Industrial Boilers: Technical Discussion Paper

Disclaimer

Executive Summary

The Equipment Energy Efficiency (E3) Program enables collaboration between the Australian Government, states and territories and the New Zealand Government to deliver a single, integrated program on energy efficiency standards and energy labelling for equipment and appliances. The E3 Program undertakes a range of activities under the Greenhouse and Energy Minimum Standards Act 2012 (the GEMS Act) in Australia and the Energy Efficiency (Energy Using Products) Regulations 2002 in New Zealand, to improve the energy efficiency of appliances and equipment sold in Australia and New Zealand. These include energy rating labelling, setting Minimum Energy Performance Standards (MEPS) and education and training.

Industrial products (pumps, air compressors and boilers) were identified as high priority and a focus for immediate attention in the E3 Program 2017/18 prioritisation plan. The Commonwealth Department of Industry, Science, Energy and Resources, on behalf of the Committee overseeing the Equipment Energy Efficiency (E3) Program began work with the Industrial Equipment Technical Working Group (TWG) to investigated policy options for improving the efficiency of industrial equipment. This discussion paper presents the work of the TWG and the department to date on boilers.

Boilers are used in a wide variety of commercial and industrial applications. They use a combustion source or electricity to provide hot water for heating or sanitation, and steam for industrial processes. They are also used in domestic and small-scale commercial applications for providing potable and sanitary hot water, and heating.

Boilers use a substantial amount of energy in both Australia and New Zealand. The energy demand for boilers in Australian industry is estimated to be 200 petajoules, around three per cent of Australia's total energy use. In New Zealand, the energy demand for boilers is estimated to be 135 petajoules, around 24 per cent of total energy demand.

The total boiler manufacturing market in Australia had an estimated annual revenue of $426.7 million in 2019-20. There is insufficient information on the boiler market in New Zealand to include in this paper.

Of the estimated 1400 enterprises in the boiler manufacturing industry, the majority (96 per cent) of the boiler industry is made up of Small and Medium Enterprises (SMEs) with a large number of those being sole-traders (54 per cent).

In Australia, energy efficiency standards are limited to new boiler installations under the National Construction Code (NCC) 2019 update, which only covers boilers installed for heating in new buildings. There are currently no energy efficiency requirements for boilers in New Zealand. The discussion paper explores key regulatory approaches in the United States and European Union, which are the two largest import markets for boilers in Australia and New Zealand.

The discussion paper seeks input from the broader industry to improve upon the available data and findings of the TWG, to inform the development of the Consultation RIS.

Contents

1. Introduction

1.1. Overview of Discussion Paper

Section 1 outlines the purpose of the paper and the role of the Industrial Equipment Technical Working Group (TWG).

Section 2 discusses the policy context, including the role of the Equipment Energy Efficiency (E3) Program in regulating equipment for energy efficiency under the *Greenhouse and Energy Minimum Standards Act 2012* (the GEMS Act) in Australia and the *Energy Efficiency (Energy Using Products) Regulations 2002* in New Zealand. It also highlights the role of standards and testing in implementing, monitoring and enforcing compliance under the Act and Regulations.

Sections 3 discusses the implications of improving energy efficiency of boilers, including:

1. An overview of the boiler market in Australia and New Zealand
2. An overview of the technologies and their use in Australia and New Zealand
3. The product coverage and scope of policy for these products in Australia and New Zealand
4. An overview of test methods and standards currently in use
5. International standards and approaches to boiler efficiency
6. An early consideration of the impacts of imposing standards in the Australian and New Zealand markets, including consideration of additional measures

Section 4 presents a set of questions for stakeholders.

Appendix 1 is a summary of the TWG views and recommendations.

Appendix 2 and 3 summarise the technical requirements of the EU and US standards respectively.

1.2. Purpose of this Discussion Paper

The aims of this paper are:

- To improve the available data which is being used to inform the policy options and associated costs and benefits
- To better understand the state of the boiler industry in the context of Australia and New Zealand
- To trigger a discussion among experts, industry representatives and other stakeholders about which boiler technologies, test methods and standards are common within the industry
- To inform stakeholders on the outcomes of the TWG.

This paper asks stakeholders to review and to provide comment on:

- Industry and company level data for the Australian and New Zealand boiler markets
- The specifications that would best define the boiler products used in Australia and New Zealand
- The technical standards and test methods that could form the basis for energy efficiency testing and performance standards
- The ability of these test methods and standards to cover the range of boilers in Australia and New Zealand
- The impacts that these standards, if applied through a MEPS regulation, could have on industry and product markets in Australia and New Zealand
- Additional energy efficiency measures in the industry, such as information materials or other incentives.

This paper assumes that stakeholders are familiar with current technology as it applies to their industry and application.

1.3. Making a submission

Written submissions on the issues raised in this paper should be provided by e-mail by 4 December 2020. Submissions should include the subject line 'Boiler Consultation'.

A set of questions is provided in Section 4. Stakeholders are encouraged to work through these questions while reviewing the paper

Submissions can be sent to:

Australian Government Department of Industry, Science, Energy and Resources.

E: GEMS.Industrial@industry.gov.au

Energy Efficiency and Conservation Authority (EECA) of New Zealand

E: star@eeca.govt.nz

1.4. Role of the Technical Working Group

The E3 Committee formed the TWG in 2018 to provide a technical understanding of industrial pumps, compressors and boilers and investigate how the E3 Program could be expanded to include these products in Australia and New Zealand.

The TWG comprised members from industry, peak bodies, academia, the Department of Industry, Science, Energy and Resources (DISER), and the New Zealand Energy Efficiency Conservation Authority (EECA).

The Energy Efficiency Advisory Team (EEAT)[1] asked the TWG to investigate and put forward a set of considerations in this paper, concerning primarily:

1. The technical underpinnings of the industry, including the descriptions of the products themselves and the specifications that define the types of pumps, boilers and air compressors used in Australia and New Zealand.

2. Which test methods are applied to test the energy efficiency of the equipment? A consistent, repeatable and reliable method for assigning equipment with an energy efficiency rating is an essential component of energy efficiency policy.

3. What technical considerations are there for Minimum Energy Performance Standards (MEPS)/energy rating labels for industrial equipment? A Consultation RIS would then seek information to find the balance between maximum savings on energy costs and greenhouse emissions, and any potential costs.

The TWG was made up of three sub-groups, one each for pumps, air compressors and boilers. An industry lead was appointed to assist the TWG Chair. The objective of the TWG boiler sub-group was to provide EEAT with a set of recommendations for:

1. What boiler equipment could be covered by the E3 Program or other policies

2. What specifications and characteristics could best define the 'scope' of the products to be included or excluded, and why

3. What proportion of energy is used by boilers in the Australian and New Zealand

4. Which test methods and standards could be used as a basis for assessing efficiency of boilers

5. Which of these test standards and methods would be effective and appropriate for use in Australia and New Zealand, based upon the types of products in the Australian and New Zealand market; the availability of test facilities and consideration of the relative costs.

The TWG held four workshops in 2019. In the workshops, the TWG investigated a set of issues, product specifications, current test methods and efficiency standards. Informal discussions were also held with industry stakeholders and participants at various trade shows and exhibitions. The department used this information to develop this paper.

Air compressors and pumps are covered in separate Technical Discussion Papers. Concurrent work also began on a draft Consultation RIS which will build upon the findings of the TWG and information provided in response to this paper.

[1] E3 Program - https://www.energyrating.gov.au/about-e3-program/who-we-are

2. Policy Context

2.1. The E3 Program

The E3 Program[2] is a cross jurisdictional program through which the Australian Government, states and territories and the New Zealand Government collaborate to deliver a single, integrated program on energy efficiency standards and energy labelling for equipment and appliances.

The E3 Program undertakes a range of activities to improve the energy efficiency of appliances and equipment sold in Australia and New Zealand. These include energy rating labelling, setting MEPS and education and training.

The objectives of the E3 Program are:

- To reduce energy bills for households and businesses in a cost effective way by driving improvements to the energy efficiency of new appliances and equipment sold
- To improve the energy efficiency of new appliances and equipment that use energy and to also improve the energy performance of products that have an impact on energy consumption
- To reduce appliance and equipment related greenhouse gas emissions through a process which complements other actions by jurisdictions.

On 1 October 2012, the *GEMS Act*[3] came into effect in Australia, creating a national framework for product energy efficiency in Australia. The GEMS Act is the underpinning legislation for the E3 Program in Australia. The Energy Efficiency and Conservation Authority (EECA) administers the E3 Program in New Zealand through the *Energy Efficiency (Energy Using Products) Regulations 2002*.

In 2018-19, the E3 Program contributed more than $1.2 billion to the Australian economy and $200 million to the New Zealand economy in avoided energy costs. [4]

Industrial products (pumps, air compressors and boilers) were identified as high priority and a focus for immediate attention in the 2017/18 prioritisation for the E3 Program.[5]

[2] About the E3 Program - https://www.energyrating.gov.au/about-e3-program
[3] GEMS Act 2012 - https://www.legislation.gov.au/Details/C2012A00132
[4] E3 Achievements 2018-19 - https://www.energyrating.gov.au/document/e3-achievements-report-2018-2019
[5] E3 Prioritisation Program 2017-18 - https://www.energyrating.gov.au/document/e3-prioritisation-plan-2017-18

2.2. Boiler Market Overview

Market scale and value

There is limited information on the boiler market, including installed stock, import data and annual sales. The most recent statistics are provided by IBISWorld, which aggregates at the industry level for Australia only. The total boiler manufacturing market in Australia had an estimated annual revenue of $426.7 million in 2019-20.[6] The boiler market in New Zealand is difficult to estimate as industry data is aggregated within both heavy industry and Heating Ventilation and Air Conditioning (HVAC) industry reports, and is considered uncertain.

While data allows for a general understanding of the market, the lack of granularity reduces its usefulness under a product centric policy approach, and the data includes manufacturing of tanks and silos, which are unrelated in their use.

Major markets for boilers include commercial and residential building HVAC – the largest single market for boilers – food and beverage manufacturing, mining, paper and pulp, and power generation.

Of the estimated 1,400 enterprises in the Australian boiler manufacturing industry, the majority (96 per cent) of the boiler industry is made up of Small and Medium Enterprises (SMEs) with a large number of those being sole-traders (54 per cent).[7]

Energy Use

Boilers are a substantial user of energy in both Australia and New Zealand. Boilers provide heating in HVAC systems, and hot water and steam for commercial use, or for use in industrial processes (process heat). In Australia, boilers account for 25 per cent of natural gas use in industrial applications.[8] In New Zealand it is estimated that boilers account for approximately 67 per cent of total industrial natural gas use.[9]

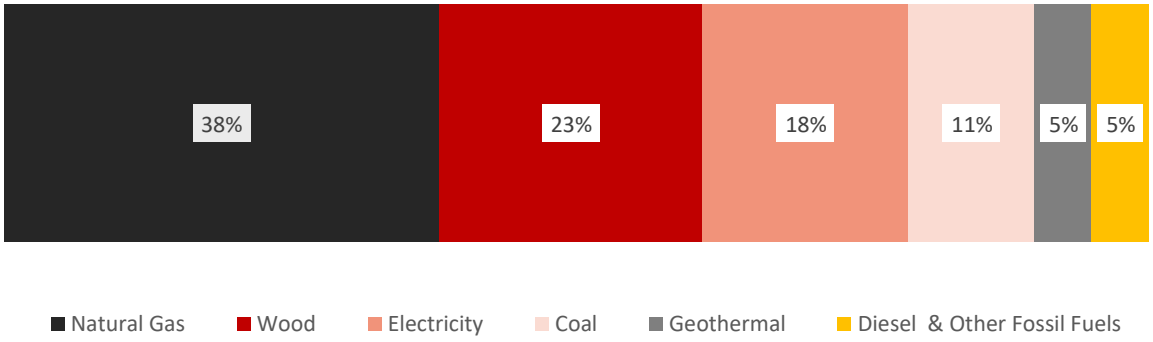
The energy demand for low to medium temperature process heat in Australian industry is estimated to be 184 petajoules.[10] The demand from boiler driven space heating in commercial buildings in Australia is estimated to be 30 petajoules.[11]

In New Zealand, process heat in industrial and commercial applications is a major user of energy and of fossil fuels, and is the second highest source of greenhouse gas emissions. The energy demand for process heat in 2016 was 199 petajoules, accounting for around 35 per cent of the total energy used in New Zealand.[12] As such, process heat is one of the three priority areas of the New Zealand Energy Efficiency and Conservation Strategy for 2017 – 2022.[13] Around 68 per cent (135 Petajoules) of this heat was provided by boiler systems.[14] While Australian boilers mostly use natural gas, New Zealand boilers use a variety of

[6] *Boiler and tank manufacturing in Australia* 2020 - IBISWorld
[7] Ibid
[8] Improving the Energy Efficiency of Industrial Equipment. - https://www.energyrating.gov.au/document/discussion-paper-improving-energy-efficiency-industrial-equipment
[9] Estimated from NZ Energy End Use Database
[10] Wide energy study: sector energy use and opportunities (prepared for Department of Industry, Science, Energy and Resources)
[11] See footnote 8.
[12] Process Heat in New Zealand - https://www.mbie.govt.nz/assets/8c89799b73/process-heat-current-state-fact-sheet.pdf
[13] Energy Strategies for New Zealand - https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-strategies-for-new-zealand/
[14] Note, most of this gas is consumed in boilers much larger than the likely scope of any regulations.

sources, due to the absence of a reticulated gas network in parts of the country. A breakdown of process heat fuel sources for New Zealand is included in Figure 1.

Figure 1. Process heat fuel sources in New Zealand (Adapted from NZ Energy End Use Database)



The majority (79 per cent) of process heat was used by the industrial sector, including saw mills, pulp and paper mills and food processing plants (including dairy). Seventeen per cent of process heat is used by the commercial and public sector including schools, hospitals, prisons and public administration buildings, and 4 per cent by the agricultural sector, mainly for glasshouses.[15]

2.3. Role of policy, standards and testing

MEPS specify the minimum level of energy performance that appliances, lighting and electrical equipment (products) must meet or exceed before they can be legally offered for sale in Australia and New Zealand. MEPS are one of a range of potential measures that could improve industrial equipment energy efficiency.[16]

Other approaches include energy rating labelling schemes (either voluntary or mandatory), introduction of voluntary standards where industry 'self-regulates', and incentives and support for manufacturers to develop and introduce more efficient products while phasing out less efficient products. These policy options will be explored in a Consultation RIS on policy options.

For any of these options, test standards must form the foundation to ensure product energy efficiency claims can be consistently tested and verified. This offers greater certainty of outcomes for policy makers, suppliers and end users.

Existing international standards could be adopted by Australia and New Zealand, or be incorporated into a new Australian/New Zealand Standard. The aim is the identification of an agreed method that can be readily adopted by industry in both countries.

[15] Ibid
[16] Improving the Energy Efficiency of Industrial Equipment. - https://www.energyrating.gov.au/document/discussion-paper-improving-energy-efficiency-industrial-equipment

The existing standards that apply to testing of boilers (in some cases, covered under water heater standards) are:

- AS/NZS 5263.1.2:2016 Gas appliances Part 1.2: Gas fired water heaters for hot water supply and/or central heating, including:
    - Test Method ZC107 Thermal efficiency test – storage water heaters
    - Test Method ZC108 Thermal efficiency, water heating capacity, start-up heat capacity and electrical power consumption test – instantaneous water heaters and circulators
    - Test Method ZC109 Thermal efficiency test – central heating boilers
- BS (British Standard) 7190:1989: Method for assessing thermal performance of low temperature hot water boilers using a test rig
- ANSI/AHRI Standard 1500-2015 Performance Rating of Commercial Space Heating Boilers
- I.S. EN 12809:2001 Residential Independent Boilers Fired By Solid Fuel - Nominal Heat Output Up To 50 Kw - Requirements And Test Methods
- I.S. EN 15502-1:2012 Gas-fired Heating Boilers - Part 1: General Requirements and Tests

In Australia and New Zealand, boilers are covered by a range of different regulatory requirements, generally related to equipment safety (e.g. pressure vessel standards). There are no uniform standards for energy efficiency of boilers.

Currently in Australia, the National Construction Code (NCC) 2019 requires boilers used in air conditioning systems in new buildings to have minimum thermal efficiencies.[17] Due to the required efficiency levels, the NCC essentially precludes non-condensing boilers from being installed in new buildings. The NCC 2019 requirements are included in Appendix 4.

The New Zealand Building Code sets performance requirements for residential-type hot water cylinders (<700l) only, with cylinders that meet the current MEPS level able to comply.

[17] National Construction Code 2019 Building Code of Australia – Volume One

3. Industrial Boilers

3.1. Boiler Technology

Boilers are used in a wide variety of commercial and industrial applications. They use a combustion source or electricity to provide hot water for heating or sanitation. Boilers are also used to provide heat or steam for low to medium heat ranges (100-500°C) for industrial processes. They are also used in domestic and small-scale commercial applications for providing potable and sanitary hot water and for hydronic heating.

Available technologies

Typically, boilers use natural gas, LPG, biogas or diesel, however, solid fuel boilers using coal, wood or waste products and biomass, and electric boilers are also available. Solid fuel boilers using coal are in wide use in New Zealand, given the absence of a reticulated gas network in the South Island.

Boilers fit into two main classifications, *fire-tube* and *water-tube* boilers.

Fire-tube boilers heat water by hot gasses passing through tubes immersed in the water. Fire-tube boilers are typically cheaper to install and operate. They are commonly referred to as “shell and tube boilers” and are effective at producing low temperature hot water and low pressure steam (typically less than 15 bar).

Water-tube boilers heat water passing through tubes via a flame. Water-tube boilers are typically more complex and expensive but are capable of producing high temperature water and high pressure steam.

Condensing boilers use latent heat in the flue gas to preheat the water entering the boiler. Hot flue gases pass over the water entering the boiler, condensing moisture out of the flue gas and heating the water prior to entering the main heating element. These types of boilers are more efficient as they convert more energy from fuel to heat.

Boilers may also be further classified by fuel type such as liquid, gas or solid fuel, by application such as hot water or steam or both, feedwater, stationary, marine, or locomotive, and natural or forced draught for example.

Turbulators are small baffles, angular metal strips, spiral blades, or coiled wires which force turbulent flow in the heating tube of a boiler, maximising heat transfer and reducing flue gas temperature. Alternative designs incorporate ribbed texture to the tube itself to provide both turbulence and increased surface area for improved heat transfer. Some boilers are fitted with turbulators. Turbulators have been highlighted as providing improved thermal efficiency in fire tube boilers. Currently in Australia and New Zealand, some brands offer “high efficiency” boiler models incorporating turbulators, and quote a five per cent improvement in thermal efficiency over their standard efficiency boiler.

Considerations for boiler selection include:

- Available fuel source e.g. solid fuel including coal, wood, woody biomass, liquid fuel including oil and kerosene, or gas such as propane.

- Temperature requirements i.e. low/high temperature water, low/high temperature steam, low/high pressure steam.
- Required capacity.
- Process requirement/purpose.

Boilers have an economic lifespan of 15 – 20 years. Despite this, it is quite common for boilers to be used for much longer periods (between 20 and 40 years). This may be due to a number of factors, including building age, mixed boiler installations, capital cost constraints and others.

Boiler Construction

Boilers are typically manufactured and sold as either packaged units, or field-constructed. The following definitions are used for this report

Packaged Boiler:	A packaged low pressure boiler, distributed in commerce for heating or space conditioning applications in buildings, or for service water heating in buildings but is not a hot water supply boiler.
Field Constructed Boiler:	Custom-designed equipment that requires welding of structural components in the field during installation; for the purposes of this definition, welding does not include attachment using mechanical fasteners or brazing; any jackets, shrouds, venting, burner, or burner mounting hardware are not structural components

Packaged boilers have specifications that are easily tested and verifiable at the point of manufacture, with consistent performance largely independent of their use case. That has led to efforts in energy efficiency standards focusing on packaged boilers. These are predominantly installed in the commercial (offices, malls) or community building (hospitals, schools) sectors. Packaged boilers only account for around 35 per cent of the boiler industry revenue[18].

Boilers used in industrial settings for process heat are usually Field Constructed. This makes it complex to test and verify performance. Boilers used for process heating account for 46 per cent of the market[19].

Definition of Boiler Efficiency

While often quoted in product literature, there is currently no standard defining ‘standard’ or ‘high efficiency’ for boiler performance. Boiler efficiency can be defined in a number of different ways including:

Gross combustion efficiency	100 per cent less the losses due to dry flue gas, incomplete combustion and moisture formed by combustion of hydrogen.
Net combustion efficiency:	100 per cent less the losses due to dry flue gas and incomplete combustion. Net combustion efficiency assumes that the energy contained in the water formed

[18] Boiler and tank manufacturing in Australia 2020 - IBISWorld
[19] Ibid

	during combustion is recovered and not exhausted. Net combustion efficiency is often not considered an accurate value as the actual latent energy recovered from the moisture is difficult to quantify in practice.
Thermal efficiency:	The ratio of the heat absorbed by the water, or the water and steam, to the higher heating value in the fuel burned.
AFUE:	Annual fuel utilisation efficiency. The ratio of the annual heat output of the boiler to the annual fossil fuel energy consumed by the boiler.
Seasonal Efficiency:	The weighted average of the boiler efficiencies at 15, 30 and 100 per cent of the boiler output.

3.2. International Standards and Test Methods

The majority of products imported into Australia and New Zealand come from the US, Europe or China, each which have boiler standards. As such products are likely to be compliant with at least one of the standards. It may impose an unnecessary cost on manufacturers to have to potentially comply with a new or additional standard.

EU Standards

The European Union has introduced energy efficiency standards through the EcoDesign requirements for:

- oil and gas fired boilers providing heat to water-based central heating systems, primarily for residential situations
- solid fuel boilers

These are for packaged units typically intended for domestic or commercial use. EU Regulations 813/2013 and 814/2013 apply to boilers under 400kW, which are typically for residential and small scale commercial applications. Regulation 813 relates to space heating applications and 814 relates to water heaters and hot water storage tanks. Regulation 1189 applies to solid fuel boilers.

The regulations are:

- Commission Delegated Regulation (EU) No 811/2013 supplementing Directive for the energy labelling of space heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device.
- Commission Regulation (EU) No 813/2013 implementing Directive for EcoDesign requirements for space heaters and combination heaters.
- Commission Regulation (EU) No 814/2013 implementing Directive for EcoDesign requirements for water heaters and hot water storage tanks.
- Commission Regulation (EU) No 2015/1189 implementing Directive for EcoDesign requirements for solid fuel boilers.

The requirements of the EU standard is included in 0.

US Standards

The United States has proposed the introduction of more stringent energy conservation standards for liquid and gas fuelled packaged boilers ranging in size from approximately 88 kW through to greater than 3,000 kW. The implementation of the new standard has been delayed. These standards only apply to commercial low pressure packaged boilers.

The requirements of the US standard is included in 0.

PRC Standards

The Peoples Republic of China introduced boiler standards GB 24500-2009 “The Minimum Allowable Values of Energy Efficiency and Energy Efficiency Grades Industrial Boilers” in 2009, with revisions due in 2019. The department was not able to determine the state of the revisions by time of publishing.

The standards cover boilers heated by coal, gas, oil and biomass or electric, with requirements based on different fuel types and boiler attributes. Industrial boilers are divided into 3 grades, with grade 3 as the minimum value of enter market.

3.3. Consideration of Impacts of Imposing Standards

The efficiency requirements set out in the NCC or EU standards essentially preclude non-condensing boilers from the market. A technical report produced for the former Department of the Environment and Energy found that there a number of issues when replacing non-condensing boilers with condensing boilers or heat pumps.

- Many traditional boiler systems are designed to have quite narrow temperature differentials to maximise heat transfer (85/65˚C). Condensing boilers require a much lower return temperature (~35 ˚C) to operate at their best efficiency point. The heat exchangers may therefore need to be re-configured, adding cost burden.
- Acidic condensate is produced as a by-product of condensing technologies. Condensing boilers extract the latent heat from the exhaust gasses, which lowers exit temperature, increasing moisture levels in the flue and causing acidic condensate to form. Corrosion may therefore occur in combined flue systems, or in systems where the flue was not designed for dealing with acidic condensate (e.g. a galvanised flue).
- Due to the extra production of acidic condensate, the installation of condensate drains with PH neutralisers may be required where there are horizontal flue runs.
- There are additional requirements if moving from an atmospheric intake to a fan forced system.

Capital upgrades to the existing system, combined with additional costs of condensing boilers (generally around two times the cost), may act as a financial barrier.

Some boiler suppliers noted that due to the typical efficiency improvements over the lifetime of a boiler, condensing boilers still prove cost effective. Suppliers added that modern product options are compact, easy to install and can offer a combined flue, dilution fans and other options to allow easy retrofit with only minimum changes to the system (e.g. condensate drain). The suppliers also noted that the market is naturally beginning to shift away from non-condensing boilers, as development in new technologies is leading to low maintenance designs using higher quality materials.

4. Questions for Stakeholders

The following questions are provided for stakeholders to comment on elements of the paper, and to request information where the department and the TWG have identified information gaps. The list of questions are not exhaustive, and the department encourages stakeholders to expand on the questions or themes raised in the paper. Any additional comments are also welcome.

Information Collection Statement

All submissions may be used by the department for the purpose of policy development.

Individual submissions to the discussion paper will not be published, however a summary of key themes may be published on the E3 Program website. Any information provided by you as part of the consultation process which is marked as confidential by you will not be disclosed outside the E3 Program. Personal information will be handled in accordance with the Department of Industry, Science, Energy and Resources Privacy Policy[20].

Any data provided as part of your submission will be treated as commercial-in-confidence. If the data is subsequently used in analysis, it will be aggregated and de-identified before publishing.

Boiler Market

1. Is the market data presented in the discussion paper representative of the Australian and/or New Zealand boiler market(s)? Are you aware of other data sources?

2. What area of the boiler industry is your business involved in? (e.g. manufacture, installation, servicing, sales etc.)

3. Could you provide an estimate of your business' annual turnover and market share for boilers in Australia and New Zealand?

4. What is the approximate number of staff employed by your business?

5. How many boiler models does your company supply? How are models defined (e.g. size, configuration)? Are you able to give information on their specifications?

6. How do you determine model numbers? Is the model number found on the boiler unit itself?

7. When boiler models are offered for supply to the market, are these units already built and ready for dispatch? Or are they representative of the models which are configured to suit a customer's specific requirements and built to order?

8. How many of your boiler products are manufactured in Australia or New Zealand? If not, from where do you source your products, and why?

[20] https://www.industry.gov.au/data-and-publications/privacy-policy

9. Are you able to provide annual sales data? Can you provide an estimate of the ratio of boiler replacements vs new installations?

10. What are the typical avenues for selling boilers? Are they direct to customer (online or in-store), or indirectly through wholesalers or engineering services? Can you provide approximate breakdown of the percentages?

11. One issue highlighted is that people involved in purchase decisions of boiler equipment are usually either the building owners or contractors, as opposed to those ultimately paying for the operating costs (i.e. the occupiers of the building). Can you comment on this issue? Who are your direct customers typically?

12. Are you aware of any direct importing of boilers for use for a commercial purpose? Can you provide examples for this type of supply?

13. Is there a market for small scale suppliers to import and sell boilers directly, in competition to you, via online platforms such as eBay or Alibaba? What is your estimate of the market share?

Standards

1. Have the Australian NCC 2019 requirements impacted your business?

2. Which test standards do you use/are you familiar with? Are you able to comment on their relative advantages and disadvantages?

3. Which of these methods have most widespread use in the Australian and New Zealand boiler industry, and why?

4. How are the boilers offered by your company tested for the Australian/New Zealand market? Are you able to provide an example of test certificates/charts for your products that we could use in our analysis?

Technology

1. Do you agree with the typical lifespan of a boilers highlighted above? What age do you typically see boilers being retired/replaced? Are new boilers expected to last as long?

2. Do unit costs vary as boilers become more energy efficient? If so, how?

3. Are customers typically concerned with upfront capital costs or ongoing operating costs?

4. Advocates for turbulators claim they are cheap, effective and easy to remove for maintenance, with minimal impacts on coking or system pressure drop. Can you comment on this? Are turbulators not effective in some situations? Could you highlight any examples?

5. Is there opportunity for the retrofitting of turbulators or other technology to improve efficiency in existing boiler installations?

6. What are your experiences on replacing non-condensing boilers with condensing boilers? Have you experienced the technical issues identified?

7. In your experience, what are the additional costs of exchanging a non-condensing boiler with a condensing one?

8. Does your business offer field-constructed boilers for industrial applications? Is efficiency a primary consideration (as opposed to size, utility, fuel type and availability etc.)? What options are there for testing boilers in these applications, and does this typically occur?

Efficiency Information

1. Has your business accessed any educational/informational programs for improving boiler efficiency? If so, could you provide details?

2. Do you/your suppliers provide any information on energy efficiency/running costs of boilers sold? Do customers request this information?

3. Are there any components or other aspects of boiler design that have a large impact on the energy efficiency?

4. What scope is there for improving energy efficiency in field constructed boilers?

Appendix 1. Technical Working Group Responses

This section summarises the Technical Working Group's views and recommendations.

Boiler Market Overview

The TWG noted the lack of comprehensive, consolidated industry data and relied on either internal or proprietary data sources, and inferred information to form a view of the market place.

The TWG highlighted that Australian and New Zealand commercial packaged units are typically used in commercial applications requiring space heating, or small process heat applications requiring low temperature steam and hot water such as dry cleaners. Larger packaged units may be used for some process applications including hospitals. Large industrial applications typically require a customised solution and would not accommodate an off the shelf package unit without significant modification.

Boiler Technology

The TWG considered a large range of technologies including fuel types, capacities, degree of standardisation, energy recovery equipment, and application. It was noted that agreeing on standard classifications of boiler technologies is difficult and is dependent on a range of factors, though the TWG generally agreed with the definitions presented in the discussion paper.

The TWG noted that coal fired boilers are becoming redundant, while other forms of solid fuel such as biomass are becoming increasingly more common.

Product Coverage and Scope

The TWG considered that equipment greater than 1MW would be difficult to investigate as manufacturers do not sell significant quantities of equipment above this size, and suggested to limit the option to gas/liquid fuelled packaged boilers under approximately 1.4MW. The final cut-off point would need to be determined through a more comprehensive assessment of the currently available boiler range in Australia and New Zealand.

The TWG noted that an arbitrary delineation of capacity may create some perverse outcomes, whereby a larger boiler than necessary is specified and installed to avoid compliance with MEPS, and therefore any size limit for the implementation of MEPS must ensure it captures all commonly available sizes, without providing an unnecessary cost burden on those products that only sell in small quantities.

The TWG raised the further point to ensure that products not intended to be covered by MEPS such as for sanitary hot water or drinking purposes cannot be substituted into applications requiring MEPS compliance.

Current Approach

The TWG noted that the US standards have different efficiencies for different boiler types, which includes both different measures of efficiency and different efficiency values. Having different measures for efficiency i.e. net thermal efficiency, gross thermal efficiency,

combustion efficiency etc. makes it difficult to compare boiler performance. The TWG agreed that a single measure of gross thermal efficiency should be used.

The TWG discussed the NCC 2019 modified the requirements for space heating in air-conditioning applications in the code update, which now requires all new gas water heaters (e.g. boilers) used as part of an air-conditioning system to have a minimum gross thermal efficiency of 86 per cent if rated to consume 500 MJ/hr of gas or less or 90 per cent if rated greater than 500 MJ/hr of gas. The NCC only applies to new buildings in Australia, and while consideration of the NCC is important, consideration must be also be given to the New Zealand market which has no equivalent building code requirements for energy efficiency. The TWG felt that any requirements should meet the stringency requirements of the NCC and that this could be meaningfully applied to both the Australian and New Zealand jurisdictions.

Technical Working Group Recommendation

The TWG discussed developing a new AS/NZS standard, choosing an existing standard and requiring all products to comply with that standard, or utilising multiple standards dependent on origin and stating equivalence, as potential options for Australia.

The TWG recommended that the ANSI/AHRI test standard be considered as is the most well-known and commonly used, with efficiency quoted as Gross Thermal Efficiency. Further work is required to benchmark the proposed standards against each other; and determine an appropriate maximum capacity for consideration, based on an assessment of available products in the Australian and New Zealand markets. The TWG also suggested that a benchmarking exercise be undertaken between the various existing standards that have been identified and enable manufacturers to demonstrate compliance via any of the approved methods.

The TWG proposed investigating an option of a MEPS standard similar to the United States, whereby all liquid and gas fuelled commercial packaged boilers are subject to energy efficiency standards, whilst the European approach be adopted for solid fuel boilers. The TWG considers a MEPS for packaged boilers, of any fuel type, up to 1.4MW approximately as feasible.

Appendix 2. European Union Standards.

The following tables summarise the applicable standards and requirements of the regulations.

European Union Regulation 813/2013		**Required Standard** (Seasonal space heating efficiency when tested as defined in Annex III and IV of the regulation)	
Boiler space heaters, cogeneration space heaters and heat pump space heaters. Use: Heat to water based central heating systems Rated output: ≤400kW Fuel Types: • gaseous or liquid fuels (including biomass <50%) • electricity ambient or waste heat			
Product Type	**Performance Characteristics**	**2015**	**2017**
Fuel boiler space heaters (excluding Type B1 ≤10kW)	Rated Output: ≤70kW	≥86%	
Type B1 boiler[1]	Rated Output: ≤10kW	≥75%	
Fuel boiler space heaters	Rated Output: >70kW, ≤400kW	Useful efficiency @ 100% heat output ≥86% Useful efficiency @ 30% heat output ≥94%	
Electric boiler space heaters	Rated Output: ≤400kW	≥30%	≥36%
Cogeneration space heaters	Rated Output: ≤400kW Max electrical capacity of <50kW	≥86%	≥100%
Heat pump space heaters (excluding low temperature heat pumps)	Rated Output: ≤400kW	≥100%	≥110%
Low temperature heat pumps	Rated Output: ≤400kW	≥115%	≥125%

European Union Regulation 813/2013		Required Standard (Seasonal space heating efficiency when tested as defined in Annex III and IV of the regulation)	
Boiler combination heaters and heat pump combination heaters. Use: Heat to water based central heating systems and heat to deliver hot drinking and sanitary water. Rated output: ≤400kW Fuel Types: • gaseous or liquid fuels (including biomass <50%) • electricity ambient or waste heat			
Product Type	**Performance Characteristics**	**2015**	**2017**
Fuel combination boiler heater (excluding type B1 ≤30kW)	Rated Output: ≤70 kW	≥86%	
Type B1 combination boiler	Rated Output: ≤30kW	≥75%	
Fuel boiler combination heaters	Rated Output: >70kW, ≤400kw	Useful efficiency @ 100% heat output ≥86% Useful efficiency @ 30% heat output ≥94%	
Electric boiler combination heaters	Rated Output: ≤400kW	≥30%	≥36%
Cogeneration combination heaters	Rated Output: ≤400kW Max electrical capacity of <50kW	≥86%	≥100%
Heat pump combination heaters (excluding low temperature heat pumps)	Rated Output: ≤400kW	≥100%	≥110%

[1] A type B1 boiler is a fuel boiler space heater incorporating a draught diverter, intended to be connected to a natural draught flue that evacuates the residues of combustion to the outside of the room containing the fuel boiler space heater, and drawing the combustion air directly from the room.

Exclusions

- Heaters specifically designed for using gaseous or liquid fuels predominantly from biomass
- Heaters using solid fuels
- Heaters generating heat only for hot drinking or sanitary water
- Heaters for heating and distributing gaseous heat transfer media such as vapour or air
- Cogeneration space heaters ≥50 kW electrical capacity

The regulation also includes requirements for:

- Water Heating Energy Efficiency
- Sound Power Levels
- Nitrogen Oxides Emissions

European Union Regulation 814/2013		**Required Standard** (when tested as defined in Annex III and IV of the regulation)		
Product Type	**Performance Characteristics**	**2015**	**2017**	**2018**
Water Heaters which are dedicated to providing hot drinking and sanitary water	Rated output: ≤ 400 kW	meet requirements set out in Annex II, points 1.1a, 1.2, 1.3, 1.4 and 1.6	meet requirements set out in Annex II, points 1.1b	meet requirements set out in Annex II, points 1.1c
Hot Water Storage tanks	Capacity: ≤ 2,000 L	meet requirements set out in Annex II, point 2.2	meet requirements set out in Annex II, point 2.1	meet requirements set out in Annex II, point 1.5a

Exclusions:

- Water heaters specifically designed for using gaseous or liquid fuels predominantly from biomass
- Water heaters using solid fuels
- Combination heaters
- Water heaters that do not meet at least the load profile with the smallest reference energy in Annex III, table 1 of the regulation
- Water heaters designed for making hot drinks and/or food only

European Union Regulation 1189/2015	**Required Standard from 2020** (when tested as defined in Annex III and IV of the regulation)
Solid fuel boilers including integrated packages of a solid fuel boiler, supplementary heaters, temperature controls and solar devices ≤ 500kW	
Boilers rated heat output ≤ 20kW	Seasonal efficiency ≥75%
Boilers rated heat output > 20kW	Seasonal efficiency ≥77%

Exclusions:

- Boilers generating heat exclusively for providing drinking or sanitary water
- Boilers for heating and distributing gaseous heat transfer media such as vapour or air
- Solid fuel cogeneration boilers ≥ 50 kW electrical capacity
- Non-woody biomass boilers

The regulation also includes requirements for:

- Particulate matter emissions
- Organic gaseous compounds emissions
- Carbon monoxide emissions
- Nitrogen oxides emissions

Appendix 3. United States Standards

The following tables summarise the applicable standards and requirements of the regulations.

