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Understanding the Environmental Impacts of Products & Systems Through Life Cycle Assessment

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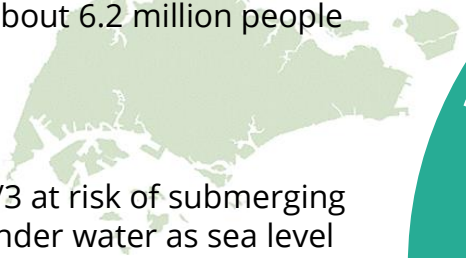
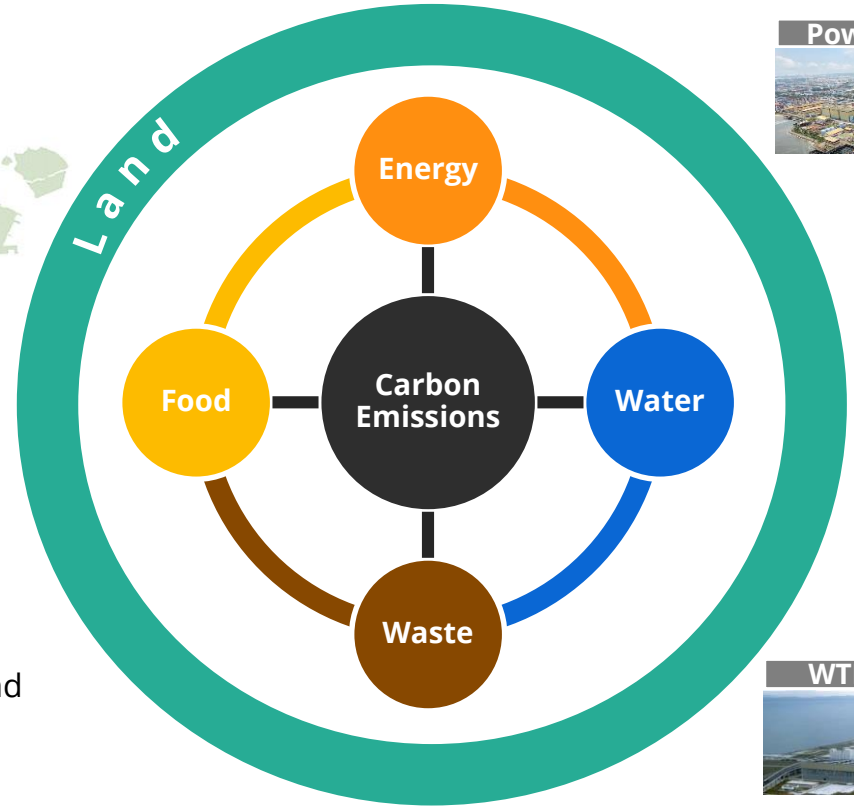
28th Oct 2020

