Global Chemicals & Petrochemicals Manufacturing Hubs in India 2021

Navigating the New Normal through Industrial Cluster Transformation

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Energy & Industrial

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About SURBANA JURONG

Snapshot of SJ Group

Surbana Jurong is one of Asia's largest consultancy powerhouses, delivering urban, infrastructure and engineering solutions to support sustainable social and economic growth for our clients

1 One-stop, end-to-end consultancy in the urban, industrial and infrastructure value chain

- End-to-end consultancy – **Plan, develop, deliver and manage**
- **Diversified capabilities and service offerings** across the Group's member companies

AETOS · KTP · SMEC · RobertBirdGroup · PROSTRUCT CONSULTING · B+H · SAA · 华太设计 BINO-SUN · atelier ten

- **SJ Capital is the established investment arm**; seeking to unlock projects within SJ network

2 Unique heritage and capabilities, sound track record

- Roots in supporting Singapore's nation-building efforts
- Ranked **#24** in ENR 2021 Top 225 International Design Firms
- Track record of **c.70 years**, having won **>600 international and local awards**

3 Extensive global reach with deep local presence

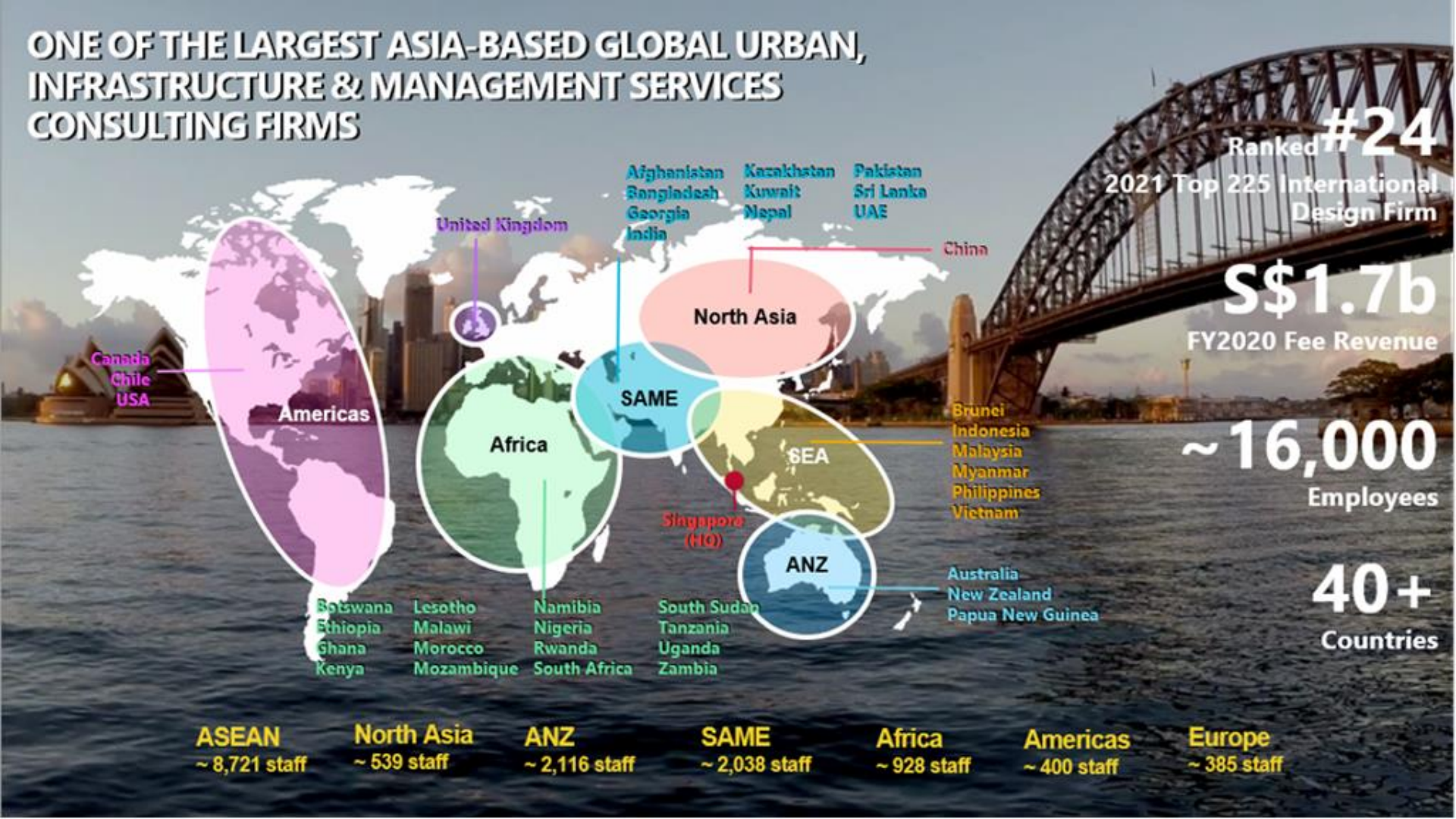
- > 16,500 employees globally
- > 120 offices
- > 40 countries
- > 70 years track record in project delivery

4 Financial strength and supportive parentage

- **$1.7 Bn** of fee revenue in 2019
- Recent focus on acquiring capabilities; completed **8 corporate acquisitions over the last 5 years**
- **100% owned by Temasek**; the only TPC with multidisciplinary engineering and development capabilities

Note: Figures as of 31 December 2019.

ONE OF THE LARGEST ASIA-BASED GLOBAL URBAN, INFRASTRUCTURE & MANAGEMENT SERVICES CONSULTING FIRMS



Ranked #24
2021 Top 225 International Design Firm

S$1.7b
FY2020 Fee Revenue

~16,000
Employees

40+
Countries

ASEAN	North Asia	ANZ	SAME	Africa	Americas	Europe
~ 8,721 staff	~ 539 staff	~ 2,116 staff	~ 2,038 staff	~ 928 staff	~ 400 staff	~ 385 staff

We anchor our solutions on sustainability

A **holistic sustainability design** approach backed by science-based performance tools

Adoption of **climate responsive design** for a better interaction with environment and communities

Use **innovative technology** including smart IOT and technology enabled solutions

SJ-designed buildings have achieved numerous **international green certifications**

We align to the United Nations Sustainable Development Goals (UNSDG). A new, universal set of goals, targets and indicators from the UN over the next 15 years.

