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Renewable Energies

I. History and Background

With the first largest gas reserves and the fourth oil reserves in the world, Iran is a global hydrocarbons giant. The Iranian policymakers, however, are very eager to develop renewable energies to increase energy security, reduce the country's dependence on hydrocarbons, and realize its growth targets in electricity demand. Iran's advantageous topography for renewables makes the fulfillment of these objectives pretty realistic and probable for the Iranian government. In addition, Iran boasts a young and educated population and currently, the country is relatively open to acquire the requisite technologies and finance. Iran, therefore, hopes to cut down hydrocarbons and replace them with the clean and renewable energy sources spread throughout the country.

II. Policies and Strategies

Major policies of energy sector based on the national document of knowledge-based development of renewable energies are as follows:

Macro Level Policies

- Taking into account the human resources as the main factor in creating competitive advantage and value-added;
- Adopting an endigenous outward-oriented approach in developing renewable energies;
- Prioritizing non-governmental sector, private sector in particular, in implementation stage of the policies while focusing on policymaking and supervisory role of the government;
- Centralizing policymaking and planning while securing decentralized implementation;
- Specifying authorities' roles and responsibilities in areas of policymaking, implementing, and monitoring;
- Considering environmental requirements and preparing the country for sustainable development of renewable energies;
- Taking benefit of the commercialized local technologies in development of renewables.

III. Capacities and Capabilities

A. Current Status

- **Hydropower**

Hydroelectric power emerged as a renewable alternative in Iran in the 1950s. Iran, unlike most Middle Eastern states, is home to a vast network of rivers that allowed the country to rapidly scale

its hydroelectric infrastructure until the early 2000s. Recent widespread droughts, however, have greatly reduced Iran's hydroelectric capacity.
Once contributing to 14 percent of Iran's base load energy supply, hydroelectric sources have been reduced to less than 5 percent, as river levels continue to fall. As a consequence, the Deputy Head of Tavanir Company recently stated that nearly all of Iran's 50 hydroelectric plants have either halted generation or have seen their capacity diminished.

- **Wind**

With 100,000 MW of potential installed capacity, Iran's wind power potential could rival that of major wind developing countries such as France and Britain. Unsurprisingly, Iranian government has given wind power priority over other renewable energy sources due to the country's topography and existing manufacturing and production capabilities.
A 5,000 MW increase of energy capacity due to new renewable energies is anticipated by 2018. Roughly 4,500 MW of that capacity is expected to come from utility-scale wind farms throughout the country. Due to its strategic location along several major wind corridors, including Atlantic, Mediterranean and Indian Ocean currents, Iran's northwest and northeast experience high winds year-round.
The relative consistency of the wind currents allows for sustainable access to wind energy that will significantly reduce the need to use peak power thermal generators for daily power generation. Iran is well-positioned to rapidly scale up its wind power sector. The country has already operated 15 wind farms and the vast majority of the components used to develop those farms have been developed locally. Due to the impact of Western sanctions, the country has made use of its abundant human capital to develop technological capabilities in turbine, generator, and inverter production, and has even considered exporting this equipment to Azerbaijan and India.

- **Solar Development**

Iran enjoys a high diversity in its climate and vast arid regions. Because the south, northwest and southeast regions receive around 300 days of sun per year, they are uniquely suited for solar energy. Iranian government has prioritized the central region in particular due to its climate and proximity to the national power grid.
Involvement of foreign partners in solar projects is both practical and economical. A lack of access to key solar technologies like inverters for voltage control and appropriately advanced semiconductors

has brought about logistical challenges to domestic Iranian companies. With the recent removal of sanctions, Iranian companies now have greater access to a wider range of increasingly sophisticated solar technologies and financing to purchase and develop them. The immediate benefits will be rapid installation of technologies and, in the long-term, the country is likely to benefit from gaining the ability to produce a significant amount of its solar infrastructure domestically.

