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**ENERGY FOR SUSTAINABLE DEVELOPMENT, INDUSTRIAL DEVELOPMENT,
AIR POLLUTION/ATMOSPHERE AND CLIMATE CHANGE:
ACHIEVEMENTS, TRENDS AND CHALLENGES IN THE UNECE REGION**

I – Introduction

1. This review provides background information from the UNECE region¹ to the United Nations Commission on Sustainable Development, which at its fourteenth session will review progress in the implementation of the thematic areas of energy for sustainable development, air pollution/atmosphere, climate change and industrial development. The various chapters of this report aim to present an analysis of achievements, trends and challenges in the UNECE region.

2. In accordance with the recommendation of governments of the UNECE region, the structure of the report follows the meeting agenda adopted for the Second UNECE Regional Implementation Meeting, covering the relevant issues in one document and with a particular focus on linkages to energy for sustainable development in each thematic area.

II - Energy for Sustainable Development

3. The framework of this chapter is made up of the sustainable energy policy objectives set out in UNECE's contribution to CSD-9, "One More Step on the Path to a Sustainable Energy Future" (ECE/ENERGY/43), which was endorsed by delegates from governments, the private sector and non-governmental organizations in 2000. These objectives are:

- a) Sustained access to high quality energy services;

* This document was submitted late due to delayed inputs from other sources.

¹ Background document by the UNECE Secretariat for the Second Regional Implementation Forum on Sustainable Development

- b) Security of energy supplies;
- c) The reduction in health and environmental impacts resulting from the production, transport and use of energy;
- d) Well-balanced energy network systems, tailored to optimise operating efficiencies and overall co-operation;
- e) Sustained improvement in energy efficiency; and
- f) Steady reduction in energy-related environmental impacts through the development and application of environmentally-sound and economically-viable technologies, and increased use of renewable energy resources.

A. Access to Energy and Energy Security

4. *Access to Energy.* About 1.7 to 2 billion individuals in developing countries - one-third of the human race - still do not have access to commercial energy or electricity. In contrast, almost all individuals in UNECE countries enjoy access to energy resources. Moreover, people in the poorer and less advanced ECE countries, as well as the poor in advanced countries, are not energy poor in an absolute sense as they tend to consume more energy per capita than the average used in developing countries. However, the problem is that this energy takes a significant component of their disposable income. Furthermore, as the traditional division of labour allocates more household tasks to women, they are disproportionately affected by energy poor households.

5. *Electricity Supply.* Electricity is widely viewed as a means of obtaining high quality energy services and, therefore, could be used as a proxy to measure access to energy services. In this respect, ten UNECE countries, mainly in Central Asia and the Caucasus, use less than 2,500 kilowatt hours of electricity (kWh) per capita each year. While this is significantly more than the average of 1,000 kWh used by developing countries, it represents only 30 percent of the OECD average.

6. *Electricity Disruptions.* The reliability of electricity supply (avoidance of black- and brownouts) is also an important quality consideration. Most economically disadvantaged UNECE countries do continue to struggle to provide continuous uninterrupted commercial energy services to their populations. Electricity services are often disrupted for prolonged periods. However, an encouraging aspect is that these disruptions are becoming less frequent as the quality of the service improves, which is a reflection of rising incomes and poverty reduction.

7. *Infrastructure Constraints.* Even in the more developed UNECE countries, there is no room for complacency. Infrastructure constraints, particularly in power generation, transmission and distribution as well as in oil refinery capacity, are impacting consumers. In recent years, there have been electricity blackouts in Italy, Switzerland, Canada and the United States. Currently, oil refinery capacity is a problem, particularly in the United States, and may be sustaining, at least partly, the recent crude oil price rise.

8. *Energy Security.* Energy security has re-emerged as a crucial issue for policy makers and the general public. The recent high crude oil prices and their volatility, the instability and continuing conflict in Iraq, the tensions in the Middle East, sabotage and terrorist attacks in major oil and gas producing countries, the growing energy import dependence of major consuming

countries have all contributed to this heightened sense of vulnerability. As have the corporate and policy failures, such as the Enron bankruptcy and the 2003 electric power blackouts in North America and Europe.

9. *Fossil Fuels.* Over 80 per cent of the primary energy consumed in the UNECE region comes from fossil fuels – oil, natural gas and coal – with nuclear, hydro, traditional fuels (such as biomass), and “new” renewables (such as solar and wind) accounting for the remaining energy consumed.

10. *Oil Import Dependence.* The increased sense of vulnerability and insecurity relating to oil has been further heightened by concerns about the growing dependence of UNECE countries on imported oil; the concentration of known oil reserves in the Middle East and North Africa; the growing reliance on the Middle East and the Organization of Oil Exporting Countries (OPEC) for oil supplies; the perceived higher costs of new incremental oil supplies; the ever increasing distance of supply routes; and the potential for political instability and social unrest in some of the major oil producing and transit countries.

11. *Conventional and Unconventional Oil Resources.* There have been stark warnings about the sharp reduction in conventional oil resources. According to some estimates, global conventional oil production could slide into terminal decline in about 35 years or less. Fortunately, there are reasonably large unconventional oil resources in a number of UNECE countries. The downside is that these resources are costly to exploit without important externality effects (environmental consequences).

