TRASH OR TREASURE: WASTE TO ENERGY INFRASTRUCTURE

Trash or Treasure: Waste to Energy Infrastructure

The world's insatiable appetite to consume has two primary consequences; increasing energy needs and mounting undesirable waste.

Given this, the question begs - is waste to energy technology the answer? Whilst embedded in the European psyche for many decades, given recent technological advancements, increasing recognition of the benefits of waste to energy is now occurring on a more global scale. The uptake of this technology in other countries, including Australia, has been rather unenthusiastic, however a recent decision from China to stop importing recyclable material may prove to be the catalyst for Australia to embrace this technology.

This article explores the benefits and costs of waste to energy technology and the economic considerations for investors. Finally, we show how Whitehelm Capital (Whitehelm) is working with institutional investors to appropriately structure their investments in this space to ensure waste to energy assets can be added to their stable of core infrastructure investments.

1. What is Waste to Energy?

Energy recovery, waste to energy, or energy from waste technologies have changed the definition of "trash". But what exactly is waste to energy (WtE)?

Whilst the definition is broad, simply put it generally refers to the process of generating energy from the treatment of waste, or the processing of waste as a fuel source. Although the concept is not new (with the first incinerator becoming operational in 1874 in the UK), the technology associated with this process is developing rapidly in terms of energy generation efficiency and environmental impacts, with a requirement for new WtE plants in OECD countries incinerating waste to meet strict emission standards.

Modern WtE plants can reduce the original waste by circa 95 percent, albeit this is dependent on the composition of the inputs and the recovery rate of material such as metals from the residual ash.

Type of energy conversion

WtE plants have the ability to utilise waste as a fuel source and convert it into either heat, electricity or a combination of heat and power (CHP). However, the efficiency rate is vastly different for generating heat and power. That is, waste is far more efficiently converted into heat than electricity.

As a pure generator of heat, WtE plants can reach up to a 90% efficiency rate, (meaning only a small amount of heat energy is lost). However, as a generator of electricity, the efficiency outcome for WtE plants is materially less, where levels only reach approximately 25%.

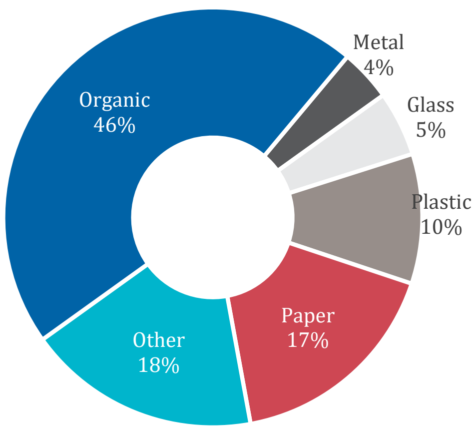
Efficiency levels from CHP plants lie in the middle and these cogeneration plants are the most common WtE facilities. Waste converted into heat and power can achieve efficiency rates of up to 40%. However, this generally assumes that all the heat used to generate electricity is captured and used. One of the main challenges for CHP is balancing the optimal ratio between heat and power generation. As heat production increases, electricity output decreases.

Furthermore, the energy efficiency rate for WtE plants as a heat and power supplier is dependent on the nature and volume of available waste. When used as a fuel source, one of the most important considerations is the calorific value of the waste input. That is, the calorific value represents how much energy can be derived from such inputs.

Type of waste

Figure 1 highlights that close to half of municipal waste generated on a global scale is organic material (plant and animal remains) with paper and plastic based products representing a further quarter.

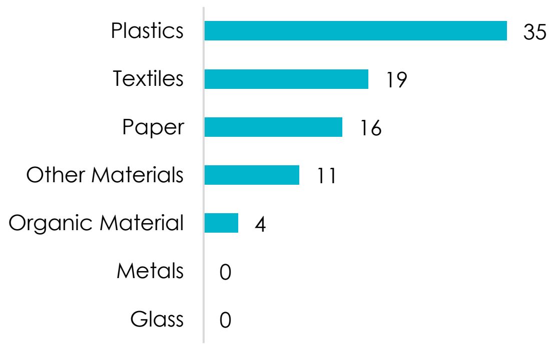
Figure 1: Composition of Global Municipal Solid Waste (MSW)



Source: Hoornweg & Bhada-Tata (2012)

Unfortunately however, organic waste is a relatively inefficient fuel source. Figure 2 shows the approximate energy content (net calorific value) for common types of Municipal Solid Waste (MSW).

