

Biofuel Cogeneration: Optimizing Green CHP



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The University of British Columbia (Vancouver)

- 1000 acre foot print
- 400+ buildings
- 15 million sq.ft. of institutional and commercial buildings
- 3 million sq.ft. private residential
- Day time pop. ~ 65,000
- Night time pop. ~ 15,000
- ~ 30% growth expected over the next 15 to 20 years



Steam

- ~1 million GJ natural gas/year
- 230 GJ/hr peak load
- 78% of campus GHG emissions

Electrical

- 330 GWh/year
- 49 MWe peak load
- 8% of campus GHG emissions

Water

- ~4.5 billion liters/year

Utilities

- Commodities ~ CD\$32M/year



What is the BRDF?

- A \$30M multi-partnership and government funded research & demonstration project using gasification technology
- Two modes of operation: Thermal or Cogen (Demonstration)
- First of kind biomass gasification cogeneration demonstration project using syngas clean up technology
- First of kind social license experiment in BC
- First of its kind Canadian produced Cross Laminated Timber (CLT) construction



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Why the BRDF?

UBC's GHG Reduction Targets

2007 emissions = 61,080 tonnes of CO_{2e}/year

33% below 2007 levels by 2015

67% below 2007 levels by 2020

100% below 2007 levels by 2050

- Supports UBC's GHG reduction targets
- A Campus as a Living Lab initiative
- Adds thermal capacity and fuel as well as thermal production diversification



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BRDF Roadmap

- Spring 2009
- Spring-Fall 2010
- Feb. 2011
- July-Oct 2012
- Nov. 2012



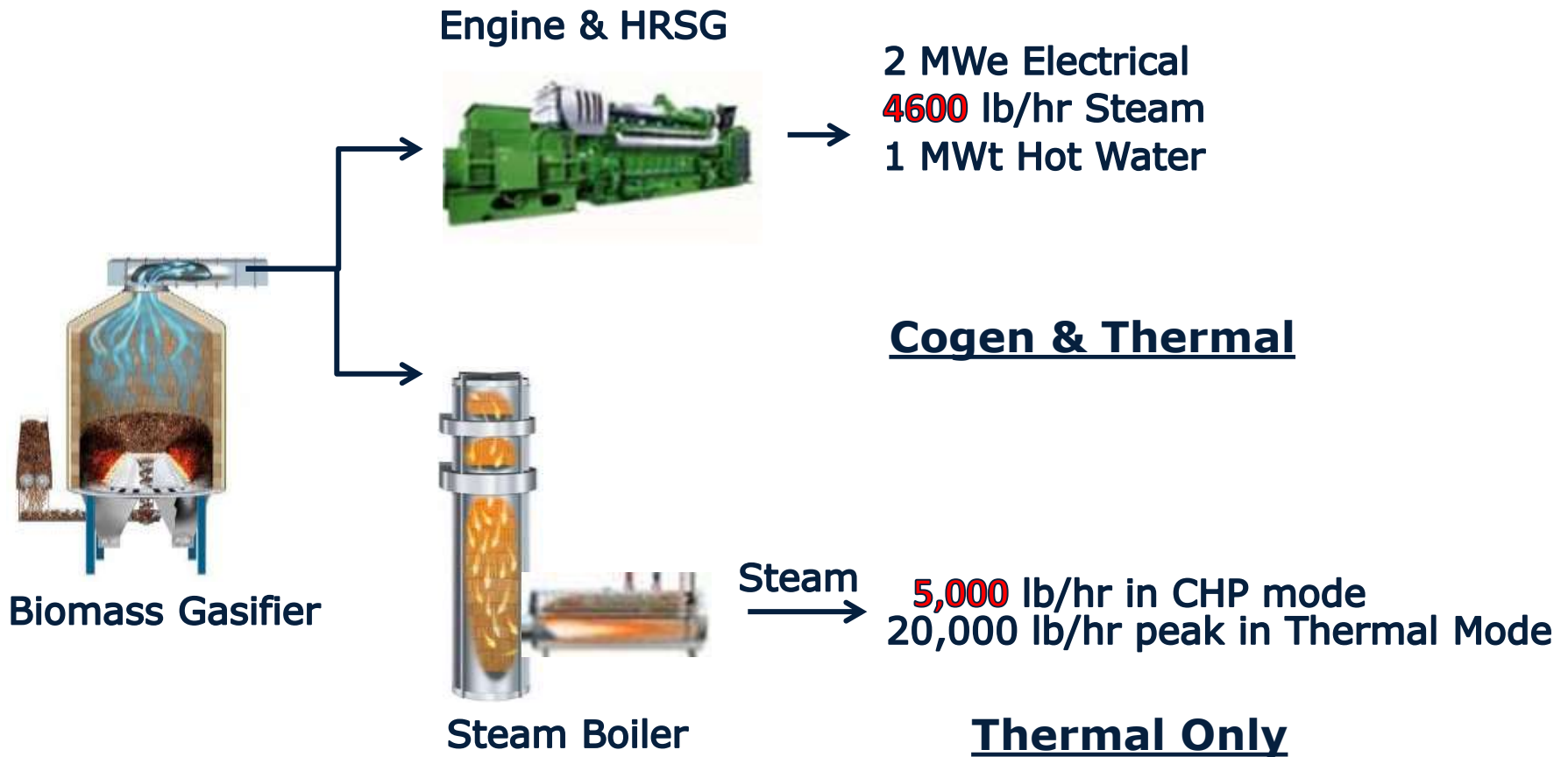
BRDF Concept devised
Public Engagement
Groundbreaking
Commissioning
Full Operation



