Wisconsin Statewide Wood Energy Team

Large-scale Biomass Heat and Power Projects: Profiles and Development Considerations

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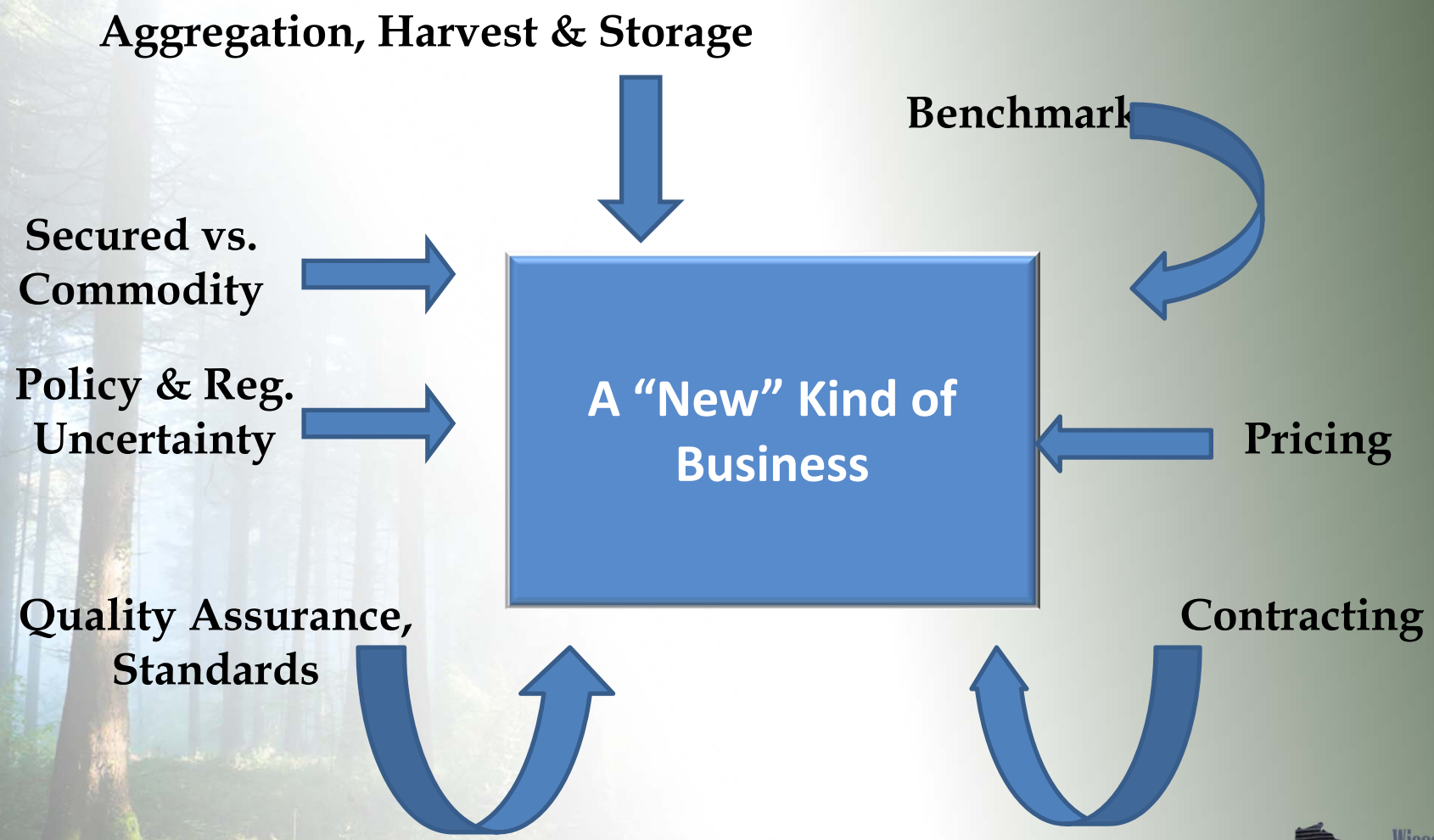
Biomass Development Challenges



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Biomass Thermal Conversion

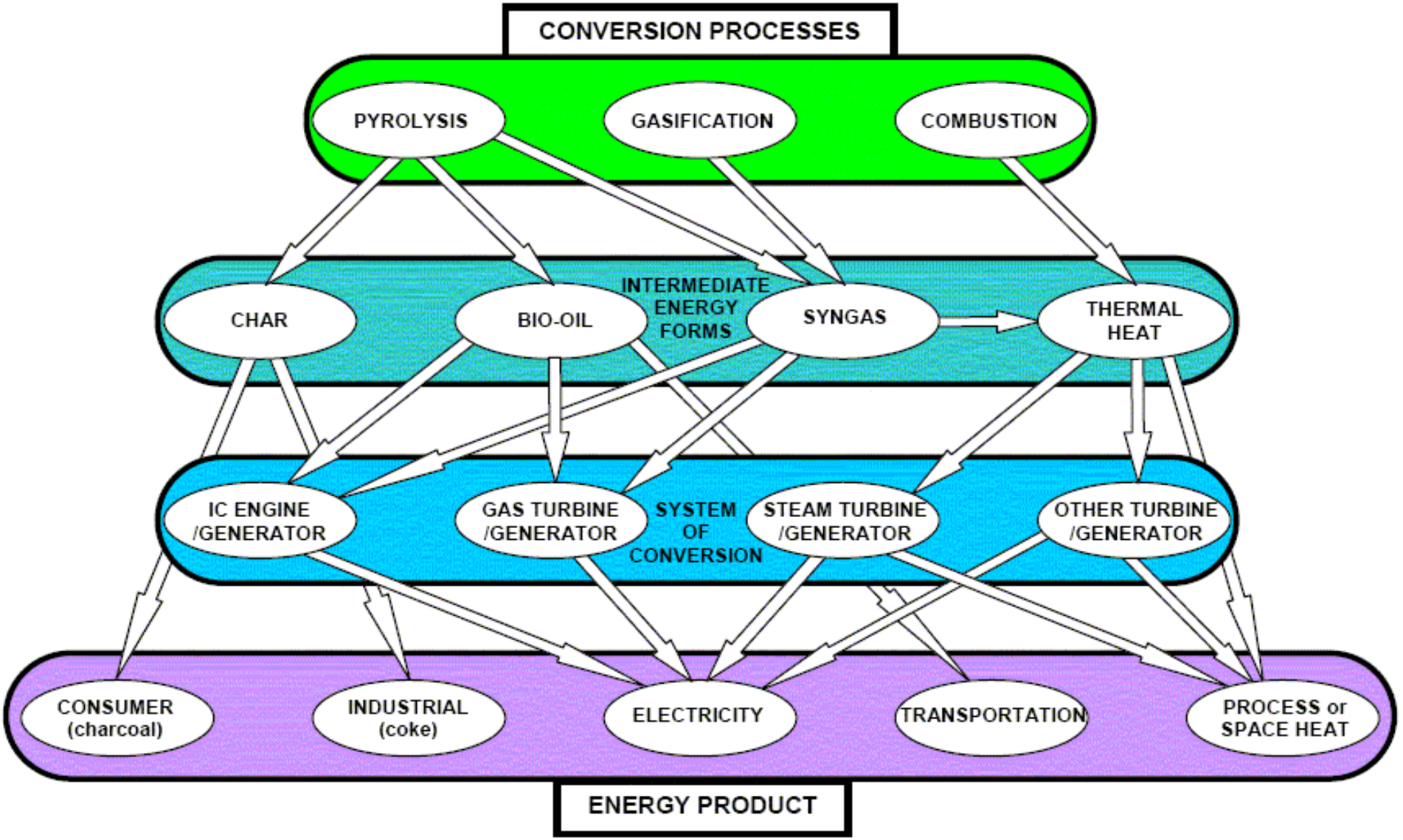
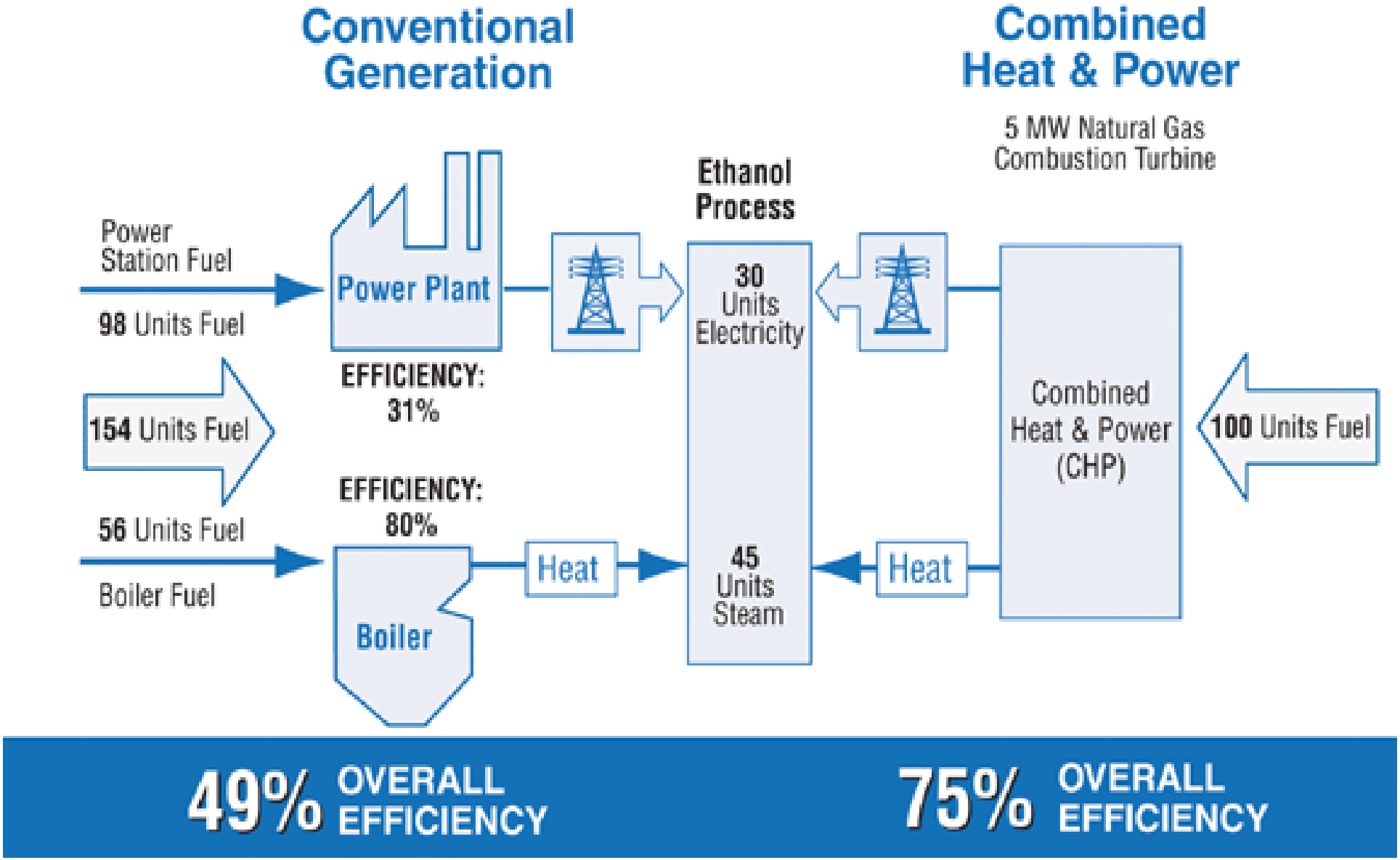


