



# Industrial Pumps: Technical Discussion Paper

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# Executive Summary

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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 E3 Program began work with the Industrial Equipment Technical Working Group (TWG) to investigate policy options for improving the efficiency of industrial equipment. This discussion paper presents the work of the TWG and the department to date on pumps.

The Australian pump market annual sales revenue is estimated at \$1.01 billion and \$540 million in New Zealand. The import and assembly of pumps supplies 65.6 per cent of the market in both countries, with the remainder of pumps locally manufactured. The major import markets are the European Union, the United States and China.

In both Australia and New Zealand, industrial pumps are significant consumers of electricity, accounting for approximately 12 per cent of total industrial electricity use. Aside from requirements for pumps and circulators in Heating, Ventilation, and Air Conditioning systems under the Australian National Construction Code, there are no energy efficiency requirements for pumps in Australia and New Zealand.

Pumps use mechanical means to move water and other fluids by increasing the head (hydrological pressure) and/or flow rate of the fluid. Pumps are used in a broad range of industries, including the water and wastewater sectors, mining, manufacturing and agriculture. The most common pump technology in both countries are rotodynamic centrifugal pumps.

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 Regulatory Impact Statement (RIS).

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# 1. Introduction

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## 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 pumps, including:

1. An overview of the pump 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 pump 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 cost benefit analysis
- To better understand the state of the pump industry in the context of Australia and New Zealand
- To trigger a discussion among experts, industry representatives and other stakeholders about which pump technologies, test methods and standards are common within the industry

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

- Industry and company level data for the Australian and New Zealand pump markets
- The specifications that would best define the pump 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 pumps 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 'Pump 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](mailto:GEMS.Industrial@industry.gov.au)

Energy Efficiency and Conservation Authority (EECA) of New Zealand

E: [regs@eeeca.govt.nz](mailto:regs@eeeca.govt.nz)

### **1.4. Role of the Technical Working Group**

E3 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 comprises of members from industry, peak bodies, academia, the Department of Industry, Science, Energy and Resources (DISER), and the New Zealand Energy Efficiency and Conservation Authority (EECA).

The Energy Efficiency Advisory Team (EEAT)<sup>1</sup> 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 pump sub-group was to provide EEAT with a set of recommendations for:

1. What pump 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 pumps in the Australian and New Zealand
4. Which test methods and standards could be used as a basis for assessing the energy efficiency of pumps
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 boilers 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.

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<sup>1</sup> E3 Program - <https://www.energyrating.gov.au/about-e3-program/who-we-are>

## 2. Policy Context

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### 2.1. The E3 Program

The E3 Program<sup>2</sup> 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 minimum energy performance standards (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 *Greenhouse and Energy Minimum Standards (GEMS) Act 2012*<sup>3</sup> 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.<sup>4</sup>

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.<sup>5</sup>

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<sup>2</sup> About the E3 Program - <https://www.energyrating.gov.au/about-e3-program>

<sup>3</sup> GEMS Act 2012 - <https://www.legislation.gov.au/Details/C2012A00132>

<sup>4</sup> E3 Achievements Report - <https://www.energyrating.gov.au/document/e3-achievements-report-2018-2019>

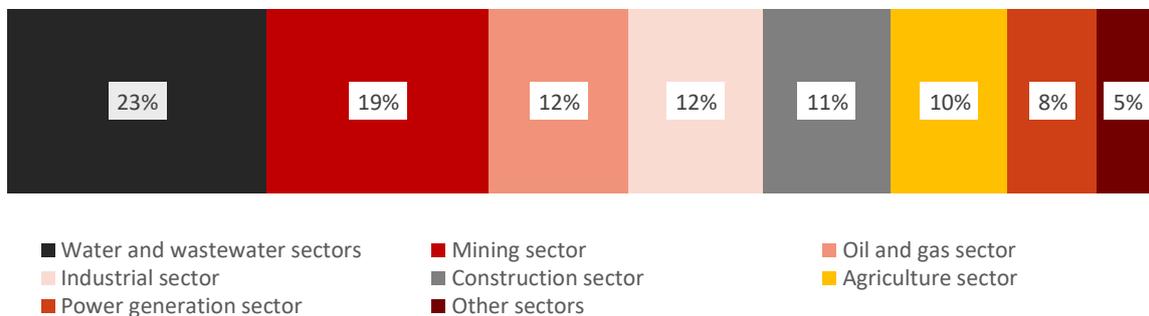
<sup>5</sup> E3 Prioritisation Program 2017-18 <https://www.energyrating.gov.au/document/e3-prioritisation-plan-2017-18>

## 2.2. Pump Market Overview

### Market Scale and Value

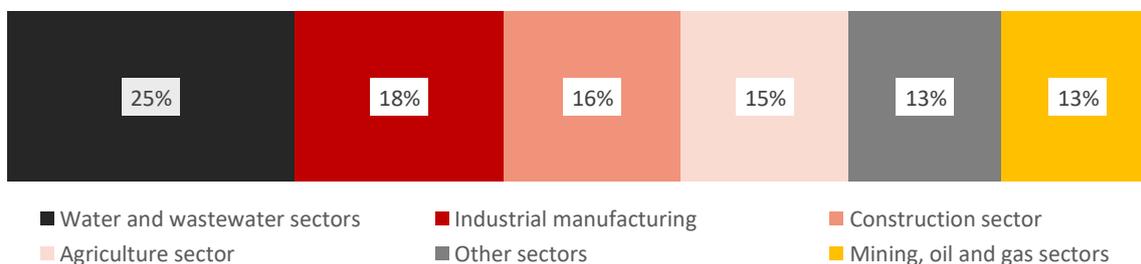
There is limited information on the Australian pump market, including installed stock, import data and annual sales. The most recent statistics are provided by IBISWorld, which aggregates at the industry level. Data for New Zealand is limited. The 2019/20 total annual sales revenue for pumps in Australia is estimated to be \$1.01billion<sup>6</sup> and \$500-540 million<sup>7</sup> in New Zealand. In Australia, irrigation and agriculture account for only 10.2 per cent of sales, while the mining, oil and gas industries account for over a third of sales. New Zealand data is unavailable. Anecdotally the proportion of sales to mining and minerals sectors is much less than Australia, with a high proportion going to agriculture. A breakdown of market segments for Australia is shown in **Error! Reference source not found.**