12. *Gas Reserves.* Concerns about the security of supply of natural gas are much less pronounced than for oil. Natural gas reserves are relatively abundant (at least 80 years supply); reserves are less concentrated than for oil; ample reserves are available in the UNECE region, notably in the Russian Federation which has 27 per cent of total proven world reserves; and medium term supplies are perceived to be relatively secure and reliable.

13. *Challenge Faced by Gas.* Natural gas is today’s fuel of choice from an environmental perspective. Hence, the rapid growth in natural gas consumption (at close to 2.5 per cent per annum) is boosting the import dependence of many UNECE countries. While this may not be a major problem in the medium term, meeting demand over the longer term could become a challenge and significant new investments in production and transportation infrastructure will be required. Furthermore, supplies will increasingly have to be transported over longer distances as new production centres are developed in more remote areas.

14. *Coal.* With regard to energy security, coal has the advantage that its global reserves are large; sources of supplies are diversified; ample supplies are available from politically stable regions; world infrastructure is well developed; new supplies can be easily brought on stream; and it can be stored safely. Nonetheless, coal is hindered by environmental concerns, which could have implications for energy security in the longer run. The future share of coal in the energy mix will depend on how quickly existing thermal power plants are refurbished, clean coal technologies are implemented, and on the future evolution of climate change policy.

15. *Nuclear.* Nuclear electricity, renewable energy and traditional fuels, such as biomass, offer considerable security of supply, particularly when available from domestic sources.

16. *Challenges of Fossil Fuels.* Fossil fuels, which currently supply over 80 per cent of the energy requirements of the UNECE region, including most of the requirements in the transport sector, are major contributors to three of the most important current air pollution problems. About 70 per cent of the greenhouse effect, a global concern, is attributable to energy; energy activities are the single largest contributors to acid rain, a transboundary problem (50 to 90 per cent of contributing emissions emanate from energy production and use); and energy is the main contributor to ground level smog or tropospheric ozone, both a local and regional problem (50 to 90 per cent of contributing emissions come from energy). Achievements made in emission reductions are detailed in section IV(A).

17. *Health Issues.* Health problems (due to pneumoconiosis silicosis, anthracosis, carbon monoxide (CO) and fine particles) and loss of life (from gas explosions, rock falls and mine collapses) continue to be of concern in a number of UNECE Member Countries, such as the Russian Federation, Ukraine, Kazakhstan and Kyrgyzstan. Exposure to oil and to other chemicals used in the energy industries, and their transportation, can cause skin damage and cancer. Significant quantities of radioactive wastes, generated by the nuclear industry, will remain hazardous to humans for decades.

18. *Energy and Climate Change.* The issue of global climate change (see also section IV(B)) is a major concern to the energy sector. Energy-related carbon dioxide (CO₂) emissions have continued to rise globally as well as in the UNECE region. Over the period 1990-2004, EU-15 energy-related CO₂ emissions rose between two and six per cent (depending upon the statistical source). In fact, emissions fell in only three EU-15 countries – Sweden, UK and in particular, Germany. In the other EU-15 countries, emissions rose - in some cases by well over 20 per cent. Emissions also rose in North America, 18 per cent in the United States and 27 per cent in Canada over the same period.

19. *CO₂ Emissions.* On the other hand, the countries of Central and Eastern Europe and Central Asia experienced significant declines in emissions – about 35 per cent in aggregate - over the same period, albeit largely due to the precipitous fall in GDP and industrial production during the early years of the transition period. Since about 1994, with improving economic performance, energy-related CO₂ emissions have started to rise once again.

20. *Meeting Emission Targets.* Existing emission targets will be difficult to meet (other than for the former transition economies) because of difficulties in significantly reducing energy-related CO₂ emissions, largely due to the transport sector (section D highlights the problems of the increasing vehicle fleet on emission levels). For example, EU-15 transport sector CO₂ emissions rose 23 per cent between 1990 and 2002, with freight transport emissions rising 40 per cent. In contrast, the performance was much better for the energy supply sector and industry overall; greenhouse gas (GHG) emissions, excluding the transport sector, actually fell in EU-15 countries over the period.

21. *Price of Technology Option.* Very significant improvements can be made in reducing energy-related emissions by applying end-of-pipe and/or new process technologies. However,

there is a trade-off here because the application of such technologies comes with the high price tag, which many countries of the UNECE region cannot afford.

B. Energy Efficiency

22. *Lowest Cost Energy Supply.* Today, governments are interested in ensuring that energy is available to their populations, but also that the economy can use it at the lowest possible cost, and that it is used in the most efficient way possible.

23. *Economic efficiency.* Economic efficiency is best promoted through decentralized and liberalized energy markets, with freely determined market prices. It involves the liberalization of markets, the privatisation of state-owned enterprises, and the regionalisation and globalisation of competition. The trend towards more liberalized energy markets has been most pronounced in North America and the European Union. While progress is also being made in Eastern Europe and Central Asia, the pace is less pronounced and more uneven.

24. *Benefits of International Co-operation.* Operating efficiencies can also be greatly improved through international co-operation aimed at integrating energy systems and energy infrastructure both regionally and globally. To further deepen international co-operation, a greater degree of convergence in energy policies, norms, standards and practices will be necessary. Likewise, there is scope for improving international co-operation on cross-border issues such as tariffs, energy transport corridors, transit, investment safeguards and dispute resolution mechanisms, as well as improving the interconnections and integration of physical infrastructure and network systems.

