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# MARKET DEMAND AS DRIVING FORCE FOR 3R TECHNOLOGY TRANSFER AND THE ROLE OF PRIVATE SECTOR

**(Background Paper for Plenary Session 3 of the Provisional Programme)**

**Final Draft**

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This background paper was prepared with inputs from Mr. Alban Casimir, Bionersis, for the Third Meeting of the Regional 3R Forum in Asia. The views expressed herein are those of the author only and do not necessarily reflect the views of the United Nations.

**BACKGROUND PAPER**

# Market demand as a driving force for 3R technology transfer and role of the private sector

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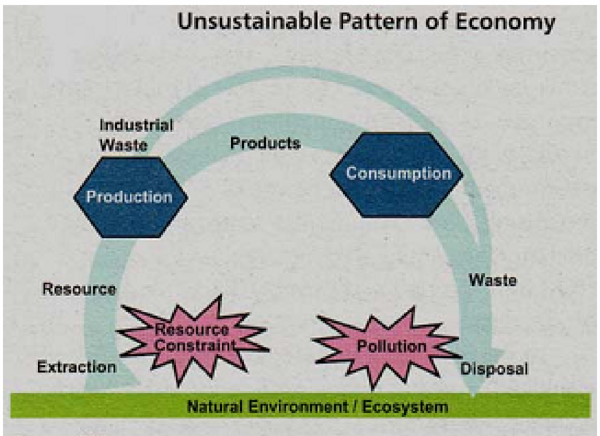
# I. Introduction

There are many examples in the history of mankind of "waste" becoming a resource thanks to technology and market conditions. One of the most famous examples is natural gas. Indeed, in the 19th and early 20th centuries, natural gas was usually obtained as a byproduct of the production of oil and had no market value and, as such, was a disposal problem in active oil fields and hence burned off. **Energy market conditions (rise of oil prices) and progress in technologies created applications for such "used to be waste" resources.**

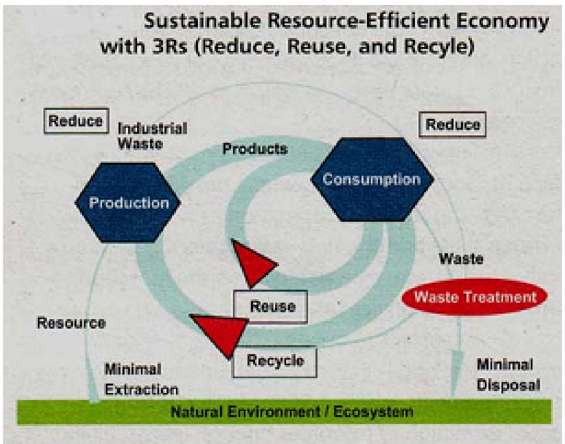
**The objective of this background paper is to elaborate on how to encourage further resource conservation and efficiency as well as integrate other "used to be waste" into the economy.**

In this respect, the 3R's of "reduce, reuse and recycle" are considered to be the basis of environmental awareness and a way of promoting ecological balance through conscious behavior and choices for both producers and consumers. It is generally accepted that it will lead to savings in materials, commodities, water, and energy which will obviously benefit the environment. At the far end of the resource efficiency spectrum is the "closed cycle," where any output either becomes an input to another manufacturing process or is returned to natural systems as a benign emission rather than a pollutant-causing environmental stress.

To achieve the transfer of efficient 3Rs technologies, the resource efficiency and waste markets must be analyzed in order to define the drivers of supply and demand sides. On the demand side, a shift of thinking about the definition of waste and producers-consumers behavior is essential for a transition to more resource-efficient societies. Indeed, waste is widely assumed to be inevitable ("reduce") or traditionally thought of as having no value ("reuse and recycle"). This leads to top economic and management practices that actually tend to promote the generation of waste. Today, with a finite earth (and hence resources) and growing population, this approach to waste management is not only impractical, but is unacceptable in terms of efficiency and corporations' social responsibilities. As shown in the figure below, the transfer of 3Rs technologies will minimize the extraction of raw materials or use of water and energy on the input side and the disposal of waste on the output side.



Source: ADB.



Source: ADB.

These 3Rs technologies have already been implemented more or less successfully on a worldwide scale. The possibilities are endless since there are so many types of waste (and several ways to treat them), so many industrial processes, and so many water and energy usages to improve.

Briefly speaking, they include compost and anaerobic degradation of municipal solid waste (MSW) and agricultural waste, incineration of MSW, at source separation of MSW, recycling end of life products (such as mobile phones, used lead acid batteries and dry cell batteries, fluorescent lamps, etc.), biomass for power generation or boilers, environmental management systems coupled with ISO 14001 in plastic industries (Bangladesh example: -30% of water consumption, -20% of chemical waste generation. and -30% of GHG emissions), recycling centers (for plastics, paper, glass, cans, etc.), green procurement, water conservation (in industries, obviously, but also rehabilitation of the public distribution network to prevent leakage or development of wastewater treatment plants), energy conservation (use of renewable energies such as solar, wind, and geothermal, building design, mass transit systems, advanced boilers and furnaces that can be operated at higher temperatures while burning less fuel[1]).

The scale of such a market, although obviously huge and expected to grow rapidly parallel to the increased scarcity of resources and public awareness about environmental conservation is, however, very difficult to assess, especially for "reduce" and "reuse" technologies. For "recycling" activities, as far as municipal and industrial waste are concerned, a figure of 70 billion € has been raised from the compilation of EU, UN, and US statistics as well as World Bank "country" environmental reports.

Financial constraints are among the most important barriers to energy and water conservation as well as proper waste management in the developing countries of Asia and the Pacific. The reform of fiscal measures and the adoption of economic instruments could help local governments by increasing revenue, causing MSW management authorities in the region to attempt to recover costs by levying fees for their services. However, the polluter pays principle[2] is not easy to enforce in countries where the population has never paid the actual cost of public services aimed at mitigating environmental damage. Since it directly affects their available income, local people often do not understand why they should pay for these services although they simultaneously expect them, since public awareness is slowly rising, and cleaner (more expensive) technologies are implemented.

The implementation of 3Rs technologies could not only conserve the environment, but also help reduce the financial burden by tapping new revenue streams (provided that the environmental impacts of open dumps for MSW and industrial waste, and air and water pollution are better internalized). Where there is waste, there is inefficiency, and where there is inefficiency, there is an opportunity to reduce costs. Reducing waste increases productivity, safeguards the environment, and strengthens corporations' economic base. Waste reduction is a demonstration of their commitment to environmental protection. For some time now, many municipalities, city corporations, and industries have been experimenting with several innovative and participatory methods of 3Rs technologies (Reduce, Reuse and Recycle waste, in particular).

Obviously, the private sector is playing a significant role in developing and implementing such technologies. Besides, it is interesting to note that these technologies are no longer merely duplicated from developed countries to developing ones, but that numerous local companies are entering this market to develop and propose their own technologies. From the concept

[1] Over 45% of the fuel used by US manufacturers is burnt to make steam. The typical industrial facility can reduce this energy usage 20% by insulating steam and condensate return lines, stopping steam leakage, and maintaining steam traps. *Source: US Department of Energy, 2010.*

[2] The polluter-pays principle states that polluters should pay the costs associated with halting the environmental degradation caused by their actions. When polluters do not pay, society as a whole must pay instead.

developed in more advanced countries, they adapt it to local conditions (in the case of MSW for instance: waste composition and humidity, costs, waste packing, staff capacities, etc.).

Then, the analysis starts from the consideration that 3Rs have been already developed successfully in several cities and industries and asks the question "Why isn't that success being fully realized and duplicated?" Often, that is for reasons that are due to failures and barriers in the economic functioning of the market – issues which may be independent of the environmental problem being tackled.

