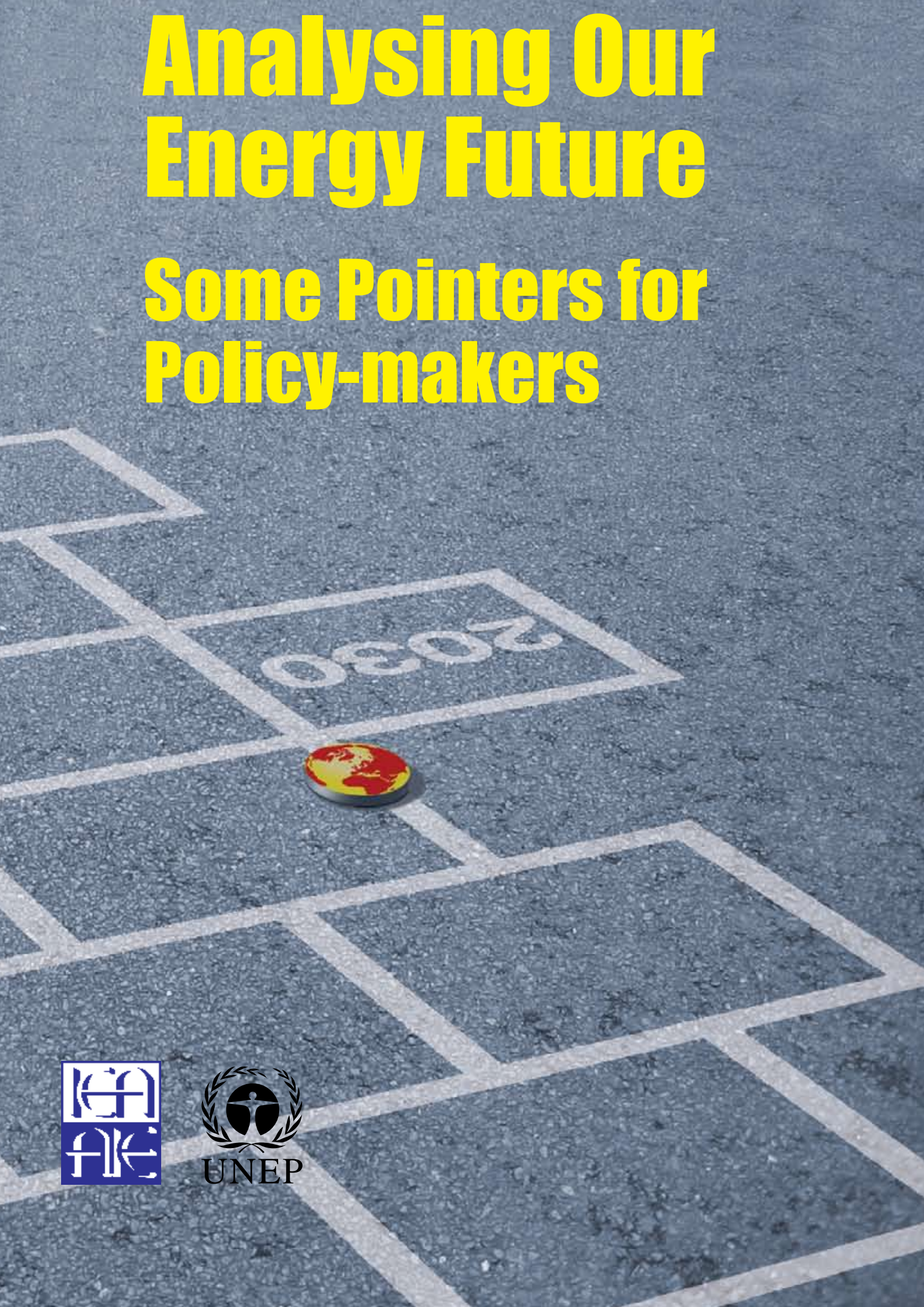
Analysing Our Energy Future

Some Pointers for Policy-makers



UNEP

Copyright © United Nations Environment Programme and International Energy Agency (2007)

This publication may be reproduced in whole or in part and in any form for educational or non-profit purposes without special permission from the copyright holder, provided acknowledgement of the source is made. The United Nations Environment Programme and the International Energy Agency would appreciate receiving a copy of any publication that uses this publication as a source.

No use of this publication may be made for resale or for any other commercial purpose whatsoever without prior permission in writing from the United Nations Environment Programme and the International Energy Agency.

Disclaimer
The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the United Nations Environment Programme or the International Energy Agency concerning the legal status of any country, territory, city or area or of its authorities, or concerning delimitation of its frontiers or boundaries. Moreover, the views expressed do not necessarily represent the decision or the stated policy of the United Nations Environment Programme or the International Energy Agency, nor does citing of trade names or commercial processes constitute endorsement.

Printed on Forest Stewardship Council-certified paper with vegetable-based inks

ISBN: 978-92-807-2812-5

[April 2007]

Policy-makers increasingly rely on prospective studies to support their efforts to set policy goals and identify the most appropriate measures to achieve them. The United Nations Environment Programme and the International Energy Agency advocate this approach and over the years have contributed, each in its own domain, a range of scenario studies.

The Track Record on Scenario-supported Policy

Scenarios of all types have become an integral part of the policy-making process. By looking at plausible future trends in a systematic manner, scenarios support the early detection of emerging issues and help policy-makers prepare for otherwise surprising developments. They provide a bridge between science and policy.

Companies such as Shell, IBM and General Motors have successfully used scenarios to frame their business strategies. For example, in the late 1960s Shell introduced scenario-based multi-annual planning that served it particularly well during the oil price shocks of the following decade.

