Date:	Thursday, 7 June 2018
To:	New Zealand Productivity Commission
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SUBJECT:	CALIBRE SUBMISSION RE: LOW EMISSIONS ECONOMY DRAFT REPORT

Calibre wishes to congratulate the Commission for this balanced and detailed DRAFT report. In our view, it identifies many viable options that have merit to effectively reduce New Zealand's domestic greenhouse gas emissions. The DRAFT report is useful to identify options, policy measures, complementing additional measures and feasible pathways to a low carbon future.

In section 14.5, the report lists new Waste to Energy projects with anaerobic digestion of food waste and industrial waste as potential "low hanging fruits" to achieve rapid reductions or GHG emission offsets at low costs. We agree with that finding. The New Zealand Waste to Energy industry has more than 30 years experience in the design and implementation of large scale anaerobic digestion systems for liquid trade waste, food waste and industrial waste co-digestion in municipal and agro-industrial factory WWTPs in New Zealand and SE Asia [5,7]. Based on this experience we would like to offer here some additional information/comment which may assist the Commission in assessing options with quantitative relevance and commercial viability. In particular, organic waste co-digestion in existing municipal WWTP anaerobic digesters designed with current technology standards and participating in a "Net Zero Carbon Economy" in New Zealand - as well as future, newly built WWTP digesters.

Key Features of Urban Waste to Energy (WtE) Programs with Anaerobic Digestion: Anaerobic digesters on municipal WWTP have typical some spare capacity which can be utilised for energy recovery from additional, brought in suitable organic materials. One low cost, high value, high return (and immediately executable) option for increased WtE programs in New Zealand is to increase that capacity by adding low cost add-on improvements [5] to existing anaerobic sludge digesters on municipal WWTP (DRAFT report section 14.5). WWTP sludge digesters in NZ today have low biogas production (65 % methane, 35 % CO_2) due to the feedstock they process. Municipal WWTP sludge digesters service currently only 53 % of the current NZ population. Typically, all municipal WWTP biogas fuel is captured and used onsite for heat and power production (with minimum GHG emissions) and surplus gas is flared.

Co-digestion of selected organic waste using the spare capacity in municipal WWTP is an established technology [1,2]. Internationally widely practiced [1,2,5,8] it has the potential to increase the biogas production in WWTP digesters by up to about 100 % [1 - 5]. Sydney Water, South Australia Water, Queensland Urban Utilities and some WWTP plants in NZ (PNCC, CCC, Watercare) are examples where this is regularly or "on demand" practiced. A large resource of suitable, easily digestible and concentrated organic waste materials from operating industrial, commercial and institutional sources is currently not utilised for co-digestion, energy production, GHG emission abatement. Often these materials are directly applied to land or even landfilled increasing our GHG emissions. The biogas from co-digestion is recognised by the International Energy Agency (IEA) and by UNFCCC as a renewable (zero carbon) fuel, suitable for use in on-site boilers and gensets or for distribution in purpose built biogas networks (for example Christchurch's council biogas network). Co-digestion treatment in municipal WWTP digesters diverts the processed additional organic waste from landfills and reduces landfill gas emissions in the process at the lowest possible capital costs. By removing H_2S, siloxanes and CO2, the WWTP biogas can be upgraded to vehicle fuel quality and is proven for use in light transport CNG vehicles, CNG trucks, CNG buses etc.. Economical gas upgrade facilities start at about 300 m^3 biogas/hour (200 L diesel equivalent/hour).

Economic Features: The main reason for lack of investment into new digester plant for organic waste digestion in New Zealand are the high capital costs for new digester plants. Added operating costs for the co-digestion treatment of organic waste in existing digesters (labour, power, chemicals) are typically much lower than CAPEX service costs for new digester plant and are more than offset by the revenue for the collected treatment fees for the imported organic waste (gate fees, see Table 1 overleaf) [1.2]. Organic materials in this category are institutional, commercial, industrial (ICI) food waste, grease trap waste (GTW, collection from commercial premises), industrial wastewater treatment sludge (DAF solids), liquid digestible waste (e.g. biodiesel glycerine waste) and municipal WWTP sludge from nearby regional centres or rural towns.

A recent life cycle assessment [3] compared the environmental impact of anaerobic co-digestion with the current waste management systems and indicated organic waste co-digestion to have less environmental impact for all categories modelled, despite the need to collect and separately pre-treat food waste.