With approximately three-fifths of the world's population, or about 3.75 billion people, such challenges are huge in the Asia-Pacific region. Indeed, a total of 13 cities count more than 10 million inhabitants and 5 cities have more than 7 million, creating new consumption needs, pressure on resources, and hence various threats to the environment. Consequently, energy and water consumption as well as wastes (municipal, industrial, e-waste, etc.) generation are rising to levels that are both difficult and costly to manage. Since freely operating market alone cannot provide appropriate incentives to accelerate and extend the scale of investment in the 3R-related technologies, governments have interest in intervening and could play an instrumental role in catalyzing such markets. They should create an institutional, administrative, legislative, and policy environment conducive to business-to-business technology transfer of 3R-related technologies and the adaptation and diffusion of such technologies.

## II. Economic and market barriers to the transfer of environmental technologies, including 3R technologies

At the beginning of the 21st century, the world experienced a series of shocks affecting both the natural resources markets and the climatic and environmental equilibrium of our planet. The explosion of prices in world markets in 2008 impacted economies, reaching their limits as much in demographic as in physical and biological terms. Rarity had suddenly returned to centre stage of our concerns. From a marginal situation, 3Rs developments such as the flows of world secondary material and energy and water conservation are becoming more essential and a veritable indicator of the world waste economy, and also the industry in general. However, numerous economic and market barriers remain and impede the proper development and transfer of environmental technologies. As will be covered later in part "IV. Potential roles of the central government," the presence of such market failure/barrier provides a rationale for government action to improve the market's efficiency in allocating resources. Each occurrence of market failure requires a unique set of policy or program tools to overcome it. Policymakers must understand the various causes of market failures to select the right remediation measure.

1. Economic barriers

- The current **low costs[3] of transportation and disposal (landfilling) of waste** (true for any type of waste) is a significant barrier to the transfer of environmental technologies, including 3Rs. Why would a company take the economic decision to spend money (either investment or operations) for something new and more expensive if not compulsory by law or needed by the consumers? On the contrary, many municipalities or national governments are moreover subsidizing the costs of transportation and landfilling. Inexpensive transportation to cheap landfilling facilities will lead these industries,

[3] Because it does not reflect true, long-term costs by internalizing all non-economic costs called externalities (such as environment and social impacts, loss of property value, and healthcare).

households, etc. to continue investing/using in this disposal method rather than implementing environmental friendly technologies and actions with the objective to reduce, reuse, and/or recycle their wastes (see box 1).

**Box 1: Case study of municipal solid waste (MSW) transportation and management in several capitals of ASEAN countries**

In Jakarta, Kuala Lumpur, and Bangkok, about 7,000, 3,000 and 9,000 tons, respectively, are collected a day. MSW is usually collected by maximum 2-ton trucks on a daily basis, with no distinction of composition although there is a partial separation of the waste at the back of the truck carried out by the waste collectors to recover easy valuables. Then, this waste is transported to transfer stations in order to be compacted and prepared for long distance (more than 50km) transport by bigger trucks of minimum 10T capacity to the city landfill.

In these cities (and in the rest of Asia, except certain cities of China and Singapore), MSW is very rich in organic content (at least 50%), which should make compost or anaerobic degradation very sensible alternatives to landfilling technically wise. However, because of the limited environmental standards to be met by the private operators in these landfills, coupled with low transportation costs, feasibility studies carried out by several institutions such as the World Bank, Asian Development Bank, and JICA prove that sanitary landfills are still the cheapest way to manage MSW (see table below).

| Technology | Plant capacity (tons/day) | Capital cost (M US$) | O&M cost (US$/ton) |
|---|---|---|---|
| Pyrolysis | 70-270 | 16 - 90 | 80 - 150 |
| Gasification | 900 | 15 - 170 | 80 - 150 |
| Incineration | 1,300 | 30 - 180 | 80 - 120 |
| Anaerobic digestion | 300 | 20 - 80 | 60 - 100 |
| In vessel composting | 500 | 25 – 40 | 30 - 60 |
| Windrow composting | 500 | 10 - 15 | 15 - 25 |
| Sanitary landfill | 500 | 5 - 10 | 10 – 20 |

Source: 2008 World Bank, Carbon Finance unit

*NB: we have to consider these numbers carefully since sanitary landfill O&M cost, for example, are triple in Europe while the capital cost for anaerobic digestion is half of what can be found in developing countries.*

However, several costs of "sanitary landfills" are not taken into account and could improve significantly the financial viability of the alternatives to landfilling:

- the leachate treatment (as per US or EU standards), there is about 1-2 M USD to be added at the capital cost while O&M cost should be raised by 5-10 USD/ton

- the transportation costs of waste over 50km will increase the O&M costs by 3-4 USD/ton

Therefore, if developing countries started to internalize just a few environmental costs of the current impacts of waste management into their calculations, composting in particular would become very sensible alternatives to landfilling cost wise.

*Source: Alban Casimir's research 2011*

- **Transportation rates system** is another barrier (particularly for reusing or recycling waste). Indeed, the current pricing structure charges more heavily relatively (price per ton per km) for small shipments moving short distances (usually those in the recycled materials industry), and less heavily for large shipments moving over longer distances. High volumes, long-haul users, namely those in the raw materials production industry, are moreover able to negotiate "preferential rates" with the carriers based on large, long-term quantities and long-haul distances.

- **Capital investment** for environmental technologies including 3Rs (documented in the waste management literature for example: Adamson 1984, Campbell 1982, Taylor 1982) is reported to provide favorable returns on relatively small amounts of capital. While such opportunities may not be available to companies at all times, a large amount of 3Rs technologies, at the early stage of their development, is possible and can be undertaken by companies without excessive amounts of capital and with relatively high returns on investment. However, as interest and pressure for 3Rs increase, a firm will exhaust the obvious, simple, inexpensive and quickly implemented ways of achieving this goal. The amounts of capital which then must be invested to achieve further 3Rs development may increase, while certainty about the return on those investments is likely to decrease. For example, 3Rs efforts in manufacturing may require changing the fundamentals of processes (less water and energy consumption) and products (less raw material and waste generation) in new and untried ways. These more complex measures may depend on intimate knowledge of specific and unique details of the company's technology, operations and products. Companies usually cannot rely on outside information and the experience of others, but must take the risks of research and implementation themselves. For most of the firms, a combination of greater investment requirements and greater uncertainty about payback become barriers to 3Rs developments at some point. Determining when this point has been reached may be a matter of management perception, regulations, and consumer needs.

- Linked to this capital barrier, there is the **discrepancy between capital and operating costs** that may confuse potential savings through pollution prevention expenditures. Industries that make onsite 3Rs investments usually incur a relatively large capital expenditure, while operating costs can be relatively low, aided by the value of the raw material, energy or water savings and recovered materials. Conversely, firms that dispose of wastes off-site or still use low-efficiency equipment grasping raw material, water and energy, will have low capital costs but very high operating costs. Unfortunately, the latest alternative is often prioritized by managers in Asia who focus on capital costs rather than operation costs.

- **Firm size** may be a critical factor for 3Rs transfer as well. Indeed, lenders are often unwilling to invest in a new, small company simply because the track record of the firm is short or not well-known and, therefore, deemed too risky. Because new and small firms are more likely to fail than large, well-established ones, lenders often prefer to work with larger companies. Thus, new, small firms working with recyclable materials or energy and water conservation technologies may be inappropriately denied access to financing because of aversion to risk.

- Another issue is that for most companies, pollution control is the known, conservative option that provides a clear result for an investment and creates little disruption or risk to current production. For many firms, 3Rs technologies is a novel approach to raw material, energy, water and waste management that may have the potential to conserve resources and turn waste into resource but also the capacity to interfere in both process operations and product quality (**3Rs vs. pollution control barrier**). For example, tracing every waste back through the process can be an overwhelming task. In Asia, firms usually wait for competitors to prove that such development is cost effective and actually achieving the inherent environment objective before considering it.

