DEDICATED TO MAKING A DIFFERENCE

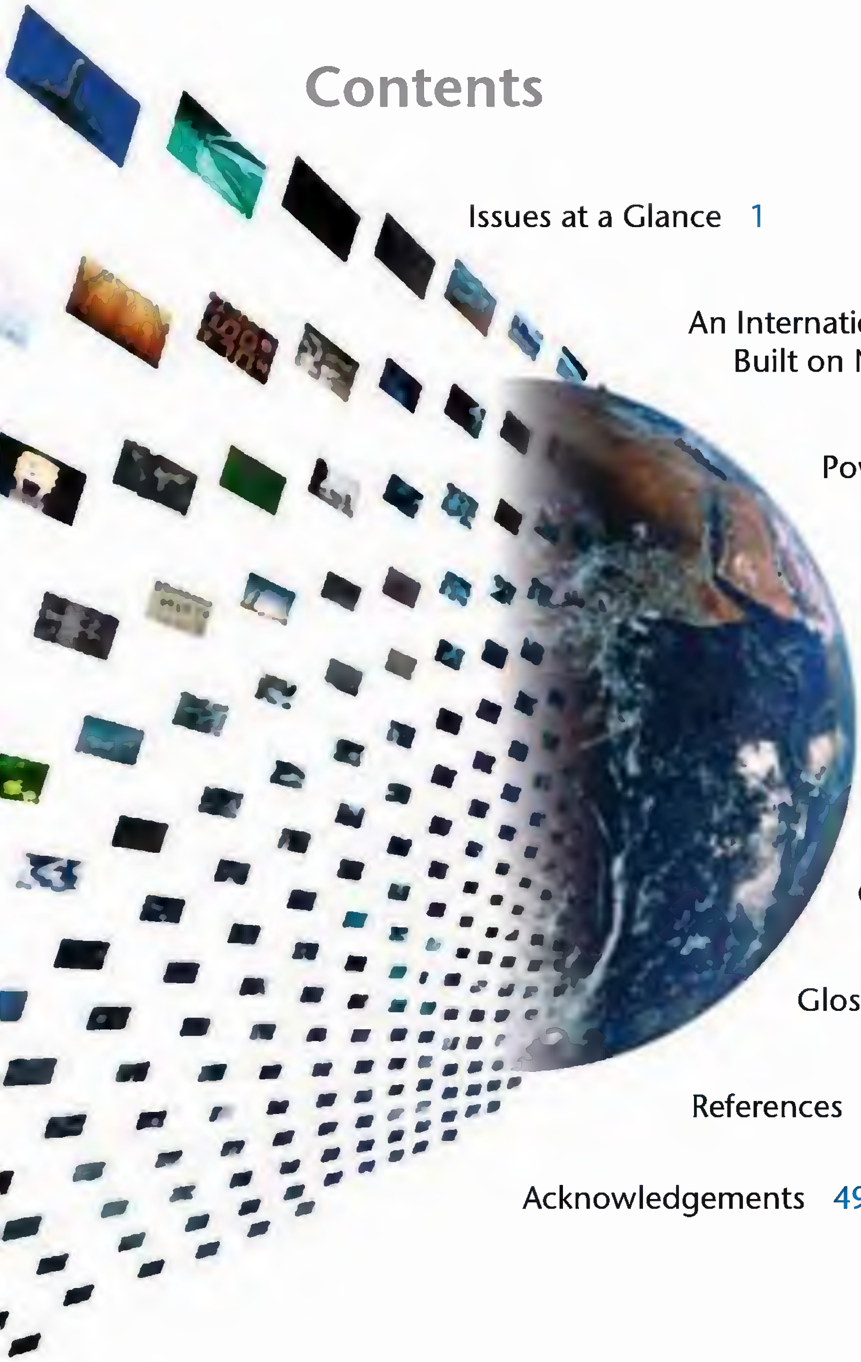
Policy Directions to 2050

A business contribution to the dialogues on cooperative action

Energy & Climate
Focus Area

World Business Council for Sustainable Development

Contents



Purpose

The WBCSD and its member companies are working to clarify the debate over energy access, energy security and climate change. There is the need to establish an equitable, clear, long-term approach to dealing with these challenges in an integrated, multi-faceted and economically sustainable way.

In its publications *Facts and Trends to 2050* (2004a) and *Pathways to 2050* (2005a), the WBCSD sought to create a basis for dialogue and action by translating the scale and complexity of these challenges into simple, illustrative pathways to 2050. This work has helped a variety of stakeholders think about the ways in which energy flows through the global economy and affects the climate. This publication, *Policy Directions to 2050*, builds on our previous publications as it explores policy ideas and concepts for the transition to a low greenhouse gas (GHG) economy.

As in our previous work, this document uses facts, simplified assumptions and extrapolations to guide readers among possible options.

It is not meant to lay out a set of "must do" policy approaches. It is not an itinerary, but a fairly concise roadmap from which routes must be chosen. It does not recommend particular targets related to climate impacts. It uses numbers to help readers understand scale. Its primary purpose is to identify and explore policy options to sustain economic growth while transforming the ways we access, produce and consume energy.

Pursuing these options requires partnerships among governments, businesses and consumers. Progress toward an energy-efficient, low-GHG future will be achieved only through decisive, concerted, sustained actions by each of these actors. The inertia is likely to be as substantial as the need to act globally. What is clear is the urgency to act now.

Issues at a Glance

Energy is essential for economic growth and social development. Over the coming decades this fact will lead to a surge in energy demand as developing economies grow. If current trends continue, fossil fuels will provide most of the planet's energy for most of this century, leading to a considerable rise in GHG emissions such as carbon dioxide (CO_2). This trend must be reversed by managing emissions, decarbonizing the world's energy mix and using resources more efficiently to stabilize and then reduce GHG emissions.

The scale of change required

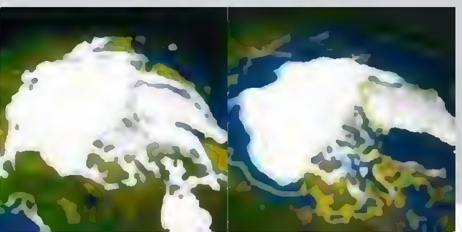
In *Pathways to 2050* we identified five key areas where actions could help stabilize GHG emissions along an illustrative trajectory toward a world of nine gigatons of carbon (9GtC) emissions per year by 2050. Some 7.8GtC were released in 2002. Large changes ("megatrends") are needed in each of the following action areas: power generation, industry and manufacturing, mobility, buildings and consumer choices. We posited that by 2050 the power sector delivers low-GHG electricity from a variety of sources, and mobility is characterized by high-efficiency vehicles, new fuel technologies and a balance between private and mass transportation. Turning such assumptions into realities will require:

Fully deploying established, advanced technologies, and developing and deploying new, breakthrough technologies over the next two decades;

Rapidly deploying existing low-GHG, energy-efficient technologies and new ones as they become available, encouraged by a range of market based instruments;

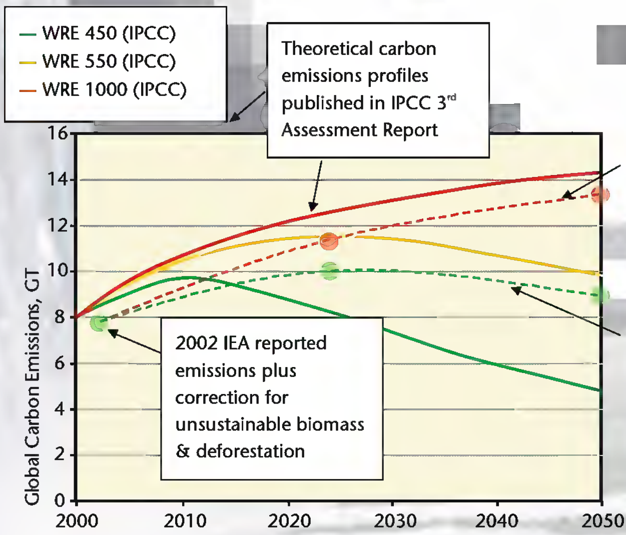
Significantly improving energy efficiency in power generation, mobility, manufacturing, buildings, and goods and services;

Increasing consumer awareness and understanding of energy issues and GHG emissions leading to greater demands for energy efficiency at all levels.



Source: NASA

Figure 1: High- and low-carbon pathways



>900 ppm trajectory energy by 2050:

- Coal over 2x, no Carbon Capture & Storage (CCS), some coal to liquids
- Oil up 50%
- Gas over 2x
- Biofuels make up 10% of vehicle fuel mix
- Electricity 1/3 of final energy
- Modest increase in nuclear
- Renewables provide 1/3 of electricity generation
- Vehicle efficiency up 50%.

<550 ppm trajectory energy by 2050:

- Coal up 50%, but half of power stations use CCS
- Oil down 10-15%
- Gas nearly 2-3x
- Biofuels make up 20% of vehicle fuel mix
- Hydrogen has arrived
- Strong shift to electricity as final energy (~50% final energy)
- Strong increase in nuclear
- Renewables provide half of electricity generation
- Vehicle efficiency up 100%
- Sustainable biomass practices.

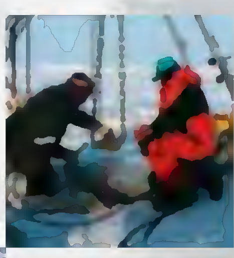
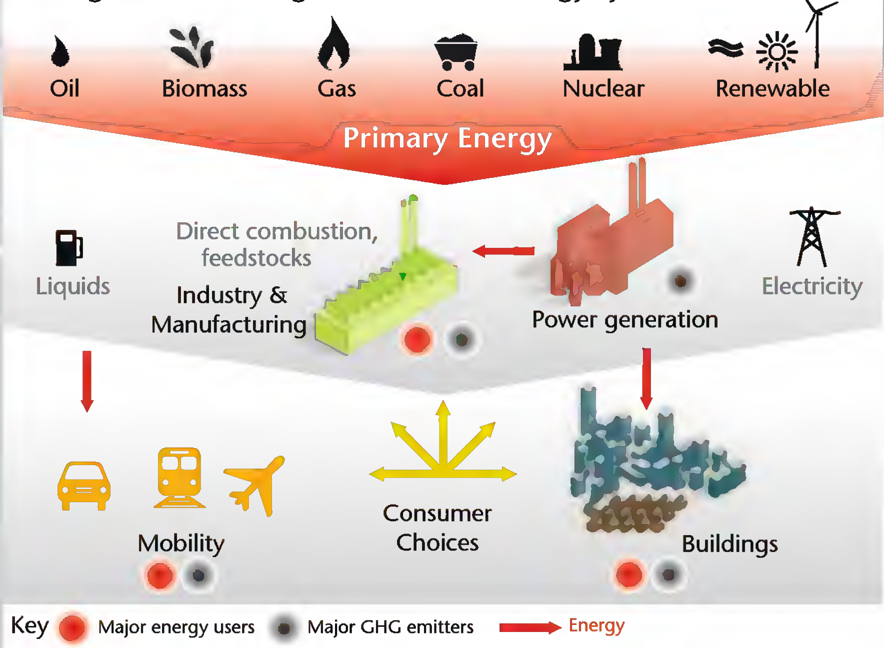


Figure 2: Five megatrends in our energy system

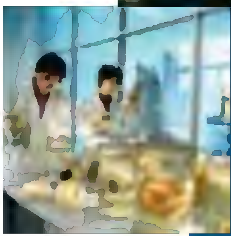


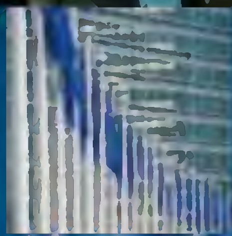
Developing & deploying technology

Reducing the energy intensity of the global economy and the CHC intensity of energy will require major breakthroughs in energy efficiency, renewables, next generation nuclear, clean coal, carbon capture and storage (CCS) and mobility. Such breakthroughs must be *developed* and then *deployed*.

Both require effective government support mechanisms. If the development phase is too costly for the private sector to sustain alone, technologies will never be able to enter the market and achieve full commercialization. Governments need to support new technologies during these critical early stages, establishing clear priorities for research, development and demonstration (RD&D).

Each technology is different and thus requires different enabling policies. For technologies that are already cost effective, policies need to focus on barriers to investment or restrictions to market entry. Emergent technologies, ready for rapid deployment, need government supports such as subsidies, tax credits, capital allowances and depreciation schemes, certificates, and tariffs. Covernments picking potential winners for their national situations (e.g., wind, hydro) must take account of the full development and deployment cycles.





Long-range breakthrough technologies such as clean coal and next generation nuclear need to be guided the whole way through research, development, demonstration and deployment. Covernments can do this through research partnerships with business or bilateral or multilateral organizations. Changing markets and consumer attitudes to speed deployment also requires appropriate policies. For example, many low- and zero-CHC emission technologies (e.g., CCS) are unlikely to succeed in the broader market without carbon pricing and direct forms of government assistance Otherwise, there may be no genuine business case to invest.

Engaging business

Many companies are using entrepreneurial innovation to adapt their business models and develop strategic approaches to reduce CHC emissions. Yet business can only go so far on its own. Before a company invests, it studies the future. If governments do not establish equitable policies that signal a future in which energy efficiency and a lower-CHC energy mix are going to be valuable to companies and society, then business will have trouble justifying investments in such innovations. Public investment and RD&D-friendly policy frameworks will foster business commitment in the early stages of development cycles.

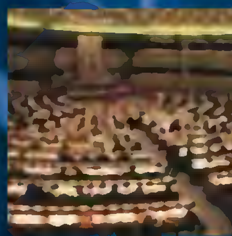
To be a force for change governments must help to reduce uncertainty for investments in higher cost, lower emitting systems. Government support in the following areas will remove barriers and uncertainty, facilitate the establishment of efficient markets, and drive technological innovation and investment.

- International political frameworks must be aligned with the long-range business investment cycle so that investments in CO_2 abatement technologies can be justified commercially.
- Many technology projects require government policies on issues such as RD&D, risk management and large demonstration projects.
- Utilizing a range of possible instruments, price signals should be created to promote innovative product and technological design. Policies that promote CHC emissions reductions will send the required signals to capital markets.
- Strong financial commitments by multilaterals will encourage development and transfer of leapfrog technologies to developing countries. Cood governance must accompany additional financing and technical support for energy and technology markets.
- Policies must include education programs encouraging consumers toward low-CHG products and services.

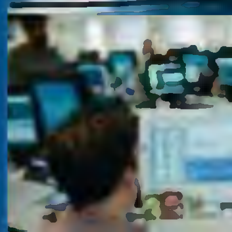
Mapping the routes

No single action will meet these challenges while sustaining economic growth. An integrated, multi-dimensional portfolio of technologies, policies and mechanisms will be required — along with a balance of global, regional and national approaches.

In these pages we explore possible approaches, concepts and ideas for action in these areas. We present a snapshot of some of the key issues and milestones regarding energy and climate between now and 2050. We explore and introduce ideas for a new international framework and address key policy issues within power generation, industry and manufacturing, mobility, buildings and consumer choices. In each of these sections we ask three basic questions. *What is needed? Why is it needed? How could it work?*



In presenting our views in this way, the WBCSD hopes to stimulate the debate, contributing business insights that — when aligned with efficient government policies at the global, regional and national levels — can help encourage the required technological and behavioral changes.



Policy priorities

International efforts on climate change must recognize the sovereignty of national energy policy decisions, but at the same time provide the necessary global context for those decisions and the tools to optimize GHG emissions management. Systematically decarbonizing the global energy mix will require a broad and efficient mix of policies and programs, and there is a need to learn from current approaches and instruments that are being used and continue to evolve at international, regional and domestic levels.

1. **A quantifiable, long-term (50-year) global emissions pathway for the management of GHG emissions established by 2010 will help build confidence to support technological development, deployment and business action.**
   - The pathway should be expressed in terms of a long-term GHG emissions trajectory and based on sound science, including up-to-date results from climate research, an understanding of the impacts of climate change, and the social and economic drivers of national and regional importance.
   - The pathway should be revisited periodically to measure progress and identify the need for any changes in approaches.
   - The pathway would form the basis for a revised, multi-faceted, international approach guiding the development of national programs, sector initiatives and sustainable development pathways for key regions.

2. **Using the existing international framework as a basis, and modifying it to build up from local, national, sector or regional programs will close the gap that would otherwise exist after 2012.**
   - The revised framework should recognize that energy and climate policy must be set in the first instance at national level. National, regional or sector programs could be based on a range of factors such as absolute reductions, efficiency goals, best available technology performance standards, or direct reductions in CO_2 emissions.
   - National or sector programs may wish to link to an evolving international GHG market, in order to introduce flexibility into the attainment of national or sector objectives.
   - The project mechanism should remain, but the definition of a project be broadened such that a whole sector in one nation or across several nations could become an eligible project. Projects could be done in any signatory nation or sector not already covered by a linked program.

   Broader participation would be encouraged through this enhanced approach, with its flexibility to introduce segments rather than the whole nation entering all at once, to provide avenues for national or multi-sector approaches, and to recognize that a growth element is necessary for developing economies.

3. **At national level, and in support of the international pathway.**
   - Robust programs to encourage energy efficiency should be developed, for example:
     - In new and existing buildings and in the small and medium enterprise sector;
     - By targeting process improvements at industrial and manufacturing facilities;
     - Through the deployment of high-efficiency vehicles;
     - By targeting consumer goods and services.
   - The range of fuels in the transport sector should be broadened, including biofuels, hydrogen and electricity.
   - All countries should boost awareness and incentives for consumers across all levels of society toward low-carbon products, services and lifestyles.

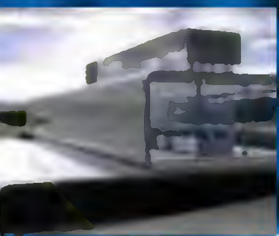
4. **A number of low- and zero-GHG technologies (e.g., nuclear, renewables, fuel cells, clean coal and CCS) must be developed and commercialized over the coming decades. These will require supporting policies and programs to address technical and cost challenges.**
   - Encourage the development of leading-edge technology projects through a program to mitigate the long-term investment risk and deliver up-front benefit for the project;
   - Supplement baseline investments in innovative energy technologies with the incremental investment cost of achieving a lower-GHG energy base;
   - Make best use of financial markets and access to capital to bring competitive low- and zero-GHG technologies to market.

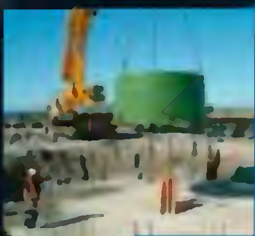
   CCS and next generation nuclear will be key technologies in certain markets, and their development and commercialization should be actively supported.

   For CCS:
   - Give suitable financial encouragement to a number of large-scale CCS demonstration projects in several regions to accelerate cost reductions, and promote the development of a global CCS industry through knowledge sharing and economies of scale;
   - Include CCS in all GHG emissions trading schemes (ETS) and in the project-based mechanisms of the United Nations Framework Convention on Climate Change (UNFCCC), and coordinate the development of standard accounting and measurement protocols for CCS projects;
   - Address the issue of long-term liability for stored CO_2.

   For nuclear:
   - Support nuclear by comprehensive non-proliferation policies, competent and credible safety authorities, clear and coherent license design and siting procedures, together with standardization and associated economies of scale;
   - Encourage new Generation III nuclear projects where they can be done reliably and safely, and achieve economies of scale with multiple facilities in those countries;
   - Invest in development and international collaboration for Generation IV nuclear technologies, including pilot projects necessary to establish feasibility.

