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Design of Management system for Smart Grids

Efektívny spôsob využívania elektriny a riadenie prenosu a distribúcie sú veľmi dôležité pri zvyšujúcom sa dopyte. Dnes sa už však využívajú aj systémy na báze fotovoltaických zdrojov a malých veterných elektrární, ktoré dokážu zásobovať odberné miesta na niekoľko hodín bez potreby pripojenia na distribučnú sieť. Centralizovaná výroba elektriny sa pomaly transformuje na distribuovanú. Aktuálna výroba elektriny nebude postačovať pre pokrytie budúcej spotreby. Podľa Parížskej dohody z roku 2015 o zmene klímy, by malo byť v budúcnosti potrebné vyrábať elektrickú energiu ekologickejšie, aby sa zabránilo nárastu globálneho otepľovania a riziku katastrofickej klímy. Tento článok prezentuje algoritmus pre nabíjanie centrálneho batériového úložiska a algoritmus dodávky elektriny v rámci ulice.

Kľúčové slová: smart grid, algoritmus, spotrebiteľ

As we know that an effective way of the utilization of electricity is very important and also control at distribution as increasing demand. Admitting the fact that rooftop solar and micro wind technology have warranted the self-dependency on electricity for the consumer at least for the few hours. The centralized electricity generation notion has dissolved now and enabled the two independent generations. Therefore, the finest infusion for the combination of distribution load and distribution generation would be an ideal target in the literature. As per current production, we cannot attain the future demand. Even in present, we are compromising in the pick demand period; we are following the demand response strategy. Additionally, according to the 2015 Paris agreement on climate change CO2 reduction should be necessary for future electricity generation to avoid a rise in global warming and the risk of catastrophic climate. This paper presents the algorithm for street storage charge algorithm and street electricity supply algorithm.

Keywords: Smart street, algorithm, consumer

I. INTRODUCTION

Smart Grid: Briefly, The Smart Grid; the digital revolution empowered certain technology which makes the grid smarter, such as bidirectional communication between utilities and consumers and also, sensing through transmission lines. Smart grid technologies can be stated as an independent system that can find the solution to complications rapidly in an accessible system that overcomes the workforce and goal durable, reliable, secure, and quality electricity to all customers. Smart grid technology emanates from earlier endeavors at using electronic control, measuring, and analyzing. The automatic meter reading was fist time used in the 1980s for monitoring loads from big customers and develop into the Advanced Metering Infrastructure of the 1990s, whose meters could reserve how electricity was consumed at different periods of the day [1]. The smart meter has the facility to steady communication so that monitoring can be done in real-time, and can be used as a gateway to demand response aware equipment and Smart Sockets in the home. Higher electricity consumption devices such as industrial and domestic air conditioner, refrigerator, heaters, dishwasher, cloth washer, and dryers adjusted their time to run to avoid activation during times the grid was on peak demand modeIn. Italy, the Telegestore project was the first-ever project on which large numbers (27 million) of homes network facilitated with smart meter connection using low bandwidth power line communication in early 2000 [2]. Some technologies are used the phase broadband over power lines (BPL), while others used wireless technologies such as mesh networking advanced for reliable connection to contrasting devices in the home as well as supporting metering of utilities such as gas and water [3].

Features of the smart grid

1. Reliability
2. Efficiency - Load adjustment/Load balancing - Peak curtailment/leveling and time of use pricing
3. Flexibility in network topology FEI KEE 32
4. Sustainability
5. Market-enabling
6. Demand response support
7. Platform for advanced services
8. Provision megabits, control power with kilobits, sell the rest

Technology [4]

1. Integrated communications
2. Sensing and measurement
3. Smart meters
4. Phasor measurement units.
5. Distributed power flow control
6. Smart power generation using advanced components
7. Power system automation

Few keynotes on the smart storage system, the storage system can enable access of renewables into market and grid application by addressing the unreliability of resources and providing potentiality to deliver the contacted schedule power. Besides, they can also alleviate the aforementioned synchronization between consumption and generation. Both stationary energy storage systems and mobile (vehicle) systems are anticipated to play an important role in this energy transition. In recent conditions, in the overall European electricity system, only about 5% of the installed generation capacity is installed with a storage system; mainly storage systems composed of pumped hydroelectric energy storage [5]. The adequate storage capacity will depend on different scenarios of RES mix in the total

production capacity. Although, storage of range in between 43 GW and 90 GW of storage capacity is expected to be introduced for European scenarios by 2050 with an approximate investment of 80 Billion $ to 130 Billion $ [5].

