Built on shaky ground: the flaws of neoclassical economics as conventionally taught

by A.R.G.Heesterman

Abstract

The paper provides a broad overview of a number of issues where the presumptions of neoclassical economics give rise to misleading information. The emphasis on numbers and calculation has caused the underlying theme of economics to mutate from the most *efficient* use of resources to meet human needs into their most *cost-effective* use. In the process, the principle that meeting human needs is the primary purpose of economic analysis has been relegated to the background. While it may be unavoidable to apply a common denominator to evaluate the option of using more of one resource whilst using less of another, the indiscriminate use of *money* as unit of account has legitimated a false price structure. Partly as a result of this the following (unrealistic) assumptions have become standard:

(1) Financial costs are a meaningful measure of the intrinsic value of resources. Although economics routinely ignores the value of natural common resources, terming this a market failure, the assumption is that the financial evaluation of products sold on the market provides a meaningful assessment of their contribution to human satisfaction. By implication valuable and vital resources, which are ownerless, such as the atmosphere, unpolluted air and the environment have no financial cost and are overstrained and mis-used.

(2) At a given set of prices, any economic activity can be performed at the same cost per unit of output, irrespective of the scale of operations.

(3) Investment (of marketable products) in the means of future production invariably contributes to future material affluence at a basically known rate, while it is postulated that more material affluence and never-ending economic growth are always desirable.

The paper reviews the impact of these illusory tenets on the state of the environment and the capacity of the market economy to deliver employment and social stability, both in the present and in the future. In relation to the future, the effect of the flawed doctrine of discounting is being compounded by delays in technological information. It is simply no longer true that essentially complete decarbonisation of energy supply is horrendously expensive.

Introduction

Economics is the science of 'good housekeeping' of society, both of one's own section of the globe and, it is to be hoped, of the entire world. The key issue is how the needs and wants of human beings had best be met by the available resources: capital goods, labour and natural resources. This very question assumes that these needs are open ended and that more is always better. The assumption leads to the view that economic growth is under all circumstances desirable. I shall come back to the issue in the relevant section below.

If it were not for the difficulty of combining zero growth with having meaningful work for most people during a phase of their life, I would agree with Wilkinson and Pickett[1] that there is an optimum level of affluence above which further economic growth is of questionable value. However, even if this postulate of open ended needs is accepted, there are problems with the neoclassical economists' notion that 'best' or 'most efficient' is equivalent to being cost effective in financial terms. Cost-effectiveness is and always has been a central theme in economic analysis, and in the abstract I have no problem with that. There are, however, three main areas where under modern conditions its practical application has become warped. These 1) the mis-statement of costs under the prevailing false price structure, 2) the effectiveness of more investment and 3) the relation of the latter to the incentives to save.

On the cost side, manpower *clearly* has a financial cost because we live in a society where people are expected to do work and be paid for doing so. An individual who does not earn money by working during at least a major part of adult life risks being considered a scrounger. Natural resources come in distinct classes: marketable ones, land and mineral resources and common, unpriced resources such as sunshine, the atmosphere and the oceans, which are freely available. Unfortunately these common resources are so far also largely free to mis-use and the notion that efficiency is equivalent to cost effectiveness evaluated at the prevailing price structure has become a serious distortion of reality, as the costs of climate change and the degradation of the oceans are routinely ignored.

The main part of the body of the paper surveys certain misconceptions and their implications for neoclassical economic theory. This follows to some extent Heesterman

Rediscovering Sustainability. It is followed by a section which summarizes new information concerning the severity of the threat of climate change and the quite affordable cost of decarbonisation.

The concluding section emphasises that the main obstacles to programmes to arrest further destabilisation of the climate is political rather than technological, while accepting the risk of catastrophic climate change also creates problems for current production and employment. My assessment of the now available and costed technology is that a rapid reduction of emissions is perfectly doable. However, taking the threat of climate change seriously also carries its own complications of managing the transition, such as the social and political implications of major past investments in infrastructure based on the use of fossil fuels and associated reserves. These are all on the books of pension funds and insurance companies as assets, while rapid decarbonisation will reveal them as being worthless.

---

[1] Wilkinson, R.G.and Pickett, K. 2009. The Spirit Level: why More Equal Societies Almost Always Do Better. London: Allen Lane.

Some misconceptions and their implications

Investment and its relation to technology

The idea that investment in the material means of future production, capital equipment or even software or education is by itself a general and open-ended source of increasing output is misleading and misguided. This is an issue on which classical economists were better informed than the present-day neoclassical ones. Had it not been for scientific and technological innovation, we would long since have arrived at John Stuart Mill's[2] stationary state with every given resource - at that stage mainly manpower and land - already as productive as possible. New equipment (or their parts) would be made solely in replacement of older, equally efficient machinery, which had become worn out by use or accidentally damaged.

Appreciation of the role of technological and scientific innovation is a classical idea:

> "The natural tendency of profits then is to fall; [. . .]. This tendency, this gravitation as it were of profits, is happily checked at repeated intervals by the improvements in machinery [. . .] as well as by discoveries in the science of agriculture [. . .]".[3]

The notion of a stable and known rate of return to new investment is an essential assumption behind the idea that the investment cost of safeguarding the environment should be balanced against an estimate of the potential financial value of the benefit of avoiding environmental degradation. This valuation of the future is then discounted at a supposedly known positive rate. However, the notion of a 'unique' rate of return to investment is an erroneous *neo*classical idea. There are other flaws in this doctrine; here the emphasis is on the return to investment.

