INNOVATION AND GLOBAL SUSTAINABLE GROWTH

A BIAC Discussion Paper

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The paper that you have in your hands is a living document. It was borne from BIAC’s unwavering belief that innovation is the key to growth, that elusive but powerful force that all OECD countries seek to harness. Over the past three years, this Discussion Paper has grown and evolved as we have expanded our analysis to include issues from almost all spheres that national and international policy makers manage. We have also had to take into account the changing global economic and political environment since the paper was first written.

The first version of this BIAC Discussion Paper was presented at the June 2000 OECD Ministerial under the title "Innovation and Growth". It focused on a simple but powerful logic stream – that it is innovation which improves productivity, resulting in enhanced living standards through growth.

The attached paper, “Innovation and Global Sustainable Growth”, now includes chapters on trade and investment and takes our original logic to another level, asserting that it is in fact through trade and investment that enables the rapid spreading of innovation, thus proliferating the creation of wealth. The concept of innovation guides the additional chapters of this paper on technology, employment and education, innovation in the environment and energy production.

An introductory Executive Summary presents an overview of the main themes covered in each chapter, and a table of contents will enable readers to quickly situate new chapters.

The common thread which ties together each chapter of this paper is in fact a question from the business community directed to all OECD Ministers: *In the context of law, regulation and practice within your purview, what are you doing to enable or inhibit innovation?* The answer determines whether or not a country will be able unleash the chain reaction resulting in Sustainable Growth.
EXECUTIVE SUMMARY

With regard to the portfolio of the Prime Minister or President, there are those who advance one policy challenge or another as the greatest. The cogent leader knows that the greatest challenge of governance is in the balancing of many priorities and in effecting change. While the global needs, such as lifting billions out of poverty and husbanding the earth’s resources, call for enormous concerted effort, their satisfaction is, to a remarkable degree, in the hands of those actively engaged in the market-based economy where wealth is created.

Because the market economy is an engine that runs with billions of spark plugs, the innovative capacity of each of its participants, its productive potential is virtually limitless. However, the blessing of this human potential can carry with it the curse of fear of the change that innovation brings. To prepare each citizen to accept and embrace change may well be the signal challenge of the century before us.

That, because the velocity and scope of change have been increased by an order of magnitude, and there is no hiding place, no plateau. This paper is a work-in-progress, but is intended to approach that signal challenge from the perspective of the private sector which shares the responsibility with governmental leadership to understand, to balance and inspire each to make her or his contribution to sustainable growth. Our “joined up” ambitions can only advance with joined up governance, both public and private.

From Innovation to Growth

Both business and the OECD have an interest in understanding how innovation impacts economic prospects, and what other factors have to be in place for a sustained, economy-wide improvement in productivity and output. We now know that the real meaning of the term "new economy" is broader than Internet technology itself, and has a scope that reaches everywhere in the "old economy" where new technology is applied.

The rate and remarkable persistence of downward price movement in ICT (information and communications technology) producing industries was one of the key factors which prepared the way for powerful Internet technologies which in turn enable efficiency gains. It is not possible to overemphasise the fact that this was achieved in an industry characterised by fierce competition and internationalisation of production, where attempts to pick winners have been distinctly unsuccessful.

While the widening availability of ICT equipment itself is merely a precursor of the new economy, an even more powerful factor is in the tremendous increase in the quality and range of business opportunities that now become possible and viable, given the ubiquity of the former. To be able to grow, the markets for new goods, services or ways of doing business have to be open to competition, which would benefit from global policy compatibility.

The OECD Growth Project has gone a remarkable way towards clarifying data and analytical issues which have rendered it difficult to make a decisive statement on what is needed to turn ICT-led innovation to growth in productivity. But, there is a need to build the policy recommendations emanating from this project on a number of policy pillars: innovation policies, labour and capital market policies and
conditions, and the policies aimed at improving the quality of the regulatory framework – as well as their interaction.

It is basically the juxtaposition of good indicators on ICT-readiness, labour market adaptability and regulatory framework, that tends to be associated with either good or improving performance in the growth of productivity and output, and especially both. The OECD could usefully develop this approach further.

Indeed, it is hard to imagine how heavy investment in ICT and even skills can lead to a widespread increase in productivity growth, in an economy where dismantling redundant or failing economic activities is routinely subject to conflict with interests vested in their protection. The Organisation should be careful to convey this message clearly and not inflate false expectations.

The U.S. economic deceleration over the past three years is not a reason to throw out the "new economy" baby with the bath water of downturn. Responsible observers and analysts, such as the OECD, have never claimed that the new factors in economic growth have eliminated the business cycle.

What was observed as "new" in many analyses was a change in macro-economic trade-offs, such as the one between output growth and inflation. Another "new" factor included reduced inventory cycles and a generally higher velocity with which firms can transform their focus and strategy. Research should focus on how those factors are altering the nature of the cycle.

And, now is the time to understand how some of the "old" well-understood policy factors such as regulatory quality and flexible labour markets affect the ability of economies to grow in this new technological environment.

An area that is in urgent need of attention is the quality, coverage and international comparability of data on the inputs and outputs of new technologies and new business models, especially in the services sector. The simple logic stream - innovation raises productivity which raises living standards - should be the starting point for all policy deliberations.

From International Trade to Innovation

It seems largely agreed that innovation driven by information and communications technology (ICT) enables significant productivity gains, so the discussion on widening its impact on economies relates closely to the discussion on broadening digital opportunities, creating wealth and raising the living standards.

On the business side, there are ICT-based opportunities to insert competing business models in the existing market structure. Regulatory reform in favour of increased competition in markets therefore is a sine qua non of developing e-business and transforming the old into the new economy. Widening the reach of international trade and investment among economies is the most effective, if not the only practical way of opening sectors to competition, and spreading this innovation-led economic evolution.

A common plea today from the lesser developed world is “give us trade not aid” and, while there is still a need for aid, the billions of people who live in poverty will never exit that state without participation in the market-based system. World trade and investment bring those instruments and institutions necessary for the proper functioning of an economy with them when they arrive at the border and they induce many others to complete an enabling policy mosaic. Millions of the poor have assets that they cannot own because they have no property rights and that they cannot leverage to obtain capital to turn their subsistence into enterprise. This element of global integration has a substantial institutional structure; its effective operation is in its active employment.
Manufacturing having been already subject to significant trade liberalisation, from the point of view of OECD economies, a strong push towards the liberalisation of telecommunications and trade in services is an essential element of their policies to enhance innovation, the uptake of technologies such as broadband, market development and growth.

Global commitment to these aspirations is best effected by a recommitment to the market-based economy through the world trading system with its roster of previous agreements and on-going negotiations as well as the aggressive pursuit of the Doha Agenda.

From Innovation to Investment

International investment and market access are primary vehicles for the cross-border transmission of innovation which assures growth and wealth creation in participating countries. This participation is based on long term economic processes such as new market development, job creation, enterprise as well as structural changes and adjustment costs. International investment liberalisation in the context of open market frameworks is essential to the diffusion of benefits created by globalisation.

A country’s capacity for change supported by its political leadership is critical to creating the optimum policy framework to benefit from innovation, especially as innovation and investment have a symbiotic “win–win” relationship. Investments applying technological enhancements have enormous impacts on services and manufacturing, and spur efficiency and productivity in these sectors, which are mutually reinforcing.

Societal innovations such as human and societal rights, education, democratic political systems and good governance enhance the possibilities for the emergence of new ideas. Education is the most important form of societal investment and is essential to reaping the benefits of investment at the local level. The lesser-developed countries should be encouraged to reach out for the benefits of investments made by others through open trade and investment.

Trade and investment activities also can have a positive impact on the environment as they both promote a more efficient allocation of resources at the same time that they contribute to economic growth. This growth should in turn lead to increased societal welfare and a reinforced demand for improved environmental policies. International investment in innovation is an essential element in upgrading not only the performance of local economies, but also in improving societal and environmental sustainability globally.

To ensure that this dynamic between investment and innovation will function, two elements in the policy framework are necessary: a transparent set of investment rules (multilateral, regional, bilateral) for investment that provides greater certainty and stability for both investors and beneficiaries of investment and, at the local level, a stable policy environment that enables, not inhibits innovation and growth -- a key element in attracting FDI. A good policy environment includes non-discrimination, national treatment, sound financial and shareholder governance, efficient and transparent administration, as well as a fair, predictable system of taxation. At the same time good corporate governance has always been fundamental to a company's competitiveness and long term success.

Whereas corporate governance addresses investor demands, the essence of the current debate is to enhance the transparency of and confidence in company performance and value. The discussion about corporate governance should not be confused with the aspirational aspects of broad corporate social responsibility. With respect to governance, every national regulatory system has to find its own balance between regulation by governments and self-regulation. Deficiencies can be largely attributed to failures in enforcement, not to the lack of a governance structure as such.
**Investment is the deployment and management of peoples’ wealth.** The public policy mosaic is part of the platform upon which confidence in investment is built. Any policy that tries to slow or constrain international investment will sooner or later bring about the loss of opportunities for the creation of domestic economic wealth, and lead to a widening divide of lost opportunities.

**Science, Technology and Innovation**

Continual advances in science and technology may be something that our societies take for granted, but in reality are enabled to a large extent by public policy. Technological creativity and advancement are key components of not only innovation and growth, but also their sustainability in the long term. Most of the economy consists of users of a given technology and is concerned chiefly by the breadth of the application of technology outside the sector that invented it. Therefore, R&D is an incomplete indicator for innovative capacity.

Intellectual property rights protection is a market-based mechanism for disseminating knowledge. Pursuit of lax IPR regimes for purposes of short-term political expediency can only damage the propensity to invest in new knowledge. Both IPR and R&D flows are strongly influenced by firm strategies operating at the global level. National science and technology policy apparatus needs to recognise and work in harmony with those strategies to be able to make best use of their work product. Cross-border flows are not a zero-sum game in trade. Why should they be in the movement of R&D or skilled personnel?

Scientific inquiry, research and the generation of inventions are important in and of themselves. It is not appropriate to harness basic research efforts to economic productivity considerations. Nevertheless, basic research still needs to develop its own performance-based evaluation systems. Pervasive application of technology has been historically slow in many sectors in a world environment that has always been characterised by mercantilism and economic rivalry. Economic openness can only help accelerate the diffusion of technology and innovation.

New technologies arise and promise new productive economic opportunities under policy environments that privilege entrepreneurship and economic liberty, messy as their initial impact on existing institutions and societal balances may be. Benefiting from technology-assisted sustainable growth requires a certain amount of risk-taking at the policy level. ICTs have just been able to make it to the stage where their impact on the economy has become widely discernible. The same should happen with biological and health sciences.

**Biotechnology**

Scientific advances are leading to unprecedented productivity increases, while at the same time reducing environmental impacts. As an example, biotechnology promises be a critical enabling technology toward achieving sustainable growth. On-going developments in modern biotechnology provide the prospect of significant steps forward in mankind’s efforts to tackle a multitude of problems that delay progress and cause human misery. These problems range from illness and diseases that levy a phenomenal societal and economic cost, to critical nutritional and environmental challenges. Whether through increased economic development, through innovation, or through improving the health of the population, modern biotechnology has an important role to play in sustainable development. **Its inhibitors have their collective thumb on the windpipe of billions.**
Innovation in Health Care

The health care sector is an important industry in OECD economies and a major employer. Increasingly, it is a source of high-quality jobs, technological innovation and various other knowledge-intensive activities that benefit modern societies. At the same time a well-functioning, efficient health care sector is fundamental for a stable and a coherent social climate that provides a basis for a sustained economic growth and innovation in other sectors.

Business and government must work together to provide citizens--now and in the future--with a high quality health care service. Although governments are responsible for ensuring solidarity and the universality of medical care, the private sector has an important role to play in improving quality and access to health care. In order to achieve the difficult balance between access for all and the quality of care and cost containment, the productivity of health care systems needs to be increased through innovation and a fair market for public and private health care providers and insurers.

Societal Innovation in a Knowledge Economy

New technologies hold the promise for higher economic growth. However, to fully realise these gains, skills must be upgraded to match the changing labour market requirements, individuals must be mobilised to seize business opportunities and firms must adapt their organisational structures.

The quality of human capital is a key contributor to innovation and economic development and is becoming all the more important in the context of the knowledge society. As trade in services and information grows, the economy of today will increasingly call for employees with new skills and competencies beyond those in the traditional economy. Therefore, an efficient education system, adapted to the needs of the labour market, and the improvement of skills and employability are crucial to continued economic growth and increased employment.

At the same time, the uptake and diffusion of ICT and its applications, such as e-commerce, have a direct impact on business routines. As globalisation proceeds, open markets, competition and the free flow of goods, services, new technologies, capital and knowledge are creating an economy in which the speed at which transactions are taking place and information is being communicated throughout the world creates new demands on business practice, work organisation and labour-management relations.

The Importance of Energy for Global Sustainable Growth

Energy is the motor of societal and economic development for an ever-increasing world population and an essential ingredient of sustainable growth, the key guarantor of our societies’ future economic well-being. Societal and economic development can be attained only if a secure, reliable and affordable supply of energy is ensured. Energy also contributes to societal development by improving public health and is essential for alleviating poverty. As these different dimensions are intrinsically linked, policies for achieving sustainable growth need to strive for a balance among the various dimensions and their interactions between them.

Energy is the driving force of modern civilisations. Access to reliable sources of electricity and energy is an especially fundamental concern of many developing countries, who must have access to the prosperity unleashed by the market economy. Major challenges lie before us to ensure a secure and reliable energy system for all, which on the other hand implies increasing pressure on existing energy supply systems.
The current energy system is not sufficiently developed to support economic growth throughout the world, and the growing requirements of OECD non-member countries create major challenges for global security. Economic growth will continue to fuel strong energy demand, including on the part of developing countries. This emphasises the importance of ensuring such growth is met in as sustainable a fashion as possible.

Innovation and the transfer of energy technology to developing countries are therefore of crucial importance. While governments continue to have an important role to play in fostering technology that can help address these challenges on a global level and in offering a framework of well-functioning and competitive markets, the engagement of the private sector is crucial. **Business has an essential role to play in innovation and in the global dissemination of technologies that can help meet the challenges ahead.**

**Societal and Environmental Sustainability and Growth**

Business is at the nexus of the interlocking concepts of economic growth, environmental protection and societal development. The central focus of any business must be on sustainable growth. Any company that wants to survive and remain competitive must strive to create shareholder value and wealth. A business that is not profitable over time ceases to exist and cannot make any further contributions. Competitiveness in the marketplace must therefore be a first concern.

Economic growth will therefore remain a central goal for successful corporations and societies, taking into account the societal and environmental impacts of human activities. Economic resources are required in order to protect and take care of our environment, while at the same time meeting societal and economic needs. In a larger context, economic growth is necessary to address societal needs, such as education, health care and employment creation. Similarly, education and societal safety are prerequisites for economic activity. The concept of sustainable development assumes that the various economic, societal and environmental aspects are integrated and interdependent and need to be considered in a balanced way, the work of Prime Ministers and Presidents.

OECD work on growth and sustainable development has reinforced the importance of human capital as an essential factor in guaranteeing positive economic and societal outcomes. Sustainable development and inclusiveness depend critically on the competencies of our citizens. Education and lifelong learning should therefore be considered as key priorities for meeting the challenges of a rapidly changing world. The success of technological and organisational innovation depends to a large extent on the ability of individuals and societies to absorb change. Fostering entrepreneurship, upgrading skills to match the changing labour market requirements and well-functioning and sufficiently flexible labour markets conducive to employment creation are key to sustainable economic growth.

Today, all companies must innovate to survive and remain competitive. Innovation and technology contribute to economic growth and have the potential to improve human welfare as well as the environment. Experience clearly indicates that innovation can contribute to breaking the link between economic growth and environmental degradation. Upgrading technology is a prerequisite for more effective use of resources and thus improving environmental performance, which becomes all the more important in view of a rapidly growing world population. In most cases, newer technologies and processes are both more efficient and less polluting than the technology they replace, allowing increased production using less material and causing less pollution. At the same time, environmental performance often presents business opportunities that enhance firm-level efficiency.
The development and application of environmentally friendly technologies and know-how are already making a significant contribution to reducing the environmental impact of economic activities. The spread of innovative approaches to non-OECD countries, which to a large extent occurs through foreign direct investment, will be crucial for environmental improvements worldwide. Given the right global framework conditions, business, through free trade, is spreading the technologies, skills, and processes that are required for sustainable development. For business to maximise its contribution to sustainable development, it requires, among others, open markets, a stable and predictable policy framework including trade and investment rules, and policies encouraging the swift dissemination of technology.

The OECD has within its Members’ grasp the elements of that enabling policy mosaic. The inhibitors are known. Only conviction, courage and leadership can capitalise on the former and escape the latter. The business community is moving forward. After all, we are the economy. Our pace, efficiency and effectiveness are, to a great extent, dependent on sound government policies.
CHAPTER I: FROM INNOVATION TO GROWTH

Discussion on the emergence of a "new economy" can lead down various paths. At BIAC, we understand our subject of discussion to be focused around the following questions: How does the interaction between innovation, be it technological or managerial, and productivity vary across the OECD countries? How is this relationship affected by other variables such as the quality of the regulatory framework, cost of capital, educational attainment of the population, etc.? Has there been a fundamental change in the kind and strength of innovation affecting productivity growth significantly in some countries? To what extent does that account for better growth performance and to what extent are other factors responsible? What can other countries do in order to fully benefit from technological innovation?

Understanding the impact of innovation is the centre of focus for both business and the OECD

Technical and managerial innovation which allows the “commoditisation” or high availability of information is particularly capable of bringing massive productivity gains to existing production processes and segments of processes which otherwise could not remain competitive in the market. This is why, whereas many types of scientific and technological innovation are important, the current discussion on productivity is focused on the impact of information technology, and services associated with it, on innovation throughout the economy.

Until recently, much of the "new economy" discussion confined itself to the impact of newly popularised Internet-based retailing on the economy. Important and fascinating as that discussion may be, it addresses only a limited facet of the ongoing technological and managerial transformations. While new business models coupled with communications technology may be generating the largest improvements in productivity, at present these are mostly internal to companies or take place in business-to-business (B2B) segment of transactions, and are thus poorly measured.

The real meaning of the term "new economy" was broader than the Internet technology itself, and has a scope that reaches everywhere in the "old economy" where the new technology is applied. The rest of the economy will grow more or less well in terms of vigour or performance to the extent that market incentives permit and innovation emerges. The key development to be studied is the reorganisation of production and commercial activity which accompanies digitisation and the adoption of network technologies, especially business processes, with attention to the raw speed with which change is occurring.

This velocity of innovation is enabled by technology, feeding on itself, permitting the management of the private enterprise model to alter its composition with remarkable speed. At the same time, that invention is opening new product and marketing possibilities for the customers of those goods and services, sometimes shifting demand so quickly that even the most sophisticated modellers cannot predict tomorrow. In the technology business, they have taken to thinking in “web years”, that is, periods of three months.
**The OECD "Growth Project"**

According to the results of the OECD Growth Project, there is evidence for widening disparities in GDP per capita growth rates across the OECD countries over the past decade. Over the 1990s the United States began to pull away from most other countries in terms of GDP per capita levels. There was a significant speedup of productivity growth in the United States around 1995, considered unusual in a country at the productivity frontier in many sectors. However, when we turn to measuring the impact of ICT on the productivity in the rest of the economy, conceptual and empirical issues render conclusions difficult. In addition to the United States, only a small number of OECD countries have shown improved or continuing good performance in terms of productivity and/or GDP per capita growth. Much of the available evidence regarding the linkage between ICT, innovation, productivity and growth is skilfully captured in the main analytical papers produced by the OECD in the last years.1

**Innovation is the enabler in the market**

OECD studies go a considerable way in clarifying that, in the last decade, a significant portion of higher GDP growth experienced in some of the member countries is due to **higher factor utilisation**. This aspect should not be lost in the final political message. Ability to increase labour input clearly accounts for the major part of higher growth per person in a number of countries (such as Ireland, Korea, Netherlands), but it is also a significant contributor even in countries with accelerating multi- (or total-) factor productivity (MFP) growth.

OECD studies still identify a significant role for MFP growth in most of the (small number of) countries, which are reckoned as having increased their GDP per capita growth rate. In turn, innovation is correctly recognised as the primary vehicle for the growth of MFP. **But**, typically, innovation does not take the form of a frontal wave of improvement starting in and moving through simultaneously in all enterprises producing a given good or service. **Instead, technical innovation, usually accompanied by the appropriate managerial innovation and adaptation, tends to be nurtured in a small number of firms and once it bursts, or proves its success, tends to spread to the rest of the sector by emulation.**

To do that, leading firms must show initially a significant performance gain above their competitors and **at the expense of them**. It is at this stage of the innovation-productivity linkage that the fortunes of countries are likely to start diverging, given widely different approaches prevalent within the OECD area to the treatment of success and failure in business by public authorities. **Indeed, to the extent that government policy and practice has a strong bias towards automatic and open-ended assistance to unprofitable enterprises, this is bound to act as a brake on incentives both to emulate innovation and respond with a competing innovation.**

**Innovation replaces the obsolete with opportunities for faster growth.**

BIAC's membership believes that the diffusion of ICT has been one of the factors playing a major role in driving innovation and growth performance in recent years. A study by the OECD Directorate for Science, Technology and Industry provides an eloquent treatment of the various channels through which ICT and

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1 "A New Economy?: The Changing Role of Innovation and Information Technology in Growth" (DSTI/ICCP/IND/STP(2000)/FINAL) and "Economic Growth in the OECD Area: Recent Trends at the Aggregate and Sectoral Level" (ECO/WP1(2000)6), and a number of supporting analyses such as "The Contribution of ICT to Output Growth" (DSTI/EAS/IND/SWP(99)4); The Sources of Economic Growth in OECD Countries, OECD 2003.
digital networks impact upon R&D and business itself, ultimately enabling higher productivity.\(^2\) But, it is crucial to recognise that the impact of ICT can fuel improvement in productivity in the economy as a whole only when that is juxtaposed with a business environment which privileges the ability to adapt – including, \textit{inter alia}, a business friendly regulatory framework and availability of low-cost capital and high-quality skills.

