Lady Bird JOHNSON MIDDLE SCHOOL

Irving Independent School District
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“I’d put my money on the sun and solar energy. What a source of power! I hope we don’t have to wait till oil and coal run out before we tackle that.”

-Thomas Edison (1931)

“We can’t solve problems by using the same kind of thinking we used when we created them.”

-Albert Einstein (1934)

“We are obligated to leave the country looking as good if not better than we found it.”

-Lady Bird Johnson (1968)
What if…

... a school could be designed and built to produce as much energy (on site) as it consumes from the electric grid?

- No/minimal electricity bill for use of air-conditioning, lighting, or power?
- Limited gas bill for heating, hot water, or cooking of food?
- No water bill for ground irrigation?

IMPOSSIBLE ???
WHAT IS NET ZERO?

“The word ‘energy’ incidentally equates to the Greek word ‘challenge.’ I think there is much to learn in thinking of a federal energy problem in that light. Further, it is important for us to think of energy in terms of a gift of life.”  

-Thomas Carr
What is it?

Net Zero

Energy Efficient Construction

Energy Production

Renewable Energy Systems

Built Environment

Energy Consumption

Human Health

Natural Environment
Did you know?

…this is the 1st net zero public school in the State of Texas

…this is the 1st net zero middle school in the country

…this is the LARGEST net zero public school in the country
WHY NET ZERO?

“I believe that the U.S. can and should be a global leader in the development of alternative energy sources…”

-President Barack Obama
Why Net Zero?

BUILDINGS IN THE U.S. ACCOUNT FOR:

- Potable Water Consumption: 14%
- Raw Materials Used: 40%
- Waste Output: 30%
- Carbon Dioxide Emissions: 38%
- Energy Use: 39%
- Electrical Consumption: 72%

- U.S. GREEN BUILDING COUNCIL
Why Net Zero?

Global Warming
- International Concern
- Greenhouse Gas Emissions in the U.S. have risen by 17% from 1990 to 2007; continue to rise 1% per year

Buildings
- Energy produces emissions
- Materials produce emissions

Net Zero
- Reverses negative trend
- Improves health and environment
Why Net Zero?

**ECONOMY**

Foreign Oil $$$
- Spent $475 billion in 2008
- $10 trillion over next 10 years

Oil Imports
- 1970-24%
- Today-65%
- 12 million barrels per day

Oil Independence
- Creation of jobs
- Money stays in U.S.
Why Net Zero?

Foreign Oil Dependence
- Must end within next 10 years
- Only means to secure a healthy environment

Education
- Sustainability
- Significance of renewable energy sources

Future Generations
- Importance of Environment
- Learn through our actions; become stewards of environment
“Because we are now running out of gas and oil, we must prepare quickly for a third change, to strict conservation and to the use of … permanent renewable energy sources, like solar power.”

- President Jimmy Carter
Strategies to Reduce Consumption
Building Energy Reduction

- Rain Water Collection
- Grey Water Harvesting
- Energy Star Rated Kitchen
- Laptop Computers /Wireless Network
- Holistic Monitoring of Energy Use
Building Envelope

- Increase Wall/Roof Insulation
- High Efficiency Glazing
- Solar Shading
- Day Light in Classrooms
- Light Harvesting
**USE OF LIGHT SHELVES**
Horizontal shelves bounce visible light from the ceiling deeper into the space.

**DAYLIGHT HARVESTING**
Automatic dimming or switching of light fixtures based on natural light in a space to maintain desirable light levels.

**Here’s the Research**

Studies have shown that daylighting has a positive effect on student attitudes and a direct correlation to improved student performance.

Students attending daylit schools for two or more years scored 14 percent better on tests than students in non-daylit schools.

Students in classrooms featuring daylighting strategies, performed 19 to 26 percent better on standardized reading tests than students in classrooms without these features. These students also performed 15 to 20 percent better on standardized math tests.
Rainwater-Grey Water Harvesting
Geothermal Technology

Geothermal Heat Pump Efficiency

1 kWh of energy from the grid

Yields:
4-6 kWh of energy for the building

Plus:
3-5 kWh of energy from the earth

Geothermal Energy for the Home

Horizontal Loop
Slinky Loop
Vertical Loop
Pond Loop
**Geothermal Technology**

The Earth is an Efficient Place to Reject Heat in Summer...

- Outdoor air design temperature: 98°F in summer
- Delta T = $ to operate!!!

