

Submission GEMS Review

Alan Pears AM

Senior Industry Fellow RMIT University and senior consultant for Australian Alliance for Energy Productivity

2/78 William Street Brighton Vic 3186 email apears@c031.aone.net.au 26 March 2018

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Background to my interest

I have had a strong interest in appliance and equipment efficiency since publication of my first householder guide *Energy to Burn* in 1981, web-based calculators including the world’s most comprehensive one for EPA Victoria in 2010 (at <http://www.epa.vic.gov.au/AGC/home.html>). I have been involved in design of high efficiency appliances. I led the Victorian government’s involvement in development of appliance energy labelling in the 1980s. I have provided occasional consulting input to Australia’s appliance efficiency program, and I continue to contribute to community education through talks and articles.

My ongoing involvement in research and consulting projects includes analysis of commercial and industrial appliances and equipment. My present focus is on the integration of energy efficiency, demand response and behind-the-meter renewable energy and storage at several commercial and industrial sites in an ARENA-funded project, and development of a lightweight, highly insulated electric oven for household application.

Summary and Recommendations

Australia is wasting a multi-billion dollar opportunity to cost-effectively reduce energy-related costs and cut climate impacts through action on appliances and equipment performance. While the past focus on mandated standards, energy labels and information has been very worthwhile, lack of high level leadership and ambition, limited resources, and limited breadth means we are missing out on many benefits. If we are to capture the full potential of appliance and equipment energy efficiency we need to address existing shortcomings and expand the scope of products and measures addressed by GEMS.

Key areas for improvement include:

- Exemption of GEMS from the requirement that each new Commonwealth regulation be matched by removal of equivalent regulatory 'burden' within the department
- Establishment of ongoing funded consumer representation to engage in development, operation and evaluation of the GEMS program, possibly within Energy Consumers Australia
- Increase in resources for GEMS based on recognition of multiple benefits and revised basis for cost-benefit analysis
- Action within energy market policy to remove distortions that work against GEMS outcomes and, more broadly, energy efficiency, while recognising the value of the benefits energy efficiency and related design and operating factors can contribute
- Removal of a higher proportion of inefficient new products from sale by setting higher stringency levels and using incentives and other methods
- Development of an appliance and equipment strategy that supports rapid transition to a zero carbon economy
- Expansion of program activity level and scope to include:
 - Coverage of a wider range of equipment including systems and their components, and low cost energy consuming items
 - Improved coordination and 'learning' between states and territories regarding programs that influence appliance and equipment energy efficiency
 - Identification of energy-wasting equipment in the field, and smart solutions to ensure ongoing efficient operation of new equipment over its operating life.
 - with states and territories, development, trialling and implementation of mechanisms and programs to increase ownership of efficient appliances by tenants and vulnerable households

- programs that provide tailored energy performance advice to contractors and buyers of 'custom' equipment, especially systems that combine several standard components in different ways in the commercial and industrial sectors
- strategies to bring a wider range of high efficiency products to Australia, reduce their cost and increase market intermediary understanding of their benefits and competence in their provision
- funding and coordination of an RDD&C program
- increased presence of Australia in international action on appliances and equipment, including international collaborations, development of Standards, RDD&C, behavioural research, etc

Introduction

This submission addresses a number of issues raised in the *GEMS Act Review Discussion Paper*. It also discusses several key issues and outlines potential future directions for Australian appliance energy efficiency policy.

Australia's appliance and equipment efficiency program has focused on application of minimum performance standards and energy labels, with supplementary information via a range of sources, including community groups, governments at all levels, energy providers, appliance retailers and manufacturers, etc.

The program could deliver far larger benefits to Australia if it was improved and expanded.

In its recent review of Australian energy the International Energy Agency noted (p.211, *Australia 2018 Review*):

Appliances consume around one-quarter of total energy used in the residential sector. Their consumption has increased by 34% from 2000 to 2015. Residential appliances are almost entirely driven by electricity, and their growth accounted for most of the increases in electricity consumption. It is noteworthy that appliances and space cooling have both increased in energy intensity, pointing to the need to strengthen product efficiency standards over time, in step with consumption and technology development.

Governance failure

Exemption from offset requirement

The appliance efficiency program is a victim of the Commonwealth government's unilateral requirement to identify the regulatory cost burden on industry of a new or revised regulation, and to find a corresponding reduction in regulatory burden, from the same department (see <https://www.cuttingredtape.gov.au/resources/guidance>).

This offset requirement is still in place, but the exact means of compliance is not clearly specified in the above website. Thorough exploration of the above website, and the calculation tool on it, failed to find a clear statement of the intent or specific requirements, or how decision makers might apply this requirement in the broader context of public benefit.

It seems that it is open to interpretation by each department, and by the Office of Best Practice Regulation, which oversees preparation of Regulatory Impact Statements. A recent GEMS Regulatory

Impact Statement (see <http://energyrating.gov.au/document/consultation-ris-household-refrigerators-and-freezers>) states:

“For Australia, a regulatory offset has not been identified to accompany Option C. However, the Commonwealth Department of the Environment and Energy is seeking to pursue net reductions in compliance costs and will work with affected stakeholders and across Government to identify regulatory burden reductions where appropriate.”

This can only be described as an ambiguous situation that leaves open significant risk that the requirement could be used to delay or block implementation of a measure that has substantial net public benefit, but which may impose a small cost or compliance burden on groups within industry, especially those that are ‘well-connected’ or prepared to use media to influence policy.

For an area of activity like appliance efficiency, where expansion is clearly necessary, this is simply ridiculous – and costly for society. It is a barrier that requires an ‘offset’ from another policy area with no relationship to the GEMS program, other than being in the same department. It undermines the intent of centralisation of the program, agreed to by all states and territories as a way of accelerating and streamlining expansion of the program.

It is also a distortion of the guidelines for regulatory impact analysis. If the Commonwealth fails to relax this constraint, there will be a strong incentive for states to act independently. More broadly, it also undermines the fundamental incentive for states to hand over policy areas to Commonwealth leadership across all activities, which is a threat to effective Commonwealth-State cooperation. This seems to be an over-zealous victory of ideology over competent governance.

