Bioenergy Research and Demonstration Facility

Low-carbon space heating symposium May 12th

Jeff Giffin, Energy Conservation Manager, Energy & Water Services
James Torcov, Thermal Energy Manager, Energy & Water Services

The University of British Columbia

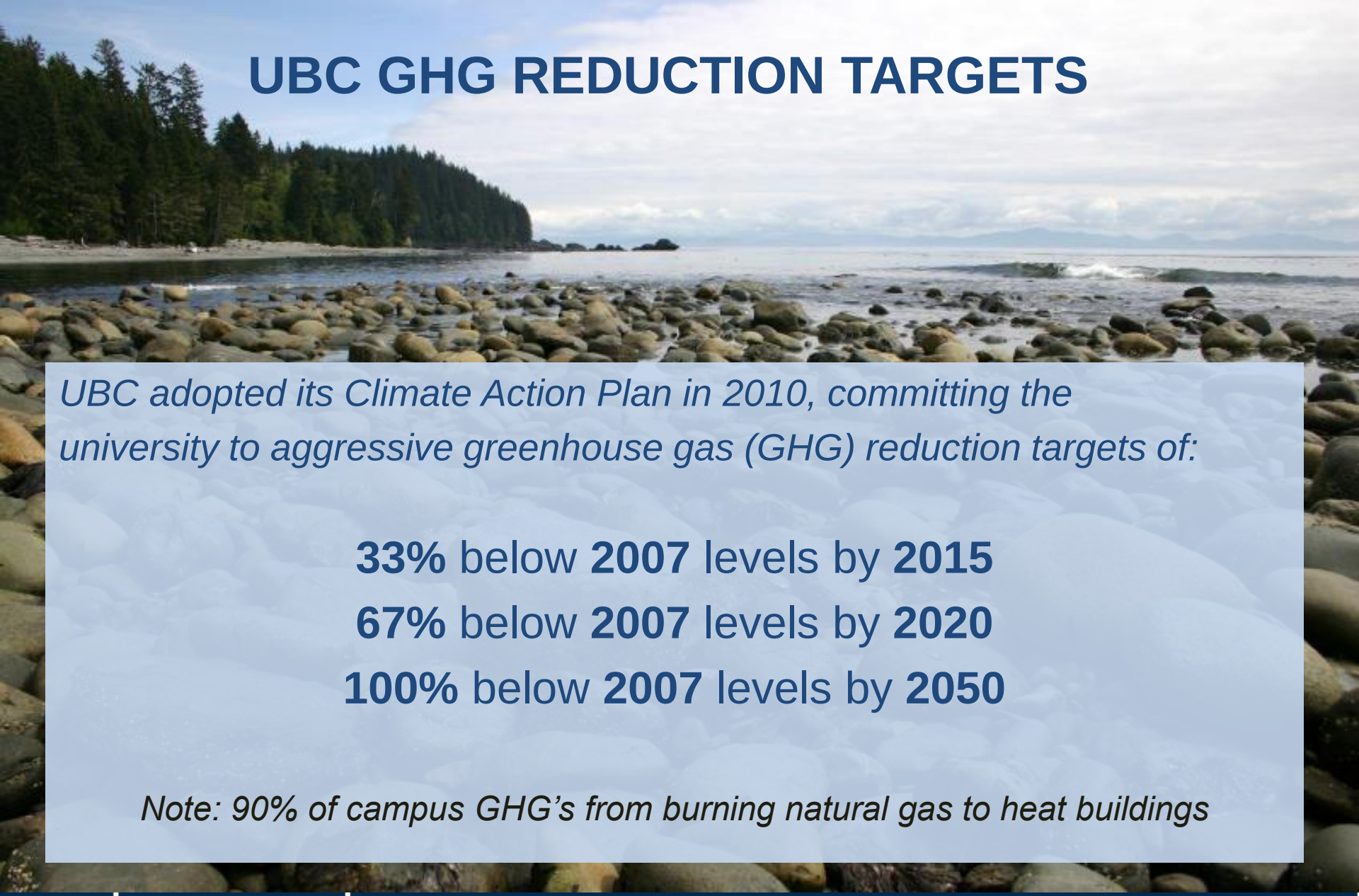
a place of mind

- 1,000 acres campus with 15 million sq.ft. of institutional & student housing
- ~60,000 daytime population with 15,000 night time residences
- 30% growth expected over the next 15-20 years

Vision

"Create exceptional learning environments that fosters global citizenship, advances a civil and sustainable society, and supports outstanding research to serve the people of British Columbia, Canada and the world"

UBC GHG REDUCTION TARGETS



UBC adopted its Climate Action Plan in 2010, committing the university to aggressive greenhouse gas (GHG) reduction targets of:

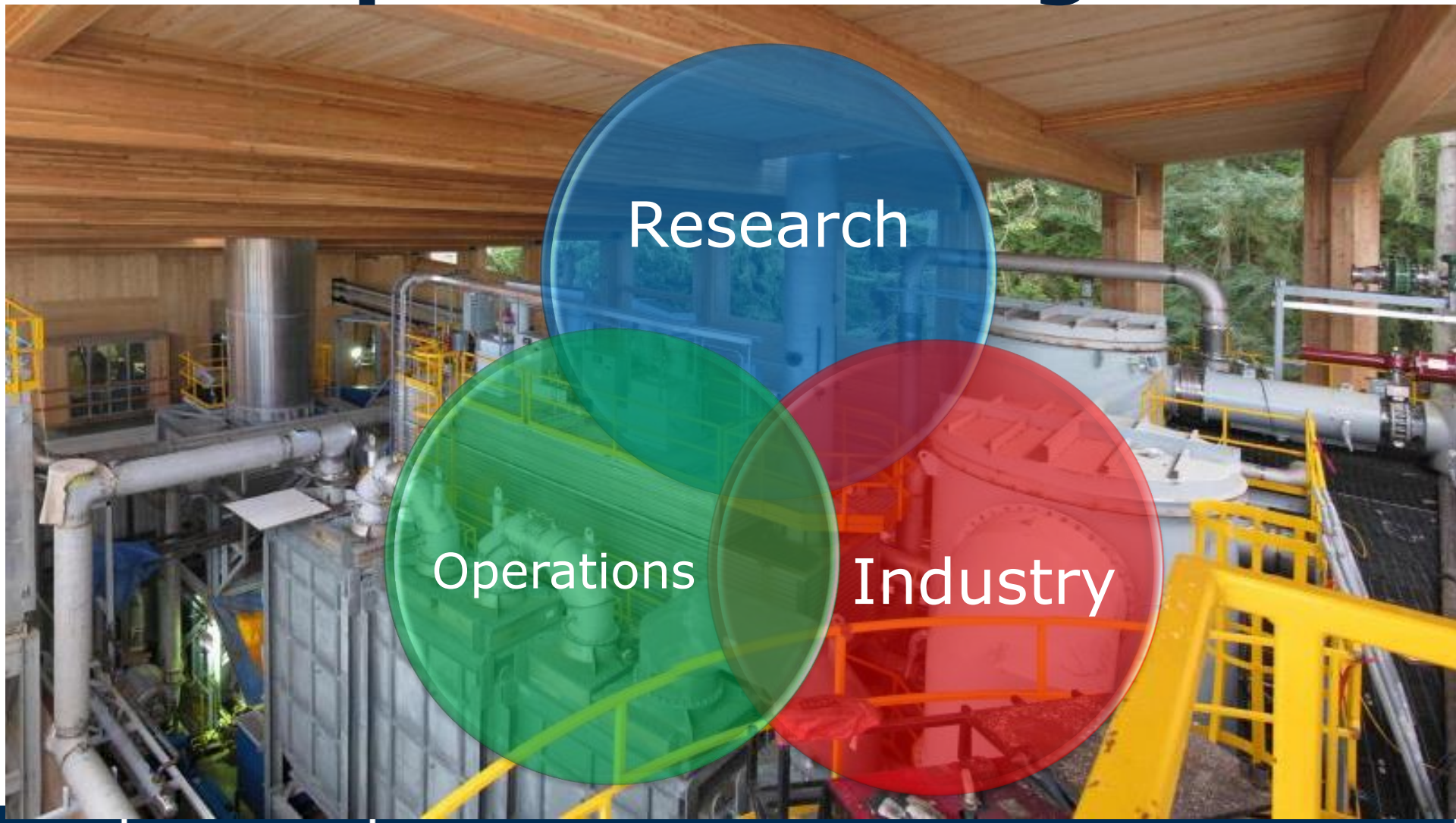
33% below **2007** levels by **2015**

67% below **2007** levels by **2020**

100% below **2007** levels by **2050**

Note: 90% of campus GHG's from burning natural gas to heat buildings

Campus as a Living Lab

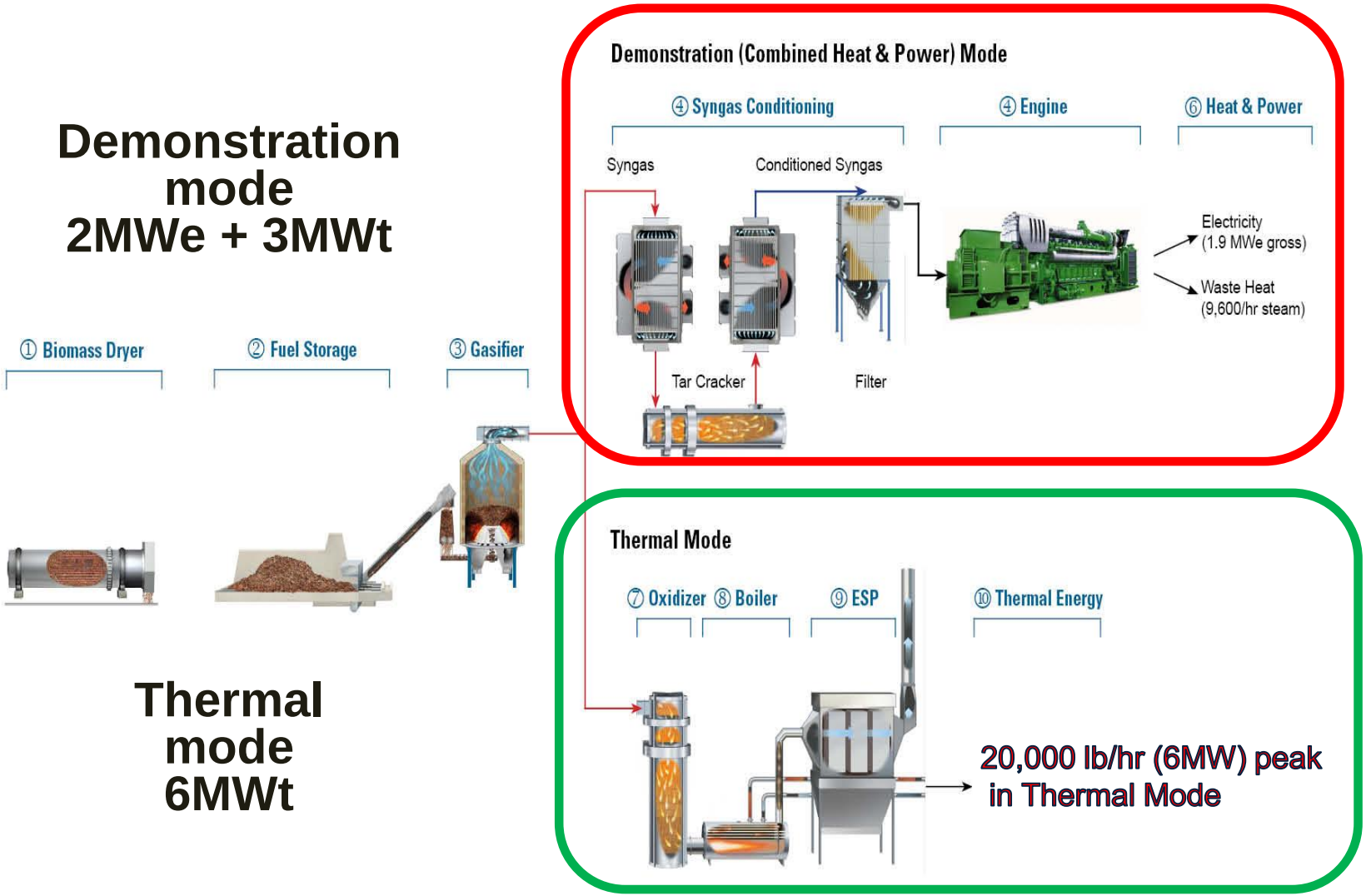


BioEnergy Research Demonstration Facility

- 1st of it's kind biomass gasification cogeneration project
- A true "Campus as a Living Lab" project
- Building constructed from Canadian produced Cross Laminated Timber
- $28M multi-partnership project ($8.35m UBC)
- 12% reduction in campus GHG's
- Positive Return on UBC's investment

