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MINI PROJECT REPORT

ON

Energy Management System

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ABSTRACT OF THE PROJECT

The purpose of the project is to design an energy system that includes non – renewable sources and renewable sources such that the system outputs a constant voltage (sum of outputs from each source) with an added optimization that the renewable sources are prioritized. In our example system, we have used three renewable sources and a single nonrenewable source. The non-renewable source is a Thermal plant represented by a temperature sensor in the diagram which reads the temperature of the boiler in the plant. The higher the temperature, the higher is the consumption of resources(coal), consequently the higher the voltage output (��). It is assumed that ���� will be 0 only when the temperature is 0 and the water's actual boiling mechanism is not considered. The ���� value linearly increases with temperature and at max temperature of 125 °C, ���� equals the required voltage(1V).The renewable sources used in our example system are:

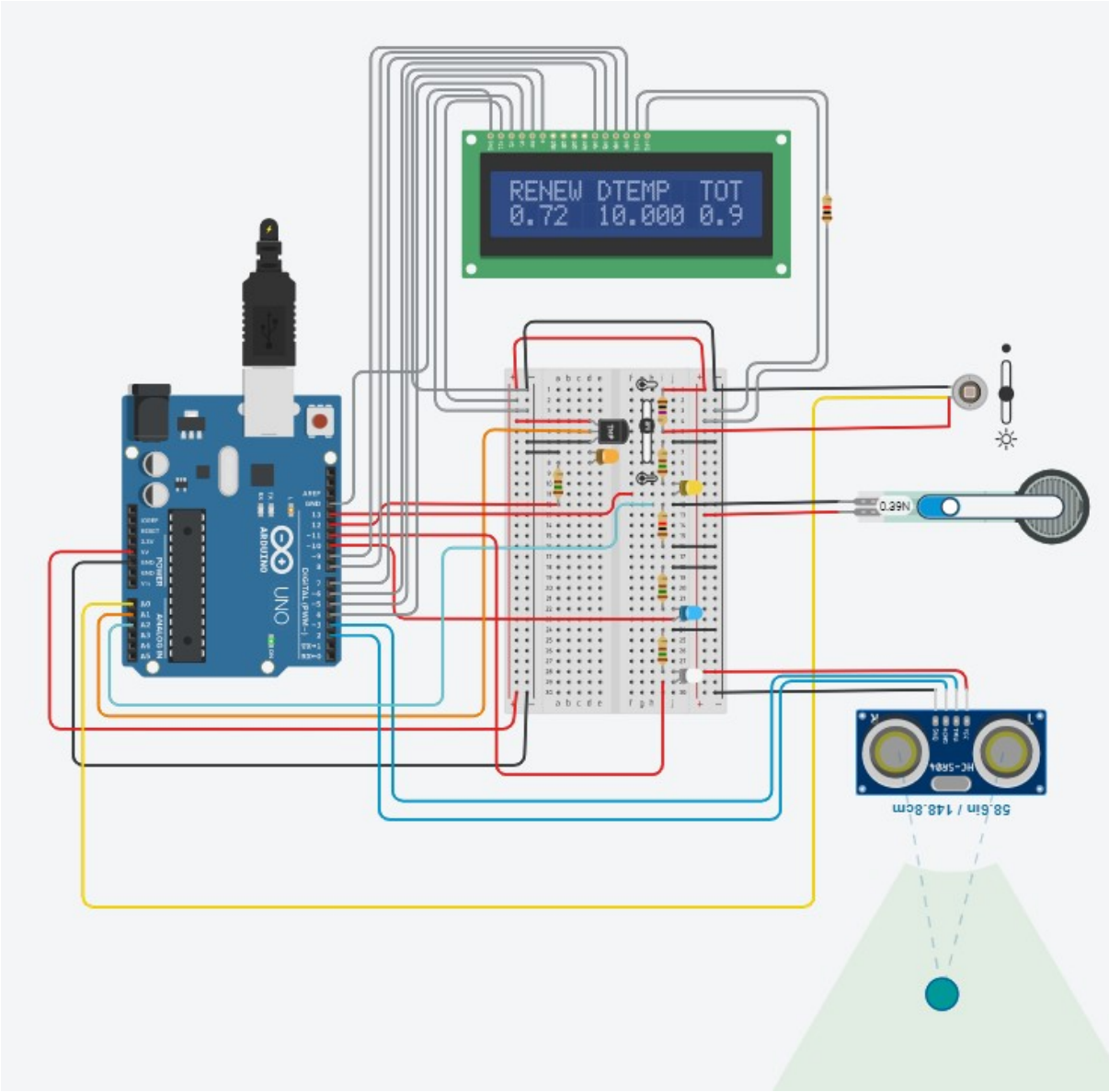
- Hydroelectric power plant: The Ultrasonic sensor which is attached to the top of a dam, measures the distance to the water surface in the dam. Lesser this distance,

