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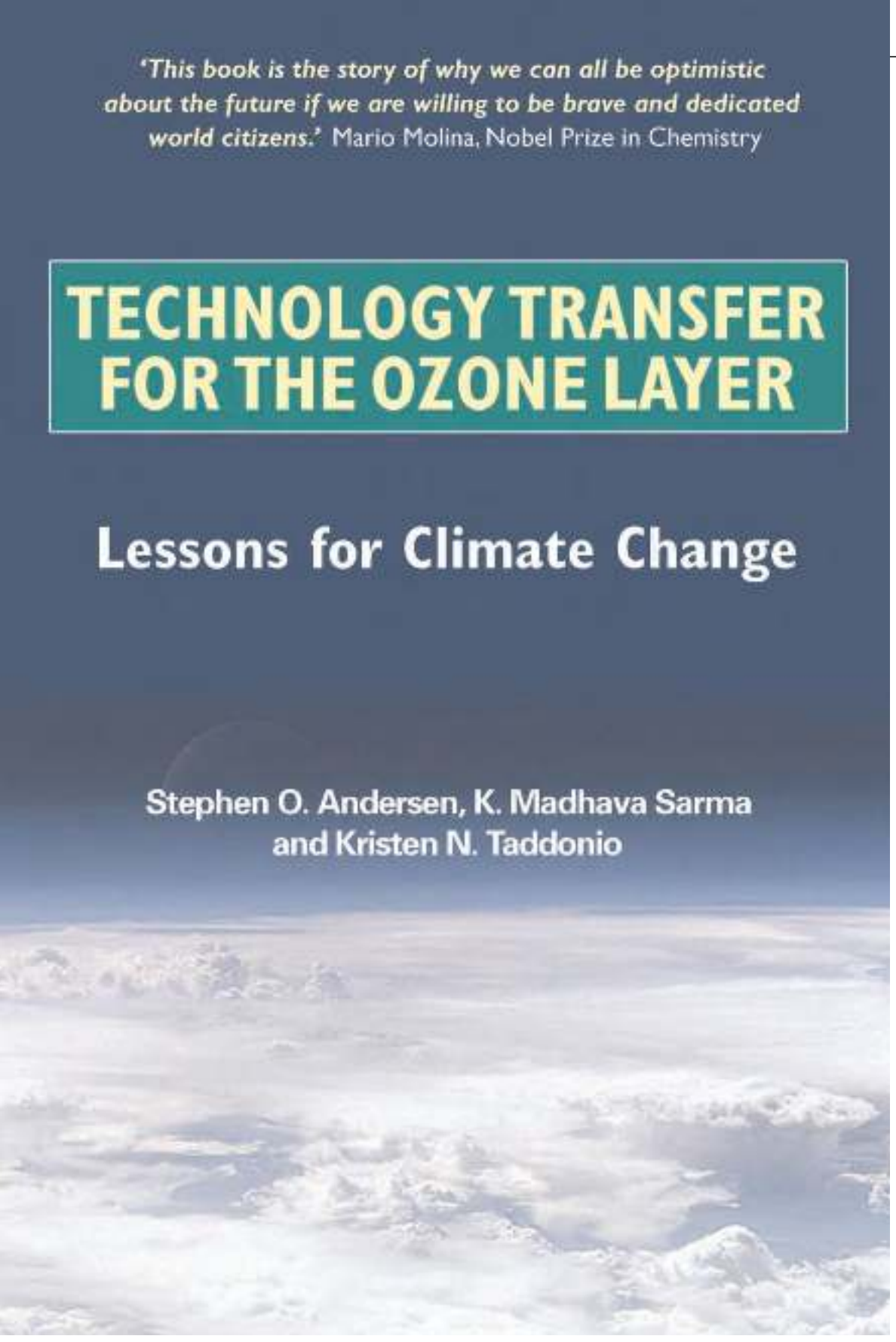
TECHNOLOGY TRANSFER FOR THE OZONE LAYER

Lessons for Climate Change

Stephen O. Andersen, K. Madhava Sarma
and Kristen N. Taddonio



Advance praise for ***Technology Transfer for the Ozone Layer***

'Imagine the pride of earning the Nobel Prize for warning that CFCs were destroying the ozone layer. Then imagine that citizens, policymakers, and business executives heeded the warning and transformed markets to protect the earth. This book is the story of why we can all be optimistic about the future if we are willing to be brave and dedicated world citizens.'

