SPQ Module 3 – Solar Power

The sun is the source of all life on earth. Yet we sometimes forget how central it is to our every activity. We stumble through our daily routine worrying about the mundane tribulations of life without stopping to reflect upon the fact that without energy there is no life, and without the sun there is no energy.

Setting out on a Polar expedition forces one to simplify one's approach to living. That which the more privileged may take for granted, such as food, light, heat, and power become dear in a land like Antarctica. An Antarctic explorer must strip down their necessities to the barest essentials to ensure survival, and this survival is based on a steady and reliable supply of energy.

Sources of energy are considered either renewable or non-renewable (finite). Renewable energy is a product of natural sources that self perpetuate such as solar, wind, tidal, hydro and geothermal energy. Ray, Richard and Kevin made a conscious decision when planning for their expedition that they would rely on as many sources of renewable energy as possible. The energy supply for the South Pole Quest expedition will come in the following forms:

Did You Know?

Solar radiation along with secondary solar resources such as wind and wave power, hydroelectricity and biomass account for 99.97% of the available renewable energy on Earth.

- **Chemical energy in food to heat and power the human beings**
- **Solar energy to power virtually all the electronic equipment**
- **Fossil fuel to melt the snow to make water**
- **Electrical energy stored in a few auxiliary batteries**

Further analysis of these forms of energy reveals that they all trace back to the sun. Food is a byproduct of photosynthesis, either directly in the form of plants that harness solar radiation for their growth and development, or animals that harness the chemical energy captured in plants or other animals. Fossil fuel is a byproduct

of ancient plants and organisms (hence the name *fossil* fuel) that have been buried and compressed for millions of years. These organisms harnessed sunlight to grow and multiply. The batteries that store electrical energy are manufactured in factories that either use fossil fuel, or electrical energy from hydroelectric plants. Hydroelectric energy is a product of the flow of water, which results from the climate driven water cycle powered by the radiant energy from the sun. Lastly the solar equipment carried on the expedition directly harnesses the sun's rays and converts it into electrical energy.

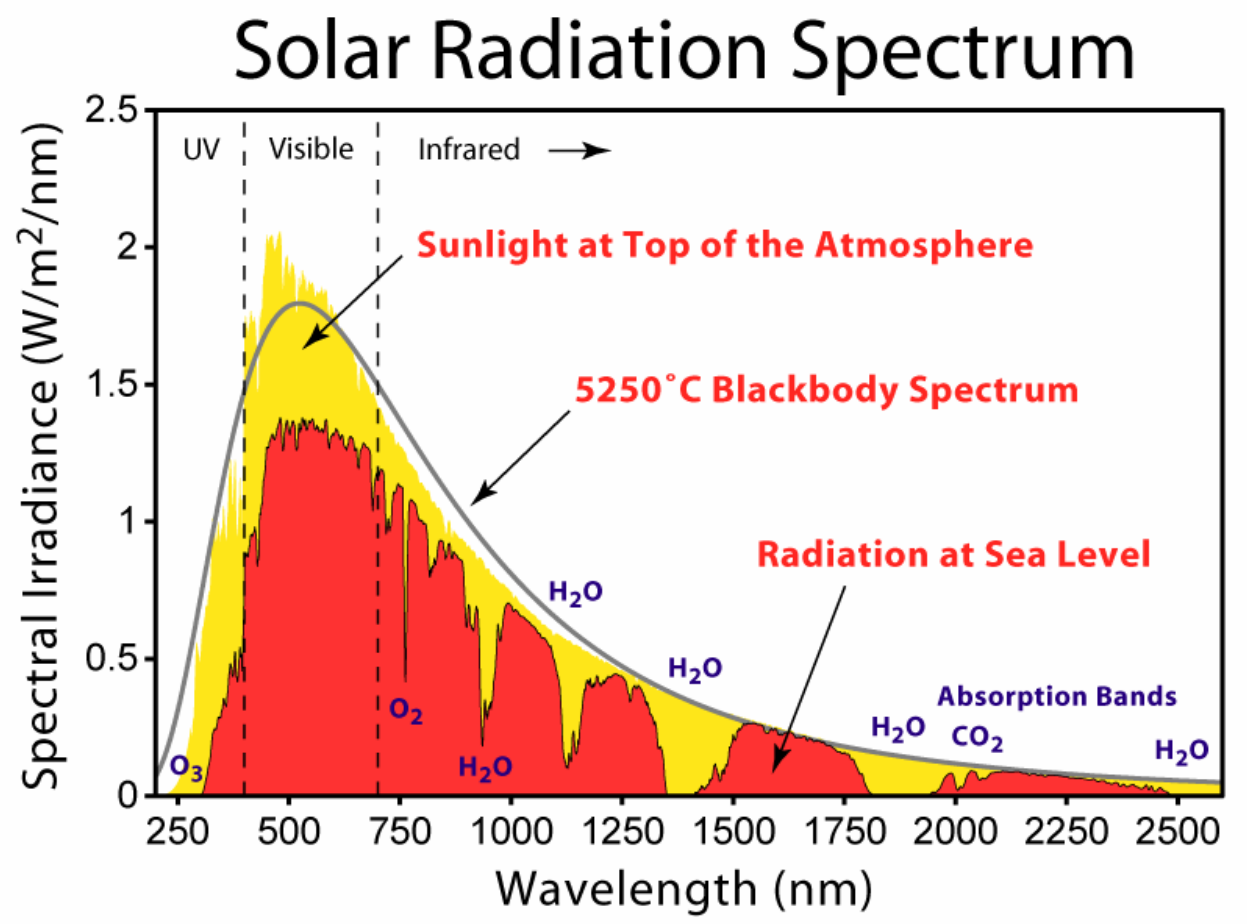

Figure 1: Solar Radiation Spectrum (source: wikipedia: en.)
The solar radiation spectrum for direct light at both the top of the Earth's atmosphere yellow) and at sea level (red). As light passes through the atmosphere, a percentage is absorbed by gases with specific absorption bands (Source: Robert A. Rohde as part of the Global Warming Art project).

