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Towards a climate change scenario that is ecologically sustainable, fair, and welfare-increasing

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1. Introduction

Anthropogenic global warming (AGW) is a symptom of a much larger problem – the larger problem is humankind's addiction to the growth of the economic subsystem relative to a finite, non-growing ecosystem

Even if a global emissions protocol emerged with the aim of stabilising GHG emissions at a safe concentration level, it will be of little value unless we do what is required to achieve sustainable development (SD), otherwise known as *sustainable qualitative improvement*

Indeed, if we continue with population and GDP growth-as usual, we will not be able to stabilise the concentration of GHGs at a safe level or achieve SD overall

My main argument is that humankind must:

Stabilise the atmospheric concentration of GHGs at no more than 450 ppm of CO_2-equivalent or 400 ppm of CO_2 (i.e., 450 ppm of CO_2-e is the upper limit of a safe atmospheric concentration of GHGs)

Between now and 2100, stabilise human population numbers at no more than 8 billion and eventually stabilise population numbers at something much lower than this

Reduce the overall rate of resource use so it is again within the sustainable carrying capacity of the planet (it currently exceeds it by at least 35%)

Improve the distribution of income and wealth between and within countries

Make the transition from a growth-based economy to a qualitatively-improving steady-state (non-growing) economy (QISSE)

High-income countries will need to make this transition immediately

Low-income countries still need more growth, albeit it must be growth that is as green, equitable, and efficient as possible – eventually they will also need to move to a QISSE

2. Sustainable development and growth

Physically, the Earth is a steady-state system:

- The Earth is finite and physically non-growing
- The inflow of energy equals the outflow of energy
- Material inflows/outflows are negligible
- Although the Earth is a steady-state system, considerable qualitative change can and does take place on it

The most critical change on Earth in recent times has been the growth of the economic subsystem and the human population inhabiting it

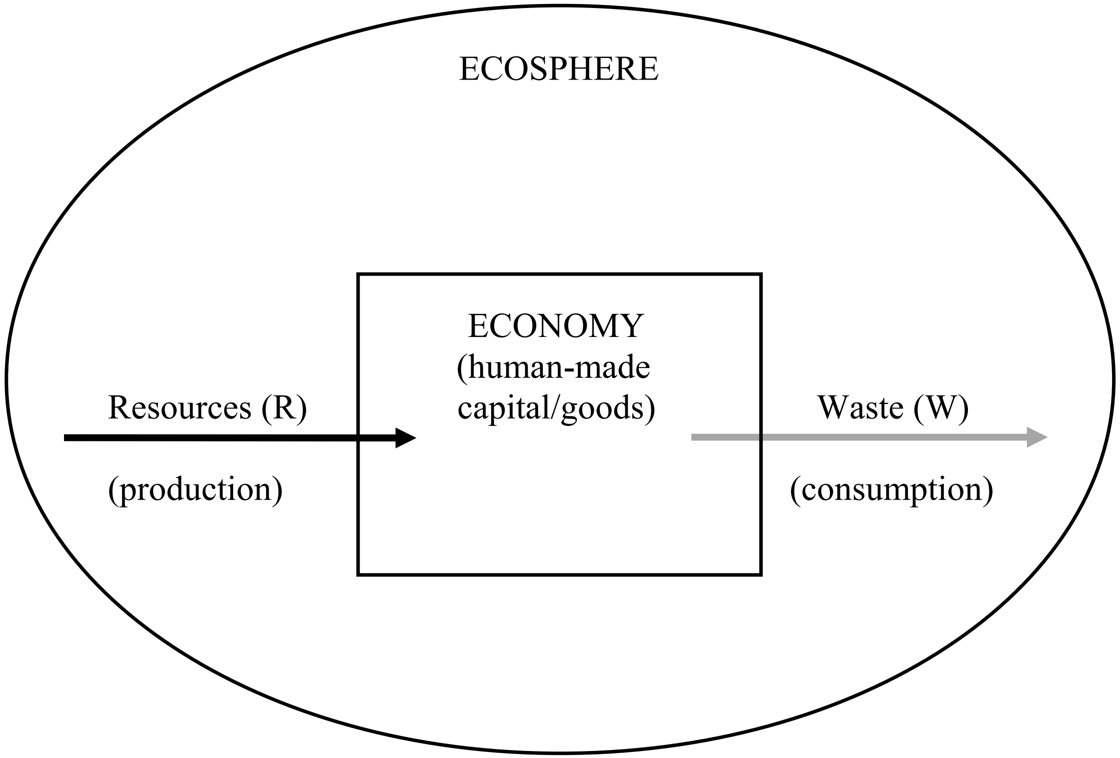
In general, as the economy physically grows:

- resource (R) inputs rise
- waste (W) outputs rise
- i.e., the rate of throughput increases

For the economy to be sustainable in the long-run, two basic rules must be adhered to:

- $R \leq$ rate of resource regeneration
- $W \leq$ rate of waste assimilation

Growth of the economy is unsustainable in the long-run because one and eventually both of these rules are violated



ECOSPHERE
ECONOMY
(human-made
capital/goods)
Resources (R)
(production)
Waste (W)
(consumption)

Some conclusions about growth and ecological limits:

- Provided the economy is 'small' relative to the steady-state ecosphere, the economy can safely and desirably grow

- As the economy becomes 'large' relative to the steady-state ecosphere, the economy must conform to the physical behavioural mode of the Earth to remain sustainable – that is, it must conform to a steady-state physical system

- Clearly, to ensure ecological sustainability, we must at some point initiate a transition from a growth economy to a SSE

How do we know when to make the transition to a SSE?

Consider, firstly, the *ecological limit to growth*

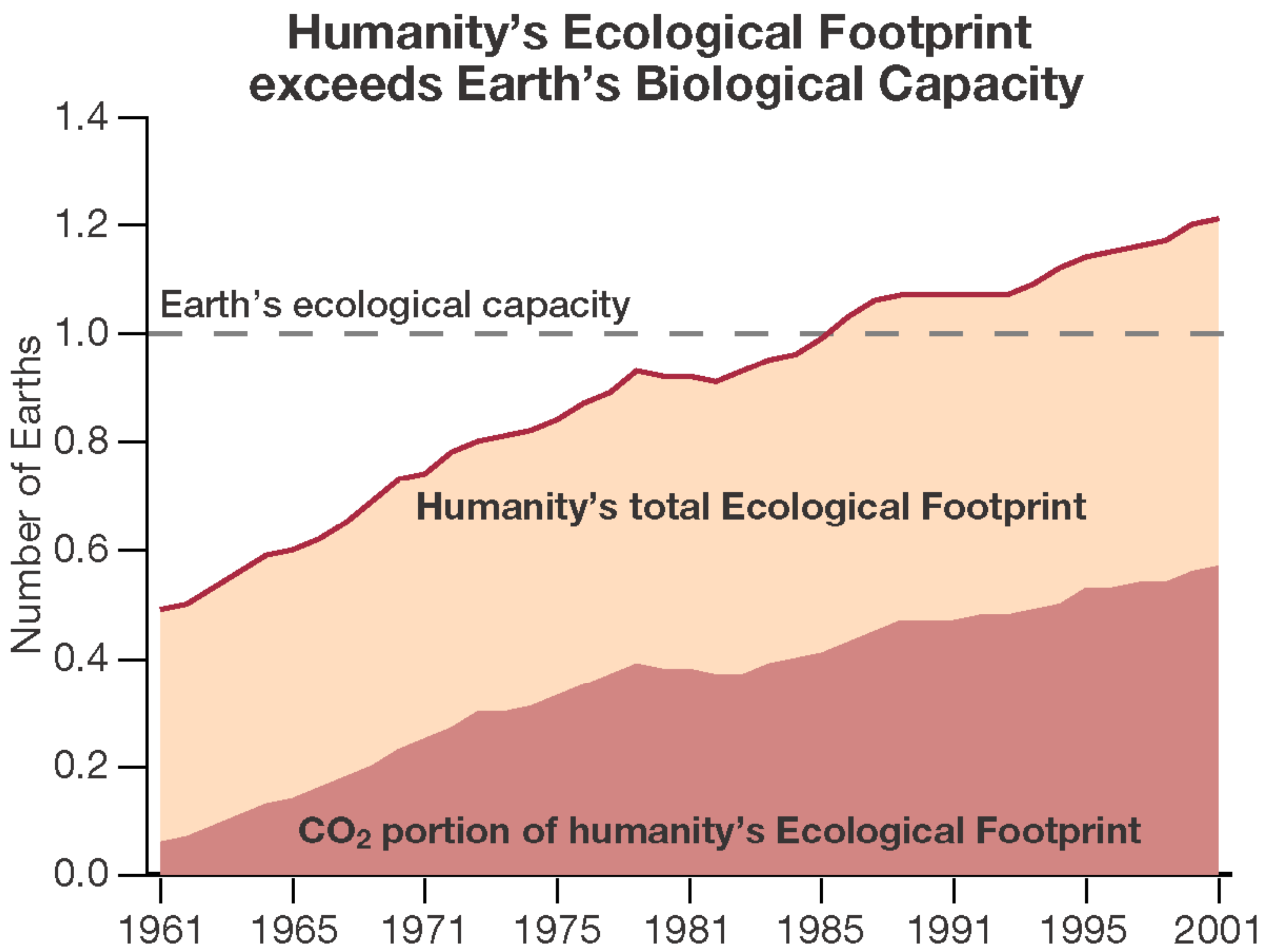
- Ecological footprint represents the area of land *required* to provide R, assimilate W, and provide critical life-support services

