



Review

Circular economy in Singapore: waste management, food and agriculture, energy, and transportation

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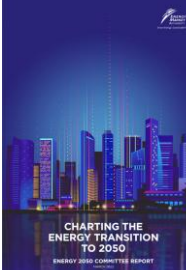
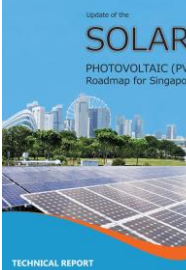

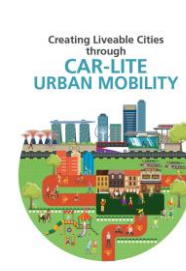
Supplementary

The following two tables list the blueprints and documents that describe the programs, policies, laws, and regulations that Singapore is currently implementing to achieve a circular economy model in the four economic sectors discussed in the article: waste management, food and agriculture, energy, and transportation. A set of photographs of Singapore's infrastructure and lifestyle are also included to help non-specialist readers as well as non-Singaporean readers easily understand the content of the article.




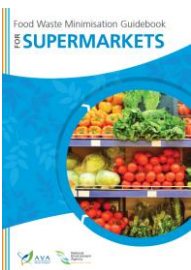
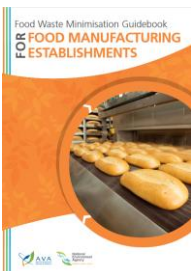

Table S1. Blueprints, reports, and guidelines outlining plans, initiatives, policies, and regulations for implementing a circular economy to make Singapore a sustainable nation in the four sectors identified as priority to accelerate environmental sustainability in the ASEAN Economic Community: waste management, food and agriculture, energy, and transportation.

Blueprint/document	Description (link)
Sustainable Singapore Blueprint 2015	Outlines Singapore's vision and plans for a more livable and sustainable Singapore to support the diverse needs and growing aspirations of Singaporeans through various initiatives (https://www.mse.gov.sg).
Singapore Green Plan 2030	Nationwide initiative aimed at advancing Singapore's national sustainable development agenda (https://www.greenplan.gov.sg).
Zero Waste Masterplan	Outlines key strategies for building a sustainable, resource-efficient, and climate-resilient nation. This includes establishing a circular economy (https://www.towardszerowaste.gov.sg).
Climate Action Plan	Outlines strategies for building a climate-resilient and carbon-efficient Singapore (https://www.mse.gov.sg).
Master Plan	Statutory land use plan that will guide Singapore's medium term development for the next 10 to 15 years (https://www.ura.gov.sg).
GreenGov.SG	Sets measures and targets to reduce carbon emissions across the public sector (https://www.mse.gov.sg).

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Blueprint/document		Description (link)
Integrated Waste Management Facility		Essential component of Singapore's long term plan for meeting future solid waste management needs (https://www.nea.gov.sg).
Charting the Energy Transition to 2050		<i>Presents perspectives</i> on key considerations, decision points, and strategic choices for Singapore's energy sector (https://www.ema.gov.sg).
Solar Photovoltaic (PV) Roadmap for Singapore		Roadmap to guide the planning and development of the solar energy sector in Singapore (https://www.seris.nus.edu.sg).
Land Transport Master Plan 2040		Describes Singapore's future land transport (https://www.lta.gov.sg).
Creating liveable cities through Car-Lite urban mobility		Key ideas on how city leaders and policy makers can collaborate with stakeholders from the private and public sectors to transition cities' mobility ecosystems to a car-lite future (https://www.clc.gov.sg).

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Blueprint/document		Description (link)
Growing Our Food Future		Reports on the state of programs and initiatives aimed at ensuring Singapore's food security (https://www.sfa.gov.sg).
Singapore food statistics		Provides a thorough coverage of the key trends in Singapore's agri-food sector (https://www.sfa.gov.sg).
Food waste minimization guidebook for food retail and establishments		Provides guidelines to assist food retail establishments in developing their own food waste reduction plans (https://www.towardszerowaste.gov.sg/foodwaste).
Food waste minimization guidebook for supermarkets		Provides guidelines to assist supermarket operators in developing their own food waste reduction plans (https://www.towardszerowaste.gov.sg/foodwaste).
Food waste minimization guidebook for food manufacturing establishments		Provides guidelines to assist food manufacturing establishments in developing their own food waste reduction strategies (https://www.towardszerowaste.gov.sg/foodwaste).
3 rd Green Building Masterplan		Aims to engage building tenants and occupants more actively in driving energy consumption behavioral change and addressing people's well-being (https://www1.bca.gov.sg).

