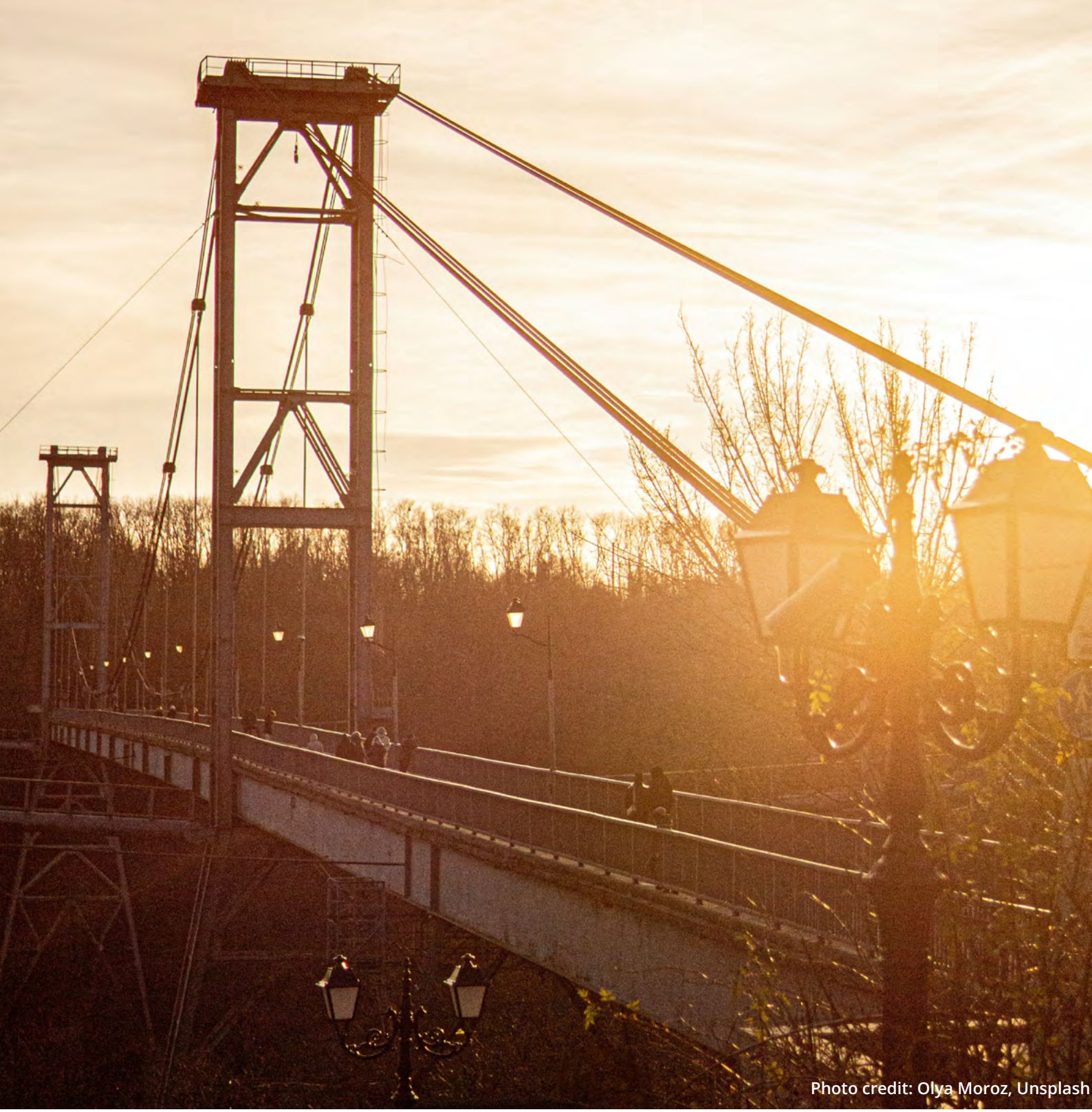

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URBAN TRANSITIONS MISSION CENTRE

POLICY BRIEF: TOWARDS MORE ENERGY-EFFICIENT CITIES

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Cities can do a lot to reduce the energy intensity of their biggest energy-consuming sectors, namely buildings and transport, given the powers at their disposal. However, various actors must work together to address the unique financial, technical, and socio-economic barriers. The example of Zhytomyr, Ukraine, illustrates the benefits of improved energy efficiency, including greater resilience.

INTRODUCTION

The rapid expansion of renewable energy generation must be accompanied by energy efficiency measures in order to make our energy system more viable. Urban areas, with their high concentration of population, infrastructure, and economic activities [1], are uniquely positioned to implement impactful changes to improve the way energy is transformed and consumed [2]. One of the benefits of energy efficiency measures is that they can be implemented in the short run and provide long-term benefits, as a number of these measures fall directly under the domain of local governments. In this context, local governments can develop and enforce policies, projects, standards, and regulations that promote and enable energy-efficient practices across a number of sectors, including buildings, transport, spatial planning, and so on.