higher is the water level, therefore higher is the voltage generated by the plant (𝑉𝑉ℎ𝑦𝑑). The value of 𝑉𝑉ℎ𝑦𝑑 is 0 if the distance to the surface is >200 as the dam cannot be opened because the water level is very low. For distance values <200, 𝑉𝑉ℎ𝑦𝑑 increases linearly.

- Solar power plant: The photodiode used represents a solar cell that converts light energy into electric energy. The higher the light intensity, the higher the voltage generated by the plant (𝑉𝑉𝑠𝑜𝑙). The value of 𝑉𝑉𝑠𝑜𝑙 is 0 if the light intensity is 0.
- Wind power plant: The Force sensor which is attached to the top of a wind turbine, measures the wind force which is proportional to the wind speed and hence is proportional to the voltage generated by the turbine (𝑉𝑉𝑤𝑖𝑛). The value of 𝑉𝑉𝑤𝑖𝑛 is 0 if the force measured is 0.

The required voltage output required from the system is taken as 1V. The total voltage generated by the renewable sources (𝑉𝑉𝑤𝑖𝑛+𝑉𝑉𝑠𝑜𝑙+𝑉𝑉ℎ𝑦𝑑). is displayed under RENEW on the lcd screen. The total voltage output is displayed under TOT on the lcd display. The usage of thermal energy is minimized and the temperature of the boiler is optimized such that the voltage generated by the plant will always be equal to TOT – RENEW. The DTEMP value in the lcd display shows value by which the temperature of the boiler must be increased or decreased by to attain the required voltage of 1V. If RENEW is 0, the required voltage must be taken only from the thermal plant and the temperature is maxed (125 °C) which then generates the required 1V, in this situation the DTEMP value will be 125-current temperature of the boiler. In the ordinary case with RENEW being 0.6, the DTEMP value will be such that the resultant temperature of the boiler (current temperature ± DTEMP) leads to the 𝑉𝑉𝑡ℎ generated being equal to 0.4 (therefore leading to a total value of 1V). In case the renewable sources themselves produce the required 1V, the DTEMP value will be – (current boiler temperature) which shows that the boiler must be shut down as the required is already met. Thus, the coal utilization by the thermal plant is always minimized while the system generates the required voltage of 1V. The renewable sources are nature controlled and the sensors act as inputs to the microcontroller and the RENEW value is not controlled by the user and only the temperature of the boiler is in the user's control. The user can set up a mechanism to automatically increase or decrease the temperature as per the DTEMP value or do it manually.

CIRCUIT DIAGRAM



The Blue LED shining signifies the Hydro-plant is on and is producing power and is contributing to the RENEW and TOT value (total voltage).

The White LED shining signifies the Wind-plant is on and is producing power and is contributing to the RENEW and TOT value (total voltage).

The Yellow LED shining signifies the Solar-plant is on and is producing power and is contributing to the RENEW and TOT value (total voltage).

The Orange LED shining signifies the Thermal-plant is on and is producing power and is contributing to the RENEW and TOT value (total voltage).

