

ENG 6 W12: Sustainable Engineering Theme

Electrical and Computer Engineering

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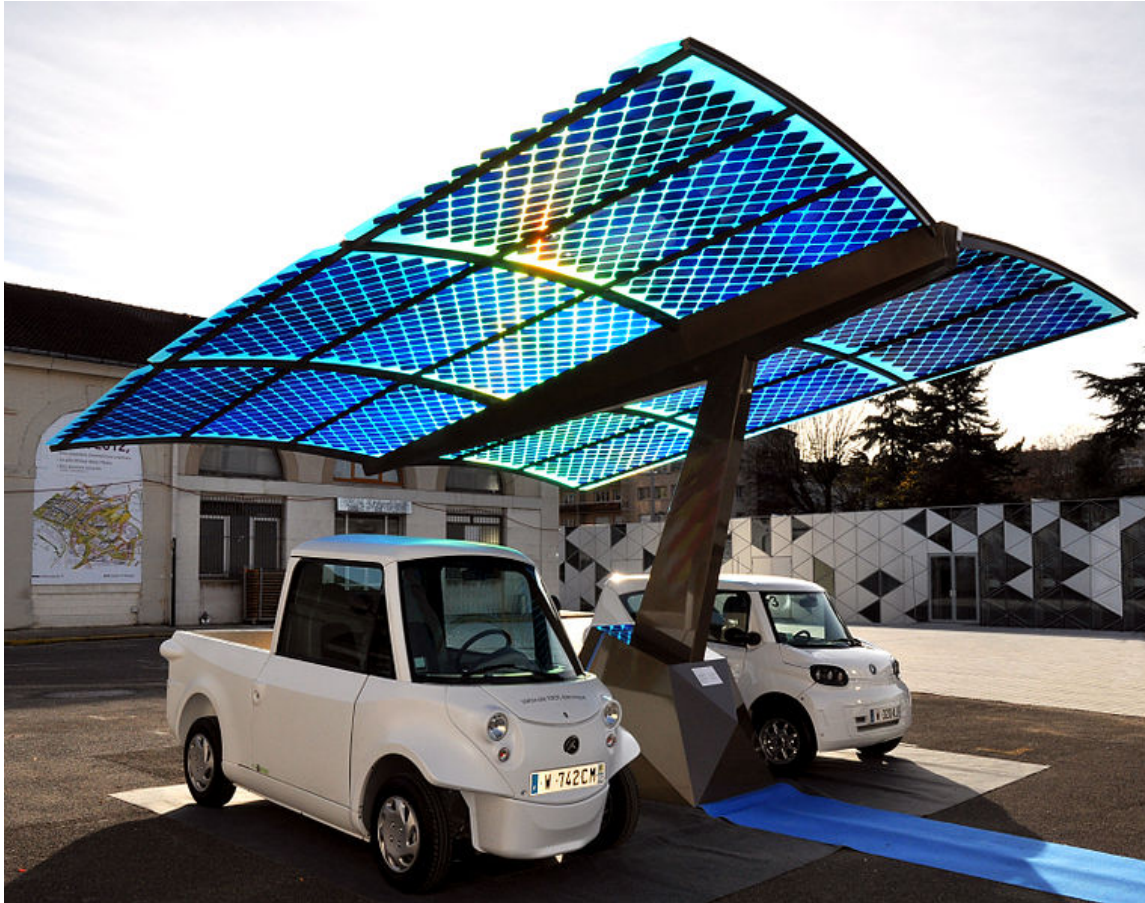
Virticulture and Enology

R. Boulton (also Chem Eng)

Introduction

- **Sustainable Engineering – Wikipedia Definition**
 - “the process of using energy and resources at a rate that does not compromise the natural environment, or the ability of future generations to meet their own needs”
- **Problems Engineers Can Help Solve**
 - Water Supply
 - Food Production
 - Energy Production and Consumption
 - Waste and Pollution Management
 - Housing and Shelter
 - Transportation

Example: Solar Powered EV Charging Station



- Transportation
- Energy Production
- Shelter

(from Wikipedia, http://en.wikipedia.org/wiki/Sustainable_engineering)

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Applying Engineering Problem Solving

- **Engineers have to do better than politicians**
- **Engineers need a quantitative, detailed, and rigorous methodology for addressing problems**
- **Engineers need to use creativity, judgment, teamwork, and tools**
 - Software (like MATLAB) is one tool we can use for solving problems
 - Hardware (like Arduino microcontrollers) are another
 - Recent experience suggests most problems can use hardware + software to arrive at the best solutions

