FutureMetrics™ LLC
8 Airport Road
Bethel, ME 04217, USA

The Next Wave of Japanese Pellet Fuel Demand will be from the Large Utility Power Stations

December 2, 2021

By William Strauss, PhD, President, FutureMetrics

Japanese demand for pellet fuel has grown rapidly in the past five years. Figure 1 below shows that monthly imports of pellet fuel are more than 5 times higher now than they were in 2017.

This growth in demand has been primarily supported by the many relatively small independent power generation projects that have been built to take advantage of the feed-in-tariff (FiT) for biomass fuels. Figure 2 below shows the distribution of the size, in MW's, of those projects. The vast majority of those FiT supported units use fluidized bed boilers that are capable of using a variety of biomass fuels such as palm kernel shells (PKS), wood chips, and wood pellets.

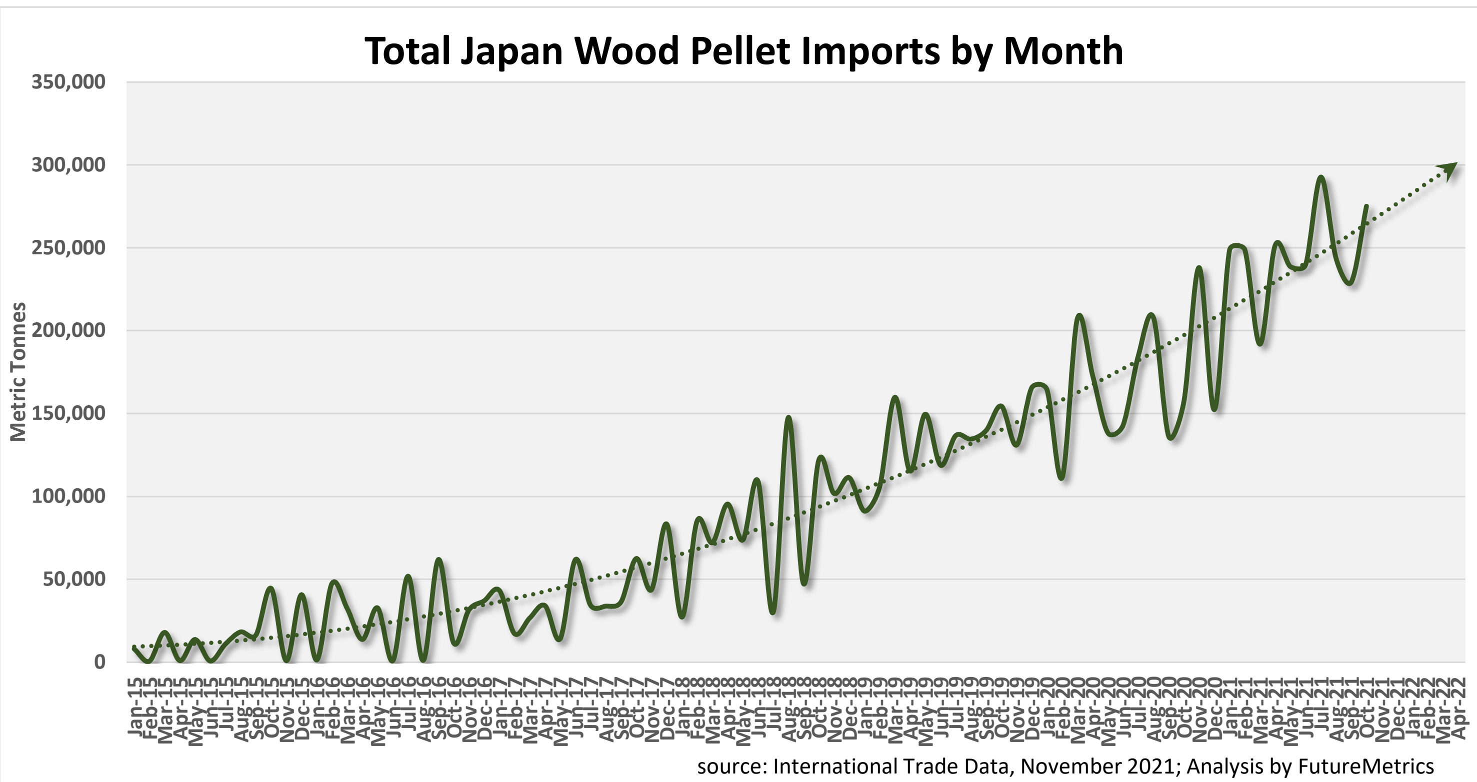

Figure 1 - Japan pellet fuel imports by month

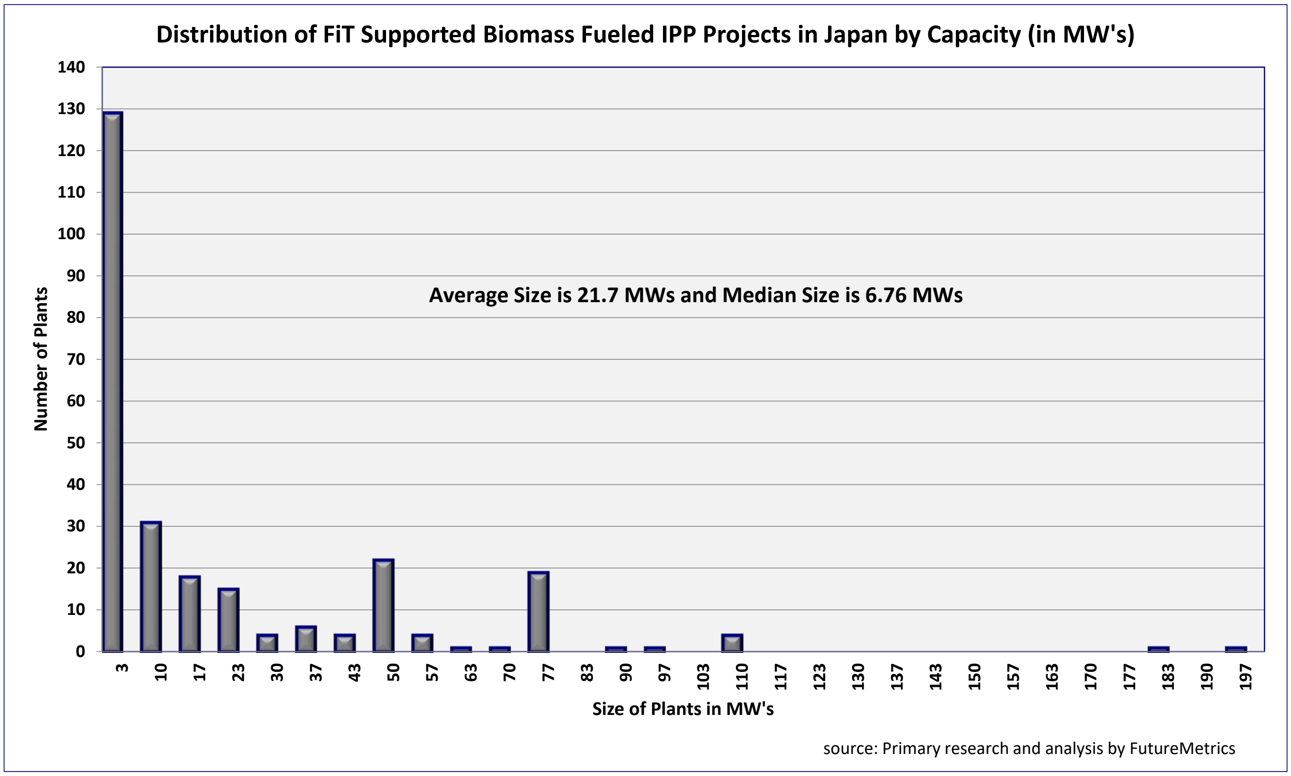

Figure 2 Distribution of FiT supported projects in Japan

Japanese policies have been successful in defining tactics for honoring their commitments to lower carbon dioxide (CO_2) emissions. This is particularly impressive when noting that almost 100% of Japan's energy for power, heat, and transportation is imported, and that Japan has suffered the loss of most of the non-CO_2 emitting nuclear power generation stations.

Japan is committed to reduce its CO_2 emissions; and to do so has recently set more aggressive goals for its energy mix by the year 2030[1]. Figure 3 below shows the historical energy mix for power generation in Japan from the years 2000 to 2020. It also shows the new 2030 goals for the proportion of power generation from fossil fuels, nuclear, and renewables.