Similarly, public policy is increasingly being supported by scenario analyses. These have been used in areas as diverse as technology and public health – for instance, to scope out the potential role that nanotechnologies could play in a wide range of societal areas and to develop remedies for infectious diseases, notably AIDS and SARS.

Last but not least, scenarios have become a central part of the climate change policy debate. The **Special Report on Emission Scenarios** produced by the Intergovernmental Panel on Climate Change in 2000 is often quoted as a landmark publication that paved the way for the widespread use of scenarios in this area.

scenarios

Annex 1 on page 14

In particular, the International Energy Agency's *World Energy Outlook* has become a key reference in energy policy worldwide. *Analysing Our Energy Future* is a summary of some of the main findings in the 2006 edition of the *World Energy Outlook*. It also draws on related materials in order to set the findings in the wider context of energy for sustainable development.

The report focuses on the *World Energy Outlook*'s Alternative Policy and Beyond the Alternative Policy Scenarios – a deliberate choice aimed to spur action by underscoring the impacts on the future of the policy decisions made today. It is written in non-technical language to make it accessible to as wide an audience as possible.

One important conclusion of this report is that the major challenges facing the global energy system today are interlinked – both financially, through global energy and capital systems, and politically, in future agreements under the United Nations Framework Convention on Climate Change. Dealing with these challenges requires both a comprehensive approach and co-ordinated action.

1 Today's Pressing Energy Needs

Scenario results have helped develop a consensus on today's most pressing energy needs:

- ensuring continued access to energy supplies[1]
- reducing emissions of greenhouse gases and
- providing universal access to modern forms of energy.

First, rising oil and gas demand, if unchecked, will accentuate consuming countries' vulnerability to supply disruptions and price shocks. Poorer countries will be especially at risk: the loss of real income and the adverse impacts on the budget deficits and current account balances of importing countries are proportionally greater for them.[2]

Second, the energy sector is the main contributor of emissions of greenhouse gases. Stabilising the concentrations of these gases at a level that would avoid human-induced interference with Earth's climate[3] requires drastic changes in the fuel mix, more-efficient production and use of energy and measures that prevent carbon dioxide from being released to the atmosphere over geological timescales.

Third, almost 1.6 billion people in developing countries, about one-quarter of the world's population, do not have access to electricity in their homes. Some 2.5 billion people rely on traditional fuels and technologies for cooking and heating. This threatens the realisation of the development goals agreed to as part of the United Nations Millennium Declaration.

Identifying cost-effective policies to meet these needs is a difficult task. Nonetheless, successful approaches do exist that warrant wider replication. Yet implementing these policies is even more difficult, as they often encounter resistance from industry and consumer interests.

While the benefits of taking corrective action toward a sustainable energy path would for the most part accrue in the future,[4] the costs would be felt today, which limits their appeal to policy-makers. Yet the costs of inaction outweigh those of implementing the needed policies, so there is clearly a need for improved dialogue between government, industry and consumers to develop effective, long-term policies.

---

1 In a recent publication (**Energy Security and Climate Change – Assessing Interactions**), the International Energy Agency puts forward a methodology for countries to assess the vulnerability of their energy systems.

2 For comparison, the estimated US$7-billion increase from 2002 to 2005 in import costs for oil-importing sub-Saharan African countries is about seven times the total annual savings in debt payments received by the 14 African countries included in the 2005 G8 debt agreement.

3 There is broad agreement that this can be achieved at concentrations in the range of 450 parts per million by volume (ppmv) of carbon dioxide equivalents or below. (Carbon dioxide equivalents are used to compare emissions of various greenhouse gases based upon their global warming potential.)

4 Measures to promote energy savings and energy efficiency are an exception, in that the payback times are short. However, mobilising the funds required to realise technically feasible and economically viable energy efficiency improvements remains a challenge, even in industrialised countries. This is partly because a range of barriers, including competition for finance with entrenched industries, stifles investment in energy efficiency projects.

Today's Pressing Energy Needs

The long life of a good deal of energy infrastructure means that the system changes only very slowly. This heightens the need for governments to establish a clear, long-term policy framework – one that, while favouring sustainable investments, allows industry to plan for the future.

The private sector, not government, has the capacity to mobilise the funds required to address today's pressing energy needs. However, industry investments will only be forthcoming if governments set targeted policies to this effect. This is all the more important in developing countries, where the perceived risks are higher and it is thus harder to attract investment.

2 The World Energy Outlook's Alternative Policy Scenario

baseline
policy
quantitative
exploratory

Annex 1 on page 14

The *World Energy Outlook 2006* describes at length two scenarios: a **baseline** case – the Reference Scenario, which assumes that no new government measures are implemented to alter underlying energy trends – and a **policy** case, the Alternative Policy Scenario. They are both **quantitative**, **exploratory** scenarios that provide projections through 2030, with an emphasis on 2015, and they contain regional and sectoral breakdowns.

This section summarises the findings of the Alternative Policy Scenario. It outlines which measures are taken into account in the scenario; presents the main projections by fuel, sector and region; and introduces key cost-effectiveness considerations emerging from the analysis. It sets these results against those of the Reference Scenario.

2.1 Policy Measures

The Alternative Policy Scenario takes into account policies and measures that countries are currently considering and are assumed to adopt and implement. While every effort was made to determine which policies are likely to be implemented at some point during the projection period and to translate those into formal assumptions for modelling, a degree of judgement was inevitable. If the assumed set of policies and measures are not implemented in a timely manner, the energy savings and emission reductions in the Alternative Policy Scenario will not be achieved.

