# Green Productivity in Asia and the Pacific Region

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**ABSTRACT**

*The Asian Productivity Organization (APO) is promoting the Green Productivity (GP) concept - a strategy for enhancing productivity and environmental performance for overall socio-economic development in its 19 member economies in the Asia Pacific region. This paper introduces the APO's GP concept on the background of the global sustainable development movement, and the changing paradigm of productivity. GP is implemented by following a step-by-step methodology comprising of six steps and 13 tasks. Implementing the GP methodology requires integrating and applying a number of key environmental management and productivity improvement tools and techniques. GP tools and techniques provide clues and directions for the generation of options and enable their systematic implementation. Different tools and techniques are used at different steps of the GP implementation process. Further, importance of the energy management issues in the context of GP is discussed with the help of a case study from a Green Productivity demonstration project in Changi General Hospital in Singapore. This case study shows how GP can be successfully implemented for continuous improvement in energy management thus leading to resource productivity and environmental performance.*

## 1. INTRODUCTION

Thirty years since the environmentally sustainable economic development was introduced at the 1972 Stockholm Conference on the Human Environment, environmental issues have rapidly taken the center stage in the international arena and have become the core of development policies across the globe.

During the 1992 Earth Summit in Rio, more than 178 governments adopted Agenda 21 and the Rio Declaration on Environment and Development. Since then, until the recently concluded World Summit on Sustainable Development in Johannesburg, though a lot has been discussed, little has been achieved unfortunately on the global level in terms of environmental protection and sustainable development, apart from the rhetoric.

However, owing to the consumer pressures and non-tariff trade barriers, industries and corporate world have taken initiatives to internalize the environmental issues in the business operations. Specifically, to address the complex industrial environmental problems, a number of preventive, innovative, voluntary and market-based environmental management approaches were introduced all over the world during the 1980s and 1990s. Most notable among these are preventive approaches such as cleaner production, pollution prevention, and waste minimization.

Cleaner Production (CP), as introduced and defined by the United Nations Environment Programme, is the continuous application of an integrated preventive environmental strategy applied to processes, products and services. It embodies the more efficient use of natural resources and thereby minimizes waste and pollution as well as risks to human health and safety.

With the Pollution Prevention Act of 1990, the U.S. Environmental Protection Agency (EPA) developed a formal definition of pollution prevention and a strategy for making Pollution Prevention (PP) a central guiding mission. According to the EPA's official definition, *pollution prevention* means "source reduction" as defined in the Pollution Prevention Act, but also includes "other practices that reduce or eliminate the creation of pollutants through: (1) increased efficiency in the use of raw materials, energy, water, or other resources; or (2) protection of natural resources by conservation."

There are other such preventive environmental management approaches, such as waste minimization, eco-efficiency, clean technology, etc., which are being promoted primarily in small and medium enterprises (SMEs) around the world. These efforts have shown small but promising success.

## 2. APO's GREEN PRODUCTIVITY [1]

### 2.1 Changing Paradigm of Productivity

While sustainable development issues were becoming a global concern, and accordingly, environmental management becoming a prime concern to the industries, the paradigm of productivity itself has also been undergoing an evolution and the scope of productivity has expanded over the years.

From the beginning of its establishment, the APO's activities were meant to be practical and useful at the very sites of the factories, firms, and organizations. Accordingly, the early emphasis for productivity increase was mainly on cost reduction and quality improvement. However, along with the growth of the global economy and technical innovations, the adverse effects of economic development also became evident. These included unbalanced population growth, widespread poverty, and degradation of the environment. There was also a concern that economic growth that ignores the limits of the environment was unsustainable in the long term. As a result, the APO also began to seek well-balanced and comprehensive improvement of productivity to achieve sustainable socio-economic development.

Under these circumstances, improvement of productivity has become a multifaceted approach. Productivity must be practiced within the framework of sustainable development. This means that productivity improvement cannot be only an economic issue, but must also include social and environmental dimensions. One has to be concerned not only with labor productivity, capital productivity, and total factor productivity but also with resource productivity.