25. *Energy Intensity.* There are large differences in energy intensity (defined as energy consumption per unit of Gross Domestic Product produced) among UNECE countries. Some of the variation is related to the efficiency with which countries produce and consume energy. Since the early 1970s, energy intensity in most Western UNECE countries has been falling, with particularly marked declines in the energy intensity of manufacturing. Notwithstanding this positive development, the rate of improvement in energy intensity in Western UNECE countries has slowed down noticeably since the mid-1980s, partly due to the drastic drop in crude oil prices at the time. It is possible that the current energy price increases, led by oil, could once again stimulate industry, individuals and economic agents to pay more attention to energy conservation and efficiency. However, governments also have a role to play here and should be more proactive to encourage the more efficient production and use of energy.

26. *Potential to Reduce Energy Intensity.* In the former economies in transition, energy intensity only started to decline much later, in many cases not until the mid 1990s, concomitant with the industrial restructuring taking place, the gradual increase in overall energy prices, together with some modernisation of energy-using devices in the home and in the transportation sector. Nonetheless, energy intensity in the former economies in transition remains high relative to its levels in Western European countries. A huge potential exists to further reduce energy intensity and improve energy efficiency in virtually all sectors - manufacturing, residential, commercial, municipal and transport.

27. *UNECE Activities.* The UNECE Committee on Sustainable Energy has undertaken considerable capacity building activities in the field of sustainable energy and, in particular, in promoting energy efficiency measures and the reforming of energy prices and subsidies. Its new project under Energy Efficiency 21 (EE21) brings together donors, beneficiaries from key countries and international experts to help develop financial engineering skills, provide access to investment project finance and assistance on policy reforms that support energy efficiency investment projects. Energy pricing policy reforms, for example, can transform an economically attractive investment proposal into a financially viable project.

C. Cleaner Fossil Fuels, New & Renewable Sources of Energy, and Research & Development

28. *The Challenge of Meeting Energy Demand whilst Minimising Environmental Impacts.* While improvements in energy conservation and efficiency can slow down the rate of growth of demand for energy services, they cannot eliminate this demand altogether. Under present and projected market conditions, the bulk of these energy services are likely to continue to be provided by fossil fuels. Hence, the conundrum of how to deliver the energy services needed while at the same time minimizing energy-related health and environmental problems will still have to be addressed. Broadly speaking, the answer lies in improving the quality of the energy mix. There are basically four ways of doing so, each with varying degrees of challenge.

29. *Natural Gas.* The first way is to switch to more environmentally benign fossil fuels, such as natural gas. But in sustainability terms, this option can only offer an interim and medium term solution.

30. *Nuclear Power.* The second option is to increasingly switch to nuclear power. Since 1973, nuclear power has significantly contributed to meeting rising electricity demand in the UNECE region. However, since the early 1980s, far fewer orders for nuclear power plants have been placed, stemming in part from public concern and political debate on the possibility and consequences of accidents, on the lack of adequate methods for disposal of nuclear waste, and over the costs of nuclear power plants themselves, including their decommissioning costs. There are signs, however, of a revival of interest in nuclear power, as evidenced by the decision of Finland to move forward with the construction of a new nuclear power reactor, continuing work on the completion of nuclear facilities in Eastern Europe (Romania, Russian Federation and Ukraine), the rise in the resale value of existing nuclear power plants in the United States and ongoing work on the construction of about 25 reactors worldwide, mainly in developing countries but also in Japan. On the other hand, it should also be noted that a number of UNECE countries, such as Sweden and Germany, have opted against the construction of new power plants and for the phase out of current plants.

31. *Renewable Energy.* The third option is increased reliance on renewable energy resources: solar, wind, wave, biomass, geothermal and hydropower resources (including small hydropower developments i.e. up to 10 MW). Government programmes and targets for renewables are ambitious; new initiatives, both at regional and national levels, are being launched; and the means for financing projects are multiplying. In particular, wind and solar technologies are being

developed quickly and the number of installations as well as the installed capacity is rapidly expanding (e.g., wind power capacities are increasing by an average of 20 per cent per annum).

32. Despite their rapid development and commercialization, the contribution of renewables to meeting growing energy demand in the UNECE region has not increased appreciably over time. Between 1990 and 2004, the contribution of renewables to meeting total primary energy requirements of the EU-15 countries rose from 4.8 per cent to 6.0 per cent, from 12.8 per cent to 14.8 per cent for electricity generation, including hydro, and from 0.6 per cent to 3.5 per cent for electricity generation, excluding hydro. The corresponding figures for North America show a reduction from 6.4 per cent to 5.6 per cent for total primary energy, 18.5 per cent to 15.1 per cent for electricity generation, including hydro, and 2.9 per cent to 2.1 per cent for electricity generation, excluding hydro.

33. *Increase R&D.* The fourth option is to increase research and development in new technologies for the production and use of coal, oil and nuclear power, in order to make them more environmentally and publicly acceptable, and in new technologies for renewable energies in order to improve their economic viability and promote their wider use. The development and introduction of advanced oil and coal combustion technologies, bio fuels for transportation, hybrid systems, hydrogen-based processes and carbon sequestration are of prime importance in this activity.

