Low Carbon Growth Options for India

Chandra Bhushan

2^0C implications

- Keeping global temperature below 2^0C above pre-industrial era implies a GHG emissions budget – a definitive amount of total emissions that the world can emit from now to a future date (2000-2050).
- This budget has to be divided based on certain principles between countries
- UNFCCC – responsibility (historical emissions), capability, equity, sustainable development

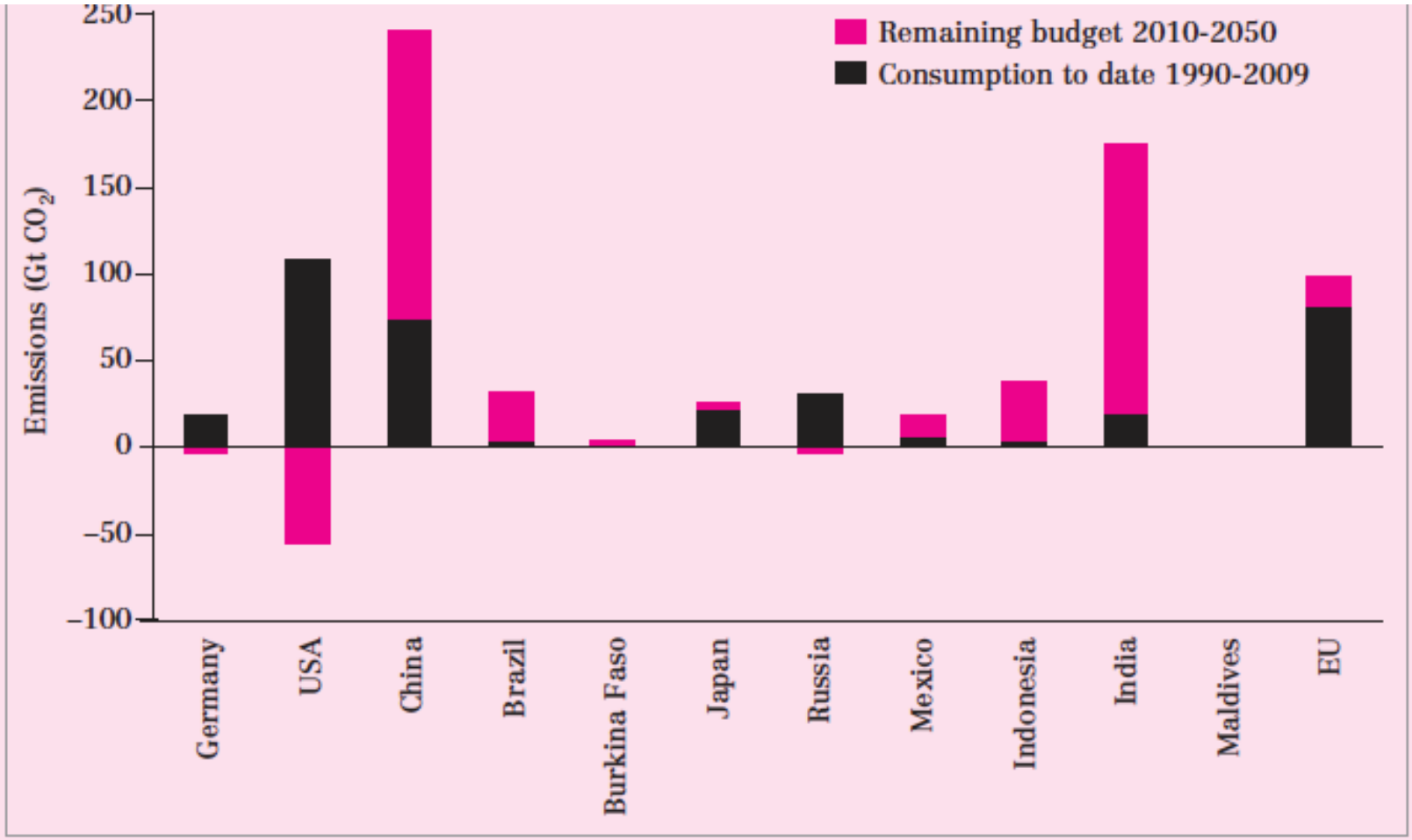
How much is the carbon budget?

- **Multiple targets with uncertainties:**
- There is total emissions budget between 2000 and 2050: 600 – 1200 Gt CO2
- Peaking year target – total global emissions world peak and then start reducing: 2020 or 2030
- What should be the global emissions in 2050 compared to 2000: 50-85% below 2000 levels
- Play with these number to make global emissions trajectory

How budget should be divided?

- Many formulations: per capita entitlement (CSE proposal); development rights (emissions rights based on responsibility, capability and certain development threshold); burden sharing (how every country should reduce emissions to meet 2050 target)
- *All formulations conclude that the developed countries have overused their budgets and should actually have negative emissions*

How budget should be divided?



Source: Anon 2009, *Solving the climate dilemma: The budget approach*, German Advisory Council on Global Change, Berlin, p 26

The study

'Bottom-up' study to understand the potential to reduce GHG emissions in five most emissions-intensive industrial sectors (Steel, Cement, Aluminium, Paper & Fertiliser) and the power sector

- **Benchmarking energy and GHG emissions with Best Available Techniques (BAT)**
- **Developed future technology deployment pathways**

The study

- **Two pathways projected till 2030-31**
  - **Business As Usual (BAU):** Changes that industry is making or will make on its own to reduce energy consumption -- **high cost of energy is the main driver of change**.
  - **Low Carbon (LC):** Policy push required to mainstream emerging, not yet commercialized technologies. In many sectors, it is also a ***'leap into the unknown'***. **Combating climate change is the main driver of change**.

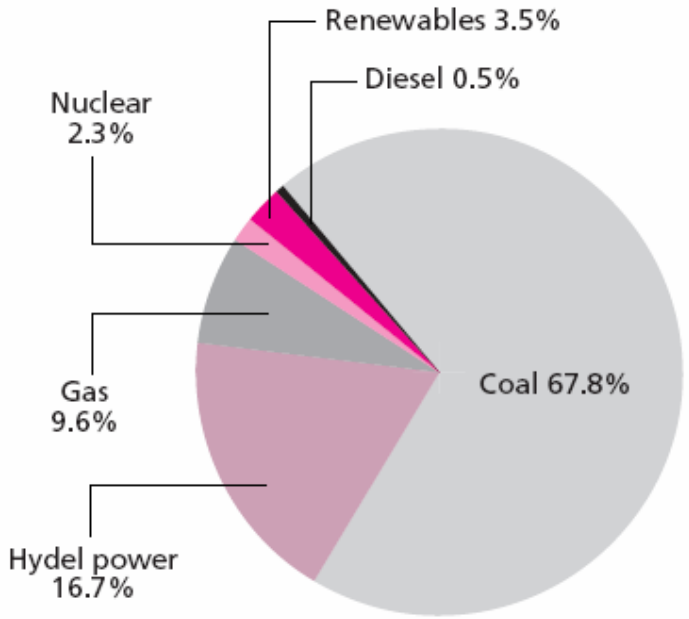
Power

Power sector

Power Sector

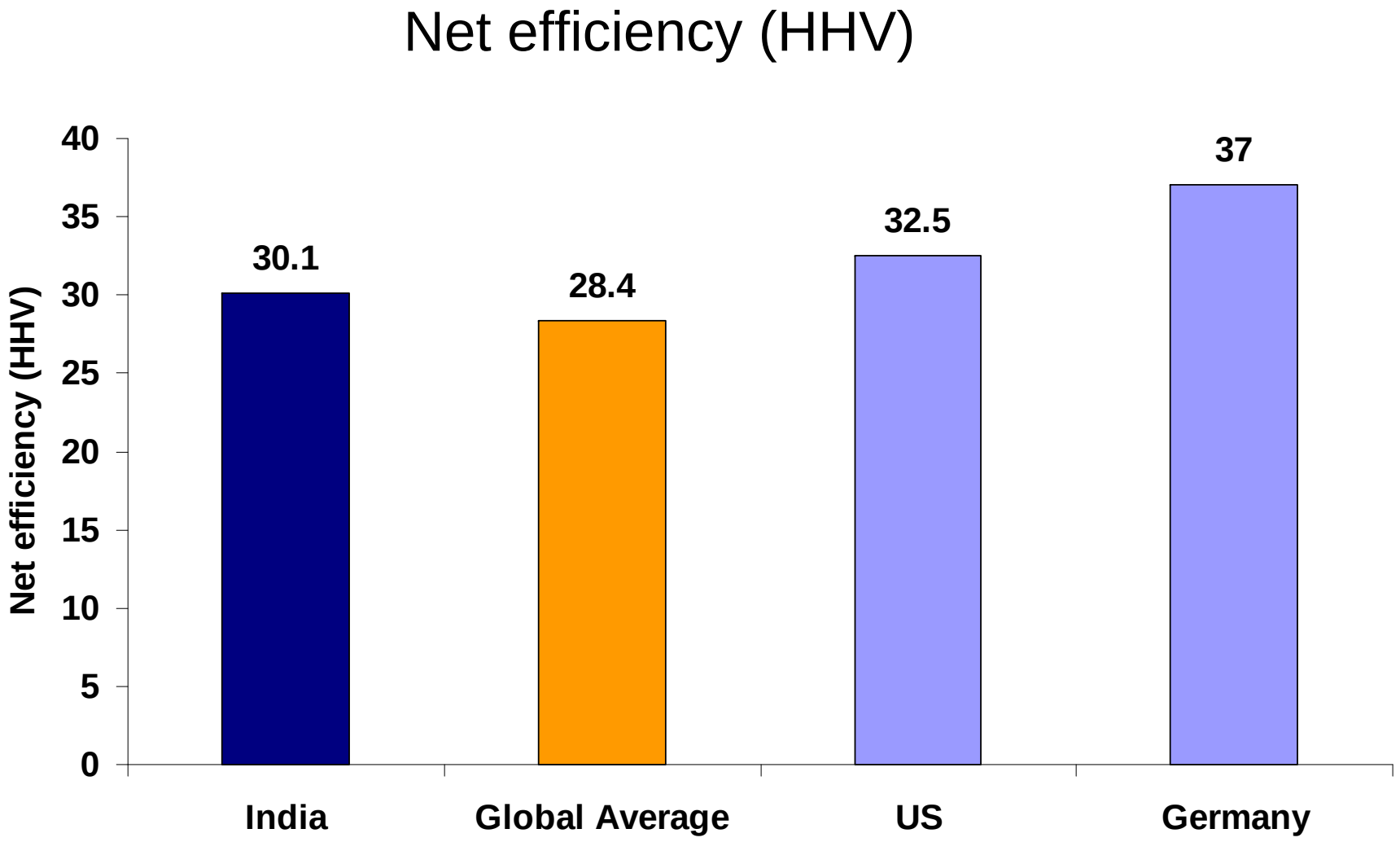
- **Sample:** 81 coal-fired plants, 8 lignite-fired plants and 42 gas-fired plants -- more than 90 per cent of the coal, lignite and gas fired power generation capacity in the country

