Here Comes The Sun – There Goes The Ice, spelled out in semaphore by artist Chris Wainwright, using the Arctic dusk as his canvas.

THE FUTURE IN PRACTICE

THE STATE OF SUSTAINABILITY LEADERSHIP 2012

2052: A global forecast for the next forty years

Professor Jorgen Randers

UNIVERSITY OF CAMBRIDGE
PROGRAMME FOR SUSTAINABILITY LEADERSHIP

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If I could persuade you of one thing, it should be this: the world is small and fragile, and humanity is huge, dangerous and powerful. This is a total reversal of the biblical perspective on humanity, and the way in which man has thought during most of his presence on Earth. But this is the perspective we need to take if we're to be sure that sustainability emerges or, at least, that the world as we know it survives for a couple of hundred more years.

I have spent the past four decades trying to make the world a sustainable place, preaching about what ought to be done from all kinds of different positions. Last year, I succumbed to the temptation to try to think through what will happen over the next 40 years. Not what I would *like* to happen, but what the parliaments and voters and semi-authoritarian regimes of the world will actually do. How is that future going to look? This is, of course, much

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This article is adapted from Professor Randers' lecture in the 10th Annual Distinguished Lecture Series in Sustainable Development, hosted by the University of Cambridge Programme for Sustainability Leadership and the Centre for Sustainable Development in the Department of Engineering on 14 March 2012. It is based on his most recent book, *2052: A Global Forecast for the Next Forty Years* (2012) – also a report to the Club of Rome – with permission from Chelsea Green Publishing, www.chelseagreen.com. *2052* is distributed in the UK by Green Books, www.greenbooks.co.uk. All figures in this article are extracts from *2052*, and the data is also available at www.2052.info.

less of a scientific activity than the type of scenario analysis I commonly do; it is educated guesswork. This article is about what I found in my crystal-ball-gazing exercise.

The danger in forecasting is, of course, that if one sees something ugly coming up it might demotivate the constructive forces trying to create a better world. The main reason why I still wanted to look ahead was because I have only about 20 more years to live, and I want to optimise my remaining years rather than continuing to struggle in directions which might be hopeless. So, partly, *2052* was written for my own purposes. Secondly, I am so old that I've started to evaluate the effect of how I've spent the past 40 years, and I'm fairly sceptical about what we old gentlemen who created and ran the environmental movement have been able to achieve. But in order to make that assessment properly, one needs to know what will happen over the next 40 years, to see the effort in full perspective. Finally, I hope my analysis can be used for something constructive. Once you know what will happen, it's much easier to derive where one should put in one's own little effort in order to create a better future. Instead of working against something which may be hopeless, you can try to concentrate on an area where you might trigger some serious results.

My forecast is internally consistent and draws on a broad base of knowledge, with a strong sense of causality; I think I understand *why*

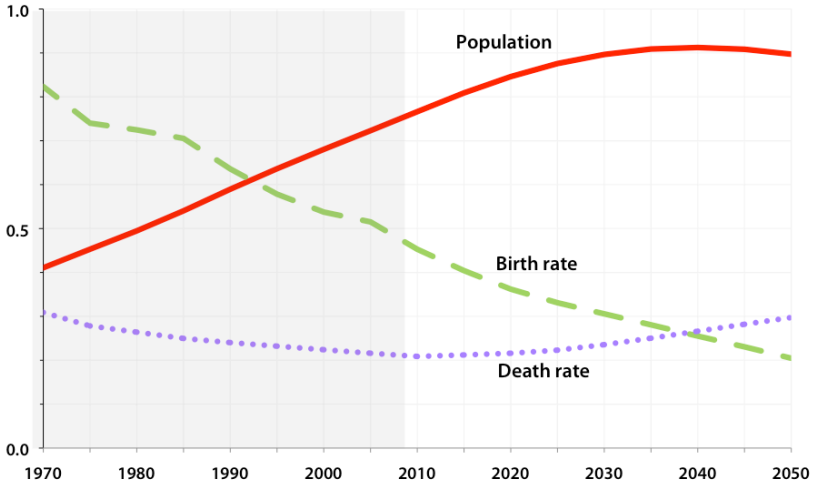

Figure 1: World Population 1970–2050. Scales: Population (0–9 billion people); birth and death rate (0–4 per cent per year).

I don't like what I see. This is not the world I would have created if I were in charge. It is not the kind of future I have been working for all along.

fertility develops the way that it does, *why* societies only invest 25 per cent of their GDP, and so on. I have also had advice and criticism from world-class experts. But while my forecast is as good as I can make it, forecasting is not a scientific activity. Things could happen tomorrow to put us on a totally different path; nothing is totally fixed. We will see in 40 years if it was worth the effort.

One final introductory comment: I don't like what I see. This is not the world I would have created if I were in charge. It is not the kind of future I have been working for all along.

So let me walk you through the future, as logically as I can. Most of the graphs which follow cover the period 1970–2050, based on a spreadsheet model which describes the world as a sum of five regions. The shaded area to the left represents historical numbers, and my forecast appears to the right. I'll address population, world GDP, wealth and investment, resources, food, water, energy, temperatures, and wilderness over the next 40 years.

Future population

When people think about the future, world population often comes first. My forecast, as you can see in Figure 1, is that the population will peak in 2040 at 8.1 billion people, and then start to decline and continue declining throughout the second half of this century. This is very low compared to the UN forecast, which talks about 9 billion people in 2050 and numbers rising from there. I have such a low forecast because I think fertility trends will continue downwards at the stupendous rate that has occurred over the past 40 years.

The number of children per woman throughout her reproductive years used to be very high, but this is falling very quickly due to the education of women, increased urbanisation, and more easily-available contraception.

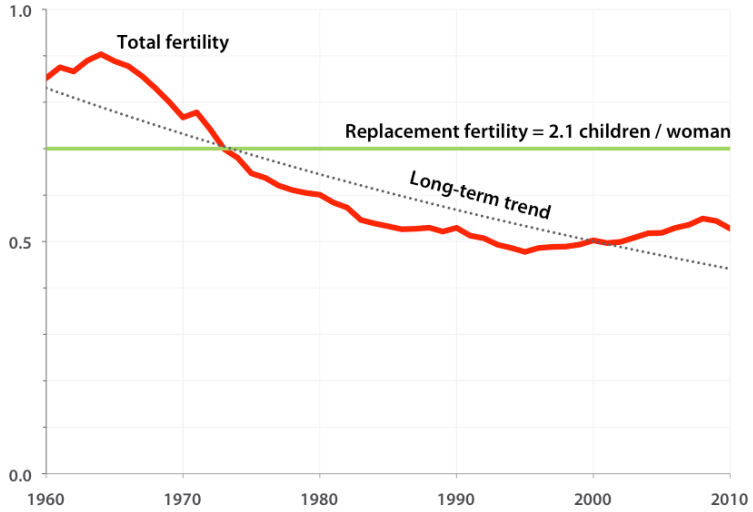

Figure 2: Fertility decline in EU15, 1960–2010. Definition: Total fertility = number of children born to each woman on average throughout her reproductive life. Scales: Total fertility (0–3 children per woman).

