U.S.-ASEAN Smart Cities Partnership

Integrated Urban Services

Regional Launch Event

August 11th and 13th 7:00-9:00AM (GMT+7)

August 10th and 12th, 8:00-10:00 PM (EDT/GMT-4)

A program of the US-ASEAN Smart Cities Partnership to sustainably secure energy, water, and food for the region's municipalities through regenerative approaches

NREL/PR-7A40-80726

Welcome

Jennifer Daw

Principal Investigator

jennifer.daw@nrel.gov

NREL

NATIONAL RENEWABLE ENERGY LABORATORY

Photo from iStock 1145536473

Day #1 Meeting Agenda

Welcome and Introduction

- Opening Remarks: William Flens | Director, Office of Multilateral Affairs | U.S. State Dept.
- Climate and Clean Development: Dr. Jill Engel-Cox | Director, Joint Institute for Strategic Energy Analysis | NREL

Setting the Stage: Background and Rationale for IUS Program

- Overview of U.S. ASEAN Smart Cities Partnership: Helen Santiago Fink | Program Manager, USASCP | U.S. State Dept.
- IUS Project Overview: Jennifer Daw | Principal Investigator, IUS Project | NREL
- Nexus Fundamentals: Dr. Josh Sperling | Urban Futures-Energy-X Nexus Engineer | NREL

Panel #1: Common Challenges and Global Success Stories

- Moderator: Carol Lynn MacCurdy | Water Policy Advisor | U.S. State Dept.
- Prioritizing Sustainability Actions at the Urban Food-Energy-Water (FEW) Nexus: Anu Ramaswami, Ph.D. | Professor of Civil and Environmental Engineering | Princeton University
- Lessons Learned from San Francisco: Paula Kehoe | Director of Water Resources | San Francisco Public Utilities Commission
- Integrated Urbanism: Dr. James Moore | Global Solutions Director, Cities & Places | Jacobs
- Q&A

Panel #2: Voices from the ASEAN Region

- Moderator: Helen Santiago Fink | U.S. State Dept.
- Realizing Smart Cities: Venkatachalam Anbumozhi, Ph.D. | Senior Energy Economist | Economic Research Institute for ASEAN and East Asia
- The Potential Role of Co-Innovation in Developing Smart City Projects: Navjeev Singh | Development Partner | Enterprise Singapore
- ASEAN Australia Smart Cities Trust Fund (AASCTF): Elizabeth Jung | Urban Development Specialist | Asian Development Bank
- Q&A

Day 1 Closing

Photo by Dennis Schroeder, NREL 39968

Day #2 Meeting Agenda

Opening Remarks and Day 1 Recap

- Jennifer Daw | NREL

Pilot City Projects and Key Milestones

- Parthiv Kurup | Pilot City Lead | NREL
- Q&A

A Tale of 3 Cities (Panel)

- Moderator: Helen Santiago Fink | U.S. State Dept.
- Restoration of Vernacular Urban Food Systems for Resilient Asian Cities: Dr. Makoto Yokohari | Professor, Graduate School of Engineering | University of Tokyo
- Lessons from the Los Angeles 100% Renewable Energy Study: Dr. Elaine Hale | Senior Research Engineer | NREL
- Regenerative Cities: Thomas Hussey | Director, Urban Design & Planning | Skidmore, Owings & Merrill
- Q&A

ASEAN Smart Cities Project Themes and Insights

- Dr. Josh Sperling | Urban Futures-Energy-X Nexus Engineer | NREL
- Q&A and Polling

Closing and Next Steps

- Jennifer Daw | NREL
- Helen Santiago Fink | U.S. State Dept.
- Q&A

Integrated Urban Services (IUS) Kickoff Workshop

Welcome

Dr. Jill Engel-Cox
Director, JISEA

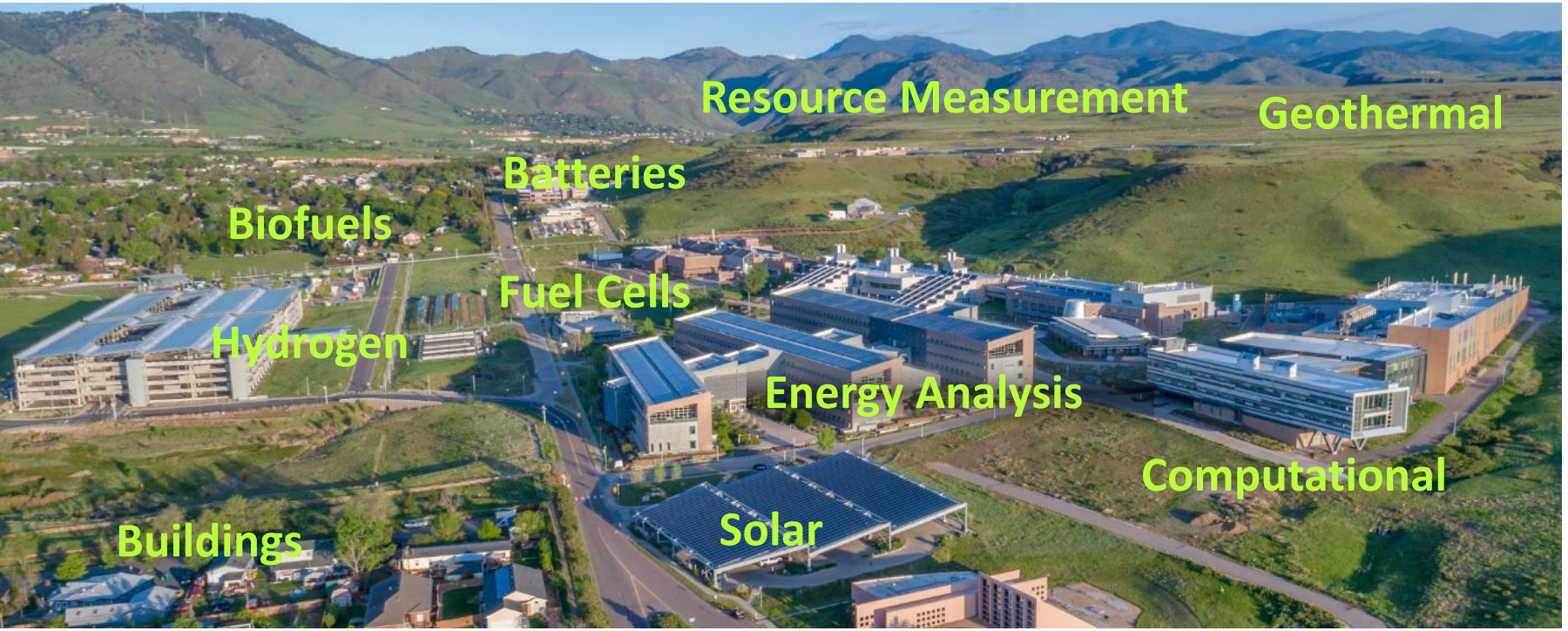
10/11 August 2021

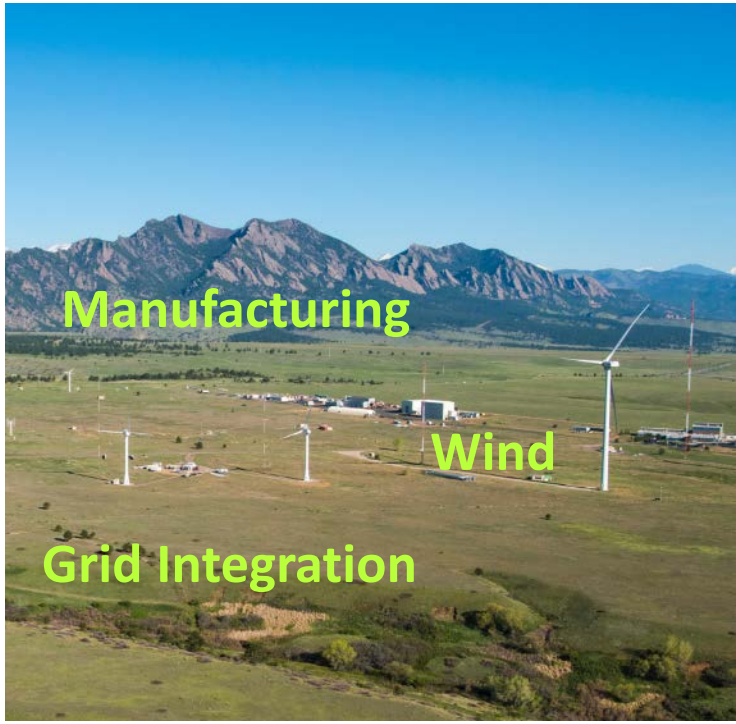
National Renewable Energy Laboratory

Mission: NREL advances the science and engineering of energy efficiency, sustainable transportation, and renewable power technologies and provides the knowledge to integrate and optimize energy systems.

www.nrel.gov/about

Example Technology Areas:





- 2,900 employees and postdoctoral researchers, interns, and visiting professionals
- 327-acre main campus in Golden & 305-acre Flatirons Campus with National Wind Technology Center 13 miles north
- 69 R&D 100 awards. More than 1,000 scientific and technical materials published annually

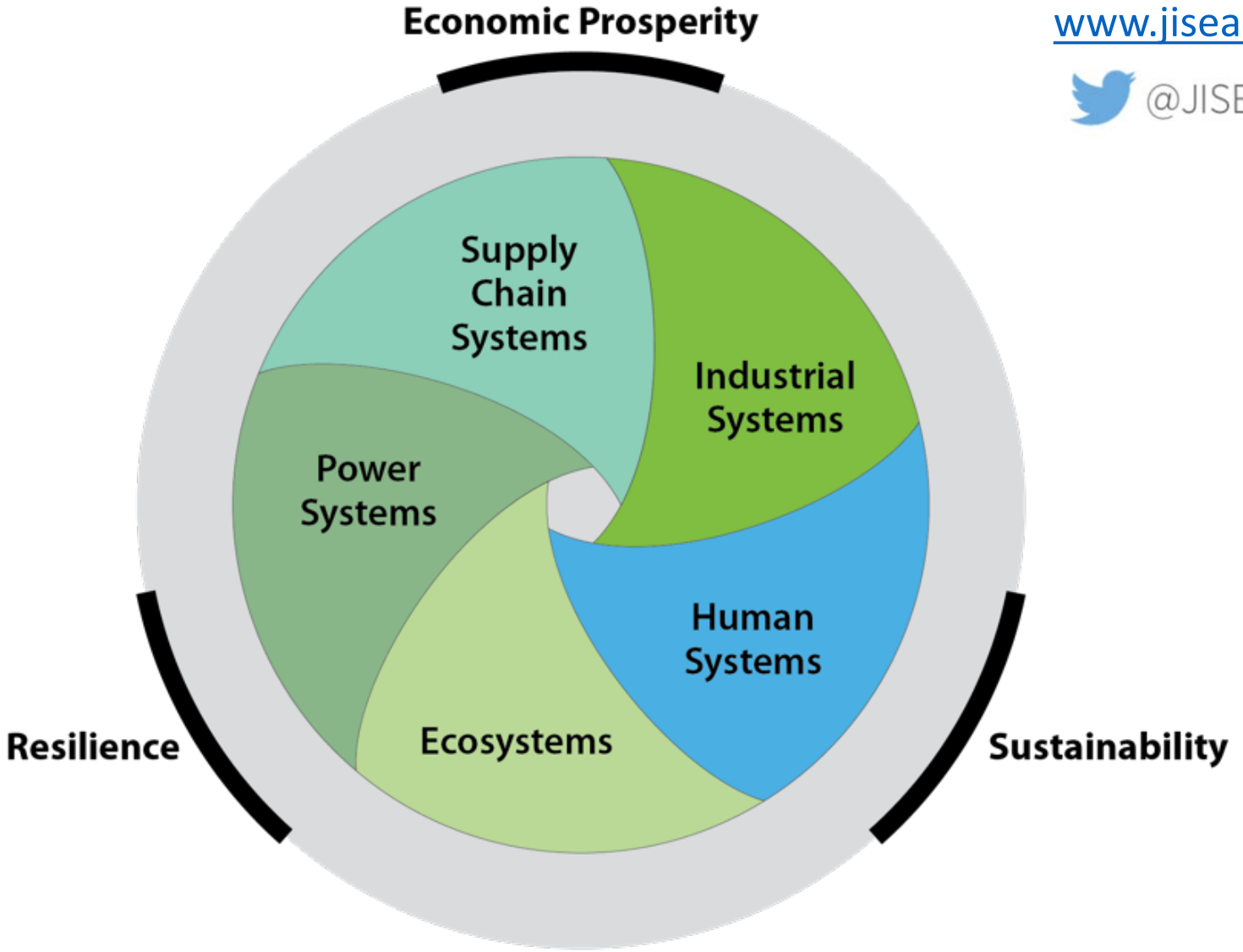
JISEA

Joint Institute for Strategic Energy Analysis

Connecting technologies, economic sectors, and continents to catalyze the transition to the 21st century energy economy.

www.jisea.org

@JISEA1



Founding Partners:

NREL Transforming ENERGY

COLORADO SCHOOL OF MINES EARTH • ENERGY • ENVIRONMENT

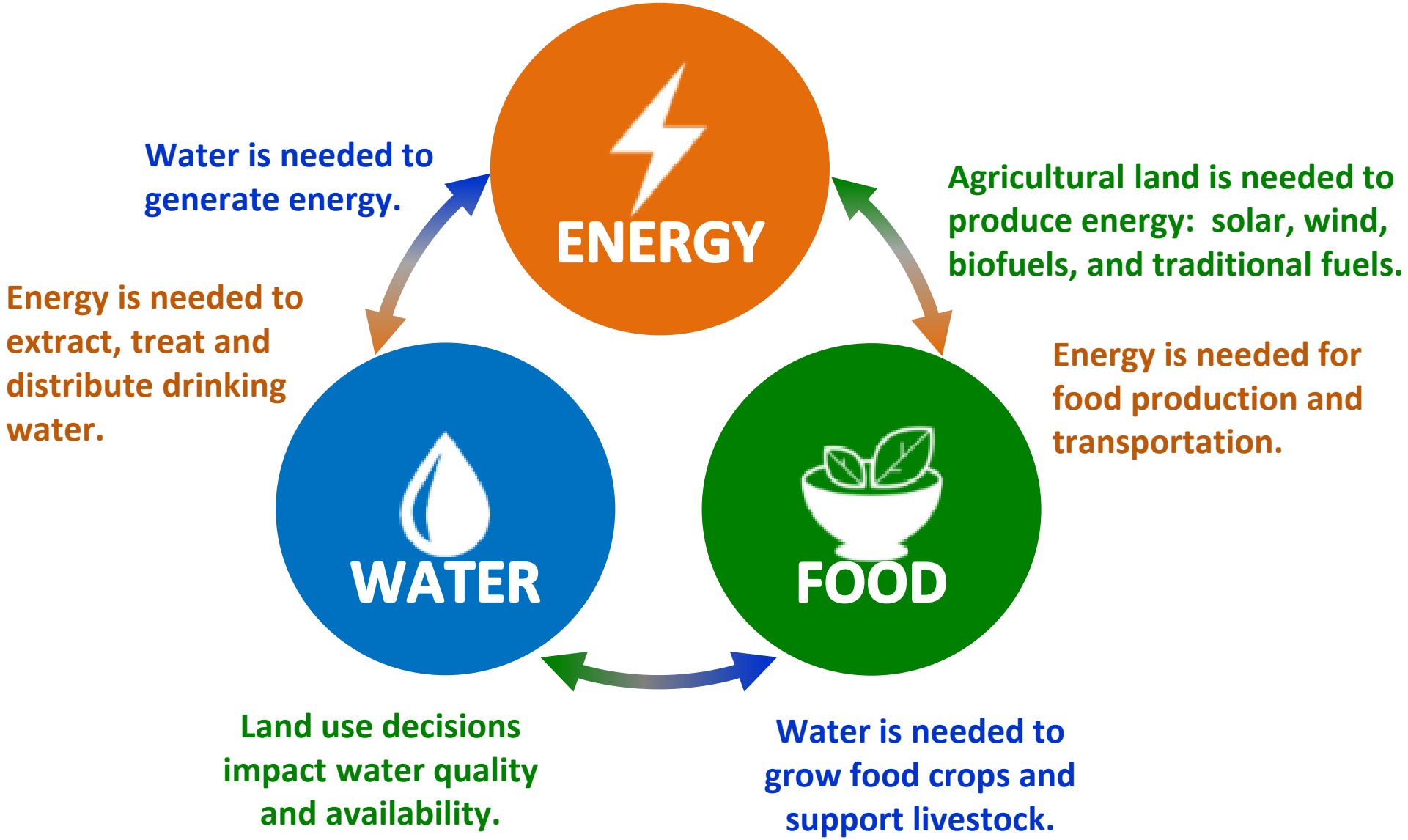
COLORADO STATE UNIVERSITY

Massachusetts Institute of Technology

Stanford University

University of Colorado Boulder

Energy-Water-Food Nexus is Central to Sustainability



Renewable Energy

Renewable Power

Solar

Wind

Water

Geothermal

Sustainable Transportation

Bioenergy

Vehicle Technologies

Hydrogen

Energy Efficiency

Buildings

Advanced Manufacturing

Government Energy Management

Energy Systems Integration

Grid Integration

Hybrid Systems

Security and Resilience

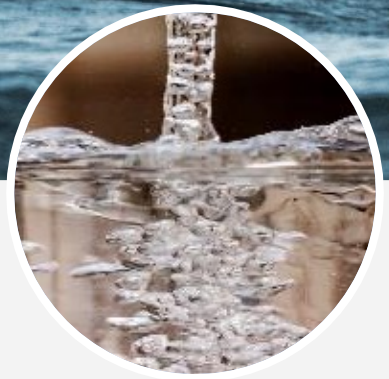
Water Systems

Water Modeling and Analysis

- ✓ System co-evolution and performance
- ✓ Focus on resilience and efficiency

Water-Grid Integration

- ✓Renewable-integrated desalination technologies
- ✓Co-optimizing flexibility of water systems and electric system



Advanced Water Treatment

- ✓ New water filter elements and membranes
- ✓ Low-cost, roll-to-roll manufacturing

Water Technology Validation

- ✓ Hardware-in-the-Loop simulation and validation at scale
- ✓ Field and pilot demonstration

Decision Science and Support

- ✓ Policy, finance, and economic technical assistance
- ✓ Innovative system designs

Food and Energy

Agrivoltaics:

- Growing food crops and graze animals under solar and wind energy infrastructure
- Cooler microclimate increases PV efficiency and can increase crop yields
- Multiple income streams for farmers

Controlled Environment Agriculture

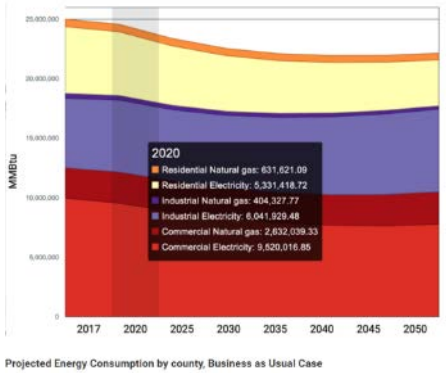
- Greenhouses with energy generation and low water use for high value crops
- Used for both urban and rural agriculture

Floating Solar

- Conserves land and reduces water evaporation
- Possible co-locations with fish farming

Sustainable Cities & Communities

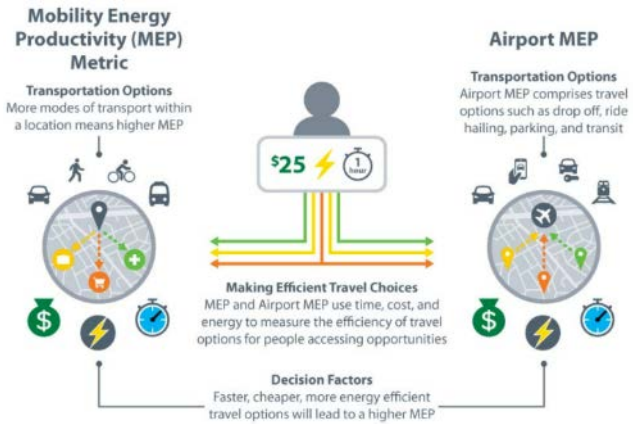
Considering people, profit, planet for just and equitable energy transitions



Projected Energy Consumption by county, Business as Usual Case

State and Local Planning for Energy (SLOPE)

Supports data-driven clean energy planning by delivering jurisdictionally-resolved energy efficiency, renewable energy, and (soon) sustainable transportation data



Mobility Energy Productivity Metric (MEP)

Measures how effectively an area's transportation system connects people to goods, services, employment opportunities, and other activities, accounting for time, cost, and energy

LA100

The Los Angeles 100% Renewable Energy Study

LA100 and other Cities

100% Renewable Energy Studies, including environmental justice, air quality, water, food, grid integration, and transportation

LEAD TOOL

LOW-INCOME ENERGY AFFORDABILITY DATA

U.S. DEPARTMENT OF ENERGY

Low-Income Energy Affordability Data (LEAD) Tool

Energy burden, housing type, vintage, tenure data down to the census tract level

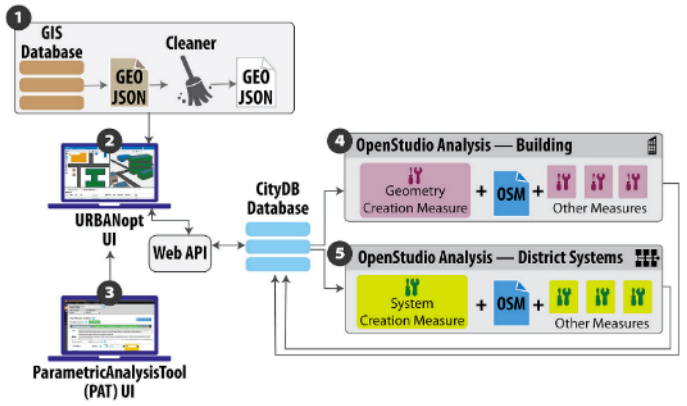


Figure 1. URBANopt advanced analytics platform architecture.

Urban Renewable Building and Neighborhood optimization (URBANopt)

Advanced analytics platform that provides energy efficiency and energy systems information at the district scale

Thank you!

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Support for the work was also provided by the U.S. Department of State under Agreement 19318820Y0008. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

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Transforming ENERGY

Setting the Stage: Background and Rational for the IUS Program

Integrated Urban Services
Program Overview

- Program under the United States-Association of Southeast Asian Nations (US-ASEAN) Smart Cities Partnership to help ASEAN cities build resilience in their energy, water, and food systems.
- The 3-year program is funded by the U.S. State Department and led by NREL.
- The program will demonstrate the socio-economic value and urban benefits of resource recovery and reuse through integrated systems that promote greater efficiency, improve water and energy security, and mitigate public health concerns.
- The program will incorporate market-based approaches, business plans, and peer learning to create the enabling environment necessary to attract public and private investors.

More information:
https://www.nrel.gov/international/integrated-urban-services.html

NREL Project Team

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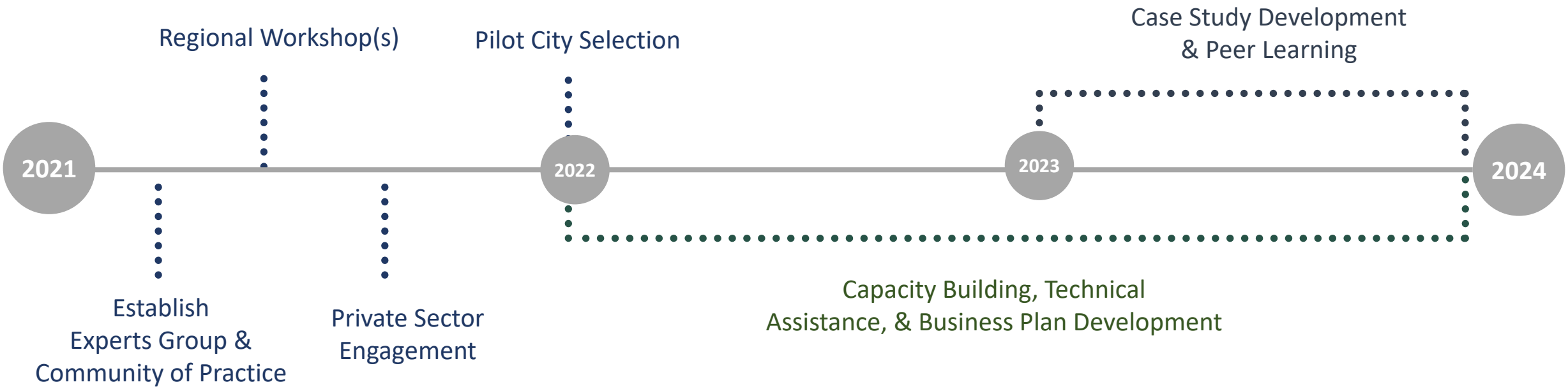
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Project Approach

Phase 1:
Engagement

Phase 2:
Capacity Building

Phase 3:
Peer Learning



1. Engagement

- **Host regional workshop** to provide information on the project, regional challenges and EWF system needs
- **Understand** EWF priorities and project implementation barriers in the region
- **Connect** with international, regional, and local stakeholders and private sector organizations
- **Conduct surveys and dialogues** with stakeholders and private sector
- **Establish an Experts Group and Community of Practice**

IUS Experts Group

American International Group, Inc. (AIG) Valerie Wilson, P.E. Global Senior Technical Advisor – Energy and Oil Rig	**Jacobs** Dr. Rick Robinson FBCS CITP FRSA AoU Director – Smart Places, Telecommunications & Digital Infrastructure	**Skidmore, Owings & Merrill** Douglas Voigt, AIA, AICP Partner
Asian Development Bank Elizabeth Jung Urban Development Specialist (Young Professional)	**Japanese Government or Academic** Dr. Makoto Yokohari Professor, Graduate School of Engineering, University of Tokyo	**U.S. Agency for International Development** Kevin Nelson Urban Governance Lead Governance Team Center for Democracy, Human Rights and Governance
East Bay Municipal Utility District Alicia R. Chakrabarti, P.E. Manager of Wastewater Environmental Services	**Princeton University** Dr. Anu Ramaswami Professor of India Studies | Civil and Environmental Engineering	**US-ASEAN Business Council** Bernard Baskin Director of Development, Sustainability, Energy
ERIA Venkatachalam Anbumozhi Senior Energy Economist | Director of Research Strategy and Innovation	**Regenerative Impact Ventures** Jan David Mueller-Volmer, Lead, Project Structuring & Finance	**U.S. International Development Finance Corporation (DFC)** Geoffrey Tan Managing Director, Asia Pacific

Community of Practice

- Individuals and organizations interested in staying engaged and informed about the IUS pilot projects and future opportunities to support the program
- Email Jennifer Daw (jennifer.daw@nrel.gov) or Jeff Gingrich (jeffrey.gingrich@nrel.gov) to join

2. Capacity Building

Provide technical assistance for 2 pilot cities to support implementation of circular, regenerative EWF system pilot projects through:

- Technology solutions
- Procurement best practices
- Modeling, analysis, and visualizations
- Policy and implementation strategies
- Business planning and project finance

Outcome: Business plans to help pilot cities turn goals into action by identifying tangible next steps with engagement of private sector partners.

How to Apply

One Application Per City

Ideally through a partnership model with different parties, including at least 1 utility

Application Opens
31st August 2021

Application will follow this workshop

Apply by
25th October 2021

Reach out for help as needed for your application

Why should you apply?

Targeted EWF solution for your city

Actionable steps after the assistance

Future potential access to green climate funds to take the solutions to implementation

3. Peer Learning

- Facilitate sharing and peer-to-peer exchange of lessons learned and best practices to help decision makers in the ASEAN region overcome obstacles to adopting integrated EWF systems.
- Lessons learned and best practices will be captured through technical assistance activities and shared at regional peer learning events and trainings.
- Regional information dissemination is aimed at helping scale implementation of integrated, regenerative EWF solutions through public-private and multi-sectoral partnerships.

U.S.-ASEAN Smart Cities Partnership

Integrated Urban Services (IUS)

Setting the Stage: Urbanization and Water-Energy-Land-Food Nexus Fundamentals for the IUS Program

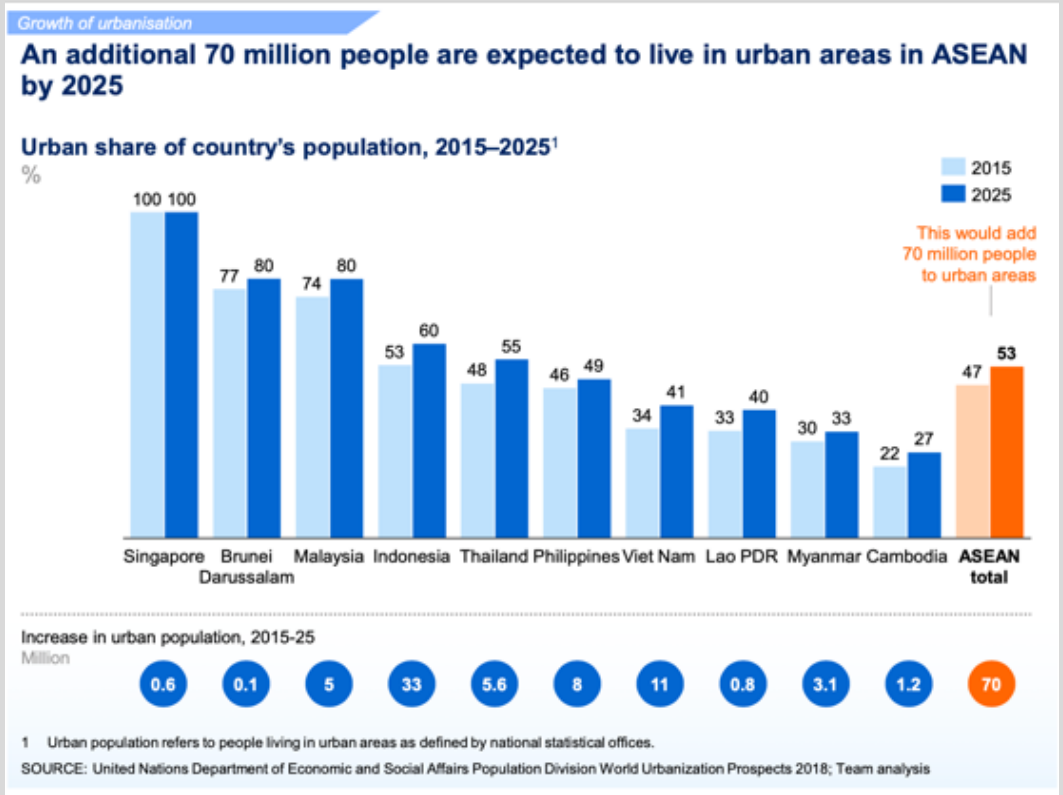
Josh Sperling, Ph.D., IUS Senior Researcher | Urban Futures & Energy-X Nexus Engineer

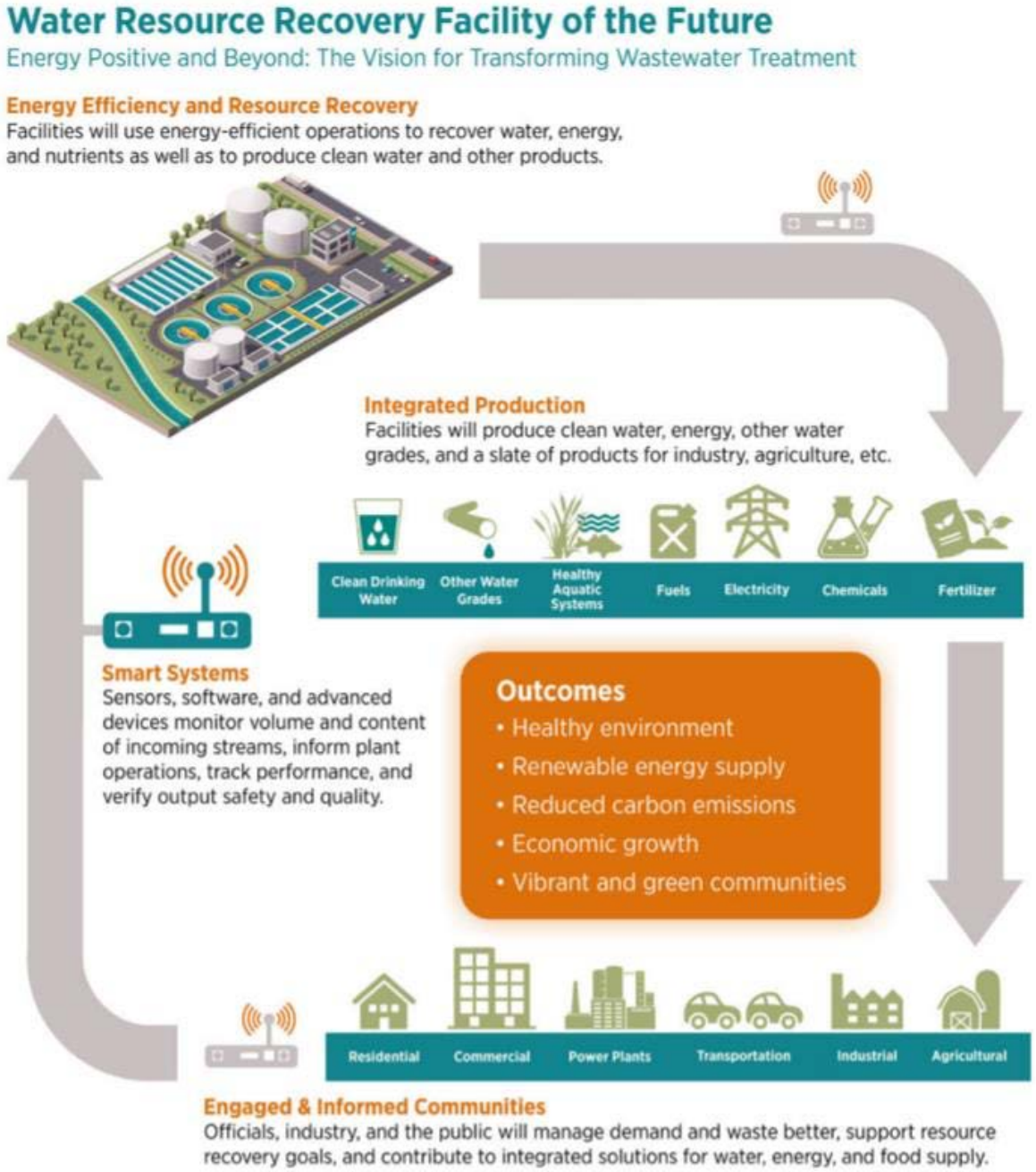
National Renewable Energy Laboratory | New Concepts Incubator

ASEAN Smart Cities:
Key Opportunities?

Most Asian cities do not have effective wastewater treatment systems. In the Philippines, for example, only 10% of wastewater is treated while in Indonesia the figure is 14%, in Vietnam, 4%, and in India, 9%.

(2012 Source: Fast Facts: Urbanization in Asia. ADB)





Source: NSF, US DOE, EPA, 2015.

Nexus and Urbanization Fundamentals for Livable, Smart, & Sustainable Cities:

Three Key Messages

1. **Energy-Water-Food-Waste-X Nexus:** dynamic interplays in urbanizing contexts
2. **'Leapfrog' Opportunities & Stability for All**: as underserved communities in focus
3. **Energy, Cities, Climate:** arenas for SDG action to *2030; next goals & key gaps? IUS?*

Source: UN, 2018.

Source: ARUP, 2009.