2 modes of operation

Demonstration mode
2MWe + 3MWt



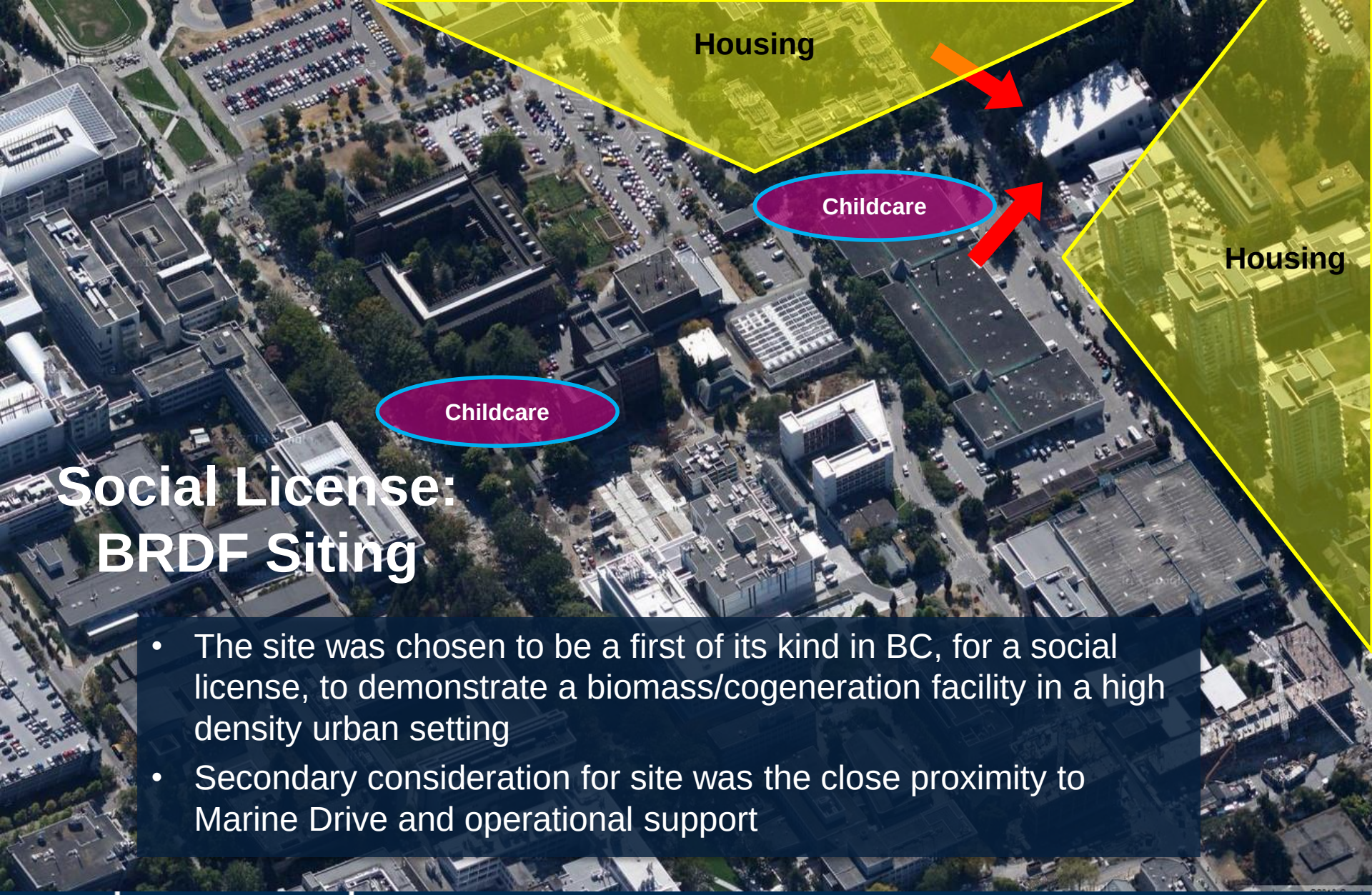
Thermal mode
6MWt

Who's Involved

UBC Operations, Faculty, Students, Researchers, with industry partnerships; Nexterra, General Electric, BCHydro and the local community UNA and SHUSH

UBC project partners include:

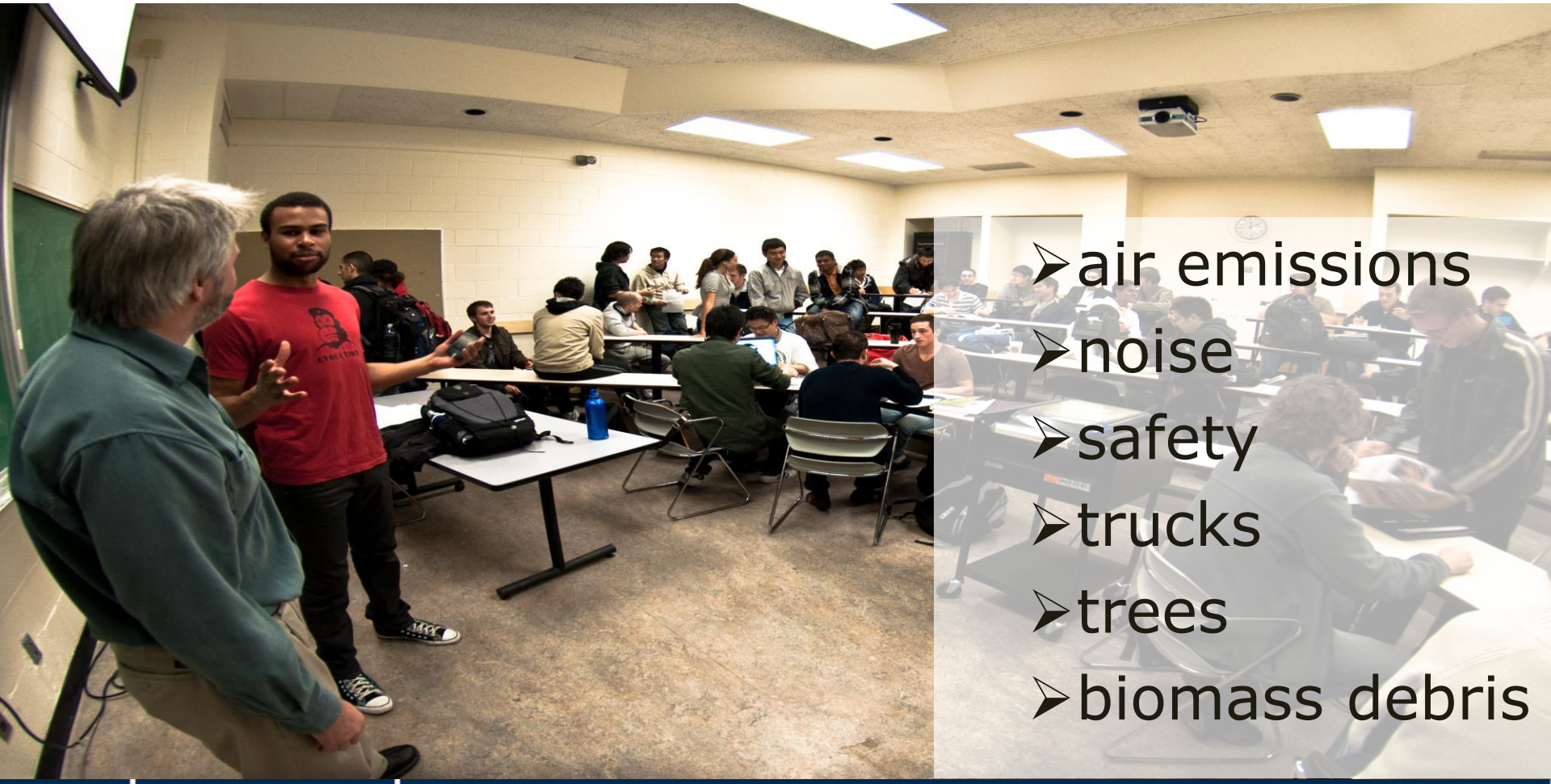
- BC Bioenergy Network
- BC Ministry of Energy, Mines
- BC Ministry of Forests
- BC Hydro
- Ethanol BC
- City of Vancouver
- FP Innovations
- GE Energy
- Natural Resources Canada
- Nexterra Systems Corp.
- Sustainable Development Technology Canada



Social License: BRDF Siting

- The site was chosen to be a first of its kind in BC, for a social license, to demonstrate a biomass/cogeneration facility in a high density urban setting
- Secondary consideration for site was the close proximity to Marine Drive and operational support

Public Consultation



- air emissions
- noise
- safety
- trucks
- trees
- biomass debris

Above & beyond: Ambient Air Monitor

- Emission Dispersion Study showed Marine Tower 5 as the most likely residential building for air emission impact
- June 2012, UBC proactively installed a real time Ambient Air Monitor on Marine Tower 5

- Automatic emails alerts if air quality limits are exceeded
  - **24 hour average PM 2.5 < 25 µg/m^3 or**
  - **1 hour NO_2 < 107 ppb**
- **Air emissions remain well below Metro Van limits**

Best in Class Air Emissions

Permit Requirements	Dryer		Boiler		Engine	
	Permit	Test	Permit	Test	Permit	Test
PM Particulate Matter	15	3.9	15	2.1	15	1.3
NO_x Nitrogen Oxides	-	-	272	230	249.7	105
VOC Volatile Organic Compounds	10.4	9.6	10.5	2.2	40.9	31
Opacity	5%	<5%	5%	0%	5%	<5%

- Verified by 3rd party testing (Al Franco)
- Unless otherwise noted, all units are in mg/m3

The Fuel: Biomass

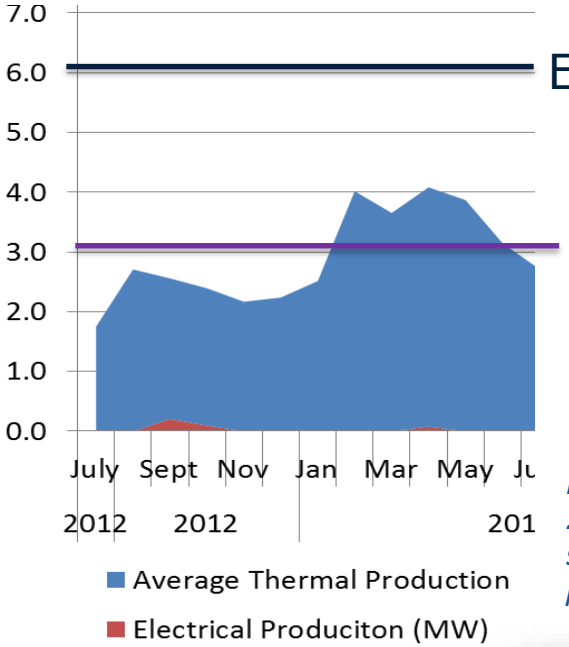
- Fuel is ground & chipped waste wood:
  - Sawmill residuals
  - Furniture/carpentry offcuts
  - Municipal trimmings
  - Land clearing operations
- Delivery of 2-3 trucks per day for 10,000 dry tonnes per year.

Successes

- **Best in class air emissions** (well below permitted levels and on par with Natural Gas)
- **1st LEED Gold facility made from BC CLT**
- **100+ of tours**
- **Achieved 2 MW electrical production using biomass engine grade syngas**
- **Strong engagement with faculty and students**

Challenges

Energy Production (MW)



