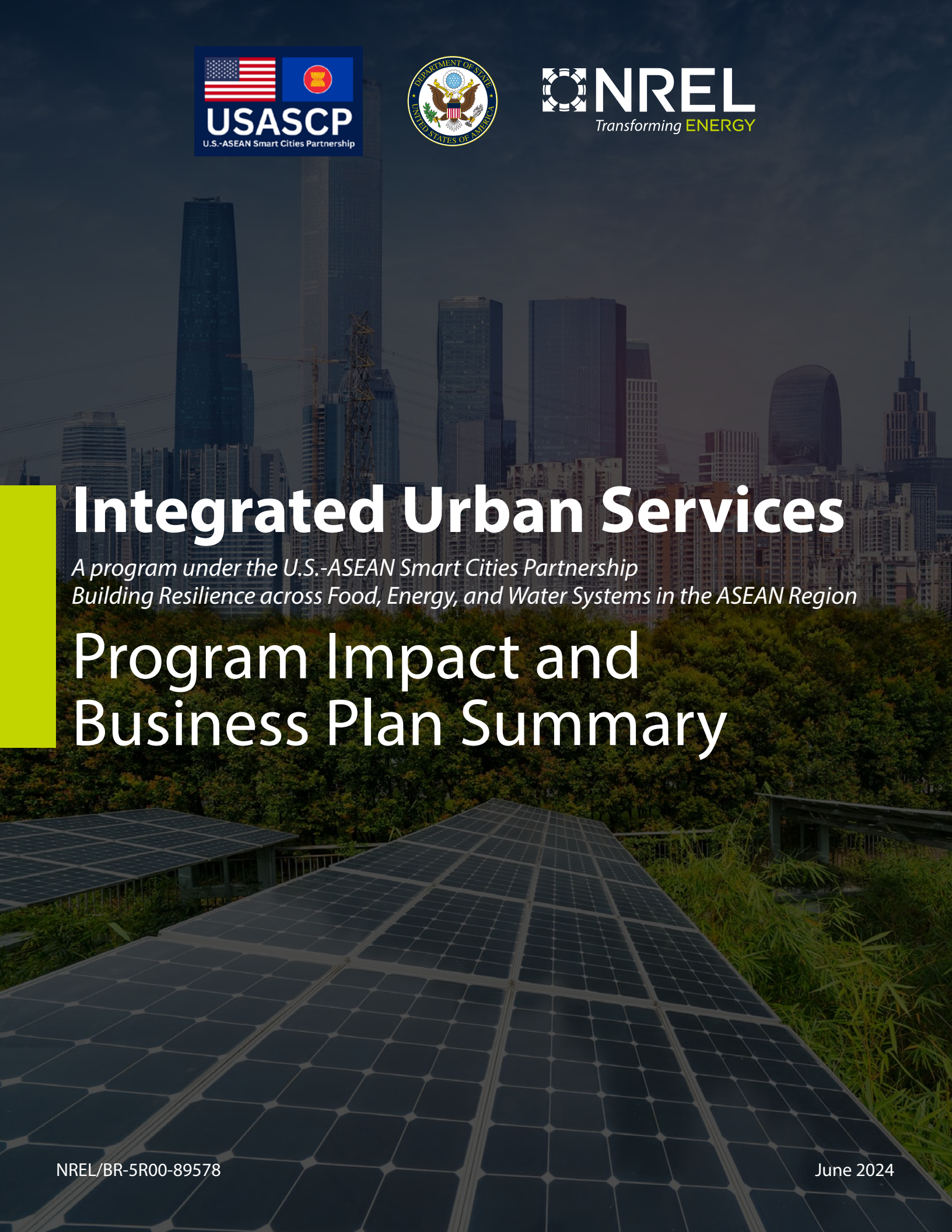


Integrated Urban Services

A program under the U.S.-ASEAN Smart Cities Partnership
Building Resilience across Food, Energy, and Water Systems in the ASEAN Region

Program Impact and Business Plan Summary

NREL/BR-5R00-89578

June 2024

Program Objectives

Launched in 2021, Integrated Urban Services (IUS) was a 3-year program funded by the U.S. State Department under the United States–Association of Southeast Asian Nations (ASEAN) Smart Cities Partnership (USASCP) to help ASEAN cities build resilience across their food, energy, and water provisioning systems.

The program, led by the National Renewable Energy Laboratory (NREL, www.nrel.gov) with technical assistance, stakeholder engagement, and business model development collaboration from Regenerative Impact Ventures (www.riv.global) and guidance from an IUS Expert Group, aimed to achieve the following objectives:

