The USS R&D Congress Science of Cities Symposium 2023

The Science of Cities Symposium 2023 was held as part of the Urban Solutions and Sustainability Research & Development (USS R&D) Congress 2023, convening international researchers, city, and industry leaders to share their scientific insights and methodologies on tackling urban challenges. The Symposium aims to connect scientific theories to urban practice, and through high quality presentations on the use of science and technologies for cities, spur fruitful discussions and engaging debates among academic researchers, urban practitioners, and industry professionals.

The Centre for Liveable Cities and Singapore-ETH Centre (SEC) also signed a Memorandum of Understanding at the Congress, witnessed by Minister for National Development, Desmond Lee. The scope of MoU includes capability development and training programmes, knowledge creation and sharing, and networking. Recently, SEC was the co-organiser for the inaugural Urban Science Workshop Series and co-organised the panel on Regenerative Cities at the Science of Cities Symposium 2023.

The Science of Cities Symposium delves into innovative strategies for urban development. It comprised three sessions where a range of Singaporean and international speakers shared their insights and knowledge, followed by engaging panel discussions. The three panels were focused around these themes:

1. Science-Based Approach to Future Scenario Planning
   This panel emphasised the importance of active urban sensing for Sustainable Development Goals, the use of foresight in urban planning, data-driven urban design, contextual analysis of urban networks, and technology-driven solutions in shaping sustainable and resilient cities.

2. Science of Decarbonising Cities
   This panel focused on reducing urban building emissions and advancing sustainability, underlining the importance of science, circularity, utilising digital twins, sufficiency, and public transportation in achieving eco-friendly and equitable urban futures.

3. Regenerative Cities: Building Sustainable Cities for the Future
   This panel explored clear frameworks, renewable energy, nature-positive urbanism, long-term planning, and creative urban intensification as central to sustainable urban development.

The full programme and the list of speakers can be found in Annex A.

Opening Keynote Address by Ms Adele Tan, Chief Planner and Acting Deputy Chief Executive Officer, Urban Redevelopment Authority

In her opening address at the Science of Cities Symposium, Ms Adele Tan, Acting Deputy Chief Executive Officer and Chief Planner, Urban Redevelopment Authority (URA), highlighted the indispensable role of science in the intricate landscape of urban planning. Singapore, as a small and densely populated island-state, faces a unique set of challenges in land use planning. She emphasised the need for adaptive and versatile strategies to accommodate a diverse array of needs, from housing and commerce to green spaces and sea utilisation.

With evolving demographics and economic structures, the city-state's approach has shifted towards a multi-pathway model, acknowledging the uncertainty and complexity of urban challenges. Ms Tan further underscored the pivotal role of modelling and simulation technologies in shaping urban planning, allowing for a dynamic, scenario-based approach that considers a range of potential outcomes.

The need for scientific research in addressing urban issues such as the relationship between the built environment and mental well-being, was the focus of the recent launch of research grants by the URA. Additionally, Ms Adele Tan underlined the need for setting ambitious decarbonisation goals and the need for innovative solutions informed by research. Beyond sustainability, she emphasized the city's obligation to regenerate and restore natural ecosystems, considering circular economies and renewable energy integration.

The Science of Cities Symposium could be an invaluable forum for sharing the latest research and exploring the intricacies of complex urban challenges. Ms Tan noted that the symposium plays a pivotal role in bridging the gap between science and policy. Effective communication and collaboration between scientists and urban practitioners are fundamental to leveraging research to enhance urban planning.

She called for investment in talent and long-term research efforts, recognising that some complex issues may take time to yield concrete solutions. In conclusion, she expressed optimism that the symposium would stimulate discussions and inspire a stronger integration of science, technology, policy, and planning for the betterment of urban environments.

Science of Cities Symposium: Science-Based Approach to Future Scenario Planning

From left to right. Panellists: A/Prof Sam Joyce, Mr Dake Wu, Dr Heiko Aydt, Mr Winston Yap, and Dr Cai Chenyi; Moderator: Dr John Sweeney and A/Prof Long Ying.

The panel featured a series of presentations on the theme and addressed crucial aspects of sustainable urban development, urban planning, and data-driven analysis for enhancing the quality of life in cities of the future.

Dr John A. Sweeney (Westminster International University) delved into "Re-imagining Urban Futures" and discussed the significance of foresight methods in urban contexts, with a focus on involving citizens in decision-making processes. By incorporating both strategic and transformative foresight, cities can better prepare for a wide range of possible futures.

This approach helps cities create more robust plans, policies, and strategies, considering not only external forces but also the aspirations and concerns of their residents.

A/Prof Long Ying (Tsinghua University) deliver a keynote on "UrbanSense" which emphasised the need for accurate urban monitoring to achieve Sustainable Development Goals. It introduced the concept of active urban sensing, providing a flexible, demand-driven approach for gathering urban data such as Noise Monitoring Assessment project (see Figure 1).
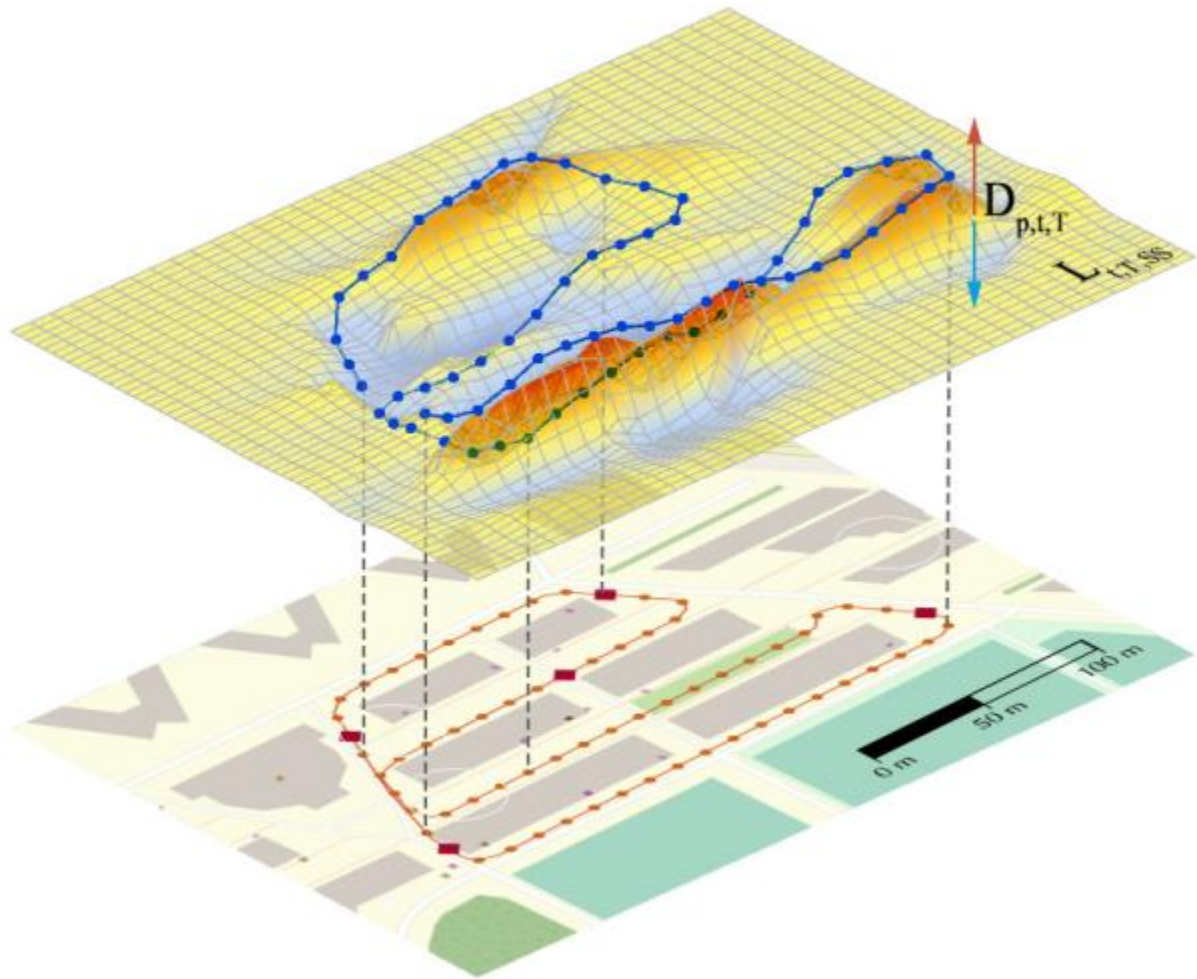
Figure 1: Noise monitoring for individual exposure assessment with Collaborative Sensing on Tsinghua campus. The stationary sensing data were averaged as a baseline value for noise, while the mobile sensing data were used to calculate the relative spatial variation in noise levels. The two were superimposed to obtain predicted noise levels for all locations within the site. The predictions based on collaborative sensing significantly outperform those based on one sensing mode only.

Dr Cai Chenyi (SEC FCL Global), and Mr Winston Yap (NUS), dived into data-driven urban planning. Dr Cai introduced a case-based search engine for mapping urban patterns and cases by integrating street view imagery, facilitating decision-making for urban design based on real-world data.

Mr Yap presented "Urbanity", a Python package automating the construction of feature-rich urban networks using open-source data, emphasising the importance of contextual features in understanding and improving urban networks.

Dr Heiko Aydt (SEC FCL Global) discussed the creation of a "Digital Urban Climate Twin" for Singapore, aiming to support the analysis of Singapore Green Plan 2030 scenarios and urban climate adaptation solutions.

One of the key components of the Green Plan is promoting sustainable and environmentally friendly transportation. A/Prof Sam Joyce's research leveraged computer vision to understand active mobility in Singapore, examining user behaviours and potential conflicts,

which can inform urban planning for safer and more efficient active mobility solutions. Finally, Mr Dake Wu (NUS) focused on analysing systemic traffic conditions in Singapore using epidemic spreading models, providing a new perspective on traffic management in complex urban environments.

These presentations collectively explored innovative approaches, data-driven insights, and foresight methods to shape the future of sustainable and well-planned urban environments, emphasizing the importance of community involvement, context-driven planning, and technology-driven analysis in urban development.

