

GEOTHERMAL ON A TRUCK – THE NATURE’S FLAME GEOTHERMAL DIRECT USE PROJECT

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ABSTRACT

In June 2019 Nature’s Flame and Contact Energy signed an energy supply agreement which will see Contact providing up to 22 MWt of geothermal energy to the Nature’s Flame wood pellet manufacturing plant in Taupo. The energy will be provided from an existing geothermal production well (TH6) which has been sustaining the Tenon Sawmill operation since 2006. This energy will facilitate the expansion of Nature’s Flame to begin exporting wood pellets to renewable energy markets in Asia, primarily Japan and South Korea, as well as providing a low carbon alternative to coal in boilers in New Zealand.

The project will make more efficient use of well TH6 and improve the operability of the system for Contact and its users, whilst providing an economical cost, reliable and low carbon energy solution for Nature’s Flame.

The energy supply system will be constructed and commissioned in late 2019, with full operation expected in November.

1. INTRODUCTION

In June of 2019 Nature’s Flame and Contact Energy signed an energy supply agreement which will see Contact providing up to 22 MWt of geothermal energy to the Nature’s Flame wood pellet manufacturing plant in Taupo, New Zealand. As at August 2019 construction of the heat plant and pipelines is underway, and by the time of the NZ Geothermal Workshop the system should be fully operational.

This paper outlines how the geothermal energy supply works, the many benefits accruing from it as well as some of the challenges that needed to be overcome

1.1 Wood Pellets

Wood Pellets are compressed wood fibre pellets used primarily as a heating fuel (they are also used as drilling additives, an absorbent for such things as removing dioxins from soil and animal bedding). There is a significant international trade in wood pellets with large demand in the United Kingdom, Europe and (increasingly) Japan and Korea. Production is dominated by the United States, Canada

and European countries, with Indonesia, Vietnam and Malaysia recent entrants.



Figure 1: wood pellets

The manufacturing process involves:

- Wood fibre (sawdust or chip) is obtained from various sawmills around the central North Island.
- The fibre is screened, ground and dried to a moisture content of <15% (this is the primary use of energy).
- The dried fibre is forced through a ring die press to form a uniform size and shape which is optimal for combustion.
- No chemicals are utilised in the process; fibres stick together by naturally occurring lignin in the wood (some wood pellet manufacturers add starch for binding).
- The pellets are packaged and sold:
 - Residential use: typically sold in 15 kg bags via hardware retailers throughout NZ. Christchurch and Dunedin are important markets due to domestic air emission restrictions. More Regional Councils around the country are imposing the same restrictions adding to growth currently.
 - Commercial / Industrial: sold in bulk bags or truck load.
 - Exported in either bulk bags or full ship holds.

Nature’s Flame’s Wood pellet product quality is governed by:

- DIN EN ISO17225-2 (A1) Solid Biofuels: Fuel Specifications and classes: Part 2 Graded Wood Pellets, for domestic use and;
- Initiative Wood Pellet Buyers: Industrial Wood Pellets Specification for industrial use.

Key quality parameters include:

- Ash content
- Energy content
- Moisture
- Bulk Density
- Ash Constituents
- Durability (i.e. pellet does not break apart during shipment)

In addition, many consumers require wood pellets to meet environmental sustainability standards such as:

- Forest Stewardship Certification (FSC)
- Programme for the Endorsement of Forest Certification (PEFC)

The Nature's Flame products utilize FSC certified wood, and hold the DINplus certification. New Zealand wood products are considered high quality due to its high calorific value (around 19 GJ/tonne), uniform feed stock from sustainable pine forest and low ash content.

2. A LONG ROAD

2.1 Solid Energy Renewable Fuels

Nature's Flame was established by Solid Energy (Solid Energy Renewable Fuels) in 2003 with the purchase of a small wood pellet manufacturer in Christchurch. Subsequently wood pellet manufacturing plants were established in Rotorua and Taupo. The Rotorua and Christchurch plants were closed in 2012 and production centered on Taupo. The Taupo plant was constructed in 2009 and has a production capacity of 85,000 tonnes of wood pellets per year (requiring around 170,000 tonnes per year of wood fibre).

