

USDA Biomass Crop Assistance Program (BCAP)

**Northern New York Willow Biomass Production Area
(Project Area 10)**

Annual Report 2013



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1) CROP AREA STATUS

Despite wet weather conditions that disrupted planting operations considerably during June, BCAP participant landowners managed to plant the entire contracted area during the spring and early summer of 2013 (**Table 1**).

Table 1: Summary of crop areas

Planting Type	Contracted	Planted	Harvested 2013
Existing Acreage	351.0	-	130
New Acreage	836.9	836.9	-
Total	1187.9	836.9	130

Technical difficulties with the planting equipment and some small-diameter cuttings (resulting from dry conditions at the nursery during the previous growing season) produced some areas with skips that were hand-filled by the grower to achieve a better stand. Limited replanting of cuttings that went in near the end of the 2013 planting season may be required in spring 2014, due to the late planting date and weed pressure. There was very heavy deer browse in a number of the fields in the Cape Vincent area, but fall inspection did not suggest that the damage was severe enough to have a significant impact on survival and re-growth in the coming season. Staff from SUNY ESF (the State University of New York College of Environmental Science and Forestry in Syracuse, NY) will continue to closely monitor crop development, crop health, and pest and weed pressure on all of the BCAP fields.

2) UTILIZATION STATUS

None of the newly planted willow will be sufficiently mature for harvest until 2016. Some of the willow in the Boonville, NY area was planted more than five years ago so these were the willow crops where harvesting was conducted in the fall of 2013 between September 9th and November 18th. A total of 2,477 tons of harvested willow was trucked to the ReEnergy Lyonsdale biopower facility in Lyons Falls, NY. During this time period, the Lyonsdale facility burned 45,355 tons of green wood chips, including 2,477 tons of willow chips (5.5% of the total biomass used). The plant produced 25,351 net megawatt hours of electricity during that time period, or approximately 1,394 Mwh attributable to the willow feedstock. The ReEnergy biopower facility in Chateaugay, NY is not yet operating at this time, but the ReEnergy Black River facility, closest to the new plantings in the Cape Vincent area and some of the younger established plantings, is operating continuously. Limited harvesting is planned in both the Cape Vincent and Boonville areas in fall 2014.

3) CHARACTERISTICS OF DELIVERED WILLOW CHIPS

There is a broad perception that shrub willow chips will be exceptionally high in moisture when delivered in green form, based on the association of some willow species with high soil moisture growing conditions. In terms of ash content, the general perception is that willow energy feedstocks will have high ash content because the shrub form of willow that is used for biomass production is presumed to result in excessive bark content in the chipped material. ReEnergy's commitment to purchase willow chips was based on limited testing at one of its plants which indicated that shrub-willow would be an acceptable fuel, and perhaps on research that has shown that the energy content of willow is generally in line with other hardwoods on a dry weight basis. Project staff have also encountered a belief that "*there isn't any heat in willow*", particularly among loggers and firewood producers, likely because of tree willow's relatively low wood density in comparison with preferred firewood species like maple and oak. Because

of the low wood density, there is less heat in a (volumetric) cord of willow than of other hardwoods. However, data that has been collected over the years shows that these opinions about the moisture and ash content of willow are misperceptions.

Various sources of data are available to address these misperceptions about moisture and ash content of shrub willow, but many of them are from small plot research studies. While this data is useful, information from large scale harvests of willow biomass crops using commercial equipment is more representative and accepted by end users. SUNY ESF was involved in large scale harvests of willow in the fall and winter of 2012/2013, as part of a project supported by the United States Department of Energy (USDOE), the New York State Energy Research and Development Agency (NYSERDA) and the Empire State Development's Division of Science, Technology and Innovation (NYSTAR). During that time, chip samples were collected from 267 trucks that were used to transport harvested willow from the field to off-site storage locations. The mean moisture content for these willow chips immediately post harvest was 44.4 % with a standard deviation $\pm 2.17\%$ (**Figure 1**) (Eisenbies et al. 2014).