Clearly the GEMS scheme should be exempted from this inappropriate requirement.

Prompt Ministerial action

States and territories agreed to national legislation as a way of speeding and streamlining implementation. However, recent experience with regard to air conditioner regulations has not achieved that outcome. Unnecessary delays at senior levels within the Commonwealth government undermine cross-jurisdictional co-operation.

Effective consumer representation

As the GEMS program expands and involves increasingly complex rating algorithms, technical issues and consultation processes, the capacity of consumer and community groups to make meaningful contributions, and to ensure the public interest is represented, becomes an increasing burden on groups with limited resources. It is unrealistic to expect public servants to fully represent the community’s views in negotiations with industry and other governments.

On this basis, we need a more effective consumer representation model. In particular this must support ongoing input, background research and analysis, and build a ‘corporate memory’ for community groups.

A potential option that could achieve this would be to expand the role of Energy Consumers Australia, by establishing a sub-group funded via a levy on energy retailers or an increase in funding of ECA, to address consumer aspects of appliances and equipment. This would minimise organisational costs. ECA is already developing expertise and networks with regard to a variety of energy-related consumer issues, and there would be significant synergies. This would also provide some desperately needed linkage to energy market policy.

Under-resourcing, lack of leadership and limited ambition undermine effectiveness

The present program has been seriously under-funded (according to IEA, Commonwealth spending was only \$16.9 million over 2013-2016), and has lacked top-level leadership for decades. It is a credit to the people involved that the program has achieved as much as it has. The program lacks ambition and breadth – and resources.

Various studies by governments have suggested that Australia's appliance efficiency program is cost-effectively saving society billions of dollars (estimates vary) and cutting carbon emissions by millions of tonnes each year (see an example of one government study in Figure 1 below). The cost of avoided carbon through the program has been estimated at between minus \$10 and minus \$118 per tonne of emissions.

The GEMS Review *Discussion Paper* states:

“GEMS regulations save the average Australian household between \$140 and \$220 on their electricity bill each year. The bulk of the benefits of GEMS regulations for households are delivered through appliances such as air conditioners, lighting and refrigerators. See **Box 2** for examples of the type of household savings on energy bills resulting from GEMS regulations.

Between 2000 and 2014, the E3 Program delivered a net benefit to consumers of between \$4.3 and \$7.8 billion. The program also reduced Australia's emissions by between 23 and 35 million tonnes. From 2015 to 2020, the GEMS regulations are projected to deliver a further net benefit of between \$5.1 and \$11 billion. In this same period, the program is projected to deliver between 27 and 44 million tonnes of greenhouse gas emissions savings.

In 2016, the net savings of GEMS regulations to the Australian economy was in the range of \$870 million to \$1.58 billion, with greenhouse gas emissions savings of between 4.5 and 6.9 million tonnes. That is the equivalent of half of Queensland's annual household emissions.

Over the 2020 emissions reduction period, equipment and appliances standards are expected to deliver between 50 and 79 million tonnes of greenhouse gas emissions savings, which equates to nine to 15 per cent of Australia's 2020 emissions reduction target.”

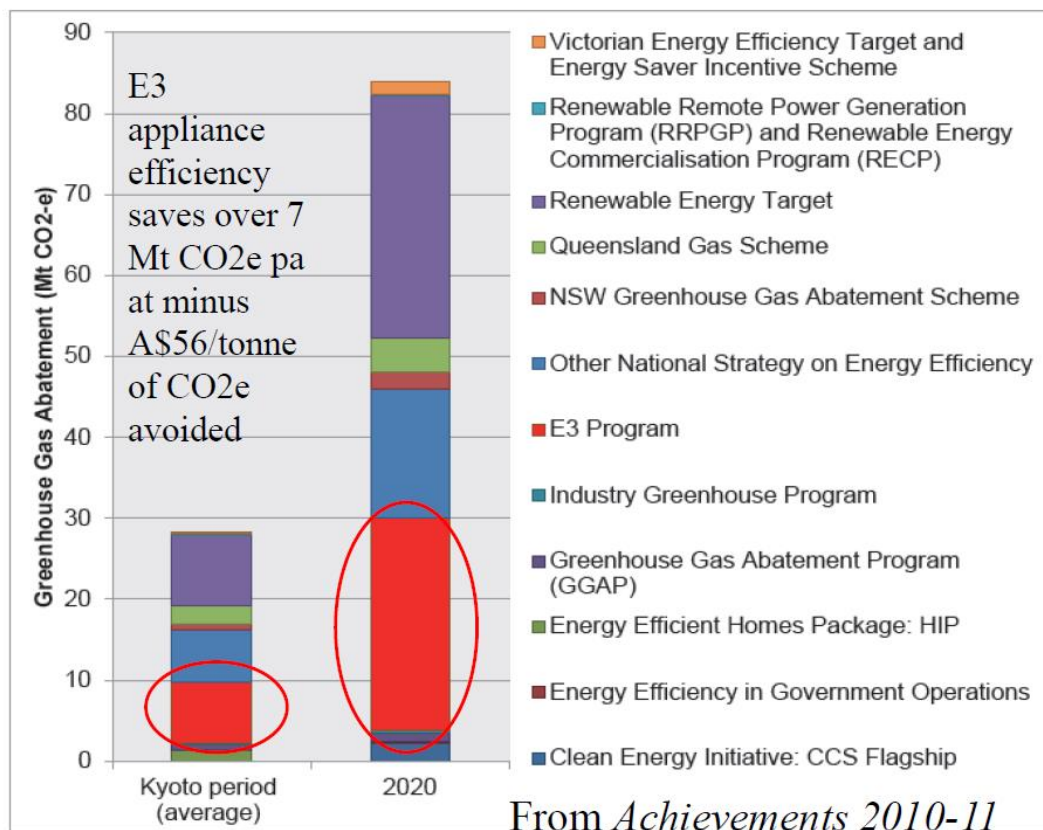
However you calculate the outcomes, the appliance efficiency program saves Australians billions of dollars and is a key element of our emission reduction program at a negative cost – that is, a significant economic benefit. Our community is profiting from appliance emission reduction.

