

ZERO energy

Recalling the past to create a sustainable future

Introduction

- Development of The Zero Energy Lab offers the university an opportunity to engage students, faculty, and staff in the continual “greening” of IIT facilities.

Background

- Machinery Hall 4th floor is representative of buildings that are energy efficient due to their typology, which was common before the widespread use of central ventilation systems in buildings.

Purpose

- To create a comprehensive zero energy solution for the 4th Floor of Machinery Hall on the IIT campus where project design, prototypes, educational outreach and research can flourish. The Zero Energy Lab offers participants the opportunity to design our sustainable future.



Construction Documents



- Energy efficient.
- Multi-use.
- Prepared.
- Feasible.

Areas of Focus

- Energy harvesting.
- Electrical distribution.
- Necessary repairs.
- Finishes.
- Budget and schedule.



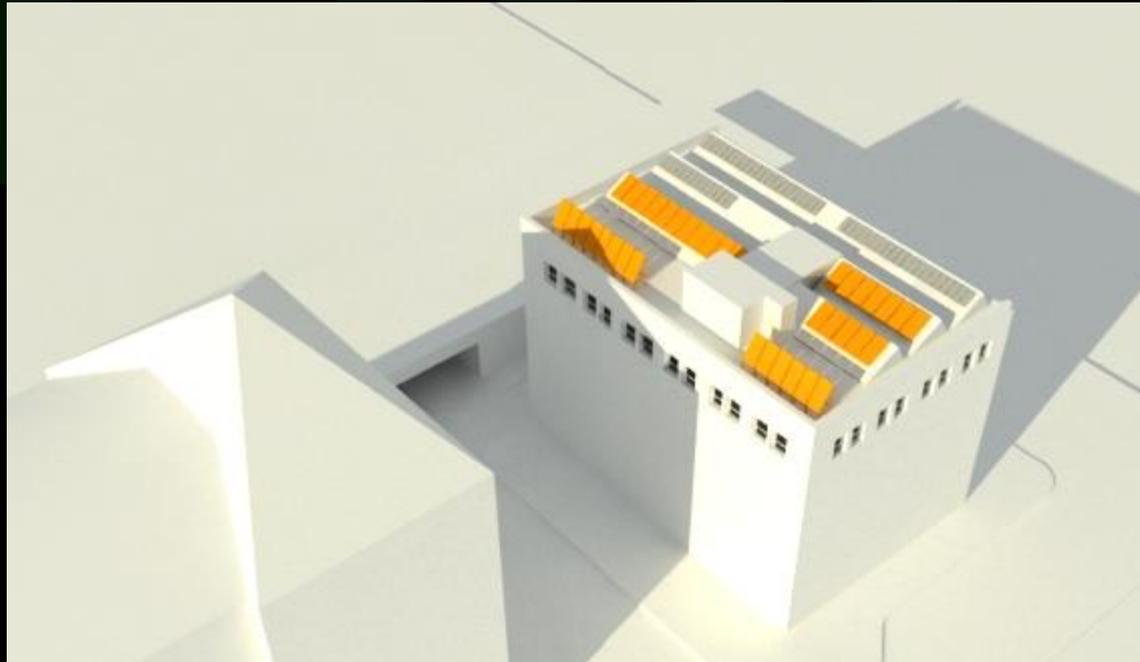
Lighting

- LC&D Control Box
 - Achieves daylight harvesting.
 - Monitors light intensity.
 - Occupancy sensor.