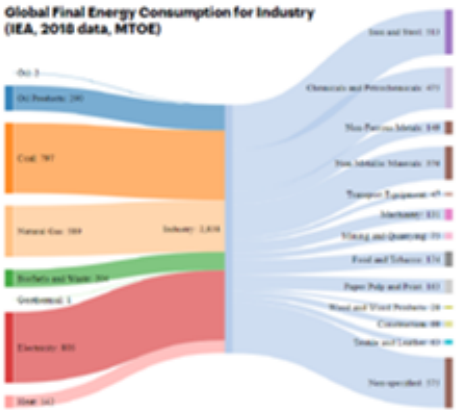
SJ is committed to the UN 2030 agenda for Sustainable Development and looks to partner with like-minded partners to build a sustainable and resilient future.

About Energy & Industrial (EIN)

Industrial Clusters – Transformation

Major Trends Facing Industrial Clusters/Parks

Industrial Clusters - Impetus to decarbonise

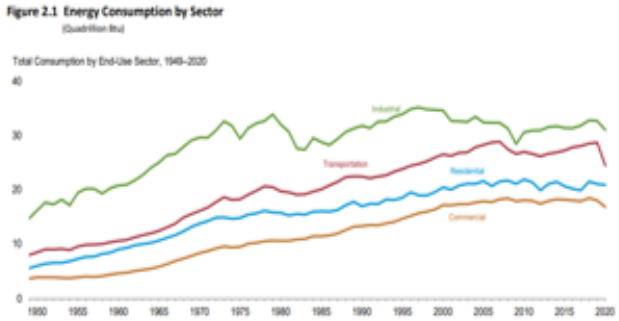


Source: WEF

- Chemicals & Petrochemicals industries is one of the major energy consumers across all other industries
- Heavy industries (comprising of chemicals/petrochemicals/iron/steel/ minerals etc. constitute about 50% of all global final energy consumption
- In 2021, the European Union (EU) Parliament also approved the inclusion of shipping into its Emissions Trading Scheme.

Industrial cluster can become a critical player in accelerating the path for the world to achieve net zero

High Energy Consumption



- The industrial sector is the major global energy consumer since 1950 till date.
- The industrial sector consumes about one third of total energy consumption by end use sectors
- According to BP's analysis, the use of electricity and hydrogen will grow significantly, particularly in industry.

Source: US EIA

High energy consumption in industries will continue to be trend in decades to come

Major Trends Facing Industrial Clusters/Parks

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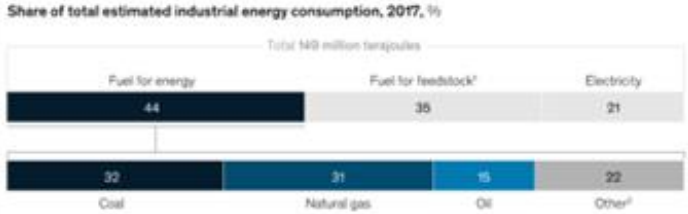
High Fuel Consumed but Low Electricity Usage

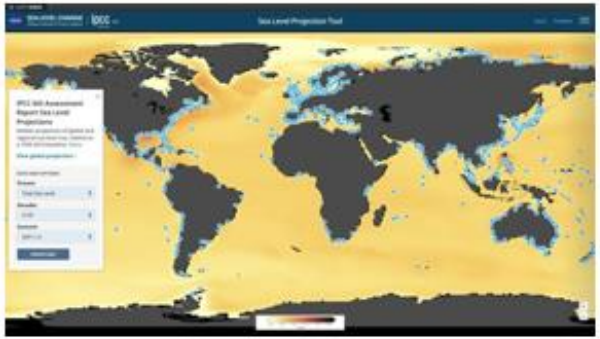


Source: Mckinsey

- About 40% of the total energy consumption in industries is fuel consumed for energy production
- Industry consumes the most energy but only about 20 percent of the energy consumed in industry is electricity
- High potential to electrify manufacturing
- Full electrification of an industrial site relies on relatively low power prices, combined with supportive regulation

Major opportunities exist to electrify the industrial parks/ manufacturing hubs

Climate Change - Global Sea Level Rises



- IPCC Report states that extreme sea level events that occurred once per century in the recent past are projected to occur at least annually at more than half of all tide gauge locations by 2100.
- Global mean sea level are expected to rise between 0.6 – 0.9 meters by 2100

Source: NASA

Petrochemical & Industrial parks within proximity of coastal areas will need to account for sea level rises

Major Trends Facing Industrial Clusters/Parks

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Global Supply Chain

- Global trade and supply chains are disrupted and going through an unusual and massive shock due to COVID pandemic
- Over reliance on specific production bases during lockdown has exposed vulnerability
- Supply chain resiliency has become the most important consideration for governments and companies

Source: Bloomberg

Industrial value chain requires rethink and restructuring in the wake to ensure supply chain resiliency

Regionalization

- Global trade may undergo more regionalization to reduce trade vulnerabilities
- Most of world trade now takes place between country pairs that have established a reciprocal trade agreement.