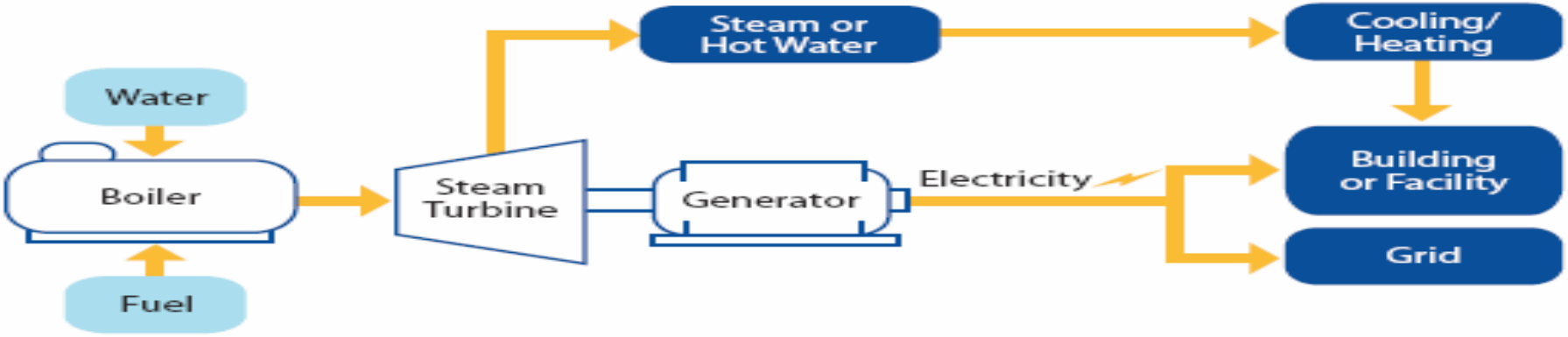
Figure I-1 Thermal Conversion Processes

Thermal Efficiency Comparison

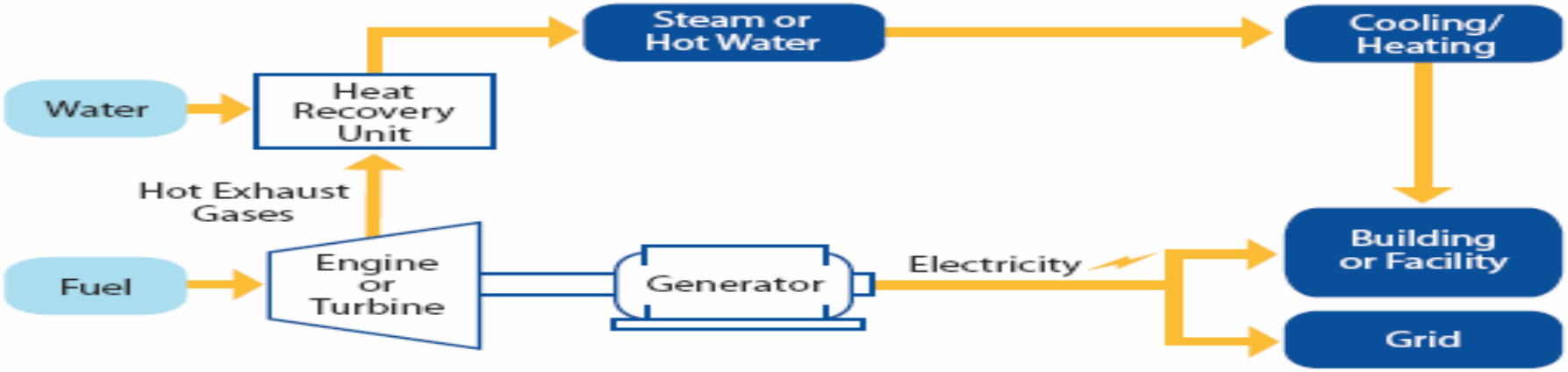


Union of Concerned Scientists
Catalyst
Summer 2009

Boiler-based CHP system

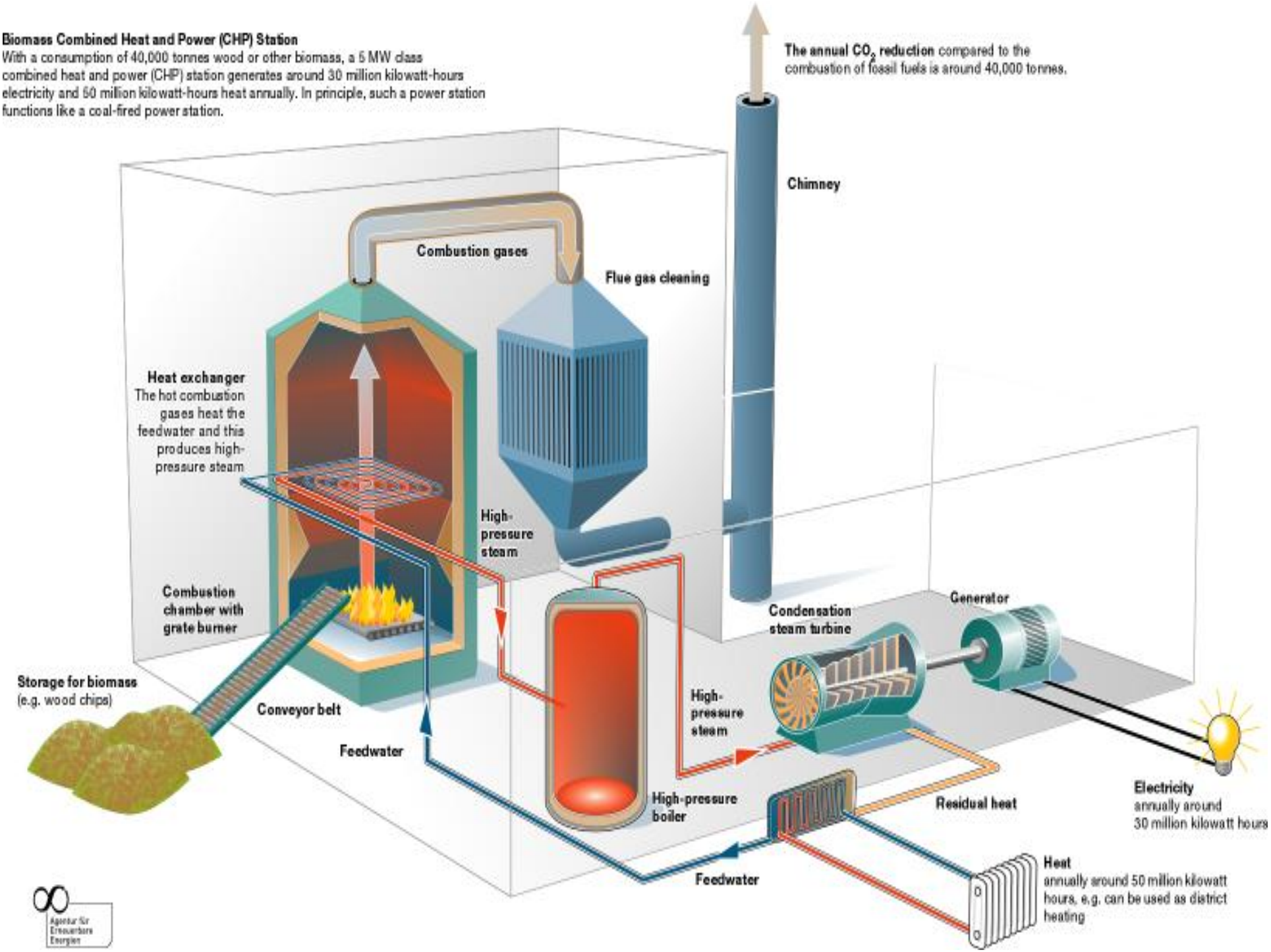


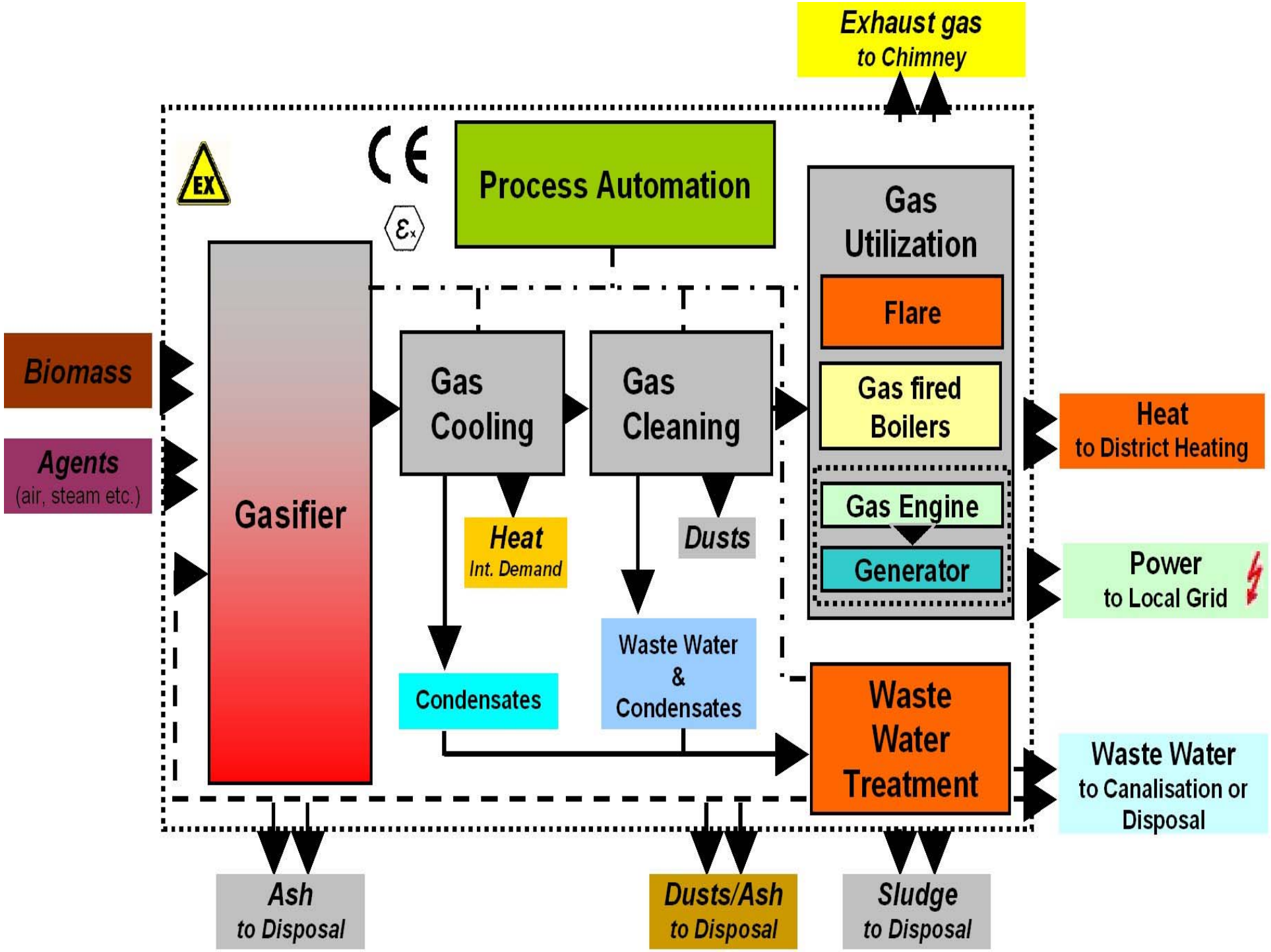
Turbine-based CHP system



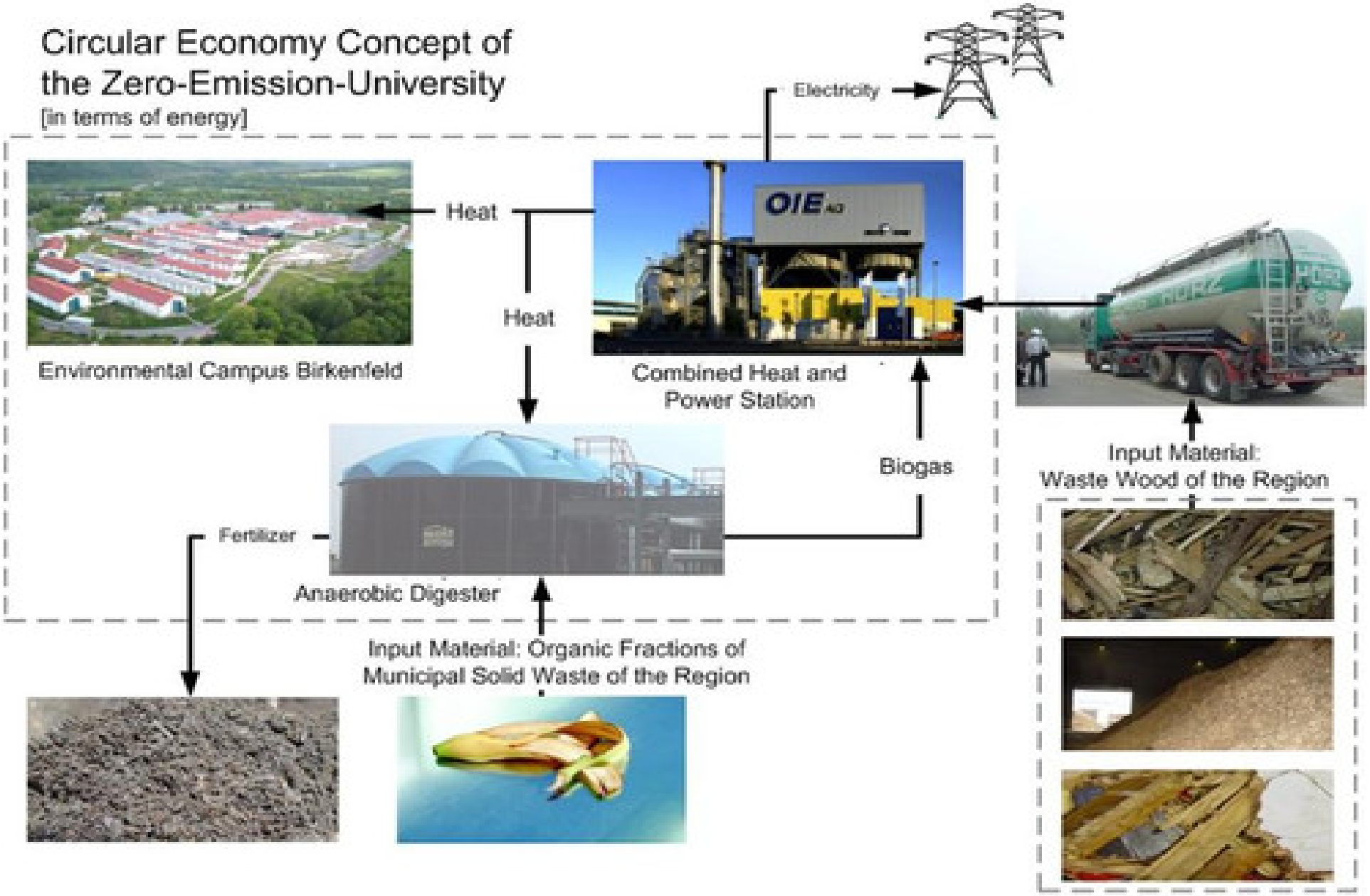
Combined heat and power (CHP) systems are typically based on one of the two configurations above, but vary in their generating capacity and fuel source, allowing them to be customized to the specific needs of a particular user.

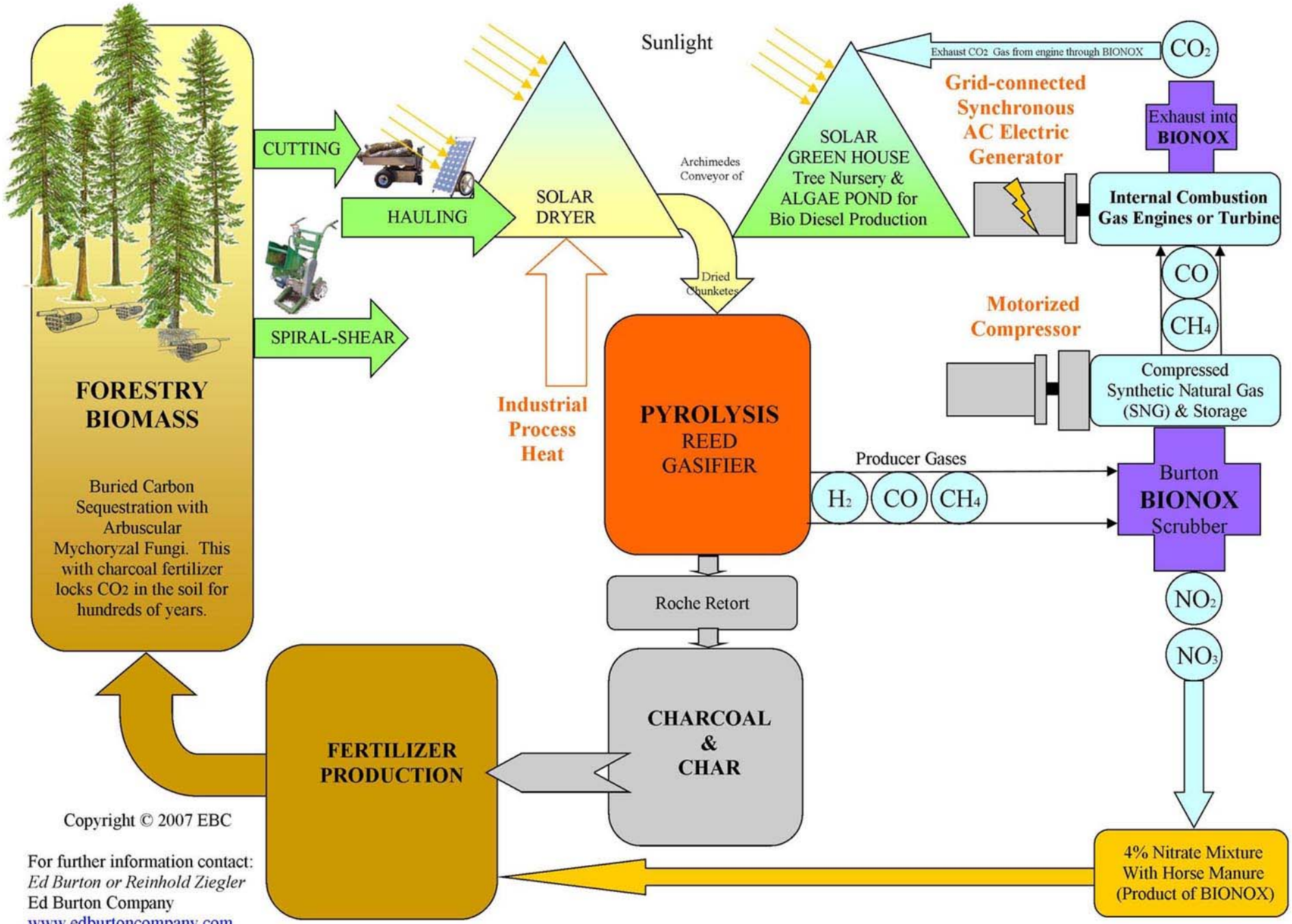
Biomass Combined Heat and Power (CHP) Station
With a consumption of 40,000 tonnes wood or other biomass, a 5 MW class combined heat and power (CHP) station generates around 30 million kilowatt-hours electricity and 50 million kilowatt-hours heat annually. In principle, such a power station functions like a coal-fired power station.




Exhaust gas
to Chimney
EX
Process Automation
Gas
Utilization
Flare
Gas fired
Boilers
Gas Engine
Generator
Biomass
Agents
(air, steam etc.)
Gasifier
Gas
Cooling
Gas
Cleaning
Heat
Int. Demand
Dusts
Heat
to District Heating
Power
to Local Grid
Waste Water
&
Condensates
Condensates
Waste
Water
Treatment
Waste Water
to Canalisation or
Disposal
Ash
to Disposal
Dusts/Ash
to Disposal
Sludge
to Disposal

Applications: Biomass & Biogas





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Xcel Energy's Bayfront Facility, Ashland, Wisconsin

Xcel Energy's Bayfront Facility, Ashland, Wisconsin