Power generation: 2007-08



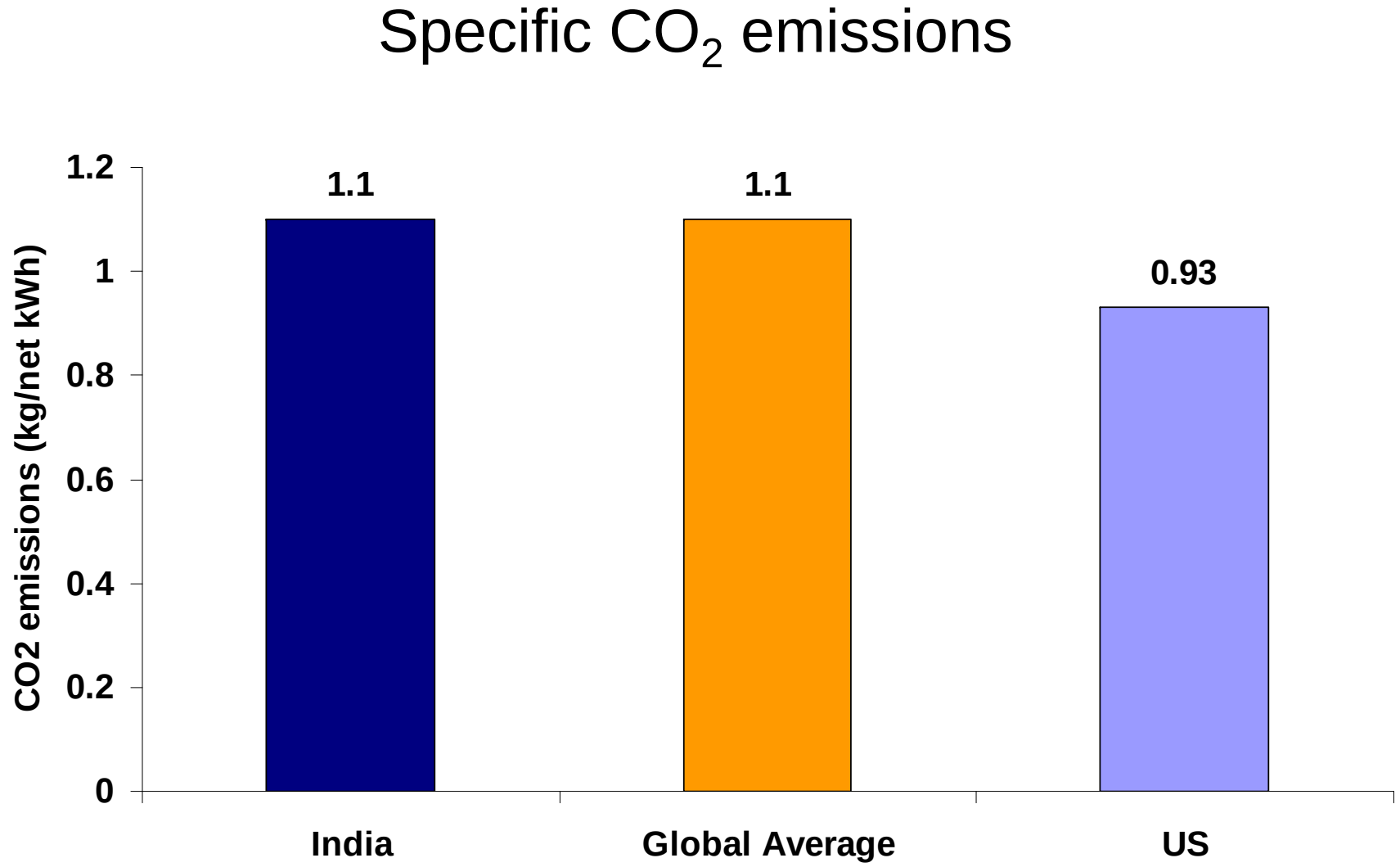
Coal and lignite plants

Power Sector



Coal and lignite plants

Power Sector



Thermal power

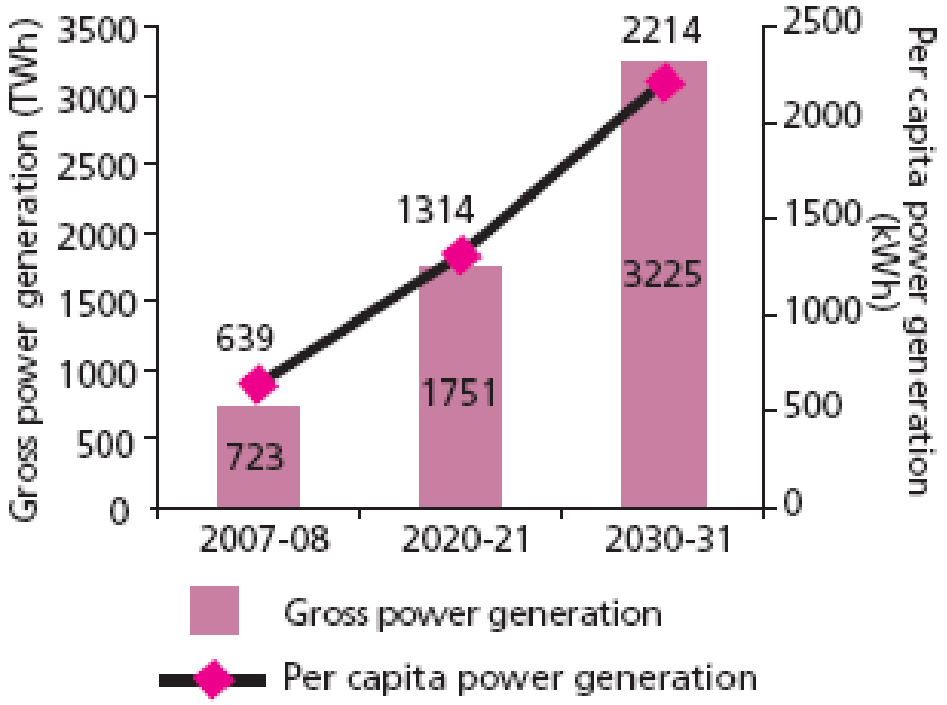
Power Sector

- Efficiency lower than what is possible with advanced steam parameters and better grid and load management practices
- However, coal quality (gone down over the years) and high temperature and humidity are limiting factors

Power generation projection

Power Sector

- Falling elasticity between gross power generation and GDP; 8% growth rate



- *India's per capita gross power generation in 2030 about one-seventh of **current** per capita power generation in the US.*

Technology roadmap: BAU

Power Sector

- Proportion of gas to total power generation constant (9.6%) – capacity 50,000 MW in 2030-31
- Hydro growth 4% per annum (last 20 years' trend)
- Nuclear 30,000 MW – government push
- Onshore wind – 40,000 MW in 2030-31 (6% pa)
- Biomass – 20,000 MW (5,000 MW each from agro waste and bagasse cogeneration; 10,000 MW wood)
- Small hydro: 8,000 MW (past trend)
- Solar – 20,000 MW
- **Rest from coal** - improved efficiency in existing stock; 30% supercritical till 2020; after 2020 only supercritical plants

Technology roadmap: LC

Power Sector

- Gas, hydro, nuclear, onshore wind – same as BAU
- Biomass – 50,000 MW (5,000 MW each from agro waste and bagasse cogeneration; 40,000 wood)
- Small hydro: 15,000 MW (entire capacity)
- Solar – 100,000 MW
- Offshore wind: 50,000 MW
- **Rest from coal** - improved efficiency in existing stock, retirement of 10,000 MW capacity; 80% supercritical till 2020; after 2020 only supercritical/ ultra supercritical plants

Installed capacity

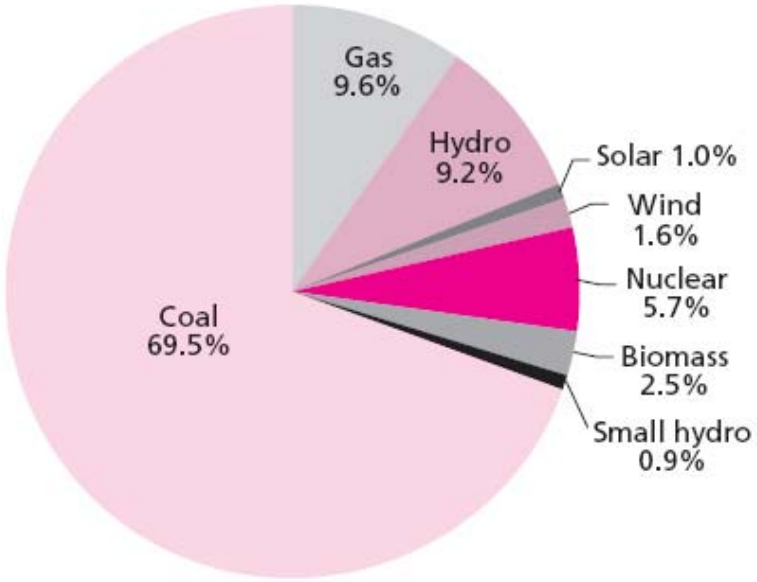
Power Sector

	2008-09 (in MW)	2030-31 (in MW)	
		BAU	LC
Coal-based power plants	81,606	3,40,000	2,80,000
Gas & oil-based power plants	18,256	50,700	50,700
Large Hydropower plants	36,885	84,500	84,500
Nuclear power	4,120	30,000	30,000
Solar PV	0	10,000	55,000
Solar thermal (CSP)	0	4000 – without storage 2000 – with storage	7,500 – without storage 15,000 – with storage
Onshore wind	10,891	40,000	40,000
Offshore wind	0	0	50,000
Biomass	1,752	20,000	50,000
Small hydropower plants	2,430	8,000	15,000
Total	1,56,000	5,89,200	6,77,700