Source: Statista

Pandemic, blockages to major trade routes, energy crunch etc. has exposed the vulnerabilities of global trade

Major Trends Facing Industrial Clusters/Parks

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Transition to Sustainable Products

- Chemicals will continue to play an integral role across a wide-range of end-markets globally
- Demand for carbon-intensive fossil fuels is expected to decline.
- Consumers would pay more for Sustainable Products designed to be reused or recycled (Accenture 2019)

Source: Accenture

Low carbon Alternatives

- 260 GW of global renewable capacity is added in 2020 during the pandemic
- Hydrogen and biofuels are other important components of the future low carbon energy mix.
- Ammonia will be very important to meet the industry's needs. Additionally, carbon capture technology will also be pivotal in the energy transition

Petrochemical Industrial Clusters will face challenges and pressure to transit towards to more sustainable petrochemical products

Industrial Clusters will also shift towards the adoption of more low carbon alternatives in its energy mix

Planning for a Future Industrial Cluster

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Refinement and upgrade of our planning processes and considerations are pertinent to ensure future industrial clusters are sustainable and relevant

Planning Process

- Industrial Positioning
- Value Chain Clustering
- Market Demand & Supply
- Site Analysis SWOT Planning Criteria
- Development Strategies
- Master Plan Design
  - Land Use Plans
  - Infrastructure Plans
  - Utilities Plans
  - Blue & Green Plans
- Physical & Natural Attributes
- Marine & Maritime Attributes
- Environment & Ecology
- Logistics Plans
- Phasing Plans

Future Added Considerations

Industrial Symbiosis

Climate Change

Energy Transition

Digitalization

Resiliency

Climate Change Resilience

CLIMATE CHANGE RESILIENCE

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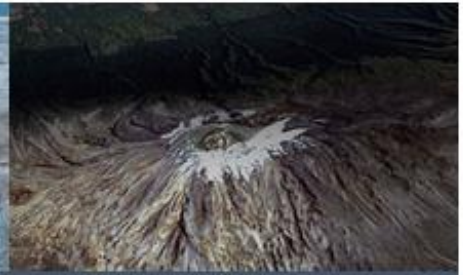
Global temperature rise

Warming ocean

Shrinking ice sheets



Glacial retreat

Decreased snow cover

Sea level rise

Extreme weather

Ocean acidification

Planning for Climate Change Resilience

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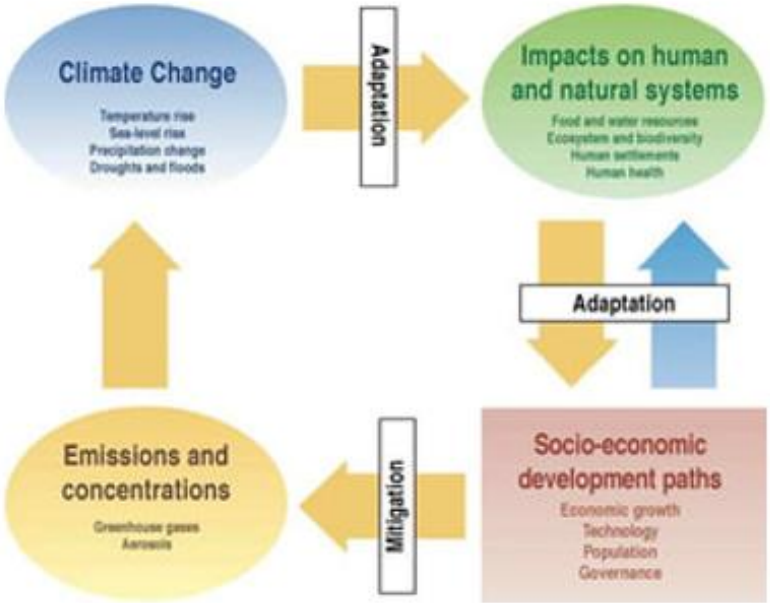
While climate change is a global issue, it is felt on a local scale. Cities and municipalities are therefore at the frontline of adaptation, and this includes industrial clusters and parks.

An Integrated Framework



Source: grimstad.uia.no

Mitigation & Adaptations

Mitigation involves reduction and/or stabilization of GHG emissions and their removal from the atmosphere; **reducing and stabilizing the levels of heat-trapping greenhouse gases in the atmosphere**

- The goal of mitigation is to avoid significant human interference with the climate system.

Agriculture is the largest contributor of non-CO_2 GHGs.

Food systems emissions contribute **19-29% OF TOTAL GHG EMISSIONS.**

Source: ccafs

Adaptation strategies can be used to reduce adverse affects and maximize any positive effects; **adapting to the climate change already in the pipeline**

- The goal is to reduce our vulnerability to the harmful effects of climate change (like sea-level encroachment, more intense extreme weather events or food insecurity).

Planning for Climate Change Resilience

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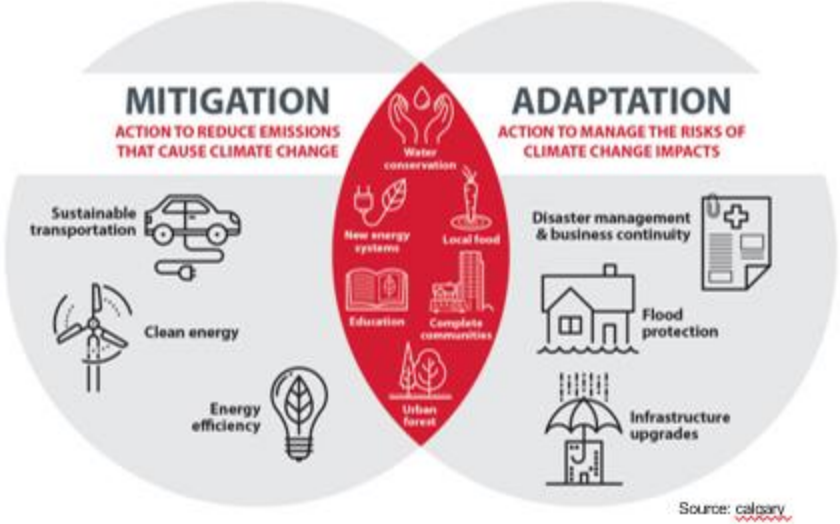
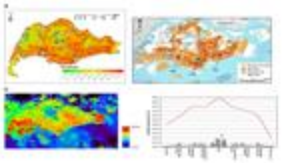
A repertoire & diverse range of skillsets are required to combat climate change and improve resilience for any industrial clusters