- **Continued Development in Geothermal**

Iran has begun development on the Middle East's first geothermal power plant. This "pilot" station in the northwest Iranian province of Ardabil is expected to have an installed capacity of 50 MW. Because of its placement in the north of Iran, where infrastructure is underdeveloped and demand for electricity outpaces supply, the impact of the plant is expected to be immediate. While development of geothermal energy in Iran is comparatively inchoate, the potential is still significant. A study conducted by researchers at Stanford University, for instance, posits that development of geothermal energy in Iran is possible in 14 separate geographies, spanning nearly the entire country.

B. Some Achievements

- **Fuel Ethanol Production from Bagasse with the Capacity of 1000 Liter/day**

Implementing this project for the first time in Iran and the region, with the mission to acquire the technology to produce alcohol fuel including new ethanol blends (e.x. B5, E5, E10, E15, E85, and E100) and the technical knowledge to produce fuel grade ethanol from bagasse, has brought Iran among the few countries with this technology.

- **Geothermal Heat Pump**

Geothermal heat pump systems are implemented to use clean renewable energy and produce the needed energy for cooling, heating, and providing hot water. Geothermal heat pump systems have already implemented in cities of Qom, Tehran, Taleqan, and Shiraz and their technology has been localized, too.

- **Feasibility Study, Site Selection, and Designing Large-scale Photovoltaic Power Plants**

Using solar energy through large-scale photovoltaic (PV) systems is a new efficient solution for areas with plenty of sunshine. Iran has been able to implement all of the stages of designing large-scale power plants including site selection, running feasibility studies, preparing overall layout of the plant

and estimating the required site area, acquiring the permission for connecting to the grid through examining topography of the proposed land, identifying the estimated location of the power plant considering technical-economic requirements, preparing detailed maps including plant layout, taking into account all the details including solar modules, structures, inverters, electrical panels, posts connected to the grid, and monitoring as well as protecting systems, etc.

- **Electric Motorcycle**

Iranian electric motorcycle with speed of 100 Km/h and traveling 100 km on a single charge can be a perfect alternative for conventional motorcycles. This model uses chargeable lithium ion batteries which could be charged in three hours. It enjoys a customizing option so that customers can select their desired features according to their own particular needs, applications, and costs.
Given the growing electric vehicle market, there is an increasing need for charging stations. In this regard, an Iranian knowledge-based company, then, has developed a smart charging station for electric motorcycle.

- **Advanced Parabolic Collector of One Hundred Meter**

This collector with 100 m length and mouth width of 5.7 m is installed at a height of 3.5 m. It can automatically track sunlight by means of a software, a protractor, and a hydraulic system consisting of two jacks and drive/control. This large advanced collector includes a foundation, a collector structure (the main part of the collector), a hydraulic system, an absorber tube, mirrors, and a tracking/control system.

- **Compact 5 KW PEM Fuel Cell System**

Polymer fuel cells are of various applications including residential use (5 KW). The main objective of this project is to adopt metal bipolar plates for PEM fuel cells. Considering the need for reducing volume and weight of the fuel cells, improving fuel cell stack heat management, and facilitating their recharging and reusing, Iranian researchers have made extensive efforts to develop metal bipolar plates in the recent years. Iran has managed to acquire this technology and fortunately, the country enjoys a range of metal reserves required to produce such metal plates. Currently, Iran manufactures 5, 10, and 25 KW fuel cells using metal plates.

• Pilot Construction and Feasibility of Conversion of Waste to Synthesis Gas and Energy Using Plasma Technology

This project aims to dispose, disinfect, and convert wastes to energy. Currently, the project for producing 100 tons/day of syngas is implemented in Tehran and it is going to be performed in other cities, as well. Some of the unique features of this project are minimizing environmental contamination, maximizing solid waste conversion, decreasing mass and volume of wastes up to 95 percent, producing clean high quality syngas, etc. This technology can be used in other industries such as oil industry to refine oil wastes and it can provide various solutions to produce energy (electricity, hot water, steam, and several fuels like hydrogen, methane, ethanol, methanol, etc.), as well.

• Hydraulic Turbine Microcomputer Digital Governor, Research Design and Industrial Sample Production

Turbine governor is one of the main parts of power plants that along with monitoring turbine performance is responsible for controlling turbine speed and output power of the generator. This unit has a complicated control algorithm and its design and manufacturing technologies are confined to some developed countries. In line with energy self-sufficiency, Iran is making efforts to acquire this technology, albeit Iranian engineers have successfully produced one model of this system which has not been installed, yet.

