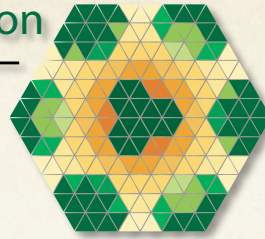


PENNSSTATE

Natural Fusion



Solar Decathlon 2009



# BIPV vs Systems Integrated PV

How the Solar Decathlons are reshaping  
the way we develop solar technology

Jeffrey R. S. Brownson

DEPARTMENT OF

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ENERGY AND MINERAL ENGINEERING

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COLLEGE OF EARTH AND MINERAL SCIENCES

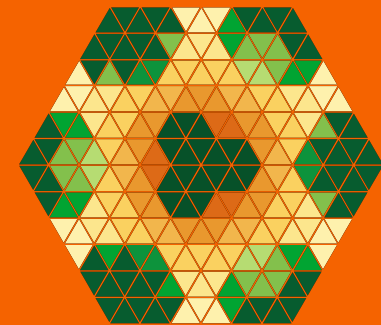


# NATURAL FUSION



## Penn State Solar Decathlon 2009

Through an integrated, holistic approach, we will develop a restorative residence for the betterment of the global environment, by utilizing renewable energies and green technologies.



Jeffrey R. S. Brownson  
Dept. of Energy & Mineral Engineering  
Faculty Director: Natural Fusion



# SOLAR DECATHLON



U.S. DEPARTMENT OF  
**ENERGY**

Design, build, and operate a solar home (2 years)