[1] See HERE.

FutureMetrics™ LLC
8 Airport Road
Bethel, ME 04217, USA

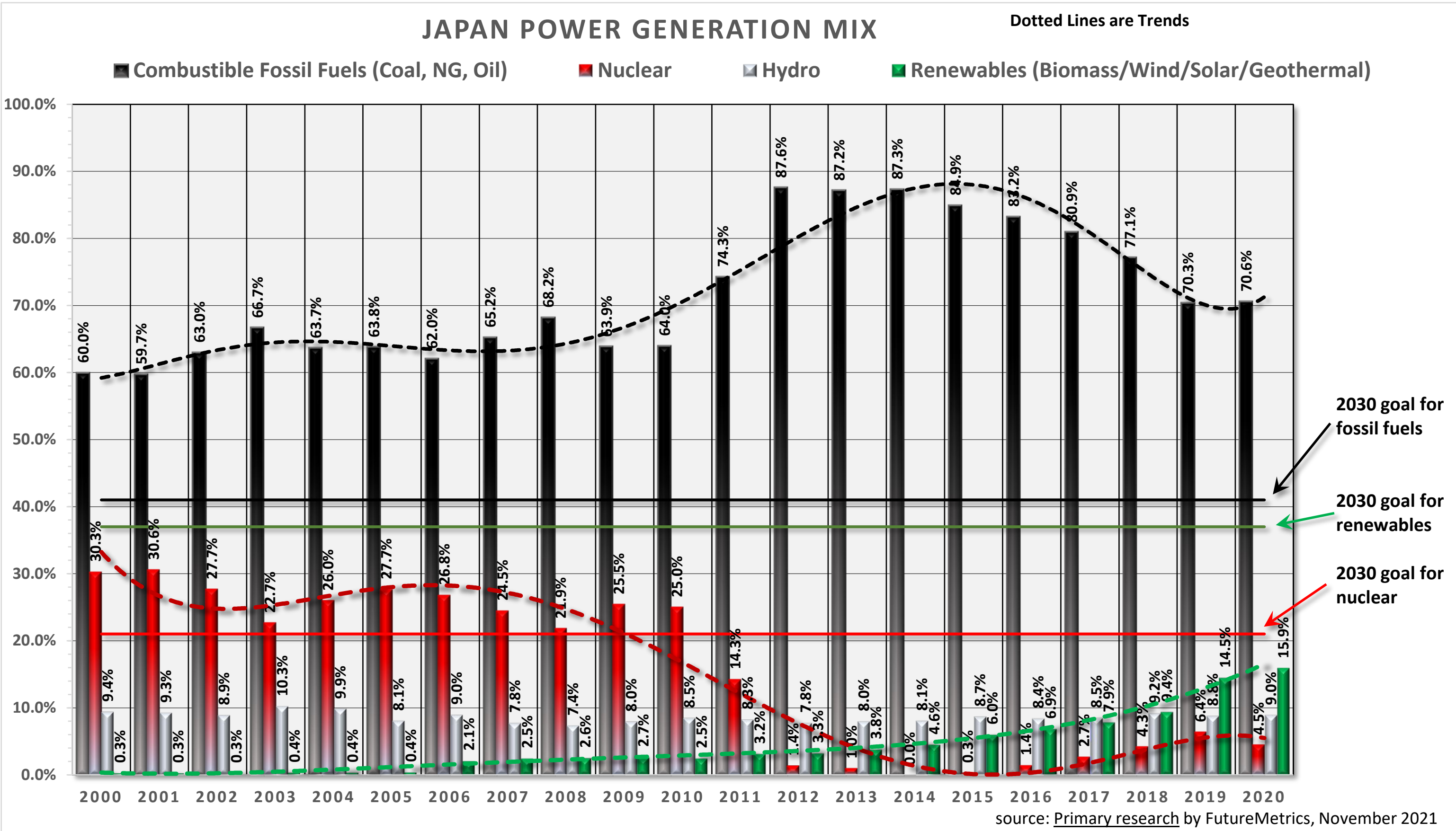

Figure 3 - Japan's energy mix from 2000 to 2020 with 2030 goals

As figure 3 shows, reaching the goals will require both a massive decline in coal-fueled generation and a more than doubling of renewable power generation from about 16% in 2020 to 37% by 2030. Furthermore, the CO_2 mitigation to be achieved by 2030 is predicated upon nuclear generation reaching 21% of the total (an increase of 4.7 times over current output).

