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Biofuels: Policies, Standards and Technologies

World Energy Council

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Foreword

Skyrocketing prices of crude oil in the middle of the first decade of the 21st century accompanied by rising prices for food focused political and public attention on the role of biofuels. On the one hand, biofuels were considered as a potential automotive fuel with a bright future, on the other hand, biofuels were accused of competing with food production for land. The truth must lie somewhere in-between and is strongly dependent on the individual circumstance in different countries and regions. As food and energy are closely interconnected and often compete with each other for other resources, such as water, the World Energy Council - following numerous requests of its Member Committees - decided to undertake an independent assessment of biofuels policies, technologies and standards.

A Task Force on biofuels was set up by WEC in late 2008 and I was delighted to chair it over the past year or so. It was a challenging group effort which resulted in this report. From the beginning the Task Force established a certain criteria for its work which included issues related to the diversity of energy supply, standardisation of biofuels, trade policies, sustainability of biofuels production and use and other topical matters with the ultimate objective of promoting a better understanding of the basic fundamentals which will define the future of biofuels worldwide.

In many peoples' minds biofuels, ethanol in particular, are closely associated with Brazil which is today a leading producer not only of biofuels but also vehicles which run on biofuels.

This is a unique combination and Brazil draws clear benefits from it. Ethanol in Brazil is produced commercially from sugar cane that has been grown in Brazil since its first settlements centuries ago and has the lowest production costs compared to other raw materials. It would be difficult to replicate these unique natural, traditional and technical factors elsewhere in the world. The report presents a global picture but focuses on the Americas. I would like to thank the members of the Task Force for their contributions to this effort, in particular my colleagues from Argentina, Analia Acosta and Raul Reimer, Ian Potter from Canada, Francesca Pigliapochi from Italy, Gerardo Bazan from Mexico, Bamidele Solomon from Nigeria, Ulf Svahn from Sweden and Richard Davis from the United States. The Task Force has also benefitted from the shared wisdom of Raffaello Garafalo and Luciana Tomozei from the European Biodiesel Board and Trevor Vyze from the International Standards Organisation. Finally, I would like to extend my appreciation to Elena Nekhaev and Catriona Nurse from the WEC London Secretariat for their support and guidance and to the Chairman of the WEC Brazilian Member Committee, Mr. Norberto de Franco Medeiros for my nomination as the Chair of the Task Force.

I sincerely hope that this report will become a succinct reference for both the decision-makers and the general public.

Sergio Fontes, Petrobras, Brazil

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Task Force Membership

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Executive Summary

The use of biofuels is growing around the world and a debate between biofuels supporters and opponents is intensifying. Given the rapidly increasing demand for energy which is projected to double by mid 21st century, it is expected that biofuels will become an important part of the global energy mix and make a significant contribution to meeting energy demand. Drivers for a wide introduction of biofuels vary across the world and include a broad range of issues from land-use to energy security, to economics and environment. The main challenge for the future is to develop biofuels which do not compete with the food chain, which are sustainable and efficient both in terms of costs and energy, and for which the carbon footprint is a net gain.

The study focuses primarily on biofuels for transportation and is divided into seven Chapters:

Chapter 1 introduces general concepts and basic information about biofuels, including international standardisation, classification and certification issues and lays down the guiding principles adopted by the Task Force.

Chapter 2 looks into the future of biofuels, including land use and impacts on food prices, and presents brief case studies from eight countries.

Chapter 3 summarises information about the various aspects defining development of biofuels: geography, feedstocks, production and end-use technologies, issues related to engine/fuel interface, energy efficiency and a technology outlook for near and longer term.

Chapter 4 addresses markets, financial issues and criteria, petroleum price volatility, vegetable oil market dynamics, supply and demand fundamentals.

Chapter 5 reviews standardisation, general policies and regulations, in particular the examples of EU and Brazil.

Chapter 6 discusses sustainability principles and criteria, including Life Cycle Assessment, economic and environmental aspects.

