



# Rapid Energy Modeling Lab

Autodesk University

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Jennifer Rupnow

Tom Vollaro

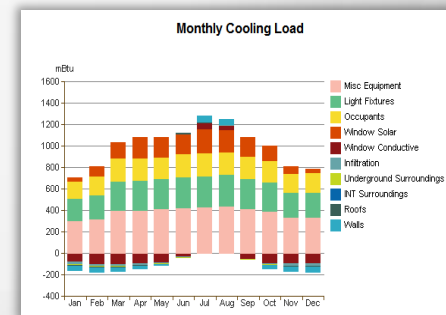
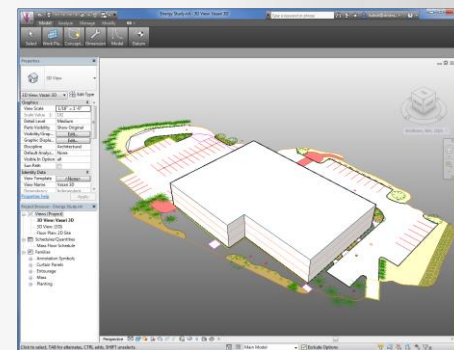
John Sullivan



AUTODESK UNIVERSITY 2013

# Rapid Energy Modeling Training Outline

- Rapid Energy Modeling (REM) Overview
- Stages in the REM Workflow
- Mass modeling using Autodesk FormIt
- Mass modeling using Autodesk Vasari
- Green Building Studio basic features and functionality

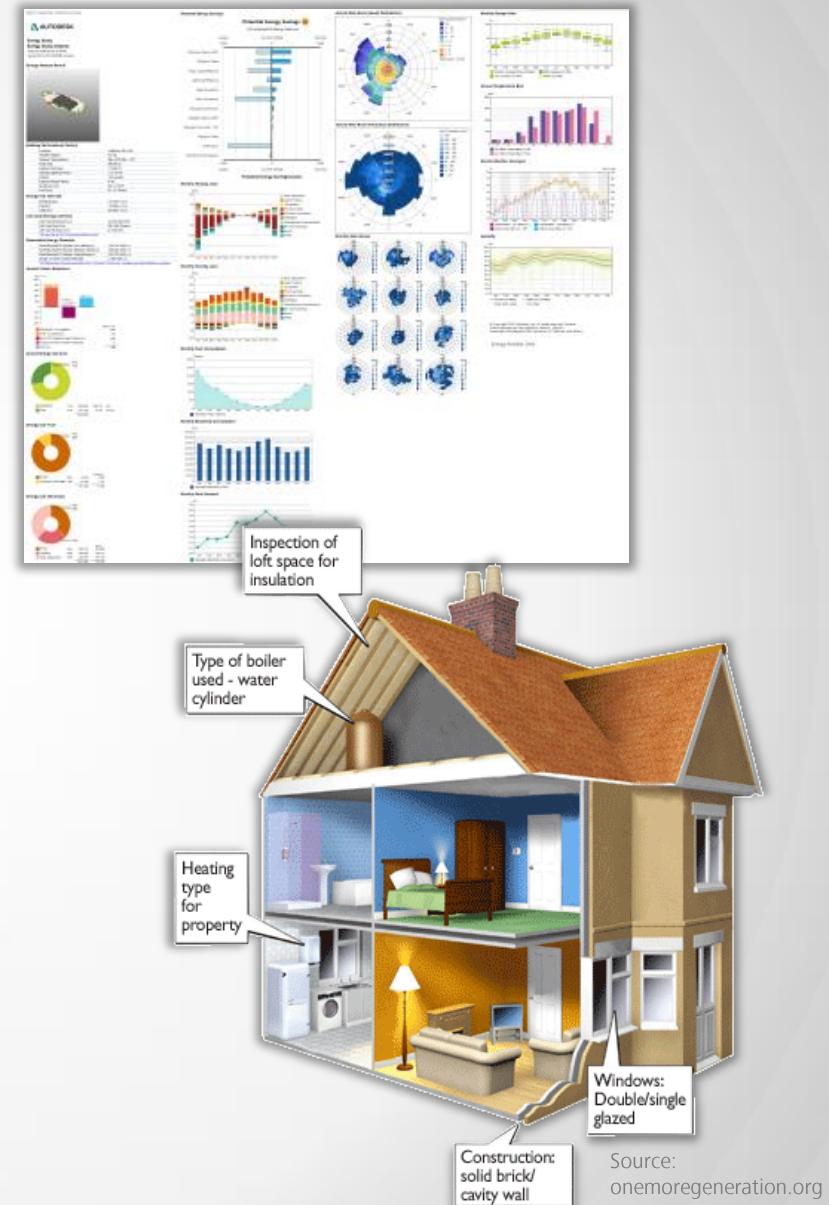


# Rapid Energy Modeling (REM)

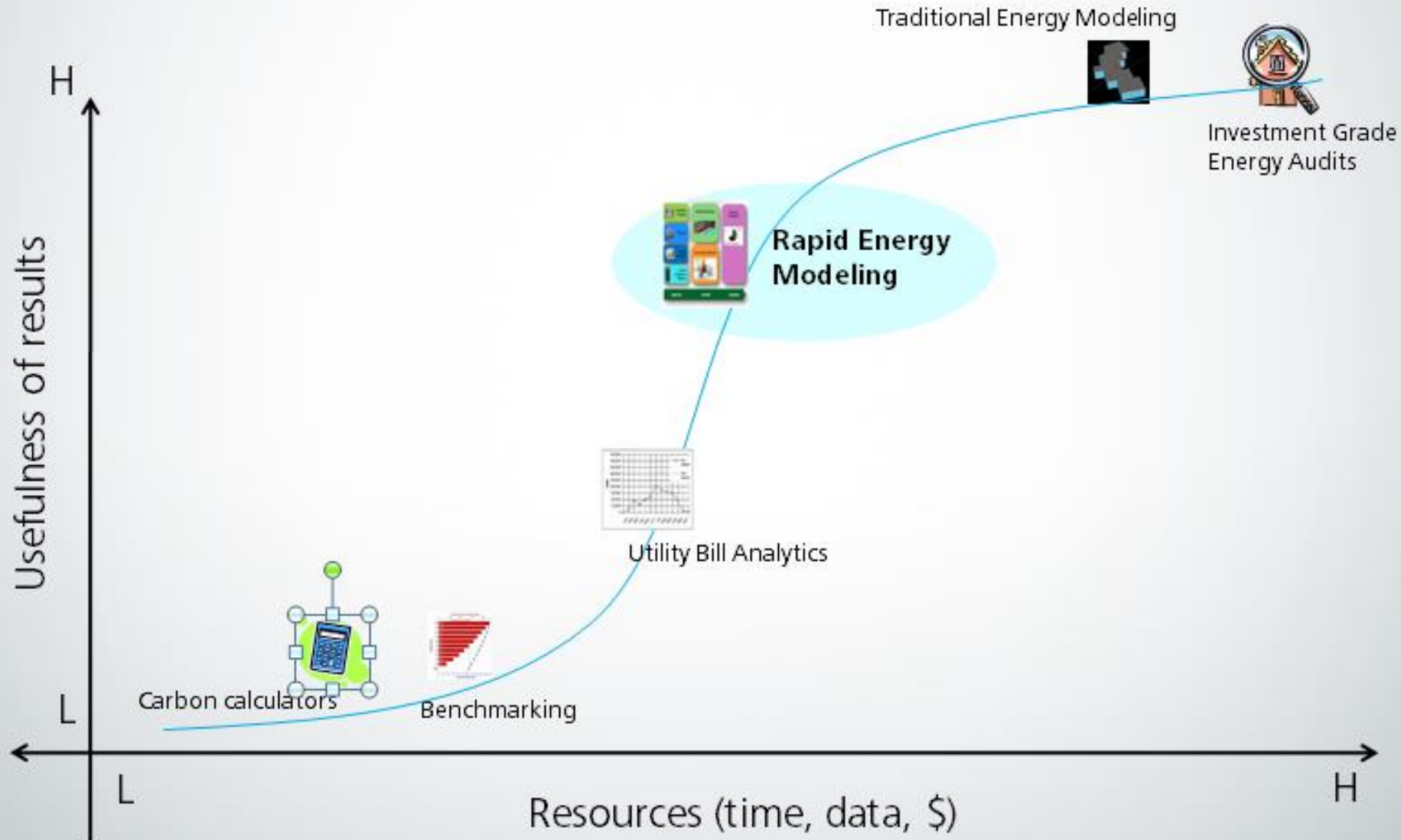
- REM is an analytical approach to simulate building energy usage using quick, low-cost techniques
- The REM process - *streamlined, to move rapidly with minimal data* - helps to rapidly evaluate energy usage and energy conservation measures (ECMs) across a portfolio of assets
- Develops an estimate of a building's energy performance based on geometry, location, design, occupancy and usage
- Stages in the REM process include:
  - Capturing existing building conditions
  - Developing this data into 3D models
  - Analyze the model to develop estimate's of a building's energy performance

