Mt Piper Energy Recovery Project

Knowledge Sharing Report

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Executive Summary

Purpose of this report

EnergyAustralia and Re.Group are proud to publish this Knowledge Sharing Report (KSR) in order to demonstrate the final outcomes of the feasibility assessment of the Mt Piper Energy Recovery Project (the Project). The report is a requirement of the funding assistance ARENA provided to carry out the feasibility assessment.

As the report will be the first published detailed document about the Project, it provides information to assist all interested stakeholders and communities understand the intention and nature of the Project, and the processes to which its final approval and implementation will be subject to.

Purpose of the proposed energy recovery project

The Mt Piper power station in the Lithgow local government area is owned by EnergyAustralia and has a 1400 Megawatt (MW) capacity providing about 12 percent of NSW's energy supply. To produce this energy Mt Piper uses about 12,000 tonnes of coal per day.

The key purpose of the Project is to enable Mt Piper to improve the efficiency of the use of its coal supply so that:

- Its coal needs are sustainable regardless of changes in the coal supply market; and
- EnergyAustralia can reduce the carbon emissions profile of the power station in a manner which is consistent with its commitments to maintain the viability of Mt Piper and transition its business to a clean energy future providing reliable and affordable power.

Nature of the proposed energy recovery project

To achieve the Project's key purposes EnergyAustralia has formed a joint venture with one of Australia's leading recycling companies, Re.Group. Together the companies have assessed the feasibility of the Project's capacity to use refuse derived fuel (RDF) to improve the efficiency of the power station.

The Project proposes to construct a standalone RDF boiler facility on the Mt Piper site, adjacent to and integrated with the existing Unit 2 coal fired boiler at the power station. The RDF boiler would use a modern combustion process and advanced emissions control system to produce steam to provide additional energy input to the power station. This would enable the power station to improve the efficiency of coal usage to produce the electricity required by the electricity grid.

RDF is a solid fuel engineered from unrecyclable waste, like plastics, paper and textiles. RDF has roughly two-thirds the heat content of black coal. RDF is commonly used in energy from waste (EfW) technologies and processes in the European Union and United States. The RDF and EfW concepts are discussed in more detail in the Fuel Considerations section of this report.

Mt Piper would NOT receive or 'incinerate' unprocessed mixed waste, as incineration of unprocessed waste has been illegal in NSW for 17 years. Nor will Mt Piper produce RDF on site. Instead Mt Piper would receive RDF produced elsewhere by Environment Protection Authority (EPA) licensed waste sorting facilities. This RDF would be transported to Mt Piper by truck.

Conclusions of the Feasibility Study

The feasibility assessment has identified that the Project is economically and technically viable. The next stage consists of further engineering work and environmental studies to define the Project and its environmental impacts.

Factors that directly contribute to the Project's feasibility include:

- The NSW landfill levy system. Currently recycling companies such as Re.Group must pay the levy for each tonne of unrecyclable waste they need to send to landfill. The Project provides an alternative approach because it offers the joint venture company the opportunity to earn a "gate fee" for accepting the unrecyclable waste and utilising it in an energy recovery service
- The availability of technology to separate recyclable and organic waste and create a fuel from the unrecyclable waste that remains.

Recyclable and organic wastes have established markets and it would be economically inefficient for an EfW process to use this waste.

- The ready availability of a steam "host" to take the RDF and transform it into useful energy that can then be monetised as electricity in the National Electricity Market. The Project would consume about 200,000 tonnes of RDF per year in the dedicated RDF boiler, translating to a thermal capacity of 87 MW. Taking into account the efficiency of the existing Mt Piper turbine, this equates to an electrical capacity of 27 MWe or around 220,000 MWh, the annual energy use of around 40,000 homes.
- It is beneficial that the Project is occurring at an existing 'brownfield' site rather than at a new 'greenfield' site. This reduces the capital investment required, because of the ability to utilise existing equipment. In addition, the existing power station would already be managing a range of environmental and other operational issues relevant to the integration of the RDF boiler, which reduces overall operating costs.

Potential benefits of the proposed energy recovery project

If the Project proceeds it creates the opportunity for a range of direct and indirect national, state and local benefits.

Securing reliable energy supply

Volatility in the supply and price of coal can create risks for long term viability of power stations, like Mt Piper. Other risks can arise from increasing demands from consumers and financiers for greener energy production.

The Project assists to manage these risks because it enables Energy Australia to produce additional electricity from a reliable, dispatchable renewable source and this helps to improve the efficiency of its NSW energy supply production.

Recovering and reusing unrecyclable waste instead of landfilling it

The Project can provide direct benefits to the circular economy, which is one in which the recycling and reuse of waste products are being maximised to reduce waste, business input costs and emissions and stimulate new opportunities in the green economy.

Currently, in mixed waste recycling facilities in NSW, between 30 and 50 percent of received waste is not recoverable. This is because technology does not exist to recycle items like soiled paper, plastic bags that have been used as bin liners or textiles that have been mixed into general waste. Other examples of unrecyclable waste include wood, rubber, plastic items like toys and post mix cups.

The Project assists to solve the environmental problems created by unrecyclable waste by diverting about 200,000 tonnes of unrecyclable waste per year away from landfill and towards reuse as RDF.

Generating renewable energy

The steam generated by the RDF boiler converts into around 220,000 megawatt hours (MWh) of electricity per year. This is equivalent to the energy requirements of around 40,000 NSW households, equivalent to the Blue Mountains and Lithgow council areas combined[1].

The Renewable Energy Act allows for the creation of renewable energy certificates from the biomass portion of the incoming RDF. It is estimated that roughly a third of the RDF constitutes biomass, predominantly wood, natural textiles and unrecyclable paper – all items originally created from plant material. This means that roughly 75,000 MWh per year of renewable energy will be produced and can contribute to the meeting of the Renewable Energy Target (the RET) or otherwise be used to supply voluntary GreenPower requirements.

[1] Source: http://profile.id.com.au/ - 2016 Census: 34,182 dwellings in Blue Mountains LGA, 9,709 dwellings in Lithgow LGA.

Reducing carbon emissions

It is estimated that the Project would result in a net reduction of greenhouse gases of more than 200,000 tonnes per year compared to the combined effect of:

- The offsetting electricity produced from fossil fuels elsewhere on the grid; and
- Landfill emissions created by landfilling the 200,000 tonnes of unrecyclable waste per year that is needed to produce the RDF. This is because the Project avoids the creation of methane in landfills associated with that waste. Methane is a potent greenhouse gas 25 times more impactful as a pollutant in the atmosphere than carbon dioxide.

Based on Australian Government calculations it is estimated that the Project would represent the same carbon intensity as a gas fired power station.

