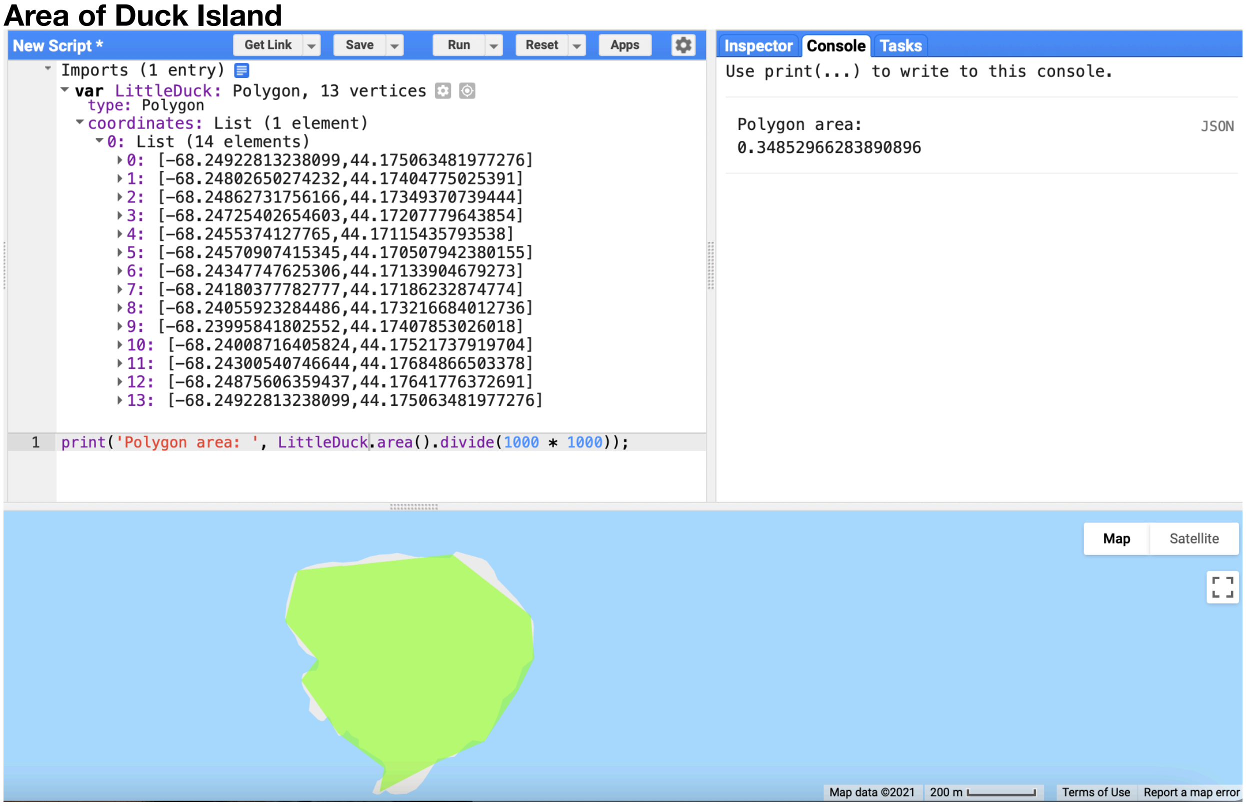
# THE DEMOCRATIC REPUBLIC OF LITTLE DUCK ISLAND

In [8]:
```
import math
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

### Area of Duck Island




***~ 349,000 m^2***

In [9]:
```
Avg_elec_load = 1 # W/ft**2
Heat_load = 6 # W/ft**2
Air_condition_load = 0
```

In [10]:
```
class Info():
    def Trees():
        rho = 1/50 # tree/m^2
        regen_coEfficient = 0
        Tree_BioMass = 1000 # kg
        E_perTree = 20 # kJ/g
        return rho, regen_coEfficient, Tree_BioMass, E_perTree

