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Dept. of Mechanical Engineering

Solar Irradiance Measuring Device

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Overview

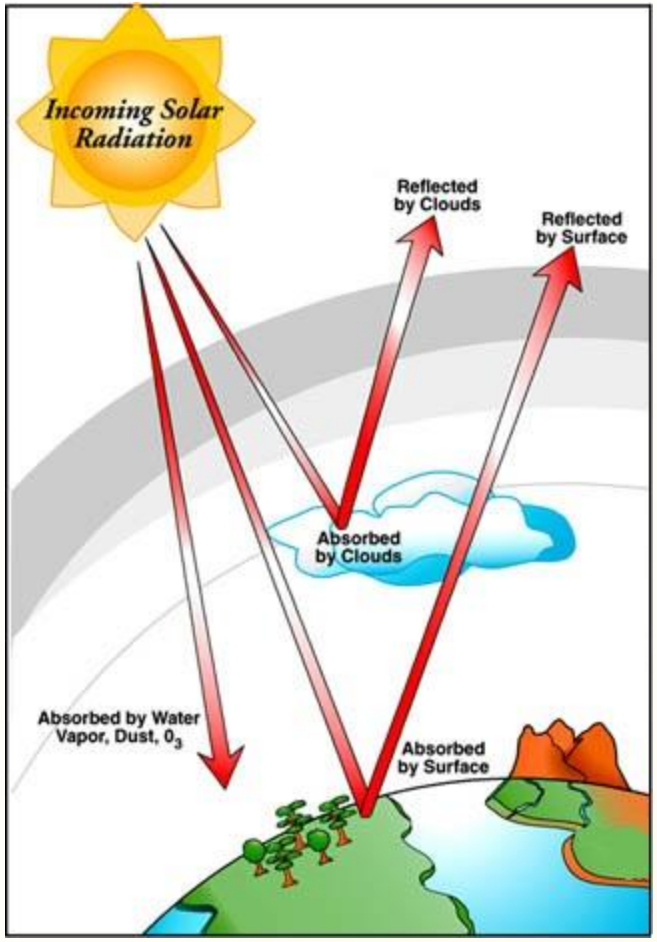
- Clients
- Project Definition
- Hardware Design
- Data Analysis
- Current Tasks
- Timeline

Clients

- **NextEra Energy**
  - **Construction and operation of energy production sites**
- **Institute for Sustainable Energy Solutions**
  - **Dr. Tom Acker**
  - **David Willy**
- **Product targeted to power companies**