# Why Employ REM?

- Provides building energy assessments and carbon reduction analyses with an efficient budget, short timeframe, small initial data set and minimal training
- Model and analyze multiple building configurations and usage characteristics simultaneously
- Quickly assess expected building energy performance characteristics and identify areas for improvement
- Create an energy usage baseline across a portfolio of buildings



# The relative benefits of energy assessment methods





# Components of the REM Process

Capture

Model

Analyze



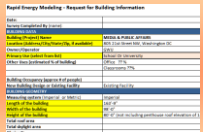
**Satellite  
& Aerial  
Images**

Google Earth  
Google Maps  
Bing Maps  
...others



**Photos**

On site  
Web views



**Bldg  
Data**

Questionnaires  
to Owner  
Records



**Drawings**

CAD Drawings  
PDFs  
As-built Sets



**Onsite**

Laser Scans  
Photogrammetry

Time Intensive

**Conceptual Model**



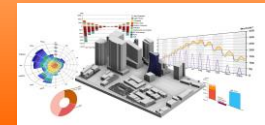
Autodesk FormIt  
Autodesk Vasari  
Autodesk Revit

**Detailed Model**



Autodesk Revit

**Energy Analysis**

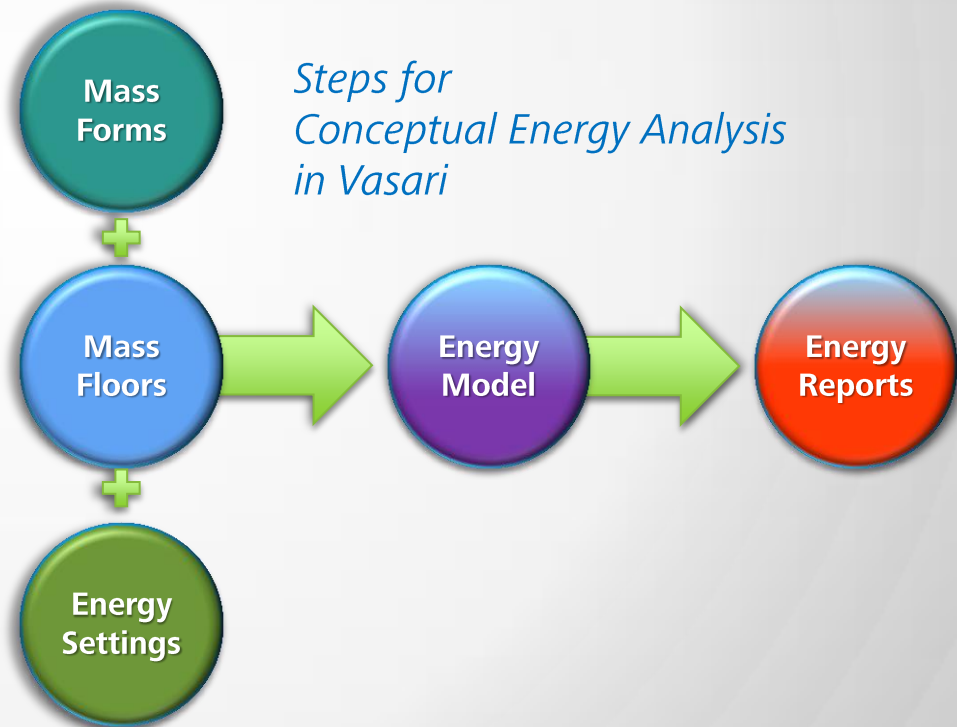
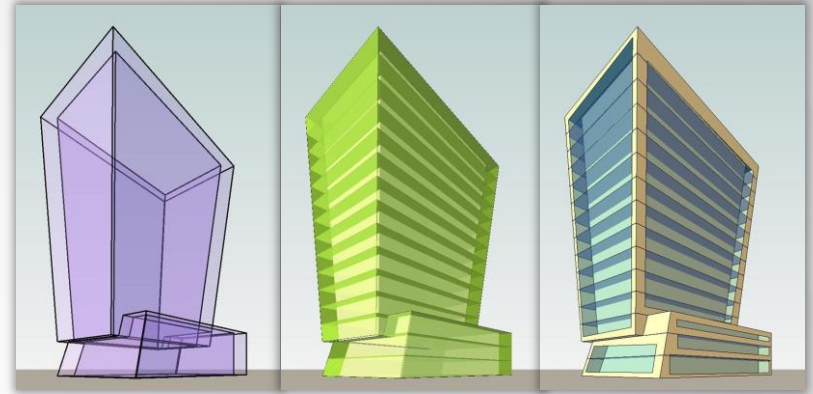


Conceptual Energy  
Analysis Tools (CEA)

- Autodesk Vasari
- Autodesk Revit
- Green Building Studio (GBS)

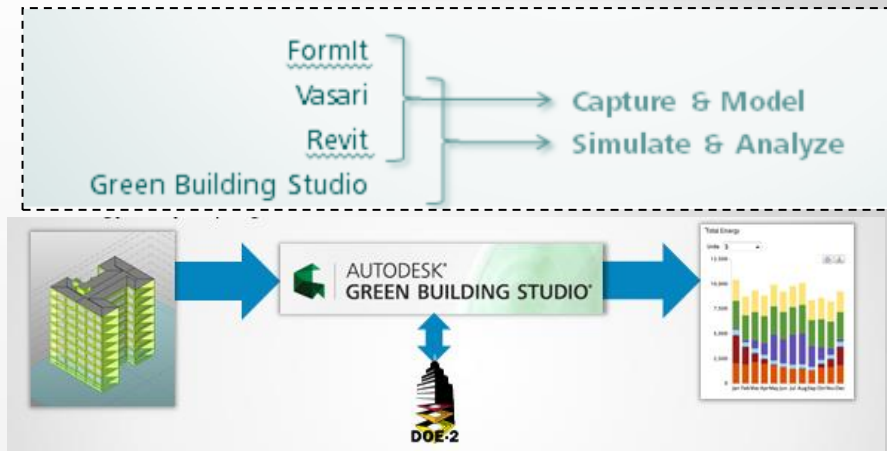
# Conceptual Energy Modeling

- What is Conceptual Energy Modeling?
  - Performing energy analysis on conceptual or mass models quickly and easily with a simple level of detail
- Energy modeling capabilities are embedded within Autodesk Revit and Vasari
- Green Building Studio (GBS) tie-in with Revit & Vasari
  - GBS is driven by the DOE-2.2 engine for whole building energy analysis
  - More detailed analyses can be done in GBS where there are more advanced options for building materials, utility and HVAC data
  - From GBS, can be imported into eQuest, Energy Plus, TRACE 700 or other applications
  - GBS uses intelligent defaults based on ASHRAE to fill in blanks



# Rapid Energy Modeling Applications & Workflows

- **Autodesk FormIt**
  - Web (beta) & mobile tablet-based app for iPad and Android
  - Mass Modeling
- **Autodesk Vasari**
  - Conceptual 3D modeler
  - Mass Modeling & energy simulation
- **Autodesk Revit**
  - Building Information Modeling (BIM) application
  - Mass Modeling & energy simulation
- **Green Building Studio**
  - Energy analysis service driven by DOE 2.2 engine
  - Enhanced energy analysis & design alternatives