    def Solar():
        Irradiance = 4 # kWh/day/m**2
        return Irradiance

    def Crib():
        Area = 2000 # ft**2
        HeatPump_COP = 3.0
        FirePlace_Efficiency = 0.7 # kJ/wood
        return Area, HeatPump_COP, FirePlace_Efficiency
```

## Scenario 1:

> **1)** In scenario 1, what is your yearly electricity and total energy requirement in kWh, and your yearly CO_2 production related to tree burning in kg , if you use only the fireplace during the heating season to heat the house.(30 pts)

> **2)** In scenario 1, what is your yearly electricity and total energy requirement in kWh, and your yearly CO_2 production related to tree burning in kg , if you only run the heat pump during the heating season remarkably. (30 pts)

> **3)** For both of the above cases in scenario 1, how many years can you run this operation before you run out of trees? (20 pts)

In [11]:
```
                                                   ### 1 ###
```

***Energy/Electricity Output Requirements***

$$heating.kwh(area, 0 < days < 121) : 6 * area$$

$$heating.kwh(area, 122 < days < 365) : 0 * area$$

$$heating.kwh(2000, onDays) : 34848kWh$$

$$heating.w(2000, onDays) : 12000W$$

$$heating.kwh(2000, offDays) : 0kWh$$

$$heating.w(2000, offDays) : 0W$$

$$electricity.kwh(area) : 1 * area$$

$$electricity.kwh(2000) : 17520kWh$$

$$electricity.w(2000) : 2000W$$

In [12]:

```
# Considering Generator with 0.5 efficiency of Carnot Effiecency that

ReqElec_Output = 17520 # kWh

# heat-to-electric generator
Th = 1000 # K
Tc = 293 # K
# convert heat to work at 1000K
CarnotE = (Th - Tc) / Th
GenEfficiency = 0.5 * CarnotE

#Heat requirement to produce required electricity given by:
ReqElec_Input = ReqElec_Output/GenEfficiency
print("The required annual energy input for matching electricity requi
```

```
The required annual energy input for matching electricity required is
49561.53 kwh.
```

In [13]:
```
# Considering fireplace with 0.7 efficiency converting wood source to

ReqHeat_Output = 34848

Fireplace_efficiency = 0.7
ReqHeat_Input = ReqHeat_Output / Fireplace_efficiency
print("The required annual energy input for matching heating required
```

```
The required annual energy input for matching heating required during
dec-apr is 49782.86 kwh.
```

## Now for $CO_2$ !

### TREE ANALYSIS

> Assuming the total available biomass of trees on my island is convertible to energy:
>
> Model energy by :
> $$E_{perTree} = Mass_{Tree} * EnergyDensity$$
>
> $$E_{perTree} = 20,000,000kJ$$

In [14]:
```
# Calculating Energy available per tree
E_perTree = 20000000

P_watts_tree = E_perTree / 3600 # convert to kWh

print("Energy available on a per tree basis:\n -> {} kWh".format(rounc
```

```
Energy available on a per tree basis:
 -> 5555.56 kWh
```

In [15]:
```
# CALCULATING CO2 USING EFFICIENCY RATIO ON FUEL SOUCE INSTEAD OF MATC
```

In [16]:
```
# for fireplace
TreeE_AvailableFireplace = P_watts_tree * Fireplace_efficiency
print("Heat energy produced by fireplace per tree:\n -> {} kWh".format

# given required heat output as ReqHeat_Output (34,848)...
No_Trees = ReqHeat_Output / TreeE_AvailableFireplace
print("\n \nI must chop {} trees down in order to meet my heating dema
```

```
Heat energy produced by fireplace per tree:
 -> 3888.89 kWh


I must chop 9 trees down in order to meet my heating demand.
```

In [17]:
```
# for generator
TreeE_GeneratorConversion = P_watts_tree * GenEfficiency
print("Electric energy produced by generator per tree:\n -> {} kWh".fo

# given required electric output as ReqElec_Output (17520)...
No_Trees = ReqElec_Output / TreeE_GeneratorConversion
print("\n \nI must chop {} trees down in order to meet my electricity
```

```
Electric energy produced by generator per tree:
 -> 1963.89 kWh


I must chop 9 trees down in order to meet my electricity demand.
```

> *So in order to satisfy my minimum heating/electricity requirements I must chop down **18 trees per year.***

In [18]:
```
# CO2 from Trees
Total_mass = 18 * Info.Trees()[2] * 1000
C_mm = 12.011
C_moles = Total_mass / C_mm

CO2_moles = C_moles
CO2_mm = 44.009
CO2_mass = (CO2_moles * CO2_mm) / 1000

print("{} kg of CO2 produced during a one year cyle.".format(round(CO2
```

```
65953.04 kg of CO2 produced during a one year cyle.
```

## 1| Solution

***Yearly Input Electricity Requirement:*** ***: 49561.53 KWH***

~~***Yearly Convertible Heating Requirement***~~ ***: 49782.86 KWH***

***TOTAL INPUT ENERGY REQUIREMENT*** ***: 99,344.39 KWH***

***Total CO2 Produced*** ***: 65,953.04 kg***

In [19]:
```
                                                        ### 2 ###
```

In [20]:
```
# NOW INSTEAD OF FIREPLACE HEATING, I ADOPT HEAT PUMP HEATING
# heat pump takes *Electricity* and produces *Heat*