Virtually all the electronic equipment carried on the South Pole Quest will be driven by solar power. Energy from the sun will power the satellite phone that enables Ray, Richard and Kevin to listen, and respond to, questions from students following the expedition. The electronic equipment list for the expedition is:

- **2 Satellite Phones.**
- **2 PDAs (Personal digital assistants – to download and manage images and film).**
- **3 IPods (for music, map images of route, and movies at night).**
- **2 video cameras.**
- **2 hand held still cameras.**
- **1 GPS (Global Positioning System).**

- **1 large back up battery that is rechargeable from the solar panels.**
- **2 roll out solar panels (10 and 20 watts) to go on sledges when traveling for recharging all equipment.**
- **3 small solar chargers to wear on backpack to run IPods continuously.**

Figure 2: Ray, Richard and Kevin organizing the electronic equipment for the South Pole Quest at base camp in Punta Arenas, Chili (Photo: Ewan Affleck)

As a location for generating electrical energy from the sun, Antarctica has both advantages and disadvantages. During the winter months solar energy is not accessible as there is twenty-four hour darkness. Conversely during the summer months there is twenty-four hour daylight and consequently long hours of exposure to radiant solar energy. However, because of the declination of the earth the solar rays reaching the surface of the earth are spread out or diffused over a larger area of ground, as compared to the sunlight striking the equator that is more concentrated. The less energy producing capacity of diffused low angle sunlight of Antarctica is made up for, in part, by the longer hours of sunlight.

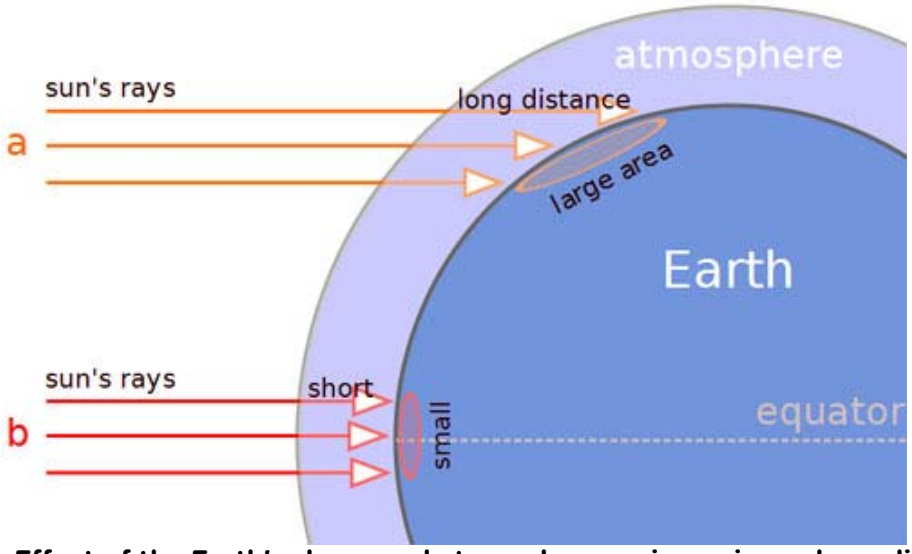

Figure 3: Effect of the Earth's shape and atmosphere on incoming solar radiation. The solar radiation arrives at an oblique angle nearer the poles, so that the energy spreads over a larger surface area, lessening its intensity. The radiation also travels a longer distance through the atmosphere, which absorbs, scatters and reflects the solar radiation (source: Peter Halasz).

Man has devised two basic means to capture solar radiation and convert it into useful energy, solar electric energy and solar thermal energy. Solar thermal energy functions by storing the heat from the sun and capturing it in water or air. This heat energy can then be transferred where it can be used, for example, to heat your home. Solar electric systems are composed of photovoltaic cells that can convert solar heat into electricity. This electricity can be used to directly power equipment or can be stored in batteries. For the purposes of the South Pole Quest two large photovoltaic panels will be secured over the sledges and used to fuel and charge all the equipment. Individual team members will carry three smaller solar units to power their personal IPods.

Figure 4: Solar Equipment taken on the South Pole Quest. Small photovoltaic

panel (in orange) for charging IPod, and two larger flexible photovoltaic panels (One rolled up) for charging general equipment (photo: Ewan Affleck)

Photovoltaic cells function by trapping the thermal energy of the sun in semi-conducting substances like silicone. A semiconductor is a solid material that can conduct electricity. Electrons are knocked off their atoms in the semiconductor by the thermal energy of the sun, allowing them to flow through the material in the form of electricity. This process is known as the photovoltaic effect.

Explorers in Scott and Amundsen's time who set out on a Polar expedition were completely cut off from civilization. If one of the team members became ill they had no means of procuring help. Today, with the help of relatively simple technology, Ray, Richard and Kevin can use the power of the sun to call for help, answer questions from students or touch base with their loved ones at home.

Did You Know?

The energy from just 20 days of sunshine is the equivalent to all the energy stored in Earth's reserves of coal, oil, and natural gas?