



Biomass Gasification

Ready to Meet Needed
Bioenergy Market Growth?

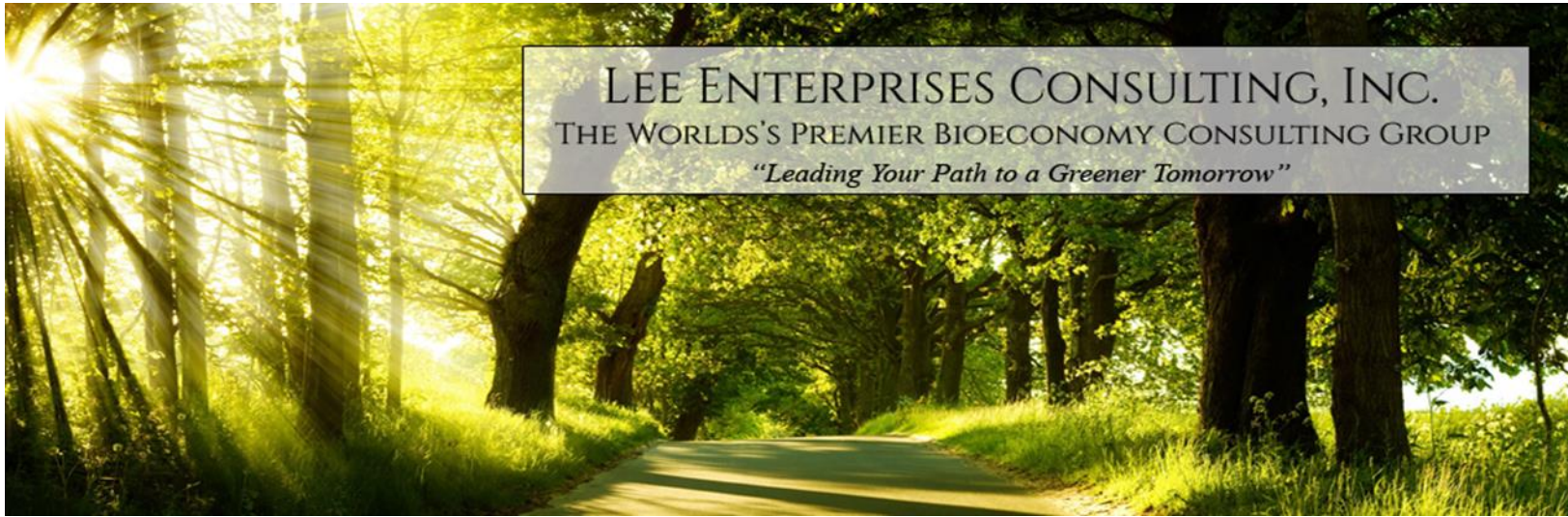
Mark Robertson, PE



Accredited Member



LEE ENTERPRISES
CONSULTING, INC.



LEE ENTERPRISES CONSULTING, INC.
THE WORLD'S PREMIER BIOECONOMY CONSULTING GROUP
"Leading Your Path to a Greener Tomorrow"

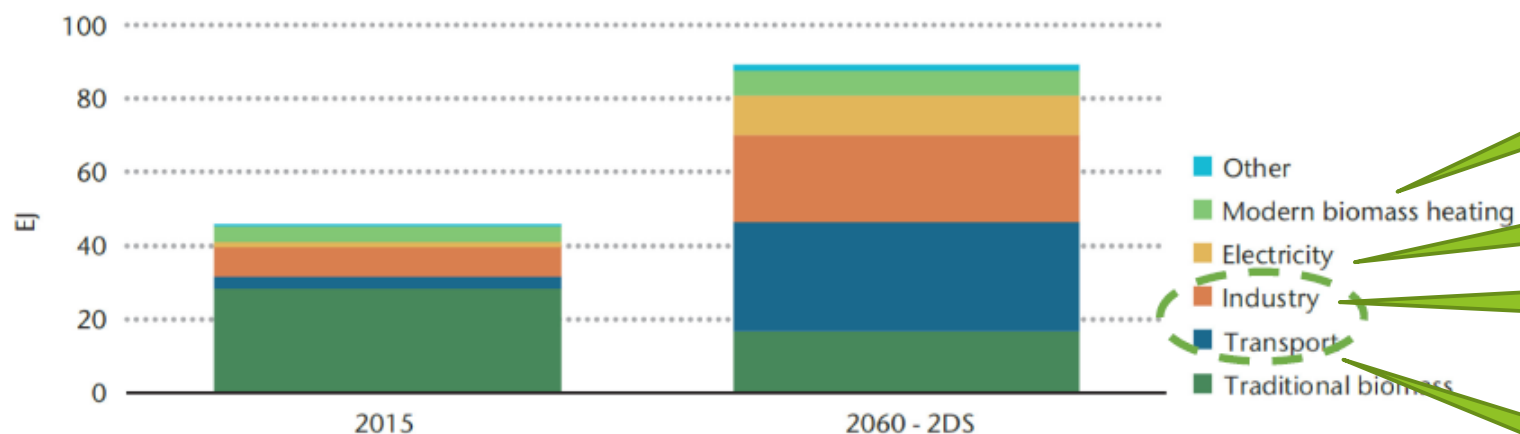
Expertise: World's largest bioeconomy consulting group - over 100 subject matter experts (SME's)- all areas of the bioeconomy.

