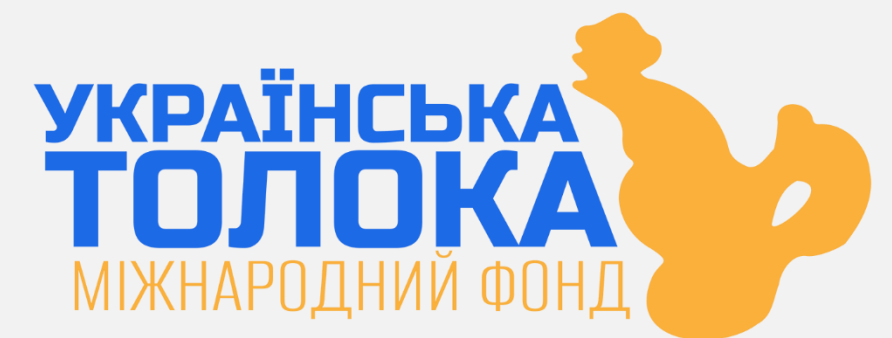




THE MATRIX HOUSE-BUILDING PLANTS NETWORK

as an Integral Part
of Ukraine's Reconstruction



Prerequisites for Creating a Network of House-Building Plants

The demand for the construction/renovation of housing and social facilities in Ukraine many times exceeds the volume that can be implemented by the network of house-building companies under this project many times over.

We anticipate having two areas of construction:

- Restoration of destroyed housing and social facilities. Such projects encompass the construction of facilities at the locations where these were destroyed.
- Construction of new housing for internally displaced persons (IDPs). In this case, along with housing, schools, kindergartens, etc. should also be built. That is, we mean a part of Ukrainians who will not be willing/able to return to their former locations.

Prerequisites for Creating a Network of House-Building Plants

In our opinion, the construction of housing for IDPs does not affect the total volume of construction, but only shifts compact construction locations from one region to another.

In total, more than 7 million Ukrainians have become internally displaced in our country due to the war, according to the Ministry of Reintegration of Ukraine. More than 1 million of them are children.

The eastern region of Ukraine is the leader in the number of internally displaced persons. There are 1.9 million IDPs in Dnipropetrovs'k, Kharkiv, and Zaporizhzhia regions.

1.7 million people have chosen western Ukraine as their place for temporary residence. These are Lviv, Ivano-Frankivsk, Chernivtsi, Zakarpattia, Ternopil, Khmelnytsky, Rivne, and Volyn regions.

The Northern region (Kyiv, Zhytomyr, Chernihiv, and Sumy oblasts) hosted 1.6 million IDPs, and the Central region (Vinnytsia, Cherkasy, Kirovohrad, and Poltava regions) hosted 1 million IDPs. In the Southern region (Odesa and Mykolaiv), a total of 0.7 million IDPs are registered.

Prerequisites for Creating a Network of House-Building Plants

For now, it is not known how many IDPs will stay in the new location and how many will have to return, but the above figures will undoubtedly affect the zoning of matrix house-building plants on the territory of Ukraine.

In our opinion, the construction of housing for IDPs will not affect the overall volume of construction but may only affect construction sites zoning.

The basis for the approximate volume of housing and social facilities' restoration in this project is the "Report on Direct Infrastructure Damage From the Destruction Caused by Russia's Military Aggression Against Ukraine as of September 1, 2022", which was developed by the analytical team of the Kyiv School of Economics (KSE) together with the Ministry of Communities and Territories Development of Ukraine, the Ministry of Infrastructure of Ukraine, the Ministry of Health of Ukraine, in coordination with the Ministry of Reintegration of the Temporarily Occupied Territories of Ukraine and in cooperation with other relevant ministries.

Prerequisites for Creating a Network of House-Building Plants

Unfortunately, there is no more up-to-date data available from the KSE. Therefore, the report's figures had to be extrapolated. Given the nature of the warfare from September 2022 to January 2023, the extrapolation factor $K=1.6$ can be conditionally accepted. It should also be taken into account that it is desirable to rebuild everything within a five-year period.

According to the CSE, 72.1 thousand residential buildings (with a total area of 30.8 million m^2) were completely destroyed (the extent of destruction was more than 40%) as of September 1, 2022. In addition, according to preliminary data, 616 administrative buildings, 289 hospitals, 1,270 schools and 786 kindergartens were destroyed as a result of the warfare. It can be assumed that as of February 1, 2023, about 50 million m^2 of housing and social facilities need to be built in Ukraine.

