The Potential for Biomass District Energy Production in Port Graham, Alaska

November 7, 2007

Department of Energy
Tribal Energy Program

EERC
Energy & Environmental Research Center

Port Graham Tribal Council Involvement

- Pat Noman, Chief
- Olga Foman, Second Chief
- Fran Norman, Tribal Administrator
- Charlie Sink, Technical Representative

EERC
Energy & Environmental Research Center

Port Graham Tribal Council and Port Graham, Alaska

- Port Graham Tribal Council is the village administrator
- There are approximately 150 Tribal Members
- ANCSA formed Port Graham Village Corporation owns a majority of land in the area that contains largest volume of woody biomass
- Native allotment owners have the second largest volume of woody biomass

EERC
Energy & Environmental Research Center

EERC Technology… Putting Research into Practice

The Potential for Biomass District Energy Production in Chugachmiut Communities

Native Energy and Economic Development Symposium

Kerryanne Leroux

Kirk Williams, Erick Zacher, and Sheila Hanson

June 15, 2007

Project Partners

- Energy & Environmental Research Center
- Chugachmiut – A Tribal Organization Serving the Chugach Native People of Alaska
- U.S. Department of Energy (DOE) Tribal Energy Program


Mount Torbert
Beluga Lake
Susitna
Flat Horn Lake
Stephan Lake
Knik
A1
Eklutna Lake
Baker 13,176 ft
Mount Spurr
Little Susitna
Figure Eight Lake
Bashful Peak
Mount Goode
Chakachamna Lake
Eagle
Anchorage
YOU ARE HERE
Fire Island
Campbell Lake
Mount Muir
Tyonek
Turnagain Arm
Chugach National Forest
Hope
Port Wells
Black Peak
Trading Bay
A L A S K A
Peak
Whittier
Nikiski
Salamatof
Chugach State Park
Prince Willia
Sterling
Cooper Landing
Kenai
Moose Pass
Kalgin Island
Soldotna
A1
Skilak Lake
Cohoe
Kenai Lake
Cooper Mountain
9
Kasilof
Chenega
Kenai National Wildlife Refuge
Clam Gulch
Cook Inlet
Tustumena Lake
Ninilchik
Seward
Happy Valley
Fox
Truuli Peak
Kenai Fjords N.P.
Anchor Point
Montague Island
Anchor
Kachemak City
Blying Sound
Iceworm Peak
Homer
Storm Mountain
Chiswell Islands
Halibut Cove
Delight Lake
Mount Diablo 3501 ft
Seldovia
Nanwalek
Port Graham
Gulf of Alaska
Nuka Bay
Chugach Islands
Pacific Ocean


Kachemak Bay
Microsoft® MapPoint®
Dangerous Cape
Cook Inlet
English Bay
Port Graham
ALASKA
Point Bede
KENAI PENINSULA


Landfill
School
N
0
200
Feet
Tank Farm
Bunkhouse
Offices/Mess Hall/Boiler
Hatchery
Power Plant
Cannery
Fish House
Runway
Storage Warehouse
Grocery Store/Bunkhouse
Carpenter Shed
Corporation Bunkhouse
Public Safety
Clinic
Tribal Building
Low
Income
Housing
Corporation
Building


WELCOME TO
The Traditional Native Village of
Port Graham
ALASKA

Purpose

- To provide the heating and power needs of Port Graham, Alaska utilizing local biomass resources that would create local jobs and provide an economic return to local landowners.

EERC
Energy & Environmental Research Center

Assumptions

- Assuming that biomass energy applications cheaper than replacing power line from Bradley Lake.
- Cost of purchasing wood would be nominal. May assume small value-added sawmill located on local land.
- Assumes biomass harvest plan and agreement between landowners and tribe to utilize their resources.
- Does not include bio-energy needs of Nanwalek, Alaska.

