



A final test model of the Extremely Low Earth Imaging Technology Explorer, seen at the NTU Satellite Research Centre on June 11. It will be the Republic's first satellite to fly closest to the Earth. ST PHOTO: GAVIN FOO

Satellite • NTU's 14th and largest set to launch in mid-2025

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The size of a small fridge, it is the largest and most complex to date and will be the Republic's first satellite to fly closest to the Earth.

Most satellites in space are found at least 500km to 800km from Earth. The new 1.3m-tall satellite, named Extremely Low Earth Imaging Technology Explorer, will soar just 250km above the globe. The research satellite is

expected to spend about 1½ years in space to test some novel technologies and capture high-quality pictures.

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S'pore's first satellite to orbit closest to Earth set to launch in mid-2025

Shabana Begum

The Republic's first satellite to fly closest to the Earth – carrying novel technologies and capturing high-quality pictures – has been built by Nanyang Technological University (NTU) and will be ready for take-off in mid-2025.

Most satellites in space are found at least 500km to 800km from Earth. The new 1.3m-tall satellite – named Extremely Low Earth Imaging Technology Explorer (Elite) – will soar just 250km above the globe.

This altitude is a relatively unexplored part of space with a harsher environment for machines since they are surrounded by highly reactive gases and atmospheric friction. Only a handful of such satellites are in very low orbit currently.

As a research satellite, Elite is expected to spend about 1½ years in space to test some novel, home-grown devices and see if it is possible for more Singapore satellites to fly closer to Earth.

The size of a small fridge, Elite is NTU's 14th satellite, and its largest and most complex to date. To top it off, the spacecraft will be launched during a period of heightened solar activity between 2024 and 2025.

While powerful solar storms and flares treat people on Earth to dazzling auroras far beyond the poles – as seen during the major storms in May – such strong activity from the Sun can be a menace to satellites, worsening friction and destroying sensitive microchips.

But instead of feeling apprehensive about the upcoming launch, NTU Satellite Research Centre wants to embrace that challenge.

“It's a good thing for us because we can prove that we can operate a satellite in high solar activity,” said Mr Lim Wee Seng, executive director of the Satellite Research Centre.

Since Elite will be half the dis-

tance from Earth compared with a conventional satellite, it can capture better quality images up to 50cm in resolution. Such satellites could allow first responders to better monitor the spread of volcanic ash after an eruption, for example. Telecommunication could also improve, as a satellite closer to Earth will reduce network delays.

With fewer spacecraft in a 250km orbit, Elite will be able to manoeuvre through space without the risk of colliding with another vehicle or disused satellite, added Mr Lim.

The latest model of the 180kg space vehicle was shown to President Tharman Shanmugaratnam when he visited NTU Satellite Research Centre on June 11.

President Tharman toured Singapore's first satellite-building facility and was briefed on the country's local space ecosystem by NTU and the Office for Space Technology and Industry, the national space office.

The current Elite model has been undergoing a series of stress tests at Thailand's space agency, including vibration and exposure to thermal vacuum conditions, to ensure that its design is fit to fly in space.

Once this model clears the rigorous tests, NTU will build the actual Elite satellite, with a plan to reach outer space in June 2025.

Singapore is not a space-faring nation, but its niche lies in building high-tech space components and small satellites. The country is home to more than 60 local and international space-tech firms, with a combined total of over 2,000 professionals and researchers.

Since 2011, Singapore has launched more than 30 satellites.

A key obstacle facing space vehicles at very low orbit is atmospheric drag, which can slow down the satellite, causing it to veer off-course and re-enter the Earth's atmosphere within days. More solar flares would also make conditions

worse for the machine.

To prevent this, Elite will have a novel and fuel-efficient engine built by Aliena, an NTU deep-tech spin-off, to help the satellite fight the friction.

Aliena's chief executive Mark Lim said: “The engine needs to deliver a significant amount of thrust with lower power to ensure that we can continue firing the satellite to compensate for drag without bleeding out the batteries.”

“You can rapidly fire your engines during unexpected events like severe geomagnetic storms, which could result in the decrease in the altitude of the spacecraft quickly.”

Being closer to Earth, the satellite can capture higher-resolution images of agricultural activities and mining, for example, with smaller camera optics. To that end, the satellite will be equipped with Singapore's first locally designed space camera, which can capture pictures of objects as small as 50cm in length.

Conventional satellite cameras have large telescopic lenses. The smaller camera on Elite is a creation of local tech firm LightHaus Photonics.

