The “green” Kondratieff
– or why crises can be a good thing

A new cycle of prosperity, generated by “symbiotic” growth.
Decisive Insights for forward-looking investment strategies
Content

4 The “green” Kondratieff – or why crises can be a good thing

6 The creative power of destruction

8 Crises as accelerators of structural change

10 Bottleneck factor: scarce resources

11 The sixth, “green” Kondratieff cycle

12 Environment – a scarce resource

14 The environment gets a price tag

15 Green wave of growth

18 “Green tech” – a growth market

23 Summary

Imprint

Allianz Global Investors Europe GmbH
Mainzer Landstraße 11–13
60329 Frankfurt am Main

Capital Market Analysis
Hans-Jörg Naumer (hjn), Dennis Nacken (dn), Stefan Scheurer (st)

Data origin – if not otherwise noted:
Thomson Financial Datastream.
The “green” Kondratieff – or why crises can be a good thing

Climate change and the crises surrounding energy supply security are the final, unmistakable wake-up call for economic and ecological truth. The need for action that is prompted by this call will trigger changes in virtually every area of the economy and lead to a new phase of growth. A cycle of prosperity, which could be characterised by global structural change from parasitic to symbiotic economic growth and/or a sustainable “green” path of growth.

To start with: in the foreseeable future, the markets – especially in industrialised countries – will probably continue to labour under the financial and debt crisis, which will also dampen global economic growth. The crisis could, however, also mark a period of radical change as once characterised by Russian economist Kondratieff. A period of upheaval, where old sectors of industry are replaced by new ones.

**Economic principles – summary**

- The crises that have occurred in rapid succession, the TMT bubble, and the recent financial and debt crisis may be presaging a 6th Kondratieff cycle. Five Kondratieff characteristics that point to a new Kondratieff cycle would seem to be fulfilled:
  1. Potential for further exploitation of an old basic innovation is exhausted (cycle of around 40 to 60 years).
  2. High level of excess financial capital (versus physical capital).
  3. Period of severe recession (period of radical change).
  5. New technologies are overcoming macroeconomic bottlenecks.

- Labour was the foremost economic bottleneck factor in all economic cycles over the last 200 years, whereas the ever increasing shortage of commodities and energy resources could well be the key factors affecting the economy in the 21st century. As such, the next long cycle of prosperity will likely be characterised by two drivers: no longer just enhanced labour productivity, but also, and above all, increased resource and energy productivity.

- A new sixth, “green” Kondratieff cycle, which could be characterised by global structural change in the economy from parasitic to symbiotic economic growth and/or a sustainable “green” path of growth. This is because under the new conditions imposed by globalisation, demographic development, climate change, scarce resources and
greater awareness of, and responsibility towards, the environment on the part of consumers, growth will probably be generated from a new mix of economics and ecology. The crucial reorganisation of energy infrastructure in this respect could prove to be a powerful engine that really gets growth going.

• The dovetailing of the 5th Kondratieff cycle with the 6th Kondratieff cycle, i.e. the connection of information technology with the “green markets” is likely to continue increasing. This new 21st century energy infrastructure will probably be based on five pillars:
  1. Switch to renewable energies
  2. Conversion of buildings into micro power stations (using renewable energies)
  3. Use of energy storage in buildings, cars and within the energy infrastructure
  4. Expansion of a global smart grid system
  5. Transport infrastructure for vehicles powered by electricity and fuel cells

• The power of “creative destruction”, as Schumpeter termed it, will probably gain further strength in the years to come. Overall, the “green-tech” markets will likely cause numerous conventional sectors of industry to fall by the wayside as demand for renewable energies, state-of-the-art environmental technologies, sustainable water management, recycling and more efficient drive technologies should increase. Management consultants Roland Berger estimate that the lead markets in environmental technology already accounted for global sales volumes of some 1.7 trillion US dollars in 2010. Between now and 2020, this volume could soar to 3.2 trillion US dollars, equivalent to an above-average growth rate of 6.5% p.a.
The creative power of destruction

No matter how ironic it may sound, the foremost lesson learned from the crises that have occurred, not just in recent years but throughout economic history since the steam engine was invented at the end of the 18th century, is that crises form an integral part of prosperity. Crisis as the expression of the “discovery mechanism” (Friedrich August von Hayek), which destroys old and creates new. These might be small crises that are perceived as economic fluctuations, or major crises that trigger new cycles of growth. And so we come full circle: The history of our prosperity is also the history of the crises. Every single Kondratieff cycle that can be measured since the end of the 18th century culminated in a crisis that was followed by a long upswing. The widespread prosperity that has emerged over the last 200 years or so is historically unique. It can only be enjoyed by those who live in an “open society” (Karl Popper) that allows crises to happen.²