ARDUINO CODE

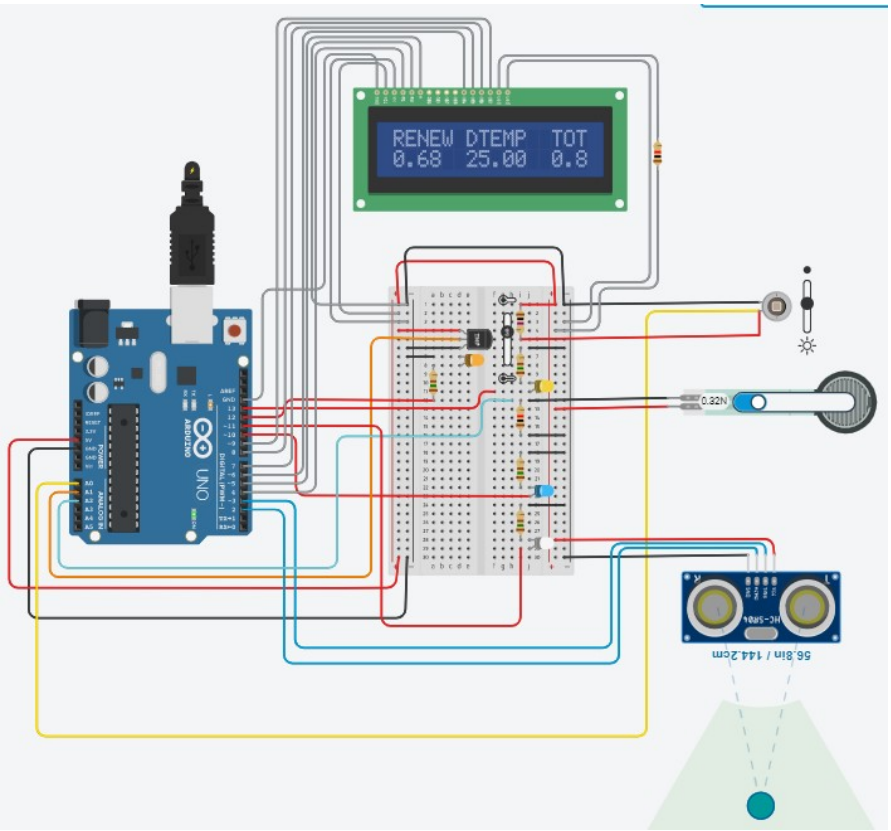
```
#include <LiquidCrystal.h>
#define echoPin 2
#define trigPin 3
#define YellowLED 13
#define OrangeLED 12
#define WhiteLED 11
#define BlueLED 10
#define REQUIRED 1
float duration; float
lightvoltage=0; float
hydrovoltage=0; float
thermalvoltage=0;
float windvoltage=0;
float renew=0; float
t=0; float total=0;
float distance; float
celsius;
LiquidCrystal  lcd(4,5,6,7,8,9);
void  setup(){      pinMode(trig-
Pin,  OUTPUT);      pinMode(echo-
Pin,  INPUT);    pinMode(BlueLED,
OUTPUT);      pinMode(YellowLED,
OUTPUT);      pinMode(OrangeLED,
OUTPUT);       pinMode(WhiteLED,
OUTPUT);      lcd.begin(16,  2);
S e r i a l . b e g i n ( 9 6 0 0 ) ;
lcd.print("RENEW DTEMP  TOT");
} void
loop()
{   total=0;
renew=0;
t=0;
  digitalWrite(trigPin, LOW);   de-
layMicroseconds(2);
digitalWrite(trigPin, HIGH);   delay-
Microseconds(10);
digitalWrite(trigPin, LOW);   dura-
tion = pulseIn(echoPin, HIGH);   dis-
tance = duration * 0.0343 / 2;   hy-
drovoltage=20.0/distance;   if(hydro-
voltage>0.1)
  {
```