COP = 3.0
PumpElec_Input = ReqHeat_Output / COP
print("The pump requires {} kWh of electricity to produce {} kWh of He
```

```
The pump requires 11616 kWh of electricity to produce 34848 kWh of He
at.
```

In [21]:
```
# Above covers heating requirements but not electric requirements, so
# requirements for total electricity:

TotalElec_InputReq = PumpElec_Input + ReqElec_Output
GenHeat_Input = TotalElec_InputReq / GenEfficiency
print("The generator requires {} kWh of heat to produce {} kWh of elec
```

```
The generator requires 82421.5 kWh of heat to produce 29136.0 kWh of
electricity.
```

Just a bit of overview:

> Yearly Elec. Consumption = 11616 + 17520
> Yearly Energy. Consumption = 82421.5

**Now for CO2 Analysis based on Energy Consumption**

In [22]:
```
# Generator supplies total electricity for both heating and consumptic
# Input heat is sourced from the burning of trees:

Nos_Trees = GenHeat_Input / P_watts_tree

print("I must chop {} trees down in order to meet my total energy dema
```

```
I must chop 15 trees down in order to meet my total energy demand.
```

In [23]:
```
# CO2 from Trees
Total_mass = 15 * Info.Trees()[2] * 1000
C_mm = 12.011
C_moles = Total_mass / C_mm

CO2_moles = C_moles
CO2_mm = 44.009
CO2_mass = (CO2_moles * CO2_mm) / 1000

print("{} kg of CO2 produced during a one year cyle.".format(round(CO2
```

```
54960.87 kg of CO2 produced during a one year cyle.
```

## 2| Solution

***Yearly Consumable Electricity Requirement:*** *: 29,136 KWH*

***TOTAL ENERGY REQUIREMENT*** *: 82,421.50 KWH*

***Total CO2 Produced*** *: 54,960.87 kg*

In [24]:
```
                                                  ### 3 ###
```

In [25]:
```
# CASE 1| To calculate longevity of my time on LDI
Trees_req = 18
Area_LDI = 349000 #m**2
TreeDensity = Info.Trees()[0]
House_Size = 185.81 #m**2
ForestedArea = Area_LDI - House_Size

No_ofTreesLDI = ForestedArea * TreeDensity
print("There are {} trees on Little Duck Island (LDI)".format(round(No

# If I need 18 trees x year in Case 1, then ->

Years_RunOutFire = No_ofTreesLDI / 18
print("\nI will run out of trees in {} years using the fireplace and g
```

```
There are 6976 trees on Little Duck Island (LDI)

I will run out of trees in 388 years using the fireplace and generato
r.
```

In [26]:
```
# CASE 2|
# If I need 15 trees x year to match total generation capabilities req

Years_RunOutPump = No_ofTreesLDI / 15
print("I will run out of trees in {} years using the generator and pum
```

```
I will run out of trees in 465 years using the generator and pump.
```

## 3| Solution

***Case 1 Years Before Resource Exhaustion:*** *: 388 years*

***Case 2 Years Before Resource Exhaustion:*** *: 465 years*

In [27]:
```
                                               ### 4 ###
```

## Scenario 2

> **4)** how much land do you need for solar PV in m^2, assuming you do not burn down any trees for heat? (20 pts)

1. 100% energy generation from Solar PV
2. Assume original 2,000 W electricity demand and 12,000 W heating demand.

In [28]:
```
# Energy vals that I need to match:
Elec_Reqs = 2000 # W
Heat_Reqs = 12000 # W
Tot_UnconvertedReqs = Elec_Reqs + Heat_Reqs

# Looking at Solar energy conversions now:
Irradiance = Info.Solar() # kWh/day/m^2
PanelEfficiency = 0.18


# Assuming 24 hour solar day
Avg_Insolation = (Irradiance * 1000) / 24 # 24-hour solar day
Collected_PowerDensity = Avg_Insolation * PanelEfficiency
print("The maximum harvestable energy from solar panel is {} W/m^2".fo

#LDI - Little Duck Island
LDI_SolarPowerArea = Tot_UnconvertedReqs / Collected_PowerDensity
print("\nNeeded area for matching energy requirements with solar panel
```