Energy-Water-Food (EWF)-Related Risks and Interdependencies Under Changing Conditions – Our Cities (and Disadvantaged Communities) as 'Hotbeds' of Risk & 'Seedbeds' of Innovation

Human use of fossil energy infrastructures in cities and related GHG emissions is causing climate change

↔

Climate change is **exacerbating current water stresses and has significant implications for all services**

Rising infrastructure and resource demands leading to inadequate basic urban infrastructure services

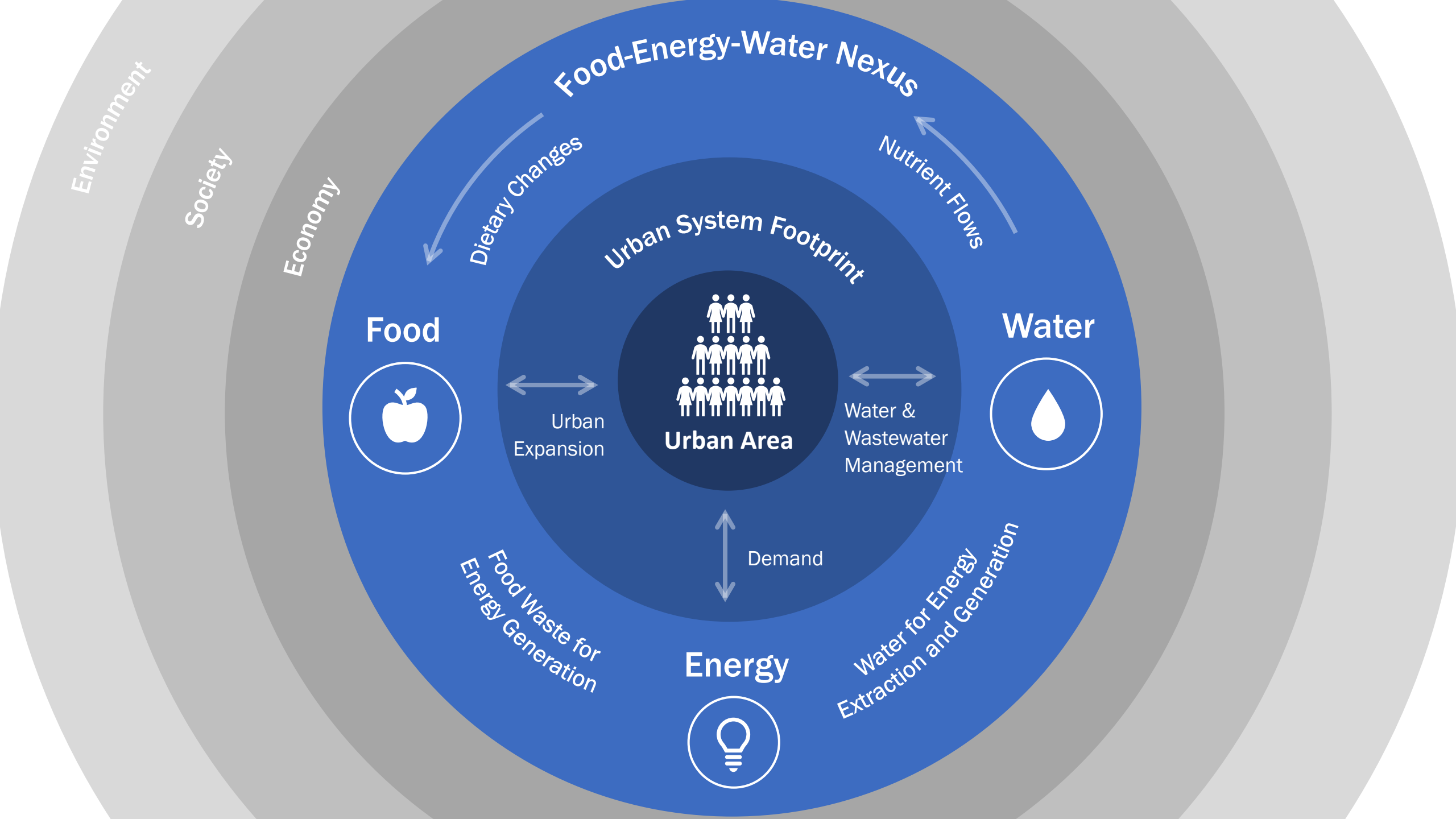
These challenges are significant, interrelated and critical to innovating at the energy-water-food nexus in cities and communities, globally.

High levels of pollution and population density exposed to pollution impacts influence health+ economic outcomes for cities

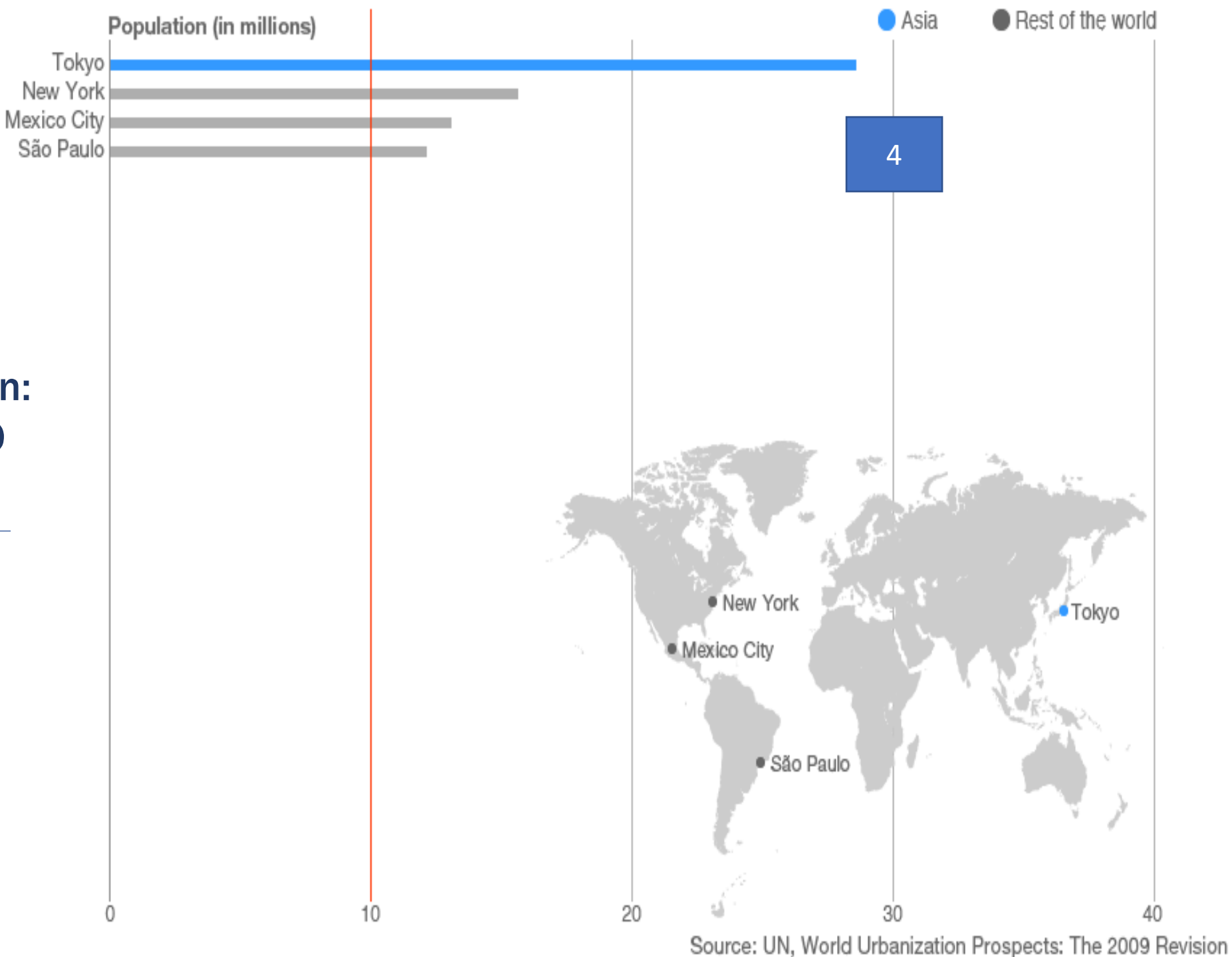
Energy shifts to mitigate CC may also pose new risks to water & energy – quality, quantity, accessibility, reliability

↔

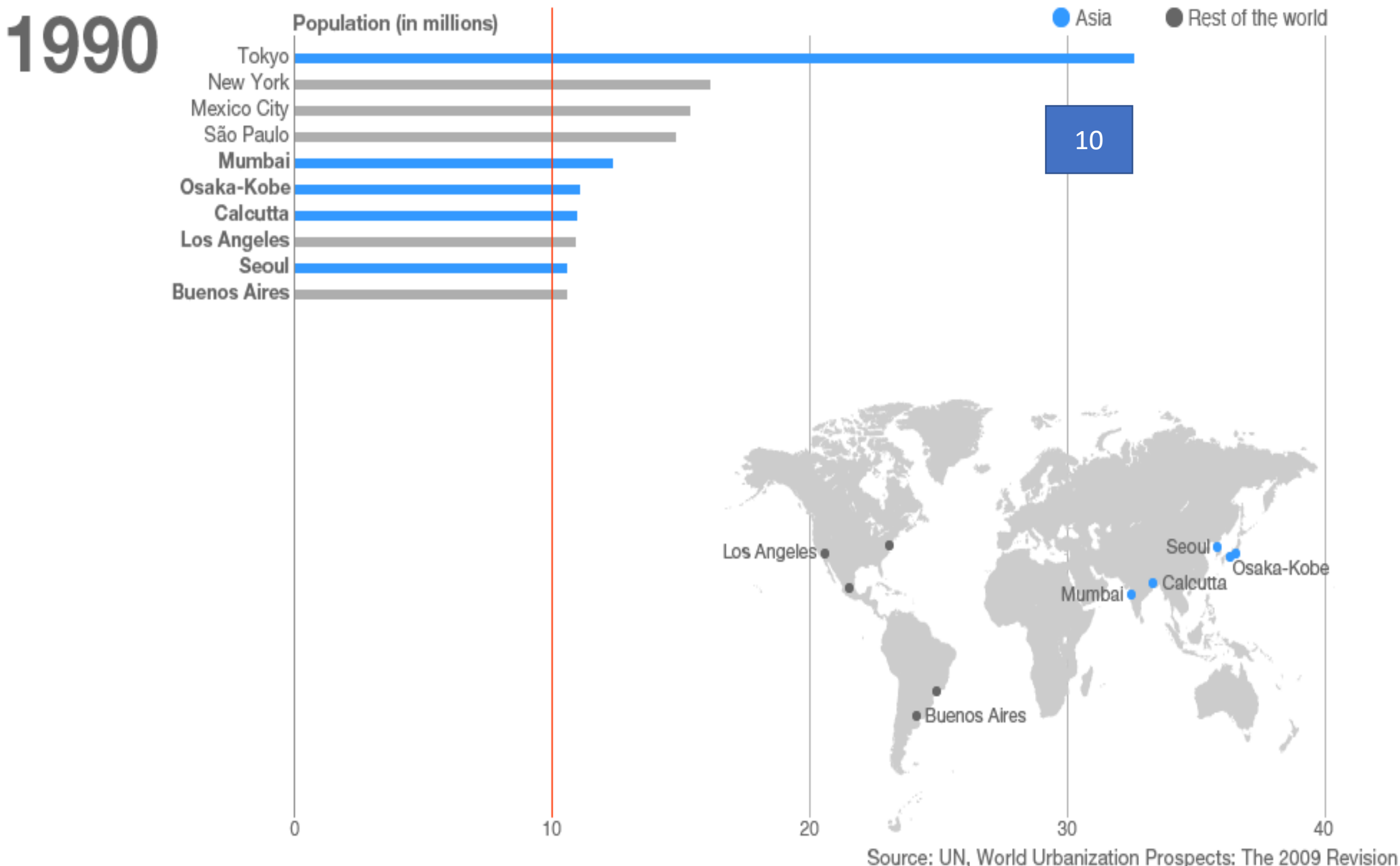
Declining water availability is already limiting food & energy choices; while power outages result in lack of access to quality basic services & health impacts

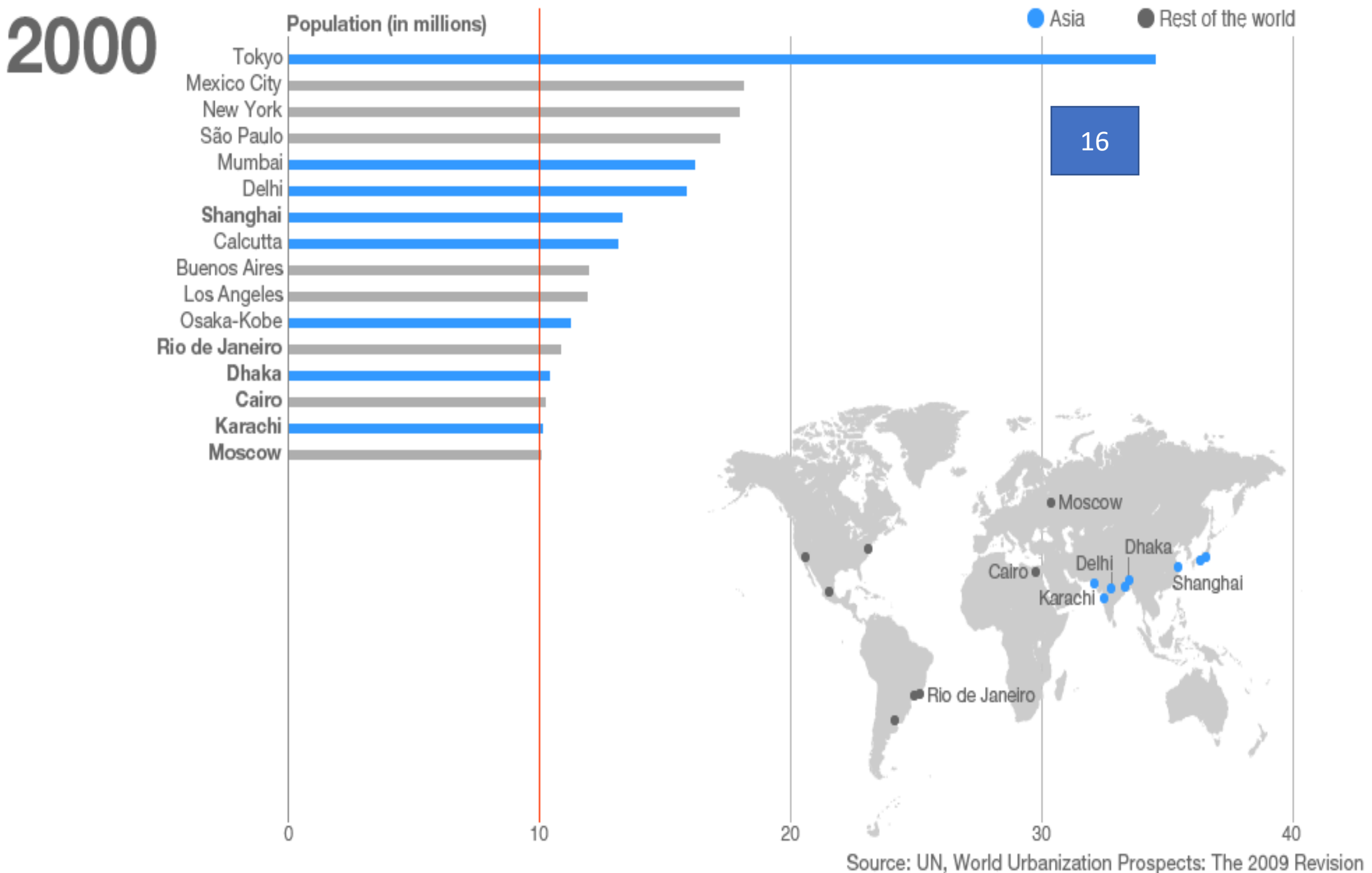

Environment
Society
Economy
Food-Energy-Water Nexus
Dietary Changes
Nutrient Flows
Urban System Footprint
Food
Water
Urban Area
Urban Expansion
Water & Wastewater Management
Demand
Food Waste for Energy Generation
Energy
Water for Energy Extraction and Generation

Recent Urbanization: Megacities in 1980



Source: UN, World Urbanization Prospects: The 2009 Revision


1990
Population (in millions)
Asia
Rest of the world
Tokyo
New York
Mexico City
São Paulo
Mumbai
Osaka-Kobe
Calcutta
Los Angeles
Seoul
Buenos Aires
10
0
10
20
30
40
Los Angeles
Seoul
Osaka-Kobe
Calcutta
Mumbai
Buenos Aires
Source: UN, World Urbanization Prospects: The 2009 Revision


2000
Population (in millions)
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Buenos Aires
Los Angeles
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Rio de Janeiro
Dhaka
Cairo
Karachi
Moscow
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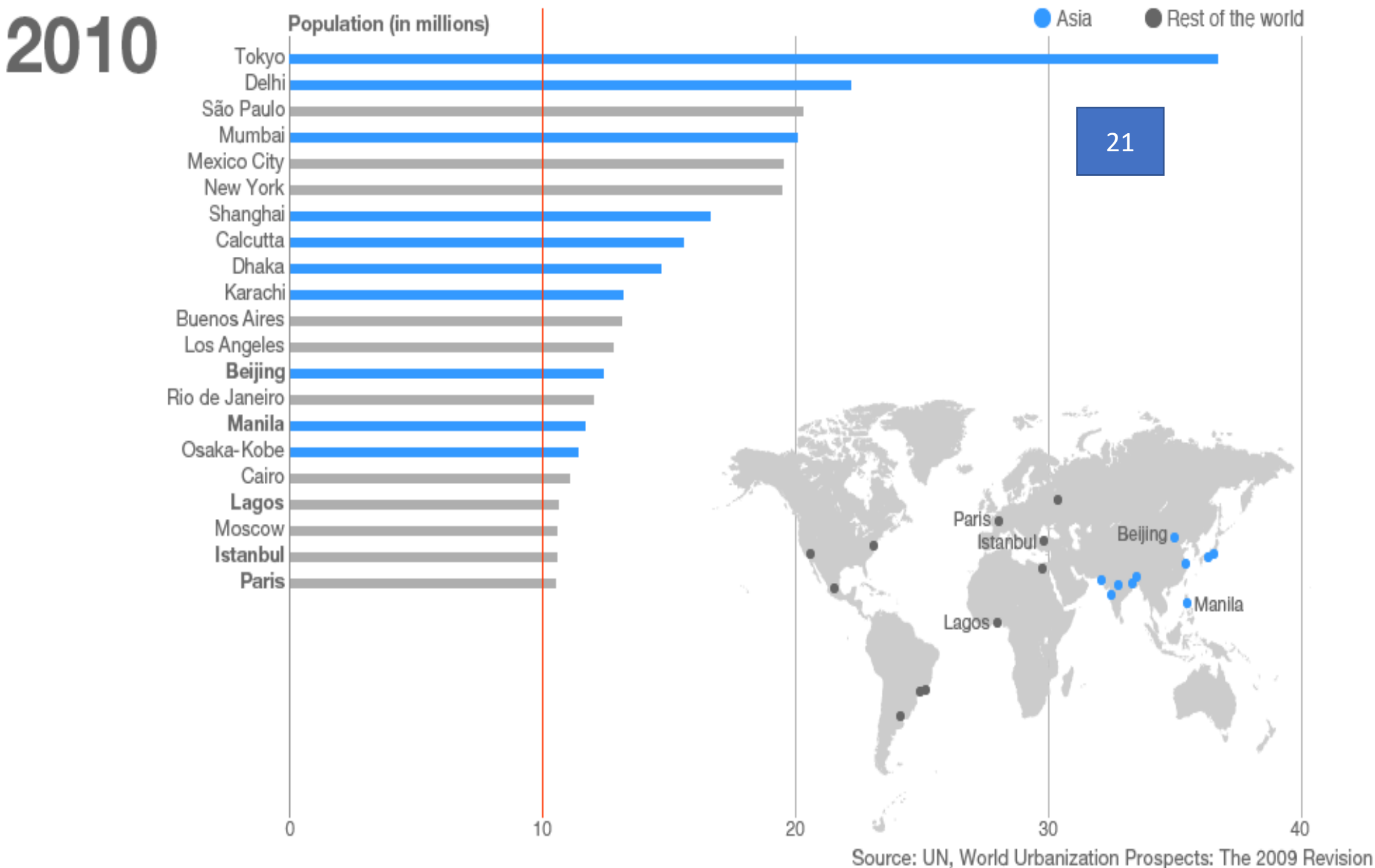
Dhaka
Delhi
Cairo
Shanghai
Karachi
Rio de Janeiro
Source: UN, World Urbanization Prospects: The 2009 Revision


2010
Population (in millions)
Asia
Rest of the world
Tokyo
Delhi
São Paulo
Mumbai
Mexico City
New York
Shanghai
Calcutta
Dhaka
Karachi
Buenos Aires
Los Angeles
Beijing
Rio de Janeiro
Manila
Osaka-Kobe
Cairo
Lagos
Moscow
Istanbul
Paris
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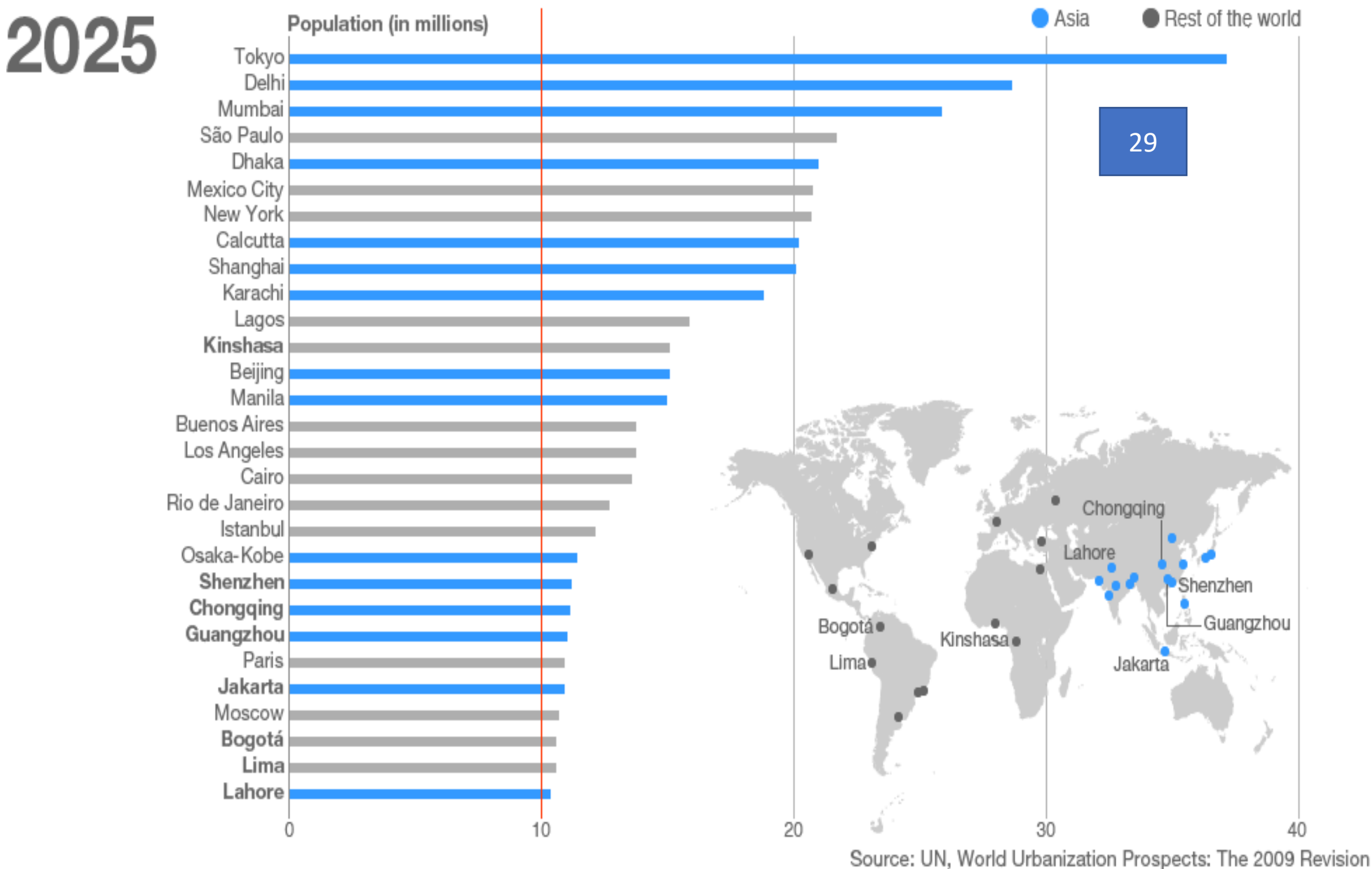
Paris
Istanbul
Beijing
Manila
Lagos
Source: UN, World Urbanization Prospects: The 2009 Revision


2025
Population (in millions)
Asia
Rest of the world
Tokyo
Delhi
Mumbai
São Paulo
Dhaka
Mexico City
New York
Calcutta
Shanghai
Karachi
Lagos
Kinshasa
Beijing
Manila
Buenos Aires
Los Angeles
Cairo
Rio de Janeiro
Istanbul
Osaka-Kobe
Shenzhen
Chongqing
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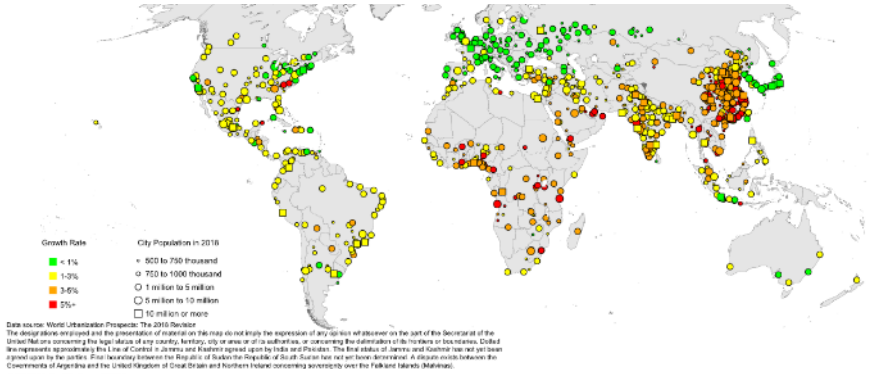
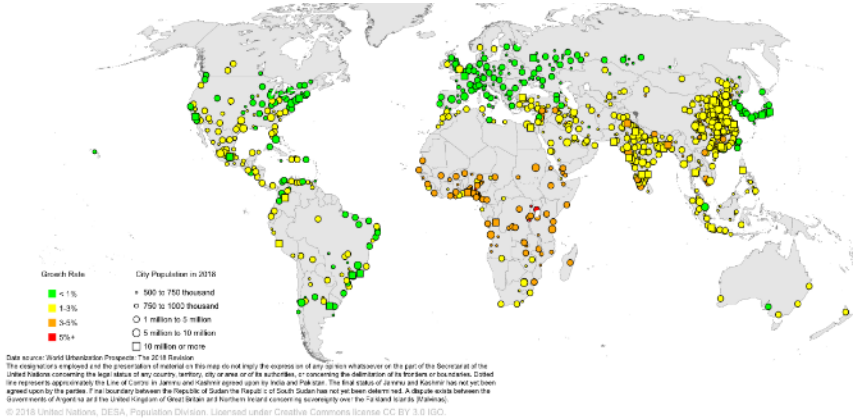
Guangzhou
Bogotá
Kinshasa
Lima
Jakarta
Source: UN, World Urbanization Prospects: The 2009 Revision

2025

1990-2018 Annual Growth Rates

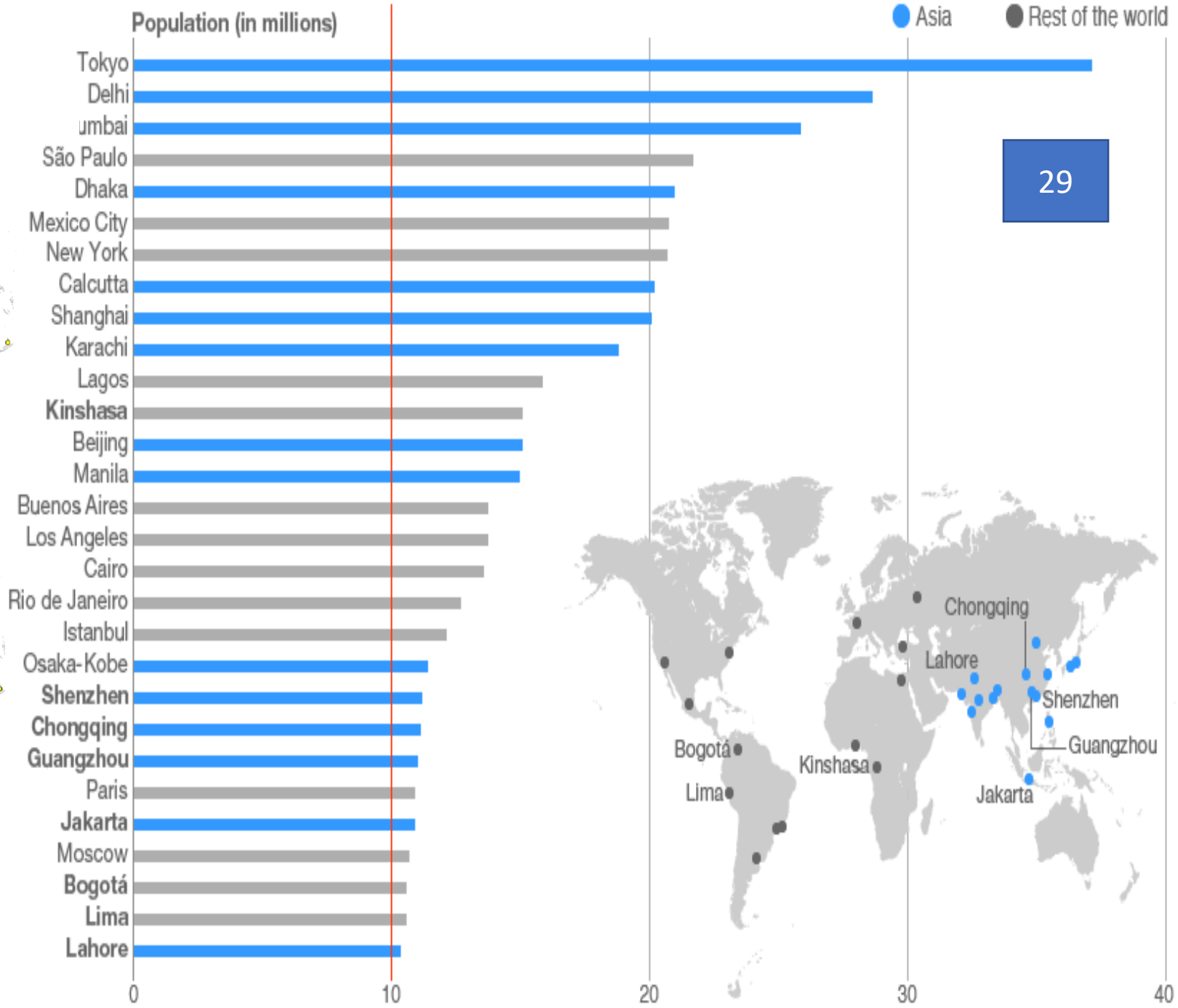


2018-2030 Annual Growth Rates



"The Age of" Megacities

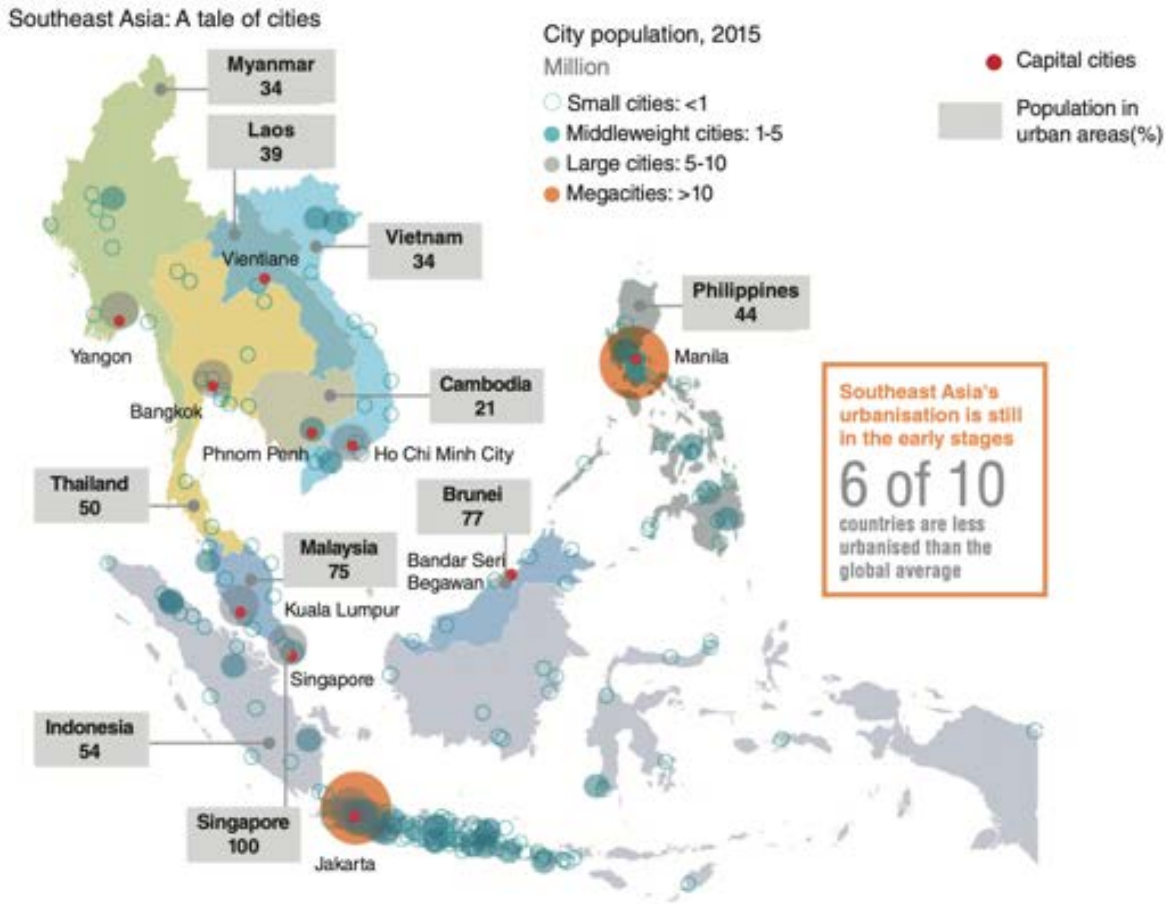
www.nationalgeographic.org/interactive/age-megacities & UN, WUP, 2018 Revision



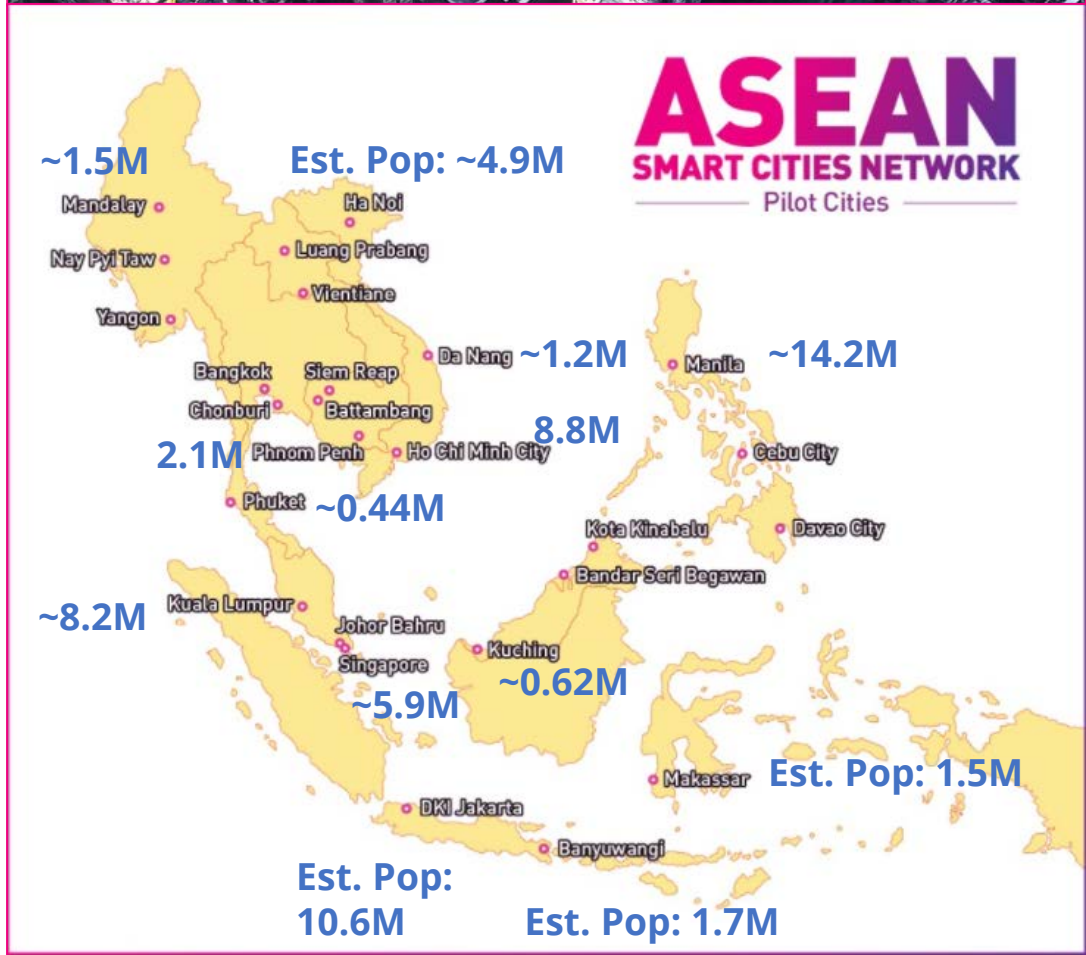
Our Common Humanity: Human-Ecological Resource Security & Our Common (Urban) Future

Figure 2. Level of urbanization in ASEAN countries

Source MGI, 2018

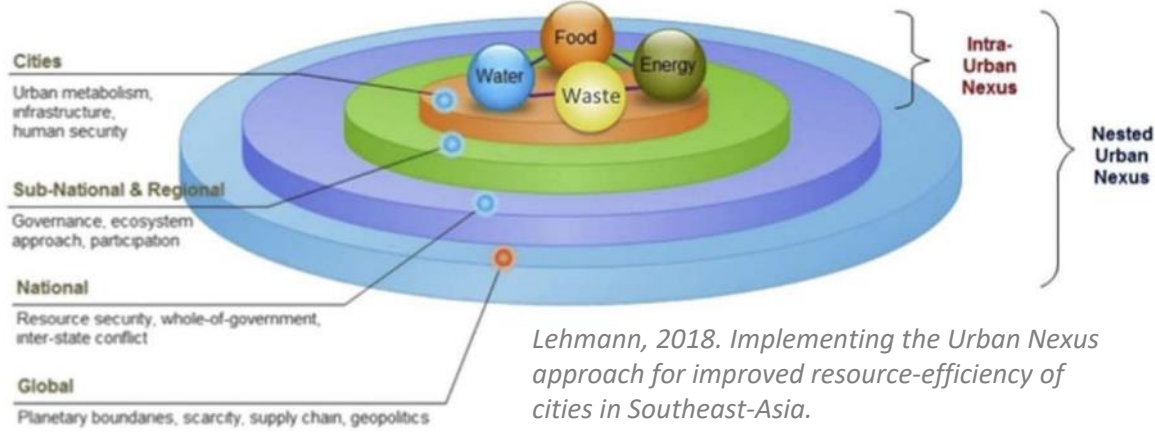


Source: Lee, 2019.