The analysis reveals that some policies are far more effective than others: for example, two-fifths of the emission reductions in the Alternative Policy Scenario are achieved by implementing only a dozen policies. Not surprisingly, these are found in regions where energy demand is high, such as the United States, the European Union and China.

Examples of Policies with Large Emission Reductions in the Alternative Policy Scenario

	Energy efficiency	Power generation
United States	■ tighter Corporate Average Fuel Economy standards ■ improved efficiency of electricity use in the residential and commercial sectors	■ increased use of renewable sources of energy
European Union	■ increased vehicle fuel economy ■ improved efficiency of electricity use in the commercial sector	■ increased use of renewable sources of energy ■ extended lifetime for nuclear plants
China	■ improved efficiency of electricity use by industry ■ improved efficiency of electricity use in the residential sector	■ increased efficiency of coal-fired plants ■ increased use of renewable sources of energy ■ increased reliance on nuclear energy

The World Energy Outlook's Alternative Policy Scenario

Notwithstanding this conclusion, the scope for improving the cost-effectiveness of the energy system is enormous in all regions. From the removal of subsidies that encourage the wasteful use of energy to the introduction of economic incentives for low-carbon technologies, a wide range of policies has proved to be particularly successful and thus merit replication.

cost-effective policies
Annex 2 on page 15

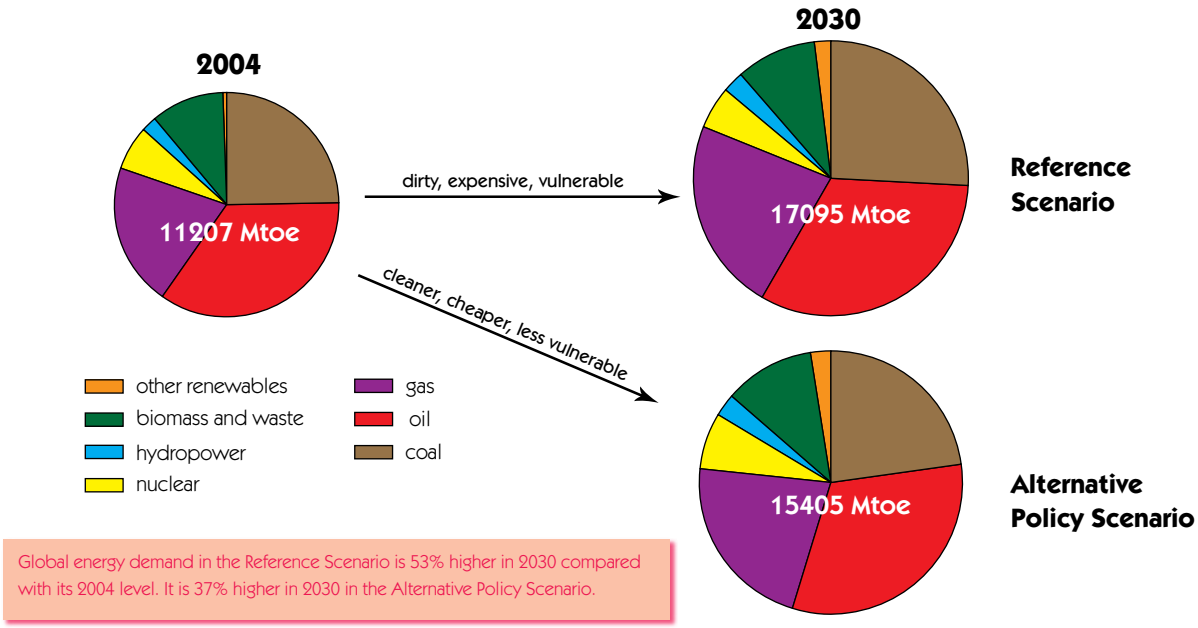
It is important to bear in mind that the Alternative Policy Scenario does not reflect the ultimate technical or economic potential: a more sustainable energy system is indeed possible, as described later, but it requires strong policy efforts that go beyond those currently enacted or proposed.

2.2 Projections

Oil, coal and gas demand are lower in the Alternative Policy Scenario than in the Reference Scenario, but these sources continue to dominate the global energy mix. Coal loses most ground, mainly to nuclear energy and to biomass and waste. Hydropower expands its share slightly. Renewable sources of energy other than hydropower and biomass and waste see their share more than double but remain insignificant contributors to total primary energy supply.[5]

data tables
Annex 3 on pages 16–19

Two Scenarios of Global Energy Mix and Demand



Global energy demand in the Reference Scenario is 53% higher in 2030 compared with its 2004 level. It is 37% higher in 2030 in the Alternative Policy Scenario.

5 These sources of energy include wind, solar, geothermal, tide and wave energy. Their Alternative Policy Scenario aggregated shares in 2004, 2015 and 2030 are, respectively, 0.5%, 1.1% and 2.4%.

The World Energy Outlook's Alternative Policy Scenario

In the Alternative Policy Scenario, growth in energy demand is much greater in developing countries (particularly in Asia) than in OECD countries. All the major net oil-importing regions continue to become more dependent on oil imports in 2030 than they were in 2004. The volume of interregional trade continues to expand – albeit considerably less than in the Reference Scenario.[6]

Energy demand from power generation and heat plants is almost 12% lower in 2030 in the Alternative Policy Scenario than in the Reference Scenario, mainly due to greater end-use efficiency. The policies that bring about these changes are mostly driven by efforts to increase the use of low-carbon technologies or to reduce dependence on imported fuels.