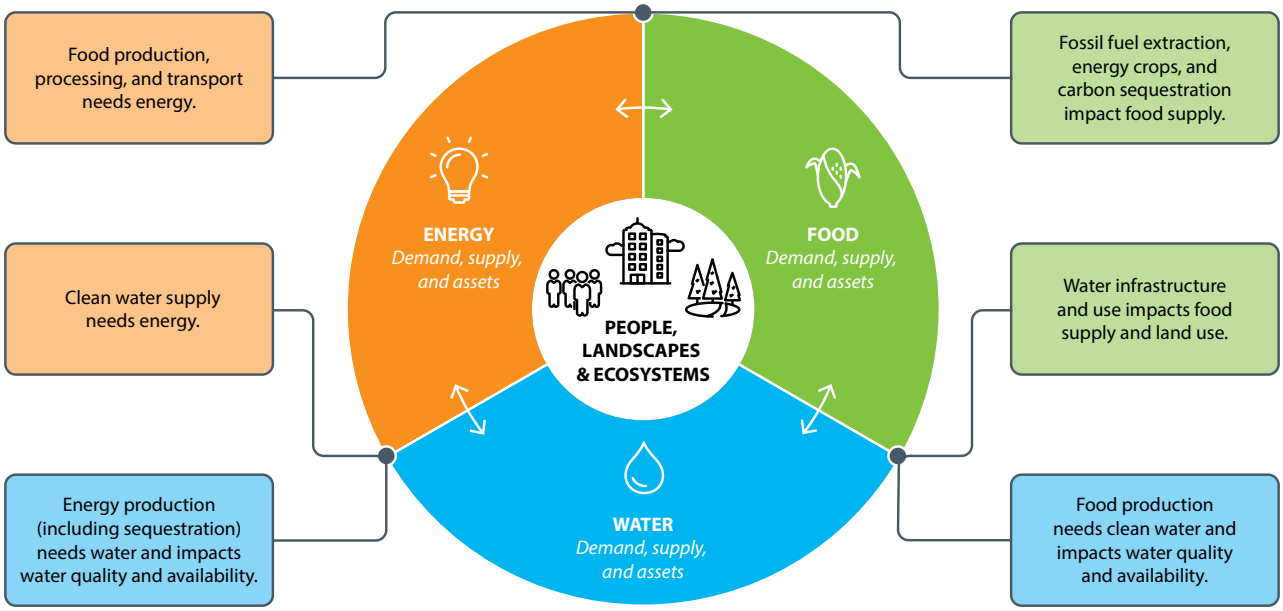
- Provide technical assistance to two ASEAN cities to support resilient, circular, and regenerative food-energy-water and waste system pilot projects
- Demonstrate the socioeconomic benefits of integrated systems planning
- Engage stakeholders and build organizational capacity on circular economic approaches and resilient planning models
- Attract private sector participation within project governance, finance, and implementation.

The goal of IUS was to help local city leaders, the private sector, financial institutions, and other stakeholders identify, design, and implement integrated, climate-smart models for urban service provision that sustainably secure and increase access to food, energy, and water services in a resource-efficient manner.

The IUS program provided technical assistance to two ASEAN cities, piloting the development of market-driven design solutions and corresponding business plans to enable each of the two pilot projects to sustainably address food production and food security concerns through the integration of energy, water, food and waste systems.

Key IUS-Supported Actions:

- Launched a first-of-its-kind technical assistance program for two ASEAN cities—Iskandar Malaysia, Malaysia and Cagayan de Oro, Philippines—focused on food security, agricultural innovation, resource circularity, and climate
- Introduced innovative private-public finance and integrated IUS development planning models into ASEAN countries' agritech industries
- Developed conceptual designs leading to market-driven business plans for each pilot city showcasing agritech investment opportunities.



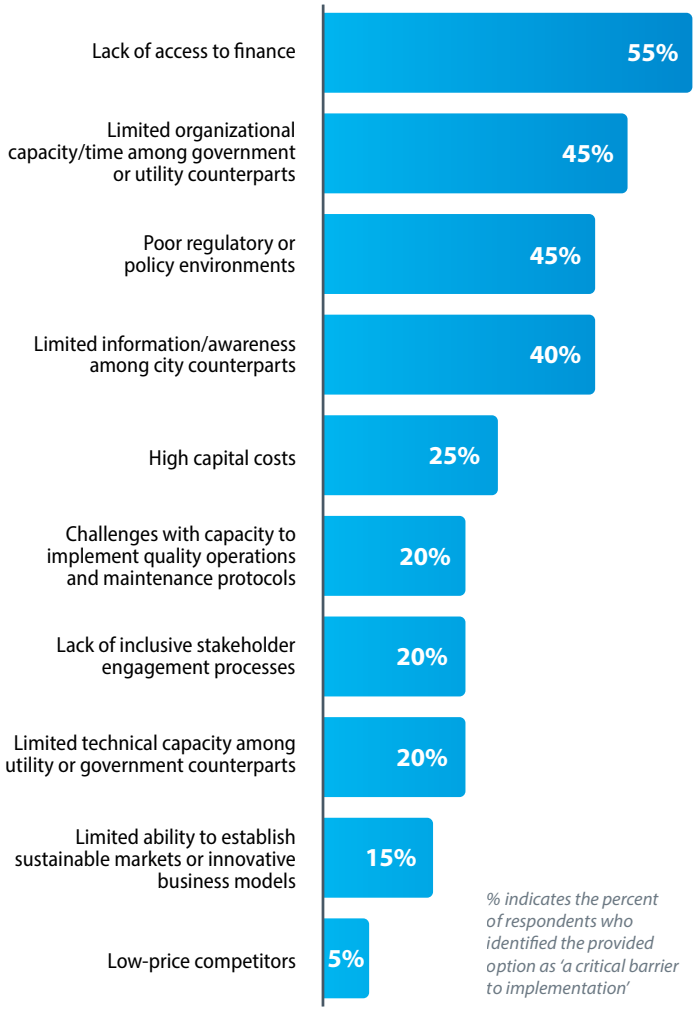
The interconnections between food, energy, and water systems. *Illustration by Christopher Schwing, NREL.*

