SRI LANKA COMMITMENT TO THE VIENNA CONVENTION FOR PROTECTION OF THE OZONE LAYER

INFORMATIVE BOOK

MARKING THE 30th ANNIVERSARY OF THE VIENNA CONVENTION

NATIONAL OZONE UNIT
MINISTRY OF MAHAWELI DEVELOPMENT AND ENVIRONMENT

UNEP
UNDP
Multilateral Fund
for the Implementation of the Montreal Protocol

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INFORMATIVE BOOK

MARKING THE 30th ANNIVERSARY OF THE VIENNA CONVENTION

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MESSAGE OF HIS EXCELLENCY THE PRESIDENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

I am pleased to send this message of greetings on the International Ozone Day, which marks the 30th anniversary of the Vienna Convention on Ozone Layer Protection and the 28th anniversary of the Montreal Protocol.

The life of all living beings is linked to the integrity of its ecosystems which is under threat of degradation today. Emerge of catastrophe due to destruction of the ozone layer that protects us against harmful UV rays was observed half a century ago and the releases of man-made ozone-depleting substances to atmosphere has created major problems in both human health and the ecosystem.

The expression of global political will to address this environment challenge was the Vienna Convention on the Protection of the Ozone Layer, which led to the establishment of the Montreal Protocol (MP) 28 years ago. The Vienna Convention and the Montreal Protocol are recognized as the most successful examples of multilateral environmental agreements and also it has contributed to a reduction of 97% in the global use of ozone depleting substances

The success of the Montreal Protocol is evident from the manner in which it integrated both environmental and economic considerations of developing countries in sustainable manner. However, Sri Lanka wishes to emphasize that most of the developing countries cannot be totally satisfied with the degree of commitment of some of the industrialized nations to the Convention and the Protocol.

It is imperative to note that our country contributes less towards destruction of the ozone layer. but susceptible to the negative effects of its destruction. Hence as a country we need to come up with environment friendly, cost effective technologies to minimize the use of ozone depleting substances and equipment. We are proud as a nation that Sri Lanka has demonstrated leadership in many areas and has been the catalyst for innovative approaches. Our Government recognizes the need for sustainable results concerning environment protection. Preservation of atmospheric heritage of mankind remains our chief concern and we look forward to continuing this success story through dedication and responsible manner.

Therefore, I join with you in celebrating the 30th anniversary of establishing Vienna Convention and international Ozone Day celebration. I sincerely offer my tribute to all those who had the good fortune to partner in creating this national success story. I wish this twin celebration every success.

Maithripala Sirisena
August 31, 2015

MESSAGE OF THE SECRETARY MAHAWELI DEVELOPMENT & ENVIRONMENT

I congratulate Vienna Convention which celebrates thirty years of its service to the whole world for taking actions to protect the ozone layer which saves life on Earth. After two years, in 1987 Montreal Protocol was established with patronage of majority of the states in the world in order to implement methodologies for protecting ozone layer more effectively. Throughout this period of time, Vienna Convention has committed in guiding whole world towards restoring fragile ozone layer back to normal.

As we know, ozone layer plays very important role for the sustainability of living beings on our planet Earth. Formation of ozone layer before appearing any life signifies the importance of ozone layer. However due to negligence of people who handle chemicals having ozone depleting potential has made a threat of survival of this natural shield that protect us and plants from harmful UV rays emit from the Sun.

Environmental degradation has been identified as common and major critical national issue for many countries of the world. Our Ministry is addressing these issues step by step seeking ways to find solution. It is understood that environment protection including ozone layer protection is an integral part of the sustainable development process. Any breakdown in the environmental stability would have serious implications to the stability of long term development of the country.

Most of the environmental initiatives are long term processes and achievement may only become visible in generations to come as we witnessing of restoring the ozone layer. However, we continue our duty enthusiastically in order to grant our future generation a more environment friendly living condition. By protecting ozone layer, we return to a safer environment which gives more health and climate benefits.

Sri Lanka is heading towards gradual phase out of Hydrochloroflurocarbons (HCFC) and introducing alternative substances and technologies which consist of characteristics such as zero ozone depleting potential, low or zero global warming potential and energy efficient without making any difficulty to the local industries and provide incentives and other facilities.

I congratulate the National Ozone Unit in timely publishing this informative book which will be a tool of information for readers.

Udaya R Senevirathne

FOREWORD
SENIOR ASSISTANT SECRETARY
DIRECTOR, NATIONAL OZONE UNIT

The year marks the Thirtieth anniversary of formation of Vienna Convention on Substances that Deplete the Ozone Layer in 1985. It acts as a framework for the international efforts to protect the ozone layer. However, it does not include legally binding reduction goals for the use of chemicals causing ozone depletion. As a result of incredible progress in reaching a global scientific consensus on the nature of the threat from ozone loss, on September 16, 1987, that the Montreal Protocol on Substances that Deplete the Ozone Layer was negotiated and signed by Canada along with 23 other countries. As of today, it has been signed and ratified by 197 countries, achieving universal participation.

Montreal Protocol is an extraordinary and still on-going success story and acting resolutely to protect all life on Earth from the Sun's harmful ultraviolet rays. The most significant commitments in the Montreal Protocol are the schedules for phasing out ozone-depleting substances (ODSs). Depending on the substance, developing countries like Sri Lanka have 10-15 additional years to meet phase-out targets compare to Developed countries. There are essential and critical use exemption provisions in which a Party is permitted to produce and consume a given ODS if specific stringent criteria are met.

While much has been accomplished, still there is unfinished business to carry forward. Completing ongoing accelerated phase out of Hydrochlorofluorocarbons (HCFCs) which mutually support for protecting ozone layer and combat climate change is the major issue. Their phase out offer a unique opportunity to acquire environment friendly technologies that not only eliminate ozone depleting chemicals, but also saves energy and maximizes climate benefits.

Establishment of National Ozone Unit (NOU) in 1994 under the Ministry of Environment is a landmark achievement of Sri Lanka's contribution to the global effort in protecting environment. The NOU has done much to the major achievements over the past 21 years in implementation of the Montreal Protocol in Sri Lanka. While we can take pride in the progress we have made, our goal is still remained. Adaptation to zero ozone depleting, Low Global Warming and Energy efficient alternative technologies and substances are the challenges that to be addressed immediately.

I hope this informative book will help readers to continue finding valuable source of information on the ozone science, recovery of the ozone layer, history of ozone protection activities, new technologies and actions that Sri Lanka has taken to date for sustainable environmental protection which has far-reaching benefits.

Finally I thank well-wishers for sending messages, experts who sent articles and NOU staff for making all arrangements. Production of this book has been a long journey and their valuable contribution has paved way for making our effort a success.

G.M.J.K. Gunawardana

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Precious Ozone, Precious Protocol

By
Tina Birmpili
Executive Secretary of
UNEP Ozone Secretariat

Thirty years ago, 28 parties decided to start preservingthe ozone layer,a shield that protects us and the environment from harmful radiation from the sun. A hole in the ozone layer had been detected over Antarctica in 1985.

Thirty years later, 197 parties are celebrating the results of their efforts to control chemicals that have been destroyingthe ozone layer. And today, there is scientific evidence that the ozone layer is healing itself and is expected to recover by the middle of this century.

The Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol on Substances that Deplete the Ozone Layer have so far led to a 98 per cent reduction globally of the historic baseline levels of the produced and consumed chemicals that destroy the ozone layer. They are therefore widely recognized as the most successful environmental treaties in history.

What have we avoided with the ozone treaties?

At a global level, we may be preventing 2 million cases of skin cancer each year by 2030.

In the United States alone, 283 million cases of skin cancer may be avoided for peopleborn between 1890 and 2100, 8.3 million cases being melanoma, according to the United States Environmental Protection Agency. In addition, 1.6 million deaths from skin cancer and 46 million cases of cataractsmay be prevented.

What have we contributed to the green economy?

In a significant boost to the green economy, the phase-outof substances that deplete the ozone layer has brought investment andchanged our daily production and consumption patterns by stimulating more efficient production processes, including energy efficiency.

The Montreal Protocol has also led to technology transfer, with the Multilateral Fund contributing more than US$3.1 billion from 1991 to date to all developing countries. Last year,countries that are parties to the Montreal Protocol agreed to replenish the Fund with US$507.5 million for the years 2015 to2017, the highest amount ever.

The phase-outof substances that deplete the ozone layer has also contributed to global gross domestic product growth by avoiding loss to agricultural and fishery yields due to increased UV radiation from the loss of ozone. According to some estimates, as much as US$460 billion may be saved during the period 1987 to 2060 due to avoided loss to agriculture, fisheries and material alone.

How much have we protected the climate through our efforts?

The Montreal Protocol has emerged as one of the most effective tools of climate change mitigation by averting more than 135 billion tonnes of carbon dioxide equivalent emissions going into the atmosphere.Without the Protocol, the world would now be suffering even more climate change impacts, including severe droughts, floods and storms.

The successes achieved through the Vienna Convention and its Montreal Protocol send three powerful messagesto the global community:

- First, we needed united action and universal membership of 197 parties to the ozone treaties to achieve the results that we celebrate today.
- Second, we needed the right science and an agreement on finance and technology to reconcile our different needs as nations and act as one on a global challenge.
- Third, we needed to be patient for 30 years to see the positive results of our concerted actions. The decisions we take now will bring results much later in the future, a fact that should be factored in during international discussions and negotiations.

But new challenges have emerged along this journey. The phase-out of substances that damage the ozone layer has led to the use of hydrofluorocarbons (or HFCs), a group of chemicals that do not deplete the ozone layer but contribute to global warming. Their emissions are growing rapidly and may in the future offset part of the good work done by the Montreal Protocol in mitigating climate change.

Countriesthat are parties to the Montreal Protocol are now discussing how best to manage HFCs using the mechanisms and the institutions of the Protocol in their ongoing mission to protect the precious ozone layer and the global climate.

The Montreal Protocol has showed what is possible for our world and within each one of us - if we dream, believe in collective action and work together.

UNEP Assistance to Sri Lanka for Ozone Layer Protection

By
Dr. Shamila Nair-Bedouelle
Head of Branch
United Nation Environment Programme, OzonAction

The Montreal Protocol on Substances that Deplete the Ozone Layer (MP) was designed to reduce the production and consumption of ozone depleting substances (ODS) in order to reduce their abundance in the atmosphere and thereby protect the Earth's fragile Ozone Layer. The original Montreal Protocol was agreed on 16th September 1987 and entered into force on 1st January 1989, which has now achieved universal ratification.

The XIX Meeting of the Parties to the Montreal Protocol in September 2007, through its decision adopted an accelerated phase-out schedule for Annex C Group 1 HCFCs. The first control is the freeze on production and consumption of HCFC from 1st of January 2013. Subsequent control steps are 10% reduction by 2015, 35% reduction by 2020, 67.5% by 2025, 97.5% by 2030 and complete phase out from 1st of January 2040.

The National Ozone Unit (NOU), established under the Ministry of Environment in Sri Lanka is the national focal point for the Montreal Protocol. Sri Lanka ratified the MP as early as December of 1989 and since then has been able to achieve Montreal Protocol targets on time without any complications due to successful awareness raising and legislative processes with assistance from the UNEP OzonAction CAP (Compliance Assistance Programme) Since, the ratification of the MP by Sri Lanka, it has successfully implemented all activities pertinent to ODS phase-out. The NOU has successfully implementing of activities associated with HCFC phase-out as stipulated under the HCFC phase-out management plan (HPMP) of Sri Lanka. UNEP CAP has been instrumental in acting as the implementing agency in supporting Sri Lanka with activities to keep in compliance with the Montreal Protocol.

Through the Multilateral fund (MLF), UNEP CAP is also assisting the NOU through the Institutional Strengthening (IS) project. The IS project is key to establishing and maintaining the institutional framework for implementing the HPMP activities in the country.

UNEP CAP is proud to have collaborated with the NOU to establish policy and regulatory framework to control the imports of HCFCs and HCFC-based equipments. Under the regulatory framework of the country, Sri Lanka has already banned the import of 54 chemicals out of the 96 chemicals that have been identified by the MP. UNEP congratulates the Government of Sri Lanka on the proposed decision of banning all equipments that could emit gases to the ozone layer by 2020.

The licensing and quota system of Sri Lanka is closely operated and monitored with the Sri Lankan Customs department; and the imports of equipments containing HCFCs would be subjected to a system of annual import quotas parallel to the introduction of the new license system for strengthening ODS control measures. UNEP has collaborated with World Customs Organization (WCO) to assist the NOU for providing training to Customs Officers on new harmonized coding system (HS). The HS for import and export for ODS is a new instrument to address the challenges of illegal trade.

The Technician Training Programme was established in June 2001 as part of the Refrigerant Management Plan (RMP) Project for CFC phase-out with assistance from the UNEP under the Montreal Protocol. This effort has strategically moved towards Technician Training Programme for phase-out of HCFC and builds on Good Practices in Refrigeration and Air-Conditioning (RAC) sector. UNEP CAP will remain committed to build the capacity of RAC service sector to handle alternatives to HCFCs, which are ozone and climate friendly.

UNEP CAP has been proactive in supporting Sri Lanka for fulfilling the spirit of Decision XIX/6 of the Meeting of Parties to the MP, which encourages Parties to phase-out ODS in the most environmentally friendly manner, including climate. UNEP is supporting Sri Lanka on the uptake of ozone and climate friendly alternatives. UNEP CAP has also organised several regional level Industry Roundtables, Technology Roadshows and Training workshops for NOU and other key stakeholders such as Standards, Energy and Procurement offices of Sri Lanka in order to build strategic institutional capacity on new ozone and climate friendly alternatives. At the national level NOU is being supported to undertake capacity building and awareness workshops on ozone and climate friendly technologies.

UNEP CAP highly values its partnership with the Government of Sri Lanka for the achieving the mandate of the Montreal Protocol. UNEP CAP will continue to strengthen its partnership with the NOU as the stage-II HPMP preparations commence and UNEP CAP team looks forward to working with the Government of Sri Lanka in future.

UNDP Lead Agency for Implementing Vienna Convention and Montreal Protocol in Sri Lanka

By
Joern Soerensen
Country Director,
UNDP - Sri Lanka

On the 30th anniversary celebrations of the Vienna Convention for the Protection of the Ozone Layer,it is with great pleasure that I communicate on this most successful treaty, ratifiedby 197 parties universally. Globally, through the dedicated Montreal Protocol Unit (MPU) established in 1991, UNDP spearhead and coordinate efforts to support developing countries as one of the implementing agencies of the Multilateral Fund. It has been UNDP's privilegeto have had the opportunity to contribute to the global success of the Montreal Protocol and stand ready to continue its support to developing countries to meet their obligations under the Protocol and assisting countries to move towards an inclusive and green development path.

In Sri Lanka, we continue to build on more than two decades of solid collaboration with the Ministry of Environment, the key focal agencyto implement the Montreal Protocol. Our partnership with the Government of Sri Lanka is one of the longest running programmes within UNDP Sri Lanka's Environmental Sustainability and Disaster Resilience Cluster. We continue to work closely with the National Ozone Unit (NOU) and the Ministry providing a variety of services which include capacity building, technology transfer, technical assistance, formulation and implementation of country and sector strategies, assistance to access and sequence funding from different sources, and facilitate public and private partnerships.

Sri Lanka's achievements standout regionally and globally, and we are proud to have been associated closely in this journey. Sri Lanka completed the phasing out of Chroloflurocarbons (CFC) ahead of time and is now phasing out a range of Hydrochlorflurocarbons (HCFC). The island is also one of the first countries to successfully complete the preparation phase of the HCFC Management Plan in the region and secure funding for its implementation. The NOU has received global and national recognition for its efforts as well. In 2007, Sri Lanka was awarded the most prestigious "Implementer's Award" at the 20th anniversary of the Montreal Protocol. The NOUhas received global and national recognition for its efforts and its projects have also successfully built public-private partnerships at the highest level.

Today, Sri Lanka is well placed to share with other countries the lessons learnt and best practices originating from its experience in successfully implementing this important international environmental convention. The success and good recognition which Sri Lanka has gained throughout this process would not have materialized had it not been for the excellent leadership of the colleagues at the NOU.

Although challenges remain, the Montreal Protocol has been recognized as a global success, demonstrated by the massive elimination of production and consumption of CFCs, halons, carbon tetrachloride, and methyl chloroform worldwide since it came into force in 1987. With the accelerated phaseout of the HCFCs in 2007, the Montreal Protocol has now turned into a treaty which protects both the ozone layer and the climate at this very crucial point in time.

On the 30th anniversary celebrations of the Vienna Convention for the Protection of the Ozone Layer, let me join in congratulating Sri Lanka on all its achievements. UNDP has been operating in Sri Lanka for almost 50 years and for 21 years we have worked closely with the NOU, Ministry and the Government of Sri Lanka to achieve these significant milestones. On this occasion, let me also assure you of our continued support. UNDP's collaboration with the Government of Sri Lankahas indeed been a privilege.

UNDP a Partner in many Achievement in Sri Lanka

By
Jacques Van Engel,
Director Montreal Protocol Unit / Chemicals Sustainable Development Cluster
Bureau for Policy and Programme Support
United Nations Development Programme

UNDP has been assisting the Government of Sri Lanka in implementing Montreal Protocol activities since 1992. The Country Programme for Sri Lanka was prepared with assistance from the Multilateral Fund and technical support from UNDP during the period 1992-94. From 1994, the Government has been implementing several activities including policies and regulatory initiatives for controlling and monitoring ODSs and ODS-using products, awareness and information outreach and capacity building activities including technical training for technicians and enforcement training for customs and enforcement officers, the implementation of investment project activities at enterprises using ODS, etc. The Government of Sri Lanka also obtained approval for its Refrigerant Management Plan in 2001 for assistance in refrigerant service sector. Through these initiatives, the Government of Sri Lanka has been able to achieve their Montreal Protocol targets successfully.

Sri Lanka also took proactive steps to achieve their Montreal Protocol targets in advance. Towards this, the Government secured approval of National Compliance Action Plan (NCAP) in 2004, with support from the Government of Japan as a bilateral partner. Along with other ODS phase-out projects, the Government of Sri Lanka was able to achieve the phase-out of CFCs, Halons, CTC, Methyl Chloroform and Methyl Bromide in 2008, 2 years in advance of their actual commitments under the Montreal Protocol.

We would like to highlight UNDP's assistance to Sri Lanka in achieving Methyl Bromide phase-out consumption in tea production. Methyl Bromide has been used in Sri Lanka since 1965 to exterminate tea nematodes, weeds and diseases from tea soils in the nursery and in the field. UNDP worked with the Government and Tea Research Institute (TRI) to assist the Ceylon Tea producers in using Methyl Bromide free alternatives. Through this project, Methyl Bromide consumption was completely phased-out in Sri Lanka in 2006. In May 2011, the "Ozone Friendly Pure Ceylon Tea" logo was launched as a remarkable success story in complying with a global environment treaty. Through the new logo, the Ceylon Tea industry is able to market the tea as a premium product that uses environmentally friendly technologies and practices in production.

Since 2011, UNDP has been assisting the Government in implementing HCFC phase-out activities to achieve their HCFC phase-out target. For this, a HCFC Phase-out Management Plan (HPMP) was prepared and approved by the Executive Committee of the Multilateral Fund to the Montreal Protocol in December 2010. Over the period 2011-2015, industries consuming HCFCs have converted to HCFC free climate friendly technologies. In addition, UNEP, as the cooperating agency, is assisting the Government in awareness and training activities relating to HCFC phase-out. Through project support from UNDP, assistance is also provided in promoting low GWP energy efficient technologies in Sri Lanka over and beyond the Montreal Protocol ODS phase-out compliance requirements. For example, Regnis has converted its foam manufacturing facilities to HCFC free low GWP alternatives as a part of a Montreal Protocol project and through its own investments converted the refrigerant technology from HFC-134a to HCs. There are also companies which sell low GWP energy efficient air-conditioners with information outreach support from the NOU under the project.

UNDP wishes to congratulate the Government on their proactive and systematic efforts in complying with the Montreal Protocol targets, and reiterate our commitments in working with the Government on future initiatives for adopting Ozone and Climate Friendly technologies in the country.

Establishment of the Montreal Protocol Unit and Sri Lanka's Initial Commitments

By
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PhD (Illinois), FIP.SL
Coordinator, MPU, 1994-99
Chief Technical Adviser,
M / Environment, 1993-99

Last year, 2014, the Ministry of Environment and Renewable Energy issued a SpecialPublication to mark the 20th Anniversary of the National Ozone Unit, originally known as the Montreal Protocol Unit (MPU). I contributed an article to this publication describing the early days of the MPU. The reader will have to bear with me forthe overlaps.

