# The Global Policy Environment for Biofuels

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## Introduction

In a global environment challenged by climate issues, shifting economic power, energy supply and reliability factors as well as volatile prices, developed and developing countries alike are both questioning and investing in biofuels and related technology. There is both public and political expectation that a biofuel industry will provide some of the solution to energy security whilst also addressing climate change through a reduction in greenhouse gas emissions from transportation fuels, in addition to providing new opportunities to farmers and contributing to regional growth.

Clearly, public policy interventions, whether they are at a local, international or global level, need to be carefully thought through if they are to be both effective in delivering desired outcomes and to also avoid unintended consequences. Agricultural producers in particular are only too well aware that public policy interventions, while assisting some, can often distort markets and opportunities for many others, especially those in developing countries and also in efficient, low-assistance economies like Australia.

This paper canvasses some recent biofuel policy interventions that have occurred in an effort to address energy security, biomass production for biofuels, as well as related environmental and regional development issues, and briefly discusses public policy interventions and instruments.

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## Energy security

It has long been considered that a major task of governments is to maintain and improve the well-being of their citizens and that economic growth is a key component. Significant economic growth over the last five decades has been made possible by the emergence and availability of low cost, high-energy-density petroleum products in significant volumes, along with the parallel development and evolution of the internal combustion engine. These changes also partially assisted the expansion of agriculture and food production so as to meet the demand of a rapidly growing world population; facilitating the transformation of horse/oxen powered systems to petroleum-fuelled mechanisation.

Government policy in respect of the security of fuel supplies and fuel prices is of extreme importance, given the fundamental contribution that energy makes to both the current economic wellbeing of communities and to their future economic growth, as well as the necessity to meet a population's basic needs.

Apart from the least developed societies, communities around the world are now highly dependant on energy for their wellbeing. In general, the greater the population and the higher the Gross Domestic Product (GDP) per capita, the greater the energy dependency, making these two factors the drivers of fuel demand (OECD 2004, 2007; World Bank 2007; EIA 2007a,b).

It is clear that future demands for oil will be highly influenced by both population and economic growth in the course of the 21st century, and this means the demand will be driven in particular by developments in the United States of America (USA), Europe, Japan, India, China and South America. Figure 1 shows oil use in the top six oil-consuming countries for the period 1960–2005. It is worth noting the rapid increase in consumption by China in recent years. It is estimated that the world's total energy demand will increase by around 60% by 2030 (OECD 2004; Waide 2007).

Given community dependence on petroleum and gas for energy supply, it is not surprising that governments focus on the security issues. These issues include the real prices, volatility of supply, production volumes and future supply capacity as determined by reserves.

Prices of oil have been, and will be, a significant influence on the drive to develop and identify alternative fuel sources. The oil price spikes of the 1970s, caused through OPEC actions, against a long-term trend of declining real oil prices, sharply focussed governments world-wide on energy security. We are now in another period of oil price shocks due to a strong world demand for energy, and supply and refining capacity issues. Additionally, unlike other commodities, oil prices are particularly subject to short- and medium-term political shocks. However, when viewed across a long time horizon (Fig. 2), it is important to note that oil prices, and energy prices in general, have generally continued to fall in real terms, and that the volatility in prices for oil has often been less than for other commodities, such as grain (ABARE 2007). Oil remains the preferred source of high-density energy relative to alternatives.

The production of oil has currently plateaued in many of the economies that are major users of the product — for example, the USA, Europe and China — leading to concerns by some that this may also be occurring in many of the major oil exporting countries. Furthermore, there has been significant debate in recent times over the level of long-term reserves of oil. Importantly it is reasonably contended by many that oil reserves are finite and have reached their limits with respect to being able to meet future world demand for energy. These issues around energy production and supply capacity are a focus of governments, concerned about meeting the energy demands of growing populations with increasing expectations of economic growth.

History demonstrates, however, that as oil reserves and production growth have been challenged, prices increase, and consequently oil exploration intensifies and thus the search for new oil fields and recovery methods also increases, as does the search for alternative energy supplies (Conn 2006).