An International Framework Built on National Approaches





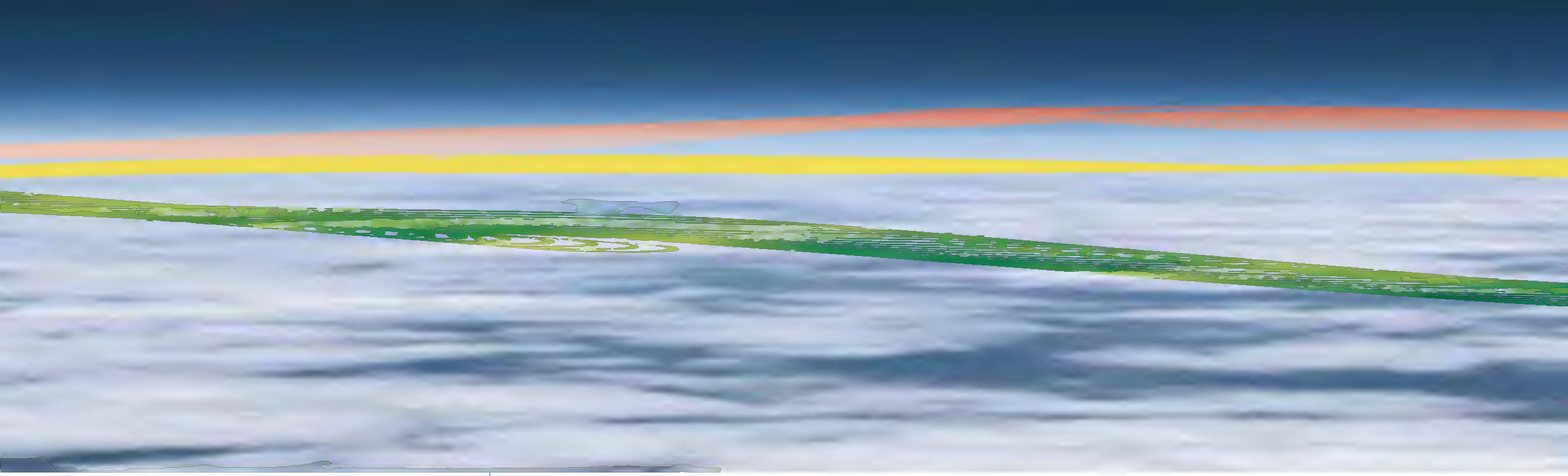
What is needed?

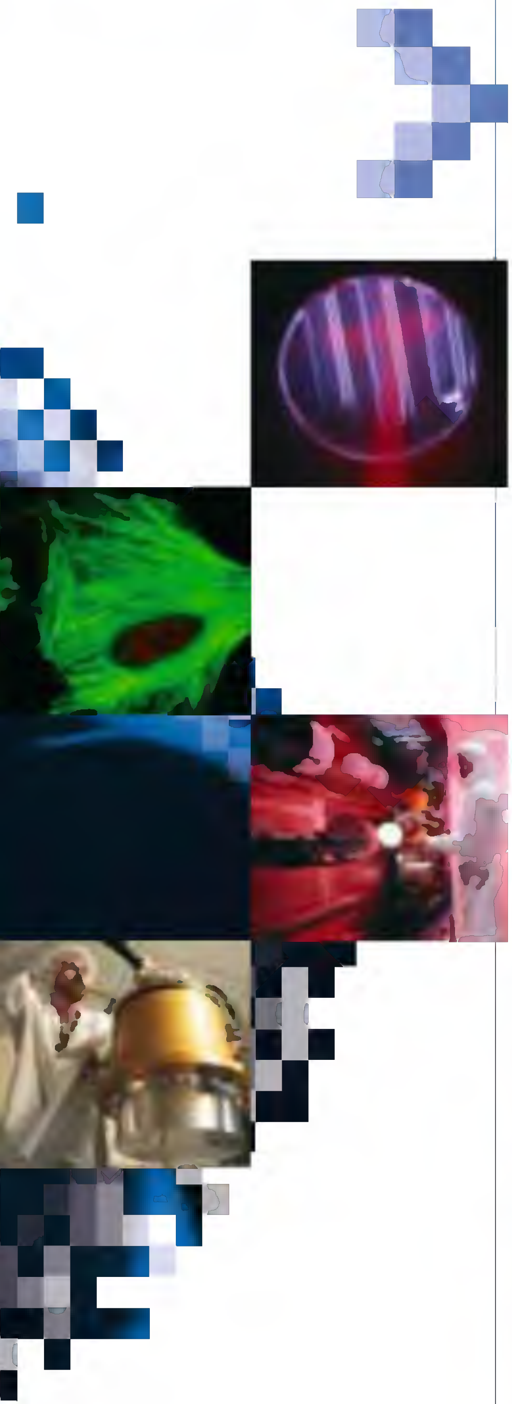
Energy policy is set at the national level against a backdrop of prevailing financial, security and environmental signals. A climate change policy framework must recognize the sovereign nature of energy policy decisions but, at the same time, provide clarity and a context within which such decisions are made. The framework should provide the tools to optimize GHG emissions management and direct capital towards low- and zero-GHG emissions technologies.

Outlined below are some key concepts that could collectively form the basis of a flexible and diverse framework to support GHG emissions reduction efforts. Specific components of the framework are detailed in the following sections. Elements include:

- Establishing by 2010 a quantifiable, long-term (50-year) emissions pathway for the management of global GHG emissions and actively disseminating its meaning through all levels of society.
- Encouraging the development and deployment of leading-edge technologies through partnerships and incentives and an approach to mitigate long-term market risk and deliver secure benefits for large-scale, low-carbon, new technology projects.
- Including ideas and lessons learned from current approaches and instruments that are being used and continue to evolve at international, regional and domestic levels.
- Modifying the existing international framework so that it builds progressively (bottom up) from local, national, regional or sector programs that contribute to the quantifiable long-term international pathway and catalyzing the implementation of such programs.
- Allowing industry sector participation across multiple facilities or technology platforms at the national level and across national boundaries, and enhancing GHG project mechanisms to allow them to cater for sector projects.
- Progressively including all countries – both developing and developed.

The points above are directed primarily at energy use and infrastructure. Further framework conditions will be required to deal with issues such as deforestation and adaptation to climate change.





Why
is it needed?

The principal existing international framework, the Kyoto Protocol, is broadly a “top-down” approach. By contrast, energy production and use patterns develop largely “bottom up” from local, national and regional policies coupled with the availability and security of energy resources.

Aligning a new international climate change framework with existing approaches to energy access and security issues would offer greater scope for encompassing the large-scale changes needed in the energy system.

A quantifiable long-term pathway, established collectively by governments, scientific and technological organizations, business, and civil society, would assist in reducing current levels of uncertainty. The long-term pathway becomes a point of reference for the development of national energy and climate policy and raises consumer awareness of the need for GHG emissions management.

All technologies face barriers of some sort. GHG emissions management technologies face additional hurdles posed by the uncertainty over long-term political action to address climate change. A diverse approach will allow business to better manage this additional risk and further encourage technological development and deployment.

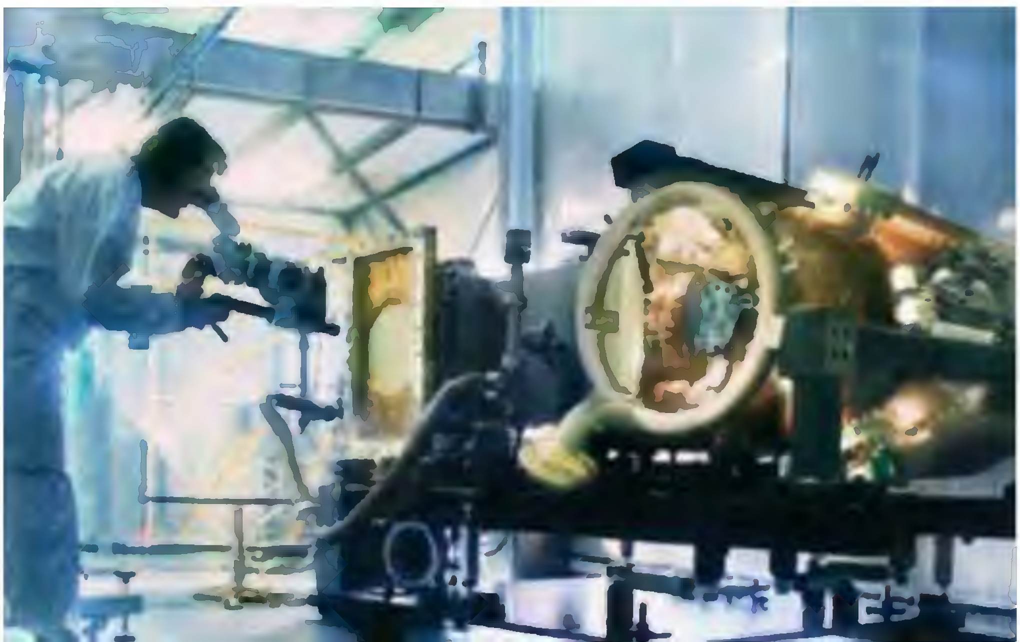
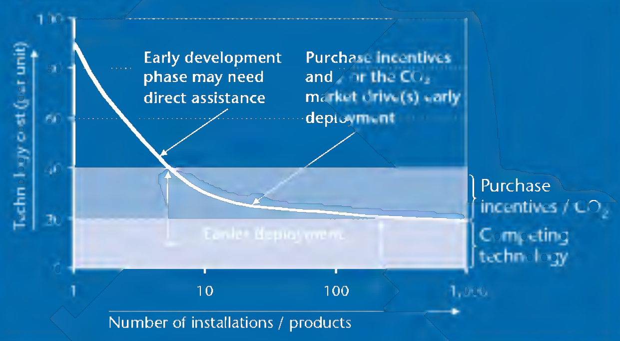


Figure 3: Technology cost curve



Framework

Kyoto – 2008-2012

Top down reduction obligations
Short-term (5-year) compliance obligation
Allocation of a reduction obligation – equitable allocation difficult to achieve politically
Least cost compliance – not enough certainty for large investments in new technologies
Emissions market
Targets – tons reduced relative to a baseline

How could it work?

The existing international framework would be revised and expanded:

- To encourage technology development to introduce change into the energy system;
- To further develop approaches to foster deployment of current best practices and existing technology;
- To deploy new energy technologies more rapidly than would otherwise be the case.

This approach is illustrated in figure 3 above.

Long-term pathway

The long-term global GHG emissions pathway should be expressed in terms of carbon equivalent emissions as a continuous path from now to 2050. The pathway would be based on the most up-to-date results from climate science research and an understanding of the impacts of climate change, and would recognize social and economic drivers of national and regional importance. Such a pathway should be in place by 2010.

The pathway would be revisited periodically, but certainly no later than 2020–25. Adjustments would doubtless be required as climate impact science continues to develop, and the rate of technology deployment confirmed or reset. Depending on the rate of technology development and the trajectory targeted, deployment would depend on ensuring that all new projects use the new technology together with an appropriate balance between early removal of existing capital stock and existing capital stock remaining to live out its life.

Technology development

The introduction of a long-term pathway should encourage new technology development and the implementation of medium to large-scale demonstration projects. But projects that are purely climate driven (e.g., CCS) simply will not happen unless there appears to be a future market or demand for such a service or technology. Two approaches could be used to overcome such risk:

1. Direct incentives for technology programs

a. At the international level, cooperative clean development networks can be established. These networks need to set aggressive targets for investment in, and commercialization of, key mitigation technologies through funded RD&D, pilot demonstrations and near-commercial full-scale demonstrations.

b. At the national level, policy can encourage the development of new technology through RD&D assistance, capital allowances for new low or zero-GHG infrastructure and early take-up incentives and consumer education programs designed to bring new products and services into the market more rapidly (e.g., GHG labeling and consumer websites).

2. Managing long-term regulatory risk
The long-term regulatory risk of a new technology project could be mitigated through the use of multilateral financing mechanisms such as the Global Environment Facility (GEF) or a mechanism that underwrites the long-term validity of the associated GHG reduction units (see box opposite).

Key components of the revised framework

The revised framework would learn and build from existing international agreements and incorporate the new long-term emissions pathway. The evolution of national and sector programs into an international framework is illustrated by a forward-looking case study in the power sector (see box in figure 4 opposite). The framework would consist of the elements outlined below.

National/industry sector programs

To accommodate national interests and promote inclusiveness, nations can introduce individual "wedges" or sectors of the economy into the international framework – e.g., X gigawatts of renewable energy by 2050, X gigawatts of nuclear by 2050, X megatons of CCS by 2050. This allows the flexibility to introduce segments of an economy rather than having the whole nation enter at once.

Industry sector programs would also be accommodated. A sector program might be structured around an energy efficiency trajectory, a "best available technology" objective or a direct reduction in CO_2 emissions. It is important to note that a sector program could cross national borders.

Projects

The project mechanism remains part of the revised framework. But the definition of a project is broadened considerably, such that a whole wedge or sector in one nation or across several nations could become an eligible project.

Projects can be done in any signatory country, but normally in sectors not covered by a specific program that may already be part of the framework. With projects taking a broader, more expansive role, there will be a need for streamlined approval processes with low transaction costs.

Technology cooperation

Technology development must be accompanied by the rapid transfer of technology between nations. Global cooperation through an international framework will be required to achieve this level of technology cooperation.

GHG market participation

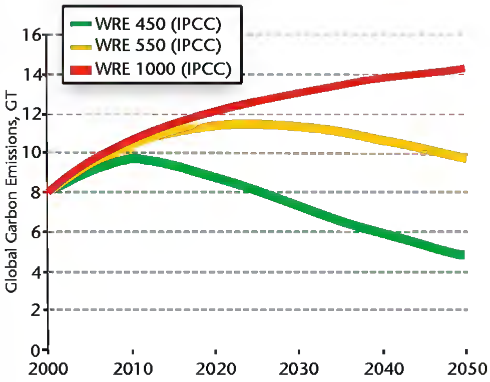
GHG market participation allows international trading between parties, sectors and projects, facilitating the movement of capital to lowest cost abatement opportunities. Emissions allowances could be issued at the international level against specific national or sector commitments and reduction units issued for projects (both subject to scrutiny). For example, the United States might enter the scheme once it has a domestic trading program up and running with its own long term targets. It would receive an allocation of international allowances equivalent to the objective of the trading program over the same period.

Many nations with rapidly developing economies and energy demands (e.g., India, Brazil, China) may enter sectors into the scheme with a rising emissions profile, but with policies in place to deliver a relative improvement over time against some metric, such as population or GDP. Emissions projections would be translated at the beginning of any given compliance period (e.g., 5-years) into an absolute value for that period, for allocation purposes. For reasons of economic development, the allocation would increase from period to period, but would represent a relative improvement in CO_2 emissions against the metric.

Industry sector programs would also be candidates for optional inclusion in the trading framework, either as a single project or as a national sector with allowance allocation.

Check-back

Creating a long-term emissions pathway requires significant international cooperation. A regular process of check-back at the international level would be needed to follow the development of national responses and assess the likelihood of collective success. This process should be based on the latest scientific information and include governments, business and civil society.

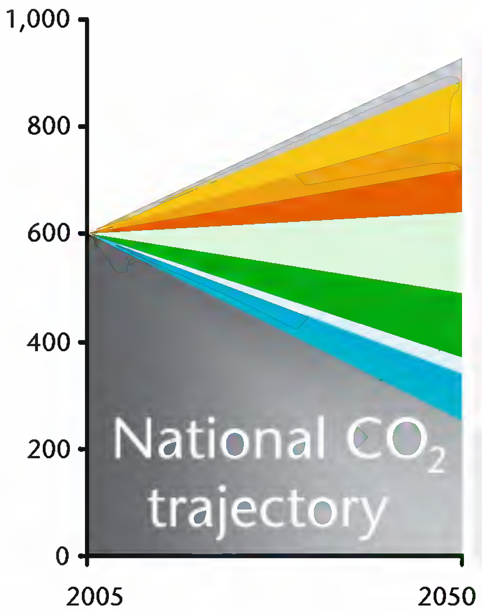


A. Opportunity wedges (national)
(developed country example)

B. A global GHG emissions pathway expressed in carbon equivalent (CO_2e) terms per annum

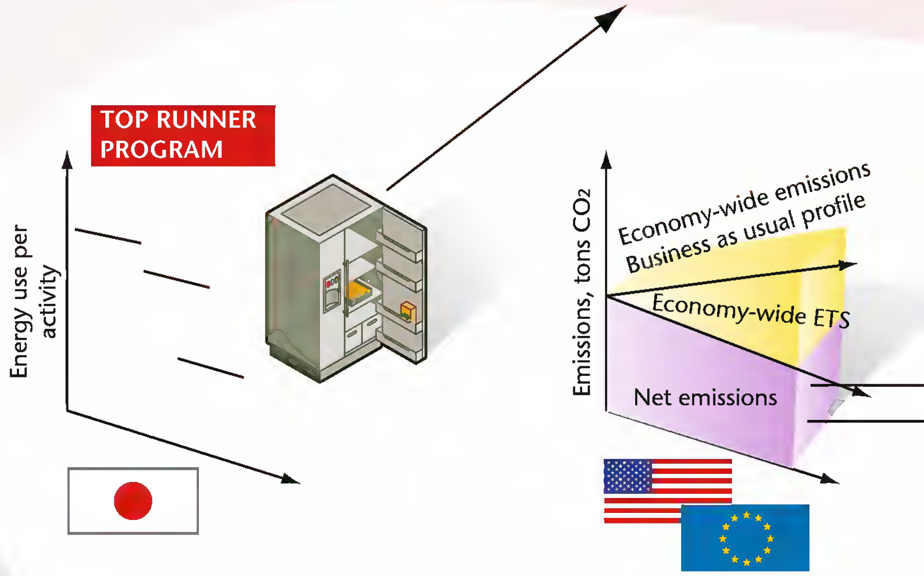
C. International framework

Technology
International partnerships to foster technology development, to set standards and to hasten technology transfer to developing countries



- Target
- Vehicle efficiency
- Renewable power
- Buildings
- Domestic
- Mobility - fuels
- Mobility choice
- CCS
- Industry
- Other actions

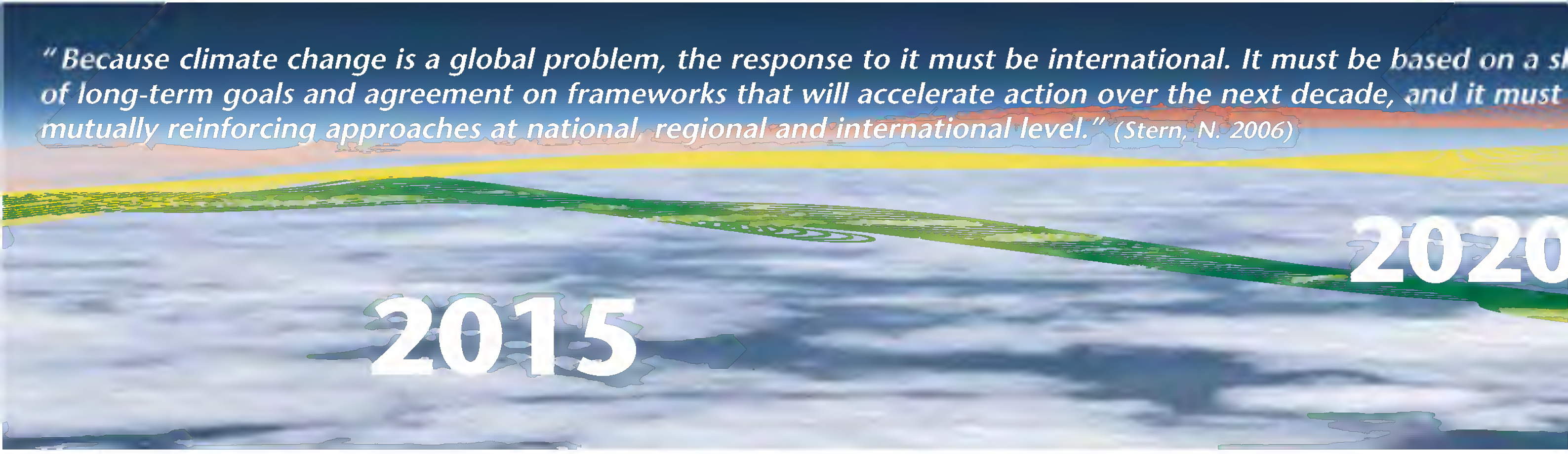
Figure 4:
Adapted from Pacala, S. and R. Socolow (2004)



Other country examples - illustrative only

GHG markets
Optimization through international GHG markets

Regular check-back on delivery of the long-term goal through national and sector action.