Program Approach

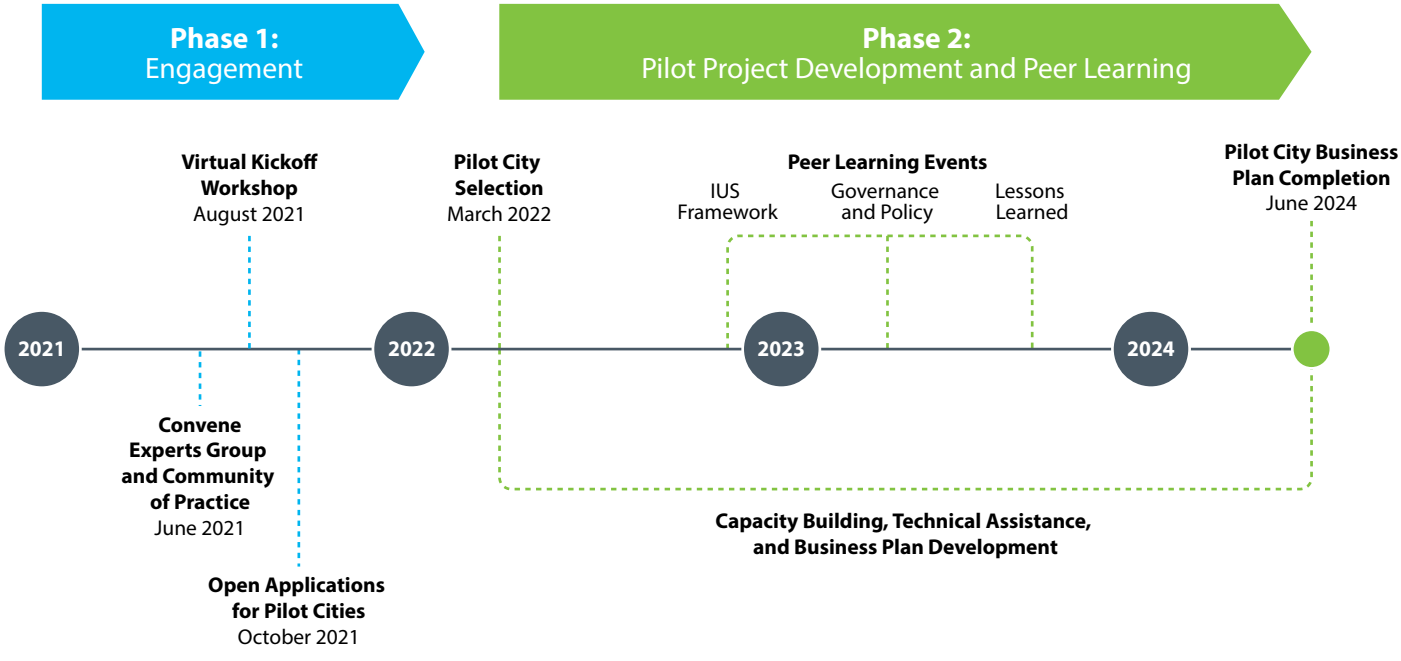
In August 2021, more than 50 experts from across the globe participated in a two-part program launch event to discuss food, energy, and water system challenges facing ASEAN cities, as well as barriers and opportunities related to implementing integrated urban service projects, including fast rates of urbanization, environmental change, resource stresses on cities, and access to adequate basic services. This feedback helped inform the IUS program's approach and evolution.

Cagayan de Oro, Philippines *Photo from Getty Images 1740347966*

A survey conducted by the IUS program of 19 private sector, research and development companies, and other stakeholders, ranked the following critical barriers to implementing solutions to address food, energy, and water system challenges.



% indicates the percent of respondents who identified the provided option as 'a critical barrier to implementation'



Program Highlights

From January 2021 to May 2024, the IUS program elevated the opportunities and challenges presented by the food-energy-water nexus to the forefront of many ASEAN cities' priorities, especially those interested in building capacity and resilience in their integrated urban service provisioning systems, governance structures, and finance approaches.

A few program highlights include, but are not limited to:

- Engaging **127 participants** through technical assistance activities, representing over **35 organizations** and **75 private sector partners**.
- Hosting **3 peer-learning events** about integrated planning and governance, circular economy, and regenerative approaches, with over **147 individuals (57 women and 90 men)** attending. 80% of attendees reported "significant knowledge gain" from these events.
- Harnessing and sharing cutting-edge knowledge from **14 renowned IUS experts** from the ASEAN region and United States to inform program approaches and best practices.
- Organizing **three cross-sectoral, private-public advisory and technical committees**, composed of local, state, and national government entities to inform and provide feedback on technical assistance activities.
- Developing **two market-driven business plans** that showcase highly productive, resilient, low-carbon agritech and renewable energy development approaches.
- **Three site visits** to each market by the IUS project team to ensure project designs reflected local interests and development priorities.