The APO has therefore expanded its program to address the needs of its member economies better in line with the latest global trends and developments in response to the challenges of the sustainable development movement. This linkage of productivity and socio-economic development with the environment is a key feature of the APO's comprehensive strategy for sustainable development.

### 2.2 Green Productivity

In an endeavor to find practical and attractive approaches for organizations to deal with both productivity and environmental protection for sustainable development, the APO introduced the concept of Green Productivity (GP) in the mid-1990s. By the definition as coined by the APO, *GP is a strategy for enhancing productivity and environmental performance for overall socio-economic development. It is the application of appropriate productivity and environmental management policies and strategies, tools, techniques, and technologies in order to reduce the environmental impact of an organization's activities.*

The objective of the APO's GP program is to enhance productivity and simultaneously reduce the negative impacts on the environment in its member economies. It seeks to realize this objective by propagating GP consciousness; by performing the roles of think-tank, catalyst, regional adviser, institution builder, and clearinghouse of information on GP; and by promoting and disseminating GP skills in its member economies.

Initially taking off in the industrial sector, the GP is now being increasingly applied to agriculture, service industry, and even communities. GP is thus evolving as a drive with comprehensive strategies for sustainable socio-economic development.

### 2.3 Green Productivity: Making a Difference

Previous approaches to environmental protection have tended to give impression or misunderstanding that they ignore economic performance. Traditional 'end-of-pipe' technology has proved costly and ineffective, while many other preventive environmental management solutions were not productivity-focused. These seemingly negative points worked to reduce the attractiveness of such approaches to business circles.

Therefore GP was formulated to make productivity improvement and environmental protection capabilities. GP thus was able to overcome the constraints inherent in the old approaches by combining environmental protection with quality, cost-effectiveness and technological innovation to bring significant competitive advantage.

In the industrial and service sectors, improvements in productivity and environmental performance achieved through GP bring many bottom-line savings — everything from reduced fuel and raw material consumption to lower insurance expenses. Cost-effectiveness, profitability, competitiveness and an improved working environment are central goals of any GP strategy. Products and by-products are more environmentally friendly, while the changes GP brings to the production process improve both workers' health and safety and product quality. Because GP encourages creativity and innovation and allows companies to capitalize on markets that demand high environmental specifications, it creates new business opportunities and helps companies to increase their market share. All in all, GP is a multi-dimensional strategy that improves both the performance of business and environment, hence the overall quality of life.

## 3. FRAMEWORK AND METHODOLOGY

To substantiate the GP concept, the APO has adopted a multi-dimensional micro-to-macro approach to promote GP practices. It focuses on the enterprise level through the applications of productivity and management tools (such as TQM, 5S, and TPM) that go in tandem with waste and emission prevention, energy conservation, pollution control, and environmental management systems.

To operationalize GP at practical levels, the APO has developed a six-step, 13-task generic methodology following Deming's plan-do-check-act (PDCA) cycle. This methodology has been successfully applied in the past few years throughout the APO region in various GP demonstration programs and has been found to be very effective and productive. While the PDCA framework provides the basic skeleton of GP implementation, the distinctive part of GP methodology is its ever-expanding set of tools and techniques to complement the PDCA framework. This methodology has been thus field-tested and is being disseminated through various training programs in APO member economies.

### 3.1 Overview of the Six-step GP Methodology

As GP focuses on productivity improvement and environmental protection, the central element of the GP methodology is the examination and re-evaluation of both production processes and products to reduce their environmental impacts and highlight ways to improve productivity and product quality. Implementation of these options leads on to another cycle of review and so promotes continuous improvement.