D. National/sector goals & targets

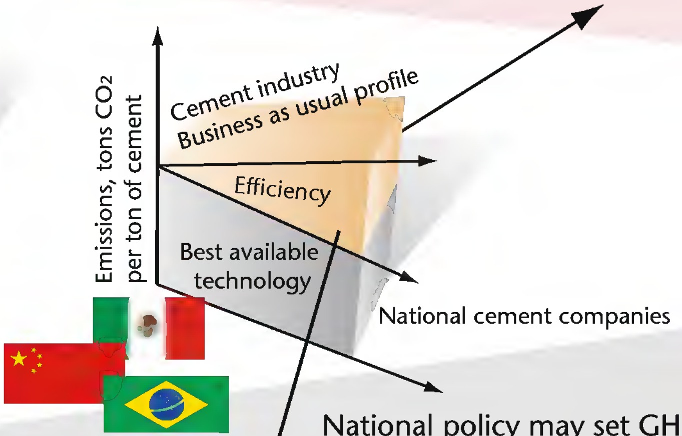
Efficiency	Buildings Industry Domestic	xx % p.a. through to 20xx
Power generation	Renewables CCS Nuclear	xx MW p.a. by 20xx xx tons CO_2 p.a. xx GW by 20xx
Mobility	Biofuels Choice	xx liters p.a. by 20xx Hybrid/diesel uptake Mass transportation

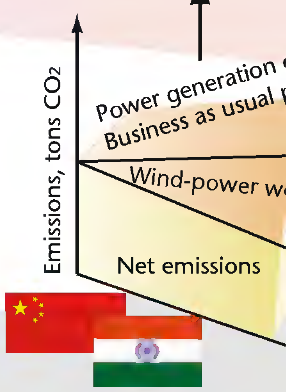
E. National p

Buildings – adopt
Industry – sector
Domestic – increa
Renewable energy
CCS – funding fo
Biofuels – targets,
Vehicle efficiency
Mobility choice -
transport network
Consumer awarer

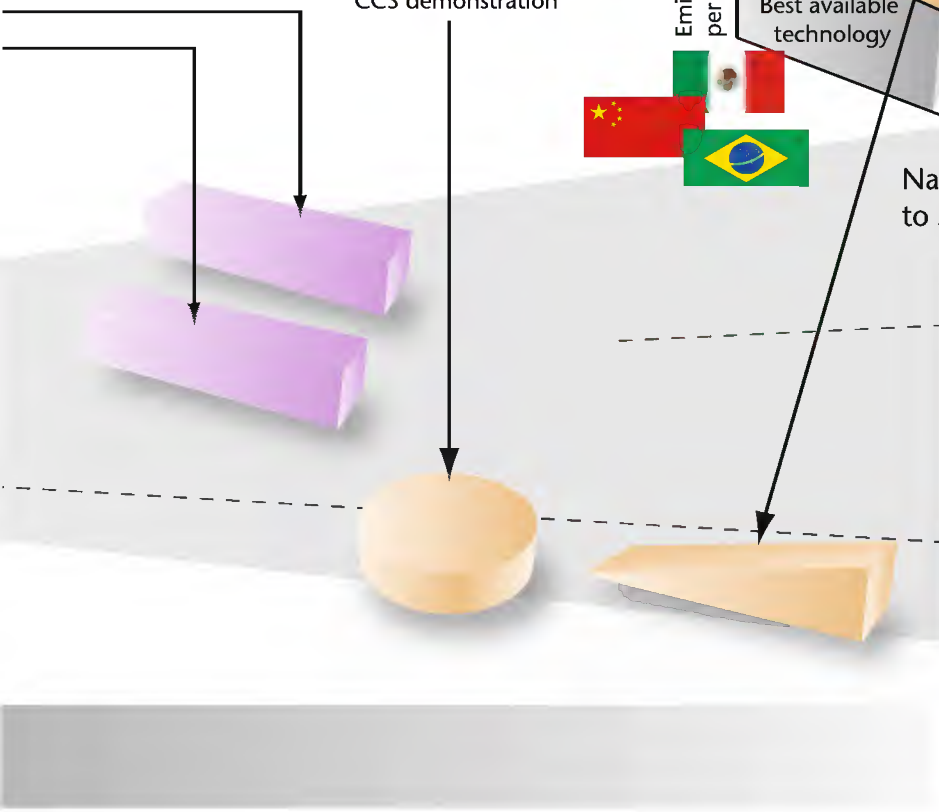
Technology transfer through application of standards

CCS demonstration





National policy may set GHG targets or allocate to specific sectors through various market mechanis



Increasing power sector emissions are a majo for rapidly growing economies

Carbon dioxide (CO_2) emissions from the power sector in rapidly more than triple by 2050.

In some cases the process of establishing energy efficiency targets power generation has already commenced. Yet the challenge rema generation. Given the scale of coal-fired power expansion, CCS wi Within a revised framework, early demonstration projects could be and direct financial assistance from the international community t generation.

In time, an expanded Clean Development Mechanism (CDM) cou large-scale Integrated Gasification Combined Cycle (IGCC) power pla new power plants could be low- or zero- GHG plants. Governments could f carbon tradable certificate program that drives renewables, IGCC-CCS program.

On the back of such national programs, governments could enter t framework. For example, in 2018 the sector program could show is then fixed thereafter. Governments could offer a two-way excha by purchasing credits from CDM projects and allowances from the them for local zero-CO_2 certificates or where a surplus exists sell lo

policies

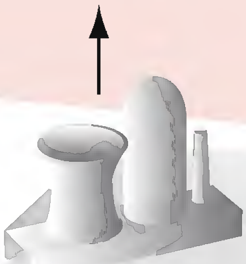
opt new country building standards, design awareness
or agreements, emissions trading, technology standards
creased standards on products (e.g., standby energy use)
ergy – renewables targets
for infrastructure, tax cuts on capital investments, price signals for GHG
ets, renewable fuel standards, support for manufacturing, GHG labeling
ncy - support technology, incentives, sector agreements
e - consumer incentives, promote public/private partnerships for
vorks
areness - GHG labeling of electrical appliances

Global technology standard: Standby power on electrical appliances

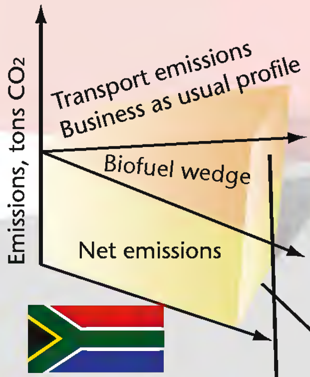
Stand-by power consumption is a surprisingly large contributor to energy demand in office buildings and residential homes. In the future it is possible that technology standards or policies targeting demand-side management such as one-watt power standby initiatives for appliances could evolve into globally applied technology standards.

Such initiatives could have wide application, particularly in government and business operations, and foster greater product innovation in the marketplace.

ion emissions
ual profile
er wedge
ns



Generation IV Nuclear



GHG incentives still apply for individual projects in countries and sectors not covered by other programs

nisms

either / or

Allocation to participating developed countries based on submitted programs

Allocation to participating developing countries based on submitted programs

Projects (carbon incentives)

ajor challenge

idly developing economies could nearly double by 2018 and

gets and ambitious plans for renewable energy and nuclear
remains to manage the CO_2 emissions from coal-fired power
CS will most likely be needed if emissions are to be stabilized.
ld be funded by forward GHC reductions, international grants
ity to demonstrate the feasibility of CCS with coal-fired power

could help generating companies begin the construction of
r plants with CCS. By 2025, with sufficient economic incentives all
uld further encourage implementation by introducing a single zero-
-CCS and nuclear. Specific 5-year targets would support the

ter their power sector (wedge) into the expanding international
how a rising emissions profile for an initial 5-year period, which
xchange program such that generators can meet their targets
n the EU-ETS (or other program that might exist) and swap
ell local certificates directly into the international GHG markets.

What national governments could do

1. Agree a long-term GHG trajectory for global emissions, stretching at least to 2050.
2. Recognize their own national contribution to such a trajectory.
3. Develop national energy and GHG mitigation policy aligned with their national contribution.
4. Support development of low-GHG emissions technologies and infrastructures suitable to the country.
5. Recognize industry sector approaches to GHG mitigation.
6. Encourage participation in global GHG markets.
7. Develop adaptation strategies.
8. Encourage demand for low-emission energy, energy efficiency and conservation.

comparison

WBCSD revised framework

Bottom-up – National / sector policies and commitments
Longer term (50-year emissions trajectory)
National opportunities and policies aligned with energy security and climate change priorities
Technology development and deployment focus
Deeper engagement of capital markets and greater influence over allocation of capital driven by a wide range of policies and a broad based emissions market
Targets still in terms of GHG reductions, but aligned to specific actions with GHG benefits – e.g., XX MW of wind power by 20XX

Technology deployment

Signatories to the long-term international objective would be expected to develop national programs to manage GHG emissions or encourage industry sector programs in alignment with the agreed global emissions pathway. Cross-border industry sector programs could also be developed.

Cooperation on technology development could lead to international agreement on technology codes and standards for industry and manufacturing, buildings, mobility and consumer products, thus hastening the adoption of new technologies globally.

Concept discussion:
Forward reductions

An approach could be developed as a special project mechanism allowing a limited number of large-scale demonstration projects to claim reductions up to 20 years into the future as current reduction units, issued once the project starts operating. These units would be tradable within the compliance period in which they were issued or could be banked to subsequent periods. This mechanism would operate at the international level and would require an overseeing body.

Development and expansion of GHG market mechanisms

International GHG markets would continue to play a role in a revised framework, directing energy investment capital in favor of low- and zero-GHG emissions projects. The market would be used to provide an outlet for project reduction units and link disparate national and international sector programs together.

Such national and sector programs need not be based on emissions trading (e.g., cap and trade). For example, GHG emissions could be decreased through programs to promote energy efficiency, more use of renewables, the expansion of nuclear energy, performance targets, offsets, carbon taxes, regulation or technology funds.

To introduce additional flexibility in achieving national or sector objectives, these programs may wish to link to international emissions trading markets provided they meet certain criteria for entry (e.g., the policy measure should recognize the international trajectory and represent a realistic and tangible contribution to GHG reductions). A linked program would become eligible for an allocation of tradable GHG allowances or would be treated as a project and granted tradable GHG reduction units. The body administering national climate policy would be responsible for distribution of GHG allocation units to the industries involved in the sector within a country.

Power Generation

What is needed?

Power generation plays a key role in the transition towards a low-GHG emissions economy. By 2050, electricity will be the preferred domestic and commercial energy carrier. Its share of total final energy will have increased sharply due to improved access, its expanded application (in the buildings, manufacturing and mobility sectors) and the continued development of societies.

Such a shift will require investments that encourage:

- Decarbonization of the fuel mix;
- GHG emissions management;
- Energy efficiency improvements in generation technology;
- Energy efficiency improvements in end-use applications;
- Electricity as the preferred domestic and commercial final energy carrier.

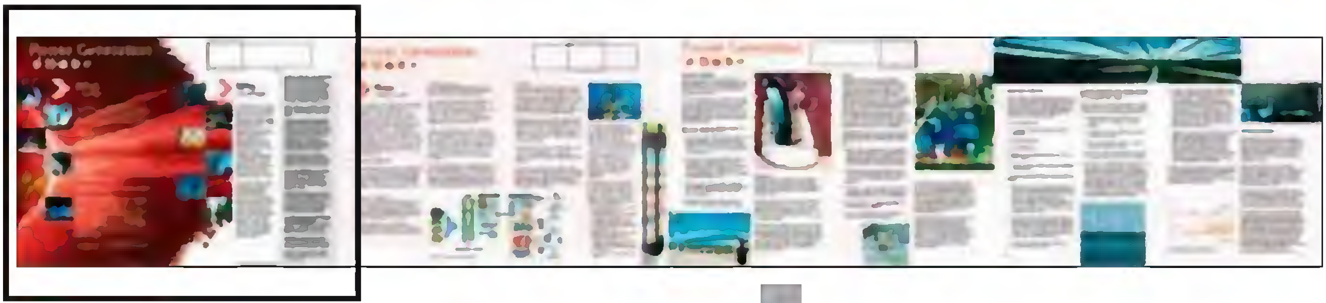
Achieving these goals will require a major change in the electric power generation infrastructure. Three key technologies will be required to deliver sufficient scale of electricity generation and GHG emissions reduction:

- Renewables;
- Nuclear power;
- Clean coal technology, including CCS.

Natural gas should continue to be used for heat and power generation, given its relatively low GHG emissions compared to other fossil fuels.

The policy framework needed to deliver the necessary changes will require the use of strong policy mechanisms. These could include some or all of the following: tax incentives, energy or emission charges, R&D support, financial assistance, emissions limits or targets, energy mix targets (such as a renewable energy target), trading of emissions or zero-GHG generation instruments, green power procurement (by governments), and/or other requirements or incentives integrated into energy markets or regulatory schemes. A future energy infrastructure with a high level of renewables may need to deal with many smaller pockets of generation and intermittency and therefore would need to be smarter and more interconnected than today's grids.

Improvement in end-use efficiency is also of equal importance and is discussed in the sections on Industry and Manufacturing, Buildings and Consumer Choices.



Why
is it needed?

Power generation assets have long life cycles. Power plants are often in use for 40 to 60 years. Thus policy horizons must match these cycles giving long-term certainty to justify the necessary investments. With the need to build new power generating capacity in developing countries and the pressure to replace aging capacity in developed countries, there is a unique opportunity to shift the infrastructure toward low-carbon technologies. Enormous investments will be needed. The International Energy Agency (IEA) has estimated that over US$20 trillion needs to be invested in the world's energy infrastructure before 2030. Some two-thirds of this should go to the power sector.

Security of energy supply is high on the political agenda of both developed and developing countries, leading in some instances to increased reliance on domestic coal resources, with high levels of associated GHG emissions. A shift toward low-GHG power generation could both ease energy security concerns and reduce GHG emissions in this sector. Highly efficient low-GHG or GHG-free solutions are available. They must be encouraged with appropriate frameworks creating long-term investment certainty.

Electricity is at the heart of the global energy challenge because power generation represents 40% of the GHG emissions of the energy sector, a huge number of plants will have to be built or replaced in the decades to come and several low-carbon and carbon-free technologies are available or promising. It thus can be part of the solution if the right decisions are made in time.

The key objectives to *Powering a Sustainable Future* as highlighted in the report of the WBCSD electricity utilities working group include:

1. Secure investments in infrastructure
Utilities must hedge against major long-term risks. It is up to policy-makers to plan policies a long time in advance, and provide direction with long-term credibility. New policy frameworks are needed that take proper account of environmental externalities, and recognize the value of security, reliability and affordability, while ensuring adequate return on investment through a sound electricity market.

2. Get more power to more people
Available and affordable electricity supply for homes and sufficient electricity to supply business and enhance economic growth.

3. Use end-use efficiency as a resource
Everybody agrees that there is a huge opportunity to reduce our primary energy needs. Utilities can provide professional advice on the efficient use of energy and policies are needed to influence behavioral patterns of end-users.

4. Diversify and decarbonize the fuel mix
In addition to fuel diversification to increase the use of lower carbon resources and much more efficient use of fossil fuels, policy frameworks should encourage investment in developing low and non CO_2-emitting technologies that are already available.

5. Accelerate research and development on promising technologies
Examples include clean coal technologies, including CCS, Generation IV nuclear, advanced solar technologies and hydrogen. Public financing will also have a key role to play.

6. Reinforce and smarten the grids
to ensure supply reliability and to reduce losses, while incorporating highly variable renewables and decentralized generation.

WBCSD Electric Utilities Project (2006a)
Powering a Sustainable Future: An agenda for concerted action.

Power Generation

How could it work?

Future power generation policy approaches should recognize that no single instrument is sufficient on its own; a suite of complementary measures is the ideal approach, with environmental values firmly integrated into the selection criteria of consumers and producers in the marketplace. Although government should not attempt to pick winners too soon, some level of national pre-screening and selection of likely technologies will be necessary to formulate the appropriate policy mix. For example, in the United Kingdom nuclear and offshore wind are increasingly being seen as key parts of the future power generation mix, and in Japan the fuel mix is being decarbonized by means of increasing the share of nuclear and natural gas. There is also growing or renewed interest in nuclear in other countries, such as the US, Australia, China, India and Brazil.

Technology development

Further development and commercialization of technologies in clean coal, CCS and next generation nuclear will be expensive. For cost reasons, the necessary investment in energy RD&D is unlikely to be delivered by the private sector alone. Therefore, for the development of zero/low GHG technologies, direct public assistance and inter-sector cooperation are keys to success.

Fossil fuel power generation

Fossil fuel power generation is dominated today by coal, with natural gas and to a much lesser extent oil making up the balance. With significant growth in both coal and natural gas supplies (driven by a growing liquid natural gas (LNG) market), fossil fuel-based generation will continue to be an important component of the electricity mix for many decades.

Long-term directions for this sub-sector include the development of clean coal technologies such as high-efficiency power generation, coal gasification and the application of CCS.

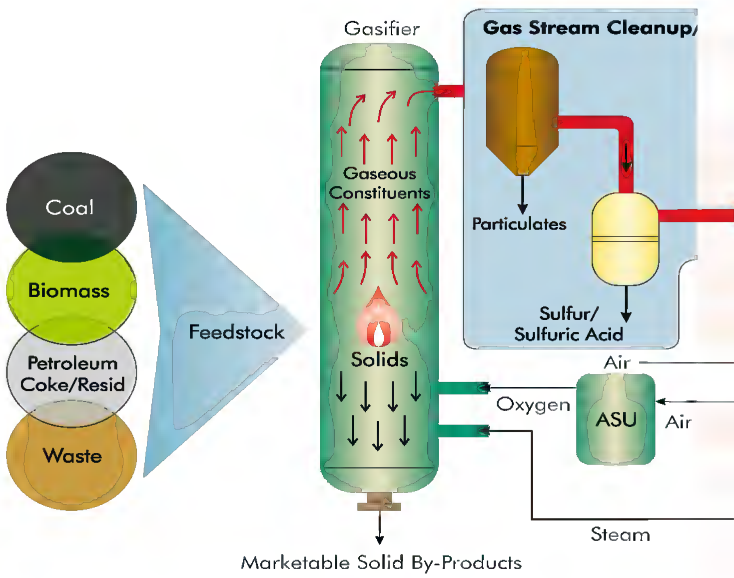
(i) Clean coal technologies

Coal gasification or more efficient direct combustion are two clean coal technologies. Benefits include improvements in efficiency, local air quality and production flexibility.

