Presentation

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Biomass Gasification: Applications in Thermal District Energy & Combined Heat Power

presentation to US Army "Net Zero" Workshop, Chicago, IL January 19th, 2012

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Presentation Outline

- Introduction
- Biomass Gasification - Syngas
- Nexterra Thermal District Energy Systems
- Nexterra Combined Heat Power Systems
- Natural Gas to Syngas Fuel Switching:

  "a phased approach to conversion from natural gas to syngas"
- Gasification Public Private Partnership Funding
- Next Steps

Nexterra Overview

Blue Chip Strategic Relationships

GE Energy	**Product Partner** –	Combined heat and power ("CHP") system
Corix Group of Companies	**Utility Partner** –	North American institutions
UBC	**Demo Partner** –	CHP demonstration, long-term fuels R&D

Overview

- Leading NA supplier of Commercially proven biomass gasification heat and power solutions, expanding internationally
- technology and systems
- Experience delivering projects with industrial and institutional customers
- Best-in-class air emissions, fuel versatility, operating and maintenance costs
- CHP and power systems deliver "game-changing" efficiency
- Proven capacity to deliver projects on time and on budget
- Vancouver-based, ~65 employees
    - Offices in Brazil;
    - Expanding into Japan and Europe
- Well capitalized

ARC financialcorp energy capital partners

TANDEM

Corix Group

- North American Multi-Utility Group
  - District Heating & Cooling, Electric, Gas, Water & Wastewater utilities
  - Operations, Services & Utility Products

- Dockside Green (LEEDS Platinum)
  - Own & operate **Nexterra** Thermal District Energy System

Military UP Contractor **(Doyon Utilities LLC)**
12 utility systems at 3 installation in Alaska (FWA, FGA, JBER) including:
20 MW coal-fired CHP Plant + 30 miles HDS
5 MW liquid CHP Plant + 3 miles of HDS
6.9 MW LandFill/Natural Gas CoGen Plant
(under construction)

Biomass Gasification - Syngas

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Biomass Syngas

- Biomass syngas is a carbon neutral energy resource (CO2e reductions are 3rd party validated)
- Biomass is a locally produced waste energy source that can be procured using secure long term contracts
- Most cities/institutions have significant sources: ie. locally produced wood residues, tree trimmings, construction and demolition waste, biosolids, etc.
- 4 MWe project needs approx. 25-45,000 tons/year (depending on moisture %)
- Typical costs are low: ie.

  $28/wet ton wood~$2/MMbtu ;