Transport energy consumption in 2030 is almost 10% lower in the Alternative Policy Scenario than in the Reference Scenario[7]. Road transport continues to dominate the modal split.[8] Policies resulting in improved new-vehicle fuel efficiency produce more than two-thirds of the fuel savings.

Industrial energy demand in 2030 is 9% lower in the Alternative Policy Scenario than in the Reference Scenario. Over half of global energy savings in the industry sector are the result of more energy-efficient production of iron and steel, chemicals and non-metallic products. Industry structure and plant size are key determinants of the sector's energy efficiency potential.

Energy use in the residential and services sectors in 2030 is 11% lower in the Alternative Policy versus the Reference Scenario. Introduction of more-efficient appliances, air conditioning and lighting account for the bulk of the savings in electricity demand, which is the main driver of energy demand growth in the sector. Stricter building codes are key to cutting oil and gas use.

The policies considered in the Alternative Policy Scenario significantly curb the growth of energy-related carbon dioxide emissions. Lower overall energy consumption and a larger share of less carbon-intensive fuels in the primary energy mix together yield, in 2030, savings of 6.3 gigatonnes in emissions compared with the Reference Scenario, a 16% decrease.

6 In the Alternative Policy Scenario, oil imports in OECD countries begin to fall around 2015 but continue to rise in developing Asia throughout the projection period.

7 Increased use of biofuels accounts for 14% of the reduction, decreased aviation fuel consumption accounts for 9% and modal shifts and reduced fuel consumption in other modes make up the remainder.

8 Road transport accounts for as much as 77% of total energy demand from transport, with annual average growth rates of 1.2% over the period 2004–30. Aviation makes up only 15% of transport energy use but is growing much faster: at an annual average rate of 2.2% over the same period.

The total avoided emissions by 2030 are equal to more than the current emissions in the United States and Canada combined. On an absolute basis, reductions are greatest in the countries and regions that emit the most, in this order: China, OECD North America and OECD Europe.

2.3 Cost-effectiveness Considerations

The energy system portrayed in the Alternative Policy Scenario achieves the same level of energy services by 2030 as that in the Reference Scenario – but it costs less, is cleaner and is less vulnerable to supply disruptions. Each year of delay in implementing the policies considered in the Alternative Policy Scenario would have a disproportionably larger effect on emissions.

In the Alternative Policy Scenario, energy producers invest less than in the Reference Scenario and end users invest more. This is because energy is used more efficiently in the Alternative Policy Scenario, which reduces the need to expand energy production and transport infrastructure.[9]

Nonetheless, consumers as a whole are better off in the Alternative Policy Scenario. This is because, on average, the savings they realise on their electricity bills more than offset the costs they incur to generate these savings.[10] In addition, since the overall level of investment is some US$560 billion lower than in the Reference Scenario, more resources are available for use in other sectors of the economy.

9 In both scenarios, for the most part, investments from producers are directed at expanding energy production and transport infrastructure, while outlays from consumers serve to purchase more energy-efficient equipment. 'Energy producers' refers to electricity, oil, gas and coal producers. 'Consumers' refers to households and firms, inasmuch as both are end users of energy services.

10 Consumers save US$8.1 trillion in their energy bills, offsetting the US$2.4 trillion in increased investment (compared with the Reference Scenario) required to generate these savings.

3 The World Energy Outlook's Beyond the Alternative Policy Scenario

security
climate
access
section 1 on pages 2–3

anticipatory
Annex 1 on page 14

While the case for the Alternative Policy Scenario is becoming increasingly clear, in many countries short-term concerns over competitiveness losses may hinder implementation of the policies it includes. And yet, this is a scenario that in the long term could be the stepping stone to meet the pressing energy **security**, **climate** change and universal **access** needs described earlier.

This section presents the *World Energy Outlook*'s Beyond the Alternative Policy Scenario, an **anticipatory** scenario that identifies a possible set of measures to cap energy-related emissions of carbon dioxide in 2030 at their current levels, which is used as a proxy for a more diverse energy future.[11]

Unlike the Alternative Policy Scenario, this one is not restricted to policies already under consideration by governments. Indeed, the Beyond the Alternative Policy Scenario assumes fast and widespread deployment of the most efficient and cleanest existing technologies as well as adoption of promising new ones.

There are many different policy paths to realise the scenario's goal. The Beyond the Alternative Policy Scenario identifies a set of initiatives that can deliver the required emission reductions and then highlights the policies needed to implement those initiatives.

To cap carbon dioxide emissions in 2030 at their current levels, a reduction of 8 gigatonnes is needed compared with the Alternative Policy Scenario.[12] The Beyond the Alternative Policy Scenario identifies six initiatives, each of which can yield a savings of 1 gigatonne of carbon dioxide emissions in 2030. It adds a seventh initiative – carbon dioxide capture and storage in power generation – that alone can save 2 gigatonnes.

