Shell Biofuels

Sustainable Low CO_2 Fuel Today

The Energy Challenge

In coming decades the world will need huge amounts of energy to support population and economic growth and improve standards of living. Supplies of conventional energy will struggle to keep up with growth in demand and energy will need to be produced in environmentally and socially responsible ways. This is the energy challenge.

An Additional Fuel Option

Road transport accounts for about 17% of energy-related* Carbon Dioxide (CO_2) emissions. Global transport fuel demand is set to rise by 45% between 2006 and 2030**. To cope with increasing demand we will need all the sustainable transport fuel options available to us. Fossil fuels are likely to remain the world's main energy source for many decades to come. Electric and Hydrogen Fuel Cell Vehicles (FCVs) will be important in the longer-term.

Biofuels offer a low-carbon alternative to gasoline and diesel today.

**Energy-related Carbon Dioxide emissions represent 62% total global Carbon Dioxide emissions*
***Shell calculations based on IEA and PIRA data*

With approximately **101,000** full-time employees in more than **90** countries and territories, Shell helps to meet the world's growing demand for energy, aiming to do so in economically, environmentally and socially responsible ways.

UPSTREAM INTERNATIONAL

Our Upstream International business searches for and recovers oil and natural gas outside the Americas, often in joint ventures with international and national oil companies. The business also liquefies gas and is active in gas to liquids technology, to provide cleaner burning fuels.

UPSTREAM AMERICAS

Our Upstream Americas business searches for and recovers oil and natural gas across the Americas. Many of these activities are carried out as joint venture partnerships, including with national oil companies. Upstream Americas includes our oil sands operations such as the Athabasca Oil Sands Project, which extracts bitumen from oil sands in Alberta, Western Canada, and converts it to synthetic crudes. Our wind power business is also part of this organisation.

DOWNSTREAM

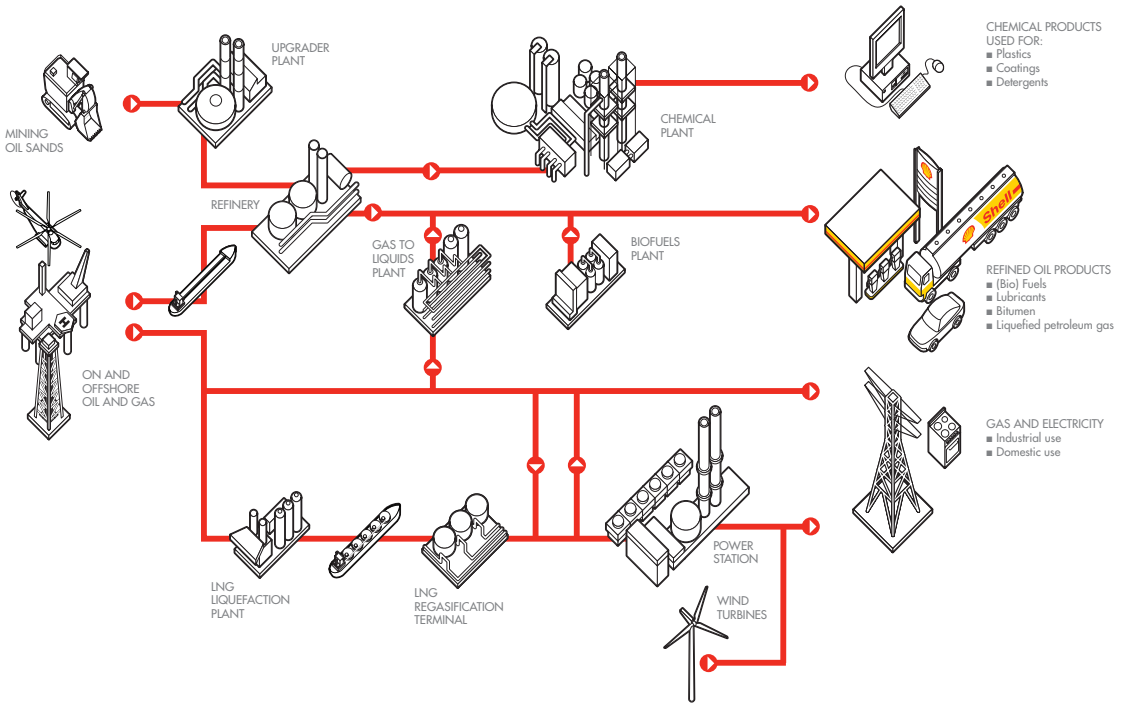
Our Downstream business includes Oil Products, which refines, supplies, trades and ships crude oil worldwide and manufactures and markets a range of products. These include fuels, lubricants, bitumen and liquefied petroleum gas for home, transport and industrial use. The Downstream business produces petrochemicals for industrial customers, including the raw materials for plastics, coatings and detergents used in the manufacture of textiles, medical supplies and computers. The business also includes our activities in biofuels and leads our CO_2 management activities across the company.

