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Future Scenarios for China's Carbon Emissions

Jim Watson and Tao Wang

Kennedy School of Government, Harvard University, 7th July 2008

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Overview

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1 **Energy and emissions trends in China**

2 **Who owns China's emissions?**

3 **Future emissions scenarios**

- Explaining our approach
- Application to China (so far …)

4 **Conclusions**

Global trends and developing countries

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According to the IEA World Energy Outlook 2007:

- World primary energy demand will grow 55% between 2005 and 2030: From 11.4 billion toe to 17.7 billion toe
- 74% of this increase will be due to growth in developing countries; 45% from China and India
- The developing country share of global energy demand will increase from 41% in 2005 to 47% in 2015, and over 50% in 2030
- China and India account for 45% of world coal demand. These countries will account for over 80% of the increase in coal demand to 2030

Recent trends in China
Primary energy demand

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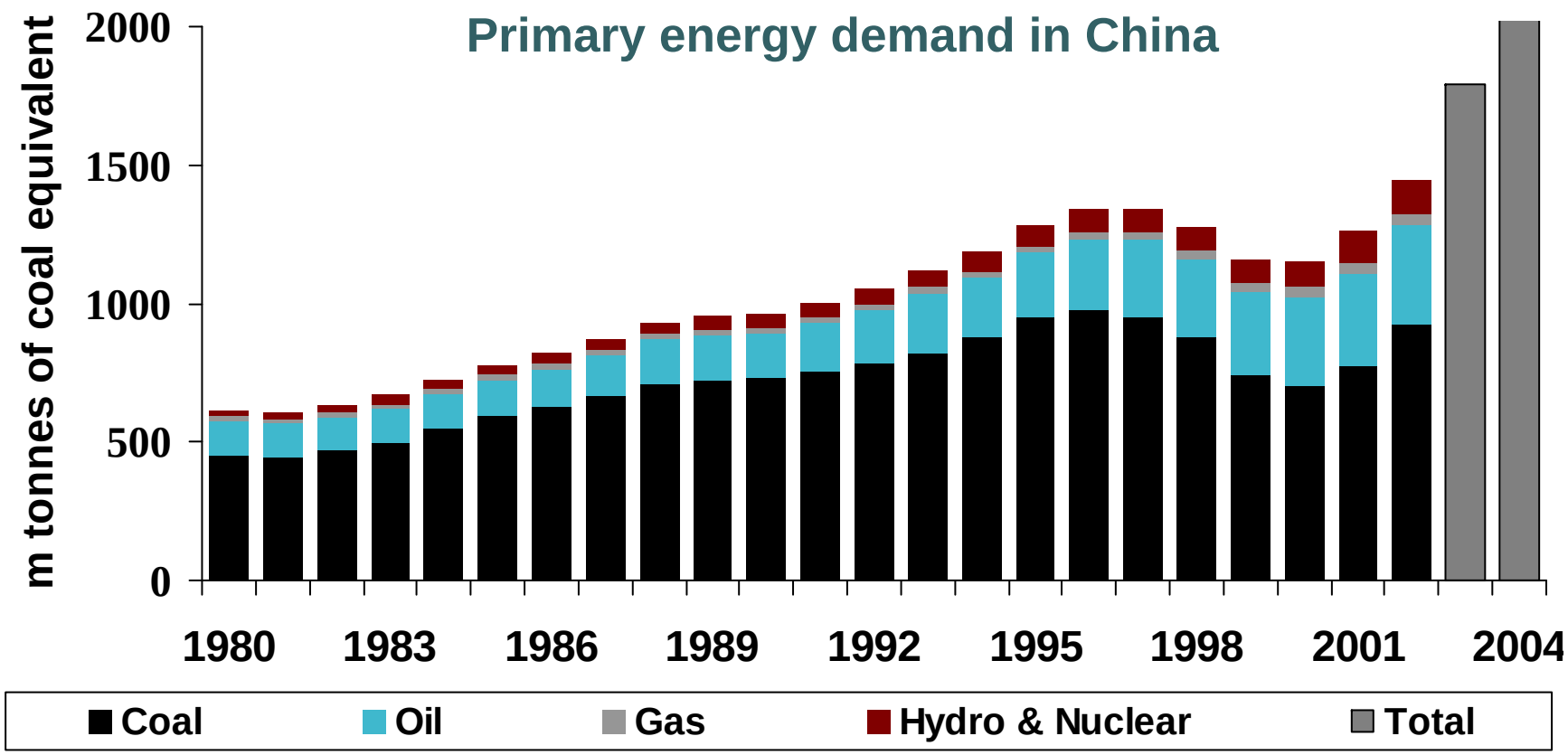