## *Solar America Initiative*

Deploy new solar technologies

Develop competency in energy efficiency

Microcosm for energy systems development



- Education
- Research
- Outreach



*Integrative Design*

**2009 Visibility:**

**Threshold Event**

**Expect ~500,000 People**



**Leveraging:**

**New Materials  
Deployment**

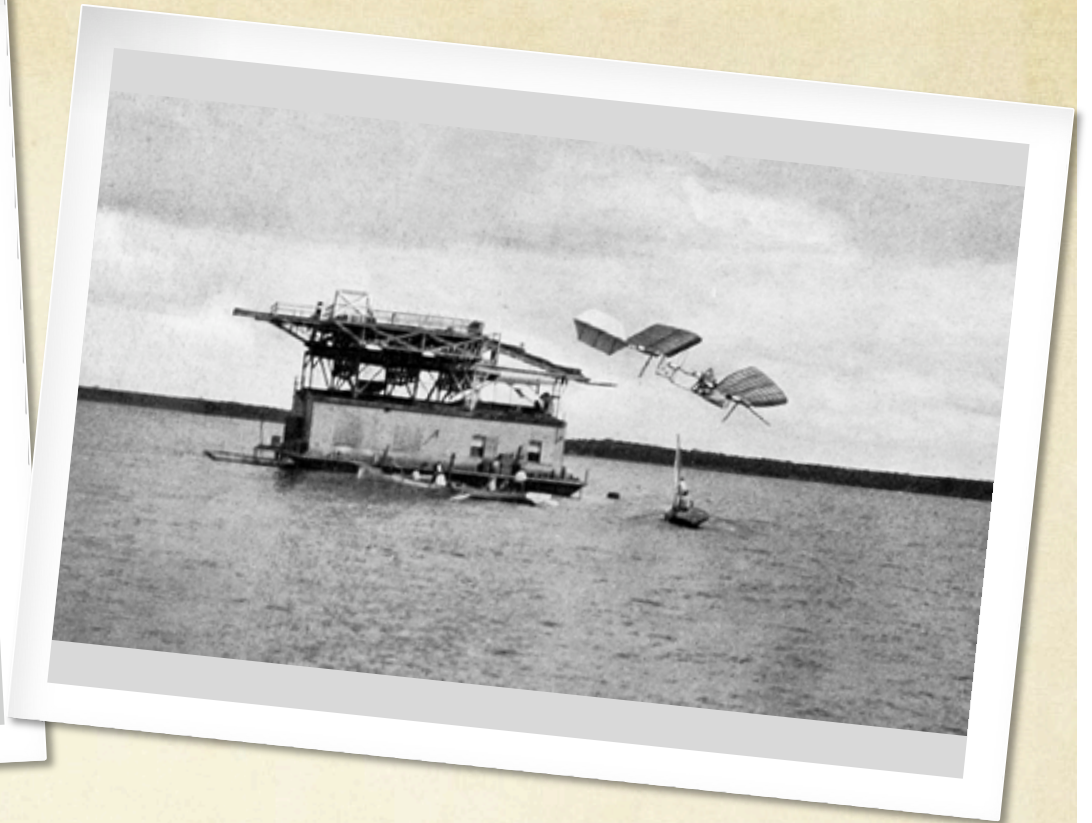
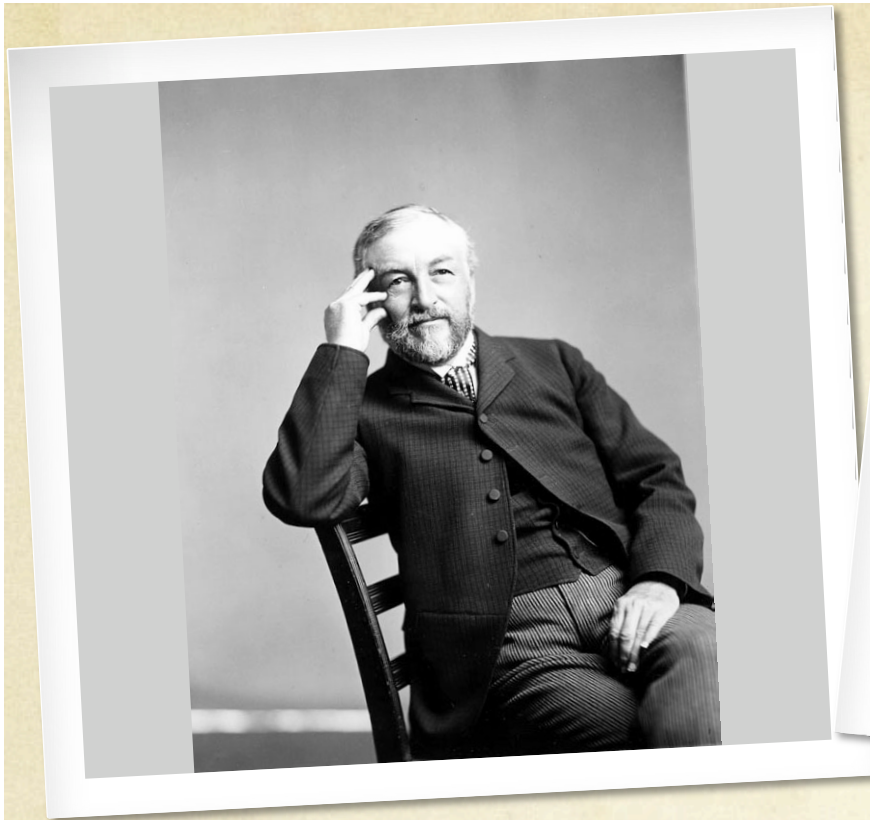
**Energy Analysis**

