The Energy Footprint for North Central Victoria: An Initial Step Toward Addressing Climate Change

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How many trees do we need to absorb our carbon emissions? Can we afford the space?

Climate change is being triggered by an excessive production of carbon dioxide (CO_2). Humans and other animals release CO_2 into the atmosphere through respiration, which is absorbed by growing plants, in turn releasing oxygen back into the atmosphere. This natural balance has been disturbed through the burning of fossil fuels (such as coal and oil), and the removal of large tracts of forest. Consequently, the production of CO_2 currently exceeds the absorption capacity of natural biological processes, releasing excessive amounts into the atmosphere.

As of February 2001, over one hundred countries accepted the Intergovernmental Panel on Climate Change's (IPCC) finding that climate change 'is' occurring as a result of CO_2 emissions, causing widespread and coherent impacts – on all continents and on all environments. The IPCC cites over 420 examples of visible change to physical and biological systems – from glacial shrinkage and declining arctic sea-ice, to extended frost-free seasons and greater frequency of extreme rainfall events (Watson 2001).

According to Roger Jones (pers. comm., 2001), the effects of climate change are already having an impact in Australia. For the north central region of Victoria, the CSIRO is predicting drier winters and springs, with more summer days over 35oC and fewer frosty days in winter. Extreme daily rainfall is also expected to increase in both frequency and intensity. The implications for our agricultural systems, biodiversity, and water supply in an already dry environment are of considerable concern, yet remain largely unimaginable by the community.

The magnitude of the problem and its implications are proving difficult to convey – such that commitment to CO_2 emission reductions is sluggish, to say the least. The ecological footprint concept, derived by Wackernagel and Rees (1997) has emerged as a powerful tool in measuring and communicating the unsustainable impact humans are having on the planet. The footprint concept provides a readily understandable indicator of the problem and the feasibility of solutions in meeting reduction targets. The footprint seeks to measure the demand placed on nature by a given population through its consumption of energy, food, housing, transport, and consumer goods and services, and is interpreted as the amount of land needed to sustain current levels. According to Wackenagel and Rees (1997), there is only enough productive land on the planet to provide every human being with approximately 1.5ha per year. Simpson et al (2000), have calculated the Australian per capita footprint at 8ha per person – indicating the extent to which our current consumption and waste patterns are unsustainable. According to Moffatt (2000) the major advantage of the ecological footprint over other environmental indicators is it

gives a clear, unambiguous message often in an easily digested form, providing a framework for community-based learning and action

Since gaining widespread publicity in the late 1990s, the ecological footprint of many nations has been calculated, including Canada, Mexico, India, United States and Australia. However, the availability of data is limited with very few countries having access to sufficient detail to produce an accurate measure of consumption and waste volumes. The data has been derived from a combination of state and national figures and global estimates provided by Wackernagel and Rees (1997). According to Simpson et al (2000), the Australian calculations are largely based on US and Canadian data due to our own data limitations.

It is well documented that global sustainability is highly dependent on local action. Regional Australia, as we all know, is facing a period of unprecedented change, in an environment of long-term, self-perpetuating structural problems. They face a future of declining environmental qualities and declining financial capital stocks, and a limited future for their young people – creating a high level of uncertainty about rural Australia's ability to respond to the imperatives of climate change. Clearly, rural communities need to think creatively about how to reclaim their future. By adopting a sustainable development approach, there appears to be a real opportunity to experience social and economic benefits of new and innovative solutions to environmental problems (Rogers and Ryan 2001). The energy footprint offers a way to introduce the issues, the opportunities and to inspire action at the local level. This research provides an example of how a region has taken the first step toward the development of a region-wide strategy to address climate change.

A Regional Profile

The 'region' involved in the Central Victorian Greenhouse Alliance is defined as all Local Government areas within the North Central Catchment Management Authority's (NC CMA) boundaries. The region includes the four major catchments of Campaspe, Loddon, Avoca, and Avon-Richardson and the nine local government areas of City of Greater Bendigo, Loddon, Hepburn, Gannawarra, Campaspe, Mt. Alexander, Central Goldfields, Macedon Ranges, and Buloke. It covers approximately 3 million hectares (13 per cent of the state of Victoria), with a current population of approximately 200,000, growing at 9 per cent per annum.

