

SINGAPORE × MONOCLE

A guide to Singapore Energy

01 Urban Energy Solutions

Introduction

The drive for sustainable development

Lacking in natural resources and vulnerable to climate change, Singapore faces tough challenges in developing energy solutions. The government's reaction has been to pledge to spend S\$1bn (€566m) in the five years from 2009 on sustainable development initiatives.

Small businesses are now connected to smart grids and can choose to purchase electricity only at specific times. Many Singaporean households have smart meters that can measure the amount of energy they consume against their neighbours.

The most public efforts, though, are being showcased in Marina Bay. Buildings there are hooked up to five central cooling towers, sharply reducing the use of electricity. Meanwhile, LED lights and outdoor fans along the promenade are powered by solar energy. — KA



Five innovative urban energy solutions

Projects and players

- 01 Singapore's Intelligent Energy System:** A smart-electricity grid pilot aims to improve grid efficiency and provide consumers with real-time consumption data.
- 02 Electric vehicles** will soon hit Singapore's streets in a S\$20m initiative to make Singapore a "living laboratory" for urban transport solutions.
- 03 Alpha Biofuel:** Makes engine-ready biodiesel from waste oil (pictured).
- 04 Punggol Eco-Town:** The country's first sustainable public housing development.
- 05 Housing Development Board (HDB):** HDB precincts are conducting Singapore's largest solar testbed. HDBs house 80 per cent of Singaporeans. — AMM

Zero-energy buildings

Braddell building

Singapore's zero-energy building in Braddell, central Singapore, sets an example of how energy-efficient mixed-use developments could be created.

A first in Southeast Asia when it opened in late 2009, offices and classrooms at the Braddell building are all hooked up to solar panels, which were retrofitted by firms such as DP Architects and the National University of Singapore, and saves up to €50,000 in energy-costs a year. — KA



Cool solutions

Air-conditioning

Singapore may be known as the "air-conditioned nation" but that doesn't mean that its air-conditioning isn't powered by green means. At the forefront of the effort to keep cool while remaining green is the District Cooling System, which has been implemented in the Marina Bay district.

The system takes advantage of the Common Services Tunnel, a network of amenity pipes, to distribute cool air from central plants to buildings in Marina Bay. This way, buildings will no longer need individual cooling units. Developers in Marina Bay will also have to achieve a Platinum or GoldPlus standard under the Green Mark Scheme, which grades buildings according to how environmentally friendly they are. To make the cut, developers have to make their projects up to 30 per cent more energy efficient than conventional buildings. — KA

Five clean energy companies

Beyond fossil fuels

- 01 Atlantis Resources:** Uses turbines to capture energy from ocean currents.
- 02 Asia Renewables:** As well as hydroelectric and solar projects, this renewable energy firm turns biomass such as cattle dung into renewable electric power.
- 03 Biofuel Research:** Has developed refining technology to turn waste cooking oils into non-toxic biofuels for use in diesel engines.
- 04 Keppel Seghers:** A waste-to-energy operator that generates enough to power more than 20,000 homes a day.
- 05 Phoenix Solar:** Provides and integrates solar power systems for homes and businesses, including Changi Airport. — AMM

Windpower central

International investment

Singapore isn't a windy place but titans such as Siemens (below), Spanish Gamesa, Korean Cygnus Power (below right) and Danish Vestas have been drawn here. Vestas, the world's largest wind-power supplier, is spending €350m to develop its largest R&D centre outside Denmark.



Lured by a robust research, finance and business environment, these firms have laid the foundation for a strong local industry. "Singapore is evolving as a wind R&D capital," says Bjørn Tore Markussen, managing director of wind consultancy firm DNV's Clean Technology Centre. "One of Singapore's strengths is its proximity and accessibility to existing and potential wind energy markets in the Asia Pacific," says Bernhard Telgmann, senior vice president and head of Siemens' Asia Pacific renewable energy division. — AMM



Q&A

Professor Subodh Mhaisalkar, Nanyang Technological University

What's next for the development of energy-efficient buildings in Singapore?

Energy-efficiency measures and retro-fitting for energy efficiency should be a focus. The test-bedding of renewable technologies are also being looked at.

What challenges are there when it comes to developing energy efficient housing?

