

Reflections on Natural Systems

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**In2:InThinking Network 2002 Forum
April 18 – 21, 2002**

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“Reflections on Natural Systems”

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Abstract:

A description of the utilisation of willow to fix carbon from the atmosphere and provide the feedstock for environmentally friendly energy production. Man's needs to take from nature for his technological attainment and the largely uncharted journey of connecting the loop so that man can put back and heal Planet Earth.

Working at improving the environment at the Yorkshire Brick Company. Nature recycles everything! How good design can reduce material waste.

Long-term management of the natural capital of the soil, seas and atmosphere is an easily forgotten pre-condition for all economic activity. It is time to draw the line and start to reduce the level of emissions from the burning of fossil fuels. Planting a willow cutting our real contribution to a sustainable world.

The Remarkable Willow

The willow is a carbon fixing system par excellence. Laboratory trials in Europe suggest that the latest clones can produce as much as 35 tonnes of dry weight of willow material per hectare a year. For several years there has been an extensive willow clone-breeding programme in Sweden testing around 20,000 clones a year and a programme at Long Aston in the UK testing 8,000 clones a year. The two programmes are complementary as the Swedish effort is concentrated on the *vinamalis* variety, which produces single stems and is suited to the climate of cold harsh winters and long dry summers. The UK effort on the other hand has looked at the multi stem varieties that fit with the warmer winters and wetter summers of the UK maritime climate. The aim of these programmes is to achieve fast carbon fixing varieties that are disease resistant. The result of the programmes so far has been the production of one or two outstandingly productive clones a year in each country. Examples of these are the Tora and Bjorn varieties in Sweden and the Ashton Stott in the UK. Tora will grow one single stem to a height of 17 feet in one year. Ashton Stott will grow several stems to a height of some 8 feet.



Harvesting 2 year-old willow (Tora) in the UK 12 February 2002

These and other varieties are grown to feed power stations for providing hot water and electricity. The system is carbon neutral. The carbon fixing process requires sunlight and takes carbon from the atmosphere. Following harvesting and drying the willow is burnt in a furnace

providing the energy for hot water or electricity production. When burnt the carbon is simply recycled back into the atmosphere.

In Sweden last year, wood chip from willow plantations was used in 35 different district heating plants (DHP). The primary output of these plants is hot water. The heated water is distributed in a grid to heat buildings in communities and towns. 7 of the plants that use willow also produced electricity. All of these DHP's use a mixture of willow wood chips and wood chips from conventional forestry. The willow part of this mixture varies between 5% and 20%. Biomass from different sources is an important and increasing energy source in Sweden and today biomass covers 20% of Sweden's total energy supply.

New, more efficient processes under investigation focus on the production of synthetic gas. A 10 mega-watt plant is currently under trial at Eggborough in Yorkshire, England. In this process the willow chip is heated to 900 degrees centigrade in the absence of oxygen. The gas produced is used to drive a gas turbine. This turbine drives a generator and the waste heat is utilised for drying the wood chip. With these processes we have a means for providing energy that is dependant on current sunlight and not on taking fossil fuels from nature's repository in the earth.

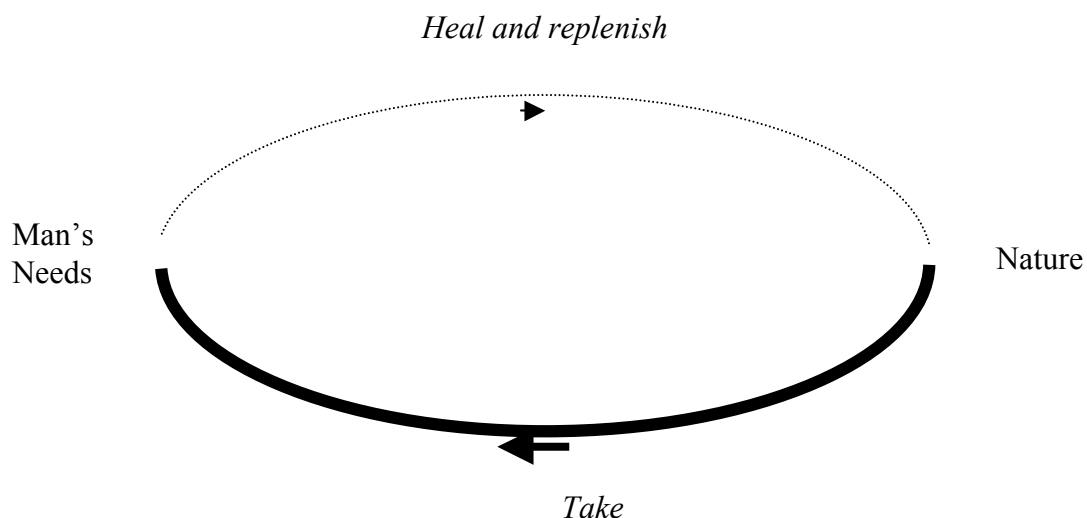
Why do we need to be doing this work in alternative energy systems? It is because the greatest environmental problem we face in the world today is the climate changes provoked by rising levels of man-made greenhouse gases in the atmosphere. It threatens to disrupt economies and ecosystems, challenge existing land uses, substantially raise sea levels and possibly trigger fundamental changes in the Earth's climate.

