Surplus Energy Economics

The home of the SEEDS economic model – Tim Morgan

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← Previous Next →

#246: The Surplus Energy Economy, part 1

FROM FIRST PRINCIPLES

Introduction

We have reached a turning-point at which economics and the economy have parted company. Orthodox economics continues to promise growth in perpetuity, but the economy itself is going in the opposite direction.

The explanation for this is simple. Conventional economics assumes that the economy is driven by money, which is entirely under our control. But the economy is, in reality, not a financial system, but a physical one, which uses energy to convert raw materials into the products and services which constitute *prosperity*. The modern economy has been built on abundant, low-cost energy from fossil fuels, but this dynamic is winding down and, as we shall see in a future instalment, we have no *complete* (or timely) alternative with which to replace it.

The aim with *The Surplus Energy Economy* is to set out a comprehensive assessment of the condition and prospects of the world economy and financial system, seen from the perspective that the economy is shaped by energy, not money. This series of articles will be as specific as

possible, using data from the SEEDS economic model.

The conclusions reached here necessarily contradict the orthodox line, which is that the supposed 'normality' of growth will soon return, and that seamless transition to renewable energy sources will deliver economic expansion in perpetuity.

The economy is analysed here as a material system which has started to contract after reaching physical constraints imposed by the availability and cost **of energy**. Similar limits apply to environmental tolerance for energy-based economic activity.

Findings will come later in this series, but we are completely unprepared for the reversal of prior growth in the economy. The ending of growth has not arrived without warning, and we can identify a *precursor zone*, starting in the 1990s, which was characterised by deceleration, followed by stagnation.

Rendered myopic by denial, and misled by a mistaken economic orthodoxy, we have been attempting the impossible task of fixing *material* economic problems with *monetary* tools. As we shall see, this has placed global finance at systemic risk.

An economy on the turn

The consensus view of current global economic problems is that they are temporary, and largely traceable to pandemic lockdowns and the war in Eastern Europe, though some observers do concede that excessive use of QE might have been a factor in the recent resurgence of inflation.

These, though, are explanations rooted in orthodox economics, which makes many fallacious assumptions. One is that the economy is entirely a financial system, not constrained by energy, resource or environmental limitations. Another is that the economy can grow in perpetuity, notwithstanding the limited physical characteristics of the Earth.

The concept of 'infinite growth on a finite planet' isn't a logical proposition, but it's been a mightily persuasive one.

Evidence is accumulating in support of an alternative view, which is that the economy is a material system, subject to physical constraints, and that *economic prosperity is determined by energy, not money*. Surplus Energy Economics interprets the economy in this way, and models it on this basis using SEEDS (the Surplus Energy Economics Data System).

Energy interpretation of the economy isn't going to be accepted by the mainstream any time soon, and not just because it demonstrates the fallacies of orthodox economics. Energy-based analysis tells us that economic growth, far from continuing indefinitely, has *already* decelerated via stagnation into contraction.

This has never been a remotely acceptable conclusion where the 'powers that be' – or, for that matter, the general public – are concerned. Over a very long period, we have been using monetary gimmickry in futile efforts to reinvigorate a floundering economy. But trying to fix a *material* economic problem with *financial* tools can be compared to trying to cure an ailing

house-plant with a spanner.

These efforts have led, via the global financial crisis (GFC) of 2008-09 and a subsequent era of monetary recklessness, to a point of systemic risk in global finance. We have a ludicrously-inflated "everything bubble" in asset prices and, even more seriously, an enormous complex of inter-connected liabilities which the system cannot possibly honour 'for value'.

Why, though, are *economics* and *the economy* going in different directions?

Origins – 'the class of '76'

When the year 1776 is mentioned, it probably reminds people chiefly of the Declaration of Independence, from which date the history of the United States begins. But two other events of profound importance also happened in that year, and both of them took place in Scotland. James Watt completed the first truly efficient steam engine in 1776, whilst Adam Smith published *An Inquiry into the Nature and Causes of the Wealth of Nations* in the same year.

