ENERGY EFFICIENCY

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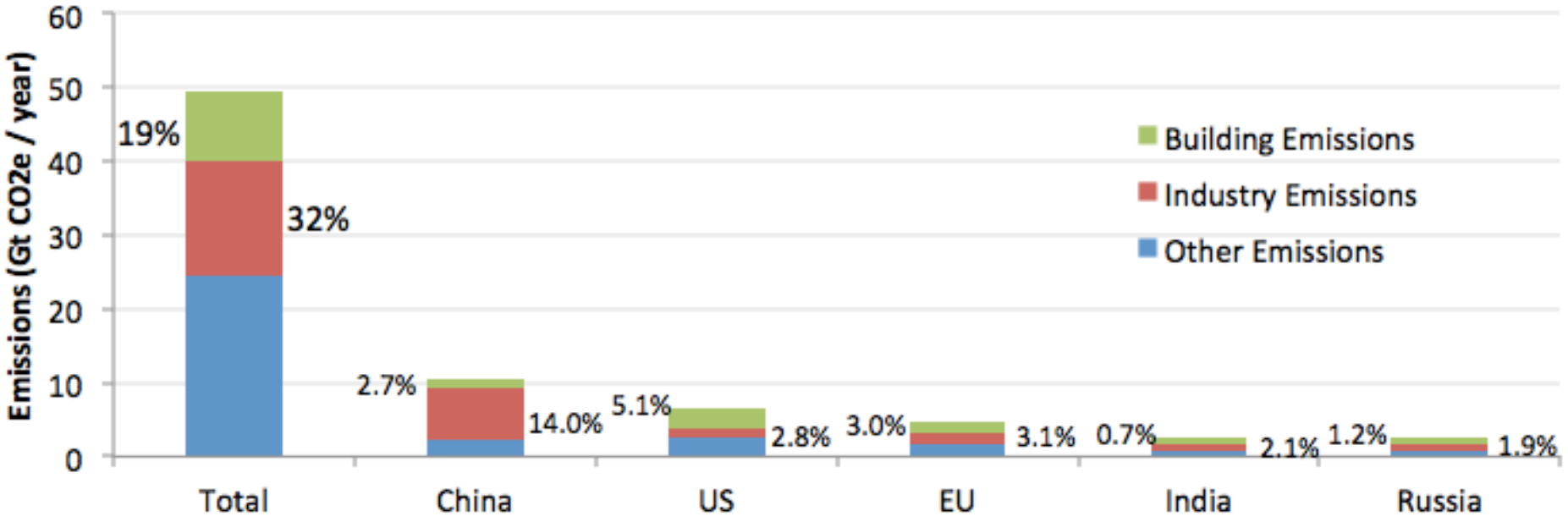
Introduction

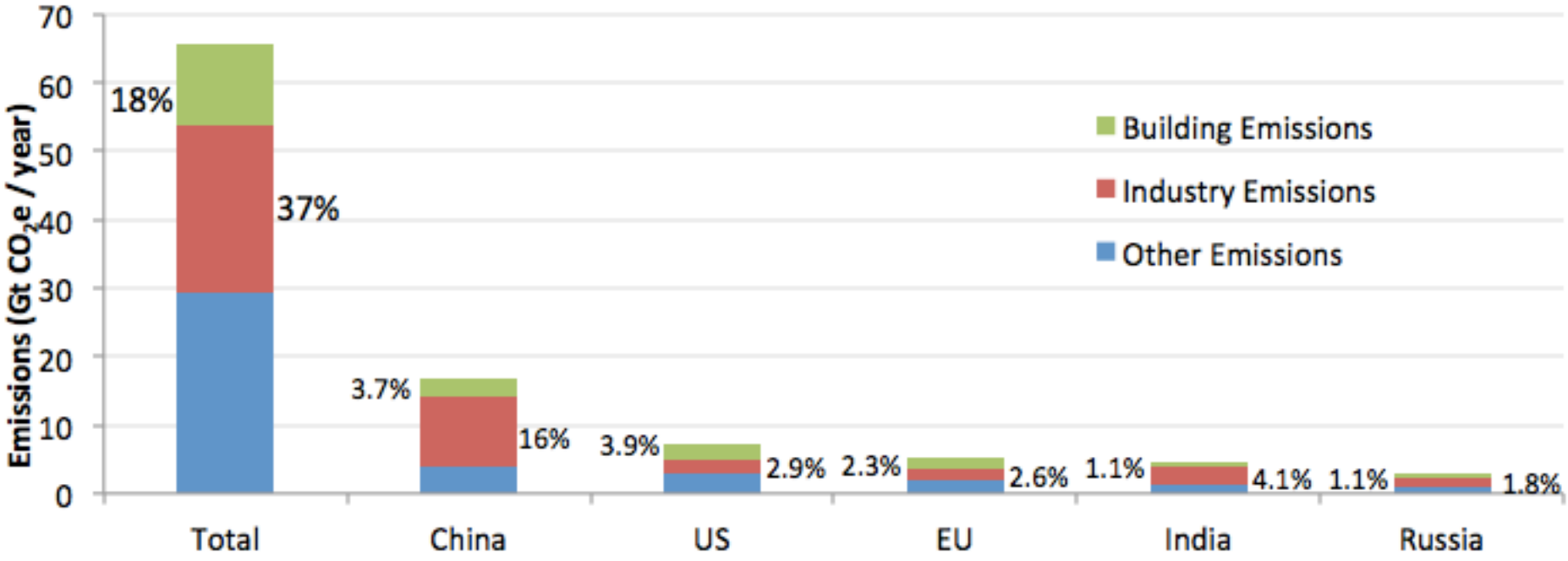
- Significant potential to reduce GHG emissions in energy efficiency sector:
  - Industry.
  - Buildings.
  - Smart Grid.