Energy Production Forecast

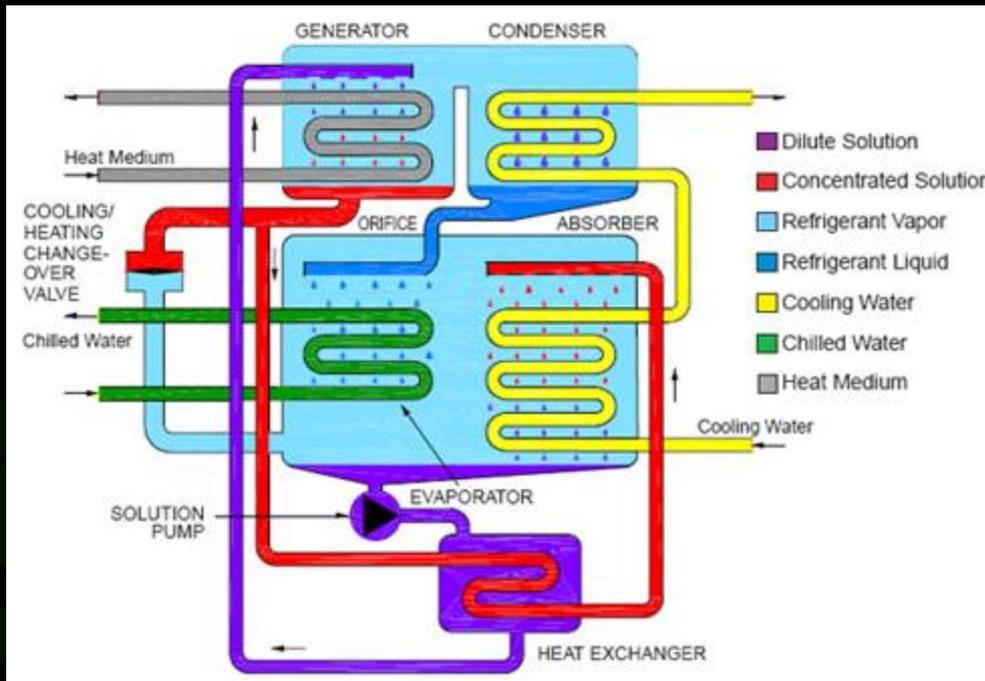
- Calculations based on:
 - Latitudinal and longitudinal position of the sun.
 - 1400 W/m^2 at zenith.
- Provides solar energy availability per day.



Solar Thermal Air Conditioning

- Old idea with new motivation.
- How it works.
- Water-fired absorption chiller
 - SC-10
- Evacuated tube solar collector
 - AP-30





Absorption chilling process.

Dehumidifying

- Desiccant system from last semester.

Winter Use

- Hot water source

Zero Energy Lab Rating (ZEL Rating)

- Detailed rating system quantifying total embedded energy in a product or material.

ZEL Purpose

- To offer quantifiable embedded energy information for products used to support LEED certified, Silver, Gold or Platinum rating.

ZEL Rating Considerations

- Energy required to create an object.
- Energy required to transport an object to its place of intended use.
- Energy efficiency of an object.
- Lifespan of an object.
- Reusability of an object.

ZEL Rating in a very general form

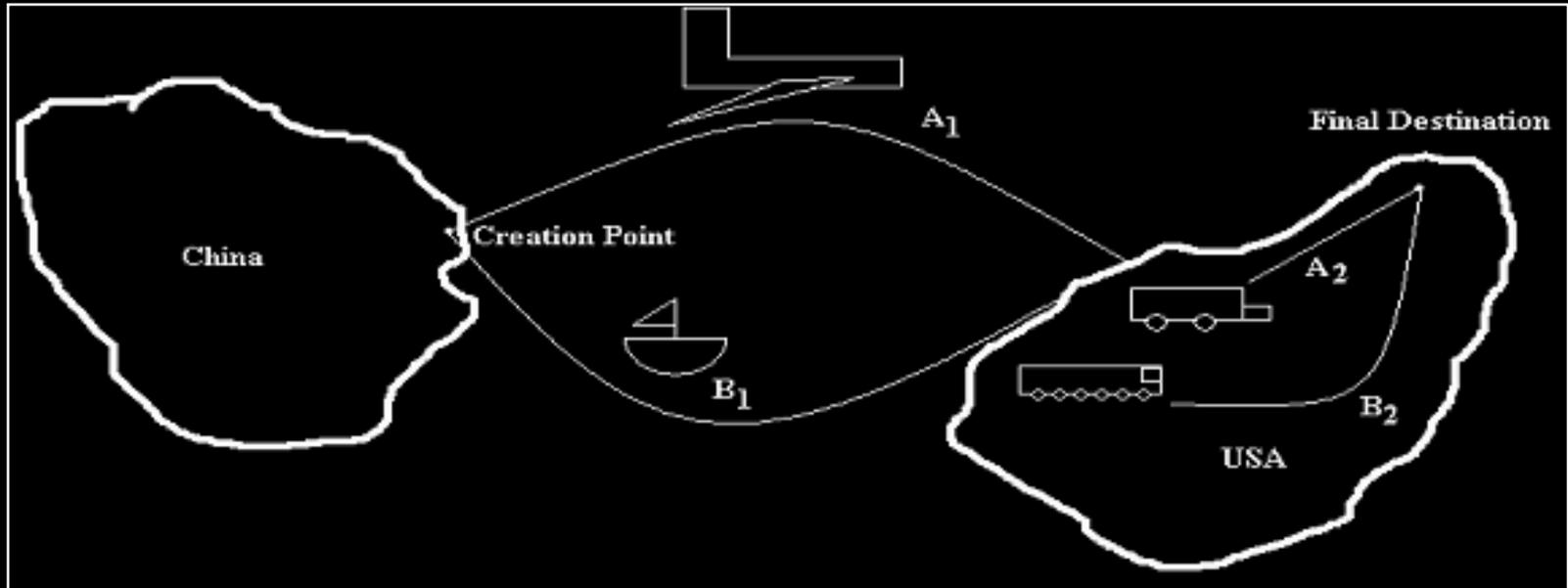
Creation energy of finished product

$$E_{creation} = \sum_{i=1}^n \left(\{E_{creation}\}_i + \{E_{transportation}\}_i \right)$$