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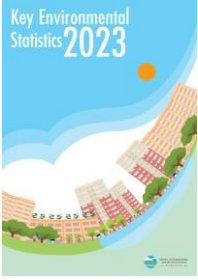


Blueprint/document		Description (link)
Green Towns Programme		Ten-year initiative to make HDB states more sustainable and livable. The programme focuses on reducing energy consumption, recycling rainwater, and cooling HDB towns (https://www.hdb.gov.sg).
Digitalization initiatives in support of the logistics industry transformation map		Guide for small and medium enterprises to assess their digital readiness and opportunities to go digital (https://www.imda.gov.sg).
Our Water, Our Future		Outlines Singapore's water strategies and plans for the next 50 years (https://www.pub.gov.sg).
Key Environmental Statistics		Annual compendium of metrics on the state of Singapore's environment. (https://www.mse.gov.sg/resources).
Sustainability @ MSE 2022		Outlines Singapore's efforts to build a more sustainable and climate resilient nation. (https://www.mse.gov.sg/resources).
Singapore's fourth biennial update report under the United Nations Framework Convention on Climate Change		Describes national efforts to mitigate and adapt to climate change. The report includes Singapore's GHG emissions inventory for 2016. (https://www.nea.gov.sg).

Table S2. Singapore's laws and regulations in place to implement of a circular economy model.

Law/regulation	Reference	Description
Resource Sustainability Act 2019	¹ Singapore Attorney General's Chambers, 2021	Tables a set of laws to improve recycling standards, including mandatory food waste segregation and treatment regulations, a mandatory reporting framework for packing waste, and new protocols for electronic-waste management that take into account the extended producers responsibility.
Carbon Pricing Act 2018	² Singapore Attorney General's Chambers, 2021	Introduces a carbon tax per tonne of GHG emissions, and outlines the measurement, reporting and verification requirements.
Active Mobility Act 2018	³ Singapore Attorney General's Chambers, 2018	Sets rules and a code of conduct for cyclists seeking safe sharing of public paths with other users.
Energy Conservation Act 2012	⁴ Singapore Attorney General's Chambers, 2021	Seeks to increase energy conservation for large energy users through regular energy monitoring and reporting, as well as the implementation of energy management systems.
Radiation Protection Act 2007	⁵ Singapore Attorney General's Chambers, 2021	Controls the import and export of radioactive materials and other related equipment, as well as the disposal, accumulation, and transportation of radioactive material.
Public Utilities Act 2001	⁶ Singapore Attorney General's Chambers, 2021	Establishes the Public Utilities Board (PUB) power, functions, and duties. PUB, as a comprehensive water authority, manages reservoirs, water works, rivers, drainage systems, water reclamation plants, and sewage systems.
Environmental Protection and Management Act 1999	⁷ Singapore Attorney General's Chambers, 2021	Consolidates laws relating to air, water, and noise pollution control in order to reduce overall environmental pollution from industrial or commercial premises.
Road Traffic (Motor Vehicles, Construction and Use) Rules 1999	⁸ Singapore Attorney General's Chambers, 2022	Specifies road traffic rules, including regulations on motor-vehicle exhaust emissions.
Hazardous Waste Act 1997	⁹ Singapore Attorney General's Chambers, 2021	Regulates the movement of hazardous waste.
Environmental Public Act 1987	¹⁰ Singapore Attorney General's Chambers, 2021	Consolidates laws governing environmental and public health.

¹ Singapore Attorney General's Chambers (2021) Resource Sustainability Act 2019. Available from: <https://sso.agc.gov.sg/Act/RSA2019>.

² Singapore Attorney General's Chambers (2021) Carbon Pricing Act 2018. Available from: <https://sso.agc.gov.sg/Act/CPA2018>.

³ Singapore Attorney General's Chambers (2018) Active Mobility Act 2018. Available from: <https://sso.agc.gov.sg/SL/AMA2017-S251-2018>.

⁴ Singapore Attorney General's Chambers (2021) Energy Conservation Act 2012. Available from: <https://sso.agc.gov.sg/Act/ECA2012>.

⁵ Singapore Attorney General's Chambers (2021) Radiation Protection Act 2007. Available from: <https://sso.agc.gov.sg/Act/RPA2007>.

⁶ Singapore Attorney General's Chambers (2021) Public Utilities Act 2001. Available from: <https://sso.agc.gov.sg/act/pua2001?ProvIds=P11-#pr2->.

