# 6th Grade Science Project

# Kush Gulati

# Wind power

# Vs.

# Hydro power

# Vs.

# Solar power

# Overall Topic Problem :

**Which form of renewable energy is the most efficient at converting energy from one form to the other (electrical energy)?**

- **Wind Power**
- **Hydro Electric Power**
- **Solar Power**

# Topic Problem

**IF the wind speed increases,**

**THEN will that cause power output of the wind turbine to increase?**

**IF the amount of water and/or height of the water dropped increases,**

**THEN will that cause power output of the hydro power turbine increase?**

**IF the amount of sunlight increases,**

**THEN will that cause power output of the solar cell to increase?**

# Hypothesis

I predict that if **wind speed** increases then **power output of the wind turbine** will increase because **more energy input should produce more energy output.**

I predict that if **height of the water dropped and/or the weight of water** increases then **power output of the hydro power turbine** will increase because **more energy input should produce more energy output.**

I predict that if **amount of sunlight** increases then **power output of the solar cell** will increase because **more energy input should produce more energy output**

# Hypothesis

I think that the solar power cell will generate the most watts because it is a widely used renewable way to generate electricity.

# Independent Variable

Solar cell: The independent variable is the amount of sunlight.

Hydro power turbine: The independent variable is height and weight of the water dropped.

Wind Power: The independent variable is wind speed.

# Dependent Variable

The dependent variable is Energy output of wind turbine/Hydroelectric turbine/solar cell (mW) = Voltage(V) X Current(mA)

The unit of measurement is milliWatts

The device that measures this is a Multimeter.

# Constants

The constants are:

Wind power

- Area of the blades of the wind Turbine.
- Gear Ratio of the wind Turbine.
- Angle of the blades to the wind direction.

Hydro Power

- Area of the blade of hydro power turbine
- Angle of the water falling on the turbine.

Solar Power

- Angle of the sun to the Solar cell.
- Area of the solar cell (Length X Width)
- Cloudiness/Visibility

# Materials

## The materials required are as follows for Wind Power:

| Wind Power | Hydro Power experiment | Solar Power experiment |
|---|---|---|
| Equipment:<br>- Wind Power Kit<br>- | Equipment:<br>- Hydropower Kit<br>- Funnel<br>- Pipe<br>- Aluminium tray to drain water. | Equipment:<br>- Solar cell<br>- |
| Consumable supplies:<br>- None. | Consumable supplies:<br>-None. | Consumable supplies:<br>- None. |
| Measurement devices:<br>- Multimeter<br>- Anemometer | Measurement devices:<br>- Multimeter<br>- Measuring tape<br>- Weighing scale<br>- Measuring jar | Measurement devices:<br>- Multimeter |
| Safety Equipment: | Safety Equipment: | Safety Equipment:<br>Sunglasses |

# Procedures and Photos

## Wind Power:

1. I first built my wind power kit
2. I went outside to the a place with wind
3. Checked and noted the wind speed on my anemometer and on the weather channel on 6 separate days
4. Each time to measure the power generated by the wind turbine, I plugged in the wires into the appropriate spot.
5. I put tape on it to hold it together.
6. I recorded the current and the voltage
7. I multiplied them both to get the power generated. It was in mW.
8. I recorded my data

# Procedures and Photos

## Solar Power

1. I went outside with my solar cell
2. I noted what angle the sun was at that time.
3. I plugged in the wires into the terminal of the solar cell.
4. I put tape on it to hold it together.
5. I got the voltage and the current
6. I multiplied them to get the power generated. It was in mW
7. I recorded my data

# Procedures and Photos

## Hydro Power

1. I built my Hydro Power kit
2. I put my built Hydro Power kit onto a aluminum foil pan
3. I connected the wires from the terminal where LED was plugged into the Hydro Power kit to the multimeter.
4. I put tape on it to hold it together.
5. Poured the different amounts of water at different heights onto the kit
6. Measured the voltage and current produced on the multimeter
7. Current was in milliAmpere. Voltage was in Volts. So I multiplied the voltage and current to get power in milliWatts
8. I recorded my data