Approach: Project interdisciplinary teams to meet exact needs of specific projects.

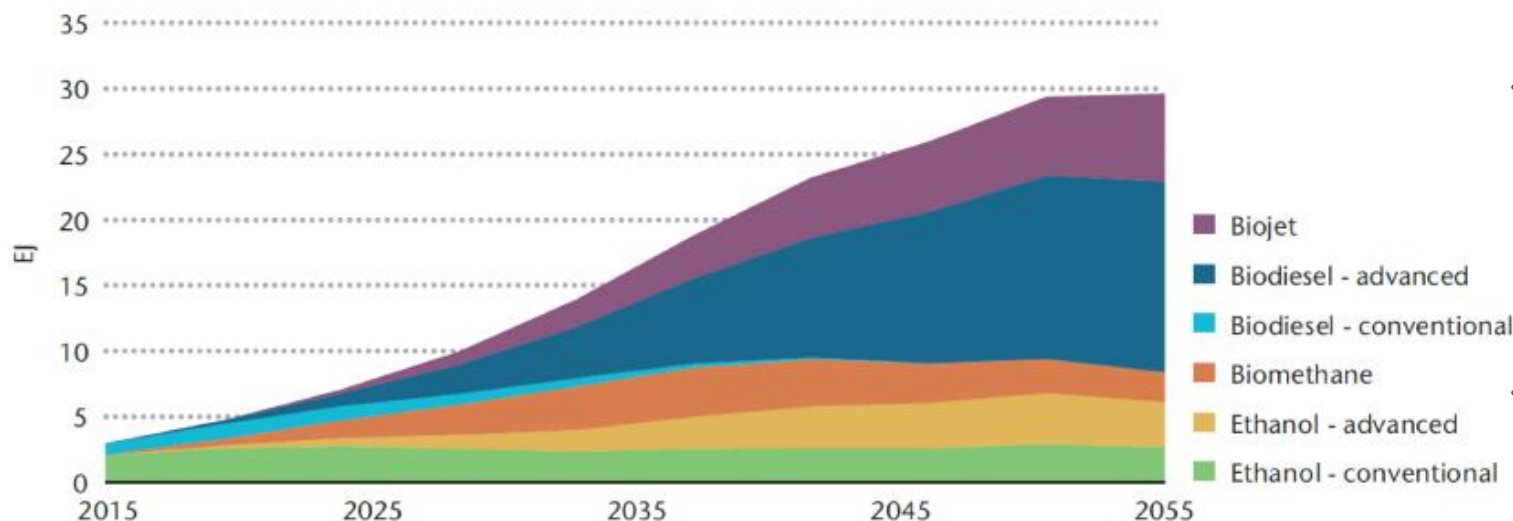
POC: Handle projects with one agreement and single point of contact.

Cost Advantage: Single POC = lower administrative costs = lower project cost.

Global Potential for Biomass Gasification



Bioenergy Use for Final Energy in the IEA Bioenergy Roadmap¹.



Biofuels for Transport in the IEA Bioenergy Roadmap¹.