PROJECTS & TECHNOLOGY

Our Projects & Technology business manages delivery of Shell's major projects, as well as driving the research and innovation to create technology solutions. This includes our coal gasification technology. It provides technical services and technology capability in both upstream and downstream activities, including advanced exploration and production information technology for Shell and for third parties. It also oversees safety and environment performance and procurement processes across Shell.

AT A GLANCE:

- >90 countries where we operate
- 101,000 number of full-time employees
- 2% amount of world's oil we produce
- 3% amount of world's gas we produce
- 3.1 million barrels of gas and oil we produce every day
- 44,000 Shell service stations worldwide
- 10 million customers buy our transport fuel each day
- >35 refineries and chemical plants we run (figures for 2009)
- 2 ranking by Fortune 500 in 2010



BIOFUELS:

A SUSTAINABLE LOW CARBON ALTERNATIVE TODAY

ABOUT BIOFUELS:

Biofuels are fuels made from biomass, usually plants. Today's most widely used transport biofuels are ethanol and biodiesel (FAME).

HOW ARE BIOFUELS MADE?

Ethanol is usually made by a process of basic fermentation of crops high in sugar or starch, such as sugar cane, maize (corn) and wheat. It is then blended with gasoline (petrol) to create a mixture that can be used in modern vehicles without modification.

Biodiesel (or FAME – fatty acid methyl esters) is made from vegetable oil crops such as rapeseed, soya or palm oil, through a process known as 'transesterification'. Biodiesel is blended with diesel and like ethanol, creates a mixture that can be used in modern vehicles without modification.

Another type of biodiesel, available in small volumes, is called HVO (hydro-treated vegetable oils). HVO uses a different process to FAME. It has improved fuel properties and can be blended into conventional diesel in higher concentrations.

Today's engines cannot use pure ethanol and FAME because of technical limitations but most modern engines can take them blended at concentrations of 5% to 10% (B5, E10). In some countries, such as Brazil, Sweden and the US, ethanol can be blended at 85% (E85). This is used in flexible-fuel vehicles with engines modified to accept higher concentrations of ethanol.

WHY BIOFUELS?

Biofuels offer a number of benefits that make them attractive as an alternative to gasoline (petrol) and diesel.

Greenhouse Gas Emissions

Road transport accounts for about 17% of energy-related* Carbon Dioxide emissions CO_2. The number of cars on the road is expected to double by 2050 and the number of trucks is expected to double**. Global transport fuel demand is set to rise by 45% between 2006 and 2030. To cope with this increased demand we will need all the sustainable transport fuel options available to us. Electric and Hydrogen Fuel Cell Vehicles (FCVs) will be important in the longer-term, but a large proportion of the world's vehicles will continue to be powered by liquid fuels.

Biofuels offer a low "well-to-wheel" CO_2***, sustainable alternative to conventional gasoline and diesel today. When used in vehicles, biofuels emit similar amounts of CO_2 as conventional fuels, but unlike crude oil, the biomass they are made from has recently absorbed CO_2 from the air during growth. In theory this leaves the carbon balance neutral.

But, the actual CO_2 reduction of biofuels depends on a wide range of factors, including the feedstock used, how it is processed, distributed and used in vehicles. For example, Brazilian sugar cane ethanol can produce up to 90% lower CO_2 than conventional fuels and typically has lower CO_2 emissions than ethanol produced from other feedstocks such as corn (maize) grown in the US.

Advanced biofuels, using new feedstocks such as crop waste or inedible crops and new conversion processes offer the potential for even greater CO_2 reductions and improved fuel characteristics. But it takes considerable time and investment to progress new technologies from lab-based process to demonstration phase and towards a full-scale commercial refinery.

