WILDEPHOR

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Town of Truckee
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RE: Truckee Bioenergy Scoping Study – Findings and Recommendations

Wildephor Consulting Services, LLC has completed the bioenergy project scoping study and subsequent refinement effort on behalf of the Town of Truckee and its partners, Truckee Fire Protection District (TFPD) and Truckee Tahoe Airport District (TTAD). The scoping study was initially undertaken to evaluate the potential for using green waste from local defensible space and forest fuels management activities to produce heat and/or power for a cluster of five facilities located at and around the Truckee Tahoe Airport, thereby offsetting fossil fuel consumption while reducing greenhouse gas (GHG) emissions and the risk of catastrophic wildfires (see Attachment 1 for utility costs and usage for the identified facility cluster). The scoping study included a series of tasks to determine whether such a project warrants a more in-depth feasibility assessment to support potential capital investment in a bioenergy facility fueled by locally generated organic wastes. The initial scoping study was conducted from September 2021 through February 2022, with subsequent refinement being completed from March 2022 through May 2022.

A total of seven (7) candidate solutions along with the baseline case of continuing to dispose of green waste at the Tahoe Truckee Sierra Disposal (TTSD) Eastern Regional Landfill (ERL) were evaluated using a multidimensional scorecard approach (see results in Attachment 5). Based on those results, the project team has identified two (2) candidate technologies that it believes should be investigated further as a means of addressing issues related to local green waste disposal. These two candidates, described in more detail below, are 1) biomass power generation using a gasifier with an electric generator; and 2) a modular combined heat and biochar (CHAB) system based on biomass pyrolysis. These two candidates could be further evaluated in a single feasibility assessment along with a market study of biochar, as outlined in the sections that follow.

Since completing the initial scoping study, the project team has determined that two disposal options which originally seemed promising for near-term management of green waste, both based on air curtain burner technologies, are not currently viable due to various operational and permitting challenges. Consequently, the two bioenergy systems described below are the only feasible pathways for long-term reuse of local organic waste that remain from the original set of seven candidate solutions.

Option A: Biomass Power

Several different power generation options were evaluated as part of the bioenergy project scoping study, namely, 1) an air curtain burner coupled with an organic Rankine cycle (ORC) generator; 2) a biomass gasification and generator system; and 3) a biomass boiler system combined with an ORC generator. Based on a range of triple bottom line factors as depicted in the scorecards in Attachment 5, the biomass gasification system was judged to be the most promising biopower candidate for the particular application being considered by the Town and is partners.

Biomass gasification is a thermochemical conversion process whereby biomass feedstock is heated in an oxygen-limited environment, preventing combustion and instead producing a hydrocarbon-rich synthesis gas ("syngas") that can then be either combusted in a gas turbine or internal combustion engine, or chemically converted to other liquid or gaseous biofuels. The evaluation was based on a representative floating fixed-bed gasifier having a nameplate capacity of 1.0 megawatt electric (MWe), which was sized to roughly match the quantity of high quality fuel estimated to be available as implementation of recently passed Measure T is ramped up over the next several years. More specifically, a model of projected green waste quantities developed with the partners (see Attachment 2) estimates a total of about 12,000 bone dry tons (BDT) of biomass being produced by annual defensible space and forest fuels treatment efforts. Of that material, it is believed that approximately half will be sufficiently high quality woody material of the type normally desired for gasification (as opposed to pine needles, leaves, brush, or other similar materials). Consistent with that preliminary estimate, a 1.0 MWe gasifier would consume approximately 6,000 BDT of wood chips annually during year-round operations.

The primary source of revenue for a biomass power system would be from a power purchase agreement (PPA) negotiated with Truckee Donner Public Utility District (TDPUD). With such an agreement, the partners would be guaranteed a long-term (e.g., 20 years) revenue stream from electricity sold into the regional grid at a stable price. For the operating expense model developed as part of the scoping study (see summary in Attachment 3) and based on initial discussions with TDPUD staff, a PPA purchase price of $0.10 per kilowatt-hour (kWh) was assumed. Further evaluation of a potential PPA pricing structure would be undertaken by TDPUD in parallel with a more detailed bioenergy project feasibility assessment should one be pursued by the partners.

A secondary source of revenue from a biomass gasification facility would be biochar sales. Biochar is a charcoal-like byproduct of biomass conversion processes such as gasification and pyrolysis that can be used for a range of purposes including as a soil amendment, a water and air filtration medium, and a construction material additive, among others. The market for biochar is rapidly evolving and consequently presents significant uncertainty, and it may not represent a reliable revenue source in the near term. Biochar does, however, provide a significant means of carbon sequestration, thus making this alternative more attractive than most others included in the scoping study in terms of its environmental benefits. A summary of available GHG emissions reductions for all the candidate technologies considered in the scoping study is provided in Attachment 4.

An additional important potential benefit of the proposed biopower generation option could be the ability to establish an islanded microgrid in the vicinity of the biomass power plant. Such a microgrid could allow critical municipal facilities to continue operating during Public Safety Outage Management (PSOM) events or other unscheduled grid outages. Based on a preliminary review with TDPUD staff of existing and planned electrical grid infrastructure, it appears that an islanded microgrid could be established to supply backup power to the Truckee Tahoe Airport, Truckee Fire Station 96 (including the co-located airport well and pump station), and the Truckee Town Hall and Truckee Police Department. Further analysis will be required to confirm system capacity and operating parameters, but at this time initial indications are that a microgrid powered by a 1.0 MWe gasification system sited on or near TTAD property would be able to serve most if not all of these critical electrical loads during main grid outages.

Option B: Combined Heat and Biochar

A second potentially viable option for the productive reuse of local green waste is a combined heat and biochar (CHAB) system using pyrolysis as the biomass conversion technology. This would be a "thermally-led" approach in that the energy content of biomass feedstocks would be converted into heat, with biochar and possibly a relatively small amount of electricity also being produced as co-products. Pyrolysis is a heat induced thermal decomposition process similar in many respects to gasification, but one that takes place in the absence of oxygen. This generally produces a greater proportion of biochar (25-30% by weight of the feedstock) compared with gasification (5-10% by weight), often along with bio-oil that can be converted into other biofuels.

The largest source of revenue from this option would be from biochar sales. As shown in the operating expense model summary included in Attachment 3, biochar sales could represent more than 80% of annual project revenues, enough to cover all the estimated plant operating costs as well as the disposal costs for residual organic material not utilized by the pyrolysis system. Additional revenues totaling more than $150,000 per year could be generated from offsetting heating and electrical utility costs at Truckee Tahoe Airport facilities. As noted in the summary of the biomass power option above, however, biochar presents a great deal of uncertainty in terms of its pricing and reliability as a revenue stream. Therefore, the intent of the proposed biochar market study would be to reduce some of that uncertainty such that the economic value of the biochar could be more accurately estimated.

Two key potential advantages of the CHAB option are its significantly lower capital cost and its modularity. As shown in the scorecards for each candidate (see Attachment 5), the capital cost of a 1.0 MWe biomass power plant based around gasification technology is estimated to be in the range of $15 million. A comparably sized CHAB system—that is, one sized to use the amount of feedstock anticipated to be available within the next 3-5 years—is estimated to cost around $7 million. Beyond its much lower initial capital cost, the payback period is estimated to be shorter based on its marginally higher annual revenues coupled with greater avoided green waste disposal costs. Second, and perhaps even more importantly, a CHAB system could be designed to be modular, such that additional units could be added in the future if local green waste streams continued to increase. For purposes of the scoping study, four (4) pyrolysis units each having a thermal output of just under 1.0 MWth were used to estimate feedstock throughput, annual operating expenses, and system outputs (i.e., heat, biochar, and behind-the-meter electricity generated using process waste heat). A summary of estimated operating expenses and revenues for a combined heat and biochar system are provided in Attachment 3.

As shown in the estimated available GHG emissions reductions included in Attachment 4, the CHAB system could produce the greatest carbon sequestration benefit of all the candidate technologies considered in the scoping study. In fact, this option could sequester more than three times as much carbon dioxide equivalent (CO2e) as the biomass power option, due to its significantly higher production of biochar. It should be noted that biochar, particularly when used as a soil amendment, can sequester up to 3 tons of CO2e for every ton of biomass feedstock used, far exceeding the GHG emissions reductions available from offsetting utility purchases and avoiding in situ biomass decomposition *combined*. Unfortunately, based on discussions with staff from the California Department of Resources Recycling and Recovery (CalRecycle), use of biochar is not currently eligible for meeting the Town's organic recycling targets established under Senate Bill (SB) 1383.

Finally, the CHAB option also could offer another unique co-benefit in the form of hydronic snow melt for portions of the Truckee Tahoe Airport. Hydronic snow melt systems utilize cross-linked polyethylene (PEX) piping embedded in paved areas to circulate hot water for surface snow removal. Based on the quantities of organic waste that the partners expect to generate, an appropriately-sized CHAB system could produce enough supplemental heat to provide hot water for snow melting along high-traffic areas of the airport property such as the main apron. Although installation of hydronic snow melt systems can be relatively costly, the excess available waste heat from a pyrolysis plant could allow such a system to be cost-effective if it were able to offset sufficient snow removal expenses. TTAD management has expressed interest in evaluating this possibility further as part of a more detailed bioenergy project feasibility assessment.