# Procedures and Photos

https://www.youtube.com/watch?v=5bLuhihNago

# Wind Power Data

## Independent vs Dependent variable

| Independent(Wind Speed in mph) | Dependent Variable (units) | | |
|---|---|---|---|
| | Voltage (V) | Current (mA) | Electric Power(mW) |
| 10 | 0.7 | 30 | 21 |
| 21 | 1.7 | 115 | 195.5 |
| 17 | 1.2 | 79 | 94.8 |
| 15 | 1.1 | 56 | 61.6 |
| 18 | 1.4 | 89 | 124.6 |
| 12 | 0.9 | 43 | 38.7 |
| Average >> | 1.16 | 68.6 | 89.36 |

# Hydro Power Data

## Independent vs Dependent variables

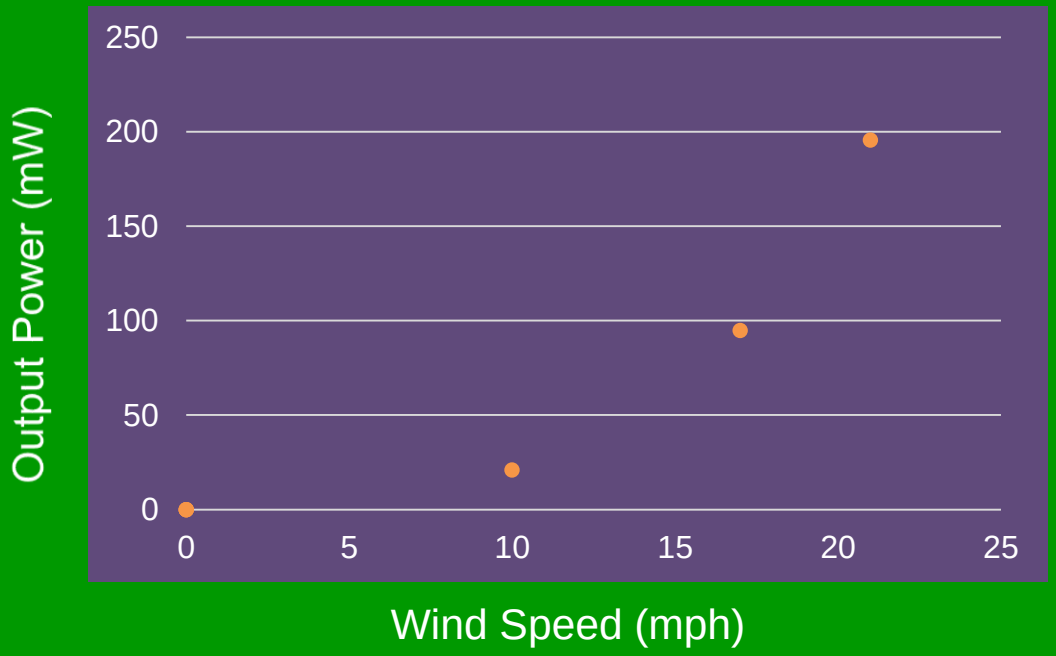
| Independent (Height of falling water) | Input Power (mW) | Dependent Variable (units) | | |
|---|---|---|---|---|
| | | Voltage (V) | Current (mA) | Electric Power(mW) |
| 36 cm X 1 kg X 9.8 $m/s^2$ | 352.8 | 1.83 | 53.2 | 97.36 |
| 72 cm X 1 kg X 9.8 $m/s^2$ | 705.6 | 2.6 | 72.3 | 187.98 |
| 36 cm X 2 kg X 9.8 $m/s^2$ | 705.6 | 2.4 | 88.9 | 213.36 |
| 72 cm X 2 kg X 9.8 $m/s^2$ | 1411.2 | 2.8 | 121.4 | 339.92 |
| Average>> | | 2.41 | 83.95 | 209.65 |