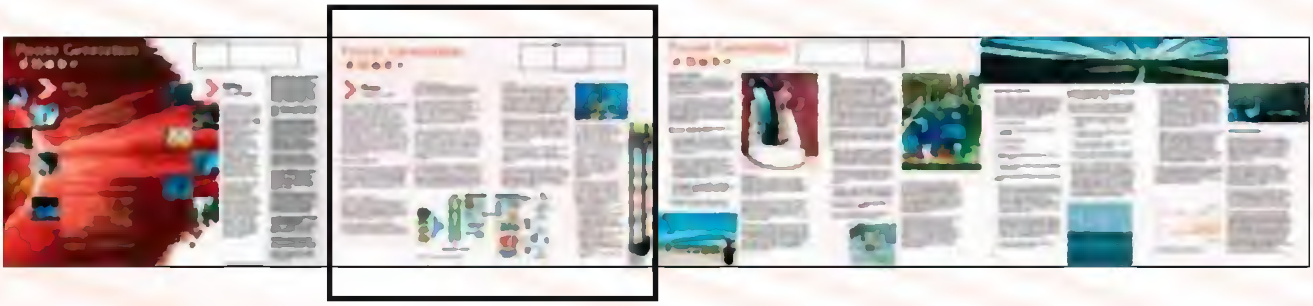
IGCC is one of the most efficient clean coal technologies that could involve coproduction of hydrogen and/or other chemicals. Current and future R&D activities could be focused on a range of aspects related to the technology (e.g., reliability/availability, refractory, syngas cooler material and deposition, coal feeding/conversion, co-gasification, dry gas desulfurization, scale up costs of hybrid cycles).

A further variation is Integrated Coal Gasification Fuel Cell Combined Cycle (IGFC), which consists of a coal gasification unit, a solid oxide fuel cell, a gas turbine, a steam turbine and ancillary equipment. Thermal efficiency of the IGFC is expected to exceed 58% lower heating value. This is an efficiency gain of over 15% compared with other advanced coal technologies, and a GHG reduction of approximately 30% is possible, suggesting a way to control GHG emissions from coal-fired power generation.

Oxygen blown clean coal processes can emit GHG such as CO_2 in a very pure, pre-combustion waste stream rather than in a mixture with other combustion gases and so can reduce the amount of gases to be treated when integrated with CCS. In this type of technology development, further demonstration is needed to increase confidence and decrease costs. Direct public assistance and inter-sectoral cooperation will be needed in support.



Source: Office of Fossil Energy, U.S. Department of Energy



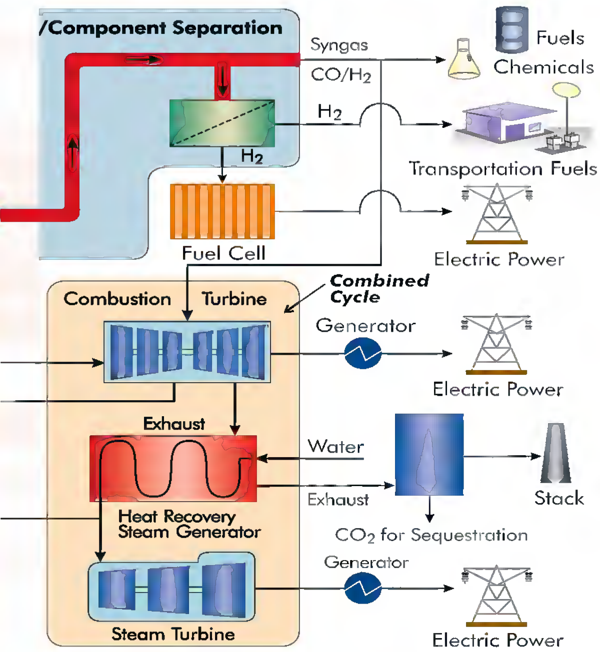
(ii) Natural gas

Natural gas plants generate the lowest GHG emissions of any fossil fuel power generation. Combined Cycle Gas Turbines (CCGT, i.e., gas and steam) now yield efficiencies in excess of 50%, while capital costs and project lead times are lower than for any other large-scale generation technology. Research and development aims to bring CCGT efficiencies up to their technical limit (over 60%) while controlling NOx emissions and to reduce costs of smaller units (engines and turbines).

Further efficiency is possible with natural gas fuel cells. All fuel cells require hydrogen, but certain types (molten carbonate fuel cells (MCFC) and solid oxide fuel cells (SOFC)), can form this directly from natural gas. Their efficiencies could be 10% higher than the most advanced CCGT. The availability of natural gas distribution networks would be a major advantage in marketing such fuel cells.

Increasing demand for natural gas continues to put pressure on availability and therefore price. As a result, policy approaches will be required to encourage both the stable supply of natural gas and even greater efficiency in generation technology.

As the search expands for natural gas, supplies are being found in locations remote from suitable markets. Development of these supply sources and bringing them to market typically require long pipelines, sometimes crossing international borders, and/or using liquid natural gas (LNG) technology so that the product can be shipped.



(iii) Carbon capture and storage (CCS)

CCS is one of the few technologies driven almost entirely by climate change. While other zero-GHG power generation alternatives exist (e.g., renewables and nuclear), they are also driven by factors such as energy costs, security of supply and local air quality. This is not necessarily the case for CCS. As illustrated in *Pathways to 2050*, CCS could play a critical role in delivering atmospheric stabilization. By 2050, some 8 billion tons of CO_2 could be captured annually from coal-fired power plants (in applicable locations) and stored underground.

The application of gasification technology (see above) allows new coal (and natural gas) generation facilities to consider CCS given the availability of a CO_2 stream from the process. But further development and deployment of the technology should be encouraged as described below:

- Give suitable financial encouragement to a number of large-scale CCS demonstration projects in several regions to accelerate cost reductions, and promote the development of a global CCS industry through knowledge sharing and economies of scale;
- Include CCS in all GHG emissions trading schemes and in the project-based mechanisms of the UNFCCC, and coordinate the development of standard accounting and measurement protocols for CCS projects;
- Address the issue of long-term liability for stored CO_2.

Power Generation

Non-hydro renewables

Non-hydro renewable energy (e.g., wind and solar) is an important component of any sustainable energy future, with potential benefits such as clean air, GHG reductions, energy diversity, improved national security, regional economic development and job creation.

Only a fraction of the resources are economically accessible with today's technologies. Reasonable costs, sufficient surface areas and practical proximity to transmission and/or load centers are required, which all vary on a local basis. Areas for further development include reducing manufacturing costs, improving lifetime and conversion efficiency and integration with building technologies.

The creation of a robust renewable energy business would require efforts along the following lines:

- A simple, high-profile, rational and highly credible national target for the quantity or share of renewables could underpin policy decisions. This needs to be a long-term vision (e.g., 20 to 30 years) and ideally supplemented by a series of interim reviews.
- Transaction costs to demonstrate eligibility for policy or other incentives should be driven down. In many jurisdictions the cost of developing renewable energy on- or off-grid is higher than for traditional energy sources. Renewable energy projects are offen small-scale and require a streamlining of administrative costs.
- Programs/incentives should complement, rather than restrict, eligibility to other renewable energy initiatives (e.g., renewable energy certificate programs, international emissions trading, etc.).
- The special aspects of renewable energy should be managed (i.e., intermittent, on/off grid, peak supply).

Hydropower

Hydropower is the major contributor of renewable energy, responsible for 89% of the world's renewable electricity production in 2002. Two-thirds of the world's economically feasible and unexploited potential is mainly concentrated in developing countries.

Hydropower is almost always free of CO_2 and CH_4 except in the particular circumstance of a very shallow reservoir in a tropical zone where decaying biomass can lead to emissions during the early years of operation. Even in such cases however, overall emissions will still be far lower than a natural gas combined cycle plant.

The development of a hydropower project can be sustainable if social and environmental impacts are properly dealt with by following guidelines that seek to mitigate those impacts. The first certified emission reductions (CERs) issued under the CDM were for hydro projects including small-scale applications in Central America in January 2005. In 2006 this extended to larger hydropower projects such as Siwha Tidal plant (254 MW) in South Korea.

Nuclear

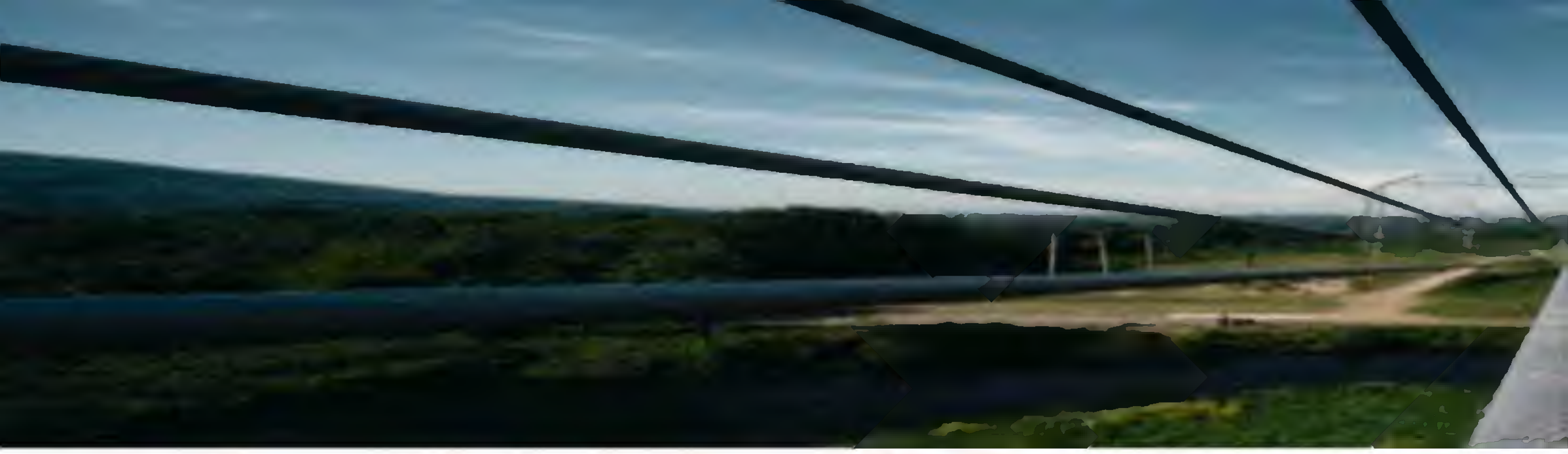
Nuclear energy remains an important zero-emission technology. *Pathways to 2050* identified the need for over 1,000 large facilities by 2050, nearly triple the number in use in 2000. Nuclear can be competitive with coal or gas-fired generation in some countries, even without monetary considerations supporting its zero-CO_2 emissions because the higher capital cost of construction is offset by lower operating costs. China, India, Brazil, Gulf Corporation Council countries, and Egypt have indicated their intention to build nuclear plants to help meet rapidly rising energy needs. In France, Japan and Finland, plans for new nuclear plants are moving ahead. Concerns about rising fuel prices, supply security and climate change have led several other developed countries to reconsider the role of nuclear in a more favorable light.

Supporting policies and programs will be required to address some of the key challenges associated with the development and commercialization of nuclear technologies as outlined below:

- There is a need to support nuclear power through the establishment of comprehensive non-proliferation policies, competent and credible safety authorities, clear and coherent license design and siting procedures, together with standardization and associated economies of scale.
- Generation III nuclear projects should be encouraged where they can be done reliably and safely, and achieve economies of scale with multiple facilities in those countries.
- Investments are needed in development and international collaboration for Generation IV nuclear technologies, including pilot projects necessary to establish feasibility.
- The value of emissions avoided through nuclear power should be formally accounted for.
- The issue of long-term liability for stored high level radioactive wastes needs to be addressed.

Governments that anticipate a major role for nuclear power must take the steps above into account to assure its safety, security and cost-effectiveness in the longer term. The operation of more than 400 nuclear power reactors worldwide provides a wealth of experience and lessons learned to guide future development. Even so, financial incentives and/or risk transfers may be needed in some countries to spur the industry to deploy Generation III technology.

Advanced nuclear technologies (e.g., Generation IV fast breeder reactors) need continued research and development that should be pursued through public/private partnerships and collaborative RD&D programs. The case for international cooperation in nuclear power is well established. Nuclear programs of this type should be managed at the global level, leading to the development of world standards for nuclear generation.



Deployment mechanisms

One way to deploy the required generation technologies and achieve environmental objectives in the medium to long term is to create market conditions that enhance capital turnover and direct that capital towards lower GHG emitting technologies. Examples of market approaches that could be employed to encourage investment include the following:

- "Green" electricity tariffs;
- Tax incentives including exemptions and accelerated depreciation;
- Soft loan public finance;
- Renewable certificates;
- Emissions trading through structures such as "cap-and-trade" systems;
- Recognizing the value of GHG reductions in government procurement plans.

Such measures should be designed based on the following key premises:

- Guide capital to where it can be used most effectively. The aim of any market mechanism should be to direct capital within a given sector to the point at which it can be most effective in achieving the objective of the policy. Conversely, the objective should not be to withdraw that capital (e.g., through taxes or auctioning of emissions allowances) from the sector and redistribute it to projects according to subjective criteria.
- The longevity of the mechanism should match the life of the infrastructure. The long-term nature of power generation investments means that market mechanisms should be stable over comparably long terms. Investment decisions cannot be made without confidence in the applicability of the mechanism over the life of the projects.
- Certainty for the continuation of energy policies and market structure must be assured.

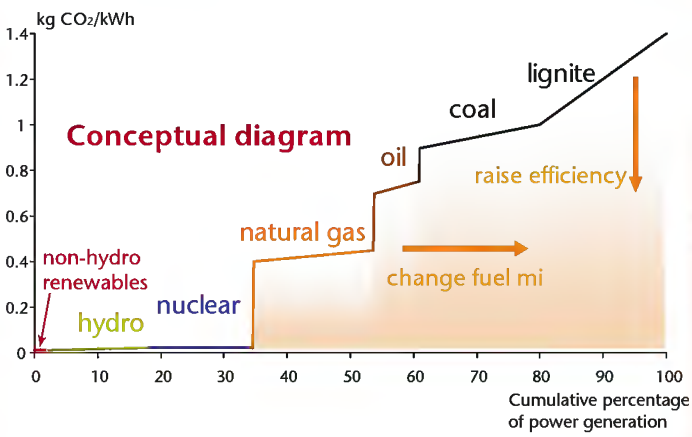
In addition to directing capital to such investment opportunities, the main purpose of public policies and regulations must be to create successful deployment conditions.

- For renewables such as wind and solar, initiatives by national and local governments that support both demand and supply of renewable energy, and could support deployment include:
    - Funding support for transmission lines to remote locations and areas with high renewable energy potential;
    - Ensuring renewable energy eligibility in international emissions trading schemes;
    - Clear, timely and objective processes for granting planning approval for new projects.
- For hydropower, biodiversity, displacements of populations and water use trade-offs must be adequately considered.
- For nuclear power, experience tells us that it can be a safe and economic means of generation, ensuring security of supply and enjoying public acceptance. A competent and credible safety authority, clear and coherent license design and site selection procedures must support it. Further, the industry should be structured to allow for standardization and the associated economies of scale. A renewed national and international approach to the nuclear waste disposal issue and comprehensive non-proliferation policies will also be required, as nuclear power capacity increases.

- For biomass generation, the production of biomass must be done in a sustainable manner. For example, to keep its CO_2 impact neutral, avoid depleting scarce water resources; optimize use of land, avoiding deforestation; and minimize competition between food and fuel. The low-energy density of biomass limits the scale at which it can be produced. Costs of conversion to fuel are lowest when the transportation of biomass is minimized, when processing can be combined with local heat and power generation, and when value adding co-products can be derived from the various processes.

- Expanding natural gas power generation in many locations will involve using LNG imports and/or long-distance pipelines. Therefore facilitating increasing natural gas supply requires obtaining permits and agreements between stakeholders on the routing and location of associated infrastructure, which may be in sensitive locations due to environmental or community factors. This will require cooperation between business, government, NGOs and people affected by such decisions.

A number of generation technologies (e.g., solar) can operate on a small scale and deliver benefits. Where such opportunities exist, government policy should seek to integrate micro-generation into new-building design. This is discussed further in the Buildings section of this document.



Source: Carbon intensity ranges: World Energy Council. "Comparison of Energy Systems Using Life Cycle Assessment". Special Report. 2004; Fuel mix: IEA. *World Energy Outlook 2004.*

Transmission and grids

Much of the electricity generated today is produced by large-scale, centralized power plants using fossil fuels (coal, oil and gas), hydropower or nuclear power, with energy being transmitted and distributed over long distances to consumers. In this paradigm, power flows only in one direction: from the central power station to the network and to the consumers.

A future energy infrastructure with a high level of renewables will need to deal with many smaller pockets of generation and intermittency – driven by weather, tidal movements, sunlight and residual power from micro-generation. Tomorrow's grid must be smarter and more interconnected than today's "islands".

The economic barrier that rural grid connection poses to renewables technologies must be recognized. A government policy framework could either encourage or require owners of national distribution and transmission networks to alleviate this natural barrier to rural renewables projects.

Investment needs for transmission and distribution grids over the coming decades could be greater than that for electricity generation itself. Investment in the transmission and distribution network is required to accommodate the optimal and efficient operation of generation facilities and also to ensure flexibility to meet future changes in primary energy supply sources. In order for business to invest in power generation facilities and an increasingly complex and interconnected network system, legal framework conditions must be considered to minimize the investment risks, simplify and streamline local regulatory processes and to ensure tariffs that reflect real costs.

Industry & Manufacturing

What
is needed?

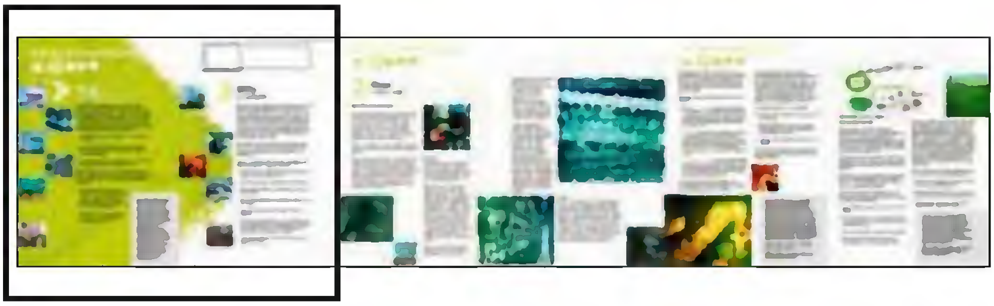
The industry and manufacturing sector worldwide includes a particularly diverse range of businesses, from metals and mining to chemicals, cement and forest products. This sector accounts for up to 32% of global energy consumption. Achieving substantial reductions of absolute emissions over the coming decades will be a significant challenge given rising demand for both energy and products driven by economic growth. Despite the diversity of industries, the required technological advances can be summarized as follows:

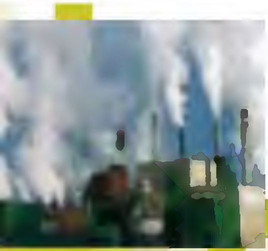
- Continuously enhance energy efficiency and lessen reliance on fossil fuels;
- RD&D to support development of low-GHG breakthrough technologies will be important in capital-intensive sectors with long investment horizons;
- Rapid deployment of best available technologies will be important particularly for operations in developing countries.

Policies for industry and manufacturing could include sector-based initiatives where local conditions are not conducive to economy-wide systems. In circumstances where a sector approach is considered it is important that:

- Project mechanisms be expanded such that a whole "wedge" or sector – in one nation or across several nations – could become an eligible project or program under the revised international framework (e.g., sector-based CDM initiative).
- Approaches developed in support of the long-term trajectory can be linked into a growing international market.

Many different policy measures are already in place or have been proposed to improve energy efficiency and reduce GHG emissions from industry. Chief among these is emissions trading, now in operation in the EU. Other measures include best available technology standards, efficiency benchmarking, voluntary agreements with government and tax incentives for certain project types. While recognizing the effectiveness of such measures, this publication has chosen to focus on sector approaches, building on the concepts laid down in the proposed International Framework section.





Why
is it needed?

