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WE FREQUENTLY come across enticing words like "sustainable cities", "green cities", "eco cities" and "smart cities". Several questions spring to mind. What are they? Why are they important to us? How would they look like?

While there is not yet a single definition, Wikipedia defines sustainable city, green city or eco-city as a city designed with consideration of environmental impact, inhabited by people dedicated to the minimisation of required input of energy, water and food, and waste output of heat, air pollution and water pollution.

A smart city uses digital technologies to enhance performance and well-being, to reduce costs and resource consumption and also to engage more effectively and actively with its citizens. The overarching objective is to make the existing cities liveable and build new cities with smart and sustainability considerations.

Cities around the world are the outcome of economic growth, and the number of urban residents vary from one million to 40 million. People move to cities or urban areas for employment, business opportunities, education, hospitals, entertainment, services and amenities.

According to UN statistics, more than half of the world's population, 3.3 billion people, is now living in urban areas. More than 6.3 billion people, or 60 per cent of the population, will be living in cities by 2050. Cities are important as they shape the economies, politics and the social and cultural conditions. Cities are complex with systems for utilities, land usage, construction, sanitation, waste disposal and transportation.

They consume considerable resources, generate waste and contaminate air and soil. Globally, cities account for about 75 per cent of the total energy consumption and 80 per cent of polluting greenhouse gas (GHG) emissions. According to an estimate, the world's emissions increased by 16 times compared to the emissions in the 1900s and about two times compared to the emissions in the 1990s.

The US contributes over 15 per cent of global GHG emissions, while China contributes more than 20 per cent. This is expected as China surpassed the US as the world's largest economy. Just as the US replaced the UK in the 19th century as the world's largest economy. Recognising the impact of urbanisation on GHG emissions and the natural eco-system, China has drawn up plans for hundreds of green and smart cities with attention to protecting the environment.

On the backdrop of economic growth, India's emissions are also growing in recent years. Experts predict that about 25-30 people will migrate every minute to major Indian cities from rural areas. McKinsey & Company, a global management consulting firm, projects India's urban population to grow to about 600 million in 2030. India is also making plans for 100 smart cities with high-tech communication capabilities and recently announced US$1.5 billion investment over the next year.

Key features include smart energy with a focus on grids, electricity metering, renewable energy and energy efficiency; smart environment with a focus on hygiene and waste management, cleaning up of rivers and water sources, and facilitating efficient mobility; smart ICT with a focus on cyber security, safety of people, and disaster management and communications; smart buildings with rainwater harvesting capabilities, building automation and management systems; and smart governance.

Several nations around the world are embarking on green and smart cities to lower the impact on the environment. Key features of these cities include a) construction and buildings that are energy efficient and require minimal maintenance, b) renewable resources are used instead of non-renewable resources, c) water treatment and recycling, d) waste is seen as a resource and is recycled, e) public transport is made safe, reliable, informative, and a viable alternative to private transport, f) pathways for walking and cycling, and sufficient per capita green open areas, g) modern sewerage networks to control diseases, h) low crime, and safe and secure to live in, i) cultural and social amenities accessible to all, j) e-governance, and k) high-speed communication networks and ubiquitous Wi-Fi hot spots.

Masdar City in Abu Dhabi is a sustainably-planned city with a low carbon footprint during construction as well as after construction use. It is powered by renewable energy, and aims to reduce the waste to near zero. The city streets and buildings are designed so as to provide comfortable environments while reducing the need for air-conditioning, heating and artificial light.

There is full pedestrianisation within the city and emphasis is given to training of all residents in sustainability.