This is especially true in the case of the new or newly commercialised network technologies, the Internet in particular, and new business models based upon them. At the initial stage, the most obvious and measurable impact of these tends to take the form of dramatic cost reductions in the business process.

By necessity, the "sector" which is subject to technology-driven innovation has to grow, albeit fast, from a small initial base. At that stage, therefore, economy-wide improvements in productivity are correlated with the ability of that economy first, to permit the dissolution of some activities and second, the ability of the rest of the economy to move resources thus "freed" to other uses. To the extent that public policy is focused on the protection of existing activities, the process of new business and employment creation is likely to be hindered.

Let us clarify our argument at this stage.

\textit{It is clear that, due to new technologies but also the new market environment (lower barriers to international movement of trade, capital and production processes and greater competition in most markets), the velocity of change with which innovation can spread in the economy is much higher today. That makes it even more important to get the public policy and attitude to support of nonviable economic activities right. In this light, many companies traditionally thought to be "old economy" have the possibility of becoming "new economy" companies as they turn to e-commerce to advance their business models and to gain competitive advantage. The object of policy discussion ought to be to identify the right combination of factors which make that transformation more or less difficult.}

\textbf{Innovation in fathoming the complex market dynamic is a key role for the OECD}

In comparison to twenty years ago, today's market dynamic occurs in a significantly different environment. The degree of openness to trade is much higher in most countries and so is the degree of globalisation of production processes. Most product markets are characterised by a higher degree of competition or, where this may be lacking, by intensifying political pressures to open them up to competition, which may have a similar effect on the longer-term expectations of managers. Regulatory reform is now widening the range of competitive pressures to sectors which hitherto enjoyed significant immunity from them.

High quality regulatory frameworks that promote competition and do not impede trade and investment should be the goal of regulatory reform agendas. Integrating regulatory policy into the mainstream of government's strategies and actions, thereby contributing to efficient markets and good governance, is an important goal of the OECD shared by business. Regulatory Impact Analysis (RIA) and administrative simplification are key aspects of such efforts.

The OECD project on E-Government shows that e-government is an important enabling tool to reform the way public administrations operate to result in more efficient customer focused public administration, that is responsive and adaptive to changing societies and economies. Developing "seamless e-government

services” is an important contributor to administrative simplification and greater efficiency for both government and business.

Many sectors are experiencing a rapid transformation through mergers and acquisitions and other forms of link-ups between enterprises, often across national borders. Indeed, the overwhelming majority of foreign direct investment is now reckoned to be associated with mergers and acquisitions. Irrespective of whether each and every merger is a success, this suggests a need to reorganise industrial capacity, including services, at geographical scales other than at the level of the nation-state.

In some countries, factor markets (i.e., chiefly labour and capital markets) have been subject to a significant amount of reform and there is significant political pressure brought to bear on countries that lag behind in this respect. Intuitively all these factors are bound to have major effects on business climate and innovation climate. The very noticeable contribution of ICT and network technologies has been added to the equation as an additional - powerful and catalytic - factor.

However, there are important gaps between countries in terms of their status and pace of movement along the various dimensions in which the business environment is changing. It would be desirable to centre the analysis of a phenomenon so central to the economy as the evolution of innovation and productivity squarely within a framework which takes account of each of these dimensions (innovation, flexibility, regulatory quality) and the interactions between them.

The OECD is well suited to conduct such an analysis, and indeed focus much of the follow up work of the "Growth project" in this fashion. In particular, the Organisation is well positioned to draw upon the results of three of its well-known "horizontal" projects: the Jobs Strategy, Regulatory Reform, Electronic Commerce and Growth. BIAC believes that there may be a high return to a project which synthesises the knowledge and understanding gained in these separate analyses in terms of how their combination and interaction affects the prospects for innovation and economic growth.

**Getting the policy message right**

The results of OECD’s existing studies lend considerable support to the hypothesis that it is indeed the juxtaposition of good indicators on ICT-readiness, labour market adaptability and regulatory framework that tends to be associated with either good or improving performance in the growth of productivity and output, and especially both.

Indeed, it is hard to imagine how heavy investment in ICT and even skills can lead to a widespread increase in productivity growth, in an economy where dismantling redundant economic activities is routinely subject to negotiation with interests vested in their protection. OECD should be careful to convey this message clearly and not inflate false expectations.

BIAC’s basic hypothesis is that, "yes technology-driven innovation does improve productivity and economic growth, but only when other conditions affecting the adaptability of the economy to change are also conducive."

If the line of reasoning of this discussion paper so far is generally accepted, then it should be clear that it is crucial for the OECD to clarify the inter-relationship between what may be "new" factors and the "old" knowledge and understanding that the Organisation has been the purveyor of fundamental aspects of economic prosperity such as labour market adaptability or regulatory reform.

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Better data

Business recognises the value of data produced by national statistical organisations and international ones such as the OECD. Serious data, i.e. blessed by governments who use up-to-date, often expensive but thorough methodologies, are valuable and merit the expenditure. This is fundamental. At the same time, any new and additional data collection needs should be balanced by a continual review of existing data collection requirements, with a view to minimise the over all survey response burden on businesses. Statistical agencies should be encouraged to integrate, as much as possible, any new information needs into existing survey vehicles and make a better use of modern information technology in the conduct of surveys.

To be able to develop the technology dimension of this debate, serious and internationally comparable data on such new indicators as software, e-business, ICT services, biotechnology and science and technology in general are necessary for a wide range of countries. This data should also cover such aspects as buying habits, penetration of new technology, value of information, etc. Such data will enable productivity measures reflect reality better. In particular, international harmonisation of ICT measures is essential to a good understanding of underlying trends. Internationally comparable data on services sector productivity is also a priority investment.

It should also be recognised that, notwithstanding the current economic slowdown which is affecting attitudes towards the "new economy discussion" and any remaining disagreements regarding policy conclusions that should come out of the Growth Study, perhaps the single most important contribution of this project has been in terms of expanding the realm of internationally comparable data and analysis on ICTs and productivity.

As new and topical issues such as e-commerce, new economy or biotechnology arise in the policy agenda and benefit from concentrated attention of policy makers, the OECD should remain vigilant in terms of reminding them how crucially the correct understanding policy choices necessitates continuing investment in less glamorous work on statistical and other indicators. That is the bedrock of the OECD.

The basic recommendation for any OECD follow up work in the area of growth and productivity is to explore its linkage to as wide a range of public policies as possible. The following parts of this paper try to live up to that recommendation by extending the discussion to policies on international trade, investment, research, education, employment, environmental management and energy to survey how these can be harnessed to achieve a sustained increase in the standard of living.
CHAPTER II: FROM INTERNATIONAL TRADE TO INNOVATION

Innovation and Digital Opportunities

In the preceding section of this paper we argued that innovation stemming from technological and managerial advances can lead to productivity gains when the regulatory environment surrounding the labour, capital and product markets is conducive to competition and adaptation. New technology and new approaches require that society accepts and encourages new businesses and new markets that may necessitate that some old ways of doing business be modified or abandoned.

In order for innovation to actually generate productivity and income impacts at the economy-wide level, the necessary inputs and conditions must also be widely available. A crucial policy challenge for the wave of innovation-led growth, at its current phase, can therefore be characterised as a problem of expansion and distribution of “digital” opportunities. To the extent that such opportunities can be spread in the economy and between countries, they can contribute to and encourage economic development. Trade and investment liberalisation is a key energiser of this global imperative.

According to recent OECD work on policies to enhance sustainable development, “International trade and investment promote economic growth and competition. In doing so they can also contribute to poverty reduction, thereby enhancing long-term development opportunities in poorer countries. Moreover, they stimulate technology development and diffusion, and promote the kinds of structural changes necessary to make more efficient use of natural and environmental resources to facilitate continued growth.”

Multilateral trade policy has an important complementary role in helping countries absorb and capitalise on the growth and development potential of a rapidly changing global marketplace. For over 50 years, the disciplines of the GATT/WTO system have made a major contribution to economic growth and improved living standards around the world. On this basis, the business community of the OECD member countries continues to support broad-based, balanced, trade negotiations under the WTO “Doha Development Agenda” as a matter of high priority.

An implication of the new economy is that it also strengthens the case for trade and investment liberalisation in traditional sectors (OECD). The benefits of technological change will only be fully realised if traditional sectors are able to operate more freely and flexibly by responding to and confronting new markets that are the result of innovation and digital opportunities.

On the other hand, to the extent that new opportunities fail to spread quickly, they can contribute to the formation of what one might call “traps” where the "have nots" fall further behind the digitally innovative "haves". By virtue of not being able to keep up with the changing requirements for skill, knowledge and context, groups without access or the skills to utilise digital technologies may fall further behind those with access. Trade supports the spread of new technologies, and is an important factor in reducing the risk of the digital divide becoming a trap for those without access to ICT. For example, implementation of lower

IT tariffs in developing countries and telecoms liberalisation – ensuring low rates, can contribute to greater diffusion of technology and Internet uptake in developing countries.

Currently, public policy discussions which are carried out under the catch word of "digital divide" seem overly focused on the divide, and do not stress sufficiently either the opportunity aspect or an understanding of when inadequate endowment turns into a trap. In order to reduce the risk that discussions on the "digital divide" become a self-fulfilling prophecy, discussion needs to focus on developing greater understanding of how to advance digital opportunities. The world trading system offers the best path. The role of the multilateral trading system in facilitating orderly adjustment, including through use of pre-commitments under the GATS, and in reinforcing domestic economic reform is critical to spreading the benefits of technological change and innovation.

Policy Link Between Innovation and the Regulatory Framework

The following broad conditions must be in place for digital opportunities to spread quickly in the context of economic activity:

- inputs of information and communications technologies (including software) must be widely available in a market-based environment;
- the regulatory environment must be strongly in favour of competition and business creation;
- incentives have to be correct for skill acquisition and necessary changes in the organisation of the workforce;
- important changes are required in the attitudes and capability at all levels of society regarding the application and use of information technology in business and non-business contexts; and
- continuation of strengthening standards world-wide for intellectual property rights protection is needed.

While the availability of inputs may appear to be a crucial issue, it is in effect an element where there is a great deal of clarity as to what policies are most appropriate. Even in the absence of any charitable activities to make ICT tools available to disadvantaged segments of our societies (and such activities remain significant) the quality/price ratio of them has been increasing rapidly and is expected to continue to evolve in a positive manner unlike any other category of commodity in recent economic history. The real challenge for the policy community there is to encourage and utilise effectively what is a rapidly widening sphere of affordability. The availability of new technology tools is merely a first, albeit essential step. The digital opportunities that we are interested in spreading are embodied in new business opportunities. In particular, any serious impact on productivity from the adoption of new business models generally takes the form of opening up to market forces elements of the production and supply chains.

While the impact of e-business is felt throughout economic sectors, and a great deal of attention has been given to the fortunes of e-commerce directed at the individual consumer, currently the most pervasive impact of e-business activity is registered in the commerce between business (B2B).

While the part of manufacturing in B2B commerce is significant, a great deal of potential e-business activity is also likely to be found in the services sector, including finance, telecommunications, logistics management, education, and energy, which are creating the reality of a global infrastructure for the world economy. That is not only because of the fact that service industries constitute the bulk (ranging from half
to three-quarters) of the GDP in advanced economies, but also because these sectors have tended to be most shielded from competition so far. An increasing number of enterprises and sectors find themselves compelled to combine a manufacturing activity with services to the customer in the increasingly competitive environment. Technology-based innovation has the greatest possibility to be a mechanism for bringing within them higher private sector productivity as well as more efficiently and effectively delivered public service.

The implication of these trends is clear: spreading the productivity impact of new technology and new operational models across the broad range of sectors in the economy in large measure requires enabling a widening selection of sectors to open to an increased degree of competition and market contestability. It is difficult to see how one can promote e-commerce without promoting competition and regulatory reform in telecommunications, financial services, distribution, transportation, energy, health, education, entertainment, government procurement.

International Linkages as Ultimate Regulatory Reform

It is not enough to review the regulatory structure of a market and remove barriers to market entry; there must also exist enterprises willing and able to enter the market. This is especially the case in sectors characterised by large fixed investments and well-established incumbent firms. Foreign competition has traditionally been one of the more powerful sources of competition for a market. The tendency that new techniques and new managerial innovations - basically new competency in any particular new venture - has a tendency to be nurtured and developed in specific locations in the world (“centres of excellence”) implies that its spread in the world economy can only take place by an intensification of cross-border trade and investment linkages.

It should be understood that, as the velocity of investment and change has increased in the private sector, the regulatory reform efforts of government have lagged behind. This is especially true of those barriers that inhibit the establishment of a robust, global services infrastructure.

There are two salient points about international trade in services. First they are characterised by a high degree of worldwide segmentation and barriers to cross border trade. Secondly, efforts at the WTO on further commitments for trade liberalisation of services must go forward. The current GATS negotiations present an important opportunity to improve the predictability of international trade in services, including via e-commerce. Thus, as many governments in the world today are publicly committed to prioritising such objectives as new technology, e-business, productivity and growth, there needs to be sufficient progress on one of the most crucial policy areas which impacts on these objectives.

The overall message, however, is that if there is going to be certainty (and investment) in global electronic commerce, there is a tremendous amount of work to be done in securing broader and deeper cross-border commitments. Advancement of the current GATS Services negotiations is critical to achieving progress in this area.

A Note on “Digital” Opportunities

As noted, the need to develop innovation opportunities brought by digital technologies, and avoid “digital divides” has appropriately captured significant attention from policy makers at the highest level. It may be

beneficial to distinguish several dimensions in which digital opportunity and divide issues may influence relative economic performance:

i) within countries, in particular for our attention, within OECD member countries;

ii) among the developed market economies (DMEs) (more or less OECD countries); and

iii) between the DMEs as a group and emerging market economies (EMEs) and developing countries as a group.

Currently business is engaged in substantive policy discussions in the BIAC-OECD context and elsewhere on both the first and third dimensions, and the results of studies underway will be of significant value to both business and the governments. However, there may be some merit in highlighting the second dimension mentioned above. Even if this may be seen as a special case of inter-country comparisons, there are implications for the decision-makers of OECD countries in a purely domestic policy context.

Until recently it could have been held with some confidence that, apart from a small number of exceptions, most OECD countries were at a similar "stage of development" with structurally similar economies and broadly comparable human development indicators (such as literacy, skills etc.). The speed of change brought by technology-driven innovation can challenge this picture significantly.

There are wide differentials in the relative levels of OECD countries with respect to such indicators as to the penetration rates of new technology tools (computers, mobile communications devices, Internet pages, secure servers, etc.), prices of services associated with them (cost of access, interconnection) and new types of business transacted on new media. Available data show that these differentials are at a scale which is not obviously justified by the differentials in current per capita income or education levels observed between the different high-income OECD economies, or their level of over-all technological development.

There is a potentially significant implication to be drawn. The differentials currently observed between OECD countries in terms of using the new digital opportunities may be reflecting not only differences in opportunity between "haves" and "have nots", but also between those who "want" and "do not want" to embrace change. In the current stage, when innovation opportunities evolve extremely rapidly, differentials in approach and attitude in a relatively small number of policy areas between otherwise similar economies may lead to important gaps between OECD countries in the foreseeable future with respect to productivity, per capita income and ultimately "development status".

This aspect of the digital divide problem should be of great concern to the OECD as an organisation, which is founded on the notion of "structurally similar economies led by like-minded governments." The OECD is particularly well placed to explore the observed differences arising between its members in the early adoption of innovative technologies and what may be equally large differences in the policy and practice with respect to regulation/self-regulation, education, labour market, openness to international trade and investment, and other policy areas that are directly related with the utilisation of new technologies and innovation.

From International Trade to Innovation

Multilateral trade policy has an important complimentary role in helping countries harness the growth and development potential of the new economy. For over 50 years, the GATT/WTO system has made a major contribution to economic growth and improved living standards around the world. It is vital that this
system remains strong and that it be adjusted and improved in the context of today’s dynamic global marketplace.

According to the OECD Study, *Open Markets Matter*, “among the reasons for the impressive queue at the WTO’s doorstep are very tangible rewards – in the form of higher living standards – which accrue to countries that take trade and investment liberalisation seriously. More open and outward oriented economies consistently outperform countries with restrictive trade and investment regimes and adherence to multilaterally agreed rules has proven time again as one of the best means of keeping markets open at home and abroad.”

*The successful conclusion of the WTO Doha Round is a prime objective of BIAC.* This includes the advancement of the built-in WTO agenda on services and the continued implementation of existing agreements and commitments made within the WTO.

The WTO negotiation mandated by the Uruguay Round, Services 2000, is a critical element in maintaining and expanding world prosperity. In general, the overarching objective of governments in the negotiations should be to both broaden and deepen the commitments made in the GATS. *Contestable markets in every sector and in every WTO member are the ultimate goals.*

International trade in services, particularly cross border trade, is conducted to a large and increasing extent through electronic means, and information technology has greatly facilitated cross-border provision of services. Accordingly, the provision of services via communications networks is covered by the GATS in the same way as all other means of delivery. Countries’ sectoral commitments under the GATS apply to transactions, whether the services are delivered over these communications networks or by more traditional delivery mechanisms.

There is considerable evidence from various sources including the OECD’s own *Open Markets Matter* and *GATS: The Case for Open Services Markets* that the expansion in the availability of affordable tools for innovation are closely related to the competitive nature of markets in which they are transacted. In the first part of this paper we noted that the markets for these products are also characterised by a high degree of internationalisation. That means that both a high share of final products sold cross border, and a high degree of intra-industry trade due to spread of production facilities and sources of supply.

In this respect, the post-Uruguay Round trade negotiations have achieved a significant level of commitments to liberalise ICT goods in major trading economies including the December 1996 Information Technology Agreement (ITA) which entered into force 1 July 1997, the February 1997 Agreement on Basic Telecommunications (ABT) under the GATS, and the May 1998 Declaration on Global Electronic Commerce. The policy priority in this respect is to complete the implementation of existing commitments, obtain deeper and broader commitments, and first time commitments from countries that have not scheduled commitments.

Trade liberalisation through the GATS Services negotiations offers the main chance for a quantum leap in world prosperity. The information revolution or the “Third Wave” – has made innovation and efficiency in the production of services integral to economic growth. Services inputs are now a central factor in competitive success in manufacturing and agriculture -- in high tech and traditional sectors alike. Telecommunications, transportation, finance, insurance, distribution, energy, and information services underpin all forms of international trade and all aspects of global economic activity.

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Conclusions Regarding Multilateral and National Trade Policy

Policy makers need to be alert to the synergies at work in today’s economy that can spark innovation. As they may not always be predictable, dialogue between private and public sector policy makers is crucial to continue building the understanding and co-operation that is essential to developing an environment where innovation can flourish and provide maximum benefits to productivity and world standards of living.

Innovation stemming from technological (such as ICT) and managerial and societal advances will lead to productivity gains when the regulatory environment surrounding the labour, capital, and product markets is conducive to competition and adaptation. An essential component to the expansion and distribution of the income impacts of innovation is trade liberalisation. BIAC strongly encourages continued OECD work in areas that impact the potential for innovation to benefit economies.

In addition to the broad policy framework attuned to the new realities of the global marketplace, the following are our trade-related priorities in enabling innovation:

Continued and significant negotiating progress on:

- Industrial goods
- Services
- Agriculture
- The relationship between trade and investment
- Trade facilitation
- Transparency in government procurement

We believe that focus should continue to be placed on:

- WTO rules on antidumping and subsidies
- Trade and environment
- Trade and competition policy
- Telecommunications and electronic commerce

Building support for results on these issues across all stakeholders will be critical to a successful completion of the negotiations within the next two years. OECD is important in developing fact-based analysis to support the development of policies that underpin open markets and their benefits. The BIAC business community played an active role leading up to and during the Doha meetings, and will remain engaged throughout the negotiations.

Policy makers should also continue to think globally with regard to issues such as transparency and technological neutrality, and keep in mind that strengthening the rules-based trading system is complementary to the development of ICT and other technological potential, which in turn can generate substantial economic, societal, and environmental benefits. At the same time, policy makers must remain alert to the potential development of impediments that could result from shortsighted or overly restrictive
policies relating to technology, innovation and e-commerce. *Strengthening the rules based global trading system is necessary to maximise opportunities for innovation, and to enhance the ability for all to reap its benefits.*

*Indeed, it might be justly said that the failure to advance vigorously the multilateral trade agenda has denied OECD countries the incremental market potential that could have offset the slowdown with which policy-makers are wrestling at the moment. The bicycle theory of continuing negotiations has relevance not just to momentum in Geneva but in the expansion of market potential, growth and the spread of the democratic market economy itself.*

For business, the decision to “go to market” through the trading system is tightly coupled with the deployment of resources through investment. *Trade and investment are both alternatives and complements.* A company trades in order to invest and invests in order to trade. This is the dynamic of the search for growth. In the next chapter, we will focus on the higher risk element of growth, the commitment of resources in the global market through investment.
CHAPTER III: FROM INNOVATION TO INVESTMENT - INTERNATIONAL INVESTMENT, INNOVATION AND GROWTH

The rapid growth of international investment in the nineties constituted an important factor of innovation, and led to growth in all participating economies. *Forward looking policy decisions on national, bilateral and multilateral levels should focus on how this enormous potential can be realised all the more in difficult times.*

**Figure 3.1: World FDI Inflows and Outflows (UNCTAD)**

Very often, investment in innovation is seen as the creation and use of new technologies. Of course, the invention of new products and processes is a core element of innovation. However, the successful application of innovation is also a matter of changes in organisational and workplace methods, even of society’s perceptions. Developments in fields such as human rights and social norms, political systems and governance, education, property rights, customer behaviour and demand creation are all elements of social innovations. Furthermore, “increased social welfare in turn generally reinforces demands for improved

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The capacity to adapt to change, call it societal innovation, is necessary to cope better with the challenges with which a society is confronted.

Technological and societal innovation are complementary processes and a prerequisite for development. Seen in a broader perspective, the acceptability of innovation relies on changes within society. One of the greatest challenges for political leadership in the decades to come is that of inspiring the acceptance of change. In business, we are convinced that those companies that are not in a constant state of change are doomed. Business leadership sees the challenge as one of inducing a culture of change, a challenge no different than that for government.