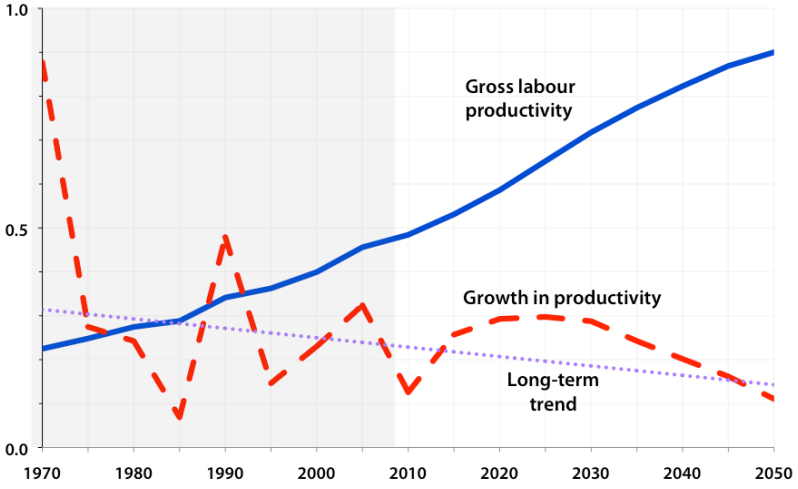

Figure 3: World gross labour productivity, 1970–2050. Definition: Gross labour productivity = GDP divided by people aged 15 to 65 years. Scales: Gross labour productivity (0–20,000 US$ per person-year); growth in productivity and long-term trend (0–7 per cent per year).

Even poor people (I mean this ironically, of course) are wise enough to understand that having a large family is not a good idea when you live in an urban area. It was a good idea to have many children in the countryside when people were farming their own food, but it doesn't work in cities. You can see this already in existing fertility statistics, which are coming down very rapidly.

The downward trend in fertility is countered by increasing life expectancy. In my forecast, life expectancy rises to around 75 years as a world average by 2050, because I think medical progress is going to continue over the next 40 years. But the effect of declining fertility is stronger than the effect of rising life expectancy, which means the global population will actually plateau around 2040. This may be surprising to you, but we have already seen a decline in the Japanese population, for example, for a decade because of this combined effect. Furthermore, Germany is already plateauing. Among the rich countries it is only nations like Norway and the USA, with wide-open borders and a lot of immigration, which still have rapid population growth. China's population will peak in 2030 because of the continuation of Deng's wise one-child policy, which will help solve China's biggest problem: how to create a sustainable society within the country's borders. The reason why the death rate rises in Figure 1 is that the number of old people will rise faster than the rise in life expectancy over the next 40 years.

For those of you who doubt my central assumptions here, Figure 2 shows fertility in the EU15 over the past 50 years. When total fertility falls below 2.1 children per woman, the population will decline in the long run, and this has been the case in the EU since 1970. Had it not been for immigration, the population would have been declining. Extreme cases like Italy, for example, have had a fertility rate of 1.3 for decades. Italian women don't want to have children because it's difficult to combine children and a job in Italy; then, experience shows, women overwhelmingly choose to have a job. So things are already developing along the lines of my forecast.

Future world GDP

Next, people are generally interested in world GDP. What will be the total global production of goods and services? The way I calculate future GDP is to take the number of people who can work – say, everyone between 15 and 65 – and multiply this number by how much each of them produces per year. The upper curve in Figure 3 is the aggregated productivity, the gross output of goods and services per person in the potential workforce. I predict that the output per person will continue to increase, but at a declining rate, and that it will level off around 2050.

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If you multiply a workforce which is declining with a productivity that reaches a plateau, you get a GDP which will plateau around 2050 and then start to decline. This is what happens in my forecast: something no Wall Street or City analyst would ever dare to think about. The world production of goods and services levels off, and finally – in the second half of the century – starts a continuing decline.

Why is the growth rate in productivity declining? The reason is that when an economy matures, all the people who were initially working in agriculture shift into manufacturing, and then onwards to service production. Then, as an economy gets really rich, like in Norway and the US today, most people end up working in services and ultimately in social care. Finally, you get to a point where there are so few people in agriculture, forestry, fisheries, and manufacturing that any productivity increase has to occur in services. But increasing productivity in offices, research groups, universities or care homes isn't easy. So the productivity rise slows once you move towards a mature economy.

In Figure 4, for example, you can see that in the early 1950s the US economy was growing at 4 per cent a year. (The trend is more important than the fluctuations around it.) Now that the US economy is more mature, you can see that the trend has come down to below 1 per cent a year. If you extend the forecast to 2020, there will be no productivity growth. And the US is the world's most productive economy, so it shows where everyone else will end up.

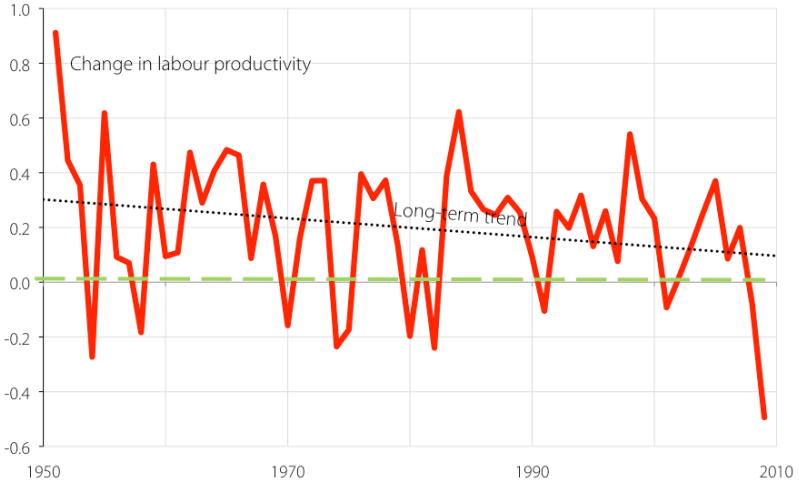

Figure 4: US gross labour productivity, 1950–2010. Definition: Labour productivity = GDP divided by people aged 15–65. Scales: Change in labour productivity (-6.0 to 10 per cent per year).

