The last refuge

We have trashed the planet we call home. But what can we do to prevent billions frying to death, while an elite is forced to build homes in the Arctic basin? Even among environmentalists, there is precious little consensus. Bryan Appleyard reports on the bitter battles being fought to save the Earth

White is the new black. Actually, white is also the new blue, grey and brown. White is everything – white clothes, shoes, furniture, houses, roads, flowers, trees, grass and, most important of all, big white hats with very wide brims. White is the cool colour for the summer, and the autumn, and the winter. In fact, white is for ever. It's fun, it's stylish and it saves the human species.

This new and exciting fashion wave is called albedo chic. Albedo – not a word previously heard on the catwalks – is a measure of reflectivity. Fresh snow has an albedo of about 90%, meaning it reflects back 90% of the light that hits it. The Earth as a whole has an albedo of about 30%. This is far too low if we keep heating the planet by increasing the number of humans and pumping 27 billion tons of carbon dioxide into the atmosphere every year. So wear white – it increases our albedo and cools the planet. Oh, and eating lettuce will be desperately unchic. (I'll explain later.)

Well, of course, it won't work. Invented half-jokingly by the physicist and SF writer Gregory Benford, albedo chic is really only a thought experiment designed to dramatise our predicament. That predicament is the destruction of the environment that sustains us, of our only home, by human activity. Anthropogenic (human-caused) global warming is real, it is happening and it is now too late to do anything about its impact over the next 30 years. Global temperatures will rise by 1.5 to 2 degrees Celsius. There will be as yet unimaginable devastation through flooding, changes in weather patterns, desertification and uprooting of entire populations. We will survive, but what then?

If we do nothing, then the temperature rise could be 5 degrees within a century, at which point the survival of our species will be in the balance. Perhaps it is too late even to prevent this. We can already do nothing whatsoever, according to James Lovelock, the great British deep-green: "Save the planet? We can't save the planet – we never could."

Lovelock invented the Gaia concept, an idea that created the discipline known as Earth systems science. Named after the Greek goddess of the Earth, this sees the planet as a single living organism. In the eyes of 4-billion-year-old Gaia, humans are just a brief but very irritating episode. We shall be destroyed by our own dirty habits. Gaia will live on.

For Lovelock, our only faint hope of survival is "sustainable retreat". No further economic or population growth is possible. Indeed, we are past the point of no return and the likely fate of the species is tribal subsistence in the Arctic basin, the last place on Earth cool enough to sustain us. All we can do now is preserve what we can of human civilisation.

Few doubt that possibility – sceptics of anthropogenic global warming are now very few and far between – but the scientific consensus is that, though the climatic history of the next 30 years is more or less written, something can be done in the long term to keep us roughly in the style to which we have become accustomed, long-lived, rich and populous. Nobody, however, thinks it will be easy, technically or politically. We have to act soon, we have to think big and we have to work together. Humans are bad at all of those things, especially the last. And the window of opportunity is closing very quickly indeed. We probably have less than a decade to get it right. What, then, must we do?

Answers to this question fall on either side of a deep conceptual divide that shows few signs of being bridged. The divide is deep because it lies between two conflicting views of how humans

should relate to nature. On one side is the conventional green lobby – people like Sir Jonathon Porritt and Zac Goldsmith – that believes in weaving ourselves more deeply into the natural world through the use of sustainable energy sources like wind, waves and biofuels. Let us call them the Sandals. On the other side are deep, less conventional greens like Jesse Ausubel in America and Lovelock in Britain, who believe that we should, in Ausubel's words, "decouple our goods from demands on planetary resources". For the latter, nuclear power and carbon-scrubbed natural gas, combined with low-energy transport and urban systems and a massive shrinkage in agriculture, are the only answer. We should not tie ourselves more tightly into nature, we should liberate it from our destructive powers. Large parts of the Earth should be returned to the embrace of Gaia. Let us call these greens the Nukes.

Currently the Sandals and the Nukes clash most obviously over nuclear power versus sustainable power sources. With Blair's recent endorsement of nuclear, the Nukes seem to be winning. Meanwhile, George Bush's acceptance of America's addiction to oil and the realisation of the strategic weakness of depending on Middle Eastern oil are turning even the most hardened neocons into born-again greens. Billions of dollars of investment are now waiting to be plunged into the most promising technologies. It is still too early to say what they will be. The Americans are naturally Nukish, favouring high-technology solutions; the Europeans tend to be Sandalish, favouring sustainables. In the long term, this conceptual divide will have to be bridged – perhaps, as some economists have suggested, through a combined approach using the best ideas from both sides.