$$\{E_{creation}\}_i = \sum_{j=1}^m \left(\{E_{creation}\}_j + \{E_{transportation}\}_j \right)$$

- Considers the sum of the energy to create each individual component of an object.

Transportation energy



$$E_{transportation} = \sum_{i=1}^p \{E_{route}\}_i$$

- Considers the sum of energy expended on each section of a route.

Efficiency

- For renewable energy sources such as solar panels or wind turbines, the quantity above is defined to be negative.

Lifespan

- A longer lifespan is desirable and helps lower the ZEL rating.

Recycleability

- Difficult to quantify.

$$\text{ZEL Rating} = \frac{E_{\text{creation}} + E_{\text{transportation}} \pm (\text{Amount of produced or absorbed Energy})}{\text{Lifespan}}$$

Creation Energy Approximation

Average Energy Consumption per Capita:

- China.....2,250,000 BTU/person
- United States.....27,250,000 BTU/person

Example:

- A company has 10 employees in USA (engineers, marketing), 8 employees in China (manufacturing), and produces 50,000 units per month. The company's electric bill averages 1000 kWh per month and gas bill averages 250,000 BTU per month.

$$\frac{\{Electrical \text{ kWh/month} \times 3413 \text{ BTU/kWh} + Gas \text{ BTU/month}\} + \{Employees \text{ person} \times Energy \text{ consumption per capita } \text{BTU/month/person}\}}{\text{Number of products created in a month } \text{unit/month}}$$

$$\frac{\{1000 \text{ kWh/month} \times 3413 \text{ BTU/kWh} + 250000 \text{ BTU/month}\} + \{10 \text{ people} \times 27250000 \text{ BTU/month/person}\}}{50000 \text{ unit/month}} = 5883 \text{ BTU/unit}$$

Transportation Energy Approximation

Average Consumption Rates:

- Heavy Duty Diesel Vehicle..... 6.6 mpg
- Plane (Boeing 747-200B)..... 0.15 mpg
- Shipping (Based on 69,000 GT)..... 96.8 mpg

Energy Content Values:

- Diesel Fuel..... 138,700 BTU/Gallon
- Jet Fuel (kerosene)..... 135,000 BTU/Gallon
- Marine Diesel Fuel..... 137,300 BTU/Gallon

Efficiency:

- Average Diesel Truck..... 45%
- Average Cargo Plane..... 60%
- Average Diesel Container Ship..... 28%

Example:

- Diesel Truck carrying 5,000 units traveling 100 miles

$$\frac{100 \text{ miles}}{6.6 \text{ miles/Gallon}} \times 45\% \times 138700 \text{ BTU/Gallon} = 191 \text{ BTU/unit}$$

$$\frac{\hspace{10em}}{5000 \text{ units}}$$

ZEL Rating vs. LEED Rating

ZEL RATING	LEED RATING
Developed to quantify the energy friendliness of products or objects (environmental friendliness is also taken into account but not as much as the energy aspect of it)	Developed to measure a building's sustainability and environmental friendliness
Categories that determine the ZEL rating include the energy required to create and transport the product, energy efficiency, recycleability, lifespan, and energy producing (these are multiplied by coefficients which will be determined after research has been done)	Points are awarded by meeting requirements in five categories (sustainable site development, water efficiency, energy efficiency, material resources, and indoor environmental quality)
Lower ZEL Rating implies a better product	Based on points; a building is certified into different levels (Certified, Silver, Gold, and Platinum)

ZEL Rating for a Building

ZEL Rating for a building = \sum ZEL Ratings for each individual component within the building

- In response to LEED.
- Considers all of the components that compose a building.

Future of the ZEL Rating

- Extensive databases containing ZEL Ratings for various products, materials, objects, etc.
- A standard consideration when doing any sort of construction.

Website

- Tools for displaying research.
- Updates information on-the-fly.
 - Uses AJAX and Javascript.
- Cohesive style elements.
 - Separate from content.
- Simple to add content.



- Additional pages can easily be inserted.
- Cross-browser compatibility.
- Live webcam feed.

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