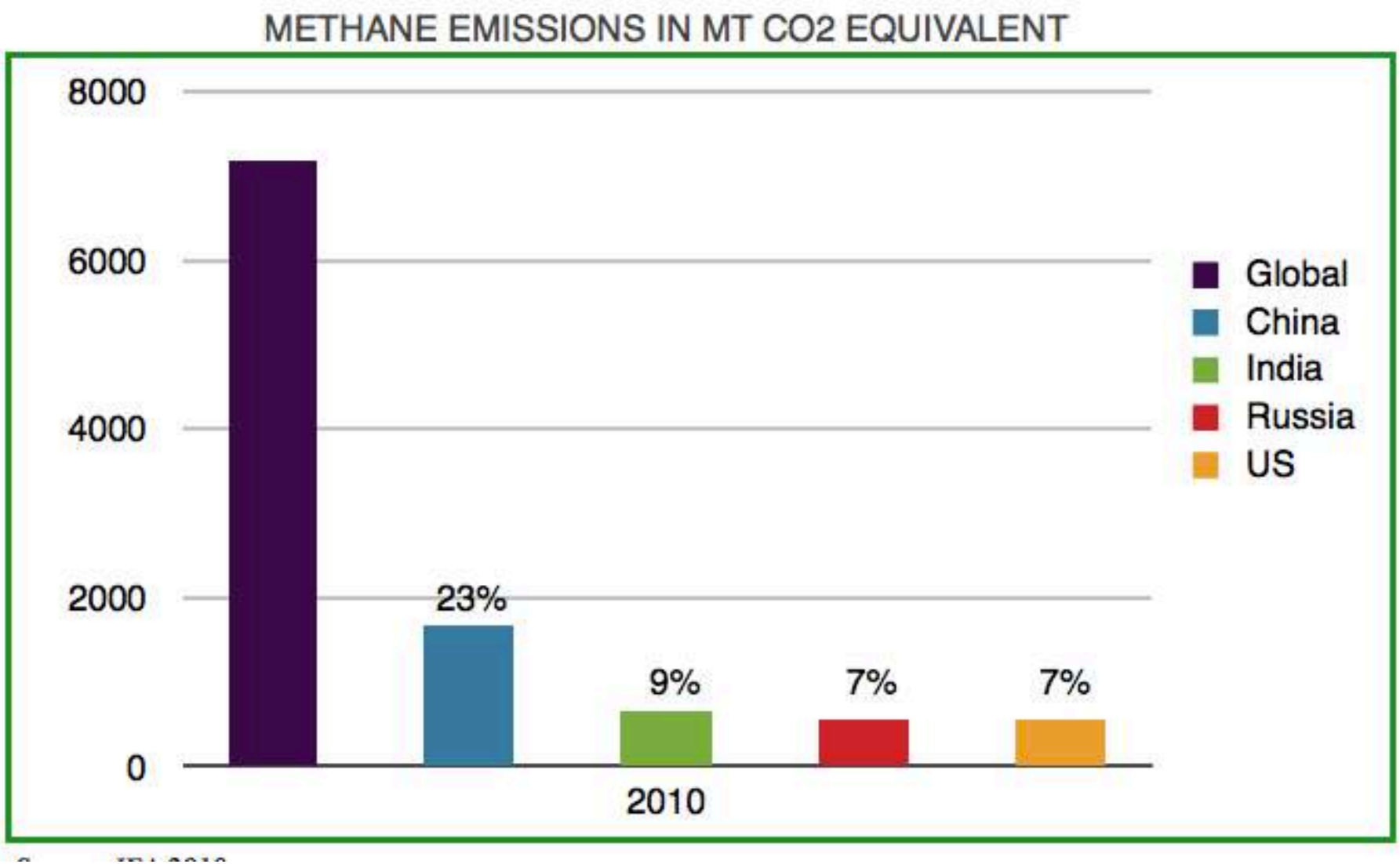
SLCF continued - Black Carbon

- Residential: Increased-efficiency cookstoves.
- Numbers:
  - Mitigation Potential: 2684 Mt CO2e assuming 60% adoption.
  - Geographic concentration: Asia (China and India).
- Barriers:
  - high upfront cost.
  - poor market linkages.
  - cultural barriers.
  - non-linear adoption.
- Recommendations:
  - Focus on increased efficiency biomass stoves.
  - Improve market linkages in remote areas.
  - Increase consumer demand through education.

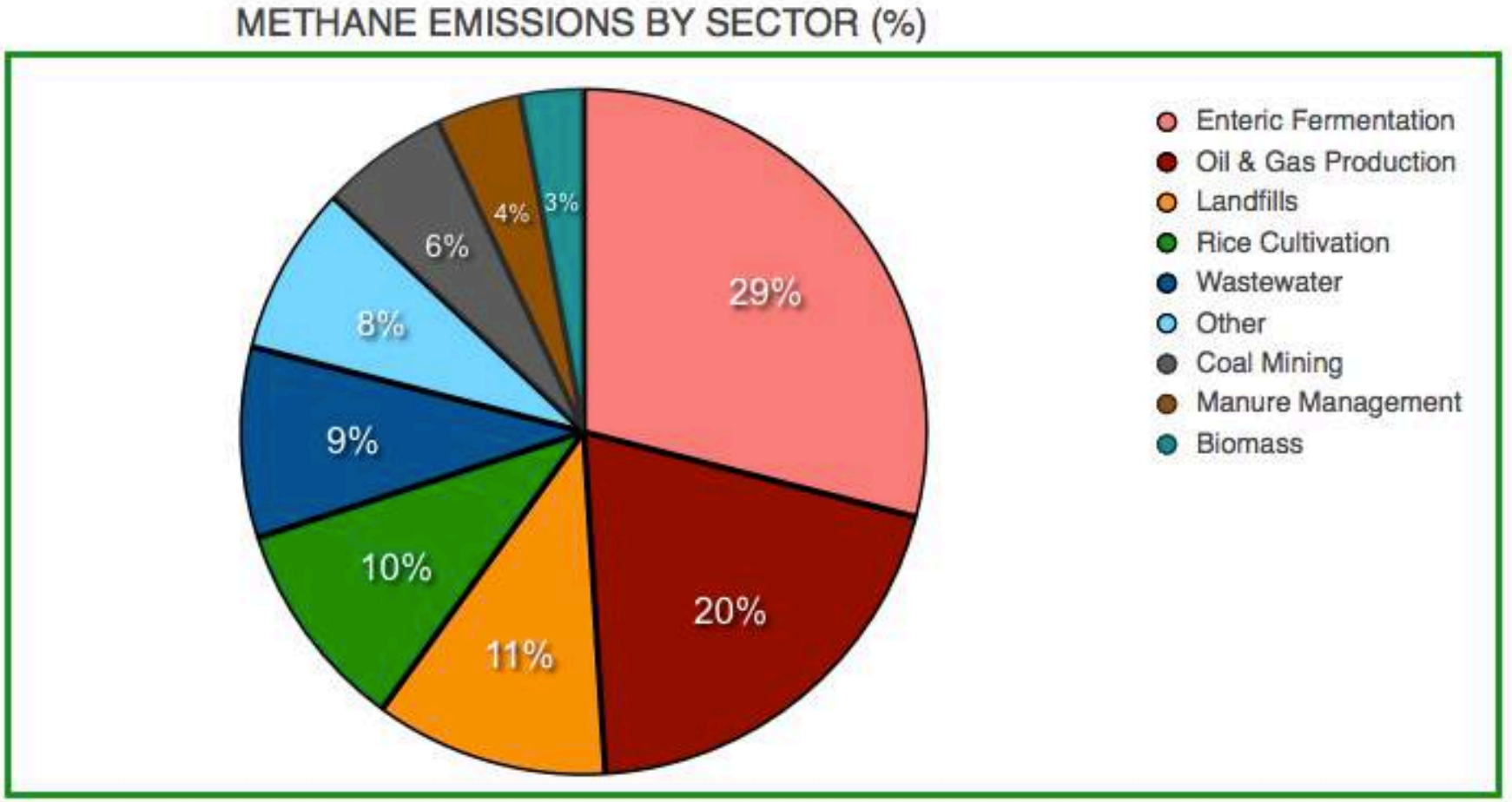
SLCF continued - Black Carbon

- Transport: Standards and Diesel Particulate Filters.
- Numbers:
  - Mitigation potential: 2060 $MtCO_2$ eq.
  - Geographic concentration: Global issue, most cities.
- Barriers:
  - Diffuse offenders.
  - Cost.
  - Political will.
- Recommendations:
  - Diesel Particulate Filters over LPG vehicles.
  - Target urban fleets and transport companies.
  - Adopt vehicle standards/improve enforcement.
  - Incentivize replacing older vehicles.

SLCF continued - Methane



SLCF continued - Methane



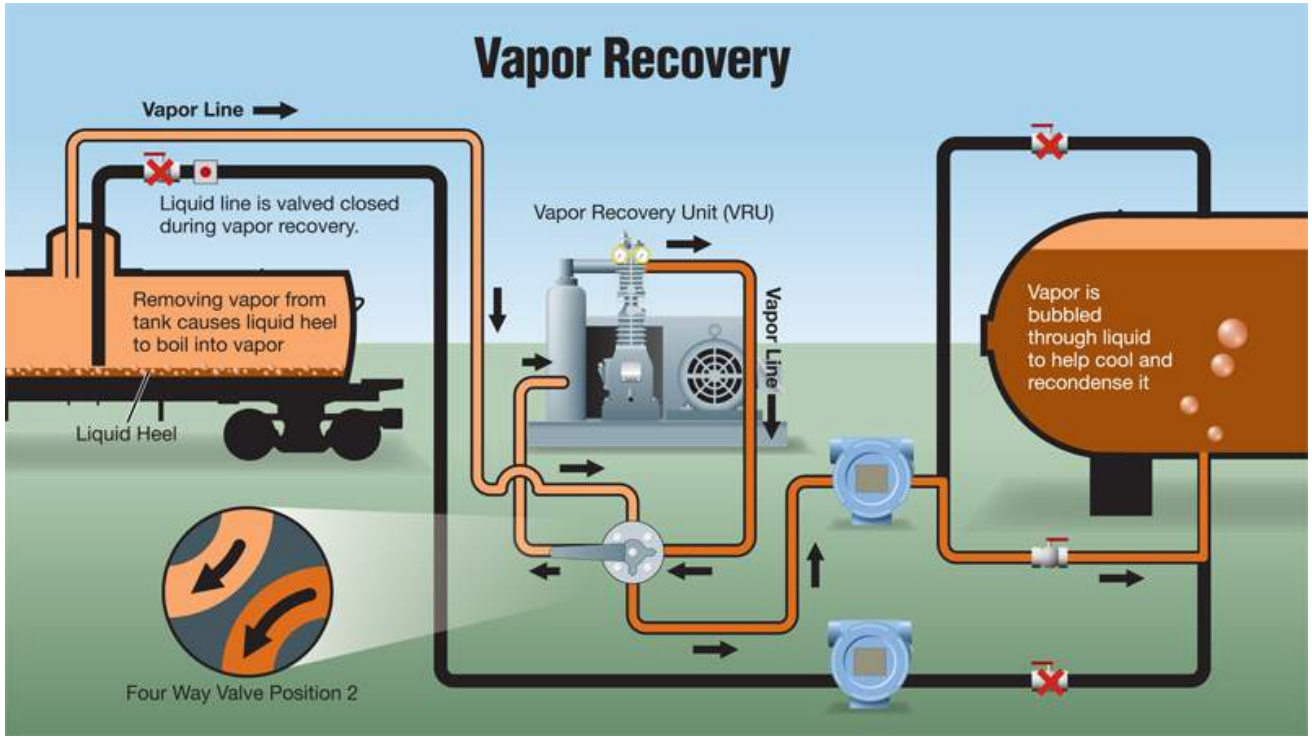
Source: EPA 2011

SLCF continued - Methane

- Oil and Gas.
- Numbers:
  - Total process emissions from oil and gas production make up 20% of global methane emissions.
  - The emissions reduction potential by 2030 for capture of vented associated gas is 643 $MtCO_2e$ for oil and 50.4 $MtCO_2e$ for gas.
- Barriers:
  - Upfront costs and lack of technical capacity for installing Vapor Recovery Units.

SLCF continued - Methane

- Recommendations:
  - CDM.
  - Tax rebates/ public financing.
  - Loans from VRU producers.



SLCF continued - Methane

- Coal Mining
- Numbers:
  - Coal mining activity is responsible for 6% of global methane emissions.
  - The emissions reduction potential from pre-mine degasification and capture of coal-mine methane in 2030 is 368 $MtCO_2e$.
- Barriers:
  - China, which emits close to seven times more coal mine methane (CMM) than the next highest emitter, does not have adequate technology for capture, especially of low-concentration CMM.
  - Costs.
- Recommendations:
  - CDM.
  - Capacity building.

SLCF continued - Methane

- Waste Management
- Numbers:
  - The storage and treatment of municipal solid waste in landfills produces 11% of total global methane emissions.
  - Sorting and treatment of biodegradable municipal waste could potentially reduced emissions by 584 $MtCO_2e$ in 2030.
- Barriers:
  - Political (especially in US).
  - Cultural/behavioral.
- Recommendations:
  - Regulations/rebates.
  - Subsidies for anaerobic digestion systems.

SLCF continued - HFCs

- HFC Amendment to the Montreal Protocol
- Numbers:
  - 8.8 billion tons of CO_2e per year by 2050.
  - Between 76,000-134,000 $MtCO_2e$ in avoided emissions by 2050.
- Barriers:
  - India.
  - Costs.
- Recommendations:
  - Pressure from China and other developing countries for India to sign.
  - Financial assistance for Article 5 countries.

SLCF continued - Conclusion

- Environmental and health benefits.
- Potential for immediate payoffs in abated emissions make SLCFs an attractive area for action on climate change.
- Buys time for CO_2 mitigation to become economically and politically viable.

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ENERGY PRODUCTION

Energy Production: Overview

- Reduction potential:
  - The IEA identifies **23 GtCO2** (55% of total) emissions reduction potential within the energy production sector in the year 2050.
  - Top 5 emitters in energy production sector account for **17 GtCO2** in 2050.
    - China, US, India, Russia, and European Union

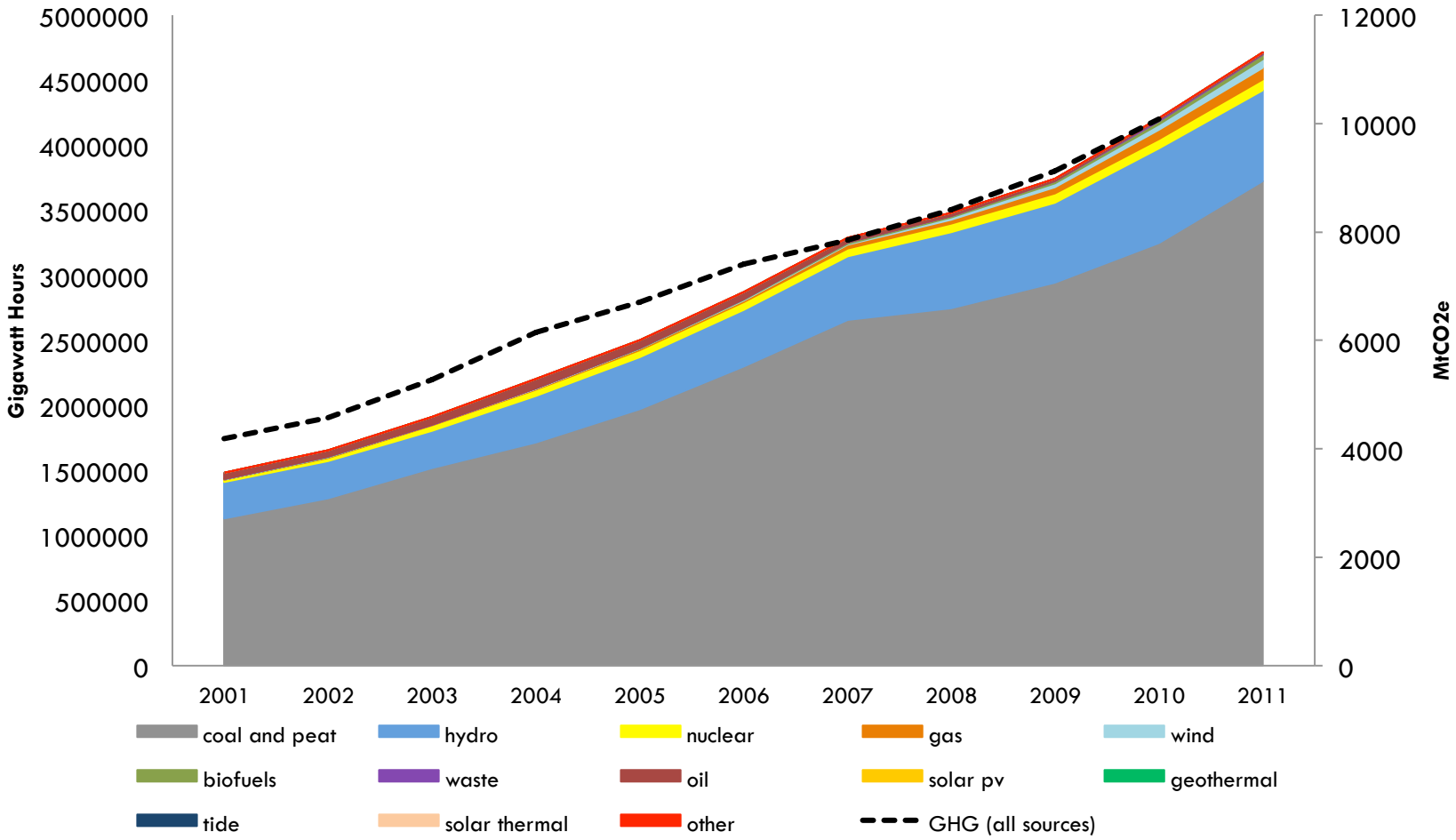
Energy Production: Key Findings

- Coal will persist as an important energy source.
- Renewables have strong potential but barriers remain.
- Shale gas revolution needs assistance to take off globally.

