

Shell Advanced Biofuels towards lowering Carbon foot print

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This presentation contains data from Shell's new Sky Scenario. Unlike Shell's previously published Mountains and Oceans scenarios, the Sky Scenario is targeted through the assumption that society reaches the Paris Agreement's goal of holding global average temperatures to well below 2°C. Unlike Shell's Mountains and Oceans scenarios which unfolded in an open-ended way based upon plausible assumptions and qualifications, the Sky Scenario was specifically designed to reach the Paris Agreement's goal in a technically possible manner. These scenarios are part of an ongoing process used in Shell for over 40 years to challenge executives' perspectives on the future business environment. They are designed to stretch management to consider even events that may only be remotely possible. Scenarios, therefore, are not intended to be predictions of likely future events or outcomes and investors should not rely on them when making an investment decision with regard to Royal Dutch Shell plc securities.

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Shell and biofuels



Trading & Supply

One of the world's largest blenders and distributors of biofuels



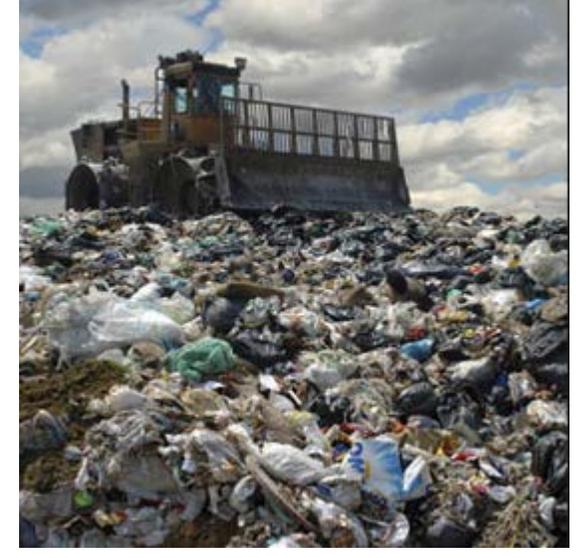
Raízen JV

Production of lowcarbon ethanol from Brazilian sugar cane



Advanced Biofuels

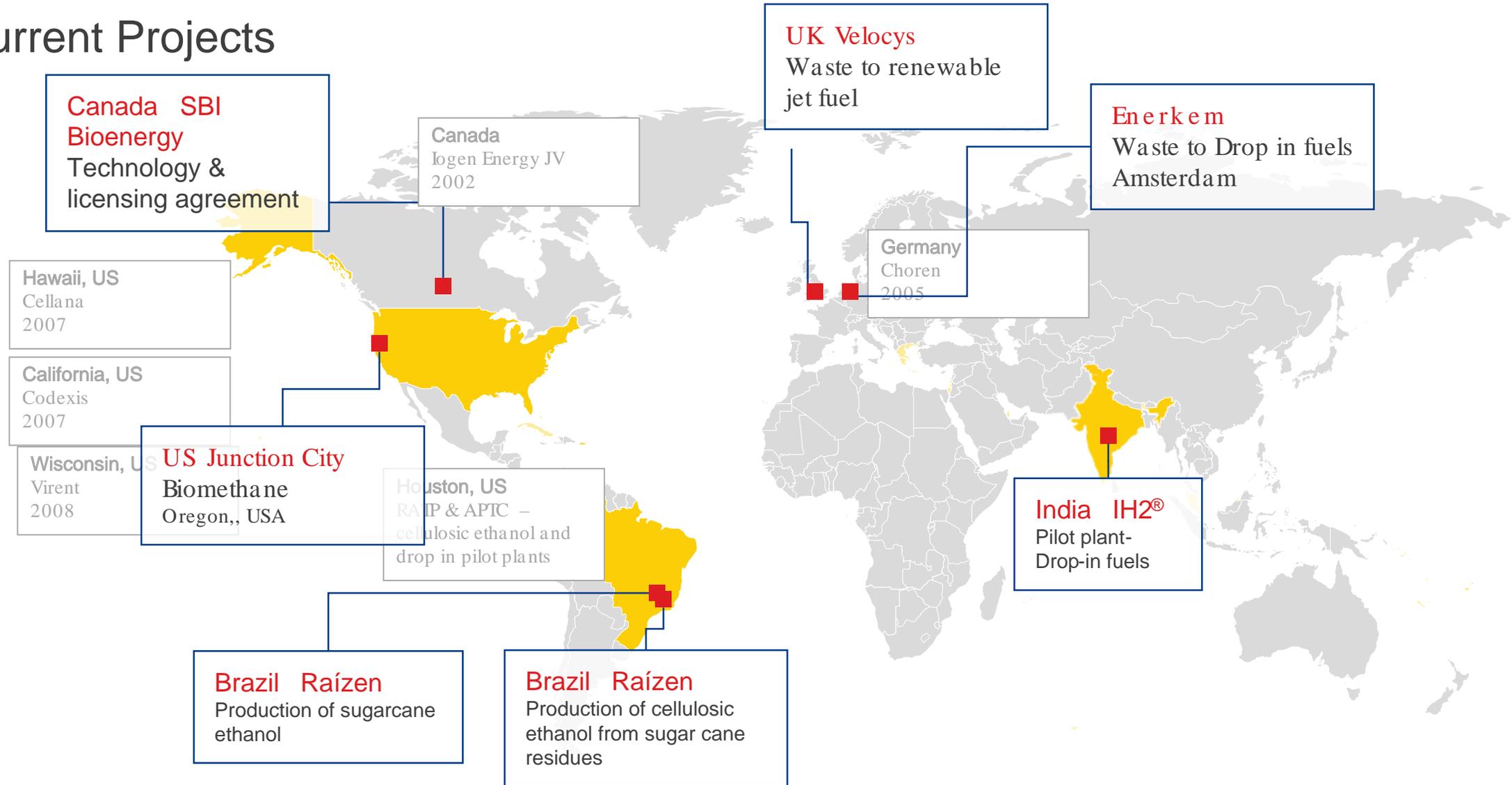
Investing in technologies using alternatives feedstocks such as waste



Sustainability

Commitment to the supply and development of sustainable biofuels

Current Projects



The Solution depends on the Problem