# Introduction to Autodesk FormIt Mobile

- Mobile application for portable devices with easy-to-use modeling tools
- Modeling as you go – on or off site
- Uses real-world location of site in a searchable maps interface
- Imports satellite image of the site
- Metric or imperial units
- Seamless BIM workflow
  - Synchronize designs to the cloud
  - Easy transfer to Vasari, Revit and other desktop applications via RVT or SAT file formats
- Available for iOS, Android



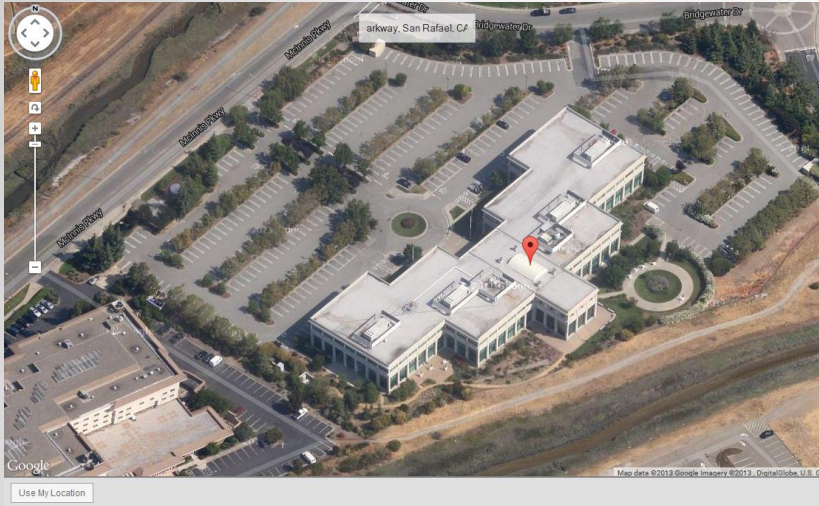
# Introduction to Autodesk FormIt Web (beta)

- The same basic drawing and modeling operations as FormIt mobile
- Open and save FormIt files created on mobile
- All files are converted to SAT and RVT
- Available now at <http://beta.autodeskformit.com>  
(Chrome and Firefox)

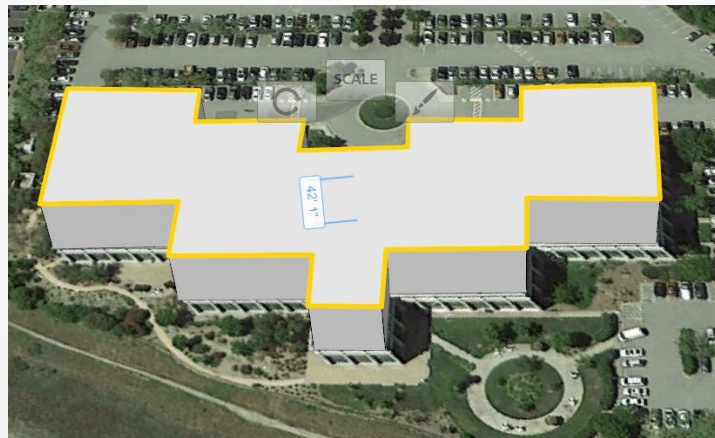


# FormIt Exercise (see handout)

## 10 Minutes



Import satellite image

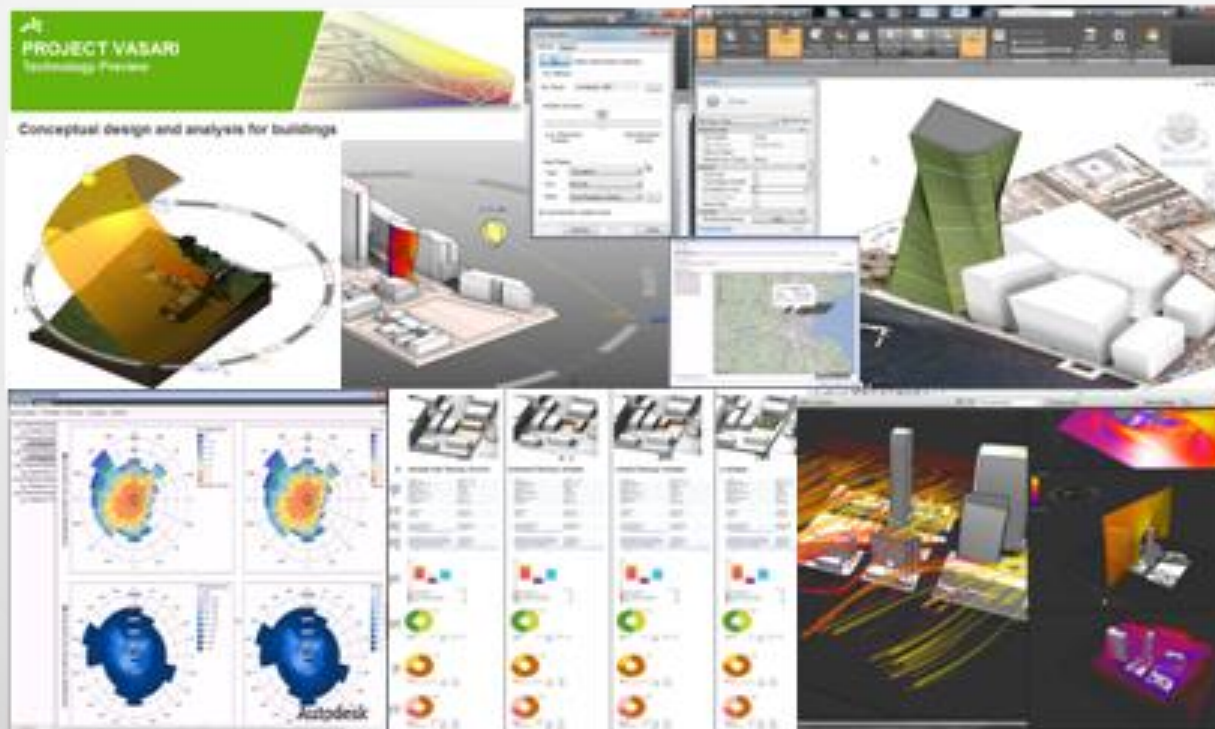


Create mass model



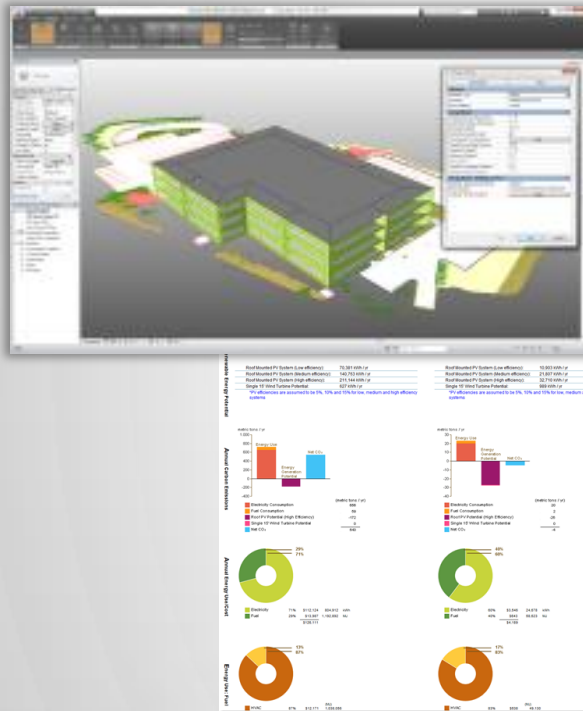
# Introduction to Autodesk Vasari

- Vasari is a BIM-based parametric conceptual modeling and analysis application
- Vasari incorporates energy modeling and analysis features which utilize Autodesk's Green Building Studio web service
- Available for free on the web at: <http://autodeskvasari.com/>