Adoption of the Vienna Convention and its Montreal Protocol

The depletion of the Ozone Layer over the Antarctica was observed by a team of British scientists during October each year commencing from mid-seventies. Concurrently, research conducted by two American scientists Mario Molina and Sherwood Rowland on the fate of chloro-fluoro-carbons (CFC), showed that chlorine atoms released from CFCs at stratospheric heights could convert ozone into oxygen catalytically causing its depletion. Identifying the link between these two findings, the United Nations Environment Programme (UNEP) took the initiative to summon a meeting of nations in Vienna in September 1985 to discuss this issue. The meeting resulted in the nations adopting the Vienna Convention (VC) for the Protection of the Ozone Layer.

With more evidence of depletion, the nations in 1987 adopted the Montreal Protocol (MP) on Substances that Deplete the Ozone Layer, a treaty with legal binding, with the objective of controlling the consumption of CFCs in order to prevent any further damage to the Ozone Layer. The MPhad incorporated specific targets, both quantity-wise and time frames, for reducing the consumption of ozone depleting substances (ODS) by all Parties. The developing country Parties consuming below 0.3 kg of ODS per capita were granted a grace period of 10 years to comply.

The original MP adopted in 1987 provided for developed country Parties to phase out 50% of ODS listed in Annex A, comprising 5 CFCs and 3 Halons, relative to consumption in 1986 by January 2000. With further depletion of Ozone Layer being reported, the MP was amended at a meeting held in London in 1990 to bring additional ODS under control (Annex B) and to phase out ODS totally by 2000 in developed countries. The Protocol was further amended thrice to bring in more substances under control (Annexes C, E and F); in 1992 at Copenhagen, in 1997 at Montreal and in 1999 at Beijing.

Accordingly, the Parties were required to change over to processes that use non-ODS substances in various applications that hitherto used ODS. The MPmade provisions for granting financial and technical assistance to developing country Parties forchanging over to these new processes. For this purpose, the MP established a Multi-lateral Fund (MF) to consider country programmes submitted by Parties and provide financial assistance to them to implement the programmes. In order to assist the MF in this exercise, several UN agencies including UNEP, UNDP, UNIDO and the World Bank were designated as implementing agencies.

Sri Lanka's programme to phase out ODS

Sri Lanka ratified both the Vienna Convention and the Montreal Protocol on 15 December 1989, designating the Ministry of Environment (MoE) as their focal point. In October 1991, a consultant from UNDP visited Sri Lanka to appraise the MoE on the availability of funding from the MF to undertake a programmefor phasing out the consumption of ODSas required by the MP. The MoE responded by submitting a proposal for carrying out a reconnaissance survey of ODS consumption and formulating a country programme for ODS phase-out. This was accepted by the MF and a sum of USD 30,000was approved in February 1992.

The UNDP consultant's visit also had another purpose – that was to identify and recommend a suitable person to implement the programme. At that time, I was attached to the Ceylon Institute of Scientific and Industrial Research (CISIR) which was then under the Ministry of Industries, Science and Technology (MIST). During 1969-1972, I had carried out research on developing a model for the neutral and ion chemistry of the middle atmosphere, for my PhD degree at the University of Illinois. This model included all possible compounds, including ozone, that can be formed in an O-N-H-C system and it involved radiative, chemical and transport processes.However, my model did not have chlorine as the depletion of the Ozone Layer was not known at

that time. After returning to the country in 1972, I made a presentation on this topic at a seminar organized by the Sri Lanka Association for the Advancement of Science (SLAAS). It provided me with an opportunity for making public my expertise on the ozone chemistry.

This resulted in the UNDP Consultantvisiting me.After finding out my background, he expressed his desire that I undertake the study. I consented subject to getting the concurrence of the MIST. The funds received by the MoE was transferred to the MIST in August 1992. After obtaining the release from the CISIR management, I sought approval from the MIST. However, MIST did not approve my release, and instead decided to seek a nomination of its own from the university system. Subsequently, a faculty member from a universitywas selected as the National Consultant (NC) to undertake the study.

Establishment of the Montreal Protocol Unit

A few months later, the MoE advertised several senior positions. I applied and was selected.I joined the Ministry as its Chief Technical Adviser in April 1993after resigning from the CISIR. At the MoE, I was assigned tasks pertaining to environmental issues linked to such topics as energy, transport and industries. In addition, I handled matters pertaining to the implementation of the international conventions on climate change and ozone depletion of which the Ministry was the focal point. In the meantime, the NC after completing the study, submitted his report to the MoE in October 1993. The MoEforwarded it to the UNDPwho in turn forwarded it to the MF in January 1994.

The MF, however, returned the report to the MoEin February 1994 requesting it be resubmitted after carrying out some major revisions within a short time, andthe task was assigned to me. After verifying the data collected, filling the gaps and recasting the text, I was able to accomplish the task and resubmit the reportwithin the stipulated time. The MF at its meeting held in March 1994 accepted thisreportand allocated a sum of USD 154,680 to implement the proposed Country Programme for a period of three years. This decision was conveyed to the Ministry in April 1994.

An agreement was signed between UNDP and the Government of Sri Lanka on 29 April 1994 for implementing the Country Programme to phase out consumption of ODS in the country. The Programme was formally inaugurated on 01 July 1994, with the establishment of a separate unit within the ministry named Montreal Protocol Unit (MPU) to handle related activities. I was appointed the head of the MPU designated as Coordinator. A Technical Officer and a Secretarial Assistant were appointed and the necessary office equipment were purchased. A separate bank account was opened with Treasury approval to receive money sent by UNDP.

Coordinating Committee for implementing the Montreal Protocol

Even before the formal establishment of the MPU, the Ministry had appointed a Coordinating Committee for implementing the Montreal Protocol (CCMP), soon after my appointment to the Ministry. The Committee met once a month and was chaired by the Secretary to the Ministry. In consultation with the CCMP, the Ministry drew up a work-plan comprising many activities including policy measures, reconnaissance surveys, fiscal measures, publicity programmes, ODS phase-outprogrammes, training programmes and awareness programmes.Once the MPU was established, it was entrusted with the task of implementing the work-plan, which was to be completed within the initial 3-year period.However, after reviewing the progress at the end of 3 years, the project was extended as several programmes were on-going and new obligations on Parties had been decided by MOP.

The CCMP comprised representatives of several ministries including Industrial Development, Science and Technology, Trade and Commerce and Foreign Affairs; several departments including Meteorology, Customs and Attorneys General; and several institutions including Central Environmental Authority, Ceylon Institute of Scientific and Industrial Research, Open University and Chamber of Commerce. In addition to making recommendations on activities to be undertaken, CCMP also performed the function of monitoring the MPU activities.

Implementation of the Work-Plan

Policy measures

The MPU took the initiative to prepare policy documents requiring amendments to regulations governing import of ODS and equipment containing ODS, in consultation with the CCMP. These documents were submitted to the relevant ministries through the MoE for publishing in the Government Gazette. In some of them the approval of the Cabinet of Ministers was also obtained.The details of the policy documents are described below.

Phase out of ODS: The MP requiresthat developing country Parties consuming less than 0.3 kg per capita of Annex A ODS shouldphase out their consumption by 01 January 2010, 10 years after their phase out in developed countries. Since it would be more economical to phase out ODS early, after discussing with the industrialists and the trade, CCMP recommendedto the Ministry that Sri Lanka should phase out the use of ODSspecified in Annexes A and B of the MP in new equipment by 01 January 2000, while allowing their use for servicing of equipment up to 01 January 2005. This recommendation was approved by the Cabinet of Ministerson 17 November 1993. Subsequently, the Ministry published a gazette notification on 20 December 1994 under the National Environmental Act No. 47 of 1980 giving effect to these regulations.

New Customs Codes: In order to facilitate the implementation of the above regulations and the collection of data on ODS imported to the country, the MPU through the Ministry recommended to the Presidential Tariff Commission in October 1994 to incorporate new Harmonized System (HS) of Codes for ODS given in Annexes A & B. The new list of HS Codes was published in a gazette notification dated 08 November 1995.

Licence forimport of ODS containing equipment: On the recommendation of the MPU made through the Ministry, the Ministry of Trade and Commerce broughtthe import of equipment containing ODS included in Annexes A & B, under a license scheme as provided for in a gazette notification dated 25 June 1996. The import licences were issued on the recommendation of the MPU.

Licence for ODSimports: On the recommendation of the MPU made through the MoE, the Ministry of Trade and Commerce broughtthe import of ODS included in Annexes A & B, under a license scheme as provided for in a gazette notification dated 13 November 1996. The import licences were issued on the recommendation of the MPU.

Surveys conducted

The following surveys were conducted to collect data on consumption of ODS in relevant applications for planning their phase-out.

ODS consumption: A survey was undertaken by the MPU on the consumption of ODS imported to the country by contacting the importers directly as there were only a few of them. The quantities imported were found to vary from 210 t in 1990 to 569 t in 1995.

Refrigerator/AC workshops: During the initial reconnaissance survey, it was found that the highest consumption of ODS was in the refrigerator and air-conditioner (AC) repair workshops. Hence a detailed survey of these workshops was undertaken island-wide, according to which a total of 450 workshops undertaking refrigerator repairs were identified. Out of these about 300 workshops undertook repair of domestic and mobile AC equipment. These were consuming 30 t of CFC11, 160 t of CFC12 and 10 t of CFC115 refrigerants, annually.

Central AC systems and cold rooms: A survey was conducted to identify central AC systems installed in commercial buildings, hotels and government offices, and cold rooms installed in food storage facilities, fisheries harbours and hospitals. Their total number was found to be about 150 having a total capacity of about 6.3 t of ODS which require about 10.5 kg annually for servicing.

Fire extinguishers containing Halon: A survey conducted to identify Halon-containing fire extinguisher equipment revealed that there were 17 installations containing 390 kg of halon 1211 and 8 installations containing 646 kg of Halon 1301. It was also noted that Halon was not imported any more to the country at that time.

Projects for eliminating ODS use in industries

The following projects were proposed to the MF seeking funding for eliminating the use of ODS in industries. In all these, the MPU prepared the pre-proposal while the detailed proposal was prepared by a visiting consultant. The implementation of the project was undertaken by the MPU.

Refrigerator factories: The country had 3 refrigerator factories in 1994 manufacturing about 30,000 units of domestic refrigerators and freezers consuming approximately 20 t of ODS annually. The ODS consumed comprised CFC12 used in compressors and CFC11 used for insulation blowing. In response to a pre-proposal submitted by the MPU, a UNDP consultant visited the three factories in November 1994 and prepared a project proposal to eliminate 20.5 ODP t. The MF approved the project in July 1995, allocating a sum of USD 773,938. The project was successfully completed in mid-1997at two factories after converting to HFC134a in place of CFC12 and to HCFC141b in place of CFC11. The MPU faced a problem with the third factory which was closed down due to a labour dispute after delivery of the equipment under the project. The equipment was later transferred to another factory with the approval of the MF.

Aerosol product manufacture: Sri Lanka had only one factory manufacturing aerosol products. It produced annually approximately 800,000 units using 5.2 t of CFC12. In response to a pre-proposal submitted by the MPU in March 1995, a UNDP Consultant prepared a project proposal which was approved by the MF in December 1995 allocating a sum of USD 38,968. The project recommended the use of Dimethyl Ether as the propellant and it was successfully completed in mid-1996.

Activated carbon industry: Sri Lanka had several factories manufacturing activated carbon (AC) from coconut shell charcoal for use in industries as an adsorbent. Carbon tetrachloride (CTC) having an Ozone Depleting Potential (ODP) of 1.1 is used as a reagent in the determination of the activity of AC. In 1995, 14 t of CTC was used in the AC industry out of a total 21 t imported. The MPU submitted a proposal for the elimination of CTC in the AC industry by using another reagent n-butane in place of CTC. However, the MF did not approve the project on an objection raised by a delegate as he felt that the project would benefit the industries in developed countries who were the main consumers of AC supplied by Sri Lanka.

Methyl Bromide in tea industry: The tea industry in Sri Lanka was using annually over 4 t of Methyl Bromide (MeBr) having ODP of 0.6 for fumigating tea nursery soil beds in the control of nematodes. At the request of the MPU, the Tea Research Institute (TRI)submitted a pre-proposal for the elimination of the use of MeBr which was submitted to UNDP in September 1995. A UNDP Consultant visited Sri Lanka to prepare the project proposal which was approved by the MF after much negotiation in view of the small quantity of MeBrto be eliminated under the project. It was noted that none of the other tea-growing countries used MeBr in their tea nurseries. The project was successfully completed by the TRI and the methodologies using alternative substances recommended under the project are now being implemented by tea plantations.

Recovery and recycling of ODS

This was a key project initiated by the MPU to prevent approximately 160 t of CFC12 released into the atmosphere during repairs to domestic refrigerators and mobile AC systems. In response to a pre-proposal submitted by the MPU in February 1996 to UNDP, a Consultant visited Sri Lanka in May 1996 and prepared a detailed proposal which sought a grant of USD 352,400 to eliminate 30 t of CFC12 annually. The proposal was approved by the MF in October 1996. The project provided for establishing 4 recycling centres and distribution of recovery equipment among workshops who responded to a press notice published calling for applications. The equipment were distributed after holding a workshop for the training of workshop staff on the recovery of CFCs from equipment during repairs. The recovered CFC was expected to be taken to a recycling centre for purification before re-use.

Awareness programmes

The MPU held a number of awareness programmes in high schools, technical colleges, scientific organizations and civil organizations to educate the participants about the adverse impacts of ozone layer depletion and the importance of phasing out of ODS. Articles were published in print media and members of the MPU participated in panel discussions in electronic media on several occasions, particularly in the commemoration of the International Ozone Day.

Conflict between the Montreal and Kyoto Protocols

Ialso place on record the significantcontribution made by me as Sri Lanka's delegate to the 17thOpen-Ended Working Group (OEWG) meeting held in Geneva in 1998 in submitting a conference room paper (CRP) highlighting the conflict between the Montreal Protocol and the Kyoto Protocol (KP) of the UN Framework Convention on Climate Change. The conflict is that the MP promotes the use of Hydro-Fluoro-Carbons (HFC), a non-ODS substance, as a replacement for chloro-fluro-carbons (CFCs) while they havebeen brought under control by the KP in view of their high global warming potentials. The deliberations that commenced in 1998 consequent to this CRP are continuingto-date 15 years later with no consensus reached. It would be in Sri Lanka's interest that this initiative be kept on record.

I take this opportunity to convey my very best wishes to the NOU for continued success in phasing out ODS consumption in the country, and in keeping Sri Lanka's flag flying at international fora.

Overview of Ozone Layer Protection as a Tool for Mitigating Climate Change

By
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Former Director,
National Ozone Unit

Atmospheric composition or amount of gases and other substances in the atmosphere is responsible for weather and climate of the earth. The physical processes and chemical composition of the atmosphere determines the energy inflow and out flow from the atmosphere. The balance or the imbalance of the energy in the earth's atmospheric system determines the climate.

Formation of the stratospheric ozone layer has taken place billions of years ago and it helps in the formation and survival of living organisms on planet Earth. The natural processes helped to keep the balance of forces including energy for the survival of living beings. The harmful high energy radiation from the Sun is filtered out from the naturally formed ozone layer in the upper atmosphere. The high energy ultraviolet (UV) rays split the diatomic oxygen O2 into atomic oxygen and the combination of three atomic oxygen forms the tri-atomic oxygen or the ozone. This happens at high level of the atmosphere where incoming UV rays first meet the atmospheric oxygen.

UV can be divided into three categories according to their wavelength and energy. UV – A ($320 < \lambda < 400$), UV – B ($280 < \lambda < 320$), UV – C ($100 < \lambda < 280$) where λ is the wavelength in nanometers.

Formation

$O_2 + h\nu$ (UV – C energy) $\longrightarrow O + O$

$O_2 + O \longrightarrow O_3$

Deformation

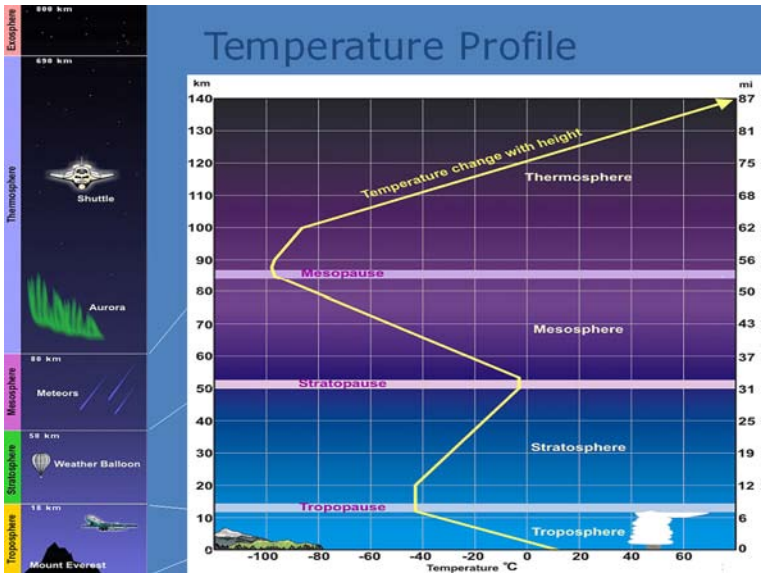
$O_3 + h\nu$ (UV – B energy) $\longrightarrow O_2 + O$

$O + O_3 \longrightarrow O_2 + O_2$

High energy in UV – C is needed to break the bond in oxygen to produce atomic oxygen. The ozone produce this way is unstable due to UV – B attacking and breaking it down to form oxygen again. So in the natural process the two reactions are taking place continuously and there is a dynamic equilibrium which keeps the amount of ozone at the stratosphere (upper atmosphere) where the ozone layer was at a healthy level.

Table 1: Formation and Deformation of Ozone (Natural)

Through this process the amount of solar energy, especially high energy radiation, reaching the lower atmosphere and the surface of the earth is controlled. A substantial amount of energy (shortwave radiation) is absorbed/trapped at the stratosphere where a temperature inversion is created and this in turn restricts the cloud height to around 10 kilometers (Figure 1).



This has a substantial effect on climate and weather of planet earth. The size (height) of the cloud determines the rainfall amount and the strength/level of lightning activity as well. Since the amount of energy reaching the surface of the earth more or less is limited to visible light (which is essential for life on Earth) and thereby the earth/ atmosphere temperature is controlled.

Problems Associated with Human Activities

In 1920s certain chemicals were produced for industrial uses and they were user friendly and were popular in many industries. The spread of these over the whole world were very rapid replacing many natural substances that were used due to their outstanding quality and usefulness. There were a series of chemicals that were produced and out of those CFCs replaced and occupied industries like refrigeration and air-conditioning as a refrigerant, as a solvent, in foam production, as a cleaning agent, as a propellant, in Metered Dose Inhalers (MDI) etc. There were others halogenated hydrocarbons that were very popular in industry, agriculture, shipping and aviation, firefighting, pest control etc.

By 1970s scientists discovered that the ozone layer was depleting. Later it was further supported by many other investigations. With this background UNEP and WMO organized a meeting of governments, policy makers and scientists that resulted in the establishment of the Vienna Convention for protection of the ozone layer in 1985. Further evidence directed to manmade chemicals such as CFCs are responsible for this disaster. As such Montreal Protocol on substances that deplete the ozone layer was born in September 1987 as the legal instrument of the Vienna Convention. Protection of the ozone layer was so important that Montreal Protocol was amended several times as London 1990, Copenhagen 1992, Montreal 1997 and Beijing 1999.

Substances that deplete the ozone layer and Montreal Protocol

There are a series of ozone depleting substances (ODSs) which are mainly produced at production plants for the use in many industries (Table 2).

Table 2: Manmade Chemicals (Ozone Depleting Substances and Greenhouse Gases)

Substances	Ozone depleting potential (ODP)	Global warming potential (GWP)
Chlorofluorocarbons (CFC)	**0.6 - 1.0**	**4,680 - 10,720**
Halons	**3.0 - 10**	**1,620 - 7,030**
Carbontetrachloride (CTC)	**1.1**	**1,380**
Methyl Bromide (MeBr)	**0.6**	**5**
Hydrochlorofluorocarbons (HCFC)	**0.01 - 0.5**	**76 - 2,270**
Hydrofluorocarbon (HFC)	**0**	**560 – 3,450**

Some of these are CFCs, Halons, Carbon tetrachloride, Methyl bromide, Methyl chloroform and HCFCs. These substances have different potentials for depleting ozone, which is labeled as ozone depleting potential (ODP) as seen in Table 2. With this evidence Montreal Protocol set targets to phase out ODSs, taking out most powerful substances early while environment friendly alternatives are proposed as replacements. Due to successful implementation of Montreal Protocol, most of ODSs are eliminated from the world by taking action to stop manufacturing, trading and sales, and usage.