The takeaways from the panel underscore the importance of data-driven, forward-looking, and context-aware approaches in urban development and planning, with the ultimate goal of creating more sustainable, liveable, and resilient cities.

1. **Active Urban Sensing for Sustainable Development:** Active urban sensing methods are crucial for achieving Sustainable Development Goals. These approaches offer more flexibility by adapting to varying demands and can provide valuable data for urban planning and development, enabling cities to work towards sustainability.

2. **Foresight in Urban Planning:** Foresight methods play a significant role in urban planning. They can help cities create resilient policies and strategies while involving citizens in the decision-making process. By distinguishing between strategic and transformative foresight, cities can better prepare for future challenges and opportunities.

3. **Data-Driven Urban Design:** Data-driven approaches are a game changer in urban design and planning. By integrating data streams and leveraging semantic urban elements, cities can create case-based search engines for urban patterns and cases, making informed decisions based on real-world data.

4. **Contextual Analysis of Urban Networks:** Understanding the contextual features of urban networks is crucial. The use of Python packages like "Urbanity" allows for the automation of feature-rich urban networks, highlighting the importance of considering context-driven factors for effective urban planning.

5. **Technology for Sustainable Urban Development:** Technology, such as computer vision, can provide valuable insights for sustainable urban development. It can be used to analyse and optimize active mobility, improve traffic management, and enhance urban planning by understanding user behaviours and interactions in shared urban spaces.

Science of Cities Symposium: Science of Decarbonising Cities

From left to right. Panellists: Dr Kang Jidong, Mr Pradeep Alva, Mr Anthony Meijer, Dr Dai Fangzhou, Dr Zhu Rui, and Moderator: Prof Arno Schlueter.

In summary, the panel on the Science of Decarbonising Cities offered valuable insights and strategies for reducing urban building emissions and advancing sustainability in urban areas, with a particular emphasis on the roles of science, data, innovative approaches, fairness, and sufficiency in addressing the challenges of climate change and urban transport.

The panel highlighted the pressing need to address climate change by reducing emissions from urban buildings. In his keynote address, Prof Arno Schlueter (ETH Zurich) emphasised the role of science in achieving rapid and effective decarbonization. He advocated for an integrated design process, data-driven interventions, and long-term planning to substantially reduce urban building emissions.

In his keynote speech, Dr Philip Rode (London School of Economics), discussed the concepts of sufficiency and justice in the context of urban transport. Dr Rode pointed out that despite various efforts to promote sustainable transportation and reduce emissions, the urban transport sector continues to experience carbon emission growth. He highlighted that the current strategies, which largely focus on efficiency, are insufficient to achieve the necessary reductions. Furthermore, the efficiency gains made so far have often led to increased consumption of the same resources, a phenomenon known as the rebound effect. He pointed out the challenges in controlling carbon emissions and the need to provide equitable access to urban opportunities. Rode opined that open engagement with the sufficiency principle and fair distribution of resources are essential to address these issues (see Figure 2).

Figure 2: Philipp Rode's Allocation Principle. The allocation principle refers to the rules or guidelines that determine how limited resources, such as transportation infrastructure and services, are distributed among different societal groups and individuals. In the context of urban transport, this principle plays a significant role in ensuring fairness and equitable access to mobility options.

Mr Pradeep Alva (NUS & SEC FRS) presented a methodology for creating Urban Digital Twins (UDTs) to mitigate greenhouse gas emissions in cities by integrating multiple data sources.

Dr Kang Jidong (SEC FCL Global) presented on Advanced Energy Communities (AECs) and their potential to accelerate photovoltaic adoption in Singapore. AECs leverage district-scale solutions and innovative business models to increase the adoption of solar energy, particularly in densely populated urban centres.

Mr Anthony Meijer's (SUTD) shared about his research which explores the material stock and circularity prospects of buildings in Singapore, assessing the stock and flow of the embodied carbon for residential and industrial buildings; thus, emphasising the importance of resource efficiency and circularity.

Dr Dai Fangzhou's (NUS Cities) presented evidence that the opening of urban rail transit lines, such as the Circle Line in Singapore, can reduce car ownership, contributing to sustainable transportation.

