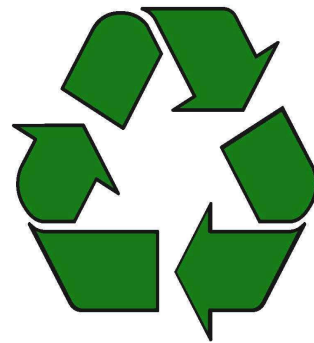




# DETAILED FEASIBILITY REPORT ON GREEN INDUSTRY

## Part I



**DEPARTMENT OF INDUSTRY  
MINISTRY OF ECONOMIC AFFAIRS  
ROYAL GOVERNMENT OF BHUTAN**

**By  
IDRG CONSULTANCY SERVICES  
In Association with Druk Associates, Bhutan  
November - 2011**



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## **EXECUTIVE SUMMARY**

## **EXECUTIVE SUMMARY**

1. There is growing realization all over the world about the adverse impact of the industrial activities on the environment and ecology. The scientific facts and observations viz. **Green House Gas Effect, Global Warming, Ozone Layer Depletion, Ecological Balance, Sustainable Development, Renewable Sources of Energy, Bio Diversity** and their implications are now much better understood and these constitute the core of future policies for industrial development. The policy framework, incentives and regulations are being considered to minimize the damage to the environment. The laws and regulatory measures are in operation to restrict activities that cause damage to habitat or wildlife by setting up wildlife reserves, parks and other conservation areas.

2. According to the International Energy Agency (IEA), industry accounts for about one-third of global energy use and almost 40% of worldwide Green House Gas (GHG) emissions. We need to switch over to clean and renewable energy to power our economies; improve the efficiency of our energy, material and water use; and practice conservation. Energy efficiency is the most cost-effective, least polluting and the most readily-available industrial energy savings option in the industrial sector, worldwide. Capturing these potential resource end-use and energy-efficiency improvements rapidly is essential to keep greenhouse gas emissions to safe levels. There is also significant potential to reduce, at low or no cost, the amount of energy used to manufacture goods.

3. Today, the industry leaders and policy planners are emphasizing at another kind of industry-led growth viz. **Green Industrial Revolution**. Rather than limiting growth, such a revolution can, and should, form the core of our response to climate change. The potential is there for new, clean methods of production; industries focusing on mitigation of impact on environment and ecology and greater use of renewable energy. Phrases like **“Going Green”, “Eco-Friendly”, “Green Technology”** and **“Sustainable Practices”** are moving from fringe buzzwords to the forefront of the investor’s lexicon. In tomorrow’s world, businesses that ignore environmental impact and don’t reform business processes and working practices will be less credited.

4. The term **"Green Industry / Green Technology"** is a broad term for more environment friendly solutions. Green technology for that matter can be used as environmental healing technology that reduces environmental damages created by the products and technologies for peoples' conveniences. It can be safely said that green technologies help in addressing the emerging issues of sustainability. It ensures meeting the needs for society in ways that can continue indefinitely into the future without damaging or depleting natural resources. **Green Technology (GT) is defined as the technology that meets the present needs without compromising the ability of future generations to meet their own needs.**

5. It is a well known fact that conservation of environment constitutes an important part of Bhutan's spatial planning strategic framework and has always enjoyed a high priority in the country's development agenda. The Tenth Plan document envisages that the strong emphasis on protecting and conserving the environment will not diminish in any way over the plan period. It is further stated that the environment sector will require more attention than before in view of the accelerated pace of economic and development activities accompanied by increased expansion of infrastructure development, urbanization, industrialization, population expansion and consumption patterns that are likely to put an even greater burden and stress on the natural environment.

6. The Vision 2020 for Bhutan envisages that while the country's economic future will be rooted in and driven by hydro-power based investments, the economy will also be well-balanced and sufficiently diversified by a thriving horticulture and organic based high-value agriculture sector, a solid and clean manufacturing base with a network of green industries and a burgeoning hospitality industry. These non-hydro power sectors are also expected to contribute in very significant ways towards generating productive employment for the growing numbers of youth entering the labor market. Accordingly, there is a felt need for undertaking a detailed analysis of green industries at different locations that have the commercial potential based on their competitive strength and comparative advantages of factor inputs and market.

7. In view of the above, it has been decided to undertake detailed feasibility studies of the green industries with a view to identify the viable green projects and to develop detailed information on the identified projects. Accordingly, the project on detailed feasibility on green industries has been assigned to IDRG Consultancy Services. The objective of the project is to identify viable green industry projects in various sectors of economy and carrying out detailed feasibility analysis of the identified projects.

8. The main areas in which setting up of green industries is being emphasized upon include **Renewable Energy Resources, Agricultural & Forest Related Products, Food Processing, Recycling of Waste, Bio-Degradable Material, Industrial Biotechnology; Pollution Free Engineering Processes & Green Chemistry based production technologies.** There exist huge potential for hydro-electric power in Bhutan; therefore the area of renewable energy was not studied in much detail.

9. Various economic sectors viz. **organic farming, agro & forest based products, non-wood forest products, value added products based on horticulture and agro produce, medicinal and aromatic plants, recycling of waste, production of bio-degradable materials** were looked into for assessing the possibility of setting up green industries in these areas by employing green technologies. On account of inadequate availability of surplus production for commercial exploitation, the areas of agro produce, forest produce and horticulture produce have not been found suitable for setting up processing facilities for production of value added goods by using green technologies.

However, there exists a potential for future development of green industries in these areas.

10. Waste recycling specially recycling of paper waste has been identified as one of the most promising area for promoting green industries. Production of gypsum board / gypsum panel has been identified as another main product for setting up green industries. In the year 2009, Bhutan imported over 5000 MT of paper which includes newsprint, writing paper, printing paper & packaging paper etc. Majority of this paper after use becomes waste paper and the current annual availability of waste paper in Bhutan would be around 5000 MT. This is further corroborated by the fact that during 2009, a quantity of 5112 MT of paper waste was exported to Indian markets. According to City Corporation, Thimphu, paper waste constitutes 17.2% of Municipal solid waste.

11. Waste paper can be recycled for the production of newsprint, packaging paper, duplex board and pulp molded products. Keeping in view, the various factors in the context of Bhutan viz. quantity and type of waste paper available, the investment considerations, environmental regulations, market scenario, it has been concluded that a unit for production of pulp molded products viz. egg trays and apple trays would be most viable in Bhutan and this would be entirely a green industry. The finished products viz. pulp molded products would be bio-degradable and green materials of packaging. The use of apple trays and other pulp molded packages would further add value to the products from Bhutan especially in export markets.

12. There has been a boom in the construction industry in Bhutan. Gypsum board & gypsum panels are modern materials of construction extensively used world over for ceiling, wall paneling, thermal insulation, acoustic applications, inner partitions and many other applications. Due to obvious reasons, wood has been extensively used in the construction of buildings in Bhutan. Over a period of time, wood has become both scarce and costly and some alternative materials need to be used in place of wood. Gypsum board and gypsum panel offer viable alternative to wood. The raw material – gypsum mineral required for the production of gypsum board is indigenously available in Bhutan. The production of gypsum board would also add value to the indigenously available Gypsum mineral resources.

13. The production process for gypsum board and gypsum panel is entirely environment friendly and there are no solid, gaseous or liquid effluents. Gypsum board and gypsum panel are recyclable and are known as green materials of construction. The use of gypsum board / gypsum panels helps in the construction of green buildings. Gypsum board is produced by automatic production lines and the investment and production turnover are relatively quite high. Keeping in view, the size of local market, investment considerations and various other factors, it has been concluded that a green industry for the production of gypsum panels based on semi-automatic process be established in Bhutan. The project for gypsum board production by automatic production line may be considered at a later stage.

14. Based on above considerations, two green industry projects viz **Recycling of Paper – Pulp Molded Products** and **Gypsum Board / Gypsum Panel for Ceiling and Insulation** have been identified as green industry projects for Bhutan. The detailed feasibility studies have been carried out for these projects in order to facilitate setting up of viable indigenous production units in Bhutan. The detailed feasibility reports on these two identified green industries have been presented in part II & part III of this report.



## **CHAPTER – 1**

### **INTRODUCTION**

## 1. Background

1.1 Industry-led growth has been the engine of the global economy for over two centuries. Almost all developed and developing nations have harnessed industry as the main driver of their prosperity, and it is still the best hope for ending the dominance of poverty over the so called Bottom Billion of humankind. In the initial phases of industrial development, the scientific facts and observations viz. **Green House Gas Effect, Global Warming, Ozone Layer Depletion, Ecological Balance, Sustainable Development, Renewable Sources of Energy, Bio Diversity** and their implications were not fully understood. In those times, capitalism was the only rule of business, and it worked very well.

