

# Steve Duckworth

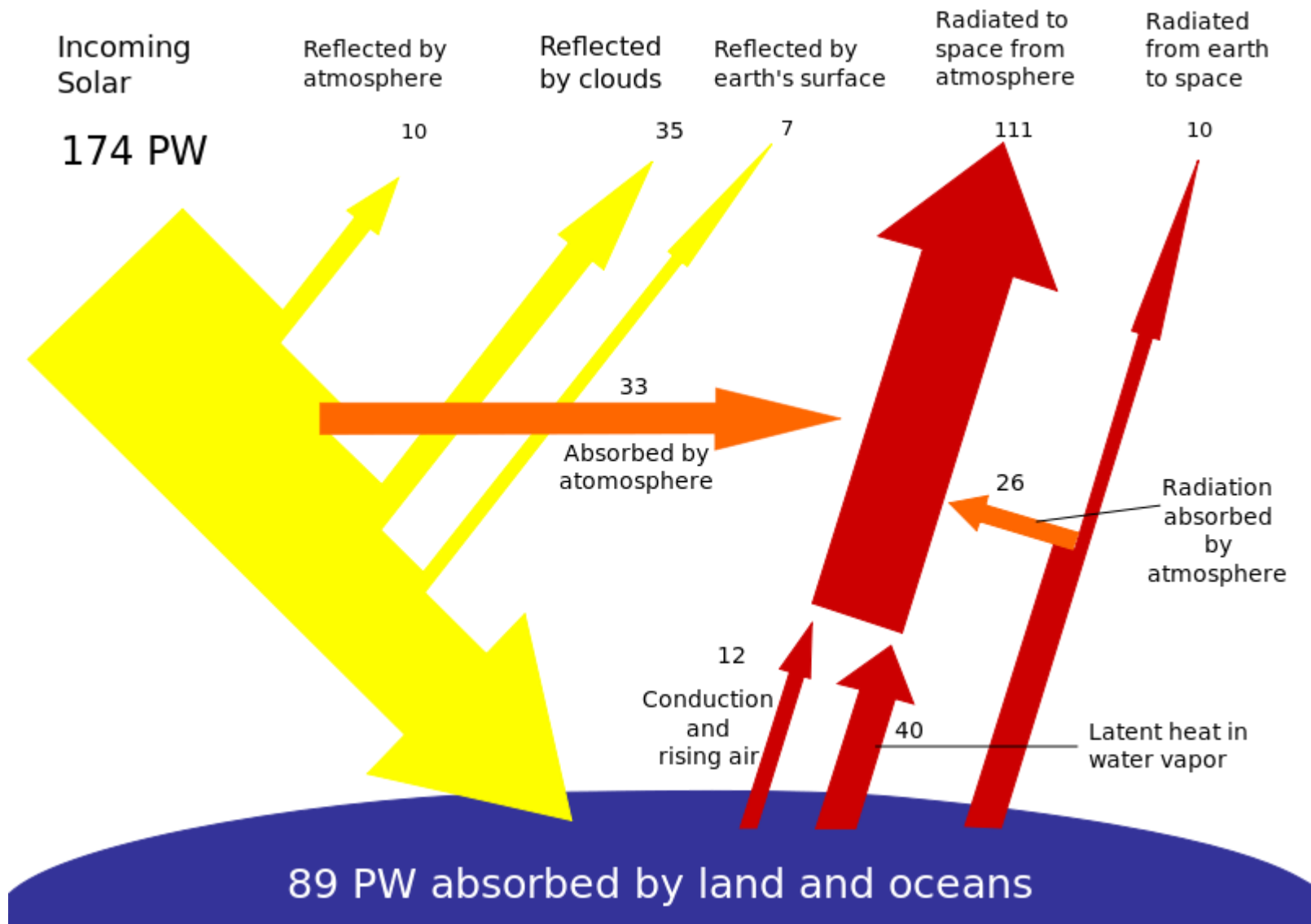
- \* Cowboy Oil Company Refinery – Electrician Apprentice
- \* A&B Electric & Cottonwood Electric – Journeyman Electrician
- \* Bemsco Defense Products – Electrical/Electronics Supervisor
- \* Graduated University of Utah – B.S. Electrical Engineering
- \* General Electric Apparatus Division – ICES manager
- \* Tektronix Inc. – Senior Sales Engineer (Instrumentation Mfr. Rep.)
- \* Cache Valley Electric – On site Elect. Engineer, American Stores Bldg.
- \* AT&T – Advanced Networks Specialists – Client Business Manager
- \* 2002 Salt Lake Olympic Committee – Loaned Executive
- \* SBC Telecom who bought at&t – Advanced Networks Marketing
- \* InterTec – Owner/Consultant – DOD small business contracts.