**Economic  
Assessment**



# Start with Flight

Imagination takes wing



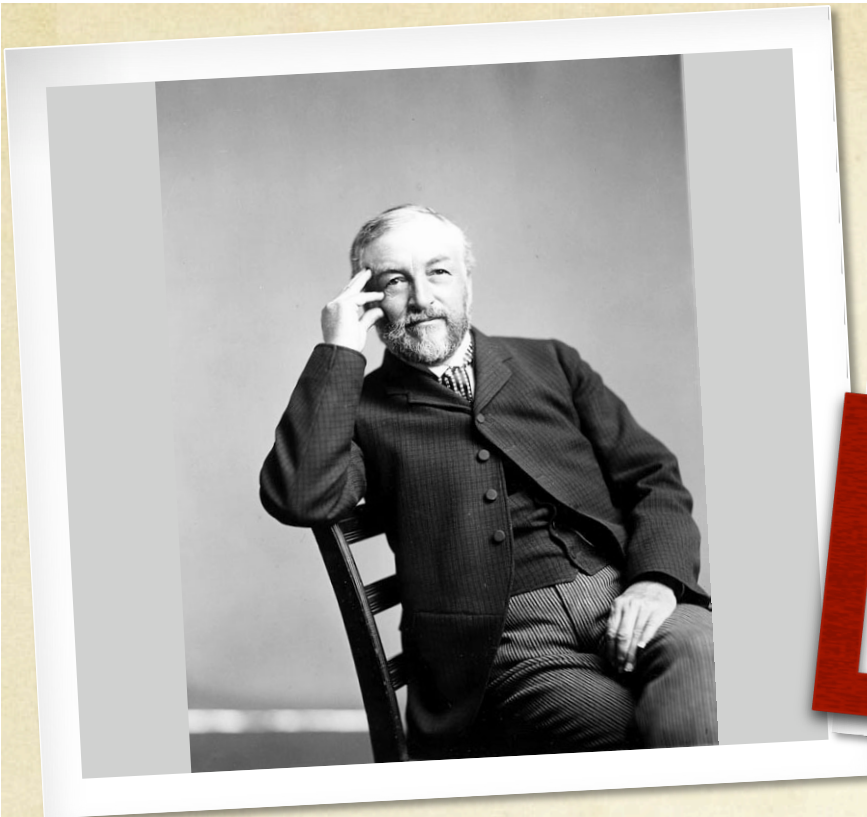
## Prof. Samuel P. Langley

Secretary of the Smithsonian (1898)

Lightweight POWER: Charles M. Manly: *52 hp*

*(don't worry about the frame)*

*\$50,000 in government funding gone over the Potomac*



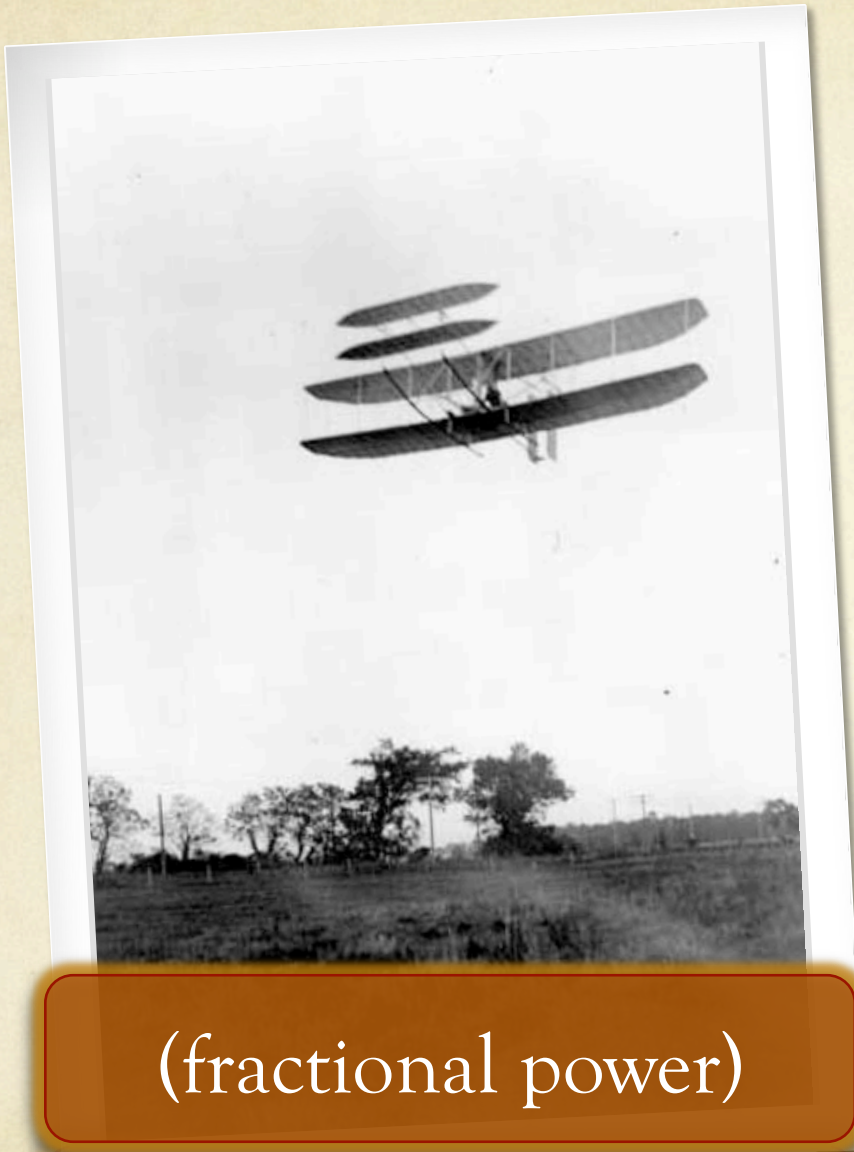
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(fractional power)

