MECHANICAL ENGINEERING

Tim Hight
Associate Professor

SES program, 2016

Mechanical Engineering

- What is Mechanical Engineering
  - Sub-disciplines in mechanical engineering
    - Trends in mechanical engineering
  - Applications and projects in mechanical engineering
- Approaching Mechanical Engineering
  - Problem motivation
  - Analytical approach
  - Modeling
  - Experiments
- The example of Energy Use and Cycles
- Solar house projects

Mechanical Engineering

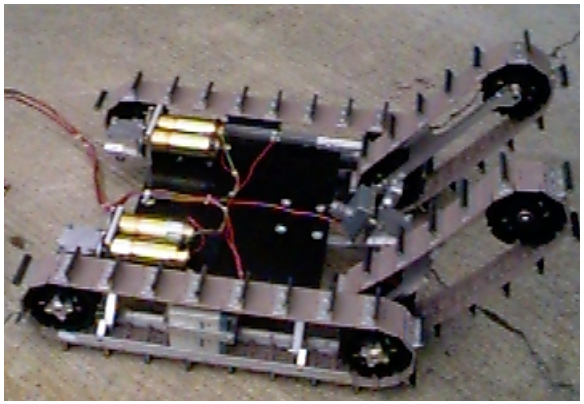
What do mechanical engineers do?

- Move objects
- Support objects
- Provide power
- Run systems
- Make products
- Develop technology

•physical objects/materials
•structures
•engines
•control systems
•manufacturing plants
•research

•dynamics/fluids/heat trans
•statics/strength of mat
•thermo/fluids
•controls
•materials/manufacturing/ machine components
•senior design

http://www.paeenterprises.com/



Mechanical Engineering

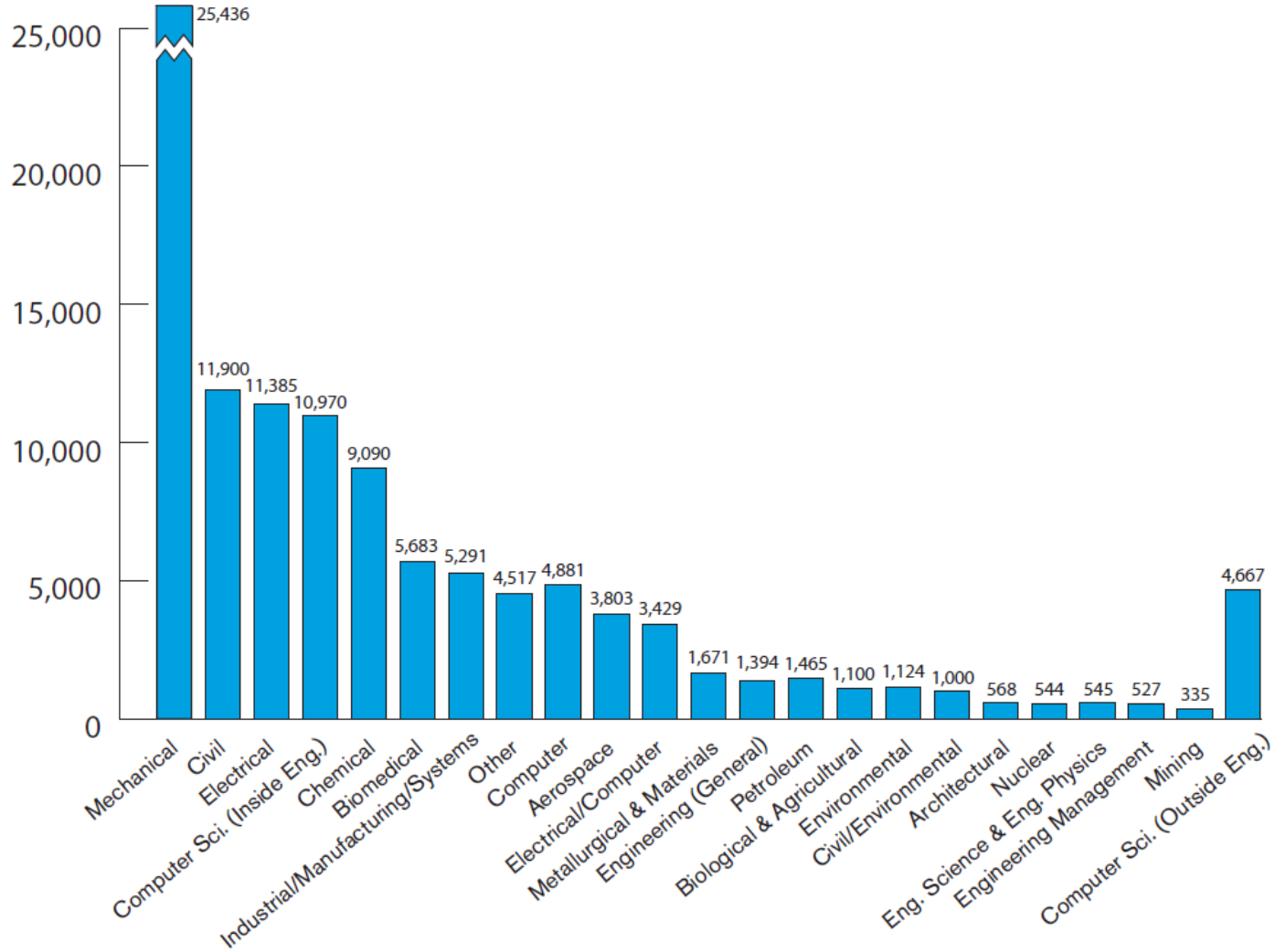
Mechanical Engineering deals with problems in energy conversion, mechanical component and system design, man and machine environments, and instrumentation and control of processes.

What are the most popular engineering disciplines?

Bachelor's Degrees, 2014–2015

By the Numbers

Bachelor's Degrees Awarded by Engineering Discipline: 106,658*



*Total does not include computer science (outside engineering).

Projects at Santa Clara
Human Powered Utility Vehicle El Salvador

Submersible Project

Other Senior Projects

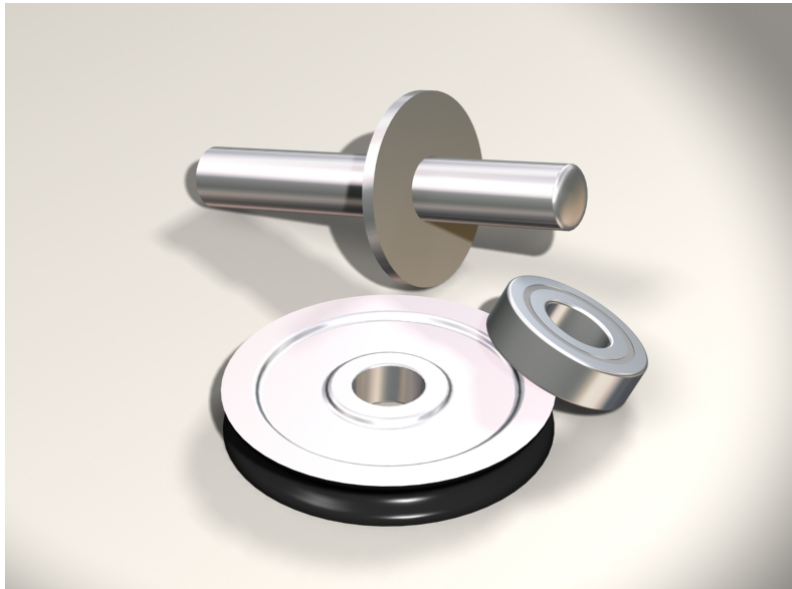
Solar water pump system

Mini-Baja car (SAE)

Steerable headlights

Computer Aided Manufacturing

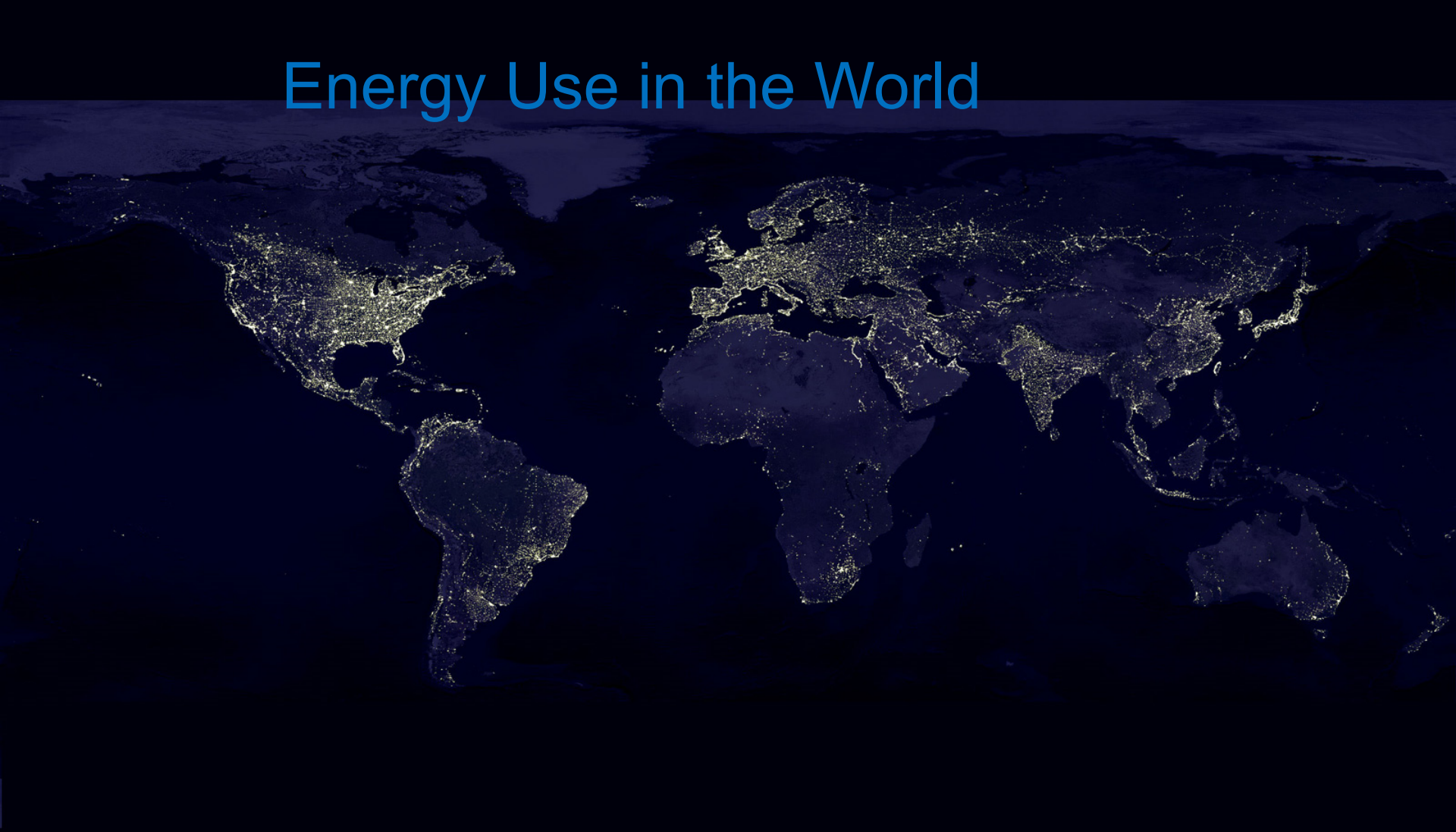
engineers can create and manufacture countless parts of machines and consumer products.



Alternative Energy Sources

In addition to being involved in traditional electric power generation, mechanical engineers are also engaged in alternative energy sources.

Energy Use in the World



“Earth at Night” from NASA Earth Observatory

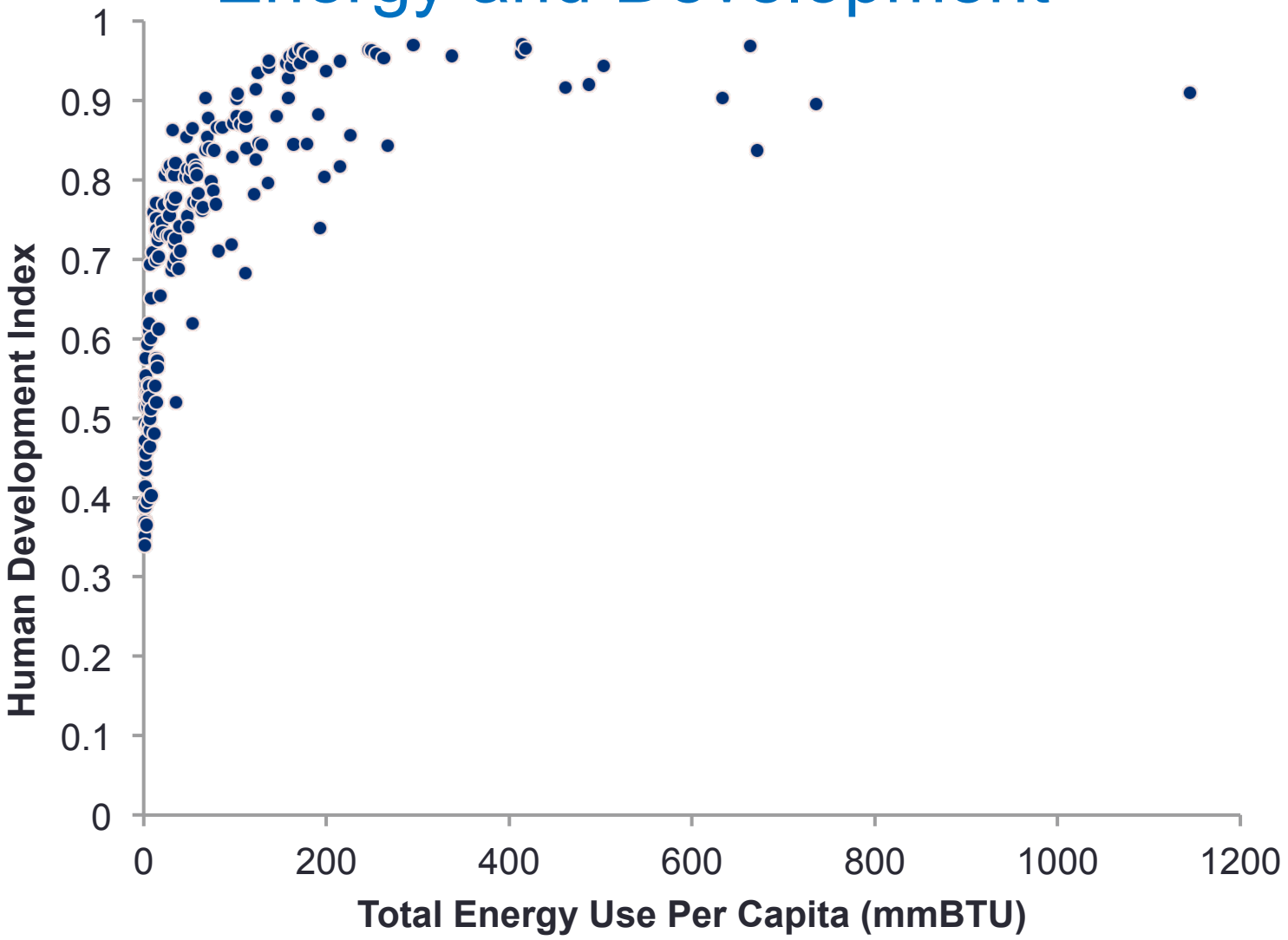
Austin Brown, BITES workshop, Oct. 12th 2012
National Renewable Energy Lab.