Instead of finding new ways to increase access for foreign direct investments, some within and outside government wish to control international investment for politically-laced economic purposes, commonly, with hollow promises to remove the downside of risk. The losses from intervention and resulting market distortions are significant, as economic history has repeatedly demonstrated. These losses are the result of the inherent contradiction that innovation is impossible to predict while policy has to be predictable to be effective. Policies that constrain international investment are likely to curb wealth creation. At the same time, the resources and changes needed to adjust to real global competition will not be created, leading to a widening “divide” of lost opportunities. There is no need to turn a contradiction into a conundrum.

This chapter tries to give an overview on how important Foreign Direct Investment (FDI) is for innovation and growth and how both public policy and companies can ensure participation in this creation of wealth.

In order to demonstrate the importance of investment liberalisation and development of a supportive public policy framework, this chapter will first focus on the interrelationship between four basic concepts: innovation, enabling technology, sustainable growth and globalisation.

After this we will give an overview of the key role of FDI in stimulating innovation and growth. To do this we will concentrate on the economics of innovation and growth as they are viewed by the OECD Growth Project, the importance of encouraging investments in societal innovation as well as the contributions of investment/MNEs to the innovative forces and sustainable growth in the host country.

In the final part of this chapter, we will tackle the question of how good politics can ensure participation in the creation of wealth through investment in innovation. We will conclude with some remarks on the tension between social responsibility vs. the competitiveness of our companies.

Innovation

There is a symbiotic relationship between innovation and investment. That relationship is what is often called a “win-win”. Two important facets of innovation include the technological/organisational aspects and societal/cultural relationships. To be effective and to avoid social dislocation and unbalanced national or regional development, these aspects should progress at the same speed.

Public and private efforts should be directed toward both aspects simultaneously by increasing the pace of societal innovation through policy actions, such as addressing macro-economic policy failings, making major investments in education and increasing the diffusion of technology.

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7 OECD, Open Markets Matter, p. 96.
Enabling Technology

We have entered a phase of sustainable global growth that is no longer based only on the exploitation of traditional raw materials, energy sources and physical products, but more and more on intangible values: information, communication, knowledge, skills, intelligence, new services and flows of creativity and invention.

ICT innovation and its application through investment presents a unique opportunity, perhaps more achievable than any time in human history, for creating the most favourable global conditions to advance innovation. In its application, ICT supports the alignment of technological, organisational and societal/cultural adjustment necessary for innovation. Biotechnology represents another field where a quantum leap in innovation will enable enormous growth.

Policy action in all countries should take advantage of the diffusion and open availability of technology to promote societal change through investment in education for all, the creation of a culture of entrepreneurship, effective financial markets and open market conditions.

Sustainable Growth

Foreign investment, international trade and open markets represent the basic elements for delivering and sharing innovation globally, and sustainable growth is more assured if societal/cultural innovation proceeds in parallel with technological/organisational innovation. This is true whether within a nation or between regions and nations. On the contrary, growing misalignment between the two aspects of innovation can produce low economic growth or decline, unemployment, social decay. Sustainability is pervasive in the national policy mosaic. This is a matter for Prime Ministers to promote via a joined up with a national strategy.

Globalisation

“Trade and investment liberalisation in the context of open market frameworks are essential to the diffusion of benefits created by globalisation.”8 Furthermore, the spread of wealth creation though globalisation serves to strengthen local values and culture. Globalisation and local development are two sides of the same coin.

Matching globalisation inputs with societal/cultural innovation through the right policy action permits government to reach a balance and a positive integration between global and local values to find the most effective path towards sustainable global growth.

The Importance of FDI for Innovation and Growth

The Economics of Innovation and Growth

The rapid changes brought about by Information and Communication Technology (ICT) are generally perceived as the most important factors contributing to innovation. Investments that apply ICT innovations have enormous impacts on both the service and manufacturing sectors. For example, in the service sector,

ICT applications enhance productivity for a broad number of operations including implementation of transaction systems (i.e. for financial services including monitoring), research and development, education and training, knowledge management, transportation services, internal and external communications, retail services, engineering – including environmental – and the management of supply processes, inventory, and procurement networks.

Manufacturing operations are equally enhanced by investments in ICT applications. Some examples include in the development, design, implementation and production of processes and products, facilitation of improvements in quality management and control, and in the development of improved inventory management. The availability of data in rapid feedback cycles to production floor operators is key as it permits more decision-making at the operational level, which in turn raises productivity and reduces waste. Flexibility in manufacturing permits the tailoring of products to customer needs, as well as rapid shifts in models or configurations on the same production line.

Importantly, the productivity benefits resulting from the application of ICT to both services and manufacturing sectors are mutually beneficial and reinforcing. Improvements in data transmission speeds, capacity and methods have increased linkages between firms and have resulted in virtual mergers of operating capacity. It is the foreign affiliates of these transforming firms that bring the benefits of change with them as a part of their investment in host countries.

Information compiled by the OECD suggests that multinational enterprises play a significant role in the OECD area economies. Time series analysis with the scarce data available suggests that the internationalisation of manufacturing is generally on the increase in the time period covered (generally 1992 to 1998) (See Table 3.1 below). The share of foreign affiliates in production and/or employment has seen important increases in Finland, Hungary, Ireland, Sweden and United States.

The data on the economic role of MNEs is incomplete for many countries, which makes a rigorous cross-country analysis difficult. However, this very interesting database and related analysis in the OECD needs to be completed and, above all, prioritised as a major work product to be disseminated by the Organisation.

One way or another, most of these economies are highlighted in the OECD Growth Study as having experienced significant positive growth impact from innovation in the 1990s. There are sharp declines in the shares of foreign affiliates in production and employment in several OECD economies such as Japan or Germany and slow progress in France. These economies are also at the bottom of the league in terms of MFP growth in the 1990s. More detailed and sectoral analysis may be necessary to determine the exact direction of causality, but it is clear that openness to investment and ability to attract it go hand-in-hand with an innovative economy.

Overall, ICT plays a central role in reducing information and transaction costs and in increasing factor utilisation in most sectors. These gains in productivity enable the production of better products at lower costs and with more efficient use of natural resources. Competition in open market economies and

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Data in Tables 3.1 and 3.2 show that in all countries multinationals account for a higher share of the wages paid to workers than their share in employment. This is mostly because they are concentrated in higher value added sectors. However, multinationals do not simply "snatch" the more productive labour from local companies, instead they contribute to the development of leading sectors in the economy in terms of productivity and wages.
investment in innovation lead to endogenous growth of productivity per capita and of GNP, creating new sources of wealth. Thus, competition is a driving factor of all innovation.

Note that all of these inputs of technology-based innovation imply the free flow of ideas and methods within the enterprise and, most important, the rapidity of action and change. There are a thousand ways that a regulatory forest can slow the spread of these innovations. There is a price for every one of them. Relatively few are worth paying. Where competition reigns and consumers rule, government should reduce them to the minimum. Investment makes the transformation local.

At the end of the day, it is the generation of a cadre of local investors that brings sustainability to the growth induced by foreign direct investment and lifts people out of poverty.
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<th>Wages</th>
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The Impact of Investment on Societal Innovation

Although the invention of the compass and of seaworthy ships was important, it took crews to explore new passages: New ideas and perceptions precede any innovation. This gives rise to the question of why some societies are creating more innovations than others. The complementary nature of technological and societal innovation gives some answers. Societal innovations such as human and social rights, education, democratic political systems and good governance enhance the possibilities for the emergence of new ideas.

For example, technologies such as the Internet cannot be used for innovation if personal access is restricted for political reasons. Or, if lack of education prevents access to ICT in many remote areas, that will be an important factor reducing digital opportunities or exaggerating a divide that existed long before there were digits to blame. Governmental policy must address long term effects and encourage investments in societal innovation that benefit the local context. The demand for skilled labour leads to improvements in educational institutions, which is the basis for the formation of future productive citizens. A long-term diffusion of technology internationally is only possible if the formation of human resources takes place locally. Without question, the most important form of societal investment is in the provision of access to education to prepare the workforce.

Figure 3.2: Labour force Evaluation Index (UNCTAD) 10

The shaping of the market economy in every country and internationally is also part of societal innovation. The establishment and spread of the market-based world trading system through the liberalisation process over the last two generations has set loose an unprecedented, dynamic increase in wealth.

The Contribution of Investment in Innovation to Sustainable Growth

Recent economic history has proved that the larger, cross border liberalisation of markets spurs innovation locally, leading to higher productivity and endogenous growth. Because labour division and degree of specialisation are enhanced in these markets, the scope of innovation has been growing. The key to international labour division in these newly innovative markets is access to technology and human capital formation. Foreign direct investment is a strategic factor for both.

For example, Table 3.2 below depicts the additional contribution of multinational enterprises (MNEs) in OECD economies. In all countries foreign affiliates account for a share of production higher than their share in employment. This suggests that MNEs bring in higher productivity technology and management. In order to be more precise, such data should be checked at a detailed sectoral level, which could also provide insight to the question of whether MNEs systematically have higher labour productivity in the same activity?

In all countries, multinationals account for a higher share of the wages paid to workers than their share in employment. This is mostly because they are concentrated in higher value added sectors. Multinationals do not simply “snatch” the more productive labour from local companies. They contribute to the development of leading sectors in the economy in terms of productivity and wages.

<table>
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<th>Table 3.2 Additional Contribution of Foreign Affiliates</th>
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<td>(Ratios of shares in national total, Index based on 100)</td>
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Source: OECD, Economic Analysis and Statistics Division of the Directorate for Science, Technology and Industry

(1): Share of MNEs in production devided by their share in employment.
(2): Share of MNEs in R&D devided by their share in production.
(3): Share of MNEs in wages devided by their share in employment.

Foreign direct investments, including mergers and acquisitions, are efficient and effective vehicles to safeguard intellectual property rights in markets with intense competition and short technological cycles. Investments reduce the internal costs of adjustment to a new competitive model. Cross border licensing and joint ventures ensure access to modern processes and products, which is necessary to improving global productivity.

In many countries, local business partners of foreign direct investors form the core of local economic development, including the entrepreneurial activities of former employees of investing firms who, once trained, establish their own businesses.

FDI brings not only access to technology that is a prerequisite to take advantage of innovation. It also creates new clusters of economic activity, due to the fact that few investors operate in isolation. These clusters of investors, direct suppliers and buyers, have a multiplier effect on local business, consumers as well as on public finances. Most important, this economic activity brings hope and motivation to communities. Business people on the ground making these investments see and experience the transformation of society when the education system has before it jobs to fill.

We assert that investment in innovation itself is a sine qua non for sustainable global growth, whether on the social, economic or environmental plane. Investments in innovation and resulting growth are needed for sustainable (stable) social systems and are an important factor in contributing to economic development. Technology transfer and diffusion as well as local human capital formation increase relative competitive advantages of the host countries. New demands lead to investments in innovative (“sustainable”) technologies which need the incentive of large global markets.

The development impact of investment goes beyond its monetary value. Other key positive side effects include the transfer of environmentally friendly technology and know how and the improvement in employee well being with the implementation of better pay and efficient management practices.

“Evidence shows that trade and investment activities will usually have a positive impact on the environment. This is because trade and investment promote both a more efficient allocation of resources at the same time that they contribute to economic growth. The result should be increased social welfare, which in turn, generally reinforces demands for improved environmental policies.”

Innovation and international investment increase variety. As all investment is local, new possibilities arise for international labour division and specialisation that empowers local economies reach out to the potential of international markets. This is especially the case for “remote“ regions, which are provided new market opportunities through the lowering of transaction and information costs.

In sum, international investment in innovation is an essential element in upgrading not only the performance of local economies, but also in improving social and environmental sustainability globally.

Getting the Policy Right

With regard to international investment, innovation and sustainability, government policy has its most profound effects in the long term. However, very often in policy discussions, the negative short term effects of investments receive more coverage than the long term benefits, which are commonly a great deal higher than the short term effects. Because investment in innovation depends on an open market economy and open society, interventionist approaches seldom form part of forward-looking policy.

12 OECD, Open Markets Matter, p. 96.
Over the last few years, there has been a noisy pressure to simply stop liberalisation instead of finding new ways to open up the access for trade and foreign direct investments. Local economic problems are attributed to “globalisation”. Of course this is the opposite of the truth and it is clear to most governments that the “noise” has other motivations than a focus on increasing prosperity.

As noted, the societal and economic losses from this interventionist approach are enormous, as economic history has repeatedly demonstrated in OECD, transitional and developing countries.

Hence, any policy that tries to slow or constrain international investment will sooner or later bring about the loss of opportunities for the creation of domestic economic wealth. However, the need for adjustment will not vanish. On the contrary, it will increase. At the same time, the resources required later to make adjustments will not be there because of missed opportunities. Thus, the constraints lead to a kind of adjustment trap. This adjustment trap is even more harmful, the longer and the more deeply government policy has intervened.

The Case for Good Governance

National policy will become even more important for investment and growth. All policy decisions must fulfil the criteria of transparency, non-discrimination, predictability, sound financial and shareholder governance, efficient and transparent administration as well as a fair, predictable system of taxation. Since investors have a long-term perspective, a stable policy environment is a key element in attracting FDI. These should be policies that enable rather than inhibit innovation and growth.

In order to trade and invest in open markets, companies seek out market environments with economic and societal stability, established rule of law, regulatory frameworks that promote competition, enabling infrastructure, quality education and training opportunities, protection for intellectual property rights, real competition, and the absence of corruption. A well communicated, sound macro-economic policy facilitates investment decisions and draws inward investment.

Those framework conditions attract opportunities for economic growth. Their absence signals at least caution if not avoidance. Good public governance is essential to attract FDI and trade, which in turn increase consumer choice, create jobs, and most importantly generate revenue for public spending on education and training that is essential for economies to adjust to and sustain the benefits of growth. There must be compatibility with an open, truly competitive market economy. Innovative processes are most beneficial without interventionist distortions. Prescriptive regimes that are not technology neutral will inhibit the potential for incremental productivity improvements.

Every dynamic change in an economy leads to adjustment costs. Policy should enhance the ability to cope with necessary changes, from bankruptcy to labour market adaptability, and not pursue policies which try to delay the inevitable frictions and adjustments by resorting to the expenditure of scarce resources.

While the private sector provides economic growth, public investments in infrastructure, education, and research are complementary and supporting. Recent experience clearly shows that privatisation can be a key to stimulating innovation in domestic markets. The rate of innovation is increased, creating new businesses, markets and jobs.

Investments today are seldom directed solely at local markets but must produce competitive offerings, goods and services that can move easily from the point of manufacture or creation to the ultimate customer over an adequate infrastructure. Indeed, investment is frequently made in the distribution channels themselves to connect over the physical or electronic infrastructure.
One of the first questions on the mind of an investor is “What about the quality and motivation of the labour pool?” While economic integration, investment, trade and diffusion of technologies support growth, they also induce adjustment by the persons and economies that reap their benefits. A fundamental requirement for addressing these adjustments lies with an adequate education system and the availability of training in basic skills. Education – including lifelong learning – is essential to enable a society to cope with the inevitable shifts and opportunities in the labour market. The quality of pre-school, primary, secondary, tertiary and life long learning educational capacity will drive the success of investors in the future. In addition to the quality of “output” in pedagogical terms, the common thread is one of a propensity to embrace change.

Human resource policy, whether education, labour market or health care, creates the necessary environment for sustainable growth and development.

It is clear, that corruption, lack of transparency, undemocratic governments or unstable policy decisions do not attract FDI. Hence, the economy will grow below its potential. There is no more common, fatal barrier to the movement of investment than poor governance. Remember, those resources are someone’s savings. Nothing is more reckless than subjecting those savings to unnecessary or excessive risk. The costs of either inadequate or burdensome government are never “lost”. They remain within the business algorithm and, with regard to many countries, are better avoided. Marginalisation is the result.

Benefits arising from trade and investment liberalisation might also be reduced by anti-competitive undertakings. Global business witnessed a proliferation of competition laws in the last decade trying to combat such phenomena such as import or export cartels. More than 80 countries have adopted competition laws. However, the competition laws in force differ widely regarding their nature, coverage and their enforcement. International co-operation between competition authorities reinforces the effectiveness of competition policy.

Most domestic competition laws in place today include provisions on mergers. Given that the nature of business is becoming more and more global, a merger often affects more than a single domestic market. Therefore, companies are facing many different merger regulations and notification requirements resulting in high bureaucratic burdens and thus increasing transaction costs. For these reasons, international co-operation between competition authorities as well as bilateral and multilateral agreements on competition policy would ease merger notifications, speed procedures and thus reduce the costs to the business community.

Governments must ensure that whatever changes made to the mosaic in order to attract investment are effective, that is, successful in increasing economic activity without either wasting the public purse or distorting opportunities for competition. Any incentive tools applied should be generally available and not discriminate among investors. They should be transparent, proportional, clearly linked, non-trade distorting, oriented towards attracting long-term investment, and temporary in relation to offsetting asset or policy gaps.

In short, open markets encourage the development of good public governance. The integration of markets and the increased removal of trade and investment barriers mean that governance instruments become all the more important to ensuring contestable markets. It is clear that good public and private governance is essential to maximising the benefits of investment made by responsible businesses.

The Case for Rules

In other OECD fora, we have presented our case with regard to investment rules. BIAC was a vigorous supporter of the OECD effort to launch a set of rules for investment and continues to believe that the goal
of a robust “world trading and investing system” is simply common sense. The source of all these commercial transactions is the private sector, which is made up of companies. Investment is intimately linked to trade, and policies for liberalisation should support both the supplier and customer chains of the investor for goods and services. Within each company itself, the balance of trading and investing is a matter of resource allocation.

To have one side of the balance governed by a clear, transparent set of negotiated rules and the other side remain dependent on ad hocery does not make sense. In an era in which investment was equated with exploitation by many countries, such a failure of multilateralism could be explained. Now, the benefits of investment are better understood, and the contrast in terms of development between those countries that have welcomed investment and those that have not has never been more vivid. We believe that it is also increasingly well understood that investment brings with it a broad range of societal benefits with few negatives.

The OECD, the World Bank and various other centres of facts and analysis have poured out the categories: consumer choice, competition to bring down prices, diffusion of technologies, management know-how, employment, fiscal contribution (both direct and through employee payments), high standards in employment practices, a level of sophistication in environmental management systems, international corporate governance, etc. There is a small investment footprint in TRIMS and a significant presence within the GATS. That we move forward -- be it bilaterally, plurilaterally or at best multilaterally -- is imperative. Domestic, bilateral, regional, and multilateral policies should enlarge access to markets. Transition and developing countries are especially in need of a rules based open world trading and investment system.

We have been asked how those countries that genuinely remain dubious as to the benefits of investment might be persuaded. We believe that those are relatively few, and it is more than curious that they are unconvinced by the facts and analyses. There may also be a number of countries that see the negotiating process as an opportunity for high stakes leverage to win concessions in other areas. While the very nature of the negotiating process may make this unavoidable, those countries need to understand that resistance to investment is a poor choice. Trade transfers wealth, but relatively slowly. Investment spurs the pace significantly.

**Corporate Responsibility and Competitiveness**

As OECD recently stated, “Business can play an important role in adopting and diffusing sustainable practices world-wide, and in many instances may be ahead of governments in implementation\(^\text{13}\).”

Companies are key players in promoting innovation and sustainable growth, and through investment and international trade they are significant agents of positive change at local and international levels. The efforts of companies in this area often go unheard, but they are inherent in the strategies and implementation of their management systems.

In this era of globalisation and economic integration, there is increasing pressure on business to be responsible for the environment, for societal conditions, poverty reduction, even for education. Companies are investing significant resources to communicate to the public what has made them competitive in the first place – good management systems -- which aim at implementing good company practices and policies related to environmental health and safety, quality of working environments, employee benefits, and community relations.

Corporate responsibility has always been fundamental to a company’s competitiveness and long-term success. Through their investment choices, research programs, personnel policies, manufacturing processes, and customer service orientation, international firms have led the way on many fronts.

What are the instruments for corporate responsibility? Indeed, there are laws and regulations. These are requirements. The notion of corporate social responsibility is quite separate and more aspirational.

From the start, it is important to remember that corporate social responsibility is about the initiatives that a company takes to develop good management systems, which in turn enhance a company’s ability to sustain their franchise, build a record of sustained growth and do so by engaging positively with the societies in which they operate.

Corporate responsibility objectives, or goals of “better practices,” may or may not be derived from “codes” but are reflected through the implementation of management systems.

The decision by a company to adopt a corporate code of conduct or one of the many corporate responsibility pacts, systems, initiatives or other instruments that are being promoted today, will depend on the objectives of the individual company and the relative value added each code or initiative can offer. The primary audience for many codes, such as codes of ethics, often remains the company itself, namely its business units, managers, employees and shareholders.

Most importantly it is the behaviour of the company that counts — not the existence of a formal set of business principles to which management “signs up.” So whether or not a company decides to adopt and publish a business code, vision, principles or similar communication vehicle should not be seen as sine qua non of its commitment to good business practices.

**OECD Guidelines for Multinational Enterprises**

As the only comprehensive set of recommendations for international business collectively endorsed by governments, the OECD MNE Guidelines serve as an important benchmarking tool for companies as they develop their internal management systems. They have played that voluntary role for more than 25 years.

The clear aim of the MNE Guidelines is to improve the climate for foreign direct investment, sustainable growth, and to promote the positive contribution that multinational enterprises can bring to society. At the outset, the Guidelines were part of the wider OECD Declaration on International Investment and Multinational Enterprises, meant to encourage a balance of responsibility between international business and governments.

Effective implementation of the Guidelines contributes to enhancing the role of investment in creating employment and wealth, raising the standard of living and fostering global sustainable growth.

**Good Corporate Governance**

Improving the climate for investment and sustainable growth is the sole common point shared by two very different policy debates, that concerning corporate social responsibility and the more recent discussion focusing on corporate governance. For the rest, these two debates target distinctively different issues.

Whereas corporate responsibility addresses general public demands and aspirations for company behaviour, the essence of corporate governance is to enhance the transparency of and confidence in
company performance and value. The discussion on corporate governance is not the right place for achieving other policy objectives.

