Virent is Replacing Crude Oil.

Biomass 2014

July 30, 2014

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CTO/Founder

VIRENT

Virent at a Glance

The global leader in catalytic biorefinery research, development, and commercialization

Employees

75 Employees

Partners & Investors

Cargill

The Coca-Cola Company

HONDA
The Power of Dreams

Technology

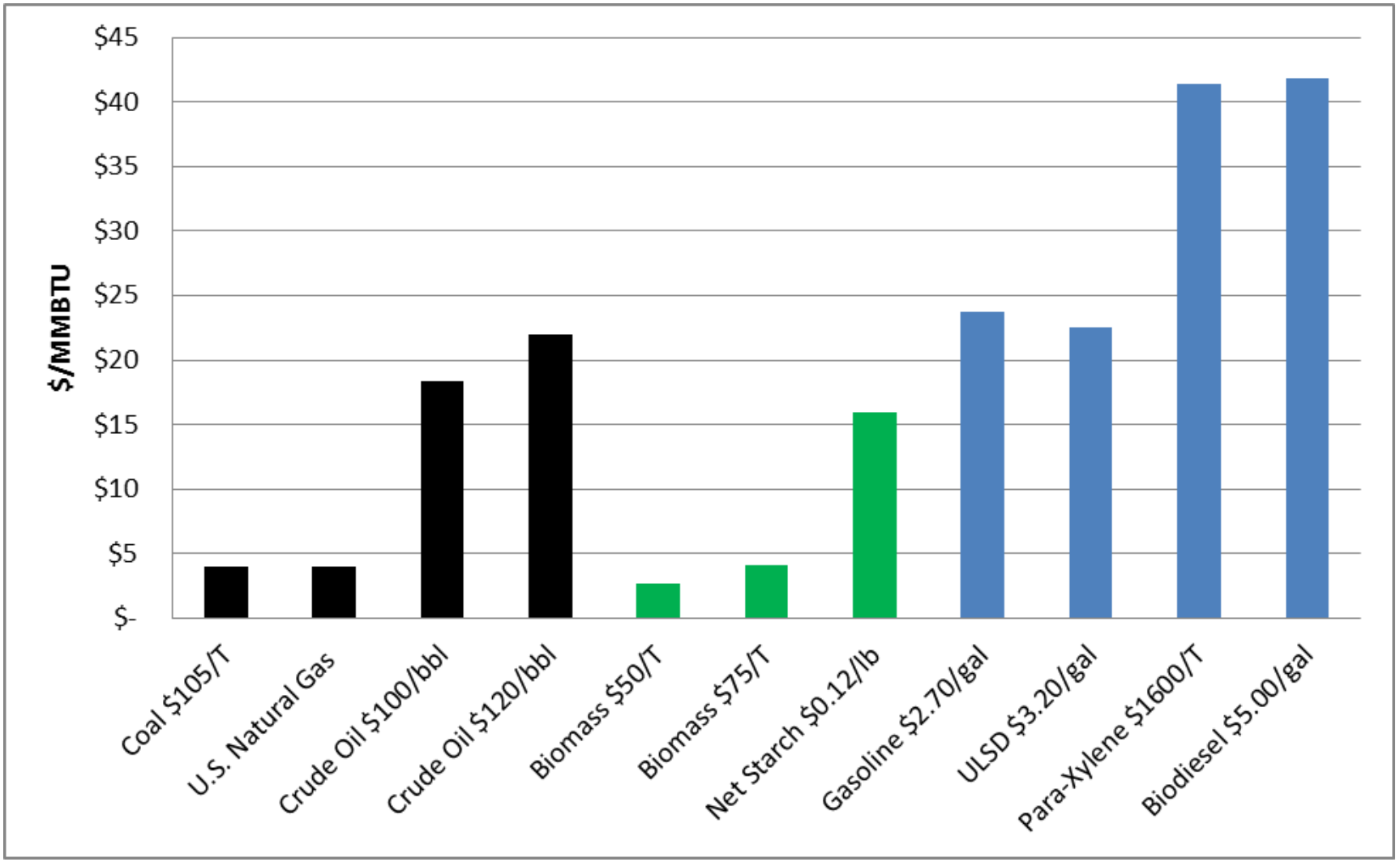
BIOFORMING PLATFORM

Converting plant-based feedstocks to fuels and chemicals

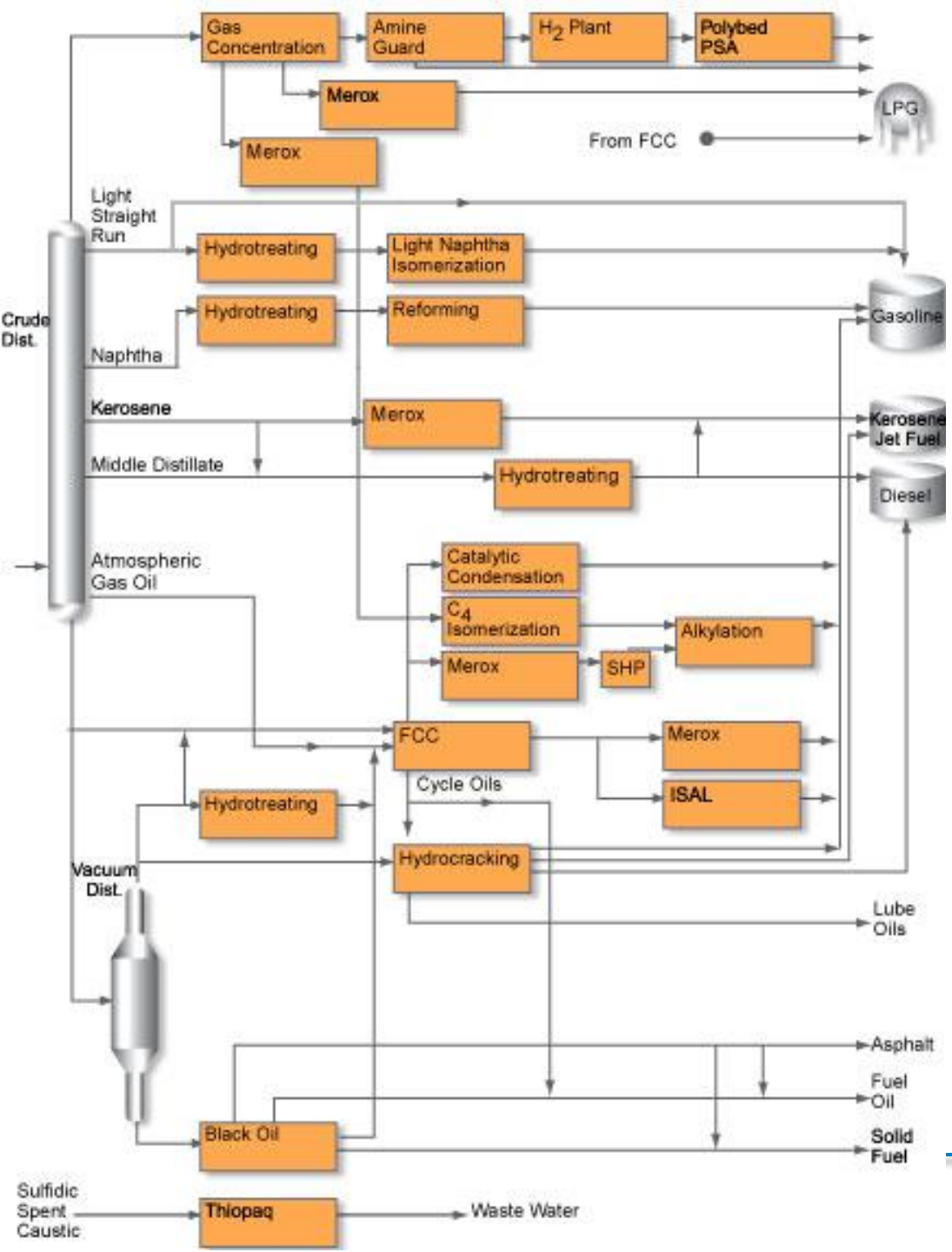
Infrastructure

25x Development Pilot Plants
2x Process Plants

Energy Cost Comparison



Heating Value Data Sources: GREET and Aspen Plus

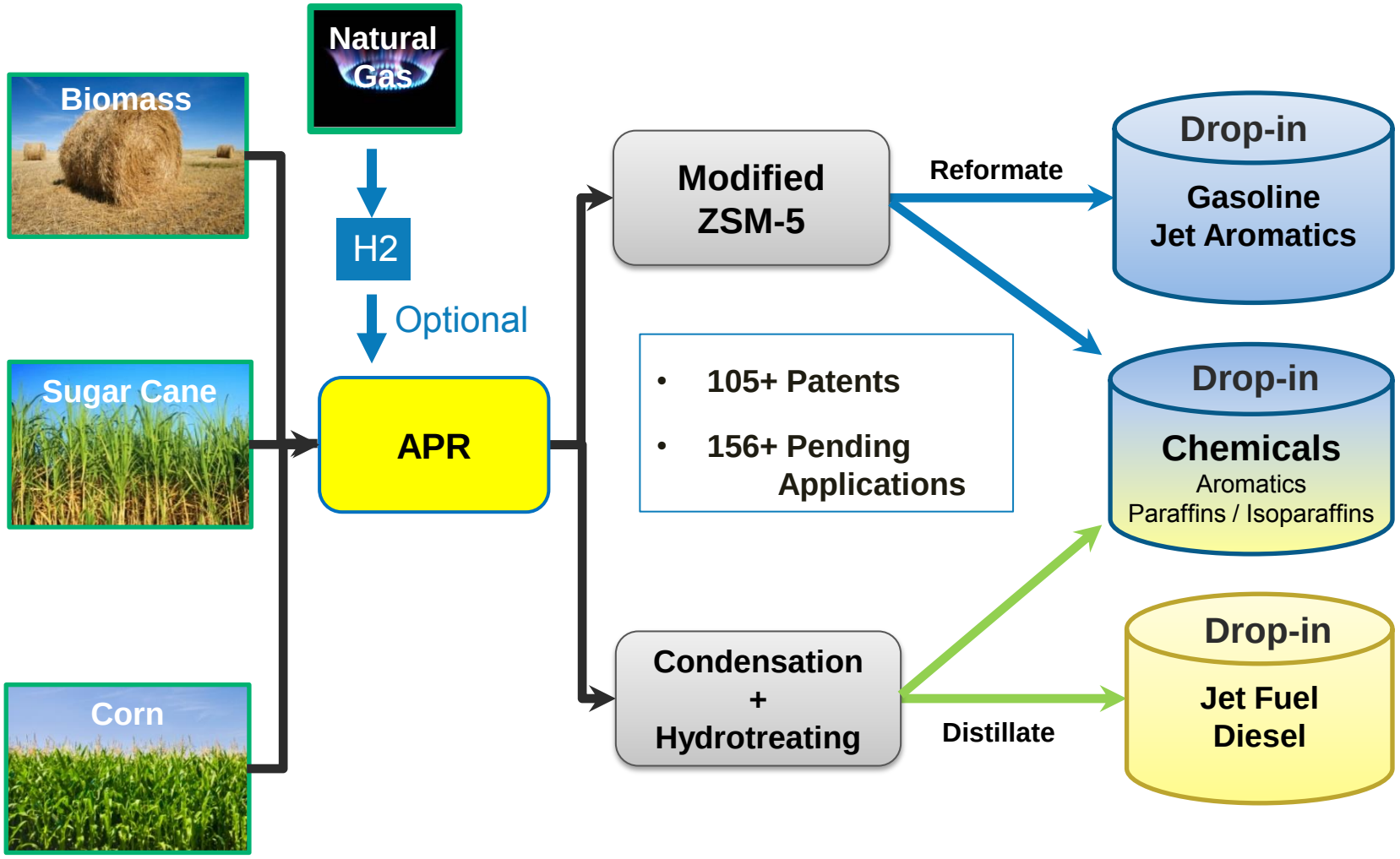