- Biocapacity represents the area of land *available* to provide R, assimilate W, and provide critical life-support services

- If EF > BC, we exceed the ecological limit (ecological deficit)

- As at 2005, global EF ÷ global BC = 1.3 (we had exceeded the ecological limit by 30%). To sustain resource use and waste levels at 2005 levels required around 1.3 Earths. The global economy is clearly unsustainable (i.e., EF > BC)

- As at 2005, 78 of 143 countries had an ecological deficit



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At the very least, we must adjust the scale of the global economy and the population of human beings to ensure an ecologically balanced budget (i.e., EF = BC)

Question: Should we operate the economy at the maximum sustainable scale (i.e., where EF = BC)?

- For precautionary reasons, we should operate where the global EF is no more than, say, 90% of global BC

- There is also a good economic reason to operate well short of the maximum sustainable scale or to operate at what I would refer to as the *'economic' limit to growth*

As the economy grows, there are associated benefits and costs

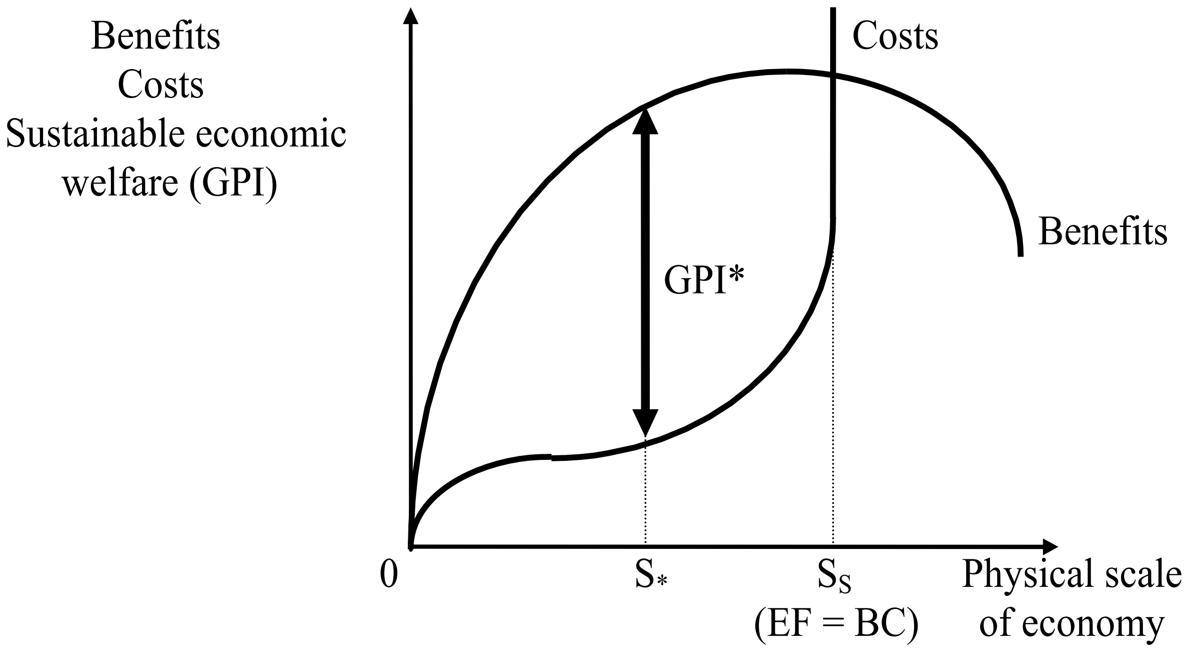
Figure – The benefits and costs of growth

There are production and consumption benefits, which increase at a diminishing rate (principle of diminishing marginal benefits).

There are social and ecological costs, which increase at an increasing rate (principle of increasing marginal costs).

The 'cost' curve is vertical at a scale of S_S, which represents the maximum sustainable scale.

The maximum difference between benefits and costs occurs at S*, which represents the optimal scale of the economy – **this is where we should be operating!**



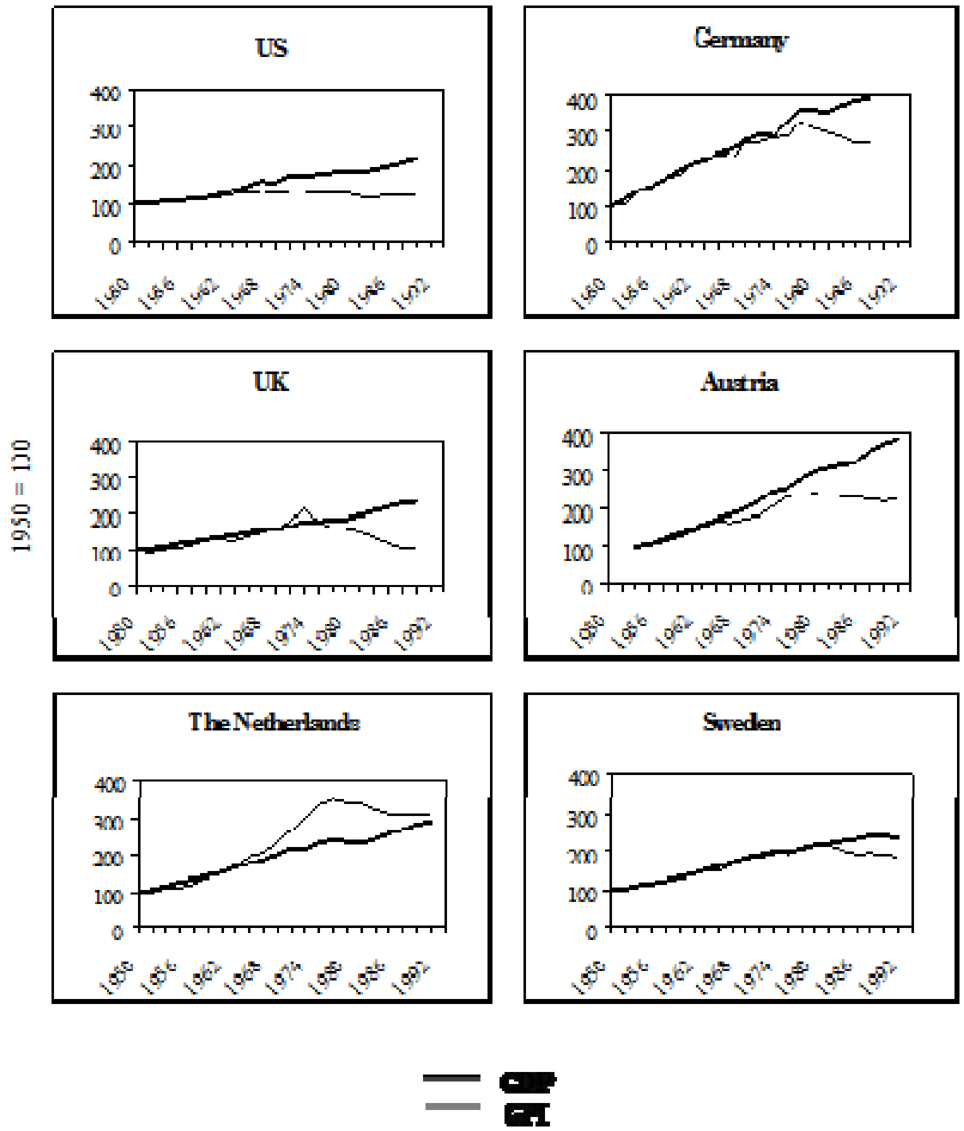
Benefits
Costs
Sustainable economic
welfare (GPI)
Costs
Benefits
GPI*
0
S*
Ss
(EF = BC)
Physical scale
of economy

Evidence?