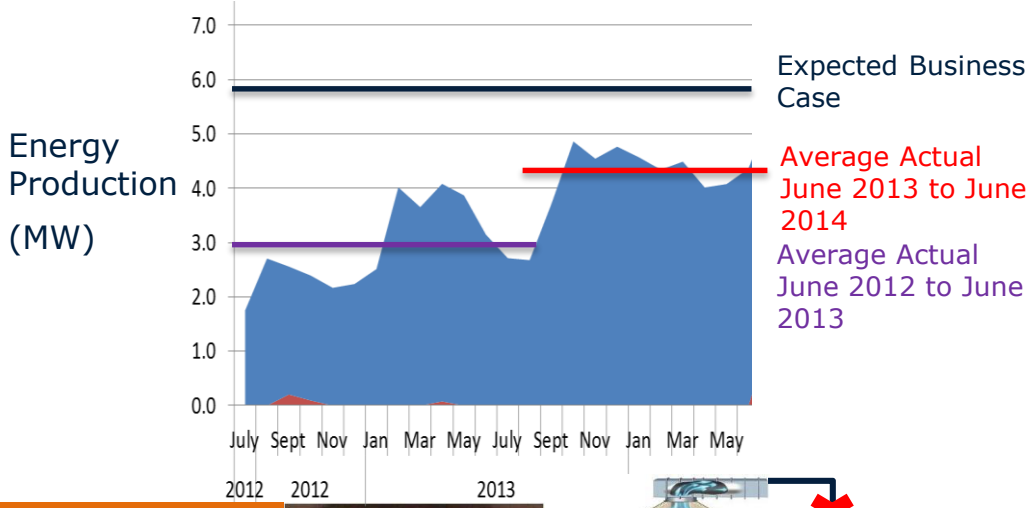
Note ~6MW = 20,000lbs steam production

- Requires a higher fuel quality than expected (Needs ~30% MC)
- Higher operational costs than expected e.g. people, maintenance and materials
- CHP Downtime

1st Year of Operation

Successes

- **33% lift in thermal energy production**
- **Employee engagement**
- **200's + tours**
- **Multiple Research projects ongoing**



Challenges

- Economic:
  - Lower then expected natural gas prices
  - Loss of electrical revenue
  - Lower than expected thermal production

- Desire to make use of stranded assets with out compromising research or GHG objectives

2nd Year of Operation

Separate Fuel Sources Utilizes the full installed capacity at BRDF and provides firm thermal supply

Renewable Natural Gas

Engine & HRSG

2 MW Electrical
4600 lb/hr (1.4MW) Steam from HRSG
1 MW Hot Water HR

Biomass Syngas

Biomass Gasifier

AND

Steam Boiler

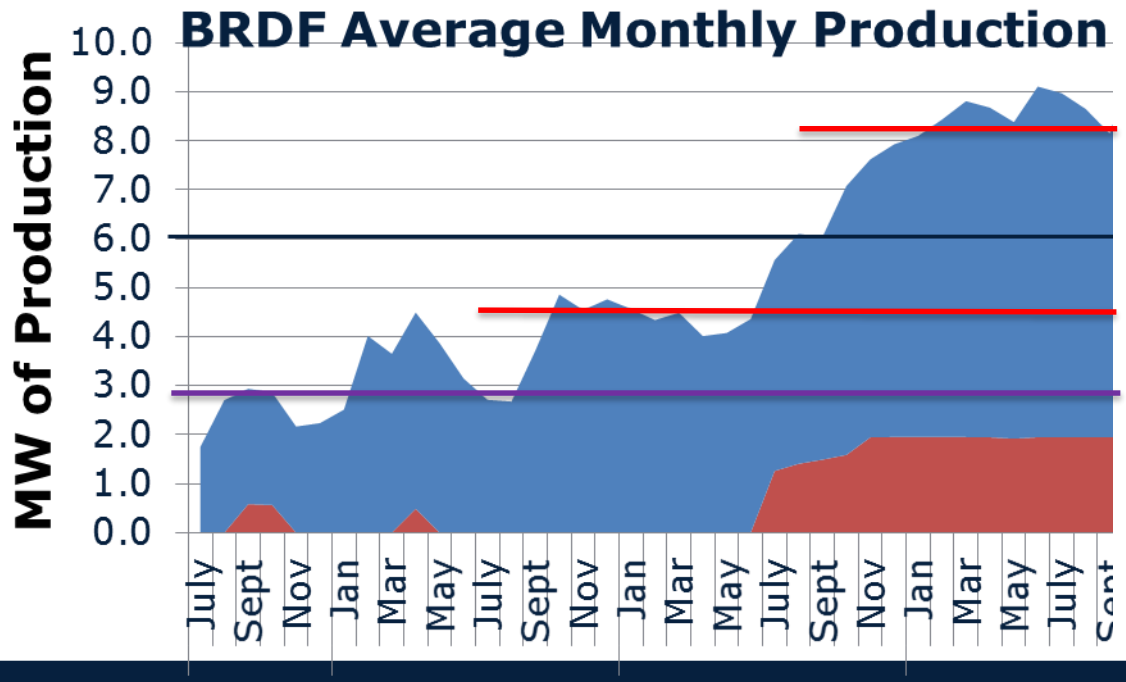
Steam → 20,000 lb/hr (6MW) peak

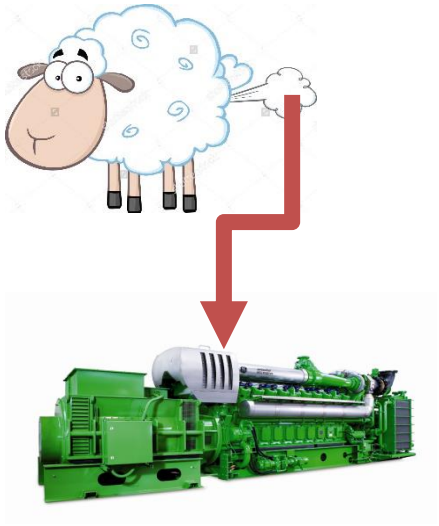
Successes

- **Duel fueling engine allows for Simultaneous Operation of Biomass and IC Engine**
- **2 fold increase in Energy production**
- **Purchase of Renewable Natural gas allows for renewable electricity to be sold to Bchydro**
- **300s + tours**
- **Multiple Research projects ongoing**

Challenges

- Economic:
  - Cost of Renewable Natural Gas (RNG) limits consumption to offset electrical projection