II. SMART STREET DEVELOPMENT

Smart Street is a concept entitled as Raspberry Pi automated electrical Smart Street. It is a union of two notions, Smart Grid + Smart Homes. Together both frame a true potential of intelligent supply of electricity. Generalized ambition for the concept is that uninterrupted, efficient, and sustainable electricity supply to the consumer. Which not only beneficial to the consumer but also to the utility. Smart Street is designed for the tomorrow and future of electricity. Vision empowered by the constant source of electricity even in islanding mode for 24 hours. It configured the great capacity of solar and wind generation at the demand side. That gives a platform to users to participate in the electricity market, get the true value of generation, and help to a reduction in electricity bills. Storage facility makes it possible to use energy at the same price during top price rate and mitigate demand response for the time of use strategy, along with it, a consumer can utilize energy according to their comfort of time. Digitalization has been growing rapidly in all sectors of technology. There is no doubt to say we live in a virtual universe. Indeed, to stay side by side or for moving forward, it would be obvious to acknowledge measures in electricity digitalization. As IoT (Internet of things) term in the computer universe, in electricity, it is known as the Internet of Electricity (IOE). It demonstrates the feasibility of real-time communication and remote control by digitalizing sensing of the delivery of electricity. Digitalize prospective also provide a platform for self-healing and instant response framework. According to the title, Smart Street will control by the Raspberry Pi device. On the air engineering, bring the user-raspberry pi interface, raspberry pi-raspberry pi interface, and raspberry pi-control center interface. Technology is assigned with a Wi-Fi communication network.

- For a deep understanding of Smart Street development, it is broken down in 10 steps that are the following:

- Smart Street Projection
- Smart Homes
- Raspberry Pi kit
- Solar (PV) control system
- Energy Storage (Battery) selection
- Smart Light Pole
- Algorithm of battery charging, Street electricity supply and home generation & supply
- Security in Data sharing

Fig. 1. Smart Street layout

Solar and wind are essential for the generation of clean and green energy, therefore we have established giant solar farms. Unfortunately, big solar farms take immensely large space and there would be no possibility of utilizing this land for any other need. For the penetration of solar energy and saving space, there should be an active contribution from the demand side to produce electricity. According to one research, the consumers will occupy 30% - 40% of the electricity market share by 2050. Raspberry Pi intelligent control kit is a key component in Smart Street development. As shown in fig. there are six different houses constructed in the street, each having distinct demand for electricity as they are diverse in size and equipped with several devices. The underground distribution line has developed for the greater operational impact. Underground distribution lines have comes with multiple advantages compared to overhead lines consist of less transient faults, minimum EMF hazard, no aesthetic look, the public hazard of electrocution is diminish and there would be no fear of arc, flashes, short circuit, and cable cut. FEI KEE 74 Generally, in the normal grid, the Distribution transformer located at one end of the street equipped with some fuses as protection, which steps down the voltage from 33 kV or 11kV to 415 V or 230 V and having power rating from 10 kVA to 2500 kVA. Then it delivers power to various homes either by overhead or by underground lines. Commonly two-step protections are available in between house and taping point on the distribution line. At tapping point, three 60 Amp fuses are composed in one box and another 40 Amp fuses are connected exactly before the main switch panel of houses. However, in case of a fault, the utility will never get to know about where the exact fault occurs until the customer does not call them and they trigger it with matching the location of a call. The smart street has planned in such a way that it can do continuous monitoring and reporting of various parameters in the distribution network. Similar to the normal distribution network the transformer will be located at one end of the street. Key measures for distribution transformer is mention here.