2. Market barriers

The list of market barriers to effective markets is most easily organized by sources of market failure. Many economies rely on the free operation of markets to provide for efficient use of resources—natural, human, and financial. However, no market operates perfectly. Impediments arise that cause markets not to provide certain goods at all or at desirable levels. These impediments are known as market failures or barriers:

- In ideal efficient markets, buyers and sellers are fully informed on the features of the good or service under consideration; they fully understand the risks and rewards. In the real world, however, existing information often is not equally available to all parties **(imperfect flow of existing information)**; instead, prejudice, misinformation, and lack of information abound. For instance, because "waste" has such a negative connotation, potential buyers may avoid products manufactured with secondary materials. They may be misinformed about some presumed negative aspects (for example, many consumers avoid buying recycled cellulose insulation for their homes, despite its lower cost, because of misconceptions about its low quality and potential flammability). As a result, some manufacturers avoid using any type of recycled material as a substitute for virgin products. Furthermore, suppliers and potential buyers of recycled products may not know of each other's existence. Producers of recycled products may not know the most cost-effective means of production (the best methods of composting green and organic wastes for the local governments, for example).

- Lenders and investors tend to be skeptical about products, processes, activities, and firms they do not know. Financiers hesitate to finance innovative products and new production techniques, especially for unproven markets (**psychological barrier for any new activities not yet proven on a large or commercial scale**). As a result, smaller, newer, and nontraditional businesses find fewer takers for their debt and equity. Such attitudes affect bankers, venture capitalists, and so forth. Only some development banks or government development finance agencies may have different goals pertaining to the sole return on investment and may take the risk.

- Markets for 3Rs technologies may be fraught with uncertainty caused by poor information about the future (**uncertainty about future markets)**. In the case of waste, questions about the future supply of secondary materials, demand for recycled products, and government regulatory framework can significantly impede market development. In the early stages of product development, market demand for the product is likely to fluctuate, given current quality and costs. For instance, almost all major printing/writing paper producers are tentatively exploring markets for recycled office paper. But commitments to producing such paper in large quantity await the determination that a high-quality sheet can be produced and that high consumer demand for the product will materialize. Uncertainty over demand also can affect potential lenders. For some materials, uncertainty over pending state regulatory decisions will inhibit markets. For instance, the long wait for implementation of the National Solid Waste management bill (more than 10 years) in Malaysia has delayed investments from private companies on waste collection and treatment.

- In efficient markets, prices of goods and services reflect fully the costs and benefits to society (including **positive and negative externalities)**. However, in the real world, prices usually only reflect the costs and benefits to the buyer and seller. The public benefits of 3Rs developments, such as the conservation of resources, are not part of the pricing process and the market has too few incentives to supply, for example, adequate amounts of clean, separated recyclable material to produce recycled products, and to buy recycled materials and products.

- Some firms produce various wastes that could be turned into high-quality secondary material, but that often go uncollected. Indeed, many businesses (and households) see the costs of participating—taking the time and energy to separate, store, and transport the material and sometimes paying a drop-off fee for the privilege—as outweighing the benefits (**business as usual barrier**). In addition, some participants in both voluntary and mandatory programs do not separate their recyclables carefully. The result is a supply of secondary materials that is difficult to process and market. To some degree, this lack of care reflects a lack of information about the importance of a clean supply (it also may reflect a lack of appreciation of the public benefits of recycling). Processors and remanufacturers that use secondary materials provide public benefits by diverting a portion of the municipal solid waste from landfills. However, these benefits are not counted as "profits" by owners of and investors in such facilities. They are concerned only about the private return on investment. Undervaluing public benefits also can be at work when manufacturers decide not to use secondary materials or cleaner technologies because of the high related costs. In many industries, particularly for smaller processing operations, automated sorting and cleaning technology are available, but too costly to implement. Consumers may not consider the environmental benefits (e.g., energy and water savings and integration of recycled materials) when purchasing a product while the common sense about an environmental friendly product is that it must be more expensive.

- **Small market size** is a potent barrier since the lack of economy of scale impedes the reduction of the price per unit. For example, recycled office paper is more expensive than virgin office paper because demand for the latter is large enough that companies produce it cheaply in great quantities. Thus, we enter a vicious circle where high unit costs (because of the current low demand) leads to demand drop that will increase even more the unit costs: without an outside player (such as the government), the market will never develop enough to lower the unit cost.

- In addition, the **assumed market volatility** of the price, supply, and demand of secondary materials discourages entrepreneurs, lenders, and equity investors who are risk-averse.

- The relative youth of the 3Rs industry means that the potential exists for many innovative manufacturing processes and recycled products. At the same time, numerous technical problems may slow down further market development for existing products using 3Rs in the products manufacturing or waste recycling processes (problems of removing contaminants, sorting mixed batches of materials, and physical weaknesses in some recycled materials such as in paper fibers recycled several times). Despite the need to address these problems, **research and development** carried out by "3Rs" firms is sometimes slowed by fears of spending significant time and effort on a new product or process that may fail or that competing companies can "reverse engineer" and gain the benefits of at a very low cost. The result may be some underinvestment in research and development for recycled products.

- If a single firm has **control of waste**, then other firms are unable to compete in the industry.

**Box 2: Cement factory to use MSW in Thailand**

Similarly to D G Khan Cement in Pakistan which has installed a municipal solid waste (MSW) processing plant to meet its energy needs at low cost, TPI Polene plans to develop this technology in Thailand. While Pakistan's project size is currently limited to 25T/day (August 2011), Thailand's project is supposed to use 5,000T/day of MSW in the Bangkok area.

This project has been in the pipe for several years now with TPI projecting to use the Clean Development Mechanism (CDM) as a supportive vector of investment. Obstacles are not coming from technology, costs, CDM methodology, management inertia or lack of expertise of the local teams, but from the continuous availability of the feedstock.

Even though local governments should be thankful for having a company reducing their waste to zero thus avoiding the siting of landfills, operations of it and the inherent public complaints related to such activities, most of the waste is still "given" to landfill operators.

It is not rare in Thailand or other countries in Asia to meet people claiming that they have control over some waste streams and you often realize that different people claim their control over the same waste stream! In these conditions, the decision of TPI of postponing the project sine die pending for clearer view over the waste streams control is fully understandable. Or a workable solution could be to use only limited amount of MSW similarly to D G Khan Cement did. But then, small market size may become a barrier.

*Source: Alban Casimir's research 2011*

- **Requirements for licenses and permits** may raise the investment and difficulties to enter a market, creating an effective barrier.

- Patents (**intellectual property**) are intended to encourage invention and technological progress by offering this financial incentive. Similarly, trademarks and servicemarks may represent a kind of market barrier for a particular product or service if the market is dominated by one or a few well-known names.

## III. Business-to-business technology transfer: Cases

To deal properly with this issue, we shall study several cases depending on the technology (reduce, reuse, and recycle) and the type of waste or resource conservation: Municipal solid waste, industrial waste, hospital waste, e-waste, and energy and water conservation.

1. Municipal solid waste

a. Reduce

The suitable technology shall depend mostly on the quantity and composition (including its humidity) of the waste, financial capabilities, presence of skilled engineers and operators locally, and so forth. Indeed, high content in organic waste shall lead to select aerobic-compost technologies (windrow, passive or in-vessel) or anaerobic-biogas technologies (concrete cells or digesters) rather than thermal (such as pyrolysis), gasification or combustion (such as incineration).

Regarding the transfer and implementation of such technologies in the Asian region, compost seems widely adopted and diffused (about 20 to 30% of the organic waste quantity is assumed to be treated that way) as well as incineration and anaerobic digestion, to a much lesser extent. However, it is accepted that most of the plants installed are either not working or operating at low capacity as studied in the cases below.

**Box 3: Biogas digester - China case study**

In Shipai Village in Jianshi County of Hubei Province, China, more than 90% of a total of 227 households have installed a 10$m^3$ biogas unit to turn organic waste into biogas. The biogas produced per household on a daily basis amounts to 1.0-1.2 $m^3$, which is used for both lighting and cooking. This has saved electricity and coal (RMB 136 per year). Use of digested slurry has saved on chemical fertilizer. The annual labour savings are substantial. In addition, social benefits have been realized, such as employment for technicians, improvement of health, and increased participation in social work by women.

