Project Title: Presenting a justification plan and business model for electrification of pilot agricultural wells in Kerman province- Jiroft

Department:	design and prototyping of high efficient motors in public application	***Employer:***	NRI
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Project Necessity: According to the data of the Iranian Water Resources Management Company, currently more than 219,000 agricultural wells have been identified with an average demand of 30-40 kW in the agricultural sector. In order to increase the growth rate of electrification to agricultural wells, the Supreme Council of Economy Resolution No. 15715610 (the subject of Clause 2 of Note 2 of the 2013 Budget Law of the whole country and citing Article 12 of the Law on Removing Obstacles to Competitive Production and Improving the Country's Financial System) The title "Electrification plan for agricultural wells" has been approved. The purpose of this plan is to support private sector investors in order to speed up the implementation of the plan to provide electricity to agricultural wells. One of the main policies adopted in this plan has been the development of the use of renewable energy sources and distributed generation in order to meet the demand of agricultural wells. Based on the contract signed on October 10, 2018 , (between Tavanir and Iran fuel conservation company) electrification of 75,000 wells with a credit amounting to 1.2 billion dollars has been started. By implementing this plan, saving 30 cents per liter of gasoline will bring benefits to the country's economy.

One of the main challenges in this project is providing energy resources to replace the existing diesel pump with electric pumps. This issue is a major challenge, especially in places far from the network and for shallow wells. So, in addition to direct connection of electric pumps to the grid, the development of renewable resources and distributed generations have been adopted as one of the technological approaches to respond the demand in the agricultural field. With this approach, it is currently possible to provide electricity by using solar panels, wind turbine, distributed generation and finally as the last solution direct connection to the grid. Repayment to investors is calculated as a savings worksheet according to the tariffs set for each of the four solutions (according to the M&V order formulated in this plan) and repay to them in short-term periods. Choosing the optimal scenario for supplying electricity to agricultural wells requires carrying out feasibility studies according to the climatic conditions, agriculture wells characteristics for each area. So, it is necessary to choose the best solution among the 4 proposed methods for of different provinces of the country by taking into account the location, demand and average working hours of agricultural wells, etc. Achieving an optimal scenario of electrification to agricultural wells requires complex steps. The most important of which include:

- Gathering of a comprehensive bank of required data (wind atlas, sun atlas, location of wells, demand, hours of operation, distribution network characteristics, cost ,etc)
- Carrying out potential studies for each of the solar, wind, distributed production and direct connection to the grid solutions and preparing a GIS map

- Cost analysis and cash flows of electrification of agriculture wells
- Using data mining algorithms for clustering and optimal allocation of energy sources for these cluster
- Presenting an intelligent algorithm for clustering and choosing the optimal scenario by considering economic and investment criteria

Achieving an analytical model with the aim of optimally solving the problem of supplying electricity to agricultural wells requires the above steps to be performed on a pilot scale. For this purpose, in this project, the above-mentioned steps have been implemented for implementation on a pilot scale in Jiroft city, Kerman province.

Project Goals: With the aim of providing optimal scenarios for supplying electricity to agricultural wells based on one of the solutions of solar, wind, distributed generation and direct connecting to the grid, the main objectives have been followed as follows:

- Gathering of a comprehensive bank of data needed to plan electricity supply to agricultural wells and prepare a GIS map using the capabilities of ARC-GIS software.
- Carrying out potential studies for each of the solar, wind, distributed generation and direct connection to the grid solutions based on multi-criteria decision making methods.
- Identifying and prioritizing of construction site of renewable units and distributed generation specific to the plan of electrification to agricultural wells with pixelated format in ARC-GIS software
- Costing and economic modeling of the plan to supply electricity to agricultural wells for each of the solar, wind, distributed generation and direct connection to the grid in the form of an investment package.
- Providing an optimal clustering algorithm specific to the electricity supply plan to agricultural wells based on an innovative methods.
- Modeling the uncertainty in the input data and considering it in the optimization method.
- Proposing investment packages for optimal scenarios in three categories of probable, Risk-on and Risk-off scenarios