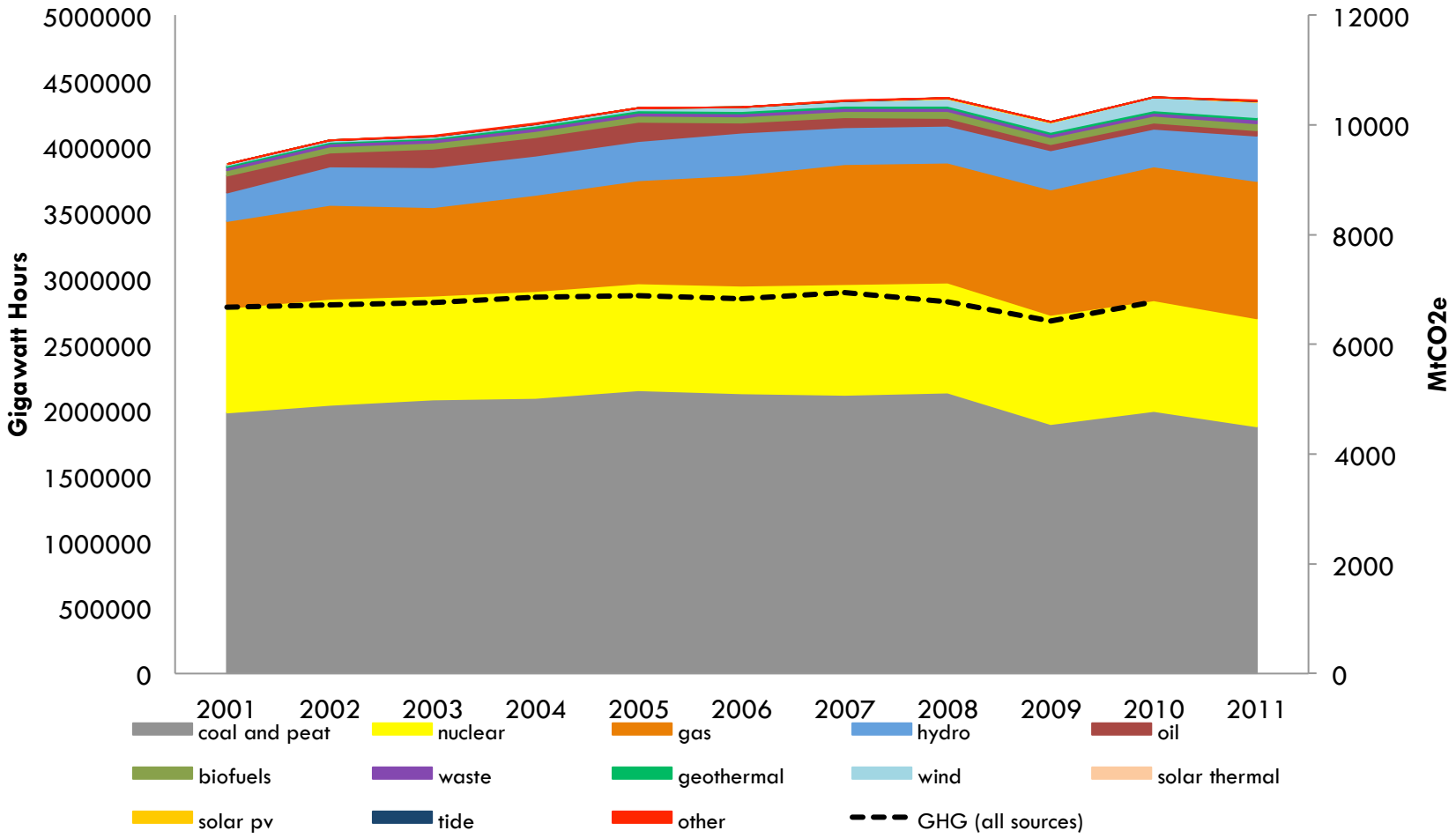
Energy Production: Solutions

- HELE / CCS:
  - High efficiency and low emission coal generation.
  - Carbon Capture and Sequestration technology.
- Renewables:
  - Portfolio of renewables generation technologies.
- Fuel Switching:
  - Encouraging the switch towards less carbon-intensive generation.

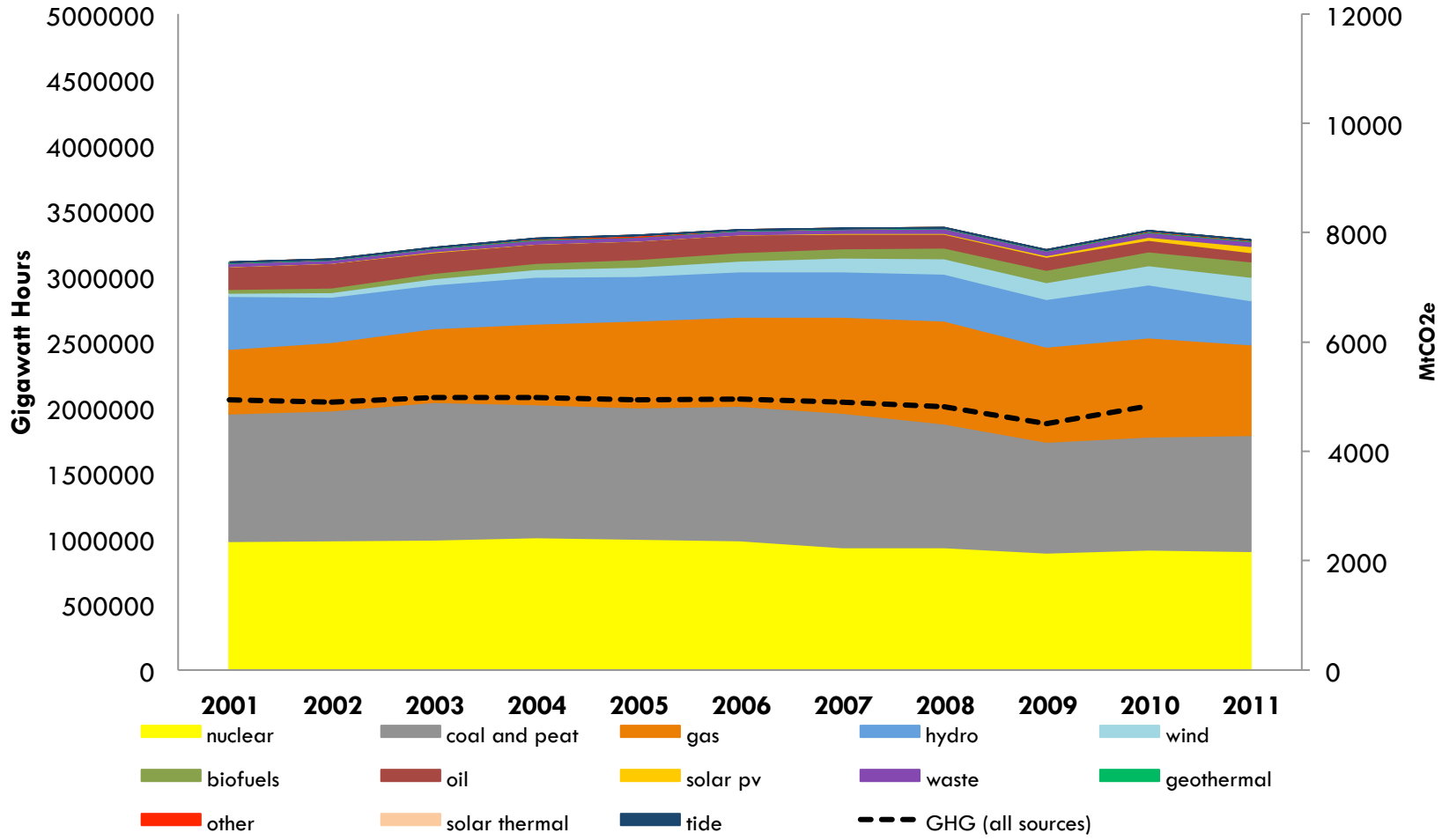
Chinese Electricity Generation



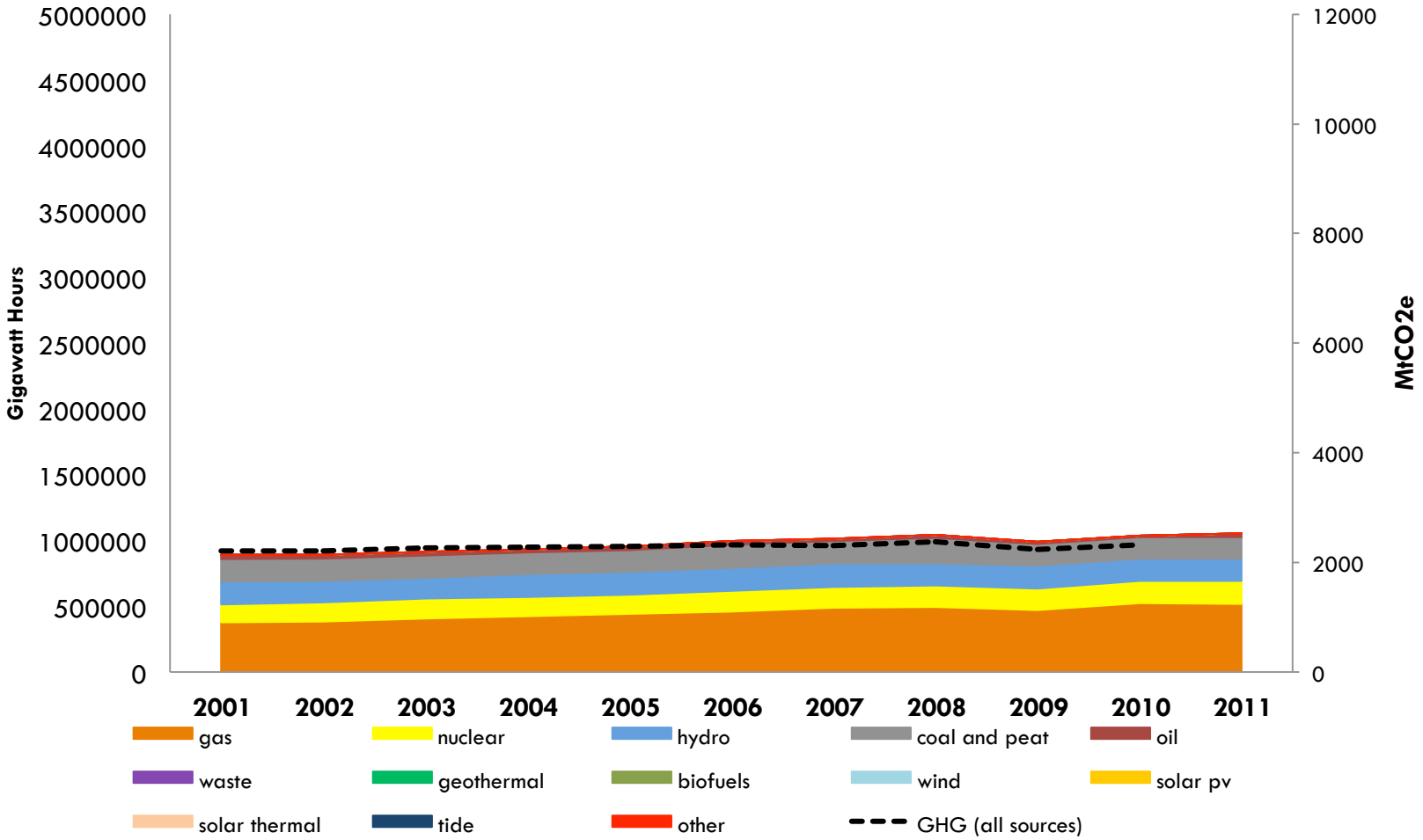
US Electricity Generation



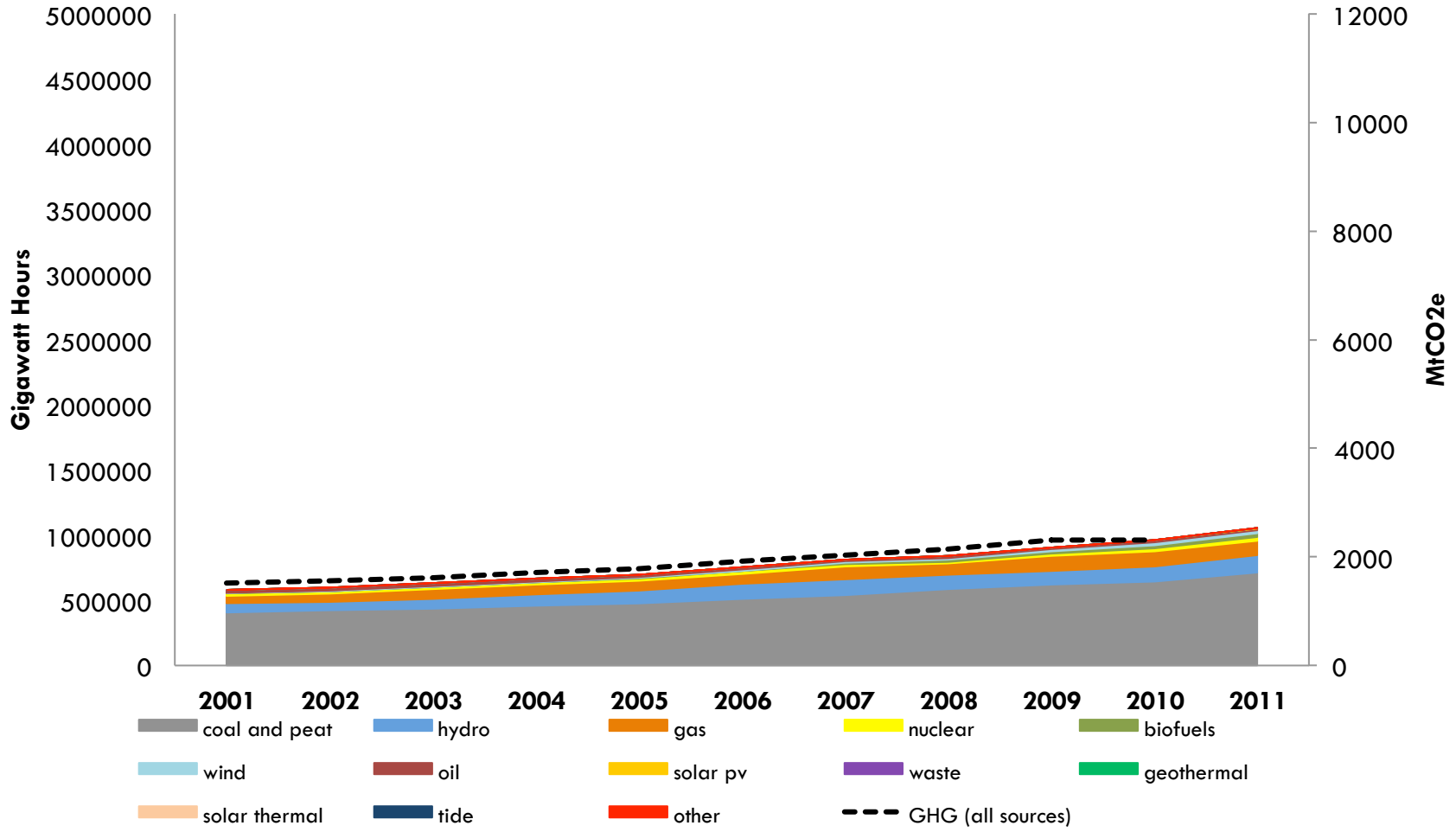
EU-27 Electricity Generation



Russia Electricity Generation



India Electricity Generation



HELE/CCS: Barriers

- Costs of technology and levels of technological immaturity.
- Air pollution and the energy penalty.
- Uncertain regulatory environment in developing world.