One Problem Solving Approach

- **Problem Definition**
- **Engineering Specification**
- **Feasibility Analysis**
- **Sanity Check**
- **Design and Verify**
 - Initial design
 - Develop model and simulate
 - Build prototype and measure
 - Final design
- **Refine and Iterate**

Robert Mondavi Institute Winery



- **UCD Robert Mondavi Institute for Wine and Food Science**
 - Includes classrooms, research labs, and teaching labs
 - First winery, brewery, and food processing facility to achieve LEED platinum certification

Problem Definition

- **Problem definition is starting point, sometimes unintentionally (or intentionally) vague**
- **Suppose you are assigned following task: provide electricity for winery building using solar energy**
- **Not enough details given to proceed, so you need to ask some questions**
- **What type of solar energy generator?**
 - Photovoltaic (solar cell)
 - Solar thermal (sunlight heats working liquid to drive a generator)
- **How much electricity is needed?**
 - Peak or average? Day or night? How reliable?

Engineering Specification

- **Knowing what questions to ask requires engineering judgment**
 - Developed through lots of practice
- **Answers to these questions leads from a vague problem statement to an engineering specification**
- **A specification is a quantifiable parameter of performance which your design must achieve under certain given conditions**

Engineering Specification Example



- **Problem Statement:**
 - Provide electricity for winery building using solar energy
- **Specification:**
 - Design a solar photovoltaic generator which supplies peak power of 1MW at 12PM to winery building when receiving 25% or more of maximum solar illumination and with 99.5% uptime

Feasibility Analysis



- **Can we meet the specification given reasonable assumptions about system components?**
 - Solar panels: 34% power efficient, 99.9% reliable
 - Solar insolation: 1kW/m² max at 12PM

Feasibility Analysis

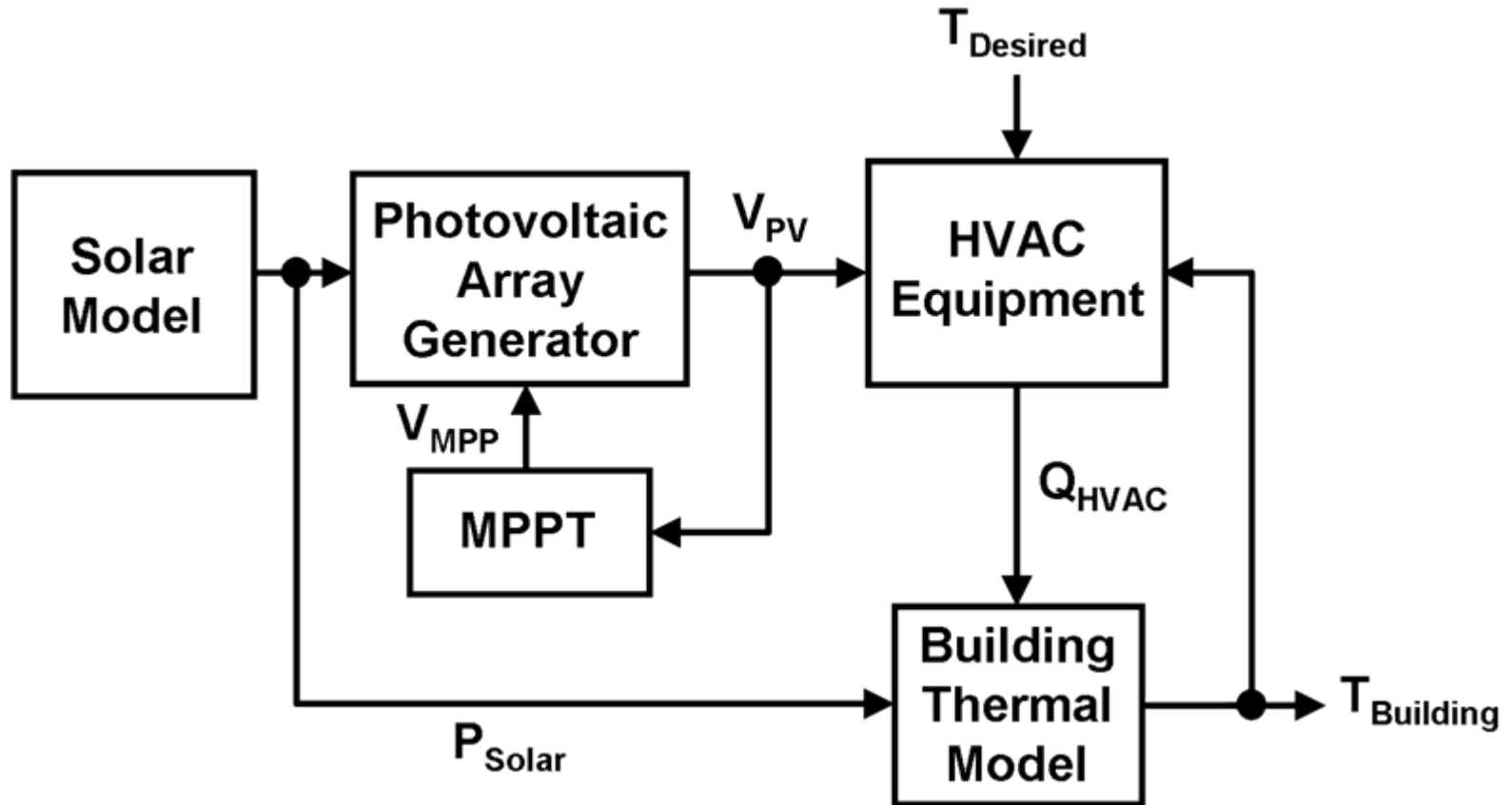
- **Given:**
 - Solar panels: 34% power efficient, 99.9% reliable
 - Solar insolation: 1kW/m² max at 12PM
- **Solar panel reliability already satisfies uptime specification**
- **Total solar panel area needed:**
 - Power Out per m² = Solar Insolation x Solar Panel Efficiency
 - Area = 1MW / Power Out per m²
 - Area = 1MW / (0.25 * 1kW/m² * 0.34) = 11,765 m²

