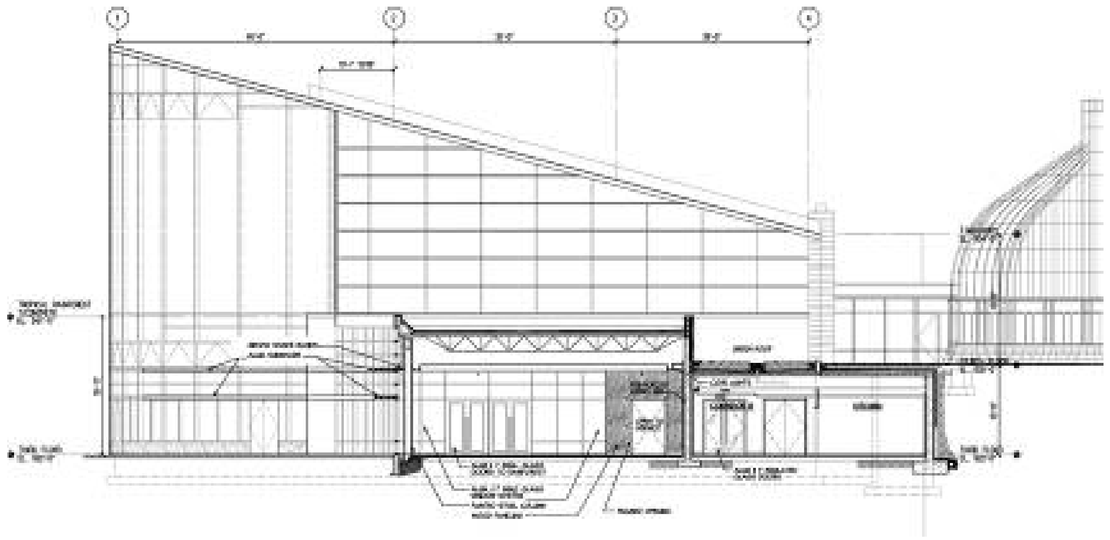
Tropical Forest Conservatory, Pittsburgh, PA, USA

Opened on December 6, 2006, Phipps' 12,000 square foot Tropical Forest Conservatory was approached as an opportunity to set a new standard in glasshouse design and construction.



Architect: *IKM, Inc.*
Client: *Phipps Conservatory and Botanical Gardens, Inc.*
Occupancy: *Assembly*
Heating Degree—Days: *-17.8 Degrees C*
Cooling Degree—Days: *32 Degrees C*
Gross Area Above Ground: *1,140 m^2*
Gross Area Including Below-Ground: *1,425 m^2*
Stories Above Ground: *One*
Estimated Annual Population: *250,000 in 2008*
Distance from Public Transport Stop: *300 Meters*
Predicted Annual Motor Car Travel by Visitors: *1,436,204 Kilometers*
Additional Design Team Members:
Greenhouse Consultant: Montgomery Smith, Inc., Burlington, KY
Owner Representative: INDEVCO
General Contractor: Turner Construction Co., New York, NY

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New and existing technology were combined with fresh design strategies to produce comprehensive solutions that eliminated many of the high costs associated with supplemental heating and cooling of a glasshouse.

Prior to construction, a building performance simulation was performed to model energy and cost savings to be achieved from the palette of innovative strategies.

The first of its kind in the country, the conservatory exhibits a different tropical forest region every two years.

Through 2008, the plants and culture of Thailand are featured. Plans are well underway for a transition to the Amazon region in 2009.

Environmental issues and the culture of each region are interpreted through plant life throughout the conservatory, allowing visitors to better appreciate diversity in our world.