HELE/CCS: Solutions

- Near-term HELE adoption in lieu of CCS commercialization.
- Tighter environmental standards to limit carbon emissions for existing plants to encourage the retirement of older, less efficient coal powered plants.
- Long-term adoption of CCS in commercial applications.

Renewables: Barriers

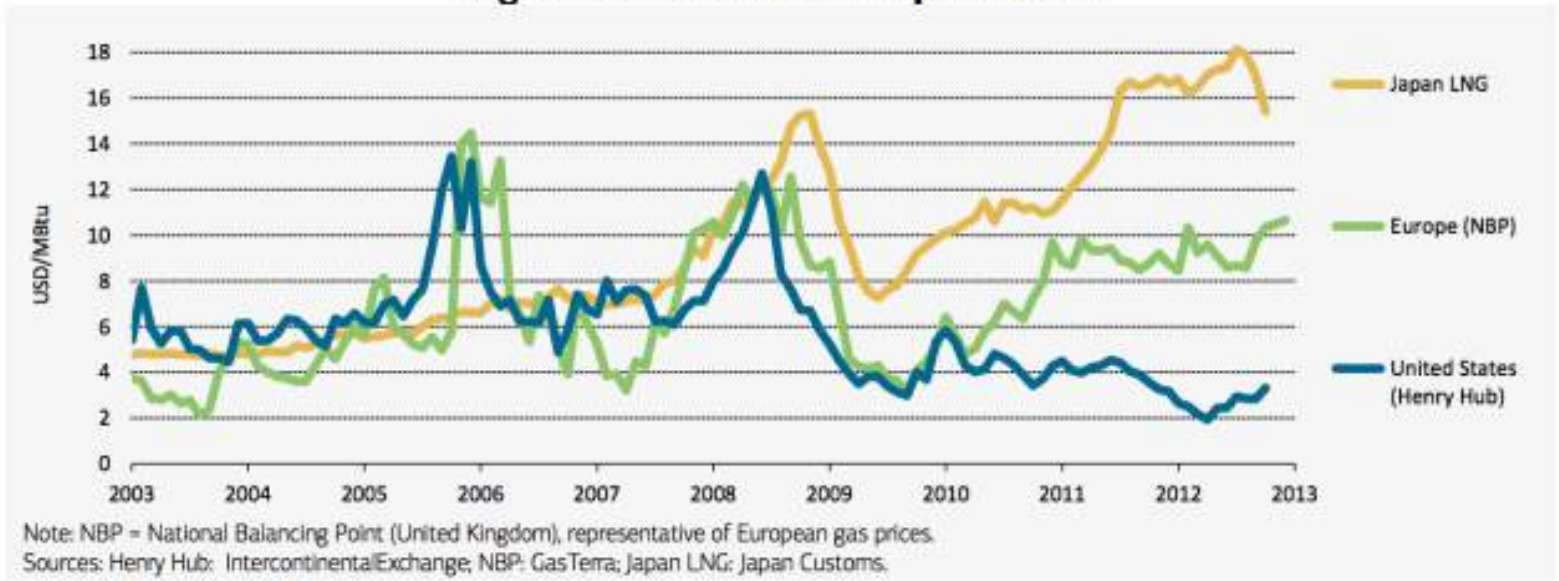
- Cost distribution/Technical Capacity
  - LCOE competitive with fossil fuel sources
- Market structures may hinder deployment of renewable technologies
  - Long term contracts may discourage investment
- Protectionism
  - Domestic content requirements

Renewables: Solutions

- The EU should better coordinate national subsidy programs within broader ETS system.
- The Chinese government should relax rigid electricity market structures that reduce incentives to invest in renewable technologies.
- The Indian government should attempt to better align existing policies.

Fuel Switching: Market Dynamics

Figure 17. Natural Gas Spot Prices



Note: NBP = National Balancing Point (United Kingdom), representative of European gas prices.
Sources: Henry Hub: IntercontinentalExchange; NBP: GasTerra; Japan LNG: Japan Customs.

Source: IEA TCEP[120]

Fuel Switching: Barriers

- Potential natural gas price volatility.
- Uncertain regulatory environment.
  - EPA 111d is still a proposal.
- Environmental concerns and uncertainty for future.

Fuel Switching: Solutions

- In the US, emission controls and low natural gas prices will encourage utilities to retire old coal power plants in favor of natural gas.
- If China and India possess considerable shale gas reserves. They should continue to develop these nascent industries.
- EU member states can reduce their reliance on natural gas exports by lifting the moratorium on hydraulic fracturing to develop domestic shale gas fields.

Agriculture and Land Use, Land Use Change, and Forestry (LULUCF)

blogs.utexas.edu/mecc/

Bilal Bawany, Stephen Farshing, Katy Wang

Outline

- Existing Emissions.
- Abatement Potential & Mitigation Strategies.
- Barriers.
- Recommendations.

Defining LULUCF & Agriculture

- "A greenhouse gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land use change and forestry activities" (UNFCCC 2012).
- Agriculture involves the cultivation of soil, production of arable crops, and livestock rearing.
- AFOLU: Agriculture, Forestry, and other Land Use.

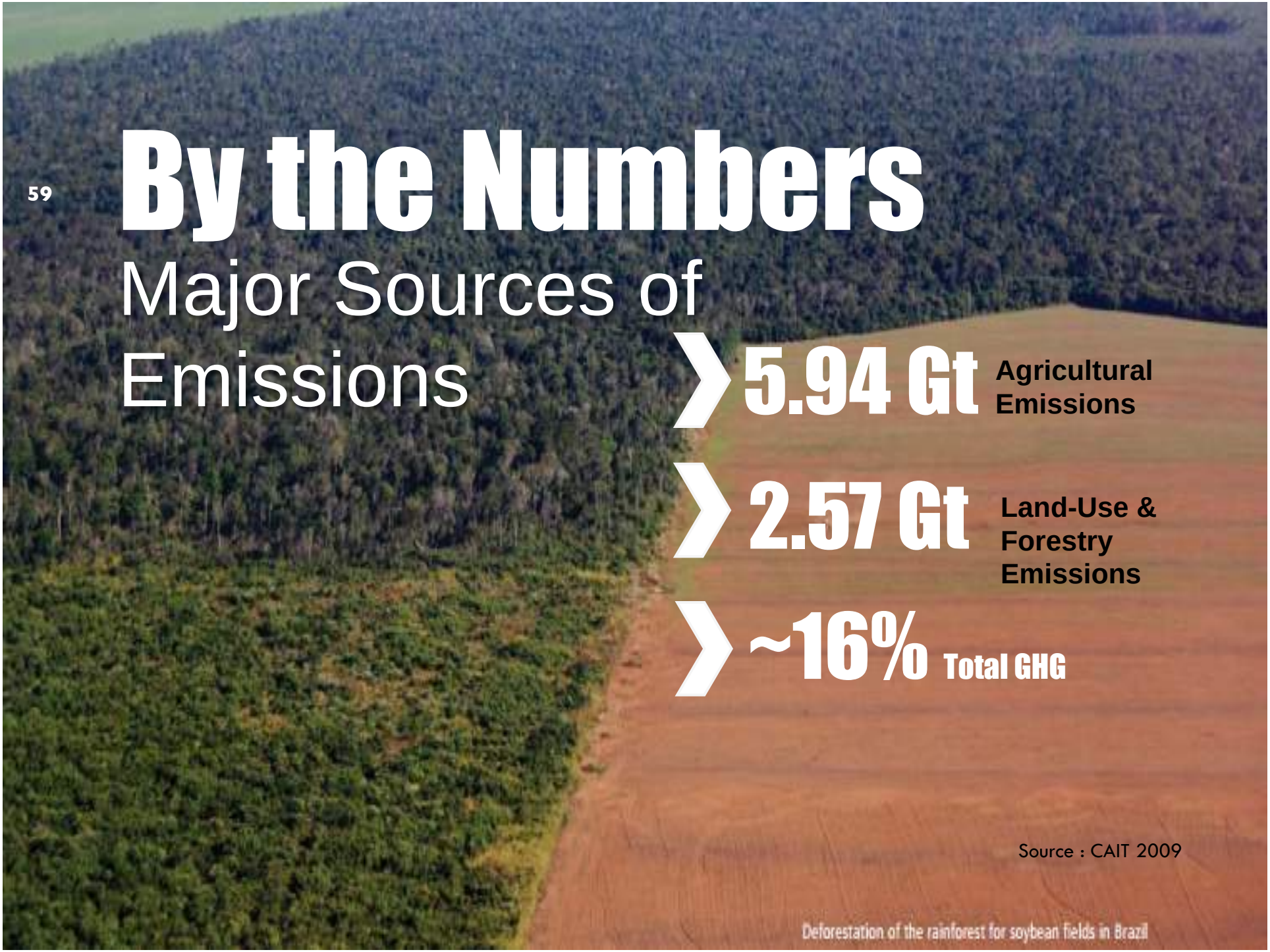
Current Emissions

By the Numbers

Major Sources of Emissions

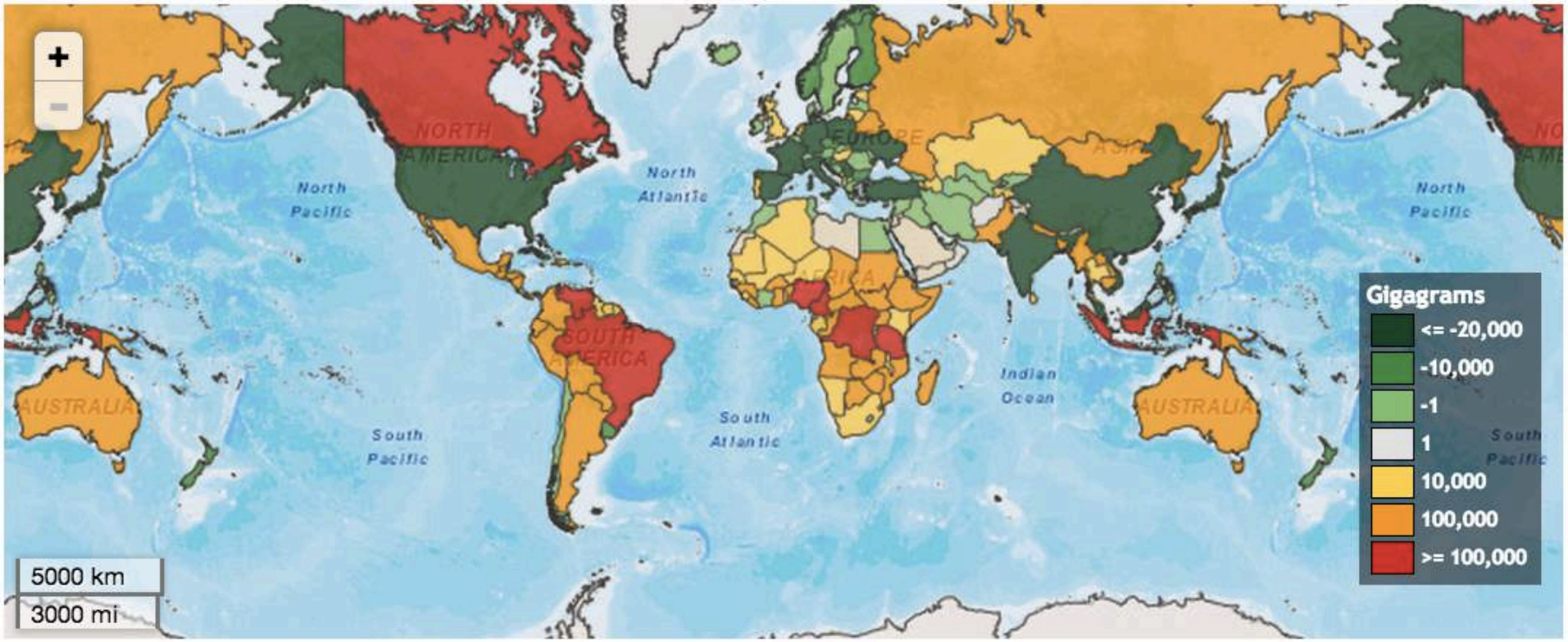
- **5.94 Gt** Agricultural Emissions
- **2.57 Gt** Land-Use & Forestry Emissions
- **~16%** Total GHG