  $0 to - $6/MMbtu for biosolids

Fuel Sources & Flexibility

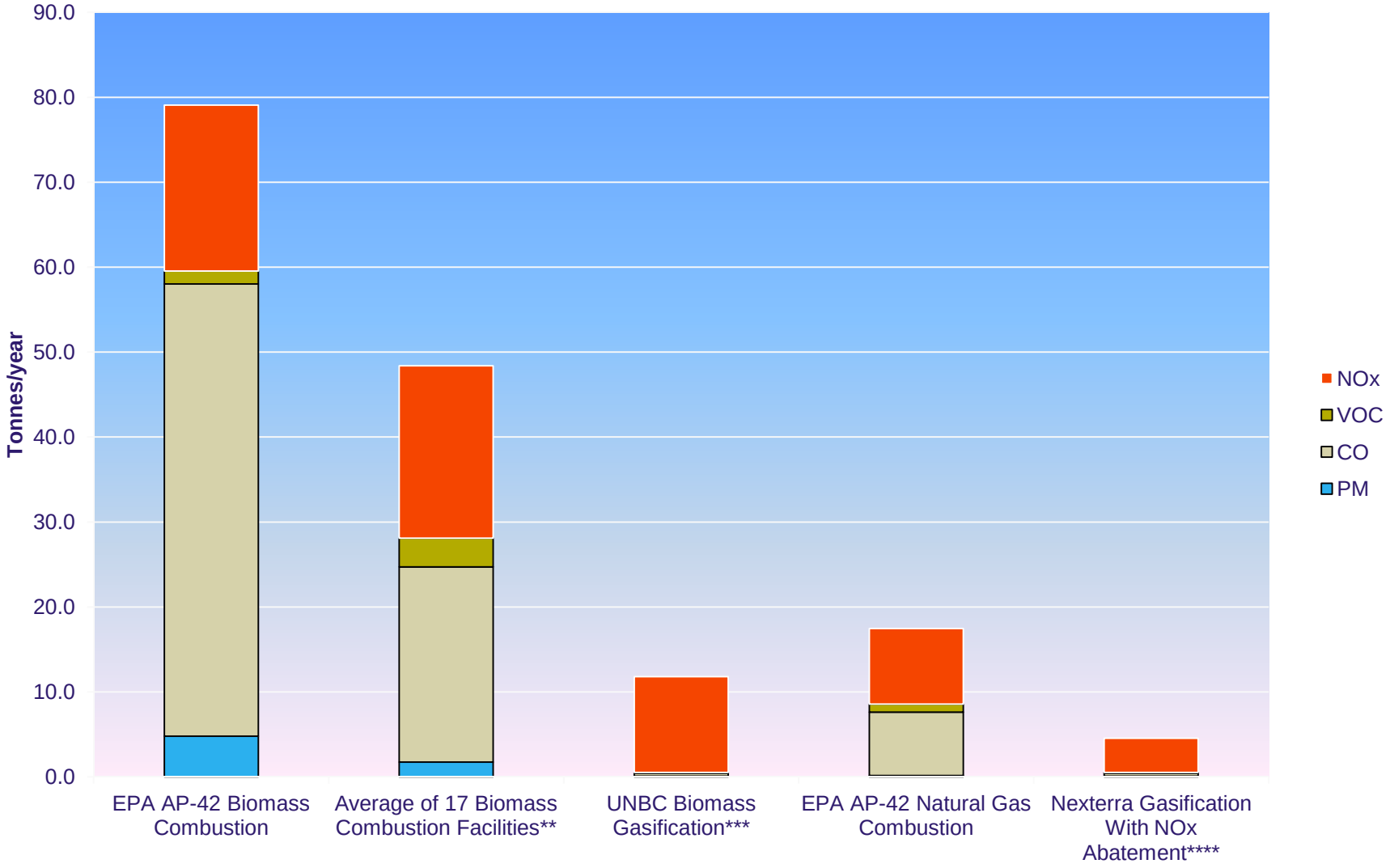
- Biomass of many sorts:
  - 6-60% MC (same vessel, controls modifications),
  - 3” minus sizing, 1” x 1” x 6” material possible

Biomass Gasification

Small-Scale Turnkey Heat & Power Systems

- Modular systems (20 – 144 MMBtu/hr net useable heat):
  - (16, 20, 24 and 36 MMbtu/hr increments)
- Direct-fired thermal systems to convert boilers from fossil fuel to syngas (ie. coal boilers, certain fuel oil, NG boilers)
- Steam power or steam CHP systems (2 –12 MWe)
- Syngas to internal combustion engine CHP systems (2 – 12 MWe)
- Fuels – wood (commercial); biosolids; pellets; grasses

Gasification Emmissions



Nexterra Thermal
District Energy Systems

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Projects

Commercially Proven Systems

Tolko Plywood Mill
(Heffley Creek, BC)

- Q2, 2006
- Savings of $2mm/yr

JCI/USC
(Columbia, SC)

- Q3, 2007
- Savings of $2-3mm/yr

Dockside Green
(Victoria, BC)

- Q2, 2009
- Savings of $700k/yr

Kruger
(New Westminster, BC)

- Q4, 2009
- Savings of $2-3mm/yr

UNBC
(Prince George, BC)

- Q4, 2010E
- Expected Savings of $1mm/yr

US DOE Oak Ridge
(Oak Ridge, TN)

- Q2, 2011E
- Expected Savings of $4mm/yr

UBC
(Vancouver, BC)

- Q1, 2012
- 2MWe CHP system

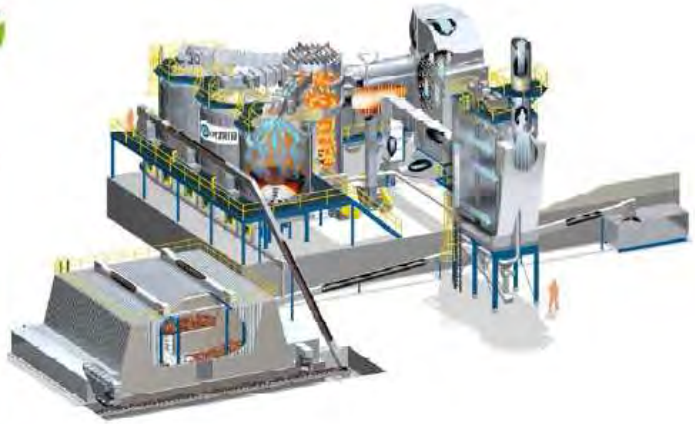
Product & Development
(Kamloops, BC)

- 2004
- Fuels & application development

Thermal DE Systems

Oak Ridge National Labs, Oak Ridge, TN

- 60,000 lbs/hr steam plant
- Annual Savings: $3 - 4 MM
- GHG Reduction: 22,000 tpy
- Operational: Late-2011



Projects

DOCKSIDE **GREEN**

Dockside Green – Victoria BC

- District Heating & Hot Water – 8 MMBtu/hr
- Fueled with Urban Wood Waste
- LEED platinum development
- Recognized by Clinton Climate Initiative
- Started up May 2009

Nexterra Combined Heat Power System

Product Development Roadmap

2005/6

1. Steam & Hot Water Systems

- **Output**: Steam, hot water or hot air
- **Apps**: Industrial, commercial and institutional heating systems

2007/8

2.Direct-Fire Syngas to Existing Boilers & Kilns

- **Output**: Hot syngas delivered to kiln or boiler to produce steam
- **Apps**: Direct-firing existing boilers and lime kilns

2009/12

3.Direct-Fire GE Gas Engines

- **Output**: Electricity and heat via internal combustion ("IC") engines
- **Apps**: Small scale CHP <10 MW direct fired with clean syngas

2013+

5.Pipeline Grade "Green Gas" & Synthetic Fuels

- **Output**: eg. Methane, Ethanol , Butanol
- **Apps**: Medium Scale 100 – 150 MMBtu/hr clean, upgraded syngas plus Fischer Tropsch or other conversion process

Wood – Mill Residue Wet & Dry Bark

Clean Construction Waste

Biosolids, sludges

AgWaste

Energy Crops

Nexterra Syngas CHP

- Small-scale, distributed power <10 MWe
- Highly efficient – up to 60% for cogeneration
- Power/Thermal Ratio - 1 MWe/1.5 MWth
- No steam engineer requirement
- Zero effluent plant
- Power generation does not require thermal load following
- Increases efficiency is becoming increasingly important as fuel prices rise

Competitive Advantages vs. Steam Power Gen

	Traditional Power Gen	Gasification - IC Engine
Efficiency	Low (16 - 22%)	High (24 - 60%)
Scale (economic)	Large (>20 MWe)	Small (<10 MWe)
Fuel Risk	High (30 MW = 240,000 BDTPY)	Low (2 MW = 12,000 BDT/yr)
Fuel Truck Traffic	High (30 MW = 30 trucks/day)	Low (2 MW = 2 trucks/day)
Footprint	Large	Small
Operating Cost	High - 24 X 7 Steam Engineers	Low – no steam engineers
PM Emissions	Low with APC	Low - NG for particulate
Permitting/Public Risk	Higher	Lower
Delivery Schedule	Long : 24 – 36 months	Medium:15 months
Grid Connection Costs	Higher	Minimal – inside the fence
Economic Development	Concentrated/centralize	Decentralized/distributed
Urban Friendly	No – scale, traffic, emissions	Yes – scale, traffic, emissions

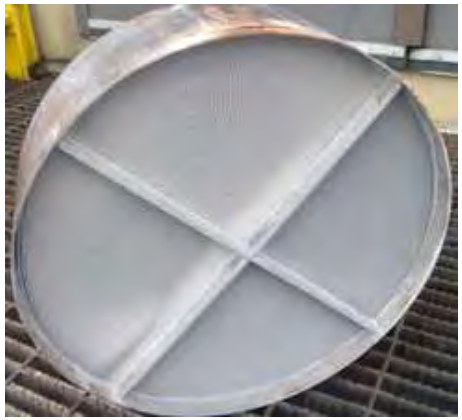
Product Development Center

Engine Inspection – 2750 hours

Turbo compressor – no tars

Spark plugs - no bridging, oil ash only

Turbo Exhaust – oil ash only



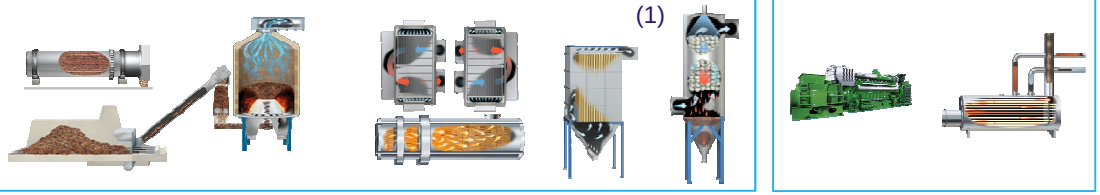
Oxy-Catalyst Element – no masking, oil ash only

Modular CHP Systems – 2 to 10 MWe

2 MWe

- Net Power: 1.6-1.9 MWe
- Net Heat Output: 10 MMBtu/hr
- Wood Fuel Req't: 12,500 Bdt

Fuel Handling (1) | Gasifier (1 x 16 ft) | Gas Clean-up (1) | Syngas Conditioning (1) | Engines (1) | Heat Exchanger (1)



4 MWe

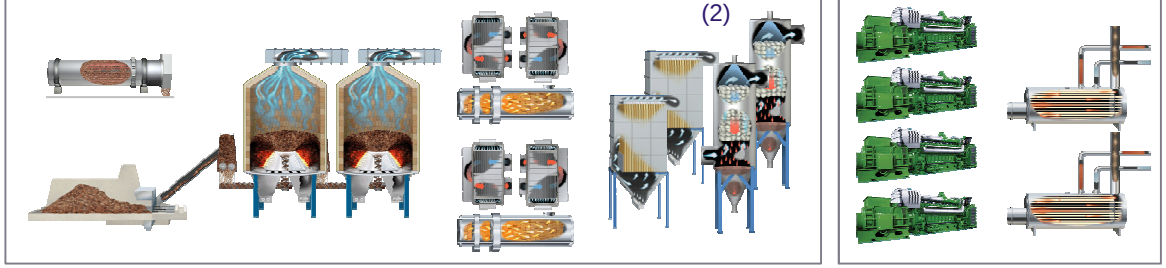
- Net Power: 3.2-3.8 MWe
- Net Heat Output: 14 MMBtu/hr
- Wood Fuel Req't: 25,000

Fuel Handling (1) | Gasifiers (1 x 20 ft) | Gas Clean-up (1) | Syngas Conditioning (1) | Engines (2) | Heat Exchanger (1)

8 MWe

- Net Power: 6.4-7.6 MWe
- Net Heat Outtut: 28 MMBtu/hr
- Wood Fuel Req't: 50,000 Bdt

Fuel Handling (1) | Gasifiers (2 x 20 ft) | Gas Clean-up (2) | Syngas Conditioning (2) | Engines (4) | Heat Exchanger (2)



Full-Scale Demonstration CHP Project

UBC – 2 MW Biomass CHP Project

- Fuel Req'd: 12,500 BDMT/year (2-3 trucks/day)
- Gross Power: 1.95 MW
- Net Thermal: 10 MMBtu/hr (80,000 MMBtu/yr)
- CO2 Red: 4,000 tpy (thermal only)
- Footprint: 180' X 90'
- Commissioning: April 2012

Commissioning Q1/2012
Startup April 2012

Natural Gas to Syngas Fuel Switching:

A phased approach to conversion of a conventional Central Plant to Biomass Syngas

Economics to Fuel Switching

- Military Objectives:
  - (1) Energy Economy , (2) Energy Diversity , (3) Energy Security

- Fuel Switching is a substitution of a known fixed capital cost with a lower fuel cost to avoid a unknown variable future energy cost
- Oil : ~$24/MMBTU
- Natural Gas : ~$ 6/ MMBTU
- Biomass : ~$30/wet ton (30% moisture) ➔ $2/MMBTU

- Gasification for Thermal economic based on the current differential.

- Gasification for CHP to be economic currently needs:
  - higher MMBTU differential,
  - capital contributions-in-aid-of-construction,
  - back-end structured capital recovery, &/or
  - willingness to accept a longer payback period

Central Plant Scenario

- New or Existing natural gas fueled Central Plant
  - 2 IC/dual-fuel Engines ➔ 3.2 – 3.8 MWe
  - 3 dual-fuel Boilers ➔ 14 MMBTU/hr (net useable heat req)
  - 3 Chillers ➔ 1,160 tons
  - Central Plant Cost excluding CHP Engines: $ 5.9