It's not only the City analyst who will worry about my forecast of slowing economic growth in the rich world over the coming decades; most people feel that growth is desirable. The fundamental reason why most people favour growth is that it is the only way modern society has found to solve three problems effectively: poverty, unemployment, and pensions. Economic growth reduces poverty at the national level by increasing average labour productivity. Growth furthermore increases total employment, and providing new jobs is the only politically-feasible technique to achieve the large-scale redistribution of income in a capitalist society: if you have a job, at least you get a piece of the total pie. Thirdly, growth is needed to fund pensions, especially in an ageing population.

If society were to get away from growth, it would need an alternative which simultaneously eliminated poverty, solved unemployment and provided adequate pensions. That alternative is not obvious, hence society pursues old-fashioned economic growth. Another solution could be to stabilise GDP and distribute that finite production in an equitable manner. This would take a wise populous! The majority would have to resolve that, rather than expanding the production of goods and services every year, they would instead keep production constant, taking increasing amounts of leisure time, and redistributing outputs. They would deliberately shift work and income from those who have a job, and give to those who don't. It's doable, but is very unlikely to happen at scale during the next 40 years. Authoritarian regimes like China might succeed, that is, create employment in spite of the market; and some will do so with positive results. But in free-market democracies it is unlikely that large-scale redistribution will happen in a peaceful

Over the next 40 years, in addition to all the resource, pollution and inequity problems that we have already, humanity will run into more problems of depletion, pollution, adaptation and repair of climate damage, because we will be trying to fit an excessive amount of activity on to a small globe.

manner. As a consequence, these societies will continue to strive for growth – but with less and less success.

Returning to my growth predictions, the industrialised world (Europe, Japan, Australia, New Zealand and the mature East Asian tiger economies) will follow in the tracks of the United States, with gradually declining growth rates. China and other successful emerging economies will catch up, but while these latter countries are capable of showing very high economic growth rates for a while, these too will decline as they catch up with the old industrial world. You can already see this happening in China: in the current Five Year Plan, the planned growth rate has been lowered from something like 10 per cent per year in the past to 7.5 per cent in the future. I am afraid I believe that the poorest region I look at, containing the world's poorest 2 billion people, will continue to experience the same slow growth in the next 40 years as it did over the past 40, and therefore still be rather poor in 2052.

In summary – and everything else follows from this view – the world population will grow for a while, but stagnate at some 8 billion people around 2040 and then decline. Global GDP will continue to grow, but not at the rates we have been used to in the past; and the total world economy will stabilise after the middle of this century, passing 2.2 times current GDP in 2052.

Future investment share of GDP

In rough terms, world GDP will double in the next 40 years. Global society will be producing roughly twice as many goods and services, and since the population will only grow from 7 billion to 8 billion, average consumption per head will go up.

But there is one very important and third central idea in my forecast: a substantial increase in the fraction of GDP which will be required for investments in infrastructure and the like – the 'investment share' of GDP. Over the next 40 years, in addition to all the resource, pollution and inequity problems that we have already, humanity will run into more problems of depletion, pollution, adaptation, repair of climate damage, etc, because we will be trying to fit an excessive amount of activity onto a small globe. At first, society will pretend that the problem does not exist. Then, after a while, we will start understanding that the problem is real – for example, that there isn't any cheap conventional oil left. At that time we will (grudgingly) put up the necessary money in order to get oil from the Arctic, from a great depth, or from shale oil.

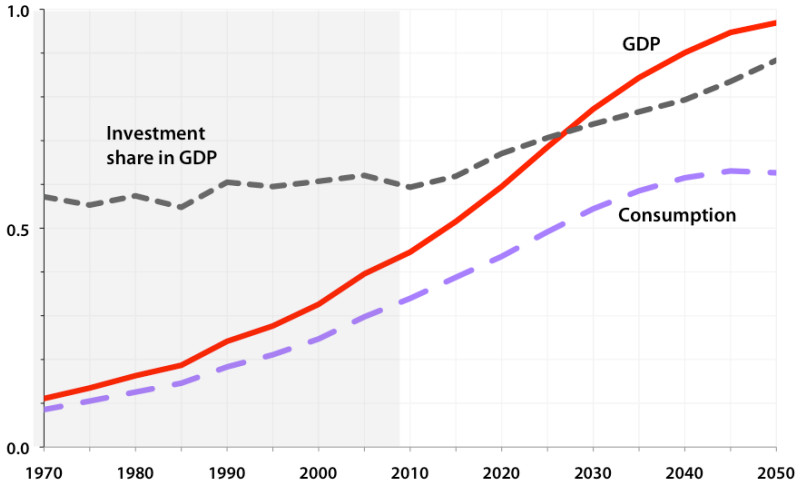

Figure 5: World production and consumption, 1970–2050. Scales: Consumption and GDP (0–150 trillion US$ per year); investment share (0–40 per cent).

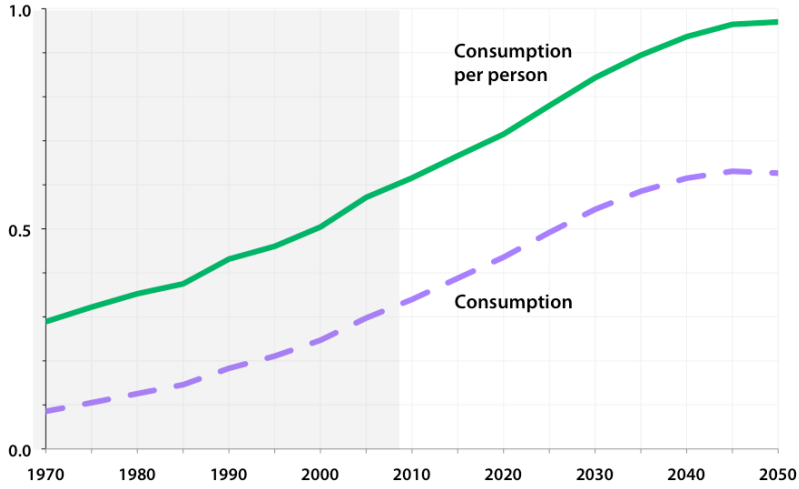

Figure 6: World consumption per person, 1970–2050. Scales: Consumption per person (0–12,000 US$ per person-year); consumption (0–150 trillion US$ per year).