Why focus on the Urban Nexus, Circular Economy, & Regenerative Approaches?

- **Global population is majority urban, with 'urban nexus'** as a response to multiple urban system challenges: inefficiencies, inadequate infrastructure, resource shortages, affordable living settlements, socio-economic issues, environment/climate impacts
- **Rapid urbanization / rising consumption is happening** in areas with already strained EWF provisioning systems, and facing poverty and increased climate-related stresses/shocks
- **Circular economy, regenerative approaches integrate multiple opportunities to move from scarcity to abundance:** integrated systems thinking, advantages of closed-loop systems for resource recovery, reuse, to ecological resilience; identifying key co-benefits, synergies (& tradeoffs) of various actions / decisions



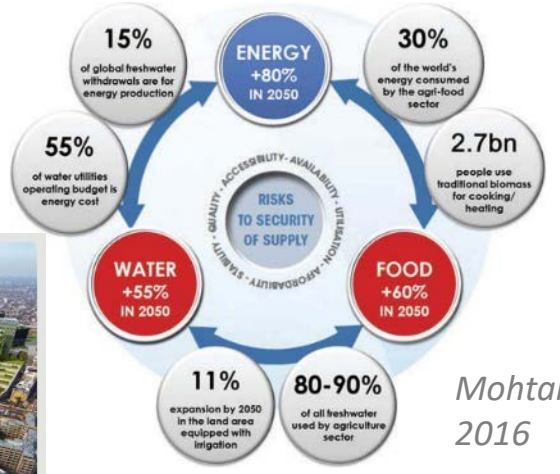
Lehmann, 2018. Implementing the Urban Nexus approach for improved resource-efficiency of cities in Southeast-Asia.

Circular, net-positive, eliminating waste/emissions, and "Creating more than consuming"

What is Regenerative Urbanism?

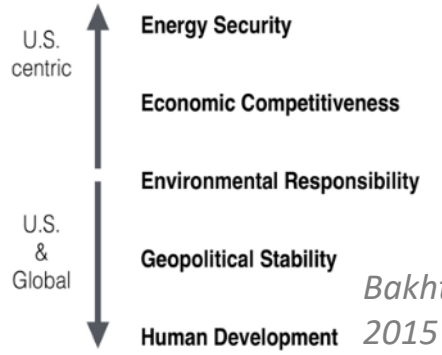
Regenerative urbanism represents a paradigm shift in urban innovation. It uses living systems as a metaphor and model for inspiring more productive, resilient, and equitable urban places, regenerative communities generate net positive impacts by:

- Creating more resources than they consume, ensuring critical resources are secure and affordable for decades to come
- Eliminating waste by managing materials, nutrients, and water within a circular metabolism model
- Eliminating pollution by powering all buildings and vehicles with renewable energy
- Cultivating abundant healthy food within the community



Mohtar, 2016

Strategic Importance of the Nexus



Bakhtian, 2015

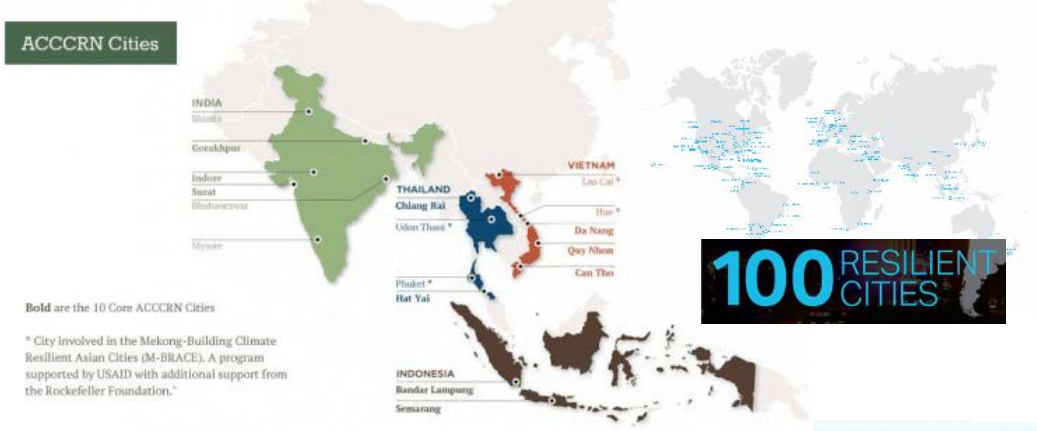
Emerging History of Urban Nexus & Resilience Projects

Participating SE Asia Countries: Indonesia, Vietnam, Thailand, Philippines

A 'Tale of Four Urban Nexus Cities' & Initial Case Study Applications:

- **Naga, Philippines**: Partnership of Sectors and Levels of Local Govt; Low-Cost, Climate-Adaptive, Efficient Tech Integration; Wastewater into Renewable Energy
- **Pekanbaru, Indonesia** – Profit-generating solid waste to energy (methane gas collection and energy generation) that feeds electricity into the grid
- **Da Nang, Vietnam** – Wastewater treatment producing biogas & fertilizer
- **Nashik, India** – 4 pilot projects: energy-efficient water pumps for agriculture, along with rainwater harvesting, groundwater recharge, and biogas development for FEW security across four urban and peri-urban sites

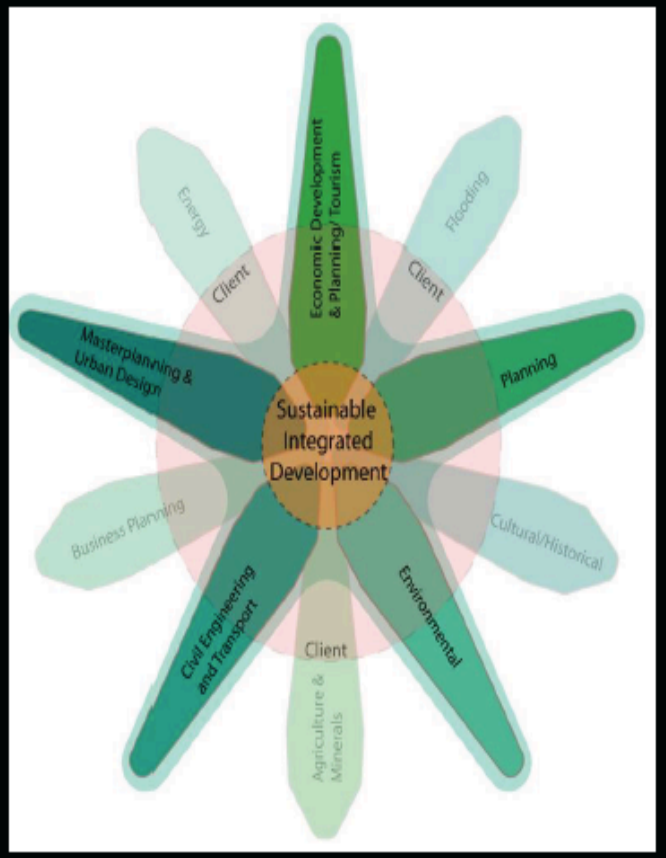
(See Lehmann, 2018 for case study details on Naga, Pekanbaru, Nashik)



integrated urbanism

- Human and Environmental Health
- Economic Vitality and Individual Prosperity
- Energy
- Housing
- Nutrition and Urban Rural Linkages
- Mobility and Access
- Communications
- Education and Culture
- Governance and Civic Engagement
- Water
- Materials and Waste
- Ecological Footprint

Integrated Team



ARUP

The Urban NEXUS is an approach

to the integrated design of sustainable urban development-service solutions.

The approach guides stakeholders to:

- Identify/pursue possible synergies of sectors, jurisdictions, technical domains
- Increase institutional performance, optimize resource management, and services quality
- It counters traditional sectoral thinking, trade-offs, divided responsibilities that often result in poorly coordinated investments, increased costs, underutilized infrastructures & facilities.

Urban NEXUS approach 'ultimate goal':
to accelerate access to services, and to increase service quality and quality of life within our planetary boundaries.

UN ESCAP, 2016. The Urban Nexus: Conceptual Framework and Linkages to Global Agendas.

2012 to 2019 US Awarded Coordination Projects on Urban Nexus Themes

1. Network on Sustainable Cities: People and Infrastructures at the Energy-Water-Climate Nexus (www.rcnsustainablecities.org)
2. City-as-Lab: FEW Nexus for Sustainable, Resilient Urban Development (urbanfew.net)

- Australia, EU, Asia, Latin America
- Focus: reducing energy use, GHG emissions, mitigating risks to water security + public health/economy in cities

Tempe/Phoenix (ASU): Spring, 2014

For more information: www.rcnsustainablecities.com

RCN SUSTAINABLE CITIES: PEOPLE AND INFRASTRUCTURES AT THE WATER-ENERGY-CLIMATE NEXUS

Research Collaborative Network Student Workshop - Phoenix/Tempe, Arizona (ASU) 4.25-4.30.14

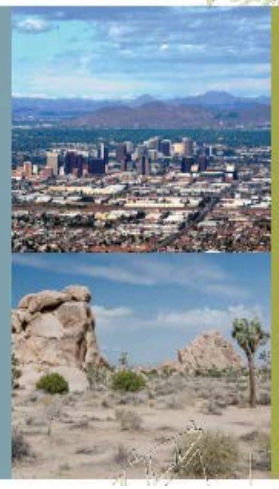
Outputs: Ph.D. Collaborative Methods Guide, Conference Abstract(s)/Paper(s), Draft Journal Article(s)

EXPLORING INTERDISCIPLINARY COLLABORATIVE METHODS:
Addressing Inequities & Reducing Risk for Advancing Sustainable City Goals

What? A PhD/Post-doc interdisciplinary methods and equity-focused workshop related to the RCN's focus on reducing energy / emissions and climate-risks to water supply and health in cities.

Why? ~15 workshop participants from ~10 US universities will meet to foster collaboration and explore interdisciplinary research methods, educational experiences, and interests related to reducing risks and addressing equity, one of the 3E's often guiding sustainable city efforts.

Activities? Conference abstract speed dating, brainstorming, short presentations, hiking, conversations, and breakout activities focused on collaboration around the challenges and opportunities for advancing social equity through sustainable cities research.



Sustainable *and* Equitable Cities: Reducing Risks & Disparities for Sustainable Urban Futures

Where? The workshop will meet at ASU, the US's largest university and located in the center of the Phoenix metropolitan area. With a population that has tripled in size over the past 20 years to reach 5 million (50% of whom were born outside the region), Phoenix's rapid growth parallels that of developing countries.

Outputs: PhD collaborative methods guide, conference abstract(s), draft journal article(s), interaction & learning.

D. Boyer, S. Brodie, E. Stokes, A. Zomer, J. Sperling. *2015. Implementing the Urban Sustainable Development Goal in Atlanta and Delhi. UGEC Viewpoints.*

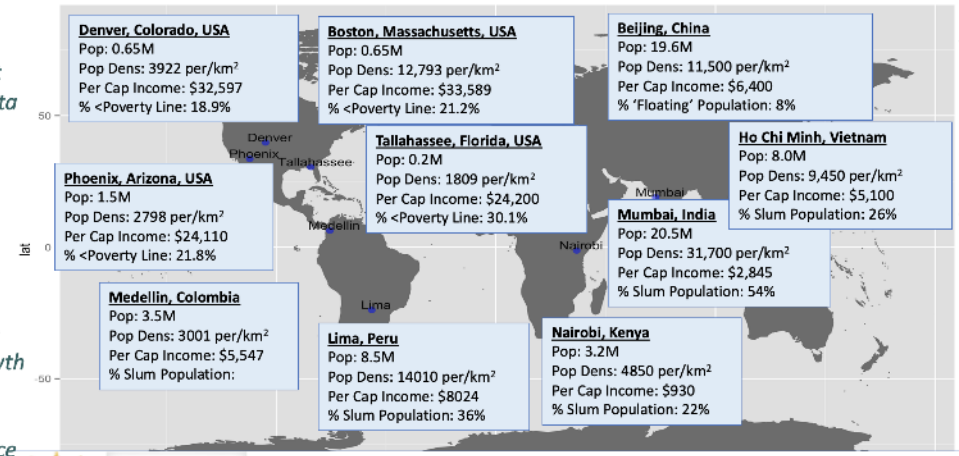
Initial indicators: Land Consumption vs. Pop. Growth Rate, Waste, Air Pollution, GHG, Resource Recovery

- Boston
- Denver
- Lima
- Medellin
- Ho Chi Minh

Global Methods and Tools for Equitable AND Sustainable CITIES

Comparative assessment/implications for cross-sector infrastructure systems and policies that integrate / reduce risk for diverse populations

- Mumbai
- Nairobi
- Phoenix
- Tallahassee
- Beijing



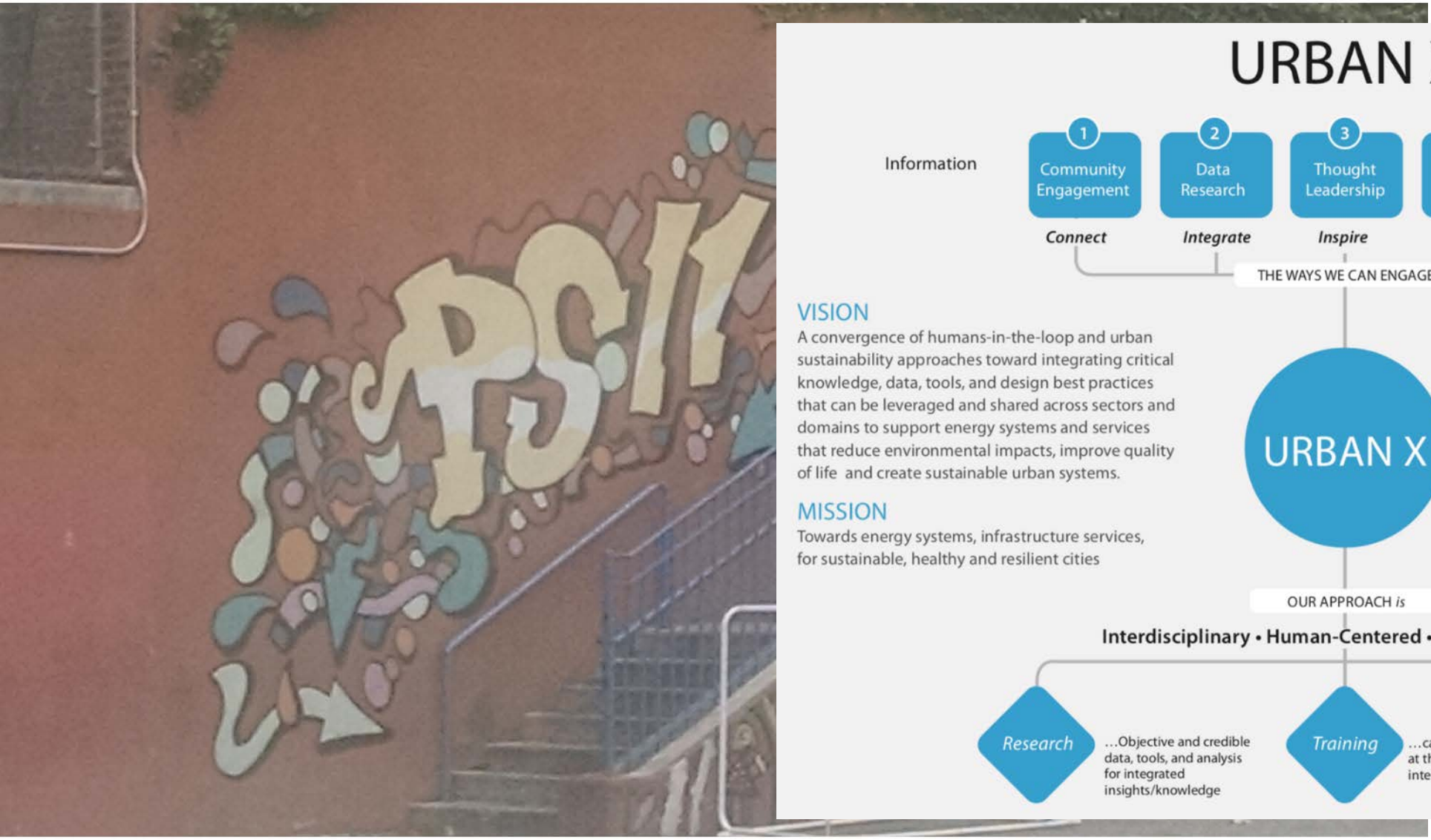
NSF · RCN: SUSTAINABLE CITIES · NCAR URBAN FUTURES · MIT · Florida State University · ASU Arizona State University

Key Concluding Questions:

- *Who collects city data to inform goals, targets, & decisions?*
- *How well do indicators capture (smart and sustainable) city goals?*
- *Challenges & opportunities of universal SDG indicators – tensions of universal vs. locally appropriate implementations*

NREL New Concepts Incubator: Looking Back, Looking Forward…

Defining a Process for Urban Nexus Innovations



URBAN X

Information

1. Community Engagement — *Connect*
2. Data Research — *Integrate*
3. Thought Leadership — *Inspire*
4. Co-Design Change — *Implement*
5. Analytical Insights — *Validate*

THE WAYS WE CAN ENGAGE

VISION

A convergence of humans-in-the-loop and urban sustainability approaches toward integrating critical knowledge, data, tools, and design best practices that can be leveraged and shared across sectors and domains to support energy systems and services that reduce environmental impacts, improve quality of life and create sustainable urban systems.

MISSION

Towards energy systems, infrastructure services, for sustainable, healthy and resilient cities

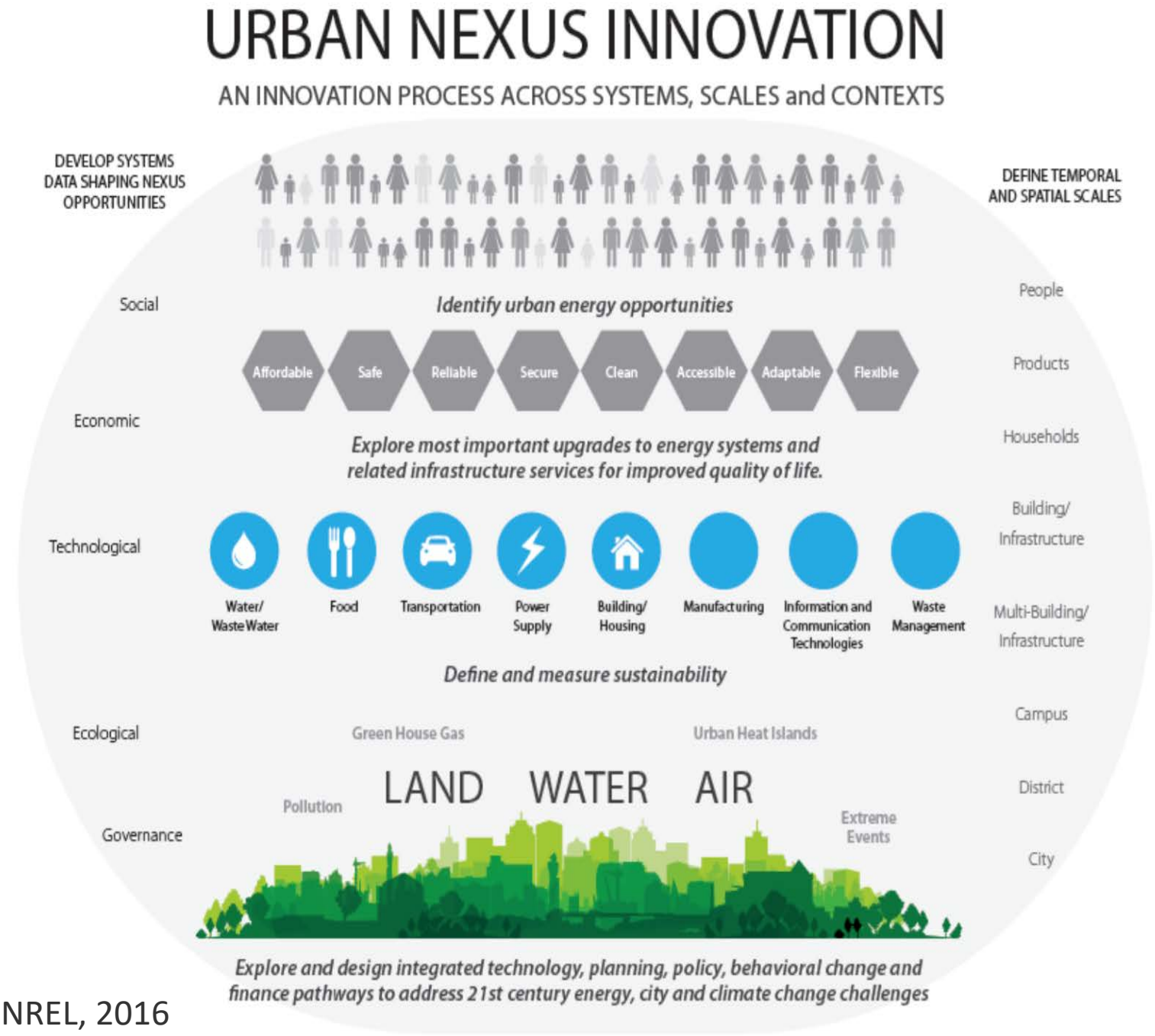
URBAN X

- City
- Design
- Policy Partners
- ADVISORY BOARD
- Regional
- EXTENDED BOARD
- Industry
- CORE TEAM
- Infrastructure Operators
- International Network
- University

OUR APPROACH *is*

Interdisciplinary • Human-Centered • Systems Oriented

- *Research* …Objective and credible data, tools, and analysis for integrated insights/knowledge
- *Training* …capacity building at the science-policy interface
- *Optimize* …to guide design of human-centered energy systems & urban services

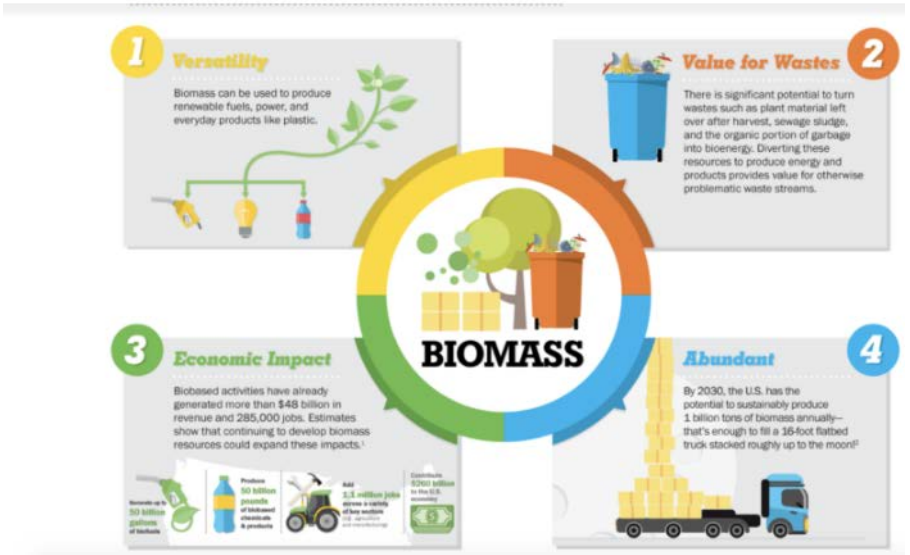


NREL, 2016

Case Study Examples:

- **CSU Spur Hydro - Urban agricultural methods that are water efficient:** aquaponics, hydroponics (with LED Grow lights), and vertical, 'smart' greenhouses;
- **National Alliance for Water Innovation: municipal wastewater treatment technologies for fit-to-purpose reuse, drinking water, energy generation** (methane), and enabling mineral/nutrient/water recovery; city/utility- level optimizing WWTP sites/selection of plants for energy generation potential.
- **Innovative energy technology and policy solutions –** e.g. utilizing waste from fish farms, biomass waste, or floating photovoltaics for energy generation; implementation of co-located solar agriculture for financially self-sustaining areas; coherence of national to regional level water, energy, urban and agricultural policies; 'smart greenhouse'; integrated service hubs

CARIBOU https://caribioufuels.com



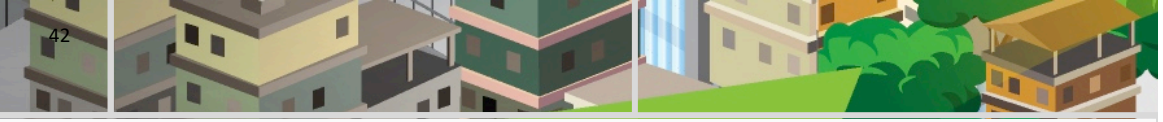
One billion people live in slums and informal settlements today. This number is expected to double by 2030.

RENEWW ZONES

A decentralized, closed-loop model of spatial planning and peri-urban service provision that harnesses inclusive innovations at the nexus of energy, water, food, and other urban systems to accelerate service access, enhance resilience, and improve living conditions through market-based, data driven approaches.

Piloting a **Renewable Energy, Nutrition, Environment, Water, and Waste** (RENEWW) Innovation Zone Model

UN Habitat General Assembly | May 27, 2019



Integrated Urban Services (IUS)

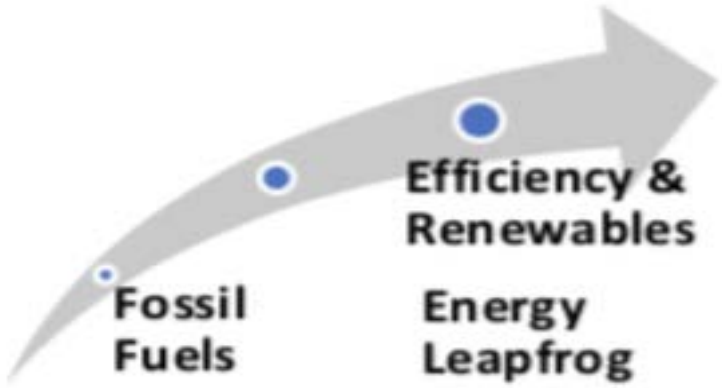
- Easily available, low-cost, high-nutrient food and safe drinking water
- Renewable electricity and fuels
- A multi-use green space
- Improved sanitation systems
- Local employment / training opportunities
- Community management & governance
- Opportunities for related micro-businesses
- Resource-efficient behaviors
- Reduced risk: heat, floods, drought, COVID
- Well-planned urban service extensions

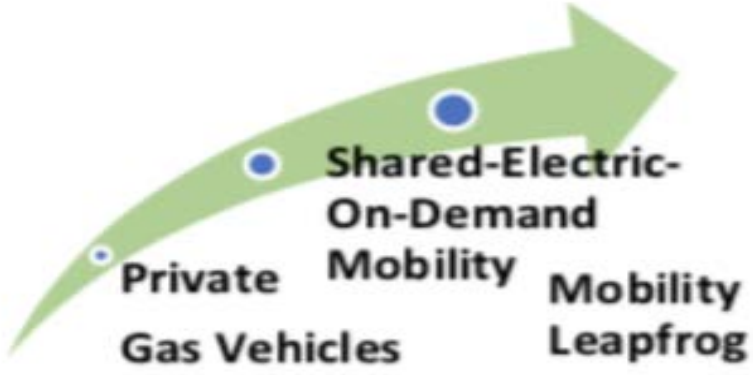
Integrated IUS concepts that can help to scale successful technology, planning, policy, business/finance, & governance models and for service areas that will have an ability to expand or self-replicate with cross-sectoral planning, design and decision-making teams

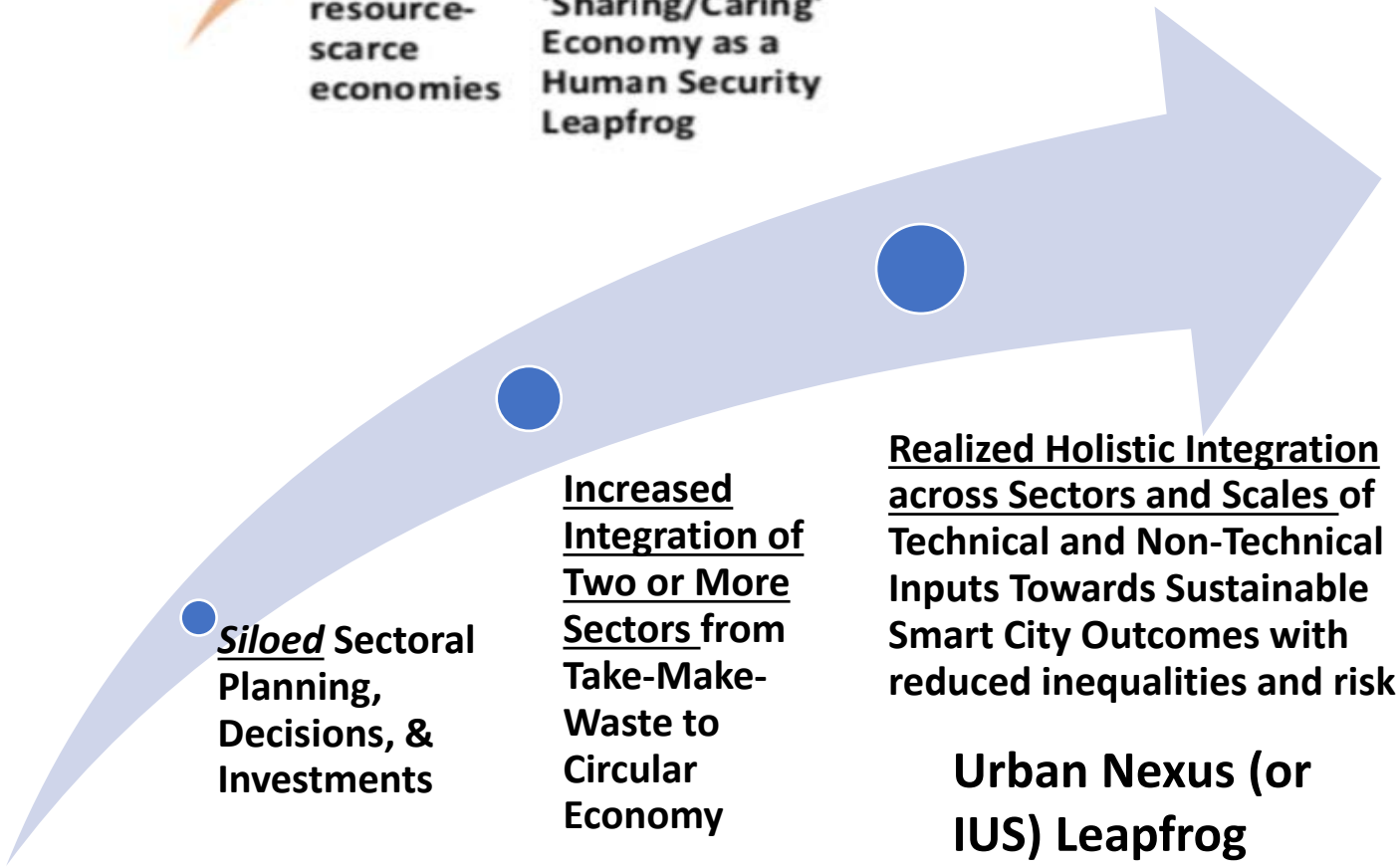
IUS or Urban Nexus Design Principles

- **Engineering - 12 Green Design Principles**
  (#12: Renewable Rather than Depleting)
- **Planning - AIA Livable Communities 10 Principles**
  (#1: Design on a Human Scale)
- **Policy/Governance – Ostrom's 8 Design Principles**
  (#7: Allocate Authority at Multiple Levels)
- **Behavioral Sciences – 8 Principles**
  (#2: Understand Situation from the Actor's Perspective)

Considering Multiple 'Smart Sustainable City' Leapfrogs - Capacity Building, Mentoring Next Generation, and Peer-Learning on New Integrated Practices & Investments







Thank you. Questions? Joshua.Sperling@nrel.gov

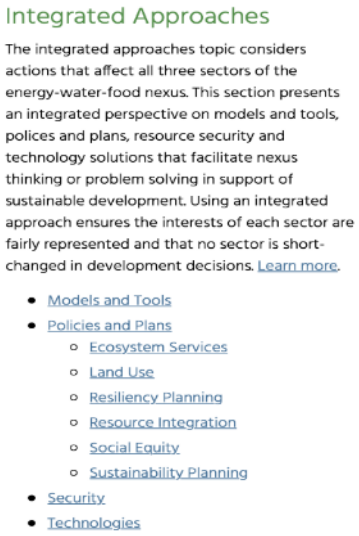
Three Key Questions
(adapted from Pierce, 2021)

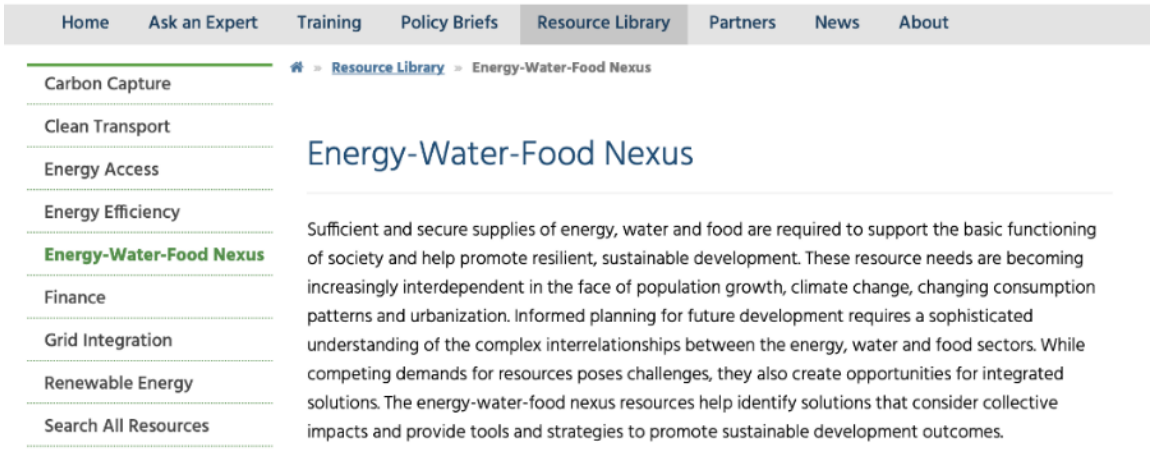
1. Will nexus, IUS, smart city innovations remain dominated by "technical" considerations, or will governance/ finance become more prominent?
2. Will combinations of social sciences, natural sciences, engineering, design and planning "acknowledge and recognize the political nature of resource use and governance"? (Wiegleb & Bruns, 2018)
3. "Nexus approaches may reproduce existing inequalities in resource allocations and power structures unless research and policy carry a fundamental critique of these very inequalities" (Artioli et al., 2017) -- *is there a role for and benefits to underserved communities?*

Case Studies of Policy & Governance Integration - NREL Nexus Resource Portal

CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

- Single access point for EWF nexus info:
  - policy best practices
  - models
  - tools
- Educates policy makers on importance, drivers, challenges, and opportunities associated with the EWF nexus





Integrated Urban Services for US-ASEAN Smart Cities

Thank You

Contact Information:

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santiagofinkh@state.gov

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Senior Water Policy Advisor
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maccurdycl@state.gov

Jennifer Daw
Principal Investigator
National Renewable Energy Laboratory
jennifer.daw@nrel.gov

U.S.-ASEAN Smart Cities Partnership

Integrated Urban Services

Regional Launch Event

August 13th 7:00-9:00AM (GMT+7)

August 12th, 8:00-10:00 PM (EDT/GMT-4)

A program of the US-ASEAN Smart Cities Partnership to sustainably secure energy, water, and food for the region's municipalities through regenerative approaches

Integrated Urban Services for US-ASEAN Smart Cities

Welcome

Jennifer Daw

Principal Investigator

jennifer.daw@nrel.gov

NREL

NATIONAL RENEWABLE ENERGY LABORATORY

Day #2 Meeting Agenda

Opening Remarks and Day 1 Recap

- Jennifer Daw | NREL
- Polling

Pilot City Projects and Key Milestones

- Parthiv Kurup | Pilot City Lead | NREL
- Q&A

A Tale of 3 Cities (Panel)

- Moderator: Helen Santiago Fink | U.S. State Dept.
- Restoration of Vernacular Urban Food Systems for Resilient Asian Cities: Dr. Makoto Yokohari | Professor, Graduate School of Engineering | University of Tokyo
- Lessons from the Los Angeles 100% Renewable Energy Study: Dr. Elaine Hale | Senior Research Engineer | NREL
- Regenerative Cities: Thomas Hussey | Director, Urban Design & Planning | Skidmore, Owings & Merrill
- Q&A

ASEAN Smart Cities Project Themes and Insights

- Dr. Josh Sperling | Urban Futures-Energy-X Nexus Engineer | NREL
- Q&A and Polling

Closing and Next Steps

- Jennifer Daw | NREL
- Helen Santiago Fink | U.S. State Dept.
- Q&A

Integrated Urban Services
Program Overview

- Program under the United States-Association of Southeast Asian Nations (US-ASEAN) Smart Cities Partnership to help ASEAN cities build resilience in their energy, water, and food systems.
- The 3-year program is funded by the U.S. State Department and led by NREL.
- The program will demonstrate the socio-economic value and urban benefits of resource recovery and reuse through integrated systems that promote greater efficiency, improve water and energy security, and mitigate public health concerns.
- The program will incorporate market-based approaches, business plans, and peer learning to create the enabling environment necessary to attract public and private investors.

