Chapter 8.16
Digital Energy:
Clustering Micro Grids for Social Networking

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ABSTRACT

Since energy use is a type of consumer behavior reflecting the interests to maximize some objective function, the human being activities seen in energy terms might be used to create the social aggregations or groups. Electric energy generated from ecologic sources brings some unpredictability. Authors model the unpredictability of the distributed generation in order to create a tool for minimization. Authors propose the novel method to build real life smart micro grids in the distributed generation context characterized by zero emissions. The proposed tool becomes an instrument to create the social aggregation of users and negotiate locally the "social" energy in real time, strengthening and mastering a virtual neighborhood of the local community.

INTRODUCTION

Electric energy distribution networks were designed to distribute the centrally produced energy, considering the top-down structures and the Supervisory Control And Data Acquisition (SCADA hereafter) systems to manage them. One possible analogy with the human body gives the blood system, distributing oxygenated flows towards the cells (consumers) starting from the central heart/lung node (producer). The brain like any SCADA ensures the constant blood pressure (load balancing) analyzing the peripheral oxygenation thanks to the nervous lines. The system sends the stimuli to the heart/lung, keeping itself well functioning within certain limits even when infusions/drawings are administered.

The renewable energy, for instance the photovoltaic one, depends on the natural factors, such as clouds, wind, and ephemeredes. The alternative sources of energy introduce some entropy because their contributions have a certain extent of unpredictability. The photovoltaic power is generated during the daytime, and the flow intensity depends on the weather condition, adding some complexity to solve by modeling (Mellit, 2006). The eolic energy production is possible only during the windy condition, which is variable as well. Consequently the released power is uncertain, unpredictable in some extent, and it adds some instability to the power grid, simply because of the physical nature of the underlying phenomena, and might be seen as topic to deal with in load balancing perspective. Due to the higher unpredictability and uncontrollability an imbalance between supply and demand of electricity has to be settled by someone, leading to the extra costs, consequently these factors could finally result in a drawback for the integration of renewable energy sources (Frunt, 2006). The load balancing in the context of an unpredictable energy in power grids is ecologically expensive, because of the compensation coming form the instant, non eco-friendly, generators. The electric energy generated from the distributed renewable energy generators might be instantly consumed locally instead of flooding into the distribution network, eliminating specific controlling interventions. From the free energy market perspective, the best option appears also the immediate consumption of the locally produced energy following the well-known short chain "producer-to-consumer" because of the possible penalties for the Service Level Agreement (SLA hereafter) violations. Even if the ecologic alternative energy production today might be stimulated by incentives, however someone (the transmission system operator or the Society) has to pay for the imbalance induced by the unpredictable energy injection. In the liberalized market context the load balancing might become more expensive than the generated economic value, requiring the solution for the minimization of the impact induced. Moreover it becomes necessary adding the unpredictability/uncertainty indicators instead of characterizing nodes by power thresholds only.

The electric energy distribution network is notably storage free, requiring the adoption of the (a) real time load balancing, which is possible monitoring constantly the digital energy in real time (REMPLI project, 2008), or using the (b) user socialisation toolkit locally in order to establish the "social condominium", or (c) negotiating the energy locally, to avoid the accounting of the transits towards the main distribution backbones. The most interesting option from the social point of view is the creation of the local (virtual or not) community of human being, presenting common social and living patterns, e.g. those contributing to consume locally the renewable energy, consequently decreasing the energy demand.

An electric micro grid (Gellings, 1981) could be defined as a low voltage distribution network with distributed energy sources altogether with storage devices and loads, which could be operated, either interconnected to the main grid or either isolated from it, by means of a local management system with a communication infrastructure allowing control actions to be taken following any given strategy and objective. The social community of human being belonging to the above-mentioned topology might be organized to exploit better the possible synergies and benefits. Consequently we investigate on the possible optimization of the above-mentioned topology trying to minimize the uncertainty by the total local consumption of the produced energy. We create the cohesion between the human actors belonging to the said topology through the new concept of the "social" electric energy. Unlike traditional energy, the social one is locally produced and locally consumed by the micro power grid, thanks to the direct interactions among producers and consumers.

Human being is social by its nature and consumes energy to achieve the goals. The artifacts created by humans, such as houses, offices, electric vehicles, and other representative devices/appli-