There are seven key economic drivers for successful co-digestion programs in municipal sludge digesters:

1. Availability of a consistent feedstock supply chain (seasonality of feedstock supply is acceptable)
2. Availability of spare treatment capacity in the municipal digester (site specific, feedstock specific)
3. Availability of waste reception facilities (one-off added CAPEX investment and space required)
4. High on site usage of the produced heat and power (site specific and seasonal)
5. Cooperation with the waste management industry to achieve attractive gate fees for brought in waste
6. Cooperation with utilities to purchase surplus power in peak demand periods
7. Sale of surplus biogas to co-sited gas users or local biogas network (flare as little as possible)

Typically, there are always some regional waste market and energy market factors that constrain some of these drivers. Co-digestion programs on municipal WWTP require thus a thoughtful and careful co-digestion business case and technical system design that de-risks these commercial aspects. Participation by or partnership with the waste management industry is always crucial as well as the availability of acceptable alternative fall back options in periods of technical issues with the WWTP.

References [1 - 5] and Table 1 further below give domestic and international examples for successful organic waste co-digestion solutions on municipal WWTP.

Table 1: Simple payback period for co-digestion upgrade of an existing digester plant for trade waste co-digestion (based on PNCC operation experience). Upgrade was achieved by addition of a liquid trade waste reception and recuperative thickening plant to a typical digester plant with 2 parallel digester process trains. This plant would be similar to the current digester plant at PNCC.

REVENUES FROM RESIDUES
(100,000 EP PLANT, 2 DIGESTER TANKS)

	Construction costs (incl. waste reception)	Operating cost	Revenue from trade waste gate fees	Revenue from biogas sales as genset fuel	Simple Payback Period
Gate fee: 30 $/m³	$ 1.1 million	$ 0.2 million/ annum	$ 0.38 million/ annum	$ 0.15 million/ annum	3.3 years
Gate fee: 50 $/m³	$ 1.1 million	$ 0.2 million/ annum	$ 0.63 million/ annum	$ 0.15 million/ annum	1.9 years

Electricity: 0.15 $/kwh.
Polymer: 10 $/kg and 6 kg polymer/t DS.
Value of biogas: 0.025 $/$kwh_{biogas}$.
Annual trade waste processing capacity: 13,000 wet t/annum

International experience: Based on experience from Europe, USA, Australia, SE Asia [1 – 8] it is now an accepted industry view that co-processing (co-digestion) of well selected, highly digestible trade waste materials together with treatment plant sludge in WWTP digesters increases WWTP gas and power production and attracts substantial additional revenue for the digester asset operation. Achieved co-digestion gains are on-site gas&power production increases from 20-30 to 50-60 % of the site energy needs without changes to the WWTP plant operation and process. In some countries, co-digestion has now become a standard practice since more than 20 years (Denmark). Recent environmental industry reviews show high numbers of urban WWTP that already utilise selected trade and industrial waste and food waste co-digestion in WWTP digesters or similar centralised digester plants : Germany (180), Italy (68) USA (19), Australia (4). Japan (3), New Zealand (3). The digesters at the Palmerston North treatment plant (PNCC) could increase the digester gas and on-site power production by about 50 % using existing digester process spare capacity for co-digestion of WWTP sludge with high fat, oil and grease (FOG) content milk and yoghurt processing factory sludge [7, base case]. Independent waste evaluation reports from Australia have confirmed the significant potential of high FOG waste for co-digestion programs [6].

Potential to increase the benefits from organic waste co-digestion: Currently, only about 53 % of the NZ population are connected to 14 WWTP with on site biogas production in anaerobic sludge digesters. The net biogas fuel is mainly used on site for power generation, some power export to grid and flaring of excess biogas. Only 3 of these plants practice trade waste co-digestion. That is a comparatively low figure. Over 250 WWTP in New Zealand have thus no anaerobic digesters on site and the raw WWTP biosolids are disposed to landfill or stabilised by other techniques. 47 % of the NZ population are presently connected to WWTP without sludge digestion services and no biogas is produced in these WWTP at all. In most cases, it was believed to be uneconomic to install sludge digesters (small scale) and these WWTP plants were designed when fossil fuels and power were reasonably cheap. The potential for co-digestion in New Zealand is thus currently restricted by the number of available existing municipal digester plants with available “spare digester capacity” and the viability of the “local co-digestion business case” when responding to the seven drivers listed above.

A recent digester capacity upgrade innovation (Recuperative Thickening; RT) has been shown to substantially change that picture and create a viable organic waste co-digestion business case (see Table 1) when added to operating municipal sludge digesters (“plug and play” installation, no changes to WWTP infrastructure). The RT add-on has been shown to reliably more than double the waste dry matter throughput and daily biogas production per digester tank (Hamilton and Palmerston North, developed by Calibre). RT addition has inherent low CAPEX and OPEX costs (Table 1 above), has been developed and already successfully used in New Zealand for WWTP biosolids digestion and trade waste co-digestion. The application of the innovation in the Palmerston North digesters combined with organic waste co-digestion has tripled the normal overall average biogas production [5,7] from 750 m^3/day per digester tank to over 2,200 m^3/day/tank without the need for construction of new digesters. The digesters with trade waste co-digestion and recuperative thickening produce now up to about 150 % of the site electricity requirements [5, 7]. Seven years of successful continuous operation with robust commercial and technical performance through increased digester throughput [5,7] have demonstrated the technical and commercial feasibility and reliability under realistic, practical operation condition.

This RT technology success has been recognised with two NZ Water Industry Awards. A similar system has also gained traction in approximately seven municipal WWTP sludge digesters in Australia (Sydney Water, SA Water, Melbourne Water). Improved digestion process robustness is an additional advantage when treating high fat content industrial materials that give the highest possible biogas yields (up to 210 Nm^3 methane/m^3 waste; grease trap waste, fat, oil&grease separator waste from dairy and meat processing, food residuals) and is proven under real world operation conditions (PNCC project). PNCC is currently in the process to add an additional food waste reception (Calibre designed) to the “60 year old” sludge digesters aiming for a final quadrupled daily biogas output (6,000 m^3 biogas/day) practicing combined co-digestion of WWTP sludge, dairy industry waste, WWTP biosolids and commercial food waste. Another advantage for co-digestion applications in existing digesters are low maintenance requirements, a compact design and very efficient solids retention. This adds to the digester process robustness.

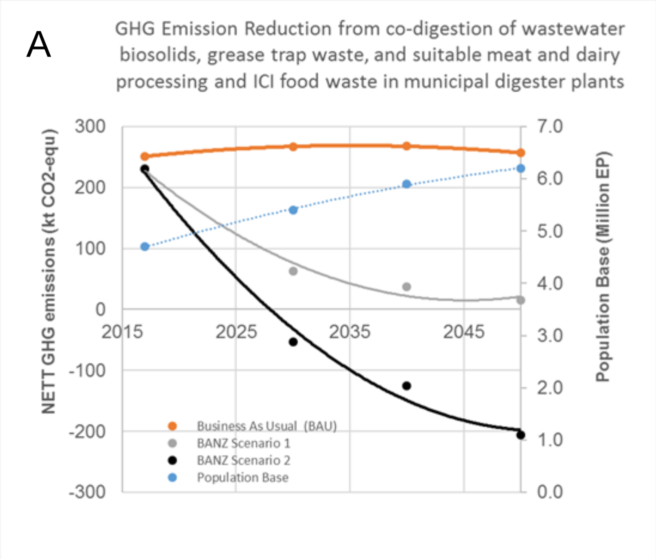
Relevance of organic waste co-digestion based Waste to energy programs for a low emission economy: Significant benefits from a nationwide organic waste co-digestion program with NZ WWTP digesters have been demonstrated in a recent report analysing the potential of the NZ WWTP infrastructure for intensified biogas production from industrial and trade waste co-digestion [8]. The report estimates that a total of 61 % of the NZ population could be connected by 2030 to organic co-digestion systems with recuperative thickening on existing digesters. With addition of new modern state of the art digesters to 8 more municipal WWTP by 2050 (all greater than 30,000 ep) this would involve less than 30 WWTP in NZ for about 70 % of the NZ population [8]. The technical potential for maximum use of this option in 2050 would be the upgrade of another 10-15 municipal WWTP with modern anaerobic digesters increasing the WWTP co-digestion program to up to 78 % of the NZ population. This estimate is based on an initial systematic implementation in 14 existing WWTP plants of the RT-digester system (shown in Table 1), efficient organic waste supply chains and co-digestion and connection of the Wellington region population to WWTP with new sludge digesters by 2030.