A geothermal heat pump cools the building in summer by rejecting heat into the earth

...and is the Source of Stored Heat in Winter...

- Outdoor air design temperature: 38°F in winter
- Delta T = $ to operate!!!

- A geothermal heat pump takes heat from the earth during winter and transfers it into the building

Insulating layer of earth
Strategies to Produce Energy

“We need to push ourselves to make as many reductions as possible in our own energy use first…and that takes time. But we must do this quickly…the climate will not wait for us.”

-Rupert Murdoch
Solar Technology

**Specifications**

- 3’ X 5’ solar panels
- 191 Watts per panel
- 550 KW solar array
- Approx 66,000 sq. ft. of solar panels
- Approx 850,000 kWh output per year
Wind Turbine Technology

- Wind Electrical Turbine
- Model: Skystream 3.7
- Rated Capacity: 2.4kW
- Rotor Diameter: 12ft.
- Weight: 170lb
- 6' Blades: (3) Reinforced Fiberglass
- Rated Wind Speed: 29mph
- Survival Wind Speed: 140mph
- 45 Ft high Galvanized Steel Monopole
- Tower Weight: 932lb
Wind Turbine Technology

Typical Connection Diagram

Design Overview

Integrated Inverter

Blade is made of compression-molded fiberglass

All nacelle castings are made from die-cast aluminum

Nose cone and isolator housing made from UV-resistant injection molded plastic

Monopole and guyed towers up to 100 ft are available

<table>
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<tr>
<th>Distance</th>
<th>Wire Size</th>
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<tr>
<td>75 ft</td>
<td>14 awg</td>
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<tr>
<td>125 ft</td>
<td>12 awg</td>
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<tr>
<td>185 ft</td>
<td>10 awg</td>
</tr>
<tr>
<td>300 ft</td>
<td>8 awg</td>
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</table>
ANATOMY OF NET ZERO ENERGY REDUCTION

- GEOTHERMAL HEAT PUMPS: 30%
- PV SOLAR: 9%
- GAS CONSUMPTION SAVED: 6%
- WIND: 4%
- LIGHTING/DAYLIGHTING: 1%
- MISC LOADS: 9%
- ENVELOPE: 41%
CUMULATIVE CASH FLOW COMPARISONS

YEAR

"SOLAR ONLY BASE BLDG"  NET ZERO  "BASE BLDGHVAC - 4 PIPE SYSTEM"  "BASE BLDG - GEOTHERMAL"

$7,000,000  $6,000,000  $5,000,000  $4,000,000  $3,000,000  $2,000,000  $1,000,000  $0

1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16  17  18  19  20  21
Lady Bird JOHNSON MIDDLE SCHOOL
Sustainable Systems Overview

- Wind Turbines
- Solar Shading and Light Shelves
- Solar Panels
- Day Lighting
- Geothermal Well Fields
- Wind Turbines

Sustainable Systems Overview
The Site

- Geothermal Well Field Locations
- Wind Turbine Locations
- Recycling Center
- Rain and Grey Water Collection Tank
The Plan – first floor
The Roof

VIEWING PLATFORM FOR STUDENT ACCESS
DAYLIGHT AT NORTH FACING CLERESTORY
600KW SOLAR ARRAY - SOLYNDRA
Building as a learning tool
“Green schools connect children to the real world in unimaginable ways. They inspire kids to want to read and do math and learn, so they can protect what they love — the oceans, the forests and wetlands, their friends and families.

As parents and as communities, we owe kids healthy, nurturing environments that also teach and inspire them.

That's what green schools do.”

— Kelly Meyer, Environmental Advocate
The Next Generation

- Hallways/sections named to incorporate different technologies
- Extension of the classroom
- 3-dimensional learning environment

- Learn through practical, hands-on experience
- Recycling becomes readily accessible
- Stewards of the environment
The Next Generation

PROJECT BASED LEARNING SCHOOL-WIDE

PROBLEM SOLVING
RUBRICS
SCAFFOLDING ACTIVITIES
PROJECT SHARE – ELECTRONIC PORTFOLIOS
GLOBAL AWARENESS UNITS – GREEN ENERGY
TECHNOLOGY FOCUS
INTERACTIVE NOTEBOOK

The Next Generation

A Message from the Principal

LBJMS is envisioned as a neighborhood middle school organized with innovative 21st century ideals. The teaching and learning will be somewhat unique in keeping with the net-zero design. Students from across the District, as well as within the LBJMS attendance zone, will learn through practical, hands-on experiences about environmental stewardship, energy conservation and such topics as geothermal science, rainwater collection, solar panel usage, and wind turbine efficiency. Because LBJMS presents unique learning opportunities for all students in the District, the campus has been designed to host 50-70 walking students on a daily basis.

