Study of Distributed Energy Management System for Energy Internet

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Abstract— The approaching energy internet emphasizes complete consumption of energy in the entire power system by coordinate multi-micro grids, which also brings new challenge for the energy organization. In this paper propose a original consensus-based distributed approach based on multi-agent framework to explain the energy management problem of the energy internet, which only requires general information substitute among adjacent agents. In this paper also explained the functions of distribution management. By way of the bidirectional power flow provided by the Energy Internet, various methods are promoted to improve and increase the energy utilization between Energy Internet and Smart-Grid. This paper proposes a original distributed coordinated controller combined with a multi-agent-based system which is applied to distributed generators in the Energy Internet. Then, the decomposed tasks, models, and information flow of the projected method are analyzed. The proposed coordinated controller installed between the Energy Internet and the Smart Grid keeps energy while providing accurate power-sharing and minimizing circulating currents. To conclude, the Energy Internet can be included into the smart-Grid seamlessly if necessary. Hence the Energy Internet can be operating as a revolving accumulates system.

Key words: Distribution Management System, Energy Internet, Functions of DMS, Agents for Energy Internet

I. INTRODUCTION

A. Distribution Management System

It is a collection of application designed to observe & organize the total distribution system powerfully and consistently. It acts as a decision maintain system to support the control space and ground operating human resources with the monitoring and control of the electric distribution system. humanizing the consistency and quality of service in terms of sinking outages, minimizing outage time, maintaining satisfactory frequency and voltage levels are the enter deliverables of a DMS.

B. Need of DMS

- To reduce the duration of outages and improve the speed and accuracy of outage predictions.
- Reduce group guard and drive times through improved outage locating.
- Improve the operational efficiency
- Determine the crew resources necessary to achieve restoration objectives.
- Successfully utilize resources between operating regions and improved consumer satisfaction.
- Provide customers with more exact predictable re-establishment period [1].

C. Functions of DMS

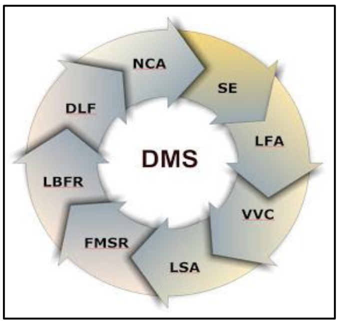

Fig. 1: Functions of DMS [2]

1) Network Connectivity Analysis (NCA)

Distribution network regularly covers over a huge area and catering power to different customers at singular voltage level. Panning & zooming provided with normal SCADA system GUI does not coat the accurate prepared condition. To locate necessary sources and loads on a superior Operator interface is extremely complex. Network connectivity analysis is a machinist specific functionality which helps the operator to identify or locate the prefer network or very easily.NCA does the essential analyses and provide show for point of various network loads. Based on the status of all the switching devices such as circuit breaker, Ring Main Unit and isolators that modify the topology of the network modeled, the existing network topology is single-minded. The NCA further assist the employee to organize in use stipulation of the distribution network instead of radial advance loops and parallel in the network.

2) State estimation (se)

The state estimator is a basic component of the in general observe and organize systems for communication networks .It given that a regular approximation of the organization voltages. This sequence starting the condition estimator flows to manage centers and file servers across the network. The variables of importance are problem-solving of parameters similar to restrictions to operating limits, health of equipment and required operator action. It allows the result of these variables of concentration with high self-assurance even with the facts that the size may be degraded by noise, or could be missing or inaccurate. Even though we may not be able to straightforwardly examine the status, it can be conditional starting examine of size which are understood to be corresponding.

3) Load Flow Applications (LFA)

Load flow study is a middle tool involving arithmetical analysis applied to a power system. The load flow learning generally uses simplified notations like a single-line diagram and focuses on various forms of AC power rather than voltage and current. It analyzes the power systems in typical steady-state operation. The purpose of a power flow lessons is to achieve total voltage angle and amount information for each bus in a authority system for particular weight and producer accurate power and voltage situation. The real and reactive power flow on each division as well as originator reactive power output can be logically determined. Power flow studies are significant for arrangement future development of power systems and determining the most excellent function of accessible system.