**Figure 1 Major Market Segments in the Pump Industry in Australia (adapted from IBISWorld)<sup>8</sup>**



There are an estimated 181 Small to Medium Enterprises (SMEs) businesses who supply pumps in Australia, accounting for almost half the total (374).<sup>9</sup> For SME pump suppliers, the major markets are the water treatment industry, construction and agriculture. This is because SME businesses tend to specialise in providing niche products to industrial supply chains, while larger firms produce larger and more powerful products that can be used in infrastructure, such as power generation projects. A breakdown of market segments is shown in **Error! Reference source not found.**

**Figure 2. Major Market Segments for SME pump businesses in Australia (Adapted from IBISWorld)<sup>10</sup>**



<sup>6</sup> Pump and Compressor Manufacturing in Australia- IBISWorld

<sup>7</sup> Industrial and Mining Machinery Wholesaling in New Zealand- IBISWorld

<sup>8</sup> \*Please note these figures include compressor sales, as they are within the same ANZSIC code.

<sup>9</sup> SME Industry Report: Pump and Compressor Manufacturing in Australia - IBISWorld

<sup>10</sup> \*Please note these figures include compressor sales, as they are within the same ANZSIC code.

The pump market in Australia is predominantly import and assembly-based (65.6 per cent of domestic demand), with the remainder local manufacturing<sup>11</sup> which notes that Australia imports pumps from:

- The EU (30 per cent),
- The US (22.3 per cent)
- China (19.6 per cent)
- Other (40.7 per cent),

Exports from Australia account for 36.7 per cent of pump market revenue, with major export markets including:

- Indonesia (19 per cent)
- New Zealand (15.1 per cent)
- Papua New Guinea (12.5 per cent)
- The US (7.7 per cent)
- Other (45.7 per cent)

## Energy Use

In both Australia and New Zealand, pumps are significant consumers of energy. Pumps account for an estimated 12.2 per cent of electricity use in Australian industry<sup>12</sup> and 9-12 per cent of total industrial electricity use in New Zealand<sup>13</sup>. Due to both their high operating hours and expected life of over 10 years, electricity consumption is the largest costs associated with operating pumps. It is estimated electricity use accounts for over half the total costs over the life of the pump.<sup>14</sup>

### **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 offered for sale or used for commercial purposes. MEPS are one of a range of potential measures that could improve industrial equipment energy efficiency.<sup>15</sup>

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.

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<sup>11</sup> Pump and Compressor Manufacturing in Australia - IBISWorld

<sup>12</sup> Improving the Energy Efficiency of Industrial Products - <https://www.energyrating.gov.au/document/discussion-paper-improving-energy-efficiency-industrial-equipment>

<sup>13</sup> NZ Energy End Use Database - <https://www.eeca.govt.nz/resources-and-tools/tools/energy-end-use-database/>

<sup>14</sup> Energy Efficiency: Pumping Systems - <https://www.energy.gov.au/business/technologies/pumps-and-fans>

<sup>15</sup> Equipment Energy Efficiency Program Discussion Paper – E3 Program

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 standard. The aim is the identification of an agreed method that can be readily adopted by industry in both countries.

The existing standards that have pump test methods are:

- AS ISO 9906: 2018 Rotodynamic pumps – hydraulic performance acceptance test – Grades 1, 2 and 3.<sup>16</sup>
- ISO 9906:2012 Rotodynamic pumps – hydraulic performance acceptance test – Grades 1, 2 and 3 (Identical to above, this is the international standard upon which it is based)
- ISO 4409: 2007 (EN) Hydraulic fluid power – Positive displacement pumps, motors and integral transmissions – Methods of testing and presenting basic steady state performance
- EN 16480:2016 Pumps - Minimum Required Efficiency of Rotodynamic Water Pumps
- Hydraulic Institute (HI) Standard 40.6-2016, “Hydraulic Institute Standard for Method for Rotodynamic Pump Efficiency Testing”.<sup>17</sup>
- ISO 12809: 2011 (EN) Crop protection equipment – Reciprocating positive displacement pumps and centrifugal pumps – Test methods
- NEN-EN 14343 – Rotary Positive Displacement Pumps – Performance tests for acceptance

There are currently no uniform efficiency standards that apply to industrial pumps in Australia and New Zealand. In Australia, the efficiency of pumps used in air conditioning systems in new buildings is currently regulated through the National Construction Code (NCC) 2019.<sup>18</sup> The NCC requirements are included in Appendix 4.

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<sup>16</sup> These apply to rotodynamic pumps, but there are no equivalent standards for positive displacement pumps. The grades allow different tolerance ranges from quoted to tested pump performance, with Grade 1 being the most stringent.

<sup>17</sup> <https://www.energy.gov/sites/prod/files/2015/12/f28/Pumps%20ECS%20Final%20Rule.pdf>

<sup>18</sup> National Construction Code 2019 Building Code of Australia - Volume One

# 3. Industrial Pumps

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Pumps use mechanical means to move water and other fluids by increasing the **head** (hydrological pressure) and/or **flow** rate of the fluid. Pumps are used in a broad range of industries, including the water and wastewater sectors, mining, manufacturing and agriculture.