Crude Oil to Liquid Fuels

Reference
http://www.uop.com/refining/1010.html

Virent's BioForming® Concept

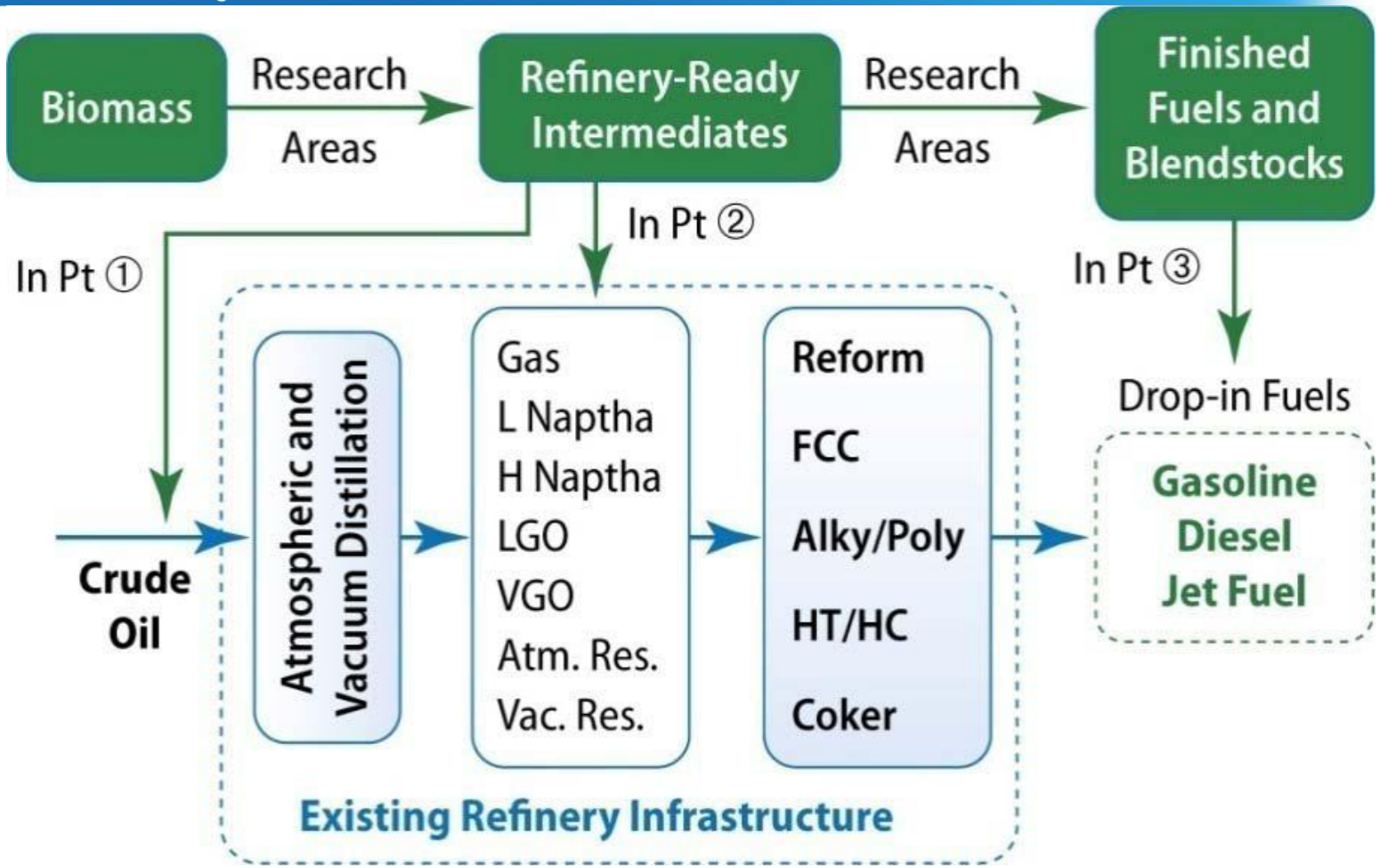
Process flexibility enables the production of gasoline, aromatic chemicals, jet fuel and diesel from a variety of raw materials.



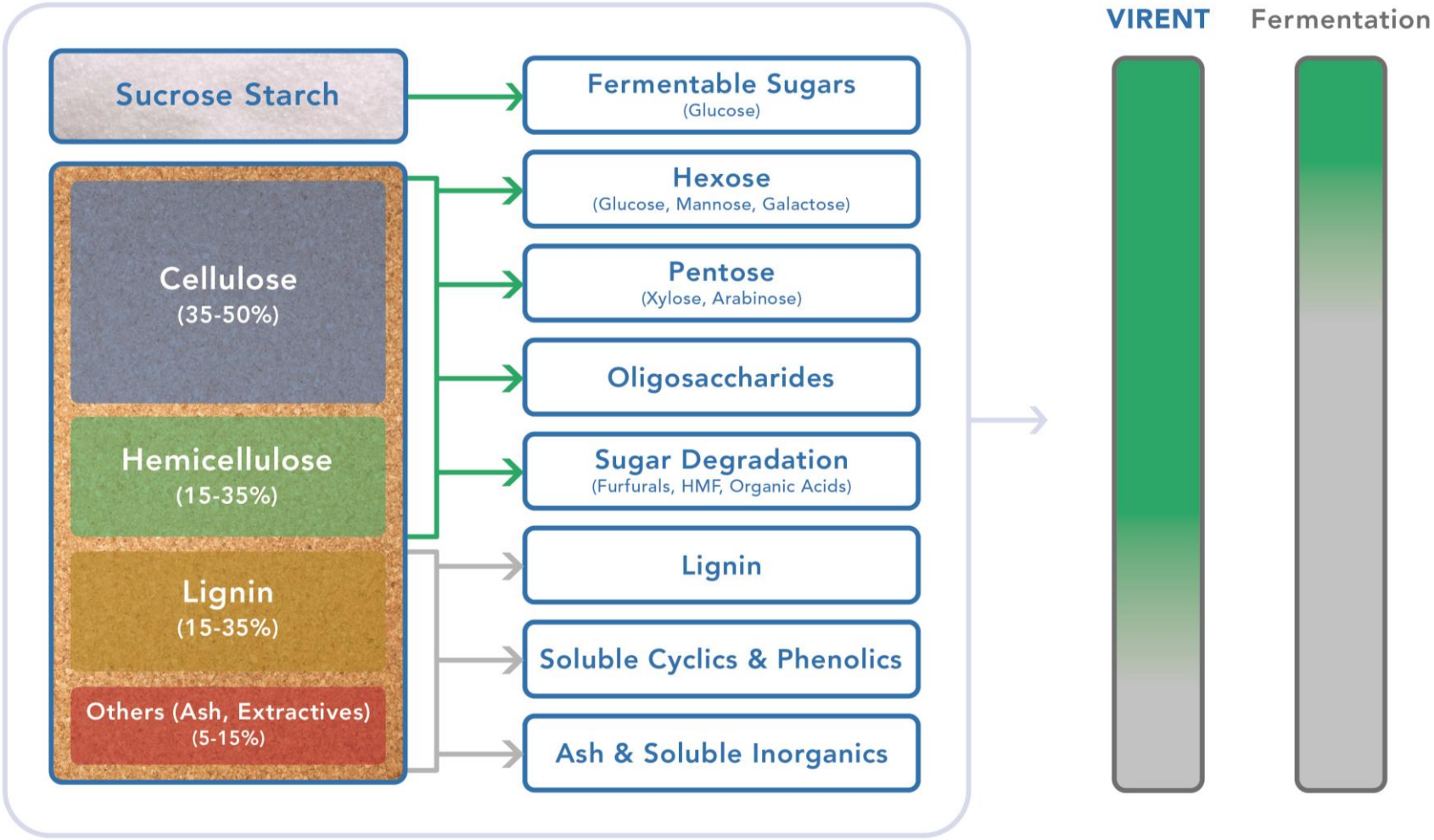
NABC
National Advanced Biofuels Consortium