4) Volt/ VAR Control (VVC)

The process of managing voltage levels and reactive power throughout the control distribution systems. There could be loads that surround immediate workings parallel to capacitors and inductors that position extra strain on the network. The reactive section of these a lot of causes them to describe more existing than an otherwise comparable resistive load would draw. The erratic modern results in both under-voltage violation as well as heating up of equipments like transformers, conductors which capacity even necessitate resizing to bring the entire current. A power system requirement to organize it by calculating the construction, combination and current of instantaneous power at all levels in the organization. A VVC application shall help the machinist to temperate such surroundings by suggestive of essential achievement plans. The plan will give the required tap position and capacitor switching to make definite the voltage to its border and thus optimize Volt Var control purpose for the convenience.

5) Load Shed Application (LSA)

Power system by its individuality have long stretch of transmission row and multiple injection points, hence instabilities which lead to critical failure or un predicted system conditions are un avoidable. Usually distribution network is composite and covers superior part, the disaster measures taken at downstream reduces lots of weight on upstream network. In a non-automated system, system attentiveness and operators ability to react to the location acting key role in improvement. If the decisions are not fast enough, the problem can grow exponentially and causes major disastrous give way.DMS requirements to present a modular programmed load cracking & return application which automate emergency operation & control supplies for any utility. The submission should cover different behavior like Under Frequency Load Shedding, limit violation and time of day based load coming off schemes which are frequently performed by the operator.

6) Fault Management & System Restoration(MSR)

Consistency and excellence of power supply are key parameters which need to be ensuring by any effectiveness. Concentrated outage time interval to customer, shall progress more all usefulness consistency indices therefore FMSR or computerized switch applications plays an important role. The two main features required by a FMSR are Switching management & optional switching plan. The DMS purpose receive fault in sequence from the SCADA organization and processes the same for identification of faults and on management switch managing purpose the consequences are converted to realization diplomacy by the applications. The action plan includes switching ON/OFF the automatic load break switches Sectionalized .The action plan can be confirmed in revision mode provided by the functionality .The switch supervision can be regular base on the arrangement.

7) Load Balancing via Feeder Reconfiguration (LBFR)

Load balancing via feeder reconfiguration is an essential purpose for utilities where they have various feeders feed a load packed area. To balance the loads on a system, the operative re-roots the many to other parts of the collection. A Feeder Load Management is necessary to allocate you to manage energy release in the electric distribution organization and recognize difficulty areas. A Feeder Load running monitors the essential symbols of the distribution system and identifies areas of concern so that the distribution operator is forewarned and can well focus attention where it is most needed. It allow for more express improvement of existing troubles and enables potential for problem escaping, leading to both enhanced consistency and energy deliverance presentation. Feeder Reconfiguration is also second-hand for failure minimization. Due to numerous system and prepared constraint effectiveness network may be operate to its greatest capacity without meaningful its consequences of losses occurring. The generally energy fatalities and revenue losses due to these operations shall be minimizing for valuable operation. The DMS principle utilizes switching managing submission for this, the victims minimization problem is solve by the most favorable power flow switching devices are created similar to above occupation.

8) Distribution Load Forecasting

Distribution Load Forecasting provides a structured boundary for creating, organization and analyzes load forecasts. It be supposed to be considered to make easy both "top-down" and "bottom-up" forecasting methodologies in the identical surroundings without introduction any limitations on the types of models existing and be supposed to maintain short-term, medium-term and long-term forecasting [2]

D. Energy Internet

Energy Internet, the circulated corresponding organizer shared with multi-agent consensus system proposed. A typical architecture of Energy Internet included with the projected controller is shown in Fig. The energy sources in an Energy Internet consist of distributed renewable energy resources distributed energy storage devices, Main-Grid. In this document, the designation of the controller structure used in an Energy Internet is based on the multi-agent system structure and each DRER, DESD, MG I controlled by each different agent winning advantages of the independent, intelligent, helpful practical and adaptive facial appearance of the multi-agent system.

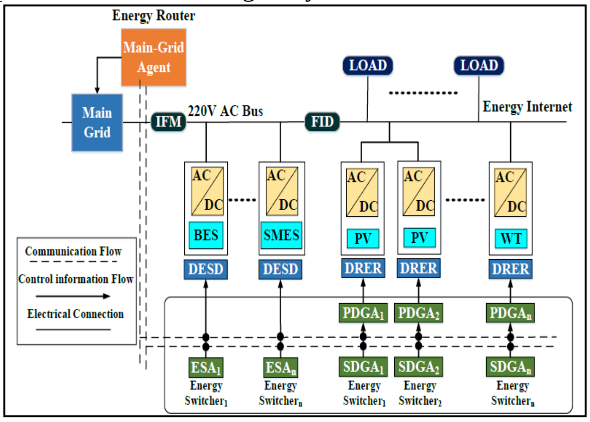

Fig. 2: Architecture of Energy Internet [3]