But at least there are some necessary goals on which we can all agree. The big, glaringly obvious goal is reducing atmospheric carbon. Carbon has been locked in the Earth for billions of years. We have always unlocked some of it by turning it into carbon-dioxide gas through burning. But, since industrialisation began in the 18th century, we have begun to burn coal and oil – so-called fossil fuels – on an increasingly massive scale.

Now we chuck a mountain into the air every year. If we solidified the 27 billion tons of carbon dioxide (over 6 billion tons of pure carbon) produced by humans annually, it would make a mountain a mile high and 12 miles in circumference. As a result, the Earth's atmosphere now contains about 380 parts per million of carbon, compared with about 280 parts, which seems to have been the default setting that made our existence possible. This traps heat and causes temperatures to rise. If we are to survive, we have no choice but to stop chucking mountains. The favoured method is carbon sequestration – essentially capturing the carbon produced by human activity and putting it anywhere but in the atmosphere. We know how to do this; we just don't know if we can do it on a big enough scale, nor whether the carbon will stay sequestered.

In the North Sea's Sleipner field, the Norwegian state oil company, Statoil, is already trying the obvious method: putting the carbon dioxide back into the Earth whence it came. A million tons annually are being pumped from the Sleipner platform into the Utsira formation beneath the sea bed. A huge bubble will be formed which has to be carefully monitored for leaks. The prospects are good, as we do know that gas had lain trapped in such saline aquifers for millions of years without leakage.

More radical, however, are BP's $600m plans for the North Sea's Miller field. The company plans to extract gas from the field and then split it into hydrogen and carbon dioxide. The hydrogen would be used to fuel a power station at Peterhead, Scotland. Hydrogen is an absolutely clean fuel, water being its only waste product. The carbon dioxide, meanwhile, would be pumped back underground into oil reservoirs. This would force out more difficult-to-recover oil and lock away the carbon dioxide.

All of which is promising, but is only a very small step. We have no idea whether there are

enough aquifers beneath sea beds to sequester billions of tons of gas. One alternative is to sink the gas into the deep ocean. Below 3,000 metres, it would be solidified by pressure and cold.

It might work. But the other half of this operation is capturing the carbon dioxide in the first place. This is currently impossible with mobile emitters like cars and planes, but perfectly feasible with static power plants. Unfortunately, it is certain to mean an increase in the cost of energy, and expensive energy is a political nightmare. It is domestically difficult for politicians to sell to their people, and internationally it requires everybody to agree on expensive, carbon-scrubbed energy production.

Nevertheless, the domestic mood in the western democracies is clearly changing. David Cameron has turned the Tories green precisely because he knows that the environment has sunk into the electorate's imagination to the point where they have begun to make sacrifices. Today they have accepted recycling; tomorrow they may accept higher energy costs and less carbon-extravagant means of transport.

Globally too, the mood might be changing. Britain is one of the leaders in the diplomatic effort to strike environmental deals. The brilliant and urbane Sir David King, the government's chief scientific adviser, is now the world's primary informal ambassador for the acceptance of green technology. This is a long road to travel, since it involves persuading emerging industrial nations not to commit our environmental crimes. Big, competitive countries – notably China and India – have huge reserves of cheap energy in the form of coal reserves. Why should they pay an environmental bill for their industrialisation that we never did? Nevertheless, there are promising signs. In China the gigantic Three Gorges dam project, though massively controversial, will provide huge amounts of clean hydropower within the next few years. Hydro doesn't work everywhere, but, when it does, it is as clean as nuclear.

America – also with huge reserves – is trying to show the way with coal. FutureGen is a $1 billion project to build a clean, coal-fired power plant. It is still on the drawing board. This will sequester carbon dioxide at the rate of 1m tons a year. If it works reasonably economically, then coal could be freely used as a power source. Yet it will remain a dirty, difficult option. Far better would be clean and efficient natural gas, though this will also require massive disposal systems for carbon dioxide.

Perhaps it would be even better simply to take the carbon dioxide straight out of the air. This is the idea of Klaus S Lackner of the Earth Engineering Center at Columbia University in New York. He has worked out that carbon can simply be filtered out of the air with remarkable efficiency. He reckons an area of 2 square feet would be enough to capture the carbon emitted by one American in a year: about 25 tons. (The world average emission per individual is 1 ton.)