# Solar Power Data

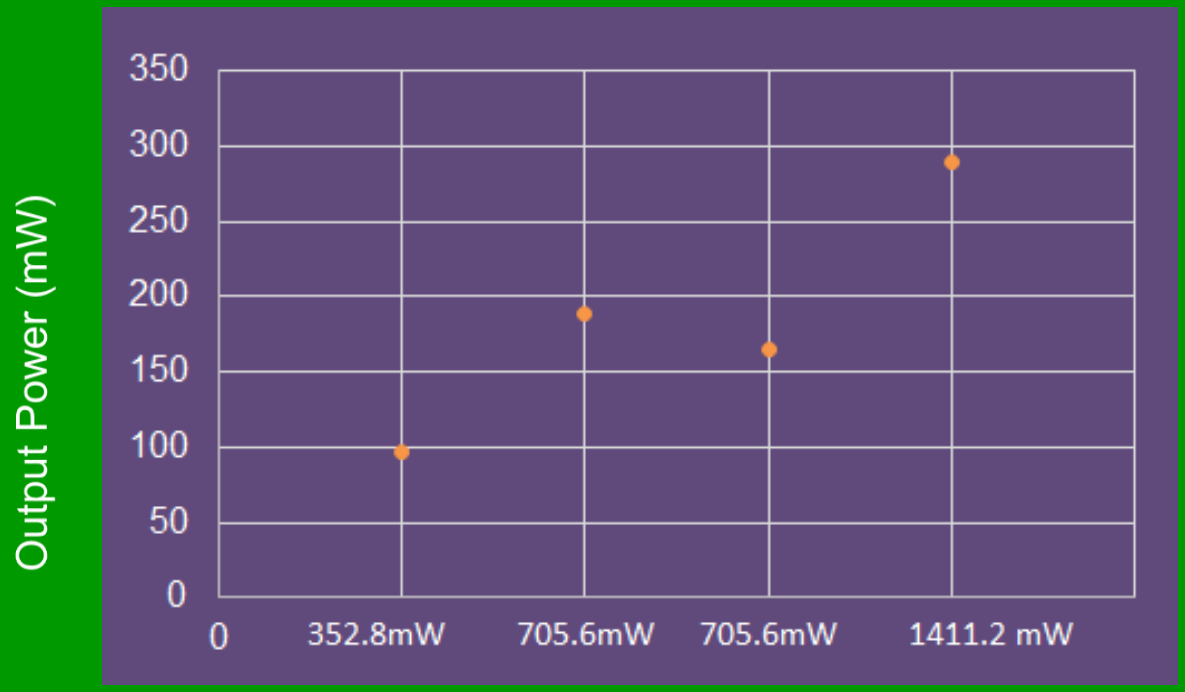
## Independent vs Dependent variables

| Independent(Time of the Day) (Angle of the Sun to the Solar Cell) | Dependent Variable (units) | | |
|---|---|---|---|
| | Voltage (V) | Current (mA) | Electric Power(mW) |
| 8 AM | 1.38 | 96 | 132.48 |
| 10 AM | 1.39 | 115 | 159.85 |
| 12 noon | 1.64 | 176 | 288.64 |
| 2 PM | 1.74 | 186 | 323.64 |
| 4 PM | 1.44 | 67 | 96.48 |
| 6 PM | 1.34 | 6.4 | 8.576 |
| Average>> | 1.4833 | 107.7333 | 168.277 |