Five long growth cycles have occurred since the industrial revolution at the end of the 18th century: the surge triggered by the steam engine, which was followed by the new technologies of steel and railways. They were succeeded by chemicals and electrification, which in turn made way for petrochemicals and the automobile. The last wave so far was characterised by information technology and communication. All of these new surges in growth were interrupted by crises, from which the new upswing emerged: Whether it was the panic of 1837, the long depression in the late 19th century, the great depression in the 1930s, or the two oil price crises in the 1970s, the “creative destruction”, as Austrian economist Joseph Schumpeter called it, always marked the beginning of a new phase.

<table>
<thead>
<tr>
<th>Kondratieff cycles</th>
<th>1st Kondratieff</th>
<th>2nd Kondratieff</th>
<th>3rd Kondratieff</th>
<th>4th Kondratieff</th>
<th>5th Kondratieff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invention</td>
<td>Steam engine</td>
<td>Railway, Steel</td>
<td>Electricity, Chemicals</td>
<td>Automobiles, Petrochemicals</td>
<td>Information technology, Communications technology</td>
</tr>
<tr>
<td>Demand area</td>
<td>Clothing</td>
<td>Mass transportation</td>
<td>Mass production</td>
<td>Individual mobility</td>
<td>Information and communication</td>
</tr>
</tbody>
</table>


¹ Russian economist Nikolai Kondratieff was murdered by Stalin in 1938 at the end of the third of the cycles that were discovered by, and named after, him.
What is interesting is that Nikolai Kondratieff discovered that a long cycle of growth which permeated and changed both the economy and society goes through a period of increasing maturity before losing strength and ending in crisis. The newly created infrastructure remains, and the crisis ends and is survived when the next cycle starts its upturn. The upswing is, however, dependent on new basic innovations that become widespread as demand for these key technologies increases. This demand is, in turn, driven by the bottleneck factor of “productivity”. New gains in productivity cannot be triggered until this bottleneck factor has been overcome.

These cycles mark times of enormous change – five long cycles in which technological networks transformed entire societies:

- Old industries were replaced by new ones.
- Corporate cultures and processes changed.
- New professions emerged.
- Extended periods of long-term growth in prosperity resulted.
- These were typically associated with rising equity markets.

In the most recent long-term cycle, for example, the PC and the Internet drove, and will continue to drive, radical changes in many aspects of daily life and work.

And in each of these structural cycles it was the financial markets that triggered the end of a cycle: as a result of excessive speculation, high levels of debt and over-inflated asset price bubbles. At the same time, they act as accelerators of the next upturn.
Crises as accelerators of structural change

At the beginning of a new Kondratieff cycle, entrepreneurs usually require a considerable amount of capital to buy a steam engine, (delivery) vehicle or IT system. Higher interest rates are not an obstacle here, as entrepreneurs increase their earnings by implementing more productive systems. But eventually, after several years, the new technology networks begin to offer diminishing returns on investment. This means demand for credit grows more slowly, and (real) interest rates move towards zero in the end. This was the case in the Panic of 1837, the crash of 1873, the Great Depression in 1929 and the oil crises in 1974 and 1980. And it was also observed in the crises that occurred in rapid succession, the Technology, Media and Technology bubble and the most recent financial and debt crisis.

Kondratieff lists five main characteristics of change that lead to a new Kondratieff cycle:

1. Potential for further exploitation of an old basic innovation is exhausted (cycle of around 40 to 60 years).
2. High level of excess financial capital (versus physical capital).
3. Period of severe recession (period of radical change).
5. New technologies are overcoming macroeconomic bottlenecks.

Closer examination shows that all five of the criteria marking the process of economic reorientation seem to apply to the current financial and sovereign debt crisis:

1. The surge in productivity caused by information technology, which started with the invention of Konrad Zuse’s “Z3” computer in 1941 appears to be slowly coming to an end. An even faster laptop, for example, does not make work processes that much more productive. The Internet has already achieved considerable penetration.
2. Similarly, until 2007, before the outbreak of the financial crisis, there was a substantial surplus of financial capital in the economy. As the credit (derivatives) economy expanded, there was too much money in too little real economy. With the dominance of financial capital over physical capital (sum of property, plant and equipment) investors sought returns in investment alternatives, which they primarily found in loans on US real estate and in financial derivatives. Then the central banks and governments added injections of liquidity. Countries launched stimulus packages to prevent economic meltdown. As a result, public budgets, which were already in deficit, descended even further into the red. The debt mountains grew. Credit ratings were given the thumbs down.
3. The result was a financial and debt crisis that became a global economic crisis, the likes of which had not been seen since 1930. The 9th of March 2009 was a historic day for investors – in a negative sense. On that day, US share prices as measured by the S&P 500 not only hit their low point, but the 10-year performance of the US equity index, with an average return of -8% p.a., also hit its lowest level in 200 years (see Figure 1). And for the first time since World War II, a Western European country – Greece – was officially declared insolvent at the beginning of 2012.