The six principal steps of the GP methodology are:

- **Getting started**: The beginning of the GP process is marked by the formation of a GP team and a walk-through survey to gain base-line information and identify problem areas. At this stage it is vital to get the support of senior management to ensure that adequate manpower and resources are available for successful GP implementation.
- **Planning**: Using the information gained in the walk-through survey along with a number of analytical tools such as material balance, benchmarking, eco-mapping and Ishikawa diagrams, problems and their causes are identified. Following this, objectives and targets are set to address the problem.
- **Generation and evaluation of GP options**: This stage involves the development of options to meet the objectives and targets formulated in the planning stage. It involves both a review of pollution prevention and control procedures that have already been devised or implemented and the development of new options. Options are screened and prioritized in terms of their economic and technical feasibility and their potential benefits. They are then synthesized into an implementation plan.
- **Implementation of GP options**: The implementation of the selected GP options involves two steps: preparation and execution. Preparatory steps include training, awareness building and competence development. This is followed by the installation of equipment and systems along with operator instruction and hands-on training.
- **Monitoring and review**: Once the selected GP options have been implemented it is vital to check whether they are producing the desired results. This involves monitoring the overall GP system to ensure that it is proceeding in the right direction and that targets are being achieved as per the implementation plan. Findings are reported for management review.
- **Sustaining GP**: In light of the findings of the GP evaluation, corrective actions can be taken to keep the GP program on target. In some cases targets and objectives themselves will have to be modified. As the program progresses a feedback system should be implemented so that new problems and challenges will be highlighted and dealt with. In this way the GP cycle will loop back to the relevant step to implement a process of continuous improvement and ensure the continuing relevance and effectiveness of the GP process.

### 3.2 GP Tools and Techniques

Implementing the GP methodology requires integrating and applying a number of key environmental management and productivity improvement tools and techniques. GP tools and techniques provide clues and directions for the generation of options and enable their systematic implementation. Different tools and techniques are used at different steps of the GP implementation process.

At the start of the GP process, flowcharts and process flow diagrams provide a graphical method of representing activities, processes and material flows. A material balance — based on a process flow diagram — allows for the quantitative assessment of material inputs and outputs.

Benchmarking is often used to identify gaps in performance by comparing the current achievements of a department or company against what others have done. Brainstorming and concentration diagrams help in the identification of the possible root causes of problems and for data collection. Ishikawa cause and effect analysis (commonly known as Fish Bone Diagram) is another problem-solving tool used to uncover the reasons behind problems. It gives a graphical representation of cause and effects, so allowing a problem to be fully analyzed.

Environmental problems can be identified using eco-mapping — a simple and practical visual tool that provides a bird's eye view of a company's operations and thus a quick inventory of practices and problems. Pareto analysis is another graphical tool used to isolate key problems that are causing the most significant impact. Check sheets are used for collecting data over time to show trends and recurring problems and control charts are used to show deviations and variability in performance.

| Tasks | |
|---|---|
| 1. Form a GP team<br>2. Walk through survey and information collection | **Step I: Getting Started**<br>Checklists, tally charts<br>Plant layout<br>Flowcharts and process flow diagram<br>Material balance<br>Benchmarking |
| 3. Identification of problems and causes<br>4. Setting objectives and targets | **Step II: Planning**<br>Brainstorming<br>Cause and effect analysis (Ishikawa)<br>Critical path analysis<br>Eco-mapping<br>Gantt chart |
| 5. Generation of GP options<br>6. Screening and evaluation of GP options<br>7. Preparation of implementation plan | **Step III: Generation and Evaluation of GP Otions**<br>Brainstorming<br>Cost benefit analysis<br>Eco-mapping<br>Failure mode and effect analysis<br>Pareto charts<br>Program evaluation review technique (PERT) |
| 8. Implementation of selected options<br>9. Training, awareness building and developing competence | **Step IV: Implementation of GP Options**<br>Training need analysis<br>Team briefing<br>Responsibility matrix<br>Critical path analysis<br>Gantt chart<br>Spider web diagrams |
| 10. Monitoring and evaluation of results<br>11. Management review | **Step V: Monitoring and Review**<br>Solution effect analysis<br>Eco-mapping<br>Failure mode and effect and analysis<br>Charts (control, tally, etc.) / Spider web diagrams |
| 12. Incorporate changes<br>13. Identify new / additional problem areas for continuous improvement | **Step VI: Sustaining GP**<br>Some of the tools are repeated here, since the activities are looped back to the previous steps |

Fig. 1 Six principal steps of the GP methodology

GP options are generated and assessed using techniques such as brainstorming and cost-benefit analysis which facilitates the comparison of alternatives in terms of the monetary costs involved and the benefits that can be obtained. Typically the tool is used in feasibility studies — often in conjunction with audits — for the selection of alternative options. As options are implemented spider-web diagrams provide a visual way of showing progress and performance against several targets at once.

