Krisstina Wilmoth
Assistant Director for Research Collaborations
& Institutional Development
NASA Ames Research Center
Moffett Field, CA

# HISTORY OF PROJECT

- ✓ Business as usual – “Renovation by Replacement”
- ✓ Mid-level managers – enthusiastic but lacked vision
- ✓ Senior management provided inspiration (“First Lunar Outpost on Earth”), broke down barriers
- ✓ Informed by enlightened visionaries – William McDonough

# GOALS AND INTENTIONS

- ✓ ONE OF THE HIGHEST PERFORMING BUILDINGS IN THE FEDERAL GOVERNMENT
- ✓ ZERO NET ENERGY CONSUMING
- ✓ LEED* PLATINUM PLUS
- ✓ LIVING TEST BED FOR NEW TECHNOLOGIES
- ✓ “NASA INSIDE”

* USGBC’s Leadership in Energy and Environmental Design (LEED)

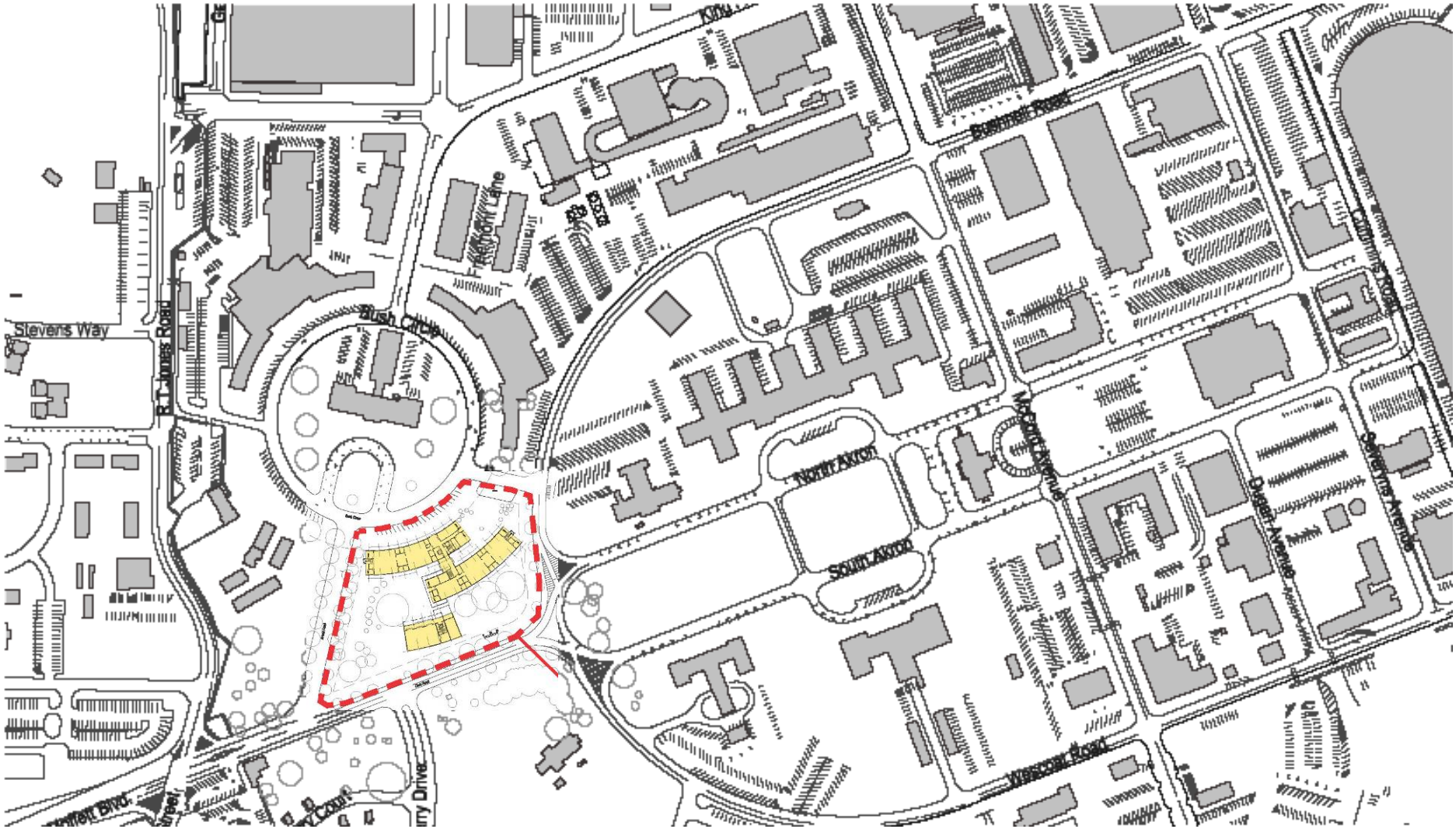
# OBSTACLES OVERCOME:

- ✓NASA HQ concern over schedule and budget risk
- ✓Federal Acquisition Regulations (FAR)
- ✓Pride of ownership and financial concerns for design team
- ✓Schedule, budget, schedule, budget, schedule, budget…

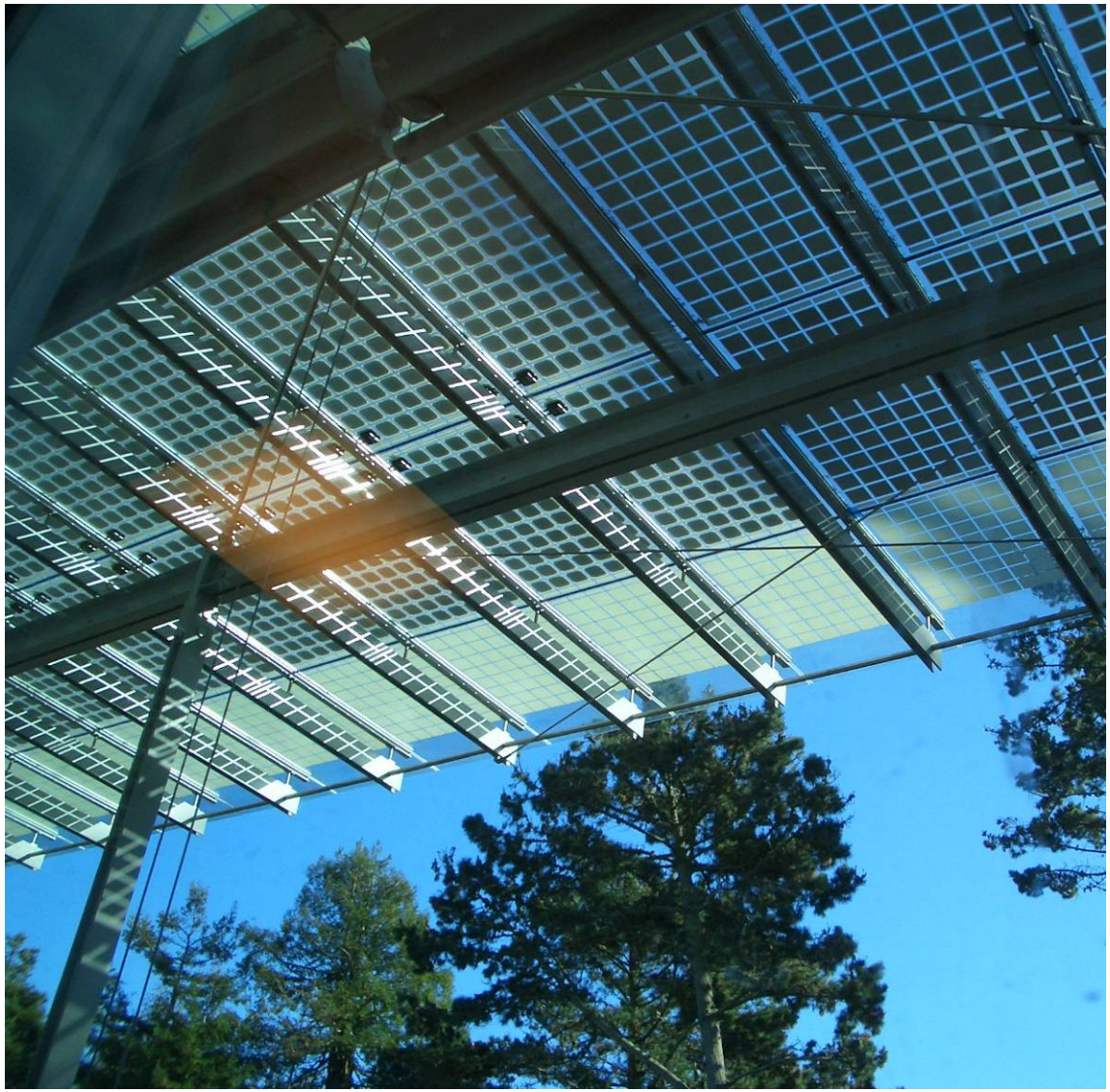
# GUIDING PRINCIPLES

- ✓"Native to Place"
- ✓Optimize passive strategies
- ✓Supplement with active strategies
- ✓On-site power generation
- ✓"Cradle to Cradle" principles
- ✓Biophilia

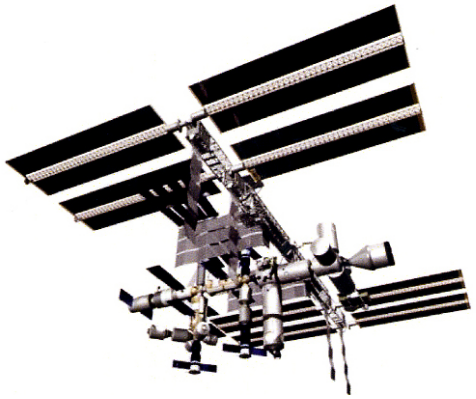
# BUILDING LOCATION ON AMES CAMPUS



# BUILDING DESIGN INSPIRATION



A canopy that shades the building, supports day lighting and provides a strong image of NASA for occupants.



# BUILDING DESIGN

# BUILDING DESIGN

# "BRIGHT" GREEN BUILDING

- ✓Dynamic living system – intelligent building + intelligent occupants
- ✓Real-time feedback key to optimizing building performance – occupant dashboards
- ✓Ethnographic analysis of work habits to optimize work performance while minimizing energy use

# WORKPLACE EFFECTIVENESS

**Goal:** Create a highly flexible, collaborative and supportive work environment. Action areas include:

- ✓ Community and Collaboration
- ✓ Operational Flexibility
- ✓ Daylight + Views
- ✓ Fresh Air
- ✓ User Control
- ✓ Healthy Materials

# WORKPLACE EFFECTIVENESS: FLEXIBILITY

A column-free interior, mindful window wall design, and raised floors allow space plan reconfigurations based on changing needs—more open office space, more enclosed offices, larger conference areas, etc.

REF: DS-309

# WORKPLACE EFFECTIVENESS: DAYLIGHT + VIEWS

**Strategies:**

- ✓ Provide adequate light levels year-round to eliminate need for ambient electrical lighting
- ✓ Design electrical lighting to respond to daylight levels; provide task lighting.
- ✓ Glare
  - ➢ Keep contrast ratios below 1:10
  - ➢ Avoid direct sunlight onto work surfaces
- ✓ Views
  - ➢ Provide multiple views from workstations to relieve eye strain and provide connections to outdoors (biophilia)