It is expected that the Project might also earn carbon credits under the Direct Action Policy and the associated Emissions Reduction Fund The Australian Carbon Credit Units (ACCUs) so created could be sold under contract to the Government or alternatively into the secondary market.

Economic benefits

The introduction of a new RDF boiler at Mt Piper is estimated to create about 300 construction jobs and 16 operational jobs.

The Project would represent a capital investment of about $160M and generate an additional estimated $3.7M per year for the local economy.

The reliance of the Project on engineered fuel produced at EPA licensed waste sorting facilities supports employment in the green economy.

Applied international best practice in energy recovery

Deriving energy from waste (EfW), as an alternative to landfilling waste, is widely and increasingly practised in Europe and the United Kingdom. We note that:

- The use of bioenergy and/or EfW represents 2.4% of energy use in Europe but only 0.9% in Australia[2]. Strict European Union regulation about the combustion and emissions control systems for EfW has stimulated new complying technologies which has enabled an uptake in EfW.
- The United Kingdom government assessed the costs and benefits of EfW in 2014 and based on the conclusions of that assessment affirmed its support for EfW[3]. This has assisted the increase in EfW usage in the UK which has tripled from 3.28 million tonnes in 2008 to 9.96 million tonnes in 2016[4].
- RDF is a routinely traded commodity between the UK and mainland Europe.

The NSW Government's EfW Policy[5], which was developed after extensive public consultation, is designed to apply international best practice and the Project is intended to do the same.

Commercial innovation for energy recovery

There are a range of structural barriers to the development of EfW projects in Australia. These are:

- Large geographic distances meaning that it is often difficult to aggregate sufficient waste to support the economies of scale required
- Unlike Europe, no specific support for EfW projects and no markets for low grade heat (such as district heating).

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[2] *The Australian Bioenergy and Energy from Waste Market*, Clean Energy Finance Corporation, 2015
[3] https://www.gov.uk/government/publications/energy-from-waste-a-guide-to-the-debate
[4] http://www.tolvik.com/wp-content/uploads/UK-EfW-Statistics-2016-report-Tolvik-June-2017.pdf
[5] Available at https://www.epa.nsw.gov.au/your-environment/waste/waste-facilities/energy-recovery

- Low or non-existent landfill levies mean that it is often cheaper to send unrecyclable waste to landfill and this discourages investment in technologies and projects to reuse, recycle or convert waste into fuel.

The Project represents an innovative approach to overcome these structural and commercial barriers to EfW.

Independent planning and environmental assessment process

The completed feasibility assessment recommends that the Project should move to the planning and environmental assessment process governed under NSW legislation.

The requirements for the preparation of an Environmental Impact Statement (EIS) were issued by the NSW Department of Planning and Environment in 2017. The preparation of an EIS is expected to be completed by mid-2018.

Extensive community consultation will occur as part of the planning and environmental assessment process.

If the Project is approved, it may be subject to a range of conditions to ensure it complies with NSW Government regulations governing the Mt Piper power station, EfW processes and technologies, RDF engineering, production and transport, environmental management, emissions control and monitoring and other issues.

Introduction

About EnergyAustralia

EnergyAustralia is one of Australia's largest energy retailers, providing gas and electricity to 2.6 million household and business customer accounts in New South Wales, Victoria, Queensland, South Australia and the Australian Capital Territory. EnergyAustralia owns and operates a portfolio of energy generation across Australia, including coal, gas and wind assets with capacity of more than 4,500 MW.

Headquartered in Melbourne, EnergyAustralia is a wholly-owned subsidiary of CLP Group, one of the largest publicly-owned integrated power businesses in the Asia Pacific.

In December 2016, EnergyAustralia announced a $1.5 billion program to underpin wind and solar projects across eastern Australia, a commitment that has identified more than 500 MW of new renewable energy capacity to date. In 2017, EnergyAustralia announced studies to investigate new cleaner-energy technologies, including this Energy Recovery Project and a seawater pumped hydro project in the Spencer Gulf of South Australia.

About Re.Group

Re.Group is an Australian privately-owned company focused on providing high quality services for the recovery and recycling of resources from waste. Re.Group's vision is to create a wasteless society; where all resources that become waste are reused and are not disposed. The company seeks to realise this vision by developing, owning, operating, funding, and improving infrastructure that enables this — facilities that target 100 per cent diversion away from landfill into positive re-use, recycling and recovery operations.

About Mt Piper Power Station

EnergyAustralia acquired the Mt Piper power station, located near Lithgow in central west New South Wales, from the NSW State Government in 2013. Mt Piper is one of the State's newest, most reliable and efficient black coal plants. It supports about 300 direct jobs and provides reliable and affordable supplies of electricity at a time when cleaner supplies of energy are being integrated into Australia's system. Built over two stages in 1992 and 1993, the plant is made up of two 700 MW coal fired steam turbine generators, which can supply up to 15 per cent of the State's electricity.

Feasibility Study Methodology

The feasibility study assessed the technical, commercial, financial and environmental/planning aspects of the proposed Project. Each of these aspects is discussed in detail within this report, but a summary is provided below.

Technical

- A pre-feasibility study was undertaken to test the high-level concept of integrating an auxiliary RDF-fired boiler with Unit 2 of the existing Mt Piper Power Station;
- Technical engineering feasibility was performed by Aurecon, in consultation with Mt Piper boiler, turbine, and controls subject matter experts, to confirm the mass and heat balances and thermal efficiency of the proposed Project;
- An Expression of Interest was launched to ascertain appropriate technology providers of RDF-fired boilers and to make a selection through the responses and subsequent clarifications;
- Fuel transport volumes and qualities were also assessed; so that
- The technical feasibility of the Project could be established.

Commercial/Financial

- A financial model was developed to establish the Project's post-tax nominal rate of return;
- Assumptions for key parameters such as gate fee, energy offtake price, capital and operating costs were established;
- Potential sources of debt and equity were considered; and
- The overall viability of the Project was then determined.

Environmental/Planning

- A Stakeholder and Communications Plan was developed;
- Initial stakeholder consultation completed, including Lithgow council and Mt Piper Community Reference Group; and
- A Secretary's Environmental Assessment Requirements (SEARS) was requested and received, through which:
    - Statutory and Regulatory approval pathways were identified;
    - Environment assessment requirements were defined; and
    - Initial assessments of the two key environmental issues were conducted: ash reuse or disposal and transport of the fuel from Western Sydney to Mt Piper.

The feasibility study was supported by funding from the Australian Renewable Energy Agency (ARENA). The additional deliverables required by ARENA include:

- Reporting and project management in accordance with the funding agreement milestones;
- A lifecycle analysis (LCA) demonstrating the greenhouse and environmental benefits of the Project, including transport and preparation of the fuel; and
- A knowledge sharing report for publication (this document).

