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Intelligent Electricity Everywhere: Making The Supply Of Energy Effective And Efficient

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Abstract: ***The challenge of delivering a reliable and sustainable electricity supply as well as managing complex interactions between electricity-suppliers and facilities that consume the supply drives the need for technology improvements in energy networks. The notion of intelligent electricity everywhere (IEE) is something impossible to ignore. In this paper the concept of IEE is discussed that involves changing production and demand characteristics resulting from the expansion of renewable generation and distributed systems. The way to implement IEE concept is discussed using a simple test model – Keystone Facilities.***

Keywords: IEE, Electrical energy, Power supply, Cost, Quality, Period of Power system

I. INTRODUCTION

The rise of *intelligent* devices, robotics, and artificial *intelligence* systems now means a different relationship to devices [1]. Power network has significantly different characteristics in the developed and developing countries. Despite these characteristics, transmission cables that carry electricity to power the utilities are seemingly *everywhere*. *The* challenge of delivering a reliable and sustainable electricity supply as well as managing complex interactions between electricity-suppliers and facilities that consume the supply drives the need for technology improvements in electricity networks [2]. The notion of intelligent electricity everywhere (IEE) is something impossible to ignore. Notably, there has been a transition from a limited number of large power generation sources to a more distributed system comprising a greater number of smaller, more technologically diverse sources of electricity.

The concept of IEE is that the period of supply must be an integral part of supply; the cost of supply must be included; consumers must be able to choose when to use power and use only what they can afford. The utility companies that supply the electricity must be held accountable for the way their activities impact the environment. As such, the energy sources must be diverse, sustainable and bring about inclusive development. The intelligent power networks must ensure that future electricity supply systems provide efficient, affordable and low-emission energy to the economy.

II. CREATING AN INTELLIGENT POWER SYSTEM

An intelligent power supply dictates that power must not just be supplied, power must be supplied in an environmentally friendly manner, in the right quality, at the right cost, at known periods, and as at when desired for effectiveness and efficiency in processes and usage. Advanced sensors and measurement will be used to achieve higher degrees of network automation and better system control, while pervasive communications will allow networks to be reconfigured by intelligent systems [3]. It is envisaged that electricity would be made available to both the present and projected future consumers through strategic planning policies ensuring that adaptive power generation and power active distribution networks or links to customers beat the increase in demand of energy always. The rate charged for electricity, features of the power supplied, and the time of availability of power become public knowledge. When such logical agreements are breached, the breaching party must then be made to pay certain compensations or lose some significant

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benefits. Any power generation diversity and/or economic changes could easily be handled: for example, changes in the nature of production/exchange/use interactions as well as changing production and demand characteristics that may result in the expansion of renewable and distributed generation. Intelligence Electricity Everywhere covers preserving the environment, promoting development, and embracing emerging smart technologies. Currently, several emerging smart techniques and technologies that have, in some cases, and could be introduced to the power supply systems to achieve its intelligence include [4, 5, 6]:

- ✓ Smart Grid System – a modernized reliable and secure transmission and distribution infrastructure that accommodates future growth, that support renewable energy, storage and new usages like electric vehicles, and that gives customers greater awareness and control of their use.
- ✓ Net Metering – that permits electrical power users to also contribute self-generated power to the power grid seamlessly and profitably.
- ✓ Renewable Energy Technologies – can help countries reduce peak load growth and increasing the ability of networks to manage and absorb distributed renewable and intermittent generation and demand side technologies, as well as helping countries meet their policy goals for secure, reliable and affordable power and meeting lower carbon trajectory.
- ✓ Electrification—critical for long-term carbon reduction goals and will represent an increasingly relevant share of renewable energy.
- ✓ Decentralization—making customers active elements of the system and requires significant coordination
- ✓ Digitization—enabling more artificial intelligent control, including automatic, real time optimization of consumption and production and interaction with customers.

The effectiveness, efficiency, and superiority of an IEE system over non-intelligent systems are measured using a simple test model on certain industrial facilities—Keystone Facilities.

III. A SIMPLE TEST MODEL

Certain metrics are used to determine the effects on productivity when power supplied is ineffective or inefficient (non-intelligent electricity) and when power supply is efficient and effective as described in the concept of IEE. The data obtained from the records of Keystone Facilities in a space of three months are tabulated in Table 1 and Table 2., and analysed using MATLAB—software due to its available optional toolbox and accessible symbolic computing capabilities.

INTELLIGENT ELECTRICITY SUPPLY (METRICS)				NON-INTELLIGENT ELECTRICITY SUPPLY (METRICS)			
WEEK	TOTAL OUTPUT	EQUIPMENT DAMAGED	RAW MATERIALS WASTAGE	WEEK	TOTAL OUTPUT	EQUIPMENT DAMAGED	RAW MATERIALS WASTAGE
1	767	0.9	1.2	1*	501	2.5	7.4
2	616	2.1	0.5	2*	24	4.7	6.3
3	790	1.2	1.5	3*	398	1.4	7.7
4	828	0.5	2.0	4*	453	0.3	8.0
5	774	0.7	1.0	5*	659	3.1	7.3
6	685	1.2	0.8	6*	230	8.6	6.4
7	691	0.6	0.8	7*	13	2.8	6.6
8	711	0.3	0.6	8*	567	4.1	7.1
9	805	0.1	0.9	9*	0	0.0	0.0
10	714	0.8	1.7	10*	417	4.2	6.9
11	819	1.0	1.9	11*	8	5.1	9.7
12	693	0.8	0.3	12*	394	0.1	8.2

*TOTAL OUTPUT in (units), EQUIPMENT DAMAGED in (%), RAW MATERIALS WASTAGE in (%)

Table 1: Key Performance Measures for Periods of Intelligent and Non-Intelligent Electricity

INTELLIGENT ELECTRICITY SUPPLY (METRICS)				NON-INTELLIGENT ELECTRICITY SUPPLY (METRICS)			
WEEK	TOTAL OUTPUT	GREENHOUSE GAS EMISSION RATE	LAND AND NOISE POLLUTION RATE	WEEK	TOTAL OUTPUT	GREENHOUSE GAS EMISSION RATE	LAND AND NOISE POLLUTION RATE
1	767	0.5	0.21	1*	501	5.4	3.7
2	616	0.45	0.19	2*	24	4.7	2.1
3	790	0.49	0.21	3*	398	4.6	3.9
4	828	0.53	0.23	4*	453	5.5	4.0
5	774	0.47	0.20	5*	659	4.3	3.7
6	685	0.46	0.18	6*	230	4.4	3.8
7	691	0.48	0.15	7*	13	4.9	3.6
8	711	0.43	0.24	8*	567	4.0	2.9
9	805	0.50	0.27	9*	0	1.0	1.0
10	714	0.44	0.22	10*	417	4.2	3.3
11	819	0.51	0.26	11*	8	5.0	4.2
12	693	0.49	0.16	12*	394	4.6	3.0

*TOTAL OUTPUT in (units), GREENHOUSE GAS EMISSION in (indices), POLLUTION RATES in (indices)

Table 2: Key Performance Measures for Periods of Intelligent and Non-Intelligent Electricity

The effectiveness and efficiency of power system were measured using several metrics for when non-intelligent electrical power is supplied against when an intelligent electrical power is supplied. Using test metrics—total output (Fig. 1), unsupervised/irregular maintenance of power tools (Fig. 2), material wastage (Fig. 3), green gas generation (Fig. 4), and land and noise pollution rate (Fig. 5)—the results verify that performance of IEE-based system is much better than the conventional power system.

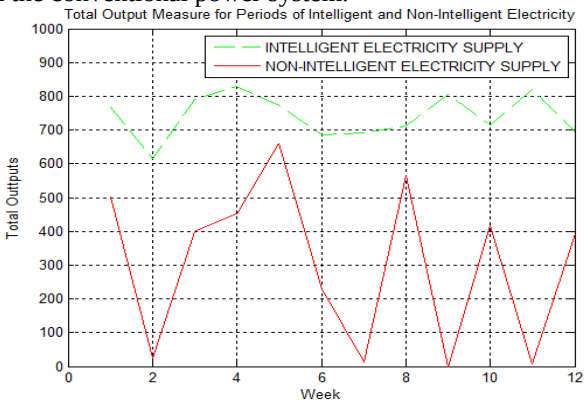

Figure 1: Total Output Measure for Periods of Intelligent and Non-Intelligent Electricity