MARIO MOLINA, Nobel Laureate in Chemistry and Professor, University of California

'In 2002 I characterized Andersen and Sarma's *Protecting the Ozone Layer* as one of the most impressive environmental books ever written. Now, with Taddonio, they have produced a timely encore that should become one of the most important books for addressing climate change. This authoritative and meticulously researched treatise cuts to the heart of the problem: the crucial issues of technology research, development and diffusion that have been largely lost in the hot air of climate rhetoric. The authors rightfully put them centre-stage, and draw on the highly relevant success of the Montreal Protocol to provide detailed prescriptions for achieving an indispensable global energy technology revolution.'

AMBASSADOR RICHARD BENEDICK, US chief negotiator of the Montreal Protocol and author of *Ozone Diplomacy*

'A major global achievement in the field of scientific understanding and effective policy has been the set of initiatives taken to save the ozone layer, which provides inspiration and a useful model for action in the field of climate change. This book is extremely valuable reading for policymakers and scholars alike particularly in the context of the challenge of climate change being faced globally.'

R. K. PACHAURI, Chairman, Intergovernmental Panel on Climate Change (IPCC) and Director General, The Energy and Resources Institute (TERI)

'2007 is the 20th Anniversary year of the signing of the Montreal Protocol and there is cause for great celebration for the leadership of both developing and developed countries that led to the proper implementation of the Protocol. This book gives an authoritative account of how impossible challenges to the transfer of ozone-friendly technologies were overcome for the good of human society and ecosystems.'

MOSTAFA K. TOLBA, Under-Secretary-General, United Nations, and Executive Director, United Nations Environment Programme, 1976–1992

'The lessons documented in this book show that solutions to climate change are attainable and in the global economic interest – if we accept the challenge and make the commitment to deal with it.'

ALAN MILLER, International Finance Corporation (IFC)

'This book provides a forward-looking, substantive account of how technology transfer, at its best, collaboratively and cost-effectively enables countries to tackle the ozone layer issue – it demonstrates the relevance of lessons learned from the Montreal Protocol to environmental issues faced today.'

MARIA NOLAN, Chief Officer of the Multilateral Fund Secretariat

'The success of the Montreal Protocol has been supported by unprecedented technology development and transfer under the international collaboration. Japanese chemists and engineers are very proud of their voluntary participation in protecting the ozone layer for future generations. We believe the lessons learned during these twenty years help the technological challenge for the climate change. Lift your spirits up by reading how technology transfer can save the Blue Planet again.'

MASAAKI YAMABE, National Institute of Advanced Industrial Science and Technology, and Asahi Glass Company, Japan

'The authors have dedicated their entire personal capacity and lives to the fight for a better environment for all. Without their intelligence and dedication, the Montreal Protocol's unique success would not be there. In this book they extend their wisdom and experience to guide actions on our most serious environmental challenge: climate change. Having negotiated intensively in both of the environment regimes for more than a decade, I can assure you that this guidance is badly needed. I urge everyone to study carefully the valuable lessons from these eminent writers and implement them expeditiously.'

JUKKA UOSUKAINEN, Acting Director General, International Affairs Unit, Ministry of Environment, Finland

'Stephen Andersen and Kristen Taddonio of the EPA and Madhava Sarma of the Ozone Secretariat (retired) do an excellent job showing the many ways that voluntary partnerships speed global environmental protection. Programmes like the Energy Star label on efficient products and initiatives under the Montreal Protocol have produced dramatic results. Imagine what we can accomplish as we continue to transfer technology to protect the climate.'

KATHLEEN HOGAN, Director, EPA Climate Protection Partnerships Division

'A highly informative, well researched compendium of technology transfers effected under the Montreal Protocol, written by authors who have traversed the length and breadth of this successful environment treaty. Stakeholders of current and future global environment treaties will be vastly benefited when they study the whole process of technology transfers effected under the Montreal Protocol to phase out ozone depleting substances.'

ARUN BHARAT RAM, Chairman and Managing Director, SRF Limited (a leading Indian chemical company)

Technology Transfer for the Ozone Layer

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GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

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About the Authors

Stephen O. Andersen

Director of Strategic Climate Projects, Climate Protection Partnerships Division, US Environmental Protection Agency