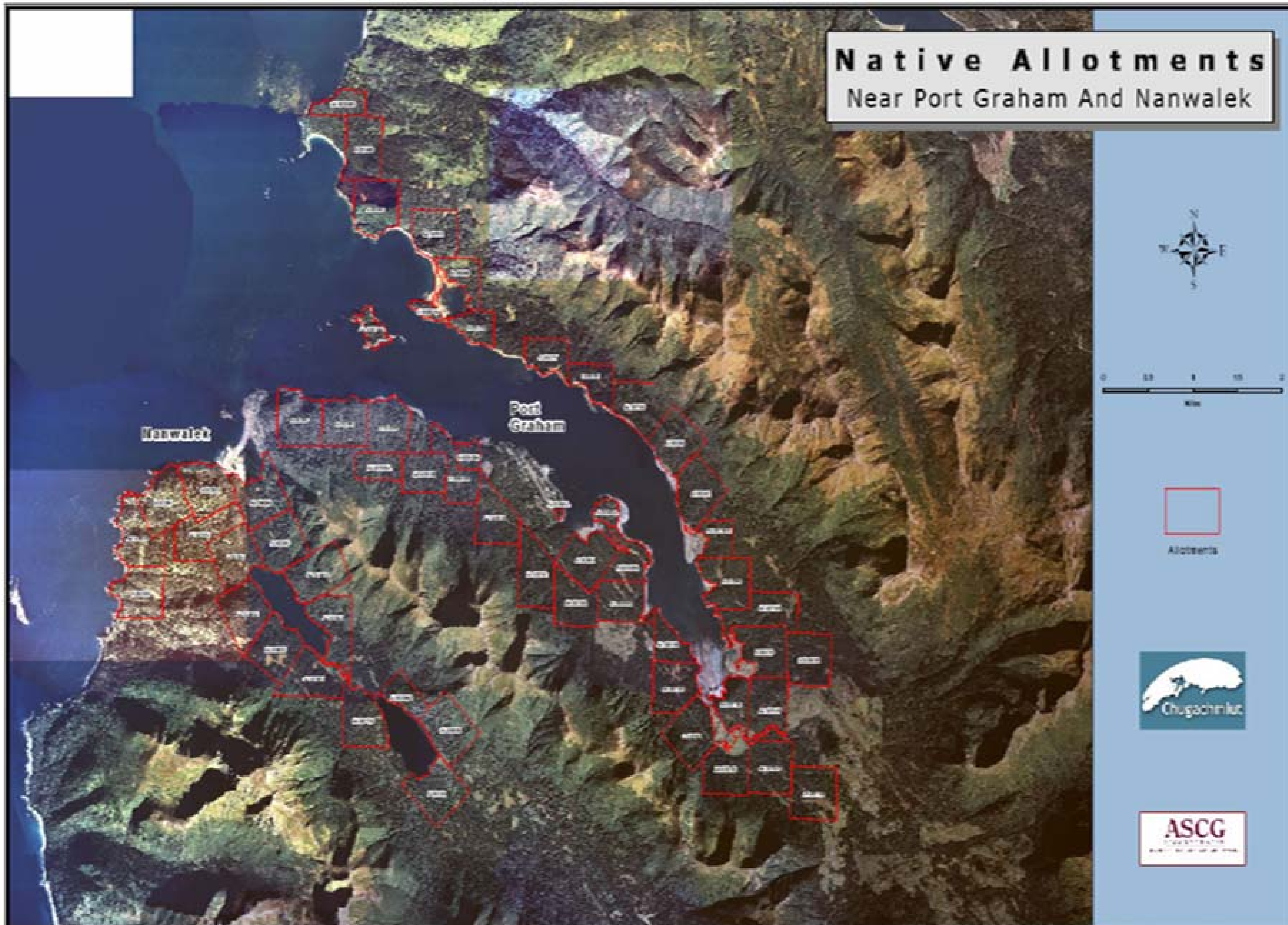
Port Graham

- Accessible only by air or water.
- Current population is about 200.
- Electricity supplied from Homer Electric Cooperative using single phase hydropower.
- Heat is supplied by fuel oil (diesel) delivered by barge.

Village Interest in Biomass

- Utilization of Land
  - Port Graham Tribal members wish to preserve cultural traditions and traditional use of their lands.
  - Would like to support subsistence through optimal utilization of their lands.
- Help prevent sale of Native allotments
  - Allotments are generally underutilized.
  - Owners and new gift deeded owners occasionally have monetary need.
  - Tribe desires to maintain cultural association with the land and the owners.