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Recent trends in China

Power generation capacity

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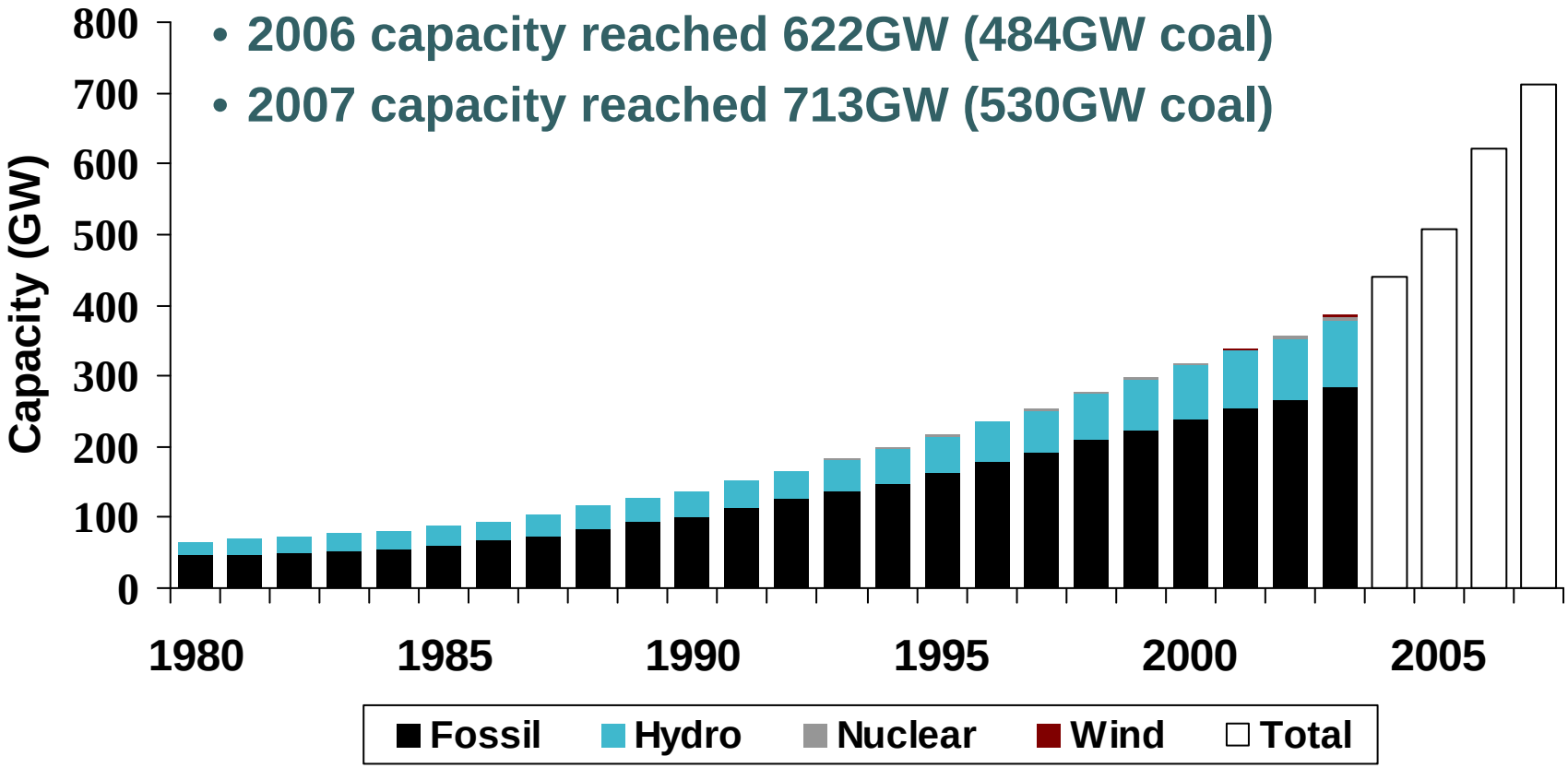

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Recent trends in China
Carbon emissions

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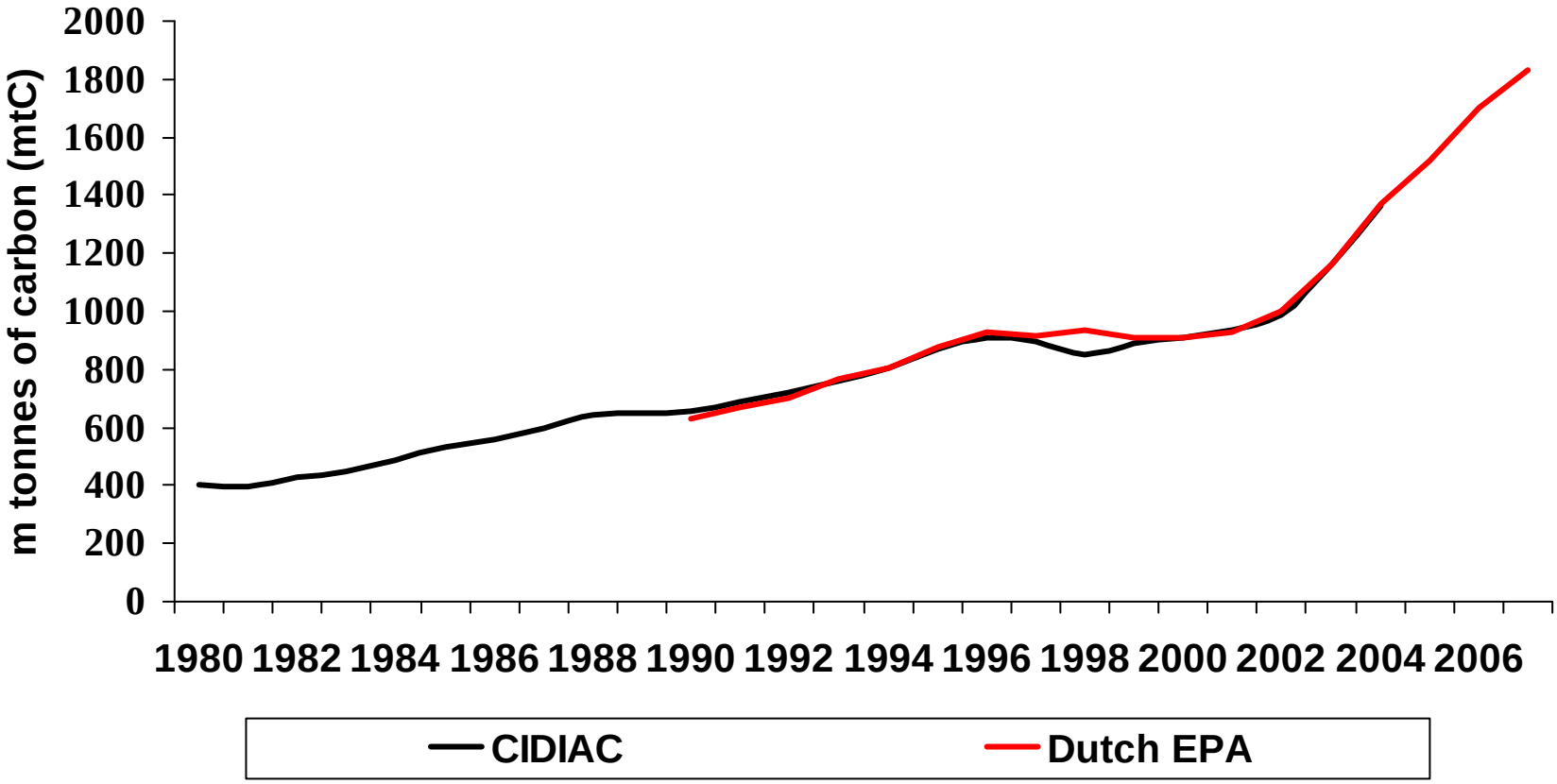

