CONVERTING RIPARIAN RESTORATION WASTE TO ENERGY:

The Working for Rivers Foundation and Community Power Corporation partner to test tamarisk biomass as a fuel for gasification

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ABSTRACT:

In the course of riparian ecological restoration work, tamarisk biomass is often piled and burned, generating air pollution, or shipped to landfills- a costly alternative. Information on processing and utilizing tamarisk biomass is becoming increasingly valuable in light of the spread of the tamarisk leaf beetle (*Diorhabda* spp.) biological control agent. As populations of the beetle expand, information on the properties of both green and beetle-killed tamarisk biomass and their suitability as feedstocks for conversion to energy will be useful for land managers seeking to offset the costs of tamarisk removal, restore wildlife habitat and ecosystem function, and reduce wildfire threat posed by standing dead tamarisk. Field trials, feasibility studies, and economic analyses are needed to enable pioneering restorationists and land managers to incorporate tamarisk biomass utilization into their project plans.

We collected both green (live) tamarisk and tamarisk killed by the tamarisk leaf beetle, and tested both as fuels for conversion to a clean producer gas via downdraft gasification and then to electricity in a spark-ignited engine/genset at Community Power Corporation (CPC) in Littleton, Colorado. Both green and dead tamarisk chips were excellent fuels for gasification, performing more efficiently than a sample of mixed softwood. Further, the data suggest that significantly more energy can be recovered from tamarisk when harvested green, compared to waiting for the tamarisk to die and age.

What is Gasification?

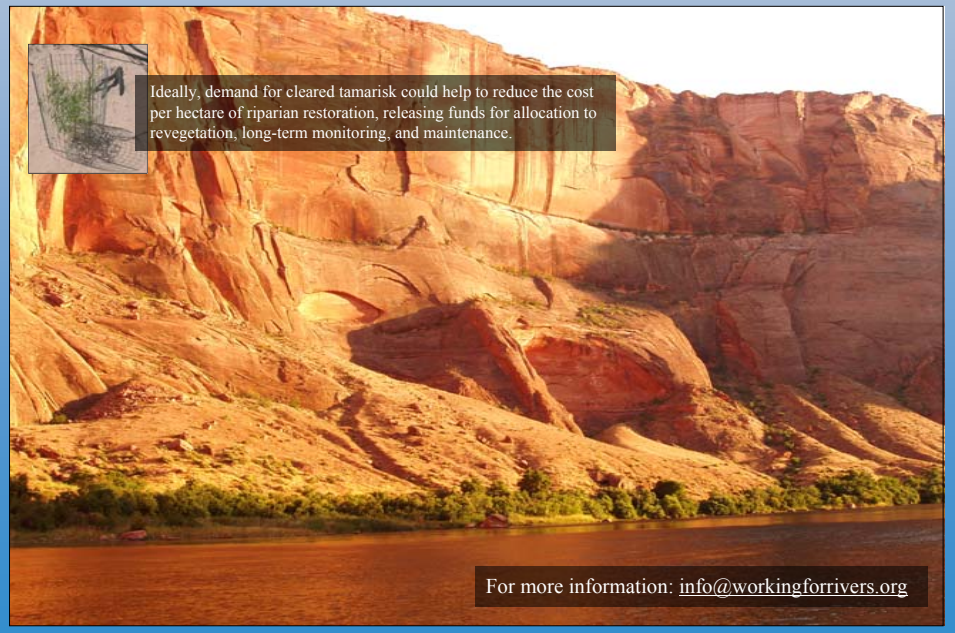
Gasification is the conversion of a carbon-rich material, or "feedstock", to a combustible gas, which can be used in place of fossil fuels. In our study, the photosynthetic energy stored in the feedstock (chipped tamarisk) was converted to producer gas, which was cleaned and used to fuel an internal combustion engine, which in turn spins a generator producing electrical power. The family of BioMax® downdraft gasifiers was developed by Community Power Corporation (CPC) in Littleton, CO, with funding from the U.S. Department of Energy, Agriculture, and Defense.

Sample Collection: Lessons Learned in the Field

- Tamarisk biomass samples collected from 2 sites adjacent to the Colorado River near Moab, Utah.
- Initially, we used a 6 inch diameter, gasoline-powered Vermeer chipper, but generated a shredded mulch which can jam in a downdraft gasifier. A larger-diameter 12 inch diesel-powered Vermeer chipper generated the correct chip size *and* processed the tamarisk significantly faster, allowing the crew to work more efficiently overall.
- With the chipper running +/- 1 hour at each site, a crew of 3 people generated 606 lbs of green tamarisk chips and 496 lbs of beetle-killed tamarisk chips at Sites 1 and 2 respectively.
- Chips were collected in heavy duty (.006 mil) clear plastic bags, sealed with duct tape, and labeled.
- The bags were secured to pallets and shipped to CPC in Littleton, Colorado, for drying, screening, and gasification.