Similarly, once climate damage destroys homes and infrastructure it will be necessary to spend funds on reconstruction. And the same with pollution damage. When CFCs destroyed the ozone layer, money was allocated to the invention of new technologies, and to build new factories to produce a substitute.

So I believe we will be facing an increasing number of problems over the next 40 years, and that society will respond by making investments in order to try to get rid of these problems. I have tried to estimate how much this will cost. World GDP can be divided into consumer goods (the goods and services that we consume each year in order to be happier) and investment goods (the things we produce in order to have consumption in the future). As you can see from Figure 5, the investment share of spending has been around 25 per cent of GDP over the past 40 years – amazingly stable. We consume three quarters, and invest one quarter in infrastructure to support future consumption: roads and factories, ships, anti-pollution equipment, education and so on. Lord Stern has estimated that dealing with the climate problem will cost around 1–2 per cent of GDP. This means that we will need to invest 26–27 per cent of future GDP to live in a world without climate damage. Adding in all the other things we need to spend money on, such as more expensive energy systems which don't run on fossil fuels, I predict that in an extreme case we might have to increase the investment share up to about 40 per cent. This growth in investment, of course, means that consumption will not grow as rapidly as GDP.

What about future employment? Luckily the number of jobs is not governed by consumption alone. You also need people to produce investment goods and services. Total employment is governed by GDP, and thus increases irrespective of whether we increase the production of toys for kids or of offshore oil platforms. Both consumption and investment involve jobs. The difference is that in the first instance, you produce a consumer good which people enjoy in the short-term. In the second case, you produce a future income stream which will make people happy in the future instead. So my forecast is that we will shift more of the world's labour and capital away from the production of consumption goods and services, towards the production of investment goods and services. That means that disposable income will not grow as fast as it would otherwise. This is illustrated in Figure 6, using consumption per person.

This graph shows the global average, but hides surprising results at the regional level. For example, per capita disposable income in the USA will stagnate over the next 20 years, and then go down for the following 20 years, in spite of continued hard work by its people. The decline will not be associated with unemployment; the decline in purchasing

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power will occur because the US will have to use a much larger portion of its workforce and its capital on investment goods, rather than on the production of consumer goods. The same thing, more or less, is the case with Europe, but Europe is in a slightly better starting position because it doesn't have a huge debt like the US.

Future resources

Many people believe that there are not enough resources – minerals and crops – in the world to solve the problems we face. I disagree. It seems to me that, luckily, because of much slower population and economic growth over the next 40 years, we will have enough of everything to maintain the expansion. In *2052*, I calculate the 'non-energy footprint' of humanity. This is the amount of land needed to maintain our current standard of living: crop land for food, grazing land for meat, forest land for wood, fish banks for fish, and the land we use for infrastructure and urban areas. Luckily, this non-energy footprint is well below the amount of available land, which I refer to as the world's 'biocapacity'. It is true that the amount of surplus unused biocapacity is being reduced (see Figure 12, below); and, yes, this discussion of land use disregards the climate effect, which must be included in the full footprint. But as long as we limit ourselves to physical land, there seems to be enough for the next 40 years.

Beyond that, around 2050, I expect us to start seeing the destruction of the global ecosystem. Our current ways are not sustainable in the long run. But my forecast only examines the next 40 years.

Many people seem to believe that limited oil is going to stop expansion. I think not. The production and use of conventional oil, measured in million tons of oil per year, already peaked in the early 1980s. Total oil consumption, however, of course continued to grow: humanity simply moved from the most easily available conventional oil, which you got in Texas or in Saudi Arabia by literally sticking poles in the ground, to less accessible deep offshore oil, which requires expensive investments in monstrous platforms. These days, unconventional and expensive shale oils are also entering the picture.

In my forecast there will be enough oil to cover demand, but the cost of producing it will go up, and so will the costs of production in terms of environmental damage. Furthermore, demand will stagnate and then decline as renewables take over. So I don't foresee a real oil crisis, nor do I see any other resource crises on the horizon. I only see a shift from cheap materials to more expensive substitutes, and luckily, it looks as if the shift is going to be fast enough to avoid the type of shocks that might derail the whole system. But once again, this 'optimistic' forecast is a consequence of the slow global growth I expect in GDP over the next 40 years.

Future food

On the food side, what do I think? There will not be enough food to avoid starvation completely, but there will be enough food to feed those who can pay. The world can produce very much more food than it does today. The reason it does not is that the world's hungry cannot pay what it takes to convince farmers to make the extra-cheap food they require. In other words, our ability to produce a lot of expensive food does not solve the problem of those who starve. There are currently some two billion relatively poor people in the world. In my forecast, there will be about the same number in 2050. This is one negative side effect of slower economic growth: in the next 40 years, growth will primarily be in China and in the big emerging economies. In the rest of the world, many will stay poor and unable to buy enough food.

Those who can afford food will eat better and better, while the poor will remain hungry… Starvation is the effect of skewed income distribution, not a physical lack of food.

Agricultural land use has, more or less, been constant for the past 40 years; it will increase a little over the next 40 years because there is land in Brazil, the former USSR, and elsewhere. So we have land available, and as the purchasing power of the Chinese continues to increase, there will be increased food production. This will be done by increasing yields by adding more fertiliser, irrigation, and GMOs. If we take food production (the red line on Figure 7), and divide by population, you see that food production per person (the blue line) will also go up – at least a little. Presently, the average food per capita in the world is 2–3 times subsistence levels. So, we are already at a fairly high average food production, and this

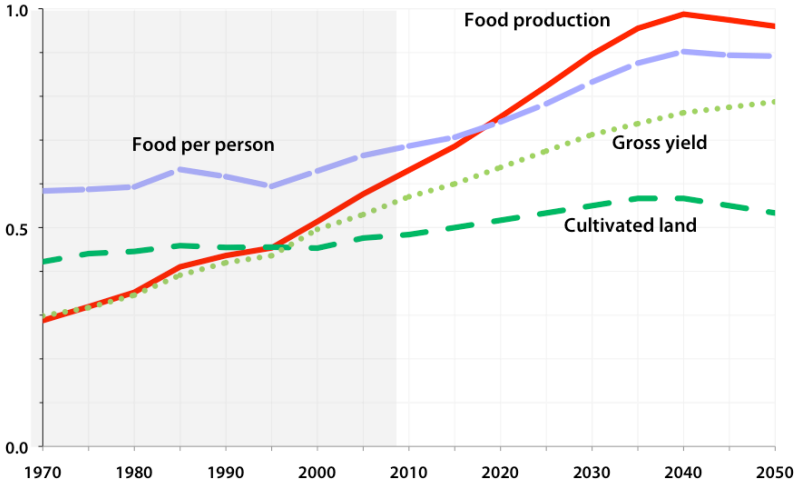

Figure 7: World food production, 1970–2050. Scales: Food production (0–10.5 billion tonnes per year); cultivated land (0–3 billion hectares); gross yield (0–8 tonnes per hectare-year); food per person (0–1.4 tonnes per person-year).

