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Feature thought:

“We have lived by the assumption that what is good for us is good for the world. We have been wrong. We must change our lives, so that it will be possible to live by the contrary assumption that what is good for the world will be good for us.”

*Wendell Berry, Recollected Essays*¹

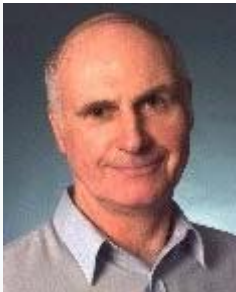
Dear Networkers:

SUSTAINABILITY NETWORK UPDATE – No 30E

Some of us have a “love-hate” relationship with mining and the metals and minerals industries, acknowledging our dependence but concerned by environmental disturbance at one end of the production chain and pollution at the other. Metals, however, when used judiciously for vital purposes, have properties in harmony with contemporary aims for improved closure of industrial process loops. Our main feature elaborates on these properties. Two additional short features look at some home truths about renewable energy, and respond to the idea of “boundary-lessness” with a more useful concept of “permeability.”

Tops at recycling: Metals in sustainable development

Terry Norgate² Terry.Norgate@csiro.au - and John Rankin – John.Rankin@csiro.au of CSIRO Minerals, are deeply involved in the research drive to improve resource efficiency and lower environmental impacts in the minerals and metals processing sector. Their work is helping industry and policy makers to assess current performance and make informed decisions based on the potential for future improvements. Here they provide us with some insights into how the recyclability of metals can contribute to more sustainable lifestyles, and into some of the issues associated with their use and re-use. The paper on which this feature is based was presented at the Green Processing 2002 Conference, Cairns, May 2002.



Terry Norgate



John Rankin

¹ Thanks to Network member Heather Smith for the quote.

² Terry Norgate has also contributed to a previous newsletter feature on Life Cycle Analysis for metals. See pp 2-3 in Update 5 at www.bml.csiro.au/SNnewsletters.htm

World resource consumption is rising rapidly, driven by population growth and rising wealth. Projections suggest the global economy may need to grow fivefold in the next thirty years to meet the aspirations of developing countries³, but there is real doubt as to whether the earth has the capacity to support such growth in resource extraction and disposal. Indeed ‘Ecological Footprint’ analysis, which estimates per capita material and energy requirements, indicates that even in 1997 the ecological footprint of the global population was at least 30% larger than Earth’s biological production capacity, and projects it may rise to 130% by 2030.⁴

Such concerns have contributed to the now widely accepted concept of sustainable development – development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This concept recognises that economic progress must incorporate social and environmental objectives – the so-called “triple bottom line”. It is generally considered that much greater efficiency in the use of resources, together with major reductions in waste and emissions, will be needed to break the link between economic progress and resource consumption.

One way of achieving greater efficiency in resource use is by “**dematerialisation**” – broadly defined as reduction in the amount of energy and materials required to service economic functions such as production of goods and provision of services. Estimates of the necessary reductions have been challenging – for example, the suggestion that industrialised economies will need to deliver the same material outputs with a tenfold (“factor 10”) decrease in resource consumption.⁵ This represents a quantum leap in resource productivity, and a fundamental re-orientation of society’s use of materials. As such, it raises critical questions for resource-extraction industries. To date, progress towards dematerialisation has been most successful in richer countries (high GDP per capita) while in poorer countries the reverse trend has occurred.⁶ Developing countries, where a large part of the new mineral wealth is concentrated, are currently expected to follow the latter path, with a period of increased material and energy intensity lasting perhaps as long as 50 years. Under such conditions, it could take in the order of 100 years to achieve “factor 10” dematerialisation on a global scale.⁴

Closure of materials loops through **re-use of materials** complements the process of dematerialisation. While smaller, lighter products with longer service lives can reduce the amount of materials required to operate the economy, re-use and recycling can help minimise fresh inputs and waste outputs. Of the materials currently used by society, metals have the greatest potential for recycling. They are not biodegradable and their elemental nature means they can have an essentially unlimited lifespan. In effect, once we have extracted them, they can be considered as renewable materials. While the natural mineral deposits from which metals are extracted, are “non-renewable”, hence finite, this does not necessarily mean scarcity. On the contrary, we now know mineral reserves are more abundant than estimated at any time previously.^{7,8}

Anticipated growth in the economies of developing countries as they strive to improve their standard of living means continuing demand for primary metals for many decades at least, even

³ World Resources Institute, 2001

⁴ Yencken, D & D Wilkinson, 2000. *Resetting the Compass: Australia’s Journey Towards Sustainability*, CSIRO Publishing, p. 103.

⁵ Schmidt-Bleek, F, 1996. *The Factor 10*. 4th High Level Seminar on Cleaner Production, UNEP-IE, Oxford.

⁶ Petrie, J & Raimondo, J, 1997. Attempts to close material cycles in industrialised countries: Threat, challenge or opportunity for minerals exporting countries, in *Proceedings of the XX IMPC*, 5:9-25.

⁷ Stewart, S, 2001. Mining, Minerals and Sustainable Development. Mining and Exploration International Conference and Expo (Minex 2001), Perth.

⁸ Young, S, 2001. Renewables/Non-Renewables: A Policy Discussion, International Council on Metals and the Environment, Newsletter, 9(1):1-2.

with increased dematerialisation and recycling. Even the achievement of “factor 10” dematerialisation would still mean a continuing “maintenance” or “make-up” need for primary metals, as the extent of dematerialisation and recycling will be limited by metal quality, product recovery, and thermodynamic constraints (i.e., 100% conversion efficiency is physically impossible).

Performed responsibly, exploration, extraction and metal processing activities can contribute to the goals of sustainable development by helping to create wealth, alleviate poverty, and improve health, education and community standards of living, particularly in remote and regional areas. In many countries, minerals and metals industries are major contributors to that country’s well-being.

Life Cycle Assessment (LCA) of metal production, covering primary (extraction) and secondary (re-use) processes, can be used to examine costs, benefits, and ways in which metals may contribute to society’s transition to more sustainable patterns of development. These can then be linked with consideration of metal reserves, future metal scarcity, recycling issues, and the potential impacts of carbon or energy taxes.

Table 1. Economic grades, reserves, production rates and years of supply

Metal	Economic ore grade (%w/w)	Reserves (Mt of metal)	Production in 2000 (Mt/y) ¹	Years of supply ^{2,3}	Year of reserve estimation
Iron/steel	30 - 60	65,000	842	77	1995
Aluminium	27 - 29	3,910	24.2	162	1997
Copper	0.5 - 2	320	14.8	22	1997
Lead	5 - 10	65	6.6	10	1997
Zinc	10 - 30	142	8.9	16	1995
Nickel	1.5 - 3	47	1.1	43	1995

Notes: 1. Includes primary and secondary metal.
 2. Assumes consumption rate closely balanced to total production rate.
 3. Assumes no recycling.

Metal Resources and Reserves

It is important to distinguish between resources and reserves. A resource is a concentration of naturally occurring material in the earth’s crust in such form and amount that extraction of a commodity is currently or potentially feasible. A reserve is that part of an identified resource which could be economically extracted or produced at the time of determination. For example, estimated world reserves of aluminium and iron are given in Table 1 at 3,910 and 65,000 Mega-tonnes (Mt) respectively, while the world resources of these metals are estimated at 11,000 and 230,000 Mt respectively⁹. In practice, estimated metal reserves change constantly, reflecting changes in metal prices and relative currency values. The world reserves of metals from existing resources could increase significantly if metal prices increase and/or new processing technologies are developed that lower the grade of ore economically recoverable from a resource. Alternatively, metal reserves may also increase through new resources being identified. The estimated current reserves of several industrial metals are shown in Table 1 along with typical economic processing grades for their ores.¹⁰ These reserves are also expressed in terms of years of current-level production (assuming no metal recycling).

⁹ Dzioubinski, O, and R. Chipman 1999. Trends in consumption and production: Selected minerals, DESA Discussion paper No. 5, (www.un.org/esa/papers.htm); U.S. Bureau of Mines, 1995. Mineral Commodity Summaries, Jan. p. 85.

¹⁰ Kirk-Othmer, 1995. *Encyclopedia of Chemical Technology*, Fourth edition, 16:316 (John Wiley & Sons).

In addition to reserves, the largest (and rapidly growing) stocks of metals are “metals in use”. These stocks represent a virtually permanent asset for society because metals are not consumed during production and use in the same way as energy or degradable materials. The best known example is gold, for which it is estimated that 80% of all gold ever produced is still “in use”. While, in principle, metals can be recycled indefinitely and passed on from one generation to the next, in practical terms, this is only possible for metals used in non-dissipative applications where the metal can be economically recovered. Figure 1 shows how the “years of supply” term in Table 1 increases as the recycling rate increases for the various metals considered (with the lines approaching infinite years of supply as the recycling rate approaches 100%). The figure pre-supposes no problem in meeting the demand for scrap metal for recycling. This depends, however, on the life-span of the various metals in particular applications.

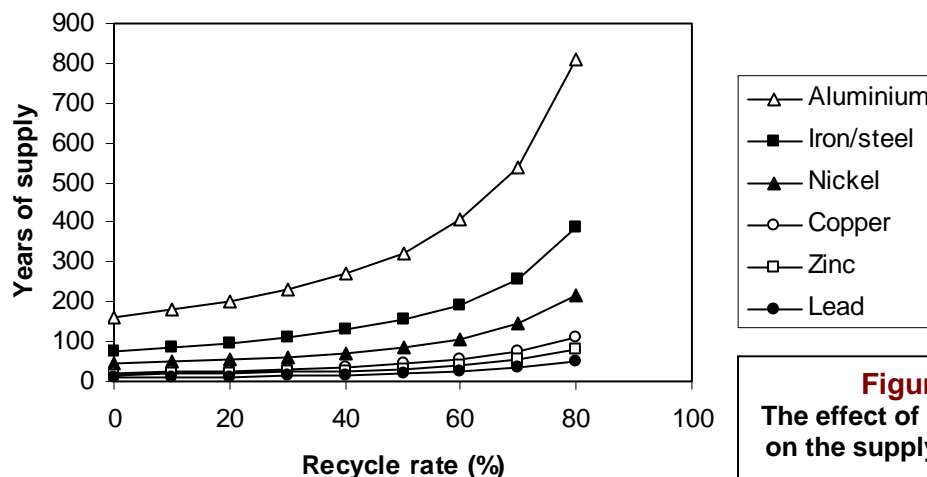


Figure 1
The effect of recycle rate on the supply of metals.

For all the foregoing considerations, it is inappropriate to link or equate the non-renewability of metal resources with expectations of future metal scarcity. The challenge is to devise policies and actions that will optimize the efficient use of metal resources and stocks while at the same time minimising their environmental impacts. This will include frameworks to guide manufacturers in their selection of materials and consumers in their choice of more environmentally friendly products. One of the tools now being used to this end is LCA.