This outcome compares with government paying around \$15 per tonne to participants for emission reductions in its *Emission Reduction Fund*. Public policy typically aims to achieve a benefit-cost ratio of about 1, where benefits roughly equal costs while a socially valued outcome is achieved.

From a public policy perspective, it is a serious distortion that the ambition and resourcing of the appliance program is not significantly greater, so that its net societal cost is comparable with other emission reduction programs. This failure is costing Australians a lot of money and undermining success in emission reduction.

Figure 1. Estimates of savings from appliance efficiency in comparison with other actions from one E3 publication, *Achievements 2010-11*. The GEMS review cites lower savings.

Figure ES1. Contribution from various programs to greenhouse gas abatement .



The level of ambition of appliance and equipment efficiency programs should be increased until the net societal costs of measures reach a level similar to a carbon price paid for other emission reduction measures.

Value of ‘multiple benefits’

The International Energy Agency has assessed the value of the ‘multiple benefits’ that energy efficiency measures provide (see the 2014 IEA Report on this topic). In many cases the non-energy benefits far exceed the value of the energy savings. For example, a well-insulated refrigerator will reduce the risk of loss of food during a power outage, and improve its capacity to contribute to demand response.

Work by the Australian Alliance for Energy Productivity with the refrigerated food chain has shown that the value of avoided food loss is an order of magnitude greater than the value of the energy saved while achieving this outcome. Sustainability Victoria has found that the value of savings on materials and waste management in energy/resource efficiency projects has been significantly greater than the value of the energy saved.

Failure to factor the value of these benefits into economic assessment of appliance efficiency measures leads to serious under-investment and loss of benefits.

How more resources could improve outcomes

The GEMS program has not kept up with the times. It needs updating in a number of ways. These include:

- mandated provision of sales data to government. At present this is difficult and costly for government agencies to access, and data lack reliability. Without high quality data, development of high quality policy and effective enforcement is difficult.
- review of the objective of cost recovery. As appliances and equipment become more diverse, and the program moves into more complex areas, attempts to recover program costs from the appliance industry become an increasing burden. As shown earlier, this program saves Australians billions of dollars. Governments should be prepared to fund it appropriately. Indeed, since activity in this area reduces operating costs for businesses as well as households, and well-designed program expansion could enhance international competitiveness of the Australian appliance industry and service providers, maybe we should look at offsetting some compliance costs and development of streamlined compliance systems as a form of industry development and support for innovation.
- labelling and related issues discussed below.

Labelling issues

For some appliance types, 5 stars is 'best on market' while in other cases 8 to 10 stars or more is 'best', as shown in Figure 3 below. The variation in 'best' star rating without effective public education means that many may be buying 4 star appliances thinking they are efficient, when they are actually poor performers. A series of focus groups I observed (some years ago) indicated that most people seem to think 3-4 stars is 'good'. This reflects the reality that the most widely-promoted star rating scheme is the hotel rating, which only goes to 5 stars. Food now uses 5 star rating for health. So our 6 and 10 star ratings are competing for understanding with some pretty powerful sectors with different messaging.

It should be noted that, in the appliance star rating scheme, all products are allowed 1 star based on electrical safety, so even the 6th star may not be fully appreciated by many consumers as being 5 stars for performance.

Of course, updating star rating scales when technologies for some appliances are changing much faster than others, and transitions in rating schemes can be confusing and costly. So there is no simple answer. But, at a minimum, this indicates a clear need for strong public information campaigns to promote 'best on market' star ratings in each appliance category.

Where rating scales have been updated, consumers must also be alerted. For example, I have visited many homes where a 1990s 5 star rating label is still on their 20 year old fridge: it now rates at about 1.5 stars on today's scale, but the owners think their fridge is efficient – so why replace it when it is still working!

For star ratings higher than 6, the voluntary 'coronet' of extra stars must be used. But this has received very little public promotion, so it is unclear whether it is effective, even though it seems like a good approach. Market research regarding consumer awareness of this feature, and effective promotion and information programs are needed.

On the *energyrating* website, the very useful tool that allows potential appliance buyers to see short lists of the most efficient appliances is difficult to find, via the obscurely named *Registration Database* button on the front page. Also, some language used can be confusing: for example, very

efficient heat pump clothes dryers are referred to as 'condenser' dryers – the same term as used for inefficient condenser dryers that use (often large amounts of) cold water to condense the exhaust water vapour. When a consumer goes to a store, it is possible that they could end up buying the wrong product.

There is very little useful information for buyers of commercial and industrial equipment to make judgements based on actual performance. This is discussed later.

The proposed zoned reverse cycle air conditioner rating label, which is very important in extreme climate zones, is still not available despite being developed some time ago.

Pool pump labelling still seems to be voluntary. Given the very large potential energy savings, and the potential role of these pumps in Demand Response (if appropriate controls are fitted), this seems like a wasted opportunity for savings. Mandatory labelling might drive down prices through higher sales volume, too.

Increasing numbers of buyers now shop on-line or via catalogues. But labelling is not mandated in these media. This means the label is becoming less useful over time.