Hiring for all Lady Bird Johnson positions will start in the Spring 2011 semester. Anyone from within the Irving ISD interested in joining this new campus will need to email me directly. If applying from outside the district, please submit an application online at www.irvingisd.net or a letter of interest and resume. We will be looking for creative, excited, and hard-working educators that want to be a part of something extraordinary. Interview questions will assess educator knowledge of best practice instructional strategies, technology integration, and ways to build relationships with all students from diverse backgrounds.

Angie Gerred, Principal
angieger@irvingisd.net

School Mascot and Colors
Mascot: Eagles
Colors: Kelly Green / Columbia Blue

New School Taking Shape
(September 8, 2010) Driveways have been poured and building support framework has been put in place for Lady Bird Johnson Middle School. ISD’s newest middle school scheduled to open in August 2011. (See image.)

Construction Report
(August 18, 2010) Lady Bird Johnson Middle School (the eighth and newest middle school in Irving ISD) is being constructed as a “Net Zero” facility – designed to produce as much energy as it consumes. The facility will house the traditional mix of classrooms and support areas as well as incorporating state-of-the-art, super-efficient mechanical systems and the use of sustainable building materials. This effort is about the

http://www.irvingisd.net/schools/Detail.htm?818/20109:35:55 AM
Welcome to Irving ISD Middle School #8!

Learning Connections
- PK-2
- 3-5
- 6-8
- 9-12
- Community

Why net zero?
- NET ZERO
- PRODUCTION
- REDUCTION

Live Data Systems
- GEOTHERMAL
- WIND
- SOLAR
- WATER CONSERVATION

Why net zero?

Why net zero?

Why net zero?

Why net zero?

Why net zero?

Why net zero?
## IISD Science Curriculum

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Activity Options</th>
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<tbody>
<tr>
<td>Grade 2</td>
<td>Collect onsite weather data and describe net zero practices and how they support conservation of natural resources</td>
</tr>
<tr>
<td>Grade 6</td>
<td>Collect data to compare energy resources at MS #8 to traditional fossil fuel uses; demonstrate energy transformations using models of wind turbines and solar cells</td>
</tr>
<tr>
<td>IPC, Physics, CTE Courses</td>
<td>Water use in landscaping, use of xeriscape techniques, GIS use in weather predictions, input and output in closed and open loop systems, green architecture technology, wind farm design, operation of solar cars, wind turbine design, research pros and cons of “going green”</td>
</tr>
</tbody>
</table>
Plug Load Control
Automated power sweeps after school ensure that there are no electrical devices left on overnight.

Energy Monitoring
Students see, in real time, the energy the classroom is consuming and learn how small changes can have a big impact. Users and administrators can see power usage in real time and can use that information to plan for future energy optimization.
WHY NOT NET ZERO?

“To truly transform our economy, protect our security, and save our planet from the ravages of climate change, we need to ultimately make clean, renewable energy the profitable kind of energy.”

– President Barack Obama
Existing Buildings

Electricity
1 Kwh = 3,413 Btu’s

Natural Gas
1 Mcf = 1,030,000 Btu’s

BUI = Total Btu’s/Bldg Sq ft

- More Energy Consumed = More Energy Produced
- More Energy Produced = Higher Initial Costs
- Energy Efficient Construction = Less Building Load = Less Upfront Costs for Renewable Energies