Key Solutions for India Business

Advanced Biofuels:

IH2® - Large quantity waste with moisture <40%- IH2® Technology

- Deployment in waves
- Several plants to come up in the current decade in India/ globally
- First wave to have woody biomass and Agri-residue
- Various Business models including strategic partnerships invited

BioCNG/RNG:

Low quantity wet waste (200 TPD) with moisture >70% Anaerobic Digestion Technologies

- Deployment in waves
- Several plants to come up in the current decade in India/ globally
- Proximity to wet waste & Industrial BioCNG markets
- Various Business models including strategic partnerships invited

Government Policy Support for Advanced Biofuels & BioCNG will help achieve in realizing

IH2® - A Large Technological Solution to significantly lower Carbon foot print

- Woody Biomass (Forestry residues)
- Agri residues (Bagasse, Paddy straw etc.)
- Sorted & segregated MSW (upto 15-20% plastics)

Biomass to Drop in Hydrocarbons



GHG Emissions Reduction based on Life Cycle Analysis : upto 92%
Energy recovery : upto 72%

Gasoline/Diesel Mode	TPD
Feed (MAF) Basis	1000
Gasoline	180-210
Diesel	78-90

Jet Mode	TPD
Feed (MAF) Basis	1000
Jet	90-100
Gasoline	120-130
Diesel	30-50

Other byproducts	TPD
Biochar	130-150
CO2	300-350
Water	200-300

IH²® Products – Road transport fuels are high quality ‘drop in’



GASOLINE / PETROL



Meets ASTM D481416d
E10 blend for regular grade



EN 228: Petrol – Jan 2009
E10 blend for regular
Blend stock (RON) otherwise



BS VI compliant
E6 blend for regular grade

Petrol is currently undergoing ASTM qualification; EN and BS qualification to follow in 2019



DIESEL



Meets ASTM D97515c



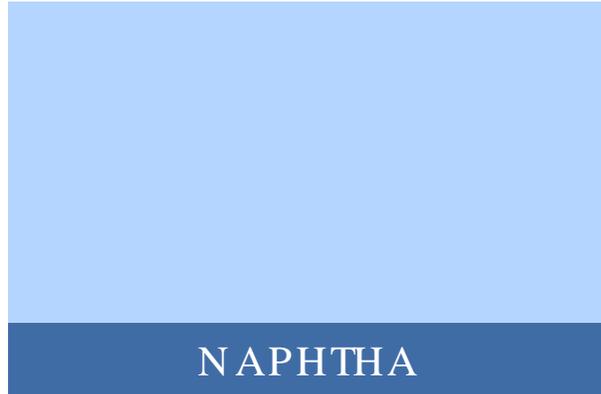
EN 590:2009+A1:2010



BS VI compliant

Diesel is currently undergoing ASTM qualification; EN and BS qualification to follow in 2019

IH²® Products – Jet mode fuels are high quality ‘drop in’



Suitable components for
 Solvents
 Steam cracker feed
 Reformer feedstock – bioBITX
 Gasoline blending



Matches the Table 1 Performance
 Criteria for:
World-wide Civil Jet Fuel Grade
Jet A/A-1
 (e.g., ASTM D1655)

Fuels are currently in ASTM
 D4054 approvals process



Meets ISO 8217 2017 specs
Meets DMB/DFB specs (Very low S)
 High on DMA/ DFA density (fixable);
 High on DMB/ DFB density (fixable)
 Exceeds Residual Fuel Spec

Fuels are currently being evaluated

5 TPD Demo Plant at Bangalore



Commercialisation of IH2®
EU, India, USA...

- First wave in various countries:



IH²® pathway from waste to value while reducing pollution



process can process sorted and segregated municipal solid waste (MSW) from various sources. It has been processed successfully at the laboratory scale, yielding high quality hydrocarbons. The hydrocarbon fuel yield from MSW is, in fact, higher than that from wood.

>250 MMT of Agri-residue & >30 MMT of MSW on MAF basis is burnt without energy recovery in India every year: CO₂, CO, fly ash*, Dioxin*, particulate matter pollution



>100 BL of transportation fuels produced from crude oil consumed in India every year. CO, CO₂, SO_x, NO_x, HC, Particulates generated

VS.



72-92% reduction of GHG from current fossil fuels



Premium transportation fuels produced from biomass lowering Air pollution significantly



* Waste to Energy Opportunity in India, Infra Insights report www.infrainsights.com

* TERI- Concept Paper on Power Generation from Municipal Solid Waste <http://www.esselgroup.com/essinfra-announcethe-successful-commissioning-of-its-flagship-waste-to-energy-plant-in-jabalpur.html>

Material quantity of feedstock is available, but with challenges to develop waste value chain



Agricultural
Waste (MAF
Basis)

~> 250 MMT



Municipal
Waste (MAF
Basis)

~> 30 MMT



Forest /
Energy
Plantation

XX MMT

- **Unconstrained Potential** to address India's need for liquid transport fuel and gas requirement
- Large Opportunity for Advanced Biofuels and BioCNG
- **Key Challenges**
 - Aggregation & Storage
 - Segregation & Consistency
 - Concessions with municipalities
 - Transport costs & scale aggregation
 - Pre-processing and densification
 - Develop new business models for feed availability

Executive summary

- Shell deploying various technological solutions to convert biomass into Advanced Biofuels to lower Carbon footprint
- Carbon footprint reduction key consideration for deployment of technology
- The Solution depends on the Problem
- IH2® Technology is considered for Large waste with low wetness
- For high wet waste BioCNG deployment is considered.