San Francisco, known for its tourist attractions, is a densely-populated city with eco-friendly commuting options. It is also known for air quality and recycling of 77 per cent of waste. San Francisco reserved 20 per cent of its land for green spaces, encourages certified green buildings and has over 160 charging stations for electric vehicles.
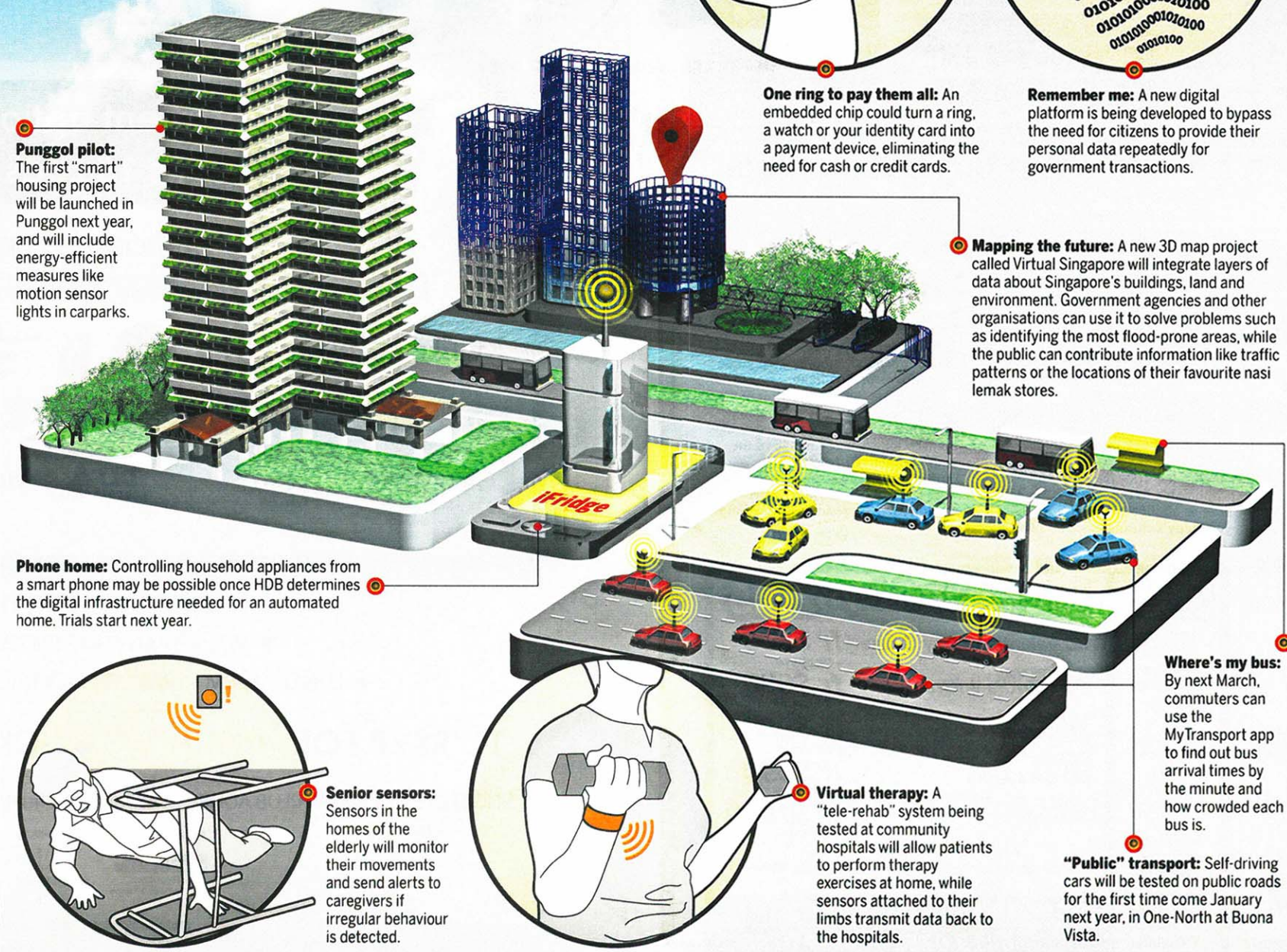
Green Oslo set aside two-thirds of its area as protected forest, agriculture land and waterways. Oslo implemented a smart system that adjusts light intensity depending on traffic conditions and weather. Car and bike-sharing programmes, 400 charging stations and over 1,700 electric vehicles with free parking, toll immunity and access to lanes generally reserved for public transport are in place. The city's heating system is currently powered by 80 per cent renewable energy, mainly from biomass from residual waste.

Shanghai is transforming into a smart city. Key developments include a) upgrading information infrastructure, including high-speed optical broadband network with full coverage of all the urbanised areas and 22,000 WLAN Hot Spots throughout the city, b) information sensing and intelligent application to facilitate management of city construction, operations safety, intelligent transportation and e-governance, c) new generation of IT industry such as cloud computing, internet of things and internet of vehicles, and d) integrating ICT with society to enable the Shanghai way of life.