The 'energy from willow' example shows a practice that is aligned to natural systems. The example also illustrates a very important point - "Nature Recycles Everything".

The Loop

The willow cutting serves as a potential bridge between man's needs to *take* from nature for his technological attainment and the largely uncharted journey of connecting the loop so that man can put back to *heal and replenish* the Planet Earth.

The take and heal loop



I studied Ceramic Engineering at college and the focus of my education was involved with the ‘take’ element. For example, in my ceramic course I gained knowledge of mining raw materials to provide the feedstock, and the use of fossil fuels to provide the energy for the firing process. Little in my education had anything to do with the other part of the loop. In recent history, man’s efforts have been concentrated to learn ‘about’ Nature, so that we can exploit Nature and control her for human well-being. Now it is time to learn ‘from’ Nature so that human existence can be made sustainable.

In fact, the vast majority of people in our society are actively engaged in the ‘take’ element. Few are engaged in the replenish element. Yet if we are to have a sustainable future we have to learn from Nature and work on healing natural systems. Many individuals have flagged its importance and signposted the way. One of the most powerful messages came from Aldo Leopold in the mid 20th century. In his book “A Sand County Almanac” Aldo introduces the concept of a land ethic: *“A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.”*

Earlier still John Muir, one of the giants of US environmental pioneers, drew a line and fought hard to preserve the remaining areas of wilderness in the West. He campaigned for the establishment of National Parks. Without his efforts the ‘take’ mindset would have removed forever many precious areas of natural beauty. John understood the value of wilderness for man as can be seen in this quote:

“Thousands of tired, nerve shaken, over civilised people are beginning to find out that going to the mountains is going home; that wildness is a necessity and that mountain parks and reservations are useful not only as fountains of timber and irrigating rivers, but as fountains of life.”

John had a natural understanding of what constituted wealth - fresh air, pure water, and pristine Sierra landscapes. He wrote passionately about it and awakened countless readers to experience the freedom of a day in the wilderness.

My Journey

My personal journey with these ideas goes back 30 years or so ago when I was CEO of a small Brickworks in Barnsley, South Yorkshire. This Brickworks was part of the AAH group and was called Yorkshire Brick Company. We employed 95 people and our organisation had 1% of the UK Facing Brick Market.

Brick manufacture started at the Yorkshire Brick site around 1900 and quarrying activities have created large worked out holes in the ground. The site processes blended raw materials by the wire-cut extrusion process. This process produces freshly formed “green” bricks, which are subsequently dried and fired in modern tunnel kilns. The output from kilns is blended and packaged into distribution packs. These are held in storage ready for distribution to customers by trucks fitted with off-loading cranes.

The late 1980’s and early 1990’s were a time of crisis for the UK brick industry and for Yorkshire Brick Company. The market for our products dropped dramatically and the number of people employed in the industry fell from 14,000 to 8,000 within a short space of time. Luckily for Yorkshire Brick Company I did not rely on previous knowledge to tackle the problem of the

Company's survival but introduced Dr Deming's 'Fourth Generation Management' concepts into the organisation. The result of introducing systems thinking, understanding variation, the theory of knowledge and people principles – psychology was profound and the business outperformed the rest of the industry by a wide margin.

It is not my purpose to delve into the success of the business in this presentation, as it has been documented elsewhere¹. What I would like to consider is what Dr Deming, if he were alive today, would be paying attention to. I can only think that he would be seeking to focus his attention on what for man is the ultimate system – the system of life on Earth. For unless we can move to a new level of understanding, life as we know it will not be sustainable. It is not possible for the major trading nations to continue with a policy of growth when we have a planet with finite resources.