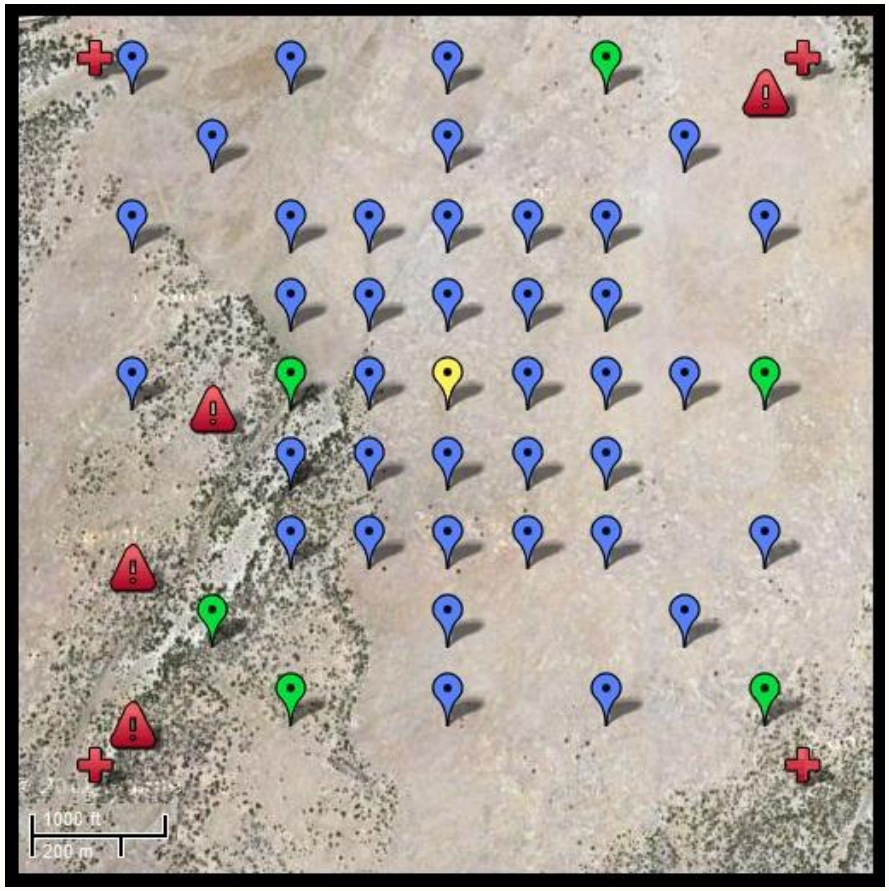
Irradiance Definition

- Energy flux $[\frac{W}{m^2}]$
- Changes with weather
  - Inconsistent output
- Variance data used to determine viability of solar site



Current Site

- **Located at COBar Ranch**
  - **35 miles north of the San Francisco Peaks**
- **1 square mile**
- **50 sensors**



Needs Identification

- **Current problems:**
  - **Large number of devices in use**
  - **Long set-up time / permanent**
  - **Large area usage**
  - **Access issues**
  - **Data collection errors**
  - **High cost**

Needs and Goals

Need Statement:

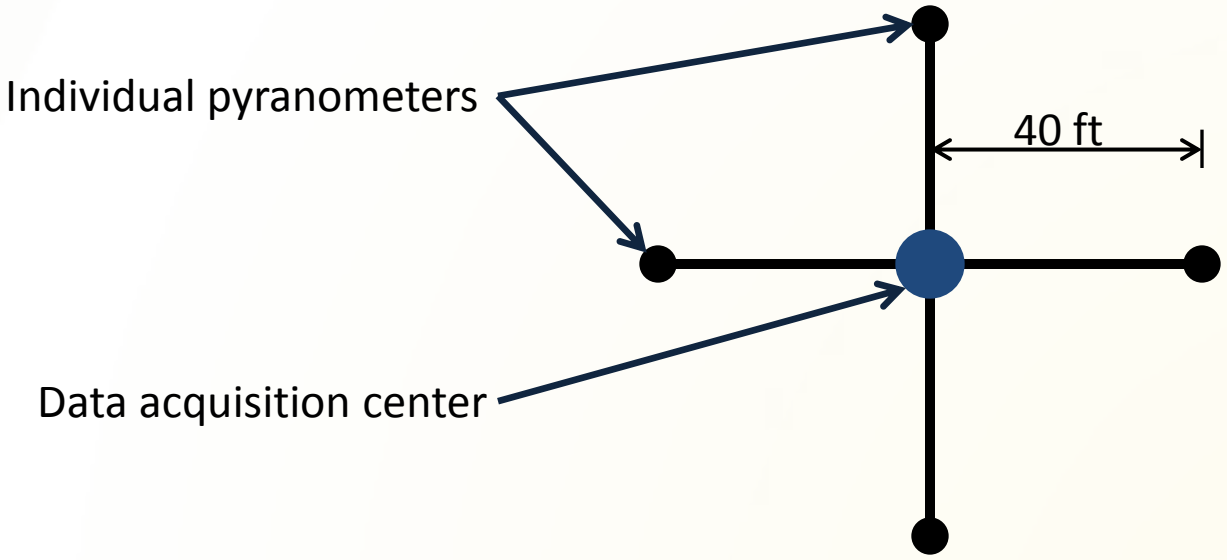
The current system is inefficient with its use of land, man hours, and produces poor data.