```
The maximum harvestable energy from solar panel is 30 W/m^2

Needed area for matching energy requirements with solar panels is 467
m^2
```

## 4| Solution

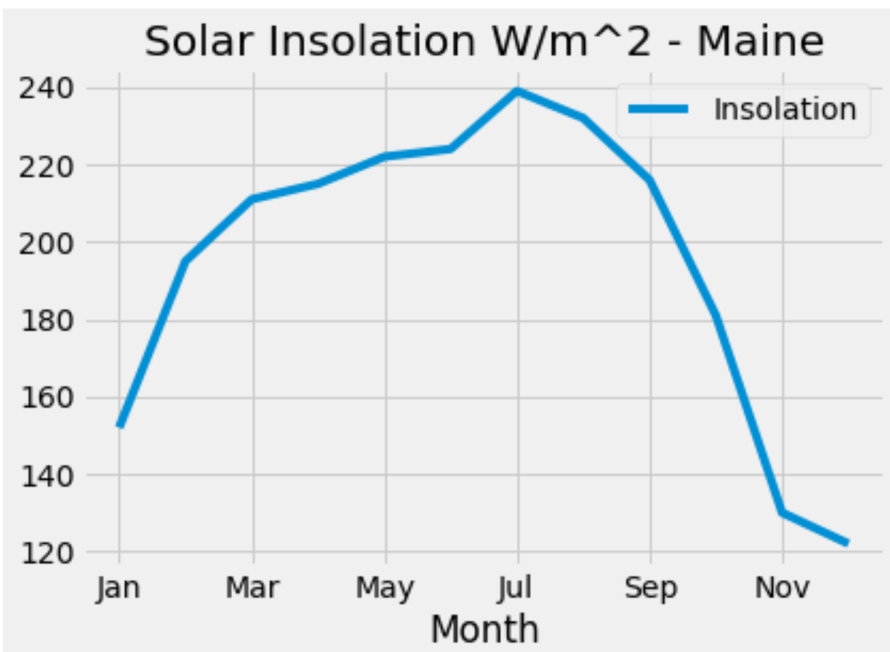
***Land Required:*** *: 467 m$^2$*

In [29]:
```
                                                   ### 5 ###
```

> **5)** Estimate the amount of battery storage you need to install to smooth out the day night cycles year round. (10 pts)

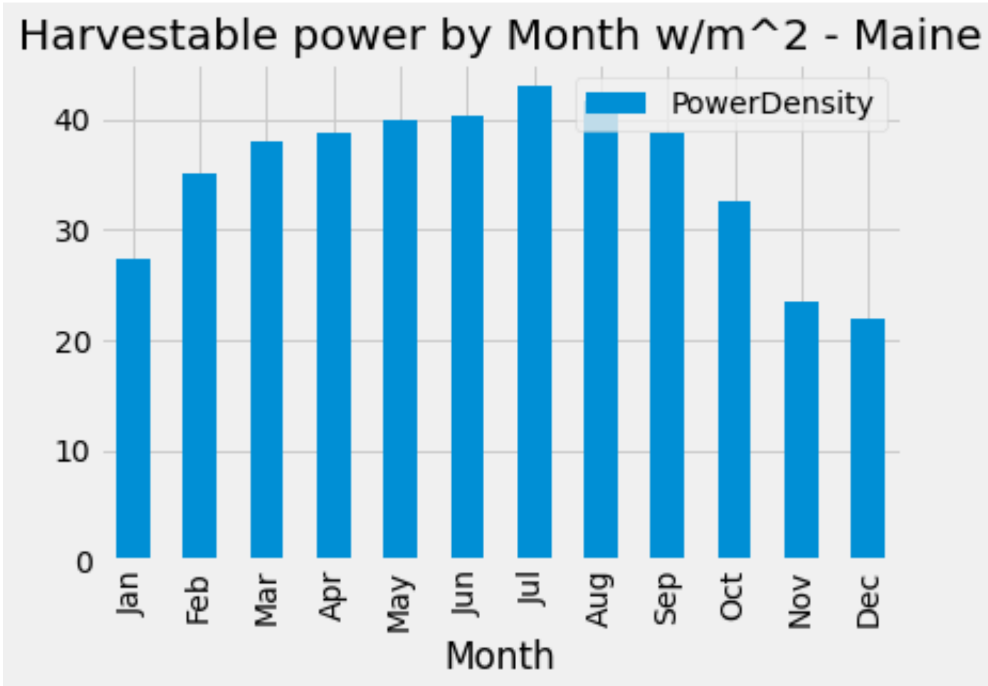
1. Batteries are 100% efficient

In [37]:
```
# Maine Monthly Irradiance (12-hour x day cycle)

Mon_SolarRadiation = pd.DataFrame([['Jan', 3.64, ], ['Feb', 4.68], ['M
#Insolation in kWh/day/m2
Insolation_Conversion = Mon_SolarRadiation['Insolation']
Converted_Insolation = [round(x * 1000 / 24) for x in Insolation_Conve
#Now Insolation in W/m2

