SUNFLOWER 46: REBUILDING HOPE

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Faculty Lead
PROJECT OVERVIEW

INTRODUCTION

CONSTRAINTS AND OPPORTUNITIES

DESIGN CONCEPT AND GOALS

DECATHALON CONTESTS

REFLECTION

CONCLUSION
Ukraine's Second Largest City

Located

Schools Damaged in War

Average Age

Population of 1.4 Million

25 Miles From Russian Border

2,600

35
**Climate (Zone 5A)**

<table>
<thead>
<tr>
<th>Location</th>
<th>Kharkiv, Ukraine</th>
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<tbody>
<tr>
<td>Climate Zone</td>
<td>5A</td>
</tr>
<tr>
<td>Elevation</td>
<td>500' / 152 meters</td>
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<tr>
<td>Mean Temp</td>
<td>47 degrees F</td>
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<tr>
<td>Heating Degree Days</td>
<td>4955</td>
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<tr>
<td>Cooling Degree Days</td>
<td>840</td>
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The south wing of Kharkiv School #46 was destroyed beyond repair. The remainder of the school is still intact, with its original concrete post-and-beam construction.
Preserving the old building saved 86 million MBTU. We also deconstructed the destroyed building and reused rubble in floor slabs and planter boxes.

26 million MBTU was saved by using sustainable building materials such as flyash concrete and mass timber.
INTRODUCTION

Constraints And Opportunities
Design Goals
Big Questions
Design Strategies

DESIGN PRINCIPLES

CULTURAL MATERIAL RECOVERY

TRAUMA-INFORMED DESIGN

ARCHITECTURE AS THE THIRD TEACHER

SUSTAINABLE LIFESTYLE

BIOPHILIC DESIGN

/ADAPTIVE COMFORT

HOW CAN BIOPHILIC AND NET-ZERO DESIGN PROVIDE HOPE AND HEALING FOR WAR-TORN COMMUNITIES?

INTRODUCTION
- Constraints And Opportunities
- Design Goals
- Big Questions
- Design Strategies
WHAT IF WE USE MODULAR DESIGN TO LOWER OUR CARBON FOOTPRINT IN POST-WAR ADAPTIVE REUSE PROJECTS?
HOW CAN WE MAKE LEARNING ABOUT SUSTAINABILITY MORE ACCESSIBLE FOR STUDENTS BY USING ARCHITECTURE AS A THIRD TEACHER?
While keeping the traditional Ukrainian school system in mind, we decided to add solar gardens to introduce learning about sustainability into the school system.
FLOOR 1
1:200

1. Solar Atrium
2. Middle School Classroom
3. Breakout Space
4. Restroom
5. Lounge
6. Winter Gardens
7. Tributary Walkway
8. Greenhouse
9. Bi-facial PV Covered Walkway
10. Intensive Green Roof
11. Gymnasium
12. Cafeteria
13. Commercial Kitchen
FLOOR 2
1:200

1. Solar Atrium
2. Vocational Classroom
3. Breakout Space
4. Restroom
5. Lounge
6. Winter Gardens
Solar Garden Library Oculus
The top floor of the solar garden library features a quiet space where you can relax between classes or grab a book.

Old and New Bridge
The bridge showcases the school's old structure while connecting to the new mass timber structure.

Living Machine® Interior Marsh
The fourth and sixth steps of the living machine are shown on the ground floor to help spark curiosity among students and visitors.
The new south wing is designed to create flexible space between classrooms, offices, study rooms, and labs.
Cross Section Through Solar Atrium Looking North

1. **Living Machine TM Effluent Wetland**
   Typical wetland species remove the remaining nitrogen through root systems and convert them to harmless nitrogen gas.

2. **Living Machine TM Tanks**
   “Wastewater is treated with bacteria, plants, algae, snails, insects, and fish. In these tanks ammonia and organic nitrogen are converted to nitrates. Each one is capable of handling 75% of the maximum daily flow.”

3. **Mass Timber Supporting Columns And Beams**
   Using mass timber to rebuild the new wind and solar atrium can reduce the embodied energy by 20-50% compared to concrete construction.