Stephen O. Andersen began work on climate and ozone layer protection in 1974 as a member of the Climatic Impact Assessment Project on the effects of supersonic aircraft. With K. Madhava Sarma, he is author of *Protecting the Ozone Layer: The United Nations History* and, with Durwood Zaelke, *Industry Genius: Inventions and People Protecting the Climate and Fragile Ozone Layer*. Prior to joining the US Environmental Protection Agency (EPA), he worked for environmental and consumer non-governmental organizations (NGOs) and was a professor of environmental economics. In 1986, he joined the fledgling EPA Stratospheric Protection team, working his way up to Deputy Director. Since 1988, he has been Co-chair of the Technology and Economic Assessment Panel and has also chaired the Solvents Technical Options Committee, the Methyl Bromide Interim Technology and Economic Assessment and the Task Force on the Implications to the Montreal Protocol of the Inclusion of HFCs and PFCs in the Kyoto Protocol. He was co-editor of the IPCC/TEAP Special Report 'Safeguarding the Stratospheric Ozone Layer and the Global Climate: Issues Relating to Hydrofluorocarbons and Perfluorocarbons'. He pioneered voluntary programmes to phase out CFC food packaging, recycle CFCs from vehicle air conditioning, halt testing and training with halon, and accelerate CFC solvent phaseout in electronics and aerospace. He created the EPA ozone and climate protection awards and helped found the Industry Cooperative for Ozone Layer Protection and the Halons Alternative Research Corporation. He helped negotiate the phaseout of CFC refrigerator manufacturing in Thailand and the corporate pledge to help Vietnam avoid dependence on ozone-depleting substances (ODSs). He served on the team that commercialized no-clean soldering and the team phasing out ODSs from solid rocket motors. He is the recipient of numerous awards, including the 1990 EPA Gold Medal, the 1995 Fitzhugh Green Award, the 1995 UNEP Global Stratospheric Ozone Protection Award, the 1996 Sao Paulo Brazil State Ozone Award, the 1998 US

EPA Stratospheric Ozone Protection Award, the 1998 UNEP Global 500 Roll of Honour, the 1998 Nikkan Kogyo Shimbun Stratospheric Protection Award, the 1999 Vietnam Ozone Protection Award, the 2000 Mobile Air Conditioning Society Twentieth Century Award for Environmental Leadership, the 2001 US DoD Award for Excellence and the 2007 US EPA Best-of-the-Best Stratospheric Ozone Protection Award. He has a PhD from the University of California, Berkeley.

K. Madhava Sarma

formerly Executive Secretary, Secretariat for the Vienna Convention and the Montreal Protocol, United Nations Environment Programme

K. Madhava Sarma is currently a consultant on ozone issues and integration of the common aspects of global environmental treaties for greater synergy. With Stephen O. Andersen, he authored *Protecting the Ozone Layer: The United Nations History* (Earthscan, co-published by UNEP, 2002). He was the Executive Secretary of the Secretariat for the Vienna Convention and the Montreal Protocol from 1991 to 2000. During his tenure as Executive Secretary, he served the Parties to the Protocol through the turbulent Meetings of the Parties in Copenhagen, Vienna, Montreal, and Beijing – including three replenishments of the Multilateral Fund for the Implementation of the Montreal Protocol. He streamlined the administration of the institutions of the Protocol, the reporting requirements and other administrative obligations so that Parties could devote their full attention to resolving challenging political issues. Prior to being recruited to head the Secretariat, Madhava Sarma was a senior member of the Indian diplomatic team involved in the Montreal Protocol negotiations between the first and second Meetings of the Parties (1989–1991). During this time, he was often an effective spokesman for the developing country perspective and cosponsored many of the provisions of the London Amendment that satisfied developing countries while creating enforceable obligations to protect the ozone layer. He made other significant contributions as the senior Indian official looking after environmental policy, law, institutions and international cooperation, including responsibility for all global environmental issues. Prior to joining the national Government of India, he served (as a member of the Indian Administrative Service) as Head of District Administration, State Water Supply Board, and as Secretary to the Government, Irrigation and Power. During this state tenure, he was responsible for planning and implementation of many water supply, irrigation and energy projects. He earned the 1996 US EPA Stratospheric Ozone Protection Award and a 1995 award from UNEP 'For Extraordinary Contributions to Ozone Layer Protection', and the 2007 US EPA Best-of-the-Best Stratospheric Ozone Protection Award.