In addition to the environmental benefits, such as reduced emissions and pollution, energy-efficient technologies and practices lead to cost savings for both local governments and residents in the long run [3]. They also enable the uptake of renewables and in doing so, enhance energy security by decreasing reliance on external energy sources and make urban areas more resilient to price volatility and supply disruptions. Additionally, energy efficiency measures support local job creation and economic growth, conserves natural resources, and increases the resilience of cities to extreme events [3].

However, the implementation of energy efficiency measures encounters several barriers, including financial constraints, policy and regulatory challenges, technical and knowledge gaps, behavioral and cultural resistance to change, lack of awareness, and infrastructure limitations that further complicate efforts. Institutional and administrative constraints, along with economic and social equity issues, such as accessibility for low-income communities and risks of displacement, also represent limitations. Furthermore, lack of data and difficulties in measuring the impact of energy efficiency initiatives make it difficult to establish benchmarks and track progress [4]. Addressing these barriers requires comprehensive strategies that include financial support, policy reforms, capacity building, stakeholder engagement, and robust data collection and analysis.

This policy brief aims to highlight the importance of energy efficiency in urban areas, examine current implementation measures, and identify the challenges faced in these efforts. In addition to providing recommendations for various stakeholders, it highlights the efforts of the City of Zhytomyr, Ukraine in implementing energy efficiency measures and its contribution to the city's resilience.

THE 'FIRST FUEL'

Energy efficiency is sometimes referred to as the "first fuel" in clean energy transitions as it provides some of the quickest and most cost-effective CO_2 mitigation options while simultaneously leading to lower energy bills and improved energy security. Together, efficiency, electrification, behavioral change, and digitalisation shape global energy intensity i.e. the amount of energy required to produce a unit of GDP, a key measure of energy efficiency of the economy [5].

USING ENERGY MORE EFFICIENTLY ACROSS BUILDINGS AND TRANSPORT

Energy efficiency measures can be adopted across almost all major energy-consuming sectors, using a variety of regulations and incentives. However, the building and transportation sectors are the most significant contributors to urban energy consumption and greenhouse gas emissions and will be the focus of this brief.

By targeting improvements in these areas, cities can address a substantial portion of their energy use and emissions, leading to significant environmental and economic benefits.

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ENERGY EFFICIENCY MEASURES IN THE BUILDINGS SECTOR

Cities often have direct control over building plans, codes, and approvals. However, they also have access to a number of other implementation mechanisms, including, but not limited to: target-setting, incentives and bonuses for developers, sustainable public procurement, infrastructure investment, etc. These can be used to spur action across the following measures:

- Upgrading HVAC systems: Adopting high-efficiency heating, ventilation, and air conditioning (HVAC) systems, such as energy-efficient air conditioners, furnaces, and boilers, can reduce energy consumption [6]. Using programmable thermostats, natural ventilation, and shading techniques can also help maintain comfortable indoor temperatures efficiently [7].

- Efficient lighting: Replacing incandescent and fluorescent lighting with LED lights can reduce energy consumption by up to 75%. LEDs are more efficient and have a longer lifespan, reducing maintenance costs. Smart lighting controls, such as occupancy sensors and daylight harvesting systems, can further enhance energy savings [3].

- Retrofitting and upgrading building envelopes: Energy-efficient walls, such as Trombe[1], ventilated, and glazed, along with advanced fenestration technologies such as aerogels, vacuum glazing, and high-performance frames, greatly improve thermal performance. Modern roofs, including green roofs, photovoltaic systems, and radiant-transmitting barriers, also contribute to energy savings. Utilizing advanced thermal insulation materials, thermal mass, and phase change materials can further reduce heating and cooling loads. Installing energy-efficient windows and doors, such as double or triple-glazed windows, to reduce heat transfer and improve insulation. Ensuring airtightness and minimizing infiltration by properly sealing gaps and cracks is crucial for maintaining indoor temperatures efficiently [8].

- Efficient district heating systems: District heating systems, which distribute heat generated in a central location to multiple buildings, can be made more efficient by switching the systems to renewable heat sources, including wastewater heat. Upgrading older distribution networks to minimize heat loss can also enhance efficiency [9].

- Energy-efficient appliances and equipment: Upgrading appliances and equipment can significantly reduce energy consumption. This includes refrigerators, washing machines, dryers, dishwashers, and office equipment like computers and printers. Regular maintenance and proper usage also play a key role in maintaining their efficiency. These actions go along with strong efforts in behavioral shifts to reduce household electricity needs [9].

