



## UOP/ENI Ecofining™ Process

### Renewable Energy and Chemicals

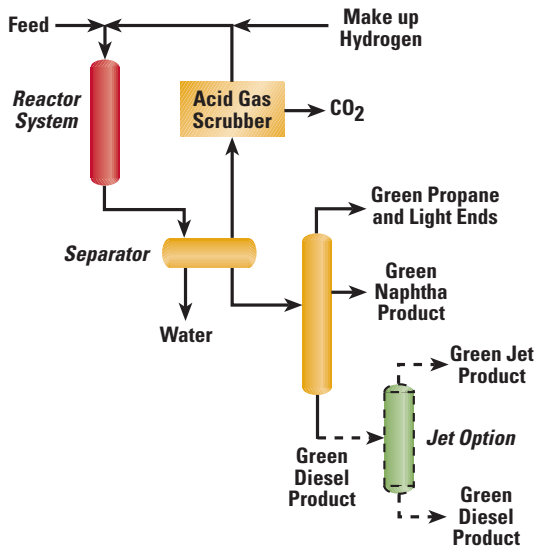
#### Introduction

The Ecofining process is UOP's solution to meeting the increasing demand for a sustainable high quality renewable diesel. The process has been jointly developed by UOP LLC and Eni S.p.a. of Italy. It combines 90 years of UOP process licensing experience with joint UOP/Eni technology and catalyst developments in the field of biofeedstock processing.

#### Applications

The Ecofining process hydrogenates triglycerides and/or free fatty acid feedstocks such as vegetable oils and animal fats. The resulting paraffins are then isomerized to create a high quality hydrocarbon known as green diesel. If desired, the Ecofining process can also be designed to produce a paraffinic green jet fuel stream in addition to the green diesel product.

#### Ecofining Flow Diagram



#### Features and benefits

The Ecofining process leverages existing infrastructure to drive down capital and operating costs, enabling licensees to position themselves with a low cost advantage while meeting biofuel targets.

When blended into an existing petroleum diesel pool, the high cetane and low density of green diesel can enhance the pool's performance characteristics. This

brings synergistic blending benefits beyond simply meeting bio-component target or mandate levels.

Life Cycle Analysis (LCA) of green diesel shows Green House Gas (GHG) savings of over 50% relative to fossil diesel depending on the feed and the calculation method used.

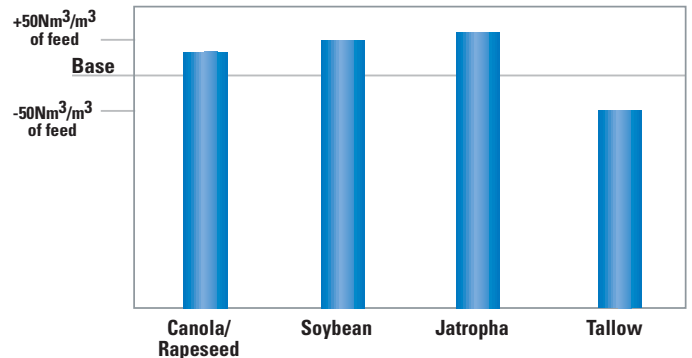
#### Yields

Typical yields from the Ecofining process are highlighted below.

	<u>Unit Yields</u>
<b>Feed</b>	
Vegetable oil %	100
Hydrogen %	2.5 – 3.8
<b>Products</b>	
Propane vol-%	2 - 4
Naphtha vol-%	1 - 10
Diesel, vol-%	88 - 98

The diesel yield and hydrogen consumption vary slightly according to the feed-stock source and the required product cloud point. The hydrogen consumption may also vary between different feeds.

#### Hydrogen Consumption Variation



#### Feedstocks

The Ecofining process can be applied to a wide range of feed stocks. It is designed with the flexibility to handle a range of pretreated vegetable oils such as rapeseed, canola, soybean, palm and jatropa and can also process refined animal fats such as tallow.

Looking forward to the second generation, Ecofining is intended to be compatible with algal oils as they become available.

### Catalysts

The Ecofining process utilizes deoxygenation and isomerization catalysts which are supplied by UOP.



### Product properties

Green diesel meets or exceeds the most rigorous diesel standards for performance, and is suitable as a blending component for EN590 or ASTM D975 diesel.

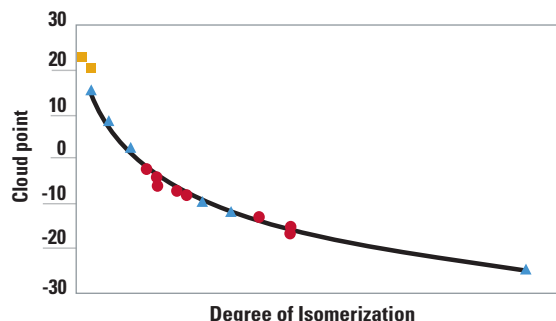
### Product Properties vs Fossil Diesel

	<u>Fossil Diesel</u>	<u>Green Diesel</u>
Oxygen content, %	0	0
Specific gravity	0.84	0.78
Cloud point, °C	-5	-20 to +10
Cetane	40-52	70-90
Sulphur, ppm	<10	<2
Energy density, MJ/kg	43	44
Polyaromatics, vol-%	8-12	0
Oxidative stability	Baseline	Baseline

Green diesel product is clear and bright in appearance.

The Ecofining process operates flexibly to make diesel product cloud points from +10°C to -20°C (+50 to -4°F), with yields increasing at higher cloud points.

### Green Diesel Cloud Point vs Degree of Isomerisation



The optional paraffinic green jet product has a freeze point of less than -40°C (-40°F) and a flash point of +38°C (100°F) min.

### Technology delivery

UOP offers basic engineering design packages of the Ecofining process to meet customer requirements. For those customers who need to progress projects quickly, UOP can deliver “off the shelf” pre-engineered basic design packages in standard capacities.

Via our alliances with leading contractors worldwide, UOP can optionally provide complete project implementation services.



### Economics/Investment

Typical ISBL (Inside Battery Limits) erected cost estimates are between 40 and 60 million US dollars for an Ecofining process unit producing ~250,000 tonnes/annum of green diesel (2008 U.S. Gulf Coast basis). Production costs for green diesel are comparable to biodiesel (Fatty Acid Methyl Ester technology) on a volumetric or energy basis. The Ecofining technology could be an ideal candidate for the revamp of a distillate hydrotreating unit, reducing capital investment significantly.

### Commercial experience

ENI has announced construction of the first Ecofining unit, with start up due in early 2010. A second unit was licensed in early 2008 amid significant market interest.

### For more information

For more information, contact your local UOP representative or our Des Plaines sales office:

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