Recommendations

Based on the findings highlighted above, it is recommended that the Town and its partners conduct a more in-depth feasibility assessment of both 1) the biomass power option using gasification; and 2) the combined heat and biochar option using pyrolysis, as two potentially viable methods of productively reusing locally generated organic wastes. A market study of biochar as a potentially merchantable co-product of either biomass conversion process also should be conducted to better assess its possible financial contributions to any future capital project that may be undertaken by the partners.

The cost of completing a detailed feasibility assessment for these two candidate bioenergy solutions is estimated to be $90,000. An additional $30,000 would be required to conduct a market study of biochar in parallel with the feasibility assessment. Together these analyses could provide the Town and its partners with a substantive basis for determining whether capital investment in a bioenergy plant would be warranted. They would include conceptual system designs, more refined capital and operating cost estimates, feedstock procurement and management strategies, and life-cycle pro forma financial models, among other items. Town of Truckee staff are currently pursuing several grant opportunities that could fund a portion or all of this next analysis phase.

Project Timeline

Assuming that the necessary funding is available and that the partners decide to go forward with a feasibility assessment and biochar market study, those analyses could be completed in approximately nine (9) months. That would put the partners on a path to being ready to engage an engineering design firm as early as summer 2023, with a detailed design package and subsequent procurement activities possibly allowing the partners to break ground on construction of a bioenergy facility sometime in 2024. While certainly possible, this timeline may be somewhat optimistic in light of current supply chain issues and labor shortages, and therefore should be considered preliminary.

Wildephor appreciates having had the opportunity to perform this important work for the Town of Truckee and its partners, and remains available for further consultation related to the scoping study as well as for additional professional services that may be desired.

Attachments

1. Partner Utility Costs and Usage
2. Partner Green Waste Summary
3. Operating Expense Summary
4. Available GHG Emissions Reductions
5. Candidate Solution Scorecards

CC: Bill Seline, Truckee Fire Protection District
Robb Etnyre, Truckee Tahoe Airport District

ATTACHMENT 1

Partner Utility Costs and Usage

SUMMARY - PARTNER TOTAL UTILITY COSTS

2018 - 2021	ANNUAL / MONTHLY			
	ANNUAL	**$ 40,565.81**	**$ 123,773.65**	**$ 164,339.47**
	MONTHLY	**$ 3,380.48**	**$ 10,314.47**	**$ 13,694.96**
Month	**Date**	**Natural Gas** ($)	**Electricity** ($)	**Total Cost** ($)
1	Oct-18	$ 2,190.15	$ 10,532.63	$ 12,722.78
2	Nov-18	$ 5,291.96	$ 9,963.01	$ 15,254.97
3	Dec-18	$ 6,715.83	$ 8,928.78	$ 15,644.61
4	Jan-19	$ 6,568.90	$ 12,434.72	$ 19,003.62
5	Feb-19	$ 8,697.63	$ 13,914.68	$ 22,612.31
6	Mar-19	$ 5,104.20	$ 10,163.44	$ 15,267.64
7	Apr-19	$ 2,805.68	$ 8,855.11	$ 11,660.79
8	May-19	$ 2,545.74	$ 8,941.66	$ 11,487.40
9	Jun-19	$ 1,004.91	$ 10,895.09	$ 11,900.00
10	Jul-19	$ 769.83	$ 10,062.04	$ 10,831.87
11	Aug-19	$ 746.05	$ 12,317.20	$ 13,063.25
12	Sep-19	$ 1,795.57	$ 10,646.55	$ 12,442.12
Year 1	**Total**	**$ 44,236.45**	**$ 127,654.91**	**$ 171,891.36**
	Average	**$ 3,686.37**	**$ 10,637.91**	**$ 14,324.28**
13	Oct-19	$ 3,070.95	$ 9,193.72	$ 12,264.67
14	Nov-19	$ 5,314.66	$ 10,824.43	$ 16,139.09
15	Dec-19	$ 6,514.84	$ 10,183.20	$ 16,698.04
16	Jan-20	$ 6,485.40	$ 10,251.79	$ 16,737.19
17	Feb-20	$ 6,168.73	$ 11,117.60	$ 17,286.33
18	Mar-20	$ 4,925.17	$ 10,096.31	$ 15,021.48
19	Apr-20	$ 2,098.31	$ 8,451.47	$ 10,549.78
20	May-20	$ 1,280.88	$ 8,709.27	$ 9,990.15
21	Jun-20	$ 840.29	$ 8,590.45	$ 9,430.74
22	Jul-20	$ 614.84	$ 9,525.86	$ 10,140.70
23	Aug-20	$ 586.76	$ 11,671.39	$ 12,258.15
24	Sep-20	$ 777.49	$ 10,724.32	$ 11,501.81
Year 2	**Total**	**$ 38,678.32**	**$ 119,339.81**	**$ 158,018.13**
	Average	**$ 3,223.19**	**$ 9,944.98**	**$ 13,168.18**
25	Oct-20	$ 1,613.73	$ 10,204.40	$ 11,818.13
26	Nov-20	$ 5,431.68	$ 9,531.66	$ 14,963.34
27	Dec-20	$ 6,511.83	$ 9,527.37	$ 16,039.20
28	Jan-21	$ 6,234.13	$ 11,366.96	$ 17,601.09
29	Feb-21	$ 5,862.17	$ 10,523.58	$ 16,385.75
30	Mar-21	$ 5,019.86	$ 9,796.07	$ 14,815.93
31	Apr-21	$ 2,849.92	$ 10,576.55	$ 13,426.47
32	May-21	$ 1,703.06	$ 9,438.75	$ 11,141.81
33	Jun-21	$ 908.23	$ 9,245.38	$ 10,153.61
34	Jul-21	$ 763.04	$ 12,628.00	$ 13,391.04
35	Aug-21	$ 890.95	$ 11,535.64	$ 12,426.59
36	Sep-21	$ 994.07	$ 9,951.88	$ 10,945.95
Year 3	**Total**	**$ 38,782.67**	**$ 124,326.24**	**$ 163,108.91**
	Average	**$ 3,231.89**	**$ 10,360.52**	**$ 13,592.41**

Prepared by Wildephor Consulting Services, LLC

SUMMARY - PARTNER NATURAL GAS USAGE

2018 - 2021	ANNUAL MONTHLY	3,834 319	$ 40,565.81 $ 3,380.48	25% $ 10.58
Month	**Date**	**Usage** (MMBtu)	**Total Cost** ($)	**Unit Cost** ($/MMBtu)
1	Oct-18	223	$ 2,190.15	$ 9.81
2	Nov-18	539	$ 5,291.96	$ 9.82
3	Dec-18	618	$ 6,715.83	$ 10.87
4	Jan-19	626	$ 6,568.90	$ 10.50
5	Feb-19	894	$ 8,697.63	$ 9.73
6	Mar-19	498	$ 5,104.20	$ 10.25
7	Apr-19	271	$ 2,805.68	$ 10.35
8	May-19	237	$ 2,545.74	$ 10.74
9	Jun-19	84	$ 1,004.91	$ 11.99
10	Jul-19	64	$ 769.83	$ 11.97
11	Aug-19	61	$ 746.05	$ 12.17
12	Sep-19	167	$ 1,795.57	$ 10.75
Year 1	**Total**	**4,282**	**$ 44,236.45**	-
	Average	**357**	**$ 3,686.37**	**$ 10.33**
13	Oct-19	293	$ 3,070.95	$ 10.49
14	Nov-19	506	$ 5,314.66	$ 10.50
15	Dec-19	629	$ 6,514.84	$ 10.37
16	Jan-20	619	$ 6,485.40	$ 10.47
17	Feb-20	492	$ 6,168.73	$ 12.54
18	Mar-20	504	$ 4,925.17	$ 9.77
19	Apr-20	217	$ 2,098.31	$ 9.67
20	May-20	127	$ 1,280.88	$ 10.08
21	Jun-20	79	$ 840.29	$ 10.66
22	Jul-20	57	$ 614.84	$ 10.75
23	Aug-20	55	$ 586.76	$ 10.73
24	Sep-20	70	$ 777.49	$ 11.09
Year 2	**Total**	**3,648**	**$ 38,678.32**	-
	Average	**304**	**$ 3,223.19**	**$ 10.60**
25	Oct-20	161	$ 1,613.73	$ 10.05
26	Nov-20	541	$ 5,431.68	$ 10.05
27	Dec-20	670	$ 6,511.83	$ 9.73
28	Jan-21	573	$ 6,234.13	$ 10.88
29	Feb-21	540	$ 5,862.17	$ 10.85
30	Mar-21	443	$ 5,019.86	$ 11.34
31	Apr-21	266	$ 2,849.92	$ 10.71
32	May-21	131	$ 1,703.06	$ 12.97
33	Jun-21	66	$ 908.23	$ 13.87
34	Jul-21	53	$ 763.04	$ 14.45
35	Aug-21	61	$ 890.95	$ 14.70
36	Sep-21	69	$ 994.07	$ 14.51
Year 3	**Total**	**3,572**	**$ 38,782.67**	-
	Average	**298**	**$ 3,231.89**	**$ 10.86**