Current Emissions



Source: McKinsey & Company Climate Desk

2030 Projected Emissions



Source: McKinsey & Company Climate Desk

Energy Efficiency: Industry

- Chemicals
- Iron and Steel
- Cement

Energy Efficiency: Industry

- 32% of current global emissions.
- China, US, and EU.
- Business as Usual (BAU) scenario - 55.4% increase.
- Almost 7 $GtCO_2e$/year abatement potential.
- Industrial abatement measures (China, India, and the US) – would eliminate 8% of world's BAU emissions.

Industry (Continued)

- **Abatement Instruments:**
  - Energy Efficiency Improvements.
  - Fuel and Feedstock Switching.
  - Co-generation or Combined Heat and Power.
  - Recycling and Recovery.
  - Carbon Capture and Sequestration.

Barriers

- **Market Barriers:**
  - Short investment payback thresholds and risk.
  - Limited access to capital.
  - Access to international shipping.

- **Cultural/Informational Barriers:**
  - Industry's role in national security and economic development.
  - Health misinformation on alternative fuels.

Barriers (Continued)

- **Regulatory Barriers:**
  - Conflicting responsibilities of regulatory bodies.
  - Lack of enforcement resources.
  - Biofuel development vs. ammonia stock reductions.

Recommendations

- Increased government adoption of technological standards and incentives.

- Development and adoption of domestic programs that assist leading manufacturers.

Recommendations (continued)

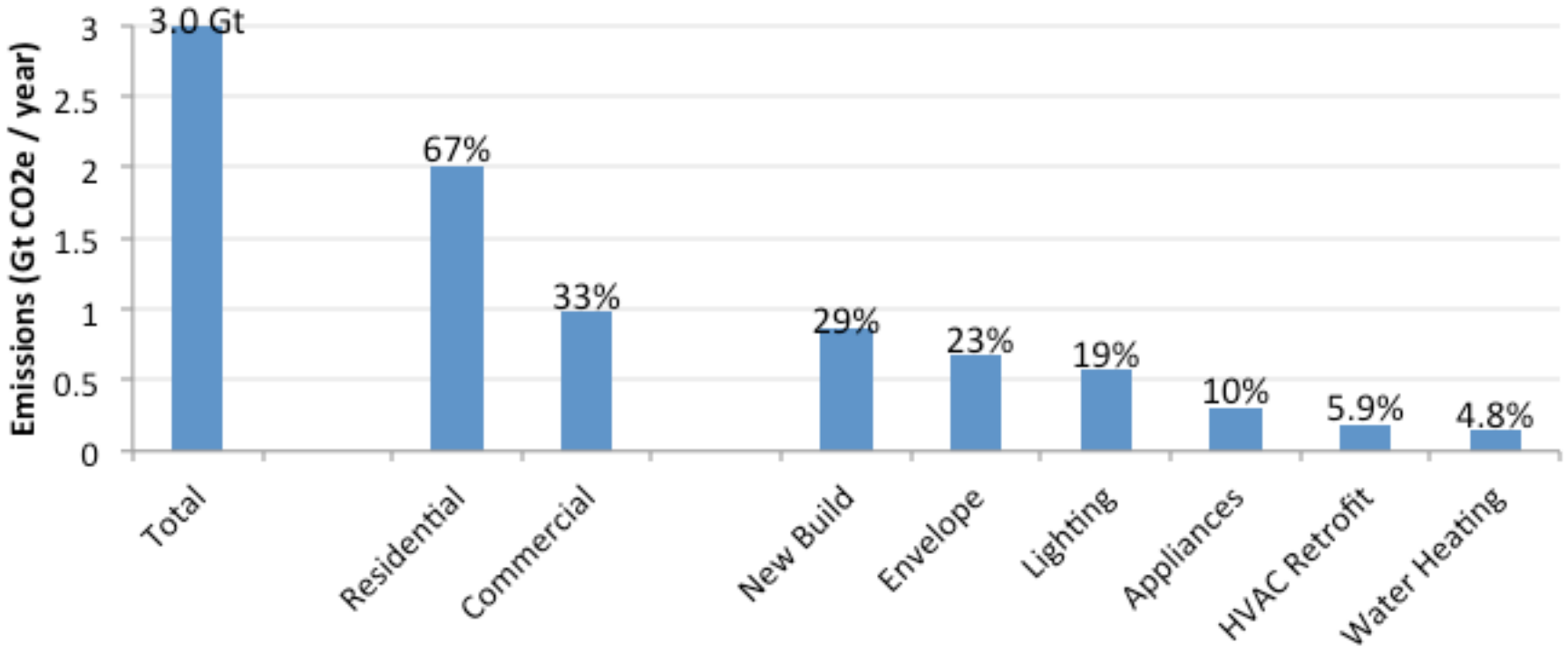
- Establish international venues to promote energy efficiency.