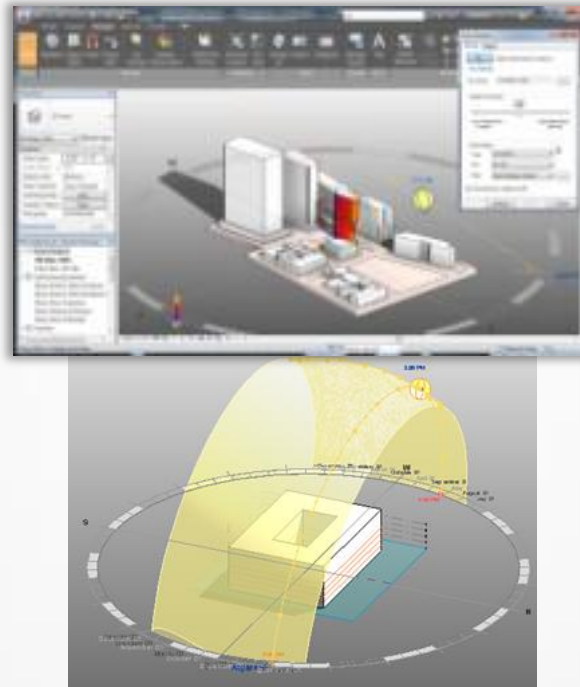


# Autodesk Vasari Analysis Tools

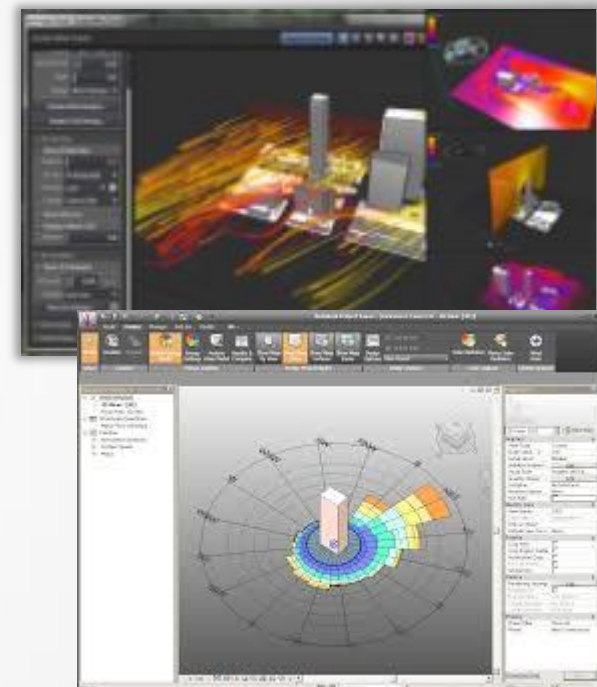
- Vasari provides building performance analytics with the following tools:



- Energy analysis



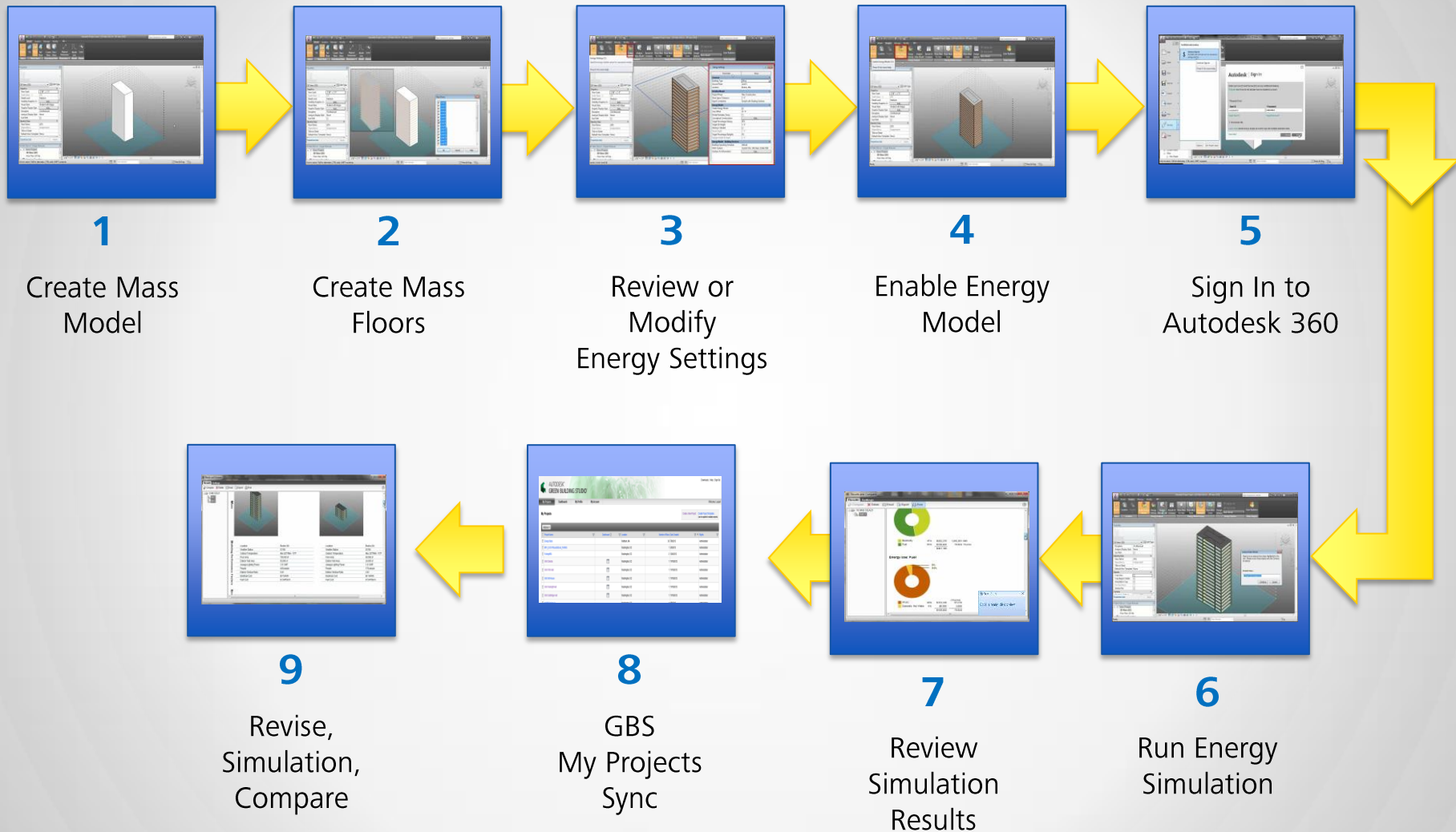
- Solar radiation analysis



- Wind analysis

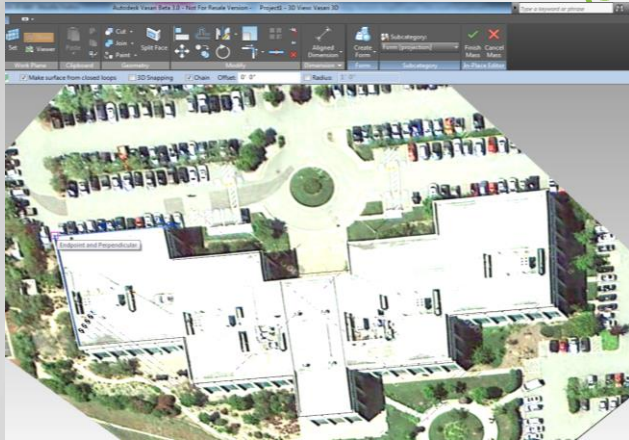


# Vasari Rapid Energy Modeling Workflow



# Exercise: Rapid Energy Modeling Workflow in Vasari

(see handout; 25 minutes)



Import satellite image



Create mass model

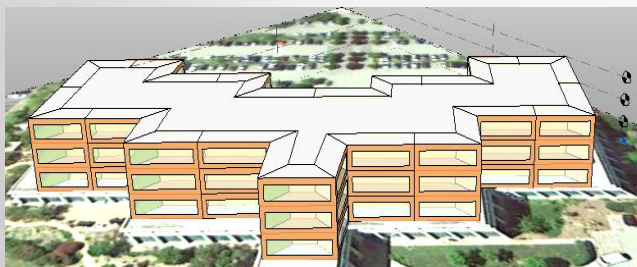
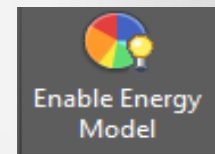


Create levels & mass floors

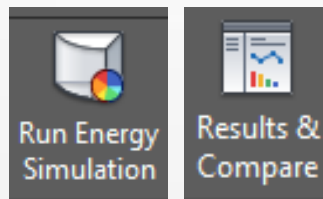
## Energy Settings

Parameter	Value
<b>Common</b>	
Building Type	Office
Location	111 McInnis Parkway, San Rafael, CA 94903, USA
Ground Plane	Level 1
<b>Energy Model</b>	
Analytical Space Resolution	1' 6"
Analytical Surface Resolution	1' 0"
Perimeter Offset	15' 0"
Divide Perimeter Zones	<input checked="" type="checkbox"/>
Conceptual Constructions	
Target Percentage Glazing	50%

Designate Energy Settings

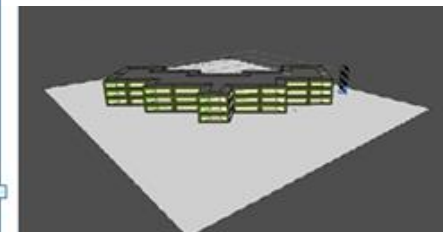


Enable Energy Model & Run Simulation



## Energy Analysis Result

AUTODESK.

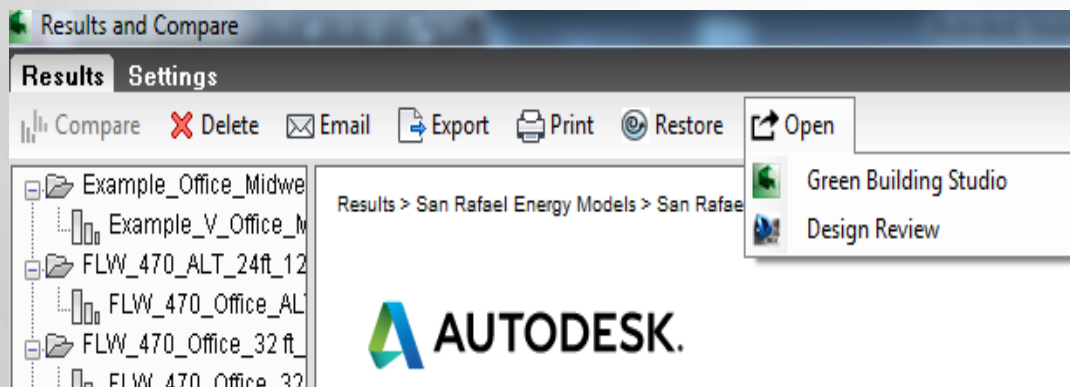
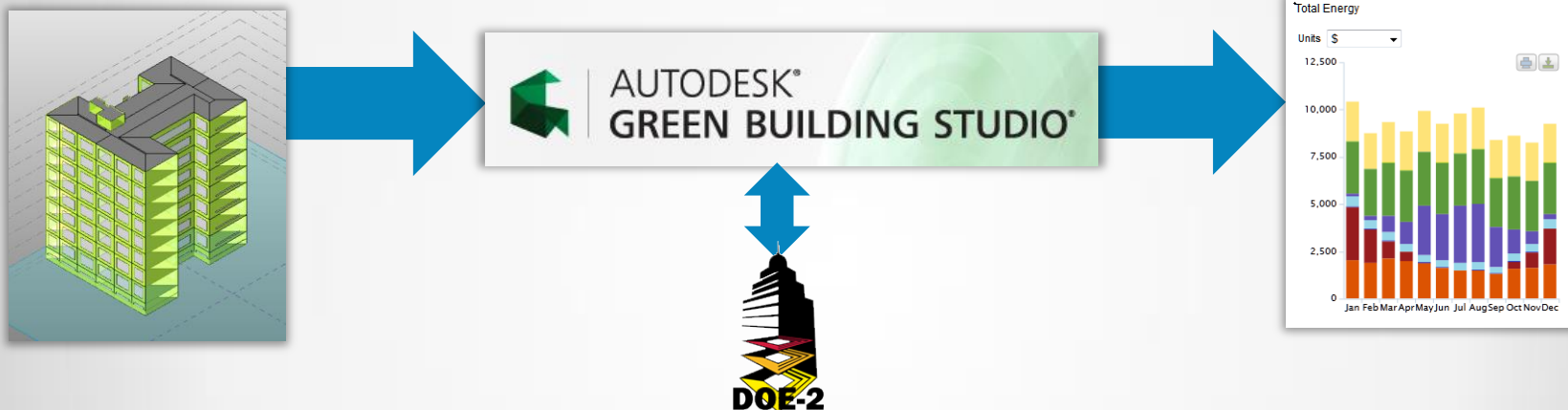


Review Results



# Energy Analysis Using Green Building Studio (GBS)

- GBS uses the industry standard DOE 2.2 (eQuest) engine for energy analysis
- If very detailed analytics are required GBS allows you to export a [DOE2/eQuest](#) INP file or an [EnergyPlus](#) IDF file to extend your analysis in those whole building energy analysis programs



- Vasari results can also be opened in GBS, or uploaded as GBXML into GBS

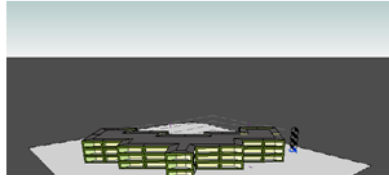
# Review Energy Report

## Energy Analysis Report



**San Rafael Energy Models**  
**San Rafael Energy Model 1**  
 Analyzed at 11/20/2013 2:13:26 PM

### Energy Analysis Result



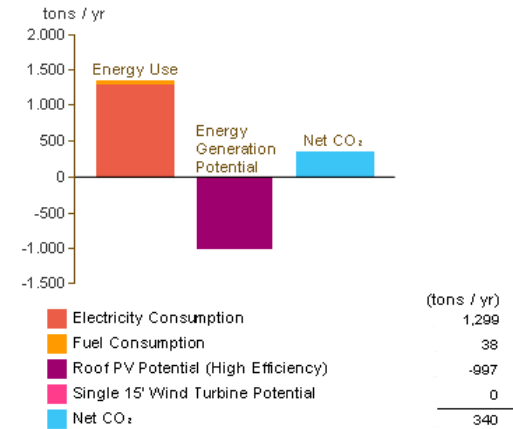
### Building Performance Factors

Location:	111 McInnis Parkway, San Rafael, CA 94903, USA
Weather Station:	4520
Outdoor Temperature:	Max: 97°F/Min: 27°F
Floor Area:	116,760 sf
Exterior Wall Area:	51,057 sf
Average Lighting Power:	1.01 W / ft²
People:	380 people
Exterior Window Ratio:	0.50
Electrical Cost:	\$0.12 / kWh
Fuel Cost:	\$0.80 / Therm

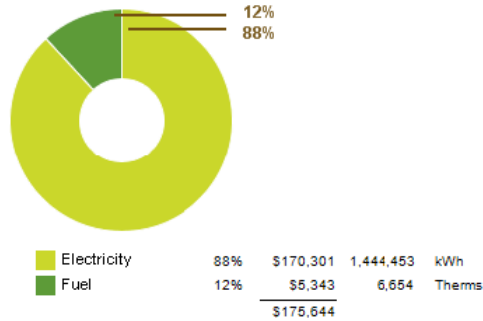
### Energy Use Intensity

Electricity EUI:	12 kWh / sf / yr
Fuel EUI:	6 kBtu / sf / yr
Total EUI:	48 kBtu / sf / yr