These goals and challenges suggest that there will be a need for on-demand power generation both to balance the variability and intermittency of wind and solar generation, and to replace the baseload characteristics of coal generation. The need for carbon beneficial baseload power will become even more pressing if nuclear generation does not reach the goal of 21% of the total.

A component of the solution to that challenge is somewhat straight forward. The strategy that can benefit Japan is already common and ordinary in the UK, western Europe, and South Korea. The strategy that is already deployed in those jurisdictions is to use sustainably sourced solid fuel that can replace coal in large utility power boilers. This solution leverages existing coal power plants and their interconnections to the grid by changing the fuel they use from coal to pellet fuel[2]. The cost to modify or convert existing pulverized coal (PC) generation units to use pellet fuel is very low compared to building new generation capacity. Co-firing or full-firing pellet fuel is a proven solution that does not degrade the existing plant's reliability or output rating. And co-firing or full firing does significantly lower net CO_2 emissions[3].

This strategy already has a foundation in existing Japanese policies.

Japan has announced a goal of a 46% reduction in CO_2 emissions by 2030[4]. Given the current energy mix and the challenges associated with reaching the 2030 energy mix goals, a strategy for using existing PC power stations seems pragmatic. Maintaining grid reliability and stability in parallel with a massive wind and solar build out, an even more massive build out of grid-level energy storage solutions, and the reliance on nuclear generation to fill the gap for baseload power from coal generation retirements suggests that it would be rational to include the use of PC power stations running on pellet fuel as part of the pathway to "Beyond Zero"[5].

Another policy pathway is based on Japan's regulators having set a floor on power plant efficiency of 43% that has to be reached by 2030[6]. Those power stations that are below the minimum efficiency requirement will have to cease operations. But there is way for those lower efficiency units to continue to operate.

Japan's regulators have recognized the environmental benefits of co-firing pellet fuel. As a result, the efficiency calculation is allowed to not include the energy from pellet fuel in the total energy input to the power station. In effect, the more pellet fuel that is co-fired, the higher the calculated efficiency. Therefore, some Japanese pellet fuel demand will be as a result of selected coal generating units co-firing pellets to achieve the minimum efficiency requirement.

---

[2] The existing coal fueled utility power stations use "pulverized coal" (PC) systems to process the fuel and deliver it to the burners. Pellet fuel can be used in the same fuel processing, feed, and burner systems with very modest modifications and, if properly modified, with no derating.
[3] See several FutureMetrics white papers on the topic of CO_2 accounting when using pellet fuel produced from certified sustainable fuel. The basic necessary condition is that the forest landscape (and thus the carbon stock held in the forest) cannot be depleted. As long as the growth rate exceeds the harvest rate in the managed forest, the carbon stock is not depleted and thus all carbon emissions from combustion of the certified fuel are reabsorbed by the new growth contemporaneously.
[4] Compared to 2013 emissions levels. See HERE.
[5] See HERE.
[6] FutureMetrics has read reports with several different metrics for the minimum suggesting that it could be between 41% and 44.3%.

Real World Events are Supporting the Efficacy of these Policies and are Foreshadowing Future Japanese Pellet Fuel Demand

The analysis in Table1 illustrates the potential for pellet fuel demand from a real-world Japanese power producer. A recent announcement by a major power generator in Japan, J-Power and a US pellet fuel producer, Enviva, is the basis of what follows[7].

The announcement defines J-Power's potential demand for pellet fuel supplied for J-Power's fleet of coal fueled power stations. They contemplate up to 5 million metric tonnes per year of pellet fuel to be transported to Japan.

J-Power has several operating units. The table below shows their units, their capacity in megawatts, the year they started operation, the type of boiler design, and the estimated weighted average heat rate and efficiency of their coal fueled fleet[8].