Diversifying the fuel supply

Biofuels help diversify the liquid road transport fuel pool and reduce dependence on oil based transport fuels. This offers the prospect of improved energy security, particularly when domestic feedstocks are used.

Compatibility with Existing Infrastructure

Once blended, biofuels can be used in existing liquid transport fuel infrastructure. Fuel companies use special trains, tanks and blending facilities to distribute, store and blend biofuels, but the customer sees no difference.

Rural Development

For some countries biofuels also offer economic and rural development opportunities. A recent Harvard University report suggested that 'developing the potential of biofuels as a new export industry could connect developing country workers and their communities with the global economy'. The report cited examples including Bolivia, Paraguay, Republic of Congo and Cameroon.

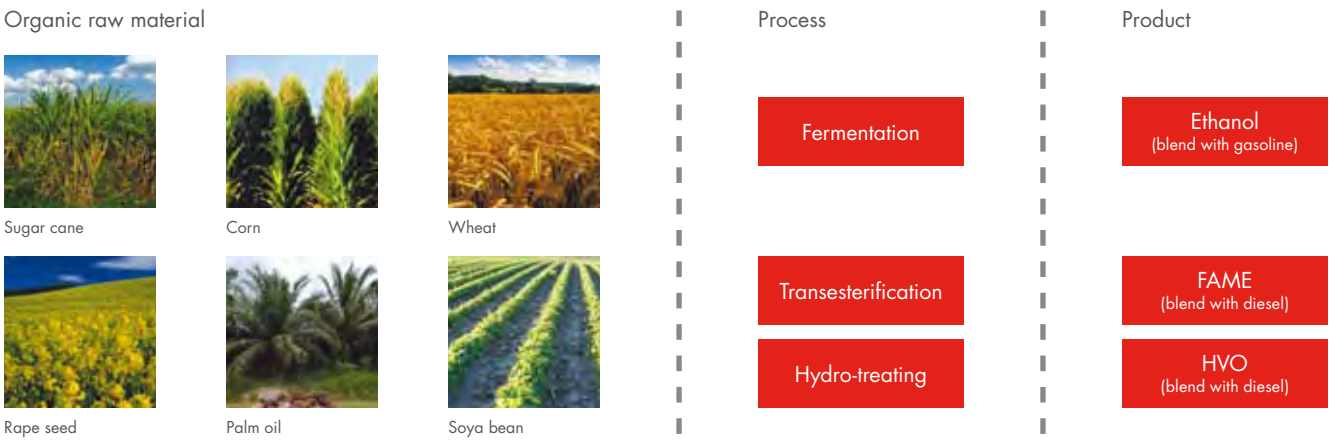
GOVERNMENT SUPPORT

Recognising the benefits of biofuels, policy makers in many countries around the world have developed or are developing renewable fuels policies that contain provisions for biofuels.

The European Union Renewable Energy Directive proposes 10% (energy basis) of road vehicle fuel should come from renewable sources by 2020.

The USA Energy Independence and Security Act 2007 requires 36 billion gallons of renewable road transport fuels by 2022.

These policies have helped to create an international market for biofuels. Today biofuels represent approximately 3% of the global road transport fuel supply. Shell's in-house calculations suggest this could increase to 9% by 2030 and the International Energy Agency has estimated that biofuels could grow to as much as 30% of the world's road transport fuel mix by 2050.



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* *Energy-related Carbon Dioxide emissions represent 62% of total global Carbon Dioxide emissions*

** *International Energy Agency*

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A LEADER IN SUSTAINABLE

BIOFUELS

SHELL AND BIOFUELS:

Biofuels offer a low carbon, sustainable alternative to conventional gasoline and diesel in the short term and could play a key role in the medium to longer term.

SHELL AND TODAY'S BIOFUELS

The International Energy Agency estimates that biofuels could grow to as much as 30% of the world's road transport fuel mix by 2050 as demand for fuels that emit less Carbon Dioxide (CO_2*) increases.

Shell has been involved in distributing biofuels for over 30 years. We continue to build capacity in biofuels that provide the best combinations of performance and low "well-to-wheel"** CO_2 performance, produced from sustainable feedstocks.

Shell is buying increasing volumes of ethanol for gasoline as well as FAME (fatty acid methyl esters) for diesel. We are one of the world's largest distributors of biofuels – about 9.5 billion litres in 2010.