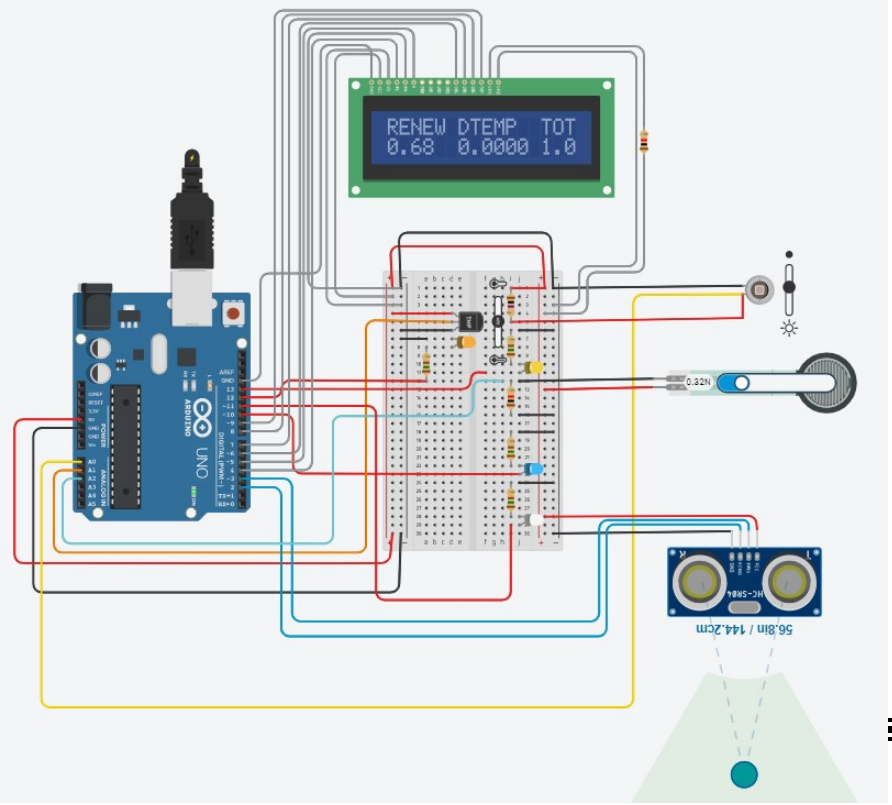
```
    digitalWrite(BlueLED, HIGH);
renew+=hydrovoltage;     total+=hy-
drovoltage;
  }
else
{
    digitalWrite(BlueLED, LOW);
  }

  lightvoltage = analogRead(A0)* (5.0 / 1023.0);
if(lightvoltage>0.1)
  {
    digitalWrite(YellowLED, HIGH);
renew+=lightvoltage;
total+=lightvoltage;
  }
else
{
    digitalWrite(YellowLED, LOW);
  }

  windvoltage = analogRead(A2)/400.0;
if(windvoltage>0)
  {
    digitalWrite(WhiteLED, HIGH);
renew+=windvoltage;     total+=wind-
voltage;
  }
else
{
    digitalWrite(WhiteLED, LOW);
  }

  celsius = map(((analogRead(A1) - 20) * 3.04), 0, 1023, -40,
125);   if(celsius<0)     celsius=0;   thermalvoltage=celsius/125;
t=floor(125*(REQUIRED-renew));     t=floor(t-celsius);   if(cel-
sius+t<0)     t=-celsius;   if(thermalvoltage>0)
  {
    digitalWrite(OrangeLED, HIGH);
total+=thermalvoltage;
  }
else
{
    digitalWrite(OrangeLED, LOW);
  }
  lcd.setCursor(0,1);
lcd.print(renew);
lcd.setCursor(6,1);
lcd.print(t);
lcd.setCursor(13,1);
lcd.print(total);

}
```

SCREENSHOTS OF THE OUTPUT

Case 1:

Current Temperature of boiler is 15 °C and the DTEMP value is 25 which means that the user should increase the boiler temp by 25 °C (to 40 °C). All three renewable sources are generating power as shown by the three LEDs being on.