# Solar Energy

**radiant light and heat** from the sun, has been harnessed by humans since ancient times using a range of ever-evolving technologies

technologies include: **solar heating, solar photovoltaics, solar thermal electricity, solar architecture and artificial photosynthesis,**





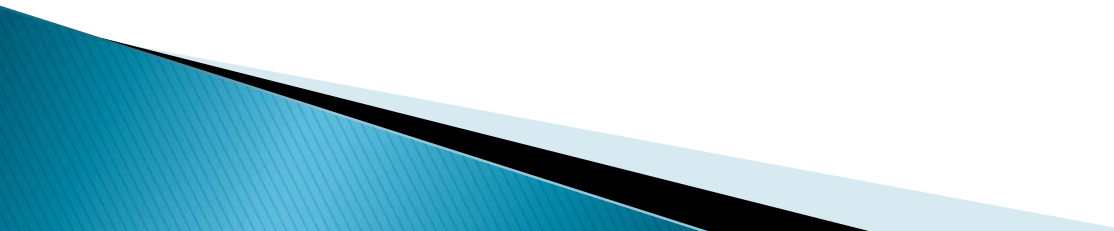
About ½ the incoming solar energy reaches the Earth's surface

# But What Is Silicon Anyway?

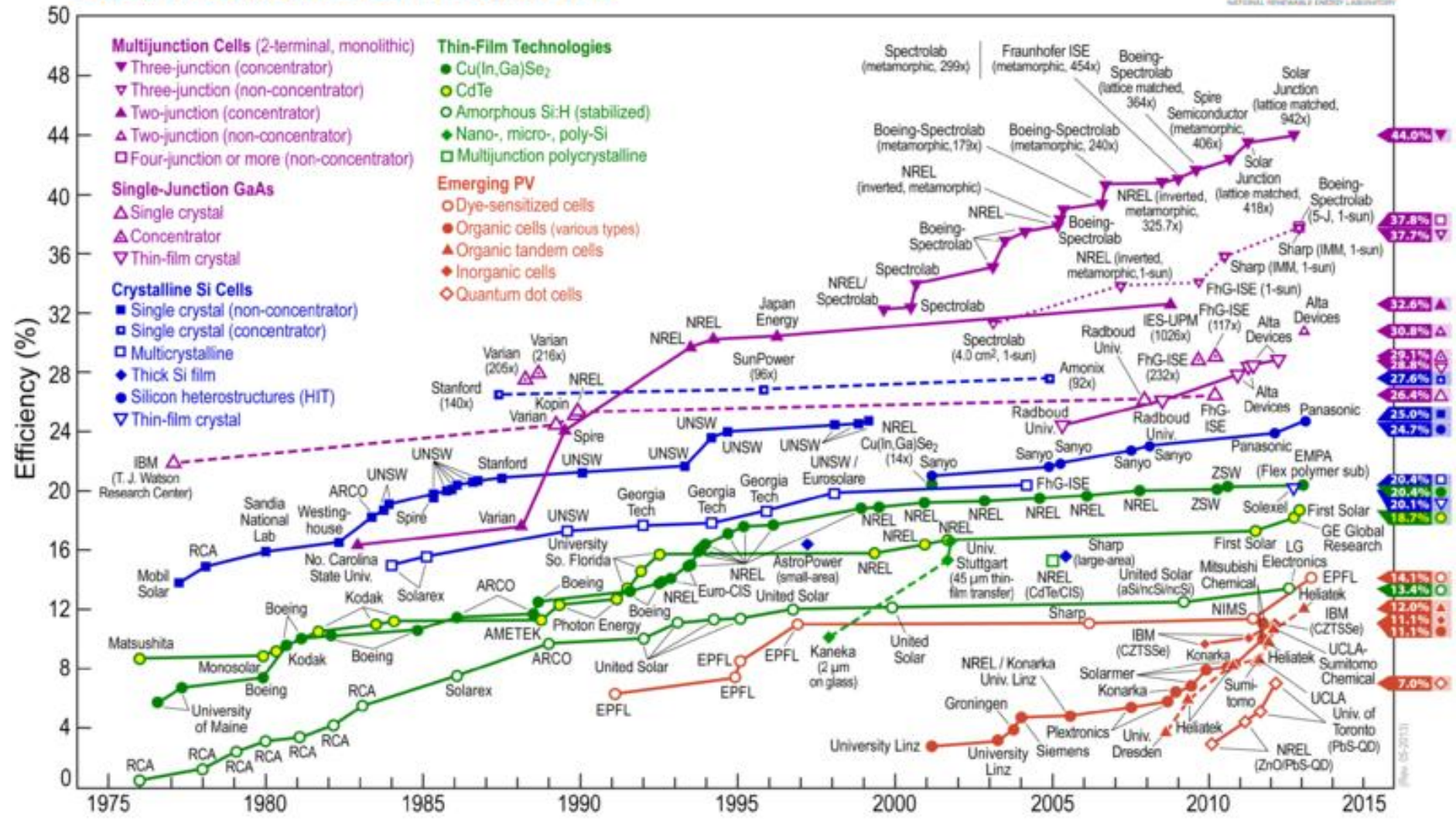
It's useful to know that silicon is a metalloid – a chemistry term to describe something that is a chemical element but which has metallic properties or in other words an element that is hard to characterise and can be both non-metal and metal.

It is the second most abundant element after oxygen in the Earth's crust and makes up 27.7% of it by mass. Silicon is the principal component of most devices requiring semiconductors, such as microchips and integrated circuits found in many modern-day appliances.

In solar panels, silicon is the key component because of its ability to function as a semiconductor at high temperatures.



# Best Research-Cell Efficiencies



From US-2013



# Monocrystalline Solar Panels

These are basically wafers cut from one single continuous cylindrical silicon crystal. Because the process involved in turning these circular wafers into solar modules/panels is more complicated the cost of each panel is therefore higher for the home owner investor. But the efficiency of the panel is higher than the other two types with some top-of-the-range models having a capacity of around **19%**



# Polycrystalline Solar Panels

A slightly different crystallisation process is used here with many wafers being cut from “ingots” of molten silicon which are then arranged in a kind of scattered mosaic within the module. Because the process is less demanding than Monocrystalline, these Polycrystalline panels are cheaper. However, their efficiency is a lot less with most models reaching between **13%-15%**.



# Amorphous Solar Panels

Thinner than the silicon wafers used in the crystallised solar panels, the amorphous “film” of silicon is layered in each module which makes them far more flexible than the other types. The efficiency is the poorest of the three, though, with ratings of between **6%–10%**. But going amorphous can be an advantage for people who have cost in mind and maybe don't want to go all-out solar.

As with many things in life the old adage applies here – you get what you pay for.

For the would-be investor in solar panels the question to ask yourself is; how much free electricity do you want to harness? But how much are you willing to spend to obtain it?



# EMERGENCY POWER OPTIONS

- ▶ Choosing between an
- ▶ Inverter and a Generator ?