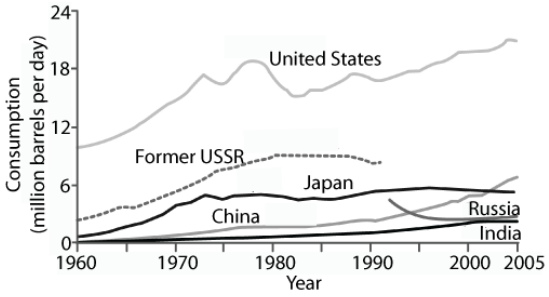


**Figure 1.** Major oil consuming countries (1960–2005). Source: EIA (2006)

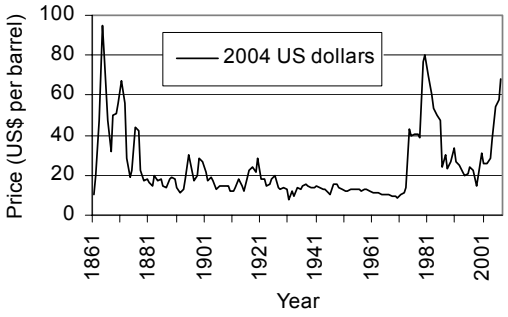


**Figure 2.** Oil prices, 1861 to 2007. Source: Campbell (2005) and EIA (2007c)

To date, oil reserves have continued to increase over time. According to the *International Energy Outlook 2007*, a research paper published by the Energy Information Administration (EIA 2007b), oil production will increase from 2004 levels (of 83 million barrels per day) by 42% to the year 2030 (or up to 118 million barrels per day), with 65% of that increase expected to come for OPEC countries, as illustrated in Table 1. Interestingly, OPEC's market share has declined since 1973 to 41% in 2004, mostly due to high oil prices driving new exploration and production technologies from non-OPEC countries.

**Table 1.** Oil production and market share, 1973 to 2030. Source: EIA 2007b

| Year | OPEC | | Non OPEC | | Total production (million barrels/ day) |
|---|---|---|---|---|---|
| | Production (million barrels/ day) | Market share (%) | Production (million barrels/ day) | Market share (%) | |
| 1973 | | 52 | | 48 | |
| 2004 | 34 | 41 | 49 | 59 | 83 |
| 2030 | 57 | 48 | 61 | 52 | 118 |

Additionally, the geographic location of oil reserves remains a major issue for governments — particularly governments in the western world — in their quest for oil-alternative energy supplies. These major economies are distinguished by the fact that their population bases, their GDP levels, their future growth and their need for oil, far exceed their relatively limited oil reserves. Furthermore, the geographic location of major oil supplies and reserves are notable for their asymmetry with those countries requiring them as inputs in significant quantities, and some of the big consumers — China and India — are growing very rapidly.

It is also worth noting that many of the major suppliers/reserve holders are countries with relatively small populations; with different political persuasions and aspirations; and in a number of cases, are politically unstable and prepared to use their oil production and reserve capacity as a policy instrument to achieve their political goals. These factors increase governments focus on the security of oil supply, price and future reserves.

In addressing energy security issues and looking at alternative energy sources in order to meet the growing world demand, it is important to broaden the debate beyond biofuels. For many countries (China, India, USA, Russia and Australia), coal is a very significant resource for future energy supplies, although current technologies principally direct it to stationary energy production. New coal technologies (gasification, synthetic gas and liquid fuels) offer promises if concurrently, carbon capture technologies become commercially effective. Although it is not used to the same extent as coal, nuclear energy is another alternative; it is also constrained in its value for transport (Conn 2006).

Other energy sources, such as hydro, wind and solar are generally suited to producing electricity — and this is available for vehicular use only if it can be effectively and efficiently stored, which to date has had limited commercial success.

Therefore, the demand for high energy density liquid fuels for transportation (particularly road, shipping and aviation) remains a key element to the future economic wellbeing of the globe in general, and to the transport sector in particular (Conn 2006). Hence the focus on biofuels.

## Biofuels

Renewable biological sources of fuel were the traditional and the major suppliers of energy for human endeavour for thousands of years. Thus the energy to meet human needs was obtained from biomass until the 19th century, when coal became dominant (Conn 2006). Since World War II petroleum and natural gas have been dominant, as Figure 3 illustrates.

