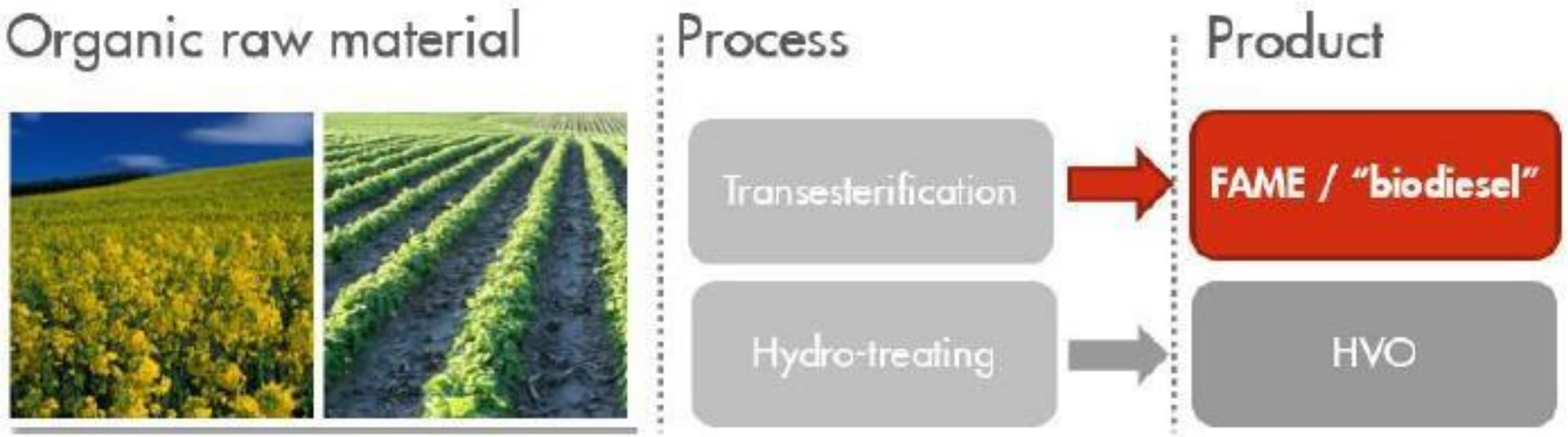

StarWest
PETROLEUM LTD.
INTRODUCTION TO BIODIESEL (FAME)
and RENEWABLE DIESEL (HDRD, HVO)

Agenda

- What is FAME & HDRD - Process Overview
- Feedstocks and Carbon Intensity
- Properties
- Product Quality Considerations
- HDRD compared to FAME
- Fuel Standards
- FAQs

What are biofuels?

- A renewable energy source
- Made of organic matter, or biomass, such as corn or sugar, vegetable oils or waste feedstocks
- Currently blended with existing fuels such as gasoline and diesel and is one of the largest sources of renewable energy today
- Can help to decarbonize the road, aviation and marine transport sectors



What is Fatty Acid Methyl Esters (FAME)

- FAME is considered a renewable energy source, produced from organic matter or biomass such as corn, sugar, vegetable oils, or waste feedstocks through Esterification
- FAME is commonly referred to as biodiesel
- Diesel blends with biodiesel content are described as "B" plus a number (IE: B20 is 20% FAME)

What is Hydrogenation Derived Renewable Diesel (HDRD)

- HDRD is commonly referred to as Renewable Diesel (R), Green Diesel, Hydrogenated Vegetable Oil (HVO), or Hydrotreated Esters and Fatty Acids (HEFA)
- HDRD is considered a renewable energy source, produced from organic matter or biomass such as corn, sugar, vegetable oils, or waste feedstocks through hydrogenation (treatment with hydrogen)
- Diesel blends with renewable content are described as "R" plus a number (IE: R30 is 30% HDRD)

Feedstocks and Carbon Intensity

- FAME and HDRD have a lower well-to-wheel Carbon Intensity (CI) than conventional diesel
- The CI of FAME and HDRD and therefore the GHG savings depends on the feedstock that is used for production
- GHG savings for FAME & HDRH based on Canola are 92% and 78% respectively[1]:
- B20 fuel offers a CO_2 emissions reduction of 15% and R30 of 23% when compared to fossil fuel diesel[2]

1. RED, ANNEX V Greenhouse gas emissions saving – default value
2. When compared with conventional diesel and based on a weighted average of FAME produced in Canada. All life cycle emissions data is taken from GHGenius v 5.01.

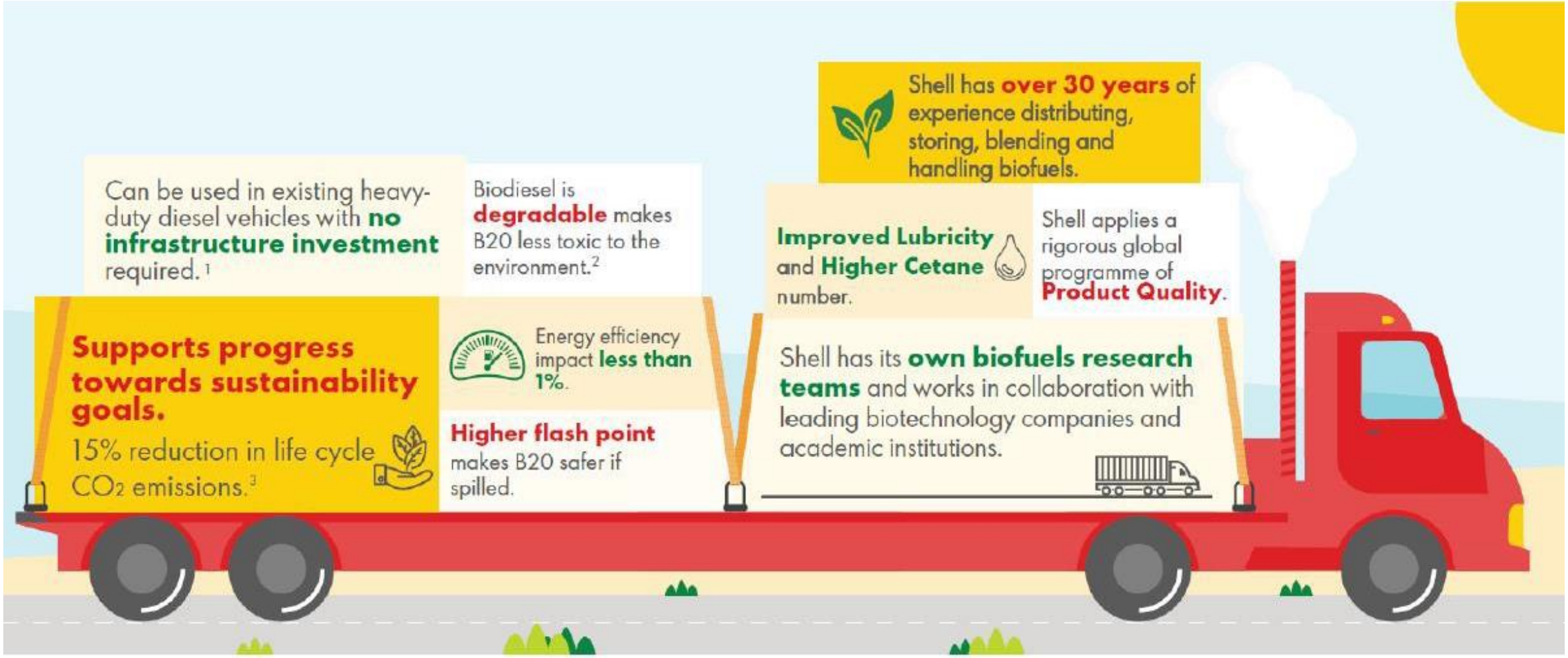
B20 Properties

- **Can be used in OEM approved engines:** Can be used in existing heavy-duty diesel vehicles with no infrastructure investment required [1]
- **Degradable:** B20 is less toxic to the environment [2]
- **Higher flashpoint:** makes B20 safer if spilled [2]
- Improved lubricity
- High cetane number
- Lower sulphur
- Lower aromatics
- Cloud Point: 0°C +/- 5 °C

1. Manufacturers' advice should be sought before running vehicles on net biodiesel or blends higher than the typical market level.
2. When compared to conventional diesel

Why Choose B20 Diesel?

Manufactured by Shell



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Properties – HVO is "manufactured diesel"

- Drop in fuel with no blend wall
- No change in the engine required
- No issues with stability, water separation, microbiological growth, impurities causing precipitation above cloud point
- Almost No aromatics
- Almost No Sulphur
- High cetane number (~70)
- The combination of a high cetane and absence of aromatics has a significant benefit on local emissions (particles, NOx, CO, THC)
- Severe winter and arctic grades available due to the isomerization process
- Wide range of cloud points possible up to -20°C
- Composition and product properties comparable with Gas-to-Liquid (GTL) fuels except that GTL is made from NG and HDRD from renewable feedstock

Product Quality Considerations - B20

- **Fuel Economy / Peak Power:** FAME is less energy dense; typical impact is less than 1% for B20
- **Cold Flow Properties:** Higher viscosity, waxing can lead to filter blocking. Depends on the feedstock
- **Lower Stability:** fuel degrades over time leading to deposits, corrosion and filter blockages
- **Microbial Contamination:** Microbes and their wastes can form deposits, plug filters and promote corrosion of fuel system components
- **Higher Solvency:** can mobilize built-up deposits and cause filter blockages.
- **Material Compatibility:** can corrode copper and copper alloys, damaging equipment.

Product Quality Considerations - HDRD

- **Elastomer Compatibility:** In some cases, the chemical composition of HDRD can interfere with elastomer expansion.
- **Reduced Fuel Economy:** In the order of 5% for R100
- **Engine Power Loss:** lower volumetric energy content can cause engine power loss in mechanically controlled, old-technology engines.
- **Injector Deposits:** Risk for moderate increase for injector deposits, as HDRD has no natural detergency. But less need to detergency because it's so clean
- **Reduced Lubricity:** Can be mitigated with an additive or blending FAME
- **Fuel Tank Level Sensor:** when the fuel tank level sensor swimmer has a density between that of diesel and HDRD.
- **Flame Sensor:** The transparent flame of HDRD cannot be detected by certain flame sensors.
- **Low Foaming:** HDRD has little to no foaming compared to conventional diesel which can cause tanks to be filled close to the maximum

HDRD compared to FAME

Pros:

- No blend wall
- Drop-in fuel in existing infrastructure and engines
- Less operational issues caused by impurities and/or microbes
- Similar CO_2 benefits, depending on feedstock

Cons:

- Limited availability – Availability varies per terminal
- Few suppliers
- More expensive

Fuel Standards

Product	Canada	United States	Europe
Diesel (Neat)	CGSB 3.517	ASTM D975	EN 590
Renewable Diesel (R100)			EN 15940
Biodiesel (Bx)	CGSB 3.520 B1 – B5	ASTM D975 B0 – B5	EN 590 B0 – B7
Biodiesel (Bxx)	CGSB 3.522 B6 – B20	ASTM D7467 B6 – B20	EN 16734 B7 – B10 EN 16709 B20 – B30
Biodiesel (B100)	CGSB 3.524	ASTM D6751	EN 14214

Bio/Renewable fuels FAQ's

Will the usage of FAME impact fuel consumption?

When using B20 biodiesel blend, fuel consumption increases are probably not noticeable. Other factors like tire pressure, wind/aerodynamic, cold temperature, maintenance, driving speed etc. would be greater contributors to increase fuel consumption than B20 alone.

Will the usage of HDRD impact fuel consumption?

Paraffinic fuels usually have a higher volumetric fuel consumption than diesel because of their low density. Sometimes this penalty is partly compensated because of the improved combustion and the positive effect that paraffinic fuels can have on diesel particle filters (less frequent regeneration, which saves some fuel).

Will HDRD or FAME harm my vehicle or its engine?

Biodiesel is safe for most vehicle engines. Canadian diesel regulations allow biodiesel blends up to 20%. Normal scheduled maintenance (regular oil changes) will ensure trouble free operation. If in doubt, you should consult your vehicle's manufacturer for advice.

Bio/Renewable fuels FAQ's Continued

What time of year is Biodiesel available?

There is a high degree of variability depending upon the region, weather, and climate.

B0-B4.9 – Some biodiesels (IE: B2) are available year-round in particular regions

B5 – Spring (Mid-March to Early May) until Fall (Early September to Mid-October)

B20 – Late Spring (Early April to Mid-May) until Early Fall (Mid-August to Mid-September)

How do I prepare to my engine for biodiesel?

Unlike the introduction of ethanol-dosed gasolines in a gasoline supply chain, bio-diesel has a minimal impact in fuel tanks and storage containers and newer engines (2011+) will have compatible hoses and gaskets. End-users can choose to switch to an engine oil formulated for use with biodiesel, or increase the frequency of oil checks and changes. We recommend consulting with OEM to get updated maintenance if permanently switching to B20; Shell has a working relationship with the most common OEM's, and can support end-users in this transition.

Bio/Renewable fuels FAQ's Continued

How can I be certain about the quality of the HDRH and FAME?

Shell has over 30 years of experience working with biofuels. With their own biofuels research teams who work in collaboration with leading biotechnology companies and academic institutions. Shell actively manages and measures product quality through a globally consistent set of standards and policies; and applies a rigorous program of quality testing throughout the supply chain.

B20 Diesel

Manufactured by Shell

Provided by

Star West Petroleum Ltd.