District heating,
CHP, RNG

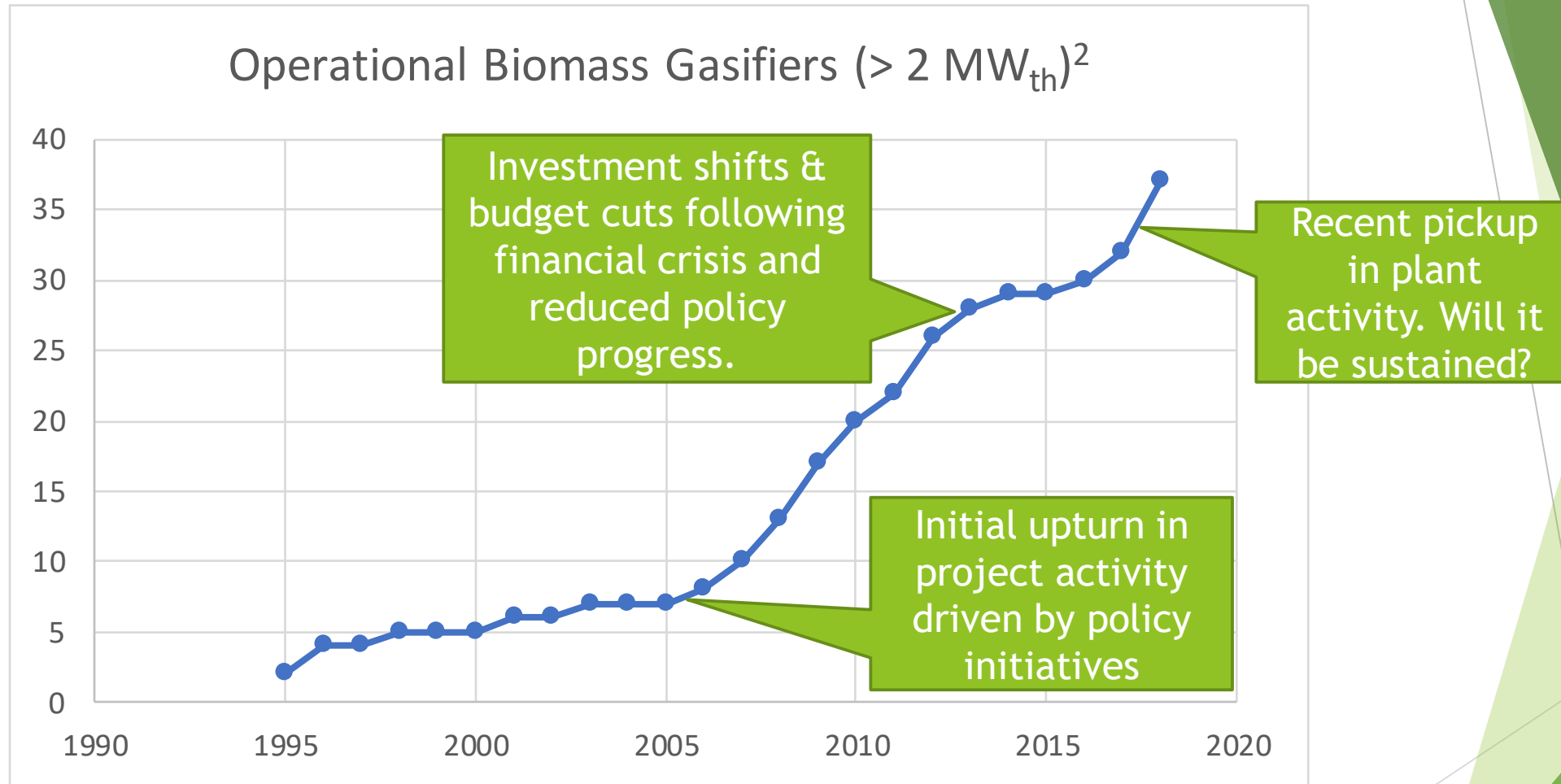
Biomass Power, CHP,
BIGCC, WtE,
repowering, fuel cells.

Syngas refueling,
hydrogen and
chemicals

Liquid biofuels,
RNG for transport

Potential biofuels
generated via
Gasification. Only a
10% share of a 20 EJ
biofuel market (in
2050) is approx. 1700
x 50 MW_{th} Gasifiers!!