# Graph : Wind Power

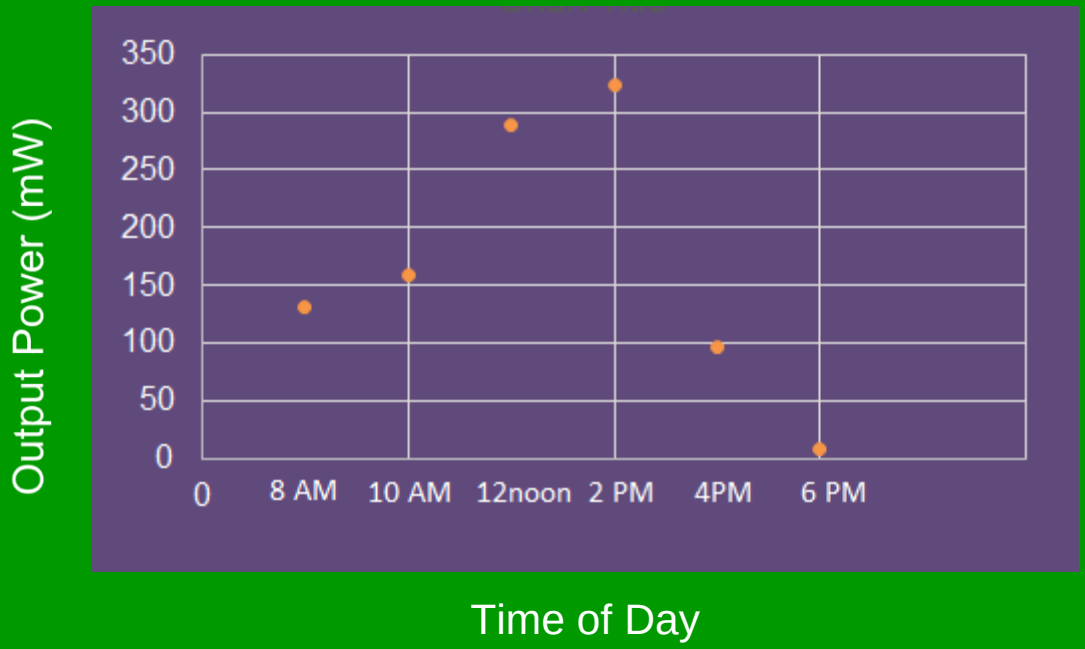


# Graph : Hydro Power




Input Power (mW) – From potential energy of water

# Graph : Solar Power



# Results

## Wind Power Turbine Efficiency Data

| v in mph | v in meters per sec | v x v x v | Power input = 0.5 * Air Density(in kg/m3) * Area of Blades (in m2) * v*v*v (in m/s) * 1000 in milliWatts | Power Output (Voltage X Current) in mW | Efficiency % |
|---|---|---|---|---|---|
| 10 | 4.47 | 89.34 | 2027.41 | 21 | 1.035807 |
| 21 | 9.39 | 827.36 | 18775.80 | 195.5 | 1.041234 |
| 17 | 7.60 | 438.92 | 9960.64 | 94.8 | 0.951746 |
| 15 | 6.71 | 301.52 | 6842.49 | 61.6 | 0.900257 |
| 18 | 8.05 | 521.02 | 11823.83 | 124.6 | 1.053804 |
| 12 | 5.36 | 154.38 | 3503.36 | 38.7 | 1.104655 |

0.5*0.41*0.06*3

Area of 3 Blades : 0.0369 sq meters

Average Efficiency : 1.014583595

## Hydro Power Turbine Efficiency Data

| Mass of water(in kg) | Height of Water (in meters) | g (in m/sec 2) | Power input = mgh/10 sec * 1000 in milliWatts | Power Output (Voltage X Current) in mW | Efficiency % |
|---|---|---|---|---|---|
| 1 | 0.36 | 9.8 | 352.8 | 97.36 | 27.59637 |
| 1 | 0.72 | 9.8 | 705.6 | 187.98 | 26.64116 |
| 2 | 0.36 | 9.8 | 705.6 | 213.36 | 30.2381 |
| 2 | 0.72 | 9.8 | 1411.2 | 339.92 | 24.0873 |