SUMMARY - PARTNER ELECTRICITY USAGE

2018 -	**ANNUAL**	**782,371**	**$ 123,773.65**	**75%**
2021	**MONTHLY**	**65,198**	**$ 10,314.47**	**$ 0.158**
Month	**Date**	**Usage** (kWh)	**Total Cost** ($)	**Unit Cost** ($/kWh)
1	Oct-18	70,829	$ 10,532.63	$ 0.149
2	Nov-18	67,757	$ 9,963.01	$ 0.147
3	Dec-18	53,142	$ 8,928.78	$ 0.168
4	Jan-19	87,245	$ 12,434.72	$ 0.143
5	Feb-19	95,121	$ 13,914.68	$ 0.146
6	Mar-19	66,038	$ 10,163.44	$ 0.154
7	Apr-19	56,228	$ 8,855.11	$ 0.157
8	May-19	56,593	$ 8,941.66	$ 0.158
9	Jun-19	71,920	$ 10,895.09	$ 0.151
10	Jul-19	65,447	$ 10,062.04	$ 0.154
11	Aug-19	81,474	$ 12,317.20	$ 0.151
12	Sep-19	69,460	$ 10,646.55	$ 0.153
Year 1	**Total**	**841,254**	**$ 127,654.91**	-
	Average	**70,105**	**$ 10,637.91**	**$ 0.152**
13	Oct-19	58,667	$ 9,193.72	$ 0.157
14	Nov-19	71,625	$ 10,824.43	$ 0.151
15	Dec-19	66,024	$ 10,183.20	$ 0.154
16	Jan-20	62,970	$ 10,251.79	$ 0.163
17	Feb-20	68,677	$ 11,117.60	$ 0.162
18	Mar-20	62,191	$ 10,096.31	$ 0.162
19	Apr-20	49,996	$ 8,451.47	$ 0.169
20	May-20	53,585	$ 8,709.27	$ 0.163
21	Jun-20	52,356	$ 8,590.45	$ 0.164
22	Jul-20	57,944	$ 9,525.86	$ 0.164
23	Aug-20	73,375	$ 11,671.39	$ 0.159
24	Sep-20	66,894	$ 10,724.32	$ 0.160
Year 2	**Total**	**744,304**	**$ 119,339.81**	-
	Average	**62,025**	**$ 9,944.98**	**$ 0.160**
25	Oct-20	64,526	$ 10,204.40	$ 0.158
26	Nov-20	58,509	$ 9,531.66	$ 0.163
27	Dec-20	58,091	$ 9,527.37	$ 0.164
28	Jan-21	70,246	$ 11,366.96	$ 0.162
29	Feb-21	64,298	$ 10,523.58	$ 0.164
30	Mar-21	58,941	$ 9,796.07	$ 0.166
31	Apr-21	65,050	$ 10,576.55	$ 0.163
32	May-21	56,298	$ 9,438.75	$ 0.168
33	Jun-21	55,865	$ 9,245.38	$ 0.165
34	Jul-21	78,227	$ 12,628.00	$ 0.161
35	Aug-21	71,066	$ 11,535.64	$ 0.162
36	Sep-21	60,437	$ 9,951.88	$ 0.165
Year 3	**Total**	**761,554**	**$ 124,326.24**	-
	Average	**63,463**	**$ 10,360.52**	**$ 0.163**

Prepared by Wildephor Consulting Services, LLC

TRUCKEE TOWN HALL - NATURAL GAS USAGE

2018 - 2021	ANNUAL MONTHLY	6,287 524	$ 6,847.79 $ 570.65	15% $ 10.89
Month	**Date**	**Usage** (Therms)	**Total Cost** ($)	**Unit Cost** ($/MMBtu)
1	Oct-18	463	$ 504.45	$ 10.90
2	Nov-18	749	$ 832.25	$ 11.11
3	Dec-18	1,039	$ 1,117.05	$ 10.75
4	Jan-19	977	$ 1,066.41	$ 10.92
5	Feb-19	769	$ 806.50	$ 10.49
6	Mar-19	747	$ 772.56	$ 10.34
7	Apr-19	455	$ 488.81	$ 10.74
8	May-19	321	$ 362.66	$ 11.30
9	Jun-19	133	$ 168.03	$ 12.63
10	Jul-19	113	$ 143.36	$ 12.69
11	Aug-19	112	$ 143.89	$ 12.85
12	Sep-19	250	$ 280.49	$ 11.22
Year 1	**Total**	**6,128**	**$ 6,686.46**	-
	Average	**511**	**$ 557.21**	**$ 10.91**
13	Oct-19	463	$ 504.45	$ 10.90
14	Nov-19	749	$ 832.25	$ 11.11
15	Dec-19	1,039	$ 1,117.05	$ 10.75
16	Jan-20	977	$ 1,066.41	$ 10.92
17	Feb-20	769	$ 806.50	$ 10.49
18	Mar-20	747	$ 772.56	$ 10.34
19	Apr-20	430	$ 424.13	$ 9.86
20	May-20	348	$ 347.91	$ 10.00
21	Jun-20	143	$ 158.30	$ 11.07
22	Jul-20	106	$ 121.01	$ 11.42
23	Aug-20	105	$ 119.69	$ 11.40
24	Sep-20	129	$ 149.89	$ 11.62
Year 2	**Total**	**6,005**	**$ 6,420.15**	-
	Average	**500**	**$ 535.01**	**$ 10.69**
25	Oct-20	355	$ 361.22	$ 10.18
26	Nov-20	1,118	$ 1,141.37	$ 10.21
27	Dec-20	1,304	$ 1,296.44	$ 9.94
28	Jan-21	1,045	$ 1,168.87	$ 11.19
29	Feb-21	983	$ 1,097.46	$ 11.16
30	Mar-21	749	$ 864.86	$ 11.55
31	Apr-21	531	$ 573.03	$ 10.79
32	May-21	209	$ 278.26	$ 13.31
33	Jun-21	115	$ 166.76	$ 14.50
34	Jul-21	91	$ 139.70	$ 15.35
35	Aug-21	102	$ 158.78	$ 15.57
36	Sep-21	127	$ 190.01	$ 14.96
Year 3	**Total**	**6,729**	**$ 7,436.76**	-
	Average	**561**	**$ 619.73**	**$ 11.05**

Prepared by Wildephor Consulting Services, LLC

NOTE: *Data for Oct-18 to Mar-19 unavailable; Oct-19 to Mar-20 data used as proxy.*

TRUCKEE TOWN HALL - ELECTRICITY USAGE

2018 - 2021	ANNUAL MONTHLY	236,800 19,733	$ 38,227.54 $ 3,185.63	85% $ 0.161
Month	**Date**	**Usage** (kWh)	**Total Cost** ($)	**Unit Cost** ($/kWh)
1	Oct-18	22,920	$ 3,274.45	$ 0.143
2	Nov-18	23,040	$ 3,317.34	$ 0.144
3	Dec-18	12,120	$ 2,237.60	$ 0.185
4	Jan-19	39,120	$ 5,178.13	$ 0.132
5	Feb-19	24,600	$ 3,729.14	$ 0.152
6	Mar-19	21,480	$ 3,428.44	$ 0.160
7	Apr-19	18,240	$ 3,008.88	$ 0.165
8	May-19	17,640	$ 2,888.25	$ 0.164
9	Jun-19	21,720	$ 3,252.63	$ 0.150
10	Jul-19	18,840	$ 2,884.13	$ 0.153
11	Aug-19	22,560	$ 3,348.66	$ 0.148
12	Sep-19	20,280	$ 3,114.67	$ 0.154
Year 1	**Total**	**262,560**	**$ 39,662.32**	-
	Average	**21,880**	**$ 3,305.19**	**$ 0.151**
13	Oct-19	18,120	$ 2,982.60	$ 0.165
14	Nov-19	22,800	$ 3,452.15	$ 0.151
15	Dec-19	21,240	$ 3,351.18	$ 0.158
16	Jan-20	19,920	$ 3,431.24	$ 0.172
17	Feb-20	21,600	$ 3,708.69	$ 0.172
18	Mar-20	18,720	$ 3,252.81	$ 0.174
19	Apr-20	15,840	$ 2,838.22	$ 0.179
20	May-20	16,320	$ 2,853.04	$ 0.175
21	Jun-20	16,080	$ 2,824.97	$ 0.176
22	Jul-20	16,320	$ 2,860.98	$ 0.175
23	Aug-20	20,640	$ 3,366.07	$ 0.163
24	Sep-20	18,600	$ 3,082.28	$ 0.166
Year 2	**Total**	**226,200**	**$ 38,004.23**	-
	Average	**18,850**	**$ 3,167.02**	**$ 0.168**
25	Oct-20	18,720	$ 3,025.61	$ 0.162
26	Nov-20	16,920	$ 2,952.59	$ 0.175
27	Dec-20	16,800	$ 2,929.81	$ 0.174
28	Jan-21	21,240	$ 3,437.45	$ 0.162
29	Feb-21	19,560	$ 3,234.11	$ 0.165
30	Mar-21	18,480	$ 3,197.00	$ 0.173
31	Apr-21	20,760	$ 3,417.32	$ 0.165
32	May-21	16,800	$ 2,959.20	$ 0.176
33	Jun-21	16,080	$ 2,715.74	$ 0.169
34	Jul-21	20,520	$ 3,285.86	$ 0.160
35	Aug-21	18,720	$ 3,039.75	$ 0.162
36	Sep-21	17,040	$ 2,821.63	$ 0.166
Year 3	**Total**	**221,640**	**$ 37,016.07**	-
	Average	**18,470**	**$ 3,084.67**	**$ 0.167**