Every national regulatory system has to find its own balance between regulation by governments and self-regulation. The current structure of systems of national corporate governance regulations should be maintained. Spectacular business failures in the recent past cannot necessarily be attributed to deficiencies in corporate governance. OECD Principles of Corporate Governance have stood the test of the years since their adoption. Deficiencies can largely be attributed to failures in enforcement, not to the lack of a governance structure as such.

**There are Limits – Strengthening the Policy Gaps**

While a company is dedicated to protecting its corporate image, brand integrity and employment reputation in all the markets in which it operates, at the same time, it is clear that there are limits on what should be expected from a company.

Companies cannot substitute for governments in building the policy mosaic, that is, the co-ordinated legal framework and basic infrastructure, needed to establish fully functioning market economies that attract business and are necessary for a company to flourish.

As stated above, good governance framework conditions, public and private, attract opportunities for economic growth. And their absence signals at least caution if not avoidance.

The mosaic of assets as well as policy enablers and inhibitors is different in each polity and the quest for comparative advantage is an irresistible force. Some of those mosaics are very poor and many concessions or offsets are required to make the choice attractive, prudent and saleable to shareholders, when viewed in contrast to all the other opportunities.

However, there are strong countervailing forces. Where the investment involves access to limited natural resources, the ability to find adequate balance in the mosaic is very difficult, as the host government has disproportionate leverage over a particular contract or business model. Another polity choice is not always available to the investor.

Whether in the context of trade or investment, national, or sub-national, economic growth fuelled by innovation and competition is the goal. Incentives can be a tool to accelerate the process.

**Conclusion**

*Investment is the deployment and management of wealth, citizens’ wealth.* Whether via cash, equities, debt instruments, intellectual property or through other vehicles, individuals put their savings at risk for a return that yields growth. At a minimum, those returns are a race with inflation. For most, they are intended to be a path to prosperity.

There are really no such entities as impersonal “institutional” investors. All non-governmental wealth is owned by people. All government wealth was taken from people through taxation. Government policies that intentionally curb investment and limit growth are an attack on citizens’ savings and hopes for prosperity. *Capital is no abstraction, and there is no way to shift the impact of policy choices away from real people.*
Growth is not a luxury but an imperative. The search for investment opportunities is a quest for growth. The potential for sustainable returns is to a large degree a function of the policy mosaic within both the home and host countries. Only the most aggressive investor can seek and support very high risk. For those with fiduciary responsibility for others’ money, a national policy environment that drives up risk is usually an impenetrable barrier to that which might constitute dramatic potential. A poor policy mosaic is self-defeating in that it obviates an opportunity for that country, especially a developing country, to participate in the growth sought by the investor.

As we have said, an inhospitable macro-economic and policy environment is a barrier to the transfer of myriad externalities such as the diffusion of technology, management skills, employment and its accompanying tax revenue, training, improved environmental conditions, the deployment of intellectual property and the spread of innovation.

For many countries, getting these basic policies right requires significant societal innovation in managing the inevitable dislocations of change and preparing the population for future economic activity. Here enters the value of an open door for innovation and investment in the public sector as well as private enterprise. The delivery of social services, especially education, can be dramatically improved through active embrace of technological and organisation innovation, again, on the path to a more effective diffusion of economic benefits.

Indeed, a first class education is the greatest benefit that can be bestowed, a blessing to which, little more than initiative needs to be added for a productive citizen.

Liberalisation alone will not automatically bring a rush of investors, but without it, few will take the step. Privatisation alone will not ensure competitiveness, but without it, productivity improvements and increased standard of living will prove elusive. Investment unlocks closed markets by bringing real competition and, while perhaps shaking local firms, brings the competition that is necessary to transform them and the market itself to join the global marketplace. To leave that local market unchallenged by real competition is to doom it to isolation. Investment is the tool that opens the door.

In addition, it is no matter of chance that those who take the pulse of an economy search for indicators of confidence, from that of the consumer or industrial purchaser to that of the other takers of risk, the holders of equity and debt. The economy is largely expectations expressed in money, peoples’ savings. To the extent that people put their savings at risk, economic growth can, has and will continue to drive the advancement of other aspects of sustainable human welfare. The public policy mosaic is part of the platform upon which confidence is built. Growth is the Grail.

Investment, through growth, enables innovation that increases productivity and raises the standard of living. One must never forget that the enhancement of living standards is the very raison d’être of government.
CHAPTER IV: TECHNOLOGY AND VELOCITY, THE TURBOCHARGER OF INNOVATION

There may be a tendency in our discussions of economic growth and innovation to take for granted some parts of the process that make innovation possible. For example, a wide range of public policy and attitudes - from the education of scientists to the financing of research and development - determine the pace and direction of the scientific output that underpins technological innovation. Therefore, the policy maker who is focused on promoting and sustaining innovation and growth should not at any moment allow the outcome of education, science and technology policies to escape his vigilant attention.

Policy linkage from scientific output to technological invention to innovation and growth is built on a number of premises, which have partly been discussed in the foundation chapters of this paper.

First, economic growth is not everything in economic policy. Equity issues, quality of life, etc. matter a great deal and are linked to the growth issue. However, without growth, little else happens, especially at the lower end of the income distribution scale.

Second, whereas innovation is not necessarily the only source of growth in any given year or even a decade, it is the main source of sustainable growth in the long term. Continued innovation is also essential if societies are to be able to deal with other aspects of their sustainability, such as environmental improvement and other aspects of quality of life. Ad absurdum, were there to be no innovation at all, the growth of output would come to a halt at the end of the last remaining product cycle. The growth of multi-(or total-) factor productivity in turn is unmistakably a sign of learning how to do things better with existing, replacement or fewer inputs, which we equate with innovation.

Third, while the specific origin of the current focus on growth was to explain recent divergence in growth performance and to link it to various potential determinants, this has opened a useful avenue of research refocusing our attention on the sources of growth in general, and not only during the recent divergence. This is useful because the change in performance may not only result from changes in the status of determinants. The impact of given institutional or other factors on innovation, productivity and growth may be changing in itself. Thus there may be changes in the outcomes (e.g., innovation) while the determinants remain more or less unchanged (e.g., the way universities and industry interact) in a country.

Why some factors that did not strongly affect economic performance in the 1960s or ’70s may do so now is something that needs to be studied and clearly elucidated. Some of this may have to do with the fact that an increasing number of OECD countries have approached the older industrialised countries in terms of economic and institutional structures, and have thus lost the ability to grow by simply “catching up” and “leapfrogging” (with a good deal of copying and technology transfer involved). This last aspect is particularly important in the context of generation and diffusion of technology, which is the subject of this chapter.

New conditions for knowledge appropriability and diffusion

Unfortunately, the environment for Intellectual Property (IP) protection has changed quite dramatically since the signing of the WTO Agreement on Trade Related Aspects of IP (TRIPs), which was the first
multilateral IP agreement that included not only minimum standards of IP protection but also minimum standards of enforcement. In particular, we are witnessing a backlash against IP protection in many of the developing countries that stand to gain the most from adequate and effective IP protection. Some countries are seeking to reopen the TRIPs Agreement, which we strongly oppose.

Although many nations have made substantial progress in the protection and enforcement of IP rights, others have failed to implement their TRIPs obligations. We continue to believe that IP rights are essential to economic development and to the encouragement of investment. It is therefore critical that minimum standards for IP protection are implemented and enforced worldwide, including in the developing world. Members of the OECD should reaffirm the current TRIPs balance between the incentives for innovation provided by IP protection and the protection of society’s interests in the disclosure and dissemination of technology and oppose all attempts at weakening the TRIPs Agreement.

Policy implications of Intellectual Property Rights

With many higher value-added economic activities increasingly dependent on IP rights, the OECD member governments must help ensure that IP standards continue to improve and be effectively enforced in order to encourage, reward and protect innovation and creativity. Strong IP protection facilitates the emergence of new technologies by balancing the benefits that products and technologies provide society as a whole with the need to provide both incentives for continued innovation and an environment in which that innovation is rewarded. The historical record in the industrialised countries of the OECD demonstrates that IP protection has been one of the most powerful instruments for economic development, export growth and the creation and diffusion of new technologies.

Policies that appear to favour the spread of a given stock of knowledge by means of relaxing IP protection can only form a strong disincentive to investment in knowledge in the longer term. Moreover, firms can elect not to avail themselves of IP protection in order to keep their inventions secret and avoid having to share knowledge. Collaborative ventures between public and private research organisations would also be more difficult to build, further depressing innovation.

In general, the challenge for the international community today is to ensure that:

− all countries set high standards of IP protection and enforcement in their national laws;
− all countries recognise the special IP needs of industrial sectors whose inventions, because of regulatory requirements, reach the marketplace with considerable lags after patent grant; and
− strong IP protection is maintained even in the face of rapidly changing technology.

In assessing the value of IP protection in fostering innovation, it is critical to recall that industry requires legal certainty, a substantial reduction in costs, prompt patent examination and continued efforts to ensure the highest levels of IP protection and enforcement world-wide. The political will for such improvements will be fostered by a move towards a uniform patent system with the same specifications and claims for all countries.

Private sector innovation could further be supported by reducing the costs of acquiring, maintaining and enforcing IP rights. Non-discriminatory trade regimes conducive to full market access for IP-protected products throughout the world are also a prerequisite to innovation.
Moreover, different industrial sectors have different priorities with respect to IP protection and enforcement. For many industrial sectors in the OECD countries -- particularly in the agricultural chemical and pharmaceutical industries -- innovation and technology development are related to the state of IP protection and enforcement outside of the OECD countries. For these industries, improved IP protection and enforcement outside of the OECD will be particularly critical. For other industries based in OECD countries, whose inventions enjoy strong protection, enforcement of the standards -- including the cost of enforcement and litigation -- within and outside of the OECD countries is paramount. For yet other industries, the need for harmonised, low cost and efficient patent systems is the principal IP issue faced.

**Technology and growth**

All scientific inquiry and technical progress does not have to aim at productivity growth. For instance, countries need to develop and perfect technologies to minimise risks from natural hazards (earthquakes, rising sea levels, etc.) all the time - it is an issue of survival. Investment in the areas of aerospace and astronomy does not need to be made in the first instance with a principal eye on spin-off inventions, and insulation technology for atmospheric re-entry vehicles was not designed with a view to develop Teflon frying pans. Less flippantly, the major breakthroughs in atomic physics 100 years ago and molecular biology 50 years ago were made without any appreciation of the economic growth that would result towards the end of the 20th century.

Such spin-offs are a bonus, the value of which cannot be calculated ex ante. There are many areas of technology, from particle accelerators to space exploration, where the initial object of curiosity serves to enlighten humanity and raise our face from the daily mud in which we toil. The principal policy discussion in relation to such basic research is not about the relative amounts of public funding allocated to them in comparison to commercially-oriented research, but the mechanisms for reviewing the effectiveness of such research in achieving its own objectives and the objectives that society has set in general, and this cannot not be subject to direct market-based verification. *Basic scientific research (and for that matter military R&D) requires its own evaluation process which is unlinked to growth and productivity, but should still be performance-oriented in some longer term fashion.*

What one needs to focus on is what level of funding is available for commercially relevant R&D, how it is financed, and how evaluation is linked to performance. Equally important as R&D, industry depends on the availability of skilled personnel in the context of applying and using technology.

It has been clear for many years that fundamental research underpins future commercially oriented R&D. In recent years, it has also become clear that in some important sectors the process is not a linear sequence of events: commercially oriented R&D can itself be highly fundamental and/or directly stimulate new fundamental work. Maintaining sufficient funding for fundamental research is therefore an economic interest as well as a scientific one. However, fundamental research cannot be evaluated in the context of economy-wide productivity. A better way to evaluate its performance is to evaluate how open fundamental research organisations are to interaction with the private sector and to determine whether there are hidden barriers that hamper fruitful cross-fertilisation, especially outside geographic boundaries. (A simple example is the question of state aid for R&D, which impacts at the interface between competition rules and national and international research and innovation policies.)

Institutions of higher learning play a dual role in terms of both providing a locus for a significant share of R&D activity as well the generation of skilled labour force. It is observed that *closer links between university staff and the economy lead to stronger ties between basic research and patent applications.* Such closer links would also help maintain the skill output of universities in sync with the skill markets.
Concerning the valorisation of IPR emanating from public institutions, profits from them should be able to flow back into public R&D and generate reward to their inventors.

Unjustifiable institutional barriers should be removed to enable scientists and researchers in industries and public research institutes to work more closely in comparatively advantageous environments and thus to develop their competitiveness based on such collaboration.

**Technology, time and policy**

In discussions on the impact of new technologies on the economy, an argument frequently raised states that there is a natural limit to how fast the use of a technology can spread. The slow diffusion of electrical and electromechanical technologies and associated products during the twentieth century is often given as a typical example.

The argument is well taken in the sense that one always has to remain humble and cautious with respect to the question of how a new set of technologies may affect productivity in the whole economy. While we must refrain from excessive technological determinism, we also need to clarify how policy can affect the rate of diffusion. *A comparison between the electrical technologies and the more recent ICTs opens an interesting insight into the role that might be played by openness in technology diffusion.*

Most of the principal scientific discoveries in the area of electrical technologies accumulated especially in the last decades of 19th century, and partly in early 20th. This was an era characterised by increasing economic nationalism, isolationism in economic policy, rising trade barriers, economic blocs (e.g., British Imperial Preference, U.S. Smoot-Hawley Tariff Act of 1930s and their equivalents), competitive devaluations and beggar-thy-neighbour policies in every manner of ways - not to mention two World Wars in which most of the countries sitting around the OECD table were engulfed.

Would the speed with which electrical technologies and associated products diffused been the greater if the world economy had been characterised between 1880 and 1940, as it was in the early 19th century, and was going to be in late 20th century, by increasingly freer trade and a wide range of economic co-operation organisations (such as the OECD)? Almost certainly.

The international openness dimension is only one of the reasons why we may expect a faster diffusion of innovation today than 50 years ago, together with shorter product cycles and other aspects of business management that enable a higher velocity investment. However, the OECD could help identify the points where *policies for openness* interact more specifically with policies for innovation and growth. Presently, policy discussions in the areas of science, technology and innovation tend to be conducted within a closed autarchic economy mindset. This is partly understandable in the sense that many science and technology and innovation policy authorities typically have few international responsibilities. But, now that innovation has been recognised as a central policy issue in economic growth, and it has long been known that our economies are largely interdependent, it is incumbent upon the OECD to highlight the cross-border aspects of innovation.

Highlighting this international scientific and technological interdependence is a particular responsibility for the OECD Committee on Science and Technology Policy. Highlighting the interrelationship between scientific and technological policy and economic openness is a responsibility for the OECD as a whole.

Another openness question relates to public preparedness for innovation. The process of discovery, evaluation and application creates opportunities but involves uncertainties and risks, and takes place against a backdrop of expectations and concerns. Superficially, it seems that too much or too little openness may be inappropriate in achieving the optimal rate of diffusion and successful innovation. A
trivial example is that an unwelcoming public may seem to set back the widespread application of biotechnology. The underlying issues are of course more sophisticated, but it is clear that the question of openness needs to be explored in rather more than its economic dimension.

Specifically, the OECD could help deepen our understanding of how openness is correlated with successful outcomes in various issue areas including:

- Cross-border R&D: its importance and impact on national innovation; is there really a dichotomy between investing in national innovation and purchasing foreign technology?
- International movement of skilled labour force: how real is the threat of "brain drain"?
- Trade in technology-intensive services (e.g., telecommunications services): how this relates to the diffusion of advanced technologies and business models?
- Societal views towards technology and the mechanisms that are used to prepare people for change

"New technologies" and the challenge of balanced policy

Two new technology clusters attract particular attention: ICTs and biotechnology. Both benefited from significant government funding at basic research level. But, their recent explosive growth in utilisation was carried out in a commercial environment, in a way driven by the private sector, in ways not anticipated by the original public research. It is fair to say this at least in the case of ICTs and the Internet in particular.

In the postembryonic phase such new technologies may need, above all, an institutional environment that privileges entrepreneurship and economic liberty. That may be messy but is also creative. That requires risk-taking at the policy level.

Thankfully, that has been largely the case in the context of ICTs up to now, hence the current intense impact of the Internet.

Can we expect a similar post-embryonic evolution in other nascent technologies such as biotechnology? Or, are some sectors of biotechnology already so stifled by non-scientific political considerations that its dynamism will be constrained? The next Section focuses on the innovation-economy linkage in the particular context of biotechnology and outlines business’ views regarding policy in this area.

Biotechnology and Innovation

Genetic modification technology facilitates improvements across a broad range of human activities more rapidly, more precisely and for a broader range of attributes. On-going developments in modern biotechnology provide the prospect of significant steps forward in mankind’s efforts to tackle a multitude of problems that cause misery and delay progress for so many people globally. These problems range from illness and diseases that levy a phenomenal social and economic cost, to critical nutritional and environmental challenges. Biotechnology benefits existing sectors, as well as creation of new areas of work for small, medium-sized, and large companies alike.

However, technological innovation raises new challenges for society which demand different policy responses as societies adapt to new technologies. These choices take place in different contexts and priorities that are defined by a country’s level of development. Managing the uncertainties of innovation
through rigorous risk assessment and risk management, built on a foundation of sound science, and including transparent consultation with representatives of all members of society, ensures the most beneficial societal choices will be made with respect to technological innovation.

Biotechnology and Sustainable Development

Whether through increased economic development through innovation, or through improving the health of the population, modern biotechnology has an important role to play in sustainable development.

Business is committed to implementing the concept of sustainable development by fulfilling industry’s primary role as a vital driver for realising the vast potential benefits of biotechnology in a way that is increasingly in harmony with environmental needs while providing human and social benefits, now and in the future. Business strongly supports sustainable development and the protection of human health through its own actions and high standards of care. It is convinced that liberalised trade, biotechnology advances and effective environmental and health protection can be mutually supportive contributors to these objectives.

Biotechnology and Sustainable Agriculture

All agricultural production represents a change to the natural ecosystem in order to provide food and fibre in a productive and cost-effective manner. To be sustainable, production systems must prove their ability to maintain a certain level of productivity while minimising the threat of long-term damage or degradation to the environment or resource base.

Modern biotechnology is one new and important tool for the agri-food industry. It facilitates the improvement of a broader range of attributes in plants and food products and achieves this more rapidly and precisely than in the past. Industry sees biotechnology as offering real potential to contribute to meeting the needs of an ever-growing world population for affordable and wholesome foods produced in an environmentally sustainable way.

Business supports rigorous testing and comprehensive regulatory systems, according to generally accepted scientific principles, to ensure the safety of new products. In return, agri-food businesses expect to be able to operate in a stable environment, regulated by a framework of internationally agreed rules based upon recognised scientific and economic principles. The implications of the use of modern biotechnology are global, so it is at this level that discussion must take place and balanced and responsible policy responses found.

Biotechnology and Human Health

Biotechnology can also significantly improve the health care provided to society. For developing countries, access to vaccines and basic health care can be improved by modern biotechnology through innovative and lower cost delivery systems, such as banana-based vaccine processing. For developed countries, the ability to increase quality of life through targeted products is an important benefit not only for the aged in society, but also in relation to economic growth and sustainability.

The November 2000 OECD Workshop on Biotechnology and Ageing recognised that biotechnology can aid in the identification, treatment and prevention of diseases and disabilities, improve health and enhanced quality of life of senior citizens; decrease the burden of care provision, and reduce the economic burden of
ageing on society. Governments should ensure that their policies, especially intellectual property rights, continue to facilitate the innovation necessary to achieve these benefits for society.

In November 2002, the BIAC Biotechnology Committee published a ‘Vision Paper’, which is meant to serve as guidance to both industry and the public sector as international biotechnology is being debated and formulated. BIAC favours an enhanced role for the OECD in analysing advances in biotechnology related to a range of applications and considering its broad implications for innovation, economic growth, improved societal health and other key public policy goals. The OECD’s high-quality analytical work and integrated analysis make the Organisation perfectly suited to have a leadership role in this area.
CHAPTER V: INNOVATION IN HEALTH CARE

The health care sector is an important industry in OECD economies and a major employer. Increasingly, it is a source of high-quality jobs, technological innovation and various other knowledge-intensive activities that benefit modern societies. At the same time a well-functioning, efficient health care sector is fundamental for a stable and a coherent social climate that provides a basis for a sustained economic growth and innovation in other sectors.

Consequently, the health care sector should not be considered simply in terms of the health care expenditures it generates, but also as an important employer, consumer of goods and leader in the field of research and development. In addition, health care systems represent a service of general interest, intended to preserve the fundamental resource of modern society, i.e. human capital.

However, it can be difficult to maintain such a widened perspective at a time when many countries are experiencing increases in the level of government debt or in statutory contribution rates. and, at the same time, a growing demand for health care services. Thus, the viability of the health care sector depends on raising productivity ratios while reducing and controlling the burden of non-wage labour costs on employers. Statutory contribution rates and taxes are already too high. In the future, a greater part of services and benefits in the health care sector will need to be financed privately.

Innovation, information and communication technologies as well as new medical technology can make a major contribution to increasing the productivity of health care services and providing both higher quality and more effective treatment. New technologies can revolutionise not only diagnostic processes but also the whole health care system by improving management of clinical and administrative data and by increasing the efficiency and quality of health care service.

The following questions must be addressed in order to improve health care policy:

− How to modernise the health care system to respond to evolving requirements.

− How to ensure that the benefits of these technologies will be greater than their costs in the medium term;

− How to create a positive climate for the development of new technologies in the health care system;

Current health care systems: the necessity for change in the organisation

It is difficult to make a precise comparison between the different health care systems of OECD countries. However, there is one factor common to all systems, no matter how differently they are structured: citizens’ wish for a well-functioning health care sector. In every country the demand for health-care is growing due to factors such as ageing of the population, rising incomes, and the desire for a higher quality of life. In this perspective, a greater homogeneity in quality standards and a better level of productivity and equity of access should be considered as crucial steps towards sustainable growth. As far as services and
resources are concerned, public and private offers of medical care, whether the provision or financing of care should become more integrated.

While taking into account the challenges mentioned above, it is necessary to underline the key role governments in providing a stable infrastructure and in granting all of their citizens equal access to standard, high quality health care coverage. Within this stable infrastructure, citizens should be allowed to choose among health care agents, insurers, physicians and hospitals, either public or private. At the same time, public hospitals and private health care institutions, both non-profit and for profit, should be put on equal footing. This will enable them to develop a competitive framework that better matches citizens preferences and thus reduces waste in resource allocation and utilisation.