The proposed Energy Internet structure and distributed coordinated controller should meet the following requirements:

1) Minimize the circulate current between different DGs to enhance effectiveness of energy communication.
2) Accomplish thin communication structure to increase the consistency and competence of the control organization.
3) achieve power-sharing in proportional among different DGs vigorously and restore the amplitudes and angles of output voltages to nominal value to keep tracking with the information from the leader.
4) Make certain the high consistency of the anticipated and maintain not to be faulted transition when Energy Internet switches between the grid-connected mode and islanded mode, which is called turning, preserve state [3].

E. Agents for Energy Internet

Each agent in the anticipated controller has its own goals and functions. According to special goal and functions, there are three singular agents designed for the distributed corresponding organizer and two supplementary agents in the normal multi-agent system. The three different agents include the Main-Grid Agent, the DG Agents which consist of the Primary-DGA and the Secondary-DGA, the Energy Storage Agents. The MGA is also called energy router which is use to normalize the authority flow connecting Energy Internet and Main-Grid. The ESA and SDGA are all called energy switcher which is use to normalize the power current surrounded by Energy Internet. The additional two necessary agents in a multi-agent system consist of the agent organization service agent who is essential and the directory facilitator agent. In calculation, the intelligent fault management, and fault isolation device are also install on the evolution lines so the reference architecture of multiagent system is shown in following figure.

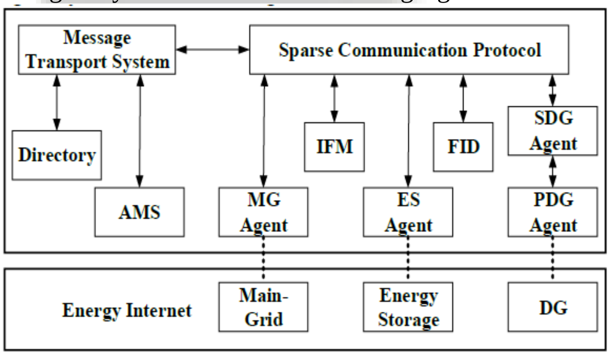

Fig. 3: Architecture of Agents of Energy Internet [3]

1) Main-Grid Agent (MGA):

It is essentially used to choose the operation modes for Energy Internet and calculate circulating currents between Main-Grid and Energy Internet. It provides the control information for the ESA and DGA. The general architecture of MGA is illustrated [4] in Figure.

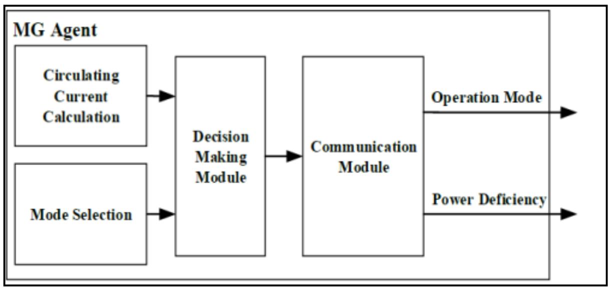

Fig. 4: Architecture of MGA [4]

2) DG Agent (DGA):

It consists of two sub-agent called Primary-DGA (PDGA) and the Secondary-DGA (SDGA) respectively. The PDGA is used to achieve local control objectives for each DG and the SDGA is used to achieve the distributed coordinated control between different DGs. The general architecture of DGA is illustrated [4] in Figure.

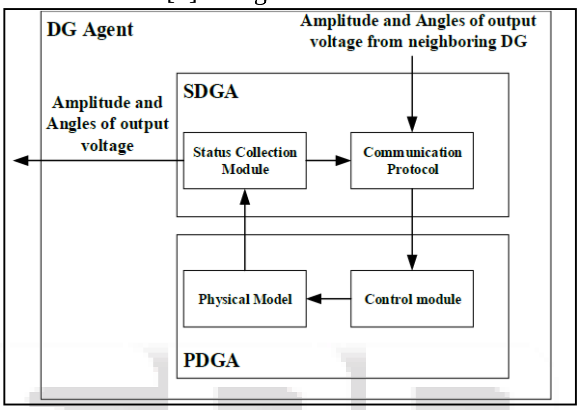

Fig. 5: Architecture of DGA Agent [4]

3) Energy Storage Agent (ESA):

It is used to control the energy storage to compensate the power unbalance timely by which the control system can provide enough time for DGA to response to the load disturbance. The architecture of ESA is shown [4] in Fig.