Mon_SolarRadiation['Insolation'] = Converted_Insolation

Mon_SolarRadiation.plot(x='Month', y='Insolation')
plt.title('Solar Insolation W/m^2 - Maine')
plt.style.use('fivethirtyeight')
plt.show()
```

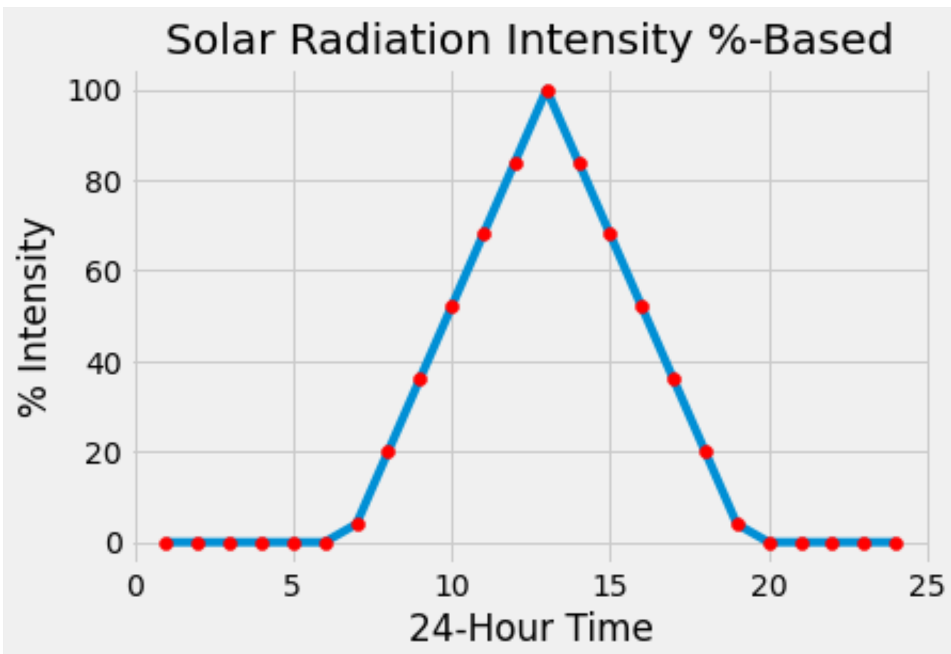



In [38]:
```
# Energy production cycles broken down by month:

# JAN
Jan = Mon_SolarRadiation.iloc[0]

Jan_Pd = Jan['Insolation'] * PanelEfficiency
# FEB
```

```
Feb = Mon_SolarRadiation.iloc[1]

Feb_Pd = Feb['Insolation'] * PanelEfficiency
# MAR
Mar = Mon_SolarRadiation.iloc[2]

Mar_Pd = Mar['Insolation'] * PanelEfficiency
# APR
Apr = Mon_SolarRadiation.iloc[3]

Apr_Pd = Apr['Insolation'] * PanelEfficiency
# MAY
May = Mon_SolarRadiation.iloc[4]

May_Pd = May['Insolation'] * PanelEfficiency
# JUN
Jun = Mon_SolarRadiation.iloc[5]

Jun_Pd = Jun['Insolation'] * PanelEfficiency
# JUL
Jul = Mon_SolarRadiation.iloc[6]

Jul_Pd = Jul['Insolation'] * PanelEfficiency
# AUG
Aug = Mon_SolarRadiation.iloc[7]

Aug_Pd = Aug['Insolation'] * PanelEfficiency
# SEP
Sep = Mon_SolarRadiation.iloc[8]

Sep_Pd = Sep['Insolation'] * PanelEfficiency
# OCT
Oct = Mon_SolarRadiation.iloc[9]

Oct_Pd = Oct['Insolation'] * PanelEfficiency
# NOV
Nov = Mon_SolarRadiation.iloc[10]

Nov_Pd = Nov['Insolation'] * PanelEfficiency
# DEC
Dec = Mon_SolarRadiation.iloc[11]