The importance of these breakthroughs is scarcely capable of exaggeration. Watt gave the world the ability to convert heat into work, which enabled us to harness the vast energy resources contained in coal, oil and natural gas. Smith's book, generally referred to as *The Wealth of Nations*, was the founding treatise of classical economics.

A significant distinction needs to be noted from the outset. James Watt was an engineer and inventor, and his practical work laid the foundations for a vast expansion in the *material* economy of products and services. Adam Smith was primarily a philosopher – he considered *The Theory of Moral Sentiments* (1759) his finest work – and can be described as a theoretician, setting out his explanation of the economy in terms of the working of money.

It's worth remembering, too, that Smith was describing an agrarian economy, and could not have anticipated the coming of the Industrial Revolution. No-one should doubt the importance of Smith's ground-breaking work, but we are entitled to wonder why, more than two centuries into the Industrial Age, his successors continue to adhere to the precepts of an economy shaped by money alone, not subject to material constraints, and capable of defying logic by delivering "infinite growth on a finite planet".

The activities which began with 'the class of '76' have continued in parallel ever since. The heirs to Watt created the huge and complex economy of modern times, accomplished on the basis of energy from fossil fuels. Classical economists, who are the heirs to Smith, have purported to *explain* this dramatic expansion in terms, not of material energy, but of money, which is an *immaterial* human artefact used primarily for the *exchange* – not the *creation* – of the products and services made available by the harnessing of energy.

So long as the economy continued to expand, there was no necessary conflict, other than at the intellectual level, between these two schools of thought. The beneficiaries of economic growth could thank Watt for their improving prosperity, or hand the credit to Smith, with most people probably giving scant thought to either.

Now, though, we have reached **a parting of the ways between economics and the economy**.

It's becoming increasingly apparent that economic growth, having decelerated since at least the 1990s (and arguably for a lot longer than that), has gone into reverse.

Classical economics says that this can't happen. As we shall see, observation makes it increasingly clear that **it has**.

This presents us with a choice of two interpretations. One, favoured here, is that prior growth in prosperity has reversed because the fossil fuel dynamic has been winding down. The other is that we can restore the economy to perpetual expansion if we work along the monetary lines specified by classical economics.

The existence of ample intellectual and observational evidence makes it imperative that we take note of economic deterioration, and then seek explanations for why it has been happening. In the modern parlance, there is a range of "narratives" which purport to tell us why the economy is struggling. We looked at these rival explanations in a previous article, so need not distract ourselves by revisiting them now.

The line of inquiry followed here is based on reasoning from first principles within a framework of evidence. Our conclusions are simply stated.

Prior growth in the industrial economy has gone into reverse, because the dynamic built on fossil fuel energy has decelerated, over a lengthy period of time, to a point of trend reversal which we might, if we so choose, call "inflexion". There exists no plausible alternative that offers a complete and timely replacement for the economic *value* hitherto sourced from oil, gas and coal.

This means that, in material terms, **the world is getting poorer**. We can see this happening, if we choose to look. At the same time, energy-intensive necessities are becoming more expensive. **The ensuing contraction in *discretionary* prosperity is one of the main economic problems created by this process**.

The other is the unravelling of the vast financial system predicated *entirely* on the assumption that the underlying economy of products and services could *never* cease to grow, let alone start to contract.

Foundation principles

The Surplus Energy Economics interpretation of the economy reasons from first principles, of which there are three.

First, **the economy is an energy system**, because literally *nothing* that has any economic value at all can be supplied without the use of energy. Other raw materials, including food and water as well as minerals and plastics, are functions of *the energy required to make them available*. Energy is 'the master resource', and is the obvious connection between our economic and environmental challenges.

To be slightly more specific, the modern economy is a *dissipative landfill system*. Energy is used to convert raw materials into products whose ultimate destination is disposal. This is

dissipative because, in thermodynamic terms, this process involves the conversion of concentrated, dense energy into the diffuse format of waste heat. The use of fossil fuels as the concentrated input to this process means that the resulting waste heat contains climate-harming gases.