Interlinkage of ozone depletion and climate change

1. When ozone layer is rapidly depleted the high energy shortwave radiation (UV, X-rays, γ-rays) from the Sun will reach the surface of the earth. With additional energy the earth's surface will attain relatively a higher temperature. This can lead to many unwanted and unexpected consequences such as climate change and natural disasters.
2. According to recent measurements the surface UV radiation has increased. When UV radiation reaches the lower atmosphere it will produce ozone by splitting oxygen at ground level. This also has led to increase in ozone at ground level. Ozone is a powerful greenhouse gas and studies have indicated an increase

of topospheric ozone which ranks as the third largest contributor among greenhouse gases. Therefore with this enhanced greenhouse effect the temperature will increase and it will lead to climate change. Furthermore studies on global troposphere ozone suggests an annual mean increase of more than 30% since preindustrial times due to anthropogenic emissions of NOX, CH4, CO which are ozone precursors. Ozone is also a toxic gas and increase of ozone at the expense of oxygen at ground level will force a dangerous health risks as well as crop damage.

3. The very effect of forming ozone at upper atmosphere is responsible (by absorbing/ trapping high energy and warming at that level) for the creation of temperature inversion which created stratosphere from 10 kilometer to 50 kilometer and producing the tropopause at around 10 kilometers from the surface of the earth. If the ozone layer is depleted the temperature inversion and the stratosphere will vanish and the tropopause which limits the convective level and the height of the cloud top will be removed as such troposphere will have a height of about 80 kilometers and a convective cloud/ thunder cloud will rise up to that level (Figure 1). Model studies also have noted rise in troposphere height and it is expected to continue even as ozone depletion in the stratosphere reduces. This certainly will have a devastating effect on weather and climate by producing heavy rainfall, floods, enhanced powerful thunder activity and severe tornado etc.

4. UV radiation is harmful not only to humans but also for all life on planet Earth including plants. Increased UV radiation will destroy plants, first the fragile ones and eventually the forests as well. Reduction in forest and retardation of growth of plants due to action of UV means less intake of carbon dioxide. Therefore it reduces the natural sink for atmospheric carbon dioxide and leads to increased carbon dioxide in the atmosphere. This in turn produces temperature increase and climate change.

5. Area of surface water bodies on the planet Earth is higher than the land surface. UV is high energy radiation and can penetrate deep into water bodies. Through this process the phytoplankton will be destroyed. Higher amounts of plant life are in the water bodies and destroying these plant species in water bodies means less absorption of atmospheric carbon dioxide and enhanced carbon dioxide in the atmosphere that leads to climate change through increase of temperature.

6. Almost all manmade ODSs are very powerful greenhouse gases with unbelievable global warming potential (Table 2). If left unattended the major role played by carbon dioxide as the main greenhouse gas would have been overtaken by ODSs such as CFCs etc.

7. Montreal protocol is an exemplary example of successful international environment treaty which phased out ozone depleting substances. But in the process of phasing out ODSs, HFC was introduced (which is also a synthetic substance) as an alternative which is ozone friendly substance. However HFC has a high Global Warming Potential (GWP) and a long life span in the atmosphere. Further due to this same reason, HFC is one of the six substances in the Kyoto basket of gases where world community has agreed to control emission into the atmosphere under Kyoto protocol of the United Nations Framework Convention on Climate Change (UNFCCC). Although many countries are party to both Montreal Protocol and the Kyoto Protocol it is surprising to note that HFC was introduced as a substitute for CFC and many other ODSs. It is hoped that HFC will be taken up at Montreal Protocol even though it is not a ODS, just to remedy the situation created by Montreal Protocol by taking into consideration the bigger environment problem created by introducing HFC as an alternative to ODSs .

HFC issue is clear indication that environment has to be considered as a whole and finding solutions to problems in isolation is not acceptable. Natural environment is a system in balance providing support for every system by providing interlinkages among them. Change in one system will influence the other. Therefore holistic view of the natural environment is necessary in order to avoid unexpected problems in many systems which will

finally affect the survival of living beings on planet Earth. Global environment is common to all on the planet Earth and it is the duty of human kind to work together with common understanding whether poor or rich, developed or developing, north or south, major or minor communities for the survival of all.

Montreal Protocol on substances that deplete the ozone layer and its unprecedented and vigorous drive to protect the ozone layer has successfully phased out most powerful ozone depleting substances. It is well understood that they are also very powerful greenhouse gases. Montreal Protocol action has led to emission reduction of over 10 Giga-tones of carbon dioxide equivalent per year, which is five times larger than the annual emission reduction expected under the Kyoto Protocol between 2008 – 2012. Therefore by removing or preventing emission of Ozone Depleting Substances (ODSs) into the atmosphere, Montreal Protocol very successfully, reduced global warming due to greenhouse effect. Even though this is an indirect effect of Montreal Protocol it has helped the environment system especially retarding rapid increase of atmospheric temperature. It is a win-win situation and final outcome is deceleration of climate change. When all these factors are taken into account Montreal protocol has been a very powerful tool which helped enormously to mitigate climate change.

Partner in Protecting the Ozone Layer

By
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Import and Exports
Control Department

It is a great pleasure to join with the National Ozone Unit on the National Ozone Day 2015 celebration and take part of it.

Inflow of Ozone Depleting Substances (ODS's) are controlled through import control licensing mechanism. Imports and Exports Control Department has published all the ODS's in import control regulations as Extraordinary Gazette Notifications in order to legalize the ODS's import control according to the Imports and Exports(Control) Act No 1 of 1969. At that end, Imports and Exports Control Department obtains recommendation from the National Ozone Unit of Ministry of Environment in order to provide space for importing ODS's into the country at strict control for necessary activities in the country.Imports and Exports Control Department doesn't issue any import control license for ODS's without the National Ozone Unit recommendation and thereby has extended the span of control to them as they are the experts in the subject. Periodically the National Ozone Unit and Imports and Exports Control Departmentcompares their licensing data and make sure that the quantities to be equal or else find out the loophole to prevent the unauthorized importations of ODS's into the country. Also, both parties are dedicated to control and prevent such hazardous substances inflow through periodical coordinating committeemeetings.

There are 42 import controlled ODS items at the moment. Most commonly importing items are the Chlorodifluromethane (HCFC – 22 /R –22), Dichlorotrifluoroethane (HCFC-141b/R – 141b), Dichlorofloroethane (HCFC – 123) and Blended Polyol Dalta foam MP 50164. Also, Import and Export Control Department has prohibited the importation of used equipment that use ODS's for their operation.

In addition to that,Imports and Exports Control Departmenthas published a phase-out of ODS's importation time by schedule II in the Extraordinary Gazette Notification No. 1821/40 dated 2013.08.08 with the cooperation of National Ozone Unit as a regulation, and thereby purport to prohibit the importation of ODS's completely by the year 2030. By that time it has to find out alternatives to ODS's and or else to use equipment that do not require such substances for their operation. This phasing out procedure was started in the year 2013 and gradually going to reduce the quantities of ODS's that are importing in to Sri Lanka.

In the process of controlling ODS's it has to emphasize the commendable role playing by the National Ozone Unit and theirsole dedication to achieving the objective of protection of Ozone layer from at least minute amounts of ODS's.It is in the process of identifying alternatives for ODS's and it is a pleasure that there are several such substances that play the same role as ODS's in equipment's they are necessary foroperation with minimum environmental effect without bad effects to the Ozone layer.

On this day, I would like to congratulate the National Ozone Unit of Sri Lanka for their all endeavors in controlling ODS's to protect the mother earth from hazardous rays that can harm to the Ozone layer and Import and Export Control Department also dedicated to join hand with the National Ozone Unit in future as well for the fulfillment of obligations of Montreal protocol as an responsible international member in the world.

Challenges Faces by Customs on Importation of ODS

By
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There are three government institution working in collaboration with each other for the successful implementation of measures stipulated in the Montreal protocol for Control ofimportation and use of ozone depleting substances in Sri Lanka from the year 1993.The Montreal Protocol on Substances That Deplete Ozone Layer is a landmark international agreement designed to protect the stratospheric ozone layer of the earth atmosphere.. The treaty was originally signed in 1987 and substantially amended in 1990 and 1992. The Montreal Protocol stipulates that the production and consumption of compounds that deplete ozone in the stratosphere--chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform--are to be phased out by 2000.

The Montreal Protocol was designed and established under the Vienna convention for the protection of ozone layer which outlines states' responsibilities for protecting human health and the environment against the adverse effects of ozone depletion. It is an international convention which sets out guidelines for the signatory states of the world for the controlling, monitoring and phasing out of ozone depleting substances from the globe in order to protect the ozone layer of our atmosphere from harmful effects of those gases introduced into our environment by human activities. Montreal protocol was ratified by Sri Lanka in 1993 and by June 2015 more than 197(including all members of UNO) countries have ratified it.

CFC gases have been phased out from world by the year 2010 and only developing countries are allowed to use them in limited quantities according to annual quota system decided by secretariat of Vienna convention. HCFC the alternative for CFC gases also will be phased out by 2040 from the world.NOU(national ozone Unit) of Environment Ministry coordinates with SRI Lanka Customs for the implementation of licensing system introduced by Import and Export Control Department to monitor and control the importation of restricted ODS and their substitutes.

Montreal protocol is considered as the most successful international treaty which has been ratified by all the members of the UNO and successfully achieved expected returns within stipulated time frame. Sri Lanka also is considered as one of the few countries in Asia pacific region to achieve desired result within stipulated period. It is a great achievement by ozone unit of Montreal Protocol unit of Environment Ministry with whole hearted support extended by Sri Lanka Customs and Import and Export Control department. These three key government institution are main partners in this important national endeavor. Montreal protocol unit of Ministry of environment is the national focal point of Vienna convention in Sri Lanka .And the Import and Export controller is the licensing authority in the country. Sri Lanka Customs is the implementation and regulatory body of importation of ODS substances.

With the able assistance provided by National ozone unit during the last twenty years Sri Lanka Customs has played very active role in monitoring and controlling of importation of ODS gases in to the country and detection of illegal and unauthorized importation of ODS gases and equipment containing prohibited and restricted CFC substances. Though it is a success story praised and appreciated locally and in various international forums, there are many challenges faced and still being faced by Sri Lanka Customs in this difficult task.

Being the major state body working at the entry and exit point of the country Sri Lanka customs is entrusted with performing four main function in delivering its services to the nation. Securing the government revenue, enforcement of law, facilitation of trade and engaging in social protection duty towards the nation are the four main functions of Customs. Further, some other functions like environment protection , ensuring economic competitiveness and development, employment generation, harmonization and simplification of procedures , removal of trade barriers and safeguarding national security can be included within these four categories of main functions. Customs officials in their day to day activities come across with situation where it is very daunting task to balance between these objectives and prevention of illegal activities.

The main challenges faced by Customs in the control of importation of ODS gases are necessary training for identifying and detecting such gases .Within last two decades Montreal protocol unit has performed very commendable task by conducting awareness programs for customs officials as well as wharf clerks who engage in clearing activities of chemicals and equipment from the harbor and Airport. These training programs were organized in such a way that almost all the officers involved in handling documents and examination of import cargo were covered in these workshops and training programs. Further National ozone unit has taken steps to provide necessary testing and identifying equipments to customs examination points to make customs officer's duty more convenient, effective and efficient. Therefore no any attempt of illegal importation CFC gases by any importer has been reported recently .And environment ministry or central environment authority has not detected any unauthorized storage of CFC gases in the country. During last decades, customs has been successfully implementing application of rules and regulation pertaining to control of importation of ODS gases into the country. It is very encouraging situation in view of controlling and phasing out aspect of ODS gases from the country.

Earlier the activities pertaining to the control of ODS gases was coordinated by policy and planning division of Sri Lanka Customs and from 2010 after restructuring of of Customs Department , coordination responsibility of import control mechanism o f ODS gases became the responsibility of newly established Consumer Protection Unit of Social Protection Directorate of Sri Lanka Customs. There is a good rapport and coordination between consumer protection unit and Montreal Protocol unit of Environment Ministry. Montreal Protocol unit obtains import details from Consumer Protection unit in every three months in order to keep them informed of current situation of importation and usage of ODS.

But ,still there are some grey areas of unreported and undetectable small quantities of ODS gases coming onto the country via UPB warehouses in used household equipments like refrigerators and Air conditioners etc. But it is very negligible in world standard and becoming less annually, since most developed countries have stopped manufacturing those equipment containing restricted and prohibited CFC and HCFC gases. In most developed countries banned CFC gases are not available. But in the imports from the Developing countries in the Asian region such banned and restricted gases may come into the country in used household appliances .Though it is negligible ,still it is a challenge for Sri Lanka Customs . These quantities may not be reflected in our statics but it is better, if we can avoid importation of such hidden ODS gases also.

Especially trade facilitation aspect of Customs' functions can be identified as the main obstacle for implementing extra vigilance instrument in customs examination procedures. Customs officials needs extra vigilance and specific information to focus selecting on highly suspicious consignment thorough examination for detecting smuggling attempt of banned and restricted ODS or any other contrabands or goods containing ODS gases. This challenge has been more intensified due to the introduction of some new elements into existing Customs procedures, like fast track goods clearance systems and government's policy of removing or minimizing trade barriers etc. The rapid increase in trade volumes and Shortage of staff in the customs are some of other challenging situation faced by customs in controlling and monitoring of importation of ODS gases into the country.

There are some instances in some countries of Asia pacific regions where importation of restricted and prohibited CFC gases in retail pickings and concealed among CFC free gas cylinders. Such cases has been reported in some countries of Asia pacific region very recently .Therefore this situation may cited as possible challenge for Sri Lanka Customs due to very low supply of CFC gases in the country against the very high demand for old household equipments. Still in use. But importation of used house hold equipment has drastically decreased due to the introduction of licensing system for such imports recently. Hence this risk may become negligible in near future. At the moment no such occurrences are reported in Sri Lanka. But we have to

be more careful since we cannot rule out such attempts by unscrupulous elements in the trading community. But while there is more emphasis on free trades facilities and simplification of procedures etc, Customs officers may find it difficult to have detailed examination.

ODS containing materials and equipment ae given below .Merely by having cursory glance at this long list we can understand the magnitude of the challenge we have to face in controlling importation of CFC containing substances and equipments into the country.

- Refrigerants: CFC-12, HCFC-22, their blends; refrigerators, air-conditioning & heat pump systems
- Blowing agents: CFC-11 or HCFC-141b; manufacture of polyurethane, polystyrene & polyolefin foam plastics
- Cleaning solvents: CFC-113, HCFC-141b; precision cleaning & general metal degreasing. Also for dry cleaning & spot cleaning in textile industry
- Propellants: CFC-11, -12, -113, -114, HCFC-22 for aerosols like deodorants, shaving foam, perfume, window cleaners, lubricants & oils
- Sterilant: Mixtures of CFC-12 & ethylene oxide used for medical sterilization
- Fire extinguishers: Halons, HCFCs & HBFCs
- Fumigants: methyl bromide, pesticide for soil, structures and products fumigation & pre-shipment & quarantine applications

By looking at the global magnitude of the illegal trade of ODS within last decades we can understand the huge responsibility placed on Customs as a challenge for performing its duty. According to UNEP statistics global ODS smuggling in 1990s was twenty thousand tons, valued at 150-300 thousand USD per year. In 2000s it was around 7-14 thousand tons ,valued at 25-60 million USD per year. Sri Lanka may not be included in these statics .But we have to be careful though we have required rules and regulations and awareness programs in place.

Control of Ozone Depleting Substances in industry - Board of Investment (BOI) Experience

By
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Snr. Dy. Director
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Board of Investment in
Sri Lanka

The Board of Investment of Sri Lanka (BOI) was set up in 1978 (then known as the Greater Colombo Economic Commission (CGEC)) for promotion and facilitation of both foreign and local investment projects in Sri Lanka. These projects are located in export processing zones/parks managed by the BOI and outside export processing zones/parks as well. At present there are 12 export processing zones/parks managed by the BOI located in Katunayake, Biyagma, Koggala, Kandy, Malwatte, Mirigama,Wathupitiela, Seethaweka, Mawahagama, Polgahawela, Horana and Mirijjawila. Approximately, 1700 BOI projects are currently in commercial operation in Sri Lanka including those in the export processing zones/parks. These projects are in manufacture, apparel, service, tourism, agriculture, information technology, infrastructure sectors.

Ozone Depleting Substances (ODS)s due to their chemical properties as coolants, blowing agents, propellants, fire fighting ability, pests controlling ability made them use in industrial and agricultural applications. In these ODS molecules, halogen atoms such as Chlorine, Bromine cause Ozone depletion. Higher the number of Chlorine atoms in the ODS molecule, higher its Ozone depletion potential.

In industries too, up to late 1990 had used ODSs such as R-11 ($CFCl_3$) and R-12 (CF_2Cl_2) as coolants in their air conditioners, cool rooms. These compounds are commonly known as Chloro-Fluoro-Carbons (CFC)s. As shown by the chemical formulas, these coolants have higher number of Chlorine atoms and therefore higher Ozone depletion potential.

In late 1990s BOI and industries were educated by the National Ozone Unit (NOU) on adverse impacts of these CFCs and therefore the need of phasing out their use. For this, a series of awareness programmes were conducted at export processing zones by the NOU. During these sessions, alternative coolants having lesser number of Chlorine atoms (hence with lesser Ozone depletion potential) were introduced by the NOU to be used as coolants. Alternatives offered were Hydro-Chloro-Fluoro-Carbons (HCFC)s. Hence, from late 1990s industries commenced replacing R-11/R-12 in their air conditioners/cool rooms with HCFCs and Hydro- Fluoro-Carbons (HFC)s as well. During this conversion, it was necessary to extract the R-11/R-12 already in place in safe manner to prevent them escaping into the environment. For this, air conditioner/refrigeration Technicians were given training on safe recovery and reuse of R-11/R-12 by the NOU.

With regard to new air conditioner/cool room installations, only those being operated by HCFC were imported by industries. BOI industries engage in the assembly of air conditioners/refrigerators also changed coolants used from R-11/R-12 to HCFCs and HFCs. Regulations were also gazetted to facilitate this conversion/change processes.

From 2010 the NOU has informed to BOI and industries that HCFCs also need to be phased out to be zero Ozone depletion potential. For this purpose, alternative Ozone friendly coolants were introduced. These are completely free of Chlorine atoms and are Hydro-Fluoro-Carbons (HFCs) such as HFC-134a. Accordingly, HCFC in air conditioners/cool rooms of industries are now being replaced by HFCs. BOI industries engage in the assembly of air conditioners/refrigerators now use only HFCs or other Ozone friendly substances such as Carbon dioxide. No HCFCs are used at present.

Hence in the above mentioned phasing out process, the following shifting pattern is noted.

- Chloro-Fluoro-Carbon (CFC)
- Hydro-Chloro-Fluoro-Carbon(HCFC)
- Hydro-Fluoro-Carbon/R-600(HFC)/R-600

It is learnt that HFCs although with zero Ozone depleting potential they have a high global warming potential. Hence, in the process of going towards Ozone friendly compounds it is also necessary to ensure that the globe temperature is not increased. For this, further investigations/new findings for suitable alternatives will be required

Foam manufacturing industries use Cyclopentane as a blowing agent and any Ozone depleting substances are not used.

In garment manufacture and electronic chips assembly industries, at the inception had used ODSs such as Carbon Tetrachloride, Methyl Chloroform as cleaning agents. Their usage has now completely stopped and instead these industries now use chemicals such as Acetone, Toluene, Iso Propyl alcohol, Ethanol for cleaning purposes.

Another ODS is Methyl Bromide (MeBr) which had been used in for pest controlling. At present, use of MeBr for all applications had completely stopped, except for quarantine and pre-shipment (QPS) purposes. Application for QPS purposes is carried out under the supervision of the National Plant Quarantine Service.

BOI projects have been enabled to phase out ODSs usage in par with the objectives and targets of the NOU. For this, the assistance and guidance given by the NOU to the BOI and its projects is highly appreciated.

Hence, while thanking and congratulating the NOU/Ozone Secretariat for being successful in phasing out ODSs it is requested from them to offer alternatives with zero/minimum potential for Ozone depletion, global warming and other adverse environmental impacts.

Introduction of Ozone Friendly Tea Logo and ITS Implementation

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Reaching 150 years of Ceylon Tea

Tea was introduced to Sri Lanka (then Ceylon) by the British on a commercial scale in 1867. Tea is approximately 5000 years old, first discovered in China and became popular in Europe and their colonies in 1600's. The Portuguese developed a trade route to ship tea from China to Lisbon and the Dutch ships transported it to Holland and France. Great Britain was the last of the great sea-fairing nations to break into the Chinese and East Indian trade routes. After the treaty of Nanking in 1840 and control of India, tea became an important part to British trade. However, the commercial level of tea plantation became a reality in Sri Lanka due to the destruction of coffee plantation by a leaf disease.