The absence of a truly global mechanism for dealing with energy and climate has prompted fragmentation in national approaches to decarbonization. Global businesses face a complex web of national schemes and industry standards, voluntary and mandatory targets and regulatory compliance obligations that vary around the world. Such factors can create environmental and economic inefficiencies, investment uncertainty, distortions to international competitiveness and concerns over "leakage" issues. These potential impacts can be most pronounced where standardized or commodity products compete in global markets on price.

The development of sector-based approaches could help address these issues by creating uniform GHG reduction priorities within a given sector to reduce emissions at the local, regional or even international level.

Industries in which one or more of the following conditions apply could be appropriate for a sector-based approach:

- If emissions represent a significant proportion of global emissions and trends show increasing growth rates;
- If it deals in high volume, standardized or commodity products;
- If the geographical spread and concentration of major players is fairly consistent;
- If the manufacturing processes and capital stock turnover rates are fairly uniform;
- If the sector competes in markets particularly sensitive to distortions;
- If the sector is highly regulated, data availability and the use of standardized reporting and measurement protocols will typically be more robust and prove useful in establishing objectives, targets, performance benchmarks and baselines;
- If operational boundaries and "leakage" issues can be clearly defined and managed.

Industry & Manufacturing

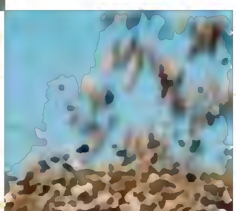
How
could it work?

Structuring sector agreements

There are a number of issues to consider when structuring a sector approach. The mechanisms employed could vary from one sector to another and be administered in various ways (e.g., regulatory or voluntary basis). Targets might be structured around a range of factors such as absolute reductions, efficiency goals, best available technology performance standards, or direct reduction in CO_2 emissions, depending on agreed priorities within the sector.

Actions may be binding or "no lose" (no penalty) or perhaps aligned with RD&D objectives if breakthrough technologies are important.

The geographical and political context and influence of other schemes (e.g., EU ETS, AP6, CDM, etc.) need to be firmly established. Governments need defined roles in monitoring progress. The convergence of sector efforts into national policy programs or an international framework is also important. Within a robust international framework, sector programs could operate globally (across national borders) or at the regional or national level. For further information on sector approaches see also WRI (2005).



Aluminum

The aluminum industry is very energy intensive and has recently done much in terms of energy efficiency and emission reductions. A uniform and highly recyclable metal, aluminum is produced by a small group of large multinational players.

The majority of emissions come from electricity use and by-products such as perfluorocarbons (PFCs) associated with primary smelting. Today, one-third of total aluminum demand is supplied through recycled metal flows, saving up to 95% of the initial energy use and primary emissions. Technologies are widely accessible, and in recent years progress has been achieved, especially in reducing PFCs. The industry is capital-intensive, and stock turnover rates are low. RD&D and rapid deployment of best available technologies will be key to reaching future goals. Governance issues and intellectual property rights will be important concerns.

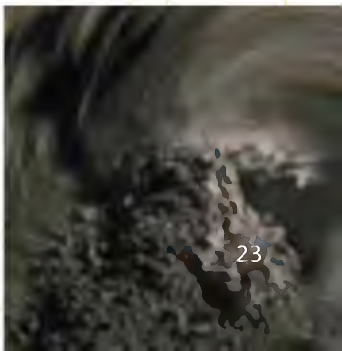
The sector is generally highly regulated; reporting systems, data management and methodologies are fairly consistent.

The global market in which aluminum competes on price prevents the industry from passing costs through to customers. This sector is particularly sensitive to policy approaches that create competitiveness issues, perverse incentives and leakage to other sectors. Steps to increase the supply of emissions credits into the market will allow the sector to meet current and future compliance obligations.

A sector-based approach for aluminum could be global and voluntary in nature, centered on the use of performance benchmarks (per unit of production) and linked, for example, to a best available technology baseline. A global approach could also operate in parallel to country commitments. The sector could participate in international emissions trading, using sector-standardized, project-based emissions credits. Agreements could be administered by a relevant global industry association (e.g., International Aluminum Institute) with monitoring and governance provided through national registries and an appropriate international review body (UNFCCC or similar).

Cement

Cement is a global commodity and the chief ingredient in concrete. Per capita consumption of cement is highest in developed countries, but is increasing in areas of rapid population and infrastructure growth, with almost half of the world's annual cement production in China. Although significant consolidation has taken place in the last decade, the industry comprises a diverse range of players, from small local producers to global corporations operating on all continents. Cement is a high-density, relatively low-cost product, with economic road transport distances limited to around 200 km and long-distance transportation of cement and clinker limited to marine shipment.



Industry & Manufacturing

Cement manufacture is energy and capital intensive; once built, facilities may last up to 50 years. However, 60% of direct emissions are from the decarbonization of limestone rather than the use of energy. The remainder is from fuel. Cement manufacture accounts for approximately 5% of global man-made CO_2 emissions.

The industry has three main technological options to reduce emissions:

1. Improve **energy efficiency** of clinker manufacture; this is very capital intensive. Current efforts center on replacing wet kiln processes with advanced dry kilns. Rotary kilns are the most likely technology for the next decades, but even existing best kiln technologies could result in significant CO_2 savings by 2050.

2. **Substitution** of fossil fuels (e.g., co-generation, coal to gas, waste-derived fuels, etc.); this is effective in terms of sustainable development, but does not necessarily lead to emissions reductions within the cement industry, but rather in other sectors that were the source of the burnable wastes or byproducts (i.e., waste disposal and incineration sectors).

3. **Reduction of clinker content** in cement through substituting materials such as fly ash, slag and natural pozzolanas (a type of volcanic ash used in cement). However, restrictive cement norms and the economic availability of substitutes can limit the application of this option in some areas.

New cement types that do not use limestone may be developed in the long term, but the feasibility and economics of such breakthroughs are not yet well defined.

Due to the homogeneous nature of the industry (technology and product), a performance-based approach (PBA) could be the basis of regulatory or voluntary mechanisms. Such approaches include emissions trading, CDM projects and/or voluntary efficiency improvement schemes. The incorporation of a sector-based "cement wedge" into an expanding international framework has potential as long as competitiveness issues are adequately addressed and avoid the potential for carbon leakage.

Practical implementation of a PBA would require:

- Definition of the unit of performance standard (e.g., ton CO_2/ton cement);

- Quantification of the performance standard, possibly including regional or technological differentiation on the basis of objective parameters;

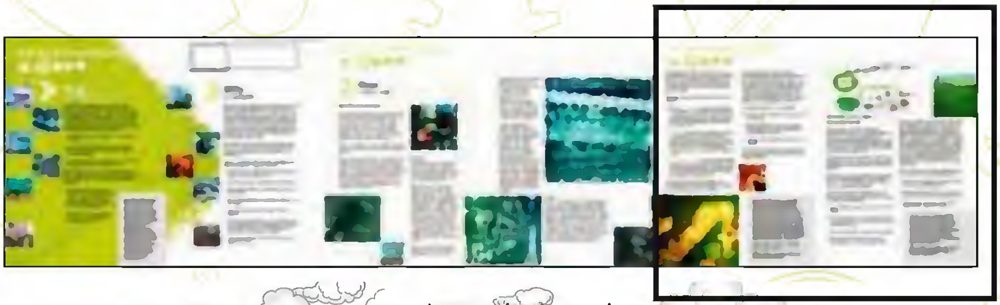
- Production volume (if absolute CO_2 emissions are to be calculated).

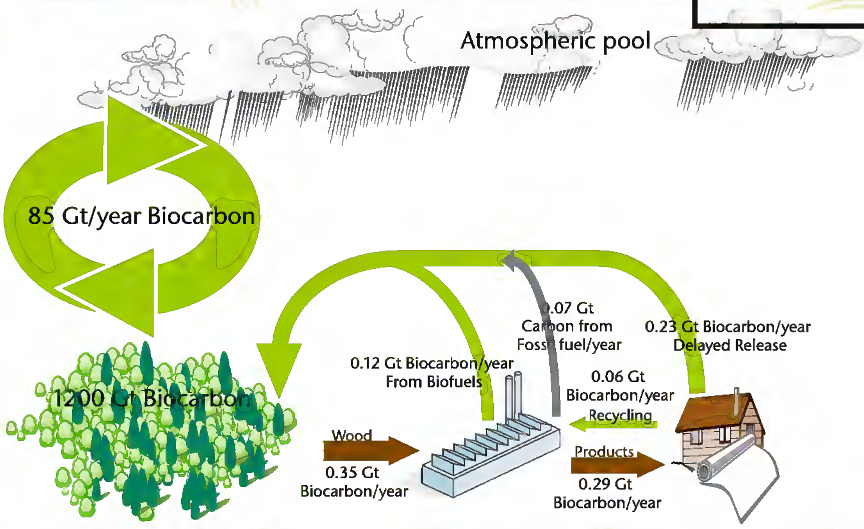
A PBA could act to decouple development from emissions growth in this sector and provide greater predictability for long-term investments.

Cement is the basis of much of civilization's infrastructure and physical development. Cement markets are growing fastest in the developing world where populations and infrastructure needs are growing most rapidly. Civen cement's key role in development, the industry needs to engage with that agenda and understand what it means for its own, and the planet's long-term future. The WBCSD's *Cement Sustainability Initiative*, has established a *Company Charter* reflecting the members' commitment to sustainability, and continue to explore meaningful ways to effectively manage CO_2 impacts including the application of sector-based approaches.

WBCSD (2005b) - *The Cement Sustainability Initiative – Progress Report*

WBCSD (2006b) - *The Company Charter of the Cement Sustainability Initiative*





Source: NCASI calculation based on IPCC publications

Forest products industry

The forest products sector is highly fragmented and geographically diverse. There are strong regional differences in forest types, ownership (public, community, private), management (ranging from protected to intensively managed), the nature of wood and paper product manufacturing and the use of biomass energy. Aside from pulp and paper production, the sector is national or regional in focus.

The biological carbon involved in forests and forest products, including biomass energy, make it an important part of regional and global efforts to reduce GHG emissions as shown in the figure above.

The industry has the extensive infrastructure essential to collect biomass. Decisions concerning fuel use, energy, production processes, raw materials and product categories extend over many years, and adjustments are difficult.

Global and regional policies that bring more of the world's forests under sustainable management and reduce deforestation are essential. These should include:

- Capacity building in countries where forest coverage is in decline;
- Use of market incentives, such as sequestration credits, to reduce deforestation rates in developing countries and also encourage reforestation;
- Removal of subsidies that cause forest conversion into crops;
- Technology improvements to increase sustainably produced fiber for raw material and biomass energy.

The industry's product and energy decisions are intertwined because the industry is energy-intensive and biomass-based. There are significant opportunities to use breakthrough technologies. Emission reductions could be encouraged by policies that promote innovation and accelerate capital stock turnover. Reducing the cost of capital through tax incentives and accelerated depreciation policies could have a significant impact on this sector and its uptake of technologies. Carbon also remains sequestered in forest products throughout their life cycle and so maximizing their use in construction and packaging can contribute to mitigation efforts. Currently forest products store an estimated 3 billion tons of carbon. WBCSD (2005c)

Policies also need to ensure ongoing recognition of biomass as a low-impact, renewable, CO_2-neutral fuel source by:

- Securing adequate supplies of sustainably grown fiber for both energy and production needs;
- Promoting an increase in the recovery of wood and paper products for both energy and production needs;
- Using sustainable production standards to prevent further forest loss and ecosystem impacts.

The Forest Products Industry supports the ongoing recognition of biomass as a low-impact, renewable and CO_2 neutral energy source. The most efficient and effective long-term policies are those that consider the emissions profile of a product over its entire life cycle. The industry can make significant contributions toward meeting the world's climate goals if certain policy recommendations are effectively implemented.

WBCSD (2005c) *The Sustainable Forest Products Industry, Carbon and Climate Change – Key messages for policy-makers*

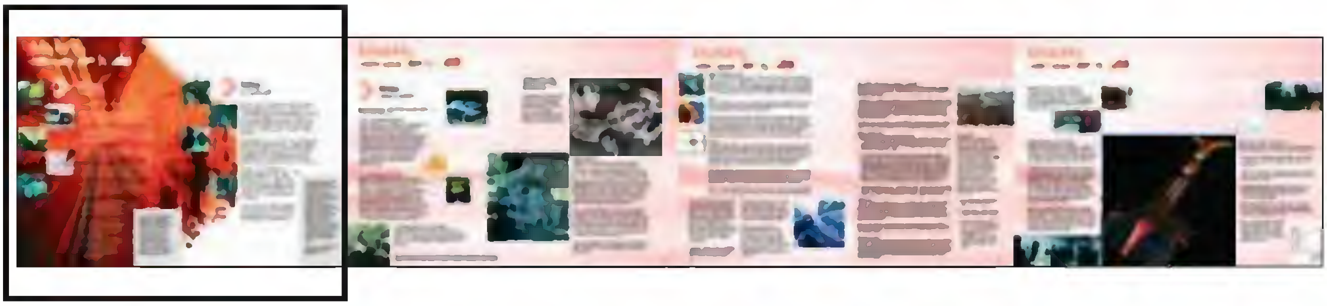
Mobility

What
is needed?

At national level and through international partnerships:

- Boost public awareness and encourage consumers everywhere in terms of making the right choices in choosing vehicles, maintaining vehicles for optimum performance, and using vehicles -- all based on the goal of minimizing GHG emissions;
- Support the development of technology to improve vehicle efficiency and the operation of vehicles on a broader range of fuels, including biofuels, hydrogen and electricity to result in lower life-cycle CO_2 emissions;
- Broaden the supply of fuels in the road transport sector by supporting the development of manufacturing technology and, where necessary, creating tax and duty differentials to encourage their widespread use;
- Encourage the development and use of advanced biofuels (e.g., ligno-cellulose ethanol from agricultural waste) by introducing CO_2 certification for biofuels as a basis for any volume obligations or mandates, fuel taxes and duty;
- Hasten the deployment of high-efficiency vehicles through consumer, government and private fleet incentives and consideration of sectoral efficiency agreements with auto manufacturers;
- Encourage the development of integrated public/private transport networks, particularly in expanding cities that will become the mega-cities of tomorrow;
- Introduce advanced technologies and alternative fuels into selected portions of the fleet based transport sector, and consider the use of GHG management programs. Options may include emissions trading, direct CO_2-linked incentives and taxes, but only where the target for regulation is directly responsible for GHG emissions and can respond to a carbon price signal.

In 2004, the WBCSD published *Mobility 2030: Meeting the challenges to sustainability*. This report defined "sustainable mobility" as "the ability to meet the needs of society to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological values today or in the future." *Policy Directions to 2050* continues to refine the previous work.



Why
is it needed?

Today, the transport sector depends almost entirely on petroleum products as the primary energy source. As a result of this and growing mobility needs, CO_2 emissions are rising in most parts of the world. The continued improvement in vehicle efficiency and advances in hydrocarbon fuel formulations are being overwhelmed by the growing number of vehicles, the increasing distance each vehicle is driven per year, the additional weight of safety and convenience equipment, and consumer preferences for sport utility vehicles in many regions.

Although the mobility sector is adapting, change is happening neither quickly enough nor on the required scale. As with other segments of the economy, the urgent and far-reaching transformation required within the global mobility sector will necessitate rapid technology shifts in both developed and developing economies. These new technologies must be fast-tracked from the RD&D stage to full commercialization and subsequently deployed across the entire sector.

Consumers, who have the potential to significantly affect emissions levels, will play a pivotal role. Mobility choices (size of vehicle, mode of transport, private vs. public mass forms of transportation) are often a reflection of lifestyle aspirations. Choosing more fuel-efficient vehicles, and thinking broadly about mobility choices and alternatives, can make a significant contribution to CO_2 reductions.

Aviation, as a sub-sector, continues to experience very fast growth rates, but at the same time there are no emerging alternatives to the use of fossil fuel technologies. The existing system must be made more efficient over the medium term.

"Today the immense benefits provided by mobility are accompanied by increasingly serious impacts. These consequences are likely to intensify given the huge global growth in transport activity forecast for the next 30 years. Finding solutions will require input from a broad coalition of governments, industry, non-governmental organizations and society working together over a sustained period. It will need to include developing countries as well as developed. Political commitment, social and economic considerations and human ingenuity will all be crucial."

WBCSD (2004b) *Mobility 2030: Meeting the challenges to sustainability*

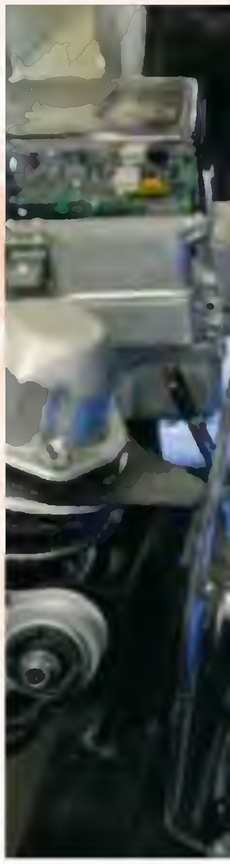
Mobility

How could it work?

Broadly there are three ways in which CO_2 emissions could be reduced in the mobility sector:

1. New, more efficient vehicles

The use of diesel fuel for automobiles offers the opportunity for significant vehicle efficiency improvements compared to gasoline. Hybrid vehicles must quickly become firmly established within a growing market. High-efficiency drive trains in future petroleum-based vehicles will require advanced fuel and lubricant formulations to operate at maximum efficiency. Changing fuel specifications or the proportion of gasoline to diesel demand affects refinery configuration and energy efficiency and the capacity of support infrastructure such as tanks and pipelines, and so it will be important to factor these life-cycle issues into policy decisions and implementation plans.



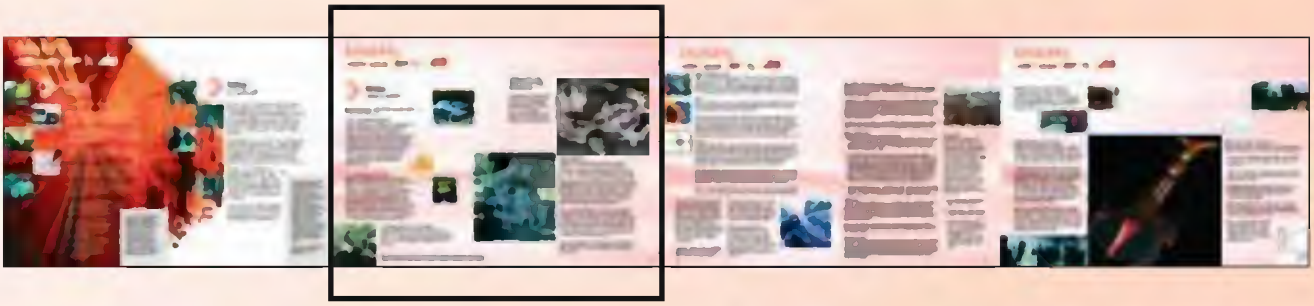
2. Low net GHG emission fuels

Biofuels can be introduced as a blend with gasoline or diesel or even used unmixed or nearly pure (e.g., E85 ethanol blend). However, the latter requires changing vehicle components and distribution infrastructure such as pipelines, storage tanks and fuel dispensers. It would also require a change in consumer behavior, perhaps triggered by some form of financial incentive, to promote the purchase of flex-fuel vehicles. Electric vehicles with new battery and drive train technology also offer potential, but electricity generated from fossil fuels would require CCS. Revolutionary fuels such as hydrogen, which are still some years away, require completely new vehicle technology and distribution infrastructure.

3. Changing the way we use mobility

Consumer incentives, road-use schemes, fuel and road taxes, congestion charges and public transport investment are examples of the ways in which governments can influence mobility choices: the places we drive, how frequently and the type of vehicles we purchase.