Life Cycle Assessment of metal production processes

LCA is a technique for assessing the potential environmental impacts associated with a material or product from “cradle to grave”, i.e., from raw material acquisition, through production, use and disposal. It involves compiling an inventory of relevant environmental exchanges throughout the life cycle of the material or product, and evaluating the potential environmental impacts associated with those exchanges. This “life-cycle” approach to process analysis had its origins in energy analysis studies in the 1960s and early 1970s.¹¹ The methodology has been refined over the last two decades and is now the subject of an international standard (ISO 14040 series).¹² The objective of most LCA studies is to find the design option that minimises the life cycle impact of the process or product. LCAs are increasingly being used by consumers of metal and other material products, environmental advocacy groups, and regulators to evaluate environmental performance along today’s increasingly complex supply chain.

¹¹ Weidema, B, 1997. Environmental Assessment of Products: A Textbook on Life Cycle Assessment, The Finnish Association of Graduate Engineers TEK.

¹² For a description of the LCA methodology, see Norgate & Rankin (2000), footnote 13.

We have carried out a series of LCAs on primary metal production processes (for copper, nickel, lead, zinc, aluminium, iron and steel) as part of the CSIRO research commitment to sustainable resource processing.¹³ These were partial LCAs, restricted to “cradle-to-gate” (from ore extraction through to the point where refined metal is made available for manufacturing). They also examined alternative process routes, such as pyrometallurgical (furnace smelting) and hydrometallurgical (extraction into solution). It should be noted, however, that in many instances there is no real choice as to which process should be used in a particular situation – this is largely determined by the nature of the deposit, particularly the ore mineralogy and grade.

Table 2. Life cycle energy, GWP & AP for various metal production processes

Metal	Process	Total energy (MJ/kg)	GWP ¹ (kg CO ₂ e/kg)	AP ¹ (kg SO ₂ e/kg)
Iron/steel	BF/BOF ²	22	2.3	0.02
Aluminium	Electrolytic ³	211	22.4	0.13
Copper	Pyromet ⁴	33	3.3	0.04
	Hydromet ⁵	64	6.2	0.05
Lead	BF ⁶	20	2.1	0.02
	ISF ⁷	32	3.2	0.02
Zinc	Electrolytic ⁸	48	4.6	0.06
	ISF	36	3.3	0.03
Nickel	Pyromet ⁹	114	11.4	0.13
	Hydromet ¹⁰	194	16.1	0.07

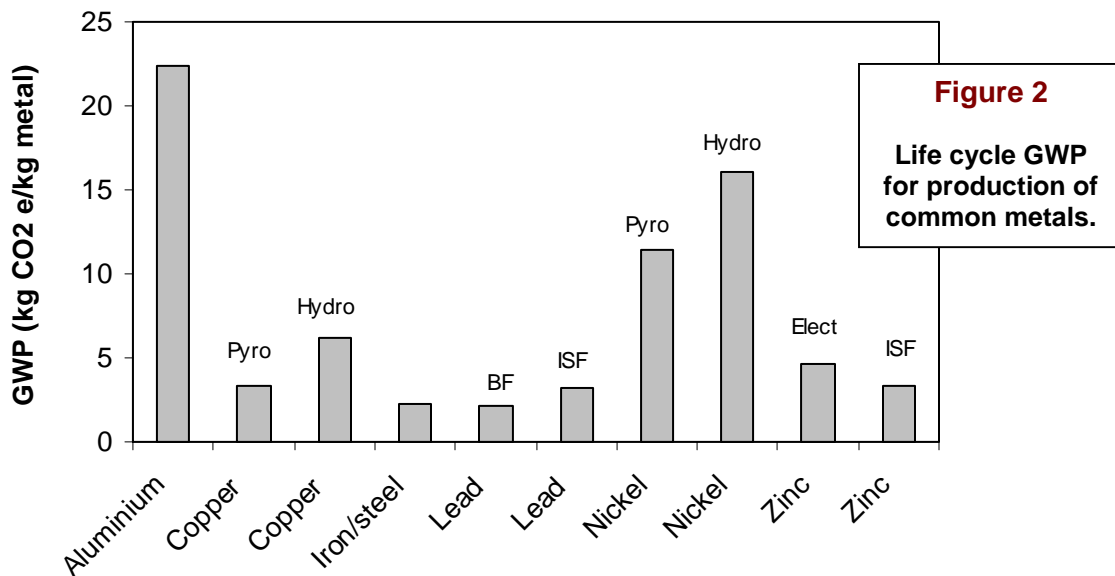
- Notes:
1. Black coal-based electricity
 2. Blast Furnace & Basic Oxygen Furnace (iron ore, 64% Fe, 50% lump, 50% fines, open-cut mine)
 3. Bayer & Hall-Heroult processes (bauxite ore, 17.4% Al, open-cut mine)
 4. Matte smelting, converting & electro-refining (sulphide ore, 3.0% Cu, underground mine)
 5. Heap leaching, solvent extraction & electrowinning (sulphide ore, 2.0% Cu, underground mine)
 6. Blast Furnace (ore 5.5% Pb, underground mine)
 7. Imperial Smelting Furnace (ore 5.5% Pb, underground mine)
 8. Roasting & electrolysis (ore 8.6% Zn, underground mine)
 9. Flash furnace smelting & Sherritt-Gordon refining (sulphide ore, 2.3% Ni, underground mine)
 10. Pressure acid leaching, solvent extraction & electrowinning (laterite ore, 1.0% Ni, underground mine)

While a number of different environmental impact categories can be included in an LCA, the ones we considered were total (full-cycle) energy consumption (based on black-coal-based electricity), Global Warming Potential (GWP) and Acidification Potential (AP). The latter two categories are the combined contributions of the various gaseous emissions to global warming and acid rain respectively, expressed in terms of kg CO₂-equivalent (CO₂-e) or kg SO₂-equivalent (SO₂-e) per kg of metal produced. The key results are summarised in Table 2 and Figure 2.

Novel innovations in production methods and improvements to existing processes may, over time, lead to significant reductions in the energy and GWP values given in Table 2. For example, in our 2001 study of aluminium (footnote 13) we reported that technologies currently being developed for the Bayer/Hall-Heroult processing route for aluminium production, such as inert anodes, drained cathodes and low temperature electrolytes, may give reductions in the order of 30% and 40% for total energy and GWP, respectively, for coal-based electricity, or 50%

¹³ Norgate, T E and Rankin, W J, 2000. Life cycle assessment of copper and nickel production, MINPREX 2000 (The AusIMM), Melbourne, pp. 133-138; Norgate, T E and Rankin, W J, 2001. Greenhouse gas emissions from aluminium production – a life cycle approach. *Greenhouse Gases in the Metallurgical Industries: Policies, Abatement and Treatment, COM2001*, Met. Soc. of the Can. Inst. Min. Met. & Pet., Toronto, pp. 275 – 290; Norgate, T E and Rankin, W J, 2002. An environmental assessment of lead and zinc production processes, *Green Processing 2002* (The AusIMM), Cairns, or contact Terry.Norgate@csiro.au

and 70%, respectively, for natural gas-based electricity. In other words, LCA analyses are capable of demonstrating potential savings on environmental impacts.



The results in Table 2 are only for the cradle-to-gate stage of the metals' life cycle. Subsequent downstream use of the metals have not been considered here. Inclusion of the latter stages of LCA (i.e., "gate-to-grave") will have a significant effect on the comparative environmental impacts of some metals.

For example, the substitution of light for heavy metals (such as magnesium for steel) in transport applications (such as vehicle manufacture) would significantly reduce the downstream life-cycle energy consumption and greenhouse gas emissions associated with use of these applications.¹⁴

The influence of ore grade

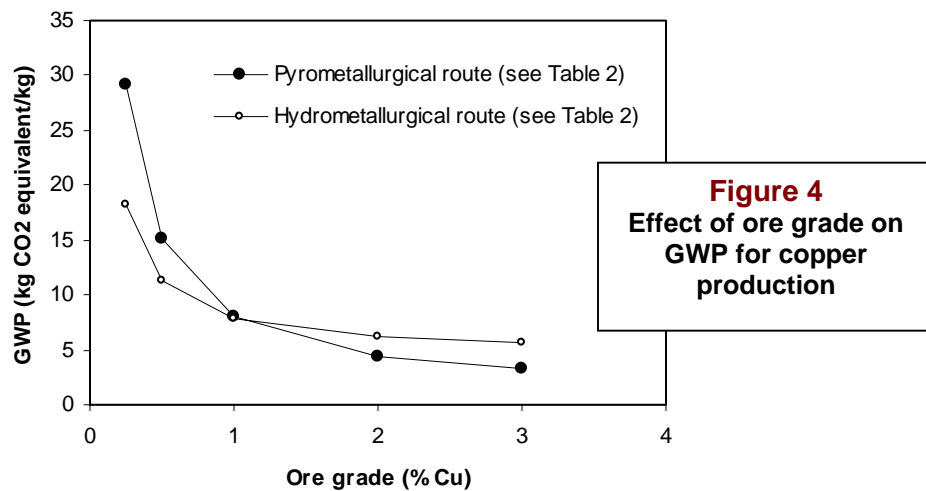
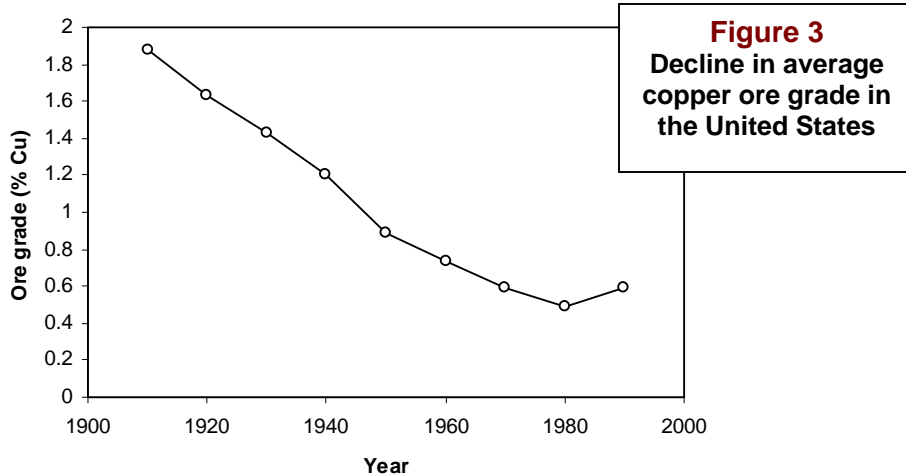
The current ranges of economically recoverable ore grades for a number of metals were given in Table 1. As higher-grade reserves are progressively depleted, the mined ore grades gradually move down these ranges. For example, the average grade of copper ore mined in the United States over the last century is shown in Figure 3.¹⁵ This reduction in grade has a dramatic effect on the energy consumption and accompanying greenhouse and acid-rain gas emissions from metal production processes. This is illustrated in Figure 4 for copper production. We have also found a similar trend for nickel production.