Proceeding from the fact that the planned capacity of one house-building plant is 120 thousand m^2 /year of total building area, a network of ten matrix house-building plants will be able to commission about 6 million m^2 in 5 years. Such volumes, of course, can in no way satisfy the overall needs, but they can be a significant contribution. At the same time, it is not appropriate to expand the network in order to increase the construction scope. As the network size grows, the problems with network manageability will increase disproportionately.

Network of House-Building Plants Concept

1. For the large-scale construction and commissioning of buildings, there is no alternative to industrial construction methods. According to a study done by McKinsey & Company, industrial construction can reduce the time for facilities construction by 20-50% and drop the construction cost by over 20%.
2. The industrial construction system is based on the following mandatory “cornerstones”:
 - Accelerating the pace of construction as much as possible
 - A substantial reduction in the average cost of facilities’ construction (\$/m²)
 - Reducing the labour intensity of construction as much as possible. Transferring labour-intensive processes from facilities to industrial production as much as possible. Given the expected “construction boom,” there are simply not enough skilled workers and middle-level ETP professionals in Ukraine available for the works under the traditional technologies (such as “well and truly laid brick”).

Network of House-Building Plants Concept

- The significant reduction in the weight of buildings reduces their transportation costs. With fuel prices at almost €1.5 per litre, the transportation component will account for an increasingly significant part of production costs.
- A significant reduction in the specific consumption of reinforcing steel, cement, etc. per 1 m². As a result of the war, the cement industry remained exclusively in the Western region of Ukraine. There are also problems with the production of reinforcing steel and construction steel.
- Consideration of the present situation in the construction materials market caused by the war. In particular, there is a shortage of insulation, gas silicate blocks, plasterboard, etc.
- Strict adherence to the principles of sustainable construction and sustainable development requirements. Specifically:
 - Reducing the carbon footprint as much as possible during the construction and operation periods
 - Requirements for the complete recycling of building materials after the end of their service life

Network of House-Building Plants Concept

3. The system of the network of "matrix" house-building plants is based on the following principles:
 - The network consists of ten house-building plants, of which one is an anchor HBP and nine are matrix HBPs. The Anchor House-Building Plant has a full range of production facilities for its own region. It will also supply the needs of nine other regional HBPs in the network:
 - Reinforcing products such as trigon frames and wide meshes for the filigree wideslabs
 - Si-X THERM insulation
 - Outer wall panels
 - Pitched roof panels

At the same time, the supply of ready-mixed concrete for the anchor HBP facilities is expected to be mainly from local suppliers at a distance not exceeding 20 km.

Network of House-Building Plants Concept

- The nine matrix HBPs will not have their own production facilities. Precast concrete structures (columns, girders, filigree wideslabs) and ready-mixed concrete will be ordered from local concrete manufacturing plants. Trigon frames and wide meshes for these products will be supplied by anchor HBP. The outer wall panels, pitched roofs and Si-X THERM insulation panels will be supplied by the anchor house-building plant.
- Meanwhile, the design and construction complexes of the matrix housebuilding plants will be identical to those of the anchor housebuilding plants. The design and construction complexes of the matrix HBPs will form the production tasks (by brands and colours of panels) for anchor HBP production lines.
- Overall, each matrix HBP will be a small construction and installation factory with up to 550 construction employees, management and ETP personnel, and its own transportation and mechanization units.
- Due to the absence of a production base, the matrix HBPs will be able to migrate across Ukraine to the places where construction projects are concentrated.

Network of House-Building Plants Concept

- Reusable models should be developed for the entire network for 2-4 and 5-7 storey block sections, which will allow for forming residential groups of any configuration. The section sets should include the following:
 - Ordinary meridional
 - Latitudinal with entrance groups from the north and south
 - North and south corners (left-right)

The sections should be designed in such a way that they meet the thermal resistance and seismic requirements in any region of Ukraine.

