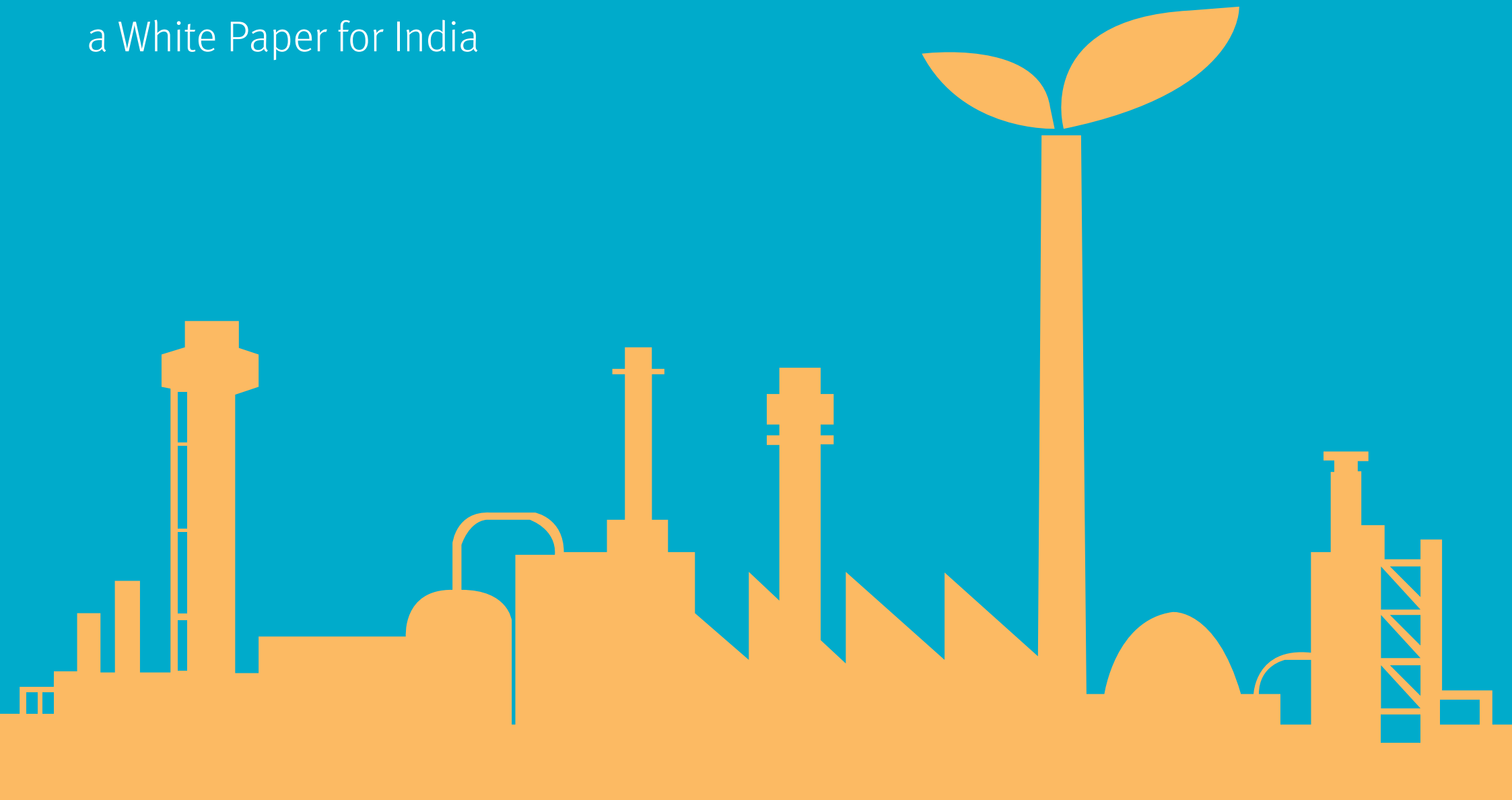
Planning & Design Guidelines for

GREEN INDUSTRIAL PARKS

a White Paper for India



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FOREWORD

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FOREWORD

DEUTSCHE GESELLSCHAFT FÜR INTERNATIONALE ZUSAMMENARBEIT (GIZ)

The Government of India has announced a National Manufacturing Policy (Nov 2011) with the objective of enhancing the share of manufacturing in GDP to 25% within a decade and creating 100 million jobs. The policy supports clean/green/energy efficient and environment-friendly technologies, and resource efficient measures. The policy promotes integrated industrial townships, known as the National Investment and Manufacturing Zones (NIMZs) with at least 5,000 Ha area, and calls for preparation of environment friendly Development Plans. Major environmental aspects are required to be taken care of in the NIMZ in the beginning itself by having proper zoning during Master Planning.

Preparation of environment-friendly Development Plans or Site Master Plans for the manufacturing zones or the industrial parks requires integration of clean/green/energy efficient and environment-friendly technologies. This requires further clarification on what are these clean/green/energy efficient and environment-friendly technologies and what are the guidelines and standards that are to be considered while preparing the Development Plans or Site Master Plans. The Policy itself has no clarifications on this aspect. It has broadly said that water conservation measures a must, viz. water audits, waste water treatment, rainwater harvesting, and renewable energy usage and green buildings are a must. Also, it says that Inter ministerial “Green Manufacturing Committee” will be formed which will fix criteria for “Clean and Green Technologies”.

The draft National Water Policy (2012), brought out by the Ministry of Water Resources of the Government of India, talks of industries having obligation to recycle/ reuse water in all water-short-regions and that the industries will be allowed to withdraw only the make up water. Also, the sources of water and water bodies will not be allowed to get polluted. Also, the ground waters will have to be protected.

The National Action Plan on Climate Change has the following relevant missions for planning of new industrial parks or manufacturing zones: National Solar Mission, National Mission for Enhanced Energy Efficiency and National Water Mission. The national minimal environmental standards for industry sectors and the ambient air/water/noise standards as set under the Environment (Protection) Act, 1986 are to be complied with.