**Why does it work leading to duplication of such technology transfer:**

- the technology of small digester is proven, easy to use and cheap
- remote areas are usually not connected to the power grid – alternative to electricity is a must
- resource needs are huge in China: there is a genuine will for resources conservation and 3Rs

*Source: Report from Netherlands Development Organization (SMV), 2006*

**Box 4: Compost of organic waste - Bangladesh case study**

Waste Concern is a non-profit organization established in 1995 that has had major successes in reducing emissions in several cities around Bangladesh, Sri Lanka, and Viet Nam by composting solid waste instead of burning or flaring, and selling it to fertilizer companies. So far, Waste Concern's model of managing waste has reduced more than 18,000 tons of $CO_2$ emissions each year in Bangladesh and generated 414 new jobs for the urban poor. It is helping to reduce the 52% of generated solid waste that remains uncollected in Dhaka. This initiative has been so far duplicated in 26 other cities.

**Why does it work leading to duplication to such technology transfer:**

- land scarcity and severe environmental impacts of landfill management (crude open dumps)
- community based MSW composting
- simple, affordable and labor intensive (for 3 tons/day: 6 workers for collection and 10 for composting process)
- suitable to the local socioeconomic and climate conditions
- waste reduction by 85% (compost 75% and recyclables 10%)
- fertilizer enriching with nutrients and screening → marketable (+efficient country-wide marketing network)
- no land issue (provided free by the administration)

*Source: Clinton Climate Initiative, 2007 – Waste Concern 2006*

**Box 5: Anaerobic digestion in Rayong, Thailand and composting plant in Bandar Lampung, Indonesia – why did it fail?**

This project in Rayong has been funded by the EU and Rayong Muncipality under the EC-ASEAN COGEN Programme Phase III. It required an investment of 3.6 M € with a theoretical pay back-period of 9 years. Technology is also coming from abroad: biogas engines from GE Jenbacher (Austria) and biogas&compost generation from MK Protech (Finland).

As of today, the engines are running only when guests visit the site and compost is no longer produced. **Why did it fail?**

- High O&M costs – initial budget did not cover the O&M
- Poor maintenance and operation of facilities
- Lack of expertise
- Incomplete separation of non-biodegradable (separation blades are not working properly because of the waste packing which is different from Europe)
- Inappropriate design of the facilities (e.g., no modification to suit developing countries' waste characteristics, staff expertise, and same technology for Europe and Thailand.)

The project in Bandar Lampung has been funded locally. Technology has also been provided locally. As of today, the plant is not running at full capacity or sometimes not running at all. **Why did it fail?**

- Lack of incentive to operate the facilities when a landfill is also available although planned for inert waste only
- Lack of waste separation (communities are not involved)
- High cost of compost compared to commercial fertilizers

*Source: Alban Casimir's research 2011*

b. Reuse

Inherent characteristics in MSW do limit greatly the possibility to apply any "reuse" technologies.

c. Recycle

The **"conventional" waste market** such as plastic, glass, metal scrap and paper would represent volumes of the order of 1 billion tons, or slightly over one quarter of world production or a third of the volume collected. Recycling appears to represent 700 million tons, with precise estimates for scrap (400 million tons)[4] and recovered cellulose fibres (250 million tons), and substantially less accurate figures for plastics. Some reliable figures exist for plastic, paper and glass recycling in Europe, with of 6 million tons recycled. About 200 million tons would be treated through energy recovery incineration, while biological applications such as composting accounts for another 100 million tons.[5]

**Box 6: Waste recycling: Thailand case study**

In 2010, Thailand managed to recycle approximately 23% of the 15.14 million tons of MSW generated a year which is remarkable considering that more than 70% is collected by the informal sector. The most active are the Sa leng, waste collectors who are easily recognized as they commonly use tricycles to collect waste. Additionally, municipal garbage collectors also sort and collect recyclables for sale on an informal basis to supplement their income. Finally, there are several thousand waste pickers or scavengers who collect waste from the landfill and sell it as a livelihood. Then, the informal sector sells the collected recyclable to garbage banks, municipal collectors or junk shops (see below for shop prices of one of these shops).

| 1 Euro = 40 Baht | **Shops prices closeby Nonthaburi landfill** | |
|---|---|---|
| *Jun-08* | Thai baht/kilo | €/Ton |
| Glass bottles | 1.80 | 45* |
| Large black plastic bags | 10.00 | 250* |
| Plastic bags (coloured) | 15.50 | 388 |
| See-through plastic | 18.00 | 450 |
| Paper and cardboard | 5.00 | 125* |
| Beer, soda cans | 45.00 | 1,125 |
| Coffee cans | 6.50 | 163 |

*: remarkably comparable with European market prices in 2008

*Source: 2008 Opportunity for recognition or threat of exclusion for landfill waste pickers? By Sonia Cautain*

The private sector is hence deeply involved such as Wongpanit along with their motto: "Waste is Gold". Wongpanit Co. Ltd's success story started in 1974, when its founder, Dr Somthai Wongcharoen, started a recycling business, with a capital of 1,000 Baht (25 €) and an old pick-up truck in the Province of Phitsanulok. Since then, the company has been growing exponentially and is now one of the leading Thai recyclable waste trading companies, with more than 400 franchise branches, both in Thailand and abroad.

[4] It is interesting to notice that internet platforms have been created to put together buyers and sellers such as the US Government Metal Scrap for instance. The system is simple; the best bidder takes the lot.

[5] 2009 Veolia report – « From waste to resource ».

Moreover Wongpanit is also famous all over the country for being a social enterprise committed to supporting local projects, temples and communities, and awareness raising campaigns. Among other activities, Wongpanit supports the creation of community waste banks, provides training and assistance in waste separation schemes to small businesses and owners of recycling shops, and has recently developed a 'Waste Separation Training for Quality of Life Improvement: Special Program for Homeless and Beggars' (http://www.wongpanit.com/).

**Why does it work and can be duplicated:**

- in developing countries, people can make a living out of waste or it does constitute, at minimum, a significant addition to their revenues;
- waste generators (households especially) are environmentally concerned, hence separating and giving out free of charge the recyclables (such as plastics and newspapers) to these waste pickers;
- network of garbage banks is extensive thus reducing the efforts of people to bring the recyclables.

*Source: 2011 Alban Casimir's research*

2. Industrial waste

a. Reduce

Any attempt to reduce industrial waste will modify the manufacturing process itself. For example:

- Change the composition of the product to reduce the amount of waste resulting from the product's use;
- Reduce or eliminate hazardous materials that enter the production process;
- Use technology (including measuring and cutting) to make changes to the production process; equipment, layout or piping; or operating conditions;
- Purchase what you need to avoid waste from unwanted materials;
- Good operating practices such as waste minimization programs, management and personnel practices, loss prevention, and waste segregation help to reduce waste at their source.

Since most of the reduction technologies are usually aiming to modify the manufacturing processes while being industry specific and often covered by intellectual property rights, such a case study may be complex and very rare to find. In this respect, we shall study a case showing the decision-making process rather than showing the complexity of a 3R technology in particular.

**Box 7: Waste reduction using the Green Productivity approach - Case study of PT Indopherin Jaya (Indonesia)**

PT Indopherin Jaya is a company producing automotive glue using phenol as the main raw material. The problem is the production process generating too much liquid waste (which contains phenol). It drove the company to seek an alternative that can reduce waste disposal and also increase the company productivity. Evaluation of these alternatives aims at choosing an alternative with a higher Green Productivity (GP) than the previous condition while saving on phenol PT Indopherin Jaya. Alternatives are evaluated by using the concept of Green Productivity Indicator (GPI), and by performing a financial feasibility analysis. The alternatives are as follows:

1. Do nothing! The tank accommodates the remaining liquid dehidralyzation separated from each reactor (R1, R2, R3) with an unique connecting pipe. The liquid temperature ranges from 30 to 40°C which limits the quantity of phenol to be retrieved from the tank.