Kristen N. Taddonio

Project Director, Climate Protection Partnerships Division,
US Environmental Protection Agency

Kristen N. Taddonio is Manager of Strategic Climate Projects at the US Environmental Protection Agency (US EPA) Climate Protection Partnerships Division. She organizes public–private partnerships for environmental innovation, harmonizes international standards to speed technology market penetration, and directly promotes technology transfer with information, leadership pledges and conferences. In the Climate Protection Partnerships Division she brought together a team of international experts from industry, government, military, and standards organizations who are removing global barriers to climate-friendly refrigerants. The success of her team will allow vehicle manufacturers to market environmentally superior technology worldwide with confidence and safety. Her partners are from Australia, Austria, Belgium, France, Germany, India, Italy, Japan, Netherlands and the United States. At the EPA, she manages an annual budget of more than US$600,000 and organizes the annual Climate Protection Awards, which were established in 1998 to recognize exceptional leadership, outstanding innovation, personal dedication and technical achievements in climate protection. Prior to her latest promotion, she was a technical writer and a marketing associate for the Energy Star programme for new homes. She earned a Masters Degree in International Science and Technology Policy and a Bachelors Degree in International Environmental Resources from the George Washington University's Elliot School of International Affairs, where she graduated *summa cum laude*. She has also earned degrees in Scientific and Technical Communication and Liberal Arts. Her papers have been featured in plenary sessions of conferences and workshops in Austria, France, India, Italy, Japan and the US. She is Co-chair of the United Nations Task Force on the Legacy of the Technology and Economic Assessment Panel (TEAP) of the Montreal Protocol (Report published April 2007, United Nations Environment Programme, and Nairobi, Kenya). In 2007, the Mobile Air Conditioning Society–Worldwide presented Kristen Taddonio with the Government Partner of the Year Award.

Foreword

Throughout the world, the Montreal Protocol is viewed as a great success and a tribute to institutions, countries, and individuals that made it happen. We at the Global Environment Facility (GEF) are proud of our role in supporting countries with economies in transition (CEITs) in their efforts to implement the Montreal Protocol. We are encouraged by these countries' successes and welcome the opportunity to show how technology transfer and financing can solve the many daunting challenges of global environmental protection.

The GEF – the largest funder of environmental protection in developing countries and economies in transition – was created in 1991, at a time when it was clear that Russia and the Newly Independent States and the other countries of Central and Eastern Europe would need the global community's support to meet their obligations to phase out ozone-depleting substances under the Montreal Protocol.

Responding to the appeal of the Parties to the Protocol, the GEF provided financial assistance to them at a crucial juncture and enabled them to implement the Protocol. In 15 years, from 1991 to 2006, these countries have decreased their consumption of ozone-depleting substances from about 296,000 tonnes to 350 tonnes – a reduction of over 99 percent.

Global environmental problems cannot be treated in isolation. At the GEF, we increasingly work with countries to intervene across domains to address climate change, biodiversity conservation, sustainable land management and chemicals management, including pollution of international waters from persistent organic pollutants (POPs).

The GEF strategies for climate change, POPs and ozone layer-depletion are indicative of the flexibility that we exercise. Within each domain of intervention, project developers are encouraged to seek synergies and co-benefits with the other areas: for example, between ozone and POPs, or between climate change and ozone. This ability to work across global environmental issues is one of the greatest strengths of the GEF.

There are two potential ways in which the phaseout of ozone-depleting substances might increase the risk of climate change: using substitutes that have a high global warming potential; and introducing less energy-efficient technologies. Therefore, the focus of GEF's work has been to help the countries transfer from ozone-depleting substances to both ozone-safe and climate-safe options. The GEF funds the conversion to technologies that have the least impact on

global warming while being technically feasible, environmentally sound and economically acceptable.

The book also points out another important dimension of GEF's work: bridging the environment and development for sustainable development. It shows that technology conversions in many enterprises were instrumental in helping a number of sectors to modernize and adapt to a market economy.

I am pleased that the authors are recording this vital technology transfer story. A performance study of GEF has praised the Montreal Protocol process for its emphasis on clear goals and for creating an enabling environment for alternatives. The authors of this book have succeeded in bringing out the best from this process. I hope that the stakeholders of climate and other treaties will examine these lessons and adopt those that are suitable for their circumstances.

Monique Barbut
CEO and Chairperson
Global Environment Facility
Washington DC
June 2007

Preface

This is the first authoritative account of how technology was transferred worldwide under the Montreal Protocol. It tells the remarkable story of how governments, industry, consumers and the concerned public can, when faced with an environmental change crisis that threatens the health of the planet, work quickly and creatively to transform markets. As such it holds lessons on how to deal with other mutual and common challenges facing the environment, livelihoods, economic stability and human health across a wide range of spheres.