Land use in the region is diverse, with agriculture the principal activity, utilising 65 per cent of the land. Approximately 13 per cent of the region is publicly owned, with much of this reserved and managed for specific purposes including state and regional parks, flora reserves and reference areas. Other land uses include forestry, mining, urban centres and 'lifestyle' or small acreage holdings. Extensive dry land farming includes sheep and cattle grazing, grains, legumes, oil seeds and hay crops. Irrigated agriculture is significant, particularly in northern areas where dairying, vegetable production and horticulture are practiced. There have been significant changes in land use in recent times with the advent of new agricultural developments including viticulture and olives and an influx of people onto small holdings that were previously used for dry land agriculture.

Land use changes since European settlement have meant extensive removal of native vegetation. In dry land areas this means less rainfall taken up by vegetation causing a gradual filling of shallow aquifers and the transport of salt to the surface. Flood irrigation practices in the north of the region have led to high levels of saline water run-off. The north central catchment has some of the highest levels of mobilised salt loads in Victoria. The Loddon, Avoca and Campaspe catchments are experiencing an average of 2200 ECUs (electrical conductivity units). The World Health Organisation considers 800 ECUs to be the upper salinity limit for drinking water (MDBC 1999, p.13).

In addition to problems of increasing salinity and rising water tables, the region faces a number of natural resource management issues including:

- biodiversity loss,
- declining soil health, and
- increased pest plants and animals.

The economic prosperity of the region is not uniformally experienced – with areas experiencing high levels of unemployment and very limited options for a sustainable future. Consequently, issues of environmental protection, let alone issues

of global warming, are not generally given the necessary attention. None-the-less, the rural crisis has created a deep appreciation of the need to be creative and innovative about the way of the future. If not the fear of climate change, then at least a vague sense of the opportunities that exist in alternative energy initiatives, has captured the attention of Local Governments in the region. While some remain tentative about the urgent need to reduce greenhouse gas emissions, they have unanimously agreed to pool resources to enable initiatives which will reduce their energy consumption and ultimately their energy costs.

The Central Victorian Greenhouse Alliance

The Central Victorian Greenhouse Alliance was formed in June 2000 in response to a Federal Government initiative to support projects aimed at achieving reductions in greenhouse gas emissions in the order of 250,000 tonnes per year. The funding involved $400m over 4 years, providing the initial impetus for the formation of the Alliance. Membership includes nine local governments; La Trobe University; the Department of Natural Resources and Environment; the North Central Catchment Management Authority; Sustainable Energy Victoria; and the Bendigo Bank.

In the absence of any single major source of greenhouse gas emissions in the region, access to this funding pool required the development of an integrated, multi-faceted proposal. Hence, the Alliance was formed with a view to crafting a region-wide proposal. The aims of the Alliance have since shifted focus, away from the need to access a specific funding opportunity, toward the development of a regional strategy.

Alliance activities include:

- creating working partnerships between all regional stakeholders – community, industry and government;
- developing cross-sectoral understanding of regional greenhouse implications and development opportunities;
- building community knowledge and understanding of greenhouse issues;
- initiating regional policies, programs and targets;
- encouraging all sectors of the regional community to accept responsibility for their contribution to global warming and work toward voluntary reduction target;
- identifying solutions that produce economic, social and environmental benefits;
- moving the region toward a future based on renewable energy.

The first major initiative of the Alliance was to pool resources to achieve a region-wide energy audit – undertaken under the auspice of the Cities for Climate Protection Program.

Cities for Climate Protection Program

The Cities for Climate Protection program (CCP) is operating worldwide as an initiative of the International Council for Local Environmental Initiatives (ICLEI). In Australia, this program has been developed in conjunction with the Australian Greenhouse Office (AGO). ICLEI was formed in 1990 at the Congress of Cities for a Sustainable Future. It bands together cities, towns, counties, and local government associations around the world, who wish to identify and implement innovative environmental processes at the local level. The AGO was developed as a separate environmental management entity, as part of Australia's $180 million climate change package. As part of this package, $13 million has been provided over five years for the management and application of the CCP program.

