WHICH PATHWAY TO THE FUTURE WILL WE FOLLOW?

by

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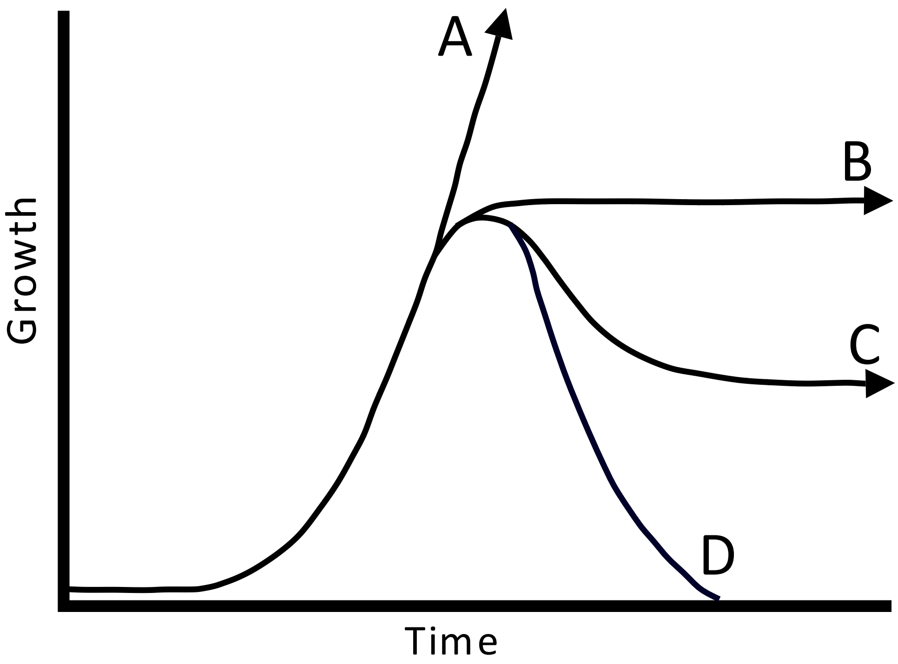
> *The point is not to see who may be the more correct, but to see the areas which will be particularly vital in the future and also to note some of the profound moral, ethical, and human questions which will be raised.* - Sir George Thomson

The following diagram maps growth in our human population and use of resources, including energy, from the past to the present and projects alternative pathways into the future.



Alternative Pathways into the Future

Pathway A shows continuing growth into the far distant future, Pathway B transitions smoothly from growth to steady state without any decline, Pathway C declines from growth to a lower level of steady state, and Pathway D collapses from growth to extinction.

Humankind relies on using energy, minerals, and resources provided by ecosystems for its survival. The surface area of our planet Earth is finite and we need to share space on Earth with ecological systems. It is therefore simply a physical impossibility for our human populations to grow forever. Reserves of minerals and fossil fuels such as oil, coal, gas, and shale are also finite. Our species will therefore either eventually become dependent on using renewable energy resources or face extinction.

All economic activity requires the use of energy and minerals. There are claims that energy can be decoupled from an economy. Improvement in the efficiency of production can reduce the levels of energy required, but there are thermodynamic limits to the efficiency of any form of energy transition involved in a production process. Waste heat is always a by-product. There are also thermodynamic limits to the extent that materials can be recycled. All materials ultimately dissipate into the environment when it becomes too energy costly to continue recycling. 100% decoupling of energy and minerals from any economy is an impossibility.

Sustained economic growth is a thermodynamic and physical impossibility and the term “sustainable economic growth” is an oxymoron. Even the most die-hard proponents of economic growth would concede that economic growth cannot continue for ever. The question of when economic growth should cease is seldom raised.

Humankind will not prove to be an exception to the laws of thermodynamics and will continue to be subject to the same laws of growth as any other organism on Earth. When our high-grade fossil fuel energy resources are eventually too expensive in energy terms to further extract from the ground, humankind will either live in a homoeostatic, steady state, symbiotic relationship with the entire ecosystem on Earth or face extinction. Continuation of blindly promoting and following pathway A runs the risk of a cascade collapse to Pathway D.

I make an assumption that humankind will continue to survive for many more millennia into the future which brings us to Pathway C. The actual level of steady state that is possible as depicted by Pathway C depends on the availability of renewable energy and mineral resources, the level of human population, and the carrying capacity of our species within the total ecosystem on Earth. The availability of renewable energy and mineral resources will also limit the level of technology that is possible. There will be fluctuations in the level of steady state because regardless of whether future society is based on a market or planned economy or a mixture of both, there are likely to be periodic runs on the use of resources which need to be curbed and reeled back.

