Global Letter Investment requirements for a 2^0C world

The requisite resources will be available: but they seem unlikely to be deployed in time.

Of the many issues that will be discussed in connection with the forthcoming COP26 meeting, one that need not be is the investment cost of switching to a green economy.

Huge dollar sums are being cited. However, it is not necessary to have detailed figures in order to establish that there need not be a financing problem – 'better to be roughly right than precisely wrong'. A thought experiment serves to make the point.

The basic calculation

Each year around 4.5% of economies' capital stock is judged by its owners to have reached the end of its useful life. At that rate, by 2050 all but a quarter of today's capital stock will have been retired.

Meanwhile, and quantitatively more importantly, between now and 2050 there will have been considerable new investment. On the assumptions that:

- The world economy grows on average, between now and 2050, at its 2009 to 2019 rate of 3%;
- World saving and investment continue at their present rate of around 25% of its GDP; and that
- All new investment from 2022 onwards is 'green compatible'.[1]

then by 2050, fully 90% of the world's capital would be appropriate for the new 'green' world.[2]

Two (surmountable) complications

Of course, it is not quite that simple. In all likelihood, and particularly in the energy-intensive sectors, some of the existing capital stock will be scrapped before it reaches the normal end of its physical life, requiring some extra investment to make up for this.[3] Moreover, other sectors too may need additional investments – a figure of the order of one-fifth of that for the energy-intensive sectors is sometimes suggested for accelerated scrappage in the rest of the economy.

On such assumptions, converting to an all-green economy would conceivably require net incremental investment to 2050 of the order of $60 tr in today's prices. Over the years to 2050 that would amount to around 1½% of global GDP. That is eminently affordable.

One further consideration is that the green investment will probably need to be front-loaded**.** However, the resources for this too are potentially available for that too – especially at present.

The world economy is probably over 5% or so below where it would have been had it remained on a (modest) 3% growth path. With the global multiplier in the range of 2 to 3, there stands to be room for a front-loaded boost to investment of the order of $1-1½tr for several years. This would take world GDP close to its (extrapolated) pre-pandemic path.[4] (For details underpinning all these calculations, see the Appendix).

Thus, even on the basis of the demanding assumptions above, so long as the process of investing appropriately for the future starts now, the requisite economic resources stand to be in place by 2050. The present state of scientific, technological, and engineering knowledge is sufficient to make a credible start. The issue is whether governments prove able and willing to make the requisite commitments and embed appropriate incentives.

The great risk, of course, is that the process will not start now: that, regardless of what pledges may be made, too many countries postpone making the policies that would enable the transition to proceed at a sensible pace. We see this as highly likely: but we could be wrong. Hence two COP26 'Watch fors'.

Watch fors

Watch for credible commitments that governments will:

- Make available adequate infrastructure that only they can provide; and
- Incentivise the myriad private sector decisionmakers – primarily by means of a carbon tax of around $100 per tonne of CO_2e emitted – such that henceforth they invest only in green-compatible capital equipment.■

Appendix

The main assumptions and calculation results are given in the notes below. The calculations were performed on the Llewellyn Consulting Solow-Denison growth accounting model, which makes it possible to investigate the consequences to changes in all the main parameter values, including: GDP growth, the investment rate; the depreciation rate, and economies of scale.