At 250km from Earth, satellites will encounter atomic oxygen, a highly reactive gas that corrodes and degrades electronic materials. To protect Elite from the corrosive oxygen, NTU Temasek Laboratories is creating an ultra-thin, transparent nanotechnology coating for the spacecraft.

Elite is a joint project between NTU, Aliena, LightHaus Photonics, NUS Temasek Laboratories and ST Engineering Satellite Systems.

As part of its 1½-year mission, the satellite will lower its orbit in stages, collecting data as it descends to Earth and burns up in the atmosphere. It will not end up as space debris or junk.

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Elite: Flying close in space

A 1.3m satellite built by Nanyang Technological University will soar 250km from Earth when it is launched in mid-2025. **Shabana Begum** breaks down the features of NTU's largest and most complex satellite, named Elite.

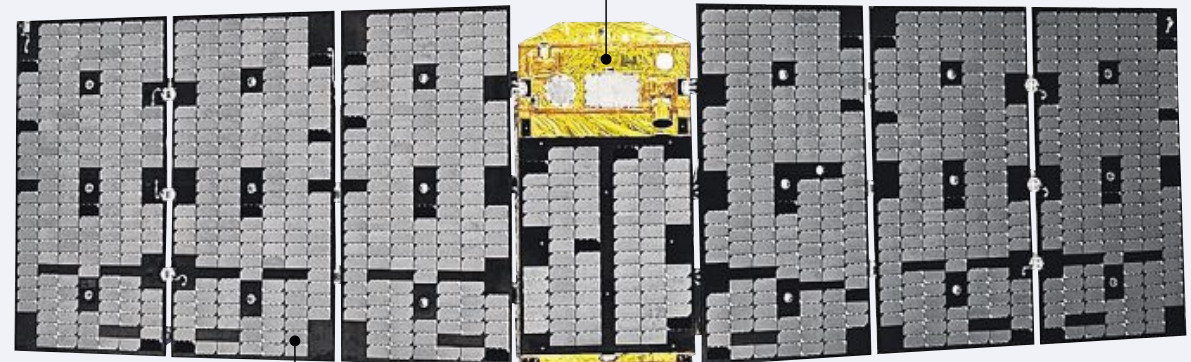
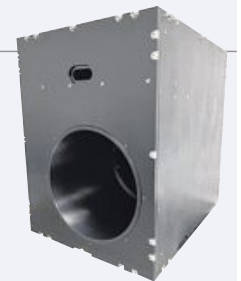


Protective coating

Ultra-thin, transparent nanotechnology coating to protect the satellite from corrosive oxygen in space.

First locally designed space camera

It can capture objects as small as 50cm in length.



Weight: 180kg



Tri-fold solar panels

Longest solar panel wings for an NTU satellite, as Elite needs a lot of power to run.

Special engine

Fuel-efficient engine provides powerful thrusts to keep the satellite in orbit, as it fights against atmospheric drag.



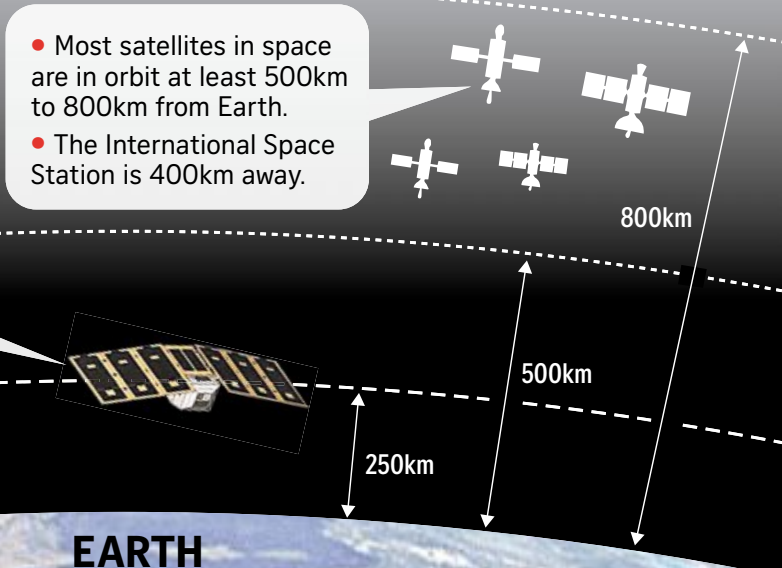
Elite will soar just 250km above Earth in a relatively unexplored part of space.

Benefits

- Being closer, the satellite will have a sharper eye on Earth.
- Lower risk of colliding with other space vehicles.