The story of the Montreal Protocol is worth repeating in all its detail. The Montreal Protocol of 1987 was the first convention based on the precautionary approach and the concept of a 'common but differentiated responsibility'. The preamble of the Protocol says the Parties to the Protocol are:

> Determined *to protect the ozone layer by taking precautionary measures to control equitably total global emissions of substances that deplete it, with the ultimate objective of their elimination on the basis of developments in scientific knowledge, taking into account technical and economic considerations and bearing in mind the developmental needs of developing countries,*
>
> Acknowledging *that special provision is required to meet the needs of developing countries, including the provision of additional financial resources and access to relevant technologies, bearing in mind that the magnitude of funds necessary is predictable, and the funds can be expected to make a substantial difference in the world's ability to address the scientifically established problem of ozone depletion and its harmful effects,*

These strategies were later made explicit in the 1992 Earth Summit in Rio de Janeiro as Principles 7 and 15 of the Rio Declaration and have been followed by virtually every environmental Convention since.

Piloted by UNEP, the Montreal Protocol allowed developing countries more time than developed countries to implement the control measures so that alternative technology would be mature and affordable. Developing countries had the advantage of 'leapfrogging' over alternatives that entered the market early but were soon made obsolete by technical progress. In 1990, on the urging of developing countries, developed countries agreed to finance the incremental costs of the phaseout in developing countries with its own financial mechanism

called the Multilateral Fund. In 1991, the Global Environment Facility (GEF) was created by the Governments to deal with a wide range of global environmental issues, including ozone depletion. The GEF financed the incremental costs of those eligible countries not qualifying for financing under the MLF, including the countries of Eastern Europe and central Asia with economies in transition. The original control measures of the 1987 Protocol were repeatedly strengthened by the Parties to the Protocol on the basis of periodic scientific and technological assessments to provide for the phaseout of nearly a hundred ozone depleting chemicals on a specified time schedule.

The success of the Protocol is now acknowledged by all, even though the phaseout of the ozone-depleting chemicals is by no means complete. 190 governments have ratified the Protocol and are actively committed to phasing out ozone-depleting chemicals. The Fund to date has granted more than US$2.1 billion to the developing countries to switch to ozone-friendly solutions. The GEF has assisted the CEIT to the tune of US$200 million. Technological cooperation over the last 20 years has led to outstanding reductions of over 95 per cent in the consumption of ozone-depleting chemicals. Continuing scientific observations through satellites, balloons and ground-based observation have confirmed this reduction, as elaborated in the periodic reports of the Scientific Assessment Panel.

Protection of the ozone layer involved a large number of stakeholders. Many United Nations organizations did their part, including: the United Nations Development Programme (UNDP); United Nations Environment Programme (UNEP); United Nations Industrial Development Organization (UNIDO); World Health Organization (WHO); World Meteorological Organization (WMO); Food and Agriculture Organization (FAO); and Regional Economic and Social Commissions. International financial institutions, such as the World Bank and the Global Environment Facility, and national financial institutions also played an invaluable part in implementation. Industry and industrial organizations eschewed their usual competitive spirit and shared technologies and techniques to phase out ozone-depleting chemicals. Non-governmental organizations not only kept an alert eye on the issue and sounded the alarm when necessary, but also developed ozone-safe technologies and spread awareness about such technologies. National governments employed many regulatory, economic and policy instruments to achieve the phaseout as planned.

Does the success of the Montreal Protocol process suggest any advice for other global environmental treaties? While the treaties differ from one another, there are many common strands among them. Most, if not all, treaties aim at replacing some of the current environment-unfriendly technologies with environmentally sound technologies. The challenges posed to the Earth's environment by some issues (like climate change) are so serious that the world community has to adopt the new technologies as soon as possible in all the countries.

This is precisely the challenge met by the Montreal Protocol process. It would be sensible for the world community to study the process and adopt its useful features so that time is not lost by reinventing the wheel with every

convention. This study will also be relevant to UNEP's Bali Strategic Plan for Technology Support and Capacity-building.

I am grateful to Stephen O. Andersen, who has been a co-chair of the Montreal Protocol's Technology and Economic Assessment Panel (TEAP) since its inception 18 years ago; Madhava Sarma, who served as the Executive Secretary of the Secretariat for the Vienna Convention and the Montreal Protocol for more than nine years; and to Kristen Taddonio, for agreeing to put together this book. It was a labour of love for them. They obtained contributions to this study from many of the people who made it a triumph. It is a timely contribution on the occasion of the twentieth anniversary of the Montreal Protocol.

I hope this history and analysis will please all those who contributed to the success of the ozone agreements, serve as an authentic record of one of the world's great achievements and assist other Conventions in their way forward.

Achim Steiner
Executive Director
United Nations Environment Programme
Under Secretary-General, United Nations