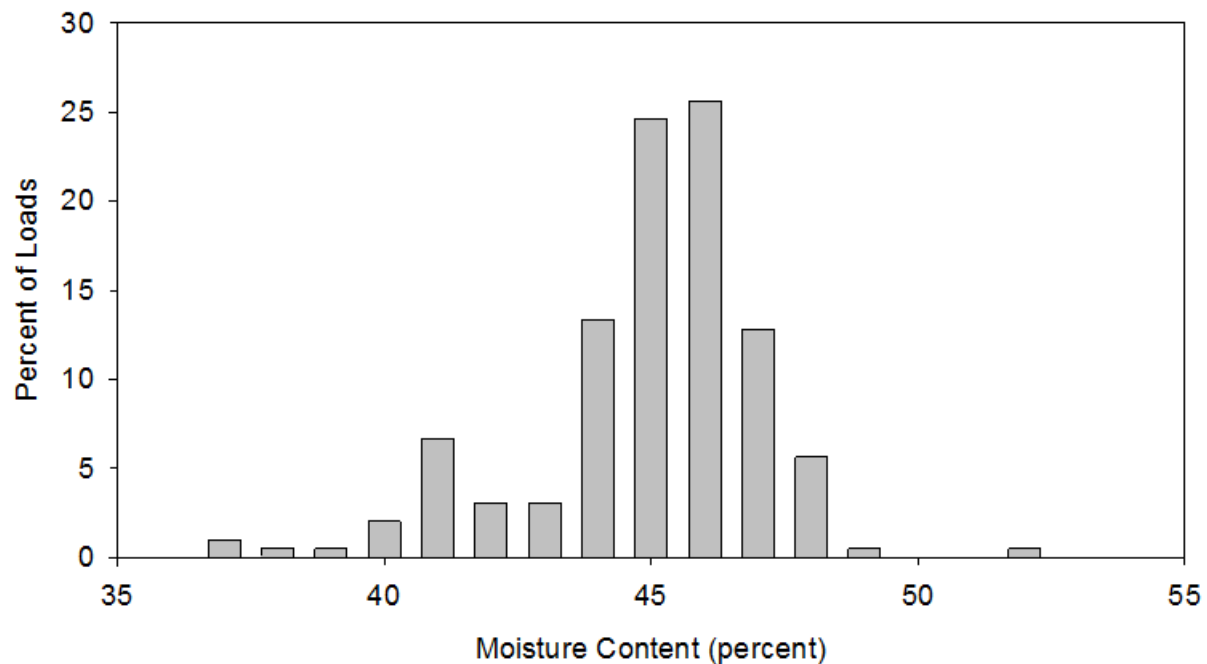


Figure 1. Moisture content for shrub willow biomass chip samples collected from harvests near Auburn and Groveland, NY conducted between November 2012 and February 2013 (Eisenbies et al. 2014). While these locations are not a part of the USDA BCAP project, they represent the largest harvest of willow to date in North America.

There was a trend for chips to have slightly lower moisture content when air temperatures were below freezing, thus the chips produced in December through February from fields in Groveland, NY had a 1.7% lower moisture content than chips produced in November through December from fields in Auburn, NY. These values are similar to freshly harvested forest wood chips from across the region (Eisenbies et al. 2014). The ash content from this same set of chip samples was 2.2% with a standard deviation of 0.6%, and there were no samples with ash content greater than 3.8% (**Figure 2, Table 2**).