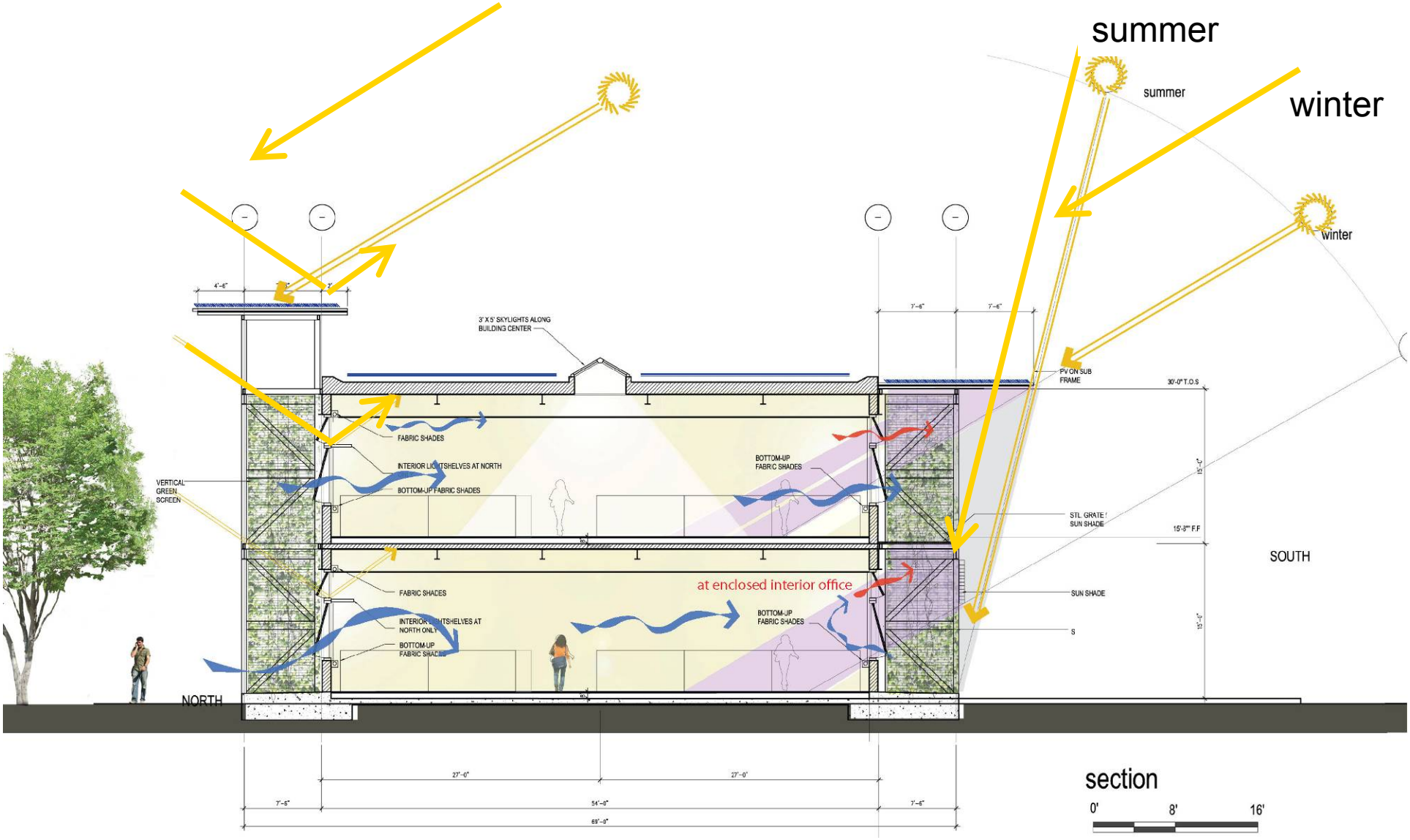
# WORKPLACE EFFECTIVENESS | COMMUNITY

Interior streets connect neighborhoods to exterior gathering spaces, offering a wide range of work environments and providing a connection to the outdoors.