More information:
https://www.nrel.gov/international/integrated-urban-services.html

Integrated Urban Services
Day 1 Takeaways

- **Systems integration** requires cooperation among **governance structures and stakeholders** and/or joint operations.
- There is a need for master planning, **capacity building, investing and adapting** of infrastructure systems to address climate change impacts, public health risks and other urban services challenges.
- **Co-innovation and multi-sector partnerships** offers new opportunities for blending public and private resources for financing urban solutions.
- Integrated urban systems warrant clear economic and quality of life **measurable objectives and performance targets** with agreed feedback mechanisms.

Pilot City Projects and Key Milestones

Parthiv Kurup | Pilot City Lead | NREL

What's in it for your city?

Improved understanding of the key issues happening in the ASEAN cities network and green economic developments

- Connections within the Smart cities network and how they are moving forward

Reputational and experiential inputs to implement vision through the support

- You will get information for suited solutions, based on the data and needs

NREL Transforming ENERGY

Working directly with a U.S. DOE National Lab on developing integrated EWF solutions

- NREL has world-class researchers in fields like renewable energy, water management, and system dynamics/modelling
- Take away: NREL enables science and technology knowledge sharing, but through this program not IP/technology transfer

Capacity building and technical assistance for key community stakeholders in the two selected pilot cities in 2022 and 2023

Pilot city assessment leads to actionable steps for your city

- Supports city sustainability and resilience goals

Key Takeaway

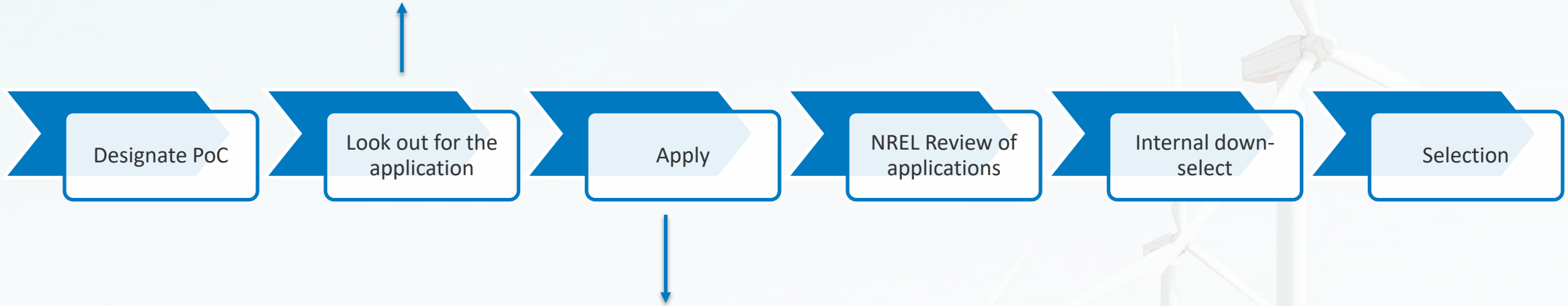
Innovations could get future funding

- **e.g., Climate funds and others like ADB**
- **There will be direct interactions and pitch opportunities to audiences of funders**

Application Process

The goal of IUS is to help local city leaders, the private sector, financial institutions, and other stakeholders **identify, design, and implement more integrated models of basic urban service provision that can sustainably secure energy, water, and food (EWF) services, in a resource-efficient, environmentally friendly manner.**

Link to the document will come after workshop



Send back the application and supporting documents via email to **Parthiv.Kurup@nrel.gov** by the **25th of October** (application opens 31st of August)

Contact us to understand and get help to walk through the process if you need. Please reach out!

Capacity Building and Technical Support

Pilot projects provide an opportunity to working directly with a U.S. Department of Energy National Lab on developing integrated EWF solutions:

- Technology or other solutions to support needs identified in city action plans and other city priorities:
  - e.g.,: Planning, design, and governance structures, etc. => **support is targeted**
  - Sustainable and low impact strategies for water supply and management (drinking, stormwater, green water, greywater) and wastewater treatment
- **Modeling and analysis of selected technology solutions** and process approaches
- Analysis and planning to develop integrated multi-sector water, energy and food action and/or business plans to effectively engage private sector stakeholders.

Selection Criteria – How are we thinking?

- **Active government, community, stakeholder and/or private support for EWF**
  - Diverse stakeholders together around novel net-zero or renewable solutions
  - Ideally a site has already been selected
- **1 application per city, lead by the city representative**
- **At least 1 of the city services should be involved e.g., utility operator, energy or water utility, land management, permitting**
  - Important for your application to have input from different parts of the city sustainable development
- **Priority will be given city in the ASEAN Network**
  - Possible for other cities to apply with good proposals
- **Priority will be given to partnerships e.g., city, universities, businesses, and NGOs.**
  - Partnership model will be preferred.
  - City/gov focused, and the city representative is the prime putting together the application
- **Dedicated staff time** from a cross-sectoral urban planning and development
  - With decision-making authority (or quick access to decision making)

What could make a good project?

- **Solution needs to use commercially ready technologies in other markets**
  - Requesting assistance for innovative, but not market ready technologies may not provide you the most help
- **Need for technical assistance in targeting a specific clearly defined EWF challenge**
  - Self-sustainability (economic, social, institutional) to own the solution
  - What are your biggest concerns e.g., resilience?
  - Do you need to understand how renewables will change your grid?
- **Access to data from the city**
  - E.g., energy loads, food demands, water utilization
  - Water desalination and treatment needs
  - Data quality e.g., hourly data of energy loads highlighting seasonal variation
- **Specific requests e.g.,**
  - Capacity building, training, integrated systems for their city
  - Business development e.g., desire and ability to take ideas on to the commercial focus

Timeline

Application Opens!
8/31/21

Webinar on Application Process
September 2021
(date TBD)

Application Deadline
10/25/21

Application Reviews
Oct. 2021 to Jan. 2022

Date of Notification
1/25/22

2022

2023

Period of technical assistance
(Feb. 2022 to Sept. 2023)

Summary: How to Apply

One Application Per City

Ideally through a partnership model with different parties, including at least 1 utility

Application Opens 31st August 2021

Application will follow this workshop

Apply by 25th October 2021

Reach out for help as needed for your application

Why should you apply?

Targeted EWF solution for your city

Actionable steps after the assistance

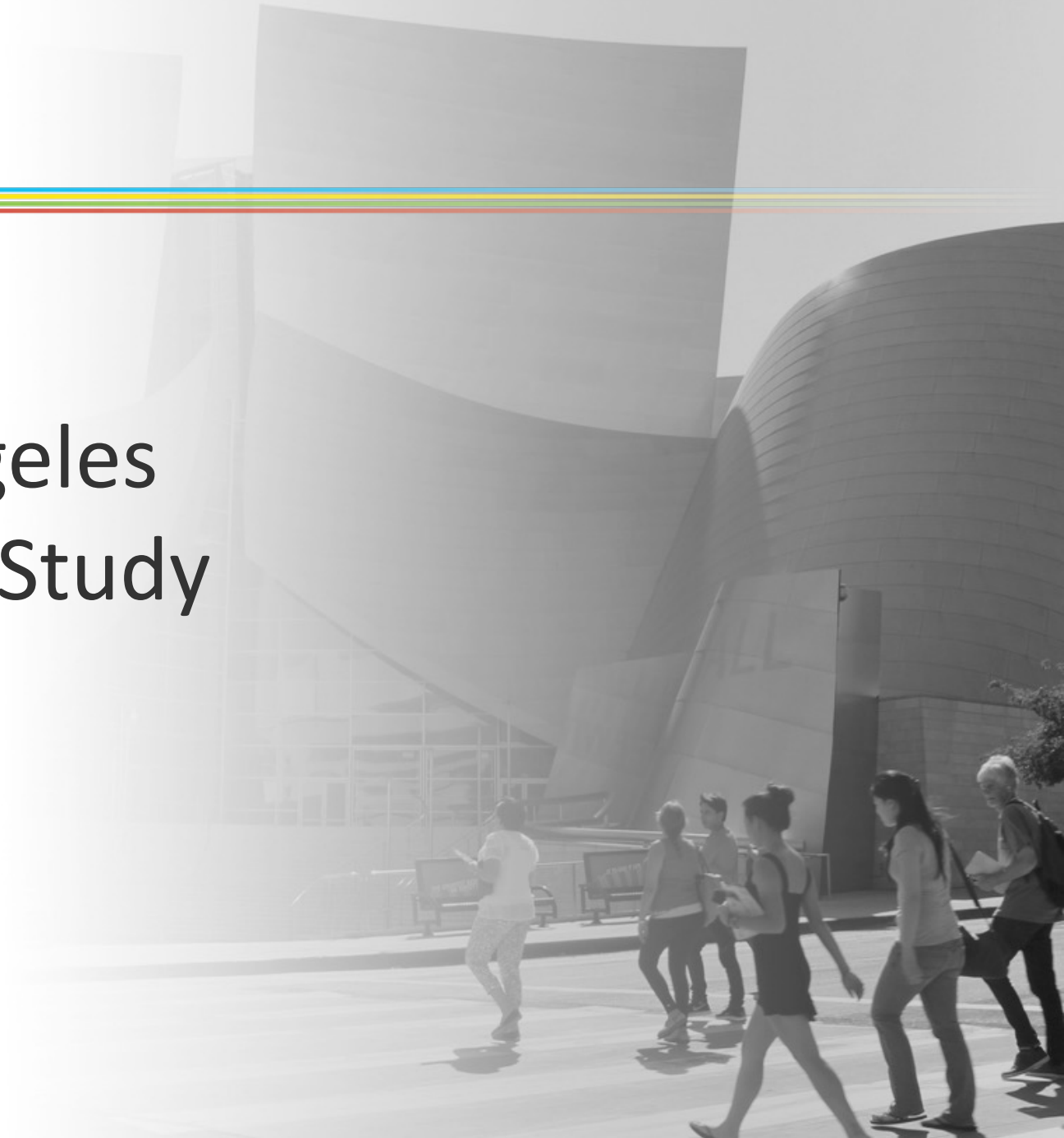
Future potential access to green climate funds to take the solutions to implementation

Questions?

Please join us for Pilot Project Q&A Webinar in September!

LA100

The Los Angeles 100% Renewable Energy Study



Lessons from the Los Angeles 100% Renewable Energy Study

Elaine Hale, Ph.D.

August 13, 2021

LA DWP Los Angeles Department of Water & Power | NREL Transforming ENERGY

Los Angeles Department of Water and Power (LADWP)

L.A.'s Current Power Grid

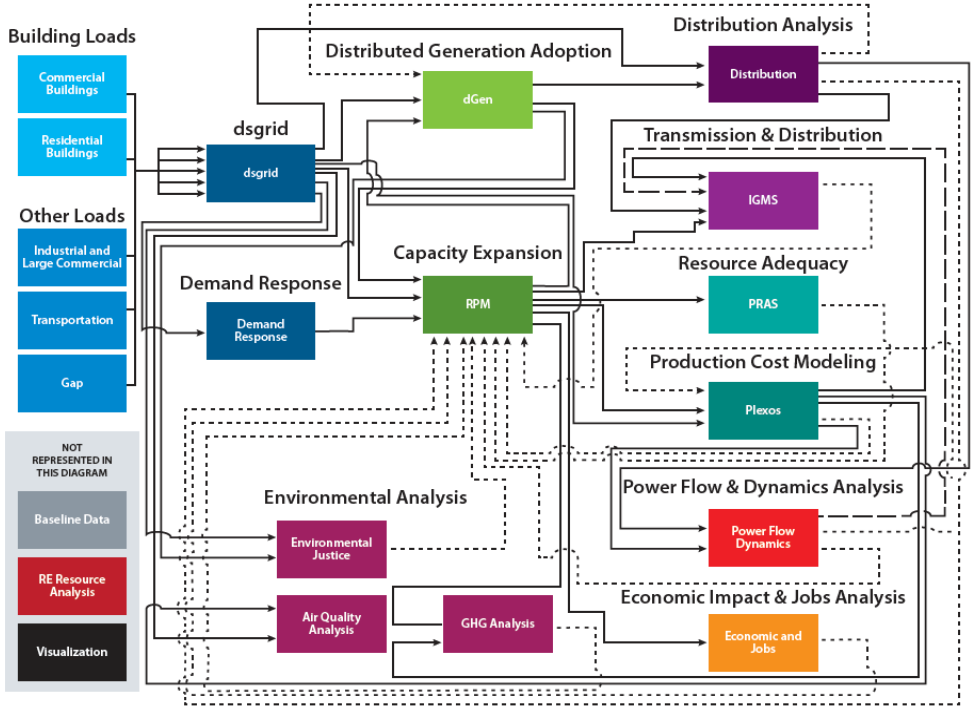
7,880 MW of Generation Capacity
Peak Load: 6,502 MW (Aug. 31, 2017)
4 million residents

Map by Billy Roberts, NREL

LA100 Approach

Advisory Group provided input and review throughout the study

Unprecedented model resolution and integration



- Over 100 million simulations
- Demand-side change
- Supply-side change
- Greenhouse gas and air quality outcomes
- Economic and job outcomes
- Environmental justice

Photos by Dennis Schroeder, NREL. Figure from Executive Summary in The Los Angeles 100% Renewable Energy Study, *NREL Technical Report (2021)*

LA100 Scenarios

Each Scenario Evaluated Under Different Customer Demand Projections (different levels of energy efficiency, electrification, and demand response)

- Moderate
- High
- Stress

SB100

Evaluated under Moderate, High, and Stress Load Electrification

- 100% clean energy by **2045**
- Only scenario with a target based on retail sales, not generation
- Only scenario that allows up to 10% of the target to be natural gas offset by renewable electricity credits
- Allows existing nuclear and upgrades to transmission

Early & No Biofuels

Evaluated under Moderate and High Load Electrification

- 100% clean energy by **2035**, 10 years sooner than other scenarios
- No natural gas generation or biofuels
- Allows existing nuclear and upgrades to transmission

Transmission Focus

Evaluated under Moderate and High Load Electrification

- 100% clean energy by **2045**
- Only scenario that builds new transmission corridors
- No natural gas or nuclear generation

Limited New Transmission

Evaluated under Moderate and High Load Electrification

- 100% clean energy by **2045**
- Only scenario that does not allow upgrades to transmission beyond currently planned projects
- No natural gas or nuclear generation

Figure from Executive Summary in The Los Angeles 100% Renewable Energy Study, *NREL Technical Report (2021)*

Across All Scenarios

Electrification
Energy Efficiency
Flexible Load

Customer
Rooftop Solar

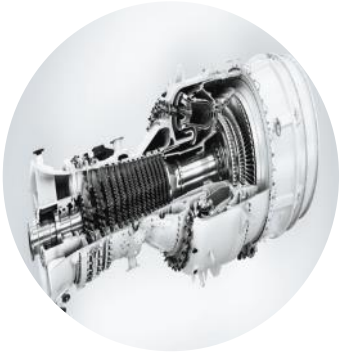
Renewable
Energy

Solar: + >5,700 MW
Wind: + >4,300 MW

Storage
(including coupled
with solar)

+ >2,700 MW

Distribution,
Transmission



Renewably Fueled
Combustion
Turbines

+>2,600 MW
(in basin)

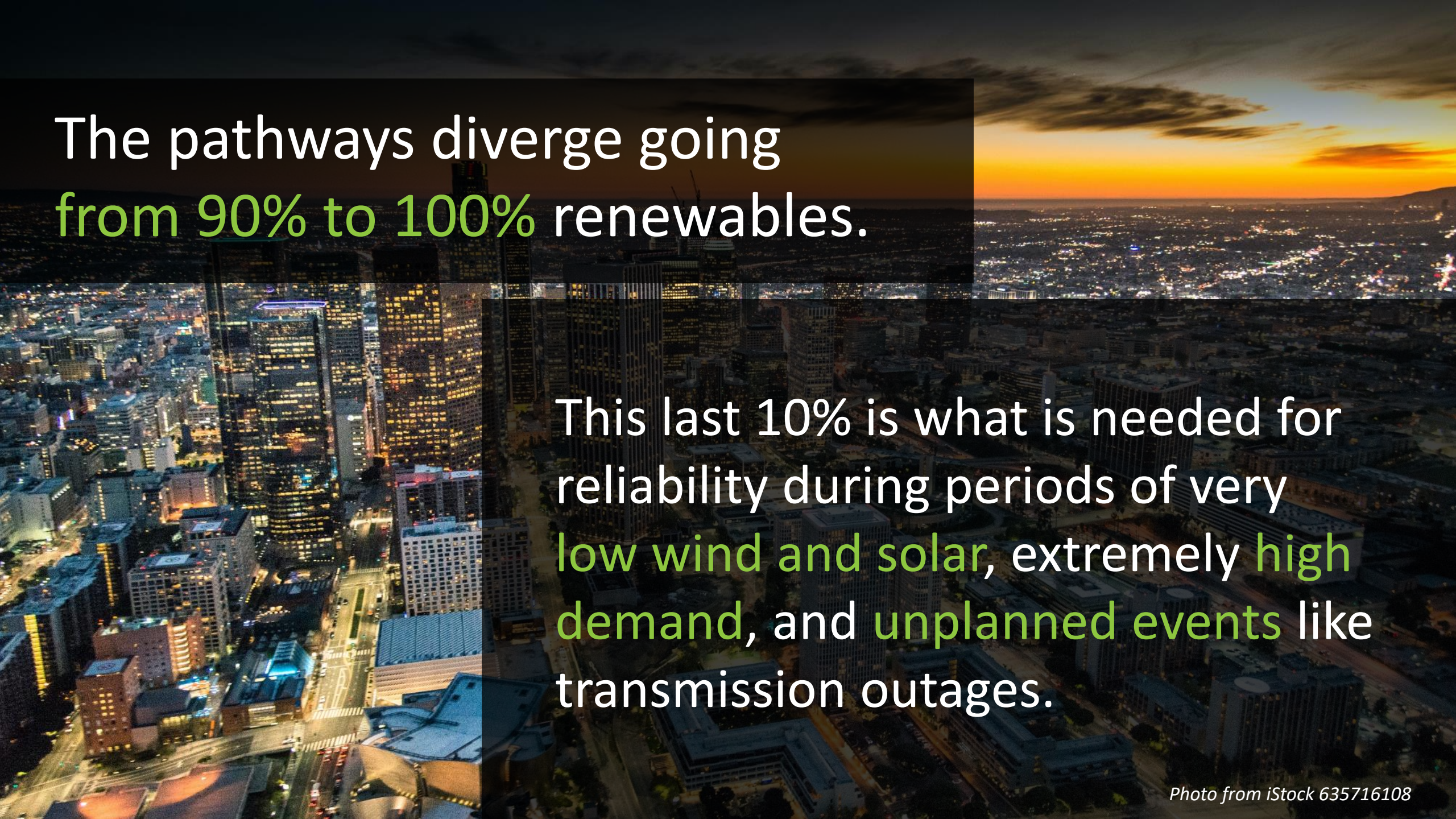
Much More

New

Natural gas	→	Biofuel/ hydrogen
Today: Daily		**Future:** Infrequently

Photos from left to right by Werner Slocum, NREL 46052, iStock, Dennis Schroeder, NREL 50710, 50688, 50667 and iStock.


In all scenarios, wind and solar provide 69%–87% of future electricity demand.
Photo by Dennis Schroeder, NREL 50710



The pathways diverge going from 90% to 100% renewables.

This last 10% is what is needed for reliability during periods of very low wind and solar, extremely high demand, and unplanned events like transmission outages.

Photo from iStock 635716108

Meeting the last 10% on the road to 100% renewables

Producing hydrogen (rather than buying commercially available RE fuels) adds ~20% to cumulative costs

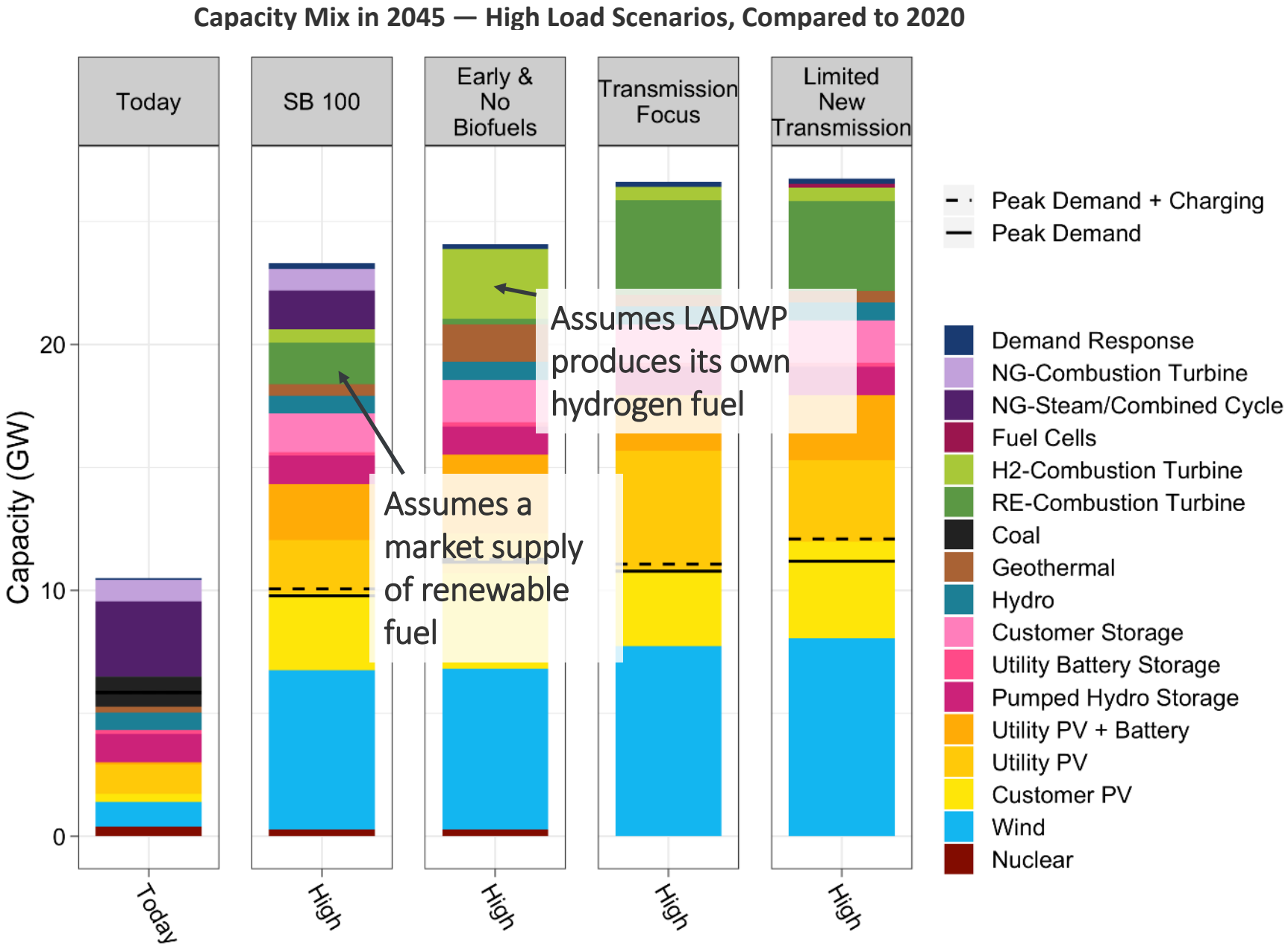
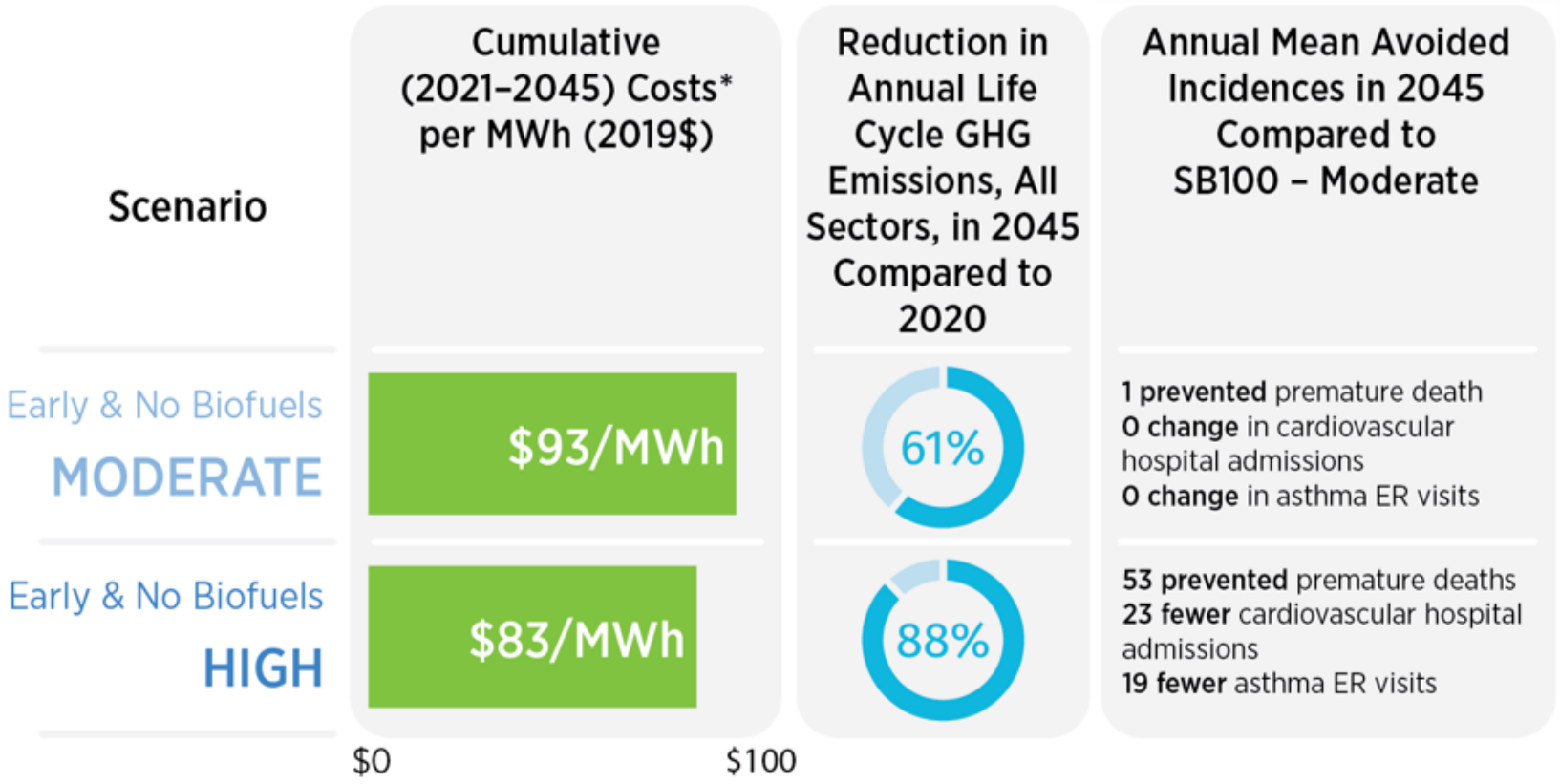


Figure from Chapter 6: Renewable Energy Investments and Operations of The Los Angeles 100% Renewable Energy Study, *NREL Technical Report (2021)*

Accelerating the target date to 2035 increases both the costs and benefits of the transition.

Photo from Pexels 248747

High vs. Moderate: Lower per-unit costs, more GHG reduction and more health benefits



*Revenue requirements per unit of generation to cover the annualized costs associated with expenditures measured in LA100--Not equivalent to rates.

Figure from Chapter 12: Synthesis of The Los Angeles 100% Renewable Energy Study, *NREL Technical Report (2021)*

Reliable, 100% renewable energy is achievable—and, *if coupled* with electrification of other sectors, provides significant greenhouse gas, air quality, and public health benefits.

Photo from iStock 596040774

Deep dive into LADWP water and wastewater systems plans—transition to more local, recycled supply

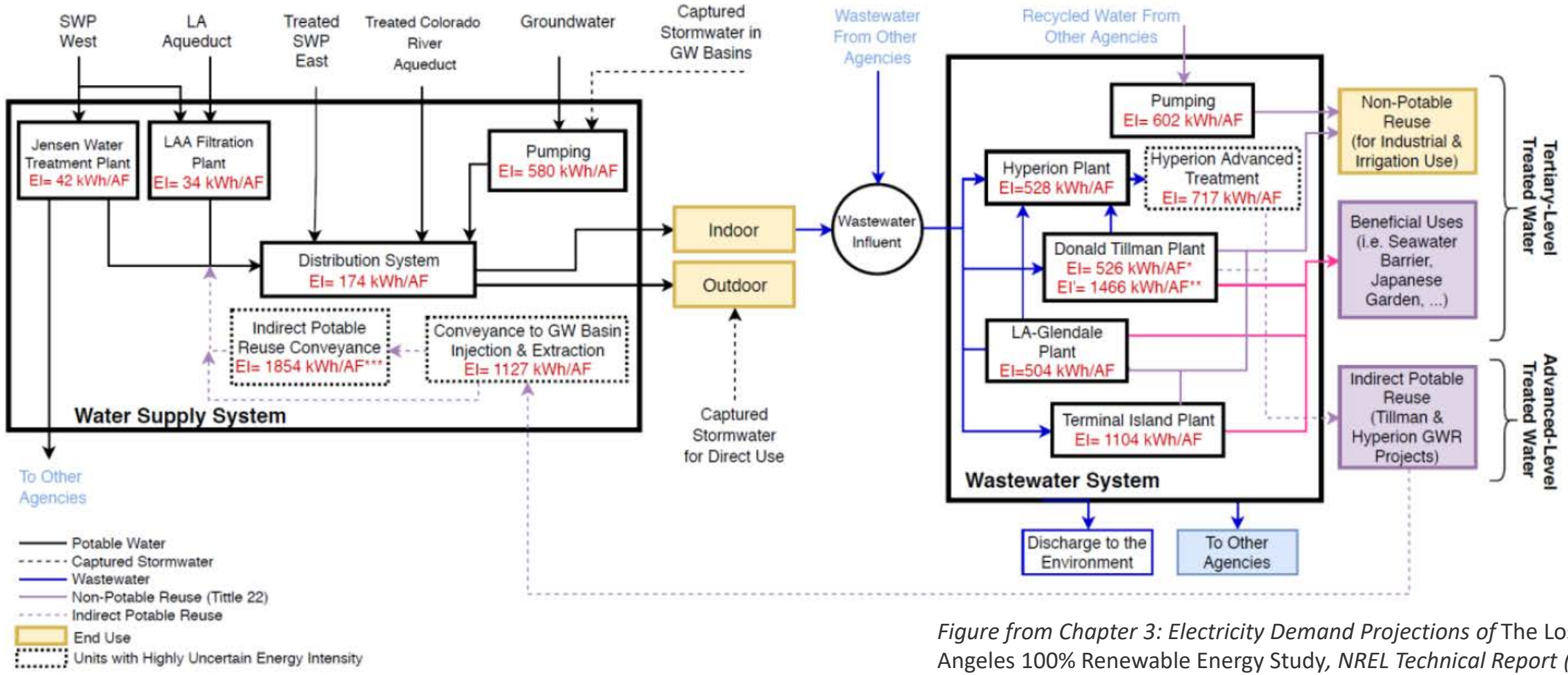


Figure from Chapter 3: Electricity Demand Projections of The Los Angeles 100% Renewable Energy Study*, NREL Technical Report (2021)*

* Average energy intensity before advanced treatment plant comes online.
** Average energy intensity after advanced treatment plant produces 30,000 AFY recycled water for groundwater replenishment project (i.e. after 2030). It is calculated as [(74,000 AF*526 (kWh/AF)+30,000 AF*2318 (kWh/AF)]/74,000=1466 kWh/AF.
*** The indirect potable reuse conveyance energy intensity is only applied to Hyperion groundwater replenishment project. No energy intensity is considered for Tillman GWR project.