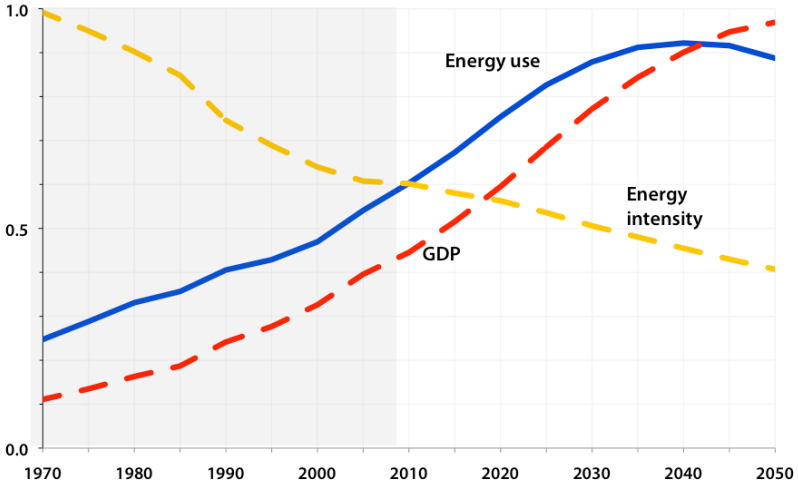

Figure 8: World total energy use, 1970–2050. Definition: Energy intensity = energy use divided by GDP. Scales: Energy use (0–20 billion tonnes of oil equivalent per year), GDP (0–150 trillion US$ per year); energy use per GDP (0–300 tonnes of oil equivalent per million US$).

The emerging water scarcity will come to an end once you put a price on irrigation water. Water will no longer be used in the wasteful ways that it is at the moment.

average will rise. This means that those who can afford it will eat better and better, while the poor will remain hungry, due to a lack of income. Of course, I don't like this, but this is what I foresee.

Future water

The next question that people typically ask is about irrigation water. My view is that the emerging scarcity will come to an end once you put a price on irrigation water. Water will no longer be used in the wasteful ways that it is at the moment, and desalination will enter the picture at even larger scale.

But won't that affect the price of food? Yes, it will affect the price of food. Does that mean that a lack of water for irrigation is going to lead to more starvation? Yes. But we would have starvation even if water remained as cheap as it is now. Starvation is the effect of skewed income distribution, not a physical lack of food.

Future energy

Once I have my forecast for future GDP, it is simple to make a forecast for energy use, based on the assumption that energy per unit of GDP – energy intensity, the yellow line – will continue its downwards trend, as shown in Figure 8. I forecast that the energy efficiency improvements we've seen over the past 40 years will continue. I assume that engineers will succeed in making cars, houses and industrial plants that use ever less energy per unit of output, so we'll continue the reduction in the amount of energy we use per dollar of GDP. To obtain future energy use (the blue line), I multiply my GDP forecast with future energy per GDP. This produces something interesting: the energy consumption of the world is going to peak around 2030 – very soon. When I die, the peak will roughly have been reached, and

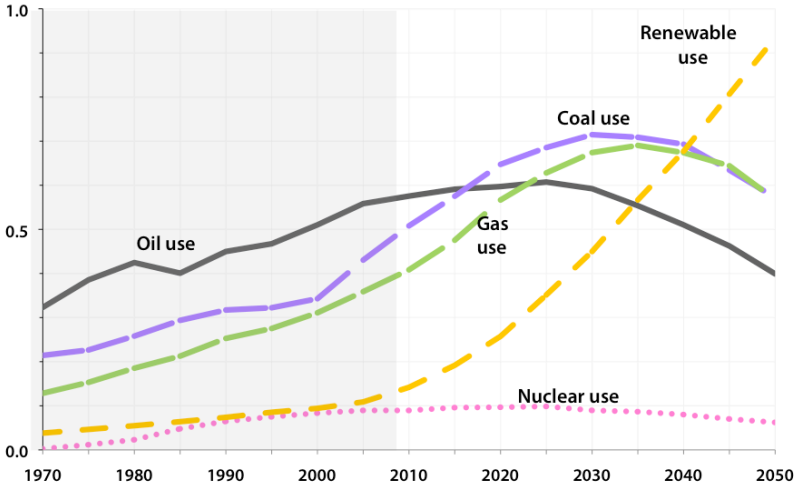

Figure 9: World energy use by type, 1970–2050. Scales: Energy uses (0–7 billion tonnes of oil equivalent per year).

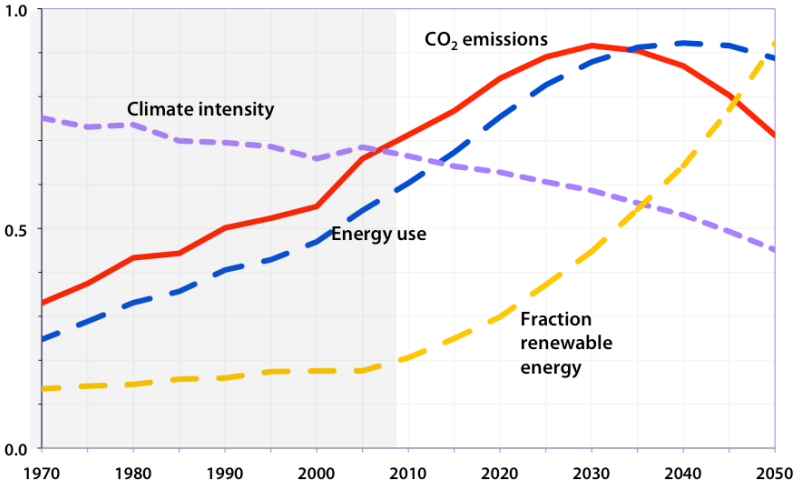

Figure 10: World $C0_2$ emissions from energy use, 1970–2050. Definition: Climate intensity = CO_2 emissions divided by total energy use. Scales: CO_2 emissions (0–45 billion tonnes of CO_2 per year); energy use (0–20 billion tonnes of oil equivalents per year); climate intensity (0–4 tonnes of CO_2 per tonne of oil equivalent); fraction renewable energy (0–40 per cent).

then the annual use of oil, coal, gas, and wind etc will start to decline. This follows directly from my forecasts of GDP and energy intensity.