EERC
Energy & Environmental Research Center


Native Allotments
Near Port Graham And Nanwalek
Port Graham
Nanwalek
N
W
E
S
Allotments
Chugachmiut
ASCG

Additional Motivation

- Limited accessibility makes traditional energy sources expensive to deliver.
- The dramatic rise in the prices of petroleum fuels have been a hardship to the village of Port Graham.
- There is a significant potential for biomass heat and power within the region by utilizing low-value forest residue and timber depleted from spruce beetle activity and windthrow.

EERC
Energy & Environmental Research Center

Goals and Objectives

- The goal is to determine the economic and technical feasibility for implementing a biomass energy system to serve the Chugachmiut community of Port Graham.
- The objectives are as follows:
  - Evaluate Port Graham energy loads
  - Analyze biomass resource availability and suitability
  - Evaluate energy and cogeneration technologies
  - Determine engineering economics of proposed technologies

EERC
Energy & Environmental Research Center

Project Approach

- A visit to Port Graham was conducted to obtain pertinent information concerning energy loads in the village.
- Wood and fish oil resources were quantified to determine annual supply and cost of procurement.
- Technologies studied
  - Wood combustion
  - Wood gasification
  - Fish oil
- Engineering economic feasibility analysis was performed to evaluate the technologies and various applications.

Port Graham Energy Needs

- Heating and electricity
  - Residential
  - Community buildings
- Processing – cannery
- Basis for current energy expenses
  - Diesel @ $3.00 per gallon
  - Electricity averaging $0.12/kWh

EERC
Energy & Environmental Research Center

Total Village Energy Load

Structure	Heating Power Required, MMBtu/hr*	Diesel, gal	Annual Heating Cost	Electrical Power Required, kW	Electricity Usage, MWh/yr	Annual Electricity Cost
Residential Sector	4.6	41,000	$120,000	260	1,000	$140,000
Community Buildings	1.3	12,000	$35,000	260	300	$39,000
Cannery	4.5	25,000	$75,000	560/260	660	$53,000
Total Village Load/Energy Expenses	**5.9**	**78,000**	**$230,000**	**560/260**	**2,000**	**$230,000**

*Assumes energy required to heat community buildings and homes in winter months is available for cannery processing in summer months

EERC
Energy & Environmental Research Center

Residential Energy Requirements

- Average home:
  - ~1000 sq ft each
  - 600 gal diesel annually
  - $2000 annual heating cost
  - 65,000 Btu/hr load
- Total residential sector
  - 70 homes
  - 41,000 gal diesel annually
  - $120,000 collective annual heating cost
  - 5 MMBtu/hr load

EERC
Energy & Environmental Research Center

Community Buildings

Structure	Heating Area, sq ft	Est. Diesel, gal/yr	Annual Est. Heating Cost	Power Required, MMBtu/hr
School	8,000	5,000	$14,000	0.5
Clinic	4,000	2,000	$7,000	0.3
Tribal Council Building	3,600	2,000	$6,000	0.2
Native Corporation Office	1,600	1,000	$3,000	0.1
Grocery Store	2,800	2,000	$5,000	0.2
Community Buildings	*20000*	*12000*	*$35,000*	*1.3*

Cannery

- Canning salmon
- Operational in summer months
- 25,000 gal diesel annually
- $75,000 annual cost operation
- 4.5 MMBtu/hr processing need

EERC Energy & Environmental Research Center

Village Electricity

- Homer Electric Cooperative
  - Diesel generators
  - Power plant in village for outages
- Peak requirements
  - 560-kW Cannery
    - Supplied by Cannery diesel generators for 3-phase
    - Needed for daytime operation (use HEC during nightime/downtime)
  - 260-kW, 1-phase for community buildings and residences (and cannery downtime)
- 2 million kWh annually
- Estimated $230,000 annually

Port Graham Energy Resources

- Wood
  - Land is either Native allotment or Port Graham Native Corporation owned
  - 40,000 acre forest resource accessible by old timber harvest road network
- Fish oil
  - Salmon is a significant component to subsistence
  - Use for wastes generated, e.g., from cannery operations

Wood Resource

- 250,000 tons available within ¼-mi preexisting roadway requiring maintenance upgrade.
- 5,000 tons wood annually on 50-year rotation.
- Wood moisture is 39% “green” and 12% seasoned.