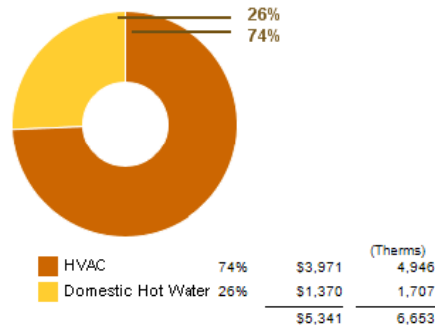
### Annual Carbon Emissions



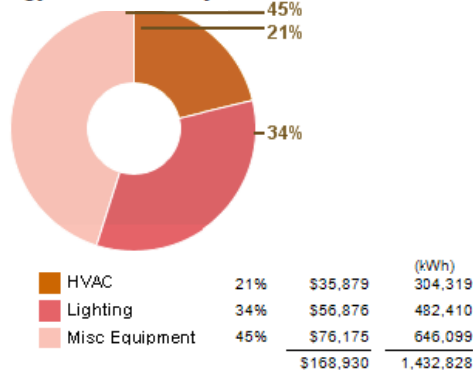
### Annual Energy Use/Cost



### Energy Use: Fuel

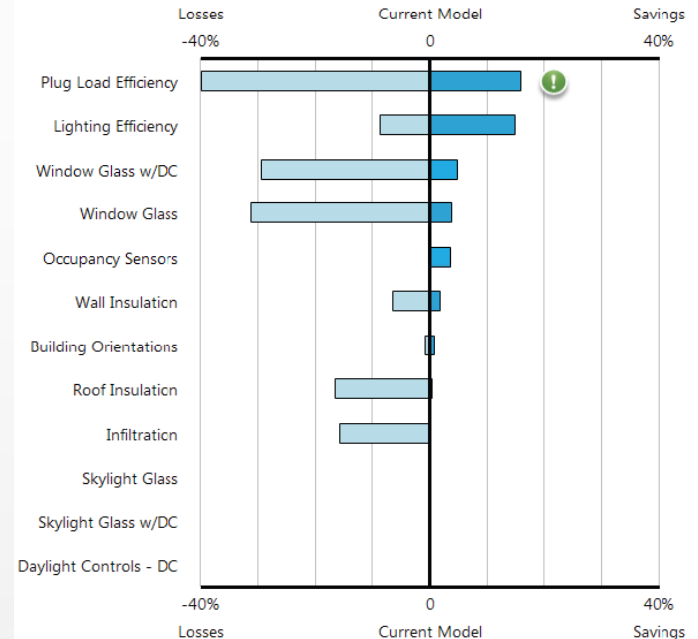


### Energy Use: Electricity



### Potential Energy Savings beta

All Analyzed Building Features

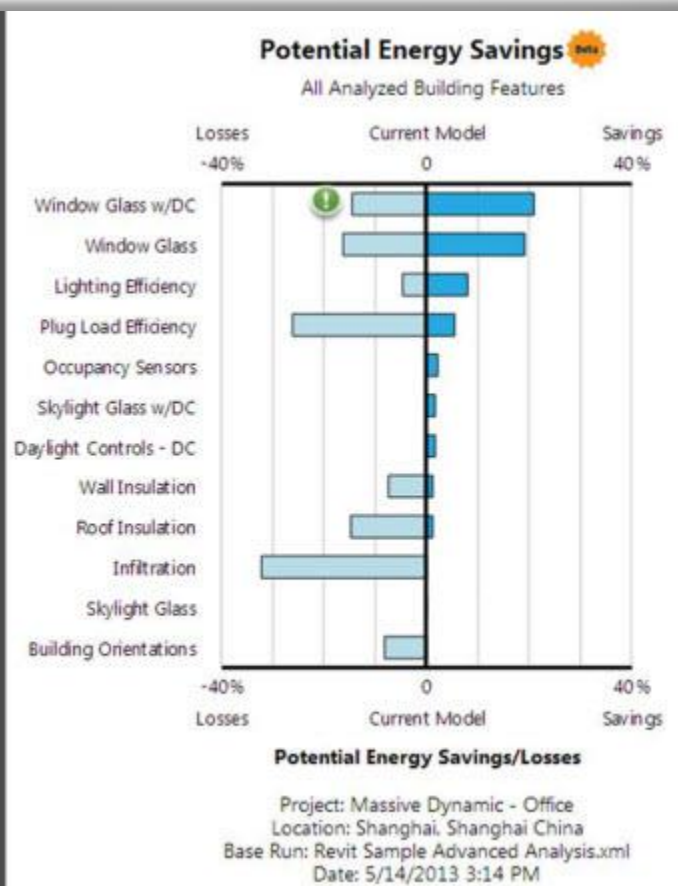
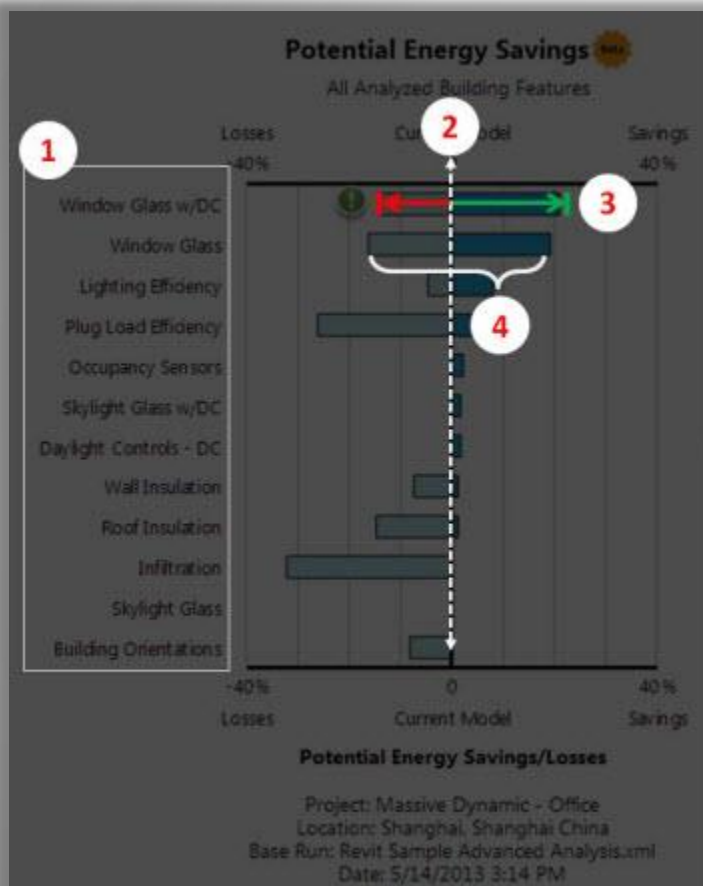


Potential Energy Savings/Losses



# Potential Energy Savings Charts

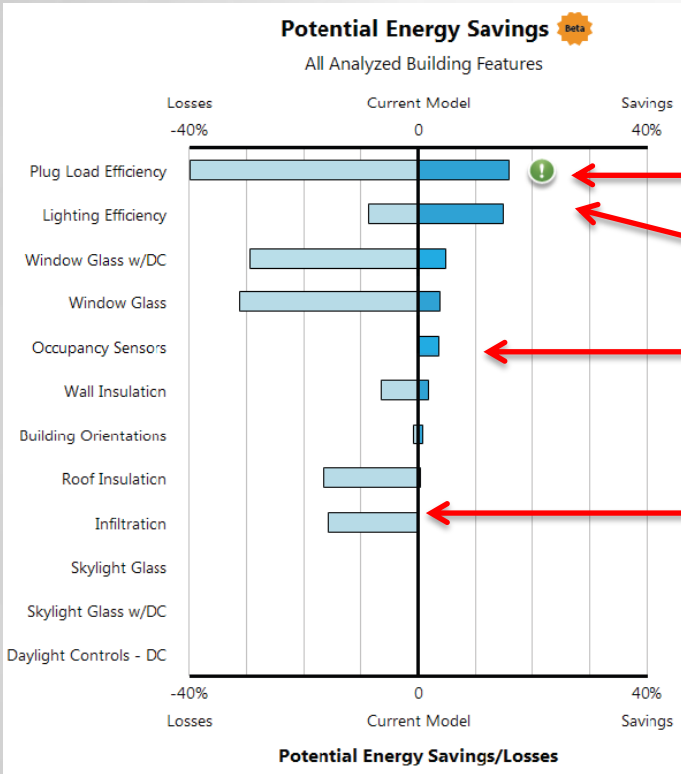
Compiled from 37 separate energy simulation runs