The impact of declining ore grade on GWP shown in Figure 4 comes about largely because of the additional energy that must be consumed in the mining and mineral processing stages to move and treat the additional gangue (waste) material. Once a concentrate or mineral product of a specified grade has been produced, the downstream processing (e.g., smelting and

¹⁴ Martchek, K and Pullen, J, 1996. Application of Life Cycle Assessment in an automotive context, in *Proceedings of the National Conference on Life Cycle Assessment*, Melbourne. Das, S, 2000. The life-cycle impacts of aluminium body-in-white automotive material, *Journal of Metals*, 52(8):41-44.

¹⁵ Kirk-Othmer, 1995. *Encyclopedia of Chemical Technology*, Fourth edition, 16:316 (John Wiley & Sons).

refining) is not significantly affected by the original ore grade. The greater the contribution of the mining and mineral processing stages to overall energy consumption, the greater will be the effect of ore grade. This point is illustrated with reference to Figure 4, where the mining and mineral processing stages contribute 60% and 30% to the overall energy consumption for the pyrometallurgical and hydrometallurgical processes respectively, with ore grade having the greater impact on the former process.



Metal recycling

One way to reduce the rate of depletion of metal reserves is by recycling of “metals-in-use”. It is already widely recognised that recycling metals gives significant energy savings (and hence reductions in greenhouse gas emissions) compared to primary metal production. For example, the following energy savings through recycling have been reported in the literature:¹⁶

¹⁶ **Altenpohl**, D G, 1998. *Aluminium : technology, applications and environment*, Sixth edition, The Aluminium Association Inc. and TMS; **Bureau of International Recycling** web site, 2001(www.bir.org); **International Iron & Steel Institute** web site, 2000 (www.worldsteel.org); **Kellogg**, H H, 1977. Sizing up the energy requirements for producing primary metals, *Eng. and Min. J.*, 178(4):61-65; **Kvande**, H, 1999. Environmental improvements in aluminium production technology, *Light Metal Age*, February, pp. 44-53; **Martchek**, K J, 2000. The importance of recycling to the environmental profile of metal products in *Proceedings of the Fourth International Symposium on Recycling of Metals and Engineered Materials*, TMS.

copper	84%	(Bureau of International Recycling , 2001; Kellogg, 1977)
nickel	90%	(Kellogg, 1977)
aluminium	95%	(Kvande, 1999; Altenpohl, 1998; Martchek, 2000)
steel	60%	(International Iron and Steel Institute, 2001)
lead	65%	(Bureau of International Recycling, 2001)
zinc	75%	(Martchek, 2000)

While the terms ‘recycling rate’ and ‘recovery rate’ are sometimes used interchangeably in the literature, they usually refer to two different measures (recovery, or reclamation, precedes recycling). The recovery rate is the proportion of scrap metal available at the end of its useful life that is actually recovered, while recycling rate is the proportion that scrap metal contributes to the total consumption of that metal (both being expressed as percentages). Thus while the recycling rate for some metals may be in the order of 40%, the recovery rates for those metals may be much higher. For example, Henstock (1996) reported that while the recycling rate for aluminium in the UK in 1988 was 31%, the recovery rate was 63%. Metal recovery rates are more difficult to calculate than recycling rates as the total amount of scrap metal available is not always known. Current recycling rates for common metals (taken from a variety of sources) are shown in Table 3 for Australia, United States and the World.

Table 3. Current recycling rates of various metals

Metal	Recycling rate (%)		
	Australia	United States	World
Aluminium	22	32	40
Copper		45	38
Iron/steel	36	64	47
Lead		60	47
Nickel			34
Zinc		40	36

Table 4. Total energy and GWP for secondary aluminium (100% recycle rate)

Application No.	Recycle No.	PRIMARY ALUMINIUM		RECYCLING		SECONDARY ALUMINIUM	
		Total energy MJ/kg	GWP kg CO ₂ e/kg	Total energy MJ/kg	GWP kg CO ₂ e/kg	Total energy MJ/kg	GWP kg CO ₂ e/kg
1	0	211	22.4				
2	1			9.0	0.55	114.6	11.8
3	2			9.0	0.55	79.4	8.0
4	3			9.0	0.55	61.8	6.2
5	4			9.0	0.55	51.2	5.0

Using aluminium as an example, Figures 5 and 6 show the effect of the number of recycles on total energy consumption and GWP respectively for secondary aluminium production at various recycle rates (assuming a closed-loop recycling system with material returned to the original process). The basis for calculations underlying these figures is given in Table 4 for the first five applications (i.e., four recycles) for the case of 100% recycle rate (i.e., the aluminium is continuously recycled with no further addition of primary metal).

For example, at recycle number 4, the total energy is equal to $(211/5) + 9 = 51.2$ MJ/kg, where the energy for primary metal production is 211 MJ/kg (Table 2) and the energy for recycling is assumed constant at 9 MJ/kg irrespective of the recycle number (i.e., 5% of the energy of the

aluminium smelting step = $0.05 \times 180 = 9 \text{ MJ/kg}$). The latter value agrees closely with a recently reported value of 8.7 MJ/kg for secondary aluminium production. A similar result to that shown in Figure 5 for total energy has also been reported by Kvande (see footnote 15).

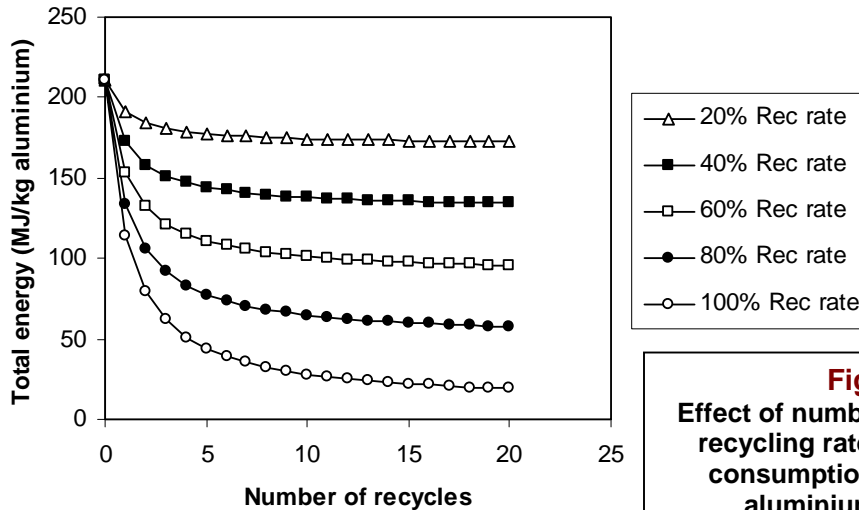


Figure 5
Effect of number of recycles and recycling rate on total energy consumption for secondary aluminium production

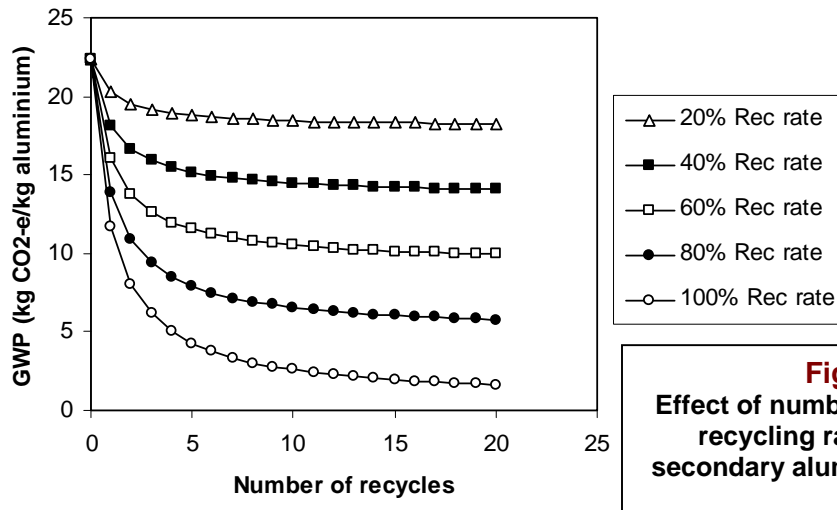


Figure 6
Effect of number of recycles and recycling rate on GWP for secondary aluminium production

Table 4 illustrates how the environmental impacts of the initial primary production of aluminium (in this case total energy and GWP) are progressively distributed over each recycle. At a 20% recycle rate, the corresponding calculation for total energy after four recycles becomes $(0.8 \times 211) + (0.2 \times 51.2) = 179 \text{ MJ/kg}$, where the first term represents the primary aluminium component and the second term represents the secondary aluminium component. In calculating the GWP for aluminium recycling (0.55 kg CO₂-e/kg Al) it has been assumed that the energy consumed in recycling (9 MJ/kg Al) is mainly thermal and that natural gas is the fuel source. Thus these two figures show how the average total energy consumption and associated GWP per application, change over the useful life of the metal, with the average values obviously decreasing as the recycling rate increases.

Metal quality and product recovery issues will affect the number of recycles possible in practice. Recycling rates are currently very dependent on metal prices, so when metal prices drop, recycling rates drop. Recycling rate targets must also take into account market growth and

metal durability (i.e., product life). The maximum amount of a material that can be recovered at any given time is a function of the quantity put into service one average product lifetime earlier. The estimation of such a lifetime is by no means simple. For example, the lifetime of copper has been reported to range from 4 to 29 years with a weighted average of 17 years, while for zinc it ranges from 1 to 25 years with a weighted average of 13 years.¹⁷ We can expect advances in technology and product design to improve recycling efficiency and economics.

Metal contamination during recycling by “tramp” elements is also an issue of considerable importance. Tramp elements, such as copper in steel and iron and silicon in aluminium, are those elements that are more “noble” (less reactive) than the host metal and, hence, very difficult (and expensive) to remove. Present strategies include better sorting of metals prior to remelting, diluting tramp elements by addition of primary metal, and using recycled metal for lower grade applications (e.g., wrought products in the case of aluminium). In the longer term, however, these strategies will need to be supplemented by development of effective refining processes for removing tramp elements. While this will presumably increase the total energy consumption of secondary metal production, it could be expected to still compare very favourably with primary metal production. (For more information on metal recycling issues, see Wright et al, 2002¹⁸.)