Singapore's Sustainable Development Challenges

- Population = 5.7 million
- Projected to grow to about 6.2 million people



- 1/3 at risk of submerging under water as sea level rises due to climate change



Power Plants

- More than 95% natural gas
- Limited land for renewable energy deployment

Water Treatment

- Up to 50% imported
- Shortage of natural surface water sources

Farms

- More than 90% imported
- Limited land for agriculture

WTE Plants

- New WTE plant every 7 years
- Semakau landfill to max out by 2035

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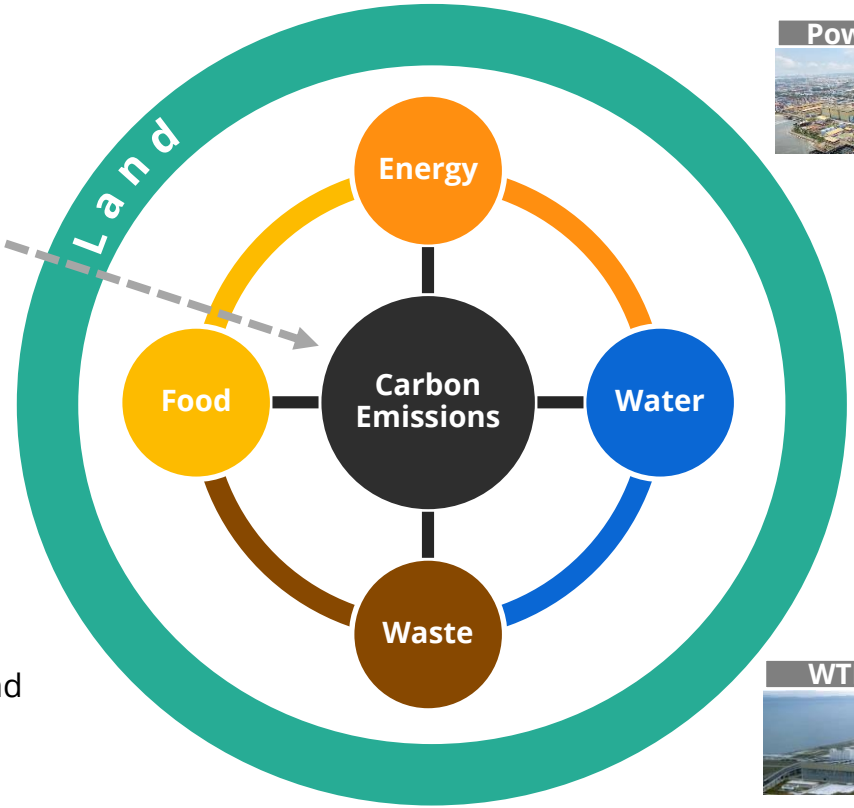
Singapore's Sustainable Development Challenges

Enhanced Nationally Determined Contribution (NDC) and Long-term Low-Emissions Development Strategy (LEDS)



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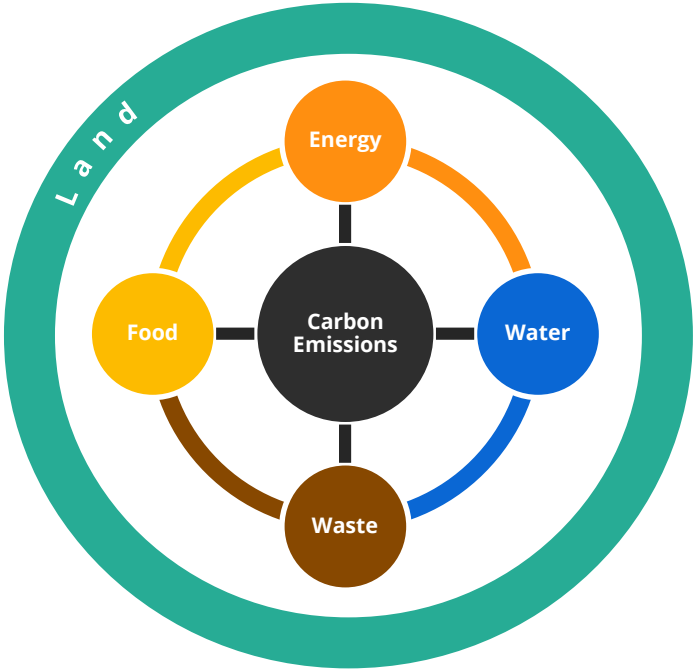
Singapore's Sustainable Development Challenges



How can we balance this **nexus of energy-water-waste-food-land-carbon** in moving towards **sustainable development**?

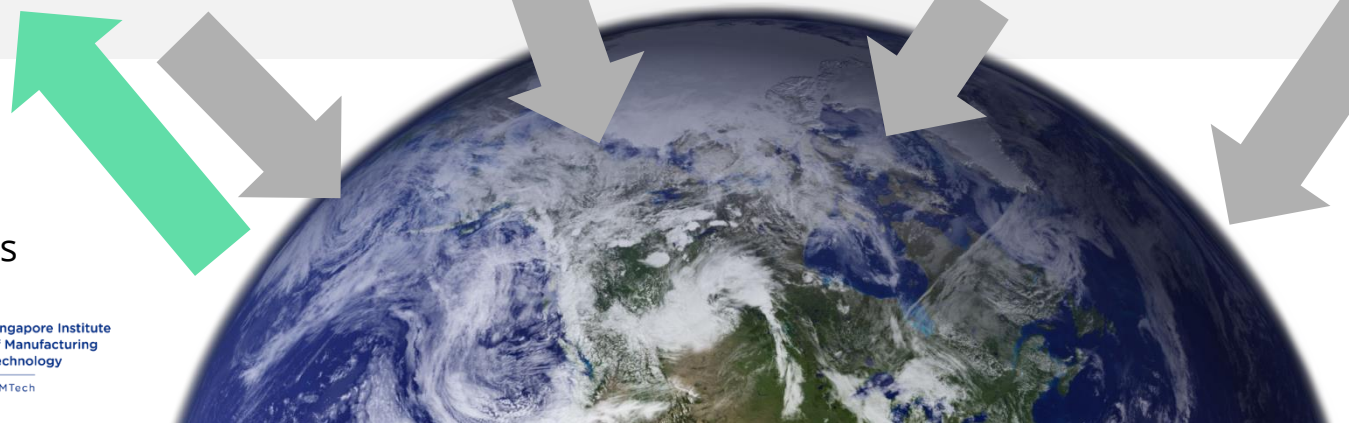
Analysing Sustainability from a Life Cycle Perspective