The objective of this trend, which can already be observed in many industrialised countries, is to bring the advantages of market efficiency to the process without abandoning the social justice guaranteed by government policy and control. Effective management and modern entrepreneurship offer the possibility to ensure the respect of human and social values while at the same time preventing the explosion of costs and the rationing of services.

To achieve the difficult balance between access for all, quality of care and cost containment, health systems must undergo reform, bearing in mind that the nature of health service is public while the actual production and functioning of the service may be either private or public. The notion of “public service” cannot be reduced to the equation between “public service = public enterprise”. In a health system where the state is able to reinterpret its role, the private sector can make an important contribution to address the many challenges health care systems are facing today. In particular, private capital can help provide additional health care facilities, both for acute and long-term care. For this, the private sector requires assurances that its role will remain stable over the long term, which is essential to encouraging private investment. Therefore the issue of financing health care is much more complex than previously thought and must to be faced with both a clear and broad perspective.

Under the systems in place today, it is increasingly difficult for governments to find financial resources to meet the growing demand for health care services. Therefore governments should strengthen their role as catalysts and regulators instead of simply that of direct owners and operators of health care facilities.

**The development of technologies in the health-care sector**

Innovation and technology are indispensable for the improvement of quality in medical assistance as well as for efficiency in health care facilities. Over the last thirty years, technologies used in the health care sector have developed exponentially, especially as far as medical equipment is concerned. Thanks to the development of electronics and computer science, machines can be equipped with the newest diagnostic tools, thus becoming increasingly powerful.

Due to their flexibility, these electronic technologies become the link between different technological sectors. With a deep integration between electronics, computer science and telecommunications technologies, we can expect the advent of a “quality jump” that will significantly benefit the health care sector. Information technology applications are gaining increased importance in the medical sector. The development of information technology will allow for such advances as: avoiding physically moving patients or medical staff by relying on the direct transfer of information through technology; accelerating response time on the part of health institutions, and reducing waste by rapidly pinpointing and activating unutilised resources.

The development of biomedical technologies is also important for the whole system of technologies used in health care and inside hospitals. The large investments made by pharmaceutical companies in
proteomics illustrate the advances that can be made in biomedical research. Instead of just searching for cures, genetic engineers are now able to study the human genome to find the causes of disease.

New health technologies can link up specific tools and machines (e.g. ultrasound scanners for diagnostic use) with networks connecting instruments, departments, and diagnostic centres and so on through a large use of information technology.

Finally, home care and telemedicine are becoming increasingly important. There is a pressing need to increase the efficiency of health care facilities, especially those featuring high-technology equipment. Above all, it is important to exploit the potentials of all health care related technologies in order to more efficiently process clinical and administrative data.

The revolution of digital technologies: the E-health revolution

Today there are new technologies enabling us to manage health care facility systems differently. New information technologies in the health care sector have helped promote the reorganisation of health care system throughout the western world and brought about many benefits.

Digital technologies have increased productivity as well as the quality of health care service starting from diagnostic screening and prevention up to care and physical rehabilitation. Today we can develop reliable and secured services by connecting together laboratories, chemists’ shops, medical care centers and private homes.

The organisational and procurement aspects of medicine have also become less costly and less wasteful. Health care facilities, hospitals/or clients of hospitals can have access to portals offering catalogues where they can search and compare a wide range of products at competitive prices. Thanks to digital technologies, medical facilities can reduce goods held in stock and thus allow for considerable cost savings.

New technologies also lead to consumer empowerment. Consumer education, informed decision-making, health promotion and disease prevention are key to improving health conditions. Examples include Web-based health information, telemedicine and consumer involvement, e.g. in monitoring blood pressure.

Thanks to all of these aspects of the e-health revolution, life saving and life quality improving innovations reach patients more quickly.

However, in spite of the benefits of new technologies, challenges remain to be addressed:

- The further development of continuity of care and increased co-operation between hospitals and general practitioners;
- The growing development of home care;
- How to supply patients with health-care service through tele-medicine;
- Ways to increase efficiency, especially in the high-tech departments (radiology, cardiology, etc.);
- How to improve patients’ clinical path by placing all the necessary information at the disposal of the patient's physicians and the facilities they are using.
The supply of tools in order to control and to monitor the whole clinical cycle inside the hospital (patient-based work-flow)

Increasing the role of out-of-hospital facilities and of general medicine (ASP, Facility management etc.)

These goals require a secure and comprehensive medical patient record, sharing of international databank information and harmonisation of medical practice standards and qualifications across the EU and beyond (e.g., to provide distance services such as telemedicine or tele-surgery).

For these goals to be reached, three important underlying problems need to be examined and resolved:

- Privacy protection
- Security in the transfer of transborder medical data flows
- Reciprocity of insurance provisions

The scenario for the application of telecommunication in the health-care sector is extremely interesting. Although difficult, it is necessary for the health-care sector to find ways to modernise itself and to promote the integration of new technologies.

**The need for an enabling environment for innovation**

To conclude, business and government must work together to provide citizens--now and in the future--with a high quality health care service. Although governments are responsible for ensuring solidarity and the universality of medical care, the private sector has an important role to play in improving quality and access to health care. In order to achieve the difficult balance between access for all and the quality of care and cost containment, the productivity of health care systems needs to be increased through innovation and a fair market for public and private health care providers and insurers.

The private sector has the flexibility to tackle structural, organisational and institutional rigidities that impede sustainable growth. It has the potential to respond to growing demand for health care and is an important source of technological innovation and quality improvement. In addition, business contributes to a more productive allocation of resources and optimises professional productivity and organisational efficiency.

Creating enabling framework conditions for investment remains crucial. Innovation is dependent upon investment, and investment relies on confidence. Governments will encounter difficulties in attracting investors in the health care sector if they do not fulfil at least two conditions: the rules for approval and reward of innovation should be open, clear and transparent, and the management and accountability of its own infrastructures should be exemplary. If confidence comes back, the private sector will mobilise resources and competencies for the development of new technologies. The potential of health technologies has never been so important. However, to succeed, the private investors need to be attracted.

In many countries, policy makers face the challenge of designing a new concept for the welfare state. The traditional concept no longer provides solutions to all the critical questions at stake. Consequently, a new “welfare market” must develop to address the many challenges concerning the production and distribution of health care services while at the same time preserving social protection and equity.
In the context of ageing societies and economic constraints, governments must take into account the institutional context and requirements for the market to work most effectively to encourage innovation and thereby generate sustainable economic growth. Therefore, priority must be given to fostering both technological and managerial innovation and encouraging competition among providers. Regulatory reform must respond to both criteria of internal coherence and external consistency within the framework of a global scenario.
CHAPTER VI: EDUCATION AND EMPLOYMENT, SOCIETAL INNOVATION IN A KNOWLEDGE ECONOMY

Throughout the series of chapters of this BIAC Discussion Paper, the magic of our central premise is its focus on the individual, which in concert, become human capital. Human ingenuity conceives markets and innovates to serve them. New technologies hold the promise for higher economic growth. However, to fully realise these gains, skills must be upgraded to match the changing labour market requirements, individuals must be mobilised to seize business opportunities and firms must adapt their organisational structures.

The quality of human capital is a key contributor to innovation and economic development and is becoming all the more important in the context of the knowledge society. As trade in services and information grows, the economy of today will increasingly call for employees with new skills and competencies beyond those in the traditional economy. Therefore, an efficient education system, adapted to the needs of the labour market, and the improvement of skills and employability are crucial to continued economic growth and increased employment.

At the same time, the uptake and diffusion of ICT and its applications, such as e-commerce, have a direct impact on business routines. As globalisation proceeds, open markets, competition and the free flow of goods, services, new technologies, capital and knowledge are creating an economy in which the speed at which transactions are taking place and information is being communicated throughout the world creates new demands on business practice, work organisation and labour-management relations.

The Growing Importance of Skills and Competencies in the Learning Process

The emergence of the knowledge economy means there is greater focus upon and recognition of the notion that people and their skills are the key to international competitiveness and sustainable growth. At the same time, it implies an increasing pace of change, for which new competencies must be acquired. To better adapt school programmes to the needs of the employment market, a careful analysis of the skills required for specific sectors/jobs and their broad commonalities is an essential step, which can be facilitated by close co-operation with the business community.

The ability to use Information and Communication Technologies (ICT) is an indispensable prerequisite for work across the wider spectrum of business. ICT skills should be a standard set of tools accessible to pupils from primary school on. Renewal of these skills and competencies should be among the main pillars of lifelong learning (LLL), starting from early childhood education and continuing throughout training in the framework of an adult's career.

Although OECD countries have succeeded in raising educational achievement levels, there are serious skill shortages due to the new demands of the current innovation-based business transformation. For example, the gap between demand for employees skilled in the application of ICT to business processes and the supply of those skills is expected to rise. The skills gap imposes costs on business in the form of lost productivity, hiring and recruiting costs and limits on growth. Educational institutions should therefore introduce new ICT curricula targeting the common needs of industry. Close co-operation with business to
tackle the skill crisis and to help define precise skill requirements, as well as partnership between industries and universities/technical institutions, are essential to deliver positive results.

While ICT skills need to be given increasing weight in today’s curricula, other basic skills, such as literacy and numeracy, must remain within the foundation of the education system. In addition to the acquisition of knowledge and the skill to handle, analyse and exploit information as well as to create new knowledge, companies need employees with good generic skills, including the ability to organise, to work in teams and to communicate effectively. Project work, self-activating learning and effective use of information resources are important elements to be added to the toolbox of learning. Personal skills derived significantly from pedagogical methods, such as a sense of responsibility, an entrepreneurial attitude and the ability to take advantage of change are the bridges to adaptation to a fast-moving work environment.

In addition to developing skills and competencies in initial education, the current and future labour force will have to acquire new skills from other sources. An economy with heavy emphasis on innovation and services requires that adults continually update their skills and competencies. Education and training systems will therefore have to offer learning opportunities targeted to groups at different stages of their lives, including young people, the unemployed and employees who are at risk of seeing their skills become obsolete due to the fast pace of change. Adaptability to technological developments will become increasingly important in work and in life in general.

Securing the Benefits from Lifelong Learning for All

Professions, old and new, are being reinvented and created rapidly, and job profiles are less stable than some decades ago. LLL is becoming more and more important as the need for re-skilling will be increasingly distributed throughout life. There is a broad realisation that a high-quality initial education prepares individuals for LLL throughout their career. For this reason, it is very important that public authorities offer a publicly-financed and high-quality initial education system as a basis for future progress. The initial education system should enable each individual to obtain the highest possible qualification according to his or her ability. Motivating students to accept change and continue learning throughout their lives should be expressed as a basic curriculum principle.

Effective transition policies are essential to facilitate smooth entry into the labour market. A flexible approach to designing pathways based on the needs of the individual, the requirements of particular industries/job markets, as well as country and regional differences are important elements to be considered. Short-term placements of students in industry as part of their university or technical institute studies should be encouraged. Although it is worth keeping a framework of well defined vocational and academic qualifications in order to have maximum transparency, those qualifications must be responsive to the velocity of developments in many sectors, which cause changing job profiles. The basic element of curricula should be complemented by a more flexible part to allow schools to adjust to the needs of their changing local environment.

Both employers and employees have a major responsibility with regard to further training. Employees need to take initiative to develop transferable skills and to be receptive to learning that is not exclusively job- or firm-specific. Employers can provide development opportunities at the workplace as well as firm- and job-specific training. Indeed, large corporations spend massively on internal training and education. In addition to initial education, Government can encourage further training by offering incentives for personal and company investment. At the same time, government has a special responsibility for those, unemployed as well as employed, who were poor performers or never reached the first level of vocational qualification in the initial education system.
Special attention should be given to the needs of SMEs. They often lack the infrastructure for internal education and training. Regional networks and initiatives of branch organisations can fill this gap. Cooperation with providers of vocational education, public as well as private, can be beneficial.

The application of ICT is an effective way of improving cost-effectiveness of the education system while at the same time increasing participation in LLL. Digital technologies can transform how, where and when learning takes place. These programmes are often more attractive as they do not involve travel and accommodation costs and are flexible with regard to timing. ICT brings to education the capacity to reach a large audience with consistent quality of content and to target groups with specific needs. The provision of education can also be made more flexible by opening up school facilities for adult training and further education and by using the potential that private providers offer. The major challenge of the 20th century was to offer good initial education to all; in the new century, our ambition should be to achieve LLL for all.

Particular attention should be paid to the concept of “life-wide” learning, which means that schools or formal training are no longer, if ever, the only places or ways to learn. There is a variety of places and methods, not the least the workplace itself and at home. We see emerging new methods, such as web-based learning, pre-school education or initial education delivered at home by cable-TV, specialised company-courses, distance learning with support of multimedia. Opening the trading system to delivery of these services will be key to the efficient diffusion of these skills globally. Much of the investment in LLL has an informal character, especially in SME’s, and does not manifest itself in surveys and statistics. Better measuring and monitoring systems are required to unveil this hidden part of personal investment. Informal learning may be difficult to define, but it promises to return considerable value in the quest to develop productive citizens. In order to make the outcome of informal learning more visible and valuable, there is a need to develop methods of assessment of learning by experience. This can also assist in the development of more targeted and efficient investments in training related activities. It also supports the employability and the mobility of the employee.

Developing Innovative Teaching and Learning

High-quality education systems are crucial to ensure an inclusive society and sustainable economic growth. In this respect, new technologies can make an important contribution. ICT has the potential to transform teaching methods by giving students more control and by offering access to an unprecedented wealth of information. Through the application of ICT, teachers can improve their students’ attention, interest and ability to retain, using activating methods. Well used, ICT enables learners to engage more directly with the subject, through interactive systems, virtual experiments and networking with other learners and teachers. To make full use of these opportunities, investment must not just be in software and hardware, but in training teachers how to use ICT in the teaching/learning process. If knowledge is wealth, its management should be as extensive, efficient and effective as any other form of investment.

Teachers are central to the reform process, which implies that their own LLL must be assured. They must keep in touch with developments in firms and society in general, for which they are preparing their students. An efficient system of training and re-training is needed to equip them for these new challenges. In order to ensure that teachers are up to date with professional developments, training must be available on an ongoing basis, including training in non-educational environments. In addition, Public Employment Services have the responsibility to provide feedback to those planning and delivering initial as well as re-skilling education.

Government policy offering new pathways to the teaching profession should be encouraged. For example, it should be possible for experienced staff to accept a teaching job in vocational education (full or part-
time), thereby sharing their practical experience with students. Although this would require additional pedagogical training, experience and high motivation should be recognised as important factors for successful teaching. In this context, schools and employers can co-operate by encouraging increased mobility between enterprises and the education system, as they are both interested in preparing students adequately for working life.

Reliable systems of accountability are needed to ensure that schools provide adequate value for money and monitor closely the various cost elements. In addition, clearly defined standards of knowledge and competencies are needed to measure achievements. The system must also provide incentives for better performance to create a rewarding system for individual schools, teachers and students. Teachers should be given the opportunity for a career which rewards good performance and offers incentives.

Maximising employment and income stability

In today’s economy, the employer/employee employment relationship has been turned upside down. Employees no longer stay with a single company for their entire career. People entering the workforce today will work for ten different organisations and change careers at least twice. A key to guaranteeing employment and income security is to ensure that employees are equipped with the skill base to easily move from one job to the next. Firms can provide high-quality work experience and set an energising context for social development, while employees need to consider the development of transferable skills and employability as a primary career goal.

Companies are shifting to a smaller core workforce, which is supplemented with a contingent workforce that has the skills needed for the current mission and marketplace dynamic. There needs to be a move from the old model that relied on individual employers to provide long-term employment and income security. Cross firm, community-based institutions are promoting mobility, lifelong learning and other services.

In many cases, regulations that hinder the mobility of employees and prevent the rapid and efficient reallocation of labour resources must be reviewed. The ability and willingness of labour to move across borders is a key factor for meeting localised skills shortages and maximising employment. Governments have to create an environment conducive to the acquisition of skills and competencies. The emphasis should be on increasing skills levels while at the same time allowing for increased mobility of labour.

Changes in work organisation and business practice

The new ICT-based technologies require more flexible labour markets. New companies start up and existing companies reorganise. Companies must invest in new working methods and introduce new organisational techniques. Governments will have to develop comprehensive public strategies that will make it easier to carry through organisational reforms in the workplace and beyond that can encourage growth in the use of ICT.

Global companies are focusing on their core business. As business structures are becoming more decentralised, the role of corporate headquarters is shifting from command and control to company governance and high-level operating policy. For decades, many international companies pursued a highly decentralised approach with regard to operations outside the home country. The intent was for operations outside the home country to be seen as national companies or local citizens. At the same time, a company might have had a more centralised approach in the home country. Today, many operational aspects of companies have been devolved to local operating entities in home and host countries. However, a centrally directed world-wide strategy is often in place within companies, including for example, company financial
reporting, currency management, marketing and sales, environment and safety-health applications, production rationalisation, research efforts, and key managerial assignments.

Dual income families are becoming the norm, which is driving the need for more flexible work arrangements that allow for better balance of work and family. These work arrangements include part-time, temporary, freelance, homework, job sharing, and tele-commuting. Flexible working time patterns initiated decades ago have become more widespread and diverse. For example, the long existing 12 hour shift schedule of the flexible work week, with the number of days worked each week varying from week to week, has expanded in design and extent of application, such as to utilisation of a work week of four 10 hour days. Flexibility in some companies has allowed employees help shape their own hours, such as hours that overlap with operations outside their home country or to meet family needs.

With the increased application of technology and telecommunications in the today’s economy, employees can be located anywhere in the world. A company headquartered in one country can have employees working for them in multiple countries half a world away. Home country operations are directly using employees in various countries for computer programming and software development. The movement from country to country of some employees, such as in technical, research, marketing and managerial work, serves to strengthen a local entity’s workforce regarding skills, knowledge and technology transfer. At the same time, there is increased international competition in the recruitment of high-skilled employees.

**Labour relations in the economy of today**

Labour relations’ laws and practices are very different from region to region. While many companies see greater benefit in individually negotiating contracts with their employees, others prefer an industry-wide collective bargaining system. However, what is clear is that whatever system is being applied, it has to be more flexible than in the past and has to offer possibilities for a quick adjustment to changing circumstance.

The economy of today requires a more flexible, decentralised approach to “managing” the industrial relations legal framework. In today’s varied workplaces, rigid regulations quickly become unworkable. Nonetheless, throughout OECD countries, there has been an increase in regulations in recent years. In 1998, the International Labour Organisation adopted with no dissenting votes a precedent setting ILO Declaration on Fundamental Principles and Rights at Work applicable to all 174 ILO member nations. The Declaration commits all ILO members to “respect, to promote and to realize…the principles concerning fundamental rights” that is the subject of seven fundamental ILO conventions. The Declaration represents a solemn commitment of the 174 ILO member nations to seek to achieve the goals and objectives, but not the detailed legal requirements, of the fundamental ILO conventions.

**Older workers**

Over the next decades, most OECD countries will experience a significant ageing of their populations, which has led to increasing concerns about the viability of our social security systems and about declines in productivity and economic growth. It is therefore essential to increase the period over which people are working.

A first consideration is that to secure employment for older workers, there must be jobs. Otherwise, there are always people who will suffer, in particular groups at the margins of the labour market. Apart from underlining the importance of creating an enabling framework for general improvements in the labour market, the following measures should be considered: Increasing the effective age of retirement; diversification of working times and work organisation; maintaining the employability of older workers;
analysing the effects of employment protection measures; encouraging more wage flexibility; promoting effective job placement

**Fostering entrepreneurship and job creation**

BIAC is disappointed that a number of countries have not given sufficient attention to the implementation of the OECD Jobs Study recommendations. The structural problems which the study highlighted still exist, and in some countries have even aggravated as persistent unemployment is still a major problem in a number of OECD member countries. BIAC has asked its member organisations to identify the main labour market problems in their respective countries. It was not surprising to learn that many employers’ organisations are facing similar problems, which among others include the following specific issues:

- Heavy burden of taxation and social security contributions, which constitute a barrier to employment, in particular with regard to unskilled or low-skilled workers.

- Over-regulation and lack of flexibility in the labour market. For example, overly rigid employment protection legislation can act as a disincentive for companies to hire due to the difficulties they encounter if the company faces serious economic problems.

- Overly bureaucratic regulations of fixed-term contracts or for the hiring of temporary workers. Both instruments should be considered as a practical way for people with lower skills to find a way into a permanent job, as companies are often inclined to integrate them into their workforce when this is possible and when they are satisfied by their performance. Greater flexibility in working patterns and work arrangements would be beneficial.

- Unbalance between the available skills and labour market demands. Close links between the education system and the labour market are necessary.

- Low activity rates of certain parts of the population (e.g., older people). Increasing employment rates will be crucial in view of the demographic challenges we face.

- People receiving income support should be actively encouraged to resume work.

These are just a few examples that show that governments need to push ahead with reforms as rapidly as possible. The OECD made an excellent contribution on how to address these problems in its 1994 Jobs Study and subsequent follow-up reports. Job growth can only be achieved if Member states implement the necessary structural reforms of their economies and facilitate policies which are conducive to greater flexibility, competitiveness and job creation. Some steps have already been taken. However, these measures frequently do not go far enough in addressing the serious structural problems that exist in most of our countries.

A key element in the sustainable growth equation is ensuring that individuals actively participate in the labour market and seize business opportunities. High administrative barriers and overly complicated regulations in the registration of new businesses add to the cost of firm creation and discourage start-ups. The creation of new businesses must be possible at competitive costs and involve regulations which are not overly bureaucratic. Governments have an important role to play in easing regulatory burdens and removing fiscal barriers. At the same time, educational systems promoting favourable attitudes toward seizing business opportunities and accepting risks can make an important contribution to encouraging entrepreneurship. Ensuring a good environment for new companies is important to growth and should be given increased attention by governments.
A sound policy framework strengthening the competitiveness of companies is an essential prerequisite for the private sector to make its full contribution to creating new jobs, and thereby to funding social networks in the future. Particular attention should be paid to encouraging self-employment and improving the conditions for the creation and growth of micro-businesses and SMEs, which play a crucial role in job creation. Economic growth and structural change, which are accompanied by improvements in public health and reforms in social welfare, are key factors for sustainable employment.