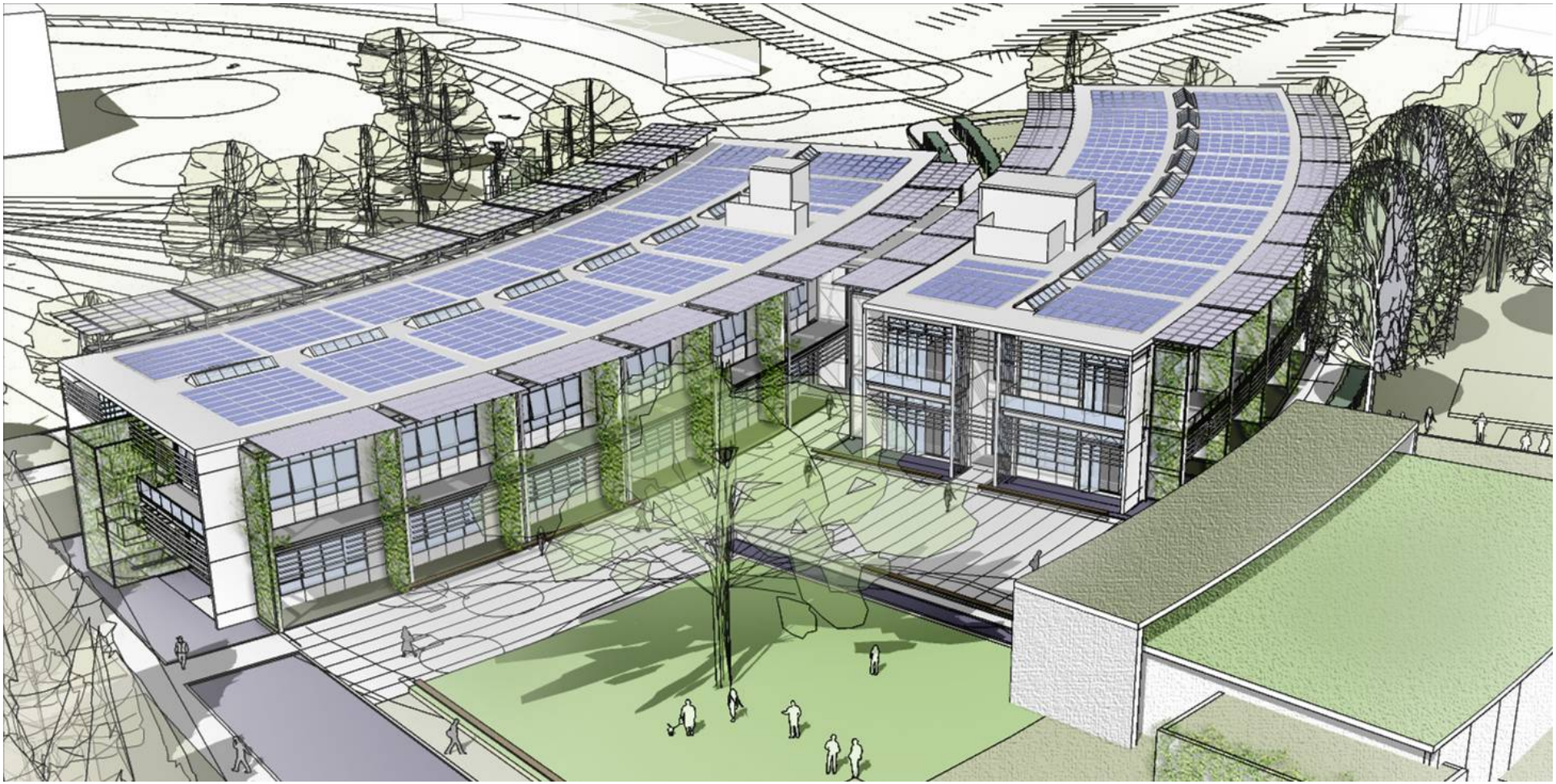
# BUILDING METABOLISMS: ENERGY

- ✓ Reduce energy demand through:
  - ➢ Natural ventilation, supplemented by 99 geothermal wells
  - ➢ Natural day lighting supplemented by high efficiency overheads and low wattage LED task electrical lighting
  - ➢ High performance building envelope/windows that both reduce heat loss/ gain and support natural ventilation and day lighting strategies
  - ➢ Intelligent adaptive controls systems connected to the building monitoring system
- ✓ Meet remaining energy demand through renewable sources, including:
  - ➢ PV roof array and advanced solid oxide H2 fuel cell