Goal:

Design a relatively small, portable solar irradiance measuring system that can accurately quantify variance in solar irradiance over a larger area.

Proposed Site

- 5 pyranometers
- One centralized data acquisition center
- Approximate radius of 40 feet

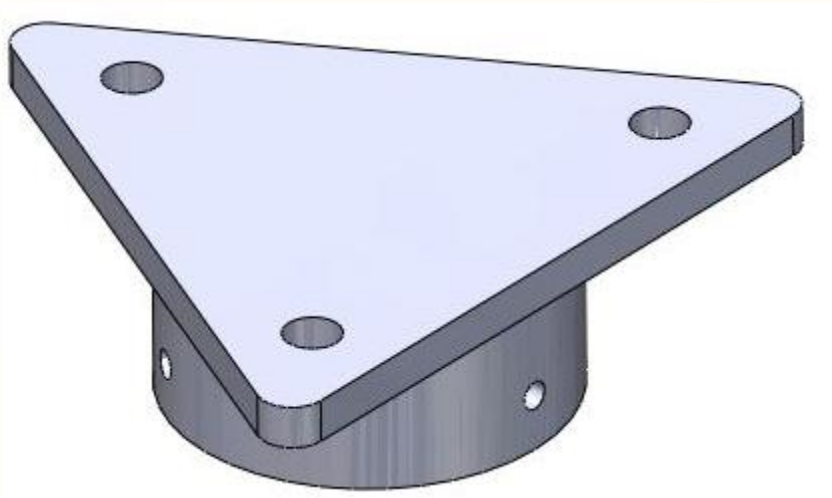


Tripod

- Pyranometers mounted on simple tripods
- Tripods secured to ground
  - Brackets at base of each leg
  - Stakes in earth
  - Expansion bolts in rock
- Galvanized Steel

Pyranometer Mount

- Slides onto top of tripod
- Secures device to tripod
- Allows pyranometer to be easily leveled
- Many inexpensive and simple options for production



Data Acquisition

- **Campbell Scientific CR-800**
  - Proven in industry
  - 6 pyranometer channels
  - Max sampling rate: 100Hz

- **Li-Cor LI-200 Pyranometer**
  - Compatible with a Campbell Scientific Data Logger
  - Average Error <5%