Energy Use in the World

"Earth at Night" from NASA Earth Observatory

A. Brown, NREL

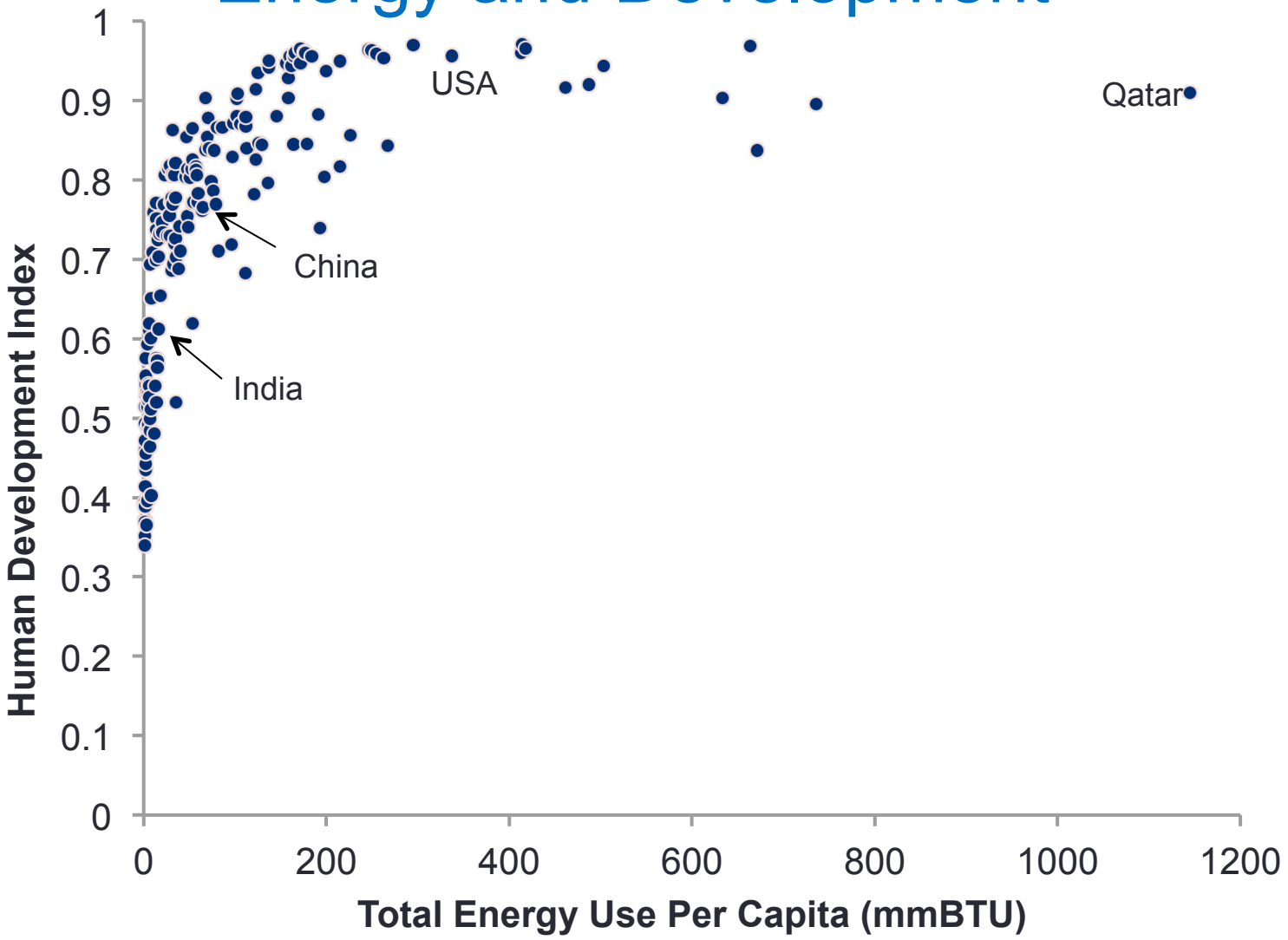
Energy and Development



HDI: United Nations
Energy Use: International Energy Agency

A. Brown, NREL

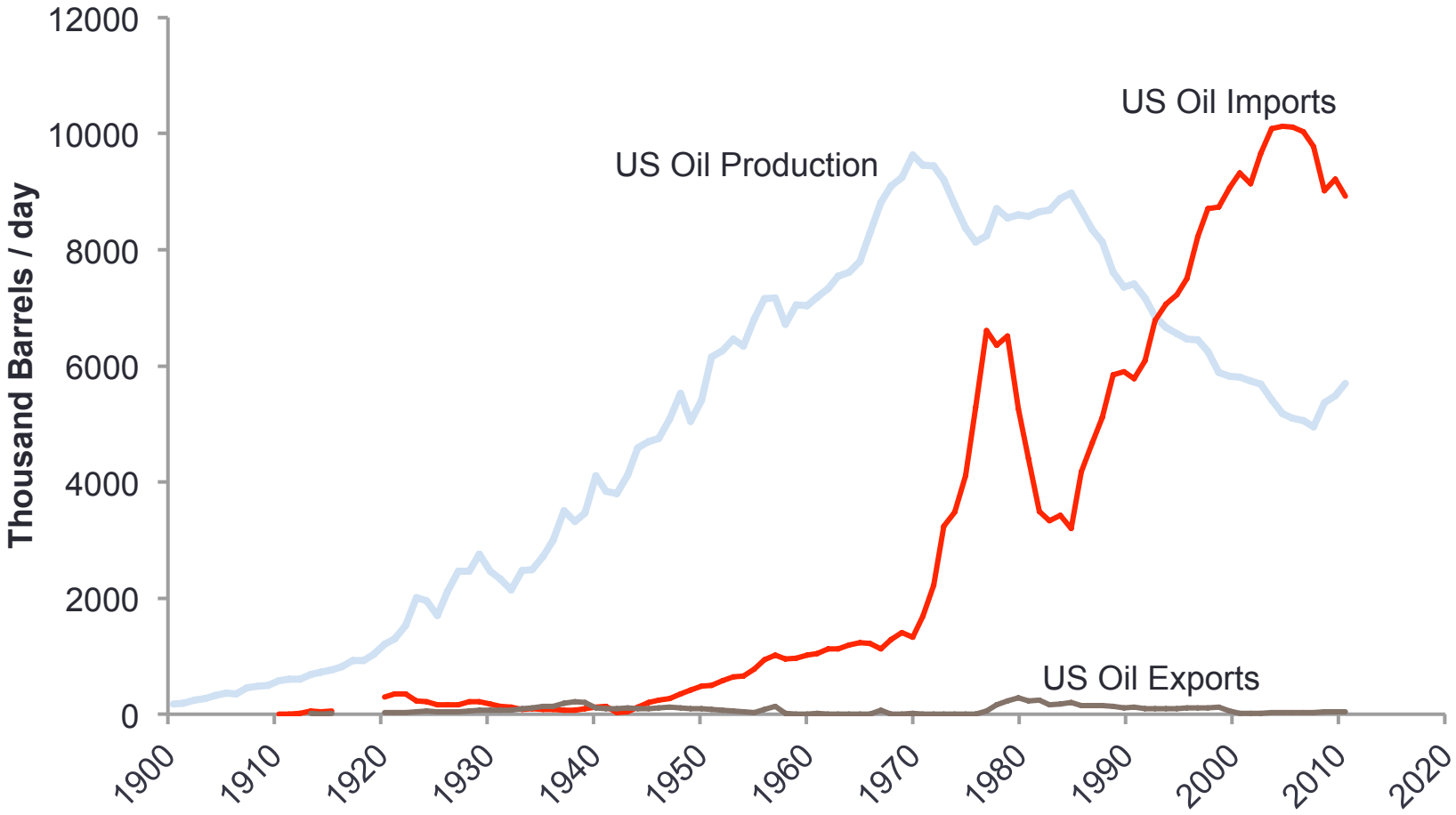
Energy and Development



HDI: United Nations
Energy Use: International Energy Agency

A. Brown, NREL

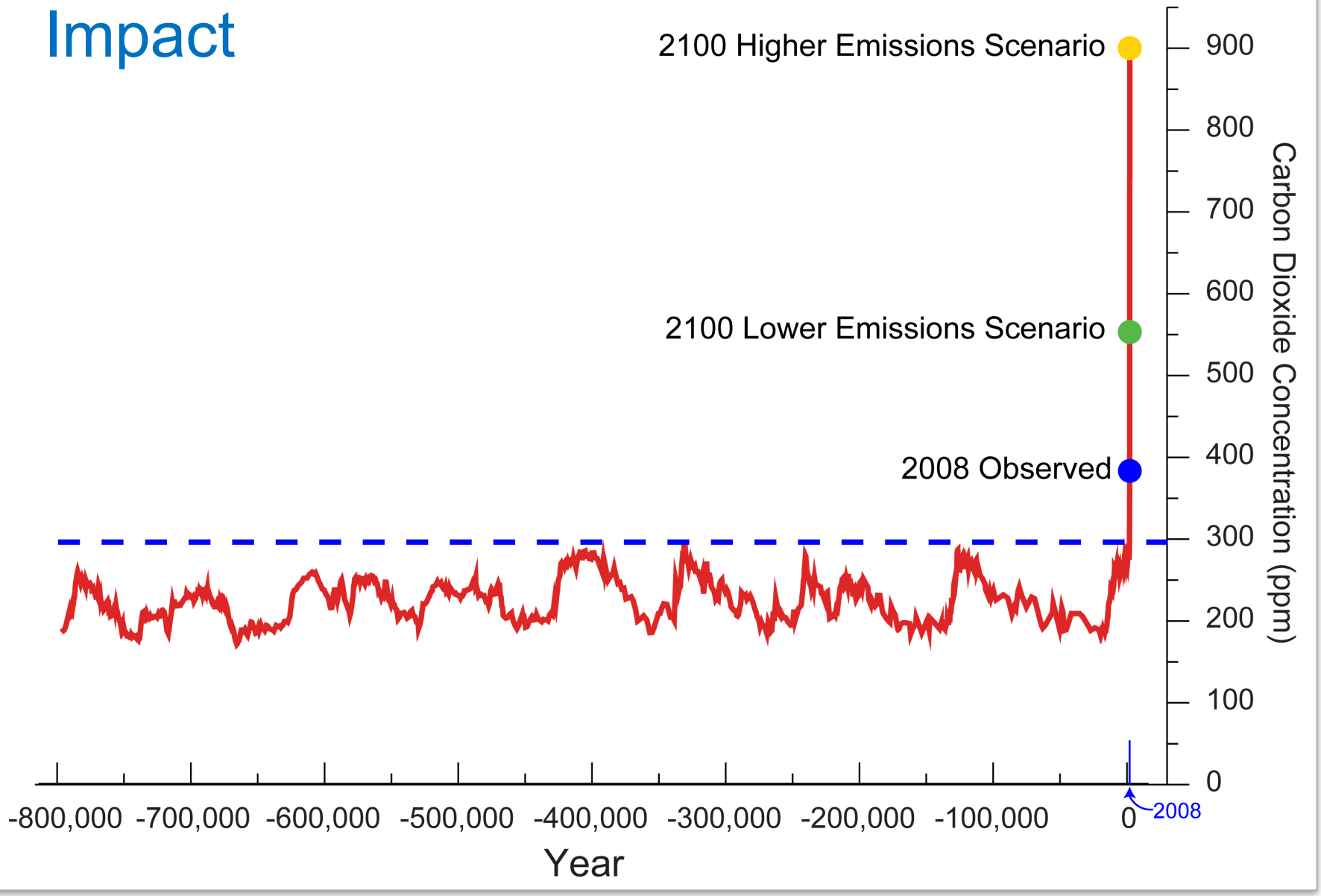
U.S. Use of Oil



U.S. Energy Information Agency

A. Brown, NREL

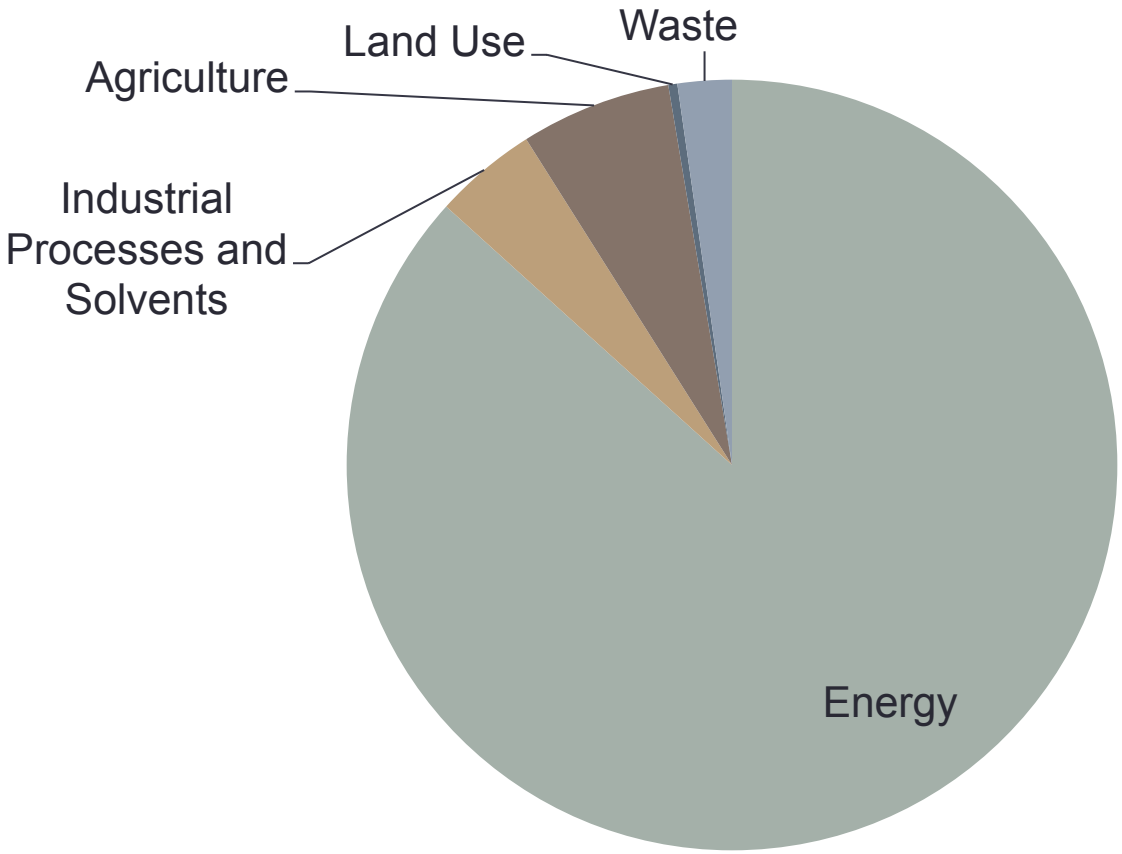
Impact



A. Brown, NREL

U.S. Global Change Research Program

Most Greenhouse Gas Emissions Come from Energy



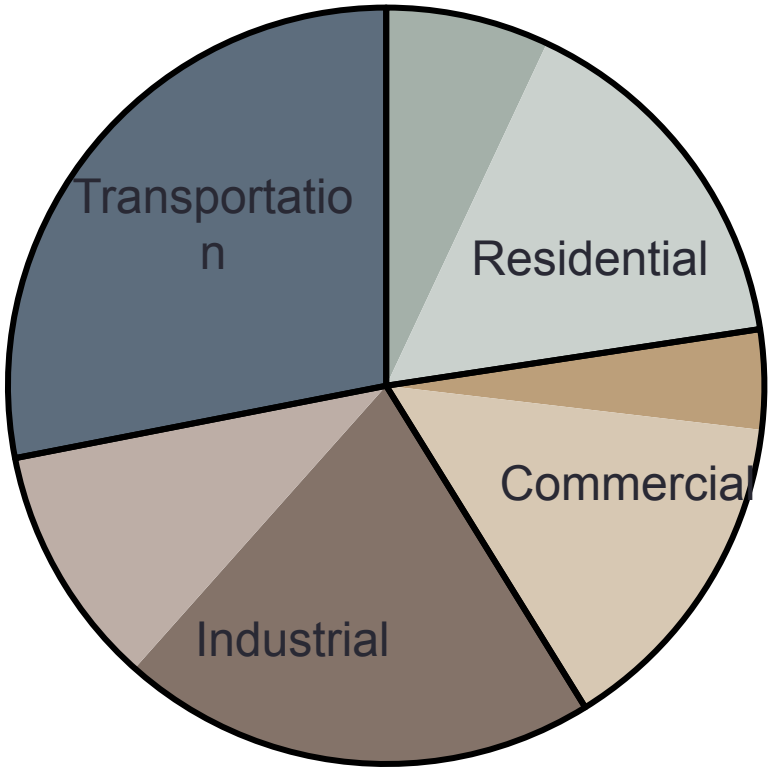
GHG emissions by source (total 6.63 billion tonnes)

U.S. Energy Information Agency

A. Brown, NREL

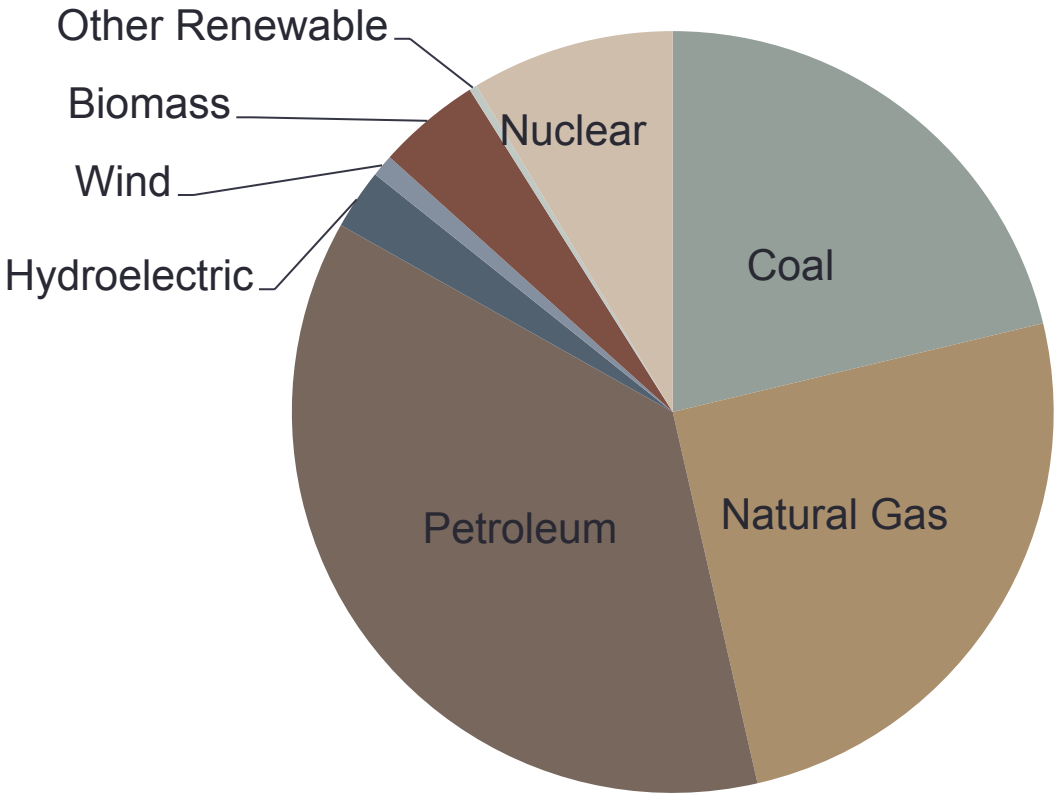
Where and What do we Use?

Primary Energy Use by Sector



Energy use (total 98 quadrillion BTU)

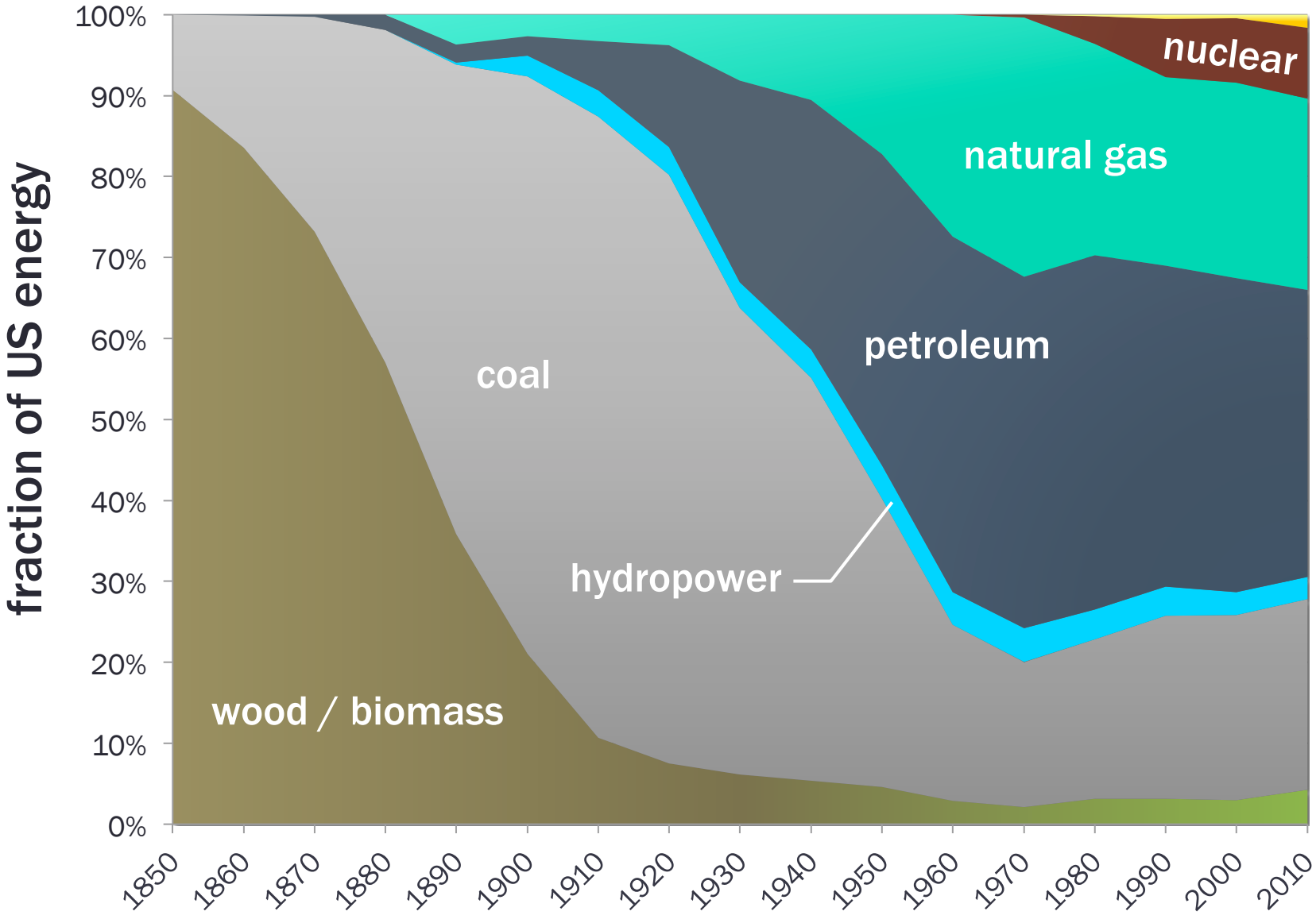
Total Primary Energy Use by Source



U.S. Energy Information Agency

A. Brown, NREL

Historic Use



U.S. Energy Information Agency

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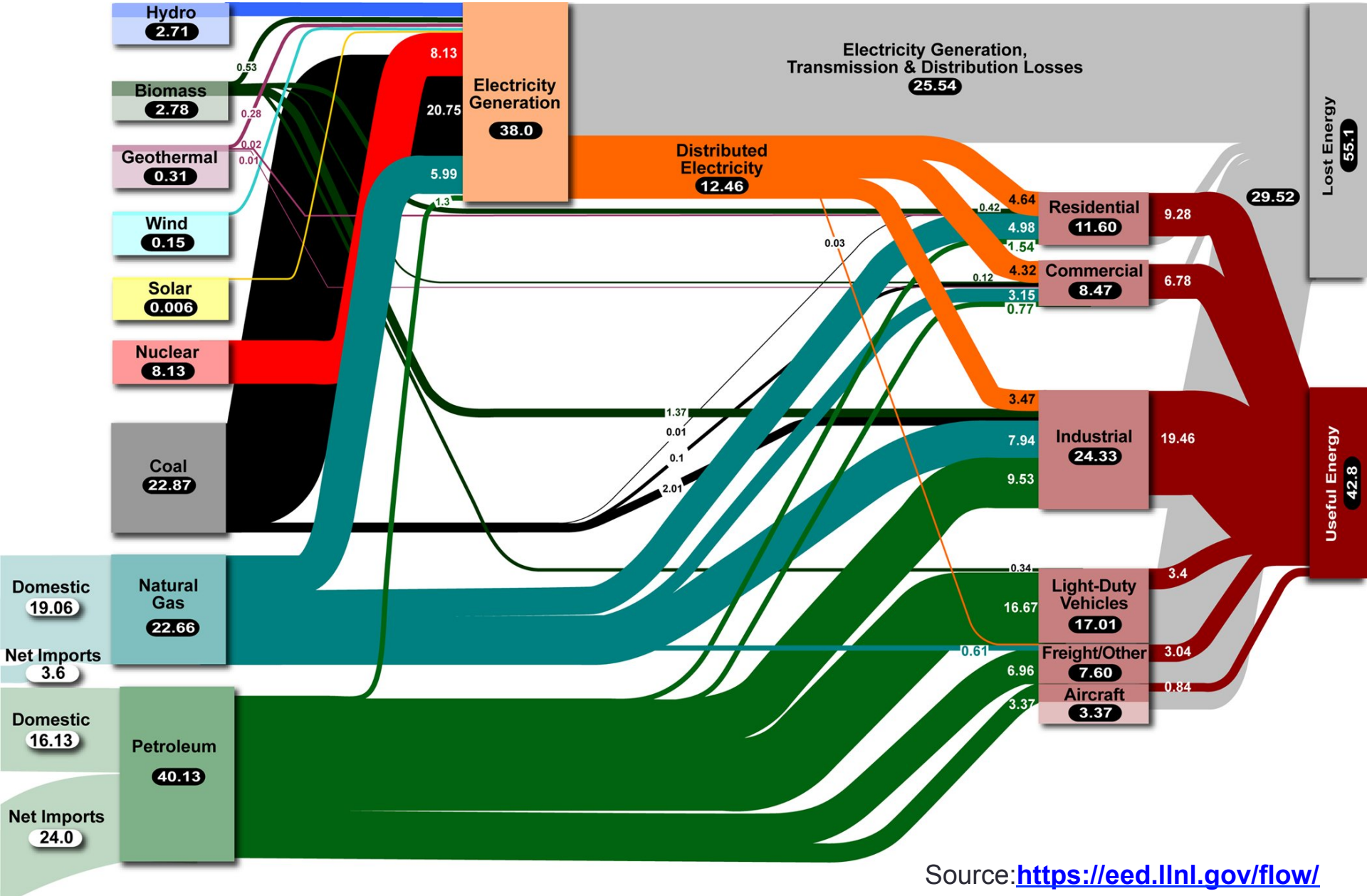
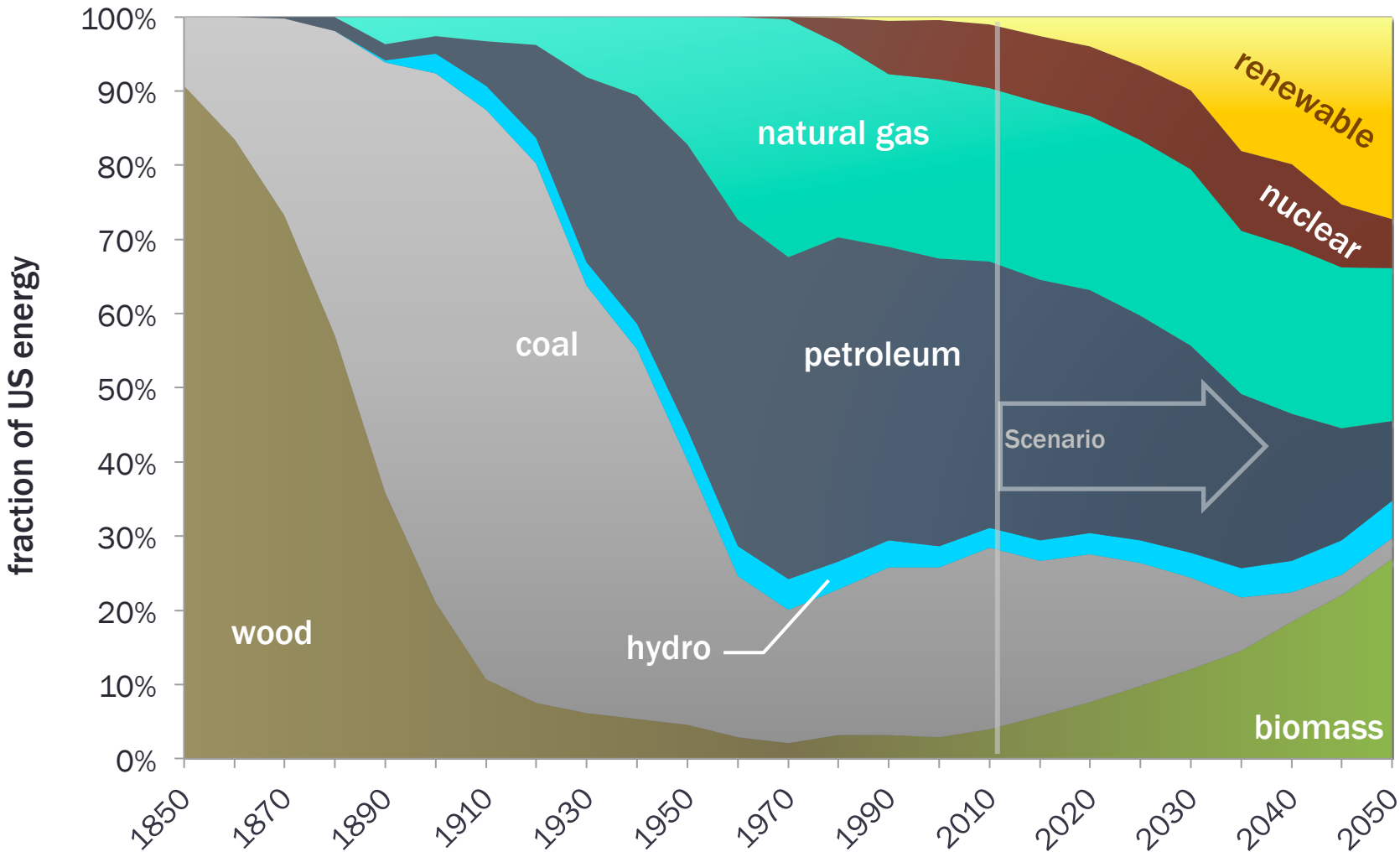
Energy Pipeline



Source:https://eed.llnl.gov/flow/

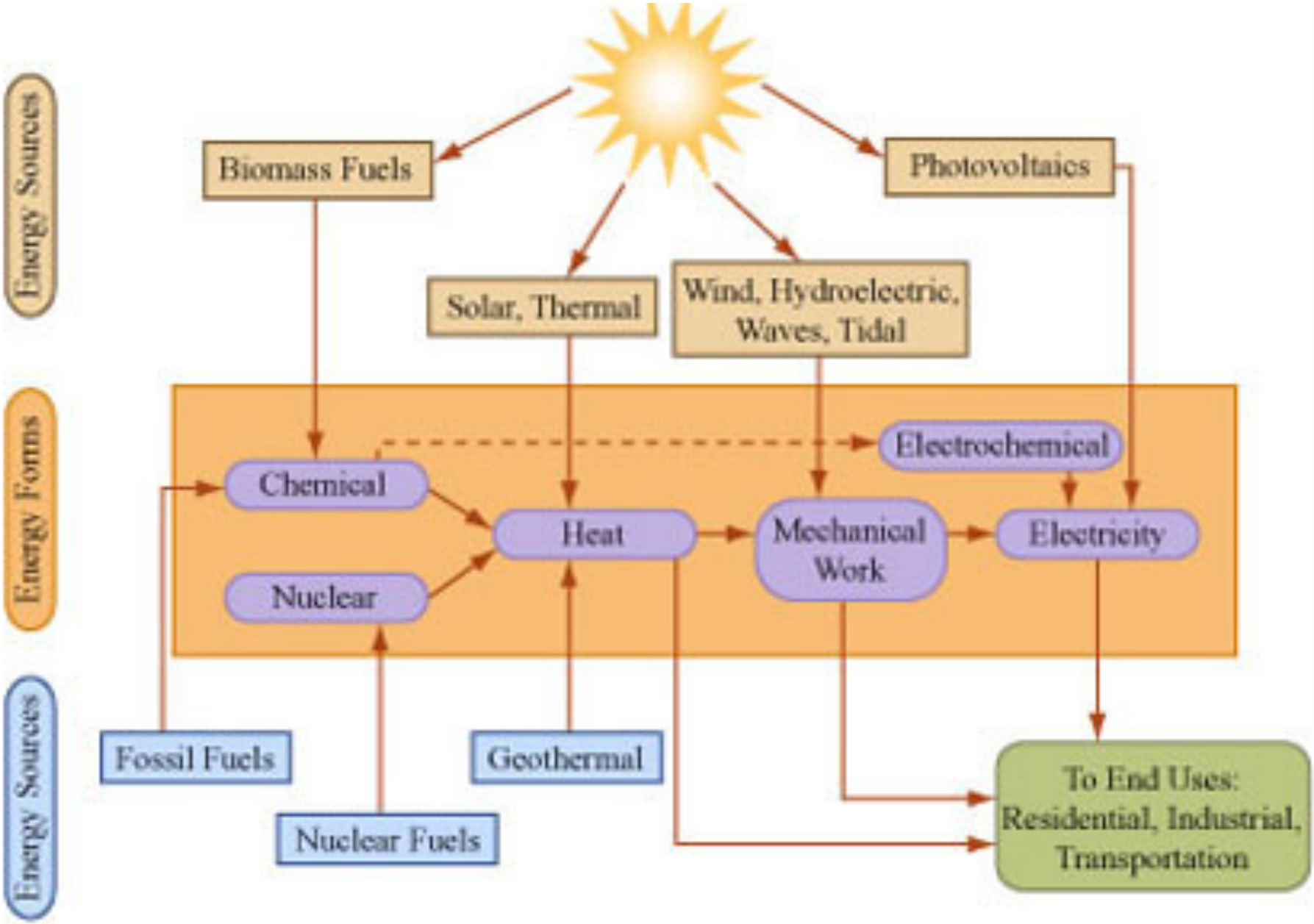
Where can we go?