Table 1- J-Power's coal fueled generation

Unit	Capacity (MW's)	Commissioning Year		Estimated Efficiency
Ishikawa power station Unit 1	156	1986	subcritical	28.43%
Ishikawa power station Unit 2	156	1987	subcritical	28.43%
Isogo power station Unit 1	600	2002	ultra-super	42.65%
Isogo power station Unit 2	600	2009	ultra-super	42.65%
Matsushima power station Unit 1	500	1981	supercritical	34.12%
Matsushima power station Unit 2	500	1981	supercritical	34.12%
Matsuura power station Unit 1	1,000	1990	supercritical	34.12%
Matsuura power station Unit 2	1,000	1997	ultra-super	42.65%
Takasago power station Unit 1	250	1968	subcritical	28.43%
Takasago power station Unit 2	250	1969	subcritical	28.43%
Takehara New Unit 1	600	2020	ultra-super	42.65%
Takehara power station Unit 3	700	1983	supercritical	34.12%
J-POWER Tachibana-wan power station Unit 1	1,050	2000	ultra-super	42.65%
J-POWER Tachibana-wan power station Unit 2	1,050	2000	ultra-super	42.65%
Total Capacity	**8,412**			
Weighted Average Estimated Heat Rate	**9,028**			
Weighted Average Estimated Efficiency	**37.79%**			

source: Global Energy Monitor, July 2021; Analysis by FutureMetrics

[7] See press releases HERE and HERE.

[8] The heat rates for the units, and thus the efficiencies, are based on the designation of the units as subcritical, supercritical, or ultra-supercritical. The actual heat rates of the units are not known and will be higher or lower than those in Table 1. But this approximation yields indicative results that show a potential scenario for pellet fuel demand.

Table 2 shows the summary of J-Power's fleet after the 2030 retirements. After the 2030 retirements, assuming no new plants, J-Power will have about 5,600 MWs of generation based on PC technology. The table below also shows the impact on the overall fleet efficiency after all of the subcritical and all but one of the supercritical plants are retired.

Table 2 - J-Power summary of capacity and efficiency after 2030 based on current retirement plans

After Retirements	
Total Capacity	5,600
Weighted Average Estimated Heat Rate	8,250
Weighted Average Estimated Efficiency	41.36%

But there may be a "plan B". Plan B would keep all of the units operating past 2030.

Using the estimated weighted average heat rate (and thus efficiency) for all the currently operating units, and assuming that all the units will co-fire, it is somewhat straight forward to estimate the tonnes per year of pellet fuel that would be needed for the efficiency calculation to reach 43% across all of the units.

On page 8 is a screenshot of the FutureMetrics dashboard for calculating the annual pellet fuel needed to meet the minimum efficiency requirement.

The dashboard is set up with the current estimated weighted average efficiency for J-Power's coal generation fleet. The controls for the power station size and the number of units are set to yield a total generation capacity that is about the same as J-Power's: 8,400 MW's. The rest of the dashboard's default setting are not changed[9].

Adjusting the "co-firing control" until enough pellet fuel is co-fired to meet the minimum efficiency requirement yields an annual demand of just under 4.425 million tonnes of white pellets (which equates to about 3.9 million tonnes per year of SE pellet fuel). That is about 15.8% white pellets and 84.2% coal by weight. This estimated tonnage number is not too much lower than the 5 million tonnes per year mentioned in the J-Power/Enviva press release. If the weighted average fleet efficiency is lowered from the estimated 37.8% to 36.2% (heat rate of 9,425) with all other inputs held the same, the annual pellet fuel demand would be about 5 million tonnes per year.

FutureMetrics does not know the actual heat rates, capacity factors, and energy content of the coals used in the J-Power fleet; and certainly, FutureMetrics does not know J-Power's strategic plans for their coal fueled generation units. Their planning probably also includes a consideration of the net CO_2 emissions per MWh of power generated[10].

[9] The reader is invited to use the dashboard to experiment with their own inputs. The dashboard is assessable from the FutureMetrics homepage. A direct link to the dashboard is HERE.
[10] See the FutureMetrics dashboard that estimates the CO_2 footprint per MWh of power generated. Direct link HERE.

But this example does illustrate that it is likely that some Japanese operators of PC generation units with efficiencies lower than the minimum will co-fire pellet fuel. And the volumes will be significant.

