Executive Summary: The Green Reconstruction of the Residential Sector of Bucha

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The residential sector has been the most heavily impacted by Russia's ongoing invasion of Ukraine, with over 250,000 buildings or 85 million square meters either destroyed or damaged, amounting to a replacement cost exceeding EUR 54 billion as of January 2024.

The city of Bucha was one of the most heavily affected cities during the first weeks of the war, but the resilience and rapid rebuilding following the city's liberation has also become a symbol and testament to the Ukrainian spirit. Extensive repairs were undertaken to both public and private buildings, with an increased focus on environmental sustainability, highlighted by the introduction of solar PV panels, heat pumps, and the application of energy-efficient technologies and strategies in the reconstruction process. Nonetheless, a more overarching, holistic approach towards the greener reconstruction of residential buildings in Bucha and many other Ukrainian cities has not been undertaken, with much of the reconstruction proceeding more ad-hoc with significant differences in the standards and quality of the rebuilt housing.

This report aims to address this gap by providing a comprehensive, quantitative assessment of both the technical aspects and monetary costs, benefits, and additional implications of upgrading more that 560,000 square meters of Bucha's damaged housing stock in a more energy efficient manner.

The analysis utilises five technical building models (with further subdivisions based on space heating and domestic hot water sources, as well as levels of insulation), which have been statistically determined to be representative of Bucha's damaged housing stock. These are scaled up to cover the entire damaged area to determine the cost of reconstructing to pre-war levels, with two levels of energy efficiency improvements then applied. The first, "Minimum Requirements" scenario is an upgrade to Class D and Class C standards of Ukraine's energy efficiency regulations, while the "Near Zero" scenario represents the Class A requirements with renewable energy sources. These two scenarios are then assessed vis-à-vis two energy price scenarios, the "Low Prices" scenario representing the current subsidised tariffs in Ukraine (with a minor annual increase), and the "Cost-covering Prices" scenario which assumes a more rapid convergence to cost-reflective tariffs.

The results of the study show are the following for the context of Bucha reconstruction:

- The cost of reconstructing Bucha's damaged housing stock to pre-war levels is estimated at EUR 106 million, with an additional investment of EUR 108 million to meet "Minimum Requirements", while upgrading to a "Near Zero" would require investments of EUR 212 million. The total cost therefore ranges between EUR 214 million and EUR 318 million.

- Physical energy savings of the energy efficiency upgrades are significant: 45% for the Minimum Requirements scenario vis-à-vis the baseline and 74% for the "Near Zero" scenario, with annual natural gas savings of up to 14.2 million cubic meters (in both direct use and district heating savings), and CO_2 emissions savings of up to 31,447 tonnes annually.

- Financial benefits for residents include significant energy bill savings, ranging from annual savings of over EUR 3.2 million with the “Minimum Requirements” upgrades and “Low Prices”, to over EUR 10 million annually with “Near Zero” upgrades when assuming cost-covering energy prices, representing a 64% energy bill reduction across all the damaged buildings.

- Payback periods for energy efficiency investments vary significantly, with the upgrades conducted under the low energy price scenarios showing a weighted average between 27 and 33.6 years, therefore mostly requiring financial support to ensure reasonable payback periods. Under the cost-covering price scenarios, payback periods improve to a weighted average of 15.3 years for minimum upgrades and 19.4 years for near-zero upgrades.

- Payback periods vary significantly by building type, with higher multi-story buildings, especially those connected to district heat performing well. Meanwhile, while single family homes register the largest percentual decreases in terms of energy consumption, the very high investment costs mean longer payback periods.

- Certain energy efficiency measures, such as solar PV panels for all building types, and individual heating substations for multi-story buildings connected to district heating, are identified as no-regret options under all scenarios. Due to their competitive payback periods and potential for significant cost savings, these measures therefore represent the most logical starting point in energy efficiency upgrading.

- Increasing energy efficiency build-out has significant potential benefits for the local economy, job creation and potentially energy efficiency equipment manufacturing supply chains in Ukraine.

Large-scale energy efficiency upgrades face financial challenges due to high initial investment needs and a pronounced funding shortfall. Access to crucial national or international financial assistance is limited for many communities, with financial viability of projects impacted by high inflation and interest rates. The case of Bucha, as well as other Ukrainian cities, underscores the inadequacy of solely depending on local and national funds for energy efficiency initiatives.

Solving the financial challenges is essential, especially:

- Support from international sources, in the form of grants and concessional loans will play a key role, but the importance of mobilising private sector investments becomes increasingly clear, demanding the creation of a supportive regulatory framework and financial incentives.

- Innovative financing strategies, such as public-private partnerships, municipal bonds, and the strategic formation of municipal consortia, are essential to unlock additional funding for extensive infrastructure and environmentally sustainable projects.

Policy reforms on the national policy level are pivotal to improving economic incentives and financial capabilities of municipalities and individual homeowners, enabling the green reconstruction on a wider scale and with reduced needs for grant support. These include:

- The adoption of a nearly Zero Energy Building (nZEB) definition aligned with EU regulations, enforcement of these standards through enhanced monitoring, and a modernisation of the outdated housing code to better incorporate energy efficiency. Reforms to the rules governing

Homeowners' Associations (HOAs) should aim at boosting their financial capabilities for energy efficiency projects.

- The much lower payback periods for the "Cost-covering Prices" scenario underscores the urgent need for energy tariff reform to establish cost-reflective prices for electricity, natural gas and district heat, making investments in energy efficiency and distributed renewable generation more financially viable.

- Carbon pricing can be complementary to energy tariff reform, reducing payback periods further and improving the relative attractiveness of clean energy solutions, such as heat pumps, over natural gas boilers.

- Phasing out energy price subsidies in favour of targeted, consumption-independent support to vulnerable consumers or broad-based social transfers will ensure a more equitable distribution of benefits while alleviating the financial strain on public budgets.

These results and overall findings of the report therefore have significant implications for both the municipal and national level contexts, necessitating significant policy changes to enable a greener energy efficiency reconstruction of both Bucha's and Ukraine's damaged housing stock.