U.S. Energy Information Agency

A. Brown, NREL

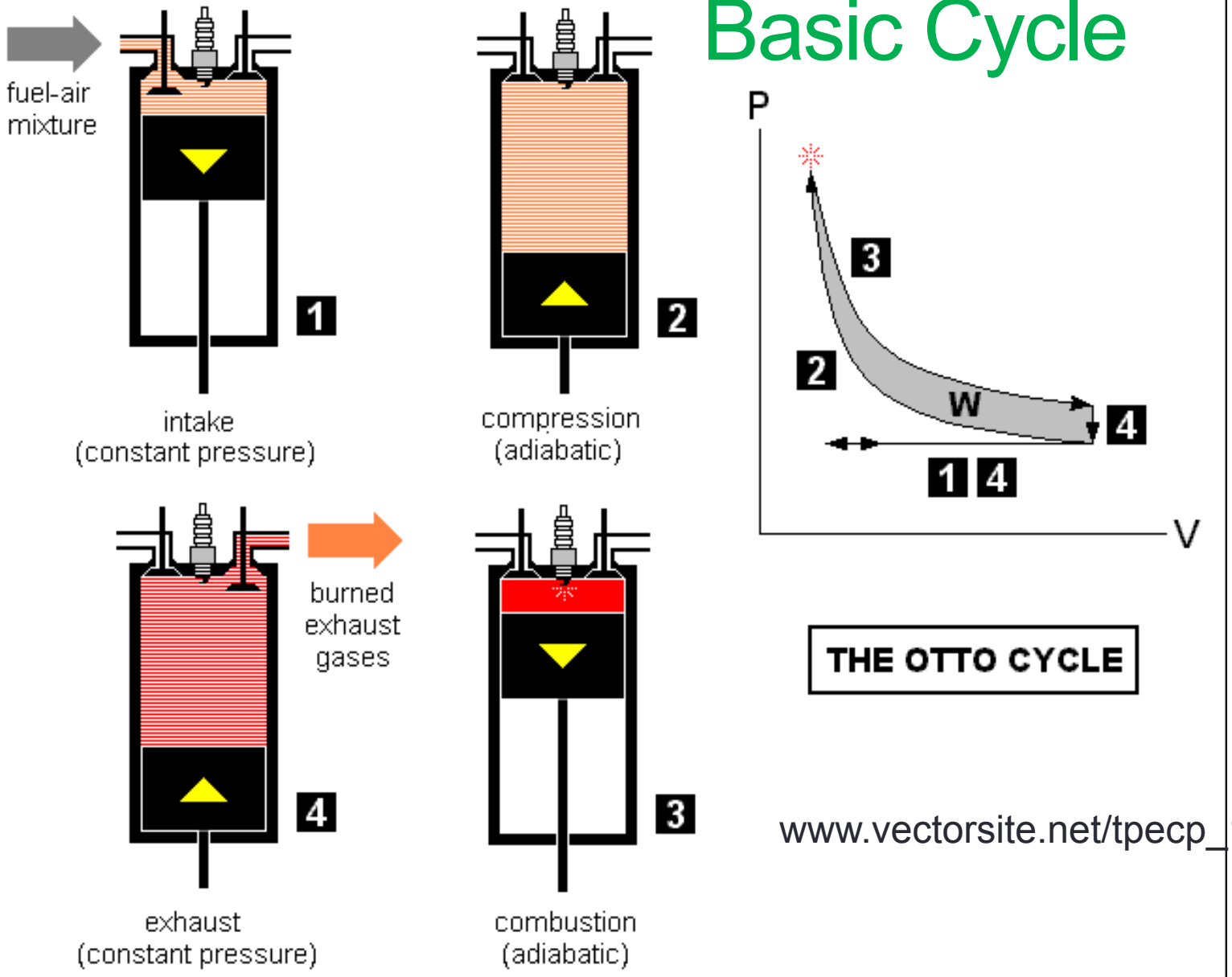
Energy Sources Conversions and Use



AIR-STANDARD CYCLES
(FROM THERMODYNAMICS CLASS)

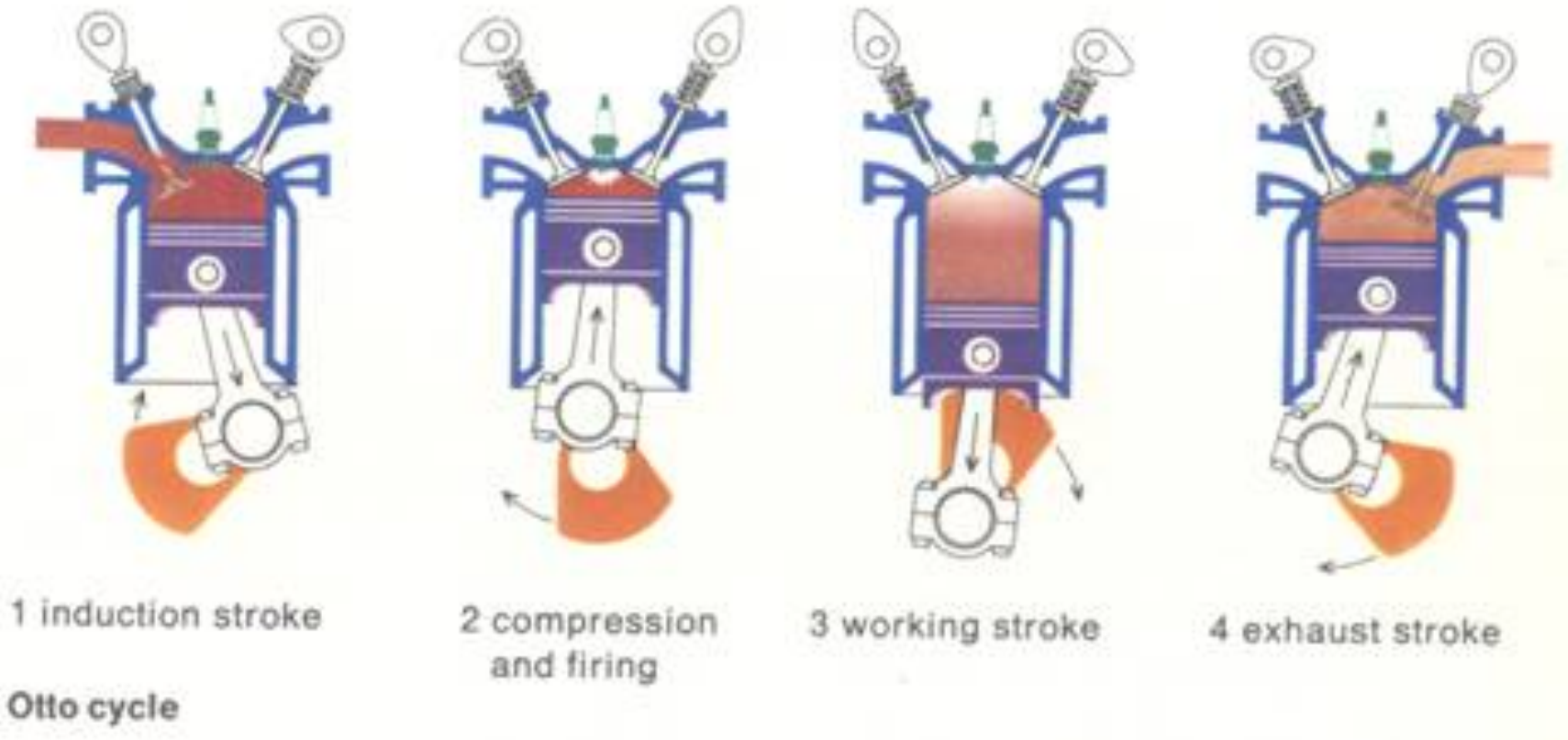
Otto (spark ignition—gasoline)

Basic Cycle



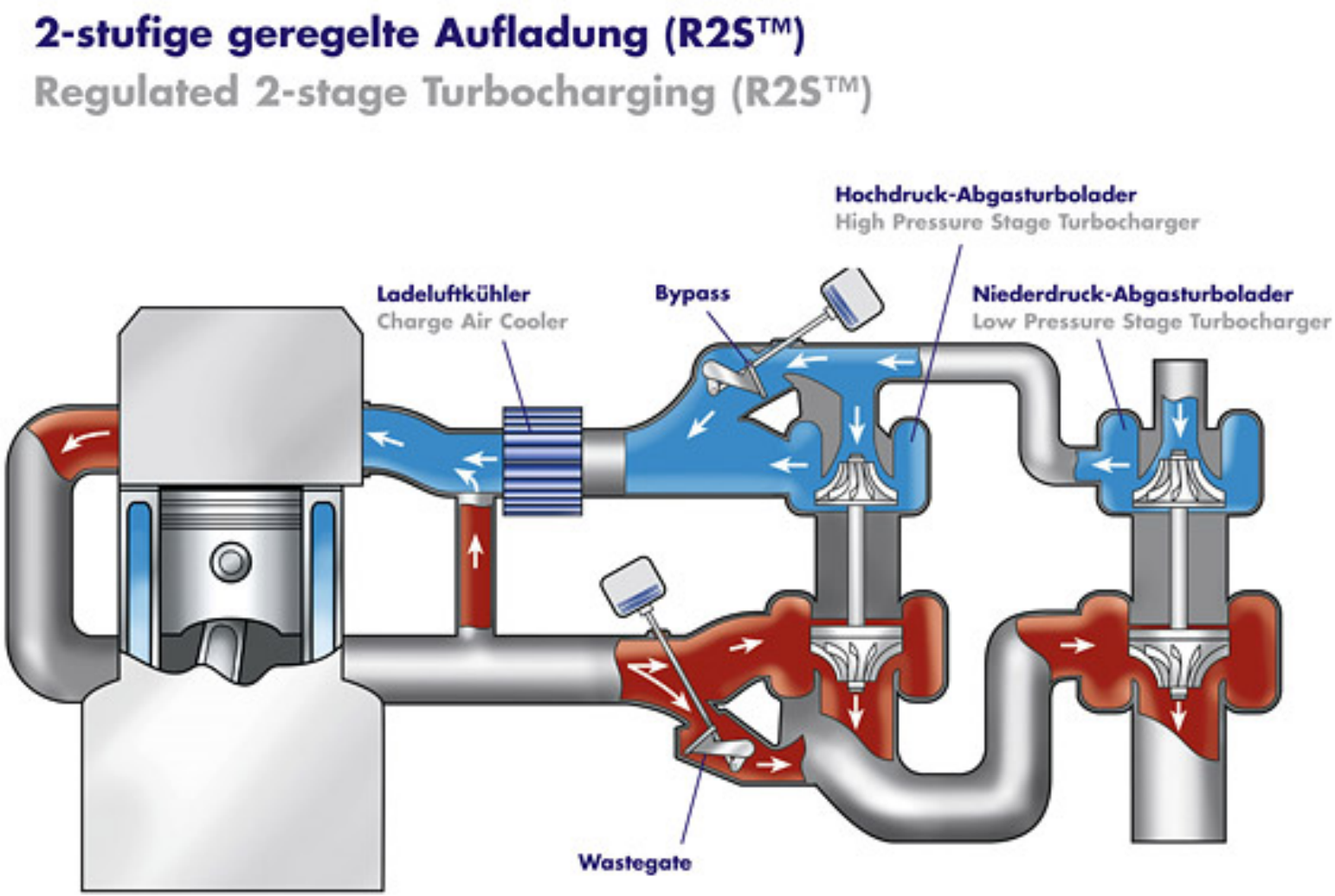
www.vectorsite.net/tpecp_10_06.png

Mechanical Operation



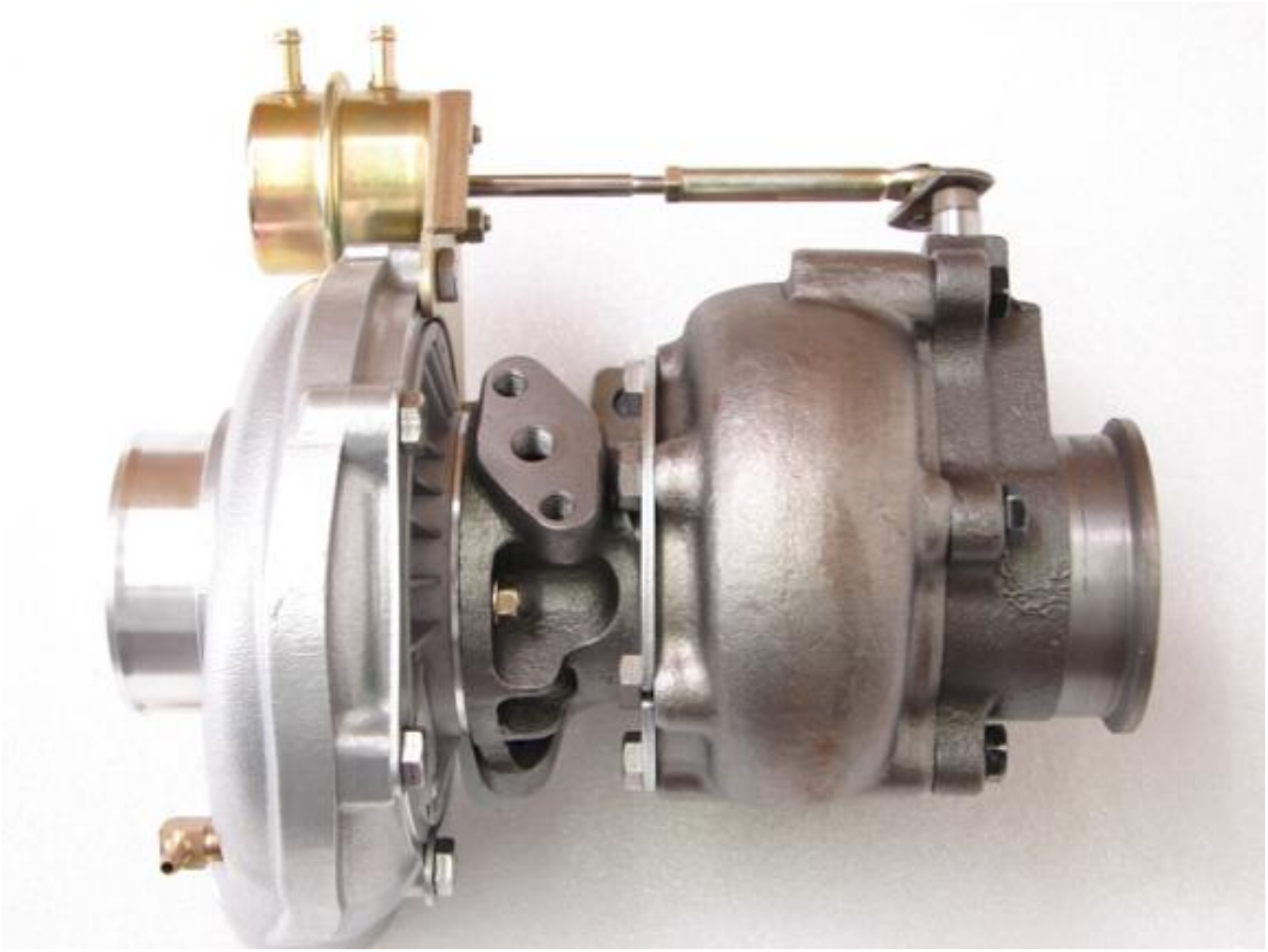
http://www.uefap.com/images/otto.jpg

Improvements—Turbocharging



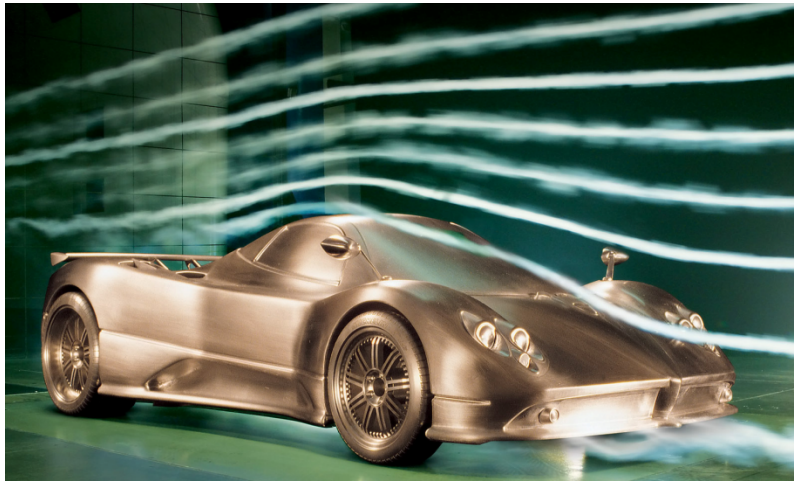
http://www.whnet.com/4x4/pix/R2S.jpg

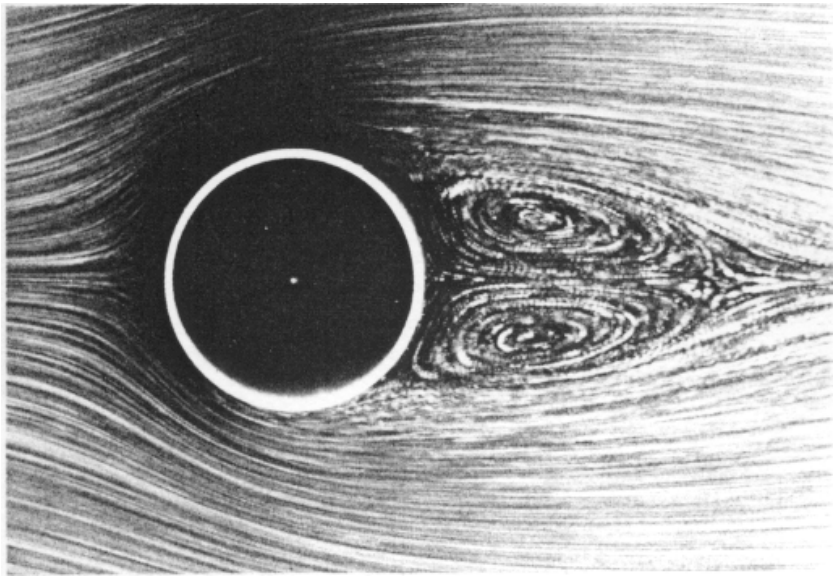
Turbocharger



http://images.andale.com/f2/104/107/24391401/2007/4/17/T3T4_WG_TURBOCHARGER.JPG

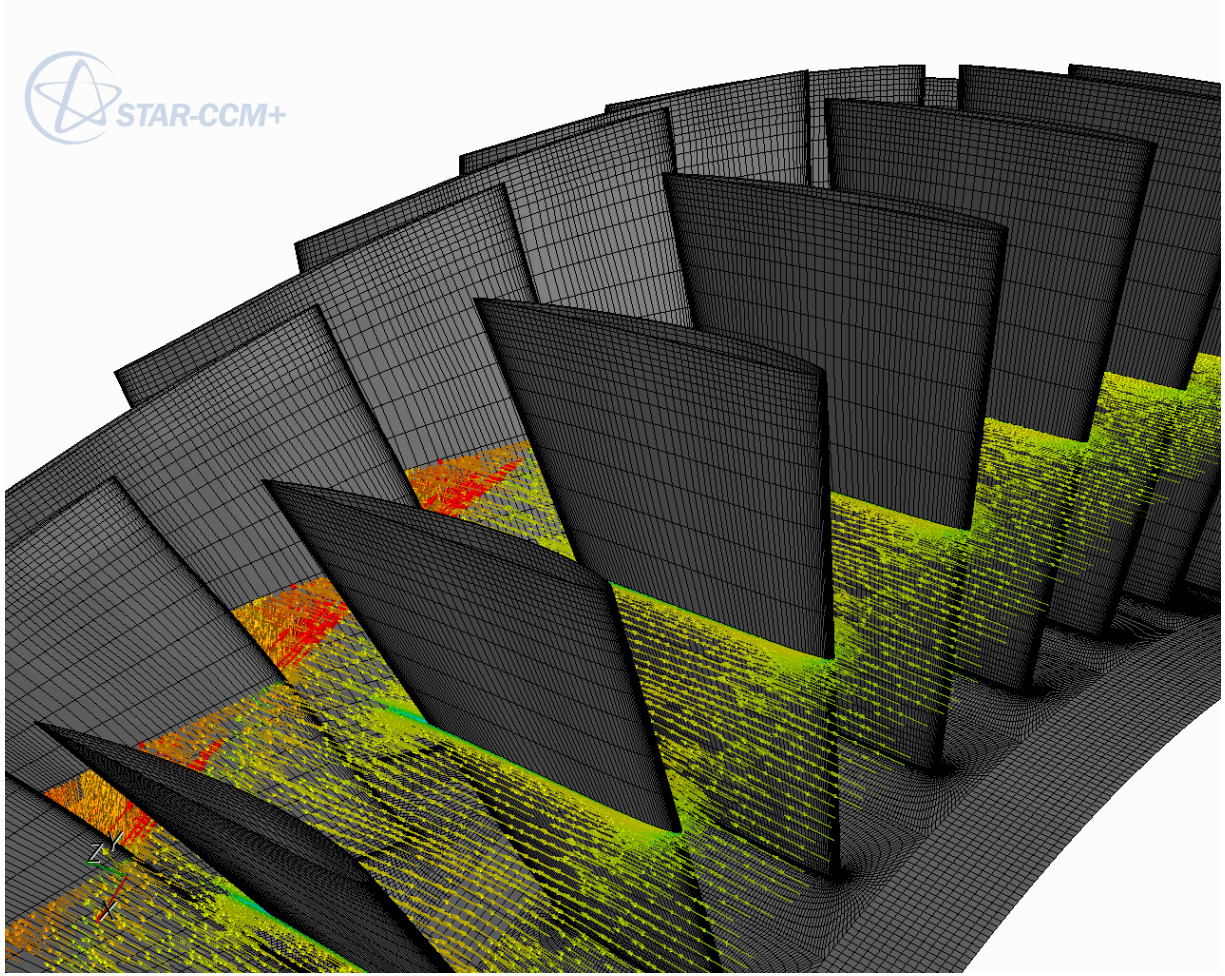
Introduction to Computational Fluid Dynamics
(From Fluid Mechanical Class Mech 122)
D. Fabris, K. Lynch, D. Rich





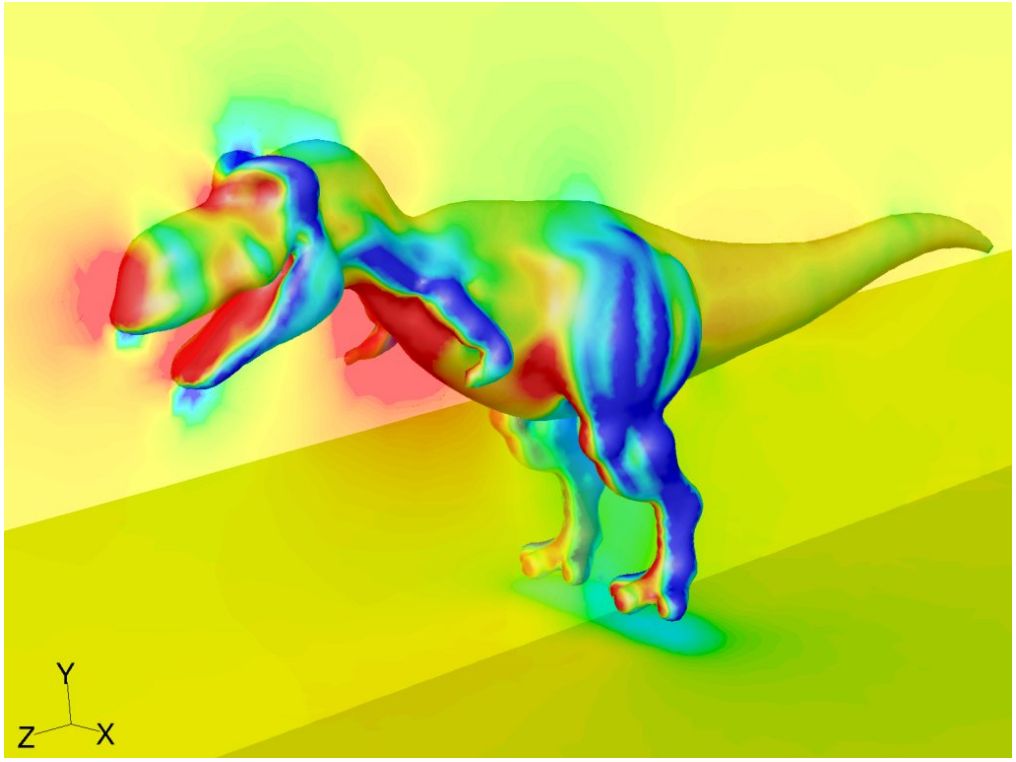
Applications of CFD

- Aerospace
- Automotive
- Biomedical
- Building
- Civil Engineering
- Chemical Process
- Environmental
- Marine
- Power Generation
- Sport Equipment
- Turbomachinery



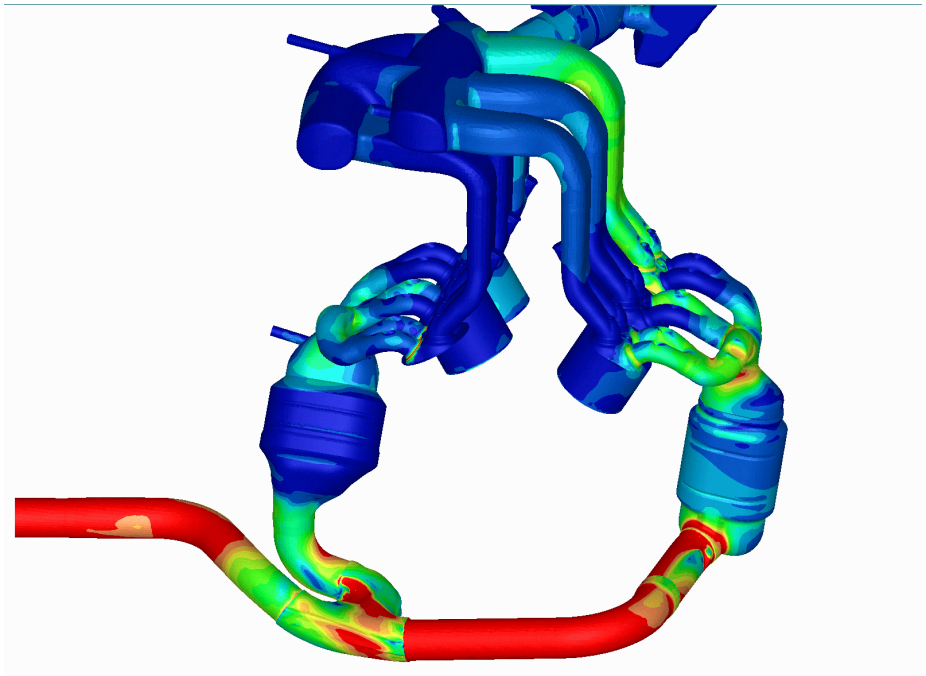
CFD - how it works

- Appropriate initial and boundary conditions are selected. Fluid properties are drawn from experiments. Simplifying assumptions make the problem more tractable (e.g., steady-state, inviscid, incompressible, two-dimensional).
- General conservation (transport) equations for mass, momentum, energy, etc., are discretized into algebraic equations.
- The conservation equations are solved iteratively to render the flow field.
- Convergence is reached when:
  - Changes in solution variables from one iteration to the next are negligible.
  - Residuals provide a mechanism to help monitor this trend.
  - Overall property conservation is achieved.