1.2 With the onset of the Industrial Revolution in Europe and America, industry began pumping ever-increasing amounts of greenhouse gases into the air. Greenhouse gas (GHG) is actually a broad category of gaseous effluents which include any gas that traps heat within the earth's atmosphere, thereby raising the planet's temperature. Similarly, indiscriminate use of forests and other natural resources and release of huge amount of toxic solid waste and liquid effluents both by industrial activities and urban habitats have created immense problems.

1.3 The coal fired power plants, petrochemical, automobile, pharmaceuticals, dye and dye intermediates and textiles industries have made our life comfortable but one should not ignore the detrimental effects of these industries to the environment.

## 2. Need for Green Industries



Global campaign for green industries

2. Today the world needs another kind of industry-led growth viz Green Industrial Revolution. Rather than limiting growth, such a revolution can, and should, form the core of our response to climate change. The potential is there for new, clean methods of

production; industries focusing on mitigation of impact on environment and ecology and greater use of renewable energy.

### **3. Global emphasis on Green Technologies**

3.1 During last few decades, there is growing realization about the adverse impact of the industrial activities on the environment and ecology. The policy framework, incentives and regulations are being considered to minimize the damage to the environment. Many global giants are in the process of creating strategies and regulations that will put a discrete cost on emission of GHG as well as other solid and liquid wastes.

3.2 For several environmentally-sensitive projects, the environmental impact assessment have been made mandatory by the respective governments to identify, estimate, evaluate and mitigate the biophysical, social, and other relevant effects of development projects. The laws and regulatory measures are in operation to restrict activities that cause damage to habitat or wildlife by setting up wildlife reserves, parks and other conservation areas. Under conservation, sustainable development is allowed, however, under preservation, it is completely restricted.

### **4. Green Industries – Their relevance to Bhutan**

4.1 Starting in early 1960s, Bhutan embarked upon planned economic development. Through successive five year plans, economy witnessed a major transformation over the last five decades. With the establishment of basic infrastructure as well as major investment in hydro-power, the overall focus is now on expansion of economic base through increased investment in business activities within the broad framework of environment friendly sustainable development.



4.2 It is a well known fact that conservation of environment constitutes an important part of Bhutan's spatial planning strategic framework and has always enjoyed a high priority in the country's development agenda. Conservation of the environment has been robustly pursued even as Bhutan is compelled to make enormous short term sacrifices to

serve the long term interests of not just the country alone but the region and world at large. It is this unwavering commitment that has brought widespread global recognition for Bhutan's efforts to protect its environment and natural resources.

4.3 The Tenth Plan document envisages that the strong emphasis on protecting and conserving the environment will not diminish in any way over the plan period. It is further stated that the environment sector will require more attention than before in view of the accelerated pace of economic and development activities accompanied by increased expansion of infrastructure development, urbanization, industrialization, population expansion and consumption patterns that are likely to put an even greater burden and stress on the natural environment.

4.4 The availability of low-cost hydro-power energy and resource endowments deriving from electricity export revenues are anticipated to help transform the industrial landscape in Bhutan. In this context, The Royal Government of Bhutan (RGB) has placed huge emphasis on preserving and protecting the environment considered as one of the pillars of Gross National Happiness (GNH) which is the guiding principle of national development and happiness, the ultimate aim of the country's development policy. The developmental strategy envisages that the goals of industrialization shall be achieved through the development of a wide range and host of clean industries and high-technology enterprises. Exports to international markets of high-value Bhutanese niche and eco-based products are also projected to contribute significantly to the national economy and gain notable prominence for their quality. The private sector is expected to grow significantly and become more dynamic, providing the major impetus for the growth in the manufacturing sector that is expected to contribute around one third of Gross Domestic Product (GDP).

## **5. Justification of the project**

5.1 The Vision 2020 for Bhutan envisages that while the country's economic future will be rooted in and driven by hydro-power based investments, the economy will also be well-balanced and sufficiently diversified by a thriving horticulture and organic based high-value agriculture sector, a solid and clean manufacturing base with a network of green industries and a burgeoning hospitality industry. These non-hydro power sectors are also expected to contribute in very significant ways towards generating productive employment for the growing numbers of youth entering the labor market.

5.2 In view of the above, it is envisaged that there is a need for identification of suitable green industries which would meet the above objectives of the sustainable

development and environmental protection and also make assessment of the financial and technical viability of the possible green industries in the country.

Accordingly, there is a felt need for undertaking a detailed analysis of green industries at different locations that have the commercial potential based on their competitive strength and comparative advantages of factor inputs and market. It is in this context, that a study has been assigned to M/s IDRG Consultancy Services for preparing a Detailed Feasibility Report on Green Industries. The above stated consideration and objectives are clearly evident in the terms of reference of this study. The terms of reference are as given at annexure-I.

## **6. Approach to Work**

6.1 The terms of reference envisaged that the study would be conducted in two phases, the first will be the preliminary studies of various sectors to identify the viable project in the field of green industries / green technology, identify project ideas and make selection of a project with maximum potential for development and the second would be to carry out detailed feasibility studies for the selected project. The approach to work shall be as under:

- Review the available literature, reports, information, and statistics both concerning Bhutan and other countries about the possibilities of adoption of green technologies as also the policy framework, regulations and incentives for promoting the green industries in various sectors.
- Review and examine the current scenario in various sectors of economy in Bhutan and make assessment about the need and possibilities of adoption of green technologies.
- Keeping in view, the policy framework for industrial development, current status of development and future projections, study some selected sectors for adoption of green technologies.
- Make assessment of the current and projected requirement of inputs, surplus produced along with future projections for possible industrial exploitation and identify the industrial activities based on green technologies.
- Shortlist the green industries / products based on green technologies in various sectors which have potential for development in Bhutan.
- Select a project on green industries with maximum potential.
- Study the selected project for preparing detailed feasibility report.

## **7. Methodology**

7.1 The methodology comprised of collecting and collating information from Government authorities, private business and other stakeholders in the various sectors of economy having potential for development of green industries. The methodology in brief comprised of the following:

- Desk review of reports and publications

- Meeting with authorities and other stakeholders
- Analysis of economic sectors
- Analysis of demand and supply scenario
- Market surveys
- Workshops and Interactive Meets
- Study visit

7.2 The study has been based on both the primary & secondary sources of information. Information & data collected through field visits and information generated from discussions with various stakeholders on green technologies has been the primary source of information. The literature review and existing reports & documents forms the basis of secondary source. The methodology is summarized as under:

- Collect and collate information from Government authorities, private business and other stake holders in various sectors of economy about the possibilities of setting up of green industries in Bhutan.
- Review the data on current and future demand projections of inputs requirements in various sectors, the surplus produce for industrial exploitation and study the possibilities for promoting manufacturing activities either based on input requirements or based on available surplus production.
- Study the by-products, waste generated in the industrial and consumer sectors and assess the possibilities of recycling the waste for production of consumer / industrial products.
- Assess the techno-economic viability of manufacture of these items/group of items through adoption of green technologies.
- Draw upon a list of green industries which are considered viable in the context of the economic development of Bhutan.
- Prioritize the green industries in terms of their techno-economic viability, importance to economy of Bhutan and also its friendliness to environment.
- Select a project with maximum potential in consultation with the Department of Industry, Ministry of Economic Affairs.
- Carry out detailed feasibility studies of the selected Green Industry project as per terms of reference.
- Submission of the final report

## **8. Consultation and review of the available information**

8.1 The work on the project assigned to IDRG Consultancy Services was started forth with on 3<sup>rd</sup> January 2011. The consultant's team had initial briefing meeting with the Chief Industries Officer, Department of Industries, Ministry of Economic Affairs. After the briefing meeting, IDRG team had a series of meetings and discussions with various stakeholders in the field of green industries and green technologies.

8.2 The team had a very useful meeting with Chief Industrial Officer, Enterprise Development Division, Department of Cottage and Small Industries, Ministry of

Economic Affairs. The areas for identifying green industries project discuss during the meeting included essential oils, bamboo, packaging, rosin and turpentine, etc. However, in the context of essential oil, it was informed that the production level of lemongrass oil has fallen from 10 MT to 4 MT. The recovery of lemongrass from wild sources is slowly decreasing and there does not appear to be much potential for promoting cultivation of lemongrass in view of the limited availability of cultivable land. Among NWFP, the promotion of bamboo cultivation and promotion of industries based on bamboo could be considered as viable areas for green industry projects.