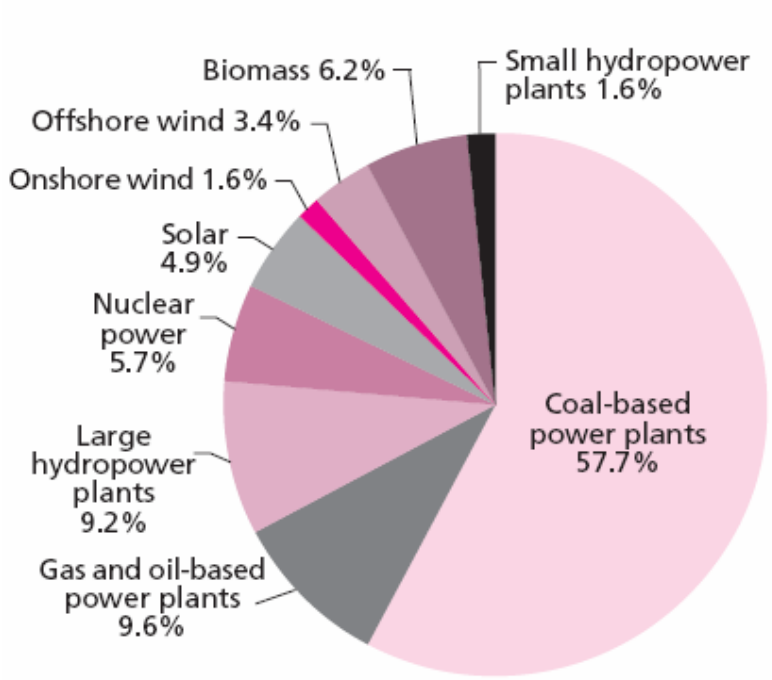
Power generation

Power Sector

BAU



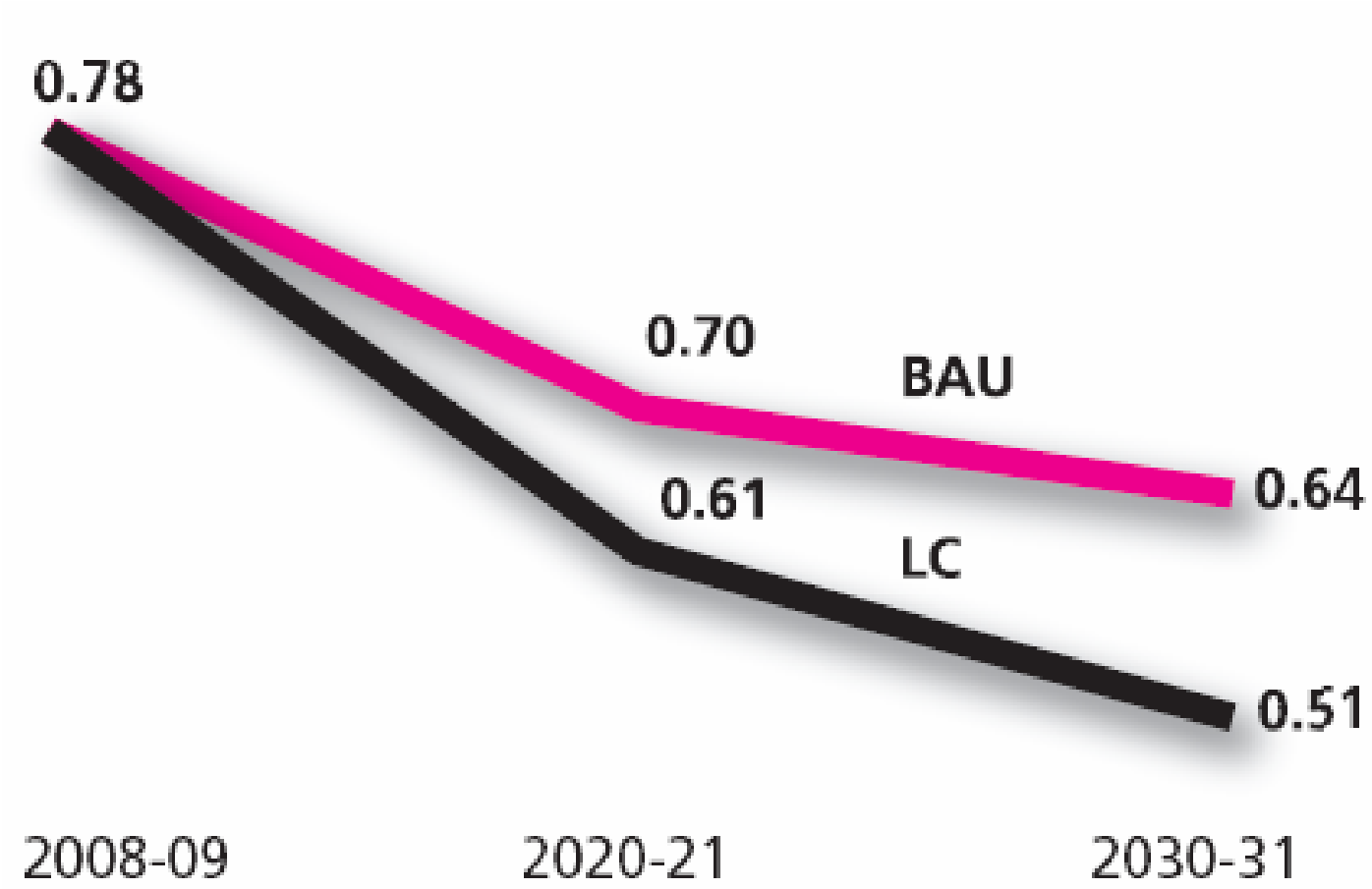
LC



Emissions intensity

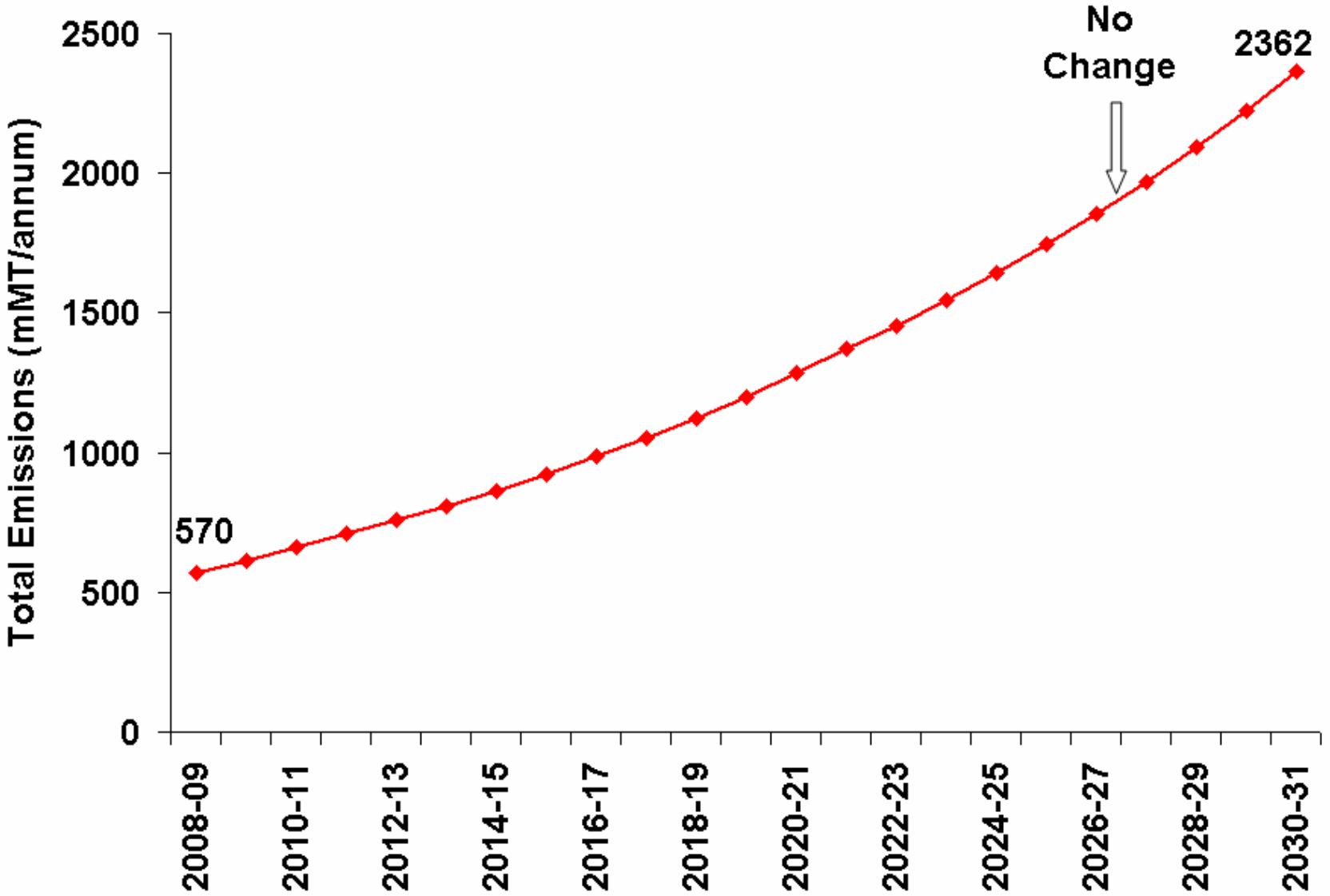
Power Sector

Kg CO_2/net kWh



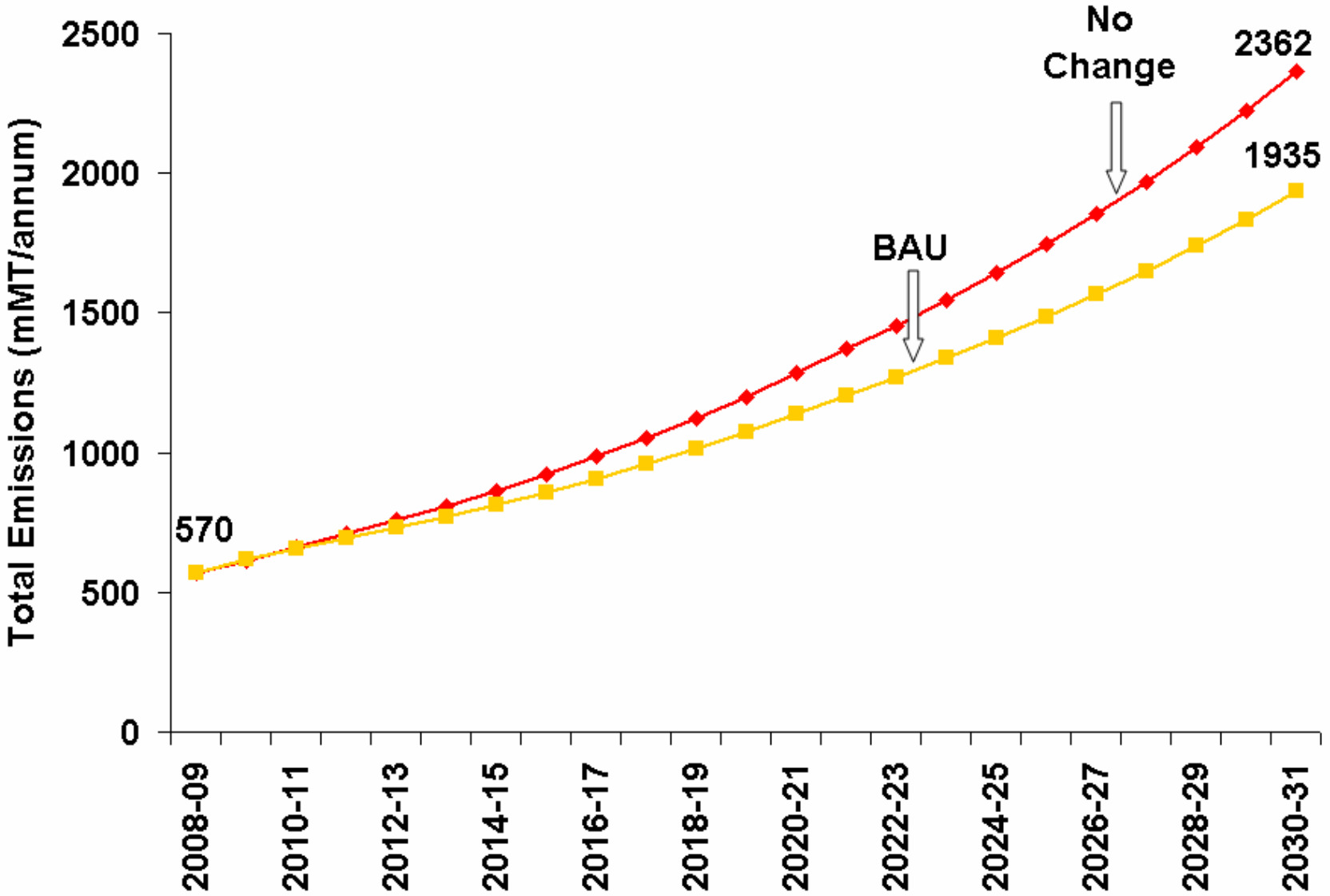
Emissions trajectory

Power Sector



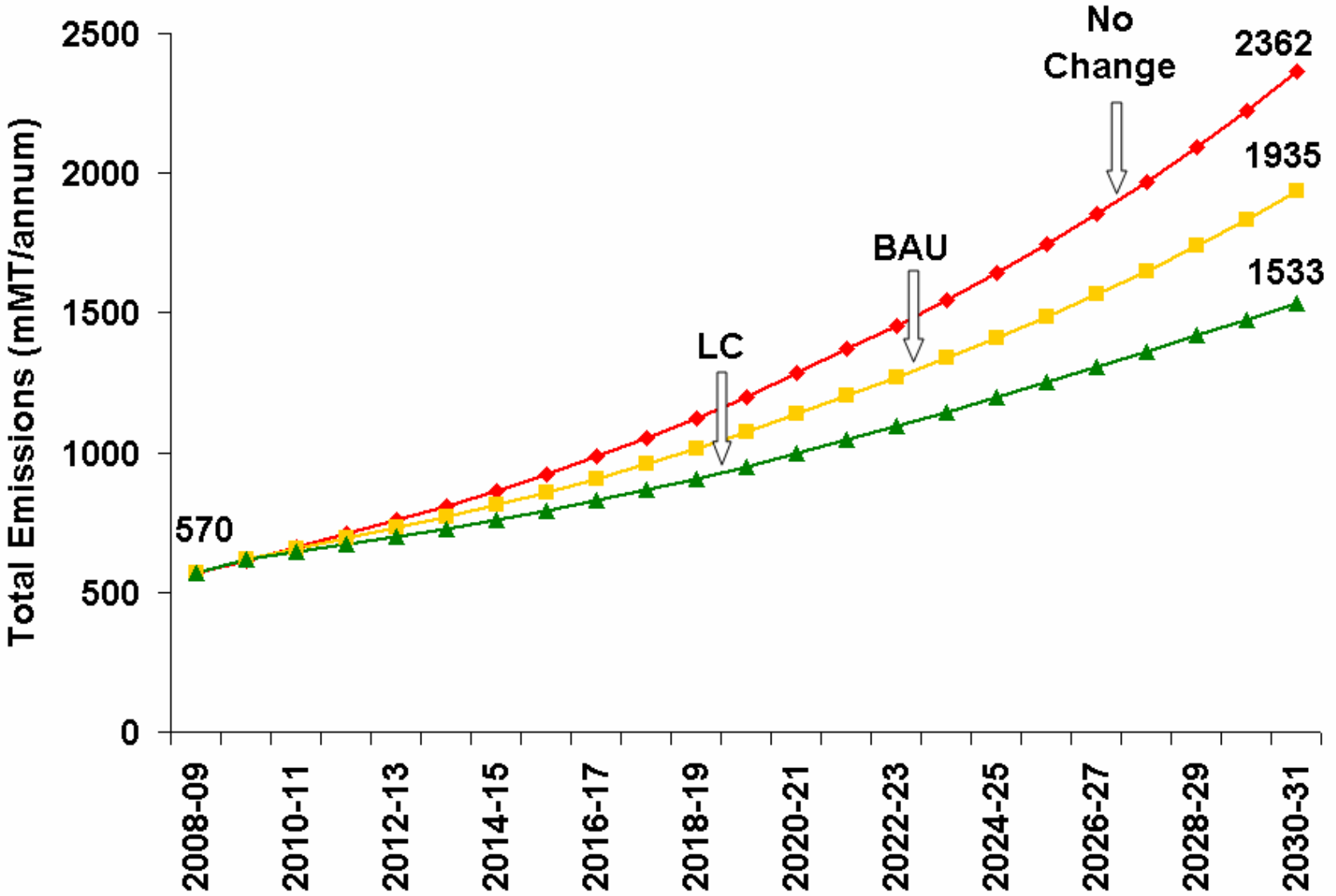
Emissions trajectory

Power Sector



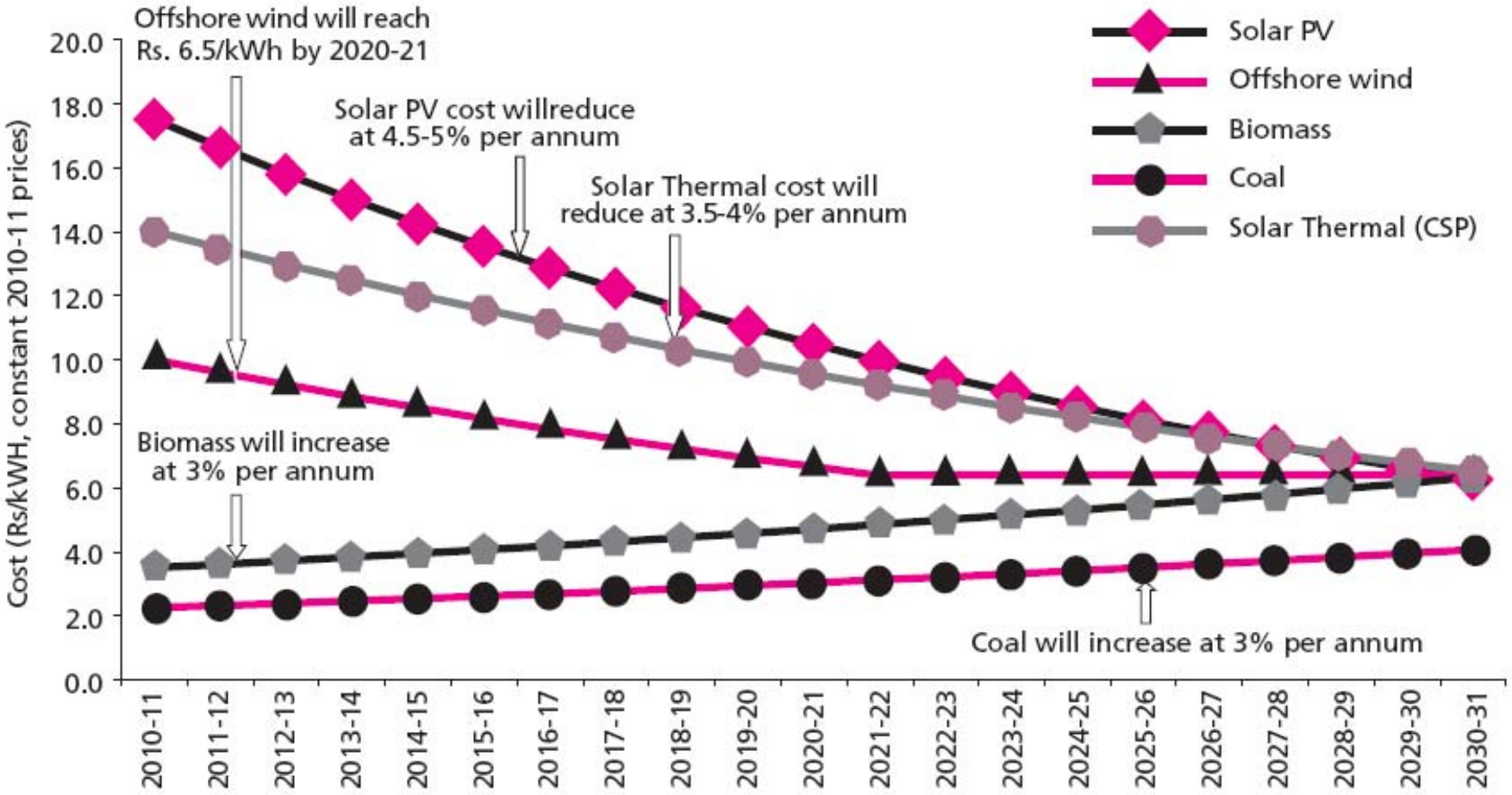
Emissions trajectory

Power Sector



Cost of low carbon

Power Sector



Cost of low carbon

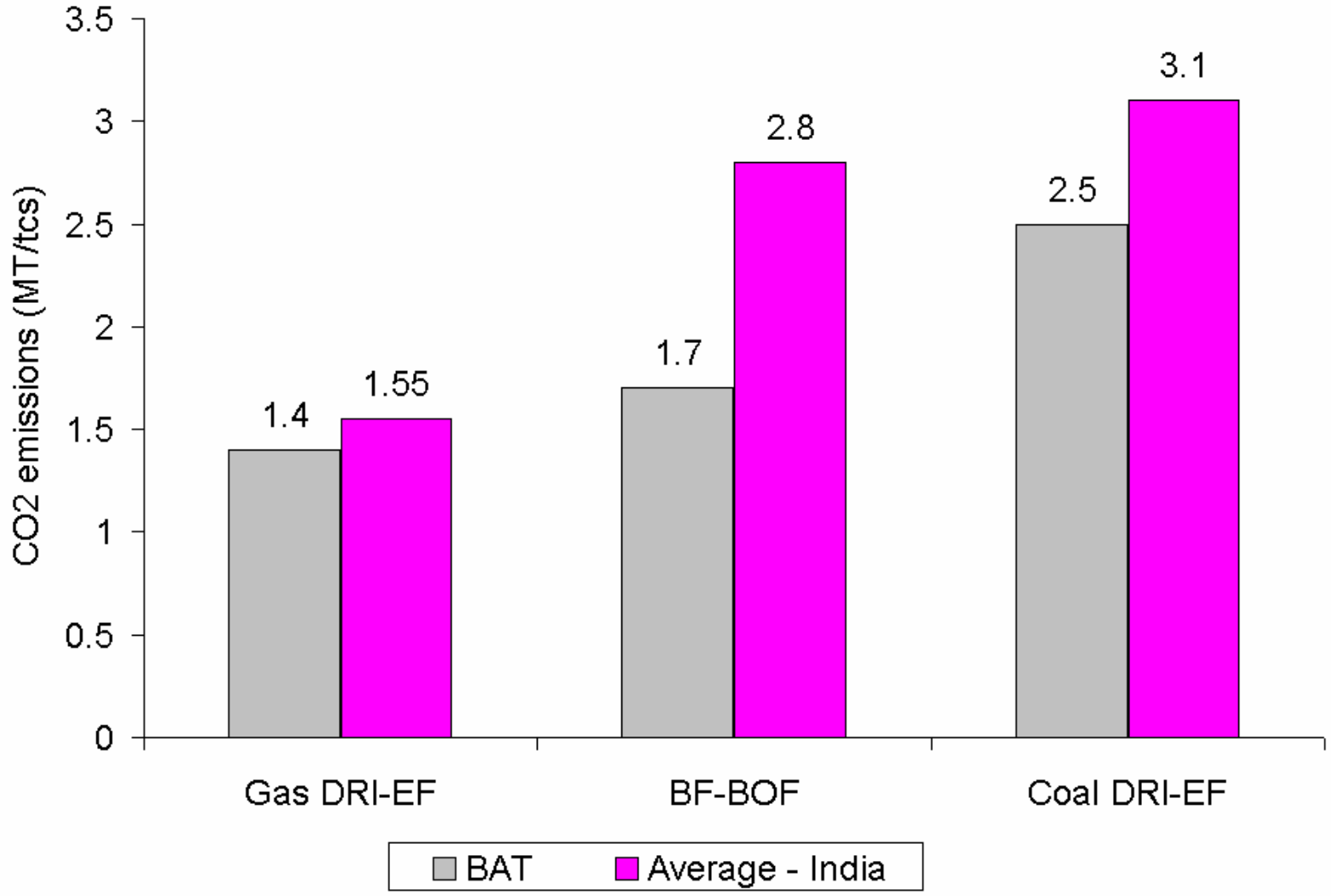