Cutting tamarisk stems to feed into the chipper.
Photo by M. Boyle

A cross-wind separates dirt and dust from tamarisk chips at the collection site.
Photo by M. Boyle



Ideally, demand for cleared tamarisk could help to reduce the cost per hectare of riparian restoration, releasing funds for allocation to revegetation, long-term monitoring, and maintenance.

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Preliminary Analysis

- Green sample contained nearly 10% more usable chips than the beetle-killed sample.
- Elemental & constituent analyses, heating values, ash fusion temp (Hazen Research Inc.): Both tamarisk samples had Heating Values (LHV) comparable with that of a mixed softwood sample.
- Green tamarisk had higher heating values and lower ash content than the beetle-killed tamarisk. This suggests that the wood of the tamarisk killed by repeated defoliation lost significant mass and heating value (19.4% of its energy) while dying and aging.

Test Parameter	Dead Tamarisk	Green Tamarisk	Softwood Chips
Feedstock Proximate Analysis			
Ash, %	3.55	2.99	0.86
Volatile, %	85.44	85.99	86.83
Fixed C, %	11.01	11.02	12.31
Total, %	100.00	100.00	100.00
Sulfur, %	0.716	0.608	0.006
Feedstock Ultimate Analysis			
Carbon, %	49.46	49.69	52.32
Hydrogen, %	5.39	5.50	6.35
Nitrogen, %	0.23	0.19	0.32
Sulfur, %	0.72	0.61	<0.01
Ash, %	3.55	2.99	0.86
Oxygen, % (by difference)	40.65	41.02	40.15
Feedstock Heating Value			
HHV, MJ/kg (Btu/lb)	18.28 (7861)	19.07 (8200)	19.6 (8400)
LHV, MJ/kg (Btu/lb)	17.11 (7355)	17.87 (7684)	18.1 (7804)
Water Soluble Alkalies			**10/19/07**
Sodium as Na_2O, %	0.331	0.243	0.0076
Potassium as K_2O, %	0.279	0.205	0.068
$Na_2O + K_2O$ w/w	1.186	1.185	0.112

Gasification

- Both Green and Dead Tamarisk chips were excellent fuels for gasification in the BioMax® 25 gasifier.
- In these tests, tamarisk appeared to perform more efficiently than softwood, due to more thorough gasification of the tamarisk char and a higher moisture content in the softwood tested.
- The engine/genset was equally efficient with producer gas from tamarisk or softwood samples.

Performance Parameter	Beetle-Killed Tamarisk	Green Tamarisk	Mixed Softwood
Conversion Efficiencies			
Dry Wood to Producer Gas, % energy efficiency	90.4	92.4	82.9
Dry Wood to Electricity, % energy eff.	≥ 22.9	25.3	23.0
Yield: Amount of Producer Gas generated per kg of wood chips, Nm³/kg	3.00	3.03	3.22
Producer Gas Composition (dry basis)			
O_2, vol %	0.2	0.4	0.6
CO, %	24.1	24.0	19.5
CO_2, %	12.1	9.6	10.6
CH_4, %	3.8	3.3	2.4
H_2, %	16.5	16.5	16.3
N_2, %	42.3	46.2	50.6
Net Heat of Combustion (LHV) of Producer Gas, MJ/Nm³	6.20	5.98	4.65
Producer Gas Thermal Energy Content, kW	95.7	90.1	***
Avg. Electrical Power Generated, kW$_e$	24.2	24.6	***
Char Yield, wt%	2.66	3.10	3.44

Tamarisk chips being fed from a hopper into a BioMax® downdraft gasifier. The yield of producer gas from the tamarisk samples was slightly lower than from the softwood sample, but its composition was much richer in carbon monoxide and methane, resulting in a higher heating values and overall energy conversion.
Photo courtesy of Community Power Corporation

Green vs. Beetle-Killed Tamarisk

- These data strongly suggest that more energy can be recovered from green than dead tamarisk. Ash content and heating value data, in combination with a larger % of usable chips in the green tamarisk sample suggest that harvesting the tamarisk while green will result in nearly 29% more energy recovery, compared to harvesting the same tamarisk after it has succumbed to repeated defoliation, aged and dried.
- **Next Steps:** We recommend that additional testing be conducted with green and dead samples from a range of sites in multiple geographic regions to verify this conclusion.