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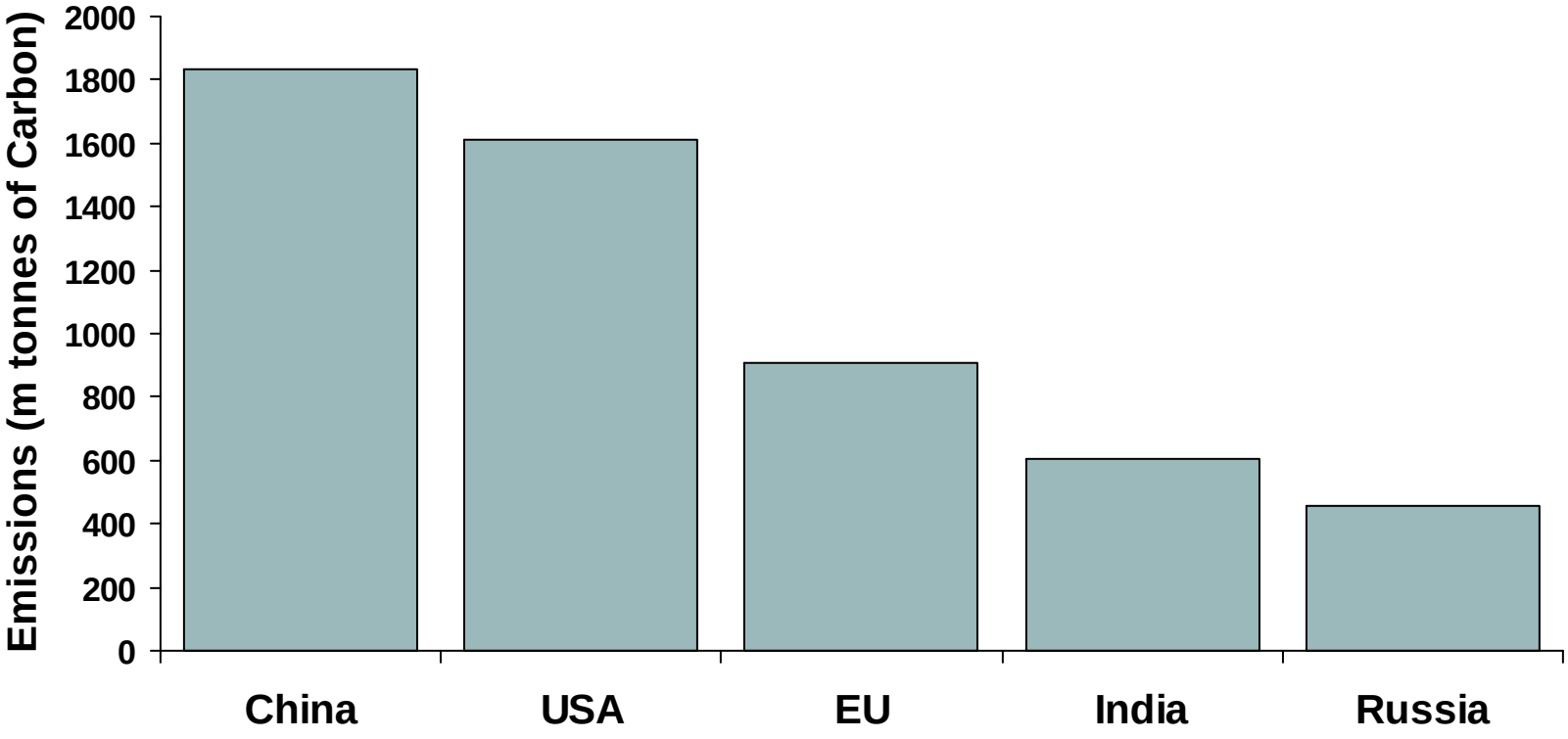
National carbon emissions in 2007

Estimates (Dutch EPA)



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Per capita emissions in 2007

Estimates (Dutch EPA)