Fuel Considerations

This Project requires around 200,000 t/a of Refuse Derived Fuel (RDF), which will be engineered from unrecyclable waste which would otherwise be disposed to landfills. Re.Group will have the responsibility for sourcing, preparing and supplying RDF for the Project. The RDF supplied to and used by the Project would meet NSW Environment Protection Authority (EPA) regulatory standards and only be engineered in waste sorting plants licensed by the EPA to do so.

RDF is not simply waste. It is a solid fuel made using only a specific portion of the non-recyclable waste stream, which is selected and separated based on mechanical and other properties. RDF comprises mainly non-recycled paper, plastic film and other combustible materials and is manufactured to a specification on calorific value, ash content and other parameters.

While there is more than 250,000 t/a of RDF produced in Australia currently, RDF is a relatively new product here. We note that, in the UK, there has been a well-documented increase in RDF production and export during the past five years, from less than 200,000 tonnes in 2011 to more than 3 million tonnes in 2016[6]. In Europe, RDF is produced, traded and consumed in the millions of tonnes each year, and is treated in many ways as a commodity fuel.

More than 800,000 t/a of potential fuel has been identified within an economic catchment within Sydney and nearby regions. This fuel has the potential to come on stream as the number of facilities utilising RDF as a fuel come online.

Energy From Waste Overview

The Australian waste industry encompasses collection, transportation, processing, recycling and the disposal of unwanted by-products from commercial, industrial and domestic household activities. *The Inside Waste Industry Report 2014-15* shows 53.5 million tonnes of waste was

[6] https://www.environmental-expert.com/news/rdf-exports-at-around-3m-tonnes-in-2016-689140

generated across Australia in 2013-14, of which 21.5 million tonnes (40%) was disposed to landfill while 31.9 million tonnes (60%) was recycled.[7]

The economic value of waste-related activities in Australia is estimated to be $14.2 billion per year[8]. In 2013, analysis by Bank of America Merrill Lynch reported the global waste and recycling industry is worth US$1 trillion annually, and could double to US$2 trillion p.a. within 7 years.[9]

The per capita rate of waste generation in NSW is one of the highest in Australia, and the most populous state accounts for more than one-third of total national waste generation. In 2013-14, 18.9 million tonnes of waste was generated in NSW alone, with 6.5 million tonnes of that (34%) disposed to landfill.

In response to overwhelming international evidence that modern EfW facilities can provide improved resource recovery outcomes[10], while also presenting a very low risk to human health and the environment, Australian jurisdictions (including NSW, VIC, WA and the ACT) have recently moved to enable and encourage the development of modern best practice EfW facilities. A significant example of this is the publication of the *NSW Energy from Waste Policy Statement* in March 2014.

The NSW EfW Policy has two main objectives:

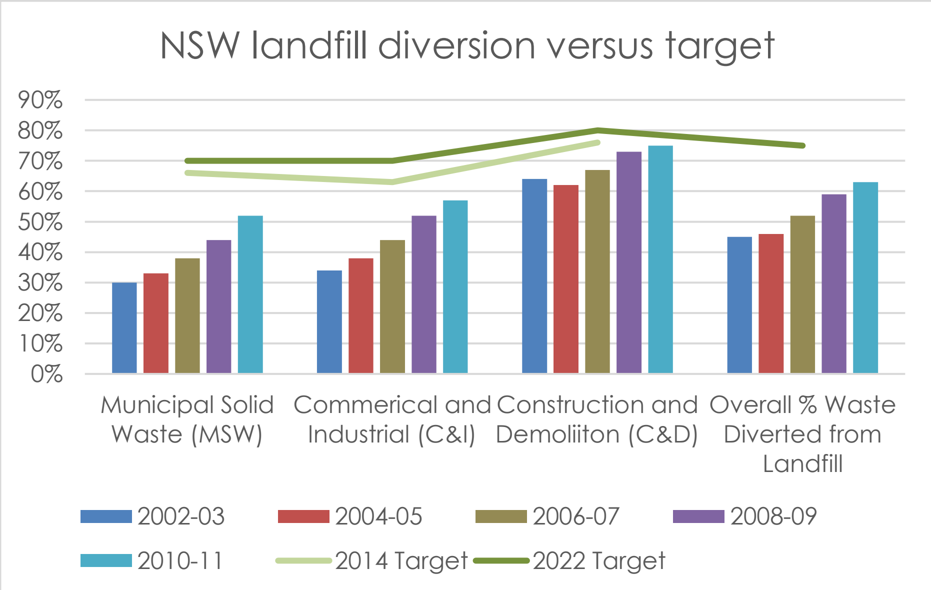
Ensure minimal risk of harm to human health and the environment, which is chiefly achieved through standards applied at the EfW facility, specifying combustion conditions and requiring 'best available technology' is used for emissions control.

Ensure 'higher order' waste management options are not undermined, which is mainly achieved through the introduction of Resource Recovery Criteria that restrict the maximum percentage of the waste stream that can be directed to energy recovery, based on the type of waste and style

[7] Inside Waste Industry Report 2014-15 (http://www.ben-global.com/Waste/insidewastereport.asp)
[8] Inside Waste Industry Report 2014-15 (http://www.ben-global.com/Waste/insidewastereport.asp)
[9] http://www.longfinance.net/images/reports/pdf/baml_waste_2013.pdf
[10] See, for example, the many reports produced by the UK Government on EfW, including https://www.gov.uk/government/publications/energy-from-waste-a-guide-to-the-debate

of collection system used. In brief, RDF cannot be manufactured from a waste stream unless best practice recycling has been conducted first.

The NSW EfW Policy was developed to help enable the State's vision of increasing resource recovery rates beyond current levels. In January 2015, the EPA released the NSW *Waste Avoidance and Resource Recovery Strategy 2014–21*[11], which sets targets to increase recycling and diversion from landfill. The Government's resource recovery targets are shown in the chart below, compared to the historical diversion performance for each of the key waste streams.



As well as developing a clear regulatory framework that supports efforts to increase resource recovery, the NSW Government applies a levy on waste disposal. The Landfill Levy specified under Section 88 of the *Protection of the Environment Operations Act 1997* (*POEO Act*) is the NSW Government's principal tool to encourage resource recovery, by *"providing an economic incentive to reduce waste disposal and stimulate investment and innovation in resource recovery technologies"*.