The tea production of Sri Lanka is oriented predominantly towards the conventional type of orthodox manufacture. The Cut-Tear-Curl (CTC) method of manufacture which is very popular in African countries and India is limited to about 7% in Sri Lanka. The annual tea production of Sri Lanka has moved upto approximately 330 million kilograms today and accounts for 8% of the global tea production

Sri Lanka exports almost 95% of its production and has been able to maintain her global exports share at around 18%. A few decades ago the country was exporting only black tea in bulk form but today it's exports profile has gone through significant development to cater to the changing world consumer demand. Sri Lanka exports a large quantity of tea packets and tea bags to add value to its tea than any other tea producing country in the World. The value added tea exports account for more than 40% of the total export volume. Ceylon Tea is exported in a wide range of packets i.e. box board cartons, foil packs, soft wooden boxes, metal cans, ceramic jars, wooden boxes etc. The tea bags component has now reached 35 million kgs (Close to 10% of total exports) per annum.

Sri Lanka teas reach approximately 160 countries today. Firstly, it was the Middle Eastern markets which opened the door for Ceylon Tea. At present over 50% Ceylon Tea exports reach Middle Eastern countries. UAE, Jordan, Saudi Arabia, Iran, Iraq, Syria, Libya, Tunisia and Lebanon are the leading importing countries of Ceylon Tea in the Middle East and Gulf region. Since early 1990s, the Russian Federation and CIS countries emerged as major buyers of Ceylon Tea. In fact, Russia is the single largest buyer of Ceylon Tea now and her annual offtake from Sri Lanka is approximately 45 Million Kgs. The European Union is also a significant buyer of Ceylon Tea and her annual import volume from Sri Lanka is around 23 million kgs while Japan, Australia and Far Eastern countries absorb another volume of 26 million kgs. The Northern American markets of USA and Canada too import more than 5 million kgs of Ceylon tea per year.

Individuality of Ceylon Tea

Ceylon Tea has been prized for its unique flavour, colour & character, which cannot be readily found elsewhere. The humidity, cool temperatures, sunshine and rainfall (two monsoons) in the country's central and southern highlands are conducive to the manufacture of unique quality teas. Tea plantations are scenic and pristine. Tea is grown, hand picked and processed in an artisanal process, unchanged for over a century.

The renowned Tea Research Institute strictly monitors use of pesticides [which are needed in minimal quantities due to the humid climate]. Ceylon Tea is reputed as the "cleanest tea in the world" in respect of pesticide residues due to these stringent controls.

Ceylon tea is divided into three groups: High Grown, Mid Grown, and Low Grown tea based on the elevation and geography of the land on which it is grown. This is similar to the terroirconcept in wine. Ceylon Tea has unique characteristics and is known for superior flavor for its high grown teas and exquisite leaf appearance for low grown teas, much favoured in the Middle East.

Global Positioning

With 8% of the global production Sri Lanka is the 4th largest manufacturer of tea in the world after China, India & Kenya. Since China is predominantly a green tea producer while India & Kenya mainly produce CTC teas, Sri Lanka is the leading manufacturer of orthodox black tea to the globe. Sri Lanka is also the second largest

tea exporter to the world after Kenya since China & India constitute of a huge domestic consumption. The export share of Sri Lanka in the global tea market is registered at around 18% as against that of Kenya which is about 22%. Since Kenya exports CTC teas in entirety, Sri Lanka is acclaimed as the world's largest exporter of orthodox black tea. Tradition is probably the most suitable word that can explain tea in the Sri Lankan context. With almost 45% of all exports in value added form, tea trade in Sri Lanka is way ahead of its competitors such as India which exports around 10% of its off-takes in packaged form and Kenya only 7%. Sri Lanka is also the first tea producing country in the world which introduced nation branding with Ceylon Tea linked to the Lion logo symbol. The industry proudly acknowledges attempts of few dynamic entrepreneurs and visionaries for building globally renowned tea brands which no other tea producing country has achieved so far.

The tea industry in Sri Lanka has created many global records in various fields and avenues. The country could boast of a highly transparent Tea Auction system in Colombo rated as the largest in the world for a single origin and always yields the fastest turn-around of tea to cash for the farmers. In respect of agro-chemical pesticide residues, Ceylon Tea has been regularly acclaimed as the cleanest by independent analysts/research labs around the world. Sri Lanka also received the accolade from Montreal Protocol in Canada as the only "Ozone Friendly Tea" in the world. Several industry players in Sri Lanka have received United Nations Global Compact Awards which other countries are yet to achieve. The contribution for Carbon Credit programs and the commitments for Corporate Social Responsibility are high. While the industry is ILO compatible it is a role model for the United Nations Environmental Program and fulfills most of the global millennium goals.

An Industry With Sustainability & Corporate Social Responsibility

Sustainability is not just a fashionable catch-phrase among members of Sri Lanka's tea industry. In recent years, the drive towards sustainable practice in all aspects of the cultivation, manufacture, storage, transportation and distribution of Ceylon Tea has gathered momentum, with new legislation and industry rules being put in place. Alliances have been forged with international conservation bodies and hundreds of individual initiatives are being practised on estates and smallholder farms throughout Sri Lanka's tea-growing districts. Concern for sustainability is not new to the Ceylon tea industry. An early industry initiative was to prohibit the use of DDT, while the use of wooden tea-chests was abandoned over twenty years ago. Sri Lanka now produces the world's only ozone-friendly tea, certified under the Montreal Protocol on greenhouse gases. This was achieved through an industry-wide effort backed by the Tea Board. Read more about this important advance.

Alarmed by warnings from the scientists, the world's nations met in Montreal, Canada in 1987 to decide upon action to protect the ozone layer. Out of this meeting came the Montreal Protocol, signed by 191 countries including Sri Lanka. Under the protocol, methyl bromide use by the Sri Lankan tea industry was progressively reduced, then done away with altogether. As a result of such prompt and effective action by the tea industry and others, Sri Lanka was acclaimed a 'leader in ozone-layer protection', receiving the Montreal Protocol Implementers Award in 2007.

All tea grown in Sri Lanka is now one hundred percent ozone-friendly. This is a distinction of which no other tea-producing nation can boast. Plans are now being drawn up to impose a total ban on methyl bromide use in applications like export packaging and shipping. As of May 2011, all Ceylon Tea is entitled to bear the new 'Ozone Friendly Pure Ceylon Tea' logo, certifying that it has been produced without the use of any ozone-depleting substances. The Tea Board has commenced the registration of the logo in thirty tea-importing countries from the year 2012. Out of 30 countries, Ozone logo registration has been completed in Japan, EU, Malaysia, Kuwait, Syria, UAE, Lebanon, Japan, Russia, Chile and Jordan.

When you reach for a cup of Ceylon Tea, you're not just refreshing yourself; you're also helping refresh and renew an environmental resource critically important to all life on Earth.

Disseminated Alternative Technologies for MeBr Use

By
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Depletion of ozone layer has become a mater of concern of everybody in the world, specially, the environmentalist, scientists who know the impact of the thinner ozone layer on all living being in the world. Therefore, the world's environmental scientists have taken their maximum efferts to identify the factors and substances responsible for the depletion of ozone layer. Chlorofluorocarbons (CFCs) and other halogenated ozone depleting substances (ODS) are mainly responsible for man-made chemical ozone depletion. Methyl bromide (MeBr), chemically known as Bromomethane is one of the substances which has a significant impact on the depletion of ozone layer. It is a colorless, odorless gas at the ambient temperature and pressure, which is used in agriculture, as a broad spectrum pesticide to control insect pests, nematodes, weeds, pathogens and rodents.

Use of MeBr in Tea industry

Methyl Bromide was used as a fumigant for eradicating root infesting nematodes and soil borne pathogens particularly the 'poria' root disease, in the tea plantation sector. It has been very popularly used for the fumigation of soils in tea nurseries to free the nursery soils from three economically important nematodes species namely; Pratylenchus loosi (Root-lesion nematode), Radopholus similis (Burrowing nematode) and Meloidogyne brevicauda (Root-knot nematode). The Root-lesion nematodes inhabit all tea lands at elevations above 750 m, while the burrowing nematodes are mostly found in the mid elevation ranges from about 200 m to 750 m which include tea lands in the Mid-country, Uva and Morawak Korale, Ratnapura and Balangoda tea planting districts in the low-country. The root-knot nematode is a rare species found only in Up-country. Thus, about 50 percent of the total tea area is prone to nematode attack. Especially, the infested nurseries have become a common occurrence in the recent past, mainly because of non-efficacious sterilization methods used in tea nurseries.

MeBr was used both by corporate tea sector and the tea smallholdings sector for fumigating the nursery soils and nursery beds to eradicate tea nematodes, until the alternatives to MeBr were introduced to phasing-out its uses in tea industry. Tea Research Institute of Sri Lanka received two projects; one to find out the alternatives for the MeBr and other one to disseminate new technologies generated, to tea growers in both corporate tea sector and the tea smallholdings sector.

Alternative technologies for phase-out the use of MeBr

After the introduction of economical and practically feasible alternatives for MeBr, now it is going to be increasingly important to implement an appropriate strategy for the technology transfer, dissemination and their adoption for sustainable application, in both corporate and smallholding sectors in tea industry.

Tea Research Institute was tasked to undertake this project as it is in constant contact with plantation managements and tea smallholders providing regular advice on pest control and other agronomic issues in tea cultivation. TRI is equally well-informed of the relevant pest infestations in tea fields in various tea growing regions and the need to implement alternatives in order to phase-out methyl bromide use in tea. The institute also has an effective, responsive and proactive extension and outreach programs to provide the technologies, research findings to tea growers.

Control of Nematodes in Tea Nurseries

Nematodes can be transmitted into a field through planting material, soil, animals, agricultural implements and any surface water that runs through such lands. They can spread nematode infestations into new fields of a given estate or to a totally new area of a region where nematodes were not found hitherto. Tea nurseries are the usual focal points of spread of nematode infestation in to tea fields. It is therefore, essential to take all precautionary measures to prevent nursery plants from being contaminated with plant parasitic nematodes as there is no curative method and the yield losses cannot be compensated by any other means. Hence, disinfection of nursery soils and the premises is compulsory in all tea growing regions.

Once introduced, their long term establishment and rate of spread will depend upon the type of soil, environmental and other relevant factors. It has now been established that these three nematode species can be encountered in all tea growing districts at variable intensities.

When the tea plants become infected with nematodes, there is very little one can do to reduce the damages inflicted upon the crop and even when available it will be at an exorbitant cost. The importance of preventing nematode infestations, starting from where it matters, that is at the nursery, cannot be overemphasised. Therefore, it becomes mandatory to treat the nursery soils and nursery beds out of nematodes. There are several methods available at our disposal for the control of nematodes. Amongst them, chemical fumigation has been found to be the most efficient and economical. In the tea nursery system, soil fumigation means an additional expenditure. But this can ensure freedom from nematodes and more importantly, healthy and vigorous plants that are going to establish well and faster in the field.

Chemical Control of Nematodes in Tea Nurseries

'Soil fumigant' is a chemical compound or a mixture of them that are capable of releasing a toxic gas capable of killing all the soil dwelling organisms.

Amongst various methods, soil fumigation using chemicals is the most effective means of nematode eradication in nursery soils. All soils use for tea nurseries should be routinely fumigated to eradicate all possible contaminations with nematode pests. A successful fumigation involves two important aspects. The first, the nematodes should be active at the time of treatment. The second, at the end of fumigation the treated soil should not have any traces of the chemical by way of residues that may harm the subsequent crop. Fumigation guarantees nematode free nursery plants and also it helps to boost growth of plants in the nursery.

It is necessary to get the several tools and materials such as; undamaged transparent polythene sheets of gauge 500, mammoties or shovel and watering can, etc., ready for fumigating nursery soils as recommended by TRI.

Chemical Recommendations to Control Nematodes in Tea Nurseries

There were several effective alternatives for MeBr, introduced by the TRI. However, all those alternatives and the technologies were not favored based on initial capital cost and on the length of treatment time for their effectiveness. Alternatively, the use of Dazomet and Metham Sodium required a long waiting period after treatment and before planting of cuttings in the nursery, but its initial treatment cost is low. In view of this, the use of Dazomate and Metham Sodium is considered to be an effective chemical alternative for MeBr.

Fumigants Recommended by the TRI:

Fumigant	Trade Name	Form	Rate Per Cube of Soil
Dazomet 98%	Basamid	Granular Powder	250 g
Metham Sodium	Metham	Liquid	800 ml

Dazomet 98% (Basamid)

When Dazomet granules come in contact with moist soil, it releases Methyl Isothiocyanate (MITC). This gas penetrates into all gaseous cavities in the soil, killing all the active nematodes, fungal and bacterial propagules, including the germinating weed seeds. The efficiency of fumigation is dependent upon; whether the organisms are active or not, the texture of soil, degree of soil wetness and finally the duration through which the soil environment is exposed to the chemical (gas). The latter could be assured by keeping the treated soil covered through a prescribed time period.

Metham Sodium

Metham Sodium is a liquid soil fumigant that also will react similar to Dazomet. No sooner the fumigant is mixed with wet soil, it starts releasing the gas MITC. This gas stimulates tearing and carries with it the hydrogen sulphide (H2S) smell. Therefore, it is very important to remember to seal the soil heap using the prescribed polythene sheet, immediately following the treatment.

Allowing these chemicals to remain intact for one week is sufficient to destroy all the active nematodes. The residual fumigants that may be trapped within soil particles are allowed to escape first by removing the polythene after one week, and second by turning the soil several times after removing the sheet.

Mode of Action of Fumigation

Once the granule or liquid fumigants used, contact with soil moisture, are transformed into active compounds, mainly the MITC which are light in weight and volatile in nature. The production of MITC depends mainly on soil moisture and temperature. The MITC fumes then penetrate spaces between soil particles destroying the active soil organisms and germinated seeds. As the effectiveness of fumigation process depends on concentration of the active compounds transformed and the length of exposure to target organisms, the texture and moisture of soil, physiological state of the organisms and degree of covering treated soil are the determining factors. Nematodes in root fragments, nematodes in resting or dormant stages, dormant seeds are unlikely to be destroyed while, all the free living and motile nematodes and germinating seeds are affected. Chemical transformation in soils occurs within 1 - 5 hours depending on the type of soil used. The odour of hydrogen sulfide and the strong eye-irritating properties of MITC can be experienced soon after application of fumigant. Immediate and complete covering would therefore be critical and helpful to avoid rapid loss due to volatilization and to enhance the performance of fumigation process. Exposure of soil for one week completely eradicates the nematodes. Thereafter, the cover should be removed to escape residual MITC fumes which would otherwise cause phytotoxic effects on cuttings. Mixing and turning the treated soils several times at regular intervals would help to enhance this process.

Major steps in fumigating soil with Dazomate or Metham Sodium

1. Moisten the sieved soil adequately, two weeks prior to the commencement of fumigation.
2. Fumigate the nursery beds two weeks prior to fumigating of soil.
3. Prepare the soil heap into a rectangular shape of 15 – 20 cm (6 – 8 in) in height and then spread Basamid or sprinkle the Metham Sodium on the heap uniformly.
4. Mix the soil well using a mammoty and make soil heap into a convenient dimension for covering with the polythene.
5. Moisten the heap using a watering can and cover the soil heap with 500-gauge polyethylene sheet and keep it undisturbed for 7 days.
6. Remove the polythene on the 8th day and mix the soil heap thoroughly using a mammoty on the 9th day.
7. Mix the soil heap again on the 12th day.
8. The final mixing has to be done on the 15th day and use the soil for filling bags on the 22nd day after administering of the fumigant into the nursery soil.
9. Introduce tea cuttings into bags on the 29th day.

Soil Solarization to Control Nematodes in Tea Nurseries

The use of thermo-therapy or heat treatment as a means of killing phytophagous nematodes is a well established technology. Studies have shown that the exposure of soils to temperatures even below 45oC can be lethal to nematodes, if happened over long periods. Sun's short wave (0.2 – 80 µm) and long wave (4 – 80 µm) radiations provide the source of energy for solarization. Ordinary transparent polythene that are in regular use allows sun's radiation in the range of 0.4 – 36 µ to penetrate. Use of polythene minimizes the loss of heat through direct convection currents and by way of water vapor. The water vapor that deposits in a film on the underside of the polythene prevents the escape of long wavelength heat radiation, thus simulating a green house effect. This could also provide additional heat under the cover, making the process more efficient.

It is recommended to use the transparent polythene of 500 gauges for soil solartization. Under dry weather conditions the solarization process normally takes about 2 months, taking progressively longer time periods if there are interruptions to the incident sunlight. Therefore, it will be necessary to initiate steps to collect soil and filling of bags, 2 - 4 months ahead of soil solarization proper.

Method of Soil Solarization

Nursery beds should be located in a place, guaranteed of plenty of sunshine, devoid of large trees or buildings. A bed should be approximately 3 ft wide and of any convenient length. There should be provision for a drain right round, to take away any excess water. Nursery bags are filled with sieved and processed soil and stacked on the beds.

Water the nursery bags well, in order to moisten the soil in the bags. This is important for two reasons. Firstly, when the nematodes in wet soils become active, they are more sensitive to heat. Secondly, since the soil is a week conductor of heat, the wetness around soil particles (thin film of water) improves the conductance of heat through soil, significantly.

A few soil-filled nursery bags must be laid on top of the stacked bags, as shown in the diagram, in order to provide for a space of a few inches between the top of the nursery bags and the polythene sheet, above them. The edges of the polythene sheet should be properly secured on all four sides of the bed. Nursery beds thus covered should be exposed to direct sunlight over a period of six weeks, when the duration of sunlight is not less than 5 hours per day. For any day that receives less than 5 hours of sunshine, an additional day of treatment should be allowed.

Soil solarization can also be effected prior to filling of nursery bags. In this situation, the soil is heaped up to a uniform height of 20 – 25 cm and then cover with the polythene sheet, while maintaining an air cavity immediately above the soil with the use of several soil filled nursery bags, placed on top of the soil heap. In preparing soil for solarization, the soil heap should be kept moist with the provision of water from overhead source, using a watering can or any other mechanism. There is no necessity to provide any water during the process of solarization.

It may not be possible to use this technology in all tea-growing districts, mainly due to limitations imposed by the sunshine hours. Accordingly, this method can be employed for controlling nematodes in Badulla District in its entirety, except for the Haputale region, Balangoda and Rakwana regions of the Ratnapura District and in Urubokka region of the Matara District.

Soil solarization does not rely on any chemical and therefore, is very environmentally friendly. Because of the simplicity of the process, it is easy to adopt without incurring heavy expenditure. The features most important in solarization are the correct determination of solar radiation hours and adjust the duration of solarization accordingly.

Use of Soil Substitutes in Tea Nurseries

When the soil is scarce for tea nurseries, soil substitutes help to reduce the volume of fumigated soil needs, by considerably cutting down the cost for fumigation. There are several types of materials of plant origin introduced by the TRI, to substitute the nursery soil. Decomposed refused tea, paddy husks and coir-dust from coconut husks when incorporated into the soil, reduce the volume of fumigated soil needed for nurseries significantly. These materials also allow the young tea plants to establish properly and tolerate the pest even when the infestation has not been fully eradicated. In combination with other methods such as the use of resistant or tolerant cultivars such amendments can help totally eradicating the nematodes. Moreover, the nematode trapping fungi that are favored in these organic media would help further to reduce any nematode population in the soil.

Recommended Soil Substitutes (Organic Materials)

The following organic materials can be used depending on their accessibility and availability.

- Well decomposed refuse tea, under natural conditions
- Fresh or partially decomposed paddy husk obtained, preferably from Japanese huller and free of bran and grain pieces.
- Fresh or decomposed coir dust (coir dust from coastal areas should be avoided).

Different alternate media could be used either in layer arrangement or as mixtures. The soil used for layers and/or mixtures should be fumigated. The organic material and soil should be lightly watered and mixed thoroughly prior to making the mixture.

Layer arrangement: In layer arrangements, the top one-third (1/3) of the nursery bag should be filled with soil to facilitate early rooting with minimum causalities. The bottom two-third (2/3) should be filled with a mixture of organic material and soil in the ratios given below which will help establish roots and growth.

- Refuse tea or coir dust at the ratio of 1 : 1 with fumigated soil
- Paddy husk at the ratios of 1 :1 or 1 : 2 with fumigated soils (1:2 ratio for areas where prolonged dry weather is expected)
- 100% coir dust or refuse tea could also be used

Mixture arrangement: The whole nursery bag should be filled with 1 : 1 refuse tea: soil or 1 : 1 paddy husk: soil or 1 : 1 coir dust: soil mixtures.
Attention has to be paid when watering the nursery bags where the alternate media are used, as frequent watering may be required when paddy husk is used as it retains less water whereas refuse tea requires less water as it retains more water.

Extension Activities Conducted to Disseminate Alternative Technologies for MeBr

Training of Trainers (TOT) Programs

The Advisory and Extension staff of the Tea Research Institute (TRI) conducted several technology dissemination and monitoring activities for the corporate tea sector while the Extension Officers of the Tea Small Holdings Development Authority (TSHDA) were given the responsibility for disseminating the technologies for tea smallholders in the country. During the project period, both these groups were given a thorough training in the aspects of raising healthy and nematode free tea plants in tea nurseries using newly developed alternates for MeBr.

Continuity of technology dissemination is the most critical issue in the sustainability of a technology adoption process. Therefore, conducting training programs to train extension workers in the tea sector was recognized as the major component of this program.