GP techniques are used to bring about the changes that will result in better environmental performance and improved productivity. They range from simple housekeeping techniques to designing 'green' products.

Throughout the GP implementation cycle, life cycle assessment is used as the basis for generating information on a product/service. Decisions are made on product design, manufacturing practices, purchasing policy, product distribution and management practices based on this information.

Another important feature of the GP methodology is the inherent emphasis on the management systems approach. Of all the tools available under the umbrella of GP, ISO 14001 is valuable for internal management improvements that align environment performance with quality and as a means of communicating these improvements to others using a globally accepted model. The experience has shown that GP methodology and ISO14001 EMS are very much complementary and result in multiple benefits for the organizations that have implemented both.

## 4. GREEN PRODUCTIVITY AND ENERGY MANAGEMENT

Energy is a basic necessity in the modern life - for day to day living as well as for economic activities. It is the most important resource closely linked with the costs and hence the profitability of the industry or service sector enterprises.

In most of developing countries in the Asian region, substantial energy is consumed for industrial operations/manufacturing processes or for other domestic uses such as temperature control in buildings. Many of the commercial buildings are normally high-rise structures that are served by central air-conditioning systems. Moreover, many of these public and commercial buildings (e.g., hospitals, hotels, and manufacturing industries) also require hot water / steam supply to control the temperature for many of their processes.

The energy costs constitute a substantial percentage of total operating cost for an enterprise. This not only leads to financial savings, but can also contribute to a more rational utilization of the resources thus contributing to sustainable development.

To empirically demonstrate that environmental protection and productivity improvement can be profitably harmonized, even in small and medium enterprises, the APO has been implementing GP demonstration projects (GPDP) in the industries, agriculture, service sector and communities, throughout its member economies, where GP implementation will have a "multiplier effect".

So far the APO has implemented more than 25 GPDPs in its member economies in various sectors such as: metal finishing, textile, tannery, food canning, cement, sugar, vegetable farms, poultry and pig farms and even communities. The success stories of these GPDPs are available on the APO website http://www.apo-tokyo.org/gp.new

## 5. A CASE STUDY ON ENERGY EFFICIENCY DEMONSTRATION PROGRAM [2]

### 5.1 Demonstration Site

The Changi General Hospital (CGH) (http://www.cgh.com.sg), a healthcare hub for the community in eastern Singapore, offers a comprehensive range of medical and paramedical services. These include general medicine, general surgery, orthopedic surgery, emergency medicine, radiology, anesthesia, urology, geriatric medicine, rehabilitation medicine, psychiatry, ENT, eye, gastro-enterology, psychiatry, neurology, dermatology, oral and maxillofacial surgery, neurosurgery and sports medicine. All these services are housed under a nine storey building with a gross area of 127,070 square meters. Occupying a land area of 5.2 hectares, the hospital has 23 wards with a total of 801 beds. Sixteen specialist clinics with a total of 64 consultation rooms cater to the outpatient needs of the community.

Managed by a professional and forward-looking management, the CGH has launched and successfully implemented a number of programs to improve its environmental performance. In line with its determination to care for the environment, a committee within the CGH set out to promote energy and water conservation. Targets were set to reduce energy and water consumption in the hospital and accordingly, CGH managed to save average consumption of electricity by 12% and water by 25%. This translates to savings of S$ 800,000 (approx. US$ 450,000) in a year that could be channeled towards improving patient care.