Source : CAIT 2009



Deforestation of the rainforest for soybean fields in Brazil

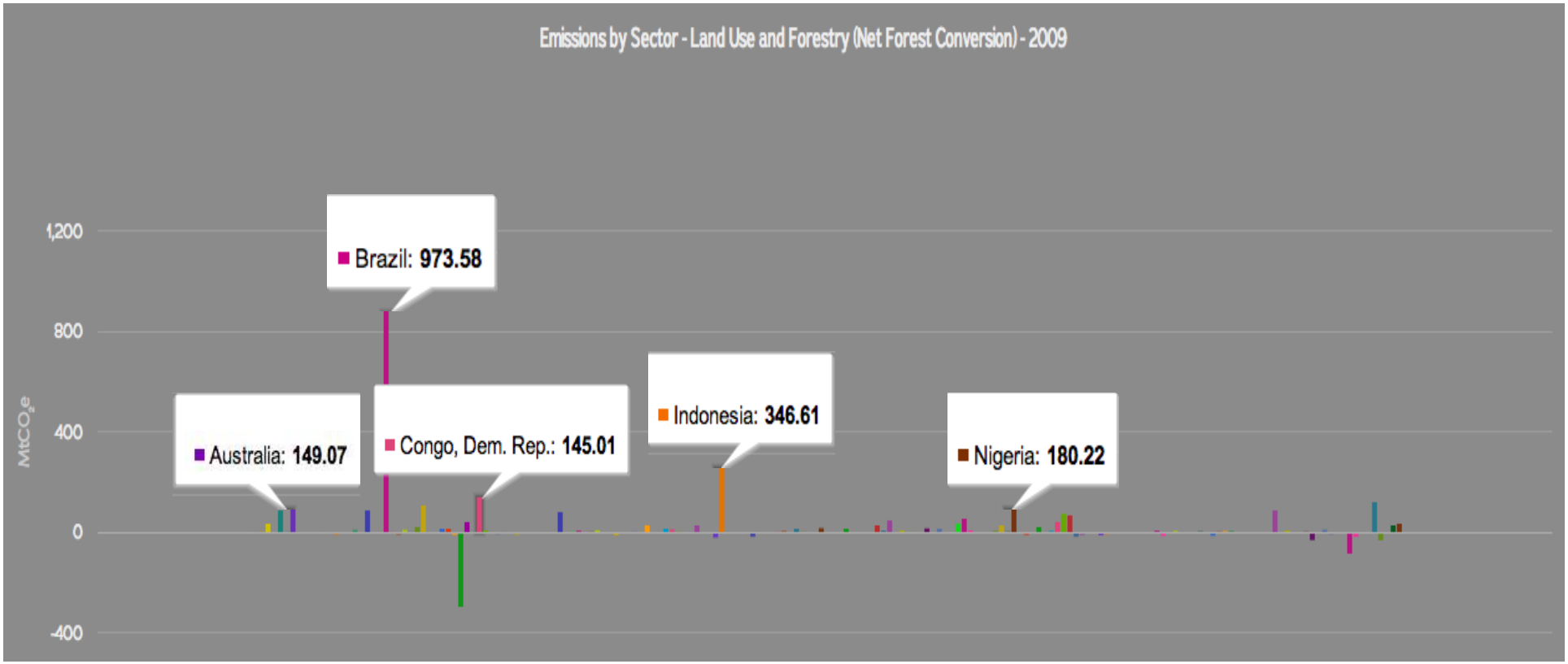
Land-use & Forestry Emissions



Source: FAO 2011

Land-use & Forestry - Country Level

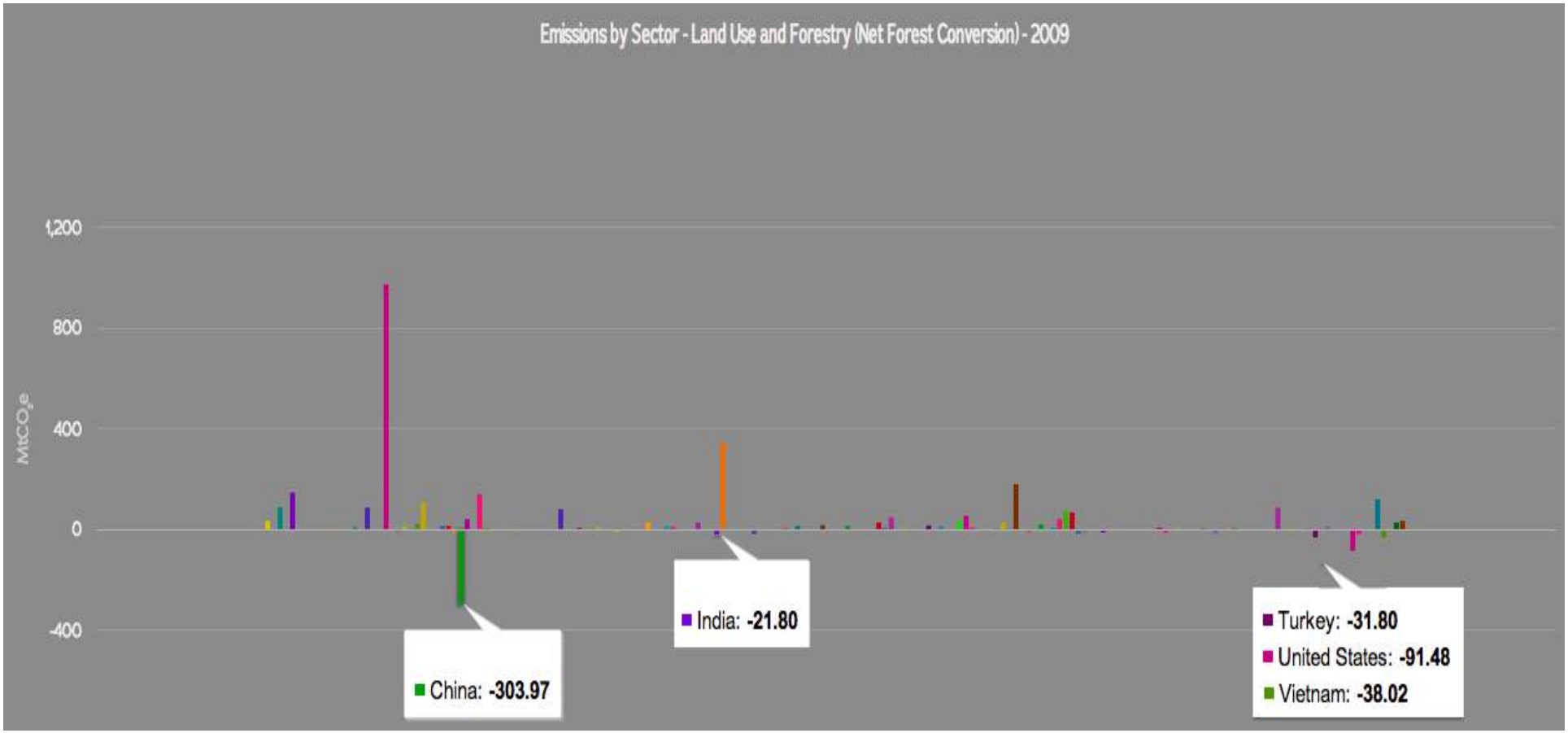
Top Five **Emitters** (as of 2009)



Source: CAIT 2009

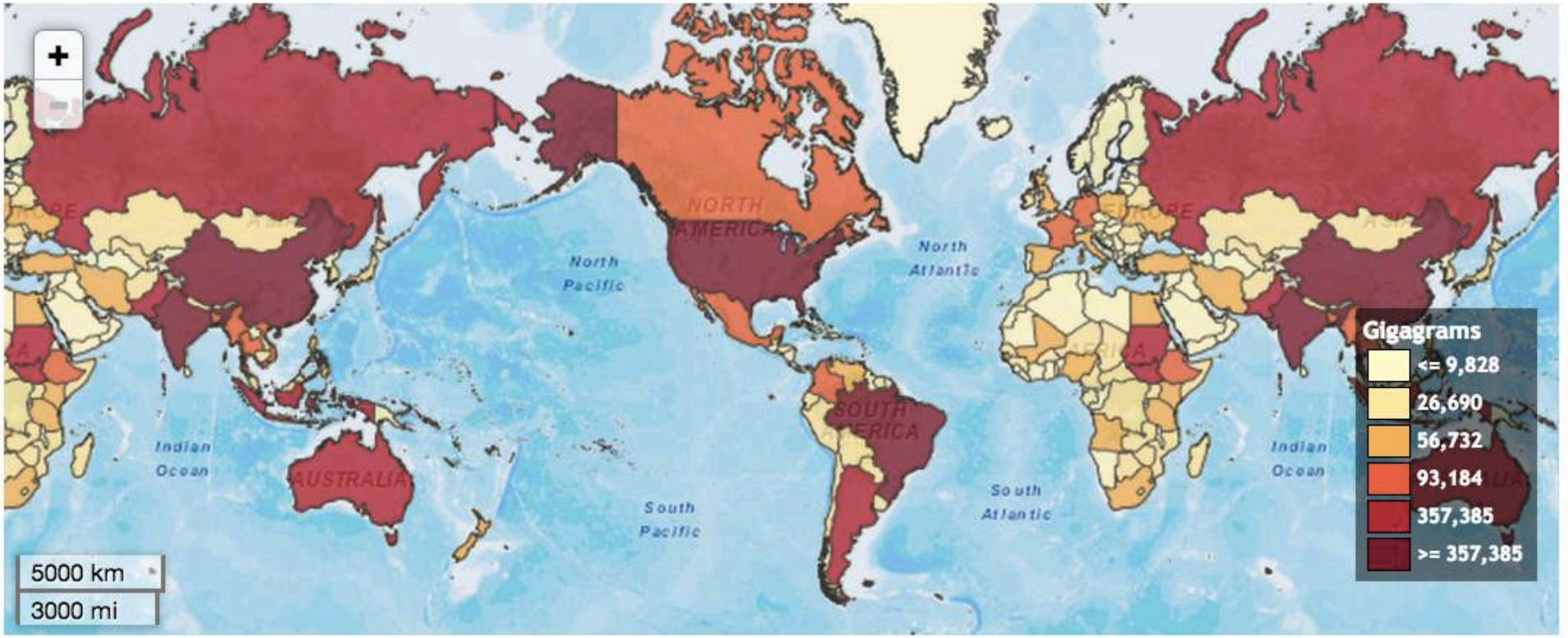
Land-use & Forestry - Country Level

Top Five **Sinks** (as of 2009)



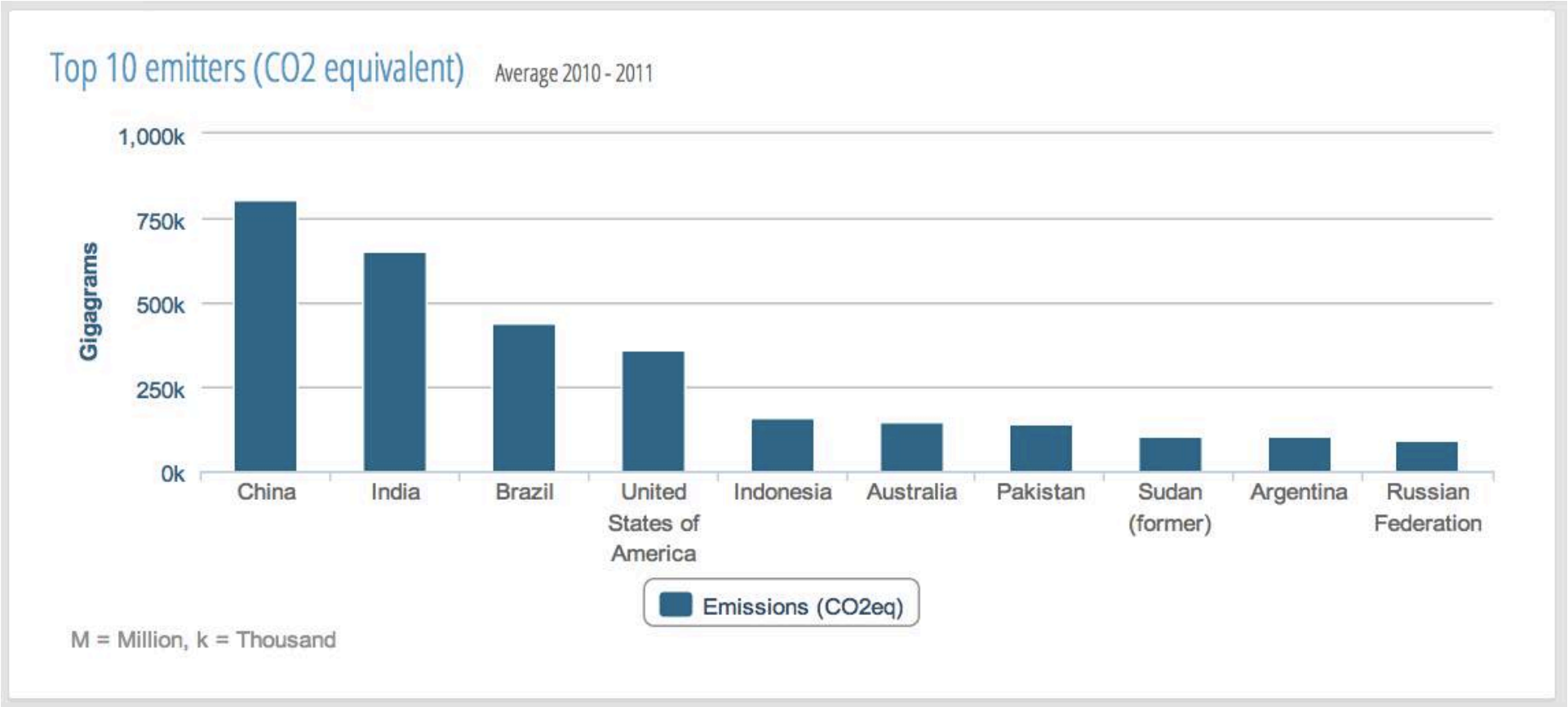
Source: CAIT 2009

Agricultural Emissions - Country Level



Source: FAO 2011

Agricultural Emissions - Country Level



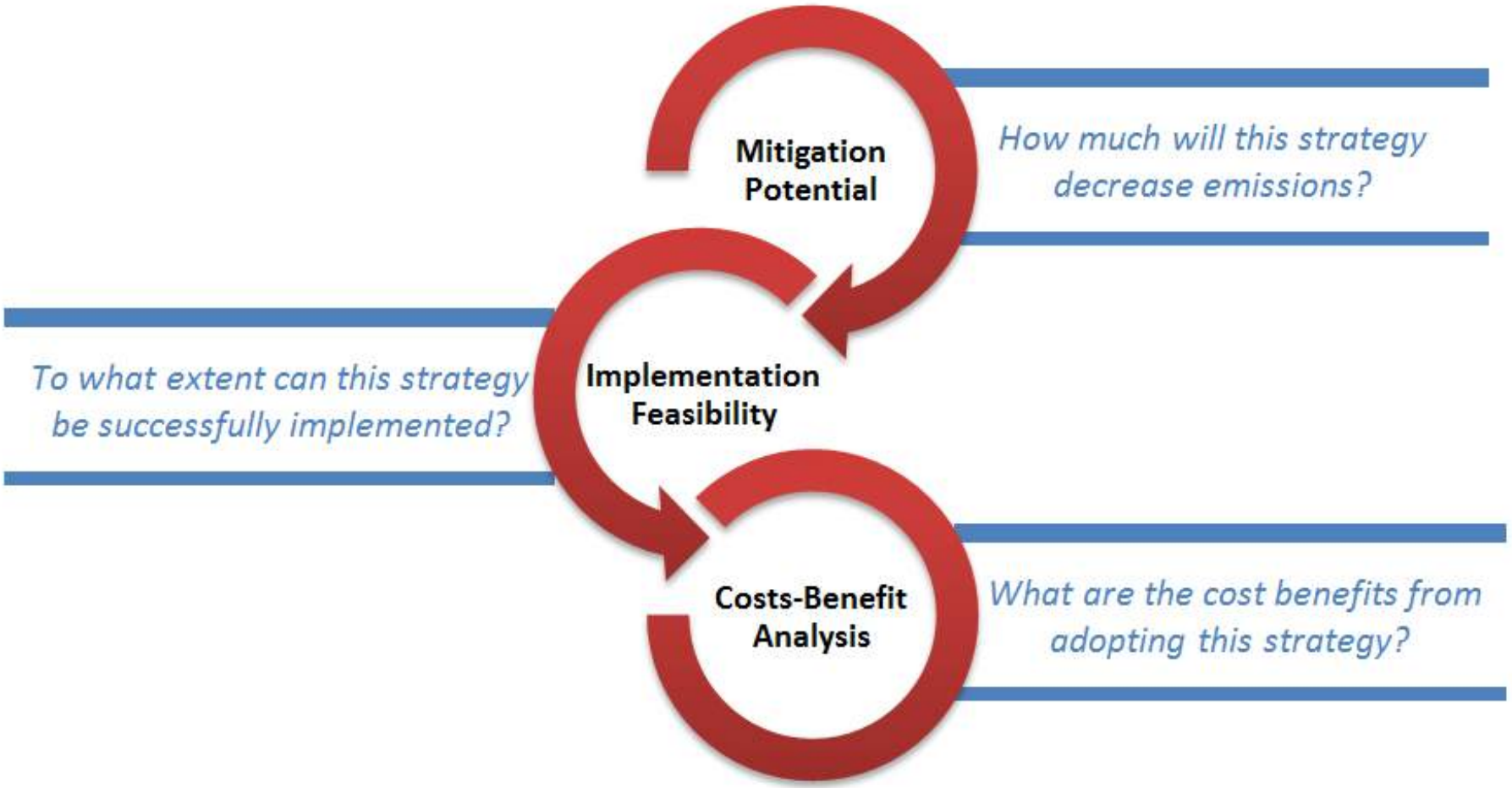
Source: FAO 2011

Existing Funding Mechanisms

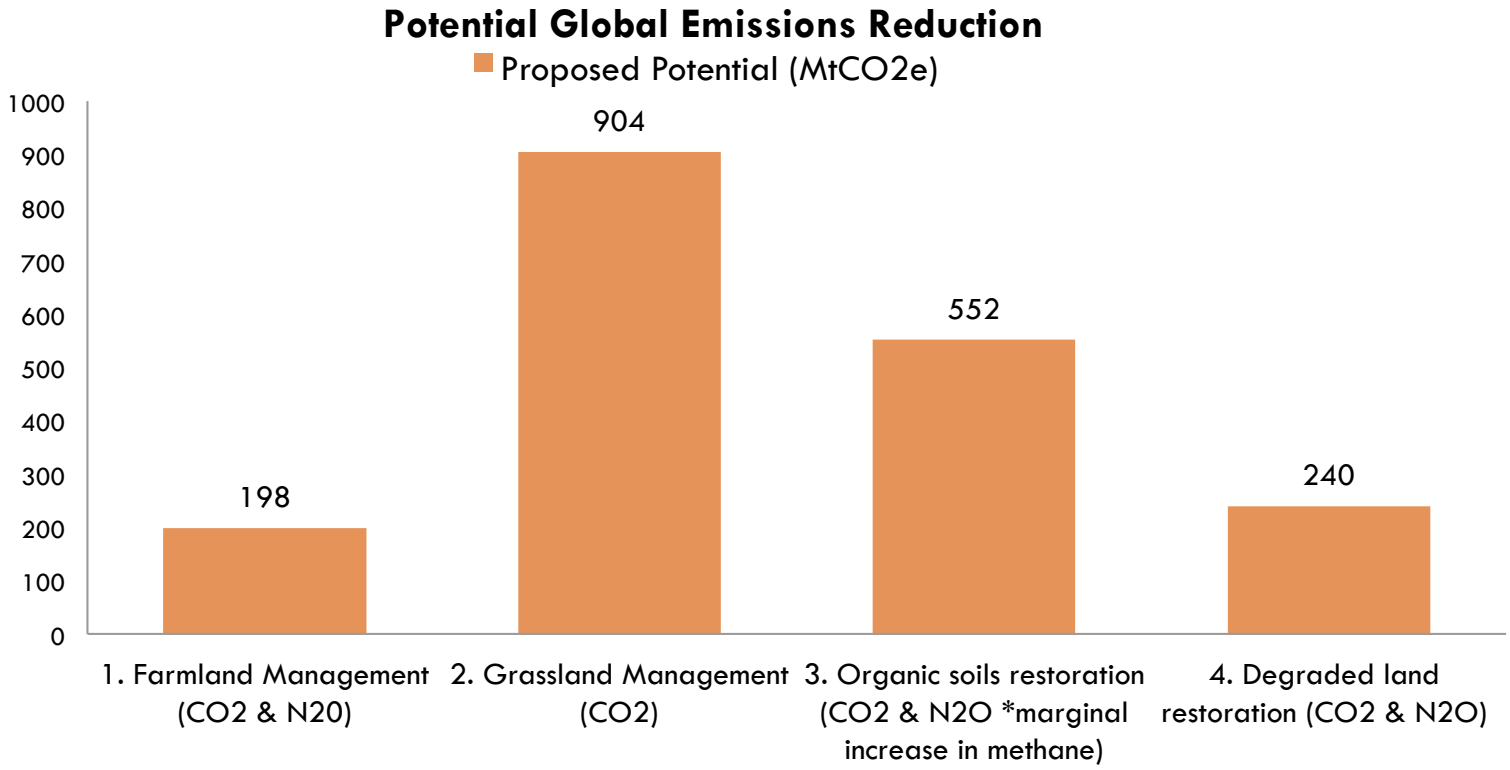
- UN-REDD Programme and REDD+.
- Forest Investment Program (FIP): $639 million to date.
- Forest Carbon Partnership Facility (FCPF): $160 million to date.

