



U20

RIYADH 2020
URBAN

Efficiency and Diversification:

A Framework for
Sustainably Transitioning to
a Carbon-neutral Economy



Circular, Carbon-neutral Economy

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List of Definitions and Acronyms

Energy Efficiency – A measure of the amount of work that can be done per unit of energy by an appliance, industrial mechanism, vehicle, building, etc. Efficiency can be improved by reducing the amount of waste heat produced, amount of energy needed for a specific process, or the need for low-efficiency processes.

Energy Diversity – A description of an energy system's generation mix. Today, most of the world's energy comes from the direct or indirect combustion of fossil fuels. In future energy systems, a diverse combination of low-impact and climate friendly energy sources such as solar, wind, hydropower, nuclear, geothermal, and storage will be needed to achieve a balanced and resilient energy system.

Paris Agreement – The Paris Agreement of the United Nations Framework Convention on Climate Change commits nations to collectively undertake ambitious efforts to limit global temperature change to 2 degrees Celsius above pre-industrial levels.

Resilience – The ability to cope with a crisis and quickly return to pre-crisis status. In the context of Energy and Climate Change, resilience is used to describe a community's preparedness for the uncertainty of natural disasters, long-term changes in temperature and precipitation, and changes to energy reliability, cost, and access as a result of the energy transition.

Distributed Energy Assets – Energy generation to storage capacity that is built on the "edge" of the grid or disconnected from a central grid network. As solar and storage technology becomes increasingly affordable, these privately or community owned systems could play an important mitigative and resiliency role for cities.



About Urban 20

Urban20 (U20) is a city diplomacy initiative that brings together cities from G20 member states and observer cities from non-G20 states to discuss and form a common position on climate action, social inclusion and integration, and sustainable economic growth. Recommendations are then issued for consideration by the G20. The initiative is convened by C40 Cities, in collaboration with United Cities and Local Governments, under the leadership of a Chair city that rotates annually. The first U20 Mayors Summit took place in Buenos Aires in 2018, and the second took place in Tokyo in 2019. For 2020, Riyadh City is the Chair city and host of the annual Mayors Summit. The first meeting of U20 Sherpas was convened in Riyadh, Saudi Arabia, on the 5th – 6th February during which the foundations were laid for the U20 2020 Mayors Summit in the Saudi capital later this year.

About the Urban 20 Taskforces

As U20 Chair, Riyadh has introduced taskforces to add additional structure and focus to the U20. These taskforces explore specific priority issues and bring evidence-based solutions to the final Communique.

Each taskforce has commissioned whitepapers led by chair cities, and with input from participating cities and knowledge partners. These whitepapers help us build an evidence-based, credible and achievable set of policy recommendations.

Taskforces activation

The taskforces workstream was an innovative and recent introduction to the three-year-old U20 initiative by the chairmanship of the city of Riyadh this year. Three thematic taskforces, each guided by one of the U20 Riyadh 2020 overarching themes of Circular, Carbon-neutral economy, Inclusive Prosperous Communities, and Nature-based Urban Solutions, were officially launched and activated during the U20 First Sherpa meeting back in February. During the meeting, the U20 priority topics that fell within the three overarching themes and intersecting with the three cross-sectional dimensions of Implementing the Sustainable Development Goals, Urban Innovation and Technology, and Urban Finance and Investment were prioritized and refined through the statements delivered by all attending cities. The top 5 topics were then chosen to be the focus of whitepapers for each taskforce.



The top 5 topics under each of the three taskforces and cross cutting dimensions were then chosen to be the focus of whitepapers for each taskforce:

TF 1 Circular, Carbon-Neutral Economy	TF 2 Inclusive Prosperous Communities	TF 3 Nature-Based Urban Solutions
<ul style="list-style-type: none"> Increasing energy efficiency & diversification Zero-carbon mobility & reshaping of mobility Reducing, reusing, recycling, and recovering materials Carbon neutral buildings and construction Sustainable production & consumption 	<ul style="list-style-type: none"> Affordable housing Cultural inclusivity Mainstreaming gender equality Upskilling for future of work – international and local opportunities Youth empowerment 	<ul style="list-style-type: none"> Resilience towards natural disasters and extreme weather events Green and blue infrastructure Ecosystem services for health, safety and wellbeing Sustainable water management, clean air, & healthy soils City-region food systems & food security
Implementing the Sustainable Development Goals	<ul style="list-style-type: none"> SDG mainstreaming in policy and planning Cross-silo, cross-sector governance 	<ul style="list-style-type: none"> Institutional capacity & governance mechanisms at local level SDG Localization
Urban Innovation and Technology	<ul style="list-style-type: none"> Smart city and 4IR technologies Innovation ecosystems 	<ul style="list-style-type: none"> Agile and economically diverse cities Social innovation
Sustainable Urban Finance and Investment	<ul style="list-style-type: none"> Access to global & local finance sources – public, multilateral, & private Investment readiness and project bankability 	<ul style="list-style-type: none"> Innovative finance instruments and value capture models Impact financing

Cities and Partner Engagement

The vast majority of the twenty-three cities who attended the first Sherpa meeting, representing 12 G20 countries, along with the U20 Conveners, agreed to the importance of having taskforces as interactive platforms to produce knowledge-based and evidence-based outcomes that can effectively feed into an actionable U20 Communique. During and following the meeting, several cities demonstrated interest in volunteering in the capacity of chairs and co-chairs, leading and overseeing the activities of each taskforce. The cities of Rome and Tshwane co-chaired Taskforce 1 on Circular, Carbon-neutral Economy, Izmir

Taskforce 2 on Inclusive Prosperous Communities, and Durban on Nature-based Urban Solutions. Others expressed interest to participate in the taskforces, some in more than one, both during and after the meeting.

Alongside interested U20 cities, several regional and international organizations proffered to engage in the work of the taskforces, in the capacity of knowledge partners, to share their knowledge and experiences with cities in producing whitepapers. Some of the knowledge partners volunteered to play a leading role as Lead Knowledge Partners, supporting the taskforces' co/chairs in review and guidance



All participants who actively took part of the taskforces were subject matter experts nominated by the cities and knowledge partners and have enriched the taskforces' discussions with their know-how and experiences. In over 3 months, all three taskforces, with great effort and commitment from all their participants, produced a total of 15 evidence-based focused whitepapers, bringing about more than 160

policy recommendations addressing the national governments of the G20 Member States.

The taskforces content development efforts is comprised of 23 U20 cities and 31 U20 knowledge partners. The 100+ experts and city representatives produced 15 whitepapers which widely benefited and informed the development of the first draft of the communique.



Content Development

Under the leadership and guidance of the co-chair cities, Rome and Tshawne , and the lead knowledge partner, OECD, the work of Task Force 1 kicked off with an orientation for all participants in mid-March.