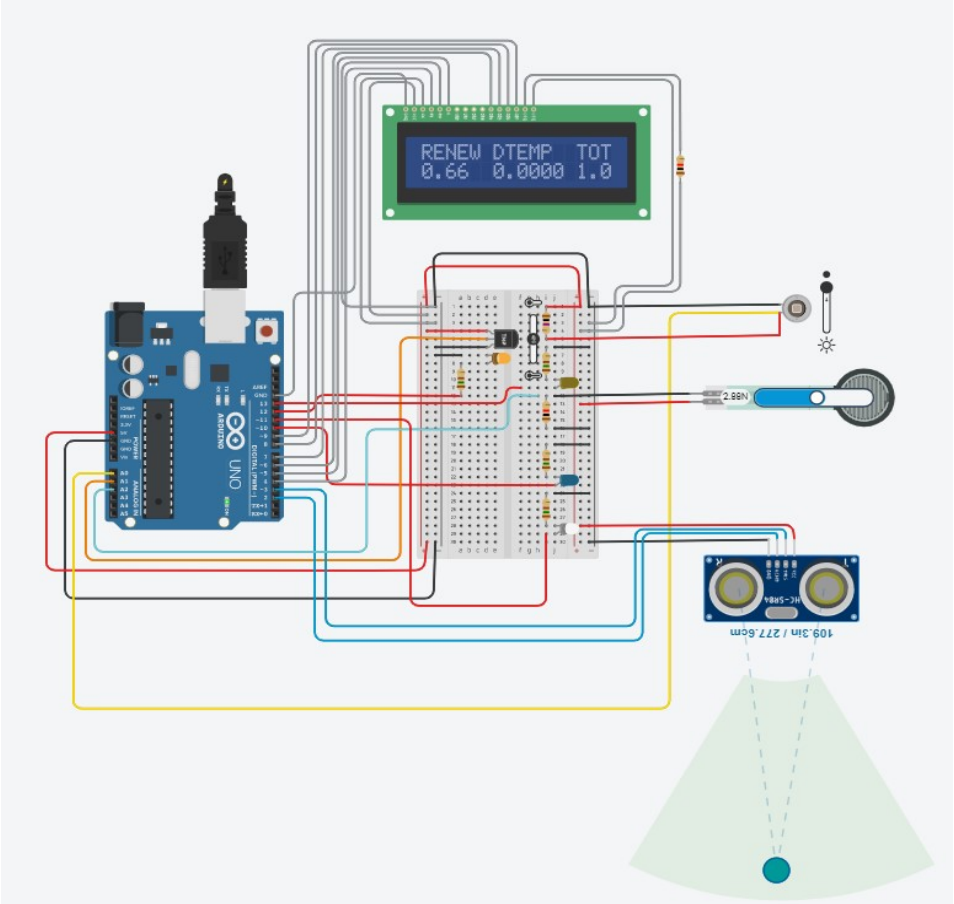


When the temperature is increased to 40 °C, TOT is

1.0, which shows that the remaining 1-0.68=0.32 V is produced by the thermal plant when the temperature is at 40 °C.