Singapore has a lack of natural resources. It has to leverage innovation and information technologies.

What role will Jurong Island play in developing clean tech?

It should focus on energy efficiency initiatives in collaboration with the logistics industry. The new experimental power grid centre there will enable a pilot test of the integration of clean tech sources into the electric grid.

Which areas of the clean energy sector will take the lead in Singapore?

Energy efficiency, solar energy, smart grids and electric vehicles.

Why is Singapore a good place for conducting clean technology research?

It provides a controlled environment for test bedding and research through supportive government policies and the availability of world-class labs. — KA

Star of solar power

An international centre

Singapore is fast establishing a reputation as an international solar energy centre. Prominent industry players here include Renewable Energy Corporation (see *overleaf*), Germany's Bosch (pictured), both running research centres for new solar technology, and Austrian thermal energy specialist Solid Asia, which is working to optimise its technology for cloudy tropical environments. — AMM



02 Clean Technology & Water

Introduction

The sustainable energy agenda

Singapore has been fast to adopt the mantra that clean tech is the way forward. The city-state estimates the clean technology industry in Singapore will contribute S\$3.4bn to the economy and provide up to 18,000 jobs by 2015. Singapore is investing S\$680m in developing the sector, which includes clean energy and environment and water. In the clean energy space, solar energy is a focus: the Singapore Economic Development Board (EDB) believes Singapore's semiconductor and engineering expertise lend it a competitive edge, as does its sunny location: there has been an influx of world-class solar firms. Water tech is also a priority, and a plethora of firms, such as Japanese Toray and German Mann+Hummel, have been invited to launch research institutes and regional HQ from its shores. — AMM

Five water technology firms

The forefront of water treatment

- 01 NUS-GE Singapore Water Technology Center:** Focuses on new solutions for low-energy seawater desalination, water reclamation and more efficient water reuse.
- 02 Toray Singapore Water Research Center:** Based at Nanyang Technological University, developing water treatment (*top*).
- 03 Norit:** Supplies its Asia Pacific operations with pumps and membrane filtration.
- 04 Siemens Water Technologies:** Working with the Singapore Public Utilities Board Singapore's national water agency PUB on a testing facility treating wastewater.
- 05 Mann+Hummel:** German filtration specialist has based the global HQ for its water division here (*bottom*). — DW



CleanTech Park

The eco-business park of the future opening from next year

Destined to become the heart of Singapore's thriving clean technology sector when completed in 2030, CleanTech Park will be a hub of collaboration and innovation, a green technology business park and a model of sustainable design. And it's almost open for business: CleanTech One – a microcosm of the park's ecological design with technology such as on-site renewable fuel-cell energy – will be ready for tenants as early as 2012. — AMM



Singapore International Energy Week

Bringing together the key international energy market players

You can count sheikhs from oil-rich emirates and ministers from resource-hungry economies among the 15,000 visitors expected to attend the fourth edition of the Singapore International Energy Week (SIEW) this October and November.

The five-day event, which is organised by the Energy Market Authority, consists of eight conferences that cover a myriad of topics. This year will also see the first edition of EMART Asia, the sister of the largest annual European energy trading conference and the sole energy trading event to take place at SIEW. "Governments and companies have found SIEW to be a useful focal point for fruitful conversations and partnerships," says Lawrence Wong, who founded SIEW in 2008.

And he's right: last year, 14,655 participants attended, three times more visitors than in 2009. Previous keynote speakers include Saudi minister of petroleum and mineral resources Ali bin Ibrahim Al-Naimi and Tepco chairman Tsunehisa Katsumata. This year, participants at the Energy Summit can expect to hear from Shell CEO Peter Voser. — KA
siew.sg

Water treatment

A key sector

Water and environmental technologies is a key growth sector. Test bedding projects on membrane bioreactor technology are being carried out at the Ulu Pandan Water Reclamation Plant. A project by Japan's Meidensha Corporation also involves testing ceramic plate membranes. — DW

Singapore clean tech going global

Local companies contracted overseas

Singapore's drive to boost development by concentrating considerable resources on the sustainable supply and use of energy is paying handsome dividends. Not surprisingly, other resource-poor countries have come calling to tap into the island-state's technical expertise in the area. Hyflux is working on its second seawater desalination project in Algeria, this time in Magtaa. In Oman, Sembcorp co-owns a power and desalination plant that, when completed next year, will have the capacity to produce 69,000 cubic metres of water a day. The Sino-Singapore Tianjin Eco-City, meanwhile, is an ambitious experiment between China and Singapore to build a city on ecological parameters. — DW