Ricardo correctly refers to "repeated intervals" i.e. spurts of inventions. This does not mean that technological innovation is random. Maybe there once was a time when inventions themselves fell on occasion from the ivory tower of some genius, to be developed either from his own wealth or paid for by a prince or benign government.

Nowadays much research and development is industry financed either directly or via grants to universities. Except in the case of military research –the usefulness of which is only questioned if it involves really huge expenditures, research projects are generally orientated towards applications regarded to become profitable in the near future. The next step from blueprints to saleable equipment has always been dependent on profitability. Technological development is also a process that takes time, starting with the acquisition of fundamental scientific knowledge through to design and application.

Profitability is mainly determined by market demand and the relative availabilities of the marketable resources. Manpower, divided into various grades of skill and local

---

2 Mill, J. S. 1852. *Principles of Political Economy*. Text consulted: 3rd edition. London: John W.Parker & Son, also 6th ed., London: Longmans, Green, Longmans, Roberts & Green, 1865. Reprint of the sixth edition: Longmans Green & Co, 1902.

3 Ricardo, D. 1817. *The Principles of Political Economy and Taxation*. London: 3d edition, 1821. Reprinted with a foreword by Michael Fogarty, J.M.Dent & Sons, London / E.P.Dutton & Co., New York (Everymans Library), 1969. p. 71

availability was perceived as *the* scarce resource per excellence with land and the geological presence of mineral ores the other classes of financially valued resource types. The perception that this arrangement provided an incentive towards the efficient use of the available resources may once have had an element of reality but is now a serious distortion of the actual effect of cost under the now prevailing conditions. Before I discuss the environmental results of this distortion in the price structure, it is useful to summarise what I see as the employment effect of technical innovation.

There were two major waves of technological innovation and new investment opportunities in the real world, although their employment impacts were by no means the same. The first one revolved around motive power: the steam engine, the internal combustion engine, the turbine and associated changes in transport mechanisms: the railway and other means of transport, based on the use of fossil fuel. The second wave of technological innovation revolved around computing. There were undoubtedly job losses for example in the case of weavers and spinners and even more so with the mechanisation of agriculture. The resulting reduction in cost per unit of production also makes it to some extent possible to produce more and different types of products without reducing the total workforce, even whilst new jobs invariable arise in different locations and require different skills.

Both waves also created employment in making these capital goods, trains, motor cars and aircraft, an then computers and software.

Whilst the two world wars made room for new investment in post war reconstruction, the first wave also had a different type of employment-creating effect. It has profoundly affected locational economics, leading to additional employment opportunities in the construction industry. Entire new cities with a significant part of the population dependent on commuting between a place to live and a place to work were built in the third quarter of the 20's century. In the UK, Milton Keynes with people commuting to London is the clearest example. In my native Netherlands, the obvious example was Lelystad, built on land reclaimed from the former Zuiderzee, with workers commuting to Amsterdam.

However, no similar job creating effect arose from the availability of the products of the second wave. On the contrary: automation became a major cause of the loss of much unskilled and semi-skilled work.

I now want to turn to the environmental cost of maintaining economic growth. Critical global capabilities of the earth, notably the potential of the atmosphere and the oceans to absorb humanity's debris, are by now arguably more important than manpower. Accordingly, the market gives the wrong incentives. Over-exploitation of fish stocks, destruction of the habitat of bottom-dwelling organisms in the process, manufacture and use of aircraft and coal fired power stations is rewarded as being commercially attractive. However, it is a wasteful misuse rather than a rational application of common global resources. What's more, unless and until the amount of strain on these global commons is drastically reduced, further increases in output per unit of manpower is a natural result of the prevailing false price structure. Unless this trend is discontinued, we have a choice between further environmental degradation or alternatively calling a halt to 'economic growth'. The latter choice will result in mass unemployment or underemployment and is bound to give rise to unfair working conditions and exploitation in its wake.

If this new pattern of relative scarcity is to be resolved according to market rationality by assigning a price to common global resources, a drastic change in the price structure is essential. Organising a market for a resource which has up till now always been an unpriced global common requires making a decision on who owns it or at least to whom or what organisation its rental value should be paid. So far, there is little sign that humanity is capable of making such a decision.

This means that as long as earning a living by working is the social acceptable norm, manpower is the main cost item of commerce and industry, and technological innovation is focused on increase in labour productivity. Regular increase of marketable production is therefore a normal result of a market economy in which approximately full employment of the available workforce is to be maintained. To the extent that this actually happens increased demands on unpriced common resources are the logical result.

To some extent these circumstances seems to imply that we are saddled with a false price structure and that the climate crisis in particular can only be resolved by abandoning or at least suspending procedures based on a market economy, resorting instead to direct allocations of finance and materials.

Fortunately there is an important qualifier to this conclusion. Clearly technological development is never random. Nevertheless the assumption that it only happens if and when it is profitable is a gross over-simplification of reality. Heertje[4] has argued that the sheer urgency to get things done can spurn technological innovation:

" . . . emergency situations produce inventions, . . ."