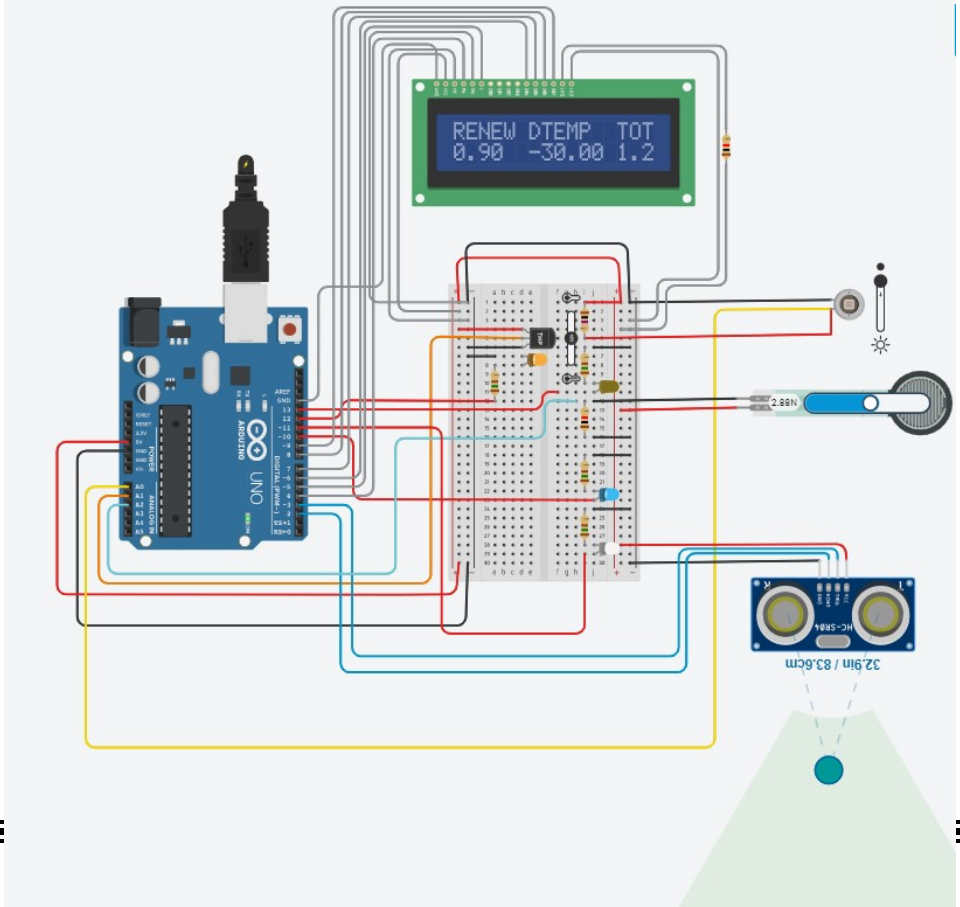
Case 2:

Temperature of boiler is 42 °C and the DTEMP value is 0 which means that the system is in producing the required 1V currently. Only the white LED is on which shows that only the wind energy is being used(dam level is too low and it is night time).