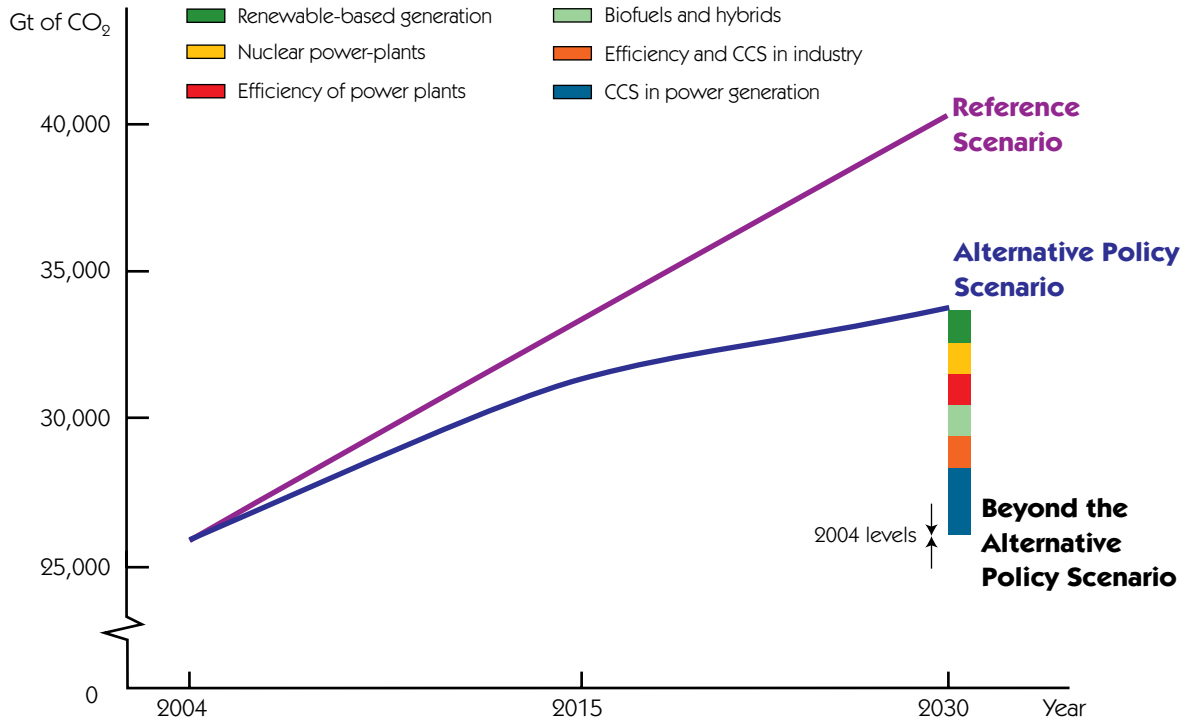
Achieving the Beyond the Alternative Policy Scenario goal will certainly require new technologies as well as improvements in those that already exist. Of the technologies currently under development but not yet commercially available, carbon dioxide capture and storage and second-generation biofuels seem the most promising. In the Beyond the Alternative Policy Scenario, some 70% of new coal-fired capacity and 35% of new gas-fired plants are assumed to be equipped with carbon dioxide capture and storage during the projection period.

11 In the Alternative Policy Scenario, energy-related emissions of carbon dioxide are 8 gigatonnes higher in 2030 than they were in 2004.

12 The reduction would be 14.3 gigatonnes below the level in the Reference Scenario.

The World Energy Outlook's Beyond the Alternative Policy Scenario

Beyond the Alternative Policy Scenario



Capping energy-related emissions of carbon dioxide in 2030 at their current levels would require major technology breakthroughs and more determined policy efforts.

In some cases, there would be synergies between the policies required to achieve the Beyond the Alternative Policy Scenario. For example, a price on carbon would reinforce efforts to promote carbon dioxide capture and storage, nuclear energy and renewable sources of energy. Other policies may be more divisive, however, which underscores the importance of integrated policy approaches.

The World Energy Outlook's Beyond the Alternative Policy Scenario

Selected Initiatives and Policies Needed to Achieve the Goals of the Beyond the Alternative Policy Scenario

Selected initiatives	Policies needed to scale up those initiatives
Increased efficiency of electricity use	■ codes and standards for residential and commercial sectors ■ incentives to introduce more-efficient motor-drive systems in the industry sector
Increased efficiency of fossil fuel use by industry, coupled with carbon dioxide capture and storage	■ increased taxes on fossil fuels ■ incentives to reduce the capital costs of more-efficient equipment ■ incentives for small-scale carbon dioxide capture and storage technologies, such as regulatory requirements or subsidies for installation
Increased efficiency of and reduced emissions from motor vehicles	■ incentives to introduce hybrid vehicles, such as vehicle purchase subsidies, regulatory standards and higher taxes on the least efficient vehicles ■ incentives to expand the use of biofuels, such as larger research and development programmes and minimum requirements for biofuels in conventional fuel blends
Increased efficiency of power plants	■ incentives to retire inefficient power plants early, such as changes in capital depreciation rates and efficiency standards for coal installations ■ incentives to introduce hydrogen fuel cells, such as larger research and development programmes, subsidies for building new power plants and policies to reduce the lending risk of capital
Increased nuclear power generation	■ incentives to expand nuclear power capacity, such as policies and technologies to improve waste management, loan guarantees to reduce the cost of capital and measures to garner public support
Increased use of renewable sources of energy for power generation	■ incentives to expand hydropower and other renewables-based power generation, such as larger research and development programmes, renewable portfolio standards or feed-in tariffs and loan guarantees to reduce the cost of capital
Introduction of carbon dioxide capture and storage in power generation	■ larger research and development programmes, incentives for large-scale demonstration plants, loan guarantees for new plants, performance standards for emissions from new plants and financial penalties on carbon emissions

Note: These initiatives are presented for illustrative purposes only, in that they highlight the large scope for improvements across the energy system. Given the wide diversity of local circumstances, the specific relevance and usefulness of these initiatives to any given local situation can only be determined on a case-by-case basis.

Many of the above initiatives would enhance energy security. This is primarily because they result in a more diverse fuel mix in which oil and gas play a smaller role and because they bring about important efficiency gains, thereby reducing the demand for energy. As a result, they have the potential to promote more rapid economic and human development, as lower expenditures for oil and gas imports in developing countries would increase the disposable incomes of households and businesses and thereby contribute to alleviating poverty there.