Carbon taxes

As a result of the 1997 Kyoto Protocol, governments around the world are increasingly looking at introducing some form of energy tax or carbon tax as a way of reducing fossil fuel consumption and greenhouse gas emissions. The aim of a carbon tax is to enable the price of goods and services to more truly reflect the environmental and social costs associated with their production. Carbon taxes have already been introduced in a number of industrialized countries, particularly within the European Union. In Sweden, where a carbon tax has been in place since 1991, it currently stands at \$US 44/t CO₂¹⁹. In 2001, France introduced a carbon tax of about \$US 6/t CO₂ in 2001, and the United Kingdom introduced an energy tax (Climate Change Levy). By assuming typical compositions and calorific values for the various fuel types, we estimated the carbon tax rate to be in the range \$US 5-11/t CO₂. However the application of these taxes is often not straightforward. All EU countries with carbon or energy taxes (except the UK) have exemptions for energy-intensive users, at rates up to 80–100% of the full rate.²⁰

The effect of a carbon tax in the range 0–50 \$US/t CO₂ (i.e., 0–183 \$US/t carbon) on primary metal prices is shown in Figure 7 based on the LCA results in Table 2 for black coal-based electricity. The figure shows that a carbon tax would have the greatest effect on the price of aluminium, followed by steel, zinc, lead, copper and nickel in that order. These values depend on the magnitude of both the GWP emissions (Table 2) and the primary metal price. The primary metal prices used are shown in Figure 7.

Some of the likely impacts of such a tax, in the absence of any form of exemption for high energy-intensive users, would be to:

¹⁷ Henstock, M, 1996. *The Recycling of Non-Ferrous Metals*, p. 30 (The International Council on Metals and the Environment, Ottawa).

¹⁸ Wright, S, Jahanshahi, S, Jorgensen, F, and Brennan, D, 2002. Is metal recycling sustainable? *Green Processing 2002*, Cairns, (The AusIMM).

¹⁹ Johansson, B, 2000. Economic instruments in practice: carbon tax in Sweden, OECD Workshop on Innovation and the Environment, Paris, June (www.oecd.org)

²⁰ Arthur D Little, 1999. Climate Change Levy – competitive impact of steel industry, UK Steel website (www.uksteel.org.uk).

- intensify efforts to develop more energy-efficient processes for metal production, particularly for energy-intensive metals such as aluminium;
- change the way in which various metals are used, e.g., reduced use of energy-intensive metals such as aluminium for construction purposes - aluminium mainly used where light weight is critical;
- shift the balance of metal use to less primary metal and more secondary metal, i.e., more recycling of metals,
- focus attention on the use of renewable (i.e., non-fossil fuel) energy, e.g., hydroelectricity, for the production of energy-intensive metals.

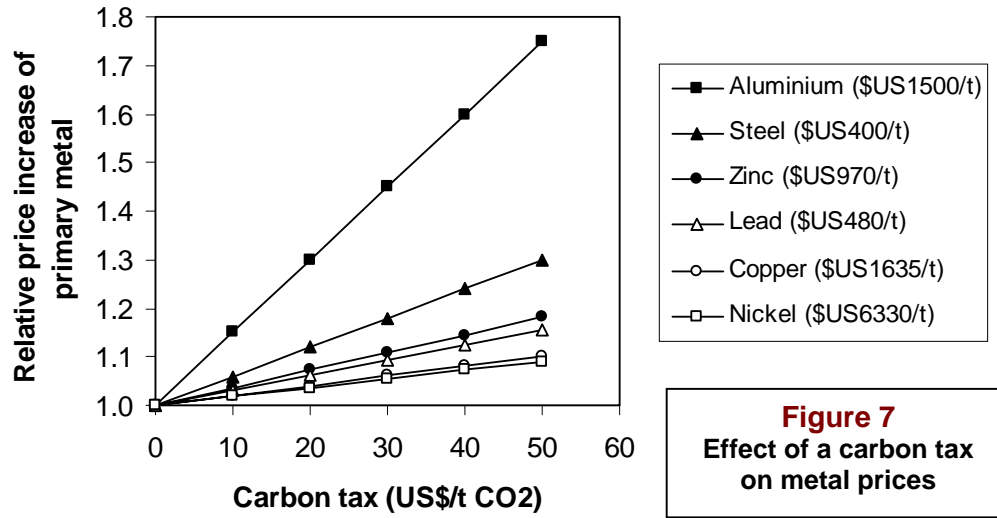


Figure 7
Effect of a carbon tax on metal prices

Metal toxicity

While metals have been, and will remain, essential for the world’s technological progress and economic growth, their toxicological properties as well as their behaviour in the environment will influence the way they are used in the future. Toxicity is the inherent capacity of a substance to cause adverse effects on living organisms that seriously damage structure or function or result in death. The term is often subdivided for separate consideration of human toxicity and ecotoxicity (affecting other organisms in the environment). Published toxicity factors for metals²¹ allow these two environmental impact categories to be included in an LCA.

Some metals are essential for proper functioning of living organisms while others are non-essential. Several non-essential metals are known to be toxic, even at very low levels (e.g., cadmium, lead, mercury and arsenic), and even metals that are biologically essential may also become toxic at high levels (e.g., zinc and copper).²² The term “heavy metal” appears to have been adopted as a convenience among policy makers for referring to metals with potential

²¹ Heijungs, R, 1992. *Environmental Life Cycle Assessment of Products*, Netherlands Organisation for Applied Scientific Research (TNO).

²²Badilla-Ohlbaum, R, 1998. International health and environmental regulations for metals: New challenges for copper. *Proceedings of Metals and the Environment: An International Symposium*, The Metallurgical Society of CIM, pp. 17-27.

toxicity.²³ For human populations in general, exposure to metals occurs mainly through food and drink.

Plants are of particular concern (particularly those species that act as “hyperaccumulators”) because they may extract metals from polluted soils and mine wastes, making them available to animals in the food chain (including livestock and humans), with the potential for concentration or “biomagnification” at successive levels in the chain. Fortunately, however, only a small fraction of the metals found in soils and natural waters is bioavailable (i.e., capable of being taken up by an organism). This is because the larger fraction is usually bound up with reacting chemicals in the environment. Laboratory toxicity tests have traditionally been conducted using artificial media in which all or most of the metal is bioavailable – so these tests have therefore tended to overestimate the toxicity of metals in the environment. More recent research²⁴ has highlighted this fact, and recognised that it is the toxicity of the bioavailable fraction that should be used to categorize the hazard of metals and metal compounds in environmental risk assessments and the drafting of environmental regulations. Revised laboratory toxicity tests (e.g., based on leaching) are needed so that actual bioavailable concentrations (in soil, solid waste, etc.) can be used in conjunction with specific metal toxicity factors to allow toxicity effects to be correctly incorporated into LCAs. Such new approaches will help to revise our view of metal toxicity.

Conclusions

The unique properties of metals will see them play an important role in society’s transition to sustainable development. They will continue to contribute to the needs of present and future generations in many familiar applications, and especially in new, emerging applications in a wide variety of areas such as electronics, telecommunications, transport and aerospace. Despite earlier concerns about possible shortages of metals, there are no indications that metal scarcity itself will become a major problem for future generations. Increased energy consumption associated with declining ore grades and the likely introduction of carbon or energy taxes will, however, see more emphasis placed on the use of recycled metals and on re-designing the supply chains of primary metals to remove energy intensive steps. It is also likely that low energy-intensive metals (eg steel) will replace high energy-intensive metals (eg aluminium) in those applications where special properties of the latter (e.g., light weight) are not particularly critical. Toxicological issues will also influence the ways in which metals are used.



The **Guggenheim museum in Bilbao, Spain**, is clad with titanium. The panels are only 0.5mm thick and are guaranteed to last 100 years. Titanium is 43% lighter than steel, stronger, more flexible – and virtually corrosion proof. See another view of this architecturally innovative building on the “Great Buildings” website: www.greatbuildings.com

²³ Berdowski, J, Bloos, J, and Visschedijk, A, 1998. The European emission inventory of heavy metals for 1990. *Proceedings of Metals and the Environment: An International Symposium*, The Metallurgical Society of CIM, pp. 85-93.

²⁴ Stubberfield, W, 2001. Environmental toxicity data for metals: Defining their utility. International Council on Mining and Metals (ICMM) (formerly ICME) Factsheet No. 1 - www.icmm.com

Materials recycling will be a critical feature of the transition towards sustainable development. Of all the materials used by society, metals have the greatest potential for recycling, as their elemental nature means they can be reused and recycled virtually indefinitely without loss of their properties. The ability to recycle metals offers opportunities to conserve resources, reduce energy usage, and minimise waste disposal, all of which represent important contributions to more sustainable lifestyles. It is recognized, however, that there are practical and economic limits to collection, transportation and recovery of metals for recycling. Given that recycling rates tend to decrease when metal prices fall, it may be necessary to devise economic drivers that encourage metal recycling even when prices decline. Dematerialisation will complement materials recycling, providing smaller, lighter products with lower material and energy intensities and longer service lives.

The challenge ahead is to devise tools policies and actions that will help society to optimize the efficient use of metal resources while at the same time minimizing their environmental impacts. Environmental management tools such as Life Cycle Assessment will be increasingly used for these purposes.

Directions in metals R&D – cleaner, greener and lighter

Major R&D drivers in the metals industries are (1) the need for greater sustainability in resource processing, and (2) the search for stronger, lighter structural materials – especially for aerospace, automotive and building applications. Australia is investing in new R&D in both these areas.

Elements of Eco-Efficiency

- Reduce the material intensity of goods and services
- Reduce the energy intensity of goods and services
- Increase the service intensity of products
- Reduce toxic dispersion
- Maximise the sustainable use of renewable resources
- Enhance material recyclability
- Extend product durability

WBCSD

The Cooperative Research Centre (CRC) for Sustainable Resource Processing

The mission of this recently established new R&D body is to find technological solutions for progressively eliminating waste and emissions from the minerals cycle, while at the same time enhancing business performance and meeting the expectations of the broader community. Its key themes are: (1) effective resource use and materials efficiency; (2) minimising energy inputs and greenhouse gas emissions; (3) reducing process waste and water consumption; (4) reducing pollution of land and water; (5) improving control of minor elements and toxic dispersion; and (6) enhancing co-product values. These themes are based on the “Elements of Eco-Efficiency” adopted by the World Business Council for Sustainable Development (see Box). The CRC is a partnership of university and CSIRO researchers with a number of commercial players in the minerals and metals processing industries.

For information about the CRC for Sustainable Resource Processing and its research programs, contact Network members Joe Herbertson – jherbert@mail.newcastle.edu.au - or John Rankin – John.Rankin@csiro.au

The National Flagship Research Program for Light Metals

Global demand for ultra-light, ultra-strong, recyclable metals is burgeoning as the world switches to lighter, low-emission vehicles, energy-saving devices, and more sustainable products. Aluminium demand is forecast to climb by 30%, magnesium demand by 200%, while for the emerging industrial light metal, titanium, it seems like the sky's the limit. Australia sees significant prospects for all three, with a

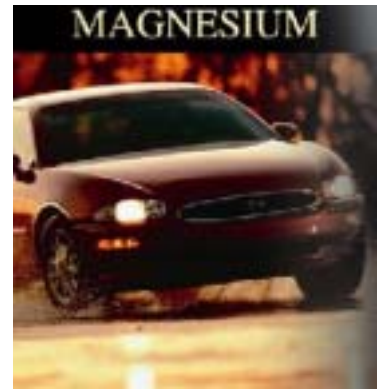


ALUMINIUM

mature \$9 billion aluminium industry already up there among our top exporters, a highly promising magnesium industry (despite the recent difficulties of AMC), and one of the world's richest titanium resources on which to build an industry for the future.