The initial market focus for the Nature's Flame business was to provide an alternative fuel to coal for use in New Zealand's homes, schools, hospitals and other institutions. Incentives were available during the 5th Labour government of 1999-2008 to government departments, of which mainly schools accepted, to assist with the cost of converting from coal to wood pellets. These incentives were reduced after the election of the 5th National Government in 2008. Due to this, and other entrants into the pellet manufacturing business, domestic wood pellet demand plateaued with Nature's Flame running its operations at part capacity, and a focused effort commenced in export markets to increase capacity.

Contact Energy and Solid Energy started discussions regarding providing geothermal energy to the (then proposed) Taupo plant in early 2008. However, by late 2008 Solid Energy had decided that there was too much risk in signing long term contracts with the looming Global Financial Crisis to proceed with investing in bringing the Taupo Plant to full capacity, and decided to utilise an existing on site 6 MW biomass boiler to provide adequate heat to run the plant at around 30% capacity.

Geothermal energy supply discussions between Contact and Solid Energy were briefly rekindled in 2011 but died as Solid Energy's opinion at the time was it was more cost efficient to invest in a large biomass boiler as opposed to the use of geothermal energy.

2.2 Norske Skog Holdings #3

In 2013 Solid Energy went into administration after financial pressure due to the overnight crash of the international coking coal market. The Nature's Flame business was purchased by Norske Skog Australasia in 2015, who were seeking to diversify their operations away from news print manufacture and saw the huge international potential for the wood pellet industry.

Norske Skog not only brought a secure supply of wood fibre to Nature's Flame, but also a sound knowledge of geothermal energy operations from its operations in Kawerau. Discussions with Contact on a geothermal energy supply to the plant re-commenced in early 2015.

However, despite bringing numerous advantages to the Nature's Flame operation, Norske Skog Industries (Norway) also brought a crippling debt. Whilst a geothermal energy agreement had been negotiated between the parties, it was unable to secure Norske Skog board approval as the company did not have the capital required to proceed.

In 2017 Norske Skog Industries (Norway) went into bankruptcy and was removed from the Oslo stock exchange. The Norske Skog operations were purchased by a London based investment firm (Oceanwood Capital Management) in a move which released the operations from the previous debt burden. This opened the door for Nature's Flame to re-contemplate expansion and a geothermal energy connection.

Discussion with Contact re-commenced in early 2018, and by the end of the year the parties had settled on terms and a final agreement had been reached. This agreement was finally signed in June 2019, over ten years from when initial discussions started.

Construction of the geothermal energy supply system has now commenced and should be operational by the time this paper is presented at the NZ Geothermal workshop in November.



Figure 2: The Nature's Flame plant and sawdust mountain.

3. THE SOLUTION

Nature's Flame will be provided with a continuous supply of fresh water heated to 135°C. The primary loop and heat plant are located on Contact's land adjacent to the existing Tenon pipelines (see plan in Schedule 1 below). The secondary loop transfers the heated freshwater 800 m to the Nature's Flame site, passing underneath Rakaunui Road. This water is then used to heat a lower pressure tertiary loop which provides the heat to the Nature's Flame driers.

The secondary loop recirculates freshwater – returning to the Heat Plant at around 90°C.

The geothermal energy supply agreement, and the geothermal energy supply system, both incorporate some unique characteristics which are outlined below.

3.2 Commercial

The Energy Supply Agreement (ESA) is a twenty year commitment by both parties. Contact will provide up to 22 MWt of geothermal energy to Nature's Flame from wells currently used to support the Tenon Sawmill operation. This amount of energy will not only support the current plant up to full capacity, but also the anticipated future expansion of the plant (which will also incorporate energy recovery systems). As the Nature's Flame supply is intertwined with the existing supply to Tenon it was important to ensure that the Tenon and Natures Flame agreements were aligned as much as possible (Contact and Tenon also signed a new twenty year Energy Supply Agreement in June 2019). Areas requiring alignment included term and price review periods, scheduling of outages and termination rights.