CGH has put in place a management system that monitors and continuously improves on its environmentally friendly performance. Environmental policies, monitoring systems, tests and maintenance measures were implemented throughout this hospital. In November 1998, CGH became the first hospital in Singapore to be certified ISO 14001.

### 5.2 GP Program at CGH

Further, in 2000, CGH joined the APO's Green Productivity Demonstration Programme (GPDP) to help the hospital improve its environmental performance and productivity through the GP approach. The aim of the demonstration project was to demonstrate the application of GP methodology in solving energy efficiency and air-conditioning comfort issues in the hospital. This program was jointly supported and implemented by the APO; United States Environmental Protection Agency (USEPA); Standards, Productivity and Innovation for Growth (SPRING), Singapore; and Novo Environmental Technology Services Pte Ltd (NOVO ETS), Singapore.

A number of GP issues were highlighted at the onset of the project. Many of these concerned the efficient energy usage – especially that of air-conditioning units leading to discomfort in certain areas; and the hot water supply system. Of these, six problem areas were short-listed for in-depth analysis for future improvement, namely:

- **Hot water distribution problem**: Every morning, when hot water taps from the ward areas were turned on, the water was cold. The cold water had to be drained for about a few minutes before hot water flowed. To alleviate the problem, the hospital increased its hot water set-point temperature from 60°C to 64°C. (Refer to Box 1 for more details about this option.)
- **Car park lift lobby comfort problem**: There were four lift lobbies, namely A, B, C and D, that served the entire basement car park at CGH. All the lift lobbies were mechanically ventilated and they were warm and stuffy. There was hardly any air movement at the lift lobbies.
- **Specialist clinic comfort problem**: There are a total of 16 specialist clinics at CGH of which, four were being served by a common Air Handling Unit (AHU). Patients had complained that the specialist clinics facing the sun, which were also at the end of the ducting, were stuffy and uncomfortable.
- **Subsidized wards comfort problem**: There are a total of ten subsidized wards at CGH. These wards were not air-conditioned and during the hot months from May to July, patients had complained that the wards were hot and stuffy.
- **Administration office comfort problem**: The temperature of the administration office at the hospital was being controlled by variable air volume (VAV). However, while some parts of the office were cool and comfortable, other parts were hot and stuffy.
- **Waste heat problem for the generation of hot water supply**: There were 14 gas-fired heaters at Changi General Hospital. Power gas or town gas was utilized for the generation of hot water supply at 60 °C. On the other hand, a lot of waste energy was being discharged to the environment through the flue gas of the gas fired heaters and from the chillers (6 x 750 tons centrifugal chillers). Options were available to recover these energy for the production of hot water.

### 5.3 GP Implementation at CGH

Energy conservation measures were brainstormed and evaluated in detail. Three GP teams were set up to study the problems identified. To familiarize the teams with the GP concept and methodology, so that they could apply them when they were solving the problems, GP consultants from NOVO ETS conducted a one-day introductory course on GP at the onset of the project.

Box 1 Hot water distribution problem at Changi General Hospital

In the past, when hot water taps in the wards were turned on early in the morning, the water was cold. The water had to be drained for about a few minutes before hot water flowed. To alleviate the problem, the hospital staff set the hot water set point temperature at 64°C, instead of the designed set point at 60°C. However, this could not solve the problem. The hospital had received many quotations from consultants to retrofit the hot water distribution network which could cost as mush as S$ 22,000 (approx. US$ 12,500).

The GP team together with NOVO ETS consultants studied the hot water network in detail and did a thorough walk through survey. During the walk through survey, it was found that the water in the hot water return piping was cold rather than hot. This suggested that the hot water was not flowing in the return piping at all. This was the cause of the hot water distribution problem.

It was found that water was not flowing in the return piping as one of the check valves in the water network was installed incorrectly. The problem was simply solved by reinstalling the check valve the correct way. This also allowed the hospital to bring down the set point temperature of the hot water substantially to 54°C. This improved the efficiency of the gas-fired heaters and reduces the amount of heat loss through the hot water piping. Actual savings was about US$14,000 per year.