2. Install separated pipes connecting the liquid from the reactors to the tank and install coils in the tank. Therefore, the water temperature will drop further (about 27°C) which should increase the amount of phenol produced compared to alternative 1.

3. Installation of an empty tank with a volume of 5 $m^3$ equipped with coils, a pump with a capacity of 1 $m^3$ per hour for recirculation and, above all, a chiller to cool further the liquid to temperature lower than 27°C.

The firm then calculates its productivity rate $= \frac{value\ of\ output}{cost\ of\ input}$

*Input usually consists in raw materials, labor and energy/water costs.*

Then, we will calculate the Green Productivity Index (GPI) for each scenario which is obtained by comparing the level of productivity of firms with environmental impact (environmental impact) on the production of PT. Indopherin Jaya. Environmental impact is obtained from the calculation with SIMAPRO 7.1 software using EDIP 2003 method (ecological footprint). Finally we will compare the Green Productivity Ratio (GPR) of each alternative.

GPI

$$= \frac{Productivity}{Impact\ assessment}$$

$$GPR = \frac{GPI_{Alternative}}{GPI_{Current}}$$

After calculations: GPR1=1.0203 – GPR2=1.0564 while the IRR1=90.75% - IRR2=95.60%

The best solution is to install the chiller (third alternative). The advantages of PT. Indopherin Jaya by installing a chiller is to increase the Green Productivity Index is shown with the Green Productivity Ratio of 1.0564, the rate of productivity increase by around 3%, and generate cost savings phenol purchases Rp 1,359,306,900 per year.

**Why does it work and can be duplicated:**

- this 3Rs technology is proven, simple to implement and operate
- saves money
- improves environmental impacts
- better image for the firm

*Source: APIEMS 2010*

b. Reuse and recycle

Use the waste material as a raw material substitute for another process. In this respect, firms from industrial estate zones may obtain significant gains by conducting audits for Cleaner Production[6] or **environmental management system** (EMS)[7].

[6] The United Nations Environment Programme (UNEP) launched the Cleaner Production Program in 1989. Cleaner Production is the continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase overall efficiency and reduce risks to humans and the environment. (UNEP, 1989). For production processes - the strategy includes conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and wastes. For products - the strategy focuses on reducing negative impacts along the life cycle of a product, from raw materials extraction to its ultimate disposal. For services - the strategy involves incorporating environmental concerns into designing and delivering services.

[7] EMS refers to the management of an organization's environmental programs in a comprehensive, systematic, planned and documented manner. It includes the organizational structure, planning and resources for developing, implementing and maintaining policy for environmental protection.

**Box 8: Eco-industrial networking towards Cleaner Production in Naroda Industrial Estate, Ahmedabad, India**

NIA (Naroda Industrial Estate) was the first to be created by the Gujarat Industrial Development Corporation as early in 1964. Today, there are nearly 900 industries employing roughly 30,000 people. A further 40,000 people can be considered to depend indirectly on the industrial estate for their livelihood. Approximately 26% of the industries in the estate fall into the chemicals category; predominantly dyestuff and dye-intermediates. Other types of chemical production are plastics (5%), pharmaceuticals (3%), and pesticides (1%). Engineering (24%), textile (5%), and trading companies (9%) complete the picture of significant industrial sectors within the estate.

The determination to enhance environmental performance beyond mere compliance combined with environmental and economic pressures have led some firms in the estate to investigate more proactive approaches such as making process modifications so as to improve their resource efficiency, and hence, their profitability. They have achieved this mainly through a Cleaner Production approach that has helped them to enhance individual environmental performance too. This now sets the scene for them to enlarge the scope of their activities and cooperate with different companies to look for recycle, reuse, and resource recovery opportunities. A study revealed that a wide variety of wastes are being generated in the chemical industries, particularly in the manufacture of dyestuff and dye-intermediates.

The most important wastes generated by this industrial sector are iron sludge from the Bechamp reduction process; waste acids, in particular, sulphuric and hydrochloric acids; chemical gypsum with varying content of calcium sulphate and chlorides; sludge containing sodium chloride and sodium glycolate; and boiler ash. Using the information on the types of waste available, opportunities for eco-industrial networking within the industrial estate were explored. The study revealed that some eco-industrial networking activities, or local partnerships, were already taking place in Naroda Industrial Estate. Based on these existing cases of resource recovery and the potential reuse of materials, wastes were classified into those with commercial value (C/V) and those without commercial value (NC/V). Further options to seek ways of revalorizing NC/V wastes, and look for higher (environmental and economic) value recovery options for C/V by-products or waste were analyzed.

The 20 possible partnerships identified through the study revealed a high potential for reusing, recycling or recovery of the following five materials:

1. Chemical gypsum

2. Biologically-degradable wastes

3. Mild steel scrap

4. Spent sulphuric acid

5. Iron sludge

An analysis of the process for recovering the gypsum as a raw material confirmed that it is economically viable. Gypsum generated by 19 chemical industries in the estate through neutralization of their acidic wastewater with lime has a potential use in the cement industry, subject to complying with certain specifications.

Biodegradable waste is produced by 9 companies in the estate. The total amount of waste is approximately 10,000 kg of solid material and nearly 90,000 liters of liquid waste per year. Digestion of this biodegradable waste has a potential to generate biogas as an energy source for either the industrial estate or a housing development located nearby. An economic analysis has shown this energy recovery process to be extremely favorable. While sulphuric acid is produced as a waste by 17 chemical industries, 16 engineering firms generate mild steel scrap. Both waste materials are possible raw materials to make ferrous sulphate, a chemical used in primary wastewater treatment at the Central Effluent Treatment Plant (CETP). Other possible partnerships that have been identified in the industrial estate, including the use of spent sulphuric acid in the manufacture of phosphate for fertilizer; use of iron sludge to prepare synthetic red iron oxide, an alternative application for chemical gypsum in the production of plasterboard; energy conservation; and a reduction in raw material consumption, in the ceramic industries.

Reuse, recycle, and resource recovery activities have been a very useful tool to initiate an eco-industrial network within the estate. The particular value of this step-wise approach has gradually encouraged the industries in the estate to focus not only on their individual environmental performance, but, also on the synergistic effects resulting from the large number of companies concentrated within the estate.

**Why does it work and is duplicated (in Amata Industrial Estate Thailand and Viet Nam, for example):**

- dissemination of information on how to reuse and recycle waste within the industrial estate;
- better environmental image for the industrial estate developer and firms within;
- opportunity for cost savings and for additional revenues;
- management motivation.

*Source: Promoting 3Rs in Asia, ADB, IGES, UNEP 2006*

3. Hospital waste

There is little room for reuse or recycling (only cardboard, plastic bottles, etc.) with hospital waste while reduce technologies consist mostly in incinerators (Thailand, Malaysia, and Viet Nam, for instance). However, low efficiency of the incinerators have led some countries (China and India, for instance) to forbid the use of incinerators for hospital waste treatment facilities using more autoclaves and microwave which merely reduce the toxicity of the waste but not the volume.

**Box 9: Health care waste - Bir Hospital, Kathmandu, Nepal**

Nepal has no medical waste management infrastructure, so many hospitals simply dispose of infectious waste with municipal waste which piles up on the city streets. Bir Hospital, Kathmandu, with about 400 beds, is Nepal's oldest hospital and the National Academy of Medical Sciences. It has recently installed two 175 litre autoclaves in a dedicated waste treatment facility to combat this public health threat and practices are being expanded from model wards. Health Care Foundation Nepal, Health Care Without Harm and the World Health Organization are supporting the effort.