4

The Urgency of Taking Action

Even if governments actually implement the policies and measures considered in the Alternative Policy Scenario, energy imports and carbon dioxide emissions would still continue to rise through 2030. Moreover, the technological breakthroughs assumed in the Beyond the Alternative Policy Scenario would be unprecedented in scale and speed of deployment. Nevertheless, the difficulties in achieving a more sustainable energy future do not justify inaction or delay, which would raise the long-term economic, security and environmental costs.

Peering into the Next Century

The International Energy Agency engaged an independent expert to examine where the **World Energy Outlook** scenarios fit in the range of scenarios reviewed in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.[13] The objective was to see how stabilisation levels in the **World Energy Outlook** scenarios compare with those in other scenarios published after 2000 and to determine if the long-term emissions paths in the **Outlook** are consistent with those found elsewhere.

The **World Energy Outlook**'s Alternative Policy Scenario is close to the median of scenarios that lead to stabilisation at 550 ppmv of CO_2-equivalent. Thus if the policies and measures in this scenario were to come into force between now and 2030, the global energy system would be on a trajectory that could eventually lead to stabilisation of atmospheric concentrations of carbon dioxide over the longer term. In the Beyond the Alternative Policy Scenario, stabilisation would occur at significantly lower CO_2-equivalent levels.

It may take the energy system about a century to reach a more sustainable path. The Alternative Policy Scenario puts the energy system on a path that allows it, in the long term, to transition to that more sustainable path.

13 Professor Nebojsa Nakicenovic of the Technical University of Vienna in Austria conducted the study on behalf of the International Energy Agency. At the time of writing, publication of the Fourth Assessment Report was expected in May 2007.

The Urgency of Taking Action

If the trends established in the Alternative Policy Scenario continue over the long term, the energy system can make the transition to a sustainable energy path late in this century. The Beyond the Alternative Policy Scenario puts the global system on course for eventual sustainability much sooner, leaving atmospheric concentrations of carbon dioxide at a level believed not to unduly change Earth's climate.

There is no sensible reason – economic or otherwise – to delay implementation. In fact, delaying implementation of either scenario would have considerable impacts. A delay of 10 years in implementing the Alternative Policy Scenario, for example, would push back the date of being on a sustainable path by several decades.

security
climate
access

section 1 on pages 2–3

Simply put, postponing action on the pressing energy **security**, **climate** change and universal **access** needs described earlier will only increase the costs of reversing negative trends as well as the time required to do so. And the challenge is already large, as illustrated by the great need to provide the underserved with access to modern forms of energy.

energy and poverty

Annex 4 on page 20

Indeed, bringing modern energy to the world's poor is an urgent necessity if the human development goals of the United Nations Millennium Declaration are to be met. Two complementary approaches can achieve this: promoting more-efficient and sustainable use of traditional biomass and encouraging people to switch to modern cooking fuels and technologies. The appropriate mix of these approaches depends on local circumstances, such as per-capita incomes and the availability of a sustainable biomass supply.

The Urgency of Taking Action

Key Findings across a Range of Energy-related Themes

Thematic clusters	Key findings from World Energy Outlook 2006
Energy for sustainable development	■ Some 2.5 billion people rely on biomass, such as fuelwood, charcoal, agricultural waste and animal dung, to meet their energy needs for cooking. Without new policies, this number will top 2.6 billion by 2015 and then 2.7 billion by 2030 because of population growth. ■ Use of biomass is not in itself a cause for concern. But when resources are harvested unsustainably and energy conversion technologies are inefficient, there are serious adverse consequences for health, the environment and economic development. About 1.3 million people – mostly women and children – die prematurely every year because of exposure to indoor air pollution from biomass.
Industrial development	■ Reduced use of coal, oil and gas in the Alternative Policy Scenario account for nearly three-quarters of the savings in global industrial energy demand relative to the Reference Scenario. Improved efficiency, particularly in developing countries, is responsible for nearly two-thirds of global savings. ■ A rapid decline in energy intensity in transition economies and developing countries is already incorporated into the Reference Scenario, on the assumption that the energy intensity of industrial production will approach OECD levels by 2030. In the Alternative Policy Scenario, the gap in efficiency between OECD and non-OECD countries narrows even further.
Air pollution and atmosphere	■ In the Alternative Policy Scenario, road transport energy demand grows by 1.2% per year over the projection period, compared with 1.7% per year in the Reference Scenario. The share of coal in the electricity generation mix drops to 37% in 2030, from nearly 44% in the Reference Scenario. ■ Local air quality is likely to worsen in all world regions, mostly due to the unabated growth in road transport demand. If they fail to switch to cleaner fuels, China, India and the OECD countries would suffer most from regional air pollution arising from coal-fired electricity generation.
Climate change	■ Energy-related CO_2 emissions in the Alternative Policy Scenario are cut by 6.3 Gt, or 16%, in 2030 relative to the Reference Scenario. OECD emissions peak by around 2015 and then decline. Emissions in Japan and the European Union in 2030 are lower than in 2004. Global emissions nonetheless continue to rise, from 26 Gt in 2004 to 32 Gt in 2015 and 34 Gt in 2030. ■ Policies encouraging more-efficient production and use of energy contribute almost 80% of the avoided CO_2 emissions in 2030, with the remainder arising from fuel switching. More-efficient use of fuels, mainly through improved efficiency of cars and trucks, accounts for almost 36%. More-efficient use of electricity in a wide range of applications accounts for 30%. Greater efficiency in energy production accounts for 13%.

Note: The information in the Table is structured around the thematic clusters that the fifteenth session of the Commission on Sustainable Development will be addressing, in an effort to support the Commission's deliberations.