⁷ Singapore Attorney General's Chambers (2021) Environmental Protection and Management Act 1999. Available from: <https://sso.agc.gov.sg/act/epma1999>.

⁸ Singapore Attorney General's Chambers (2022) Road Traffic (Motor Vehicles, Construction and Use) Rules 1999. Available from: <https://sso.agc.gov.sg/SL/RTA1961-R9>.

⁹ Singapore Attorney General's Chambers (2021) Hazardous Waste Act 1997. Available from: <https://sso.agc.gov.sg/Act/HWCEITA1997>.

¹⁰ Singapore Attorney General's Chambers (2021) Environmental Public Act 1987. Available from: <https://sso.agc.gov.sg/act/epha1987>.



Figure S1. High-rise public housing developments, locally known as HDBs, dominate Singapore's landscape. Almost eight out of ten residents live in one of them. All HDB states are surrounded by lush vegetation aiming to restore nature into the urban environment.



Figure S2. Citizens are constantly encouraged to recycle plastic, metal, paper, cardboard, and glass in commingled recycling bins. All of these bins clearly indicate which items can and cannot be recycled, as shown in panels (a-c). All other waste should be disposed of in green refuse bins. Unfortunately, scenes similar to those depicted in panels (d-e) do occur.



Figure S3. (a) Textile and paper recycling bins managed by *SG Recycle* (<https://www.sgrecycle.com>). (b) Textile recycling bin managed by *Cloop* (<https://cloop.sg>). In both cases, the bins were insufficient to accommodate the amount of deposited clothing.



Figure S4. Community urban farm in a densely populated heartland town.



Figure S5. Floating photovoltaic system at Singapore's *Tengeh* reservoir.

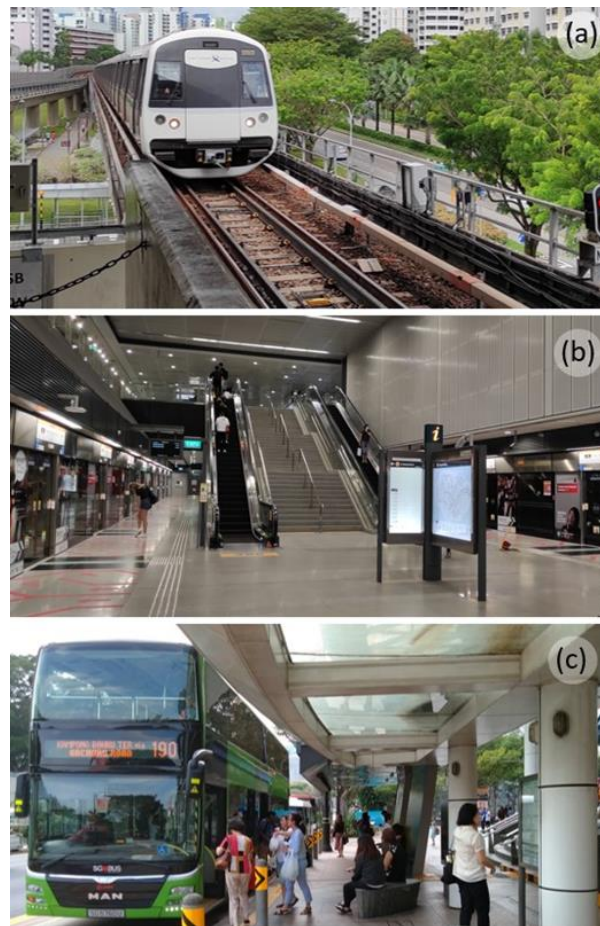


Figure S6. The rail and bus networks are the backbone of Singapore’s land transportation. (a) The rail network is called Massive Rapid Transit (MRT) and currently covers 230 km. (b) More than 130 well-equipped, modern, and clean stations on six MRT lines serve over 3-million passengers daily. (c) Almost 6,000 buses operate along more than 300 routes throughout the city.



Figure S7. BlueSG, Singapore’s first large-scale electric-car sharing service.



Figure S8. (a) Dockless shared bicycles next to a bus stop. (b) Guidelines for cyclist and motorists seeking the safe sharing of public paths.



Figure S9. Advertisements encouraging excessive consumerism are ubiquitous throughout the city and work against the implementation of a circular economy model.



Figure S10. The constant pursuit of economic progress often blinds Singaporeans to what it takes to be truly happy. A circular economy will only be possible if they change their work-life balance paradigm and forget about a life full of material aspirations.



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