SUSTAINABLE TECHNOLOGIES FOR THE NEXT DECADE

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DWINDLING RESOURCES
Can technology help us, or will rising populations and increasing resource scarcity create a downward spiral?

DOING MORE WITH LESS
While we wait for renewable energy to come on line, what can we do to make better use of current sources?

REPLACING SCARCE RESOURCES
We can't put Indium and other rare earths back in the ground, but can we use technology to find alternative sustainable technologies before it is too late?

CONCLUSIONS
How can we use the current 'golden age of science' to transition to a sustainable future while maintaining economic growth?

Sustainable Investment Strategies for the 21st Century

Dwindling resources and lack of mechanisms to exploit technology present opportunities as well as risks

Prophets, priests, scientists and environmentalists have been gleefully predicting the end of the world for several millennia but it won't happen. One of the reasons that the human species has been so successful has been our ability to adapt to changing environments, enabling us, like viruses, to colonise almost every part of the planet, and make use of every available resource.

But there is a problem - we have made use of every available resource, and while some, like silicon make up 25.7% of the Earth's crust by weight and are to all intents and purposes inexhaustible, many others such as indium are not. The problem is compounded by many of the scarcer elements being a small cog in a large wheel, so while materials such as aluminium, steel and many plastics can be and are recycled, recovering the small amounts of indium from broken touch screens is neither feasible nor cost effective.

So what can we do with increasingly scarce resources? The problems with elements, as opposed to compounds, is that as fundamental building blocks we cannot create more material, nor is there an abundant source of material containing the elements in question. If we need hydrogen or oxygen they can be simply made from water, but there are few abundant compounds containing rare earths. As a result we need to find a new solution, and quickly.

Which brings us to the question of investment in emerging technologies. The first decade of the 21st Century was characterised by unfocussed hype, with investors piling in and then out of ill-defined areas such as nanotechnology and cleantech, leaving few of them richer or any the wiser. The problem was that, seduced by visions of a technological utopia (or perhaps too much Star Trek), bets were placed on technologies not products, but faced with being left behind in a Gold Rush, many investors were quite happy to toss their investing rule book out of the window, again and again, and again.

However, the same decade was also characterised by an unprecedented level of global scientific investment in areas from nanotechnology to synthetic biology, and while the investment community was either wrestling with pushing technologies onto a tech-agnostic world, or reliving the dot.com days, this has led to somewhat of a technological overhang (i.e. while the markets may not have needed some of the recent technological developments, they are there and waiting to be exploited). Over the coming decade we expect this glacier of emerging but rapidly maturing science to calve a number of world changing technologies.

With this technological overhang waiting to be exploited, and in order to prevent the waste of yet more billions by venture capital, local and regional development agencies, and companies, here's our view of where the hot new growth areas of the second decade of the century will be and why we need to focus on the applications, not the technology.

We see the opportunities falling into two broad categories, 'Doing More With Less' and 'Replacing Scarce Resources.' Taking both areas together we have the basis of a real 21st Century sustainable technology investment model, one that fills the gap between the grimy present reality and the sunlit sustainable future.

Doing More With Less

Most of the focus of 'Clean Tech' has been on producing new sources of sustainable energy, wind, solar, and new forms of electric propulsion being the poster children. However, the attention showered on these areas has led to an intensely competitive situation, with both the amounts of investment required to become a 'player' and the deal valuations climbing into the billions of dollars.

Konarka Technologies, one of the earliest players in the thin film photovoltaics area, has burned through over $100 million in VC funding without seeing much in the way of revenues, while Nanosolar has raised $295 million to date. While we are confident that the problem of producing cheap, high-output, photovoltaics using a roll-to-roll process will be solved one day, it will take several hundreds of millions of dollars to become a major player, and that's not something many investors can stomach.

It is a similar story with battery technologies, huge amounts of investment, a large number of players, an uncertain market and an end result of two or three dominant technologies. This looks like shark-infested waters from an investment point of view.

With much of the silly money already committed to the more obvious clean-tech projects such as solar, where then should we look for value?

While the chase steps up for new energy sources (remembering that fusion has been twenty years away for the last forty years) a quicker and cheaper solution is to make better use of existing resources. Assuming that

•It will take ten to twenty years for new sources for renewables to become competitive with existing sources and

•Market forces will drive up the cost of dwindling resources in the meantime

•Current investment levels in renewables have priced many investors out of the market

then many of the real opportunities lie in mitigating the economic impact of dwindling resources, i.e. making better use of what is currently available as discussed in our March 2007 white paper "Nanotech: Cleantech."

Typical examples are better insulated buildings using aerogels which can help reduce 30% of carbon emissions generated from households, while lighter, stronger materials based on nanotechnology are being used in cars, buses and aeroplanes to dramatically improve fuel efficiency. Simultaneously, advances in fuel cells and hybrid electric powered vehicles are enabling the world's largest automotive manufacturers to produce low- or zero-emission vehicles that combine energy efficiency with the kind of performance with which consumers have grown accustomed. Nanomaterials such as graphene and carbon nanotubes are crucial in these applications. In the meantime, the use of fuel-borne catalysts based on nanomaterials are being used to improve diesel fuel efficiency by as much as 10%.