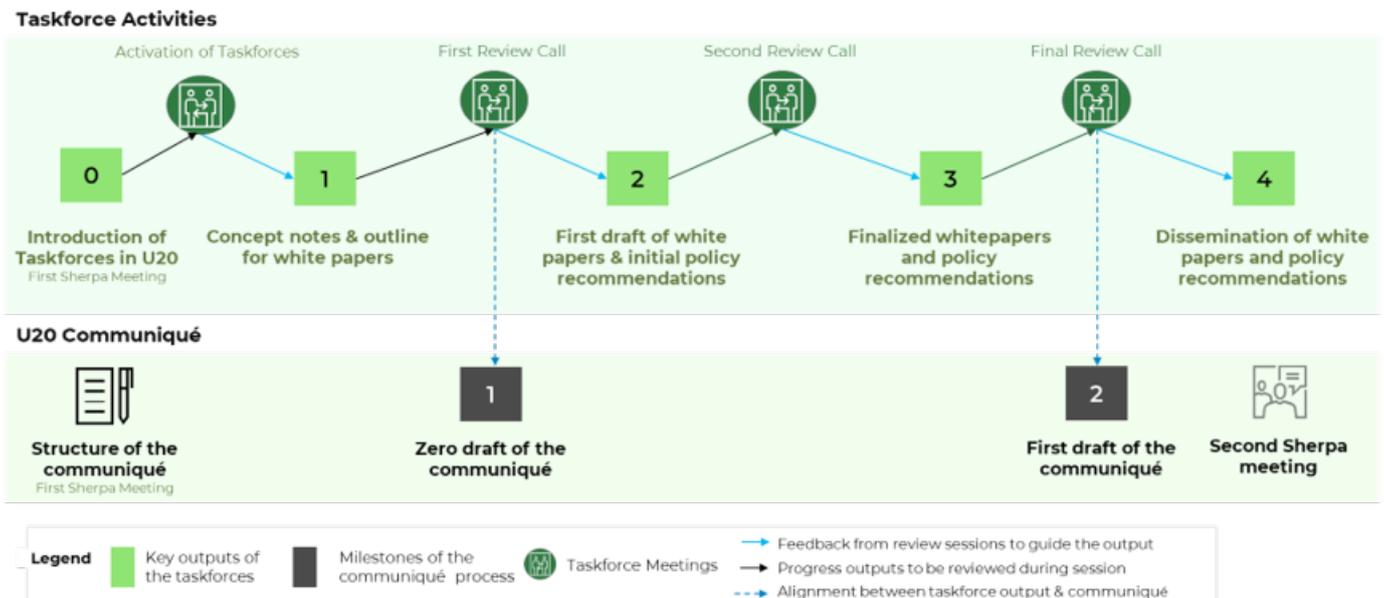
During the period between March and April, the participants of Taskforce 1 presented more than 20 concept ideas and 12 concept notes and

developed initial outlines for the whitepapers focusing on topics of interest. Teaming up into four author groupings, the cities and knowledge partners developed four outlines of whitepapers. Refined and revised outlines were then developed into draft whitepapers that underwent several iterations for development and finalization, ensuring that each paper delivers a set of concrete and targeted policy recommendations that address the different U20 stakeholders.



The four whitepapers under task force 1 (listed below) started with the exploration of the concepts of circular economy across different sectors, with the other three papers zooming into the concepts of circular economy in energy, mobility and buildings sectors :

1. The Post-COVID-19 Circular Economy: Transitioning to Sustainable Consumption and Production in Cities and Regions
2. Efficiency and Diversification: A Framework for Sustainably Transitioning to a Carbon-neutral Economy
3. Reshaping Mobility in Cities for a Carbon-neutral Future
4. Carbon-neutral Buildings and Recycled Materials : How Cities Want to Solve the Challenge



Along the taskforces timeline of activities, three review meetings were held where co/chairs and lead knowledge partners presented and discussed with the U20 Executive Team the progress and findings of the taskforces they represent, leading to the U20 Second Sherpa meeting that took

place during the first week of July. Parallel to the taskforces activities, the first draft of the U20 communiqué was developed by the U20 Executive team incorporating recommendations presented at the third (and final) review meeting.



About the Circular, Carbon-neutral Economy Taskforce

Meeting the global climate targets requires transforming our urban energy systems to be more efficient and based on clean renewable energy sources, while also shifting from a linear material economy to a circular model that reduces, reuses, recovers and recycles scarce and carbon intensive resources

De-carbonization measures in cities such as building retrofitting for energy efficiency, provision of sustainable mobility of people and urban freight based on public transportation and vehicle electrification coupled with the expansion of renewable energy sources could deliver over half

15 cities

U20 Participating cities

Buenos Aires	Riyadh
Guangzhou	Sao Paulo
Madrid	Strasbourg
Mexico city	Tokyo
Rio de Janeiro	



13 knowledge partners

Knowledge partners

- Cities Climate Finance Leadership Alliance
- Inter-American Development Bank
- King Abdullah Petroleum Studies and Research Center
- National Institute of Urban Affairs
- Université Nationale Gustave Eiffel
- Center for the Implementation of Public Policies for Equity and Growth
- International Finance Corporation
- World Economic Forum
- University of Pennsylvania, Institute for Urban Research
- World Wildlife Fund
- Coalition of Urban Transitions
- International Association of Public Transport

of the emission reductions needed to keep global temperature rise below 1.5 degrees Celsius City planning and management approaches can greatly encourage Carbon-neutral lifestyles, through neighborhood walkability and cycling infrastructure, reorganization of food production and distribution for local and organic produce, or support programs for green technology and investment Greenhouse gas emissions from material processes such as infrastructure construction, industry, and household waste need to be taken into account in a full life cycle approach Cities need to reduce the use of carbon intensive and otherwise scarce materials, reuse urban infrastructure and consumer products to extend their lifespan, recover carbon intensive or otherwise scarce material from household waste, industry and physical infrastructure and recycle all materials from plastic to steel, from organics to rare earth materials in a circular economy model that decouples economic growth from carbon emissions.

Co-chair cities

Rome
Tshwane

U20 Observer cities

Amman
Dammam
Helsinki
Singapore

Lead knowledge partner

OECD



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Disclaimer note

The views, opinions, positions and recommendations expressed in this White Paper are developed under the chairmanship of the City of Riyadh as U20 Chair City 2020 and are those of the authors and contributors, including contributing U20 cities and partners. They do not necessarily represent the views of all the U20 cities or any of its chairs, conveners, and partners. Many of the references in this White Paper will direct the reader to sites operated by third parties. Neither the institutions nor the authors of this White Paper have reviewed all the information on these sites or the accuracy or reliability of any information, data, opinions, advice or statements on these sites.



Executive Summary



Executive Summary

Presenting a framework for adopting circular economy approaches to increasing energy efficiency and diversity, this paper outlines exemplary projects in several cities. In addition, it surveys implementation efforts spanning monitoring, capacity building, and financing. It

discusses needed research and concludes with policy recommendations to be brought to the attention of G20 members. Appendix contain detailed relevant case studies from Mexico, Rome, and Amman.





Background



Background

Energy efficiency and diversification is an issue of great concern for the G20. In the previous two G20 convenings, Leaders' Communiques have acknowledged the importance of enhancing the transformation of energy systems into affordable, reliable, sustainable, and low GHG emissions systems as soon as possible. At the urban level, in the 2019 Tokyo U20 Declaration, Mayors committed to decarbonizing the energy grid, with 100 percent renewable electricity by 2030, and 100 percent renewable energy by 2050. As part of the 2018 Buenos Aires U20 Communique, Mayors committed to supporting policies to achieve the

objectives of the Paris Agreement and accelerate a global shift away from fossil fuels toward clean, renewable energy. These commitments included adoption of carbon pricing that reflects the social cost of carbon, increasing investment in climate solutions, reduction or removal of fossil fuel subsidies, and other measures as appropriate.

While cities are largely dependent on, and shaped by, the regulations and technologies of national and global markets, they play powerful roles in implementing national strategies in several key areas.



Introduction



Introduction

The fundamental basis for energy efficiency is found in the very notion of “circular.” Energy efficiency is not just a characteristic of energy production and energy consumption, but of the interaction between these two sides of the equation. In simplest terms, the avoidance and recovery of waste is the essence of energy efficiency. The fundamental basis for energy diversification is likewise found in the very notion of “Carbon-neutral”. Fossil fuels are extraordinarily energy dense, transportable, and storable. They have created an economy built on reliability and continuous energy provision. A Carbon-neutral energy system, however, must be built on a diverse system of interacting sources in order to meet the economy-scale demands for energy in the modern world. Together, these fundamental realities place increasing energy efficiency and diversification at the very center of any circular, Carbon-neutral economy. It is, indeed, priority number one, on which other priorities depend.