Lastly, Dr Zhu Rui's (IHPC A*STAR) shared how his research showcased the significant carbon mitigation potential of installed rooftop photovoltaics in Singapore, highlighting their rapid carbon offset and energy efficiency benefits (Figure 3).
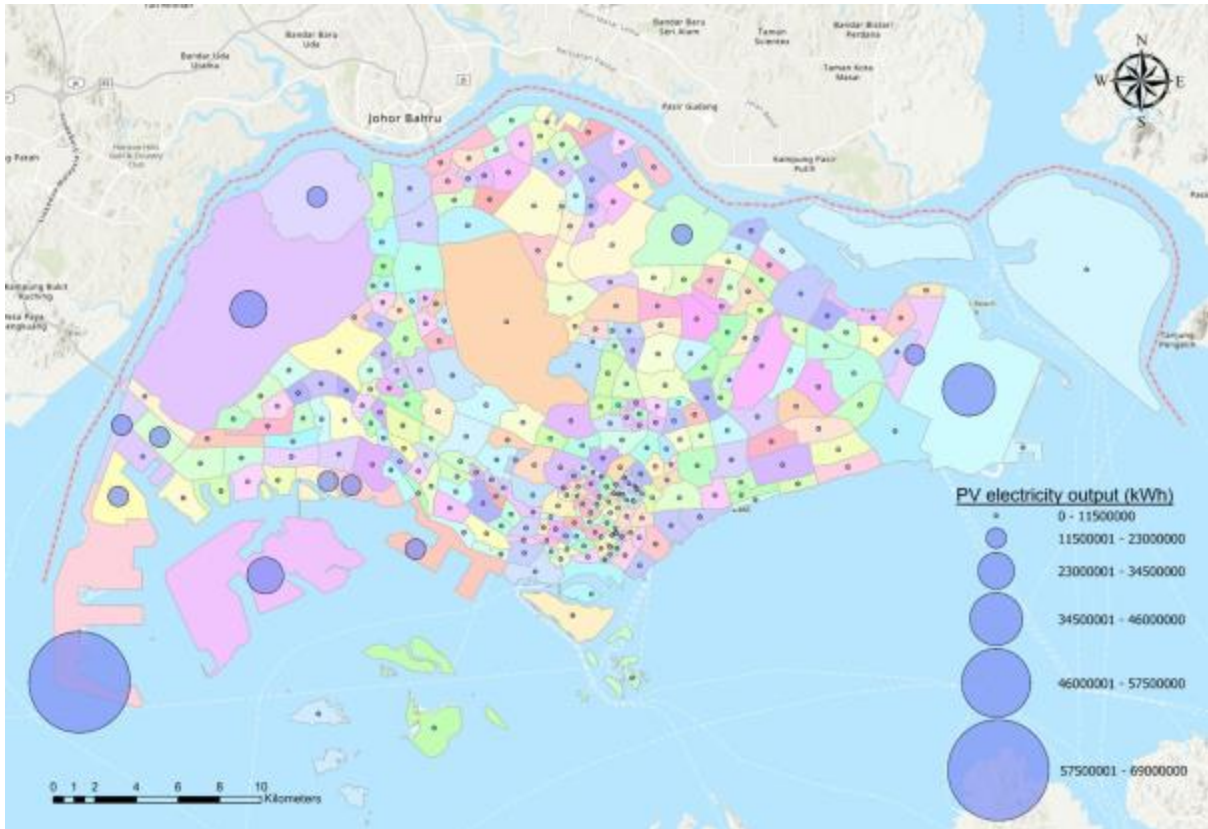
Figure 3: Distribution of PV electricity generation. Annual electricity output of installed rooftop PV categorized by districts.

Overall, the panel stressed the significance of holistic, data-informed approaches, the pursuit of equity in urban transitions, and the importance of sustainable practices for building a more eco-friendly and sustainable urban future. The five overarching key takeaways from the panels are:

1. **Science-Driven Solutions**: Science and data-driven approaches are crucial for achieving decarbonization goals in urban areas. Integrating science into the decision-making process can help identify effective strategies to reduce building emissions (Figure 4).
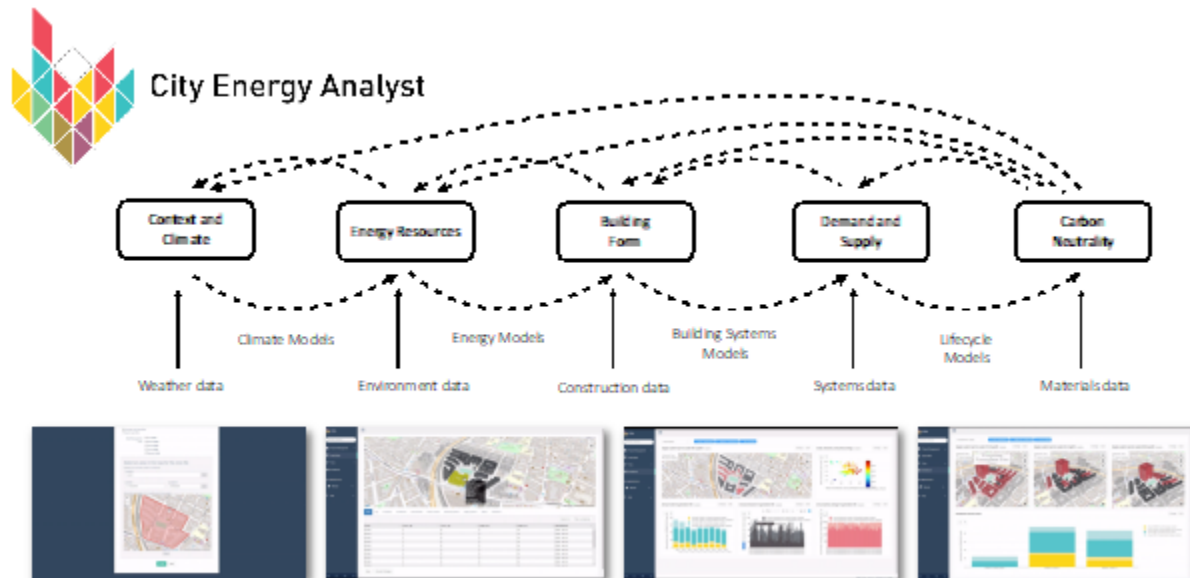

Figure 4: City Energy Analyst. CEA is open-source urban building energy modelling framework, capturing interdependencies through computational analytical toolsets.