Raw material acquisition

Production

Usage

Disposal



Natural resources

Waste

Emissions

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Life Cycle Assessment (LCA)

An Evidence-based Approach

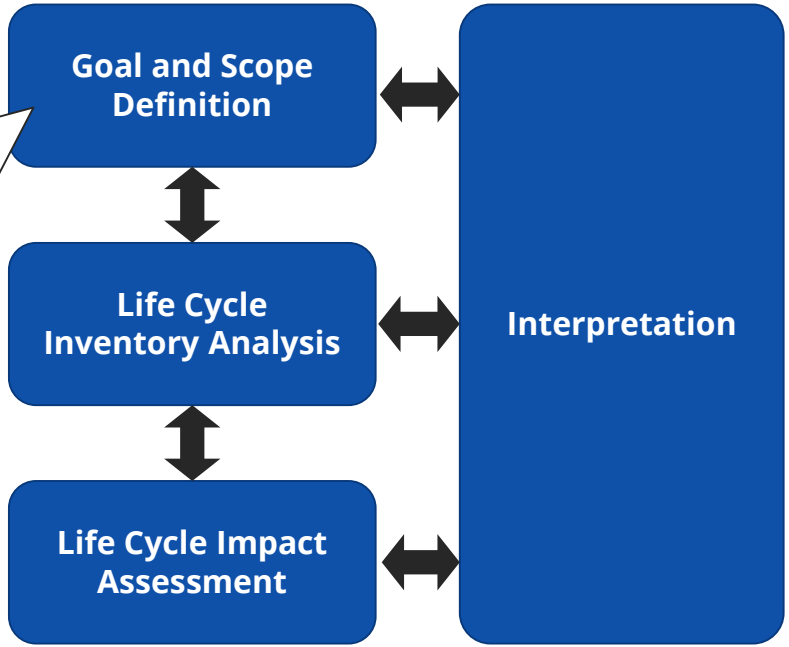
Life Cycle Assessment (LCA)

- Methodology as prescribed in ISO 14040/44.

Framing the Study

- Purpose of the study
- Target audience/ stakeholders
- Questions to be answered..?

✓ Define functional unit and system boundary



Life Cycle Assessment (LCA)

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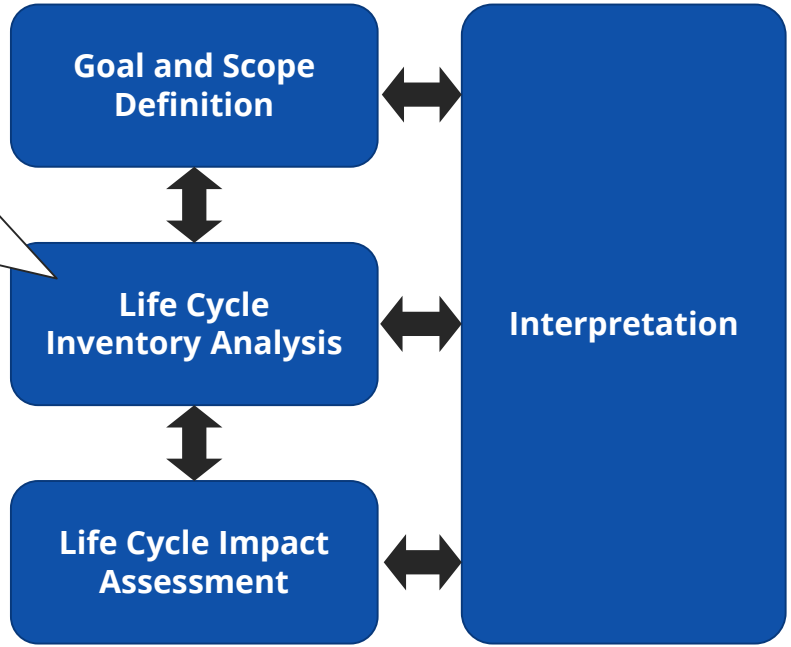
Building the Model