Wasteland

When I arrived at Yorkshire Brick in the summer of 1973 I found a site that had been quarried for raw materials for some 70 years. Of the 70 acres owned by the Company some 30 acres were derelict worked out quarries. In addition, the site was located in the South Yorkshire coalfield and the immediate area was a mess with colliery waste, collieries, coal stocking areas and railway sidings. It seemed to me that the countryside had been plundered all in the name of 'progress'. It was a heart-rending example of the 'take' philosophy without any thought for the cost. As well as the visual pollution, the atmosphere was treated as a 'no cost' dump with noxious emissions from nearby coking plants. The brick manufacturing plant was also out of date having had little investment in new equipment over several decades. What new equipment had been added was lying idle, as there was no market for its product.

Restoration Begins

In 1974 the UK government introduced a Health & Safety at Work Act. Under this Act I had to consider the risks to children swimming in ponds in the worked out quarries. The Act laid the responsibility for any accidents on the Company and to minimise risks we set about restoring the worked out land with domestic and commercial waste. This was a stroke of good fortune, for not only did the activity produce a significant income, but also in addition on the 5th of May 1981 we discovered the site was producing Landfill Gas – a source of energy for firing our products. Landfill Gas is a mixture of methane and carbon dioxide that is formed by the biodegrading of the organic fraction of the waste. We established that there were large commercial quantities available and by 1983 we had implemented a Landfill Gas recovery system that enabled us to use the gas as a substitute for natural gas in our kilns. The benefit to date is several million dollars and the emissions produced when the gas is burnt are less dangerous to the planet than if they were allowed to leak into the atmosphere. (Methane is 27 times more potent a contributor to global warming than carbon dioxide.)

The rate of input of waste was impressive, with as many as six vehicles a minute delivering to the site. I was left in no doubt that the scale of this activity was far in excess of our brick manufacturing operations. The restoration of the derelict quarry land proceeded apace. The new landforms created were covered with multi layer caps of low permeability clays and then a layer of soil was added. The major part of the area was restored to grassland but pupils from a nearby

school planted a significant area with trees. They also planted 5,000 willow cuttings to capture carbon from the atmosphere. New footpaths were developed and the local community was encouraged to use the amenity provided.

What is remarkable about this story is that we now had a system in place that substituted the use of natural gas from sources many millions of years old with gas that came from similar organic sources only a few years old. The revenue from the operations was a welcome addition to our income and we were in the business of restoring the worked out land to a high standard. The work with the local community was an added bonus and very soon a whole range of new activities were underway with local schools, universities, research organisations, the local council, various charitable trusts and even the local jail. We built a small kiln for the local school and the pupils were soon harvesting, stripping and burning the willow to provide drawing charcoal.

Another initiative was a partnership with the local council, which led to the production of several hundred tonnes of compost being manufactured in 1993. This pilot project resulted in savings in waste disposal charges for the council of some \$49,000 per annum.

I found through my experience at this site that there is no conflict between running an organisation with a focus on quality and achieving a high standard in environmental performance. The situation is quite the opposite in fact. Sound environmental management is good business.

Antique Brick

At the same time as these environmental initiatives were taking place the production capacity of the site was increased five fold from 5 million to 25 million units a year. This was achieved through investment in new machinery and through fostering a culture of learning and development for everyone working at the site. Adoption of the Deming Philosophy led to a massive reduction in waste and rework, and the value of the output increased as we developed a process for improving our products and service. The Yorkshire Brick Company is a good example of how Taguchi's notion of 'loss to society' can be applied to create employment and profits whilst benefiting the environment and the community.

We also moved into new markets. One innovation was related to manufacturing new bricks to high standards coupled with an old looking, timeworn appearance. I took time out to visit villages that had originally been on the sea coast of Holland. The brick buildings there had mellowed with the impact of several centuries of salt laden winds fresh from the North Sea.

On the UK side of the North Sea, I found a small building in the Essex marshes that had been built in 654 AD by St Cedd who brought Christianity to the area from Holy Island far to the North in Northumbria. What is unusual about this church is that the masons used reclaimed brick from a Roman Fort that had been built four hundred years previously during the Roman occupation. Not only is this a fine example of early recycling but also is an example of how man inadvertently over-engineers the things that we make. We are insensitive to the waste in resources that is inherent in much of what we manufacture

The universe contains a finite amount of energy. In Nature we have near-perfect recycling systems that are driven by energy inputs from the sun. The design of the components fits the life requirements of the system and the systems are closed loops where the waste of one part is the food or building blocks for the next.