PHIPPS

IKM

Radical Roof Design

- North sloping roof allows for insulated double-pane roof glass
- Half of the 12,000 sf roof opens
- Eliminates the "greenhouse effect"
- Inspired by open-roof greenhouse technology
- First ever computer-controlled Venturi effect
- Totally passive system to suck hot air out of the conservatory
- No enormous energy-consuming exhaust fans
- Vents run by Argus Control System

Energy Blankets

- Prevent convective and radiant heat loss
- Provide shade in summer
- Thermal insulation in winter
- Argus computer controlled
- Tied electronically to weather station

Earth Tubes

- Totally passive cooling
- Uses the earth to cool the air
- Replaces need for HVAC
- Largest conservatory installation in USA
- Six 24" diameter concrete tubes each 300' long/German technology
- Earth at 15' below grade is a steady 55° year round
- Hot outside air cools as it travels through the tubes into the conservatory
- Vacuum created by hot air exiting the roof vents pulls the cooled air into conservatory
- In the winter, makeup air is partially heated as it travels through the tubes

Sophisticated Computer Control

- Uses Argus, a fully integrated environmental control system
- Computer system opens and closes vents according to internal conditions and outside wind direction & speed
- Anticipatory computer controlled weather & temperature reacting system
- Maximum energy and irrigation efficiency
- Smoother, more uniform growing conditions
- Better plant quality and uniformity
- More comfortable environment for visitors
- Precise equipment control and advanced data recording system

First Fuel Cell

- First fuel cell in the world in a conservatory
- 5kW Solid Oxide Fuel Cell efficiently produces electricity from natural gas
- Siemens & PA state funded prototype
- Waste heat captured and used to heat tempered water system
- Reduced emissions minimize contribution to global warming
- No nitrous or sulfur dioxide

On the Boards

- CO_2 pumped back into greenhouses
- Carbon sequestered by plants

Symbiotic Heating Systems

- Thermal massing in NW and NE walls collects passive solar energy daytime
- Foot-thick concrete wall insulated on outside
- Slowly releases heat back into exhibit at night
- Radiant root zone heating for plants
- Radiant floor heat for visitors
- Minimal fin tube heating system
- Green roof over support facilities
- Selective double-pane glass and energy blankets conserve heat
- Earth tubes pre-heat makeup air
- Argus controlled for maximum efficiency

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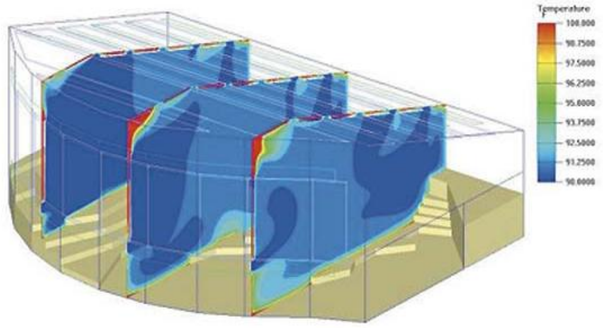
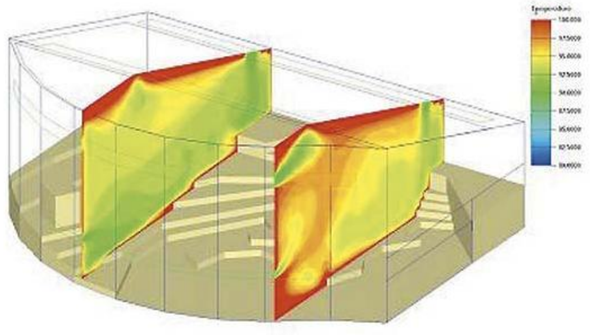
Performance Potential
Fluid Dynamics Study

The Tropical Forest Conservatory design incorporates glass roof openings every other row, creating a passive cooling effect.



Phipps Tropical Forest Conservatory Design



Traditional Conservatory Design

In contrast, traditional glasshouse design incorporates minimal venting openings, creating significantly higher temperatures within the building

Trane Trace 700 Energy and Economics Simulation

Construction: Tropical Forest Conservatory
- Double pane Insulating Glass in specific areas
- Automatic Shading at night
- Rootzone Heating and Unoccupied Setback to 16°C

Annual Energy Consumption:
- 250 million btus per year for space heating
- 265,000 pounds of steam used per year
- $2,370 annual cost from local steam provider
- $168 annual electrical cost to operate root zone pump during unoccupied hours

Construction: Conventional
- Single pane glass throughout
- No shading
- Maintain 22°C space temperature

Annual Energy Consumption:
- 1,780 million btus per year for space heating
- 1,880,000 pounds of steam used per year
- $16,800 annual cost from local steam provider

Architect: IKM, Inc.
Client: Phipps Conservatory and Botanical Gardens, Inc.