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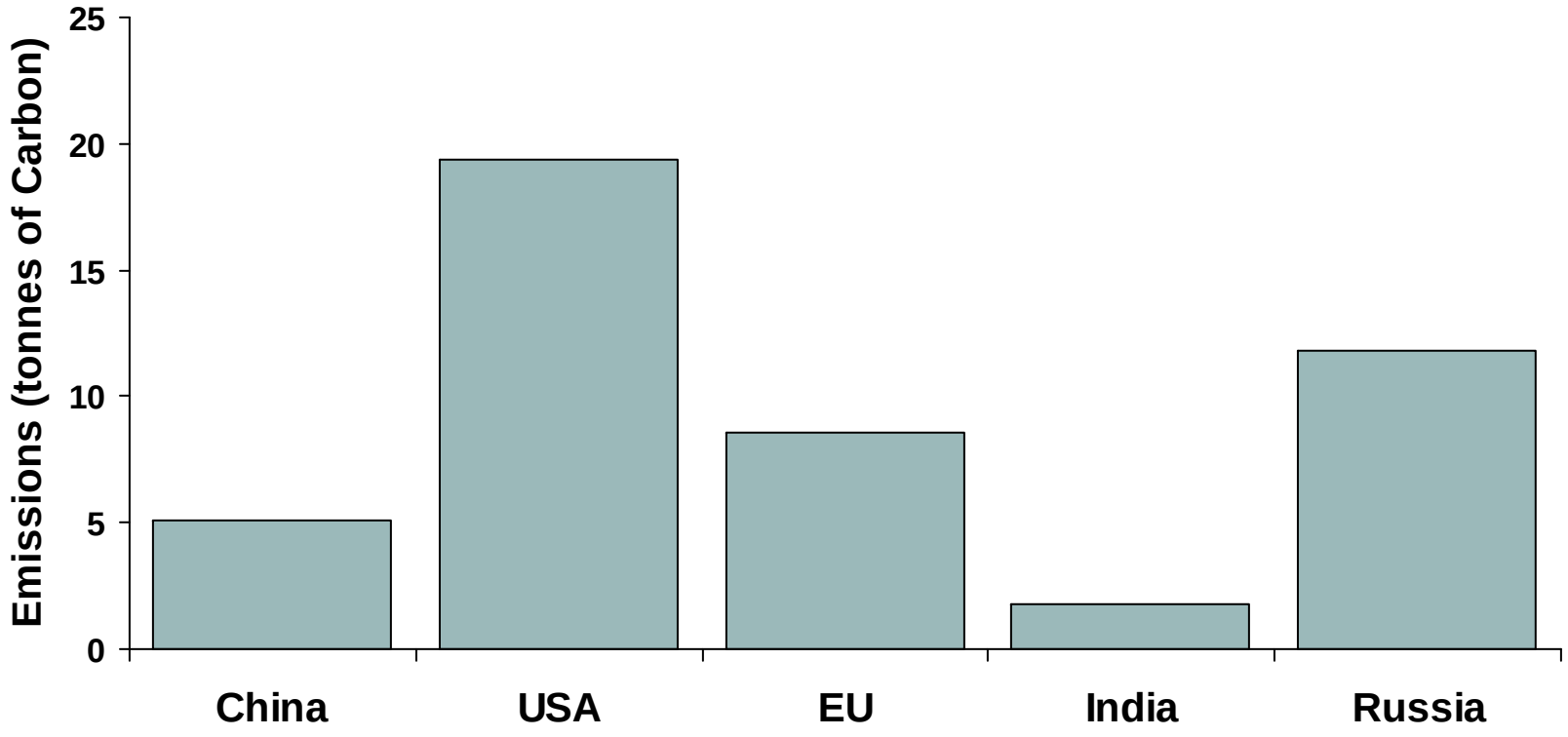

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China also faces serious climate change impacts

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- **Chinese studies project a range of impacts, e.g.**
  - Decreases in agricultural yields and increased costs of food production
  - Decreased run-off of rain water in northern China; increased run-off in Southern China. Adds to water imbalance that is already causing problems
  - Expected increases in storms; vulnerability of prosperous coastal zones (e.g. Shanghai) to small sea level rises
- **As a result, climate change taken increasingly seriously at national level – focus is reducing energy intensity**
- **Government has a climate change co-ordinating group and has produced a climate change strategy**

But who owns these emissions?

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- The extent to which carbon emissions in China should be ‘owned’ by China has been the subject of much debate
- China has emerged as a major trading economy – with a rapidly growing trade surplus with the developed world
- How much of China’s carbon footprint is due to its exports?

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Who owns China's emissions?

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- **Headline results:**
  - Emissions from exports in 2004 :1490 million tonnes of CO_2
  - Emissions avoided due to imports: 381 million tonnes of CO_2
  - Combining these, **23%** of China's emissions due to net exports
- **One reason is large (& growing) trade surplus: tripled between 2004 and 2005 to $102bn, rose again to $177 bn in 2006, and over $250bn in 2007**
- **Another reason is relatively high carbon intensity of Chinese economy. In 2000, the US produced 0.5 kg CO_2 per dollar of economic activity whereas China produced 2.76kg per dollar**
- **This result challenges production-based emissions targets, and suggests that consumption-based targets could be better**

Who owns China's emissions?