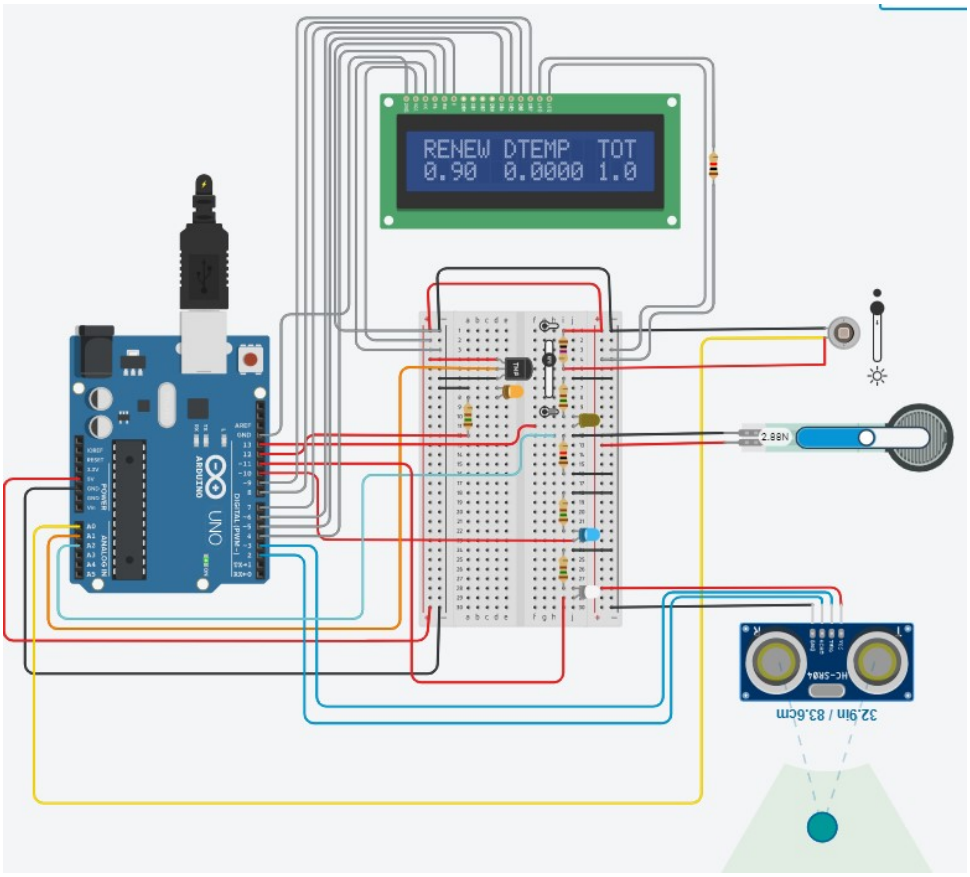


RENEW = 0.66 (□□□□)
F (Wind Force) = 2.88N
T=42 °C
Thermal Voltage (□□□□) = 1 – 0.66 = 0.34V

When the dam becomes full and starts producing power, it produces a □□□□ of 0.24V and as the F value is unchanged (2.88N) The □□□□ remains 0.66. Thus, the RENEW value is □□□□ + □□□□ which is 0.90. Due to this the earlier thermal voltage of 0.34V is excessive and the user must reduce the boiler temperature by 30 °C (to 12 °C) to just produce the extra 0.1 V needed.



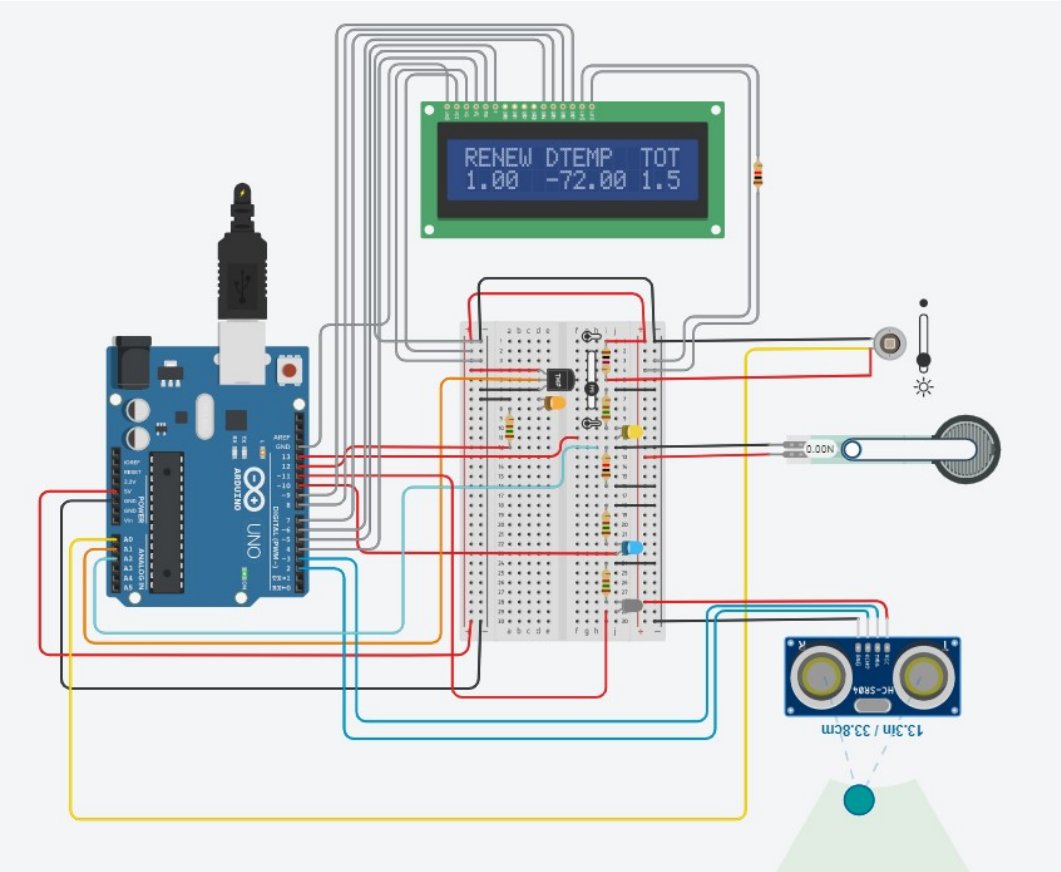
Upon doing said temperature reduction.