1. Building Features Analyzed
2. Current model baseline
3. Savings/Losses potential
4. Sensitivity



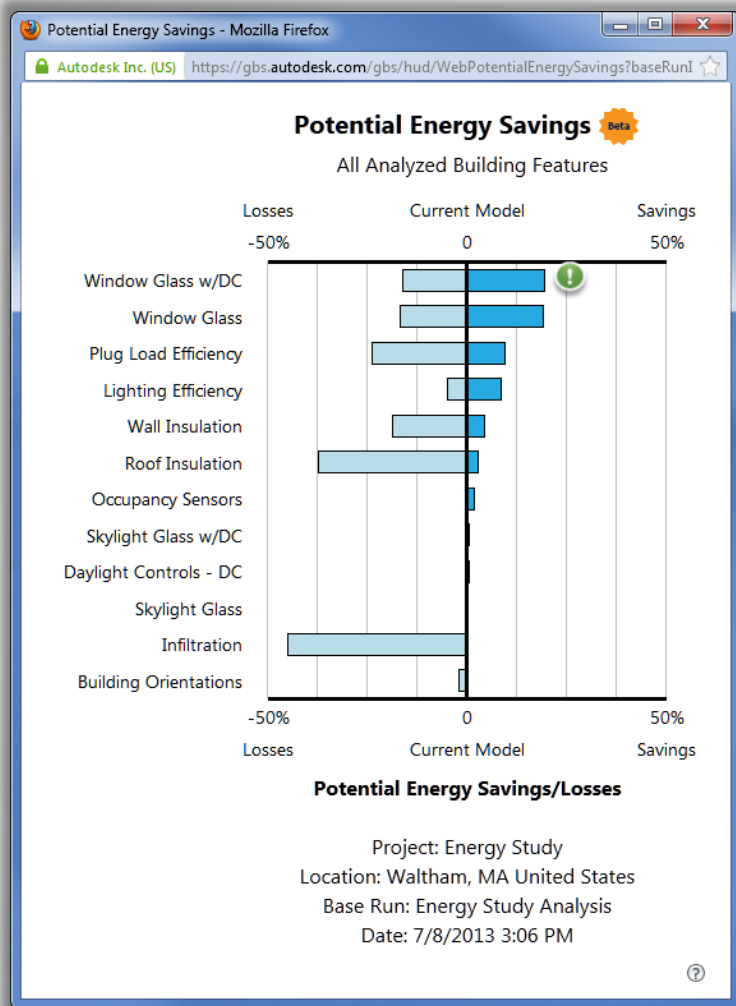
# Potential Energy Savings Chart



- Large bars are important building features affecting energy use (more sensitive)
- Bars that extend further to the right of the baseline have higher potential for energy savings
- Smaller bars are less important to energy use (less sensitive)
- Bars that extend further to the left have higher potential for energy losses

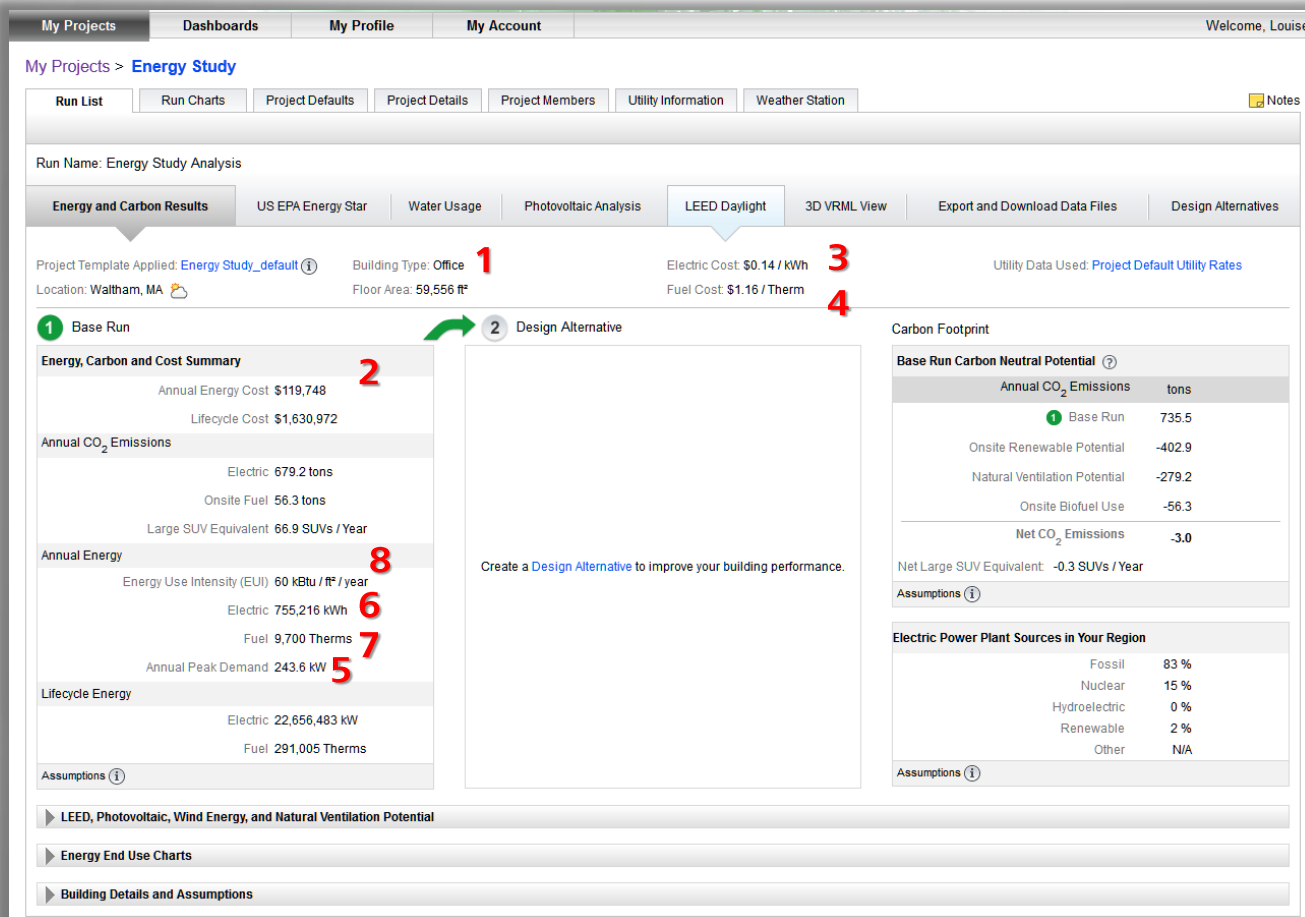
# Using the Potential Energy Savings Charts

Use this data to help focus on the building features that have the biggest impact on energy performance



- **Focus on the largest opportunities to improve on the baseline**  
Investigate the features at the top of the list that have large bars on the right of the vertical line.
- **Avoid reducing energy performance..**  
...by making sure you don't backslide on building features that have large bars on the left of the vertical line.
- **Know where you can be flexible**  
Building features where modifications will have little effect on energy performance have small bars on both the left and right side of the vertical line.
- **For an existing building, prioritize your time during the building audit.**  
Building features that have a big impact should get more of your attention during an audit and subsequent efficiency studies.