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Xcel Energy's Bayfront Facility, Ashland, Wisconsin

Xcel Energy's Bayfront Facility, Ashland, Wisconsin

- Owned by NSP-W, operating capacity is 73MW steam turbine/boiler technology.
- Fuel types include coal, natural gas, tires, and woody biomass. Currently, nearly all biomass
- Since 1979, the Plant has converted over 4 million tons of biomass into renewable electricity.
- The Plant currently consumes approximately 233,000 green tons of biomass per year.
- Biomass fuel purchases approximately 7 million dollars annually.

Domtar/WE Energy's Rothchild, Wisconsin CHP

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Domtar/WE Energy's Rothchild, Wisconsin CHP

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Domtar/WE Energy's Rothchild, Wisconsin CHP

- Domtar paper mill in Rothschild and We Energies partnered on developing a 50-megawatt cogeneration plant.
- Supported by an electrical rate case supplies electricity to We Energies and heat to the Domtar plant. It came fully online in 2013
- Cap Ex ~$269 million
- 130,000 TPY of biomass. 50,000 TPY Domtar's process residuals
- 370,000 tons/yr of (wood, waste wood and sawdust) biomass is purchased from other regional suppliers.

DTE's Stoneman Plant
Cassville, Wisconsin

While in-plant components such as generator turbines (left) remain relatively unchanged from the days of coal, the fuel-handling array (above) south of the main building has transformed. Note the elevating ramp for quick off-loading of trucks.