Prepared by Wildephor Consulting Services, LLC

TFPD STATION 96 - NATURAL GAS USAGE

2018 - 2021	**ANNUAL**	**6,788**	**$ 7,564.93**	**36%**
	MONTHLY	**566**	**$ 630.41**	**$ 11.15**
Month	**Date**	**Usage** (Therms)	**Total Cost** ($)	**Unit Cost** ($/MMBtu)
1	Oct-18	284	$ 279.11	$ 9.83
2	Nov-18	1,057	$ 1,025.26	$ 9.70
3	Dec-18	1,082	$ 1,194.60	$ 11.04
4	Jan-19	905	$ 974.27	$ 10.77
5	Feb-19	1,407	$ 1,389.47	$ 9.88
6	Mar-19	922	$ 956.30	$ 10.37
7	Apr-19	483	$ 504.78	$ 10.45
8	May-19	322	$ 354.84	$ 11.02
9	Jun-19	102	$ 131.30	$ 12.87
10	Jul-19	80	$ 103.41	$ 12.93
11	Aug-19	82	$ 106.87	$ 13.03
12	Sep-19	260	$ 283.63	$ 10.91
Year 1	**Total**	**6,986**	**$ 7,303.84**	-
	Average	**582**	**$ 608.65**	**$ 10.45**
13	Oct-19	535	$ 564.97	$ 10.56
14	Nov-19	828	$ 885.99	$ 10.70
15	Dec-19	1,250	$ 1,290.85	$ 10.33
16	Jan-20	1,191	$ 1,245.97	$ 10.46
17	Feb-20	1,057	$ 2,301.74	$ 21.78
18	Mar-20	1,019	$ 991.04	$ 9.73
19	Apr-20	478	$ 457.26	$ 9.57
20	May-20	203	$ 208.12	$ 10.25
21	Jun-20	83	$ 97.59	$ 11.76
22	Jul-20	97	$ 109.70	$ 11.31
23	Aug-20	87	$ 99.19	$ 11.40
24	Sep-20	117	$ 134.89	$ 11.53
Year 2	**Total**	**6,945**	**$ 8,387.31**	-
	Average	**579**	**$ 698.94**	**$ 12.08**
25	Oct-20	284	$ 286.78	$ 10.10
26	Nov-20	1,112	$ 1,108.16	$ 9.97
27	Dec-20	1,221	$ 1,190.82	$ 9.75
28	Jan-21	987	$ 1,082.73	$ 10.97
29	Feb-21	996	$ 1,083.52	$ 10.88
30	Mar-21	802	$ 918.83	$ 11.46
31	Apr-21	464	$ 504.29	$ 10.87
32	May-21	212	$ 281.86	$ 13.30
33	Jun-21	92	$ 137.47	$ 14.94
34	Jul-21	90	$ 138.28	$ 15.36
35	Aug-21	84	$ 132.94	$ 15.83
36	Sep-21	88	$ 137.95	$ 15.68
Year 3	**Total**	**6,432**	**$ 7,003.63**	-
	Average	**536**	**$ 583.64**	**$ 10.89**

Prepared by Wildephor Consulting Services, LLC

TFPD STATION 96 - ELECTRICITY USAGE

2018 - 2021	ANNUAL MONTHLY	80,680 6,723	$ 13,560.78 $ 1,130.06	64% $ 0.168
Month	**Date**	**Usage** (kWh)	**Total Cost** ($)	**Unit Cost** ($/kWh)
1	Oct-18	5,000	$ 818.44	$ 0.164
2	Nov-18	5,400	$ 882.16	$ 0.163
3	Dec-18	6,000	$ 977.73	$ 0.163
4	Jan-19	6,440	$ 1,053.21	$ 0.164
5	Feb-19	9,360	$ 1,518.37	$ 0.162
6	Mar-19	5,640	$ 925.77	$ 0.164
7	Apr-19	4,520	$ 747.36	$ 0.165
8	May-19	4,640	$ 766.47	$ 0.165
9	Jun-19	6,160	$ 1,008.61	$ 0.164
10	Jul-19	5,560	$ 913.03	$ 0.164
11	Aug-19	7,920	$ 1,288.98	$ 0.163
12	Sep-19	6,200	$ 1,014.98	$ 0.164
Year 1	**Total**	**72,840**	**$ 11,915.11**	-
	Average	**6,070**	**$ 992.93**	**$ 0.164**
13	Oct-19	5,400	$ 887.54	$ 0.164
14	Nov-19	6,800	$ 1,110.56	$ 0.163
15	Dec-19	7,440	$ 1,212.51	$ 0.163
16	Jan-20	7,040	$ 1,183.99	$ 0.168
17	Feb-20	8,240	$ 1,381.15	$ 0.168
18	Mar-20	6,800	$ 1,144.56	$ 0.168
19	Apr-20	6,720	$ 1,131.42	$ 0.168
20	May-20	6,280	$ 1,059.12	$ 0.169
21	Jun-20	4,720	$ 802.82	$ 0.170
22	Jul-20	5,760	$ 973.69	$ 0.169
23	Aug-20	7,600	$ 1,276.00	$ 0.168
24	Sep-20	6,520	$ 1,098.56	$ 0.168
Year 2	**Total**	**79,320**	**$ 13,261.92**	-
	Average	**6,610**	**$ 1,105.16**	**$ 0.167**
25	Oct-20	5,720	$ 967.12	$ 0.169
26	Nov-20	6,760	$ 1,137.99	$ 0.168
27	Dec-20	9,040	$ 1,512.59	$ 0.167
28	Jan-21	10,520	$ 1,818.88	$ 0.173
29	Feb-21	9,320	$ 1,614.52	$ 0.173
30	Mar-21	8,040	$ 1,396.53	$ 0.174
31	Apr-21	7,240	$ 1,260.29	$ 0.174
32	May-21	6,040	$ 1,055.93	$ 0.175
33	Jun-21	6,120	$ 1,069.56	$ 0.175
34	Jul-21	8,120	$ 1,410.16	$ 0.174
35	Aug-21	6,920	$ 1,205.80	$ 0.174
36	Sep-21	6,040	$ 1,055.93	$ 0.175
Year 3	**Total**	**89,880**	**$ 15,505.30**	-
	Average	**7,490**	**$ 1,292.11**	**$ 0.173**

Prepared by Wildephor Consulting Services, LLC

TTAD SUMMARY* - NATURAL GAS USAGE

2018 - 2021	ANNUAL MONTHLY	25,265 2,105	$ 26,153.10 $ 2,179.42	27% $ 10.35
Month	**Date**	**Usage** (Therms)	**Total Cost** ($)	**Unit Cost** ($/MMBtu)
1	Oct-18	1,485	$ 1,406.59	$ 9.47
2	Nov-18	3,584	$ 3,434.45	$ 9.58
3	Dec-18	4,055	$ 4,404.18	$ 10.86
4	Jan-19	4,376	$ 4,528.22	$ 10.35
5	Feb-19	6,766	$ 6,501.66	$ 9.61
6	Mar-19	3,311	$ 3,375.34	$ 10.19
7	Apr-19	1,772	$ 1,812.09	$ 10.23
8	May-19	1,728	$ 1,828.24	$ 10.58
9	Jun-19	603	$ 705.58	$ 11.70
10	Jul-19	450	$ 523.06	$ 11.62
11	Aug-19	419	$ 495.29	$ 11.82
12	Sep-19	1,161	$ 1,231.45	$ 10.61
Year 1	**Total**	**29,710**	**$ 30,246.15**	-
	Average	**2,476**	**$ 2,520.51**	**$ 10.18**
13	Oct-19	1,930	$ 2,001.53	$ 10.37
14	Nov-19	3,484	$ 3,596.42	$ 10.32
15	Dec-19	3,996	$ 4,106.94	$ 10.28
16	Jan-20	4,026	$ 4,173.02	$ 10.37
17	Feb-20	3,093	$ 3,060.49	$ 9.89
18	Mar-20	3,273	$ 3,161.57	$ 9.66
19	Apr-20	1,263	$ 1,216.92	$ 9.64
20	May-20	720	$ 724.85	$ 10.07
21	Jun-20	562	$ 584.40	$ 10.40
22	Jul-20	369	$ 384.13	$ 10.41
23	Aug-20	355	$ 367.88	$ 10.36
24	Sep-20	455	$ 492.71	$ 10.83
Year 2	**Total**	**23,526**	**$ 23,870.86**	-
	Average	**1,961**	**$ 1,989.24**	**$ 10.15**
25	Oct-20	966	$ 965.73	$ 10.00
26	Nov-20	3,177	$ 3,182.15	$ 10.02
27	Dec-20	4,170	$ 4,024.57	$ 9.65
28	Jan-21	3,700	$ 3,982.53	$ 10.76
29	Feb-21	3,425	$ 3,681.19	$ 10.75
30	Mar-21	2,877	$ 3,236.17	$ 11.25
31	Apr-21	1,666	$ 1,772.60	$ 10.64
32	May-21	892	$ 1,142.94	$ 12.81
33	Jun-21	448	$ 604.00	$ 13.48
34	Jul-21	347	$ 485.06	$ 13.98
35	Aug-21	420	$ 599.23	$ 14.27
36	Sep-21	470	$ 666.11	$ 14.17
Year 3	**Total**	**22,558**	**$ 24,342.28**	-
	Average	**1,880**	**$ 2,028.52**	**$ 10.79**

