

Summary of Key Findings from the Energy Technology Roadmaps

Solar Photovoltaic

There is room for Singapore to grow our solar energy industry and step up efforts to maximise solar deployment, notwithstanding the limited land for large scale deployment of renewables. Solar energy is advantageous to Singapore as it produces no carbon emissions, and enhances our energy security by reducing reliance on fuel imports. This Roadmap was commissioned to examine the potential technical and cost trajectories of solar photovoltaic (PV) up to 2050, as well as potential Research, Development, Demonstration & Deployment (RDD&D) strategies for solar energy in Singapore.

The Roadmap developed various hypothetical scenarios to estimate the amount of solar PV installations and their potential contribution to our overall electricity generation. The current estimated levelised cost of electricity (LCOE) is already cost-competitive with conventional electricity generation for some larger-scale projects, and is expected to fall even further with improvements to the efficiency and yield of solar PV.

As the amount of solar energy continues to grow, there is a need to ensure that such intermittent forms of generation are smoothly integrated into the grid, so as to ensure system security, grid stability and power quality. The Roadmap further identified other key areas where Singapore has a competitive advantage, ranging from developing solutions and products for the tropical climate to developing creative uses of space for solar PV installations.

Carbon Capture and Storage/Utilisation

Carbon capture and storage/utilisation (CCS/U) from major stationary sources is a potential technology which can help Singapore reduce carbon emissions from its power and industry sectors in the longer term future. While several technology options are possible for CCS/U, most are nascent and require further R&D.

Besides the common challenges of high energy requirements, high cost of carbon utilisation as well as potentially limited international demand for CCU products, Singapore faces unique challenges in CCS/U deployment such as our low CO₂ concentration stream, lack of local storage sites and high cost of long distance transport of CO₂.

Given our lack of domestic options for CCS, CCU presents greater potential for longer term CO₂ mitigation in Singapore. Potential approaches for CO₂ utilisation in Singapore include producing liquid fuels such as methanol, ethanol, and hydrocarbons, and mineralisation products for the construction industry. However, much work is still required to lower the cost of carbon utilisation, improve CCU process energy efficiency, as well as to find a market for CCU products.

This roadmap identified the major sources and concentrations of CO₂ emissions, highlighting those with highest potential for CCS/U. It also reviewed the various possible CCS/U options, identified the challenges and opportunities and evaluated their feasibility within Singapore's context.

Green Data Centre

Singapore is the data centre hub of Southeast Asia. In 2012, it hosted 58% of the region's data centre capacity. Supported by favourable factors such as socio-political stability, well-developed telecommunications infrastructure, the presence of a large number of multinational companies and government initiatives like the planned Data Centre Park, the data centre industry is expected to continue to experience strong growth. As data centres are energy-intensive facilities, there is a need for them to significantly improve energy efficiency.

The Green Data Centre Technology Roadmap examined technology trends in data centres, spanning the gamut from facility systems to IT systems, highlighting the challenges and opportunities for Singapore. The goal of the roadmap is to outline a framework upon which the research community and data centre industry can progressively assess their technology options, in tandem with Singapore's energy efficiency initiatives to achieve sustainability objectives.

Building Energy Efficiency

Energy consumption in the building sector is trending upwards due to increasing population and higher economic activity in most parts of the world. In Singapore, buildings including households consume about 50% of the country's electricity. It is hence essential to focus on reducing energy use in this sector via technologies that can significantly improve the energy efficiency of buildings, while ensuring liveability and long term sustainability.

This Roadmap is envisioned to help Singapore to attain our medium to long term goal of "Low Energy High-rise Buildings in the Tropics". It outlines research and development (R&D) pathways to improving energy efficiency within the building stock via technology improvements and policy recommendations. These R&D pathways span four technological focus areas integral to raising energy efficiency in buildings. The four technological focus areas are (a) Integrated design (ID), (b) Building Envelope and Façade Systems (BEFS), (c) Building Management and Information Systems (BMIS) and (d) Air Conditioning and Mechanical Ventilation (ACMV).

Based on innovative technologies identified in each of these focus areas, the roadmap identified strategies to help meet the long term goal of "Low energy High-rise Buildings in the tropics" and improve overall building energy efficiency.

Industry Energy Efficiency

The industrial sector is an important contributor to Singapore's economic growth and was responsible for 19% of Singapore's gross domestic product in 2010. The sector accounts for more than half of Singapore's energy demand, due to the presence of energy intensive export-oriented industries such as petroleum refining, chemicals, pharmaceutical and wafer fabrication. Hence, improving industry energy efficiency is important to further reduce greenhouse gas emissions while reducing total energy usage, making the economy more competitive and improving environmental sustainability.

This Roadmap identified emerging and next-generation technologies in 5 segments: (a) Petroleum, (b) Petrochemical and Chemicals, (c) Semiconductor, (d) Pharmaceutical and (e) Others. The technical and economic energy efficiency potentials of these technologies in Singapore, together with prevailing best available technologies were then estimated for the medium to long term. Technologies which offered the highest potentials for energy savings were found to be system solutions and energy efficient heating processes such as refinery and chemical plant integration, smart manufacturing/ advanced facility automation, improved catalysts, catalytic cracking of naphtha for olefin production and super-critical CO₂ cycle heat recovery systems.

In order to improve the performances of industrial plants, the Roadmap recommended supporting further RDD&D programs, based on the technologies identified. A robust monitoring and evaluation framework is also required to ensure the progress of the technology from R&D to deployment.