

Cooling NZ: institutional drivers behind the growth in air-conditioning

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ABSTRACT: Cooling by air-conditioning in buildings has been claimed to be addictive to the occupants. But for every addict there is 'pusher' who has introduced and supplies the product. This paper examines the motives of the institutional pushers that promote air-conditioning in the built environment in New Zealand. Compared to many countries, New Zealand has lagged behind in the growth of air-conditioning in the built environment. This makes it an ideal place to observe how various institutions and organisations are either deliberately or unselfconsciously promoting cooling to a population that has, until recently, survived well without it. The paper does not address the air-conditioning industry, as it is self-evident that it will promote its own products. Instead it focuses on those institutions that may ultimately suffer from their own actions. Central government, local government, the electricity supply industry, the Green Building Council, the Property Council, the New Zealand Institute of Architects and others are all 'pushing' air-conditioning, even though some may not be aware of it. Behind this is the assumption that there is a never-ending supply of energy and that the narrow band of comfort resulting from air-conditioning is healthy, promotes productivity, reduces complaints, enhances architectural style and is energy efficient. This paper will review the role that each of these institutions plays in the promotion of air-conditioning and discusses the ultimate demise of any building that relies on an uninterrupted supply of grid supplied energy in order to remain habitable. This research into the understanding of how these institutions operate to promote air-conditioning may eventually assist in reversing the process.

Conference theme: Buildings and energy

Keywords: institutions, promoting, air-conditioning, energy

1. INTRODUCTION

The air-conditioning of buildings has the advantage of providing a comfortable working environment in hot weather conditions. However, it has the disadvantage of consuming more energy, and hence carbon emissions, than a naturally ventilated building. A rough rule of thumb is that an air-conditioned building uses twice much energy than a naturally ventilated building, so the decision to air-condition a building has significant long-term implications for operational costs especially as there is little scope to easily convert a sealed air-conditioned building back into a naturally ventilated building.

The advantages of air-conditioning diminish in situations where the average summertime external temperatures are already within normal comfort ranges and where appropriate passive design decisions can ensure that internal temperature are within normal adaptable comfort temperatures. In these circumstances, it is difficult to justify air-conditioning on grounds of comfort and it is generally done for other reasons such as prestige, rental value or poor architectural design that causes buildings to overheat.

This paper is an initial study into the drivers behind the installation of air-conditioning in buildings in Auckland, New Zealand. Auckland, the largest city and largest electricity consumer in the warmest climatic zone, has maximum summertime temperatures of between 20°C and 27°C (Mullan, Tait and Thompson 2009). These temperatures are well within the range of being controlled by appropriate building design (Givoni 1994) to provide comfortable internal temperatures.

However, air-conditioning in both the home and at work in New Zealand are increasing with apparent little concern into the longer term implications on electricity demand and consequent infrastructure upgrading to ensure that supply can match demand (Byrd 2012a). The addictive nature of air-conditioning has the potential to spread demand for 'coolth' from places of work to the home (Prins 1992). If this continues, the pattern of use could follow that of Australia where the growth in the installation of home air-conditioning has resulted in need for upgrading both the electricity supply infrastructure and generation capacity in order to meet the new demand of electricity for cooling (Fanning 2011).

Research into the issues of air-conditioning use has tended to focus on human comfort (Nicol, Rudge and Kovats 2005; Tuohy et al. 2010). This research is tackling the problem from the point of view of comfort standards and has made significant progress in shifting international standards from the Predicted Mean Vote to the Adaptive Comfort

models. The greater comfort tolerances in the Adaptive model allows more freedom to designers of buildings and the mechanical systems to adopt either natural ventilation or mixed mode strategies to cool buildings.