If you ever spend time at a landfill, as I have, you will be appalled by the wealth of material discarded by society. Design, in the broadest sense, consists of shaping flows of energy and materials for human purposes. Yet so many things that are discarded follow a ‘one trip’ mentality. There is a fundamental flaw inasmuch that the designers and manufacturers of the vast majority of material goods are not responsible for the full life cycle of the product. They do not have to take back the item at the end of its life and recycle its components. Instead it is left to the ‘waste disposal’ industry and local councils to struggle to cope with the flood of ‘waste’ material. Mark Strutt, a waste campaigner for Greenpeace, has commented:

*“We want producers to take responsibility for making the materials they use recyclable. That way consumers pay for disposal when they buy a product rather than everyone paying for it later through their taxes.”*²

Waste destined for landfill contains an ever-increasing amount of man-made material that does not break down in Nature’s systems. We have given up the centuries of wisdom gained by working with natural materials. A few years ago a 13th century basket was discovered in an archaeological excavation in Perth in Scotland. Finding such an article is rare, as the conditions have to be just right for it to be preserved for so long. The basket is similar in appearance to baskets made by basket makers today. Countless numbers of baskets must have been made, used and discarded by generations since the 13th century but very few remain to clutter up our planet. That will not be the case with many non-biodegradable man-made objects today.

Even with today’s far from satisfactory situation with regard to the upstream management of waste, high levels of recycling and waste reduction are possible. I visited the village of Wye in Kent in the early 1990’s to see a waste project started in 1989. This project has recently been in the news with an article in the Guardian newspaper. Wycycle is the brainchild of Richard Boden who started the not-for-profit company when he was a student at a nearby agricultural college. 1989 saw a surge of environmental awareness in the UK.

“Farming students were sitting around in the union talking about it, but, being a business management student, I got off my backside and did something.”

says Boden. The average British household produces about 1,000kg of rubbish a year. Through schemes set up by Wycycle, households in Wye and neighbouring Brook are down to an average of 250kg. This 75% saving puts the scheme in the premier league of waste reduction projects, according to the UK pressure group Waste Watch.³

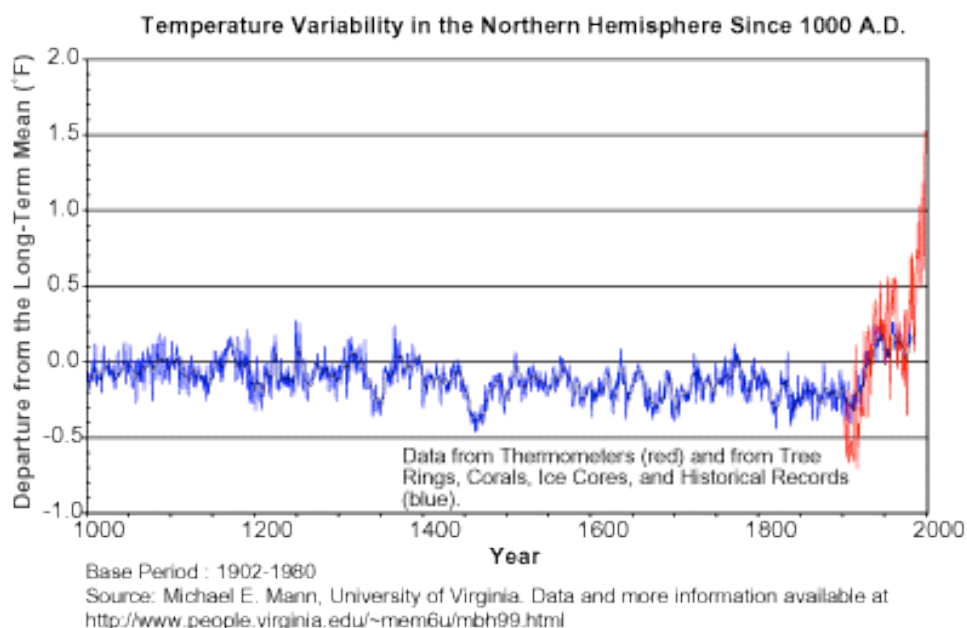
Global Warming

The Aegiranum Marine Band is a band of sediment from the Carboniferous period of the Earth’s history. During the Carboniferous epoch there were some 70 separate ‘global warming’ periods where sea levels rose and marine sediments were deposited on the land. Three of the seventy were major events and the Aegiranum band is the top one of the three. The band outcrops at the Yorkshire Brick site at Barnsley, tracks across Europe to the East as far as the Urals, and as far West as Texas, with the portion of where we have the Atlantic Ocean missing. The sediments

contain a myriad of fossils and are a great attraction to children of all ages. They are also dark grey in colour with circa 3% carbon.