8.3 A meeting was held with Chief Research Officer of Bhutan Chamber of Commerce and Industry (BCCI). Packaging cartons for handicraft and other products, honey processing, herbal medicines and floriculture were suggested as the possible areas for studying the possibility of green industry project.

8.4 IDRG team had detailed discussion with officials of Department of Agriculture, Marketing and Cooperatives, Ministry of Agricultural Forests with a view to assess the possibilities of green industry project in the field of agricultural produce. It was mentioned during discussion that rice, potato, apple, orange constitutes the main export items from Bhutan in terms of quantum and value. M/s Bhutan Agro and M/s Druk Food are the major processing units. They do not appear to be much scope for creating additional processing facilities in view of the limited availability of agro and horticultural produce. In the export field, packaging is the constraining factor and there is a need to switch over to good quality paper cartons.

8.5 Social forestry projects are gaining momentum in Bhutan. A meeting was held with Senior Forest Ranger, Social Forestry Division in order to identify the product areas which have potential for development of green industries. It was informed during discussions that social forestry is a relatively new program launched recently. They are assisting in formation

of farmers group at village / community level and carrying out sensitization and training programmes. At present, most of the products are based on collection from wild sources. They have identified 19 different products for extensive marketing support. Some plantation projects have also been started in central and southern regions in collaboration with National Resource Development Corporation (NRDC). Bamboo has also been covered under social forestry. It was mentioned that due to limited availability of Non Wood Forest Products (NWFP), there does not appear to be much scope for their industrial exploitation.

8.6 Royal Government of Bhutan has placed huge emphasis on organic farming. A National Organic Program has been launched by the Ministry of Agriculture and Forest. IDRG team had detailed discussions with Coordinator, National Organic Program regarding the viability of green industry project based on organically grown agricultural and horticultural produce. The main topic of discussion was availability of the produce from organic farming for processing into value added products as also the input requirement viz organic fertilizers and organic pesticides for organic farming. It was revealed during discussions that lemongrass oil is the only Organic Certified Product. For other organic farm products, the cost benefit ratio does not favor the process of organic certification mainly due to low quantum of production. It was also informed that in view of the limited operations of organic farming, there is not much requirement of organic fertilizers and organic pesticides and their requirement is being met by farmers through in house production of manures, viz FYM. Similarly, sufficient quantity of organically produced surplus is not available for setting up commercial manufacturing facilities for production of value added processed food products.

8.7 IDRG team had also a series of meetings with industrial units' viz. Bhutan Agro Industries Ltd, Bhutan Board Ltd. The team also had meeting with the President, Bhutan Export Association.

## **9. Presentation of the inception report**

Based on the information from various concerned government departments & agencies, other stakeholders, review and analysis of available literature and reports on green industries, IDRG Consultancy Services submitted an inception report on the subject. At a meeting held on 24<sup>th</sup> March 2011 in the Ministry of Economic Affairs wherein all stakeholders were present, IDRG team made a presentation on the findings of the inception report on the detailed feasibility study of green industries project in Bhutan. IDRG team suggested a list of potential green industry project and also indicated the most preferred product areas for detailed feasibility studies. During the presentation, it was suggested that the two main products out of the various products identified for green industry projects be studied for detailed feasibility analysis. IDRG team was advised that based on the inception report and the presentation made by IDRG, Department of Industry, MOEA would decide the two product areas for detailed feasibility studies. Subsequently, as desired by MOEA, further facts and figures were submitted to the Department of Industry, MOEA along with additional justification for identification of



green industry projects by IDRG. Finally, the following green industry projects were finalized for detailed feasibility studies.

- **Recycling of Paper – Pulp molded package**
- **Gypsum board / gypsum panel – Ceiling & Insulation based on indigenously available gypsum mineral**

## **10. Organization and institutions contacted**

10.1 Subsequent to the presentation of inception report, IDRG team had another round of meetings and correspondence with concerned organizations and institutions in order to collect detailed information relating to identified projects and also the details on availability of land and other infrastructure, availability of finances, existing marketing channels, current prices scenario etc. Back in India, the team had extensive discussions and meetings with a large number of industrial units, concerned organizations, knowledgeable persons engaged in the manufacture of similar products, manufacturers of machinery and equipment, manufacturers and suppliers of raw materials in various parts of the country. Quotations and indicative prices of various items of machinery and equipments and raw materials were obtained from the concerned manufacturers through meetings and correspondence.

10.2 The team's endeavor has been to collect maximum possible information and details on green industries projects. The list of the organizations visited and all the persons who were kind enough to spare their time for discussions with IDRG team during their visits to Bhutan is given in Annexure II.

10.3 The information available during discussions was further supplemented by the published literature and the information available on internet in public domain. List of documents and articles consulted by IDRG team is given in annexure III.

10.4 The list of industrial units, organizations and institutions visited in India through correspondence and meetings is quite extensive. The relevant names and addresses of the concerned organizations have been given along with the detailed feasibility analysis of the two identified green industry projects in the list of machine and equipment supplier and raw material suppliers. The detailed feasibility analysis of Pulp Molded Products and Gypsum board / gypsum panel have been covered in part II and part III of this report.

## **CHAPTER – 2**

### **GLOBAL OVERVIEW OF GREEN INDUSTRY**

## **1. Defining the term Green Technology / Industry**

1.1 In the context of industrial development and production of goods, the technologies are applied for utilization of resources to produce various industrial and consumer products with the overall objective to generate economic activities and employment opportunities. To avail optimums benefits from technologies it need to be successfully linked with country's / region's overall development objectives and applied to solving socio-economic problems.

1.2 The ideal technology should be efficient, practical, cost effective and free from pollution hazards. The sustainability factor and environmental aspects have become of paramount importance in global context and the application of green technologies is being emphasized and encouraged world over. The term Green Technology / Green Industries is a broad term for more environmental friendly solutions as it minimizes the environmental damages created by products and technologies for people's convenience. It can be safely said that green technologies help in addressing the emerging issues of sustainability. It ensures meeting the needs for society in ways that can continue indefinitely into the future without damaging or depleting natural resources. The application of green technologies enables meeting the present needs without compromising the ability of future generations to meet their own needs.



1.3 Accordingly, the "Green Industry / Green Technology" is a broad term for more environment friendly solutions. Green technology for that matter can be used as environmental healing technology that reduces environmental damages created by the products and technologies for peoples' conveniences. It is believed that GT promises to augment farm profitability while reducing environmental degradation and conserving

natural resources. GT covers a broad group of methods and materials for generating energy to non-toxic cleaning products. This area has become significantly important because people expect a dramatic innovation and changes in their livelihood. The development of alternative technology should attempt to benefit the planet and truly protecting the environment.

1.4 Although it is difficult to precisely define the areas that are covered by green technology, it can safely be said that GT helps addressing the emerging issues of sustainability because of the advancement in science and technology. This technology should meet the needs of society in ways that can continue indefinitely into the future without damaging or depleting natural resources. In short, **GT is defined as the technology that meets the present needs without compromising the ability of future generations to meet their own needs.**

## **2. Why green industry?**

2.1 According to the International Energy Agency (IEA), industry accounts for about one-third of global energy use and almost 40% of worldwide GHG emissions. We need to switch over to clean and renewable energy to power our economies; improve the efficiency of our energy, material and water use; and practice conservation. Energy efficiency is the most cost-effective, least polluting and the most readily-available industrial energy savings option in the industrial sector, worldwide. Capturing these potential resource end-use and energy-efficiency improvements rapidly is essential to keeping greenhouse gas emissions to safe levels.

2.2 There is also significant potential to reduce, at low or no cost, the amount of energy used to manufacture goods. In the IEA's stabilization scenario for greenhouse gas emissions, over a quarter of all energy-efficiency gains need to come from the industrial sector by 2050. Changing our present paradigm of development will not be easy. But many countries in Asia are already taking concrete steps to encourage and expand the use of clean energy and improve their resource efficiency. China has reduced the energy intensity of its economy by over 60% since 1980 and expects to reduce it further by 20% by 2010. It plans to double the proportion of energy it uses from renewable energy sources by 2020. China has also become the world's leading renewable energy producer in terms of installed generating capacity and has now surpassed Japan as the world's largest manufacturer of solar photovoltaic technology. It is also expected to become the world's leading manufacturer of wind turbines.

## **3. Areas of applications of Green Technology:**

3.1 Indian Institute of Technologies and others have offered following categories of cleaner and green technologies:

- Renewable Energy Resources
- Agricultural/Forest Related Practices and Food Processing

- Recycling / Production of Potable Water
- Recycling of Waste
- Biodegradable Materials
- Industrial Biotechnology
- Pollution Free Engineering Processes
- Green Chemistry

3.2 While advocating the use of affordable eco-friendly technologies for sustaining growth in the Asian region, the leaders and environmental activists have emphasized the development and use of technology that converts waste into wealth.