Visualization

- Graphical tools:
  - Grid, contour, and vector plots.
  - Pathline and particle trajectory plots.
  - XY plots.
  - Animations.
- Numerical reporting tools:
  - Surface and volume integrals and averages.
  - Flux balances.
  - Forces and moments.



Summary

- Mechanical Engineering is composed of many subfields
- Mechanical Engineering Approach
  - Problem motivation
  - Analysis
  - Modeling
  - Experiments

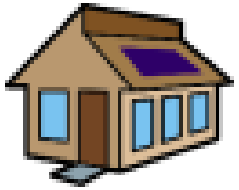
  → Solutions, machines and knowledge

SOLAR DECATHLON 2007, 2009, 2013

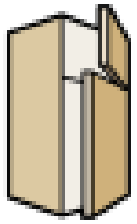
Solar Decathlon Overview

- 10 contests, 20 university teams
- Judging – some numeric, some subjective – 1000 points total
- 18 months to design, analyze, document, build, test, transport 800-1000 ft^2 solar powered home
- Fully functional home (except toilet): kitchen, living room, bedroom, bathroom, with all appliances
- Built on SCU campus and trucked to Washington DC/ Irvine CA for competition

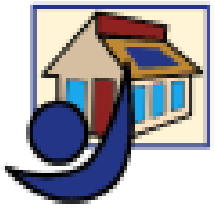
2009 contests



Architecture

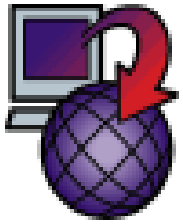


Appliances



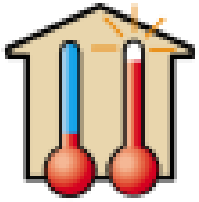
Engineering

Net Metering

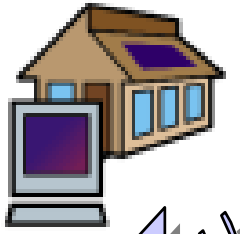


Graphics and Communication

Lighting

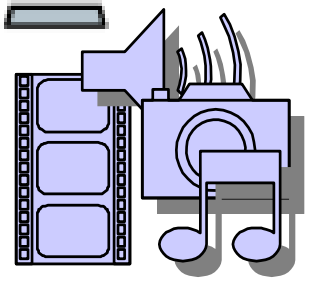


The Comfort Zone



Market Viability

Hot Water



Home Entertainment

Santa Clara Approach

- Our perspective is that this is a student run, and student driven project
- Students come up with the designs, perform the analyses, and build the systems (with expert help as needed)
- Students organize themselves, and make the decisions
- The faculty's job is to mentor, advise, facilitate, oversee, and encourage the team

History - 2007

- SD 2007 – Ripple House
  - Biggest, highest profile project ever undertaken by SCU students
  - Almost totally undergrad, minimal architecture input
  - 21st school chosen, accepted after CalPoly dropped out – 3 months behind others (3/2006)
  - Smallest engineering school, and may have been smallest school overall

2007 Teams

Carnegie Mellon University

Cornell University

Darmstadt University of Technology

Georgia Institute of Technology

Kansas State University

Lawrence Technological University

Massachusetts Institute of Technology

New York Institute of Technology

Santa Clara University

The Pennsylvania State University

Team Montreal (École de Technologie Supérieure, Université de Montréal, McGill University)

Texas A&M University

University of Cincinnati

University of Colorado

Universidad de Puerto Rico

University of Illinois

University of Maryland

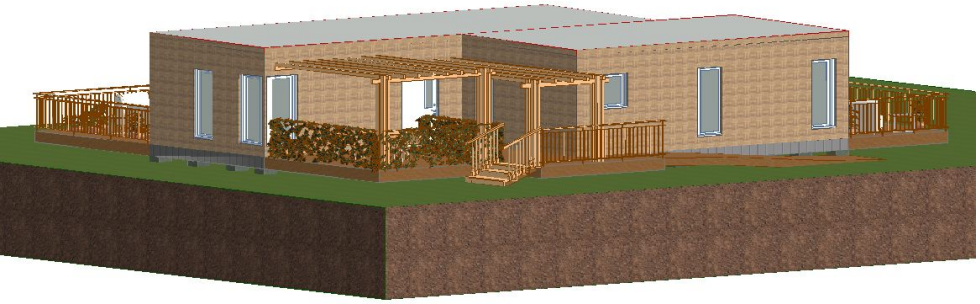
University of Missouri - Rolla

Universidad Politécnica de Madrid

The University of Texas at Austin

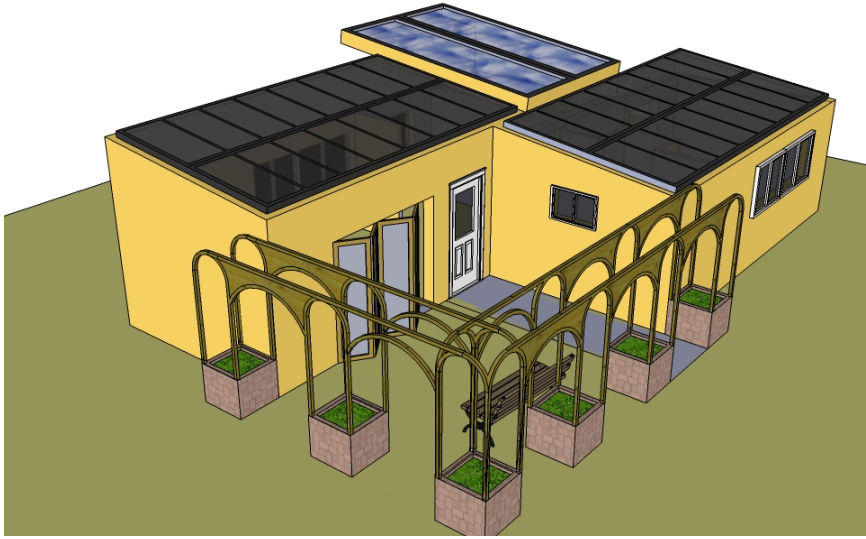
SD 2007 Timeline

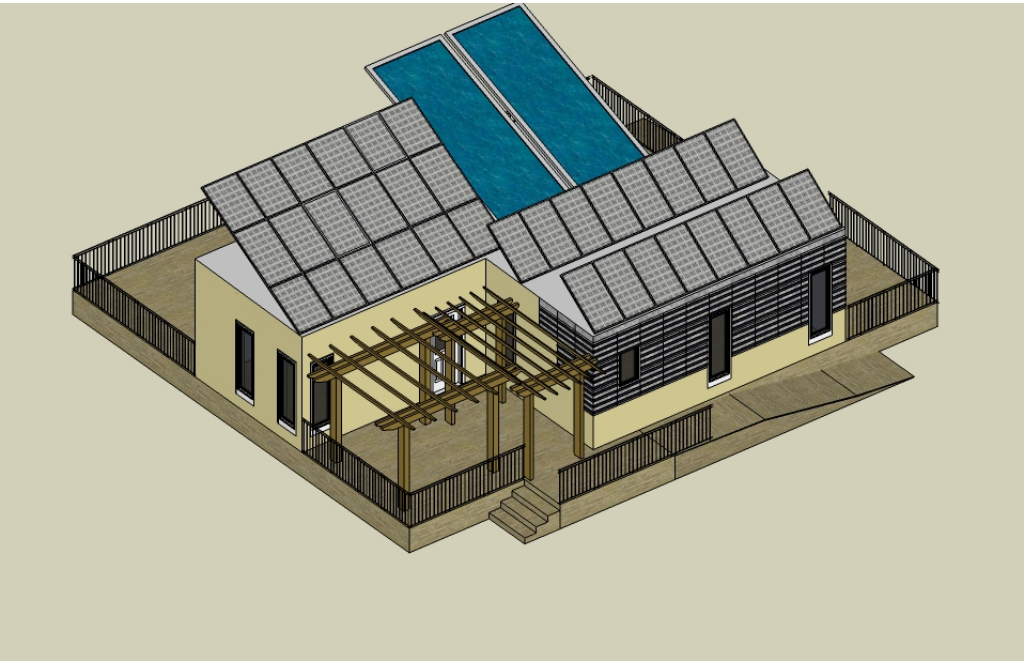
- March 2006 – entry (other schools started in January)
- August 2006 – first major design deliverable
- October 2006:
  - Comprehensive Energy Analysis Report
  - Website Content
- March 6, 2007:
  - Construction Drawings and Specifications
- June 1, 2007:
  - Begin construction
- August 7, 2007
  - Updated Construction Drawings & Specs
- October 2007 - contest

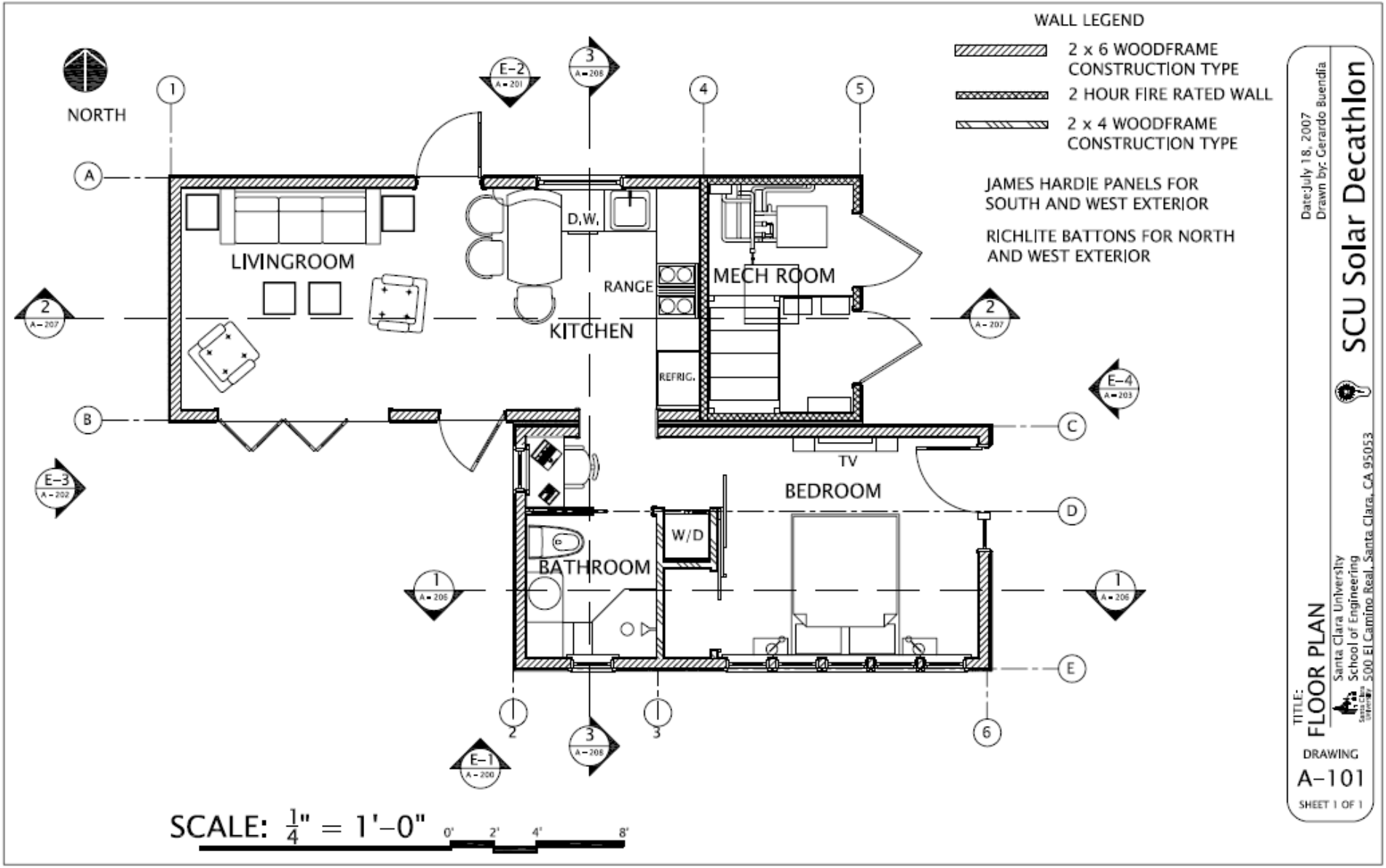


GRAPHISOFT.

February-March ‘07






NORTH
WALL LEGEND
2 x 6 WOODFRAME CONSTRUCTION TYPE
2 HOUR FIRE RATED WALL
2 x 4 WOODFRAME CONSTRUCTION TYPE
JAMES HARDIE PANELS FOR SOUTH AND WEST EXTERIOR
RICHLITE BATTONS FOR NORTH AND WEST EXTERIOR
LIVINGROOM
D.W.
RANGE
KITCHEN
MECH ROOM
REFRIG.
TV
BEDROOM
W/D
BATHROOM
SCALE: 1/4" = 1'-0"
0' 2' 4' 8'
Date:July 18, 2007
Drawn by: Gerardo Buendia
SCU Solar Decathlon
Santa Clara University
School of Engineering
500 El Camino Real, Santa Clara, CA 95053
TITLE:
FLOOR PLAN
DRAWING
A-101
SHEET 1 OF 1


CAUTION


OVERSIZE LOAD


OVERSIZE LOAD
El Camino Real

2007 SOLAR

Sept 25 - depart

Breakdown IA

Solar Decathlon 2007 Schedule

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Sept 30	Oct 1	Oct 2 12:01 AM Team Registration	Oct 3 Assembly Begins	Oct 4	Oct 5 SCU Arrives 8 PM	Oct 6
Oct 7 Rest Day	Oct 8 Assembly	Oct 9 Instrument Houses & Web Connect	Oct 10	Oct 11 Final Inspections ********** VIP & Media Tours VIP Reception	Tours/Workshops Oct 12 Opening Ceremony (10 AM) Scoring Begins	Tours/Workshops Oct 13 Judging
Tours/Workshops Oct 14 Judging	Tours/Workshops Oct 15 Performance Testing Begins	Tours/Workshops Oct 16	Oct 17 24-hr Performance Testing (no tours)	Tours/Workshops Oct 18 Building Industry Day	Tours/Workshops Oct 19 Scoring Ends 1 PM Awards Ceremony 2 PM	Oct 20 Tours and Workshops Awards Reception PM
Oct 21 Disassembly	Oct 22 Disassembly	Oct 23 Disassembly	Oct 24	Tour Hours: 11 a.m – 3 p.m. Weekdays 10 a.m. – 5 p.m. Weekends		


500


SOLAR DECATHLON

Summary

Darmstadt

1st Architecture
1st Engineering
1st Lighting
3rd Appliances
1st Energy Balance

Maryland

1st Communications
2nd Architecture
2nd Lighting
2nd Market Viability
1st Energy Balance

Santa Clara

2nd Communications
2nd Appliances
1st Hot Water
2nd Getting Around
1st Energy Balance

Colorado

1st Getting Around
3rd Engineering

Illinois

1st Market Viability
1st Comfort Zone

Texas A&M

1st Appliances


SOLAR DECATHLON
THIRD

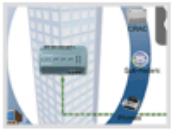
Building Energy Management System Solutions

Serious Energy provides Energy Efficiency Platforms that drive ongoing energy efficiency and savings in commercial buildings.

A secure web-based platform, SeriousEnergy Manager gives building owners and facility managers real-time, always-on insight and control to continuously optimize and cut energy usage in all types of commercial buildings.

While other "energy management" solutions specialize in monitoring and prevention of system failures and malfunctions, SeriousEnergy Manager goes beyond this "one time tune-up" approach. SeriousEnergy Manager continuously drives savings by finding systems out of tune, running at incorrect times, or running inefficiently. The combination of persistent commissioning, proprietary algorithms, and customized settings provides customers with unmatched analytics and rule-based controls to continuously optimize and save energy usage.

download SeriousEnergy Manager Overview Brochure



Building Energy Management System

Solutions

Case Studies

CISCO

Key SeriousEnergy Manager Alliances

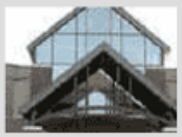
Members-Only Partner Portal

SeriousEnergy Manager Customer Login

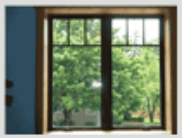
SERIOUS ENERGY FEATURED PROJECTS

Empire State Building

UMG Universal Studios



Manheim Township High School



Passive House by Bilyeu Homes

CoreHaus

2009 SOLAR DECATHLON

Collaboration

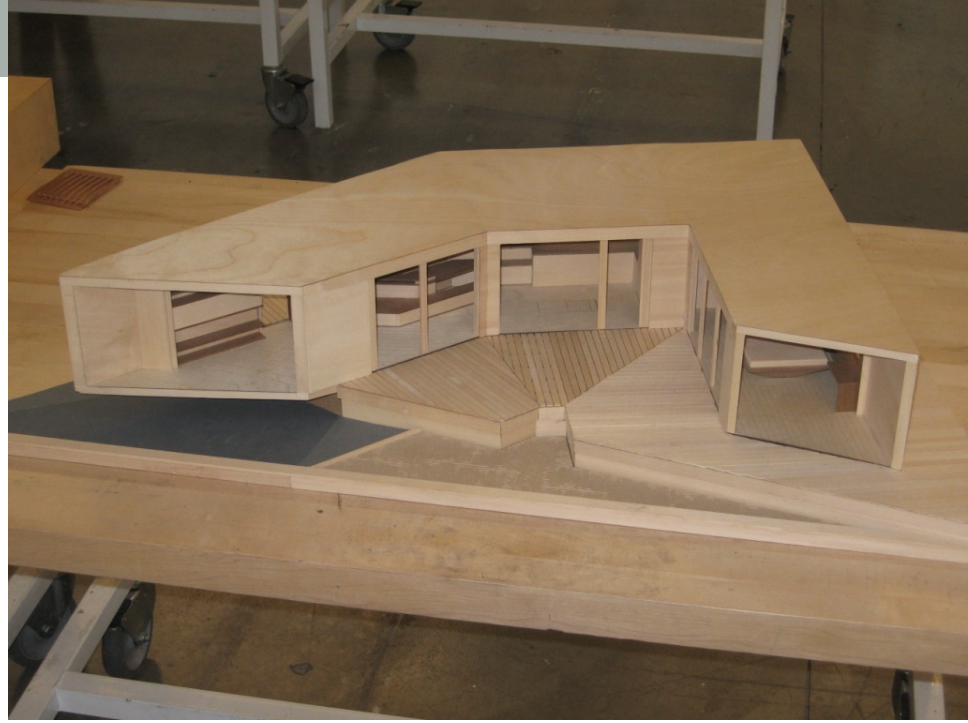
- SCU participated in 2007 SD on its own
- Placed 18th in architecture and sought to do better in 2009
- Several partners were considered before CCA was picked
- Team grew from faculty connection between schools

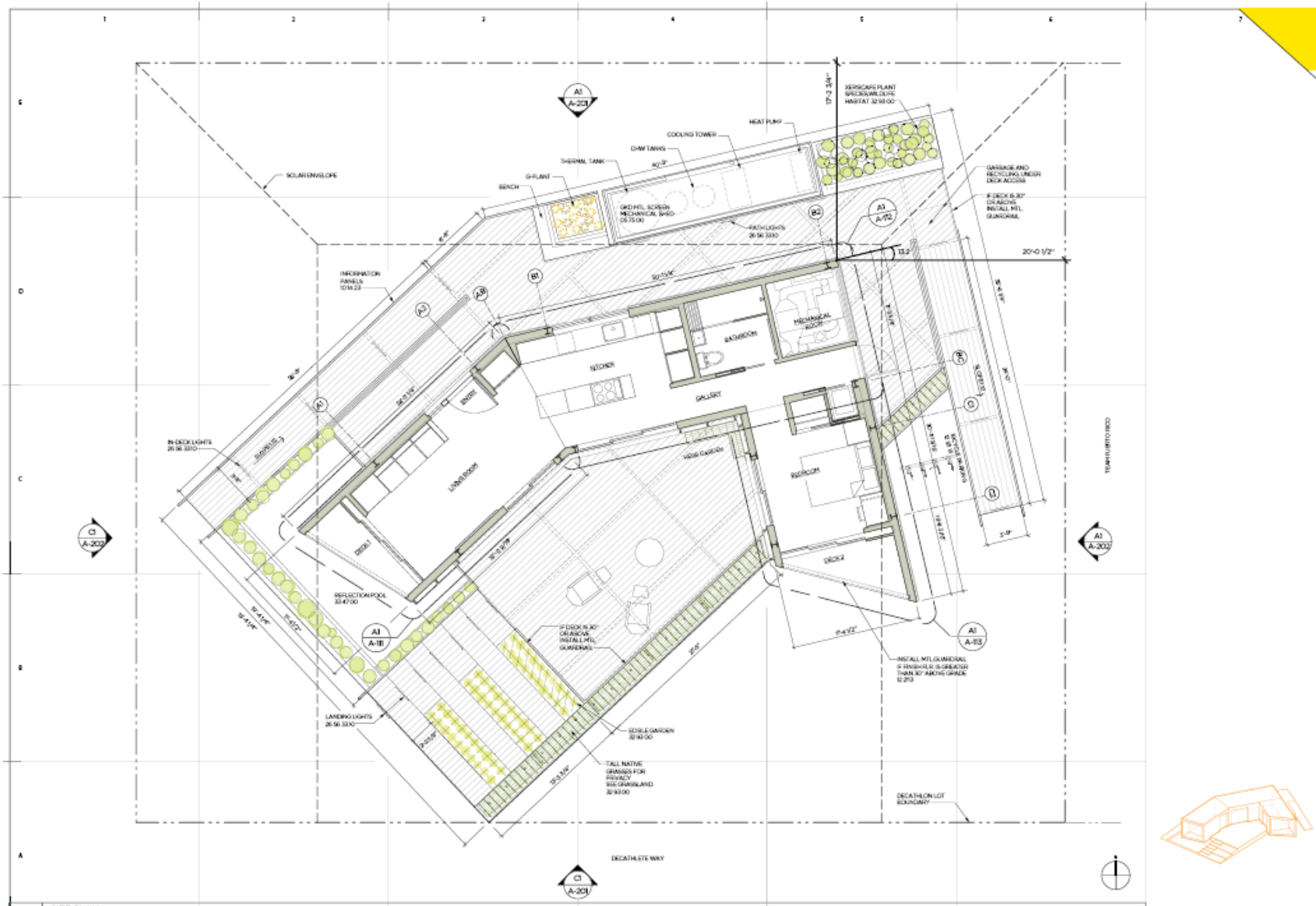
REFRACT HOUSE

SANTA CLARA UNIVERSITY & CALIFORNIA COLLEGE OF THE ARTS

- Thinking “outside the box” – don’t need to be a cube
- Refract – “bent box” outline
- House design and use follow sun path (E to W)
- California lifestyle- outside/deck is integral part of house
- Reflecting pond, rain catchment
- Reclaimed redwood and elm
- Billboard rain barrier
- Extensive glazing, daylighting
- Focus on livability and efficiency

Architectural Features





A1 SITE PLAN
1/4" = 1'-0"

REFRACT HOUSE

U.S. DEPARTMENT OF ENERGY SOLAR DECATHLON
WWW.REFRACTHOUSE.COM

SANTA CLARA UNIVERSITY
500 EL CAMINO REAL
SANTA CLARA, CA 95053

CALIFORNIA COLLEGE OF THE ARTS
1111 8TH STREET
SAN FRANCISCO, CA 94107

DATE: JUNE 02, 2009

ISSUE: DOE
DESIGNED BY: TEAM CAL
DRAWN BY: STUDENTS
CHECKED BY: RMA
SHEET TITLE:

SITE PLAN

A-106

- University of Arizona
- Cornell
- Darmstadt
- Illinois
- Iowa State University of Scie and Technology
- University of Kentucky
- University of Louisiana @ Lafayette
- Madrid
- University of Min
- Missouri University of Science and Technology

- Ohio State
- Penn State
- University of Puerto Rico
- Rice
- SCU / CCA
- University of Calgary / SAIT Polytechnic / Mount Royal College
- Boston Architectural Colleg Tufts
- University of Waterloo / Ryerson / Simon Fraser
- VPI
- University of Wisconsin - Milwaukee

Structure

- For transportation, house divided into three modules 11.5 feet wide
- Open tubes required extensive steel to resist moments
- Finished modules weighed 16-22,000 lbs