# Green Building Studio Results – Energy and Carbon Screen



1. Floor Area
2. Total Annual Energy Cost
3. Electric Cost (/kWh)
4. Fuel Cost (/Therm)
5. Annual Peak Electric Demand (kW)
6. Annual Electric Use (kWh)
7. Annual Fuel Use (Therm)
8. Energy Use Intensity (EUI)

# Additional Results on the Energy and Carbon Results Screen

## LEED, Photovoltaic, Wind Energy, and Natural Ventilation Potential

## Energy End Use Charts

## Building Details and Assumptions

Note: Details shown below are for the Alternate Run Energy Study Analysis\_Orientation\_(-)90

Updating your building assumptions (i)

### Building Summary - Quick Stats

Number of People: 194 people ↓  
 Average Lighting Power Density: 1.01 W / ft²  
 Average Equipment Power Density: 1.34 W / ft²  
 Specific Fan Flow: 1.2 cfm / ft²  
 Specific Fan Power: 0.900 W / cfm  
 Specific Cooling: 287 ft² / ton  
 Specific Heating: 20 ft² / kBtu  
 Total Fan Flow: 69,376 cfm  
 Total Cooling Capacity: 207 tons  
 Total Heating Capacity: 2,997 kBtu/h

↑ higher than typical value  
 ↓ lower than typical value

### Alternate Run Construction

Roofs	R20 over Roof Deck - Cool Roof U-Value: 0.04 (i)	19,852 ft²
Exterior Walls	R13 Wood Frame Wall U-Value: 0.08 (i)	17,900 ft²
Interior Walls	R0 Metal Frame Wall U-Value: 0.41 (i)	20,818 ft²
Interior Floors	R0 Wood Frame Floor U-Value: 0.20 (i)	39,704 ft²
Slabs On Grade	Uninsulated concrete slab U-Value: 0.03 (i)	19,852 ft²
Fixed Windows	North Facing Windows: Double Clear U-SI 3.16, U-IP 0.56, SHGC 0.69, VLT 0.78 (9 windows) U-Value: 3.16 W / (m²·K), SHGC: 0.69, Vlt: 0.78	1,488 ft²
	Non-North Facing Windows: Double Clear U-SI 3.16, U-IP 0.56, SHGC 0.69, VLT 0.78 (27 windows) U-Value: 3.16 W / (m²·K), SHGC: 0.69, Vlt: 0.78	5,672 ft²

> 3D VRML View

### Alternate Run Hydronic Equipment

Note: this information should not be used for sizing purposes.

(i) Hot Water	Boiler Capacity	2,994,226 Btu/hr
	Pump Flow	150 gpm
(i) Secondary Chilled Water	Pump Flow	497 gpm
(i) Primary Chilled Water	Electric Chiller Capacity	2,545,990 Btu/hr
	Pump Flow	497 gpm
(i) Condenser Water	Pump Flow	579 gpm
	Cooling Tower Capacity ( Approach:2.8 )	2,925,016 Btu/hr
(i) Domestic Hot Water	Average Demand	36,426 Btu/hr

### Alternate Run Air Equipment

Note: this information should not be used for sizing purposes.

(i) Variable Air Volume	Supply Fan Flow	5,476 cfm
	Annual Supply Fan Run Time	5,393 Hours
	Cooling Capacity	192 kBtu/hr
	Heating Capacity	237 kBtu/hr
(i) Variable Air Volume	Supply Fan Flow	1,251 cfm

# Design Alternatives in GBS

Actions ▾

Upload gbXML File (Creates a base run) ...

Export run list to Excel (CSV file format) ...

Create a Design Alternative ...

Hide

Create a design alternative.

Design Alternatives

Demo: Design Alternatives  
Play (wmv file)

Adjust parameters from the tabs below, enter the alternative name, then select the "Add Alternative" button.  
After all alternatives are added to the list below, select the "Run Added Alternatives" button.

Project: Energy Study

Run List

Base Run: Energy Study Analysis, Energy Cost: \$119,748

Project settings

General	Lighting	Roof	Northern Walls	Southern Walls	Western Walls	Eastern Walls
Rotation 0	Lighting Efficiency No change	Construction No Change	Construction No Change	Construction No Change	Construction No Change	Construction No Change
HVAC No Change	Lighting Control No change		Glazing Type No Change	Glazing Type No Change	Glazing Type No Change	Glazing Type No Change
Outside Air Flow Per Person Value default	Equipment Power Density Value Default		Glass Amount No change	Glass Amount No change	Glass Amount No change	Glass Amount No change
Infiltration No Reduction	Light Power Density Value Default					
Infiltration Value Default	Equipment Efficiency No change					
Outside Air Flow Per Floor Area Value 0 CFM/sqft	Number of People Default					
Outside Air Change Per Hour Value 0 ACH	Occupancy No change					
Outside Air Flow Per Person No change	Daylighting Control Off					
Outside Air Flow Per Floor Area No change	Occupancy Sensor Off					

Select Changes Below.

2. Enter Alternative Name:

3. Add Alternative

4. Run Added Alternatives

Reset Dropdown Selections Below

Save Added & Unrun Alternatives

Cancel & Don't Save Added Alternatives

General	Lighting	Roof	Northern Walls	Southern Walls	Western Walls	Eastern Walls	
Alternatives	Annual Energy Cost	Rotation	HVAC	Outside Air Flow Per Person Value	Infiltration	Infiltration Value	Outside Air Flow
Energy Study Analysis, Lighting 1.3 W/sqft	\$128,098	0	No Change	default	No Reduction	Default	0 CFM/sqft
Energy Study Analysis, Lighting 0.48 W/sqft	\$102,098						
Energy Study Analysis, PlugLoad 2.60 W/sqft	\$163,309						
Energy Study Analysis, PlugLoad 0.78 W/sqft	\$101,127						
Energy Study Analysis, Orientation (-)135	\$121,194	-135					
Energy Study Analysis, Orientation (-)90	\$121,330	-90					
Energy Study Analysis, Orientation (-)45	\$121,124	-45					
Energy Study Analysis, Orientation (+)180	\$118,772	+180					
Energy Study Analysis, Orientation (+)135	\$121,209	+135					
Energy Study Analysis, Orientation (+)90	\$121,332	+90					

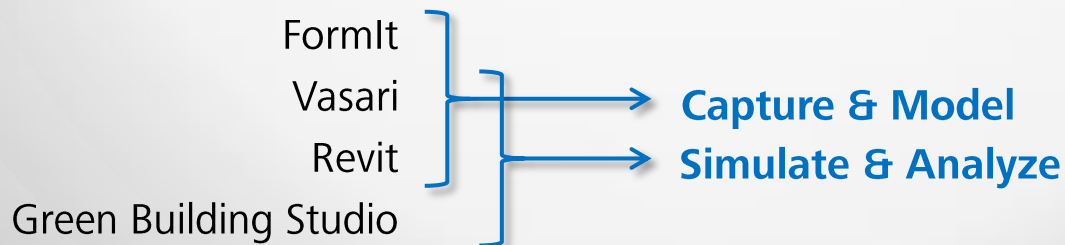
## Parameter options:

- Rotation
- HVAC
- Lighting Efficiency
- Lighting Control: Occupancy Controls
- Daylighting Sensors and Control
- Roof Construction
- Roof Glazing Type
- Roof Glazing Amount
- Wall Construction
- Wall Glazing Type
- Wall Glazing Amount
- The top portion of the table has standard links to the Run List
- The bottom portion of the page has tabs corresponding to the values in the run



# REM in Review

- REM is an analytical approach to simulate building energy usage using quick, low-cost techniques
- The REM process ...
  - Is streamlined, to move rapidly with minimal data
  - Helps to rapidly evaluate energy usage and energy conservation measures (ECMs) across a portfolio of assets
- Develops an estimate of a building's energy performance based on geometry, location, design, occupancy and usage
- Stages in the REM process include:
  - Capturing existing building conditions
  - Developing this data into 3D models
  - Analyze the model to develop estimate's of a building's energy performance
- REM is performed using following Autodesk applications



# Vasari Rapid Energy Modeling Workflow