Figure 2: Net Calorific Value (MJ/kg) Common MSW



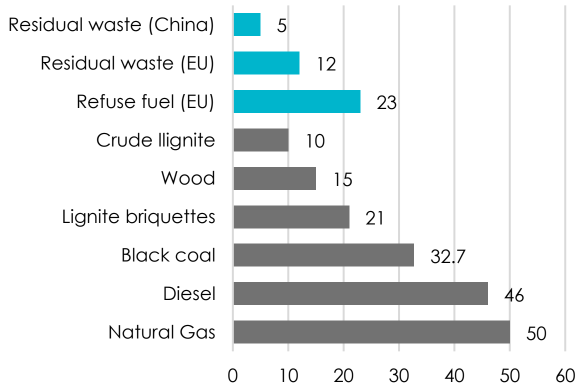
Source: ISWA (2013)

Is waste a good alternative to other fuel sources?

Given the high content of organic matter (with low calorific value) it is not surprising that in general, MSW as a fuel source is inferior to traditional fossil fuels.

Figure 3 shows that residual waste (the remaining material after recycling has been applied) is significantly less effective as an energy source compared to natural gas, diesel and black coal.

Figure 3: Calorific Value of Selected Fuel



Source: Ecoprog (2015)

However, assessing WtE plants through the sole lens of a pure energy source is only half of the story. Waste is a non-desirable outcome of growing global consumption and is a clear burden on society. Therefore, we need to consider whether in addition to being an energy source, the burning of waste has a positive effect on the environment.

2. Waste to Energy – Environmental impacts

Reduction of landfill

In 2012, the World Bank estimated that humans generate circa 1.3 billion tonnes of solid waste on an annual basis. Furthermore, they predicted that as developing nations mature, consumption in these countries is likely to materially rise. This is set to drive waste to 2.2 billion tonnes per year by 2025. This equates to 1.5 kg of waste per urban resident per day, more than twice the 0.65 kg daily rate in 2000.[1]

Most residual waste is either burned or buried (landfill). Despite the advances in technology in WtE plant efficiency and emission reduction, in most parts of the world, landfill remains the most economical, viable and accessible option of waste disposal. However, landfill sites have adverse health and social effects on the residents near them, as well as wider negative environmental impacts.

Greenhouse gas reducer

In efforts to curb the impact of humans on global climate change, the renewable energy sector has grown rapidly with increasing demand from both government and the private sector. Renewable energy technologies like solar, wind and even nuclear power all seek to reduce the amount of greenhouse gas emissions in electricity production. These technologies produce close to zero emissions, however they all do have their own idiosyncratic challenges, e.g. disposal of radioactive waste, susceptibility to variable weather conditions.

The United States' EPA reported that WtE is the only electricity generating technology that actually possesses a negative greenhouse gas emission status[2]. That is, the incineration of waste to generate electricity reduces greenhouse gases that would otherwise be emitted if the waste was buried in landfill. The EPA estimated that savings are approximately one tonne of greenhouse gas saved per tonne of MSW burned instead of being landfilled.

Recovery of valuable resources

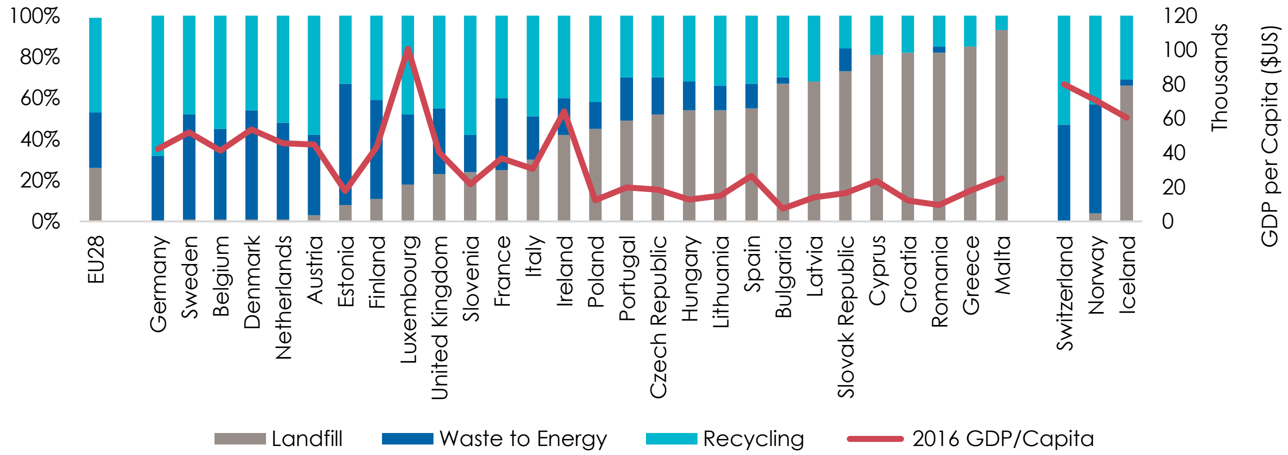
Given widely adopted waste management practices in European countries, the Confederation of European Waste to Energy Plants (CEWEP) reported that landfill only makes up 26% of the total municipal waste treatment in Europe. This can be seen in Figure 4.

[1] World Bank: 'What a Waste: A Global Review of Solid Waste Management" [March 2012]

[2] http://www.powermag.com/energy-waste-greenhouse-gas-winner-pollution-loser/

Figure 4 shows that WtE conversion offers a real solution to recover energy from what would otherwise be sent to landfill. Figure 4 shows that (excluding waste that can be recycled) it is possible to recover energy from almost all residual waste. For example, Germany, Sweden, Belgium, Denmark, the Netherlands, and Switzerland had almost zero percent of their municipal waste going to landfill.

Figure 4: Municipal Waste Treatment Across European Countries -2015



Source: Confederation of European Waste to Energy Plant, World Bank, Whitehelm Analysis

Figure 4 shows that, in general, European countries with higher levels of GDP per capita exhibit higher level of recycling and WtE conversion. Conversely, countries with lower GDP per capita predominately rely on landfill with the one exception being Iceland (with a high GDP) where more than 90% of the population are serviced by district heating from direct geothermal sources - leading to no incentives for incinerating waste.

Given there appears to be a natural progression for countries with increasing GDP to turn to WtE technology, what are the barriers preventing more countries from adopting this technology?

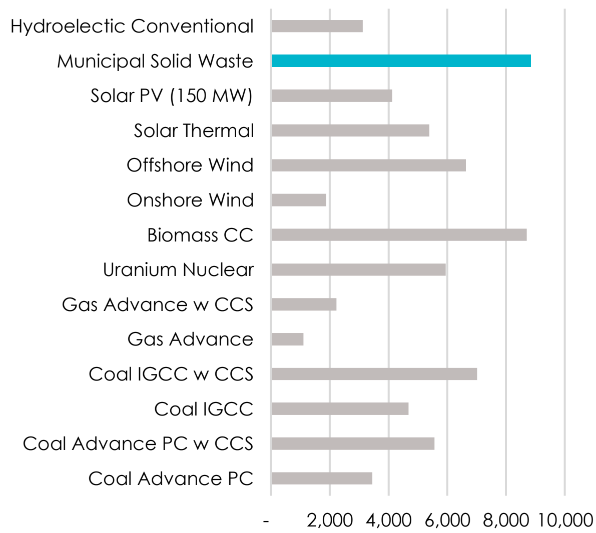
3. The Economics of Waste to Energy

WtE has been a hot topic of debate in recent times, with both the public and private sectors expressing immense interest in this space after realising the benefits and longer term need for WtE processes. Recent notable acquisitions of WtE facilities are outlined below. However, WtE plants are significant investments with high resourcing requirements to construct and operate. When considering such investments, investors, be it the public or private sector, need to undertake thorough analysis and feasibility studies of the proposed project. Some of the key factors for consideration are discussed below.