## 4. Feasible Green Technologies

### 4.1 Renewable Energy

Following are the selected renewable energy technologies;



Solar Panels

**4.1.1 Solar Photovoltaic** – Solar photovoltaic technology converts sunlight into electricity using semi-conductor modules. Used generally for meeting lighting requirements, they can also be used for pumping water, refrigeration, communication, and charging batteries. Solar photovoltaic technology has application as green agricultural energy source for pumping water street lighting in villages and lighting in rural houses. Since the modern technology, efficiently produces low-cost, high-power photovoltaic cells, this new generation of solar energy can be one of the most affordable and efficient energy sources in the future.



Wind energy – a leading source of renewable energy

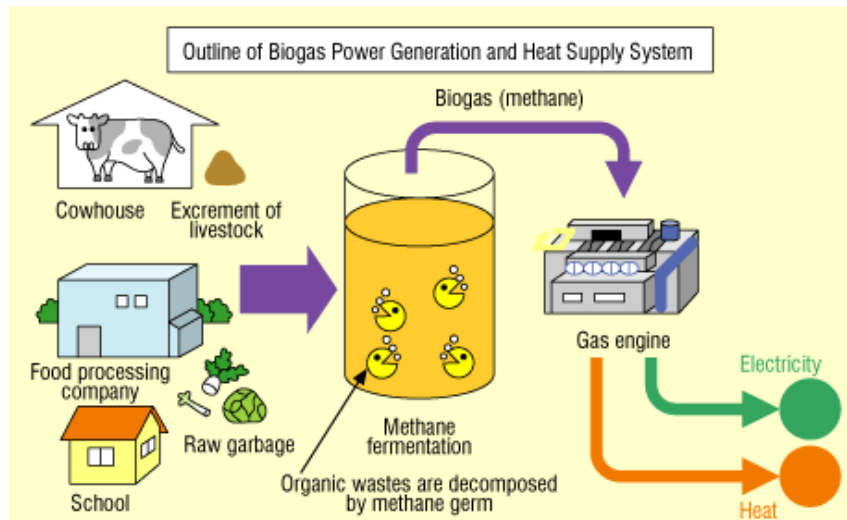
**4.1.2 Wind Energy** – Windmill farms are sprouting up around the world. Australia, Europe and the United States are all investing in wind energy as a leading source of renewable energy. The business of wind energy, not only includes the generation and sale of power, but also the design and construction of wind turbines and parts. Few countries rely on wind energy for more than a tiny fraction of their power generation needs, but many countries are interested in exploring the possibility for generation of wind energy. Overall, wind energy contributes only 1% of the global electricity generation, but some countries and regions are already producing up to 20% of their total requirements. Its importance is increasing in the sense that as compared with other sources; the wind energy produces less air pollutants or greenhouse gases.



Jathropa – the main source of bio-fuel

**4.1.3 Bio-fuel** –Bio-fuel as bio-ethanol and bio diesel have the potential to assume an important portfolio in future energy platter. Certain cautions are mandatory in evaluating bio-fuel as green agricultural technology. Food security concerns and risks to

environment and biodiversity are parameters that necessarily need to be assessed while analyzing sustainability linkage of agriculture and biofuel. Also, conversion of wasteland to farmland with some crop options can be viewed for having more positive impacts.



**4.1.4 Biogas** –Biogas is the product of anaerobic digestion of organic matters by methanogenic bacteria. Biogas qualifies on the merits that this technology utilizes organic agricultural waste and converts it to fuel and fertilizer. Direct impacts of biogas are saving of fuel-wood, utilization of agriculture residue, livestock manure and kerosene savings. Increases in soil fertility and crop production have also been observed. Biogas also solves the problem of indoor air pollution and improves household or community sanitation.

## 4.2 Agriculture/forest related practices and food processing

Following are the some of the selected technologies in the field of agro and forest products





Organic farming is becoming popular world over

**4.2.1 Organic farming** – Organic and biodynamic farming systems have soils of higher biological, physical, and in many cases chemical quality than that of conventional counterparts. When productivity in terms of inputs applied and outputs obtained and social costs of conventional farming are accounted, organic alternatives have been found to be economically competitive. The possible green manufacturing activities relating to organic farming include organic fertilizers, organic pesticides, value added products based on organic farming products and processed honey.



Value added products based on agro and forest produce

**4.2.2 Agro and Forest based value added products** – For sustainable development of agriculture and forest, there could be a number of green technologies which could be employed for value addition to agro and forest produce. These could include timber and bamboo based products, canned fruit and vegetables, range of food products based on



agro and horticulture produce, rosin and turpentine, fuel briquettes, essential oils and fractions, herbal products, nutraceuticals, etc.



**4.2.3 Production of potable water** – One of the most important natural resources we have is water. It is a necessity for our survival. However, there has been a lot of fear that we are running out of clean water sources as the global population continues to grow. To investors this has created a clear opportunity to invest in companies that collect, clean and distribute water.



**4.2.4 Recycling of waste** - Recycling has become a standard commercial practice in recent decades. The stuff that was formerly thrown away and trucked off to the landfill is now turned into useful products. Most people are aware that household products such as paper, metal and glass are reprocessed and reused, but they never stop to consider the business behind these endeavors. Of course, these aren't the only items that are reused; waste oil, vegetable oil, batteries, cell phones, computers and even parts from cars can have a second life. Recycling these items involves a business enterprise humming along

in the background. Some of the possible green technologies include recycling of paper, recycling of waste water, recycling of plastic materials, etc.

**4.2.5 Biodegradable materials** – World over, there have been lot of emphasis on maximizing the production and use of biodegradable materials and thus replace the synthetics and non biodegradable materials. A number of countries and governments have imposed restrictions on the use of plastic bags including in Bhutan and switched over to biodegradable materials like paper, cloth and jute bags. The possible green technologies include production of biodegradable plastics, paper packaging, and cotton and jute materials for packaging.

**4.2.6 Industrial biotechnology** – The use of Bio Transgenic (BT) also referred to as Genetically Modified Organisms (GMO) has been growing in developing countries. Mostly in India and China, farmers have planted *Bacillus Thuringiensis* (Bt) cotton. Recent developments like modified high yield oil seed varieties can trigger rapid spread of transgenic crops. The possible green industries could be tissue culture laboratory, production and processing of GM seeds.

**4.2.7 Pollution free engineering processes** – In a number of manufacturing activities, no solid, liquid or gaseous effluents are discharged during the production process and these products are also safe for environment. Production of parts and components for green technologies projects viz. wind turbines, solar panels, etc is also considered as green industry. Production of cement bricks, tiles, Plaster of Paris blocks and tiles would also qualify to be termed as green industry as there is no adverse impact on environment during the process of manufacture or while using the product.

**4.2.8 Green chemistry** – The green chemistry industry involves the design of chemical products and processes that reduce or eliminate the use of hazardous substances. Many large companies are rushing to develop products that do not contain the chemicals, which consumers fear to be bad for environment. Companies like Clorox have brought out a range of products that will perform the same tasks as the traditional cleaners, but these are based on phyto-chemicals and not the petro-chemicals.

**4.2.9** Extensive research and development work is being carried out world over for developing green technologies and green products. An interesting example is the reported development of manufacture of calcium carbonate cement by a company named Calera in US. The Calera's process essentially mimics marine cement, which is produced by coral when making their shells and reefs, taking the calcium and magnesium from seawater and using it to form carbonates at normal temperatures and pressures. Calera's technology, like that of many green chemistry companies, works more like Jell-O setting. By employing catalyst instead of heat, it reduces the energy cost per ton of cement. And in this process, CO<sub>2</sub> is an input, not an output. So, instead of producing a ton of carbon

dioxide per ton of cement made as is the case with old-school Portland cement, half a ton of carbon dioxide can be sequestered in the production process.

4.2.10 More than 2.3 billion tons of cement produced each year, reversing the carbon-dioxide balance of the world's cement industry would amount to be a solution equivalent to the magnitude of the world's climate change problem. The company has setup its first demonstration site next to Dynegy's Moss Landing power plant in California. However, in the context of present study, the example of green industry relating to cement could be of academic interest only.