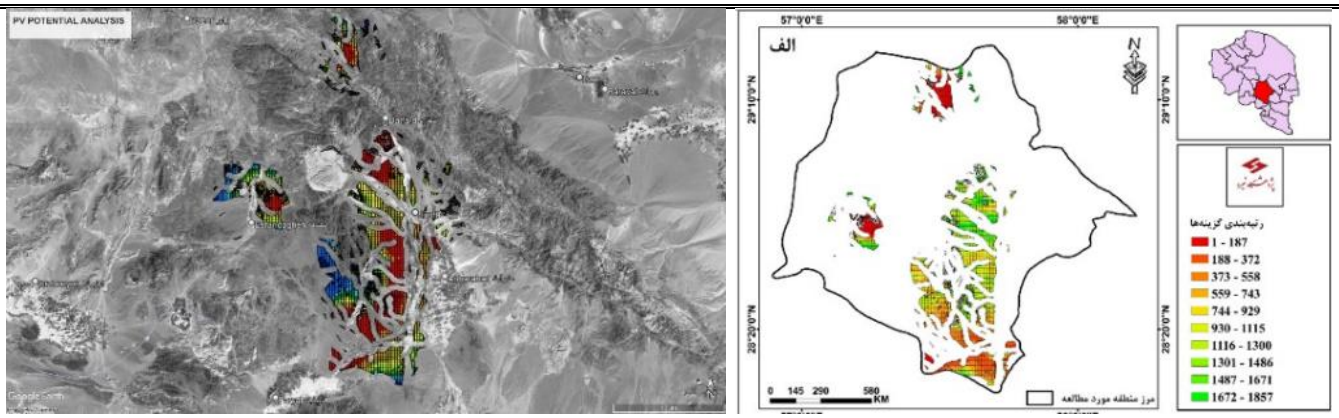
Abstract: One of the main challenges in the plan to supply electricity to agricultural wells is to respond to the load demand in remote place of the network. The effective strategy in order to solve this challenge is the development of renewable sources and distributed generation in suitable areas. Identifying the potential points and determining the optimal scenario for clustering and allocating the best energy supply solution requires collecting a large amount of field data and using appropriate algorithms. Accordingly, in this project, various stages of feasibility studies have been carried out, from the stage of collecting the required data to determining the optimal scenarios of electricity supply for the Jiroft pilot in Kerman province. In the first step, all the required data was collected, and in the next step, its GIS map includes different layers of data (wind atlas, sun atlas, position, demand and working hours of agricultural wells, etc.) was created in the ARC-GIS software environment. In the next stage, using a computational algorithm based on the TOPSIS multi-criteria decision-making method, studies on the potential of renewable sources (wind and solar), distributed generation and connection to the grid were carried out. Finally, the results of the feasibility studies were carried out in the order of their priority for each of the solutions in the form of a pixelated map for the Jiroft pilot. In this research, due to the existence of uncertainty in a number of input parameters, the probabilistic uncertainty modeling method has been used. In the next phase of the project, using an innovative algorithm based on the DBSCAN clustering method, optimal scenarios for the construction of solar and wind power plants, distributed generation and direct connect to the grid have been presented. Finally, considering the uncertainty, investment packages have been presented based on three different approaches, probable, Risk-on and Risk-off scenarios for the Jiroft city pilot.

Steps and Methodologies: In order to achieve the goals of the project, the steps and methods used are as follows:

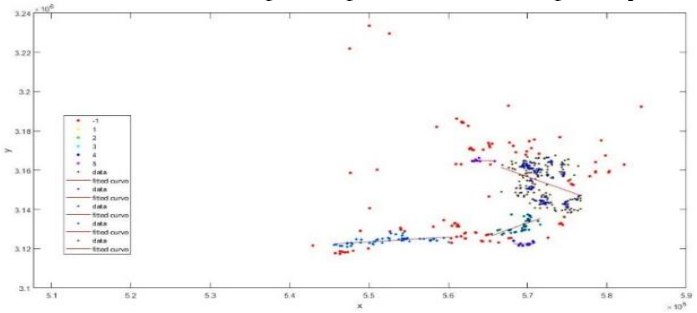
1- Data collection and GIS map preparation:
   - 1-1- Data collection of agricultural wells and network from South Distribution Company of Kerman Province, Kerman Regional Water Company, Kerman Agricultural Jihad, preparation of layered GIS map in ARC-GIS software
   - 1-2- Gathering wind and sun atlas data and preparing GIS map in ARC-GIS software
   - 1-3- Collecting geographic data (regions, slope, height , etc.) and preparing a layered GIS map in ARC-GIS software
2- Preparation of a graphically ranked (pixelated) potential measurement map for each of the solar, wind, distributed generation sources and direct connect to gride using the TOPSIS and multi-criteria decision making method coupled with ARC-GIS software.
3- Uncertainty modeling in input data (radiation level, wind speed, operating hours, etc.) using probabilistic methods.
4- Cost modeling of the implementation of the project using any of the solar, wind, distributed generation and grid connection solutions and calculating the incoming and outgoing cash flows as well as calculating the economic indicators of net present value, internal rate of return, investment return period.
5- Providing an optimal clustering algorithm specific to the electricity supply plan for agricultural wells based on an innovative method combined with the DBSCAN clustering algorithm
6- Proposing investment packages for optimal scenarios in three categories of probable, Risk-on and Risk-off scenarios.

Main Results (technical outputs, patents, papers, books, reports, etc.):

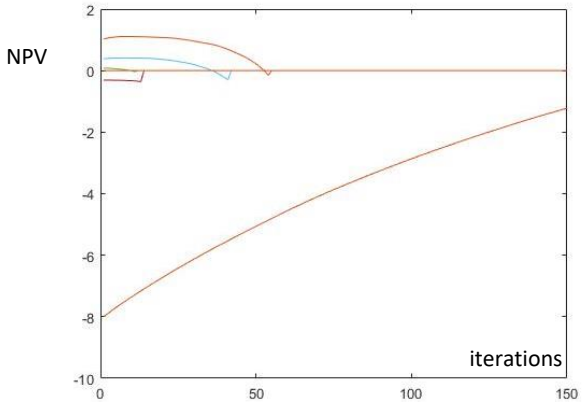
- Preparing a GIS map for electricity supply to agricultural wells, including distribution network data, location of agricultural wells, hours of operation, demand for agricultural wells, geographical characteristics (slope, height, radiation angle, boundaries, etc.) Layered in ARC-GIS software
- Preparation of pixelated graphical potential map and by considering of priority for each solar, wind, distributed generation and grid connection solutions.
- Preparation of a software package with the aim of modeling the uncertainty of input data using the probabilistic method
- Providing an optimal clustering algorithm based on DBSCAN clustering algorithm and an innovative method
- Providing a software package in order to implement different stages of optimal clustering and optimal location of solar, wind, distributed generation sources and direct connection to the grid solutions
- Presenting the final scenarios in the form of investment packages based on three approaches: probable, Risk-on and Risk-off scenarios.



An example of the potential map for the simultaneous construction of solar and wind power plants in order of priority



Clustering of agricultural wells and estimation of main feeders



NPV curve for the most probable case for the PV scenario in 150 iterations

Optimal clustering results for solar energy solutions and the best cluster in terms of NPV index

Scenario type:	probobility	NPV	Number of wells (for maximum NPV)
probable	0.1224	1.603111209	84
Risk-on	0.1042	1.7504828925	91
Risk-off	0.0828	1.480666204	64

[1]Hossein azizi moghaddam, saman nadizadeh," Potential measurement of optimal solar energy areas for power supply to agricultural wells using spatial analysis (Case study: Jiroft)" ,Fifth International Conference on Technology Development in Iranian Electrical Engineering" , 2021 ,Tehran

[2] Hossein azizi moghaddam, saman nadizadeh," Designing and implementing a location-based model to identify areas suitable for multi-renewable energy development for supplying electricity to agricultural wells "Renewable Energy, under review