A windmill would have to be 400 times as large to save as much carbon.

His filtering devices would be like large trees and could be placed anywhere. They would, of course, still produce a vast quantity of carbon to be sequestered. Lackner's preferred method involves turning it into magnesium carbonate and burying it in the earth or the deep ocean. Global Research Technologies in Tucson, Arizona, is currently working on making these devices, but will say nothing about progress, only that it is looking forward to the day "when we can invite the world into our shop to share the developments and let the public 'kick the tires'. Hopefully, that day is not too far off, for all our sakes".

But, beyond the immediate issue of carbon capture and sequestration, the Sandals and the Nukes really start to diverge. The Sandals want the use of more sustainables like solar power, windmills and generating systems that use wave power. They tend to support low-tech solutions, rejecting nuclear power, genetic engineering and intensive farming. There is a back-to-nature

mood to their advocacy. This is understandable. It is, after all, technology that created our environmental predicament; rejecting high technology now might seem sensible.

The Nukes, on the other hand, believe that only technology can rescue us from technology. Their immediate answer is nuclear power, a technology that decouples us absolutely from dependency on sunlight – it was the sunshine that created fossil fuels in the first place – and from the weather. It is, once operational, emission-free. It is also reliable and controllable. All sustainables have problems with supply unreliability and energy storage. A wind-free day in a community dependent on windmills would be a disaster unless there was something like nuclear as a backup.

Nuclear's reputation as a dangerous power source is also undeserved. Since Chernobyl, around the world there have been thousands of reactor-years run without a serious incident. Furthermore, new "pebble bed" reactors that use graphite instead of water to control reactions are even safer. These are now being pioneered in, among other places, China. Finally, we should have fusion power available within about 40 years. This is absolutely safe nuclear power because, as the fusion scientist Miklos Porkolab at Massachusetts Institute of Technology (MIT) proudly points out, if it goes wrong it doesn't melt down, it just quietly cools down. Yet, for the moment, nuclear power remains at the very centre of the conceptual divide.

Also deep in the divide is biomass. Within the green business, this arouses even stronger emotions than nuclear. The idea is to grow plants specifically to make fuel. This has been done highly effectively with sugar cane in South Africa and Brazil. The process is "carbon-neutral" because, in growing, the plants absorb carbon dioxide, which is then released when the fuel is burnt. No new carbon is thus being unlocked from the Earth. Biofuels could drive power stations, cars and, possibly, planes through the production of ethanol or hydrogen.

The biofuel specialist Greg Stephanopoulos at MIT admits big problems remain. There are, for example, deep discussions about the best plants to use and the scale of the plantations required, and it is not yet clear which conversion technology is the most efficient. But Stephanopoulos is convinced that a substantial proportion of American cars could be biofuelled in the near future. Aside from green issues, this would have the politically desirable consequence of cutting US dependence on Middle Eastern oil. With petrol prices at – to the Americans – an unprecedentedly high level of about $3 per gallon, there is now a lot of pressure to develop biofuels. One plan involves planting swathes of the prairies with switch grass, a tall, fast-growing plant of which George Bush seems to be a fan.

Stephanopoulos is concerned that if petrol prices fall, the pro-biofuel political mood will evaporate. A disaster would then be needed to rekindle green aspirations. The one he would like is a move by the Brazilians to start destroying their rainforests on an even greater scale. This would mean the developed nations would have to pay Brazil to stop.

He suggests, since cars are driven by both oxygen and petrol/ethanol, that we should pay for the oxygen as we do for the other half of the fuel equation. Rainforests give us oxygen, so let's pay the Brazilians for its production.

The Nukes, however, are horrified by biofuel. "It will be an environmental disaster. It's criminal. It will fail," says Ausubel. "A catastrophe," says Lovelock. The problem is that biofuels would involve a huge expansion of the amount of agricultural land, and all the Nukes agree that "agriculture is the greatest rapist of nature". Biofuel plantations would be vast, monocultural and would lack, therefore, the healthy diversity the Nukes believe is necessary for rebalancing the planet through the benign workings of Gaia. Their sheer scale would be a vast encroachment on the wilderness we need. Furthermore, the plantations would impoverish the land on which they grew, creating new deserts.

Whoever is right, biofuels currently have the most political momentum. Stephanopoulos sees this as the benign product of a desire to get away from oil dependency. Ausubel sees it as the malign outcome of a partnership of desperate farmers and big businesses like the giant Illinois-based Archer Daniels Midland Company that would benefit from the processing of biofuels.

