



Potential Demand for Renewable Wood Energy Products (RWEPP) in Southeast Alaska

Prepared by:

Dr. Allen M. Brackley, Team Leader and Research Forester,
USDA Forest Service PNW Sitka Wood Utilization Center, Sitka,
AK 99835



RWEPs that may Satisfy Potential Demand

- Traditional cordwood (bole wood, limbs, sawmill residuals)
- Chips including
 - Clean chips (pulp wood quality from sawmills or in wood chipping)
 - Complete (Biomass) tree chips
- Wood pellets (most of produced from residuals)
- Wood Briquettes (recycled wood, residuals, hogged wood)
 - Pucks
 - Bricks
- Various sawmill residuals (slabs, edgings, sawdust, bark, planer shavings, trim ends)



Sectors that may use RWEF

- Residential Sector
 - Traditional cordwood
 - Wood Pellets
 - Briquettes
 - Selected residues (slab wood, edgings, trim ends)
- Commercial Sector (Building with multiple housing units, Community building, Commercial buildings) - All of above buildings are of limited size
 - Chips (all forms)
 - Selected residues (bark, sawdust, hogged items)



What factors will stimulate conversion to renewable alternative?

- Price of alternative sources of energy
 - Natural gas
 - Oil
 - Electricity
 - Various bottled gas products
- Availability of wood
- Government policies that encourage conversion



Price comparison

- Convert a range unit prices for alternative energy cost to million Btu units
- Convert price per Btu from above to equivalent volumes and \$ value of renewable wood energy products
 - All wood energy products are initially measured in tons
 - Higher Heat Value (HHV) of all wood species and form considered as 8,200 Btu/pound
 - Recoverable energy calculated based on moisture content and rated efficiency.



A comment,

- In following tables the value of the RWEF is based on the Btu cost of an alternative energy product.
- To use the RWEF it must be **harvested, processed and delivered at a price lower than the reported Btu alternative** for it to be a viable replacement.
- **Costs for converting existing energy system to RWEF** systems must also be taken into consideration



\$Value of Btu's in wood, based upon \$value of Btu's in a **GALLON of **FUEL OIL** burned in a system with 78% energy efficiency (GHV recovered)**

| \$/ton value of wood at 16% MC, \$/Cord (green) and \$/MBF (green) value of logs based on \$ value of the Btu's in gallons of HEATING OIL at selected \$/gallon values | | | | | | |
|---|---|--|---|---------------------------------------|---|--|
| Cost of HEATING OIL \$/gallon | Air dry ton wood at 16% MC¹ | Green Weight of the material tons² | Recalculated value to green ton (50% MC) | Value per cord @ 2.5 tons/cord | Value per MBF @ 5.5 green tons/MBF | Increase in value by drying, but weight is reduced by 40% |
| \$2.00 | \$128 | 1.66 | \$77 | \$193 | \$424 | \$51 |
| \$2.50 | \$160 | 1.66 | \$96 | \$241 | \$530 | \$64 |
| \$3.00 | \$190 | 1.66 | \$114 | \$286 | \$630 | \$76 |
| \$3.50 | \$223 | 1.66 | \$134 | \$336 | \$739 | \$89 |
| \$4.00 | \$254 | 1.66 | \$153 | \$383 | \$842 | \$101 |
| \$4.50 | \$287 | 1.66 | \$173 | \$432 | \$951 | \$114 |
| \$5.00 | \$318 | 1.66 | \$192 | \$479 | \$1,054 | \$126 |
| Current Price Range Oil - "If the price of oil is \$3.50 gallon the Btu's in a green ton of wood are worth \$134!" | | | | | | |
| ¹ Btu value of a ton of wood @ 16% MC (green basis), assuming 50% efficiency = 6,888,000/ton | | | | | | |
| ² The Ton wood at 16% moisture content weighs 1,660 pounds (0.83 tons) bone dry and 3,320 pounds (1.66 tons) green or 50% moisture content. | | | | | | |
| Assume 1 cord = 2.5 tons | | | | | | |
| Assume 1 MBF = 11,000 lbs or 5.5 tons | | | | | | |