Looking at the sediments it struck me that here we had an excellent example of a carbon repository in the Earth's crust, a 'deposit' of plant remains made by Nature some 310 million years ago that we are in the process of withdrawing. To facilitate our lifestyles we are withdrawing carbon from the crust at a colossal rate and converting it into carbon dioxide in the Earth's atmosphere. Data taken from ice cores representing several hundred thousand years shows a remarkable correlation between the levels of carbon dioxide and the global mean surface temperature.

More recent data shows that global mean surface temperatures have increased 0.5 to 1.0 degree F. since the late 19th century. The 20th century's 10 warmest years all occurred in the last 15 years of the century.⁴ Of these 1998 was the warmest year on record. The snow cover in the Northern Hemisphere and floating ice in the Arctic Ocean has decreased. (The ice in the Arctic ice cap is now some 40% less thick than in the late 60's and the ice at the North Pole melted last year.)⁵ Data taken from tree rings, corals, ice cores, historical records and thermometers shows the dramatic warming that has occurred since 1950. The Intergovernmental Panel on Climate Change has concluded that this is due to man-made emissions of greenhouse gases.



The carbon taken from the Earth's crust to feed our power stations, our cars and a host of other systems is having a serious impact on our climate and is set to have an even greater impact. Carbon dioxide concentrations in the atmosphere were around 275 parts per million before the industrial revolution. They are currently 370 parts per million and are forecast to reach levels in the range of 540 to 970 parts per million by the year 2100.⁶ The process of burning fossil fuels to satisfy our needs for energy is a linear 'take' one and the products of combustion are ending up in what has been considered to be a 'free' dump – the planet's precious atmosphere.

Long-term management of the natural capital of the soil, seas and atmosphere is an easily forgotten pre-condition for all economic activity. Put bluntly, no planet, no business. But the rich

only measure financial debts. The cost to the environment and its value is not taken into account, even though that debt dwarfs all others. Burning fossil fuels incurs a debt owed by the developed world for mismanagement of the atmosphere and its associated costs. Already the economic damage attributable to climate-change-driven natural disasters has been put at more than \$280bn per year. Who ends up paying for this?

At least five small island states are at risk, due to global warming, of ceasing to exist in the next 30 years. For example, sea level rise in the range expected by the Inter-governmental Panel on Climate Change would devastate the Maldives. While relatively few people live in small island states, in Bangladesh 20 million could be displaced, and up to 10 million forced to move in the Philippines, while millions more in Cambodia, Thailand, Egypt, China, and across Latin America would be threatened.⁷

It is Time to Draw the Line

John Muir drew the line and the development of the National Parks followed. With global warming it is time to draw the line and retain a habitable planet. The link between our wealth and comfort, and the Third World upheaval, is inescapable. Fossil fuels provide 87% of commercial primary energy, but burning them adds to climate change. Conservative estimates suggest that the OECD spends around \$60-80bn per year on energy subsidies, including fossil fuels and fossil fuel-based activities to make the problem worse. Embarrassingly less goes to helping the victims adapt.

The awareness that emissions to the atmosphere are not ‘free’ anymore is growing but the *action* required to slow down and reverse the trends in carbon dioxide emissions is currently failing to address the problem. Last year Shell, Europe’s largest oil group, announced plans to spend up to \$1bn on wind power and solar energy over the next five years. Karen de Segundo, Chief Executive of Shell Renewables, said it aimed to increase its solar business by 25% a year, in line with the market. She admitted that the commitment to spend between \$500m and \$1bn by 2006 was subject to:

“Ongoing economic review”

And the figures are *dwarfed* by its expenditure on oil and gas.⁸ In reality in view of the size of the global problem the expenditure levels need to be the other way around. It is wrong for Industrial nations to continue to be dependant on an economy based on fossil fuels when emissions from the burning of these fuels threatens homelessness due to flooding for many millions throughout the world.

In the words of Aldo Leopold:

“A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.”