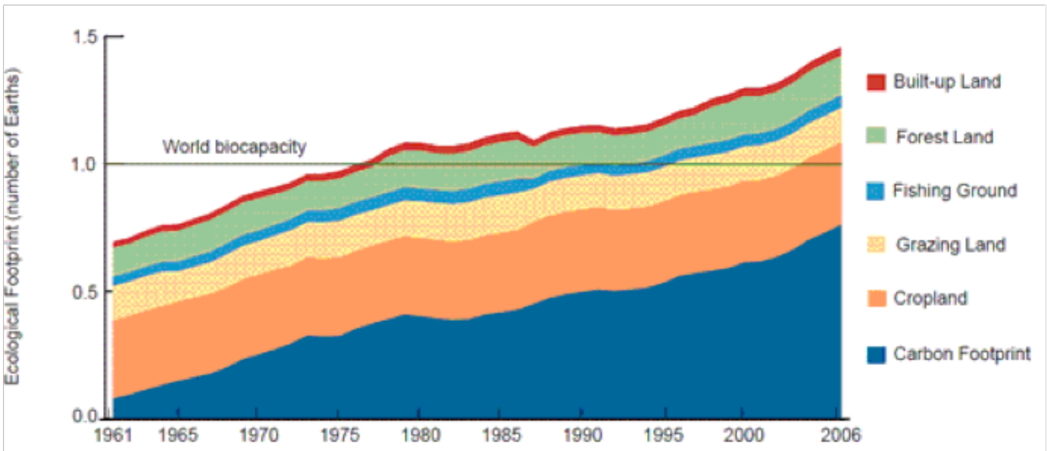
Replacing scarce resources

The last twenty thousand years of human society has been characterised by an increasing sophistication in our use of materials sourced from the natural environment. As a species we have moved from early tools fashioned from 'found' materials such as bone and flint to increasingly sophisticated and engineered materials.

However, despite our technological sophistication, many of these materials, steel and aluminium for example are still based on ore extraction, many polymers are still based on oil, and even highly sophisticated devices such as semiconductors are based on the energy intensive modification of naturally occurring materials.

Even commonly used drugs are based on natural resources whose supply can be affected by global trade and climatic variations. The limiting factor in the manufacture of the antiviral drug Tamiflu (oseltamivir), for example, is the availability of shikimic acid, which is obtained industrially from the spice star anise. Roche already buys some 90% of the harvest, with thirteen grams of star anise making 1.3 grams of shikimic acid, which can be made into 10 oseltamivir 75 mg capsules.

With a rapidly increasing global population, the demand for resources of all kinds is increasing, from steel to electricity, from food to medicine. The Global Footprint Network estimates that "It would now take nearly one and a half Earths to generate all the resources humanity consumes and absorb all our CO2 emissions, according to the latest Ecological Footprint and biocapacity calculations"



Our Ecological Footprint (Source Global Footprint Network)

This leads to a number of major problems, both economic and political. The issues of oil supply and energy independence are well documented, but an article published in New Scientist in April 2007 paints a rather pessimistic picture of the state of many natural resources indicating that some crucial materials such as Indium have only fifteen years supply left.

A global recession has changed the picture somewhat, with resource prices tumbling from their 2008 peak, and market forces will, of course, put a brake on the use of some materials as scarcity drives up prices, but it is an inescapable fact that we are approaching the end of the line in some areas, if not in fifteen years, then in twenty or thirty.


The old way of doing things

Of perhaps more concern is the reliance on extractive industries for the supply of a number of highly important rare earths that are relatively concentrated in a few locations. The situation is exacerbated by the lack of rare earth processing available outside China. As a result China now controls 97% of the global supply of 17 rare earths.

Global demand for rare earths has tripled from 40,000 tonnes to 120,000 tonnes over the past 10 years, during which time China has steadily cut annual exports from 48,500 tonnes to 31,310 tonnes.

Avalon Rare Metals, a Toronto-listed mining company, estimates that about 25% of new green technologies rely on minor metals and rare earths. A typical example is Neodymium, one of the most common rare earths, which is a key part of neodymium-iron-boron magnets used in hyper-efficient motors and generators. Around two tonnes of neodymium are needed for each wind turbine. Lanthanum, another REE, is a major ingredient for hybrid car batteries (each Prius uses up to 15kg), while terbium is vital for low-energy light bulbs and cerium is used in catalytic converters.

Each electric Prius motor requires 1 kilogram (2.2 lb) of neodymium, and each battery uses 10 to 15 kg (22-33 lb) of lanthanum. That number is expected to nearly double under plans to boost the fuel economy.

The Toyota Prius - Clean, green but highly dependent on rare earths

While the supply of petrochemicals and rare earths is grabbing headlines, a similar situation exists across many commodities, with limited supplies and political independence threatening the feedstock of industries ranging from semiconductors to construction.

While some may recoil in horror at the apocalyptic scenarios being suggested, others may view this as an opportunity. Previous attempts at predicting the relationship between population growth and resources have always failed to take technological advance into account, and there is no reason to believe that the 21st century doomsday scenarios will be any more valid than Thomas Malthus' 18th century ones.