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Modes of operation: Thermal only or CHP/Thermal



Thermal Mode Performance

	2013/14
Steam Produced (Million of lbs)	102
Portion of Campus Use	15%
GJ of NG offset	134,500
Tonnes CO2 offset	6,747

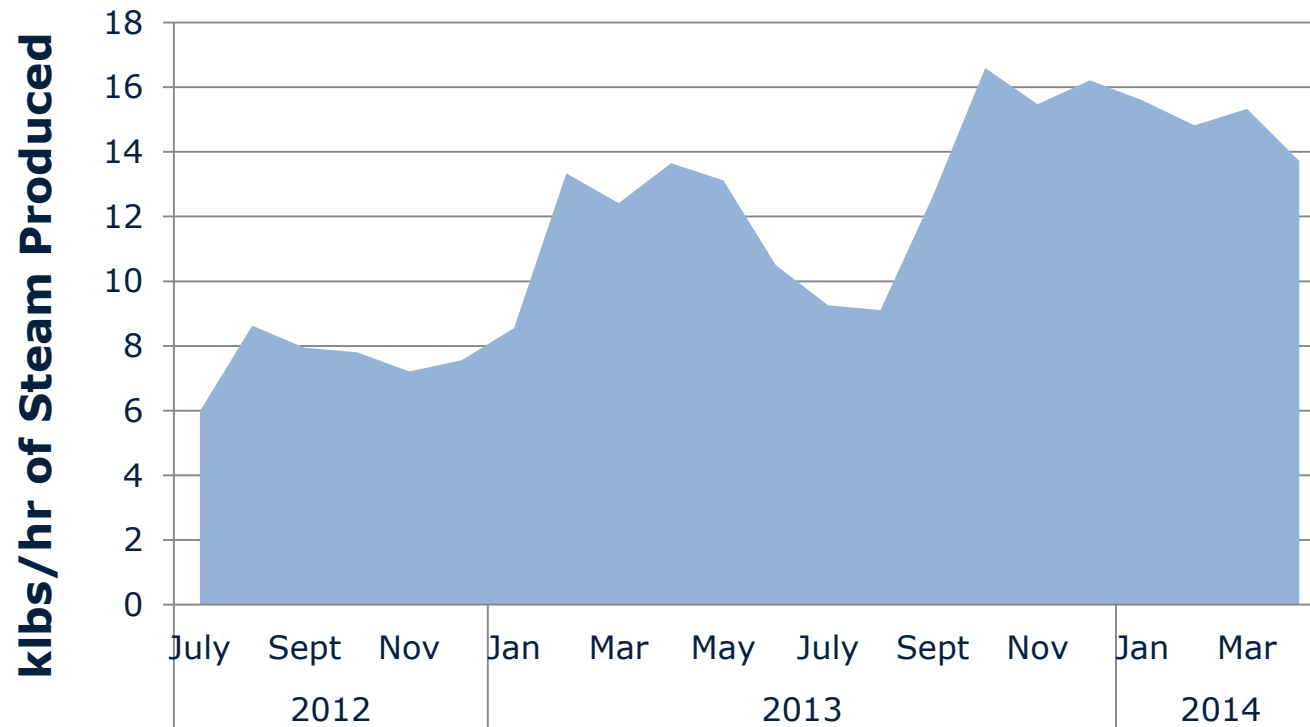
Photo Credit: Don Erhardt



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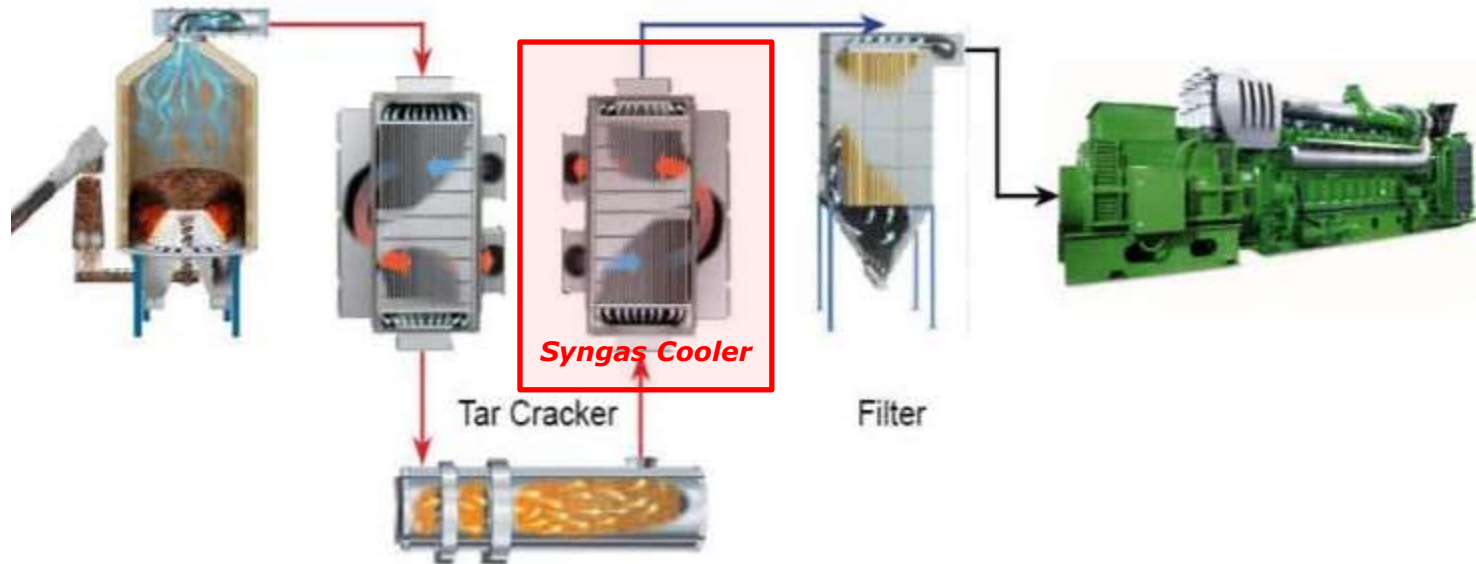
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BRDF Monthly Average Steam Rate



- Continuous improvement on gasifier uptime and production rate

CHP Performance with Biomass Syngas



- CHP demonstration Trials: Fall 2012 and Spring 2013
- 406 hours of clean engine grade Syngas Produced
- 220MWh of Electrical Production
- Challenges with Syngas Cleaning Equipment and Process
- Spawned multiple UBC Masters and PhD level research projects

Syngas Cogen Challenges

- Requires a higher biomass fuel quality than expected (<30% MC)



- Syngas clean up process equipment failures. Requires several system upgrades to resolve

- Higher operational costs than expected e.g. people, maintenance and materials

Has not Added Reliable Capacity to date

CHP: A Solution is Required

GE Jenbacher 620 Engine

- Provide reliable engine uptime and electrical generation
- That improves the business case and is cash flow positive
- Provides a firm (N+1) 2.4MW thermal capacity
- Congruent with UBC's Climate Action Plan and GHG targets
- That continues Academic research opportunities
- That respects industry partnerships

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Moving Forwards

BIOMASS SYNGAS

OR

RENEWABLE NATURAL GAS



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Renewable Natural Gas

- Renewable Natural Gas (RNG) is upgraded biomethane captured from sources such as landfill sites, agriculture waste and wastewater treatment facilities