- Demand response: This involves balancing power grid demand and reducing peak demand by encouraging customers to shift their electricity usage to periods when energy is more abundant or when overall demand is lower, often through pricing strategies or financial incentives [11]. Awareness campaigns play a crucial role in educating consumers about the benefits of demand response, promoting behavior changes that enhance participation and overall program effectiveness. For successful implementation, it is crucial to work with a wide variety of actors, such as building managers, utilities, etc.

ENERGY EFFICIENCY MEASURES IN TRANSPORT

Cities also have a high degree of influence on transport in their jurisdictions, whether through direct ownership of public transport companies or through their planning powers. Mechanisms such as sustainable procurement, capacity building, communication campaigns, people-centered urban planning, etc. can be used to shift transport towards greater efficiencies.

- Electrifying transport: Replacing traditional buses with electric or hybrid models can significantly reduce emissions and fuel consumption [12] as EVs tend to be more efficient than ICE vehicles. Optimizing rail routes and schedules to improve operational efficiency also plays a critical role. Energy-efficient driving can also optimize the speed profile at each section to minimize tractive energy consumption [13].

- Promoting active transportation: Developing extensive bicycle lanes and bike-sharing programs to encourage cycling and creating pedestrian-friendly streetscapes with safe, accessible walking paths. Increasing the use of bicycles and walking reduces the number of cars on the road, which helps alleviate traffic congestion, including health benefits, and reduces the carbon footprint of urban transportation [14].

- Urban planning and zoning: Planning urban development around transit hubs to reduce the need for long car trips (transit-oriented development) and encouraging mixed-use development to minimize travel distances between residential, commercial, and recreational areas [9].

1 The Trombe wall is a passive static solar type system that is made of dark-colored building materials and covered with vertical glass, whereby ventilated air can circulate between the wall and the glazing. Vents are located at the wall's top and bottom to allow air to enter indoors [10].

Yet, cities face significant barriers depending on their context. They can broadly be categorized as:

- **Financial barriers:** Some energy efficiency measures require high initial investment, and so smaller municipalities may struggle to attract investors or secure loans [4]. Lack of financial incentives to encourage the adoption of energy-efficient technologies can slow progress [15].

- **Technical and knowledge barriers:** City officials, builders, and developers may lack the technical knowledge required to implement advanced energy-efficient technologies and practices, necessitating capacity-building initiatives.

- **Regulatory and policy barriers:** The absence of strong policies and regulations mandating energy efficiency can lead to lack of adoption or inconsistency [4]. Complex and long bureaucratic procedures that can delay implementation.

- **Social barriers:** These include the reluctance to change habits and a low awareness of the benefits of energy efficiency [15]. Disparities in access to efficiency improvements can also exacerbate social inequities, such as upgrading buildings can lead to increased property values, potentially displacing low-income residents.

- **Data and measurement barriers:** A lack of reliable, local level and updated data on energy consumption and efficiency can make it difficult to set milestones, track progress, and make informed decisions.

EMPOWERING CITIES TO ENHANCE ENERGY EFFICIENCY

As cities face numerous barriers and to address these challenges and successfully implement energy efficiency measures, multi-stakeholder collaborative efforts are needed. This section provides recommendations for each of these stakeholders to support and accelerate the adoption of energy-efficient practices and technologies in urban areas (including all levels of government, financial actors, etc.)

For local and regional governments (LRGs):

- Develop and enforce policies such as building codes and energy performance standards along with incentives, such as tax credits, rebates, and grants.
- Simplify administrative procedures to reduce delays in the approval and implementation of energy efficiency initiatives. Foster collaborative work between departments to ensure cohesive and efficient project management.
- Assess the specific needs and characteristics of different neighborhoods, and tailor energy efficiency interventions accordingly.
- Launch public awareness campaigns about the benefits of energy efficiency, energy-saving tips, success stories, etc. to increase citizen uptake. Leverage media such as social media, local television, radio, and print to reach a broader audience.
- Involve community members, particularly from vulnerable populations, in the planning and decision-making processes of energy efficiency projects to avoid exacerbating social inequities, such as displacement and rising rent prices. This approach fosters a sense of ownership and inclusion among residents, leading to more equitable and sustainable outcomes.