Annex 1: Understanding Scenarios

The word scenario is borrowed from performance theatre, where it refers to the sequential elements of a screenplay. It was taken over by strategic planners after the Second World War to describe a method of war game analysis, and it eventually entered the civilian vocabulary.[14]

In common usage, a scenario now refers to a sequence of emerging events or an account of a projected course of action or events. The Intergovernmental Panel on Climate Change describes scenarios as "images of the future, or alternative futures" that are neither predictions nor forecasts but an image of how the future might unfold.

The Rationale for Developing Scenarios

The future cannot be extrapolated or predicted, because the current state of a system and the forces governing its dynamics are seldom sufficiently understood. Even if precise information were available, complex systems are known to exhibit turbulent behaviour. In addition, the future is unknowable because it is subject to human choices that have not yet been made. In the face of such indeterminacy, scenarios offer a means for examining the forces that shape our world, the uncertainties that lie before us and the implications for tomorrow of our actions today.

Scenarios draw on science – our understanding of historical patterns, current conditions and physical and social processes – and on the imagination to conceive, articulate and evaluate alternative pathways of development. In so doing, scenarios can illuminate the links between issues, the relationships between global and regional development and the role of human actions in shaping the future. It is this added insight, leading to more informed and rational action, that is the foremost goal of scenarios – not the words and numbers that make up the scenario itself.

Scenarios can be qualitative or quantitative. Qualitative scenarios have the advantage of being able to represent the views of several stakeholders and experts. Quantitative scenarios, on the other hand, can be more transparent and provide numerical information that is often central to policy-making.

A further distinction can be made between 'baseline' and 'policy' scenarios. Baseline scenarios depict the future state of society in the absence of any additional policies,[15] while policy scenarios present the future consequences of policy interventions. Ultimately, both seek to inform the policy-making process.

Finally, scenarios can be 'exploratory' or 'anticipatory'. The former take the present as their departure point and explore trends in the future. Anticipatory scenarios work backwards from a prescribed vision of the future – optimistic, pessimistic or neutral – to illustrate how this vision could be achieved.

14 This section is partly based on a 2001 report by the European Environment Agency (**Scenarios as tools for international environmental assessment**) and a 2004 report by the United Nations Environment Programme (**Global Environment Outlook scenario framework – background paper for UNEP's third Global Environment Outlook report**).

15 More precisely, baseline scenarios present the future state of society in the absence of any additional policies **or** a future in which the policies already implemented have no further discernible influence on the system under analysis.

Annex 2: Cost-effective Policies

The table below provides an illustrative, non-exhaustive list of policies that have proved particularly successful in a range of energy-related areas. They are included here in an effort to promote their dissemination and ultimately support energy policy-making.

Examples of Cost-effective Energy Policies

Energy efficiency	
Standards and labels	Top Runner Programme (Japan) http://www.eccj.or.jp/top_runner/index.html
Audits	Energy Audit Programme (Finland) http://www.motiva.fi/en/
Renewable sources of energy	
Feed-in tariffs	Renewable Energy Sources Act (Germany) http://www.bmu.de/english/documents/doc/3242.php
Building codes	Barcelona Solar Thermal Ordinance http://www.barcelonaenergia.com/eng/operations/ost.htm
Portfolio standards	Texas's Renewable Energy Mandate http://www.dsireusa.org/library/includes/printincentive.cfm?incentive_code=TX03R
Transport	
Road charging	London Congestion Charge http://www.cclondon.com/
Bus rapid transit	Transmilenio (Colombia) http://www.transmilenio.gov.co/transmilenio/home_english.htm
Access to modern forms of energy	
Prepaid electrification	Prepayment Meters (South Africa) http://www.prepayment.eskom.co.za/default.asp
Climate change	
Emissions trading	Emissions Trading Directive (European Union) http://ec.europa.eu/environment/climat/emission.htm
Financing mechanisms	
Funds	FIDEME (France) http://www.ademe.fr/Entreprises/Aides/documents/fideme.pdf
Tax incentives ■ Tax relief	Energy Investment Tax Relief (Netherlands) http://www.senternovem.nl/eia/English.asp
■ Accelerated amortisation	Accelerated Amortisation for Energy Efficiency and Renewable Energy (France) http://www.ademe.fr/centre/energie/com/amortissement_exceptionnel.pdf
Capital subsidies	Residential Solar Rooftop Programme (Japan) http://www.meti.go.jp/english/

Annex 3: Data Tables

Global Fuel Mix in the Reference and Alternative Policy Scenarios

		2030		
	2004 (Mtoe)	Reference Scenario (Mtoe)	Alternative Policy Scenario (Mtoe)	Alternative Policy relative to Reference Scenario (percent change)
coal	2,773	4,441	3,512	–20.9
oil	3,940	5,575	4,955	–11.1
gas	2,302	3,869	3,370	–12.9
nuclear	714	861	1,070	24.3
hydro	242	408	422	3.2
biomass and waste	1,176	1,645	1,703	3.6
other renewables	57	296	373	26.1
Total primary energy supply	**11,204**	**17,095**	**15,405**	**–9.9**

Note: 'Other renewables' includes wind, solar, geothermal, tide and wave energy.
Source: **World Energy Outlook 2006**

Global Total Final Energy Consumption in the Reference and Alternative Policy Scenarios

		2030		
	2004 (Mtoe)	Reference Scenario (Mtoe)	Alternative Policy Scenario (Mtoe)	Alternative Policy relative to Reference Scenario (percent change)
industry	2,511	3,932	3,595	–8.6
transport	1,969	3,111	2,804	–9.9
residential, services and agriculture	2,905	4,221	3,772	–10.6
non-energy use	254	400	370	–7.6
Total final energy consumption	**7,639**	**11,664**	**10,542**	**–9.6**