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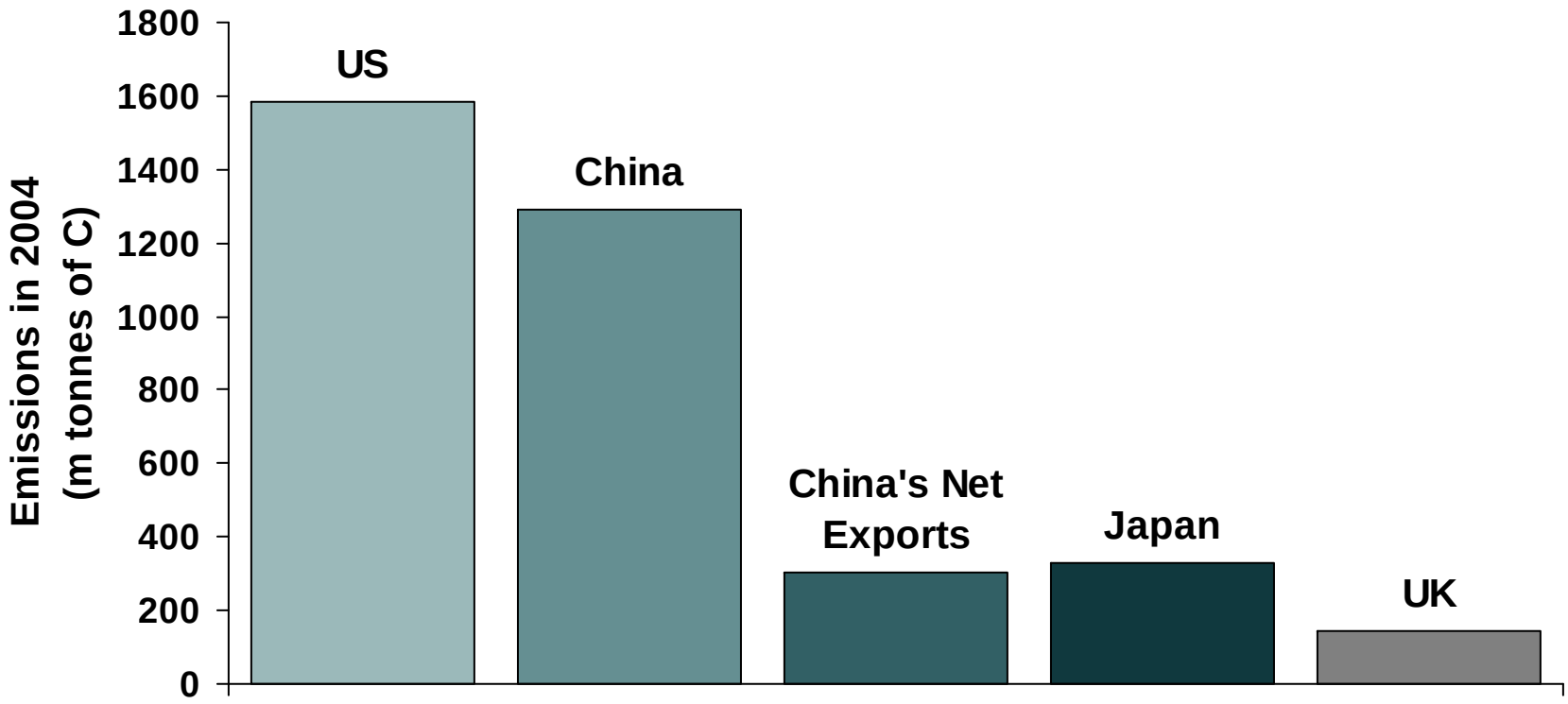

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Analysing future emissions
A carbon budget approach

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- The main aim of our Tyndall Centre project is to develop a set of scenarios to explore future carbon emissions in China – and analyse implications
- There are a number of scenario options – e.g. exploratory or more goal-driven
- We are using a cumulative emissions method so scenarios meet a specific target; used previously by Tyndall for the UK
- Tyndall's scenario tool enables us to quantify possible trends in different Chinese sectors (e.g. transport & households)
- Collaborating with organisations in the UK & China, including workshops in Beijing and London to discuss key features

Why cumulative emissions?
The UK Climate Change Bill

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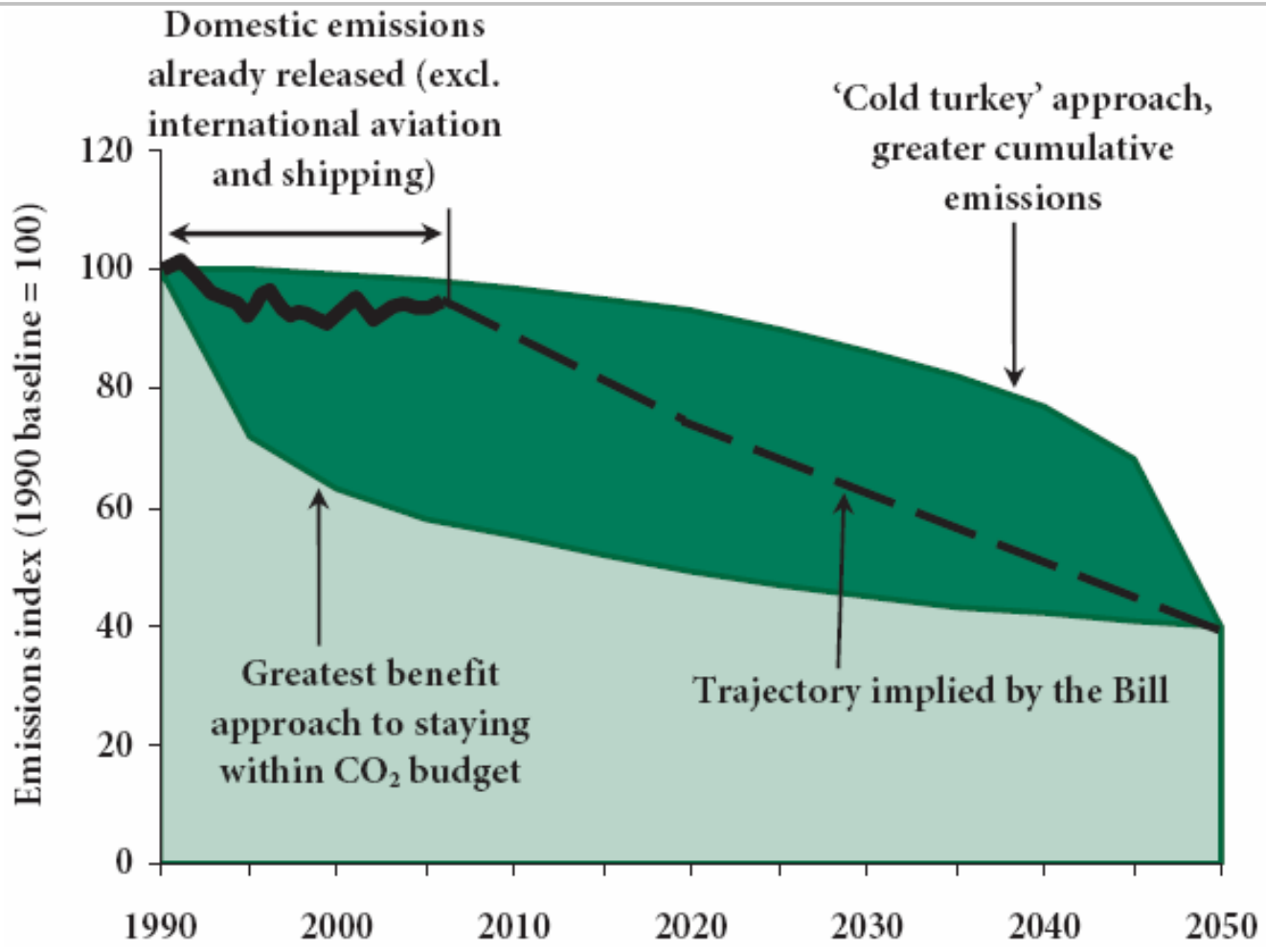