Urban Heat Island



Energy Efficiency

CCUS

Flood Mitigation

Coastal Protection

Renewables

Industrial Symbiosis and the Circular Economy

Circularity in Industrial Clusters

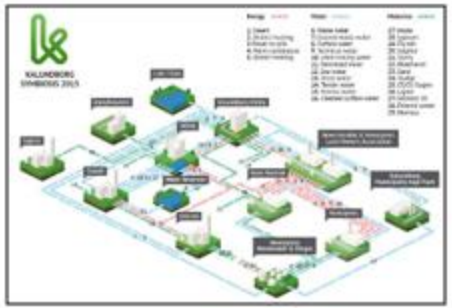
Reduce resource use

Reduce and re-use waste

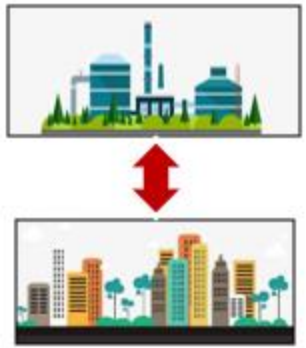
Maximise product output

Micro-Level
Within Single Enterprise

Meso-Level
Inter-Enterprise
Within Industrial Park



Macro-Level
Between Industrial Park and Town/City



Circularity in Industrial Clusters

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IMPLEMENTATION METHODS

1

Integrated Chemical Value Network Design

Establish complete chemical value chain from crude oil, intermediates through to fine/specialty chemicals with upstream suppliers. Ensures maximum added value chemical products are made and achieves economies of scale in chemical production.

2

Clean production initiative

Emphasis on adopting new innovative technologies which converts waste to re-usable material, controls and utilizing chemical processing routes with minimal pollutant emission. Prioritize introduction of clean materials and projects which has minimal environmental impact in the industrial park. Limit number of high hazard projects and enforce stringent clean production practices and audits in the industrial park.

3

Inter-Business Industrial Symbiosis

Identify and develop opportunities for integrated circular economy between diverse existing and future incoming businesses through R&D and project optimization initiatives in the region.

Promoting Industrial Symbiosis in Industrial Clusters

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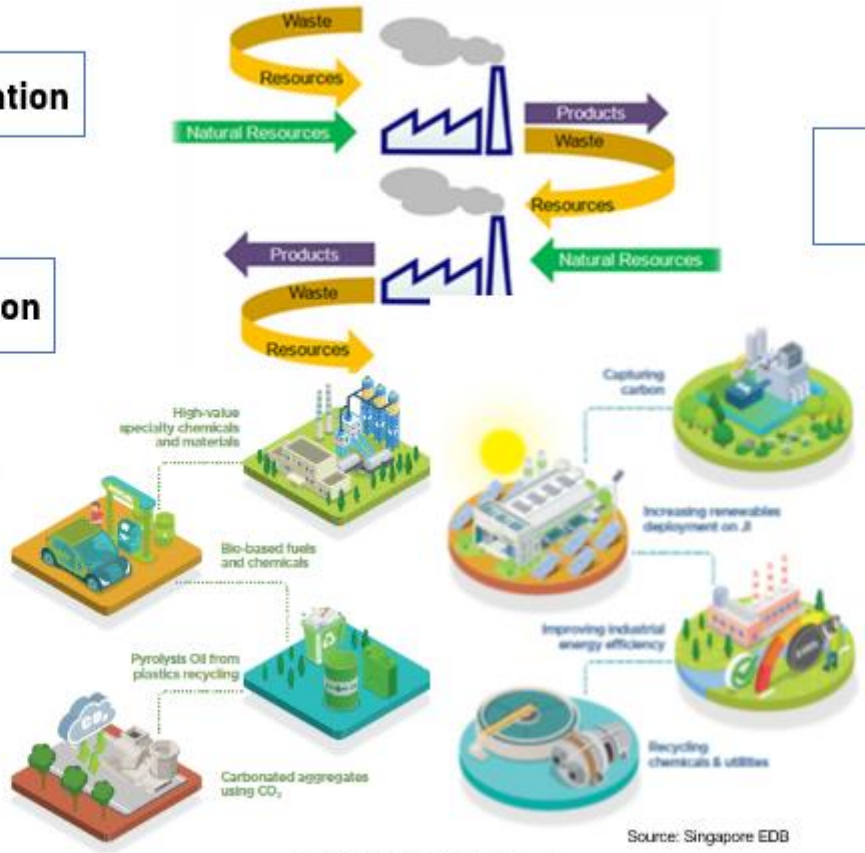
Processes Integration

Resources Integration

Energy Diversification & Integration



Source: Singapore EDB

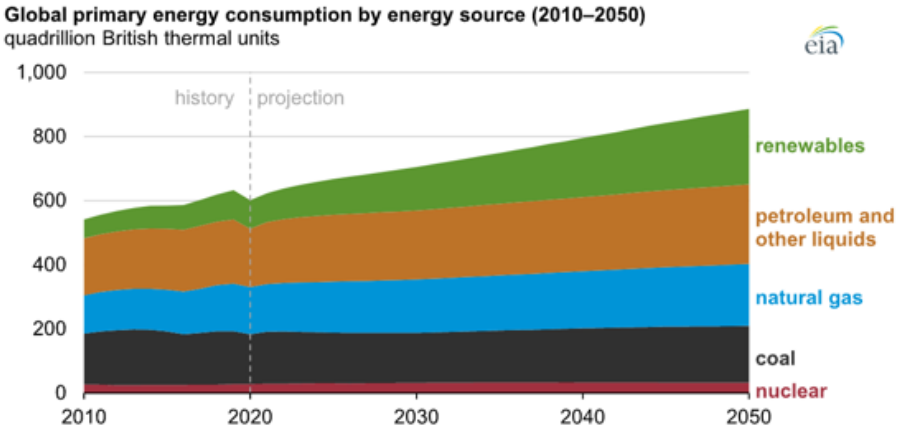
Shared Centralized Engineering Facilities

