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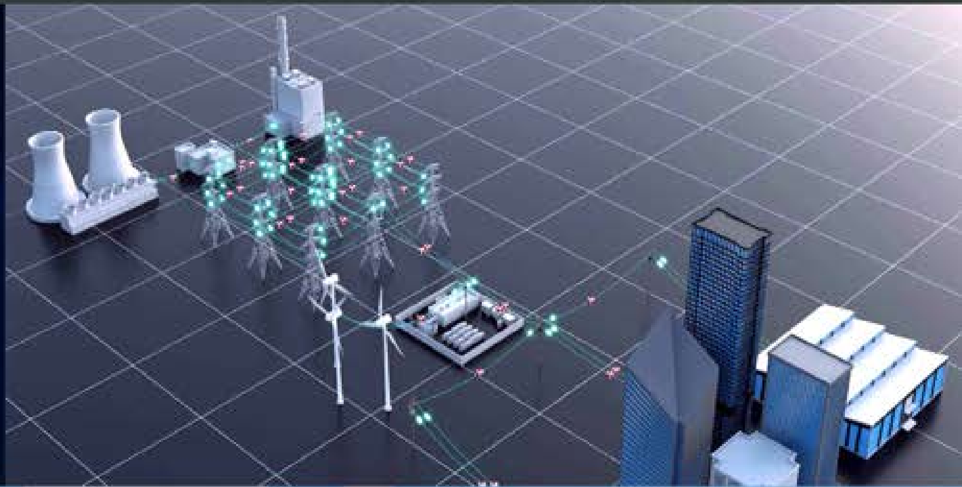
NEWSLETTER/ EEE/ VOLUME 5: ISSUE 3- JANUARY 2017



K.L.N. COLLEGE OF ENGINEERING

Department of Electrical and Electronics Engineering

(4th time Accredited by NBA, New Delhi)

Approved by AICTE and Afflicated to Anna University
An ISO 9001:2008 Certified Institution
Pottapalayam - 630 612, Sivagangai Dt., Tamilnadu.

INSPIREEE

INspirational **S**cripts, **P**ersonalities and **I**nnovative **R**esearch of **EEE**

VISION

To become a high standard of excellence in Education, Training and Research in the field of Electrical and Electronics Engineering and allied applications

MISSION

To Produce excellent, innovative and Nationalistic Engineers with Ethical values and to advance in the field of Electrical and Electronics Engineering and Allied Areas

K.L.N. College of Engineering

Pottapalayam – 630 612, Sivagangai District, Tamil Nadu, India

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MESSAGE FROM HEAD OF THE DEPARTMENT

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FIE, MISTE, MIEEE (USA)

Professor & Head, EEE,

K.L.N. College of Engineering

MESSAGE

Greetings,

I am very happy to inform that the EEE Department got Accredited, 4th time by NBA, New Delhi and this is valid up to 30.6. 2019. It is a very prestigious moment for us. I wish to thank, in this occasion, all the well-wishers of KLNCE-EEE for their kind support and valuable assistance.

Issues 3 and 4 have been nicely prepared starting with beautiful cover page. Topics focusing latest trends in EEE filed covering FACTS, Smart Grid etc., are well informed. The articles by Final year students show their dedicated work, presenting the material in a nice manner, and their depth of knowledge. The fourth issue is focusing on social impact of Electrical field. Their presentation is also very good. Engineers should develop such writing skills, once they reached the quality, they are the expert. Engineers can acquire the best of their writing skills by reading Novels, Newspapers and watching best Hollywood movies. Once they develop such skills, their writing will like a thriller, everyone love to read, and thereby the reader get benefitted. Students can claim later, anywhere about their contribution on the work they submitted for the Newsletter. I thank the contributors of this issue for publishing as per the schedule. Best wishes to all.

Dr. S.M. KANNAN

Head of the Department - EEE

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FACTS AND HVDC

V.SRINIDHI TRISHNA (132304), FINAL YEAR – EEE-C

OVERVIEW:

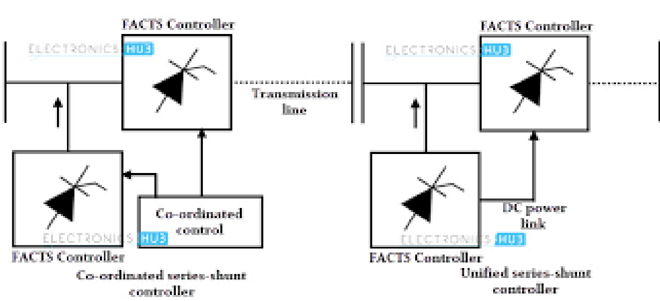
Interconnection of power systems with either AC or DC links may offer important technical, economic and environmental advantages. In the future of liberalized power markets, these advantages will become even more important: pooling of large power stations, sharing of spinning reserve, use of most economic energy resources, as well as ecological constraints: nuclear power stations at selected locations, hydro energy from remote areas, solar energy from steppes and deserts, and connection of large off-shore wind farms.

IMPROVED TECHNOLOGIES:

Since the 60s, FACTS (Flexible AC Transmission Systems) and HVDC (High Voltage Direct Current) transmissions have developed into a mature technology with high power ratings.