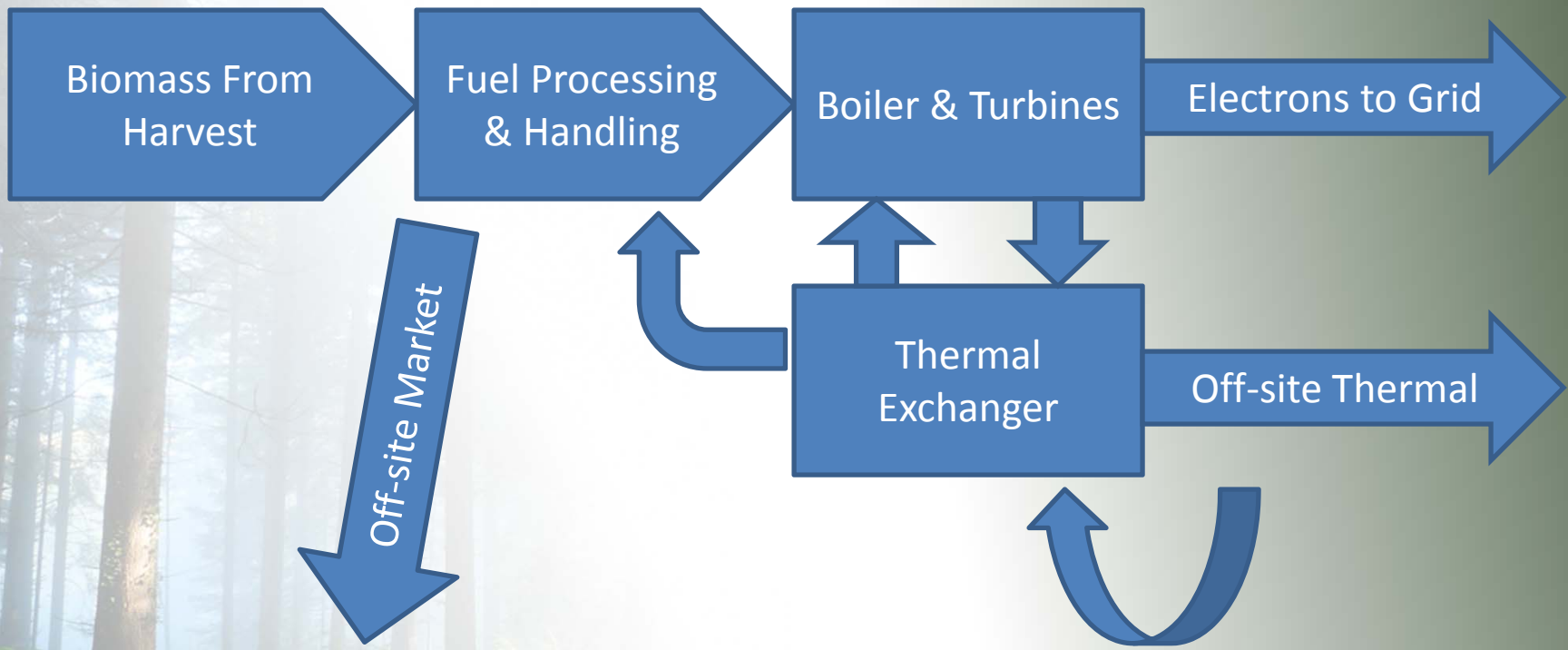
DTE's Stoneman Plant
Cassville, Wisconsin

- Detroit Edison's (DTE) Cassville, Wisconsin facility operates a 40 MW facility approximately 100 miles south of XFI.
- DTE's facility primarily burns primarily construction/demolition wood and railroad ties.
- DTE consumes ~ 300,000 BDT/yr
- Power sold via PPA to Dairyland Power Cooperative, LaCrosse, WI

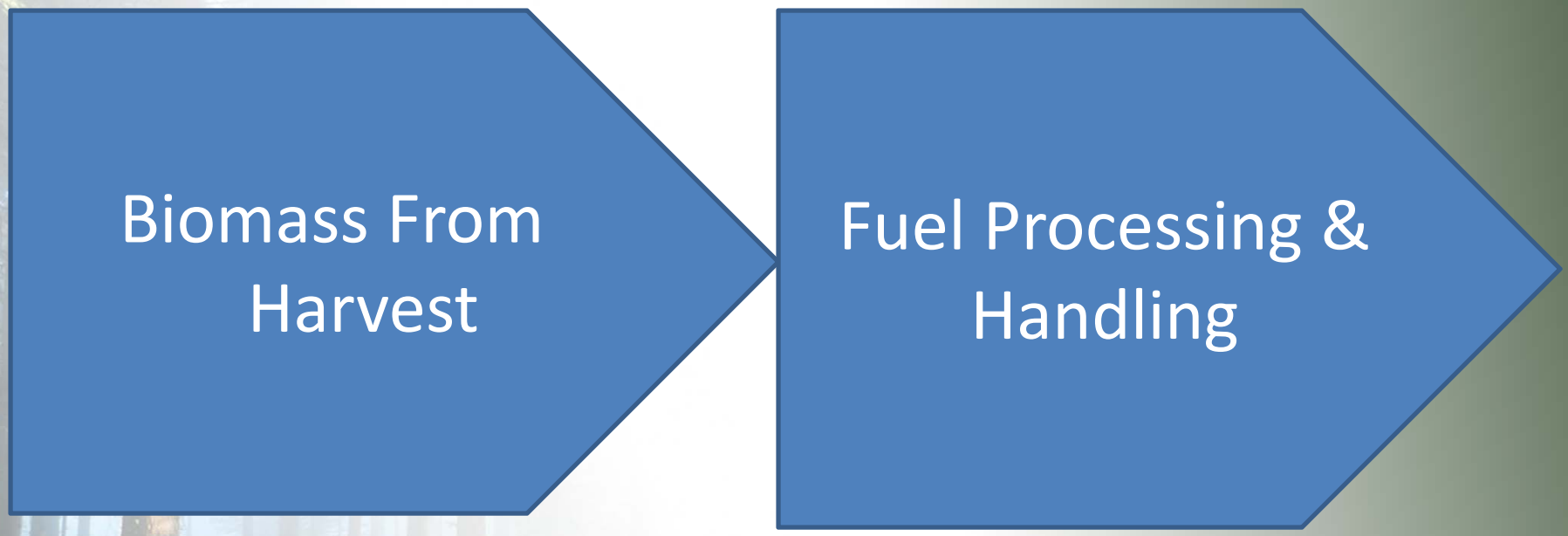
Biomass CHP: Key Economic Drivers

- Cost and Quality of Biomass Derived Fuel
- Capital & Operating Cost of Conversion and Distribution Assets
- Thermal Conversion Efficiency
- Electrical Power Revenue/Savings
- Thermal Energy Revenue/Savings
- Perceived Riskiness of Venture: Funding

Biomass CHP: Process Flow



Biomass Fuel Cost & Quality



Biomass Fuel Cost & Quality

- Regional Characteristics
- Available/Potential Biomass
- Opportunity Costs of Stakeholders
- Collection, Harvest, Storage, Transport
- Environmental/Sustainability Issues
- Transaction and Carrying Costs
- Processing Specs and Costs

Biomass Supply Structure Functions

- Broker/Dealer
- Producer
- Harvester/Collector
- Transport/Storage and Logistics
- Processor
- Business/Financial Service Provider

Biomass Supply Structure

- Business Model Options

1. Vertical Integration:
   a) Convertor Owned/Financed
   b) Convertor Owned/Operate

2. Outsourced:
   a) Convertor Partnership/Funded
   b) Turnkey/Standalone Vendor

Biomass Supply Structure

- **Converter's Fuel Mix/Matrix Strategies**

1. **Simple/Internal:** Delivered "as-is." Feedstock requirements/mix managed by Convertor

2. **Complex/Outsourced:** Feedstock Mix managed by Vendor. Vendor paid by Feedstock Characteristics. Consistent Quality Expected.

Biomass Supply Structure

- Converter's Procurement Strategy
  - Internally managed
  - Externally managed (outsourced)
  - Mixed

Biomass Supply Structure

- **Internally Managed Procurement Strategy**
  - Defined: ***Converter's Staff and Systems Managing Fuel*** Recruitment, Purchasing, Quality Assurance and Supply Chain Management
  - **Requires**: Staff, Systems, Financial/Accounting/Legal and Technical Support suited for biomass procurement
  - **Requires**: Familiarity with Business Practices/Culture of Biomass Supply/Sources (e.g. "net 10")
  - **Requires**: Familiarity with All Relevant Government Programs, both Incentives and Regulatory (including air, water and ash permits)
  - **Converter's** staff and systems **responsible for managing** biomass **fuel mix and contracting** (e.g. acquisition, pricing, quality, quantity, timing, chain of custody etc.)

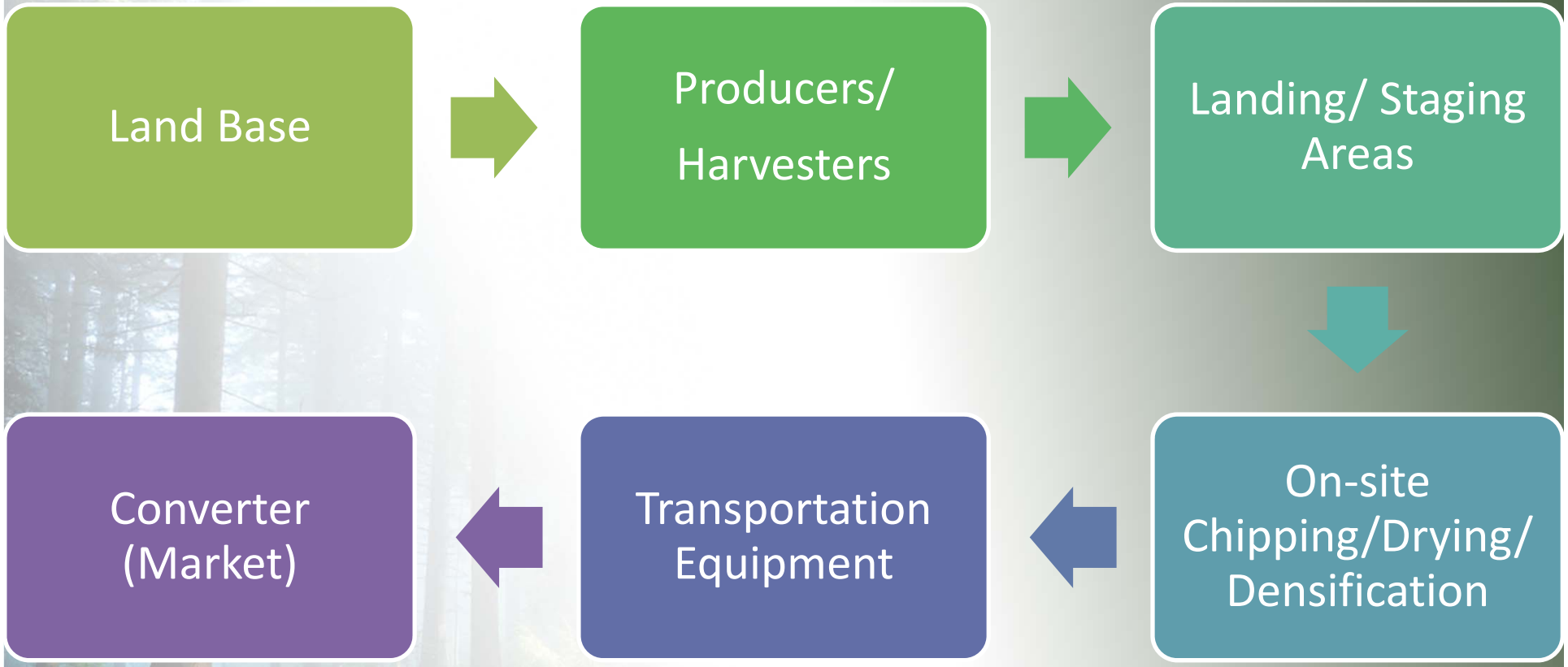
Biomass Supply Structure

- **Externally Managed Procurement Strategy**
  - **Requires:** Vendor provided Staff, Systems, Financial/ Accounting and Technical Support suited for biomass procurement
  - **Defined:** Fuel Recruitment, Purchasing, Quality Assurance and Supply Chain Management ***Contracted with Outside Firm/Vendor(s)***
  - **Converter's** staff and systems **responsible for managing vendor relationship** and monitoring performance of biomass fuel "value" (e.g. contract execution, pricing, quality, quantity, timing, etc.)