34. There are many barriers to energy innovation at each stage from the laboratory, through demonstration and early deployment, to comprehensive dissemination. Between 1983 and 1997 reported energy R&D expenditures in IEA member countries fell by nearly 40 per cent in constant US dollar terms, and from 0.158 per cent to 0.034 per cent of GDP. Even R&D expenditures on renewable energy fell by over 40 per cent. There is no evidence of a reversal in this trend since 1997. The pattern of energy R&D expenditure also provides grounds for concern, with only about 8 per cent of the total being allocated to renewable energy and about 18 per cent to energy efficiency. This low level of R&D spending, combined with the age and slow turnover of energy-processing and energy-using capital stock and equipment (from oil refineries to buildings and vehicles), means that long lead-times are required before major changes at the regional and global levels can be achieved.

D. Energy and Transport

35. Transport plays a major socio-economic role and provides accessibility to basic services, such as health and education. It is also vital to the smooth functioning of the economic activities, to the production and distribution of goods as well as to trade. Transport is indispensable to promote inter and intraregional communication. The transport sector, including the vehicle manufacturing industry and their suppliers, accounts for a large share of GDP in many countries.

36. *Trends in Transport Demand.* The growth in incomes together with the opening of frontiers, have generated greater needs for mobility in Europe. Transport volumes grew at a fast rate in Western Europe (WE) in the 1990s: both freight and passenger volumes have more than doubled since 1970. They fell sharply in Central and Eastern Europe (CEE) and Eastern Europe, Caucasus and Central Asia (EECCA) in the first part of the decade following economic recession, but are

again on the rise. At the same time transport demand has shifted away from the more environmentally friendly modes towards road and aviation. Rail and public transport still have a higher share in CEE and EECCA countries than in WE, but the share is declining.

37. *Transport Energy Consumption.* The increase in transport demand, in particular for road transport and aviation, has led to a growth in the transport energy consumption (which in the 1990's rose by almost 2 per cent/year in WE and almost 3 per cent/year in CEE) and — given its almost entire reliance on fossil fuels — the sector's green house gas emissions (notably carbon dioxide, CO₂) are growing considerably, threatening to offset emission reductions in other sectors. Energy consumption in transport (excluding maritime transport) for the same period in the UNECE was of 996 Mtoe in 1990, 1,036 Mtoe in 1995 (+ 4 per cent) and 1,143 Mtoe in 2000 (+10 per cent), representing 27.4 per cent, 29.5 per cent and 30.9 per cent of the total final energy consumption in the region. In EECCA the transport sector's share in energy consumption is still much lower, accounting on average for 17 per cent of total energy use, ranging from 29 per cent in Tajikistan to 6 per cent in Turkmenistan, as compared to the WE (30 per cent in 1999) and CEE (22 per cent in 1999). However, energy consumption and CO₂ emissions are expected to grow rapidly in EECCA as economies recover and the demand for transport increases.

38. *Impacts of Transport Growth.* The above developments increase congestion on roads and, therefore, energy consumption and emissions. The growing volumes of transport are also partly offsetting the important environmental gains that have been achieved in terms of the reduction in air pollution through the ECE regulations on vehicle technology and improvements in fuel quality, as well as through fleet renewal, particularly in WE. The consumer preferences for larger, heavier, and more powerful models are also contributing to the offsetting of these efficiency gains. Transport is responsible for ground level ozone precursors and particulate matter that are associated with a heavy health burden, in particular for the urban populations of Europe. The elevated concentration of lead in ambient air in a number of EECCA countries is mostly due to the continuing use of leaded petrol.

39. *Sustainable Transport Strategies.* Gains in eco-efficiency seem not sufficient alone to mitigate the negative impacts of the rapid growth of road transport and infrastructure volumes. A large number of political, legal, technological and fiscal measures will be necessary to reach a long-term more sustainable transport system. Sustainable transport strategies that assure the commitment and involvement of all the relevant parties at the national and local levels are key to both restraining traffic growth and promoting more environmentally friendly and energy efficient transport, without compromising the competitiveness of the sector and the economy in general. Strategic environmental assessment (SEA) can be a useful tool to help integrate sustainability concerns at various transport policy and planning levels.

40. *Reducing the Impact of New Vehicles.* ECE vehicle regulations and fuel improvements have proved to be effective in reducing the impacts of new vehicles significantly, particularly air pollution, and should be pursued. Voluntary agreements with car manufacturers can efficiently contribute to improvements in energy efficiency and reductions of CO₂ emissions of new cars. Vehicle manufacturers from Europe, Japan and South Korea have made a commitment on CO₂ emissions' reductions that will contribute more than 15 per cent to the total emissions savings required under the Kyoto Protocol in the EU, accordingly with the estimations by the EC. This commitment to bring into the market individual car models with CO₂ emissions of 120 g/km since

2000 will be revised with a view to moving the new car fleet average further towards 120 g/km by 2012. These voluntary requirements should also be extended to air and rail transport.

41. The implementation of ECE vehicle regulations and fuel standards in CEE and EECCA countries is in progress but an effective enforcement and inspection regime is needed to fully benefit from these developments. Crucial short-term challenges for most of these countries are to phase out leaded petrol and move towards cleaner vehicles. The transport sector currently relies on mineral oil for more than 90 per cent of its energy, and a growing proportion of this will have to be imported in the future. Efforts should be pursued for promoting cleaner vehicles such as electric and hybrid vehicles and alternative fuels for existing vehicles such as liquid biofuels, either bioethanol or biodiesel. In the longer term, development of alternative transport, such as fuel cells and hydrogen, could also prove useful.