Transmission ratings of 3 GW over large distances with just one bipolar DC transmission systems are state of the art in many grids today. In China, however, there are new transmission schemes in the planning phase with ratings of 4 - 6 GW (at +/- 800 kV DC and 1000 kV AC).

Reason for such high ratings is the need for bulk power transmission corridors with 20 GW for system interconnection.



POWER INTERCONNECTION APPLICATIONS:

Power exchange in the neighboring areas of interconnected systems offering most advantages can be realized by AC links, preferably including FACTS for increased transmission capacity and for stability reasons. The transmission of larger power blocks over longer distances should, however, be utilized by the HVDC transmissions directly to the locations of power demand. HVDC can be realized as direct coupler without a DC line – the so-called Back-to-Back solution (B2) or as point to point long distance transmission via DC line. The HVDC links can strengthen the AC interconnections at the same time, in order to avoid possible dynamic problems which, exist in such huge interconnections.

CONCLUSION:

FACTS and HVDC solutions together with advanced communication, computing and control technologies will fulfill.

(a) To facilitate electricity trading;

(b) To optimize the overall performance and robustness of the system;

(c) To react quickly to disturbances to minimize their impact and prevent the system against blackouts and;

(d) To restore the system to the normal operating level after a disturbance e above requirements. With the continuous effort in R&D of control technologies, it is likely that the costs will be further reduced, and hence they will be more widely used in electric power grids in the next 5 to 10 years.

FACTS & HVDC APPLICATIONS

M.VEERALAKSHMI (132039), B.E-EEE-IV YEAR-C

INTRODUCTION:

The application of FACTS and HVDC technologies, in the form of Voltage Sourced Converter (VSC) based designs, continue to be implemented throughout North America and other parts of the world for improved transmission system control and operation. FACTS and HVDC-link technologies allow more efficient utilization of existing transmission networks and help to better facilitate needed transmission system expansion.

The wide-scale application of these technologies leads to numerous benefits for electrical transmission system infrastructure, including increased capacity at minimum cost; enhanced reliability through proven performance; higher levels of security by means of sophisticated control & protection; and improved system controllability with state-of-the-art technology concepts.

Both conventional and advanced forms of FACTS and HVDC transmission technologies exist and are in operation today. Advanced solutions are in the form of VSC based designs, including configurations for Static Synchronous Compensators (STATCOM), Unified Power Flow Controllers (UPFC), Static Synchronous Series Compensators (SSSC), and VSC-based Back-to- Back DC Links (VSC-BTB), to name a few. This paper highlights the advantages provided by the VSC design concept for FACTS and HVDC-Link system applications.

KEYWORDS:

Flexible AC Transmission Systems (FACTS), High Voltage DC Transmission (HVDC), Voltage Sourced Converter (VSC), static Synchronous Compensator (STATCOM), Unified Power Flow Controller (UPFC), Static Synchronous Series Compensator (SSSC) Back-to-Back DC-Link (BTB), power electronics equipment.

VSC DESIGN ADVANTAGES:

There are number of advantages associated with implementing VSC-based designs for FACTS and HVDC applications, summarized as follows: - Continuous operation, compensation, and control for reactive power requirements and voltage control/ stability applications

1. Rapid and continuous response characteristics for smooth dynamic control.
2. Independent control of voltage and power flow for direct power transfer applications
3. Automated real and reactive power control for both steady-state and dynamic system conditions
4. Superior performance for weak system conditions (low short circuit ratio application)
5. Inherent modularity and redundancy for increased reliability and availability
6. Advanced control methodologies for high-performance operation
7. Elimination or reduced equipment’s for harmonic filtering.
8. Ability to add energy storage as the sourcing element (e.g., batteries, super-conducting elements etc.)
9. Compact size and reduced volume for installation flexibility and reduced construction Costs.
10. Easy expansion and mobility for future system considerations.

BASIC DESIGN CONCEPTS:

Basic one-line diagrams for VSC application systems are shown in Figures 1 through 4 for A) STATCOM; B) SSSC; C) UPFC; and D) BTB (DC-Link) configurations. Table 1 summarizes the application systems in terms of these VSC configurations and/or combinations of VSC configurations. There are other configurations as well, which are variations of these four basic concepts and that include applications for energy storage as the sourcing element. Figure 1 – STATCOM Configuration Figure 2 – SSSC configuration Figure 3 – UPFC Configuration

As a typical configuration, the VSC is a six-pulse converter consisting of six power semiconductors switching devices (GTO, GCT, IGBT, etc.) with anti-parallel connected diode together with heat sinks and auxiliary equipment for gating, monitoring and grading. In a high-power converter, a number of semiconductor devices may be connected in series or in parallel. Figure 5 – Basic VSC Schematic Diagram 3 From a D.C input voltage source, provided by a charged capacitor or a D.C energy supply device, the converter produces a set of controllable three-phase output voltage at the fundamental frequency of the A.C system voltage. The output voltage waveform may be a square waveform (Figure 6a) or a pulse width modulated (PWM) waveform (Figure 6b), depending on circuit topology and pulse modulation method. As described below, various techniques are adopted to neutralize and minimize the harmonic contents of the output voltage waveform.