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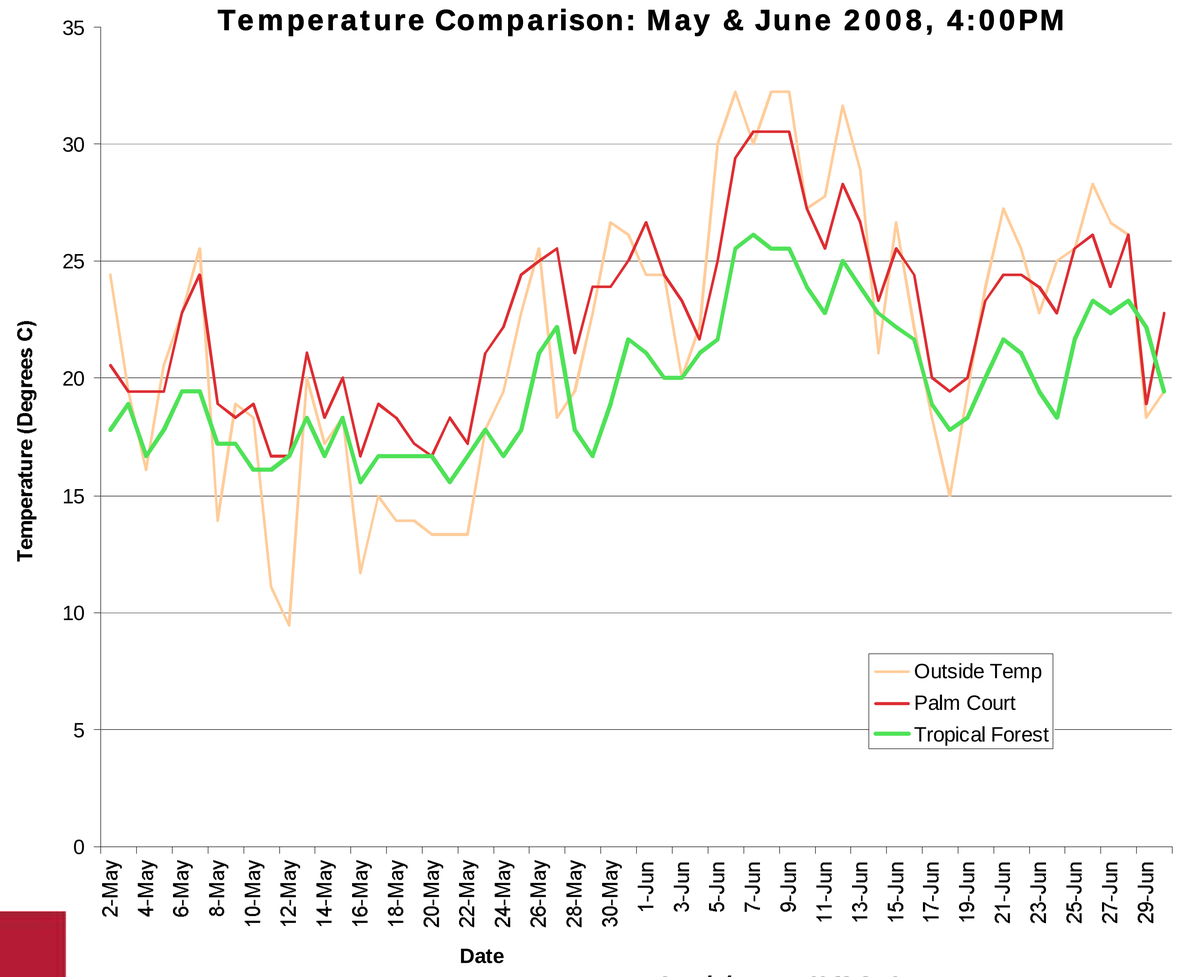
The Tropical Forest Conservatory is equipped with Argus software, a fully integrated environmental control system, maximizing energy and irrigation efficiency. The anticipatory computer controlled weather and temperature reacting system opens and closes vents according to internal conditions and outside wind direction and speed. While using less energy and water resources, the Tropical Forest Conservatory continually maintains an average cooler temperature of 3 degrees than a traditional glasshouse such as the Palm Court at Phipps Conservatory & Botanical Gardens.



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