- Strengthen low-carbon chemical and steel joint ventures between developed and developing countries.

Energy Efficiency: Buildings

- 19% of current global emissions.
- US, EU, and China:
  - over 50% of emissions.
- BAU scenario - 26% increase by 2030.
- US, EU, and China abatement:
  - 14.5% of global BAU emissions in building sector.

2030 Abatement Potential



Source: McKinsey & Company Climate Desk

Abatement Instruments

Instrument	Overall Effectiveness	Cost Effectiveness
Appliance Standards	High	High
Energy Efficiency Obligations & Quotas	High	High
Demand-Side Management Programs (DSMs)	High	High
Labeling & Certification Programs	Medium	High
Building Codes	High	Medium
Energy Audits	High	Medium

Source: UNEP SBCI, *Buildings and Climate Change: Summary for Decision-Makers*, pg. 24

Barriers

- **Market Barriers:**
  - Fragmentation of stakeholders.
  - Upfront costs and delayed payback period.

- **Information Barriers:**
  - Inflated costs.
  - Lack of awareness.
  - Access to information & imperfect information.

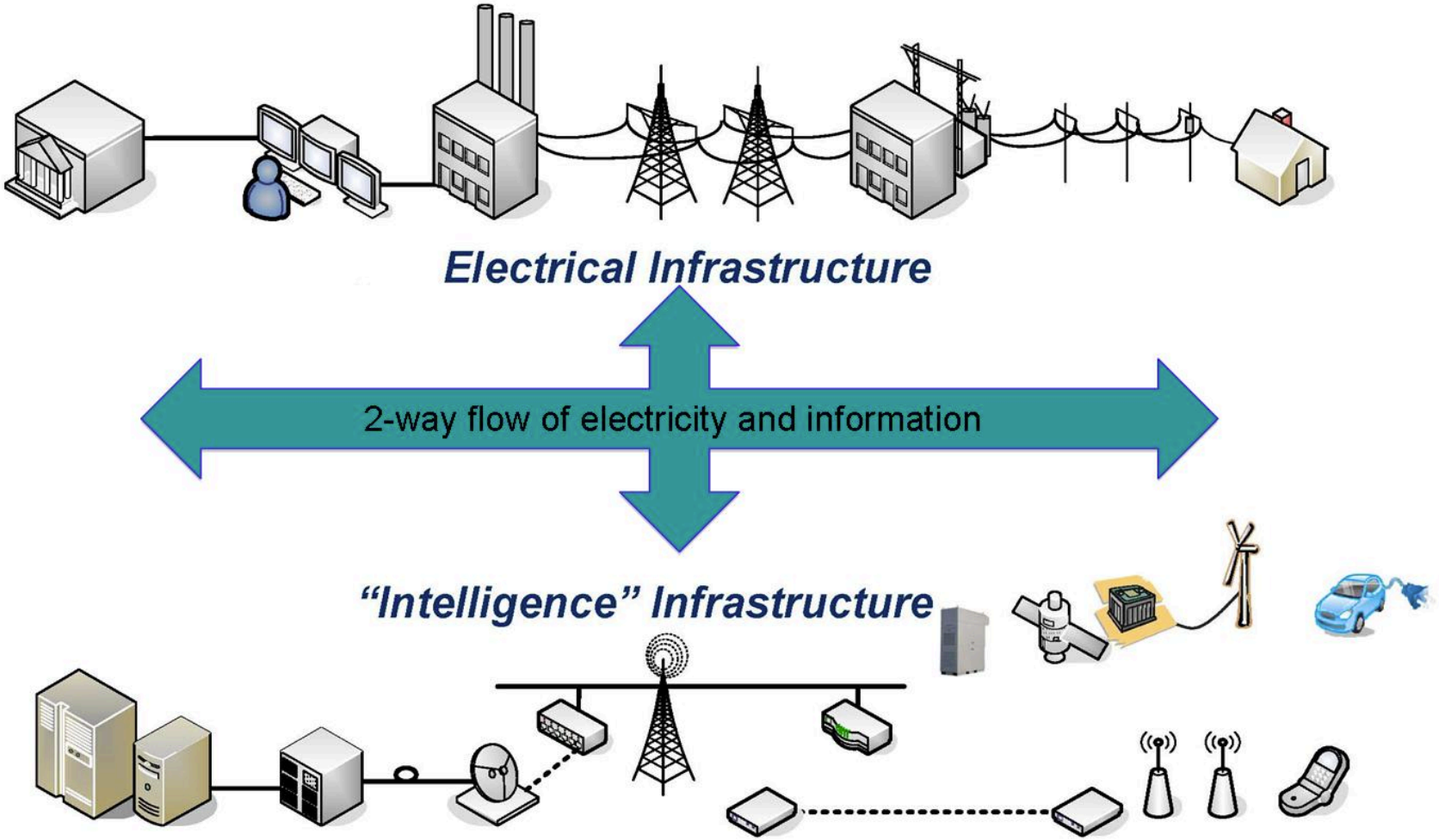
Barriers (continued)

- **Regulatory Barriers:**
  - Inadequate support of policies.
  - Regulatory uncertainty within building codes.
  - Lack of enforcement of building codes.