Biomass Supply Structure

- **Mixed Procurement Strategy**
  - **Internal and External biomass procurement functions distributed and delegated**
  - Assumes each party leverages existing/acquired strengths
  - May provide extended benefits in meeting "non-direct" economic benefits
    - E.g. Target purchases by geographic region, "politically influenced" purchases, public relations

Biomass Supplier Basic Assets



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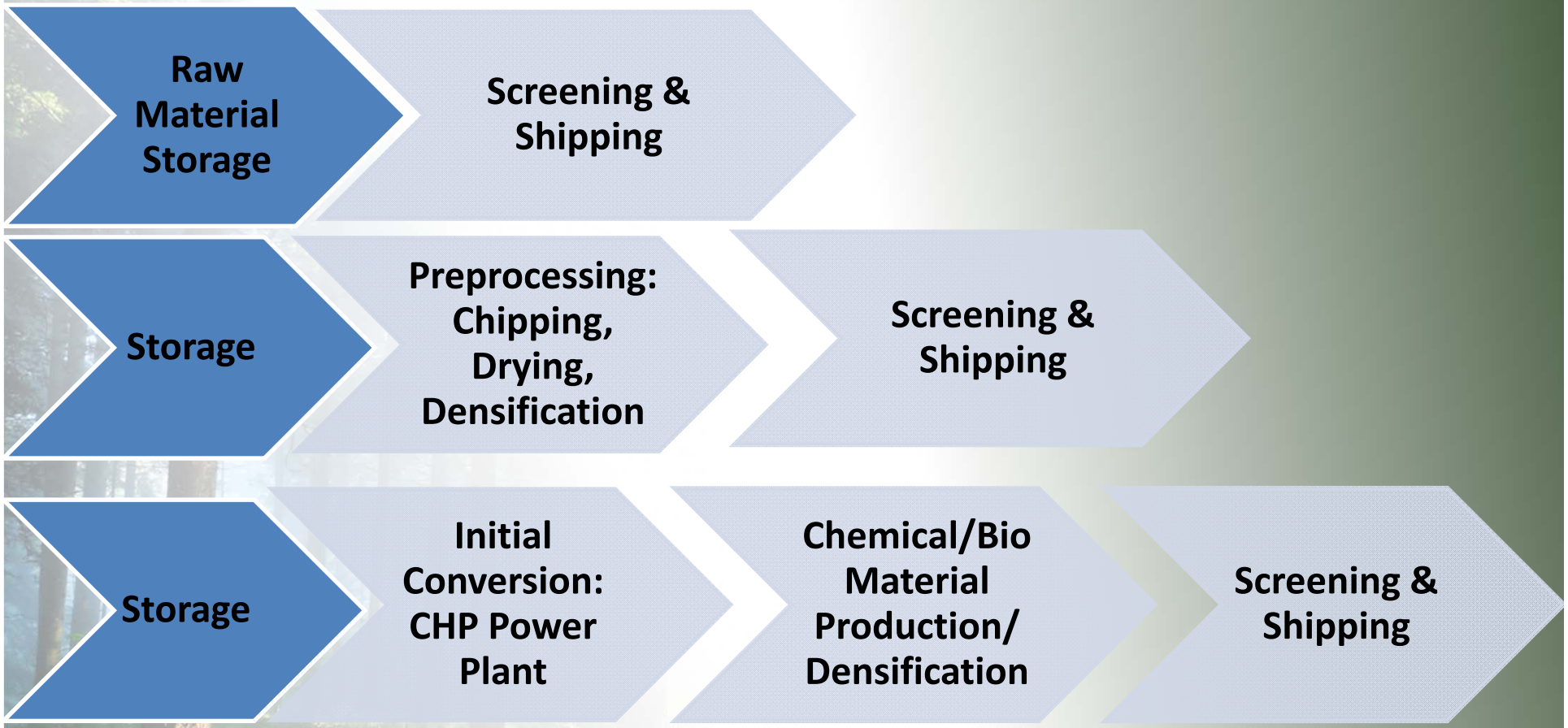
Biomass Aggregation Centers: Process Options



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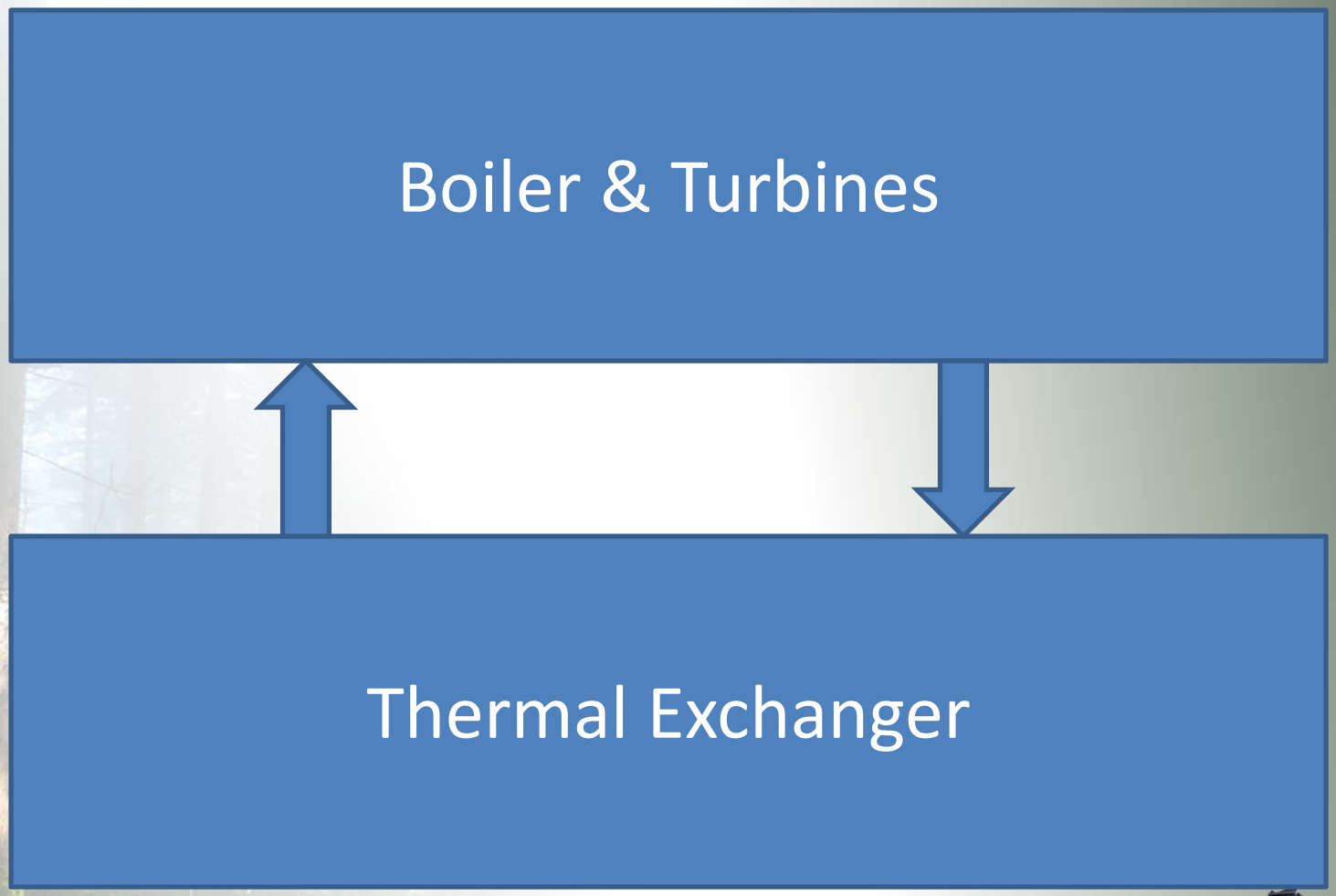
Feedstock Assumptions							
1. Raw Material:	Switchgrass	Corn Stover	Green Wood Chip	Dry Wood Chip	Densified Wood	Other	
2. Delivered, Raw Material Fuel Value: BTU per pound	7,600	6,000	5,200	8,000	8,000	5,000	
3. Raw Material Fuel Value, MMBTU per Ton	15.2	12.0	10.4	16.0	16.0	10.0	
4. Raw Material Price per ton	$50.00	$20.00	$30.00	$30.00	$30.00	$40.00	
5. Harvest Price per ton	$17.00	$17.00	$0.00	$0.00	$0.00	$4.00	
6. Transport Price per ton	$5.00	$5.00	$5.00	$5.00	$15.00	$2.00	
7. Storage Price per ton	$4.00	$4.00	$2.00	$4.00	$4.00	$4.00	
8. Processing Price per ton	$5.00	$5.00	$13.00	$30.00	$60.00	$5.00	
9. Total Price per ton	$81.00	$51.00	$50.00	$69.00	$109.00	$55.00	
Ave. Cost ($/MMBtu)	$5.33	$4.25	$4.81	$4.31	$6.81	$5.50	
Average Yield per Acre (tons)	4.00	1.75	13.00	0.00	0.00	0.00	Totals
Expected Percent of Feedstock Supplied to Project	45%	10%	45%	0%	0%	0%	100%
Estimated Annual Tonnage	46,890	13,199	68,532	0	0	0	128,620
Acreage Required	11,723	7,542	5,272	0	0	0	24,536
Estimated Annual Feedstock Costs ($)	$3,798,097	$673,133	$3,426,584	0	0	0	$7,897,814
					Ave Cost/ MMBtu		$4.986

Capital Costs & Conversion Efficiency



CHP Capital & Operational Costs

- Conversion Technology Dependent on Off-take
- Conventional Boiler versus Gasifier
- Dedicated or Co-Fired (e.g. Natural Gas, Coal)
- Capital Cost/KwH Capacity
- Capital Cost/M^3 Steam or Hot Water (Quality?)
- Site, Infrastructure (incl. distribution & recovery)
- Fuel Handling/Processing
- Staffing, Maintenance and other Operational Costs