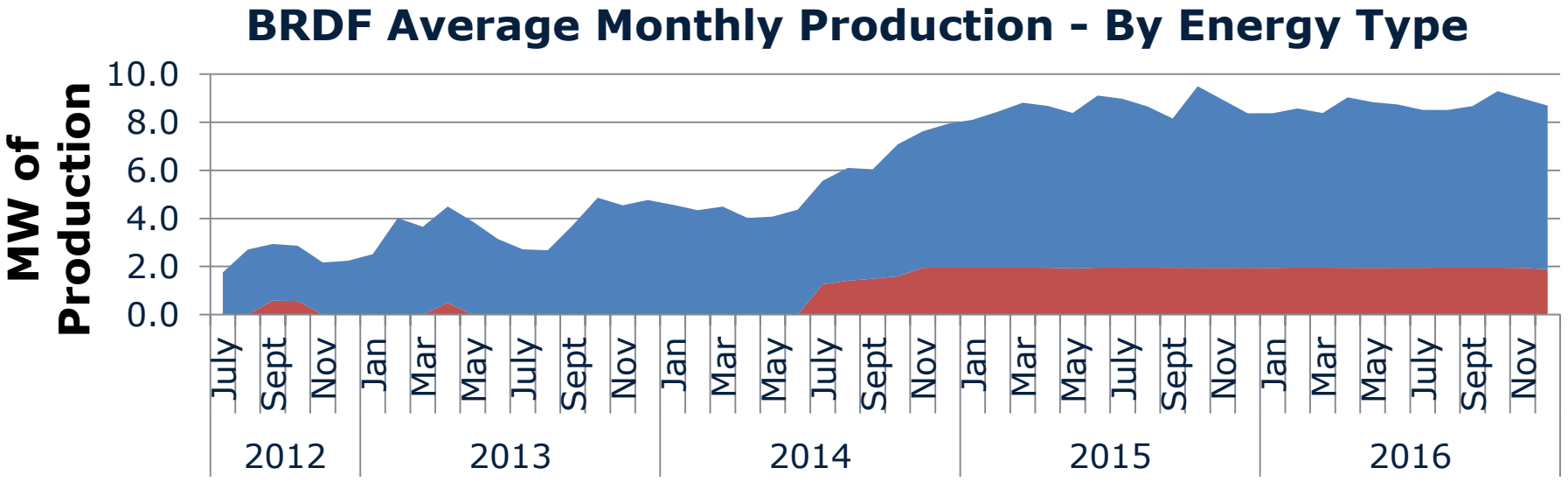
3nd Year of Operation

Successes

- BRDF provides **reliable** thermal and electric energy to the campus
- 30% of thermal energy and 5% of electrical
- 14% GHG reduction greatly contributing to **UBC's 34%** reduction since 2007
- Over 700 tours
- Long term contract for purchase of Renewable Natural gas in place

Challenges

- UBC District Energy System Peak Thermal Demand has exceeded N-1 capacity
- UBC Board of Governors reinforces 2020 Climate action commitments



Present Day

2017 What's Next for BRDF?

Research and Biomass Production Expansion

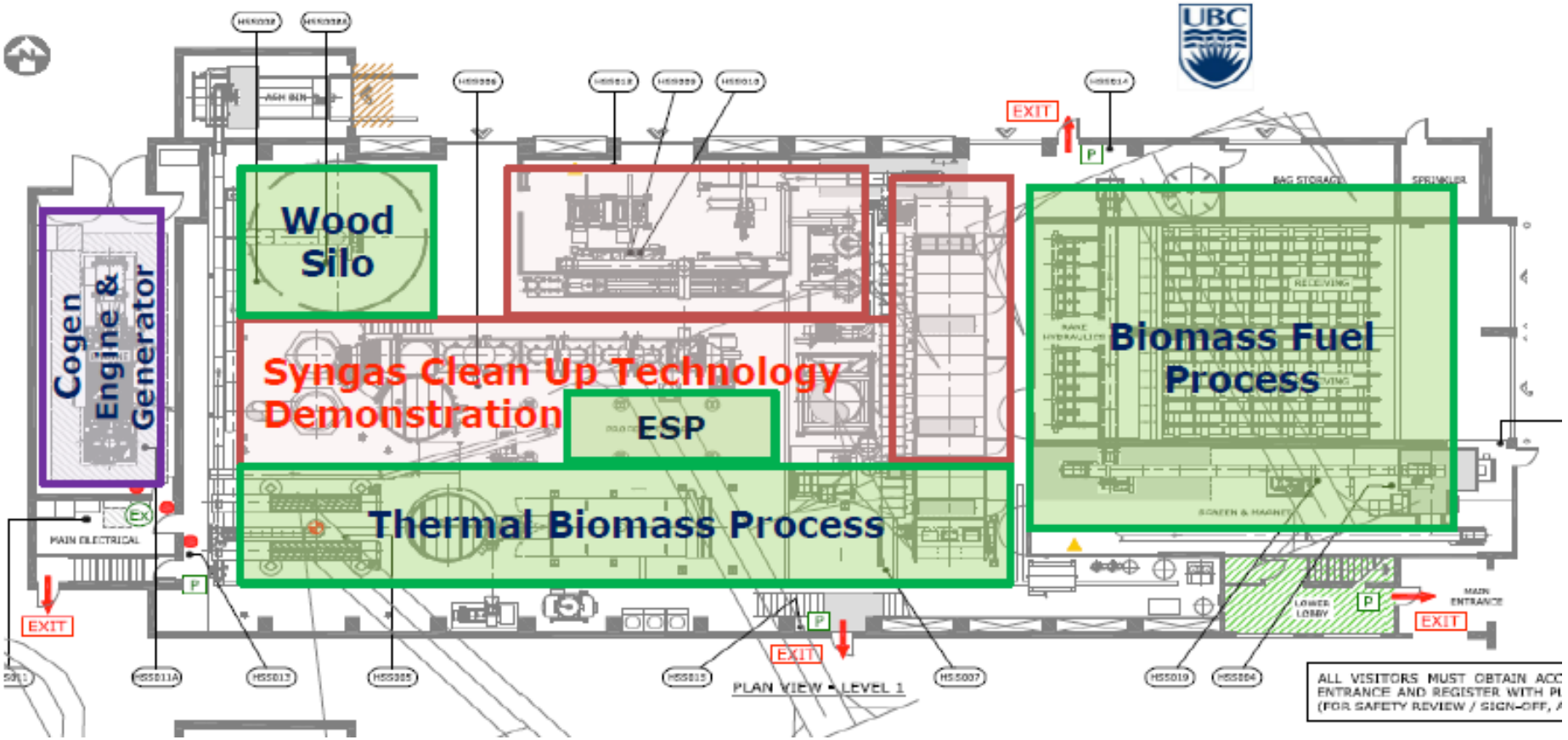
12 MW Expansion

- Hot Water Boiler
- To come on line by 2019
- Biomass will now produce ~60% of UBC total annual Thermal load requirements