The Green SEZ Rating System for Industrial Estates brought out by the Indian Green Building Council (IGBC) has considered a few of the

criteria, viz. site preservation and restoration, reduced use of fossil fuels, energy efficiency, water efficiency, handling of solid waste, materials & resources and innovation & design process. The Indian Green Building Council (IGBC) has also rating for "Green Factory Buildings" and "Green Buildings".

The "Comprehensive Environmental Pollution Indexing" (CEPI) for Industrial Estates brought out by the Central Pollution Control Board was used to identify critically polluted industrial estates based on "pollutants" (Toxins. Probable carcinogens, known carcinogens), "pathway" (ambient pollutant concentration – critical, high, moderate, low) and "receptor" (number of people effected, level of exposure, additional risks due to ecologically/socially sensitive area).

The ASEM Programme of GIZ (formerly GTZ) has made several pilot attempts for planning and developing eco-industrial parks in India (ref. publication on "Pathway to Eco Industrial Development in India", GIZ, Oct 2012). The document has references to concepts and cases on site suitability assessment, environmental impact assessment, Site Master Planning, transformation of existing industrial parks, waste management, common effluent treatment plants, disaster risk management, climate change mitigation & adaptation etc.

A well planned and designed Industrial Park is expected to result in:

- A Site Master Plan that integrates sustainability aspects (e.g., social, economic and environmental considerations).
- Innovative and viable technical solutions in areas of waste water, storm water, wastes, ecological landscapes, energy efficiency/renewable energy, green buildings etc. for upcoming industrial parks.
- Address issues of environment protection (e.g., decreased emissions, wastewater and waste; reduction of potential negative environmental impacts), climate change (adaptation & mitigation), resource efficiency (e.g., reduced usage of natural resources, viz. water, materials, energy), and renewable energy & energy efficiency.
- Integrate cost effective common infrastructure and services in the Industrial Park, including the special requirements of different groups, such as gender, differently-abled, etc.
- Use management structures for collective resource and service management within the industrial park.

A research and pilot work on preparing environment-friendly Development Plans or Site

Master Plans for upcoming industrial parks to showcase integration of clean/green/energy efficient and environment-friendly technologies at the planning stage itself is a much needed effort. A team of national and international experts with several years of standing experience in applied research and collaboration services were brought together for this task, in areas of wastewater treatment, green buildings, building materials, renewable energy systems, efficient rain water harvesting, landscaping/ afforestation and waste management.

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INTRODUCTION

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INTRODUCTION

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Overview

Government of India's National Manufacturing Policy envisions increasing the manufacturing sector's contribution to GDP by 25% by the year 2022. In the last decade, an increase in industrial infrastructure investments and planning initiatives such as the Delhi Mumbai Industrial Corridor (DMIC) project that envisages creating opportunities for new industrial clusters spread across 2,700 km. On the one hand, this presents a unique opportunity for creating innovative models for industrial development generating jobs and strengthening the manufacturing sector; while on the other hand, if not planned properly and conceived with integration of contemporary sustainability-driven planning principles, this could lead to products that continue using out-dated approaches and yielding results that might not be necessarily aligned with integrated and balanced systems-driven planning processes. For example, there are several instances throughout the world and in India where local governments - in the absence of any structured site suitability analysis methodologies - continue to locate industrial uses on productive agricultural lands thereby creating an imbalance in the socio-economic-environmental equation. Often achieving sustainability as an end goal in designing new industrial parks is applied in an ad hoc and superficial manner resulting in a disconnect between the ecology and the resulting human interventions in terms of new development.

In the context of developing environmentally and socially responsible sustainable industrial development models, especially in India, the thrust to-date has been on competitiveness as opposed to collaboration and synergetic development models aimed at maximizing resources and efficiency optimization. Several state-led industrial parks constructed in the past two decades are merely a scaling-up of individual industrial units and do not tap into the full-potential of alternative concepts of sustainable industrial development such as industrial ecology and eco-industrial development.

Integrated systems-based management oriented planning models are still in nascent stages of development in the country. Guide-

lines for Sustainable Industrial Development in the Indian context such as the IGBC Factory Building Rating criteria focus specifically on the built environment and do not merge the various activities of a typical industrial set-up such as materials sourcing, production processes, management, and its relationship to the larger region. Eco-industrial Development is one such model that attempts to balance the physical aspects of industrial development with the economic viability, social justice, and ecological restoration goals forcing a multi-disciplinary approach.

In the Indian context, recent initiatives by the Government of India in promoting large-scale economic clusters such as Special Investment Zones/Regions, National Manufacturing and Investment Zones (NMIZ), and Petroleum Chemicals and Petrochemical Investment Zones (PCPIR), in addition to the SEZs and the more traditional industrial estates and industrial parks, warrant formulating a customized definition of "sustainable industrial development" that is specific to the Indian social, economic and cultural attributes. The goal of these initiatives needs to be first to initiate a vision that is larger than just economic development and processes that are greater than merely creating "green" industrial buildings.
In this respect, the concept of Eco-industrial Development in India needs to be re-defined beyond the scale of an industrial park or an industrial unit, and is more of a comprehensive model integrating social, economic and ecological aspects at various stages of planning. The challenges faced by agencies in promoting Eco-industrial Parks (EIPs) in general and more specifically in India are daunting considering the complexities involved with lack of policy support at different levels of the government and lack of enforcement related to industrial processes.

Furthermore, the premise of EIPs is the reliance on cyclical industrial processes and by-product exchanges, which is currently not being undertaken at any scale in the Indian context. It is taking into consideration these challenges that this paper intentionally focuses on master planning of Green Industrial Parks and not Eco-industrial Parks; however, where appropriate principles of EIPs are integrated into the discussion especially as it relates to the planning and design processes.

This paper presents a preliminary master planning approach to develop new industrial parks based on a literature review and examination of case studies in India. It is envisioned that this preliminary analyses could pave the way forward for further research in developing an integrated planning systems template for future industrial parks.

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PLANNING NEW INDUSTRIAL PARKS AS GREEN INDUSTRIAL PARKS

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PLANNING NEW INDUSTRIAL PARKS AS GREEN INDUSTRIAL PARKS

AUROSERVICE

Definitions

An industrial park is defined as “a large tract of land, sub-divided and developed for the use of several firms simultaneously, distinguished by its shareable infrastructure and close proximity of firms” . A similar definition by the Government of India’s Industrial Park Scheme 2008 states that: “‘Industrial Park’ has been defined to mean a project in which plots of developed space or built up space or a combination, with common facilities and quality infrastructure is developed and made available to the units for the purposes of industrial activities or commercial activities in accordance with the scheme.” While these definitions provide the fundamental idea of industrial parks, more concepts related to encourage interactions between the activities are constantly evolving.

Internationally, new concepts such as Industrial Ecology, Industrial Symbiosis, Eco Industrial Parks, and Green Industries have emerged as alternative models for sustainable industrial development. In India, most of these concepts are still in its infancy with some successful examples in different industry sectors and a recent push in examining the applicability of Green Industrial Parks (GIPs).

The concept of Industrial Ecology draws its impetus from natural ecosystems, which principally function, on the notion of symbiosis, interdependence, sustenance and safeguarding the natural dynamics of the bioregion. In this concept the processes and proceedings of the industrial agglomeration within an estate aim at closing material and energy loops, in an attempt to diminish the environmental footprint.

An alternate definition presented in the Journal of Industrial Ecology states that “Industrial ecology is ecological in that it (1) places human activity -- industry in the very broadest sense -- in the larger context of the biophysical

environment from which we obtain resources and into which we place our wastes, and (2) looks to the natural world for models of highly efficient use of resources, energy and by-products."

From this fundamental concept, there are several definitions of Eco Industrial Parks that have evolved over the last two decades globally. In 1994, Research Triangle Institute and Indigo Development International provided the basis for defining the term, Eco Industrial Parks as "developments that are more than:

- A single by-product exchange pattern or network of exchanges;
- A recycling business cluster (resource recovery, recycling companies, etc.);
- A collection of environmental technology companies;
- A collection of companies making 'green' products;
- An industrial park designed around a single theme;
- A park with environmentally friendly infrastructure or construction;
- A mixed use development (industrial, commercial and residential)."

In 1995, Coˆte´ and Hall proposed a definition for Eco Industrial Parks : "An Eco Industrial Park is an industrial system which conserves natural and economic resources; reduces production, material, energy, insurance and treatments costs and liabilities; improves operating efficiency, quality, worker health and public image; and provides opportunities for income generation from use and sale of wasted materials."

"Lowe and Warren indicate that an Eco Industrial Park may include many of these features but the essential feature is the interactions among businesses and between the businesses and the natural environment."

A summarized definition for EIPs based on some of the key concepts discussed above could be re-stated as: "an industrial park in which businesses cooperate with each other and with the local community in an attempt to reduce waste and pollution, efficiently share resources (such as information, materials, water, energy, infrastructure, and natural resources), and help achieve sustainable development, with the intention of increasing economic gains and improving environmental quality. An EIP may also be planned, designed, and built in such a way that it makes it easier for businesses to cooperate, and that results in a more financially sound, environmentally friendly project for the developer. The ultimate goal is to ensure that the combined environ-

mental, economic and social benefits of such projects is balanced with a systemic approach from the conception of the project."

Benefits of Green Industrial Developments

As mentioned earlier, GID concepts are crucial in creating an enabling environment that fosters a holistic, integrated and resilient approach towards promoting new industrial parks that are able to reap benefits from co-location of resources and facilities while at the same time bringing positive change in the larger region where the development model will be implemented. The following are some of the key benefits offered by EIDs that are pivotal in creating successful models of sustainable integrated industrial parks.

Economic

- Decrease in production costs through increased materials and resource exchanges
- Common shared facilities resulting in lower operation and maintenance costs in the long-term
- Networking and cross-training to improve performance
- Diverse Revenue generating opportunities for park management
- Reduced cost from environmental legislation
- Reduced costs from transportation

Social

- Local Economic Development: Job-creation, skills development and infrastructure upgrades
- Improved quality of life for employees and residents by better integration into the host community
- Local entrepreneurship and Women empowerment opportunities
- Increased cooperation and participation

Environmental

- Cleaner, climate-friendly industrial production processes
- Minimized environmental impacts such as reduced pollution levels, waste management, context-sensitive designs
- Sustainable building design and construction practices
- Maximize energy efficiency
- Contribute to climate change mitigation measures by improving micro-climate and curbing GHG emissions

Challenges for Green Industrial Parks (GIPs)

Similar to any new concept being integrated into established systems, new industrial parks face a myriad of complexities that warrant integration of multiple design, management, and decision-making realms. Ultimately, the success of GIPs in developing countries such as

India will depend on the ability to first identify the challenges and eliminate the roadblocks that may need policy changes at the national/ state level or changes to established building regulations at the local level.

The following lists typical challenges in India related to integrating principles of ecological industrial development.

Regulatory related

- Comprehensive systems-based design processes not integrated into regulations and approval process
- Innovations in GIPs generally require a lengthy approval process by the local government
- Lack of technical expertise in local governments to assess GIP projects
- Planning & Design related
- Lack of technical expertise available in implementing sustainable planning principles
- Determining 'areas of influence' or 'catchment areas' in terms of pollution sources, access to workforce, and water availability is understood at a larger scale but most GIP project planning is limited to the site-level
- Interdisciplinary planning approaches are considered a time consuming and expensive process
- Higher up-front capital costs to develop shared infrastructure and common facilities compared to conventional development
- Costs and savings in GIPs are calculated for a longer time frame than in typical industrial parks
- Control of toxic industrial waste and selection of units that can take advantage of exchanging by-products is challenging

Management related

- Networking among companies in the GIP is often time-consuming
- Financial hurdles related to perceived high risk investments for new models by banks and lending institutions
- Lack of a clear, common vision between tenants and park management
- Lack of awareness of sustainable practices
- Lack of GIP management expertise
- Loss of autonomy and flexibility in decision making of individual industrial units

4

GUIDING PRINCIPLES

4

GUIDING PRINCIPLES

AUROSERVICE

As evident from case studies and literature review, a “one-size-fits-all” approach for developing Green Industrial Parks is strongly discouraged. However, the following guiding principles for sustainable industrial development set the foundation for formulating planning processes on a project-specific basis. These principles need to be further refined as soon as the project idea is formulated and throughout the planning process:

1. CONTEXT SENSITIVE PLANNING AND DESIGN

Planning and designing of new Parks need to ensure that they are able to integrate with their surroundings at different levels and dimensions. Instead of regarding industrial systems as independent of the natural systems, broader urban planning processes need to be incorporated to create a sustainable community plan that goes beyond the physical attributes of the site. The key components of context sensitive planning and design include:

a. Regional Context: The applicability of this component starts with the project definition stage and is crucial in the site selection process. The relationship between the site and its larger region in terms of transportation access, utilities and infrastructure availability, watersheds, surrounding land uses are some of the key factors to be taken into consideration during the planning stages.

b. Planning and Regulatory Context: Existing local regulations and planning norms must be considered for setting boundaries and limitations for any project before formulating the development programme, rather than as an afterthought. If required, negotiations with the local agencies regarding the environmental goals for the project need to be initiated early in the process to get the necessary support.

c. Socio-Economic Context: Developing industrial parks are directly related to the ability to attract skilled workforce from the surrounding areas. Location of the workforce, availability and skill levels of existing population, travel behaviour and transportation options available, and relative cost of labour in the region

are some of the key considerations for GIP planning.

d. Natural Environment Context: Industrial operations should be seen within the larger context of the surrounding air, water, landscape and natural features that they will be a part of. The disturbance of the natural eco-system may negatively impact on the surrounding areas that may be dependent on the same resources. A delicate footprint and a symbiotic relationship with natural resources are pivotal for the success of an eco-industrial development. The natural environment considerations to assess include: topography, native vegetation, water resources, soil capacity and quality, and presence of productive agricultural lands.

2. CLUSTERING AND NETWORKING

Potential tenant industries must be clustered in a manner that reduces waste generated by making optimum use of by products. Thus a positive consumption cycle is created where no industry operates in isolation, but instead mimics a natural eco-system, and thereby efficiently shares resources. Forming synergetic and symbiotic networks among the recruited industries is a key component for achieving goals of resource optimization and maximizing efficiency in any sustainable industrial development project. However, this often means creating a more sophisticated management and support system than conventional industrial parks. Clustering of industries could be based on the following factors:

a. Toxicity levels of waste generated
b. Material exchanges: Sourcing and Production Processes
c. Transportation needs
d. Type of labour force needs
e. Theme-based GIP recruitment such as Agro-GIPs or Renewable Energy GIPs

Case Study: Kalundborg, Denmark

Eco-industrial development is NOT an environmental affair

The oldest successful and most publicized example of applied industrial ecology is the Industrial Symbiosis at Kalundborg, Denmark, a group of companies and the City of Kalundborg. http://www.symbiosis.dk/ Kalundborg's industrial symbiosis developed over a period of 25 years, evolving and now has partnerships in 19 projects (see chart below). Today, these 19 different projects concern recycling of water, transfer of energy and recycling of waste products between the six independent symbiosis partners.

The original incentive for the industrial symbiosis was the improvement of performance from economic investments. All exchange projects were negotiated commercially between partners, often between two partners at a time. The industrial symbiosis did not develop as a well-planned network but as a number of single projects among a limited number of partners. Over the years it evolved into a network of synergy projects, an Eco-industrial Network, since the site is not an industrial park and has no management.

The Industrial Symbiosis at Kalundborg is a popular example for industrial synergies since it demonstrates some of the key elements necessary for successful eco-industrial development:

- It is based on a close social relationship between the key actors, the chief executives of the companies involved; the Rotary Club in the small town of Kalundborg provided the platform for networking.
- The companies are close to each other, making physical connections (pipelines, trucking) economical.
- Based on commercial agreements and market prices, the symbiosis did not receive any incentives or subsidies.
- Many promising synergy projects were never implemented due to lack of financing or commercial feasibility.
- Aside from the 19 projects between companies, many more projects have been implemented within the companies.
- With over 25 years of development, the system is a continuing improvement process as the companies and production technologies are evolving.

Since the implementation of the first symbiosis projects most of the original managers of the involved companies, the ‘champions’ of the system, have retired. With the new managers a generation change has taken place, both in age and management style. The new managers needed to be introduced to the principles of industrial ecology and the mechanisms of symbiosis system. Last but not least, they needed to establish the new social network necessary for continuing improvements. Due to its popularity and numerous visitors from around the world, the partners at Kalundborg have set up the Symbiosis Institute to monitor and publicize the evolution of the symbiosis system.

Source: Andreas W. Koenig, The Eco-industrial Park Development, page 7

3. MINIMIZED ECOLOGICAL FOOTPRINT

One of the key goals of eco-industrial development is to mitigate the negative impacts of industrial development on the environment. Sensitive design and planning of new industrial parks as EIDs have the potential of preserving natural systems at the local level for reducing greenhouse gas emissions thus minimizing climate change on a global scale.

a) Environmental Performance Targets: Establishing measurable targets to achieve a specific level of environmental performance for industrial facilities are pivotal in ensuring accountability for tenants and park management in GIPs. Ideally, these should be set up at the state or local municipality level but considering the infancy of the GIP concept, the initiatives could be private-sector driven initially and over time the learning's could be applied to a policy level.

b) Environmental Impact Assessment: Environmental Impact Assessments (EIAs) are often mandatory in several jurisdictions for projects above a certain threshold (e.g. site area greater than 100 acres). Conducting an EIA for all new industrial park projects ensures that issues are identified early in the planning process and reduce unexpected cost increases or regulatory roadblocks later on.

c) Sustainable Planning, Architecture and Construction: Planning and designing the built environment (buildings, infrastructure and landscapes) in a manner that embodies "green" or "eco-friendly" or "low-impact development" techniques and design strategies are instrumental in directly minimizing the carbon footprint of development. During the construction phase, strategies such as minimizing site disturbances and using local materials that have minimum processing and pre-treatment contribute significantly in maintaining the ecological balance.

4. LAND REGENERATION

Typically new industries are located in peri urban areas that were either formerly agricultural lands either due to economic productivity reasons or changes in local ecosystems. Often agricultural practices are dependent on polluting and water-intensive practices that are destructive to the ecosystem. The integration of sustainability principles in GIPs can help preserve rural lands and water systems and regenerate or restore the lands back to their productive state.

- Agro-GIPs
- Organic Farming/ Community Gardens
- Buffers and Productive Landscaping

5. DESIGN FOR FLEXIBILITY

Flexibility in designing the built environment should be integrated from the early stages of site master planning and programming stages in order to plan for future expansion and integrating the whole life-cycle costs into the financial budgeting. Flexible design principles include :

- Adaptability: easy to modify
- Multiplicity: accommodate mixed-use buildings for multiple uses and/or users
- Convertibility: ability to integrate future technologies
- Integration: create a multi-disciplinary design team early in the process comprising of personnel form the planning, architecture, construction, landscape, energy and management realms.

6. WASTE MINIMIZATION

Establishing a defined waste management hierarchy is a crucial component of GIPs. Equally important is the need to educate tenants on an on-going basis to follow established guidelines for waste management. Key components of the waste minimization strategy in GIPs include:

- Source Reduction
- Recycling
- Disposal
- Hazardous Waste

Case Study: Innovative Solid Waste Management in the Philippines

The Mayor of Bustos, Bulacan (a medical doctor) mobilized the Local Health Board to conduct a comprehensive campaign to raise the people's awareness on the importance of and the interaction between health and the environment. The aim was to adopt an ecologically-sound waste management system which includes waste reduction, segregation at source, composting, recycling and re-use, more efficient collection and finally, more environmentally sound disposal. Community assemblies, zonal dialogues and household teach-ins were conducted. Women's organizations, the youth, NGOs and other civic and religious groups were tapped. Residents were organized into small groups to carry out:

- The construction of backyard compost pits;
- The construction of storage bins where recyclable and reusable materials are stored by each household;
- The construction of storage centers where recyclable and reusable materials collected by the ecology aide (street sweepers) are stored prior to selling same to junk dealers;

- Maintenance of cleanliness in yards and the streets;
- The greening of their respective areas; and,
- Motivating others to join.

An ecology training center was set up for the production of organic fertilizer and to train people on livelihood projects using waste materials. Regular monitoring and evaluation was facilitated by mobilizing the existing structure of the barangay health workers (volunteers). Started in 1993 in just one barangay and some schools, this program has now beautified and improved the sanitation of the entire municipality. (Gozun undated)

Ernest A. Lowe, October 3, 2001, Eco-industrial Park Handbook for Asian Developing Countries (2001 edition), Chapter 6, Indigo Development, USA, pages 16.

Case Study: ENERGY STAR

The ENERGY STAR program was initiated in the US but has now spread globally, works with manufacturers, national and regional retailers, state and local governments, and utilities to establish energy efficiency criteria, label products, and promote the manufacture and use of ENERGY STAR products. ENERGY STAR products include clothes washers, refrigerators/freezers, dishwashers, room air-conditioners, windows, doors and skylights, residential water heaters, compact fluorescent lamps, and solid state lighting luminaires.

In 2006 the ENERGY STAR program lowered the total energy consumption of the year by almost 5%. On the ENERGY STAR webpage (www.enenrgystar.gov) there is information about the products that have qualified to achieve the ENERGY STAR. For instance for CFLs there is list of products with wattage, light output, lamp life, color temperature, and model type. To qualify a bare CFL lamp efficacy should be at least 50 lm/W, if the lamp power is less than 10 W, 55 lm/W 10 W ≤ lamp power < 15 W and 65 lm/W when lamp power is more than or equal to 15 W.

Detailed specifications are given for e.g. color quality (CRI ≥ 80), starting and run-up time,

and power factor. The lamp life is considered with rapid cycle stress test and lumen maintenance during burning hours (ENERGY STAR 2008). For CFLs, the ENERGY STAR webpages provide a buyers guide and information on how they work, their recycling, and the amount of mercury.

Lighting and energy standards and codes.pdf, page 85 for Asian Developing Countries (2001 edition), Chapter 6, Indigo Development, USA, pages 16.

7. INCREASED ENERGY EFFICIENCY

Optimizing total energy use and maximizing use of renewable sources are critical components of a GIP project. Planning for increased energy efficiency helps in minimizing the impact of industrial development on the local resources including achieving an Energy Neutral or Energy Positive Industrial Park. Key components for achieving increased energy efficiency include:

- Integrated Energy Planning (IEP): The objective of IEP is to decide how to meet energy demand in the most efficient and socially beneficial manner keeping control of the economic costs.
- Establish an energy demand baseline in order to plan for energy supply
- Energy Benchmarking
- Renewable Energy Technologies

8. WATER RESOURCE MANAGEMENT

Within industrial systems, it is important to understand water consumption, treatment and disposal in the manufacturing process. Integrated water resource management entails evaluating and optimizing all water resources used on site.

a) Water Conservation: Reducing water use through improved operation of existing equipment and processes.

b) Water Reuse: Understanding quality requirements for water demand and matching the wastewater from one area as makeup for another area.

9. EFFICIENT CIRCULATION AND MOVEMENT SYSTEMS

Availability of efficient transportation modes are pivotal for the success of industrial parks, primarily because of reliance on delivery of raw materials and collection of finished products. The planning process must pay attention to the environmental goals of the proposed transportation infrastructure including: prioritizing pedestrian movement, reducing energy use, air emissions and ground contamination. Key components while designing transportation infrastructure include:

- Ensuring regional connectivity
- Prioritizing infrastructure for pedestrians and cyclists
- Access Management and Internal Circulation
- Truck and Freight movement
- Parking
- Cleaner fuel alternative transportation modes (internal circulation)

10. EFFECTIVE RESOURCE MOBILIZATION

One of the significant benefits established for GIPs is their capacity to share resources and engage in by-product exchanges amongst tenants. The focus within the context of industrial processes typically encompasses:

- Energy Use
- Water Use
- Material Use
- Waste Recycling and Reuse
- Common Park Amenities

11. COLLABORATIVE MANAGEMENT SYSTEMS

Industrial parks whether GIP or conventional, have distinct management needs represented by two parties: property management and industry tenants. However with GIPs, sharing of resources and business networking adds another level of complexity. Key components that need to be considered when formulating the appropriate management model include:

- Park Management: Primary functions include overall park maintenance and operations, provision of common facilities and services, maintaining tenant stability, supporting by-product exchange, monitoring, coordinating administrative functions, ensuring financial viability, and enforcing guidelines.
- Community Management: Main functions include community viability and synergy among members, conflict resolution among tenants (or owners), and support park management in capacity building of the tenants.
- Tenant Selection: Tenant selection is critical and should be tied with socio-environmental quality standards.
- Monitoring and Evaluation: Regular monitoring of the park to measure the success of the park based on environmental performance benchmarks and economic indicators should be conducted on a regular basis.
- Environmental Management Systems: This includes management of GIP Environmental Facilities (such as product testing laboratories, shared water treatment facilities etc.), handling of hazardous waste; compliance with regulation related to pollution prevention, labour rights, and others.
- Emergency Management Systems: Maintaining

fire, ambulance, hazardous waste collection, and other allied services including prevention, preparedness and crisis response systems.

12. ECONOMIC VIABILITY AND MARKET ACCEPTANCE

The economic viability of a Green Industrial Park is directly related to the capacity of Real Estate (developers, landowners, tenants, users, government), competitiveness of products, and the financial viability to make the GIP a successful venture. Achieving the financial and economic objectives of property development and balancing it with socio-environmental objectives is dependent on various macro-level and micro-level factors, including:

- Financial Incentives
- Revenue Generation
- Public-Private Partnerships or the People-Public-Private Partnership (4P model)
- Joint-Venture between Developer and Tenants
- Branding and Marketing
- Phasing and Incremental Planning
- Life-Cycle Costing and Risk Reduction Evaluating the costs of operating buildings over their full life-cycle helps in ensuring that long-term benefits of sustainable building techniques are taken into consideration during the initial budgeting phase of the project.

13. INTEGRATION OF TECHNOLOGY

Due to the inherent principles of resource sharing, by-product exchanges, and business networking, integration of technology into the overall planning plays a critical role in the design of new industrial parks. Key opportunities to introduce technology in improving the overall efficiency of a GIP include:

- Geographic Information Systems (GIS)
- Energy Savings
- Building Automation Systems
- Property Management
- Information Technology
- Safety and Security

14. CAPACITY BUILDING, EDUCATION AND ENFORCEMENT

Creating a long-term sustainability programme for GIPs require support and participation from tenants, management employees, and the local community. By virtue of the GIPs being a relatively new concept, training programmes explaining the basic principles of Green Industrial Parks and clearly explaining each individual's role in achieving the performance objectives in a collaborative manner is crucial. Equally important is explaining the enforcement mechanisms proposed in a transparent manner to the tenants and getting their buy-in from the inception of the project.

5

MASTER PLANNING PROCESS

5

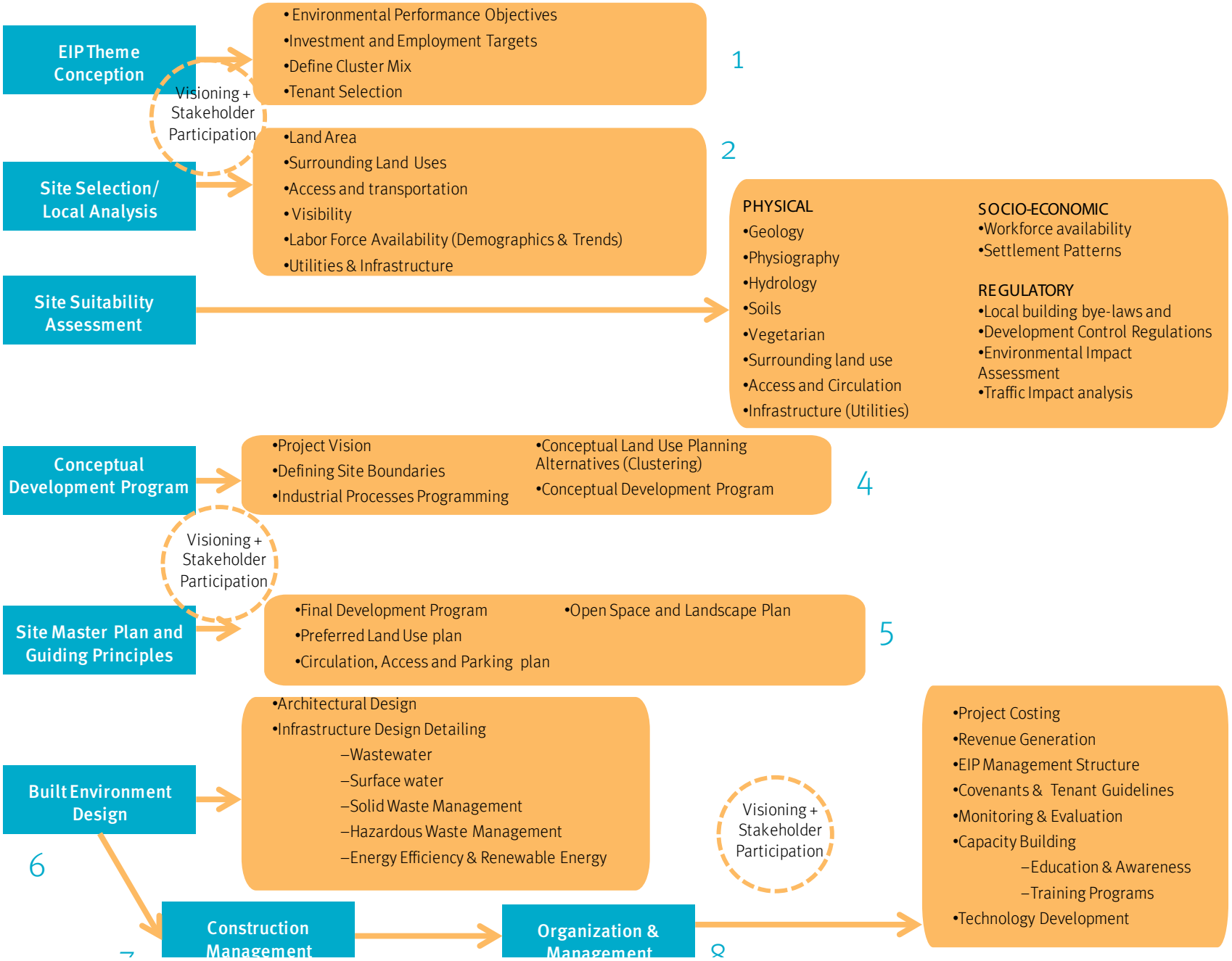
MASTER PLANNING PROCESS

AUROSERVICE

The main steps in the master planning process of a green industrial park are:

1. EIP theme conception
2. Site selection/local analysis
3. Site sustainability assessment
4. Conceptual development program
5. Site master plan and guiding principles
6. Built environment design
7. Construction management
8. Organization and management

The following flow-chart summarises the above steps that future GIPs could adopt as a tool to translate the Guiding Principles into a physical development and management programme.


EIP Theme Conception
• Environmental Performance Objectives
•Investment and Employment Targets
•Define Cluster Mix
•Tenant Selection
1
Visioning + Stakeholder Participation
Site Selection/ Local Analysis
•Land Area
•Surrounding Land Uses
•Access and transportation
• Visibility
•Labor Force Availability (Demographics & Trends)
•Utilities & Infrastructure
2
Site Suitability Assessment
PHYSICAL
•Geology
•Physiography
•Hydrology
•Soils
•Vegetarian
•Surrounding land use
•Access and Circulation
•Infrastructure (Utilities)
SOCIO-ECONOMIC
•Workforce availability
•Settlement Patterns
REGULATORY
•Local building bye-laws and
•Development Control Regulations
•Environmental Impact Assessment
•Traffic Impact analysis
Conceptual Development Program
•Project Vision
•Defining Site Boundaries
•Industrial Processes Programming
•Conceptual Land Use Planning Alternatives (Clustering)
•Conceptual Development Program
4
Visioning + Stakeholder Participation
Site Master Plan and Guiding Principles
•Final Development Program
•Preferred Land Use plan
•Circulation, Access and Parking plan
•Open Space and Landscape Plan
5
Built Environment Design
•Architectural Design
•Infrastructure Design Detailing
–Wastewater
–Surface water
–Solid Waste Management
–Hazardous Waste Management
–Energy Efficiency & Renewable Energy
6
Visioning + Stakeholder Participation
•Project Costing
•Revenue Generation
•EIP Management Structure
•Covenants & Tenant Guidelines
•Monitoring & Evaluation
•Capacity Building
–Education & Awareness
–Training Programs
•Technology Development
Construction Management
Organization & Management

4

ACKNOWLEDGEMENTS

giz

DEUTSCHE GESELLSCHAFT FÜR INTERNATIONALE ZUSAMMENARBEIT

About GIZ/IGEP:

Germany has been cooperating with India by providing expertise through GIZ for more than 50 years. To address India's priority of sustainable and inclusive growth, GIZ's joint efforts with the partners in India currently focus on various areas including "Sustainable Urban and Industrial Development". The Indo-German Environment Partnership (IGEP) Programme caters to this focus area of 'Sustainable Urban and Industrial Development'. The IGEP Programme aims to respond to some key challenges identified in the policy framework of the Ministry of Environment and Forests, Government of India. The overall objective of the IGEP Programme is, "Decision makers at national, state and local level use innovative solutions for the improvement of urban and industrial environmental management and for the development of an environment and climate policy that targets inclusive economic growth decoupled from resource consumption".

IGEP cooperates with public and private sectors at the national, state and local levels, including the Ministry of Environment and Forests, Ministry of Urban Development, Ministry of Housing and Urban Poverty Alleviation, Pollution Control Boards, NGOs, industry associations. IGEP supports its partners in establishing sustainable solutions for environmental infrastructure in urban and industrial areas. It focuses on:

- Up scalable pilot measures for sustainable urban and industrial environmental management and climate protection.
- Legal regulations and policy level initiatives on national, state and urban level that support the dissemination of innovative solutions for a sustainable environmental management.

IGEP has four thematic areas of work, viz. Sustainable Urban Habitat, Sustainable Industrial Development, Policy for Environment & Climate and Cross cutting areas of Capacity Building, Climate Change and Gender Mainstreaming. For the thematic area of the "Sustainable Industrial Development" of the IGEP Programme, the three core topics are:

- Waste water management
- Environment friendly techniques in industry sectors (e.g., textiles, pulp & paper)
- Planning of new industrial parks and investment zones

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ASSOCIATION OF LADY ENTERPRENEURS OF ANDHRA PRADESH (ALEAP)

About ALEAP:

The Association of Lady Entrepreneurs of Andhra Pradesh (ALEAP), established in 1993, is a state Level Organization with an objective of upliftment of women and empowerment through establishing Small and Medium Enterprises. ALEAP has developed the first Women Entrepreneur's Industrial Estate in India at Gajularamaram, near Hyderabad in Ranga Reddy District of Andhra Pradesh. ALEAP has developed another multi product Industrial cluster for women entrepreneurs with a thrust in Food Processing at Nunna near Vijayawada in Andhra Pradesh. ALEAP is now proposing to develop yet another industrial estate at Nandigama near Hyderabad, in an area of about 78 acres.

ALEAP was the dream of women entrepreneurs, who wanted to train, guide, support and enhance the lives of other women. It was established with the aim of bringing women entrepreneurs together on a common platform, in order to empower and promote women entrepreneurship. ALEAP's aim is to make women economically independent, through motivation, counseling, training and handholding. Over the last two decades, an increasing number of women have entered the field of entrepreneurship and gradually changing the face of the economy of Andhra Pradesh.

Address:

Association of Lady Entrepreneurs of Andhra Pradesh (ALEAP)
H.No. 8-3-677/6, Sri Krishna Devaraya Nagar, Yousufguda, Hyderabad, India.
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AUROVILLE

About Auroville:

Auroville (City of Dawn) is an experimental township in Villupuram district in the state of Tamil Nadu, India, near Puducherry in South India. It was founded in 1968 by Mirra Alfassa (also known as "The Mother") and designed by architect Roger Anger. As stated in Alfassa's first public message about the township, "Auroville is meant to be a universal town where men and women of all countries are able to live in peace and progressive harmony, above all creeds, all politics and all nationalities. The purpose of Auroville is to realize human unity."

About Auroville Foundation:

The Auroville Foundation Act was enacted by the Parliament of India in 1988 after the experience of Auroville Emergency Provisions Act 1980 which was promulgated to take over the affairs and management of Auroville and all its undertakings pursuant to the order of the Supreme Court of India.

The Auroville Foundation was notified on 29.01.1991. The office of the Auroville Foundation at Auroville, Tamil Nadu has been functioning under the administrative control of Ministry of Human Resource Development as a statutory (autonomous) body corporate, Govt. of India.

Address:

Auroville Foundation Bhavan,
Administrative Area, Town Hall,
Auroville 605101, Tamil Nadu, India.
Email: foundation@aurovillefoundation.org.in

auroville COLLABORATIVE

AUROVILLE COLLABORATIVE

About Us:

Auroville Collaborative aims to communicate the collective expression of Auroville through media, events and design. We facilitate collaboration between units of Auroville, its residents and volunteers from around the world. The enthusiastic and creative contributions from all participating individuals has helped us complete and propose projects in diverse fields such as ecology and sustainability, arts and crafts, design, education etc.

Auroville Collaborative is managed by Auroville Consulting, a business unit under the non-profit organization Auroville Foundation.

Team:

Martin Sherfler, Vikram Devatha, Vimal Bhojraj

Address:

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Email: info@aurovillecollaborative.org

AUROVILLE
UNIVERSAL
TOWNSHIP

AUROSERVICE

About Us:

AuroService has been offering consultancy services in architecture, town planning, landscape architecture, urban design and other related engineering disciplines for industrial townships, institutional campuses and hospitals over the last 37 years.

Address:

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Team:

Bankim Kalra, Masoom Moitra, Ojas Vyas and Kaja Delezuch

AUROVILLE CONSULTING

AUROVILLE CONSULTING

About Us:

We provide strategic planning and monitoring services for corporate and government initiatives to realize the vision of sustainable habitats.

Founded in 2010, Auroville Consulting is a business unit of the non-profit organization Auroville Foundation, set up in 1991 by Government of India.

Team:

Alexander Broersma, Aurosree Biswas, Balu Ramalingam, Buvana Kaliaperumal, Catherine Vallet, Harshini Mugundan, Ishita Biswas, Mamata Volvoikar, Martin Scherfler, Shefali Mendon, Toine van Megen, Vikram Devatha, Viktoriya Koleva and Vimal Bhojraj

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AUROVILLE DESIGN CONSULTANTS

AUROVILLE DESIGN CONSULTANTS

About Us:

Auroville Design Consultants established in 1988 and is functioning under the “Auroville Center for Scientific Research - Auroville Foundation”. The team consists of Suhasini Ayer – Principle Architect, supported by associate architects, experts in renewable energy and waste water management.

Team:

Dorle Heller and Suhasini Ayer

Address:

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EcoPro

ECOPRO

About Us:

The EcoPro team contributes to an ecologically sound management of natural resources, primarily of water and soil. We promote an integrated management of liquid and solid "wastes", eco-friendly approaches in environmental hygiene and sanitation, and sustainable methods and technologies in food production. This is our contribution to environmental health and public hygiene.

Team: Lucas Dengel

Address:

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Email: ecopro@auroville.org.in

AUROVILLE BOTANICAL SERVICES

About Us:

Botanical Services is the commercial unit of the Auroville Botanical Gardens dedicated to bringing ecologically sustainable solutions to the commercial, private and government sectors, drawing upon the experiences of the Auroville International Township as well as the past years experience of creating the Auroville Botanical Gardens. The Auroville Botanical Garden was initiated in August 2000 on an empty piece of land, devoid of vegetation. In years since it's establishment this 50 acre site has been transformed into a luxuriant garden that serves as an area for research in to environmentally sustainable approaches to land management as well as a location for environmental education.

Team: Paul Blanchflower

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CSR
Auroville Centre for Scientific Research

CENTER FOR SCIENTIFIC RESEARCH

About Us:

Auroville Centre for Scientific Research (CSR) is an international voluntary organisation working towards a sustainable future in the field of renewable energy systems (wind, solar, biomass), appropriate architecture & building technologies, waste water recycling and sanitation, and the transfer of these technologies through training programmes. CSR was founded on January 6th, 1984. After the Indian Parliament passed the 'Auroville Foundation Act' in 1988, the assets of CSR were transferred to an autonomous institution, the Auroville Foundation. From April 1998 CSR was registered under two trusts, one for its research activities, Auroville Centre for Scientific Research, the other for its commercial activities, Aurore Trust.

Team: Gilles Boulicot, Lars Kostedde and Tency Baetens

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