42. *Cost Internalization.* Internalization of external costs of transport through a restructuring (and in many cases increasing) of fuel, vehicle and infrastructure taxes and charges may provide direct incentives to improve the energy efficiency of transport and to change behavior of users to drive cleaner and safer vehicles and avoid peak hours. Key priorities for most of the CEE and EECCA include the abolition of fuel subsidies and introducing self-financing of the transport system via fuel taxes.

43. *Long-Term Measures.* Well-balanced land-use planning policies are essential in reducing mobility needs, travel times and dependence on passenger cars, in particular in urban areas. Education and raising awareness can also play a great role in inducing more sustainable mobility patterns in the longer run.

44. Shifting the balance between modes of transport should be promoted to achieve sustainable development. Rail transport, short-sea shipping and inland waterway transport could provide viable alternatives for road transport and aviation, provided, inter alia, that services and the connections between ports and the rail and inland waterway networks are improved and that environmental and safety rules are respected. In urban areas, developing public transport should be a key priority that also encourages walking and cycling. The use of economic instruments, as well as investments in development and maintenance of infrastructure, should increasingly aim at rendering the more sustainable means of transport competitive and viable alternatives to private road transport.

III - Industrial Development and Linkages to Energy for Sustainable Development

45. The World Summit on Sustainable Development (WSSD) Johannesburg Plan of Implementation calls for a stronger contribution of industrial development to poverty eradication and sustainable natural resource management through, inter alia, an enhancement of industrial productivity and competitiveness as well as an intensification of efforts in cleaner production and the transfer of environmentally sound technologies. This chapter presents an overview of industrial development trends and challenges in the UNECE region, of progress achieved in

environmentally sustainable production and consumption with a focus on countries in transition, and addresses linkages with energy for sustainable development.

A. Industrial development trends in the UNECE region

46. *Industrial Sector Trends.* Over the past two decades, significant changes have taken place in the industrial sector in the UNECE region. In North America and Western Europe, structural changes in the production system have resulted in a shift from material- and energy-intensive sectors to services. There has been a shift from traditional industries such as iron, steel and petroleum refining towards electronic and electrical industries, telecommunication, data processing and fine chemicals. In UNECE transition economies, the industrial sector has shown varying trends in different groups of countries. While the share of mining has tended to drop in countries of central Europe, it has increased (production of petrochemicals and minerals) in several republics of the EECCA region. Over the last ten to fifteen years, western as well as central and eastern European economies have increasingly imported raw materials moving the environmental burden associated with their extraction to other parts of the world. At the same time, the EECCA countries have become major exporters of raw materials to the EU and have had mixed success in bringing about a shift towards less resource-demanding industrial sectors.

B. Industrial development and environmentally sustainable production and consumption

47. *Decline in Industrial Pollution.* Over the last 15-20 years the industrial sector has reduced its detrimental impact on the environment. Industry has become the first target of environmental regulations in many countries, which have encouraged the use of environmentally-friendly technologies. In the EECCA countries and south-east Europe, the decline in industrial pollution is associated with the transitional slump of the 1990s, and the environmental situation may deteriorate with the industrial output recovery.

48. *Air Pollution.* In Western Europe, the United States and Canada SO₂, NO_x and NH₃ emission dynamics have shown a clear de-coupling from GDP growth and this is also the case in the new EU member States (Czech Republic, Hungary, Poland, Slovakia, and Slovenia), where the economic restructuring and environmental actions also appear to have reduced air pollution levels.

49. *CO₂ Emissions.* Energy-related CO₂ emissions from manufacturing industries and construction over the past decade have also declined. In North America, Western Europe and Central Europe this is explained by structural shifts from manufacturing to a service-based economy, switching from solid fuels to gas, and efficiency improvements. In contrast, the dynamics of emissions generated by industrial processes differed for North America and the European Union countries. In the former area over the last 12 years these emissions increased by about 2 or 3 per cent, while in the latter they dropped by 15 per cent.

50. *Water.* Although the UNECE region has witnessed significant improvements in industrial wastewater treatment, heavy metals, nitrogen and phosphorous loading remain a problem. While the situation has improved in North America and Western Europe, progress has been less spectacular in Central and East European countries.

51. *Waste.* Since the early 1990s, the industrial eco-efficiency in the region has also improved. However, in North America and Western Europe the economic growth still couples with waste generation, and a comparable trend is developing in countries of Central and Eastern Europe. While in poorer parts of the region the consumption is much lower than in more developed areas, waste disposal remains a major problem there because of the lack of proper management.

52. *Soil Degradation.* Overall, damage to soils from industrial activities in the region is increasing; the main cause of soil degradation and loss being the sealing of soil surfaces as a result of increased building activities in densely populated areas. In many cases, the inappropriate location and inefficient management of industrial landfills, as well as mine waste deposits (overburden and tailings ponds), especially in transition economies result in land degradation due to soil pollution by heavy metals, oil products and other hazardous substances.