Cities represent a key implementation platform for the circular, Carbon-neutral economy. This platform operates at the nexus of market and policy processes, operating both within and far beyond the jurisdiction of these cities. This whitepaper identifies several key capacities needed to empower cities to fulfill their potential roles as both actors and a platform for implementation of the circular, Carbon-neutral economy. It presents a framework for identifying the urban role in promoting energy efficiency and energy diversification (See Figure 1). The framework presents city programs categorized into either technology or regulatory challenges arrayed against opportunities specific to either energy efficiency or energy diversity. This typology of city programs demonstrates the critical capacities necessary for successful implementation. The paper concludes with suggestions for additional research to fill gaps in knowledge about this subject.

Figure 1.

A Circular Economy Framework for Energy Efficiency and Diversity

	ENERGY EFFICIENCY		ENERGY DIVERSITY	
	RECOVERY	REDUCTION	NATIONAL	LOCAL
TECHNOLOGY	Capture Waste	Avoid Waste	Maximize Reliability	Scale Investments
REGULATORY	Commodify Load	Enforce Standards	Scale Investments	Distribute Assets



Introduction

This white paper has three parts and an appendix: Part One Challenges and Opportunities discusses the framework and issues related to its implementation. Part Two Recommendations suggests policies needed to execute the

framework discussed in Part One, and Part Three References offers key sources to pursue this subject in depth. The attached Appendix provides detailed case studies.





Challenges and Opportunities



Challenges and Opportunities

Challenges

Successful city efforts to improve energy efficiency and/or energy diversification face two interrelated but distinct sets of challenges: technology disruption and regulatory roadblocks. In turn, these technology and regulatory challenges generate additional challenges for the capacity of cities to monitor their progress, to develop the needed workforce, and to finance the move away from a linear economy. While much is known about energy efficiency and diversity, knowledge gaps remain.

Technology Challenges

Technology disruption in the energy sector challenges cities in many ways: (a) knowledge capacity, i.e. to understand state of the art technology and expected futures, (b) administrative capacity to procure and leverage technology for public operations as well as influencing private operations, and (c) enforcement capacity to ensure the performance of technology to achieve policy.

Regulatory Challenges

Regulatory roadblocks also challenge cities in many ways: (a) capacity to understand how

local jurisdictions engage the energy sector, (b) administrative capacity to design and implement programs that can encourage positive policy outcomes, and (c) enforcement capacity to promulgate the performance of regulation.

Monitoring Challenges

Cities need to develop methods to assess baseline conditions and progress toward achieving a successful circular economy approach to energy efficiency and diversity. This presents a complex accounting problem for governments and enterprises at all scales. The subject of energy efficiency suggests a set of boundary conditions that help cities start with a simple focus on energy waste, especially waste heat, that is relatively measurable and leads directly to opportunities for recovery and reuse.

Workforce Challenges

Growth in this area will call for qualified personnel to supply, operate, and maintain the elements of the programs encompassed in this framework, to oversee the monitoring systems, and to develop financial tools to support it.



Challenges and Opportunities

Financial Challenges

More and more cities are mobilizing to promote the clean energy transition, in line with the Paris Agreement. However, most cities today do not have sufficient funding needed to undertake such approaches. While, cost figures vary, in 2018, IRENA put a price tag of a trillion dollars a year until 2050 to decarbonize the power system—as an indicator of the scale of the investment needed.[1] Overall, financing the energy transition at the city level will require substantial investments from the public and private sectors. The business case for such investments needs strengthening. Finally, COVID 19 recovery packages may support the financing of more efficient and diverse energy systems as a critical component of resilient local economies and public health and safety systems.

Opportunities for Energy Efficiency

In the context of energy efficiency in a circular economy, cities can deploy technology and regulation programs to encourage two broad impacts to achieve policy goals: either reduce waste before it occurs or recover waste that has potential for reuse. Local programs use different powers and practices to implement these approaches, and each approach engages different local constituencies with interests and incentives that cities must recognize and steward in order to improve policy outcomes.

Figure 2.
Opportunities for Energy Efficiency in a Circular Economy

	ENERGY EFFICIENCY	
	RECOVERY	REDUCTION
TECHNOLOGY	Capture Waste (e.g., Municipal Sewage Heat Recovery)	Avoid Waste (e.g., District Heating and Cooling)
REGULATORY	Commodify Load (e.g., Dispatchable Demand Aggregation)	Enforce Standards (e.g., Building Codes)



Challenges and Opportunities

Capture Waste: Heat loss represents a potential source of energy in cities. In the case of an incandescent light bulb, where 90 percent of its energy demand is lost to heat, the efficient solution is simply to switch to LED lights. However, in many settings, the efficient solution is to recover rather than avoid the waste. Up to 50 percent of energy used in industry is wasted heat in exhaust gases, cooling water, hot equipment, molten slag, and heated products. There is also wasted heat

generated in municipal sewage treatment. The size and density of cities lowers the costs of recovering this waste and deploying it as energy supply. Cities can document and inventory these sources of waste energy to facilitate the development of markets for their recovery. Cities can use their land use planning powers to facilitate connections between producers of waste heat and consumers of heat.

Example: Municipal Sewage Heat Recovery

The False Creek Neighborhood Energy Utility in the City of Vancouver uses waste heat from local sewage to provide space heat and hot water to 534 km² of residential and commercial building space. This recycled heat reduces carbon emissions from heating by 60 percent.

Link: <https://vancouver.ca/home-property-development/southeast-false-creek-neighbourhood-energy-utility.aspx>

Avoid Waste: Perhaps the most typical understanding of “improved efficiency,” cities can promote high efficiency appliances and weatherization practices in new and existing buildings as well as high efficiency transportation alternatives within their jurisdiction. This energy use reduction by consumers not only improves the overall efficiency of cities, but also simultaneously can work to tackle another urban challenge: equity and energy affordability. These changes can be as basic as changing lightbulbs or as extensive

as installing high-efficiency electric heat pumps. Either way, demand side technology improvements help reduce citywide energy demands and costs and, in many cases, can offer a rapid ROI for consumers. Beyond these examples of improved technology at the point of final energy demand in households or buildings, cities are uniquely well-positioned to create, maintain, and extend district-scale solutions that avoid inefficient household- or building-scale equipment for heating and cooling.



Challenges and Opportunities

Example: District Heating and Cooling

The majority of homes in Helsinki are connected to a district heating and cooling system which receives 90 percent of its power from combined heat and power natural gas plants. This system uses heat and cooling accumulators to regulate supply to meet variable demand.

Link: <https://www.helen.fi/en/company/energy/energy-production/energy-production2>

A number of other cities in Europe have recognized the benefits of district heating and cooling systems as well and are pursuing a range of strategies for local deployment.

Link: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC104437/study%20on%20efficient%20dhc%20systems%20in%20the%20eu%20-dec2016_final%20-%20public%20report6.pdf

Example: Rome's Urban Greening

In an effort to avoid wasted energy from cooling urban buildings, Rome has sought to contain urban heat through measures to increase urban albedo, reverse the loss of permeable surfaces, and increase urban green space (including urban agriculture).

Commodify Load: Many advanced electricity systems and their regulators recognize the thermodynamic symmetry between a megawatt of generated new energy and a so-called “negawatt” of energy made available to the grid through intentional reduction in demand. This regulatory approach creates extremely valuable markets for load shifting by flexible energy users

at a fraction of the marginal cost of meeting peak energy demands on a large grid. Private firms have emerged in the past decade to identify and manage this dispatchable load as an intermediary between utilities and users. Cities represent a large reservoir of valuable demand response that can be aggregated and deployed as virtual generation rather than simply wasted.

Example: Dispatchable Demand Aggregation

Several dispatchable demand aggregation demonstration projects jointly undertaken by the Bonneville Power Administration and their partners have successfully executed dozens of load reduction events in the Northwest United States, ranging from 18 to 28 MW.