Although Heertje referred to conditions of war, there is some indication that the climate crisis has prompted concerned people and organizations to initiate investments and develop technology for reasons other than profit. Most notable in that respect is the DESERTEC foundation,[5] founded with the support of the German Club of Rome Association. This organization has mapped a proposed renewable energy supply network for Europe, North Africa and the Middle East, and started to build solar power stations in desert areas with desalinization of seawater as a by-product. We are now in the situation that the idea that renewable energy is of an order of magnitude more expensive than burning fossil fuel is seriously out of date Crucial to this conclusion is, however the long distance transport of energy via High Voltage Direct Current (HVDC) electricity cables.

One may doubt whether commercial firms like Siemens would, without DESERTEC's initiative, have invested as much in research and development in this direction as they did. This relates to the design of the hardware and instrumentation required to coordinate this form of energy transport efficiently with local AC current, and to the programming of the associated software.[6] Would they have done so? Well, that is a question that hangs in the balance.

---

4 Heertje, Arnold: Economics and Technical Innovation London, Weidenfeld and Nicholsen, 1977 , p. 109 (Dutch original: Economie and Technische Ontwikkeling, Stenfert Kroese 1973)

5 The DESRTEC concept https://dl.dropboxusercontent.com/u/2639069/DESERTEC%20Concept.pdf

6 M. Claus, D. Reizman, D. Sörangr and K. Uecker (of Siemens): "Solutions for Smart and Super Grids with HVDC and FACTS" paper presentented at the 17th Conference of the Electric Power Supply Industry 27-31 October 2008 http://www.ptd.siemens.de/CEPSI08_Art.pdf

Scale economies market structure and the supergrid

Standard neoclassical analysis is based on the assumption that the cost of production per unit of ouput is independent from the scale of operations. This leads to the conclusion that the price of any product is determined by the market and is not affected by the activities of any separate firm.[7] The cornershop is assumed to be able to compete effectively against the supermarket and by implication competition always promotes efficiency. Therefore anything that limits competition is regrettable. In such a world of uniform cost (or constant return to scale as the more general economics terminology names that assumption), the scale of operations of any separate firm is irrelevant.[8] There are, however, physical reasons why 'large' is efficient, when it concerns the production of some types of marketable resources. For example doubling the size of refrigerated large containers which need to be kept at a constant temperature in all directions cubes their content, with a factor 8, while only four times the energy is needed. Similar considerations apply to, for example the size of supertankers and aircraft.

There is a slightly more general assumption than Sauelson's, according to which there is an optimal scale at which average costs per unit of output is at its lowest. The source author of this assumption is to my knowledge Bain[9], who simply postulates the existence of such an optimal scale. Thompson[10] motivates it on the ground that larger factories become more difficult for management to remain aware of what is going on.

It is at this point important to distinguish between what is most cost effective for society as a whole, and its consistency with market equilibrium. In this respect my concern is less about the possibility that luxury items, such as Lamborghinis for the pensioner market, may not be produced as cost effective as possible than about the optimal efficiency of renewable energy generation.

This issue relates specifically to the construction of a high voltage direct current (HVDC) electricity supergrid covering a large geographical area.

Transport of energy over long distances via High Voltage Direct Current electricity cables is by now a well established technology and it has three distinct advantages.

- Renewable forms of energy can be harvested where and when they are naturally abundant, e.g. solar energy in deserts and in the middle of the day and geothermal energy in volcanic areas and used where required.
- Pooling of resources: supply over time zones reduces the maximum capacity needed to meet peak demand.
- Installations can normally be used at a level close to their maximum design capacity whenever the local supply of renewable energy such as sunshine is available. When the local supply exceeds local demand the energy can be used or stored

---

7 "uniform costs" Samuelson, P.A. Foundations of Economic Analysis (Seventh printing, Harvard University Press, Cambridge, USA, 1963), p. 79

8 "…indterminite output for each firm" Samuelson, P.A. Foundations of Economic Analysis (Seventh printing, Harvard University Press, Cambridge, USA, 1963), p. 79

9 Bain, J.S. 1956. *Barriers to New Competition, Their Character and Consequences in Manufacturing Industries*. Cambridge, Mass.: Harvard University Press. Third printing, 1965 consulted.

10 *Economics of the Firm Theory and Practice*, 4th edition, Prentice Hall, pp. 227 ff., p. 230 (pipeline).

elsewhere. In the event of insufficient local supply demand can be met by import of energy from somewhere else.

The scale economies now arise because this is an issue which is not fully resolved by the installation of just a few HVDC cables, whilst that is much more likely when somewhere else means from a different locality within a large geographical area. It rather looks that both Bain and Thompson seem to think that there can be no competition at all unless either constant returns to scale or an optimum size is postulated. This is not really the case. A degree of competition between large firms is possible, even if bigger is more cost effective at all levelsofopewration. I refrain from providing a proof and from fully explaining the conditions for market equilibrium under monopoly or oligopoly here[11], suffice it here to say that for a product equivalent to one which is to one which is identical from a user's point of view, a natural monopoly arises.