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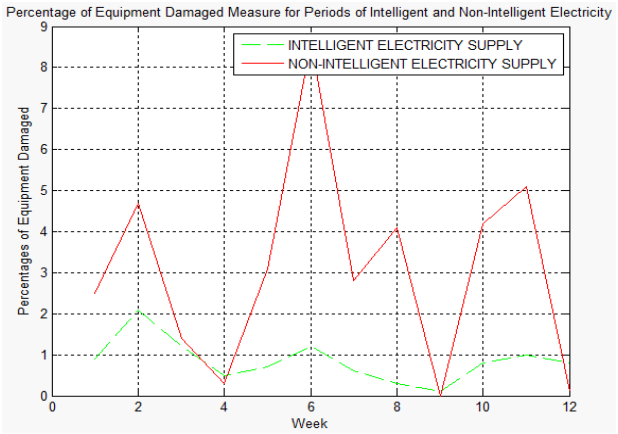

Figure 2: Percentage of Equipment Damaged Measure – Intelligent and Non-Intelligent Electricity

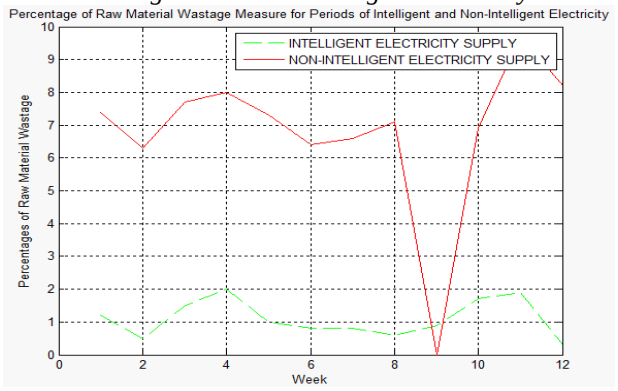

Figure 3: Percentage of Material Wastage Measure for Intelligent and Non-Intelligent Electricity

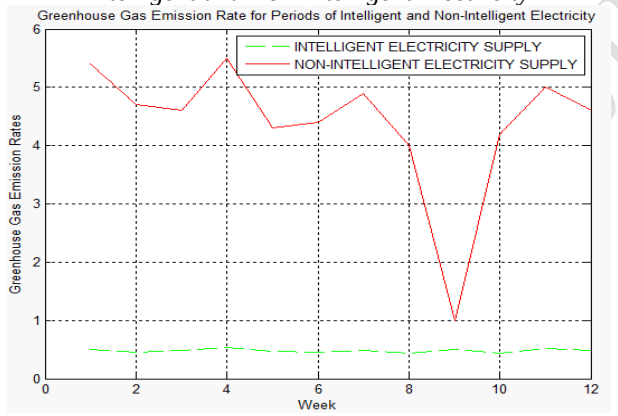

Figure 4: Greenhouse Gas Emission Rate for Periods of Intelligent and Non-Intelligent Electricity

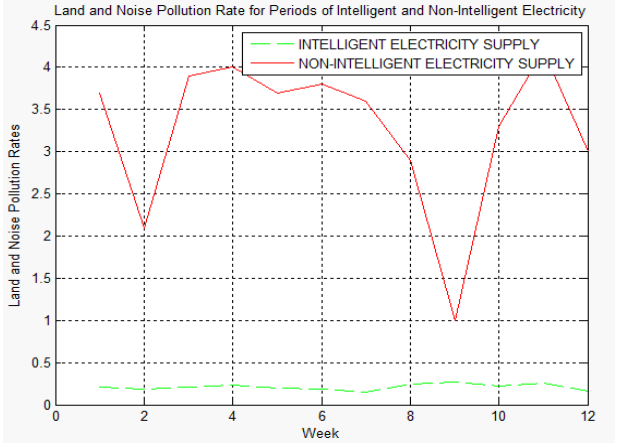

Figure 5: Land and Noise Pollution Rate for Periods of Intelligent and Non-Intelligent Electricity

IV. CONCLUSIONS

The challenges facing energy network include the increased penetration of embedded generation, and enhanced reliability requirements that meet customers' expectations and requirements. The application of Intelligent Electricity Everywhere (IEE) concept has been discussed in this paper that addresses the ways to operate power networks and/or grids with distributed and renewable resources and giving customers greater awareness and control of their use.

The effectiveness, efficiency, and superiority of an IEE system over non-intelligent systems have been demonstrated with a simple test model. The results show that IEE systems are clearly better judging by the performance metrics selected. Progressively enforceable and economically viable policies that bring about more efficiency into the power supply systems and accommodate environmental friendly energy generation activities should be encouraged by adopting the techniques of achieving IEE.

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