Power Sector

- **Cumulative emissions avoided by opting for LC over BAU is 3.4 billion MT CO_2 @ US $60 / tonne CO_2 avoided**
- **This is 3 - 4 times the price of CERs under CDM**

Iron and Steel

GHG emissions

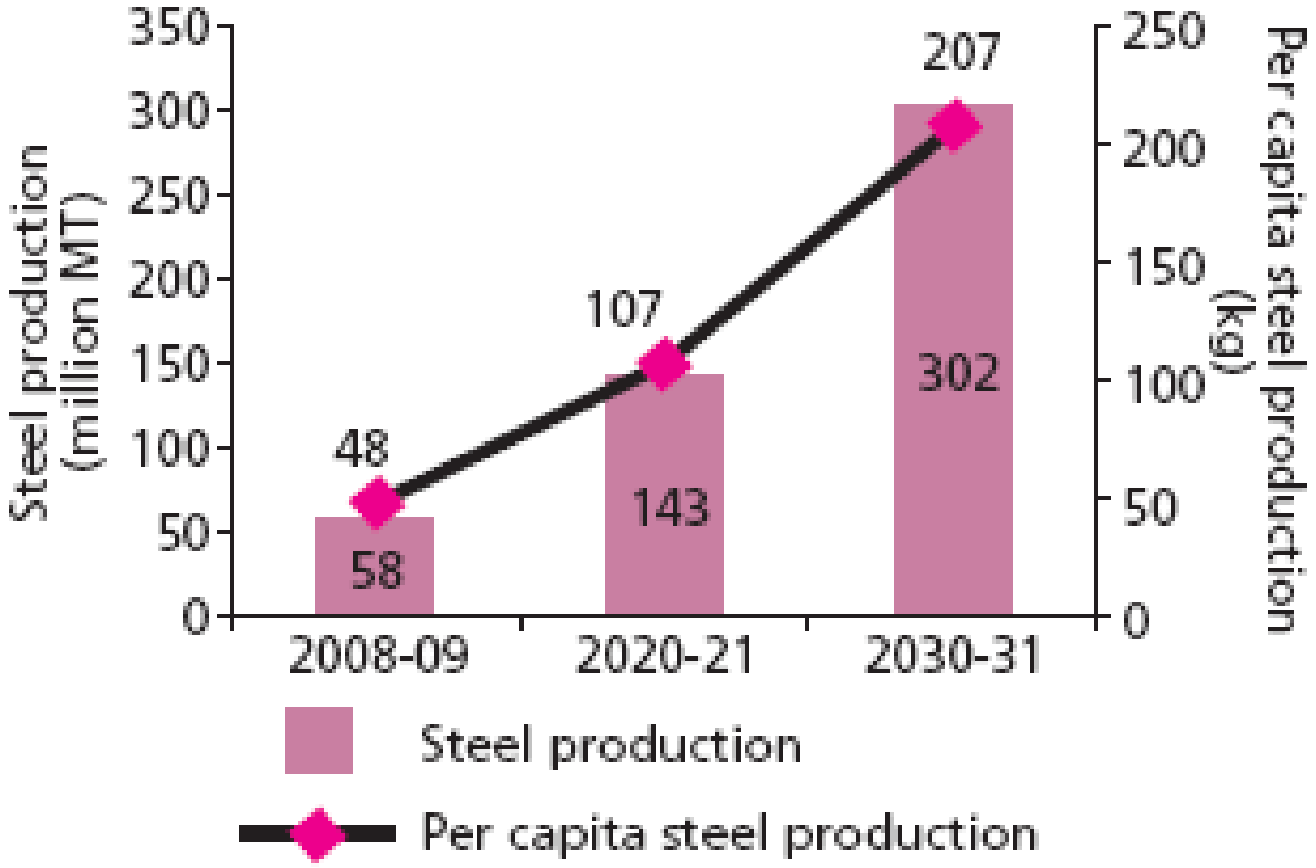
Iron and Steel



Highest potential in BF-BOF; about 25% in coal DRI-EF

Production projection

Iron and Steel

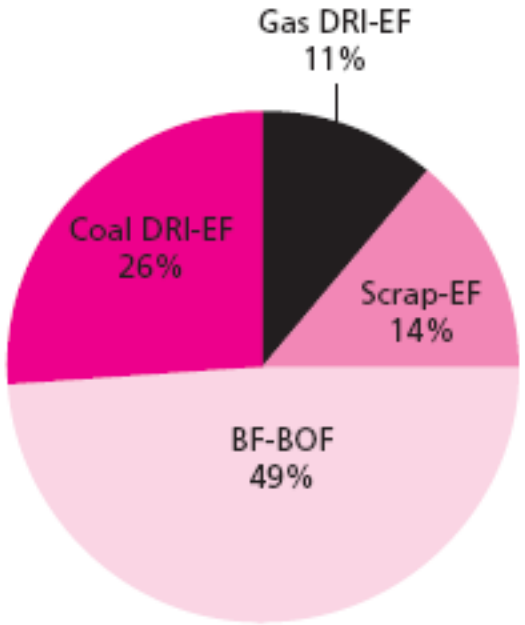


Per capita steel production in 2030-31 will be about 210 kg; equal to the <u>current</u> global per capita steel consumption