    District Energy Distribution Network (8,300 m, 4-8”): $ 13.6

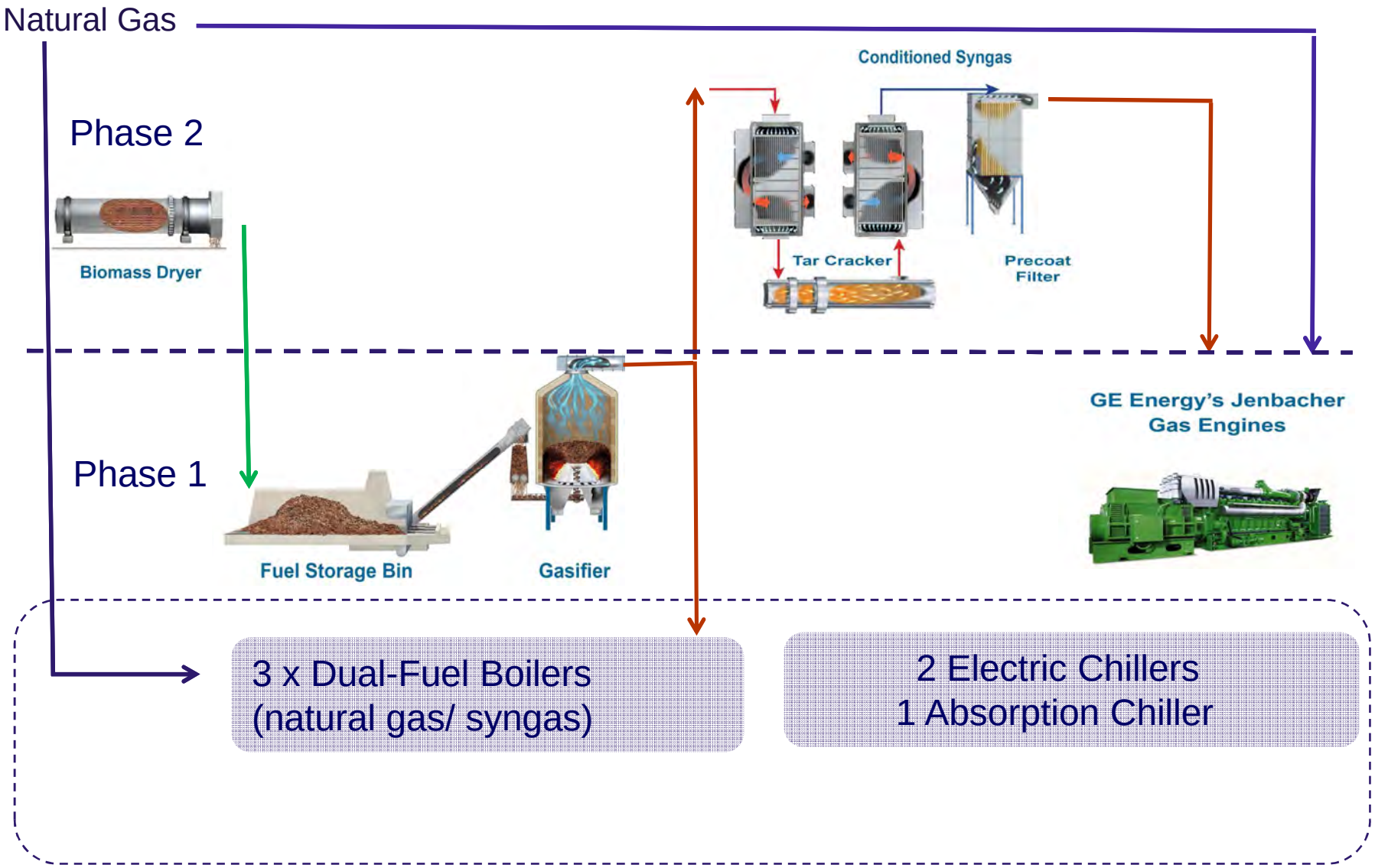
    Central Plant & DE Network Cost w/o CHP **$19.5 mm (40%)**
  - Dual-Fuel (natural gas, syngas) IC Engines: +/- $ 8.0 (15%)

    $27.5 mm (55%)
- Biomass Gasification train (Gtee’d) +/- $ 5.5 (11%)
- Syngas Conditioning train (Gtee’d Q2/2013) +/- $17.0 (34%)