Abatement Potential & Mitigation Strategies

Selection Rationale

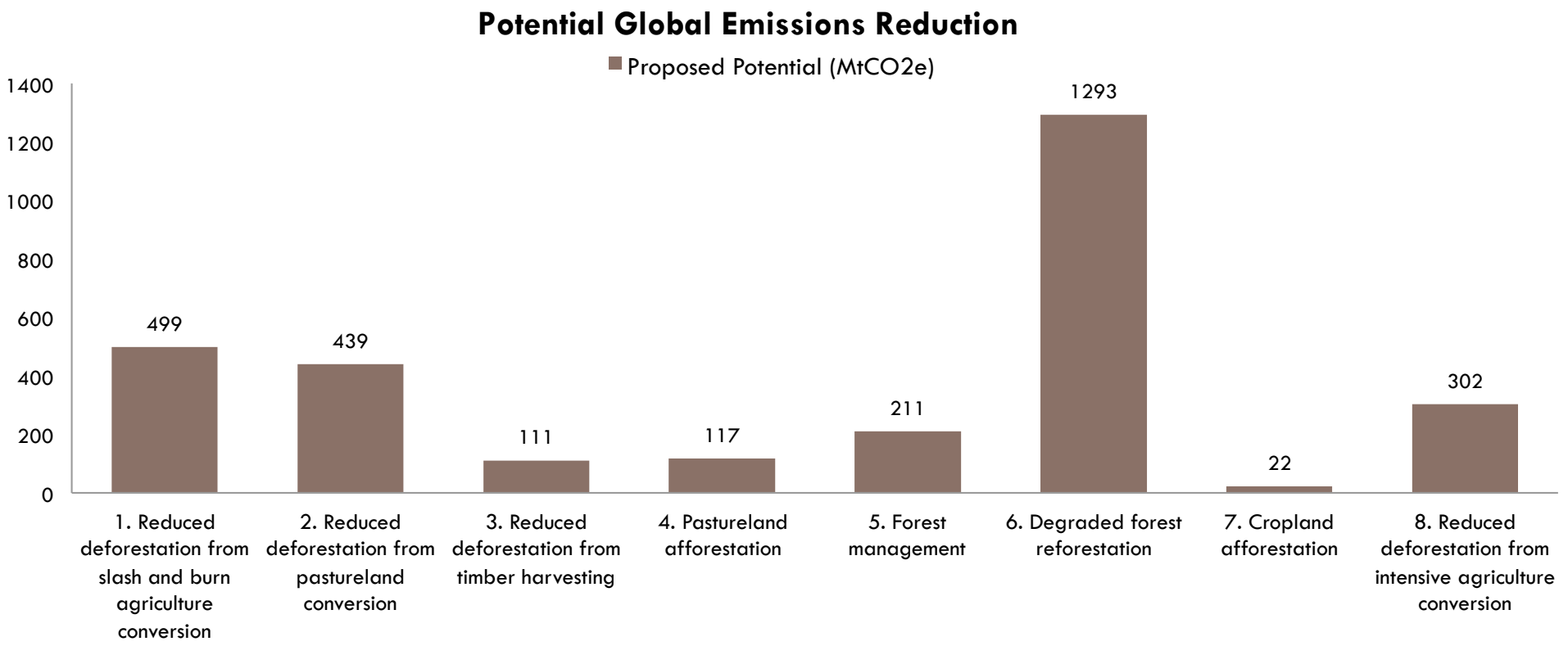


Proposed Agricultural Strategies - Potential



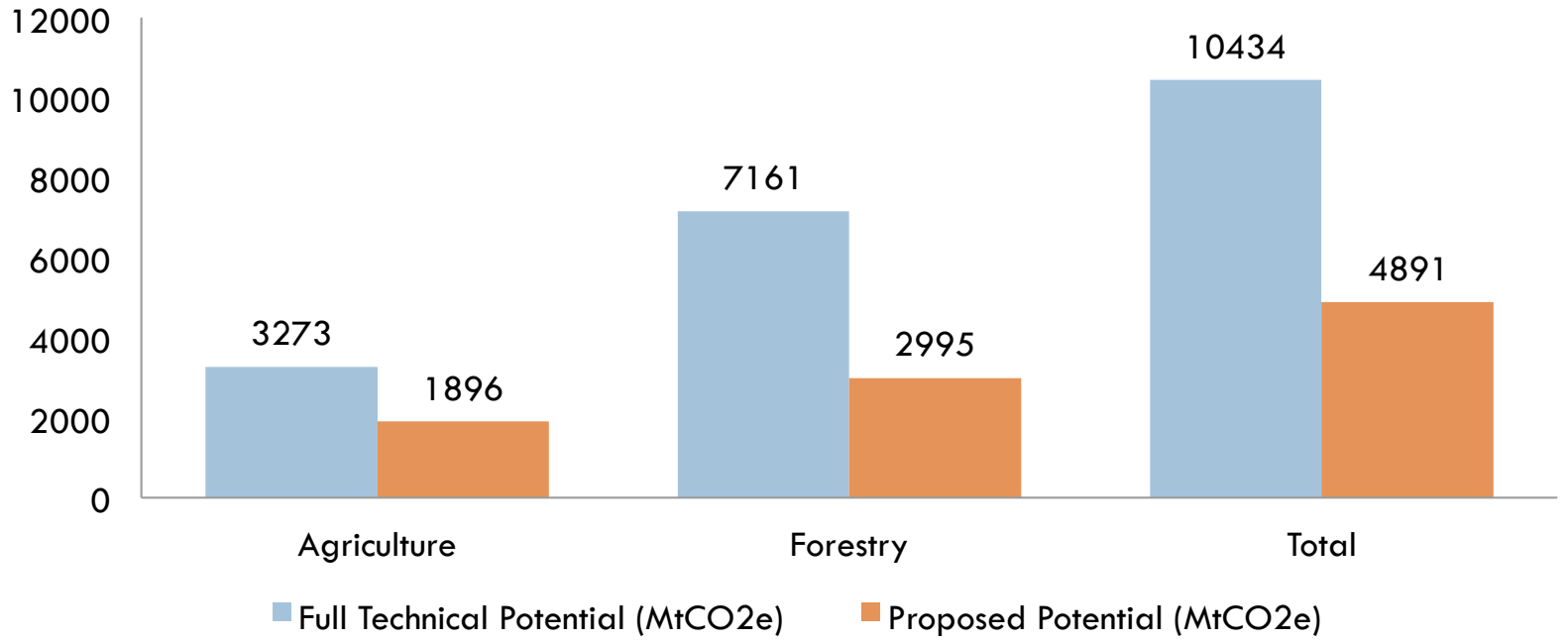
- Total Technical Potential from 4 Agriculture Mitigation Strategies : 3273 $MtCO_2e$.
- Proposed Potential : 1896 $MtCO_2e$ (58% of total potential).
- Cost Savings on global, national and local level - $8bn (2020), $3bn (2030).

Proposed LULUCF Strategies - Potential



- Total Technical Potential from 8 Agriculture Mitigation Strategies : 7161 $MtCO_2e$.
- Proposed Potential : 2995 $MtCO_2e$.

Proposed Mitigation Strategies – Total



- Total Technical Potential from 12 Mitigation Strategies : 10434 $MtCO_2e$.
- Proposed Potential : 4891 $MtCO_2e$ (47% of total potential).

Barriers & Recommendations

Agriculture - Barriers

- Uncertainty, risk, and high upfront costs for smallholders.
- Politically motivated subsidies.
- Poor R&D, lack of access to information, and lack of locally informed professionals in developing world.
- Industrial and political dominance of large agribusiness and fertilizer companies.

Agriculture - Recommendations

- Short-to-medium time frame (present – 2030).
  - Leverage cost savings opportunities in agriculture.
  - Leverage abatement potential in major economies (US, China and India) to drive funding, research, technical assistance and capacity building.
- China & India: Incentivize smallholder farmers through access to credit, insurance, supply-chain support.
- Incentivize better corporate behavior through taxation policies and support NGO lobbying for improvements of supply chain for food and beverage industry.

Forestry - Barriers

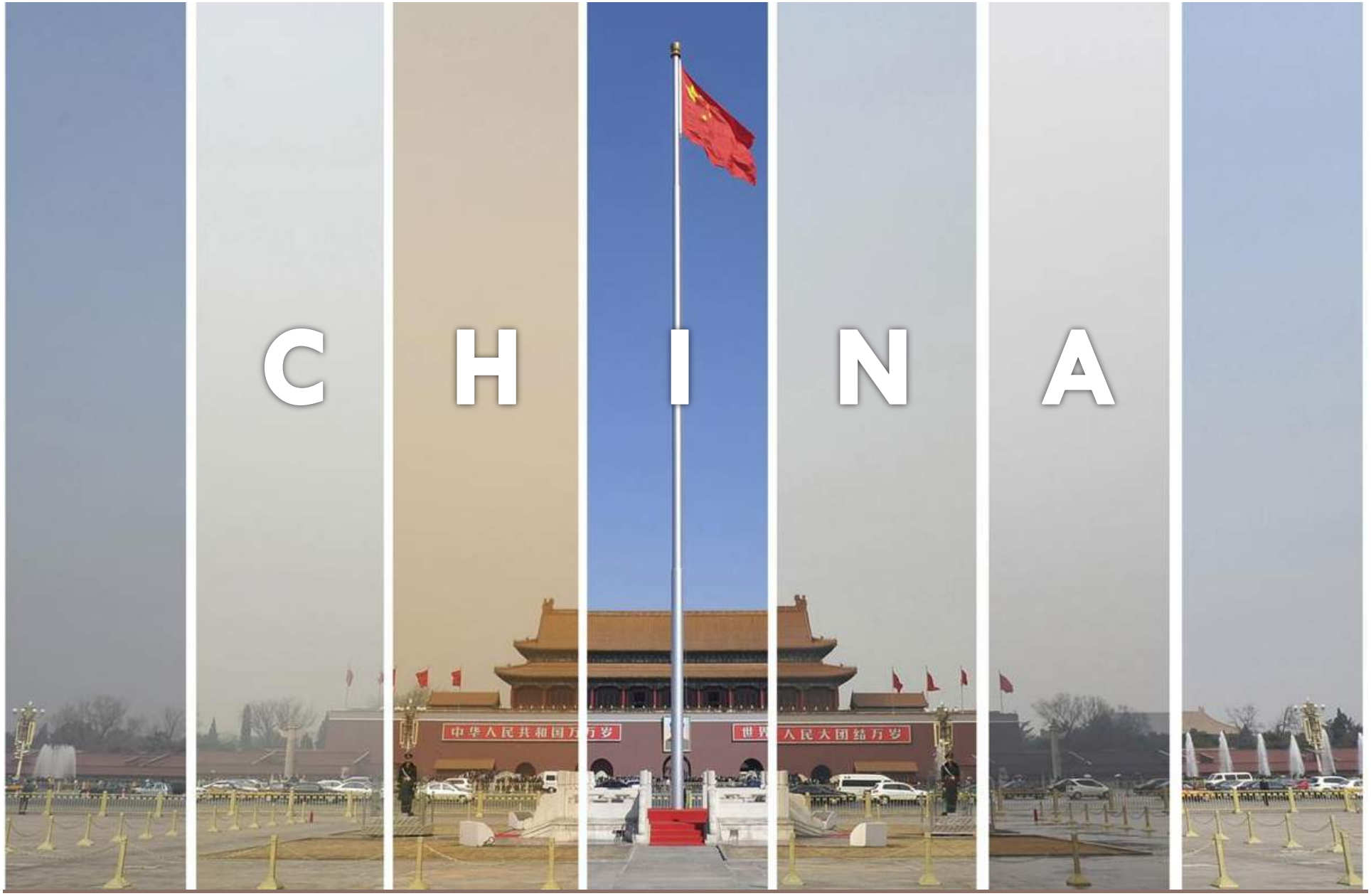
- Difficulty in institutionalizing and devolving MRV practices.
- Physical, market, and financial pressures from land-use regulation and macroeconomic policies.
- Activities other than reforestation/afforestation are not included under the CDM.
- REDD does not fund local level projects which could inform national action plans.

Forestry - Recommendations

- Increasing funding for technology transfers and MRV, including Landsat forest cover monitoring systems, at the local, regional, and national levels.
- Federal governments can incentivize public-private partnerships at subnational level to realize national level plans.
- Expanding the CDM's mandate to apply to other LULUCF-related activities.

Conclusion

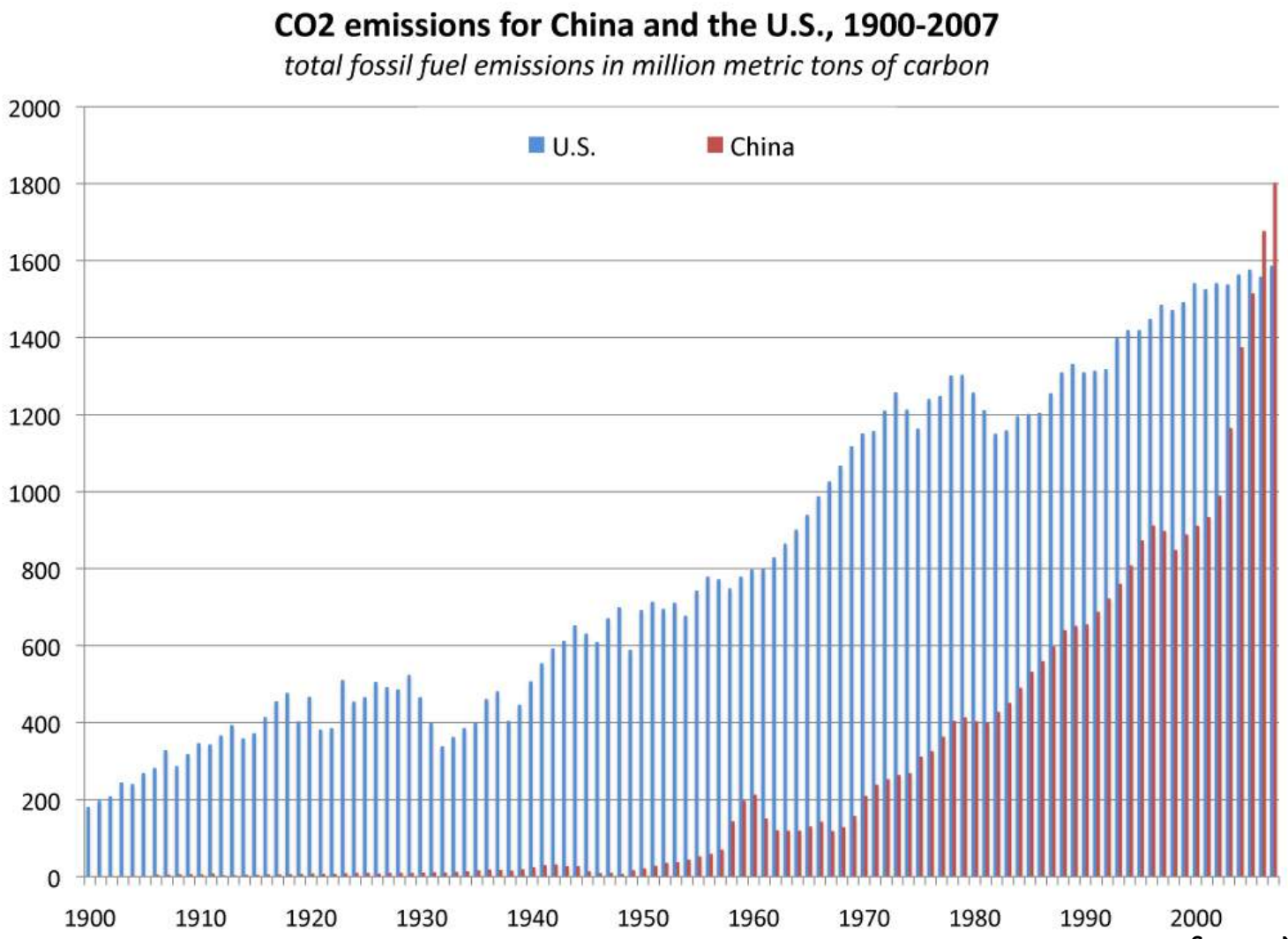
- Must overcome barriers by:
  - Changing incentives for supply chain actors.
  - Influencing the market.
  - Improving monitoring, reporting and valuation.
  - Building on existing initiatives: expand REDD+.
- Agriculture & LULUCF is a story about Brazil, Indonesia, China, U.S.
  - DRC & CAR: Impetus for political stability.


C H I N A

Outline

- Introduction
- Emissions Rationale
- Co-benefits and Policy
- Industry
  - Energy Production
  - Energy Efficiency
  - Transport & Buildings
- Conclusion

Introduction



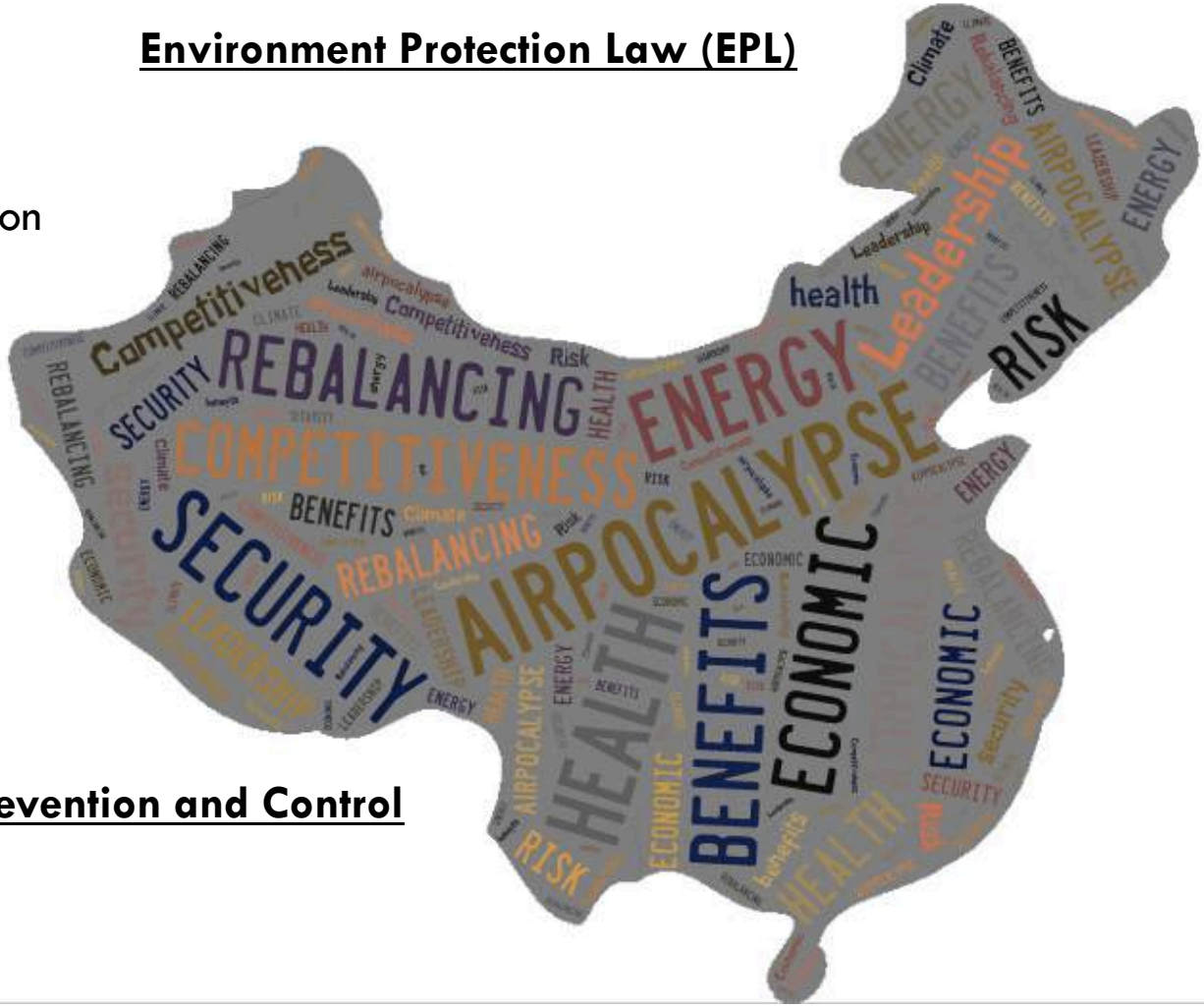
Source: Mongabay, 2009

Identifying Co-benefits and Policy

12th Five-Year Plan (FYP)

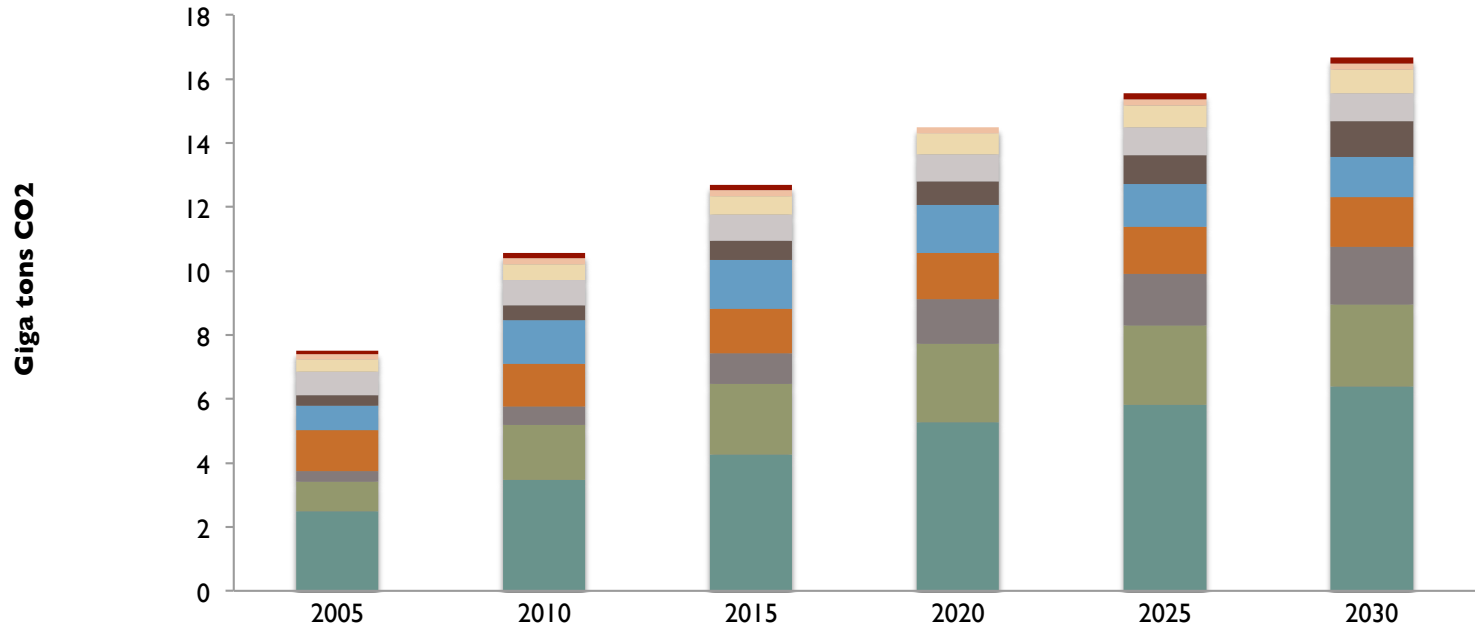
- Sustainable growth
- Industrial upgrading
- Promoting domestic consumption
- Priority Industries
  - Energy
  - Automotive
  - IT Infrastructure
  - Biotechnology

Environment Protection Law (EPL)



State Council Action Plan on Prevention and Control of Air Pollution

Emissions Rationale



	2005	2010	2015	2020	2025	2030
Cement	0.109	0.153	0.178	0	0.189	0.182
Waste	0.174	0.18	0.186	0.19	0.195	0.2
Chemicals	0.394	0.488	0.561	0.65	0.684	0.728
Agriculture	0.738	0.814	0.841	0.847	0.868	0.862
Forestry	0.324	0.456	0.601	0.733	0.896	1.117
Iron and Steel	0.749	1.364	1.521	1.522	1.338	1.273
Petroleum and gas	1.278	1.321	1.374	1.435	1.49	1.547
Other industry	0.343	0.583	0.98	1.387	1.59	1.809
Transport road	0.91	1.731	2.185	2.451	2.508	2.566
Power	2.5	3.46	4.273	5.28	5.802	6.38

Source: McKinsey, 2009

Airpocalypse

- Triggering policy changes
  - Shift in production (East to West)
- 12th Five-Year Plan (2011-2015) sets a cap on total production of coal by 2015 and requires large coal plants (600 Megawatts or greater) to employ supercritical or ultra-supercritical technology.
- The overall goal of the increased efficiency standards for coal plants is to reduce the carbon intensity of power generation no less than 17 percent (from 2010) by 2015 and 40-45 percent by 2020.

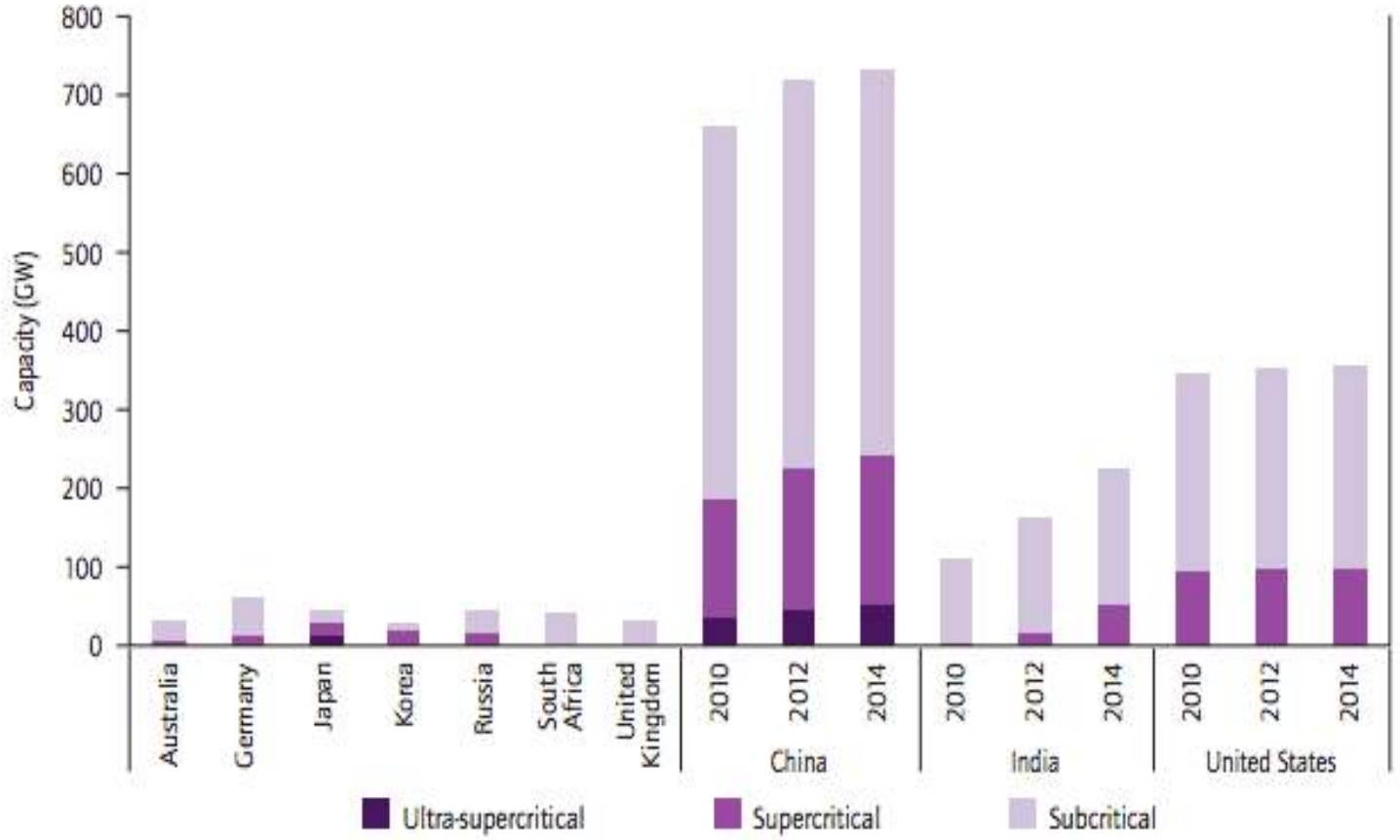
Air Pollution – Policy Goals

- 12th Five-Year Plan (2011-2015) sets a cap on total production of coal by 2015 and requires large coal plants (600 Megawatts or greater) to employ supercritical or ultra-supercritical technology.
- The overall goal of the increased efficiency standards for coal plants is to reduce the carbon intensity of power generation no less than 17 percent (from 2010) by 2015 and 40-45 percent by 2020.

Recommendation: CCS

- **Policymakers in China should enact clearer regulatory guidelines around the implementation of CCS technology.**
  - The State Council Action Plan on Prevention and Control of Air Pollution, March 5th
  - Fight pollution with the "same determination" with which the government fought poverty
  - Regulatory reforms part of the plan

Installed HELE Capacity China / Worldwide



Source: OECD/ IEA, 2012

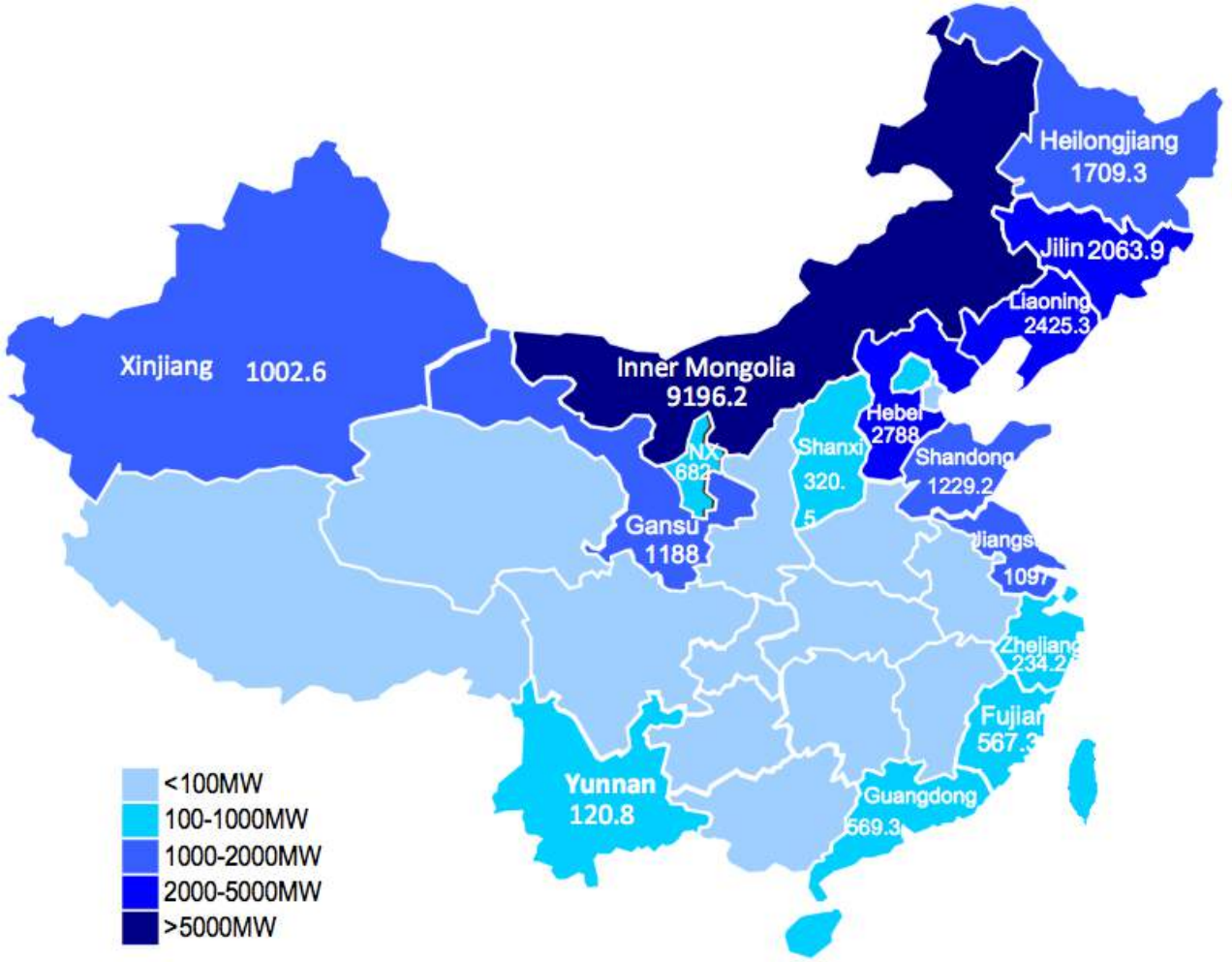
Recommendation – HELE / CCS

- **Policymakers should move towards limiting CO_2 emissions in an effort to spur the adoption of high-efficiency low-emission technology in new coal generation.**
  - Chinese government is careful in pushing for CCS, approving only 100 pilot programs and being stringent with subsidies, asking mostly for companies to pay for technology development.