The output voltage waveform of the VSC contains a large number of harmonics as illustrated above. In order to eliminate harmonic content from the output voltage, various techniques can be adopted. A multiple-pulse arrangement by combining the output of parallel VSCs can be adopted as a solution using a multi-winding transformer or inter-phase transformer magnetic.

A multi-level technique or a pulse width modulation (PWM) technique can be another solution, in which case standard two-winding transformers can be implemented. Harmonic filters can be also adopted in combination with the above techniques. With respect to the cooling system, the heat dissipation is produced in the power semiconductor switching devices, snubber circuit, resistors and valve reactors, when switching and conducting the current. The heat is removed from these components by a coolant in the cooling system design. The VSC module can easily be connected in parallel to increase modular and inherent design redundancy, providing many advantages for reliability.

Designs are implemented such that if one VSC module in a system is out-of-service, the others maintain operation, thus increasing overall system availability and on-line performance. Examples of this concept are described in Section 4 – VSC Application Examples. The examples also utilize PWM control, allowing for simplified two winding interconnecting transformer designs.

VSC GENERAL PEFORMANCE:

Shunt Connected VSC:

In this case, the VSC is connected to the power system via a shunt connected transformer, as in the STATCOM configuration of Figure 1. By varying the amplitude and the phase of the output voltages produced, the active power and the reactive power exchange between the converter and the a.c. system can be controlled in a manner similar to that of a rotating synchronous machine. The reactive power exchange between the VSC and the power system can be controlled by varying the amplitude of the output voltage.

If the amplitude of the output voltage is increased above that of the ac system voltage, the VSC generates reactive power to the power system. If the amplitude of the output voltage is decreased below that of the ac system voltage, the VSC absorbs reactive power from the power system. The real power exchange between the VSC and altering the phase angle between the output voltage and the ac system voltage can control the power system.
If the output voltage is made to lead the ac system voltage, the VSC supplies real power to the ac power system. If the output voltage is made to lag the ac system voltage, the VSC absorbs real power from the ac power system. An energy supply or absorb device is required for the real power exchange. This role is played by another VSC or a dc energy storage device like a super-conducting magnet or a battery. The exchange of real and reactive power is implemented individually. The product of the power system voltage and the maximum output current determines the VA rating of the VSC.

Series Connected VSC:

In this case, the VSC is connected to the power system in series via a series connected transformer, as in the SSSC configuration of Figure 2. By varying the amplitude and the phase of the output voltages produced, the magnitude and the angle of the injected voltage can be controlled. The VSC output voltage injected in series with the line acts as an ac voltage source. The current flowing through the VSC corresponds to the line current. The VA rating of the VSC is termed by the product of the maximum injected voltage and the maximum line current. If the injected voltage is controlled with a quadrature relationship to the line current, the VSC provides only reactive power to the ac power system and there is no need for another VSC for energy storage device on the dc terminal. If the injected voltage is controlled in a four-quadrant manner (360 deg.) to the line current, the VSC provides both real power and reactive power to the ac power system and another VSC or energy storage device is needed for the real power exchange on the dc terminal.

FACTS DEVICES IN POWER TRANSMISSION SYSTEM

T.L. Santhana Krishnan (132024), 4th Year C Section

Interconnection of power systems with either AC or DC links may offer important technical, economic and environmental advantages. In the future of liberalized power markets, these advantages will become even more important: pooling of large power stations, sharing of spinning reserve, use of most economic energy resources, as well as ecological constraints: nuclear power stations at selected locations, hydro energy from remote areas, solar energy from steppes and deserts, and connection of large off-shore wind farms. Examples of large interconnected systems are the Western and Eastern European systems UCTE (installed capacity 530 GW) and IPS/UPS (315 GW), which are planned to be interconnected in the future. Up to now, the power systems in China are more separated: China with 7 large inter-provincial grids and India with 4 large regional grids. However, interconnections by AC and increasingly by DC are in progress in Far East, too. Since the 60s, FACTS (Flexible AC Transmission Systems) and HVDC (High Voltage Direct Current) transmission have developed into a mature technology with high power ratings. Transmission ratings of 3 GW over large distances with just one bipolar DC transmission system are state of the art in many grids today. In China, however, there are new transmission schemes in the planning phase with ratings of 4 - 6 GW (at +/- 800 kV DC and 1000 kV AC). Reason for such high ratings is the need for bulk power transmission corridors with 20 GW for system interconnection. In general, for transmission distances above 700 km, DC transmission is more economical than AC transmission (≥ 1000 MW). With submarine cables, transmission levels of up to 600 - 800 MW over distances of nearly 300 km have already been attained, and cable transmission lengths of up to 1,300 km are in the planning stage. As a multi-terminal system, HVDC can also be connected at several points with the surrounding AC networks. FACTS are applicable in parallel connection (SVC, Static VAR Compensator – STATCOM, Static Synchronous Compensator) or in series connection (FSC, Fixed Series Compensation - TCSC, Thyristor Controlled Series Compensation – TPSC, Thyristor Protected Series Compensation) or in combination of both (UPFC, Unified Power Flow Controller) to control load flow and to improve dynamic conditions. Rating of SVCs is up to 800 MVAr, series FACTS devices are implemented on 550 and 735 kV level to increase the line transmission capacity up to several GW. In the paper, benefits of FACTS and HVDC for system interconnection and for grid enhancement are depicted, and preferences of applications are explained. Study and project examples are given.