SUNSTATE EQUIPMENT
SOLAR DECATHLON 2009

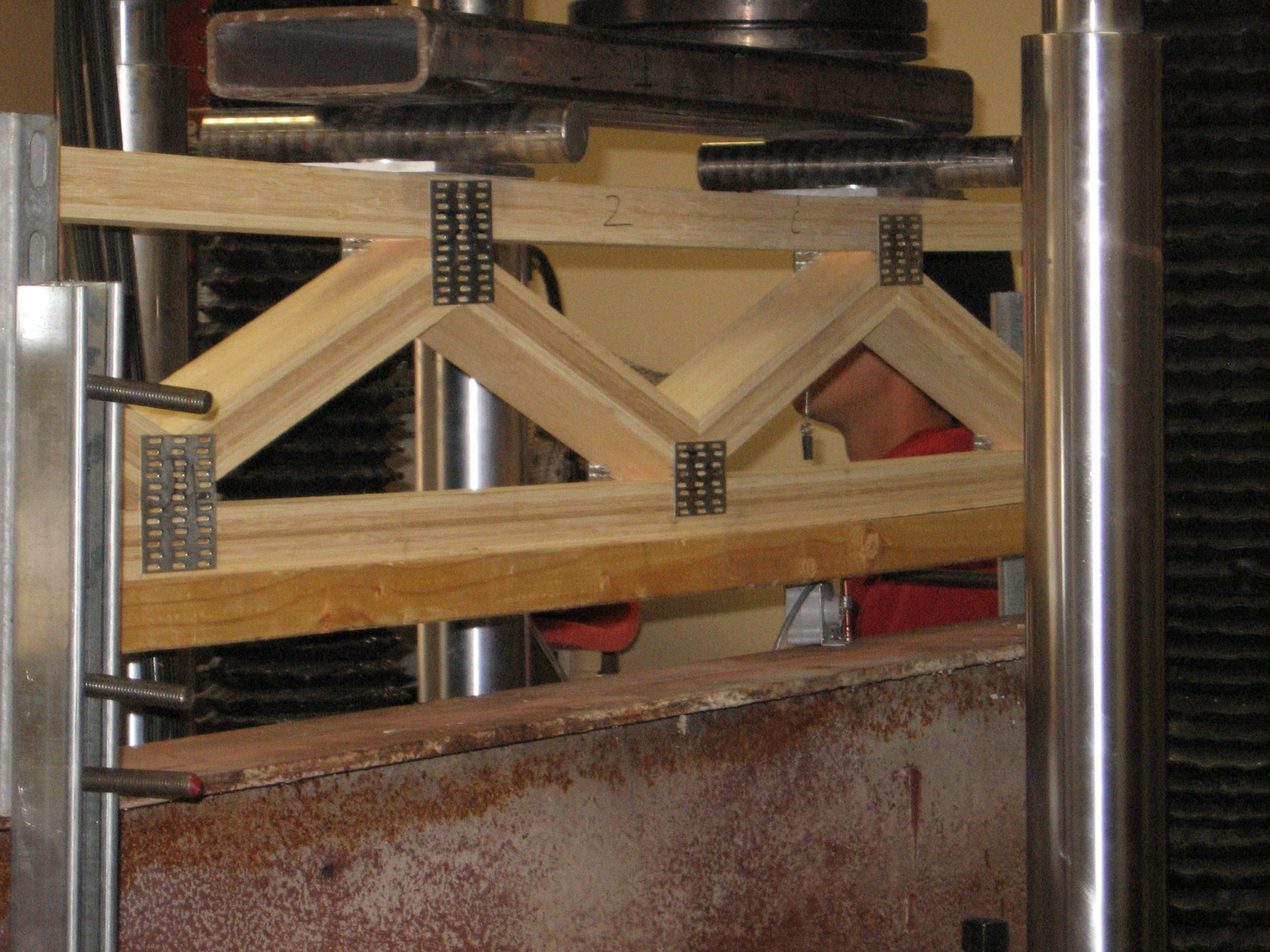
PV

- In July, forced to abandon solar thermal system and go all electric
- 38 SunPower 225 panels - ~10.2 kW peak
- Integrated into roof line at ~8 degrees
- Restricted in angle due to height limitation
- Two Sunny Boy 5000 inverters


Conway

Bamboo Truss

- Original design by SCU students and faculty
- Bamboo I-Beams successfully developed and used in 2007 house
- Open web trusses developed to reduce material and ease wiring
- Extensive testing done on campus to qualify beams as load bearing members




WIDE LOAD

Results

- Juried contests:
  - Architecture: 1st, 98/100
  - Market Viability: 3rd, 92/100
  - Engineering: 2nd, 95/100
  - Communications: 1st, 69.75/75
  - Lighting Design: 6th, 68.25/75

Results

- Objective Contests
  - Comfort Zone: 14th, 63.088/100
  - Hot Water: 3rd, 95/100
  - Appliances: 2nd, 92.58/100
  - Home Entertainment: 2nd, 92.183/100
  - Net Metering: 12th, 100.239/150
- Overall
  - Team Germany: 1st, 908.297/1000
  - Illinois: 2nd, 897.300/1000
  - Team California: 3rd, 863.089

Contest	Team California	Illinois	Germany
Architecture	1 – 98	12 – 77	3 – 94
Market Viability	3 – 92	14 – 86	5 – 91
Engineering	2 – 95	5 – 88	4 – 91
Communications	1 – 69.75	10 – 60.75	15 – 53.25
Lighting Design	6 – 68.25	2 – 70.5	3 – 67.75
Comfort Zone	14 – 63.088	2 – 91.652	1 – 92.008
Hot Water	3 – 95	1 – 100	2 – 95.2
Appliances	2 – 92.58	1 – 93.537	5 – 89.051
Home Entertainment	2 – 92.183	1 – 92.625	4 – 87.038
Net Metering	12 – 100.239	2 – 137.236	1 – 150
Total	**3 – 863.089**	**2 – 897.300**	**1 – 908.297**


112


120
University of Illinois at
Urbana-Champaign

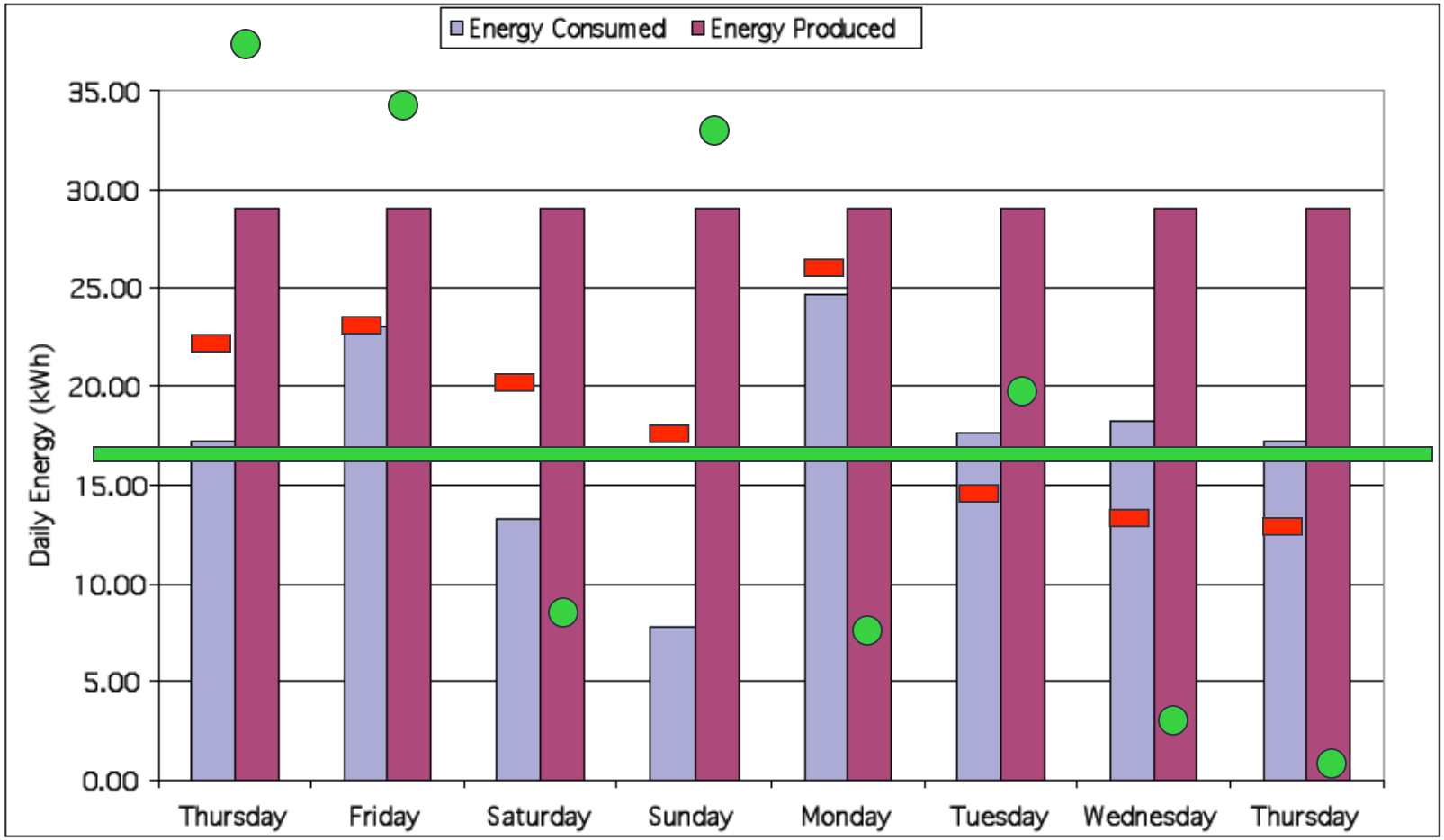


Figure 17: Expected house energy consumption and production during a competition week


CCA

Afterlife

- Set up on campus now
- Used as tour site, education center, and research site

- Submited a proposal to NREL, December 2011, and selected to participate
- Proposal includes:
  - Technical innovation and design
  - Fundraising and team/institutional support
  - Curriculum integration and project planning

Solar Decathlon 2013

Solar Decathlon 2013 -- Changes to contest

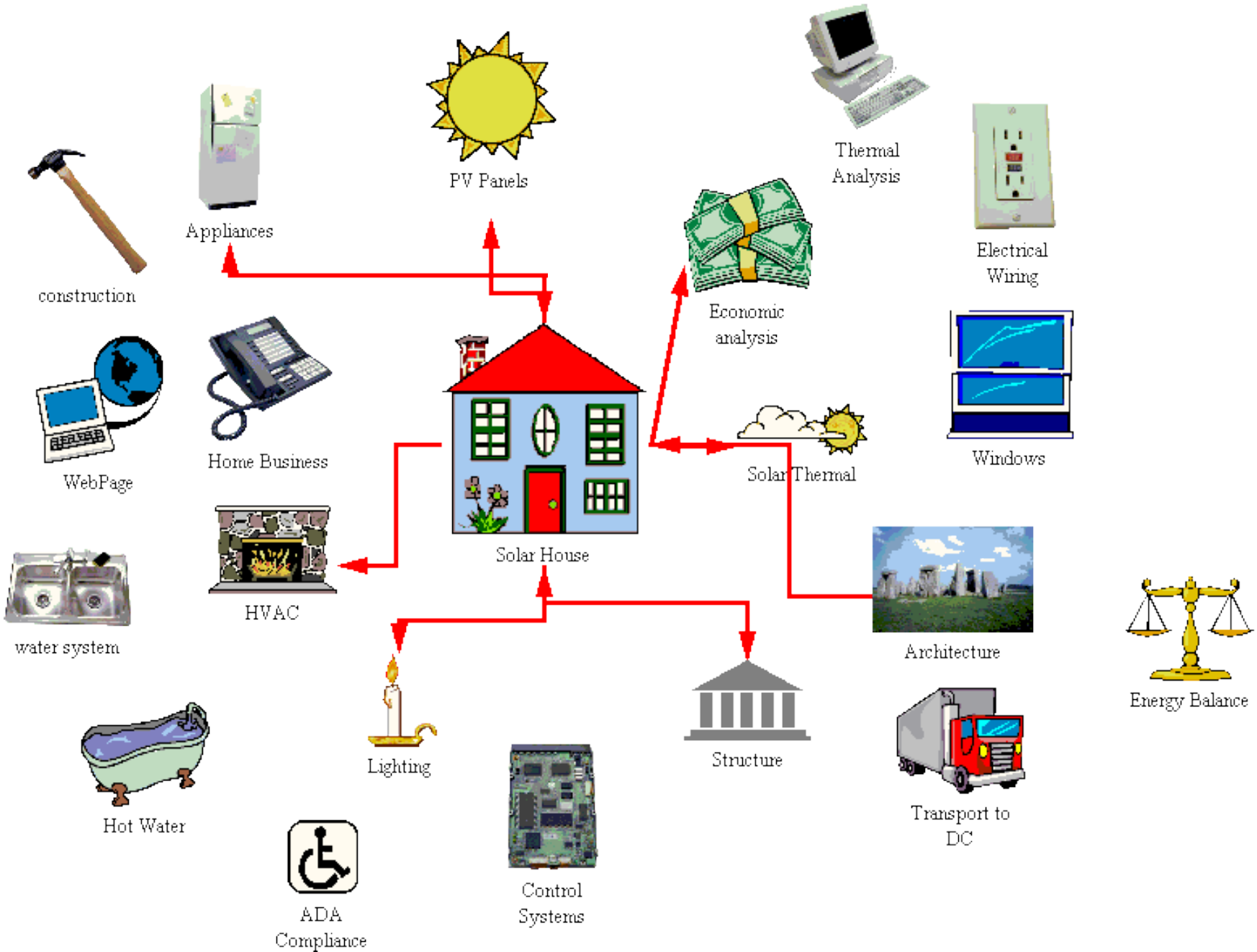
- Location – Great Park of Orange County (former El Toro Naval Air station)

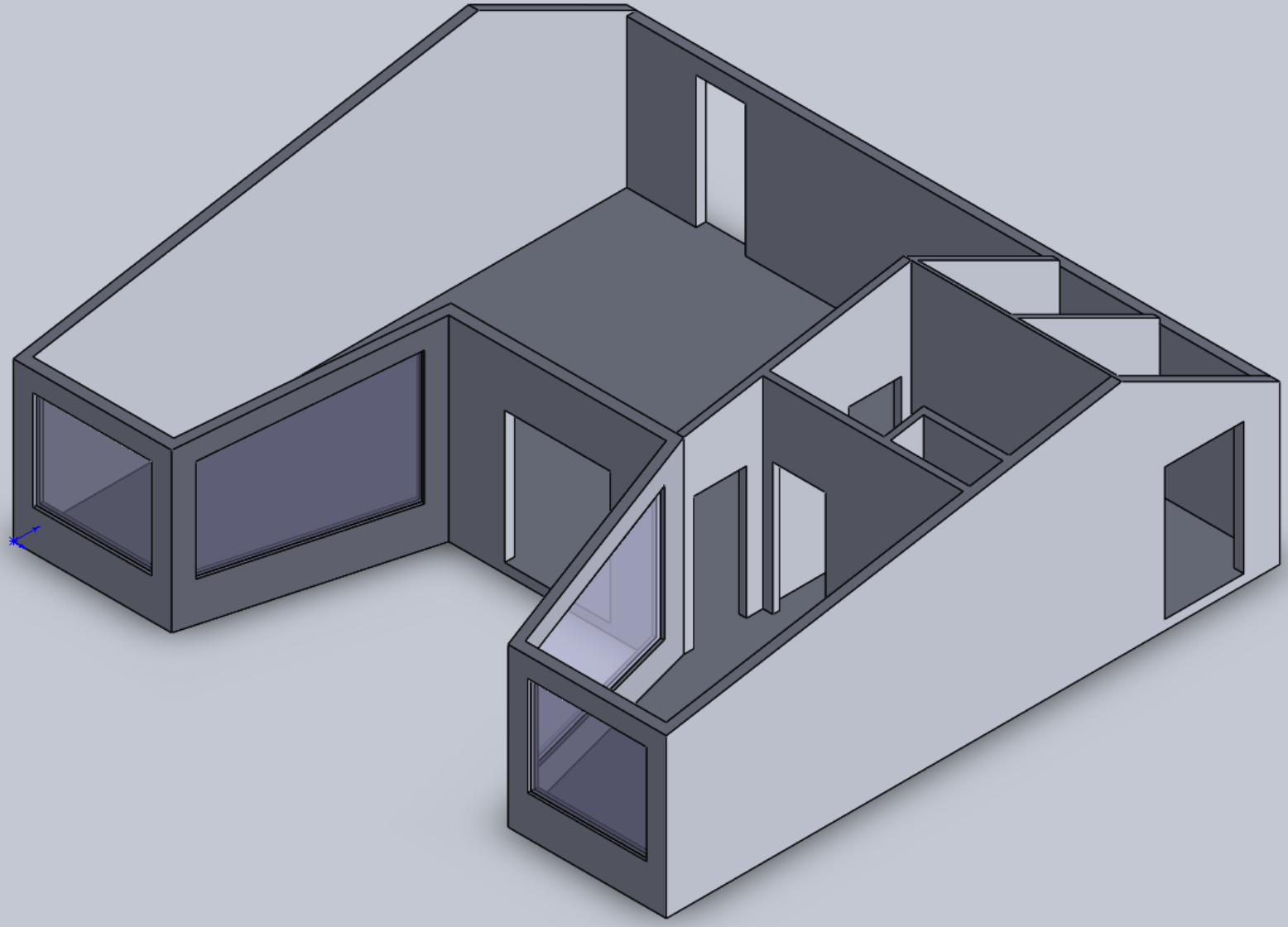
- New contest – affordability (max points for $250k or under)

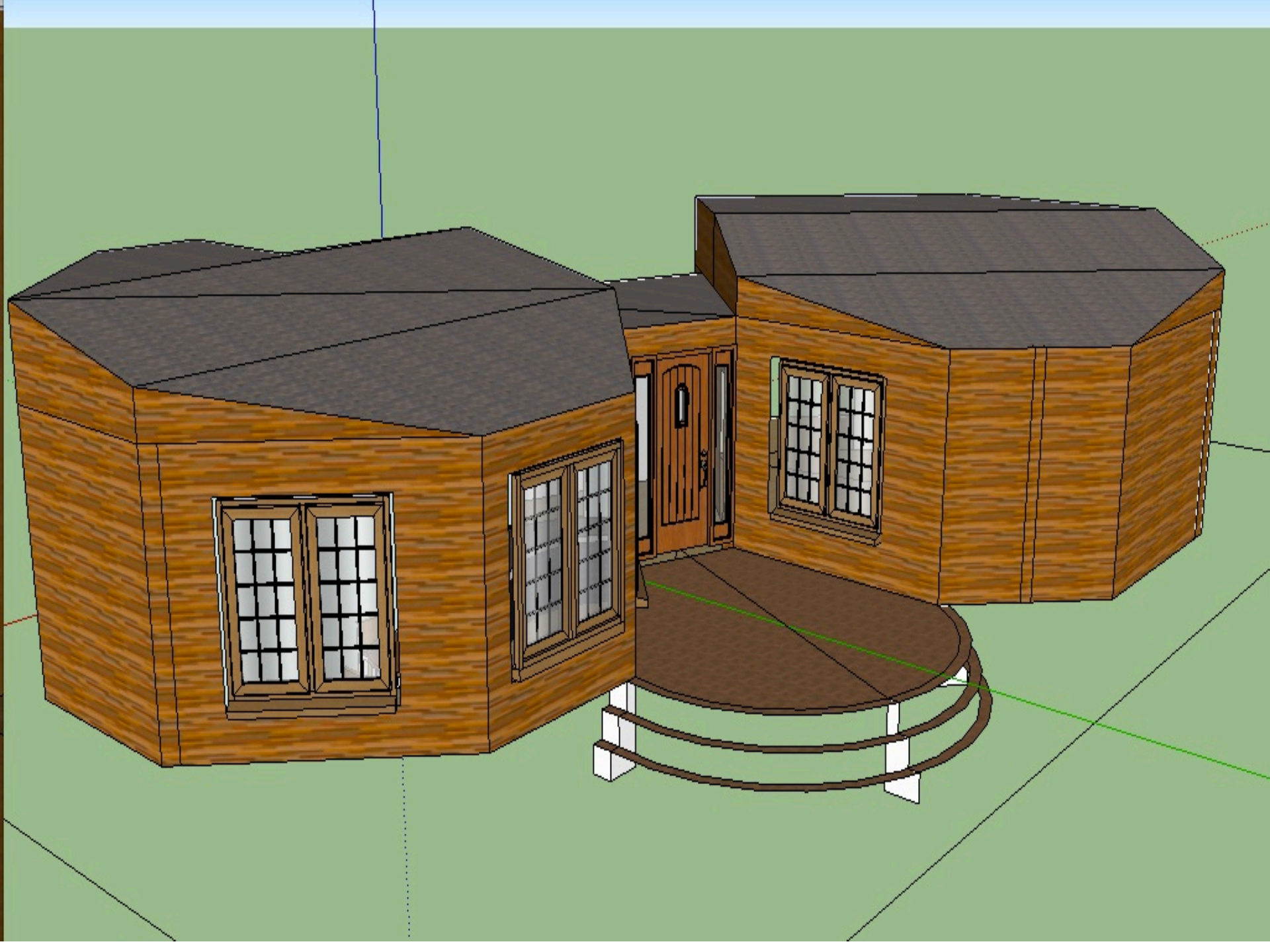
Design Process

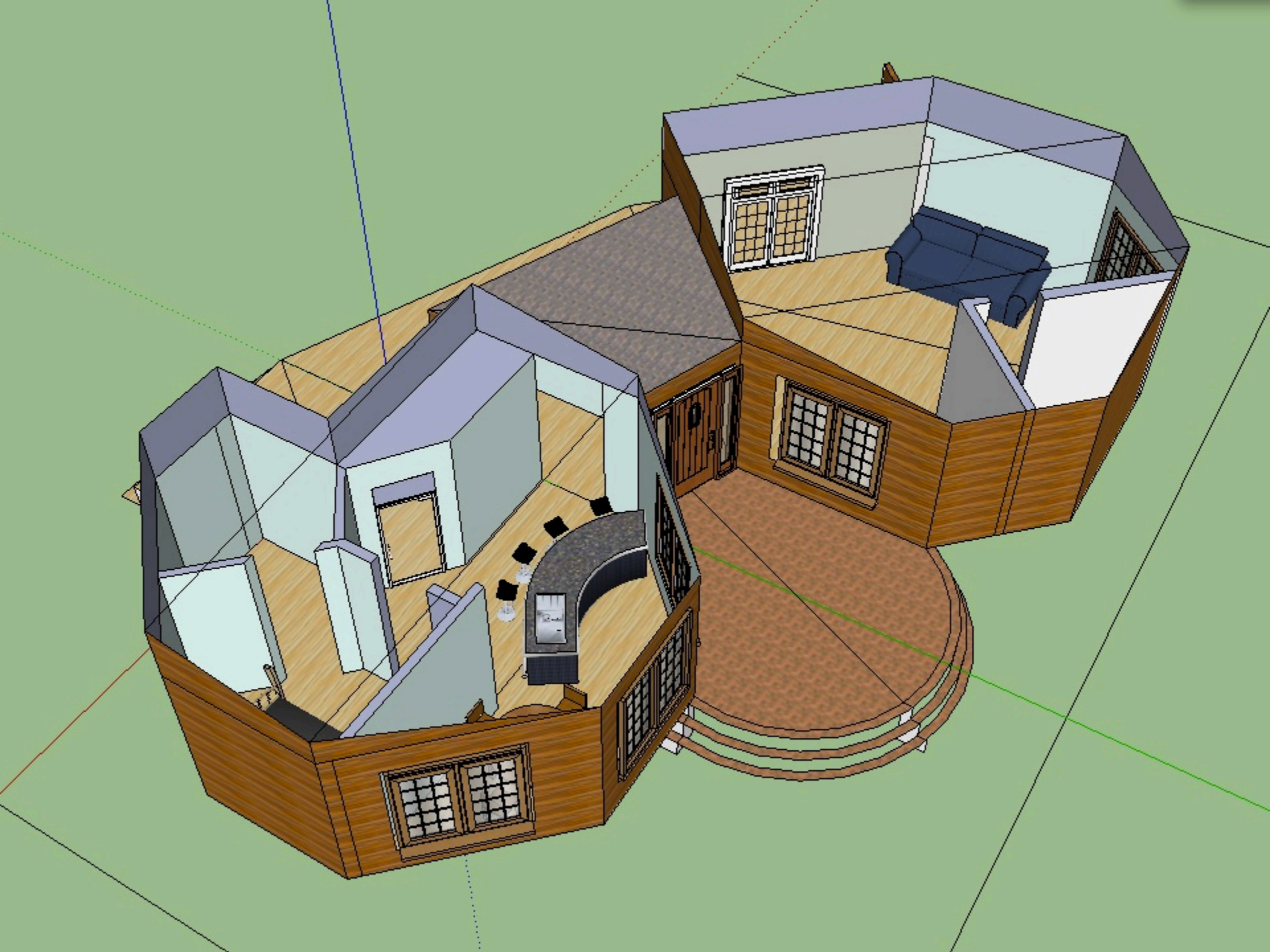
- Need: ~1000 sq ft home, totally solar powered, delivered to Irvine in Sept. 2013
- Problem Definition: ???
- Information Gathering: Find products and designs on the market, study past contests, become expert on your area, know the rules and regulations, find potential sponsors/donors, etc.