Biofuels for Advancing America

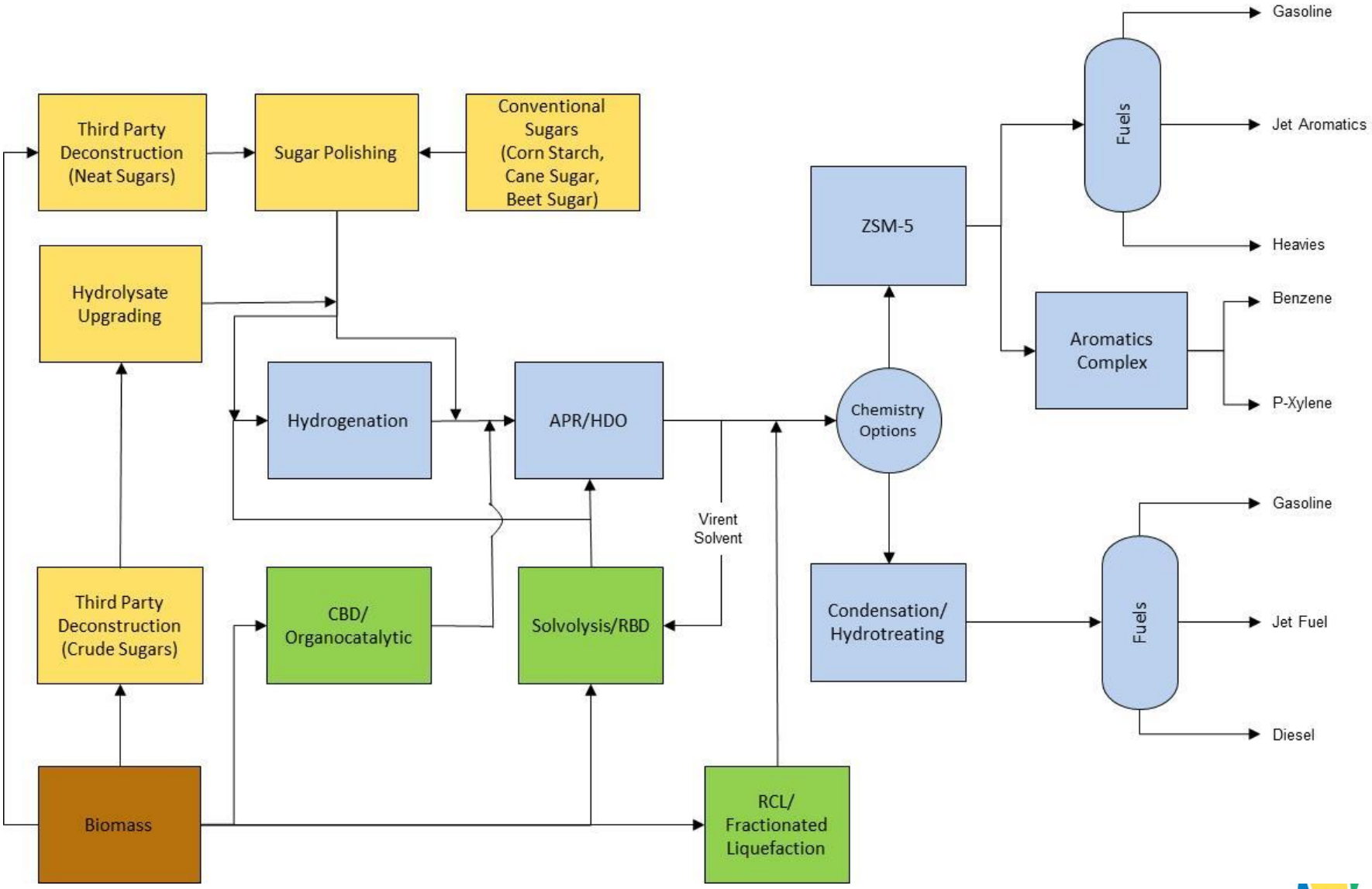
Infrastructure Compatibility Strategy



BioForming® Feedstock Advantage



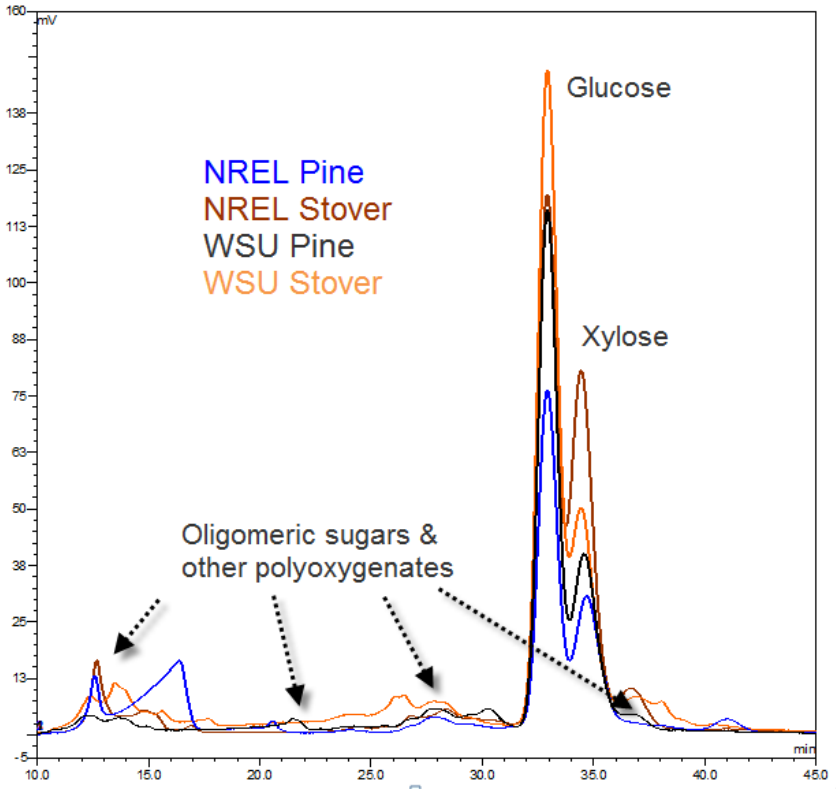
Virent's Carbohydrate Platform

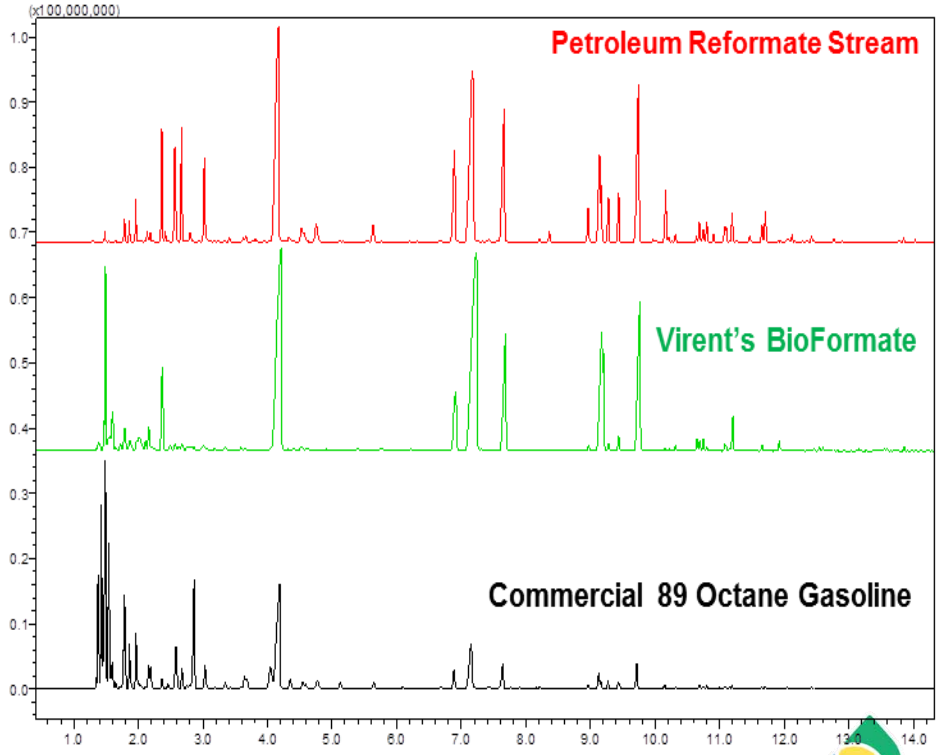


Biomass to BioFormate

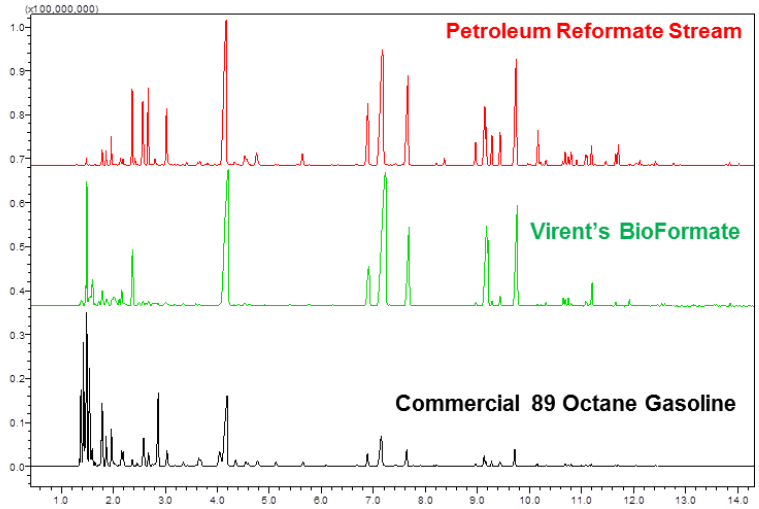
NABC Work