1. Development of Power Transmission

The development of power systems follows the requirements to transmit power from generation to the consumers. With an increased demand for energy and the construction of new generation plants, first built close and then at remote locations from the load centers, the complexity of power systems has grown. This development is schematically shown in Fig. 1.

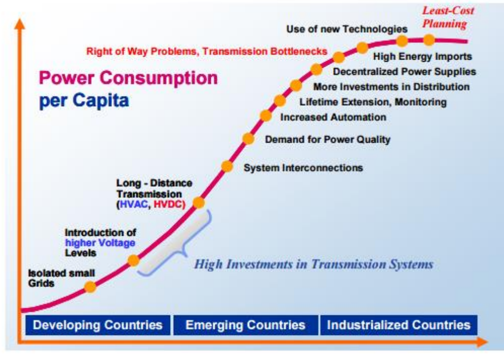


Fig. 1: Development of Power Systems and per Capita Consumption

To transport the energy from generation to consumers, the development of power systems considers locations of expected load requirements on the one hand, and the suitable location of power stations on the other hand. However, on a long-term basis, it can be expected that the transmission systems will stagnate in their development, since an increasing part of power generation will be transferred into the distribution or low voltage networks in the future [1, 3]. Since the load flows existing today can change considerably, this altering environment decisively influences further development and optimization of transmission networks. The ancillary functions required for smooth operation of the networks, such as frequency control, load-flow control, reactive-power and voltage control, as well as the responsibility for system security, are in the hands of the system operator. To support the operation and to increase the reliability of heavily loaded networks, FACTS and HVDC need to be installed. Higher investments into grid interconnections must be made to achieve cost benefits. Based on a large number of studies on power system development in different world regions, the following general trends can be expected:

- Increasing Power Demand - from 3,560 GW in 2000 to 5,700 GW in 2020 Strong Environmental Constraints – Limitation for Power Plant Expansions Natural Energy Resources far away from Load Centers Severe Right of Way Constraints ¾ A Strong Issue in many Countries, especially in Europe.

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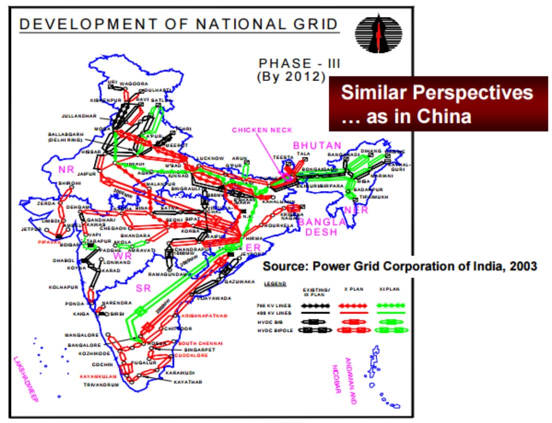
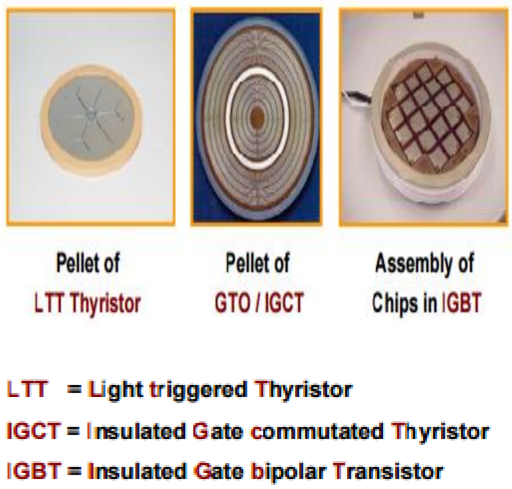


2. Transmission Solutions with FACTS and HVDC

FACTS and HVDC use power electronic components and conventional equipment which can be combined in different configurations for switching or controlling reactive power, and for active power conversion. Conventional equipment (e.g. breakers, tap-changer transformers) offer very low losses, but the switching speed is relatively slow. Power electronics can provide high switching frequencies up to several kHz, but with an increase in losses. A view on the different kinds of semiconductors is given in Fig. 2. In Fig. 3, the stepwise assembly of the thyristors in modules and valve groups is shown.



