INSTITUTION OF AGRICULTURAL TECHNOLOGISTS,

BENGALURU

EVALUATION OF RKVY PROJECTS

OF

UNIVERSITY OF AGRICULTURAL SCIENCES,

RAICHUR

"DEVELOPMENT, EVALUATION AND DEMONSTRATION OF SOLAR AND OTHER RENEWABLE ENERGY SYSTEMS"

INSTITUTION OF AGRICULTURAL TECHNOLOGISTS,

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DEVELOPMENT, EVALUATION AND DEMONSTRATION OF SOLAR AND OTHER RENEWABLE ENERGY SYSTEMS

EXECUTIVE SUMMARY

Energy is the lifeblood of technological and economic development. Energy is a vital component of any society playing a pivotal role in the national development. Although estimates vary, the world's proved, economically recoverable fossil fuel reserves include almost 1 trillion metric tons of coal, more than 1 trillion barrels of petroleum, and over 150 trillion cubic meters of natural gas. In addition to fossil fuels, mineral resources important to energy generation include over 3 million metric tons of uranium reserves. Global energy consumption draws from six primary sources: 44% petroleum, 26% natural gas, 25% coal, 2.5% hydroelectric power, 2.4% nuclear power, and 0.2% non-hydro renewable energy (Jeffrey Chow et al, 2003). A considerable amount of primary energy is converted to electricity either in the course of initial harvesting (as for hydroelectric, wind, and geothermal) or by combustion (as for fossil, biomass, and waste fuels).

Oil will remain the single largest fuel in the global primary energy mix, even though its share will fall marginally from 36% in 2002 to 35% in 2030 (Solangi et al, 2011). For the past 150 years or so, humans have relied heavily on coal, oil, and other fossil fuels to power everything from light bulbs to cars to factories. While a majority of the world's current electricity supply is generated from fossil fuels such as coal, oil and natural gas, these traditional energy sources face a number of challenges including rising prices, security concerns over dependence on imports from a limited number of countries which have significant fossil fuel supplies, and growing environmental concerns over the climate change risks associated with power generation using fossil fuels.

As a result of these and other challenges facing traditional energy sources, governments, businesses and consumers are increasingly supporting the development of alternative energy sources and new technologies for electricity generation. Renewable energy sources such as solar, biomass, geothermal, hydroelectric and wind power generation have emerged as potential alternatives which address some of these concerns. As opposed to fossil fuels, which draw on finite resources that may eventually become too expensive to retrieve, renewable energy sources are generally unlimited in availability.

Renewable energy is sustainable as it originates from sources that are inexhaustible (unlike fossil fuels). Sources of renewable energy include wind, solar, biomass, geothermal and hydro, all of which occur naturally. Renewable energy, generally speaking, is clean energy and non-polluting. Many forms do not emit any greenhouse gases or toxic waste in the process of producing electricity. It is a sustainable energy source that is reliable for

the long-term. Renewable energy is cost-effective and efficient. The challenge of climate change compels many nations to set a renewable energy target. Increasingly, governments around the world are turning to renewable energy to end our dependence on fossil fuels.

For centuries, people have harnessed the energy of river currents, using dams to control water flow. Hydropower is the world's biggest source of renewable energy by far, with China, Brazil, Canada, the U.S., and Russia the leading hydropower producers. While hydropower is theoretically a clean energy source replenished by rain and snow, it also has several drawbacks.

Harnessing the wind as a source of energy started more than 7,000 years ago. Now, electricity-generating wind turbines are proliferating around the globe, and China, the U.S., and Germany are the leading wind energy producers. From 2001 to 2017, cumulative wind capacity around the world increased to more than 539,000 megawatts from 23,900 mw—more than 22-fold increase (Christine Nunez, 2019).

Used for thousands of years in some countries for cooking and heating, geothermal energy is derived from the Earth’s internal heat. On a large scale, underground reservoirs of steam and hot water can be tapped through wells that can go a mile deep or more to generate electricity.

Nuclear energy cannot really be termed renewable, since there is only a finite amount of uranium on this planet. The reactors also produce a by-product other than the power they generate. This is toxic harmful waste that must be stored indefinitely.

Solar energy is a renewable free source of energy that is sustainable and totally inexhaustible, unlike fossil fuels that are finite. It is also a non-polluting source of energy and it does not emit any greenhouse gases when producing electricity. Solar energy will never die of shining, since the Sun still has 6.5 billion years of life according to NASA. As the publication Renewable Energies Info estimates, the Earth’s surface receives 120,000 Terawatts of solar irradiation, “which represents 20,000 times more power than the whole planet needs”. As little as 18 days of solar irradiation on Earth contains as much energy as all the world’s coal, oil and natural gas reserves put together. Solar radiation can satisfy our energy needs 4,000 times over (Acciona, 2020).