The CCP program empowers Local Government to reduce greenhouse gas emissions by adopting a 'Milestone Framework' process. The CCP Australia program invites all members to pledge to reduce greenhouse gas emissions and to improve the energy efficiency in their local communities by agreeing to a five-step milestone process.

This involves:

- *Inventory and forecast* - conducting a base year emissions analysis and forecast of municipal and community-wide greenhouse gas emissions (corporate and community);

- *Set reduction targets* - develop a local action plan that spells out a greenhouse gas reduction target and the policies and measures that will achieve that target;
- *Plan implementation* - active implementation of the climate protection measures contained in the local action plan; and
- *Measure progress* - monitoring and verification of progress in achieving emission reductions.

The CCP program distinguishes between local government and community energy consumption. The local government data were derived directly from each area of operation – involving information on fuel and energy volumes associated with buildings, street lighting, vehicle fleets, and water/sewerage and waste management.

The community data encompasses all sectors outside local government – ie. residential, industrial, and commercial. The volume of energy consumed by the community is provided by CCP, based on manipulated national statistics. Hence, until specific community data can be gathered the emissions load produced by residential, industrial and commercial sectors remains a loose approximation, with limited ability to analyse the different sectors in any great detail. The use of economic techniques such as input/output analysis is emerging as a significant source of sector data and analysis at the local level (work by Lenzen and Murray unpublished; Pinge unpublished). The pooling of resources has enabled the establishment of a region-wide database and created greater co-operation and interaction between local government areas. It has also enabled an initial energy footprint to be calculated for each local government and the region as a whole.

Mapping the Region's Energy Footprint

Calculation of the *full* ecological footprint, for a given population is based on the amount of land needed for:

- built infrastructure, crops and pasture, minerals;
- production of wood based products;
- absorption of CO_2 emissions;
- land required for bio-diversity (at least 12 per cent).

The energy footprint, however, only relates to the land area required to absorb CO_2 emissions. As this paper is concerned with a regional response to climate change, only the energy footprint is derived to communicate the extent of the problem at the local level.

The visualisation of land area required to sustain current consumption patterns at the local level produces an immediate appreciation of earthly limits – and how far they are being exceeded, opening the way for new developments in more efficient, sustainable technologies.

In simple terms, it addresses questions like, how many hectares of reforested land would be required to absorb Bendigo's CO_2 emission load? How much land is required to produce food, to provide housing and other built infrastructure? How much land is required to ensure the maintenance of bio-diversity, so that other species may also live. And finally, is there enough land available to meet growing demand. Keeping in mind that 65 per cent of the total land area of the region is taken up by agricultural production, 13 per cent is protected as national park or nature reserve, and the remaining 22 per cent being used for urban and transport infrastructure, the implications for different strategies to reduce greenhouse gas emissions can be more effectively explored.

The energy audit for each participating local government produced a measurement of greenhouse gas emissions from a range of sources. Tables 1 and 2 present the volume of emissions produced by both local government operations (Table 1) and the rest of the community (Table 2).

Based on the data produced through the CCP process, and recognising some data gaps, total emissions by the people of north central Victoria is estimated at 3.4 million tons per year – and growing.

Table 1. Local government Greenhouse Gas Emissions (tonnes emitted as at 1999)

Energy Source	Bendigo	Buloke	Campaspe	Cent.Gold	Loddon	Mt Alexander
Electricity	9,462.00	753.00	2,939.00	1,278.00	562.00	801.00
Natural Gas	356.00	0.00	791.00	0.00	0.00	0.00
Heating oil	0.00	0.00	0.00	0.00	0.00	0.00
Diesel	1,847.00	1,499.00	1,086.00	449.00	1,273.00	348.00
Petrol	870.00	0.00	74.00	0.00	0.00	0.00
LPG	10.00	439.00	0.00	298.00	261.00	203.00
Paper products	88.00	1.00	14.00	2.00	2.00	2.00
Food waste	74.00	1.00	11.00	2.00	2.00	2.00
Plant debris	-2.00	0.00	0.00	0.00	0.00	0.00
Wood/textiles	-4.00	0.00	-1.00	0.00	0.00	0.00
Other Waste	0.00	0.00	0.00	0.00	0.00	0.00
Total	12,701.00	2,693.00	4,914.00	2,029.00	2,100.00	1,356.00

Note: Data for Gannawarra, Macedon Ranges, and Hepburn were not available at the time of writing.