Circular Economy Data Information Systems

Energy Efficiency

ENERGY TRANSITION

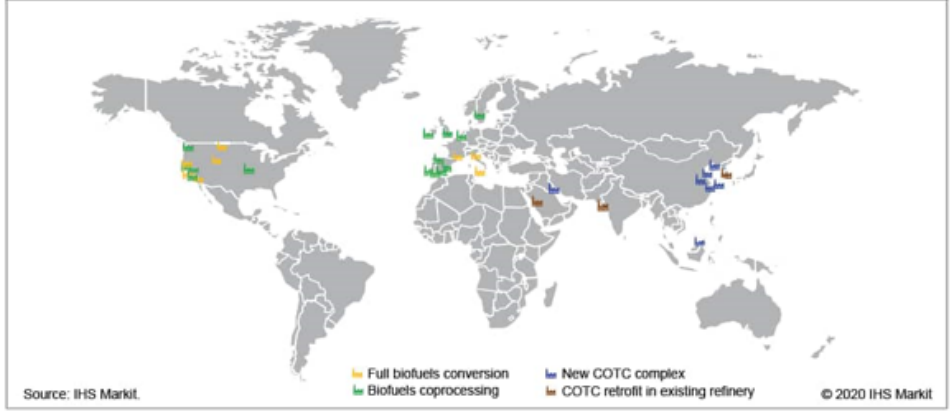
Renewables expected to be the fastest-growing energy source



- Renewables expected to grow to **nearly the same levels** as petroleum and other liquid fuels by 2050
- Growth in renewables supported by **falling technology costs and incentives** from government policies

Demand for Petrochemical feedstocks to gradually displace fossil-based fuels due to the energy transition and associated electrification

Figure 1: Current and announced refinery conversions to biofuels and crude-to-chemical refineries



- In recent years, refineries have been shut down, converted to logistics terminals or converted (partially or totally) to **biofuels**. There has also been investment in **crude oil-to-chemicals (COTC)** facilities.
- The **integration of refinery and petrochemical facilities** provide the advantages of a diversified product slate and the potential to generate economies of scale and operational synergies.

Industries play a major role in energy transition

The O&G sector needs to reduce its emissions by at least 3.4 gigatons of carbon-dioxide equivalent a year by 2050, compared to "business as usual i.e. **90% reduction in current emissions**, to meet global climate change goals.

How can we prepare for 'The New Normal'?

Shifting Supply and Demand Trends

- Pandemic has brought about a demand downturn in construction and automotive sectors.
- Large degree of uncertainty and opportunity lies in the gas market where gas increasingly displaces coal in power generation.

The Energy Transition and Green infrastructure

- Industry and society as a whole is faced with an urgent need to focus on sustainability and decarbonize.
- Green infrastructure (renewables) is expected to have a greater impact on job creation with a rise in the ESG agenda globally
- Electrification presents tremendous opportunity to reduce emissions and combat climate change.

Source: McKinsey; SJ Analysis

Industrial Clusters are the Hardest to Abate Category of Industrial Emissions

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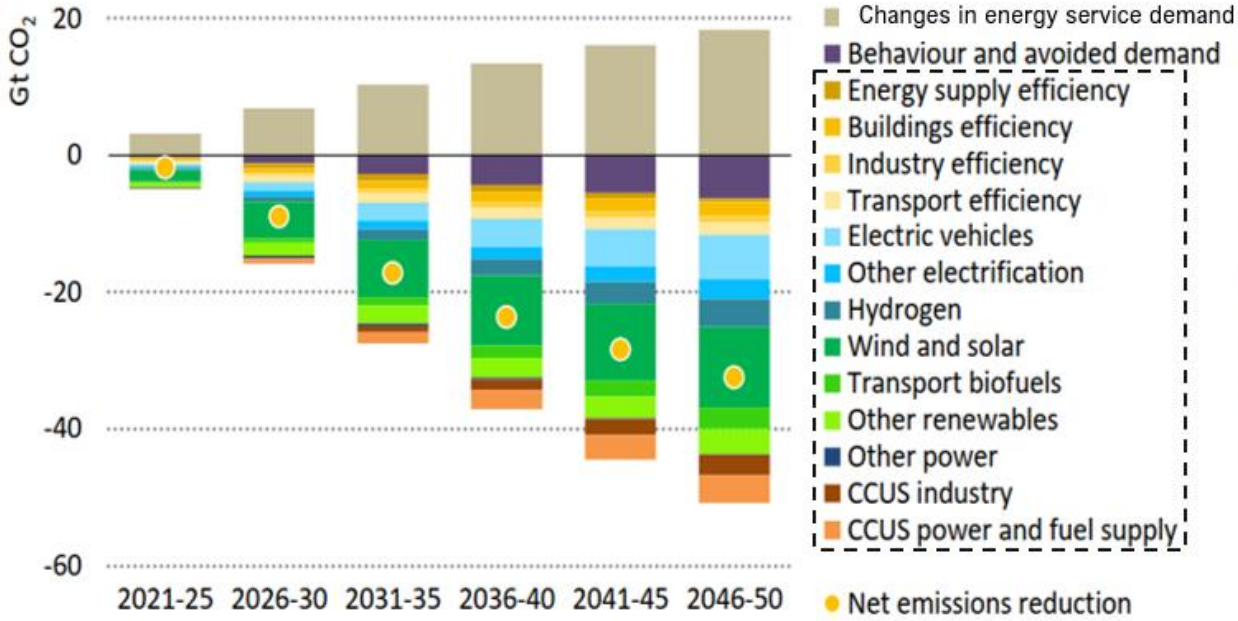
Average annual CO2 reductions from 2020 in the Net Zero Emissions by 2050 scenario



A suite of technologies are needed to achieve the NZE scenario, of which **Renewables and Electrification** are expected to make the largest contribution to emission reductions , followed by **Carbon Capture, Hydrogen, Energy Efficiencies, and Biofuels**

Energy innovations help reduce total global energy consumption to mitigate the increased demand from population and economic growth