Renewables Challenges – Grid in China

Source: Wang, 2009.

Renewables - Installed Wind Capacity



CWEA, 2010.

Renewables Recommendations

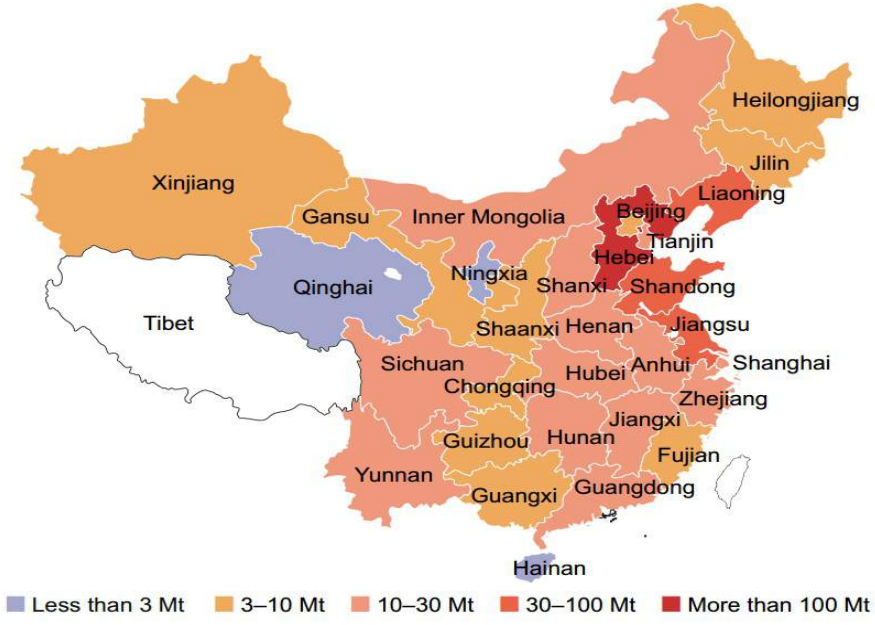
- **The Chinese government should relax rigid electricity market structures that reduce incentives to invest in renewable technologies.** Long-term contracts lock different regions into selling at fixed prices, often at a loss, thus discouraging investment in renewables capacity.

Industry – Energy Production

Energy Production	2005	2010	2015	2020	2025	2030
BAU	2.5	3.46	4.273	5.28	5.802	6.38
Full Technical Potential	2.756	2.756	2.756	2.756	2.756	2.756
Abatement ($GtCO_2e$)			**0.612**	**1.008**	**1.916**	**3.624**

Industry – Energy Efficiency: Iron & Steel

Iron & Steel	2005	2010	2015	2020	2025	2030
BAU	1.092	2.015	2.534	2.825	2.883	2.940
Full Technical Potential	1.092	2.015	2.260	2.293	1.891	1.424
Abatement ($GtCO_2e$)			**0.274**	**0.532**	**0.992**	**1.516**



Source: Reserve Bank of Australia, 2009

- Largest Producer of Steel
  - 716 million tonnes
  - Japan -107.2 million tonnes
- Hebei, Liaoning, Shandong, Jiangsu
- BOF constitutes 90%
  - EAF only 10%

Industry – Energy Efficiency: Iron & Steel

Barriers

- Administrative capacity of Environment Ministry
- Lack of firm, local, and provincial level technical data
- Industrial nationalism: symbol of development
- Financing costs and challenges for smaller producers

Industry – Energy Efficiency: Iron & Steel

Recommendations

- Encourage more Electric Arc Furnace adoption through subsidies
- Expand the availability of emissions data
- Engage in multilateral and bilateral technology programs

Industry – Transport & Buildings

A story of mega-cities and population clusters…

Transport	2005	2010	2015	2020	2025	2030
BAU	0.343	0.583	0.98	1.387	1.59	1.81
Full Technical Potential	0.343	0.583	0.916	1.202	1.28	1.349
Abatement ($GtCO_2e$)			**0.064**	**0.185**	**0.31**	**0.46**

Source: McKinsey, 2009

Buildings	2005	2010	2015	2020	2025	2030
BAU	2005	2010	2015	2020	2025	2030
Full Technical Potential	0.906	1.343	1.649	2.004	2.213	2.443
Abatement ($GtCO_2e$)			**1.56**	**1.755**	**1.776**	**1.825**

Source: McKinsey, 2009

With the majority of the population slated to live in these **mega urban centers,** challenge will be **to strike the perfect balance between productivity, improved urban quality of life and environmental soundness.**

Conclusion

"China is a "cross the river by feeling the stones" country, often employing pilot programs to test new strategies and policies before deciding whether to scale-up"

Multi-pronged approach: increasing industry standards, changing consumer and market behavior, investing in technology

Address the issues based on co-benefits to domestic issues, international recognition less convincing for change

India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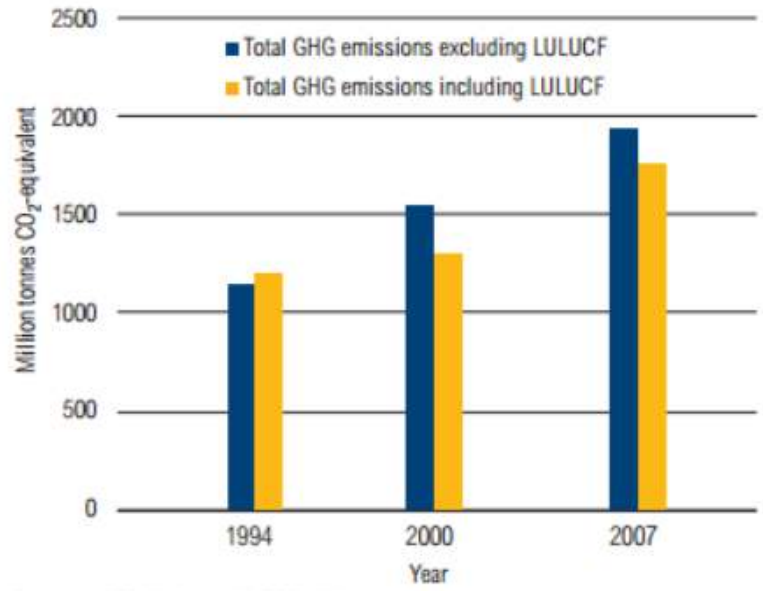
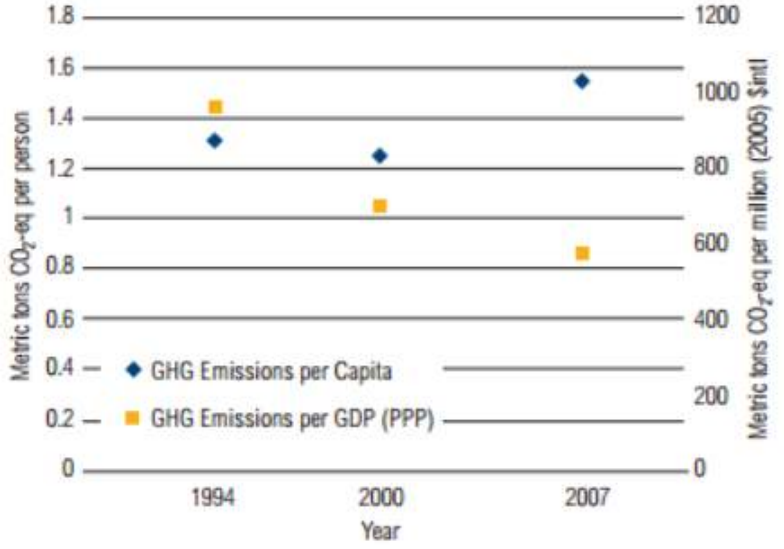
GHG Emissions

| Total India GHG Emissions



Sources: MoEF, 2012; and UNFCCC, 2014.

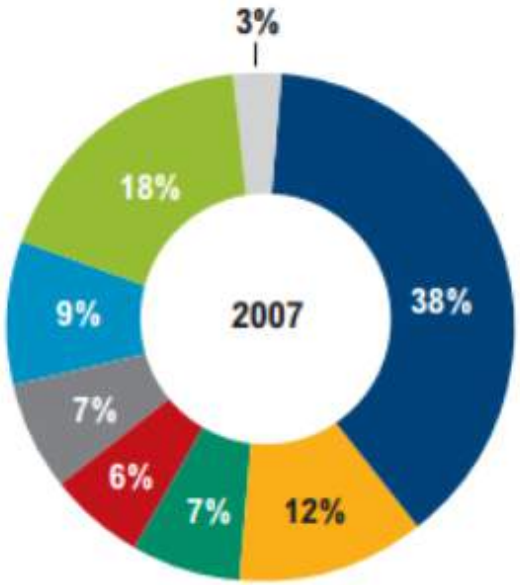
| India GHG Emissions per Capita and GHG Emissions Intensity



Source: Calculated using MoEF, 2012; UNFCCC, 2014; and World Bank, 2014.
Note: GHG emissions totals include the land use, land-use change, and forestry (LULUCF) sector.

Emissions profile

Emissions from Key Sectors and their Corresponding Nodal Ministries/Agencies with Legal Authorities



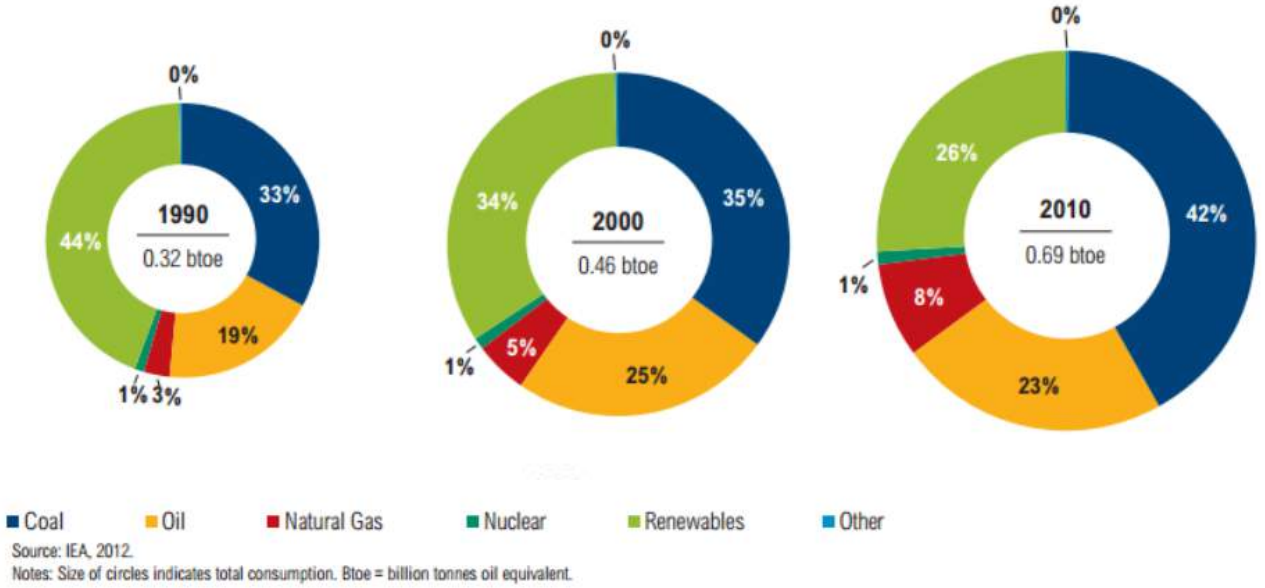
Source: INCCA, 2010a; and author assessment.

SECTOR	NODAL MINISTRY/AGENCY
Electricity	Central Electricity Authority (CEA); Central Electricity Regulatory Commission (CERC) and State Electricity Regulatory Commissions (SERCs)
Other energy industries	Ministry of Power (MoP); Ministry of New and Renewable Energy (MoNRE); Central Electricity Authority (CEA); Central Electricity Regulatory Commission (CERC) and State Electricity Regulatory Commissions (SERCs); Bureau of Energy Efficiency (BEE)
Transport	Ministry of Road Transport and Highways (MoRTH); Ministry of Environment & Forests (MoEF); Central Pollution Control Board (CPCB) and the State Pollution Control Boards (SPCBs)
Iron & steel	Ministry of Iron and Steel; Ministry of Power (MoP); Bureau of Energy Efficiency (BEE)
Cement	Ministry of Industry; Ministry of Power (MoP); Bureau of Energy Efficiency (BEE)
Other mfg. industries	Ministry of Industry; Ministry of Power (MoP); Bureau of Energy Efficiency (BEE)
Agriculture	Ministry of Agriculture
Waste	Ministry of Environment & Forests (MoEF); Ministry of Industry; Central Pollution Control Board (CPCB) and the State Pollution Control Boards (SPCBs)

Energy production

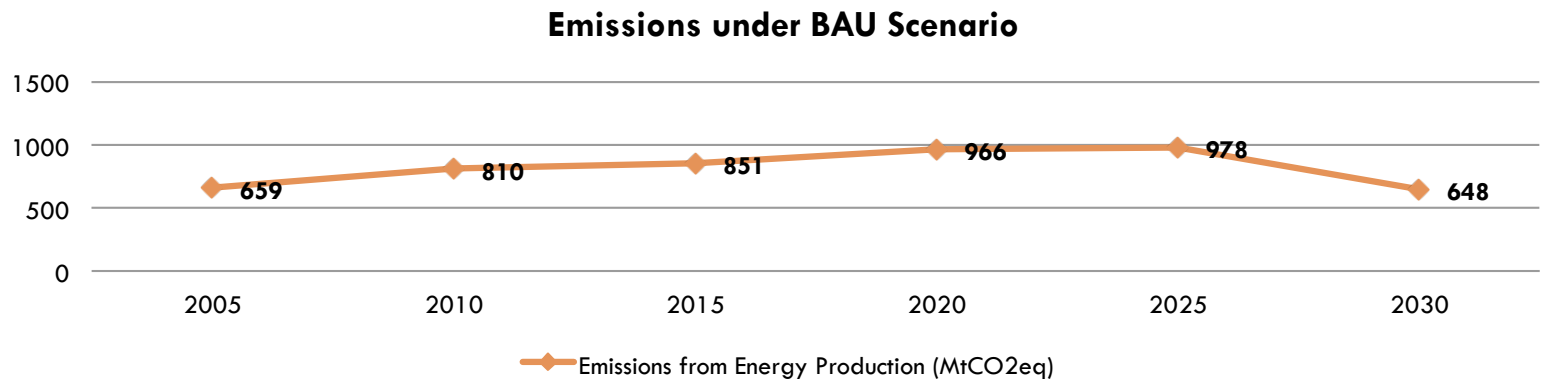
- Narrative of development, energy security & co-benefits
- Energy production capacity increasing (CSO)
  - 670 MTOE (2016-2017), 71% of demand
  - 844 MTOE (2021-2022), 69% of demand