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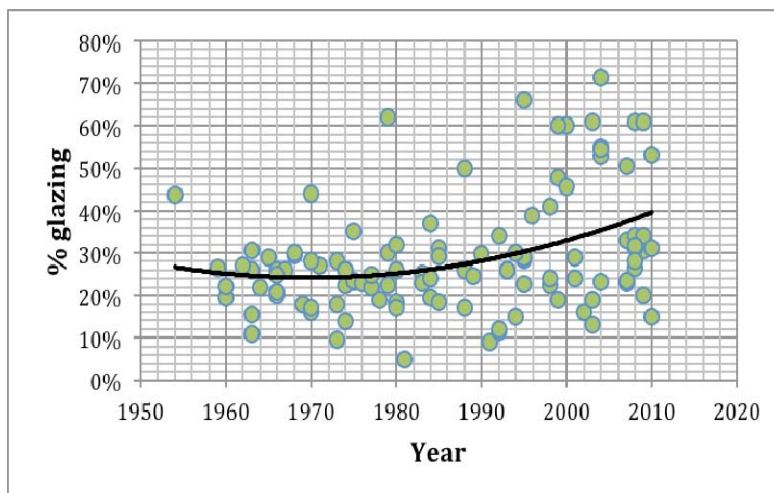
However, the main drive for air-conditioning in buildings is not coming from the occupants but from other institutions involved in the commissioning, design, promotion and operation of buildings. While occupants succumb to the apparent 'addiction' of 'coolth', the 'pushers' are those who benefit in other indirect ways. The market forces from the air-conditioning industry and the cultural origins of 'addiction', including consumer behaviour and technological dreams, have been described elsewhere (Prins 1992; Brager & de Dear 2003). These forces have a clear motivation of advertising on the one hand and maintaining socio-economic status on the other.

However, there are other forces that are pushing air-conditioning. These are the institutions that may gain in the short-term by supporting the drive for economic status but may eventually suffer for their own actions. The following sections investigate how key institutions in New Zealand are promoting air-conditioning either directly or inadvertently. They are not involved in the air-conditioning industry but they are all, possibly unknowingly, actively promoting the industry. The institutions that will be discussed are: the New Zealand Institute of Architects (NZIA), the New Zealand Property Council, the New Zealand Green Building Council, the New Zealand Government and Auckland Council.

2. THE NEW ZEALAND INSTITUTE OF ARCHITECTS (NZIA)

As an institution, the NZIA celebrates good architecture through its awards to designers of buildings of architectural merit. In the housing category, awards reflect styles that come and go through time making it possible to reasonably accurately date a house depending on its style. Styles that win awards get published and influence other designers and their patrons. A distinctive trend in New Zealand has been the proportion of glass in houses that has increased over the decades resulting in buildings with large areas of unprotected glazing causing overheating.

A study (Byrd & Nash 2012) was carried out on the performance of award winning houses over the last 50 years. Houses from every year were modelled to assess the proportion of glazing and both the cooling and heating loads. Figure 1 illustrates the trend in the increase in the proportion of glazing. Not only was the proportion of glazing increasing but also the tendency was for designs to orientate the glazing towards the equator and not to provide adequate shading. As a result, average heating loads have steadily increased by about 0.5% per year. However, cooling loads have increased at an average of 10% per year (20 times faster than the heating load increase).



Source: (Byrd & Nash 2012)

Figure 1: The proportion of glazing in award winning houses

Architectural awards are generally for appearance only and while the houses may look sexy, the trends indicate that their designs lead to an ever increasing demand for cooling and consequent dangers for the resources required to provide the energy to cool them.

The NZIA is also known to give awards, which should be based on performance, to buildings that self-evidently do not perform. For example, the 2010 award for 'sustainability' went to a multi-storey office building that was fully glazed on all sides and had no solar protection. In Auckland, these types of buildings require cooling throughout most of the year.

It was not made very clear by the NZIA why it had won the award stating only that the building had been given, “a new and more profitable lease of life” (Celsias 2011a). However, the architects later stated (Celsias 2011b) that the significant environmental feature concerning its energy performance was that the building had been double-glazed; a mandatory requirement for a building that is fully glazed. It is curious why a sustainability award should be given to a building that complies with Building Code; the minimum legal standard.

3. THE NEW ZEALAND GREEN BUILDING COUNCIL (NZGBC)

The same office building made the front cover of the World Green Building Council report in 2009. A building that complied with the minimum legal standards of its country, however the design that had not applied any form of good practice in reducing its cooling loads. This begs the question: how can such a building get through the rating system of the Green Building Council? The answer is that the rating system encourages both excessive glazing and air-conditioning.

Previous research (Byrd 2012) has demonstrated how the NZGBC rating system encourages over-glazing. In brief, the requirement for daylight is over emphasised (the more glass, the more credits) resulting in a significant number of buildings having 80% glass or more (Byrd and Leardini 2011) and little emphasis being placed on reducing energy use. The points available for internal noise level are lost if windows are openable, so a sealed building that relies on mechanical ventilation obtains more credit.



Source: (World Green Building Council Report 2009)

Figure 2: Front cover of the World Green Building Council

Figure 2 shows the illustration of the 4-Star rated building in Auckland that is fully air-conditioned, almost 100% glazing and has no significant solar protection. Of greater concern in the NZ Green Building rating system, is the number of points given to mechanical systems that result in air-conditioning. Research by Cichy (2011), has shown that weighted points that can be achieved by a 'passive design' amount to a potential of 32.4% while the points that can be achieved by 'mechanical systems' amount to 51.4%. While the NZGBC recognises the advantages of natural ventilation in its rhetoric, it does not credit it in its points allocation.