- **Loggernet**
  - Datalogger interface program

Data Transfer

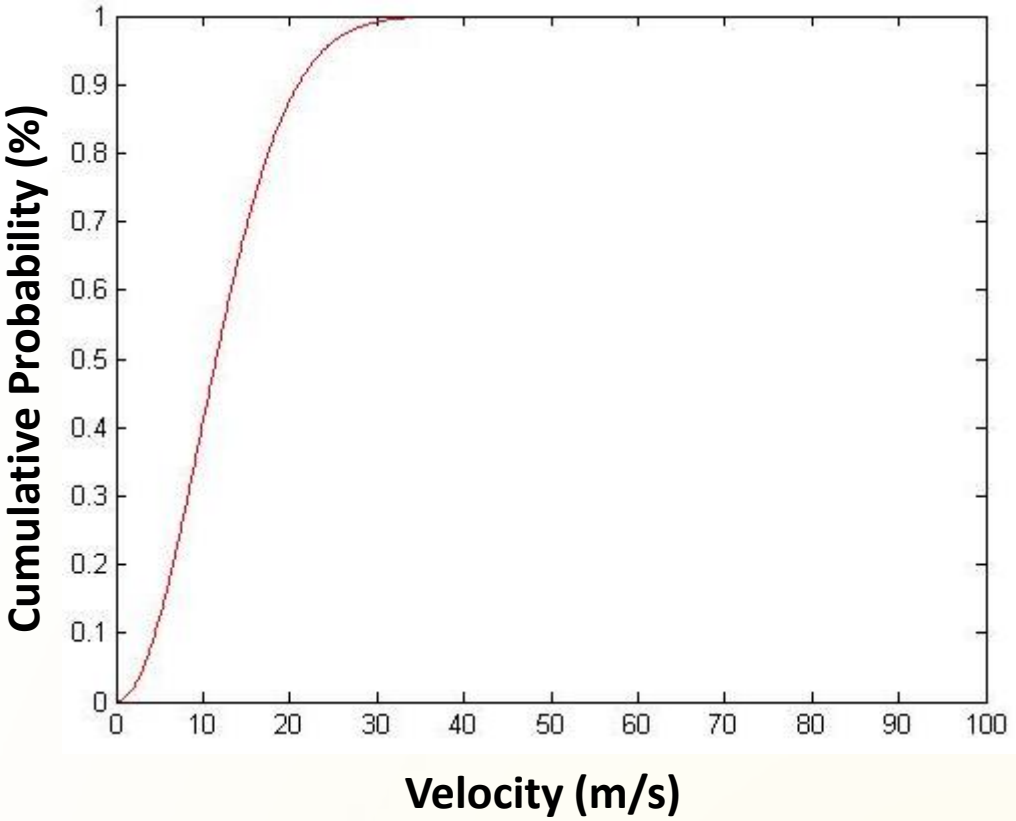
- **Wired:**
  - **Simple setup**
  - **Sensors come with 50 foot cable**
  - **Negligible voltage drop**
- **Wires will be housed in flexible conduit**
- **Protects wires from**
  - **Cows**
  - **Rodents (eg. field mice)**
  - **Ultra violet rays**
  - **Water**

Data Correlation

- **Correlating Stations 14 and 18 to Station 13 gives X and Y components of velocity.**
- **Magnitude of found velocity: V=12.2$\frac{m}{s}$**

Data Correlation Cont.

- **Applied a special statistical distribution and found a cumulative distribution function (CDF)**



Data Correlation Cont.

- **Using percentages from the CDF, the cloud velocities were found.**

- **Knowing these velocities and the distance between new sensors, a sampling rate was found.**

Data Correlation Cont.

Cloud Velocities that can be Captured (Percent)	Sampling Rate (Hz)
65	1.16
70	1.24
75	1.33
80	1.43
85	1.56
90	1.71
95	1.96
100	∞

