A Lightweight Dish/Thermal Solar Concentrating System

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A Better Focus Co.

Problem

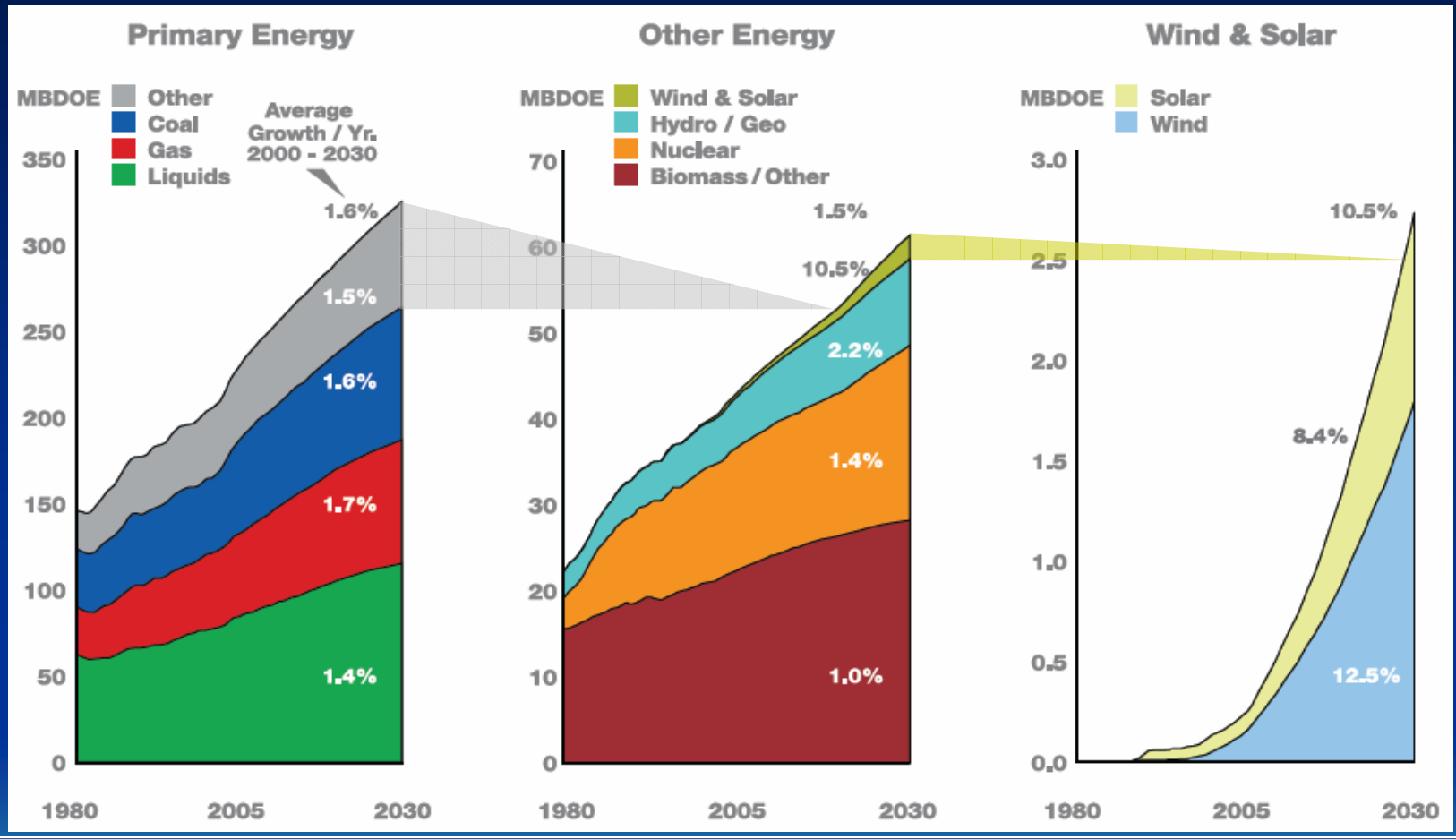
- Solar Energy is Plentiful

- But Widely Dispersed

Concentration

- Concentrated solar energy opens many applications
  - Steam
    - Process
    - Rankin cycle
  - Thermal Engines
    - Sterling, Brayton, etc.
  - Concentrated Photovoltaics

Forecasted Growth of Energy Production



Most of the world's growing energy needs through 2030 will continue to be met by oil, gas, and coal.