More electricity is used to reduce dependence on imported water

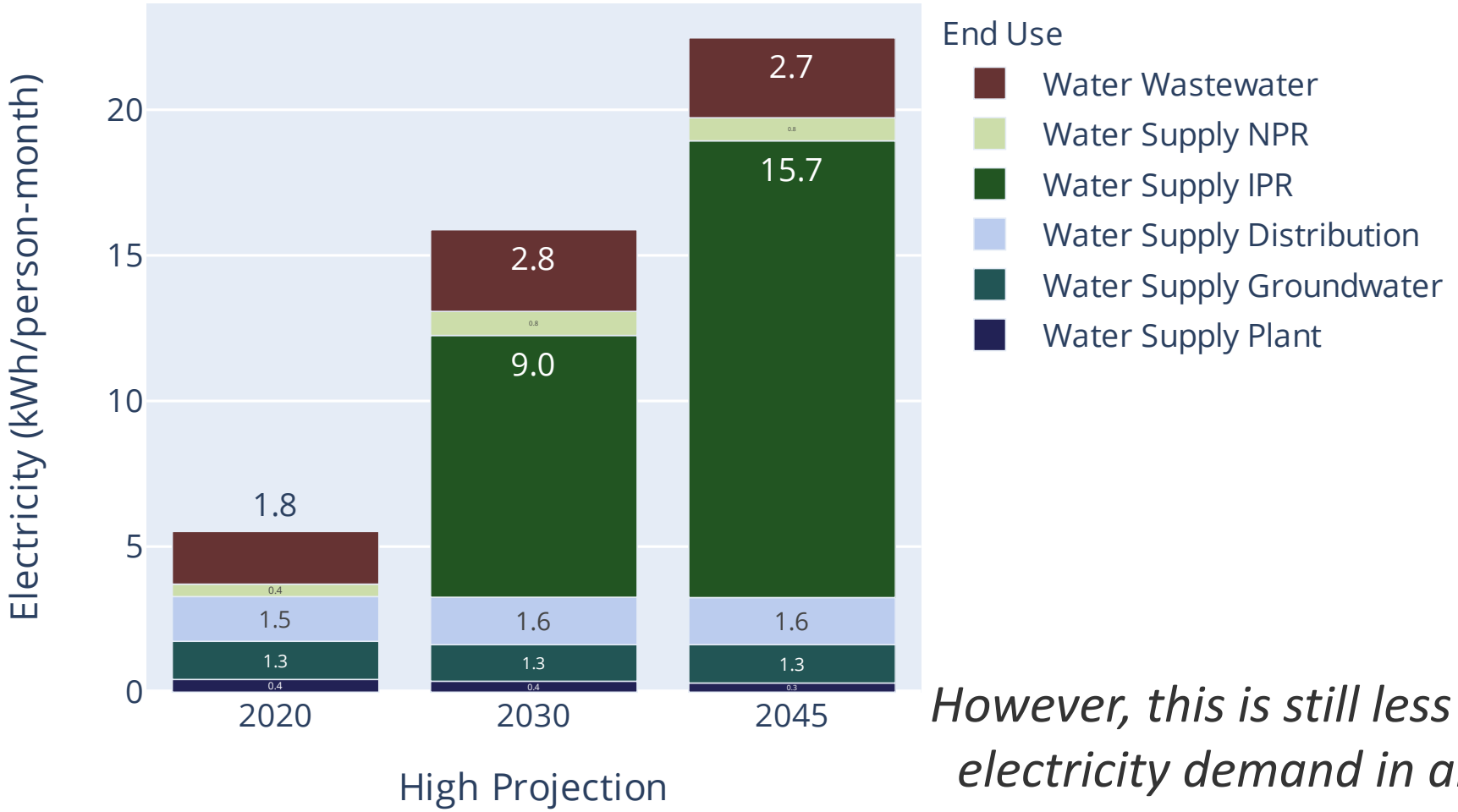


Figure from E. Hale based on results in Chapter 3: Electricity Demand Projections of The Los Angeles 100% Renewable Energy Study*, NREL Technical Report (2021)*

However, this is still less than 5% of LADWP electricity demand in all projection-years (up from about 1.5% today)

The water system is a demand response resource that is expected to grow as LA's water supply "electrifies"

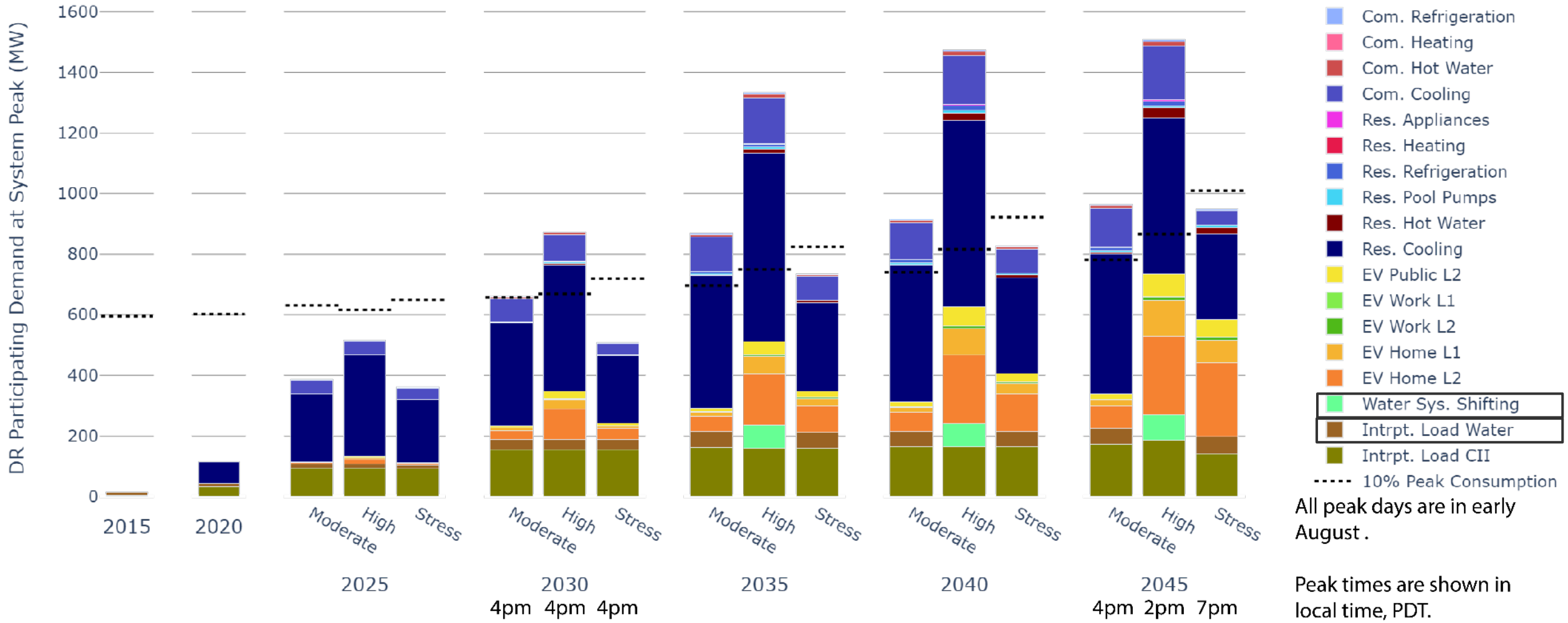


Figure from Chapter 3: Electricity Demand Projections of The Los Angeles 100% Renewable Energy Study, *NREL Technical Report (2021)*

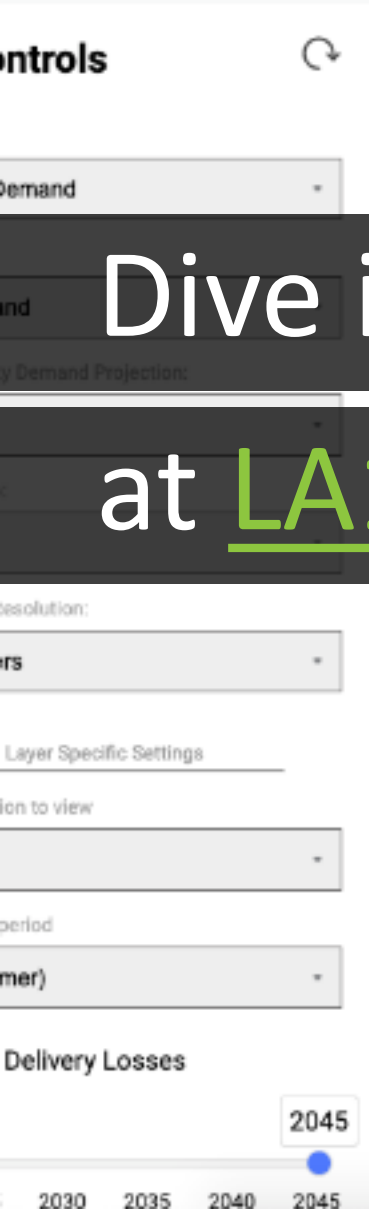
LADWP may be able to coordinate electricity and water operations more closely to enable shift-, in addition to shed-, type demand response

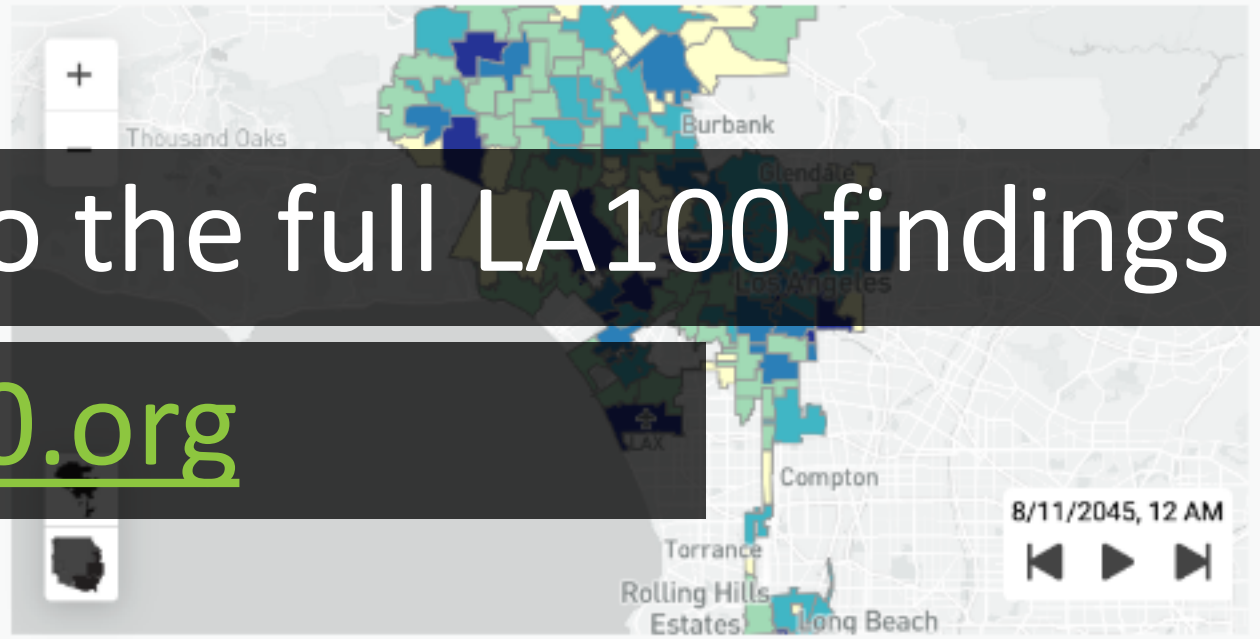
LA100: The Los Angeles 100% Renewable Energy Study

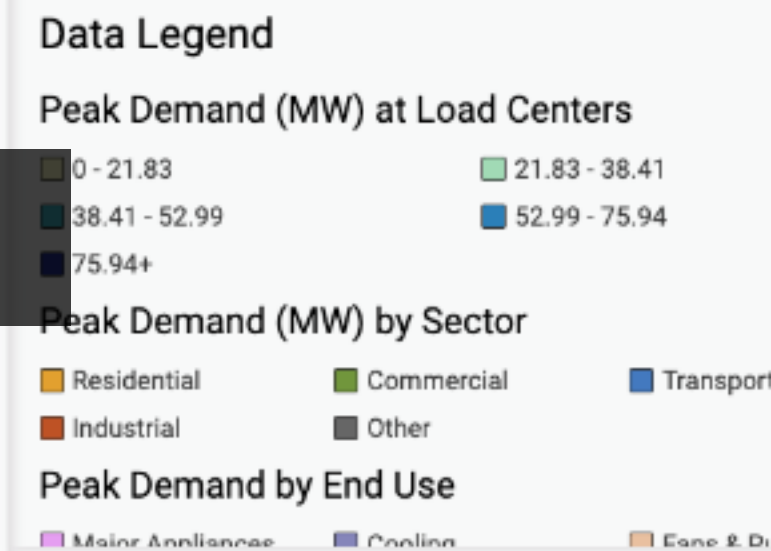
NREL Transforming ENERGY

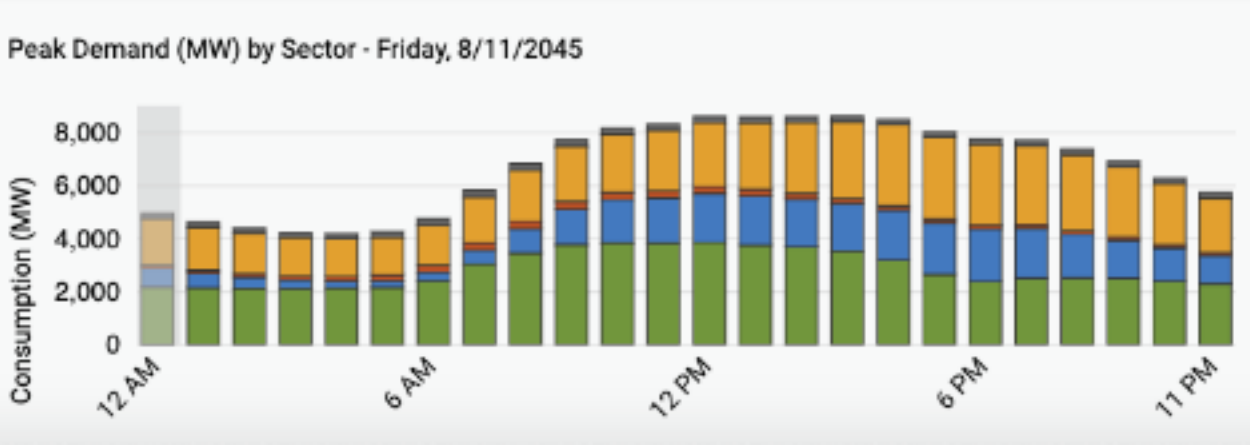
Home | Key Findings | Exploratory Questions | Data Viewer | About | Glossary

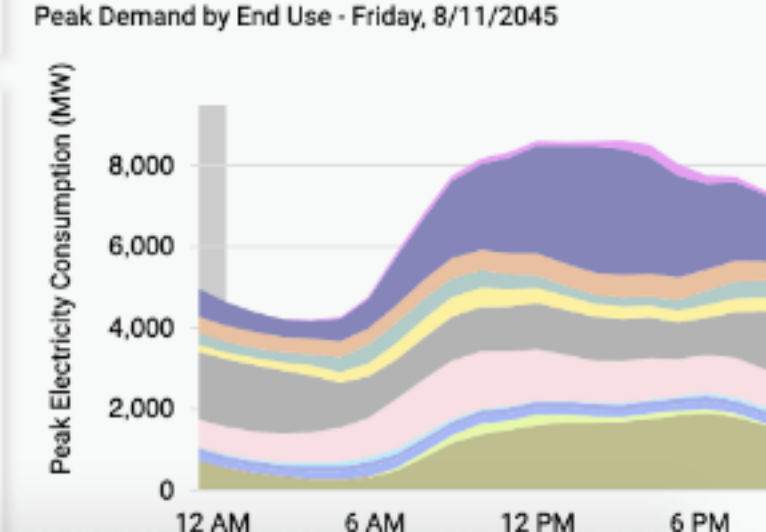
Dive into the full LA100 findings at LA100.org











Backmatter

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Growth in customer demand for electricity

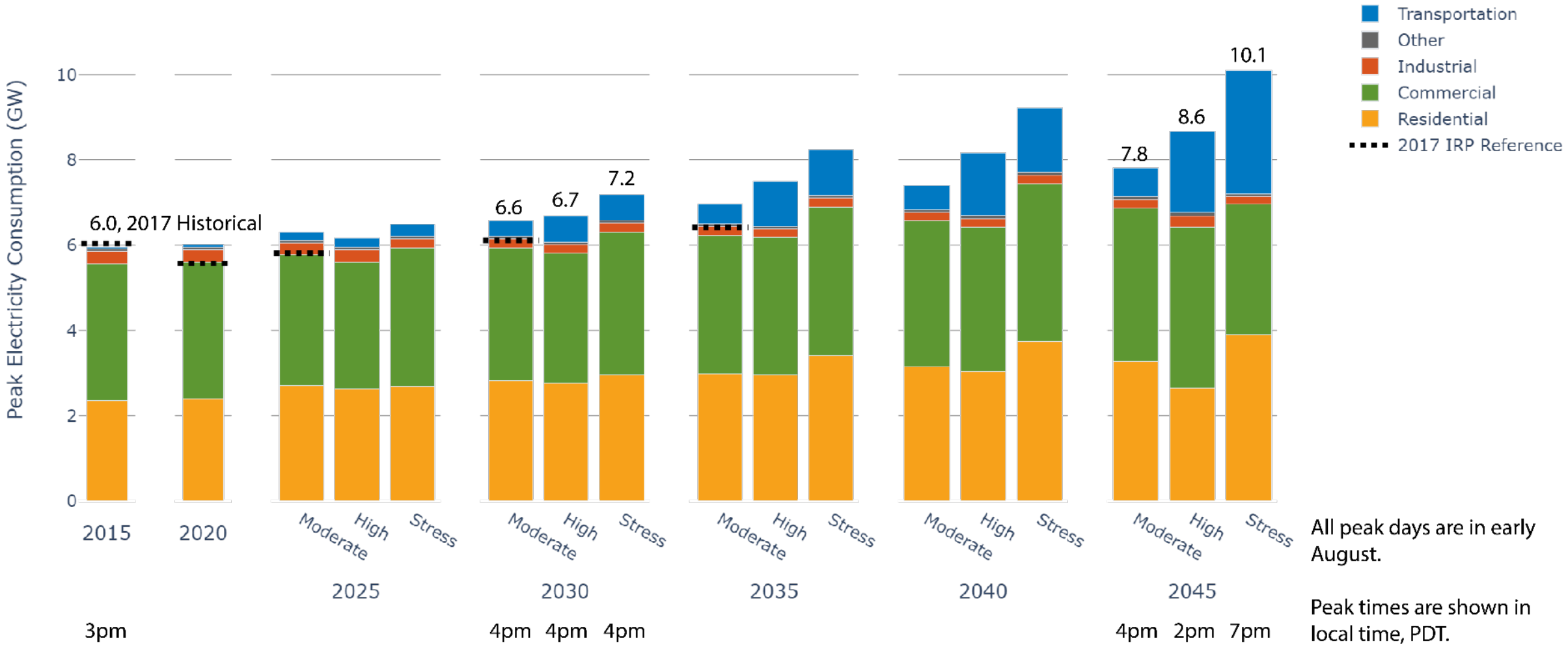


Figure from Executive Summary in The Los Angeles 100% Renewable Energy Study, *NREL Technical Report (2021)*

By 2045 rooftop solar would be an economic choice for nearly all households and businesses

Adoption would occur on 22%–38% of all existing single-family homes, up from 6% in 2020

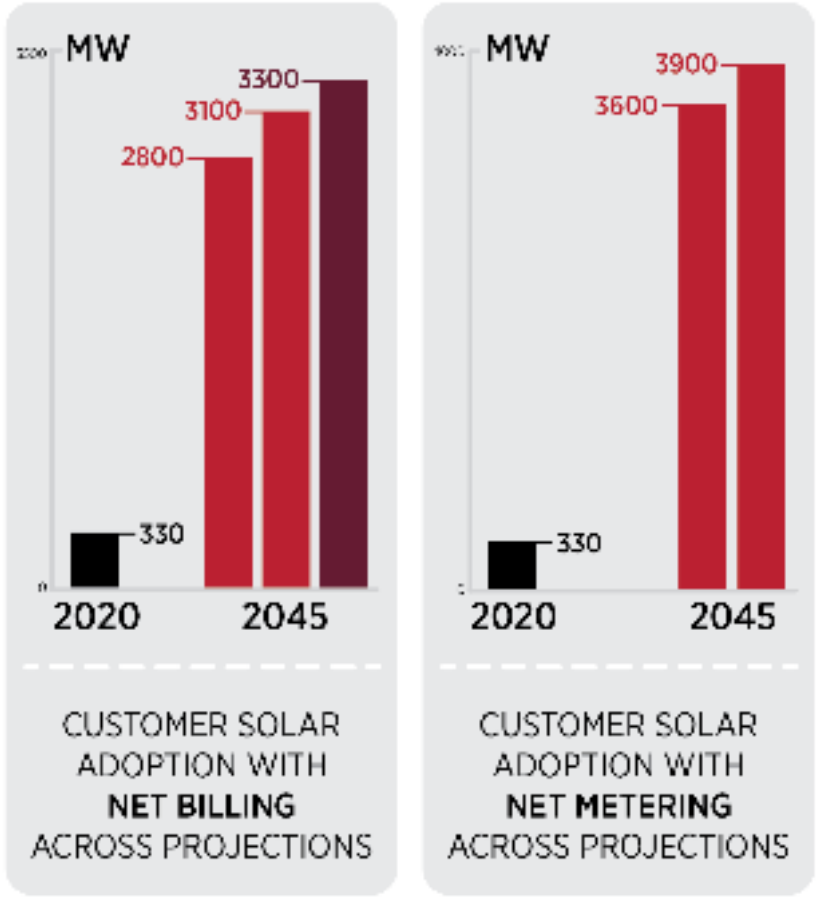


Figure from Chapter 12: Synthesis of The Los Angeles 100% Renewable Energy Study, *NREL Technical Report (2021)*

Role of Seasonal Storage

A different resource mix is required if natural gas is excluded

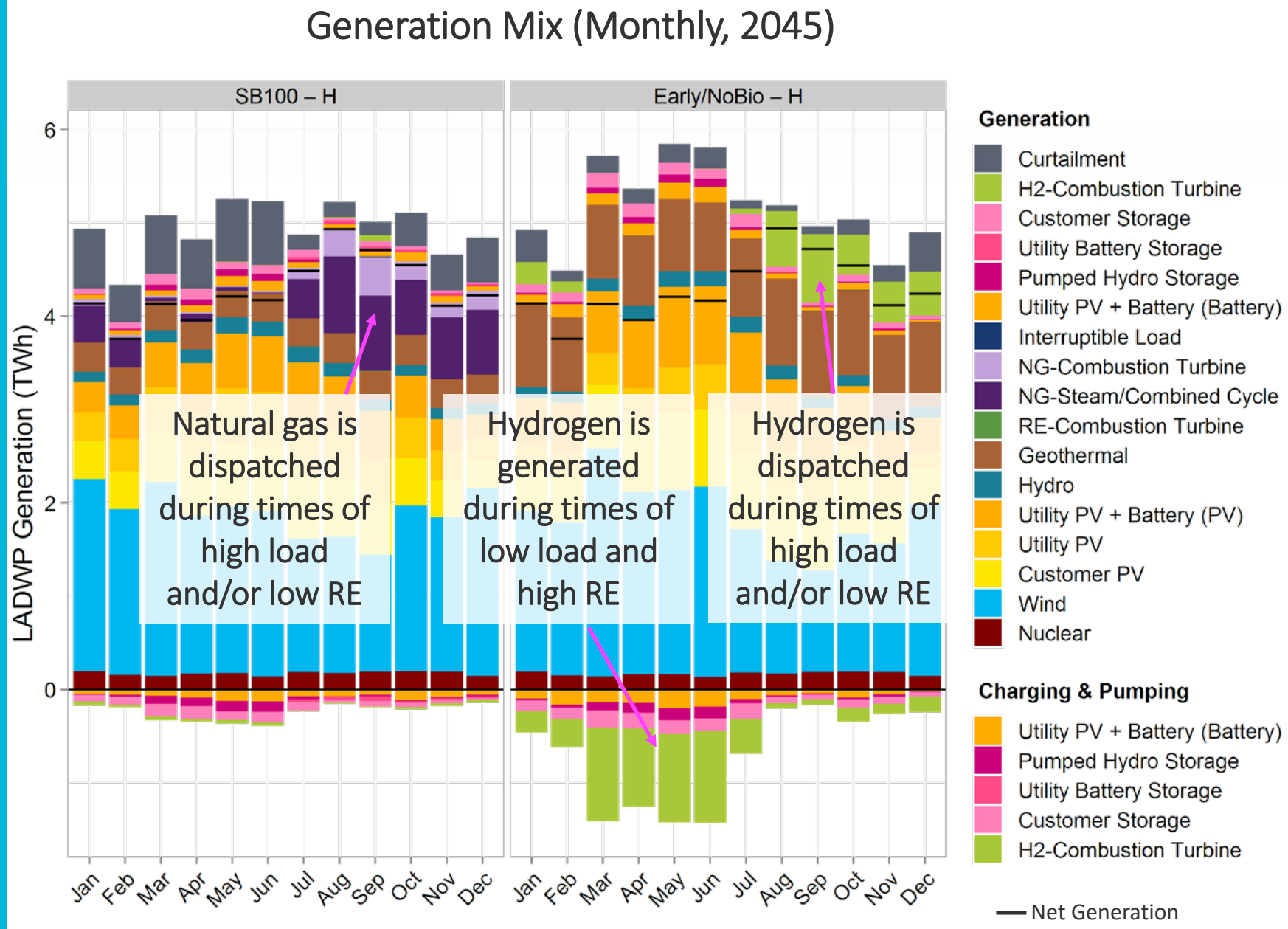


Figure from Chapter 6: Renewable Energy Investments and Operations of The Los Angeles 100% Renewable Energy Study, *NREL Technical Report (2021)*

Identifying alternative options for firm, in-basin capacity likely represents the largest opportunity to reduce the costs of the transition and points to the highest priorities for R&D: hydrogen and extended demand response.

Photo from iStock 1255388575

U.S.-ASEAN Smart Cities Partnership

Integrated Urban Services with ASEAN Smart Cities

From Urbanization and Nexus Fundamentals to Metrics, Design Principles, & Smart-Sustainable City Insights

Josh Sperling, Ph.D., IUS Senior Researcher | Urban Futures & Energy-X Nexus Engineer

National Renewable Energy Laboratory | New Concepts Incubator

August 13, 2021 | Day 2 - Integrated Urban Services Kickoff

Agenda

- **Motivation and Measuring Success:**
  - **Motivation**: why an integrated approach leads to better outcomes?
  - **Metrics**: how 'successful' outcomes come through as a result of integrated approaches?
- **Day 1 Recap – Looking Back:**
  - **Urbanization:** 70 million more in population to be added to ASEAN urban areas, creating significant new demands for services (that may outpace municipal capacity)
  - **'Total Design' principles**: moving towards interdisciplinary, context-specific integration of govt, industry, utility, R&D
  - **Ingredients to success:** for Integrated Urban Services
- **Day 2 Session – Looking Forward:**
  - **ASEAN context, City Reviews, Surveys:** preliminary results
  - **Expert Interviews:** initial insights and on-going interactions
  - **Polling:** informing consensus-building on where to focus

OneWaterSF Metrics – from Paula Kehoe, SF Water

21st Century: Engineering-Planning-Policy-Behavior Sciences for Urbanization

Bigger picture of urbanization challenges (prepared for Rethinking Cities, World Bank, 2014):

- **CHALLENGE**: 10B urban people? 87% urban planet? 21st century = 3x more urban residents in 'less developed' world? What will be the infrastructures/institutions of a healthy urban planet?
- **OPPORTUNITY:** "Urban population will be split unevenly, with just 1.2B living in cities of what we now think of as developed countries and 8.6B in cities of the developing world."

What is Regenerative Urbanism?

Regenerative urbanism represents a paradigm shift in urban innovation. It uses living systems as a metaphor and model for inspiring more productive, resilient, and equitable urban places, regenerative communities generate net positive impacts by:

- Creating more resources than they consume, ensuring critical resources are secure and affordable for decades to come
- Eliminating waste by managing materials, nutrients, and water within a circular metabolism model
- Eliminating pollution by powering all buildings and vehicles with renewable energy
- Cultivating abundant healthy food within the community

The Developing World's Urban Population Could Triple by 2210

	Urban residents			Population
Year	Less developed	More developed	World	World
1910	4% 0.04	15% 0.14	19% 0.18	0.93
2010	38% 2.6	14% 0.96	52% 3.6	6.9
2110	71% 7.8	11% 1.2	82% 9.0	11.0
2210	76% 8.6	10% 1.2	87% 9.8	11.3

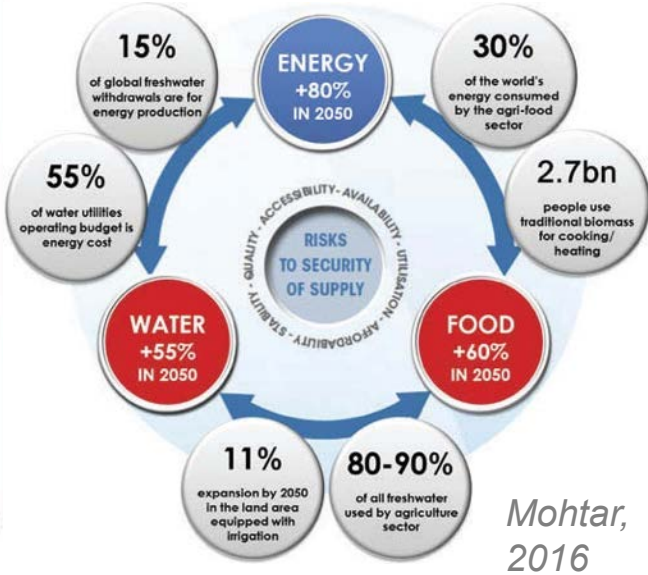
Fuller and Romer, 2014. Urbanization as Opportunity. (Calculations based on UNDESA, 2012)

IN THE NEXT 3 DECADES, ALMOST 2 BILLION ADDITIONAL PEOPLE WILL POPULATE THE EARTH. THIS GROWTH WILL CREATE DEMANDS ON AN UNPRECEDENTED SCALE FOR:

ENERGY PRODUCTION	FOOD SUPPLY	WATER PRESERVATION	WASTE DISPOSAL
ENVIRONMENTAL CLEANUP	SUITABLE LIVING CONDITIONS	HEALTH CARE	INFRASTRUCTURE
MATERIALS HANDLING	LAND STABILIZATION	EARTH MOVING	TRANSPORTATION DEMAND

Amadei, 2009

Foss, 2017



Mohtar, 2016

UCD: Urban Trans-Boundary Challenge
Integrated Approaches Open New Opportunities

Key Urban Flows

-Food

- Water

- Energy
  Electricity
  ….(Scope 2)
  Transp Fuel

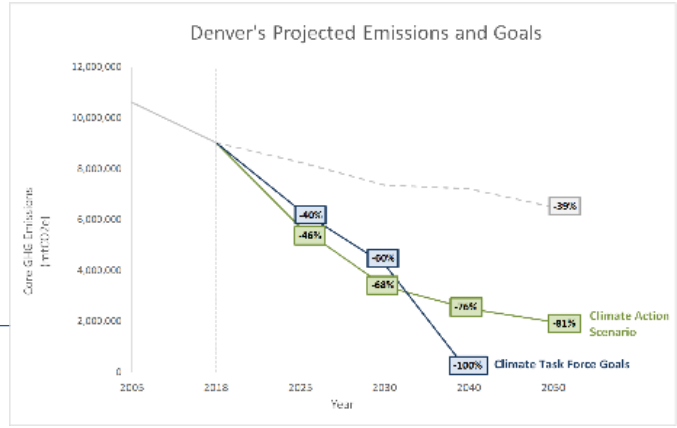
- Shelter
  Cement
  …

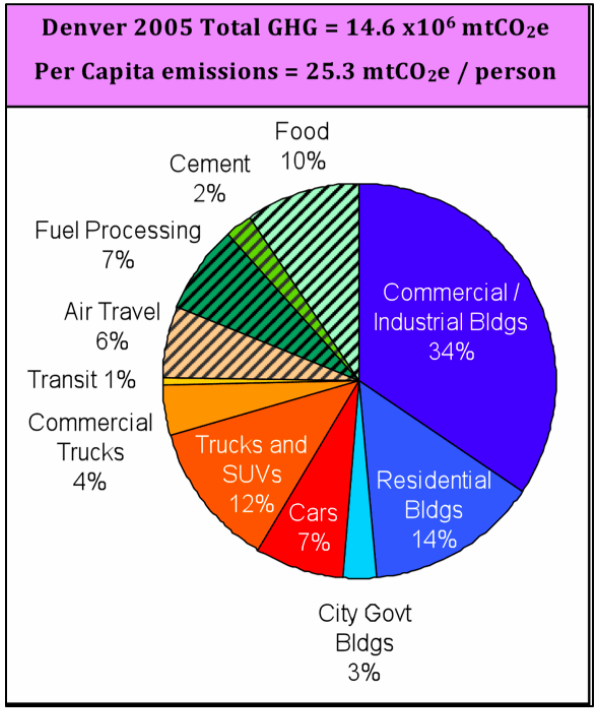
Freight & Goods

Airline Travel

Commuter

City or Urban Region w/ Buildings, Vehicles, Industries (Scope 1)





Ramaswami et al., 2008.

Case of City of Denver, USA - Cross-Sector GHG Emissions Accounting & Climate Action Impact

Between averted impacts and savings, the minimum value of climate action investments are

$20.2 Billion

Denver Climate Action 2020 Recommendations Report

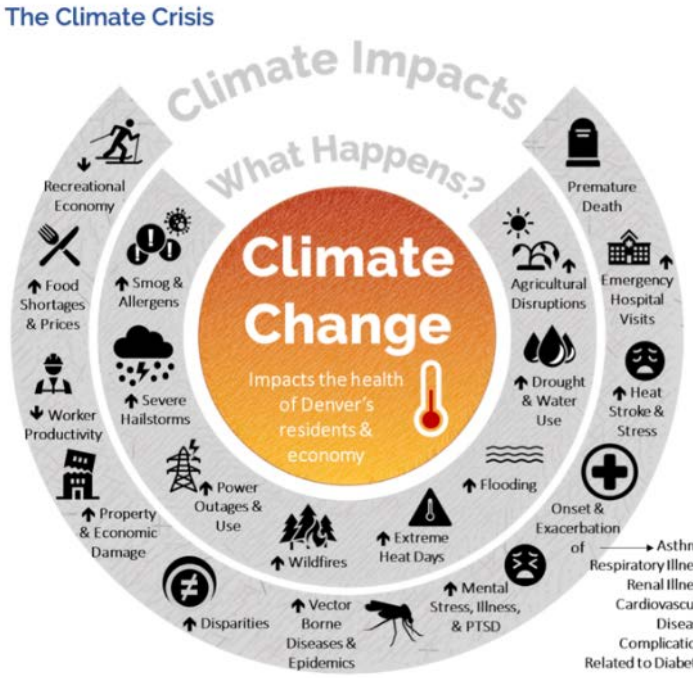
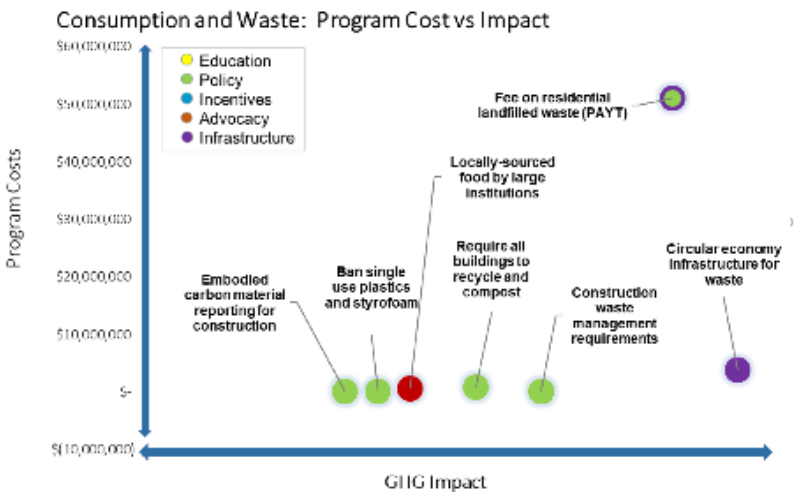
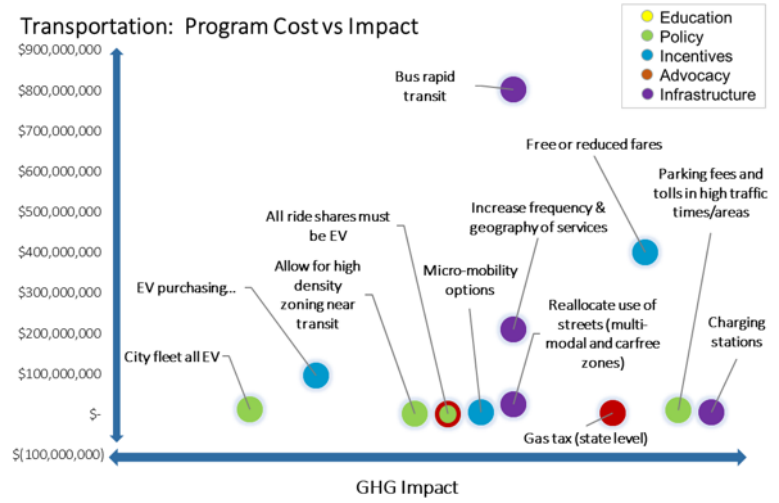
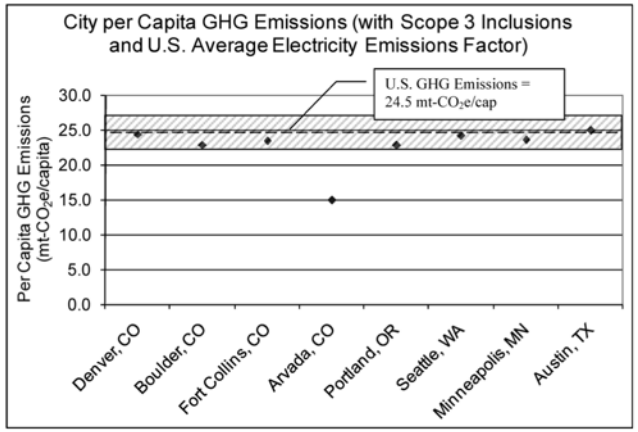


Figure ES 1. Climate change effects and impacts in Denver.

