the Energy to Lead

GTI Biorenewables
Vision, Challenges, Programs, and Status

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- Not-for-profit research, with 65+ year history
- Facilities
  - 18 acre campus near Chicago
  - 200,000 ft^2, 28 specialized labs
- $60 million in revenue
- Staff of 250
- A growing business
- 1000 patents; 500 products
- Commercial partners take our technologies to market

Offices & Labs

Flex-Fuel Test Facility

Energy & Environmental Technology Center

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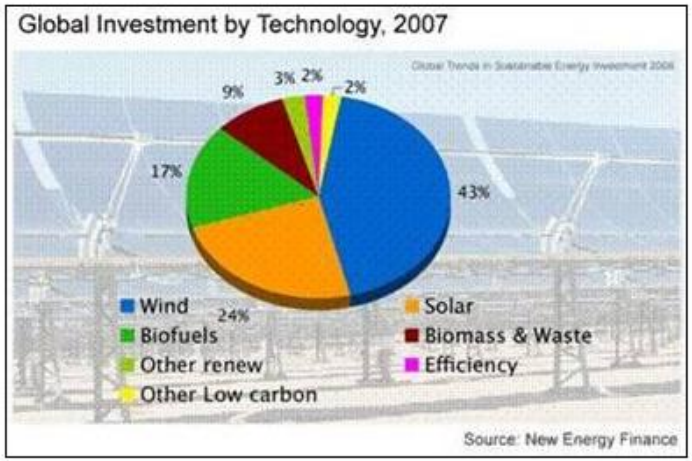
Reducing carbon emissions to the environment

Renewable Energy - Premises

- Fastest growing area in energy R&D
  - Global R&D spending up 20% in 2006
  - Corporate $9.1B; * R Y$¶7Ø/B
- Increased domestic (and continuing international) concerns about energy independence, sustainability, global warming, and need to hedge fossil prices



Biofuels required to meet mandated RPS, renewable fuel targets in many states and countries, with increasing interest from suppliers

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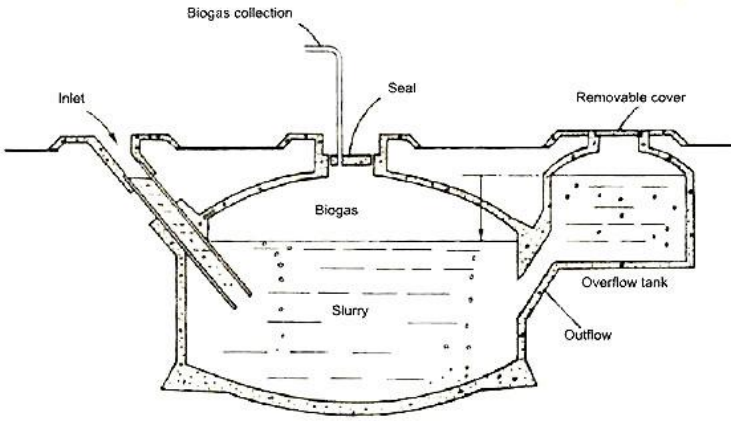
Biogas- 1 D W X U H ¶ V 2 O G H V W

- Manure or waste to methane via anaerobic digestion ideal for low-solids streams
- First recorded us in Assyria ca 10 BC to heat bath water
- Millions of small systems in China and India
- US and Europe primarily using biogas for power generation; missed opportunity for higher-value uses



Biogas Challenges

- Push
  - EU mandates to redirect organic waste from landfill, ban sludge and manure spreading, and required access to gas and electric grid for renewable energy
  - US mandated biogas recovery from landfills and wastewater treatment plants
  - US emerging regulations on manure
- Pull
  - Renewable Portfolio Standards and favorable incentives (currently only when used for electricity)
  - Project developers and gas industry interested in pipeline quality gas
    - Gas contract higher value than power contract, albeit with higher capital cost
    - Creates transportable low- F D U E R Q I X H O V R H O H F W U L F X W L O L W L H V F D Q U H S R power plants as green facilities, meet RPS requirements, and access renewable credits
    - CO_2 credits from GHG abatement add 10% to product value

- Addressing the higher-value pipeline gas market requires a new approach to gas processing and harmonized gas quality specifications
- Selling gas into the gas grid requires robust, fully-qualified, packaged solution encompassing compression, clean-up, and instrumented custody transfer