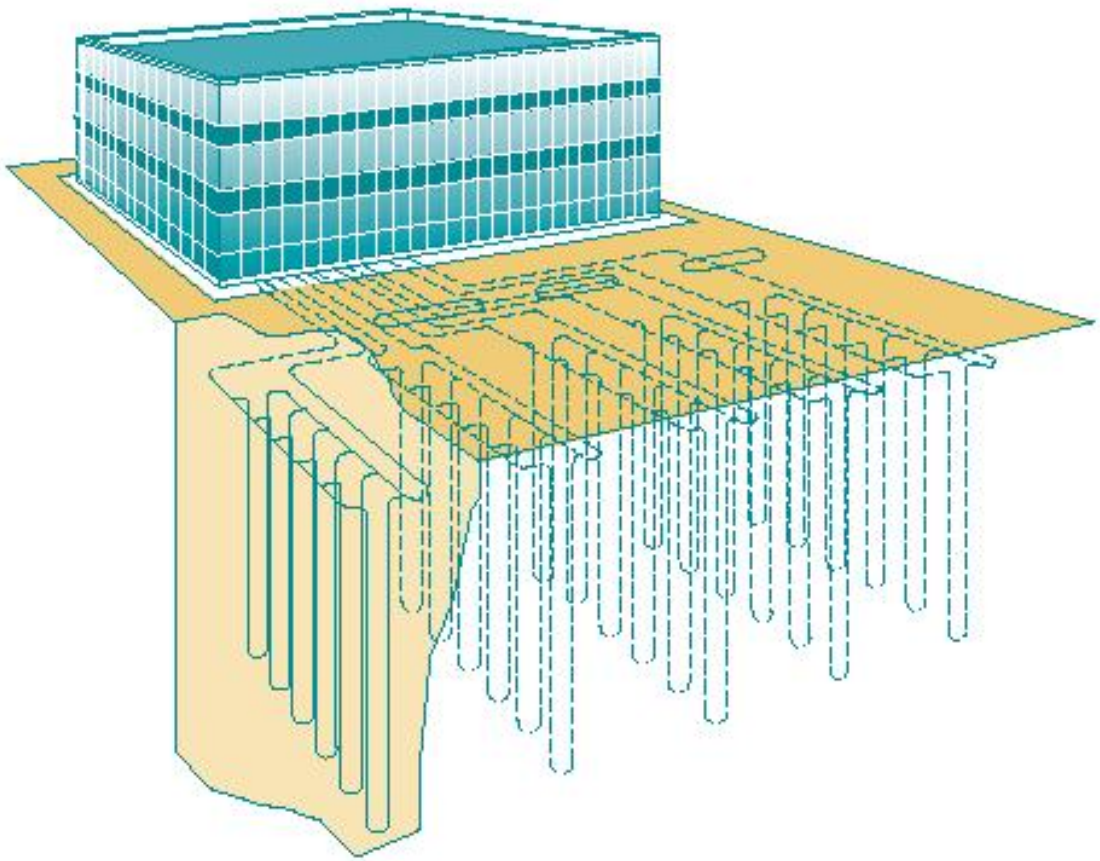
# BUILDING METABOLISMS | ENERGY: Passive Solar



# BUILDING METABOLISMS | ENERGY: Active Solar Coupled with Advanced Hydrogen Fuel Cell



# BUILDING METABOLISMS | ENERGY: Geothermal



- When natural ventilation cannot meet comfort criteria, a radiant heating/ cooling system is employed.
- Separating thermal comfort from air delivery allows for wider comfort zones and promotes mixed mode operation with reduced energy losses.
- Connecting a radiant system to a geothermal system further improves overall energy performance

# BUILDING METABOLISMS: WATER

**Strategies**:

- ✓ High performance fixtures
- ✓ Gray water capture systems
- ✓ Rainwater capture systems
- ✓ Connections to local non-potable sources
- ✓ Intelligent landscape design

90% reduction

## Water
**Low flow devices**
Smart Water Metering
**Rainwater Collection**
Storm water Quantity Control
**Water Efficient Landscaping**
Water Quality Control
**Water Use Reduction**
**Wastewater Technologies**

## Energy Efficiency
**Appliances**
**Computers**
**Displays**
**Floor Coverings**
**Insulation**
**Lighting**
**Telecommunications**
**Windows**