- Stover from ISU, pine residues from Catchlight
- NREL, WSU, and Virent making Hydrolysates
- Virent converted hydrolysates into BioFormate™ gasoline product

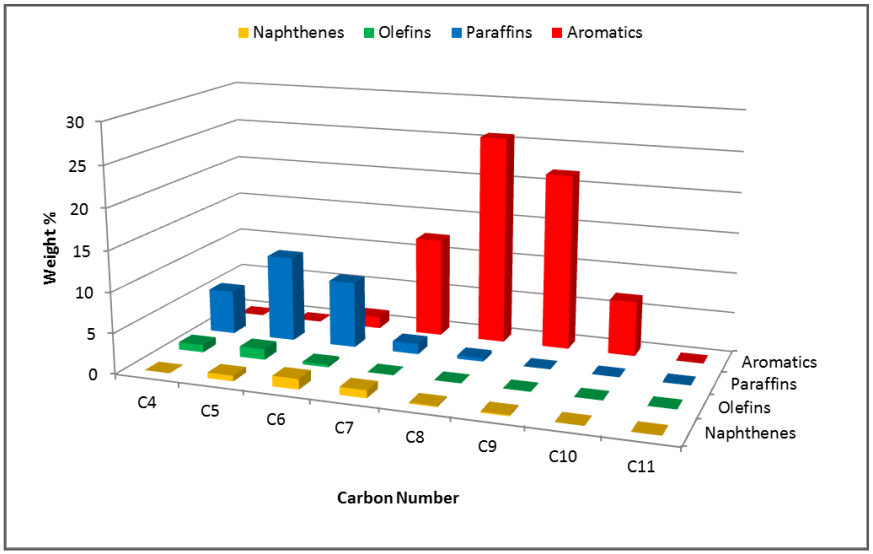




Comparison with Reformate



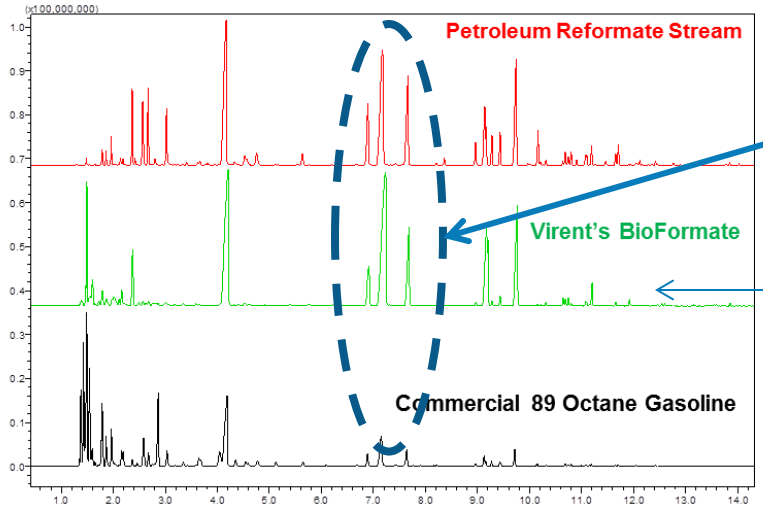
	Typical Reformate (Vol%)	Virent BioFormate (Vol%)
Paraffins	27	26
Olefins	1	3
Naphthenes	1	3
Aromatics	71	68



Virent's Product in Scuderia Ferrari Race Fuel

Virent has conducted 4 separate campaigns in Eagle to provide volumes for Shell to blend for Ferrari

Comparison with Reformate



C_8 Aromatics

Note that this particular BioFormate® was made from *cellulosic* material (corn stover)

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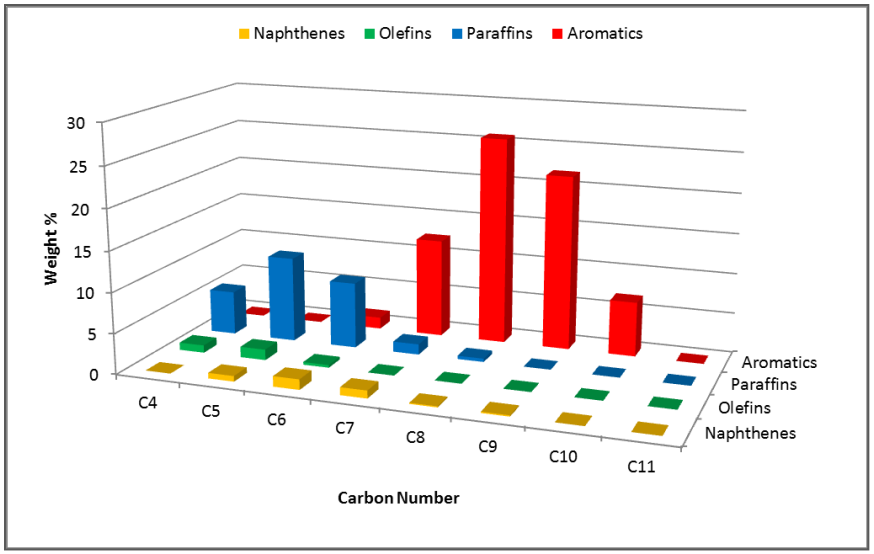
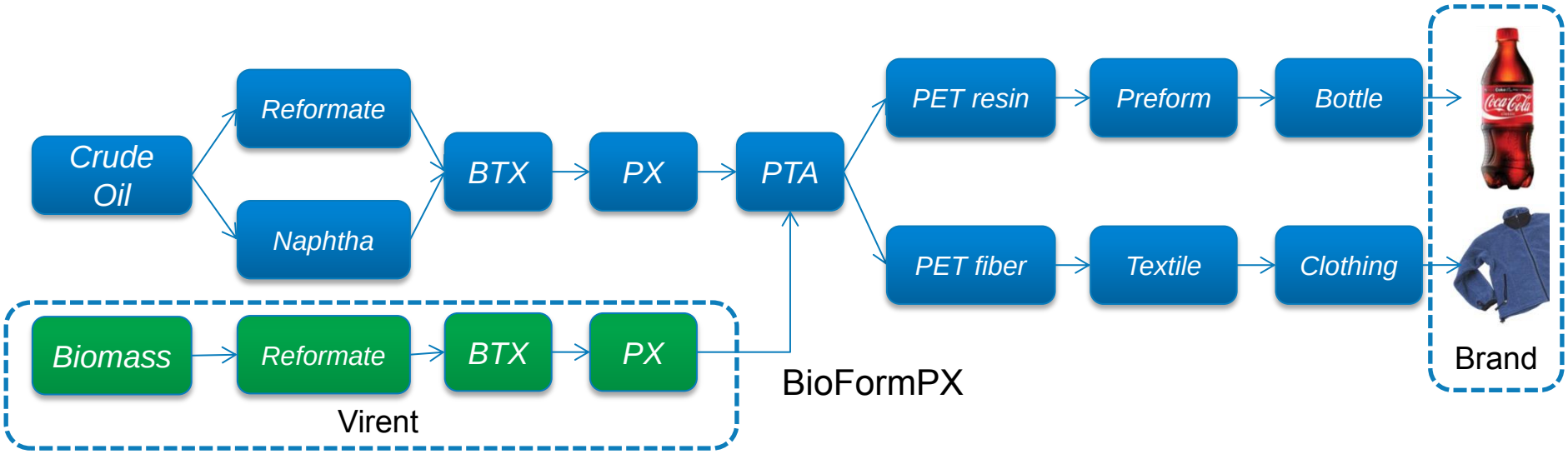


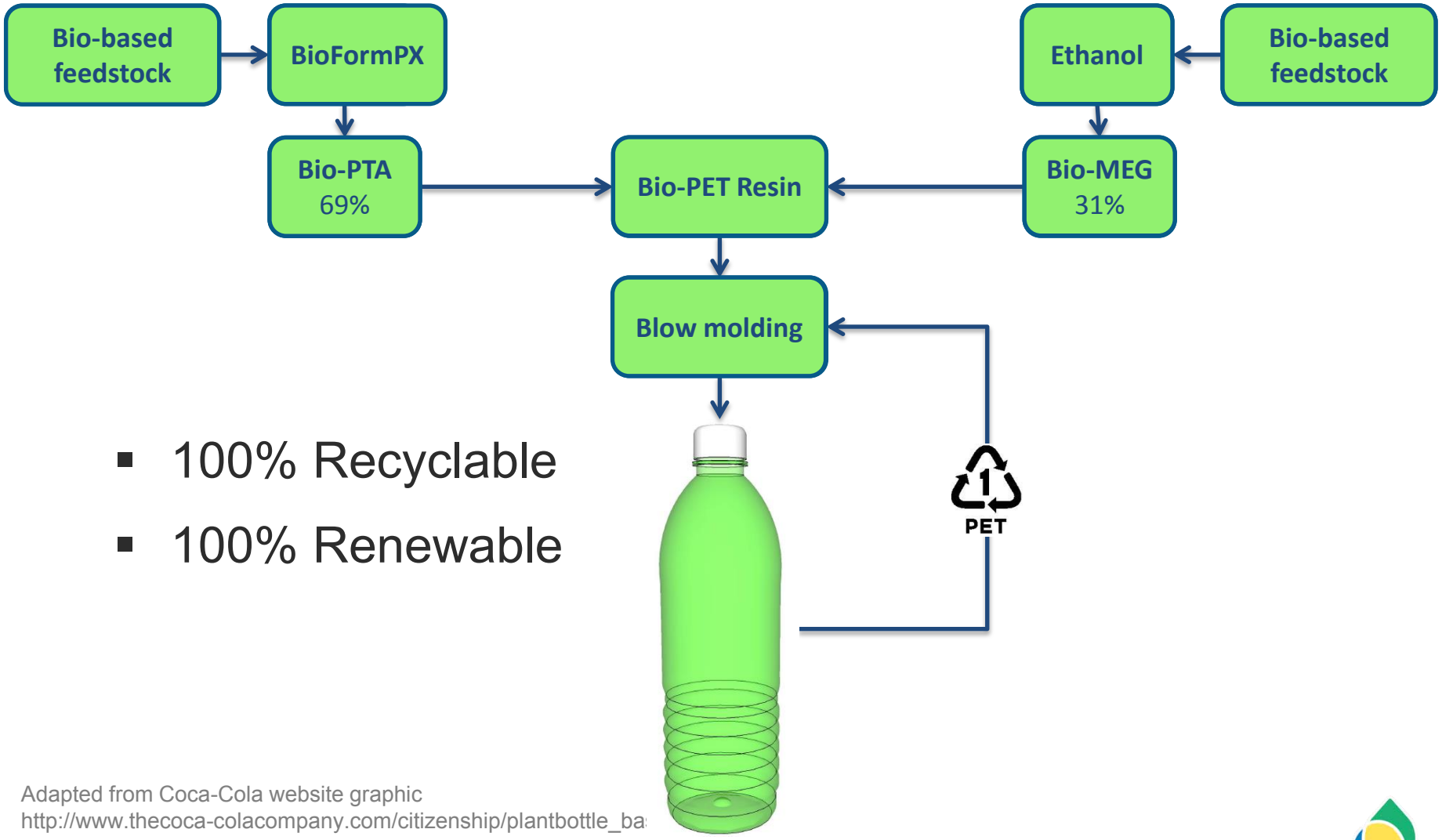
Supply Chain – How to fit in?



Supply chain innovation

- Opportunity to vertically integrate all the way back to raw feedstock.
- Reduce exposure to crude oil volatility, increase security of supply.
- Address sustainability requirements of the consumer and regulator.
- No impact to recycling infrastructure.

Virent Enables 100% RR-PET



- 100% Recyclable
- 100% Renewable

Adapted from Coca-Cola website graphic
http://www.thecoca-colacompany.com/citizenship/plantbottle_ba

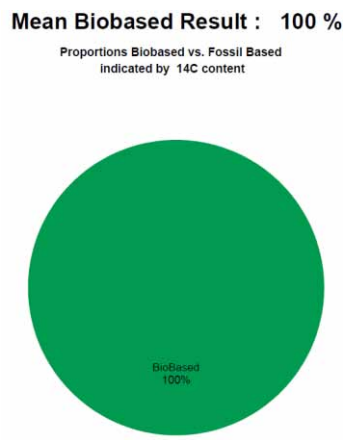
Steady Progress Towards 100% Renewable PET

100% renewable bottles successfully made using:

VIRENT — BioFormPX™

遠東新世紀 FAR EASTERN NEW CENTURY — PET Resin

BETA ANALYTIC Radiocarbon Dating



Jet Fuel Activities - Summary

Certification Activities

Synthetic Aviation Fuels Specification
ASTM D 7566
(New Annex to be Approved)

7566 Annex X

HDO SK

Hydro-Deoxygenated
Synthesized Kerosene

Catalytic Conversion of Sugars
Task Force

Jet Product Development Activities

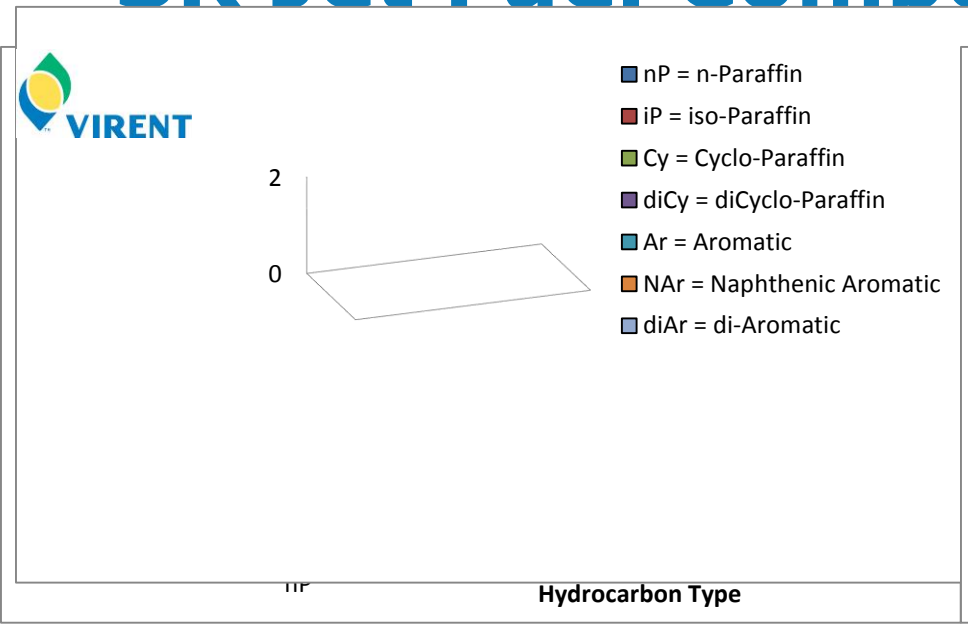
FAA-CLEEN Program
Fuel Testing
Down-Select Finalist

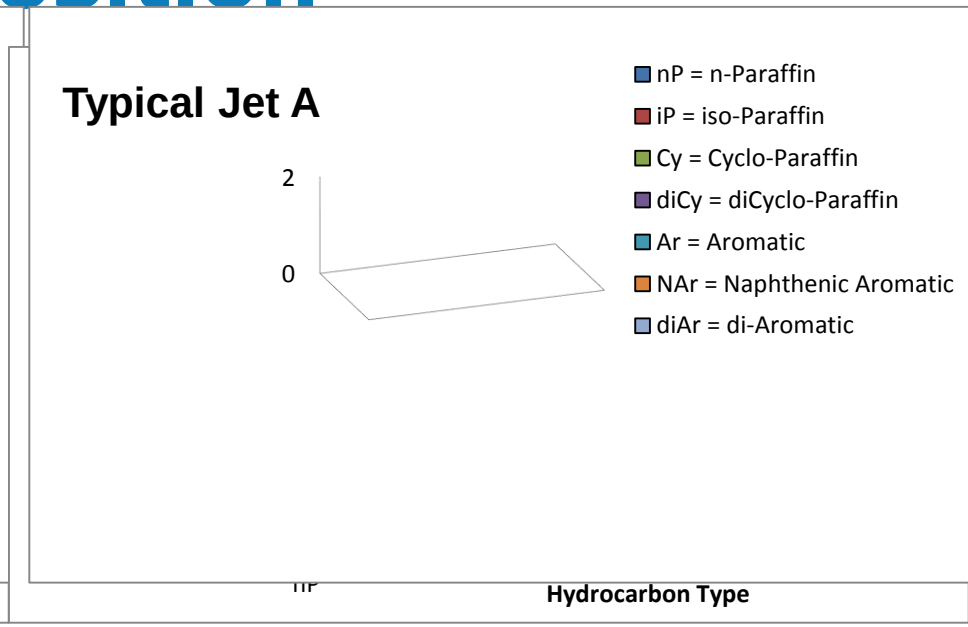
FAA Award
$1.5 MM Grant
Scale-up & Certification

Shell – Virent Collaboration
Technology Development

DOE Award
$13.4 MM Grant
Stover-to-Jet

SK Jet Fuel Composition





- Same hydrocarbons present in SK and Jet A
  - Broad carbon number range
  - Higher cyclo-paraffin content
  - Low aromatic content

Fully Renewable Synthetic Jet

Cellulosic Biomass to Jet Fuel, 3/26/2012

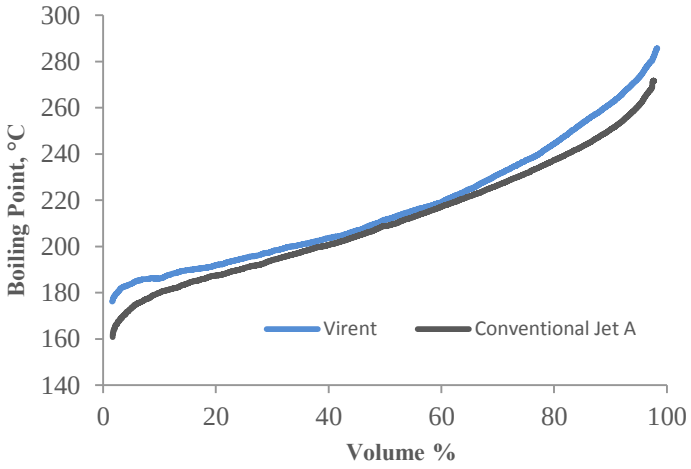
Analysis from Wright Patterson AFB

Specification Test	MIL-DTL-83133G Spec Requirement	JP-8	VIRENT
Physical and Chemical Properties			
Heat of Combustion (measured), MJ/Kg	≥42.8	43.3	43.3
Flash point, °C	≥38	51	40
Freeze Point, °C	≤-47	-50	<-60
Density @ 15°C, kg/L	0.775 - 0.840	0.804	0.805
Distillation			
10% recovered (T_{10}), °C	≤205	182	164
EP, °C	≤300	265	290
T_{90}-T_{10}, °C	≥22	62	86
Thermal Stability			
Temperature		260°C	325°C
Tube Deposit Rating	<3	1	1
Change in Pressure, mm Hg	≤25	2	0

BIRD Israel-U.S. Binational Industrial Research and Development Foundation

VIRENT virdia

Virent D-86 comparison to Jet-A



Very high thermal stability

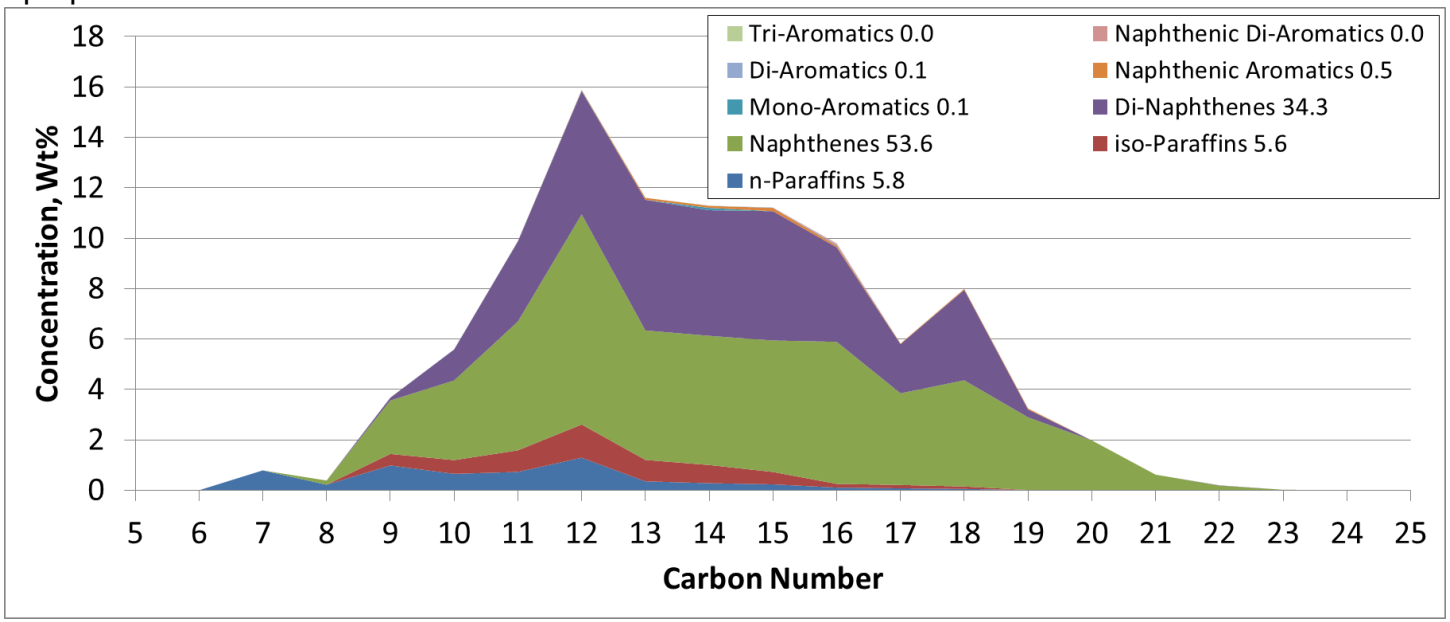
Product Quality

Diesel

	ASTM D975 No.2 Diesel Requirement	Virent Diesel	Petroleum Diesel*
Cetane	>40	49.6	48.4
Density	>820 kg/m^3	836	842
Sulfur	15 ppm (ULSD)	<5	7.5
Cloud Point	--	-40°C	-16°C

*Commercial sample analyzed for comparison purposes

- All specification testing meets ASTM D975
- High cyclic content provides good cetane and density
- Tune fractionation to vary jet/diesel cuts
- Could produce necessary volumes for certification with current assets



Thank you.

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VIRENT