High capital investment

One of the hurdles impeding the growth of WtE technology utilisation is the high capital cost. Figure 5 illustrates the average capital investment required for power generation across different types of energy sources in the United States. Compared to other energy sources, MSW is one of the most capital-intensive methods of power generation. In the absence of subsidies/incentives offered by government organisations, this high capital cost is a major barrier in utilising WtE technology to generate electricity.

Figure 5: Capital Investment (US$/kW)



Source: US Energy Information Administration (2016)

Furthermore, compared to other energy generation processes, WtE is often more complex and requires a higher level of technology and expertise for its construction. The construction cost of a WtE plant typically include items such as waste storage facilities, boilers, energy conversion plant, gas clean up systems, generators and turbines, cooling systems and emission treatment systems.

Waste composition

Waste composition is highly dependent on the demographics of the economy. High income nations generally produce a higher level of waste per capita due to their higher consumption patterns. The waste in these countries is also comprised of a higher proportion of plastics and paper, which as we have discussed are more favourable for recycling and energy conversion.

Conversely, low income countries on average have a much higher composition of organic material, which is not ideal for energy conversion. Furthermore, these countries typically do not have proper waste collection and transportation infrastructure that further reduce efficiency when converting WtE.

WtE facilities are long term investments, and the demographics of the economy can change during the life of the plant. Accordingly, it is prudent for investors to consider whether the current WtE plant can be modified to suit the potentially changing composition of waste over time. Even though most WtE plants are constructed to be flexible to accommodate changing composition of waste, they have their limitations.

The potentially changing waste composition over time makes it difficult to assess whether the current technology applied will continue to be appropriate in years to come.

Waste supply

The long-term supply of available waste is another key factor that must be considered before investing in WtE infrastructure projects. Generally, for WtE plants to be effective and achieve the necessary economies of scale, a certain level of waste must be available to be processed at all times. Investors in this space need to consider the long-term prospect of obtaining waste material and back up plans (e.g. importing waste from neighbouring regions) should the volume of local waste decline.

For example, it has been reported in Australia that one of the reasons for the slow take up of WtE development is due to insufficient residual MSW being generated by local councils, and amalgamation of waste between councils has proved to be challenging and relatively unsuccessful.

The ability to access a reliable supply of waste is a key consideration for any long-term investor, particularly against the backdrop of many nations and global corporations taking action to reduce global waste.

Geography

Location of the WtE plant is another important consideration. The identification of a suitable site is often challenging due to a number of factors. To minimise the cost of transport, the location of the plant should ideally be situated close to primary sources of MSW. Good infrastructure and transportation should also be available and accessible to the plant.

Depending on the consumer of the energy product, the WtE site ideally should be close to a suitable electricity grid, distribution network, district heating network and/or industrial facilities which require heat and/or power.

Regulatory and environmental issues in respect to the zoning and use of land often create further challenges that can be difficult and time consuming to resolve.

Finally, even if the above conditions are met, the developer must address any remaining issues with the local community. This is especially challenging if the WtE plant is to be built near residential estates.

Certainty of revenue

The two main revenue components of a WtE facility are waste gate fees and revenue generated from the sale of heat and/or power (offtake product).