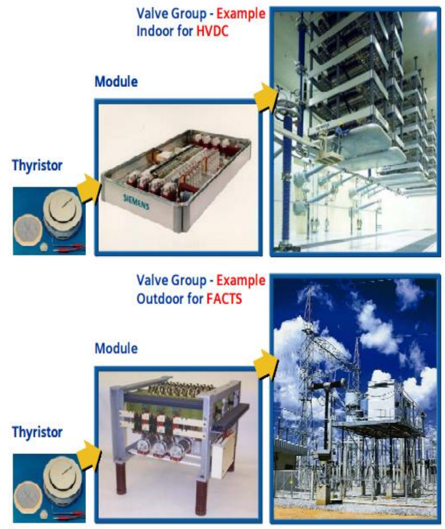


Fig. 3: HVDC and FACTS - Advanced Power Electronics for High Voltage Systems

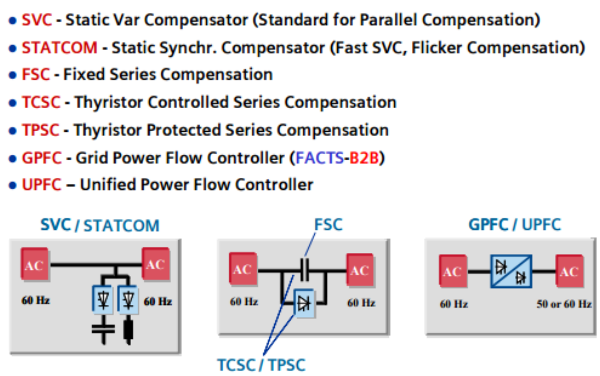


Fig. 4: FACTS - Flexible AC Transmission Systems: Support of Power Flow

FACTS DEVICES

SWEETY ZIONY S (152069), EEE –SECOND YEAR 'C'

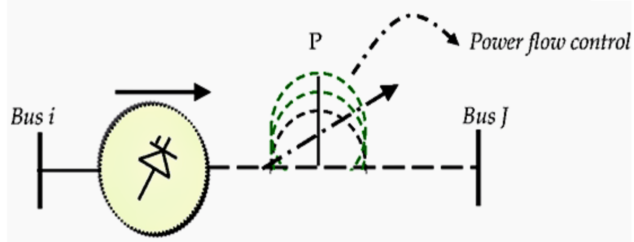
- **Flexible Alternating Current Transmission System** (FACTS) simply refers to a **combination of power electronics components** with traditional power system components. They are intended to improve our power system reliability, power transfer capability, transient and dynamic stability improvements, voltage regulation etc.…
- With the advent of improved semiconductor technologies, these FACTS devices have been proven in their speed and flexibility. But there do exist some cost and complexity issues.
- There can be **series** as well as **shunt compensation** for the transmission lines using these FACTS devices. In series compensation, line impedance is modified, that means net impedance is decreased and thereby increasing the transmittable active power. For shunt compensation, reactive current is injected into the line so as to regulate the voltage at the point of connection.

TYPES:

- SERIES CONTROLLERS
- SHUNT CONTORLLERS
- COMBINED SERIES-SERIES CONTOLLERS
- COMBINED SERIES-SHUNT CONTROLLERS

SERIES CONTROLLERS:

Series controllers are being connected in series with the line as they are meant for injecting voltage in series with the line. These devices could be **variable impedances** like capacitor, reactor or power electronics based variable source of main frequency, sub synchronous or harmonic frequency, or can be a combination of these, to meet the requirements.
If the injected voltage is in **phase quadrature with the line current**, then only supply or consumption of variable reactive power is possible.



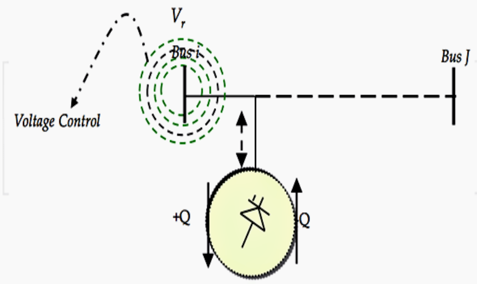
In order to handle real power also, any other phase relationship has to be involved. These types of controllers include:

- **SSSC** – Static synchronous series compensator,
- **TCSC** – Thyristor controlled series capacitor,
- **TCSR** – Thyristor controlled series reactor,
- **TSSC** – Thyristor switched series capacitor and
- **TSSR** – Thyristor switched series reactor.

SHUNT CONTOLLERS:

Shunt controllers will be connected in shunt with the line so as to inject current into the system at the point of connection. They can also be **variable impedance**, **variable source**, or **a combination of these**.

If the injected line current is in quadrature with the line voltage, **variable reactive power supply or consumption could be achieved**. But any other phase relationship could involve real power handling as well.

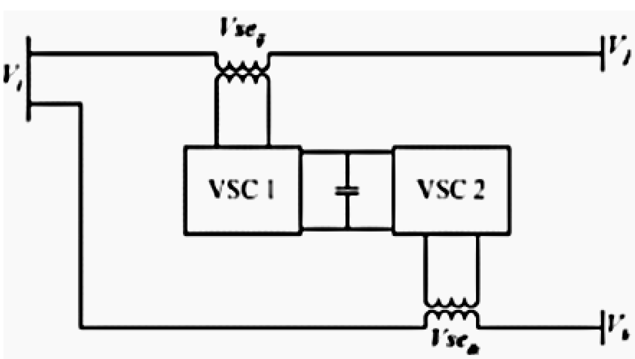


This category includes **STATCOM** (Static synchronous compensator) and **SVC** (Static VAR compensator). **The common Static VAR compensators are:**

- **TCR** – Thyristor controlled reactor,
- **TSR** – Thyristor switched reactor,
- **TSC** – Thyristor switched capacitor,

COMBINES SERIES-SERIES CONTOLLERS:

This category comprises of separate series controllers controlled in a coordinated manner in the case of a multiline transmission system. It can also be a unified controller in which the series controllers perform the reactive power compensation in each line independently whereas they facilitates real power exchange between the lines via the common DC link.