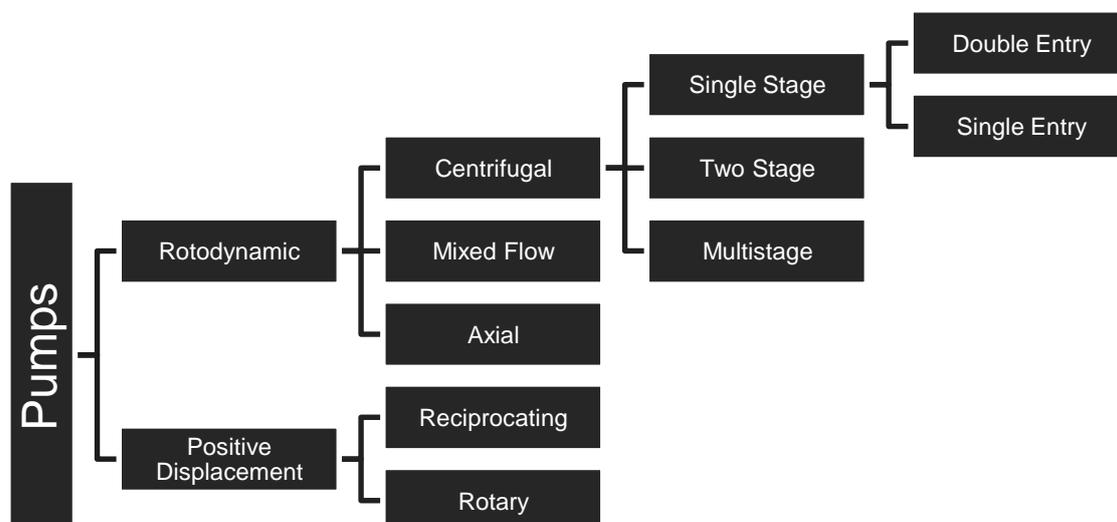
## 3.1. Pump Technology

### Available technologies

There are two main pump types – rotodynamic and positive displacement pumps – which are classified based on how they move fluid, further subdivided as shown in below.

- Positive displacement pumps typically use a displacement through mechanical means to create a pressurised fluid that is forced through the pump.
  - Rotary pumps use a rotating element (gears, vanes, screws etc.) to provide displacement.
  - Reciprocating pumps use pistons to provide displacement in the fluid chamber.
- Rotodynamic pumps move fluid by doing work on the fluid via kinetic energy transferred by rotating impeller.
  - Centrifugal pumps use a rotating vane or blades (impeller) to move the fluid radially. Multiple stage pumps use a number of impellers in series or to increase pressure.
  - Axial pumps move the fluid along the axis of the pump
  - Mixed flow uses a combination of both centrifugal and axial flow.

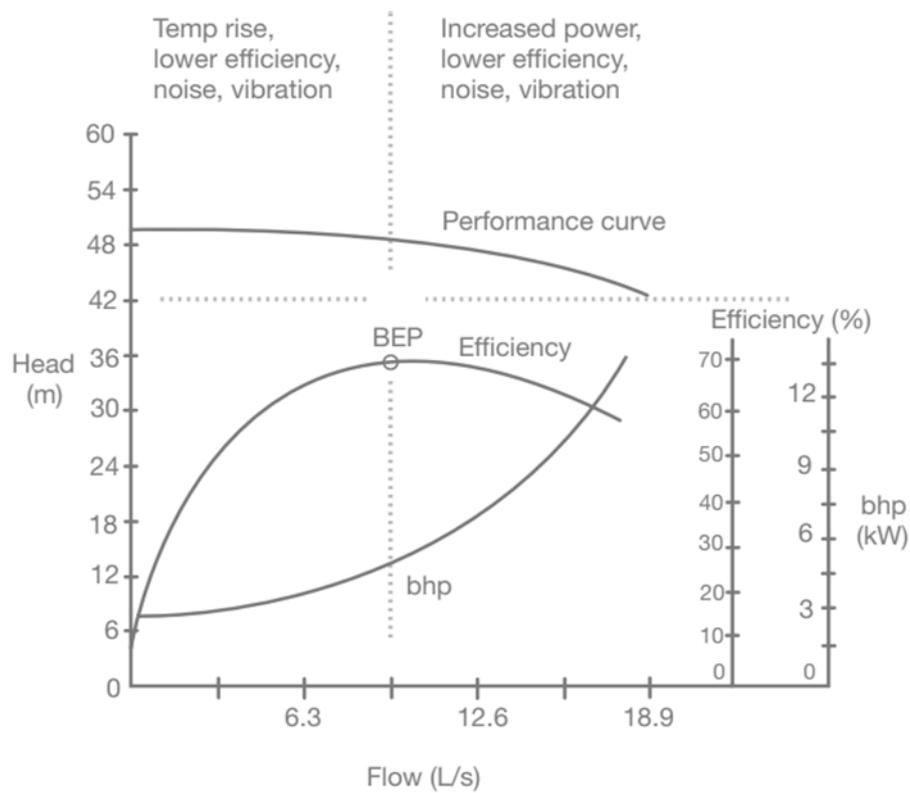
*Figure 3 Major pump technologies available in Australia (Adapted from the Pump Industry Association)*



Centrifugal pumps are the most common type of pump representing 44.5 per cent of the Australian market alone, whilst rotary and reciprocating pumps make up 13 and 12.1 per cent of market share, respectively.<sup>19</sup>

The efficiency of a pump relates to the amount of ‘work’ that can be done by the pump per unit of mechanical input, but does not extend to the electrical efficiency of the motor. Pump performance varies depending on the pump design and system design. The efficiency of a given pump will vary with flow rate (Q) and head (H), usually shown in product literature as a specific pump curve. Pumps should therefore be specified with a nominal “duty point” of flow rate and head, also known as the Best Efficiency Point (BEP), to obtain the most efficient pump for the purpose. While pumps rarely operate within static conditions, operating the pump away from the BEP will reduce efficiency. An example of a pump curve with BEP is shown in Figure 4.

**Figure 4. Example of a pump curve, showing the relationship of head, flow and efficiency<sup>20</sup>**



<sup>19</sup> Pump and Compressor Manufacturing in Australia - IBISWorld

<sup>20</sup> Energy Efficiency: Pumping Systems - <https://www.energy.gov.au/business/technologies/pumps-and-fans>

## 3.2. International Standards and Test Methods

The European Commission Regulation No. 547/2012 *Ecodesign requirements for water pumps*<sup>21</sup> was released in June 2012, with a review conducted in 2019. The US standard *Energy Conservation Standards for Pumps*<sup>22</sup> was not in effect when the TWG conducted its work in 2019. The Peoples Republic of China Standard GB 19762-2007 *The minimum allowable values of energy efficiency and evaluating values of energy conservation of centrifugal pump for fresh water*<sup>23</sup> was released in June 2008. The E3 Program are contacting international counterparts in these jurisdictions regarding each standard.

The Pump Industry Association highlighted that the majority of pumps advertised in Australia and New Zealand provide performance curves as per AS ISO 9906 – 2018 *Rotodynamic pumps — Hydraulic performance acceptance tests — Grades 1, 2 and 3*. This standard is based off the International ISO 9906 standard, which is referenced by both the EU and US standards.