Source: "The Outlook for Energy", ExxonMobil 2006

Problems

- Increasing energy costs, coupled with global warming concerns make all solar applications more viable
- But-- there is still a significant cost differential between delivered solar energy, and traditional sources
- We must close this cost gap in order for solar technology to gain widespread acceptance

Best Cost Concentration

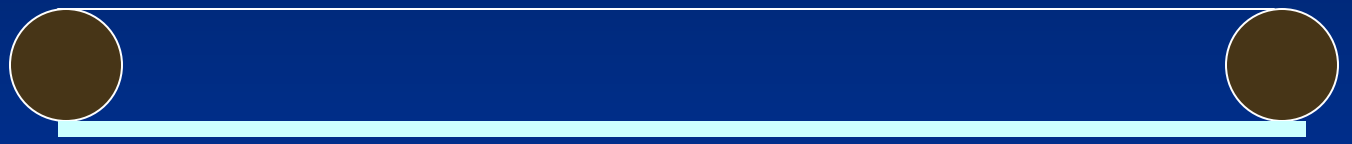
- A Better Focus Co. is dedicated to designing and manufacturing a “best cost” concentrating solar dish
  - Lowest materials cost
  - Superior performance to glass mirror systems
  - Good long-term weatherability

Solar Cooking Roots

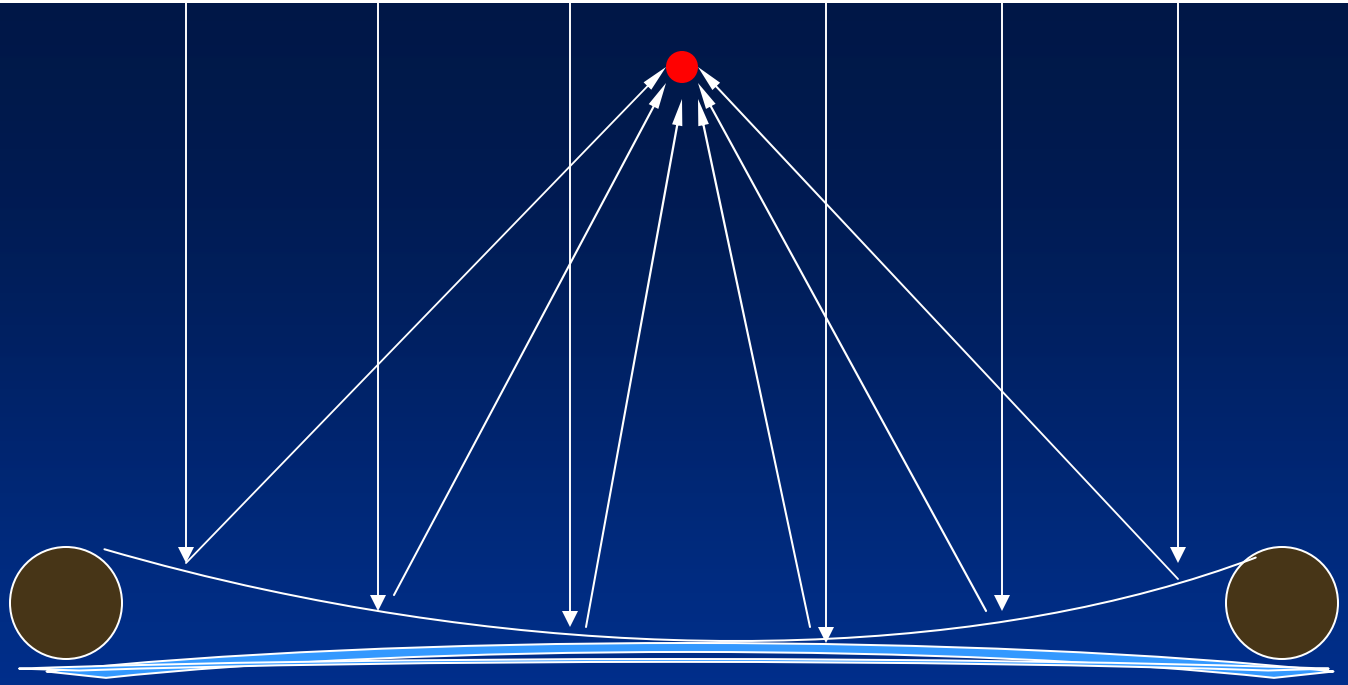
Vacu-Dish Technology

How Does it Work?