The ESA also encourages the parties to work together to explore mutually beneficial business opportunities. Both Contact and Nature's Flame are strategically focused on decarbonising New Zealand, so are naturally aligned. A potential area for cooperation is in supporting geothermal direct use opportunities which require a low carbon peaking fuel – fuels able to either deliver process temperatures in excess of what geothermal can, or cover peaks in energy demand which the (inherently baseload) geothermal energy cannot meet, such as the loads common in dairy processing. Contact and Natures Flame are currently also exploring a biomass alternative to diesel generators to provide localized electricity grid support.

3.3 Technical

A key challenge in designing the Nature's Flame energy supply system was how to optimise the use of the energy available downstream of the Tenon sawmill operations.

Contact has been providing geothermal energy to Tenon's lumber drying kilns since 2006 from production well TH6. TH6 is a robust production well which provides more energy than Tenon can utilise. Introducing the Natures Flame energy supply onto this well will utilise the well's full capacity.



Figure 3: Well TH6, with Nature's Flame in the background.

Depending on the load in Tenon's kilns, the outlet temperature from the Tenon heat plant can vary between 180°C and 130°C. The Nature's Flame heat plant had to be

designed to accommodate these fluxes and provide a steady 135°C in the secondary loop to Nature's Flame. Additionally, at times there would not be enough heat available downstream of Tenon to meet Nature's Flame requirements. To accommodate this, geothermal fluid directly from TH6 is also introduced into the heat plant. Initially it was planned to do this through a second heat exchanger, but this added complexity and cost to the project. It was decided to utilise a sparge to mix the two phase fluid direct from TH6, and the single phase fluid from downstream of Tenon. It is believed that this is the first time such a system has been used to mix single phase and two-phase fluid geothermal fluids.

4. THE MARKET

Demand for wood pellets in New Zealand is relatively stagnant, with moderate growth in the residential market, mainly driven by local air emission controls and the phasing out of wood fires. More recently with the advent of the Emissions Trading Scheme new enquiries are being fielded from larger industrial users.

Whilst Nature's Flame will continue to provide product into the New Zealand market, the primary growth in the market for wood pellets is most likely in Asia. Both South Korea and Japan have ambitious climate change targets they have committed to meet but are chronically under resourced in low carbon energy sources. The ability to co-fire or fully convert to wood pellets in existing coal facilities, with minimal retrofitting, has resulted in a significant boom in the demand for wood pellets, particularly those sourced from sustainable forests. In Japan especially there are planned and approved projects to build new, purpose built, wood pellet facilities for the electricity sector. Demand for wood pellets in these two countries is expected to rise from a current (2018) 6.6M tonnes per year to 17.2M tonnes by 2025 (Futuremetrics 2018), primarily displacing coal, oil and gas combustion. Nature's Flame may be able to satisfy 1% of that market.

Global supply of wood pellets is dominated by Canada, the United States and European nations (US Department of Commerce 2016). Whilst several south east Asian nations have begun producing pellets (Vietnam, Indonesia and Malaysia) they in the past have not met the sustainability and environmental standards demanded by Japan and Korea, but more recently have been focused on achieving these standards.

Historically Canada has provided the majority of wood pellets imported into Japan and Korea, at around 80% market share (Futuremetrics 2018). Canada will continue to be a significant supplier into Asia, but it is not expected they will be able to keep up with the anticipated demand growth.

5. GEOTHERMAL ON A TRUCK

Whilst geothermal energy is a fantastic resource, one of its limitations is that it is very hard to transport over significant distances. Geothermal pipelines longer than 5km are rare in New Zealand primarily due to the cost of installation and securing land access. Historically this has been overcome by converting the energy into electrons, and exporting it to market via transmission lines. Otherwise, the geothermal energy must be used close to the source.

The Nature's Flame project will take that geothermal energy and encapsulate it in a transportable, durable and low carbon energy product, allowing less renewably blessed nations to benefit. Contact is eager to explore how this transformation can be replicated in the forms of hydrogen, methanol or biofuels – all ways to get Geothermal on a Truck.

6. CONCLUSION

There is general consensus that geothermal direct use projects are an excellent use of our unique resources. However, as this paper highlights, the road to fruition can be long and complicated, and can be impacted by things well outside the parties control – in this case parent company issues, government policy (in NZ and abroad) and market dynamics.