53. *Biodiversity.* Industry-related pressures have badly affected biodiversity in both developed market and formerly planned economies, and much of the remaining biodiversity is at risk in major industrialized areas. Throughout the region, chemical pollution and climate change are the major hazards to the diversity of species and habitat distribution.

54. *Industrial Accidents.* In contrast to accidents in fixed industrial installations, major oil spills from marine transport and offshore installation accidents have shown a certain downward trend. In addition to spills, leakage from old industry installations and pipelines and dam safety problems are of high concern, especially in Central Europe and the EECCA region, due to the environmental and health risks involved. In North America, Western and Central and Eastern Europe, there have been significant improvements in preventing environmental impacts of trans-boundary accidental surface water pollution. Minimizing the accident pollution risk and establishing an efficient warning system prove to be the most efficient tools to this end.

55. The Convention on the Trans-boundary Effects of Industrial Accidents aims at improving industrial safety and harmonizing safety standards across the entire UNECE region. The Convention facilitates cooperation among Parties to prevent industrial accidents, prepare for and respond to them. The implementation of the Convention is quite advanced in Central and Western Europe, while there are many challenges faced by many of the countries of East, South East Europe, Caucasus and Central Asia in implementing it. To assist the efforts of the EECCA and SEE countries in their efforts to implement the Convention and to improve safety at their hazardous industrial facilities, an internationally supported assistance programme was launched by the Conference of the Parties in 2004.

56. *New Strategies and Approaches.* The European Union's Integrated Pollution Prevention and Control (IPPC) Directive of 1996 aims to minimise pollution from various point sources throughout the EU and covers most industrial installations. It imposes Best Available Techniques on facilities in order to receive operating permits and, in many cases, can lead to quite radical environmental improvements, but may require large investments and much financial assistance in transferring new technology, especially to the transition region. Other initiatives such as the European Pollutant Emission Register (EPER), the new European Pollutant Release and Transfer Register (E-PRTR) and the EU's Environmental Management and Audit Scheme (EMAS) were conceived to help monitor industrial facilities' emissions. In parallel, the ratification of the Aarhus

Convention Protocol on PRTRs, which covers 37 countries in the UNECE region is now expected as early as 2007. The Protocol requires its Parties to establish national registers on emissions and transfers of 86 of the most environmentally significant pollutants, including greenhouse gases, acid rain pollutants, heavy metals and cancer-causing chemicals such as dioxins.

57. Other strategies such as life-cycle analysis have potential to help improve product design and the manufacturing processes. However, it is clear that this must be coupled with a change in consumption patterns and attitudes. Also, more must be done to engage SMEs that lack the resources of large multinationals to target environmental and social concerns.

C. Linkages to Energy for Sustainable Development

58. *Energy Consumption.* Energy consumption per unit of GDP in the emerging markets of the UNECE region is typically higher than in Western countries. The legacy of the planned economy plays a key role in accounting for the lower energy efficiency levels witnessed in these countries. The generally prevalent under pricing of energy resulted in an excessive consumption per unit of output vis-à-vis benchmark levels prevalent in market economies. The weakness of the system of incentives and poor allocation mechanisms promoted waste. Economic specialisation in energy-intensive activities was the result of the under pricing of energy and a deliberate bias towards industry, in particular heavy industry. These distortions were more acute in the former Soviet Union but they were also present in the rest of the region, resulting in typically higher shares of industrial and agricultural employment and a lower weight of services than those observed in market economies with similar levels of development.

59. *Energy Efficiency Measures.* While the transition to a market economy has promoted the incentives for energy saving, it is to be noted that wasteful practices and low relative prices of energy have been embedded in the existing capital stock, which limits the speed at which a more efficient pattern of energy consumption may emerge. This requires the replacement of the stock of capital inherited from the former system and this can only be achieved gradually. Structural change, resulting in a different composition of industrial output and the shift towards knowledge-based activities that are less material-intensive can, for the same reason, only evolve gradually even if the systemic transition progresses well. Investment is required to bring about both technical change within sectors and variations in the overall output mix.

60. Further gains in energy efficiency can be expected, particularly in EECCA where the scope for reducing energy consumption per unit of output is particularly large, even taking into account climatic differences. Energy prices are set to increase further, thus encouraging energy saving and promoting a structural shift towards less energy intensive activities. The speed in the elimination of the initial distortions and the changes in the structure of production have been correlated with the pace of implementation of economic and institutional reforms. Further progress in these areas will be instrumental in achieving higher energy efficiency, in particular through the hardening of budget constraints.

61. However, while energy efficiency in the emerging markets of the ECE region is lower than in Western economies, energy use per capita remains much lower, reflecting lower incomes. The impact of rising incomes has started to prevail in most countries over the reduction of energy

intensity, resulting in an overall increase in primary energy consumption. As the potential for income catch up is very large, this trend is expected to eventually dominate.

IV - Air Pollution/Atmosphere and Climate Change and Linkages to Energy for Sustainable Development

62. The key issues of air pollution and climate change are summarized below noting chapter 9 of Agenda 21 and the commitments in the Johannesburg Plan of Implementation. This section in particular considers interlinkages between air pollution and climate change, with sustainable energy development and with other issues. For additional information on the links between energy consumption, air pollution and climate change cf. paragraphs 18-21 above.