Other issues potentially worth revisiting after 30 years of the same labelling approach could include:

- removal of the 'free' first star so that the label clearly shows the performance-based star rating
- review of the underlying 'efficiency' approach for the algorithms, which is energy per unit of service (eg per place setting, kilogram of clothes, volume of chilled storage, etc) and replacement with a total energy use value – although that has some communication disadvantages
- mandating inclusion of labels for on-line sales and print catalogues is fundamental to maintain the profile of energy information
- complementing the fixed label with 'smart labels' via smart phone using a code on the fixed label, that allow a user to explore the impact of changing variables such as wash program, or level of usage on energy use, could enhance usefulness
- revision of gas appliance labelling (and MEPS) is needed. For example a 5 star gas storage hot water service still has a pilot light: this directly increases standby losses but also limits the amount of insulation that can be used to avoid overheating, especially if the HWS is exposed to hot summer sun. The gas label (and other hot water ratings, including Small Technology Certificates) use outdated daily hot water usage information that dilutes the significance of standby losses in the star rating. For most appliances, a daily draw-off of around 200 litres/day is used for energy rating, when average household hot water usage is more like 120 litres/day. At this lower rate of usage, a storage gas HWS would look much less efficient than a 5 star rated instantaneous gas heater
- the rollout of NBN means many consumers are replacing modems and installing additional communications equipment. We have already seen the energy wasting problem of cable TV suppliers providing inefficient set-top boxes as part of their 'package'. So it is critically important that high efficiency equipment is provided by internet service providers when it is included in packages or supplied by them during the NBN transition. I have had some anecdotal advice from

energy assessors than they have seen significant increases in energy use due to NBN equipment. We need to remember that minimising the cost to the provider can lead to much less efficient equipment and higher energy costs and carbon emissions for consumers. The GEMS program must engage with communications providers and set high standards for equipment energy performance, as the IT sector and related consumer equipment is consuming a large and increasing proportion of Australian electricity. Information and (simplified) labelling of products, along with formal requirements for disclosure of running costs of equipment may be necessary. Given the rapid rollout of new equipment this is a very urgent issue

- supplementary ratings (and maybe MEPS) for peak demand, power factor, detergent use, embodied energy or emissions, etc could help to reduce overall energy service costs. These could be accessed via smart phone using a code
- other issues may emerge from consultation, focus groups and other market research

It is also important to recognise that the complexity of appliances has increased, with many 'smart' appliances, multiple options and other factors making it more difficult to reflect performance with a simple label. So there is a case for providing additional information and offering interactive calculators (see the detailed mode of the EPA Victoria *Australian Greenhouse Calculator*, which I developed in 2010, for examples of the kinds of information consumers may value). Nevertheless, a simple star rating label is needed for many consumers who are not interested in more detailed rating information.

Need to modify energy market policy to support GEMS and broader energy efficiency

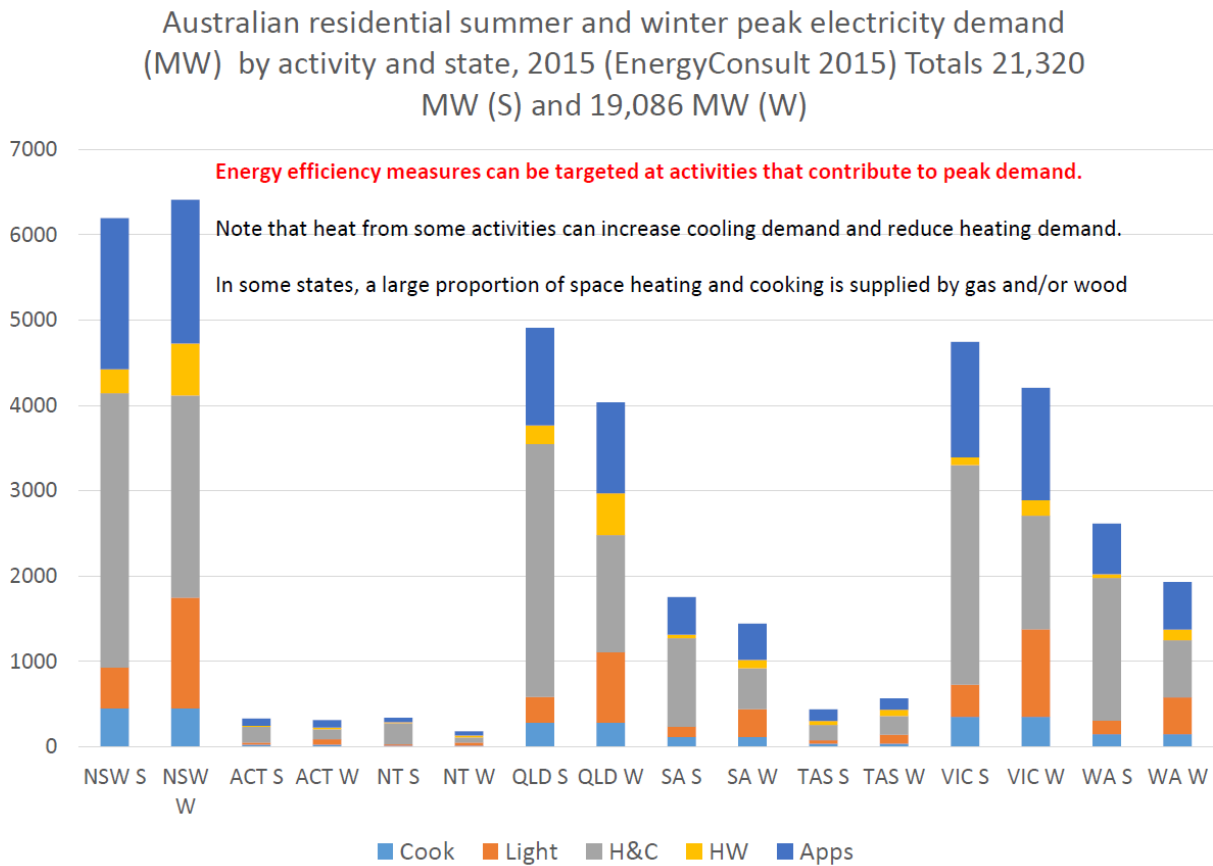
High fixed supply charges and low marginal energy prices contradict policy objectives of 'efficient pricing' intended to send signals to consumers about future energy supply costs, as well as emerging 'no worries' fixed price deals (modelled on mobile phone contract design) undermine the price incentive for energy consumers to invest in energy efficient appliances and equipment. For example, fixed charges offered under many electricity contracts for residential consumers in Victoria are 2.5 to 3 times the proportion of bills that they were in 1991, before energy reform.