Drawbacks

- Atmospheric drag at very low orbits can slow down the satellite, causing it to veer off-course and re-enter Earth's atmosphere.
- The satellite will encounter atomic oxygen, a highly reactive gas that corrodes and degrades electronic materials.



Life
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World
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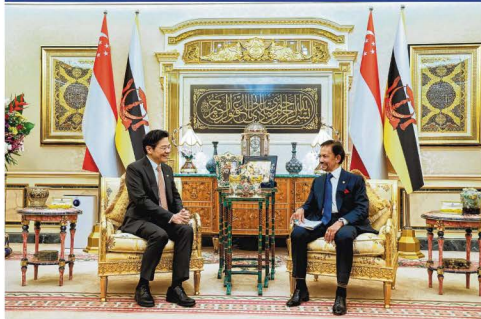


Sport
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THE STRAITS TIMES

Ties reaffirmed as PM Wong meets Sultan Hassanal Bolkiah



Prime Minister Lawrence Wong having an audience with Sultan Hassanal Bolkiah at the Istana Nurul Iman in Bandar Seri Begawan on June 8. In his introductory visit to Brunei, PM Wong, who is also Singapore's Finance Minister, expressed his appreciation to the Sultan for his steadfast support over the past 40 years and reaffirmed Singapore's commitment to continue strengthening the special relationship between the two countries. PM Wong and the Singapore delegation were later hosted to a lunch and left for Malaysia in the evening. PHOTO: MCI SEE THE BIG STORY - A3

Work to begin in 2025 on mega floating solar farm at Kranji Reservoir

Project will be major boost to Singapore's efforts to harness more renewable energy

Cheryl Tan
Correspondent

Construction work for a new mega floating solar farm is expected to begin at Kranji Reservoir in 2025, now that an environmental study has found that the installation of solar panels is unlikely to have a major impact on the biodiversity there.

The project - which will be the country's largest solar farm to date - will be a major boost to Singapore's efforts to harness more renewable energy.

The solar farm is expected to be able to produce 141 MW peak (MWp) of clean energy, or 82.5MWp when converted to AC, which is the voltage used by the electricity grid and most of Singapore's electrical appliances.

This will contribute around 7 per cent of Singapore's target of 2 gigawatt peak of solar capacity by 2030, according to the environmental assessment report. The 2GWp target can generate enough energy to meet the annual electricity needs of around 300,000 households.

Information then to explore the possibility of a 100MWp floating solar panel system for private-sector use.

EDB said that as companies turn to renewable energy to reduce their carbon footprint, the availability of renewable energy in Singapore is viewed as a favourable consideration for business investments and expansions.

In 2019, information technology company Malinka, a subsidiary of Meta - which also owns social media platform Facebook - was selected by EDB to study the technical feasibility of the project, and its potential environmental impacts.

The results of the environmental study were published online on June 7, and concluded that impacts of the construction and operation of the solar farm on biodiversity in the reservoir could be "adequately managed with mitigation measures".

Construction work for the Kranji solar farm will begin in 2025, and the solar farm will be operational from around 2027 to 2028.

Kranji Reservoir is situated close to various ecological sensitive areas, such as the Kranji Marshes, the Sungai Bahi Wetland Reserve, and Mandai Mangrove and Mudflat.

According to the environmental impact assessment, conducted by environmental consultancy ERM for Malinka from 2020 to 2023, a number of bird species of conservation concern were identified to

have foraged in the reservoir, or around the reservoir's edges.

These species, which consist of migratory and resident waterbirds, feed mostly on the reservoir's fish, and often forage in the central western area of the shoreline - close to the Kranji marshes - and the southern part of the reservoir, the report noted. Some migratory waterbirds also feed on the reservoir's aquatic plants.

Many of these birds are nationally endangered, such as the little tern, purple heron, and the white-winged tern.

To mitigate the project's potential impact on these species, only 2.5 per cent of the reservoir's surface area will be covered with solar panels, and a 50m boundary should be established between the panels, and the western shoreline, according to the report's recommendations.

In addition, each cluster of solar panels has been reconfigured such that areas frequented by foraging birds are avoided, said the report.

Doing so can also help to mitigate potential impacts to water quality, which may indirectly arise due to the lack of light penetration, and changes to wind drag and heat exchange, said the report.

Large solar photovoltaic clusters were also broken up into smaller ones, to create a 30m to 40m corridor to the plant's operational vessels to pass through, and to ensure access for emergency Singapore Civil Defence Force boats.