If we find ourselves in a severe climate crisis scenario, life as we know it will be impacted across all sectors. Figure ES 1 depicts some of the impacts to Denver's economy and our health. The stakes are high, and action is urgently needed, which is why the Denver 2020 Climate Action Task Force has laid out an aggressive policy and solutions agenda that is to be implemented as rapidly as possible over the next decade.







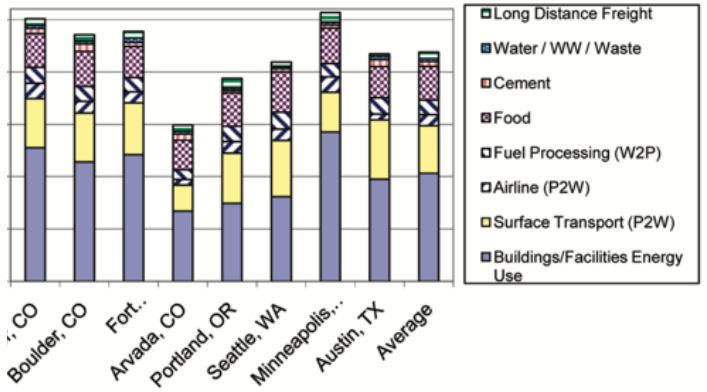


FIGURE 3. Per capita GHG emissions (metric tonnes CO_2e) for eight U.S. cities incorporating Scope 3 inclusions and the U.S. average electricity emissions factor, compared with national U.S. average per capita emissions. The hatched area represents ±10% of the national per capita GHG emissions.

Contents lists available at ScienceDirect

Applied Energy

journal homepage: www.elsevier.com/locate/apenergy

Implications of high renewable electricity penetration in the U.S. for water use, greenhouse gas emissions, land-use, and materials supply ☆

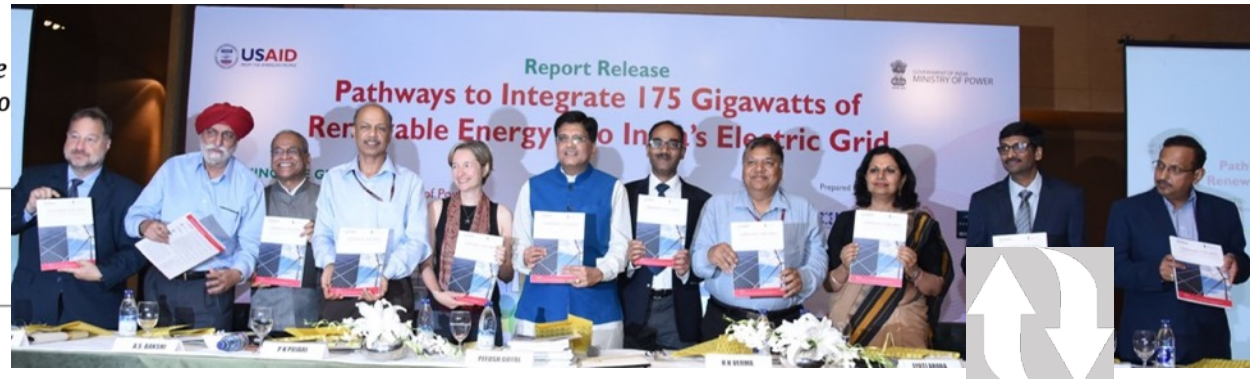
Doug Arent [a], Jacquelyn Pless [a,*], Trieu Mai [a], Ryan Wiser [b], Maureen Hand [a], Sam Baldwin [c], Garvin Heath [a], Jordan Macknick [a], Morgan Bazilian [a], Adam Schlosser [d], Paul Denholm [a]

[a] National Renewable Energy Laboratory, 15013 Denver West Parkway, Golden, CO 80401, USA
[b] Lawrence Berkeley National Laboratory, 1 Cyclotron Road, Berkeley, CA 94720, USA
[c] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Headquarters 1000 Independence
[d] Massachusetts Institute of Technology, Joint Program on the Science and Policy of Global Change, Center for Glo
Cambridge, MA 02139, USA

At 80% renewable electricity, annual GHG emissions in 2050 in the U.S. power sector were **reduced by approximately 80%** on both a direct combustion basis and on a full life cycle basis, and **annual power-sector water withdrawal and consumption could be cut by roughly 50%**; on **only 3% of land area of USA.**
>> *Translating to India; LA100, ASEAN cities?*

HIGHLIGHTS

- Renewable electricity generation could supply 80% of U.S. generation in 2050.
- GHGs are reduced proportionally and water use is reduced by 50%.
- Gross land-use impacts total less than 3% of land area of the contiguous U.S.
- Some clean energy technologies rely on materials that face short-term risks.
- No insurmountable long-term constraints to materials supply were identified.



*"On most polluted day last month, fine particulate levels in **New Delhi** reached **over 900 µg/m3**, blowing past E.P.A.'s definition of "hazardous" air (which maxes out at 500) and into **extreme** territory." – **NYT, 2019***

Contents lists available at ScienceDirect

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci

From risk to WEF security in the city: The influence of interdependent infrastructural systems

Patricia Romero-Lankao[a,*], Antje Bruns[b], Viviana Wiegleb[b]

[a] Urban Futures, National Center for Atmospheric Research (NCAR), Research Affiliate Center for Science, Technology and Policy Research (CSTPR), Colorado University, United States[1]

[b] Governance & Sustainability Lab, Fachbereich VI Raum- und Umweltwissenschaften, Universität Trier, Campus II – Behringstraße 21, 54296 Trier, Germany

ARTICLE INFO

Keywords:
Water-Energy-Food (WEF)
Urban
Interdependencies
Cascading effects
Security
Climate risk
Governance
Infrastructures

ABSTRACT

Across the planet, interacting threats are converging in urban areas beset with pressures brought on by global processes such as urbanization and climate change, and the challenges of creating water, energy and food (WEF) security for their populations. With an increased probability of floods and other extremes, goes a heightened potential for cascading effects as WEF security is at risk from an array of tightly bound interdependencies undergirding the WEF nexus. Such interdependencies heighten risk for generalized disruptions, as, for instance, when heavy precipitation triggers a breakdown of transportation infrastructure, leading to failures in energy generation, and provision of food and water. In this paper, we apply a framework to examine how inter-dependent WEF infrastructural systems mediate the risks that climate extremes pose to urban WEF security. Given that urban WEF security often hinges on dynamics that take place in regions outside city boundaries, we also examine the effect of this dependence on urban FEW security risk. We compare the pre- and post-event governance and infrastructural conditions shaping WEF security in four cities: Boulder Colorado and New York (USA) illustrative of WEF security risks posed by low probability high impact extreme events; and Accra (Ghana) and Mexico City (Mexico), illustrative of governance and infrastructural arrangements that can fail even under low risk high probability extreme events. We find that complex technological and governance failures can

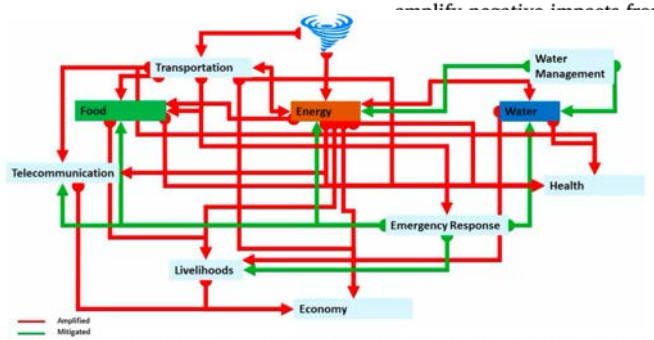


Fig. 2. Infrastructural System Interdependencies in New York. This mental model maps the factors that amplified/mitigated cascading effects triggered by Hurricane Sandy in New York. Green, positive arrows indicate risk mitigation and red, negative arrows indicate risk amplification. Own using Fuzzy Mental Modeler (mentalmodeler.com). Design by Rachel Norton. (For interpretation of the references to colour in this figure legend and text, the reader is referred to the web version of this article.)

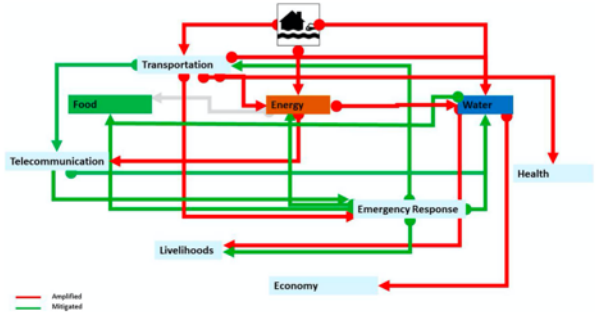
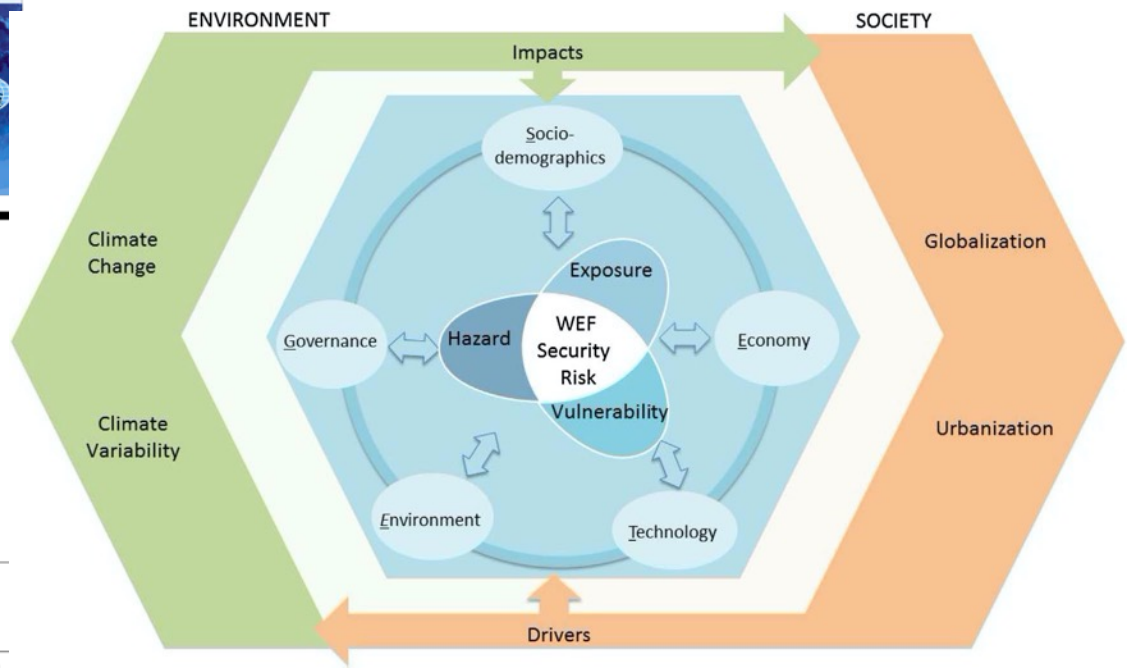


Fig. 3. Infrastructural System Interdependencies in Boulder. This mental model maps the factors that amplified/mitigated cascading effects triggered by the September 2013 Boulder Floods. Green, positive arrows indicate risk mitigation, red, negative arrows indicate risk amplification, and arrow with a question mark indicates no clear effect. Own using Fuzzy Mental Modeler (mentalmodeler.com). Design by Rachel Norton. (For interpretation of the references to colour in this figure legend and text, the reader is referred to the web version of this article.)



Configuration of infrastructure networks is often based on a coming together of a mixture of urban, national and international institutional settings, policies and interventions and informal institutions and practices. Existing infrastructure networks in these cities show **high levels of socio-spatial segregation** and often fail to cover the complete urban agglomeration, thus creating a distinct pattern of socio-spatially **differentiated risk and vulnerability**. The **lack of infrastructure is particularly relevant in peri- urban areas, the dynamic frontiers of urban development, where supply-systems emerge in a largely ad hoc way**.

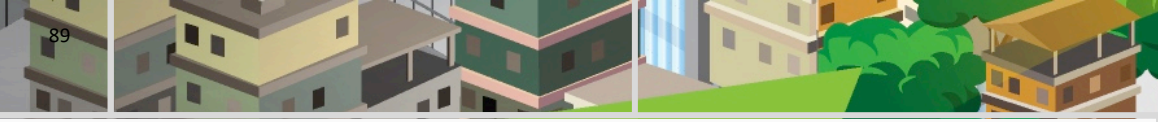
One billion people live in slums and informal settlements today. This number is expected to double by 2030.

RENEWW ZONES

A decentralized, closed-loop model of spatial planning and peri-urban service provision that harnesses inclusive innovations at the nexus of energy, water, food, and other urban systems to accelerate service access, enhance resilience, and improve living conditions through market-based, data driven approaches.

Piloting a **Renewable Energy, Nutrition, Environment, Water, and Waste** (RENEWW) Innovation Zone Model

UN Habitat General Assembly | May 27, 2019



Integrated Urban Services (IUS)

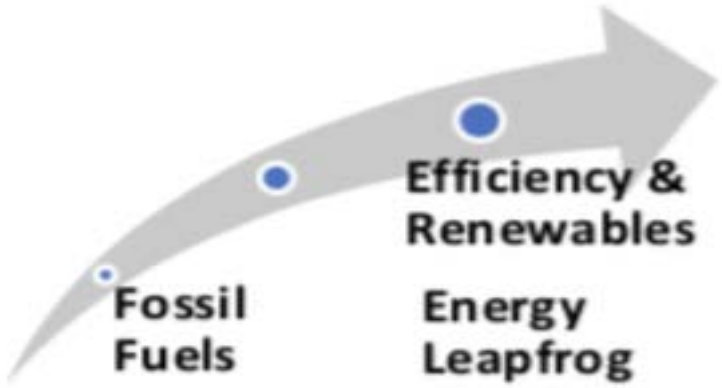
- Easily available, low-cost, high-nutrient food and safe drinking water
- Renewable electricity and fuels
- A multi-use green space
- Improved sanitation systems
- Local employment / training opportunities
- Community management & governance
- Opportunities for related micro-businesses
- Resource-efficient behaviors
- Reduced risk: heat, floods, drought, COVID
- Well-planned urban service extensions

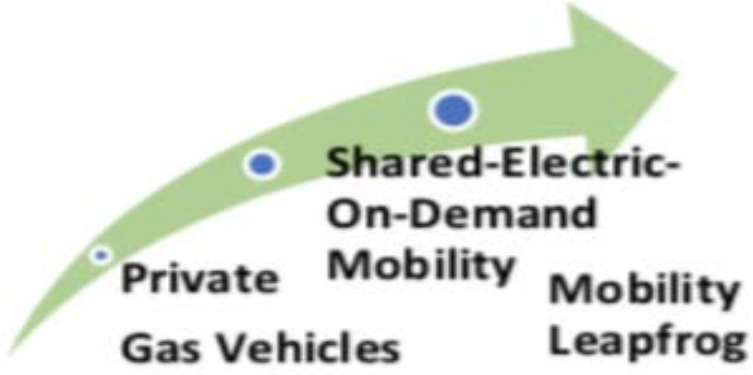
Integrated IUS concepts can help scale successful technology, planning, policy, business/finance, & governance models and for service areas that will have an ability to expand or self-replicate with cross-sectoral planning, design and decision-making teams

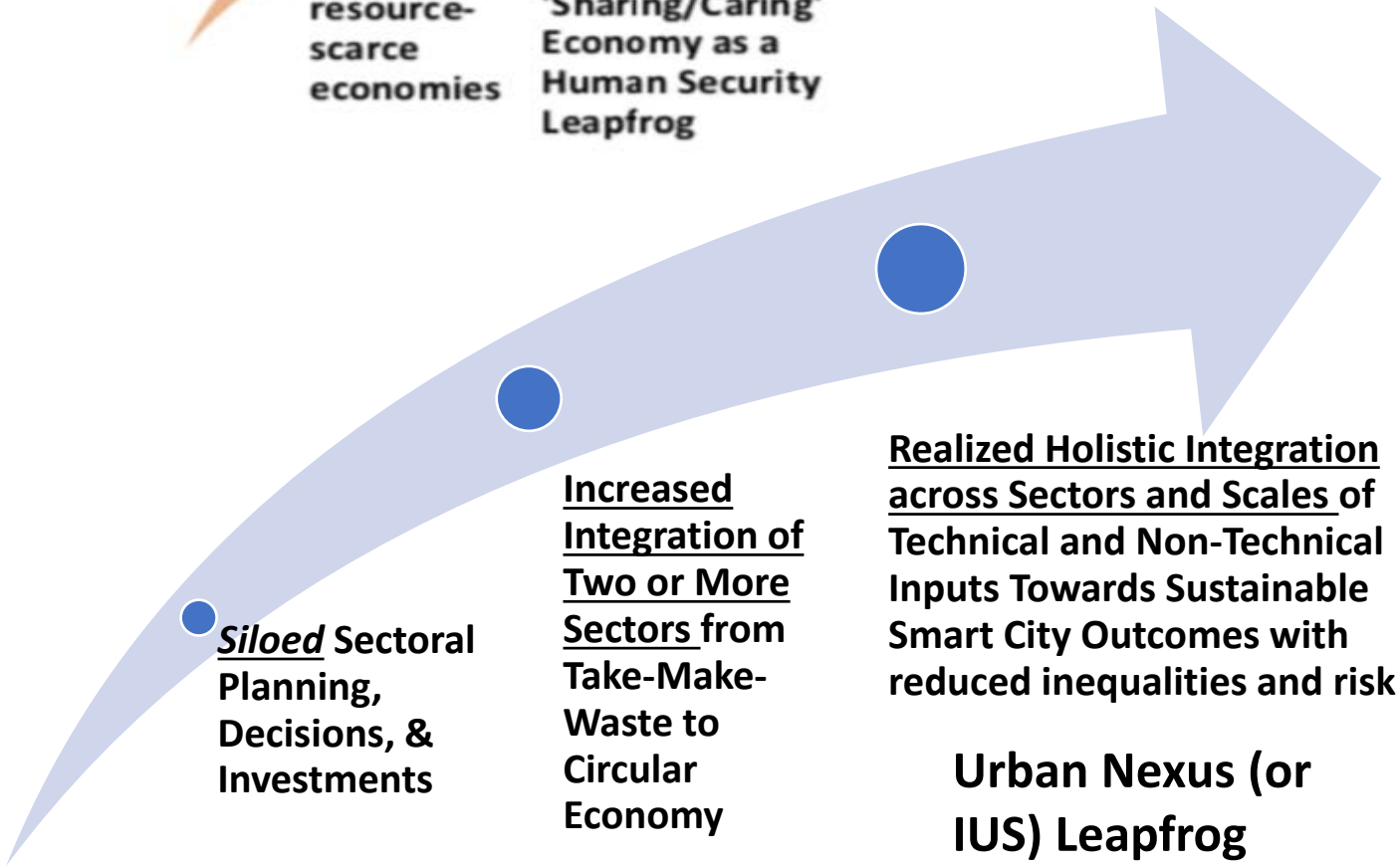
IUS or Urban Nexus Design Principles

- **Engineering - 12 Green Design Principles**
  (#12: Renewable Rather than Depleting)
- **Planning - AIA Livable Communities 10 Principles**
  (#1: Design on a Human Scale)
- **Policy/Governance – Ostrom's 8 Design Principles**
  (#7: Allocate Authority at Multiple Levels)
- **Behavioral Sciences – 8 Principles**
  (#2: Understand Situation from the Actor's Perspective)

Considering Multiple 'Smart Sustainable City' Leapfrogs - Capacity Building, Mentoring Next Generation, and Peer-Learning on New Integrated Practices & Investments







Critical Role of Governance and Solutions Resources?

"Integrated management does not emerge just because people say it should for resource efficiencies. Places need a strong champion with legitimacy & authority to compel participation/policy integration over time (despite competing priorities)"

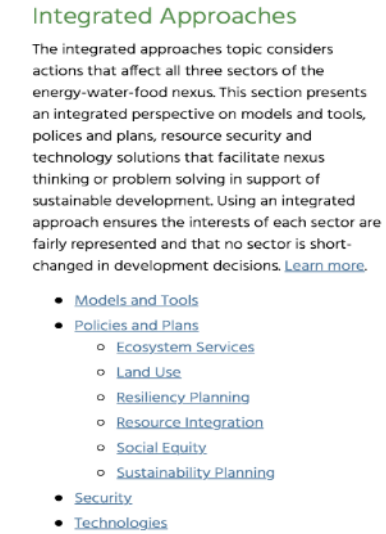
Three Key Questions
(adapted from Pierce, 2021)

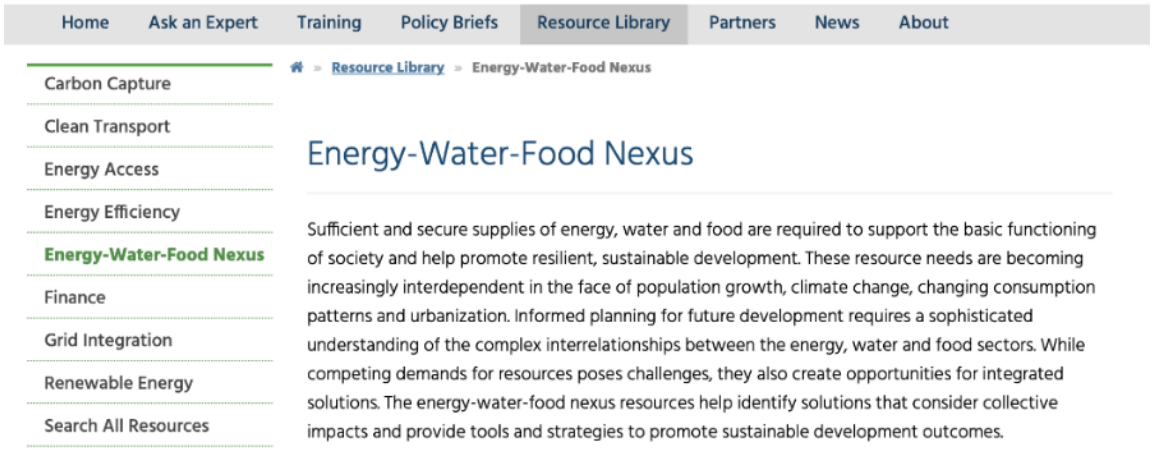
1. Will IUS /smart city innovations remain dominated by "technical" considerations, or will governance/ finance become more prominent?
2. Will the natural sciences, engineering, design and planning "acknowledge and recognize the political nature of resource use and governance"? (Wiegleb & Bruns, 2018). Need for social/economic/behavior & decision sciences?
3. "Nexus approaches may reproduce existing inequalities in resource allocations and power structures unless research and policy carry a fundamental critique of these very inequalities" (Artioli et al., 2017) -- *will initial business models have a role for and benefits to underserved communities? Will solutions be co-created?*

Case Studies of Policy & Governance Integration - NREL Nexus Solutions Resource Portal

CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

- Single access point for EWF nexus info:
  - policy best practices
  - models
  - tools
- Educates on the importance, drivers, challenges, and opportunities associated with the EWF nexus





Rapid urbanization endangers the supply of water and sanitation systems, energy, food and land

The Urban Nexus concept is a guiding framework for implementing global development agendas at the local level

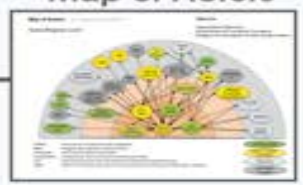
Create opportunities to shift from a linear economy to ***circular economy*** by capturing resources in energy and mass flow cycles

Circular Economy

Urban Nexus Wheel

Promote ***cross-sectoral infrastructure*** to manage the ***synergies and trade-offs*** of water, energy, food and land

Map of Actors



Strengthen institutions and ***collaborative governance***, and ***build capacities*** for integrated planning and management

Case 1: Naga City, Philippines
BISCAST Climate Change Resilient Pilot Housing

Challenges
- Natural hazards: typhoons, flooding, landslides and earthquakes
- Lack of affordable housing for low-income groups

Solutions
- Housing designed to withstand major hazards
- Low-cost technologies
- Climate-adaptive and energy efficient devices

Results
- CCRPH is half as expensive as conventional social housing
- 30% less waste material and wastewater generated on site
- 25% less electricity consumed
- Water conservation via rainwater harvesting
- Treated wastewater used as fertilizer for gardening

Case 2: Korat, Thailand
Efficient Water Supply Pumping Systems

Challenges
- Rapid population growth increasing demand for water
- Supplying water requires large amount of electricity
- 35-45% leakage in network results in wasted water and energy

Solutions
- Build capacity of technical officers to maintain system efficiency
- Old and inefficient pumps replaced with energy efficient equipment
- Repair leakage in water provision system

Results
- Practitioners learned to reduce water losses, save energy and lower costs
- Systematic operation and maintenance process introduced to manage pumps
- 30% reduction in electricity consumption

Case 3: Da Nang, Viet Nam
Innovative Wastewater Management

Challenges
- Rising pressure on infrastructure due to urban growth and increasing population
- Inadequate sanitation services
- Inefficient wastewater treatment
- Methane emissions from treatment plants
- Soil and groundwater contamination due to leaking household septic tanks

Solutions
- Vacuum wastewater collection system
- Wastewater treatment that produces biogas and fertilizer
- Compulsory sewer line connection regulation

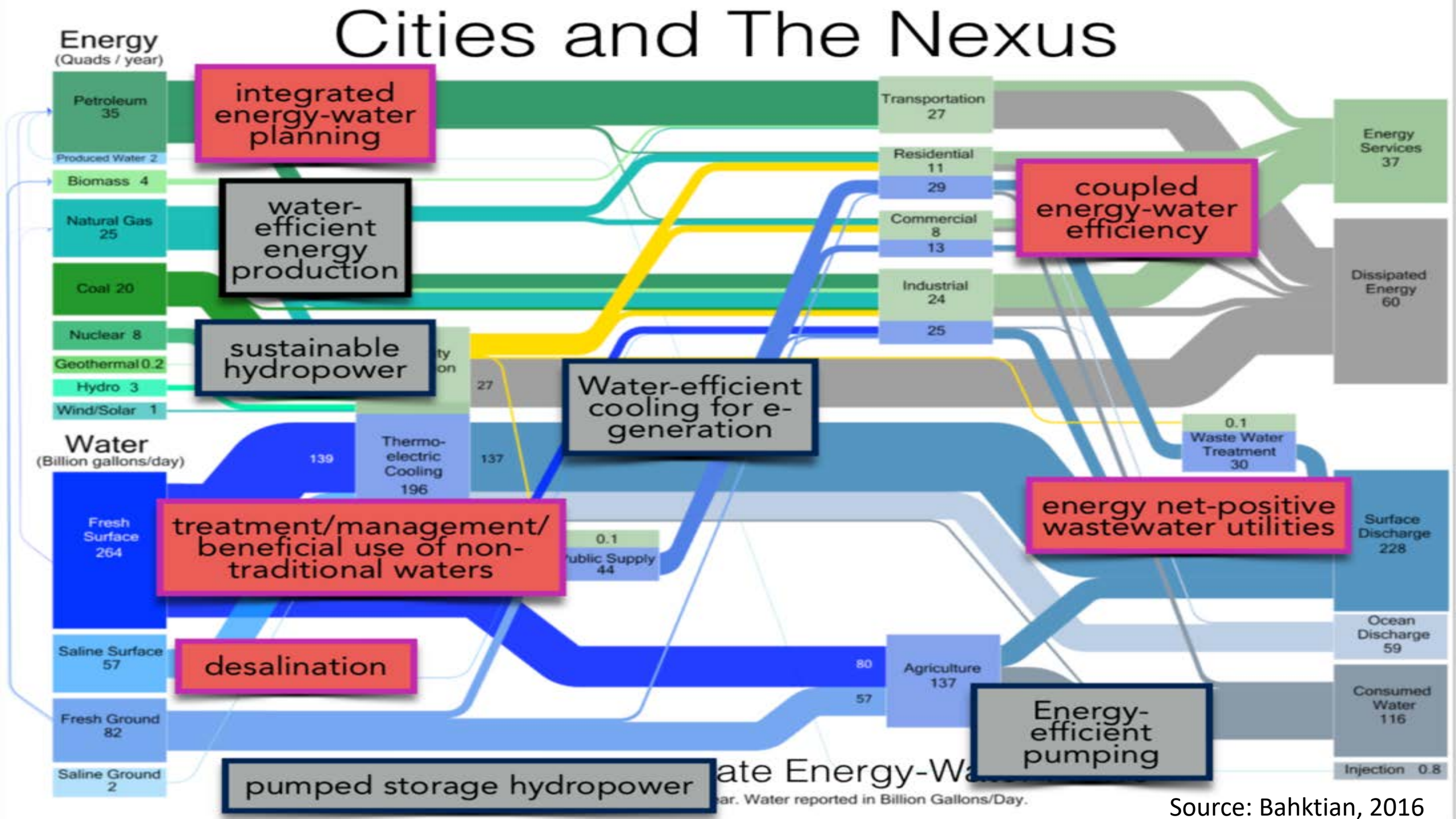
Results
- Improved sanitation resulting in better environment and health
- Sludge and organic waste from households and restaurants used to produce energy
- Production of fertilizer with agricultural residues
- Reuse wastewater to irrigate urban agriculture and green spaces

The Urban Nexus Wheel examines 5 enabling factors to consider when applying the urban nexus approach

5 Enabling factors
- **Governance**: collaboration and principle of subsidiarity
- **Science, Technology & Innovation**: data, cross-sectoral infrastructure and integration
- **Urban Planning**: integrative spatial and land-use planning
- **Finance & Business**: institutional capacity building and alternative financing mechanisms
- **Inclusive Decision-making**: participatory planning, equity and gender mainstreaming

Source: UNESCAP, 2019

Cities and The Nexus



Source: Bahktian, 2016

ASEAN Key challenges – Recent Aug 2021 Headlines

Research Suggests Rapid Urbanization Increases Flood Risk Worldwide

- New research suggests that rapid urbanization and migration are increasing the number of people exposed to floods worldwide. The researchers found **that between 2000 and 2015, the number of people living in flood-prone areas worldwide increased from 58 million to 86 million**. The authors hypothesized that the **development of cities in risky areas with large river basins and large population growth amplified the vulnerability of populations to floods, noting that megacities in Southeast and South Asia, such as Dhaka, were the most exposed to major flooding events.**

Lockdown in Metro Manila As Thousands Rush for Vaccine

- Last week, the Philippine government placed Metro Manila, an urban sprawl of 16 cities and home to **13 million people, under lockdown hours after thousands of residents rushed to vaccination sites**. The near-stampede of residents flocking to vaccination sites also led authorities to shut certain vaccination centers. While the government says they will **provide low-income families and individuals approximately $20-$80 during lockdown, out-of-work residents fear they still lack sufficient means to buy food and other essential items.**

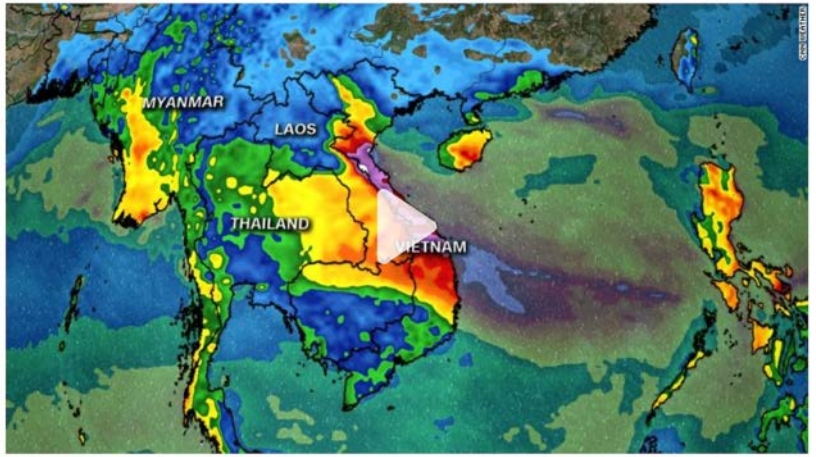
Indonesia blackout: Huge outage hits Jakarta and surrounding area

5 August 2019

Typhoon Molave makes landfall in Vietn aftermath of deadly floods

By Michael Guy, CNN

Updated 4:25 AM ET, Wed October 28, 2020



Vietnam braces for more flooding rain 01:20

(CNN) — Typhoon Molave made landfall just south of the Vietnamese resort city Da Nang on Wednesday, lashing the coast with powerful rains and winds, and inflicting further misery on an

ASEAN Smart Cities Project Themes & Insights: Case of Singapore as a Pioneer and Location of Key Issues

Beyond the immediate health crisis, technology has the potential to offer new opportunities and overcome economic and socio-economic challenges

Singapore is focused on the use of technology to transform in the core areas of Economy, Government and Society:

DIGITAL ECONOMY

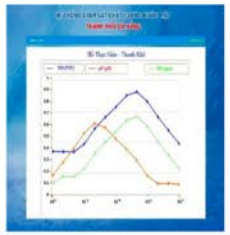
Digitalise industries to increase business efficacy and create new job opportunities.

DIGITAL GOVERNMENT

Provide integrated and seamless Government services and use tech to transform policy-making and operations.

DIGITAL SOCIETY

Citizens have access to technology and use them confidently and effectively.



- Development of the system of databases
- Smart water management system
- Developing the Integrated service Platform for environment monitoring and public disclosure of figures on mobile apps

1

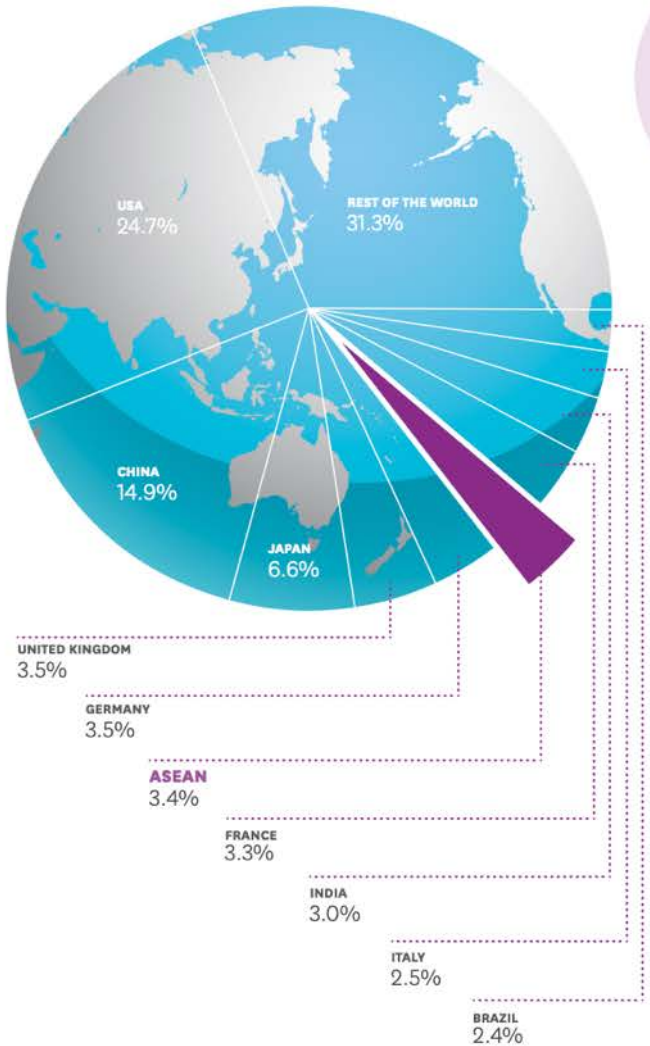
"**Singapore is an impossible city:** we have no energy, no water and no food within a very small area of sight more than 700 sq km. We have solved our water issues, we closed the loop by the 4 water taps (desalination, water catchment, new water and water from Malaysia). We are on the way to solve our food shortage (by diversifying our import sources from more than 140 countries and working towards self sufficiency of 30% of our food demand) . We have not cracked the energy issues yet if we are truly to be zero carbon. Working towards it. I can't remember the detailed data but they are available at our websites."