\$Value of Btu's in wood, based upon \$value of Btu's in a ccf of **NATURAL GAS** burned in a system with 78% energy efficiency (GHV recovered)

| \$/ton value of wood at 16% MC, Cord (green) and \$/MBF (green) value of logs based on \$ value of the Btu's in 100cf Natural Gas at selected \$/ccf values | | | | | | |
|---|---|--|---|--------------------------------|---|---|
| Cost of heating with NATURAL GAS \$/ccf | Air dry ton wood at 16% MC ¹ | Green Weight of the material tons ² | Recalculated value to green tons (50% MC) | Value per cord @ 2.5 tons/cord | \$value of material converted to MBF @ 5.5 green tons/MBF | Increase in value by drying, but weight is reduced by 40% |
| \$0.80 | \$68 | 1.66 | \$41 | \$102 | \$225 | \$27 |
| \$0.90 | \$77 | 1.66 | \$46 | \$116 | \$255 | \$31 |
| \$1.00 | \$86 | 1.66 | \$52 | \$130 | \$285 | \$34 |
| \$1.10 | \$94 | 1.66 | \$57 | \$142 | \$311 | \$37 |
| \$1.20 | \$103 | 1.66 | \$62 | \$155 | \$341 | \$41 |
| \$1.30 | \$111 | 1.66 | \$67 | \$167 | \$368 | \$44 |
| \$1.40 | \$120 | 1.66 | \$72 | \$181 | \$398 | \$48 |
| Current price of natural gas in Anchorage/Valley area shown above | | | | | | |
| \$2.35 | \$202 | 1.66 | \$122 | \$304 | \$669 | \$80 |
| \$2.45 | \$210 | 1.66 | \$127 | \$316 | \$696 | \$83 |
| \$2.55 | \$218 | 1.66 | \$131 | \$328 | \$722 | \$87 |
| Current price of natural gas in Fairbanks area. | | | | | | |
| ¹ Btu value of a ton of wood @ 16% MC (green basis), assuming 50% efficiency = 6,888,000/ton | | | | | | |
| ² The Ton wood at 16% moisture content weighs 1,660 pounds (0.83 tons) bone dry and 3,320 pounds (1.66 tons) green or 50% moisture content. | | | | | | |
| Assume 1 cord = 2.5 tons | | | | | | |
| Assume 1 MBF = 11,000 lbs or 5.5 tons | | | | | | |



\$Value of Btu's in wood, based upon \$value of Btu's in **kwh of ELECTICITY** using baseboard system



| \$/ton value of wood at 16% MC, Cord (green) and \$/MBF (green) value based on \$ value of the Btu's in 1kwh ELECTRICITY | | | | | | |
|--|---|--|---|---------------------------------------|---|---|
| Cost of heating with ELECTICITY \$/kwh | Air dry ton wood at 16% MC ¹ | Green Weight of the material tons ² | Recalculated value to green tons (50% MC) | Value per cord @ 2.5 tons/cord | \$value of material converted to MBF @ 5.5 green tons/MBF | Increase in value by drying, but weight is reduced by 40% |
| \$0.10 | \$202 | 1.66 | \$122 | \$304 | \$669 | \$80 |
| \$0.20 | \$404 | 1.66 | \$243 | \$608 | \$1,339 | \$161 |
| \$0.30 | \$338 | 1.66 | \$204 | \$509 | \$1,120 | \$134 |
| \$0.40 | \$606 | 1.66 | \$365 | \$913 | \$2,008 | \$241 |
| \$0.45 | \$909 | 1.66 | \$548 | \$1,369 | \$3,012 | \$361 |
| Approximate price in Alaska (non bush areas) supplied by hydro | | | | | | |
| ¹ Btu value of a ton of wood @ 16% MC (green basis), assuming 50% efficiency = 6,888,000/ton | | | | | | |
| ² The Ton wood at 16% moisture content weighs 1,660 pounds (0.83 tons) bone dry and 3,320 pounds (1.66 tons) green or 50% moisture content. | | | | | | |
| Assume 1 cord = 2.5 tons | | | | | | |
| Assume 1 MBF = 11,000 lbs or 5.5 tons | | | | | | |