Small but powerful

Clean tech SMEs

Singapore is big on small to medium-sized (SMEs) firms (and no wonder, considering that they contribute 50 per cent of GDP). The same goes for clean technology SMEs – small firms such as biodiesel refinery experts Biofuel Research and solar efficiency specialists NavSemi are often major drivers of innovation in the niche markets where they excel.

US- and Singapore-based GreenWave Reality is one example of a firm that has successfully launched locally. It has been lauded for its elegant solution to home-energy management (*pictured*); it collects data from home-wireless appliances hooked up to a wireless network, showing where energy is wasted in the home while suggesting how home owners can conserve energy.

To provide grants and support for even more Singapore-

Marina Barrage

An eco-friendly model

Marina Barrage created the only freshwater reservoir to be built in the middle of the city, and stretches 350m across the mouth of the Marina Channel. With a catchment area of 10,000 hectares, or one-sixth the size of Singapore, it is the lynchpin in the country's water-catchment project.

But a key feature is the barrage's green credentials. Its green roof is built on energy-saving principles using recycled plastics and drainage cells. Double-glazed glass panels reduce air-conditioning power, water-less urinals conserve water and 405 solar panels generate 50 per cent of the reservoir's daytime power requirements. — DW



based clean tech start-ups as well as firms relocating to Singapore, a local Quickstart programme has also been set up. — AMM

Three SMEs:

- 01 Omega Thermal:** Omega Thermal's technology captures waste heat from home air-conditioning units and uses it to heat water, at no extra cost, in minutes.
- 02 Cleantech Ventures Asia:** Clean tech companies who

Design for Efficiency Scheme Big business goes green

Administered by the National Environmental Agency, the Design for Efficiency Scheme (DfE) provides large energy consumers – such as production plants, office buildings, hospitals and schools – with funding and incentives to incorporate energy and resource efficiencies into their manufacturing development plans. — DW



Q&A

Goh Chee Kiong, director of clean technology at the Singapore Economic Development Board (EDB)

What is the EDB doing to develop clean technology in Singapore?

It is helping to grow the clean tech industry by developing R&D, manpower, grooming Singapore-based enterprises, nurturing a clean tech ecosystem and branding the industry internationally.

What particular kinds of clean technology is the EDB focusing on?

Owing to our location in the tropics, as well as competencies in high-end electronics, there is a focus on growing solar energy.

What does Singapore have to teach other countries about clean technology?

An ability to bring together governmental and non-governmental parties to support experimentation. Singapore has developed water management technologies and is a global hydro-hub.

How do you see the local clean technology industry in a decade's time?

Clean tech is expected to contribute S\$3.4bn to Singapore's economy by 2015. Singapore is positioning itself as a living laboratory, where firms can test and commercialise future-oriented solutions. — AMM

03 Jurong Island & Renewables

Introduction

Moving towards a greener energy policy

Unwelcome visitors don't make it to Jurong Island – metal barriers shoot up through the expressway leading to the island to stop trespassers. Little wonder it's so safely guarded: formed of seven islets in southwestern Singapore, Jurong houses the country's oil and petrochemicals industries. With conglomerates such as Shell operating there Jurong is crucial to the local energy and chemicals industry and takes third place among the world's largest export refining centres.

But with China and Malaysia aggressively expanding their refining industries, Singapore is climbing up the value chain by developing clean technology. China's Huaneng Group recently opened a S\$2bn (€1.1bn) clean coal plant at Jurong and Rolls-Royce is investing in smart grid research facilities on the islets. — KA



Jurong Island in numbers

Facts and figures

Number of companies: 99 as of February 2011

Number of people employed: Over 15,000 as of February 2011

Money invested to date: S\$38bn as of February 2011

Percentage of local economy: 2.4 per cent of GDP in 2010

Cost of land reclamation in Singapore: S\$7bn

Amount of reclaimed land: 3,200 hectares or 32 sq km

Big players: Shell, ExxonMobil, Singapore Refining Company, Sumitomo Chemical, Mitsui Chemicals

Places of learning: The Chemical Process Technology Centre and The Institute of Chemical Engineering and Sciences

Total crude oil refining capacity: 1.3 million barrels a day

Oil storage capacity: 20 million cubic meters — KA

Solar energy

Sunshine state

It's not surprising the solar industry leads Singapore's renewable energy sector. The city-state is blessed with months of sunshine.