- Distribution Transformer:

For efficient and long life cycle use of any equipment, continuous observation and maintenance are necessary, similar the are also applied to distribute ion transformer. A smart distribution transformer will be facilitated with numerous key sensors that inform the condition of transform the er and working mode of it. The sensor that is contributing in the effectiveness of transformer; current value, voltage value, oil temperature (applicable in oil-filled transformer), level of oil (applicable in oil-filled transformer), power consumption, active power, reactive power, power factor, blackout and brownout, Harmonic of voltage, harmonics of current, power quality measurement, self-monitoring and life cycle assessment. - This data will be stored in a raspberry pi kit panel and via the Wi-Fi network, it sends it to the control center. Data will transfer through cloud-based technology. Security will be enhanced with blockchain cybersecurity technology. Data will be transfer after every 15 minutes cycle. Each raspberry pi will be coded with some specific digit and GPS sensor that make it very easy to trace in case of emergencies. - Two varieties of a transformer can be offered: 1) Dry-type transformer 2) Oil filled transformer. - Outage management and protection: Two-sided fuse as well as smart over-voltage, under-voltage, over-current, and under current sensor will be placed which will shut the transformer in such type of event. If a less severe fault occurs then it will proceed for the self-healing and after continuous fault occurrence time graded message will be delivered to utility with an indication of the type of fault. By just reverse message from the utility, it will re-establish a connection to the grid. After the transformer protection, cable will move into the Smart control Panel, Smart control panel has three type of power supply point:

1. Direct Grid Supply
2. Distribution storage Supply
3. Direct distribution generation supply

Smart Control Panel also provides an option to send distribution generation energy to a utility grid. Power Electronics said to be nerves for the conversion of energy to a different level and in different transitions.

- **Voltage regulation sensor**

It will compare the actual voltage magnitude required with receiving magnitude and accordance with it, it triggers a voltage regulator at a control panel or sends the command to a utility center for any changes. The voltage regulation sensor's aim is to provide steady voltage to the consumer irrespective of how much power is drawn from the lines.

- **Automatic alert sensor for transmitting electricity to the grid from smart street**

When distribution generation oversize the demand and when the battery is also full charge then this sensor will send alert to the utility for the permission to transmit electricity from smart street to utility grid. The utility can handle remotely and give a command from the center to establish the connection.

- **Automatic street light turn ON – OFF sensor**

This sensor is time-dependent, it will turn ON-OFF the light according to day-night time. The utility can also give a command from the center to turn ON-OFF.

- **Missing sensor identification**

This sensor can link with all the sensor, work is just to notify whether all sensor is working properly or not. 6) Self-healing device sensor: - If a fault does not have a severe cause and does not detect continuously then this sensor will give the command to reestablish the connection.

- **Smart Homes**

Fig. 2. Smart Home

Smart Homes are something more than just an ordinary home, but in what sense! Smart Homes will work with the Home area network, which means this network comes with the boundary of Home. This network is connected with the internet to link with all the devices. A network can drive by the microcontroller. Smart homes pertain as a most convenient home setup where all electronics, as well as electrical appliances and devices, can be automatically monitored and controlled remotely. Using mobile or tablet application anyone can operate different devices such as lighting, door lock, air-condition, washing machine, dishwasher, temperature measurement, digital media, and many more things by staying anywhere in the world. Smart homes set up can be possible through wireless or wired systems or both. It is obvious that the wireless system is easy to install and it can be possible for all types of the house as it does not need extra proofing. Smart homes are very convenient in terms of energy-saving and reduction in bills. Automated smart home management systems switch off the lights and other equipment in the absence of a person. The latest electronics and electrical equipment are designed with advance and small microprocessor-based technology that require very little power to operate; that helps to a reduction in bills. Solar panel and wind turbine base renewable generation homes are more cost-effective to save energy and money. The storage system enables a user to operate their heavy electrical equipment in pick hours and effective as back up protection. Some other benefits of smart homes are as medical facility and emergency alert system (Call to Police, Ambulance and firefighters), Smart homes system are quite simple so anyone can take benefits from it, child-friendly and senior citizens as well. It minimizes the energy and maximizes the comfort zone. Two types of load can be observed in a smart home, Controllable and Uncontrollable. Air condition, pool filter pumps, non-programmer washer, and semi-automatic equipment can connect at smart plugs that can be trigger by the application. One of the best features of a smart home is to control lighting automatically; the smart sensor detects the natural light in the house and in accordance with it turn ON-OFF the lights which is really cost-saving technology.