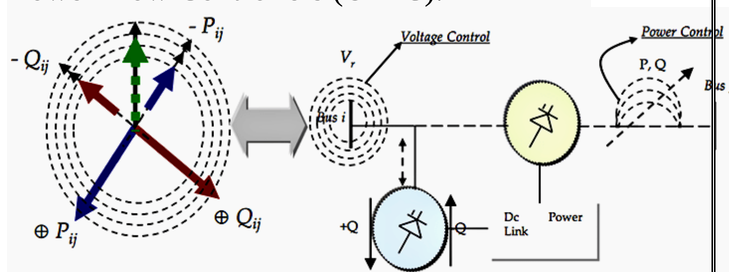


Because, in unified series-series controllers like **Interline Power Flow Controller (IPFC)**, the DC terminals of the controller converters are all connected together.

COMBINES SERIES-SHUNT CONTOLLERS:

It is a combination of separate series and shunt controllers, being operated in a coordinated manner. Hence, they are capable of injecting current into the line using the shunt part and injecting series voltage with the series part of the respective controller.

If they are unified, **there can be real power exchange between the shunt and series controllers** via the common DC power link, as in the case of Unified Power Flow Controllers (UPFC).



ADVANTAGES OF THESE CONTROLLERS:

- ✓ Improving power transfer capability
- ✓ Confining power flow to designated routes
- ✓ Transient and dynamic stability improvement
- ✓ Damping of power system oscillations
- ✓ Better voltage regulation
- ✓ Flexible operation and control of the system
- ✓ Secure loading of the transmission lines close to their thermal limits
- ✓ Prevention of cascading outages by contributing to emergency control

HVDC IN TRANSMISSION LINE

S. Radhika (132036), EEE-B, Final Year

High voltage is used for electric power transmission to reduce the energy lost in the resistance of the wires. For a, given quantity of power transmitted, doubling the voltage will deliver the same power at only half the current. Since the power lost as heat in the wires is proportional to the square of the current for a given conductor size, or inversely proportional to the square of the voltage, doubling the voltage reduces the line losses per unit of electrical power delivered by a factor of 4. While power lost in transmission can also be reduced by increasing the conductor size, larger conductors are heavier and more expensive.

High voltage cannot readily be used for lighting or motors, so transmission-level voltages must be reduced for end-use equipment. Transformers are used to change the voltage levels in alternating current (AC) transmission circuits. Because transformers made voltage changes practical, and AC generators were more efficient than those using DC, AC became dominant after the introduction of practical systems of distribution in Europe in 1891 and the conclusion in 1892 of the War of Currents, a competition being fought on many fronts in the US between the DC system of Thomas Edison and the AC system of George Westinghouse.

Practical conversion of power between AC and DC became possible with the development of power electronics devices such as mercury-arc valves and, starting in the 1970s, semiconductor devices as thyristors, integrated gate-commutated thyristors (IGCTs), MOS-controlled thyristors (MCTs) and insulated-gate bipolar transistors (IGBT).

Electromechanical (Thury) systems:

HVDC in 1971: this 150 kV mercury-arc valve converted AC hydropower voltage for transmission to distant cities from Manitoba Hydro generators.

Bipolar system pylons of the Baltic Cable HVDC in Sweden

The first long-distance transmission of electric power was demonstrated using direct current in 1882 at Miesbach-Munich Power Transmission, but only 1.5 kW was transmitted.[11] An early method of high-voltage DC transmission was developed by the Swiss engineer René Thury and his method was put into practice by 1889 in Italy by the *Acquedotto De Ferrari-Galliera* company. This system used series-connected motor-generator sets to increase the voltage. Each set was insulated from electrical ground and driven by insulated shafts from a prime mover. The transmission line was operated in a 'constant current' mode, with up to 5,000 volts across each machine, some machines having double commutators to reduce the voltage on each commutator. This system transmitted 630 kW at 14 kV DC over a distance of 120 km. The Moutiers–Lyon system transmitted 8,600 kW of hydroelectric power a distance of 200 km, including 10 km of underground cable. This system used eight series-connected generators with dual commutators for a total voltage of 150,000 volts between the positive and negative poles, and operated from c.1906 until 1936. Fifteen Thury systems were in operation by 1913. Other Thury systems operating at up to 100 kV DC worked into the 1930s, but the rotating machinery required high maintenance and had high energy loss. Various other electromechanical devices were tested during the first half of the 20th century with little commercial success.

One technique attempted for conversion of direct current from a high transmission voltage to lower utilization voltage was to charge series-connected batteries, then reconnect the batteries in parallel to serve distribution loads. While at least two commercial installations were tried around the turn of the 20th century, the technique was not generally useful owing to the limited capacity of batteries, difficulties in switching between series and parallel connections, and the inherent energy inefficiency of a battery charge/discharge cycle.

