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MANAGEMENT OF SOLAR WATER PUMPING SYSTEM THROUGH IOT & MACHINE LEARNING

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Abstract— *Water resources are essential for satisfying human needs, ensuring food production and energy as well as for sustainable development. The main problem in this evolving time is the scarcity of water, and we are lagging behind in having a Smart Storage and Supply System. To overcome this problem, we have used Renewable Energy Source that is Photovoltaic System (PV) using Maximum Power Point Tracker (MPPT) for maximum efficiency. Through MATLAB with actual irradiance data investigates the possibility of efficiency calculation for the designed DC Submersible Pump System with a Photovoltaic (PV) power source. The results of the simulation will be presented in terms of output parameters like total energy generated. Looking at the future scenario with Machine Learning the demand is predicted by analyzing the previous values and the supply cycle is generated accordingly and Internet of Things (IoT) are used for Smart Storage and Supply of Water, respectively.In this paper we present that MPPT can improve efficiency and performance of PV array, Machine learning helps to reduce the water wastage and future demands of water can be estimated and water can be supplied in a smarter and efficient way with the use of Internet of Things (IoT) and Adafruit.*

Keywords — *PV array, MATLAB, DC Submersible Pumps, Management of Water Supply, Machine Learning, Internet of Things.*

I. INTRODUCTION

Looking at India's water crisis scenario it's often attributed to lack of state planning, increased corporate privatization, industrial and body waste and government corruption. In addition, water scarcity in India **is** predicted to worsen because the overall population **is** predicted to extend to 1.6 billion by year 2050.Water scarcity is being driven by two converging phenomena: growing freshwater use and depletion of usable freshwater resources.

The renewable energy sources of solar is used for power generation. The PV system consists of PV array, Maximum Power Point Tracking (MPPT), DC-DC boost converter. Since the performance of PV array is very low compared to the operating stage. A step-up chopper i.e. DC-DC boost converter is employed to boost it to operational level.

Machine Learning is utilized to determine the estimated value on daily basis so that the real value can cope up with the requirements of the users. This will also help the Indian Government to build such systems which can reduce the amount of water which is depleted daily and can be stored for further use in future.

This paper also deals with the supply of water in the given sectors with the usage of Internet of Things (IoT) which is an promising system of Inter Connected Networks and software based system and also a Cloud system which is Adafruit along with some sensors to determine the level of water and supply water accordingly without unnecessary wastage of water.

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II. CURRENT WATER MANAGEMENT SCENARIO

A. Universal story line.

On a global scale, the percentage rise in water usage has surpassed twice that of population growth in recent decades. As a result, more and larger regions across the world are experiencing water stress, with existing water usage and consumption rates, let alone desired rates, becoming unsustainable. The demand for water and the supply of it are both changing. It is unknown what they will become in the future, but it is clear that they will evolve. Population growth and higher per capita water consumption in the increasing urban, domestic, and industrial water sectors are driving demand. Everyone is worried about the possibility of water shortages as the world's population grows. Water demands, as well as their implications for energy and food production. According to the World Economic Forum's Global Risk Perception Survey of 900 recognized experts, the water crisis will have the greatest societal effect over the next ten years. Indian story line.

B. India's Story line

According to a study released by India's Central Ground Water Board, 100 million people in India lack access to safe drinking water and face a variety of challenges. Human, livestock, agricultural, and industrial waste contaminate nearly 75% of India's surface water, and its groundwater often contains high levels of fluoride and other mineral pollutants. Water and sanitation-related diseases account for 70-80% of all disease in the world. Drought-related water shortages, a lack of education, and the sheer number of people living in severe poverty add to the difficulty. Bad implementation and a lack of funding at the local level stymie progress in resolving these issues. Because of problems with source sustainability and water quantity, many of India's rural water systems fail. Communities lacking the expertise to maintain their water supplies as a result of insufficient organizational controls and maintenance schemes, further compounding the difficulty of India's water issues.