- **Raspberry Pi Kit**

This section will provide information about the "What is Raspberry pi?", "Features of Raspberry Pi" and "how it will possible with raspberry pi to use in the smart street?"

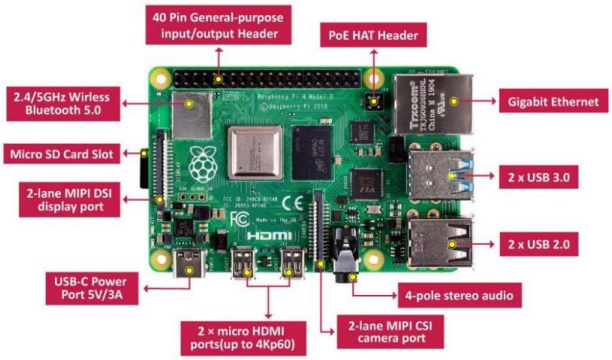

Fig. 3. Raspberry Pi 4 [6]

Raspberry Pi is a tiny device that has functionality exactly like any computer, that's why we can say it as a pocket computer. Its size is almost like a credit card. Raspberry pi was designed with the intention of a computer learning platform for children. It is a low-cost computer that allows you to do coding, listening to music, watching HD videos, making a spreadsheet, playing games, surfing on the internet and much more activity as any normal computer offer. Raspberry pi can directly connect with any monitor screen via USB to VGA cable. Mouse and keyboard can also directly linked with the raspberry pi as it offers 4 USB ports.

III. ALGORITHM: ALGORITHM OF BATTERY CHARGING, STREET ELECTRICITY SUPPLY AND HOME GENERATION & SUPPLY

All the algorithm used in smart street are based on closed loop control.

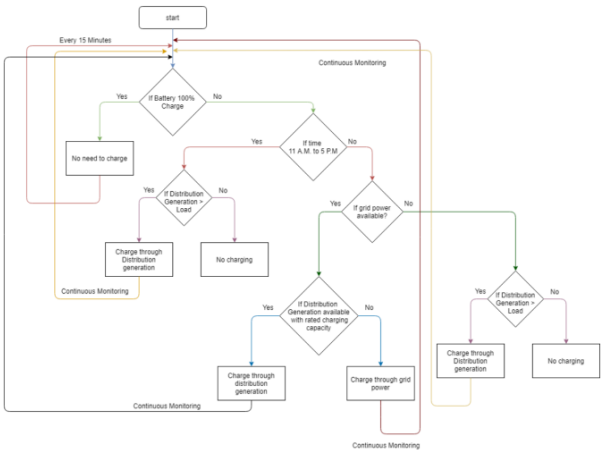

Fig. 4. Street Storage Charging algorithm

A. In the case when battery is full charge then it will not allow contact to connect with either distribution generation or to main grid connection. After every 15 minutes of delay controller will check the state of charge of battery.

B. However, command will move forward when battery identified as not 100% charged. Electricity is time dependent and therefore it has to watch time while taking power from the main grid. For the time in between 11 AM to 5 PM battery will only take power from the distribution generation.

C. Then it will check distribution generation has greater power compare to demand and if yes then it will closed the distribution generation power to charge battery. Event of the less generation then it remain in disconnection FEI KEE 104 mode. Charging will be carry out until battery get full charge or generation become less than the demand.

D. Cycle will extend for the all-time except 11 AM to 5 PM. Further it has to make confirmation that electric grid has availability of power.

E. If grid power is available then it will verify whether distribution generation has sufficient power to charge battery, if it has then charge will proceed through distribution generation else through grid power.