The second principle is that energy is never 'free'. Whenever energy is accessed for our use, some of that energy is **always** consumed in the access process. Energy is used at every stage in the creation, maintenance, operation and replacement of the systems which supply us with energy. This 'consumed in access' component is a cost deduction, because it is energy which cannot be used for any other economic purpose. It can be thought of as a rent levied upon economic activity by the material character of energy resources.

It is known here as the Energy Cost of Energy, giving us **the principle of ECoE**.

This means that material *prosperity* is a product of the supply, value and cost *of energy*. Prosperity, therefore, is, first and foremost, a material concept, not a financial one.

Money has no *intrinsic* worth, but commands value *only* as a man-made 'claim' on the material output of the energy economy. It is worthless unless there is something material for which it can be exchanged.

Our third and final principle is that of **money as claim**.

'Two economies'

As well as being self-evident, these principles lead us to an obvious conclusion. This is that we need to think conceptually in terms of '**two economies**'. One of these is the 'real' or *material* economy of products and services made available by the use of energy. The other is the 'financial' or *parallel* economy of money and credit.

From this, it follows that the financial economy is a representational counterpart or *proxy* of the real economy. If these 'two economies' are in a reasonably close relationship, we are in a situation of equilibrium where the *claims* that constitute the financial system can be honoured by the *material* economy.

As we shall see, the situation now is one of **extreme disequilibrium**, meaning that we have created an enormous quantity of *excess claims* which cannot be 'honoured for value'. This is why major downsizing of the financial system has become inescapable, and will *look like* 'value destruction'.

The reality – though it's of scant comfort – is that much of the 'value' that will be destroyed never really existed in the first place, and consisted of monetary *claims* that the real economy of the future was never going to be able to honour. We are, in fact, in two bubbles – the "everything bubble" in asset prices, which is destined to burst, and the 'delusion bubble' of gigantic financial commitments that must be relinquished because they cannot possibly be honoured.

A brief history of now

The central proposition which emerges from first principles is that prosperity is a function of **surplus** energy, meaning total energy less the ECoE cost of making that energy available for use.

In pre-industrial times, almost all energy was sourced from human and animal labour. The dynamic here was that human energy was obtained from nutrition, and expended in hunting or finding that nutritional energy. The same equation exists in nature, where an animal or a bird survives only if the energy sourced from consuming food exceeds the energy expended in obtaining it.

Agriculture made this process more efficient without, of course, changing the fundamental dynamic. If, say, twenty people could now be fed by the labour of nineteen, an *energy surplus* existed which enabled the release of the twentieth person for non-subsistence activities. These activities were varied, and included capital investment in buildings, tools and infrastructure, all of which increase productivity in the future by sacrificing consumption in the present. But a surplus of 1/20 is very small, which explains why pre-industrial systems of investment, craft manufacture, education, law and government were rudimentary by later standards.

Accessing fossil fuels was completely transformative. In today's developed economies, very few people work in agriculture, and their labour is supplemented enormously by inputs and services made available by fossil fuel energy. Modern agriculture, no less than industry, is a system built on oil, gas and coal.

Classical economics, which traces its origins to the pre-industrial era, is prone to ignoring the energy dynamic to the point of absurdity. For example, the statistic that only about 6% of world GDP is attributable to agriculture leads to the absurd proposition that the remaining 94% of the economy could carry on unaffected if we lost the ability to produce food. In many economies, activities like tourism and financial services are statistically larger proportions of GDP than agriculture *or the supply of energy*, and are thus deemed to be 'more important', and worthier of more investment and policy attention, than these basics.

Classical economics side-steps issues of scarcity by promising infinite substitutability, a claim which, where energy is concerned, is now being disproved, with brutal economic consequences.

Conventional economics has been described as "the dismal science" and, whilst it might indeed be dismal, it certainly isn't a science. What classical economics is pleased to call the "laws" of economics are merely *observations* about the behaviour of the human artefact of money, and are in no way analogous to the laws of science.