In a country where air-conditioning is not required in buildings for comfort purposes, provided it has reasonable means of avoiding peak summer-time temperatures, and where noise levels in urban areas are well within tolerance limits, the NZGBC encourages over-glazed, sealed buildings with air-conditioning. For developers and architects, 'green building' accreditation is an important marketing strategy. With few exceptions they will produce buildings to achieve green points rather than consider environmentally conscious design.

4. THE PROPERTY COUNCIL OF NEW ZEALAND

The Property Council has a Quality Grading Matrix for offices in the central business district (Property Council of New Zealand). Offices are graded A, B, C or 'Other' depending on characteristics of the building. The higher the grading, the higher the rent that can be charged. In order to be graded A, B or C an air-conditioning system is required. This rating system is based on providing prestige offices and is the single most significant influence for the implementation of air-conditioning systems in commercial property. This actively discourages passive design solutions and energy efficient design principles.

Interestingly, a recent development in Auckland (Ironbank) was designed specifically not to require air-conditioning and tenants are prohibited from retrofitting it. A post-occupancy evaluation (Onyeizu & Byrd 2012) of this naturally ventilated building was carried out after one year of occupation and found tenants to be comfortable and to have few adverse comments about the internal environmental quality. The 'Air in summer overall' score was in the 87th percentile for 'satisfactory' of international benchmarking.

This building is proof that a naturally ventilated building can not only be comfortable but also achieve standards of internal environmental quality that can induce productivity as much as any air-conditioned building. However, this building is the exception and most developers will choose an air-conditioned solution based on prestige.

5. THE NEW ZEALAND GOVERNMENT

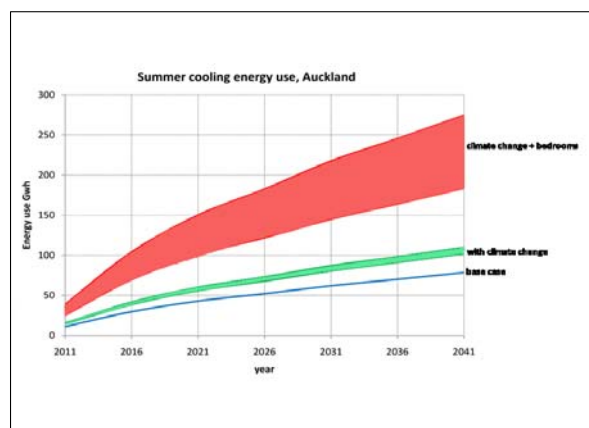
New Zealand has actively avoided state subsidies on the principle that they interfere with the market. For example, there is no feed-in tariff for distributed generation of energy, as there is in all other OECD countries, and the grant towards solar hot water heating was removed in 2012. However, these market driven principles seem not to apply to air-conditioning since reversible heat pumps remain subsidised.

Heat pumps were originally subsidised to induce households to move away from using electrical resistant heating devices. However, several surveys (Byrd 2012a) found that they tended to be bought by households to replace wood for heating, did not significantly offset electrical heating and thereby added to the national electrical demand. Furthermore, households were using them for cooling and thereby added another new, and unnecessary, electrical load. Despite this evidence they remain subsidised, interfere with the market and increase electricity demand.

Predictions of the impact of this over time were made by Byrd & Segedin (2010). Figure 3 illustrates 3 curves of the predicted increase of energy use in Auckland due to combination of climate change and increased use of heat pumps that are subsidised by the Government. The lowest curve predicts the increased electricity demand in Auckland as a result of increased growth and assumes one heat pump. The intermediate curve shows the increased electricity demands if average increase in temperatures due to climate change is taken into account. The top curve indicates the range in electricity demand if heat pumps are installed not only in living rooms but also bedrooms.

Recent research on the energy savings by heat pumps (Grimes et al, 2011) has shown that there is no greater saving in electricity by heat pumps that there is by adding insulation to a house. There seems little logic in subsidising a relatively short-lived piece of mechanical equipment when the long-lasting passive methods of increased insulation are just as effective.

This problem is exacerbated by the New Zealand Building Codes and Standards that do not require an assessment of the cooling loads of a dwelling to be taken into account. Over-glazing of residential buildings without any form of solar protection benefits from this as only the beneficial solar gains are considered.