✓ Model and collect data on the flows of resources into, within and out of the system



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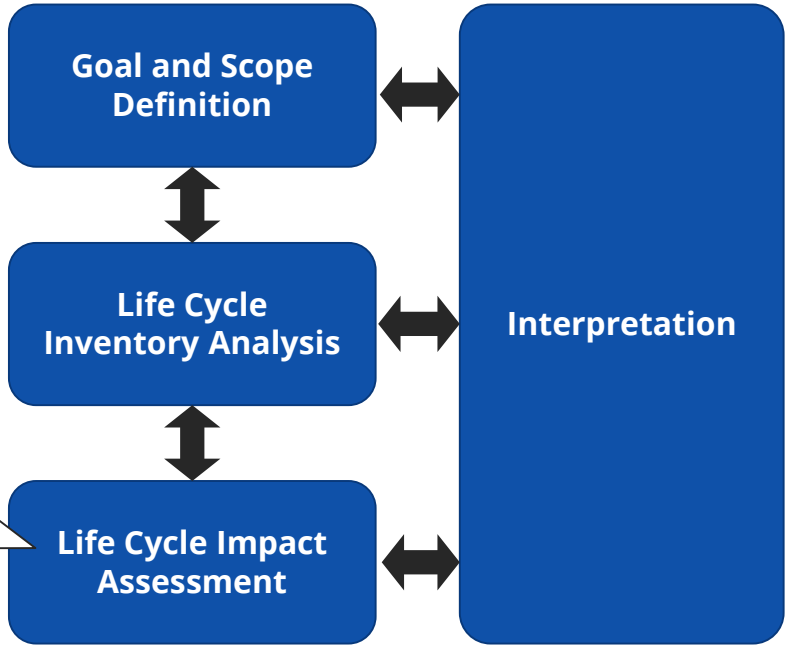

Computing the KPIs

✓ Convert the LCI data into relevant indicators

Life Cycle Assessment (LCA)