Link: <https://www.utilitydive.com/news/why-bpa-sees-aggregation-as-the-future-of-demand-response/401242/>



Challenges and Opportunities

Enforce Standards: Cities can play a crucial role in pushing regional industry to adhere to strict standards regarding best available technologies and reward those industrial entities for reducing usage and waste through innovation and best practices. Further, cities can help ensure that the

distribution of energy resources is maintained at a high level or repair it, reducing system losses. This not only improves efficiency, but also offers urban residents the opportunity for a cleaner and safer local environment.

Example: Energy Efficiency Standards in Singapore

Singapore will soon institute strict minimum energy efficiency standards (MEES) for water-cooled and chilled water systems in industrial facilities. These industrial regulations are intended to dramatically improve energy efficiency.

Link: <https://www.nea.gov.sg/our-services/climate-change-energy-efficiency/energy-efficiency/industrial-sector>

Example: Saudi Building Codes

The Saudi Vision 2030 Initiative includes ambitious Green Building guidelines and standards as well. [The Saudi Energy Conservation Code](#) goes into extreme detail for both low-rise and non-low-rise construction, outlining specific efficiency standards for various kinds of opaque building elements as well as fenestration.

Opportunities for Energy Diversification

In the context of energy diversity in a Carbon-neutral economy, cities' policy choices are limited by technology and regulation defined by national or global jurisdictions. The technology and regulation of historically centralized monopolies is being disrupted by new and more distributed technologies that require new regulatory

approaches. Cities can play powerful roles in implementing national policy strategies. For example, we tend to think of cities as sources of energy demand, but cities are increasingly understood as sources of energy supply—in both a narrower sense of supplying distributed solar or fuel cell resources and a broader sense of organizing dispatchable load or resilient microgrids.



Challenges and Opportunities

Figure 3.
Opportunities for Energy Diversity in a Carbon-neutral Economy

	ENERGY DIVERSIFICATION	
	National	Local
TECHNOLOGY	Maximize Reliability (e.g., Seasonal Energy Storage)	Integrate Systems (e.g., Microgrid Design)
REGULATORY	Scale Investments (e.g., Power Purchase Agreements)	Distribute Assets (e.g., Rooftop Solar Expedited Permits)

Maximize Reliability: Solar power is available during the day and peaks in the summer, while wind power is strongest during the night and peaks in the late winter. Together, they help mitigate the intermittency of renewable energy supply, which is a key to replacing the reliable baseload supply from coal and natural gas. However, there are summer days and winter

nights when the sun does not shine nor the wind blow. In order to ensure a balanced grid at all times of the year and under all weather conditions, seen or unforeseen, a Carbon-neutral generation mix needs to be as diverse as possible, deploying a variety of technologies in a geographically decentralized pattern.

Example: Grid-level Energy Storage

The Hornsdale Power Reserve, the world’s largest grid-connected battery storage system, located outside of Adelaide, Australia, has already saved southern Australian Utilities over AU\$40 million in frequency control ancillary services since its completion in 2017.

Link: <https://www.inverse.com/article/51515-tesla-s-battery-has-already-saved-south-australia-a-huge-amount-of-money>



Challenges and Opportunities

Integrate Systems: Various methods of energy storage provide a far more productive path to a balanced grid than curtailment of an overbuilt generation system. By seeing intermittency as a benefit rather than a cost, we can use periods of excess solar and wind generation (during which the cost of energy is essentially zero) to charge electric vehicles, perform electrolysis to

produce renewable hydrogen, or prime gravity/momentum-based storage technologies, heat homes, and charge vehicles and appliances. Coordinating this ramping up of demand during times of high supply will require the integration of smart technologies that can all work together to ensure energy is being put to meaningful use at all times of the day and night.

Example: Microgrid Design and Deployment

Hartford built a fuel cell-powered microgrid that began operating in March of this year. Set up in the city's core, the microgrid can unplug from the main grid in an emergency and keep power flowing to critical resources, including a health center, a school, a grocery store and a gas station.

Link: <https://www.fastcompany.com/90450772/how-have-puerto-ricos-new-microgrids-performed-during-its-massive-power-outage>

Scale Investments: As the demand for a Carbon-neutral energy system grows, innovative methods of diversifying our energy supply will be needed to better fit the expectations set by two centuries of fossil fuel power. This will require innovation and investment in new and unproven technologies, despite those technologies not competing directly with established wind, solar, or even gas power.

Overcoming this will require policy and market solutions that prioritize a diverse grid. Cities and communities can help guide the diversification of regional electricity systems through PPA's. These contracts allow innovative and high-capital-cost energy projects to move forward by assuring those producers a stable and guaranteed customer base after project completion.

Example: Power Purchase Agreements

The City of Philadelphia has a power purchase agreement with ENGIE to buy enough solar power from the company's 80 MW Adams County solar farm to supply 22 percent of all municipal building electricity. This illustrates the city's ability to influence the energy mix of a large RTO/ISO and, ultimately, the national energy grid.

Link: <https://www.engie.com/en/engie-and-city-philadelphia-announce-power-purchase-agreement>



Challenges and Opportunities

Distribute Assets: Cities do not have to remain in the role of consumer. By incentivizing the deployment of distributed energy generation and storage (e.g. roof-top solar, community solar, roadside wind, and home batteries) cities can truly become 'pro-sumers' producing a share of

the electricity being fed into the grid. Distributed generation and storage cannot replace grid-level systems, but if deployed wisely, they can reduce the burden on grids and improve local resilience through the use of micro-grid networks.

Example: Rooftop Solar Incentives

Montgomery County regulation requires the Department of Permitting Services adopt a fast track review process for installation of solar photovoltaic system for single family homes.

Link: https://www.montgomerycountymd.gov/DPS/green_dps.html

Example: Mexico City Solar City Strategy

The Mexico City government has started several renewable energy programs focusing on the use of solar energy in public buildings.

Link: <https://ciudadsolar.cdmx.gob.mx/programas/programa/una-politica-energetica-sustentable-para-la-ciudad-de-mexico-2019>

Opportunities for Monitoring

Programs for assembling and managing large databases as well as mapping technologies are becoming more accessible to cities. They provide the basis for establishing baseline and progress

reporting on the use and reduction of energy. This capacity helps cities make decisions in the face of uncertainty. Well-designed monitoring capacity can provide foresight into emerging threats and opportunities over time.

Example: Performance-based budgeting and Citistat

The City of Baltimore began using the [Citistat system](#) (a data collection and monitoring system based on NYC's controversial Compstat crime and police monitoring program) in 1999 to ensure personal accountability and transparency from all major agencies. The financial effectiveness of this program has been considerable by ensuring that the city budget is targeted, and by increasing the effectiveness of available funding.



Challenges and Opportunities

Example: OpenDataPhilly

The City of Philadelphia has a [database](#) of over 250 datasets available to the public in multiple viewable and processable formats. This program is designed to help departments share data with each other and with the public, thereby improving government accountability, data-driven decision-making, and civic engagement.

Example: Amman's SURE program

The Sustainable Urbanization and Resource Efficiency program incorporates a systematic approach for Greater Amman Municipality's (GAM) measuring and reporting on resource efficiency.

Link: <https://c2e2.unepdtu.org/wp-content/uploads/sites/3/2019/01/amman-sustainable-urbanization-and-resource-efficiency.pdf>

Opportunities for Training

In the aftermath of the global COVID-19 crisis, cities around the world will be faced with many rebuilding challenges, not the least of which will be job recovery. A crucial element of this recovery will be investment in [workforce training programs](#). These investments will need to be targeted to

reflect the realities of the economic damage caused by the pandemic, and equally need to be structured to prepare us to tackle future crises that are on the horizon. Transforming our cities into catalysts of a green transition will require a capable and driven local workforce and local governance that recognizes the economic value to be unlocked as part of this transition.