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HOVEN


HURST

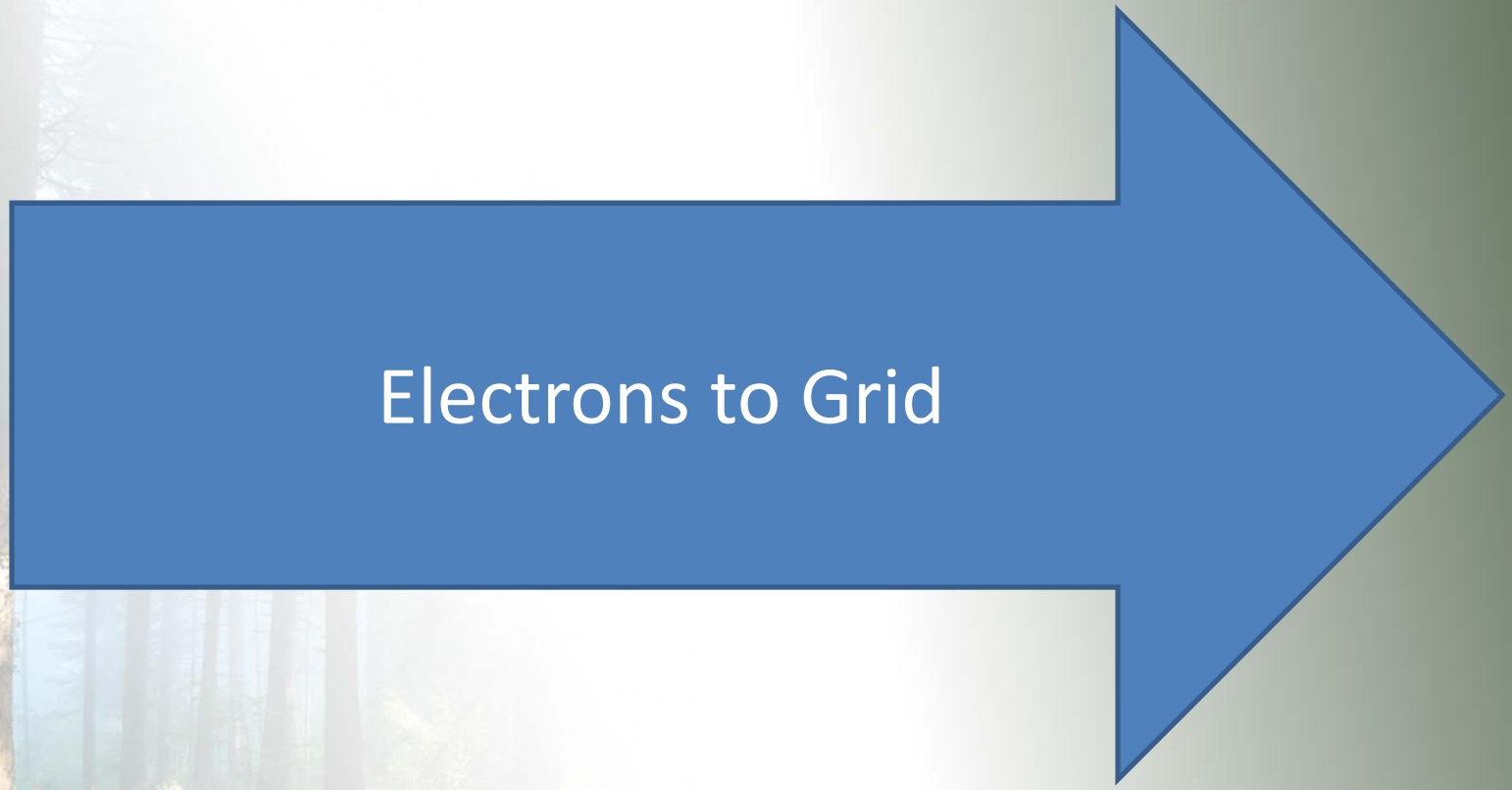
CHP Capital Costs

- Impact & Availability of Credit Enhancements
- Tax Investment Options and Credits
- Debt/Equity – Underwriting Criteria
- Terms and Conditions of Debt Financing
- Performance Guarantees by Technology Vender or EPC Contractor
- Parasitic Load

CHP Conversion Efficiencies

- Feedstock Robustness of System (flexibility)
- Fuel Btu conversion to KwH or Steam/Hot Water (i.e. heat rate)
- Efficiency of End-User Systems and Hot Water Thermal Recovery
- Integration of Thermal Off-take for Fuel Processing
- Incentives/Disincentives for Co-Combustion (NG?)
- Emissions and Controls

Electric Power Revenue/Savings



Power Purchase Agreement

- Published Tariff or Negotiated Contract?
- Base-load/Full Capacity? Over-Capacity? Under?
- Capacity Payment?
- Length, Terms and Conditions of Contract?

(note: length expected to = loan amortization)

- Are Fuel Risks Addressed?

Power Purchase Agreement

- Dovetailing on Existing PPA or New Contract?
- Credit Support Provider
- Qualify for Rate Case (e.g. Customer is Regulated Utility)?
- Environmental Attributes: RECs? PTC? Offsets?
- Operating Entity?
- Ownership Options: Construction…onward

Electrical Power Savings

- "Smaller Scale" – Facility Specific Project
- "Revenue" Represented by Electrical Savings: "Net Metering"
- Typically Requires Cooperation/Contract With Existing Utility/Electrical Provider
- Potential for Highest Value Project "Revenue" – Offsetting retail priced power
- "Over-the-fence" Contract

Thermal Energy Revenue/Savings

Thermal Purchase Agreement

- Product Sold: Steam, Hot Water, Both
- Pricing: Avoided Costs, Fixed Rate, Indexed
- Point of Ownership
- Recovery/Make-up
- Distribution Infrastructure Responsibility
- System Capacity Conditions and Performance
- Turn-key thermal or pre-heating water
- Back-up Systems?

Thermal Energy Savings

- "Smaller Scale" – Facility Specific Project
- "Revenue" Represented by Thermal Savings
- Commonly Requires Cooperation with Existing Fuel Provider (e.g. NG supplier)
- Potential for Highest Value Project "Revenue" – Offsetting retail priced fuel
- "Over-the-fence" Contract – Requires Transparency Between Parties

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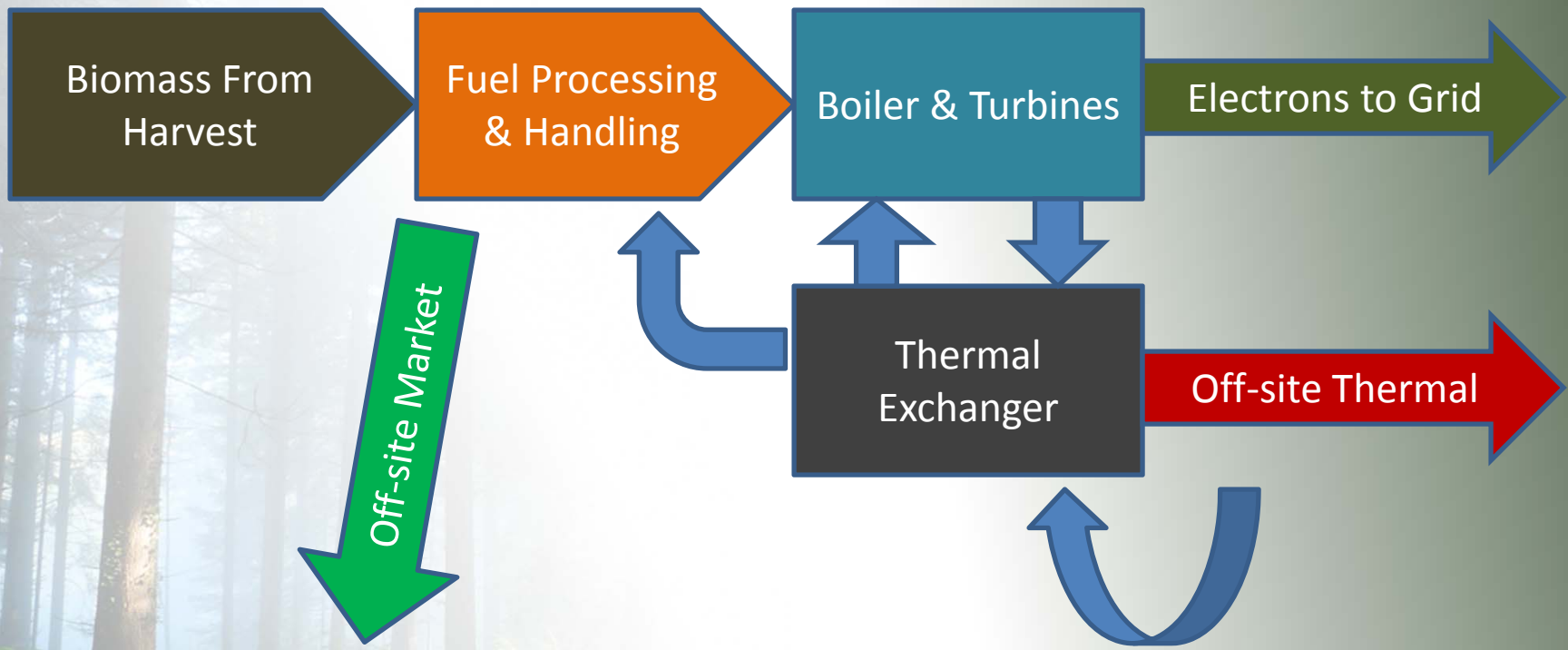
Perceived Riskiness of Venture: Funding



Perceived Riskiness of Venture

- Technology Risk
- Operational Risk
- Supply Risk
- Market Risk
- Price and Competitive Risk
- Contractual Risk

Perceived Riskiness of Venture

- Ownership Structure and Strength of Parties
- Policy Risk
- Regulatory Risk
- Funding and Financial Risk
- Appropriate Business Model

Business Risk to Convertor

Internal Risks (Bio Power Example)

- De-rating boilers – due to variable quality of fuels
- Employee health risks: dust, molds and other
- Price risks: Lack of bondability by suppliers & transaction instruments (e.g. future contracts)
- Storage/handling modifications, fire/inventory degredation & related investments
- Potential increased O&M costs
- Dispatchable price of kWh
- Regulatory consistency
- Downtime – meeting steam loads

Business Risk to Convertor

External Risks

- Lack of Infrastructure to guarantee delivery
- Lack of Infrastructure to support long-term production risks
- Lack of Risk Management Tools to assure supply
- Increased cost of capital due to supply concerns
- Lack of quality control standards for the biomass industry
- Potential high degree of competition for biomass
- Environmental Services not increasing in value
- Regulatory uncertainty & Environmental Oversight

Contractual Issues of the Biomass Supply-Value Proposition

- Business Model & Value Proposition For Supply Chain
- Address Metrics: Both up and Down the Chain
- Address Expectations and Standards
- Address Opportunity Costs
- Staying power, long term commitment of off-taker
- Contingency for catastrophic change in fuel supply and/or demand

Contracting: Risk Management

- Supplier Price Risk
  1. Price-Point vs. Indexing to Fossil Fuels
  2. Environmental Benefits Sharing
  3. Long-term "partnering" vs. Bid-n-Deliver
  4. Inventory cost risk
  5. Standardized Value (Quality)

- Biomass Crop Price Insurance

Contractual Transparency

- Key To Customer/Supplier Relationship
- Transparent Pricing Provides "Signal" to Supply-Chain Regarding Profitability Metrics
- Allows "Actors" to Pursue Pathways to Increase Profits
- Provides Enhanced Measurement and Documentation of Sustainability Issues
- Improves Biomass Quality & Project Risk Management