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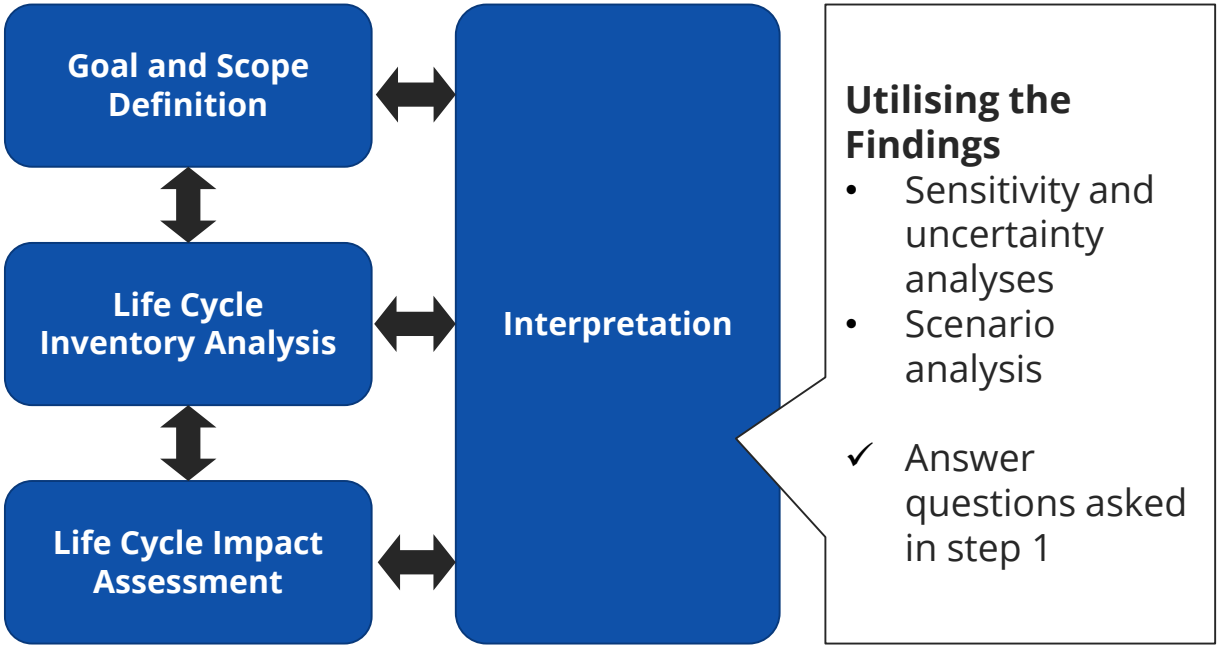
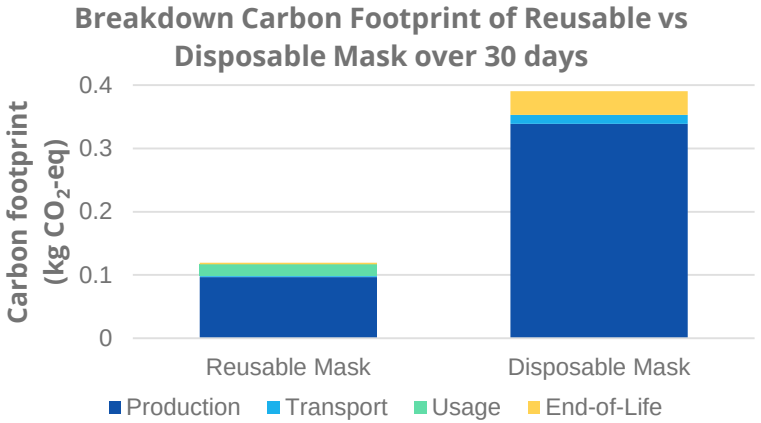
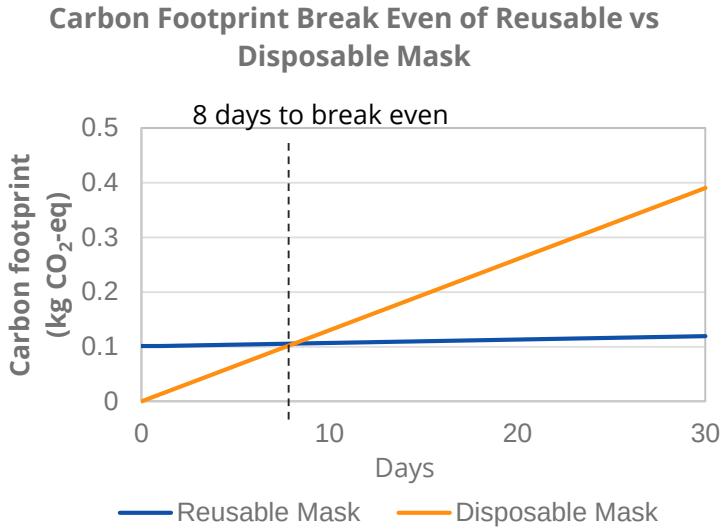


LCA Case Studies

Reusable vs Disposable Masks – Carbon Footprint

Using the reusable mask has a lower carbon footprint in the long term.





Assumptions:

- The disposable mask is used for a day.
- The reusable mask is used for 30 days.
- 1/3 of SG population return to work/school post-CB.

Over a 30-day period, using the reusable mask as compared to a disposable mask:

- Has **3.3 times less carbon footprint**.
- Has a lower carbon footprint after only 8 days.
- Can avoid a total carbon footprint of 590 tonnes of CO_2e.

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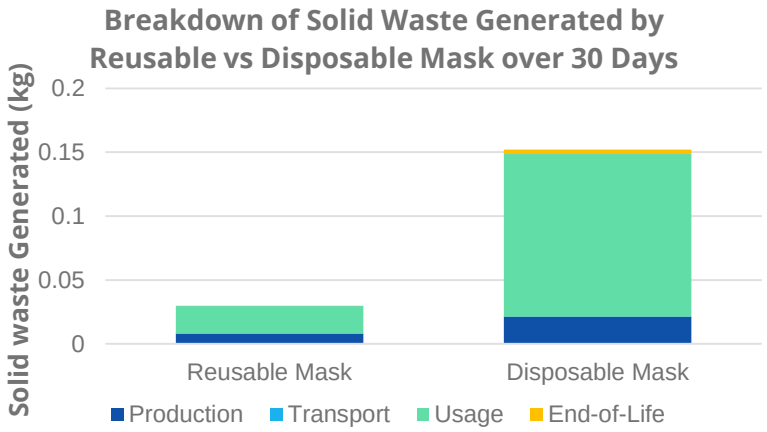
Reusable vs Disposable Masks – Solid Waste

Using the reusable mask generates less solid waste than disposable masks in the long term.