---

4. At the same time, the new globalised world is resulting in new forms of corporate and cross-border cooperation in numerous areas of political, economic and social activity. It is primarily the growth countries that are benefitting from the opening (both politically and technologically) of the markets. Commonly known as the emerging markets, many of them are witnessing the birth of new democracies and new levels of prosperity. Equally, work is currently underway to create a new global financial regulatory architecture that is intended to form the basis for a sustainable economic and financial system. Banks, for example, have to maintain higher levels of equity to underpin their business, and many countries have anchored debt ceilings in their national legislation. At the same, ecological, social and governance aspects ("ESG criteria") are playing an increasingly important role in corporate and investment decisions.

5. Last but not least, the most recent crises — such as the conflicts in North Africa and the Middle East or the reactor disaster in Fukushima – clearly demonstrate the need to focus ever more on guaranteeing a secure supply of commodities and energy. 2011 was an excellent year for demonstrating that, unlike the past, it is no longer a question of producing as much as possible as quickly as possible – with no regard for the burden this might place on debt balances or the environment. On the contrary, the macro-economic bottleneck factor of the 21st century seems to be the scarcity of resources. And that includes the “environment”.

---

**Figure 1: Crises – The Power of Creative Destruction**
Rolling 10-year returns on the S&P 500 since 1814

Not a forecast of future performance of a fund investment.
Bottleneck factor: scarce resources

One thing is certain: over the long term, ever faster, higher and stronger is not going to be an option given the limited commodity and energy resources. In the last 50 or so years alone, global gross domestic product has increased 11 times over. Over the same period, gas consumption increased five-fold, oil nearly three-fold, and coal about 2.5 times over. At the same time, environmental pollution has soared as CO₂ emissions have increased some 400% since 1965 (see Figure).

A look at the growth perspectives in the emerging markets deepens rather than lessens the worry lines. This is where the mega trends of demography, urbanisation and globalisation all come together. According to United Nations estimates (UN Population Division), the world population will increase by 2 billion between now and 2050, of which 70% will live in towns and cities (currently about 50%). The demand for commodities will probably, however, increase not just in terms of quantity, but also with regard to quality. As the new middle class continues to expand, consumption will become more focused on commodities. The middle class already accounts for 140 million people in China and 60 million in India. And it is growing fast: according to a study conducted by the OECD, Asia’s middle class alone will grow by some 1.2 billion people – the equivalent of the entire population in Europe and North America – over the next ten years, whose consumption behaviour will resemble that of the West. (The OECD defines middle class as households with an income of USD 10 - 100 per day.)⁵ So just imagine if every single person in Europe and North America needed a new apartment, new supermarkets, their first ever car – and even had the money to pay for it all. According to McKinsey, 2 billion people in emerging markets already spend 6.9 trillion dollars each year on consumption. In ten years, this figure will have increased to 20 trillion dollars per year, twice what it currently is in the USA. Accordingly, the OECD predicts an increase of 80 percent in global primary energy consumption between now and 2050.⁶

Figure 2: Environment – a scarce resource
Growing Economy = Increased Demand for Energy = Rising CO₂ Emissions

Source: BP, Maddison (GDP to 1979), IMF (GDP from 1980), Allianz GI Capital Market Analysis.

⁵ Source: OECD “The Emerging Middle Class in Developing Countries”, 2010.
On top of the rise in demand, we have a situation where hardly any new production capacity has been created in recent years. This means that developing new reserves will increasingly involve more effort, and accordingly be more expensive. This becomes particularly clear with fossil energy sources, which are neither regenerative nor recyclable. In the case of crude oil in particular, the International Energy Agency (IEA) assumes that the absolute maximum production capacity of about 96 megabarrels (2011: 89 megabarrels) will be reached over the next 10 to 20 years. And then there is a risk of production capacities significantly declining in the subsequent years. The conflicts in the Middle East also explain why commodity importers are increasingly focusing on supply security. Consequently commodities are likely to become ever scarcer, and therefore, increasingly expensive. Tomorrow’s winners will probably be those companies and/or entire economies who respond quickly to the global bottleneck factors.