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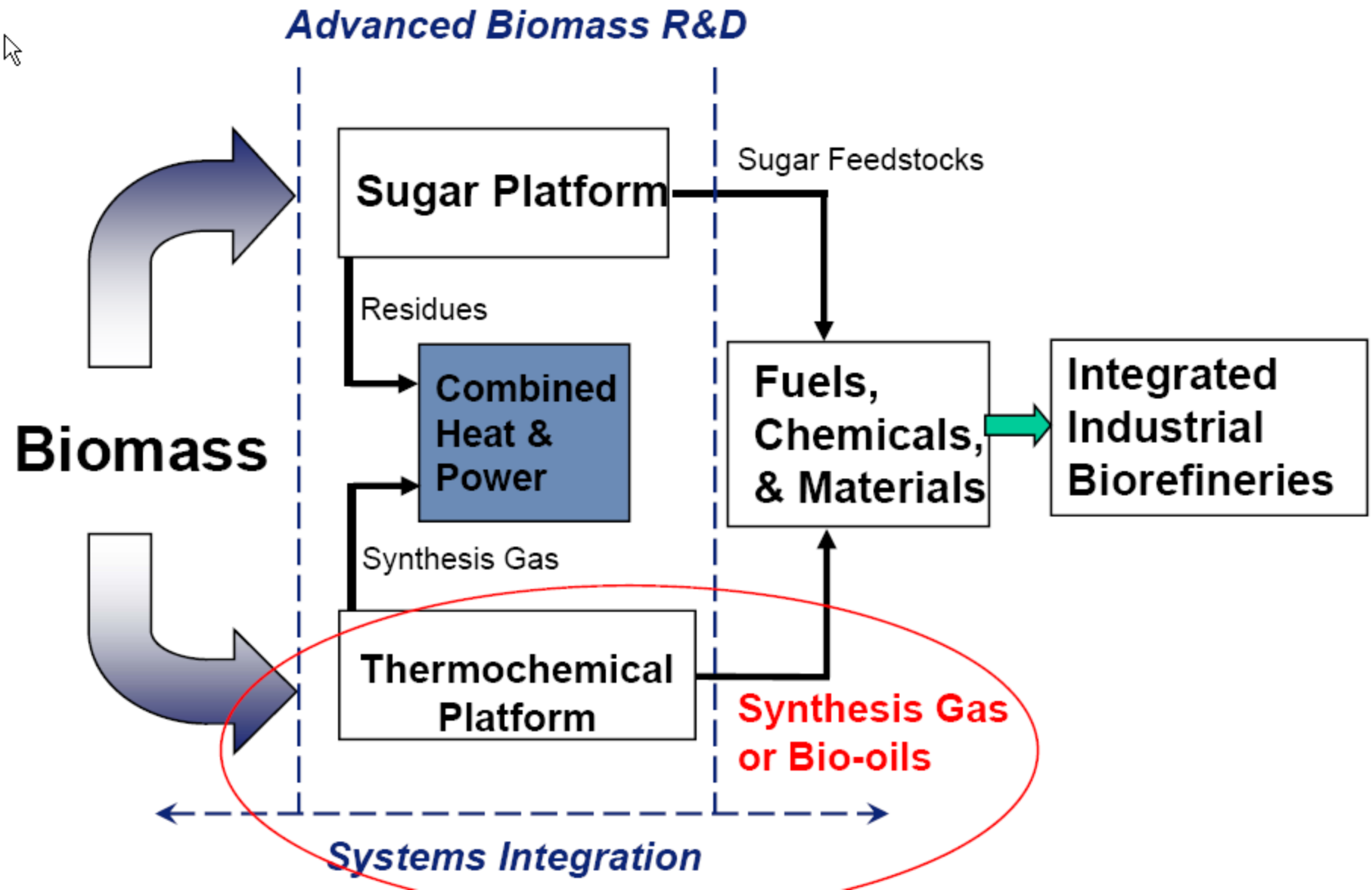
Research Focus on the Biorefiner



Product Property Comparison

	Fast Pyrolysis Oil	IH^2 product
% Oxygen	50	<1.0%
% Water	20	<0.1%
TAN	200	<2
Stability	Poor	Good
Heating Value Btu/lb	6560	18000
% C_4- 430° F	Non-distillable	92
% 430 - 650° F	Non-distillable	8
% 650° F +	Non-distillable	<1
Compatibility with crude oil or refinery products	No	Excellent
Relative transportation cost	1.0	0.3