What is the Cost/Benefit of Compliance?

At this time the consequences for non-compliance to the CO_2 emission goals and the minimum efficiency goals are not fully defined. Because pellet fuel has historically been more costly per GJ than coal, there has to be policy that addresses this cost difference that either subsidizes the cost of generation or penalizes the generator for failing to meet requirements.

With that said, at the 15.8% cofiring ratio used in the analysis above, the incremental generation cost over 100% coal is estimated to be less than $8/MWh (less than $0.008/kWh). Figure 4 below shows the estimated increase in cost using a number of input assumptions at a co-firing rate of 16%[11].

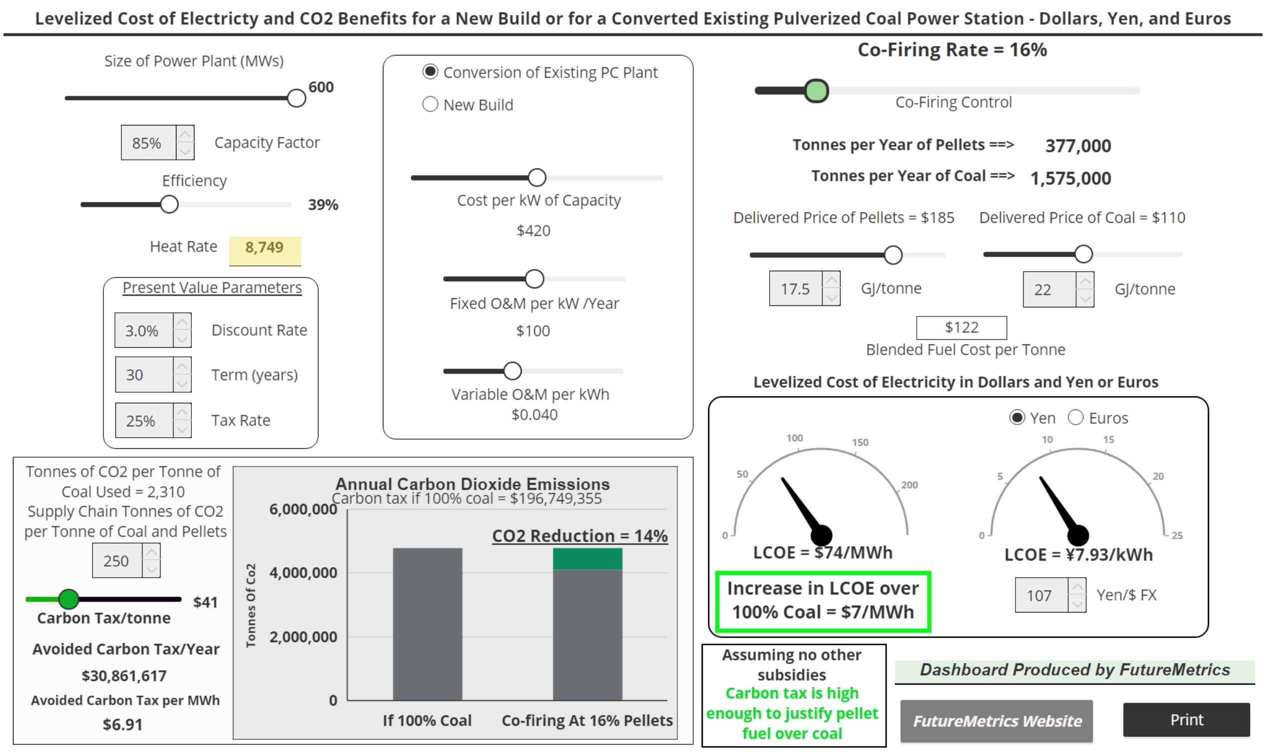

Figure 4 - Screenshot of LCOE Dashboard

At current exchange rates, an increase of about $0.008/kWh is about ¥0.9/kWh. The dashboard also shows that the CO_2 emissions are about 14% lower than would be the case with 100% coal.

The cost is very low, but the benefits are high!

[11] The reader is invited to experiment with the dashboard. A direct link to the dashboard is HERE.

FutureMetrics™ LLC
8 Airport Road
Bethel, ME 04217, USA