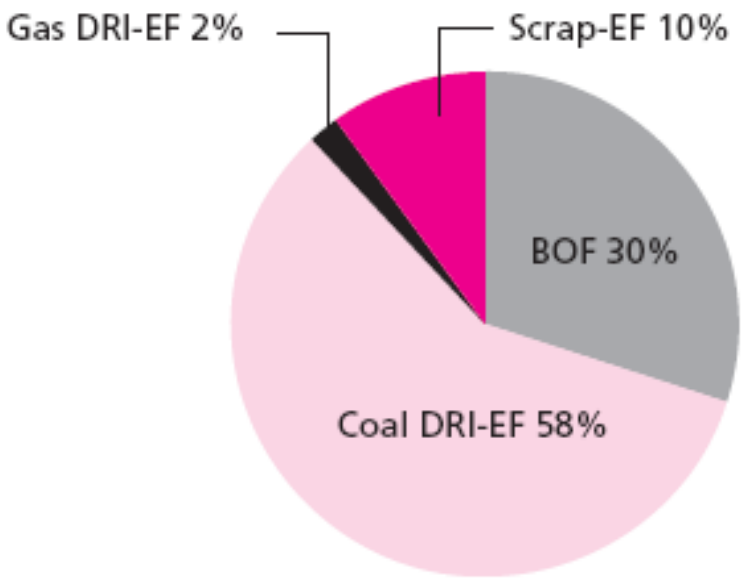
Process route: steel production

Iron and Steel

2008-09

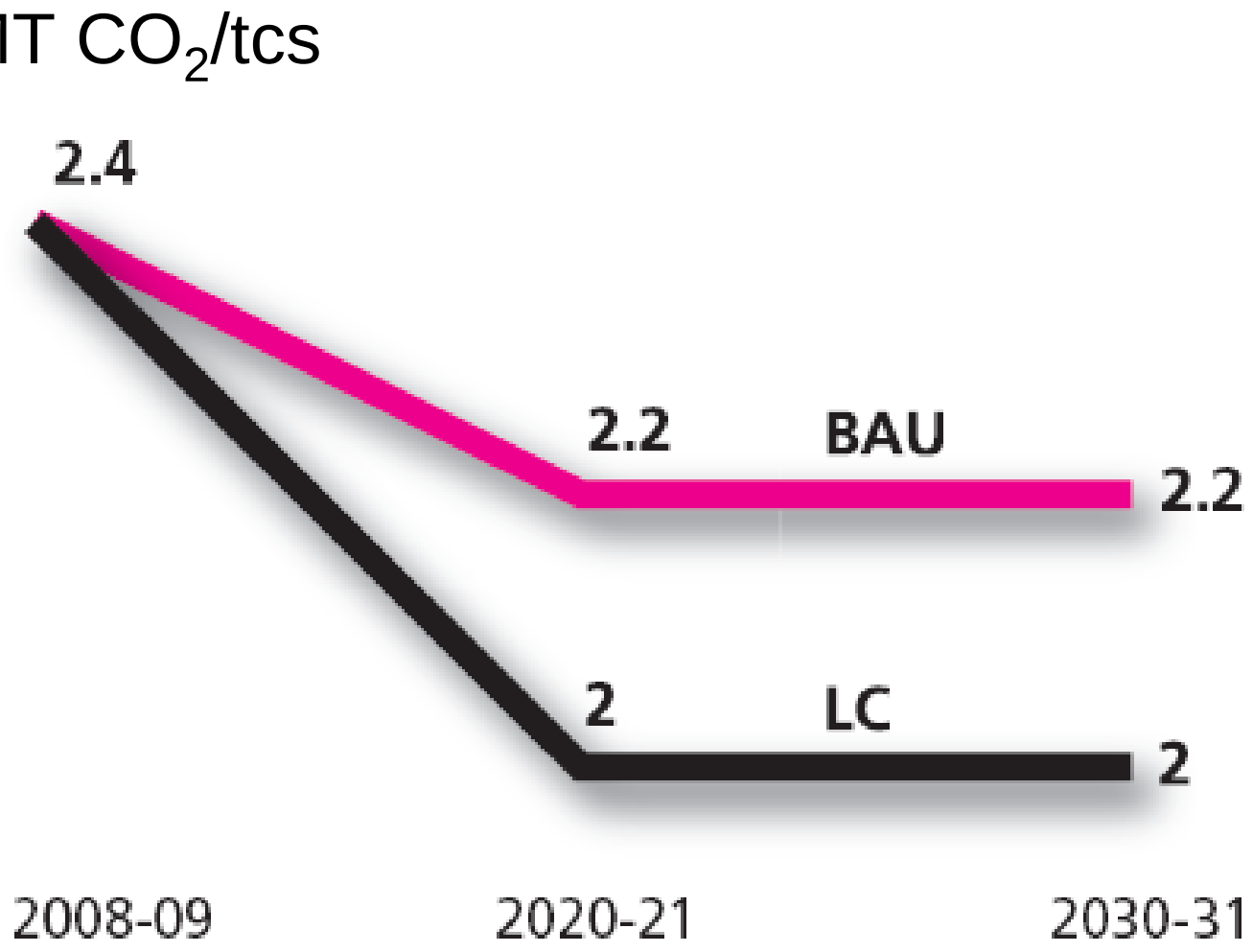


2030-31



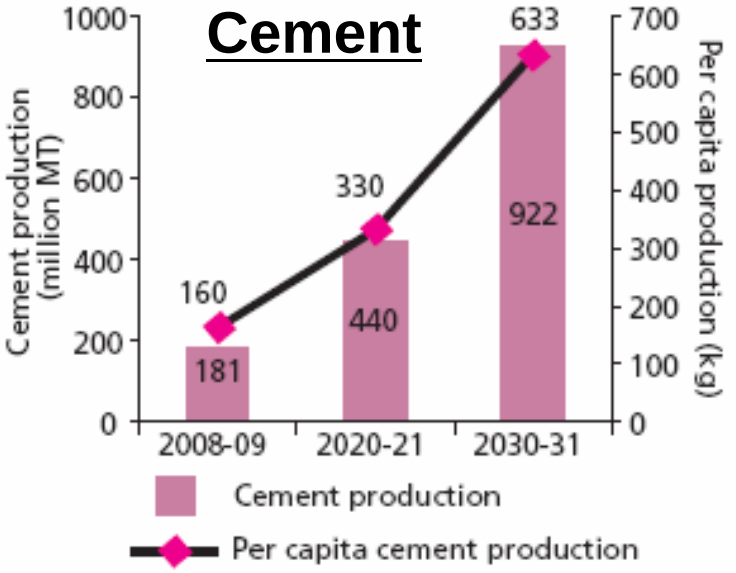
Emissions intensity

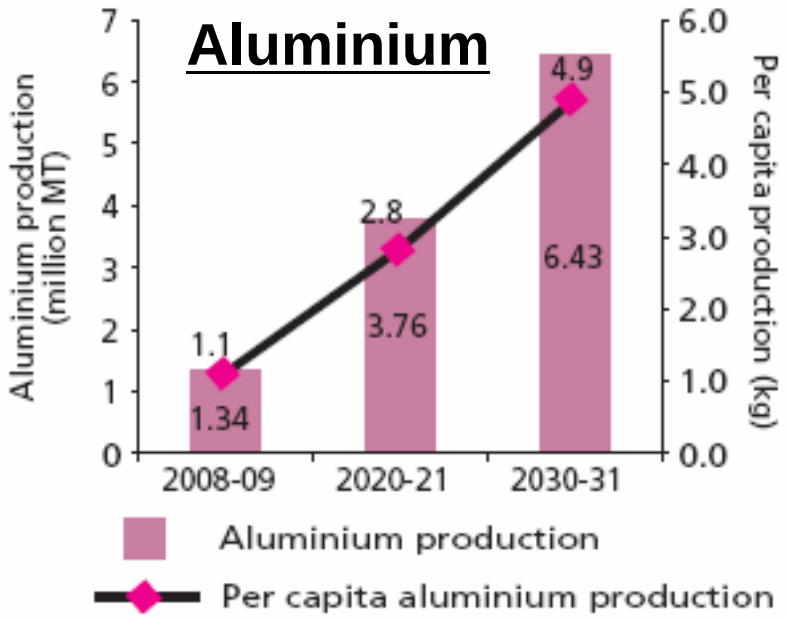
Iron and Steel

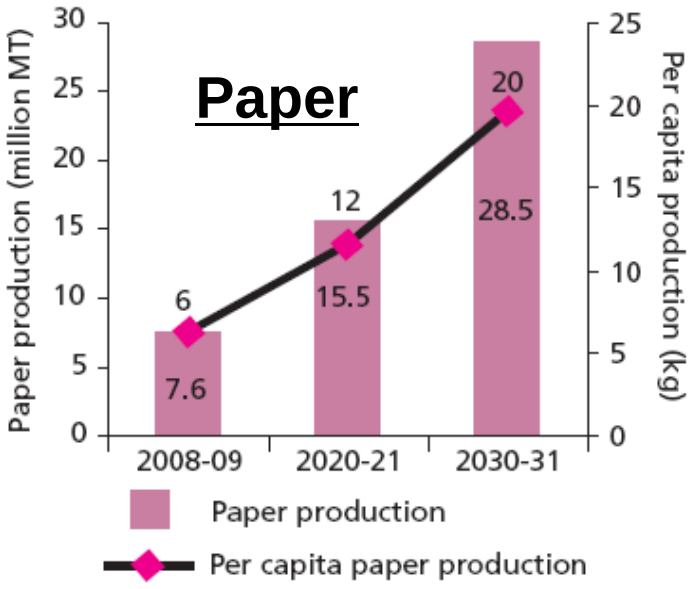


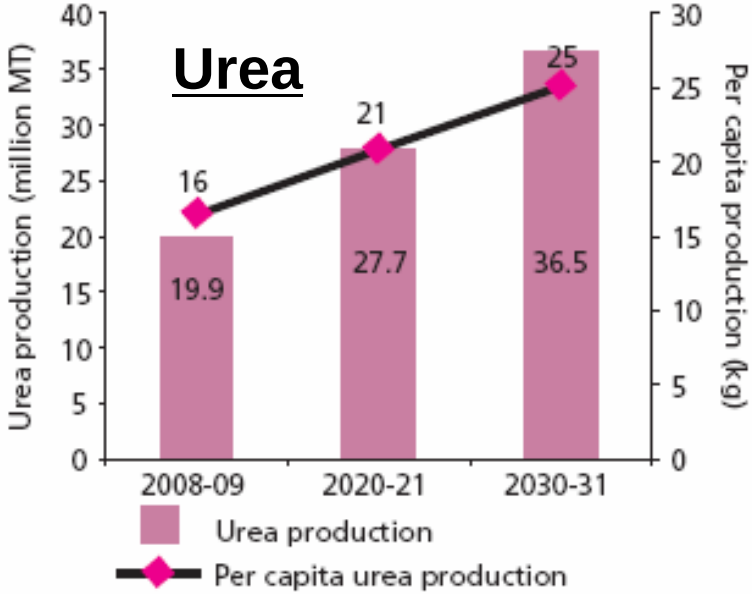
- Cement
- Aluminium
- Paper
- Fertilizer (Urea)