Why cumulative emissions?

Tyndall UK scenario for 450ppm

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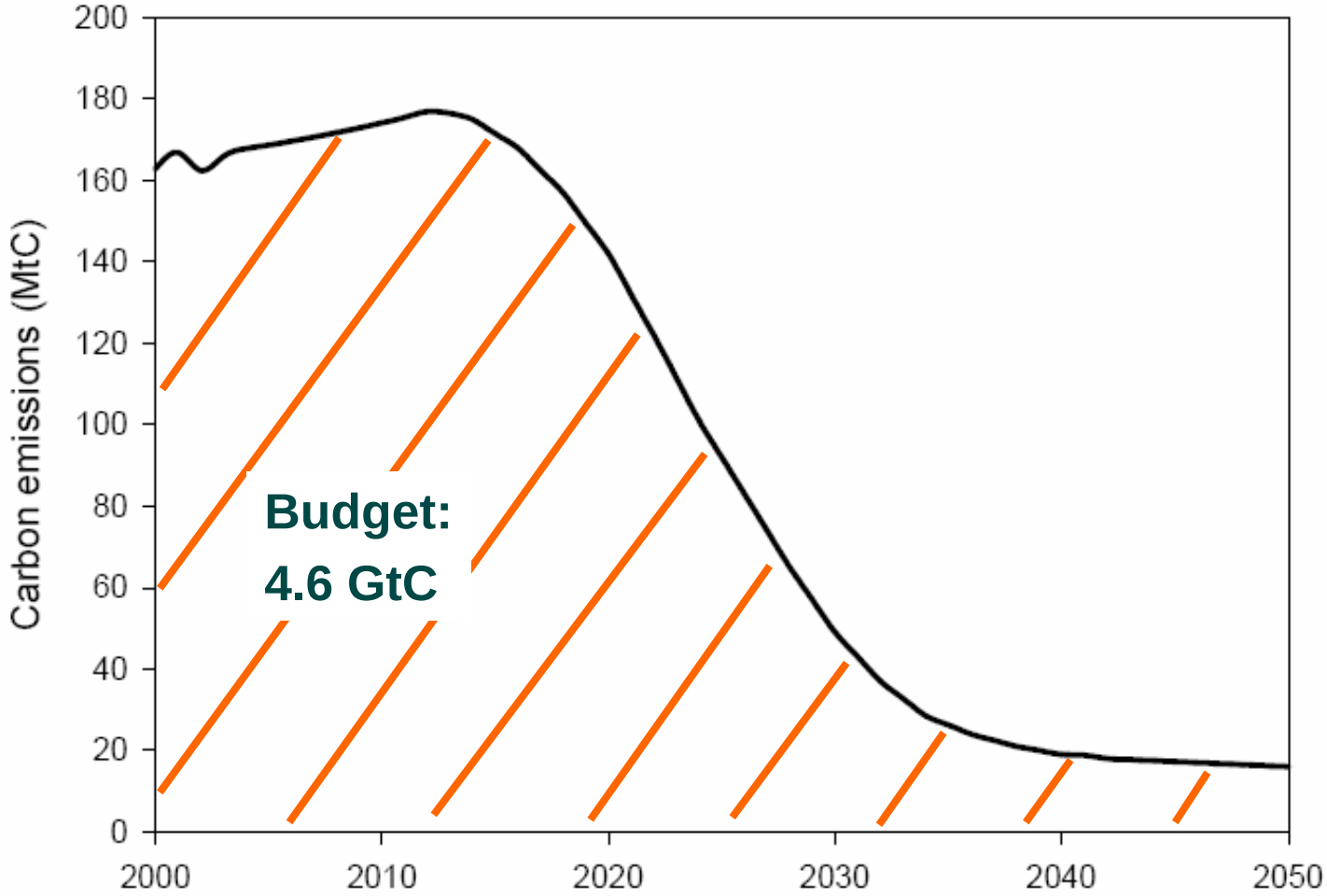

Analysing future emissions
A carbon budget approach

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- **We have used IPCC Assessment Report 4 global budget**
  - 490GtC for 21st century
  - Stabilise at 450 ppm CO_2
  - Likely range of 1.9-4.4°C temperature rise
- **Two different approaches to deciding China's cumulative emission budget for this period:**
  - Equal carbon emissions per capita
  - Equal carbon emissions intensity of GDP
- **Two medium-term pathways to connect these budgets to current policy analysis**

Analysing future emissions
Medium term pathways

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- **Critical issues for Chinese policy (& identified in our workshops) is change in industrial structure & innovation**
- **Challenge for China is 'rebalancing growth'**
  - Away from energy intensive investment …
  - Away from export-led growth …
  - … towards domestic consumption; value added; innovation
- **Medium term pathways rebalance with different speeds / extents**
  - IEA 'Alternative Policy' scenario. Includes some policies but is conservative about possible shift in emissions pathway
  - ERI scenario B (2004) includes govt efficiency targets, shift from heavy industry etc. Gives ambitious emissions goal for 2020

Analysing future emissions
Medium term pathways

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We will … promote the shift from the pattern of economic growth that relies mainly on investment and exports to one that relies on a balanced combination of consumption, investment and exports.