EERC
Energy & Environmental Research Center

Fish Oil Options

- Biodiesel
  - Small or transportation applications (must comply with ASTM International standards).
  - No processing facilities currently exist in Alaska.
  - Requires importation of catalyst and methanol, as well as a market for glycerin by-product.
- Fish oil (straight)
  - Large applications, such as boiler fuel.
  - Maximum blend of 50% fish oil because of high cold-flow properties (cloud point ~0°C).
  - Energy of salmon oil is about 124,000 Btu/gal, or 96% diesel energy by volume.

EERC
Energy & Environmental Research Center

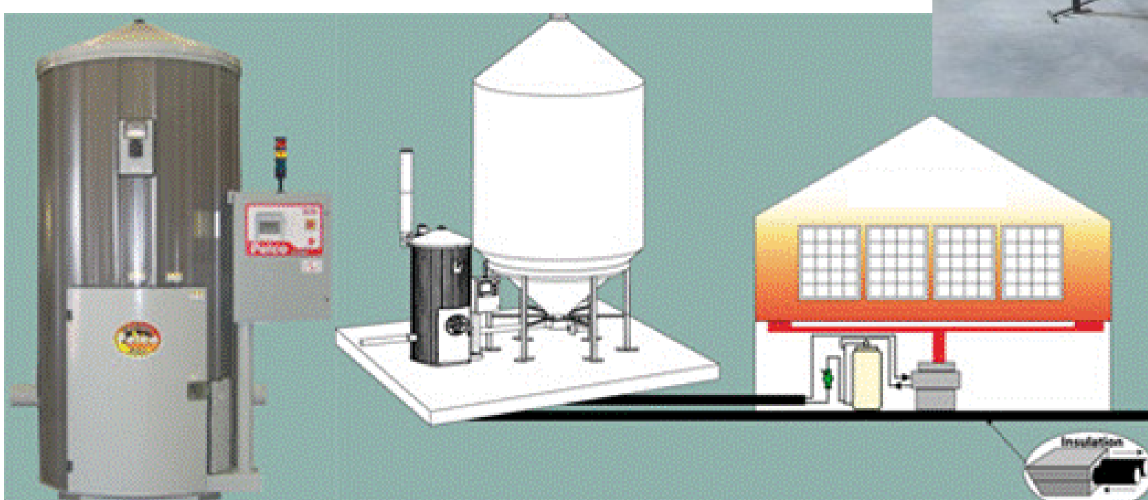
Technologies Considered

- Wood combustion
- Wood gasification
- Fish oil (utilization of existing infrastructure)

EERC
Energy & Environmental Research Center

Combustion Systems

- Indoor wood boilers
- Outdoor wood furnaces
- Full-scale systems



EERC
Energy & Environmental Research Center

Gasification

- Cogeneration opportunities
- Converts solid fuel into low-Btu syngas for
  - Steam production in existing fire-tube boiler.
  - Electricity generation using a microturbine.

EERC
Energy & Environmental Research Center

Fish Oil

- Considered only straight fish oil because of the economics of biodiesel.
- Maintains existing energy infrastructure.
- A portable processing facility could be available from the Alaska Energy Authority (AEA), processing up to 50 tons of fish waste per day.

EERC
Energy & Environmental Research Center

I. Wood Combustion Scenarios

A. Wood Furnaces/Boilers	Feedstock: Logs, wood chips, or pellets
1. Indoor Wood Boilers	Individual homes' and village buildings' heat
2. Small Outdoor Wood Furnaces	Individual homes' and village buildings' heat
3. Moderate Outdoor Wood Furnaces	Multiple (3–4) homes' and village buildings' heat
B. Automated Combustion System	**Feedstock: Wood chips**
1. Moderate Combustion System	Village buildings' heat and cannery steam
2. Large-Scale Combustion System	Entire village, i.e., homes and village buildings' heat and cannery steam