In 2011 we moved into the production of today's biofuels. Shell and Cosan have formed joint venture company Raízen for the production of ethanol, sugar and power, and the supply, distribution and retail of transportation fuels in Brazil. The joint venture will enable Shell and Cosan to establish a scalable and profitable business in more sustainable biofuels by building a market-leading position in the most efficient ethanol producing country in the world. With annual production capacity of more than 2 billion litres each year, the joint venture is one of the world's largest biofuel producers.

SUSTAINABLITY

Some difficult issues are linked with increased production of biofuels, so strict environmental and social safeguards are needed.

We support the adoption of "well-to-wheel" CO_2 standards to reward low CO_2 biofuels and disadvantage those that do not perform well in terms of CO_2 emissions. We also support the use of a single robust approach for calculating the "well-to-wheel" carbon intensity of fuels.

We are working to ensure that the biofuels we purchase for blending are produced in a more sustainable way – safeguarding the environment and delivering benefits to communities and wider society.

We are introducing sustainability clauses into new and renewed supplier contracts. By the end of 2010, 83% of the biofuels we purchased (by volume), were from suppliers who had signed up in full or in part to our sustainability clauses.

We have systems, policies and resources in place to help us assess potential sustainability risks in our biofuel supply chain, to implement controls and to monitor and report progress.

We are also working with other industries, such as food and cosmetics, governments and NGOs to raise standards and improve practices across the feedstock industry. This includes participating in several multi-stakeholder initiatives to develop international sustainability standards.

ADVANCED BIOFUELS

Advanced biofuels, using feedstocks such as crop wastes or inedible crops and new conversion processes offer the potential for improved CO_2 reductions and improved fuel characteristics.

Shell was one of the first energy companies to invest in advanced biofuels. Our technology division has a dedicated bio team working in four research centres in the UK, the US, the Netherlands and India.

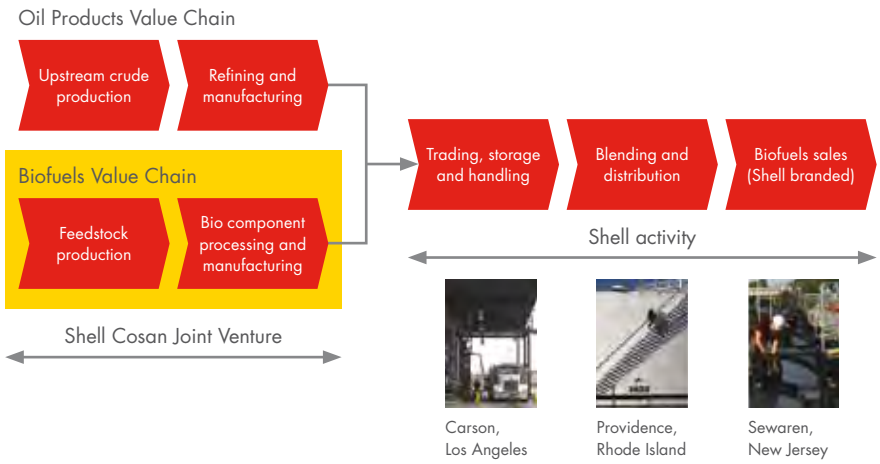
These are complimented by agreements with experts in academic institutions across the world***.

Shell has technical partnerships with leading biotechnology companies exploring new technology platforms for the production of advanced biofuels (**see separate fact sheets for further information on these partnerships)**. These include the processing technology that enables ethanol to be made from straw using enzymes (Iogen), the development of 'super-enzymes' for biofuel production (Codexis) and a development effort to convert plant sugars directly into gasoline and gasoline blend components (Virent).

Breaking down and converting new biofuel feedstock options into fuel is far more complex than converting the crops used to produce some of today's biofuels. Processing them efficiently at scale, in terms of cost and CO_2 emissions is challenging. It will take time and investment, but we are successfully progressing new technologies from lab-based process to demonstration phase and towards commercial scale-up.

Shell takes a milestone approach to research, development and commercialisation of advanced biofuels pathways. We aim to narrow down technology options to a feasible set of commercial solutions. In the long term biofuels will need to be cost competitive with all transport fuels.

Financial systems that recognise and reward certified CO_2 savings will accelerate development.