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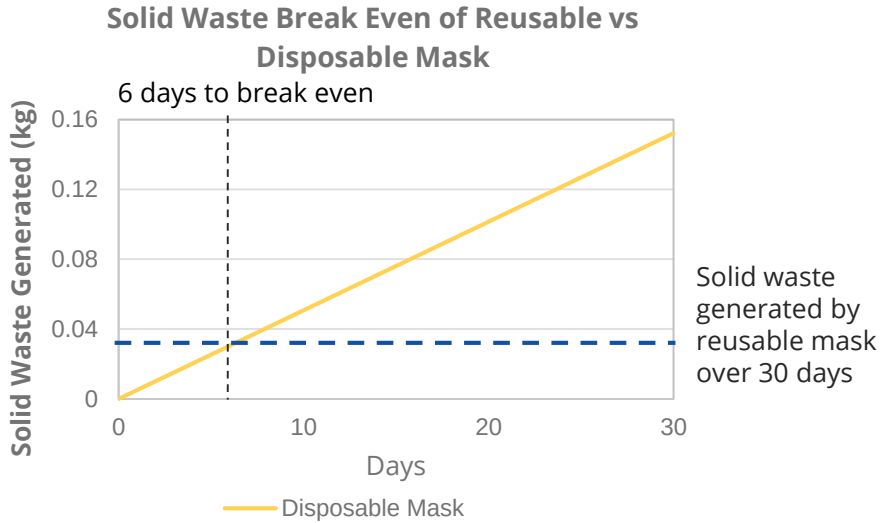

Over a 30-day period, using the reusable mask as compared to a disposable mask:

- Generates **5 times less solid waste**.
- Generates less solid waste after only 6 days.
- Can avoid a total of 220 tonnes of solid waste.

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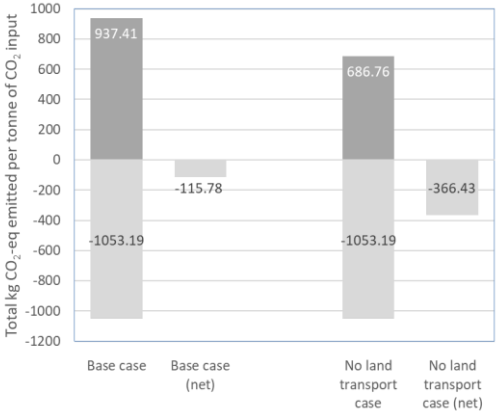
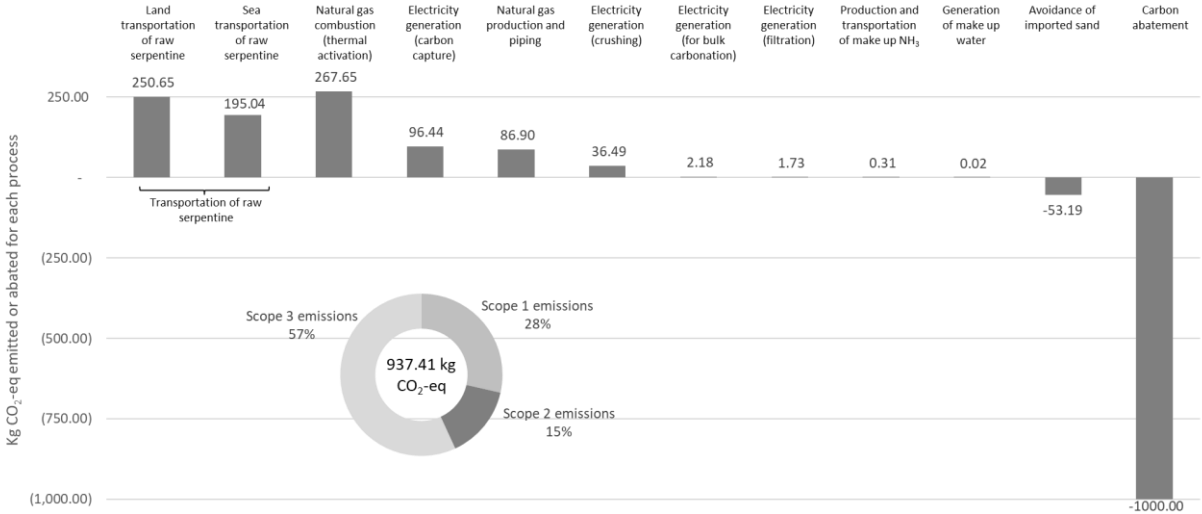
Technology Development – CO_2 Mineralisation