## **5. Economic sectors in Bhutan having potential for green industries**

5.1 In the context of present study technologies have been examined with respect to selected sectors of economy of Bhutan. Renewable energy happens to one of the important sectors for adoption of green technologies. However, in case of Bhutan, in view of the immense potential for hydro-electric power generation, the other options of renewable energy resources do not offer much socio-economic advantage. The other key sectors of economy viz. agriculture, horticulture, organic farming, non-wood forest products, education, tourism, construction, etc. need to be examined in details for exploring the possibilities of adoption of green technology and setting up of green industries. Accordingly, in the context of this study, the following sectors which have potential for setting up manufacturing facilities have been reviewed-

- Organic farming – Green Industries based on input requirements or for value addition of agro products.
- Social forestry – Green Industries based on products of social forestry products.
- Non wood forest products
- Medicinal & Aromatic plants
- Recycling of waste paper

## **CHAPTER – 3**

### **SECTORAL REVIEW FOR IDENTIFICATION OF GREEN INDUSTRIES IN BHUTAN**

## **1. Economic sectors reviewed**

1.1 As mentioned earlier in chapter 2, IDRG team has identified five different sectors / areas which have potential for developing green industries. The choice of the five sectors is based on the availability of resources, their current level of utilization and existing economic scenario. In this chapter, it has been endeavored to review these sectors and identify the possible green industries either for supplying the input materials or for value addition to the produce from these sectors. The economic sectors reviewed include the following:

- Organic farming
- Social forestry
- Non wood forest products (NWFP)
- Medicinal & Aromatic plants
- Recycling of waste paper

## **2. Organic farming**

2.1 Organic farming is a production system, which excludes the use of synthetically compounded fertilizers, pesticides and growth regulators. It relies on organic manures produced from farm wastes and other biomass. Organic farming is gaining acceptance throughout the globe as it has potential to provide pragmatic solutions to mitigate the sequel of maladies of conventional modern farming.



**2.2 Organic farming in Bhutan** – Bhutan has a large rural population still practicing traditional farming due to the lack of access to facilities and know-how. Farmers have been producing food crops simply using forest litter and farm yard manure. There is potential to increase productivity of these traditional farming systems by adopting organic farming, which include development of farming systems applicable to the local soil and agro-climatic conditions and local crop species, crop rotation and intercropping, efficient production of vermi-compost and FYM from farm wastes, organic farming plant materials, and pest management with improved farming systems with the use of botanical and other natural formulations. Such practices could change farming from subsistence to sustainable, providing safe and quality nutrition and ensuring food security. Value could be added to surplus production to meet domestic and international market requirements.

2.3 To support the organic farming practices and also to provide them marketing support, a National Organic Program (NOP) has been initiated by the Government of Bhutan. The main problem in marketing of organic produce from Bhutan relates to certification procedures and costs involved therein. It was revealed during discussions with authorities concerned with NOP that only lemongrass oil has organic certification. Other products are intended to be marketed as ‘Bhutan Natural’. A number of organic products are also collected from forest resources. In terms of input required for organic farming as also the value added products based on organically produced agricultural and horticultural produce, the following green industries could be considered.

- Organic fertilizers
- Organic pesticides
- Processed vegetables
- Potato products
- Value added products based on other organic farming produce
- Processed honey

2.4 The discussions with the concerned government authorities and other stakeholders have revealed that due to limited size of operations, the requirement of inputs viz organic fertilizers and plant protection additives are quite small. Most of the requirements are being met by farmers through in-house production of manures and plant extracts.

### **3. Social Forestry**

3.1 The word ‘Social Forestry’ is in use for last few decades essentially meaning that the forests are raised not only to meet the growing demand of the rural poor but also to maintain the ecological balance in the surrounding areas. In India, the social forestry concept has been used both for poverty alleviation as well as for meeting the requirement of industrial raw materials through public-private partnership (PPP) model. A project implemented through joint collaboration of WIMCO, a private safety-match company and a nationalized bank for plantation of soft wood trees required for production of matches is a classical example of PPP model in the field of social forestry in India.



**Social forestry program in Bhutan**

3.2 Social forestry is still relatively new to Bhutan. This gives the Bhutanese a unique opportunity to learn from the successes and difficulties that their neighbors have experienced and to create an approach most appropriate to the local context. As of July 2009, there were 173 community forests covering an area of 21,025 ha and involving approx. 8,650 households.

3.3 The social forestry program in Bhutan presently aims at promoting farmers group at community level providing them training for collection of forest produce, processing the forest produce and also in marketing. Under social forestry program, plantation has also been started in central and southern regions in collaboration with Natural Resource Development Corporation, Bhutan. Presently, most of the activities are related to collection of non-wood forest products from forest and wild growth. The social forestry division has identified a list of 19 different items which would be under main focus for development under social forestry program. The list of these items is given in Annexure IV.

3.4 In view of the ongoing plans for plantation, in future, the social forestry program could generate resources for commercial exploitation. The main raw material resources which could be generated through social forestry program include bamboo, aromatic and medicinal plants, plant stocks for natural dyes, etc. Accordingly, following possibilities exists for promoting green industries based on social forestry program.

- Essential oils and value added products
- Natural dyes
- Bamboo based products

#### **4. Non-Wood Forest Products (NWFP)**

4.1 The term Non-wood Forest Products (NWFPs) encompasses a very wide range of forest products. Examples of NWFPs include fruits, nuts, seeds, oils, spices, resins, gums, and fibers, which can be used as raw or in processed form. Many NWFPs are commercial products. Individual forest products may be processed into one or more marketed products, and traded through a variety of different value chains.





A number of products in Bhutan are based on forest produce

4.2 There is a growing evidence of the potential of NWFPs to achieve large scale impacts in poverty alleviation and sustainable forest management. The value of global NWFP trade has been estimated to be US\$11 billion, and NWFP account for as much as 25% share of the income of close to one billion people. The Bhutanese make considerable use of wood for houses, shingles, tools, fences, and numerous other items, as well as for cooking and heating. But it is the extensive use of non-wood forest products by the Bhutanese that is especially striking.

4.3 The country's forests provide food, fodder, medicine, oils, resins, fibers, dyes, and raw materials for baskets, traditional paper, houses, brooms, mats and numerous other items. Until recently, most non-wood forest products were used locally by the Bhutanese people. Increasingly, however, these products are attracting the interest of outside buyers and consumers in far-away countries. This interest presents both opportunities and risks for Bhutan. Opportunities include cash income for the rural people, revenues for the Government for developing the country, and increased investment in rural infrastructure and processing centers. Risks include potential over-exploitation of natural resources, inequitable distribution of benefits, and shortages of raw materials that might otherwise be used for traditional and local needs. Bhutan's main non-wood forest resources are summarized below:

**4.4 Pine Resin** – Pine resin collection and lemon grass distillation are relatively recently introduced activities in Bhutan. More than 270 tons of resin are collected every year by villagers in the country's eastern districts and sold to a factory. As the work is carried out close to their farms, farmers supplement their incomes by doing such collection when they are free from farm work. These activities pump more than Nu 30 million into the country's rural economy.





Cup & lip method for pine resin collection

4.5 Resins are obtained from mature chir pine (*Pinus rox-burghii*) greater than 40 centimeters in diameter, using the “French cup and lip” method. In Bhutan, tapping of chir pine is primarily carried out by Tashi Resin & Turpentine, a branch undertaking of Tashi Commercial Corporation. The processing plant's production capacity is 300 tons of resin per annum. All products are sold to India.

**4.6 Bamboo** – Bamboo grows naturally because of the country's largely undisturbed forests and the limited agriculture practiced in areas where bamboo proliferates. The Kingdom probably has the greatest variety of bamboo species of all the Himalayan countries, with contributions from Chinese-Japanese origins, and some Southeast Asian and South Indian locations. Bhutan has 15 genera and 31 species of bamboo. Possibly as many as 50 more species exist, but have yet to be identified. Most of the bamboos are of sympodial (clumping or clump forming) type but also includes two genera of monopodial type.



Bhutan has a large number of species of bamboo

4.7 Bamboos are also used in making bridges in the rural areas; farmland fencing materials, fodder for cattle, and young shoots are used as vegetable, which is a delicacy in some areas. While bamboo has a huge potential, the forest reserves appear to be depleting and attention is required to have proper bamboo management guidelines in order to check further degradation of natural bamboo resources. With the demand for wood constantly increasing, the Department of Forestry Services has focused attention on the development of bamboo as an alternative and a 15-hectare bamboo plantation is to be set up in Samtse. The Cane and Bamboo Technology Centre in Guwahati, Assam has been actively

involved in training Bhutanese artisans in cane and bamboo processing, bamboo-based housing, handicraft and furniture making.



Extensive growth of cane in Bhutan

**4.8 Cane** -There are 13 genera of Palmae found in Bhutan. *Calamus acanthospathatus* is a common climber which grows extensively in Bhutan. It yields strong cane and is used as a substitute for the rope and as a cable for suspension bridges. It is also used for wickerwork, baskets and containers. Thicker cane is used for making furniture frames, walking sticks and umbrella handles. The shoots of this plant are edible.