Solar energy can be a major source of power in the future. Its potential is 178 billion MW which is about 20,000 times the world’s demand for power. Even if we can use only 5% of this energy source, it will be 50 times the demand for power in the world. Solar power generation has emerged as one of the most rapidly growing renewable sources of electricity. Solar power generation has several advantages over other forms of electricity

generation, viz., reduced dependence on fossil fuels, environmental advantages, modularity and scalability, flexible locations, government incentives, avoids global warming, reduces energy imports, generates local wealth and jobs, contributes to sustainable development and can be applied alike for large-scale electricity generation and on a small scale in areas isolated from the network.

Karnataka receives solar radiation in the range of 5.1 to 6.4 kwh/ sq.m. during summer, 3.5 to 5.3 kwh/ sq.m. during monsoon and 3.8 to 5.9 kwh/ sq.m. during winter. Since Hyderabad Karnataka region is blessed with perennial solar energy that can help to meet the electricity shortage, it was proposed to develop/ establish, evaluate and demonstrate the technical soundness of various solar and other renewable energy systems to popularize the same among the people in the region.

Keeping this in view, the project, **"DEVELOPMENT, EVALUATION AND DEMONSTRATION OF SOLAR AND OTHER RENEWABLE ENERGY SYSTEMS"** was taken up by University of Agricultural Sciences, Raichur with Rashtriya Krishi Vikas Yojana funding. The project was implemented from 2013-14 to 2015-16. The details of the project are as under:

1.	**Title of Project**	**:**	**"DEVELOPMENT, EVALUATION AND DEMONSTRATION OF SOLAR AND OTHER RENEWABLE ENERGY SYSTEMS"**
2.	**Nodal officer and Principal Investigator**	**:**	**Dr. M. Veeranagouda,** Dean, College of Agricultural Engineering, University of Agricultural Sciences, Raichur
3.	**Implementing Institution (S) and other collaborating Institution (s)**	**:**	Department of Farm Mechanization and Power Engineering
4.	**Date of commencement of Project**	**:**	2013-14
5.	**Approved date of completion**	**:**	2015-16
6.	**Actual date of completion**	**:**	2015-16
7.	**Project cost**	**:**	Rs. 175 lakhs

The objectives of the project are as follows:

1. Establishment of Renewable Energy Park
2. Evaluation and Demonstration of Solar Pumping System
3. Testing and promotion of solar energy assisted cold storage unit for enhancing shelf life of horticultural produce

The focus of Evaluation is:

i. To evaluate the usefulness of establishment of renewable energy park in demonstrating the use of various equipment powered by renewable energy sources to the farmers.
ii. To evaluate the efficiency of solar pumping system developed in terms of energy saved.
iii. To evaluate the impact of solar cold storage unit for storage of horticultural produce.

University of Agricultural Sciences, Raichur has established a first of its kind Renewable Energy Park. Several equipment and machinery operated by renewable energy sources are on display in the park. The equipment on display include mini multi rack solar dryer, mini multi rack solar dryer with baffle plates, high capacity multi rack dryer, forced convection solar drying system, solar tunnel dryer, solar pumping system, cookstoves, inverted downdraft gasifier wood stove, solar powered knapsack sprayer, solar powered cycle mounted sprayer, solar cooker, parabolic solar cooker, solar water heaters, wind powered water lifting pump, hybrid water pumping system. While the efforts made by the University in establishing the renewable energy park is commendable, **there is need to maintain the equipment in good working condition so that visitors get a very fair idea of the uses of renewable sources of energy. Many equipment on display were not in working condition.**

While the University has established the Renewable Energy Park, systematic programmes to enlighten the farmers, students and general public about the equipment on display have not been chalked out. Description of each equipment and its performance efficiency should be displayed in front of each equipment in local language as well as in English. Well trained guides should be available to escort the visitors and explain the equipment and other details. Sufficient publicity should be given about the Renewable Energy Park. The experience of Vishwesvaraya Industrial and Technological Museum, Bengaluru is worth emulating.