A key asset in bringing these projects to fruition is an ability to collaborate, resilience and above all perseverance. After ten years it is satisfying to see pipelines being laid, and hopefully by November the energy will be flowing.

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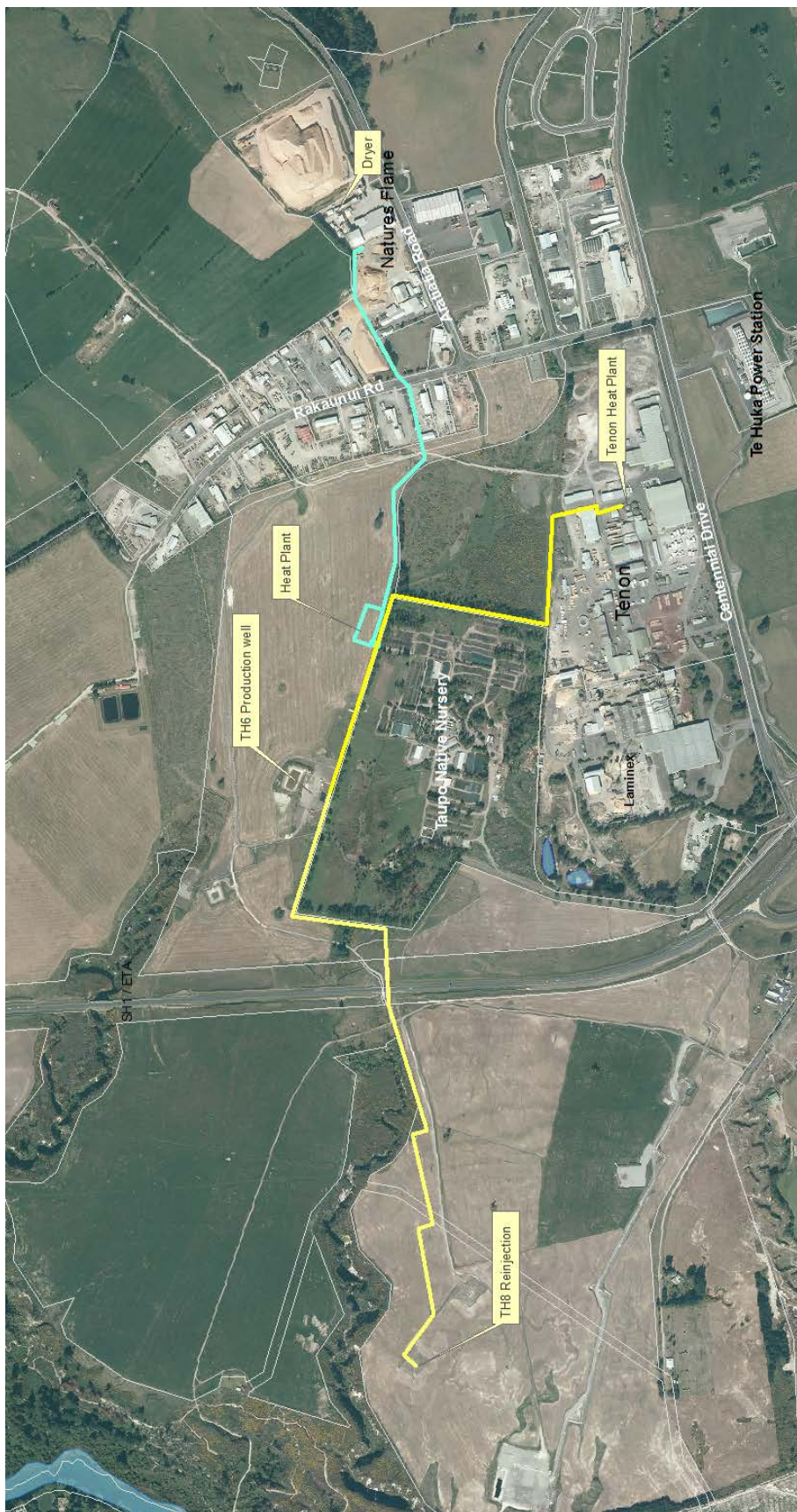


Figure 2 : Aerial Plan