Example: Mexico City Solar Training

To help create jobs, improve competitiveness, and encourage investments in sustainable energy supply systems among micro, small, and medium companies in the city, the Secretariat of Economic Development, implemented the Institutional Action for the Strengthening of the Competencies in Solar Energy in Mexico City. The initiative is directed to everyone older than 16 years of age with an interest in receiving training and becoming certified in the design, installment, and promotion of photovoltaic and solar water heating systems.



Challenges and Opportunities

Opportunities for Finance

According to *Bloomberg News*, sustainable finance was the fastest growing investment sector in 2019 with over \$460 million in new issues (Marsh 2020). Most of that came in the form of green bonds, where the proceeds must be used for projects that generate environmental returns. But the fastest growing sub-sector came in the form of green loans, which have variable interest rates linked to the borrower's performance on measurable environmental impacts.

National Development Banks (NDBs) can be key contributors to helping cities and subnational authorities secure and allocate investment to low carbon, climate-resilient infrastructure, and particularly the energy transition. NDBs are focused on their domestic market, understanding and often informing national development planning efforts and have extensive knowledge of the barriers and opportunities to investing in cities. Most NDBs can also borrow from international capital markets or institutional investors to finance cities in local

currency and assemble tailored financing packages to meet specific project needs.

Given the urgency of climate change, and the role of cities to reduce its impacts, the need for collaboration to finance urban energy transition infrastructure is more critical than ever. The Cities Climate Finance Leadership Alliance is the only multi-level and multi-stakeholder coalition existing currently aimed at closing the investment gap for urban subnational climate projects and infrastructure worldwide. The Alliance is a coalition of leaders committed to deploying finance for city-level climate action at scale by 2030. The Alliance serves as the main platform for cooperation, partnerships, and advocacy in the field of subnational climate finance, aiming to amplify ambition and to bridge demand and supply along the investment chain for city-level climate-related finance. Its members represent many of the world's major public and private financial institutions, governments, international organizations, NGOs, research groups, and city and subnational networks.

Example: Identifying Clean Energy Finance in Mexico City

The Institutional Action to Foment the Transition and The Energetic Sustainability of Medium, Small, And Micro Companies, gives specialized technical advice to services, trade, or industrial companies, for them to correctly identify and scale the right energy systems for their needs. It also offers these companies links to certified renewable energy tech suppliers as well as accessible financing sources that were developed to boost renewable energy exploitation. In this way, Mexico City seeks to eliminate barriers that impede further deployment of renewable energy technologies.



Challenges and Opportunities

Opportunities for Research

Each city presents unique social, economic, cultural, and physical properties, but they have much in common with other cities and are almost always part of larger regional and national systems that help define their challenges and opportunities. The National Science Foundation is currently seeking proposals for its [Civic Innovation Challenge](#), a grant opportunity to fund a local project designed to

address local resiliency needs by engaging local community members and empowering them with the data and capability to monitor and improve their own resilience to local threats. These kinds of initiatives can be focused on meeting local community needs while also generating yield translatable lessons about technology, data-collection, civic-engagement, local governance, and urban preparedness.

Example: Rome's support for Research Organizations

Cities can be enormous supporters of local research as well. Roma Capitale signed several partnerships with prestigious organizations and research centers for the purposes of being supported from a technical and scientific point of view by the best Italian public centers of excellence. In doing so, Roma Capitale also helped these institutions engage with and understand the community.



Recommendations





Recommendations

Energy Efficiency

- Energy Efficiency efforts simultaneously address cost, reliability, and emissions concerns. In order to ensure continued local support for efficiency initiatives, cities should work to identify which of these three beneficial outcomes is the priority for local residents and work to frame initiatives around that concern. This can be achieved through public surveys, stakeholder meetings, and other locally appropriate methods of community engagement.
- Efficiency gains can be achieved through energy waste recovery or waste reduction. Both yield energy savings but are achieved with a different set of policy and technology tools. Recovery requires the development of new and innovative systems of use while reduction demands improvement and upkeep of existing systems. Depending on the specific infrastructure or energy system in question, local decision-makers ought to consider carefully whether efficiency gains are more easily addressed through recovery or reduction efforts. This may have to do with the nationally or internationally determined value of the existing system, and the local opportunities to utilize waste energy.

Energy Diversity

- Cities can help to drive the demand for energy diversity and can contribute to energy diversity through locally deployed renewable energy assets. However, large-scale diversification of the energy system ultimately requires regional and national buy-in and leadership. Cities can

advocate for a cleaner or more diverse energy supply but can only exert direct change through local efficiency efforts, distributed energy investments, and power purchase agreements.

- The legacy system of centralized utilities and regional monopolies is being fundamentally disrupted by the transition to zero-carbon generation technologies. National governments and the international community as a whole need to accept this pattern of disruption and direct it to building a resilient energy system that delivers affordable, reliable, and low-carbon energy to all. In some jurisdictions this may mean rethinking utility business models.
- Energy diversity refers not only to the energy mix within an energy system, but also to the variation between systems. National governments should understand and embrace regional geophysical and climatological conditions and allow that unique profile to shape an energy mix that is best suited to national demands and is regionally appropriate on the scale of the electricity grid. This can be achieved through technology specific subsidies or by finding ways to encourage new generation in optimal regions.

Monitoring

- Local and national governments should encourage investment by individuals, businesses, and industries in data-based monitoring and reporting systems for key energy-intensive end uses (e.g. heat, water) by implementing time of use pricing and load aggregation services.



Recommendations

- Monitoring is not only a tool for project planning and performance assessment. Monitoring can be an essential tool in the realization of local or regional efficiency gains through the use of smart technologies, load aggregation, and demand response.

Workforce

- Ultimately, increasing energy efficiency and diversification comes down to investing in energy infrastructure. Like any infrastructure investment, a narrow consideration of capital costs can lead to deferral; whereas a comprehensive consideration of the economic gains from this investment (e.g. job growth, long-term cost savings, industry development and expertise) can galvanize action. This requires both local communication to the public as well as international agreements that reduce uncertainty for energy investors (e.g. carbon pricing).
- The energy transition is a brown to green transition and will disrupt the existing energy workforce. Retraining programs and investment in communities impacted by the decline of the fossil fuel industry can help reduce the burden on those communities, but this one-for-one transition will be limited by geography. National governments have a responsibility to focus on creating jobs where the energy transition demands them and to ensure that there is sufficient job-training in place for the local workforce to meet that demand. Nations also have a responsibility to protect and aid communities that are negatively affected by the

need to transition away from locally available industries like oil, coal, or gas.

- Implementing low-carbon measures in cities could support 87 million jobs by 2030 in sectors such as clean energy and public transport.¹

Finance

- National governments should spearhead public investment efforts that can galvanize the transformation of key sectors (e.g. LED lighting, solar-powered systems in municipal buildings, EV charging stations, food waste programs) and spur future private sector investment. These national initiatives should be looked at in the same way as any critical infrastructure investment plan.
- Cities can provide fiscal incentives for households to engage in energy reduction (e.g. smart meters, rooftop solar systems for water heating) in a way that is both fiscally sustainable and helps cities reach their emissions goals.
- Cities should undertake public-private partnerships and develop clean energy and energy efficiency financing tools such as green bonds to further local energy goals and attract private sector investment.
- Increase the role of National Development Banks (NDBs) as key contributors to overcome barriers that cities and subnational authorities face in securing and allocating investments in low carbon, climate-resilient infrastructure that furthers a national energy transition.

¹. Coalition for Urban Transitions. 2019. Climate Emergency, Urban Opportunity. World Resources Institute (WRI) Ross Center for Sustainable Cities and C40 Cities Climate Leadership Group. London and Washington, DC. Available from: <https://urbantransitions.global/urban-opportunity/>



Recommendations

- Cities can promote more cooperation and partnerships among different stakeholders as an effective way of tackling the challenges cities face on access to finance.