\$Value of Btu's in wood, based upon \$value of Btu's in a **gallon of PROPANE burned in a system with 78% energy efficiency (GHV recovered)**

| \$/ton value of wood at 16% MC, Cord (green) and \$/MBF (green) value based on \$ value of the Btu's in 1 gallon of PROPANE selected \$/gallon values | | | | | | |
|--|---|--|---|---------------------------------------|--|---|
| Cost of heating with PROPANE \$/gallon | Air dry ton wood at 16% MC ¹ | Green Weight of the material tons ² | Recalculated value to green tons (50% MC) | Value per cord @ 2.5 tons/cord | \$value of material converted to MBF @ 5.5 green tons/MBF | Increase in value by drying, but weight is reduced by 40% |
| \$2.70 | \$261 | 1.66 | \$157 | \$393 | \$865 | \$104 |
| \$3.00 | \$290 | 1.66 | \$175 | \$437 | \$961 | \$115 |
| \$3.50 | \$338 | 1.66 | \$204 | \$509 | \$1,120 | \$134 |
| \$4.00 | \$386 | 1.66 | \$233 | \$581 | \$1,279 | \$153 |
| \$4.50 | \$435 | 1.66 | \$262 | \$655 | \$1,441 | \$173 |
| Current price range in Alaska (non bush areas). | | | | | | |
| ¹ Btu value of a ton of wood @ 16% MC (green basis), assuming 50% efficiency = 6,888,000/ton | | | | | | |
| ² The Ton wood at 16% moisture content weighs 1,660 pounds (0.83 tons) bone dry and 3,320 pounds (1.66 tons) green or 50% moisture content. | | | | | | |
| Assume 1 cord = 2.5 tons | | | | | | |
| Assume 1 MBF = 11,000 lbs or 5.5 tons | | | | | | |



Estimated costs of various sources of energy (October 2008) and cost per Million Btu's at October 2008 prices.

| Estimated cost of 1,000,000 Btu's from various energy sources using Btu and burning efficiency values from EIA sources | | | | | |
|---|---------------|-------------------|-----------------------|-------------------------------|---|
| Energy Product | Units | Btu's/ unit | Burning Efficiency | ≈ Oct 2008 Alaska Price | Estimated Cost per million Btu's |
| Fuel Oil ***** | gallon | 138,690 | 78% | \$4.39 | \$40.58 |
| Fuel Oil | gallon | 138,690 | 78% | \$3.00 | \$27.73 |
| Natural Gas | ccf | 103,000 | 78% | \$0.87 | \$10.83 |
| Electricity (Hydro Generated) | kwh | 3,412 | 95% | \$0.093 | \$28.69 |
| Electricity (Oil Based)***** | kwh | 3,412 | 95% | \$0.200 | \$61.70 |
| Propane (not all taxes and cost included)***** | gallon | 91,333 | 78% | \$2.70 | \$37.90 |
| Firewood (Air Dry 16% GB -50% Eff.) | ton | 13,776,000 | 50% | \$300 | \$43.55 |
| Firewood (Air Dry 16% GB -80% Eff.) | ton | 13,776,000 | 80% | \$300 | \$27.22 |
| Pellets | ton | 16,500,000 | 80% | \$350 | \$26.52 |
| Kerosene (not all taxes and cost included)***** | gallon | 135,000 | 75% | \$3.55 | \$35.06 |
| Coal (Alaska coal is extremely low quality) | ton | ????????? | | | |
| | | | | | |



In summary

- Fuels most likely to be replaced by efficient RWEF and energy systems
 - Fuel Oil (above \$3.00 gallon)
 - Propane
 - Kerosene, and
 - Electricity from non hydro sources
- **Natural gas** (where available) **will replace other alternatives** in Anchorage/Valley areas.