Reflective film is precisely stretched across a perfectly round frame



A tight seal is required so that a vacuum can be pulled inside the frame



With Application of vacuum,
The film deforms into a concave shape,
focusing light to a single hot spot.
The backboard also becomes slightly concave,
Increasing the total strength of the assembly

Vacu-Dish Technology

- Development problems, and solutions
- Past shortcomings of stretched membrane techniques, and solutions
- Latest development activities

Vacu-Dish Development Problems, and Solutions

- Reflective membranes are not new,
  - First patents for solar applications date back to 1962
  - Many others have moved the art forward, but there have been problems
    - Expensive and heavy support structures
    - Wrinkling of film
    - Thermal stability
    - Vacuum overhead
    - Spherical aberrations, and scaling difficulties
    - Weather ability
      - UV, rain, wind, abrasion resistance
      - Catastrophic Wind and Hail Events
    - Cost

Design Solution- Strong, Lightweight, Dish

- Just Film- no underlayment
- Self-supporting- Requires external frame for sun tracking, only

8’ dia. dish weighs 65lbs

U.S. Patent #7374301

Vacu-Dish Development Problems, and Solutions

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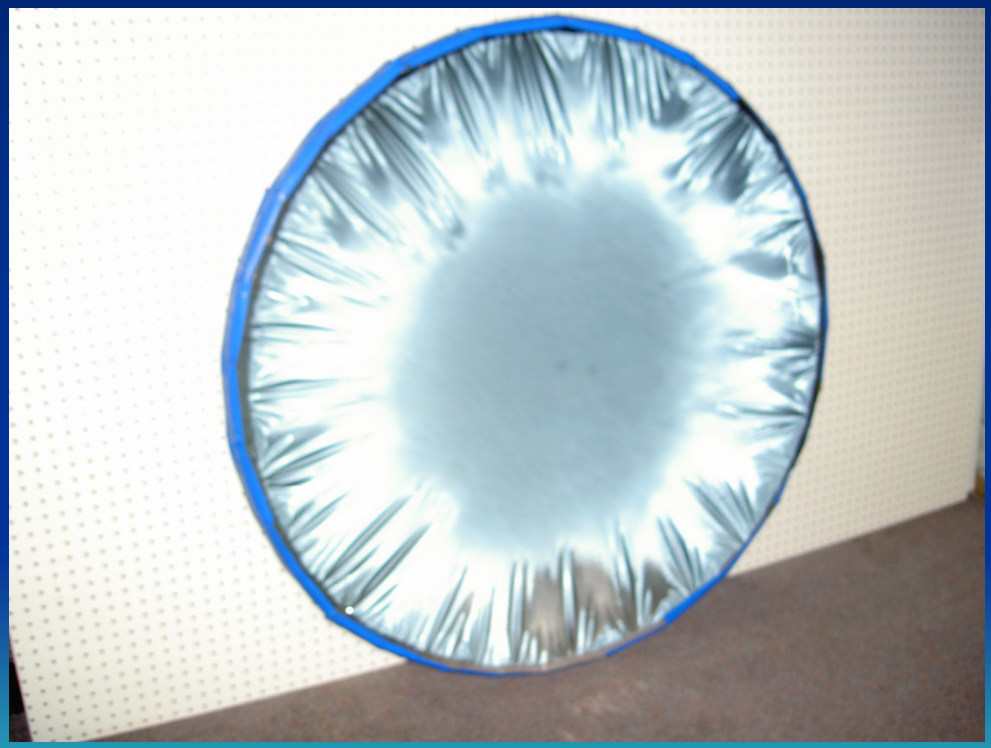
Design Problem- Film Wrinkling

- Film Wrinkling
  - Reflective film tends to wrinkle badly as the vacuum deforms it into a concave shape
  - Past designs have utilized a stainless steel sheet or other underlayment to prevent this phenomenon



Design Solution- Floating Batten

- Film Wrinkling
  - Just Film- ABF technology utilizes no underlayment
  - Solution to film wrinkling is a floating batten that stops the inward propagation of the wrinkles.