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** 'Well-to-wheel' CO_2 analysis calculates the CO_2 emissions relating to a particular fuel pathway. The calculation divides the pathway into two parts: (i) 'Well-to-Tank' (WtT) CO_2 emissions – from the production and distribution of the fuel feedstocks and the actual fuel (ii) 'Tank-to-Wheel' CO_2 emissions – from the use of the fuel in the vehicle

*** Massachusetts Institute of Technology (MIT), Massachusetts, US; University of Campinas (Unicamp), Sao Paulo, Brazil; Institute of Microbiology, Chinese Academy of Sciences (IMCAS), Beijing, China; Qingdao Institute of Bioenergy and Bioprocess Technology, Chinese Academy of Sciences (QIBEBT), Qingdao, China; Centre of Excellence for Biocatalysis, Biotransformations and Biocatalytic Manufacture (CoEBio3) based at Manchester University, UK; School of BioSciences Exeter University, UK.

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RAÍZEN:

A JOINT VENTURE FOR MORE SUSTAINABLE BIOFUELS

RAÍZEN:

Building a market-leading position in the most efficient ethanol producing country in the world.

Shell and Cosan are forming a $12 billion joint venture for the production and commercialization of ethanol and power from sugar cane and the distribution of a variety of industrial and transportation fuels through a combined distribution and retail network in Brazil.

Raízen will enable Shell and Cosan to establish a scalable and profitable business in more sustainable biofuels by building a market-leading position in the most efficient ethanol producing country in the world. With annual production capacity of more than 2 billion litres, the joint venture will be one of the world's largest biofuel producers. And we have significant growth aspirations.

Brazilian sugar cane ethanol produces less Carbon Dioxide (CO_2), from cultivation through to use, than any other conventional biofuel available in commercial volumes today. Raízen is further reducing its overall CO_2 impact by using waste material to power its own plants and delivering surplus electricity to the national grid.

Brazil leads the world in the use of biofuels in its transport fuel mix. Like other producers in Brazil, Raízen will apply new technologies to enhance productivity and create new export opportunities.

SUSTAINABILITY

Raízen will be committed to delivering an industry leading approach to the management of sustainability issues. The joint venture agreement includes a set of sustainability principles which aim to drive continuous improvement.

These principles include a robust assessment of the potential direct and indirect impacts of any expansions. They seek to ensure that feedstock is not procured from land recognised as having a high conservation value. They also require Raízen to work with suppliers, contractors and owners of leased lands to build capacity to manage sustainability issues and implement sound land and water management practices.

Raízen will require suppliers to respect the human rights of their workers, responding to any community issues and engaging external stakeholders in a respectful, transparent and meaningful way.

A programme of continuous improvement will be developed with the aim of ensuring all Raízen mills achieve BonSucro certification in coming years*.

ACCELERATING ADVANCED BIOFUELS

Shell is including interests in Iogen Energy and Codexis in the joint venture. This will help link a large-scale sugarcane ethanol platform – including feedstock supply chains, production, distribution and infrastructure – to our advanced biofuels programme. This has the potential to accelerate the commercial production of biofuels from crop wastes and inedible plants.

cosan

* *The BonSucro Standard is a global voluntary standard aimed at promoting best practice in terms of managing the social and environmental impacts of sugar cane production*

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BIOFUELS:
FINDING A SUSTAINABLE WAY FORWARD

BIOFUELS: FINDING A SUSTAINABLE WAY FORWARD

Safeguarding the environment and delivering benefits to communities and society.

Some difficult issues are linked to the production of biofuels. Strict environmental and social safeguards are needed.

We know that the 'well-to-wheel'* Carbon Dioxide (CO_2**) performance of biofuels can vary widely depending on the feedstocks and production and processing techniques used. We also recognise concerns about working conditions, competition for agricultural land, land use change, impacts on local communities and use of water. Shell is working to ensure that the biofuels we purchase for blending are produced in a more sustainable way – safeguarding the environment and delivering benefits to society. But this is not easy.

Shell's approach has three areas of focus:

SHELL'S BIOFUELS SUPPLY CHAIN

As a significant purchaser of today's biofuels for blending, Shell has been championing sustainability standards in our own biofuels supply chain for a number of years.

Since 2007 we have had a clear policy and dedicated resources to assess potential risks, implement controls, monitor compliance and report our progress.