Table 2. Community Greenhouse Gas Emissions (tonnes emitted as at 1999)

Energy source	Bendigo	Buloke	Campaspe	Cent.Gold	Gannawarra	Loddon	Mt Alexander
Electricity	597,759.00	51,965.00	427,425.00	125,678.00	117,679.00	61,833.00	112,686.00
Heating Oil	1,390.00	133.00	35.00	209.00	210.00	160.00	268.00
Fuel Oil	10,140.00	183.00	6,106.00	3,373.00	625.00	532.00	1,327.00
Petrol	167,040.00	15,057.00	68,769.00	25,229.00	24,212.00	17,497.00	32,960.00
Diesel	93,556.00	26,589.00	73,164.00	17,860.00	34,129.00	30,637.00	24,432.00
LPG	33,676.00	2,742.00	11,215.00	4,336.00	4,060.00	2,834.00	5,434.00
CNG	175.00	16.00	72.00	26.00	25.00	18.00	34.00
Brown Coal	2,000.00	40.00	470.00	685.00	85.00	698.00	1,090.00
Black Coal	97,540.00	1,711.00	57,449.00	30,833.00	5,729.00	4,657.00	12,103.00
Coal Briquettes	4,729.00	268.00	3,384.00	922.00	775.00	494.00	1,470.00
Coke	47,405.00	534.00	25,674.00	14,932.00	1,518.00	1,449.00	3,221.00
Kerosene	44.00	38.00	88.00	16.00	45.00	41.00	15.00
Paper products	7,126.00	1,105.00	0.00	1,265.00	0.00	0.00	2,356.00
Food	13,416.00	2,081.00	0.00	2,382.00	0.00	0.00	4,435.00
Plant debris	-937.00	-145.00	0.00	-166.00	0.00	-17.00	-310.00
Wood/textiles	-1,625.00	-252.00	0.00	-288.00	0.00	-29.00	-537.00
Other Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	1,259,553.00	112,952.00	753,309.00	263,433.00	208,231.00	138,117.00	237,249.00

Note: Data for Hepburn, and Mt Macedon were not available at the time of writing.

Table 3: Total Greenhouse Gas Emissions for North Central Victoria (tonnes emitted as at 1999)

Location	Community	Local Government
Bendigo	1,259,553	12,701
Buloke	112,952	2,693
Campaspe	753,309	4,914
Central Goldfields	263,433	2,030
Gannawarra	208,231	awaiting data
Loddon	138,117	2,100
Macedon Ranges	457,787	awaiting data
Mount Alexander	237,249	1,356
Hepburn	awaiting data	awaiting data
Total	3,430,691	25,794 (partial)

