Lessons from the Europe's "Greenest City"

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ABSTRACT

In 2007, the City of Växjö in Sweden was voted the greenest city in Europe. Over an 18-year period, greenhouse gas emissions per resident have been reduced by 41%. How has Växjö achieved this impressive result and are there any lessons that could be transferred to Australian cities? This paper describes research which compares Växjö with the Victorian City of Ballarat. The research shows that per capita emissions for Ballarat are 133% higher than those in Växjö. Upgrading the typical Ballarat home to a 6-star rating, and installing a gas-boosted solar water heater and 4.0 kW PV system on the roof could reduce per capita emissions to similar levels to those in Växjö.

Keywords: greenhouse gas emissions, Växjö, Ballarat, lessons and opportunities

INTRODUCTION

The need to reduce greenhouse gas (GHG) emissions is now more urgent as the impacts of global warming are increasingly confirmed by climate science. In Australia, nearly 90% of the population lives in cities (UNPIN, 2009) and per capita GHG emissions are amongst the highest in the world (Turton, 2004). Action to reduce the emissions from Australian cities is therefore particularly pressing. There is the potential to learn from those cities overseas which have successfully reduced their emissions. One of those cities is Växjö, in southern Sweden, which in 2007 was named the "Greenest City in Europe" by the BBC because it had reduced its GHG emissions by 41% over 18 years. How has this been achieved and could the lessons learned be applied in Australia? This paper describes research which has compared Växjö and the measures taken to the Victorian City of Ballarat.

VÄXJÖ AND BALLARAT

The City of Växjö is the administrative centre of the municipality of the same name in the county of Kronoberg. In 2012, Växjö was the country's 38th largest city with a population of 84,800 (Statistics Sweden, 2013). The city hosts a university, a hospital and some 7000 businesses. Average per capita income from employment in 2008 was A$35,714 (Vk, 2013a). With a population of 85,935, the Victorian regional City of

Ballarat is the third largest urban concentration in the state. It has a hospital, a university and various types of industry. There are 8000 businesses registered in the Ballarat region (COB 2013a).The average annual income of the medium lowest and highest quartiles in 2011 was A$34,294.

DEMOGRAPHY, CLIMATE AND ENERGY USE

Although the two cities have comparable urban populations, other key parameters which define the demography of the two cities are quite different (Table 1). The climates of the two cities are also significantly different and are key determinants of energy use and potential renewable energy exploitation (Table 2). The annual daily average value of horizontal global solar radiation is 70% higher in Ballarat. The ambient temperatures in Ballarat are significantly higher than in Växjö, resulting in about half the number of heating degree days. Neither location has a significant cooling demand. The mean wind speed in Ballarat is 50% higher than that of Växjö.

Table 1 Key population and land statistics for the cities of Växjö and Ballarat

Demographic Parameter	Växjö	Ballarat
Population (Locality or UCL)	82,000	85,935
Urban area (km^2) (Locality or UCL)	30.28	113.7
Urban population density (p/ha)	27.1	7.6
Municipality or LGA area (km^2)	1674	739

(sources: Vk 2013b; Statistics Sweden, 2013; ABS, 2011)

Table 2 Key climatic variables for the cities of Växjö and Ballarat

Climatic Variable	Växjö	Ballarat
Average daily horizontal global solar radiation (MJ m^2 d^{-1})	9.3[1]	15.8[2]
Average ambient air temperature (°C)	6.3[1]	12.2[2]
Mean wind speed (m s^{-1})	3.5[1]	5.3[2]
Heating degree days (18°C base) [3]	4101	2250
Cooling degree days (26°C base)	0	99

(sources: [1]SMHI; [2]BoM 2013; [3]BizEE 2013;)

Figure 1 shows the per capita GHG emissions for transport, heating and electricity between 1993 and 2011 for Växjö (Johansson, 2013). Total per capita emissions fell from 4.6 to 2.7 tonnes i.e. 41%. Most of this reduction is due to the fall in emissions from residential heating. Electricity use per capita has fallen by 17%. Transport emissions per capita rose steadily from 1993 and peaked in 2005. Since then, they have steadily declined and in 2011 were 9% lower than they were in 1993.