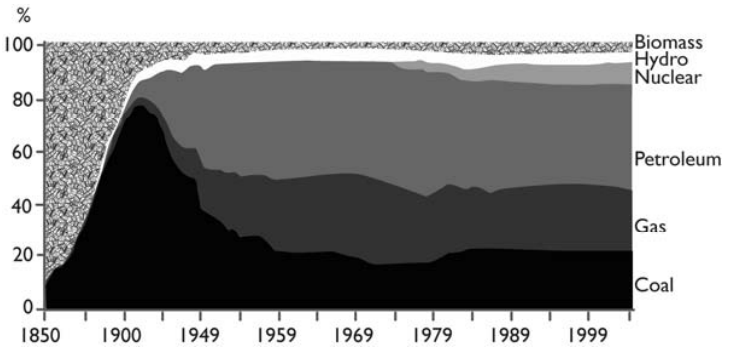


**Figure 3.** Energy consumption chares by source. An additional category, 'Other', is not large enough to depict at this scale. Source: Conklin (2007)

Since the beginning of the 19th century, there has been huge growth in world population and economic production. Biomass now plays a diminutive role relative to petroleum, gas, coal, nuclear and hydro, as illustrated in Figure 4. In a global policy sense, it is evident that biofuels can have only a partial role in the energy security equation.

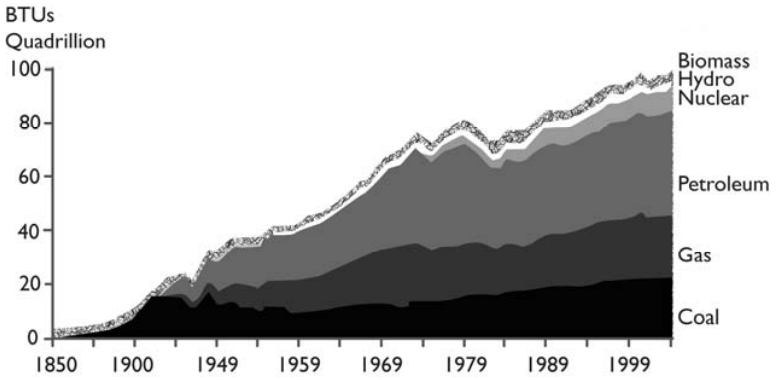


**Figure 4.** Energy consumption: quantity by source. An additional category, 'Other', is not large enough to depict at this scale. Source: Conklin (2007)

Furthermore, energy suitability and substitutability of biofuels for oil derivatives (in terms of both government policy and market signals) is an important issue in the search for alternatives to our current transport fuels. Significant policy questions arise with respect to relative energy efficiency, technical feasibility and price.

The biofuel production process is fundamentally dependant upon converting the solar energy of the sun into energy in stored biomass, by way of photosynthesis, and subsequently converting that biomass into some form of biofuel. This process is also dependant on having suitable substrates for the biomass, such as land, water and nutrients.

This 'biomass equation' is part of the inherent appeal of renewable energy sources such as biofuels; but each of the elements in the equation potentially puts limits on the long-term supply of biofuels. From a policy development perspective each of these elements needs to be addressed in detail. The following brief observations demonstrate some of the underlying issues with respect to the 'biomass equation':

i). **Solar energy** is a key input into biofuel production. Clearly in order to maximise the production of biofuel systems the greater the access to solar energy the better. Thus, in simple physical terms, locations close to the equator are much more desirable than areas of the globe near the poles.

ii). **Land** availability is a critical element in biomass production as land is likely to be the most suitable production substrate. This means factors such as available area and terrain suitable for cultivation and the harvesting of a biomass production system. The most useful sites for land biofuel production are currently in use for arable crop production, grazing or forestry, or are ecologically sensitive (even if of low economic value) so that in a policy sense biomass production for biofuels is mostly in competition with existing purposeful land use. While biomass production systems of plant material (e.g., algae) in a substrate of water are theoretically possible, these systems are presently not extensively commercially available, and in future such developments may also give rise to significant environmental policy concerns.

iii). **Water** availability is an essential ingredient in land-based biomass production and processing systems. Already much of the developing world is suffering water stress, and the question of available water supply and price needs to be addressed in terms of any large-scale biomass production and processing system. Variability in climate and water supply are also important practical and policy issues for a reliable long-term biomass production process aimed at producing an alternative to other energy sources.

iv). **Nutrients** are an essential ingredient in each of these biomass production systems and it is essential to carefully assess the externality and policy implications of fertilisers and pest management required by these systems.

v). **Plant** species/varieties are then the critical input for biomass generation. The biomass in 'first-generation' technology biomass production systems is usually starch/carbohydrate used for fermentation and conversion to ethanol, or oil extracted from oil seed to contribute to biodiesel production. 'Second-generation' technologies are focussed on using other components of

the biomass, particularly cellulose, together with specialised enzymes, as direct inputs into biofuel production. These second-generation systems are less well developed, and more dependant on the success of current research and development initiatives and subsequent commercial implementation of new processing methods.

The biological material to be chosen to take advantage of each of the preceding elements is dependant on the climatic suitability of the area, the particular suitability of the plant species being used and its capacity to deliver the appropriate volumes of biomass for optimal biofuel production. So-called 'new species' or new genetic material, while often suggested as having significant potential, are unlikely to have much overall production impact.

In practice, few countries have large unused areas of land, drenched in solar energy, suitable for an efficient biomass production and harvesting, and served by adequate water and nutrient supplies. These issues have been considered by many authors, including von Braun and Pachauri (2006), de Almedia (2007) and Doornbosch and Steenblik (2007).

Furthermore, when farmers come to make production choices they are confronted by a wide range of production possibilities highly influenced by:

- physical factors
- their own technical capability
- the availability of suitable resources to facilitate a production system
- the performance of the production system within this framework
- the relative costs and prices of the different possibilities at the farm gate.

Policymakers wanting to encourage biomass/biofuel production must understand that farmers respond to more remunerative opportunities as these arise. Certainly farmers considering producing biomass for ethanol using existing production systems (for example, sugar cane, corn, wheat, soybean and canola) find the switch relatively easy because it is only the price variable they have to respond to, as opposed to a changed, different or more complex production system. This simple response to relative prices is a choice that farmers have been familiar with for a long time.

On the other hand, farmers considering establishing a new cropping system — whether it be a grain, oilseed, sugar or other biomass source — with which they are unfamiliar, will want to understand in detail the biological material and its varieties; physical methods of production; harvesting, handling and distribution; the scope for improving yields and returns; and the risks associated with each of these issues.

In new production systems there is often much greater variability in output than in existing systems. Farmers will be interested in adopting production systems with a long-term higher return, provided the risks are not excessive.

Unfortunately, when communicating the virtues of new varieties, approaches and systems and making comparisons, technologists often focus on the highest sustainable yields in the presence of adequate land, nutrients, water and disease management, rather than looking at the range and probabilities within each factor. As well, little attention may be given to relative costs and prices, and their variability, as compared to more traditional products.

In summary, for farmers, biomass production is a matter of:

- available technology
- variability and risk associated with that technology
- scope for technological improvement
- potential yields
- long-term as well as short-term costs and prices.

Another significant element in the conversion of biomass to biofuels that requires consideration by policymakers, farmers and investors alike is the availability and cost of transportation. Biofuel is a high-volume, low-value commodity and as such the cost of transporting feedstock to production sites critically affects the financial viability of operations. Other energy sources such as gas or oil are regularly transported using pipeline distribution networks, which are comparatively more cost efficient than the road or rail transport system used in the biofuel industry. Therefore the proximity of biofuel processing plants to cropland, or biodiesel production plants to ports, is a major cost factor in respect of biofuel production.

## Biofuels — environmental issues

One of the policy expectations of a biofuel industry is that it produces better environmental outcomes through use of renewable energy sources and greenhouse gas abatement. Biodiesel in particular is thought to offer considerable potential for greenhouse gas reductions. The level of net benefit, however, varies greatly with the feedstock, and plant design and operation (Steenblik 2006; Doornbosch and Steenblik 2007; Marshall 2007).

The International Transport Forum and Organisation for Economic Cooperation and Development (OECD) Joint Transport Research Centre Round Table on *Biofuels — Linking Support to Performance* recently concluded that there is a 'high degree of uncertainty over the net greenhouse gas emissions from producing and consuming biofuels in place of gasoline or diesel' (ITF 2007). Policy settings need to promote the use of the 'cleanest' biofuel product and therefore need to focus on the relative greenhouse gas contributions of the various fuel sources. There is now significant technical and policy debate on these questions, which needs careful investigation.

The development of an energy supply based on renewable crops is a significant positive aspiration, but calculating and offsetting externalities also need careful assessment. Common externalities include the ability to maintain soil fertility and structure, water utilisation and nutrient management, as well as overall greenhouse gas emissions.

Biofuel development will have, like almost all investments, both positive and negative environmental impacts, and these need to be carefully assessed in any overall environment evaluation. Without such analysis, the extent to which biofuels can make a positive contribution is not always clear (Jacobson 2007).

While commercial application of second-generation technologies is yet to be proven, they do offer the prospect of producing biofuels with a much better greenhouse performance, without competing with food production.

## Biofuels — regional development

The effect of new technologies in regional areas, in respect of economic, social, infrastructure and environmental consequences, are always important when changes are being driven by government policy interventions. Policy interventions for biomass production have been focussed upon it as being a means of providing for regional economic development — in particular, policies underpinning prices for relevant crops, policy interventions supporting bioenergy production, and policies encouraging investment of new capital and development at the local level.

As discussed earlier, it is more cost effective for biofuel processing plants to locate close to biomass source, and this is most likely to be in rural areas or regional coastal areas close to ports. In any phase of biofuel expansion there is a significant need for infrastructure, and given the newness of the industry and the physical and chemical characteristics of the fuel, a level of both production and distribution technology needs to be introduced which will almost certainly give rise to short-term economic growth.

This pattern of investment and development will be advantageous if policies and circumstances supporting biofuel prices remain in the long term. If not, there is the risk that some capital investment will be jeopardised by subsequent negative policy and/or price change. This can lead to asset values in regional communities falling and possibly becoming fixed, leading to general dysfunction.

In Australia, regional development has been one of the key drivers behind the government's interest in promoting the development of a viable domestic biofuel industry. Construction and operation of biofuel production facilities provides direct employment in regional Australia. The facilities also provide an alternative market for agricultural products, including poorer quality feed grains which otherwise would yield lower monetary returns.

There are always risks associated with long-term subsidies for particular products in a competitive marketplace. While producers of biofuel feedstock and biofuel producers may welcome subsidies, ongoing subsidies can:

- distort markets and lead to inefficient outcomes
- enable biofuels to compete directly and unfairly with other industries using the same inputs (e.g. intensive livestock production)
- be an expensive and inefficient approach to achieving the government's regional policy objectives, including the creation of jobs
- increase pressure on natural resources, including water.

The risks from ongoing subsidisation are highlighted in the current 'food or fuel' debate regarding the merits of encouraging large-scale switching of grain production from being a feedstock for food production to one for transport fuel production (Doornbosch and Steenblik 2007).

## Biofuels — public policy interventions and instruments

Public policy interventions by governments usually take place when they consider the market is responding inadequately to a range of matters. In respect of biofuels, a number of reasons have been given as the basis for intervention, including:

- improving energy security
- managing climate change and abating emissions of greenhouse gases
- improving environmental outcomes through increased use of a renewable energy source
- regional development
- improving incomes for farmers
- improving international market opportunities for developing countries.

As developments take place for biofuels, it is useful to have an understanding of the policy instruments that are being used by governments, and to have some knowledge of how these might play out within the global policy environment for biofuel operatives.

Given that the extensive range of policy interventions by European, North American and South American governments (Steenblik 2006; von Lampe 2006; de Almeida 2007), it is clear that these governments believe that there are some serious extensive market failures and, given that situation, there is a need for governments to directly intervene, thereby over-riding normal market signals.

Furthermore, it is evident that existing oil production systems give rise to externalities which are not fully priced and that indirect costs are being imposed upon the rest of society. This applies, in particular, to greenhouse gas emissions which occur as part of existing oil-based fuel technologies.

Given the long-term supply chains involved in biofuel and alternative energy sources, it is useful to have some framework for evaluating the various policy interventions.

In general, a critical requirement in managing economies on a national basis is to set robust and independent economic frameworks within which industries may succeed — or fail (Conn 2006; von Lampe 2006).

For the most part within this framework, the production of biofuels has been relatively limited; accordingly governments, sensing market failure, have sought to intervene to provide long-term signals to industry in respect of future government priorities.

Thus, to assist discussion of the question posed by the conference title, it is important to briefly address the policy measures being used globally to facilitate the establishment of biofuel industries. These policy instruments include:

- research and development
- infant industry start-up assistance policies
- regulation
- taxes, charges and excises
- production and processing subsidies/rebates
- demand side support
- market access restrictions
- export subsidies.

### *Research and development*

Government support for research and development at all stages of biofuel production and processing is extensive, increasing and desirable. Knowledge derived from this work is increasingly widely available and in most cases effectively transferred between countries. In a policy sense, it can be expected that funding (both public and private) will continue to grow across the entire biofuel supply chain.

### *Infant industry start-up assistance policies*

Governments in many countries support infant industries through grant programs, assisting 'first movers' to offset the high costs typically involved in the start-up phases of a new industry.

These grant programs normally apply for a defined period, phasing out as production costs decrease through efficiencies of scale, technological advances and normal competitive pressures.

It is argued by some, however, that start-up grant programs are not warranted in this industry as the production of ethanol — using the same fermentation process traditionally used in the production of alcohol — is a long-established industry. Others nevertheless make a strong case for continuing support, given the circumstances of fuel security and the opportunity for renewable energy supply.

### *Regulation*

Direct government intervention and regulation occurs to force desired behaviour where markets have been or are unsuccessful in achieving government objectives. Regulatory measures include:

- standards (fuel quality and emissions controls)
- targets
- mandates
- non tradeable permits.

Regulatory interventions are used particularly when market demand for the product to be constrained is inelastic, or where market forces will work too slowly, or may be too costly, to meet policy objectives. Invariably, however, regulatory compliance requires enforcement and penalties, and leads to increases in overall costs.

All countries facilitating biofuel development have used a range of regulatory measures to assist biofuel production and consumption.

### *Taxes, charges and excises*

Taxes, charges and excises are often imposed on fuel, particularly petroleum fuels, as a means of raising revenue and indirectly attaining other policy goals.

The value of such interventions in influencing a switch from oil-based fuel to biofuel-based alternatives is dependant on the relative prices of available alternatives. In facilitating the relative competitiveness of biofuels, most governments have provided exemptions of some form from excise duties relative to petroleum fuels (Steenblik 2006; Doornbosch and Steenblik 2007).

### *Production and processing subsidies and rebates*

Rebates as well as production and processing subsidies are also used as policy instruments to provide assistance. These measures also include:

- direct payments
- grants
- soft loans
- tax allowances.

All these policy measures are used by governments to provide incentives to biofuel production, and extensively so in the USA and Europe. In the long term, such subsidies are likely to lead to undesirable distortions in the marketplace and inefficiencies in an economy.

### *Demand-side support*

Demand-side support policies come in various forms, and in the case of biofuels, the aim is to facilitate biofuel uptake relative to other fuels. Measures include vehicle engine design, for example the production of 'flex-fuel' cars in Brazil, and grants for petrol stations to convert and install biofuel tanks and pumps.

### *Market access restrictions*

Invariably the domestic support policy measures, noted above, artificially raise domestic prices and attract competition from imports. Thus governments, concerned not with competition but with domestic issues, respond in such circumstances with:

- tariffs and quotas, as has been the case with most western countries
  or with
- non-tariff trade barriers, as is proposed by the European Union and based on the claim of protecting rainforests in Brazil.

### *Export subsidies*

As well the preceding market intervention policies can also lead to export subsidies, so as to deal with surplus production. Export subsidies have often been used to facilitate the disposal of production surplus to domestic market needs. This policy failing is unlikely to be significant as, apart from Brazil, few biofuel-producing countries have been able to meet their own domestic requirements, let alone contemplate the international market.

## Conclusion

The globe's population will continue to grow, as will its demand for energy to facilitate the economic improvement of communities. The geopolitical situation is likely to increasingly encourage governments to seek improved reliability of energy supplies from domestic sources, as well as to proactively address the challenges of greenhouse gases. The latter will almost certainly require the implementation of successful carbon capture technologies, while in respect of the former, biofuels will play a partial role.

From a global perspective, the best approaches will:

- have a minimum of market distortions
- have properly priced externalities of all fuel production/utilisation systems
- consider long-term sustainable solutions
- include a mix of all energy sources
- use public and private investment to drive research and development in priority research areas
- facilitate the adoption of recent technologies.

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