The above considerations suggest an integrated approach to managing transport emissions at national levels involving fuel producers, vehicle manufacturers, government and the consumer.



Development and deployment of new technologies

The development of vehicle and fuel technology must be accelerated to reach the 2025 and 2050 mobility milestones outlined in *"Pathways to 2050"*. As well as continued improvements in conventional vehicle efficiency, new drive train and fuel technology must also come to the fore.

Vehicle efficiency

Automobile sector approaches (in which auto manufacturers collectively work towards a specific industry goal agreed with governments) are operating in the EU and Japanese markets. In the EU, a voluntary agreement is in place through industry associations (ACEA / JAMA / KAMA) seeking to reduce the average CO_2 emissions of new passenger cars to 140 g CO_2/km in 2008/2009. This voluntary agreement puts the onus on industry to deliver, but without the need for regulation. However industry generally recognizes that failure to deliver under such schemes may result in regulation. It is important that governments review the state of technology to determine whether further reductions can be cost effective and also provide support for technology development and deployment.

In Japan, a similar agreement is in place, part of the government's "top-runner" program. The policy is driven by benchmarking the existing fleet by weight and technology components and then using this benchmarking with an assessment of future technology progress to set the target. This approach to target setting gives benefit to the current "top-runner" (front-runner) as other manufacturers strive to catch up. To promote consumer awareness, the program offers early tax incentives for vehicles that meet the target.

A sector approach driven by benchmarking, purchase incentives and specific government policy (such as EU policies to promote diesel) offers a viable pathway to improve fleet efficiency and drive down CO_2 emissions.

Mobility

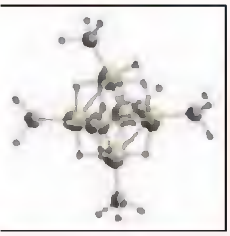
Fuels and energy carriers

Biofuels are currently the only mainstream available alternative to fossil fuels in the transport sector, and they are not yet applicable in all areas (e.g., aviation). Looking forward, hydrogen is a potential alternative, as is electricity, although considerable development will be required for both of these. In all cases, the manufacturing and distribution technology is still undeveloped. As a result, the fuel produced is more expensive than traditional fossil fuel per energy unit delivered.

Biofuels

In the case of biofuels, government will need to support the development of alternative fuel manufacturing technology (advanced biofuels from lignin) and where necessary create tax and duty differentials to incentivize their widespread use.

Consideration of infrastructure will also be important. For example, bio-ethanol can be a low percentage blend with gasoline (E10) or a high percentage blend (E85). Ethanol E85 offers greater CO_2 reduction potential, greater fuel diversity, relative stability of prices and local and regional economic development. However, the blend will need infrastructure modifications and alternative flex-fuel vehicles to use it. By comparison E10 can use some existing infrastructure and is suitable for current vehicles, but of course limits bio-ethanol uptake to 10%.



Hydrogen

Hydrogen, produced from low-carbon sources, could become an important fuel in the energy mix in the coming years, and the industry is already well advanced. Substantial markets for hydrogen-powered, fuel-cell vehicles will most likely start to develop around 2015-2025, but this could happen sooner. Actual timing will depend on the funding of the transition to mass production, which will depend on public policy developments, including the right government incentives to vehicle and fuel-cell manufacturers and fuel providers.

The hydrogen industry is ready to move from isolated demonstration projects with a research mindset to creating mini-networks of retail sites supplying small fleets of vehicles on a semi-commercial basis. Public/private partnerships comprising governments, vehicle manufacturers, fleet companies, and energy companies should be formed to undertake such projects.

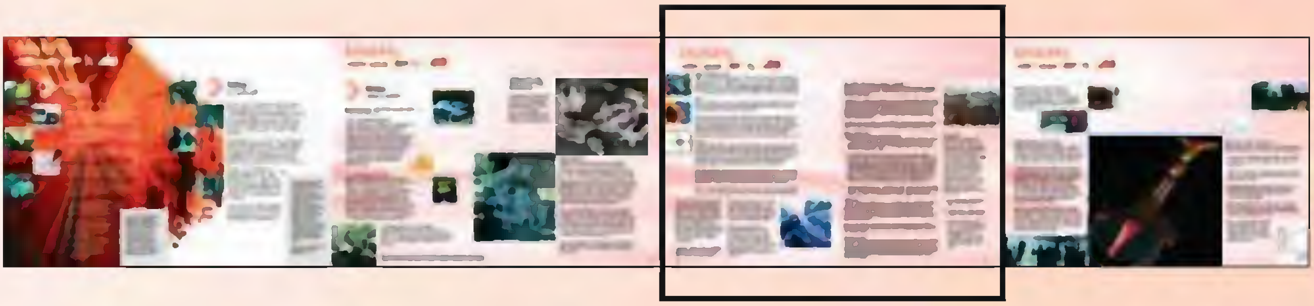
Programs will also be required to educate key audiences about such advanced vehicle technologies and fuel systems to facilitate commercialization and market acceptance of these technologies.

While all of these alternatives broaden the range of fuels available for the transport sector, their potential contribution to CO_2 mitigation is a more complex discussion. Biofuels encompass a number of different products and manufacturing routes. The most widely used biofuel, ethanol, is currently made mainly from sugar in Brazil, from corn in the United States, and potentially from the lignin in agricultural waste. Each approach has a different CO_2 footprint.

Hydrogen is typically made by reforming a fossil fuel such as natural gas with CO_2 emitted in the manufacturing process.

Although not cost effective now, hydrogen can also be made by electrolysis of water, with the electricity coming from sources as diverse as coal and wind. In both approaches, CCS storage could play a role. Again, each approach has a different CO_2 footprint.

Fuels policy needs to tackle the manufacturing/distribution cost and CO_2 footprint issues. In the case of the CO_2 footprint, the development and use of advanced fuels (e.g., lignin-derived biofuels) can be encouraged by introducing CO_2 certification for fuels as a basis for any volume obligations or mandates, fuel taxes and duty.



Discussion: Emissions trading & transport

The role of an ETS is to direct capital within the economy to the point at which it can be most effectively used to mitigate emissions. The capital is used to invest in facilities and mitigate emissions through projects.

An efficient market requires that the holder of allowances be both the emitter and the party that can initiate the projects that create the reductions. This means the emitter can use the emissions market to help finance the project by selling the future reduction in the forward market and bringing capital back. Alternatively, if no reduction opportunities present themselves, the emitter can purchase allowances for compliance and thus channel capital into the market for others to use for their projects.

In an industry ETS, this model can work well. The allowance holder can potentially switch fuels, implement energy efficiency projects and even change the mode of operation of the facility.

Personal road transport

The personal road transport sector challenges the model:

- The vehicle driver is the emitter and can be considered as the initiator of reductions (buying a new, more efficient vehicle, driving differently or choosing a biofuel blend). However, regulating at this point is very difficult, as each individual driver is a very small emitter; transaction costs could be very high.

- An “upstream model” could place the allowances with the fuel supplier. While this mechanism has the advantage of much simpler administration, it also has the disadvantage that the fuel supplier has no direct mechanism for reducing emissions as consumer choice dictates vehicle, fuel type, mileage and driving style. Fuel price then becomes the means by which the supplier influences fuel use, and the trading system simply becomes an additional fuel tax rather than a mechanism to drive investment and/or operational excellence (i.e., efficiency). In addition, the carbon or GHG price signal delivered through the fuel price is neither clear to, nor likely to influence, the consumer. A price of US$20 per ton of CO_2 equates to some 4 cents per liter, considerably less than many existing fuel taxes.

- A third approach could see allowances held by the vehicle manufacturer. This method links the allowance holder with efficiency projects, but the link with emissions reduction is again indirect as consumer choice still dictates vehicle, fuel type, mileage and driving style.

Fleet transport

Aviation is an example of fleet transport, as is a bus or commercial transport company. These sectors are a better fit for the ETS model. In the case of aviation, the carrier, as allowance holder, can adjust the mode of operation to some extent through schedules, types of plane used on different routes and cooperation with airport authorities in ground operations and taxiing. Efficiency can be improved gradually by fleet turnover but the carrier currently has no influence over the fuel used.

Fleets may be able to use various options such as emissions trading, direct CO_2 incentives or taxes, but only where the target for regulation is directly responsible for emissions and can act on a carbon price signal.

Standards and offsets

An alternative approach could be to utilize the GHG market to source offset credits to help meet standards. A standard might be set for the embedded carbon in the fuel (on a well-to-wheel basis). The supplier, against whom the standard is measured, can meet the standard by making changes to the product supplied or by purchasing sufficient credits from the market to make up any difference. Such an approach could also be used the generate credits in the event the standard was exceeded.

Large fleets

Fleet operators controlling large numbers of vehicles, either road, sea or air, potentially have much greater opportunity and motivation to control emissions than individual vehicle users. The turnover of vehicles is often faster, the operator responds to economic signals more predictably, and the scale of the operation may mean that emissions management processes (e.g., measurement, reporting, verification, etc.) can be undertaken at relatively low cost per distance traveled. A number of options exist to speed deployment in this sub-sector:

- Government fleets purchasing on the basis of CO_2 emissions;

- Substantial early vehicle purchase incentives, linked to CO_2 emissions;

- GHG management tools such as ETS (see box) could be applied in these areas to further enhance the deployment of low-GHG technologies, in contrast to their application in personal transport where the scope appears to be limited.

Mobility

Mobility options and choices

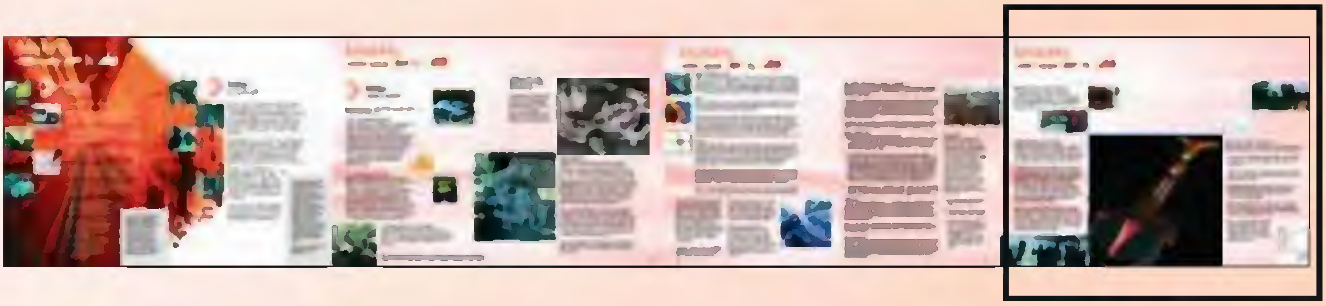
A number of options are available to accelerate the development and deployment of new vehicle technologies. However, consumer choice remains a key issue. (Find further discussion of consumer roles in mobility in the section on Consumer Choices.)

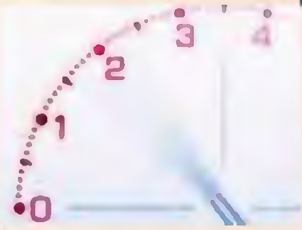
Integrated public/private transport

Mobility choices are influenced by the quality, availability, convenience and cost of the various alternative means of travel. A frequently available, high-quality mass transit system can have a marked impact on the use of private transport and therefore the overall CO_2 emissions per kilometer of passenger travel.

While there are a number of outstanding examples of urban transport planning, many of today's mega-cities are struggling with vehicle congestion and emissions and are racing to retrofit public transport systems. Equally, many smaller but rapidly growing cities are allowing private transport to fill the expanding demand for mobility, rather than beginning the process of installing an integrated public/private transport network. These cities, some of which will become mega-cities in the decades to come, are foregoing an opportunity to develop sustainable mobility practices.

Globally, transport policy should focus not only on mega-cities, but even more on today's smaller cities where there is still an opportunity to implement change relatively easily. For example, Bogotá has reduced individual travel and associated emissions by introducing an improved bus transport system, increasing parking fees and gasoline prices, and substantially extending the existing bike lane system.



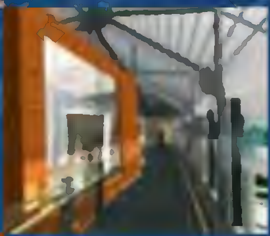


Vehicle care, use and maintenance

Consumer choice can play a significant role in the fuel performance of a vehicle, based simply on how it is driven and how it is maintained.

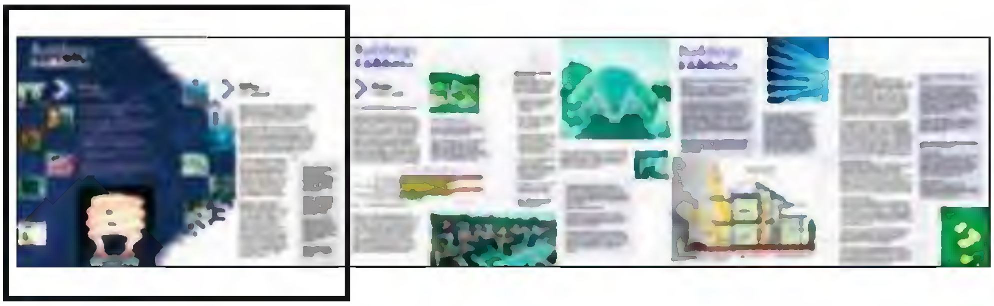
- Aggressive driving (speeding, rapid acceleration and braking) can lower efficiency by up to 33% at highway speeds and by 5% around town.
- While each vehicle reaches its optimal fuel economy at a different speed (or range of speeds), vehicle efficiency usually decreases at higher speeds (see graphic).
- Tires significantly influence the performance of vehicles, as they account for 20-30% of fuel consumption. Using low rolling resistance tires and maintaining the correct tire pressure maximizes vehicle fuel efficiency.
- Good vehicle maintenance keeps efficiency high. A clogged air filter can reduce efficiency by up to 10% and even the choice of motor oil (e.g., using 10W-30 motor oil in an engine designed to use 5W-30) can shift efficiency by 1-2%.
- Driver awareness through for example dealer education programs, owner's manuals, consumer websites, product labeling schemes for tires, and other mobility products can assist in delivering the necessary changes.

Buildings



What is needed?

- Clear and easily understandable mandatory energy performance labeling, standards, rating schemes and codes for buildings, appliances and lighting.
- Robust government incentive programs and market-based mechanisms to trigger improvements in energy efficiency in new and existing buildings and to foster innovation in the design and operation of buildings.
- Education programs for operators and occupants of commercial and residential buildings to promote energy efficiency and to drive changes in their behavior.
- Government policies that promote building materials with lower associated GHG impacts.
- Greater transparency, awareness and control of energy demand in new and existing buildings, coupled with financial incentives to retrofit and renovate existing housing and commercial building stocks.



Why
is it needed?

Buildings are one of the main consumers of energy and a significant contributor of GHG emissions. There is significant scope in cities and residential developments to improve energy efficiency and lower carbon intensity. A megatrend shift toward improved energy efficiency and GHG elimination should be encouraged now.

The urgency in the building sector stems from the fact that the incorporation of low-energy and low-GHG designs is more easily implemented in new construction than through retrofit. However, due to the long lives of buildings retrofit of existing buildings must also be a priority. These actions can significantly reduce the carbon footprint of the world's cities. In the short term, energy efficiency improvements can be achieved by using energy-efficient appliances, low-energy lighting and behavioral changes driven by greater awareness.

Many design practices and technologies that can make a real difference are available today but not always used. Encouraging their use, for example, through holistic design approaches could improve energy efficiency and the corresponding carbon footprint by as much as 50% for renovation projects and upwards of 80% for new construction projects. The use of more local materials and certified wood in buildings will also reduce CO_2 impacts and depletion of natural resources.

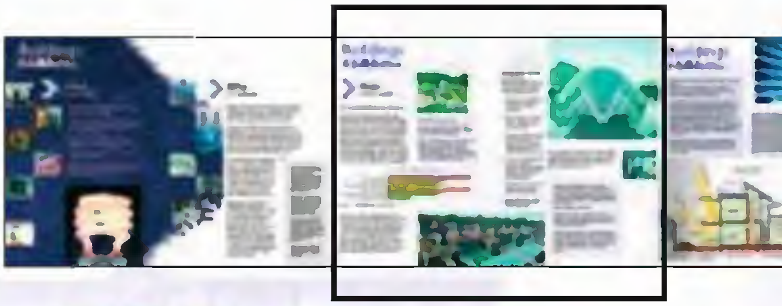
Education and awareness could create significant improvements in energy consumption by altering the behavior of the users and occupiers of buildings. We should take a lesson from the auto industry, in which hybrid vehicles are equipped with elaborate user displays that provide immediate feedback to the driver. This allows decisions to be made real-time, such as changes in throttling, to positively effect fuel consumption. In a similar fashion, building owners provided with the right information would be able to make bottom-line decisions very rapidly on use of lighting, appliances, or envelope adjustments such as shading through the use of blinds.

"If energy consumption in buildings continues to rise at current rates, by 2050 buildings will use almost as much energy as industry and manufacturing and mobility combined. The technology exists today to prevent this from happening."

The WBCSD's new Energy Efficiency in Buildings Project (www.wbcsd.org/web/eeb) brings together companies with the shared vision of a world where buildings consume zero net energy.

"There are already residential buildings around the world that generate as much energy as they use. The main obstacles to achieving our vision are market structures and practices, more than technical difficulties."

WBCSD Energy Efficiency in Buildings (2006c) *A world where buildings consume zero net energy*



How could it work?

Innovative building design and materials use

Urgent innovation is required in new building design (commercial and residential), building form and alignment, heating, cooling and ventilation systems, lighting, and choice of materials. All these have a substantial impact on a building's energy demand and carbon footprint over its entire lifetime. The planning and approval process is a major opportunity for governments to encourage low-carbon innovation through guidelines, performance codes and/or mandated building standards (e.g., Energy Star Building Ratings, EU Directive on Energy Performance of Buildings). In the absence of such codes and standards, contract builders have little incentive or desire to develop energy-efficient buildings, since the savings will typically flow to the owner/tenant. Attention in this area is also required for major renovations and retrofit projects on existing buildings.

Discussion: The Pearl River Tower

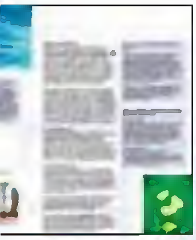
The 71-story, 200,000m^2 Pearl River Tower in Guangzhou, China "breaks all the rules" when it comes to traditional building design.

The tower is designed to have a "net" zero energy footprint, using a combination of strategies, including wind turbines, radiant slabs, micro-turbines, geothermal heat sinks, ventilated facades, waterless urinals, integrated photovoltaics, condensate recovery, and daylight responsive controls.

CO_2 emissions for different wall constructions

Source: www.roadmap2010.eu/wisd/pdfs/42.pdf

Governments can help by supporting this process with incentives that reward energy-efficient design features. While such schemes are already in place in various parts of the world, they need to be more widely implemented across the world's cities, in particular in rapidly growing economies where many major construction projects are planned or underway. Government support in terms of technical assistance, education and awareness of innovative energy-efficient design would help change behavior across this industry by government planning departments, contractor builders, design architects and the purchasing public.

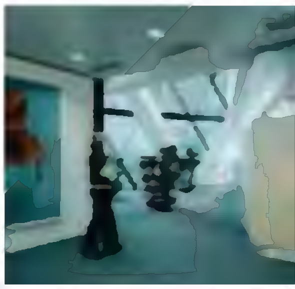


Building design: Insulation and ventilation

Significant energy efficiency gains and GHG emissions reductions can also be achieved in buildings by addressing cooling and heating requirements:

- The shape, form and orientation of a building and shading devices affect heating and cooling requirements.
- Improved insulation – coupled to adequate ventilation with a heat recovery system reduces the demand for heating.
- Cooling and heating needs can be supported by heat pumps, which use stable temperatures in the ground, air and water to support cooling requirements in the summer and heating in the winter.
- “Low–E” glass coating reduces the amount of sunlight that is absorbed and helps keep buildings cool. Glass with the reverse effect and double-glazing reduces heating requirements.
- Combined heat and power (CHP) technology increases energy efficiency by using waste heat.
- Energy-efficient boilers and solar thermal panels reduce water heating requirements.