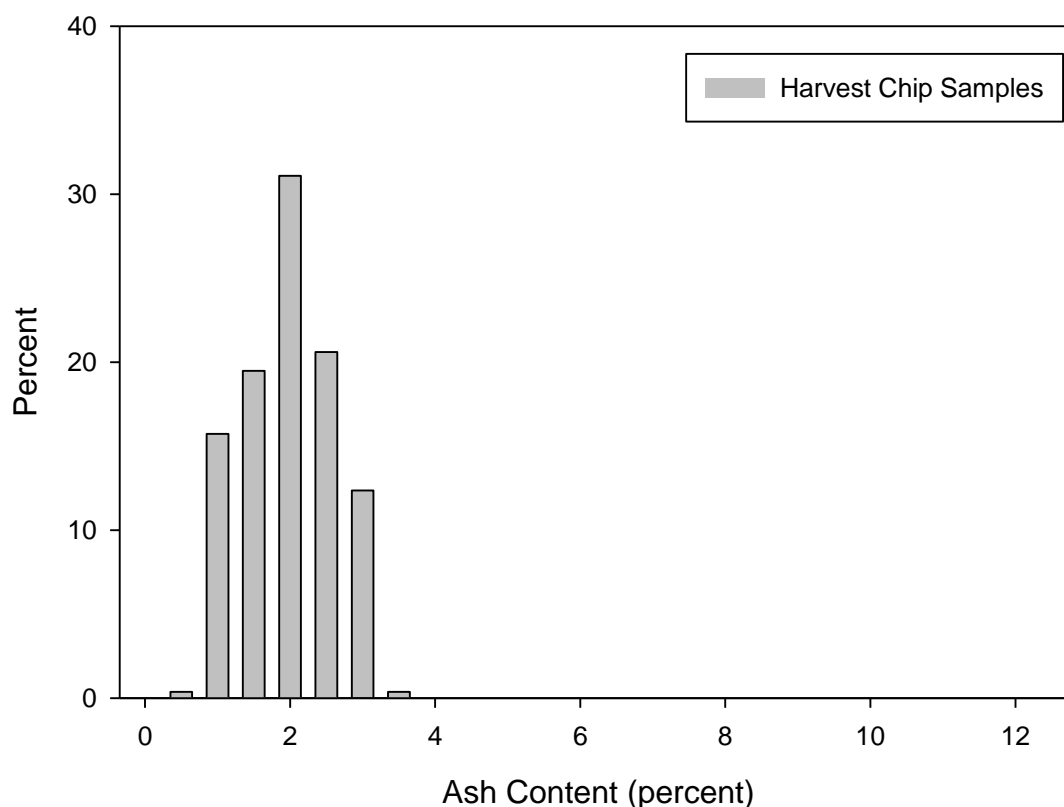


Figure 2. Ash content for shrub-willow biomass chip samples collected from harvests near Auburn and Groveland, NY conducted between November 2012 and February 2013 (Eisenbies 2014). While these locations are not a part of the USDA BCAP project, they represent the largest scale harvest of willow to date in North America.

During the 2013 fall harvest, staff at the ReEnergy Lyonsdale biopower facility collected samples from 15 different truck loads of shrub willow that were delivered to the plant from harvests of BCAP enrolled fields. Moisture content was measured at the plant and SUNY ESF staff collected the samples at a later date and analyzed them for ash and energy content.

Table 2. Moisture, energy and ash content of willow biomass delivered to the Lyonsdale plant in the fall of 2013.

	Mean Value	Range	St. Dev.
Moisture (%)	43.4	34.9 - 55.5	5.6
Energy (BTU/dry lb)	8238	8158 - 8323	74
Ash (%)	3.0	1.9 - 4.5	0.7

The moisture content was similar to the values from the harvest that occurred the year before at another location. Because the harvest occurred sooner in the fall in 2013 compared to the 2012/13 harvest, there was an expectation that moisture content would be higher. While there were a few samples with higher moisture content, the averages and variation were similar. The average energy content was 8,238 Btu/dry lb and was very similar to the energy content of mixed hardwood chips. The ash content for these samples was slightly higher than the levels from the previous harvesting season. This was probably due to the fact that there was still some foliage on the willow when they were harvested earlier in the fall of 2013. These ash values are similar to what is found for whole tree hardwood chips and was somewhat lower than

target levels for whole tree chips in general (which should generally come in at or below 2%), and nowhere near high enough to present any operational problems for a power facility, or other heat customers used to burning chips from bark-on processing systems.

4) CROP MONITORING AND RESEARCH

Two project staff members were on hand for field operations through a majority of the planting season to conduct GPS tracking of planting machinery, and to document mechanical and operational issues as they occurred. As the diameter of some of the willow cuttings began to emerge as an operational challenge, sampling of delivered planting material was undertaken as well. Plant counts were undertaken with a sampling protocol developed by SUNY ESF, as were the GPS dimensions of all newly planted areas. Weed development was monitored by growers and project staff, with expert advice on problem weed control supplied by project specialists. Stand counts were taken and analyzed for all of the newly planted areas covered by the BCAP project. A systematic sampling design for soil testing of all newly planted areas was developed by a subcontractor, and soil samples were taken by SUNY ESF students and analyzed by a private soil testing laboratory. The harvesting operations that occurred from September through November were monitored with frequent visits by project staff, and sampling of delivered willow chips for moisture levels was arranged with the biomass conversion facility. A detailed technical meeting took place among all of the project's key participants (SUNY ESF and its subcontractors, growers, the planting material supplier, Cornell willow breeding staff, and NewBio project staff) to summarize lessons learned and to identify economic bottlenecks and possible short- and long-term solutions. Most of the monitoring work, as well as outreach to potential growers and other stakeholders, was supported by a two-year grant from NYSERDA.