- RNG is a certified carbon neutral fuel in BC, launched by FortisBC in March 2012
- UBC has Secured 100,000GJ annually of RNG
- Convert engine to dual fuel capability (Natural Gas or Biomass Syngas)



BRDF with RNG utilizes the full installed capacity and provides firm thermal supply

Renewable
Natural Gas



Engine & HRSG

2 MW Electrical
4600 lb/hr Steam from HRSG
1 MW Hot Water

AND



Biomass Gasifier



Steam Boiler

Steam
→ 20,000 lb/hr peak

Benefit of Better Use of Capacity

BRDF	Biomass Thermal	Biomass Cogen	Biomass Thermal & RNG Cogen
Steam Boiler	6.0 MWt (20,000lbs)	1.5 MWt (5,000lbs)	6.0 MWt (20,000lbs)
Heat Recovery Steam Generator (HRSG)	-	1.4 MWt (4,600lbs)	1.4 MWt (4,600lbs)
Hot Water Engine Heat Recovery	-	1 MWt	1 MWt
Electrical Energy	-	2 MWe	2 MWe
TOTAL	6 MW	5.9 MW	10.4 MW*

Note 1MWt = 3,333lbs steam

***75% increase in energy production**



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BRDF RNG Conversion Road Map



In Construction

✓
Dec 2013
Project Funding
Approval

✓
March 2014
Installed natural
gas line to
engine

↓
June 2014
Engine
converted to
dual fuel
capable

July 2014
Thermal
upgrades
complete

Conclusions

- BRDF is a valuable production unit to UBC
- CHP with Biomass Syngas has been proven but does not provide firm thermal capacity, reliability and has many operational challenges
- Cogen dual fuel conversion provides:
 - The BRDF with additional thermal capacity & fuel diversification
 - Provides 2.4 MWt firm (N+1) thermal capacity and maximizes electrical production
 - Allows UBC to further reduce UBC's CO₂ emissions
 - Business case enhanced to pay back loans and improves early years cash flow
 - Maintains significant UBC–Industry–Research partnerships
- UBC continues to benefit from in-kind world attention to BRDF through sustainability agendas, tours, CLL, research and more





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