Average Efficiency : 27.14073129

## Solar Cell Efficiency Data

| Area of solar cell (in sq meters) | input to solar cell (in Watts / sq | Time of the Day | Power input = Area * Solar power input * 1000 in mW | from cell ( Voltage X Current) in MilliWatts | Efficiency % |
|---|---|---|---|---|---|
| 0.0048 | 1000 | 8:00 AM | 4800 | 132.48 | 2.76 |
| 0.0048 | 1000 | 10:00 AM | 4800 | 159.85 | 3.330208 |
| 0.0048 | 1000 | 12 noon | 4800 | 288.64 | 6.013333 |
| 0.0048 | 1000 | 2:00 PM | 4800 | 323.64 | 6.7425 |
| 0.0048 | 1000 | 4:00 PM | 4800 | 96.48 | 2.01 |
| 0.0048 | 1000 | 6:00 PM | 4800 | 8.576 | 0.178667 |

Average Efficiency : 3.505784722

# Conclusion

The most efficient renewable energy source is Hydro power. Hydro power was the oldest way of making renewable energy. My hypothesis was wrong and it was not the solar cell that was most efficient.

# Research Summary

- **Wind power Input : is calculated by finding out the kinetic energy of wind which is hitting the blades of the wind turbine per unit time.**

$$E_{Kinetic} = \frac{1}{2} mv^2$$

$$E_{Kinetic} = \frac{1}{2} \rho V v^2$$

$$\frac{E_{Kinetic}}{\Delta t} = \frac{1}{2} \rho A \frac{\Delta s}{\Delta t} v^2$$

$$\frac{E_{Kinetic}}{\Delta t} = \frac{1}{2} \rho A v^3$$

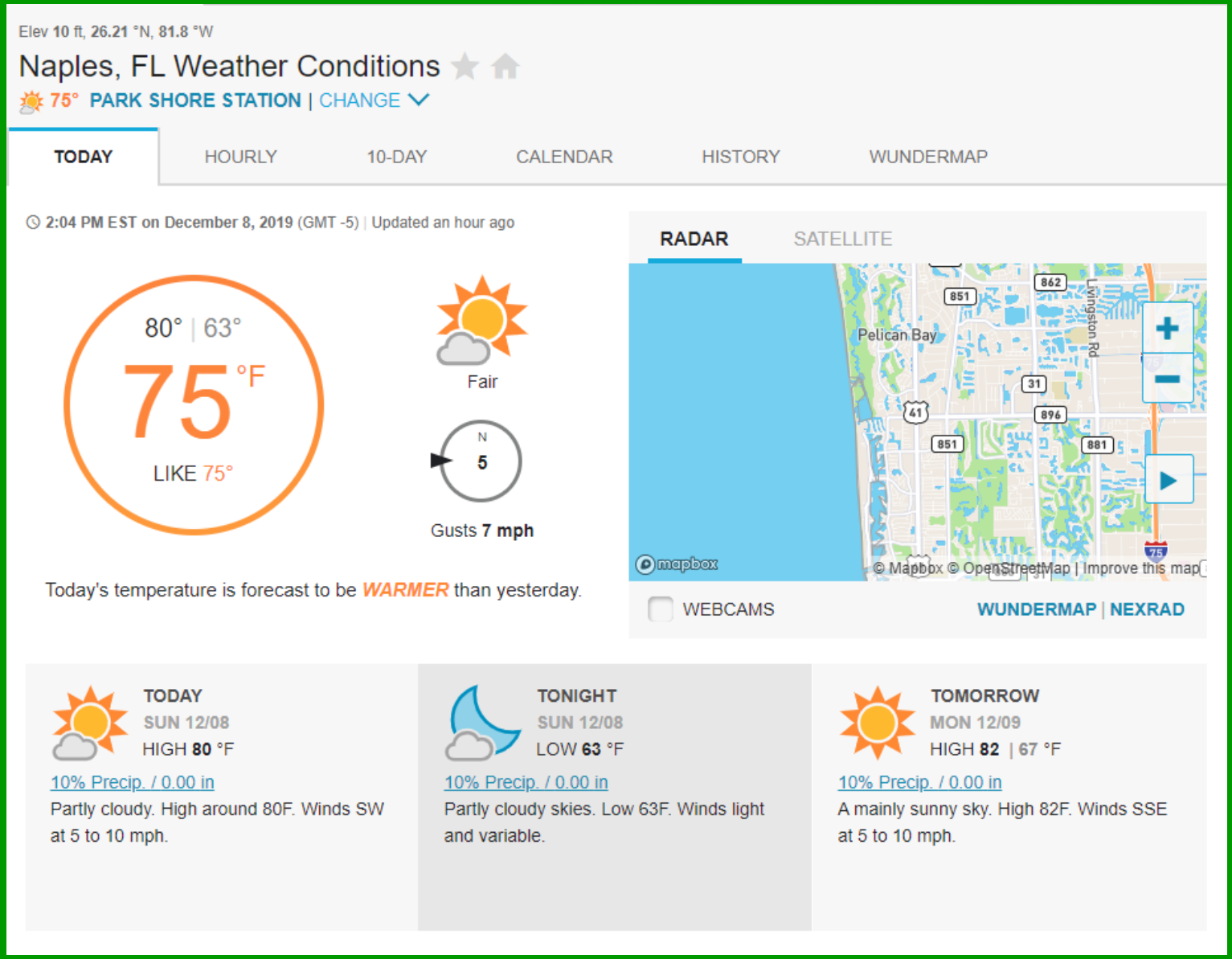
$$Power_{input} = \frac{1}{2} \rho A v^3$$