[11] http://www.epa.nsw.gov.au/resources/wastestrategy/140876-WARR-strategy-14-21.pdf

Fuel sources

Re.Group has identified more than 800,000 t/a of RDF that could be economically sourced (in accordance with the NSW EfW Policy) through the development of Fuel Preparation Facilities. Some of this could be sourced from existing recycling facilities, where waste is already processed and partially recovered, and could come online within a short time. Additionally, more than 500,000 t/a of fuel is available through new 'greenfield' opportunities with waste that is not currently processed at all, which could be developed over the lifetime of the Project.

Flexibility and Non-RDF Fuels

It is important to note that the waste streams used to prepare the fuel will change over the life of the Project, as trends in consumer products trickle down to the waste mix. For example, plastic bag bans in supermarkets may reduce the amount of film plastics disposed.

As such, one of the critical design considerations for the Project will be fuel flexibility, to allow stable, long-term operation even if the fuel characteristics change over time. The two boiler technologies considered for the Project are both capable of handling a wide variety of fuel parameters. The design will be based on an agreed firing diagram and design fuel range. Variation of the fuel within the design range is not expected to significantly impact the Project viability.

Options for blending other fuels will also be investigated during the operation, with the potential to source other biomass fuels subject to appropriate gate fees. The assessment of using fuels that were not considered in the Project approvals, will require additional modelling, monitoring and analysis to confirm that environmental impacts are not increased. The use of any new fuels would require regulatory approval and need to comply with existing or new development conditions.

Transport

A bulk of the RDF is expected to derive from Western Sydney which has a number of EPA licensed resource recovery facilities. This therefore requires the transport of 200,000 t/a of RDF on the M4 and Western Highway through the Blue Mountains to the power station, a journey of just over 100km. Lycopodium was engaged to examine transport options, including truck and rail, and concluded that for this scale (and for any scale up to around a million tonnes per year) trucking was the more cost effective solution. The best available rail option would rely on unloading facilities in Bathurst, and trucks would still be needed from Bathurst to Mt Piper (over 50 km). The transport of this amount of RDF equates to approximately 12 trucks per day in a 6 day per week operation. This is small in the context of the number of westbound truck movements currently across the Blue Mountains of just under 1,000 per day[12].

[12] http://www.rms.nsw.gov.au/about/corporate-publications/statistics/traffic-volumes/aadt-map/index.html - Station Id T0299

Energy Considerations

A transformative shift is underway in the Australian energy market. An underlying trend is for the retirement of coal-fired baseload capacity over time and replacement with renewables (predominantly wind and solar) combined with storage technologies such as batteries and pumped hydro. This trend will take many decades to play out fully but has immediate implications for existing and future energy assets.

As of 2014, demand for centralised power had dropped for five successive years and market prices were depressed to the point ($30-35/MWh) where returns on generation investment were well below industry's cost of capital. In the context of wholesale over-supply, there was no signal for new investment in either capacity or energy other than that driven by the Renewable Energy Target (RET).

However, with the retirement of ageing coal-fired power stations Wallerawang (NSW, 1000MW, 2014), Northern (SA, 540MW, 2016) and Hazelwood (VIC, 1600MW, 2017), the energy market has been fundamentally revalued with dramatically higher wholesale market prices. This has been exacerbated by the tripling of wholesale gas prices in recent times, given that gas has become the replacement fuel for energy previously provided by coal.

This has brought the wholesale market in NSW to $80-100/MWh levels and, along with it, a case for new investment in energy supply. The bulk of this new investment is forecast to be mainly wind and solar projects, many of which are already committed. This investment wave over the next few years has resulted in a declining forward curve for wholesale power, for example, NSW CAL18 is priced at $76/MWh and CAL20 at $72/MWh[13].

In summary, there now appears to be a market environment where additional sources of energy, and especially 'green' energy as would be provided by the Project, can be incentivised. Of course, any significant investment in a project of this nature needs to take a long term, forward-

[13] www.asxenergy.com.au; accessed 22 March 2018

looking perspective on the market, given that the asset would be operating in the market for at least two decades.

Technology Considerations

Introduction

Many coal-biomass hybridisation projects in the past have attempted to add biomass into an existing coal boiler. Rather than take this approach, the Project relies on a separate, dedicated RDF boiler. This has significant advantages over the direct use of RDF in the existing Unit 2 boiler at Mt Piper Power Station, including:

- The RDF boiler is designed specifically for RDF, which has different specifications and characteristics to coal. Use of RDF in the existing boiler would require significant modifications to fuel handling, mills, furnace, boiler and flue gas treatment, and would also result in less efficient conversion of the fuel into steam.
- The RDF combustion technology is established and well proven. Firing of similar solid fuels for steam generation has been in use for more than 100 years, allowing furnace, boiler and flue gas treatment technology to be advanced and refined.
- RDF-related issues such as fuel handling, boiler fouling and boiler corrosion will not impact on the reliability of the existing plant. It is expected that the design will allow the RDF boiler to be brought in and out of service with minimal disruption to normal Mt Piper Power Station operations.
- The RDF boiler will be separately permitted under environmental requirements. In addition, the existing reuse of coal ash can continue without any changes.

Summary of Technology Options

The Project found two categories of combustion technologies that were technically suitable for the Project. The most commonly used modern Energy from Waste combustion technology available is a grate-fired furnace. Another type of combustion system uses furnace bed fluidisation, which occurs when the material to be combusted is added to a bed of sand, with air from below that lifts and circulates the hot sand to keep consistent temperatures throughout the boiler. Both of these technologies are in extensive use across Europe, the UK and North America. We also considered some less common technologies however found these to be technically unsuitable for this project.

These technologies are coupled with a dedicated emissions control system to capture and treat air emissions from the RDF boiler in order to minimise the release of particulates and other pollutants to the atmosphere.

Grate-Fired Technologies

The majority of Energy from Waste facilities use a grate-fired boiler. In this system, waste enters the boiler onto a grate, which moves, shakes, or otherwise causes the waste to travel through the furnace. Air flows from beneath the grate, and the main burning zone is on or near the grate. Ash and unburned material is discharged from the end of the grate into an ash hopper. Secondary air is introduced above the grate to complete the combustion.

The primary advantage of this technology is its simplicity. Apart from the moving parts of the grate, the process is mechanically simple. A very large body of reference sites demonstrate grate-fired systems can handle a wide range of input material, without significant preparation.

The main disadvantage of this technology is the need to ensure the consistency of the fuel's calorific value and avoid localised areas of high temperatures, which in the long term are detrimental to the grate. Some technologies address this by circulating water through the grate.

Another issue is that the high temperature zones are more likely to produce NO_x emissions, which can increase the cost of flue gas treatment compared to other technologies.