For national governments (LRG):

- Create a supportive policy framework while providing guidelines for LRGs to implement energy efficiency standards effectively, for example fuel or other national standards.
- Allocate funding to support energy efficiency initiatives, and promote financing alternatives such as tax incentives, grants, and subsidies to encourage investment.
- Promote training programs to enhance technical expertise of LRG officials, personnel, and developers, and facilitate public awareness campaigns on the benefits of energy efficiency measures.
- Establish national mechanisms for tracking and monitoring the progress of energy efficiency initiatives.
- Facilitate partnerships and collaboration across levels of government to ensure the cohesive and integrated implementation of energy efficiency measures.
- Establish collaboration platforms for government agencies, the private sector, NGOs, and other stakeholders to share best practices and coordinate efforts.
- National governments can play a critical role by providing seed funding and guarantees to lower the risk for private investors, or by setting up revolving loan funds for energy efficiency improvements, ensuring a continuous flow of capital for such projects.
- Facilitate public-private partnerships to attract private investment in energy efficiency projects sharing knowledge, expertise and benefits between stakeholders.

For financial actors:

- Develop financial solutions that allow LRGs to access financing opportunities. These could include the creation of specialized green bonds and energy efficiency loans that provide favorable terms for municipalities [15]. On-bill financing programs can allowing cities and community members to repay energy efficiency investments through savings on their utility bills.
- Invest in pilot projects and scalable initiatives to demonstrate the viability and benefits of energy-efficient technologies.

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GET TO KNOW: ZHYTOMYR, UKRAINE

Zhytomyr, a city of over 260,000 people in the north of Ukraine, serves as a compelling example of how energy efficiency measures can improve a city's resilience.

Zhytomyr's energy efficiency journey began with an upgrade of its utility networks. Aging infrastructure meant that significant amounts of water and heat were lost. Despite the high costs, the upgrades reduced network losses from 25-30% to an average of 4.5%, the lowest in Ukraine compared to the national standard of 14%.

The city replaced old equipment at the Vodokanal pumping station which reduced electricity consumption by 20%. New sewage treatment plants are being built, and solar panels have been installed on the water supply system to ensure a self-sufficient power source. Zhytomyr has built high-tech thermal power plants that run on wood chips and pellets, reducing dependency on external heat supplies, while providing heat and electricity. Plans are underway to utilize recycled garbage as a fuel source, further decreasing reliance on gas.

Additionally, the city has undertaken thermal modernization and insulation projects for hospitals, and schools, significantly reducing gas consumption. Technologies such as heat pumps and solar panels have been implemented across various sectors. It is also the first city in Ukraine where all the streetlights are LED.

The impacts on overall resilience are evident

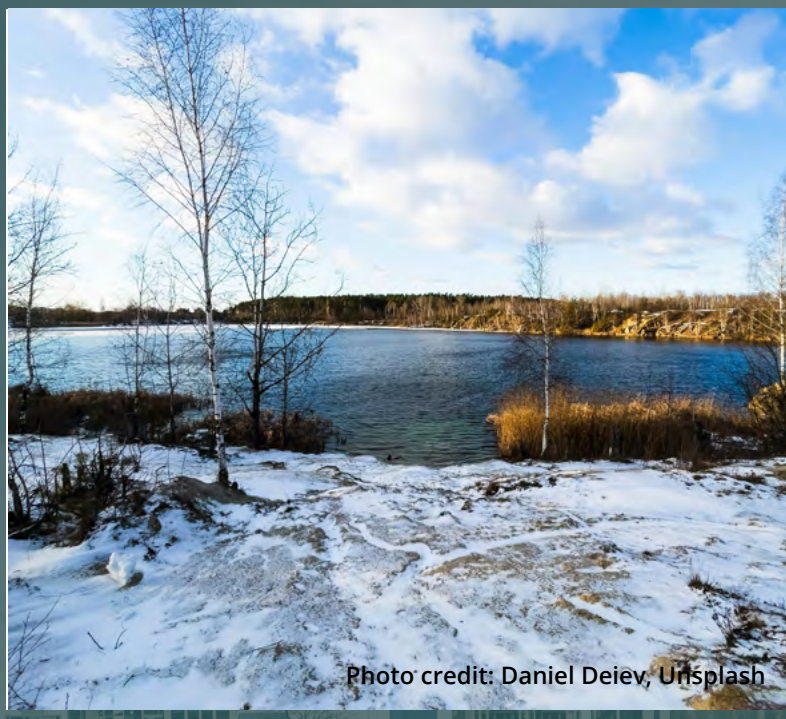

Photo credit: Daniel Deiev, Unsplash

—Zhytomyr avoided blackouts in the winter of 2022-2023 by efficiently managing its energy resources and infrastructure, such as by reducing peak loads and turning off non-essential power consumption. These actions were enabled by the decentralization reform project launched in Ukraine in 2014, which empowered cities to manage local taxes and budgets independently. This allowed Zhytomyr to attract international grants and manage its financial resources effectively.

From 2012 to 2024, Zhytomyr's gas usage has halved from 100 million m^3 to 47 million m^3. The city aims to reduce this further to 10 million m^3 by using alternative fuels, particularly waste, which only serves to highlight the overall systemic benefits of improved resource use.

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