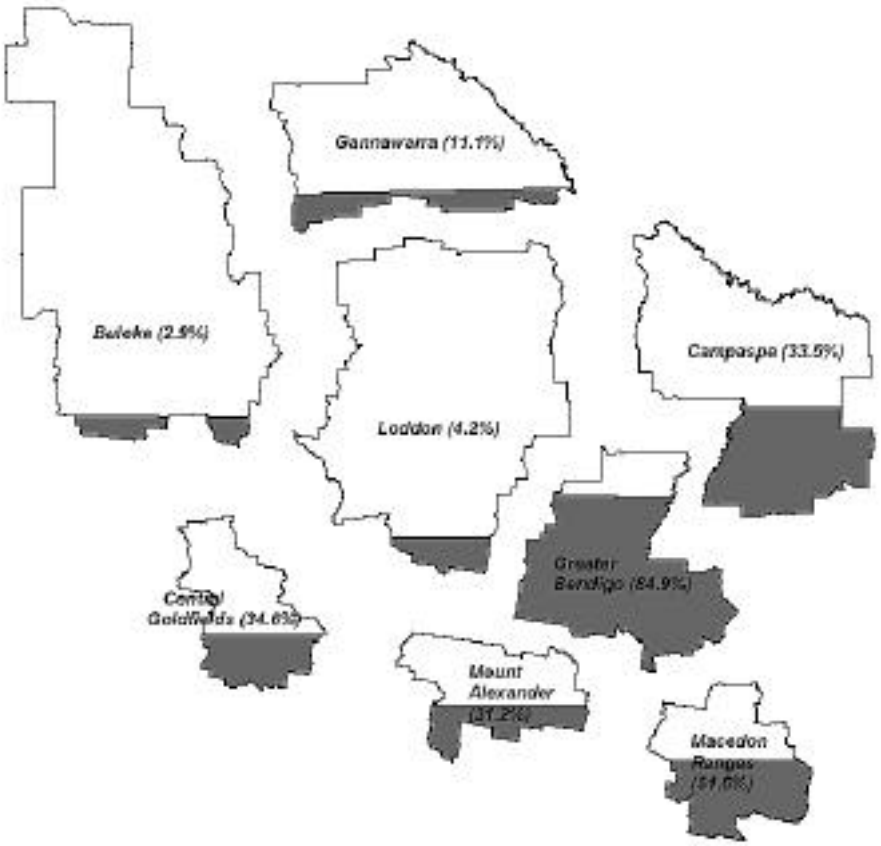
Let's now look at the energy footprint for north central Victoria. If we are to reduce our impact on climate change by increasing plant growth (sequestration), growth rates across the region become critical. Given the low rainfall and poor soils, Park (pers. comm., 2001) believes the most realistic growth rate estimate in this region is between 2 and 5 tons of CO_2 absorption per hectare. With a carbon load of 3.4m tonnes per annum, north central Victoria would need to have between 680,000 (20 per cent of land area) and 1.7 million hectares (56 per cent of land area) of new tree growth – managed on a sustainable harvest basis to ensure a consistent level of absorption over time (refer Table 4 and Figure 1).

Table 4. Land area required for CO_2 sequestration in north central Victoria

Absorption Rate	Land area required
2 Tonnes / Hectare*	1.7 million Hectares
5 Tonnes / Hectare	680,000 Hectares

Note: * considered the more realistic growth rate for most of the north central region.

Figure 1: Proportion of land area required for tree planting at 5ha per tonne within each Shire



Hence, the energy footprint of the people of north central Victoria is 3.4 to 8.5 ha per person (680,000 to 1.7m ha divided by the population), depending on which growth rate is used. This is interpreted as the amount of land that each individual requires to absorb the amount of greenhouse gas they produce.

Table 5 takes the analysis a step further, showing differences in consumption levels between local government areas – raising important questions about why this might be the case. The scope of this paper is not to venture into the detail of each local government area's consumption – the question is merely indicative of how the footprint can be useful.

Table 5. The per capita Energy Footprint for each local government area (at 5 tonnes/ha)

Shire	Population Area	Required Land	Footprint (ha)
Bendigo	62,419	254,450	4.1
Buloke	7,599	23,129	3.0
Campaspe	23,306	151,644	6.5
Central Goldfields	12,322	53,092	4.3
Gannawarra	11,922	41,646	3.5
Loddon	8,566	28,043	3.3
Macedon Ranges	32,367	91,557	2.8
Mount Alexander	15,930	47,721	3.0
Hepburn	-	-	-

Considering Wackernagel and Rees (1997) conclusion that a sustainable level of all consumption and waste production is that which requires 1.5ha per person, the energy footprint of north central Victoria is clearly unsustainable in the global context. There simply is not enough land area to accommodate this, and a growing level of consumption.

Regional Development Opportunities

The Central Victorian Greenhouse Alliance is currently evaluating the energy, economic, and social merits of a range of long and short term strategies and options for improved energy efficiency and alternative energy technologies, including:

- a combination solar power/food production plant;
- street lighting – regional retrofit program;
- new fuels – biodiesel and A55 (a diesel/water mix developed in the USA) - being piloted in the region;
- carbon sinks – tree plantings for biodiversity, salinity, water quality, and greenhouse purposes; and
- community power – aimed at harnessing collective bargaining power.