Figure – Genuine Progress Indicator (GPI) of six high-income countries

Most high-income nations exceeded the economic limit to growth (S*) in the 1970s/80s when per capita GDP reached somewhere in the range of Int$15,000-20,000 – led to a threshold hypothesis regarding GDP and sustainable economic welfare (Max-Neef, 1995)

Most high-income nations should have initiated the transition to a SSE at this time



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Per capita GPI versus per capita GDP – Australia, 1962-2007

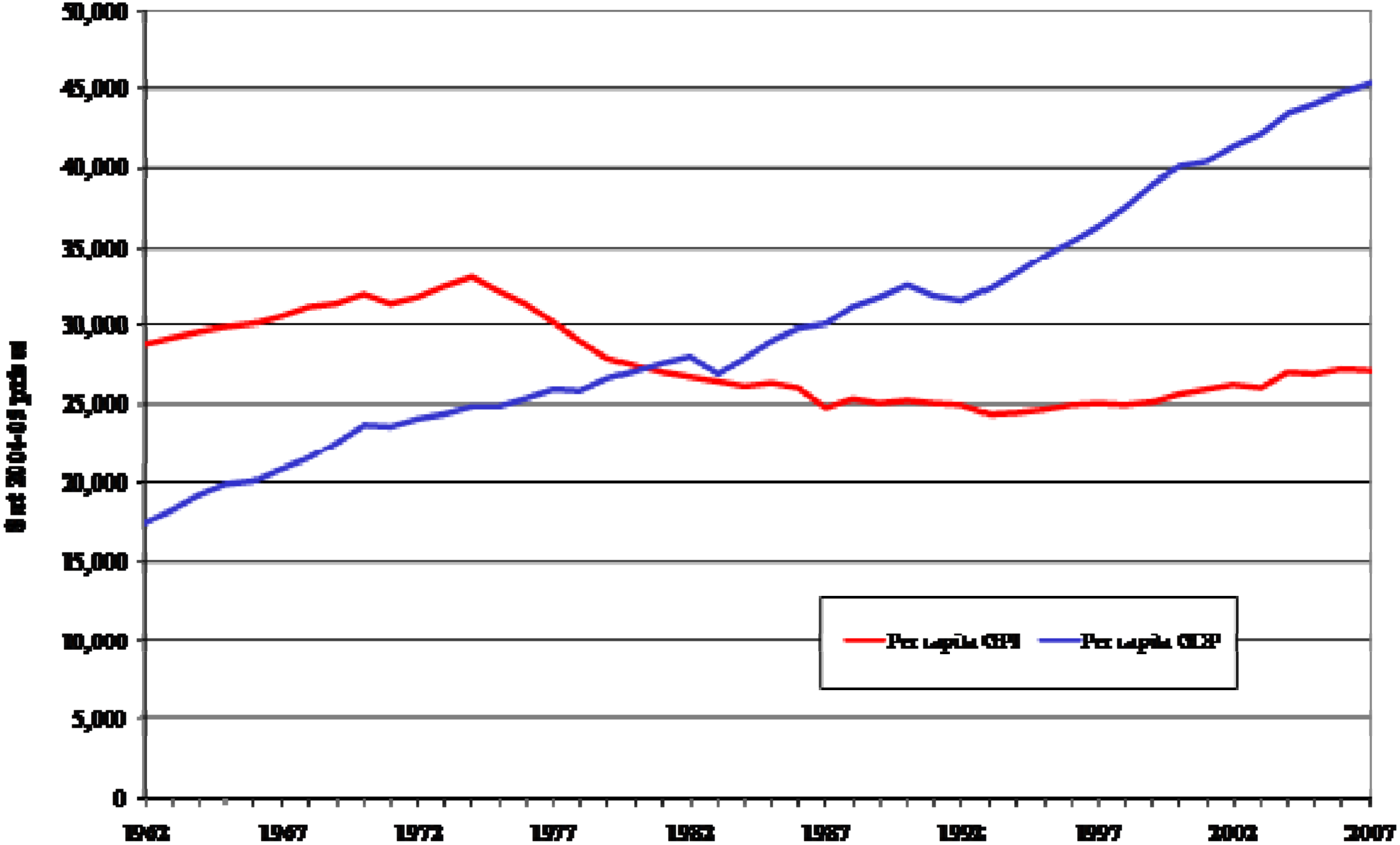


Figure – GPI of seven Asia-Pacific countries

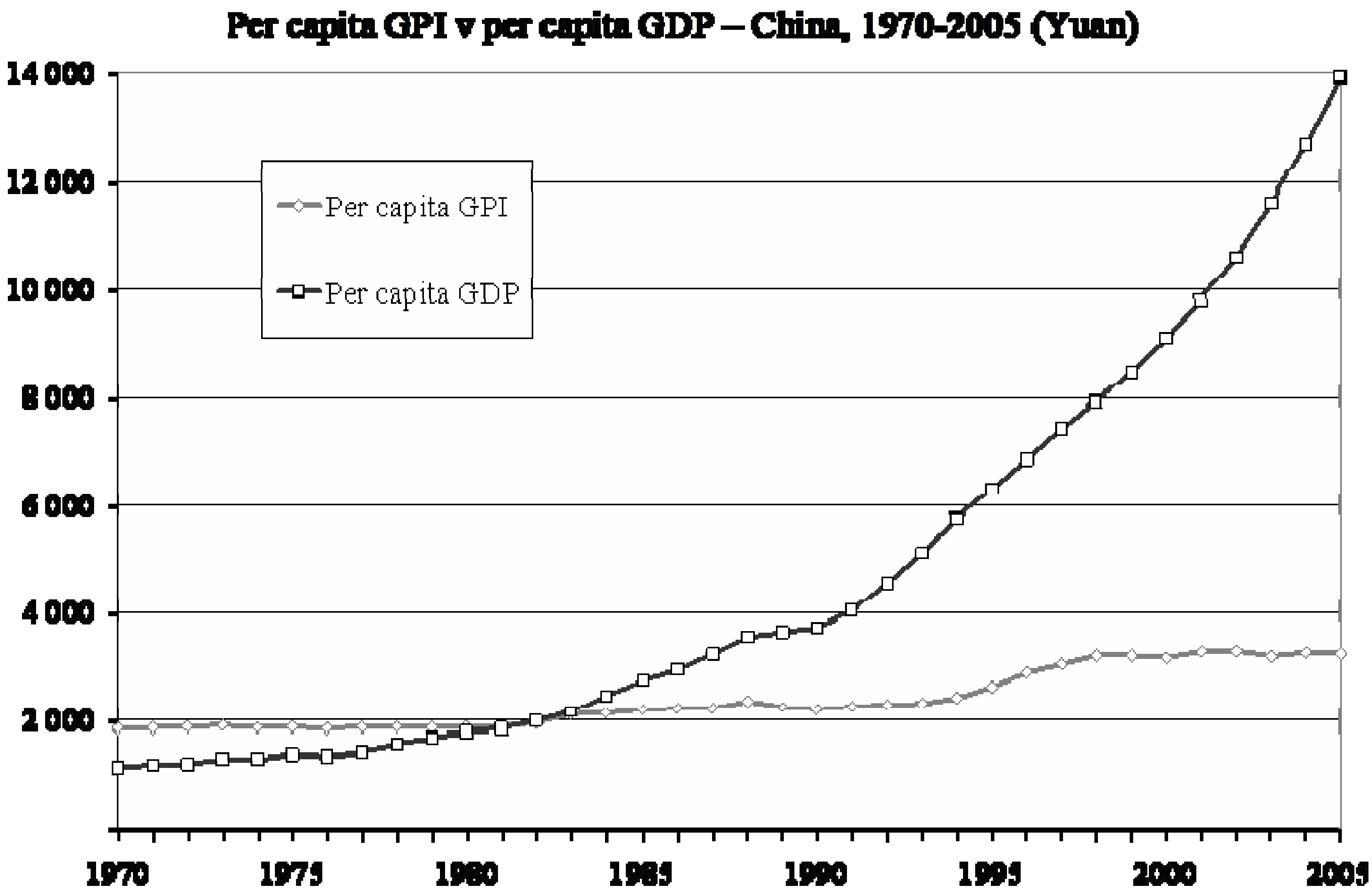
Some low-income nations appear to have reached an economic limit to growth

China – threshold reached at Int$5,000 p.c.