Equipment	**Required Energy Conservation Standards** (When tested as defined in 10 CFR 431.86 and 10 CFR 431.87 using ANSI/AHRI Standard 1500-2015)		
	Size Category (input)	**2012**	**Proposed**
Small Gas-Fired Hot Water Commercial Packaged Boilers	≥300,000 Btu/h, ≤2,500,000 Btu/h ≥87.9 kW, ≤732.2 kW	80.0% E_T	84.0% E_T
Large Gas-Fired Hot Water Commercial Packaged Boilers	≥2,500,000, ≤10,000,000 Btu/h ≥732.2 kW and ≤2,929 kW	82.0% E_C	85.0% E_C
Very Large Gas-Fired Hot Water Commercial Packaged Boilers	≥10,000,000 Btu/h ≥ 2,929 kW	82.0% E_C	82.0% E_C
Small Oil-Fired Hot Water Commercial Packaged Boilers	≥300,000 Btu/h, ≤2,500,000 Btu/h ≥87.9 kW, ≤732.2 kW	82.0% E_T	87.0% E_T
Large Oil-Fired Hot Water Commercial Packaged Boilers	≥2,500,000, ≤10,000,000 Btu/h ≥732.2 kW and ≤2,929 kW	84.0% E_C	88.0% E_C
Very Large Oil-Fired Hot Water Commercial Packaged Boilers	≥10,000,000 Btu/h ≥ 2,929 kW	84.0% E_C	84.0% E_C
Small Gas-Fired Steam Commercial Packaged Boilers except natural draft boilers	≥300,000 Btu/h, ≤2,500,000 Btu/h ≥87.9 kW, ≤732.2 kW	79.0% E_T	81.0% E_T
Small Gas-Fired Steam Commercial Packaged Boilers natural draft boilers	≥300,000 Btu/h, ≤2,500,000 Btu/h ≥87.9 kW, ≤732.2 kW	79.0% E_T	From March 2022 79.0% E_T
Large Gas-Fired Steam Commercial Packaged Boilers except natural draft boilers	≥2,500,000, ≤10,000,000 Btu/h ≥732.2 kW and ≤2,929 kW	79.0% E_T	82.0% E_T
Large Gas-Fired Steam Commercial Packaged Boilers natural draft boilers	≥300,000 Btu/h, ≤2,500,000 Btu/h ≥87.9 kW, ≤732.2 kW	79.0% E_T	From March 2022 79.0% E_T

Very Large Gas-Fired Steam Commercial Packaged Boilers except natural draft boilers	≥10,000,000 Btu/h ≥ 2,929 kW	79.0% E_T	79.0% E_T
Very Large Gas-Fired Steam Commercial Packaged Boilers natural draft boilers	≥300,000 Btu/h, ≤2,500,000 Btu/h ≥87.9 kW, ≤732.2 kW	77.0% E_T	From March 2022 79.0% E_T
Small Oil-Fired Steam Commercial Packaged Boilers	≥300,000 Btu/h, ≤2,500,000 Btu/h ≥87.9 kW, ≤732.2 kW	81.0% E_T	84.0% E_T
Large Oil-Fired Steam Commercial Packaged Boilers	≥2,500,000, ≤10,000,000 Btu/h ≥732.2 kW and ≤2,929 kW	81.0% E_T	85.0% E_T
Very Large Oil-Fired Steam Commercial Packaged Boilers	≥10,000,000 Btu/h ≥ 2,929 kW	81.0% E_T	81.0% E_T

E_T is Thermal Efficiency; E_C is Combustion Efficiency

Appendix 4. National Construction Code 2019 Requirements

The following is the requirement for boilers outlined in the National Construction Code 2019 Section J.

J5.9 Space heating

(i) A heater used for air-conditioning or as part of an air-conditioning system must be—

a. a solar heater; or

b. a gas heater; or

c. a heat pump heater; or

d. a heater using reclaimed heat from another process such as reject heat from a refrigeration plant; or

e. an electric heater if

f. the heating capacity is not more than—

i. (aa) 10 W/m^2 of the floor area of the conditioned space in climate zone 1; or (bb) 40 W/m^2 of the floor area of the conditioned space in climate zone 2; or

ii. (cc) the value specified in Table J5.9 where reticulated gas is not available at the allotment boundary; or

iii. the annual energy consumption for heating is not more than 15 kWh/m^2 of the floor area of the conditioned space in climate zones 1, 2, 3, 4 and 5; or

iv. the in-duct heater complies with J5.2(a)(ii)(C); or

v. any combination of (i) to (v).

*(ii) A gas water heater, that is used as part of an air-conditioning system, when tested in accordance with **AS/NZS 5263.1.2**, must—*

a. if rated to consume 500 MJ/hour of gas or less, achieve a minimum gross thermal efficiency of 86%; or

b. if rated to consume more than 500 MJ/hour of gas, achieve a minimum gross thermal efficiency of 90%.