Mr Muhammad Nury, the executive director of the Singapore Youth Voice for Biodiversity, told ST that most birds generally seem

to dive along the shoreline, and the 50m boundary would give them sufficient leeway to do so.

According to the report, a 25m boundary was initially proposed, but this was later increased to 50m after consultations with nature groups.

While the 30m to 40m gaps between the solar panel clusters may not be sufficient for birds like the white bellied sea eagle and little terns which dive into the reservoir to search for food, other species like herons may be able to adapt, using the solar panels as a platform to forage in the reservoir waters - as was the case in Tengah Reservoir, said Mr Nury.

Mr Ho Xiang Tian, co-founder of environmental group LepidinkSG, said that in the longer term, more herons and egrets could end up being attracted to the solar panels, resulting in a potential net gain in bird species.

Asked whether changes to the reservoir's water quality or ecosystem would affect food sources for birds, Mr Ho noted that only the northern half of the reservoir would be affected.

The white-bellied sea eagle would be able to forage for fish from boat movement within the reservoir, while little terns, which are also reservoir divers, could benefit from the solar panels for the project.

Solar energy is the most promising renewable energy option for Singapore, which lacks access to other forms of renewables such as hydropower or wind energy. An earlier report commissioned by the EMA had found that it was feasible for Singapore's power generation sector to reach net-zero emissions by 2050.

Given its land constraints, Singapore has been ramping up its solar capacity on its reservoirs, with the first such farm rolled out at Tengah Reservoir in July 2023, with a capacity of 60MWp.

Other than the upcoming installation at Kranji Reservoir, two more large-scale solar farms are currently in the works - a 100MWp solar farm in Lower Seletar Reservoir, and a 144MWp solar farm in Pandan Reservoir.

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SEE THE BIG STORY - A2

SIA offers \$13,500 as compensation to SQ321 passengers with minor injuries

Aqil Hamzah and Kok Yuhong
Transport Correspondent

Singapore Airlines (SIA) has sent out offers of compensation to passengers on board the turbulence-hit SQ321, with those who suffered minor injuries being offered US\$80,000 (S\$13,500).

The national carrier said in a Facebook post on June 8 that those who had more serious injuries were invited to discuss compensation offers that would "meet their specific circumstances".

It added that it has offered US\$25,000 as an advance payment for passengers who suffered serious injuries that require long-term medical care and are requesting financial help.

The payment will address their immediate needs and be part of the final compensation they receive.

Besides compensation, SIA said it will also provide a full refund of the airfare to all passengers who were on the flight, which experienced "sudden extreme turbulence" over the Irrawaddy Basin in Myanmar on May 25 as the Boeing 777-300ER aircraft made its way to Singapore from London.

The pilot declared a medical emergency and landed the plane at Bangkok's Suvarnabhumi Airport.

A British passenger, 73-year-old Geoffrey Kitchen, died of a suspected heart attack, while dozens of others were injured.

There were 21 passengers and 19 crew members on board, and the injured were taken to Samitivej Srinakorn Hospital, Samitivej Sukhumvit Hospital and Bangkok Hospital for treatment.

The refund will also be given to passengers who were not injured. SIA said that those who are "dealing with compensation" given, in line with regulations in either the European Union or Britain.

Under these regulations, passengers may be entitled to financial compensation if their flight is delayed on arrival by three hours or more.

Passengers had also been given \$10,000 each upon departing from Bangkok, where SQ321 made an emergency landing. The payments were to cover their immediate expenses.

SIA said it has been covering the medical expenses of those injured, and arranged for family members and loved ones to travel to Bangkok upon request.

"All affected passengers should have received their offers of compensation via e-mail, along with information on how they may proceed with their claims," the airline said.

One offer, dated June 10 and seen by The Straits Times, showed that SIA would pay \$600 (S\$87) as delay compensation, in line with European regulations.

According to the e-mail sent to a passenger, the airline has 21 days to accept the offer.

Passengers who wish to make claims for any unforeseen costs arising directly from the turbulence incident were also told to inform the airline and provide supporting evidence for further consideration.

Those who need further help or have questions or concerns have been asked to reply to the e-mail sent by SIA or contact the carrier through an e-mail address provided.

Public relations professional Amelia Lam, who was on board flight SQ321, said the compensation offer she received from SIA did not include the US\$80,000 for minor injuries, even though she had suffered scratches to her face, whiplash, a concussion and chest trauma due to the incident.

She has contacted SIA to find out what constitutes a minor injury and whether the would qualify for the US\$80,000 sum. **IRRAWADDY BASIN**

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