Seventeen (17) Advisory and Extension officers of the Tea Research Institute and 8 Regional Managers, 7 Assistant Regional Managers and 250 Extension Officers of the Tea Small Holdings Development Authority received intensive training in all aspects of producing healthy and nematode free tea plants in tea nurseries, using newly introduced alternates to MeBr. Moreover, these officers were sufficiently equipped with the knowledge and skills in effective extension and teaching techniques, enabling them to conduct effective training programs in the future.

Moreover, several awareness programs for tea smallholders, commercial tea nursery owners, management and the field staff of corporate tea sector were conducted on the new technologies of nursery management. Among them, twenty one awareness programs, including three extension campaigns, seven workshops, eleven field day programs were conducted to educate commercial nursery holders, tea small holders, senior and middle management, field and nursery staff of corporate sector tea plantations in Up, Mid, Low and Uva regions, on the importance of phasing-out MeBr and using alternative nursery techniques for the tea industry. Total number of participants were 3,707 of which 1,147 were from the corporate tea sector and the balance 2560 from the tea smallholdings sector.

Establishment of Demonstration Sites

Eight demonstration nursery sites were established in Deniyaya, Ratnapura, Galle, Kandy and Talawakelle regions to demonstrate and monitor the performance of selected alternatives for MeBr.

Development of Regulatory Procedures for the Certification of Commercial Tea Nurseries:

The preliminary activities were initiated to develop appropriate modalities to ensure and enforce the phase-out of methyl bromide used in the tea sector by way of establishing procedures for producing, certifying and issuing the healthy and nematode free tea nursery plants for field planting. The guidelines of the procedures were prepared and submitted to the relevant organizations and the Ministry of Plantation Industries (MPI) for their comments and suggestions for using as a pre-requisite to obtaining legal authority for the implementation of the certification procedure.

Public Awareness Activities

Several outreach materials (Posters, Sticker and Digital hoardings) were produced to make the general public aware of the MeBr phase-out and to produce "Ceylon tea" with added value, following ozone layer friendly techniques and for the long term sustenance of the tea industry in Sri Lanka.

A video film on tea nurseries management in English with the title of "The Road Map for a Flourishing Tea Field" and in Sinhala with the title of "**සරු තේ ඉඩමක පෙරමග සලකුණු**" and a training manual on tea nursery management to use by the trainers in tea cultivation, a book on Methyl Bromide: Quarantine and Pre-shipment uses, two tea Newsletters containing news on phase-out of MeBr and related subjects; in Sinhala and English languages, three booklets on "Soil Fumigation" and "Nursery Management (Sinhala, Tamil and English)", a wall-chart on "Tea Nursery Management", Ten types digital posters, five types of banners on soil sterilization techniques, two posters (Sinhala and English) on identification of Tea Diseases and other publicity materials such as a Sticker, a T-shirt carrying "Ozone Friendly Ceylon Tea" logo were prepared to make tea growers and general public aware on the phase-out MeBr.

Technology Dissemination Activities Conducted by the TRI

Technology Dissemination Materials Producued by the TRI

Integrated Standards and Labelling Programme

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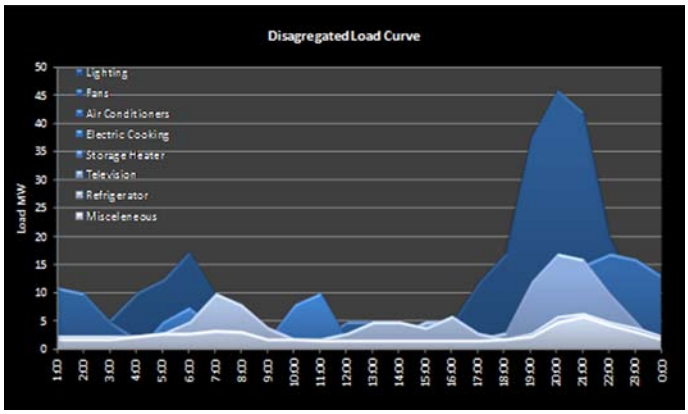
Appliance market is showing steady growth in Sri Lanka, the impending energy crisis and the dire need for mechanisms to cope up with the increasing electricity demand has necessitated an energy efficiency improvement programme on end use energy efficiency. Sri Lankan markets have been inundated with various energy-consuming appliances, mostly from low cost sources which invariably turn out to be inefficient. Whether these appliances are energy efficient or not is always a matter of debate as very little is known of their energy performance. This leaves the consumer in a dilemma and places the onus on the energy sector agencies in providing necessary guidance. Sri Lanka has approached this issue with a two pronged strategy;

(1) Setting a Minimum Energy Performance Standard (MEPS)
(2) Assigning an Energy Label to appliances based on their energy efficiency

These two strategies are applied in an integrated programme of standards and labelling. The appliances are required to meet a certain minimum energy performance under the MEPS scheme, after which the comparable appliances from different vendors are ranked according to a hierarchy of energy efficience. The highest performing brands acquire five stars, whilst the minimum performance brands receive one or two stars.

Historical Evolution

Realising the urgent need to arrest the disturbing trend of proliferation of poor quality appliances at low prices, the DSM branch of the CEB, in association with Sri Lanka Standards Institution (SLSI) and the National Engineering Research and Development (NERD) Centre jointly initiated an energy labelling scheme for Compact Fluorescent Lamp (CFL)s in year 2000. The respective standard for the certification of CFLs under the energy labellingprogramme is SLS 1225:2002 and it was published as a Sri Lanka standard in 2002. CFLs were chosen as the first appliances of the labellingprogramme since they were in wide usage, and could have the key to resolve the significant evening peak resulting from the lighting load.



Source: Load Research Programme, Ceylon Electricity Board 2000

Figure 1: Disaggregated Load Curve - Colombo West

This scheme, launched as a voluntary scheme had no incentive other than a marketing proposition for vendors. To get vendors into the scheme, the CEB made it compulsory for vendors to reach the 3 star level if they are to be included in the easy payment scheme offered by the CEB to its consumers. In this programme, four labelled CFLs were given to customers, on a cost recovery basis within twelve months, in equal instalments through the electricity bill. Many CFL vendors volunteered to adopt the standards initially, to gain from the increased market resulting from the loan scheme but their commitment gradually decreased after the withdrawal of the loan scheme by the CEB in 2004.

With the enactment of the Sri Lanka Sustainable Energy Authority Act No. 35 of 2007, the Sri Lanka Sustainable Energy Authority (SEA) took the labellingprogramme to the next logical level, which is a mandatory regime. This effort streamlined the energy labelling process rendering it highly beneficial to consumers as well as traders, thereby creating motivation for compliance. In this instance also, the first appliance selected was the CFL, mainly to counter the importation of poor quality lamps to the country. The

Figure 2:
Energy Label in the Voluntary Labelling Programme

agencies involved in the scheme remained as it was, in the form of a committee. In year 2008, the labelling standards were revised to incorporate other concerns and also to make it more accommodative and a new performance grading formula was agreed upon. This standard is the effective standard for CFL energy labelling at present. Mandatory requirement of CFL energy labelling was legally enacted in 2009 under the gazette number 1611/10 dated 22nd July 2009.

Performance Grading = {(Efficacy x 0.9) + (Power Factor x 100 x 0.1) + Colour Correction Coefficient}

The number of stars designates the efficiency of the appliance, ranging from 1 to 5. The higher the number of stars, the more efficient an appliance is. The new label also displays the following details:

- Actual power consumption (in Watts)
- Likely monthly electricity consumption based on actual power consumption
- Model Number
- Brand

The difference in power consumption in lamps with different number of stars was quite significant. For instance, the difference between lamp which fails to obtain star rating and 3-star CFL was 5 watts, while the difference between a non-qualified lamp and a 5-star lamp was estimated to be around 9 watts. Furthermore, the country could save over LKR 3,710 million per annum by replacing no-star CFLs with three star CFLs. At present, the market is dominated by 3-star products, as shown in Figure below.

Figure 3:
Energy Label in the Mandatory Programme

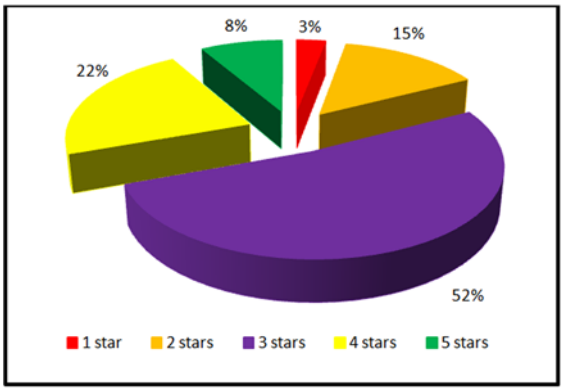


Figure 4:
Market Shares of Energy Labelled CFLs in the Mandatory Programme

With the introduction of CFL energy labellingprogramme and with technological development there has been a visible market progression towards energy efficient CFLs. It is estimated that with the implementation of energy labellingprogramme for CFLs, around 300 MW of electricity demand reduction has been achieved. A market vigilance initiative was taken in late 2013 to evaluate the compliance level of the programme. The evaluation revealed that out of the 634 outlets surveyed, only four outlets carried stocks of non-compliant products.

At present, the final draft of the first revision of CFL star rating is available and will be presented to the Advisory Committee with SLSEA for necessary recommendations. During this revision of the standard, non-energy attributes such as the amount of permissible mercury content of a lamp will be introduced, and will be a required qualification for the MEPS. In the new revision, the star rating is given under two schemes based on the power of the lamp as shown in Table 1 and Table 2.

Table 1: Parameter Used in Energy Labelling of CFLswith rated wattage equal or less than 60 W

Performance Grading	> 72	67 - 72	62 – 67	57– 62	54 – 57
Number of Stars	5	4	3	2	1

Table 2: Parameter Used in Energy Labelling of CFLswith rated wattage greater than 60 W

Performance Grading	> 75	70 - 75	65 – 70	60 – 65	57 – 60
Number of Stars	5	4	3	2	1

Status Quo of the ISLP

After the success of the CFL labellingprogramme, ceiling fans were the secondly addressed appliance and testing of ceiling fans has been initiated in the test facility established at the University of Moratuwa. Other appliances such as tubular fluorescent lamps, ballasts, electric motors, refrigerators and room air conditioners are in the pipeline of energy labellingprogramme with varying degrees of success.

Energy Labelling of Ceiling Fans

The respective standard for the certification of Ceiling Fans under the energy labellingprogramme is SLS 1600:2011 and it was published as a Sri Lanka standard in 2011. Mandatory requirement of Ceiling Fan energy labelling was legally enacted in 2013 under the gazette number 1794/15 dated 22nd January 2013.

The standard preparation was done by a committee appointed by the Board of Management of SEA and it was finalised in collaboration with the SLSI. In preparation of the standard, technical assistance was obtained from the University of Moratuwa.

Although the gazette was published and it is a mandatory requirement at present, testing facilities are not fully functional. The established test facility located at University of Moratuwa has to refurbished and procurement of new testing equipment (multi channel flow meter) is also in progress. Energy labelled ceiling fans will be available in the market once the test facility is established.

Energy Labelling of Tubular Fluorescent Lamps and Fluorescent Lamp Ballasts

The respective standard for energy efficiency rating for tubular Fluorescent Lamps and Fluorescent Lamp Ballasts are SLS1625:2012 and SLS 1200:2002 respectively. Draft regulation on energy labelling Double-capped Tubular Fluorescent Lamps and Fluorescent Lamp Ballasts prepared with the assistance of Legal Draftment's Department and now it is before the Board of Management for approval. Cabinet Memorandum with the approval of the Board of Management is requested to submit the energy efficiency standard for Double-capped Tubular Fluorescent Lamps and Fluorescent Lamp Ballasts to the Ministry of Power & Energy to initiate the process for issuing it as a Government gazette notification.

Energy Labelling of Refrigerators

The respective standard for energy efficiency rating for household refrigerators, refrigerator freezers and freezer is SLS 1230:2003. Since the bench marks on star rating which is stated in Section 2 of SLS 1230:2003 were derived more than a decade ago, there is a need to review them. Accordingly the refrigerator test facility has established at NERDC and a few suppliers have provided sample refrigerators for testing.

Testing of 15 refrigerators to determine the bench marks for the energy labelling is going on. Only five samples were tested as at August 2015. Once sufficient number of units is tested, standard can be finalised with new bench marks with the assistance of the technical committee. This is considered as an opportunity to recognise the great strides made in refrigerator manufacturing, with technologies such as inverters and super insulation are taken into consideration in a new ISLP. Non-energy attributes such as the avoidance of high Global Warming Potential (GWP) and Ozone Depletion Substances (ODS) will also be considered in the new revision.

Energy Labelling of Room Air Conditioners

With the experiences in energy labellingprogramme, preparation of the standard is in progress. Monthly technical committee meetings are now taking place. Here again, this effort is considered as an opportunity to recognise the great strides made in air-conditioner manufacturing, with technologies such as inverters is taken

into consideration in a new ISLP. Non-energy attributes such as the avoidance of high Global Warming Potential (GWP) and Ozone Depletion Substances (ODS) will also be considered in this new ISLP.

Energy Labelling of LED Lamps

LED technology is the most recently immerged lighting technology and it is increasingly becoming popular due to the claims on its high efficacy levels and long life span compared to other lighting technologies. However, low quality LED lamps, having poor efficacy levels and short life spans have entered the market. Further it was revealed that those lamps make negative effect on the grid when connected in large numbers. Hence it is expected to develop MEPS for LED lamps as an initial step, and with time it will be expanded up to preparation of bench marks on star rating as for the other appliances addressed under the energy labellingprogramme.

Minimum requirements to comply with the standard were finalised by the technical committee consisting of experts in the relevant field. The parameters such as lumen output, efficacy, power factor, Colour Rendering Index (CRI) were considered when determining minimum requirements.

Energy Labelling of Computers

Computers are also identified as a highly popular appliance in the country and there is a trend of further increasing the number of computers in future. With the demand for computers, various brands of Computers with different efficiency levels have come into the market. It is predicted that load for Computers will become a significant share in the daily electricity load curve. Hence it is expected to prepare energy performance standards for computers. To develop the star rating criteria, sample tests are going on at University of Moratuwa.

It is expected to cover energy labelling standards for following categories with due consideration on technological advancement and socio-economic factors in the country.

- Desktop Computers
- Notebook Computers
- Tablet Computers
- Small scale servers

Future Outlook

Key decisions are required to be taken in selecting appliances for the ISLP. Thus far, the selection criteria had been quite simple (i.e. penetration level and energy demand exerted) as shown below in Table 3.

Table 3: Criteria used in selecting appliances for ISLP

Rank	Appliance	% Penetration	Rank	Appliance	kWh / Month
1	Lighting	100.00	1	Air Conditioners	120
2	Television	91.24	2	Lighting	108
3	Electric Iron	79.84	3	Television	95
4	Hand Phones	65.17	4	Refrigerator	54
5	Refrigerator	62.12	5	Washing Machine	48
6	Fan	48.27	6	Water Heater	30
7	Cassette	47.86	7	Fan	24
8	Radio	47.66	8	Hot water Heater	15
9	CDMA Phone	42.77	9	Computer	14
10	Rice Cooker	39.92	10	Electric Iron	11
11	Water Pump	37.88	11	Rice Cooker	11
12	Grinders / Blender	37.07	12	Pans	9
13	Water Heater	26.27	13	Bakery / Oven	8
14	DVD Player	25.05	14	Electric Kettle	7
15	Computer	19.55	15	Oven	6

However, it is argued that lower levels of penetration offers and opportunity to establish higher MEPS for newer appliances, allowing the country to leap frog to a higher level of overall efficiency. The outcome of the ranking produced below in Table 4 is supporting this view.

Table 4: Ranking of appliances for ISLP

Rank	Appliance	kWh / Home at National Level
1	Lighting	108
2	Television	88
3	Refrigerator	34
4	Fan	12
5	Electric Iron	9
6	Water Heater	8
7	Washing Machine	7
8	Rice Cooker	4
9	Computer	3
10	CDMA Phone	2
11	Grinders / Blender	1
12	Electric Kettle	1
13	Air Conditioners	1
14	Water Pump	1
15	Oven	1

Technical Education, a Vital Factor to Prevent ODS Emission

By
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In the span of only a few decades refrigeration has grown into the giant and rapidly expanding industry that it is today. This explosive growth came about as the result of several factors. First and foremost reason was the development of precision manufacturing methods which became possible to produce smaller, more efficient equipment. The development of "Safe" refrigerant became another factor. Therefore, refrigeration and air conditioning (RAC) is widely used for industrial, commercial, transport, marine and domestic uses. As a result of rapid expanding of RAC applications, more young people interested to select Refrigeration & Air Conditioning as their tertiary education which is one of the prospective carrier paths for them.

We have updated our knowledge and skills according to the rapidly growing and changing with the new technology. Considering the RAC industry, there were no such remarkable changes during 1950 -1980periods, due to RAC applications were limited to industrial and commercial sector such as cold rooms, ice plants and to several hotels, etc. Therefore, significant changes for technical training programme too in RAC were not taken place. However, after introducing of open economy policy in 1978, RAC started to grow leaps and bounds. RAC equipment containing Chloroflurocarbons (CFCs) had stared replacing the place had been for ammonia which has toxicity and flammability. CFCs were safe, non-flammable, non-toxic and therefore these manmade chemicals became very much popular. With the increase of RAC usage, requirement for new technical education was needed changes and upgraded.

In 1974 Sherry Rowland and Mario Moline publish their hypothesis that CFC s destroying stratospheric ozone. Early 1980's debate was started among scientists that Ozone Depleting Substances (ODS) should be phased out gradually to protect Ozone layer. The Montreal Protocol was established in 1987 to address these controlling measures.

According to Montreal Protocol, Sri Lanka also made a plan for phasing out of CFC refrigerants. But initially most of the industry and technicians who were already worked with CFC refrigerant compromised for the change. Therefore, phase out CFCs quickly was a difficult task. Montreal Protocol Unit (presently, National Ozone Unit) prepared the training programme for 'Train The Trainer' and training of technicians with the assistance of United Nations Environment Programme (UNEP), to support country programme of CFC phase-out. Recovery, Recycle and Reuse technology was included to the syllabus accordingly. 'Good practices in refrigeration' were the key element of this curriculum.

Sri Lanka's achievement in technical training is impressive. From the beginning of Technician training which started by the NOU in collaboration with Vocational and Technical Training Authorities, more training programmes, technical session with practical were conducted island- wide mainly based at Vocational & Technical Training Institutes. Ceylon German Technical Training Institute is still in forefront in implementing these training programmes. Training module for 3 day workshop was included very important subjects such as, Introduction of Ozone and Ozone layer, Ozone Depleting Substances (ODSs), Health and environmental effects of ozone depletion, recovery and recycling of refrigerant, alternative technologies, lubricants, etc. Several Training of Trainers (ToT) programmes were conducted to upgrade the capacity of Instructors attached to Technical colleges who teach RAC subjects.

Main training activities that were carried out are highlighted as follows.

- Conducted awareness programme for RAC trainees and technicians regarding to the Ozone depletion substances use in RAC sector including as flushing agents, other sectors such foam blowing and solvents.
- Conducted theoretical and practical sessions for refrigerant recovery and recycling methods

- Provide technical assistance to build low cost refrigerant recovery machine by the technicians for day to day repair and servicing works that carryout at their workshops. Most technicians recovered CFC refrigerant without emitting to the atmosphere and saved environment as well as able to gain economic benefits.
- Conducted several technical training programme of "Good practices in refrigeration", aiming to make the Environmental friendly knowledge based RAC Technicians.
- Provided technical details about alternative refrigerants and lubricants. Also practical sessions with demonstrations for how to convert or retrofit refrigeration equipment use with ozone friendly alternative refrigerants with existing refrigerants.
- At present, people are more concerned about environment friendly, energy efficient refrigerant and equipment, especially household equipment. Therefore, technology on Hydrocarbon 600a (R 600a) was introduced and trained technicians on how to use HCs safely. Safety Standard on use of HCs also developed.

Now our training is stepping into another environment friendly technology. It is introduction of refrigerant reclaiming which is a technology of purifying recovered refrigerant to virgin status. This programme is introduced under the HCFC Phase-out Management Plan (HPMP)

It is a requirement and obligation to continue training programme for RAC sector, because more and more technicians will be produced through increasing vocational and technical institutes and training centres. They have a bigger role to play when they passed out as graduates or qualified technicians in future. Our duty as Trainers is to prepare and release a complete RAC technician to industry for not only to work & earn but also to make them sensitive people to the environment, They can prevent both ozone layer depletion and reduce the global warming and can be become partners of environment friendly practitioners to grant better environment for future generation.