A waste management committee has been established and hospital staff has helped develop segregation procedures and adapt trolleys to segregate waste at the bedside. Syringes are destroyed immediately after use by needle cutters and destroyers. Mercury thermometers and sphygmomanometers are being replaced by digital thermometer. Polystyrene foam food containers have been replaced by biodegradable containers. Infectious waste is transported to the treatment centre separately and dealt with in different parts of the building. Non-infectious plastic, paper, glass, and metal are sold to recyclers. Infectious waste is disinfected in autoclaves that have been validated using chemical and biological indicators and will be regularly tested to check if they continue to work effectively.

**Why does it work and can be duplicated:**
- training (talks, quizzes, games, exhibitions, redemption cards, etc.) to create recycling awareness among the staff and the management;
- training to learn how to separate and label the different types of waste;
- support from hospital management, local administrations, and universities;
- creation of recycling stores at every floor of the hospital;
- income from recyclables was used for internal and external tokens (80% given back to the staff);
- financial penalty for staff who skipped their "recyclable shift";
- additional responsibilities of the staff (recyclables committee member) were compensated by lucky draw, door gift, and complementary lunches.

*Source: 2008 WHO - Penang Case study of AIT 2009*

4. E-Waste

E-waste management is one of the rising problems due to peer pressure to buy newer, better, and latest things with indifference to the impact of our actions on the environment.

The "reduce" part depends obviously from the capacity of the firms to reduce the amount of materials used in electronic gadgets (and hazardous substance in particular) but mostly (and even though it is not related to business to business 3R technology transfer) on the consumer behavior as they can postpone decision to buy an electronic gadget like computer, cell phone or its upgrade and use their current one to the extent possible.

**Box 10: The case of mobile phones**

Consumers bought almost 900 million mobile phones in 2006 and over a billion in 2007, according to UNEP estimates. A big percentage of those devices are just thrown in the trash, or given to local collectors who extract precious metals from them in environmentally hazardous ways. The study predicts that by 2020, the amount of e-waste from dumped mobiles in China will be about seven times larger than it was in 2007, and in India 18 times higher. At present, India alone produces about 1,700 tons of e-waste from mobiles, Columbia about 1,200 tons, and Kenya another 150 tons.

Mobile phone and PC making gobbles up 3% of all the world's gold and silver available each year, not to mention 13% of all palladium, 15% of cobalt, and plenty of copper, steel, nickel, and aluminum as well. These spew tons of carbon dioxide into the atmosphere.

In developing countries, much of this e-waste is mined yet again by "backyard recyclers" who take apart the discarded devices for their tiny quantities of gold and other precious metals, a practice that releases "steady plumes of far-reaching toxic pollution," but recovers very little value compared to more efficient and modern industrial recycling plants.

In this respect, the world's largest mobile phone manufacturer appointed the Singapore-based electronic recycler TES-AMM to recycle Nokia-used phones. But unlike the "backyard recyclers" (Madurese in Indonesia and Sa Leng in Thailand), who act more as scrap metal traders, the company is at the top-end of the recycling chain. It has adopted a hydrometallurgical recovery process for precious metals and a sophisticated pollution control system that does not release harmful dioxins or carbon dioxides into the atmosphere.

Nokia's Singapore-based recycling center covers all ASEAN countries while Nokia acts on voluntary campaigns to collect the phones. For example, during a Give & Grow campaign encouraging people to voluntarily handover their telecommunication devices for recycling purposes carried out last year in Indonesia, Nokia collected more than 10,000 mobile phones[8].

**Why does it work and could be duplicated:**

- "Only 3 percent of people owning mobile devices claim to recycle them. If all of the around 4.6 billion people using mobile phones recycled at least one of their unwanted devices, this could save 370,000 tons of raw materials and reduce gases to the same extent as taking 6 million cars of the streets," Nokia says in a statement → cost and environmental impacts saving;

- Nokia is a worldwide firm that everybody knows and keeps watch on and hence cannot afford wrong environmental behavior and publicity in less regulated countries since it will negatively impact its image globally;

- Business is very profitable when mobiles are given free of charge under a voluntary program.[9]

*Source: 2008 UNEP report on E-Waste – Jakarta Post 2010*

[8] There are about 140 million users of mobile phones in Indonesia as of 2009 (Source: Nokia).

[9] However, recycled quantities under this scheme are relatively small and recycling program would be more effective if people received financial or other more concrete incentives. In some countries, Nokia had introduced discounted prices or door prizes for recycling their mobile phones.

5. Energy and water conservation

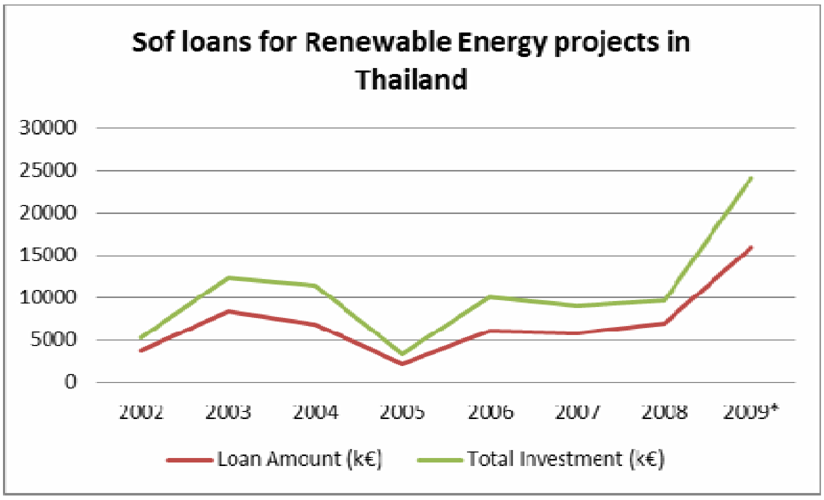
A myriad of equipment and technologies exist to help achieving energy and water conservation. It is impossible to cover this subject in a single paragraph. Therefore, we shall limit our study on a few examples only:

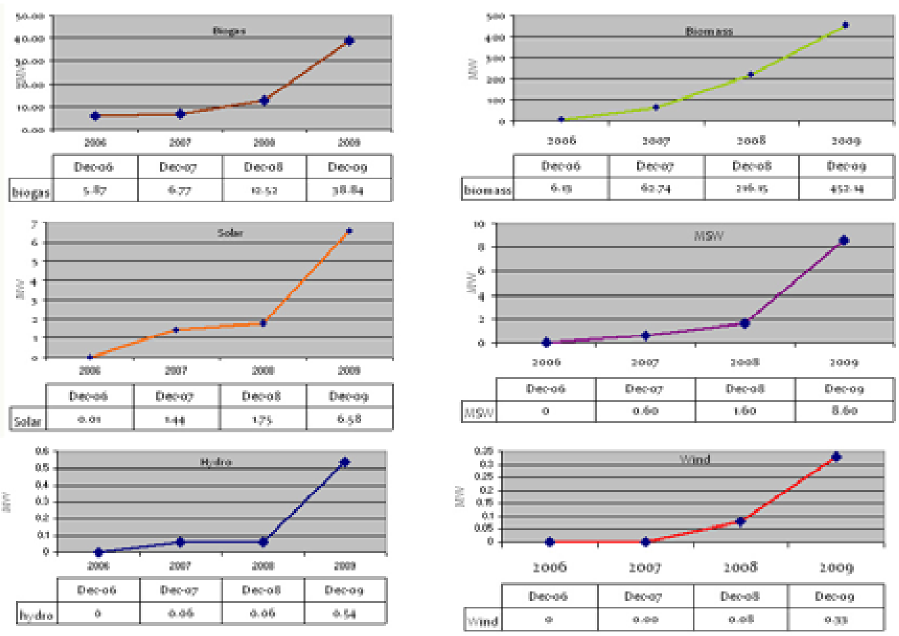
- **In a world where demand for water** is on the road to outstripping supply, many companies are struggling to find the water they need to run their businesses. In 2004, for instance, Pepsi Bottling and Coca-Cola closed down plants in India that local farmers and urban interests believed were competing with them for water. In 2007, a drought forced the US Tennessee Valley Authority to reduce its hydropower generation by nearly a third. Some $300 million in power generation was lost. The same situation has occured in Laos, Viet Nam, and China, for instance. Scarcity is raising prices and increasing the level of regulation and competition among stakeholders for access to water. To continue operating, companies in most sectors must learn how to do more with less. Achieving that goal is an opportunity as well as a necessity. Many of these same companies are developing products and services that can help business customers raise their water productivity. In agriculture, improved irrigation technologies and plant-management techniques are yielding "more crops per drop." New approaches now rolling out will help oil companies, mines, utilities, beverage companies, technology producers, and others use water more efficiently. Closing the gap between supply and demand by deploying water productivity improvements across regions and sectors around the world could cost, by our estimate, about $50 billion to $60 billion annually over the next two decades.[10] Private-sector companies will account for about half of this spending, government for the rest. Many of these investments yield positive returns in just three years.