EERC Energy & Environmental Research Center

Example of Outdoor Wood Furnace Layout

II. Gasification Scenarios

A. Gas Production	Feedstock: Wood chips
1. Moderate Steam (Gas)	Syngas→ steam boiler → cannery steam, steam heat for community buildings
2. Moderate Gas and Steam	Syngas → steam boiler → cannery steam Syngas → community buildings for heat
3. Large Gas	Syngas → steam boiler → cannery steam Syngas → community buildings, homes for heat
B. Gas and Electricity Production	**Feedstock: Wood chips**
1. Moderate Steam and Electricity	Scenario II.A.1. + electricity generation (1-phase, 260 kW)
2. Moderate Gas, Steam, and Electricity	Scenario II.A.2. + electricity generation (1-phase, 260 kW)
3. Large Gas and Elect.	Scenario II.A.3. + electricity generation (1-phase, 260 kW)
C. Electricity Production	**Feedstock: Wood chips**
1. High-Power Electricity and Heat	Electricity generation for power and heat (3-phase, 560 kW)
2. High-Power Electricity	Electricity generation for power (3-phase, 560 kW)
3. Low-Power Electricity	Electricity generation for power (1-phase, 260 kW)

Example of Cogeneration Layout

III. Fish Oil

A. Moderate Steam (Oil)	50% fish oil–diesel blend → steam boiler → cannery steam, steam heat for community buildings
B. Moderate Oil and Steam	50% fish oil–diesel blend → steam boiler → cannery steam 50% fish oil–diesel blend → community buildings for heat
C. Large Oil and Steam	50% fish oil–diesel blend → steam boiler → cannery steam 50% fish oil–diesel blend → community buildings, homes for heat

EERC
Energy & Environmental Research Center

Economics

- Feedstock
- Capital
- Operating
- Savings
- Simple payback

Feedstock Costs

Feedstock	Heating Value	Price/Cost	Per MMBtu
Diesel	130,000 Btu/gal	$3.00/gal	$23.00
Wood, dry	8,100 Btu/lb	$55/ton	$3.90
Logs, 12% moisture	7,100 Btu/lb		
Chips, 12% moisture	7,100 Btu/lb	$97/ton	$6.80
Pellets, 5% moisture	7,700 Btu/lb	$240/ton	$15.00
Fish Oil	120,000 Btu/gal	$1.00/gal	$8.50

EERC
Energy & Environmental Research Center

Capital Investment

- Totals range from $260,000 to $2.1 million
- Estimations included
  - Main energy system price.
  - Hot water, gas, and/or steam piping.
  - Heat exchangers for structures currently heated by forced air.
  - Refurbishing the existing fire-tube steam boiler.
  - Gas or electric boilers for gasification scenarios producing syngas or electricity for heat.

Operating

- Totals range from $1700 to $67,000 annually.
- Estimations included
  - Fuel preparation and delivery.
  - System labor requirements.
  - Ash management.
  - Utility needs.

EERC
Energy & Environmental Research Center

Savings and Payback

- Total estimated savings range from incurred cost to $89,000 annually.
- Savings calculated from difference in current energy expenses and estimated feedstock, capital, and operating costs.
- Paybacks ranged 2–28 years.
- The simple payback provides estimated return on investment.

EERC
Energy & Environmental Research Center

Economic Viability (top 10)

Rank	Scenario	Annual Feedstock Requirement		Total Capital	Annual Savings	Pay-back
1	Indoor Wood Boilers	600	tons logs	$270,000	$89,000	2.4
2	Large Oil and Steam	42,000	gal fish oil	$260,000	$80,000	2.4
3	Large-Scale Combustion System	850	tons chips	$1,000,000	$83,000	5.6
4	Moderate Outdoor Wood Furnaces	900	tons logs	$420,000	$64,000	4.0
5	Small Outdoor Wood Furnaces	900	tons logs	$620,000	$45,000	5.8
6	Large Gas	900	tons chips	$1,300,000	$58,000	6.9
7	Large Gas and Elect.	3300	tons chips	$1,400,000	$61,000	6.9
9	Moderate Combustion System	400	tons chips	$620,000	$20,000	7.6
10	High-Power Electricity	2900	tons chips	$870,000	$20,000	8.1