5) PLANS FOR 2014

Growers are hoping to be able to replant approximately 30 acres where acceptable stands were not achieved as a result of weather (wet soil conditions), mechanical issues, and weed pressure in some parts of the fields. There was heavy deer damage on many stands, as noted above, but it does not appear to have seriously compromised overall stand health. In some cases where deer browse is consistent, coppicing of the willow before the start of the 2014 growing season will not be necessary. Other fields will be coppiced before the start of the growing season to promote the development of multiple stems on each plant. Monitoring of crop development, including estimates of biomass values for the newly established fields, will be carried out in 2014, as well as observation of harvesting and delivery logistics for the remaining area of pre-established willow planting incorporated in this project. A second summary technical meeting will review progress in the project area at the end of the year. At least two outreach/training events will be conducted in 2014, as they were in 2013. Deliveries to the conversion facility will be entirely from the older production area in 2014, as they were in 2013. The first deliveries of biomass from the new plantings are expected in 2016.

If additional BCAP funding should become available, ReEnergy Holdings will review the possibility of contracting for increased willow plantings within the project area, since current demand from the two operating biopower facilities is many multiples of the amount of willow biomass that will be available from the current project area, even when it is in full production.

References

Eisenbies, M., T. Volk, L. Abrahamson, R. Shuren, B. Stanton, J. Posselius, M. McArdle, S. Karapetyan, A. Patel, S. Shi, and J. Serpa (In review). Development and Deployment of a Short Rotation Woody Crops Harvesting System Based on a Case New Holland Forage Harvester and SRC Woody Crop Header. Final report for USDOE project DE-EE0001037.