Importantly, the IUS program could not have been successful without strong collaboration and excellent contributions from its partners and pilot city representatives.

The IUS project team presents the projects with pilot city leads at USASCP's Symposium on Accelerating Science, Technology, and Circular Innovation in Southeast Asia in Jakarta, Indonesia, in September 2023.

"I learned so much from the webinar session and look forward to future collaboration on potential projects in Iskandar Malaysia."

VP, Resilient Environment Division, Iskandar Regional Development Authority

"The experts have imparted their knowledge and experience of their respective fields, which inspires us most."

Disaster Risk Reduction and Management Office, San Carlos City, Philippines

"This has been an excellent platform for understanding challenges for building integrated urban services across various country contexts."

Professor, UP School of Urban and Regional Planning, Manila, Philippines

Technical Assistance: Integrating Food-Energy-Water Urban Services and a Circular Economy

The IUS project team worked directly with two pilot cities—Iskandar Malaysia, Malaysia and Cagayan de Oro, Philippines—on 18-month technical assistance projects with a goal of designing and planning the implementation of circular and regenerative energy, water, waste management, and food system projects. The IUS Experts Group served as a key resource for ongoing feedback and guidance on project design and delivery as well as current research, best practices, and outreach to support integrated food, energy, and water systems in the ASEAN region.

Pilot cities were selected through a competitive solicitation and application process; overall, the USASCP and NREL teams evaluated 10 pilot city applications from various ASEAN cities. The evaluation was based largely on defined needs and challenges for food, energy, and water solutions; technology potential; alignment with larger development plans; and potential for active support and participation by government, community, private sector, and other key partners. Based on this evaluation, NREL, with support from the IUS Experts Group, awarded assistance to the Philippines Agricultural Productivity Office (APO) in Cagayan de Oro and the Iskandar Regional Development Authority (IRDA) in Iskandar Malaysia. The IUS Experts Group served as a key resource for ongoing feedback and guidance on project design and delivery as well as current research, best practices, and outreach to support integrated food, energy, and water systems in the ASEAN region.

Technical assistance involved biweekly virtual meetings and three site visits. The site visits, hosted by the cities, provided an opportunity for in-person stakeholder meetings with local, state, and national officials and community members, including local farmers, utilities, water and waste management companies, and other symbiotic agritech partners and industries. These engagements, coupled with the peer-learning events, ensured that the technical assistance projects aligned closely with the cities' original IUS goals and needs described in their applications.

The technical assistance culminated in developing business plans for each pilot city, detailing each city's project vision, conceptual design, business models, financial analysis, and market-driven approaches for promotion. The plans also function as tools for seeking partnerships with potential interested investors, financiers, and partners who can support certain aspects of the project.

Pilot City Profile: Iskandar Malaysia, Malaysia

Iskandar Malaysia, an area of 2,300 square kilometers, has been growing rapidly—optimizing its position within Malaysia's southernmost state of Johor. Primed with abundant land, natural, and human resources, Iskandar Malaysia is the main economic development corridor in Southern Johor.

As of 2020, Iskandar Malaysia's population was 1.96 million, although the region estimates their population will grow to 2.72 million by 2025, creating significant new demand for services. With this in mind, the Malaysian Investment Development Authority is targeting cumulative outside investments of RM636 billion (Malaysian ringgit) into the region by 2025.[1] The region's economy is mainly driven by the service and manufacturing sectors, but the agriculture sector also contributes significant economic value, especially the agrifood subsector. Iskandar Malaysia's vegetables, cash crops, and herbs contributed more than one-third of Johor State's production in 2021. With its rapid growth, land use in Iskandar Malaysia has experienced a high rate of conversion from agricultural land to urban development, and the remaining areas are predominantly commodity plantations, with palm oil being the dominant crop.

Iskandar Malaysia seeks to be internationally competitive and innovative, with a vision of a "Strong and Sustainable Metropolis of International Standing." Iskandar Malaysia's food systems are governed by the National Agrofood Policy, aspiring for the agrifood sector to be more sustainable, resilient, and technology-driven, and aligned with Malaysia's low-carbon commitment, which was renewed at COP21 in Paris. At the COP21 conference, Malaysia also set a target to achieve 45% reduction in emission intensity of gross domestic product by 2030 compared to 2005 levels.