Batten depicted on the outer surface of the film for clarity

Dish with floating battens attached to the inner surface of the reflective film.

U.S. Patent #7374301

Design Solution- Floating Batten

- 8’ diameter dish

U.S. Patent #7374301

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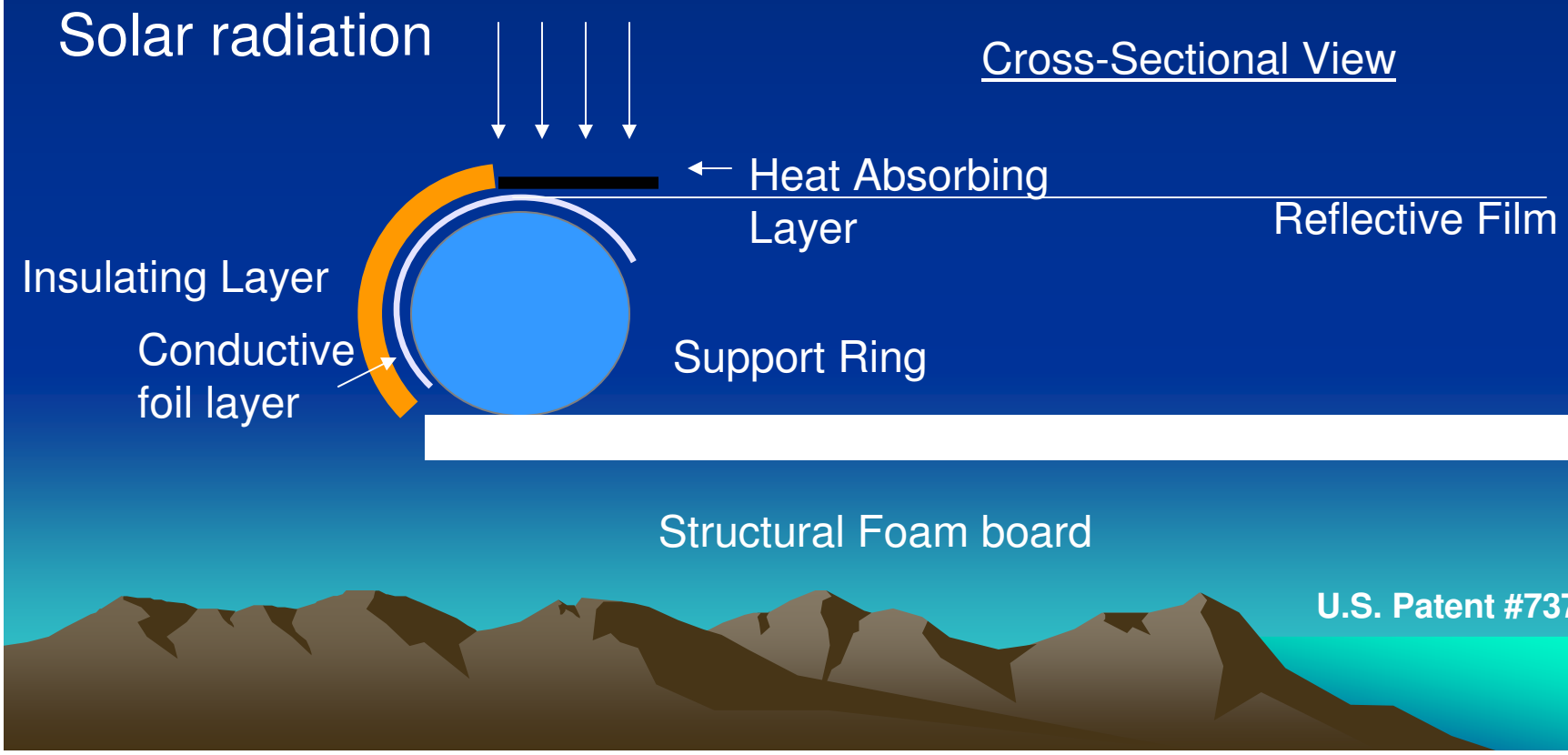
Design Problem

- Thermal Stability
  - Reflective film has a different coefficient of expansion than the supporting ring.
  - Film gets loose when exposed to temperatures lower than those at which it was stretched.