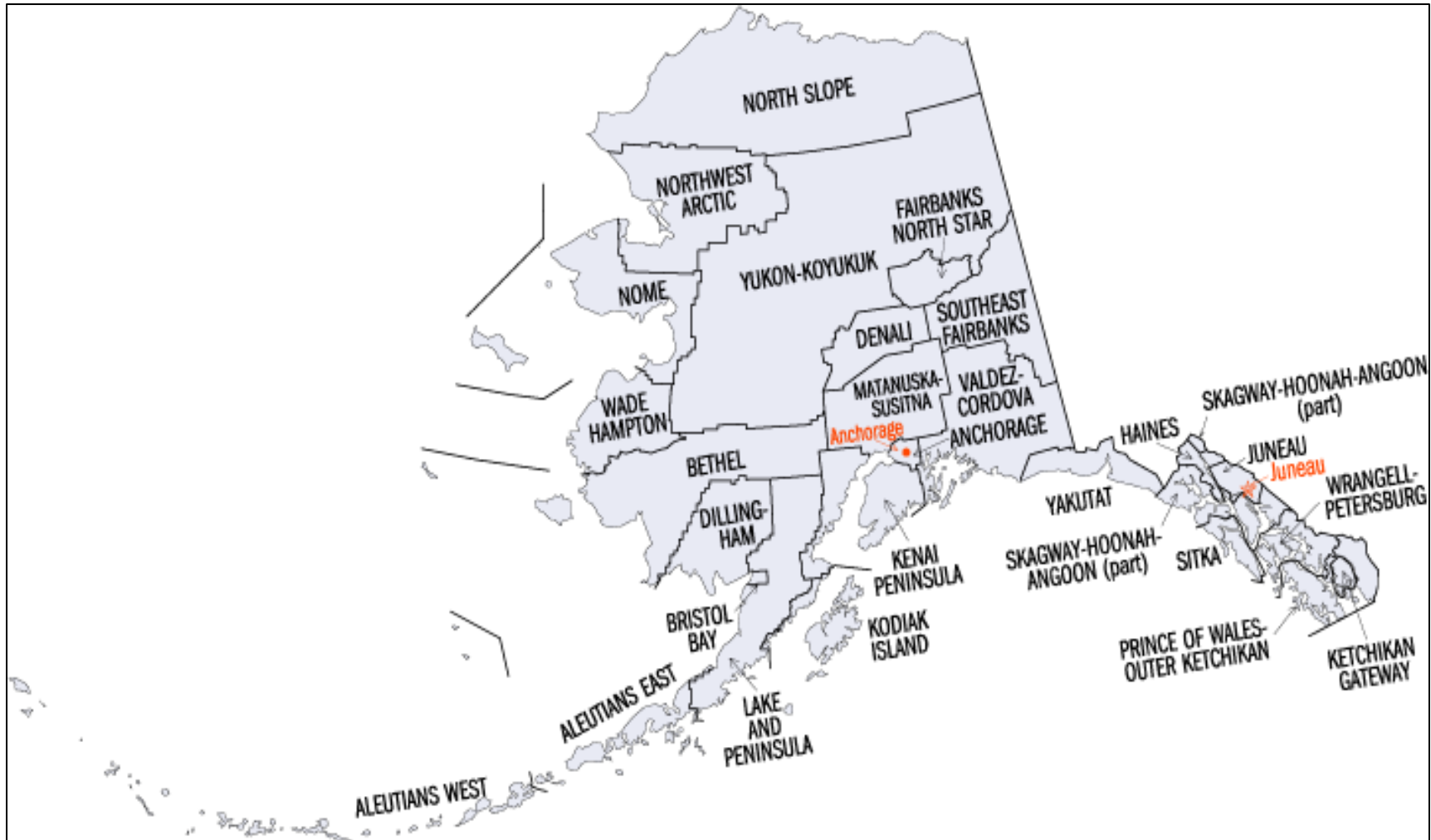


Estimates of potential volumes of RWEPP required in Alaska and SE Alaska are presented in following tables (Note)

- **Housing units based on 2006 Community Survey Reports (note: not all housing units are occupied).**
- **Household energy source used for heating based on 2000 Census data.**
- **Level of energy consumption based on 2006 Department of Energy, Energy Information Agency data. (note: Residential component is defined differently by USBC and EIA).**
- **In this project, commercial volumes based upon a multiplier derived from EIA reported volume.**



The following table make reference to Census units





Preliminary estimate of volume of RWEF required to replace all of the fuel oil currently used for home heating (Residential Sector) in various regions of Alaska

| Region | Estimate oil Btu | Gallons fuel oil for residential heating @ 138690Btu/gallon | Pounds of dry wood at 8,200 Btu/pound | Bone dry tons 0% MC | Green Tons 50% MC | Cords @ 2.5 tons/ cord | MMBF @ 5.5 tons/ MBF |
|-----------------------|-------------------|---|---------------------------------------|---------------------|-------------------|------------------------|----------------------|
| Anchorage/Valley | 2,021,669,712,511 | 14,649,781 | 252,708,714 | 126,354 | 252,709 | 101,083 | 45.947 |
| Fairbanks/North Star | 3,237,074,906,222 | 23,457,065 | 394,765,232 | 197,383 | 394,765 | 157,906 | 71.775 |
| Aleutians/North Slope | 674,629,123,019 | 4,888,617 | 82,271,844 | 41,136 | 82,272 | 32,909 | 14.959 |
| Southeast Alaska | 2,700,418,270,671 | 19,568,248 | 329,319,301 | 164,660 | 329,319 | 131,728 | 59.876 |
| Southwest Alaska | 1,341,585,793,343 | 9,721,636 | 163,608,024 | 81,804 | 163,608 | 65,443 | 29.747 |
| Total | 9,975,377,805,766 | 72,285,346 | 1,222,673,116 | 611,337 | 1,222,673 | 489,069 | 222.304 |

Note: Conversion based on HHV of fuel oil and wood. Dry wood adjusted to reflect green moisture content values.



Preliminary estimate of volume of RWEF required to replace all of the fuel oil currently used for home heating (Residential Sector) in communities in southeast Alaska

| Borough/Census Area | Estimate oil Btu | Gallons fuel oil for residential heating @ 138,690Btu/gallon | Pounds of dry wood at 8,200 Btu/pound | Bone dry tons 0% MC | Green Tons 50% MC | Cords @ 2.5 tons/cord | MMBF @ 5.5 tons/MBF |
|------------------------------|--------------------------|--|---------------------------------------|---------------------|-------------------|-----------------------|---------------------|
| Haines | 93,699,716,395 | 678,983 | 11,426,795 | 5,713 | 11,427 | 4,571 | 2.078 |
| Juneau | 1,074,403,810,825 | 7,785,535 | 131,024,855 | 65,512 | 131,025 | 52,410 | 23.823 |
| Ketchikan | 553,673,359,909 | 4,012,126 | 67,521,141 | 33,761 | 67,521 | 27,008 | 12.277 |
| Prince Wales-Outer Ketchikan | 189,900,397,682 | 1,376,090 | 23,158,585 | 11,579 | 23,159 | 9,263 | 4.211 |
| Sitka | 323,872,460,859 | 2,346,902 | 39,496,642 | 19,748 | 39,497 | 15,799 | 7.181 |
| Skagway-Hoonah-Angoon | 148,685,794,030 | 1,077,433 | 18,132,414 | 9,066 | 18,132 | 7,253 | 3.297 |
| Wrangell-Petersburg | 284,628,867,033 | 2,062,528 | 34,710,837 | 17,355 | 34,711 | 13,884 | 6.311 |
| Yakutat | 31,553,863,937 | 228,651 | 3,848,032 | 1,924 | 3,848 | 1,539 | 0.700 |
| Total | 2,700,418,270,671 | 19,568,248 | 329,319,301 | 164,660 | 329,319 | 131,728 | 59.876 |

Note: Conversion based on HHV of fuel oil and wood. Dry wood adjusted to reflect green moisture content values.



What about the commercial sector?

- Many community buildings and small business buildings use oil and can be converted to RWEF
- EIA data suggest conversion of all commercial sector oil would require 1.63 times the values in previous two tables.
- Potential volume of RWEF to allow conversion
 - In all of Alaska – **1,993,000 green tons or 362 MMBF**
 - In southeast Alaska – **538,000 green tons or 98 MMBF**



What about LP, Kerosene and Electricity above \$0.20 kwh?

- LP and Kerosene would increase previous estimates by a factor of 1.073.
- Difficult to estimate potential replacement of electricity. Such estimates require community by community analysis's of amounts and costs that are beyond scope of this project.



How do wood volumes become available.

- If 50% of material entering sawmills can be converted into energy products, total required saw log harvest in southeast Alaska must increase to a level of **200 MMBF** annually
- Increases in utilization that **remove trees currently left in the woods, tops and branches** can supply material on a ton by green ton basis and reduce saw logs to mills.
- **Young-growth thinning**



Ultimate outcome and volume of RWEF in southeast Alaska will depend upon:

- Supply of wood from lands in southeast Alaska
- Continued high price for alternative sources of energy
- Availability of labor and capital to harvest, transport and process RWEF.
- Public policy to promote conversion and development.



Questions may be directed to
Dr. Allen M. Brackley
Team Leader & Research
Forester

**USDA, Forest Service, Pacific Northwest Research
Station**

Sitka Wood Utilization Center

Sitka, Alaska 99835

abrackley@fs.fed.us