A more competitive environment must be created, in which labour markets are sufficiently flexible so that companies can match the right skills, employees and work organisations in response to changing circumstances. Companies require flexible labour markets in order to respond to changing market shifts, customer needs and competitive pressures. The overall public burden of taxation on both citizens and companies will and should be under continuous pressure.

Companies and their employees must have a capacity to innovate and be prepared to invest in new technologies and implement new organisational change. The success of technological and organisational innovation depends to a large extent on the ability of individuals to absorb change. The advent of the knowledge society, the diffusion of new technologies, ageing populations, increased cross-border movement of people and ideas will define the key challenges for education policies, work organisation and labour markets for the years to come.
CHAPTER VII: INNOVATION AND THE ENVIRONMENT – LEARNING FROM OUR SUCCESSES

Working toward sustainable growth is a key challenge for the new century. Business and industry is fully committed to advancing the complementary themes of economic growth, environmental health and social development, which benefit all sectors of society, which are, broadly speaking, our markets. Contributing to these objectives should be considered in the context of business opportunities, which requires researching and harnessing innovations in product design and manufacture, management systems, and their nexus with public policy. Increasingly complex environmental challenges will require continuous innovation in science, technology and management systems to find environmentally sustainable solutions that spur, not impede, economic growth.

Continuous improvements in environmental performance through innovation

Experience indicates that innovation can contribute to breaking the links between economic growth and environmental degradation. Upgrading technology is a prerequisite for more effective use of resources and thus improving environmental performance, which becomes all the more important in view of a rapidly growing world population. In most cases, newer technologies and processes are both more efficient and less polluting than the technology they replace, allowing increased production using less material and causing less pollution. At the same time, environmental performance often presents business opportunities that enhance firm-level efficiency.

Technology development depends on the effectiveness of the R&D efforts both in the public and private sectors. While government efforts are key, most non-defence R&D takes place in the private sector. There are continuous, robust industry research programmes under way in the areas of materials, materials management, process engineering, etc., which are focused on the efficient and cost-effective use of product inputs and natural resources. Public policies need to take into account both the potential and the complexity of these environmental innovations, as well as of the flexibility, support and incentive structure that encourages firms to innovate and diffuse new technology, bearing in mind that commercial success depends upon carrying out business in value-creating ways.

Business opportunities through better environmental performance

Firms that give priority to resource productivity, process change and product innovation can achieve significant performance gains at lower cost. A competitive firm must have as robust a programme of cost reduction as it does in the pursuit of market share. Strategies to improve performance often also reduce negative environmental impacts. The first point of departure is to search for ways to reduce the use of inputs or materials and natural resources. Another focus is on the reduction of energy use. Lower costs, driven by competition, bring prices down and can in many cases improve environmental performance. More efficient production processes and products through innovation and a reduction in resource use and pollution can be mutually reinforcing objectives.
Offer a sound regulatory framework for innovation

The market depends on a stable and supportive framework of public policy. Business benefits from regulation that is predictable and consistent, but not overly prescriptive. It is critical that the regulatory framework encourages innovation and fosters beneficial technological change. Given the economic, environmental and social importance of innovation, regulatory programmes need to fully take into account the effects of regulations on the development of new technologies. This can involve the revision of a single regulation, a regulatory regime, or the improvement of processes for managing reform. Regulatory reform to increase competition and encourage new market entrants is key to innovation. Policies need to be flexible and incentive-based and be designed to stimulate dynamic efficiency. Innovation policy approaches need to look for creative ways to enhance co-operation across sectors, from research & development to commercialisation, as well as public-private partnerships to meet particular research challenges.

Use market-based incentives as a tool for environmental improvement

Regulatory programmes that take advantage of market forces can achieve impressive environmental results with lower transaction costs and fewer prescriptive requirements than traditional approaches. These tools – which rely on marketplace incentives rather than direct, command-and-control requirements to achieve environmental performance – need to be extended to a wider range of pollution control and prevention programmes. Innovations in product design, pollution prevention and resource management will work best in a regulatory system that builds on business's proven success in meeting requirements through investments in science, technology and process innovation. Fiscal policies need to provide incentives, e.g. lower statutory rates, R&D credits or deductions, for firms to invest and innovate, thereby improving environmental performance. For instance, an R&D credit that leads to particularly successful innovation in environmental technology, with the agreement of the environment and finance ministers, could be raised to some multiple or transformed into an ongoing, repetitive deduction.

Develop policies and strategies that focus on performance

Drawing on many recent innovations in environmental stewardship that have emerged from government and the private sector, public policies should foster a culture of performance-based management. This culture would focus on defining, measuring and rewarding environmental results and reorienting core regulatory functions so they are driven primarily by performance goals. Policies need to set clear, transparent goals that establish desired environmental outcomes and give business greater flexibility in determining how to achieve these outcomes. Regulatory renewal and a performance focus by industry to effectively track and communicate progress should also be encouraged.

Support voluntary actions in environmental policy

Industry relies on innovation to improve production efficiency and reduce environmental impacts. Voluntary actions represent a promising approach with respect to many environmental problems. They are based on a comprehensive consideration of technical trends and other management-related issues and allow those with the best knowledge about their own business to propose and execute measures that are effective from a cost-benefit standpoint. Especially compared to other more prescriptive policy tools, they provide a flexible framework for innovation and creativity that allows for new approaches, the opportunity to improve environmental competitiveness and more rapid changes than would be possible under mandatory programmes. In addition, they promote awareness of existing and new technical management practices and encourage the dissemination and implementation of effective technologies. Improvement in actual
performance will more easily occur through private sector initiative and invention than through imposed
government constraints, which do not allow the flexibility needed for ongoing progress. Business should
be encouraged to play its part.

**Promote environmental innovation world-wide**

The advance of democratic governments, the rule of law, market liberalisation, and international
communication have made more vivid the linkages between environmental, social, and economic values.
These trends have created significant benefits for society through greater wealth, freedom and mobility,
increased opportunity, and improved access to products and services. Economic growth permits higher
environmental and living standards world-wide. The global diffusion of the market-based economy has
brought with it an algorithm of value that has led to serious efforts to combat domestic corruption and
improve the implementation of existing regulations, both of which have had significant benefits for the
environment and society at large. As national regulations are further developed, policies should be
designed that promote innovation and the absorption of technology and thereby reinforce improved
environmental performance.

**Encourage the transfer of environmentally friendly technologies**

The development and application of environmentally friendly technologies and know-how are already
making a significant contribution to reducing the environmental impact of economic activities. The spread
of innovative approaches to non-OECD countries will be crucial for environmental improvements. The
main vehicle for this form of co-operation between industrial and developing countries has been and will
continue to be the private sector, through its day-to-day business activities of technology development,
foreign direct investment and technology sales and dissemination. The development impact of foreign
direct investment goes beyond its monetary value and includes positive side-effects such as the transfer of
environmentally-friendly technology and know-how and the spread of efficient management practices.
This is due to the managerial links between parent and subsidiary and the advantages of employing
comparable environmental procedures throughout a multinational firm’s operations. Trade and investment
liberalisation is therefore essential to speed the transfer and diffusion of clean technologies. Governments
should set enabling legal, fiscal, economic and social framework conditions for private investment and
technology co-operation to take place.

**Develop new forms of dialogue and partnerships**

Establishing a sound dialogue with those who have a stake in these issues will become increasingly
important. Efforts should be made to create public/private partnerships to meet particularly difficult
research challenges and stimulate investment in environmentally beneficial technologies. These should
include processes for business and government collaboration and supportive incentives for private sector
R&D in environmental technology. Dialogues that follow the “life chain” of products, from producer to
consumer, may create a better understanding of the range of possibilities and consequences. Dialogue and
partnership can also help to increase public understanding of complex subjects, such as technological
change, and raise awareness of the fact that a broad base of action is needed to involve all parts of society
to work towards sustainable development.
CHAPTER VIII: INNOVATION IN ENERGY

The fundamental importance of energy for global sustainable growth

Energy is the motor of societal and economic development for an ever-increasing world population and an essential ingredient of sustainable growth, the key guarantor of our societies’ future economic and social well-being. Societal and economic development can be attained only if a secure, reliable and affordable supply of energy is ensured. Energy also contributes to societal development by improving public health and is essential for alleviating poverty. As these different dimensions are intrinsically linked, policies for achieving sustainable growth need to strive for a balance among the various dimensions and their interactions between them.

Energy is a driving force of modern civilisations. Access to reliable sources of electricity and energy is an especially fundamental concern of many developing countries, who must have access to the prosperity unleashed by the market economy. Major challenges lie before us to ensure a secure and reliable energy system for all, which on the other hand implies increasing pressure on existing energy supply systems.

The current energy system is not sufficiently developed to support economic growth throughout the world, and the growing requirements of OECD non-member countries create major challenges for global security. Economic growth will continue to fuel strong energy demand, including on the part of developing countries. This emphasises the importance of ensuring such growth is met in as sustainable a fashion as possible.

Innovation and the transfer of energy technology to developing countries are therefore of crucial importance. While governments continue to have an important role to play in fostering technology that can help address these challenges on a global level and in offering a framework of well-functioning and competitive markets, the engagement of the private sector is crucial. Business has an essential role to play in innovation and in the global dissemination of technologies that can help meet the challenges ahead.

Keep all energy options open

Maintaining a stable supply of energy is a core objective in the pursuit of sustainable growth. No radical changes in energy trends are likely to occur in the near future, as market penetration of energy systems is a very long-term process. New technologies, changes in capital stock and institutional reforms take time to have a major impact on the global scale. Therefore, there can be no sudden changeover from existing major energy systems to new ones.

Energy resources are plentiful, but their regional endowment and the pace at which they are developed and distributed may not be entirely satisfactory. Long-term energy security calls for a balance between energy sources in order to reduce exposure to sudden problems. Therefore, the continuing diversification of our energy systems needs to be supported. National circumstances and policies will determine the mix of fuels – oil, natural gas, coal, nuclear or renewable energy – which is necessary to contribute to energy security and sustainable economic growth.
While fossil fuels will continue to meet the greatest share of our energy needs, renewable energy offers alternative sources of energy and has a role to play in this energy mix. However, it is often still a very expensive alternative and needs to become much more competitive. In addition, large amounts of land are needed for the market penetration of wind and solar energy, for example. The productivity of the earth with respect to specific natural resources must be taken into account. Non-renewable resources can often produce more wealth per unit of land used compared to so-called renewable resources. This is a consideration that should be included in issues related to the most effective use of land resources as well as the protection of natural spaces, biodiversity, the footprint of society and a sound balance between food production, energy and the environment.

In its contribution to the OECD horizontal project on sustainable development, the Nuclear Energy Agency (NEA) presented an excellent analysis of the role of nuclear energy in a sustainable development perspective, highlighting the opportunities and challenges that lie ahead in this respect. Overall, there is a growing recognition that nuclear energy use, when properly regulated and managed, has an important role to play in the pursuit of sustainable growth and in ensuring the security of energy supplies and the stability of energy prices. In addition, non-carbon sources, such as nuclear energy and renewable energy sources, can make an important contribution to reducing emissions.

The importance of innovation for a sustainable energy future

Today’s challenge is to support world-wide economic growth with a secure and reliable energy supply while at the same time taking into account environmental concerns. Large-scale energy efficiency improvements take time and require a policy approach that is transparent and consistent. Innovation, research, development and deployment will be needed to bring about new energy technologies to address these challenges. Upgrading technology is a prerequisite for more effective use of resources, which becomes all the more important in view of a rapidly growing world population and the future energy needs of the developing world.

The path towards a future of sustainable energy must be continuously redefined and re-balanced with the development of new technical solutions and technologies. Providing support for innovation and technological change in the area of increased energy efficiency will be of crucial importance. Moreover, to come into widespread commercial use, currently non-commercial energy technologies will have to become able to compete in the marketplace against improved versions of existing technology.

However, premature turnover of capital stock and forced obsolescence of viable technologies can result in high economic and human costs. Therefore, while this evolution of technology is ongoing, it is unrealistic to expect a rapid transfer from existing major energy systems to new ones. Consequently, strong research, development and deployment efforts are needed to incubate and advance new energy technologies and systems that will complement existing infrastructures and approaches.

Current investment in research and development, in both the public and private sectors, needs to be encouraged to surpass the obstacles ahead. As innovative developments can take a long time, Governments have a particular responsibility in the area of early, speculative R&D. The challenge will be to work towards improved energy efficiency, a more efficient use of energy and the development and diffusion of new energy technologies.

Technology will affect the choice and costs of future energy systems. Because of the importance of energy to sustainable growth and the need to meet increasing demand for energy services while reducing overall environmental impacts, continued research & development by both government and industry will be essential. Innovative developments will determine the impact of energy over the next decades.
Improving energy efficiency

Industry works continuously to improve existing processes and products to achieve competitive advantage. Technological progress and, in particular, improvements in energy efficiency have the potential to achieve progress towards sustainable growth. Many industry sectors are tackling energy efficiency and have in many cases achieved major results. Besides direct efforts to improve efficiency, efforts to reduce waste and conserve resources also promote more effective energy use. Both financial and environmental management systems drive continuous improvements in these areas.

Attempts to save energy often lead to challenges about the way that work is carried out and to new approaches that improve the overall efficiency of the company. Improving energy efficiency is a complex challenge, which involves, among others, taking a close look at the use of energy sources and technologies, choices, waste generation, transport, requirements in the area of heating, lighting and others. The improvement of energy efficiency can provide substantial benefits to companies as well as to individual consumers and has the potential to reduce costs and increase productivity, in addition to minimising the environmental impact. Continued research and development are crucial and need to be further supported to make this happen.

Innovative energy technologies

On its own and working with others, industry is the major source for research, development and deployment of innovative energy technologies. Many examples illustrate this trend over recent decades. New materials and technologies, especially combined cycle gas turbines, have led to significant improvements in the efficiency of electric power production. Hybrid vehicles, improved conventional engines and design, and new materials have substantially improved fuel economy in all classes of vehicles. New engines and fuels have dramatically reduced tailpipe emissions from vehicles. Three-dimensional seismic exploration and extended reach drilling have fundamentally transformed strengthened and transformed the outlook for economically viable petroleum resources.

Similarly, continuous improvement in technology for extraction and processing of tar sands has made these vast resources commercially viable today so that they are now a growing part of the mainstream supply of liquid hydrocarbons. Substantial improvements have occurred in renewable power technologies, especially wind and solar. Advanced technologies and regulatory improvements have led to an expansion of combined heat and power at many industrial facilities. And advances have occurred in hundreds of end-use applications from appliances to insulation and building design.

Extensive research, much of it proprietary, proceeds for innovative technologies that could substantially alter major sources of energy supply and use and associated emissions. Fuel cells hold promise of substantial efficiency gains and pollution reduction in a variety of end-use applications from heat and power for buildings to transportation. Carbon capture and disposal could dramatically reduce CO₂ emissions from power plants and factories and could open the door to innovative technologies to generate hydrogen without CO₂ release.

New processes and genetic engineering could improve prospects for power and fuels, including hydrogen, from biomass. Advances in super-conducting materials could significantly improve techniques for energy storage and distribution, and thus enhance prospects for intermittent renewables such as solar and wind. However, more research will be required to bring any of these technologies to commercialisation, and deployment will require massive investment and development of associated infrastructure over many decades. In addition, scientists in academia and government laboratories for years have been considering innovative, challenging approaches that remain much further off before they could become commercial.
Nonetheless, breakthroughs could make them viable in the future. These include R&D, for example, related to fusion, space-based solar technology, and geo-engineering to capture CO₂ directly from the atmosphere.

**Offer a supportive public policy framework**

Addressing the need for energy accessibility, availability and acceptability is fundamental to achieving a sustainable future for the world. The energy industry in all of its diversity is a key provider of wider accessibility to commercial energy services, of the availability of uninterrupted power supply, and of more socially and environmentally acceptable energy products. The speed, scale and nature of these developments depends in part on enabling frameworks provided by government in establishing free, fair and stable markets, the wishes and support of other social actors, and the deployment of the required technologies and financing. Governments have an obligation for well-functioning and competitive markets.

Mobilising the investment for the development of energy infrastructure is a major challenge and will require the lowering of regulatory and market barriers. Governments have a crucial role to play in encouraging competition among markets and suppliers, improving market access, liberalising trade and promoting enabling conditions for energy technology development, dissemination and improvement. The rapid spread of regulatory reforms and institutional changes in certain parts of the energy sector has the potential to create new prospects for innovation, lower prices and increased growth. Although market reform can imply a difficult transition period before the full benefits are realised, regulatory reform can lead to important gains in efficiency, lower supply costs and promises to deliver long-term benefits worldwide.

Governments need to offer a stable and consistent framework for decision-making, which includes incentives to stimulate sustainable choices. Public policies need to take into account both the potential and the complexity of these innovations, as well as of the flexibility, support and incentive structure that encourages firms to innovate and diffuse new technology. Furthermore, local governments have an important role with regard to urban development and long-term infrastructure planning.

Business benefits from regulation that is predictable and consistent, but not overly prescriptive. It is critical that the regulatory framework encourage innovation and foster beneficial technological change. In this context, the role of voluntary initiatives and agreements and emissions trading should be underlined. With a conducive framework, the private sector can play a powerful role in driving technological progress and bringing energy services to the developing world. Structural change as well as innovation and technological progress have the potential to arrive at solutions that address economic, social and environmental challenges at the same time.

**Addressing climate change**

Energy accounts for the majority of total greenhouse gas emissions in the OECD, and there is a growing contribution to greenhouse gas emissions from developing countries. Actions to control these emissions will have a significant impact on our energy policies. We can tackle this major environmental challenge in a number of ways, such as increasing energy efficiency, fostering renewable and nuclear energy and encouraging less energy-intensive production and consumption patterns. However, it is essential to consider the trade-offs between the economic, societal and environmental considerations to decide on the role that the various energy options should play in a country’s energy mix. Fostering innovation and technology is of crucial importance.
Strategies to reduce greenhouse gas emissions must be achievable and be designed in a sustainable growth context. By maximising flexibility, voluntary initiatives and flexible approaches, such as emissions trading, have an important role to play in the policy mix. Any climate change policies to be adopted need to take into account a number of criteria to guide the complex response that is required. They must be cost-effective, credible and consistent with a wide range of economic, societal and environmental objectives. An engaged business community is essential to successfully tackling the climate change challenge, while at the same time the responsibilities of all parts of society in affecting climate change have to be addressed in an equitable and efficient manner.

Since the effects of climate change are of global nature, climate protection policy must be addressed worldwide, and measures to protect the climate must not distort international competitiveness. Therefore, it is important to include steps to improve the ability of developing countries to reduce emissions, while at the same time recognising their needs for economic development. The main vehicle for this form of cooperation has been and will continue to be the private sector, through its day-to-day business activities of technology development, foreign direct investment and technology sales and dissemination. Technology dissemination, technical assistance and co-operation with non-member countries will be especially important in the light of the growing demand for energy in those countries.

The importance of international co-operation

The growing importance of non-OECD countries in global energy consumption has important implications for global supply issues and environmental consequences. The private sector has an important role to play in helping to provide electricity to those people currently without access through foreign direct investment and through this, technology transfer. Private sector foreign and domestic capital is the major source of finance for energy-related infrastructure investments in developed and developing countries. At the same time, it has to ensure the operation of energy equipment under high safety standards, taking into account environmental considerations.

Governments have to create appropriate conditions for a well-functioning and competitive market. To attract foreign investment, developing countries need to set enabling legal, fiscal, economic and social conditions for private investment and technology co-operation to happen. With the correct regulatory, legal and economic framework in place, OECD-based companies - applying their experience and expertise in both home and foreign markets - will continue to contribute to economic prosperity while at the same time improving the environmental performance of their operations. The OECD, and its subsidiary bodies have an important role to play in this respect.

In addition to its participation in the important committee work of the OECD, BIAC works closely with the IEA on several key issues and recently started a very constructive dialogue with the NEA. International co-operation is important to exchange best practice on and ensure good safety standards in the operation and maintenance of energy equipment and putting in place appropriate mechanisms to respond to potential failures.

The IEA plays a crucial role in promoting rational energy policies in a global context through co-operative relations with its members, non-member countries, industry and international organisations and in contributing to improving the world’s energy supply and demand structure. The NEA is the only inter-governmental nuclear energy organisation which brings together developed countries of North America, Europe and the Asia-Pacific region in a non-political forum and has an important role to play in pooling this expertise and address nuclear energy issues in the context of sustainable growth.
International co-operation is especially relevant to enhance the overall efficiency of national efforts and facilitate technology development. Governments and industry can benefit from pooling resources and working together. International organisations, like the OECD, NEA and IEA have an important role to play in this regard, and business greatly appreciates the opportunity to work closely with them.
ANNEX TO CHAPTER VI: INNOVATION AND THE ENVIRONMENT – LEARNING FROM OUR SUCCESSES

Business Practises Contributing to Success

Companies have begun to take a pro-active stance towards the environment, recognising the value proposition that this implies and the potential economic reward in efficiency. The following examples illustrate the contribution that specific sectors and companies have made, for example, in the area of greenhouse gas emission reduction and the reduction of resources used per output unit. All of these industries rely on innovation to improve production efficiency while at the same time reducing environmental impact.

Voluntary reduction of Perfluorocarbon by-products from the Aluminium sector (IAI)

The Aluminium industry plays its part in responding to the challenge of climate change by reducing its own energy consumption and emissions through more efficient production and recycling. It also contributes to energy saving and emission reduction in key sectors of the global economy such as transport, packaging and construction. It has been one of the first industrial sectors to reduce voluntarily significant amounts of greenhouse gas emissions from its internal operations. PFCs are one of the few greenhouse gases which are actually in decline. A recent IAI Survey of PFC emissions covering over 60% of the world's primary aluminium production, excluding Russia and China, showed that in the seven years between 1990 and 1997, there was an overall reduction of 47% in the specific emission rate of CF4 (kg per tonne of aluminium production).