Research

- The international research community needs to work together to develop rigorous models that relate climate change to other economic, political, and environmental shocks (such as COVID-19), with particular attention to public health and wellbeing.
- Pursue public-private partnerships that help cities finance efficiency and diversification initiatives while allowing local industry to gain expertise and test new technologies and market structures.
- There is still a gap between widely available technology and the technology needed to fully decarbonize the energy system. Public investment in early-, mid-, and late-stage R&D is critical if nations are going to achieve cost, reliability, emissions, and efficiency goals. Countries who invest early in energy R&D will benefit in the global economy of the coming decades by being able to help other lagging nations reach nationally determined emissions targets. It does not make long-term economic sense for a nation to stall their own investment in clean energy until others have demonstrated their commitments. Capital and development costs now will be recouped in the form of patent licensing agreements, corporate earnings, and local expertise.



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Appendices





Mexico City Case Study

Challenges and Opportunities

Mexico City, as the main center of economic activity in the country, has moderate adequate energy services coverage, nevertheless it has a narrow margin to face any possible energy market conflict regarding gas, gasoline, and diesel. The city has great opportunities to optimize its energetic use and also has potential to diversify and introduce energy generation of several sources, mainly renewable. We have the opportunity to accelerate the energetic transition to clean energy with all the positive green effects that come along with it, but taking into account the social benefits, such as job creation and entrepreneurship related with the use of renewable energy in Mexico City, as well.

The challenge is to use and produce energy with the least possible damage to the environment, benefit the local economy, and guarantee the long-term supply. For this, Mexico City must have a high quality reliable energetic system with accessible prices for different layers in the social structure.

With the previous in mind, Mexico City government has started initiatives based on renewable energies, mainly solar, under the [Solar City Strategy](#), which includes programs such as: [Solar Energy Training](#), [Solar Energy in Medium, Small, and Micro Companies](#), and [Public Buildings with Solar Energy](#). These initiatives look to boost the growth of solar energy economic activities and enhance its benefits related to job and wealth generation. Programs include: professionalization actions in areas like installation and supervision; promotion of photovoltaic systems and solar water heating systems; encouragement of adoption of solar energy in the productive processes of medium, small, and micro companies; incorporation of photovoltaic systems in the public sector; actions for the correct internalization of the local environmental norms that make the usage of solar heated water mandatory on new buildings; and efforts to recollect used edible oils to produce biodiesel, among others.

Success of the measures heavily relies on the participation of commercial users, solar energy integrators, government, and citizens in general, in designing and implementing the initiatives.

Challenges-Opportunities

Mexico City economic development requires a sustainable energetic growth. Therefore, there is the need to mitigate impact of the activities of medium, small, and micro companies on air quality and the atmosphere. Mexico City has great solar energy potential, which could be exploited to generate electricity via photovoltaic systems, or through solar water heating systems, all of which can benefit medium, small, and micro companies. The boost to installment of renewable energies harvesting systems will create more job opportunities, more businesses, and add value to the green energy sector of the city. It must be considered that Mexico City has over 20,000 registered economic units in sectors of intensive demand of hot water, where introducing solar water heating systems is a highly profitable technological intervention. Also, there are over 100,000 economic units where

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Mexico City Case Study

photovoltaic systems would allow to reduce electricity consumption and cut production costs, which in turn would increase its competitiveness along with significant environmental benefits for Mexico City.

Within this context, to help the transition towards energetic sustainability, improve medium, small, and micro companies cost effectiveness and competitiveness, bring down greenhouse gases related with energy consumption, and contribute to decarbonizing the Mexico City economy, the Secretariat of Economic Development implemented the Institutional Action to Foment the Transition and the Energetic Sustainability of Medium, Small, and Micro Companies. The initiative is directed to services, trade, or industrial companies, to whom specialized technical advice is given to correctly identify the right energetic system for their needs in addition to links with certified renewable energy tech suppliers and accessible financing sources developed to boost renewable energy exploitation. In this way, we look to eliminate barriers that impede further deployment of renewable energy exploitation technologies as we link potential users with suppliers of those technologies and accessible financial sources, always looking to maintain the quality of the technology. The sustained growth of the renewable energies sector will depend on the technical certainty and the trust that users give to systems, which must be based on quality, that at the same time, relies on the professionalization of the system's installment activities. Accordingly, with data from the National Council of Standardization and Certification of Labor Competencies, there are, at national level, around 5,000 people² certified on "Installment of Thermosiphon Solar Water Heating System in Sustainable Housing", "Installment of Forced Circulation with Thermostat Solar Water Heating System", and "Installment of Photovoltaic Systems in Houses, Business and Industry". Even as in the last years an increase in the demand of qualified personnel to supply, design, install, research, and develop solutions for the solar sector was showed, the supply of such personnel is not enough, since, according to the National Association of Solar Energy, less than 22 percent of the national personnel that works³ in the sector have formal education in the matter. Therefore, there is a need for courses, professionalization tools, and certification processes related to the exploitation of renewable energies in general, and of solar energy in particular.

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² This Council is a parastatal entity presided over by the Secretary of Public Education and has the participation of other Secretariats, such as Labor and Economy, the business sector (trade and industrial cameras), and workers (workers confederations). The Council's goal is to give the country, through the National Competencies System, a tool to strengthen economic competitiveness, capacity to grow, and social progress. The National Competencies System is a national agreement between business, society, academia, and government to have structures and mechanisms of national reach that allow development of competency standards to boost organizations' competitiveness and certify individuals.

³ The National Association of Solar Energy was formed officially in San Luis Potosí, Mexico in 1980 and is a pioneer institution in the country regarding the promotion of solar energy use derived from solar radiation as well as from indirect phenomenon such as wind, biomass, and microhydraulic.



Mexico City Case Study

Hence, the need to strengthen the quality of the activities relative to the installment of photovoltaic, solar water heating, and energetic efficiency systems through training/certification in competencies standards or through the best practices available, was identified in order to generate technical certainty in the renewable energy sector in Mexico City, and use it as element to create jobs, improve its competitiveness, and encourage investments in sustainable energy supply systems among micro, small and medium companies in the city. To achieve that purpose, the Secretariat of Economic Development, implemented the Institutional Action for the Strengthening of the Competencies in Solar Energy in Mexico City, directed to everyone older than 16 years of age with interest in receiving training and becoming certified in design, installment, and promotion of photovoltaic and solar water heating systems.

The two strategies are reinforced with the influx to the solar energy market the government can exercise through its acquisitions. To encourage the solar energy market the program “Public Buildings with Solar Energy” was developed. The program installs photovoltaic systems on 300 public buildings owned by Mexico City Government, where technical and economic feasibility is found. In this way, the government sets an example of transition towards renewable energy sources and stimulates the sector’s development, with quality standards and local specialized workforces incorporated.

Examples

The Solar Energy for Medium, Small, and Micro Companies Program is one of the most relevant for Mexico City since it is oriented towards the adoption of clean energies as a general practice in the productive sector, the change of paradigm and consciousness, and as an engine of economic development.

The Public Buildings with Solar Energy Program is characterized for the average 50 kWp installations per building. It will install a photovoltaic capacity near to 15 MWp, with estimated annual benefit of 12,000 CO2 avoided tons and savings of 70 million pesos per year, that, during the 25 years lifespan of the systems will get to 302,000 tons of gas and savings of 1,750 million pesos. This project also seeks to be a replicable model for all government, where savings in energy consumption will amortize the photovoltaic systems investment.