Production projection



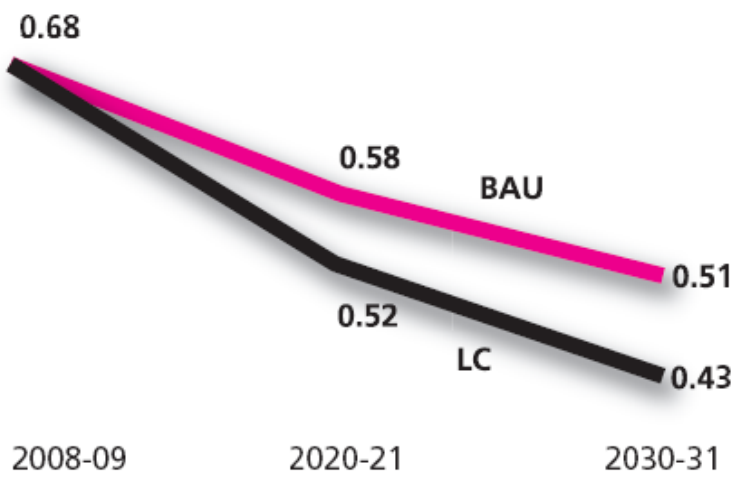




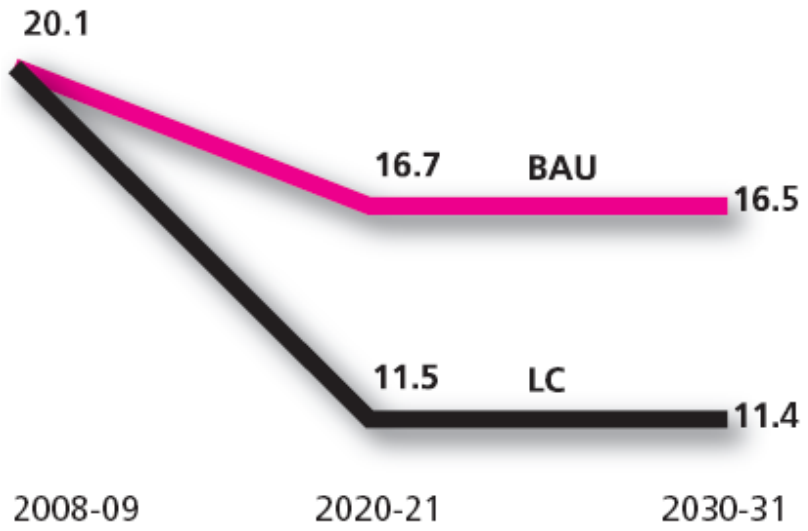


Emissions intensity

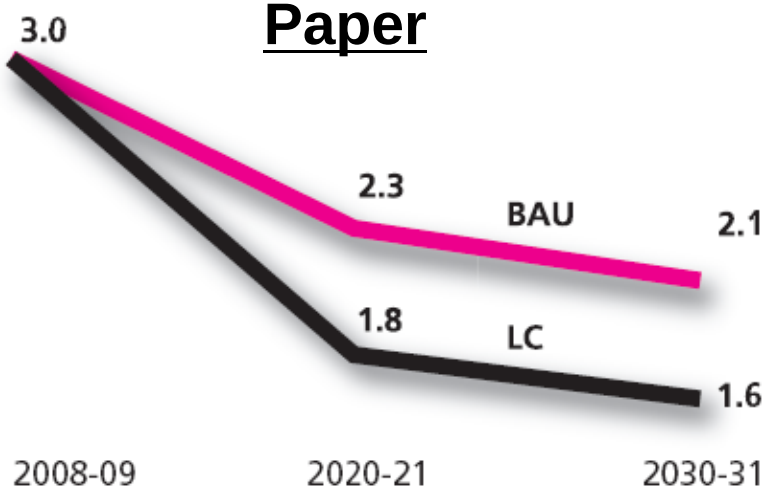
Cement



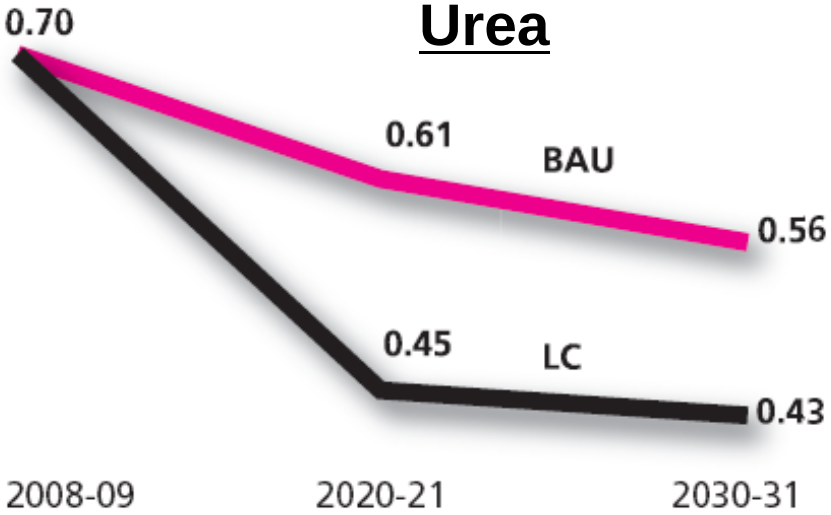
Aluminium



Paper



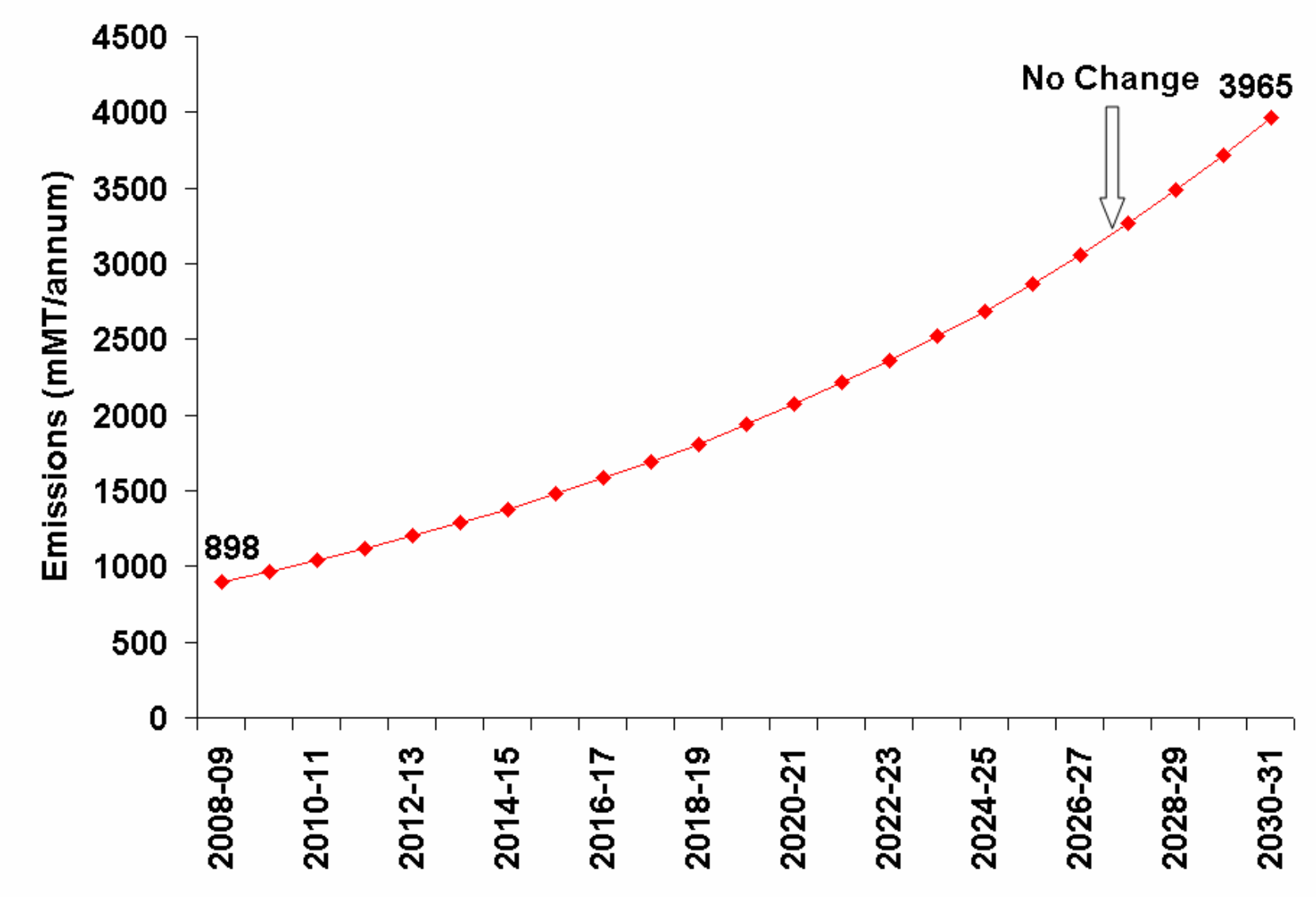
Urea



Emissions and Emissions intensity of GDP

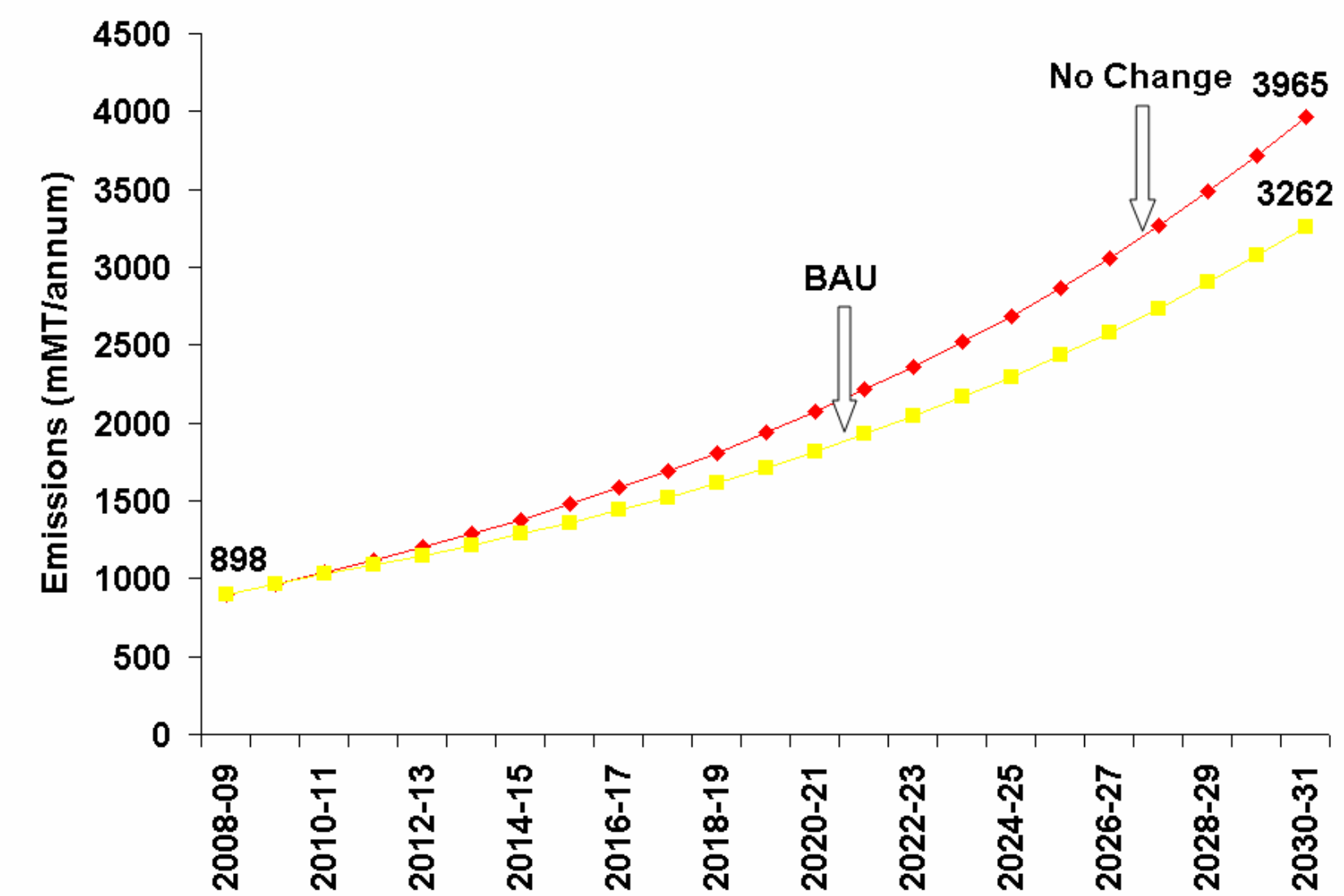
GHG emissions scenario

Low carbon growth



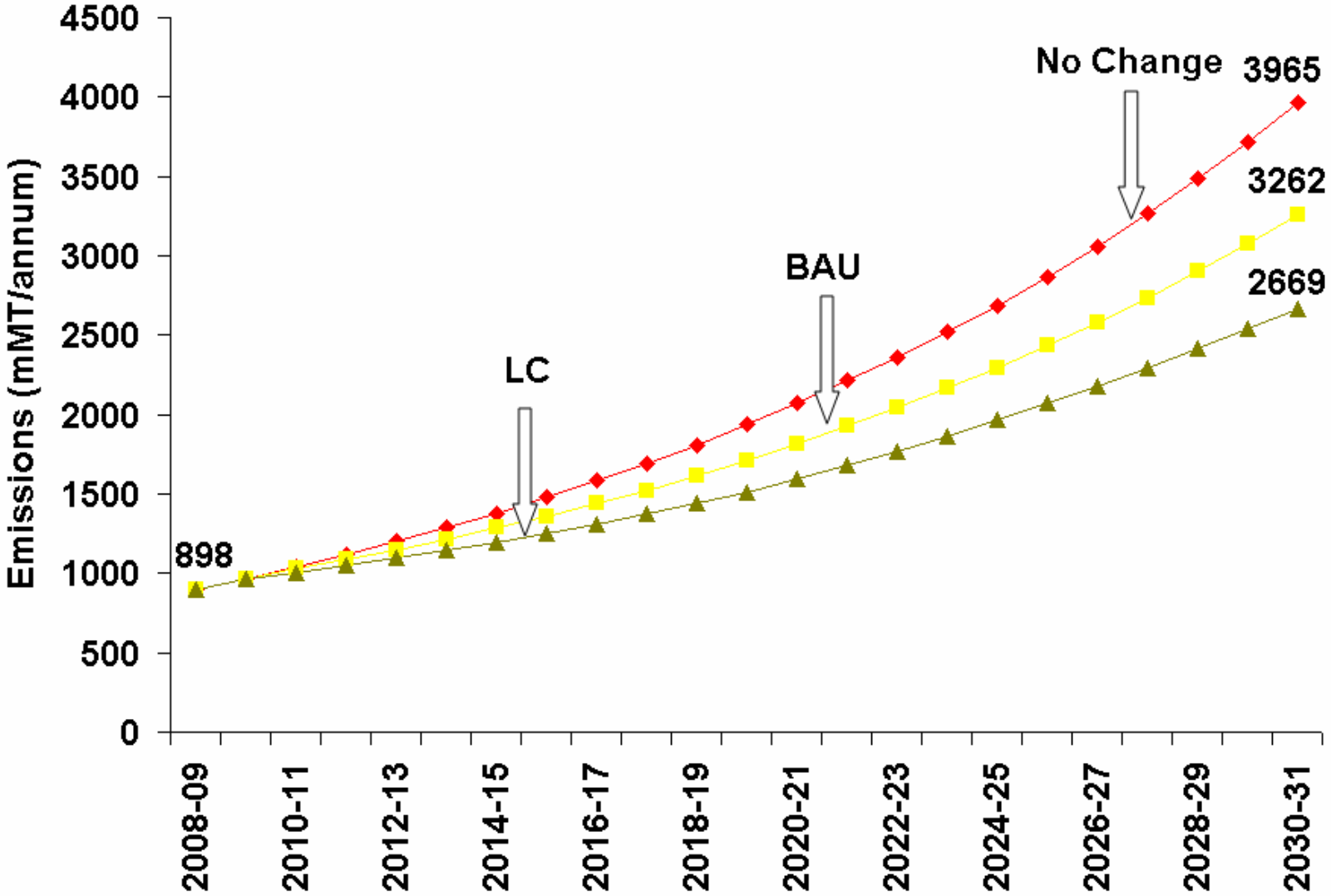
GHG emissions scenario

Low carbon growth



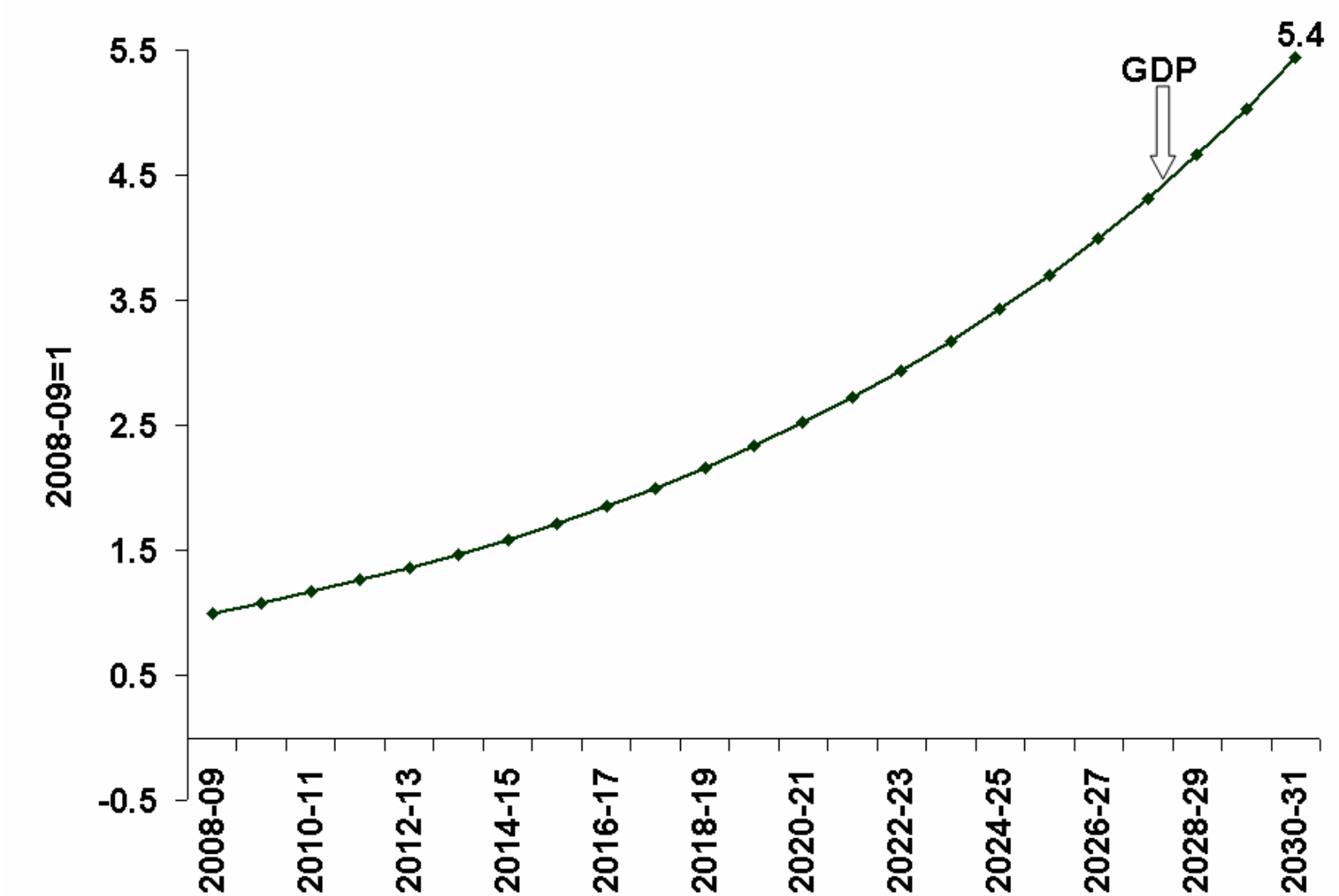
GHG emissions scenario

Low carbon growth



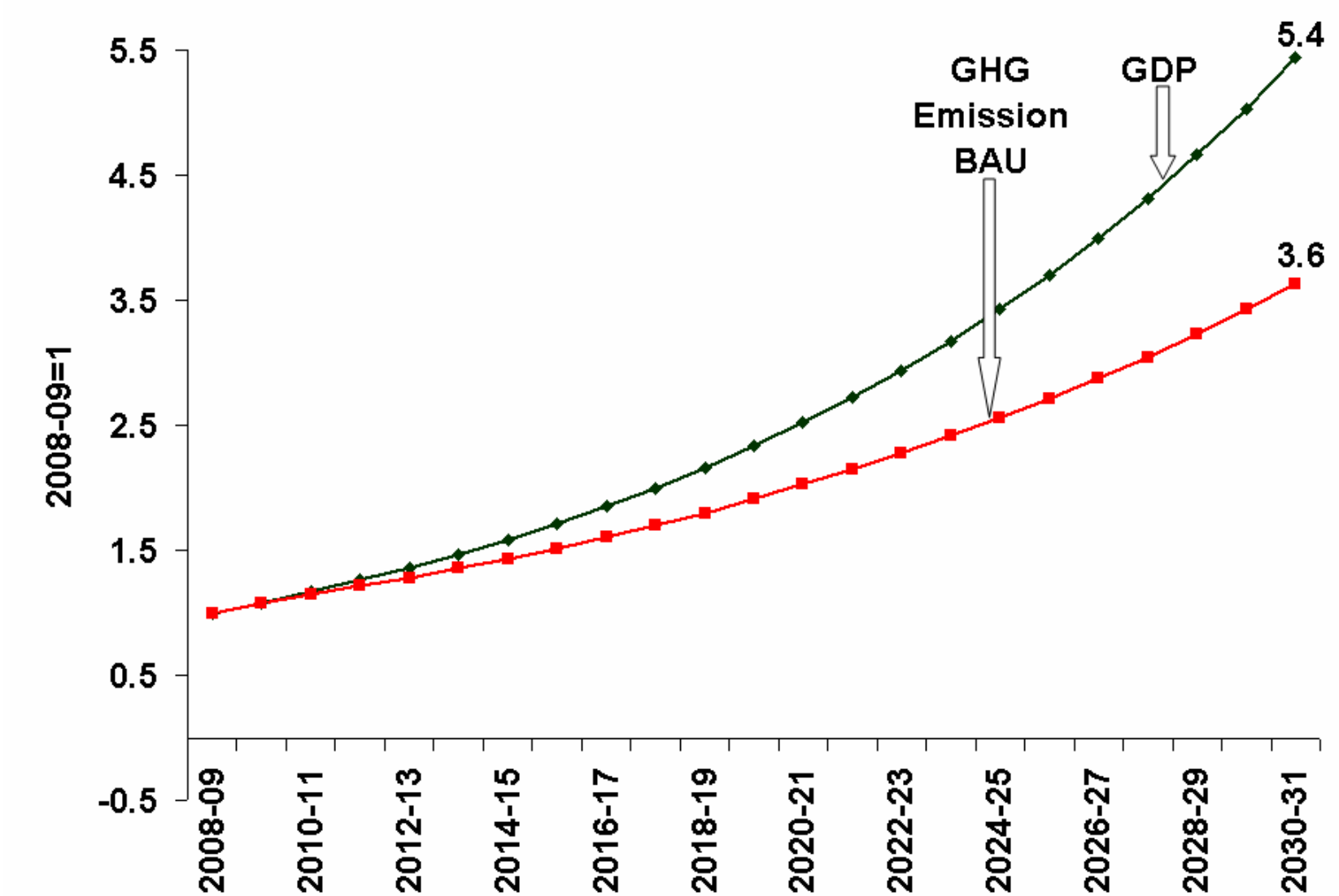
Emissions intensity of GDP

Low carbon growth