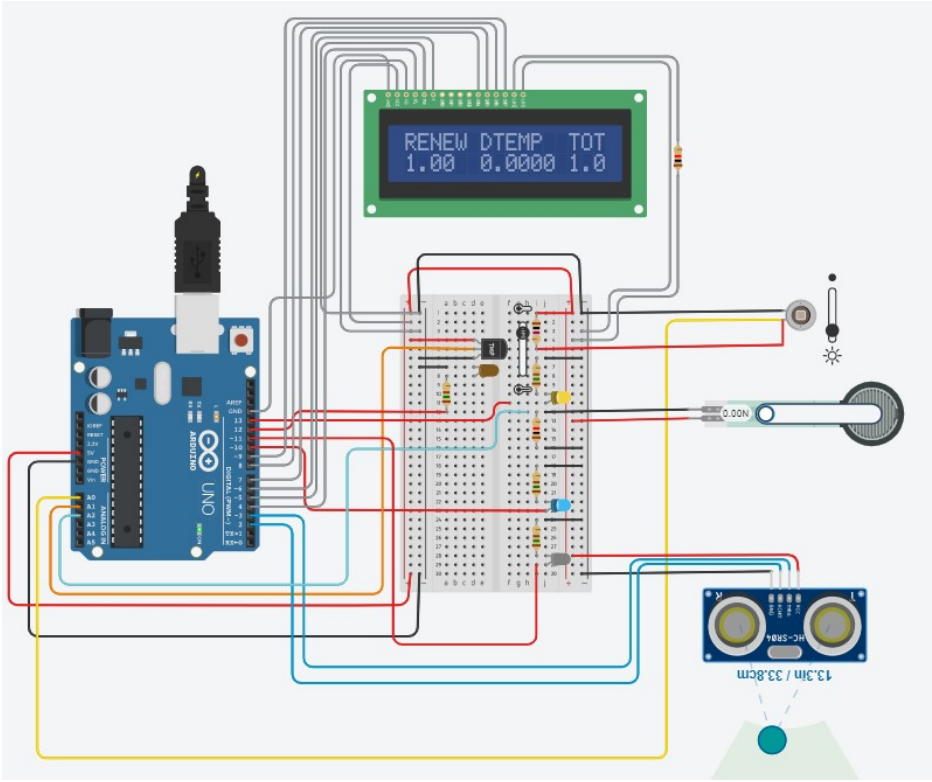
Case 3:

Temperature of boiler is 72 °C and the DTEMP value is -72 which means that the system is in producing the required 1V only from the renewable resources currently. The Blue and Yellow LED is on showing that both those sources are generating power and the wind energy is not being used(no wind case).

Since the DTEMP
is -72, it is signaling the user to shut down the thermal plant completely as the requirement is satisfied by the renewable sources themselves.



Upon reducing the boiler temperature to 0, the orange LED is off which shows that the thermal plant has been switched off.



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