III. BLOCK DIAGRAM

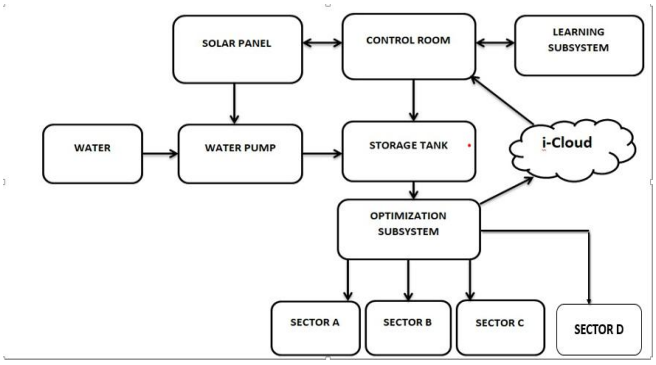

Fig. 1: Block diagram of the Solar system along with Optimization Sub system and Learning Subsystem.

Using power driven from solar panel we operate DC Submersible pump to retrieve water from ground and store it into our storage tank, using the command from control room water is supplied to optimization subsystem which will, distribute water to the particular sectors according to the data predicted

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by the learning subsystem(using Machine learning prediction model) and using the IoT devices and switches the flow/supply of water will be monitored and controlled and its data will be collected using Adafruit and it will connect optimization subsystem to control room using the Adafruit I-cloud service.

IV. METHODLOGY

A. Proposed Photovoltaic System.

Photovoltaic System (PV) is used to generate the energy required to drive the pump and extract water. A Solar panel of Multi-Crystalline cut cells are used, to convert solar energy to Electrical energy. A DC-DC boost converter is used to increase the voltage and power level of the system.

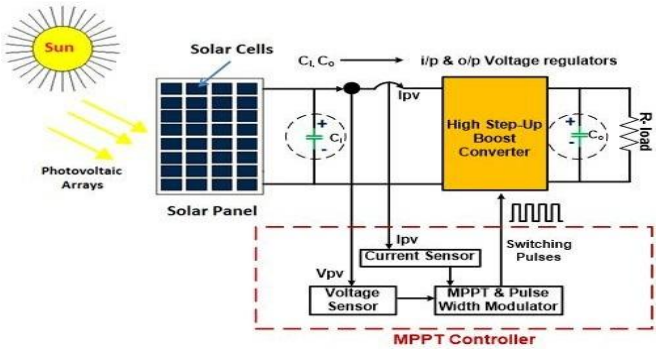

Fig.2: PV array model with DC-DC boost converter.

B. Proposed Machine Learning and IoT Model

Machine Learning and IoT is also one of the most promising systems that can be used for supplying water without wasting it, using Optimization Subsystem.

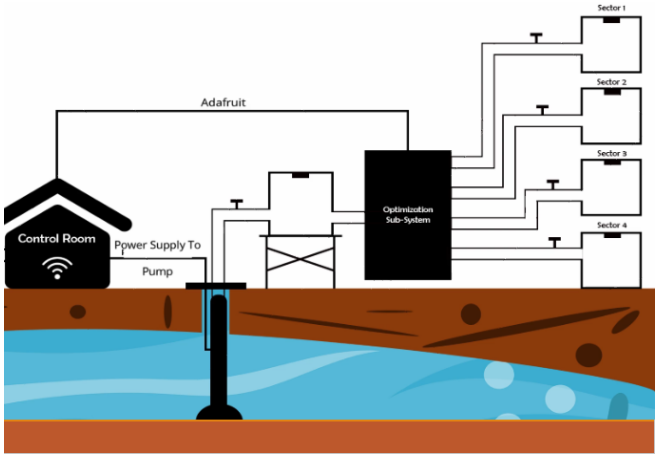

Fig. 3: Machine Learning and IoT model.

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Using the Machine learning prediction model system, control panel will receive the predicted value of water supply sector-wise according to usage, water pump will retrieve only the required amount of water and will be supplying to the optimization subsystem via Main storage tank. Using Internet of Things, distribution of water is controlled by automatic transfer switch, to supply only required amount of water and it will also collect data and send it to the Learning subsystem and Control room via Adafruit cloud services.