Why? Because just as improvements in agriculture ensured that the growing population would not be limited by food production, improvements in areas such as nanotechnology, industrial biotechnology and synthetic biology are all showing the potential to alleviate a raw materials crisis.

Nanotechnology is engineering on the scale of atoms and small molecules. What that means to natural resources is that instead of extracting and purifying ores we can now start to think about what properties an ideal material for a specific application might be and begin to design one. If that sounds far fetched then we only have to look at how nature has designed almost perfect materials for structures (bone, that is rigid without being brittle and to some extent self healing), data processing (neurons) and data storage (DNA contains all the instructions needed to build a complex structure like a human being, and fits all of this into less space than Microsoft Office would take up).

Deng Xiaoping - Resource Visionary?

Through the use of nanotechnologies we can now start to develop processes that do not use rare resources, for example using carbon nanotubes and metallic nanoparticles in polymers to make them conducting rather than applying thin layers of indium tin oxide. As resource prices climb, engineering alternative materials becomes increasingly viable, both from a scientific and a financial viewpoint. We should be clear here that the holy grail of 'materials by design' is some way outside the investment horizon for most institutions, but there is a half way house already available, by combining new and old materials, nanotubes and polymers for example, to create something more suitable than traditional materials. Typical examples include conducting polymers for applications from electronics to the automotive industry, and nanomaterials reinforced composite materials designed to replace heavier materials such as steel or costly ones such as aluminium or titanium.

While it is unlikely that these new materials will ever completely replace existing ones, in the same way that new electronic materials will never fully replace silicon, the increased range of options allows us to reduce the rate at which natural resources are being depleted.

Industrial, or White Biotechnology has acquired something of a bad name recently due to its use in the production of biofuels from, or at the expense of, food crops but the potential for sustainability runs much deeper.

By engineering organisms to convert a basic feedstock into a higher value product, applications, industrial biotechnology allows a more sustainable chemistry to be developed, both reducing the chemical industry's dependence on petrochemical products and allowing smaller scale, more local production to take place. By concentrating on using byproducts as feedstock rather than as a primary product, the technology has the potential to create high-value fine chemicals and pharmaceuticals from what would otherwise be classed as waste materials.

As with nanotechnology, industrial biotechnology will never replace existing production methods, but once again gives us a wider range of more sustainable options to choose from. In the end, it will be resource prices and market demand that drive the industry.

Conclusions

The world is going through what some have described as a 'Golden Age of Science,' but more importantly the combination of scientific advances plus computing power plus Internet communication is allowing science to proceed at an ever faster rate, while the communications via the Internet, twitter and mobile devices such as iPads have increased scientists awareness of other disciplines. The age of microfiches and ordering reprints of journal articles is long gone, which has vastly increased scientific productivity.

New materials and production methods are emerging, some of which have the potential to initially supplement, and possibly replace existing materials and production methods.

While that means that business opportunities based on science and engineering are increasing dramatically, these must be carefully mapped to the addressable markets. We believe that 'Doing More With Less' and 'Replacing Scarce Resources' represent an irresistible market pull, and something that smart investors will use to channel the fruits of the new scientific renaissance.

About Cientifica

Cientfica was founded as CMP Cientfica in Madrid in 1997 in order to meet the advanced analytical needs of the European Space Agency. The ESA awarded a contract to CMP Cientfica to run the advanced materials characterization program for the Astrophysics research division. Simultaneously the company began to move into networking and information, with the launch of the European Science Foundation sponsored EuroFE network in 1999, linking all the key researchers working on applications of field emission related technologies.

By 2000 the company was already meeting the increasing demand for information on emerging technologies to both the business and academic communities. Cientfica also launched Europes largest nanotechnology conference, TNT 2000, the world's first conference dealing with investing in nanotechnologies, I2Nano, and the worlds first weekly information source dedicated to Nanotechnology, TNT Weekly.

In 2002 Cientfica published the first edition of The Nanotechnology OpportunityReport, described by NASA as "the defining report in the field of nanotechnology." With nearly 20 years experience in the field of science and research, and nearly 10 years in providing information on the business and science of emerging technologies.

Cientfica is distinct from all other companies providing consulting and information services in its knowledge of both the science and business of emerging technologies. Cientifica employees are from a variety of backgrounds, but all are highly experienced technical project managers and familiar with the commercialization of technology and the transfer of science from the laboratory to the market place.

Cientificas numerous reports on commercial aspects of nanotechnology and other emerging technologies are well known for cutting through the hype and getting to the root of the issues. In the same way,

Cientifica uses its experience in the reality of commercializing technologies and its wide network of international science and technology practitioners to provide down-to-earth and practical advice to companies, academics and governments.

Cientifica also provides advice to investors who are considering investment in emerging technology companies.

Through this experience Cientifica has a deep understanding of the drivers and associated risks associated with investment and management of cutting edge technology projects.

Cientifica has worked in a wide variety of markets, from Oil and Gas to flooring technology, biotechnical to automotive providing technology advice on all aspects of the realities of emerging technologies across all these markets.

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