Prepared by Wildephor Consulting Services, LLC

**10356 Truckee Airport Road, 10266 Truckee Airport Road, and 12110 Chandelle Way.*

TTAD SUMMARY* - ELECTRICITY USAGE

2018 - 2021	ANNUAL MONTHLY	464,891 38,741	$ 71,985.34 $ 5,998.78	73% $ 0.155
Month	**Date**	**Usage** (kWh)	**Total Cost** ($)	**Unit Cost** ($/kWh)
1	Oct-18	42,909	$ 6,439.74	$ 0.150
2	Nov-18	39,317	$ 5,763.51	$ 0.147
3	Dec-18	35,022	$ 5,713.45	$ 0.163
4	Jan-19	41,685	$ 6,203.38	$ 0.149
5	Feb-19	61,161	$ 8,667.17	$ 0.142
6	Mar-19	38,918	$ 5,809.23	$ 0.149
7	Apr-19	33,468	$ 5,098.87	$ 0.152
8	May-19	34,313	$ 5,286.94	$ 0.154
9	Jun-19	44,040	$ 6,633.85	$ 0.151
10	Jul-19	41,047	$ 6,264.88	$ 0.153
11	Aug-19	50,994	$ 7,679.56	$ 0.151
12	Sep-19	42,980	$ 6,516.90	$ 0.152
Year 1	**Total**	**505,854**	**$ 76,077.48**	-
	Average	**42,155**	**$ 6,339.79**	**$ 0.150**
13	Oct-19	35,147	$ 5,323.58	$ 0.151
14	Nov-19	42,025	$ 6,261.72	$ 0.149
15	Dec-19	37,344	$ 5,619.51	$ 0.150
16	Jan-20	36,010	$ 5,636.56	$ 0.157
17	Feb-20	38,837	$ 6,027.76	$ 0.155
18	Mar-20	36,671	$ 5,698.94	$ 0.155
19	Apr-20	27,436	$ 4,481.83	$ 0.163
20	May-20	30,985	$ 4,797.11	$ 0.155
21	Jun-20	31,556	$ 4,962.66	$ 0.157
22	Jul-20	35,864	$ 5,691.19	$ 0.159
23	Aug-20	45,135	$ 7,029.32	$ 0.156
24	Sep-20	41,774	$ 6,543.48	$ 0.157
Year 2	**Total**	**438,784**	**$ 68,073.66**	-
	Average	**36,565**	**$ 5,672.81**	**$ 0.155**
25	Oct-20	40,086	$ 6,211.67	$ 0.155
26	Nov-20	34,829	$ 5,441.08	$ 0.156
27	Dec-20	32,251	$ 5,084.97	$ 0.158
28	Jan-21	38,486	$ 6,110.63	$ 0.159
29	Feb-21	35,418	$ 5,674.95	$ 0.160
30	Mar-21	32,421	$ 5,202.54	$ 0.160
31	Apr-21	37,050	$ 5,898.94	$ 0.159
32	May-21	33,458	$ 5,423.62	$ 0.162
33	Jun-21	33,665	$ 5,460.08	$ 0.162
34	Jul-21	49,587	$ 7,931.98	$ 0.160
35	Aug-21	45,426	$ 7,290.09	$ 0.160
36	Sep-21	37,357	$ 6,074.32	$ 0.163
Year 3	**Total**	**450,034**	**$ 71,804.87**	-
	Average	**37,503**	**$ 5,983.74**	**$ 0.160**

Prepared by Wildephor Consulting Services, LLC

**10356 Truckee Airport Road, 10266 Truckee Airport Road, and 12110 Chandelle Way.*

ATTACHMENT 2

Partner Green Waste Summary

PARTNER GREEN WASTE SUMMARY

Town of Truckee	**Cubic Yards**	**Green Tons**	**Bone Dry Tons**	**Disposal Cost**	
2019 TTSD/ERL	21,084	4,217	3,373	$ 7,942	*Partial payments only*
2020 TTSD/ERL*	30,798	6,160	4,928	$ 255,526	*$41 per green ton*
2021 TTSD/ERL*	23,530	4,706	3,765	$ 252,287	*$54 per green ton*
Annual Average	**25,137**	**5,027**	**4,022**	**$ 253,907**	***33%***

**Includes residential programs (carts/dumpsters/drop-offs) and Town vegetation project.*

Airport District	**Acres**	**Green Tons**	**Bone Dry Tons**	**Disposal Cost**	
Removal	129	2,580	2,064	-	*Not projected for 10 years*
Mastication*	20	320	256	-	*Would require collection*
Annual Projected		**320**	**256**		***2%***

**Assumes 16 green tons per acre @ 20% moisture.*

Truckee Fire	**Acres**	**Green Tons**	**Bone Dry Tons**	**Disposal Cost**	
Defensible Space	-	2,000	1,600	-	*New curbside pick-up program*
Fuels Reduction*	500	8,000	6,400	-	*Projected based on Measure T*
Annual Projected		**10,000**	**8,000**		***65%***

**Assumes 16 green tons per acre @ 20% moisture.*

PARTNER TOTAL		**12,278**	**BDT/Year**	***100%***
	Heat output @ 70% boiler efficiency	144,388	MMBtu/Year	
	Electrical output @ 5% ORC efficiency	2,116,012	kWh/Year	

Prepared by Wildephor Consulting Services, LLC

ATTACHMENT 3

Operating Expense Summary

	OPERATING EXPENSE SUMMARY		Disposal			Biomass Power		Biomass Heat		
			A-1	A-2	A-3	B-1	B-2	C-1	C-2	C-3
			TTSD Landfill	Air Curtain Burner	ACB + Biochar	ACB + Generator	Gasifier + Biochar	District Heating	Heat + Power	Heat + Biochar
1	Disposal Cost	$/yr	$ 1,200,000	$ -	$ -	$ -	$ 610,000	$ 820,000	$ 750,000	$ 320,000
2	Heat Revenue	$/yr	$ -	$ -	$ -	$ -	$ (40,000)	$ (40,000)	$ (40,000)	$ (40,000)
3	Electricity Revenue	$/yr	$ -	$ -	$ -	$ (40,000)	$ (760,000)	$ -	$ (110,000)	$ (120,000)
4	Biochar Revenue	$/yr	$ -	$ -	$ (240,000)	$ -	$ (200,000)	$ -	$ -	$ (890,000)
5	System O&M Cost	$/yr	$ -	$ 220,000	$ 180,000	$ 240,000	$ 410,000	$ 170,000	$ 160,000	$ 560,000
	Net Annual Operating Cost	**$/yr**	**$ 1,200,000**	**$ 220,000**	**$ (60,000)**	**$ 210,000**	**$ 20,000**	**$ 950,000**	**$ 760,000**	**($160,000)**

Prepared by Wildephor Consulting Services, LLC

NOTE: *All values rounded to nearest $10k; discrepancies in annual totals due to rounding.*

ATTACHMENT 4

Available GHG Emissions Reductions

AVAILABLE GHG EMISSIONS REDUCTIONS

Source	Value	Units	Annual (MT CO2e)	%	25 Years (MT CO2e)
Natural Gas Offsets	3,834	MMBtu	203	30%	5,087
Electricity Offsets	782,371	kWh	122	18%	3,043
Avoided Decomposition	20	Acres	363	53%	9,072
PARTNER TOTAL			**688**	**100%**	**17,202**
			150	Cars*	3,740

**Typical passenger vehicle emits roughly 4.6 metric tons of CO2 annually (U.S. EPA, 2021).*

	Source	Value	Units	Annual (MT CO2e)*	% Up	25 Years (MT CO2e)
A-3	Biochar Production	600	tons/yr	1,633	237	40,824
B-2	Biochar Production	493	tons/yr	1,342	195	33,543
C-3	Biochar Production	2,216	tons/yr	6,031	877	150,776

**Assumes 3 metric tons of CO2 sequestration per metric ton of biochar produced (T. R. Miles, 2021).*

Candidate Totals	ID	Biochar (Y/N)	Annual (MT CO2e)	Cars (Annual)	25 Years (MT CO2e)
TTSD Landfill (Baseline)	A-1	N	0	0	0
Disposal	A-2	N	363	79	9,072
Disposal with Biochar	A-3	Y	1,996	434	49,896
Biomass Power	B-1	N	485	105	12,115
Biomass Power with Biochar	B-2	Y	2,030	441	50,745
Biomass Heat	C-1	N	566	123	14,159
Combined Heat and Power	C-2	N	688	150	17,202
Combined Heat and Biochar	C-3	Y	6,719	1,461	167,977