Haphazard investment and unneeded development projects in energy intensive and highly polluting industries and industries with excess production capacity will be resolutely stopped.

Wen Jiabao, March 2008

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Analysing future emissions

Medium-term pathways

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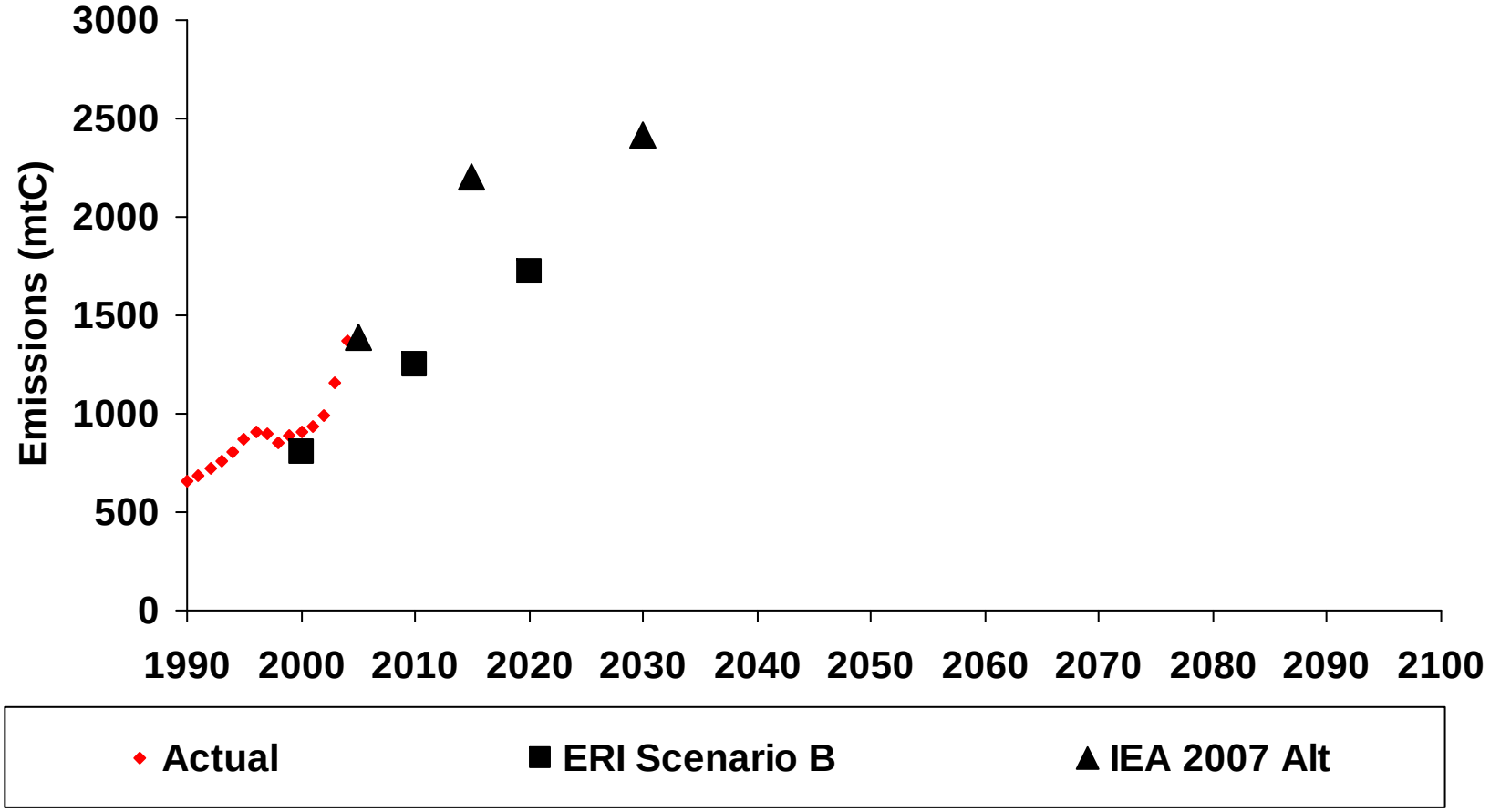

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Analysing future emissions
From medium to long-term

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- **Calculated budgets from 490GtC (global) using two methods**
  - Per capita gives 70GtC for China (UN population projections)
  - Per unit of GDP gives 111GtC for China (IEA growth projections)
- **Turning points in 2020 and 2030**
  - Pre 2020 thought to be too early / ambitious
  - Post 2030 risks running out of budget
- **Adjustment to lower per capita budget to make it compatible with higher medium-term pathway. Raise to 90GtC.**