IH^2 Advantages

‡ Infrastructure-compatible products

‡ Avoids ^ • š µ ((made in pyrolysis t PNA, free radicals

‡ Higher energy density products

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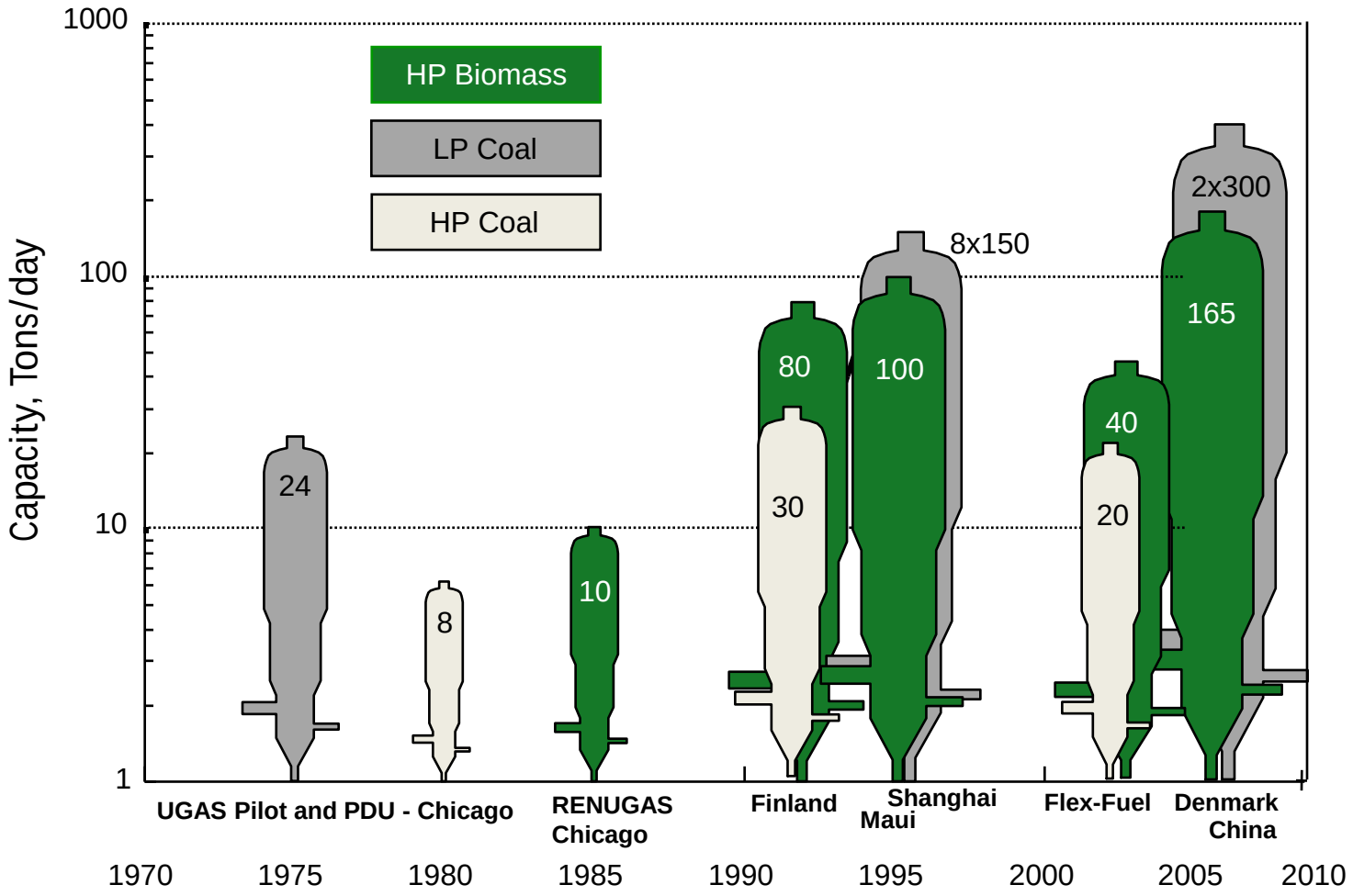
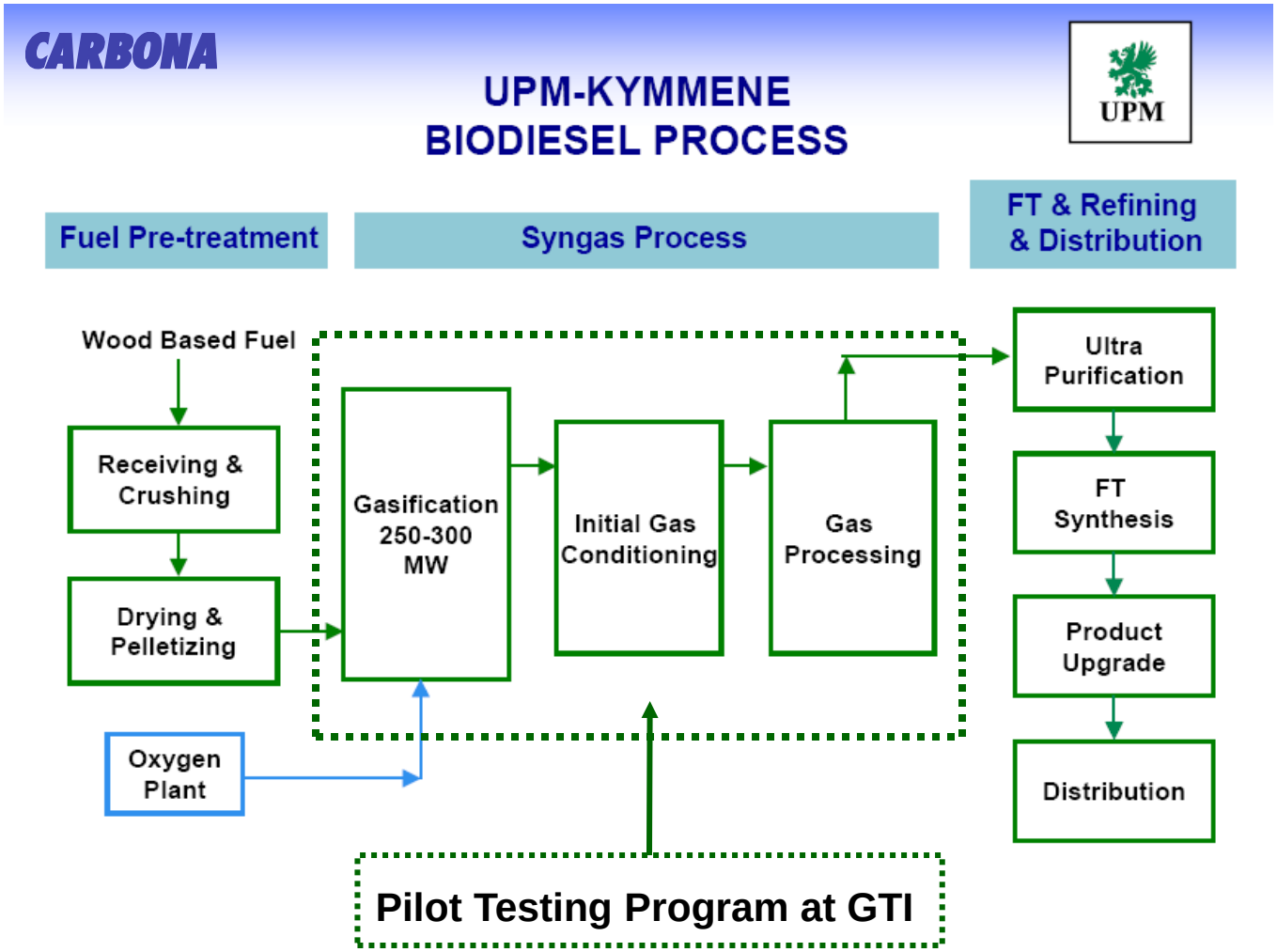
Scale-up History of GTI Gasification Technology



2nd Generation Biofuel Production from Wood by Fluidized Bed Gasification and F-T



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Summary

- Many renewable bio-energy options; producing fungible products that integrate with existing energy infrastructure is key
- Anaerobic digestion of low-solids wastes is energetically favorable; biogas applications active area of RD&D
- Biomass pre-conditioning likely required for large-scale aggregation for renewable fuels
- Gasification of high-solids biomass is energetically favorable route to syngas, fuels, and CHP
- GTI is developing integrated hydropyrolysis route to address low-temperature liquid fuels production
- tcbiomass is a great opportunity to learn more

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