Natural dyes are preferred world over

**4.9 Natural Dyes** – Natural dyes comprise a group of non-wood forest products associated with Bhutanese traditional arts and culture. Cloth weaving is an important

economic activity in the central and eastern Dzongkhags. At one time, the colouring of textiles was entirely done by using natural dyes. Many plants were cultivated for this and some were even exported to Tibet. Commercial viability of production of natural dyes needs to be studied in detail. However, in the context of this study, the limited availability of raw materials resources may be a constraining factor in setting up the commercial manufacturing facility for natural dyes.

In view of the above consideration, the following green industries could be possible based on NWFPs-

- Rosin and turpentine
- Value added products based on rosin
- Bamboo based products
- Natural dyes

## 5. Medicinal & Aromatic plants



Forest in Bhutan – A rich source for medical & aromatic plants

**5.1 Medicinal Plants** – A number of medicinal plant species growing naturally in Bhutan have international market value. Among these are agar wood (*Aquilaria agallocha*), *Rauvolfia serpentina*, tshe (*Ephedra gerardina*), Himalayan yew (*Taxus baccata*), chutsa (*Rheum nobile*), chumtsa (*Rheum accuminita*), kutki/putish-ing (*Picorrhiza kurroa*), pangpoi (*Nardostachys jatamansi*), tsenduk rig (*Aconitum* spp.) and yartsa-gunbu (*Cordyceps sinensis*). All are in high demand for pharmaceuticals. If present trends of ad hoc harvesting/collection continue, the scope for economical harvesting of all medicinal plants from the wild, on a sustainable basis, appear extremely limited. The only option remaining is to introduce large-scale cultivation through artificial propagation. Natural resources are presently being depleted in the natural forests due to non-scientific collection of the various species on an ad hoc basis. New settlements and the expansion of land under cultivation also threaten the survival of natural forests. Unless artificial propagation is adopted, it is only a matter of time before some of these plants become extinct.

**5.2 Aromatic Plants / Essential Oils** – Essential oils, also known, as 'volatile oils' are odoriferous substances widely distributed throughout the plant kingdom. Because of the odor and high volatility, essential oils have a variety of uses, in soaps and cosmetics, pharmaceuticals, confectionery, aerated water, scented tobacco and incense, among others.



Lemon Grass

**5.2.1 Lemon grass** - Lemongrass is found over the large areas in Mongar, Lhuentse, Trashigang Districts. It is common in chir pine forests, especially on sandy or gravelly, sloping areas. The farmers on a contractual basis mainly produce the lemon grass oil in the eastern part of the country with the technical support from governmental agencies. Lemon grass oil is mainly exported to India and Europe. It has been able to capture niche markets in Europe where it is used as a fragrance by the perfumery and cosmetic industry. Lemon grass distillation employs some 400 families in the eastern Dzongkhags. To these families, this activity has become even more important than farming.

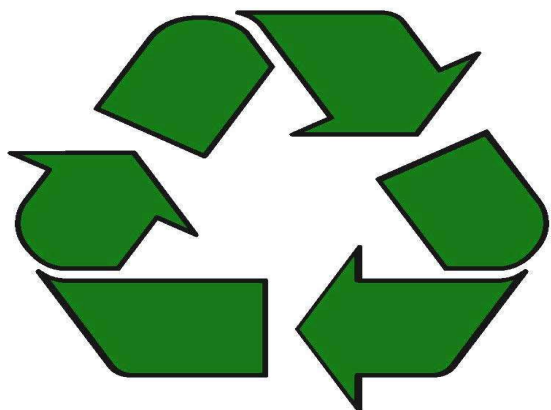
**5.2.2** Besides lemon grass oil the following essential Oils have scope for commercial production in Bhutan.

- Palma-Rosa Oil –
- Winter Green Oil
- Agar-Wood Oil
- Pine-needle Oil
- Cedar wood Oil
- Champ Oil
- Calamus Oil (calamus perfume)



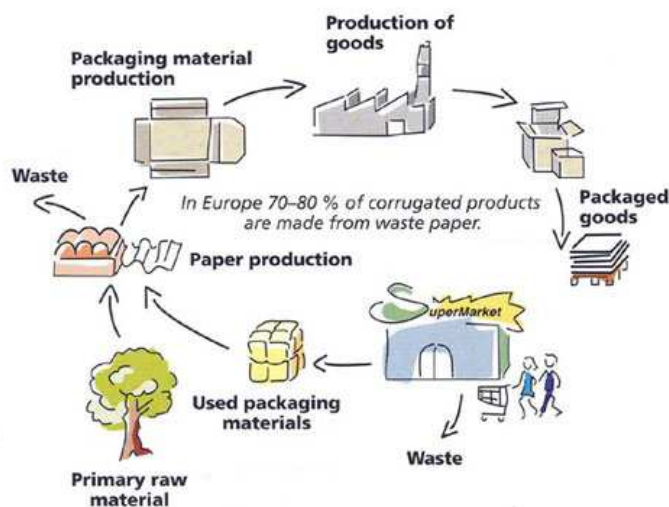
- Ginger Oil and Oleoresins
- Keora Oil

## **6. Recycling of waste paper**



6.1 Paper recycling is the process of recovering waste paper and remaking it into new paper products. There are three categories of paper that can be used as feed stocks for making recycled paper: mill broke pre-consumer waste, and post-consumer waste. Mill broke is paper trimmings and other paper scrap from the manufacture of paper, and is recycled internally in a paper mill. Pre-consumer waste is material which left the paper mill, but which has been discarded before it was ready for consumer use viz. during paper conversion process. Post-consumer waste is material discarded after consumer use, such as old magazines, old newspapers, office waste, old telephone directories, and residential mixed paper waste. Paper suitable for recycling is called "scrap paper". The industrial process of removing printing ink from fibers of recycled paper to make deinked pulp is called deinking.

### **6.1.1 Rationale for recycling**



6.2 The atmosphere, environment and planet depend on resources such as trees to survive. Paper remains a product used by many, even in this technological age. Newspapers use a type of paper called newsprint. Wood pulp, used in the production of paper, comes from trees. 90% of paper pulp is made of wood. Paper production accounts for about 35% of felled trees, and represents 1.2% of the world's total economic output. Recycling one ton of newsprint saves about 1 ton of wood while recycling 1 ton of printing or copier paper saves slightly more than 2 tons of wood. This is because Kraft pulping requires twice as much wood since it removes lignin to produce higher quality fibers than mechanical pulping processes. Recycling newspapers cuts down on the amount of wood pulp needed to make newsprint. Additionally, it takes 23% less energy to recycle newspapers into newsprint than it does to create new paper.

6.3 In 1989, the newspaper recycling rate was 35 percent. Today, over 73 percent of all old newspapers in the United States are recovered and recycled. The average amount of recycled fiber content in newsprint used by U.S. newspapers has increased from 10 percent in 1989 to more than 30 percent today. 73% of today's newspapers are placed into recycling bins in US and 30% of that goes to making newsprint. This paper can be made primarily from recycled newspapers to greatly reduce the environmental impact of its production

6.4 The process for recycling newspapers takes the newspapers full circle from the newspaper production building and right back to it as newsprint ready to be printed again. Newspapers collected in recycling bins first arrive at a processor who sorts them to remove any unsuitable inserts. After shredding, the paper is mixed with water to create a pulp. After the pulp softens, screens and cleaners remove ink and contaminants such as glue. Hydrogen peroxide added to the pulp whitens it after which rollers flatten it and squeeze out excess water. Then the dried, cut and baled paper is sent to the newspaper production buildings to be printed as fresh newspapers. Newspaper contains enough fiber to recycle 4 to 7 times before the fibers break down. One ton of recycled paper creates 700,000 fresh newsprint pages or 150 copies of the Sunday paper. Because many people

have turned to online newspaper reading, newspaper consumption has dropped. For this reason, newspaper-recycling efforts may have reached their upper limits in the developed World; however, there is tremendous scope for recycling in developing economies.

6.5 Not only have old newspapers been used to produce recycled newsprint, newspapers are recycled into other products such as cereal boxes, egg cartons, pencil barrels, grocery bags, tissue paper, cellulose insulation materials, and many more diverse products. The manufacturing of these products can be more economical and environmentally safe than shipping old newspapers out-of-state to distant mills for recycling into new newsprint.