With regard to the solar pumping system, studies regarding the efficiency of solar pumping units at different heads of pumping may be conducted. It is generally believed that solar pumps are not efficient in pumping water from greater depths. Experiments done at Visvesvaraya National Institute of Technology, NAGPUR, INDIA have revealed that

the discharge of water decreases as the head of pumping increases. However, with increase in solar radiation intensity the curve shifts upwards giving more discharge at the respective head (Arunendra Kumar Tiwari et al., 2015). Hence, it will be necessary to choose suitable pumping system depending on the depth of pumping.

The studies with solar assisted mini cold storage unit have revealed that they could be utilized for storing the horticultural produce. The results obtained by storing tomato in the cold storage unit revealed that the minimum and the maximum solar intensities were 340 Wm^{-2} and 630 Wm^{-2} with the panel efficiency of 79.95 % and 43.81 % on a clear sunny day during summer. In fruits stored at 5 °C, 90 % RH pH value, TSS value of fruits, microbial activity and colour loss was less, the fruits retained firmness longer.

REFLECTIONS AND CONCLUSIONS

1. While the efforts made by the University in establishing the renewable energy park is commendable, there is need to maintain the equipment in good working condition so that visitors get a very fair idea of the uses of renewable sources of energy. Many equipment on display were not in working condition.
2. While the University has established the Renewable Energy Park, systematic programmes to enlighten the farmers, students and general public about the equipment on display have not been chalked out.
3. Description of each equipment and its performance efficiency should be displayed in front of each equipment in local language as well as in English. Well trained guides should be available to escort the visitors and explain the equipment and other details. Sufficient publicity should be given about the Renewable Energy Park. The experience of Vishwesvaraya Industrial and Technological Museum, Bengaluru is worth emulating.
4. With regard to the solar pumping system, studies regarding the efficiency of solar pumping units at different heads of pumping may be conducted to choose suitable pumping system depending on the depth of pumping.
5. Technical bulletin and publication have been brought out on the various uses of renewable sources of energy. There is need to organize field visits, training programmes and demonstration trainings involving farmers after giving wide publicity.
6. The economics of operation of equipment using renewable sources of energy need to be done systematically to establish their viability vis a vis traditional equipment.
7. There is need to commercialise manufacture of proven equipment under PPP model. Patents may be taken for the equipment designed and developed by the University.
8. There is need to maintain the equipment on display in the Renewable Energy Park in good working condition.

ACTION POINTS

1. There is need for quantification of solar energy available for utilization in the region and its duration.
2. The solar pumping systems have failed in the State due free power available to farmers for emergising their traditional water pumps. However, this is a challenge to Agricultural Universities and there is need to develop a policy by converging the line departments on the benefits of solar energy and ecology and climate.
3. The economics of solar powered cold storage needs to be worked out besides total volume of storage needed in the region may be worked out with its economics.
4. There is greater scope of convergence of other line departments and focus on PPP model needs to be explored.
5. The wind energy turbines established by private sector needs to be evaluated in terms of their impact on climatic factors more so on aridity and soil moisture and impact on crop growth and yield in and around wind mills.
6. Human resources training on solar gadgets developed/ evaluated needs to be strengthened.
7. While the University has established the Renewable Energy Park, systematic programmes to enlighten the farmers, students and general public about the equipment on display have not been chalked out.
8. Description of each equipment and its performance efficiency should be displayed in front of each equipment in local language as well as in English. Well trained guides should be available to escort the visitors and explain the equipment and other details. Sufficient publicity should be given about the Renewable Energy Park. The experience of Vishwesvaraya Industrial and Technological Museum, Bengaluru is worth emulating.
9. Technical bulletin and publication have been brought out on the various uses of renewable sources of energy. There is need to organize field visits, training programmes and demonstration trainings involving farmers after giving wide publicity through mass media (TV, Radio and newspapers).
10. There is need to commercialize manufacture of proven equipment under PPP model. Patents may be taken for the equipment designed and developed by the University.
11. Utilization of photovoltaic energy application in agricultural greenhouses for and water pumping.
12. Solar PV operated water lifting / pumping system.
13. Solar based processing of agricultural produces.
14. Establishment of Testing center for Solar Photovoltaic Water Pumping System and other solar gadgets as per MNRE (MINISTRY OF NEW AND RENEWABLE ENERGY) Guidelines.

RESEARCHABLE ISSUES

1. Studies regarding the efficiency of solar pumping units at different heads of pumping may be conducted to choose suitable pumping system depending on the depth of pumping.
2. The abundantly available solar power needs to be quantified and documented in different agro climatic zones coming under the jurisdiction of the University.
3. Develop protocols for solar energy usage in cold storages and value additions through PPP mode.
4. Need for developing mobile solar dryers and harvesters.