Capital-output ratios

- Capital-output ratios nowadays range (across a range of high per capital income countries) from 2.6 to 4.4.
  - See Michael Berlemann and Jan-Erik Wesselhöft, 2014. Estimating Aggregate Capital Stocks Using the Perpetual Inventory Method – A Survey of Previous Implementations and New Empirical Evidence for 103 Countries. Figure A-11. http://www.review-of-economics.com/download/Berlemann_Wesselhoeft_2014.pdf
  - Interestingly, the ratios for the United Kingdom (2.6) and the United States (2.7) are at the low end of the spectrum.
- In the past, capital-output ratios have been higher e.g. in the UK the ratio, estimated at 4.6 for 1865, rose to 6.6 in 1885, but subsequently fell back, to 6.6 in 1926-28 and 5.0 in 1932-34. – see Deane P. and Cole, W. A. 1969. British Economic Growth 1688 – 1959. Cambridge University Press. Second edition, Table 71, p. 274.
  - Arguably it was industrialisation that reduced the capital-output ratio somewhat: "… it is of the essence of a pre-industrial economy that additions to capital are not always fully productive and it is one of the features of the process of industrialisation that it makes some forms of existing capital more productive than at the time of their creation." (Deane and Cole, op. cit. p. 277.)
  - It is conceivable that in the coming decades the IT revolution may lower it further – working from home, at weekends etc.
- We take a value of 3 – the average for the G7 economies taken together – as our base figure for the world as a whole. (Alternative assumptions can readily be taken into our model.)

Depreciation

- Economies continually 'retire' assets that have reached the end of their 'useful life', replacing them with new ones. The rate at which assets reach the end of their 'useful life' – depreciate – differs considerably by type of asset:
  - Vehicles, computers, office equipment and the like typically reach the end of 'useful' life after only 5 years or so.
  - Other assets, ranging from ships to agricultural and horticultural structures to water treatment plants, last 10 to 15 years; while at the other extreme
  - Non-residential buildings typically have a 'useful life' of 40 years and often more.
- The overall depreciation rate for the 22 economies in the OECD database taken together is taken to have risen slowly since WWII from 3.5% in 1950 to nearly 4.5 % in 2021 - see Berlemann and Wesselhoff, op. cit. Figure 3 p. 12.
- At this rate, by 2050, around three-quarters of today's capital stock will have been retired.
- Meanwhile, there will have been considerable new investment. On the assumption that the world economy: grows at its 2009 to 2019 annual rate of 3%; continues to save and invest around 25% of GDP; and that all new investment from 2022 onwards is 'green compatible', then by 2050 fully 90% of the world's capital stands to be appropriate for the new 'green' world. (For the calculations that underpin these last figures, see the section below, Macroeconomic assumptions and calculations.)

Macroeconomic assumptions and calculations

- World GDP is currently approximately $85 tr.
- The value of the world's capital stock is around $255 tr.

- Over the period 2009 to 2019, the world saved, and invested, around 25% of its GDP.
- Assume that:
  - Such a savings and investment ratio continues;
  - Between now and 2050 the world economy grows at its historical 2009 to 2019 annual rate of 3%;
  - Depreciation continues at its historical average rate of 4.5% per year; and
  - All new investment from 2022 onwards is 'green compatible'.
- On that basis, by 2050:
  - **World GDP** will be of the order of $200 tr; and
  - The **total capital stock** will be of the order of $ 660 tr, composed of:
    - That small proportion (25%) of today's capital stock that will have survived – around $65 tr; **plus**
    - The cumulated net new investment over the 30 years to 2050 – around $600 tr.
- Thus fully 90% of the world's capital would be capital appropriate for the new 'green' world.

[1] All output is produced, in the final analysis, by capital and labour. Of course the individual firm also buy in inputs, and countries buy in imports from abroad. But at the level of the world as a whole there are no bought-in inputs: all output is produced by the two factors of production labour and capital. Hence a 'green compatible' investment, is taken to mean an addition to the capital stock that will be able to function with inputs that have been produced in a 'green' manner.

[2] The calculations in this *Global Letter* have been made using our basic Solow/Denison 'growth accounting' model.

[3] For example, the Energy Transitions Commission (ETC) has a 'bottom-up' figure of $1.6 tr per year; the International Energy Agency (IEA) has a similar figure − $1.8 tr per year in the 2030s; and the International Renewable Energy Agency (IRENA) has a similar figure. There are many other estimates, but care has to be taken in interpreting them: they often include investments that would have been undertaken anyway.

[4] Helpful also is that the costs of renewables often fall, sometimes dramatically – solar and wind are two examples. Such investment would have to be undertaken in part by government (especially infrastructure) and in part by the private sector.