2. **Circularity and Resource Efficiency**: Recognizing the importance of material stock and circularity in the construction sector is key to sustainable urban development. Promoting material reuse and sustainable practices can contribute to reducing the environmental impact of construction.

3. **Digital Twins for Sustainability**: Urban Digital Twins (UDTs) offer promising tools for enhancing sustainability in cities. They allow for data integration to improve the efficiency of city systems, helping to develop strategies for reducing emissions and achieving carbon-neutral objectives.

4. **Sufficiency and Equity in Urban Transitions**: The concept of sufficiency and fairness is central to urban transitions, especially in the context of reducing carbon emissions. Addressing questions of fairness, resource allocation, and equitable access to urban resources is vital for achieving sustainability.

5. **Promotion of Public Transportation**: Supporting and expanding public transit systems plays a pivotal role in achieving sustainable and low-carbon mobility. Well-designed transit systems can reduce car dependency and promote eco-friendly transportation options in cities. Scientific methods can be used to show the correlation between the availability of public transport options vs car-dependency.

Science of Cities Symposium: Regenerative Cities

The panel focused on the theme of "Regenerative Cities: Building Sustainable Cities for the Future" and featured multidisciplinary research converging on the pivotal theme of sustainable urban development and regenerative cities. The panel offered a comprehensive exploration of sustainable urban development, renewable energy, and innovative urban living and reflects how scientific methods can be deployed in creating eco-friendly cities that embody the principles of regenerative design and sustainability for the future. The speakers collectively demonstrated the importance of clear definitions, holistic approaches, nature-positive urbanism, and adaptive planning in building cities that are both environmentally conscious and liveable.

Photo From left to right. Prof Thomas Schroepfer, Dr Pieter Herthogs, Prof Arno Schlueter, Dr Srilalitha Gopalakrishnan, Prof Sacha Menz, Dr Prateek Bansal, A/Prof Cheong Siew Ann, Dr Alberto Costa.

Dr Pieter Herthogs (SEC FCL Global) highlighted the significance of establishing common understandings and terminology in the realm of socio-technical transitions. His discussion illuminated the distinctions between "Urban Mining" and "Urban Harvesting", and "Circular" and "Regenerative Cities", where clear definitions and frameworks will lay a solid foundation for knowledge sharing and innovative breakthroughs in the domain of sustainable urban design.

Singapore's commitment to sustainable urban development is particularly evident in the focus on renewable energy. Prof Francis Lee Bu Sung (NTU & SEC FCL Global) introduced the concept of Building Integrated Photovoltaic (BIPV) technology, a holistic approach that combines data-driven analysis with modelling to inform evidence-based decision-making. This approach is crucial, given Singapore's limited land space.

Dr Srilalitha Gopalakrishnan (SEC FCL Global) extended the discussion with a nature-positive approach in urbanism, emphasising the active restoration and regeneration of ecosystems and the promotion of biodiversity. She opined that nature is more than a resource to exploit; it's a valuable partner in creating healthy, resilient, and sustainable cities.

Dr Alberto Costa (SEC FRS) presented long-term solar energy planning, outlining a robust optimisation model to facilitate solar photovoltaic (PV) planning. This model accounts for uncertainties, land use, and national adoption targets, providing a decision-support tool to meet sustainability goals.

Shifting the focus to urban life as social reactors, A/Prof Siew Ann Cheong (NTU & SEC FCL Global) drew parallels between cities and cell membranes in intensifying interactions. He posited that intensification doesn't necessitate geographical expansion or uniform population density increase; rather, it can be achieved through creative scheduling of self-organized social interactions.

Finally, Dr Prateek Bansal (NUS & SEC FCL Global) underscored the significance of sustainable transportation in the context of electric vehicles (EVs). His presentation outlined strategies for adaptive planning of EV charging infrastructure, acknowledging the bidirectional relationship between infrastructure deployment and market-level EV adoption. He explored how to develop decision making approach for deploying charging infrastructure that can evolve over time in response to market-level adoption of electric vehicles (Figure 5). This adaptability is crucial as it ensures that the infrastructure keeps pace with the increasing demand for EVs.
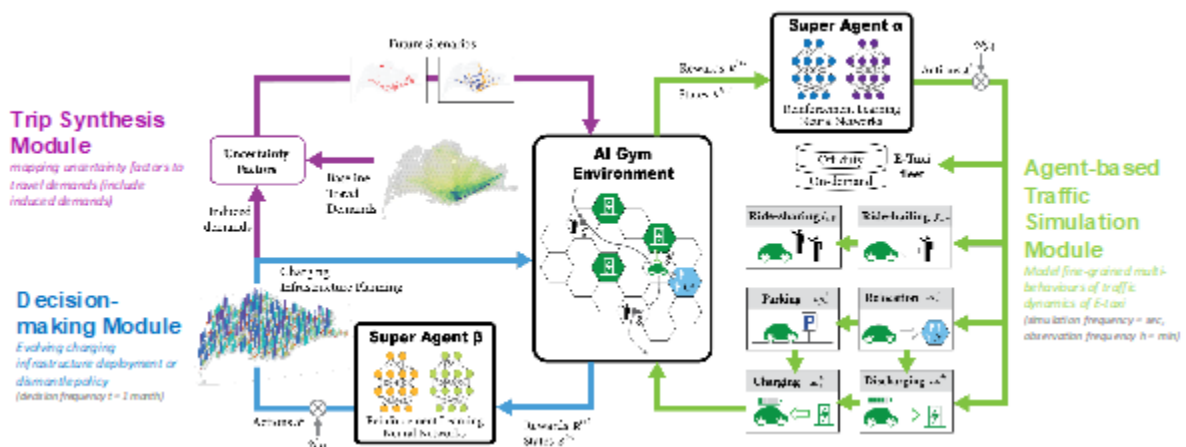

Figure 5: Sequential Decision-Making Approach. Three modules and two super agents optimally controlled at distinctive frequencies, which interact with the system in an AI gym environment.

The below-mentioned takeaways from the panel collectively underscore the multifaceted and interdisciplinary nature of sustainable urban development.

1. **Clear Frameworks and Terminology Are Fundamental:** The symposium emphasized the importance of establishing clear frameworks and terminology in the field of sustainable urban development. Common understandings of concepts such as "Urban Mining" vs. "Urban Harvesting" and "Circular" vs. "Regenerative Cities" are crucial for shaping knowledge, fostering innovation, and driving meaningful progress in urban planning.

2. **Renewable Energy is Central to Sustainability:** A significant focus of the symposium was on renewable energy, particularly in urban areas. Solar energy, especially through Building Integrated Photovoltaic (BIPV) technology, is highlighted as a holistic solution, combining data-driven analysis and modelling to support evidence-based decision-making. The transition to renewable energy is recognized as a vital step in reducing carbon emissions in urban environments.

3. **Nature-Positive Urbanism Is the Future:** A notable shift toward nature-positive urbanism was a central theme. This approach goes beyond merely reducing the negative impact of cities on the environment; it actively seeks to restore and regenerate ecosystems and promote biodiversity. Nature is considered a valuable partner in creating healthy, resilient, and sustainable cities.

4. **Long-Term Planning and Adaptivity Are Key:** The symposium showcased the importance of long-term planning and adaptability in the pursuit of sustainability. Presentations on long-term solar energy planning and adaptive infrastructure deployment for electric vehicles highlighted the need to consider uncertainties, land use, and market dynamics in achieving sustainability goals.

5. **Urban Intensification Through Creative Scheduling:** The discussions on urban life as social reactors and the intensification of interactions within cities emphasized that making cities larger or denser isn't always the solution. Instead, creative scheduling of self-organized social interactions over time can intensify desired interactions without excessive demands on physical space, fostering diversification and innovation.

The International Journal for Smart and Sustainable Cities (IJSSC) publishes research papers and insights drawn from the Science of Cities Symposium. Issue #1 featured some of the research presented at the 2022 Symposium and is now available online with free-access at https://www.worldscientific.com/toc/ijssc/01/01.

Speakers of at the Symposium 2023 are invited to submit their full articles to the journal for peer-review. Additionally, 32 research posters were presented at the Science of Cities Symposium this year at the exhibition halls. The full list of posters can be found in Annex B.

These posters will be made available for viewing online and presenters will be invited to submit full article to IJSSC.

The sessions recording of the symposium will be made available online on CLC's you tube channel. Stay tuned!

Acknowledgements

Annex A: Science of Cities Symposium Programme

0900 – 0910	Opening Address	**Ms Adele Tan** **Acting Deputy Chief Executive Officer and Chief Planner** **Urban Redevelopment Authority (URA)**	OPENING KEYNOTE SPEAKER
	Panel 1: Science-Based Approach to Future Scenario Planning **HIBISCUS JUNIOR BALLROOM**		
0910 – 0920	UrbanSense: Empowering Communities through Active Sensing for Sustainable Urban Development	Dr Long Ying Associate Professor School of Architecture, Tsinghua University Director and Founder, Beijing City Lab	KEYNOTE SPEAKER
0920 – 0930	Re-imagining Urban Futures: How Cities Can Leverage Strategic & Transformative Foresight	Dr John A. Sweeney United Nations Educational, Scientific and Cultural Organization (UNESCO) Chair for Futures Studies in Anticipatory Governance and Sustainable Policymaking Westminster International University	KEYNOTE SPEAKER
0930 - 0940	A Case-based Search Engine for Mapping Urban Patterns & Cases Integrating Street View Imagery	Dr Cai Chenyi Postdoctoral Researcher Future Cities Laboratory (FCL) Global	SPEAKER
0940 - 0950	Urbanity: Automated Modelling and Analysis of Multidimensional Networks in Cities	Mr Winston Yap PhD researcher National University of Singapore	SPEAKER
0950 - 1000	A Digital Urban Climate Twin of Singapore to Analyse Green Plan 2030 Scenarios	Dr Heiko Aydt DUCT R&D Lead, Cooling Singapore Head, SEC Digital Twin Lab Future Cities Laboratory (FCL) Global	SPEAKER
1000 – 1010	Analysing Systemic Traffic Conditions in Singapore through Epidemic Spreading Models	Mr Dake Wu Master Researcher, Physics Department of NUS	SPEAKER
1010 – 1020	Understanding Active Mobility using Computer Vision and Data Visualisation	Dr Sam Joyce Assistant Professor Singapore University of Technology and Design (SUTD)	SPEAKER
1020 - 1100	Panel Discussion	All Speakers	
1100 – 1130	Networking Break	F&B Area in the Exhibition Hall (Hibiscus Main Ballroom)	