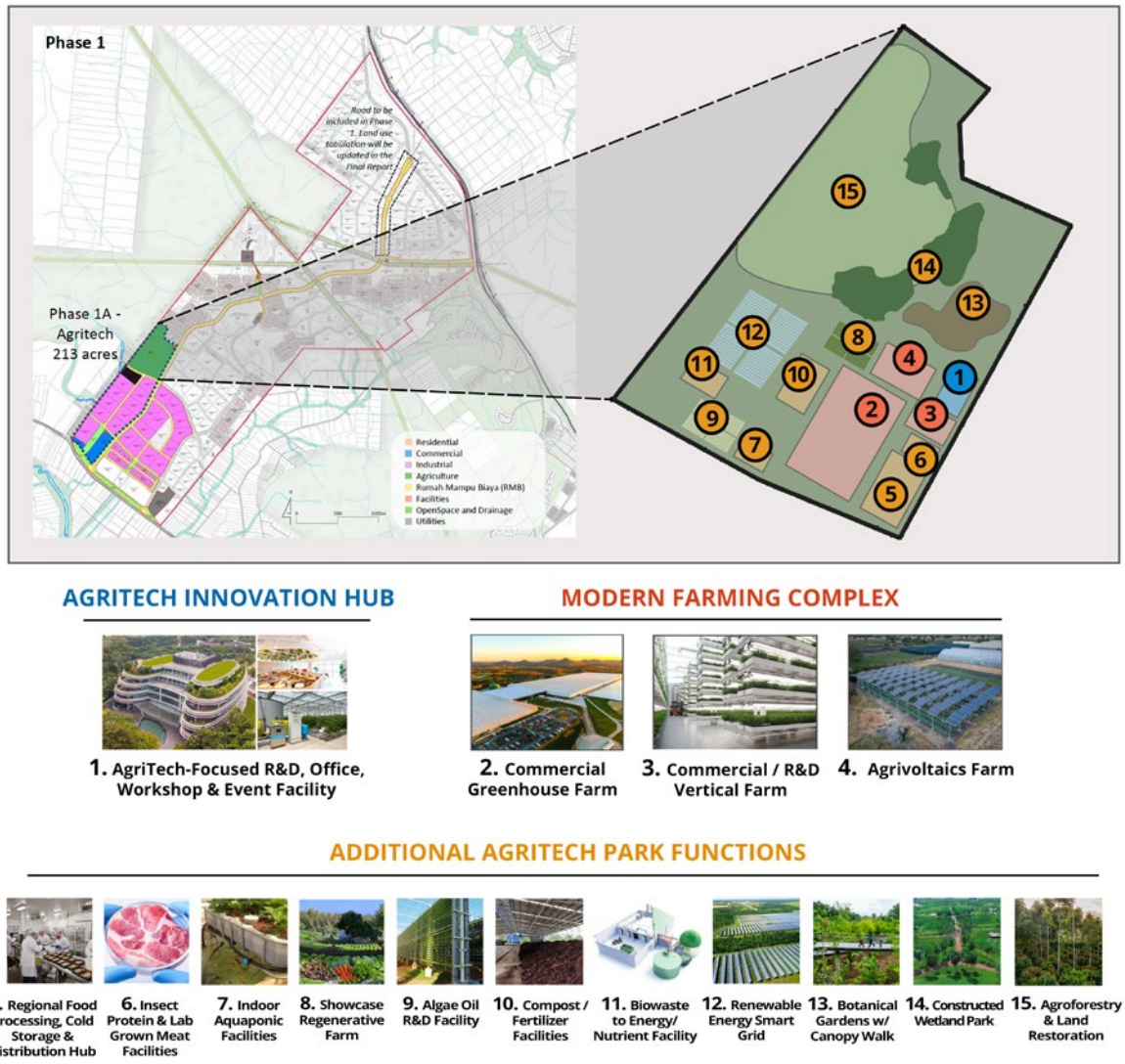
Technical Assistance

IRDA asked for technical assistance to test and apply integrated planning approaches within its 7,719-hectare Flagship F innovation zone. As one of six designated Flagship zones (A–F), Flagship F is slated to emphasize agritech, research and development facilities, health care, and high-tech industries. The area is largely a greenfield site with a mix of existing and retiring legacy business operations, notably aging monoculture oil palm plantations. With this context in mind, the IUS team worked closely with IRDA to:

Members of the IUS team during a site visit to Iskandar Malaysia.
Courtesy of Regenerative Impact Ventures.

- Review existing legacy land-use policy and planning frameworks, examining opportunities to support greater levels of innovation and technology integration in complex, large-scale projects
- Identify and evaluate a mix of innovative design features spanning agriculture production and land-use functions, infrastructure, utilities, and placemaking features aimed at sustainably increasing agricultural productivity, resilience, and attraction to the region
- Apply a consultative project prioritization and selection methodology with the Executive-Level Steering Committee to enhance the project vision and elevate projects of most interest and value
- Provide capacity-building on enabling investment and project governance models positioned to support high-aspiration, low-carbon, integrated developments
- Develop a conceptual design and business plan for an AgriTech Park, aiming to attract bids for finance, investors, and technology partners.

[1] IRDA sets new cumulative investment target of RM636b by 2030 - MIDA | Malaysian Investment Development Authority. (2024b, February 6). https://www.mida.gov.my/mida-news/irda-sets-new-cumulative-investment-target-of-rm636b-by-2030/



Conceptual site plan of AgriTech Park campus. *Courtesy of Regenerative Impact Ventures.*

Through facilitated engagement with IRDA and local stakeholders, the IUS project team envisioned key features and elements of a future AgriTech Park and Investment Ecosystem to be located within Flagship F's 2,940-acre Ladang Air Manis development parcel. The AgriTech Park features groundbreaking infrastructure and public amenities that showcase and accelerate promising agritech adoption and ultimately serve as a focal point for agritech investment in the region. The proposed AgriTech Park would be a 213-acre campus of coordinated facilities hosting a unique mix of investment-oriented functions and concentrated novel agricultural production activities.