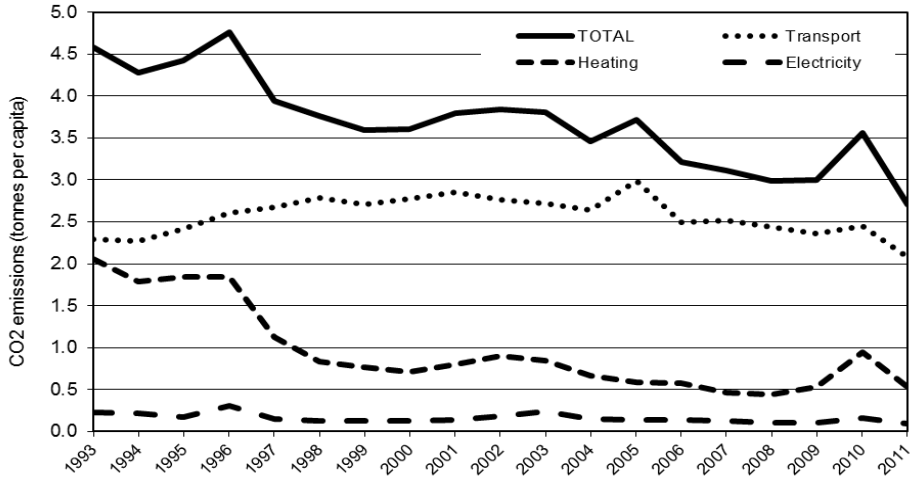

Figure 1 Per capita GHG emissions (tonnes) in Växjö between 1993 and 2005
(source: Johansson 2013)

Gas and electricity usage by Ballarat City residents for four years (2004-2007) has been published (DSE 2009) and covers an estimated population of 89,665 persons occupying 33,608 dwellings. The data indicates that on average the city's residents used approximately 58.5 GJ of gas per customer and 5.75 MWh of electricity per dwelling. The GHG emissions for heating, cooling and appliance use have been calculated using the emissions coefficients published by DCCEE (2010) and are 3.0 and 7.88 tonnes per customer and per dwelling respectively from gas consumption and electricity usage. Assuming customer and dwelling numbers to be the same, per capita emissions due to gas and electricity consumption are 4.08 tonnes per annum. Transport emissions for Ballarat residents are not available. However, car ownership figures are published by the ABS. In 2011, there were 52,429 vehicles recorded for the 81,338 residents in Ballarat Urban Centre and Locality (UCL). Assuming an annual consumption of 1500 litres of fuel per vehicle and energy content and emission factors from DCCEE (2010), then each vehicle would generate 3.42 tonnes of CO2-e and each resident would be responsible for 2.21 tonnes. Combining the estimated per capita emissions for transport, gas and electricity for the average Ballarat resident gives a total of 6.29 tonnes i.e. 133% higher than the 2011 level for the average Växjö resident (Table 3).

Table 3 GHG emissions for Växjö and Ballarat (t CO_2-e/cap/a)

	Transport	Electricity	Heating	Total
Växjö	2.08	0.09	0.53	2.70
Ballarat	2.21	2.95	1.13	6.29

THE GREENING OF VÄXJÖ

The achievements of Växjö need to be seen within the context of the overall Swedish energy supply system and its associated emissions. The widespread use of low emission energy supply technologies nationally has meant that emissions across all sectors in Sweden in 2009 were approximately five tonnes per capita (SEA, 2011). Växjö has pursued an aggressive policy of its own to reduce emissions. Their commitment began in the 1980s with the conversion of the existing district heating system from oil to a renewable source and then in the 1990s the municipality took the decision to eventually become a fossil-fuel free city (Vk, 2010). The Kronoberg county municipalities' association has also decided to be fossil-fuel free by 2030. Targets and indicators are essential for such an ambitious process and seven specific targets have been set for 2015 (Vk, 2010). To have achieved their emission reductions to date (and the future), various initiatives have been (and continue to be) undertaken. The City of Växjö uses the ICLEI program ecoBUDGET to guide and follow up on these initiatives. The completed and on-going collaborative (national and international) projects include:

- International – ELMOS (electric mobility), Trailblazer (goods delivery co-ordination) and Dreams (support to some South East Asian cities)
- Completed projects include: ENGAGE (promotes EU energy and climate goals), CLIPART (tools and procedures to support climate policy and planning), ANSWER (energy efficiency events and competitions), EcoRegion (development of Baltic Sea sustainable development) and SESAC (European projects involving three cities: Delft, Grenoble and Växjö). SESAC projects include: a 532 panel PV system on a senior school; demonstration of the cost-effective utilization of biogas from the sewage plant; and construction of 88 low energy apartments and pre-school;

The initiatives of Växjö have been boosted by the city's membership of various international and national networks. Signing agreements with organizations with similar goals offers mutual support, enables problem sharing and provides the impetus of a public commitment to action. The international networks to which Växjö belong include:

- The Covenant of Mayors - a commitment of signatory towns and cities to exceed EU GHG reduction target for 2020 by 20%.
- Energy Cities – a European association (founded in 1990) of more than 1000 municipalities in 30 countries. Växjö joined in 2002.