**The sixth, “green” Kondratieff cycle**

During the current Kondratieff cycle, the information age produced a tremendous increase in labour productivity, whereas the key to a strong and sustainable economy in the next long cycle seems to lie in raising resource and energy productivity. This is because under the new conditions imposed by globalisation, demographic development, climate change, scarce resources and greater awareness of, and responsibility towards, the environment on the part of consumers, growth will probably be generated from a new mix of economics and ecology. The crucial reorganisation of energy infrastructure in this respect could prove to be a powerful engine that really gets growth going. A “green” Kondratieff cycle that will probably cause us to shift from formerly parasitic to more symbiotic growth in future.

---

8 For more information on the term “green Kondratieff”, see also: Ernst Ulrich von Weizsäcker, “Factor Five”, 2009.
Environment – a scarce resource

However, it is not only resources that are in increasingly short supply – we are also slowly running out of environment. Unlike just a few years ago, the debate about climate change no longer revolves around the questions of whether it exists at all and who the culprits are. The facts are now well known:

- 13 of the last 15 years alone were among the warmest on record since 1880 (see Figure 3)\(^9\).
- Between 1992 and the end of 2009, sea level rose by 3.3 mm on average each year. This increase is about 50% higher than was measured for the entire 20th century.\(^10\)
- In the period from 1992 to 2009, the Arctic and Antarctic together lost 36 gigatonnes more of ice each year than they had done the year before (equivalent to an ice block measuring 36 kilometres in length).\(^11\)
- Global CO\(_2\) emissions reached their highest ever level on record in 2010 and have increased four times faster than was the case a decade before.\(^12\)
- Extreme weather events, such as droughts or floods, have increased disproportionately in recent years, and scientific evidence proves that they are closely linked to the global warming caused by mankind.\(^13\)

Based on the assumptions of “RECIPE” (Report on Energy and Climate Policy in Europe), a joint study by the WWF Environmental Foundation and the Allianz Group, without measures to protect the climate, CO\(_2\) emissions would increase to 2,500 gigatonnes by 2050 and push global temperatures up by seven degrees over pre-industrial levels. The ”Stern Review”, which examined the economic cost of climate change, concluded that without further climate protection measures, climate

---

\(^10\) Source: Commonwealth Scientific and Industrial Research Organisation (CSIRO).
\(^11\) Source: American Geophysical Union (AGU).
\(^12\) Source: US Energy Information Administration.
\(^13\) Source: Potsdam-Institut für Klimafolgenforschung (Potsdam Institute for Climate Impact Research, PIK).
change would reduce global economic output by about 5%–20% by 2050. According to estimates by the German Institute for Economic Research (DIW), even if climate protection measures were to be taken starting from 2025, the global damage caused by climate change would increase to around 3.8 trillion US dollars (USD) by 2050. If around USD 500 billion were to be invested in climate protection measures today, the economic costs of global warming could be reduced to as little as USD 1.3 trillion (see Figure 9).

**Figure 3: Climate Change – (greatest) Challenge of the Future**
Temperature Deviation from the Average (1961–1990)

Mankind’s impact on climate and atmosphere

Preliminary conclusion: the environment is becoming an increasingly scarce resource.

**Figure 4: Ecology and Economics are Converging.**
Estimated Cost of Climate Protection and Damages Caused by Climate Change (Worldwide, in billion US Dollar)

Source: DIW 2005; Allianz GI Capital Market Analysis.
The environment gets a price tag

Political support is needed to speed up the structural change from parasitic to symbiotic economic growth. This change will only gain pace once environmental consumption becomes a cost rather than scarcity factor, and polluters internalise their environmental costs more strongly. The first steps are already being taken in this direction. For example, polluters are increasingly being forced to foot the bill through trade in CO₂ emission rights — currently the bilateral trade between the Kyoto Protocol signatories and, within Europe, the EU emissions trade for enterprises. Moreover, many governments are increasingly tailoring their taxation and subsidy policies to more sustainable management. For example, the number of countries who have added the expansion of renewable energies or similar policies to their political agendas more than doubled, from 55 to 119, between 2005 and 2011. And what is really astonishing is that more than 50% of these countries are emerging markets. China, for example, has made the expansion of renewable energies one of the core themes of its current five-year plan. Between now and 2020, it aims to increase their share to 15% of the total Chinese energy mix (2010; approx. 9%).