At least both sides can agree that mobile carbon emitters have to be fixed. We have begun this process with hybrid petrol/electric cars like the Toyota Prius, but the gains so far are very limited. A hybrid capable of 250 miles per gallon – the Prius manages around 60 – has been designed by AFS Trinity in Washington state. This would be plugged into the mains at night, making it capable of running purely on electric power for the first 40 miles. Hydrogen cars might come to our salvation.

Operationally these would be totally clean, emitting only water, but the initial production of hydrogen is energy-intensive, as are its storage and distribution. We would have to ensure that whatever energy was expended in these processes was carbon-scrubbed.

Planes, however, are a nightmare. For the moment, they can only run on kerosene and their carbon emissions are huge. It is possible they can fly on biofuels but, as yet, nobody seems to know for sure. Hydrogen appears to be out of the question, as it has to be kept under pressure in tanks that would be far too heavy to be carried on an aircraft. It is now perfectly conceivable that, at some point in the near future, we will simply have to stop flying.

Consolation might come in the form of maglev trains. These are trains that run on a monorail which they do not actually touch, as the whole vehicle is raised by magnetic repulsion. Air provides the only friction the trains have to overcome. Maglevs are now working successfully in China. But the full power of the technology will only become apparent when we bury the trains underground. By running them through tunnels with lowered air pressure, we can bring the friction close to zero. This would allow them to reach speeds comparable to current aircraft: 800 kilometres an hour or more. They would need electricity, of course, but surprisingly little, as the trains would spend the first half of their journey accelerating and the second half slowing down. During this deceleration phase, the movement recharges the batteries: exactly what the Prius does now.

Ausubel, of the Program for the Human Environment at Rockefeller University, New York, is very keen on maglevs. He sees them joining all our big cities in the future. He also speaks of “maglev settlements”, which would be towns built round a station. They would be populous but small enough to walk round, so there would be no cars. The trains would provide the only transport necessary.

In fact, this idea of high-density human populations may be crucial to our entire future. The old planners’ desire to spread cities out into the countryside is now out of the question. We have, both as farmers and as urban dwellers, to retreat from the land. The solution is to pack more people into cities. There, energy efficiency can be maximised because neither people nor supplies have to travel far.

In addition, city people seem to be evolving naturally towards low-energy lifestyles. Mobile phones and computers are great news environmentally. They keep people distracted for hours with minimal energy usage.

Further efficiency gains can be made – and more land returned to Gaia – if we can persuade people to eat differently. One of the great ironies of current dietary habits is that what we think is good for us is, in fact, very bad. Lettuce, as I hinted earlier, is a pointless affront to the planet. It uses up a lot of space and energy but provides hardly any nutrition. In fact, the same is true of most salad ingredients. Health obsessions have made us want these so much that they now take

up vast agricultural acreages and, in greenhouses, they are grown all the year round using artificial light. We'll know the world has really started to go green when supermarket salad bags take on some of the social stigma of smoking.

In addition, we currently eat only about half of what we buy from supermarkets and about the same proportion of the food in restaurants. And yet we also eat more than we need. Massive energy and land savings could be made if, as Mother told us, we ate all the food on our plate and no more. Best of all, we could go vegetarian. This would cut our need for farmland and pasture by 50%. If we felt the need for the taste of meat, this could easily be synthesised. We are now close to the technology to grow steaks in vats that would be much better, I am told, than anything from a Notting Hill organic butcher; also cheaper, though that would not be difficult. The appalling depletion of fish stocks around the world could be overcome by a global programme of feeding – all sea life seems to thrive when iron is added to the oceans.

Beyond all these earthbound, practical steps, there are even more ambitious plans to save the planet that come under the heading of geo-engineering. Clouds may be crucial. The strange thing about clouds is their absolute familiarity combined with quite a high degree of ignorance about what they do and how they are made. Most clouds are bad, in that they tend to lock in heat – a cloudy night is usually warmer than a cloudless one. But one type of cloud is very good indeed. This is marine stratus, the low, thin film of cloud that forms over the sea. This reflects sunlight and cools the oceans.

Marine stratus seems to be closely associated with the activities of algae in the sea. But these algae die at temperatures above 12C. Global warming is killing them and, therefore, may be reducing stratus cloud cover. This is one of the many viciously positive feedback loops with which humans are now assaulting Gaia. We may be able to break this loop by cultivating the algae, feeding them on an iron-rich cocktail. This would also benefit sea life in general.