Prepared by Wildephor Consulting Services, LLC

ATTACHMENT 5

Candidate Solution Scorecards

TRUCKEE BIOMASS UTILIZATION SUMMARY SCORECARD 6/8/2022	CANDIDATE SOLUTIONS							
	A. Disposal			B. Biomass Power		C. Biomass Heat		
	1. TTSD Landfill (Baseline)	2. Air Curtain Burner	3. AC Burner with Biochar	1. AC Burner with Generator	2. Gasifier with Generator	1. Hydronic District Heating	2. Combined Heat and Power	3. Combined Heat and Biochar
EVALUATION CRITERIA		DROP	DROP	DROP	KEEP	DROP	DROP	KEEP
Technical Factors								
1 Commercial Availability *(Maximize)*	High	High	High	High	Moderate	High	High	Moderate
2 Operational Efficiency/Flexibility *(Maximize)*	Moderate	High	High	Low	Moderate	High	High	High
3 Size/Footprint *(Minimize)*	> 10,000 SF	> 10,000 SF	> 10,000 SF	> 10,000 SF	1,000 - 10,000 SF	1,000 - 10,000 SF	1,000 - 10,000 SF	1,000 - 10,000 SF
4 Scalability *(Maximize)*	Moderate	High	High	High	Low	Moderate	Moderate	High
5 Operational Structure *(Nominal)*	Other Parties	TOT & Project Partners	TOT & Project Partners	TOT/Partners & TDPUD	TOT/Partners & TDPUD	TOT & Project Partners	TOT/Partners & TDPUD	TOT & Project Partners
6 Schedule/Timing *(Minimize)*	2022	2022	2022	2023	2024	2023	2023	2024
Economic Factors								
7 Life Cycle Capital Cost *(Minimize)*	$0	$300,000	$750,000	$2,000,000	$15,000,000	$5,000,000	$6,000,000	$7,000,000
8 Net Annual Operating Cost *(Minimize)*	$1,200,000	$220,000	($60,000)	$210,000	$20,000	$950,000	$760,000	($160,000)
9 TDPUD Ratepayer Impacts *(Minimize)*	None	None	None	Marginal	Substantial	None	Marginal	Marginal
Environmental Factors								
10 Green Waste Reuse *(Maximize)*	< 50%	< 50%	< 50%	> 100%	50 - 100%	< 50%	< 50%	50 - 100%
11 Life Cycle GHG Reductions *(Maximize)*	< 50k MT CO2e	< 50k MT CO2e	< 50k MT CO2e	< 50k MT CO2e	50k - 100k MT CO2e	< 50k MT CO2e	< 50k MT CO2e	> 100k MT CO2e
12 Community Impacts *(Minimize)*	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Social Factors								
13 District Heating/Snow Melt *(Nominal)*	No	No	No	No	Yes	Yes	Yes	Yes
14 Renewable Power Generation *(Nominal)*	No	No	No	Yes	Yes	No	Yes	Yes
15 Biochar Production *(Nominal)*	No	No	Yes	No	Yes	No	No	Yes

TRUCKEE BIOMASS UTILIZATION
CANDIDATE SOLUTION SCORECARD

ID	A-1	**Type**	Offsite Disposal - TTSD Landfill (Baseline)	**Date**	6/8/2022
Supplier/Provider		Tahoe Truckee Sierra Disposal (TTSD) Eastern Regional Landfill (ERL) - www.waste101.com		**Location**	Truckee, CA
Description		Collecting green waste produced by defensible space and fuels reduction programs from residential, commercial, and municipal sources and hauling in bulk for disposal at ERL. ***Unit disposal costs have more than doubled from $6.35/CY in 2018 to $15.00/CY in 2022 ($250k/yr current disposal cost).***			

CRITERIA	FACTOR	EVALUATION	
1. Commercial Availability	Technical	Local disposal of green waste is expected to continue to be available at ERL; however, downstream uses for the material (e.g., large-scale bioenergy plants) are uncertain.	High
2. Operational Efficiency/Flexibility	Technical	TTSD is facing rapid increases in green waste receipts and is working to adjust its material handling processes to segregate and manage additional green waste cleanly.	Moderate
3. Size/Footprint	Technical	Area required to store projected green waste quantities from partner organizations could exceed 10,000 SF per month of storage at ERL.	> 10,000 SF
4. Scalability	Technical	Local disposal of green waste is expected to continue to be available at ERL; however, capacity issues could arise in the future as a result of Measure T waste streams.	Moderate
5. Operational Structure	Technical	Disposal of green waste at ERL is subject to material handling requirements and tipping fees as set by TTSD.	Other Parties
6. Schedule/Timing	Technical	Disposal of green waste at ERL is currently available.	2022
7. Life Cycle Capital Cost	Economic	Additional heavy equipment purchases may be required to effectively implement expanded biomass removal consistent with Measure T fuels reduction goals (not included).	$0
8. Net Annual Operating Cost	Economic	Town anticipates paying at least $15/cubic yard for disposal at ERL going forward. At that rate, disposing of projected future waste quantities (~12,000 BDT/yr) would cost >$1MM annually.	$1,200,000
9. TDPUD Ratepayer Impacts	Economic	Disposal of green waste at ERL does not directly impact the electricity rates paid by Truckee Donner PUD customers.	None
10. Green Waste Reuse	Environmental	Disposal of green waste at ERL would not allow the partners to directly reuse material projected from green waste recycling and/or other biomass removal programs.	< 50%
11. Life Cycle GHG Reductions	Environmental	Disposal of green waste at ERL does not allow the partners to directly control reduction of their carbon footprints.	< 50k MT CO2e
12. Community Impacts	Environmental	Disposal of green waste at ERL is projected to require more than 800 trucking round trips annually in the Truckee area.	Moderate
13. District Heating/ Snow Melt	Social	Disposal of green waste at ERL does not allow the partners to directly offset any of their current natural gas usage.	No
14. Renewable Power Generation	Social	Disposal of green waste at ERL does not allow the partners to directly offset any of their current electricity usage.	No
15. Biochar Production	Social	Disposal of green waste at ERL does not allow the partners to produce biochar as a potentially merchantable co-product of biomass removal.	No

TRUCKEE BIOMASS UTILIZATION CANDIDATE SOLUTION SCORECARD						
ID	A-2	**Type**	Onsite Disposal - Air Curtain Burner	**Date**	6/8/2022	
Supplier/Provider		Air Burners, Inc. www.airburners.com		**Location**	Palm City, FL	
Description		**FireBox** air curtain burner combusts unprocessed biomass waste onsite. Designed as a pollution control device for an alternative to open pile burning, reducing particulate matter and black carbon emissions. ***Would allow onsite disposal with some improved environmental impact but at high operating costs.***				

CRITERIA	FACTOR	EVALUATION	DROP
1. Commercial Availability	Technical	Technology in use since 1990. Demonstrated in the Tahoe Basin starting in 2001. Smaller versions owned and operated by USFS. Similar units currently permitted and used by CAL FIRE.	High
2. Operational Efficiency/Flexibility	Technical	Clean, efficient combustion that effectively burns gases and particulates. Can manage wide variety in moisture, size, and density of feedstocks, including whole logs.	High
3. Size/Footprint	Technical	100 Series: 2-5 t/hr; skid-mounted with floor; < 30' length. 200/300 Series: 5-13 t/hr; skid mounted; 30-40' length. 70,000 SF working circle required for safety.	> 10,000 SF
4. Scalability	Technical	15-100 t/day throughput; 12,000 BDT could be burned in 8-10 months with larger units (@ 8 hr/day). Can manage variable fuel loads and be moved to different locations (no concrete pad).	High
5. Operational Structure	Technical	Two operators required: loader/excavator to feed burner and utility for wood handling and fire control. Could be operated by TFPD or other municipal staff.	TOT & Project Partners
6. Schedule/Timing	Technical	Delivery in ~6 months. Rapid commissioning. Air quality permitting required as alternative to open pile burning; currently difficult based on discussions with regulators.	2022
7. Life Cycle Capital Cost	Economic	Equipment - $125-200k; Commissioning - $20k; Freight and indirect costs - $40k.	$300,000
8. Net Annual Operating Cost	Economic	Roughly 80% less than projected annual cost for disposal at ERL. Assumes two operators working 8 hr/day, accounting for ~90% of total annual cost.	$220,000
9. TDPUD Ratepayer Impacts	Economic	Disposal of green waste using air curtain burner would not directly impact the electricity rates paid by Truckee Donner PUD customers.	None
10. Green Waste Reuse	Environmental	Disposal of green waste using air curtain burner would not allow the partners to directly reuse material projected from green waste recycling and/or other biomass removal programs.	< 50%
11. Life Cycle GHG Reductions	Environmental	GHG emissions reduction available from avoided anaerobic decomposition of green waste that is currently masticated.	< 50k MT CO2e
12. Community Impacts	Environmental	Onsite/mobile air curtain burner could eliminate hundreds of trucking round trips annually in the Truckee area versus hauling to ERL.	Low
13. District Heating/ Snow Melt	Social	Disposal of green waste using air curtain burner would not allow the partners to offset any of their current natural gas usage.	No
14. Renewable Power Generation	Social	Disposal of green waste using air curtain burner would not allow the partners to offset any of their current electricity usage.	No
15. Biochar Production	Social	Disposal of green waste using air curtain burner is not designed to produce biochar; however, some usable biochar could be produced with additional 2 hr/day of manual operations.	No

TRUCKEE BIOMASS UTILIZATION
CANDIDATE SOLUTION SCORECARD

ID	A-3	**Type**	Onsite Disposal - Air Curtain Burner with Biochar	**Date**	6/8/2022
Supplier/Provider		Tigercat International Inc. www.tigercat.com		**Location**	Ontario, Canada
Description		**6050 Carbonator** mobile air curtain burner with biochar recovery by Tigercat (formerly ROI Equipment). Combustion unit mounted on tracks with grate and augers to remove biochar after quenching. ***Leasing could be a low-cost option to test producing biochar as a co-benefit of green waste disposal.***			