A. Air Pollution

63. Regional control of air pollution by UNECE member States has developed under the 1979 UNECE Convention on Long-range Trans-boundary Air Pollution - hereafter called the UNECE air pollution Convention (www.unece.org/env/lrtap). Forty-eight countries and the European Community are party to the Convention, a framework agreement with eight protocols with detailed obligations to control SO₂, nitrogen oxides (NO_x), volatile organic compounds (VOC), ammonia, heavy metals and persistent organic pollutants (POPs). Agenda 21, chapter 9.27(e) stresses the importance of implementation of such regional agreements for limiting trans-boundary air pollution.

64. Through implementing the Convention's protocols Parties have achieved large decreases in their pollutant emissions. Emissions of SO_x are down by nearly 70 per cent in Europe and more than 50 per cent in North America from their 1980 levels. NO_x and VOC emissions are declining but more slowly; while NO_x emissions in Europe have fallen by about 30 per cent overall, achievements of different countries vary and while energy and industry emissions have declined by 40 per cent, motor vehicles trail at 25 per cent. Controls on POPs and heavy metals are being implemented through Convention protocols. Overall, with the declining levels of pollutants, parts of the environment, such as acidified waters, are showing signs of recovery.

65. The Convention's protocols are built on sound science and the Convention's scientific networks on monitoring and modelling provide this. The scientific results are important inputs to decision-making. The Convention's integrated assessment modellers use the results to calculate maximum benefit, cost optimal abatement scenarios, which provide the basis for negotiating national emission ceilings.

Continuing challenges

66. *Pollution Effects.* Environmental recovery from acidification is often slow due to soil processes; so further cuts in SO_x and NO_x emissions are needed to speed recovery. Other pollutant effects persist; excess nitrogen deposition continues and the chronic effects of ozone and

PM remain. Even with the agreed controls, in 2010 there will still be problems; in Europe, 108 million hectares will have excess nitrogen deposition and the number of days with excess ozone concentrations will only fall by 50 per cent. Furthermore, protocol controls for PM emissions are lacking, and these have major impacts on human health across the UNECE region. For all pollutants further cuts in emissions are still needed to protect man and his environment.

67. *Shipping and Air Traffic Emissions.* While most sectors are cutting emissions, shipping and air traffic give increasing cause for concern. Although technology exists to clean up ship emissions, ships are largely uncontrolled in international waters and shipping traffic is increasing. Sulphur emissions from ships will soon surpass land emissions in Europe and NO_x emissions will be of increasing significance. Action on shipping is vital to protect some parts of the region. Air traffic also, while becoming more efficient, continues to increase in volume so pollution emissions are not falling.

68. *Road and Off-road Vehicles.* As explained above (cf. paragraph 40) there has been significant progress in improving the efficiency and emissions from motor vehicles. However, emissions from vehicle fleets are slow to fall due to the increasing size and age of most fleets. The trend for larger and more powerful engines, and increased road congestion, also offset technological improvements.

69. *Implementation of Air Pollution Convention.* Key to effective air pollution control is implementation of the UNECE air pollution Convention across the region. Many EECCA countries are still not party to many of the Convention's protocols and have noted the technical difficulties they have with implementation. A UNDA funded project on clean coal technology and air pollution control aims to help Central Asia States accede to the UNECE air pollution Convention and its protocols. The project is being expanded, using donations from Parties, to include other EECCA countries but more action is needed to achieve effective implementation.

70. *Links to Other Regions.* Parties to the UNECE air pollution Convention recognize other regions face major challenges to control air pollution. There is no global agreement for air pollution and other regional agreements are in their infancy. Even so, other regions are keen to share the Convention's scientific and technical knowledge and the Convention's work and achievements over the past 25 years provide an example of regional cooperation on air pollution.

71. *Regional, Global and Hemispheric Movement of Air Pollution.* In recent years the UNECE air pollution Convention has recognized that transboundary movement of pollutants takes place between, as well as within, regions, and it has held workshops and set up a Task Force on Hemispheric Transport of Air Pollution. The Task Force, while scientifically focused, is bringing together experts from countries across the northern hemisphere to consider global scale movement of pollution. Such inter-regional cooperation is essential for understanding pollutants that travel between regions, but at the regional level governments will need to appreciate what cannot be achieved by regional action alone.

72. *Agriculture.* Ammonia emissions from intensive agriculture are known to cause local pollution effects and excess nitrogen deposition has been identified as a major problem worldwide. However, ammonia reacts with sulphates and nitrate emissions to create particulates that affect human health and visibility. The particles can travel great distances and are a principal

component of the long-range transport of sulphur and nitrogen. Controlling ammonia emissions from agricultural sources has been much more difficult than expected and control measures have been unambitious. A first international step has been taken by the UNECE air pollution Convention which has included ammonia controls in its most recent protocol as well as drawing up guidelines for controlling ammonia emissions. However, much more action is needed to bring ammonia emissions under control.

73. *Use of Chemicals.* It is not just the energy and industrial sectors that are major emitters of air pollutants. The use of chemicals, e.g. as solvents, industrially, in farming and domestically is also important. Ozone formation is a result of emissions of both NO_x and VOCs that react together in sunlight; many UNECE countries are also implementing VOC controls in line with the UNECE air pollution Convention's protocols. In addition, more recent protocols on heavy metals and persistent organic pollutants (POPs) are controlling emissions of mercury, lead and cadmium and banning or limiting the use and emissions of 16 POPs. Many UNECE member States are also party to the Stockholm Convention on POPs that is concerned with 12 of the POPs of the protocol. UNEP also has a global mercury initiative that has the support of many UNECE States.