Addition of new state-of-the-art organic waste co-digestion capacity at municipal WWTP could increase municipal biogas production from 0.55 PJ/annum to up to 3.2 PJ/annum in 2050 (Figure 1 B; over 30 years, full capture of urban ICI food waste and on average stabilising 70 % of the industrial WWTP DAF sludge resource from dairy processing and meat processing factories in New Zealand). This is the gross biofuel energy potential, no transmission losses and waste transport energy allowed for and parasitic digester operation energy was already subtracted. For simplicity, it is assumed (based on international experience, see [3]) that the transport energy required for the supply chain of organic waste to the WWTP and then to final digester effluent disposal is similar to or less than the alternative current organic waste transport energy use [3]. It is recommended that details on this point are confirmed in a number of feasibility studies for NZ conditions.

The co-digestion biogas gross energy (parasitic digester operation process energy already subtracted) is available for replacing natural gas or coal use in the industrial heat, transport or peak demand power production applications.

The GHG abatement benefit from this option equates to negative emissions of – 450 kt CO_2-e/annum, resulting in “zero carbon emissions” from WWTP biosolids treatment and an additional offset of – 200 kt CO_2-e/annum (due to the GHG abatement benefits of biogas use in the industrial hear sector) from the organic waste co-digestion at the municipal WWTP digesters.

Conclusion: This submission supplies the Productivity Commission with additional data and international experiences that demonstrate the commercial viability, technical feasibility and GHG abatement benefit from a nationwide program of systematic implementation of anaerobic co-digestion of municipal WWTP sludge and selected liquid and solid trade waste and industrial wastewater solids. These materials are normally disposed to landfills or applied to land without energy gains and significant GHG emissions. Municipal WWTP are currently the "low hanging fruits of the waste sector (section 14.5 of the Productivity Commission DRAFT report). The proven advantages the co-digestion option could offer to a NZ Low Carbon Economy do warrant a targeted effort to enable the initiation of this program.



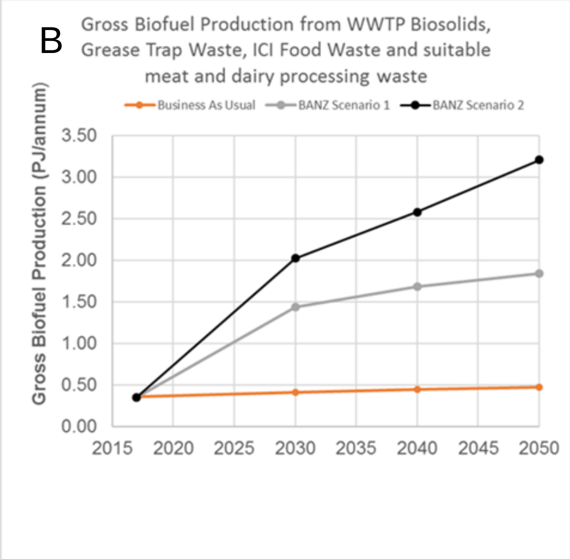


Figure 1 A: Comparison of the projected annual GHG emission reduction in the BAU scenario, scenario1 (trade waste and grease trap waste co-digestion) and scenario 2 (industrial waste co-digestion). Please note that scenario 1 with a simple digester efficiency upgrade (recuperative thickening) treating ICI quality pre-consumer food waste and grease trap waste by co-digestion and without use of additional industrial waste is already able to "nearly fully" offset the current and future GHG emissions from biosolids and GTW management in the BAU scenario. Please note that co-digestion of 70 % of suitable meat and dairy processing industry waste material in scenario 2 is expected to generate an additional GHG offset for the NZ economy of about – 200 kt CO_2-equ/annum.

B: Projected annual biogas production in the BAU scenario, scenario1 and scenario 2. Please note that scenario 1 with a simple digester efficiency upgrade (recuperative thickening) without use of additional industrial waste is already able to more than triple the biogas output from current municipal treatment plants. The majority of this additional biogas is available for use as biofuel for industrial/commercial heat production in proposed regional industrial parks. These new industrial parks are proposed to be constructed close to the existing urban and new regional co-digestion sites. About 1.5 PJ/annum of biogas from co-digestion of industrial waste is expected to be produced in 2050 (difference between scenario 2 and scenario 1).

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