6) PHOTO APPENDIX

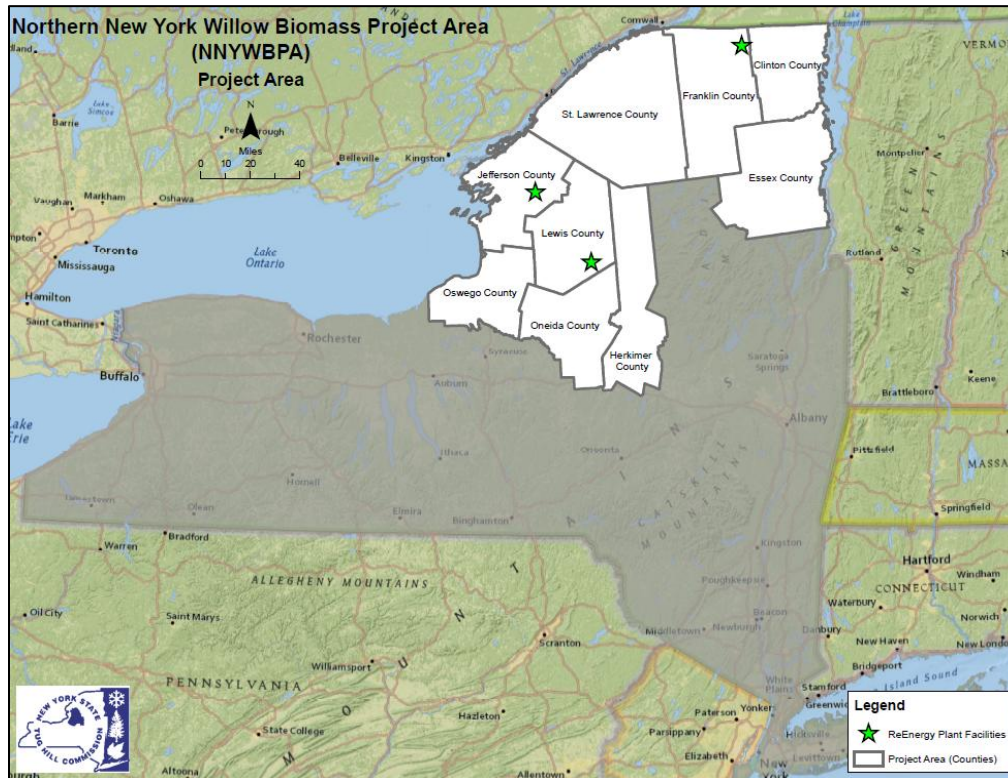


Image 1: Map of Northern New York Willow Biomass Project Area, including three biopower conversion facilities

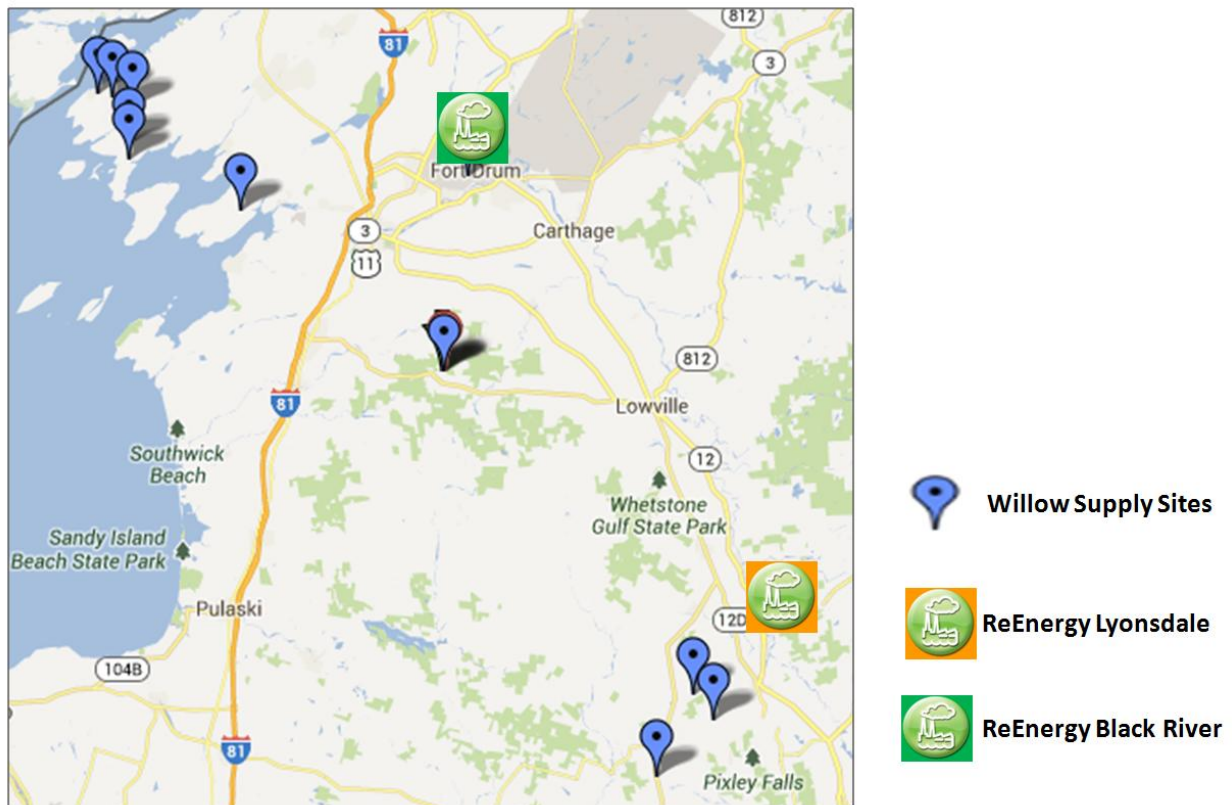


Image 2: Map of newly established willow supply sites near Black River biopower facility, and previously established legacy acreage near Lyonsdale biopower facility



Image 3: Shrub willow planting stock delivered to project sites in the form of dormant unrooted stem cuttings in six foot long “whips”. The different colored stems represent the mix of several hybrid cultivars used in the plantings to create biodiversity within the willow fields