B. Climate Change

74. The United Nations Framework Convention on Climate Change (hereafter called the Climate Change Convention) and its Kyoto Protocol aim to tackle problems of a changing climate through controls of GHG emissions. At the regional level nearly all UNECE member States are Parties of the Framework Convention. Many member States have already made considerable efforts to cut their GHG emissions. Emissions trading may offer much potential for decreasing the overall emissions of GHGs.

75. Current scientific evidence collected by the Intergovernmental Panel on Climate Change (IPCC) suggests that further emission controls will be needed to avoid the problems of a warming climate (see below). Strategies to develop the necessary emission controls are not proving easy and there may be potential for considering joint control strategies for air pollution and climate change.

Continuing challenges

76. *The Continued Risk of Global Climate Change.* While considerable effort is being made by many countries to control emissions of GHGs, models indicate that much greater measures are needed to avoid the predicted changes of a warmer climate with increased risks of extreme events. Furthermore, such measures need to be taken globally for any chance of success. Studies show that global climate change is likely to cause rising sea levels, affect the sustainability of water supplies, agriculture, biological diversity etc in many parts of the world including areas of the UNECE region.

77. *Energy Efficiency Measures.* To meet the objectives of the Kyoto Protocol very large energy efficiency investments are needed especially in Eastern Europe, South-eastern Europe and the

Commonwealth of Independent States (cf. paragraphs 22-27). These areas have the highest carbon emissions that can be reduced most cost-effectively. Even so, the energy efficiency market in Eastern Europe is vast, estimated to be over Euro 200 billion. However, comparatively few energy efficiency investments have been launched in Eastern Europe due to policy barriers, inadequate financial engineering skills and the lack of appropriate financing mechanisms.

C. Linkages and synergies between air pollution and climate change

78. Many of the air pollutants covered by the UNECE air pollution Convention and the GHGs covered by the Climate Change Convention have common sources. Emission control strategies for such sources may simultaneously address air pollutants and GHGs.

79. Some air pollutants (e.g. tropospheric ozone and aerosols) also exert radiative forcing. Tropospheric ozone has the third largest positive radiative forcing after CO₂ and methane. Fine particles can also have a greenhouse gas effect though some may also cool. Other air pollutants, such as NO_x, carbon monoxide and VOCs, can act as indirect GHGs influencing the lifetime of GHGs such as methane. The chemistry in global circulation models has only recently begun to take full account of the important roles of conventional air pollutants.

80. Understanding the synergies in emission controls and simultaneously addressing local, regional and global objectives can achieve the most cost-effectiveness solutions. The International Institute for Applied Systems Analyses (IIASA) has shown the costs of reaching the UNECE air pollution Convention's emission ceilings targets could be reduced by more than €5 billion per year by implementing energy system changes that may be made domestically in line with the Kyoto Protocol (i.e. without international CO₂ emission trading).

81. As well as the synergies in emission controls for air pollution and climate change, it should be noted that there might also have to be trade-offs. Some air pollution abatement measures may increase energy consumption causing increased CO₂ emissions. Catalytic converters may increase nitrous oxide emissions. While cutting CO₂ emissions using biomass (e.g. fuel wood) could increase particulate matter (PM), CO and VOCs.

Continuing challenges

82. *Linking Air Pollution and Climate Change Policy.* So far links above have not stimulated much international action. Further scientific work, for example using the UNECE air pollution Convention's work on integrated assessment modelling to examine the links could be extended to include sustainable development strategies. Also, contacts between experts in air pollution and climate change should be enhanced, both nationally and internationally. For example, the European Environment Agency has linked climate change and air pollution in its European Topic Centre on Air and Climate Change. Cooperation between the UNECE air pollution Convention and IPCC would have obvious benefits.

83. *Linking Air Pollution and Climate Change Effects.* Both air pollution and climate change affect ecosystems, for example, biodiversity and forest growth. The mechanisms for the effects

are quite complex so there is a need for in-depth scientific work to identify the effects and their inter-relationship with other factors. Work under the UNECE air pollution Convention has shown, for example, that air pollution can be a predisposing factor to forest damage by insects and fungi. Such work should enable better predictions of the effects of continued pollution levels in a changing climate.

D. Linkages to energy for sustainable development

84. Energy development policies are important for promoting sustainable development and addressing consumption. However, the energy sector, together with transport and industry, have significant health and environmental impacts (see section II.B. above). In the past, energy production has contributed a major share to the SO₂ and NO_x emissions of many countries in Europe and North America, however emission controls on these sources have resulted in significant improvements in many areas. A great number of policies and measures are undertaken in the energy sector in line with Chapter 9.B of Agenda 21.

85. Reports by Parties to the Climate Change Convention show that cleaner fossil fuels, such as natural gas, were favoured because of their environmental advantages as well the decreases in emissions of CO₂.

86. To cut GHG emissions under the Kyoto Protocol, energy policy reforms and the institutional framework for emissions trading still need further development in UNECE member States. A number of Parties have reported progress in reversing their increasing trends in GHG emissions partly through implementation of policies such as emissions trading, carbon taxes and green certificate trading.