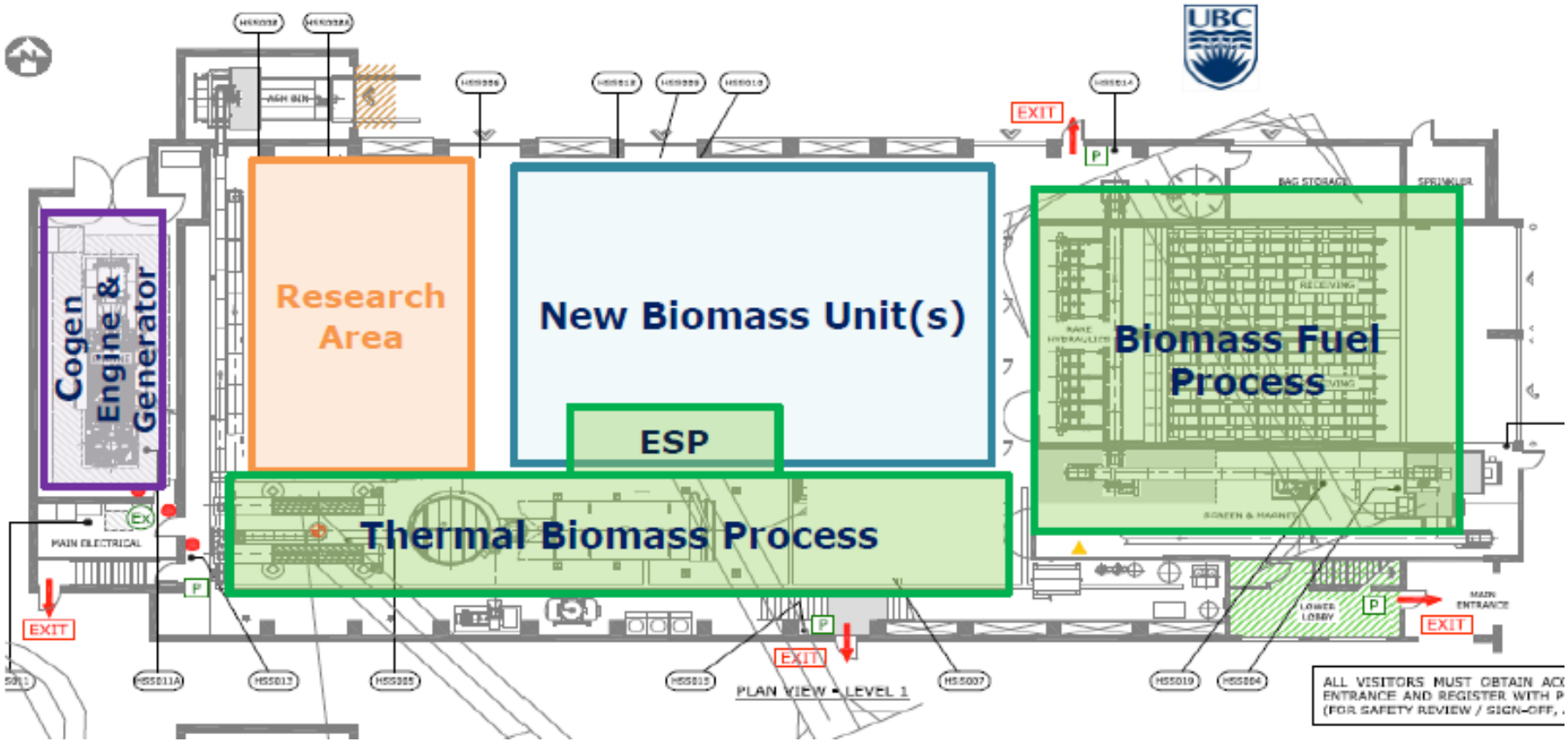
Current Plant Layout: Original Biomass & Syngas Clean up Technology