Action is needed within energy market policy to reduce fixed energy charges, limit 'take-or-pay' contracts, limit 'declining block tariffs' and other measures that distort 'efficient' pricing and undermine price signals to energy users. Where such actions may cause hardship, unreasonably limit marketing models or constrain competition, alternative mechanisms should be developed and implemented, such as incentives funded by levies on energy retailers and network operators. The National Energy Productivity Plan includes additional actions to address other factors impacting on appliance energy efficiency. There is also a case to create strong incentives for energy market participants to support and implement energy efficiency measures, as discussed in my submission to the Finkel Review (see <http://www.environment.gov.au/submissions/nem-review/pears.pdf>)

Large potential for appliance efficiency to reduce peak electricity demand and provide useful services

Policy makers have not adequately considered the value of appliance efficiency to reduce peak energy demand, and associated investment in supply and over-dependence on reliability of energy supply. Figure 2 shows the estimated contribution of household activities to system peak demand, from the 2015 Residential Baseline Study (EnergyConsult, 2015).

Figure 2. Residential energy using activity contribution to summer and winter peak electricity demand.



Appliances and lighting are clearly significant contributors to peak residential demand. Further, heating and cooling peak loads are driven as much by equipment efficiency as by building envelope performance. Yet appliance efficiency programs (and building codes to date) place little emphasis on this issue. Comparison of the residential baseline study peak data with state summer peak demand values from AER for 2016 suggest that residential peak demand comprised from 44% (in NSW) to 57% (in Qld) of total peak electricity demand. Residential cooling alone comprised from 23 to 34%. Clearly this must be factored into appliance efficiency and energy market policy.

Recent analysis for building energy regulation by consultants Energy Action working for ASBEC has used a notional value for avoided peak electricity demand of around \$2,000 per kilowatt of avoided peak residential heating and cooling, and around \$800 for commercial cooling. This may be applicable to appliance economic analysis, too.

If an effective program reduced residential peak electricity demand by 25%, the saving on energy supply infrastructure investment could therefore be around \$10 billion. Further, the growth in rooftop solar equipment is shifting the summer system peaks later in the evening, so the importance of appliance efficiency to manage peak demand is becoming greater.

More efficient appliances can also improve potential for active demand management, and enhance resilience to cope with failure of energy supply due to supply system problems or increasing climate extremes. For example, a well-insulated refrigerator (possibly with thermal storage built-into it – as my existing moderately high efficiency refrigerator has) can keep food cold for longer. So it could be

remotely controlled in demand response programs, and could reduce the cost of food loss resulting from blackouts.

Energy efficiency can also provide other valuable services to energy markets. For example, increased penetration of high efficiency equipment in fringe-of-grid areas where high powerline losses and risk of power outages, bushfire prevention and other factors would enhance the value of energy savings (as each end-use unit of electricity saved is equivalent to up to 2 units at the generator) and improved operational resilience. It can also improve voltage, frequency and Power Factor management – partly because many items of equipment at present create problems that could be avoided or reduced by improved design.

Exclude more inefficient products from the market

Australia's appliance and equipment minimum standards fall well below cost-effective levels. They allow many inefficient products to remain on our market. This weak MEPS situation increases the risk that Australia will be a dumping ground for inefficient appliances.

Figure 3 shows graphs of the data from the EnergyRating site for a range of household appliances. It shows the range of star ratings for appliances available on the Australian market. Clearly there is scope to increase stringency of MEPS without significantly reducing consumer choice. The variation in star ratings of 'best on market' between products also creates room for consumer misinformation, as discussed elsewhere in this submission.

Role of appliances and equipment in rapid progress towards a zero carbon economy

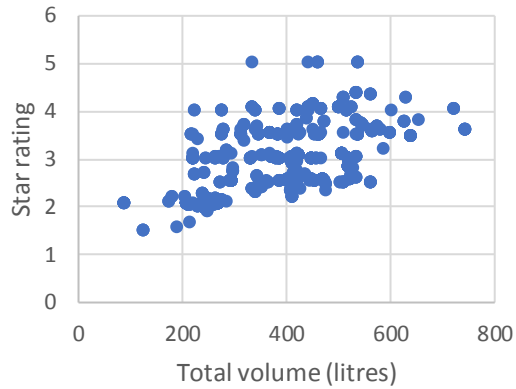
There is increasing urgency in the race to cut carbon emissions. Australian and global carbon budgets are small, and are declining rapidly because of both slower than needed abatement action and refinements in climate science that tend to paint a more challenging picture.

While appliances typically have much shorter lives than buildings, each investment in an inefficient appliance locks-in significant emissions. Further, the lack of performance standards for many replacement items (eg commercial HVAC systems) and the tendency of tradespeople to replace 'like-with-like' equipment means the lock-in of high emissions can extend beyond the life of an individual appliance.

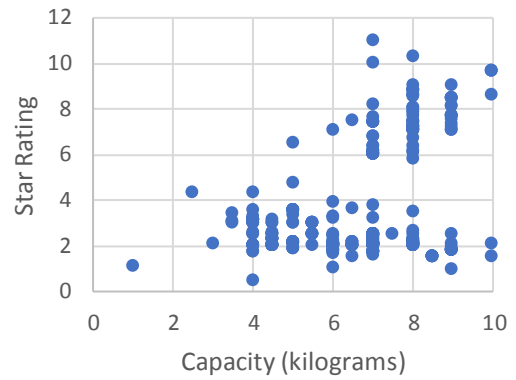
This long-term impact can be reflected in economic analysis that applies a negative discount rate to energy prices, or includes an escalating carbon price.