One of the top firms is the Norwegian Renewable Energy Corporation (REC). It set up the world's largest solar manufacturing complex in Singapore last year, pouring \$2.5bn (€1.4bn) into a state-of-the-art facility in Tuas, western Singapore.

REC is confident that the new plant, which may more than treble its production, will increasingly allow it to offer products that compete with grid-based electricity – a boon, as solar prices fall, for the many Asians with no access to grid electricity. — (AMM)



Q&A

Lee Tzu Yang, chairman, Shell Singapore

What do Shell's operations on Jurong Island involve?

Shell's operations consist of Shell Chemicals Seraya, which is one of the largest petrochemical production and export centres in Asia-Pacific, and two glycol chemicals operations.

What made you decide to set up on Jurong Island?

Its plug-and-play model eliminates the need for investors to build import-export and storage facilities. Being located in an established petrochemical hub was also important, as was the strong support from the Singapore government and the many skilled workers.

How does Shell see the future of Singapore's energy industry?

We expect that many customers will announce investment plans here over the next year. More companies are coming now because there is feedstock and infrastructure. Jurong Island is very attractive as a manufacturing base to supply China, India and the rest of ASEAN.

How is Shell helping develop the clean energy sector in Singapore?

In Singapore, energy efficiency is the most relevant element. Shell invested more than US\$1bn (€700m) last year in researching alternative energies and energy solutions.

How has the Singapore government helped Shell invest here?

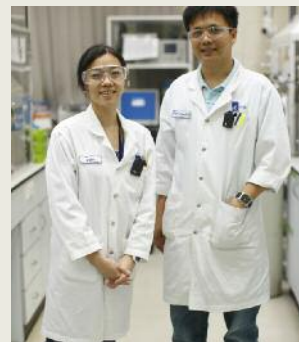
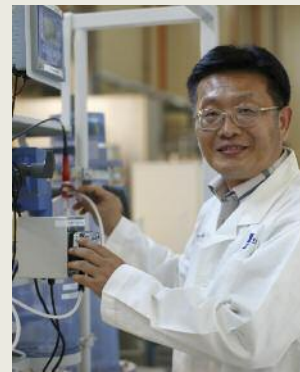
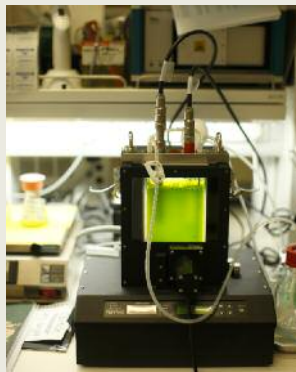
Without the Singapore government's support we would not have been able to make significant investments. There was a lot of infrastructure that needed to be built and many government agencies were involved. — KA

Education

Teaching the future players

With Singapore's petrochemical industry becoming an increasingly important component of its economy, educational programmes to groom the next generation of energy professionals (2,000 are expected to graduate over the next five years) have sprouted up on Jurong Island.

The Singapore Economic Development Board (EDB) has opened the Chemical Process Technology Centre, which has a full-sized petrochemicals plant on campus. The EDB also works with the National University of Singapore on the Singapore Certified Energy Manager programme, which teaches students how to retro-fit buildings to run on low carbon energy. Meanwhile, students at the Institute of Chemical Engineering and Sciences (*right*) are developing chemical patents for the energy industry. — KA



Neste Oil

The latest international firm choosing Singapore as its regional hub

International energy firms are increasingly eyeing Singapore as a regional headquarters. One of the newcomers is Neste Oil, the Finnish oil refiner, which completed its third renewable diesel plant at the industrial area of Tuas in Singapore late last year.