Thailand – threshold reached at Int$7,500 p.c.

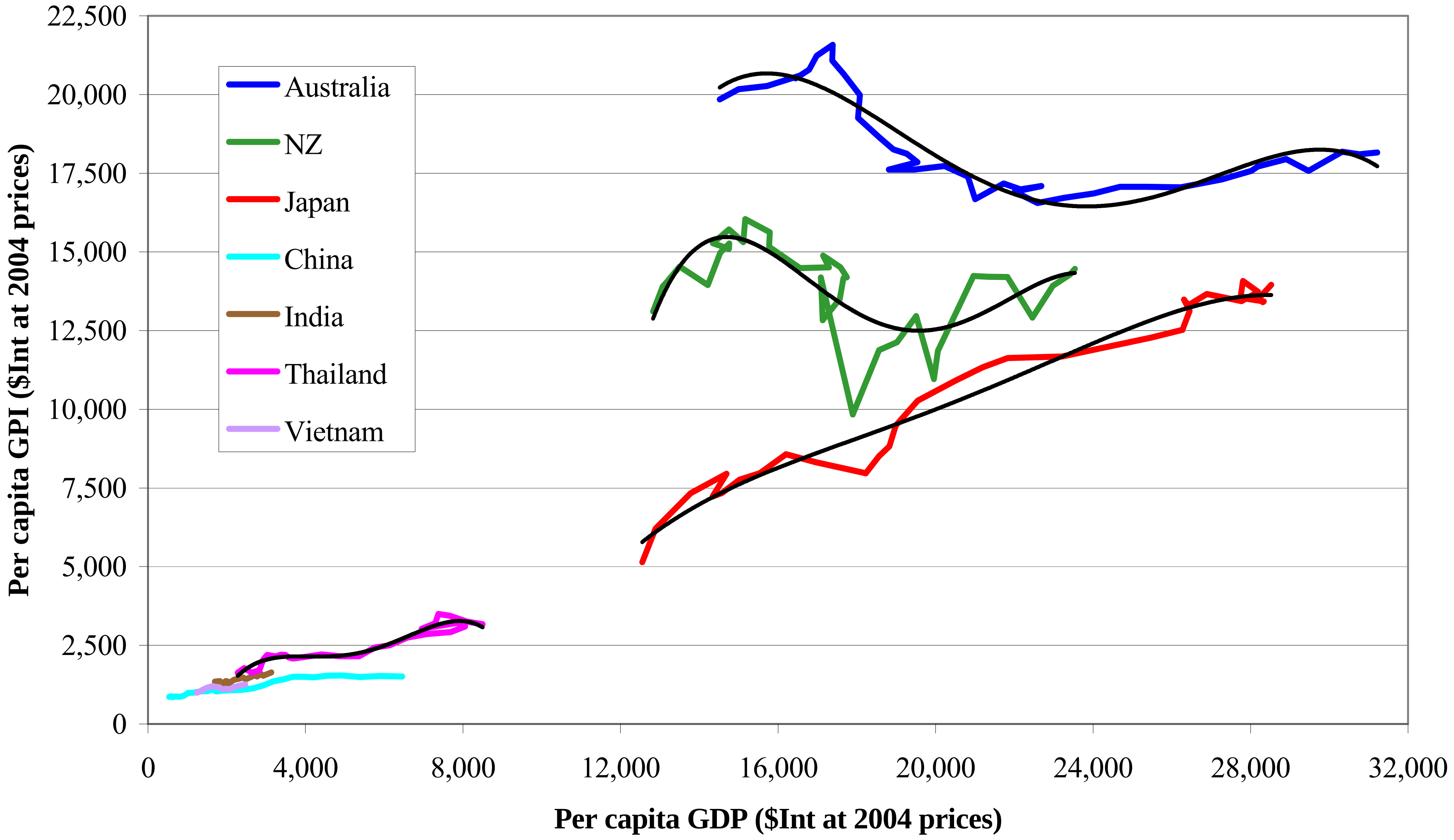
This is a concern because they have not reached the levels of economic welfare enjoyed by high-income nations

Why has this happened? Low-income nations are attempting to grow their economies in a full world. High-income nations initially grew their economies in an empty world. The marginal cost of growth is now higher and the economic limit to growth (S*) is being reached sooner



Source: Wen, Yang, Lawn, 2008

Per capita GPI versus per capita GDP of selected Asia-Pacific countries



High-income nations need to reduce the scale of their economies:

- for their own benefit (i.e., to increase their own economic welfare)
- to provide the world's low-income countries with the 'ecological space' they need to enjoy a brief, welfare-increasing phase of growth

Overall, to achieve SD, we need to do the following:

To operate sustainably:

Global ecological footprint (EF) ≤ global biocapacity (BC)
Best to reduce EF so it is 90% of BC (i.e., EF = 0.9BC)

Stabilise the human population at something less than 8 billion, but probably something less than this

Stabilise the concentration of GHGs in the atmosphere at no more than 450 ppm of CO_2-e

To maximise sustainable economic welfare

Stabilise per capita GPI at Int$15,000 per person

3. Growth-as-usual scenario (up to 2100)

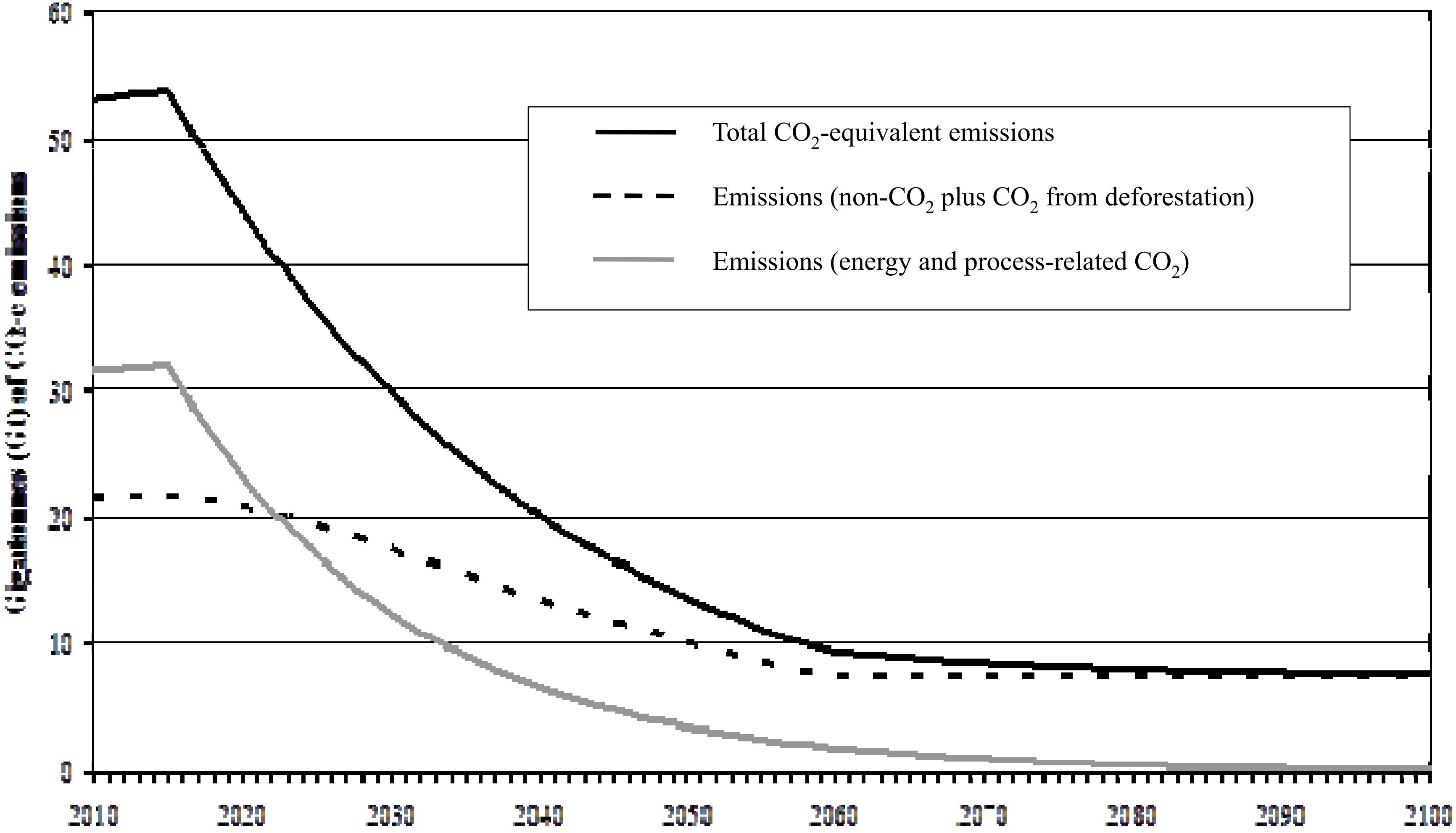
Assumed in this scenario is the following:

The global population increases to a peak of 9.57 billion by 2082 and is 9.52 billion by 2100 (as projected)

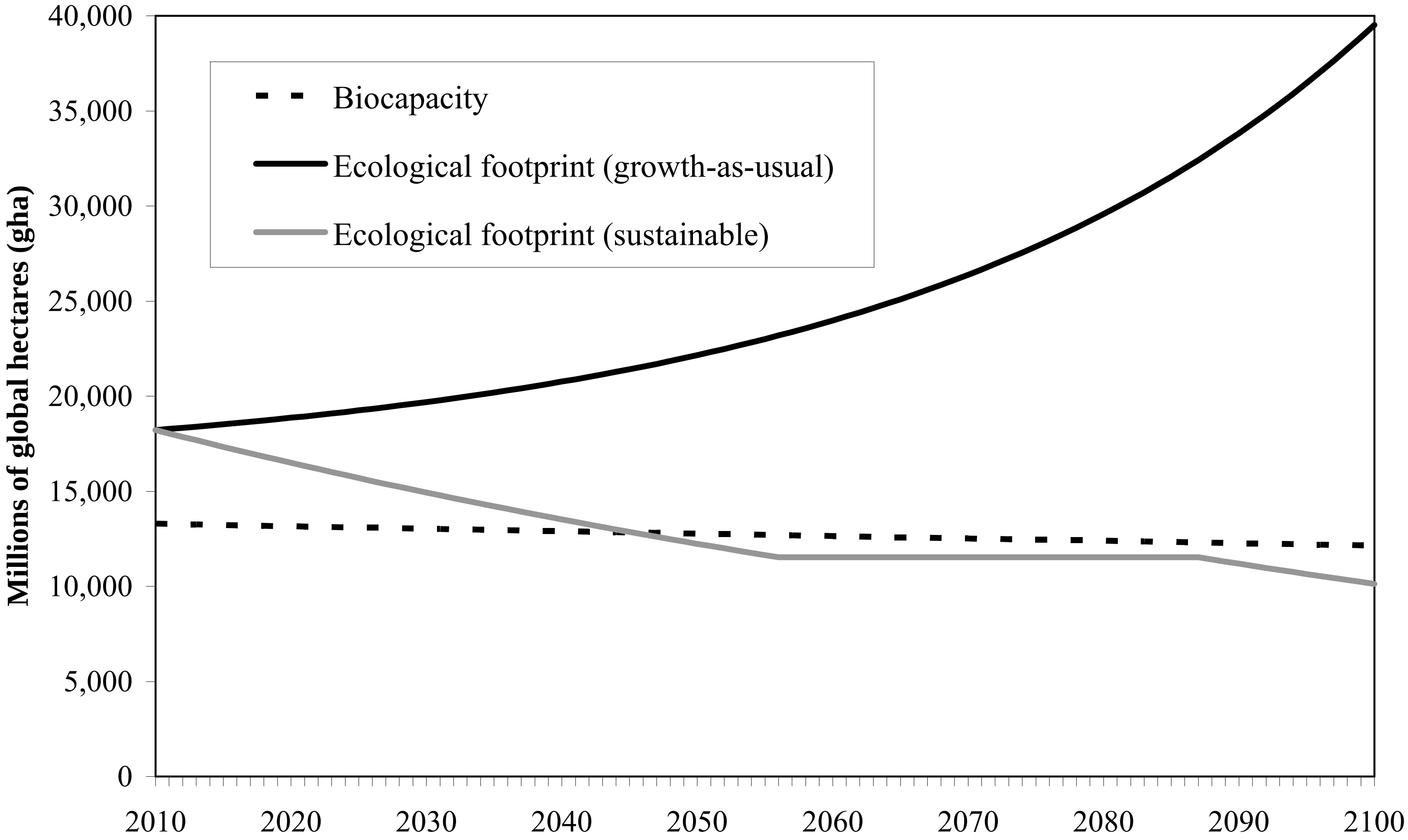
Gross World Product (GWP) increases at an average rate of 2.3% per annum

Significant technological progress increases the technical efficiency of production by a factor of 3.6 (1.4% p.a.)

Question: Can ecological sustainability and a 450 ppm GHG target be achieved?



60
50
40
30
20
10
0
Gigatonnes (Gt) of CO2-e emissions
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Total CO2-equivalent emissions
Emissions (non-CO2 plus CO2 from deforestation)
Emissions (energy and process-related CO2)



Ecological footprint versus biocapacity – World, 2010-2100

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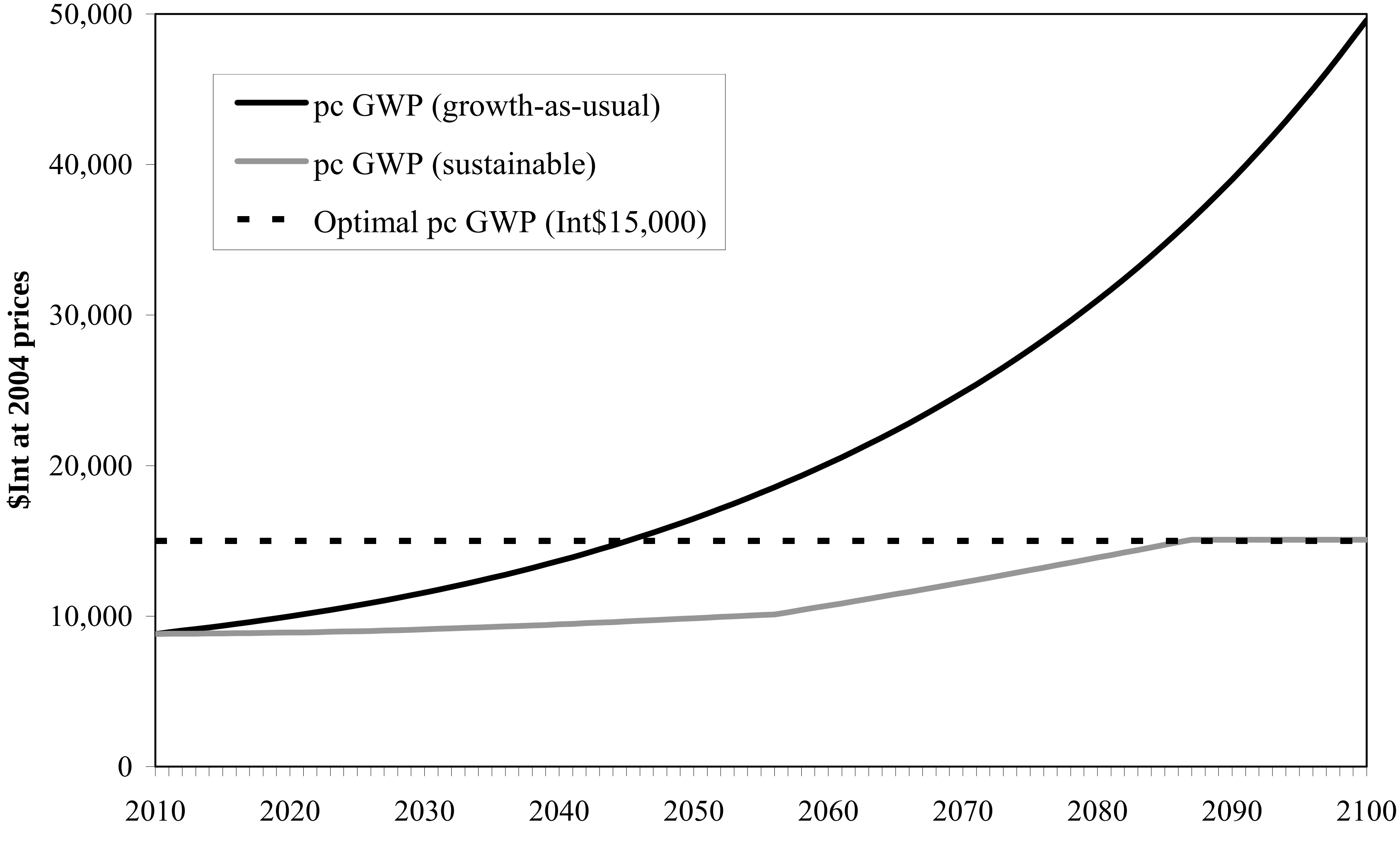