(fractional power)

# A Few High School Dropouts

Brothers who ran a bike shop

Lightweight design

Studies in the glider system

First wind tunnel

Lightweight engine: *12 hp*

What was different?





# Integrative Design

Balance of design, inquiry,  
engineering, and entrepreneurship

# Short film break...

And now for something completely different.

LINK: [http://current.com/items/88825317\\_solar\\_decathlon\\_07](http://current.com/items/88825317_solar_decathlon_07)



**BIPV: Replace façade materials with PV materials!**

*Materials Basics: Let's replace a cool roof with a PV roof.*

System is now is a hot roof

PV has nowhere to vent

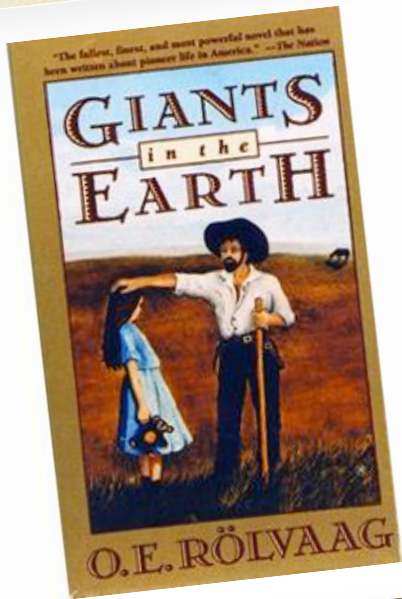
**Congratulations!**

You now have an expensive roof that performs poorly

**BIPV: you didn't even  
know you needed it.**  
(in fact, you don't)

Let's consider BIS:

# Building Integrated Sod





*This is a greenroof!*

# Sod in a Roof System?

We can call that a greenroof



## **Integrate with the System**

Buildings are collections of systems

Roof, Wall, Façade, Floor, Windows

**“The fundamental first step...maximize energy efficiency within the building’s energy demand...This way, the entire energy system can be optimized.”**

**Patrina Eiffert & Gregory Kiss (NREL, 2000)**

Reduce the Loads  
First Step of  
Integration  
Reduce the Loads





Reduce the Loads ( $\times 3$ )

Increase the Solar Fraction of power!

# **PV as a medium**

What else do you want in your system?