Image 4: Shrub willow cuttings being planted with step planter - Cape Vincent, NY, May 2013 (Celtic Energy Farm)



Image 5: Feed mechanism on step planter where shrub willow “whips” are fed into the plant and subsequently cut into down 6 – 8 inch cuttings during planting



Image 6: Young shrub willow cuttings that have sprouted and are showing new leaves and softwood growth just a few days after planting in May, 2013

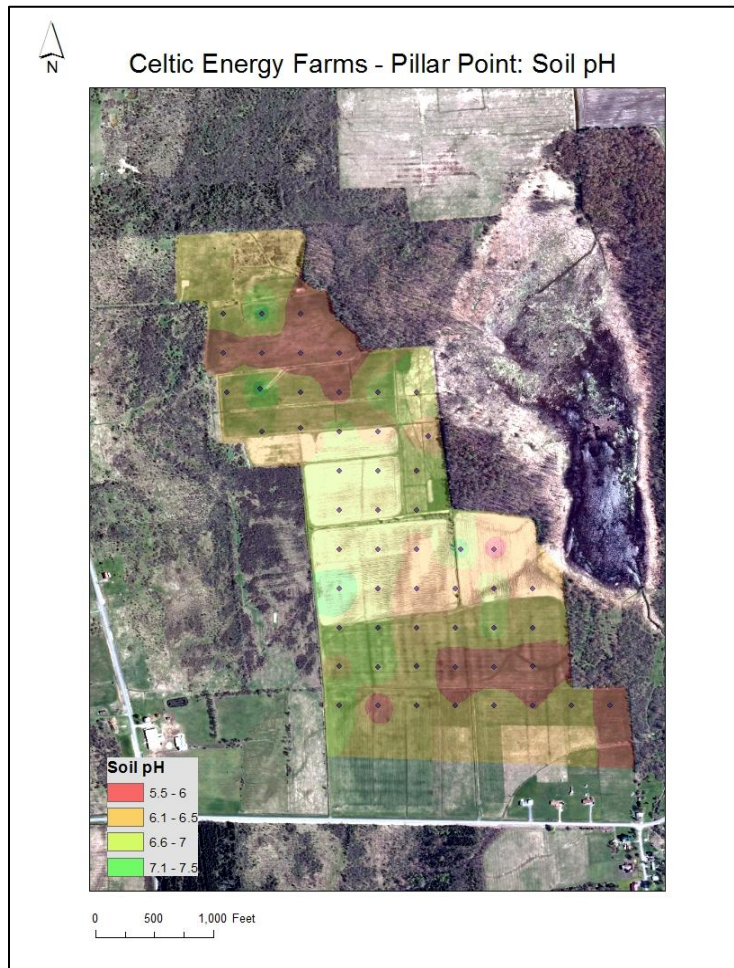


Image 7: Map of a 150 acre land parcel containing several individual fields planted with shrub willow in 2013 in Dexter, NY. Map shows parcel perimeter, soil sampling points spaced at 2.5 acres, and interpolation of soil pH values from lab test results



Image 8: Shrub willow crops in Dexter, NY near the end of the first growing season showing good establishment and survival rates despite heavy deer browse that occurred in this field



Image 9: Harvest Field Day, Boonville, NY 10-17-13: Dr. Tim Volk explains the production cycle of shrub willow and other details about the crop and answers questions



Image 10: Live demonstration of shrub willow harvesting technology and processing by Celtic Energy Farms staff, Harvest Field Day, Boonville, NY 10-17-13.



Image 11: Specially designed New Holland shrub willow cutter head on forage harvester



Image 12: Dump wagon filled with harvested shrub willow chips



Image 13: Emptying dump wagon onto chip pile at harvest site for short-term storage before transport to ReEnergy Lyonsdale biopower facility



Image 14: Chip storage at ReEnergy Lyonsdale biopower facility showing forest wood chips (foreground) and shrub willow chips harvested in fall 2013 in background



Image 15: Newly opened ReEnergy Black River, 60-megawatt biopower facility in Fort Drum, NY, that will burn the first shrub willow harvested from the newly planted crops in the Cape Vincent area in 2016