These considerations and commercially available technologies would benefit from government incentives to find a stronger position in the marketplace. Alignment is required between building codes, performance standards, planning approval processes and building design practice.



Development and deployment of heat pumps

A heat pump is an electrically powered device for use in commercial and residential applications that transfers air or water for cooling or heating purposes. The energy efficiency of heat pumps is indicated by a “Coefficient of Performance (COP)” - the ratio of energy output to electricity input.

Technological innovation, collaboration among power companies and technology manufacturers, and technology standards have lead to continued improvements in the performance of this technology.

Compared with conventional water heaters, heat pumps can achieve up to 30% savings in primary energy demand and approximately 40% reductions in GHG emissions. State subsides for such technologies have proved crucial in the early stages of deployment and have facilitated cost reductions.

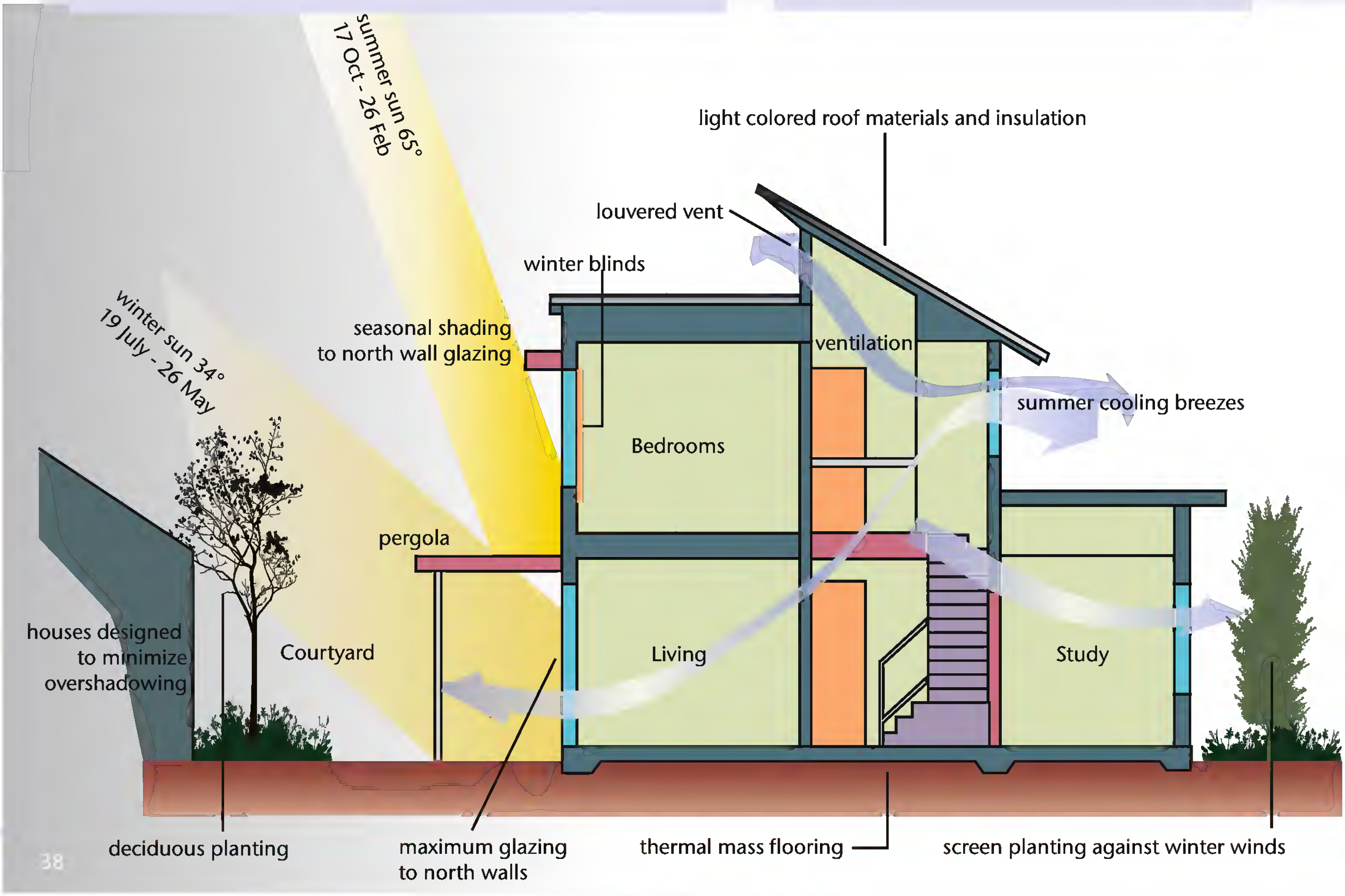
Buildings

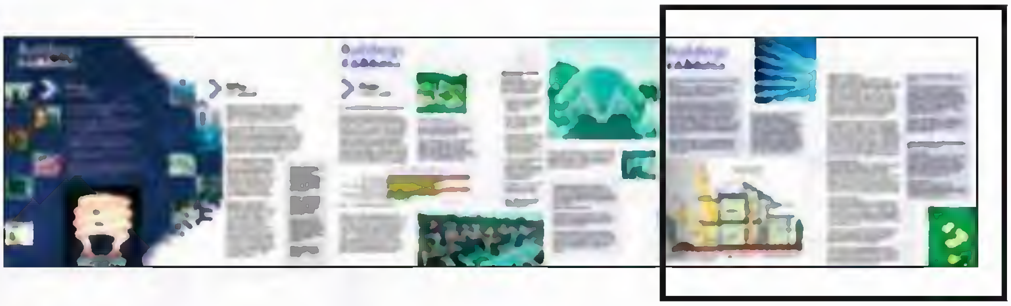
Development of combined heat and power systems (CHP)
Providing local power to buildings can be an effective way to reduce power purchases from the grid and provide power to certain critical facilities in the case of blackouts.

When combined with heat recovery from exhaust streams by on-site generators, such as micro-turbines, the waste heat can be converted into cooling, heating or dehumidification energy using available thermal conversion technologies. These systems can directly increase the efficiency of energy use, typically between 30% to 80% depending on the balance between heat and electricity demand. The effectiveness of a system is evaluated by the difference between avoided indirect emissions and direct emissions. Systems can be dedicated to buildings or multiple buildings on a micro-grid scale.

Further deployment of these systems could benefit from policy instruments such as domestic tax relief and grants in immature markets, appropriate tariff and billing structures, and assured access to the grid.

Raising minimum efficiency standards in US residential air conditioning
In January 2006, the US raised its minimum efficiency standards for home air conditioning systems from a seasonally adjusted rating of 10 Seasonal Energy Efficient Rating (SEER) to 13 SEER. Affecting over 26 million homes in the US, this 30% increase will result in an estimated reduction of 33 MTC, eliminating the need for 39 new power plants in the US and has the net effect of taking 3 million cars off the road.





Lighting and appliances

Lighting is one of the major energy consuming factors in commercial and residential buildings. Energy consumption can be reduced cost-effectively by introducing intelligent lighting systems (motion detectors) in buildings and by switching to energy-efficient fluorescent light bulbs, which consume up to 80% less energy. Although initial costs are higher, life-cycle savings in energy bills can far outweigh the initial investment. Consumers could be encouraged to adopt these products by government backed information and product labeling schemes that clearly explain efficiency levels and cost savings over the life of the product, helping consumers to make informed choices.

Another significant contributor to energy demand and emissions in the buildings sector are appliances. In many countries appliances have to display an energy efficiency label and are grouped into different categories, providing the consumer with an indication of the energy consumption of the appliance. However, further product information that indicates the scale of financial savings that could be achieved by an energy-efficient appliance over the life of the product would enable consumers to compare the true life cycle cost of a cheap-to-buy but less efficient appliance with one that was more expensive to buy but more efficient with lower running cost.

Fossil fuel alternatives

The use of alternative sources of power should be encouraged for residential and commercial buildings. Low- or zero-GHG technologies installed locally can supplement total energy demand. The use of renewable energy sources could lower GHG emissions by reducing demand for fossil-based grid electricity. Incentives such as tax breaks, renewable certificates, subsidies and feed-in tariffs could make investments in these technologies more attractive for owners/tenants of residential and commercial buildings.

Cost and finance issues

Homeowners need to become more aware of residential energy consumption. They should be educated to realize that leaving appliances plugged in, leaving lights on, or keeping TVs running when not in use increases consumption, emissions and household costs. Government-backed advertising programs and metering systems informing households of their energy expenses could help raise much-needed awareness.

In the residential and commercial sector, positive incentives from governments in the forms of tax breaks or credits will almost certainly be required to encourage substantial up-front investments in, for example, solar technologies.

Energy assessments can identify opportunities for efficiency improvements or selection of equipment, appliances, materials or behaviors to lower GHG emissions and should be encouraged to help homeowners focus their priorities and renovation financing to areas where the most gains can be achieved.

Discussion – One watt initiative: Standby power devices

In the US, government agencies are required to take account of the standby power demand of office appliances as part of their procurement requirements. Under the initiative, each product must use not more than one watt in their standby power-consuming mode. If such products are not commercially available, products with the lowest standby power wattage are required (Executive Order 13221).

Stand-by power consumption is a surprisingly large contributor to energy demand in office buildings. Such initiatives could have major effects, particularly in government and business.

Current schemes that successfully reduce energy demand and GHG emissions

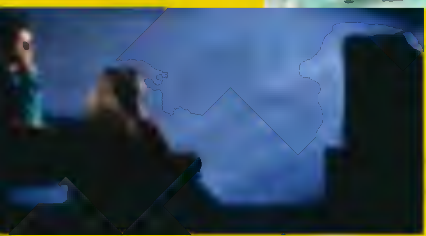
Emissions trading

In 2005 the mandatory, state-based New South Wales Greenhouse Gas Abatement Scheme in Australia reported a doubling in the creation of tradable GHG certificates (t/CO_2) generated from energy efficiency projects. The majority of the increase came from projects targeting the residential sector.

Top-runner approach

This approach sets a given timeframe for manufacturers to upgrade their products to catch up with energy efficiency levels that are already achieved by the most efficient products today.

Consumer Choices



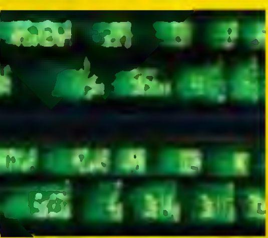
What
is needed?

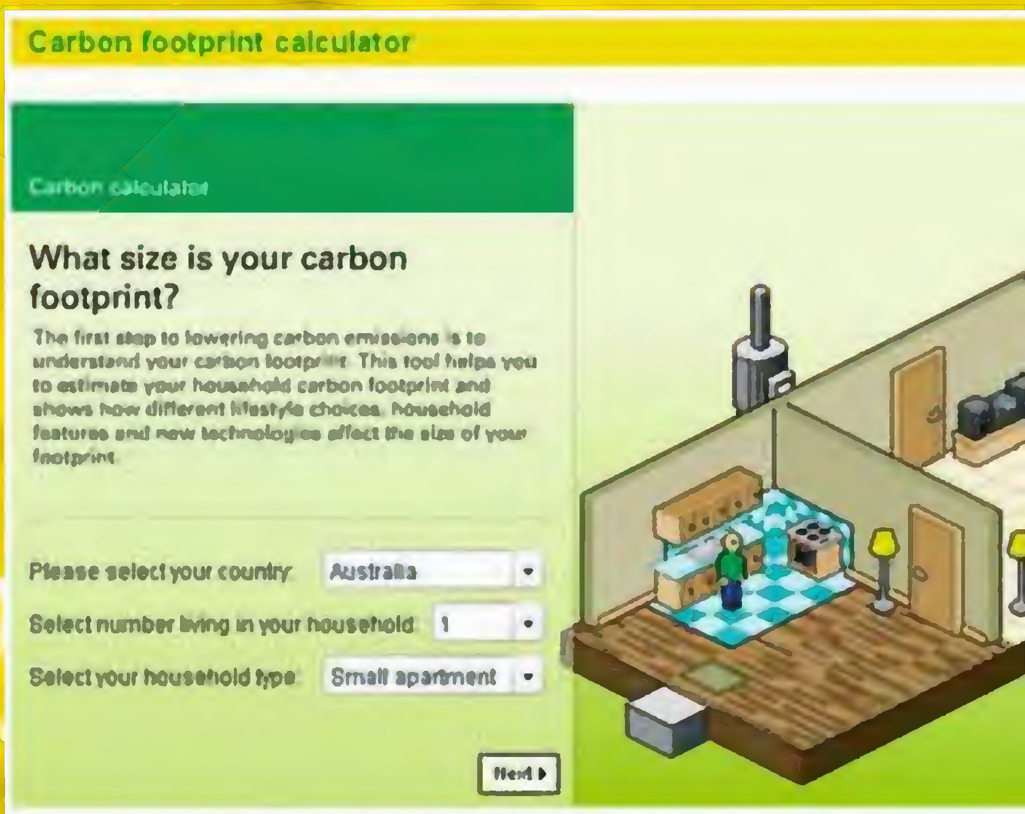
- Increased consumer awareness and understanding of the energy/GHG emissions issue, leading to further demand for advanced energy efficiency at all levels. Consumers have to clearly understand that everyday choices have a significant effect on global GHG emissions.

- Robust programs that encourage energy efficiency by directly targeting consumer goods and services.

- Education, awareness programs and incentive packages aimed at consumers across all levels of society to encourage sustainable consumption and choice of products, services and lifestyles associated with lower GHG emissions.

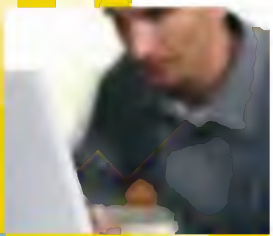
- A value for emissions reduction that allows consumers to recognize the signal throughout the value chain, stimulating changes in consumer behavior, and that gives highly efficient and low-GHG products and services an advantage in the competitive market.





Source: www.bp.com

Why
is it needed?



Consumer choice is a crucial ingredient in increasing energy efficiency and reducing GHG emissions. As individuals, we contribute significantly to emissions through mobility choices, consumption of goods and services, the way we run our households, our lifestyles and the way we earn a living. Everyday choices across all facets of society have a major influence on GHG emissions in all key megatrends. Consumption drives economic activity, and consumers have the ability to help drive society toward an energy-efficient and low-GHG economy. Awareness and innovation must be key features of policy directed at sustainable consumption.

Triggering the required changes will require concerted and sustained action by consumers, governments and business. In the absence of additional financial or product feature incentives, consumers tend not to alter consumption habits on purely environmental grounds. Consumers in both developed and developing countries must be encouraged to change their behaviors in favor of a low-GHG lifestyle.

Any shift toward more sustainable consumption in developed countries is likely to have a global influence. There is an urgent need to ensure that consumers in developing countries, particularly those with emerging middle classes, grasp present opportunities and do not follow the unsustainable consumption paths of developed countries. Such issues must become the focus of policies and action. Consumers need to understand the life cycle issues associated with a product or the energy intensity of a particular decision (e.g., transport option) so that they are able to make informed choices at the time of purchase. Additional incentives will almost certainly be required.

Voluntary offsets

The voluntary offset of GHG emissions by individuals and companies should be further encouraged by setting clear standards that certify voluntary GHG offsets as genuine, valid reductions. Potentially, offsets can have a valuable role to play in programs to address carbon footprints. This market is already emerging in various parts of the world. Using such schemes has allowed several companies to declare themselves “GHG or carbon neutral”, a step that helps to address the climate issue, raises awareness, enhances their reputation as a good corporate citizen and motivates and empowers their staff. Some airlines and vehicle manufacturers offer such schemes to customers, allowing them to manage their personal transport emissions. Such programs can effectively raise consciousness and should be scaled up.

Consumer Choices

How could it work?

Products and services

Every product or service we buy requires some form of energy input during its life cycle – production, use, disposal or recycling. This is where business must play its role in significantly increasing the production of eco-efficient goods and services and bringing these to market. Significant change in global consumption patterns will require businesses to innovate and transform the nature and form of what we consume, shifting toward less energy and resource-intensive products and services. This will encourage competition and further innovation of new products. Increased consumer demand for such products and services must be stimulated, which would provide further incentive for business to steer production in favor of highly efficient/low-GHG products.

Some of the possible tools

- Removing subsidies promoting unsustainable consumption patterns;
- Providing information to consumers, including:
  - Best practice
  - Product labeling schemes
  - Product life cycle information;
- Green purchasing programs;
- Product performance standards;
- Capacity building and support programs to producers in developing countries;
- Traffic management and speed controls;
- Taxes and incentives;
- Grants for innovative products and services.

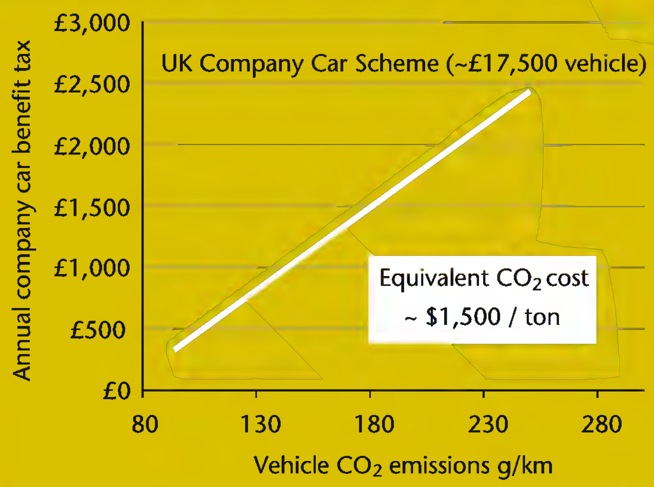
Product and service design also have to extend beyond just technical or engineered improvements. Business should develop emission-avoiding goods and services in tune with consumer attitudes relating to aesthetics, cultural expression, market value and creativity. Companies should motivate consumers by creating desire for ownership, possession or use, to communicate value, identity, status and enjoyment of a low-GHG lifestyle. Governments could support innovative, climate friendly business models, products and services more actively through financial incentives such as tax credits, cash back schemes, procurement programs, sharing expertise, and by openly encouraging consumers to support business in producing eco-efficient products.

Mobility

Low-GHG and low-energy consumption transport options must gain advantage in the market and become the preferred choice. Highly energy-efficient and low-GHG solutions appropriate to a given situation, including mass transportation, walking, or cycling, or vehicles such as hybrids, diesels and flex-fuelers have to become attractive alternatives, supported by appropriate policies, on a service, quality and price comparison. But it also requires awareness programs and the willingness to change.

Vehicle choice

The United Kingdom has aggressively targeted CO2 emissions through public policy incentive schemes. These are beginning to influence the choice of vehicles purchased, but it also demonstrates the high underlying cost of carbon connected with tackling transport CO2 emissions and the difficulty posed by trying to integrate transport into other CO2 mitigation schemes (e.g., emissions trading).