Recommendations

- Increase adoption of strict building codes.
- Conduct city-wide reviews of existing building codes.
- Promote use of required energy labels.
- Increase focus on public-private partnerships.

Energy Efficiency: Smart Grid



Source: nist.gov

Abatement Potential

Amount Reduced	Type of GHG	By This Year	% Reduced from Projected World Emissions	Source	Region	Report Title
60 – 211 MMT/yr	CO2	2030	0.23 – 0.85%	ERPI	US	The Green Grid
277 – 359 MMT/yr	CO2	2030	1.07 – 1.38%	PNNL	US	PNNL Smart Grid Estimation of Energy and CO2 Benefits
0.7 – 2.1 GT/ yr	CO2	2050	4.38 – 13.13%	IEA	World	IEA Smart Grid Technology Roadmap
0.2 – 0.5 GT/ yr	CO2	2020	0.59 – 1.47%	IEA	World	IEA TCEP

Barriers

- Financial Barriers:
  - Upfront costs in developing nations.
- Market Barriers:
  - Disparity between who pays and who gains.
  - Uncertainty about consumer response.
- Information & Cultural Barriers:
  - Fears resulting from limited knowledge/information.
- Regulatory Barriers:
  - Cyber security.
  - Interoperability standards.

Recommendations

- International collaboration.
- Smart meter policy development.
- Investment in R&D, pilot programs, marketing.
- Education programs.
- Development of regulatory mechanisms & policies.

Summary

- Significant potential for GHG emissions reductions through energy efficiency measures
- Industry – almost 7 $GtCO_2e$/year abatement potential
  - Chemicals, Iron & Steel, and Cement
- Buildings – 3 $GtCO_2e$/year
- Smart Grid – 1 to 2 $GtCO_2e$/year

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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