EERC
Energy & Environmental Research Center

Conclusions

- Port Graham energy requirements
  - Heat: 9,000 MMBtu/yr (6 MMBtu/hr)
  - Electricity: 2,000 MWh/yr (560/260kW)
- Sufficient resources (5,000 tons/yr) exist for Port Graham to utilize wood as an energy fuel
- The most economically viable solution:
  - Install moderate outdoor furnaces, which could provide heat to three to four homes or village buildings per furnace.
  - Requires 600 tons logs annually for $90,000 annual savings and <3 year ROI of $300,000.
- Challenges
  - Assurance of emissions compliance
  - Coordination of wood procurement, storage, and delivery
  - Operation and maintenance of mechanical components on the remote village

EERC Energy & Environmental Research Center

Next Steps

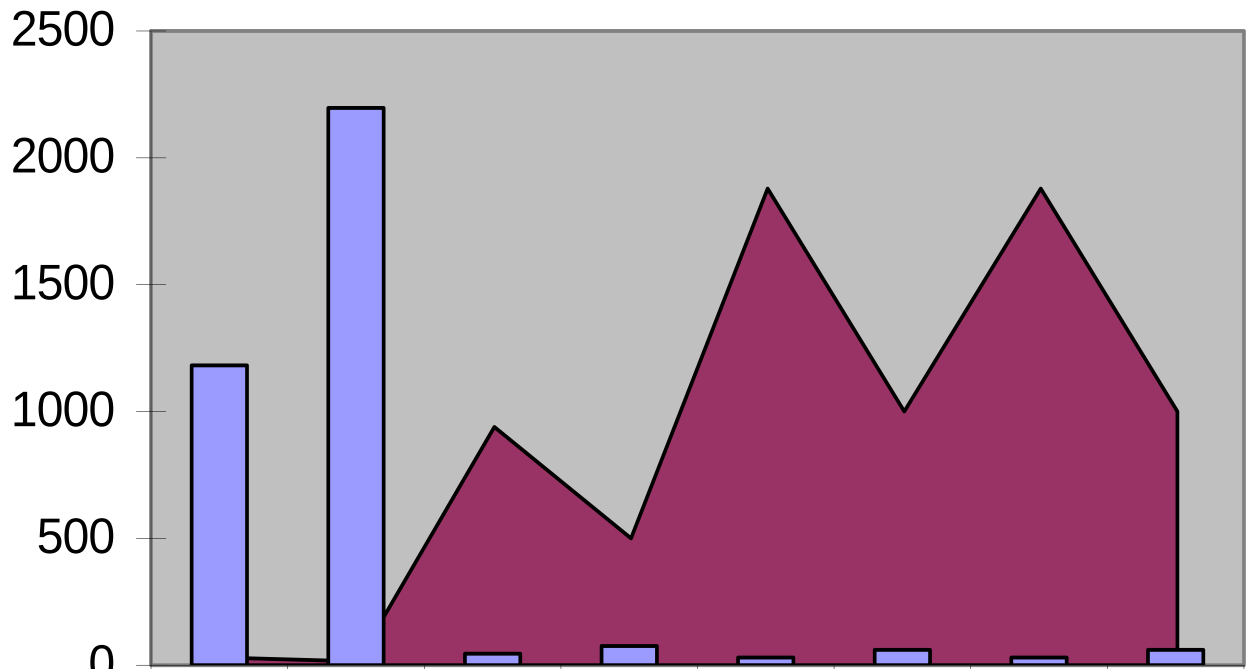
- Chose energy scenario and derive approach plan
- A formal engineering design and quote, including guarantee or proof of emission compliance
- Secured financing
- Equipment procurement and installation
- Personnel hire and training
- Coordination of feedstock delivery and potential loading services
- Ash disposal plan
- Small or Big

EERC
Energy & Environmental Research Center

QUESTIONS?

EERC
Energy & Environmental Research Center

Chart Comparison of 1-, 5-, and 10-Mw Biomass Load to Supply Rotation



	PG 2.9kt	PG 2.9kt	PG 80kt	PG 80k t	PG+ N	PG+ N	PG+ N+A	PG+ N+A
acres need	33.99	18.2	937.7	502.2	1875	1004	1875	1004
rotation period	1177	2197	43	80	32	60	36	68