We Are Each Responsible

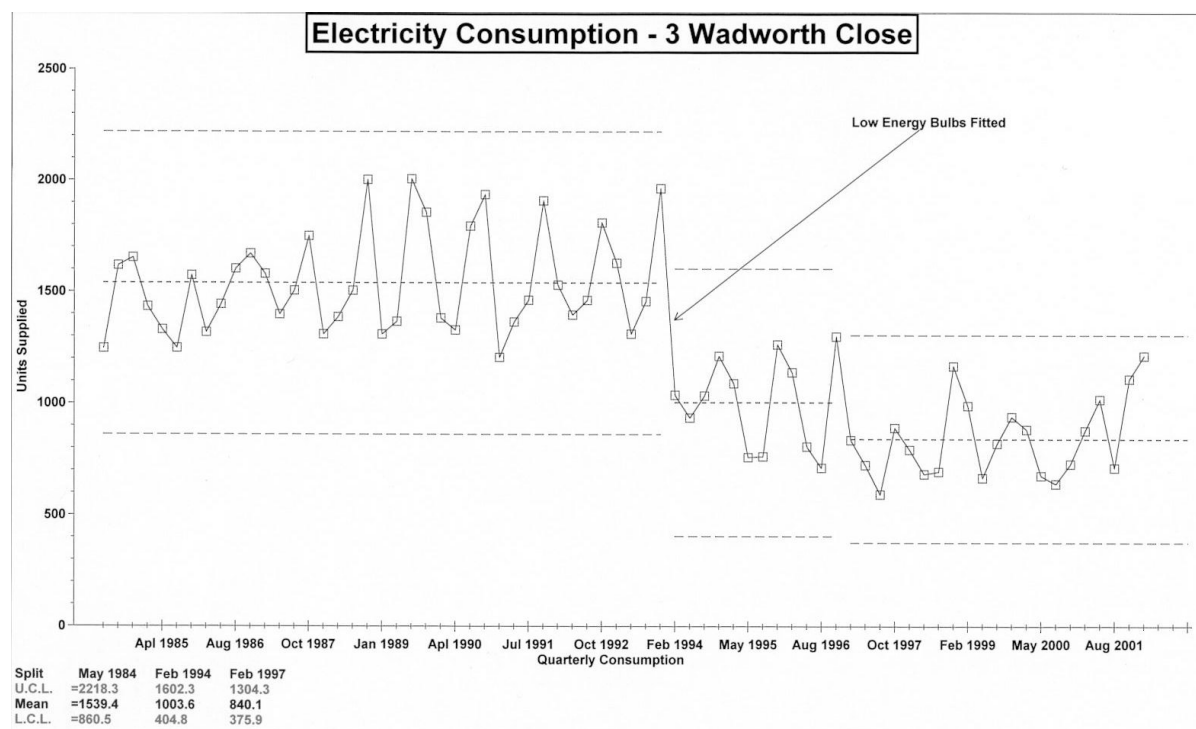
As we know from the Richard Boden example, talking about an issue and doing something about it are quite separate and with global warming now is the time to be taking action. As David Langford learned from Dr Deming in his early days at Mount Edgecombe School in Sitka, Alaska, we are all in charge of something and we simply start there doing what we can, when we

can, with the resources that are available at the time. It is all you can ask of yourself and all you can be asked to do.

The WWF web site www.org.uk/whocares shows that the WWF is lobbying government and industry, but everyone can make a difference. The site includes a page related to global warming. Bearing in mind the advice of Mahatma Ghandi:

"You must be the change you wish to see in the world."

I have been seeking to reduce our family energy consumption. Following the WWF guidelines I have been able to markedly improve the fuel efficiency of my car. The fuel consumption has improved from 27 mpg eight years ago to 51 mpg now. Energy consumption for our central heating and hot water supplies has decreased by over 30% in the past year due to the installation of a modern oil fired boiler and a new solar system for our hot water. (Consumption of Kerosene was 2800 litres in 2001 compared with an average consumption of 4400 litres over the period 1996 to 2000.) Fitting low energy light bulbs brought about a significant decrease in our electricity consumption. From an environmental standpoint this decrease pales into insignificance compared to the situation where we have recently switched to an electricity supply from a renewable source. In this contract the supplier guarantees to match our consumption from a renewable resource such as wind power or hydropower.



Units of electricity (kWh) supplied quarterly to 3 Wadworth Close.

It was Thomas Edison in the early part of last century who said:

“We are like Tenant Farmers, chopping down the fence around our house for fuel, when we should be using nature’s inexhaustible sources of energy – sun, wind and tide. ...”

