Impacts of Energy Transition in Iran on Vulnerability of Infrastructure to Natural Hazards

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ABSTRACT: Energy, as a fundamental component of modern society and life, has a direct impact on each human activity and plays a critical role in socio-economic development. Indeed, energy is deeply embedded in each component of mankind development: economic, social and environmental ones. Energy is a crucial element for functioning of modern society and any break down in the energy sector, which affects energy supply, has negative impacts on all other economic sectors and spheres of human activity. Iran is an energy superpower, which has the fourth largest oil reserves and the second largest natural gas reserves in the world. Energy consumption in Iran is significantly higher than international standards and continues to grow. Iran has the third highest level of consumption of natural gas in the world and its domestic consumption is projected to grow by making Iran the largest natural gas consumer in the world. Despite abundance of fossil fuels, Iran is considering deployment of renewable energies sources and these plans are driving energy transition in the country.

***Keywords*:** Rural Development, Renewable Energy, Electricity Transmission, Social Acceptance

1. INTRODUCTION

Currently the development of renewable energy sources (RES) in Iran is in its preliminary stage with a minor share in the final energy mix (Fadai et al., 2011) but potentials are significant for such sources as biofuels, hydropower, wind, solar and geothermal (Hosseini et al., 2013). Ambitious plans exist at international, regional and national governance levels to deploy renewable energy sources to cover local growing energy needs, to diversify energy supply and to benefit from electricity trade. In the year 2010 hydro and wind capacity already existed in Iran and the government settled a target to deploy 2GW of additional RES capacity by the year 2015. In the year 2012 Iran allocated 500 million Euro to the National Development Fund for renewable energy projects and established a state-sponsored Renewable Energy Organization of Iran.

Energy transition is on-going in Iran and creates new requirements for electricity transmission networks. The growing volumes of energy consumption and deployment of new energy sources will create new challenges for electricity transmission grids in the country. For instance, currently volumes of wind energy are modest (Saeidi et al., 2011) but potentials are estimated to be about 6.5GW (Fadai et al., 211) or even higher, between 20GW and 30 GW of wind electricity, which might cover a half of the Iranian energy consumption (Alamdari, 2013). Further deployment of RES, and especially of such volatile sources as wind energy, would require deployment and upgrading of existing transmission capacities. The existing in Iran electricity transmission infrastructure was designed several decades ago to satisfy the needs of energy generation, which was dominated at that time by fossil fuels, with energy generation sources being located nearby energy consumption areas. The new requirements on the grid architecture are to integrate volatile and intermittent electricity coming from renewable energy sources, which are located in different geographic areas. These requirements will lead to new forms of grid architecture such as smart grids to balance intermittency of renewable energy sources, and super grids to transfer large volumes of electricity over long distances.

RES are variable and cannot be controlled. Therefore, the power generation cannot be scheduled according to the demand and the probability is high that demand and supply peaks would not correlate. The transmission systems operators would need to balance these irregularities to keep frequency and voltage within a stable range. Deployment of RES in zones far from consumption centers requires that grids will be also able to gather and send through the output from the flexible and back-up power plants. If existing and future flexible and back-up units cannot be located close to renewable energy generation and use the same transmission grid, the need for more lines and smarter grid management will increase. This situation creates an urgent need to increase capacity of transmission lines and to reduce congestion during key period to guarantee stability of the grids.

Electricity transmission grids are already subject to impacts of natural hazards such as extreme weather events, earthquakes, cyclones, storms, heat waves and others. All these impacts affect physical integrity of electricity transmission grids and decrease transmission capacity. Heat waves can also result in higher risks of flash-overs when high-voltage discharges are caused by lightning. However, there is no correlation between rising number of black-outs and rising temperatures, droughts or increased frequency of extreme events (Customer Average Interruption Duration Index). But the share of weather – related outages and black-outs is high. However, there is correlation between the state of electricity transmission infrastructure and its vulnerability to natural hazards. For instance, electricity grids which are pushed to the limit of their capacities are more vulnerable to flash-overs from trees. Correlation also exists between reduced transmission capacity of the grids because of the climate extreme events and the probability of black-outs.

2. CONCLUSION

Several scientific works exist on the topics of economic and technical feasibility of energy transition. However, deployment of new technology cannot be driven by availability of technical and economic capacities alone. Stakeholders, who are implementing the technology and who will be consumers of energy generated by it, are driving energy transition. The need to understand human factors as an essential element of energy policy is also caused by the fact that development and acceptance of any innovation is not a purely rational process, settled in a top-down manner by policy-makers through advice of scientists and then communicated to stakeholders. Public acceptance of this new infrastructure is one of the main barriers for further its further deployment. Because nowadays no technological or legislative choice on any energy model can be effectively implemented without social acceptance. The citizen protests might delay construction and upgrading of new grids for several years. These protests also often happen when inhabitants are recognizing the need for energy transition, in general, but are concerned with local impacts of new or upgraded overhead lines on their communities

The resilience of electricity transmission grids includes all activities, which are needed to ensure their functionality, continuity and integrity in order to deter, mitigate and neutralize a threat, risk or vulnerability. It is a very complex issue as the electricity system consists of three main parts: generation, transmission and distribution. All these components are interconnected and include a large number of elements, such as interconnectors, edges and nodes. The overcapacities of electricity grids make them more vulnerable to impacts of natural hazards. Therefore, this contribution has two research aims:

- The first one is to understand and to classify factors which impact electricity transmission infrastructure in Iran in light of the on-going energy transition and which make electricity transmission infrastructure more vulnerable to impacts of natural hazards.

- The second one is to understand patters of public and social acceptance of energy infrastructure and how these patters can affect deployment and upgrading of electricity transmission grids and become a barrier for resilience of electricity transmission system.

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