Emissions intensity of GDP

Low carbon growth



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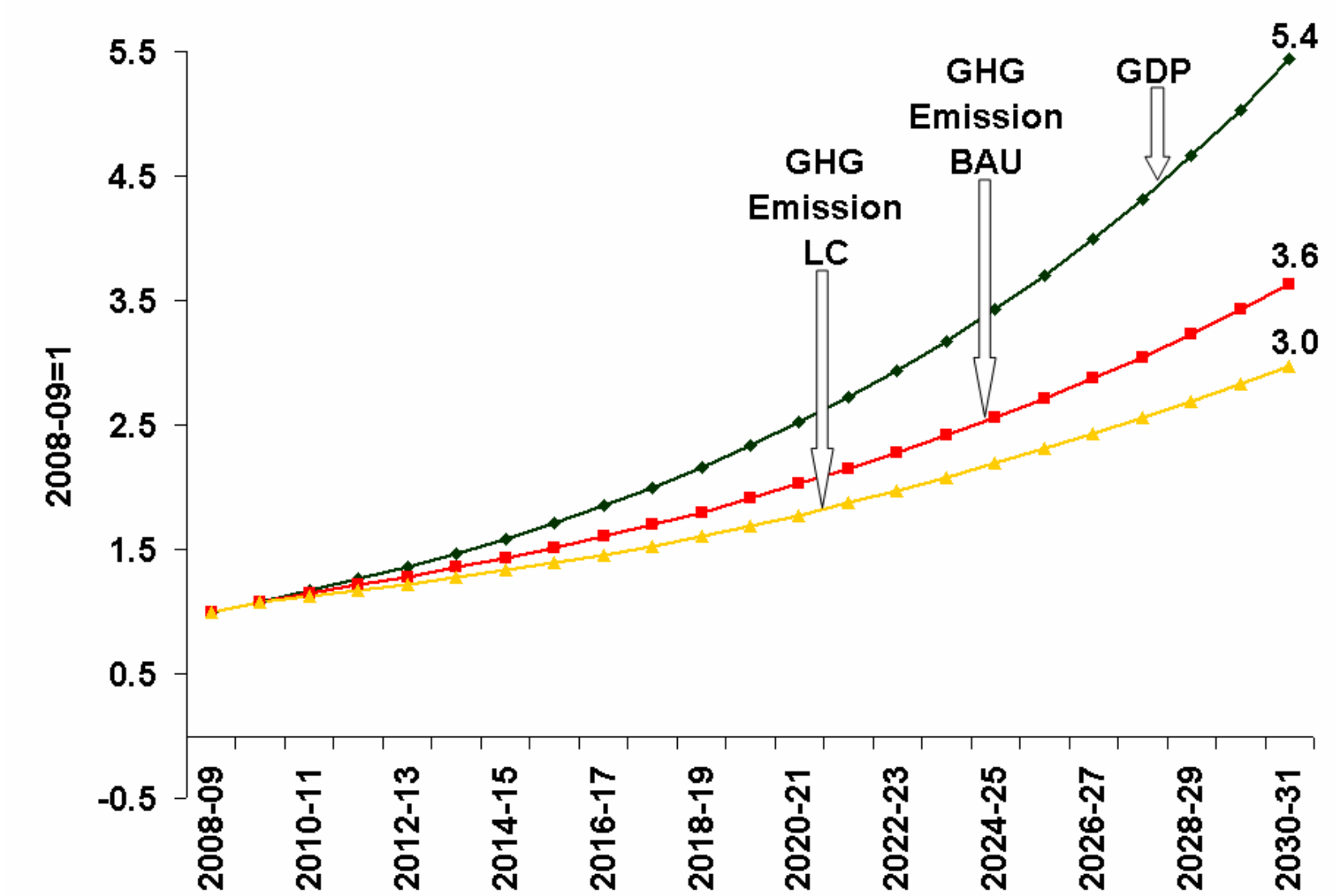
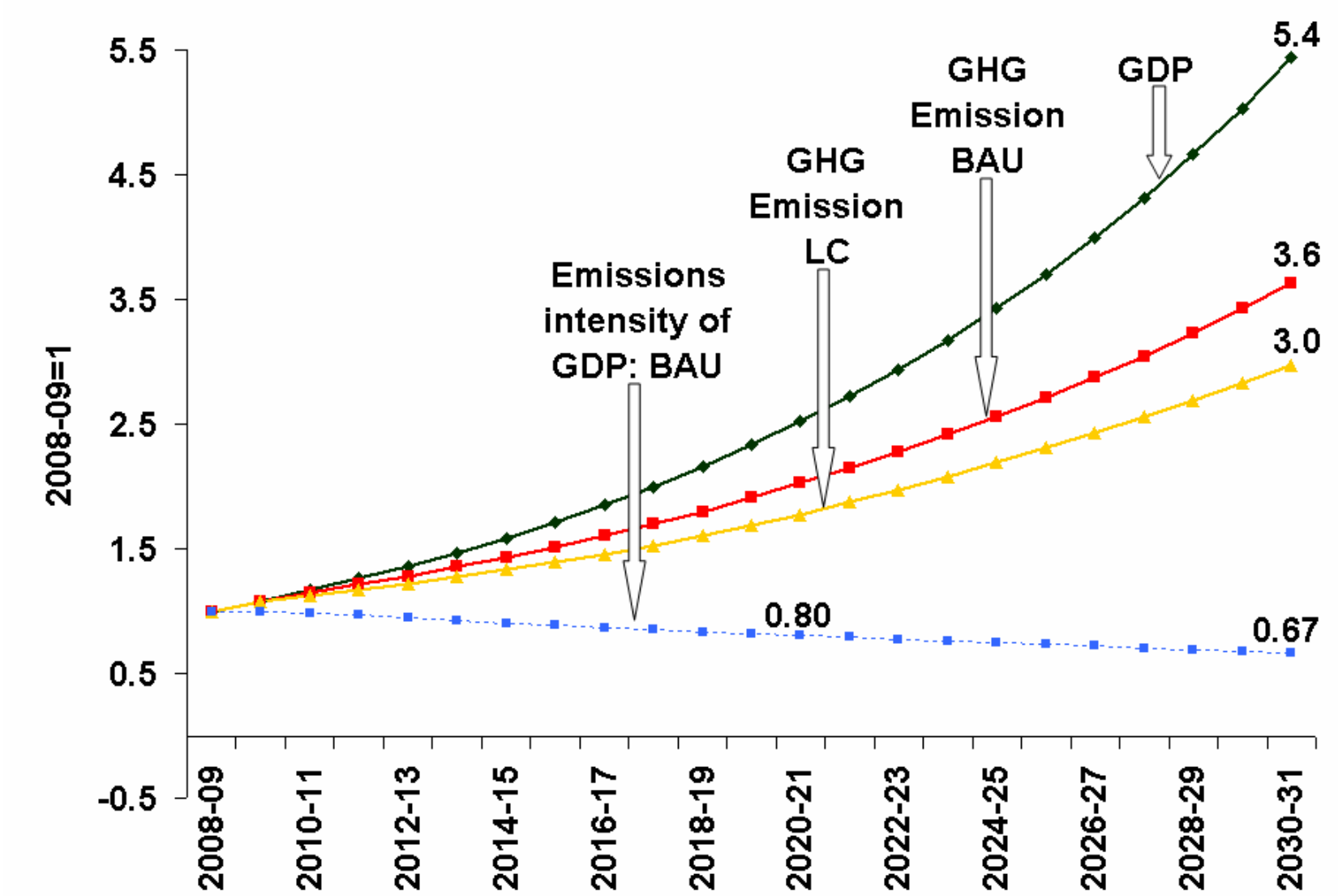
Low carbon growth



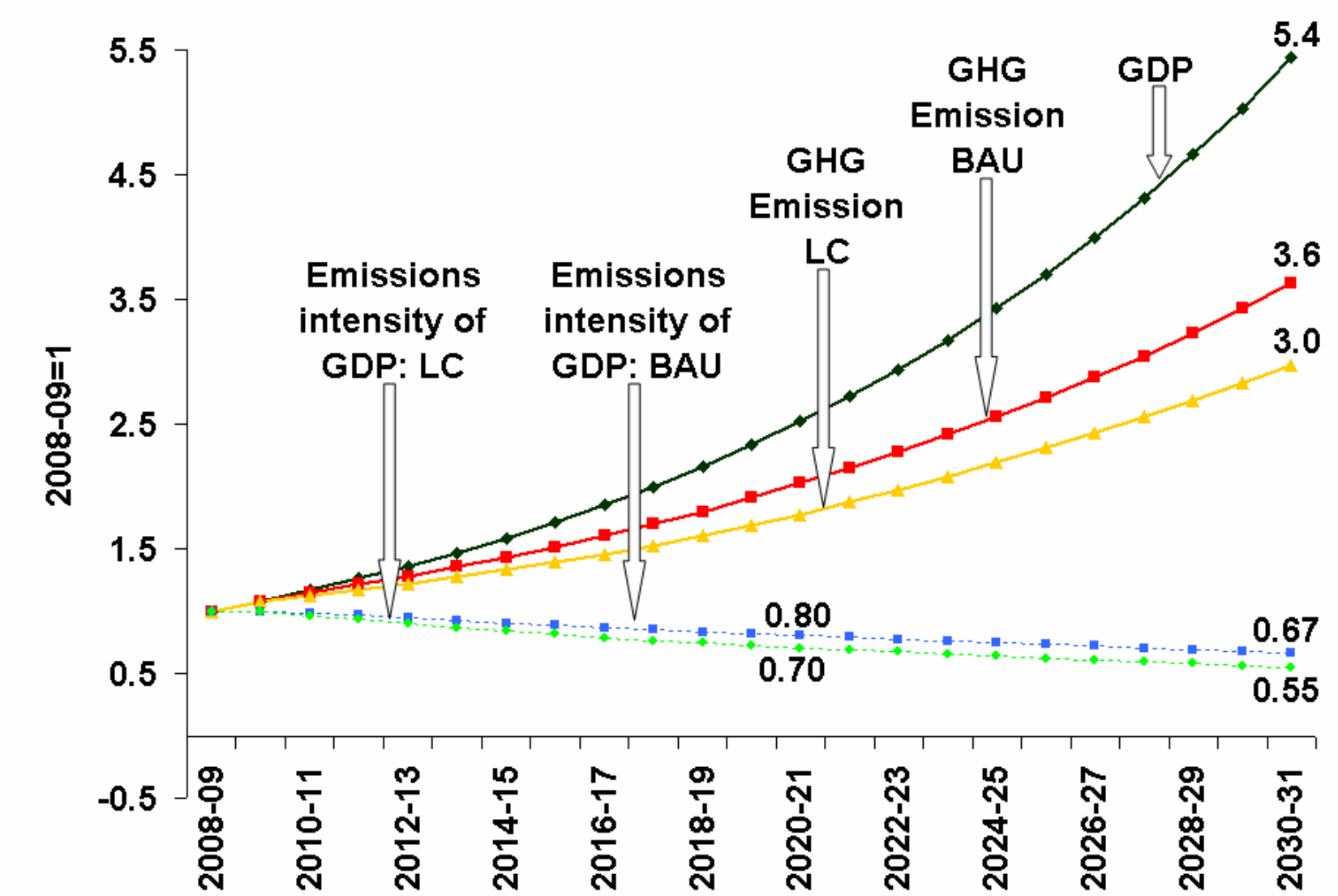
Emissions intensity of GDP

Low carbon growth



Emissions intensity of GDP

Low carbon growth



What the future looks like

Low carbon growth

- In both BAU and LC, major reductions in emissions intensity will be achieved by 2020-21.
- After 2020-21, in steel, aluminium and fertilizer the emissions intensity stagnates; in paper and cement, the reduction is moderate and largely because of change in raw material.
- By 2020-21, aluminium, cement and fertilizer will operate at BAT levels; steel and paper will operate at highest possible levels considering the structure, technology and limitations.
- Everything in power sector depends on how ambitious we are in deploying low/no-carbon technologies. Cost is the factor.

What the future looks like?

Low carbon growth

- Reducing emissions post-2020 will be a challenge.
- By 2020, we will exhaust all ‘low hanging’ options as well as high-end commercialized technologies.
- Implications

a. Need for big-ticket technology development and deployment, which will in turn require drastic emission reduction targets in industrialised countries

b. Need to ensure that equity, remains the basis of negotiations