And

“I’d put my money on the sun and solar energy. What a source of power! I hope that we don’t have to wait till oil and coal run out before we tackle that. I wish I had more years left!”⁹

On the wider issue of moving to a more sustainable lifestyle I have included a list of “50 things you can do to lead a more sustainable lifestyle” in the appendix. This year the Deming Forum is holding the UK Deming Forum at the Earth Centre in the UK on the 15th and 16th May. The Earth Centre’s mission is to become the centre of first choice for the understanding and application of sustainable development in everyday life. The list is taken from the Earth Centre’s Action Plans. It is aimed at householders in the UK but many of the items are relevant to US households.

Finally, everyone can make a start here and now by planting a willow cutting and experiencing the magic of fixing carbon from the atmosphere. Our willow cuttings are going to be an element in the *real* solution to a sustainable world.

Notes:

1. See papers: How Business and Stakeholders Can Build Win/Win Relationships For A Vibrant Community Today and Tomorrow. OQPF’s 12th Annual Deming Conference August 16-17-18-19, 1998. Systems Thinking in Practice. British Deming Association Eighth Annual Conference 10 May 1995.
2. Article in Guardian Society, Fired up for action, 16 January 2002.
3. Article in Guardian Society, Sorted for ease, 2 January 2002.
4. Information from www.epa.gov/globalwarming/climate/index.html
5. Article in the Guardian, Global Warming A world of extremes as the planet heats up. 23 January 2001.
6. Article in The Guardian, Global Warming A world of extremes as the planet heats up. 23 January 2001.
7. Article in Guardian Society, Plunder in paradise, 6 March 2002.
8. Article in The Guardian, Shell’s \$1bn green energy plan pleases campaigners, 15 June 2001.
9. Thomas Edison quotations by kindness of the *Uncommon Friends Foundation* Fort Myers, FL.

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Deming, W.E., The New Economics, first edition, MIT CAES, Cambridge, Massachusetts, 1993.

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Resources:

Willow cuttings are available in the US from Bonnie Gale, 412 County Road 31, Norwich, NY 13815-3149. Telephone 607 336 9031 & Fax. Email address bonwillow@ascent.net

In the UK they are available from Lionel Hill MBE, Dunstall Court, Feckenham, Near Redditch, Worcestershire. B96 6QH. Telephone (0)1527 892472 Fax (0)1527 893401.

The UK Basketmakers Association and IACR Long Ashton Research Station have produced a useful guide to the cultivation of willows. The title is "*Cultivation and Use of Basket Willows 2001.*" Copies (price £5.00) are available from: The Basketmakers Association (Sales) 216 Walton Road, East Molesey, Surrey, KT8 0HR, UK and via www.basketassoc.org

Acknowledgements:

I would like to thank: Murray Carter of Ingerthorpe Hall Farm, Markington, Harrogate, North Yorkshire, UK for the up to date information relating to growing willow for energy crops in the UK. Stig Ledin, Nils-Erik Nordh and Par Aronsson of the Department of Short Rotation Forestry, Swedish University of Agricultural Sciences at P.O. Box 7016, S-75007, Uppsala, Sweden who kindly gave me information and a set of images relating to willow growing and harvesting in Sweden. Paula Tagg and Damian Culshaw of Biomass Energy Limited, 91, Hanover Street, Edinburgh, EH2 1DJ, who were kind enough to invite me to a demonstration of the Mantis Willow Harvester in Penrith, Cumbria, UK. Thanks also to Andy Oldridge, Fuel Supply Officer of ARBRE Energy Limited, Energy Information Centre, Selby Road, Eggborough, DN14 0FG, who supplied me with information about the ARBRE project.

Finally my thanks to Hazel Cannon, Director of PRISM-TBM, Paul Hollingworth, Director 4GM, Christine Robertson, Environmental Manager, Marshalls PLC and Margaret Morgan, President of the Lindbergh Symposium for taking time to read the draft documents and for providing helpful commentary.