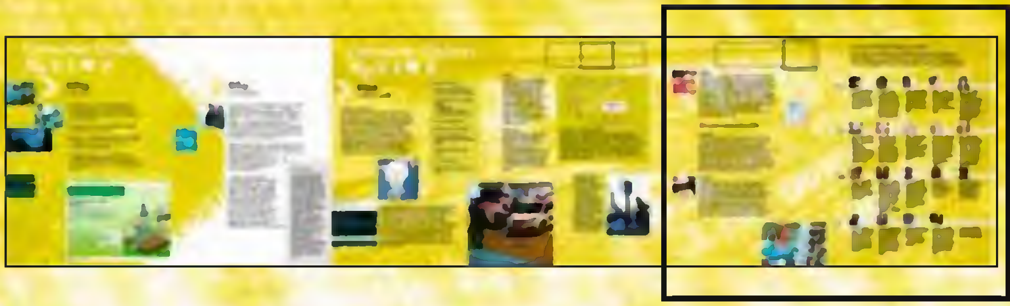


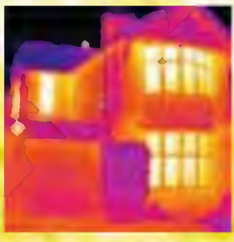
Case Study: UK company car program

The purchase of a vehicle through a company car program is common practice in the UK, with up to half of all new vehicles purchased in this manner. When an employee's company offers a car, the employee must pay the appropriate tax to the government, on the basis of the annual cash value of the benefit. The UK government has now linked the tax rate associated with this benefit to the CO2/km emissions of the vehicle, with the best performing vehicles achieving a tax rate of up to 25% less than the highest marginal tax rate on income.

Case Study: London congestion charge

A charge of £8 per day is now levied on vehicles that wish to drive through central London on a weekday. This charge is waived for alternative fuel vehicles, including hybrids (deemed to run partly on electricity). Not surprisingly the hybrid vehicle is becoming a common sight in central London, far more than in other parts of the UK or in the rest of Europe.





Homes

In our homes we can directly influence our energy consumption and carbon footprint. Households are often slow at altering their behavior due to lack of awareness, reluctance to change existing habits and concerns over perceived additional costs. Simple things like reducing household energy consumption - turning off lights and appliances when not in use - can make a significant difference on an aggregated basis. These actions can also save money through lower household energy bills. Bigger reductions can be achieved by installing available technologies such as residential CHP, heat pumps, double glazing, and solar panels. Such features need to become routine considerations, particularly with new housing developments and large-scale household renovations.

Key areas for government action

Education

Consumers are unable to make informed choices due to a lack of awareness regarding the energy efficiency or life cycle emissions associated with the product or service on offer. Government education schemes could encourage sustainable consumption, helping to make the GHG emissions impact of a product or service an important purchase criterion. The removal of subsidies favoring energy intensive products and a transparent value or price for GHG reductions or carbon emissions would allow consumers to recognize the price signal throughout the value chain. This could have a major impact in encouraging changes in consumer behavior.

Labeling

Consumers should be fully aware of the energy intensity of products and services. Energy ratings and GHG impact have to become part of the purchasing decision alongside value for money. Current energy efficiency ratings displayed on appliances in many developed countries are not sufficiently informative. Policy-makers must encourage more robust, conspicuous and informative labeling programs for products and services. Such programs will help drive innovation in the business world as energy efficiency and GHG content will become a decision criteria for consumers when making their product or service choices.

Consumer lifestyle changes to 2050

Each year about 30 young executives from WBCSD member companies form the Council's Young Managers Team (YMT) and work on sustainability issues. Part of the 2006 YMT focused on consumer preferences in the energy sector. Below are some of the consumer choices that they imagined being made over 2007-2050 as governments, business and civil society follow the policy pathways described above.

Im Liu

2007

"Like most people living in rural China, I walk to school while my parents go to work by bicycle. We don't have many luxuries at home and use coal for our heating."

2015

"I still live with my parents, but now I use natural gas powered bus transportation to go to school in the city near our home. When we can afford new household appliances, I make sure that they are the most energy-efficient available."

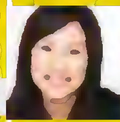
2025

Im Liu is married and has one child. She lives in her own house in the village and has a small electric motorcycle. Her family has changed the source of their power to renewable sources.

2035

Im Liu now works as a teacher of civic education and teaches a sustainable development course in the town her village has grown into. She has purchased a diesel-electric hybrid car.

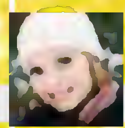
2050



Im Liu's old town has become part of the expanding nearby city, where she and her husband live in an apartment. They no longer own a car, instead using well-structured hydrogen-powered public transportation and lease a gas-electric hybrid car when needed.

Lenny

2007



"I love to follow the latest fashions. When "carbon labeling" was introduced in California, supplementing "nutritional labeling" on some products, my friends and I thought it was cool to choose low-carbon footprint products."

2015

Lenny's first home is an architectural award winning modular "pod" apartment near her favorite beach; it has good techno-wiring allowing her to work from home. Subsidies on water and energy for the efficient home reduce costs.

2025

"My new hydrogen car is much more stylish and delivers higher performance than earlier hybrid models. I can refill it locally without any inconvenience, and I avoid paying higher taxes on gasoline."

2035

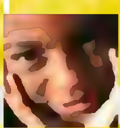
Lenny and her family focus on "eco travel" and spend their holidays helping to restore their local nature reserve in order to avoid "travel taxes". This lets them stay within their personal GHG budget and they still get away together to favored destinations.

2050

Once the children have moved out, Lenny and her husband reduce their modular living space and install a personal waste-to-energy (electricity, heat & cooling) unit, which also allows them to export electricity to the grid and is a viable tax break, which will help to fund their retirement.

Kelechi

2007



"Since my father died I have the responsibility for feeding my family. Like most of my friends in Nigeria, I don't have much time to worry about the environment."

2015

Kelechi is now married and his main priority is still to meet basic needs, but since his employer receives funds from a foreign bank to produce power from agricultural waste under the Clean Development Mechanism, he has become more aware of world energy and climate problems.

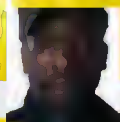
2025

With support and funds from the foreign bank, Kelechi is running his own biofuel farm. He drives one of the first flexfuel cars in Nigeria and teaches his three children about energy savings using the now common product carbon labels.

2035

Kelechi benefits from governmental tax incentives and installs solar panels on his farm, which now employs twenty people.

2050



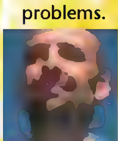
"I am proud to own a 100% energy independent farm that supplies biofuel to a whole region. My grandchildren love the new biofuel-hybrid car I could afford recently."

Karl

2007

"Fuel is very expensive in Germany. My boss agreed for me to work from home part time, rather than make the long commute to work. I also recently decided to swap my SUV for a smaller, more fuel-efficient car."

2015

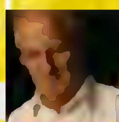


Karl uses his hobby farm to grow a dedicated bio-diesel crop, which enables him to earn additional income, and as a producer avoid fuel taxes. Living in the country, he joins a growing "buy local" movement supporting surrounding farmers.

2025

In his retirement, Karl uses his banking background to cultivate his "green investment portfolio" which is outperforming standard investment portfolios.

2035



"My daughter has taken over my bio-diesel business and I have decided to move to a new retirement villa complex. The complex is one of those which I helped set up as part of my green fund portfolio and is self-sufficient in water and energy."

2050

Karl wills the majority of his green fortune to help fund nuclear fusion, which is close to a breakthrough.

Glossary

Accelerated depreciation
A method of depreciation that allows greater deductions in the earlier years of the life of an asset.

Asia-Pacific Partnership on Clean Development and Climate (AP6)
A partnership established by Australia, China, India, Japan, Republic of Korea and the United States in July 2005 in an effort to accelerate the development and deployment of clean energy technologies. The partners have approved eight public-private sector task forces which include: cleaner use of fossil energy; renewable energy and distributed generation; power generation and transmission; steel; aluminium; cement ; coal mining; buildings and appliances.

Best available technology (BAT)
With respect to energy consumption, the use of current best available technologies can reduce energy intensity levels.

Bioenergy
Any source of energy that is produced from biomass products.

Carbon capture and storage (CCS)
A long-term alternative to emitting carbon dioxide to the atmosphere is capturing it at its source of emission and storing it. Geological carbon storage involves the injection of CO_2 into subsurface geological formations.

Carbon dioxide (CO_2)
The principal gaseous product from the combustion of hydrocarbons such as natural gas, oil and coal. CO_2 exists naturally in the atmosphere, is a greenhouse gas, and its concentration has been rising over the last century. This publication concentrates on reducing carbon dioxide emissions, representing around three quarters of all greenhouse gases (see "Greenhouse gas").

Carbon footprint
A geographic representation of the amount of carbon dioxide emitted through the combustion of fossil fuels. It is generally referred to as a measure of the amount of carbon emitted; in the case of a business, as part of their everyday operations; in the case of an individual or household, as part of their daily lives; or a product or commodity in reaching market.

Carbon pricing
Refers to the action of putting a price on a ton of carbon. There are several possibilities to establish a carbon price. Options include the adoption of a carbon tax or a cap and trade scheme.

Certified Emission Reduction (CER)
A certified reduction in greenhouse gas emissions resulting from a CDM project. One unit under the Kyoto Protocol equals one metric ton of CO_2e.

Clean coal
Mainly refers to coal gasification and fluidized bed combustion technologies. Clean coal offers more radical environmental improvements and is in an earlier stage of deployment than advanced coal technologies.

Clean Development Mechanism (CDM)
A mechanism established by Article 12 of the Kyoto Protocol for project-based emission reduction activities in developing countries. The CDM is designed to meet two main objectives: to address the sustainability needs of the host country and to increase the opportunities available to Annex 1 Parties to meet their GHG reduction commitments. The CDM allows for the creation, acquisition and transfer of CERs from climate change mitigation projects undertaken in non-Annex 1 countries.

Clinker
Cement is manufactured by blending different raw materials and firing them at a temperature in order to achieve precise chemical proportions of lime, silica, alumina and iron. The finished product of this process is known as cement clinker.

CO_2 concentration
The amount of CO_2 in the atmosphere at any given time, typically measured in parts per million (ppm). In this publication CO_2 concentration refers only to CO_2 and does not include other greenhouse gases.

Coefficient of performance (COP)
The ratio of energy output to energy input for an appliance in operation.

Combined cycle gas turbine (CCGT)
A state-of-the art technology for power generation utilizing natural gas, combining steam and gas turbines.

Combined heat and power (CHP)
A process or technology that uses waste heat from power generation, and significantly raises the efficiency of energy exploitation.

Decarbonization
The action of reducing the carbon content required (carbon intensity) to produce a product or service.

Distributed micro-generation
Typically refers to decentralized small-scale generation such as renewable, including small hydro, wind and solar power and small combined heat and power.

E10 ethanol blend
A fuel blend consisting of 10% ethanol and 90% gasoline.

E85 ethanol blend
A fuel blend consisting of 85% ethanol and 15% gasoline.

Energy intensity
The level of energy input per unit of output.

European Automobile Manufacturers Association (EAMA)
Industry association representing 13 major European car, truck and bus manufacturers in the EU.

European Union Emissions Allowance (EUA)
This corresponds to one ton of carbon dioxide equivalent. Under the EU-ETS, caps are placed on the number of EUAs permissible in any EU member state.

European Union Emissions Trading Scheme (EU-ETS)
In January 2004 the European Union Greenhouse Gas Emission Trading Scheme began operation as the largest multi-country, multi-sector GHG emission trading scheme worldwide. It covers over 11,500 energy-intensive installations across the EU, which represent close to half of Europe's emissions of CO_2. The aim of the EU-ETS is to help EU member states comply with their commitments under the Kyoto Protocol (see also GHG market).

Final energy
The energy actually used in vehicles, homes, offices and factories. For many consumers, final energy is consumed in the form of electricity, gasoline and natural gas for cooking and heating.

Flexfuel vehicles
A flexfuel vehicle is able to run on either regular gasoline or biofuels without any modifications.

Fuel cell
An electrochemical conversion device that produces electricity efficiently from external supplies of hydrogen (fuel) and air (oxidant). Efficiency can be enhanced when fuel cell technologies are combined with waste heat recovery.

Generation IV fast breeder reactors
A nuclear reactor approach still in the R&D stage; six different technologies are being explored.

GHG intensity of energy
The quantity of GHG produced relative to total energy output.

GHG market
A GHG market is similar to a stock market. However, in the GHG market GHG allowances or certificates are traded instead of stocks. GHG markets are designed to offer flexibility to market participants in meeting mandatory/voluntary targets and to help identify cost-effective GHG emission reduction opportunities.

Gigatons of Carbon (GtC)
Given the scale of carbon emissions to the atmosphere, they are often measured in gigatons (one gigaton = one billion tons).

Global Environment Facility (GEF)
Established in 1991, the GEF helps developing countries fund projects and programs that protect the global environment. GEF grants support projects related to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants.

Green electricity tariffs
An additional fee charged by the electricity provider to supply the customer with electricity generated from renewable sources. The electricity provider uses the additional costs to cover its higher costs and/or for further investments into renewable energy sources.

Greenhouse gas (GHG)
A gas in the Earth's atmosphere that absorbs infrared radiation, thus allowing the atmosphere to retain heat. Such gases occur through both natural and human influenced processes. Primary GHGs, aside from water vapor include carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6). Gases such as halogenated carbon compounds (CFCs and HCFCs) also require ongoing attention in both developed and developing countries.

Gross Domestic Product (GDP)
It is the total market value of all final goods and services produced in a country in a given year. It is equal to total consumer, investment and government spending, plus the value of exports, minus the value of imports. It is the most commonly used measure of the size of the economy.

Heat pump (HP)
An electrical device that takes heat from one location and transfers it to another. A typical refrigerator is a type of heat pump since it moves heat from inside to outside the refrigerator. Heap pumps can work in either direction (i.e., they can take heat out of an interior space for cooling, or put heat into an interior space for heating).

Integrated Coal Gasification Fuel Cell Combined Cycle (IGFC)
A technology that consists of a coal gasification unit, a fuel cell, a steam turbine and ancillary equipment.

Integrated Gasification Combined Cycle (IGCC)
This technology involves the gasification of coal to increase efficiency of coal-fired power plants and provide a basis for pre-combustion CCS.

Intergovernmental Panel on Climate Change (IPCC)
Established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to assess scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation.

International Aluminium Institute (IAI)
A global forum of aluminum producers dedicated to the development and wider use of aluminum. It is composed of 26 member companies, responsible for 80% of world primary aluminum production and a significant proportion of the world's secondary production.

International Energy Agency (IEA)
An intergovernmental body committed to advancing security of energy supply, economic growth and environmental sustainability through energy policy cooperation.

Japan Automobile Manufacturers Association (JAMA)
A trade association representing 14 Japanese car, truck, bus and motorcycle manufacturers.

Korean Automobile Manufacturers Associate (KAMA)
An association representing the interests of five leading automakers in Korea.

Kyoto Protocol
A UNFCCC international agreement that sets binding targets for the reduction of GHG emissions by industrialized (Annex I) countries.

Leakage
That portion of cuts in GHG emissions within developed countries (countries trying to meet mandatory limits under the Kyoto Protocol) that may reappear in other developing countries not bound by such limits. For example, leakage can sometimes occur if business operations are relocated from a developed to a developing county. The environmental benefit of reduced emissions in the developed country may be negated or offset by the increase in emissions in the developing country. Under certain scenarios leakage can also originate in developing countries and is therefore an important consideration in undertaking CDM projects.

Life cycle cost
The total cost of an asset, from raw material extraction, to final disposal.

Liquified natural gas (LNG)
Natural gas that has been processed to remove impurities and heavy hydrocarbons and then condensed into a liquid.

Low-E glass coating
Low-emittance (Low-E) coatings are microscopically thin, virtually invisible, metal or metallic oxide layers deposited on a window or skylight surface to suppress radiative heat flow.

Market instruments
Carbon taxes, carbon trading, and subsidies and tax breaks for low-carbon technologies are all examples of market based instruments that aim to enhance the competitiveness of low-carbon technologies.

Nine gigatons of carbon (9GtC)
This term refers to the 9GtC world established in *Pathways to 2050*. The WBCSD's 9GtC illustration indicates the level of emissions that can be emitted in 2050 in order to stabilize emissions at approximately 550 ppm.

Perfluorocarbons (PFCs)
Compounds derived from hydrocarbons by the replacement of hydrogen atoms with fluorine atoms. They are potent greenhouse gases with a lifetime of up to 50,000 years.

Pozzolanas
A mineral mixture (e.g., volcanic ash) that acts as a supplement to standard Portland cement and creates additional binding in the concrete mixture.

Primary energy
The total energy contained in a naturally occurring raw material (such as coal, oil or natural gas) or generated by any energy system before being converted into an end-use form.

Renewable certificates
A tradable certificate that represents the technology and environmental attributes of one megawatt-hour of electricity generated from eligible renewable sources. Renewable certificates are in use as a tradable compliance unit in several markets around the world where domestic policies are targeting an overall increase (% share) of renewables in the energy mix.

Research, development and demonstration (RD&D)
The stages new technologies have to run through before they can be commercialized.

Rotary kilns
Rotary Kilns are commonly used for heat processing of minerals and aggregates such as lime, cement and iron ore.

United Nations Framework Convention on Climate Change (UNFCCC)
An international convention adopted on 9 May 1992 in New York, and signed at the Earth Summit in Rio de Janeiro by more than 150 countries and the European Community. Its objective is to stabilize GHG concentrations in the atmosphere to levels that would prevent dangerous anthropogenic interference with the climate system. The convention entered into force in March 1994.

Watt, KiloWatts (KW), MegaWatts (MW), GigaWatts (GW) and Watt-Hour (Wh)
A watt is a measure of the rate of energy use, and is equivalent to a joule per second. A MegaWatt is one million watts, a GigaWatt is one billion watts. Power generation is typically expressed in watt-hours (Wh), which is the supply or use of one watt for a period of one hour. Households express energy use in kilowatthours (kWh).

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About the WBCSD

The World Business Council for Sustainable Development (WBCSD) brings together some 190 international companies in a shared commitment to sustainable development through economic growth, ecological balance and social progress. Our members are drawn from more than 30 countries and 20 major industrial sectors. We also benefit from a global network of 50+ national and regional business councils and partner organizations.

Our mission is to provide business leadership as a catalyst for change toward sustainable development, and to support the business license to operate, innovate and grow in a world increasingly shaped by sustainable development issues.

Our objectives include:

Business Leadership – to be a leading business advocate on sustainable development;

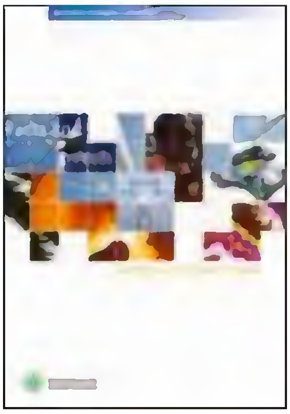
Policy Development – to help develop policies that create framework conditions for the business contribution to sustainable development;

The Business Case – to develop and promote the business case for sustainable development;

Best Practice – to demonstrate the business contribution to sustainable development and share best practices among members;

Global Outreach – to contribute to a sustainable future for developing nations and nations in transition.

Energy and Climate Trilogy

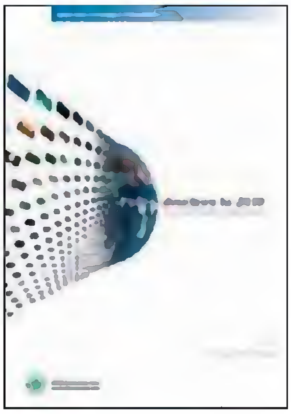


Facts and Trends to 2050

Presents key facts and trends related to energy and climate change and outlines corresponding dilemmas. Primarily designed for business, the issues are presented succinctly and illustrated by graphs and projections.

Pathways to 2050

Builds on *Facts and Trends to 2050* and provides a more detailed overview of potential pathways to reducing CO_2 emissions.



Policy Directions to 2050

Explores potential policy approaches and mechanisms that might be deployed to introduce the required changes in the energy system.

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