F. In the absence of grid power, it will verify for distribution generation and if it is available then charging will start and charge until the battery get 100% of SOC or availability become lessen; if generation is not sufficient then charging process will not start.

Street Electricity Supply algorithm:

IV. STREET ELECTRICITY SUPPLY ALGORITHM

A. Electricity supply process can be start with examine the main grid electricity presence. If grid electricity is available then it will verify the time. Two time variant are available, whether 11 AM to 5 PM or rest. If time is not belong from the 11 AM to 5 PM then electricity will be supplied through the main grid.

B. If time fall in 11 AM to 5 PM,

- It will make confirmation that distribution generation sufficient power or not to match with the demand. If power is in sufficient manner then power will be supplied by distribution generation. Two type of monitoring will lead the scenario, one will continuously check whether distribution power is sufficient or not and other will check timing after every 15 minutes.
- If distribution generation will have lessen power then it will compare battery percentage minimal value 15%. If battery has, sufficient power than power will delivered through the battery and distribution generation. Continues monitoring will be done for battery percentage. Second monitoring will check time of the day repetition of 15-minute cycle.
- If battery has no adequate power, consequently ensure the main grid power. Supply will be carry out with distribution generation and limited amount of main grid power. Fifteen minute cycle also be apply here for verifying timing. d. For the situation of no power condition, controller redirected connection to individual home only, the house owner can use their generation power if available and if not then connection will cut off all the way. Power condition will be in continuous monitoring until it get over and if it is in cut off condition then frequent signals will be send for confirming utility power.

C. In the case of absence of main grid power process will start from the point (a)

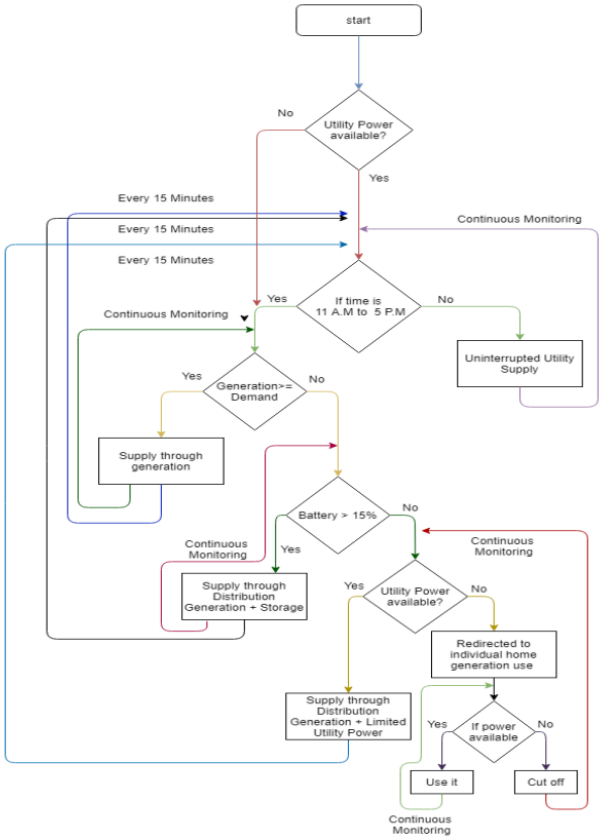

Fig. 5. Street electricity supply algorithm

V. CONCLUSIONS

All in all Rasp Smart Street development's main intension was to make street compatible for future advanced load and make self-sustainable in case of a severe condition. Dependability on utility power has to have a deduction at a certain level. The more the power generates at the demand side more the power can utilize for self-gratification. Smart Street development entitles equalization to a customer by the development of a street storage plan. The smart street pole is one of the key development topics for the higher generation at the distribution level. The smart vehicle charging station in the street is an essence for the globalization of electric vehicle and especially the idea to link the charging cost with electricity bill will make more

comfortable for user payment. The major advantage is that person can charge their vehicle anywhere in the city with respective login id and password. Rasp Smart street application can handover user to trade their electricity generation. Live electricity generation and consumption, monitoring, and control provide a platform to a user for better understanding of electricity bill prediction.

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