Biomass Gasification costs **$ 22.5 mm**

Total District Energy w. CHP system cost: **$50.0 mm (100%)**

Central Plant – Building Blocks



Gasification

Public Private Partnership Funding

Renewable Energy Incentives to Private Sector

Incentive	Type	Description	Timing/Comments
Renewable Portfolio Standards (RPS)	Mandate	REC's trade to comply with RPS requirements. Prices differ by state $0.50-$40/MWH	Most: 20-30% of power generated to be renewable by 2020
MACRS	Accelerated depreciation	Allowable depreciation varies per year. Biomass equipment depreciated over 5 years	
Greenhouse Gas Offsets (GHG)	Carbon Credits	$3-$10/ton CO2 equiv. Participation in US Market is voluntary	
Production Tax Credit (PTC)	Tax Credit	$22/Mwh for Closed loop biomass $11/MWh for Open loop biomass	PTC earned for first 10 years of commercial operation. Project in service by 12/31/2013
Investment Tax Credit (ITC)	Tax Credit	30% of qualifying capital cost for biomass	Project in service by 12/31/2013
ITC Grants (S1603)	Cash Grant	30% of qualifying capital cost for biomass	Project must be under construction by 12/31/2011 and operational by 12/31/2013
DOE Loan Gtee Program	Loan Gtee	Up to 80% of project costs	Project must be under construction by 9/30/2011

Public Private Partnership Funding Option

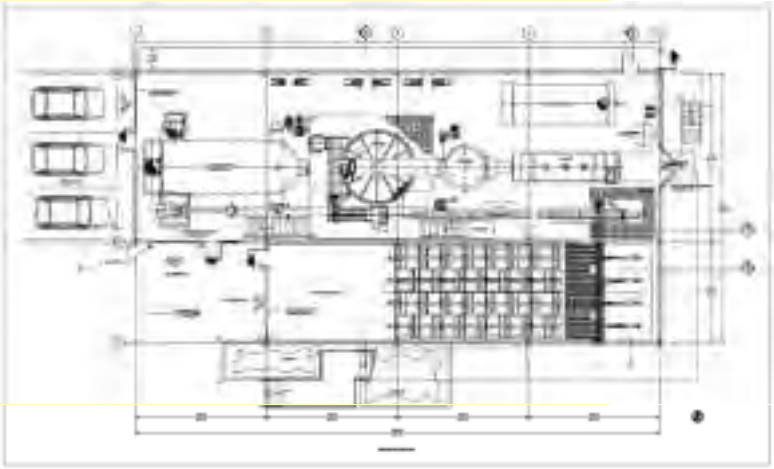
1. **Gov't funding** for basic Central Plant & District Energy components (i.e.: boilers, chillers, electrical, balance of plant : ~ 40% of total project cost)
2. **Private funding/ownership** of biomass gasification and IC Engine
3. **Energy Services Agreement** between Private and Installation for:
   - Sale of Electrical & Thermal Energy to Installation from renewable syngas
   - O&M/ Asset Management of Central Plant and District Energy
   - Establishment of Micro-Smart Grid (supply side & demand side energy mgmt)

     Benefits realized by private entity on RES, MACRS, GHG, PTC and ITC flow-through to Installation in the cost of energy.
4. **Title to Facilities**
   - **Option 1**: Installation transfers title of Central Plant and DE system to private utility and receives a Payment Credit against future energy costs, or
   - **Option 2**: Private Entity transfers title to biomass gasification and power equipment at end of term of PPA to Army Installation (after tax benefits have been realized)

Next Steps

Preliminary Assessment

1. Electrical & Gas costs
2. Other avoided costs (biosolid disposal)
3. Boiler /Chiller efficiency & spec's /type
4. Carbon footprint of installation
5. Required emission standards
6. Electrical load profile (daily , degree days)
7. Thermal load profile (net usable heat)
8. Fuel availability & costs (woody biomass, biosolids)
9. General arrangement drawings of Central Plant
10. Site layout



Next Steps

1. **Preliminary Assessment (2-3 months)**
2. **Detailed Assessment (3-6 months)**
   - System size and configuration
   - Permit
   - Location selection
   - Building design specifications
   - Fuel supply
   - Financial model
   - GHG credit validation
   - Campus procurement process
   - Incorporate learning center
3. **Prepare Submission of Project for Approval**
4. **Procure Equipment and Services (3 months)**
5. **Procure Permits (3-12 months concurrent with 2,3,4)**
6. **Supply and install system (12 months)**

Thank You
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