### EU Standards

European Commission Regulation No. 547/2012 is the regulation which covers the EcoDesign requirements for water pumps. The European standard EN 16480:2016 *Pumps - Minimum Required Efficiency of Rotodynamic Water Pumps* is the test standard specified under 547/2012, for evaluating a pumps performance. EN 16480 heavily references the ISO 9906:2018 standard.

The EU standard applies to the pump only (excluding the driver/motor). The standard requires the hydraulic pump efficiency to be calculated at the Best Efficiency Point (BEP), at part load and overload. The required efficiency is determined by a Minimum Efficiency Index (MEI). The MEI values are derived from the percentage of the market that would be deemed compliant at the efficiency level (for example, an MEI of 0.4 means 40% of pumps on the market at the time of development of the standards would be non-compliant).

The current minimum level of MEI required by the standard is MEI>0.4, with best practice defined as any pump that meets an MEI>0.7.

The calculations for the required efficiency of the standard are included in Appendix 2.

The standard covers the following pump classifications:

- **End suction, own bearing (ESOB):** An end suction water pump with its own bearings.
- **End suction, close coupled (ESCC):** An end suction water pump, in which the motor shaft is extended to become the pump shaft.
- **End suction, close coupled inline (ESCCi):** An end suction water pump, in which the water inlet of the pump is on the same axis as the water outlet.

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<sup>21</sup> Ecodesign requirements for water pumps - <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32012R0547>

<sup>22</sup> Energy Conservation Program: Energy Conservation Standards for Pumps - <https://www.energy.gov/sites/prod/files/2015/12/f28/Pumps%20ECS%20Final%20Rule.pdf>

<sup>23</sup> The minimum allowable values of energy efficiency and evaluating values of energy conservation of centrifugal pump for fresh water - <https://www.codeofchina.com/standard/GB19762-2007.html>

- **Vertical multistage (MS-V):** A glanded multi stage rotodynamic pump in which the impellers are assembled on a vertical rotating shaft.
- **Submersible multistage (MSS):** A multistage rotodynamic water pump designed to be operated in a bore hole.

### Learnings from the EU

The European Union released an extended EcoDesign Pump Review<sup>24</sup> in January 2019 and a draft Commission Regulation for the EcoDesign requirements of water pumps and pump units. The findings of the review are now under consideration. The report includes key learnings from a review of the current regulation, including:

- Ensuring that products are labelled in a simple and effective manner to enable Market Surveillance Authorities (MSAs) to determine if a product is within scope.
- Pumps for some special purposes (e.g. pumping milk in food manufacturing) are often misunderstood as exempted from regulation.
- The definition of “clean water” as distinct from “drinking water” needs to be reinforced, so that products are not incorrectly labelled as out of scope.
- Some manufacturers were not supplying the required documentation. Requirements should be simplified to reduce burden on manufacturers, retailers and MSAs
- Pumps should be tested at their rated nominal speed and use C-values that correspond to the closest speed defined in the regulation.

Furthermore, the report identified loopholes in the current legislation that could be exploited, including:

- The lack of definition of self-priming water pumps creates a potential loophole for covered water pumps that also have a self-priming function. For the purposes of the regulation, the report recommends that the definition of a self-priming pump is: *a pump that moves clean water and which can start and/or operate also when only partly filled with water and which its intended use is pumping clean water.*
- The absence of multistage horizontal pumps. Many vertical multistage pumps can be installed horizontally, and be used for the same purposes.

### Extended Product Approach

The EcoDesign Pump Review includes a recommendation for an extended product approach (EPA) for pumps, where efficiency of a pump unit as a whole, comprising of a bare shaft pump, motor and variable speed drive (VSD) (if applied) is considered. Currently the standards apply to the bare shaft pump only.

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<sup>24</sup> EcoDesign Pump Review - <https://www.ecopumpreview.eu/>

Europump, which represents the pump manufacturing industry in Europe, has also proposed an Energy Efficiency Index (EEI) to evaluate the energy efficiency of products considered under an EPA<sup>25</sup>.

## US Standards

The US Department of Energy standard came into effect on 27 January 2020. Its pump classifications are similar to that of the EU, including:

- **End Suction, Close Coupled (ESCC)**
- **End Suction, Own Bearings (ESFM)**
- **In Line (IL)**
- **Radially Split, Multistage, Vertical, In-line Diffuser Casing (RSV)**
- **Submersible Turbine (VTS)**

The US standard prescribes a minimum efficiency requirement known as the Pump Efficiency Index (PEI). The PEI is the ratio of the weighted averages of:

- the pump input power (with or without variable speed controls) at load points of 75%, 100% and 110% of BEP, and
- the input power for a pump of the same characteristics that is minimally compliant with standard, serving the same hydraulic load.

The PEI method requires significant testing, measurement and calculation. The standard uses the test method specified in the Hydraulic Institute (HI) Standard 40.6-2016, "*Hydraulic Institute Standard for Method for Rotodynamic Pump Efficiency Testing*", which is harmonised with ISO 9906.

## Learnings from the US

The US Department of Energy uses four screening factors to determine if a technology option is suitable for consideration in standards rulemaking. If a technology option fails any of the tests it is not considered further.

These factors are:

1. Technological feasibility: technologies incorporated in commercial products or in working prototypes will be considered technologically feasible.
2. Practicability to manufacture, install and service: if mass production of a technology in commercial products and reliable installation and servicing of the technology could be achieved on the scale necessary to serve the relevant market at the time of the effective date of the standard, then that technology will be considered practicable to manufacture, install and service.
3. Adverse impacts on product utility or product availability.

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<sup>25</sup> A pump is not a light bulb, Europump - <https://europump.net/uploads/news/Europump%20-%20Press%20Release%20-%20The%20Extended%20Product%20Approach%20-%20a%20pump%20is%20not%20a%20light%20bulb%20-%20January%202020.pdf>

#### 4. Adverse impacts on health or safety.

On this basis, the US Department of Energy ruled out the following technologies as being appropriate for inclusion in their pumps standard:

- Improved surface finish on wetted components
- Reduced running clearances
- Reduced mechanical friction in seals
- Addition of variable speed drives
- Improvement of variable speed drive efficiency
- Reduced variable speed drive standby and off mode power usage.