Figure 3. Distributions of star ratings for a range of products

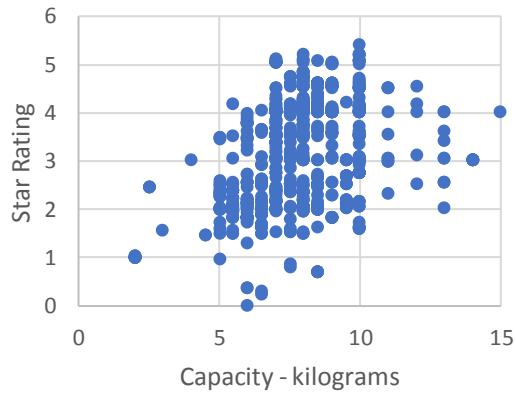
Frost-free 2 door refrigerators
Total volume vs star rating



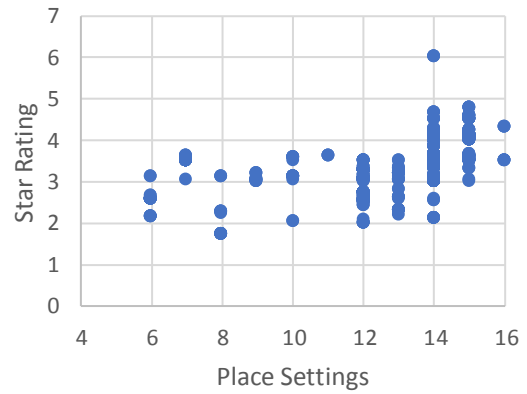
Clothes Dryer star rating vs
capacity



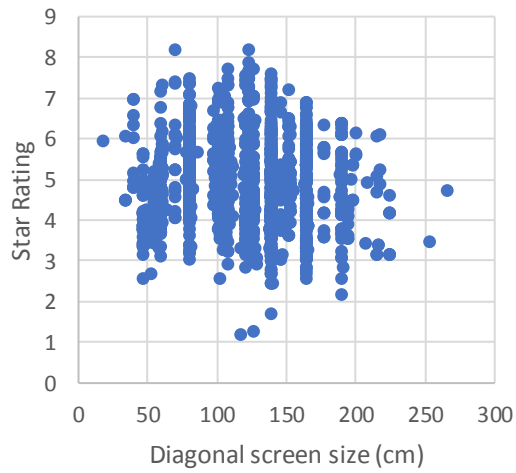
Clothes washer star rating vs
capacity



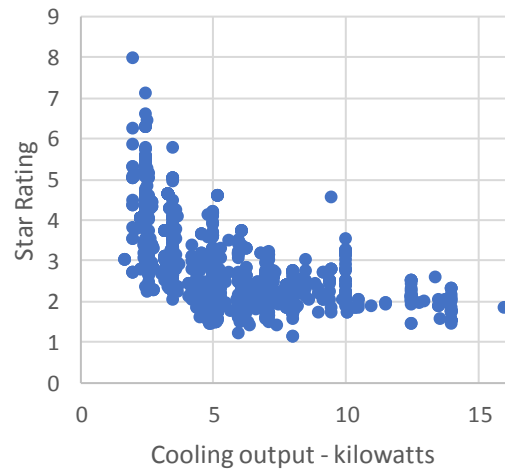
Dishwasher star rating vs
capacity

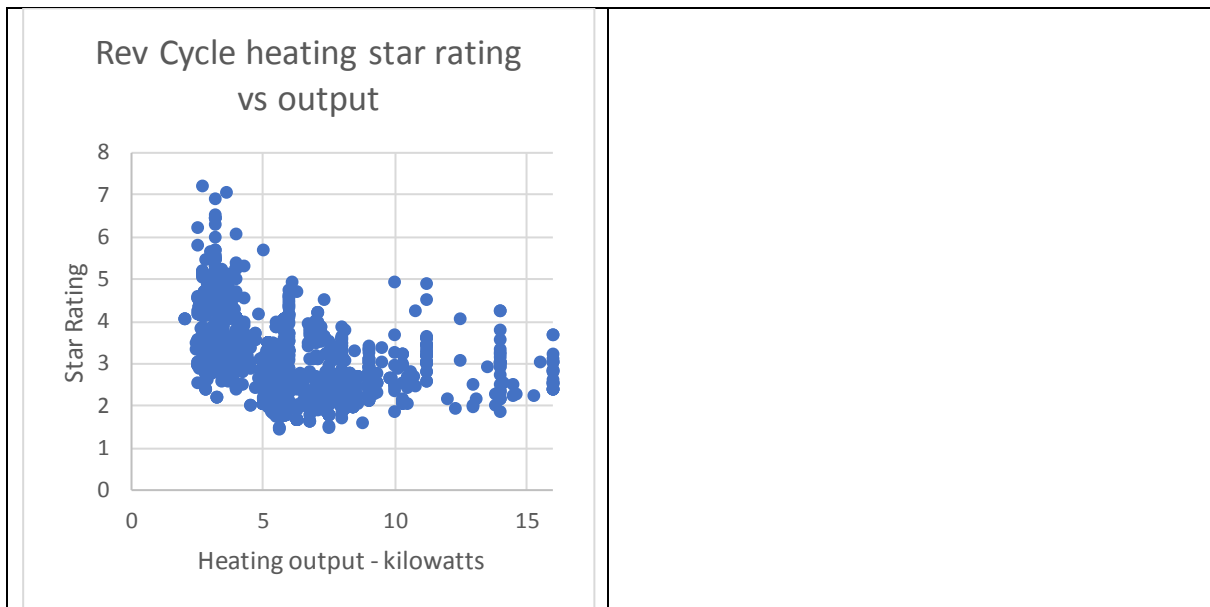


TV star rating vs Screen size
(cm diagonal)



Rev Cycle cooling star rating
vs output





Expansion of program focus

Wider coverage

The world has changed a lot since appliance energy labelling and MEPS were introduced in the 1980s and 1990s. In the residential sector, internet/IT equipment (including end-user NBN equipment) are much bigger contributors to energy use, while cooking is also a major factor driving peak electricity demand. New (and often inefficient) technologies like thermo-electric refrigerators have emerged, but have not been covered by energy labels or MEPS. Other countries and regions have introduced energy labels and/or MEPS for some of these items. Research and analysis have overcome limitations through evaluation projects, and have provided improved information on usage patterns.

Energy use in the commercial sector has grown rapidly, and has increased its share of energy and electricity use.

So energy labelling now covers a smaller proportion of total electricity and energy use than it used to. And it is less useful for consumers. MEPS have also fallen behind in their coverage. And our MEPS are weak in comparison with some other countries, exposing us to the risk of becoming a dumping ground for inefficient products that can't be sold elsewhere.