It is at this point obvious that the tradable permit system is not the most cost effective route towards reducing emissions. It is a scheme designed to arrange for competition between energy providers, whist ignoring the fact that the supergid is a natural monopoly. It gives producers of electricity using fossil fuel a licence to continue to operate whilst not giving producers of renewable energy the potential cost advantage of the supergrid until it is actually operative. Taxation of emissions whilst using the revenue to help funding the overhead cost of building the supergrid would be more efficient.

It is against this background that I am coming to the conclusion that provided a HVDC supergrid is built on a sufficient scale it could expose the use of fossil fuels as an obsolete technology. Under these circumstances, the 20 percent per year reduction in emissions as demanded by Professor Kevin Anderson (to whose views I will come back), is not even particularly costly, provided the initial investment in building the grid is realised, reducing the need for additional local investment in consequence.

However, the write-off of past mis-investment in equipment dependent on fossil fuel using as well as of the perceived reserves of coal, oil and gas reserves and the specialised equipment for finding more of these is bound to be perceived as a cost of the transition.

The relation between savings, investment and asset inflation

Another topic where neoclassical economics as conventionally taught misrepresents reality relates to the capital market. In a closed economic system, in this case the world as a whole, the supply of funds from savers is identical to the demand for their use in the purchase or production of capital goods.

The standard assumption in economics that the supply and the demand in any market are equated to each other by the appropriate price has quite generally an element of over-simplification. In addition there are two circumstances which make this assumption particularly problematic in the case of the market of loanable funds.

[11] Refer to pp. 76 ff. of the book.

1) The first is that while it is obvious that when house prices fall, the construction of new homes soon becomes a commercially unattractive activity, the same does not apply to savings. Indeed, one could argue that a fall in the rate of interest may well motivate people of working age to save more in order to be still certain of having sufficient funds available to spend in retirement.

2) The second is that whereas merchants trading in a physical product will stop buying unless they expect to sell a roughly equal amount in the near future, financial institutions will not turn any investment moneys away, saying: "Sorry there is currently a shortage of investment projects, so we can't invest your money. Please stop saving."

There is a simplified assumption according to which being paid interest is the only reason why people save. Once one accepts that there are other motives for saving, an issue of consistency between savings and investment arises. These two variables are logically identical, but respond to different incentives. A central part of the Keynesian analysis is that there no logical reason why the rate of interest at which the level of savings out of full employment income will become equal to the available commercially attractive investment opportunities should be at a positive rate. During the heyday of the Welfare State, private savings fell short of investment and many large corporations used retained profits to finance their own investment[12]. Since then, the Welfare State has largely been dismantled and deregulation of capital markets may also have created an incentive for management of major firms to have the financial reserves to see off, or to mount a take-over bid. I submit that we are now again in a situation which existed in the 1930s: Realised savings are curtailed by lack of income. Full employment of manpower cannot be realised because it would cause an ability to save for among other purposes retirement which would imply more savings than the available commercially attractive investment opportunities could employ.

The main reason that this reality has not hit us already in the 1980s is. I submit, that there are mechanisms that can for some time appear o bridge the gap. The potential excess of savings over spending on capital goods may drive up asset prices. The increased values of assets will then be perceived as savings and converted back into consumption by 'successful speculators'.

The category 'Successful speculators' includes pensioners outliving the expected life span used to calculate the pension fund contribution withheld from their salaries during their working life. They are unlikely to be even aware that normal payment of their pension is partly based on the increase in share prices rather than on income as defined by national income accounting. In addition, deregulation of financial markets may increase the possibility for people to run up debts, or, in the case of the latest deregulation of the pension system in the UK, to spend accumulated assets in ways they may later come to regret. An important compensation for an excess in private intended savings in the real world has also been public spending for purposes that do not contribute to any increase in future production, such as means for potential destruction in particular: "Military Keynesianism". Such mechanisms may well help to maintain employment for a certain time, but they are clearly not sustainable.

[12] Cole, G. D. H. *Money, Trade and Investment*. London: Cassel & Co. 1954 p. 142

Economic growth and its support by migration: are these always desirable?

It is first of all necessary to say something about the purpose of economic growth understood as increasing material affluence. The axiom that growth is by itself self-evidently desirable is clearly a fallacy. We agree with Wilkinson and Pickett[13] (1) that there is an optimum level of affluence below which any an increase in per capita GDP helps to reduce poverty. Further growth, in particular in combination with inequality reduction, is beneficial to social stability and society, whereas any increase in affluence beyond this optimal level of affluence is by itself of questionable benefit, and (2) that more egalitarian societies tend to be more stable and populations more content with their personal status.

According to conventional neoclassical theory this second point is refuted by the argument that rewarding effort and skill might help to increase productivity. However an IMF staff discussion note[14] reinforces the view that the opposite is the case: more egalitarian societies are more financially stable and are characterised by a more stable and regular rate of growth.

Whilst the first point might suggest that there is a limit to the benefit of economic growth, there are two important issues which need mentioning in this respect. To begin with, in the case of a large part of humanity the optimum level of affluence has not been remotely reached and people must get a chance to escape from poverty. Secondly, as long as working for one's livelihood is seen as a social requirement, for at least some part of people's lives, money paid for employment in the production of marketable commodities is bound to remain an important be significant component of the cost.

Secondly, as discussed on pp. 92-93 of our book *Rediscovering Sustainability* there is some evidence that migration is part of the social process of economic growth. While this has been demonstrated with respect to Germany[15] and China[16], we also argue that relocation to areas that are already affluent is part of this economic process.