- The Asian Development Bank (ADB) during 2005-09 funded 67 projects in the energy sector. Fourteen projects reduced the energy requirements by adopting energy-efficient systems or by introducing improved insulation which led to reduce transmissions losses, the use of fuel due to improved heating/insulation, energy-efficient water supply and treatment, and the introduction of energy efficient lighting. Other projects consisted of coal bed methane recovery and reuse projects in China while 44 projects were funded under the Clean Development Mechanism (CDM) through the Asia Pacific Carbon Fund (APCF)[11];

[10] Source: Mc Kinsey 2010.
[11] Source : ADB 2010

- Thailand's Very Small Power Producer (VSPP) Program[12]: historically, Thailand has relied extensively on fossil energies for electricity generation (especially on natural gas, above 70%). Considering the rise of fossil energies costs and the environmental protection awareness, the Thai Government decided in 2001 to launch a subsidy campaign for power producers from renewable energies. As you shall below, the subsidies offered were significant enough to stimulate private investments to install 507.03 MW as of 2009 compared to 12.01 MW in 2006 (prior to the subsidies package): a tremendous yearly 248% increase! There is always money available for 3Rs technologies when the regulatory framework is known and profitable.




*Source: NSTDA 2010. *: new, more attractive adder scheme*

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12 Source: EPPO 2010

At this stage, we feel it to be important to summarize what has been achieved so far, the main market drivers for the implementation, success, and hence duplication of environmental technologies, including 3Rs in Asian countries:

- On the technological side:
  - Proven, easy to operate and cost effective
  - Community based and labor intensive
  - Adapted to local specific conditions and needs
  - When complex, proper training must be carried out

- Country specificities:
  - Lack of resources
  - Land scarcity
  - Remote areas in vast countries

- Government and citizens:
  - Public environmental awareness
  - Political will

- Firm:
  - Image
  - Consumer- and regulation-driven demand
  - Management will
  - Trainings
  - Incentives and fines
  - Additional responsibilities

## IV. Potential roles of central governments in catalyzing the market formation for 3R technology transfer

As mentioned in the introduction, freely operating market alone cannot provide appropriate incentives to accelerate and extend the scale of investment and development of the 3R-related technologies; governments have an interest in intervening (e.g., environmental, social, economic, and employment) and should play an instrumental role in catalyzing such markets. They should create an institutional, administrative, legislative and policy environment conducive to business-to-business 3R-related technologies transfer and their adaptation and diffusion by lifting, whenever possible, the economic and market barriers.

- Internalize the positive and negative externalities by the market or regulation in order to reduce the low cost transportation and disposal barrier;

**Box 11: MSW management in Bangkok, Thailand**

The entity responsible of the waste management in Bangkok is the Bangkok Metropolitan Authority (BMA). The BMA has concessionaires to take care of the MSW collection and landfilling. Since 1991, the BMA has slowly but surely raised the required standards for the landfill infrastructures and operations. Obviously, these higher standards have led the BMA to pay higher bill for MSW management. However, it also created opportunities. Thanks to the tipping fee nowadays required by the landfills concessionaires to build and operate their facilities, a compost project has been developed in 2010 which has diverted 1,000 tons of fresh waste from landfills to the compost plant.

*Source: Wasadupanturakit landfill operator, 2011*

- Mitigate the investment barrier, on MSW in particular, by ensuring the permanence of their investment to the potential investors: duration, revenues, and fair legal framework of the concession. The return on investment must be certain for the private investor, otherwise the money will be allocated to safer investments;

- Create rewards (quantitative and qualitative) for firms that not only meet the pollution control standards but also develop 3Rs technologies to conserve the resources and reduce, reuse or recycle their wastes;

- Green procurement of central and local governments will help to create a local 3Rs market or strengthening its existing small size in order to generate economies of scale. Central governments could also phase out, from public bids, all companies not certified ISO 14001 for instance;

- Facilitate the access conditions to commercial and public finance for 3Rs projects: interest rate, collaterals, repayment period, among others;

- Create database and organize seminars and so forth to fight against the lack of reliable information;

**Box 12: Industrial Waste Exchange Program in the Philippines**

In 1987 the Industrial Waste Exchange Program (IWEP) was started as a pilot project assisted by the International Development Research Centre (IDRC) and conducted by the Department of Environment and Natural Resources (DENR). IDRC is a Canadian public corporation created by the Canadian parliament. In 1998, DENR transferred the IWEP to the Philippine Business for the Environment (PBE) and PBE disseminated the information regarding the activities of IWEP. PBE is a non-profit organization, which assists Philippine businesses to address its environmental issues and concerns. The United States-Asia Environmental Partnership (US-AEP) had also supported the PBE's projects. IWEP maintains a database of waste generators and waste buyers/recyclers and releases the information through the PBE publication "Business and Environment Magazine" and IEM Knowledge Network. The IWEP contains the following information for each waste item registered: volume of waste, frequency of generation, industrial process that generated the waste, classification of waste, physical state and current handling of waste (packaging). Each product is assigned a code and technical information, such as pH and any contaminants. However, company identity and location remain confidential at this moment. When two companies come to an agreement, producers and users start to negotiate all agreements directly. More than 130 companies have registered in IWEP and 1,153 recyclable materials and waste that are either for sale or wanted have been registered.

*Source: Philippine Business for Environment (PBE), 2006*

- Show the path to local governments and firms by developing pilot projects based on success stories from other countries;

- Facilitate the granting of licenses and permits for construction and operation of 3Rs projects (e.g., creating dedicated 3Rs technologies industrial estate).

Besides, central governments can also take part in international cooperation for 3R promotion:

- Promotion of high level 3R policy dialogues at the subregional, regional, and international levels;
- Fostering international collaborative activities including those facilitated by bilateral aid agencies, UN, and other international and regional organizations such as the Secretariat of the Basel Convention, UNCRD, UNEP, ADB, UN ESCAP, and others;
- Establishing regional and international networks on the 3Rs (e.g., knowledge and technology, basic information, internet-based knowledge transfer, e.g., an ADB and UNEP initiative on eKH — e-Knowledge Hub in Asia, training workshops);
- Public-private partnership (PPPs) on 3R areas within and beyond borders;
- Close association of 3R activities with sustainable production and consumption (SCP) task forces with significant links to EPR (extended producers responsibility) and product design;
- Encouraging day-to-day communication among customs, port, and maritime authorities to monitor transboundary movements of waste and to prevent illegal movements;
- Informal sector must not be marginalized but rather protected and integrated into the formal sector. This should start by providing protective gears to the informal sector thus reducing the health hazards associated with such work. The overall objective is to turn

the informal sector work in 3R activities into "decent work," and hence become socially acceptable.