Figure 9 shows what kind of energy sources we will be using: oil, coal gas, nuclear or renewables. Coal use will expand dramatically over the next 20 years. This is largely because of China and the big emerging economies. Total oil use – the sum of conventional oil and unconventional oil – is very close to its peak, as mentioned above. I think there will be a 20-year period of flat consumption before it declines. 'Peak oil' will occur, but not as a sharp peak.

Gas will increase dramatically, because this will be the cheapest and most politically-expedient energy source in many industrialised countries like the UK and the US. Particularly in countries which tend to postpone difficult decisions, new generating capacity will not be built until there are brown-outs. When brown-outs are a fact, the fastest thing to do is to build new gas-powered utilities. They can be ordered and built within two years, and this is the backstop solution that is probably going to happen in the UK and in many other places. In the US, utilities running on shale gas are currently much cheaper than the nuclear alternative. This will accelerate the rapid shift to gas. Gas is better than coal because it emits one-third as much CO_2 per kilowatt-hour. Gas also has a beneficial future use as a back-up for intermittent sources like wind and solar, for when it's night or the wind doesn't blow.

I forecast a tremendous increase in the installed capacity of wind, solar and biomass energy, but in 2050 renewables will still only make up around 40 per cent of total energy consumption. In my forecast, nuclear faces decades of slow decline. By 2050 there will be few nuclear plants in the industrial world. Most of those plants are currently in the US and the UK, France, and Russia. Forty years down the line they will largely have moved to China, India, Pakistan and the big emerging economies.

Once I know future energy use, I multiply the use of each energy type with its CO_2 emissions per ton of oil equivalent. This gives me the central variable in international climate change negotiations: global CO_2 emissions per year. This is the red line in Figure 10. The right-hand part of Figure 10 is my forecast for what will come out of the ongoing negotiations, which, as far as I can understand, will go on for another 20 years with little result. You can see that CO_2 emissions will not peak in 2015, as is required to keep global warming below 2°C, but around 2030, and then decline fairly rapidly. Interestingly, emissions in 2050 will be more or less the same as they are today. The agreed UN goal is to halve 1990 emissions by 2050. My forecast is that we will not reach that goal.

Future temperatures

If you take my CO_2 forecast and you put it into one of the climate models, you can see how warm it's going to get in my future.

That's the red line in Figure 11: a rise in global temperatures of more than 2°C in 2050 relative to pre-industrial times. Out of curiosity, in my research I also looked further ahead: I assumed that CO_2 emissions will reach zero in 2100, by which time we will have phased out all use of coal, oil and gas. The climate model I used gave me a peak temperature of plus 2.8°C in 2080.

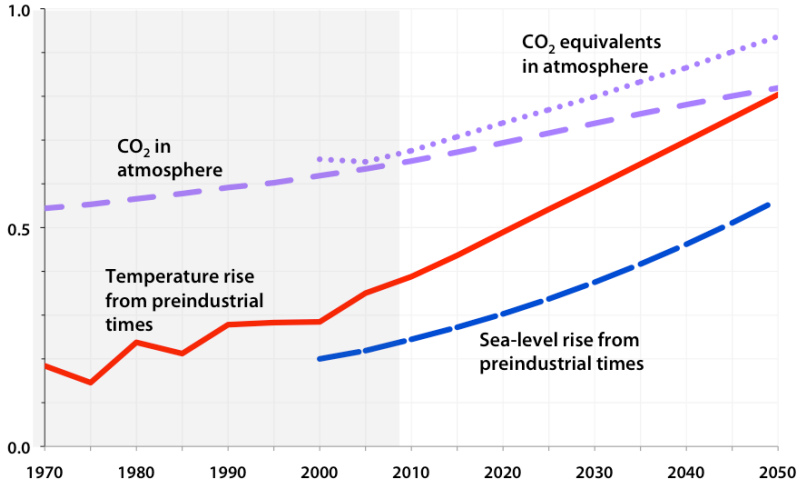

Figure 11: World climate change, 1970–2050. Scales: Temperature rise from pre-industrial times (0–2.5°C); sea level rise from pre-industrial times (0–1 metre); CO_2 in atmosphere (0–600 parts per million); CO_2 equivalent in atmosphere (0–6000 parts per million equivalent).

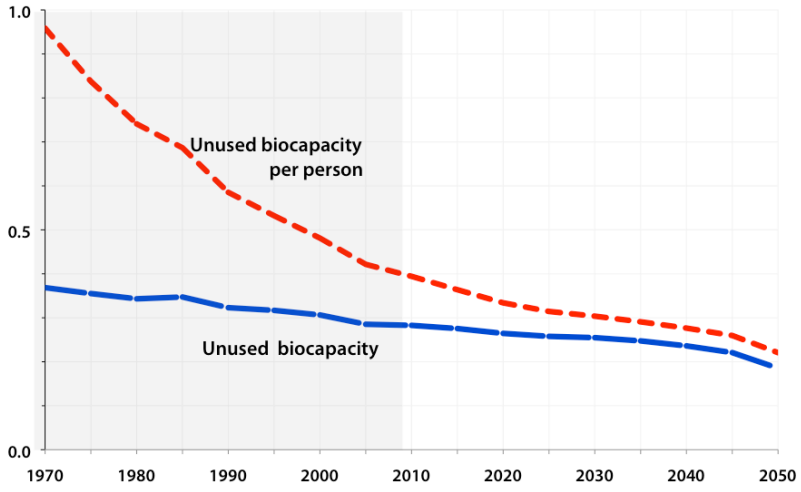

Figure 12: World biological capacity, 1970–2050. Scales: Unused biocapacity (0–12.5 billion global hectares); unused biocapacity per person (0–1.3 global hectares per person).

In free-market democracies it is unlikely that large-scale redistribution will happen in a peaceful manner. As a consequence, these societies will continue to strive for growth – but with less and less success.

We don't know for sure, but plus 2.8° may well be a problem. Global society has agreed that 2°C might be OK; plus 2.8°C might melt the Tundra and start self-reinforcing climate change. Oceans will continue to expand, and will be up another foot over these next 40 years.

Future wilderness

People like me love the wilderness, the forest and untouched nature. Will there be anything for us tree-huggers in the future?

In Figure 12, I've taken the unused biocapacity, the biologically-productive areas of the world that are not being used for human purposes, and divided them by the number of people. This is my (very approximate) indicator for how much wilderness there will be for each of us. It's going down pretty rapidly, so in 2050, I am afraid there will be no real nature outside parks. Most untouched nature will be inside protected areas. Everything outside will either have been cut down or used for agriculture or urban areas.