- **Wind power output : is measured using the Voltage and current being produced using the multimeter.**

$$Power_{output} = V(Voltage) X I(Current)$$

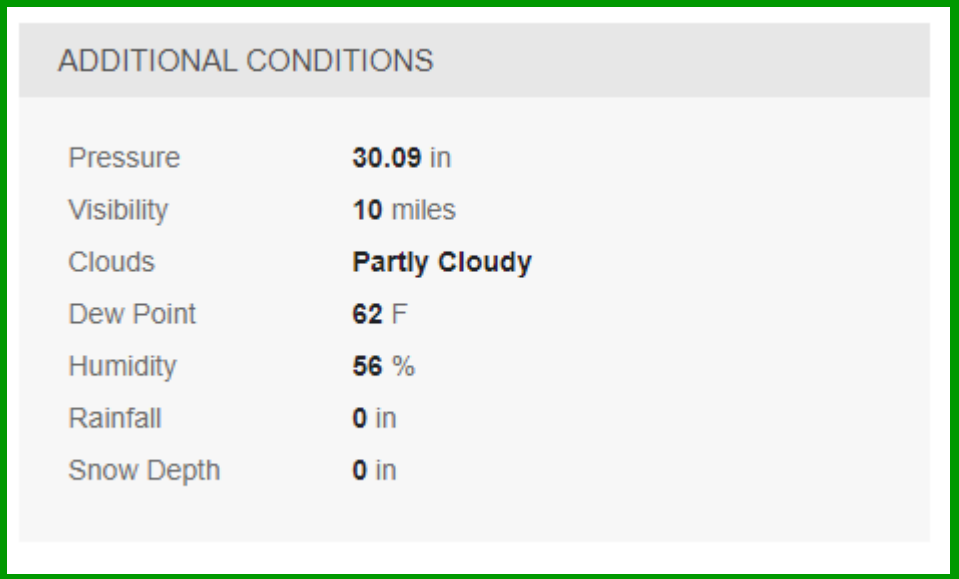
# Research Summary – Wind Power

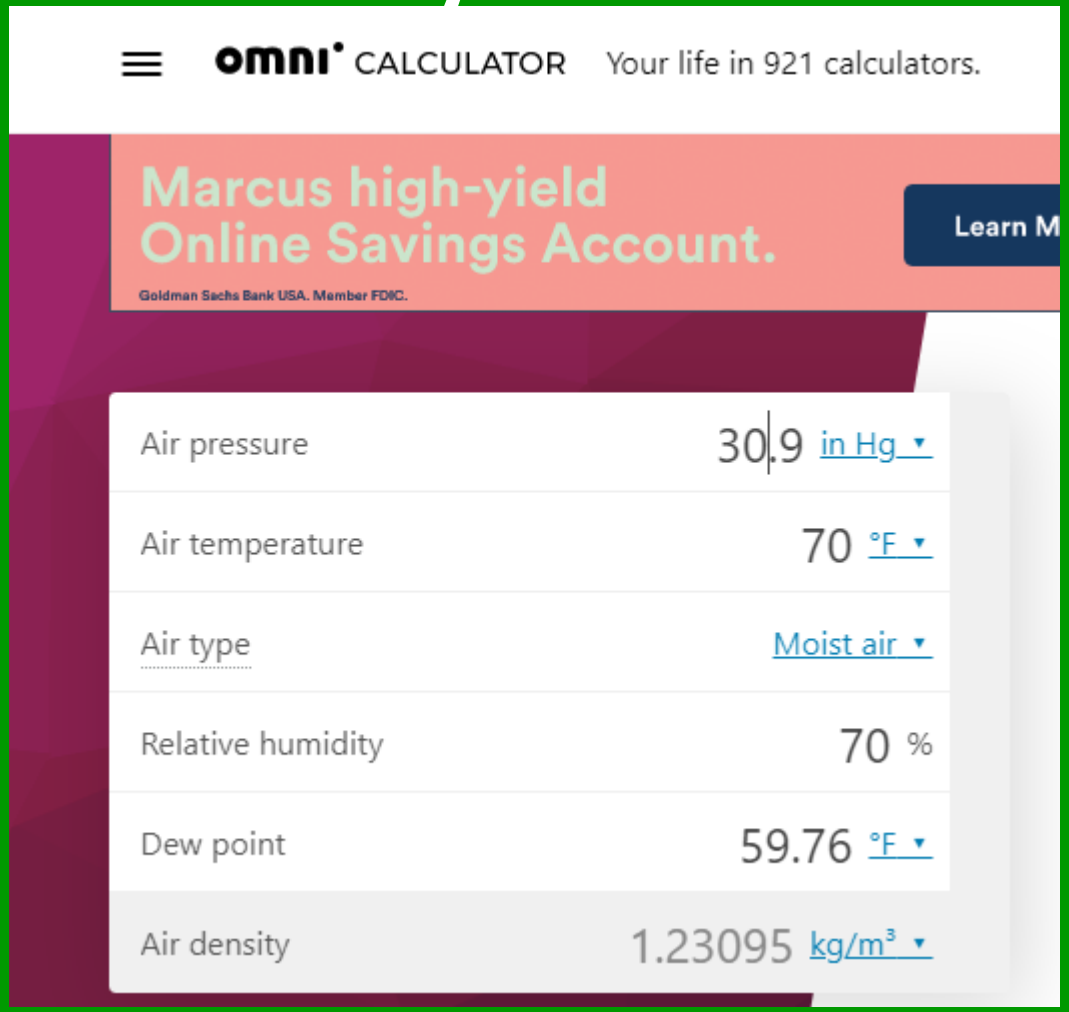
## Weather report for Wind Speed



# Research Summary – Wind Power

## Wind power – Using Omni calculator to calculate air density



# Research Summary – Wind Power

- **Wind power turbine efficiency =** $Power_{output} / Power_{input} \; X100$

# Research Summary

- **Hydro power Input : is calculated by finding out the potential energy of water which is hitting the blades of the Hydro electric turbine per unit time.**

- **Hydro power output : is measured using the Voltage and current being produced using the multi-meter.**

$$Power_{output} = V(Voltage) X I(Current)$$

- **Hydro power turbine efficiency =** $Power_{output} / Power_{input} \; X100$

# Research Summary

- **Solar power Input : is calculated by finding out the energy of sun which is hitting the solar cell per unit time. On a clear sunny day in Naples, FL this can be assumed to be 1 solar unit = 1000 Watts/$m^2$**
- **Solar power output : is measured using the Voltage and current being produced using the multimeter.**

$$Power_{output} = V(Voltage) X I(Current)$$

- **Solar cell power efficiency =** $Power_{output} / Power_{input} \; X100$

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