Chapter 7 summarises the main messages and presents conclusions and recommendations.

Background

The idea of using biofuels in an internal combustion engine dates back to 1929 when Rudolph Diesel first fired his newly invented diesel engine with raw vegetable (peanut) oil. However, Diesel and others discovered that fuelling a diesel engine with vegetable oils could reduce atomisation, lower heating value and worsen combustion and cause other long-term problems including pump wear and carbon/coke deposits.

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To be able to compete with fossil fuels, biofuels producers have achieved significant improvements in crop production and processing and today the volume of biofuels

produced in a specific planted area is several times higher than it used to be. Improved production methods and technologies are expected to increase efficiencies even further.

Technology is a key factor to enhance both food and bio-energy production and increase the output without adverse economic and environmental implications.

One of the main goals of developing the biofuels sector is sustainability. The sustainability driver is based on the three pillars of economic, social and environmental sustainability. In economic terms, biofuels production has to be cost-effective and competitive.

In social terms, biofuels development can create a massive new demand in the agricultural economy. As biofuels production is an agricultural process,

the same elements and inputs contribute to its overall efficiency as for existing agricultural production systems.

International Standards

Many barriers that today constrain world trade in biofuels can be removed by introducing international specifications and standards. Not only must properties of final biofuels products be harmonised but also methodologies for measuring these properties. International bodies such as the International Standards Organisation (ISO) are the appropriate forum to discuss this subject with participation of all stakeholders.

ISO is currently working on developing certain biofuels standards, and the outcomes of this effort are eagerly awaited. The subsequent International Standards will help the broad development of biofuels worldwide.

Technical Standardization

Although major refiners like ConocoPhillips, British Petroleum/BP and others blend currently biofuels into transportation fuels like gasoline and diesel, this is not supported by sufficient technical standardization which would allow and facilitate robust growth of biofuels on a global scale. Large, well-established refiners have the wherewithal to blend different source types into current transport fuels, but it typically requires new additions to traditional petroleum refineries that are expensive.

Establishing biofuel technical standards would, over the long run, help reduce capital expenditures for large and small refiners, benefit new participants in the refining business, and help capital markets develop more specific products for syndicating debt for biofuel refining.

Global Outlook for Biofuels

According to the latest available statistics, in 2007 global production of biofuels reached a record level of over 34 Mtoe accounting for 1.5% of total road related fuel consumption. There are a number of

reasons for the strong interest in biofuels which is currently spreading around the world and driving increasing production of biofuels. These reasons include the need to diversify supply sources, mitigate the impacts of crude oil price volatility, reductions in biofuels production costs and growing concerns
about the global environment. In some regions, development policies also play
an important role.

In terms of land use, the projected growth would lead to an increase in the arable land used for biofuels production from about 1% of total available land today to approximately 2.5% in 2030.

Currently, two countries: Brazil and USA account for nearly 80% of global biofuels production. Both countries produce mainly bioethanol: USA from maize and Brazil from sugar cane.In the next few decades, global demand for transport fuel is expected to grow significantly – by up to 55% by 2030 compared to 2004. This will accelerate the growth in demand for biofuels, as they are expected to make an increasing contribution to meeting future energy needs of the mankind.

Despite the projected tripling of biofuels production from 20 Mtoe in 2005 to almost 60 Mtoe in 2015 and over 90 Mtoe in 2030, their share in the total road-transport fuel is not expected to surpass 4-5% by 2030. Biofuels production costs still remain comparatively high and substantial cost reductions are required for cost types to become commercially competitive.

Impact on food prices

The spreading concerns about the impact of increasing production of biofuels and possible competition with agricultural land and impact on the food prices require a holistic assessment since there is a number of various factors at play, including poor management of the agricultural sector during the last decades, unfavourable weather conditions, lack of investment in production capacity and infrastructure, distorted agricultural markets and the dismantling of support policies for domestic market in developed countries which all might have contributed to the recent increases in food prices all over the world.

The United Nations Food and Agriculture Organisation (FAO) estimated in 2008 that biofuels accounted for approximately 10% of the recent food price increases around the world. In certain countries biofuels have had a more significant impact on food prices, however it was mainly because of national agricultural support programmes and protectionist measures rather than increased production of biofuels.

The key success factors for the future of biofuels will be gradual expansion in cultivated land and considerable increases in agricultural productivity. This will require a broad political commitment, including introduction of badly needed land reforms, better irrigation, use of fertilizers and further development of transport infrastructure.

The development of second-generation biofuels based on conversion of cellulosic resources, such as grasses, sawdust and fast growing trees from non-food sources that can help to limit the direct

competition between food and biofuel that is associated with mostly first-generation biofuels should be a priority for sustainability of biofuels

Land Use

A major debate continues around the world about biofuels production and its impact on traditional agriculture, i.e. the perceived competition for land and the risk of displacing production of human and animal food by biofuels.

Although land devoted to fuel production could reduce land available for food production, this is at present not a serious problem. In the longer term, lignocellulosics are likely to become the primary source of biofuels. It is important in each particular case to evaluate the sustainability of raw material production to ensure that biofuels are developed in areas that do not affect the use of the basic resources of agricultural ecosystems such us soil, water, air and biodiversity. In addition, taking into account the climate and geographical diversity, initiatives for the use of semi-arid soils and other marginal lands could be implemented, for the benefit of supporting the development of rural populations in poor regions.

The use of appropriate biotechnological tools and techniques for improving the plants yield, drought tolerance and multiplication offers the best solution in case of unforeseen adverse environmental conditions.

Analysis of areas today used for conventional crops production which are planned to be converted into biofuels producing areas is an important starting point for the evaluation.

Generally, in many countries, the land used today for agriculture and biofuels production accounts for a small share of the total arable land.

The expected continued growth in the use of biofuels would increase global demand for agricultural products and result in the creation of new jobs in harvesting, processing, distribution, etc. A biofuels industry that is local and where farmers produce fuel for their own use would produce direct and multiple benefits to a rural community. Soil productivity has also been increasing all the time, due to better chemical fertilisers, physical fertility and more efficient water economy.

Intensive agricultural systems based on the most advanced technologies and knowledge management, use less inputs per unit production than many other systems. The challenge addressed by the science-based agricultural industry is to maximize productivity while reducing the use of land, water and chemical inputs. The key to that goal is held by the dissemination of the latest technological advances in the life sciences worldwide.

Identifying the right place for biofuel production in the agricultural economy, including choices of the actual types (diesel from vegetable oil, ethanol from sugar or starch crops, solid biofuels from wood or grass sources) is a significant policy challenge.

All agricultural policies and strategies are based on local, national or in some cases regional circumstances and they include the mix of environmental (land, water, climate), social (population, education) and economic (costs, infrastructure, governance) factors. It is therefore impossible to develop “one-size-fits-all” policies for biofuels.

Agricultural practices that are environmentally sustainable, socially accepted and that promote efficient use of energy should be supported. All possible energy crops in each region should be assessed, including the second generation biofuels crops - to promote the sustainable production (e.g. non-conventional oil seed and lignocelluloses materials).

Geography and logistics

A general assessment of opportunities for biofuels production should include basic information such as location, associated transport and relevant infrastructure logistics. Some countries have their production base far from the main consumption centres and ports, in other countries it is the opposite. The origin of the crops or vegetable oils used for biofuels production is another aspect. Are they produced in the country or coming from other regions of the world?

For instance, in Argentina the raw material is produced in an area located 500 km from the biofuels processing plants but these plants, on the other hand, are located close to the ports and this is an unusual and beneficial situation.
Biofuels production shall not rely on raw material coming from areas such as:

- Forests where there has not been significant human interference or where the last human intervention was long ago and where the natural species and processes have re-established themselves.
- Areas designated for nature protection purposes, unless evidence is provided that the production of biofuels does not interfere with those purposes.
- Forests and rainforests, unless they are managed using sustainable practices.
- Wetlands, i.e. land that is covered with or saturated by water permanently or for a significant part of the year, including peat land.
- Permanent grassland, i.e. rangelands and pasture land which have been under grassland vegetation and pasture use for at least 20 years and are not classified as forest.

Biofuels for Transportation

In the past few years there have been important advances in the field of alternative transportation fuels, primarily bioethanol and biodiesel. Only biodiesel and bioethanol are considered in this report due to their similar inherent properties compared to fossil-based fuels, especially auto-ignitibility. There is a longer-term potential for other biofuels such as biobutanol and biogas but little research effort has been seen in either regular or small engines.

Bioethanol is an alcohol, made by fermenting any biomass with a high content of carbohydrates through a process similar to beer brewing. Today, bioethanol is made from starches and sugars. In

the future, cellulose and hemicellulose fibrous material will be used.

Bioethanol is currently the most commonly used biofuel in an internal combustion engine and in fact, many countries have gasoline fuel standards that require 10% and 20% bioethanol blends. Depending on the controlled parameters in the manufacturing process, properties of fuel bioethanol can be varied and therefore, a standard is required.

Bioethanol is mostly used as a direct blending agent or/and as ETBE, with gasoline to increase octane and oxygenation and cut down carbon monoxide and other emissions. There are two broad groups of bioethanol feedstocks referred to as the "first" and the "second" generation feedstock. The majority of the first generation of feedstocks for bioethanol production are those that are also widely grown for food and animal feed, hence the current debate about biofuels impact on food."

The first generation of biofuels feedstocks include:

i. Saccharine (Sugar Containing) Materials
ii. Starchy Materials
iii. Cellulose Materials

Biodiesel is made by combining alcohol (usually bioethanol) with vegetable oil, animal fat, or recycled cooking grease. These materials contain triglycerides and other components depending on type. Some of the feedstocks are palm oil, coconut oil, canola oil, corn oil, cottonseed oil, flex oil, soy oil, peanut oil, sunflower oil, rapeseed oil and algae. It can be used as an additive to reduce vehicle emissions or in its pure form as a renewable alternative fuel for diesel engines. In the near future, agricultural residues such as corn stover (the stalks, leaves, and husks of the plant) and wheat straw will also be used.

Fuel blends

Flexible-fuel vehicles (FFVs) can operate on any blend of bioethanol with gasoline up to 100% (E100). About seven million FFVs are currently used in the USA running on fuel with 85% bioethanol (E85). US auto companies have committed to manufacturer a larger number of FFVs, in a wide variety of models, to be available at prices competitive with conventional vehicles.

Biodiesel can be legally blended with petroleum diesel in any percentage. The percentages are designated as B20 for a blend containing 20% biodiesel and 80% petroleum diesel, B100 for 100% biodiesel, and so forth.

Using B20 (20% biodiesel and 80% petroleum diesel) provides substantial benefits but avoids many of the cold-weather performance and material compatibility concerns associated with B100. B20 can be used in nearly all diesel equipment and is compatible with most storage and distribution equipment. B20 and lower-level blends generally do not require engine modifications.

Not all diesel engine manufacturers however cover biodiesel use in their warranties. Biodiesel contains about 8% less energy per gallon than petroleum diesel.

Algae biodiesel

While algae biodiesel has the same characteristics as conventional fuel, the production process can be also used to capture CO_2 from power stations and other industrial plants (synergy of coal and algae).

Algae oil production per acre is extremely high and does not even require agricultural land as it can be grown in the open sea, open ponds or on industrial land in photo bioreactors. Moreover algae biodiesel production can be combined with wastewater treatment and nutrient recycling, where polluted water (cleaned by algae) acts as a nutrient in their growth. But most importantly is that algae biodiesel jet fuel represents the best potential answer for the sustainability of the aviation industry today.

It is a well-known fact that different types of biofuels as well as different production technologies for the same biofuel can have very different energy efficiencies. When deciding which type of biofuel to grow and where, energy efficiency must be taken into consideration and weighed against GHG savings and other criteria.

When the harvested biomass is entering the actual biofuel production process, there are further decisions to be made, as different technological options perform differently in terms of energy use. Given a relatively limited availability of biomass, energy efficiency assessment of the entire biofuel cycle should be an essential part of the overall assessment of different alternatives.

Biogas

Biogas is used as transportation fuel in a number of countries although in Europe it is only Germany, Sweden and Switzerland that use biogas-fuelled vehicles to a somewhat significant extent.

For example, in Sweden, in 2008 approximately 15,000 cars and hundreds of buses and trucks were running on biogas. Biogas accounted for 0.3% of the total car fuel consumption, while Bio85 accounted for 0.4% and Bio95 for 2%.
Biogas is produced from four main sources:

- Sewage treatment plants
- Landfills
- Cleaning of organic industrial waste streams
- Mesophilic and thermophilic digestion of organic waste.

Biogas can be used in both heavy duty and light duty vehicles. Light duty vehicles can normally run both on natural gas and biogas without any modifications whereas heavy-duty vehicles without closed loop control may have to be modified if they are to run both on biogas and natural gas.

Issues related to Engines and Engine/Fuel Interface

Combustion characteristics of biofuels are different from those of regular fuels due to:

- differences in fuel flow,
- physical phase change,
- fuel atomization to chemical reaction, and
- heat exchange.

In addition to combustion issues, replacing fossil-based fuels with biofuels can lead to other concerns about engine performance, durability and fuel storage.

The effects of replacing fossil-based fuels with biofuels depends on the inherent properties of the fuels and engine operating principles.

Technology Outlook for Biofuels

The recent developments in biofuels suggest that the rapid growth of biofuels use could continue for decades.

The potential for biofuels is particularly large in tropical countries, where high crop yields and lower costs for land and labour provide an economic advantage. It has been estimated that worldwide sugar cane production could be expanded so that crop alone could displace about 10 percent of gasoline use worldwide.

Attracting substantial finance and investment is a prerequisite for scaling up the development of biofuels internationally. The challenge is to introduce the right policy frameworks and financial tools to enable biofuels to achieve their market potential.

Capital flows to the market environment which demonstrates strength, clarity and stability. That environment must be specific enough to improve the bankability of projects and provide conditions for steady market growth. Rules and incentives need to be stable and sustained for a duration that reflects the financing horizons of the projects.

Generally, the development of biofuels on a global scale makes a lot of sense. So what then can and should be done about the diversity of source types available for biofuels and the diversity of geographical assets (e.g. Brazilian sugar cane, American corn, India's cassava, Africa's sorghum, Europe's wheat, etc)? How will Brazil's sugar cane be used in the United States or how will African sorghum be used in Europe or how will American corn be used in Asia?

Biofuels and Climate Change Regulations

Calls for global carbon regulations are growing. The Conference of the Parties 15 (COP15) held in Copenhagen in December 2009 was expected to reach a global far-reaching agreement to replace the Kyoto Protocol. This did not happen, although certain progress has been achieved on a number of points.

Defining the sustainability criteria for biofuels is a complex task which may have crucial implications for market development. Broad stakeholder involvement and comprehensive consultation are necessary for a balanced and feasible outcome of the process.

It is necessary to look into the greenhouse gas emissions savings and accounting principle. This principle is drafted in accordance with key policy indications facilitating the inclusion of legislative provisions in future sustainability meta-standards.

The Life Cycle Assessment (LCA) of the production of biofuels for energy applications or other end uses represents the tool most widely used for the GHG balance accounting.

Policy aspects

The world´s transport system is based on one single fuel - oil and today there does not seem to be any realistic alternative to oil. Demand for oil is expected to grow for decades to come, along with the overall demand for energy. Biofuels can help meet this demand, and even if they will not replace oil, they should be regarded as an integral part of the energy mix.

To achieve a rapid scaling-up in biofuel production that can be sustained over the long term, policies that are consistent, long-term and supported by broad stakeholder participation are needed. They should also fit in the context of larger transportation goals. Increasing efficiency still remains the cheapest way to alleviate the pollution and security risks associated with petroleum use.

Supportive government policies have been essential to the development of modern biofuels over the past two decades. Blending regulations, tax incentives, government purchasing policies, and support for biofuels- infrastructure and technologies have been the most successful in increasing biofuels production.

Countries seeking to develop domestic biofuel industries will be able to draw important lessons—both positive and negative—from the industry leaders, in particular Brazil, the United States, and the European Union.

The criteria for decision making may be general, based on the three pillars of sustainability, but the relative weight given to economic, social and environmental aspects should be a matter for local decision making. For example, in areas of exceptional biodiversity, the weight of environmental considerations will likely to be different from that applied in areas with dense and poor rural populations.

Another key issue is compatibility. Biofuels need to be compatible with current vehicles and transport logistics. This means that a fuel needs to meet current fuel specifications and can be blended into current fuel or use the same logistics. Fuel properties also need to be sufficient to be compatible with future engine designs.

Investment issues

Subsidies for biofuels feedstock can also distort markets. They may contribute to inefficient allocation of resources, and thus lead to distortion of food markets.

Further, the debate on climate change is likely to produce regulations world-wide that will encourage and/or subsidize biofuel investments. To help overcome the risk of oil price volatility undermining investment in biofuels, regulators will need to enact particular policies to encourage investment into biofuels.

In general, as an alternative to oil, biofuels is not a safe investment today. As a potential help to climate change regulation, biofuels looks like a good investment.

Finally, the market players will determine the relevance of different standards. They will decide upon their individual needs (imports/exports into/from different countries, marketing purposes, costs etc.).

It is key to remember that costs are the main drivers for all economic activities which will include now more and more corporate and social responsibility (CSR), and sustainability aspects. In a cost and CSR-driven economy, the role for voluntary higher standards will remain clearly mitigated.

Guiding Principles

The guiding principles of this report aim at a common framework for public and private sector entities to consider and focus their efforts related to biofuels development and deployment. These principles are:

- Diversify supply of transport fuels, enhance security of supply, mitigate economic volatility related to oil price fluctuations, and improve global environment through sustainable biofuels practices.
- Identify technical criteria which can be used to standardise production of biofuels through different processes from different feedstocks.
- Pursue trade policies that support the growing use of regional transportation fuels.
- Foster the development of a sustainable biofuels industry through favourable tax, trade and public policy measures without impeding the development of a global marketplace for biofuels.
- Cultivate the competitive advantages of regional and national biofuels feedstocks (sugar cane, corn, cassava, sorghum, wheat, etc.), but not at the expense of destabilising fuel or food markets.
- Strengthen the investment flowing into biofuel development through transparency in public sector requirements and technological breakthroughs.
- Conduct a cradle-to-grave LCA for evaluation of economic, energy and environmental impacts using a common, objective and transparent methodology.
- Utilise existing literature to advance understanding of biofuels (see References and Bibliography).

Conclusions and Recommendations

Biofuel policies should focus on market development and facilitate sustainable international biofuel trade. The geographical disparity in production potential and demand for biofuels will necessitate the reduction in barriers to biofuel trade. Free movement of biofuels around the world should be coupled with social and environmental standards and a credible system to certify compliance.

Tax incentives have been used effectively in Brazil, Germany, the United States and other countries to spur biofuel production and reduce biofuel prices at the pump. The enormous purchasing power of governments has been used successfully in a number of countries to expand the market for various products.

Consumer demand could be a powerful driver of the renewable fuels market. Strategies to increase the public's awareness about biofuels include various forms of public education, such

as formal awareness campaigns, public announcements, university research, etc.

More sustainable feedstock and technologies are needed, including those that provide enhanced net reductions in GHG emissions and in fossil inputs.

If biofuels continue their rapid growth around the globe, the impact on the agricultural sector will be dramatic. Increased jobs and economic development for rural areas in both industrialized and developing countries is possible if governments put the appropriate policies in place and enforce them. The more involved farmers are in the production, processing, and use of biofuels, the more likely they are to benefit from them.

Enabling farmer (and forest material producer) ownership over more of the value added chain will improve rural livelihoods. This not only helps improve the well-being of farm families, it increases the positive effects as greater farm income is circulated in local economies and jobs are created in other sectors. As biofuel industries grow, this multiplier effect will have impacts on the regional, national, and international levels. Greater farmer ownership will also help prevent large processors exert pressure on small producers. In regions where access to modern forms of energy is limited or absent, government and development agency support for small-scale biofuel production can help provide clean, accessible energy that is vital for rural development and poverty alleviation.

While it is recognised that biofuels have the capacity to reduce greenhouse gas emissions compared to fossil fuels, their production and use are not entirely without environmental implications. Depending on the crop type, carbon emissions are not always lower than for traditional fuels.

International trade may help to ease fuel supply issues, linking a larger number of producers in order to minimize the risk of supply disruption. Also as renewable fuel use becomes more widespread, opportunities for countries with more developed biofuels industries to export their technologies will expand.

Biofuels may be categorized as agricultural goods under the WTO Agreement on Agriculture. Industry may seek an exemption from the Agreement's restrictions on domestic price supports.

Alternatively, if biofuels are categorized as industrial goods, they may qualify for treatment as "environmental goods." To be included in such a category they should be required to meet strict environmental standards for their production.

Governments should promote biofuels within the context of a broader transformation of the transportation sector. Biofuels alone will not solve all of the world's transportation-related energy problems.

To achieve their full potential to provide security, environmental, and social benefits, biofuels need to represent an increasing share of total transport fuel relative to oil.

1. Governments should pursue efforts that lead to diversification of transport fuel sources to improve economic, energy and environmental security.

"Safety and certainty in oil lie in variety and variety alone"

Winston Churchill

2. Agricultural policies should balance the need for food and water supplies with biofuels production.

3. When performing analysis of fuel source and type, a cradle-to-grave LCA is necessary for understanding of economic, energy and environmental impacts using a common, objective and transparent methodology.

4. Governments should conduct research to gain a better understanding of impacts of biofuels production and use on public health and local environment, as for other energy sources.

5. Governments and industry should invest in biofuels research and development to stimulate breakthrough technologies and share best practices and technologies for biofuels production and use.

6. Governments should pursue policies to encourage private sector investment into commercial scale production of biofuels – for proven technologies, including incentives for scaling-up technology from pilot to demonstration to commercial scale.

7. Each country should strive to develop open and free markets for biofuels, although grandfathering subsidies, tariffs and other tools might be needed until domestic markets have been established.

8. All agricultural policies and strategies are based on local, national or in some cases regional circumstances and they include the mix of environmental (land, water, climate), social (population, education) and economic (infrastructure, governance) factors. It is therefore impossible to develop "one-size-fits-all" policies for biofuels production.

9. Identifying the right place of biofuel production in the agricultural economy, including choices of the actual types (diesel from vegetable oil, ethanol from sugar or starch crops, solid biofuels from wood or grass sources) is a significant policy challenge.

10. While it is recognised that biofuels have the capacity to reduce greenhouse gas emissions compared to fossil fuels, their production and use are not entirely without environmental implications. Depending on the crop type, carbon emissions are not always lower than for traditional fuels.

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