## Engine powered Generator – Easy way to supply your house with Emergency Power

- Relative inexpensive (typical 5kw for aprox. \$600 – \$1,200)
- Produces clean 120 – 240 volt sine-wave power
- Consumes about 1 gallon of (gas/ diesel/propane) every 2 hours @ 1,000 watt output
- Use of power extension cords, easy of set-up

### Disadvantages :

- Fuel Storage problem (stabilizing required)
- Engine Maintenance (oil & fuel lines)
- Exhaust ventilation issues
- Noise pollution



## Power Inverter – Electrical device that converts 12 volt DC to 120 volt AC

- Typically powered by a Car battery (or) deep cycle (AGM) battery
- An easy and inexpensive AC power solution under 200 watts (modified sine wave)
- Larger inverters up to 2,500 watts (2.5kw) cost about \$600 – \$1,000
- Can be used in a Solar Generator system w/ battery storage capability

### Advantages :

- They are silent (except for cooling fans)
- They are maintenance free
- They can deliver a pure sine wave output (added cost)

1000W + 2 Clips  
+ Cigarette lighter cable



## Emergency Power Options & Goals

- To generate normal 120 volt AC power
  - Buy a engine powered generator (Gas/Diesel/propane/natural gas)
  - Buy a Power Inverter (pure sine wave) powered by Deep cycle battery /Solar panel system
- Decide what your goals are during a power failure
  - Provide the very minimal set of power comforts ( 100 watts))
  - Power a few lights (LED's), Cell Phone, Radio and operate a fan etc. ( 500 watts)
  - Operate a microwave oven, TV, lights, and my computer ( 1000 watts)
  - Keep my refrigerator and freezer running with some lights and small appliances (3.5kw)
  - Power my Well pump, Air Conditioner, Water Heater and furnace blower (5kw)



<u>Device</u>	<u>Typical wattage</u>	<u>Surge Wattage</u>
Light bulb	60 watts	60 watts surge
Fan	75 watts	150 watts surge
Small black/white television	100 watts	150 watts surge
Color television	300 watts	400 watts surge
Home computer and monitor	400 watts	600 watts surge
Electric blanket	400 watts	400 watts surge
Microwave oven	750 watts	1,000 watts surge
Furnace fan	750 watts	1,500 watts surge
Refrigerator	1,200 watts	2,400 watts surge
Well pump	2,400 watts	3,600 watts surge
Electric water heater	4,500 watts	4,500 watts surge
Whole-house A/C or heat pump	15,000 watts	30,000 watts surge

Generac offers homeowners a range of backup-power solutions including generators and transfer switches capable of protecting every circuit in any size home, for complete whole-house protection.



One of the most powerful air-cooled generators on the market today, this unit provides whole house power protection for many homes. In addition to essential circuit coverage, the 20 kW unit can back up multiple air conditioners and remaining rooms in your home like home theaters and offices.



# Goal Zero Switch 8 Recharger



Guide 10 Plus Battery Pack



Escape 150 Power Pack

# Sherpa 50 portable



Extreme 350 Power Pack



Goal Zero Yeti 1250 Solar





Strain Ranches

# 902kW Microinverter System Powers Agriculture Business

Get the inside story. ➔

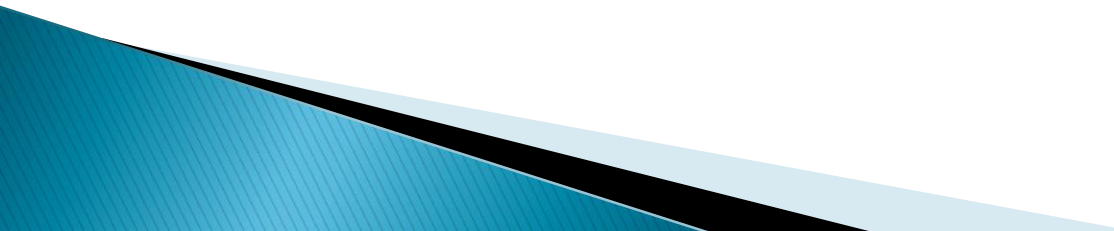




## Grid-Tie with Battery Back-Up (Grid-Interactive)

Just like a basic Grid-Tie system, a Grid-Interactive system generates electricity when the sun is shining, and supplies power to your house while selling any excess power back to the utility to reduce your electric bill. Like the basic Grid-Tie system, the system does not “sell” to the grid if there is a power outage.