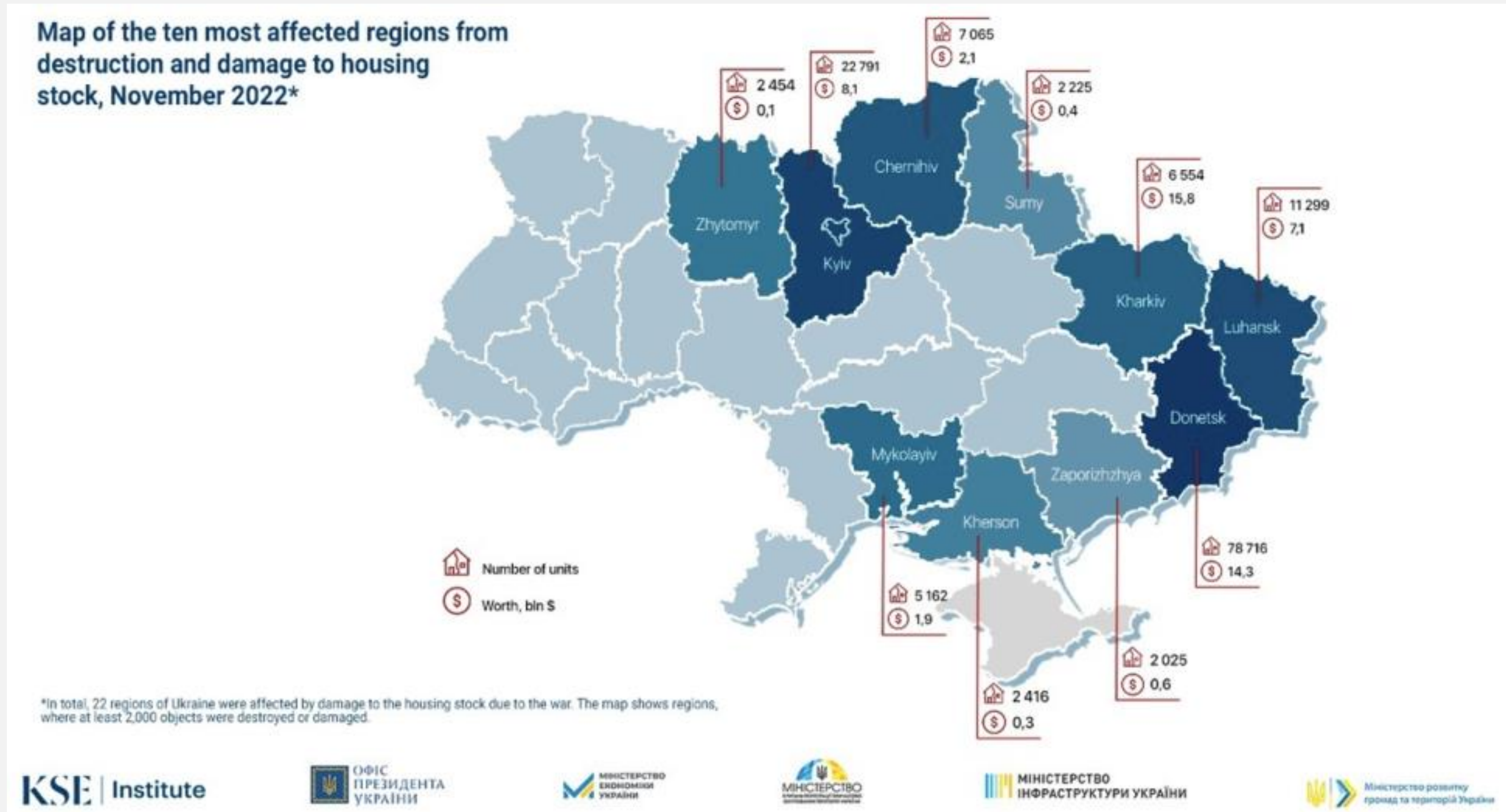
The section designs should be developed with the variability of ground floors:

- Residential floor
- Commercial floor
- Residential floor with access to the "front gardens"

Network of House-Building Plants Concept

4. Zoning of the matrix HBPs network

For the preliminary zoning of the matrix HBPs network, a map was taken from the KSE's report as of September 01, 2022 and the data provided by the Ministry of Reintegration



Network of House-Building Plants Concept

Based on the available baseline data, taking into account the existing ferro-concrete/concrete production base and the fact that matrix HBPs will migrate across the country if necessary, the tentative network map may look as following:



Network of House-Building Plants Concept

However, the network has only one fixed/anchor house building plant in the Kyiv region. As the network is built/developed, additional capacities for the production of Si-X THERM insulation, exterior wall panels and pitched roofs can be added.

In fact, the need for construction in the regions of Ukraine is impossible to determine professionally at this time. The location of the facilities will be heavily influenced by figures from the industry ministries and new jobs created in the regions under the upcoming Marshall Plan for Ukraine.