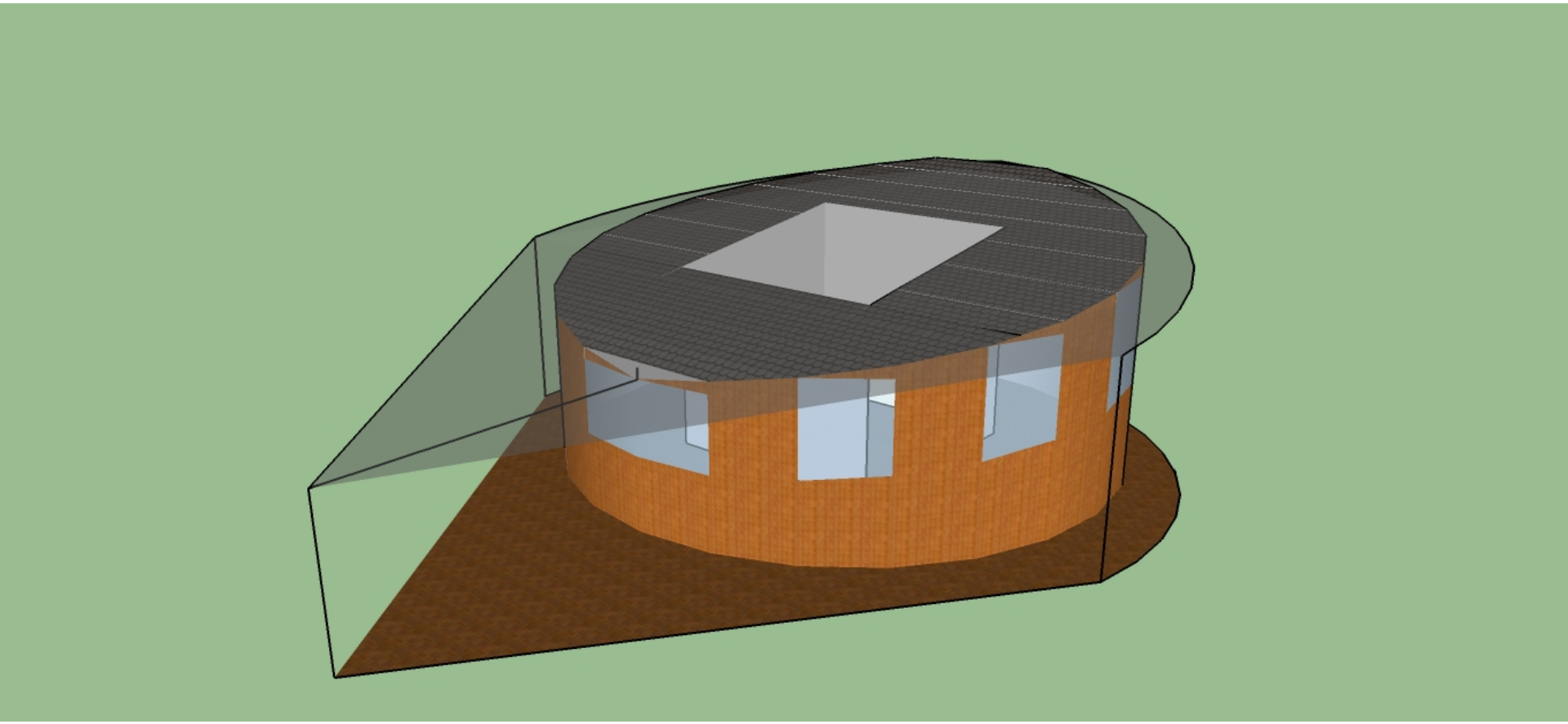
Solar House as System

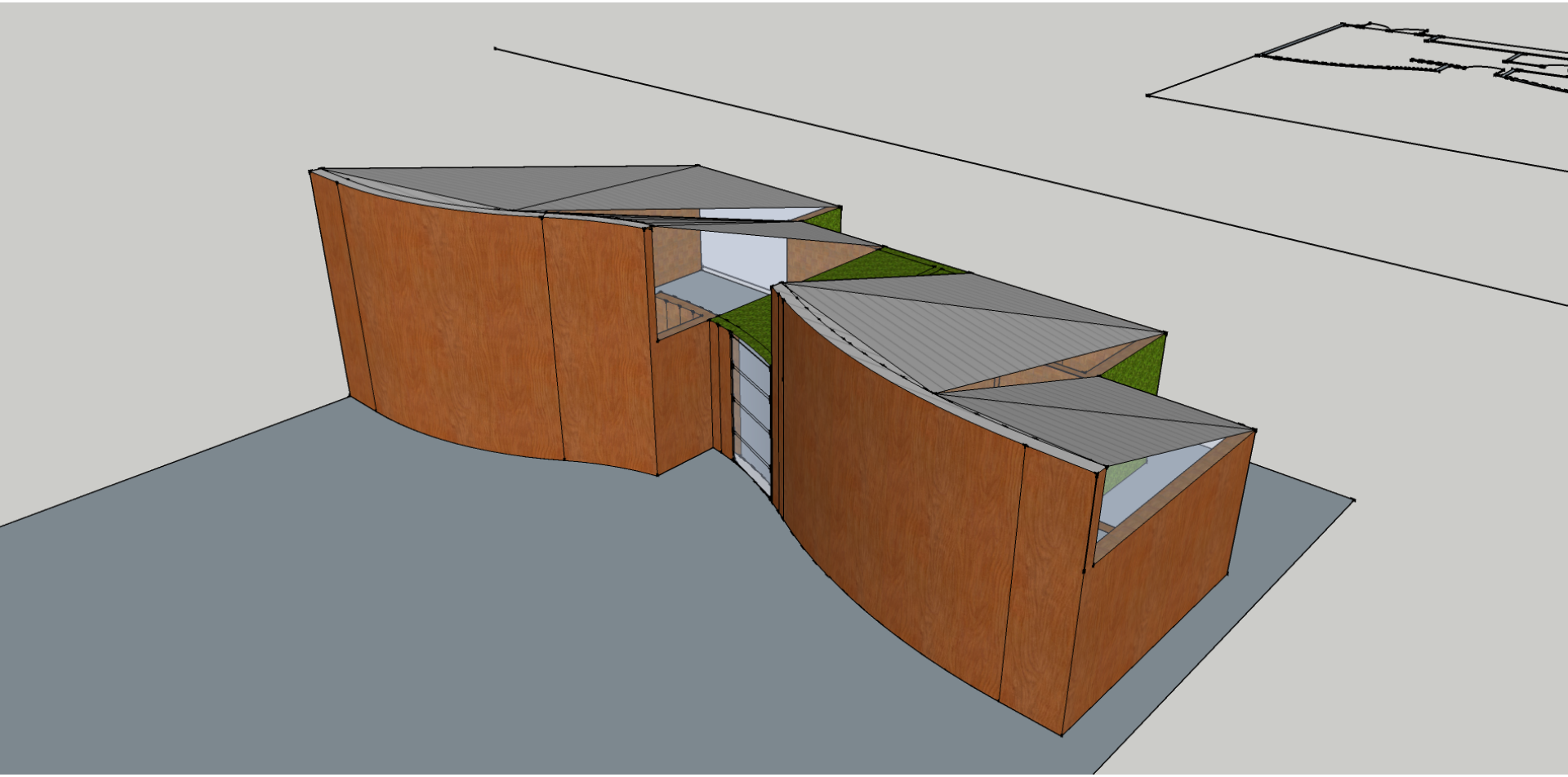


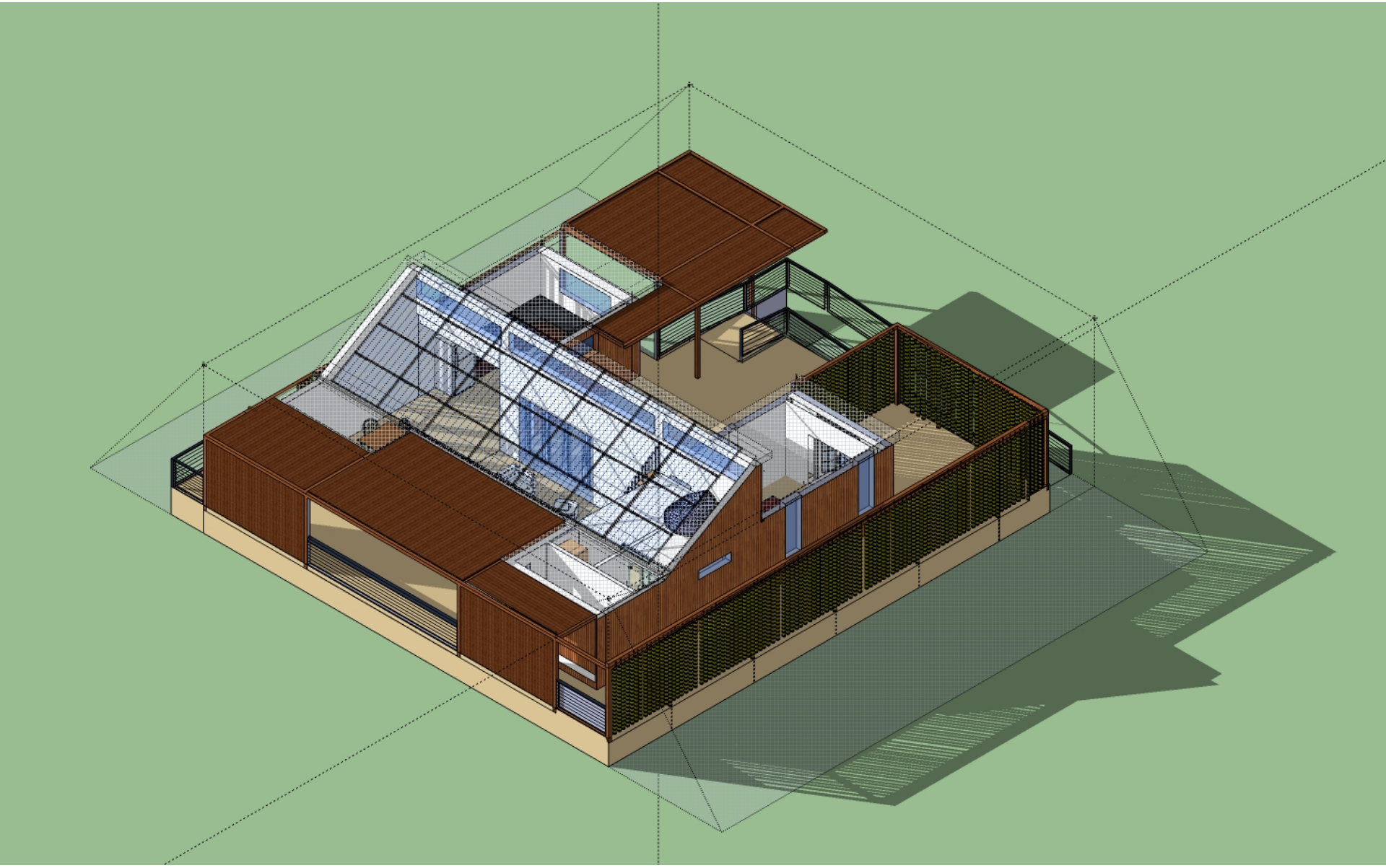




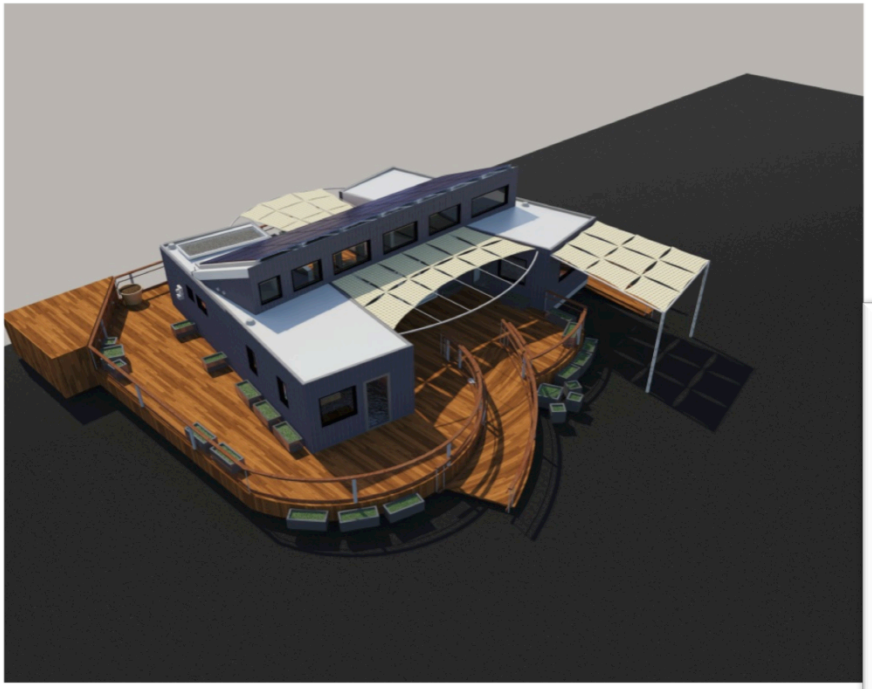




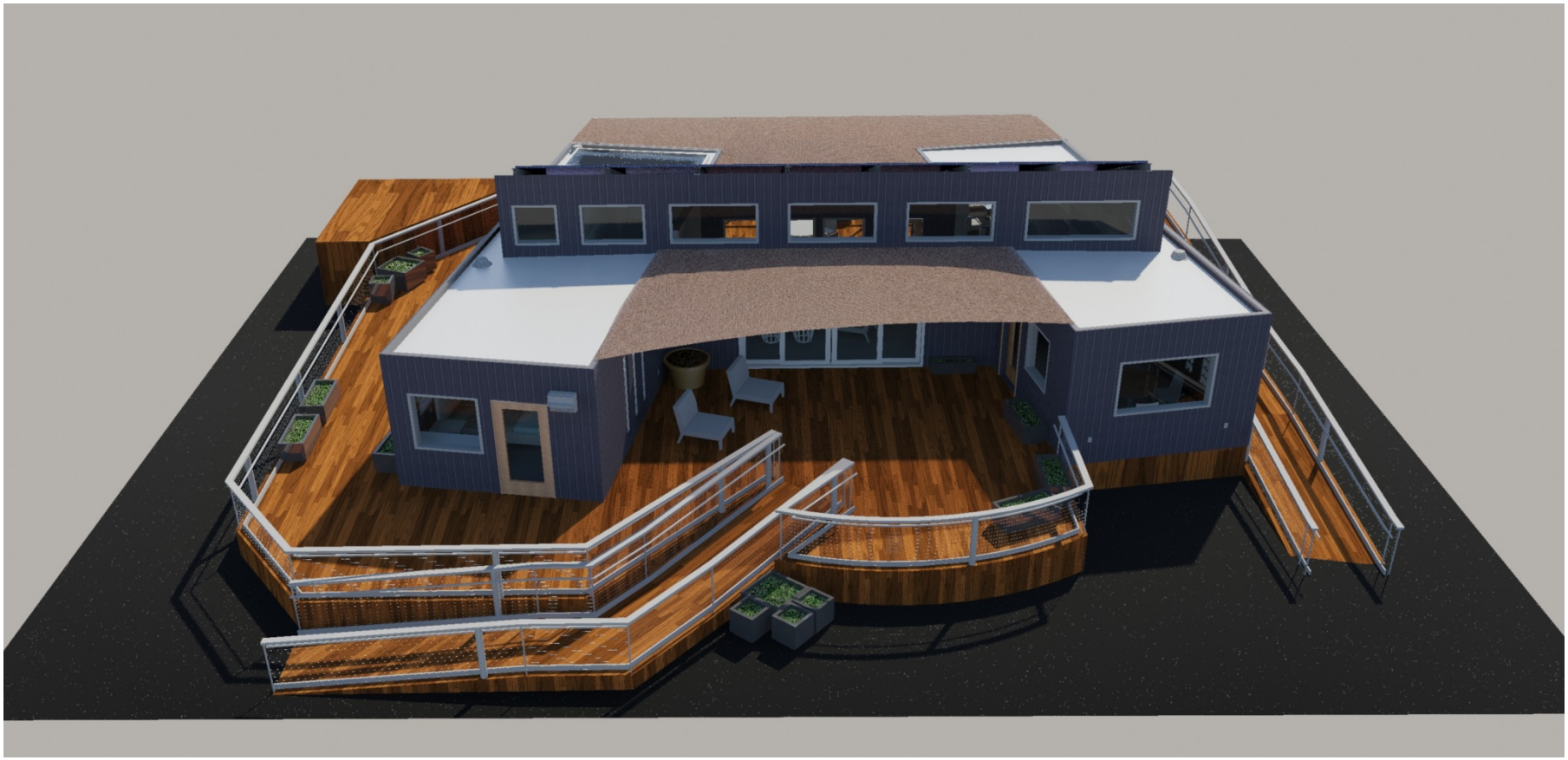




Design – Radiant House



Design – Radiant House



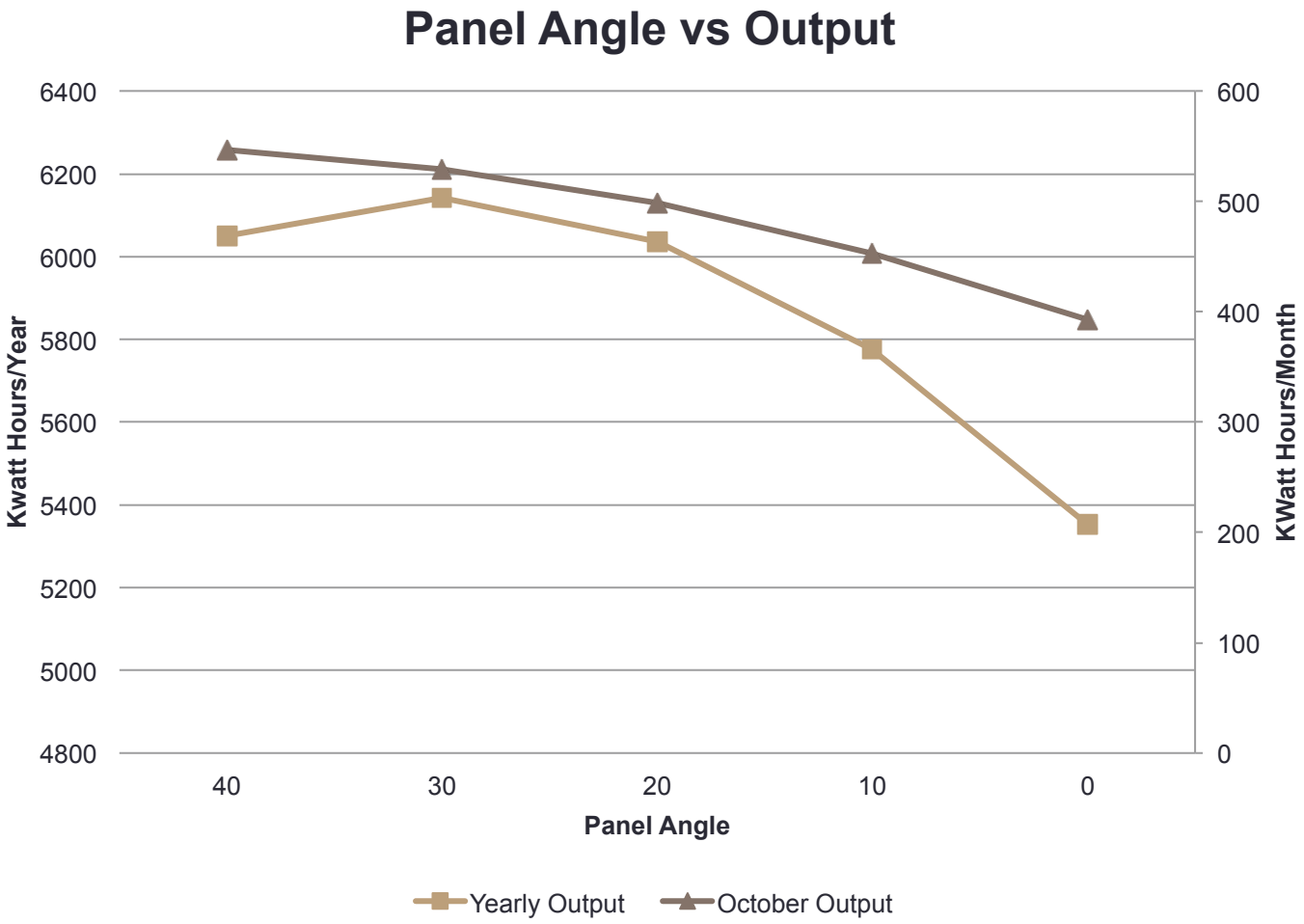
Sample Tradeoff

- Solar Panels
  - What type?
    - High efficiency, high cost ($2.5/watt, 20% efficient)
    - Lower efficiency, lower cost ($0.7/watt, 12% efficient)
  - What angle?
    - Ideal is perpendicular to the sun ~35 deg., but self shades
    - Integrated roof line, ~20-25 deg.
  - How much of roof for PV vs. Solar Thermal?
    - Thermal, ~50% efficient
    - Hot water less versatile than electricity
- Cost/ Energy use vs. production/ Points

Effect of Panel Slope

Angle	Yearly Output
40	6051
30	6143
20	6037
10	5775
0	5353

Panel Slope Effect



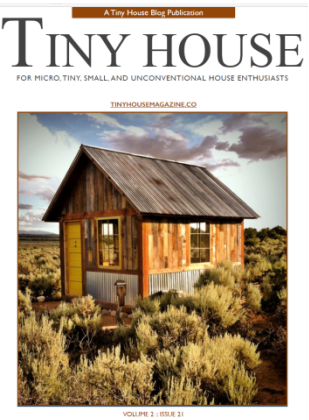
Summary

- SCU has utilized the Solar Decathlon competition as a focal point for sustainable development
- This experience has led us naturally to the Tiny House Contest

Tiny House in Context

- The Tiny House movement is part of an international drive to minimize the cost

  and the ecological footprint of housing, while expanding choice and opportunities
- The tiny house contest is a newly created intercollegiate contest for California colleges and universities.



TINY HOUSES

And the people who live in them

The tiny house phonomenon redefines what makes a house a home, empowers the people for a better future and leads a movement that breaks the mold every day. Tiny house people come from all walks of life. This is their story.

SIXTY-EIGHT PERCENT

of tiny house people have no mortgage, compared to 29.3% of all U.S. homeowners.[1]

YOU CAN BANK ON IT

55% of tiny house people have more savings than the average American, with a median of $10,972 in the bank.

A HOME THAT YOU OWN

78% of tiny house people own their home, compared to 65% of homeowners with traditional houses.[2]

THE REAL COST OF HOUSING

The average cost to build a tiny house is $23,000 if built by the owner.

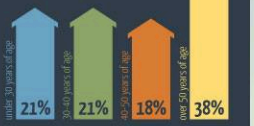
The average cost of a standard-sized house is approximately $272,000.[3]

Add $209,704 interest on a 4.25% 30-year loan and it's $481,704!

TINY HOUSE, BIG LIVING

The average tiny house is 186 sq/ft while the standard U.S. house takes up nearly 2100 sq/ft. That adds up to nearly 11.3 Tiny Houses![4]

APPROXIMATELY 2 OUT OF 5 TINY HOME OWNERS ARE OVER 50 YEARS OF AGE



ISLAND SAVINGS TIME

32% of tiny house people have more than $10,000 saved for retirement.

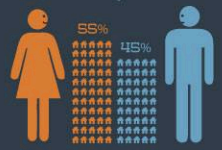
62% of tiny house people have less than $5,000 saved for retirement.

GIVE YOURSELF SOME CREDIT

89% of tiny house people have less credit card debt than the average American, with 65% of tiny house people having zero credit card debt.[5]

THE FAIRER SEX WINS

More women own tiny houses than men.



$42,038

per capita income of tiny house people.

EARNING $478

more annually than the average American.

Tiny house people are twice as likely to have a masters degree, while they are on par with the average college graduation rates.

Sources:
1- http://www.latimes.com
2,3,6 - http://www.census.gov
4 - http://www.nahb.org
5 - http://www.nerdwallet.com

THE TINY LIFE
TINY HOUSES, TINY LIVING

2016 Tiny House Competition

- Sponsored by SMUD
- Based on SD, but simplified
- 100-400 sq ft built on trailer, net zero, off grid
- October 10-16, 2016, on Cosumnes River College campus
- 10 teams including: UCB, UCSC, SJCC, Laney, Chico, Sac State, CRC

rEvolve House

- What's in a name?
- Ripple – Refract – Radiant - … rEvolve
- Evolution of Housing

Contest Scoring

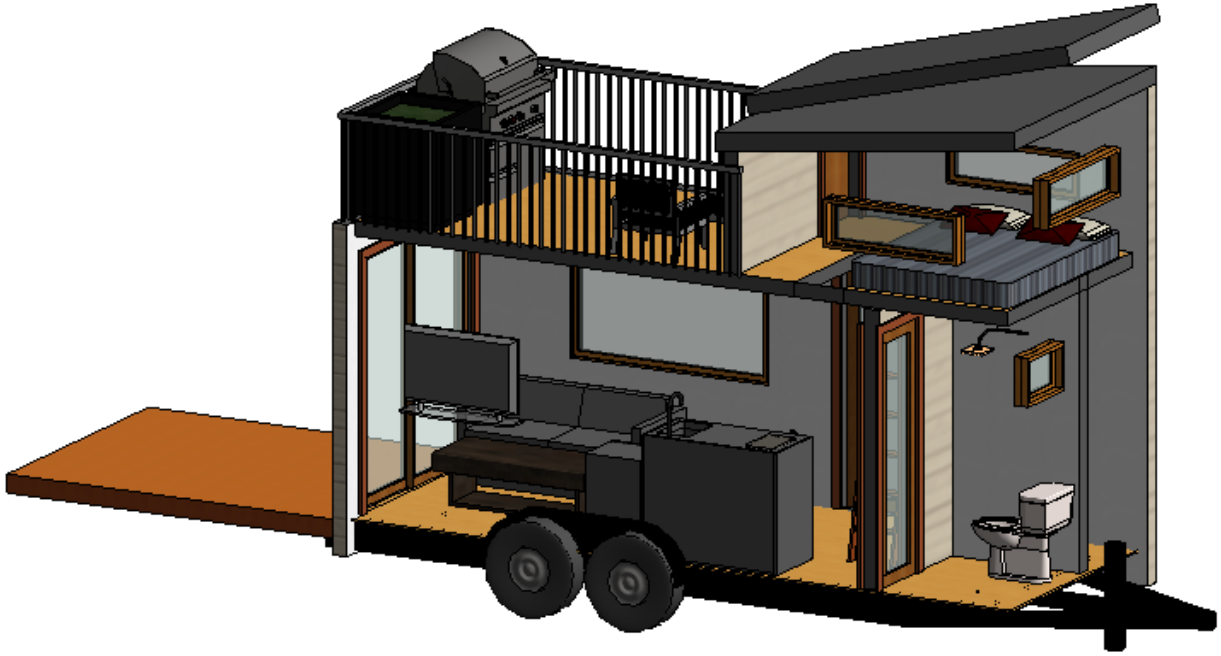
- Architecture (300)
- Energy (300)
  - Net zero
  - Energy balance, consistency, and calcs
  - Appliances and cooking
  - Lighting and comfort
- Home life (200)
  - Includes cost target of $25k, not incl. trailer and labor
- Communication (200)