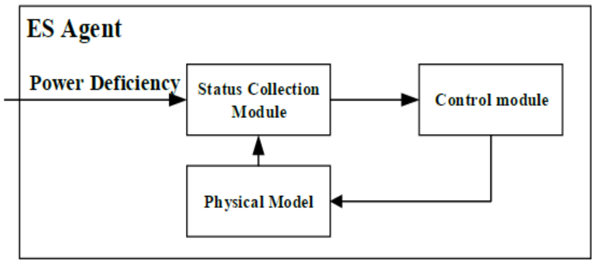

Fig. 6: Architecture ESA agent [4]

– Agent Management Service Agent (AMSA): It acts as a white page, maintaining a directory of agents registered within the control system.
– Directory Facilitator Agent (DFA): It acts as a yellow page, maintaining a directory of agents and the services they can offer other agents. The general architectures of AMSA and DFA are illustrated [5].

II. How to Organize Energy Internet

Energy Internet can be operated under two modes. The first mode is that Energy Internet has no responsibility to attach with Main-Grid and can be operate in the remote mode. In this mode, one of the DGs should be selected as the organizer in the organize system. In accumulation, the organizer DG should be restricted to output rated power in order to certification its leader in sequence with a constant and standard value. The second mode is that Energy Internet should be associated to the Main-Grid if essential; the in sequence beginning Main-Grid should be as the organizer in series. In this approach Energy Internet can be operated less than the rotating preserve situation with bidirectional power current to balance the control disturbance in mutually Main-Grid and Energy Internet. The most important difference among the two modes is whether Energy Internet should be coupled with the Main-Grid. Excluding with the principle of other operation of the planned organizer of Energy Internet is equal. The projected organizer individual with the task corrosion and in sequence flow essential for the control system [6].

- Step 1: Energy Internet confirms the operation modes. If Energy Internet is operated under the first mode, the MGA should decide one DG as the organizer in the system. If Energy Internet be supposed to be operated less than the second mode, the leader's information should be detected from the Main-Grid.
- Step 2: The huge circulate current caused by the power disturb capital the big deviations of amplitudes and angles of voltages among DGs in Energy Internet. In order to compensate the power unbalance timely, the ESAs should be activated. At the present, this function can give sufficient time for DGAs to balance power disturb. In this document, it is undetermined that the DGs have enough power to give designed for the weight, thus the ESAs are used for the short term.
- Step 3: SDGAs can correspond with its neighbors' in sequence by multi-agent statement procedure which is calculated according to the multi-agent agreement .The deviation of angles and amplitudes of voltages among DGs are designed by every SDGA through multi-agent agreement.
- Step 4: PDGAs want just limited information exclusive of announcement. Every PDGA should institute the nonlinear model of each DG. From end to end the advice linearization technique, the nonlinear model can be changed to the linear model. In sequence is embedded in every PDGA which is use to organize the local DG. Then, by using the in sequence sent beginning the SDGAs, the PDGAs can analyze the limited organize indicator. in conclusion, the amplitudes and angles of voltages can be coordinated with the leader's in sequence thus the circulating existing can be efficiently minimize and the production control of DGs can be common in percentage according to the power disturb can be salaried successfully. It should be emphasize with the purpose of not each DGA requirements to take delivery of the leader's in sequence since if single DGA can collect the principal in sequence, the additional DGAs be able to generate the logical power sign to its individual DGs. As a result, Energy Internet can be extremely well-organized and trustworthy.

III. Conclusion

The organize issue of in Energy Internet were investigate in this paper. The multi-agent system architecture is collective to propose the control structure and control technique functional in Energy Internet. The decayed responsibilities, recognized and altered model, in sequence stream for every agent are studied. The arrangement of multi-agent system and multi-agent consensus algorithm will provide an infrastructure for opening examine use in Energy Internet. The production voltages in Energy Internet can be well again although individual corresponding with the leader. Energy Internet provide consumers a consistent and capable control supply, though minimizing energy expenses and as long as the dissimilar type of renewable energy property the opportunity to stop in absent at some time. This document propose a novel distributed move toward to resolve the energy management problem of energy internet, whose solution is obtained by the agent system by means of exchange and giving out restricted in sequence [7].

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