The economic units within the Solar Energy for Medium, Small, and Micro Companies Program, in which a solar water heating system or a photovoltaic system is installed, can have gas and electricity savings between 40 percent and 70 percent. Such is the case of the maize dough for tortilla industry, where solar thermal energy can represent up to 70 percent of the required energy in the industry, with the savings that come along. There are other productive sectors in Mexico City like hotels, textiles, paper, and restaurants, among others, that could benefit from solar water heating

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Mexico City Case Study

systems; meanwhile industries such as food processing, automotive, wood, graphic arts and printing, machinery, chemistry, and services like grocery trading and department stores, can benefit from using photovoltaic systems.

The effect that the projects could have on environmental issues mitigation and the creation of a sustainable economic model will depend on project continuity and strengthening of the technology itself, with emphasis on job quality and local benefits of green activities.

Recommendations

Some recognized lessons and challenges from these policies are:

- Quality procurement of the renewable energies exploitation systems is fundamental for its general adoption; a high-quality system generates trust among users and financing sources.
- Government acquisitions and new governmental financial models can boost renewable energies growth.
- Specific financial mechanisms in the renewable energy sector, that are flexible and attractive in order to appeal users, must be generated. In Mexico, one of the barriers that medium, small, and micro companies, that are willing to invest in renewable energies, face is the lack of specialized financing sources, and the ones that exist establish loan requirements that companies hardly fulfill. Clean energy benefits diffusion as well as success stories among potential users is a key element for any energetic transition program.
- The strengthening of linked economic activities to solar energy (installation, supervising, promotion) allows for employment generation and business creation, especially in an adverse economic scenarios.
- Solar thermal energy has better prospects and chances because it has greater energetic efficiency values compared with photovoltaic solar energy and requires smaller investment amounts. However, promoting a greater usage of the solar thermal energy technology through specific policies to generate wider knowledge of it is required, because there is a common understanding that solar energy is focused on photovoltaic systems.
- To be able to develop renewable energies projects within the government in a more dynamic way, greater efforts to change ideas behind current government management models are required.
- The gap between diffusion and training needs for activities related to solar energy—Installation, promotion, sales, supervision, norm enforcement, government acquisitions, etc.—is still important.



Amman Case Study

Challenges & Opportunities

Amman is the Capital of Jordan and its most populous city. It is also the country's economic, political, and cultural center, with a population around (4.5 Million) inhabitants—more than 40 percent of Jordan's total population. The city continues to grow and change at a fairly rapid pace, which means more energy consumption, higher demand on resources, more GHG emissions, and increasing building activity.

The city faces natural resource shortages, as well as economic and social challenges that have been exacerbated by a large influx of refugees, climate change impacts, and a lack of quality urban infrastructure. The sharp rise in the city's population has placed a strain on the city's resources and infrastructure, including water, education, jobs, transportation, housing, and medical services.

With fossil fuel imports the main energy source for the country, stationary energy emissions, and specifically building electricity use, are the largest source of emissions for the city.

As Amman grows, it will need to balance the demands of growth, equity, and environmental protection. Moving toward sustainable development can help achieve this balance, especially if all entities work together in solidarity. Good governance and collaboration are the basis for sustainable urban development.

Other challenges include the lack of effective tools and methodologies for measuring and reporting climate resilient and resource efficiency related to urban development, accompanied with not having a shared database between entities like the municipality, water and electricity companies, department of statistics, and the segregation of data. To face these challenges and solve these problems, an efficient and sustainable methodology must be in place, consisting of constant measuring, monitoring and actioning through facilitation and implementation.

Smart city technologies and solutions are becoming more and more popular, with the use of big data, internet of things, and shared knowledge in urban systems to manage assets, resources, services, and decision making. This is seen in one of the U20's cross-cutting themes, smart city and 4IR technologies.

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Amman Case Study

Example

The city of Amman is currently working on a project called SURE (The Sustainable Urbanization and Resource Efficiency). It's a UNDP-GEF project aiming to establish a systematic approach for Greater Amman Municipality (GAM) to implement benchmarked, standardized tools and methodologies for measuring and reporting climate resilience, resource efficiency, and urban development of the city.

Complying with the National Energy Efficiency Action Plan (NEEAP) and with the use of the Urban Sustainability Framework (USF), this project focuses on indicators used for benchmarking, monitoring, and evaluating the sustainability of a city. Some Indicators relate to environment, resource efficiency and climate change:

A Systemic Approach to Sustainable Urbanization⁴ and Resource Efficiency in Greater Amman Municipality (GAM) - Supplementary Annex 2: Policies, Strategies and Ongoing Initiatives to Encourage Energy Efficiency and Emission Reductions.

Energy Use

- Percentage of population with access to electricity, this is to measure the coverage of electricity and accessibility for the population. Access to electricity is considered a basic living essential and thus is an appropriate proxy for quality of life. It is also important to recognize the difference between authorized and unauthorized access to electricity, depending on the city's population characteristics.
- Electrical energy consumption per capita (in kilowatt-hour) (per dwelling unit may also be possible), This is to assess how much electrical energy is consumed on a per capita basis in the city. It can be a starting point for trying to understand how sustainable/balanced the city's electrical energy consumption is in relation to its population
- Total final energy consumption in 1000 tons of oil equivalent (ktoe)
- Average number of electrical interruptions per year and average of the length of interruption, this is related to the idea that access to electricity is a living essential and that interruptions in electricity lower the quality of living. Quantifying the service interruptions may help to galvanize support in enhancing the service.

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⁴ A Systemic Approach to Sustainable Urbanization and Resource Efficiency in Greater Amman Municipality (GAM) - Supplementary Annex 2: Policies, Strategies and Ongoing Initiatives to Encourage Energy Efficiency and Emission Reductions



Amman Case Study

Energy Efficiency

- Sectoral energy efficiency (industry, residential, commercial and public sector, transport). Energy used in (ktoe) for the following: Industry (in toe per unit of value added), Residential (in toe per capita), Commercial and public sector (in toe per sq.km. floor space), and Transport (in toe per 1,000 vehicle-km).
- Carbon intensity of electricity generation (tons of CO₂ equivalent emitted per kwh of electricity generated) (NUS), This is related to the “electrical energy consumption per capita” indicator above; it tries to quantify the CO₂ emissions emitted per kwh of electricity generated, essentially differentiating between the emissions impact from various energy sources (natural gas, oil, coal, etc.).

Alternative Energy

- Percentage of renewable energy in total energy generation

Water Availability and Use

- Internal renewable freshwater per capita and its use (NUS) / availability of water resources
- Total water used (M³/capita per day, trend; annual water consumption per capita), this may be used to understand how much water the city consumes, whether by consumers, industry, etc.
- Sectoral distribution of water used (e.g. residential, commercial, agricultural, industrial, etc.), In conjunction with the metric for total water used/capita, this sectoral distribution may help identify the major water uses by sector, helping to target strategies/policies to reduce water consumption.

GHG Emissions

- City's overall GHG emissions
- Sectoral distribution of GHG emissions, Distribution by energy supply, industries, buildings (including households), transport, and others (agriculture, forestry, waste and wastewater).
- Methodology and inventory used for assessing emissions, An indication of the assessment year, and the frequency of monitoring

This Project also focuses on governance and integrated urban planning issues and indicators, from stakeholder participation to data management and trend analyses, land use and zoning, transport and mobility, urban growth patterns, informal settlements, and cultural heritage.

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Amman Case Study

Stakeholder Participation

- Identify stakeholders involved in decision making and encourage community engagement.

Data Management

- Using Geographic Information Systems (GIS) platform, data sharing and integration between agencies.

Trend Analyses

- Relation to population growth and density.

Land Use and Zoning:

- Average share of the built-up area of a city that is open space for public use.
- Transit Oriented Development (TOD).
- Mixed-Use Development.

Transport and Mobility integrated with Land Use:

- Proportion of population that has convenient access to public transport.
- Balanced Transportation Demand: Jobs-to-Housing Ratio.
- Walkability, access to services and trip times.

Urban Growth Patterns:

- Ratio of land Consumption rate to population growth rate.
- Patterns and behaviors of urban growth trends over the years.

Informal Settlements:

- Proportion of urban population living in slums, informal settlements or inadequate housing.

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Amman Case Study

Cultural Heritage:

- Total expenditure per capita on the preservation, protection, and conservation of all cultural and natural heritage, and the number of world heritage sites within 100km.

One of the main objectives of this project is to develop a constantly-updated GIS database connecting all the stakeholders (municipality, electricity and water companies...), and presenting it in a smart interactive way to be more accessible and comprehensible for decision makers, also to address and analyze many of the indicators mentioned above.

For example, by intersecting the municipality's land-use and built-up area layers with both the electricity and water consumption data for each building at any given time, it will give precise indicators at various scales, of how much energy or water has been consumed, both net and gross, wasted energy or resources and how efficient the consumption was compared to previous time periods for example, and other variables, which can be very helpful in understanding patterns, making decisions and for predicting future scenarios.

Also, by monitoring consumption behaviors in various land use types, especially residential, commercial and industrial areas, and given the general population data of any area provided by the Department of Statistics, comparisons would also be conducted regarding indicators like population density, work hubs and other related urban patterns.

The project also aspires to promote smart solutions like the use of lighting with motion sensors and monitoring GHG emissions (MRV).

Recommendations

- Developing a shared database for the city, connecting all stakeholders and encouraging community participation in the planning and management processes through smart solutions for both the public and decision makers on different levels.
- The use of constantly updated data and monitoring methods in decision making on the urban scale leads to a more sustainable, energy efficient and resilient city.
- Promote the use of energy efficient lighting solutions.
- Facilitate thermal insulation codes and Carbon-neutral construction methods into building codes for more efficient and sustainable buildings.



Rome Case Study

Challenges and Opportunities

Roma Capitale is currently working on the adoption of an “Action Plan for sustainable energy and climate- SECAP” outlining key actions needed to reach one or more goals towards a climate-neutral economy by 2030.

Roma Capitale signed several partnerships with prestigious organizations and research centers, such as the National Energy Services Manager (GSE), the National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) and the Institute for Environmental Protection and Research (ISPRA), for the purposes of being supported from a technical and scientific point of view by the best Italian public centers of excellence. In collaboration with ISPRA, Roma Capitale carried out research on the city’s energy consumption in terms of greenhouse gas emissions, outlining an inventory of greenhouse gas emissions from 2003 to 2015 and making an estimation of expected emission trends up to 2030.

The forthcoming SECAP document will define a list of key priority actions in different sectors towards a climate-neutral economy. The plan will enable Rome to comply with the EU binding target to cut emissions by at least 40 percent below 1990 levels by 2030. In addition to this target, the Action Plan will include a 2050 vision with the aim of reducing greenhouse gas emissions by 90 percent by 2050 (carbon-neutrality).

The above-mentioned analysis of energy consumption through the inventory of greenhouse emissions showed the high consumption of fossil fuels, especially in road transport, and of natural gas for heating and generating electricity, mainly in the residential sector (70 percent of the overall consumption).

For this reason, the study and planning of actions focus on increasing the use of renewable energy sources and energy efficiency in both public and private sectors. These actions will contribute up to 70 percent of a reduction of greenhouse emissions.

With the purposes of identifying key priority actions, six technical round tables were organized between April and June 2018, in partnership with GSE and ENEA, and over 100 stakeholders took part in the debate on energy efficiency and diversification. The objective of the round tables was to start a dialogue with the main stakeholders who will be involved in the definition and implementation of actions to be included in the plan.

The technical meetings along with promotion and participation initiatives (such as conferences, seminars, etc.), allowed the administration to define actions to be implemented between 2020 and 2030. The Action Plan is intended to be a “Participated Plan”, since municipalities, stakeholders (companies, associations, universities, financial Institutions, etc.) and citizens could interact and provide inputs to support the city in this strategic path.

(Continue)



Rome Case Study

With regard to renewable energies, the plan aims to develop photovoltaic systems in both the public and private sectors. This will be achieved through:

- Raising awareness and enhancing knowledge of citizens, businesses, and all future users;
- Training of installers and operators;
- Partnerships for the implementation and coordinated management of plants;
- Co-financing and/or activation of structural funds;
- ESCOs and/or financial institutions to support initiatives and management.

The analysis of mature technology and safety systems of energy production also investigated the potential of: biogas plants, fueled by manure treatment and agricultural waste of the Rome countryside; and plants powered by solid biomass, coming from the maintenance of forests and pine forests owned or managed by Roma Capitale as well as from periodic pruning of public greenery located in parks and in municipal villas. The analysis also considers the aerobic digestion component that must be ensured.

Energy efficiency measures cover the entire building park, from public and private residential buildings—redirecting and increasing the demand for energy redevelopment towards global interventions on the Building System—to hospitals, schools, hotels, public and private swimming pools, and the renewal of the household appliances.

Training and information activities are considered crucial to increase awareness. The opening of public offices specialized in the field of sustainable energy has been planned. These offices will assist citizens and constitute a physical network where citizens will be able to find all the information necessary for reducing energy waste, installing renewable energy, or carrying out energy requalification interventions. Employees (30 already trained) will be able to illustrate various feasible technical opportunities, savings, benefits etc.

The concept of energy transition is one of the pre-eminent themes of the plan, as it is naturally associated with the challenges posed by climate change.

The policies identified as effective and feasible are summarized below. Emphasis is placed on the following actions:

- The reduction of greenhouse emissions, according to most of the initiatives already identified in the SECAP (improvement of the energy efficiency of buildings through insulation and diffusion of heat pump systems, photovoltaic generation, storage, containment of energy dissipation, awareness/information activities).

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Rome Case Study

- The containment of urban heat through measures to increase the urban albedo, to reverse the consumption of soil, and to increase green surfaces (including urban agriculture).
- The promotion of a sustainable and active mobility (extension of cycle-pedestrian paths, expansion of limited traffic areas, electric mobility, car sharing and carpooling, smart working).
- The development of intelligent street lighting LED (smart lighting).
- The promotion of projects for the requalification of the area along the Tiber river, so that it can become a more friendly environment for cycling, walking, spending leisure time and entertainment activities.
- The creation of a disaster management center to deal with natural disasters and increase city resilience.

The current administration strongly believes in the importance of resilience. As a result of that, the municipality of Rome has been the first city in Italy to publish a strategic plan for Resilience. Resilience not only means preparing cities to better respond to natural disasters, perhaps even more importantly, it also means taking steps to prevent disasters. Urban resilience can also refer to building a diverse economy that can weather economic downturns. The city of Rome has benefited from two important projects on urban resilience: the *100 Resilient Cities initiative*, promoted and financed by the Rockefeller Foundation and the *European H2020 Smart Mature Resilience project*. Both projects focused on the important issues of climate change, critical infrastructures, and social dynamics, managing to identify most of the interdependencies between risks and situations of chronic stress to which the city is subject. In the framework of this analysis, the most effective resilience policies were evaluated—according to the methodology proposed by the two projects—increasing the level of urban resilience in Rome.

The main result was the establishment of the Rome's Office of Resilience, probably the best governance tool for understanding disaster risk scenarios and the socio-territorial framework of the city. The office helps to avoid interference and overlaps between city stakeholders, and it is a resilience policy itself. Furthermore, the implementation of policies at a local level was facilitated by a variety of local measures already in place (or already planned). The functions of the office are basically to coordinate and evaluate the effects of these policies. The new methodologies applied for assessing the interdependence of risks and level of resilience, standardizing of indicators, and participation and networking activities between cities all over the world, are shaping a new way of managing cities that will focus even more on resilience challenges.



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