Keys to Biomass CHP Project

Project Designed to Meet Existing Demand

Transparent & Competitive Pricing: Valuing the Fuel/Energy

Integration of Environmental Services into Pricing Models

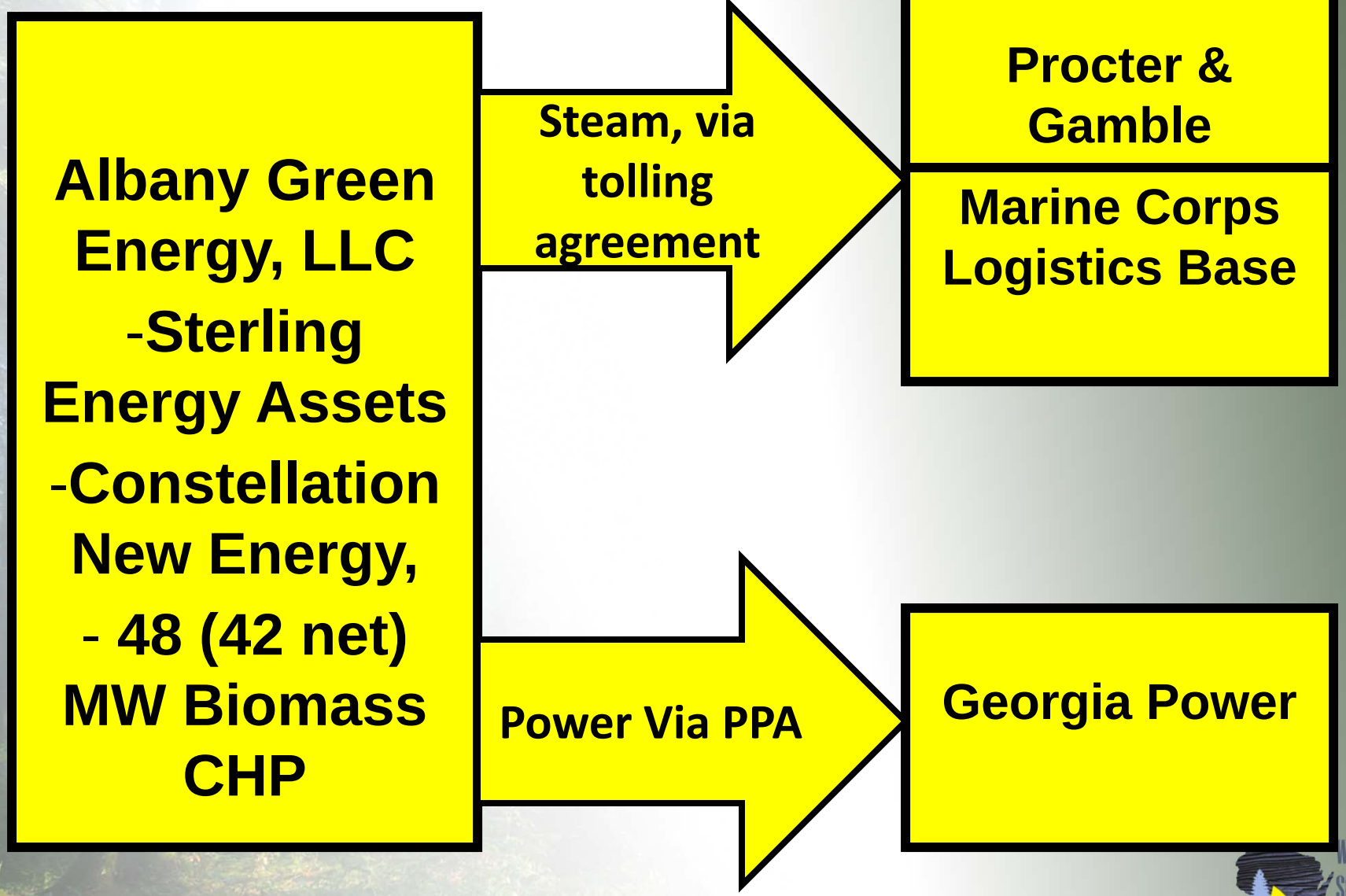
Appropriate Technology & Ownership

Meet Funding Requirements

Case Study: Albany, Georgia Combined Heat & Power

- Procter & Gamble with Ambitious Internal Sustainability Target: 30% renewable energy (power and thermal) by 2020
- Existing biomass (pulp-wood and fuel) supply system
- Internal ROI hurdle – applies to RE investment
- Military base within 10 miles with appetite for "Y" MW
- Georgia Power operates as Southern Company subsidiary
- Georgia is regulated state with No Renewable Portfolio Standard

Albany Georgia CHP Project



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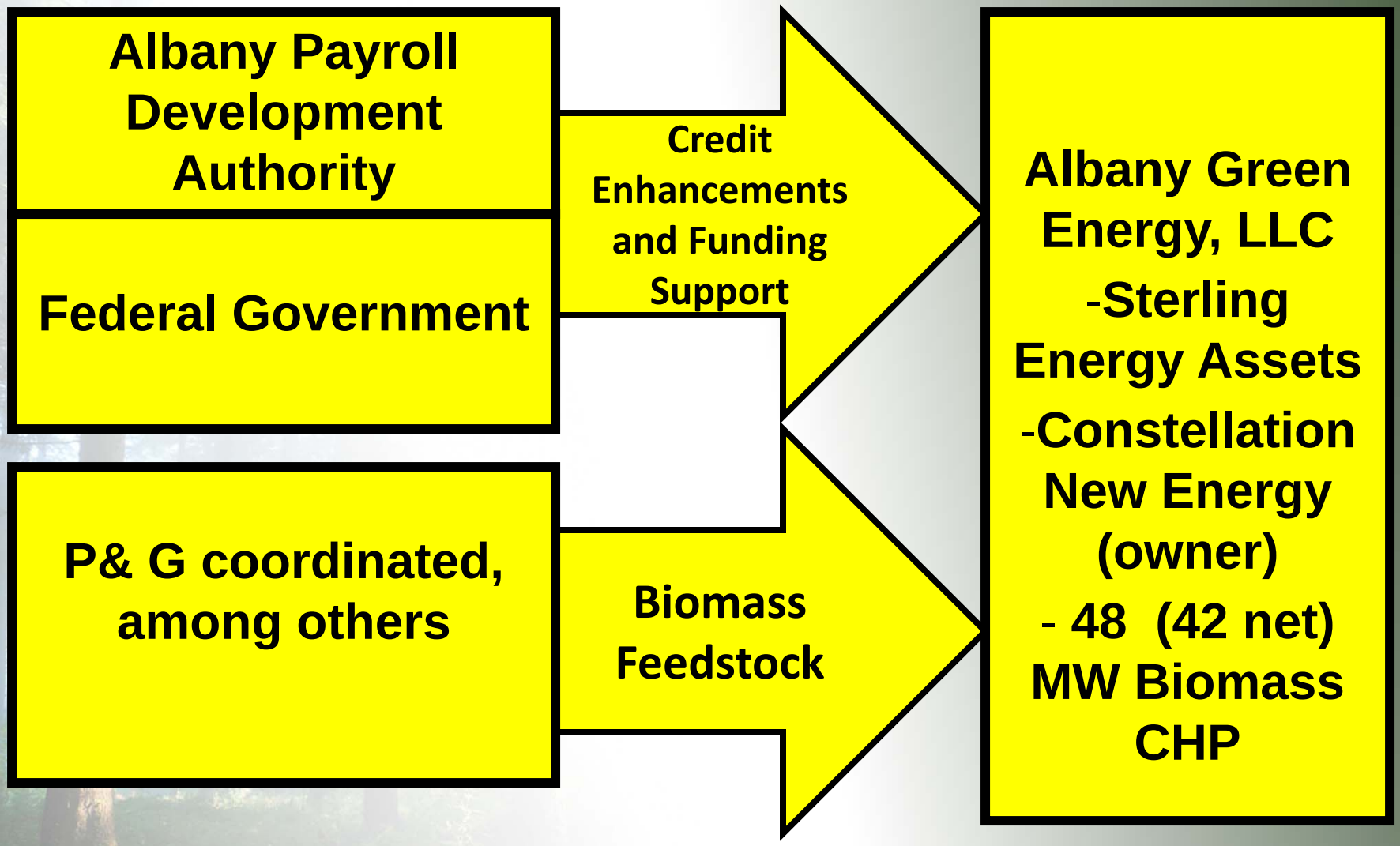
Albany Georgia CHP Project



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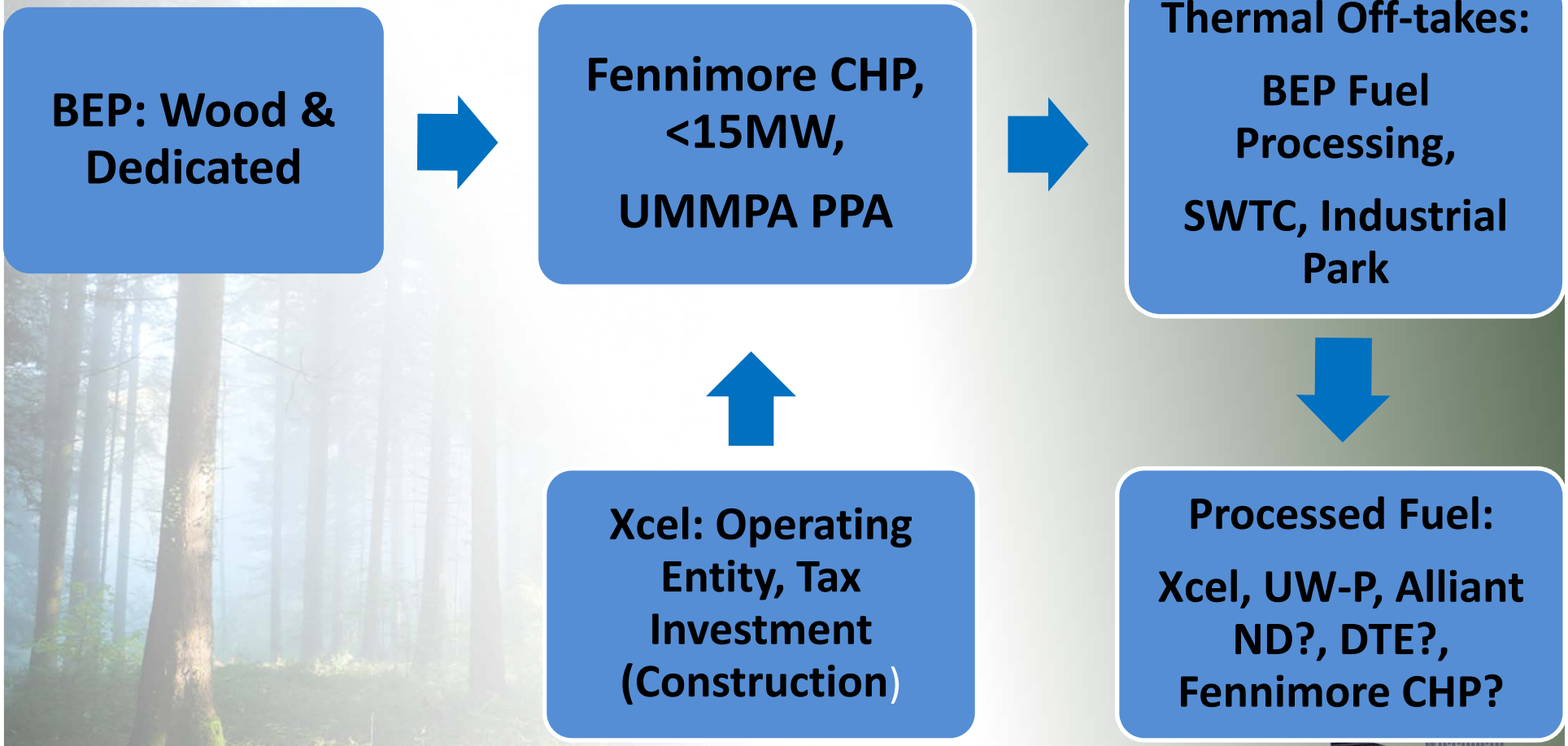
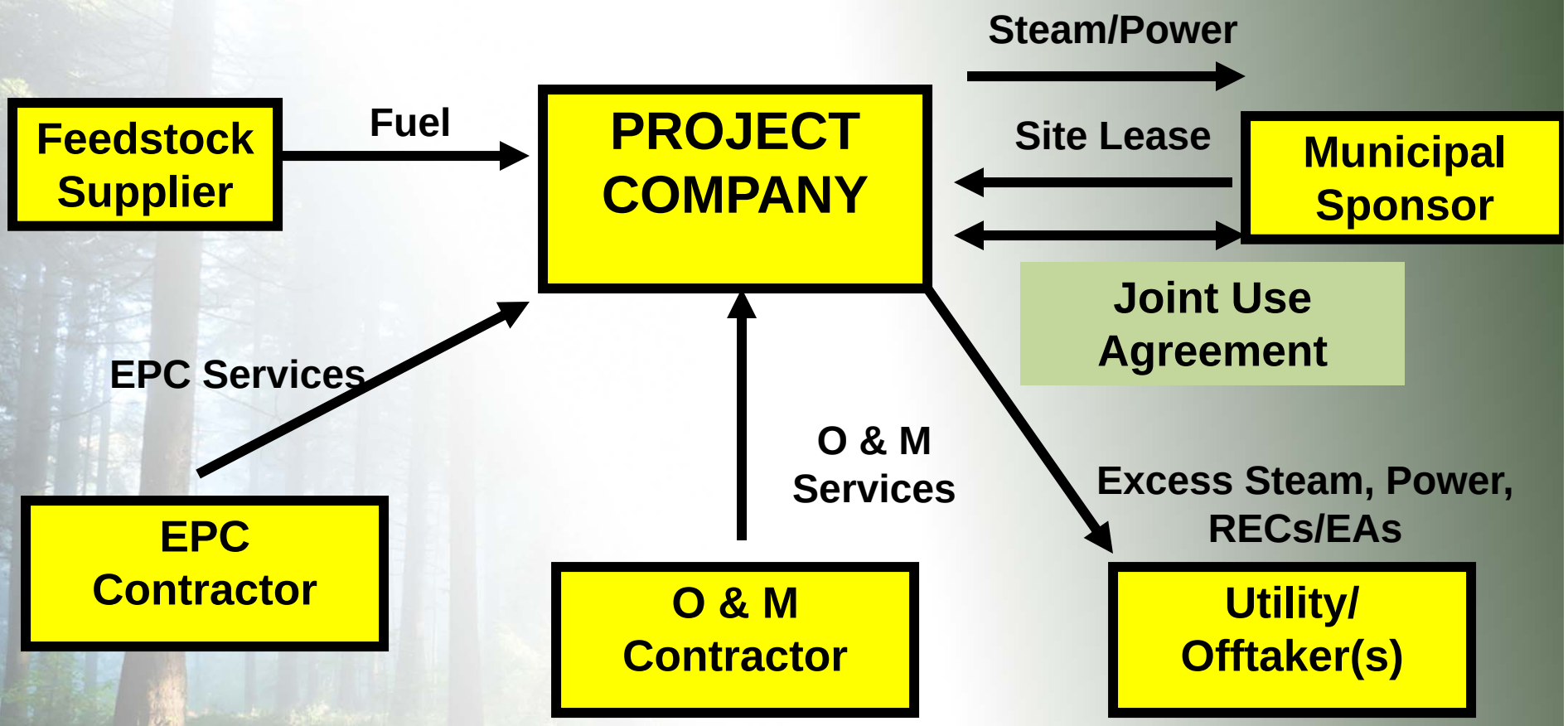
Albany Green Energy, LLC