- ICLEI – Local Governments for Sustainability, which is an international environmental organization with more than 1000 member cities.
- Plus DME (diesel), REVES (social development) and UBC (Baltic City cooperation)

and the national networks to which Växjö belong include:

- Climate Municipalities (Klimmat Kommunerna) – an association of 22 municipalities and one county covering two million inhabitants committed to reducing emissions.
- Regional network covering Småland, Öland, Blekinge and Halland for environment and sustainable development projects
- Internal environmental network within Växjö e.g. meeting with representatives from each municipal-owned company.

TRANSFORMING BALLARAT

The City of Ballarat has already taken some steps to reduce carbon emissions. In 2003, the City of Ballarat developed a Local GHG Emission Reduction Plan., which aims to achieve effective carbon neutrality for its own activities by 2025 (CoB 2013b). At a regional level, Ballarat is part of the Central Victoria Solar City project, launched in November 2009. Several solar projects have been initiated. These include a 'Solar Park' with a 300 kW PV system, expected to generate approximately 420 MWh annually and reduce GHG emissions by 567 tonnes, and two medium-size PV systems (25 and 35 kW) on two Ballarat Health Service buildings, as well as two 9 kW 'green' car shelters and two electric vehicles (CSVC, 2010). The GHG emissions associated with electricity use is the largest contributor to the annual per capita emissions of Ballarat residents (Table 3). In contrast, emissions associated with travel are the biggest component (77%) of the annual per capita emissions of Växjö residents. Per capita travel emissions in the two cities are quite similar, Ballarat being 6% higher (Table 3). Emissions associated with heating are more than twice as high in Ballarat compared to Växjö because a significant proportion of the latter's heat is provided by the biomass CHP system. Emissions for electricity use are two orders of magnitude lower in Växjö due to the combination of the use of low emission technologies nationally and local generation from the biomass CHP.

Ballarat has significant opportunities to enable a similar transition to low emission technologies for heating. Only 4% of dwellings in Ballarat have a solar water heater and assuming that 40% of the gas usage is for water heating, each solar water heater

on a dwelling would reduce the annual emissions per resident to 0.18 tonnes. The emissions associated with space heating can be reduced by improving the building envelope. The average star rating of the houses in Australia is only 2.5. New homes are required to have a rating of at least 6 stars. A 62% reduction in energy use is possible by upgrading a 2.5-star house in Ballarat to a 6-star rating (NatHERS, 2012). Assuming 50% of the gas usage is for space heating, then energy use for space heating and emissions could be reduced to 11.12 GJ per dwelling and 0.21 tonnes CO2-e per resident respectively. There are significant options for the generation of electricity from local renewable energy sources. Each kW of PV installed saves approximately 1.89 tonnes of greenhouse emissions. Currently, only 3.8% of homes in Ballarat have PV systems (AusGov CER, 2013). A 4.0 kW PV system on a home in Ballarat would reduce its emissions by 7.56 tonnes per annum and reduce per capita emissions to 0.12 tonnes. The area surrounding Ballarat has already proved itself to have significant wind resources. The Waubra wind farm, 35 km northwest of the city, consists of 128 turbines with an installed capacity of 193 MW. Each MW of the Waubra wind farm reduces CO_2 emissions by approximately 3400 tonnes annually (Acciona Australia, 2013). Other renewable technologies need to be encouraged if further reductions are to be made. Biofuels for transport are being demonstrated in Sweden on a large scale. Studies indicate that within a radius of 80 km of Ballarat up to 300,000 tonnes of biomass is available and could provide up to 30% of the city's transport fuel (CHAF, 2013).

CONCLUSIONS

Known energy efficiency strategies and proven solar and wind technologies could reduce per capita emissions for Ballarat residents to levels comparable with Växjö. The existence of technologies to reduce GHG emissions alone is insufficient to meet GHG reduction targets. Växjö has demonstrated that leadership and policies are required. A vision – perhaps a "Green Ballarat" - should be promoted by the council. Although the City of Ballarat has taken the initial steps in this direction, a bolder approach will be required. A vision of carbon neutrality for the community needs to be annunciated. Emission reduction targets and indicators for assessing the effectiveness of policies need to be established. Support for a "Green Ballarat" needs to be widened through international, as well as national, alliances. Moreover, like Växjö, an understanding that a change of this magnitude will take at least 20 years, is required.

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