However, the PV energy system continues to operate during a grid outage. The batteries provide quiet, uninterrupted back-up power for sub-panel loads such as refrigerators, lights, pumps, and computers, while your PV array continues to produce power and charge the batteries during the day. When the grid is restored, the inverter/chargers help recharge the batteries to their full state of charge while the grid powers all AC loads. Once the batteries are recharged, the system returns to normal operation.





## Basic Grid-Tie System

A basic Grid-Tie system generates electricity when the sun shines, supplying power to your home and sending any excess power back to the utility. DC power produced from your solar array is converted by the Grid-Tie inverter into AC power, which is then sent to your main electrical panel to be used by your household appliances. Any excess power generated is sold back to the utility through “net metering” to reduce your electric bill.

An advantage of this system is it is relatively inexpensive to install. A key disadvantage is the system does not operate when the grid fails. These systems do not provide power to your home during a power outage.

## Using OutBack Grid-Interactive Products in Conjunction with Honda EU Generators for Extended Run Times

In applications that require more than one to two days of run time without utility or solar power, OutBack recommends using Honda EU generators in conjunction with our Grid-Interactive products to charge batteries. The solar energy system reduces generator run-time and fuel use, and the recharged batteries will provide quiet power at night.

### How long does it take to install a Grid-Interactive system?

With the new fully integrated SmartRE Grid-Interactive system, typical installation time is 3-4 hours. The unpredictable part of most installations is moving the backed-up circuits from the Main Panel to the Secure Load Sub-Panel which can cause installation times to be longer.

### How do Grid-Interactive systems and Basic Grid-Tie systems compare in cost?

A basic Grid-Tie Solar Energy system typically costs \$8-\$10 per watt. A Grid-Interactive system typically costs \$9-\$12 per watt (or more) depending on the size of the battery bank required. A secure variable in the cost of the system is the size of the battery bank.

### Example #1

“OutBack” Average 5kw: Net metering system Aprox. **(\$40k – 50k)**

:Net metering w/Battery back -up Aprox. **(\$45k – 60k+)**

### **How long will the batteries last? How much maintenance is required?**

Sealed lead acid and AGM batteries, which are typically used in Grid-Interactive applications, last an average of 10 years in a Grid-Interactive application. There is little to no maintenance involved, which is why this type of battery is popular.

### **How much run time on batteries can I expect?**

Typical battery banks for Grid-Interactive systems range in size from 4kWh to 20kWh, ranging from several hours to a few days.

### **Can I power my entire home?**

Usually this isn't feasible unless a home uses very little power. Large power consumption devices such as heaters and air conditioners are not recommended to be powered by the systems discussed. Spot coolers and some newer, energy efficient room air conditioners can be supported. We recommend only backing-up important loads, such as lights, TV, refrigerator, and well pumps, to maximize run time.

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## Example #2

Net Metering ONLY – **No Battery back-up power**

Installed July 2012

Creative Energy – Wyoming, (Installed in Cottonwood Heights)

(That's \$4.6 per watt)

12ea 3'x5' Solar installation – **3kw @ \$14k**

Obtained 6 quotes all within \$ 200 (“Utah Solar” same \$’s)

10/20 year warranty

N-Phase “on-line” inverter monitoring

Rocky Mountain Credit \$ 4,650 – Disc. charge credit per kw

Federal credit 30%

State credit 10%



## Example #2

Quoted this last month: **10kw Net Metering (Only) system \$ 30k**  
**(That's \$9 per watt )**

Using 40 each – REC 250 Solar panels w/micro inverters

N-Phase “on-line” inverter monitoring

Rocky Mountain power application approved last November '12

30 % Federal credit

10% State credit

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Average Solar power system in Utah **4kw @ \$6.25 per watt (\$25k)**

6kw @ \$37,500    3kw @ 18,750

Rocky Mountain power credit allows only 120% of historical power usage