CRITERIA	FACTOR	EVALUATION	DROP
1. Commercial Availability	Technical	Distributed by major mobile equipment suppliers, with nearest location in Reno, NV. Machines operating in 40+ countries. May be available to lease for monthly/seasonal use.	High
2. Operational Efficiency/Flexibility	Technical	Mobile operation can handle wide variety in moisture, size, and density of feedstocks, including whole logs. Can operate during winter on burn days.	High
3. Size/Footprint	Technical	40' x 12' x 12' air curtain burner on tracks; 16" ground clearance for mobile operations on uneven terrain. Required operating radius of ~200-300'.	> 10,000 SF
4. Scalability	Technical	80-160 t/day throughput (10-20 t/hr). 5-7 months to process 12,000 BDT (@ 8 hr/day). Additional units could be purchased or leased if needed.	High
5. Operational Structure	Technical	Two operators required including excavator for loading waste. Units can be purchased, leased, or contracted. Would require water tanker from TFPD or elsewhere.	TOT & Project Partners
6. Schedule/Timing	Technical	Rental units available; purchases delivered in 3-6 months. Air quality permitting required as alternative to open pile burning; currently difficult based on discussions with regulators.	2022
7. Life Cycle Capital Cost	Economic	Base price ~$650k. Lease @ $30k/month could be good option to test before annual green waste quantity ramps up.	$750,000
8. Net Annual Operating Cost	Economic	OPEX could be more than offset by biochar sales. 4,800 CY of biochar could generate ~$240k in annual revenue. Simple payback = 13 years.	($60,000)
9. TDPUD Ratepayer Impacts	Economic	Disposal of green waste using air curtain burner would not directly impact the electricity rates paid by Truckee Donner PUD customers.	None
10. Green Waste Reuse	Environmental	Disposal of green waste using this air curtain burner would allow the partners to reuse ~5% of material projected from green waste recycling and/or other biomass removal programs.	< 50%
11. Life Cycle GHG Reductions	Environmental	GHG emissions reduction available from avoided anaerobic decomposition of green waste that is currently masticated. Additional 1,600 MT CO2e/yr sequestered with biochar.	< 50k MT CO2e
12. Community Impacts	Environmental	Onsite/mobile air curtain burner could eliminate hundreds of trucking round trips annually in the Truckee area versus hauling to ERL. Requires quench water @ up to 5 gpm.	Moderate
13. District Heating/ Snow Melt	Social	Disposal of green waste using air curtain burner would not allow the partners to offset any of their current natural gas usage.	No
14. Renewable Power Generation	Social	Disposal of green waste using air curtain burner would not allow the partners to offset any of their current electricity usage.	No
15. Biochar Production	Social	Estimated revenue from biochar sales: ~4,800 CY @ $50/CY = ~$240k annually.	Yes

TRUCKEE BIOMASS UTILIZATION CANDIDATE SOLUTION SCORECARD						
ID	B-1	**Type**	Biomass Power - Air Curtain Burner with Generator	**Date**	6/8/2022	
Supplier/Provider		Air Burners, Inc. www.airburners.com		**Location**	Palm City, FL	
Description		**PGFireBox** combines an air curtain burner with an organic Rankine cycle (ORC) generator provided by ElectraTherm to produce up to 250 kWe of emissions-free power from combustion waste heat. ***Allows offsetting of grid power purchases along with avoided landfill disposal costs.***				

CRITERIA	FACTOR	EVALUATION	DROP
1. Commercial Availability	Technical	Air curtain burner technology in use since 1990. Partnered with ElectraTherm for power generation module in 2006. Multiple grid-connected units now operating at landfills in California.	High
2. Operational Efficiency/Flexibility	Technical	Clean burning operation up to 8 hr/day at 6-8 tons/hr. High combustion efficiency; very low electrical efficiency using ORC process (<5%) but good for maximizing waste disposal.	Low
3. Size/Footprint	Technical	Comparable to 200 Series FireBox with attached containerized power module installed on slab with grid connection. 70,000 SF working circle required for safety.	> 10,000 SF
4. Scalability	Technical	50-70 t/day throughput; 12,000 BDT/yr could be processed using a single unit (@ 8 hr/day). System can be disassembled and relocated. 150 kWe maximum size currently available.	High
5. Operational Structure	Technical	Two operators required: loader/excavator to feed burner and utility for wood handling and fire control. Would require net metering or power purchase agreement with TDPUD.	TOT/Partners & TDPUD
6. Schedule/Timing	Technical	Delivery in ~6 months. Additional engineering required for grid connection. Air quality permitting required as alternative to open pile burning. Up to 6 months for grid interconnection.	2023
7. Life Cycle Capital Cost	Economic	Equipment - $6,400-9,000/kW; plus installation on slab and electrical connections.	$2,000,000
8. Net Annual Operating Cost	Economic	Electricity sales offset only about 15% of annual O&M costs. Payback not possible even at 1 MWe scale (currently under development) without additional subsidies.	$210,000
9. TDPUD Ratepayer Impacts	Economic	250 kWe generating capacity could produce ~375 MWh/yr.	Marginal
10. Green Waste Reuse	Environmental	Disposal of green waste using PGFireBox would allow the partners to reuse 1.3x material projected from green waste recycling and other biomass removal programs.	> 100%
11. Life Cycle GHG Reductions	Environmental	GHG emissions reductions available from avoided anaerobic decomposition of green waste that is currently masticated and avoided electricity purchases from TDPUD.	< 50k MT CO2e
12. Community Impacts	Environmental	Onsite air curtain burner could eliminate hundreds of trucking round trips annually in the Truckee area versus hauling to ERL. Requires 725 gpm of cooling water.	Moderate
13. District Heating/ Snow Melt	Social	Disposal of green waste using air curtain burner would not allow the partners to offset any of their current natural gas usage.	No
14. Renewable Power Generation	Social	Installation of a 250 kWe PGFireBox could offset ~50% of the electricity currently consumed by the five buildings examined for the scoping study.	Yes
15. Biochar Production	Social	Disposal of green waste using air curtain burner is not designed to produce biochar; however, some usable biochar could be produced with additional 2 hr/day of manual operations.	No

TRUCKEE BIOMASS UTILIZATION
CANDIDATE SOLUTION SCORECARD

ID	B-2	**Type**	Biomass Power - Gasifier with Generator	**Date**	6/8/2022
Supplier/Provider		SynCraft Engineering GmbH www.syncraft.at/en		**Location**	Innsbruck, Austria
Description		**CW1800x2-1000** floating fixed-bed gasifier with 1 MWe nominal output. Wood chips thermochemically converted into synthesis gas for combustion in an engine generator, with biochar as co-product. ***Offers somewhat low utilization (~50%) of projected green waste volumes at relatively high capital cost.***			

CRITERIA	FACTOR	EVALUATION	KEEP
1. Commercial Availability	Technical	Several operating systems in Austria and Germany. Novel floating bed technology has demonstrated reliability. Supplier will not sell in US without strong partner and good support.	Moderate
2. Operational Efficiency/Flexibility	Technical	Efficient power conversion with ~10% high-quality biochar co-product. Good turndown and load response. Best to run engine at > 80% full load. Requires well-formed wood chips.	Moderate
3. Size/Footprint	Technical	50' x 120' footprint; ~8,000 SF total for multi-story building with fuel storage and drying (1 week supply).	1,000 - 10,000 SF
4. Scalability	Technical	1,900 lb/hr = 23 t/day fuel feed rate. ~6,000 BDT/yr of green waste consumed. Composed of two 500 kWe modular units.	Low
5. Operational Structure	Technical	Plant can be automated to operate 24/7 with daily oversight by trained staff (~1.0 FTE). Best to have an operator experienced with IC engines. Would require a PPA with TDPUD.	TOT/Partners & TDPUD
6. Schedule/Timing	Technical	Long delivery lead time. International supplier will require establishing US distributor to oversee design and installation. Up to 6 months for grid interconnection.	2024
7. Life Cycle Capital Cost	Economic	Small-scale gasifiers driving internal combustion engines are expensive on a per unit of output basis (up to $10,000/kW in equipment costs).	$15,000,000
8. Net Annual Operating Cost	Economic	Engines require frequent maintenance, with overhauls every 10,000 operating hours. Payback challenging without subsidies at 1 MWe scale (assuming PPA rate of $0.10/kWh).	$20,000
9. TDPUD Ratepayer Impacts	Economic	1 MWe generating capacity could produce ~7,600 MWh/yr. Terms of PPA could set precedent for other generators in TDPUD service area.	Substantial
10. Green Waste Reuse	Environmental	Disposal of green waste using gasifier system would allow the partners to reuse roughly 50% of material projected from green waste recycling and/or other biomass removal programs.	50 - 100%
11. Life Cycle GHG Reductions	Environmental	GHG emissions reductions available from avoided anaerobic decomposition and avoided electricity purchases from TDPUD. Additional ~1,300 MT CO2e/yr sequestered with biochar.	50k - 100k MT CO2e
12. Community Impacts	Environmental	Additional processing of wood waste (e.g., chipping, grinding) could create noise and some dust in excess of what would be required for disposal using air curtain burner.	Moderate
13. District Heating/ Snow Melt	Social	Disposal of green waste in this type of gasification system also could allow the partners to offset their current natural gas usage through heat recovery.	Yes
14. Renewable Power Generation	Social	1 MWe gasifier could generate nearly 10 times the electricity currently consumed by the five buildings examined for the scoping study.	Yes
15. Biochar Production	Social	Estimated revenue from biochar sales: ~3,900 CY @ $50/CY = ~$200k annually.	Yes

TRUCKEE BIOMASS UTILIZATION
CANDIDATE SOLUTION SCORECARD

ID	C-1	**Type**	Biomass Heat - Hydronic District Heating	**Date**	6/8/2022
Supplier/Provider		Messersmith Manufacturing Inc. www.burnchips.com		**Location**	Bark River, MI
Description		Advanced wood-fired boiler system used to generate hot water for hydronic district heating or other applications. Combined heat & power (CHP) systems available for applications needing electrical generation. ***System economics limited by relatively low concentration of existing heating loads.***			