Issues such as peak demand, smart management, and fault self-diagnosis have become more important, or capacity to deliver new functions has increased.

And other countries have implemented a variety of different approaches to driving appliance and equipment efficiency improvement. For example, Japan's *Top Runner* program uses the best existing product in a category as a benchmark that others must meet within a few years.

We should learn from the experience of others, as well as expanding the GEMS program to capture more savings.

Options could include:

- for low cost, high volume products such as lamps, ceiling and portable fans, modems and other IT equipment, etc, introduction of a small, simple star rating label (with link to support website) that could be easily printed on packaging or added using a sticker.
- a more flexible policy framework to support development and implementation of effective measures for more complex products and systems (see later discussion), and products for which there is high turnover of models on sale
- introduction of labels and ratings for cooking equipment, as well as incentives to limit the peak demand of electric cooking equipment and inform consumers about this factor, which impacts significantly on installation costs and compatibility with on-site energy storage and electricity generation
- improved coordination and 'learning' between states and territories regarding programs that influence appliance and equipment energy efficiency. For example, several states and the ACT offer incentives to buyers of high efficiency appliances (eg Victorian Energy Upgrades, NSW Energy Saving Scheme, SA REES). An example of the value of improved coordination is the recently announced Queensland appliance rebate scheme: for air conditioners, this does not require replacement of an inefficient existing product. So it may underpin an increase in energy use. It also requires evidence of payment in full, so low income households without access to capital may not be able to access it (see <https://www.qld.gov.au/community/cost-of-living-support/appliance-rebate-faq>). Other states have addressed these issues and could offer advice.
- it would be worthwhile to increase appliance and equipment rebates and incentives to reflect value of avoided capital investment in energy supply infrastructure.
- there may be a case to provide incentives directly to manufacturers and importers to improve appliance and equipment performance on efficiency, peak demand, etc, as a given incentive is much more significant at the point of manufacture than at the point of retail sale: factory price is often less than a third of retail price. So, for example, \$50 at the factory could fund a higher efficiency compressor, better insulation, tooling up for production changes etc, while it may be seen as a modest incentive at the point of retail sale
- improved techniques for identification of energy-wasting equipment in the field, and smart solutions to ensure ongoing efficient operation of new equipment over its operating life. Faulty and inefficient appliances and equipment are responsible for a disproportionate amount of energy use, so it makes sense to target these opportunities: 5% of households consume about 15% of household electricity. Data analytics can help to identify high consumption equipment and households . Built-in or plug-in 'smarts' can monitor energy use and relevant parameters such as ambient temperature and activity level, and benchmark actual performance against design intent, then alert operators of deviations.
- with states and territories, develop, trial and implement mechanisms and programs to increase ownership of efficient appliances by tenants and vulnerable households. As the proportion of properties rented instead of owned increases, population ages and the spread of incomes and wealth expands, this is becoming a much higher priority issue.

- programs that provide tailored energy performance advice to contractors and buyers of 'custom' equipment, especially systems that may combine several standard components in different ways in the commercial and industrial sectors, are needed. This is a difficult area, but it must be addressed because it is a very significant area of energy use, and offers valuable 'multiple benefits' to business consumers. Modern analytical and modelling tools such as Computational Fluid Dynamics (CFD) software, engineering toolboxes, data analytics, etc mean it is possible to develop tools so that manufacturers, fabricators, designers and installers can predict performance of systems and, in turn, provide reasonable estimates of energy use. Information systems can be introduced as voluntary schemes to develop expertise and confidence, and packaged with incentives and customer information programs, inclusion in energy assessment programs, etc. As competence and confidence improves, mandatory application can be considered.
- We are seeing increasing design and installation of 'systems', such as central hot water, heating and cooling in apartment buildings and tenanted commercial buildings. Many of these are very inefficient, through poor design, equipment selection, installation or commissioning. Development of simple monitoring and benchmarking systems that allow operators or tenants to identify poor performance are needed
- Often elements of systems are sold separately, such as insulation, or can impact on sizing (and capital and installation cost) of appliances – such as advanced glazing and thermal performance of cookware. Alternatively, they may be incorporated into products or systems, but are not properly regulated and practices are inadequately monitored. The GEMS program could be expanded to include such items, or GEMS staff could be allocated to work with policy makers and program development/implementation teams in the relevant areas
- legally binding 'declarations' of energy performance based on modelling and/or overseas tests or tests outside formal Standards offer another option to provide information. I believe these have been used in the EU, but a lack of enforcement has undermined their effectiveness. These could be used both for low cost products and for complex systems or components of systems
- should rooftop PV, storage and home/building energy management systems be included in GEMS? As we move towards more integrated energy solutions, it could make sense as a way of coordinating development and managing consumer issues.
- strategies to bring a wider range of high efficiency products to Australia, reduce their cost and increase market intermediary understanding of their benefits and competence in their provision could bring significant benefits. Around the world there are exciting developments (see discussion regarding topten.eu, IEA technical centres), and local awareness of these can support early introduction of the latest products and systems. Display of leading edge products from overseas or laboratories at trade and consumer shows and home expos, incorporation into trade training and a communications strategy via industry and consumer magazines can help to create markets for advanced products and build community awareness and engagement.
- funding and coordination of an RDD&C program is needed, possibly with additional funding fed through ARENA, that complements international manufacture of products, supports local production where it is potentially competitive, reduces installation and commissioning costs and

complexity, facilitates improved maintenance and identification of faulty equipment, and enhances the role of appliances in provision of services that reduce energy market costs and build community resilience. Many aspects of appliance and equipment design, installation, commissioning and operation are controlled or can be influenced by Australians, even when products are designed and manufactured overseas. For example, Australian car designers work internationally. Locally designed add-on modules can optimise in-field appliance and equipment performance. And local businesses, often SMEs with limited RD&D capability, still manufacture a lot of equipment and products: we could grow this activity.