Accordingly, extending the neoclassical postulate that the market knows best to the issue of 'free movement of people', combined with global and national policies of demand management to maintain approximately full employment could substantially increase measured global production and affluence. In my view several millions could move from poor to rich countries and find employment there. However, given the prevailing false price structure with emissions and other forms of environmental degradation not counted as a cost, the environmental result of such a development would be catastrophic.

---

[13] Wilkinson, R.G.and Pickett, K. 2009. The Spirit Level: why More Equal Societies Almost Always Do Better. London: Allen Lane.

[14] Ostry, J.D., Berg, A., and Tsangerided, C. G.: Redistribution, Inequality and Growth IMF staff discussion nte February 2014 http://www.imf.org/external/pubs/ft/sdn/2014/sdn1402.pdf:

[15] Hochstadt, S. 1999. Mobility and Modernity. Ann Arbor, MI: University of Michigan Press.

[16] Huang P. and Zhan, S. 2005. Internal Migration in China: Linking it to Development. Paper for Regional Conference on Migration and Development in Asia. Lanzhou, 14–16 March 2005, organized by the People's Republic of China. Available at: http://219.141.235.75/english/papers/default.htm.

Cost Benefit Analysis

It follows from the qualified nature of the desirability of economic growth discussed in the previous section that the liveability of the planet cannot simply be regarded as a question of balancing the benefits of avoiding climate change with the cost of the reduction of emissions in the present, whether by a decrease in output or by investment in renewable energy. This being said, the standard neoclassical defence of discounting the value of the future is also flawed in its own terms. The errors in reasoning of the standard neoclassical defence of discounting are surveyed in some detail in Chapter 10 of *Rediscovering Sustainability* and I summarise them briefly here as follows.

- The assumption is that economic growth can carry on forever.
- The now customary application of differential calculus, whereby future value of estimated income over an infinite (and indefinite) period of time is accumulated, is questionable as a mathematical practice: The integration of total (discounted) affluence over in infinite period of time has a finite value only, when the discount rate is greater than the rate of growth.
- Sacrifice of current affluence for the sake of investment is seen as a *cost*, without taking into account that it might also contain other forms of environmental degradation than the one under analysis.
- It also needs pointing out that the potentially vast cost[17] of future catastrophes wreaked by weather events related to climate change has so far largely been disregarded in any cost-benefit analysis exercises.

Although economic growth may benefit poorer countries for the sake of poverty alleviation, a limited amount of growth is, in my view, a necessary condition for the maintenance of approximately full employment in more affluent countries. Nor do I think it is right to try to convert everything into a money value. The implication of the application of CBA to issues such as climate change is that the loss of biodiversity and the harm to human health are considered of no importance, unless these are seen to be financially valuable.[18]

The latest information

Climate science

Kevin Anderson [19] insists that to avoid dangerous climate change we need total decarbonisation by around 2040 and that to achieve this emissions must peak by about 2020 and then start to be reduced by around 20% per year. He is not the only climate scientist pleading for rapid reductions in emissions.[20] This is more drastic than even the

---

17 Wagner, G. and Weitzman, M.L. 2012. 'Playing God,' *Foreign Policy*, http://www.foreignpolicy.com/articles/2012/10/22/playing_god?page=0,2&wp_login_redirect=0 (Registration required to read the article)

18 Heinzerling, L. and Ackerman, F. 2002. 'Pricing the Priceless, Cost-Benefit Analysis of Environmental Protection,': Georgetown Environmental Law and Policy Institute, Georgetown University Law Center, http://www.ase.tufts.edu/gdae/publications/C-B%20pamphlet%20final.pdf

19 See his blog at http://kevinanderson.info/blog/wp-content/uploads/2013/01/EcoCities-presentation-for-distribution-.pdf

20 Corinne Le Queré: The scientific case for radical emissions reductions http://www.tyndall.ac.uk/sites/default/files/le_quere_radical_emission_reductions.pdf

most emission restricting scenario (RCP2.6) considered in the most recent IPCC report.[21] Seemingly IPCC only took emission scenarios into account which appeared to offer a plausible economic pathway.

> "The … suite of scenarios were developed using Integrated Assessment Models and resulted from specific socio-economic scenarios from storylines about future demographic and economic development, ….."[22]

However, I agree with Anderson that the forecasted additional 1.5 degrees C for such a scenario[23] is not something to look forward to, given what we have seen of just 0.8 degrees of global warming. As a matter of fact, several IPCC authors appear to agree with me on this issue, as may be illustrated by the following extracts from a report of the IPCC press conference[24]:

> Carbon storage has to expand rapidly, or coal burning has to cease, if the world is to avoid dangerous climate change
>
> [The world is on track for dangerous climate change, ….]
>
> Without such CCS hopes of restraining climate change to no more than 2 degrees C warming are "no longer feasible," Edenhofer argued. "In the end, two degrees means the phase out of fossil fuels without CCS entirely in the next few decades."