	Panel 2: Science of Decarbonising Cities HIBISCUS JUNIOR BALLROOM		
1130 – 1140	Design to Decarbonise: Effective Tools to Reduce Urban Building Emissions	Prof Arno Schlueter Head, Architecture & Building Systems Institute of Technology in Architecture, ETH Zurich Management board of the ETH Energy Science Centre Principal Investigator, Singapore-ETH Centre	SPEAKER
1140 – 1150	Sufficiency, Justice and Urban Transport	Dr Phillip Rode Executive Director of LSE Cities Associate Professorial Research Fellow London School of Economics Please note: This is a pre-recorded presentation	SPEAKER
1150 - 1200	A Global Bottom-up Approach to create Urban Digital Twins (UDT): Mitigating Greenhouse Gas (GHG) Emissions	Mr Pradeep Alva Research Associate and PhD Researcher Singapore-ETH Centre and National University of Singapore (NUS)	SPEAKER
1200 - 1210	Material stock-service and circularity prospects of buildings in SG	Dr Anthony Meijer Senior Research Assistant Singapore University of Technology and Design (SUTD)	SPEAKER
1210 - 1220	Can New Urban Rail Transit Lines Reduce Car Ownership? — Evidence from the Opening of the Circle Line in Singapore	Dr Dai Fangzhou Research Fellow National University of Singapore (NUS)	SPEAKER
1220 – 1230	Significant Carbon Mitigation Potential from Installed Rooftop Photovoltaics in Singapore: A GIS-integrated Life Cycle Assessment	Dr Zhu Rui Scientist Institute of High Performance Computing (IHPC) Agency for Science, Technology and Research, Singapore (A*STAR)	SPEAKER
1230 - 1240	Accelerating PV Adoption in Singapore: The Potential of Advanced Energy Community	Dr Kang Jidong Research Fellow Future Cities Laboratory (FCL) Global	SPEAKER
1240 - 1330	Panel Discussion	All Speakers	
1330 – 1430	Lunch	F&B Area in the Exhibition Hall (Hibiscus Main Ballroom)	

	FCL Global Co-curated Panel: Regenerative Cities HIBISCUS JUNIOR BALLROOM		
1430 – 1435	Welcome Address	Prof Sacha Menz Professor, ETH-Zurich Programme Director and Principal Investigator, Future Cities Laboratory (FCL) Global	OPENING KEYNOTE
1435 – 1440	Opening Address	Prof Thomas Schroepfer Professor, Singapore University of Technology and Design (SUTD) Programme Co-Director and Principal Investigator, Future Cities Laboratory (FCL) Global	OPENING KEYNOTE
1440 – 1450	From Urban Mining to Urban Harvesting: Building Shared Frameworks for Circular Future Cities	Dr Pieter Herthogs Senior Researcher and Co-Investigator Future Cities Laboratory (FCL) Global	SPEAKER
1450 – 1500	Integrating Renewables within the City	Dr Francis Bu Sung Lee Associate Professor, Nanyang Technological University (NTU) Principal Investigator, Future Cities Laboratory (FCL) Global	SPEAKER
1500 – 1510	Dense and Green Cities for a Nature-Positive Future	Dr Srilalitha Gopalakrishna (MODERATOR) Associate Director Research, Future Cities Laboratory (FCL) Global	MODERATOR / SPEAKER
1510 – 1530	Panel Discussion on "Circular Districts"	All Speakers	
1530 – 1540	Long-term Solar PV Planning in High-Density Urban Systems	Dr Alberto Costa Senior Researcher and Cluster Coordinator Singapore-ETH Centre (SEC) Future Resilient Systems	SPEAKER
1550 – 1600	Cities as Social Reactors	Dr Cheong Siew Ann Associate Professor, Nanyang Technology University (NTU) Principal Investigator, Future Cities Laboratory (FCL) Global	SPEAKER
1600 – 1610	Adaptive Planning of Charging Infrastructure for Electric Vehicles	Dr Prateek Bansal Assistant Professor, National University of Singapore (NUS) Principal Investigator, Future Cities Laboratory (FCL) Global	SPEAKER
1610 – 1630 20 mins	Panel Discussion on "Transformation Strategies"	All Speakers	
1630 – 1730	**Industry Networking Evening Hosted by FCL Global** **Science of Cities Symposium:** **Poster Exhibition**	**Hibiscus Main Ballroom (F&B Area/Poster Exhibit Area)**	