Source: IEA

An Example of Integration of DERs to Achieve Lower Carbon Footprint

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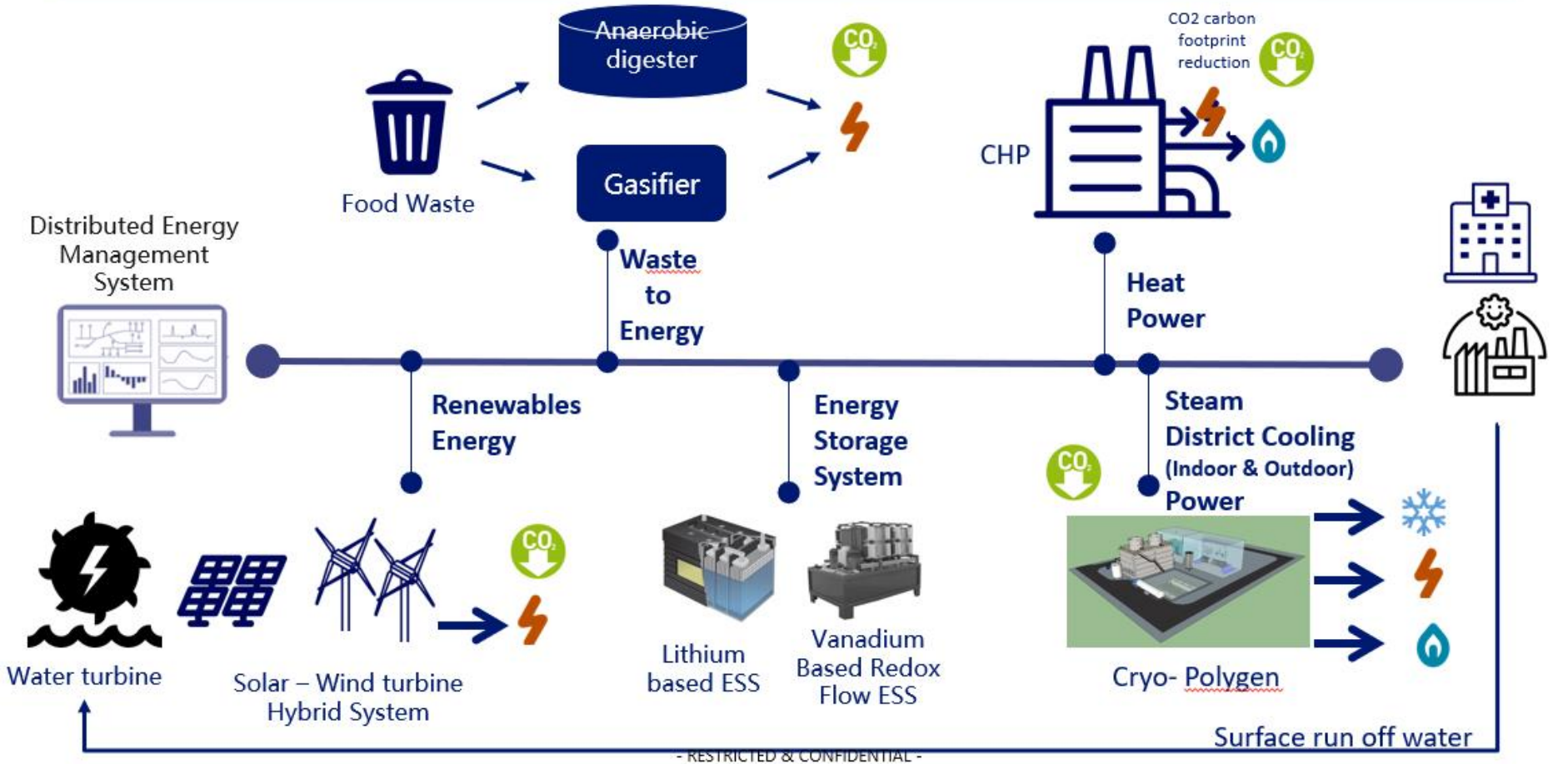

Advanced algorithms enable users to drive energy efficiency

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Supply Side Management

- Turbine power generation
- Solar PV
- Wind Thermal Storage
- Electrical Storage
- Others DERs

Data Driven Insight

- Load Forecasting
- Supply Forecasting
- Asset Failure Prediction
- Benchmarking
- System Economic Dispatch
- Curtailable Load Availability

Demand Side Management

- Industrial Load
- Building load (Air conditioning, Heating, lighting)
- Storage system (Thermal, Electrical)
- Building Grid

Grid Resilience & Market Monetization
Demand response program, Interruptible load program

Digitalization

SMART INDUSTRIAL PARK

Architecture for Smart Developments

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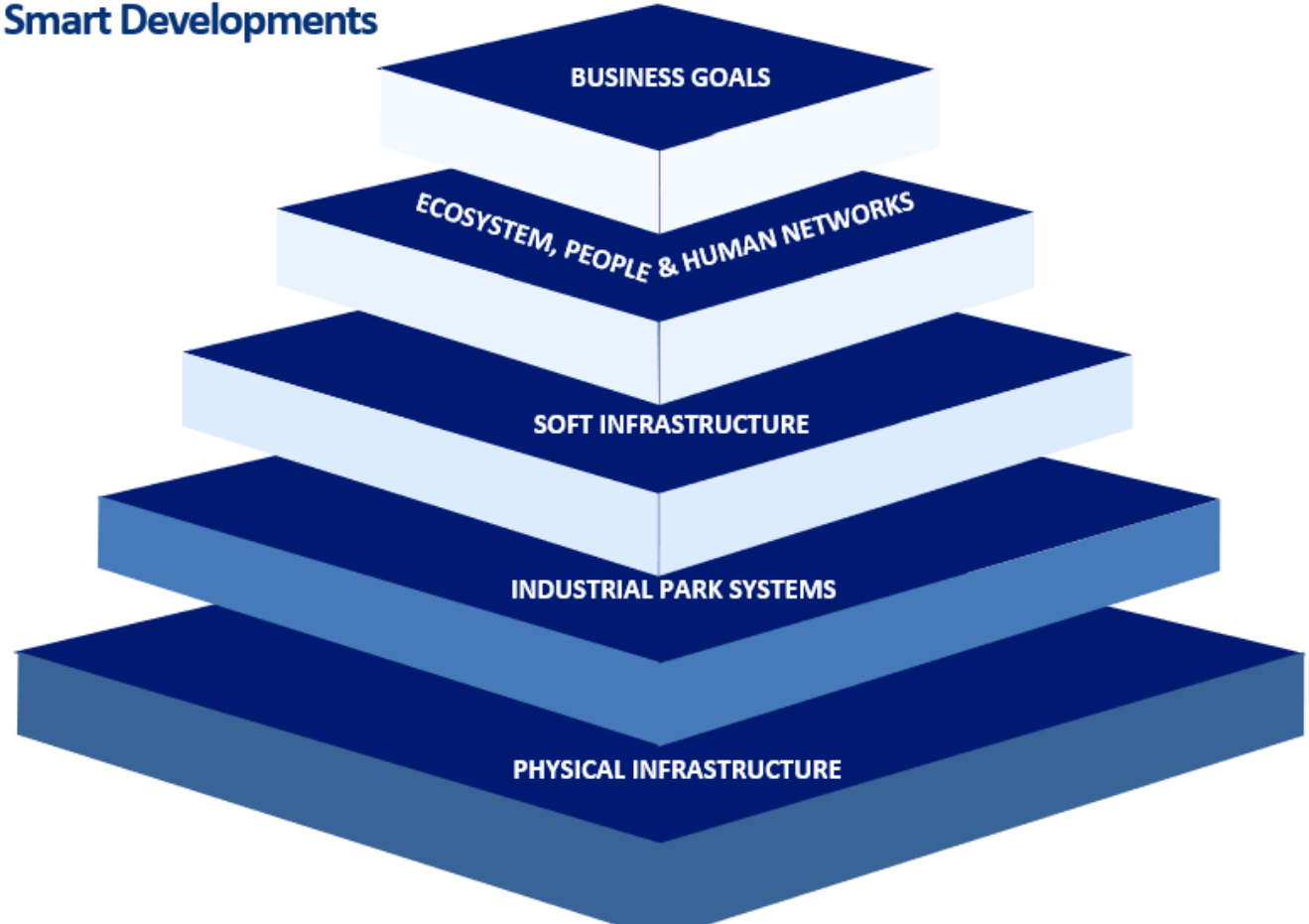

SMART INDUSTRIAL PARKS

Smart Space, Smart Features

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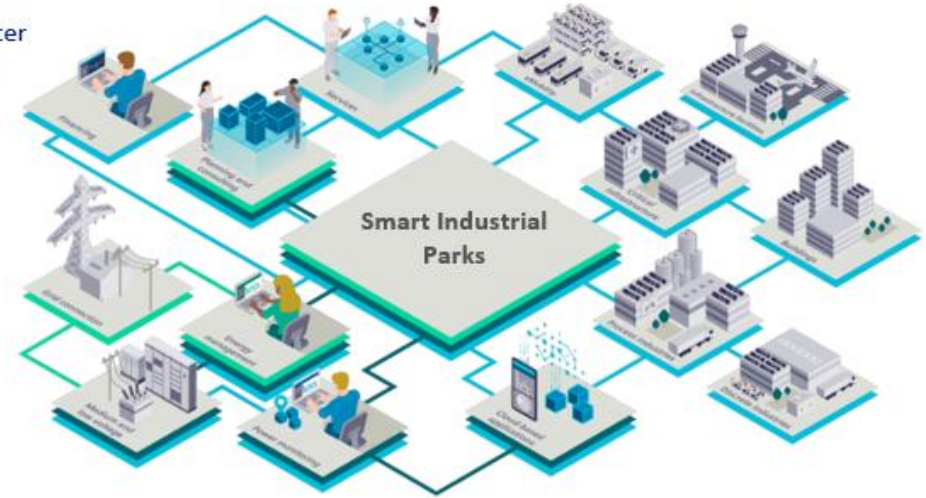
Smart Industry is at the heart of the Fourth Industrial Revolution. Smart Industry offers the possibility of sharing of information, resources, office spaces and training within a Smart Industrial Complex, allowing the best expected outcome to be produced for all parties involved.

Smart Energy allows energy from traditional and green sources to be stored and managed efficiently for greater energy, reliability, resilience and independence

Smart Surveillance leverages on video analytics to detect abnormalities or misbehaviours



NB-IoT or 5G as a commercial telco offering. Businesses, tenants and operators can deploy sensors connected to their respective back-ends at a lower cost. NB-IoT or 5G is critical to enabling modern sensor or 'Fog' sensor arrays.

Sensors can be used to monitor the water level in water bodies to trigger overflow and flood warnings in advance. Smart platforms can use the data for public advisory and dynamic route planning for commuters and other road users.

Sensors in waste bins and collection points transmit real time information to allow for on-demand waste collection and dynamic routing of waste collection vehicles.

and industries

Smart Street Lamps: With sensors and intelligent control, light levels can be adjusted for different conditions and human presence, saving energy and providing a better user experience. Failure of lights can also be detected with repairs triggered automatically.

OVERLAYING MASTERPLANS WITH SMART SOLUTIONS

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Artificial Intelligence-powered traffic management

Smart lamp poles as basis for sensor network

Vehicle electrification to reduce carbon emissions

Integrated Command Centre for park operations & security

Biometric access control system for tightened security

Renewable energies for eco-sustainable operations

Pandemic Resilience

VULNERABILITIES UNCOVERED BY THE PANDEMIC

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Traditional efficiency-driven supply chains were inflexible and struggled to adjust to the supply & demand shocks

Forbes

Nov 18, 2021, 04:02pm EST | 301 views

Acceleration To Supply Chain 4.0: Ensuring Agility And Sustainability As We Forge A New Way Forward

NOKIA

Rahul Aggarwal Brand Contributor
Nokia Industry 4.0 BRANDVOICE | Paid Program
Business

INTERNATIONAL MONETARY FUND | IMFBlog

Longer Delivery Times Reflect Supply Chain Disruptions

OCTOBER 25, 2021

THE STRAITS TIMES BUSINESS

FOR SUBSCRIBERS

Rising demand, global supply chain disruptions drive logistics firms to diversify and expand

Global value chains built upon complex interconnectivities also increased interdependencies

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GLOBAL TIMES

SOURCE / ECONOMY

Chinese firms in Vietnam face logistics disruptions, labor shortages

Chinese firms face persistent labor shortages, logistics woes

By Zhang Dan and Liu Yang

Published: Oct 25, 2021 04:53 PM

ICIS

US Ford, GlobalFoundries to collaborate on chip production; global shortage to stretch into 2022