Waste gate fees

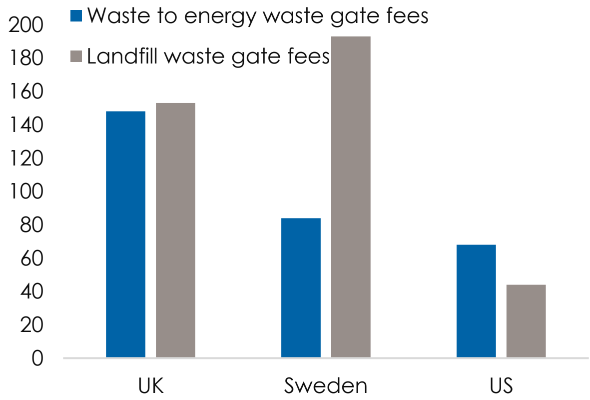
According to the waste management hierarchy, residual MSW will either be used to recover energy or disposed of by landfill. There is a cost for the disposal of waste and waste producers are charged for the collection, management and disposal of this undesirable product.

As such, WtE facilities and landfill sites are typically paid a gate fee for the disposal of the waste that they receive. In many instances, waste gate fees are significantly influenced by the respective levies that are imposed by the government. Waste gate fees to both WtE facilities and landfill can vary greatly between countries and even between states within a country.

If the gate fees for WtE facilities are too high, users will seek alternative methods of disposing of waste such as landfill, shipping waste to different countries and in extreme cases, even illegal dumping. Given that landfill sites are (in the short-term) more cost effective, from an economic stand point, users are likely to gravitate towards landfill, as long as there is sufficient available capacity.

Figure 6 shows the average waste gate fee for landfill and WtE facilities for the United Kingdom, Sweden and the United States.

Figure 6: Waste Gate Fees (US$/tonne)



Source: World Energy Council (2016)

The success of WtE plants in Europe is largely attributed to high landfill levies across many countries, which have been set to encourage recycling and waste recovery. In contrast, in the United States, where landfill levies are relatively low, the uptake in WtE development lags its neighbours across the Atlantic.

Overcapacity of WtE facilities and/or undersupply of waste can reduce waste gate fees which can make up a large proportion of the total revenue of WtE plants. For example, Hicks and Rawlinson (2010) reported that in the United Kingdom, 70% of the revenue from WtE plants came from waste gate fees (albeit we note that this is substantially lower in continental Europe). This can provide owners of WtE assets the potential for long term stable and inflation linked cash flows for a significant revenue steam if they can structure these waste gate fees as long-term contracts - which many municipalities are willing to offer.

Energy fees

Whilst WtE facilities witness a range in contract lengths (some can be up to 20 years) for the disposal of waste and therefore income from waste gate fees, securing long term contracts for the energy offtake is often more challenging.

The structure of this revenue stream is dependent on the type of energy produced, the buyer and the supply agreement, as well as the proximity of the facility to its offtaker. At one extreme, revenue can be fully exposed to merchant energy prices from day one, which increases the risk of the investment given the volatility in energy markets. Whilst at the other end of the spectrum, all the future energy supply can be precontracted on a take or pay basis at a pre-agreed price, therefore limiting the risk of renewal of the contract and the counterparty risk of the offtaker.

Given the efficiencies in generating heat and the inadequacies in generating electricity at this current stage, WtE facilities that provide heat, or a combination of heat and power, are likely to be more feasible and compelling from a financial perspective.

Operating and financing expenses

Initial capital costs for WtE plants are very intensive but ongoing expenses are typically low. Well operated plants can generate a healthy profit margin (often seen in core infrastructure assets) given limited ongoing operating and maintenance expenses which include: transportation costs for the waste, compliance costs, labour costs, energy costs, and ongoing maintenance.

Given the long-term fixed contracts associated with these facilities, it will come as no surprise that many of these assets are geared to enhance equity returns. However, leverage is a double-edged sword, whilst it can enhance the returns of the investment it can also quickly destroy value created by the asset. Careful consideration needs to be taken in respect to the quantum and structure of debt, and whether the asset can continue to service the debt in a changing environment.

Regulation and policies

Despite recent technological advances, as mentioned, WtE is still considered to be a relatively ineffective energy source compared to fossil fuel. In the absence of government intervention, landfill is still economically superior if environmental externalities and long-term impacts are not priced in, and as such it will likely be the preferred disposal option for many.