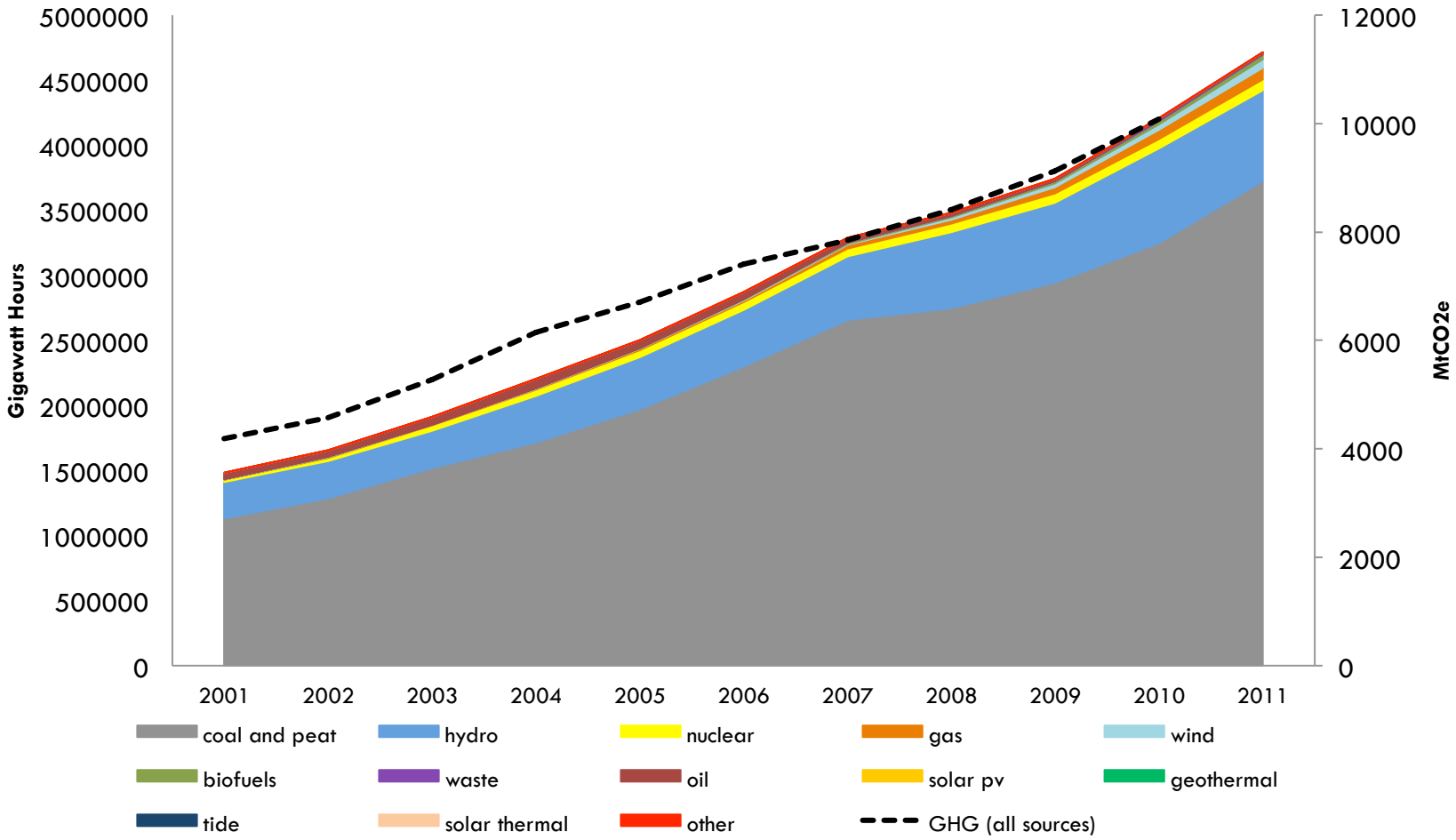
Energy Production: Key Findings

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

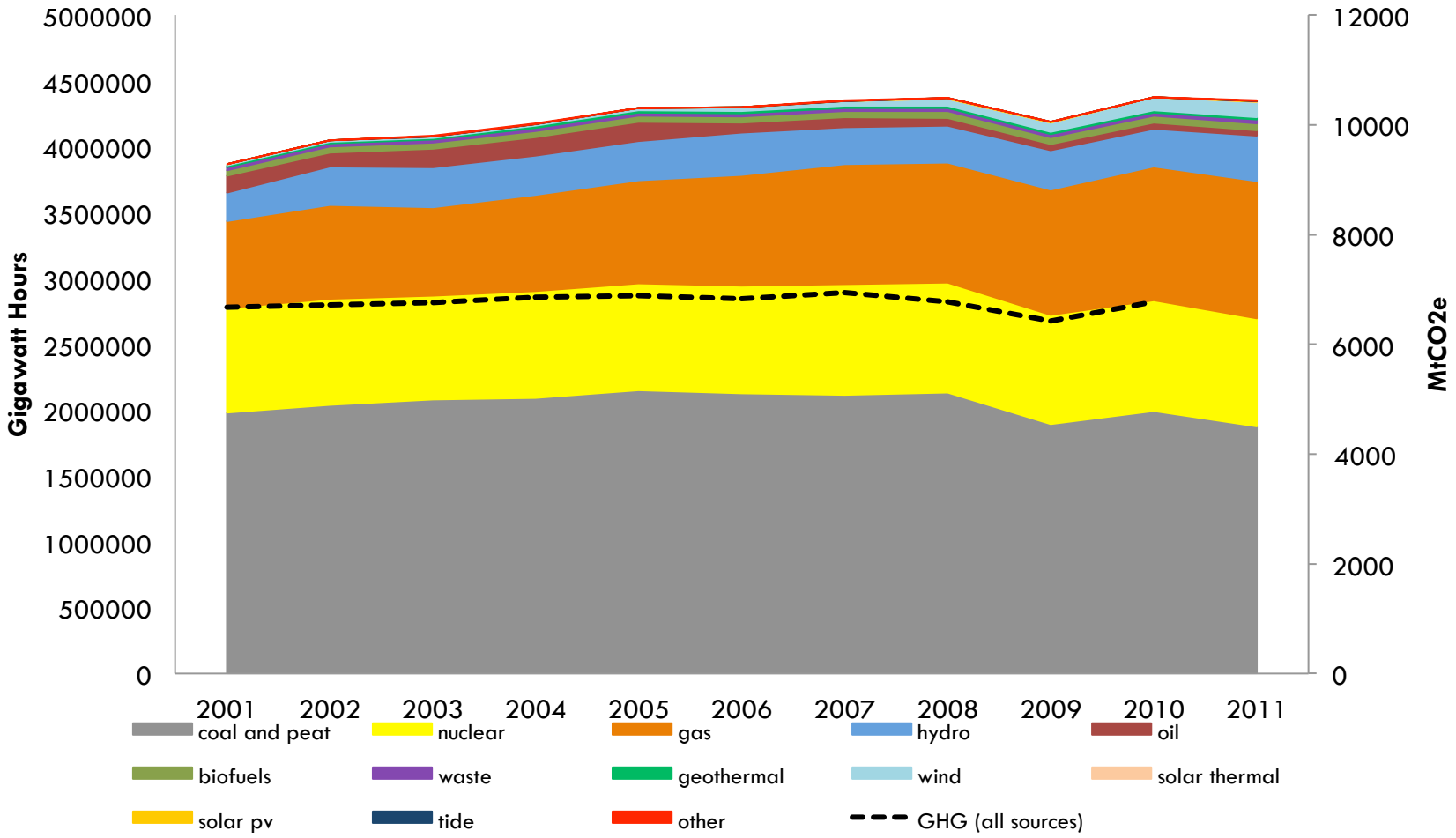
Energy Production: Solutions

- 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.