- PPA & Tolling Agreements
  - 20 year tenor, production and capacity payment
  - Non-premium baseline (sub $60/Mwh)
  - Escalator Weighted indexed pricing of power, from initial baseline (PPI, Employment Cost Index, diesel and timber market)
  - Steam sold to P&G who resells to MCLB
- New Market Tax Credits to Payroll Authority

Case Study: Fennimore CHP & Processing



Basic Project Structure:
Special Purpose Entity/Project Finance



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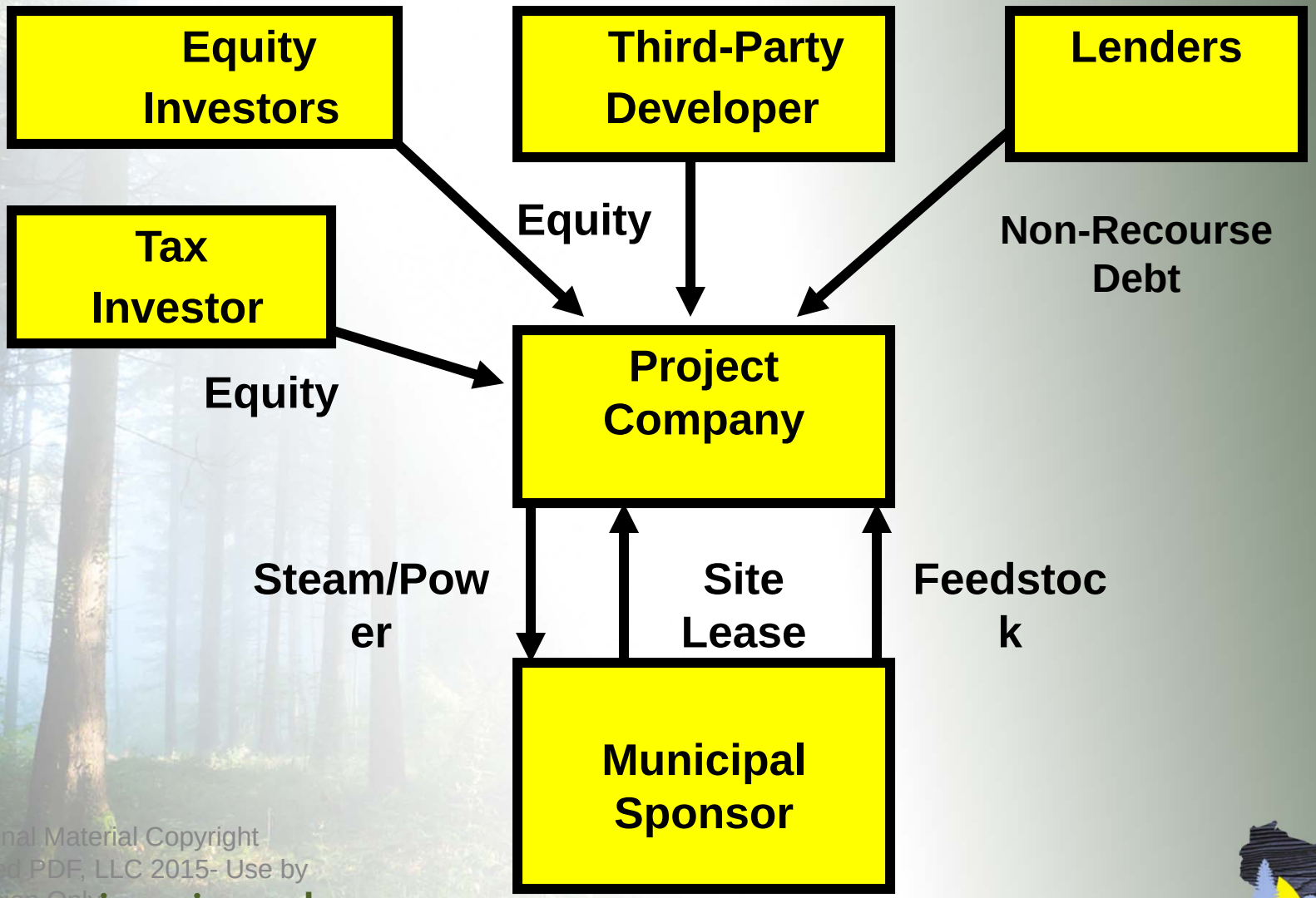
External Developer Project



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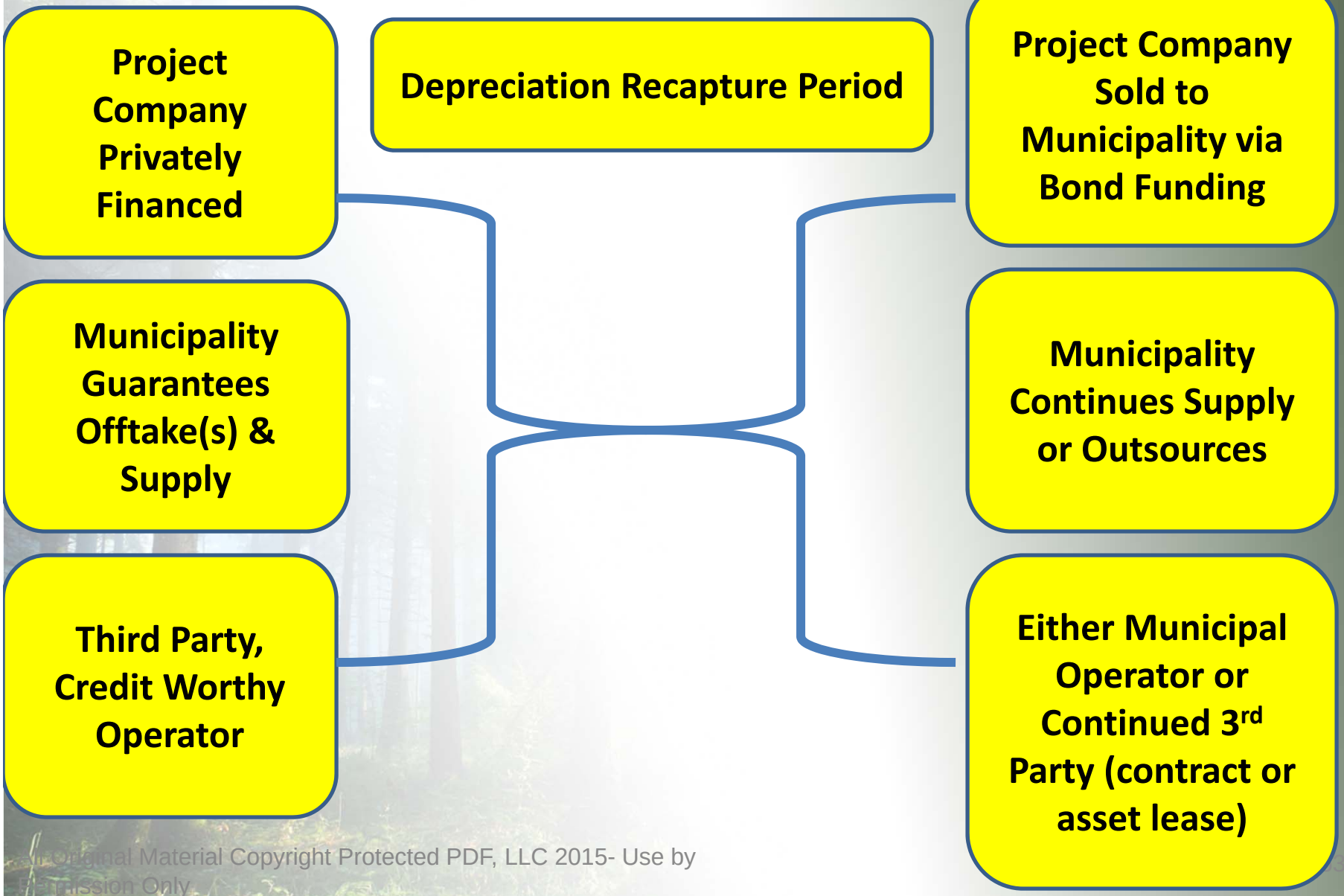
Ex: Public/Private Flip Model: Private Funding



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