Project Vision

This pilot project's vision is to:

- Become an internationally recognized development—a new model for productive, resilient agriculture in Malaysia and aan integrated agriculture, energy, and water testbed for the ASEAN region.
- Serve as a catalytic destination for modern agricultural investment and climate-oriented capital.
- Become a verifiably sustainable, resilient, and circular development.
- Demonstrate world-class design and placemaking.
- Prioritize integrated and mixed-use development to attract top partners and talent.

Project Concept

Two key elements developed in the business plan comprise the initial AgriTech Park campus investment.

1. A state-of-the-art agritech innovation hub that serves as a focal point for regional investment in modern agriculture; provides curated collaborative research and development, office, workshop, and event spaces; and offers business development services to support regional farming communities.

2. A modern farming complex that tests high-productivity agriculture models and produces high-quality organic food for local and export markets. The 60-acre complex has potential to include a vertical farm, commercial greenhouse, and demonstration agrivoltaics farm that collectively enhance agricultural productivity fourfold, compared to conventional production models, and produce enough renewable energy to power the Park.

Potential Impact

An initial catalytic capitalization of approximately $50 million USD is required to launch phase 1 of the AgriTech Park. $15 million USD is requested from government-led financial mechanisms to build the Innovation Hub and invest in the Modern Farming Complex, while private sector can support the remaining $35 million needed for the Modern Farming Complex.

As modeled, the AgriTech Park is projected to generate over $150 million USD in investment into Flagship F over its first 8 years. Over 20 years, resulting investments are projected to deliver $1 billion USD in broad economic returns through agricultural productivity, exports, and sustainable development goal impacts, delivering a return ratio of 1:20 to the initial government investment in its economic impacts.

The multiplier effect on initial government capital investment is achieved through:

- Direct investments
- Increased exports
- Access to concessional finance capital via multilateral development banks or impact funds
- Cultivation of local talent pool and locally generated knowledge base/intellectual property
- Improved livelihoods for local producers and communities
- Higher land productivity or yields (compared with legacy agricultural development model)
- Diversified agricultural base
- Averted land degradation or improved long-term growing conditions and productivity
- Improved watershed management
- More-efficient water use
- Averted or reduced flood risks
- Development of allied industries and supporting infrastructure.

Explore the IRDA Pilot Project Profile:
www.nrel.gov/docs/fy23osti/87095.pdf

Iskandar Malaysia, Malaysia *Photo from Getty Images 1194497499*

Pilot City Profile: Cagayan de Oro, Philippines

With a population of 728,000, Cagayan de Oro is the capital of Misamis Oriental province and serves as the regional center and business hub of northern Mindanao. The city has 80 barangays, or small administrative districts, forming the most local level of government and spread into two congressional districts, with 40 classified as urban and 40 rural.

Cagayan de Oro faces many pressing challenges, including rising food prices and insecurity, high poverty rates and disengaged youth, increasing volumes of unmanaged waste, and increasingly severe and costly impacts from climate change. The local government is interested in addressing these challenges by investing in innovative, integrated solutions that can work across sectors, systems, and locations and create opportunities for synergistic resource use.

Technical Assistance

The city applied for IUS assistance to increase urban and sustainable agricultural productivity and food security, establish climate-resilient urban farming approaches, attract investments for broader implementation, and improve resource management and efficiency in the food, energy, and water sectors.

The IUS technical assistance has supported the APO in transforming multiple urban sites into model hubs of innovative, high-productivity, integrative agricultural functions and basic service provision that meet the goals of Cagayan de Oro and surrounding communities. With this background, the IUS technical assistance team worked with Cagayan de Oro's APO to:

- Pursue promising agricultural applications and technologies (such as hydroponics, aquaponics, agrivoltaics, and commercial black soldier fly production) that increase urban and peri-urban agricultural productivity
- Examine various project sites and their viability to host innovative infrastructure solutions
- Provide capacity-building on modern farming practices and integrated planning approaches
- Engage with key local stakeholders and incorporate their interests and perspectives into project

During an IUS team-facilitated workshop, Cagayan de Oro representatives from the local barangays and farms discuss their perspectives about the potential impacts of the project and the challenges and opportunities presented if implemented.

- Review and promote policy and governance models positioned to support greater levels of innovation
- Develop a conceptual design and business plan for urban agriculture and resource management activities with an aim toward attracting bids for finance, investors, and technology partners.

The ventures examined in the IUS-supported business plan represent Phase 1 of an initiative called Investments in Integrated Material Productivity, Agriculture, and Climate Transition (i-IMPACT CdeO). Focused attention was placed on developing a conceptual design and business plan for an urban precision agricultural complex and a black soldier fly facility, with initial siting analysis done in an EcoPark in Barangay Carmen and landfill in Barangay Pagalungan. These ventures are designed to showcase and accelerate modern farming innovation and resource productivity throughout Cagayan de Oro City and Northern Mindanao, aligning with the broader i-IMPACT CdeO development pillars of Agriculture Innovation, Waste Management, and Climate Resilience.