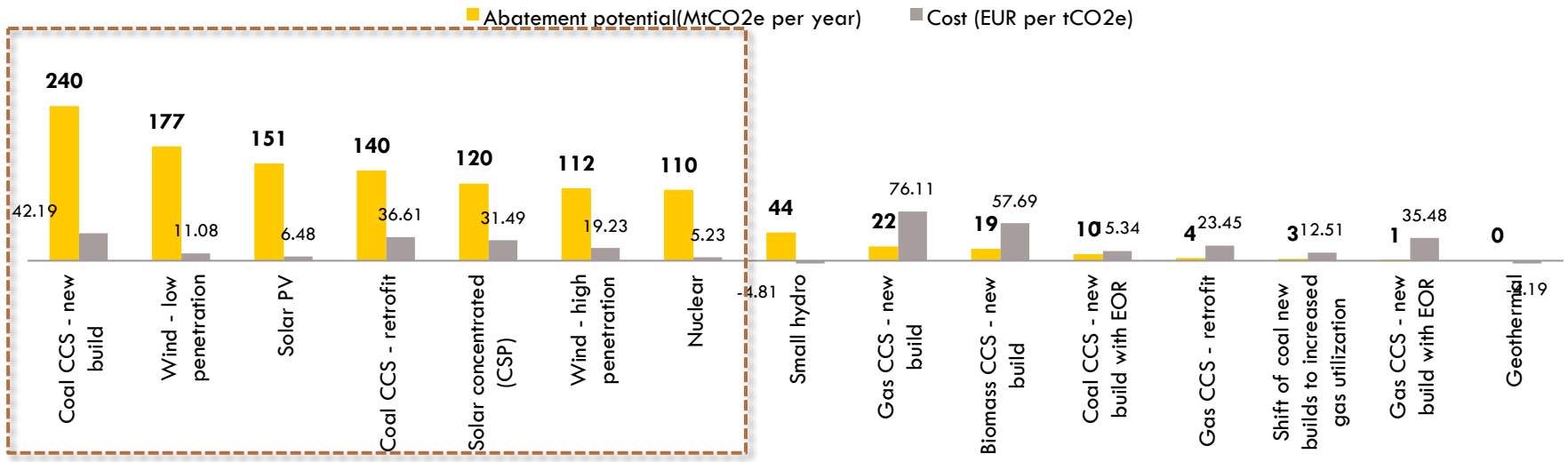
- Contribution to energy production 1990-2010 (EIA)
  - Renewables ↑30%, Coal ↑180% , Gas ↑400%, Oil ↑164%
- Energy consumption of electricity sector 23% →38%



Source: IEA, 2012.
Notes: Size of circles indicates total consumption. Btoe = billion tonnes oil equivalent.

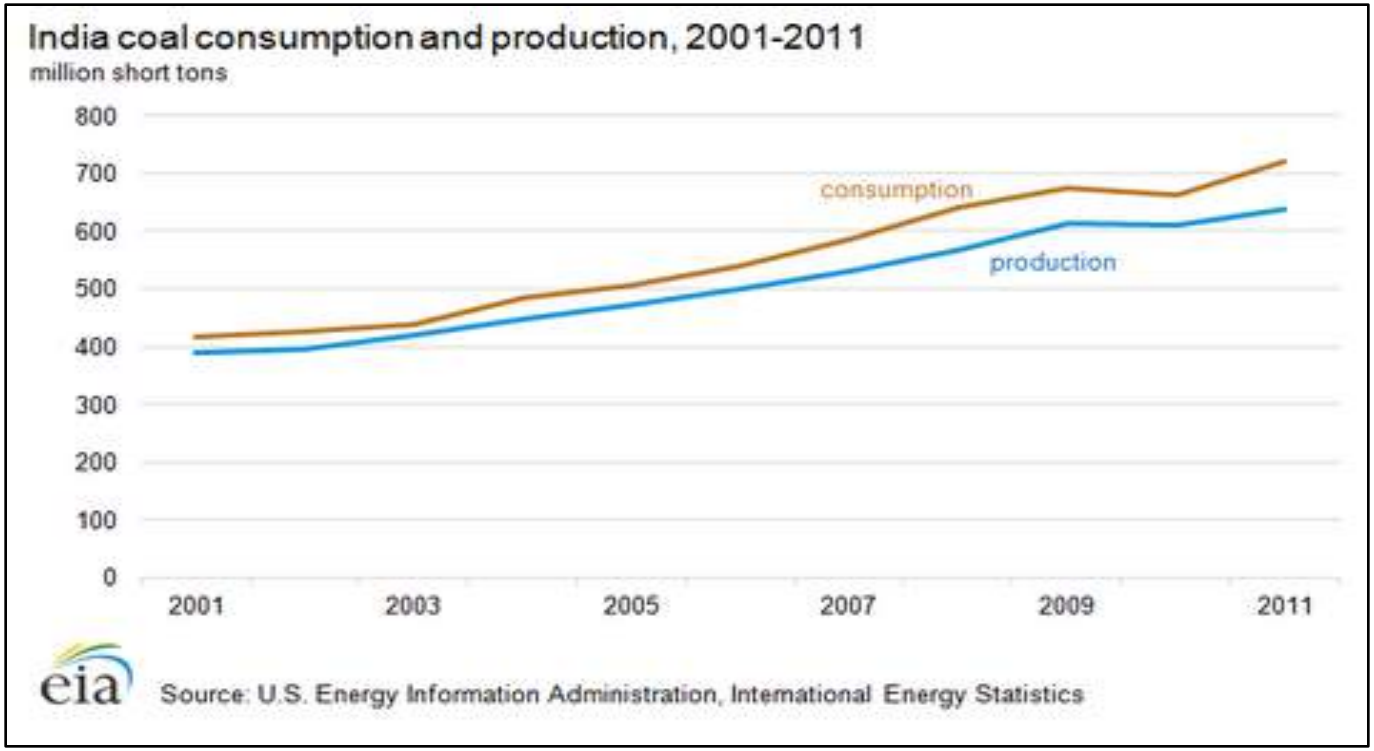
Energy production - Emissions





COAL DEPENDENCE AND TRANSITION TO LOW-CARBON GENERATION TECHNOLOGIES

- Dependence on coal : Resources + Infrastructure
- Domestic Production needs to increase 8% annually along with imports
- 572 proposed plants, very small % of HELE



CCS

- CCS as a long term strategy
- Fit into overall goals for greater electrification

Barriers

- Technical Barriers
  - Department of Science and Technology (DST) runs the National Program on Carbon Sequestration (NPCS) – Long Term Strategy
  - Lack of demonstration via large scale deployment internationally.
  - Lack of accurate geological storage site.
- Financial Barriers
  - Per Unit Cost & Output
  - Capital Costs
- Institutional Barriers
  - Retrofitting impact on TOR
  - Regulation requirements linked with finance

Recommendations

- Knowledge Building & Capacity Development
  - Educating Policy Makers
- Storage Site Assessments
  - Technical Training for CCS outcomes
  - Involvements with site assessments abroad
- Capacity development of Financial Institutions
  - Different norms demand different types of financial evaluation
  - Global practices and legislation development

HELE

- Medium term strategy
- 13th Five Year Plan – All new plants must be supercritical

Barriers

- Technical Barriers
  - Varying qualities – Gasification Challenges
  - Component Erosion
  - O&M Standards and variations
- Financial & Institutional Barriers
  - IP rights
  - Environment for technology dissemination
  - Financial incentives for new tech distorted by market structure
  - CDM

- Other Coal Related Policies
  - Taxation Policy
  - Low cost alternatives

Recommendations

- Identify R&D Priorities.
  - Larger (660/800 megawatt [MW]) thermal units based on supercritical technology
  - Align policy planning, finance, regulation
- Regulatory & Financial Incentives
  - Efficiency and emissions related regulatory incentives
  - Public Private Partnerships
- Capacity Development
  - O&M capacities
  - Technology transfer mechanism under the UNFCCC.

RENEWABLES : WIND

- High Potential : Low Penetration (171mtco2e) , High Penetration (112 MtCo2eq)
- Twelfth Five Year Plan : 1,03,000 MW by 2030, 30,000MW by 2020

Barriers

- Technical Barriers
  - Wind potential is unevenly distributed and concentrated in 5 states
  - Seasonal and intraday variations
  - Intermittent Backup capacity
- Institutional Barriers
  - Land Availability
  - Accelerated tax depreciation policy

Recommendations

- Regional Planning & Coordination
  - Regulatory Framework for RPOs
- Revisit Land tenure policies
- Invest in R&D
  - Storage (compressed air and high power density batteries)
  - Complementary Sources
- Increase competitiveness and drive down prices
  - Suppliers control from proposal to O&M
  - More expensive
- Explore Off-shore potential

RENEWABLES : SOLAR

- JNNSM : 20,000 megawatts (MW) of grid- connected solar power by 2022.
- Two major types incentives : Generation based and capital subsidies.
- Bundling & Reverse Auctioning > 2000 MW

- Financial Barriers
  - Limited availability of unallocated thermal generation
  - Lack of SCB involvement (Risk & Crowding out by concessional lending)
  - Phase II of JNNSM will require US $4.1b
- Technical Barriers
  - Lack raw materials, limited access to low-cost financing, underdeveloped supply chains.
- Institutional Barriers
  - Planning Challenges e.g Domestic Content Requirement (DCR
  - Regulatory Quagmire for Land Use

Recommendations

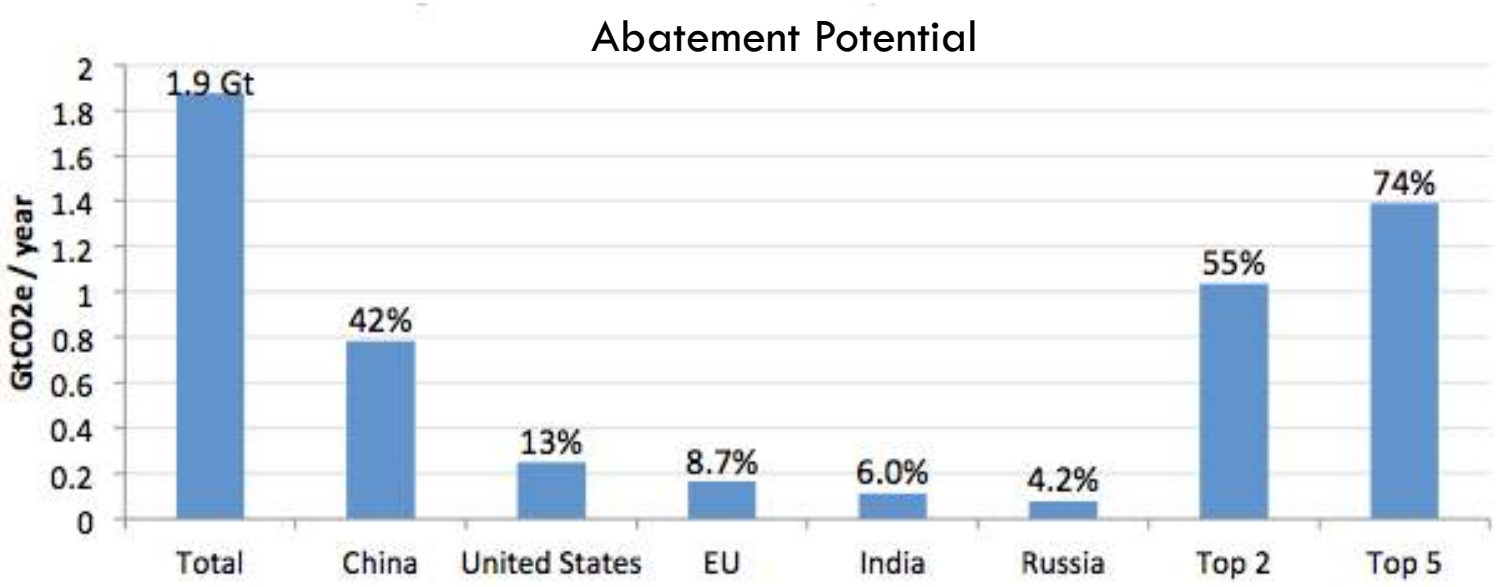
- Address structural impediments to Public Finance
  - Risk-reducing instruments and financial innovations
- Encourage local manufacturing through coordinated industrial policies
  - DCR ⇔ Industry Policy
  - Comparative Advantage & Linkages
- Invest in Public Private Partnerships
  - Reduce Risk (Scoping)
  - Regulatory Standardization
- Adopt cluster based approach

Industry

- India has the fourth highest level of energy consumption for industrial activities in the world.
- Industrial sector CO_2 emissions (including direct and indirect emissions) in India in 2010 were 633 $MtCO_2$
- 38% of India's total CO_2 emissions
- Industrial emissions in India are expected to rise by 1.7 $GtCO_2e$ (165.2%) in the BAU scenario

Industry: Iron & Steel

- India's emissions from the iron and steel industry are the third highest in the world
- Current emissions are 0.3 $GtCO_2e$
- Expected to see a 0.4 $GtCO_2e$ (264.4%) increase by 2030

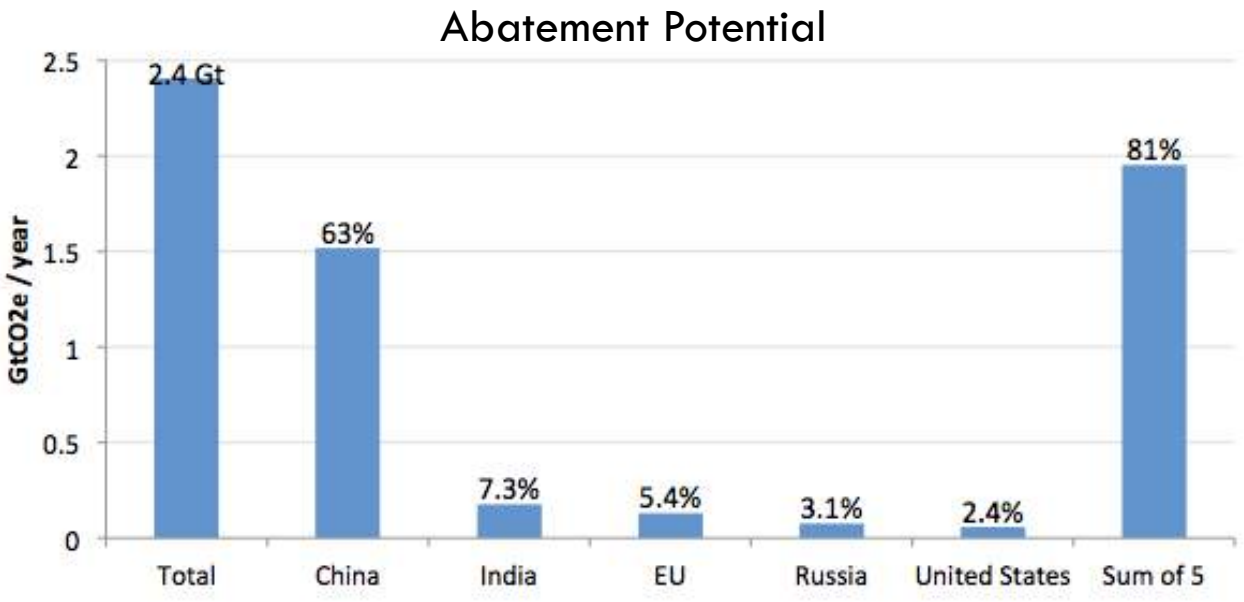


Industry: Iron & Steel

- Recommendations:
  - Energy Efficiency Improvements
    - Smelting reduction, FINEX
    - Top-gas recycling blast furnaces
  - Fuel and Feedstock Switching
    - Use of charcoal and waste plastics
    - Natural gas
    - More efficient coal
  - Co-generation or Combined Heat and Power (CHP)
  - Recycling and Recovery
    - Steel recycling
  - Carbon Capture and Sequestration (CCS)

Industry: Cement

- India's emissions from the cement industry are the third highest in the world
- Current emissions are 0.2 $GtCO_2e$
- India's cement industry emissions are projected to increase by 298.3%, a 0.5 $GtCO_2e$ rise, by 2030



Industry: Cement

- Recommendations:
  - Energy Efficiency Improvements
    - Clinker substitutes
    - Fluidized bed kilns
  - Fuel and Feedstock Switching
    - Natural gas
    - Alternative fuels
  - Co-generation or Combined Heat and Power (CHP)
  - Recycling and Recovery
  - Carbon Capture and Sequestration (CCS)

blogs.utexas.edu/mecc/