“Sustainability” is a topic that is featuring ever more strongly, not just in politics but also in the free economy. As the consequences of climate change may increasingly become a business risk, more than 6,000 large companies and 655 institutional investors, with combined total assets of around USD 78 trillion, have now joined together in the Carbon Disclosure Project (CDP). They not only support the use of uniform standards for measuring emissions and the inclusion of climate change considerations in equity analysis, but also encourage businesses to develop their own climate protection strategies and to reduce their emissions.

Figure 5: Economic Policy is Becoming Increasingly „Green“
Countries with Political Targets for Renewable Energy Expansion

More in-depth analyses on the investment topics “SRI, Sustainability und ESG” can be found at http://www.allianzgi.de/capitalmarketanalysis

* Target by 2025
** Not official; New Energy for America, Obama; 2009

All these factors – the introduction of CO₂ emission rights, rising commodity prices and climate change as a business risk – contribute to putting a price tag on the consumption of the environment. Since the environment is increasingly becoming a cost and risk factor, finding answers to these challenges is purely a matter of economic common sense and ecological responsibility.

These economic and ecological scarcity factors – “commodities, energy and the environment” – could induce radical changes that will probably impact on virtually every area of economic activity. Future focus will have to centre, above all, on increasing resource and energy productivity in global value creation and practising more sustainable management. At the same time, this trend also provides opportunities for growth.

**Green wave of growth**

The infrastructure needed to form the backbone of the new wave of prosperity would already seem to be in place. Back in the 19th century, it was the steam engine and railways, above all, which formed the infrastructure for mechanical communication and transport. In the 20th century, a new infrastructure for individual mobility was created with electronic means of communications and the automobile. And in the 21st century, it will probably be the interaction between digital communications technology and new energy systems that will drive a paradigm change in the energy infrastructure. 15

Digital technology and the Internet have made it possible to separate the production and consumption of energy in terms of both space and time. Economist Jeremy Rifkin describes this energy turnaround that is characterised by a shift from supply-to-demand-oriented energy policy and a transition from centralised to decentralised energy generation as the “democratisation of energy supply” that influences society as a whole.

The dovetailing of the 5th Kondratieff cycle with the 6th Kondratieff cycle, i.e. the connection of information technology with the “green markets” is likely to continue increasing. According to Rifkin, five supporting pillars will form this new, 21st century energy infrastructure, which could drive a new wave of future symbiotic growth – for the global economy as a whole, and for companies or sectors in particular:

The economic and ecological scarcity factors – "commodities, energy and the environment" – could induce radical changes that will probably impact on virtually every area of economic activity. Future focus will have to centre, above all, on increasing resource and energy productivity in global value creation and practising more sustainable management.”

15 See also Jeremy Rifkin, "The Third Industrial Revolution", 2011.
1. Switch to renewable energies
2. Conversion of buildings into micro power stations (using renewable energies)
3. Use of energy storage in buildings, cars and within the energy infrastructure
4. Expansion of a global smart grid system
5. Transport infrastructure for vehicles powered by electricity and fuel cells

Although this shift will take several years yet, the roots are already in place and the shoots are clearly visible. The global economic system has, for example, already taken environmental protection, resource conservation and corporate social responsibility on board in many areas − particularly in the industrialised countries. In the minds of many consumers, especially in developed countries, consumption now takes place under a completely different set of assumptions about ethical-ecological criteria and sustainability. For example, more than 2 million hybrid cars have been sold over the last 10 years in the USA, an increase of 9 percent\(^\text{16}\), nearly 90 % of all waste paper and glass is recycled in Germany\(^\text{17}\) and Sydney is Australia’s first city to have its street and park lamps fitted with LED lights. In emerging countries such as China, there were, for example, around 51,000 protests against environmental pollution as far back as 2006\(^\text{18}\). In addition, consuming with a clear conscience seems to be an increasingly powerful engine for growth in other economic sectors as well. The market for organic food is booming, as are “green” investments and fair-trade products.

It is therefore hardly surprising that the most growth potential is seen in those sectors that play a key role in energy and resource efficiency and, as such, in sustainable human and health development. Management consultants Roland Berger estimate that the lead markets in environmental technology (incl. renewable energies, resource-efficient products/processes, recycling, water technologies) already accounted for global sales of some 1.7 trillion US dollars in 2010. Between now and 2020, this volume could soar to 3.2 trillion USD, equivalent to an above-average growth rate of 6.5 % p.a (see Figure). The power of “creative destruction”, as Schumpeter termed it, will probably gain further strength in the years to come. An economic shift that will likely impact on virtually every area of economic activity. Overall, the “green-tech” markets will most likely leave many traditional industrial sectors far behind. For example, analyses by the DIW, Fraunhofer ISI and Roland Berger Strategy Consultants carried out on behalf of the Federal Environment Ministry show that by 2020 environmental technologies will be of greater significance for the German economy than the automobile industry.