Project Vision

The vision for the pilot project is to be nationally recognized model for integrated resource management, agritech innovation, and climate resilience planning.

This supports Cagayan de Oro's development by catalyzing innovation, boosting agricultural economic productivity, creating high-value jobs, improving community livelihoods, and enhancing climate resilience and ecosystem function while operating as a self-sustaining public-private partnership model.

Objectives

- Provide facilities and resources to test, commercialize, and scale precision agriculture technologies, modern farming and agrivoltaic methodologies, and nutrient recovery/ conversion facilities
- Facilitate research and development for commercially scaled food production enterprises that produce high-value crops for local and export markets
- Provide workforce development and training opportunities in modern farming and renewable energy technologies and operations
- Use high-quality architecture and landscape design to create strong identities of place
- Offer unique public-facing attractions and learning experiences that draw public interest
- Provide blended deal-making expertise that accommodates and leverages public and private sector interests
- Put Cagayan de Oro on the map by enhancing its reputation for innovation.

Project Concept

Two key elements developed in the business plan comprise the initial investment.

1. An urban precision agricultural complex featuring four coordinated greenhouses that will house precision agricultural equipment, including vertical aeroponic tower modules, hydroponic equipment, and aquaponic tanks to cultivate fresh fish. An additional agrivoltaics farm will showcase agricultural production beneath solar panel arrays.
2. A pilot-scaled black soldier fly facility that will incorporate organic municipal solid waste from several sources across the city and convert this waste into valuable commodities such as liquid fertilizer, protein (larval body) animal feeds, and compost. The voracious appetite of black soldier fly larvae for organic matter enables efficient conversion of a wide range of organic waste materials.

Potential Impact

- Advance an integrated urban investment planning approach that seeks to address efficient resource use, agricultural productivity, energy, and climate challenges in Cagayan de Oro
- Create an innovation focal point for testing, incubating, and scaling novel approaches to urban agricultural production aligned with local needs and market conditions
- Engage and support the surrounding regional farming base via linkages with extension and business development services aimed at improving the livelihoods of the farming community
- Avert an anticipated 50%–80% of total municipal waste (the typical organic waste component generated in Cagayan de Oro) from the landfill with corresponding reductions in required design capacity and operational costs of currently planned engineered landfills.

The IUS project team met with the Cagayan de Oro's city planner representing the Mayor's office to discuss the leadership vision of the project. The project aligns closely with the city's Regional Leadership, Institutional Development and Participatory Governance, Safety, Security, and Human Development and Economic Recovery agenda.

A representative from the Philippine's National Economic Development Agency presents results from the workshop discussion to the group of participants.

IUS project team meeting with Cagayan de Oro's Barangay Lumbia's local government unit and discussing farming methods, crop and agricultural selection, partnerships, and training opportunities provided by and to the local farmers and community.

Explore the IRDA Pilot Project Profile:
www.nrel.gov/docs/fy23osti/87095.pdf

Looking Ahead: Investing in Future Integrated Urban Services

The State Department's USASCP investment, reinforced by the participation across other agencies, pilot cities, and partners, was critical to advance understanding of and highlight the multifaceted opportunities presented by systems integration and circularity approaches in the food production infrastructure and value chain.

By implementing this first Integrated Urban Services program, USASCP established a baseline model to replicate and share lessons not only for the ASEAN region, but for cities all around the world. Further underscoring the program's economic, social, and environmental impacts, both pilot cities are positioned to pursue the subsequent phase of resource support for the actualization of the business plan and next steps for each project's development.

Although the IUS program has ended, the USASCP, NREL, and its partners worldwide have strong interest in continuing to explore and incentivize investments in resilient, circular, and regenerative food-energy-water-system projects across the globe. The outlined next steps and lessons learned of the program provide the foundation for other cities or countries to understand the benefits and opportunities of embracing the principles of circular economy for resource efficiency through a systems integration model that can be applied across urban sectors.

Lessons Learned

- Potential exists for accelerated returns derived from innovative, integrated agriculture approaches.
- Early and diverse stakeholder engagement is highly valuable.
- High crop productivity is still possible in cities with low agricultural land areas.
- A waning and aging workforce is a common challenge in agriculture and farming industries.
- Capacity-building in new concepts, such as circularity and integrated planning, is critical to establishing shared understanding across stakeholders.
- Engaging champions and partners across sectors, disciplines, and levels of government is key to a project's success.
- Public-private partnerships and supportive governance structures are essential for getting projects to bankability.
- Peer-learning provided by NREL helped government officials with complex project development and planning.
- Site visits proved critical to accelerating project definition and alignment with pilot city goals.
- A consultative decision-support process for executive leadership is valuable in guiding project screening and selection.

Next Steps

The next stages of project development for the two IUS pilot projects requires additional funding and support to achieve transactional closure and subsequent project groundbreaking. Blended finance structures are anticipated, including anchor private sector investors and/or development partners, as well as catalytic support and incentives provided by the respective government sponsors.