To address the opportunity, a National Flagship Research Program for Light Metals has been set up – involving commercial companies, government agencies, universities, and other research organisations

like CSIRO and CRCs. The aim is to further develop whole value chains, from mine to finished products, with new technologies enhancing every link.



MAGNESIUM

- The Goals of the Light Metals Flagship are to help:**
- ✓ Double the value of Australian light metal production to \$10 billion by 2010
 - ✓ Cut by a third the energy needed to make light metals
 - ✓ Cut by a half the life-cycle environmental impact of light metal products
 - ✓ Develop new, more efficient manufacturing systems for light metal and alloy products
 - ✓ Develop uses for by-products as inputs to other industrial processes.
 - ✓ Develop technology to create a new titanium metal industry



TITANIUM



Magnesium crystals

For information about the Light Metals Flagship research program, see the website: www.lightmetals.csiro.au or contact Program Director Dr Tony Filmer: Tony.Filmer@csiro.au

Renewable energy & the ecology of energy transformations

Network member Frank Fisher is Director of the Graduate School of Environmental Science (GSES) at Monash University in Melbourne, where he is an Associate Professor and the Founder of the Centre for Environmental Management. "My life's work," says Frank "involves facilitating the following view proposed by Abraham Maslow in *The Psychology of Science*":

"If humanistic science may be said to have any goals beyond sheer fascination with the human mystery and enjoyment of it, these should be to release the person from external controls and to make her/him less predictable to the observer..."

Frank also contributes volunteer time to health and disability issues. You can contact him for discussion at: Frank.Fisher@arts.monash.edu.au

The following feature is adapted from ENERGY NEWS: J.A.I.E., September 2002.

At the rate industrialised peoples have grown used to using energy, no energy form can be used, and no energy transformation to electricity can occur, without environmental problems. On the whole, all societies are profoundly ignorant of energy as engineers understand it, and even less aware of energy as ecologists understand it. Hence the title of this feature and the impetus behind it.

I should say at the outset that as the instigator of a large [75MW]²⁵ inland wind energy project in Victoria, I can hardly be said to be opposed to the use of renewable energies. Nevertheless, I am seriously concerned with the cavalier approach to renewable energies apparent in even our most responsible media.

The very idea of renewables fosters the illusion that our present ignorant ways with energy can continue. The more viable renewables become and the more they are able to compete with fossil fuels – *most of whose costs are simply ignored* – the more they suppress energy conservation.



Frank Fisher

Energy conservation is our cheapest and most socially and environmentally benign energy source.

Conservation can be *mined* just like coal!

If we could see this, it would become exciting as an opportunity for venture capitalists and be reflected in our economic and regulatory structures.

Renewables, not conservation are sold as a panacea. Renewables are marketed on the basis that they will permit us to continue to live in the ways we have grown accustomed to but with “zero emissions.” This is a mischievous and dangerous illusion.

On average each Australian demands some 2kW (three horsepower) of electricity generating capacity and much more than that from our other energy systems (heating, transport, etc.). Most of these systems are based on fossil fuels, which are of course not

renewable and place a tremendous burden on the environment in transformation to electricity.

Large-scale renewable systems involve mining sunshine via plants and the heat and movement the sun gives to the atmosphere and oceans; hence hydro and wind power. Attempting to fill the current demand with renewables creates a raft of environmental, social and even moral concerns. Take, for example, “energy cropping” for electricity and automotive fuels. Energy cropping means “growing fuels” and burning them directly to generate electricity, distilling alcohol from sugar cane or squeezing oils from other plant materials and then burning these liquids in internal combustion engines to drive vehicles or again, in boilers to generate electricity. In the case of electricity it means wasting 60-80% of the crop because burning it to generate electricity is at best only 40% efficient. As auto fuel, however, it means wasting more than 99% because most of it then goes to drive the auto-system and not the motorist. Only 20% is turned into motion by the car’s engine; then more than 90% of that is used to move the car, which is at least ten times heavier than its driver-passenger. Quite apart from all the environmental damage implied here, there is a real case to ask whether it is *moral* to use potential food-bearing cropland that wastefully? It might be noted that I could ask what all this

²⁵ About 1% of Victoria’s total installed electricity generating capacity, although developments indicate that this will be reduced for reasons associated with fragility of the local grid.

energy use and travelling is for!? But in this feature I shall “restrain” myself to questions of technical efficiency.

For all their relative benignity, solar energies - mined through hydroelectric plants (solar energy lifts the water), wind generators and natural draft towers such as the 1km high tower proposed for Mildura – generate a broad range of ecological implications. Just consider the implications of the Snowy Mountains hydroelectric installation for the Snowy River and for the social and ecological systems that lived along and *in* it. If *all* humans aspire to demand the same 2kW from the wind say, as we in Australia currently expect from fossil fuels (coal, oil and gas), the energetics of the atmosphere will change as surely as through burning fossil fuels. For the record, it needs to be said that solar cell electricity or photovoltaics is not an answer for the kind of bulk electricity demands we have today – even here in Australia. That’s because the quantities available per square metre per day are small, especially after deducting the energy costs of making and installing the energy-capture systems.

In addition to ecological effects, all energy infrastructure costs energy to create, transport, install, maintain, defend²⁶, and dismantle when its life is done. If more kilowatthours of energy are used to set up, maintain, dismantle and repair damages associated with an energy form than it actually delivers, one can be excused for asking questions about it. That is almost

Electricity in industrial society's diets is the equivalent of meat or milk in the individual's diet.

Meat and milk are valuable nutrients that can provide humans' entire dietary needs, but, in the majority of biosystems, meat and milk as human staples come at great ecosystem cost.

Therefore, unless we are Canadian Inuit or other desert dwellers with no alternative, the majority of our nutrition can be provided by thermodynamically lower quality foodstuffs to the benefit of the environment and even to the benefit of our own metabolisms.

Similarly, most current bulk electricity uses can be replaced by direct, thermodynamically lower quality energy forms such as solar energy - and by conservation.

Electricity treated with the respect it deserves.

certainly the case with nuclear power, and therefore the sanity of its use has to be questioned even before we concern ourselves with issues of radiation and the potential for nuclear terrorism. The reason that this general view is not taken is, again, that virtually no-one sees it and, consequently, that we have not yet created the necessarily international structures that would enable us to act upon it.²⁷

Wind generators and natural draft towers will unequivocally deliver more electricity than their energy costs. However, they are patently *not zero emission* generators. And even in service, they suck energy from meteorological and ecological processes with various, as yet largely unknown, effects. In construction, monitoring, maintenance and dismantling, they have the usual multifarious energy and ecological implications.

There are simply no such things as energy and environmental cost-free energy forms. Even conservation requires its techniques to be set in place, monitored, maintained and ultimately, dismantled.

²⁶ C.f. the military excursions to defend oil supplies or guard radioactive waste handling processes.

²⁷ See e.g., my expansion on this theme in “Needed: a new way of thinking”, Eureka St. 8(7):25-27 (2000).

Driver-only automotive commuting is a category of energy use so wasteful that it deserves special mention. It is in a class of inefficiency all its own. The transport energy system pays a 10,000%+ premium for moving each of us. While virtually all of us are engaged in this activity, the scale of inefficiency is such that one is surely entitled to ask whether it is reasonable, let alone moral, to throw 100 units of renewable energy at an urban commuter, merely to get just one unit of kinetic energy? This is a task that a bicycle coupled with trains could do faster, more healthily and more eco-sustainably for a tiny fraction of the energy cost.

Issues such as these, however, simply do not figure on the public radar because there are no publicly recognised energy indicators, let alone efficiency indicators. Which is not to say that there are no indicators, only that they are not publicly recognised! Few of us actually read our electricity bills, let alone graph the efficiency of our cars. Most of us would not know where to start. Perhaps an energy efficiency meter could be given prominence as a new dashboard indicator!? The problem would be working out with manufacturers what to include in the calculation.

The price of energy is too low, joules and kWh are still too obscure as measures, and most of the really large-scale pollutants associated with energy transformations such as water, carbon dioxide and heat are all invisible and, in any case, seem not even to be “pollutants”. The ecological costs such as the irretrievable destruction of habitats and species’ extinctions are, if it’s conceivable, even less visible.

It is theoretically possible to calculate the energies that would have to be found to make good some of this damage – e.g., to suck the excess carbon dioxide out of the atmosphere and sequester it safely. (Deep geological sequestration was proposed by the Victorian Government in July 2002). If we were to add these energy-for-ecological-repair costs to the other energy costs of our renewables, let alone those of our fossil fuels, few of our current energy sources would make much sense – i.e., few would qualify as genuine sources!

With all this in mind, our richest energy lode is unequivocally conservation techniques. So, change that favours the economics and fun associated with reuse/recycling generally can be combined with the advent of economic and other incentives that favour low energy productions and pursuits such as in health, sport, communication, the arts, knowledge industries and so on.

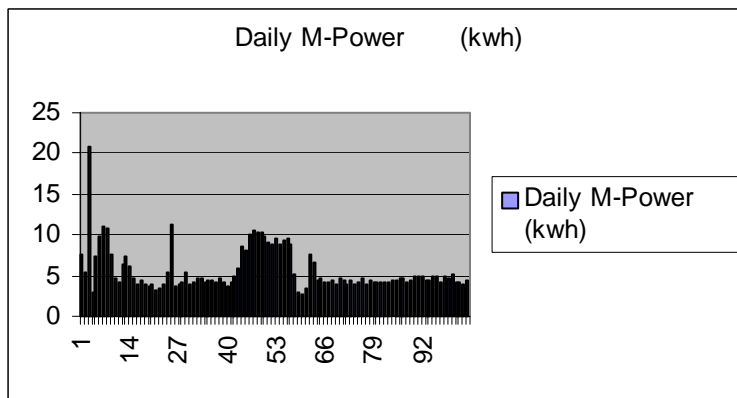
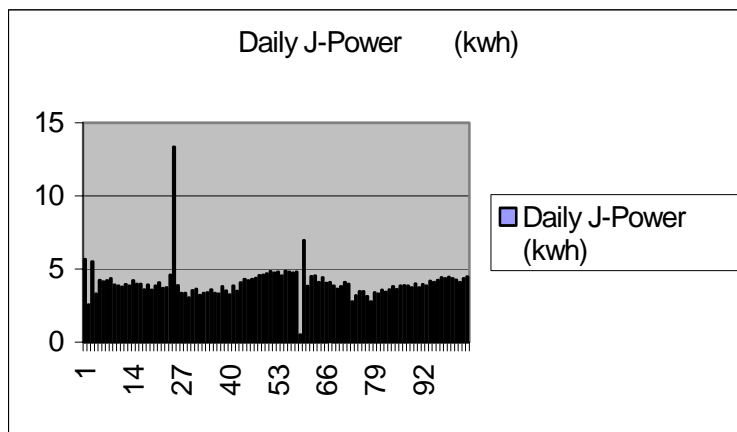
A conservation focus means that while definitely the way to go for new electricity generation, renewables should not be permitted to eclipse conservation. Many of these activities can be pursued by individuals with no help from government, but government does have two important roles. The first is to reverse the many perverse incentives²⁸ that continue to make nonsense of so many energy-conserving activities. The second is to educate the whole community about energy matters, not just about enhanced greenhouse effects. The results could be transformative, socially as well as ecologically.