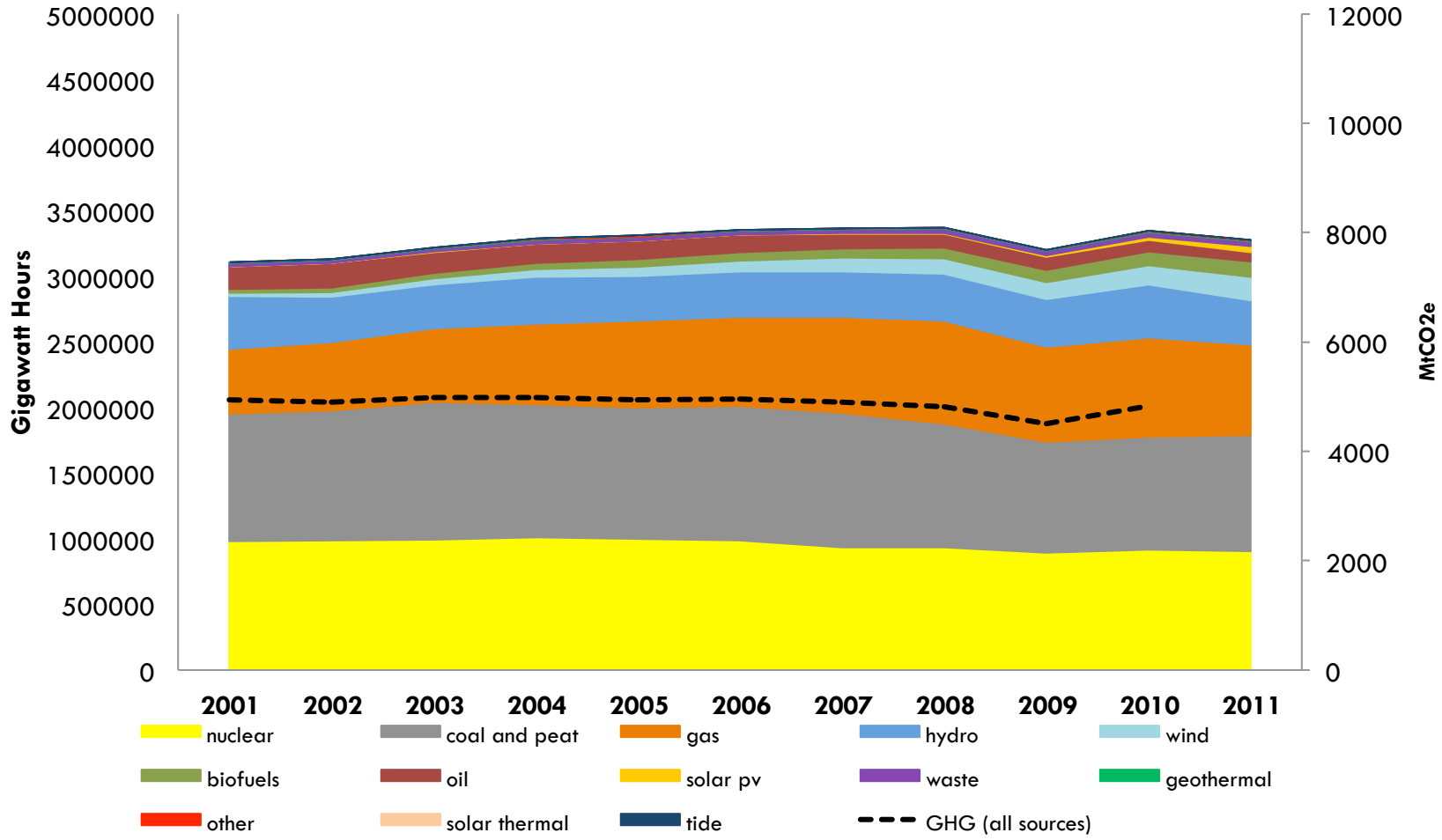
Chinese Electricity Generation



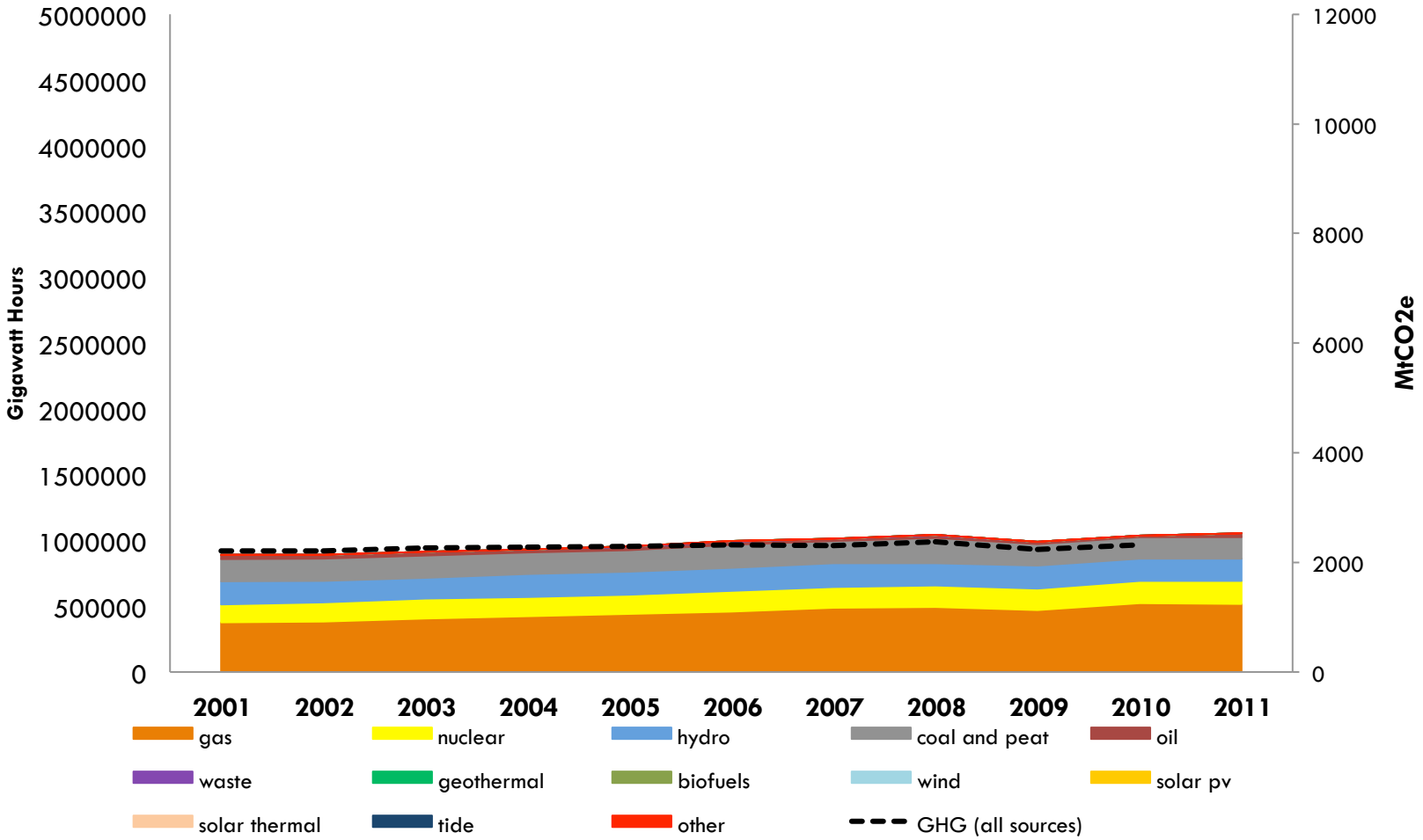
US Electricity Generation



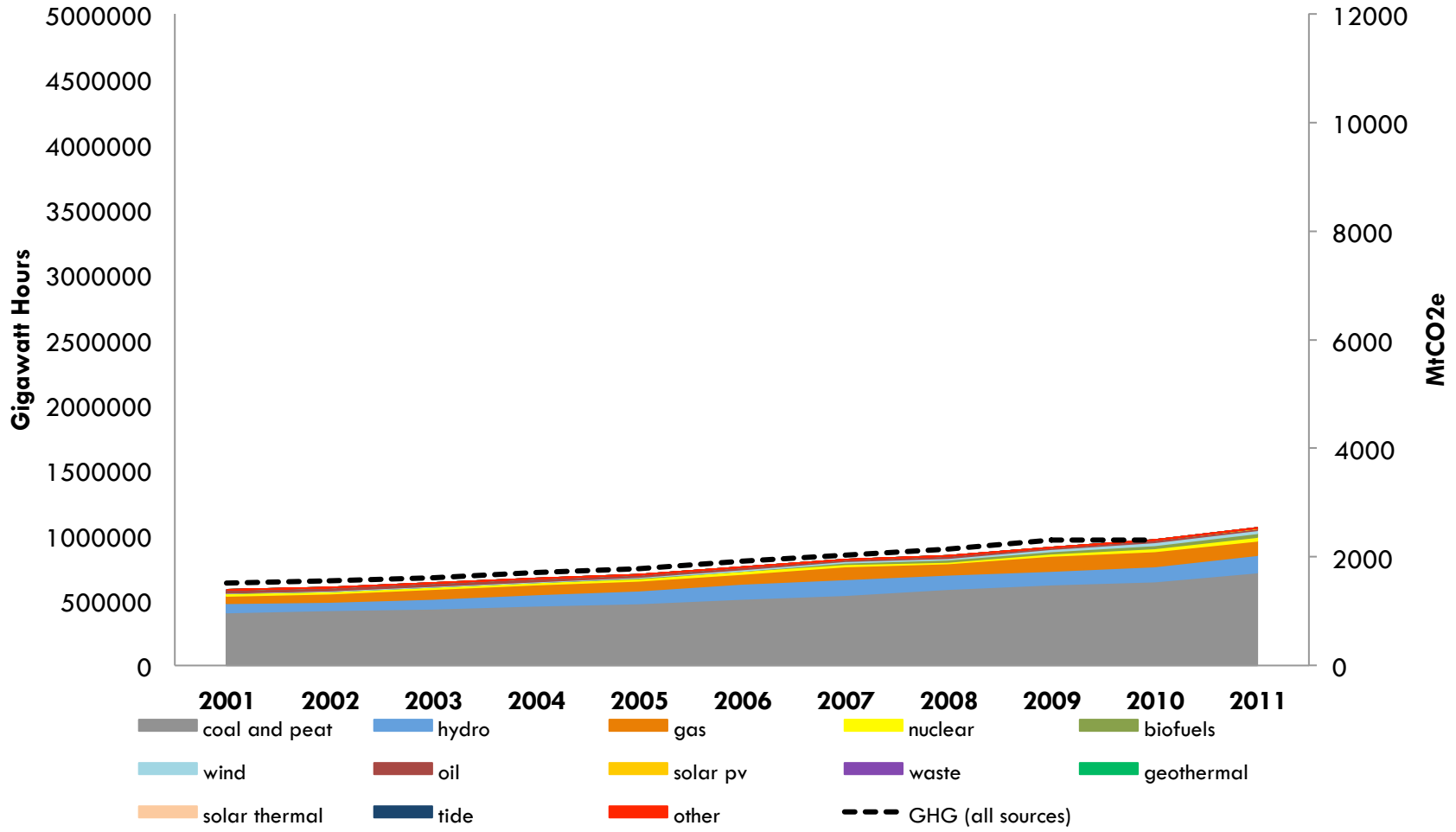
EU-27 Electricity Generation