Note: Totals may not add up due to rounding.
Source: **World Energy Outlook 2006**

Annex 3: Data Tables

Energy-related Emissions of Carbon Dioxide in 2004

	Emissions (million metric tons)	Share of total emissions (percent)	Emissions per capita (metric tons per person)	Emissions per unit of GDP (metric tons per million US$)
United States	5,769	22.1	19.6	480.9
China	4,769	18.3	3.7	574.7
European Union	3,847	14.8	8.4	310.8
Russia	1,512	5.8	10.5	1006.5
Japan	1,211	4.6	9.5	314.9
India	1,103	4.2	1.0	313.2
Brazil	323	1.2	1.8	211.3
Middle East	1,183	4.5	6.5	854.5
Africa	815	3.1	0.9	366.3
Rest of the world	5,547	21.3	3.3	458.6
World	**26,079**	**100.0**	**4.1**	**443.7**

Notes: Emissions from fuel combustion only.
GDP in billion US$ at 2005 prices and PPPs.
Source: **World Energy Outlook 2006**

Annex 3: Data Tables

Energy-related Emissions of Carbon Dioxide in 2030 in the Reference Scenario

	Emissions (million metric tons)	Share of total emissions (percent)	Emissions per capita (metric tons per person)	Emissions per unit of GDP (metric tons per million US$)
United States	7,138	17.7	19.9	325.9
China	10,425	25.8	7.2	309.4
European Union	4,216	10.4	9.1	205.6
Russia	1,883	4.7	15.0	524.1
Japan	1,154	2.9	9.4	206.4
India	2,544	6.3	1.8	196.8
Brazil	551	1.4	2.3	165.7
Middle East	2,460	6.1	8.6	643.3
Africa	1,447	3.6	1.0	238.5
Rest of the world	8,602	21.3	3.9	301.5
World	**40,420**	**100.0**	**5.0**	**288.8**

Notes: Emissions from fuel combustion only.
GDP in billion US$ at 2005 prices and PPPs.
Source: **World Energy Outlook 2006**

Annex 3: Data Tables

Energy-related Emissions of Carbon Dioxide in 2030 in the Alternative Policy Scenario

	Emissions (million metric tons)	Share of total emissions (percent)	Emissions per capita (metric tons per person)	Emissions per unit of GDP (metric tons per million US$)	Alternative Policy relative to Reference Scenario (percent change)
United States	6,266	18.4	17.5	286.1	–12.2
China	8,801	25.8	6.1	261.2	–15.6
European Union	3,465	10.2	7.4	168.9	–17.8
Russia	1,685	4.9	13.4	469.0	–10.5
Japan	955	2.8	7.8	170.8	–17.2
India	1,999	5.9	1.4	154.6	–21.4
Brazil	458	1.3	1.9	137.7	–16.9
Middle East	2,060	6.0	7.2	538.7	–16.3
Africa	1,222	3.6	0.8	201.4	–15.5
Rest of the world	7,169	21.0	3.2	251.3	–16.7
World	**34,080**	**100.0**	**4.2**	**243.5**	**–15.7**

Notes: Emissions from fuel combustion only.
GDP in billion US$ at 2005 prices and PPPs.
Source: **World Energy Outlook 2006**

Annex 4: The Challenge of Energy and Poverty

The *World Energy Outlook 2006* takes an in-depth look at current trends and future prospects for energy demand for cooking in developing countries. Although steady progress is made in expanding the use of modern household energy services, the Reference Scenario projects that some 2.7 billion people still depend on fuelwood, charcoal, agricultural waste and animal dung for cooking in 2030.

The inefficient and unsustainable use of biomass has severe consequences for health, the environment and economic development. Indoor air pollution from burning biomass causes some 1.3 million premature deaths each year. There is evidence that in countries where local prices have adjusted to recent high international energy prices, the shift to cleaner, more-efficient ways of cooking has actually slowed and even reversed.

In the Reference Scenario, one-third of the world's population will still rely on fuelwood, charcoal, agricultural waste and animal dung, a share barely smaller than today. There will still be 1.6 billion people in the world without electricity. To achieve the Millennium Development Goals, this number would need to fall to less than 1 billion by 2015.

Action to encourage more-efficient and cleaner cooking fuels is needed urgently. Alternative fuels and technologies are already available at reasonable cost. Halving the number of households using biomass for cooking by 2015 – a recommendation of the UN Millennium Project – would involve 1.3 billion people switching to liquefied petroleum gas or other cleaner fuels. This would have an insignificant impact on world oil demand and the equipment would cost, at most, $1.5 billion per year. But vigorous and concerted government action – with support from industrialised countries – is needed to achieve this target, together with increased funding from both public and private sources. Policies would need to address barriers to access, affordability and supply and to become a central component of broader development strategies.

About the International Energy Agency

The International Energy Agency is an autonomous body which was established in November 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme. It carries out a comprehensive programme of energy co-operation among twenty-seven of the OECD's thirty member countries.

About UNEP's Division of Technology, Industry and Economics

The Division of Technology, Industry and Economics of the United Nations Environment Programme helps governments, local authorities and decision-makers in business and industry to develop and implement policies and practices focusing on sustainable development.

The Division works to promote sustainable consumption and production, the efficient use of renewable energy, adequate management of chemicals and the integration of environmental costs in development policies.

For more information see:
www.iea.org/
www.unep.fr/

DTI/0937/PA