Author: Adam Yanelli

2021/11/18

CONSTRUCTIONWEEKONLINE

Home > People

Supply chains move from globalisation to regionalisation

V Raju, senior VP CL, chemical, pharma & food sector, Avvashya CCI Logistics, on regional supply chains

Mercom India

Growth of Domestic Solar Manufacturing Hindered by Global Supply Chain Disruptions

The rise in raw material prices and freight charges have been challenging for domestic manufacturers in the last six months

NOV 16, 2021 / RAKESH RANJAN / MERCOM RESEARCH FOCUS, OTHER

MULTI-PRONGED APPROACH TO STRENGTHEN RESILIENCE WITHOUT COMPROMISING COMPETITIVENESS

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DEVELOPMENT PLANNING

Masterplanning should be done in a purposeful and tactical manner to provide companies with the flexibility to adjust manufacturing operations or capacities. This can be done through land planning with buffers, taking into consideration accessibility to major distribution channels and export facilities etc.

CENTRALIZED SERVICES

Centralised provision of supporting services in the industrial park can provide economies of scale, operational efficiencies and allow companies to focus on core activities.

DIGITALIZATION

Digitalization can provide innovative solutions to allow supply chain visibility and improve flexibility and speed up response. The ability to get a more complete profile of component sources and make the supply chain more transparent and predictive can mitigate the "bullwhip effect".

STRATEGIC POSITIONING

Strategic positioning of the park to enable clustering of complementary activities can catalyze industrial symbiosis and create a self-sustaining ecosystem.

EMERGENCY RESPONSE & BUSINESS CONTINUITY PLANNING

Risk events that may create catastrophic impact or extensive business disruption should be identified and response plans prepared in collaboration with stakeholders. This will facilitate swift and coordinated responses to incidents and reduce the downtime and loss of business revenue.

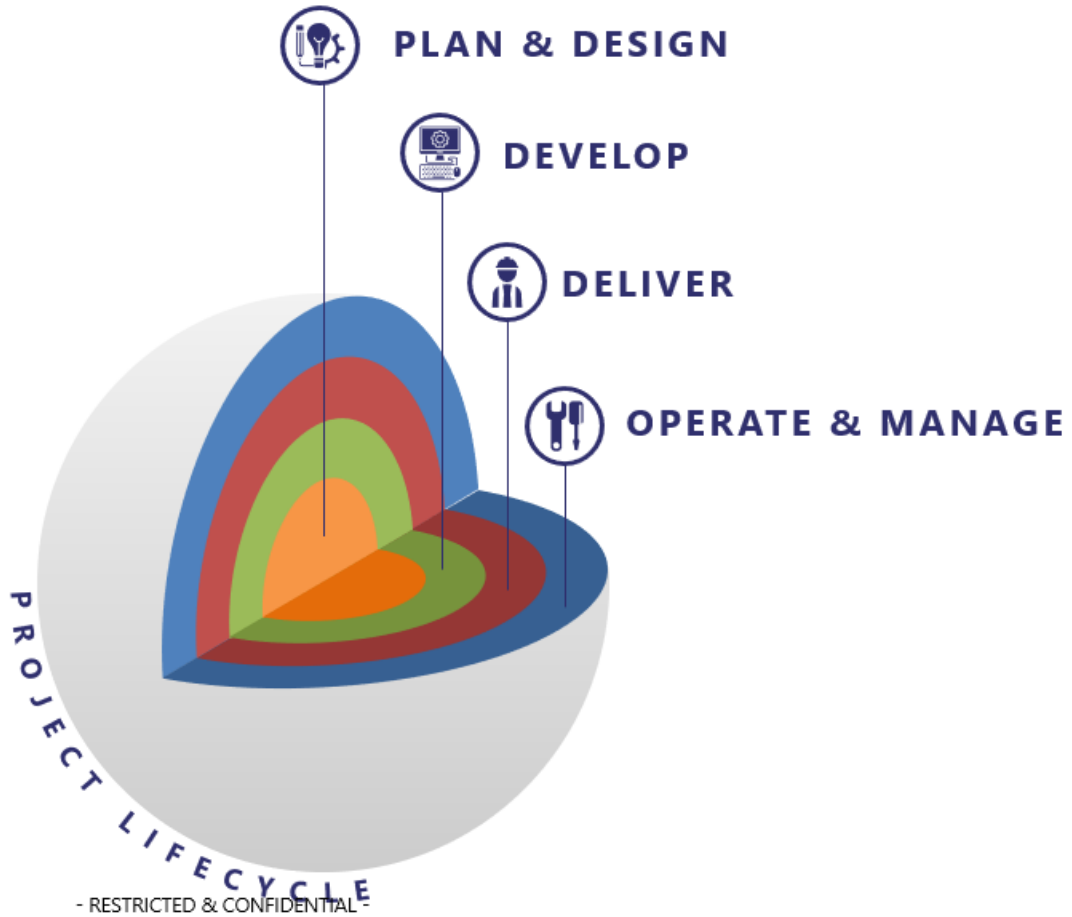
Value Proposition

Complete Value Chain Delivery

Our value proposition

Surbana Jurong and our member companies connect and collaborate to assist our clients solve their challenges through our multidiscipline technical expertise across all phases of a project's lifecycle.

Our single vertically integrated delivery system provides access to over 15,000 experts across our global family of brands.



Complete Value Chain Services

Our value proposition

PLAN & DESIGN

Concept & Feasibility Studies

Master Planning

Development & Project Financial Services

Sustainability & Environmental Consultancy

DEVELOP

Architecture & Landscaping

Engineering & Specialist Services

Quantity Surveying & Cost Management

DELIVER

Project Management

Construction Engineering

Site Supervision

Contract Advisory

OPERATE & MANAGE

Smart City Solutions

Facilities Management & Asset Enhancement

Safety & Security Services

Defence Services & Training Solutions

SUPPORTED BY OUR FAMILY OF SPECIALISTS

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Contact us to create a smart, sustainable and resilient future.

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