CRC School Map

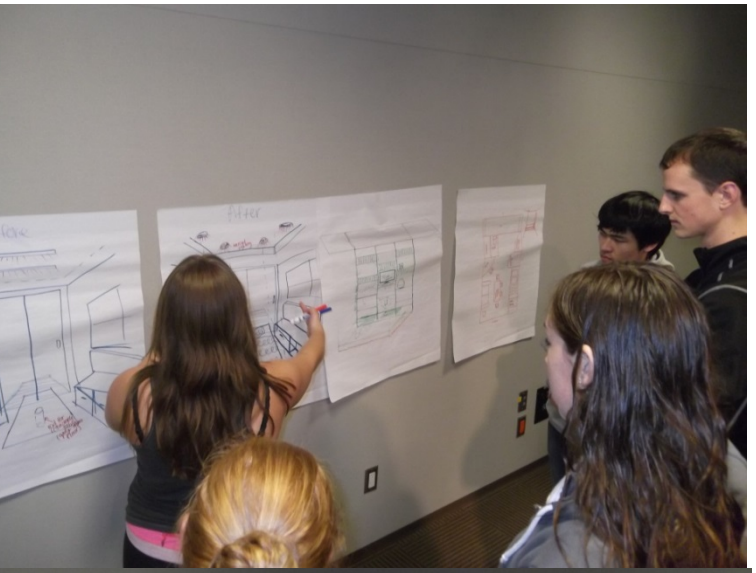
Team

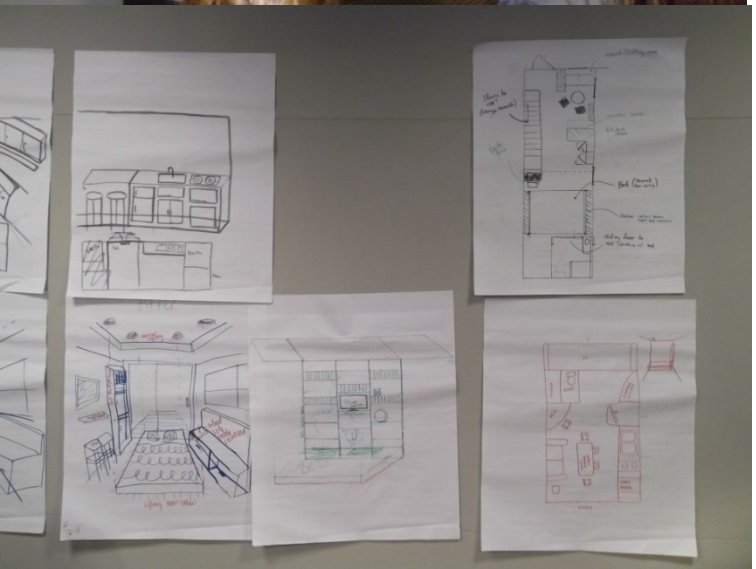
- Team organized in November 2014
- Met weekly, winter and spring
- 4 students worked over last summer
  - Initial design and analysis
  - Trailer specified, bought, and received
  - Partner chosen for receipt of rEvolve House
- “50%” drawings due November
- Two meetings per week in the fall
- Winter & spring ~25 enrolled in Tiny House course
- 10 students hired over this summer for construction of the house

Early Design

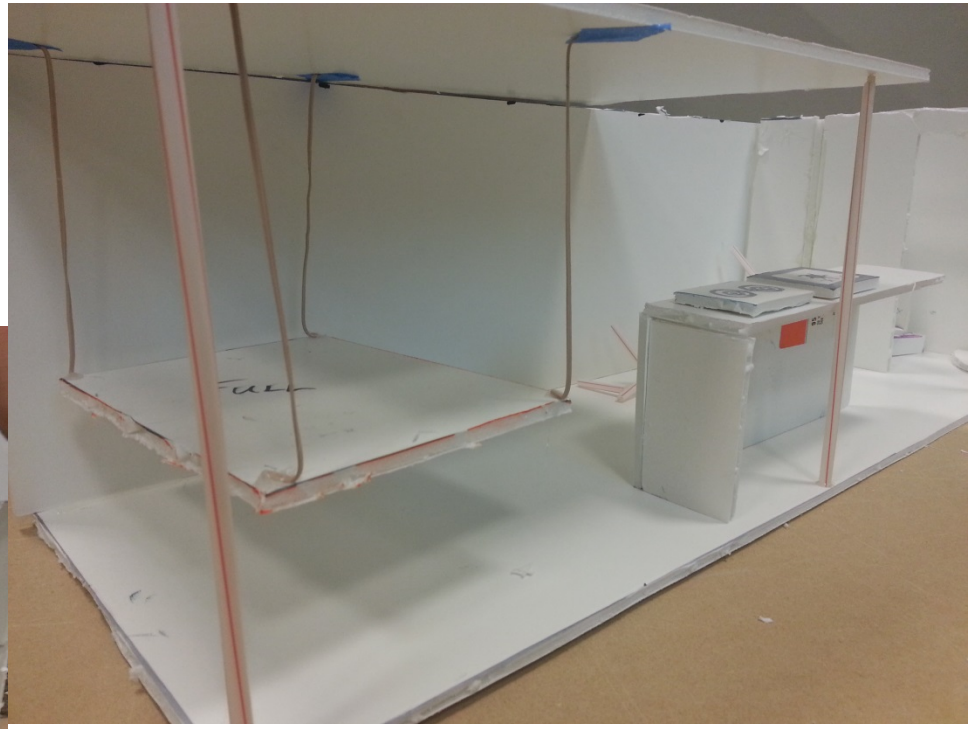


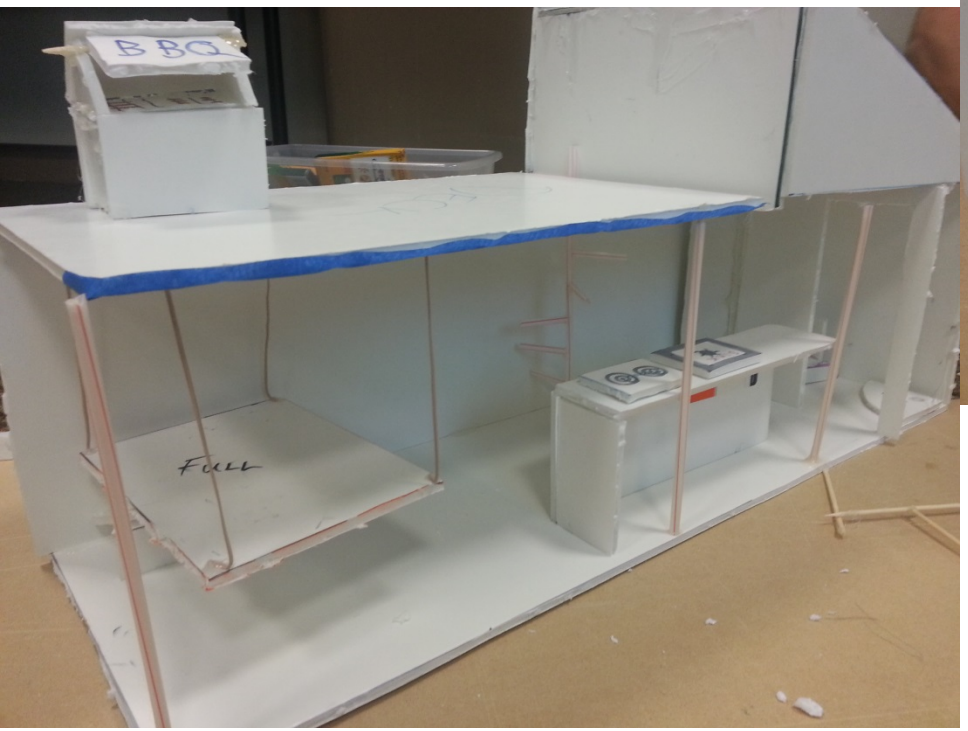
Jan 2015 Team Brainstorming – Charrette 1





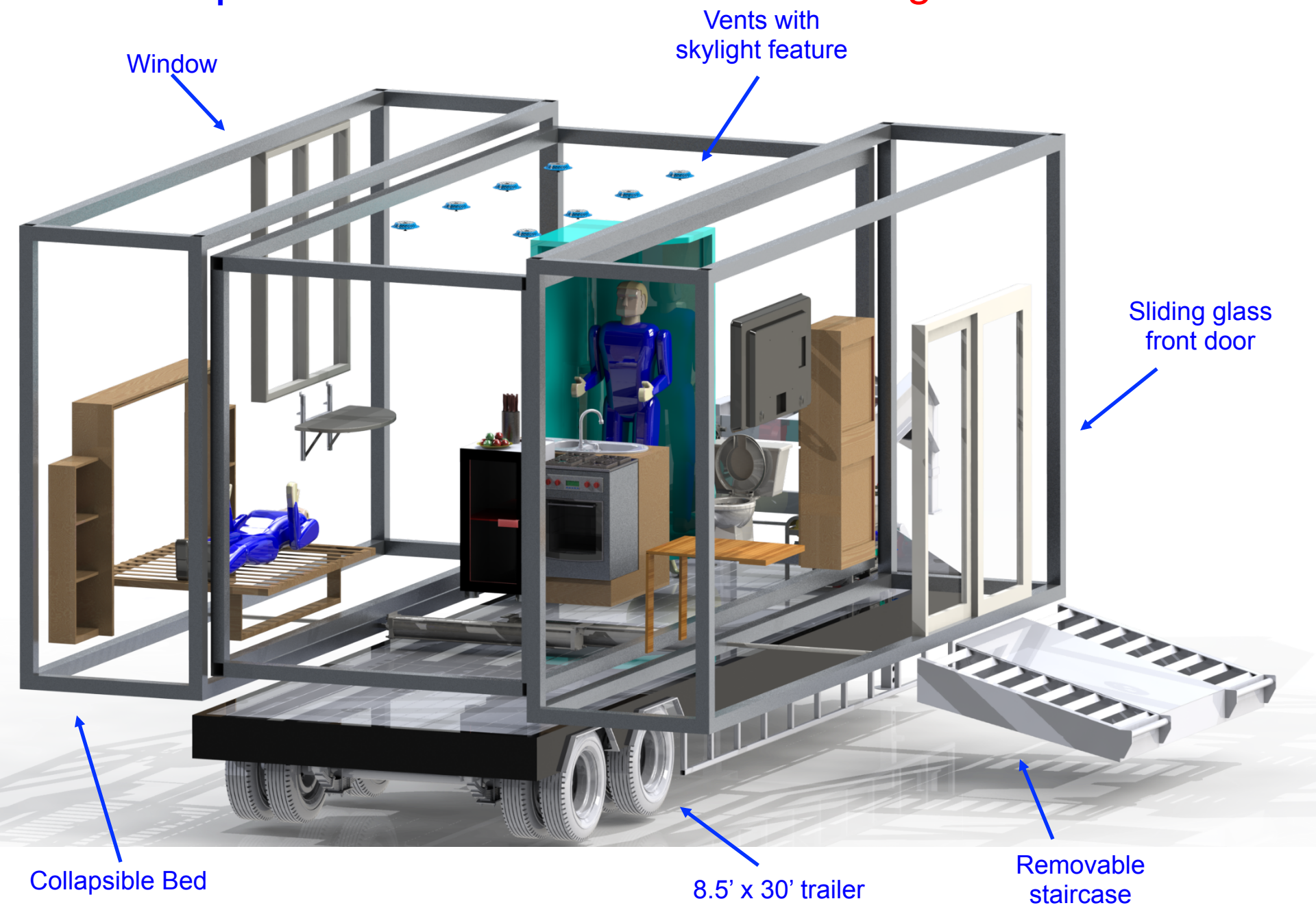
Second Charrette
Feb 2015

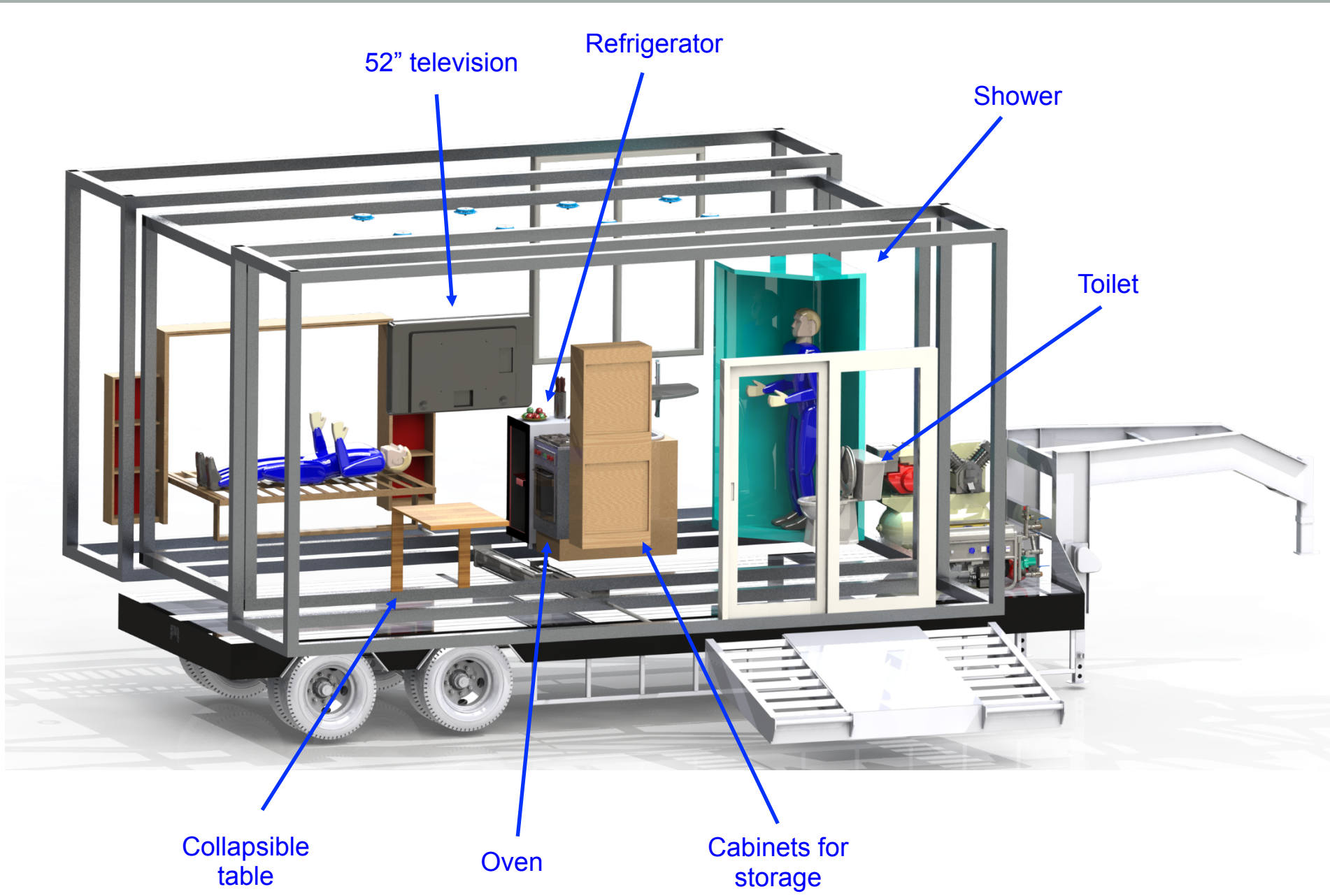




Final concept

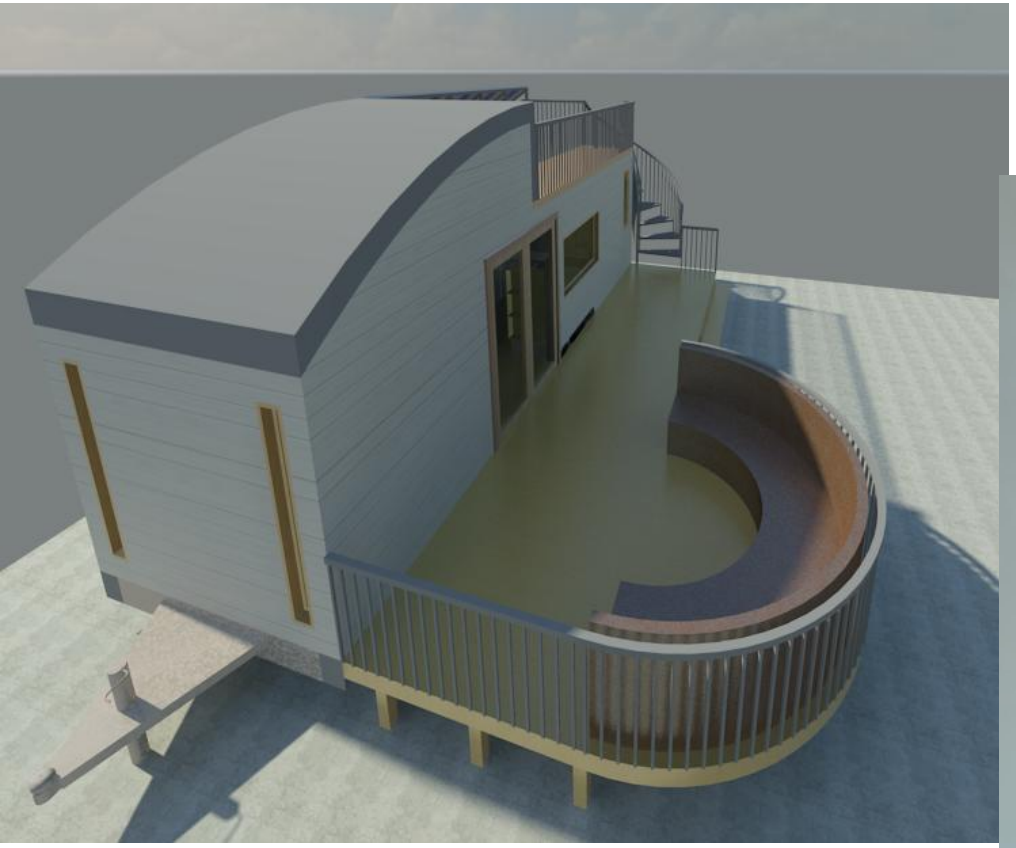
Also had more ambitious design ideas



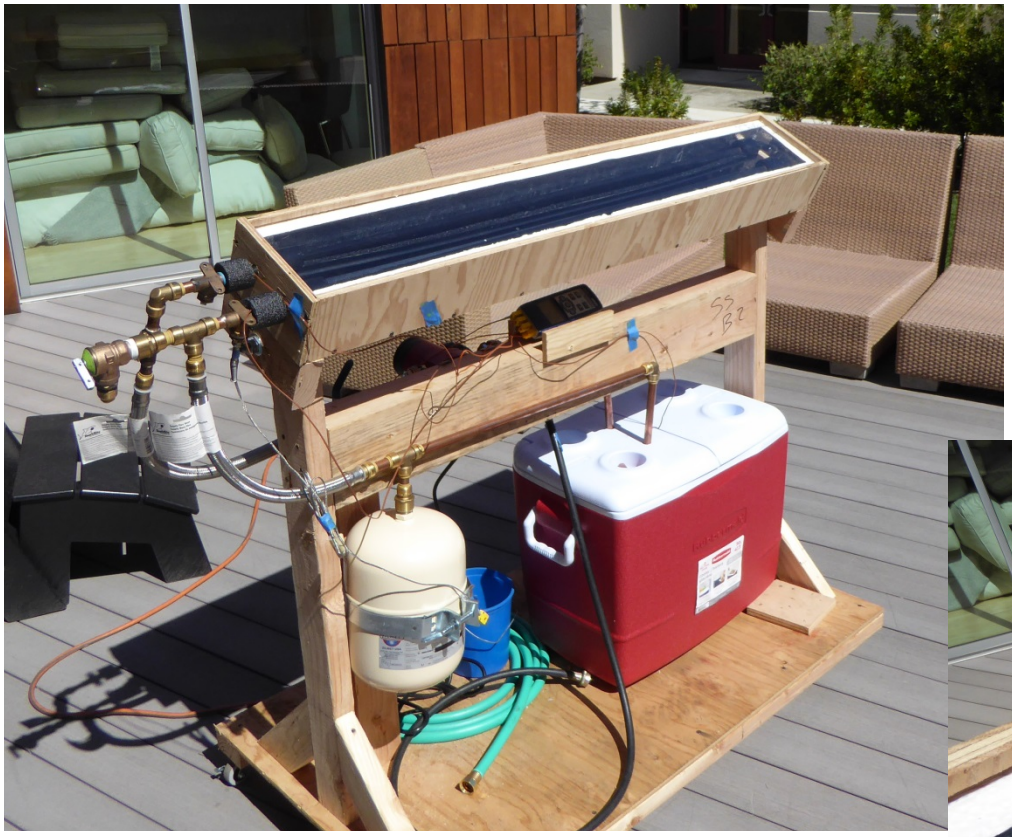

52” television
Refrigerator
Shower
Toilet
Collapsible table
Oven
Cabinets for storage