Design Solution- Solar Heating of the Support Ring

- Thermal Stability
  - Solution is solar heating of the support ring
  - Since a heliostat is intended to always face the sun, this heating is always at work



U.S. Patent #7374301

Design Solution- Solar Heating of the Support Ring

- Thermal Stability
  - 26 degree F ambient temp.
  - RH dish w/o solar tensioning
  - LH dish with solar tensioning

Vacu-Dish Development Problems, and Solutions

- Expensive and heavy support structures
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- Vacuum Overhead
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Design Solution- Better vacuum sealing

- Vacuum Overhead
  - Stretched membrane systems require a vacuum to focus light
  - Energy required to establish and maintain a vacuum must be subtracted from the total energy generated
  - Leakage rates have reduced steadily with improvements to manufacturing fixtures
  - Latest dishes will hold vacuum for several days before requiring repumping

- *Safety Note- Vacuum deformed membrane dish can be pressurized to establish a safe convex condition if sun tracking control is lost.

Vacu-Dish Development Problems, and Solutions

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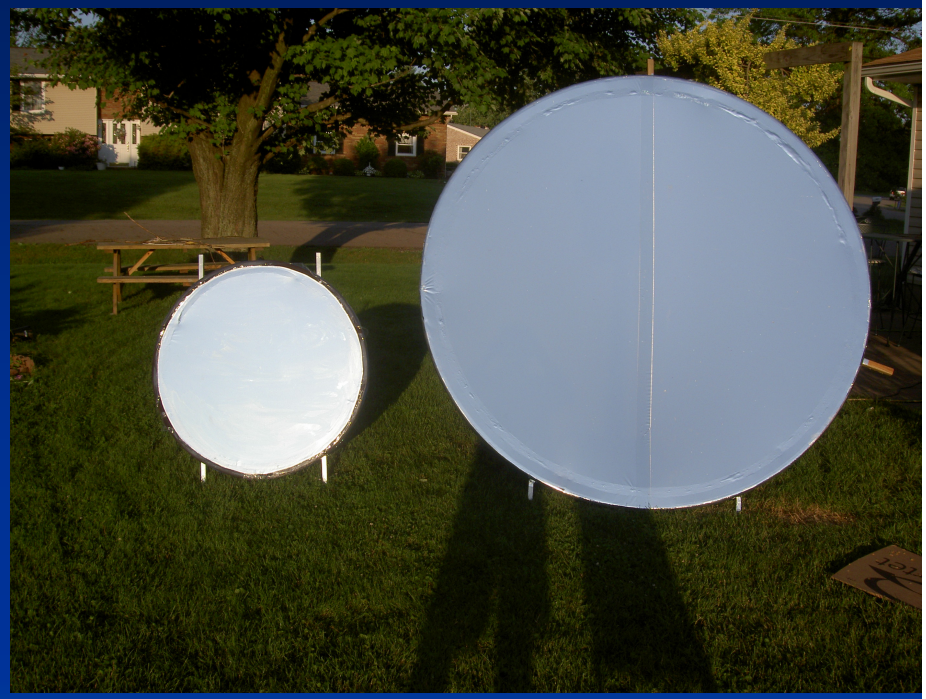
Design Solution- 250 + concentration ratios are demonstrated

- Dish profile is spherical (as opposed to parabolic)
  - 4’ diameter- 130 suns 8lbs.
  - 8’ diameter- 250 suns 65 lbs.
  - 10’ diameter- est. 400 suns 110 lbs.
  - 4’ diameter dishes are currently manufactured in low volumes.
  - Three 8’ diameter prototypes have been made
  - 10’ diameter is likely