The success of WtE is highly dependent on the regulatory and political direction of the government. The country's waste management policies, landfill directives, waste incineration policies, energy policies and approach to climate change will have a significant impact on the success of a country's WtE development.

Stability of the government's regulations and policies is also critical to the success and growth of the sector. Regulatory stability inherently reduces the risk of the investment thereby attracting more investment. Conversely, frequent policy change reduces investor confidence.

The WtE sector is still in its infancy in some countries where regulations and policies are still immature. This is particularly unfavourable for long-term investors as immature policies are subject to change, which may not be in the best interests of the sector.

The impact of regulation and governance in the sector cannot be overstated and varies widely between nations. The following case study illustrates that poor regulation in the sector could lead to detrimental effects, which can erode investor confidence.

4. Fit for institutional investors

Is there appetite for this type of infrastructure?

With low correlation to listed markets, low risk, and cash yielding nature, at present there is no shortage in global capital available to invest in well-structured and reasonably priced infrastructure opportunities.

Given the positive investment attributes, including long term contractual cash flows that can be exhibited by WtE infrastructure, the sector is likely to become a mainstream infrastructure asset class. As such, if structured appropriately, these types of investments should be able to tap into the significant amount of capital available for investment in infrastructure.

Institutional clients investing in the infrastructure asset class typically demand stability in projected equity cash flows. As such, it is important that the risks involved in WtE projects are properly considered and addressed in order to entice private capital.

The following discussion highlights the key risks faced by WtE investments and how institutional investors can overcome these hurdles.

Regulatory risk

As discussed, the WtE sector is dependent on the country's waste management hierarchy, landfill directives, waste incineration policies, energy policies and approach to climate change and recycling. In addition, WtE plants typically require a concession with certain obligations and durations. Regulatory instability is often a risk that institution investors avoid as these risks are often unpredictable and uncontrollable.

To minimise these risks, investors often look to deploy capital in countries where there is a long history of regulatory stability (especially in regard to its energy and waste management regulations and policies). To further minimise this risk, Whitehelm often seeks direct contracts with the current government.

In considering foreign investments, we often seek trusted local partners or co-investors who have a sound understanding of local operations and the regulatory environment. This strategy helps us align our interest with local experts and provides us with additional assurance.

Thorough due diligence in respect to the regulatory environment is also undertaken as part of our investment process. Typically, this due diligence is commissioned to be undertaken by an independent local expert.

Mitigation of regulatory risk also requires:

- the continuous monitoring of the political and regulatory situation;
- creating ongoing involvement and presence in the community;
- as well as frequent communication with regulators and other public entities to better understand and anticipate any potential regulatory changes.

Finally, investors need to ensure that any residual regulatory risk is reflected in the expected returns generated by the asset.

Construction risk

The cost of construction is important to investment returns as it impacts the viability of the project, the financing options, and the overall financial performance of the asset.

When analysing any potential opportunities, we help institutional investors address construction risk, utilising several different strategies. The first strategy is to consider brownfield opportunities where construction has already occurred and where there is an operating history to underpin the investment case.

When considering greenfield opportunities, a range of strategies can be used to minimise construction risk, including:

- using fixed price construction contracts;
- stipulating time delay clauses;
- including adequate liquid damages provisions in the contracts;
- selecting only reputable construction firms and proven WtE technology; and
- ensuring adequate insurance cover is obtained.

Revenue risk

WtE plants require high capital outlay that is likely to be locked away for a long period given lack of an alternative use for such facilities. Long-term contracted revenue and recurring revenue is important for assets of this nature as it will provide investors with protection for the duration of the investment.

The main revenue components of a WtE facility are waste gate fees and revenue from the sale of the energy generated. In many European countries (especially those with cooler climates), the generation of steam and connection to a district heating network can further improve the efficiency of a WtE facility, resulting in an increased overall profitability and a reduction in the exposure to market-based electricity prices.