Solar power/food production plant

The Alliance's working group on solar power is currently investigating the feasibility of co-locating a Solar Systems Big Dish power generator alongside hydroponics and aquaculture industries. The big dish contributes electrical power to the grid and the attendant waste heat is used for hydroponics and aquaculture. Such a plant would reduce the regions energy footprint and attract new investment to the region.

Energy efficient street lighting

Streetlighting is a major cost and energy consumer for councils, accounting for an average of 47 per cent of greenhouse gas emissions. Research is underway to determine the reliability of low-energy systems for minor roads and the cost-savings of such systems for major roads. The savings in each case are likely to be substantial. Such systems could also be introduced in parallel with solar powered lighting (already in place in at least one shire) and timed dimmer systems that reduce energy consumption at certain times of night. This project would substantially reduce the corporate footprint and financial expenditure on energy.

New Fuel

There is considerable potential for 'climate-friendly' vehicle fuel in the region. Biodiesel could offer particular advantages in this region given the volume of canola oil that is produced. Existing distribution facilities can be used, limited changes are needed for service stations, capital investment is small-scale, and the potential for increased employment is considerable. Research has indicated the potential to increase employment by one person per ten hectares dedicated to energy crops. Elsewhere in Victoria, bus fleets are already being converted to ethanol, with solar-hydrogen technology more or less market ready. Diesel mixed with water (A55) is another new fuel being produced by Clean Technologies (USA). Initial testing of this fuel in Australia has been conducted in the Buloke Shire, with further tests planned. Current diesel consumption is estimated to produce 306,869 tonnes of CO_2 per year (6502 + 300,367 corporate and community respectively). This requires 60,773ha of land for sequestration if a carbon neutral strategy was employed – representing a 0.3ha per person footprint.

Geothermal heating and cooling

The energy requirements of building account for an average 37 per cent of emissions from councils that have completed corporate emissions inventories as part of CCP. Geothermal energy uses existing technology that draws on the heating and cooling capacity of the earth beneath or around a building and offers up to 60 per cent reduction of costs and greenhouse gas emissions. Already installed in a number of sites around Victoria, geothermal heating and cooling offers particular advantages to facilities with 24-hour energy requirements such as hospitals, prisons and swimming pools.

Carbon Sinks

In addition to 'offsetting' CO_2 emissions, revegetation can provide very significant collateral environmental and social benefits related to salinity and water management, biodiversity, employment and tourism. Incorporating carefully planned revegetation as part of an overall program to reduce emissions offers particular advantages to north central Victoria in areas where land is suitable for revegetation.

Carbon-fixing 'alley farming

The integration of 'alley farms' of trees into agricultural land has been shown to offer environmental benefits and financial opportunities while not reducing agricultural yields. Indeed, improved agricultural practices can account for very considerable increases in carbon sequestration in soils.

Community Power

Following the lead by Local Government in the South East of the state (Darebin, Port Philip and Moreland Shires), the Consortium is exploring models of collective bargaining. The Bendigo Bank is particularly interested in this concept, and is discussing the feasibility of establishing a community-based energy company along similar lines to Community Telco - a community based telecommunications company.

Concluding Discussion

While a call for action at the local level may seem like 'tilting at windmills', there can be no doubt that this issue will be one of the major economic drivers of the future. Changes in energy consumption, production, waste/by product disposal, market structures, and community behaviour present substantial regional development challenges and opportunities.

Now that we know the extent of our impact (our energy footprint), we can use the footprint as an indicator of progress – as a tool to mobilise political and community leaders. The Alliance believes that its goals are achievable by the implementation of both short term, low cost actions and a longer term, more costly region-wide strategy. The energy footprint helps us to take the first step in conveying this important and complex information to the community. It is hoped that this type of analysis will stimulate support and an unstoppable momentum toward a major shift in community attitudes and the development of a region-wide strategy to shift the source of energy toward more sustainable technologies. The success of the Alliance lies in the collaboration between the major institutions and the strength of their commitment to the process over the long haul.

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