What about Singapore? According to Asian Green Cities Index, Singapore is No. 1 with 66 sq m of green space per person. One hundred per cent of the population has access to piped water and sanitation, and the waste is adequately disposed. On Nov 25 last year, PM Lee outlined the vision of a "smart nation" for Singapore.

This initiative will enable people to access maps and build up geospatial databases by contributing information such as animal sightings, traffic incidents, etc. Virtual Singapore will integrate layers of data about Singapore's buildings, land and environment, which is useful to identify most flood-prone areas and know traffic patterns. Sensors to detect irregular behaviour of elderly persons will send alerts to their caregivers. Digital infrastructure to control household appliances from a smartphone will be in place. A central database of health records will help doctors to keep track of patients' health across hospitals.

Tele-rehab systems at community hospitals will allow patients to perform therapy exercises at home, while sensors attached to their limbs transmit data back to the hospitals. A ring, a watch or an identity card with an embedded chip will be turned into a payment device so as to eliminate the need for cash or credit cards.

Singapore schools will groom the next generation with capabilities to code and develop new apps. The smart nation project is enabled by communications backbone, sensor networks, big data analytics, and real-time information to empower individuals, communities, businesses and policymakers.

Jurong Lakeside comprises 70ha of water body and 220ha of land. Since June last year, several "smart city" innovations are being piloted at the Jurong Lake District. These include sensors to control and monitor everything from traffic to street lights and crowded buses; traffic light timings adjusted automatically to ease the traffic gridlock; sensors to send information to smartphones on best transport options in the case of traffic jams and improved apps on bus arrival time and how crowded the bus is for planning journeys for enhanced convenience and comfort. Illumination in the parks will be adjusted automatically based on factors such as time of the day and motion detection, energy-efficient motion sensor lights in carparks. There will sensors to detect illegal smoking and determine the cleanliness of parks and vicinities.

Self-driving vehicles to ferry people from the MRT stations to nearby buildings. Apps to locate covered walkways for the people. Environmental sensors to monitor the air quality and provide locality-specific PSI numbers. Developments of the Lake District include an Olympic-sized ice-skating rink, parks, playgrounds, a 24km network of park connectors, shopping malls, and waterfront hotels, a 700-bed hospital and a 286-bed community hospital. What would a smart, green and liveable city look like? Our neighbourhood would provide a glimpse into the future!

A good example of community-led sustainability efforts is the Ground-Up Initiative's Kampung Kampus located in Yishun (www.groundupinitiative.org). A nature inspired and low carbon footprint 26,000 sq m Kampung Kampus is being developed with tropical sustainable architecture, building methods and technologies. NUS alumni Siddharth is working with the founder, Mr Lai Hock Tay, in developing the 21st Century Kampung Kampus.

Investments in smart and green cities around the world are projected to increase in the coming years, and there is ample scope for innovators to show their creativity and enterprising passion.

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Smart and green

Smart Singapore

Singapore is expanding its use of technology to entrench its position as a leading global city and improve Singaporeans' quality of life. Here are some upcoming initiatives:

Punggol pilot: The first "smart" housing project will be launched in Punggol next year, and will include energy-efficient measures like motion sensor lights in carparks.

Phone home: Controlling household appliances from a smart phone may be possible once HDB determines the digital infrastructure needed for an automated home. Trials start next year.

Senior sensors: Sensors in the homes of the elderly will monitor their movements and send alerts to caregivers if irregular behaviour is detected.

One ring to pay them all: An embedded chip could turn a ring, a watch or your identity card into a payment device, eliminating the need for cash or credit cards.

Remember me: A new digital platform is being developed to bypass the need for citizens to provide their personal data repeatedly for government transactions.

Mapping the future: A new 3D map project called Virtual Singapore will integrate layers of data about Singapore's buildings, land and environment. Government agencies and other organisations can use it to solve problems such as identifying the most flood-prone areas, while the public can contribute information like traffic patterns or the locations of their favourite nasi lemak stores.

Virtual therapy: A "tele-rehab" system being tested at community hospitals will allow patients to perform therapy exercises at home, while sensors attached to their limbs transmit data back to the hospitals.

"Public" transport: Self-driving cars will be tested on public roads for the first time come January next year, in One-North at Buona Vista.

Where's my bus: By next March, commuters can use the MyTransport app to find out bus arrival times by the minute and how crowded each bus is.

GRAPHICS: THE STRAITS TIMES