Institutional Framework for Energy Efficiency

By
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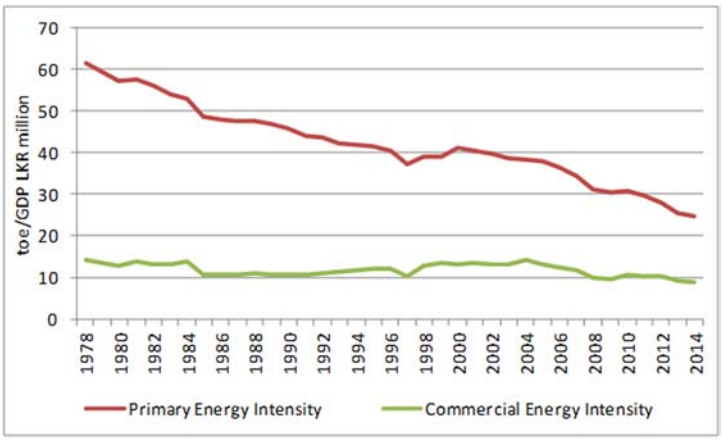
National economy of Sri Lanka had been quite low in energy intensity since days under colonial rule. Many factors have contributed to this, the relatively stable weather conditions throughout the year, considerable lower transport needs due to the smaller geographical size and low level of industrialisation could be cited as the key drivers of the lower energy intensity of the Sri Lanka's economy. With the ever increasing cost of energy, the energy intensity of economy has shown a trend of going down even further, as depicted in the graph below.



Source:
Sri Lanka Energy Balance 2014, Sri Lanka Sustainable Energy Authority

Graph 1: Decreasing Trend of Energy Intensity of Economy

However, this seemingly stable energy intensity may display an upward trend when economic conditions improve with the industrial and commercial developments envisaged in the coming years.

The lower energy intensity of economy in the 1970's was a blessing for Sri Lanka to withstand the first oil crisis. But this blessing which insulated Sri Lanka from adverse impacts of oil price hikes also prevented any meaningful policies being formulated at national level, targeting energy efficiency improvement and conservation during this period. The evaluation of energy efficiency policies was presented in a chronological sequence, to elaborate the necessity of an all encompassing approach in formulation of policies and designing legislative framework. In this respect, a clear evolution is seen in the policy focus as depicted below.

Figure 1: Changing Policy Focus

From the above, it is obvious that the policy has undergone a continuous expansion in focus areas, and a continuous increase of complexity within a span of four decades.

This evolution could have two underlying forces beneath the path it has taken. Firstly, the understanding of the inadequacy of area under focus, roles and failure of simpler approaches may have driven the policies towards the complex form which exist today. Secondly, the economic and technology development which made most previous approaches ineffective or obsolete may have driven the energy policies towards the current status. It is most likely that both these factors may have contributed towards the policy development in Sri Lanka. However, the role played by energy prices shall not be discounted here, as it was one of the most dominant forces which catalysed all policy development efforts in the energy sector of Sri Lanka. Another significant aspect of policy evolution is the change of policy format from a quite abstract generic nature to a very descriptive specific nature. Over the years, this too may have been due to the inability of a generic policy to effect any change in the vast array of energy uses and consumers, present in the complex energy markets of today.

This article is an attempt to present the historical evolution of energy efficiency sector in Sri Lanka and its status quo.

Beginning of Energy Efficiency

The second oil crisis, which adversely affected all economies in the mid 1980's saw nearly a half of Sri Lanka's export earnings consumed for oil imports. This severe blow managed to influence the government policy towards energy efficiency to a certain extent. Under severe strain from the oil price hike, the Ministry of Industries initiated the first ever coordinated energy management programme in the early 1980's, appointing Energy Managers to all Corporations functioning under the Ministry. An ensemble of around 20 Energy Managers conducted many energy conservation projects and conducted monthly meetings to report progress as well as to share experiences. This collection of Energy Managers gave birth to an important institution – the Sri Lanka Energy Managers Association (SLEMA). It celebrated its 30th anniversary in 2014. This association has kept a group of likeminded professionals together, contributing to preserve a vital knowledge base in times of lower energy costs where any government tend to lose interest in energy efficiency improvement and conservation. A further strength was added to SLEMA when the association was formally incorporated by the Sri Lanka Energy Managers Association (Incorporation) act No.1 of 1994 by the Parliament of Sri Lanka. This gave the association a new level of legitimacy in carrying out energy management work.

Formation of SLEMA and also the training given to the Energy Managers appointed by the Ministry of Industries in the 1980's was the first foray of the then Ministry of Irrigation & Power in to the area of Energy Management. The efforts of the Ministry of Irrigation & Power to compile a policy guideline through a committee of the Natural Resources Energy & Science Authority (NARESA) - renamed now as the National Science Foundation (NSF) – could be cited as the first instant where a policy element was included in a national document. An important outcome of the policy guideline was the establishment of the Energy Conservation Fund (ECF) by an Act of Parliament in 1985.

The Government having indentified lack of access to funds required to implement energy efficiency improvement projects created this Fund within the Ministry of Irrigation & Power. Hence, the main focus of the legislative framework behind the Energy Conservation Fund Act No. 2 of 1985 was on finances, as detailed below.

The primary objective of the ECF was to finance, promote and initiate activities and projects relating to the improvement of any or all aspects of energy demand management and conservation programmes in Sri Lanka'. This phrasing clearly identified funding as the key responsibility of the ECF. The ECF also had a detailed mandate covering the full spectrum of energy supply and demand as explained below.

(a) Identifying available technologies for improving efficiency in energy use (in agriculture, industry, commercial, domestic and transport sectors; and also in energy supply sector (including conversion, storage and heat recovery)

(b) Identifying policy measures such as economic incentives / disincentives, education & information provision and institutional arrangements

(c) Creating a core of active managerial level personnel to develop action oriented energy conservation programmes

(d) Promote energy efficiency improvement and Demand Side Management (DSM) programmes and provide funds and to support such programmes initiated by other parties

(e) Assisting public and private sector agencies to carry out energy efficiency, DSM or conservation programmes

(f) Initiating, promoting, conducting and coordinating energy efficiency, DSM and conservation related R&D efforts

(g) Organising seminars and workshops and provision of information and education for the general public on efficient use of energy

(h) Specifying standards, norms, codes and other criteria for maintaining quality and for reducing wastage

(i) Carrying out R&D and pilot studies leading to energy substitution schemes with a focus on new and renewable energy

(j) Promoting and carrying out long term energy planning and policy analysis

(k) All dissemination services with regard to energy efficiency, DSM or conservation

(l) Providing funding for participation in international programmes

National Energy Policy recognising Energy Efficiency

A Committee was appointed by the Ministry of Power & Energy to initiate a policy formulation effort to gather all aspects of the energy sector into a single process in 2005. The main elements of the policy are presented below.

1. Providing Basic Energy Needs
2. Ensuring Energy Security
3. Promoting Energy Efficiency and Conservation
4. Promoting Indigenous Resources
5. Adopting an Appropriate Pricing Policy
6. Enhancing Energy Sector Management Capacity
7. Consumer Protection and Ensuring a Level Playing Field
8. Enhancing the Quality of Supply
9. Protection from Adverse Environmental Impacts of Energy Facilities

Out of the above elements, the third bullet indicated the importance placed on energy efficiency and a detailed description of this policy element is presented in the ensuing section.

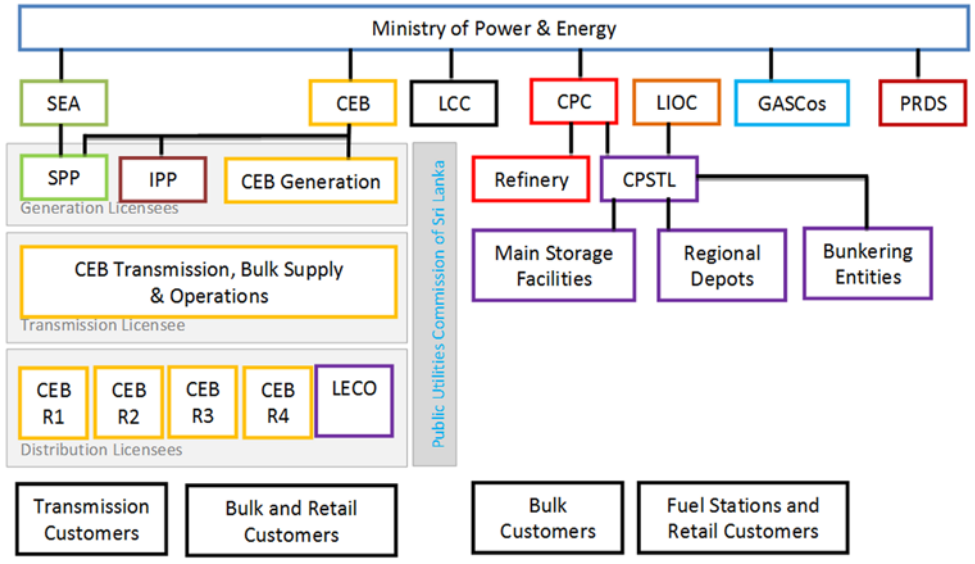
The main policy statement states: 'Energy supply systems will be efficiently managed and operated while also ensuring efficient utilisation and conservation of energy' and is further elaborated as follows. Efficient management and operation of the energy sector utilities are vital to ensure minimum cost of supply to consumers. Efficient utilisation of energy by all concerned, from utilities (supply-side management) to final consumers (demand-side management) not only saves valuable resources of the country but also reduces the overall cost of energy to the consumer. Meaningful conservation of energy will be pursued at all times.

This statement is followed by several strategies, explaining how the stated policy objectives would be met by the relevant player. The implementing strategies are;

- Supply side and end-use energy efficiency will be encouraged through financial and other incentives / disincentives in respect of energy end-use and mandatory measures such as appliance energy labelling, building codes and energy audits.
- Private sector participation in providing expert services on energy efficiency will be promoted and facilitated.
- Financial resources required to continuously improving efficiency in energy conversion, transmission, distribution and utilisation will be acquired from within and outside the energy sector by levying appropriate energy charges and formulating long term funding programmes with financiers.
- The Energy Conservation Fund (ECF) will be entrusted to coordinate all the activities relating to energy conservation and management, and the Energy Conservation Fund Act will be amended to accommodate these new responsibilities.

- An aggressive public education and awareness program on energy efficiency and conservation will be carried out on a priority and a sustainable basis.
- Technologies such as efficient stoves will be widely disseminated in the household and informal commercial/industrial sectors.
- The use of existing petroleum distribution infrastructure will be optimised.
- Power generation and network losses will be brought down to the lowest possible levels and capacity will be improved through necessary generation, transmission and distribution investments and efficient management of the supply systems.
- Efforts will be made to encourage electrification of viable sectors of the railway network and inter-modal shift in passenger and goods transport towards more energy efficient systems.
- A modal shift towards larger-capacity vehicular transport modes, which are less energy intensive per passenger kilometre or freight-tonne kilometre, will be promoted. Railway transportation will receive priority over road transportation.
- Better coordination of road and rail transport will be promoted as a key implementation strategy of achieving greater efficiency in the transport sector.
- A strategic plan for street lighting will be formulated for the country to ensure proper management of street lighting, which will enhance the safety of motorists and pedestrians, and also contribute to energy conservation with a better aesthetic sense.

The key policy change in energy efficiency improvement strategies took place with the enactment of the Sri Lanka Sustainable Energy Authority Act No.35 of 2007, and resulted in dramatic changes in the institutional framework which governed the energy efficiency improvement and conservation (EEI&C) activities of Sri Lanka. The next section explains these changes. The institutional framework which exists today is shown below.



Abbreviations

CEB	Ceylon Electricity Board
CPC	Ceylon Petroleum Corporation
CPSTL	Ceylon Petroleum Storage Company
GASCos	LP Gas Marketing Companies
IPP	Independent Power Producer
LCC	Lanka Coal Company
LECO	Lanka Electricity Company
LIOC	Lanka Indian Oil Company
PRDS	Petroleum Resources Development Secretariat
SEA	Sri Lanka Sustainable Energy Authority
SPP	Small Power Producer

The energy sector comes under the purview of the Ministry of Power & Energy. Ceylon Electricity Board (CEB), Lanka Electricity Company (LECO), Lanka Coal Company (LCC)), Ceylon Petroleum Corporation (CPC), Ceylon Petroleum Storage Terminals Limited and Sri Lanka Sustainable Energy Authority (SEA) are the statutory boards which are supervised by the Ministry. The major role of a regulator is played by the Public Utilities Commission of Sri Lanka (PUCSL). Petroleum exploration is carried out by the Petroleum Resources Development Secretariat (PRDS), an entity reporting to the Ministry of Power & Energy. Petroleum distribution company Lanka Indian Oil Company (LIOC) and the two LP Gas companies Litro and Laugfs too are lightly regulated by the Ministry.

This piece of legislation could be cited as the first-ever focused attempt to tackle the EEI&C programme in a comprehensive manner in Sri Lanka. Enacted on 1st October 2007, this Act repealed the Energy Conservation Fund Act No. 02 of 1985.

Objects of the Authority Among the four objects of the Authority, energy efficiency improvement and conservation received a prominent place as given below.

Section 4. The objects of the Authority shall be to

(a) Develop Renewable Energy Resources

(b) Declare Energy Development Areas

(c) Implement Energy Efficiency Measures and Conservation Programmes

(d) Promote Energy Security, Reliability and Cost Effectiveness in Energy Delivery and Information Management

Except the object (b) on renewable energy development the remaining two objects (c) & (d) too have a signification bearing on the energy efficiency improvement & conservation.

Power, Duties and Functions of the Board The Sri Lanka Sustainable Energy Authority Act No. 35 of 2007 confers significant amount of power to the Authority, targeting two aspects, Renewable Energy Development and Energy Efficiency Improvement. Out of the many powers, duties and functions the items relevant to EEI&C area are quoted below.

Section 5. The Board shall exercise, perform and discharge the following powers, duties and functions

- Assist the Minister in the formulation of the national policy on energy;
- Develop a conducive environment for the encouragement and promotion of investments in renewable energy development, energy efficiency improvement and conservation, rural energy services and for ensuring the sustainability and well-being of the energy sector in the country including
    - (i) The promotion of programmes to mobilise funds for renewable energy development, promotion of energy efficiency, improvement and conservation and rural energy services through credit enhancement and other facilities;
    - (ii) The provision of funds, including subsidies and seed capital for pilot projects in renewable energy development, energy efficiency improvement, conservation and rural energy services that reduce the dependence on imported energy;
- Provide technical and financial assistance for capacity building of the energy sector stakeholders and for research and development activities carried out by any stakeholder, consistent with the objects of the Authority;

- Function as a National Technical Service Agency for Clean development Mechanism (CDM) in Sri Lanka that provides technical assistance to the Designated National Agency for Clean Development Mechanism and project developers, on energy sector clean development project activities, including
    (i) The designing, developing and implementing innovative schemes that assist project developers to overcome barriers and access commercial financing;
    (ii) The facilitation and provision of assistance to project developers to access concessionary finances made available under any environment protection initiative by any organisation;
- Facilitate the access to green funds for investors in on-grid and off-grid renewable energy projects, for energy efficiency improvement and conservation measures and rural energy services;
- Provide funds and design, develop and implement credit enhancement facilities, such as loan guarantee schemes and access to commercial credit for investors in on-grid and off-grid renewable energy projects, investments in energy efficiency improvement and conservation and knowledge management in the energy sector;

Energy Efficiency Improvement & Conservation Programme The above duties and functions are to be performed using power vested in the authority. The Act goes even further to derive many programmes on EEI&C under the Part VII. The provisions in this part are quoted as below.

Section 35

(1) The Board shall be responsible for the adoption and implementation of measures to conserve energy and improve efficiency in harnessing energy, processing, conversion, transportation, storage, co-generation and heat recovery techniques, in the use of energy in all consumer sectors.

(2) For the purpose of carrying out its responsibilities under Section (1), the Board shall

(a) Identify, analyse, develop and recommend policy measures which can be implemented by all consumer sectors, to prevent wastage of energy used by them in their various activities;

(b) Promote and facilitate the implementation of energy efficiency and energy conservation policy measures, by organizing seminars, workshops and courses in energy efficiency, demand management or conservation;

(c) Educate and provide information to the public regarding energy demand management and conservation;

(d) Improve any or all aspects of energy demand management which promotes rational use of energy and reduces the use of non-renewable energy sources in Sri Lanka;

(e) Identify the available technologies and facilitate deployment of such technologies for improving efficiency in the harnessing of energy, processing, conversion, transportation, storage and use of energy;

(f) Implement energy labelling programs for appliances and devices and establish benchmarks;

(g) Specify and enforce standards, norms, codes, measurement and verification protocols and building codes, for the efficient use of energy and for reduction of wastage of energy in building; and

(g) Initiate, promote, conduct and co-ordinate research, surveys and investigations in regard to specific aspects of energy efficiency, conservation and demand management.

Powers vested in the Authority Powers vested in the Authority to carry out the above mentioned programmes are presented in Section 36.

Section 36

(1) The Board may from time to time by regulations made in that behalf, establish specific energy consumption benchmarks to be complied with by all energy consumers.

(2) For the purpose of ensuring that the benchmarks established under subsection 91) are being complied with, the Board may, where it considers it necessary

(a) Enter and inspect with the consent of relevant persons concerned, any premises, compound or facility, collect information, verification of information and conduct any other investigations;

(b) Direct any person to furnish information rerating to energy utilization, production, procurement and sales;

(c) Monitor, with the consent of all relevant persons concerned, energy consumption in buildings and industrial premises and monitor fuel efficiency of land vehicles, ships and aircrafts, in association with relevant agencies;

(d) Specify in association with relevant agencies, energy consumption limits and energy performance standards of appliances and direct the display of such particulars on labels attached to appliances, in such manner as may be prescribed from time to time;

(e) Control the manufacture, import, sale or purchase of appliances which do not conform to the specifications prescribed under paragraph (d);

(f) Enforce limits and codes of practices for existing and proposed buildings, industrial premises, land vehicles, ships and aircraft, in association with relevant agencies; and

(g) Develop educational material and recommend educational curricula, on efficient and rational use of energy and conservation of energy.

Curtailment of Energy Waste The curtailment of energy waste is dealt separately under the Section 37 which also proposes a fairly elaborate measures as shown below

Section 37

(1) Where the Board is of the view that any person or categories of persons (including any public body), is consuming unacceptable levels of energy in their respective premises or installations, over and above the benchmarks, established by the Board under section 36 of this Act, such person or category or persons may be called upon to submit to the Board a detailed audit report compiled by an accredited energy auditor and a detailed plan of action on remedial measures that are proposed to be taken by such person or category of persons, as the case may be, to reduce the energy consumption to acceptable levels.

Mandatory Energy Auditing The first step in EEI&C, the thorough investigation of energy using facilities, which status from energy auditing and concludes with post improvement monitoring is extensively dealt with in the Act. All actors in the energy efficiency services (EES) provision is identified and are expected to be accredited and ranked by the Authority as detailed in the Section 38. Mandatory energy auditing is dealt in the Section 39 which follows.

Section 38

(1) The Board shall appoint and rank persons having such qualifications as prescribed, to be

(a) Energy managers, who shall assist in promoting practices relating to efficient energy management;

(b) Energy Auditors, who shall be qualified to conduct energy audits; and

(c) Energy Service Providers.

Section 39

(1) The Board shall from time to time by rules made in that behalf, specify

(a) The persons or categories of persons including public bodies, who shall be required to have an energy audit carried out in their respective installations or premises; and

(b) The manner and the period during which an energy audit shall be required to be carried out.

Policy Formulation Apart from the above mentioned specific measures, wide ranging policy formulation tasks too are given in the mandate of the Authority under Section 41.

Section 41

The Board shall be responsible for promoting security and reliability and ensuring cost effectiveness of energy delivery within Sri Lanka, and for that purpose

(a) Examine the energy sector performance, review and integrate institutional and sub-sectoral plans, conduct policy analysis, review compliance with national energy policy and strategies and make policy recommendations to the Ministry on the energy sector in general, and more specifically on renewable energy resources and energy efficiency;

(b) Conduct surveys and investigations, collect and compile data in collaboration with the Department of Census and Statistics, publish national energy balance reports and other documents providing information relating to the energy sector in general, and more specifically to energy resources, conversion, supply, utilisation, conservation and economics;

(c) Identified and analyse policy measures and recommend to the Ministry and other relevant agencies, specific policy measures pertaining to fiscal incentives and disincentives, including pricing policies, taxation and institutional arrangements;

(d) Obtain information relating to energy resources, research, reserves, conversion facilities and conversion levels, storage facilities and storage levels, transmission and distribution systems, sales, customers, costs, prices, income from sales losses, employees and development plans of any institution, company or individual engaged in the business of energy or having jurisdiction over resources that possess an energy value; and

(e) Inspect and obtain information about potential or existing energy supply facilities and their utilization and consumption.

This Section is seen to be a vital piece of legislation in deriving fiscal policy measures in battling entry of inefficient energy wasting equipment and appliances into the Sri Lankan market.