Fluidised Bed Technologies

A less common but still widely used technology is fluidised bed combustion. The "fluidised bed" refers to a mix of sand and ash which is fluidised by air introduced at the base of the furnace. The bed is maintained at a target temperature by water tubes in the bed and the fuel is discharged into the bed where it burns in a controlled way. Ash becomes part of the bed and is periodically extracted by a removal system. Secondary air is introduced above the bed to complete the combustion.

Fluidised bed boilers are typically smaller in size than grate-fired boilers for the same thermal capacity. They also provide a high level of temperature control, which tends to reduce the cost of downstream flue gas treatment.

Fluidised bed combustion is adaptable and suited to diverse waste fuel types with varying energy values and moisture content. The scrubbing action of the bed material on the fuel particles enhances the combustion process, which allows oxygen to reach the combustion material for better combustion efficiency.

The main advantages of the fluidised bed technology are that it has few moving parts, operates at higher efficiency, provides lower emissions of oxides of sulphur and nitrogen, and more flexible operations.

The main disadvantages are a higher 'parasitic' electrical load because of the large fans for fluidisation of the bed, and in some cases higher capital costs due to the larger refractory area than grate boilers.

Environmental Management

Flue Gas Treatment

All of the technology providers considered nominated very similar technologies to capture the emissions from the RDF boiler. In brief, these are:

- Selective Non-Catalytic Reduction (SNCR) — an emissions control technology that reduces nitrogen oxides (NO_x) by injecting ammonia into the flue gas path in the boiler with optimum temperature for its effective reaction.
- Dry scrubbing — an emissions control technology where solid adsorbents (lime and activated carbon) are injected in the flue gas stream. The adsorbents capture contaminants from the flue gas and then are removed in the bag filter.
- Bag filter — an emissions control technology that consists of very fine fabric filters to remove particulate matter (including adsorbents from the dry scrubbing system). The bags are pulsed to drop the solids into a hopper for removal.

These technologies are all considered Best Available Techniques for emissions control in the European Union. Further investigation and confirmation of the most appropriate design for effective flue gas treatment will be required as part of the EIS process.

Ash

Combustion of solid fuel such as coal or RDF creates an ash, which is the residual inorganic material (mainly solid oxides) that remains after all the hydrocarbons are burnt. Ash is typically stored or disposed of in dedicated facilities, mostly co-located with power stations. WSP/PB (an international engineering consultancy) was engaged to conduct a review of the options for disposal or reuse of the ash and residues from the Energy Recovery Project. There are typically two ash streams, depending on the technology chosen:

- Boiler ash and bottom ash is composed of the non-volatile, non-combustible part of the fuel stream. It is a relatively stable and homogenous waste stream with relatively low contamination that can be disposed of to an inert waste landfill or ash repository. This is normally the largest stream of residue.
- Fly ash is carried through the boiler and captured in the bag filter in the final stage of the flue gas treatment process. This ash is likely to be contaminated and therefore has less options for reuse or treatment. It is thus treated as a restricted or hazardous waste based on the NSW EPA's *Waste Classification Guidelines* and must be handled and dealt with accordingly. Fly ash is typically a small proportion of the total ash stream.

Given that Mt Piper already produces significant quantities of ash from its existing coal-fired operations, it is likely that the volume of the ash produced from the RDF boiler (equating to around 30,000 tonnes or around 2% of the ash produced by Mt Piper) can be managed on site.

Technical Feasibility

A pre-feasibility study into the earlier 100,000 tonnes per year plant was completed by Boiler & Power Plant Services (B&PPS) with the following scope:

- Proposed concept plant design for the new facility;
- Proposed plant tie in to the Unit 2 Boiler at Mt Piper;
- Calculation of steam pressures and temperatures for the new plant and tie ins;
- Heat mass balance calculations for the full load range;
- Water and steam flow for optimum output;
- Performance of the steam cycle;
- Side stream boiler concept design;
- Heat Rate determination of the proposed design; and

- Steam turbine performance output from Unit 2 with the new facility connected.

The B&PPS study confirmed that the concept was technically feasible and met minimum efficiency benchmarks as required under the NSW EfW Policy; and also identified the optimum plan for the integration between the RDF boiler and the steam provided to the Mt Piper turbine.

Following on from the pre-feasibility study, Aurecon developed a technical specification and a technical feasibility report to cover the following key parameters:

- Plant interface requirements defined to a new facility;
- Technical risks identified based on the proposed design;
- Validation of the heat mass balance calculations derived in the pre-feasibility study;
- Considerations for fuel receival, storage and feeding;
- Confirm plant emissions are within the specified environmental regulations and proposed emission control equipment is satisfactory;
- Confirmation of the basic layout design for the proposed facility;
- Key assumptions and limitations for the feasibility study; and
- Outstanding design and engineering needed for the next phase of works.

Based on the above criteria, Aurecon recommended that the proposed Energy Recovery Facility at Mt Piper Power Station was technically feasible, based on the assumptions and operating parameters mentioned in the feasibility study. After the decision was made to double the capacity of the plant, Aurecon produced a supplementary report considering the larger, 27 MW project, and concluded that there are no technical barriers to this size.

It should be noted that further engineering definition is required to mitigate against some of the risks identified in this phase of the Project.

Site Requirements & Arrangement at Mt Piper

Development for the proposed Energy Recovery facility will occur within a previously disturbed site immediately adjacent to the existing Unit 2 Boiler within the Mt Piper existing power station plot, which will result in considerably less social and environmental impacts compared to a greenfield site. The area was previously assessed for the potential future expansion of the power station and is ideally suited to new development. However, EnergyAustralia has no current plans to proceed with the construction of additional coal-fired units.

The proposed site location looks at the accessibility of fuel receival and the use of existing services and infrastructure at the Mt Piper Power Station, which will minimise capital expenditure that would be required for associated infrastructure at another site.

The proposed site location and layout is shown below:

Mt Piper Energy Recovery Project
FIGURE 1: Proposal overview

Criteria for Selection

The main criteria for selection for the proposed site can be summarised by the following key points.

- Proximity to Unit 2 Mt Piper Boiler;
- Proximity to Unit 2 Steam Turbine and Generator;
- Proximity to existing plant interfaces and auxiliary services;
- Access to roads for fuel receival and storage;
- Within existing plant boundary to minimise land approvals;
- Relatively flat land away from any major waterways and environmental constraints;
- Space for construction laydown areas and stockpiles; and
- Space for contractor facilities during construction

The selected location provides advantages to the Project in the ability to share operating resources with the existing Mt Piper Power Station operations, including a shared workforce, integrated control systems and shared infrastructure and maintenance resources.

Planning & Other Approvals

Existing Approvals

Mt Piper Power Station operates under DA 80/10060, which was issued in May 1982, and Environment Protection Licence 13007.