V. COMPONENTS

A. Multi Crystalline Solar Panel:
A 144 Cell (157mmX57mm Size) Multi crystalline silicon cell gives more area to absorb sunlight. It has high power output and lower BOS cost**.** Minimised micro-cracks are also present in the cell.
e.g: Waaree Aditya Series WSD-325 to WSD-350.

B. DC Submersible Pump:
The purpose of DC submersible pumps is to push water to the surface. They resemble a metal tube. This type of tube pump hides the engine inside the tube to prevent the liquid outside the pump from having access to the electrical parts inside the pump.

C. Brush Less DC Motor:
BLDC motor-pump is taken into account more suitable thanks to its higher efficiency over wide operating range as compared to AC pumps. As compared to an AC pump, a brushless DC motor-pump with higher efficiency produces more water for the same solar panel power.
pump with higher efficiency produces more water for the same solar panel power.

D. Raspberry pi:
The Raspberry Pi 4 Model B (Pi4B) is the first of a new generation of Raspberry Pi computers that features more RAM and substantially improved CPU, GPU, and I/O performance while maintaining the same form factor, power envelope, and cost as the previous generation Raspberry Pi 3B+.

E. Arduino Uno:
The Arduino Uno is a microcontroller module based on the ATmega328. On the frame, there are 14 digital input/output pins (six of which are PWM outputs), six analogue inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It includes a USB cable and an AC-to-DC adapter, as well as all you'll need to get started with the microcontroller.

F. Ultrasonic Ranging Module HC - SR04:
The HC - SR04 ultrasonic ranging module has a non-contact measurement range of 2cm to 400cm and a ranging precision of 3mm. Ultrasonic transmitters, receivers, and a control circuit are included in the modules.

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G. Adafruit IO:
Online, you can see your data in real time. Link your project to the internet. Control motors, read sensor data, and more! Connect projects to web services like IoT, RSS feeds, weather services, etc. Connect your project to other internet-enabled devices all of the above is do-able for free with Adafruit IO.

VI. PERTURB & OBSERVE

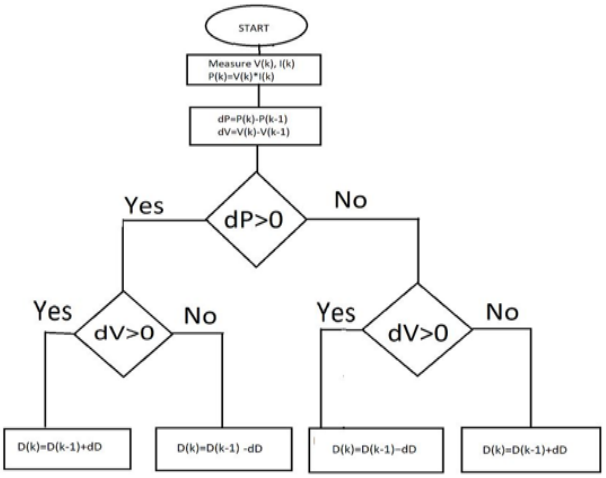

Fig 4: Perturb & Observe Algorithm

There are various MPPT algorithms "Hill Climbing", method under which "Incremental Conductance" and "Perturb & Observe" methods are the most efficient algorithms. Fig 4 shows that Perturb & Observe algorithm is the most common method, but it can result in oscillation of output power and it is very to implement comparing to the other algorithms which are present .If a proper predictive and adaptive hill climbing strategy is used, the perturb and observe method which result in top-level performance. Given below is the code for Perturb and Observe algorithm.

Algorithm.

```
function Vref = RefGen (V, I)

Vrefmax = 415;
Vrefmin = 0;
Vrefinit = 300;
deltaVref = 1;
persistent Vold Pold Vrefold;

dataType = 'double';
 if isempty(Vold)

 Vold = 0;
```

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```
    Pold = 0;
    Vrefold = Vrefinit;
end

p = V*I;
dV = V-Vold;
dP = Pold;

if dP ~= 0
    if dP<0
        if dV<0
            Vref = Vrefold + deltaVref;
        else
            Vref = Vrefold - deltaVref;
        end
    else
        if dV<0
            Vref = Vrefold - deltaVref;
        else
            Vref = Vrefold + deltaVref;
        end
    end
else Vref = Vrefold;
end

if Vref >= Vrefmax | Vref <= Vrefmin
    Vref = Vrefold;
end

Vrefold = Vref;
Vold = V;
Pold = p;
```

VII. SIMULATION MODEL

The MATLAB simulation model depicts that using Maximum Power Point Tracking (MPPT) and Perturb & Observe algorithm along with a DC-DC Boost Converter can give us a more efficient result of the Solar Panel which can help us to drive the Submersible Pump at a good amount of speed to extract water from the ground. An irradiance of 1000 w/m^2 and Temperature of 25 degree. An Input voltage of 295 Volts and Current 287.9 Ampere is generated by the Solar Panel

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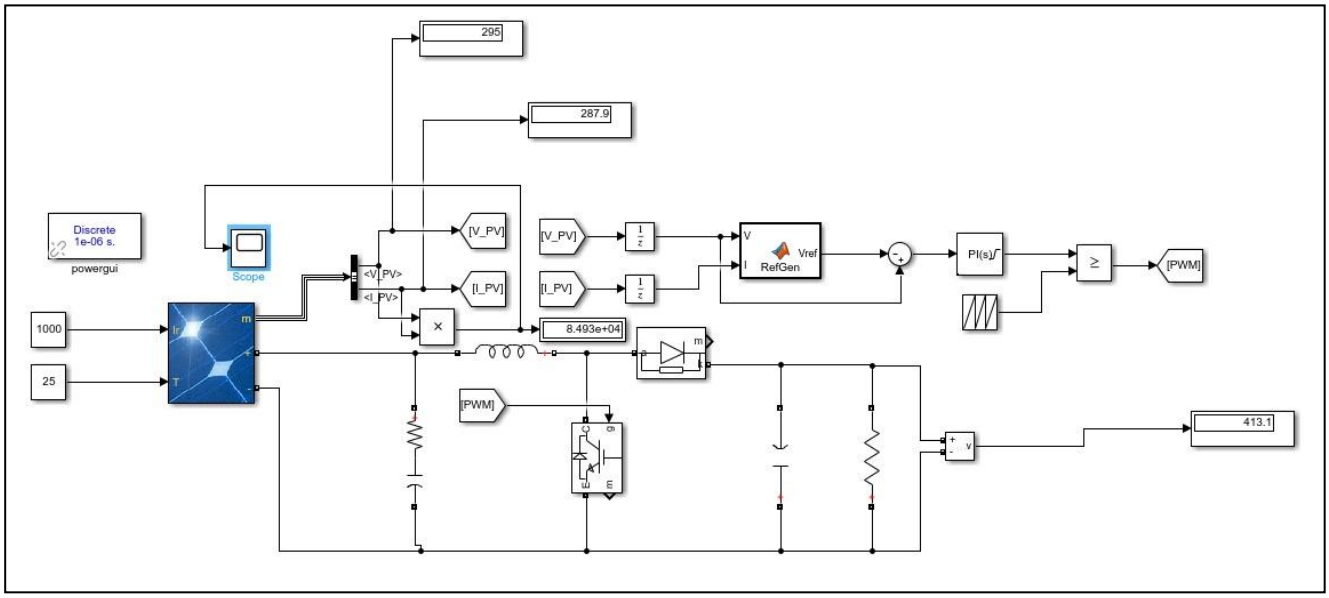

Fig.5: Simulation Model of Maximum Power Point Tracking

Fig 5 shows that with the help of MPPT algorithm the Module is operated at its maximum power during the day. With the help of DC-DC Boost Converter operating voltage can be increased and the required output is generated

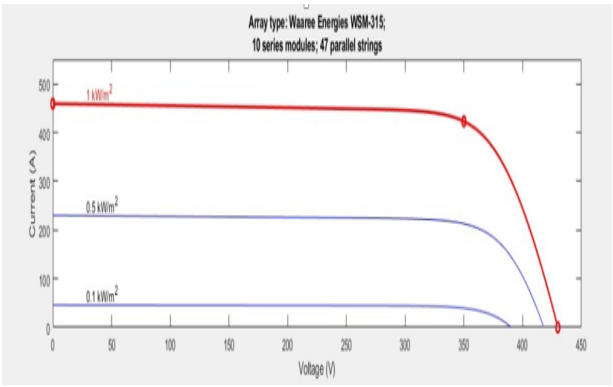

Fig 6: IV Curve of Solar panel

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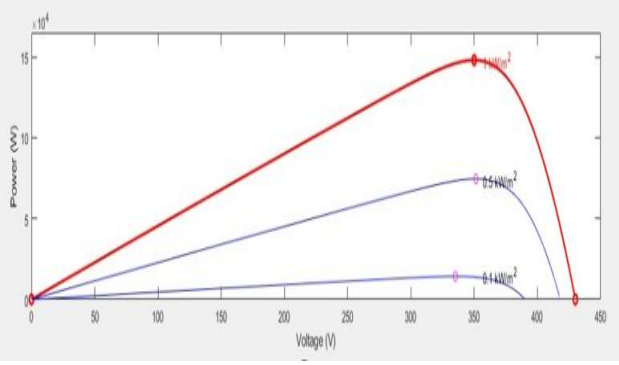