In 2007 we also introduced environmental and social clauses into new and renewed contracts for the biofuels that we purchase for blending. Our sustainability contract clauses require suppliers to seek to ensure that:

- Biofuels and feedstocks are not knowingly linked to the violation of human rights and have not knowingly been cultivated, produced or manufactured in areas of high biodiversity value
- Suppliers develop and implement supply chain traceability systems
- Suppliers join relevant international bodies developing sustainability criteria for the production of particular feedstocks

By the end of 2010, 83% of the biofuels we purchased (by volume), were from suppliers who had signed up in full or in part to our sustainability clauses. We are providing detailed advice and location-specific information to help more of our suppliers sign up to our clauses.

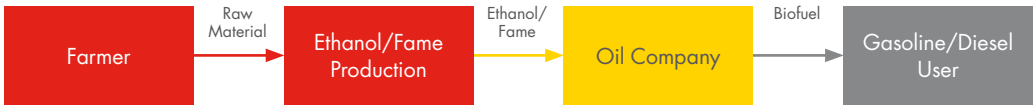
We require suppliers to work with Shell to develop a more sustainable supply chain. We review their progress on a regular basis and reserve the right to conduct independent audits and to terminate contracts.

PROMOTING STANDARDS FOR SUSTAINABILITY AND CO_2 REDUCTION

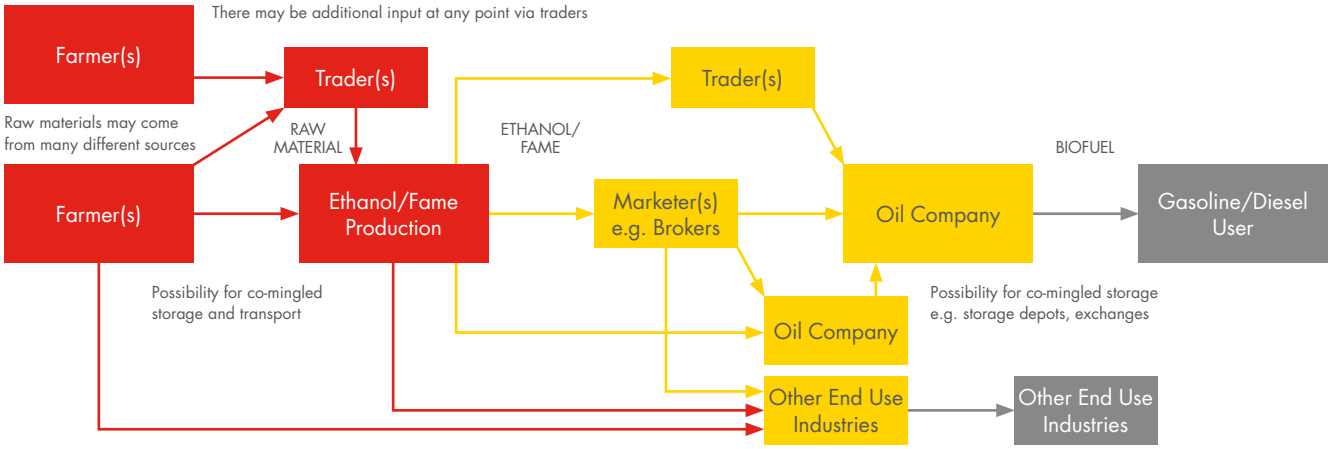
Shell believes that governments should encourage and reward biofuels that demonstrate good CO_2 performance and are produced from more sustainable sources.

We are encouraging the adoption of international standards for sustainable sourcing and we participate in several initiatives that are working on voluntary guidelines for particular feedstocks. These include the Roundtable on Sustainable Biofuels (RSB), the Roundtable on Sustainable Palm Oil (RSPO), the Round Table on Responsible Soy (RTRS) and BonSucro, formerly the Better Sugarcane Initiative (BSI).

The basic supply chain may appear straightforward...



The reality may be more complex, with multiple players and combinations



We have pledged our support for an international multi-stakeholder coalition, which is seeking to enforce a moratorium on rainforest and peatland clearance associated with expansion of oil palm plantations in Southeast Asia.

In Europe, we have been working with the European Committee for Standardisation (CEN), which is developing sustainability requirements in support of the European Renewable Energy Directive and the European Fuel Quality Directive.