We will also have the problem of rising temperatures, which will move the climate zones some five kilometres per year towards the poles: northwards in the northern hemisphere and southwards in the southern hemisphere. This means the ecosystems will escape the carefully-made national parks, which sit still. For me, the tree-hugger, this is very sad, but completely unstoppable. The only good thing is that most of the damage, the serious damage, has already occurred. Untouched forests have already been reduced dramatically in area, and coral reefs are already being bleached. Luckily I don't see any other

Rising temperatures will move the climate zones some five kilometres per year towards the poles. Ecosystems will escape the carefully-made national parks, which sit still. I don't see any huge, sudden biodiversity collapse, just the sad continuing impoverishment of all things natural.

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A mild crash with global limits

So, in sum I don't expect a global collapse within the next 40 years. The world will continue, more or less, its sad ways, building towards a climate crisis – which will not, however, reach full bloom until the second half of the 21st century. The world economy in 2050 will be much smaller than most people expect, and many will be less well-off than anticipated. This relative poverty will occur in two areas: in the rich world the majority will be poorer because we won't have much economic development over the next 40 years, and in the poorest parts of the world, there will be many poor because we won't have succeeded in lifting their incomes substantially.

Another effect of the smaller GDP is a beneficial one, namely that the ecological footprint of humanity will be smaller than it would otherwise have been. So, in many ways, we will not hit the resource ceiling and the pollution absorption capacity of the world with as high a speed as we once feared. The crash into global limitations will be further softened by rising investment to counter depletion, pollution and other ills. Thus, global society will, to some extent, be rational and start to meet the challenges; but this will limit growth in disposable income. Citizens of the rich world will not be very much richer in 2050 than today.

The root cause: short-termism

Personally I am saddened by this forecast, because it is so absolutely unnecessary. Global challenges could be solved if we only pulled ourselves together and decided to do something. This is particularly true for the climate problem. We already know the technologies that can cut greenhouse gas emissions sufficiently to avoid dangerous warming. These technologies are more expensive than the traditional solutions, but not very much so. It will only cost one or two per cent of GDP to make the shift to a climate-friendly future.

So why don't we do this? The root cause, as I see it, is the fact that human activity is dominated by short-term considerations. Neither the capitalist system nor democratic society appears to be willing to sacrifice short-term advantage in order to create a better life for our grandchildren. So my sad future will be imposed on us by our own decisions – which largely mean the pursuit of maximum short-term advantage. This short-termism is actually one of the reasons why it is intellectually possible to make a forecast for the next 40 years, because there is a certain stability in the decision-making structure that underlies all the important national and international action. For example, I think the short-termism of voters will stop politicians from agreeing on the type of regulation that could easily steer our capitalist markets to work for the social good – rather than only for maximum profit.

Bluntly speaking, short-termism in democracies and in capitalism will hinder a meaningful response. If we just decided to do something, it could easily be done. The problem is not a lack of technology, nor the economic cost, but the way we have chosen to organise our societal decision-making.

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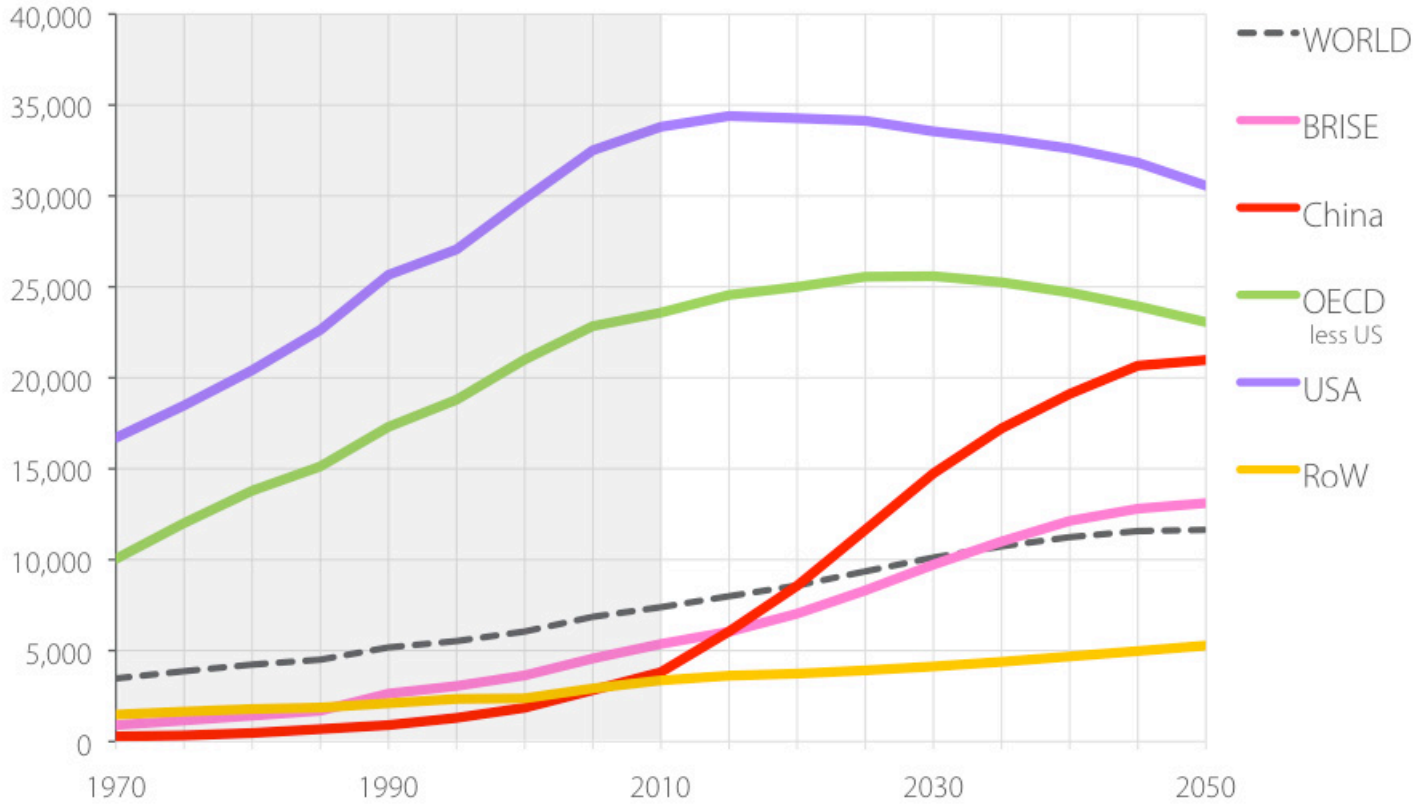

Figure 13: Consumption per person, 1970–2050 (in 2005 US$ purchasing power parity per person-year).