Fragmentation of Legal Framework Just as energy efficiency legislation evolved into a complex and specific form, relative positioning of the energy efficiency legislation among other laws and interrelationships between energy efficiency laws and other laws have undergone many changes. Since most other laws too have changed into more complex forms, well defined relationships (between Acts and Regulations) which was possible in a less complex context has now become almost impossible to visualise. For example, even the few references to

CDM in the Sri Lanka Sustainable Energy Authority Act has failed to attract attention of the legal experts working in the environmental protection legislations who prepared the incorporation papers of the Sri Lanka Carbon Fund, a focal point on CDM in Sri Lanka.

The fragmentation of legislation has given rise to a situation where implementation of most energy efficiency policy require other means of integration such as standing committees, working groups and advising committees to iron out differences between non-complementary legislative framework. Another drawback of the fragmented legislative framework is the poorly defined roles of agencies. For example, the energy labelling programme requires close interactions between several organisations whose roles and responsibilities sometime overlap whilst certain tasks remain unassigned to any agency.

Implementation Issues In spite of significant developments in the energy efficiency legislative framework in Sri Lanka, opportunities for improvement crop up in the efforts to implement the policy changes. A closer examination of proven systems in other countries where the policies were implemented before would have made implementation a much easier task. Special attention must be paid to areas where enforcement is required as more often than not, existing legal entities and instruments have to be used (e.g. customs, the police and other arms of the law enforcement establishment) to implement many energy efficiency policies. Hence the policy development effort must be preceded by a detailed analysis of existing enforcement structure of the country with regard to intended policy implementation.

Prioritisation Having laid out a wide mandate covering all aspects of energy use, the SEA now finds it difficult to focus on a particular area, as the political authority is expecting speedy implementation of all provisions. Ideally, the implementation time table would have been derived from an in depth study of cost/benefit aspect of each measure.

Utility Involvement Just as ill defined roles of energy sector agencies hamper implementation, the specific assignments of all EEI tasks to a new agency too has created a situation where the utilities severing all relationships with DSM activities, as they see the entry of a new agency as a signal to exit of the utilities from EEI efforts. The much needed cooperation of utilities in driving EEI programmes may suffer as a result of this. Even though the new Legislation has emancipated the capacity of utilities to focus on supply side efficiency programmes, the role to be played by them in DSM cannot be down played, even after the entry of the SEA into the system. A clearer understanding of the utility role in DSM and laying out legislative framework to assure utility participation in EEI programmes would have been helpful.

Current Institutional Relationships in Energy Efficiency

When the main entity (SEA) responsible for energy efficiency was placed under the Ministry of Environment and Renewable Energy, it lost most of its access to energy sector utilities in both electricity and petroleum sectors. This impeded the entire EEI&C programme for a period of three years. With the integration of all energy sector entities under one ministry, several programmes which lay dormant were reactivated. The ongoing efforts in various end use sectors necessitated different institutional arrangements which are described below.

Industry Since the industrial base of the country is not much developed, the EEI&C approach to this sector had been simple. The industrial sector is divided to few sub areas such as Tea and Apparel and bench marks for specific energy are established. This is conducted by SEA in association with the energy services companies (ESCOs). The industries are then nudged to achieve energy efficiency beyond the benchmark levels through a network of energy managers appointed to the designated industries. At present the number of designated industries is around 1,500. Apart from this, sector specific awareness and capacity building programmes are frequently delivered by SEA. Common industrial appliances such as electric motors are being labelled on their energy performance to guide the industrial energy user.

Commerce Commercial buildings of the country are expected to follow the Energy Efficiency Building Code (EEBC) which is presently offered as a voluntary measure. Due to poor acceptance, it is being reviewed and will be implemented as a mandatory instrument. In the proposed code, the implementation will be done by SEA, through the building regulations enforced by the Urban Development Authority (UDA). The emerging structure of the code will require Architects and Building Services Engineers to treat energy performance of buildings as a prime requirement, since the enforcement of the code will require them to prove the energy performance of the building as a part of the building's certificate of conformity (CoC).

Households Although there is policy intent to improve the energy efficiency of homes as in the case of the commercial buildings, it may take a longer time to implement even in the voluntary mode. Therefore, primary institutional arrangement in this regard will be centred on the appliance labelling programme. The programme involves the Sri Lanka Standards Institute (SLSI) to prescribe appliance standards and Department of Customs to control entry of appliances to the country. Internal trade irregularities are dealt in the standard practices using the legal powers of the Department of Police. Common appliances with high energy impacts are chosen for the labelling programme, and once labelled such appliances become controlled items, which are required to comply with certain technical requirements, mostly aligned to the energy performance. The programme requires extensive testing of each model of any appliance and a network of test facilities housed in research organisations and universities provide such facilities for a fee. Apart from local testing, accredited laboratories elsewhere too can issue test certificates for imported appliances.

Transport The EEI&C programme in the transport sector is relatively young. The programme at present involves the petroleum distribution utilities in a road user awareness programme. An ambitious programme to issue energy labelling to road vehicles was launched in 2013, involving the Road Development Authority and a university. As a first step, a driving cycle for urban road sectors will be developed and applied on motor vehicles to derive energy efficiency indices for each vehicle class.

General Public Having recognised the importance of engaging the citizens in the energy efficiency programme, especially the conservation aspect, SEA has conducted many media campaigns targeting them. However, the longer term strategy in this regard had been to involve the future citizens (who are currently in various educational pursuits) through their curricular and co-curricular activities. SEA is working with the Department of Education and the National Institute of Education (NIE) to inculcate energy conservation knowledge, attitudes and skills in the students via the Science subject in Year 7 – 11 curricula. The Department of Education is also involved with SEA on an island wide programme of establishing energy clubs in schools, culminating with an annual award.

HFC Survey in Sri Lanka

By
Prof. W.L. Sumathipala &
M.M.M. Seneviratne

Ozone layer depletion was reported in early 1970s and scientists were looking for reasons that led to this problem. Later it was understood that manmade chemicals that were used in industries such as Refrigeration, Air-conditioning, foam blowing, fire fighting, as well as use of propellants were responsible for this rapid depletion. The Montreal Protocol for substances that deplete the ozone layer was initiated to phase out ozone depleting Substances (ODSs) in 1987 as the legal instrument of Vienna convention for protection of the ozone layer. A variety of natural substances such as hydrocarbons that are ozone friendly are being used as alternatives/replacements for ODS. The irony is that all over the world CFC's were phased out mainly by introduction of HFCs in many applications. Later it was noted that even though ozone friendly, HFC was a very powerful greenhouse gas, which if emitted to the atmosphere contributes to climate change.

Under these circumstances the Montreal Protocol is interested in eliminating HFC use even if it is a not an ODS. As the first step, in order to have an idea about the magnitude of the problem and amount of HFCs in use, conducting a survey was recommended. Many developing countries are in the process of conducting this important survey.

In Sri Lanka this survey was initiated in January 2015. Since Sri Lanka does not manufacture HFC and its consumption is supplied by imports, it was planned to obtain the help of Sri Lanka customs to gather the imported amount. Since HFC are mainly used in the AC/Ref sector in Sri Lanka it was decided to obtain the end user data by contacting technicians and repair shops and workshops of AC/Ref. sector.

Survey

The objectives of the initial survey of HFC consumption in Sri Lanka for establishing the current consumption of HFCs and to provide future projections of growth patterns by substance and to the extent feasible, by sector and also to identify opportunities and challenges for transition to low-GWP alternatives for various applications. Establishing use and growth patterns for various species of HFCs in the country at this stage would provide data to facilitate selection of appropriate safe and efficient low-GWP alternatives, wherever currently available for various applications, thus contributing to direct and indirect emission reductions, when implemented.

Data Collection

Institutional Level Data collection

First it was decided to collect data from Sri Lanka Customs, Department of Motor Traffic, Board of Investment (BOI) and Ministry of Industries mainly because they are the key Government Institutions involve with import of HFC or equipment containing HFCs. The data available with these institutions were in various forms but was useful to obtain an overall idea about the total amount of HFC entering the country. Next it was necessary to collect data from middle level organizations and the focus was on Importers, Distributors, and retailers in order to obtain quantity of HFCs and mixed blend imported.

ii.National Level Data Collection

In order to collect maximum and accurate data from all parts of Sri Lanka and from each sector where HFCs are used, it was decided to form 12 teams to do the survey at national level. Each team consisted of one instructor from a Technical College as the Leader of the team and 4 students of technical colleges. According to the geographical demarcation and Technical Institution where the Team Leader works, 12 teams were formed to cover Administrative Districts of the Island. For the district of Colombo two teams were appointed due to large numbers of HFC users. Some teams were allocated 2-3 districts due to reduced concentration of HFC use and number of workshops.

National survey team had to recognize places and collect HFC use in particular districts according to the General Questionnaire. Team Leaders were authorized to select the workshops and to summarize the data according to the type of users. A MS EXEL Format was prepared to record the collected data.

Questionnaires for Survey

HFC consumption data were collected through Questionnaire Survey and cross checked with the import data. A set of questionnaires for each sector were developed to cover various sectors that use HFCs. Questions pertaining to availability and use of alternatives formed part of the relevant questionnaire. Separate questionnaires were developed for Customs, Refrigerant Importers/ Dealers, Equipment Importers, Equipment Manufacturers/ Assemblers, Service workshops and Military establishments.

Import of HFCs.

During the survey, detailed discussion was carried out with the National Ozone Unit of Ministry of Mahaweli Development and Environment regarding the list of HFC importers in Sri Lanka. Data on imports were collected from the importers through the specific questionnaire designed for the purpose and compiled. From the survey it was found that HFC 134a and other HFCs are mainly used in RAC applications in servicing and installation, manufacturing domestic refrigerators and bottle coolers

Over the last few years, consumption of HFCs has been increasing due to demand prevailing in the servicing sector and in relation to economic growth in the country. HFC consumption is expected to grow further in the next few years primarily driven by consumption growth of RAC applications in the country and rapid increase of vehicle population in the transport sector. HFC blends are used mainly in Unitary Air Conditioning, Commercial Air Conditioning, refrigeration applications and refrigerated transport.

Estimated End users by Sub sectors

- ***Domestic Refrigerators***

Currently HFC 134a is not used to manufacture domestic refrigerators. Until August 2014, the sole manufacturer of refrigerators in Sri Lanka 'REGNIS Lanka Ltd' converted its plant to manufacture refrigerators using hydrocarbon R 600 a. Approximately 30-35 MT of R 134a had been used annually by REGNIS, until termination in 2014

- ***Commercial Refrigerators***

Commercial refrigeration equipment using HFCs are primarily used in display units for fruits, vegetables, meat/ fish and dairy products and for storage requirement for these products. These are used in large supermarkets and medium size stores selling house-hold products. In supermarkets and medium size stores, HFC-134a and R-404A are used. There is very limited use of HC based equipment in Sri Lankan markets.

The large supermarkets and medium sized stores have cold stores using HFC 134a for storing food products. These stores have small capacity (3 TR) cooling units. For Frozen Products applications, R-404A based and HFC-507A based units are used.

Currently in Sri Lanka, commercial equipments are manufactured or assembled by 4-6 companies. HCF based refrigeration equipments are installed at supermarkets and shopping malls by themselves or through service contracts with Service Companies. In addition to the above, there are a very few unorganized individuals who intermittently assemble commercial equipment.

The equipments working with HFC are imported from China, Japan, Germany, Australia, Malaysia, Thailand, Korea and in small quantities from USA. According to the survey 39.5 MT of HFC 134a, 8.7 MT of R404A, and 0.3 MT of R507A were used in commercial equipment production or assembling in Sri Lanka for 2014.

Given the economic growth rates expected in the near future, the demand for these equipments are expected to increase with increase in number of distribution outlets in the country. It must be noted that this growth will include both HFC based and non HFC based equipment (CO_2, Ammonia, etc.). However, at present higher levels of HCFC 22 equipments are in these applications. With the present phase-out schedule of HCFCs, it is anticipated that a significant growth would be for HCFC free equipment.

- ***Domestic air-conditioners***

Currently, domestic air-conditioners are not manufactured in Sri Lanka, except for a small quantity which is imported and assembled in the country. There were three manufacturers, namely Haikawa International,

Frostaire, and Abans. All three manufacturers started manufacturing unitary air-conditioning equipment about 10 -15 years ago but due to price competition from international brands/products coming from China, India and Korea, Haikawa International has closed down operations long ago and the other two companies have reported that small quantities are assembled by them. Quantity may vary in between 5,000 – 6,000 per annum and most of them use HCFC 22

- ***Industrial refrigeration and air-conditioning equipment***

HFC 134a based industrial air-conditioning equipment (Chillers) are widely used for comfort cooling in large buildings, hospitals, hotels, garment factories and other various type of factories. R 404 A, R 407 C, R 134a are used in processing/ cooling/chilling and freezing applications for food, chemical and pharmaceutical industries.

These equipments are installed by local companies which undertake contracts for installation and commissioning chillers. Most of these companies are importers as well as installers. There are likely to be additional small companies in the informal sector who operate intermittently.

Typically, servicing is done by the installing Companies or undertaken through annual maintenance contracts by service agencies. The estimated service quantity for servicing equipment varies and depends upon the equipment characteristics. Refrigerant for service are purchased from the dealers.

- ***HFC Use in Service Sector***

The servicing Sector basically engages with repair and maintenance of domestic refrigeration, unitary air-conditioning system and Mobile Air Conditioning. However they used to take installation of new Air Conditioners and also repair and maintenance of the commercial RAC system. According to the survey questionnaires, it was revealed that 98% of domestic refrigerators are HFC 134a systems. Since R600A systems were recently introduced and are serviced by service agents of the Manufacturers or Importers, Service workshops are not receive/handle refrigerators with R 600A. According to service workshops they usually handle HCFC-22 system in unitary air-conditioning systems, and R410A Air Conditioning systems and are still new and these hardly come for repair. They purchase R 410 A for the charging the new Air Conditioners at the time of installation.

CONCLUSIONS

Today most HFCs are used in refrigeration and air conditioning (RAC) equipment. R22 (HCFC 22) is still the most important refrigerant currently used in this sector. However, HCFCs are gradually being phased out and demand for HFC refrigerants is expected to increase significantly in the short and medium term, to satisfy expected growth in hotels, condominiums, office buildings and supermarket refrigeration etc., in particular. Household refrigerants are mostly working with HFC 134a even though refrigerant R 600a is already introduced in Sri Lanka. Systems have improved drastically but some concerns are still there with the public about the flammability issue. Therefore it will take some time for the domestic refrigerant market to be changed to R 600a or any other alternatives. Retrofitting option is not available here from HFC to R 600a as in the case of CFC to HFC change over. The mobile air-conditioning (MAC) sector accounts for a major share of the countries use of refrigerant, and alternatives are not well known and are not widely and freely available. Therefore it is expected to stay HFC in this sector for a longtime to come.

Further Sri Lanka is a middle income country and moving rapidly in the development ladder. This in turn has increased the demand for household refrigerators and with the increase of the automobile fleet the MAC sector demand will grow at a very rapid rate.

However, with the enormous effects of climate change in Sri Lanka a proper direction from the government and the higher authorities will be forthcoming for replacing high GWP refrigerant. In order to achieve it decision makers will have to be educated properly on the subject. This will help to bring about a policy decision and necessary changes. On the other hand the general public will have to be well educated because the rules and regulations alone will not be able to achieve the expected goal.

Thirty Years of Ozone Protection and Role of Communication

By Nalaka Gunawardene

About the contributor:
Science writer and communications consultant Nalaka Gunawardene has been associated with ozone communications for over 15 years. He worked with UNEP to prepare a communications strategy for IEC activities that form a part of the national HCFC phase out strategy in Sri Lanka.

This is a special year for everyone concerned with the protection of the ozone layer - the natural 'shield' in the upper atmosphere that protects all life on Earth from the Sun's harmful ultra-violet rays.

In 2015, we mark the 30th anniversary of the adoption of the Vienna Convention for the Protection of the Ozone Layer, which serves as a framework for global efforts to protect the ozone layer.

Concerns that human activities were damaging the ozone layer had been raised from the early 1970s, and some Western governments started taking precautionary measures. But the real turning point came in 1985, when scientists of the British Antarctic Survey detected a large and still growing gap in the ozone layer over the Earth's Southern Hemisphere.

Although this 'ozone hole' was centered over Antarctica, its growth appeared to correspond with a dramatic increase in skin cancer rates in Australia, New Zealand and other countries of the Southern Hemisphere.

This discovery of the 'ozone hole' created news headlines worldwide and galvanised governments worldwide to take collective action. The Vienna Convention was the international treaty that provided a framework for negotiating regulation of all ozone-depleting chemicals.

By the end of 1985, some 20 nations - which included the world's leading producers of such chemicals – had signed the Vienna Convention.

Global negotiations under the auspices of the United Nations, which typically take years, were fast-tracked in this instance. They culminated in September 1987 with the Montreal Protocol on Substances that Deplete the Ozone Layer. It provided a legally-binding timeframe for phasing out the use of close to 100 chemicals that were known to damage the ozone layer.

Sri Lanka and Ozone Protection

The Montreal Protocol is a prime example of how good science, well covered by the media, led to specific and sustained policy response. By end 2014, it has been signed and ratified by 197 countries: it is the most widely subscribed international treaty of all time.

Sri Lanka's accession to the Vienna Convention was on 15 December 1989. On the same day, Sri Lanka also ratified the Montreal Protocol. Both the Convention and the Protocol entered into force on the same day – from then onwards, Sri Lanka has been an active participant of the global ozone protection efforts at inter-governmental levels. Sri Lanka later also ratified all the amendments to the Montreal Protocol (i.e. London, Copenhagen, Montreal and Beijing).

Sri Lanka continues to be an active member country (or 'Party') of the Vienna Convention, and has been well ahead of many other developing countries in fulfilling the Montreal Protocol commitments.

The National Ozone Unit (NOU) of Ministry of Environment has been acclaimed as a leader in ozone layer protection efforts in the world, and received the Montreal Protocol Implementers Award in 2007. The following year, in 2008, Sri Lanka was appointed as chair of the conference of the Parties held in Montreal.

IEC for Ozone Protection

For over a quarter century, Sri Lanka's participation in ozone protection activities has been driven by policies, laws and regulations as well as by public education and awareness raising work.

This is because ozone layer recovery is a long term process and awareness creation among different target groups is essential to sustain protection efforts that are needed for decades to come. An informed public, as well as enlightened policy makers and industry managers, are an integral part of the successful implementation of Montreal Protocol phase-out targets.

Sri Lanka's NOU has pursued good public communications on ozone from the early days. As it completes 21 years in 2015, information, education and communication (IEC) activities remain important, alongside activities such as law enforcement, industry support, capacity building and compliance monitoring.

Among the developing Asian countries implementing the Montreal Protocol, Sri Lanka was among the first to recognize the value of IEC activities. That started in 1994, when it embarked upon the national strategy and action plan for phasing out ozone depleting substances.

Having successfully phased out CFCs by 2008, Sri Lanka has now started phasing out anther category of chemicals known as HCFCs. The international target for their total phase-out is 2040. Here, too, IEC activities are being dove - tailed into other interventions covering policy, legal, regulatory, technological and financial aspects.

Hard work over the years by NOU staff and its partners has helped Sri Lanka achieve a basic awareness on ozone protection issues. HCFC phase-out is therefore adopting a more strategic and cost-effective method: engaging the primary user groups through tightly focused activities, and gradually expanding that engagement to involve other user groups.

Phasing out HCFCs will be an incremental process for which the Montreal Protocol has provided a timeline extending up to 2040.

It has been my privilege to be associated with the Sri Lanka NOU's various IEC activities for much of the past 20 years. While we can draw satisfaction from progress made so far, more work remains to be done. Changing public attitudes and behaviour is a gradual process which requires sustained engagement.

Thus, good communications will continue play an important part in Sri Lanka's journey towards phasing out all chemicals that damage the ozone layer.

Development of Alternatives for MeBr In Tea Industry: Research Experiences

By
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Tea is a perennial crop grown in Sri Lanka mainly for export purpose. Since inception of commercial tea cultivation, the Tea Research Institute (TRI) facilitated with technical guidance on appropriate agronomic and cultural practices from land selection, establishment, cultivation, pest management, harvesting and up to manufacturing of tea etc. Resultantly, Sri Lankan (Ceylon) tea is continued to famous in the international market for its quality and also gained the accolade of being the 'cleanest in the world with respect to pesticide residues'.

Presently, tea is cultivated in wide agro ecological regions by corporate sector, proprietary and small holder growers in up, mid and low elevations. The stakeholders include growers, manufacturers, processors, exporters and traders. Besides the immense foreign exchange earnings of the industry, it strengthens socio economic and political status of the country through direct and indirect employments, livelihood benefits and sustaining cultivated lands and their surrounding environments. Therefore, it has been made mandatory to follow all Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs) recommended by TRI and the guidelines of the Sri Lanka Tea Board (SLTB). TRI and SLTB periodically revise recommendations in meeting global economic, environmental and social requisites, consumer preferences in the beverage industry and sustainable development goals for implementation by the stakeholders.