Per capita GWP – World, 2010-2100

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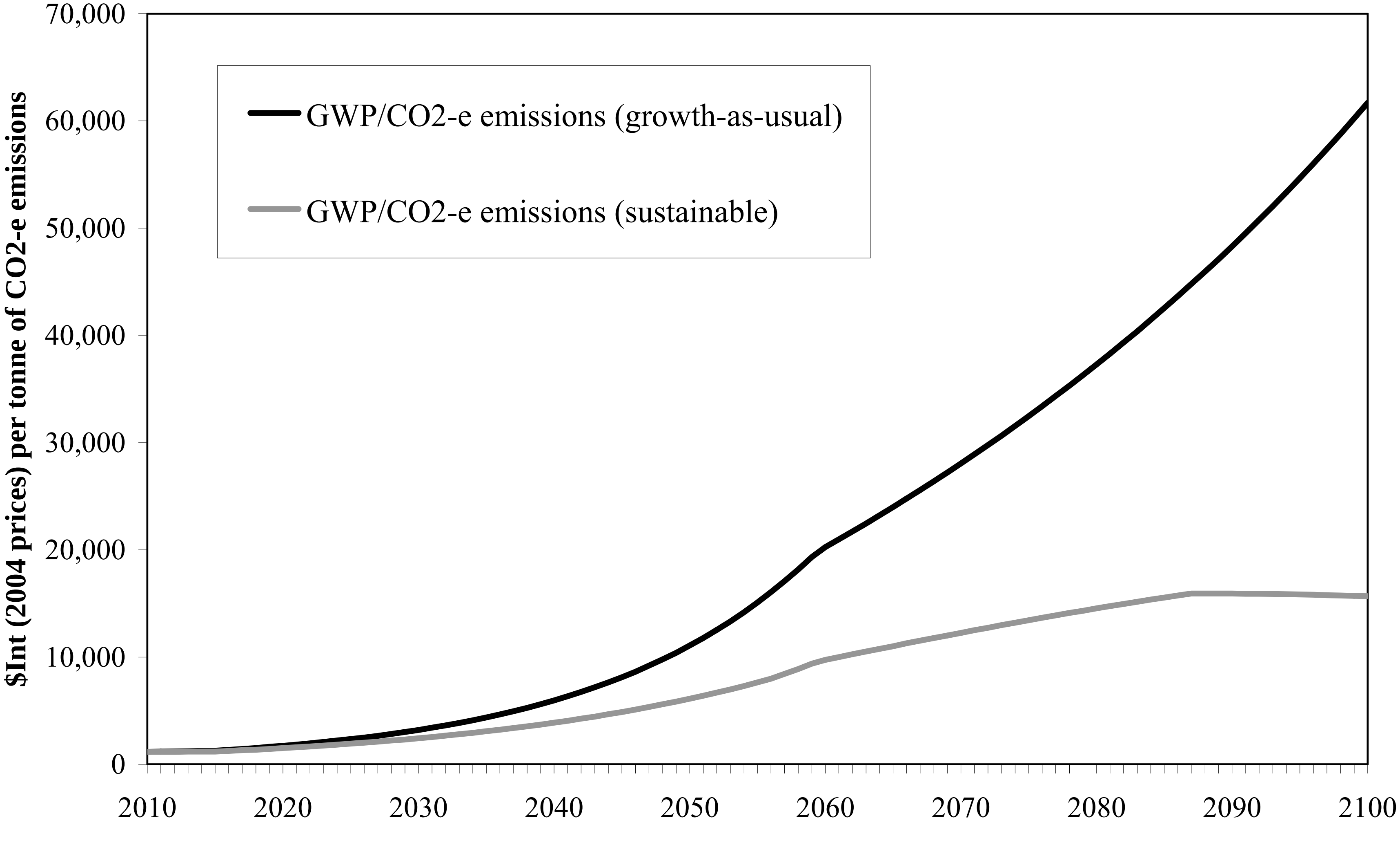


Required emissions efficiency – World, 2010-2100

Conclusions about the GAU scenario

The GAU scenario is ecologically unsustainable. By 2100:

EF = 3.16BC (i.e., 3.16 Earths would be required to sustain 2100 consumption rates)

Requires a 53.9-factor increase in GWP/emissions ratio. This is basically impossible

The GAU scenario is economically undesirable

Even though per capita GWP increases to Int$49,607 per person:

- this is well beyond the optimal scale of Int$15,000 per person
- the per capita GPI is likely to be low because of the enormous costs involved

4. Sustainable scenario (up to 2100)

Assumed in this scenario is the following:

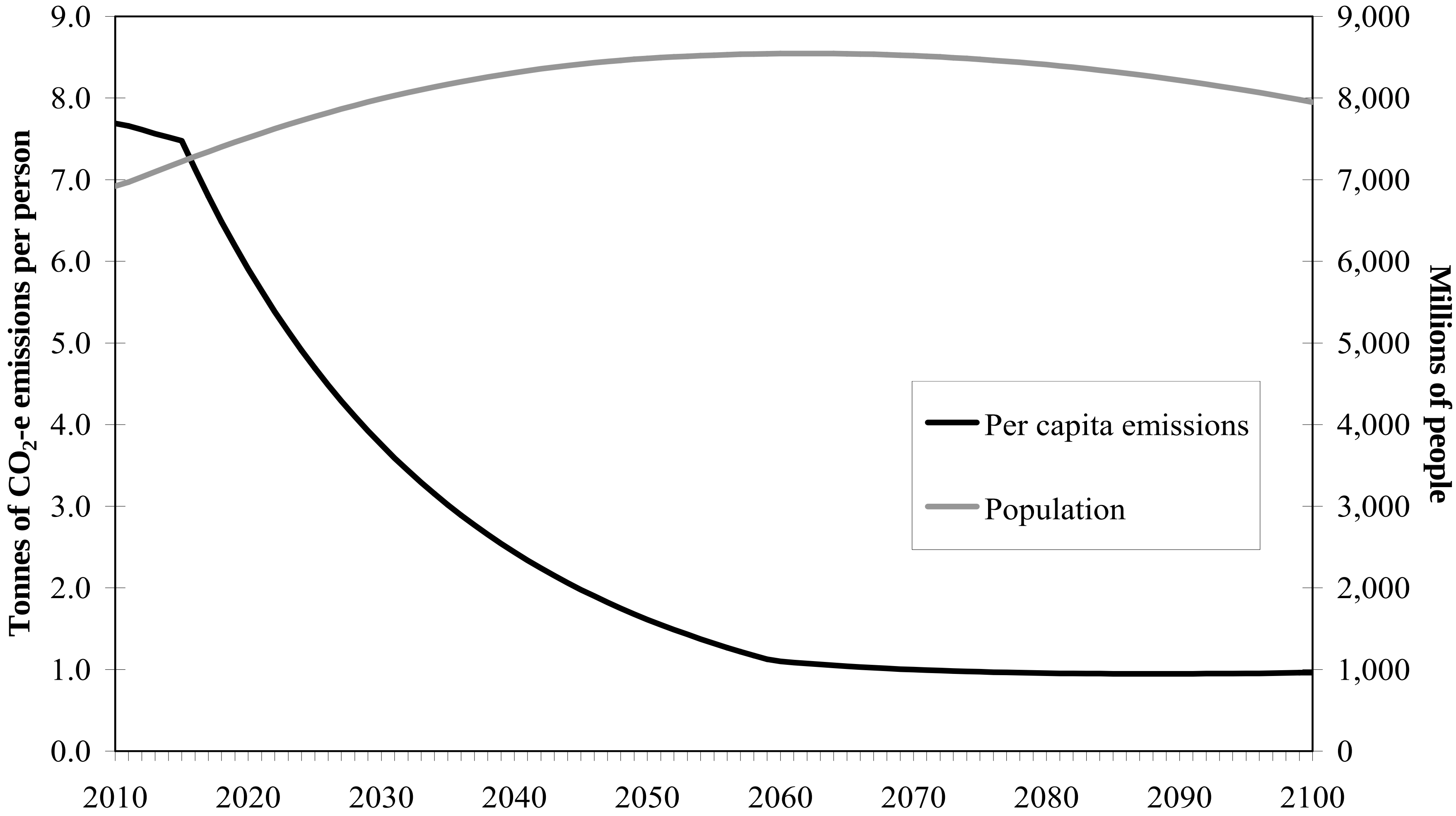
Population policies cause population to peak at 8.55 billion in 2062 and decline to 7.95 billion by 2100

Per capita GWP increases to Int$15,000 and no more – emphasis shifts to qualitatively improving the stock of human-made wealth

Significant technological progress increases the technical efficiency of production by a factor of 3.6 (1.4% p.a.)