My assessment of the current state of technology is that a rapid phasing out of emission is possible and less expensive than CCS which in any case captures only *a fraction of* emissions. In addition, I submit (see above) that there are substantial scale economies in building a HVDC supergrid which imply that the rapid reductions in emissions he proposes are not as costly as they are often perceived to be. In addition, I also suspect that IPCC members perceived investment in renewable energy and retrofitting buildings with improved insulation purely as a cost, without considering the Keynesian argument that it is a useful application of otherwise un-used or under-utilised real resources as well as a route towards a return to full employment. However, management of such a transition is problematical under market economy conditions.

I am also concerned about the following statement reported by David Bello in the same interview, which I gather from other reports[25] is also Edenhofer's:

> "Fracking to free more natural gas from shale can help displace even more polluting coal in more developed countries such as the U.S. but can only serve as

---

[21] IPCC 2014; SPM Summary for Policy Makers http://report.mitigation2014.org/spm/ipcc_wg3_ar5_summary-for-policymakers_approved.pdf

[22] IPCC 2014 WGIAR5_Chapter01_Final http://www.climatechange2013.org/images/report/WG1AR5_Chapter01_FINAL.pdf BOx 1.1 (Re-edited by replacing IAMs by the full words for this acronym)

[23] The summary box for E.1 Atmosphere: temperature states that for *all other* scenarios exceptRCP2.6 the increase in temperature is likely to exceed this figure.

[24] David Bello (correspondent of the *Scientific American*): "How to Solve Global Warming: It's the Energy Supply" http://www.scientificamerican.com/article/how-to-solve-global-warming-its-the-energy-supply

[25] Damion Carrington *The Guardian* Monday 14 April 2014, p. 4: "Fighting climate change is affordable, says UN"

> a bridge—and a very short bridge—to the zero-greenhouse-gas pollution future, unless also outfitted with carbon capture and storage to eliminate pollution."

This argument overlooks the critical role of the timescale of the decay of greenhouse gases. The main component of shale gas, methane is a much more potent greenhouse gas than CO_2, but it oxidises fairly rapidly under the impact of (ultra-violet) sunlight into CO_2 and water vapour. The 'global warming potential' of any gas is related to the time horizon over which the calculations are made. This is because certain gases, notable CO_2 and the CFCs remain much longer in the atmosphere than others. Global warming potentials of greenhouse gases tend to be calculated on a time-scale of perhaps 80 to 100 years. In the case of methane this timescale is unfortunate. When calculated over "a few decades" (20 years),[26] the global warming potential of methane equals 86 times that of CO_2. That means that if just 2% of any shale gas, which is mostly methane, escapes in unburnt form into the atmosphere, shale gas is (for the next 20 years during which we need to get climate change under control), dirtier than coal.

In relation to what was mentioned above about the political aspect of any policy of rapid decarbonisation, it is relevant to mention that there has been concern that the *Summary for Policy Makers* of this report, which requires the agreement of governments appears to give a sanitised, watered down version of the real opinion of scientists.[27] I gather an important aspect of that issue is the question of how it should be funded:

> "All mention of transferring hundreds of billions of dollars a year from rich to poor countries to pay for going green were removed."[28]

Technology

Rediscovering Sustainability and the text of this paper so far have been written against the background of the assumption that the use of renewable energy would be more expensive in commercial terms under the prevailing false price structure than burning fossil fuels. This assumption now needs to be qualified. Gregor Czisch's book[29] is a translation of his 2005 University of Kassel thesis. Already by that time the only qualification with respect to the optimality by 2050 of an electricity supply based exclusively on renewables was gas fired Combined Heat and Power. What has since happened to gas prices strongly suggests that this caveat no longer applies. Crucial for this conclusion was and still is the construction of a HVDC supergrid as discussed above. I assume that this comment generalises to North America and other high emission areas.

---

[26] Figures form Wikipedia at http://en.wikipedia.org/wiki/Global-warming_potential#Importance_of_time_horizon, referring to IPCC 2013, whilst also reporting a much lower GWP for a time horizon of 80 years.

[27] Nick Miller: "IPCC report summary censored by governments around the world" *The Sydney Morning Herald* April 14 http://www.smh.com.au/world/ipcc-report-summary-censored-by-governments-around-the-world-20140414-zqugm.html

[28] Damian Carrington, see above for details.

[29] Gregor Czisch: *Scenarios for a Future Electricity Supply. Cost-optimised variations on supplying Europe amd its neighours with electricity from renewable energies*. Stevenage, UK, 2011

Nevertheless it is clear that Stern's conclusion:[30]

> "To stabilise at 450 ppm CO_2e without overshooting, global emissions would need to peak in the next 10 years and then fall at more than 5% per year reaching 70% below current levels by 2050. This is likely to be unachievable with current and foreseeable technologies."

is no longer applicable and was already behind the technological information available at the time. There clearly is a problem of inadequate dissemination of technological information. Thus, Rosen and Guenther[31] basically argue that, given the horrendous risks of climate change, we should start with decarbonisation, even whilst we *cannot know* the cost. In fact, these costs are clearly affordable.

Whilst this technology was known, well tested and costed by the time the Stern Review came out, the deployment of an alternative method of avoiding the investment cost of installing wind turbines for when there is wind, solar panels for when the sun shines and hydropower for when it rains, in the form of large batteries is now becoming available as well.