Our latest initiative by the Singapore government, is the Singapore Green Plan (SGP) 2030, in which there are five pillars that span across varied challenges faced and our committed approaches. www.greenplan.gov.sg

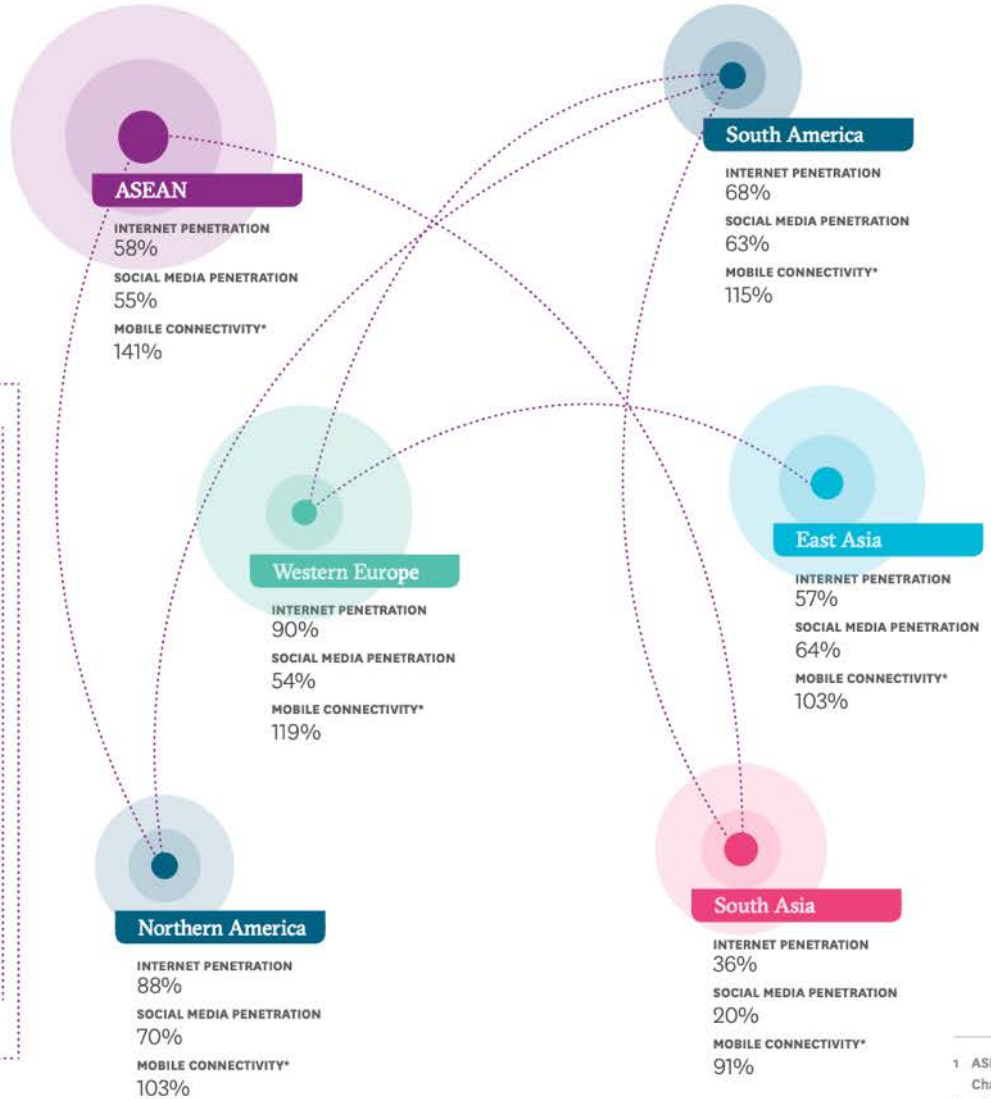
- **Ong Eng Kian, Director, Centre for Liveable Cities, Ministry of National Development, Singapore**

ASEAN in statistics

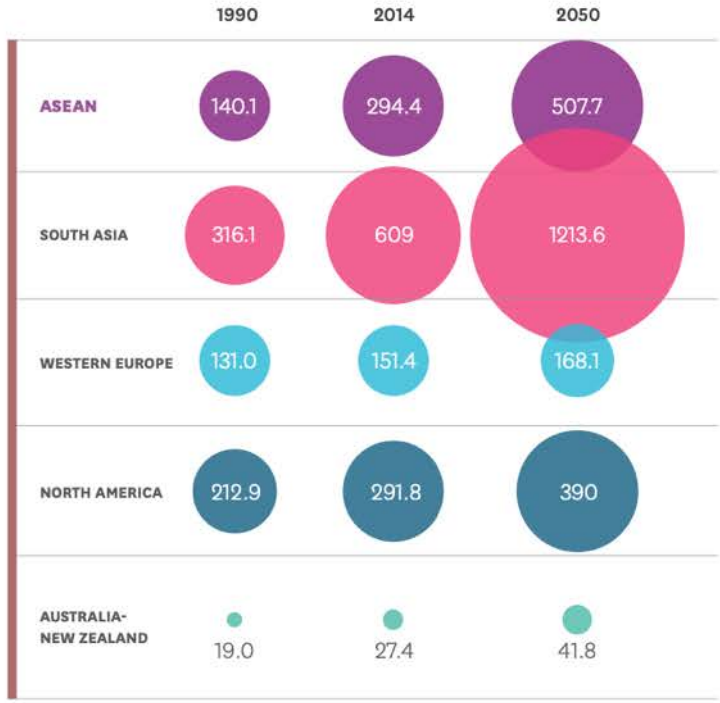
Share of the World's GDP[1]



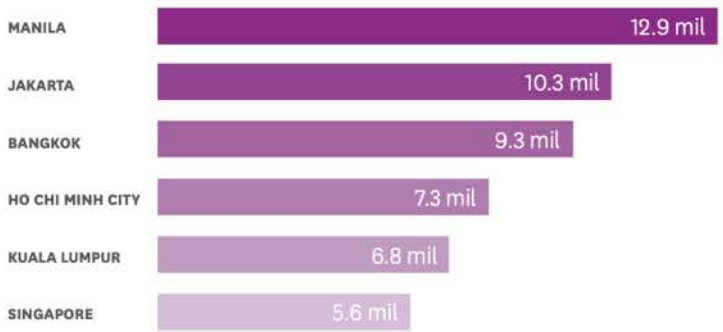
Digital Connectivity[2]



Urban Population (millions)[3]



ASEAN Cities (metropolitans) Larger than 5 Million[4]



1 ASEAN Secretariat, "ASEAN Economic Community Chartbook 2017".
2 ASEAN[up], "Southeast Asia, digital, social and mobile 2018", aseanup.com/southeast-asia-digital-social-mobile/
3 United Nations, "World Urbanization Prospects", 2014.
4 ASEAN[up], "Top Cities and Urbanization in ASEAN", aseanup.com/infographic-top-cities-urbanization-asean/
* not unique users

Most Asian cities do not have effective wastewater treatment systems.

Myanmar

GDP (MILLIONS OF US$) [1]
69,322

GDP PER CAPITA (US$) [1]
1,298

MEDIAN AGE [2]
27.9

% IMPROVED SANITATION FACILITIES [3] *
94

% IMPROVED DRINKING WATER SOURCE [3] *
86

INTERNET SUBSCRIBERS PER 100 PERSONS [3]
21.8

CELLULAR PHONE USERS PER 100 PERSONS [3]
76.7

Viet Nam

GDP (MILLIONS OF US$) [1]
223,864

GDP PER CAPITA (US$) [1]
2,343

MEDIAN AGE [2]
30.4

% IMPROVED SANITATION FACILITIES [3] *
78

% IMPROVED DRINKING WATER SOURCE [3] *
81

INTERNET SUBSCRIBERS PER 100 PERSONS [3]
52.7

CELLULAR PHONE USERS PER 100 PERSONS [3]
130.6

Lao PDR

GDP (MILLIONS OF US$) [1]
16,853

GDP PER CAPITA (US$) [1]
2,457

MEDIAN AGE [2]
21.9

% IMPROVED SANITATION FACILITIES [3] *
71

% IMPROVED DRINKING WATER SOURCE [3] *
76

INTERNET SUBSCRIBERS PER 100 PERSONS [3]
18.2

CELLULAR PHONE USERS PER 100 PERSONS [3]
53.1

Thailand

GDP (MILLIONS OF US$) [1]
455,220

GDP PER CAPITA (US$) [1]
6,593

MEDIAN AGE [2]
38

% IMPROVED SANITATION FACILITIES [3] *
84

% IMPROVED DRINKING WATER SOURCE [3] *
93

INTERNET SUBSCRIBERS PER 100 PERSONS [3]
39.3

CELLULAR PHONE USERS PER 100 PERSONS [3]
125.8

ASEAN Urban Population (thousands) [4]

	2014		2050	
BRUNEI DARUSSALAM	335	77%	458	84%
CAMBODIA	3,161	21%	8,167	36%
INDONESIA	133,999	53%	227,770	71%
LAO PDR	2,589	38%	6,435	61%
MALAYSIA	22,342	74%	36,163	86%
MYANMAR	18,023	34%	32,206	55%
PHILIPPINES	44,531	44%	88,381	56%
SINGAPORE	5,517	100%	7,065	100%
THAILAND	33,056	49%	44,335	72%
VIET NAM	30,495	33%	55,739	54%

Philippines

GDP (MILLIONS OF US$) [1]
313,595

GDP PER CAPITA (US$) [1]
2,989

MEDIAN AGE [2]
24.2

% IMPROVED SANITATION FACILITIES [3] *
100

% IMPROVED DRINKING WATER SOURCE [3] *
100

INTERNET SUBSCRIBERS PER 100 PERSONS [3]
40.7

CELLULAR PHONE USERS PER 100 PERSONS [3]
118.1

Cambodia

GDP (MILLIONS OF US$) [1]
22,158

GDP PER CAPITA (US$) [1]
1,384

MEDIAN AGE [2]
23.9

% IMPROVED SANITATION FACILITIES [3] *
62

% IMPROVED DRINKING WATER SOURCE [3] *
59

INTERNET SUBSCRIBERS PER 100 PERSONS [3]
19

CELLULAR PHONE USERS PER 100 PERSONS [3]
133

Malaysia

GDP (MILLIONS OF US$) [1]
314,500

GDP PER CAPITA (US$) [1]
9,944

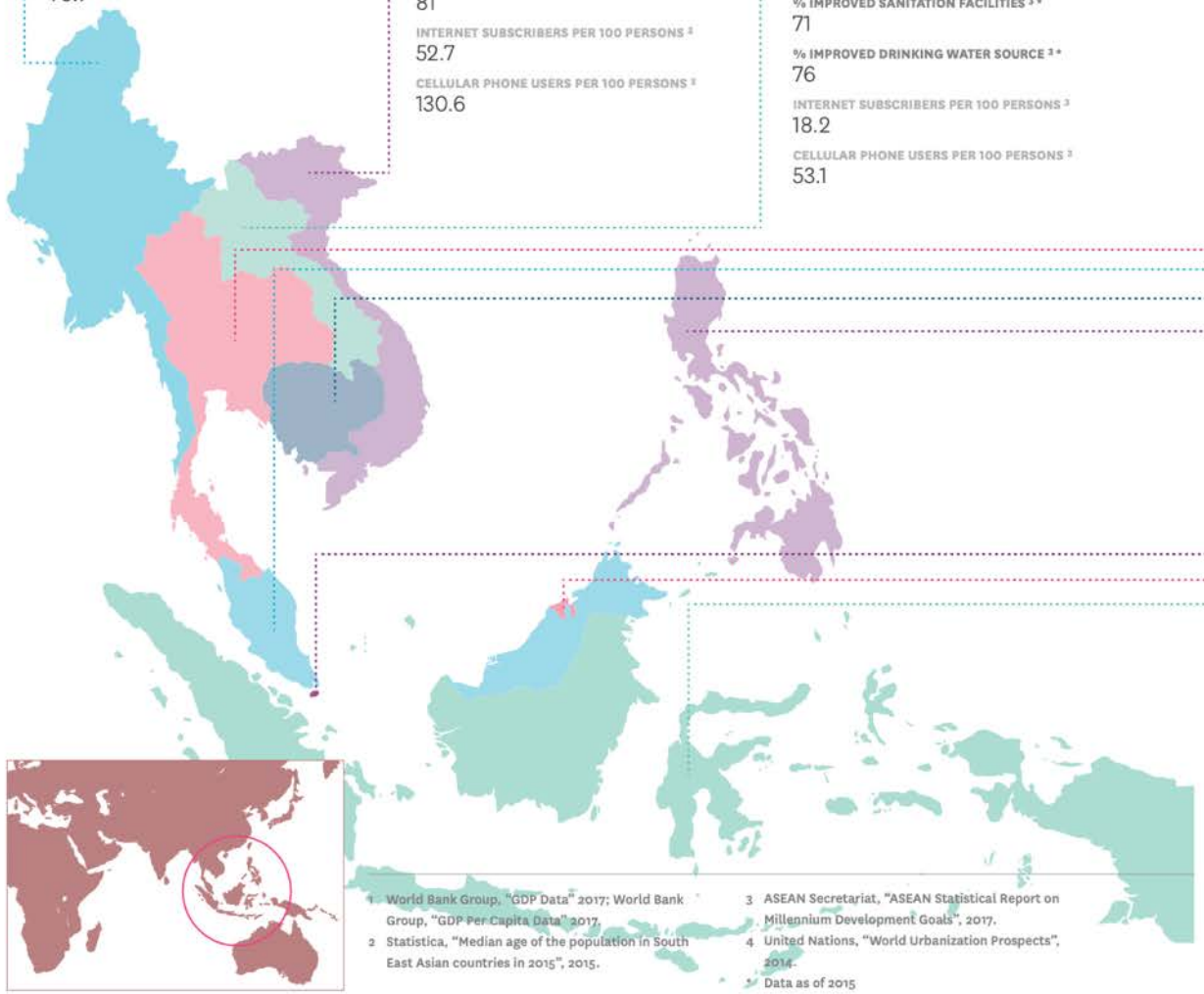
MEDIAN AGE [2]
28.5

% IMPROVED SANITATION FACILITIES [3] *
100

% IMPROVED DRINKING WATER SOURCE [3] *
95

INTERNET SUBSCRIBERS PER 100 PERSONS [3]
71.1

CELLULAR PHONE USERS PER 100 PERSONS [3]
143.9



Indonesia

GDP (MILLIONS OF US$) [1]
1,015,539

GDP PER CAPITA (US$) [1]
3,846

MEDIAN AGE [2]
28.4

% IMPROVED SANITATION FACILITIES [3] *
62

% IMPROVED DRINKING WATER SOURCE [3] *
71

INTERNET SUBSCRIBERS PER 100 PERSONS [3]
22

CELLULAR PHONE USERS PER 100 PERSONS [3]
132.3

Brunei Darussalam

GDP (MILLIONS OF US$) [1]
12,128

GDP PER CAPITA (US$) [1]
28,290

MEDIAN AGE [2]
30.6

% IMPROVED SANITATION FACILITIES [3] *
87

% IMPROVED DRINKING WATER SOURCE [3] *
100

INTERNET SUBSCRIBERS PER 100 PERSONS [3]
68.8

CELLULAR PHONE USERS PER 100 PERSONS [3]
108.1

Singapore

GDP (MILLIONS OF US$) [1]
323,907

GDP PER CAPITA (US$) [1]
57,714

MEDIAN AGE [2]
40

% IMPROVED SANITATION FACILITIES [3] *
100

% IMPROVED DRINKING WATER SOURCE [3] *
97

INTERNET SUBSCRIBERS PER 100 PERSONS [3]
82.1

CELLULAR PHONE USERS PER 100 PERSONS [3]
146.1

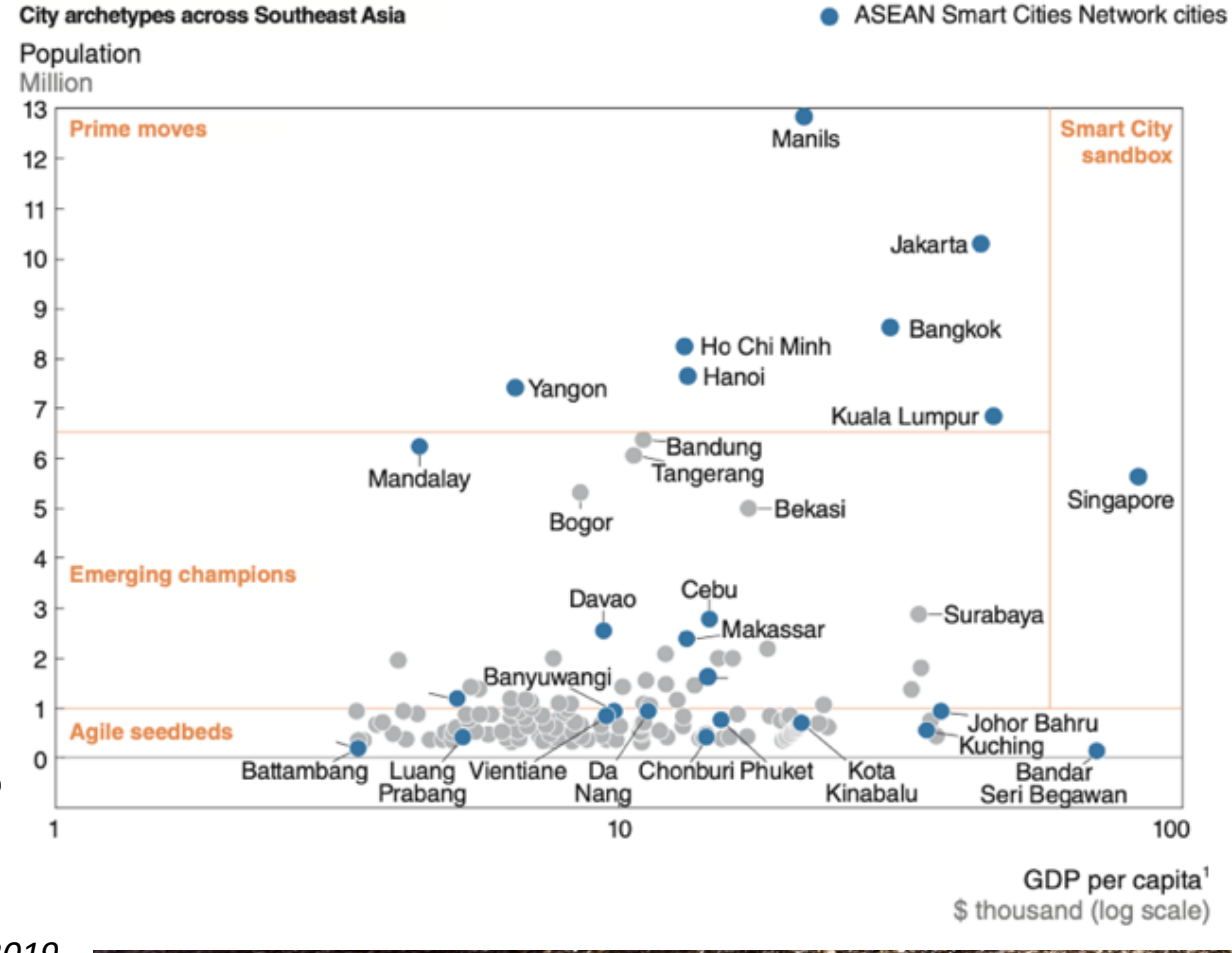
1 World Bank Group, "GDP Data" 2017; World Bank Group, "GDP Per Capita Data" 2017.
2 Statistica, "Median age of the population in South East Asian countries in 2015", 2015.
3 ASEAN Secretariat, "ASEAN Statistical Report on Millennium Development Goals", 2017.
4 United Nations, "World Urbanization Prospects", 2014.
* Data as of 2015

Preliminary Survey Results

- Challenges
- Areas for Impact
- Why

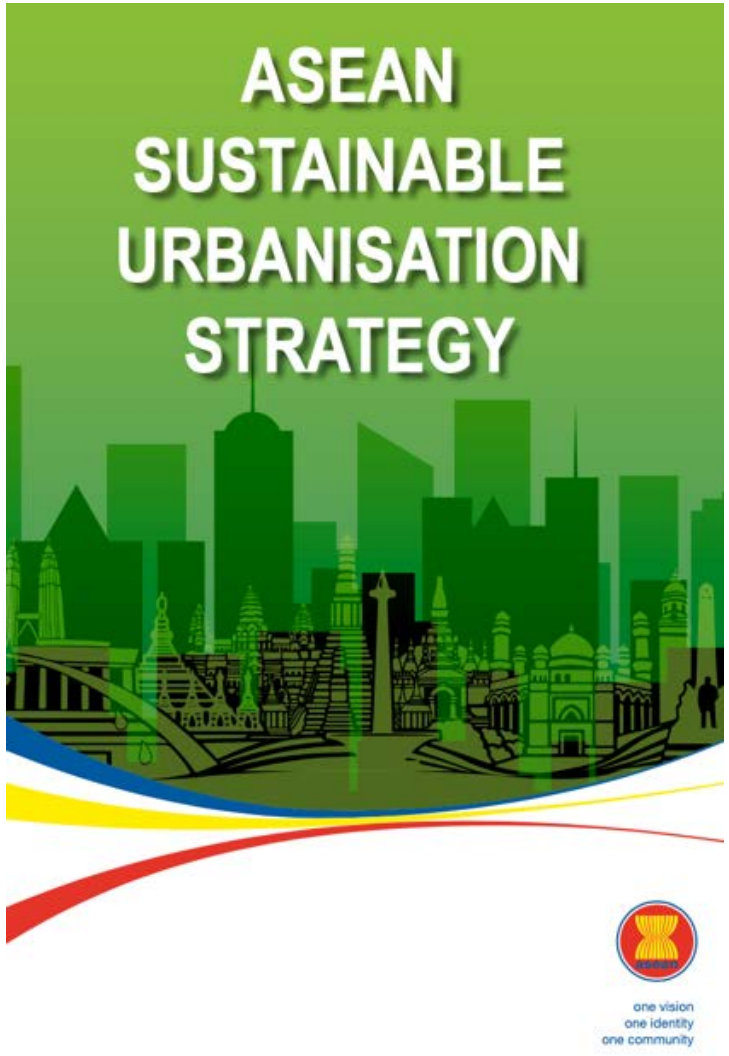
Note: initial assessment of existing surveys, then conducting our own initial IUS survey efforts; next targeted interviews -- focus on selected pilot cities?

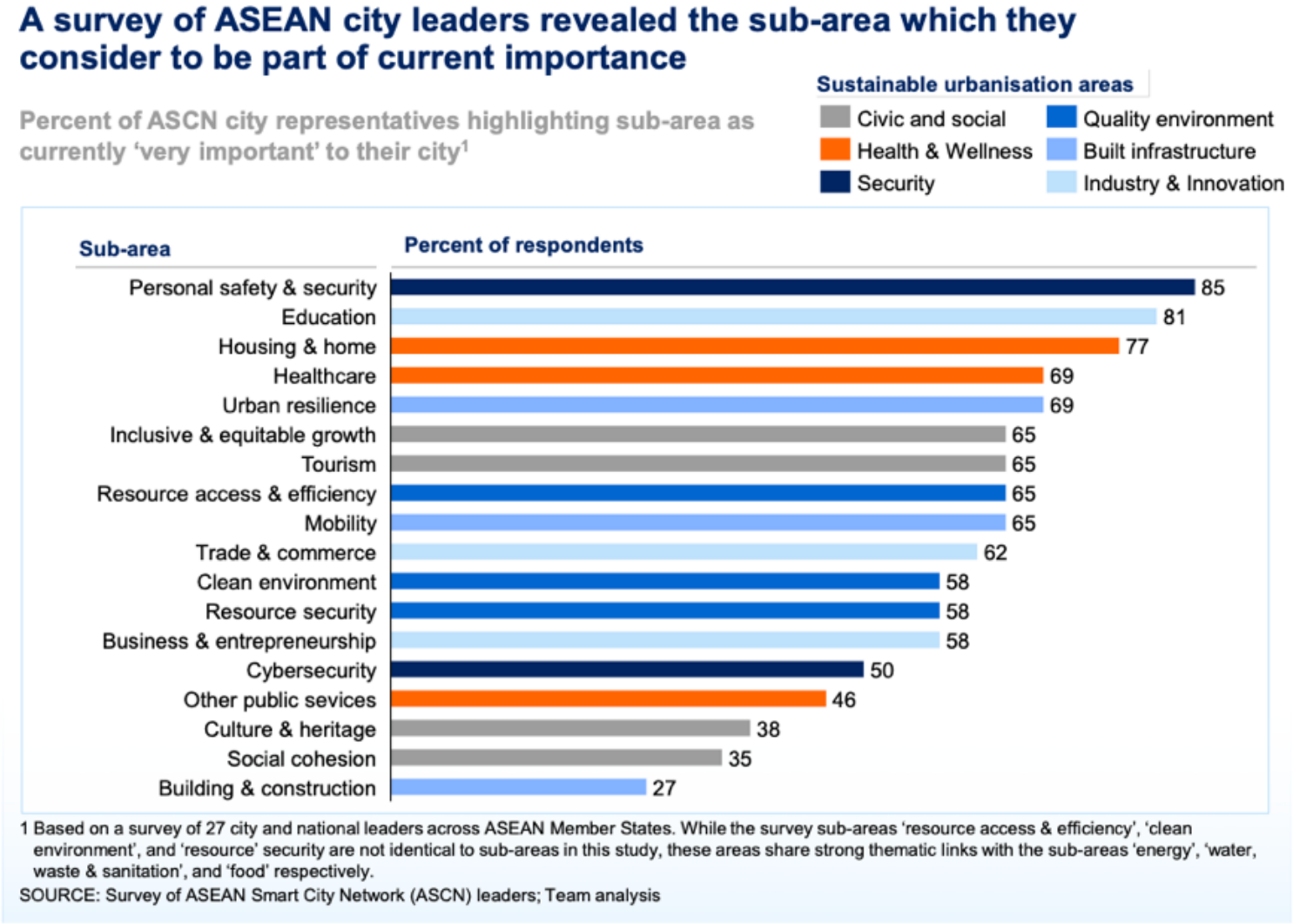
Figure 3. Classification of ASCN cities by population and GDP



Bum Hyun-Lee/KRIHS Special Report, 2019.

IUS-Relevant Survey Priorities: human and resource security, resilience, equity, growth, resource access & efficiency, clean environment





Private-Sector Survey Results

What cross-cutting integrated urban service challenges are you most interested in?

Resource recovery / Leveraging productive waste

E.g., waste to biofuels, wastewater to irrigation or other productive uses

Resilient city planning - energy-food-water nexus interconnection and solutions

Governance and policy – providing community access to public services

Strategies for aligning infrastructure investments to leverage maximum benefits.

Ensuring that informal settlements in cities are adequately addressed

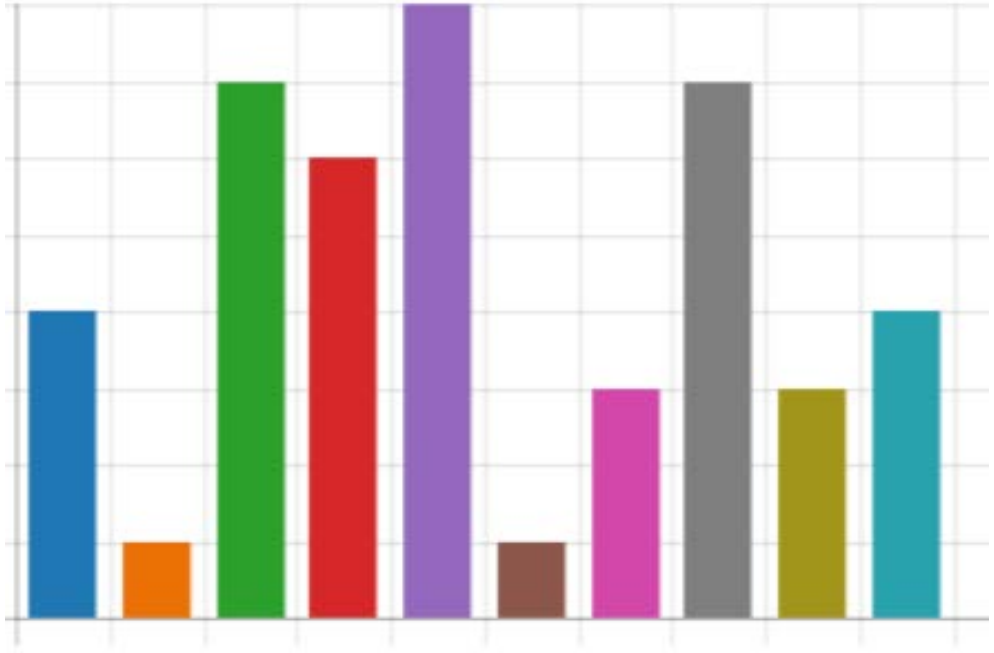
Provision of basic services through integrated utility centers and systems (co-location of wastewater treatment, energy generation, circular resource management (biological and technical waste), and food production)

Nature-based solutions and green infrastructure

Urban and peri-urban water, sanitation and hygiene

What are the biggest challenges to implementing integrated water-energy-food solutions in terms of identifying, designing, and implementing projects, including any barriers related to scaling solutions?

- A) High capital costs
- B) Lower price competitors
- C) Lack of access to finance
- D) Limited information/awareness among city counterpart
- E) Poor regulatory or policy environments
- F) Limited ability to establish sustainable markets or innovative business models
- G) Limited technical capacity among utility or government counterparts
- H) Limited organizational capacity/time among government or utility counterparts
- I) A lack of an inclusive stakeholder engagement process
- J) Challenges with capacity to implement quality operations and maintenance protocols



What are the primary areas where the IUS project could provide technical support to cities in ASEAN?

A) Technology or other solutions (eg: planning, design, data, nature-based solutions, policy and governance structures, etc.) to support city priority needs, including sustainable and low impact strategies for energy and water supply and management (drinking water, stormwater, green water, greywater) and wastewater treatment)

B) Procurement best practices that adhere to international standards for bankability and transparency and that can facilitate engagement of technology, equipment, and service providers in project delivery

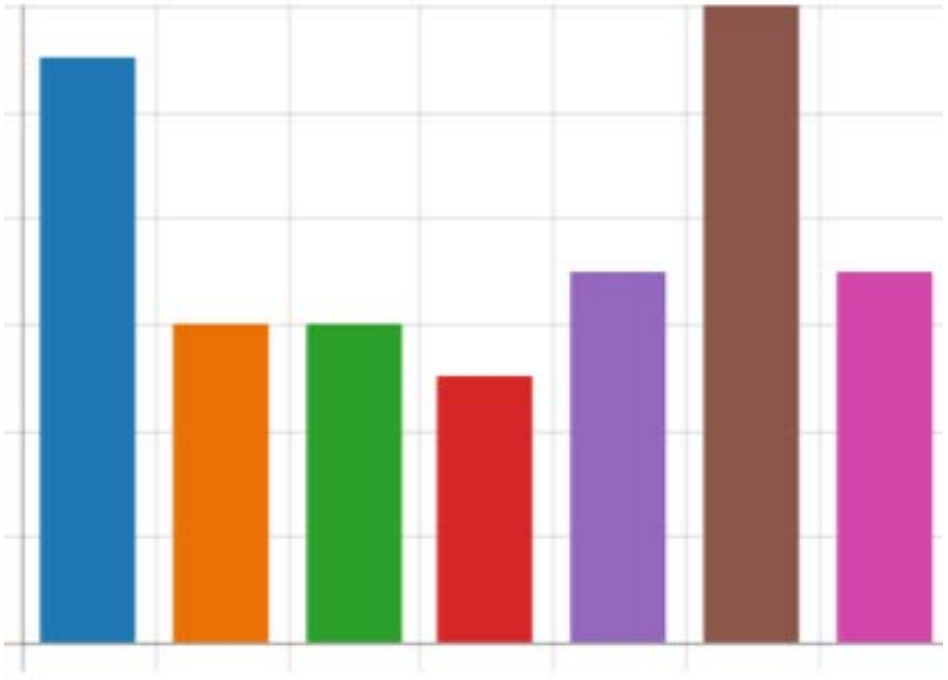
C) Modeling and analysis of selected solutions and process approaches

D) The many codes, standards, and policies that govern water resources as they relate to power generation, ecosystem and water body health, urban agriculture, and competing usage with other sectors

E) Models and visualizations to understand the sustainability impacts and benefits of new codes, policies and technologies on energy-water-food security, affordability, sustainability, reliability, livelihoods, jobs and the economy

F) Analysis and planning to develop integrated multi-sector water, wastewater, food, and energy resource plans to effectively engage and represent the needs and perspectives between urban and rural communities in the region

G) Guidance on using numerous and disparate data sets, including regional climate projections, to make effective decisions



What areas do you think are most valuable for stakeholders in ASEAN to exchange during potential webinars, workshops, etc., that could help advance nexus technologies regionally?

A) Engaging in public-private sector co-design of solutions

B) Sharing lessons learned from pilot projects

C) Jointly developing a business case and procurement toolkit

D) Identifying best practices for procurement and contracting to attract market entry of innovative technologies

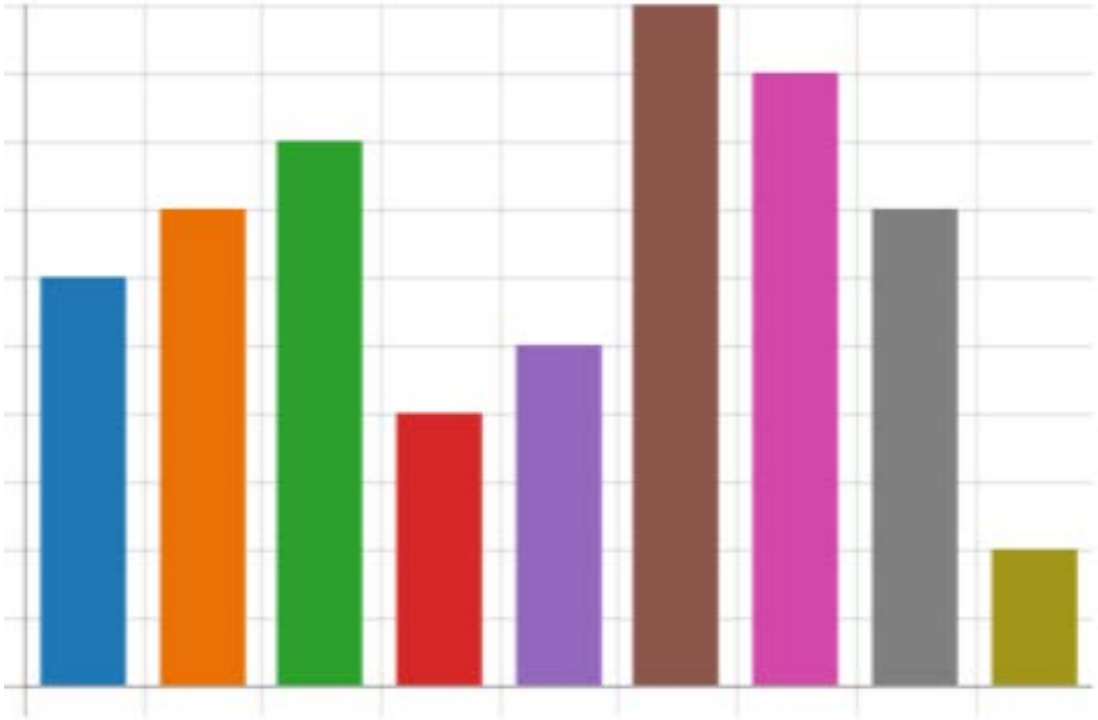
E) Developing approaches for aggregating projects to lower risks and costs

F) Accessing tools for inclusive policy, planning, and project development

G) Identification of renewable energy technologies that integrate across the EWF nexus to support more flexible and cost-effective infrastructure

H) Determining how urban food production & food waste recycling can provide profit centers to offset losses in the wastewater sector

I) Other



IUS Experts Group

American International Group, Inc. (AIG) Valerie Wilson, P.E. Global Senior Technical Advisor – Energy and Oil Rig	**Jacobs** Dr Rick Robinson FBCS CITP FRSA AoU Director – Smart Places, Telecommunications & Digital Infrastructure |Global Technology Leader, Connected, Secure & Smart Cities & Places	**Skidmore, Owings & Merrill** Douglas Voigt, AIA, AICP Partner
Asian Development Bank Elizabeth Jung Urban Development Specialist (Young Professional)	**Japanese Government or Academic** Dr. Yokohari Professor, Graduate School of Engineering, University of Tokyo	**U.S. Agency for International Development** Kevin Nelson Urban Governance Lead Governance Team Center for Democracy, Human Rights and Governance
East Bay Municipal Utility District Alicia R. Chakrabarti, P.E. Manager of Wastewater Environmental Services	**Princeton University** Dr. Anu Ramaswami Sanjay Swani '87 Professor of India Studies Professor of Civil and Environmental Engineering	**US-ASEAN Business Council** Bernard Baskin Director of Development, Sustainability, Energy
ERIA Venkatachalam Anbumozhi Senior Energy Economist | Director of Research Strategy and Innovation	**Regenerative Impact Ventures** Jan David Mueller-Volmer, Lead, Project Structuring & Finance	**U.S. International Development Finance** Corporation (DFC) Geoffrey Tan Managing Director, Asia Pacific
Ernst & Young Representative TBD	**Singapore** Representative TBD	

IUS – Initial Expert Group + CoP Listening Sessions and Continued Stakeholder Engagement

Smart Solutions in the Philippine Setting in the midst of the COVID-19 Pandemic

Department of the Interior and Local Government
National Representative

Third ASEAN Smart Cities Network (ASCN) Annual Meeting
17 July 2020 via video conference

Phase 1:

Engagement

Stakeholder consultations and private sector engagement

Interviews & Listening Sessions

Objectives:

>> Inform the IUS program and regional kickoff workshop

>> Co-design *survey of ASEAN-focused firms and universities as to potential contribution to project*, and dialogues that will *engage private-public-research-entrepreneurial sectors*

>> *A*ssess interests, perceptions, barriers to investment and implementation of technologies and equipment to support EWF pilot projects

Key Points, Takeaways, and Expert Inputs/Questions from Interviews

7 Initial Sessions with technical institutes, private sector, government partners

- Note: synthesis does not identify individuals/orgs (Chatham House Rules)

High-level expert analysis:

- **Enablers**: starting with need, relevance, efficiencies, strong leadership, public-pvt partnerships, moving from conceptual to testing/learning in real-world, scenarios, biz model planning, data
- **Barriers**: finance, institutional capacity, policy/regs, corruption, siloes, no defined outcomes or monitoring/upgrading over time, treatment requirements, sophistication/simplicity levels
- **Leading country cases**: Singapore, Vietnam, Cambodia, Philippines,

Quotes

"Decentralized is much more cost effective - energy efficient and cost-efficient"

"Energy, water, food, education, health are all critical; a lot of mobility and access interest too"

Questions

US vs. local/regional teams from pvt sector? Scale? Right partners? Retrofit v. new development?