Reduced mass weight of vehicles by material substitution (IAI)

The Aluminium sector assists its customers in the transportation sector to achieve their goals of producing vehicles that will emit lower greenhouse gas emissions. Aluminium’s contribution to reducing vehicle weight and therefore fuel consumption means that every tonne of aluminium, which replaces 2 tonnes of conventional heavier materials used in automobiles saves the equivalent of 20 tonnes of CO2 emissions over the lifetime of the average automobile. Other applications such as trucks, buses, railroad cars, air crafts and ships contribute even larger GHG savings. The global use of aluminium in transport has increased from 2.5 million tonnes in 1991 to nearly 4.5 million tonnes in 1999. This use of aluminium for 1999 would have
the potential over the lifetime of the vehicles to reduce GHG emissions by 90 million tonnes per year assuming that all this aluminium was used to replace denser materials.

**GHG emissions reduction and energy saving through the recycling of materials (IAI)**

At the end of their useful life, aluminium products can be recycled again and again to produce new products without any loss of value. The increasing use of recycled metal saves on energy and the mineral resources needed for primary production. It can therefore over time make a major contribution towards the goal of sustainable development through the reduction in the use of energy and raw materials and by cutting down on greenhouse gas emissions. Recycled aluminium saves up to 95% of the energy required to produce primary aluminium. Greenhouse gas emissions from secondary production are only 5% of those from primary production. Just over 7 million tonnes were recycled in 1998 worldwide, which fulfilled 20-30% of the global demand. The aluminium industry is working with the automobile manufacturers to enable easier dismantling of aluminium components from cars to improve still further the sorting and recovery of aluminium.

**Shell's greenhouse gas emission reduction**

Shell’s greenhouse gas emission strategy is best understood in the context of fundamental changes in the company’s approach to its world-wide operations, which took place in the mid 1990’s. Two main changes include:

- the view that sustainable development encompasses all of financial, social and environmental aspects, and is an integral part of all business decisions

- a revision in business principles towards openness and transparency. This included a decision in 1997 to monitor and report 24 key health, safety and environment parameters, and to have 12 of these verified by an independent agency

For GHG emissions we have set ourselves an absolute emission reduction target of 10% over 1990 emission levels by 2002. We have also developed an internal emissions trading system, the Shell Tradeable Emission Permit System (STEPS) and have developed a CDM demonstration programme. In 2000, Shell’s GHG emissions increased slightly, mainly as a result of higher production. GHG emissions are now 11% below 1990 levels in line with the reduction target. Shell is achieving its emission reductions primarily through the reduction of venting and flaring of natural gas associated with oil production, and energy efficiency in refineries and chemical plants. Continuous venting will be phased out by 2003, while continuous flaring will cease by 2008.

**EnviroEngine technology makes seafaring environmentally friendly (Wärtsilä)**

The Finnish company Wärtsilä has developed a totally smoke-free EnviroEngine marine power plant based on its 4L6D engine. The technology employed in the engine makes it smoke-free even at low revolutions or when used in port for lighting, air conditioning or other crew quarters systems. EnviroEngine diesel engines go well beyond international emissions standards.

Wärtsilä will deliver the first engine for the Carnival Spirit cruise liner about to be completed in the spring of 2001 at the Kvaerner Masa-Yards Helsinki shipyard. Engine orders have also come in from Portugal and Italy. Wärtsilä developed the engine in co-operation with the U.S.-based Carnival Corporation. Wärtsilä is the world’s leading maker of ship propulsion systems and a significant provider of power plants for
dispersed energy production and of maintenance and operating services. The consolidated group also includes a Nordic specialty steel producer. Wärtsilä employs 10,500 persons, 3,500 of whom work in Finland. Consolidated net sales totalled EUR 2.7 billion last year.

*From Vision to Reality: The “Three-Litre Car” (Volkswagen)*

The vision of sustainable development and sustainable mobility has increasingly developed into an important global challenge for international auto-manufacturers. As a global player, the Volkswagen Group accepts its responsibility in achieving this vision. The VW Lupo 3 L TDI, the world’s first serial production made car capable of consuming only three litres of fuel per hundred kilometres, stands for the Volkswagen Group’s determination to make a direct contribution towards sustainable mobility. The launch of the “three-litre car”14 in summer 1999 has been a major step in fulfilling Volkswagen’s voluntary commitment to reducing the volume of CO2 emissions. It also contributes to the German automobile industry’s joint voluntary undertaking to reduce the average fuel consumption of new cars by 25 percent between 1990 and 2005. The “three-litre” Lupo is the first passenger car that easily outperforms the target of 90 grams per kilometre for carbon dioxide emissions.

Volkswagen has developed the “three-litre” Lupo with the aim of creating a passenger car that uses as little fuel as possible but still has a full equipment specification and also complies with the company's own high standards of safety. Numerous innovations have been introduced in the Lupo’s engine, transmission, running-gear, body and aerodynamics areas. Features include systematic weight-saving design and construction, an optimised aerodynamic drag coefficient of only CD =0.29, tyres with reduced rolling resistance and an extremely economical power train. When the engine was developed, the main objective was to create not only an exceptionally economical unit but also one with adequate power for this class of vehicle, and in this way to ensure that fuel consumption in the MVEG cycle did not exceed 2.99 litres per 100 kilometres. The “three-litre” Lupo is powered by a three-cylinder turbocharged diesel engine with charge-air intercooler, using the pump/ injector mixture formation principle.

The engine has a start-stop circuit, meaning that it shuts down automatically after the car has come to a halt, and restarts when the accelerator pedal is pressed. It enables the engine to run for longer periods in the most favourable fuel consumption and emission speed ranges. The 5-speed direct-shift gearbox is one of the principal components used in the “three-litre” Lupo. Its simplicity compared with a conventional automatic transmission, the measures taken to reduce weight and the improved efficiency obtained with freely selectable shift points all lead to a definite reduction in fuel consumption. The market as well as press and environmental organisations have paid significant attention to the Lupo: The German Association for Transport and the Environment (VCD), an environmentally committed NGO, evaluated the performance of the Lupo 3L TDI. This organisation compares the environmental performance of all production models available on the German market every year, awarding points for the environmental and health impact of vehicle emissions. The Lupo 3L TDI is top of the current 2000 “Cars and the Environment” table, as it was in 1999.

*Diesel Technology Innovations: The Diesel High Direct Injection (Hdi) (PSA)*

The Hdi is a high-pressure direct injection engine combining common rail technology with state-of-the art engine architecture and electronics. It is one of the “cleanest” engines on the market today. The combustion system of the Hdi engine is one of its strong points. It comprises two key components:

14 This figure does not of course refer to its engine size but to the amount of fuel the car needs to cover 100 kilometres, according to the European method of measuring fuel consumption.
− The high-pressure injection system, comprising the high-pressure pump, the common feed rail and an electronic control unit. Electronic management of the injectors makes it possible to inject fuel at very high pressure.

− The combustion chamber, designed specifically to optimise the air-fuel mixture. This system ensures extremely fine atomisation of the fuel in the cylinder for clean, complete combustion.

The common rail technology, combined with completely new engine architecture, reduces consumption by around 20 % compared with a standard indirect injection diesel engine with pre-combustion chamber and by 40 % compared with a petrol engine. Exhaust emissions are also substantially reduced, since high-pressure injection ensures more “complete” combustion whatever the engine speed. In comparison with a conventional diesel engine with a pre-combustion chamber, The Hdi engine offers a reduction of:

− 40 % of carbon monoxide emissions,
− 40 % of unburned hydrocarbons emissions,
− 60 % of particulate emissions.

The high-performance Hdi engine also enhances driving pleasure, with more torque at low engine speed, less noise and less vibration.

**Diesel Technology Innovations: The Particulate Filter (PSA)**

Designed for use with the Hdi engine, the particulate filter works with the electronic system managing the engine’s fuel supply. A major technological breakthrough, the filter sweeps away any hesitations concerning the use of diesel engines by reducing particulate emissions to the detection threshold. The filtering process is simple. It relies on a porous silicon substrate comprising a number of channels to force exhaust gases through the walls. The most significant technical obstacle to be overcome during the development phase was the problem of filter regeneration, since particles must be burned at a temperature of roughly 550°C. A cerine-based product was added to lower the combustion temperature to 450 °C, but even this is not sufficient, particularly in city driving, as the temperature of diesel exhaust gases is around 150 to 200 °C.

This is where the Hdi engine comes into play: the electronic management system injects fuel during the expansion phase. The resulting post-combustion boosts the exhaust gas temperature to about 450 °C, thereby allowing the filter to be regenerated. This post-injection also produces additional unburned hydrocarbons, which are treated by the oxidizing catalyst located upstream of the particulate filter.

The particulate emissions of a 607 with a particulate filter are around the measurable limit: 0.004 g/km (the particulate emission limit in the European legislation is at the moment: 0.05 g/km). Several independent European laboratories verified this performance.

**Eco-Design Contributes to Sustainable Development (ATOFINA)**

The inherent properties of Orgalloy® (polyamide-polyolefin alloy) make it suitable for the manufacture of lubricating oil and air supply lines. In the latter case, Orgalloy® is processed by sequenced extrusion blow-moulding into a single component combining flexible and rigid parts. Air lines for turbo-diesel engines have traditionally consisted of some 20 different parts made from metal, rubber or plastic and joined
together by mounting rings and clamping screws. They are now being replaced by a single component made of just 3 parts produced from two Orgalloy® grades. As a result, the weight of the pipe has fallen from 2.5 kg to 1 kg, which compounds the weight reduction afforded by the use of plastics in many automative components, and therefore further contributes to fuel savings throughout the car’s life.

**Electro technologies (EDF)**

The utilisation of electro-technologies is a means of reducing energy consumption, pollutant emissions and wastes. Therefore, it greatly contributes to sustainable development. As an example, in the cast iron industry, two processes are in competition: the cupola furnace uses 150 kg of coke per ton of scrap and therefore emits 520 kg of CO2/t. The induction furnace needs no coke but 600 kWh of electricity per ton of scrap. The corresponding CO2 emission would be 264 kg/t if an average European kWh were used and is only 60 kg/t in the French case (because of the very low CO2 content of electricity). In France, the CO2 savings due to the 40% market share of induction furnace are currently about 350 000 tons of CO2 per year. If a market share of 75% is reached, the additional savings of CO2 emissions will be 300 000 tons per year. EDF has made a large R&D effort in this field with vendors and has participated in several pilot projects.

**Designing an environmentally sensible chlorine alternative to imitate naturally occurring antimicrobials**

STABREX™ Microorganism Control Chemical15 is the first biomimetic industrial biocide, having been designed to imitate the stabilised bromine antimicrobials produced in mammalian immune systems. STABREX is original and unique: It is the first biomimetic industrial biocide and it is the first stabilised liquid bromine product ever developed. Scientific validity and commercial significance have been recognised by industry observers and featured in the press. Competitive imitations of the product in development further confirm the importance of the innovation.

Far more chlorine is used to control microbial fouling in industrial water compared to any other chemical. An environmentally sensible chlorine alternative is needed because handling the gas is hazardous, the liquid is not stable, combined residuals are not effective, free residuals do not control biofilms, and disinfection by-products are toxic. STABREX is an order of magnitude that is less toxic, less volatile, easier to handle, more compatible with other water treatment chemicals, more effective against biofilms, and generates less than half the disinfection by-products compared to chlorine or other alternatives. Replacing seventy million pounds of chlorine from use in the field with STABREX since commercial introduction in 1997 has reduced environmental and human health risks. Four hundred billion gallons of industrial water have been successfully treated worldwide.

**New-generation fluorine-containing compounds with low environmental burden**

Nippon Zeon Co., Ltd. and National Institute of Materials and Chemical Research (NIMC) have recently developed jointly ozone non-depleting fluorine-containing compounds, i.e., heptafluorocyclopentane useful for cleaning solvents and octafluorocyclopentene for dry etching gas in semiconductor manufacturing. Both compounds show zero ozone depletion coeff., and Nippon Zeon/NIMC were awarded with the Stratospheric Ozone Protection Award from the US EPA in 1998 for the development of the former material.

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15 STABREX™ is a trademark of Nalco Chemical Co., Naperville, IL.
Re-use of recycled PET for raw materials of alkyd resin coatings

Kansai Paint Co., Ltd. has recently developed the technology to manufacture alkyd resin coating materials from recycled PET resin. Kansai is operating the plant since October 2000, with the capacity to process 100 ton/month of recycled PET resin, expecting 500 ton/month soon.

Thermal decomposition of nitrous oxide gas

Asahi Kasei Corp. implemented the new technology in 1999 to thermally decompose nitrous oxide gas, which is produced in the process of manufacturing adipic acid from cyclohexanol by using nitric acid. Nitrous oxide has 310-folds of greenhouse effects vs. carbon dioxide and is produced 0.25 ton per 1 ton of adipic acid production. The technology contributes to 1/20 of the national target of greenhouse gases reduction which was set by the Kyoto Protocol.

Bio-based materials for industrial processes

DuPont is working to meet the needs of more people with fewer materials and less energy, and has set an important goal of gaining 10 percent of energy needs and 25 percent of its revenues from renewable resources by 2010. Biotechnology has allowed the development of polymers from corn starch. DuPont is now looking for a number of industrial applications to use specialty corn starch developed through this new process. DuPont Sorona(tm), a bio-based polymer used to create fully recyclable fibers from renewable resources, will be available by 2003. A pilot plant test to produce the key raw material from corn starch is now underway in Decatur, Illinois. Other bio-based materials for industrial applications are down the road: Bio-based clothes and plastics: New processes that make fully recyclable fibers, clothes, and plastics from renewable resources such as corn. New consumer-friendly products: New building blocks for polymers from fermentation processes, thereby creating materials with enhanced performance (lighter weight, stronger).

Réduction des émissions de SO₂ (Lafarge)

La cimenterie de Retznei est située dans le sud de la Styrie. Les matières premières qui l’alimentent proviennent des carrières voisines de Rosenberg et de Haupstock. En raison de la forte teneur en sulfure de fer de ces matières premières, la cimenterie de Retznei présentait un niveau de SO₂ relativement élevé. En 1997, celles-ci dépassaient 400 mg/Nm³. Elles pouvaient donc, dans cette région touristique, avoir des effets néfastes sur les forêts et les vignobles environnants.

Après avoir étudié plusieurs solutions possibles, Lafarge Perlmooser a opté pour le traitement des fumées du four au moyen d’un laveur humide. Ce procédé, en utilisant les poussières du four comme réactif pour capter les vapeurs soufrées, représente une innovation. De plus, il génère comme sous-produit de la désulfuration des fumées du gypse qui est intégralement valorisé dans le procédé comme ajout lors du broyage du ciment. La mise au point de cette technologie a bénéficié des compétences et de l’expertise du Centre Technique pour l’Europe Centrale (CTEC) du Groupe, basé à Vienne. Depuis la mise en service du nouveau filtre en mars 1998, le taux d’émission a été réduit de moitié. Avec moins de 200 mg/Nm³, les émissions sont d’ores et déjà très inférieures à la future norme autrichienne. Cette performance traduit la volonté de Lafarge Perlmooser de jouer un rôle moteur au sein de la profession en terme de protection de l’environnement en Autriche.
Application of cogeneration in the milk produce transformation industry

(example provided by Gaz de France)

Description: Cogeneration enables heat and mechanical energy to be produced simultaneously from a single fuel. The mechanical energy generated by a gas engine or a gas turbine is used in the majority of cases to drive alternators generating electricity. Thermal energy is recovered by captation of a large part of the heat release which is normally lost when producing mechanical energy, and which produces process steam into recovery boilers. Heat and mechanical energy are provided by cogeneration at an overall efficiency distinctly higher than that achieved through two separate production streams. The main environmental advantages of cogeneration are fewer releases of greenhouse gases (CO2) due to, both, lower emission factor of natural gas and improved efficiency compared to traditional generating facilities and in situ generation of electricity avoiding need for power transmission lines impairing landscape and generating problems in the event of severe tempests.

The milk transformation plant whose cogeneration system is described here processes 800,000 litres of milk per day, to produce fresh cheeses, yoghurts, etc. using specific processes such as pasteurisation, fasts skimming, homogenisation, maturing, additives, all requiring electric and/or thermal energy. As their former oil-fired boiler system had become obsolete, the plant managers decided to replace it with a cogeneration facility comprising two 1.1 Mwe unit gas turbines and one 6 t/h steam recovery boiler for the November- March period, and with a steam generation plant comprising two high efficiency, low Nox emission 5 t/h steam gas-fired boilers for the April-October period.

Characteristics and Results: Installation efficiency: overall 67 %

Cogeneration part: 72 % (of which electricity: 40%, steam 32%)

Mean gas consumption of turbines: 265,000 kWh/day

Gas consumption during summer season (excluding cogeneration): about 32 GWh

Lower CO2 emissions

Improved energy efficiency, easier control of the boiler installation, less maintenance and disappearance of dust and other sources of pollution

Low cost electricity production during the winter: source of savings

Improvement of thermal efficiency of thermal power generation

TEPCO has introduced an advanced combined cycle power generation system to improve the thermal efficiency of thermal power stations in pursuit of economic efficiency, a reduction of CO2 emissions and effective use of resources.

The combined cycle power generation system that makes use of the merits of both gas and steam turbines is the mainstay of the operation at LNG-fired thermal power stations. Since 1996 they have operated the advanced combined cycle technology that allows the combustion temperature in a gas turbine to be raised from 1,100C to 1,300C, and its thermal efficiency has reached a world record of some 54% on Low Heat Value basis (LHV). Moreover, they are planning to introduce the more advanced combined cycle (MACC) technology in their thermal power stations that envisages a further improvement in the thermal efficiency to 58% (LHV).
Compared with the case whereby the thermal efficiency in fiscal year 1999 remained unchanged from fiscal 1970, a rise in the efficiency from nearly 42% to 44% (LHV) has resulted in CO2 emissions reduction by 3.1 million t CO2 (equivalent to a reduction of 1.1 million kl of oil).

**CO2 Underground Storage – The Sleipner Case**

Storage of CO2 in underground geological formations has the potential of avoiding emission of huge quantities of CO2 from fossil fuels to the atmosphere, and thus possibly reducing adverse climatic effects. Beginning in 1996, 1 million tons of CO2 per year has been stored at the Statoil operated Sleipner field in the North Sea. The capacity to store CO2 underground within Europe is probably more than 800 billion tones of CO2, particularly under the North Sea. This is the first case of industrial scale CO2 storage in the world. It is being injected into the “Utsira” formation – a thick saltwater-bearing sandstone at a depth of approximately 1000 meters under the seabed. Being the first case, the behaviour of the CO2 injected has been carefully monitored by an international R&D project “SACS – Saline Aquifer CO2 Storage”.

**INNOVATION** - In addition to demonstrating the long-term feasibility of storage of CO2 in the Steipner field case, it is a particular aim also to provide solid scientific documentation of underground CO2 storage as a method. It may be applied in other geographical areas and by other industries such as power generation.

**INTERNATIONAL CO-OPERATION** - Statoil, BP, ExxonMobil, Norsk Hydro, BGS, BRGM, GEUS, IFP, NITG-TNO, SINTEF, NERSC, GECO and IEA GHG and ministries/research councils in NO, DK, NL, UK and FR. Inter-continental co-operation with similar projects in Canada, USA and Australia is under development, co-ordinated through the IEA Greenhouse Gas R&D Programme.

**EXPECTED RESULTS** - The project will generate a working methodology for evaluation of subsurface CO2 storage from a technical and an environmental point of view, in order to satisfy authorities and the general public as to the feasibility, safety and reliability of the saline aquifer CO2 storage process.

**REFERENCE** - Statoil – Den Norske Stats Oljeselskap AS, [www.jeagreen.org.uk](http://www.jeagreen.org.uk) and look for “Practical Research”

**Increasing efficiency in fertilizer production through technical innovation (IFA)**

As regards the production of fertilizers, there has been considerable environmental progress during the past thirty years. One expert calculated that energy consumption using best available production techniques was about half in 1998 what it was in 1968 (2743 Gigajoules (GJ) versus 5040 GJ for 134 million tonnes total nutrients). This improvement can be directly attributed to improved production technology.

A reduction in energy consumption in the fertilizer industry is accompanied by an even greater reduction in greenhouse gases. Because of increasing energy efficiency, some estimate that the fertilizer industry’s carbon dioxide emissions will remain near 1990 levels in absolute terms. In 1995, the European Fertilizer Manufacturers Association (EFMA), published a series of booklets on best available techniques (BAT) for the production of fertilizers. According to these, achievable emissions levels for plants built after 1990 are often 25-30% of those for older, less innovative facilities. EFMA carries out a benchmarking exercise to help member companies see how their performances compare with these goals; benchmarking against BATs is currently being put in place at the global level. Improved technology, proper operation, maintenance and housekeeping are all important in reducing emissions to a minimum. Further significant limitations of emissions will largely depend on the continuing replacement of old, inefficient factories by new ones.
Coal – providing solutions through the deployment of technology and innovation

(contribution provided by the World Coal Institute)

Coal is getting cleaner – clean coal technologies increase energy efficiency and reduce coal-related greenhouse gas (GHG) emissions. The deployment of higher efficiency technology in new and replacement combustion facilities and the introduction of efficiency management programmes improves the performance of coal. All stages of the coal cycle should be recognised as potential contributors to improved efficiency and emission reductions via innovation and technical enhancement. Improved coal technology and efficiency can provide significant benefits, in both developed and developing countries. It is not the use of coal, but rather how coal is used that must be the focus for action. The following examples demonstrate some of these opportunities.

Belle Vue Coal and Bagasse Dual-Fired Power Plant in Mauritius

Dual fuel bagasse-coal electric power plants, such as Belle Vue in Mauritius, create significant opportunities to optimise use of locally available renewable bagasse resources. The bagasse partnership with coal at Belle Vue reduces the amount of coal (or other fossil fuel) inputs to supply the community’s electricity demand by over one-third and saves foreign exchange exposure for Mauritius by reducing fuel import requirements. The new Belle Vue facility, a 70 MWe power plant, comprising two 35 MW units, is projected to burn around 280,000 tonnes of bagasse per year and 130,000 tonnes of coal. The bagasse component is equivalent to around 100,000 tonnes of coal. Over the six months from July to December the Belle Vue plant will mainly burn bagasse. During this period, coal is available (and used) as the standby fuel to cover any disruption in the delivery of the bagasse to the boilers to ensure the integrity of the operation. The Belle Vue plant is the fourth one of its type to be built in the world, with two similar plants (Bois Rouge and Le Gol) on the nearby island of Réunion and a plant (Le Moule) recently commissioned in Guadeloupe. Harnessing the full value of the available bagasse into the production of energy for both the supply of process steam and the generation of electricity brings major fuel savings – and creates the opportunity for win-win solutions for efficiency and reduced GHG emissions per unit of energy produced.