Annex B: List of Poster Exhibitors

No.	Poster Presenter	Affiliation	Poster Title
1	Elif AYDIN	Singapore University of Technology and Design	Urban Heat Island Scenario Exploration: A Generative Design Approach for Optimally Cool Urban Plans
2	Andrea BARTOLINI	Singapore-ETH Centre, Future Resilient Systems	An ontological framework to model urban metabolisms for future urban scenarios
3	Song CHEN	Centre for Climate Research Singapore	Urban Modelling for Singapore's Weather and Climate
4	Franciso CHINESTA & Marida DI CROSTA	CNRS@CREATE	Physics Aware Digital Twins as Reliable, Responsible Tools to Predict and Manage Disruptions in Urban Complex Systems
5	Jeanette CHOONG	Nanyang Technological University	Non-asset-based Risk Models for Quantifying Future Climate Risk in Cities
6	Tongchaoran GAO	Future Cities Laboratory (FCL) Global	Designing for Diversity: Examining the Impact of Visual Features of Public Spaces in one-north, a High-Density District
7	Markus HOFMEISTER	CARES	Cross-Domain Flood Risk Assessments for Smart Cities using Dynamic Knowledge Graphs
8	Yujun HOU	National University of Singapore	Global Streetscapes—A Worldwide, Geospatially Enriched Dataset of 7 Million Street-level Images over 677 Cities for Urban Science Research
9	Neil HUYNH	Institute of High-Performance Computing	Impact of the Built Environment and Its Social Outcomes in the Singapore Context
10	Rakhi MEPPARAMBATH	Institute of High-Performance Computing	The Impact of COVID-19 Pandemic on the Fundamental Urban Mobility Theories using Transit Data from Singapore
11	Ahmed MEERAN	Singapore University of Technology and Design	Towards a Heuristic for Demand Driven Adaptive Pressure for Airports a Global Perspective
12	Mohamed Faisal Bin MOHAMED SALLEH	National University of Singapore	Self-Organised Criticality in a Model of Supply Chain Network
13	Irina ORLENKO	Future Cities Laboratory (FCL) Global	Emergent Spatial Distribution of Social Hotspots: Analysis of Three Planning Areas in Singapore
14	Anjanaa SRIKANTH	Singapore University of Technology and Design Future Cities Laboratory (FCL) Global	Pedestrian Movement Distribution Patterns in Multilevel Urban Environments
15	Xize WANG	National University of Singapore	The Roads One Must Walk Down: The Relationship between Commute and Depression
16	Daniel WONG	Singapore University of Technology and Design	Mapping Urban Green Space Networks with Visual Analysis
17	Lei XU	Future Cities Laboratory (FCL) Global	Enhancing Urban Resilience against Heat Exposure: Space use patterns through Spatial Network Analysis and Thermal Comfort Assessment
18	Heiko AYDT	Future Cities Laboratory (FCL) Global	A Digital Urban Climate Twin of Singapore to analyse Green Plan 2030 Scenarios
19	Chenyi CAI	Future Cities Laboratory (FCL) Global	A Case-based Search Engine for Mapping Urban Patterns and Cases Integrating Street View Imagery

20	Sam JOYCE & Nazim IBRAHIM	Singapore University of Technology and Design	Understanding Active Mobility using Computer Vision and Data Visualisation
21	Dake WU	National University of Singapore	Analysing systemic traffic conditions in Singapore through epidemic spreading models
22	Pradeep ALVA	National University of Singapore Singapore-ETH Centre	A Global Bottom-up Approach to Create Urban Digital Twins (UDT): Mitigating Greenhouse Gas (GHG) Emissions
23	Fangzhou DAI	NUS Cities National University of Singapore	Can New Urban Rail Transit Lines Reduce Car Ownership? — Evidence from the Opening of the Circle Line in Singapore
24	Jidong KANG	Future Cities Laboratory (FCL) Global	Accelerating PV Adoption in Singapore: The Potential of Advanced Energy Communities
25	Anthony MEIJER	Singapore University of Technology and Design	Material Stock-service and Circularity Prospects of Buildings in Singapore
26	ZHU Rui	Institute of High-Performance Computing	Significant Carbon Mitigation Potential from Installed Rooftop Photovoltaics in Singapore: A GIS-integrated Life Cycle Assessment
27	Koichi ITO	National University of Singapore	Sidewalk the Talk: Translating Street View Imagery to Correct Perspectives to Enhance Bikeability and Walkability Studies
28	Anuj JAIN	BioSea	Biomimicry: Learning from Nature to Decarbonise the Built Environment through Effective Thermoregulation Strategies
29	Brenda MA	Ramboll	SURE by Ramboll – Freeware for Sustainability Based Remediation Options Assessments
30	Doreen MOLTE	Singapore University of Technology and Design	Adaptability of Buildings for Sustainable Built Environment: A Review
31	Hou Yee QUEK	CARES	Interoperable Building and Solar Energy Simulations for Augmented Cities using Dynamic Knowledge Graphs
32	Zhongming SHI	Future Cities Laboratory (FCL) Global	The City Energy Analyst (CEA) Toolkit Empowers Everyone in the Game of Decarbonising Cities