Building Utilization Index (BUI)
## New Buildings

### Sustainable Design Data

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<tr>
<th>Description</th>
<th>Cost</th>
<th>Cost per sf</th>
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<tbody>
<tr>
<td>Solar Array - 600KW array</td>
<td>$2,976,972.00</td>
<td>$19.55</td>
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<tr>
<td>Wind Turbines - 12 Skystream units</td>
<td>$143,217.00</td>
<td>$0.94</td>
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<tr>
<td>Geothermal HVAC</td>
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<td></td>
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<td>Water Well</td>
<td>$277,194.00</td>
<td>$1.82</td>
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<td>Water collection tank</td>
<td>$27,125.00</td>
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<td>Native landscaping/ bio swales</td>
<td>$3,000.00</td>
<td>$0.02</td>
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<tr>
<td>Energy monitoring system - Convia</td>
<td>$265,000.00</td>
<td>$1.74</td>
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<tr>
<td>Recycling centers - located throughout building</td>
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<tr>
<td>Kitchen Pulper</td>
<td>$65,000.00</td>
<td>$0.43</td>
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<td>Sustainable interior finishes</td>
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<td>Building components with recycled content</td>
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<td>Recycling construction material</td>
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<td>LEED Components</td>
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<td>LEED basic commissioning</td>
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<td>Construction Budget</td>
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<td>GMP Approved</td>
<td>$29,407,559.00</td>
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<td><strong>NET ZERO DIFFERENCE</strong></td>
<td><strong>$3,757,559.00</strong></td>
<td><strong>$24.68</strong></td>
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Annual Energy Use

Btu’s (Millions) vs. Calendar Months

Total Energy Consumption

Total Energy Production
Other Benefits…
Why Net Zero?

**Initial Expense**
- Utilize bond funds, fund balance, etc.
- Identify additional expense from the start stressing long-term benefits

**General Operating Budget**
- Significant annual utility savings
- Direct impact to M & O budget

**M & O Costs**
- Sustainable features / building design
- Less maintenance costs over life of building
Other Considerations

Operational Strategies Employed

- Energy Conserving Systems employed at Lady Bird Johnson.
  - Siemens Apogee EMS for HVAC control and monitoring
    - HVAC systems scheduled by zones
    - Room temperatures set at 74 degrees cooling and 70 degrees heating
  - Convia for lighting and plug load control and monitoring
    - Motion sensor lighting throughout the building
    - Vacancy mode used instead of occupancy in classrooms
  - Gridpoint Energy Manager to monitor solar PV production and total building consumption
  - Eaton Xpert 2000 sub-meters to monitor total building consumption, HVAC systems consumption, total solar PV production, solar PV production per inverter, and wind turbine production
Operational Strategies Employed

- Other cost saving measures at Lady Bird Johnson
  - Pulper for all organic waste
    - All food waste and organic utensils are processed and composted for use on District grounds
    - Allows the use of one 8yd dumpster instead of two
  - Water well for athletic fields
  - Grey water and rain water harvesting for landscape irrigation
  - Low maintenance flooring is easier to clean and does not require stripping and waxing
  - No window blinds or treatments in rooms reduces cleaning effort and eliminates replacement costs
  - No personal appliances allowed in the facility
  - Limited number of copiers and printers
Actual Operation

Lady Bird Johnson Consumption and Production 2012

- Building Consumption
Actual Operation

Lady Bird Johnson Consumption vs. Energy Model

- Building Energy Use
- LEED Energy Model Energy Use

Bar chart showing monthly energy consumption from January to December, with actual energy use represented by black bars and LEED energy model energy use represented by green bars.
Actual Operation

Lady Bird Johnson Net Zero Status 2012

Percent of Total building Consumption negated by renewable sources

Jan 63.01%  Feb 65.99%  Mar 75.00%  Apr 80.07%  May 80.59%  Jun 94.52%  Jul 109.52%  Aug 120.42%  Sep 112.53%  Oct 104.53%  Nov 101.97%  Dec 99.27%
Actual Operation

Lady Bird Johnson Energy Use Intensity (EUI) vs. other Texas Middle Schools

- Lady Bird Prediction: 22.8
- Lorenzo de Zavala: 59.0
- Average Texas Middle School: 53.0

Energy Use Intensity (kbtu/ft²/yr)
Energy Management Best Practices

- **Building Automation Systems**
  - Scheduling
  - Room/Unit Operation
  - Temperature band control
  - Preventive Maintenance

- **Motion Sensor Lighting**

- **Integration into Facilities Services**
  - Unit replacement and operational strategies
  - Roof materials

- **Billing Analysis**

- **Education**
  - Staff
    - Energy Use Presentations
    - Appliance Policy
  - Students

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APOGEE BACnet System Architecture with APOGEE Insight

**What's new:**
- PXG tested web pages
- In sight BTL listed as B-AWS
- PXG-24 Unitary Equipment Controller
- PointPick-Up Module
- PXM10DS Local Controller User Interface
- Programmable BACnet IEC
Questions?

“We do not inherit the earth from our parents, we borrow it from our children”
– Chief Seattle