Fig.7: PV curve of Solar panel

VIII. SIMULATION RESULTS

Electrical Parameters:

- Irradiance=1000 W/m^2
- Temperature= 25 degree
- Short Circuit voltage = 430 Volts
- Open Circuit Current = 450 Amperes

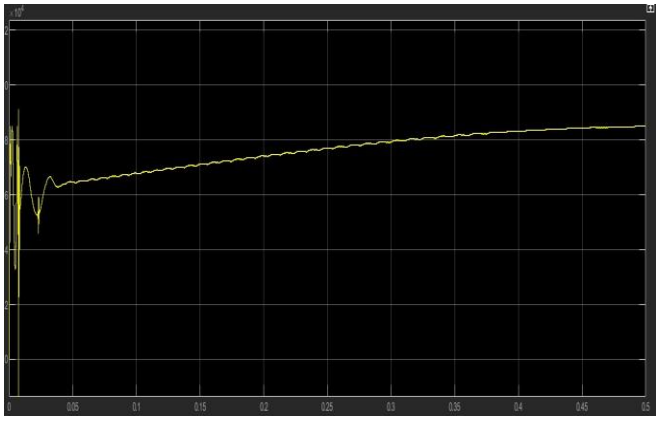

Fig.8 Simulation Output

Fig.8 shows the desired results that would be generated using the simulation model along with MPPT and DC-DC Boost Converter with an Irradiance of 1000W/m^2 and a constant temperature of 25 degrees we get the Output power generated which is 8.5 Kilowatts which would be required to drive the DC Submersible pump.

IX. MACHINE LEARNING

Machine learning (ML) is that the study of computer algorithms that develop themselves over time as a results of experience and data. It is regarded as a part of artificial intelligence. Machine learning algorithms create a model supported sample data, mentioned as "training data," so as to form predictions or decisions without being specifically programmed. Machine learning algorithms are used in a broad range

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of applications, including medicine, email filtering, and computer vision, where developing traditional algorithms to perform the required tasks is difficult or impossible. And using data from different households, the machine learning module uses its prediction algorithm and train the algorithm using the datasets and after training the module it predicts the outcome of water needed per building and disguise it between full, half, and reserves tank categories of a sector or a building.