Sanity Check



- Does this system use an insane amount of area (11,765 m²) ?
- Compare to other reference points
 - Football Field: 360 feet x 160 feet = 5351 m²
 - Mondavi Institute Total Building Footprint: 131,000 sq. ft. = 12,170 m²

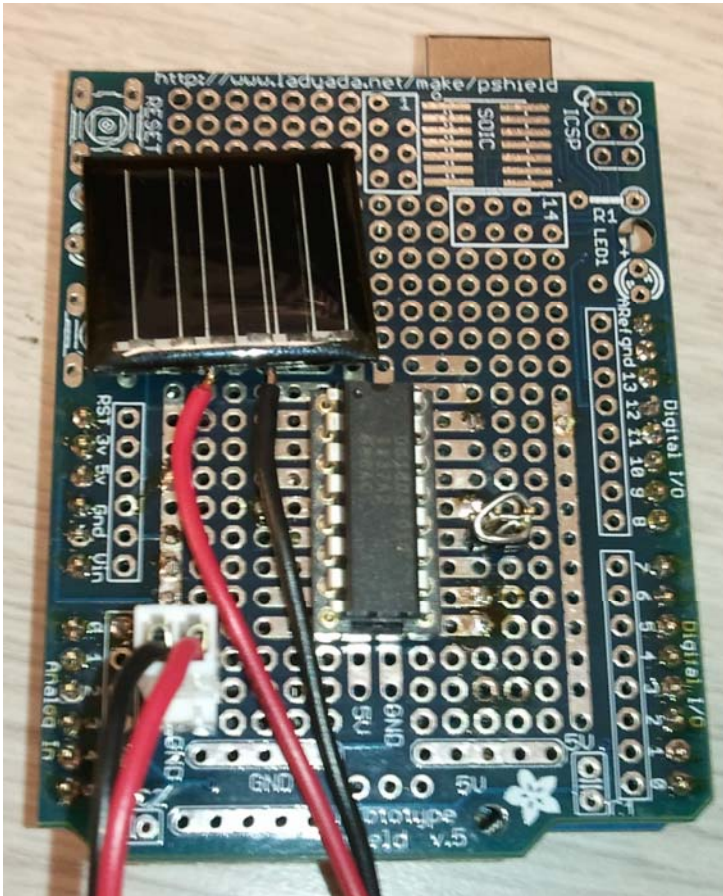
Detailed Modeling, Design, and Analysis



- **MATLAB and other software can help with next stages of designing and implementing system**

Prototyping and Measurement

- **Microcontrollers and other programmable electronic hardware can help you build prototype systems quickly and experimentally verify assumptions or design**



- **Arduino microcontroller and solar panel lab module**
 - Developed by TA Stanley Hsu with support from MathWorks
 - Interfaces to MATLAB for configuring load circuit, measuring voltage and current
 - Will use in some later labs

Conclusion

- **Sustainable Engineering Theme in ENG6**
 - Provide insight into pressing societal problems which engineers can help solve
 - Help motivate you to think about problems like an engineer
 - Expose you to software and hardware tools that can help you solve problems
 - Help you have fun!