²⁸ Built into the system in more ignorant days when ‘environment’ and ‘embodied energies’ went unrecognised. *[And even today perverse incentives are being introduced. For example, in South Australia, you can claim a Government greenhouse-gas reduction rebate on a solar hot-water system. However, you are not eligible for a rebate on an electric-boost system if gas is available in your street – even if you have elected to purchase 100% green power or will be generating your own electricity with your own full solar PV system! So, in providing an incentive to switch from coal-based electricity to cleaner gas, they are introducing a disincentive to investing in even cleaner power with even lower emissions than gas! I have protested but there are no plans to change this anomaly any time soon. E.G.H.]*

Measure and manage

As a postscript to Frank's feature, I can't resist putting my two cents worth of comment – in two additional energy-related areas. I would welcome feedback: Elizabeth.Heij@csiro.au

First: Recognition of the commercial benefits of energy conservation has been around for some time – long enough to make me wonder why, as a society, we are so slow on the uptake. At the end of the 1980s, while working for a time in the State of Georgia (USA), I lived in the outer suburbs of a small city in an area where electricity was supplied by a cooperative of several hundred homes and small businesses that bulk-purchased from Georgia Power. The executive manager employed by the co-op operated by the philosophy that the more power everyone could save, and the flatter the daily and seasonal peaks of usage could be made, the more customers could be serviced. Accordingly, the co-op offered significant incentives, as well as practical advice and assistance to absolutely minimise usage (and bills!) in individual households. It also offered big incentives to fit radio-controlled switching on major electrical devices like water heaters and heating units to allow rotation of short off-intervals at peak consumption periods. (I can vouch for the fact that any effects of these short off-intervals were completely imperceptible in practice.) The co-op also put out a regular informal newsletter full of handy hints on saving energy, cooking more efficiently, etc., and giving data on total co-op energy-savings, finances, and other performance indicators in a way that generated a sense of achievement among co-op members. Now why is it taking so long to get similar services into our Australian markets???



Second: How do YOU compare for domestic electricity usage?

Here's my personal record of domestic daily energy usage in kwh for our two-person household for 105 weeks up to the end of last month (July 2003). Daily average usages are calculated from weekly meter readings. J-Power is off-peak water heating (outdoor storage tank). M-Power is other usage on the standard tariff.

Currently we live in Adelaide in an all-electric, typically 'eco-unfriendly', uninsulated, suburban brick-veneer home (vintage 1970s). (We expect to do better when we move to a new more eco-friendly home next year.)

The graphs cover three winters and two summers (July 2001 to July 2003) with the last week of July at x-axis positions 2, 52 and 104. (The large fluctuations in the first few weeks represent me learning to read the meters!!) The dramatic increases in usage around week 25 represent 7 houseguests over Christmas 2001

(including 4 teenage girls who spent a lot of time in the shower and watching videos). The fluctuations around week 57 represent a short period where we were both away – with heating and hot water turned off, and hot water subsequently turned back on to heat from a cold start.

The J-Power record reflects mainly seasonal temperature fluctuation. Trying to reduce usage here involves more than just "demand management" – i.e., we would need to re-build the whole hot-water

delivery system or, preferably, switch to solar hot water. The M-Power record, however, does reflect a change in behaviour. This winter (2003), we are testing the effect of putting on extra thermal layers of clothing instead of automatically turning on the heater in the evenings as we did during the previous two winters. You can clearly see the effect!

Keeping records this way is very little work and is personally quite interesting if you are into experimenting with your own ecological footprint. After all, as 'the man said', you have to be able to measure it to manage it!

“Boundarylessness” – a response

*In Update 29E (p. 14) we aired some commentary from CSIRO on “death of silos” and the desirability of being “boundaryless”, admitting in the process that the clumsy word “boundarylessness” sits awkwardly as a descriptor of the desired state. This was too tempting for Network member **Val Brown**, who has responded with her very wise thoughts on the impossibility of “boundary-lessness.” In essence, she is pointing out that boundaries are a fact of life, and what we really need to be on about is **permeating** them rather than wasting time knocking our heads on them.*

Valerie A. Brown is an Emeritus Professor at the Australian National University (ANU) in Canberra, where she holds a Visiting Fellowship with the School of Resources, Environment & Society (SRES <http://sres.anu.edu.au>) and the Centre for Resource & Environmental Studies (CRES <http://cres.anu.edu.au>). She is a true integrative thinker across all areas of the so-called “triple bottom line” of sustainability, and has published widely in these vital linkage areas. You can meet Val and read more about her work at: <http://sres.anu.edu.au/people/brownv.html>

Silos, boundaries, and a brave new world

There is a strong temptation to wish that knowledge boundaries did not exist, to call for “boundary-lessness”, by those of us who suffer from the apparently impermeable boundaries that bar coordinated decision-making and limit our overall access to knowledge. But it is an idle wish, since there is no such thing as a boundary-less world. Living cells are bounded. Molecules and atoms, even neutrons are bounded. I am not so familiar with prions, but I think that they are bounded too. Our bodies and our societies are bounded. All of those boundaries are permeable and adaptable; the boundaries act as access points as well as walls. Strangely, the most impermeable boundaries of all seem to be reserved for the ways in which we manage knowledge.

Why is it that we have so much trouble working with the idea that categories of knowledge are changeable and permeable too, so much so that it seems easier to do away with boundaries altogether than to open them up? To work across these divisions for cross-fertilisation of ideas, collaboration, and mutual learning, is rewarding, productive of synergies - and even fun. But to expect them to go away, after they have produced such valuable results as a man on the moon and mapping the genome, is surely to throw the baby out with the bath water.

The wounds from compartmentalisation are self-inflicted, determined by how we choose to structure our experience of the world. Disciplines and professions have become tightly bounded through deliberately closed allocations of content, skills, methods of inquiry, and training. The boundaries have transferred to administrative departments, where they have earned that unkind, but too often accurate, label of “silos”. We are so familiar with this process that it is easy to forget that these packages are humanly constructed, designed as convenient ways to parcel investigation, findings, and organisation, and are not fixed mirror images of reality.

Collectively, we have arrived at an era where the calls for synthesis, for integrated decision-making, for cross-disciplinary and trans-disciplinary investigation, and for transformative thinking, are outstripping calls for more detailed information. The trend is apparent in research funding, in political decision-making, in professional education and in community expectations of science.

These new processes, (for they *are* new, not re-vamps of what we have been doing before) are not formless ways of approaching knowledge, nor do they treat knowledge as if it had no boundaries. They are networking between existing knowledges, opening new dialogues, and finding mutual involvement in open learning, while still respecting the existing forms of inquiry. Yet cries of traitor, and saboteur of academic standards, continue to issue from inside the silos.

Re-defining boundaries does not mean simply moving them around, or hoping that they will go away. It means re-thinking the ways in which we design and undertake research and professional practice, and re-considering the interactions between the various avenues through which we construct reality, that is, the specialisations, communities, industry and governments. It also means shifts in power from established fiefs to collaborative teams. This will ask the established fiefs to open up their boundaries and be happy about it. Is this perhaps too big an ask?

References:

Brown, Valerie A (2001) Planners and the Planet. Reshaping the people/planet relationship: do planners have a role? Australian Planner, 38(2):67-74. July 2001.

Aslin, H & VA Brown (2003) whole-of-community engagement: a toolkit of strategies. MDBC (forthcoming, September 2003).

*Thanks, Val. This is a very helpful redefinition of what we need to achieve – **not so much to remove silo walls but to fill them full of welcome communication channels.** I have a mental picture of an army of carpenters putting windows and doors into blank silo walls – of the light pouring in, and people talking and walking excitedly through all the new openings. E. G. H.*

If Noah were tackling today's conservation issues !

Here's a piece of humour especially for new Network members in New Zealand. Australian members will readily relate to the problems it highlights. Unfortunately, they appear to be commonplace in today's world. Right when we need urgent action to move to more sustainable patterns of living, it often seems like wading through wet cement! Sometimes, all we can do is smile at our own seeming stupidity – and PERSEVERE.

And the Lord spoke to Noah and said, "In one year, I am going to make it rain, and to cover the whole earth with water until all flesh is destroyed. But I want you to save the righteous people and two of every kind of living thing on the earth. Therefore, I am commanding you to build an Ark." In a flash of lightning, God then delivered the specifications for an Ark. In fear and trembling, Noah took the plans and agreed to build the Ark. "Remember," said the Lord, "You must complete the Ark and bring everything aboard in one year."

Exactly one year later, fierce storm clouds covered the earth and all the seas of the earth went into a tumult. The Lord saw that Noah was sitting his front yard weeping. "Noah," he shouted, "Where is the Ark?"

"Lord, forgive me!" cried Noah. "I did my best, but there were big problems. First, I had to get a Resource Consent for construction, and your plans did not meet the codes. I had to hire an engineering firm to redraw them and then get an engineer's report from the Council. Then I got into disputes with the

Fire Service over whether or not the Ark needed a sprinkler system and smoke alarms, and with the Ministry of Health over provision of smoking and non-smoking areas. Then the Residents' Association objected, claiming I was violating SAM zoning ordinances by constructing in my front yard an Ark that was a recreational watercraft and therefore a threat to existing homes.

Then I had problems getting enough wood for the Ark, because of the ban on native logging on the West Coast. They tried to get me to use Fijian Jara, but I couldn't get the necessary dispensation from Customs & Excise to import timber from a Pacific Island nation that wasn't party to the international working party on the life cycle of native timbers. Finally I convinced DOC that I needed the imported wood to save the endangered kakapo from extinction. However, the Royal Forest and Bird Society objected, and refused permission for me to capture a pair of kakapo for the Ark. So, no kakapo, no wood!

While all this was going on, the carpenters formed a union under the new Employment Relations Act and went out on strike. I had to negotiate a settlement under the provisions of good faith bargaining before anyone would pick up a saw or a hammer. Then OSH arrived and told me I have to produce a Hazard Management and Safety procedure before they start work; and ACC are insisting we pre-pay our annual premiums now on the basis we may not be returning. So now I have 16 carpenters on the Ark, but no kakapo and no wood.