\(^{16}\) Source: Hybridcars.com.
\(^{17}\) Source: BDE Bundesverband der Deutschen Entsorgungs-, Wasser- und Rohstoffwirtschaft e.V. (German federal association of waste disposal, water and commodity industries).
\(^{18}\) Source: China’s State Environmental Protection Administration (SEPA).
“Green” growth will probably also have a noticeable impact on the employment market. In Europe alone, some 2.7 million new jobs could be created between now and 2030, according to forecasts by the European Renewable Energy Council, as the process of energy system transformation strives to achieve Europe’s energy targets (incl. 20% CO₂ reduction, 20% share of regenerative energies by 2020). Here again, "creative destruction" should be clearly visible: while nearly 2.5 million jobs are lost in the traditional energy sectors of coal, gas and oil, some 5.3 million new jobs will probably be created in the field of renewable energies.¹⁹ As part of an optimistic scenario devised by UNEP that limits global CO₂ emissions to 450 ppm and global warming to 2°C, three-quarters of the labour directly employed in the energy sector will probably be working in the fields of regenerative energies and energy efficiency (especially in the construction industry) by 2050 (see Figure).²⁰

¹⁹ Source: European Renewable Energy Council (EREC), 2011.
“Green tech” – a growth market

The Intergovernmental Panel on Climate Change (IPCC) drafted 164 different future scenarios to determine that, on average, global energy demand will virtually double between now and the middle of this century, while at the same time the share of regenerative energy sources will grow from currently about 16% to about 30%. One optimistic scenario even estimates a 77% share of regenerative energies.

Regardless of whether photovoltaic, wind, geothermal or biomass power, the share of renewable, CO₂-neutral sources of energy in the global energy market should continue to grow. A growth process that is already visible today:

- Worldwide, new photovoltaic systems with 27.4 GW capacity were installed in 2011 – an increase of about 70%.21
- In 2011, new wind power plants offering 40.5 GW capacity were built around the world – an increase of more than 20%. Interestingly, China and India accounted for 50% of this growth.
- The current installed capacity of geothermal systems around the world is 10.9 GW. The International Geothermal Association (IGA) estimates that this capacity will increase to 18.5 GW (+14% p.a.) between now and 2015.
- Since 2005, ethanol and biofuel consumption has increased three and six-fold respectively.22

Figure 8: Solar and wind power – Two Growth Markets

Wind Power, Existing World Capacity, 1996–2010

Solar PV, Existing World Capacity, 1996–2010

Source: UN, REN21 2011, Allianz GI Capital Market Analysis.

21 Source: European Photovoltaic Industry Association (EPIA), 2011.
As technology progresses, and thanks to government subsidies, the cost of electricity generated from renewable energy sources has declined over the last three decades, and is showing signs of decreasing further, which could well stimulate additional growth in the "green-tech markets". The average cost of a photovoltaic module per watt of solar energy was USD 94.81 in 1975, USD 12.17 in 1985, USD 5.76 in 1995, USD 4.34 in 2005, and USD 0.96 at present. According to Goldman Sachs, the cost will drop further, to USD 0.84 in 2013 (see Figure).

A study conducted by the Fraunhofer Institute discovered that wind energy plants in good wind locations are already as competitive as conventional power plants. The cost of producing electricity from onshore wind energy plants is currently between 0.06 and 0.08 Euro/kWh and is similar to that of conventional (coal, lignite, nuclear) power plants.

**Figure 9: Huge Learning Curve for Solar Energy**

Development in Costs of Solar Modules (in USD per Watt)