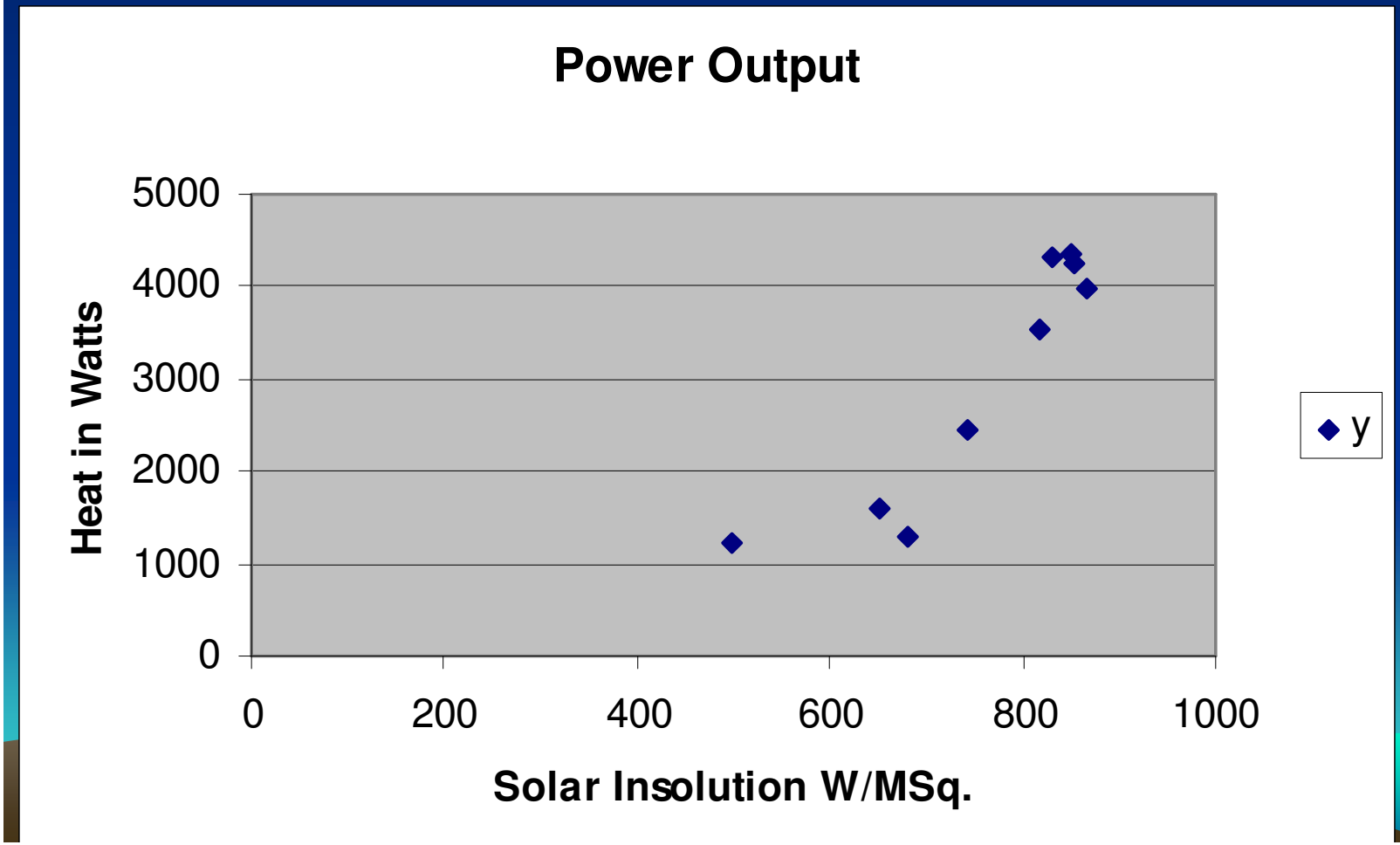


Performance

- 8’ diameter dish testing
- Receiver test rig
  - 922C Max temp at 987 W/M2
  - Heating water in Insulated pot
  - 250 suns concentration- 6-8” dia. spot.

Performance

- ASAE Standard x580
- $W=(T_f-T_i)MC_v/S$, where
  - W= Watts
  - T_f= Final Temperature
  - T_i= Initial Temperature
  - M= Mass of Water + Mass of pot
  - C_v- Specific heat of water and pot
  - S= Seconds



Vacu-Dish Development Problems and Solutions

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Design Solutions

- Weather ability
  - All current dish materials are weatherable
    - PVC lined foam board with hard coat
    - Aluminum mounting plates
- NREL's Advanced Materials Group has conducted accelerated life testing on film materials. Minimum 10 year life is expected.