Source: (Byrd & Nash 2012)

Figure 3: The predicted energy use in Auckland due to residential cooling loads

6. AUCKLAND COUNCIL

Research on the use of air-conditioning in public buildings in Auckland (Budin & Byrd 2012) has involved interviews with property managers of the Council. This research was initiated because of the increase in numbers of public buildings that were being retrofitted with air-conditioning. According to the interviewees, there appear to be two main causes for this increase.

The first is as a response to complaints from occupants, in particular those that have been moved from an air-conditioned building to a naturally ventilated building. Such complaints are seen to be valid by health and safety personnel. Personal thermometers are not uncommon in the workplace and slight increases above recommended temperatures (22°C) often results in complaints that health and safety personnel are keen to resolve to the satisfaction of fellow employees.

The second is related to recent changes in local government structure in Auckland that has resulted in job losses and reduced pay. The installation of air-conditioning has been used as a more economical method of appeasement than offering increased pay. It appears that coolth is used to boost morale.

A case study was investigated of a library owned by Auckland Council that had won awards for its design that included passive cooling. After working satisfactorily for almost ten years, the floors in the building were fully carpeted that not only negated the thermal mass but also blocked up the fresh air inlets. To rectify the problem, air-conditioning was installed and, once installed; there was reluctance to reinstate the natural ventilation system that had previously worked effectively.

7. DISCUSSION

The above analysis on the key 'pushers' of 'coolth' has highlighted that air-conditioning is financially rewarding for developers, results in awards for architects, is subsidised for creating additional electrical loads and is used to appease a disgruntled workforce and thereby increase the number of 'addicts'.

These attributes of air-conditioning completely outweigh any advice on caution in its widespread use for environmental reasons of energy efficiency or reducing carbon emissions. However, there are economic reasons that all sectors of society will have to pay for if the implementation of air-conditioning continues to increase in New Zealand. The de-regulation of the electricity supply in New Zealand has come with the proviso that any increase in demand must be met by the suppliers.

Carried to its extreme, this means that there must be an infinite amount of energy to satisfy demand and no supplier can ration electricity in the way that water might be rationed in a drought. Given that almost two-thirds of electricity in New Zealand is produced by hydro-power from small hydro lakes, the longer term prospects of having adequate water to supply an infinite amount of electricity seems unrealistic (Byrd, 2012a).

The increase in the use of air-conditioning in New Zealand buildings has lagged behind Australia. This is largely because there is very little need for air-conditioning in New Zealand. Peak summertime temperatures and good air quality do not warrant the cooling of buildings provided they are designed to 'good practice' standards. The main reason for cooling in New Zealand buildings is prestige, poor design, appeasement and financial inducement.

However, the lessons from Australia have not been learned in New Zealand. The dramatic increase in Australia's power bills (in particular Brisbane, Sydney and Melbourne) has been partly because of the increased investment in upgrading the electrical infrastructure to meet the new power demands due to cooling: *"Every time someone in Australia installs a \$1500 air conditioning system, it costs \$7000 to upgrade the electricity network to make sure there's enough capacity to run that system on the hottest summer day"* (Fanning: *The Hidden Cost of Infinite Energy* 2012).

New Zealand also suffers from an ageing and inadequate electricity infrastructure and, in a deregulated electricity supply industry; there is little incentive to invest in infrastructure (Beder 2003) in a timely way. Ultimately the consumers will pay the price with the consequential risk of fuel poverty that has been identified in Australia by Simshauser, Nelson and Doan (2010) in their paper: "The Boomerang Paradox: how a nation's wealth is creating fuel poverty...". The low cost of electrical appliances, including air-conditioning, combined with the current low cost of electricity in New Zealand is inducing the unnecessary use of air-conditioning that will ultimately need to be paid for.

8. CONCLUSION

New Zealand has a mild climate and provided a building is designed in accordance with good practice, there is no necessity for air-conditioning. However, air conditioning in both commercial and residential properties is increasing. This results in an increased electricity demand, increased CO₂ emissions and a requirement to upgrade the electrical supply infrastructure.

While it is only to be expected that the air-conditioning industry will promote their products and that building owners will be enticed to install it for reasons other than comfort, many of the institutions that might be expected to be cautious about the impacts of higher energy demand are also promoting air-conditioning.

Lessons of the implications of such widespread use of air-conditioning are increased energy use, increased cost of electricity, increased carbon emissions, fuel poverty, an addiction to cooling and the design of buildings that lack resilience. These negative impacts of a technology, for which there is little need for in New Zealand, are being given awards, being subsidised by the tax-payer, being used for appeasement in lieu of salary and promoted internationally as 'green'.

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