Mercury arc valves

First proposed in 1914,[18] the grid controlled mercury-arc valve became available for power transmission during the period 1920 to 1940. Starting in 1932, General Electric tested mercury-vapor valves and a 12 kV DC transmission line, which also served to convert 40 Hz generation to serve 60 Hz loads, at Mechanicville, New York. In 1941, a 60 MW, ±200 kV, 115 km buried cable link was designed for the city of Berlin using mercury arc valves (Elbe-Project), but owing to the collapse of the German government in 1945 the project was never completed. The nominal justification for the project was that, during wartime, a buried cable would be less conspicuous as a bombing target. The equipment was moved to the Soviet Union and was put into service there as the Moscow–Kashira HVDC system. The Moscow–Kashira system and the 1954 connection by Uno Lamm's group at ASEA between the mainland of Sweden and the island of Gotland marked the beginning of the modern era of HVDC transmission.

Mercury arc valves require an external circuit to force the current to zero and thus turn off the valve. In HVDC applications, the AC power system itself provides the means of *commutating* the current to another valve in the converter. Consequently, converters built with mercury arc valves are known as line-commutated converters (LCC). LCCs require rotating synchronous machines in the AC systems to which they are connected, making power transmission into a passive load impossible.

Mercury arc valves were common in systems designed up to 1972, the last mercury arc HVDC system (the Nelson River Bipole 1 system in Manitoba, Canada) having been put into service in stages between 1972 and 1977. Since then, all mercury arc systems have been either shut down or converted to use solid state devices. The last HVDC system to use mercury arc valves was the Inter-Island HVDC link between the North and South Islands of New Zealand, which used them on one of its two poles. The mercury arc valves were decommissioned on 1 August 2012, ahead of commissioning of replacement thyristor converters.

Thyristor valves

Since 1977, new HVDC systems have used only solid-state devices, in most cases thyristor valves. Like mercury arc valves, thyristors require connection to an external AC circuit in HVDC applications to turn them on and off. HVDC using thyristor valves is also known as line-commutated converter (LCC) HVDC.

Development of thyristor valves for HVDC began in the late 1960s. The first complete HVDC scheme based on thyristor valves was the Eel River scheme in Canada, which was built by General Electric and went into service in 1972.

On March 15, 1979, a 1920 MW thyristor based direct current connection between Cabora Bassa and Johannesburg (1,410 km) was energised. The conversion equipment was built in 1974 by Allgemeine Elektricitäts-Gesellschaft AG (AEG), and Brown, Boveri & Cie (BBC) and Siemens were partners in the project, the late completion date a result of the civil war. The transmission voltage of ±533 kV was the highest in the world at the time.[11]

Capacitor-commutated converters (CCC)

Line-commutated converters have some limitations in their use for HVDC systems. This results from requiring the AC circuit to turn off the thyristor current and the need for a short period of 'reverse' voltage to effect the turn-off (turn-off time). An attempt to address these limitations is the *Capacitor-Commutated Converter (CCC)* which has been used in a small number of HVDC systems. The CCC differs from a conventional HVDC system in that it has series capacitors inserted into the AC line connections, either on the primary or secondary side of the converter transformer. The series capacitors partially offset the *commutating inductance* of the converter and help to reduce fault currents. This also allows a smaller *extinction angle* to be used with a converter/inverter, reducing the need for reactive power support. However, CCC has remained only a niche application because of the advent of voltage-source converters (VSC) which completely eliminate the need for an extinction (turn-off) time.

SMART CITY

N. NIVETHA (142064), EEE, III Year 'B' Sec

INTRODUCTION:

A smart city uses digital technologies or information and communication technologies (ICT) to enhance quality and performance of urban services, to reduce costs and resource consumption, and to engage more effectively and actively with its citizens.

CONCEPT INVOLVED:

"MAKING *CITIES BETTER AND*

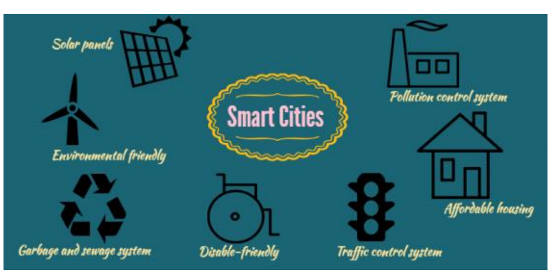
MAKING BETTER CITIES"

BASIC INFRASTRUCTURE:

Assured water and electricity supply, sanitation and solid waste management, efficient urban mobility and public transport, robust IT connectivity, e-governance and citizen participation, safety and security of citizens.

SMART SOLUTIONS:

Public information, grievance redressal, electronic service delivery, citizens' engagement, waste to energy & fuel, waste to compost, 100% treatment of waste water, smart meters and management, monitoring water quality, renewable source of energy, efficient energy and green building, smart parking, intelligent traffic management system.



SCOPE OF SMART CITIES IN INDIA:

India is drawing on the development of smart cities at global level. 'Digital India' has a plan to build 100 smart cities across the country.

"CITIES IN THE PAST WERE BUILT ON RIVERBANKS. THEY ARE NOW BUILD ALONG HIGHWAYS.

BUT IN THE FUTURE, THEY WILL BE BUILT BASED ON AVAILABILITY OF OPTICAL FIBER NETWORKS"

India's smart city plan is a part of a larger agenda of creating industrial corridors between India's big metropolitan cities in India. These include the Delhi-Mumbai industrial corridor, the Bangalore-Mumbai economical corridor and the Chennai-Bangalore industrial corridor. It is hoped that many industrial and commercial centers will be re-created as Smart cities.