8' dia. dish with Reflectec Solar film

Design Solution- Weathervaning Mount to Survive High Wind Events

- Blowing particulate can scratch reflective surface
- Frost and Ice loading on reflective surface
- Blowing hail events
- Structural failure in high winds
- Solution- Test rig weathervanes in high winds, turning reflective surface away from the oncoming wind.
- 8’ diameter prototype has survived two winters, so far

Dish test rig has survived winds to 37 MPH to date

Dish Failures

- Failure of inner tube bumper destroyed first dish in Jan. 08.
- Rippling of film in wind causes the floating batten to detach from back of film. Solution is to keep film taut at all times with vacuum or pressure

Surviving High Wind Events

¼ scale 4-Dish tracking frame design
Optimizes weathervaning properties

Bends like the Willow

vs.

Stands like the Oak

Oak Tree in Snow, Caspar David Friedrich

Patent pending

Vacu-Dish Development Problems and Solutions

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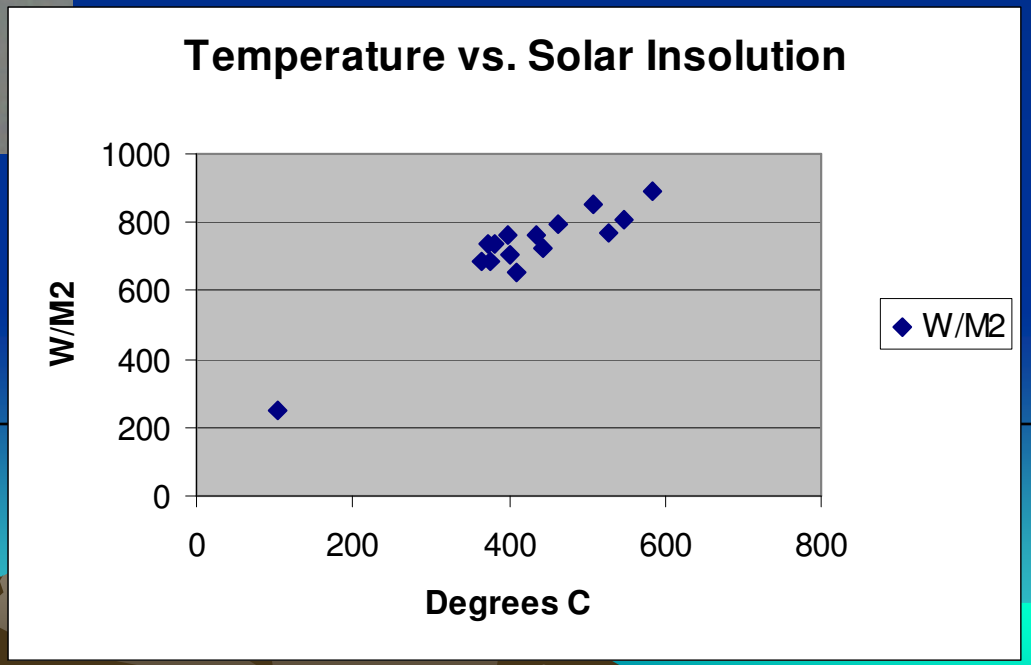
Design Solutions

- Material Cost
  - 4’ diameter dishes are currently manufactured in low volumes
  - Material cost is $ 24/M^2
  - 8’ diameter prototype with weatherable film material cost is $55/$M^2$
- Labor hours are currently very high, but the design is suitable for high-volume manufacture
  - Powered rotary fixtures
  - Combining multiple operations in each revolution

Latest Progress- ¼ Scale Model of a 4 Dish Sun-Tracking Thermal System

Patent pending

4 dishes focused to a 5” dia. Spot



Next Step

- Improve test rig design, and continue outdoor testing
- Continue testing of ¼ scale model
- Find a user-partner for the construction of a full scale 12-15 Kw dish-thermal system.
  - Industrial/Institutional user with a year-round need for steam or pressurized hot water
  - Must have good solar resource
  - Must be willing to share performance data
  - Must be willing to share in the construction costs

Thank You- Questions?

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Please join us at our hospitality reception
in the Royal Palm #6 room from 5:00-7:00 PM