4. **Terracotta Shading Screen**
   Using terracotta in beneficial for our building due to its mass production, long life cycle, low maintenance and insulative properties.
Product: Isolofoam Isorad V2 Hydronic Radiant Concrete Slab Heating
Location: Whole building floor plates in climate regulated zones
Function: Regulates temperature of building through hydronic radiant concrete slabs
Features:
- Enables separation of heating zones through multidirectional tube retention
- Reduces heat loss through EPS thermal barrier
- Greenguard Gold-certified product

Product: SolerPalau HRSB and HRSD Fresh air Supply and Return Roof Vents
Location: Rooftops of classroom wings and library
Function: Fresh air supply and exhaust to classroom wings and library
Features:
- Rated to over 56,000 CFM
- Static pressure capability up to 3/4”

Product: Ecodan QAHV Monobloc Air Source Heat Pump
Location: Gymnasium and cafeteria
Function: Heating and cooling for gym and cafeteria
Features:
- Operational limit -25°C
- Utilizes CO₂ refrigerant with a GWP of 1
- Uses a spiral gas cooler to enhance energy efficiency

Product: Water Furnace Envision NZD Geothermal Heat Pump
Location: Mechanical room in gymnasium
Function: Regulates temperature of R-410A liquid feeding into radiant floor slabs
Features:
- Efficiency: Up to 3.5 COP; Up to 22.0 EER
- Size: 15 ton dual compressor
- 60% energy cost reduction compared to conventional systems

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Product: SunEarth Indirect Loop Glycol Solar Hot Water System
Location: Rooftops of wings, interspersed with solar panels
Function: Provides hot water for building use
Features:
- Impervious to freezing
- High efficiency relative to other types of solar water heating
- Used in combination with SunEarthCASCADE 2 Hot Water Station

Product: FieldControls Model FC200ERV Energy Recovery Ventilator
Location: One per floor per classroom wing, ceiling-mounted
Function: Fresh air supply and exhaust to classroom wings and library, heat recovery from outgoing hot air to incoming cold air (winter)
Features:
- 83% effectiveness at 32°F
- Humidity regulation via polymer membrane
INTENSIVE GREEN ROOF
WITH 10” MEDIA DEPTH
ANNUAL AVERAGE HEAT FLUX OF 17.2
THIS ROOF WILL HELP KEEP BUILDING TEMPERATURES STABLE

RAINWATER COLLECTION
TOTAL ANNUAL RAINWATER COLLECTION POTENTIAL: OVER 1,000,000 GALLONS

GEOTHERMAL WELL
THIS SYSTEM USES THE EARTHS RELATIVE SUBSURFACE TEMPERATURE TO ADD AND REMOVE HEAT FROM THE BUILDING
EUI Target vs EUI Reached

Site Energy Use Intensity

EUI: 0 kBtu/ft²

Annual Energy Consumption (kBtu/ft²/year) & CO₂ KgCO₂/ft²/yr

<table>
<thead>
<tr>
<th>Fuels</th>
<th>End Uses</th>
<th>Site Energy</th>
<th>Source Energy</th>
<th>CO₂ Emissions</th>
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<td>Heating</td>
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<tr>
<td>TOTAL (ex renewables)</td>
<td></td>
<td>29</td>
<td>82</td>
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Wall Detail
Material Integration

Efficiency

Grid-Interactivity

Life Cycle

Health

Market

Community

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Solar Decathlon - Sunflower 46
Team 19142 - University of Oregon
Cultural Material Application

**CORN AND SUNFLOWER INSULATION**
Using Ukraine's large exporting that produce excessive waste, fiber insulation can be made. This insulation can sequester carbon while standard insulation contributes to carbon emissions.

**FLY ASH CONCRETE**
Concrete is responsible for 10% of CO2 emissions. The use of fly ash can increase carbon uptake life and strength of concrete and partially replace cement use.

**UKRAINE'S TOP EXPORTS:**
- SUNFLOWER PRODUCTS
- CORN
- IRON ORE

**REUSE OF RUBBLE**
In new concrete: reuse + longevity. Using materials from the impacted southern wing to build landscaping and some rubble walls limit the need for new materials.
The new double loaded wing allows for light to enter through skylights in the hallways lighting the classrooms, offices and labs with natural daylighting. The new wing also supports a large amount of photovoltaic panels that get extensive sun exposure.
The use of a large opening in the solar garden allows for light to travel and disperse throughout open floor. In the classroom wings there is sufficient light during the day limiting the need for electric lighting cutting down on overall operational costs.