The shift from conventional energy production to renewable energies will very probably cause massive changes in the energy sector. Instead of generating electricity in huge power plants with capacities of, in some cases, more than 1000 megawatts (nuclear, lignite and coal plants), more and more power is being produced in small systems with capacities of just a few kW (e.g. photovoltaic systems). Accordingly, the IPCC predicts that the investment requirement for expanding renewable energies – especially technology advancement and infrastructure growth – could range between 1,360 and 5,100 billion US dollars between now and 2020. A range of 1,490 to 7,180 billion US dollars is forecast for the period from 2020 to 2030. In 2011 alone, 260 billion dollars were invested in “clean energy” around the world – 250% more than in 2005 (see Figure). Interestingly, both China and India rank among the world’s top 5 countries with the highest levels of investment in environmental technology. High-tech industry is also expected to benefit significantly from the green transformation of the markets, because the demand for renewable energies, advanced environmental technologies, sustainable water management, recycling and more efficient propulsion technologies is rising. For example, tremendous growth prospects are foreseen in the field of “smart grids”, known as the “Internet of energy”. The decentralised production of energy – primarily renewable energy – in a growing number of households and businesses is making the efficient management of the energy system increasingly important. Current measurement and management via the Internet, as well as virtual power plants, which create a balance between production and consumption in the “energy web”, are likely to play a significant role in the future of the energy markets. This makes the market potential of this new technology appear very promising. The Smart Grids European Technology Platform estimates that 390 billion

Figure 10: Investment in Regenerative Energies Promotes Sustainable Energy Production and Global Climate Goals
Development of global investment in regenerative energies (2004–2030, in billion USD in %)

Source: BNEF, Global corporate renewable energy index (crex), 2011; for 2015-2030E: IEA, New Energy Finance Global Futures; Allianz GI Capital Market Analysis

23 Source: IPCC, “Special Report on Renewable Energy Sources and Climate Change Mitigation” (SRREN)
24 Source: Bloomberg New Energy Finance
Figure 11: Regenerative Energies Do not just Feature on the Agendas of Industrial Countries
Investment by Country and Sector, 2011 (in billion USD)


Euros will have to be invested in Europe by 2030 to provide comprehensive smart grid coverage. Of this amount, 300 billion euros alone will be put into renewing and expanding the electric power infrastructure, and 90 billion into electricity transmission. Cisco Systems, one of the world’s largest grid providers, predicts that its own sales in the field of smart grids will reach 20 billion USD per year from 2013 onwards. The company assumes that the energy web will ultimately be 100 times bigger than the internet.

Figure 12: Smart Grid – the Internet of Promising Energies
Global Smart Grid Investment Forecast (in billion US Dollar)

e = expected
Source: IC Insights; Allianz GI Capital Market Analysis.
Smart Grid

Smart grids are power grids that, in addition to conventional electric power transmission, allow the bidirectional flow of power and (electrical) data communications. The decentralised production of energy – primarily renewable energy – in a growing number of households and businesses is making the efficient management of the energy system increasingly important. More and more consumers are using solar, wind or geothermal power plants to become electricity producers themselves. The goal of this new technology is to make power generation, distribution and consumption on the energy market of the future as efficient as possible. The smart grid has three core components:

1. **Smart metering**: an intelligent electricity meter which allows the measurement of consumption and production via data transmission over the Internet. This makes it the cornerstone of the smart grid. Smart meters also allow variable prices to be charged for electricity, depending on the overall demand and network utilisation.

2. **Grid intelligence**: the name for the power grid infrastructure and the associated control equipment. This virtual power plant creates an efficient balance between production and consumption in the “energy web”.

3. **Utility IT**: intelligent data management systems, which automatically control billing and the storage of customer data and parameters of power line networks.

The smart grid is also referred to as the “Internet of energy” or the “energy web”. There are already some examples of how it will be used in the future:

- The production of energy in the desert of North Africa or on a wind farm on the high seas requires intelligent power distribution networks that distribute (sometimes irregular volumes of) electricity directly to the source of consumption.

- If the North Sea winds are blowing at night, when consumption naturally decreases and electricity is generally cheaper, a wide variety of storage devices, including batteries for electric cars and trains, could be charged or thousands of washing machines could be activated.

- In summer, when hundreds of thousands of photovoltaic systems all across the country are feeding electricity into the grid at the same time, intelligent controls ensure that power plants can be shut down or their output reduced, as necessary.

*Sources: Siemens AG, Wikipedia.*
Summary

The environment itself has become a scarce asset. It can no longer be consumed free of charge – which should never have been allowed to happen in the first place. This means that costs / prices must reflect its consumption – e.g. in the shape of CO₂ emissions. Ernst Ulrich von Weizsäcker is right to demand that prices must tell, not just the economic, but also the “ecological truth”.

Climate change is the final and unmistakable wake-up call for this ecological truth. The need for action that is prompted by this call will cause changes in virtually every area of the economy and lead to a new phase of growth. This growth will differ from everything that has gone before.