**6.6 Recycling of paper – Potential in Bhutan** – In Bhutan has a remarkable increase in print media, expanding from one newspaper to six in the span of a few years only. The print media uses quality paper much better than the standard newsprint. Besides, a lot of paper waste is generated from paper bags, books, exercise books and other paper stationery items. The use of plastic bags has been prohibited in Bhutan leading to extensive use of paper bags which would further increase the availability of waste paper. Based on the latest available trade statistics, the current level of import of newsprint and various other types of paper in Bhutan is around 5000 metric tons per annum. With the restriction on use of polythene bags leading to use of paper bags, this quantity of import is likely to further expand. The fast pace of urbanization will further boost the requirement of all types of paper leading to emergence of still high quantum of paper waste. It has been observed that there exists a system for collection of paper waste, majority of which is transported and sold in adjoining Indian market for further processing.

6.7 In view of the above, it is all the more desirable that a systematic recycling of newspaper need to be considered. The experience world over demonstrates that a systematic recycling of paper creates job opportunities, reduces the load on the landfill, increases material efficiency and reduces the dependency on imports, this would ensure a better flow of revenues inside Bhutan and serve as a catalyst for economic growth based on available resources. Prof. Gunter Pauli in their report has also suggested for setting up the facilities in Bhutan for recycling of newsprint on above said considerations.

6.8 The production and recycling of paper leaves short fibers behind which do not have the necessary characteristics for paper. However, these short cellulose fibers could be reconditioned as insulation material. Further, gypsum mineral is indigenously available in Bhutan. Gypsum board and gypsum panels based on gypsum mineral would be the useful construction material for the construction industry in Bhutan. These boards could be reinforced with waste cellulose fibers for imparting them insulation property. Keeping in view, the boom in construction industry in Bhutan, the production of gypsum board / gypsum panel would be a economically viable project. There is no pollution angle in the production of gypsum board / gypsum panel and these being recyclable are known as green materials of construction. Based on the above considerations, the following green industries could be considered.

- Recycling of waste paper for manufacture of pulp molded package for poultry / horticultural / handicraft products
- Gypsum board / gypsum panels
- Recycling of paper for manufacture of packaging paper
- Corrugated paper and duplex board cartons



**CHAPTER - 4**

**SELECTION OF GREEN INDUSTRY PROJECT**

## **1. Potential green industry projects – Issues and approach**

1.1 Production of value added products based on agro and horticultural produce are considered as green industries. At the same time, such industries ensure a better price to farmers and growers for their produce and thus help in sustainable development. However, in the context of this study, the following points need to be kept in view while considering the prospects of setting up such industries in Bhutan.

- There are already two units for fruit and vegetable processing in Bhutan
- With the increase in urbanization, consumption of fresh vegetable and fruits is growing at a fast pace
- Not much surplus production is available for industrial exploitation

1.2 Similarly, the quantum of consumption of farm inputs viz. organic fertilizers and organic pesticides is also quite low. Most of the requirements of organic fertilizers are being met through FYM. As such the commercial production of these products also does not appear to be economically viable. The forest based products viz. rosin and turpentine is also not considered economically viable due to limited availability and problems in collection of resin from chirpine tree forest. Moreover, there is already one unit in Bhutan for the production of rosin and turpentine. Products based on medicinal and aromatic plants could be ideally suited for Bhutan. However, due to declining trend in the availability of aromatic plants from forest resources (lemongrass) and there being no possibilities for cultivation of such plants in near future, setting up of such production facilities does not appear to be feasible.

1.3 Recycling of paper has a strong positive impact on environment. Recycling of paper is popular world over as it helps in paper waste management by reprocessing the waste paper and cut down the cost in production of paper. It also helps in saving the forest resources. The consumption of paper is growing at a fast pace in Bhutan and recycling would help in waste disposal as well as production of paper products without any adverse impact on forest resources. Presently, the waste paper newsprint, packaging and others are being collected and transported to border area markets in India. Setting up of paper recycling facility would enable the production of pulp molded package / packaging paper for various applications. Recycling of paper especially for pulp molded package involves the use of clean technology and there are no harmful effluents. Recycling of paper would therefore protect, promote and sustain the environment. This would also help in resource conservation and saving in transport costs. This would also help in meeting the requirement of packaging material for poultry, horticulture and handicrafts products. The size of the recycling plant and the product mix would depend upon the quantum and type of paper waste presently available and the future projections.

1.4 Natural fiber reinforced gypsum board / gypsum panels could be used for insulation in buildings in Bhutan and these could be exported also. The starting material for Gypsum board / gypsum panels is Gypsum mineral / hemi-hydrate gypsum which is being produced in Bhutan. Production of hemi-hydrate gypsum has environmental impact but in production of Gypsum board / gypsum panels, there are no environmental concerns. The process is based on making slurry of hemi-hydrate gypsum and fibers followed by casting and it would be a green technology. Short fibers from paper recycling and other natural fibers could be used for reinforcement. Presently, substantial quantity of wood is being used in buildings in Bhutan including for insulation. Gypsum board / gypsum panels would be a part replacement to wood which is going to become scarce and costly in future. Accordingly, production of Gypsum board / gypsum panels would help in resource (wood) conservation and shall have no adverse impact on environment. As the starting material for the product is hemi-hydrate Gypsum, the production process and the product could be totally environment friendly and shall help in resource conservation.

## **2. Potential green industry projects – Techno-Economic viability Analysis**

2.1 As mentioned in previous chapter, the potential green industry projects in various sectors of economy have been identified. With a view to assess the viability of these identified green industry projects, various issues related to techno-economic viability were considered for these projects in each sector. These issues included availability of raw material resources and their present utilization pattern, market scenario in Bhutan and in adjoining areas, investment considerations, environmental issues, etc. The issues examined in each sector to assess the techno-economic viability of the identified projects are summarized as under:

### **2.2 Green Industries based on Agro and Horticulture produce**

- Two major units for fruit and vegetable processing in Bhutan
- With increase in urbanization, consumption of fresh vegetable and fruits growing at a fast pace
- Not much surplus production available for industrial exploitation
- Limited demand of inputs viz. organic fertilizers and organic pesticides

### **2.3 Green Industries based on forest produce**

- Limited availability of NWFP
- Problem of accessibility and availability of labour for collection
- Not much surplus for commercial exploitation
- Already one unit for rosin and turpentine
- No cultivation of aromatic plants

### **2.4 Green Industries based on Agro and Horticulture produce**

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#### 2.5 Green Industries based on forest produce

- Limited availability of NWFP
- Problem of accessibility and availability of labor for collection
- Not much surplus for commercial exploitation
- Already one unit for rosin and turpentine
- No cultivation of aromatic plants

#### 2.6 Recycling of waste paper

- Substantial quantity of waste paper available
- Presently being sold in adjoining markets of India
- Identified packaging needs of horticulture, agriculture, handicrafts & poultry products

#### 2.7 Gypsum board / gypsum panels

- Fast pace of development in construction industry
- Insulation boards and panels needed for building construction
- Wood to become scarce and costly
- Fiber reinforced gypsum boards / gypsum panels can partly replace wood.
- Gypsum being indigenously produced in Bhutan
- Clean technology for production of gypsum boards / gypsum panels

### **3. List of viable green industry projects**

3.1 Based on the above considerations, review of available literature, documents and recommendations made in the various reports, discussions with various concerned authorities and other stakeholders and also keeping in view, the parameters and criterion prerequisite for techno-economic viability of green industries, IDRG team identified the following items / product groups which are considered viable for Bhutan.

- Recycling of paper
- Gypsum board / gypsum panel
- Essential oils and value added products
- Processed vegetables
- Potato products
- Rosin and turpentine & rosin modified products
- Organic fertilizers
- Organic pesticides

#### **4. Selection of green industry**

4.1 In order to select the most suitable green industry for Bhutan in the context of the present study, the following parameters need to be considered-

- Protection of Environment
- Promotion of Environment
- Environmentally sustainable
- Based on renewable resources
- Use of renewable and clean power
- Use of clean technology
- Savings in transport costs
- Resource conservation and sustainability

#### **5. Matrix Model for prioritizing the green industries**

5.1 Based on the above stated list of identified green industries and the critical parameters which need to be considered for selecting the most viable green industry, the following matrix model has been attempted to prioritize the green industries in order of preference.