Most of the educational spaces are receiving 2-5% DF and 90% of the areas have a DA 300 lux.
**Energy Model Output Report**

**Project:**

**Design Team:**

**Address:**

**Climate File:**

UKR_Kiev.333450_IWEC.epw

**Owner:**

**Simulation:**

Actual system.aps

**Conditioned Area (ft²):**

115641.1499

**Annual Energy Consumption (kBtu/ft²/year) & CO2 KgCO2/ft²/yr**

<table>
<thead>
<tr>
<th>Energy End Use</th>
<th>Site Energy</th>
<th>Source Energy</th>
<th>CO2 Emissions</th>
</tr>
</thead>
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<tr>
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<tr>
<td>Fans Interior</td>
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<td>Heat Rejection</td>
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<td>DHW Electricity</td>
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<td>Receptacle</td>
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<tr>
<td>Data Center</td>
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<td>Cooking</td>
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<td>Refrigeration</td>
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<td>0.0</td>
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<tr>
<td>Process</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td><strong>TOTAL (ex renewables)</strong></td>
<td>26</td>
<td>82</td>
<td>0</td>
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**Site Energy Use Intensity**

**Annual Fuel Costs and Peak Demands**

<table>
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<tr>
<th>Fuels</th>
<th>Cost (£)</th>
<th>Peak Day</th>
<th>Peak Time</th>
<th>Peak Demand</th>
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<tr>
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<td>0.0 kBtu/h</td>
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<tr>
<td><strong>Total</strong></td>
<td>84,506.00</td>
<td>01-Jan</td>
<td>0:00</td>
<td>0.0 kBtu/h</td>
</tr>
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</table>

**CLT roof with exposed wood finish**

**Operable envelope for direct access to roof garden and urban**

**Diffuse daylighting with roof monitors**
Integrating photovoltaic systems (PVs) into a building's design offers numerous benefits, especially with innovative technologies like bifacial panels for covered outdoor walkways and one-axis tracking systems on roofs.
If we had designed this as a traditional building the concrete use would make up 89% of the global warming potential, while with the reuse of rubble our LCA analysis the concrete only makes up 5% of global warming potential.
Global Warming Potential: Comparing Three Scenarios

- **Our Project**: 254,409 kg CO2 eq
- **Full rebuild Concrete Mass Timber Hybrid**: 2,112,932 kg CO2 eq
- **New Concrete Construction**: 2,365,021 kg CO2 eq
FIVE IMPLEMENTED PRINCIPLES OF TRAUMA-INFORMED DESIGN

1. Autonomy and Control
2. Minimal Clutter
3. Views of Nature
4. Varied Lighting Strategies
5. Residential Finishes

SIX IMPLEMENTED PRINCIPLES OF BIOPHILIC DESIGN

1. Natural Forms and Shapes
2. Human Nature Relationships
3. Natural Patterns and Processes
4. Environmental Features
5. Light and Space
6. Plant-based Relationships

Petals of Design
Access to Greenery

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Solar Decathlon - Sunflower 46
team: 3142 - University of Oregon
Providing green space for students allows for connection to the outdoor and with peers through natural play.
Green space is essential to health, we have implemented a living system into our solar garden allowing for quick access to greenery.
Rubble from deconstructed wing was reused in landscaping and trombe walls.

The adaptive reuse wings were lightly touched on with facade treatments while reusing 90% of existing structure.

With adaptive reuse construction costs are lower and CO2 emissions are lowered.
Choosing to retrofit allows familiarity for students, faculty and community as well as lower market cost allowing for an effeicent rebuild for a country rebuilding.
Using local material in our building allows for familiarity and connection to the community of Kharkiv. Using these materials also reduces carbon and cost.
Collaborating with students Diana Hritsay, Hanbin Guo, Maryna Meshchieriakiov, and Professor Serhii Ilchenko from the University of Kharkiv on rebuilding School 46 has been an inspiring and transformative experience. Despite the adversity faced by their community, the students from Kharkiv bring a remarkable resilience and determination to the project. We empathized with their struggle to envision a future of hope and our collaboration brought out the joy in designing for students to inhabit a school again.
REFLECTION
Thank You

U.S. Department of Energy
Solar Decathlon Organizers
Solar Decathlon Jurors

Kharkiv Academy Of Design And Arts
Professor Serhii Ilchenko
Students - Diana Hritsay, Hanbin Guo, Maryna Meshchieriakova

Ihab Elzeyadi
University of Oregon
Solar Decathlon Studio Winter 2024 and Reviewers

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Izzy Chew
Quincey Dunlap