Potential outputs of the next funding stages include:

Project Design

- Site selection and finalization, project design, and master planning
- Geospatial modeling, land use, and natural asset assessment (carbon, habitat, biodiversity)
- Township planning strategy
- Market engagement strategy
- Program implementation road map.

Project Enablement - Governance, Investment, and Finance

- Integration with other initiatives
- Enterprise structuring, project governance frameworks, agreements, and phase-in plans
- Economic and financial modeling (external; intended to serve investor base)
- Assessment of project finance options and structures (debt, equity, bonds, credit)
- High potential technology and vendor engagement
- Anchor investor partnerships formed and agreements finalized and signed.

More Information and Resources

Explore the recordings and resources from the peer-learning events:

IUS Kickoff Workshop, Day 1 (youtu.be/KaYcrqEBvYk**) and Day 2 (**youtu.be/y4mETS3H9Fs**):** The launch event introduced the IUS program and pilot projects to regional and global stakeholders and engaged interested smart cities to understand their energy-water-food system needs, priorities, and barriers to project implementation.

Where To Start: Integrated Urban Services Planning (youtu.be/gM4i6WKIFRM**):** The IUS program, in partnership with ICLEI, showcased lessons learned from implemented projects in the ASEAN region. Experts from ICLEI's Urban Nexus program and city officials involved in the implementation of Urban Nexus pilot projects discussed best practices related to kick-starting integrated urban service projects.

Governance and Policy for Integrated Urban Solutions (youtu.be/ZaF0Mhum8h8**):** Panelists from across the IUS program and pilot cities discussed common policy challenges and barriers to integrated urban services projects, identified experiences and tactics project implementers can use to overcome these common policy challenges and barriers, and shared policy and governance learnings from the IUS Program pilot projects.

Learn more about the IUS program: www.nrel.gov/international/integrated-urban-services.html.

Learn more about USASCP: www.usascp.org.

Explore how NREL can work with your organization by visiting: www.nrel.gov/international/work-with-us.html

Implementing Partner Spotlights

Mission: Promoting sustainable, resilient, and inclusive solutions to advance urban quality of life in Southeast Asian Nations.

Role: Program funder and lead program manager and development

- Helen Santiago Fink, Program Manager, santiagofinkh@state.gov.

Webste: www.usascp.org

Mission: Transforming energy through research, development, commercialization, and deployment of renewable energy and energy efficiency technologies.

Role: Lead pilot city projects, provide renewable energy and agrivoltaics research and expertise, manage program finances

- Jennifer Daw, Principal Investigator, jennifer.daw@nrel.gov
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- Jeff Gingrich, Project Controller, jeffrey.gingrich@nrel.gov
- Dr. Joshua Sperling, Senior Researcher, joshua.sperling@nrel.gov.

Webste: www.nrel.gov

Mission: To advance a regenerative model of integrated planning, development, and investment that leads to more productive, resilient, and healthy communities and ecosystems.

Role: Technical assistance and pilot city implementation lead (i.e. conceptual design and business plan development)

- Jan David Mueller-Vollmer, Co-Founder and Project Structuring and Finance Lead, jandavid@riv.global
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Cagayan de Oro's APO

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Iskandar Malaysia: Local Technical Steering Committee

Ministry of Agriculture and Food Security

Ministry of Science, Technology, and Innovation

Sustainable Energy Development Authority

Majlis Perbandaran Kulai

Southern Catalyst Sdn Bhd

Bdan Kawal Selia Air Johor

Malaysian Communication and Multimedia Commission

Plan Malaysia Johor

Tenaga Nasional Berhad

Ranhill SAJ

Telekom Malaysia

Koridor Utility Johor

Gas Malaysia Distribution Sdn Bhd

The Legend Golf and Country Resort

Solid Waste Management SB

Solid Waste Corp

Sepakat Setia Perunding Sdn

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Ministry of Economy

Ministry of Science, Technology, and Innovation

Ministry of Agriculture and Food Security

Local Stakeholders:

Majlis Perbandaran Kulai (Municipality of Kulai)

Malay Farmers in Kulai

Johor Corp Data Center

Durian Zhong Cheng Fruit Farm

Sime Darby Plantation

JBioTech

AJC Planning (Ladang Air Manis Master Plan and Feasibility Report)

APUDG (Modern Farming in Iskandar Malaysia feasibility study) teams in Kuala Lumpur

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Sir Bensay

Councilman Pascual

Councilman Esparcia

Councilman Nacaya

Engr. Armen A. Cuenca, MPA, EnP, CLENRO Director

Finance, Trade, and Investment Promotions Center

City General Services Office

City Legal Office

City Planning Office

National Government:

National Economic Development Authority

Department of Science and Technology
Department of Agriculture

Technical Education and Skills Development Authority

Local Stakeholders:

Urban Container Household Gardening program participants

Material Recovery and Composting Facilities

Vermi Culture Producers Cooperative

Barangay Carmen Local Government Unit

Col. Cervantes SQF Garden

Canitoan Farmers' Cooperative

Cagayan Electric Power & Light

City Water District

Eco Park Urban Precision Agriculture Complex Association

EcoBricks, Inc

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