The shift to renewable energies, in particular, demonstrates that growth will be much less consuming and much more regenerating. The key word is sustainability. If we think even further outside the box, we might say that growth in respect of our planet Earth will shift from being parasitic to symbiotic. Most of the underlying technologies that Kondratieff would stipulate as necessary for this change are already in place.

As investors with a long-term horizon – which by all means includes environmental protection – we should see the world through the eyes of Schumpeter and Kondratieff and look beyond the crisis. The signs of the next growth cycle are already appearing.

Dennis Nacken
Sources:

Kondratieff
→ Erik Händeler, portrait of the economist on: www.kondratieff.biz
→ Information portal on the economic theory of “Long waves”: www.thelongwaveanalyst.ca
→ Jeremy Rifkin, “The Third Industrial Revolution”, 2011

Bottleneck factor: Scarce resources
→ Allianz Global Investors Capital Market Analysis “Megatrend: Scarce resources”, 2010
→ Allianz Knowledge Page - Information portal on the foremost global topics of our time: http://www.wissen.allianz.de/
→ American Geophysical Union (AGU): www.agu.org
→ BMU (German federal ministry for environment, nature conservation & nuclear safety), “Die dritte industrielle Revolution – Aufbruch in ein ökologisches Jahrhundert” (The third industrial revolution – Entering an ecological century), 2008
→ Commonwealth Scientific and Industrial Research Organisation (CSIRO): www.csiro.au
→ International Energy Agency (IEA), ”World Energy Outlook”, 2010
→ OECD Environment: http://www.oecd.org/environment
→ OECD, “Environmental Outlook to 2050”, 2012
→ OECD “The Emerging Middle Class in Developing Countries”, 2010
→ Potsdam Institut für Klimafolgenforschung (Potsdam Institute for Climate Impact Research, PIK): www.pi-k-potsdam.de
→ US Energy Information Administration: www.eia.gov
→ World Meteorological Organisation (WMO): www.wmo.int

Green-tech markets
→ BDE Bundesverband der Deutschen Entsorgungs-, Wasser- und Rohstoffwirtschaft e.V (German federal association of waste disposal, water and commodity industries)
→ Bloomberg New Energy Finance
→ China’s State Environmental Protection Administration (SEPA)
→ European Photovoltaic Industry Association (EPIA): www.epia.org
→ European Renewable Energy Council (EREC): www.erec.org
→ Homepage, BMU/Renewable energies: www.erneuerbare-energien.de
→ Homepage, Worldwatch Institute: www.worldwatch.org
→ Hybrid cars: www.hybridcars.com
→ Information portal on smart grids: www.smartwatts.de or www.smartgrid.gov
→ IPCC, “Special Report on Renewable Energy Sources and Climate Change Mitigation” (SRREN)
Do you know the other publications of Capital Market Analysis – the investment think tank?

Analysis & Trends

- US High-Yield Bond Market - Large, Liquid, Attractive
- High-Yield corporate bonds
- Germany: a Tower of Strength
- The Chinese Renminbi – The New Global Currency
- High payout ratio = high earnings growth in the future
- Dividend strategies in an environment of inflation and deflation
- Dividend stocks – an attractive addition to a portfolio
- Dividends set for 1980s-style comeback
- Emerging-Markets Bonds
- Demographic Turning Point (Part 1)
- Pensions in a Demographic Transition (Part 2)
- Demography as an Investment Opportunity (Part 3)
- Demographics: From Turning Point to Investment Opportunity
- From emerging markets to growth markets
- Asia on the move – gravitational centre of the 21st century?
- The sixth Kondratieff – long waves of prosperity
- Outsmart yourself!
- Investing in Scarce Resources
- Turning Point
- Turning Point: 10 Theses on the Right Way to Invest over the Turning Point
- China – Driving Global Growth
- The Renminbi internationalisation gains momentum
- Tiger and Dragon
- Fighting inflationary pressure
- China’s new age of growth
- Decisive insights in a “Changing World”
- China Focus – “Hard Landing”?
- China Focus – China’s Concern: Inflation
- To gold cling all?

PortfolioPractice

- Credit-Spreads – Compensation for Default
- Bond (Fund) strategies – Behind or in front of the curve
- Sustainable – Responsible – Themed strategies
- The new Zoology of Investment Risk Management
- Is small beautiful?
- Active Management
- Sustainable Investing: just a fad?
- Responsible Investing reloaded
- Fiduciary Management
- Behavioral Finance and the Post-Retirement Crisis

You can find all the latest publications and podcasts of Capital Market Analysis under: www.allianzgi.de/capitalmarketanalysis
Notes