## Renewable Energy
**Geothermal Heating/Cooling**
**Green Power Purchase**
**Onsite Renewable Energy**
Fuel Cell (biofuel)
**Rooftop Photovoltaic**
**Solar Thermal**
Sterling Engine
**Wind Turbines**
**Outdoor PV Charging Stations**
**Vehicle Charging Stations**

## Pollution and Waste
**Air Quality**
Carbon Reduction
Composting
**Cradle-to-Cradle Products**
Disposal Diversion
eWaste Reduction
Green Cleaning Program
**Paper Reduction**
Regenerative Waste
**Storage/Collection of Recyclables**
**Ventilation**
**Water Quality**

## Materials
**Drywall**
**Glass**
Materials Simulation
Metals
Nanotechnology
**Paint**
Plastics/Polymers
Rapidly Renewable
**Recycled/Reused**
**Regional**
Structural

## Human Factors
**Acoustics**
**Auto vs. Manual Controls**
**Collaborative Working**
**Dashboard Interface**
**Human Comfort**
**Human/Machine Interface**
**Human/Building Interaction**
**Sustainable Education**
Wearable/Mobile Devices

## Intelligent Technology
**Intelligent/Adaptive Learning**
**Analytic Tools**
**Automation**
Carbon Management
**Data Processing/Storage**
**Digital Controls**
**Energy Management**
**Energy Simulation**
**Green IT**
**Grid Interface**
**Interactive Models**
Lifecycle Analysis
**Sensors**
**Smart Energy Metering**
**Supercomputer Modeling**
**System Optimization**

# CURRENT STATUS

- ✓Construction began September
- ✓Building to be completed and occupied May 2011
- ✓On track for a LEED Platinum certification from the U.S. Green Building Council
- ✓Received GSA “2010 Real Property Award” for Sustainability in the entire Federal Government and the 2010 “Green Project of the Year Award” from the SVBJ

# SUMMARY

- ✓A model for both NASA and entire Federal sector
- ✓The built environment need not consume 40% of total US energy consumption
- ✓No sacrifice and marginal up-front cost differential with significant ROI in less than 10 years
- ✓NASA a good steward of tax payer funds

Learn more about Sustainability Base at:

http://www.nasa.gov/sustainability-base

Backup slides

## Water
**Low flow devices**
Smart Water Metering
**Rainwater Collection**
Storm water Quantity Control
**Water Efficient Landscaping**
Water Quality Control
**Water Use Reduction**
**Wastewater Technologies**

## Energy Efficiency
**Appliances**
**Computers**
**Displays**
**Floor Coverings**
**Insulation**
**Lighting**
**Telecommunications**
**Windows**

## Renewable Energy
**Geothermal Heating/Cooling**
**Green Power Purchase**
**Onsite Renewable Energy**
Fuel Cell (biofuel)
**Rooftop Photovoltaic**
**Solar Thermal**
Sterling Engine
**Wind Turbines**
**Outdoor PV Charging Stations**
**Vehicle Charging Stations**

## Pollution and Waste
**Air Quality**
Carbon Reduction
Composting
**Cradle-to-Cradle Products**
Disposal Diversion
eWaste Reduction
Green Cleaning Program
**Paper Reduction**
Regenerative Waste
**Storage/Collection of Recyclables**
**Ventilation**
**Water Quality**