Dec_Pd = Dec['Insolation'] * PanelEfficiency

Pd_df = pd.DataFrame([['Jan', Jan_Pd], ['Feb', Feb_Pd], ['Mar', Mar_Pc
Pd_df.plot('Month', 'PowerDensity', kind='bar')
plt.title('Harvestable power by Month w/m^2 - Maine')
plt.style.use('fivethirtyeight')
plt.show()
```


Harvestable power by Month w/m^2 - Maine
PowerDensity
0
10
20
30
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

In [39]:
```
# Solar Intensity is directly correlated to the angle of solar radiati
def SolarIntenseCurve():
    global time, Percents
    time = [x for x in range(1,25)]
    Percents = [0,0,0,0,0,0,4,20,36,52,68,84,100,84,68,52,36,20,4,0,0,

    plt.plot(time, Percents, zorder=1)
    plt.scatter(time, Percents, zorder=2, color='r')

    plt.title('Solar Radiation Intensity %-Based')
    plt.xlabel('24-Hour Time')
    plt.ylabel('% Intensity')
    plt.style.use('fivethirtyeight')
    plt.show()
    plt.style.use('fivethirtyeight')
SolarIntenseCurve()
```




**So out of the 24-hour day cycle, 12 hours deliver 0 electricity.**

**requirements:**

1. Elec : 1 W/ft^2 (Jan-Dec)
2. Heating : 6 W/ft^2 (Dec-Apr)
3. House size: 2000 ft^2

> ElecDemand: 1 W/ft2 * 2000 ft2 = 2000 W
> HeatingDemand: 6 W/ft2 * 2000 ft2 = 12000 W

Heating Energy Demand: 34848000 Wh (heating szn)
Electricity Energy Demand: 17520000 Wh (year round)

Heating Energy Demand: 288000 Wh (x day during heating szn)
Electricity Energy Demand: 48000 Wh (x day year round)

**USING SOLAR LAND REQUIREMENT FROM Q4)** *But w/ a 12-hour window*

In [ ]:

```
```

In [33]:

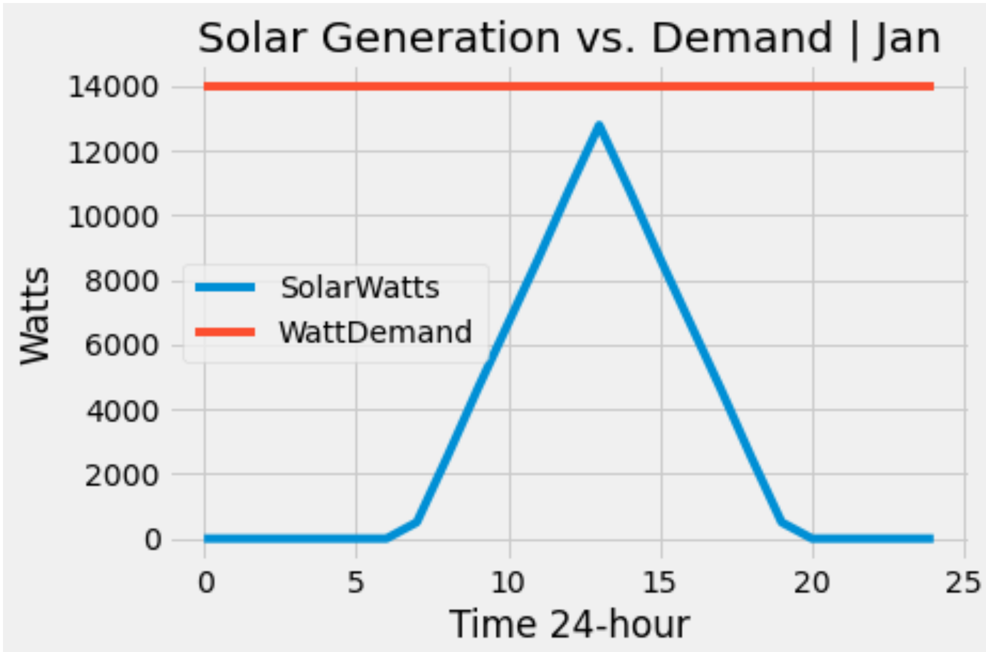
```
# Dec-Apr Calculations w/ Solar
PerDay_Demand = 14000 # watts

# function to break down 12-hour window into realistic intensities
def SolarDays(SolarMONTHpd):
    TwentyFourToOne = SolarMONTHpd * (Percents[0]/100)
    OneToTwoPD = SolarMONTHpd * (Percents[1]/100)
    TwoToThreePD = SolarMONTHpd * (Percents[2]/100)
    ThreeToFourPD = SolarMONTHpd * (Percents[3]/100)
    FourToFivePD = SolarMONTHpd * (Percents[4]/100)
    FiveToSixPD = SolarMONTHpd * (Percents[5]/100)
    SixToSevenPD = SolarMONTHpd * (Percents[6]/100)
    SevenToEightPD = SolarMONTHpd * (Percents[7]/100)
    EightToNinePD = SolarMONTHpd * (Percents[8]/100)
    NineToTennPD = SolarMONTHpd * (Percents[9]/100)
    TenToElevenPD = SolarMONTHpd * (Percents[10]/100)
    ElevenToTwelvePD = SolarMONTHpd * (Percents[11]/100)
    TwelveToThirtPD = SolarMONTHpd * (Percents[12]/100)
    ThirtToFourtPD = SolarMONTHpd * (Percents[13]/100)
    FourtToFiftPD = SolarMONTHpd * (Percents[14]/100)
    FiftToSixtPD = SolarMONTHpd * (Percents[15]/100)
    SixtToSeventPD = SolarMONTHpd * (Percents[16]/100)
    SeventToEighteenPD = SolarMONTHpd * (Percents[17]/100)
    EighteenToNinetPD = SolarMONTHpd * (Percents[18]/100)
    NinetToTwentyPD = SolarMONTHpd * (Percents[19]/100)
    TwentyToOnePD = SolarMONTHpd * (Percents[20]/100)
    TwentyToTwoPD = SolarMONTHpd * (Percents[21]/100)
```