It hardly needs be said that energy cannot be lent into existence by commercial banks, or created out of the ether by central bankers. We can't overcome environmental problems by sending a cheque to the universe, and neither, for that matter, can we make energy transition to renewables possible by using QE – any such exercise would be self-defeating, because it would simply push up the prices of every raw material input required for the expansion and maintenance of renewables.

Output and prosperity

Two terms used frequently here are *output* and *prosperity*, and we need to be clear about the difference between them. The understanding of prosperity, defined in material terms, ought to be the primary objective of economics, and the calculation of prosperity is at the centre of the SEEDS economic model.

The difference between output and prosperity is cost, much as necessary expenses are the difference between individuals' total and *disposable* incomes. At the macroeconomic level, *output* is the value created by the use of energy, and *prosperity* is what remains *after ECoE has been deducted* from output thus defined.

The principal metric in orthodox macroeconomics is gross domestic product, which is often, – though quite mistakenly – assumed to be a measure of output or prosperity. In fact, GDP is a quantification of financial *transactional activity*, and it's perfectly possible, indeed commonplace, for transactions to take place without any economic value being created.

One technical point needs to be made here before we examine economic output. There are two ways in which other currencies can be converted into dollars for purposes of comparison and global aggregation. One of these is to use market exchange rates, and the other is known as purchasing power parity (PPP). PPP is the convention used in measuring global growth, and it is the one used here, except where otherwise stated. Monetary amounts need to be expressed at constant ('real') values, so the nomenclature is '$PPP 2021'. SEEDS analysis of national economies is undertaken in local currencies, again at constant 2021 values.

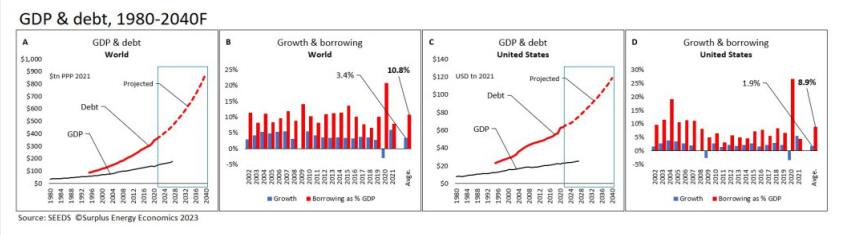
When it comes to internationally-comparable conventional economic statistics, the International Monetary Fund can be regarded as authoritative. In its most recent set of data, published in October, the IMF stated that world gross domestic product fell by 3.0% in 2020, during pandemic lockdowns, grew by 6.0% in 2021, and was likely to have increased by 3.2% during 2022.

From the same source, world GDP was $146 trillion (PPP) in 2021. Adjusted for broad inflation (using the GDP deflator), the equivalent number for 2001 was $73tn, meaning that reported real GDP doubled (+101%) between those years.

Over the same period, though, global debt increased by 180% in real terms, in a relationship illustrated in **Fig. 1**. Over a period in which reported GDP grew by $73tn, total public and private debt expanded by $232tn (Fig. 1A), meaning that each dollar of reported growth was accompanied by $3.15 of net new borrowing. Another way to look at this is that borrowing averaged 10.8% **of GDP** during a period in which reported growth in GDP averaged 3.4% (Fig. 1B).

For the United States, growth in GDP of USD 7.3tn (46%) was accompanied by a USD 34tn (115%) increase in aggregate debt. On this basis, USD 4.66 of net new debt was added for each dollar of reported growth, whilst borrowing averaged 8.9% of GDP during a period when GDP itself grew at an annual average rate of 1.9%.

Fig. 1



Given that GDP is a measure *of transactions*, a direct connection exists between borrowing and changes in GDP. A simple example illustrates this point. If a government were to use borrowed money to employ 10,000 people to dig holes in roads, and another 10,000 to fill them in again, the wages paid to both groups would be added to GDP, *even though no economic value has been added*. The spending of these wages would contribute to GDP measured as expenditures and, most absurdly, the work would count as 'value added' for computational purposes, even though no such value has in fact been created.

The cost of employing these workers would be added to government debt, where it would be disregarded by anyone choosing not to make the connection between the two. The technical terms for these are *flow* (in this instance, of GDP) and *stock* (of debt).

What this amounts to is that you can report just about as much "growth" as you like, depending upon how much you are willing and able to borrow. Historic data illustrates this connection. Between 2001 and 2021, average growth in the United States was 1.9%, and annual borrowing averaged 8.9% of GDP, as we have seen. China reported far more growth than America over this period (averaging 7.8%), but also borrowed very much more (an average of 24.7% of GDP).

A reflection on absurdities

This relationship between stock and flow cautions us, not just against an unquestioning acceptance of GDP as a measure of output, but also against relying on the ratio of debt to GDP, because these are not discrete data series.

We are sometimes told that debt "doesn't matter", which, of course, is absurd. We are also informed that borrowing now can create growth which, in due course, 'pays off' the debt taken on to create it. Individual enterprises can indeed do this, but a borrowing-to-growth ratio of 3:1 (and often higher) makes this a mathematical absurdity at the macroeconomic level.

Whilst we're pondering absurdities, few are more readily accepted than aggregate 'valuations' of assets. We are routinely told that market movements have 'added' or 'wiped out' billions, or even trillions, in investor value. Statisticians – who really should know better – frequently tot up the supposed value of property and other assets and then deduct liabilities to produce a 'national balance sheet'. The results usually echo Harold MacMillan when he told the British public (in 1957) that they'd "never had it so good".

The reality, of course, is that the only potential buyers for the entirety of a nation's housing stock are *the same people to whom it already belongs*. Foreign buyers don't affect this other

than at the margin and, in any case, their investment merely shifts property demand between countries.

The same applies to any asset class, including stocks and bonds. Aggregates are arrived at by multiplying average prices by the number of units of the asset in question. This implies that the entire asset class could be sold for that sum, which is completely impossible. The error involved here is the application of *marginal* transaction prices to the *aggregate* of stock.

Property is an appropriate example, because we are often treated to the proposition that real property prices can never fall because 'demand is always increasing as population numbers expand'. The mistake made in such glib statements is the conflation of 'demand' with 'want'. You or I might 'want' a new sports car, but that 'want' only counts as *demand* to the extent that we have the wherewithal to implement it. Likewise, 'wanting' or 'needing' a home does not count as 'demand' unless prices are within the reach of those who want or need one.

It's much more meaningful to think of asset prices as the inverse of the cost of capital. What this in turn means is that *stock* – not just of asset values, but of liability viability as well – is a temporal function of economic *flow*.

This leads us, as a precursor to measuring prosperity, into a consideration of what really constitutes economic 'output'.

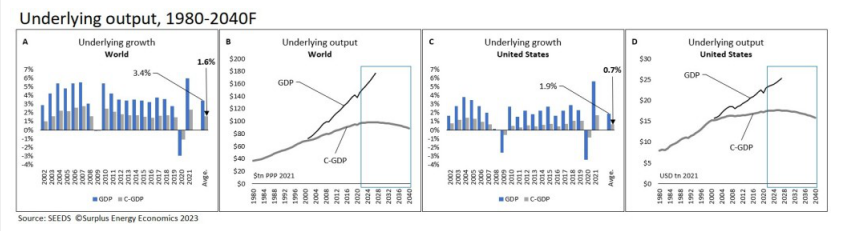
Underlying output

As we have seen, much of the economic 'growth' of recent times has been created by credit expansion. The SEEDS economic model strips out this 'credit effect' to calculate underlying or 'clean' economic output, known here as *C-GDP*.

This is illustrated in **Fig. 2**. On this adjusted basis, underlying annual average growth in the global economy between 2001 and 2021 was only 1.6%, rather than the reported 3.4% (Fig. 2A).

Over this period, the expansion in C-GDP was only $27tn, or 39%, rather than the reported increase of $73tn, or 101% (Fig. 2B). Put another way, within total reported growth in the global economy over those two decades, only 37% ranks as organic expansion, and the remaining 63% was *the cosmetic effect of pouring huge amounts of borrowed money into the system*, and counting the ensuing transactions as 'output'.

Fig. 2



We can 'cut to the chase' here by looking back at Fig. 1A and asking ourselves whether the

pattern illustrated there is sustainable – in other words, can we carry on, indefinitely, adding more than $3 of debt for each $1 of "growth", or does a point arrive at which it becomes apparent that this debt can never be repaid?

When that point does arrive – which, of course, it must, and perhaps now *has* – the result is a collapse in confidence, which happens at the moment *when enough people realize that debts and other commitments owed to them cannot be honoured 'for value'*. This will trigger defaults, which may be 'hard' (reneging on debts), 'soft' (allowing inflation to destroy the real value of debt repayment), or a combination of the two. Since one person's debt is another person's asset, there is no cost-free way of simply writing off outstanding debts.

One thing is certain – we cannot create *material* economic value by borrowing, or by producing new money out of the ether.

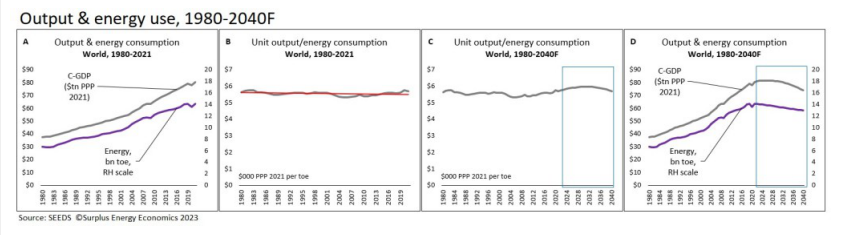
The energy connection

For most purposes, the SEEDS calculation of C-GDP commences in 2000 – as we scroll back through the 1990s and beyond, necessary data for some economies is not available, and starting more than two decades ago provides a sufficiency of historic information for our purposes.

In a recent exercise, though, the SEEDS clock on global C-GDP was started, not in 2000, but in 1980, and the results of this investigation, when compared with energy use, were startling. As illustrated in **Fig. 3**, the relationship between underlying economic output (C-GDP) and primary energy consumption was not just linear but strikingly consistent (Fig. 3A).

The *ratio* of economic output and energy use, shown in Fig. 3B, *didn't vary by more than +/- 4% in any one of the forty-two years between 1980 and 2021*. Given the vicissitudes experienced in both the economy and the supply of energy over that very lengthy period, this consistency is remarkable (and was completely unexpected before the calculations were made).

Fig. 3



This finding might seem surprising, because it implies that there has been no improvement, over a very long period, in the efficiency with which energy is converted into economic value.

There are a number of possible explanations, and these might repay investigation in the future. Just one of these may be that advances in efficiency are cancelled out by deterioration in the quality of *non-energy* raw materials. In minerals, for example, a decline in ore densities could easily offset any progress made in the efficiency of extraction and processing.

Be that as it may, the clear implication is that **we cannot "de-couple" the generation of**

economic value from the quantitative use of energy. As you may know, the European Environmental Bureau dismissed the concept of de-coupling in a 2019 paper entitled *Decoupling debunked: Why green growth is not enough*. The report remarked that the case that has been made for de-coupling is "a haystack without a needle".

Energy itself will be addressed later in this series, but the general conclusion is that the availability of primary energy is poised to decrease, mainly because the supply of alternatives, such as renewables, nuclear and hydroelectricity, will not be able to expand at rates sufficient to offset the impending decline in the production of fossil fuels.

From an environmental perspective, this is positive, but we should be in no doubt at all that a decreasing availability of primary energy means that economic output will contract. The economic outlook suggests broad re-prioritization, and this might provide a modest, and probably transitory, improvement in conversion efficiency (see Fig. 3C). But we should be in no doubt that **reduced energy use will result in a smaller economy** (Fig. 3D).

Starting from first principles, we have seen how economic output is a linear function of the energy available to the system. In the next article, we'll look at how the cost of energy feeds into these equations, and how we can conclude – whisper it who dares – that prior growth in material prosperity has gone into reverse.