Once Int$15,000 p.c. is reached, technological progress is aimed solely at further reducing the EF

Question: Can the 450 ppm target be achieved?



Population and per capita emissions – World, 2010-2100

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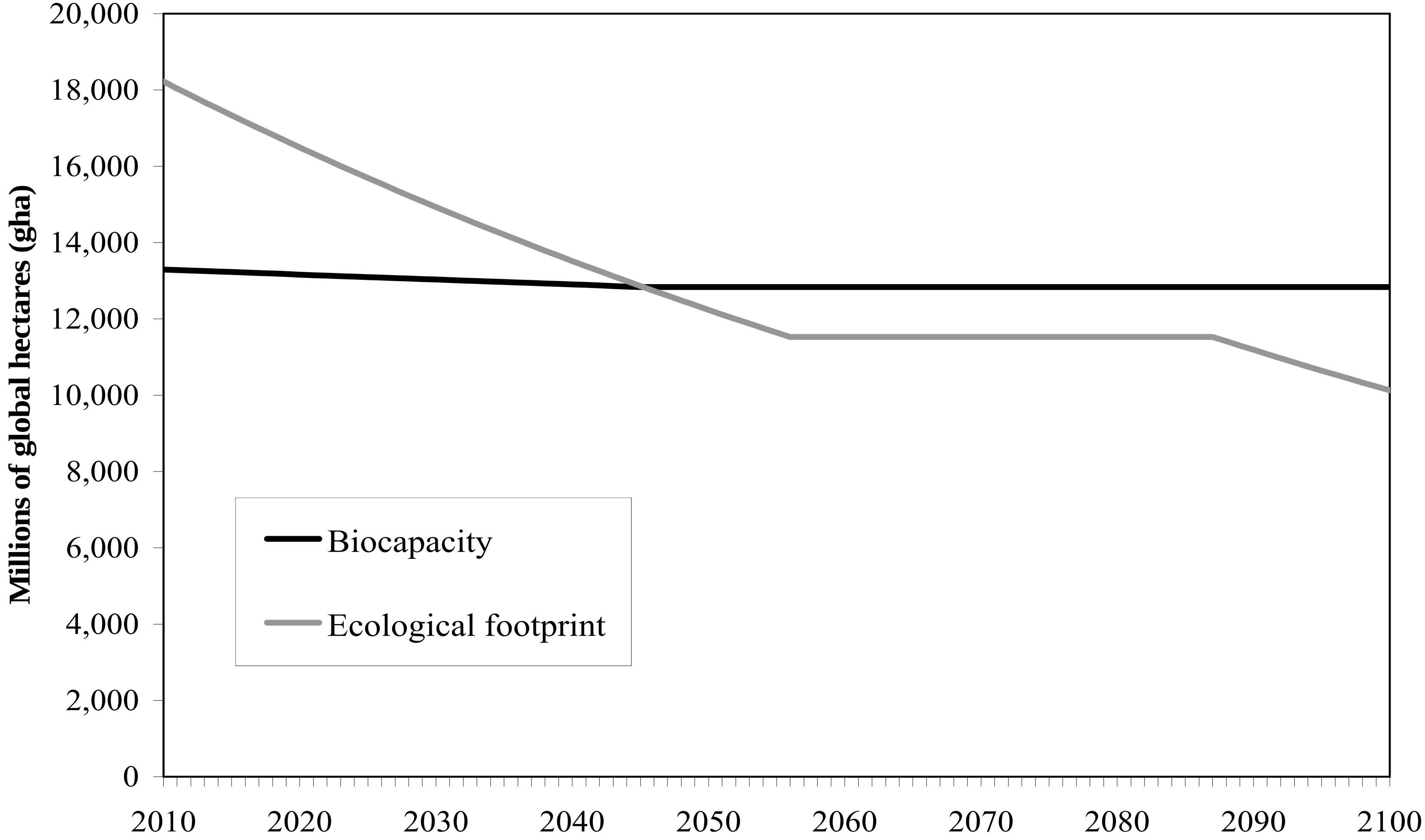
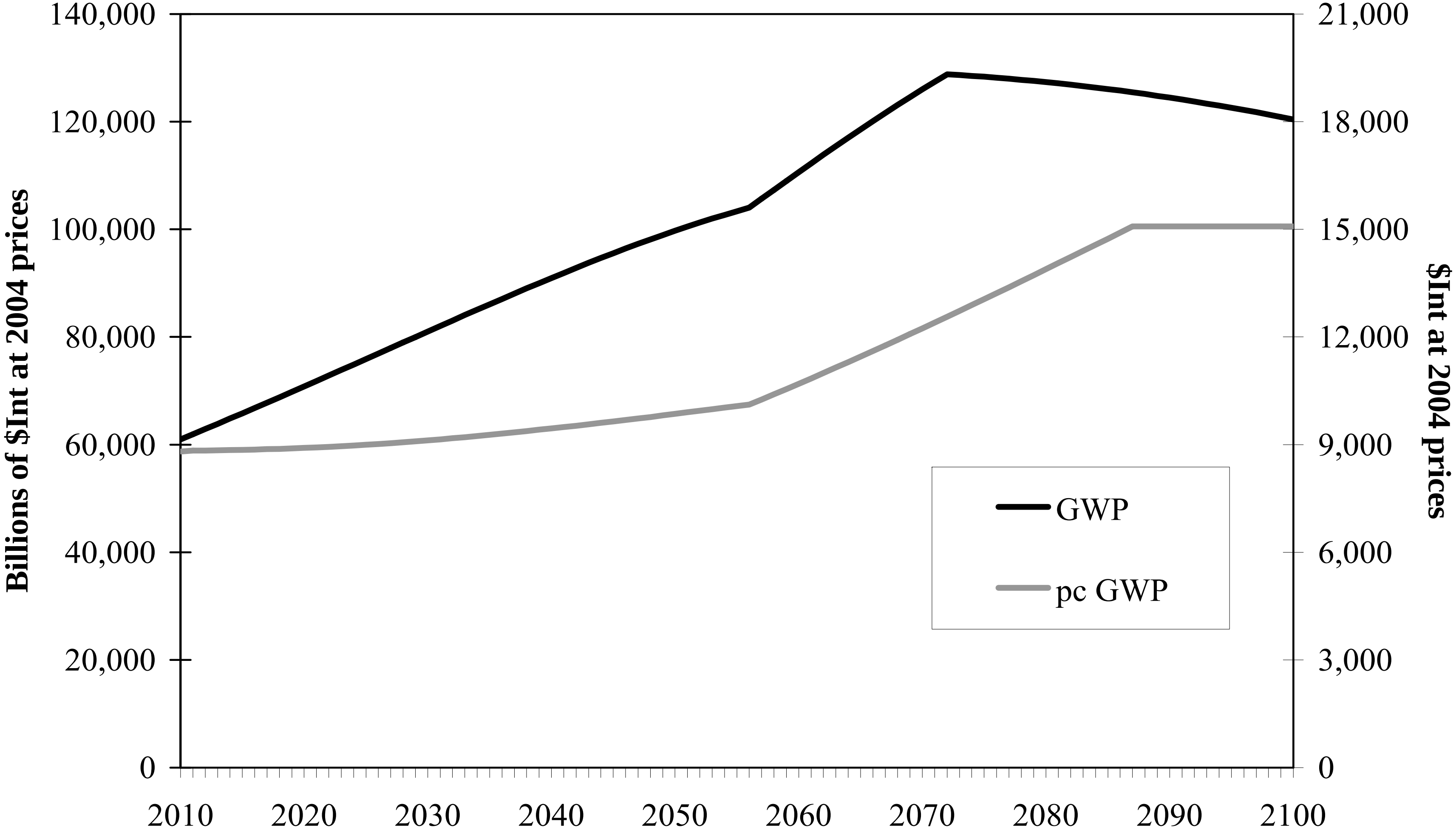
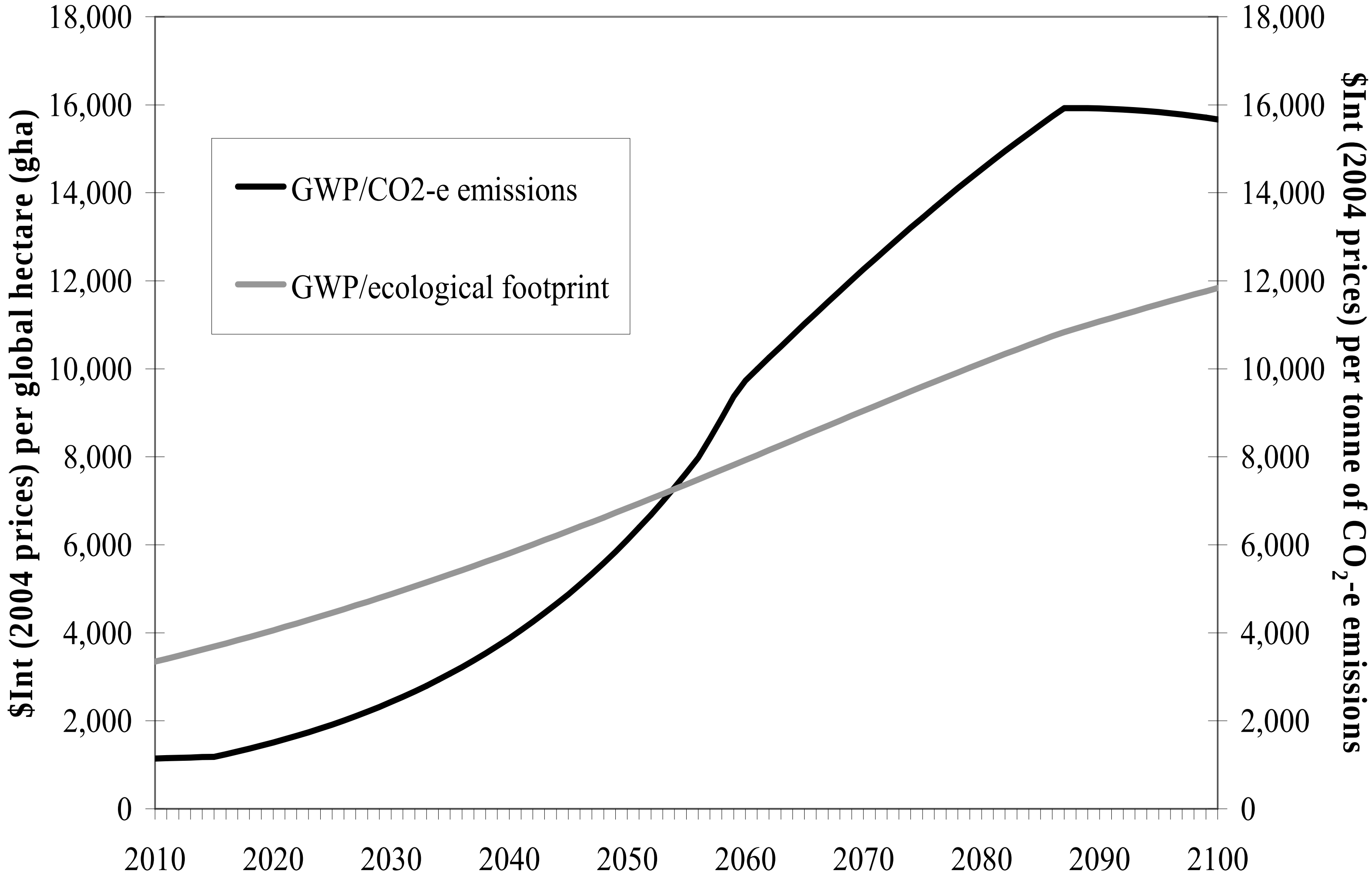