The CO_2 mineralisation technology can potentially help alleviate Singapore's dual need of decarbonisation and sand.





In the base case scenario, the CO_2 mineralisation technology:

- Abates a net total of 182 kilo-tonnes of CO_2-eq per year.
- Produces 11.83 million tonnes of sand per year.

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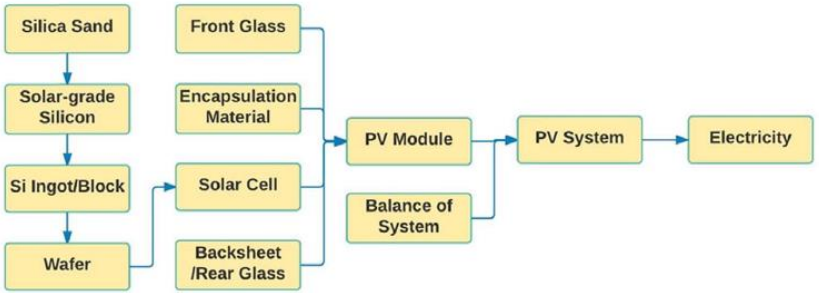
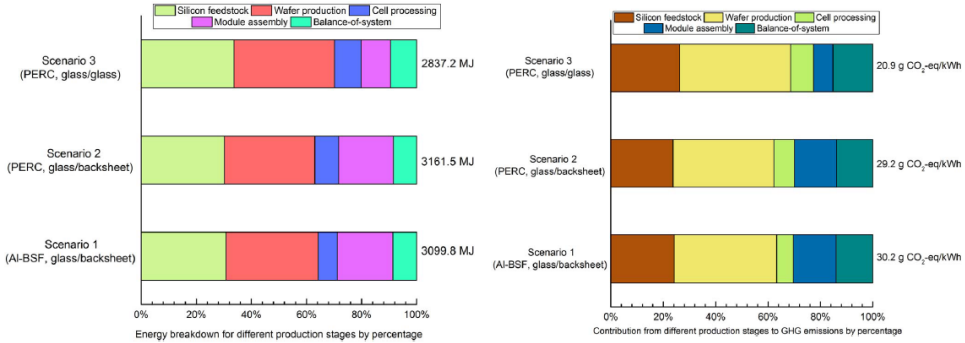
Photovoltaics Technologies





Shifting from aluminum back surface field (Al-BSF) to passivated emitter and rear cell (PERC) technology reduces the energy payback time by 2.7% and greenhouse gas emissions by 3.3%

Mitigation of LID in PERC solar cells is critical for maintaining their competitiveness relative to Al-BSF cells

NUS National University of Singapore

SERIS

W. Luo, Y.S. Khoo, A. Kumar, J.S.C. Low, Y. Li, Y.S. Tan, Y. Wang, A.G. Aberle, and S. Ramakrishna (2018), “A comparative life-cycle assessment of photovoltaic electricity generation in Singapore by multicrystalline silicon technologies”, Solar Energy Materials and Solar Cells, vol. 174, pp. 157-162.