The Mt Piper Power Station Extension Project (MP 09_0119) Concept Plan was approved in 2009 under Part 3A of the *Environmental Planning and Assessment Act 1979* (*EP&A Act*). The approved extension included the construction and operation of two additional units, with a capacity of up to 2,000 MW, which could be fuelled by either coal or gas. However, EnergyAustralia does not intend to proceed with the additional units.

The Energy Recovery Project will be located within a portion of the study area of the extension project. However, as the proposal differs fundamentally from the extension project, a separate planning approval has been sought.

The placement of ash at Mt Piper Power Station currently takes place under various approvals including the Mt Piper Power Station Ash Placement Project (MP 09-0186) and Mt Piper Ash Placement Brine in Ash Co-placement (S90/01696). It is anticipated that furnace ash from the Project may be placed within the Lamberts North area. The most appropriate approvals pathway will be determined once the detailed characteristics of the ash and repository have been confirmed.

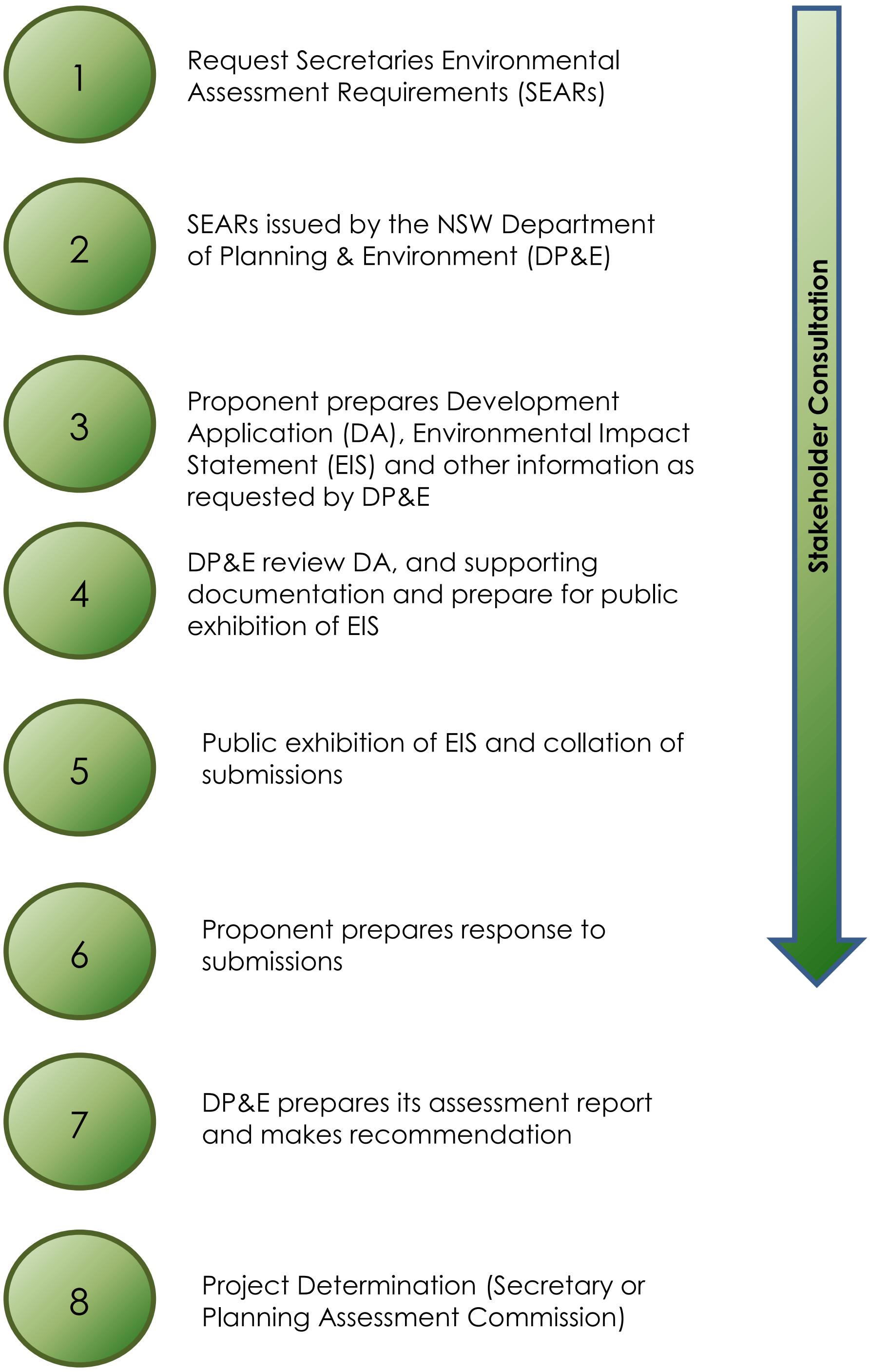
Approval pathway

State Environmental Planning Policy (State and Regional Development) 2011 defines certain developments as State Significant Development (SSD), based on certain criteria. SSD criteria provided in Schedule 1 of the State and Regional Development SEPP includes:

- Development for the purpose of electricity generating works that has a capital investment value of more than $30 million; and
- Development for the purpose of waste incineration that handles more than 1,000 tonnes per year of waste.

As the proposal is a development for the purpose of electricity generating works, with a capital investment value of greater than $30 million, and would result in the consumption of more than 1,000 tonnes per year of waste, it meets the definition of SSD.

The *Lithgow Local Environmental Plan 2014* permits electricity generating works, with consent, in the SP2 Infrastructure zone. Approval for SSD projects is required under Division 4.1 of Part 4 of the *EP&A Act*. Section 78A (8A) of the *EP&A Act* requires a Development Application (DA) for SSD to be accompanied by an Environmental Impact Statement (EIS). Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* (the EP&A Regulation) requires an EIS to be prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) issued for the proposal. A general schematic of the approval pathway under division 4.1 of the *EP&A Act* is shown below.



Secretary's Environmental Assessment Requirements

Aurecon was engaged to prepare a Preliminary Environmental Assessment (PEA) on behalf of Re.Group and EnergyAustralia. The purpose of the PEA is to request, and inform the content of, the SEARs for the proposal. The SEARs provide the requirements for the Environmental Impact Statement (EIS) that will be prepared to accompany the Development Application for the proposal. This document also serves to inform agencies and the public of the proposal.

The request for SEARs was lodged on 1 March 2017 and the Department of Planning and Environment (DPE) issued the SEARs on 11 April 2017.

Environmental Impact Statement (EIS)

The SEARs issued by the DPE NSW for the Project outline the form and content requirements of the EIS. In summary, the EIS must include a detailed description and justification of the development, alternatives considered and likely interactions with existing approvals and other approved and proposed operations in the site area.