Persuading the airlines to put sodium in their fuel might have a comparable effect. It would release particles into the atmosphere that would rise to form a high-level haze that also might help to block sunlight. Some have suggested that the same effect could be achieved by blasting sodium shells into the air from naval guns or floating it into the upper atmosphere with high-level balloons.

Even more ambitious would be stopping the sunlight before it gets here. One suggestion is that we fly a spacecraft to the Lagrangian point between the Earth and the sun. This is the point at which the gravity of the two bodies is cancelled out. An object left there simply does not move. The craft would unfurl a huge curtain of fine mesh that would block a small percentage of sunlight, not enough for us to notice but enough to offset global warming for perhaps a decade. Space has also been suggested as the site for thousands of orbiting mirrors that, rather more efficiently than white clothes, would increase our planetary albedo.

Finally, if all else fails, we could construct huge nuclear weapons to be exploded inside Earth's orbit and which would blast us further away from the sun. This has seriously been discussed, but is generally regarded as a touch risky.

But whatever we should do, the big question is: will we do it? Humans are natural born wreckers. Deep within us, as Ausubel puts it, we have a "snake brain" – the neural vestige of our reptilian ancestry – which constantly subverts our reason. The snake brain manifests itself in crime, wars, futile rivalries and, most alarmingly, in our complete inability thus far to agree on anything remotely effective that should be done globally to offset the onrushing environmental catastrophe. This catastrophe, our reason tells us with absolute clarity, is bound to happen unless we act now. Maybe it won't, says the snake brain, and anyway, maybe I can fix all this to my advantage,

sunbathe, surf and grow rare orchids in Greenland while billions die in the superheated equatorial regions.

Furthermore, if Lovelock is right, it may already be too late. He compares most anti-global-warming technologies to kidney dialysis machines – great news if you have kidney failure, but it's much better to have healthy kidneys. Globally our kidneys are failing fast and we are now planning to construct machines to keep us alive. It was much better, says Lovelock, when we lived at peace with Gaia. Now we must war with her just to survive.

In the short term, snake-brain issues between the Nukes and the Sandals must be resolved, as must all the conflicts of interest between the fast-growing, energy-hungry economies of China and India and the developed West. If nothing is resolved, you might as well start buying camels for the long desert trek to the land you should have already bought in the Arctic basin.

My own view – aesthetically as much as scientifically determined – is that the Nukes are right. The Sandal vision of weaving ourselves more deeply into nature's systems through, primarily, renewable resources seems inadequate to the task at hand. Also, it is riskier than may at first be apparent. We would still be trespassing on Gaia's realm and, as every green should know, our ignorance about her workings is colossal. Far better to let her be, to embark on a controlled high-technology retreat from as much of her realm as we can, to let the wilderness return, to submit to the higher logic of the system from which we sprang and to which we must return. Far better, in short, to be home.

Sandal thinking

The "Sandals" belong to the back-to-nature green lobby, and believe that humanity should be woven more deeply into the natural world through the use of sustainable energy sources. They tend to support the following:

Wind power — constructing windmills and wind farms to harness the power of the weather.
Solar power — using technology such as solar panels or mirrors to harness the sun's radiation.
Wave power — generating electricity by harnessing the natural power of the ocean.
Tidal power — exploiting the regular movement of the tides, by means of barrages constructed in river estuaries, to generate electricity.
Biofuel — growing plants with the specific purpose of making fuel. Key crops include sugar cane, corn, soya beans, flax, rape and switch grass. Biofuels could be used to drive power stations, cars and even aeroplanes through the production of ethanol or hydrogen.

Nuke thinking

The "Nukes" are less conventional green thinkers who believe that only technology can rescue us from our doom. They favour schemes to detach our goods from usage of the planet's natural resources. Big ideas include:

Nuclear power — more atomic power will reduce our dependency on the weather. New "pebble bed" reactors are safer than old-style reactors.
Sunlight reduction — as accomplished naturally by the haze produced by volcanic eruptions (above). Cultivating algae will increase the amount of marine stratus cloud. More ambitiously, a huge mesh curtain could be placed between the Earth and the sun, or orbital mirrors could be launched to deflect the sunlight. Even more drastically, the Earth could be blasted further away from the sun.
Halting salad production — lettuce uses up considerable agricultural space and energy, though it provides hardly any nutrition.