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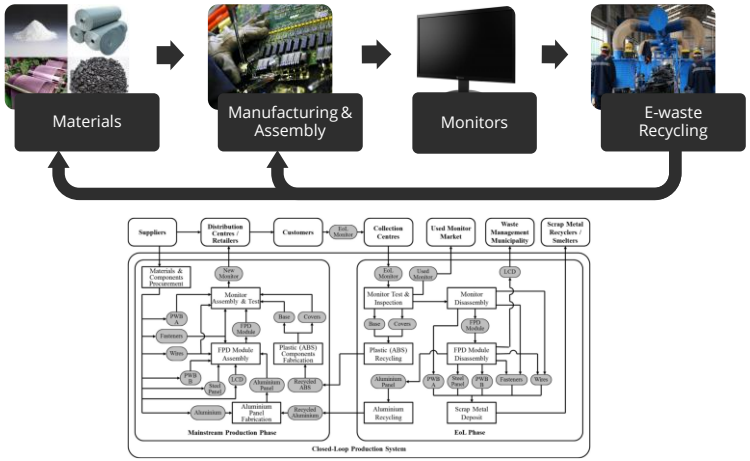
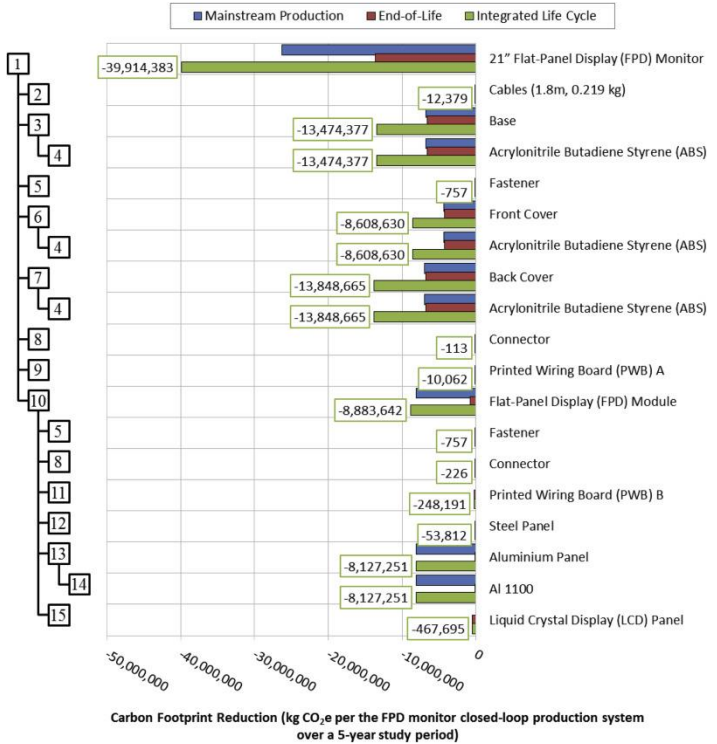
Circular Production System for Flat-panel Display Monitors





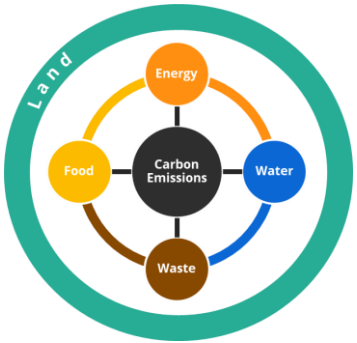
Incinerating flat-panel display monitors at their end-of-life produces significant amounts of carbon emissions

Major carbon emission reduction opportunity lies in the recycling of acrylonitrile butadiene styrene (ABS)

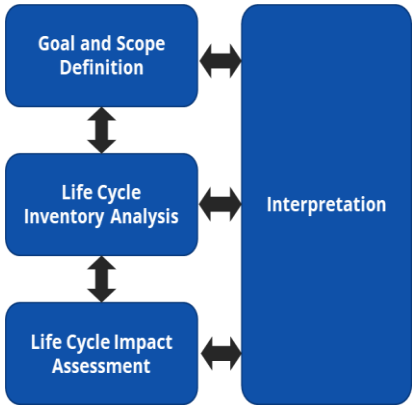
J.S.C. Low, W.F. Lu, and B. Song (2016), "Adaptation of the Product Structure-based Integrated Life cycle Analysis (PSILA) technique for carbon footprint modelling and analysis of closed-loop production systems", Journal of Cleaner Production, vol. 120, pp. 105-123.

Key Takeaways

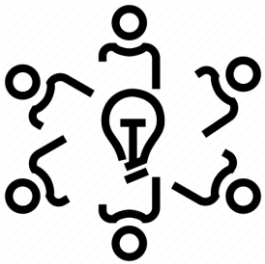
Key Takeaways



- **Evidence-based decisions and planning** will be crucial in our pursuit of sustainable development.



- To support evidence-based decisions and planning, tools such as **Life Cycle Assessment (LCA) will be needed**.



- Based on evidence and science, **collective, collaborative and decisive action** can be implemented to achieve our sustainable development goals.

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