A letter in Nature[32] makes it clear that whilst this is as yet not a technology which simply needs rolling out, the possibility to store large amounts of energy locally is a matter of now well established physics

The one caveat to the conclusion that 100% de-carbonisation is easily attainable as well as affordable relates to aviation. However, even in that area there is a prospect the implement a more sustainable technology. The regional government of New South Wales has signed a contract with a firm called Algae.Tec to build a facility to convert CO_2, using algae and sunshine to make an oil-like substance from which aviation kerosene can be made.[33] Kriegler et al[34] also report that the biological route is the more cost effective one. By contrast Michelle Nijhuis[35] reports that engineers evaluating the pilot plant at Mountaineer came to consider CCS a "parasitic load" which would require 30% of the energy produced for the chemical capture of all the CO_2. Unfortunately the focus of this Australian pilot project as well as, I gather of Kriegler et al is on CCS with the view of continuing to burn fossil fuels. As mentioned above, CCS inevitably involves capturing only *part* of the emissions. There should be no coal fired power stations as a static source of energy at all.

---

30 Stern Nicholas: The Economics of Climate Change: The Stern Review Cambridge University Press, Cambridge, UK 2009 :218

31 Rosen, Richard A and Guenther, E,: "The economics of mitigating climate change: What can we know?" Technological Forecasting and Social Change, In Press, Corrected Proof, Available online 22 February 2014

32 **"**A metal-free organic–inorganic aqueous flow battery**"** Brian Huskinson, Michael P. Marshak, Changwon Suh, Süleyman Er, Michael R. Gerhardt, Cooper J. Galvin, Xudong Chen, Alán Aspuru-Guzik, Roy G. Gordon & Michael J. Aziz. *Nature* 505, 195–198 (09 January 2014) doi:10.1038/nature12909

33 Australia to Build First CO2 Capture for Algae Biofuel Enervironment News Service, 5 July 2013, at http://ens-newswire.com/2013/07/05/australia-to-build-first-co2-capture-for-algae-biofuel/

34 Elmar Kriegler; O. Edenhofer; L. Reuster; G. Luderer and D. Klein: "Is atmospheric carbon dioxide removal a game changer for climate change mitigation?" *Climatic Change*

35 Michelle Nijhuis: "Environmentalists say that clean coal is a myth: Of course it is". *National Geographic* April 2014, p.37

There are no valid reasons why either technology, once operational could not also be used with air from the atmosphere, even whilst this might be more costly. It might then be used, not only to produce aviation kerosene but also to generate "negative emissions", i.e. to pump synthetic oil-like fuel into oilfields and start bringing the CO_2 content of the atmosphere down. There is, however, every indication that the use of renewable energy is and will remain more cost effective than CCS.

Concluding remarks

There is a considerable degree of tension between the maintenance of growth for the sake of social stability and employment and the implied strain on the environment. However, as far as the immediate threat of a climate crisis is concerned, a relatively rapid replacement of the use of fossil fuels by renewable energy is perfectly possible from a technological point of view.

The main problem is not even its costs, but the fact that any such proposal is bound to run into a climate change denial storm. Known reserves of economically exploitable fossil fuel deposits already amount to several times the quantity we can afford to burn without running a substantial risk of exceeding the 2 degrees target.[36] The obstacle is political as much as technological or economic.

It might be thought that the implementation of Professor Anderson's recommendation could be problematic because of a scarcity of the readily available supply of minerals. However, as far as Molybdenum, a metal which is essential for the manufacture of electric power turbines[37] and other quality steel structures[38] is concerned, I gather that there are ample ore reserves.[39] Other energy technologies have been identified and are being put into practice, such as the use of anaerobic digestion of food waste and the use of tidal lagoons.

As far as manpower is concerned, provided public financial backing is made available, a major program of building renewable energy supply capacity, construction of new zero carbon buildings and retrofit of older housing with better insulation to contain energy demand for heating and/or cooling may serve as Keynesian investment to get back to full employment. Another necessary task to strengthen the resilience of society is the promotion of local food production, especially in sustainable agriculture, reversing current trends of ever increasing, carbon wasting imports.

However, any implementation of Professor Anderson's recommendation would bring the bankruptcy of the main energy companies and their specialised suppliers in their wake, as long as these continue to rely on fossil fuel production. This would undoubtedly put the solvency of pension funds providers and insurance companies at risk. I am not aware of any other serious research by accountants into the severity of this problem. What I do know is that when I approached the finance director of the Universities Superannuation Scheme (USS) with a suggestion to diversify into more

---

36 Carbon Tracker: Unburnable carbon 2013: Wasted capital and stranded assets http://www.carbontracker.org/wastedcapital

37 https://www.mineralseducationcoalition.org/sites/default/files/uploads/mec/fact_sheet_wind_turbines_0.pdf

38 http://www.useofmolybdenum.net

39 Private oral information from Dr. Linda Kemp-Heesterman (my daughter), who is an experienced exploration geologist by university training and career.

sustainable financial assets with a reference to the Carbon Tracker report, my plea fell on deaf ears. There also is a reference to this issue by the authors of the latest 2014 IPCC report *Mitigation of Climate Change* by Working Group III which was picked up by a journalist at the press conference:

> "…; huge stocks of coal, oil and gas will have to remain in the ground; countries and companies relying on fossil fuels may suffer big financial losses." [40]

However, no similar phrase appears in the Working Group III, *Summary for Policymakers*,[41]

The nearest to any recognition of this reality is:

> "Mitigation policy could devalue fossil fuel assets and reduce revenues for fossil fuel exporters, ….."