Appendix

50 things you can do to lead a more sustainable lifestyle

1. Only use as much detergent as you need. It contains phosphates, which can kill fish and other organisms in lakes and rivers. Use eco-friendly products where possible.
2. Encourage wildlife in your garden. Plant flowers to attract insects (butterflies particularly like buddleia, honeysuckle and large daisy-like flowers). Birds like berries and fruit. Put up a bird table, bird or bat box.
3. Take showers instead of a baths. Replacing one bath with a shower a week can save 25 litres of water.
4. Don't put things down the toilet, which are not broken down by the sewerage process (e.g. sanitary products and condoms) as they pollute the water system.
5. Turn down your thermostat by 1 deg. C. or use 1 hour less heating per day, to cut household carbon dioxide emissions by 5-10%.
6. Insulate your loft with glass fibre or mineral wool and lag hot water heaters, tanks and pipes.
7. Change to fluorescent light bulbs. These produce the same amount of light for about one fifth the energy of ordinary light bulbs and last 8 times longer.
8. Only boil as much water as is needed in the kettle.
9. Cool foods to room temperature before putting them in the fridge or freezer.
10. Use cooler wash temperatures and full loads in washing machines, and let clothes dry naturally.
11. Ask your electricity company for renewable power or a green tariff to promote renewable power generation.
12. Avoid unnecessary packaging – e.g. buy loose fruit and vegetables.
13. Avoid disposable products - buy longer lasting items and repair products whenever possible.
14. Walk or cycle. Short journeys, before your car engine is warmed up, cause most pollution.
15. Stop junk mail coming through your letterbox. Remove your name from the mailing lists by registering with the: Mailing Preference Service, Freepost 22, London W1E 7EZ.
16. Choose products in reusable packaging (milk bottles can be reused up to 100 times) and ones for which you can buy refills, and reuse packaging for storage – boxes, jars, etc.
17. Set up an allotment. By growing your own vegetables you can be sure to avoid chemical fertilizers and pesticides, and the vast distances food so often travels.
18. Replace washers in dripping taps. A tap dripping one drop per second can waste 5 litres of water an hour – that's 2700 gallons per year.
19. Try to use easily recyclable materials. e.g. glass instead of plastic, and buy products made from recyclable materials.
20. Encourage your local authority to improve its recycling facilities, perhaps by providing a plastic recycling point or a doorstep collection scheme.
21. Have a catalytic converter fitted if your car has not already got one.
22. Help reduce the damage done by the waste already out there: Join in an organised clean-up event such as National Spring Clean (organised by the Tidy Britain Group)
23. Avoid using hoses or sprinklers. Instead, install a water butt and use rainwater or buckets of water from other uses.

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24. Buy organic food and goods. These are produced without chemicals such as pesticides, herbicides or growth regulators, without unnecessary cruelty to animals and using a sustainable system.
 25. Use public transport. On average, public transport uses less than half as much fuel per passenger mile than a private car.
 26. When buying a car, go for something small and fuel efficient, with an engine size of 1.4 litres or less.
 27. Avoid using chemical fertilizers and pesticides in your garden and make your own compost.
 28. Driving at 70mph uses 30% more fuel than at 50mph.
 29. Buy less. In the richest countries, 20% of the world's population consume 80% of the natural resources. Make a shopping list so you do not buy things you do not need.
 30. Water plants in the morning or evening to allow water to get to the roots rather than just evaporating.
 31. Lobby your local supermarket not to put premiums on the cost of organic food and goods.
 32. Keep your car properly maintained to ensure lower emissions and higher efficiency.
 33. Buy local. Transporting fruit and vegetables across the world needs 4 litres of fuel for each kg of produce and generates pollution from the planes and lorries used. Buying locally grown food supports your local community. It is also less likely to have preservatives, irradiation treatment, false ripening, etc. before it gets to you.
 34. Wait until you can wash a full load in your dishwasher or washing machine, and use the short cycle.
 35. Buy a low-volume toilet unit, which uses less than half the water of old models.
 36. Switch off lights and appliances when not in use, including turning the TV and video off rather than leaving them on standby.
 37. Turn off your car engine when stuck in traffic for more than two minutes.
 38. Close curtains at dusk to reduce heat loss through windows.
 39. Use mains power rather than batteries. If you must use batteries, use rechargeable, which can last 15 times longer than ordinary batteries.
 40. Compost your kitchen and garden waste.
 41. One of the easiest ways to avoid exploitation of producers is to buy 'fair-trade' products to guarantee that producers get a fair share of the price you're paying. This includes 'premiums' used to benefit the community, for instance towards providing better education opportunities, increased medical care or improved living conditions.
 42. Consider a local holiday, and if possible travel by boat or train rather than flying.
 43. Make ethical investments.
 44. Volunteer to help in your local school or community.
 45. Join a car-share scheme, or share the journey to work or school.
 46. Join a local box scheme for organic produce delivered direct to your door.
 47. Have solar panels fitted to your roof.
 48. Use your own shopping bag rather than plastic carrier bags.
 49. Place foil behind your radiators to reflect heat back into the room.
 50. Buy products that are built to last. Choose ones with long guarantees and ask if the shop will take the product back to be recycled at the end of its lifecycle.

Taken from the Earth Centre's Action Plans

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