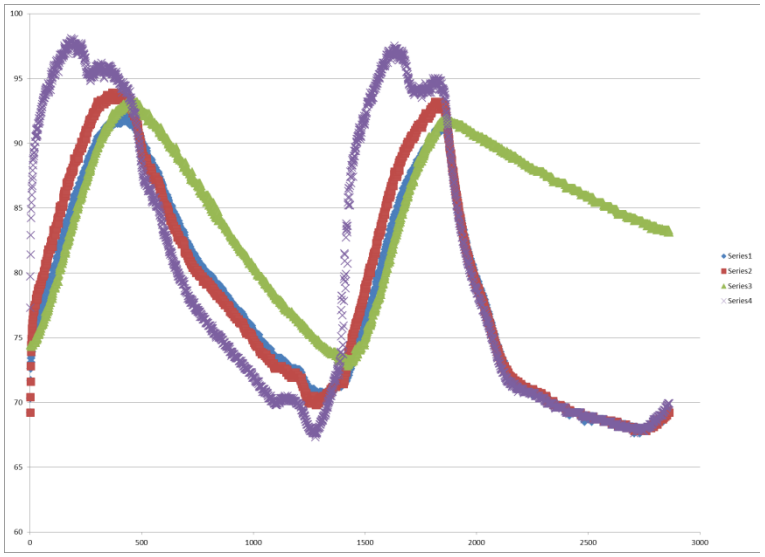
Trailer

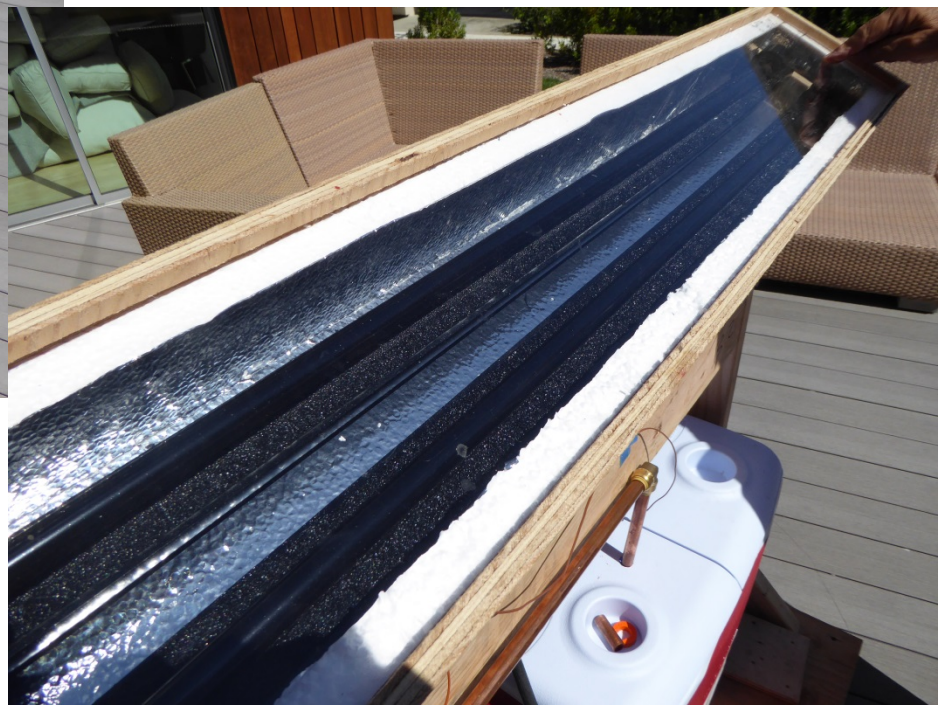
Design Fall 2015 – rEvolve House



Summer prototyping








RELAX
GOT YOUR BA

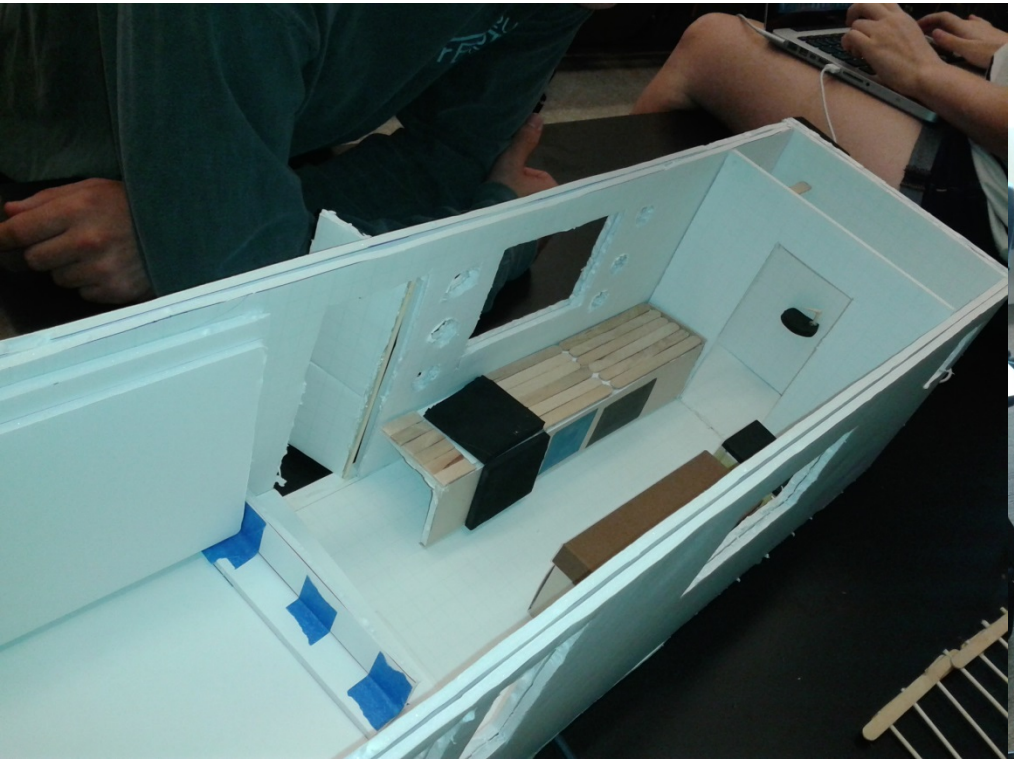
Partner

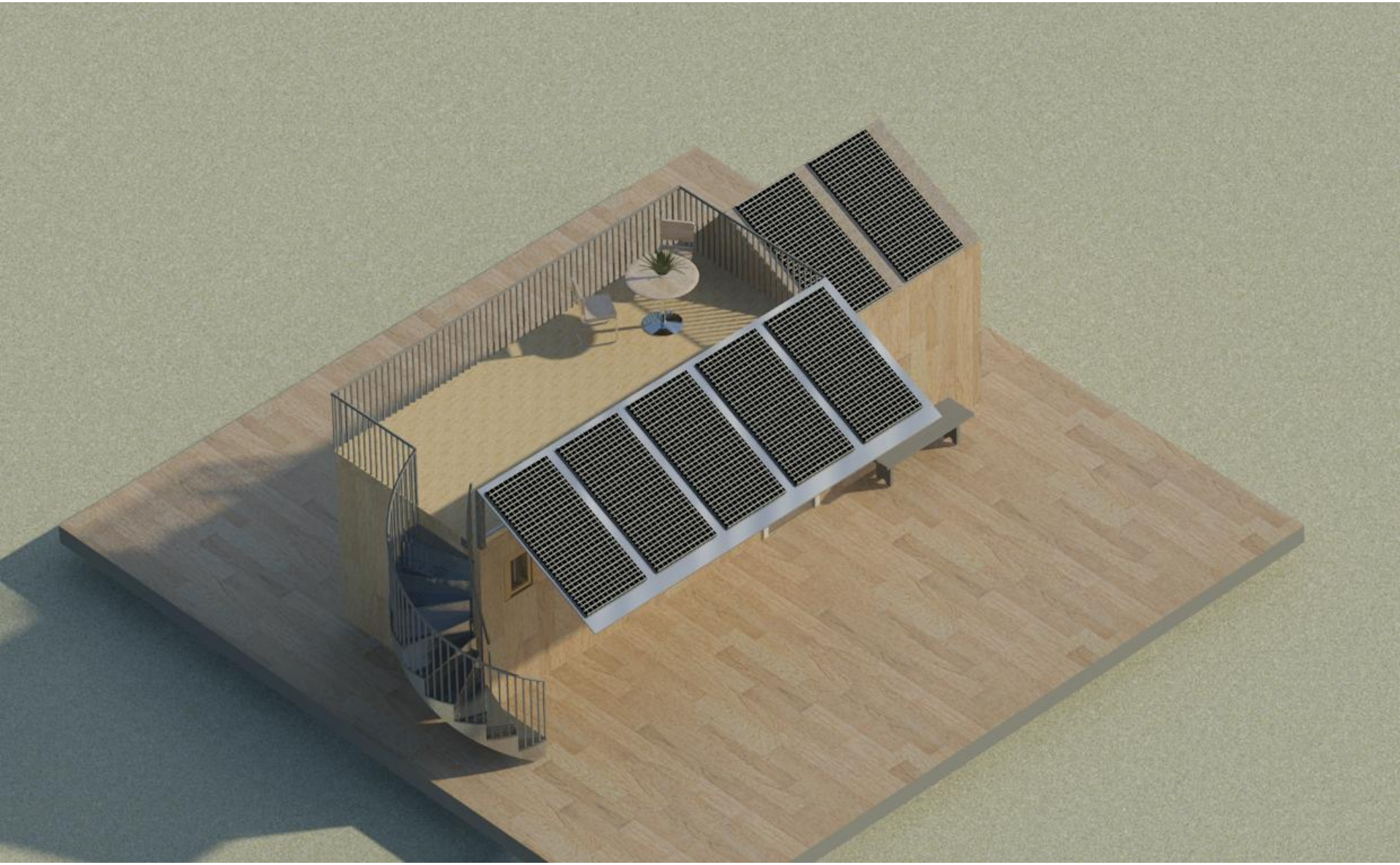
- Operation Freedom Paws
- San Martin NGO dedicated to training and providing resource dogs to vets and others in need
- We train the individual to train their own dog, and then certify them together as a service dog team in a 48-week program. Most of the dogs come from rescue shelters. This unique opportunity enables our clients to feel safe and secure, and to manage their day-to-day lives. The very special therapeutic canine-human relationship helps them get back out in their communities and begin to view their future with renewed hope.

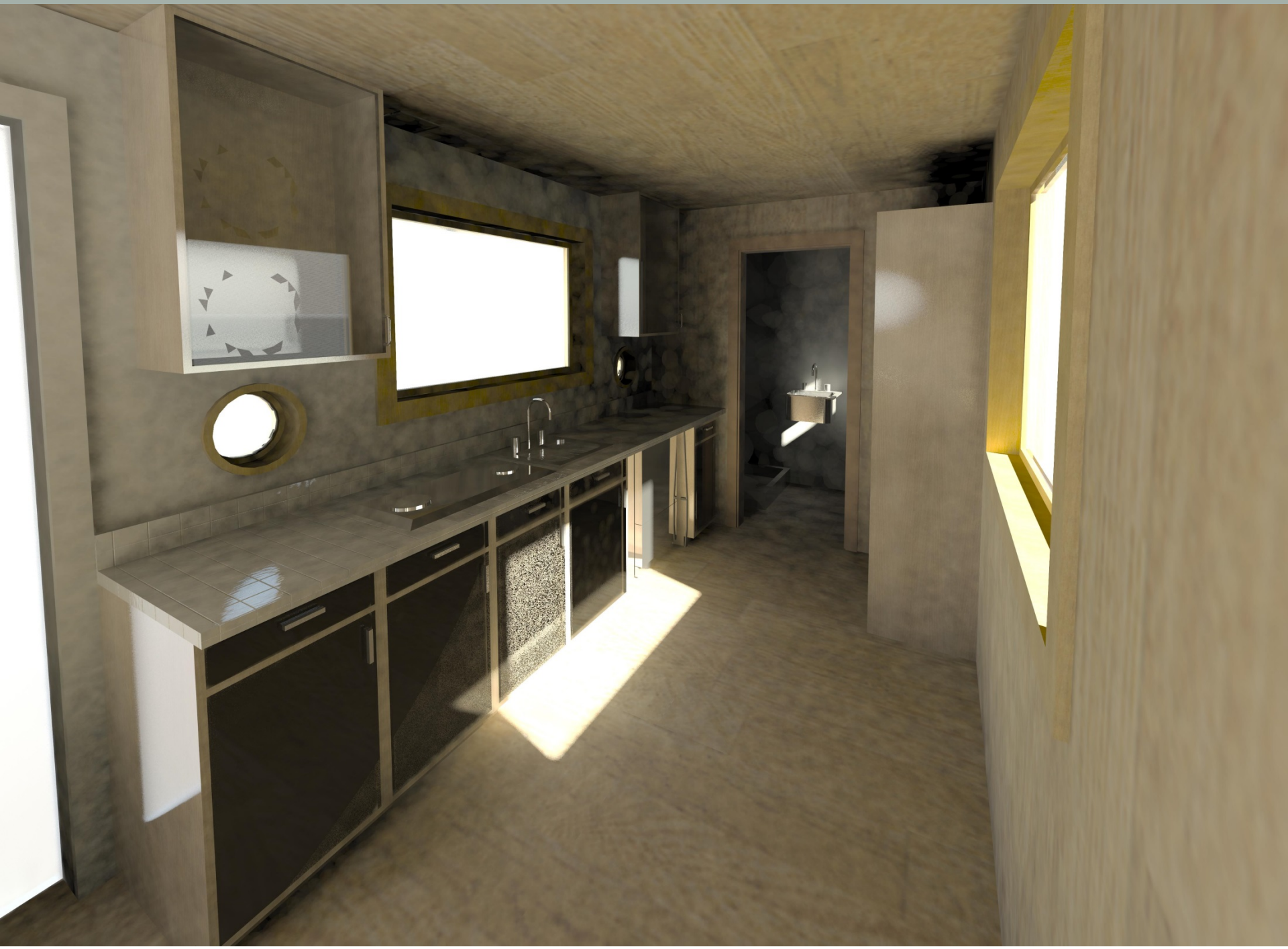

VETERANS PARKWAY

Since Summer 2015

- Team developed a more structured approach
- Design sub-teams were formed and leadership emerged
- Total review of the summer design
- Much more detailed design and analysis was undertaken







Fly Through

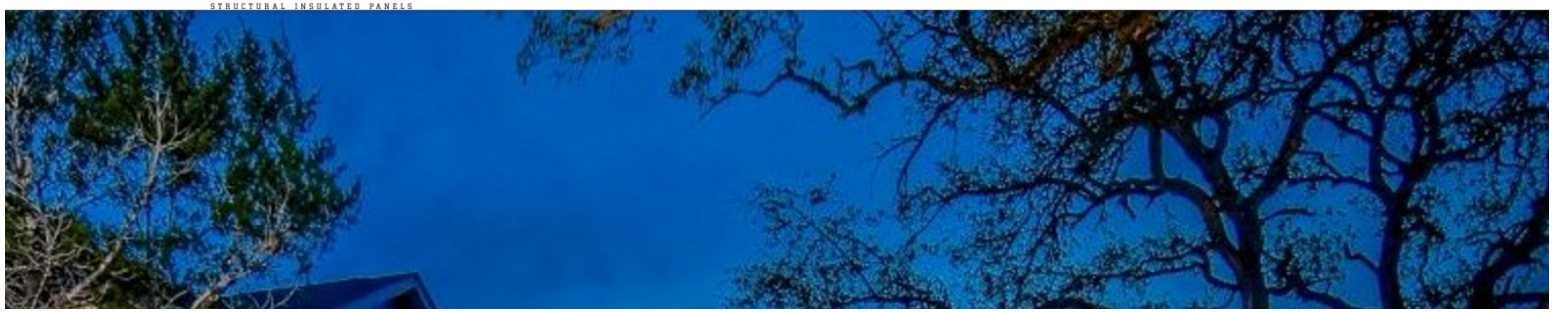
C:\Tiny House
petition\presentatic

New Contacts/Partners

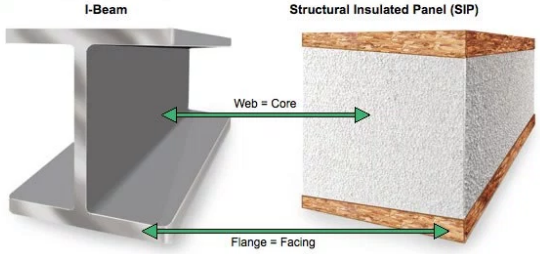
- GeoFaze SIPs
- Colossun

GeoFaze™
STRUCTURAL INSULATED PANELS

HOME | SIP NEWS | PORTFOLIO | RESOURCES | CONTACT US



STRUCTURAL INSULATED PANELS



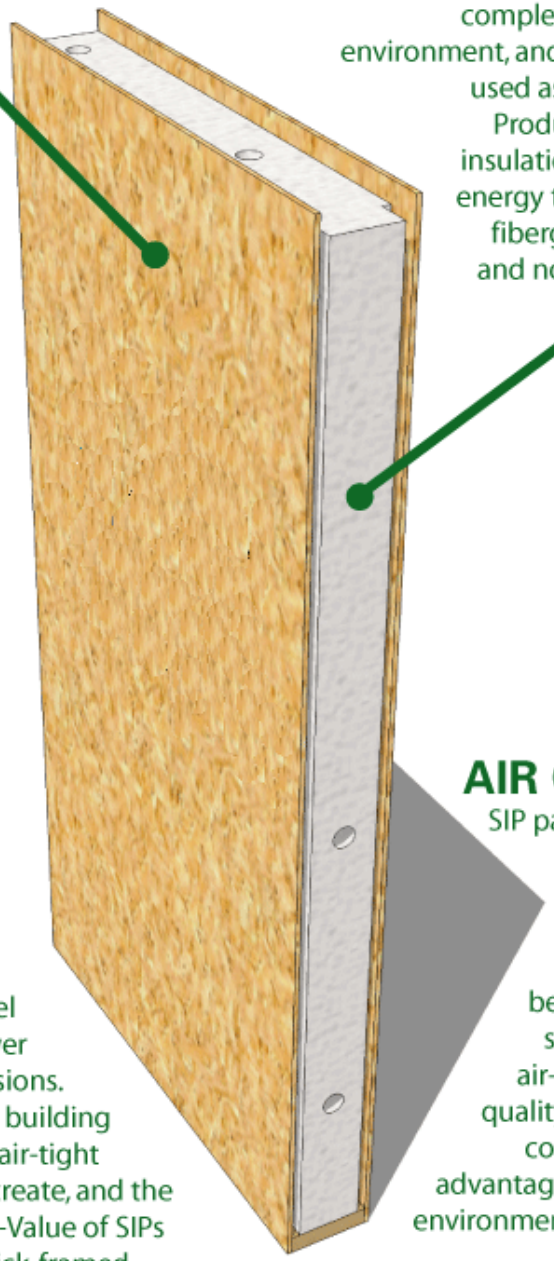
Structural Insulated Panels (**SIPs**) consist of a foam core (EPS) sandwiched by two engineered wood facings (OSB). SIPs are a high-performance building system for residential and commercial construction. SIPs are manufactured under factory controlled conditions and can be fabricated to fit nearly any building design. SIPs are the most airtight and well insulated building systems available. An airtight SIP building will use less energy to heat and cool, allow for better control over indoor environmental quality, and virtual eliminate construction waste.

Watch SIP Video

Mariposa Meadows

OSB is made from fast-growing, small-diameter trees that can be harvested from plantations, avoiding the need for cutting old-growth trees. Even the smallest scraps of wood can be turned into OSB, virtually eliminating waste.

EPS FOAM is a recyclable material that is completely inert in the environment, and is in fact often used as a soil additive. Producing EPS foam insulation requires less energy than producing fiberglass insulation, and no CFCs are used in the process.



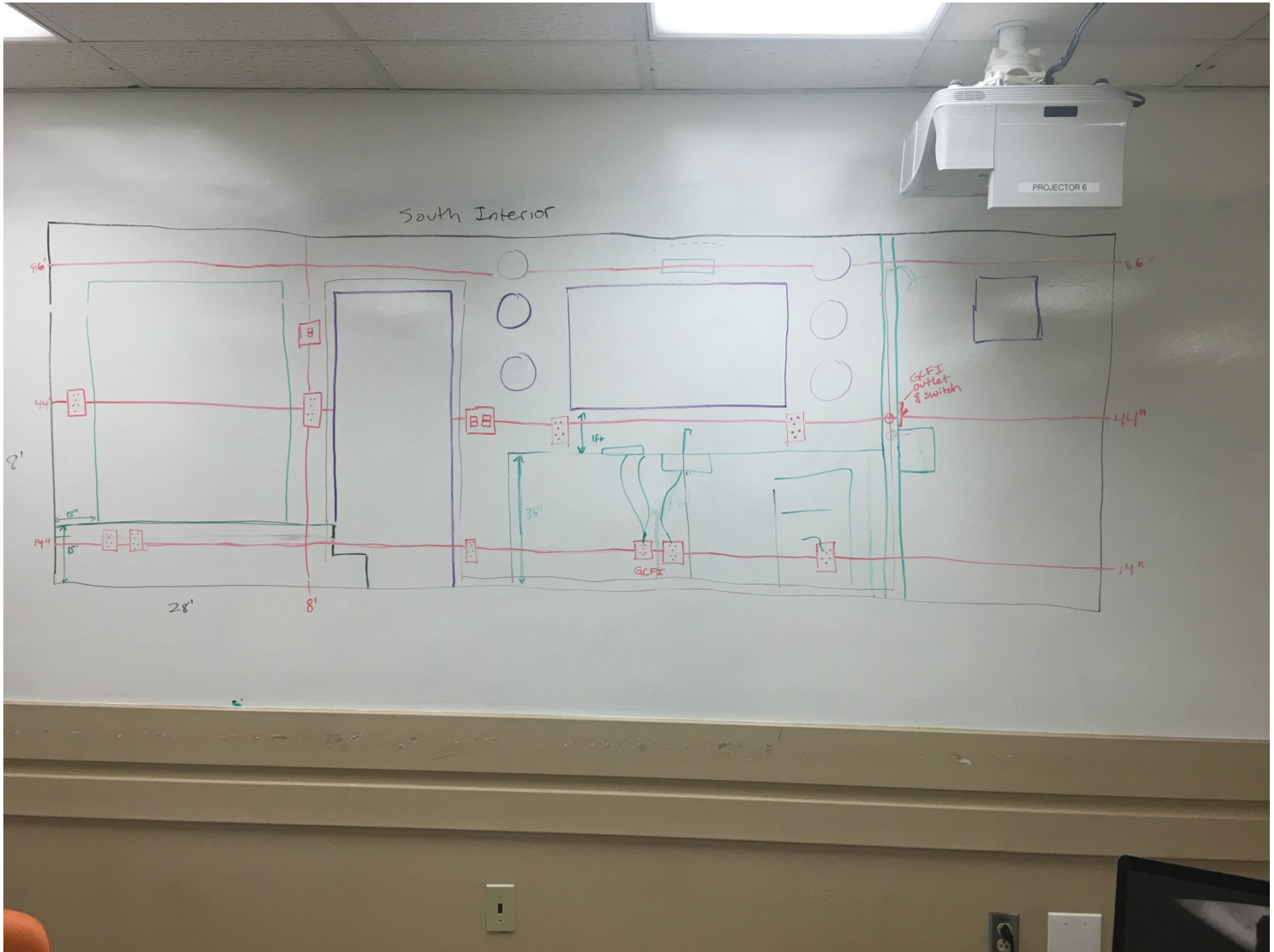
ENERGY EFFICIENCY

SIP homes require up to 50% less energy to heat and cool than stick-framed homes, meaning less fossil fuel consumption and fewer greenhouse gas emissions. The efficiency of a SIP building is a result of both the air-tight envelope the panels create, and the substantially higher R-Value of SIPs when compared to stick-framed walls.

AIR QUALITY

SIP panels release no volatile organic compounds (VOCs). Furthermore, because SIP-built structures are so air-tight, indoor air quality can be closely controlled, a huge advantage for those with environmental or chemical allergies.

Detailed wall layouts




TA55UB
TA55UB
TA55UB
TA55UB
TA55UB
TA55UB


SPACE BOARDS
AIR
BE AWARE
USA
10


SPACE BOARDS
SPACE BOARDS
EVOLVE
TA-55UB


SPACE
BOARDS


LONESTAR
Terraform
TINY HOUSE
TerraformTH.com

Other issues to deal with, such as weight

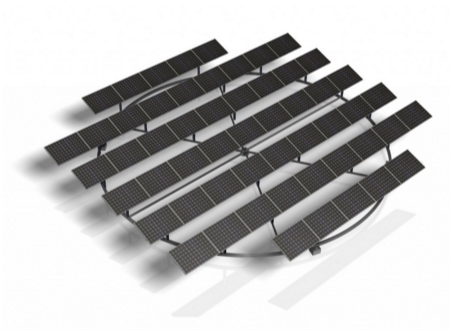
Team	Item	Weight (lbs)	Location	Limit	remaining	
		10090.95		9940	-150.95	
Civil	outside door	100	s			1416.8
Electrical	Solar panel	357	S			
Mech	Water pump	28.6	E			
Need to weigh						
	Inverter	62	W			
	Charge controler	11	W			
	Batteries	520	W			
	Fridge	52	S			
	Toilet	26	W			
	Tv	12	NE			
	wall mount	9	NE			
	stove	15.2	S			
	t oven	17	S			
	hvac	86	E tongue			
	smoke detector	1	middle			
	Misc	100	Everywhere			
	AC breaker panel	20	W			
	dc	24	W			structure
	bathroom door	100				
	kit win	120				
	bath windoq	25	s			
	e window	100	e			
	window	75	n			
	bathroom window	120	n			
	kit win	25	n			
	sips	900	n			
	sips	300	e			
	sips	900	s			
	sip	300	w			
	roof	1500	m			
	plywood sub floor	525	m			
	trailer insulation	20	m			
	platform for bed	350	E			
	bathroom wall	200				
	cold water tank	24	E			
	hot water tank	16	e			
	grey water tank	82	e			
	filtration	25	e			
	shower head	1	w			
	kitchen sink	18	s			
	bathroom sink	16	w			
	flash water heater	7	e			
	bed	430	e			
	Misc	30				
	pipes	20				
	roof decking	325				
	siding	170				
	cabinets					
	railing	240				
	roofing shingles	40				
	back splash tiles	70				
	drywall	580				
	towel rack	7				
	faucet	6				
	solar water heater	200	S			

CATALOG

COLOSSUN SPVG - 9

COLOSSUN SPVG - 15 | COLOSSUN SPVG - 40 | COLOSSUN SPVG - 50

COLOSSUN SPVG 9 is a photovoltaic generator designed for residential customers. If you generate the energy you consume, you reduce the power purchase bills and you get significant savings. This model has an installed power of 9 kWp per machine. At present it is the most profitable photovoltaic system, because of its performance and its very competitive acquisition cost. Up to 40% increased yield of the solar panel. This produces as stable electrical power during all hours of direct sunlight.



DC Power Rating:	**8.960 Wp**
Voltage DC:	**309.12 V**
DC intensity:	**24.87 A**
AC Power Rating:	**8.60 kW**
Maximum system efficiency:	**97.7 %**
Total area:	**75 m2**
PV area:	**50.50 m2**

The solar installation built with the best components:

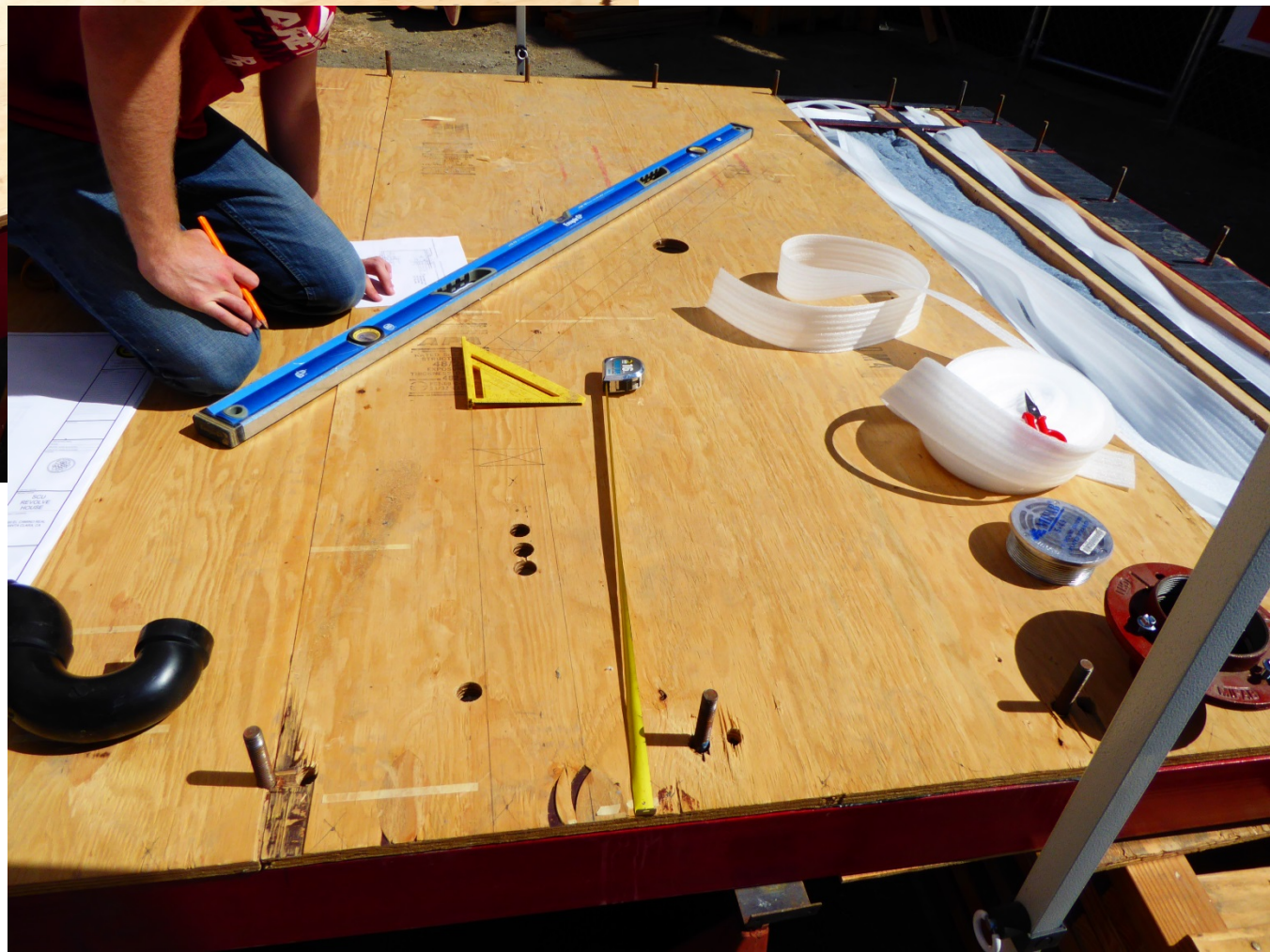
- COLOSSUN Tracking System CTR 1.0: 1u.
- FOTOSSUN PV panels CFS320M: 28u.
- INVERSSUN CIS8.6TL: 1u.
- CLS Control System 2M: 1u.

Conclusion

- SCU is committed to support hands-on learning experiences for our students
- SCU Tiny House rEvolve is “in it to win it!”
- Find us/like us: rEvolvehouse.com, Santa Clara Tiny House (facebook), Youtube, etc.


DANGER
KEEP OUT
Gibson


SIMPSON
Strong-Tie

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Questions ?