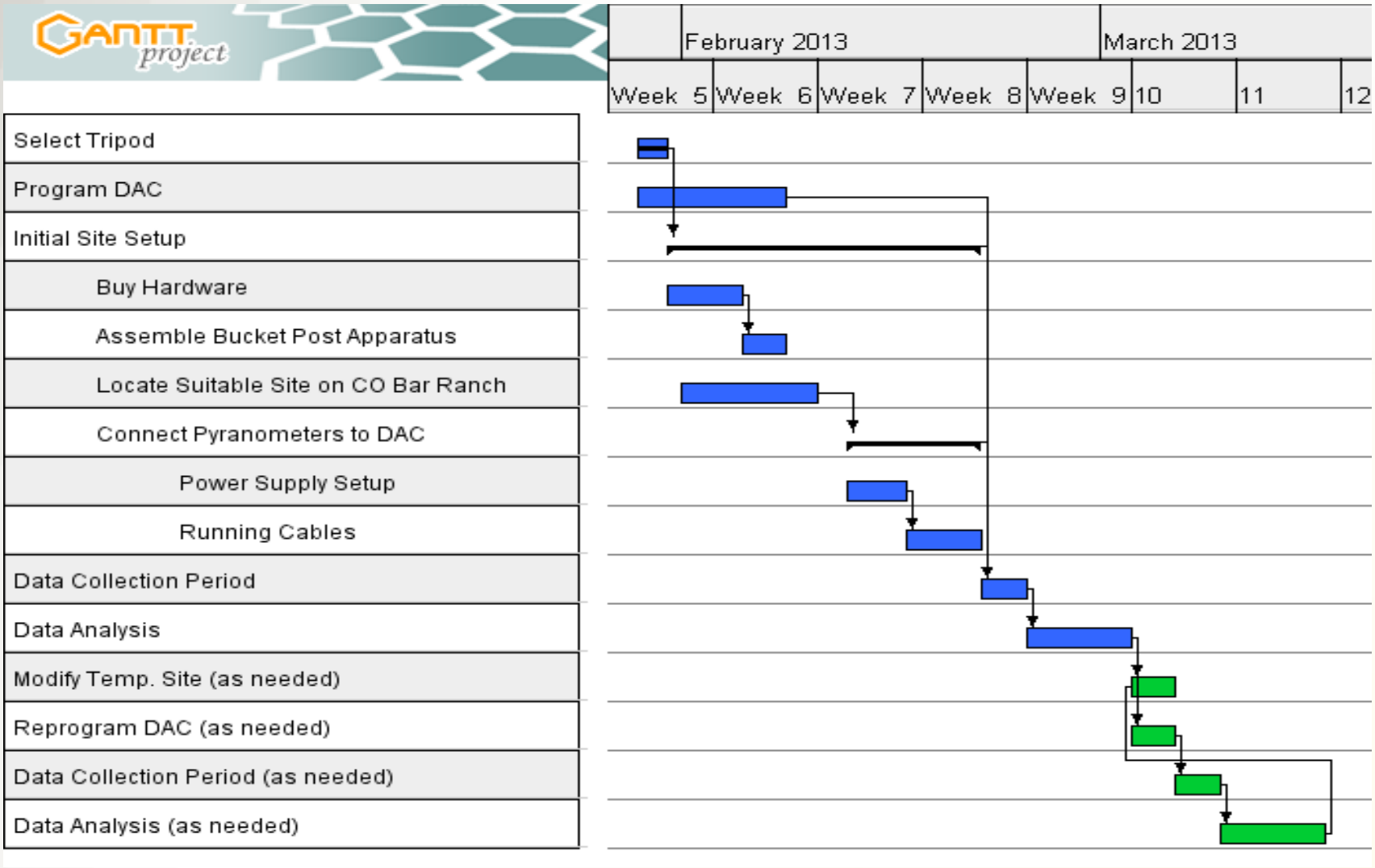
Current Individual Tasks

- Nick Jurik – Data analysis coding.
- Allie Venezia – Site setup coordinator.

- Joey Cavaretta – Pyranometer mount fabrication.
- John Hills – Pyranometer mount fabrication.

- Peter Journell – Hardware and software interface.
- Tim Tormey – Hardware and software interface.

Timeline


GANTT project
February 2013
March 2013
Week 5
Week 6
Week 7
Week 8
Week 9
10
11
12
Select Tripod
Program DAC
Initial Site Setup
Buy Hardware
Assemble Bucket Post Apparatus
Locate Suitable Site on CO Bar Ranch
Connect Pyranometers to DAC
Power Supply Setup
Running Cables
Data Collection Period
Data Analysis
Modify Temp. Site (as needed)
Reprogram DAC (as needed)
Data Collection Period (as needed)
Data Analysis (as needed)

Resources

- Twidell, John, and Weir, Tony. *Renewable Energy Resources*. New York: Taylor and Francis Group, 2006.
- <www.envcoglobal.com/taxonomy/term/685/0>
- <http://www.envcoglobal.com/catalog/product/davis-sensors-and-accessories/weather-station-mounting-tripod.html>
- "Prevailing Wind Direction." *Http://www.wrcc.dri.edu/*. N.p., n.d. Web. 03 Nov. 2012. <http://www.wrcc.dri.edu/htmlfiles/westwinddir.html>
- Flood, Ronald K., Dr. Tom Acker, and David Willy. *Prescott Airport Solar Facility Solar Variability Study*. Tech. N.p.: n.p., n.d. Print.

Questions