```
    TwentyToThreePD = SolarMONTHpd * (Percents[22]/100)
    TwentyToFourPD = SolarMONTHpd * (Percents[23]/100)

    return list([TwentyFourToOne, OneToTwoPD, TwoToThreePD, TwoToThree


month_insolation = [Jan['Insolation'],Feb['Insolation'],Mar['Insolatio

def GrouperFunc(varM):
    # Takes Calculated Fractional Insolation based upon time-of-day an
    NewList = []
    for x in SolarDays(month_insolation[varM]):
        Insol = round(x) # W/m2
        EHarvest = Insol * PanelEfficiency * 467 # W
        NewList.append(EHarvest)
    return NewList

GrouperFunc(0)
# print('Daily Generative Capabilities for January is {} W.'.format(Gr
# print('Daily Generative Capabilities for February is {} W.'.format(G
# print('Daily Generative Capabilities for March is {} W.'.format(Grou
# print('Daily Generative Capabilities for April is {} W.'.format(Grou
# print('Daily Generative Capabilities for December is {} W.'.format(G


#Create two plots and distance between them is battery storage require

listoNos = []

for x in range(0,25):
    listoNos.append(14000)

listoPos = []

for y in range(0,25):
    listoPos.append(2000)

#-------------------
JanuaryTest = pd.DataFrame([GrouperFunc(0), listoNos]).T

JanuaryReal = JanuaryTest.rename({0:'SolarWatts', 1:'WattDemand'}, axi

JanuaryReal.plot()
plt.title('Solar Generation vs. Demand | Jan')
plt.xlabel('Time 24-hour')
plt.ylabel('Watts')
plt.show()
#-------------------
FebruaryTest = pd.DataFrame([GrouperFunc(1), listoNos]).T
```

```
FebruaryReal = FebruaryTest.rename({0:'SolarWatts', 1:'WattDemand'}, a

FebruaryReal.plot()
plt.title('Solar Generation vs. Demand | Feb')
plt.xlabel('Time 24-hour')
plt.ylabel('Watts')
plt.show()
#--------------------
MarchTest = pd.DataFrame([GrouperFunc(2), listoNos]).T

MarchReal = MarchTest.rename({0:'SolarWatts', 1:'WattDemand'}, axis='c

MarchReal.plot()
plt.title('Solar Generation vs. Demand | Mar')
plt.xlabel('Time 24-hour')
plt.ylabel('Watts')
plt.show()
#--------------------
AprilTest = pd.DataFrame([GrouperFunc(3), listoNos]).T

AprilReal = AprilTest.rename({0:'SolarWatts', 1:'WattDemand'}, axis='c

AprilReal.plot()
plt.title('Solar Generation vs. Demand | Apr')
plt.xlabel('Time 24-hour')
plt.ylabel('Watts')
plt.show()
#--------------------
MayTest = pd.DataFrame([GrouperFunc(4), listoPos]).T

MayReal = MayTest.rename({0:'SolarWatts', 1:'WattDemand'}, axis='colum

MayReal.plot()
plt.title('Solar Generation vs. Demand | May')
plt.xlabel('Time 24-hour')
plt.ylabel('Watts')
plt.show()
#--------------------
JuneTest = pd.DataFrame([GrouperFunc(5), listoPos]).T

JuneReal = JuneTest.rename({0:'SolarWatts', 1:'WattDemand'}, axis='col

JuneReal.plot()
plt.title('Solar Generation vs. Demand | Jun')
plt.xlabel('Time 24-hour')
plt.ylabel('Watts')
plt.show()
#--------------------
JulyTest = pd.DataFrame([GrouperFunc(6), listoPos]).T

