Deep-Performance Dwelling:
Canada’s 2018 Solar Decathlon China Competition Entry

Prepared for:
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**2018 Solar Decathlon China: Deep-Performance Dwelling**

**Introduction**

**Competition Summary Points:**

- Launched by the US Department of Energy (DOE) in 2002.
- The **2018 China International Solar Decathlon Competition** involved 19 Collegiate Teams from four continents.
- Team Montreal (McGill and Concordia) is the sole Canadian entry: Deep-Performance Dwelling (DPD)
- 2018 competition will be held in **Dezhou – the sun city of China.**
- Each team is required to design and build a two-story, **Net Zero Energy capable designed, solar-powered house** with a floor area of 120-200 m² (1290-2150 ft²).
- The jury will evaluate the house’s cost feasibility, power efficiency, environment adaptability, power generation capacity, and architectural quality. Final judging is determined by a total of **ten contests** (5 measured, 5 juried contests).
First Place

TeamMTL:
- Only team to place in all juried competitions
- Only team to fully build its entry
- 22-days construction

Third Place
URBAN DENSITY AND AFFORDABLE HOUSING

The Deep-Performance Dwelling is intended as an urban single-family home that answers the pressing global challenge to provide affordable and robust housing in cities that must achieve greater environmental and cultural sustainability, livability, and social equity. It includes nested layers of private/shared/public space.

“DEEP” performance means a socially, culturally, and technologically sophisticated architecture built for 21st century urban life.
The ongoing transformation in the social dynamics and variability of composition of the contemporary family unit is a primary driver for innovation toward urban sustainability. The need for flexibility and adaptability over time for diverse living configurations (live/work/play, intergenerational, extended family) is an inspiration for the architecture of the Deep-Performance Dwelling.
DEEP-PERFORMANCE DWELLING
NESTED PUBLIC AND PRIVATE SPACES
DEEP PERFORMANCE DWELLING
PASSIVE HOUSE PANELIZED ENVELOPE

THERMAL ENVELOPE COMPOSITION

ROOF ASSEMBLY (INTERIOR TO EXTERIOR)
- 5/8" PLYWOOD PANELING CEILING FINISH
- 2X4" RAFFTER, 24" O.C., WITH 1.5" MINERAL WOOL INSULATION
- 3.4" ZIP SHEATHING (AIR AND VAPOR BARRIER)
- 16" OPEN-WEB I-JOIST, 24" O.C., WITH 15.5" MINERAL WOOL INSULATION
- 3.4" ZIP SHEATHING
- TAPERED RIGID INSULATION (12" TO 2.5" THICK)

WALL ASSEMBLY (INTERIOR TO EXTERIOR)
- 5/8" PLYWOOD PANELING INTERIOR FINISH
- 3/4" OSB PANEL
- 2X4" STRUCTURAL STUD WALL, 24" O.C., WITH 3.5" MINERAL WOOL INSULATION
- 3.4" ZIP SHEATHING (AIR AND VAPOR BARRIER)
- 12" OPEN-WEB I-JOIST, 24" O.C., WITH 1.5" MINERAL WOOL INSULATION
- 1X3" VERTICAL STRAPPING
- 1X2" HORIZONTAL STRAPPING
- 1/2" CHARRED EASTERN WHITE CEDAR CLADDING

FLOOR ASSEMBLY (INTERIOR TO EXTERIOR)
- 3/8" ENGINEERED WOOD FLOORING
- 3/4" ADVANCED SUBFLOOR
- 3.4" ZIP SHEATHING (AIR AND VAPOR BARRIER)
- 16" I-JOIST, 24" O.C., WITH 15.5" MINERAL WOOL INSULATION
- 3.4" ZIP SHEATHING

PASSIVE HOUSE METRICS

R VALUES
Walls: 60
Floor: 60
Roof: 100

Exposed surface area to volume ratio: 0.6
Air Changes per Hour @ 50 Pascals: 0.35
ERV SRE @ 64CFM & 0°C: 84%

Space Heating Energy Demand: <15 kWh/m²yr
The DPD utilizes **off-site (factory) prefabrication methods** of construction. It is designed for **both modular & panelized** options. Prefabrication addresses issues of affordability, reduction of waste, health and safety of workers, greater export capacity, and quality control to achieve high-performance building standards.
The rooftop BIPV/T system over the front volume of the house provides 11.24 MWh of energy throughout the course of the year, enough to satisfy the annual demands of the house.

Heat captured from the photovoltaics is converted with an air-to-water heat exchanger and used to supply the hydronic heating system of the house. This operation also cools the photovoltaics, allowing them to operate at a higher efficiency.
DEEP-PERFORMANCE DWELLING
SMART-GRID CAPABLE (FUTURE READY)
Examples of normalized demand curves for an electrical grid, **winter peaking on the left** and **summer peaking on the right**, and possible associated signals from the utility company.
DEEP-PERFORMANCE DWELLING
22 DAYS: CONSTRUCTION PHOTOS - DEZhou, ShANDONG PROVINCE, CHINA
DEEP-PERFORMANCE DWELLING

22 DAYS: CONSTRUCTION PHOTOS - DEZHOU, SHANDONG PROVINCE, CHINA
DEEP-PERFORMANCE DWELLING INTERIOR
DEEP-PERFORMANCE DWELLING
EXTERIOR
MOMENTUM
LIVING LAB RESEARCH & DEVELOPMENT PROGRAM

Architecture-Construction-Energy
(research program)

Building-Architecture-Research Node
(fabrication, prototyping, testing facility)

Design-Build Workshop/Studio
(academic program)

Lead researchers: Salmaan Craig, Rosetta Elkin, Michael Jemtrud, Kiel Moe

Coordinated programs focus on advancing low-energy and low-carbon building construction:

• **High-performance building** systems and construction including new and deep-energy retrofit, prefabrication, breathing wall research and development, dynamic insulation, on-site resource management, high-efficiency MEP integration;

• **Grid-friendly** high-performance construction as it is integrated with on-site (renewable) energy production; storage, automation, and control systems; home-to-grid and vehicle-to-grid capability; smart and micro-grid integration;

• **Trans-scalar construction ecology** analyses of carbon, material, and energy inputs in the construction of buildings focused on decarbonization including the political, social, and economic drivers, barriers, and ramifications.

• **Broad-based network** of industry, public and private sector partners. As a ‘living lab’ it seeks to install the outcomes of the research (buildings and prototypes) in the world and to test, analyze, verify component and whole-building performance and durability.
A series of living lab demonstration projects are being formulated and pursued. Funding will be a combination of sources and partners depending on opportunities and timeframe ranging from private development to public sector funding available.

**Deep-Performance Dwelling – Montreal:** Build 3-6 homes in Montreal to be given to families in need of affordable housing. The house performance will be monitored over time as an ongoing research program for both McGill and Hydro Quebec.

Potential Partners:

- Hydro Québec
- SHDM
- Société d’Habitation Québec
- Montréal
- Transition Énergétique Québec