The EIS must include a detailed assessment of the key issues identified by the DPE and any other significant issues identified in the risk assessment. Key issues that require assessment by the DPE as outlined in the SEARs include:

- Strategic and Statutory Context;
- Air Quality and Odour;
- Human Health Risk;
- Waste Management;
- Soils and Water;
- Traffic and Transport;
- Noise and Vibration;
- Biosecurity;
- Hazards and Risk;
- Visual;
- Greenhouse Gas and Energy Efficiency;
- Flora and Fauna;
- Aboriginal and non-Aboriginal Cultural Heritage;

- Bushfire Risk; and
- Contributions.

The *EP&A Act* provides for the Minister or Secretary of DPE to request the Planning Assessment Commission (PAC) to hold a public hearing into a state significant development and infrastructure applications. The current Ministerial delegation may refer to the Commission to determine major project applications.

The referral to the Commission may take place at any time, however, in general, this would take place after the DPE has completed its assessment report and recommendations, and these become available on the DPE website.

In cases where the Commission finds it will benefit from additional public inputs into its decision-making process, they may decide to meet with relevant stakeholders (for example Council) or decide to hold a public meeting.

Other approvals required

Approvals and licences required for the proposal will be determined in the EIS. In addition to approval under Division 4.1 of the *EP&A Act*, other approvals likely to be required include:

- An environmental protection licence (EPL) under the NSW *Protection of the Environment Operations Act 1997* (*POEO Act*).

Under section 89k of the *EP&A Act*, these approvals cannot be refused for a project that has been approved under Division 4.1 of the *EP&A Act*.

Stakeholder and Public Engagement

For the initial phase of the Project, Re.Group and EnergyAustralia prepared a Stakeholder Engagement Plan that coordinated consultation with key stakeholder groups including the community, local council, regulators and the NSW State Government.

Previous work to understand local community perceptions around the Mt Piper power station was used to inform the development of the initial plan and this focused on early and relevant engagement. Likewise, the local council, local member and the State Government had clear interests in understanding the nature of the proposal and to ensure key risk areas were being carefully considered during the feasibility work.

Prior to submission of the Preliminary Environmental Assessment, the team consulted with a range of stakeholders including:

- Lithgow City Council
- Paul Toole, Local State Member
- The Office of the NSW Minister for Planning
- The Office of the NSW Minister for Industry
- NSW Department of Planning and Environment
- NSW Department of Resources and Energy
- NSW EPA (Waste section, and the local Bathurst office)
- WaterNSW
- NSW Department of Primary Industry — Energy
- NSW Department of Primary Industry — Water
- The local community, through the Mt Piper Community Reference Group.

Feedback indicated broad local support for the Project as it provides jobs and affirms a long-term commitment to the Mt Piper Power Station. However, stakeholders require more detailed answers to questions raised, specifically around the following issues:

- More explanation will be needed about RDF as it is a new concept to many stakeholders;
- The EPA will ensure compliance with the EfW policy, and will expect a high standard of evidence to demonstrate compliance;
- The local community's main concerns are emissions to air and local impacts from transport;
- Several stakeholders raised concerns about odour. Odour controls will need to be robust to avoid impacts on the Mt Piper workforce; and
- Stakeholders recommended extending the consultation to include community groups in the wider region, including the Blue Mountains.

Stakeholder engagement will continue as part of the Project planning process, and if the Project is approved will continue during construction and operation.

The Community Reference Group for the Mt Piper Power Station was briefed on the proposal in February 2017 and updated at each meeting since that time. The Group will continue to be updated as the Project evolves. Local and state government representatives and departments were briefed, and discussions with these groups will continue during the approvals process. The Project team remain committed to providing clear, relevant and useful information to stakeholders, and incorporating feedback into the Project's design cycle. An updated Stakeholder Engagement Plan will be developed for the next phase of work.

Life Cycle Assessment

Edge Environment conducted a Lifecycle Assessment (LCA) that independently assessed the energy recovery capabilities of the Project based on the earlier considered alternative of using 100,000 tonnes of RDF per year in the new proposed boiler.

The report contained results that can be shared with the public and other stakeholders to keep them informed of the benefits of the Mt Piper Energy Recovery Project. The key findings of the LCA include:

> *The proposed model for energy recovery from refuse derived fuel (RDF) has a lower impact than electricity production from coal for all impact categories:*
>
> - *Climate change (-110%)*
> - *Fossil fuel energy use (-93%)*
> - *Fossil fuel resource depletion (-86%)*
> - *Particulate matter formation (-39%)*
> - *Eutrophication (-457%)*
> - *Consumptive water use (-102%)*

In addition, the report states that the Project is predicted to make the following savings when compared to electricity production from coal:

- 108,000 tonnes of CO_2-e per year
- 178,000 m^3 of water equivalent per year
- 4,600 kg $PM_{2.5}$ particulate matter per year

Given that the feasibility assessment has concluded that the Project is viable with a throughput of 200,000 tonnes of RDF per year, it is expected that these environmental benefits will be further increased.

Further modelling may be undertaken of these benefits during the EIS.

Risk Assessment

A risk assessment process was conducted to identify the most likely key risks faced in developing and operating the Project. This process included formal facilitated discussion forums and a technical workshop with the project team and advisers.

The outcome of this process is the Key Risks Register shown below. These are the key project risks that will need to be addressed at the close of the feasibility study and, where applicable, carry over to the Project's next phase.

Risk	Mitigation
Contracting strategy Achieving appropriate EPC terms, including performance guarantees and plant reliability warranties	Early discussion of terms with prospective partners
Political/Economic/Societal/Community/Cultural Adverse community sentiment potentially impacting reputation of both Re.Group and EnergyAustralia	Genuine and effective stakeholder consultation prior to making fundamental decisions
Mt Piper interfaces Project causes disruptions in Mt Piper operations	Operational input and sign-off early in the design
Funding/Commercial Increased capital expenditure, requiring more debt and equity — unable to secure financing	Contingency allowances, risk transfer/sharing
Fuel supply to plant Variance in volume or quality of RDF delivered to the plant either in commissioning or operation	Diversity in supply, realistic fuel supply profile, fuel storage and offsite buffering

Risk	Mitigation
Transportation Unable to find suitable fuel transport solution	Early transport study and engagement with regulator and other stakeholders
Air emissions	Air modelling will be conducted as part of the EIS. RDF boiler will have emissions performance and fuel-based specifications; quality control (stack monitoring, fuel quality); combustion control; flue gas emission control; continual monitoring. Stack height and design to meet approved EPA and EIS requirements.
Regulatory risk on LGCs Risk of the volume of LGCs able to be produced from the facility	Early engagement with the Clean Energy Regulator
Market Risk Movements in the value of energy and LGCs	Offtake agreement with EnergyAustralia
Fire risk in fuel storage area	Management procedures for transportation and storage. Gas detection; ventilation monitoring; fire services.
Odour from fuel storage area	Design to include negative pressure environment within the shed and include odour minimisation in the technical specifications of the RDF boiler.