When news got out that I was to round up other animals, MAF arrived and insisted I build quarantine facilities to hold them in for the 6 months before sailing. They also wanted blood samples to prove no genetic engineering practices had been applied to the world's future biotic resources.

Next thing I know, the Regional Council is knocking on my door. They want an Environmental Impact Report on the proposed flood: the area it will cover, the amount of water involved, velocity and force of the water, impact on local ecosystems, cost to manufacturing, production and local transport, areas for possible relocation and resettlement. I tried telling them they were missing the point entirely but they appeared not to understand. Right now, I am trying to resolve a complaint filed with the Equal Opportunities Commission and the Race Relations Office that our staff selection criteria do not fairly reflect the age, gender, religious and racial diversity of Earth."

I really don't think I can finish the Ark for another five or six years, "Noah wailed.

The sky began to clear, the sun began to shine and the seas began to calm. A rainbow arched across the sky. Noah looked up hopefully. "You mean you are not going to destroy the earth, Lord?"



No," said the Lord sadly. "I don't have to. The government with its 'red tape' already has."

Thanks to a couple of frustrated colleagues across the Tasman for passing on this wry smile!

The Commercial Built Environment – Can you help with information?

David Beyer, Sustainability Consultant with LandCorp (WA Land Development Authority) is putting out a call for Network members to help him locate contacts, information and resources in the following areas relevant to LandCorp business:

1. Research or case studies on best-practice subdivision planning and design for commercial²⁹ industrial parks or estates, which may include:
 - density and compact development,

²⁹ Refers to a mix of heavy industry, light industry fabrication, wholesale and storage, and urban commercial associated industry.

- vertical integration vs. large area on-ground storage,
 - road layout and vehicle access,
 - stormwater management and reuse,
 - biodiversity preservation
2. Industrial building design and construction: The local market is dominated by concrete tilt-up construction, which has high embodied energy, or light-weight metal construction, which has poor thermal performance. Of particular interest is research on LCA of industrial building including:
 - embodied energy,
 - appropriate materials and component selection,
 - adaptable design,
 - passive solar options,
 - thermal performance,
 - operational cost – e.g., heating, cooling, lighting.
 3. Future use options and retro-fitting to alternate uses/re-zoning. Many industrial parks have a very limited life before they may need to be re-developed for residential or other commercial uses. Is there any research or analysis on adaptability to retro-fit the built form?
 4. Information on industry synergies and closed-loop resource sharing

If you have any relevant information, please contact David – david.beyer@landcorp.com.au; Phone: (08) 9482-7488 or 0407-427-927; or Postal: 40 The Esplanade, Perth, WA 6000.

Other Information Resources and Links of Interest

[Thanks to SustNet Members Alan AtKisson of AtKisson Inc, Chris Ryan of RMIT, Isabelle Sennery of Creaction, Michael Smith of ANU, Peter Fisher of CQU, and Simon Buckley of AusAID, for alerts in this section.]

ACCELERATING SUSTAINABLE DEVELOPMENT – New Electronic Newsletter **WaveFront – from the Sustainability Change Agent Network and AtKisson Inc.**

WaveFront is a new, free electronic news resource that aims to keep readers “up to speed” and “ahead of the curve” with material that can immediately be used in presentations, planning, and discussion with decision makers. Subscribe by entering your email address at the bottom of the SCAN webpage: www.atkisson.com/scan/

International Institute for Industrial Environmental Economics www.iiiee.lu.se

Based at the University of Lund in Sweden, the Institute aims to contribute to sustainable development through multidisciplinary education and research, and positive engagement with change. It seeks strategies to prevent environmental degradation, and to challenge current technological, economic and social systems and existing modes of thinking.

WATER

World Bank Water Resources Management Strategy – (February 2003) [http://inweb18.worldbank.org/ESSD/ardext.nsf/18ByDocName/PAGES1-14WaterResourcesSectorStrategyAnoverview368KB/\\$FILE/sectorstrategy1.pdf](http://inweb18.worldbank.org/ESSD/ardext.nsf/18ByDocName/PAGES1-14WaterResourcesSectorStrategyAnoverview368KB/$FILE/sectorstrategy1.pdf)

The above URL accesses an overview of the strategy. The full document, together with background on its development, is also available.

Blueprint for a National Water Plan – The Wentworth Group & WWF www.clw.csiro.au/new/WWF0703-02%20A4%20Horiz.pdf

The document summarises the principles of water reform recommended by the Wentworth Group of concerned scientists and WWF to the Council of Australian Governments (CoAG).

Principles for a Long-Term Australian Water Policy Framework & Action Plan

www.nff.org.au/pages/pub/NFF_ACF%20Joint%20Statement.pdf

A Joint Statement by the Australian Conservation Foundation (ACF) and the National Farmers' Federation (NFF) to the Prime Minister, Premiers and Australian Community on the principles of sustainable water management.

Robust Reform: The Case for a New Water Entitlement System for Australia – Summary

http://www.clw.csiro.au/new/robust_reform_summary.pdf (650 kb)

Mike Young – Mike.Young@csiro.au - and Jim McColl argue that despite efforts to increase environmental flows in the Murray-Darling Basin, under present practices there will be significantly less, not more, environmental flows. They say only a new purpose-designed water entitlement system can solve the problem. Find the full paper in The Australian Economic Review 36(2):225-234. **ALSO:**

Robust Separation: A Search for a Generic Framework to Simplify Registration and Trading of Interests in Natural Resources

www.clw.csiro.au/publications/consultancy/2002/Robust_Separation.pdf

Mike Young – Mike.Young@csiro.au - and Jim McColl report the search for an economically efficient and equitable system of defining, allocating, and managing use of natural resources such as water – a system that will also prove robust in that its fundamental principles can remain unchanged over time.

Groundwater and its susceptibility to degradation: A global assessment of the problem and options for improvement – Report from United Nations Environment Program (UNEP)

www.unep.org/dewa/water/groundwater/groundwater_report.asp

The Australian Water Partnership (AWP)

www.gwpaustralia.org

The AWP is the Australian Chapter of the Global Water Partnership (GWP). It aims to promote integrated water resource management through sharing of ideas and exchange of know-how.

GREENHOUSE GAS EMISSIONS, RENEWABLE ENERGY & CLIMATE CHANGE

Greenhouse Gas Emissions by Big Industry – The Carbon Disclosure Project

<http://194.242.156.103/cdproject/index.asp>

This London-based Project keeps watch on the greenhouse gas emissions of major international businesses from the point of view of investor risk, competitive position, and shareholder value.

Renewable Energy ... Into the Mainstream – IEA Working Party Report

www.iea.org/public/freepdfs/2003/binnenwerkiea2.pdf (1.5 Mb)

Summarises the technological status and market development of the major renewable power options already coming into use.

Dealing With Climate Change – IEA Delegates' Website and Database

www.iea.org/envissu/pamsdb/index.html

The site accesses an IEA database of actions being taken or planned to mitigate global climate change by all member countries over the period since 1999. The record offers an increasingly accurate picture of how national climate strategies are developing.

Renewable Energy: Database of Policies and Measures in OECD Countries

<http://library.iea.org/renewables/index.asp>

The site accesses an evolving database of current national policies for renewable energy acceleration.

Wind Power – Summaries of industry growth

www.earth-policy.org/Updates/Update24.htm ; <http://ens-news.com/ens/jul2003/2003-07-14-01.asp>

Upbeat reports on wind power's progress from the Earth Policy Institute and Environment News Service.

TRANSPORT

The WA Transport Energy Strategy – Interim Report of the Strategy Committee

www.dpi.wa.gov.au/sustain/committee.html (Download PDF 742 kb)

Gives discussion of issues in transport energy planning for WA as released for public comment.

Candidate Actions to Progress Road Pricing Initiatives

www.nrtc.gov.au/publications/report-108.asp?lo=public

There is increasing discussion in Australia of the use of road pricing (road-use charges) to achieve a variety of policy objectives – particularly reduced congestion and reduced emissions. This paper from the National Road Transport Commission identifies a set of projects or actions which would be required to progress broader road pricing initiatives in Australia.

Health & Environmental Benefits of Cycling

http://stcwa.org.au/journal/23July2003/1058698265_11546.html

Short summary of benefits by Miles Dracup for the journal of the Sustainable Transport Coalition of WA

HYDROGEN DEBATE

Making Hydrogen?

http://stcwa.org.au/news/1052977014_1948.html

Tom Standing, for the Sustainable Transport Coalition of WA, does calculations to conclude that the vision of hydrogen and fuel cells becoming the energy system of the future is an illusion. Widespread production of hydrogen from any source will greatly increase industrial energy consumption. Technical advancements cannot overcome the thermodynamic hurdles that make hydrogen production and its utilization in fuel cells, a net energy loss.

AVIATION

New Studies Confirm Environmental and Health Harm!

www.areco.org/studies.htm ; www.areco.org

A set of recent studies and reports posted by the Alliance for Residents Concerning O'Hare

ARCHITECTURE & DESIGN

ICIS Foundation – International Centre for Creativity and Innovation for Sustainability

www.icisfoundation.org

Based in Denmark, the Centre provides international, multi-disciplinary support for innovation in design, architecture, advertising, science, law, academia and ICT. **Check “Resources” at top of page and look at “Innovations” to see some interesting creative thinking under “Boase” (Eco-Building), “Sustainable Textiles” and “The Green Furniture”.**

The Eco-Sense Design Studio Network

www.eco-sense.info

Eco-Sense is a network of design studios in universities – a networked “what-if” space in educational programs created to produce a series of visionary products, services and systems for a sustainable future-in-the-present. The site also provides links to websites of participating design programs.

PRODUCTION & CONSUMPTION

Global Status 2002: Sustainable Consumption and Cleaner Production

www.uneptie.org/pc/pc/qs2002.htm

The site provides free access to three status reports from the United Nations Environment Program, Division of Technology, Industry and Economics, Production and Consumption Branch. They comprise: the executive summary, and two separate reports for Sustainable Consumption and Cleaner Production, which can be downloaded in sections in PDF format.

ROLES OF UNIVERSITIES AND TRADE UNIONS

www.acfonline.org.au/asp/pages/publications.asp

(Click on “Reference Material: Tela Papers” at bottom of page.)

Universities and Sustainability

Universities have a key role in leading society towards a sustainable future, both in education of the world's future decision makers and in their own practices. The paper looks at initiatives taken by Australian universities to implement sustainable practices in curricula and procedures, highlighting areas of deficiency and presenting case studies from Australia and overseas.

Unions and the Environment

At the turn of the millennium, unemployment and environmental degradation have both risen markedly. The paper uses case studies to illustrate relationships between jobs and environmental protection. While some argue that jobs and environmental protection are in conflict, the paper argues, it is not environmentalists that threaten employment, but those who downsize workforces and destroy the environment in the interests of short-term profitability. Working-people's interests and environmental imperatives are not in real or long-term conflict.