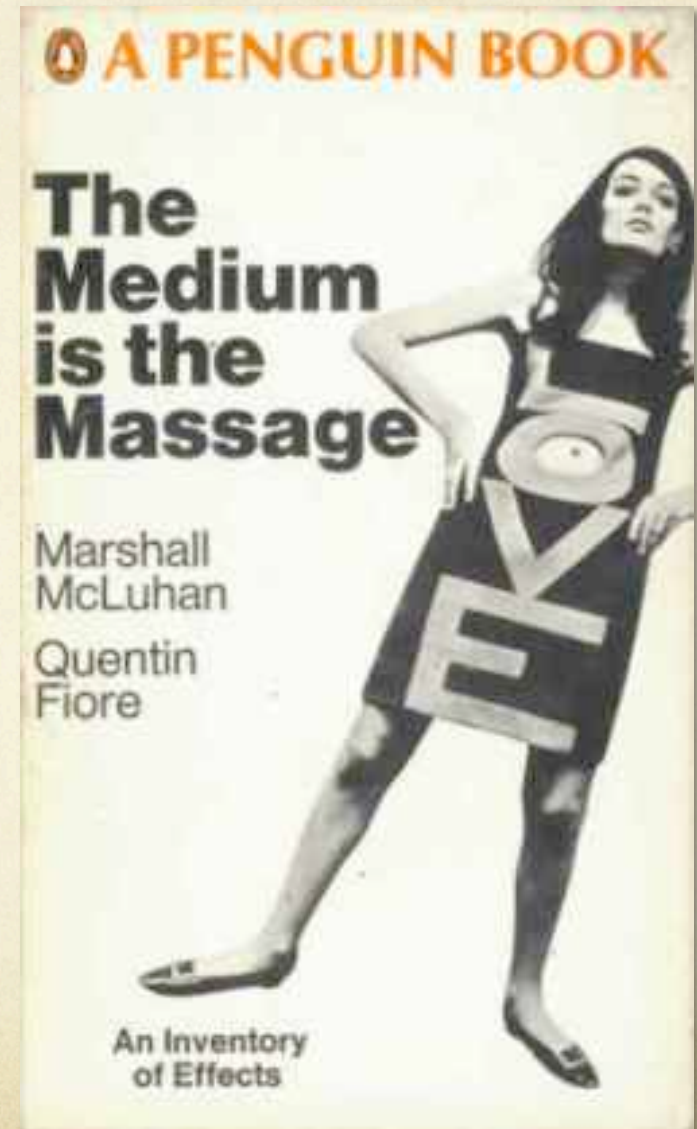
# The medium is the message

*The implemented object  
conveys a message that  
affects how the object is  
perceived*

No content like a newspaper

Yet there is a social effect

Consider PV as you  
would a piece of chalk



# The Light Bulb

"a light bulb creates an environment by its mere presence."

M. McLuhan,  
*Understanding Media*



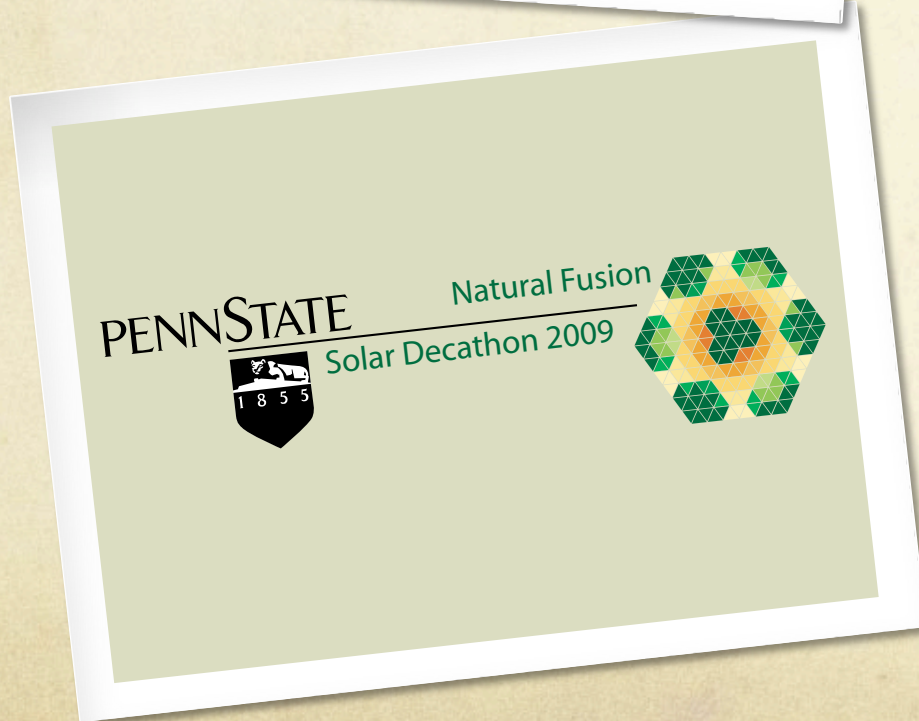


## A different perspective

How do the following sound:

*Building integrated windows*  
*Building integrated plumbing*

*Building integrated air conditioners?*





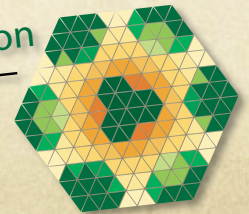
# GRIPV

System: greenroofs!

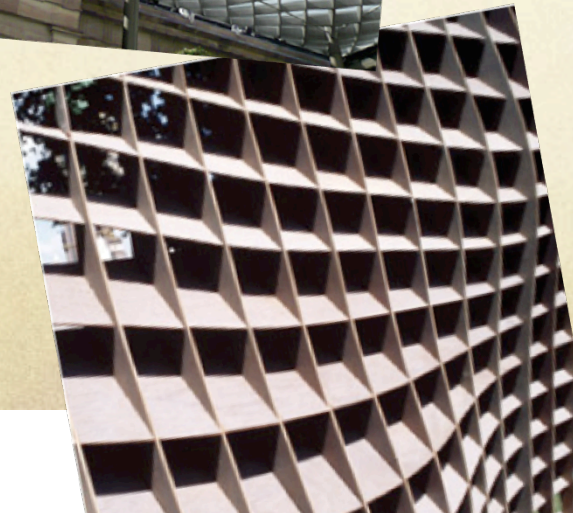
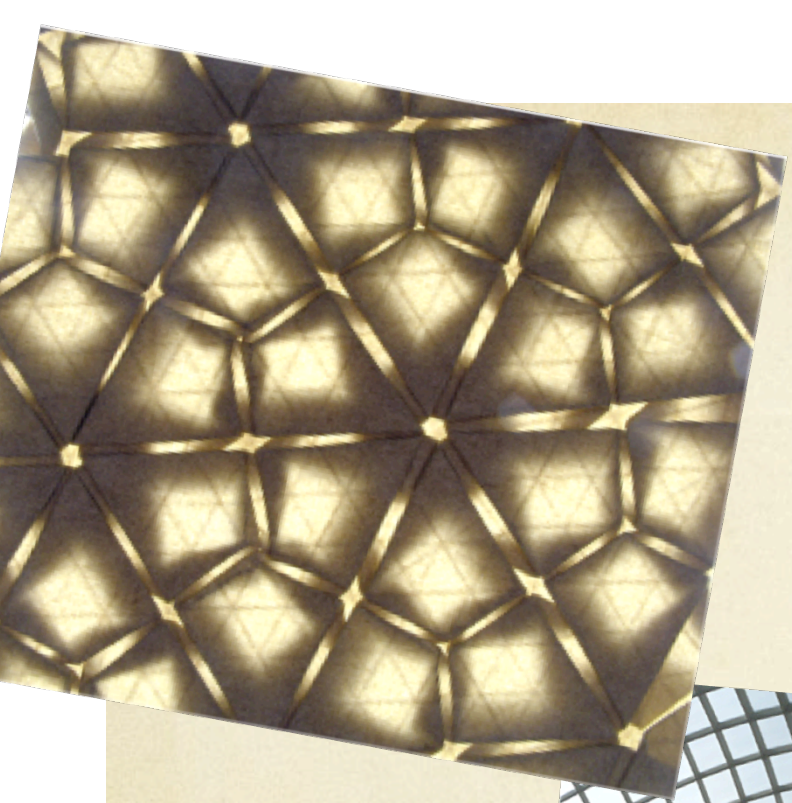
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*What other systems are  
out there?*





[solar.psu.edu](http://solar.psu.edu)