Petri Jokinen (*right*), managing director of Neste Oil Singapore, says it was a combination of "good infrastructure, competent personnel, good service providers and a well functioning economic system" that attracted Neste to Singapore. Employing 120 people, the €550m plant has an annual production capacity of 800,000 metric tons of NExBTL renewable diesel, which is distributed mainly in Europe and North America. Feedstock processed at the plant, including palm oil, is imported from neighbouring Malaysia and Indonesia. — KA



04 Future of Singapore Energy

Overview_

Projects and investment in the pipeline

The phrase of choice among players in Singapore's energy industry is "smart energy". And with ambitious plans to reduce energy intensity by 35 per cent from 2005's levels by 2030, little wonder.

Reaching this target will be made easier by Singapore's willingness to spend up to S\$680m on clean technology R&D. The bulk of this budget is being focused on solar technologies.

Much of this smart energy is slated to be generated through the 2,060 hours of sunshine that Singapore receives each year. Norway's Renewable Energy Corporation has set up the world's largest solar manufacturing complex here, while the government is also fortifying existing energy sources: a large portion of Singapore's electricity comes from natural gas, much of which is piped in from Malaysia and Indonesia. With a view to diversifying sources, Singapore is increasing its use of liquefied natural gas (LNG), which can be imported from further away. By 2013, a S\$1.5bn LNG terminal on Jurong Island is expected to come online. Asia's first open-access, multi-use terminal will be "capable of importing and re-exporting LNG from multiple suppliers", says Chee Hong Tat, chief executive of Singapore's Energy Market Authority.

Chee's organisation is also heavily promoting new technologies, such as a pilot programme for an integrated smart grid. "We're working to make Singapore a 'living laboratory' for novel energy solutions," he says.

Singapore's willingness to support clean tech has set up a chain of foreign investment. Denmark's Vestas has built a S\$500m R&D centre here while Rolls-Royce has set aside S\$10m to work on developing fuel cells with local manufacturers. Powered by these different sources of energy, the future of Singapore's energy industry is looking auspicious. — KA



In the pipeline_

Top 10 innovative energy projects

- 01 CleanTech Park:** Located on a 50 hectare site at Jalan Bahar in the northwest, Singapore's clean technology park will be the region's first when it opens in 2030. 20,000 employees are expected to put their clever hats on here and come up with new ideas in green technology and urban low-energy solutions.
- 02 Gardens by the Bay:** UK architecture firms Grant Associates and Gustafson Porter are designing the project Gardens by the Bay; three gardens on a prime 101 hectare harbour-front site that will feature "super-trees" – vertical gardens stretching up to 50 metres – and glass-structures kitted out with solar panels for energy-generation. The Gardens are expected to open at the end of this year.
- 03 Green island:** Plans are afoot to transform Pulau Ubin, an island northeast of Singapore, into a green haven powered on solar, tidal and wind-energy. Naturally, Pulau Ubin will run on biofuel.
- 04 Punggol Eco-Town:** Already partly opened on Singapore northeastern coast, Punggol Eco-Town (due for completion in 2015) is the place where new sustainable energy technologies will be tested. The goal is to replicate the project island-wide.
- 05 Lorong Halus power-plant:** A new electricity power plant at Lorong Halus in northeastern Singapore will serve new industrial and commercial developments in the area.
- 06 Intelligent Energy System:** Singapore's Energy Market Authority is rolling out its S\$30m smart-grid pilot at Nanyang Technological University, the CleanTech Park and Punggol Eco-Town over the next two years, allowing 4,500 students, homeowners and office-workers to control their energy-usage.
- 07 Liquefied gas terminal:** Come 2013, Jurong will have a brand new liquefied natural gas terminal. The government-sponsored S\$1.5bn project will be able
- 08 Liquefied natural gas pipeline:** Singapore's liquefied gas supply to areas at Tuas, Jurong Island and northern Singapore will flow a lot easier when SP PowerGrid opens three new gas pipelines connected to Jurong's new Liquefied Gas Terminal in two years.
- 09 Keppel Energy power-generation:** Singapore's power-plant operator Keppel Energy is expanding its natural gas plant on Jurong Island. The S\$900m project is due for completion in 2013.
- 10 Jurong Rock Caverns:** There isn't an abundance of storage space on Jurong Island. That problem will be solved in two years when local JTC Corporation completes the underwater construction of huge caves where up to 1.47 million cubic metres of crude oil can be stored. — LL