## V. Recommendations and conclusions

"Whereas actions to promote the 3Rs are required both in developed and developing countries, most of the developing countries lack the required financial resources (since the polluter-payer principle is extremely limited), knowledge, technology, and policy frameworks. Fundamental issues in most of the developing countries include inadequate 3R orientation of environment and industrial policies, limited public and media awareness, limited corporate awareness specifically among SMEs, and lack of a robust knowledge base on the 3Rs". *Source: "National 3R strategy development: A progress report on seven countries in Asia from 2005 to 2009". UNCR, AIT and IGES.*

Nevertheless, the situation of 3Rs in Asia is, in our opinion, more optimistic than this assessment: **transfer and implementation of environmental technologies, including 3Rs, is already a reality**. Many projects have been developed, though with various success rates, but it proves that private companies and governments are proactive and walking the path of 3Rs developments even though market failures and barriers remain. To strengthen this booming but immature market, hereafter are some recommendations that the regulator could choose to implement:

- The **establishing of a national 3R focal point**, a well-organized institutional set-up, is a prerequisite for implementation of 3R and its sustainability;

**Box 11: The Thailand Greenhouse Gas Management Organization (TGO)**

TGO is not the 3R focal point of Thailand (unlike the *3R Wing* at the Ministry of Environment and Forests in Bangladesh for instance), but the Designated National Authority (DNA) also known as the CDM focal point. It's mission is: promoting low carbon activities, investment and marketing on GHG emission reductions, establishing a GHG information centre, reviewing CDM projects for approval, providing capacity development, and outreach for CDM stakeholders. In short, nothing more than the normal job of other DNAs in Asia. Why is this TGO so special and why do we take it as an example for 3R focal point?

Because TGO is a public and autonomous governmental organization and as such is allowed to make profit from the implementation of CDM projects in Thailand (similar organization exists in China, for example). Beyond the obvious dedication and expertise of the staff, similar to other DNAs in Asia, profit making is definitely the reason why TGO is considered, by many CDM developers, one of the most active and supportive DNA among Asian countries.

We take it as an example because we believe that the 3R focal point could be inspired of the possibility of profit making from 3R projects development (the ideal profit scheme remains is to be discussed depending on each country, industry, type of waste, etc.). Obviously, the additional cost on the 3R developer must not constitute a financial barrier therefore fees levied by this 3R focal point must be reasonable.

*Source: Alban Casimir's research 2011*

The main roles of such 3R focal point could be:

- It obviously starts with promoting 3R activities, investment and marketing on 3R implementation and transfer, establishing a 3R information centre, providing capacity development and outreach for 3R stakeholders, and increasing public awareness;
- **Levying waste collection and disposal charge to all waste generating sources**, preferably based on volume of waste, is important to 3Rs technologies transfer in waste. Research and experience suggest that people are willing to pay when there is a correspondence between a service received and payment made for it;
- **Assist firms and local administrations to access international funding** such as official development assistance (ODA) kind of support for the initial piloting and demonstration stage or international financial institutions (IFIs) funding for scaling up;
- **Creation and management of a 3R Promoting Fund** at the national and city levels. The role of financial leverage can hardly be overemphasized. Microfinance can also be considered to support informal sector entrepreneurs in 3R-related activities;

**Box 12: The 3R Fund in Singapore**

The 3R Fund is an $8 million co-funding scheme to encourage organizations to undertake waste minimization and recycling projects. Any organization in Singapore, including companies, non-profit organizations, town councils, schools, institutions, building owners and industry associations can apply.

Projects must result in an increase in the quantity of solid waste (this excludes toxic and chemical wastes) recycled or a reduction in the quantity of solid waste generated. Projects with new and innovative processes and concepts, and which target waste streams with low recycling rates such as food, plastic, glass and used household batteries will be given higher priority. The projects could include the following:

(i) Redesign of processes to reduce waste at the production stage, including redesign of packaging or products;
(ii) Installation of new waste recycling infrastructure such as separate chutes, containers or receptacles for the collection of recyclables, as well as refurbishment work to provide additional storage space for recyclables;
(iii) Installation of innovative waste sorting or recycling systems/equipment; and
(iv) Upgrading, installation or implementation of new operation/system to reduce waste or increase recycling.

The 3R Fund will co-fund up to 80% of qualifying costs, subject to a cap of $1 million per project. The funding level will depend on the quantity and type of waste reduced or recycled. The grant will be calculated based on key outcomes such as the actual quantity of waste reduced or recycled.

Qualifying costs refer to the followings: (i) manpower. (ii) equipment and consumables. (iii) professional services. (iv) other costs relevant to the project

*Source: National Environment Agency, Singapore, 2010*

- **Partnership development** with donors, IFIs, owners, FDI sources, government departments and agencies, private sector, nongovernmental organizations, community-based organizations such as the resident welfare associations (RWAs) in India, and media.

- **Financial and technical assistance for R&D in order to develop appropriate technologies** (cost effective, employment generating, and environmentally sound). Indeed, promoting R&D is central to supporting investment in the environment and water and energy industries for resource efficiency and sustainable waste management. Most of the new technologies originate in the more developed countries, although some adaptations of these technologies or indigenous technologies are also produced in developing countries. R&D may be carried out by educational and research institutions, by industry institutes, and by the companies themselves. Government can encourage R&D by providing grants through nonprofit institutions such as universities and by offering tax credits or similar incentives to firms for R&D expenditure, so long as a result will be publicly available. Developing green industrial parks can also help centralize research and extension services by providing a home for new and expanding business, along with business associations, incubator services, and a research base to improve the success of investment in various sectors. Government should emphasize the development of economically viable products and processes that require fewer reagents, fewer solvents, and less energy and water than conventional processes. Green chemistry R&D searches for new solutions in several basic areas, including changes in chemical process design (e.g., alternative catalysts and regents for chemical production processes);

changes in manufacturing process (e.g., getting more output per unit of chemical input); and new products that replace polluting chemicals (e.g., benign petrochemical products, biomaterials and bio-fuels);

- Related to R&D, governments should ensure **3R-related education and awareness school curricula**;

- **Strong marketing campaign** of compost and similar recycled products through well-established commercial/private sector marketing channels. Experience has shown that without tapping such channels 3R entrepreneurs, who are still largely social or civic entrepreneurs, on their own cannot market their products;

**Box 13: Composting from household in Indonesia**

In several provinces of Indonesia, households have been equipped with compost bins (in cast iron), located just in front of the house. Unfortunately, the system does not work as well as expected and household still unsort the waste, using the all-waste bins instead. The main factors of failure are the lack of public awareness campaign as well as the absence of overhaul of the waste fees structure based on volume of waste.

Conversely, such initiative has rather been a success in Surabaya (still in Indonesia) thanks to the extensive and continuous public awareness campaign carried out by the Municipality for several years. Indeed, a decade ago, the new mayor had the objective of turning Surabaya into the cleanest city in Indonesia by obtaining the highly prized Adipura award (which Surabaya won again in 2011).

*Source: Alban Casimir's research 2011*

- **Government support for allowing access to land and other essential services** for doing business in 3R and ensuring policy support;

- **Market-based instruments such as subsidy and tax should be used:**
    - subsidization of 3Rs technologies (switching of subsidy from chemical fertilizer to organic compost – subsidy on green electricity (like in Thailand or Malaysia for instance) – differentiated taxation (customs tariff, for environmental friendly businesses), and subsidy to preserve informal sector's involvement in 3R activities and to recycled material-using factories and industries;
    - Revenue generation through taxing polluting products and charging activities such as use of construction and demolition materials used for filling vacant land; or introduction of Green custom charges on items with high disposal costs;

- Greater use of deposit-refund scheme for reuse and recycle of items (glass bottle and mobile phones for instance).

To conclude, 3Rs transfer and implementation in Asian cities, particularly for the wastes, still face many problems. The current regulation system is not perfect while the existing management system and the collection facilities may not fit the present requirements. Wastes are still collected without separation at the source, treatment facilities are limited, and the collected wastes are mostly dumped haphazardly in open areas. But governments, NGOs, CBOs, and the private sector are working hard to improve this situation with several achievements and success stories waiting for duplication. Implementation of some recommendations mentioned above will surely concur in improving the overall picture of environmental technologies transfer and implementation, including 3Rs in Asia for the years to come.