Whatever the overall level of steady state might be, there will be a gradual and inevitable decline in that level because it is physically impossible to 100% recycle the mineral resources that we are currently reliant on using in a technological society. As time progresses, it will become more and more energy expensive to extract mineral resources from the ground. The peak production process that applies to extraction of oil and other non-renewable energy sources from the ground also applies to mineral resources used in a technological society. 100% recycling is possible in natural ecosystems, so an inevitable decline of a technological society might ultimately result in a return to a hunter-gatherer society with a much-reduced population in the far distant future. Ultimately Earth will face a fiery death when, in a few billion years' time, the Sun will expand into a Red Giant. We need not dwell on the far distant future. Our immediate challenge is to confront a transition from fossil fuels to renewable energy in the here and now.

Pathway C, a decline over a hump down to a lower level of steady state, is more likely than a gentle transition from growth to steady state as shown in Pathway B for the following reasons. Humankind currently faces a double whammy. In order to avoid severe consequences of climate change, we need to curb our use of fossil fuels which adds greenhouse gases to the atmosphere. We are still reliant on using energy, so we need to transition over to renewable energy sources. Setting up alternative infrastructure that provides and supports renewable energy will require additional use of fossil fuels at the very same time that we need to curb our use of those fossil fuels in order to reduce emissions of greenhouse gases to the atmosphere. In the long run, viable renewable energy source systems need to be able to maintain and replace themselves in order to be truly sustainable, but renewable energy systems are initially unable to bootstrap themselves through a transition without assistance of fossil fuels in the short-term.

There are already indications that we have reached the stage of peak conventional oil where the rate of conventional oil production has already started to plateau. Ideally, humankind needs to divert the use of fossil fuels from unnecessary consumption to that of investment in renewable energy. However, regardless of voluntary curbing of the use of fossil fuel on consumption, the ultimate peaking of all forms of fossil fuels will increasingly limit the rate of supply of fossil fuels in the future. Delays in enabling a transition from fossil fuels to renewable energy can only but exacerbate the difficulties of transition over time.

The big question is whether we are able to simultaneously curb our generation of greenhouse gases and transition to non-renewable energy. Given our response over the last 40 years to early warnings of climate change and the consequences of peak oil, I have limited confidence that both targets will be met. I am essentially an optimistic pessimist. I want there to be and hope for a smooth and peaceful transition to a stable steady state economy for all nations with greater equity between and within all countries. However, given the multiplicity of information and data from diverse and what seem to be the most reliable sources of information, I fear that the future before 2100 will be strife for millions around the globe. Society has ignored warning signals about both climate change and peak oil over the past 40 years and tends to respond only to emergencies. I suspect that even now insufficient action will be taken in New Zealand and other countries to fully address the issues of climate change, peak oil, and the need for zero population growth.

Yes, the elephant in the room is population growth, and the need to curb population growth has been ignored and shelved. Steady state for humankind requires zero population growth (ZPG). If all countries were to immediately adopt a policy of ZPG, then the global population would continue to grow for a number of decades due to population momentum despite the low growth and even declines in the natural population of a number of developed countries. Continued increases in population during a transition from fossil fuels to renewable energy can only but result in a Sisyphus like undermining of any efforts for a smooth transition.

Continuing with a focus on Pathway C, renewable energy currently includes hydro-electricity, phytomass (plant material), wind power, solar energy concentrators, photovoltaic cells, geothermal power, and tidal waves. The scale and extent that each of these energy systems can be used by future human settlements depends on the availability of mineral resources needed to create these energy systems, the resulting net energy produced by these energy systems, and the convenience of the form of energy that is generated. For example, hydrogen is a convenient concentrated form of energy suitable for transport, but the production of hydrogen does not result in net energy because it takes more energy to produce than the energy content available in the hydrogen. Hydrogen is a convenient carrier of energy, but is not an additional energy source independent of the energy required to produce it.

I have strong reservations about the use of nuclear fission as an energy source on ethical grounds that we bear a responsibility to future generations of humankind and other species not to endanger their existence and leave them a heritage of nuclear waste that will have to be guarded for centuries. A number of energy researchers who I highly respect advise against ruling out nuclear energy. Nuclear energy is a can of worms. New Zealand is fortunate in that the use of nuclear energy is unnecessary because New Zealand already has a high level per capita of hydro-electricity, high potential for wind power, and potential to expand its current generation of geothermal electricity. Should our current level of technology improve in the future to include nuclear fusion, then our consumer level of life could increase, but within physical, thermodynamic, and ecological limits. We would still need to keep within planetary boundaries.