Structuring & Financial Considerations

Commercial Structure

EnergyAustralia and Re.Group would form a Special Purpose Vehicle (SPV) to carry out the Project. This requires the Project to stand alone without cross-subsidy by the other operations of either partner. It also allows non-recourse project financing. Under this model, the SPV is the owner of the plant and it holds major long-term contracts with its partners, and potentially other service providers. This is very similar to the principal model for most renewable energy facilities in the Australian market and its appeal to infrastructure investors stems from the stable long-term cash flows and the associated due diligence requirements.

The construction of the plant will be under a 'turn-key' Engineering-Procurement-Construction (EPC) contract. The EPC contract would involve the selected technology provider, along with a local construction company.

Revenue Sources

The main sources of revenue for the Project are as follows:

1. Gate Fees will be paid by Re.Group to the SPV for the delivery of RDF to the facility. This is one of the main revenue drivers for the Project. Re.Group is able to pay for RDF to be delivered and used by the facility due to the fact that it will be providing improved outcomes for customers (recovery of energy resources in material that cannot be recycled) while also avoiding the landfill levy charged under NSW Legislation. Re.Group will be responsible for the long-term sourcing, transport and delivery in both volume and quality terms for the Project.

2. EnergyAustralia will pay for energy offtake through the purchase of steam from the facility. This is an equally important key revenue source for the Project. EnergyAustralia would be responsible for converting the steam into electricity.

3. Under the *Renewable Energy Act*, section 17(q) allows for the creation of Large Generation Certificates (LGCs) from biomass. Given that about one-third of the RDF supply is made up of biomass (essentially the paper fraction), the Project will create LGCs, which it can then sell into the market. EnergyAustralia is the party best placed to create and monetise these certificates, so the energy offtake price described above also contains an element representing the renewable component of the RDF supply. This will need to be calculated by taking into account the measured fraction of biomass in the RDF supply and the conversion efficiency of RDF to renewable energy via the RDF boiler and the Mt Piper Power Station steam to power cycle, as per the established methodology published by the Clean Energy Regulator. Mt Piper is already accredited to produce LGCs, having explored biomass co-firing previously.
4. Carbon credits known as ACCUs (Australian Carbon Credit Units) may be able to be created through this Project, under the Alternative Waste Treatment methodology. This is less certain revenue and Re.Group is the best placed party to secure this potential revenue stream, given that it is mainly concerned with the waste stream used to produce the RDF.

Expenses

The main recurring costs for the Project involve the operation and maintenance of the plant and the ash disposal. One of the main benefits of co-locating the Project with the Mt Piper Power Station is the availability of the existing workforce, with the intention that only a relatively small addition to the shift-based staff will be required to manage the RDF feed supply and boiler. EnergyAustralia will therefore provide the vast majority of the operations and maintenance services; there may be, however, some reliance on third parties, notably the original equipment manufacturer for major outages and some maintenance services and advice, and potentially some ash disposal services for any ash that may not be able to be stored within the existing Mt Piper Power Station ash repositories.

Financial Analysis

The detail of the financial analysis is not included in this public knowledge report as it is commercially sensitive. However, the following conclusions can be drawn:

- The Project has significantly lower capex than a standalone RDF-fired power station of the same electrical capacity, because of the use of the existing turbine, generator, developable land, secure high voltage grid connection and other ancillary equipment and services.
- The Project can achieve the required thermal efficiency of conversion to electricity with mild steam parameters, reducing the overall maintenance costs.
- The most significant financial benefit of the hybrid proposal is in the operating cost. Co-location within an existing power station with an experienced workforce reduces the costs compared to a standalone facility.
- Capital cost estimates are highly variable between suppliers and can change significantly with changes in exchange rates and commodity prices.

The overall conclusion of the financial modelling is that, at current costs and considering long-term trends in the fuel, electricity and LGC markets, the Project is financially viable at 27 MWe, but not at the smaller 14 MWe size.

Implementation & Schedule

The phases of the Project are:

	Phase	Key Activities
1	Pre-feasibility	Initial investigation
2	Feasibility	Detailed investigation, initiate legals, initiate approvals
3	Development	Concept design, environmental approvals, funding, complete legals
4	Implementation	Design, construction, commissioning
5	Operations	Operation of the plant

This report, along with the completion of the deliverables to ARENA, comes at the end of phase 2.

Key Activities in the Next Phase

If the Project were to proceed, the next phase of the Project would cover all activities necessary to reach a Final Investment Decision. The key streams of work would be:

- Engaging an EPC contractor and technology partner and progressing the engineering design of the Project.
- Securing the required approvals for the Project. This is anticipated to be a critical path for this phase and includes preparation of an Environmental Impact Statement (EIS) and extensive consultation and public discussion of the Project.
- Securing and contracting the commercial arrangements such as RDF supply, energy offtake, asset management (operations and maintenance), ash management and RDF transport.
- The sourcing of debt and equity for the Project, with debt most likely under non-recourse project financing, and establishment of the SPV.

Schedule

A schedule of activities from the feasibility study to completion of commissioning has been prepared. In brief, it shows that the plant could be in operation within 3 years, subject to approvals.

Achieving this schedule will require careful management of the interfaces between the approvals and design teams, and early appointment of the technology provider and the owners' dedicated project teams, to ensure the activities on the critical path proceed smoothly.

Conclusion

The Energy Recovery Project is a technically viable opportunity to:

- Hybridise a renewable energy technology with the existing coal-fired Mt Piper Power Station;
- Provide baseload renewable energy;
- Divert waste from landfill in NSW;
- Provide additional employment in the Lithgow region;
- Implement a widely used international technology for the first time in Australia, with lower cost and less risk than a standalone facility; and
- Provide a local reference facility for future hybrid renewable energy projects at other power stations.

The costs of the Project are significantly higher than initially anticipated. As a result, the Project would be unlikely to secure debt and equity funding at the original (14 MWe) size, but is financially viable at the 27 MWe size proposed.

Recommendations & Next Steps

The project team recommended that the Project study is continued to the next phase of development. Based on this study, Re.Group and EnergyAustralia have decided to continue the Project to the next stage of development. The next stage consists of further engineering work and environmental studies to define the Project and its environmental impacts.