Schwarze Pumpe Power Station – New Generation of Advanced Lignite-Fired Electricity Generating Plants

One of a new generation of lignite-fired power plants, Schwarze Pumpe in Germany has two 800 MW generating units achieving 41% overall operating efficiency. The new facility replaces an old power station, which had an operating efficiency of 32%. The efficiency level at the new plant is further enhanced to 55% fuel utilisation through the cogeneration of heat and steam. Compared with the results from the old power station previously operated at the site, the new Schwarze Pumpe plant has reduced SO₂ emissions by 91%, NOx emissions by 61% and dust/particulate emissions by over 98%. CO₂ emissions have fallen by 31% per unit of energy produced over the previous plant levels. This modern plant requires around one third less lignite to generate the same amount of electricity –not only reducing emission levels, but also conserving valuable natural resources. Equipped with the latest in power generation technology, Schwarze Pumpe has achieved improvements in performance, efficiency, availability and reliability.

Methane Recovery and Utilisation at Moura Coal Mine

Located in Australia’s Bowen Basin coalfields, Moura is a typically gassy mine with major methane gas (CH₄) deposits co-located with the coal resource. Traditional mining practices involved the release of this CH₄ to the atmosphere as a safety measure. However, in more recent times, concern over the loss of this
potential energy source – together with the effect that CH₄, as a GHG, may have on the global climate has initiated the collection of this gas for commercial use. The drainage and capture of gas from the Moura Mine coal seams has a two-fold benefit: reduced CH₄ emissions to atmosphere from the mine contributes towards Australia’s GHG reduction programme; drainage of the CH₄ from coal seams over several years in advance of mining reduces the cost of gas drainage compared to the current ‘just in time’ gas drainage employed at many coal mines.

At design capacity the CH₄ drainage will represent a significant reduction in on-site GHG emissions. Based on an expected production of 18,000 GJ/day and an assumed energy content of Queensland gas of 37.3 MJ/m³, density of 0.68 kg/m³ and CH₄ content of 98.5%, this represents an annual utilisation of 119,000 t CH₄. GHG emissions associated with this level of CH₄ were it to be vented or otherwise released into the atmosphere are more than 2.5 Mtpa CO₂ equivalent, based on a GWP for CH₄ of 21. The Moura Mine Seangas Operation is a positive outcome for coal, coal safety and for the environment via the significant GHG emission reductions achievable.

Mlada Boleslav’s New Coal-Fired Cogeneration Plant in the Czech Republic

Following a major upgrade, Volkswagen’s Mladá Boleslav Power Plant in the Czech Republic is now one of the most advanced coal-fired cogeneration district heating plants providing 70 MW of electricity to the Skoda automobilova sa car factory as well as 140 MW of district heat for Skoda and around 10,000 households in the town of Mladá Boleslav. Fuel conversion and use of state-of-the-art energy-efficient technology during modernisation of the plant has led to significant energy savings and emissions reductions. The old Mladá Boleslav plant based in North Bohemia was built over 40 years ago and until 1998 was primarily fired on local high-sulphur lignite. The new Mladá Boleslav coal-fired cogeneration plant utilises local hard coal to fuel two base load circulating fluidised bed boilers. The new plant has an electrical output of 70 MW and an overall thermal capacity of 300 MWt. As a result of cogeneration overall fuel utilisation efficiency is approaching 80%, which means the energy content of the fuel is being utilised to a far greater extent than in normal condensing power plants. Mladá Boleslav Plant is now operating well within Czech Republic emission levels for SO₂, NOₓ, CO and dust and is also complying with the more stringent German standards. Through increased fuel and plant efficiency, CO₂ emissions have been significantly reduced by over 60% compared with the old plant. The whole modernisation of the CHP plant is estimated to have reduced GHG emissions by some 280,000 t CO₂ per annum.

German Cement Industry*

Specific fuel consumption has fallen consistently since 1987. In 1998 it was 2,905 kJ per kilogram of cement, which was 70 kJ down on the foregoing year. Taking the average of all cement plants in Germany, this level of consumption represents an efficiency of approx. 77.5% (2,250 kJ per kilogram of cement). According to the cement industry, this is above all a result of the following actions:

- Utilisation of the hot waste air from the clinker cooler to generate electricity in the Organic Rankine Cycle process - a new ORC power plant was commissioned at Lengfurt cement plant. The ORC process involves a conventional steam turbine configuration with an added expansion turbine that utilises industrial waste heat. Developed specially to exploit low temperature media for power generation, this innovative concept is being used for the first time in a cement plant. The new power plant has a net capacity of 1.13 MW which is used entirely in cement production and covers 12% of the cement plant’s total power demand. The remaining process stages account for approx. 16% of the electricity consumption.
− Installation of the expert system “LINKman” to harmonise kiln operation in two units at Göllheim cement plant.

− Substitution of kiln flue gas for natural gas in the clay dryers at Karsdorf cement plant. A new kind of dryer which went into service there in 1998 employs a granulation process for chemical dehydration. Under exactly defined conditions the clay is mixed with an additive which absorbs part of the water contained in it. The result is dried in a stream of hot flue gas that was previously released unused. This measure has enabled the cement industry to save 2 million m³ of natural gas by exploiting waste heat and the new drying process also reduces the CO₂ emissions of the cement plant by 3,550 tonnes a year.

− Better thermal energy recovery through improvements to pre-heater cyclones and clinker coolers.

− Substitution of granulated blast furnace slag cement for conventional Portland cement (Amoeneburg cement plant).

German Iron and Steel Industry*

The iron and steel industry implemented numerous technical innovations affecting energy consumption. Efforts to increase the efficiency of energy use were directed at nearly all stages of the production process. The investment and modernisation programme was particularly aimed at coking plants, sintering plants, blast furnaces, combined energy cycles, oxygen refining and electric furnace processes. In 1998 CO₂ reductions due to modernisation and new construction measures amounted to at least 315,000 tonnes. Reductions achieved by the steel industry are especially attributable to the concentration of pig iron production facilities. For example, at the Dillingen steelplant Blast Furnace 3 (design capacity 660,000 tonnes p.a.) was shut down and pig iron production concentrated in Blast Furnaces 4 and 5 dating from 1974 and 1985. A prerequisite for this measure was the relining of Blast Furnace 4 which appreciably boosted its productivity. The relining operation, which required capital expenditure of DM 150 million, principally involved enlargement of the frame to increase useful volume, modernisation of the technology to state-of-the-art and reinforcement to prolong service life. Increasing the efficiency of the wind heaters by 5% was in itself sufficient to achieve an annual reduction in CO₂ emissions of 69,100 tonnes.

Trials were carried out on a new kind of heating system for use in arc furnaces. This innovative system works on the rotary generator principle, transferring heat from a waste gas stream to the surface of a rotor which subsequently pre-heats a stream of primary furnace air to temperatures in excess of 1,000°C. By comparison with conventional systems this means fuel savings of up to 50%. The trials performed at a steelplant demonstrated that using the rotary generator burner system (DREBS) would reduce natural gas consumption by 460,000 m³ or 38% under identical load conditions. The resultant reduction of CO₂ emissions amounted to 846 tonnes p.a. Specific reducing agent and energy consumption fell by 12.8% in the period 1990–1997 and by another 1% in 1998. Accordingly, the production of one tonne of rolled steel in Germany requires around 21.2 GJ of electrical and thermal energy. This corresponds to a drop in specific CO₂ emissions from 2,089 kg to 1,794 kg per tonne of rolled steel.

German Chemicals Industry*

Sizeable savings were achieved in Ludwigshafen, a major location of the chemicals industry, as a result of the commissioning of a natural gas fuelled combined cycle power plant. The plant is fitted with waste heat boilers utilising the exhaust from the gas turbine (500°C) in an optimised double pass system. The high-
pressure steam generated in the boilers is expanded in a tapping turbine and fed into the plant’s service circuit at 6 bar. In the year it was commissioned this combined cycle power plant generated 4 million tonnes of steam and 2,800 GWh of electricity. By comparison with the coal fired cogeneration plant at BASF, which was 70% decommissioned in 1998, the new plant results in a reduction of CO₂ emissions in the order of 1.2 million tonnes. As the coal fired cogeneration plant was taken out of service entirely in 1999, the contribution of the combined cycle plant to the reduction of CO₂ emissions has gone up to 2 million tonnes.

According to the information provided by the chemicals industry the greatest reductions resulting from process oriented measures in 1998 were attributable to the deployment of more efficient chlorine production techniques. Conversion of conventional electrolysis plants with an annual capacity of 500,000 tonnes to the energy saving membrane process resulted in a reduction of the chemicals industry’s electricity consumption in the order of 110 GWh, which is reported to represent a reduction of CO₂ emissions of at least 60,000 tonnes.

*German Glass Industry*

The replacement of old plants and equipment with new furnaces burning an oxygen / gas mixture instead of an air / gas mixture, the ongoing improvement of energy use whenever regular repairs and overhauls take place and the increased use of waste glass as a secondary raw material have all resulted in appreciable energy savings. Up to 98% of production waste is recycled, as a result of highly efficient sorting procedures. Despite the level of glass recycling being already very high, the glass industry was able to improve the recycling quota still further in the period 1995 to 1998 (to 80.7%): Of the annual 3.4 million tonnes of container glass sold in Germany the glass industry recycles 2.8 million tonnes in its production processes. Increasing the broken waste glass content in the melt by 10% results in energy savings of up to 5%.

ANNEX TO CHAPTER VII: INNOVATION IN ENERGY

Application of cogeneration in the milk produce transformation industry

(example provided by Gaz de France)

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Characteristics and Results:

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Low cost electricity production during the winter: source of savings

Measures for the Simultaneous Achievement of the Three Es – Energy, Economy and Environment

(The Tokyo Electric Power Company)
As a part of its business philosophy aiming at building a sustainable society suitable for the 21st century, TEPCO has been pursuing the simultaneous achievement of the three Es, namely energy security, economic growth and environmental protection. The “Best Mix” of major energy sources - nuclear power, LNG, oil and hydropower - constitutes the main pillar in the measures for achieving this goal.

With regard to the climate change issues, TEPCO has set a specific goal of reducing the CO2 emission intensity by 20% in FY 2010 from FY 1990 level. The company is taking a wide range of supply-side measures such as the expanded use of non-fossil energy sources including nuclear power. The optimal use of nuclear power alone, for instance, achieved emissions reduction of 92.1 million t-CO2 in FY 2001 that is greater than TEPCO’s actual emission of 87.4 million tons in the same year. LNG-fired power generation, which was introduced as early as in 1970 and now accounts for 37% of total amount of electricity generated/purchased by TEPCO, is also a major contributor to the CO2 emission reduction – 32.3 million t-CO2 in FY 2001.

The efficiency of thermal power generation and transmission/distribution loss rates have also been improved continuously. The improvement reduced CO2 emissions in FY 2001 by approximately 4.2 million tons compared to FY 1990.

TEPCO is committed to the promotion of renewables. In 2000, TEPCO launched the “Green Power Fund” that is intended to support the diffusion of renewable energy such as wind power and photovoltaics. The fund consists of contributions from individual consumers and the same amount (“matching gift”) from TEPCO. In FY 2001, TEPCO received a total of \108 million and entrusted it to the Fund, along with the matching gift. TEPCO also established “Green Power Certification System” in 2000, with a view to mediating between wind power generation companies and entities wishing to support such green electricity. As of March 2002, 28 companies and 1 local government were participating in this system, and the aggregate amount of electricity they contracted to purchase was 35.2 GWh.

On the demand side, TEPCO promotes and supports customers’ energy conservation efforts that lead to the improvement of overall efficiency of the society. Examples of TEPCO’s activities include R&D and deployment of high-efficiency equipment, enhancement of rate options to promote such equipment, and provision of information helpful in conserving energy.

Further information can be found on the website at http://www.tepco.co.jp/index-e.html

**Fiat Auto - Complete range at the state of the art for low/zero emissions vehicles**

Fiat’s investments in research and development, with ongoing programs focusing on process and product innovation, have enabled it to produce on an industrial scale a complete range of cars with alternative drive systems. Fiat Auto is a leader in every segment of this market. Its vehicles include cars that run on CNG, as an alternative to gasoline or diesel fuel, while others are powered by electric or hybrid drive systems.

The **Fiat Multipla Hybrid Power** is a five-seat, front-wheel-drive car. Thanks to dual electric and gasoline power, it is ideal for city driving because, with electric operation, it is quiet and ensures zero emissions. At the same time, with hybrid operation, it is capable of highway driving with performance comparable to that of conventional combustion-engine vehicles.

The future evolution of the hybrid vehicles calls for the functional integration of electric car with the combustion engine. The batteries, with their high specific power and limited size, supply the energy required during acceleration transients and do not require recharging from the grid. This vehicle concept, known as the minimal hybrid, is capable of reducing consumption by 30 to 50%, while maintaining the
overall performance of current cars. The system developed by Fiat, called Ecodriver, uses an axial motor-generator integrated between the combustion engine and the automated transmission (selespeed).

The prototype Fiat Elettra H2 Fuel Cell (presented in 2001) uses hydrogen as a fuel to produce 48V of electrical energy with a maximum power output of 7 kW. The Fuel Cell is fitted to a hybrid system equipped with a 30 kW electric drive engine. The car performs in much the same way as the Seicento Elettra, but can be driven for 140 km without recharging.

The Multipla Blupower runs exclusively on CNG and takes full advantage of the ecological features of this fuel. With a dual CNG-gasoline fuelling system, offers a greater CNG driving range. The vehicle’s height from the ground makes it possible to position the CNG tanks beneath the bed, without sacrificing any space in the vehicle’s interior or trunk. Today, the Bipower is the best seller among the alternative drive vehicles. Other models of CNG cars and commercial vehicles are going to be introduced in the market in 2002. Another recent innovative drive system (unique in the world) is the Gasdriver (Fuel + CNG), prototype open to further developments and to commercial diffusion.

Energy Efficiency Benchmarking Covenant

On 6 July 1999, the Dutch government concluded the Energy Efficiency Benchmarking Covenant with industry. In it, the energy-intensive industry pledges to be among the world leaders in terms of energy efficiency for processing installations by no later than 2012. In exchange for this undertaking, the government has agreed not to impose any extra specific national measures governing energy conservation or CO2 reduction on the participating companies.

Detailed information is available at the following website: http://www.benchmarking-energie.nl/index.php3

IAI Contribution

Energy Efficiency

Production of primary aluminium requires significant energy and the industry has a long tradition of self-improvement in this area. The average energy consumption and subsequent emissions per tonne of production have fallen by 70% over the past hundred years, due to research and continuing process developments. In the 1950's on average around the world it took about 21 kWh (kilowatt-hours) to make a kilogram of aluminium from alumina. In 2000 it took one of the newest smelters just 13.4 kWh. The IAI carries out an annual energy consumption survey covering 70% of the world’s primary production facilities. The results are benchmarked to encourage improved performance. The following graph shows a steady reduction in electrical power used in primary aluminium production from 1899-1999. Since 1990 the electrical energy requirement to produce aluminium has declined in average at a rate of 0.5% per year.

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Energy Supply

More than 55 per cent of the world's primary aluminium is produced using hydro-electric power which is clean, CO₂ free and renewable. In certain countries like Brazil, Norway, Canada and Russia the percentage is much higher e.g. over 80% for Russia, 95% for Brazil and 100% for Norway and Canada. The global distribution of energy sources is as shown in the following pie chart. Some aluminium smelters are located in areas where there is a surplus of energy for which there is insufficient economic local use. Also when energy shortages develop, power can be diverted from aluminium electrolysis to supply the power grid, thus helping to reduce peak period prices for other power users and reduce the need for the construction of marginal peak period electrical generating capacity. This is the case where aluminium producers provide power to the grid at peak times (e.g. Quebec/Brazil) or shift production from aluminium for longer periods as happened for example in the British Columbia and Brazil, to free up electricity for other uses.

Recycling of aluminium

The increasing use of recycled metal saves both the energy and mineral resources needed for primary production, using only about 5% of the energy required for primary production and generating only 5% of the greenhouse gas emissions. Scrap aluminium has significant value and commands good market prices. The recycling of aluminium beverage cans eliminates waste and conserves landfill space. Aluminium recycling often helps communities to fund the recycling also of less valuable materials such as glass, paper and plastics.
Aluminium is durable and does not rust, which leads to reduced maintenance costs. Most of the 680 million tons of aluminium that has been produced is still in use, which is estimated to amount to between 400 and 500 million tonnes. Aluminium products have a longer life and require less maintenance than other building materials, and thus conserve energy and resources. With the use of aluminium in construction, its initial energy-intensive manufacture is more than compensated for in use phase and can be fully recycled on demolition. When used in “things that move” the energy used to produce the aluminium initially is saved many times over through fuels use reduction over the life of the vehicle in which it is used. For example, the use of a kilogram of aluminium in a typical automobile to replace two kilograms of a more dense material can result in an energy savings over the life of the car that is 20 times greater than the energy requirement to produce the aluminium part. For other vehicles like trains, buses, trucks, trailers or ships which run longer distances during their life-times than cars, these savings are even significantly higher.

At present approximately a third of world demand is met from recycled metal. It is interesting to note that the recycled aluminium usage in 2000 was higher in volume than the entire primary production of aluminium in 1965.

"Variable Speed Drives"

Industry uses about half the electricity generated in the world. Electric motors in industry are responsible for about 65 percent of industrial electricity consumption. Most motors that drive pumps, fans and compressors are fixed-speed devices, designed for maximum capacity requirements. They always run at full speed and their output is controlled by mechanical devices whilst requirements in the industrial processes are usually lower. The efficiency of such a system is poor.

A frequency converter connected to an AC motor can vary the motor speed steplessly. Varying motor speeds to match process requirements improves process control flexibility, accuracy, productivity and energy efficiency. In some cases, the variable speed control can save as much as 70 percent of the energy and so reduce the CO$_2$ emissions significantly.


**Carbon Sequestration : Geological Storage in Oil Reservoirs**

*The Weyburn Project: Carbon Sequestration and Enhanced Oil Recovery (EOR)*

Large scale CO2 injection into a geological reservoir is currently taking place in N. America, providing valuable data for research into the viability of carbon sequestration. A CO2-rich waste gas stream from the coal gasification process at the Great Plains Synfuels Plant in North Dakota, USA is being used in an innovative enhanced oil recovery project at the Weyburn field in S.E. Saskatchewan. CO2 is pumped as a supercritical liquid at high pressure into the oil reservoir, forcing oil out of the pores and cavities of the reservoir and thereby increasing productivity. Much of the CO2 remains in the oil field after injection, thereby avoiding the release of more than 1 million tonnes per year.

The Weyburn CO2 EOR flood is an important and novel project being undertaken to enhance oil recovery, with significant environmental benefits via the CO2 sink created. Over the twenty or so years of the project some 19 Mt of CO2 will be stored. As CO2 storage/sequestration attracts costs and benefits in the market in the future, the application of the CO2 storage potential from an EOR flood process in an oil production project such as Weyburn could become the primary, or complementary, commercial activity.

An international monitoring programme has been established to learn about the behaviour of CO2 in this reservoir - an important opportunity to expand our experience with a key method of carbon sequestration.

**Airline Best Practices to Improve Energy Efficiency in Flight Operations**

(provided by IATA)

International air transport makes a valuable and unique contribution to the sustainable development of global society. Efficient and affordable access to regional and global markets helps improve living standards and foster economic growth which, in turn, alleviates poverty and is conducive to less environmental degradation and a more sustainable world.

In the near term, it is highly unlikely that any fuel other than kerosene will be available for widespread use in flight operations by the global airline industry. Although research is underway into a range of potential substitutes to kerosene, many hurdles need to be overcome on issues such as technological feasibility, safety, reliability of supply, operational requirements, economic and environmental implications, and public perception.

Because of the lack of viable alternative energy sources, the only option for airlines in the near term to minimise their in-flight energy requirements and related environmental effects is to continuously increase the fuel efficiency of their operations. To achieve this, airlines make large investments in modernising their fleets. Fleet-wide energy efficiency improvements, however, take time because of the large size of the total fleet, the long lead times for new technology to be developed, and the high cost involved - one new wide-body aircraft typically costs between 100 and 150 million USD.

In addition, operational measures such as flight management and route planning techniques, maintenance and load factor improvement provide further possibilities to produce energy efficiencies. For example, a growing number of airlines are using a minimal number of engines to taxi aircraft between the airport gate and the runway. On-board power generation (to provide electricity and preconditioned air to aircraft at the gate) is increasingly being replaced by the use of ground-based electrical equipment.
As an illustration, consider airline focus on reducing “unnecessary” weight in aircraft operations. The empty weight of an aircraft, the catering and service items, the amount of fuel loaded and the payload (i.e. cargo, mail and passengers) all contribute to an aircraft’s overall weight and have an important bearing on in-flight energy use. Efforts to reduce overall weight include:

- reducing the number and range of service items carried on board (e.g. china items carried in first class, excess children’s toys and magazines);
- removing unnecessary equipment (brake cooling fans, drinking water coolers, second auxiliary power generators);
- reducing the weight of passenger seats, cushions, life jackets and life rafts, cargo containers, and cabin service trolleys;
- using zonal drying equipment to remove moisture from insulation blankets;
- purchasing policies and inventories that reduce the weight of in-flight products;
- matching catering and in-flight service items to actual amounts required through specially developed reservations and catering communications systems; and
- setting targets to reduce catering weight by an agreed percentage per year.

Overall, today’s global aircraft fleet consumes on average 4.8 litres of fuel for every passenger carried over 100 kilometres, equivalent to 49 passenger miles per US gallon. Even so, the world’s airlines anticipate a further 10% average improvement in energy efficiency over the next ten years. This could reduce the total release of CO₂ into the atmosphere by almost 350 million tonnes for this period.