Like other crops, tea is subjected to vast number of insect and nematode pests, foliar and root diseases and weeds during cultivation owing to the conducive cool and humid conditions in the tea ecosystem (19, 34). Post manufacturing environments due to poor handling, practices and handling etc. also favor microbial and insect contaminations in made tea. The field losses range from 5-30 per cent in yield while the damages rise up to 100 per cent when the quality is deteriorated due to contaminations of the final product. In managing the tea pests, TRI advocates integrated pest management strategies incorporating various biological, agronomic and cultural methods with control through rational use of pesticides by identifying critical points in the whole value chain.

Plant parasitic nematode species i. e. Pratylenchus loosi and Radopholus similis and root diseases i. e. red root or Poria disease (Poria hypolateritia), black root disease (Roselliinia arcuata), charcoal root disease (Ustulina zonata) and white root disease (Fomes lignosus) have been identified to cause devastating and unrecoverable economic damage in nurseries and field (18, 19, 20, 21, 30, 34, 36). Eradication of such pre plant or post plant pests and diseases is recommended since 1926 by means of sterilization and fumigation in nurseries and field. In warehouses, the opportunities to get microbial and insect contaminations are minimal owing to the hygienic standards in recommendation but fumigation is made mandatory for ISPM regulations applicable is ware house and exports.

Methyl bromide (MeBr), which is a broad spectrum fumigant that has been in use for over 70 years, has been effectively used in the tea industry for control of nematodes and root diseases and for warehouse fumigation as a disinfectant as a ISPM requisite. The pre MeBr chemical treatments and non chemical practices practiced in the tea plantations for control of plant parasitic nematodes and root diseases are presented in Table 1 (19, 34).

Table 1
Pre MeBr treatment recommendations of TRI for eradication of economically important pre plant and post plant pathogenic organisms in tea

Pathogenic Species	Site of Damage	Pre MeBr treatments / Attempts / Recommendations
Root lesion nematode (Pratylenchus loosi) Burrowing nematode (Radopholus similis)	Nursery / field	Shell DD, Nemagon
Red root or Poria disease (Poria hypolateritia)	Field	Lime, sanitation, destruction and burning infested parts, Guatemala, 1,3-dichloropropene (DD)
Black root disease (Roselliinia arcuata) Charcoal root disease (Ustulina zonata) White root disease (Fomes lignosus)		None except sanitation, destruction and burning infested parts

Rationale for Development of MeBr Alternatives in Tea

In general, MeBr has been used as a quarantine treatment for plants and to control insects in buildings and commodities; it was also widely used as a pre plant soil fumigant to control nematodes, insects, pathogens and weeds. The emissions of MeBr from soil fumigations has been estimated to be 40–90% of the dosage applied, whereas the other uses as a fumigant released 70–99% of the initial gas which eventually reached the ozone layer.

Hence, in 1992, MeBr was listed as an ozone-depleting substance under the Montreal Protocol on substances that deplete the Ozone layer and the bulk of its consumption was to be eliminated with innovative solutions. Initial refinements of techniques included precision trapping for mapping pest infestations over space and time, biological control, new chemical insecticides, high-pressure fumigation and recycling of MeBr etc. Phase out of MeBr in Sri Lanka became a special project to work on global environmental needs and as a bilateral agreement. It was evident that a considerable volume of MeBr has been in use for fumigation tea nurseries in Sri Lanka. Hence, as compared to other sectors, MeBr usage in the tea sector in Sri Lanka was recognized as crucial. Thus, TRI being the pioneering Institution in the country was given the task for research and development in making appropriate recommendations on MeBr alternatives to the corporate and small holder sectors in Sri Lanka (34). Moreover, TRI took the initiatives in planning, execution and promotion of appropriate MeBr alternatives in accommodating user and environmentally friendly and cost effective recommendations which will also pave avenues in promotion of Sri Lankan tea internationally.

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Approach in Determining MeBr Alternatives for Tea

Nurseries are the focal points of spread of soil borne pathogens such as nematodes, fungi, bacteria and weed seeds to hitherto uninfested areas which will cause economic damage in future (20, 21, 22, 24, 30). Hence, plant parasitic nematodes were recognized as the priority candidate in tea as other root diseases were found to occur seldom and in isolated localities and sterilization of nursery soils and premises are of paramount importance. Therefore, in the first phase of the MeBr Phase out R&D Project, development of alternative soil and nursery sterilizing of protocols and cleaner production of planting materials free of nematodes was aimed. Available MeBr alternatives were studied and assessed through an intensive literature survey. As the end users, ordinary nurseries and large scale central nurseries in corporate sector tea plantations, commercial nurseries run by individuals and medium and small nurseries of small holders were targeted. Figure 1 presents the R&D approach taken by the Tea Research Institute of Sri Lanka in determining various possible alternatives and testing them for applicability in making appropriate recommendations to the industry.

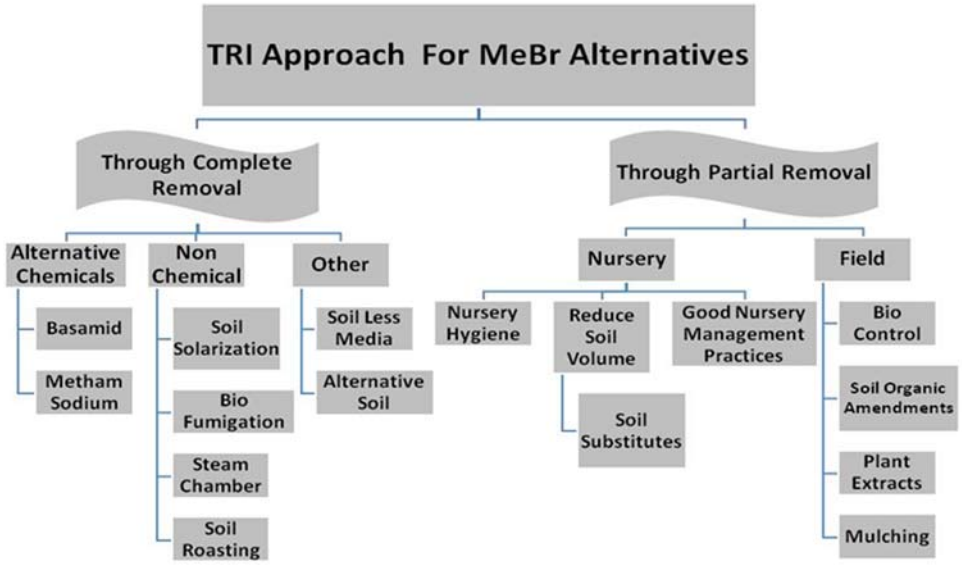

Figure 1 TRI approach in development of MeBr alternatives for tea nurseries

Criteria in selecting methods or materials for replacement of MeBr were the capacity of eradication of soil borne pathogens to ensure quarantine requirements as well as guarantee as nursery treatment. Priority was given for none ozone-depleting and POP chemicals and carbon negative substances and practices. In the case with chemical fumigants, candidate active ingredients with no regulatory approvals and no reported resistance to pests were searched. Local availability, traditional practices, user friendliness and cost effectiveness were evaluated in choosing non chemical alternatives to MeBr. Due consideration was given to anticipated limitations of the prospective MeBr alternatives as test treatments and practices for research purpose in view of better adoption of the alternate technologies tea industry in Sri Lanka as presented in Table 2.

Table 2 Potential MeBr alternatives identified and their limitations in Sri Lanka

Type	MeBr Alternatives / Options / Methods Available	Limitations Identified
Physical Alternatives	Heat and cold Extreme Temperatures	Practical applications
	Flooding Soil roasting Soil burning	Incompatible with requisites for tea nurseries

Fumigant Alternatives	Chloropicrin 1,3-dichloropropene Methyl Iodide	Cost
	Metham Sodium	Application Techniques
	Sodium Azide	Requirement of drip irrigation facilities makes it less adoptable by small scale operations
	Phosphine Carbon dioxide Iodomethane Dazomet	Application Methodologies Cost -
Non-Chemical Methods	Crop Rotation Use of Resistant Cultivars	Practicality -
	Organic Matter Incorporation Plant Extracts Mulching	Absolute Eradication of Soil Pathogens not Foreseen
	Solarization	Erratic Weather Conditions in Tea Growing Regions
	Soil less Media	Appropriate Media for Rooting and Growth of Nursery Cuttings
	Soil Substitutes Alternate Nursery Soils Biofumigation Steaming	- - Mass scale production Cost and practicality
Biological	Bacteria, nematode trapping fungi species	Maintenance of inoculated microbial densities under normal conditions
Irradiation	Gamma rays Microwaves Infra red X-rays	Application Devices and Effective Doses

For R&D purposes therefore, most suitable chemical and non chemical methods and practices were chosen with less limitations. In the first phase, the study protocol included preliminary bioassays with the nematode species in the laboratory, pot and glass house trials, micro plot studies under controlled conditions and field scale studies in different agro ecological regions. Surveys and farmer centered research and adaptive trials were also perfected prior to make the final recommendations to the stakeholders.

Outcome of MeBr Phasing out Project carried out by TRI

Various R&D attempts were made in testing appropriate methods, materials and practices for effective use as alternatives to MeBr and feasible as cost effective, affordable and environmental and worker safety. The methods, materials and practices covered both chemical and non chemical methods and over 75% of the findings were of non chemical alternatives as shown in Figure 2.

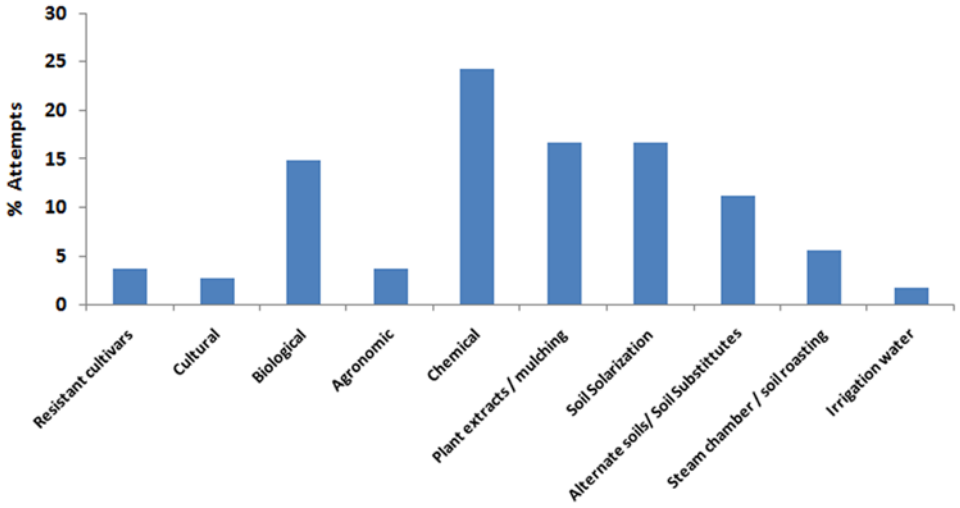

Figure 2 R&D attempts made by the Tea Research Institute of Sri Lanka to develop chemical and non chemical MeBr alternatives

Salient findings

The R&D attempts in searching MeBr alternatives for tea nurseries resulted in many research outputs. The salient chemical and non chemical methods, materials and practices proved to be effective chemical alternatives are given below.

1. Selection of suitable tea cultivars resistant / tolerant to Pratylenchus loosi and Radopholus similis for up, mid and low country.
2. Grafting of nematode susceptible scion on to a nematode resistant/tolerant stock to P. loosi and R. similis was found to induce resistance/tolerance in such combinations.
3. Mapping Pratylenchus loosi and Radopholus similis active and prone areas in the tea growing regions and strengthening location and area specific integrated nematode management strategies.
4. Incorporation of various locally available soil organic amendments was found to help manage nematode populations in tea soils. Organic materials with nematicidal, growth promoting and biological enumeration properties were effective in lowering parasitic nematode populations and increasing tolerance to damage caused by parasitic nematode populations. They included well decomposed tea waste, spent tea, neem (Azadirachta indica) seed cake, castor (Ricinus communis) oil cake, mahuva (Madhuca indica) oil cake, Karanj (Pongamia glabra) oil cake coconut poonac, poultry manure, freshwater hyacinth (Eichornia crassipes) etc.
5. Promising bio control agents of tea nematodes were recovered from Sri Lankan tea soils; they included the endospore forming bacterium, Pasteuria penetrans and the nematode trapping fungi (Arthrobotrys musiformis Dreshsler, A. oligospora Fres., Arthrobotrys sp., Dactylella sp.) and Monacrosporium sp. and other fungi Fusarium sp, Paecilomyces sp. and Trichoderma sp. (Figure 19).
6. Owing to constraints in large scale mass production, application and maintenance of these microbial antagonists and other natural enemies such as micro arthropods, collembolans, tardigrades and free living nematode species in tea soils, adoption of important cultural practices such as incorporation of soil organic amendments, burying of prunings, grass rehabilitation, forking, mulching, rational use of soil agrochemicals etc. was encouraged in view of activation, multiplication and conservation of the organisms.

7. As soil substitutes, soil mixtures of organic materials such as tea waste (1:1), paddy husk (1:1 or 1:2) and coir dust (1:1) were found to be beneficial in filling the lower 2/3 of the nursery bag. For the whole bag, 1:1 ratio was workable with tea waste, paddy husk and coir dust. Locally available and accessible soil substitutes helped minimizing soil requirement by 1/3 and thereby chemical fumigation as well (Figures 14 and 15).

8. 100 % coir dust compressed into a coin structure was identified as a promising soil less media for tea nurseries. This will serve as an absolute alternative to MeBr. However, further refinements and determination of sizes etc. suit to tea nursery plants are pending. (Figure 17)

9. Soil solarization was effective in killing nematode species. However, mortality of all stages of nematodes was not possible. Further, possibility of anhydrobiosis of nematodes was anticipated. More importantly, expose of the nurseries to soil solarization process for minimum of 6 weeks with a minimum of 5 hour solar radiation in all tea growing regions was found difficult due to erratic weather conditions (Figure 10).

10. Soil roasting was effective in killing nematodes at all stages. However, roasting destructed structure of tea nursery soils and made inferior for rooting and establishment of tea cuttings.

11. Complete sterilization of soils was possible using steam generated through a steam chamber operated though LP gas; user friendliness, cost and practical application were seen as limitations to tea growers (Figure 16).

12. Biofumigation using agricultural and animal wastes like raddish, cabbage and fish waste showed potential of releasing gases containing biocidal properties and proved to be effective in killing soil borne pathogens. Further work is required to improve the biofumigation prototype developed for small scale and mass scale nematode eradication (Figure 18).

13. Potentials of harnessing Eucalyptus and Pinus soils as alternate soil sources were evident which would not require sterilization as they do not accommodate any nematode species pathogenic to tea. As such soils are significantly deficient in organic matter, N and C:N ratio possess favorable soil physical properties and pH levels for tea propagation, additional benefits such as early callusing and greater root biomass were evident besides act as solution to practical limitations with conventional use of forest and Mana soils.

14. Antagonistic plant species which posses nematicidal properties and help reduce populations of P. loosi and R. similis were determined. They include Tithonia diversifolia (wild sun flower), Adhathoda vasica, Lantana camara, Eragrostis curvla, Vetiver (Vetiveria zizanoides) and Marigold (Tagetes erecta, T. patula). These could be used as mulches, plant extracts, soil amendments or for planting in vacant areas in infested tea fields.

15. For prevention of using nematode contaminated irrigation water, sedimentation tank system comprising of three water tanks placed at three levels was designed in view of drawing nematode free clean water from the final tank after 48 hours. However, adoption rate is found to be low owing to cost factor, maintenance and time taken on the operations (Figure 13).

16. As alternative to sedimentation tanks, treatment of irrigation water with Bleaching powder was detrmined at 0.1 g / 100 ml water basis as the most effective dose with nematode mortality. Mixing 1 kg bleaching powder per 1000 l water on daily basis was decided for application in nurseries.

17. All Good Nursery Management Practices (GNPs) were listed to guarantee the nursery premises, beds and soil bags are free of soil borne pathogens. They include site selection by avoiding locations with a history of nematodes as far as possible to reduce risk of possible contaminations and to avoid subsequent contaminations by ensuring hygiene without contaminated sources i.e. soil, water, implements, materials etc., raised beds and supply of clean water for irrigation purpose (Figure 8).

18. Treatment for nursery soils using Dazomet 98% powder and Metham Sodium liquid at 250g and 800 ml per soil cube was determined. In order to maximize the fumigation process, minimize losses of chemical fumes and ensure safety of workers and environment, uniform application of the chemicals to wet soils, turning soil and mixing, immediate light watering, covering the treated soils with a polythene cover, turning soils at periodic intervals after opening the polythene cover were recommended. The fine tuned method brought down the time period for fumigation process from 42 days to 22 days resulting in savings on cost, labor and space. Further, imposing a Restricted Entry Interval (REI) of 8 days in view of worker and animal safety and record keeping, displaying sign boards and fumigation schedule were made compulsory (Figures 6 and 7).

19. For control of Poria, extended grass rehabilitation for a period of 4-5 years, destruction of infested bushes, field sanitation, treatment of affected roots with systematic fungicides i.e. Bitertanol, Propiconazole Triadimefon, Tridemorph etc.

20. Trichoderma (Trichoderma viride) recovered from Poria infested fields were recognized as a good bio control candidate and mass propagation is in the process for field applications.

Out of the above findings, the most effective, locally available, feasible and cost effective MeBr alternatives were transformed into recommendations by further evaluations through adaptive trials conducted by the TRI advisory and extension staff and stake holder responses. Such operation and methods converted in to TRI Advisory Circulars are shown in Table 3.

Table 3 Recommended MeBr alternatives to the stake holders

No.	MeBr alternative	Recommendations given in TRI Advisory Circulars	Reference
1	Fine tuned methodologies of alternate fumigants	PM 11	11
2	Soil substitutes	PN 2	12
3	Alternate soil sources – Pinus and Eucalyptus soils	PN 2	12
4	Good Nursery Management Practices (GNPs)	PN 2	12
5	Nursery hygiene	PN 2, PM 8	12.9
5	Resistant and tolerant tea cultivars	PN 1	8

The second phase of the MeBr Phase out Project covered assessment, awareness, extension and promotion of the MeBr alternatives developed by TRI in the corporate sector, proprietary and small holder growers.

Research meets Industry: "OZONE-FRIENDLY PURE CEYLON TEA" Logo

Sri Lanka's efforts to phase out Methyl Bromide in tea plantations were initiated by the National Ozone Unit of the Ministry of Environment over a decade ago. The TRI working with tea plantation companies tested and found environment friendly alternatives.

A remarkable success story was presented by the Tea Research Institute of Sri Lanka by demonstrating the ready recommendations of MeBr alternatives in complying with a global environmental treaty. As recognition in May 2011, the "Ozone Friendly Pure Ceylon Tea" logo was launched (Figure 3).

It was the culmination of a process that took many years and involved collaboration between government agencies, private companies, scientists and the international community. Considering the worldwide popularity of Ceylon Tea, this success will greatly contribute to the global efforts to protect the ozone layer. Through the new logo, the Ceylon tea industry aims to market the tea as a premium product as the first country to do so. The logo is already displayed on the packing of some tea manufacturers and distributors and will be rolled out to cover all tea exports from the island by 2012.

Figure 3 The world's first ozone friendly logo for tea

Further, this also demonstrated how TRI's R&D outcomes meet industry needs and additional benefits to the stakeholders in the whole value chain while enhancing a major export industry.

Figure 4: Early days of Nursery Soil Fumigation with MeBr to eradicate Plant Parasitic Nematodes

Figure 5: Early days of Field Sterilization with MeBr to eradicate Poria Disease

Figure 6: Safe Application of Dazomet as MeBr Alternatives for Fumigation of Tea Nurseries

Figure 7: Safe Application of Metham as MeBr Alternatives for Fumigation of Tea Nurseries

Figure 8: Hygiene and Sanitation of Tea Nurseries

Figure 9: Large Soil Volumes Required for Tea Nurseries

Figure 10: Use of Soil Solarization as MeBr Alternatives for Fumigation of Tea Nurseries

Figure 11: Commercial Scale Tea Nurseries

Figure 12: Healthy, Standard Quality and Nematode Free Tea Planting Materials

Figure 13: Use of Sedimentation Tank Systems to Avoid Contamination of Nematodes through Irrigation Water

Figure 14: Use of Soil Substitutes in Tea Nurseries to Minimize Soil Volumes

Figure 15: Soil Substitutes used in Nursery Bags as Layer Arrangements

Figure 16: Use of Steam Chamber for Soil Sterilization

Figure 17: Use of Soil less Media as Alternate Propagation Media

Figure 18: Production of biocidal gasses using agricultural and animal wastes for Biofumigation purpose

Figure 19: Use of biocontrol agents to reduce parasitic nematode populations in soil

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