ECO-COMMUNITIES

Green Edge – An Interactive Ecovillage & Sustainable Development Forum

www.greenedge.org

Website of the forming Somerville Community Ecovillage at Chidlow, near Perth, WA - still accepting expressions of interest

Aldinga Arts Eco-Village³⁰

www.aev.net and www.aldinga-artsecovillage.com.au

Websites for community information and expressions of interest respectively, of the forming Aldinga Arts Eco-Village in Aldinga, near Adelaide, SA – there are still lots available.

PERSONAL DEVELOPMENT IN THINKING AND LIVING MORE SUSTAINABLY

www.creaction.com.au - “*Creaction*” for a Positive Future

www.planetleadit.com - Be a leader who helps make the world work for all.

www.bigpicturesmallworld.com - Check the video intro. It really “puts us in our place” in humanity.

www.awakeningearth.org - Resources for building a sustainable and compassionate future

www.evolve.org - Global Community Centre for Conscious Evolution

SUSTAINABILITY SCIENCE – Reminder

Check new postings on the Harvard Forum on Science & Technology for Sustainability:

<http://sustsci.harvard.edu>



A BIG GREEN TICK FOR VICTORIA

Hats off to the Victorian Government for last month's announcement that, from July 2005, five-star energy ratings, solar hot water and rainwater tanks will be mandatory for new homes. About time – (but why wait so long?) Let's hope other States follow suit ASAP

Events of Interest

ISOS Online and Face-to-Face Conference – “In Search of Sustainability”

Online: February – November 2003. Face to Face: Canberra, 14 November.

An innovative and progressive Internet conference open to Australians from all walks of life, concluding with a plenary face-to-face conference. Jointly managed by Australia 21 Ltd, Nature and Society Forum Inc, & Sustainable Population Australia Inc, in association with The Australian Collaboration. Information: www.isosconference.org.au **Themes:** February: **Water**. March: **Human health & wellbeing**. April: **Land use & natural ecosystems**. May: **Energy**. June: **Equity & Peace**. July: **Economic Systems**. August: **Climate**. September: **Labour force & work**. October: **Transportation & urban design**.

Water Conferences listed by the International Water Association (IWA):

See: www.iwahq.org.uk/template.cfm?name=events

³⁰ My future home from early next year if all goes according to plan! *E.G.H.*

Water, Governance & the Political Economy: Water security and poverty reduction in Asia-Pacific
 Canberra, **19-20 August**. <http://devnet.anu.edu.au>

Complex Systems Science: Introductory Course run by CSIRO
 Canberra, **19-20 August**. www.dar.csiro.au/css/Operate.htm or Paul.Walker@csiro.au

2nd Annual Renewable Energy Conference (with 14th Annual National Power & Gas Conference)
 Sydney, **19-22 August**. www.powergenerationworld.com under "Events"

Eco-Innovation and Sustainable Development – Short Course (3- or 5-day option)
 Canberra, **20-24 August**. Info from convenor Janis Birkeland – janis.birkeland@canberra.edu.au

Water, Sanitation & Health: Sustainability & the role of aid to reach the Millennium Development Goals
 Canberra, **21 August**. Contact Simon_Buckley@ausaid.gov.au

Queensland Landcare & Catchment Management Conference & Awards
 Gympie, **22-25 August**. www.gympielandcare.org.au or conference@gympielandcare.org.au

Hydrogen Opportunities for Clean Energy Delivery – Workshop presented by Nanomaterials Cntr, UQ
 Brisbane, **28 August**. <http://nanomac.uq.edu.au/hydrogen.html>

Praga 2003 – Landscape and Water – International Conference on Nature Conservation
 Prague, Czechoslovakia, **25-29 August**. www.landscape-water.cz or info@landscape-water.cz

Water Recycling Australia 2nd National Conference & Workshop
 Brisbane, **1-2 & 3-4 September**. Conference 1-2 Sept; Workshop on 'Quantitative Microbial Health Risk Assessment' 3-4 Sept. Info: awaq@powerup.com.au or brianw.davis@epa.qld.gov.au

Balancing environment & community expectations in the future viability of farming
 Adelaide, **3 September**. A conference of the Agricultural Bureau of SA. Info from ABA Exec. Officer Greg Cock – cock.greg@saugov.sa.gov.au

Farming Systems in the Future – First National Farming Systems conference 2003
 Toowoomba, Qld., **7-10 September**. www.afsa.asn.au and stewartc@usq.edu.au

Who pays for the environment? Conference hosted by Greening Australia (Qld)
 Brisbane, **8 September**. www.greeningaustralia.org.au/GA/Qld under "What's New" or contact Alex Cooper - acooper@greeningaustralia.org.au

Waste & Recycle 2003 Conference – Sustainable Outcomes: Making it Happen
 Perth, **9-12 September**. www.keynotewa.com or enquiries@keynotewa.com

3rd Conference of the Regional Government Network for Sustainable Development: Regional Governance for Sustainability – and accompanying academic forum (nrg4SD).
 Perth, **17-19 September**. www.sustainability.dpc.wa.gov.au/conferences.htm

3rd National Conference of Sustainable Campuses
 ANU Canberra, **24-26 September**. www.anu.edu.au/acts2003

Building Maintenance & Management: Effective methodologies to achieve efficiencies
 Sydney, **28-30 October**. www.iir.com.au/property

Energy Savings-Immediate Payback. Managing significant energy savings for new & existing buildings
 Melbourne, **29-30 September**. Training course. info@iir.com.au or www.iir.com.au/infrastructure or contact Jay Nair on (02) 9923 5082 & quote discount code BD02

Finding the Path from Johannesburg: Engaging Civil Society in Implementing WSSD Outcomes
 Bangkok, Thailand, **29-30 September**. <http://www.asef.org/dir/ie/env/wssd>

Climate Change and Health – Symposium (29/9) and Short Course (29/9 – 2/10)
 Canberra, **29 September – 2 October**. http://nceph.anu.edu.au/Envir_Collab/Climate_Change_course.htm

Organic Futures for Australia – OFA 2003 – 2nd National Organic Conference
 Adelaide, **2-3 October**. www.ofa.org.au or <http://conference.ofa.org.au>

GIN2003: Innovating for Sustainability – 11th International Conference – The Greening of Industry Network
 San Francisco, **12-15 October**. www.greeningofindustry.org/gin2003.htm

Sustainability: Are we making genuine progress? Canadian Society for Ecological Economics
 Jasper, Canada, **16-19 October**. <http://www.cansee.org/docs/Conferences.htm>

International Conference on Water-Saving Agriculture & Sustainable Use of Water & Land Resources
 Yangling, Shaanxi, P.R. China, **26-29 October**. Working language, English. Information from local Australian contact: Lu.Zhang@csiro.au

Emerging Transport Technologies – Future of the motor car – Greenfleet, World Solar Challenge & CSIRO
 Adelaide, **28-29 October**. www.greenfleet.com.au/transport/sustainable.asp

NSW Infrastructure – Economic Infrastructure Investment Opportunities in NSW – Future trends.
 Sydney, **29-31 October**. www.iir.com.au/infrastructure

Coal – Contributing to Sustainable World Development – 12th International Conference on Coal Science
 Cairns, **2-6 November**. Hosted by Australian Institute of Energy, the International Energy Agency, and IEA Clean coal Centre. www.aie.org.au/iccs or iccs@aie.org.au

Sustainability in a New World – International Solid Waste Association (ISWA) Congress 2003
 Melbourne, **9-13 November**. www.iswa2003.net

In search of Sustainability [Face-to-face component of the Online ISOS Conference listed at top]

Canberra, **14 November**. www.isosconference.org.au/novconf.html

“Sustainability” and the Social Sciences: Theory and Practice – A one-day Round-Table
 Sydney, **Early December**. Expression of interest to Lucy.Hall@uts.edu.au; enquiries to Convenors, Helen.Cheney@uts.edu.au or Fiona.Solomon@csiro.au

Sustainable Living Festival
 Melbourne, **13-15 February 2004**. www.slf.org.au and www.sustainablelivingfestival.org

HydroSalinity Abatement & Advanced Techniques for Sustainable Irrigated Agriculture – Training Wkshop
 Lahore, Pakistan, **22-27 March 2004**. Contact Wkshop Secretariat center@xcess.net.pk

Salinity Mitigation for Water Resources Management – International Seminar
 Lahore, Pakistan, **26-28 March 2004**. Contact Seminar Secretariat center@xcess.net.pk

Enviro 04 Convention & Exhibition
 Sydney, **28 Mar – 1 April 2004**. www.enviroaust.net or quitz@bigpond.net.au

Sharing Indigenous Wisdom – An international dialogue on sustainable development
 Wisconsin, USA, **6-10 June 2004** (was 8-12 June 2003). www.sharingindigenouswisdom.org

Sustainability Engineering & Science – NZSSES International Conference
 Auckland, New Zealand, **7-9 July 2004**. www.nzsses.org.nz/Conference/

World Water Congress & Exhibition
 Marrakech, Morocco, **19-24 September 2004**. www.iwa2004marrakech.com

9th International Conference on Wetland Systems for Water Pollution Control
 France, **27-30 September 2004**. www.iwahq.org.uk/template.cfm?name=wetland_systems

6th International Conference on Waste Stabilisation Ponds
 France, **28 Sept – 1 Oct 2004**. www.iwahq.org.uk/template.cfm?name=waste_stabilisation_ponds

AgroEnviron-2004: Role of multi-purpose agriculture in sustaining global environment – Intl. Symposium
 Udine, Italy, **20-24 October 2004**. www.dpvta.uniud.it/~agroenv

And Finally – Notes and Reminders

Our Web Site: www.bml.csiro.au/sustnet.htm

The site is maintained by Lyndon Hirst at CSIRO's Black Mountain Library – Suggestions welcome.

- **To find back issues of Sustainability Network newsletters directly, go to our web archive at:** www.bml.csiro.au/SNnewsletters.htm
- **Pass it on!** The Sustainability Network is intended to be inclusive rather than exclusive. If you know someone who might be interested in this newsletter, by all means forward it to them or give them our web address.
- **Want to make contact with scientists?** If you can see an application for the science featured in these newsletters and need to contact the scientists involved, let me know by email.
- **Want to see a particular area of sustainability science featured?** If there is a particular area of sustainability-related science that you would like to see featured as a “spot” in a future newsletter, send me an email or call me by phone to discuss it.
- **Give me your feedback.** I would be interested in your comments as to whether these newsletters are interesting, useful, and pitched at the right level for your particular purposes. Do you have suggestions? Thanks to all those who have already sent in comments and alerts.



Milestone: Our Sustainability Network
 now has over 640 members.

Sincerely,

Elizabeth Heij

Network Facilitator