Waste Tyres for Power Generation

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Introduction

This memorandum investigates the possibility of using waste tyres for power generation, which could appear to be an attractive option in South Africa in times of inadequate national generating capacity. It gives some context and sets out why it is that whilst waste tyres could be used for electricity generation in some limited cases, they are not going to contribute significantly to the national electricity generation capacity.

We present two estimates of the effective equivalent size of a power station built to use all waste tyres. The two estimates are **117 MW** (based on theoretical available energy), and **51 MW** (based on a comparison against an Eskom power station's coal consumption).

This represents 0.1% to 0.25% of Eskom's total thermal power capacity of about 44 000 MW[1].

Waste Tyre Quantities

The number of waste tyres available is directly related to new tyre production. New tyres will enter the market at much the same rate – in units – as they leave it as waste, since most tyres are replacements of old tyres, either directly or as new vehicles replacing old vehicles (the size of the national car park does not grow drastically from year to year). The most reliable source for estimating total tyre production in South Africa is to look at the SARS data for waste tyre levies collected. Every producer (manufacturer or importer) of tyres is required to report to SARS on the total net mass of tyres produced, and to pay a levy of R2.30/kg excluding VAT. From this, we can calculate the mass of tyres entering the local market.

In 2018/19, Treasury reported R730m tyre levy revenue[2], which equates to 317 000 tonnes. New tyres replacing old tyres are, on a like for like basis, heavier, because tyres wear in use. General estimates of the attrition tyres experience during their life are in the range 18%-20%. In addition, there are waste tyres that are diverted to uses such as weights for silage cover, racetracks barriers, playgrounds, illegal exports as second-hand tyres, and other miscellaneous diversions. Taking into account attrition and other 'leakage', a reasonable estimate of the mass of waste tyres arising is that it is 25% less than the mass of new tyres entering the market.

Based on the above, in round numbers, the theoretically available volume is **240 000 tonnes of waste tyres per annum**.

The number of historical waste tyres in the country is harder to estimate, but to get an estimate we can suppose a constant production rate and an accumulation over 10 to 50 years. This will be on the high side, as production has certainly increased over 50 years, but it gives us a range of **2.4 million to 12 million tonnes in stockpiles.**

[1] https://www.eskom.co.za/wp-content/uploads/2022/03/GX-0001-Generation-Plant-Mix-Rev-25.docx.pdf

[2] www.treasury.gov.za/documents/national%20budget/2022/review/FullBR.pdf

Available Energy

Waste tyres contain about 30MJ/kg. This is comparable to, but about 10% higher, than the energy content of coal. (Sometimes higher figures are quoted, but those are typically based on tyre shreds or powder, whereas whole waste tyres contain about 15% steel by weight.)

These figures suggest total waste tyre energy content figures of:

- 7.2 million MJ per annum
- 72 million to 360 million MJ in stockpiles

These are figures for raw energy.

A thermal power station generating electricity from boilers can achieve about 32% efficiency[3]. If we apply these numbers and convert tie total energy from the annual waste tyres arising to available electricity in MWh, the equivalent generating capacity of the annual arisings of waste tyres is about 640 000 MWh, equivalent to **a 117MW power station operating 15 hours/day for a year[4]**.

Comparison with an Eskom Power Station

The calculations above can be tested against an Eskom power station. As an example, we will use the Lethabo[5] power station.

Eskom's Lethabo station has 6 turbines of 618MW for a total capacity of 3708 MW, which Eskom says consume 50 000 tonnes of coal per day. This means our annual waste tyres arising is equivalent in energy input to about 5 days of Lethabo's needs.

Annual Waste Tyres Arising

If we could scale down Lethabo to use all available waste tyres arising at a steady rate, that would work out to 3708 MW x 5/365 = **51 MW**.

This is less than half the number calculated in the previous section, but there we assumed operation for just 15 hours/day. It does however indicate that we are in the right numerical range.

Stockpiles

The total stockpiles were estimated as being in the range of 10 to 50 years' worth of production. This would mean that the total stockpile could **power Lethabo for between 53 and 265 days**.

In other words, Lethabo would exhaust all available tyres, stockpiles and new arisings combined, in a few months, and after that, would only be able to run for 5 days a year.

Conclusion

The scale of national electricity generation is vast compared to the availability of waste tyres. Modifying existing facilities to accept waste tyres as a fuel would involve significant engineering changes to the feed mechanisms, boilers, and pollution control. The different burn characteristics of

[3] See for example https://yaleclimateconnections.org/2022/10/energy-loss-is-single-biggest-component-of-todays-electricity-system/

[4] 1MWh = 1MJ x 3600 seconds; at 15 hours/day x 365 days/year ≈ 19.7 million MJ

[5] https://www.eskom.co.za/wp-content/uploads/2021/08/CO-0002-How-Electricity-is-produced-in-a-Coal-Fired-Power-Station-Rev-13.pdf

tyres would also require changes to the process control system. This would be a very expensive project that cannot be justified for the relatively tiny contribution to the national grid that it would deliver.

It could be feasible to build a new, dedicated facility designed to absorb a significant fraction of new waste tyre arisings plus a portion of stockpiles, which would have an operating life of, for example, 10 years. Such a plant would operate at no more than 50MW, otherwise it would exhaust feedstock too quickly to provide any return on investment.

It might also be worth considering a plant that could incinerate tyres mixed with other waste (primarily plastics) as this would have prospects of a longer working life. This would have its own challenges and is certainly not a quick fix.

Incineration in kilns is a more direct path to exploiting the energy latent in waste tyres. This remains as a viable option as there is already practical experience of this in South Africa.