Original Syngas Cleanup Equipment to be Removed

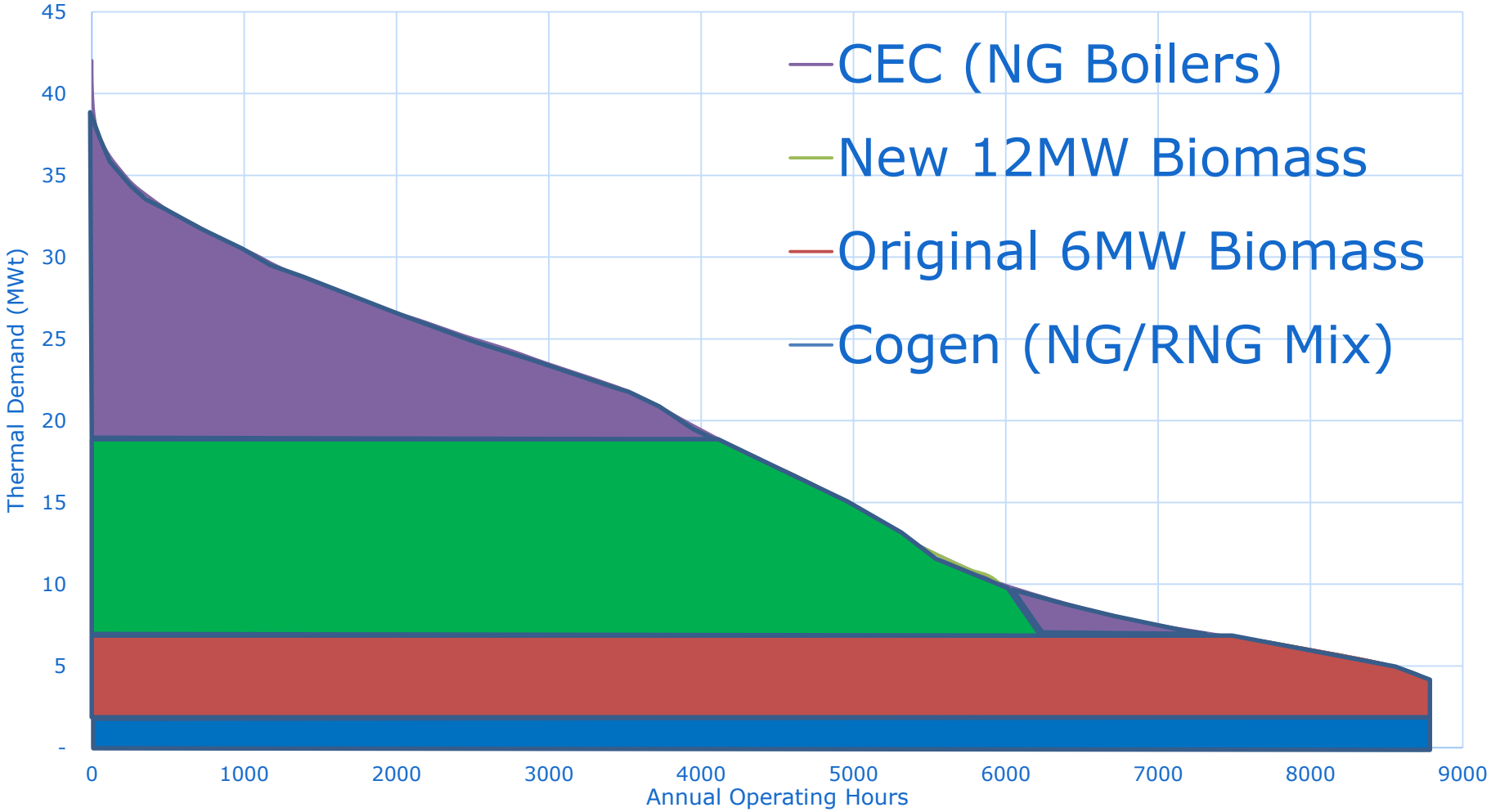
Existing Plant Layout



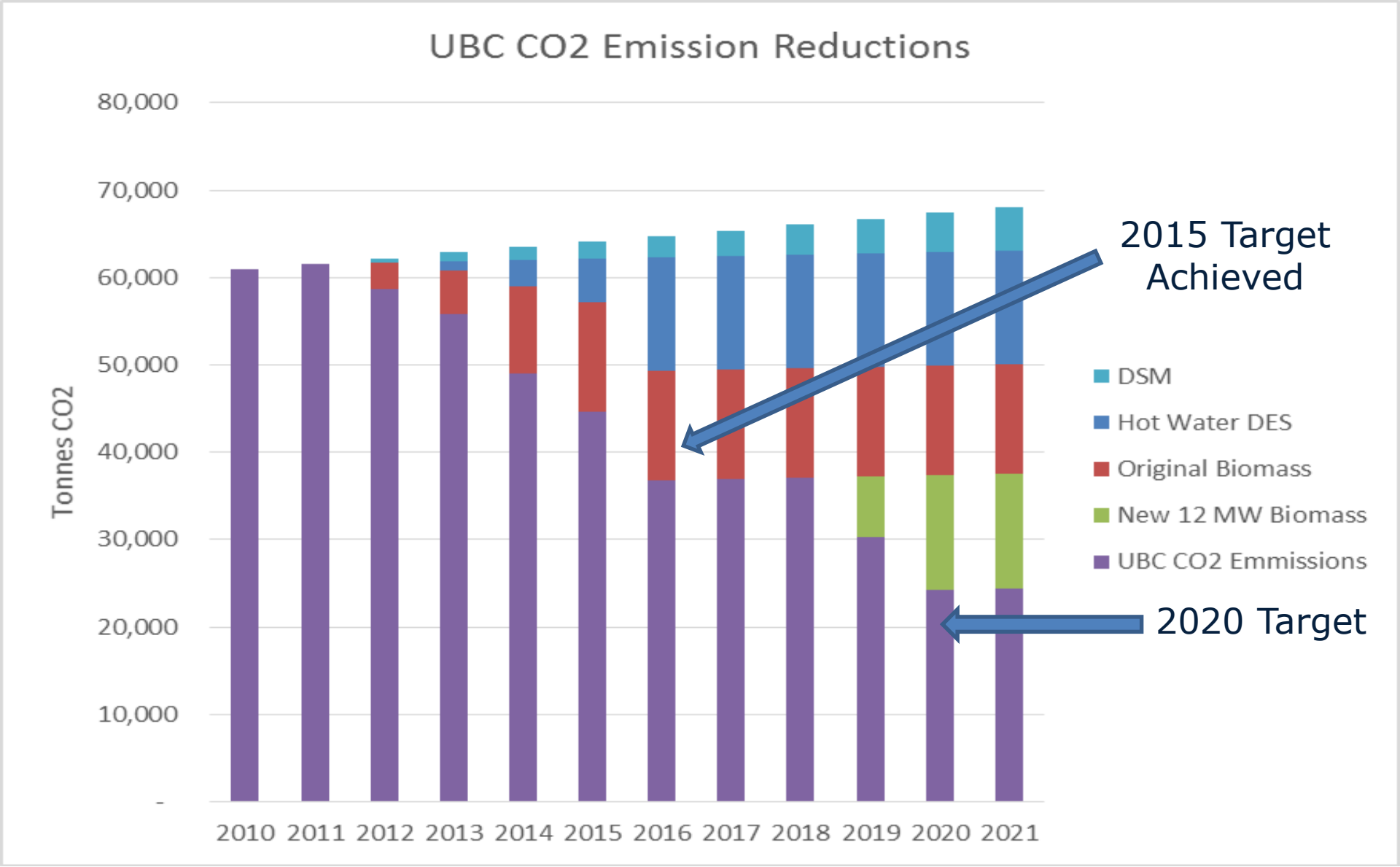
Future Plant Layout



UBC Thermal Load Profile with New Biomass



Currently ~30% annual thermal production now supplied by BRDF
Future capacity increase; up to 60% of UBC's annual thermal production by BRDF



UBC would achieve ~61% CO2 reduction by 2020 from 2007 baseline, with new biomass addition

UBC GHG Emissions Profile: Active & Planned Projects

Conclusions to Date

- BRDF now provides 30% of campus District Energy demand and has successfully reduced UBC's GHG emissions by ~14%
- Separation of Thermal and Cogen Processes has provided:
  - Combined ~8MW's thermal capacity & with fuel diversification
  - Provides 2MWe reliable power production
- Enabled a smooth transition from steam to hot water heating
- Enabled future GHG reductions and research opportunities
- UBC continues to benefit from in-kind world attention to BRDF through sustainability agendas, tours (~700+), CLL and ongoing research, including new research laboratory space to be added.

Thank You

Jeff Giffin, jeff.giffin@ubc.ca
James Torcov, jim.torcov@ubc.ca