Current Biomass Gasification Status



Biomass Gasification Technologies

- Informal survey results: 250+ Biomass Gasifier Technology Companies

- General Categories and Features:

- Dual Fluidized Bed
- Fluidized Bed
- Entrained Flow
- Moving Bed: Updraft, Crossdraft and Downdraft
- Cyclonic
- Plasma
- Indirectly Heated
- Electric Arc
- Molten metal
- Induction Heated
- Stoker/Fixed Grate
- Rotary Drum
- Air/Enriched Air/Oxygen/Steam Blown
- Slagging/non-slagging
- Bubbling/Turbulent/Fast/Circulating/Spouted Fluid Bed
- Low Pressure / High Pressure
- Low Temperature/ High Temperature

Feed Pretreatment / Gas Cleanup Requirements

Biomass Gasification Technology Selection

Technology Screening:

- Project Scale
- Project Location
- Feedstock(s)
- End Product(s)
- Technology Readiness Level (TRL)
- Commercial

Number of Potential Technologies reduced from 250+ to a few, based on only a few simple criteria

Technology Evaluation:

- Technoeconomic Analysis (TEA)
- Environmental incl. LCA and waste management
- Reliability/Availability
- Hazard & Risk Analysis
- Technical & Commercial Due Diligence
- Pilot/Demo testing

Technology Selection

Gasifier Technology Screening (Examples)

Large Scale (5000 BPSD) Woody Biomass to Liquids (BtL) Plant:



- High pressure gasifier
- High specific O₂ consumption
- Entrained flow or high pressure oxygen blown fluidized bed gasifier
- Extensive biomass pretreatment (e.g. torrefaction, pyrolysis, pelletization, etc)
- Centralized BtL plant and distributed biomass collection & pretreatment

Medium Scale (5 MMSCFD) Woody Biomass to Renewable Natural Gas (RNG) Plant:



- Low to Medium pressure gasifier
- Nil to medium specific O₂ consumption
- Dual Fluidized Bed or low/medium pressure steam/oxygen blown fluidized bed gasifier
- Minimal biomass pretreatment (typically drying & size reduction)
- Co-located pretreatment & gasifier plant

Common Gasification Technical Challenges

- Biomass feedstock non-homogeneity
- Biomass Tars
- Fouling & alkali deposition
- Ash agglomeration and slagging
- Solid fuel feeding
- Syngas impurities and downstream impacts
- Air, water & solid emissions and byproducts
- Refractory and metal erosion & chemical attack
- Transient syngas quality and flow
- Reliability & availability
- High specific capital and operating costs and need for scalable designs, modularization, automation and design standardization.
- Efficiency losses at small/medium scale.
- High parasitic power demand and water usage.

Other Biomass Gasification & Bioenergy Project Challenges

- Feedstock(s) sustainable supply volumes, long term contracts, data availability, accessibility, competition, quality, seasonality, collection, transportation and delivered costs.
- Low forecast natural gas and oil prices.
- Competition from other renewables including solar, wind and biogas.
- Product market access barriers and uncertainty.
- Project risk due to lack of commercial deployment and non-standardized first-of-a-kind(FOAK) plant designs.
- Regulatory/policy uncertainty, risks and barriers.
- Project financing barriers and costs
- Burdensome permitting and project approvals for small and medium scale projects.

Biomass Gasification Opportunities

- Large scale of the potential (future) market, especially for transportation fuels (jet/diesel/RNG), renewable chemicals and industrial applications.
- Potential to utilize plentiful low cost feedstocks such as MSW and other industrial, forestry and agricultural wastes and residues.
- Increasing number of semi-commercial (demonstration) and commercial plants and subsequent technology licensing options.
- Revenue generation from byproduct sales (e.g. biochar and waste heat).
- Geographic “hot spots” with favorable feedstock supply, markets and policies.
- Remains to be seen where bioenergy regulatory supports, economic supports and carbon pricing trend. In specific geographies trends seem hopeful (e.g. Canadian Federal & Provincial carbon pricing).

Biomass Gasification Outlook

- Current period of increased project activity. Will it be sustained?
- Multiple near-commercial or commercial biomass gasification technologies available.
- Rigorous technology and project selection required. Use technology screening to narrow the technology field initially.
- Need to understand common technical problems, manage risks appropriately and not remake the mistakes of the past.
- Although there are significant challenges, opportunities do exist in specific geographic locations and product markets.
- Very large market opportunity IF technologies can get over FOAK, technical & financial hurdles.



Mark Robertson
Small Planet Engineering
mark@smallplanetengineeringco.com
1+ 720 216-7573

Lee Enterprises Consulting
www.lee-enterprises.com
1+ 501 833-8511