WORKING WITH OTHERS TO PROGRESS INDUSTRY KNOWLEDGE

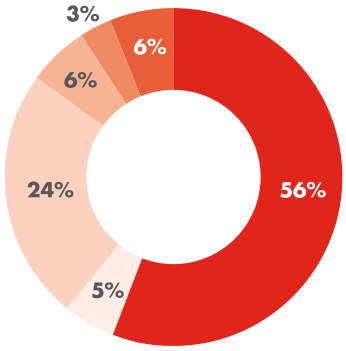
We are working with environmental and social experts to develop projects that help address potential direct and indirect impacts of biofuels production and to share experience and expertise.

We are building on our long-term collaborative partnership with the International Union for Conservation of Nature (IUCN) to exchange knowledge and expertise. IUCN's experience in managing species and ecosystems is helping us to address conservation and livelihood risks and opportunities in the decisions we take. As one of the world's largest distributors Shell provides opportunities for IUCN to influence global markets towards more sustainable production processes.

With other oil companies, and with technical input from environmental NGOs such as WWF and the IUCN, we are investigating ways to promote sustainable production of biofuels feedstocks on underutilised or marginal lands. These are areas that could be cultivated without negative environmental and social impacts and without pushing existing agricultural activities out to other areas. For example, they could be arable lands that have fallen into disuse and are away from areas of high biodiversity value.

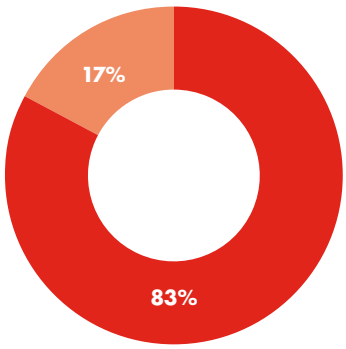
Automated sugarcane harvesting

Shell Global Biocomponent Feedstock Purchase Q4 2010



- Corn – 56%
- Sugar Cane – 24%
- Oilseed Rape – 6%
- Other – 6%
- Wheat –5%
- Soy – 3%

Shell's Biocomponent Purchases Covered by Sustainabilty Clauses



- Fully signed up – 83%
- Yet to sign up – 17%

BONSUCRO™ BETTER SUGAR CANE INITIATIVE

Roundtable on Sustainable Biofuels

RSPO Roundtable on Sustainable Palm Oil

RTRS Round Table on Responsible Soy Association

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IOGEN:

CELLULOSIC ETHANOL FROM AGRICULTURAL WASTE

IOGEN:

Developing the processing technology that enables ethanol to be made from agricultural residue.

In 2002, Shell and Iogen Corporation formed a joint venture company called Iogen Energy, to develop the processing technology that enables ethanol to be made from agricultural residue, such as wheat and barley straws using enzymes.

Iogen's technology uses enzymes to break down the cellulose in non-edible plants or crop waste and convert it to sugars, which are then fermented and distilled into ethanol.

The four stages of production are feedstock pre-treatment, enzyme production, enzymatic hydrolysis and ethanol fermentation/distillation.

Cellulosic ethanol has identical molecules to conventional ethanol. The difference between conventional ethanol and cellulosic ethanol is that cellulosic ethanol is derived from the non-food portion of the crop.

If used at 100%, cellulosic ethanol produced by Iogen could deliver "well-to-wheel" Carbon Dioxide emission (CO_2) reductions of as much as 90% compared to conventional gasoline.

IOGEN DEMONSTRATION PLANT

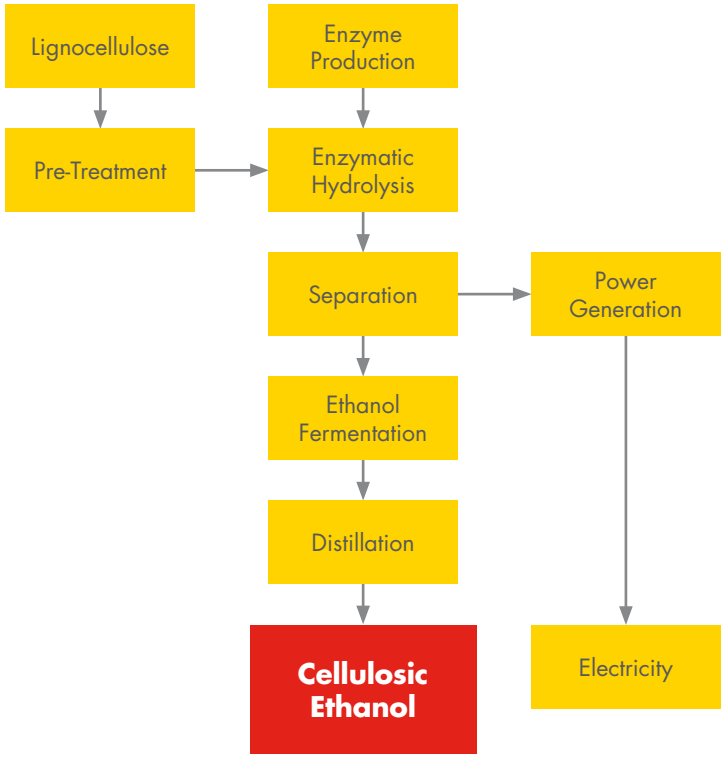
An Iogen demonstration plant opened in Ottawa in 2004 as a research and development facility to enable the company to continuously improve process towards commercial production.