JulyReal = JulyTest.rename({0:'SolarWatts', 1:'WattDemand'}, axis='col
```

```
JulyReal = JulyTest.rename({0:'SolarWatts', 1:'WattDemand'}, axis=1

JulyReal.plot()
plt.title('Solar Generation vs. Demand | Jul')
plt.xlabel('Time 24-hour')
plt.ylabel('Watts')
plt.show()
#-------------------
AugustTest = pd.DataFrame([GrouperFunc(7), listoPos]).T

AugustReal = AugustTest.rename({0:'SolarWatts', 1:'WattDemand'}, axis=

AugustReal.plot()
plt.title('Solar Generation vs. Demand | Aug')
plt.xlabel('Time 24-hour')
plt.ylabel('Watts')
plt.show()
#-------------------
SeptemberTest = pd.DataFrame([GrouperFunc(8), listoPos]).T

SeptemberReal = SeptemberTest.rename({0:'SolarWatts', 1:'WattDemand'},

SeptemberReal.plot()
plt.title('Solar Generation vs. Demand | Sep')
plt.xlabel('Time 24-hour')
plt.ylabel('Watts')
plt.show()
#-------------------
OctoberTest = pd.DataFrame([GrouperFunc(9), listoPos]).T

OctoberReal = OctoberTest.rename({0:'SolarWatts', 1:'WattDemand'}, axi

OctoberReal.plot()
plt.title('Solar Generation vs. Demand | Oct')
plt.xlabel('Time 24-hour')
plt.ylabel('Watts')
plt.show()
#-------------------
NovemberTest = pd.DataFrame([GrouperFunc(10), listoPos]).T

NovemberReal = NovemberTest.rename({0:'SolarWatts', 1:'WattDemand'}, a

NovemberReal.plot()
plt.title('Solar Generation vs. Demand | Nov')
plt.xlabel('Time 24-hour')
plt.ylabel('Watts')
plt.show()
#-------------------
DecemberTest = pd.DataFrame([GrouperFunc(11), listoNos]).T

DecemberReal = DecemberTest.rename({0:'SolarWatts', 1:'WattDemand'}, a
```

```
DecemberReal.plot()
plt.title('Solar Generation vs. Demand | Dec')
plt.xlabel('Time 24-hour')
plt.ylabel('Watts')
plt.show()
```






**It's clear to see that harvestable watts fluxuates dependant on the month.**

In [34]:
```
# a, b, c, d = points of intersection between demand and solar watts c
# HEATING SZN

a = [10.06, 14000]
b = [15.94, 14000]
Base = math.dist(a,b)
Height = 25250 - 14000
OverSupplyW = round((Base * Height) / 2)
print('From 10am to 4pm, the solar panels oversupply {} W of electrici

c = [7, 1008]
d = [7, 14000]

BaseUnder = math.dist(d,a)
HeightUnder = math.dist(d, c)
UnderSupplyHeat = round((BaseUnder * HeightUnder) / 2)
print('From 6pm < time < 6am, the demand is undersupplied by {} W of e
```

```
From 10am to 4pm, the solar panels oversupply 33075 W of electricity
From 6pm < time < 6am, the demand is undersupplied by 19878 W of elec
tricity
```

In [35]:
```
# w, x = points of intersection between demand and solar watts curve u

w = [7.1, 2000]
x = [18.9, 2000]
y = [6,1600]
BaseWX = math.dist(w,x)
HeightWY = 2000-1600
UnderSupplyNoHeat = round((BaseWX * HeightWY) / 2)
print('From 6pm < time < 6am, the demand is undersupplied by {} W of e
```

```
From 6pm < time < 6am, the demand is undersupplied by 2360 W of elect
ricity
```

## Now, take Li-ion batteries as our super-efficient storage device -->

> Power Density of Li-ion batteries (source: cei.washington.edu): 250-270 Wh/kg

In [36]:
```
# BATTERIES MUST HARVEST >19878 W OF ENERGY IN ORDER TO BALANCE THE DA
# Take Lithium Ion Battery with 250 Wh/kg Energy Density

BatteryPD = 250 * 12 # W/kg - 12hour cycle for batteries

TotalBatteryStorageReq = round(UnderSupplyHeat / BatteryPD, 2) # cance

TotBatStoReq = round(UnderSupplyNoHeat / BatteryPD, 2)

print("I will need {} kg of Li-ion batteries to account for my day-nig

print("I will need {} kg of Li-ion batteries to account for my day-nig
```

```
I will need 6.63 kg of Li-ion batteries to account for my day-night i
mbalance w/ solar during the heating season.
I will need 0.79 kg of Li-ion batteries to account for my day-night i
mbalance w/ solar during the non-heating season.
```

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]: