Reimagining India's Industrial Parks

Mains: *GSIII – Infrastructure*

Why in News?

China's Hangzhou Green and Low-Carbon Digital Energy Port demonstrates how existing industrial parks can become low-carbon ecosystems through renewable energy, storage, digitalisation and resource efficiency.

What is Hangzhou's Low-Carbon Industrial Park Model?

- **Hangzhou's Model** – The model transforms conventional industrial parks into integrated energy systems that generate, store, distribute and consume electricity efficiently.
- **Industrial Transformation** – Established in 1993, Shangcheng Industrial Park was retrofitted without expanding its 0.61 sq km footprint.
- **Industrial Scale** – Houses over 1,000 enterprises, including seven listed companies, consuming over 40 million kWh annually.
- **Technological Integration** – Since 2025, around 200 technologies developed by 16 enterprises have been integrated.
- **Emission Reduction** – Aims to reduce annual emissions by 8,717 tonnes and carbon-emission intensity by 45.9% by 2030.

What are the Major Features of the Hangzhou Model?

- **Renewable Energy Generation and Storage**
  - **Advanced Solar Technologies** – Integrates cadmium-telluride, heterojunction and perovskite tandem cells with wind power.
  - **Battery Storage** – Uses liquid-cooled, immersion-cooled and solid-state batteries.
  - **Energy Efficiency** – Ground-source heat pumps provide heating and cooling, while direct-current systems reduce conversion losses by 5–8%.
- **Smart Energy Management**
  - **Bidirectional EV Charging** – 800 charging points enable electric vehicles to supply electricity back to the grid.
  - **Virtual Power Plant** – 31.9 MW peak-shaving capacity integrates microgrids across 37 industrial plots.
  - **Digital Monitoring** – Smart Energy Brain connects over 3,000 devices to monitor energy generation and consumption.
- **Circular Economy and Innovation**

- **Waste Management** – Promotes industrial waste utilisation, material recycling and conversion of waste gases into useful products.
- **Carbon Capture** – Explores microbial carbon capture and direct air capture technologies.
- **Innovation Ecosystem** – Hosts 96 high-tech enterprises, 701 invention patents and six accredited laboratories.

What is the Significance of the Hangzhou Model?

- **Sustainable Industrial Growth** – Enables manufacturing growth without proportionate increases in energy consumption and emissions.
- **Energy Security** – Integrated generation and storage improve electricity reliability and reduce conventional energy dependence.
- **Climate Mitigation** – Renewable energy and resource efficiency contribute to industrial decarbonisation.
- **Land Conservation** – Retrofitting existing industrial parks avoids additional land acquisition and expansion.
- **Technological Innovation** – Collaboration between industries and research institutions strengthens indigenous technological capabilities.

What Can India Learn from the Hangzhou Model?

- **Modernising Existing Industrial Parks**
  - **Industrial Infrastructure** – India Industrial Land Bank maps 4,523 parks across 770,000 hectares, including 306 plug-and-play parks.
  - **Retrofitting** – Existing clusters should undertake energy audits and upgrade infrastructure without expanding their geographical footprint.
- **Integrating Renewable Energy**
  - **Measurable Targets** – Establish targets for renewable electricity, energy storage, peak-demand management and digital integration.
  - **Integrated Energy Systems** – Coordinate renewable generation, storage and consumption within industrial parks.
- **Developing Sustainable Industrial Cities**
  - **Green Infrastructure** – Integrate smart grids, renewable energy, storage and digital monitoring during initial planning.
  - **New Industrial Cities** – The 12 cities approved in August 2024, including Agra and Prayagraj, offer opportunities for low-carbon development.
- **Promoting Circular Economy** – Encourage industrial symbiosis, waste recycling, resource efficiency and sustainable material management.

What are the Challenges in Adopting the Model in India?

- **Infrastructure Constraints** – Ageing electricity networks and limited land hinder renewable energy and storage integration.
- **High Capital Costs** – Battery storage, smart grids and digital monitoring require substantial initial investments.
- **Institutional Fragmentation** – Weak coordination among developers, manufacturers, utilities and government agencies affects implementation.

- **Technological Limitations** – Renewable energy intermittency requires reliable storage and demand-management systems.
- **Emerging Technology Constraints** – Direct air capture faces cost, energy and scalability challenges.

What could be Done?

- **Decarbonisation Targets** – Establish measurable renewable energy, emission reduction and resource-efficiency targets.
- **Infrastructure Upgradation** – Prioritise energy audits and shared clean-energy infrastructure in existing clusters.
- **Digital Integration** – Introduce real-time monitoring of energy consumption and industrial emissions.
- **Green Industrial Planning** – Incorporate low-carbon technologies and circular economy principles into new industrial cities.
- **Institutional Coordination** – Strengthen partnerships among developers, manufacturers, utilities and government agencies.

What lies Ahead?

- The Hangzhou experiment demonstrates that industrial parks can become integrated low-carbon ecosystems rather than merely collections of factories.
- India should adopt this approach to balance manufacturing growth with energy security and environmental sustainability.
- Industrial development must therefore be measured not only by production capacity but also by energy efficiency, resource conservation and environmental protection.

Reference

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