I have no direct evidence that this pronounced discrepancy between the tone of what the authors said at the press conference and the text of the government-approved summary is directly related to the issue of the summary being 'sanitised' as discussed above. However, it is a thought which obviously arises. In any case, if decarbonisation proceeds at a pace which stands a chance of avoiding dangerous climate change would mean that I cannot take the continued payment of my pension for granted in a decarbonising world. It would be necessary to revive the Welfare State, otherwise many retired people could be impoverished. Eventually, after the required surge in investment to build renewable energy systems, a restoration of the Welfare State may also be helpful in maintaining full employment at a reduced level of savings and therefore of investment. A reduced level of investment is also likely to slow down the speed by which work by humans is replaced by robots.

There also is bound to be a surge in the promotion of climate change scepticism, in many cases not unrelated to the concerns of vested interests.[42] The real obstacles against getting on with decarbonisation are not really its cost and associated loss of material affluence. In this respect Grubb[43] hits the nail on its head. Not only emphasises he the relevance of inertia, existing technology and infrastructure. He also confirms the relevance of vested interest :

> "A low carbon transformation would be against grain of the dominant and established technologies, systems and interests"

---

[40] Damian Carrington *The Guardian* Monday 14 April 2014, p. 4: "Fighting climate change is affordable, says UN"

[41] IPCC 2014; SPM Summary for Policy Makers (Working Grooup III –mitigation- http://report.mitigation2014.org/spm/ipcc_wg3_ar5_summary-for-policymakers_approved.pdf

[42] Brulle, R.J. 2013. 'Institutionalizing delay: foundation funding and the creation of U.S. climate change counter-movement organizations' *Climatic Change*, published online 21-12-13, prior to the printed version at http://www.drexel.edu/~/media/Files/now/pdfs/Institutionalizing%20Delay%20-%20Climatic%20Change.ashx, DOI 10.1007/s10584-013-1018-7

[43] Grubb Michael: *Planetary Economics*, London/New York Routllege 2014, pp.257 ff. (summary of societal obataclees agains rapid decarbonisation, p.359 quoted passage.

It is perhaps useful to mention here that one of the donors of the Global Warming Policy Foundation is reported to be Michael Hintze,[44] who happens to be the founder and chief executive of CQS Rig Finance[45] and also a trustee of the *Institute of Economic Affairs*.[46] In this respect, permit me an aside. I trust I am forgiven to mention our interpretation of the flavour of a review of our book, at three pages so far the longest we have seen so far.[47] The reviewer picks up the reference to Houghton's *Global Warming* on p.250. We emphasised that there is no shortage of renewable energy to harvest by referring to Houghton. The reviewer, however, adds his personal opinion that the abundance of solar energy might explain a *change* in the earth's temperature. This is a standard misconception beloved by climate change deniers and expertly refuted by the climate scientists publishing on the Skeptical Science website.[48] He also informs the readers of *Economic Affairs* that […"in geological terms the levels of CO2 in the atmosphere are very low indeed, …"].That unsupported assertion by Malcolm Rees, or may be not[49] be meaningfully true, but in any case it is totally irrelevant: an atmosphere with a much higher carbon content would not be greatly conducive to human life. Perhaps you might think that the remark "The book is almost completely lacking in humour" is more relevant? – I never realised this ought to be a significant feature of a critique of customary economic theory and practice. I would, however also comment that, whilst the outright denial of the existence of a climate change crisis may have an element of flat earth science, I would also expect a certain amount of renewale economics obstifiation, emphasising the outdated perception that a transition to renewables would impya substantial loss of material affluence.

Be it as it may, what I want to emphasise is that it is still possible, despite the many setbacks, to take steps towards the development of a more inclusive and resilient society. It depends on the cooperation of many disparate groups, individuals and official bodies, the employment of innovative technologies and above all on the political will of governments.

Aart Heesterman

Email: A.Heesterman@bham.ac.uk
Website: RedicoveringSustainability.org.uk

---

44 http://www.theguardian.com/environment/2012/mar/27/tory-donor-climate-sceptic-thinktank

45 http://michael-hintze.com/?gclid=CLj92erErr0CFa3LtAod-FgAAQ

46 http://www.iea.org.uk/about/people

47 Malcolm Rees: "Rediscovering Sustainability: Economics of the Finite Earth" *Economic Affairs* Vol 34 nr. 1, 24 Jan 2014 pp. 123-126 http://onlinelibrary.wiley.com/doi/10.1111/ecaf.12059/pdf

48 https://www.skepticalscience.com/solar-activity-sunspots-global-warming.htm

49 For roughly the latter half of the earth' more than 4 billion years of existence when there was life on earth, it probably was not. There are clear indications that there have been periods of several millions of years' duration in which most of the oceans were covered with ice. (Reference: Daniel P. Schrag and Paul F. Hoffman: "Geophysics: Life, geology and snowball earth" *Nature*, 18 January 2001, doi:10.1038/35053170). Frozen over tropical oceans obviously mean that the earth' natural greenhouse climate effect was at cerain times in the geological past much weaker than it was at any time when there were humans on earth.