```
PS C:\Users\peeyu\todo> & C:/ProgramData/Anaconda3/python.exe c:/Users/peeyu/Downloads/supervised_learning.py
<class 'sklearn.utils.Bunch'>
     Building A  Building B  Building C  Building D
0           5.1         3.5         1.4         0.2
1           4.9         3.0         1.4         0.2
2           4.7         3.2         1.3         0.2
3           4.6         3.1         1.5         0.2
4           5.0         3.6         1.4         0.2
5           5.4         3.9         1.7         0.4
6           4.6         3.4         1.4         0.3
7           5.0         3.4         1.5         0.2
8           4.4         2.9         1.4         0.2
9           4.9         3.1         1.5         0.1
10          5.4         3.7         1.5         0.2
11          4.8         3.4         1.6         0.2
12          4.8         3.0         1.4         0.1
13          4.3         3.0         1.1         0.1
14          5.8         4.0         1.2         0.2
<class 'numpy.ndarray'> <class 'numpy.ndarray'>
(150, 4)
['Full', 'Half', 'Reserve']
[[4.8, 4.8, 4.3, 5.8], [3.4, 3.0, 3.0, 4.0], [1.6, 1.4, 1.1, 1.2], [0.2, 0.1, 0.1, 1.2]]
[2 1 0 0]
PS C:\Users\peeyu\todo>
```

Fig 9: Predicted Values that are generated using previous values.

In the figure given above we have the dataset of water utilized by 4 households in the past 15 days using Machine Learning model is created which analyses the data set and trains itself accordingly to predict the values of the upcoming days which can help the user with the amount of water they consume on daily basis and how can they control or limit the usage of water and it also helps the government in getting an idea about the water that has to be extracted and stored in the overhead tanks and supply it to the subsystems accordingly.

X. INTERNET OF THINGS

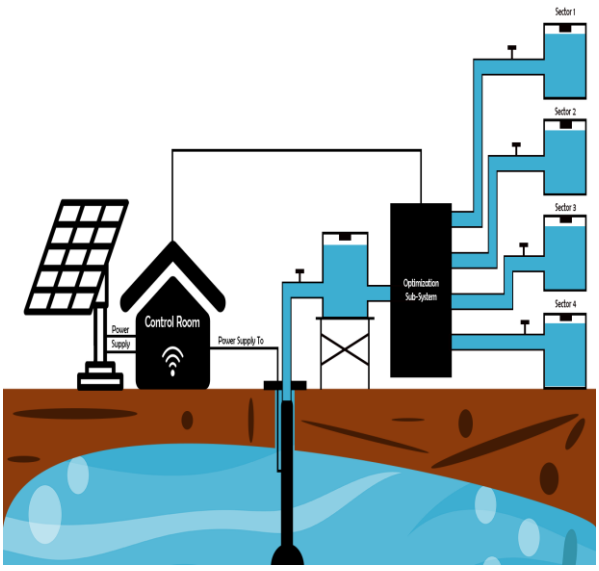

Fig10: Water Supply through Internet of Things (IoT) and ATS.

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After getting the predicted amount of water into the optimization system, using Arduino uno and automatic transfer switch, it will control the flow of water into the sectors/building overhead tank and using HC-SR04 sensors it will give the status of tank i.e "full", "half", "empty". And after distributing the water it will send its data to, I cloud (Adafruit) from where our learning subsystem will use it to get next predicted data. This data, is stored on Adafruit, so that the user has direct access. It is also programmed in the manner that when there is need of water supply it will turn on and supply the required amount of water to the user. And the data is stored on Adafruit I-cloud too.

XI. FUTURE SCOPE

This project is to utilize the maximum amount of Renewable energy as doable to decrease the dependency on Non-Renewable sources of energy alongside intelligent systems that are capable of accelerating the potency rate of installation to rural areas notwithstanding the normal ways in which. The longer term conjointly includes the implementation of this model on an oversized scale. The major future scope of this project is to produce water for each household in Asian nation, underneath the theme launched by the Government of Asian nation named Jal Jeevan Mission.

In the future, we can conjointly implement the strategy to visualize the hydrogen ion concentration, TDS (Total Dissolved Solids), Residual chemical element, Fluoride, Arsenic, and Nitrate of water. This model may be deployed in villages, semi-rural, semi-urban levels and even developing sensible cities. By Future development within the field of Machine Learning and IoT, the water quality check and therefore the amount of water provided may be measured by reducing Human errors.

XII. CONCLUSION

Hence we have a tendency to conclude by speech communication that by solar PV Systems we will drive the DC Submersible pumps and store water within the overhead tanks. By deploying Machine Learning , in our project we will confirm the calculable and real values over time and check the usage of water specifically areas. Lastly by inculcating the IoT program, in our model we will, with efficiently and build up a water network for distribution of water resource over completely different sectors.

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