The demonstration plant has a maximum capacity of 1 million litres of cellulosic ethanol per year and produced more than 500,000 litres in 2009.

For one month in June 2009, a Shell services station in Ottawa sold gasoline containing 10% cellulosic ethanol from the Iogen demonstration plant.

Iogen Energy and Shell are making good progress towards a full-scale commercial cellulosic ethanol plant.

We have met a number of significant milestones and the feasibility and design assessment work are well advanced. We continue to review potential sites within Canada.



IOGEN® CORPORATION

CODEXIS:

NEW ENZYMES TO CONVERT BIOMASS TO HIGH-PERFORMANCE TRANSPORT FUELS

CODEXIS:

Shell and Codexis have a joint technology development programme to 'evolve' natural enzymes into improved variant enzymes, or 'super enzymes' to convert biomass into fuel.

Since 2007, Shell and Codexis have a joint technology development programme to 'evolve' natural enzymes into improved variant enzymes, or 'super enzymes' to convert biomass into fuel.

Our work with Codexis will also increase our knowledge of a number of non-food biofuel feedstocks, new conversion processes and alternative fuel products.

As part of the agreement, Codexis will work closely with Shell and Iogen Energy to enhance the efficiency of enzymes used in the Iogen cellulosic ethanol production process.

Together we are also exploring new enzymes to convert biomass directly into components similar to gasoline and diesel.

TECHNOLOGY

Natural enzymes catalyse change throughout nature. But, they operate on a very small scale and are inadequate for commercial use.

Codexis scientists gradually 'evolve' natural enzymes into improved variant enzymes capable of performing to specification.

First, Codexis identifies and characterises organisms that produce a promising family of enzymes with commercial scale potential.

After the optimal biocatalyst is developed, it is verified to meet the performance criteria in pilot production.

Once the process is verified on pilot production scale, it could be migrated to a commercial manufacturing facility.

CODEXIS®

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VIRENT:

CONVERTING PLANT SUGARS DIRECTLY INTO HIGH PERFORMANCE TRANSPORT FUELS

VIRENT:

Since 2008 Shell and Virent have had a joint technology development programme to convert plant sugars directly into a range of high performance liquid transport fuels, rather than ethanol.

Shell and Virent have had a joint technology development programme to convert plant sugars directly into a range of high performance liquid transport fuels.

Virent's technology platform has the potential to produce a range of liquid hydrocarbons. We are currently focusing on gasoline, but we are also researching jet fuel and diesel options.

Traditionally, sugars have been fermented into ethanol and distilled. Virent's technology uses catalysts to convert plant sugars into hydrocarbon molecules like those produced at a petroleum refinery.

The sugars can be sourced from today's biofuel feedstocks such as wheat, corn and sugarcane and from non-food sources such as wheat straw and sugarcane pulp.

Virent biofuels have the same properties as conventional gasoline and diesel. This means they do not require specialised infrastructure and can be transported using existing pipelines.

VIRENT DEMONSTRATION PLANT

Since March 2010, Shell and Virent have operated the world's first demonstration facility to convert plant sugars directly into gasoline and gasoline blend components, rather than ethanol.

The demonstration plant in Madison, USA, produces up to 38,000 litres of biogasoline each year. This biogasoline is used for engine and fleet testing to verify compatibility with current and next generation engines.

Shell and Virent are evaluating the "well-to-wheel" Carbon Dioxide (CO_2) emissions reduction of Virent biogasoline produced at the plant. Our research suggests that it will be better than processes to convert sugars to ethanol by conventional fermentation.

VIRENT™

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