During the project, the team members were exposed to various GP tools and techniques, e.g., walk through survey, brainstorming, energy balance, fish bone diagrams, etc. Through the GPDP, staff in the hospital realized the importance of understanding a problem and finding the root causes to the problem. Once the root causes had been identified, many options were brainstormed and they were systematically evaluated based on technical, economical as well as environmental grounds.

## 5.4 Implemented GP Options

Most of the problems studied were resolved using very simple methods. The GP options identified and adopted are summarized in Table 1.

At the end of the project, the GP options that were identified during the GPDP led to more than US$ 110,000 per year potential savings to the hospital in terms of energy cost. A detailed report and a video of the GP Demonstration Project at CGH can be obtained from the APO (*E-mail: env@apo-tokyo.org*).

Table 1 GP options identified and adopted

| GP Problem | GP Option Adopted |
|---|---|
| Hot water distribution problem | Reinstalled check valve that blocked the flow of hot water |
| Car park lift lobby comfort problem | Relocated fresh air ducting |
| Specialist clinic comfort problem | Installed tower fans to cool staff by evaporative cooling |
| Subsidized ward comfort problem | Changed ceiling fans to oscillating fans to provide better focused air flow to the patients |
| Administration office comfort problem | Relocated temperature sensors controlling the variable air volume (VAV) |
| Waste heat problem for the generation of hot water supply | Installed new chiller and recover energy from this chiller to produce "free" hot water for the hospital |
| Other energy conservation measures | Installed variable speed drives (VSDs) for the cooling towers |

## 6. CONCLUSIONS

One important point to note here is that in all the GP demonstration projects, the APO did not provide any hardware for implementing GP. Companies and organizations prepared their feasibility studies and, implementation plans, under the guidance of the APO experts, and made their own investment decisions. Therefore, the success of these projects has confirmed the APO's belief that GP can profitably harmonize the environmental protection and productivity improvement.

It was also found that all the companies involved in GP activities were able to comply with the level of compliance of environmental standards and regulations of the countries where the companies are located.

The GP program is a first step towards the achievement of ISO 9000 and/or ISO 14001 certification as implementing GP results in fulfilling many of the requirements of the ISO standards. Many companies that joined the demonstration program have attained ISO 14001 certification after the completion of the GP project. For example, Rama Phosphate Limited in India achieved ISO 14001 certification as a result of its GP implementation.

Implementation of GP has also been found to be continuously beneficial even after the company has attained ISO 14001 certification, because the GP approach incorporates the mechanism of continuous improvement. For example, Spindex Precision Tool and Changi General Hospital, Singapore, adopted the GP methodology for their continuous improvement program and made further savings.

The commitment and support from the top management have been very crucial for the success and sustainability of the GP practices in the organizations. In companies where the CEO's were actively involved, GP was effectively implemented. Top management commitment for the GP program can only be achieved if and when the CEO comes to understand that productivity and profitability gains could be derived from GP implementation.

The generic GP methodology, based on the Plan-Do-Check-Act (PDCA) cycle, is an important element in achieving GP results. This methodology has been standardized and incorporated into the APO's training manual.

The APO's experiences of operationalizing GP through the APO-sponsored GP demonstration projects have shown that GP works in the industry, agriculture, service sectors as well as in communities to address the issues of resource management, environmental protection, and enhancing bottom-line benefits. It thus leads to triple bottom-line improvements for any organization and poverty alleviation and sustained quality of life for communities. The message is simple: It is essential to integrate productivity concerns in our quest for sustainable development. GP is a practical and workable strategy for this aim.

## 7. REFERENCES


[1] APO's Green Productivity website and various publications: http://www.apo-tokyo.org/gp.new

[2] Tay, Boon Keat. 2002. Case study of APO's GP/Energy Efficiency Demonstration Programme in Changi General Hospital, Singapore. In *Proceedings of the APO's Workshop on Green Productivity for Green Energy*. New Delhi, India, 11-15 November, 2002.


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