Will selecting two cities in same country be more impactful? Or explore for different regs/policy?

Plans to Address and Explore Further in Year 1

- Workshops/webinars, learning from down-selected cities to address enablers/ barriers in specific contexts; and institutional mapping of key actors

- Presentations, webinars, and visuals to catalyze further learning, dialogue, and concept understanding of the potential for/demonstration of integrated urban services for efficient resource recovery / reuse.

- Advance IUS key findings, priorities to recommend next steps for project delivery/business model planning.

From 2020 Thailand Presentation at 3rd ASEAN Smart Cities Network Annual Meeting (virtual)

More Smart City Action Plan Review, Updates, Emerging Challenges – Examples: Battambang, Cambodia to Luang Prabang Laos

BATTAMBANG

STATUS OF THE SELECTED FOCUS AREAS

Focus Areas

1. Civic and Social; 2. Quality Environment, 3. Built Infrastructure

Project 1
Urban Street and Public Space Management

Project 2
Solid and Liquid Waste Management

Challenges

Challenges to Implementation

- The absence of the national framework for smart cities development, and therefore there is no national budget allocated for specific smart cities projects.
- A lack of resources for smart cities development.

Support and Partnerships Required

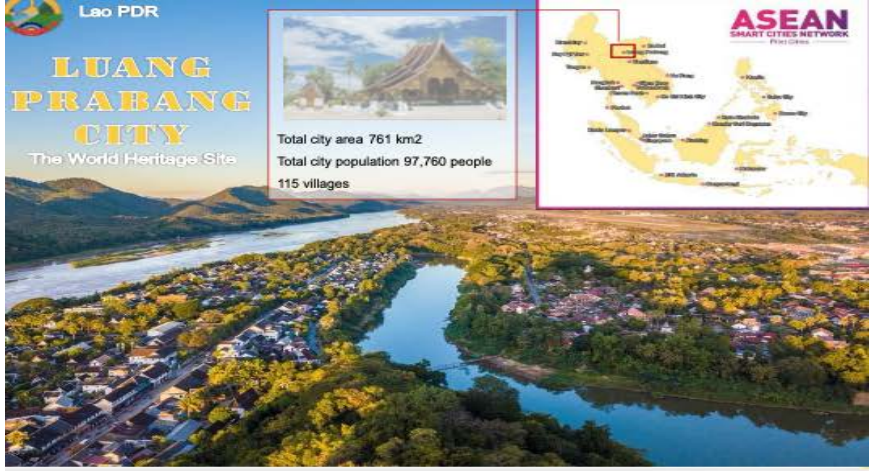
- Local authorities and local development partners
- Discussing financial and technical supports from ASEAN-AUSTRALIA SMART CITIES TRUST FUND through ADB
- Ministry of Public Work and Transport is an implement agency.
- Development partners, such as ADB, KEI

Challenges to Implementation

- Budget constraints
- Economic development of city

Support and Partnerships Required

- Central government's support
- Private investors' interests
- Private banks for mortgage



Smart City Project 1: Restoration of wetlands for green spaces and habitats

Smart City Project 1: Restoration of wetlands for green spaces and habitats

Progress of the Project

There are more than 100 small wetlands located within the boundary of world heritage site of Luang Prabang. These wetlands are considered as a part of the heritage site's values that need to be preserved alongside with the world heritage properties.

- Some pilot projects of wetlands preservation have been implemented alongside with wastewater treatment, drainage construction, and public awareness in past years, but due to budget limited, so not yet covered all areas

Challenges to Implementation

The specific challenges being faced in implementing the project:

- Most of the projects are implemented independently with limited costs.
- The issues occurring with the wetlands are related to all social, economic and environmental aspects

Support and Partnerships Required

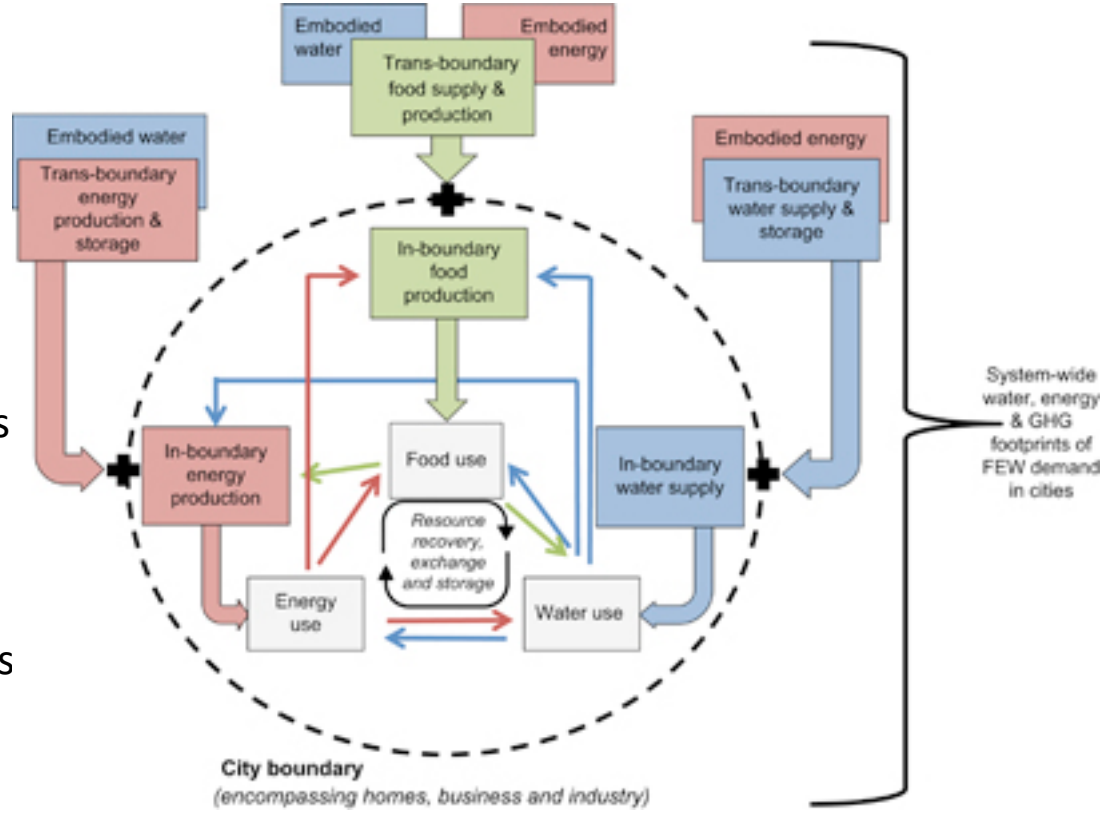
Key support and partnerships required:

- External support
- Technical assistance

Key Questions Ahead

The Food-Energy-Water Nexus
16th National Conference and Global Forum on Science, Policy and the Environment
January 19-21, 2016
Hyatt Regency Crystal City at the Washington, DC National Airport

- How to move from the **FEW nexus** (conceptually) to ***MANY*** Sustainable, Smart Cities:
  - **What are key inputs** to Address Risks, Interdependencies, Priorities?
  - **How to take action** by generating new access to finance, institutional capacity, market-based solutions for people / infrastructure services at the food-energy-water nexus?
  - **Where is best entry point to nexus innovation** in your city? Is it emerging tech, policy, or change in human behaviors? Or perhaps business models that include some of each of these pathways?
  - **How best to utilize or co-create new nexus, urban resilience, or integrated urban service design principles** that lead to desirable outcomes: e.g. energy-water savings, cost savings, GHG emissions reduction, new jobs/livelihoods, and/or higher quality of life?
  - What scales and boundaries should be considered by cities in their pilot city applications?



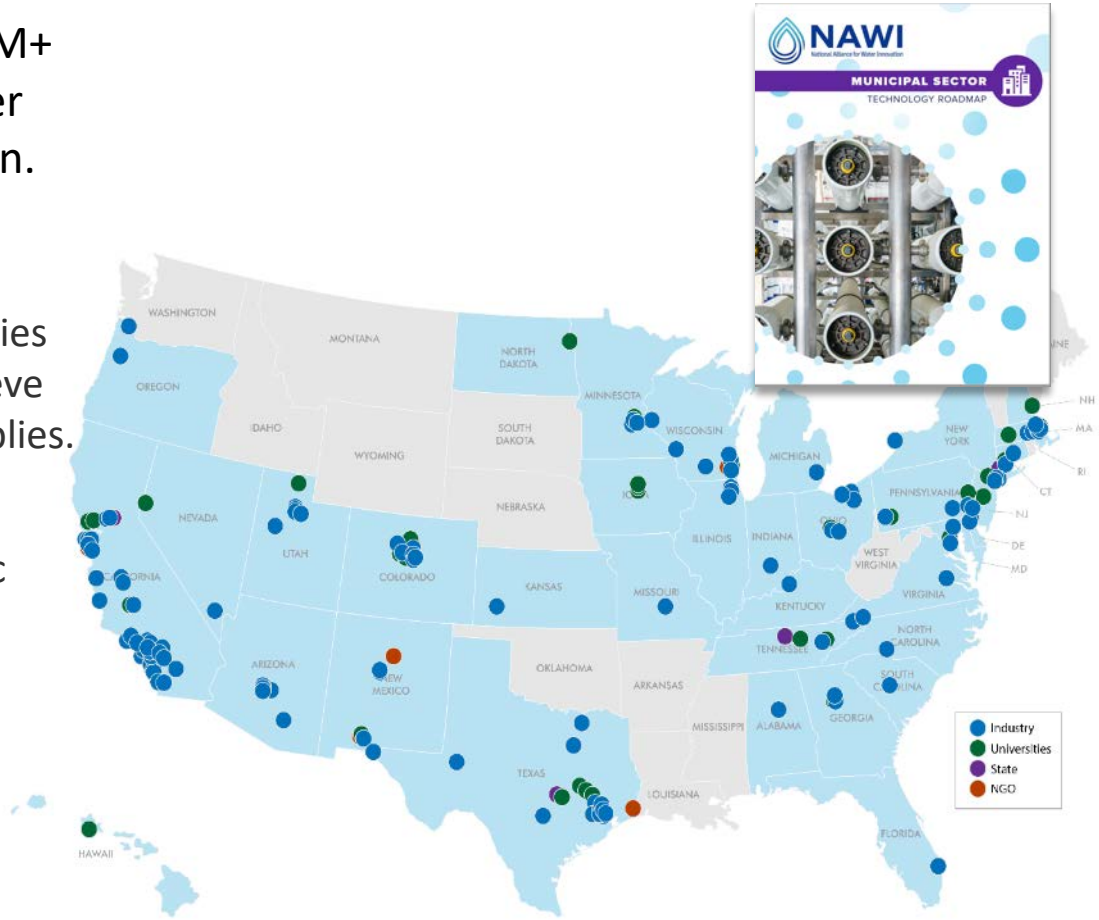
Source: Ramaswami et al, 2018

An Opportunity for Sharing: National Alliance for Water Innovation (NAWI) -- Water Security Research

NAWI is led by three US national labs as a 5-year, $110M+ DOE investment in early-stage applied research to lower cost and energy of water security, including desalination.

The NAWI partnership will:

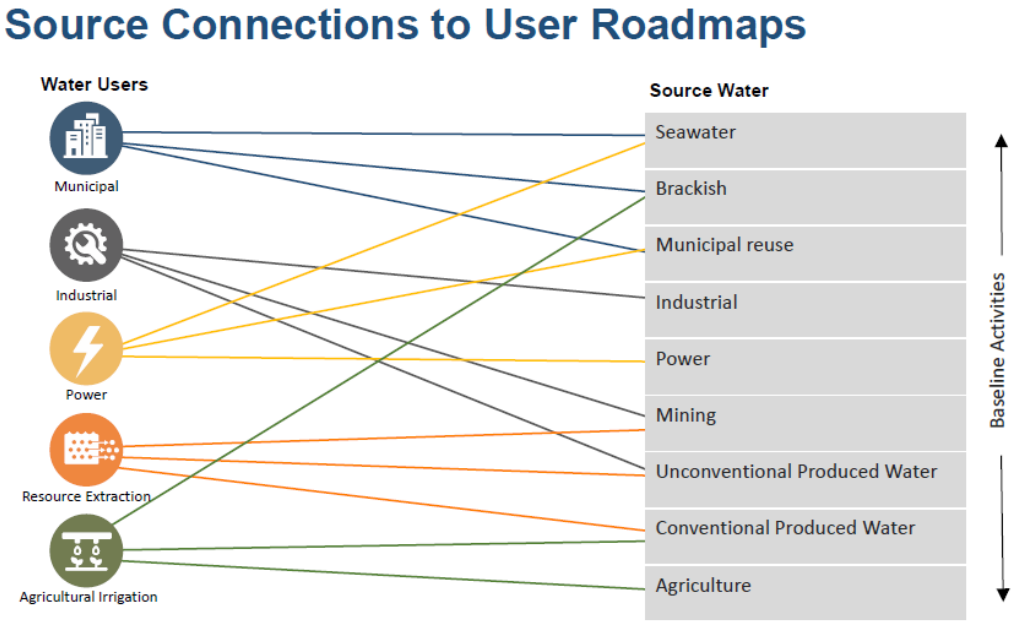
- Develop next-generation water /desalination technologies to enable 90% of non-traditional water sources to achieve “pipe-parity” and secure reliable, affordable water supplies.
- NREL has multiple leadership roles in this initiative, including leading the Data, Modeling, and Analysis topic area that conducted NAWI’s Roadmapping efforts.

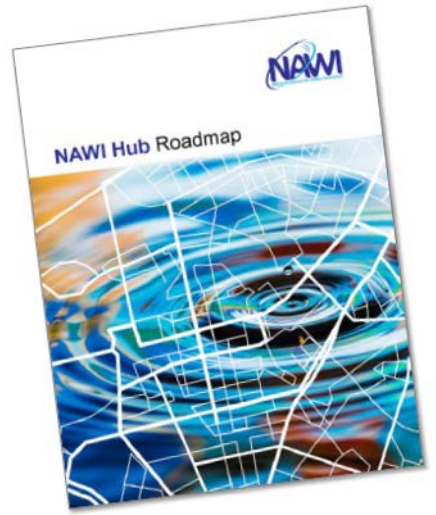


www.nawihub.org: Securing a Resilient National Water Supply for the 21st Century

Moving From Vision to Reality: Roadmaps and NREL Nexus Case Studies Library

- NAWI – municipal, seawater, industrial, agricultural source waters/ end uses with on-site renewable energy, waste en*ergy capture, and efficient/ advanced treatment*
- *Municipal reuse:*
  - *4 initial case studies*





WATER SECURITY GRAND CHALLENGE

Abundance Through Innovation

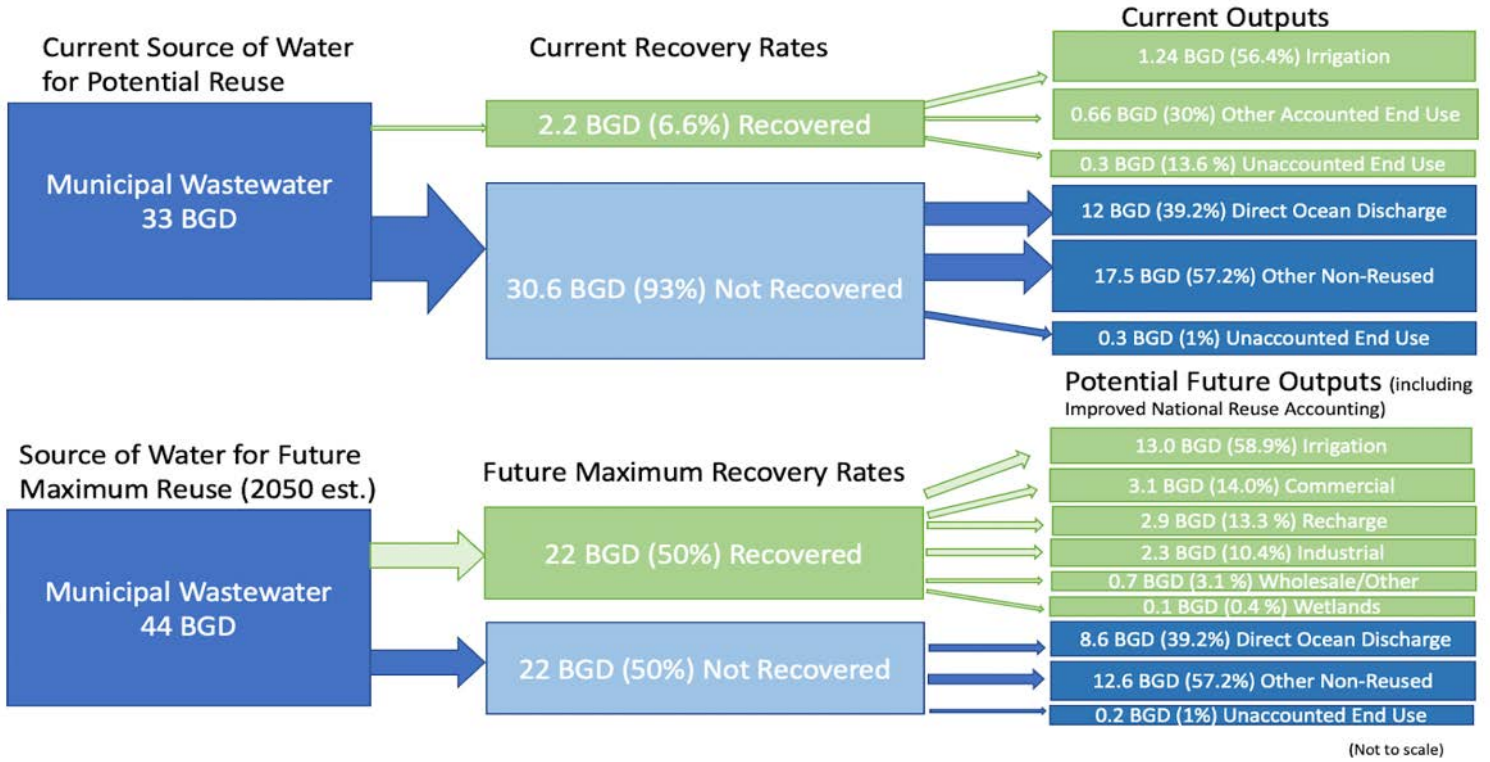
Water Security Grand Challenge

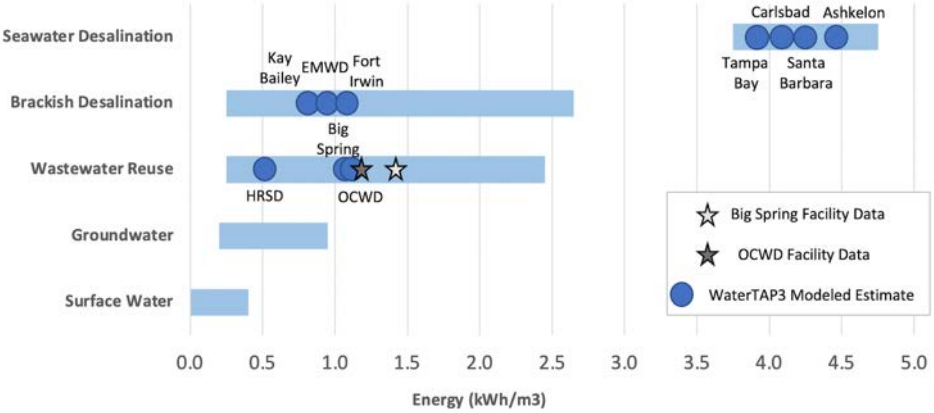
The Grand Challenge has set the following five goals for the United States to reach by 2030 - Goals:

1: Launch desalination technologies and deliver cost-competitive clean water
#2: Transform energy sector's produced water from waste to resource
#3: Achieve near-zero water impact for new thermoelectric power plants, significantly lower freshwater use intensity for existing fleet
#4: Double resource recovery from municipal wastewater
#5: Develop small, modular energy-water systems for urban, rural, tribal, national security, disaster response settings

NAWI Potential:

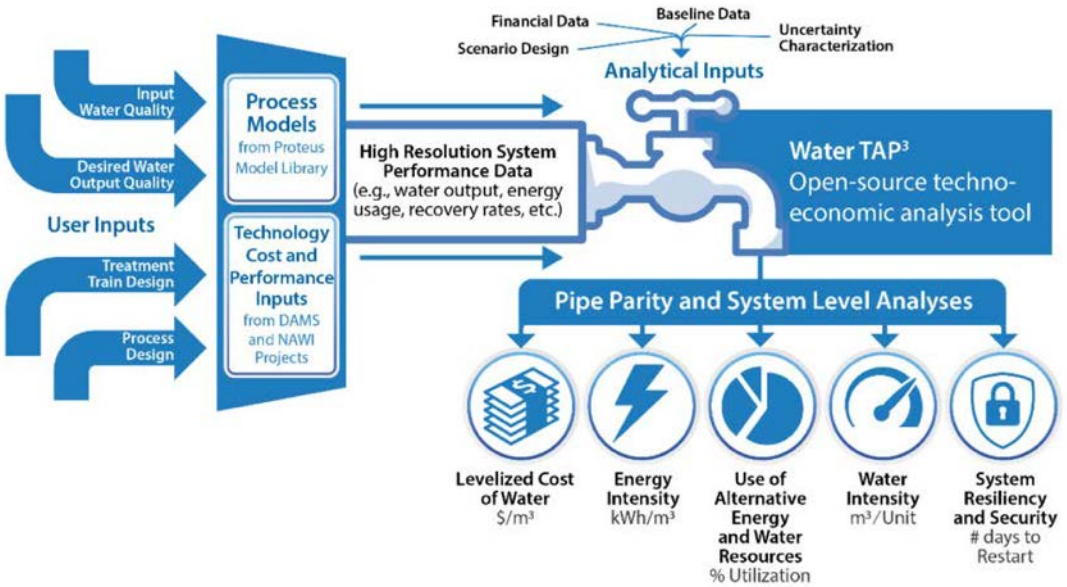
- Advancing treatment technology and reducing energy, GHG, and costs for alternative sources of water treatment for ensuring secure supplies





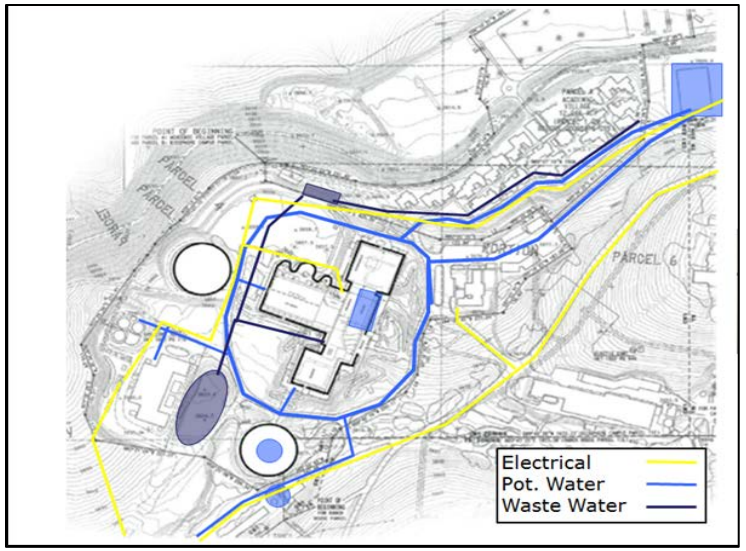
Water Techno-economic Analysis Pipe Parity Platform (Water-TAP^3)

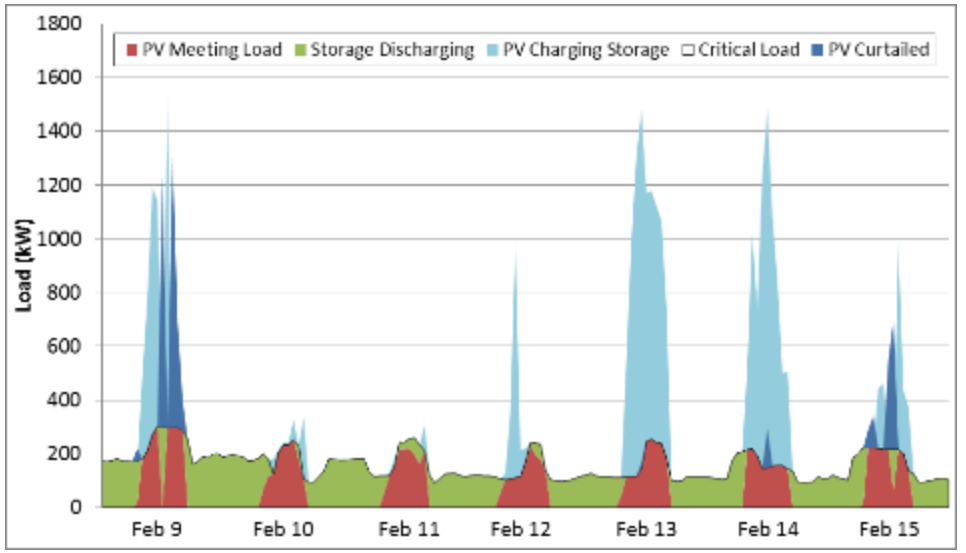
Water-TAP^3 will be an analytically robust platform for evaluating water technology cost, energy and environmental trade-offs across water sources, sectors, and scales.



Biosphere 2/University of Arizona

- Off-grid, distributed energy & water systems, such as microgrids, provide greater diversification
- Continued access to power & water
- Flexibility in operations
- Reduced peak demand costs/ water system grid services





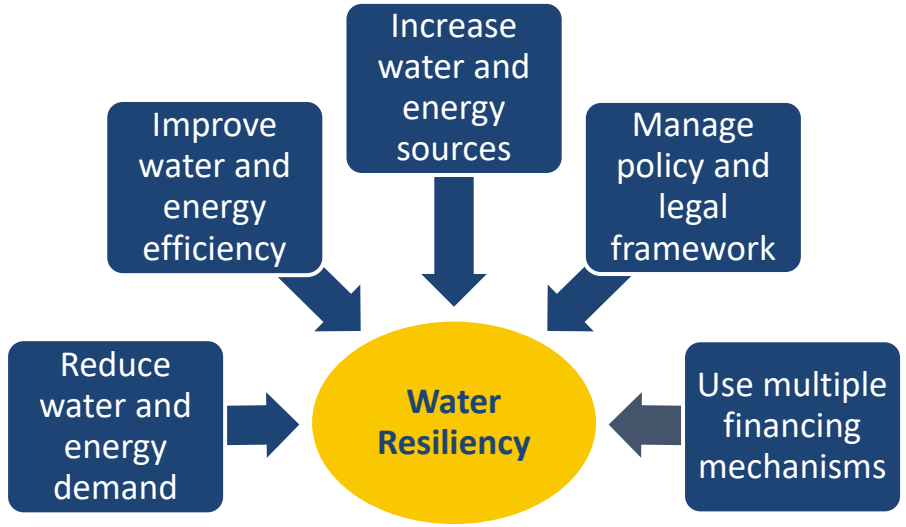
PV and Storage Sustain Critical Load in 100% RE microgrid

Financing Strategies & Economic Models

Example: Department of the Navy Energy Water Project

Improve Water Security in the SW

- Evaluated Water Costs and Consumption
- Identified High Water Risk Installations
- Prioritized ~240 WEN Project Opportunities
- Defined WEN Alternative Financing Models
- Now Supporting WEN Project Execution



NAWS China Lake: WEN Microgrid

Install new pumps, controls and PV to reduce waterline breaks, power water wells, optimized energy system

Camp Pendleton: Water Reuse

Upcycle reclaimed water and cost effectively preserve primary groundwater sources to support long-term continuity of mission

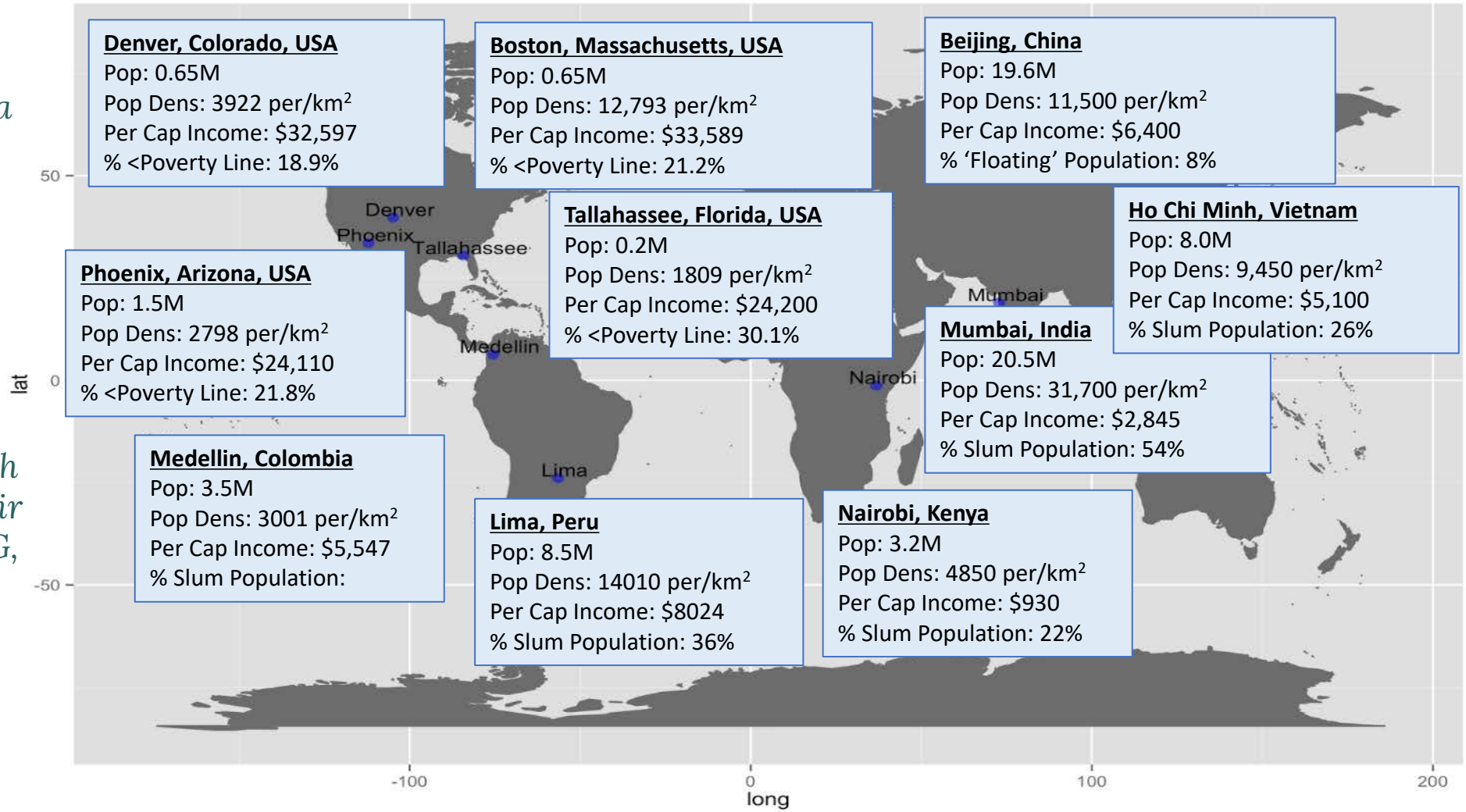
Global Methods and Tools for Equitable AND Sustainable CITIES

Comparative assessment/implications for cross-sector infrastructure systems and policies that integrate / reduce risk for diverse populations

- Boston
- Denver
- Lima
- Medellin
- Ho Chi Minh
- Mumbai
- Nairobi
- Phoenix
- Tallahassee
- Beijing

D. Boyer, S. Brodie, E. Stokes, A. Zomer, J. Sperling. 2015. *Implementing the Urban Sustainable Development Goal in Atlanta and Delhi. UGEC Viewpoints.*

Initial indicators: Land Consumption vs. Pop. Growth Rate, Waste, Air Pollution, GHG, Resource Recovery



Key Concluding Questions:

- *Who collects city data to inform goals, targets, & decisions?*
- *How well do indicators capture (smart and sustainable) city goals?*
- *Challenges & opportunities of universal SDG indicators – tensions of universal vs. locally appropriate implementations*

Closing Question, if time after polling:

- What can we do to catalyze feedback /input from the region?
- Case studies UNESCAP:
  - **Naga, Philippines**: Partnership of Sectors and Levels of Local Govt; Low-Cost, Climate-Adaptive, Efficient Tech Integration; Wastewater into Renewable Energy
  - **Pekanbaru, Indonesia** – Profit-generating solid waste to energy (methane gas collection and energy generation) that feeds electricity into the grid
  - **Da Nang, Vietnam** – Wastewater treatment producing biogas & fertilizer

  - Any Da Nang representative? Any outcomes from Urban Nexus nexus project? Asian Cities Climate Change Resilience Network? 100 Resilient Cities? USASCP?
  - Any other cities willing to share recent experiences, barriers, what was learned?
  - Does anyone have experience in ASEAN - key opportunities they'd like to share?

Summary

The IUS program fosters green and healthy recovery through sustainable practices that support both economic growth and long-term climate goals (as per East Asia Summit Leaders' Statement on Sustainable And Green Recovery 2021).

Nature-based solutions

Low carbon energy

Low carbon Water and food production

Circular economy approaches

Summary

Mobilizing government, the private sector, international organizations, and other stakeholders is encouraged to support smart cities development towards accelerating equitable, inclusive and sustainable growth.

- *As per East Asia Summit Leaders' Statement on Sustainable And Green Recovery 2021*

Summary

The IUS program aims to advance local climate, health and well-being goals through innovation, resource efficiency and partnerships.

Improving delivery of critical urban services helps mitigate greenhouse gas emissions and strengthens urban resiliency.

Pilot Projects: Next Steps

Application Opens
31st August 2021

Application will follow this workshop

Pilot City Webinar
September (TBD)

Join to ask questions about the application and selection process

Application Deadline
25th October 2021

Reach out for help as needed for your application

How to Get Started?

Establish your city's project team and designated pilot city representative

Lookout for an email with application instructions

Contact the IUS team (parthiv.kurup@nrel.gov) with questions

Thank You!

- We will be distributing slides and a recording of the workshop after the event – along with information on the pilot city application process
- Please contact us if you would like to join our Community of Practice
- Please provide your feedback in our post-event survey

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Integrated Urban Services for US-ASEAN Smart Cities

Thank You

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