• Back-Up PV Invertor

This project is designed to acquire technical knowledge to manufacture back-up PV invertors. Gird-tie invertor can inject the surplus energy into the grid and when it is off-gird, it can supply the requisite energy for sensitive and priority loads. Iran has accomplished developing such systems as a domestic production.

• Reference Testing Laboratory for Thermal Solar Systems

This reference laboratory is built to conduct technical and functional indoor/outdoor tests in accordance with global standards for solar thermal systems including thermal collectors, storage tanks, and solar water heaters in an attempt to commercialize and localize these systems and obtain SOLAR KEYMARK standard in turn. Some of the activities of this laboratory include

conducting thermal performance and efficiency tests, rain penetration tests and thermal shock tests (internal and external), and measuring mechanical strength (under stress and tension) and thermal impacts (by steel ball and ice ball) through a portable system.

- **Prepregs for Wind Turbine Blades**

Epoxy resin prepregs are important products in designing and manufacturing wind turbine blades. Features such as cleanness and ease of use, less material waste, increased speed and precision of manufacture process, product quality consistency, and controlled kinetic and rheological parameters during firing process have made this product popular in many strategic industries including designing and manufacturing wind turbine blades.

- **Wind Turbine Gear Box**

With the mission to localize gearbox of 660 KW wind turbine and acquire technical knowledge of manufacturing components of wind turbines domestically, Iran has succeeded to manufacture a gearbox for 660 KW wind turbine by means of reverse engineering.

- **660 KW Wind Turbine Generator**

Wind turbine asynchronous generator is one of the most complicated parts of wind turbines which has been designed and developed domestically in Iran.

- **Solar Cell (PV Cell) Module**

Iranian solar panels are under TUV and CE° certificates and enjoy high efficiency and appropriate warranty. Iranian solar manufacturers, along with producing and supplying these panels, are active in other areas of solar power projects such as lighting, residential, telecommunications, industry academia, research, agriculture, nomadic and rural, and power plant.

- **Solar Residential Water Heater and Desalination System**

Due to the need for supplying sanitary drinking water throughout the country, solar water heater and solar water heater/desalination system have been designed and manufactured using humidification and dehumidification processes and now are in operation in many of the central, eastern, and southern areas of the country.

IV. Authorities

A. Renewable Energy Technology Council

In July 2008, the Renewable Energy Technology Council was founded by the Vice-Presidency for Science and Technology with the aim to activate all the country's human and finance resources, avoid overlapping work, provide the requisite platform for transparency, criticism, and assessment of activities, identify available capacities, and finally commercialize research outputs as the main ring of the innovation chain of renewable energies in the country.

B. Renewable Energies Organization of Iran (SUNA)

The Renewable Energies Organization of Iran (SUNA) was established by the ministry of energy in 1996 with the missions of evaluating the country's potentials and implementing several renewable projects (solar, wind, geothermal, hydrogen, and biomass), performing pilot projects, and designing and constructing power plants with cooperation of public and non-government sectors. It is also responsible for guaranteed purchase/sales of renewable electricity with the aim of encouraging private sector's participation in this field, providing the required platform to study renewables, and paving the way for utilizing various renewable resources using the country's rich capacities and capabilities.

C. Universities, Research Centers, and Laboratories

Currently 51 universities and research centers and 83 laboratories are working on renewable energies.

V. International Cooperation

The attractiveness of Iran's renewable energy potential has not gone unnoticed. As early as 2014, German, South Korean, Danish and Indian businesses began closely examining the sanctioned country's renewable energy industry as a long-term investment opportunity. Iranian officials responded with enthusiasm to Western curiosity by reducing bureaucracy in the energy sector, streamlining its licensing process, and presenting competitive incentives to renewable energy infrastructure developers and equipment suppliers. For instance, SUNA modeled its new feed-in tariff policy on the German equivalent, guaranteed government purchases of power for 20 years, and introduced a bonus (30 percent higher electricity price) for companies that use domestic components.