Improved hydraulic design was included as it met all four screening factors. It was not expected to increase the production or purchase costs of the pump impeller or pump volute. The US Department of Energy noted, however, that hydraulic redesign would lead to significant conversion costs for manufacturers as they bring their pumps into compliance with the standard. These costs include product conversion costs (research, development, testing, marketing and other non-capitalised costs) and capital conversion costs (investment in new plant and equipment), which are necessary facilities to manufacture new product designs.

While the *GEMS Act 2012* is technology agnostic on how a product meets performance requirements, it is important to note the findings of the US Department of Energy when determining potential impacts of testing and standards.

### PRC Standards

PRC has a mandatory energy efficiency standard for industrial clean water centrifugal pumps (GB 19762-2007). The standard covers single-stage single-suction, single-stage double-suction and multi-stage centrifugal pumps.

Based on the nominal rated flow and motor specific speed, pumps are classified into the minimum allowable values of energy efficiency.

PRC is currently revising the standard. The pump types and sizes covered by revised version of GB 19762 will differ from those covered by the European standard EN 16480-2016.

## 4. Further Questions for Stakeholders

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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<sup>26</sup>.

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.

### Pump Market

1. Is the market data presented in the discussion paper representative of the Australian and/or New Zealand pump market(s)? Are you aware of other data sources?
2. Could you provide an estimate of your business' annual turnover and market share for pumps in Australia and New Zealand?
3. What is the approximate number of staff employed by your business?
4. Approximately how many pump models does your company supply? How are models defined (e.g. by size, configuration)? Are you able to give information on their specifications?
5. How do you determine model numbers? Is the model number found on the pump unit itself?
6. When pump 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?
7. How many of your pump products are manufactured in Australia or New Zealand? If not, from where do you import your products? If not, where do you source your products and why?

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<sup>26</sup> <https://www.industry.gov.au/data-and-publications/privacy-policy>

8. Are you able to provide annual sales data? Can you provide an estimate of the ratio of pump replacements vs new installations?
9. What are the typical avenues for selling pumps? Are they direct to customer (online or in-store), or indirectly through wholesalers or engineering services? Can you provide approximate breakdown of the percentages?
10. Are you aware of any direct importing of pumps for use for a commercial purpose? Can you provide examples for this type of supply?
11. Is there a market for small scale suppliers to import and sell pumps directly, in competition to you, via online platforms such as eBay or Alibaba? What is your estimate of the market share?
12. Do unit costs vary as pumps become more energy efficient? If so, how?

## Standards

1. Are you aware of the EU 547/2012 standards for pump efficiency?
2. Regarding AS ISO 9906:2018, what grade are your products are tested to, or what certification do your suppliers provide to you? What test methods are used by your company and your suppliers? Are you able to provide some examples of test certificates/charts for your products that the department could use in its analysis?
3. Which international pump standards are your company's products subject to?

## Technology

1. Are there any pump technologies not included in the discussion paper?
2. Do you agree with the typical lifespan of pumps highlighted above (10 years)? What age do you typically see pumps being retired/replaced?

## Efficiency Information

1. Are operators of pumps typically aware of the energy use of pumping systems?
2. Has your business accessed any programs for improving pump efficiency? If so, could you provide details?
3. Do you/your suppliers provide information on the energy efficiency of pumps you supply? Do customers typically request this?
4. What are typical product development costs for Australian and New Zealand pump businesses?

# Appendix 1. Technical Working Group Responses

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This section summarises the TWG’s views and recommendations.

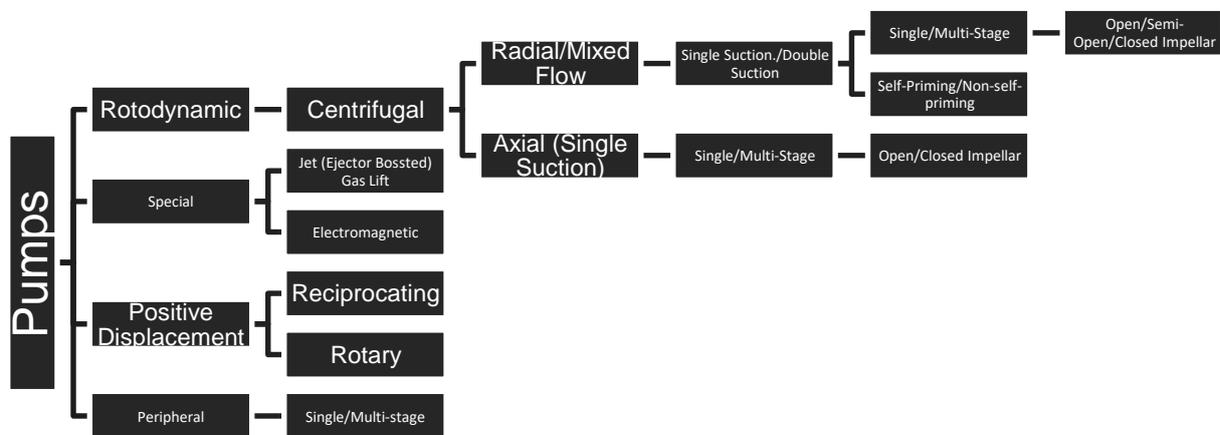
## Pump Market Overview

The TWG noted the lack of comprehensive, consolidated industry data and relied on either internal or propriety data sources, or inferred information to form a view of the market. The TWG noted that the Australian market is considered more resource and infrastructure sector based, whilst the New Zealand market has a predominant focus in agriculture and process applications.

## Pump Technology

The description of pump technologies in section 3.2 were generally considered appropriate for the types of pumps used in Australian and New Zealand applications. However, the Pump Industry Association provided an alternative classification for pumps, shown in Figure 5, which expands on centrifugal pumps and adds special pumps.

**Figure 5 Pump Industry Association alternative pump classifications**



## Current Approach

Stakeholders agreed that the list of standards identified were the most relevant to pumps in Australia and New Zealand. It was noted that the Australian National Construction Code (NCC) introduced new requirements for pumps and pumped systems in air-conditioning applications in 2019. The final requirements, which were different to those initially proposed, align with European Union Commission Regulations discussed in this paper. The NCC’s approach includes a performance-based trade off within the ‘Deemed-to-Satisfy’ provisions, whereby pump efficiencies can be below the nominated levels if this energy is saved elsewhere in the pump system.