CRITERIA	FACTOR	EVALUATION	DROP
1. Commercial Availability	Technical	Domestic supplier of automated biomass boiler systems for more than 35 years. Strong reputation for project delivery and long-term reliability.	High
2. Operational Efficiency/Flexibility	Technical	Able to burn green fuel with up to 50% moisture content, including whole tree chips. Boiler turndown ratio up to 10:1. Very high combustion efficiency that can exceed 99%.	High
3. Size/Footprint	Technical	50' x 100' footprint = 5,000 SF total for single-story building with fuel storage at or below grade (1-2 week supply).	1,000 - 10,000 SF
4. Scalability	Technical	Systems ranging from 1-60 MMBtu/hr heat output (analysis used 7 MMBtu/hr). Multiple boilers can be installed in phases to allow for future expansion and/or operational flexibility.	Moderate
5. Operational Structure	Technical	Boiler plant could be highly automated, with 24/7 operations possible with daily system checks by existing municipal staff. District heating may require heat purchase agreements.	TOT & Project Partners
6. Schedule/Timing	Technical	4-6 months for delivery of boiler equipment following completion of detailed design package and down payment, subject to ongoing supply chain constraints.	2023
7. Life Cycle Capital Cost	Economic	Equipment - $2.5MM (installed); plus site work and central boiler plant building, balance of plant, district piping, building interconnections, and professional services.	$5,000,000
8. Net Annual Operating Cost	Economic	Relatively low avoided costs for existing heating are insufficient to offset plant operating costs. Capital investment could not be recovered through heating alone at this scale.	$950,000
9. TDPUD Ratepayer Impacts	Economic	Operation of a biomass-fueled district heating system would not directly impact the electricity rates paid by Truckee Donner PUD customers.	None
10. Green Waste Reuse	Environmental	Operation of a biomass-fueled district heating system would allow the partners to reuse ~30% of material projected from green waste recycling and/or other biomass removal programs.	< 50%
11. Life Cycle GHG Reductions	Environmental	GHG emissions reductions available from avoided anaerobic decomposition of green waste that is currently masticated and avoided natural gas purchases from Southwest Gas.	< 50k MT CO2e
12. Community Impacts	Environmental	Additional processing of wood waste (e.g., chipping, grinding) could create noise and some dust in excess of what would be required for disposal using air curtain burner.	Moderate
13. District Heating/ Snow Melt	Social	7 MMBtu/hr boiler system would allow the partners to offset 100% of current natural gas usage. Significant boiler capacity also could be available for hydronic snow melt system.	Yes
14. Renewable Power Generation	Social	Operation of a biomass-fueled district heating system without CHP would not allow the partners to offset any of their current electricity usage.	No
15. Biochar Production	Social	Disposal of green waste in a biomass boiler would not produce biochar as a potentially merchantable co-product of biomass removal, but could produce usable ash.	No

TRUCKEE BIOMASS UTILIZATION CANDIDATE SOLUTION SCORECARD						
ID	C-2	**Type**	Biomass Heat - Combined Heat and Power (CHP)	**Date**	6/8/2022	
Supplier/Provider		ElectraTherm, Inc. www.electratherm.com		**Location**	Flowery Branch, GA	
Description		Using heat from a 7 MMBtu/hr Messersmith biomass-fired boiler to generate electricity with a grid-connected **POWER+** organic Rankine cycle (ORC) generator. ***CHP system allows offsets of utility heat and electricity purchases to improve environmental impacts, but still cost prohibitive at this scale.***				

CRITERIA	FACTOR	EVALUATION	DROP
1. Commercial Availability	Technical	More than 100 ORC generators operating worldwide, including units powered by waste heat from biomass-fired boilers. Domestic manufacturer, with support staff in Reno, NV.	High
2. Operational Efficiency/Flexibility	Technical	Demonstrated availability factor of ~95% when heat source is available. Minimum operating output of 25 kWe. Closed loop system having extremely low maintenance requirements.	High
3. Size/Footprint	Technical	50' x 120' footprint including liquid loop radiator (LLR) and biomass boiler building.	1,000 - 10,000 SF
4. Scalability	Technical	125-150 kWe gross power output. 75 kWe units also available. LLR allows shedding of waste heat to atmosphere in response to fluctuating heat demand.	Moderate
5. Operational Structure	Technical	No additional operators required beyond those required for biomass boiler plant. Would require net metering agreement with TDPUD.	TOT/Partners & TDPUD
6. Schedule/Timing	Technical	Delivery of boiler plant would control lead time for CHP project. Turnkey system with relatively simple connection to biomass boiler. Up to 6 months for grid interconnection.	2023
7. Life Cycle Capital Cost	Economic	ORC Equipment - $300k; plus grid connection (in additional to estimated $5MM CAPEX for boiler plant).	$6,000,000
8. Net Annual Operating Cost	Economic	Savings from avoided natural gas purchases and electricity sales insufficient to offset annual boiler system O&M costs. Payback not achievable at this scale (snow melt not considered).	$760,000
9. TDPUD Ratepayer Impacts	Economic	150 kWe generating capacity could produce ~1,100 MWh/yr.	Marginal
10. Green Waste Reuse	Environmental	Operation of a biomass-fueled CHP system would allow the partners to reuse ~35% of material projected from green waste recycling and/or other biomass removal programs.	< 50%
11. Life Cycle GHG Reductions	Environmental	GHG emissions reductions available from avoided anaerobic decomposition of green waste that is currently masticated and avoided natural gas and electric utility purchases.	< 50k MT CO2e
12. Community Impacts	Environmental	Closed loop ORC system produces no odor, smoke, or other emissions. 72 dBA operating noise level at 1 meter. Primary impacts would be from biomass boiler plant.	Moderate
13. District Heating/ Snow Melt	Social	7 MMBtu/hr boiler system would allow the partners to offset 100% of current natural gas usage. Additional boiler capacity could be used to supply hydronic snow melt system.	Yes
14. Renewable Power Generation	Social	150 kWe ORC generator could offset 100% of electricity currently consumed by the five buildings examined for the scoping study.	Yes
15. Biochar Production	Social	Disposal of green waste in a biomass boiler would not produce biochar as a potentially merchantable co-product of biomass removal, but could produce usable ash.	No

TRUCKEE BIOMASS UTILIZATION
CANDIDATE SOLUTION SCORECARD

ID	C-3	**Type**	Biomass Heat - Combined Heat and Biochar (CHAB)	**Date**	6/8/2022
Supplier/Provider		Pyrocal Proprietary Ltd www.pyrocal.com.au		**Location**	Queensland, Australia
Description		Gasification system utilizing an advanced thermal treatment (i.e., pyrolysis) process known as Continuous Carbonization Technology (CCT) to convert biomass into thermal energy while sequestering carbon in the form of biochar. ***Capital cost recovery is highly dependent on revenue from biochar sales.***			

CRITERIA	FACTOR	EVALUATION	KEEP
1. Commercial Availability	Technical	Proven technology implemented on a commercial scale in Australia since 2014, now with more than 30 installations in eight countries. Currently no projects in the US.	Moderate
2. Operational Efficiency/Flexibility	Technical	High overall conversion efficiency to heat. Requires long operating hours for biochar production and sales to be economical. Includes emissions control equipment.	High
3. Size/Footprint	Technical	**Pyrocal CCT 12** - 2.8 MMBtu/hr boiler with heat exchanger. Containerized reactor and heat recovery unit. 550 lb/hr of fuel per gasifier. 75' x 120' footprint = 9,000 SF for 4 containers.	1,000 - 10,000 SF
4. Scalability	Technical	Modular system allowing multiple units to be connected. Good turndown ratio and flexibility to adapt to changes in feedstock sizing and composition.	High
5. Operational Structure	Technical	Highest operating costs of all candidate solutions due to high volumes of biochar production. Adding power component would require PPA or net metering agreement with TDPUD.	TOT & Project Partners
6. Schedule/Timing	Technical	Fabricated and shipped from Australia. System of this scale may require longer than normal lead time.	2024
7. Life Cycle Capital Cost	Economic	Equipment - $4MM; plus site work, district piping, building interconnections, and professional services; includes 150 kWe ORC unit for generating electricity from excess heat.	$7,000,000
8. Net Annual Operating Cost	Economic	Assumes processing ~8,800 BDT/yr for heating and electricity offsets and biochar sales. Payback highly sensitive to biochar revenue.	($160,000)
9. TDPUD Ratepayer Impacts	Economic	150 kWe generating capacity would produce ~1,200 MWh/yr.	Marginal
10. Green Waste Reuse	Environmental	Operation of a biomass-fueled CHAB system would allow the partners to reuse ~75% of material projected from green waste recycling and/or other biomass removal programs.	50 - 100%
11. Life Cycle GHG Reductions	Environmental	GHG emissions reductions available from avoided anaerobic decomposition and avoided gas and electric utility purchases. Additional 6,000 MT CO_2e/yr sequestered with biochar.	> 100k MT CO_2e
12. Community Impacts	Environmental	No additional impacts would be produced by the gasification system relative to standard biomass boiler plant. Biochar would require removal by truck (up to 200 loads/yr).	Moderate
13. District Heating/ Snow Melt	Social	11 MMBtu/hr boiler system would allow the partners to offset 100% of current natural gas usage. Additional boiler capacity could be used to supply hydronic snow melt system.	Yes
14. Renewable Power Generation	Social	150 kWe ORC generator could offset 100% of electricity currently consumed by the five buildings examined for the scoping study.	Yes
15. Biochar Production	Social	Estimated revenue from biochar sales: ~18,000 CY @ $50/CY = ~$900k annually.	Yes