- increased presence of Australia in international action on appliances and equipment, including international collaborations, development of Standards, RDD&C, behavioural research, etc can build a culture of efficiency improvement, and underpin Australian export of intellectual property and services, while providing our businesses with access to ideas.

Potential benefits of stronger action

It is important to recognise that appliances and equipment form one element of a system that delivers services people and businesses want or desire. These include provision of services such as cleaning, information communication, comfort, entertainment, business profits, etc. A system-based approach to appliance efficiency offers potential for much larger energy savings. A lifecycle perspective is also increasingly important, particularly for products that use little operating energy, when energy embodied in production can be the dominant impact.

Enormous potential for improved in-field efficiency of appliances

The present program lacks focus on delivered field performance of appliances and equipment. Yet maintaining performance over appliance life is extremely important. Faults, poor maintenance and management can double appliance energy consumption. For example studies show that the clogging of heat exchanger fins in display refrigeration units can increase consumption by over 20%. Smart monitoring systems could pick up problems like the, and alert the operator.

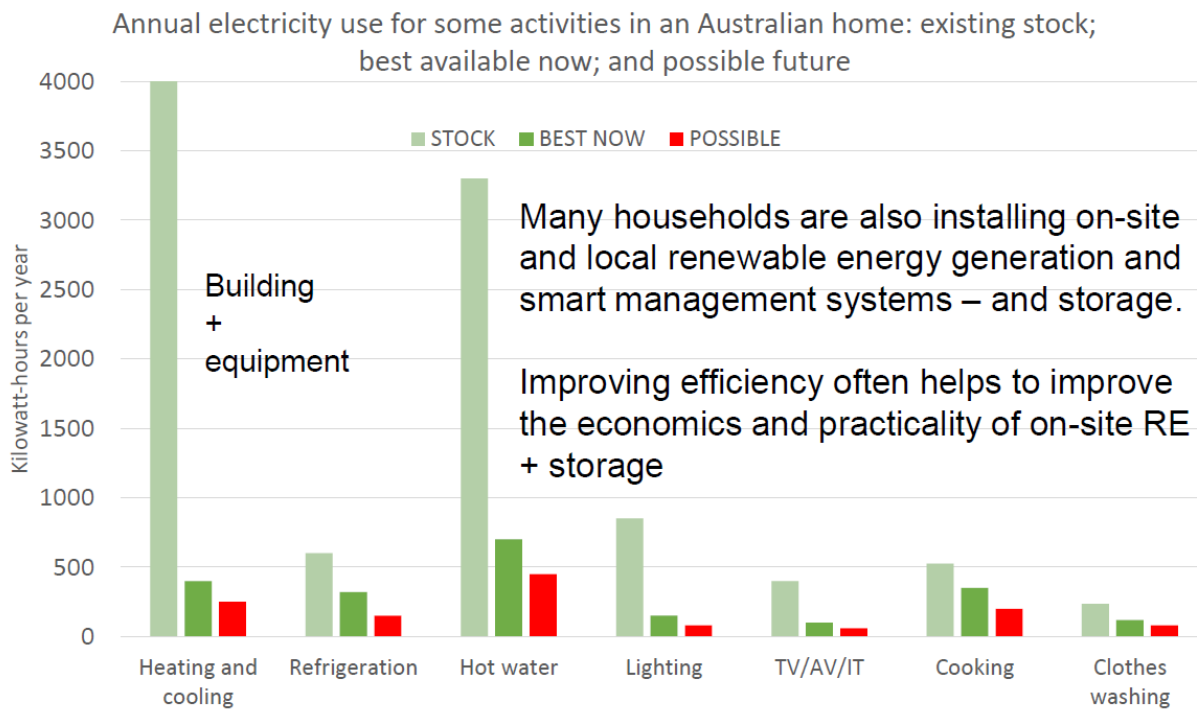
An analysis I carried out in 2014 shows the enormous gap between average Australian household appliance stock energy use, best on market/best practice, and near-term potential performance (Figure 4). My work in industry and commerce indicates that the gap between stock and potential is even larger. The European Union website (<http://topten.eu/>) shows the best performing high efficiency products available there.

We have no similar website, and it seems that Australians are missing out on access to many high efficiency products produced elsewhere in the world: we need to understand why, and to change this.

Figure 4. Analysis of gap between appliance stock energy use and potential.

Residential: Technology transformation

(Based on Pears presentation to Sydney A2SE Workshop, April 2014)



Rapidly changing energy and technology context

We face increasingly rapid change in energy, including rapid adoption of behind-the-meter renewables and energy storage, need to manage demand and supply as old and high emission power stations are closed down, and the need to manage gas costs. More broadly, we need to progress rapidly towards a net zero emission economy as fast as possible. Appliances can play a crucial role in addressing these issues. For example:

- Efficient appliances with low peak demand require smaller, cheaper energy storage, inverter capacity and on-site generation to deliver a given service. When they replace existing equipment, especially old and inefficient items, they can free up existing supply capacity
- Features can be incorporated in appliances and equipment that support smarter demand response and management
- Poor energy pricing practices undermine incentives for change, as discussed earlier.
- Many appliances and items of equipment are significant contributors to distortion of supply power quality and Power Factor: there is often scope to cost-effectively improve performance at the equipment level, rather than having to fix the problem in the supply system
- The rapid emergence of *Industry 4.0* and *Society 4.0*, smart, flexible and connected equipment, sites and services creates urgency to ensure that new appliances and equipment can take advantage of the potential offered by this transition.

- There is increasing recognition that more intervention is required to address appliance issues in rental properties (both residential and business), for vulnerable consumers, and for businesses struggling to adapt to disruptive change in their business environment
- As technology changes, there are potential problems and costs associated with poor design or selection of appliances and equipment that should be addressed as early as possible, to limit future problems. An example of this is the peak demand issue (including high rewiring costs in many existing homes) related to induction cooking, as well as potential peak load problems from installation of electric technologies (eg heating and industrial processes) to replace gas equipment.

Conclusion

Australia's appliance efficiency program has served us well for over 30 years. It is time to step back, to redesign the program so we can capture the enormous opportunities for community and business benefit.