Whilst it is common for waste gate fees to be contracted, the duration of these contracts varies. As such, a thorough analysis of the availability of local waste is important to understand, for example the impact under various scenarios such as increased recycling rates or competing WtE plants in the region.

Revenue from the sale of energy can be fixed but may be related to power prices, as electricity is usually the next-cheapest alternative for producing heat. A larger exposure to power prices increases the variability of cash flows and hence the risk of the investment.

Whilst there are many strategies to mitigate revenue risks, some of the common ones that Whitehelm has applied include the following:

- Only to consider opportunities with long-term contracts, or analyse potential alternatives which the key customers / offtakers could have access to. For a WtE plant delivering steam to an industrial customer or which is connected to a district heating network, the renewal risk could be less severe as customers would face high switching costs and as such be considered as 'locked-in'.
- If renewals of contracts are required in the short term, we seek to structure the investments so that this risk could be passed on to the sellers. For example, proposing an earn-out structure where we will pay a minimum amount initially followed by a bonus (earn-out) if the contracts are successfully renewed.
- Explore viable alternatives to adopt if there was a sudden loss of a revenue stream. For example, can the facility source and process waste that is imported from neighbouring municipals or countries? Or can the energy produced be sold to other buyers or to the grid?

Operational risk

As WtE plants are running on a 24/7 basis at very high temperatures and will only generate revenues when operational, ongoing maintenance is paramount for securing stable operations, which typically also involves planned stops lasting for a few days. In addition, there is always a residual list of some components of the waste causing an unplanned stoppage of the WtE plant, which could last anytime between one day and several days, depending on the severity of the issue and the repair speed.

As such, it is important to factor into the business plan a reasonable availability and load factor, which takes into account such unplanned outages. This is especially critical during the ramp-up phase of the first 2-3 years as it is common for greenfield WtE plants to experience lower availabilities than in the long-term. In addition, having a well-trained operational team familiar with the plant and capable of fixing these issues as well as a well-stocked spare parts reserve can significantly reduce downtimes.

Finally given that the waste demand can sometimes be seasonal, sufficient waste should be held on stock to smooth potential supply gaps and avoid a shutdown of the WtE plant due to temporary waste shortages.

5. Whitehelm Capital & Waste to Energy

Whitehelm has been a proponent of WtE infrastructure assets for several years. The nature and characteristic of such assets align with our investment philosophy, our approach to responsible investment and our expertise in mid-size, core infrastructure assets.

SAE – Case Study

In July 2016, Whitehelm acquired on behalf of one if its Australian investors, a mid-size WtE plant (SAE) located in Sarpsborg (Norway), 90km south of Oslo. SAE is a waste incineration and heat generation plant that exclusively supplies all of its power under a long-term offtake agreement to several biochemical processing plants owned by Borregaard, a Norwegian company that produces advanced and environmentally friendly biochemicals and biomaterials that replace oil-based products.

SAE has an installed capacity of 32.4 MW, with two production lines and gross production of 255 GWh. The feedstock is circa 80,000 tons waste per year of household and commercial waste.

The investment benefits from a high degree of revenue visibility. Furthermore, the waste required to operate the plant is largely procured from Norwegian municipalities on a medium-term basis.

Whitehelm recognises that WtE facilities are not the silver bullet in solving the world's waste disposal problem, but rather they are part of a more fulsome solution that includes a reduction in waste producing consumption and higher rates of recycling.

Given their place as a key contributor in reducing the world's waste, as well as being a low emission power and heat source (after including the benefits of emissions abatement), WtE infrastructure opportunities align with our active approach to Responsible Investment.

If structured correctly, which includes ensuring a high visibility over waste gate fees and heat and electricity offtake coupled with waste supply certainly, WtE assets can be attractive opportunities for long- term infrastructure investors.

Whitehelm is currently working with both Australian and European investors to appropriately structure WtE investments to ensure that we not only protect the real value of these investments but provide investors with long term predictable cash returns.

This feature article is a condensed version of a more in-depth article. If you are interested in accessing the longer-form version, contact Nicole McMillan at Nicole.McMillan@WhitehelmCapital.com

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