Analysing future emissions

From medium to long-term

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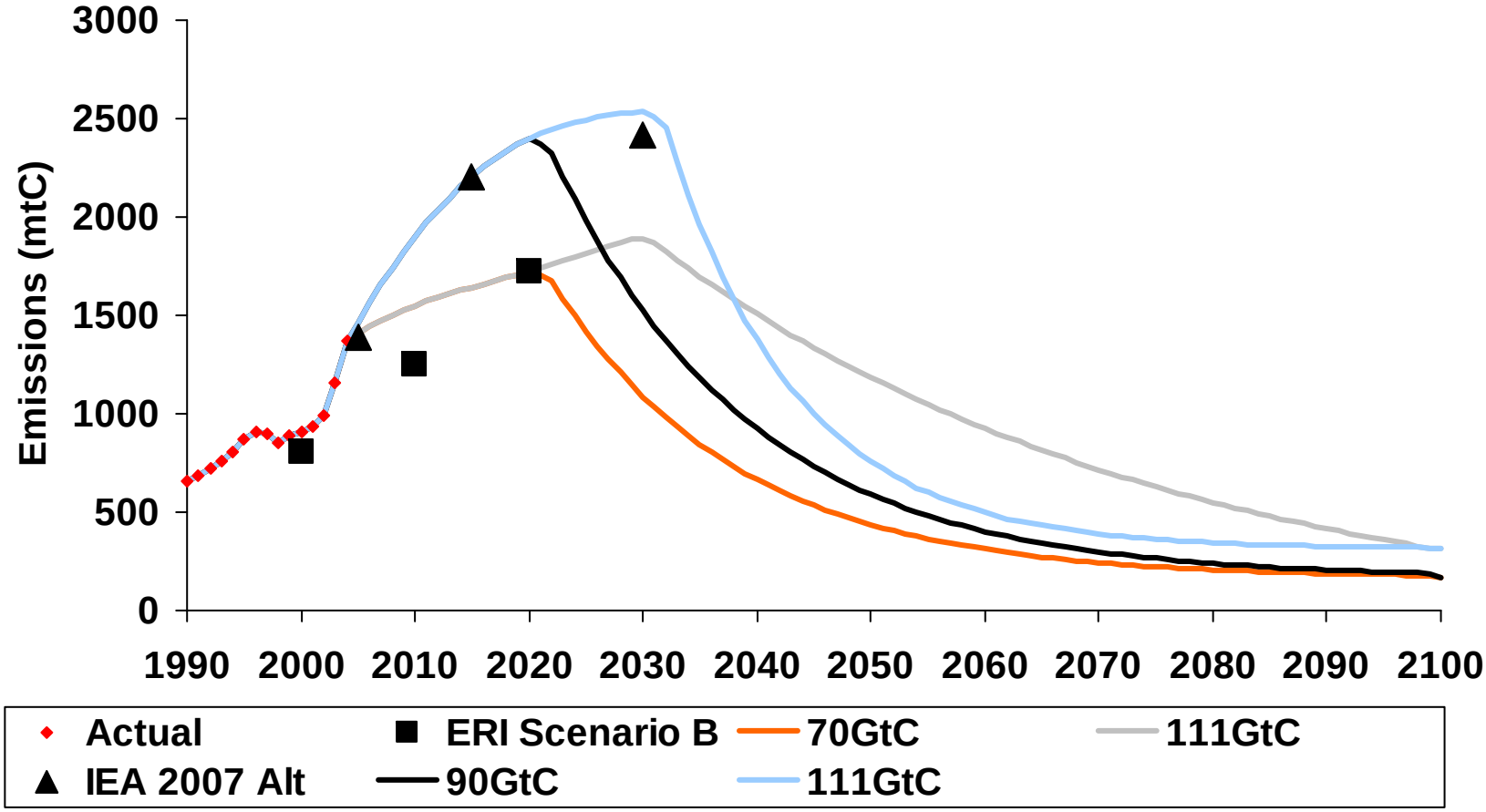

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Analysing future emissions

Our four scenarios

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	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Cumulative budget	70GtC	111GtC	90GtC	111GtC
Medium-term pathway	ERI	ERI	IEA	IEA
Year of peak	2020	Low Peak 2030	2020	2030
GDP growth rate	2-4%	5-8%	4-6%	2-8%
Population growth rate	UN 2004 prediction			

Analysing future emissions

Our four scenarios

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	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Economic & industrial Structure	Service sector dominant / moderate industry; mostly 'innovative'	Moderate service sector Strong 'innovative' industry	Service sector largest Strong trad industry; some 'innovative'	Service & industry strong Traditional manufacturing dominant
Nature of innovation	Radical	Radical Slower diffusion than scenario 1	Significant Incremental	Incremental Focus on legacy industries

Analysing future emissions

Our four scenarios

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	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Energy demand	Slow growth	Moderate growth	Moderate growth	High growth
Primary energy priorities	Renewables Fossil fuels or nuclear	Renewables Fossil fuels	Nuclear Fossil fuels Renewables	Fossil fuels Nuclear Renewables
Energy demand	Stringent efficiency standards; quick behaviour change	Moderate standards Slower change in behaviour	Slow efficiency progress Significant behaviour change	Incremental efficiency Slow behaviour change

Analysing future emissions
Some emerging issues

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- **Some technologies / options may be critical**
  - Hard to see how CCS can fail to be critical: speed of implementation and extent may vary
  - We may need ‘reality check’ on transport: e.g. balance of efficiency and low carbon alternatives to oil
- **Changes in institutions and governance are not developed enough within scenarios, e.g.**
  - Energy decentralisation more than a technical phenomenon
  - Extent to which behaviour change is possible
  - Relationship between central, provincial and local govt
  - Relative strength of environmental vs economic policy

Next steps

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- Draft working paper summarises scenarios so far: comments are welcome
- Iterative process with spreadsheet tool so changes in emissions in different sectors fit within overall carbon budget
- Identify critical areas for early action that are common across most scenarios
- Develop policy implications: for China and for international community (especially UK)
- Launch of final results in early 2009

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Thanks

http://www.sussex.ac.uk/sussexenergygroup

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