The NCC only applies to new buildings in Australia, and while consideration of the alignment of MEPS with the NCC is important, consideration must also be given to the New Zealand market which has no equivalent building code requirements for energy efficiency.

## Technical Working Group Recommendation

The TWG recommends that a MEPS option be investigated for electric driven rotodynamic pumps used in commercial and industrial applications in Australia and New Zealand. This would be applied at point of sale for new pumps only and would not affect pumps already installed.

The TWG also recommended investigating the adoption of the hydraulic pump efficiency test methods in the European Union Commission Regulation No. 547/2012 utilising AS/ISO 9906: 2018 as the basis of testing.

Consideration should be given to extending the original proposed pump types to include horizontal multistage pumps and booster sets as identified by the EU in their work on the review and revision of the Commission Regulation (EU) No. 547/2012.

Consideration should include an assessment of various efficiency levels. However, due to the large quantity of imported products from Europe, the United States and China, it is considered impractical to impose higher efficiency requirements than those applied in these markets.

Consideration could also be given to an extended product approach as proposed by the EU using an Energy Efficiency Index (EEI) for pump units.

# Appendix 2. European Union Standards

European Union Commission Regulation No. 547/2012 published in June 2012<sup>27</sup> covers the EcoDesign requirements for water pumps. Under the EU regulation, a broad range of rotodynamic water pumps became subject to energy performance standards.

The full range of products covered under the EU regulations are given in the following table.

## EU Regulation No 547/2012

Pump Type	Performance Characteristics	Required Standard
<b>End suction, own bearing (ESOB):</b> An end suction water pump with its own bearings.	Glanded, single stage, end suction rotodynamic pump for <ul style="list-style-type: none"> <li>pressures up to 16 bar,</li> <li>specific speed <math>n_s</math> between 6 and 80 RPM,</li> <li>min flow rate of 6m<sup>3</sup>/h,</li> <li>max shaft power of 150W,</li> <li>max head 90m at 1450 RPM</li> <li>max head of 140m at 2900 RPM</li> </ul>	<ul style="list-style-type: none"> <li>Minimum efficiency at the BEP of at least minimum required BEP using C value for MEI 0.4</li> <li>Minimum efficiency at part load of at least minimum required PL using C for MEI 0.4</li> <li>Minimum efficiency at overload of at least minimum required OL using C for MEI 0.4</li> </ul>
<b>End suction, close coupled (ESCC):</b> An end suction water pump, in which the motor shaft is extended to become the pump shaft.		
<b>End suction, close coupled inline (ESCCI):</b> An end suction water pump, in which the water inlet of the pump is on the same axis as the water outlet.	Glanded, single stage, end suction rotodynamic pump for <ul style="list-style-type: none"> <li>pressures up to 16 bar,</li> <li>specific speed <math>n_s</math> between 6 and 80 RPM,</li> <li>min flow rate of 6m<sup>3</sup>/h,</li> <li>max shaft power of 150W,</li> <li>max head 90m at 1450 RPM</li> <li>max head of 140m at 2900 RPM</li> </ul>	
<b>Vertical multistage (MS-V):</b> A glanded multi stage rotodynamic pump in which the impellers are assembled on a vertical rotating shaft.	Glanded, multi stage ( $i>1$ ), rotodynamic pump with impellers assembled vertically for <ul style="list-style-type: none"> <li>pressures up to 25 bar,</li> <li>max flow rate of 100m<sup>3</sup>/h,</li> <li>max shaft power of 150W,</li> <li>nominal speed of 2900 RPM</li> </ul>	
<b>Submersible multistage (MSS):</b> A multistage rotodynamic water pump designed to be operated in a bore hole.	Submersible, multi stage ( $i>1$ ), rotodynamic pump with nominal outer diameter of 4" or 6" designed to be operated in a borehole <ul style="list-style-type: none"> <li>nominal speed of 2900 RPM</li> <li>temperature between 0°C and 90°C</li> </ul>	
<b>Exclusions</b> <ul style="list-style-type: none"> <li>pumps designed for operating at temperatures &lt; 10°C or &gt; 120°C</li> <li>firefighting pumps</li> <li>displacement water pumps</li> <li>self-priming water pumps</li> </ul>		

<sup>27</sup> Ecodesign requirements for water pumps - <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32012R0547>

The EU standard, which currently applies to the pump only (excluding the driver/motor), requires the hydraulic pump efficiency to be calculated at the best efficiency point (BEP) for the specified duty and at part load and overload for the best efficiency point. The minimum efficiency requirement at the BEP is given by the following equation for a given minimum efficiency index (MEI):

$$(\eta_{BEP})_{\min \text{ requ}} = 88.59 \times \ln(n_s) + 13.36 \times \ln(Q) - 11.48 \times (\ln(n_s))^2 - 0.85 \times (\ln(Q))^2 - 0.38 \times \ln(n_s) \times \ln(Q) - C_{\text{Pump Type, rpm}}$$

Where:

Q = flow in m<sup>3</sup>/h

n<sub>s</sub> = specific speed in min<sup>-1</sup>

C = value specified in the Table below, and depends on the pump type, nominal speed and MEI value

Pump Type, Rotation Speed (rpm)	C Value for MEI > 0.40 (Standard Efficiency)	C Value for MEI >0.70 (Best Practice)
ESOB, 1450	128.07	124.85
ESOB, 2900	130.27	127.06
ESCC, 1450	128.46	125.46
ESCC, 2900	130.77	127.75
ESCCi, 1450	132.30	128.98
ESCCi, 2900	133.69	129.83
MS-V, 2900	133.95	130.37
MSS, 2900	128.79	123.84

The minimum requirements for part load and overload are:

$$(\eta_{PL})_{\min \text{ requ}} = 0.947 \times (\eta_{BEP})_{\min \text{ requ}}$$

$$(\eta_{OL})_{\min \text{ requ}} = 0.985 \times (\eta_{BEP})_{\min \text{ requ}}$$

The Minimum Efficiency Index (MEI) values are derived from the percentage of the market that would be deemed compliant at the efficiency level (for example, an MEI of 0.4 means 40% of pumps on the market at the time of development of the standards would fail).

The current level of MEI required by the EU is MEI>0.4, with best in market currently any pump that meets an MEI>0.7.

The standards apply to pumps used with clean water which is defined as a liquid having a:

- Maximum non-absorbent free solid content less than 0.25 kg/m<sup>3</sup>;
- Maximum dissolved solid content less than 50 kg/m<sup>3</sup>, provided that the total gas content of the water does not exceed the saturation volume; and a
- Fluid temperature range between -10°C and 120°C.

## Circulators

European Union Commission Regulation No. 641/2009<sup>28</sup> and 622/2012<sup>29</sup> cover the EcoDesign requirements of circulators. Circulators are impeller pumps with or without a pump housing designed for use in heating systems or secondary circuits of cooling distribution systems.

EU Regulation No 622/2012 (replaces EU Regulation 641/2009)

Pump Type	Performance Characteristics	Required Standard
Circulators	Glandless and glandless standalone circulators with rated hydraulic output between 1W and 2.5kW designed for use in heating systems or in secondary circuits of cooling distribution systems.	<ul style="list-style-type: none"><li>Glandless standalone circulators with the exception of those specifically designed for primary circuits of thermal solar systems and of heat pumps, shall have an energy efficiency index (EEI) of not more than 0.27, calculated in accordance with Annex II point 2.</li><li>Glandless standalone circulators and glandless circulators integrated into products shall have an energy efficiency index (EEI) of not more than 0.23 calculated in accordance with Annex II point 2.</li></ul>

<sup>28</sup> Ecodesign requirements for water pumps - <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32009R0641>

<sup>29</sup> Ecodesign requirements for circulators - [https://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/ecodesign/circulators\\_en](https://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/ecodesign/circulators_en)

## Revised European Commission Regulations

The European Union released an extended report of the EcoDesign Pump Review<sup>30</sup> in January 2019 and a draft Commission Regulation for the EcoDesign requirements of water pumps and pump units.

The report recommends the following pump definitions as part of the final scope to be covered by the regulation:

**End suction own bearing pumps (ESOB):** A glanded single stage end suction rotodynamic water pump with own bearing designed for a maximum shaft power up to 150 kW, which does not have a self-priming function and which its intended use is pumping clean water.

**End suction close coupled pumps (ESCC):** A glanded single stage end suction rotodynamic water pump of which the motor shaft is extended to also become the pump shaft, designed for a maximum shaft power up to 150 kW, which does not have a self-priming function and which its intended use is pumping clean water.

**End suction close coupled inline pumps (ESCCi):** A glanded single stage end suction rotodynamic water pump of which the water inlet of the pump is on the same axis as the water outlet of the pump, which does not have a self-priming function and which its intended use is pumping clean water.

**Submersible borehole multistage pumps (MSSB):** A multi stage ( $i > 1$ ) rotodynamic water pump, designed to be operated in a borehole at operating temperatures within a range of 0-90 degrees C, designed with a nominal outer diameter up to 6" which does not have a self-priming function and which its intended use is pumping clean water.

**Vertical multi-stage pumps:** A glanded vertical multistage ( $i > 1$ ) rotodynamic water pump in which the impellers are assembled on a rotating shaft, which is designed for pressures up to 40 bar, which does not have a self-priming function and which its intended use is pumping clean water.

**Horizontal multi-stage pumps:** A glanded horizontal multistage ( $i > 1$ ) rotodynamic water pump in which the impellers are assembled on a rotating shaft, which is designed for pressures up to 40 bar, which does not have a self-priming function and which its intended use is pumping clean water.

**Self-priming water pump:** A pump that moves clean water and which can start and/or operate also when only partly filled with water and which its intended use is pumping clean water.

**Booster-set:** A booster-set is either a single pump or an assembly of parallel connected pump units with a maximum shaft power of 150 kW to be operated with backflow prevention and additional components influencing hydraulic performance and components necessary to control pressure in open loops inside buildings and which is placed on the market and/or put into service as one single product and its intended use is to pump clean water.

**Swimming pool pumps:** A small pump packaged in plastic comprising an integrated unit of motor, pumps and controls typically with a maximum shaft power of 2.2 kW (with built-in strainer) and designed specifically for pumping swimming pool water for circulation and filtration.

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<sup>30</sup> EcoDesign Pump Review - <https://www.ecopumpreview.eu/>

**Centrifugal submersible radial vortex wastewater pumps:** A rotodynamic water pump that has a radial inflow and a vortex impeller and it is designed to operate under water with a maximum shaft power of 160 kW, and which its intended use is to pump wastewater. A vortex impeller is an impeller that drives the flow by creating a whirlpool.

**Centrifugal submersible channel radial wastewater pumps:** A rotodynamic water pump that has a radial flow and an impeller inside the flow channel with a maximum shaft power of 160 kW and it is designed to operate under water, and which its intended use is to pump wastewater.

The proposed revision requirements are summarised in the table below:

Pump Type	Performance Characteristics
<b>End suction, own bearing (ESOB):</b> An end suction water pump with its own bearings.	Glanded, single stage, end suction rotodynamic pump for <ul style="list-style-type: none"> <li>• pressures up to 16 bar,</li> <li>• specific speed <math>n_s</math> between 6 and 80 RPM,</li> <li>• min flow rate of 6m<sup>3</sup>/h,</li> <li>• max shaft power of 150W,</li> <li>• max head 90m at 1450 RPM</li> <li>• max head of 140m at 2900 RPM</li> </ul>
<b>End suction, close coupled (ESCC):</b> An end suction water pump, in which the motor shaft is extended to become the pump shaft.	
<b>End suction, close coupled inline (ESCCi):</b> An end suction water pump, in which the water inlet of the pump is on the same axis as the water outlet.	Glanded, single stage, end suction rotodynamic pump for <ul style="list-style-type: none"> <li>• pressures up to 16 bar,</li> <li>• specific speed <math>n_s</math> between 6 and 80 RPM,</li> <li>• min flow rate of 6m<sup>3</sup>/h,</li> <li>• max shaft power of 150W,</li> <li>• max head 90m at 1450 RPM</li> <li>• max head of 140m at 2900 RPM</li> </ul>
<b>Vertical multistage (MS-V):</b> A glanded multi stage rotodynamic pump in which the impellers are assembled on a vertical rotating shaft.	Glanded, multi stage ( $i>1$ ), rotodynamic pump with impellers assembled vertically for <ul style="list-style-type: none"> <li>• pressures up to 25 bar,</li> <li>• max flow rate of 100m<sup>3</sup>/h,</li> </ul>
<b>Horizontal multistage (MS-H)</b> A glanded multi stage rotodynamic pump in which the impellers are assembled on a horizontal rotating shaft	Glanded, multi stage ( $i>1$ ), rotodynamic pump with impellers assembled horizontally for <ul style="list-style-type: none"> <li>• pressures up to 25 bar,</li> <li>• max flow rate of 100m<sup>3</sup>/h,</li> </ul>
<b>Submersible multistage (MSS):</b> A multistage rotodynamic water pump designed to be operated submersed.	Submersible, multi stage ( $i>1$ ), rotodynamic pump with nominal outer diameter of 2.5" (63.5 mm) or 6" (152.4 mm) designed to be operated submersed <ul style="list-style-type: none"> <li>• nominal speed of 2900 RPM</li> <li>• temperature between 0°C and 90°C</li> <li>• nominal flow rate &gt; 1.75 m<sup>3</sup>/h</li> </ul>
<b>Booster Set:</b> Single water-pump unit or an assembly of water-pump units connected in parallel.	

The proposed revision includes the following 'Energy Efficiency Requirements of Water Pumps':

From 01/01/2022, water pumps shall have:

- a minimum efficiency at the best efficiency point (BEP) of at least  $(\eta_{\text{BEP}})_{\text{min requ}}$  when measured according to Annex III and calculated with the C-value for MEI – 0.4, according to Annex III
- a minimum efficiency at part load (PL) of at least  $(\eta_{\text{PL}})_{\text{min requ}}$  when measured according to Annex III and calculated with the C-value for MEI – 0.4, according to Annex III
- a minimum efficiency at over load (OL) of at least  $(\eta_{\text{OL}})_{\text{min requ}}$  when measured according to Annex III and calculated with the C-value for MEI – 0.4, according to Annex III

# Appendix 3: United States Standards

The U.S. Department of Energy (DOE) standard<sup>31</sup> came into effect on 27 January 2020.

It specifies the following requirements for pumps:

Pump Type	Performance Characteristics	2020
End Suction Close Coupled (ESCC)	<ul style="list-style-type: none"> <li>25 gallons per minute (5.652 m<sup>3</sup>/h)</li> <li>459ft head (140m)</li> <li>Specific speed less than 5000 (in US customary units)</li> </ul>	Compliant if PEI is less than or equal to 1 for given C value
End Suction Frame Mounted / Own Bearings (ESFM)	<ul style="list-style-type: none"> <li>25 gallons per minute (5.652 m<sup>3</sup>/h)</li> <li>459 ft head (140m)</li> <li>Specific speed less than 5000 (in US customary units)</li> </ul>	Compliant if PEI is less than or equal to 1 for given C value
In Line (IL)	<ul style="list-style-type: none"> <li>25 gallons per minute (5.652 m<sup>3</sup>/h)</li> <li>459 ft head (140m)</li> </ul>	Compliant if PEI is less than or equal to 1 for given C value
Radially Split, Multistage, Vertical, In-line Diffuser Casing (RSV)	<ul style="list-style-type: none"> <li>25 gallons per minute (5.652 m<sup>3</sup>/h)</li> <li>459 ft head (140m)</li> </ul>	Compliant if PEI is less than or equal to 1 for given C value
Submersible Turbine (VTS)	<ul style="list-style-type: none"> <li>25 gallons per minute (5.652 m<sup>3</sup>/h)</li> <li>459 ft head (140m)</li> <li>Bowl diameter less than 6"</li> </ul>	Compliant if PEI is less than or equal to 1 for given C value

Exclusions from the US Standards:

- Fire pumps
- Self-priming pumps
- Prime-assist pumps
- Magnet drive pumps
- Pumps for nuclear facilities
- Pumps meeting military specifications

The US Standards apply to pumps used with clean water which is defined as a liquid having a:

- free solid content less than 0.25 kg/m<sup>3</sup>
  - dissolved solid content less than 50kg/m<sup>3</sup>
- fluid temperature range between -10°C and 120°C.

<sup>31</sup> Energy Conservation Program: Energy Conservation Standards for Pumps - <https://www.energy.gov/sites/prod/files/2015/12/f28/Pumps%20ECS%20Final%20Rule.pdf>

# Appendix 4. Pump Requirements in the National Construction Code 2019

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## J5.7 Pump systems <sup>32</sup>

- (a) **General** — Pumps and pipework that form part of an air-conditioning system must either—
- (i) separately comply with (b), (c) and (d); or
  - (ii) achieve a pump motor power per unit of flowrate lower than the pump motor power per unit of flowrate achieved when applying (b), (c) and (d) together.
- (b) **Circulator pumps** — A glandless impeller pump, with a rated hydraulic power output of less than 2.5 kW and that is used in closed loop systems must have an energy efficiency index (EEI) not more than 0.27 calculated in accordance with European Union Commission Regulation No. 622/2012.
- (c) **Other pumps** — Pumps that are in accordance with Articles 1 and 2 of European Union Commission Regulation No. 547/2012 must have a minimum efficiency index (MEI) of 0.4 or more when calculated in accordance with European Union Commission Regulation No. 547/2012.
- (d) **Pipework** — Straight segments of pipework along the index run, forming part of an air-conditioning system—
- (i) in pipework systems that do not have branches and have the same flow rate throughout the entire pipe network, must achieve an average pressure drop of not more than—
    - (A) for constant speed systems, the values nominated in Table J5.7a; or
    - (B) for variable speed systems, the values nominated in Table J5.7b; or
  - (ii) in any other pipework system, must achieve an average pressure drop of not more than—
    - (A) for constant speed systems, the values nominated in Table J5.7c; or
    - (B) for variable speed systems, the values nominated in Table J5.7d.

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<sup>32</sup> Table references are from the NCC 2019 Building Code of Australia - Volume One and omitted here for brevity