**Matrix Model for prioritizing the green industries in order of preference:**

S. No	Name of the Green Industry	Protection of environment	Promotion of environment	Environmentally sustainable	Based on renewable sources	Use of renewable and clean power	Use of clean technology	Savings in transport costs	Resource conservation and sustainability	Total (out of 80)
1	Recycling of Paper	10	10	9	10	8	8	9	9	73
2	Gypsum board / gypsum panels	8	8	9	8	7	7	9	8	64
3	Essential oils and value added products	7	9	7	8	4	7	5	5	52
4	Processed vegetables	8	8	6	6	5	4	7	5	49
5	Potato products	8	8	6	6	5	4	7	5	49
6	Rosin and turpentine & rosin modified products	6	6	7	8	4	5	6	5	47
7	Organic fertilizers	9	8	4	3	3	4	4	4	39
8	Organic pesticides	7	6	4	3	3	4	4	3	34

5.2 The table above shows the ranking of various projects Based on above matrix model, **recycling of paper** appears to be the most suitable green industry for Bhutan followed by **gypsum board / gypsum panel** based on gypsum mineral / hemi-hydrate gypsum. The final selection of the Green Industry Project shall be made in consultation with Department of Industry, Ministry of Economic Affairs.

5.3 Based on the study of various economic sectors and findings of the study, IDRG team submitted an inception report on green industry projects in Bhutan. A presentation was made on the findings of the inception report in a meeting held on 24<sup>th</sup> March 2011 in the Ministry of Economic Affairs where all stakeholders were present. During the presentation, IDRG team presented two green industry projects viz. **Recycling of Waste Paper for the production of Pulp Molded Products and gypsum board / gypsum panels based on gypsum mineral resources in Bhutan** to be considered for detailed feasibility analysis.

5.4 Detailed discussions were held during presentation mainly regarding the project for recycling of paper. Subsequently, Department of Industry, MOEA sorts certain additional information and clarifications about the viability aspect of these two identified green industry projects. These details were submitted to Department of Industry, MOEA. Finally, it was decided that IDRG shall carry out detailed feasibility studies for the following two green industry projects.

- **Recycling of Paper Waste – Pulp Molded Products**
- **Gypsum board / gypsum panels – ceiling and insulation**

# **ANNEXURES**



## **Annexure I**

### **Terms of Reference - SCOPE OF SERVICES OF THE CONSULTING FIRM**

- 1.1 The Consulting firm will carry out an intensive investigation in close consultation with the Ministry of Economic Affairs, and other relevant organization, and;
- 1.2 Study and identify suitable projects
- 1.3 Identify most suitable location(s) for the plant, giving due consideration to its distance from the raw materials sources and the availability of infrastructure
- 1.4 Review in detail the existing reports on related resources/plants.
- 1.5 Determine the most economic and environment friendly technology
- 1.6 Shall look into the following marketing aspects of the product:
  - Study of existing related plants and industries - names and addresses of plants in the region and target market. Details of their performance.
  - Study of end users - analysis of market for the products / services and assessment of consumers in the target market, annual past demand and future demand projections.
  - Present Demand - Supply situation of the product/services in the target market as well as the projections for demand supply for next ten years.
  - Study in depth the existing marketing programmes and strategies in the target market area (if relevant).
  - Study in detail method of packaging and mode of transportation adopted.
- 1.7 Based on above, the consultant shall determine market segmentation for the product, product mix, appropriate capacity and appropriate technology and equipment.
- 1.8 Shall recommend sources of plant, equipment and technology including design engineering aspects, fabrication facilities, requirement of laboratory equipment, etc.
- 1.9 Shall recommend suitable marketing strategy including market promotion and distribution network to penetrate existing markets as well strategies to develop the market.
- 1.10 Shall recommend suitable mode of transportation of inputs and the outputs.
- 1.11 Prepare a thorough economic and financial analysis of all aspects of the project including social cost benefit analysis and inter-industry linkages.
- 1.12 Prepare process flow chart and other layout drawings as necessary.
- 1.13 Prepare a feasible implementation schedule.

- 1.14 Prepare in detail capital cash requirements, cost of production, cash flow chart for 10 years, proforma profit and loss statement for 10 years; calculate break-even points, internal rate of return, financial rate of return and payback period; conduct sensitivity analysis on these financial indicators.
- 1.15 Review likely environmental impact and recommend suitable measures to reduce/control adverse effects.  
Prepare a detailed feasibility report for green industries in Bhutan.
- 1.16 Recommend the possibility of establishing other down the line industries for manufacture of value added products/services.

## **Annexure II**

### **ACKNOWLEDGEMENT**

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- I. Mr. Loknath Chapagai, Department of Industries, MOEA
- II. Mr. Sangay Wangdi, MD, M/s Bhutan Board Ltd.
- III. Chief Industrial Officer, Enterprise Development Division, MOEA
- IV. Coordinator, NOP, Ministry of Agriculture & Forests
- V. Program Director, NSSC, Ministry of Agriculture & Forests
- VI. Mr. Chhine Tshering, Department of Agriculture, Marketing and Cooperatives
- VII. Senior Forest Ranger, Social Forestry, Ministry of Agriculture & Forests
- VIII. Chief Research Officer, BCCI
- IX. Marketing Manager, M/s Bhutan Agro Industries Ltd.
- X. President, Bhutan Exporters Association

All concerned officers of Department of Industries, MOEA and other stakeholders who provided necessary guidance and support.

### **Annexure III**

#### **List of references**

1. Tenth Five Year Plan document 2008-2013
2. Market-based Certification and Management of Non-Timber Forest Products in Bhutan: Organic lemongrass Oil, Poverty Reduction, and Environmental Sustainability (ADB report)
3. Recycling of Paper – [www.environmentgreen.com](http://www.environmentgreen.com)
4. Evolution of Green Business
5. Calera's Green Cement
6. Green Technologies – Earth Friendly Innovations
7. Feasibility study on the Application of Green Technologies for Sustainable Agriculture Development (APCAEM report)
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10. List of Eco Friendly Business
11. New Green Industries
12. Paper Recycling (Wikipedia.com)
13. Innovative Approach with Non-timber forest products
14. A Guide to Organic Agriculture in Bhutan
15. National Framework for Organic Farming in Bhutan
16. Trade Statistics – Bhutan
17. Investment Opportunity Study – 2006
18. Environmental Assessment Act
19. Reference Manual for Environmental Impact Assessment Training in Bhutan
20. National Environment Protection Act 2007
21. Opportunities for Bhutan by Prof. Gunter Pauli
22. Regulations for the Environmental Clearance of projects
23. Policy Document “Vision 2020”

## Annexure IV

### List of selected Non-wood Forest Products in Bhutan

SN	Scientific Name	Vernacular Name	Parts used and form
1	<i>Aconitum ochrochryseum</i>	Bikhma, Shodu	Dried roots
2	<i>Acorus calamus</i>	Bojho	Dried root
3	<i>Amomum subulatum</i>	Alaichi	Dried fruit
4	<i>Illicium griffithii</i>	Doomleeshing	Seed pods
5	<i>Nardostachys grandiflora</i>	Jatamanshi, Pang-poe	Rhizome dried
6	<i>Neopicrorhiza scrophulariiflora</i>	Kutki	Dried root
7	<i>Paris polyphylla*</i>	Satuwa	Root
8	<i>Phyllanthus emblica</i>	Amla, Chooru	Dry fruit (WOS)
9	<i>Piper longum</i>	Long Pipla, Pipling	Dried fruit
10	<i>Piper spp.</i>	Round Pipla	Dried fruit
11	<i>Rubia cordifolia</i>	Majitho, Tsoy	Dried twigs
12	<i>Sapindus mukorossi</i>	Soap-nut	Whole Fruit
13	<i>Shilajit</i>	Shilajit, Dragzhuen	Raw
			Pre-processed
14	<i>Swertia chirayita</i>	Chirayita, Latiz	Entire plant
15	<i>Terminalia bellerica</i>	Barro, Baru	Fruit (WOS)
16	<i>Terminalia chebula</i>	Harro, Aru	Fruit (WOS)
17	<i>Thysanolaena latifolia</i>	Broom grass	Inflorescence
18	<i>Zanthoxylum armatum</i>	Timur, Thingey	Dried fruit (WS)
19	<i>Zingiber officinale</i>	Ginger, Aduwa	Fresh
			Dried

Source: Social Forestry Division, Ministry of Agriculture and Forests

## **Annexure V**

### **ABBREVIATIONS USED IN THE REPORT**

MOEA – Ministry of Economic Affairs  
IDRG – International Development Resource Group Consultancy Services  
GNH – Gross National Happiness  
GDP – Gross Domestic Product  
GT – Green Technology  
GI – Green Industry  
GHG – Green House Gases  
IEA – International Energy Agency  
BT – Bio Transgenics  
BT – Bacillus Thuringiensis  
GMO – Genetically Modified Organisms  
GM – Genetically Modified  
NOP – National Organic Program  
NSSC – National Soil Service Centre  
PPP – Public Private Partnership  
NRDC – National Resource Development Corporation  
NWFP – Non-wood Forest Products  
FYM – Farm Yard Manure  
Ha – Hectares  
BCCI – Bhutan Chamber of Commerce and Industry