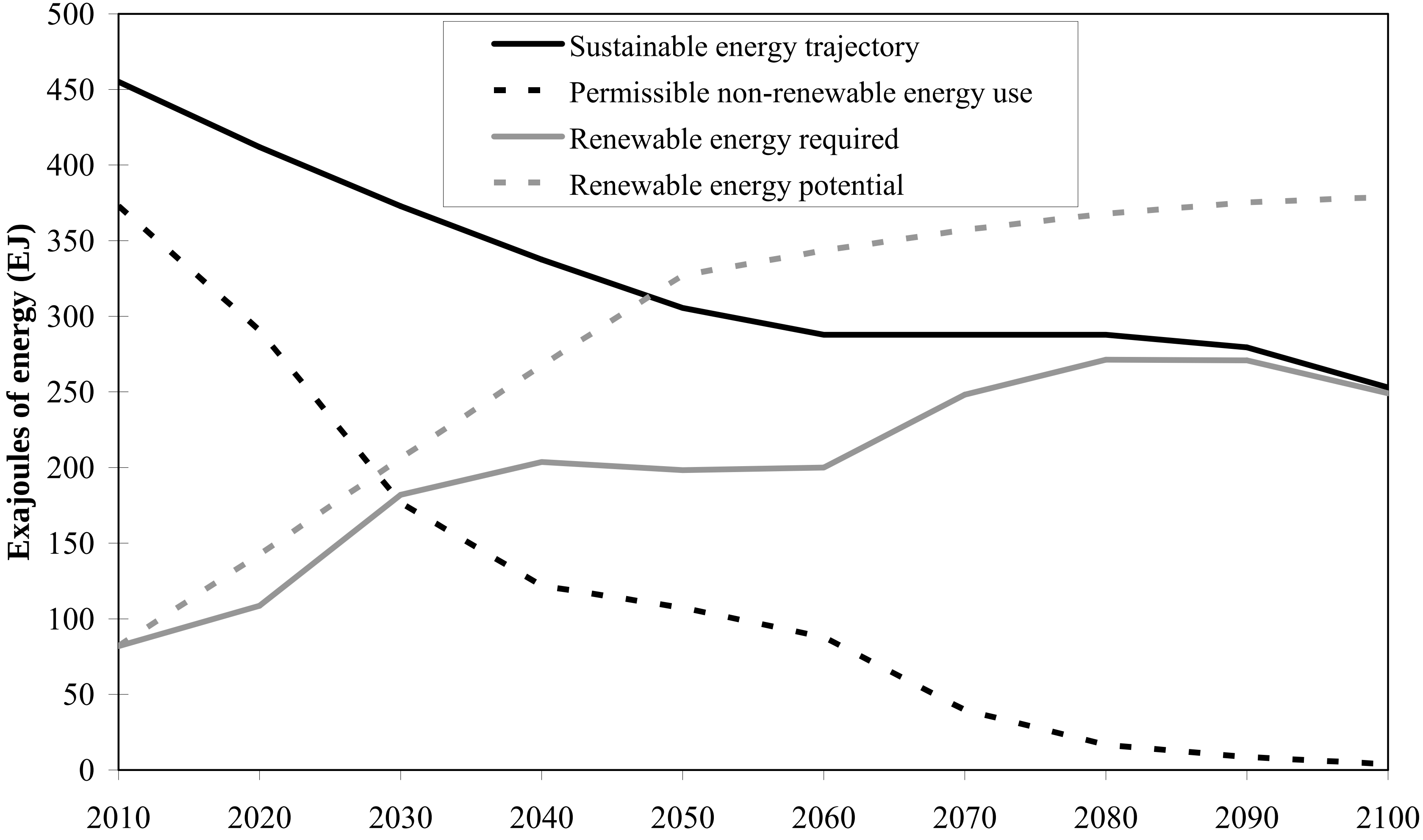
Ecological footprint versus biocapacity – World, 2010-2100



GWP and per capita GWP – World, 2010-2100



Required footprint and emissions efficiency – World, 2010-2100



World energy trajectory in a sustainable scenario with greenhouse gas stabilisation at 450 ppm of CO_2-e, 2010-2100

5. Conclusions

The alternative scenario is ecologically sustainable. By 2100:

EF = 0.76BC (i.e., requires 76% of one Earth)

Requires a 13.7-factor increase in GWP/emissions ratio – feasible

Energy needs can be adequately met

The alternative scenario is economically desirable

Per capita GWP stabilises at Int$15,003 per person – this maximises sustainable economic welfare

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