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

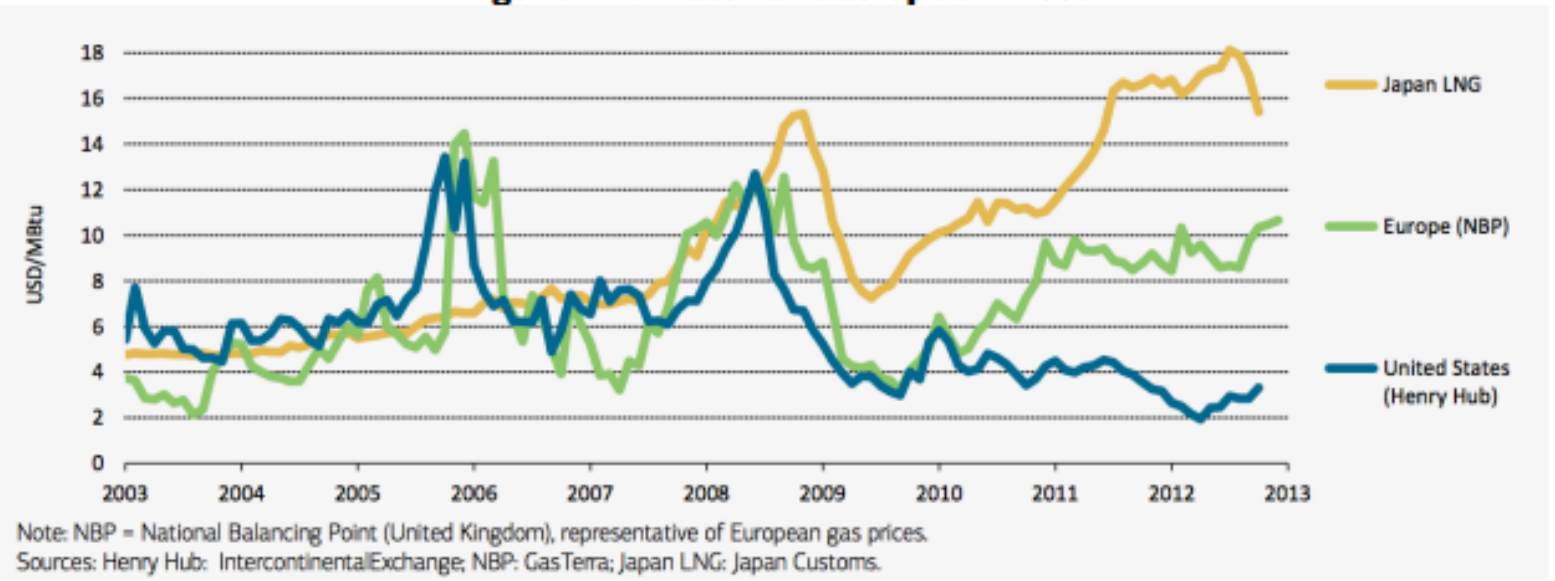
- Cost distribution/Technical Capacity
  - LCOE competitive with fossil fuel sources
- Market structures may hinder deployment of renewable technologies
  - Long term contracts may discourage investment
- Protectionism
  - Domestic content requirements

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.

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