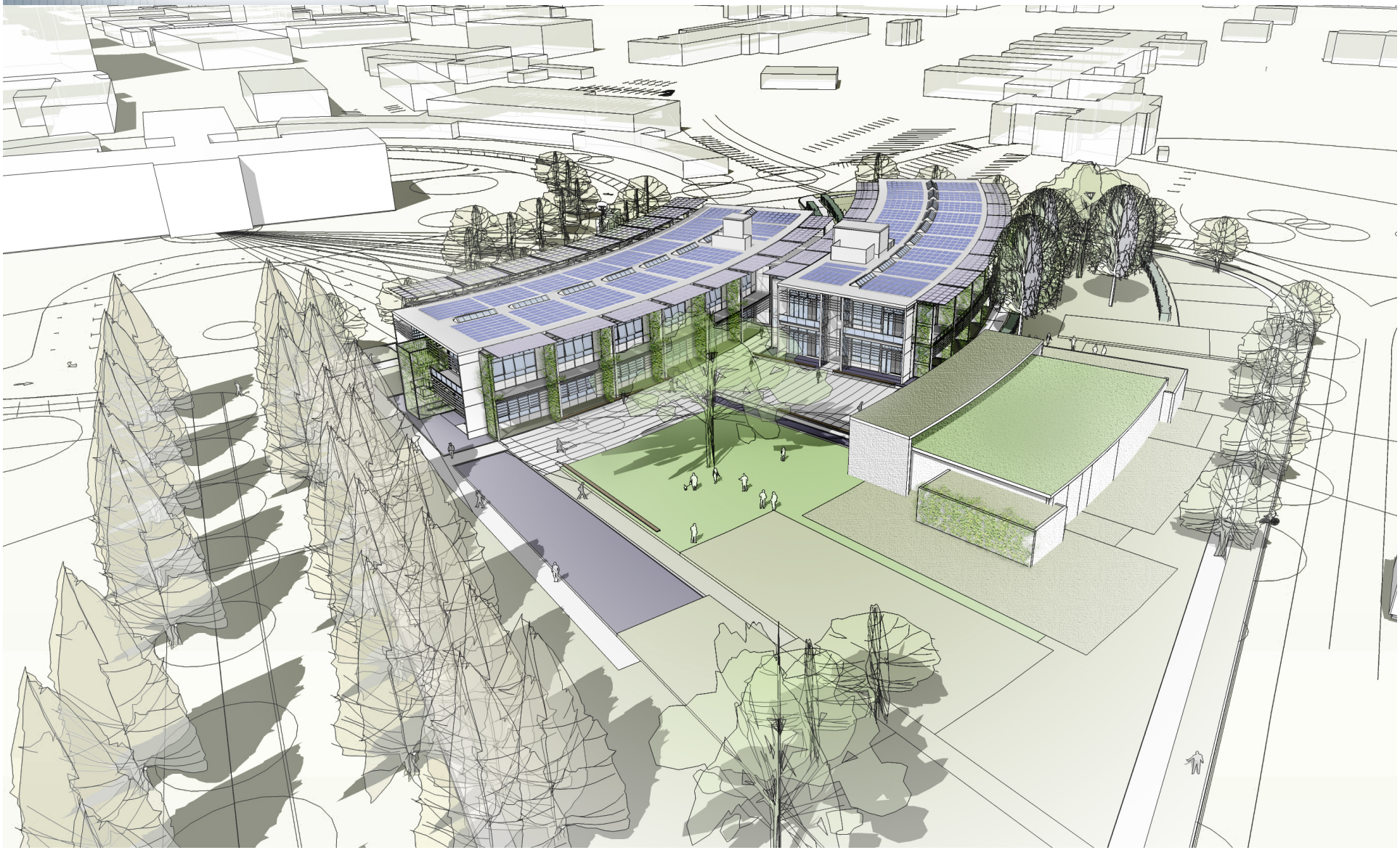
## Materials
**Drywall**
**Glass**
Materials Simulation
Metals
Nanotechnology
**Paint**
Plastics/Polymers
Rapidly Renewable
**Recycled/Reused**
**Regional**
Structural

## Human Factors
**Acoustics**
**Auto vs. Manual Controls**
**Collaborative Working**
**Dashboard Interface**
**Human Comfort**
**Human/Machine Interface**
**Human/Building Interaction**
**Sustainable Education**
Wearable/Mobile Devices

## Intelligent Technology
**Intelligent/Adaptive Learning**
**Analytic Tools**
**Automation**
Carbon Management
**Data Processing/Storage**
**Digital Controls**
**Energy Management**
**Energy Simulation**
**Green IT**
**Grid Interface**
**Interactive Models**
Lifecycle Analysis
**Sensors**
**Smart Energy Metering**
**Supercomputer Modeling**
**System Optimization**

SUSTAINABILITY BASE

Window to the Future on Earth



SUSTAINABILITY BASE
Window to the Future on Earth