Regional futures

Finally, to make the forecast a little less abstract, Figure 13 shows per capita disposable income (consumption per person) over the past and the next 40 years, for each of the five regions I use in my forecast. Let's start with the red curve, which is China. There will be a tremendous expansion in the income of ordinary Chinese people. Their per capita real disposable income will go up by a factor of about five. By 2050, the red line gets close to the green curve, which is OECD countries except the US. In this part of the industrial world (which includes the UK), disposable income will be more or less the same over the next 20 years. It will perhaps go up a little, and then go down a little. In practical terms, the typical Brit will have an endless feeling that the rent and the gas are always expensive.

The US is in a slightly worse situation, in my book, than the rest of the OECD. As far as I can understand, actual per capita disposable income in the US is already at its peak. It won't get higher, partly because the US economy is the world's most mature, partly because of the nation's huge debt, and partly because of the inability of the US government to make forceful and quick decisions on any issue involving the redistribution of income and wealth. I love the US, but I am afraid its decision-making ability won't improve within my lifetime.

Then, you have what I call 'BRISE': Brazil, Russia, India, South Africa and the ten largest emerging economies, including Thailand and Venezuela. Big things are about to occur there, and I predict they'll do a fairly good job over the next 40 years, doubling or perhaps trebling per capita incomes.

Finally there is the rest of the world, an eclectic mix of some 140 different nations, which I don't think is going to get very far in this period because of a continuing inability to achieve dramatic economic development – for various reasons. These countries will continue to experience slow growth over the next 40 years, as during the past 40.

Actual per capita disposable income in the US is already at its peak… partly because the US economy is the world's most mature, partly because of huge debt, and partly because of the inability of the US government to make forceful decisions on any issue involving the redistribution of income and wealth.

Individual perspectives

So is this good or bad? It depends on who you ask. In 2052, if you ask a Chinese peasant, who is by then living on the 36th floor in high rise number 115 in town 72, he will tell you that the past 40 years have been the most marvellous epoch in the history of China. He will say: "I have this wonderful apartment, I have a view, there's fresh air outside, I have the most unbelievable electronic entertainment, the gaming and the Internet and all. What else could anyone want? I can even, once in a lifetime, go to Rome, although it's very crowded." So from a Chinese peasant's point of view the next 40 years is going to be great.

Then you can ask someone in the manufacturing sector in middle America. If I go there and ask about quality of life today, he says, "I haven't had a raise since 1980." The real disposable income for automobile workers in the US has essentially been constant for 30 years. Workers have not had a raise; the élite has taken almost all of the new added value in the country. If I go and visit the same autoworker 40 years down the line, he will say, "The past 40 years have been endless hell. I am worse off now than I was 40 years ago. My children didn't have as good life as I had in the 1990s. They couldn't buy a decent house in 2010, and have been living in rental." So from the US autoworker you will get a totally, dramatically, opposite story to that of the Chinese peasant.

What do I think a UK office worker is going to say in 2050? Her real disposable income will be essentially the same as it is today, with no real change in the goods and services which she can buy for her money. That means that 40 years down the line, the feeling will be one of stagnation: it has been the same all along, it is still expensive to pay the rent, it is still expensive to get hold of the fuel for your car.

And there will be two new irritating elements. First whenever you take your vacation in the Mediterranean, the Canary Island or Spain, there are these hordes of Chinese and Indians! And second you will hear people say: "Where did all that cheap clothing go? You know, all those cheap goods; everything was so cheap in 2010. You could get a heater and cooker and washing machine for nothing!"

The reason, of course, is that the Chinese, who currently produce these things for us at ridiculously low prices, will by then be five times richer and will only produce expensive stuff. You might ask, why couldn't we get cheap things from those other places that are still poor in 2052? We could, if we managed to engineer economic development in those countries; but I don't think we will.

What to do?

So what should we do about this sad story?

First, have fewer children, and that's particularly important when you're rich. I'll repeat this: my daughter, who is 29 and Norwegian, is the most dangerous animal on the surface of the Earth. She consumes between 10–30 times as many resources and generates 10–30 times as much pollution as an Indian child. So, it's much more important to have one less rich kid than it is to have 10–30 fewer Indians. I'm serious. Population control in the rich world should be the prime focus.

Secondly, reduce your CO_2 footprint. Don't drive big cars, don't drive them so far, don't fly so long, and insulate your home.

You might ask, why can't we get cheap things from those other places that are still poor in 2052? We could, if we managed to engineer economic development in those countries; but I don't think we will.

We don't have strong government... or, to be exact, we don't have support for strong government. Civilised, solution-oriented citizens ought to be in favour of collective action.

Third, support strong government. As mentioned above, most of the solutions to today's global problems exist, and the only reason they're not implemented is that we don't have strong government. Or to be exact, we don't have *support* for strong government. Thus civilised, solution-oriented citizens ought to be in favour of collective action. I think we will see 40 years down the line that it was the Chinese who did, in the end, solve the climate problem for us – through collective action. They will produce the electric cars and the technologies we will need, and they will implement them in China through centralised decisions. Meanwhile, we will be fiddling around with half-baked quota systems that provide insufficient incentives – which might modify development somewhat, but doesn't solve the problem.

And then, fourth and finally, if we want to help the world's poor, we (the rich) should build and pay for a complete clean energy infrastructure in the poor world. This would ensure that they don't have to build a cheaper, carbon-intensive energy system for the energy they sorely need: electricity, fuel and heat. If we did nothing else, that would solve a substantial part of the future climate and poverty problem.

That, my friends, is what I see. I don't like it... but still, feel free to shoot the messenger.

The State of Sustainability Leadership is CPSL's annual thought leadership report, delivering insight and challenge from our world-wide network of business leaders, policymakers and academic experts. This year's edition, to be published in full in December 2012, is focused on the theme of business and the long-term – what leaders can do to understand and shape the future. CPSL is an institution within the University of Cambridge's School of Technology. www.cpsl.cam.ac.uk

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In 2010 the artist Chris Wainwright journeyed with Cape Farewell on an art and science expedition to the High Arctic. Struck by the light against the quickly changing landscape, he used semaphore, the tool of last resort for lost travellers, to spell out his amazement and concern: *"Here comes the sun, there goes the ice"*. CPSL is proud to be working with Cape Farewell, which works with artists and scientists on a cultural response to climate change. www.capefarewell.com