Humankind continually comes across limits in every sphere of life. The ultimate peaking and decline of easily accessible high-grade energy fossil fuels and mining of minerals are but some of many limits. A crisis can develop when humankind does not accept there are limits. Humankind induced climate change is an example. Limits exist and we need to accept them and act accordingly in order for humankind to continue to survive in future millennia. A growth philosophy has enabled development of civilisation in the past. Further development does not require further growth. We now need to cast aside a growth philosophy which ignores the consequences of limits.

We, our children, and our grandchildren are privileged to be living in a period of transition that is unparalleled in the entire history of humankind. The decisions and actions that we have made in the past and the decisions and actions that we will make over the next number of decades have and will limit the options of current and future generations. We need clear visions of pathways to transition from growth to steady state.

For those who wish to explore issues of sustainability in more detail, please visit my website www.insearchofsteadystate.org and use the search engine on the Home page to hunt down resources and information.

The following table lists the attributes of growth versus steady state settlements which can be used to backcast from what is possible and then plan forwards instead of planning forwards based on extrapolations of what was possible in the past.

Settlement Attribute		Growth Settlement	Steady State Settlement
Economic Philosophy			
	Primary Concept	Scarcity	Scarcity
	Attitude to Scarcity	Conflict	Acceptance
	Purpose of Production	Consumption	Maintenance
	Emphasis on Production	Productivity	Distribution
	Timescale Horizon	Narrow	Wide
	Incentive for Work	Income for consumption	Satisfaction
	Typical Attitude to Work	Necessary imposition	Accepted part of life
	Work and Leisure	Differentiated	Little difference
	Place of Humankind in Ecosystem	Domination	Participatory
Population			
	Typical Annual Growth Rate	2.0%	Average 0 % (Small fluctuations in population)
	Doubling time	35 years	No doubling time
	Age Composition Profile	Triangular	Cylindrical
	Age Dependency Ratio Proportion of dependents per 100 working-age people in the population. (Workers aged between 15 to 64)	Global peak of 77% in 1967 (high proportion of children under 15) and declined to 54% in 2014 as growth rate declined. 66% if constant 2.0% growth rate. Dependent on life expectancy.	≈ 72% (High proportion of people over 65). Dependent on life expectancy
	Total Fertility The average number of children in each family	Global peak of 5.10 in 1964 declining to 2.44 in 2016	Approx. 2.11
	Net Reproduction Rate The ratio of women in one generation to the next	Global peak of 1.892 (1965-1970) declining to 1.099 (2015-2020). Dependent on death rate.	1.000
	Time to Re-stabilise	70 years	Already stable
	Family Structure	Nuclear family	Extended family
	Urbanisation	High (80%)	Low (20-40 %?)
Capital Stock			
	Durability	Low	High
	Maintenance Energy Cost	High	Low
	Recycling	Limited	Optimised within inevitable dissipation and energy constraints
	Creation of New Capital Stock	A large proportion of new capital stock is additional capital stock using additional materials.	New capital stock is replacement capita stock. Materials of old capital stock are recycled within above constraints

Energy Production			
	Source	Energy stock	Energy flow
	Limits of Production	Peaking (maximum rate of extraction) and inevitable EROI decline to 1.0	Level of technology and availability of key scarce minerals
	Permanence of Source	Non-renewable	Renewable over medium time scale, but ultimately long-term technological decline as minerals dissipate
	Level of Pollution	High Pollution	Low Pollution
	Pattern of Energy Flow	Increasing then decline	Slow decline
Consumption			
	Pattern per Capita	Increasing per capita	Constant per capita with minor fluctuations
	Goods and Services Consumption	Unnecessary consumption	Necessary consumption
	Tertiary Sector	Large tertiary sector	Small tertiary sector – self sufficiency
	Distribution of Consumption	Unequal distribution	Equal distribution
	Wastage	High wastage	Low wastage
Industrial Production			
	Pollution	Heavy pollution	Light or no pollution
	Energy Consumption	High energy consumption	Low energy consumption
	Technological Accidents	Frequent and serious	Infrequent and insignificant
	Type of Processes	Complicated	Comprehensible
	Impact on other Life Forms	Destruction of other life forms	Participatory dependence of on other life forms
	Risk of Processes	Ecologically dangerous	Ecologically adapted
Food Production			
	Type of Agricultural System	Monoculture	Permaculture and diversification
	Participation in Food Production	Industrialised production by large farm units	Production of food involves every family
	Factors of Production	Energy and capital intensive	More labour intensive
	Use of Fertilisers	Artificial fertilisers	Natural fertilisers
	Use of Animals	Animals used primarily as food source	Animals perhaps used again for mechanical energy value
	Impact on Soil	Erosion and depletion	Replenishment
	EROEI of Food	Low < 1.0	High > 10
	Control of Pests	Dangerous pesticides used	Ecological techniques used