CRITICAL PILLARS OF INDIA'S SMART CITY PROGRAM:

1. **Smart Governance:**

Investments of about US$1.2 trillion will be required over the next 20 years across areas such as transportation, energy and public security to build smart cities in India. Urban Development has plans to develop 2 smart cities in each of India's 29 states. Delhi Mumbai Industrial Corridor Development Corporation Ltd (DMICDC) plans seven "smart cities" along the 1,500-km industrial corridor across six states with a total investment of US$100 billion.

2. Smart Energy:

Three crucial dimensions of smart energy systems are: Smart Grid Electrification of all households with power available for at least 8 hours per day by 2017.India needs to add at least 250-400 GW of new power generation capacity by 2030.The Power Grid Corporation of India has planned to invest US$26 billion in the next five years Smart Meters India to install 130 million smart meters by 2021.

3. Smart Environment:

Three crucial dimensions of ensuring sustainable development are: The Indian Ministry of Water Resources plans to invest US$50 billion in the water sector in the coming years. The Yamuna Action Plan Phase III project for Delhi is approved at an estimated cost of US$276 million. Government of India and the World Bank have signed a US$500 million credit for the Rural Water Supply and Sanitation (RWSS) project in the Indian states of Assam, Bihar, Jharkhand and Uttar Pradesh.

4. Smart Transportation:

The Government of India has set ambitious targets of developing public transportation system to support the ever-growing urban population Green Transport: The Government of India has approved a US$4.13 billion plan to spur electric and hybrid vehicle production by setting an ambitious target of 6 million vehicles by 2020.Electric vehicle charging stations in all urban areas and along all state and national highways by 2027.

Railways Metro: Ministry of Urban Development plans to invest more than US$20 billion on the metro rail projects in coming years

High Speed Rail: The proposed 534 km Mumbai-Ahmedabad high speed rail project will have an investment of around US$10.5 billion.

Monorail: India's first monorail project at Mumbai will cost around US$500 million, of which US$183 million has been spent on phase I

5. Smart IT & Communications:

Connections to 175 million users by 2017 Security and Surveillance Under the flagship "Safe City" project, the Union Ministry proposes US$333 million to make seven big cities (Delhi, Mumbai, Kolkata, Chennai, Ahmedabad, Bangalore and Hyderabad) to focus on technological advancement rather than manpower Disaster Management.

6. Smart Buildings:

India is expected to emerge as the world's 3rd largest construction market by 2020, by adding 11.5 million homes every year.

7. Smart Health Hospitals:

Special focus on improving affordable healthcare for all. To establish six new AIIMS like institutes and 12 government medical colleges in the country Accessible, affordable and effective healthcare system for 1.2+ billion citizens.

8. Smart Education:

Budget has allocated US$78.5 million to set-up five new IITs and five new IIMs. Ministry of Human Resource Development plans to have 1,000 private universities for producing trained manpower to meet services and industry requirements.100% FDI allowed in the education sector India's online education market size expected to be US$40 billion by 2017.

CONCLUSION:

The smart cities concept has gained a lot of attention lately and it will most likely continue to do so in the future. Cities are publishing smart plans. Smart technologies can provide solutions for cities by helping them save money, reduce carbon emissions and manage traffic flows. But the complexity of the agenda is hindering its progress. It involves a large number of stakeholders (local authorities, citizens, technology companies and academics) each having their own vision of what a smart city should be; most of the debate gets bogged down on trying to understand what 'smart' means rather than focusing on how it can help cities meet their goals. Moreover, since the market for smart technologies is relatively new, it needs new business models and ways of working which are yet to be developed and implemented.

"***SMART CITY A SAFE CITY"***

"SMART CITY" WITH GLOBAL ANALYSIS

SOWMIYA.M 2ND YR EEE-C

WHAT ARE SMART CITIES, EXACTLY?

A 'smart city' is an urban region that is highly advanced in terms of overall infrastructure, sustainable real estate, communications and market viability. It is a city where information technology is the principal infrastructure and the basis for providing essential services to residents. There are many technological platforms involved, including but not limited to automated sensor networks and data centers.

AS THE SMART CITY PHENOMENON SPREADS AROUND THE WORLD, HOW IMPORTANT WILL IT BE FOR CITIES TO COLLABORATE IN SHARING KNOWLEDGE AND BEST PRACTICE IF THE GLOBAL COMMUNITY IS TO GET SMARTER, FASTER?

Something that has become very apparent is that smart cities are an ecosystem of parts played by many different actors. No one company can do the whole thing, and it really is a case where organizations need to focus on delivering their core competencies and collaborate across well-defined interfaces with many other players. When this happens a "whole is greater than the sum of its parts" effect happens and a smart city emerges.

WHAT IS THE SCOPE OF SMART CITIES IN INDIA?

India is drawing on the development of smart cities at the global level. Prime Minister Narendra Modi's vision 'Digital India', has a plan to build 100 smart cities across the country. Modi in his speech said, "Cities in the past were built on riverbanks. They are now built along highways. But in the future, they will be built based on availability of optical fiber networks and next generation infrastructure."

WHAT NEEDS TO BE DONE?

Given to the aforementioned statistics, the picture of growth is not as sad as it seems. Basic levels of development are being achieved like, the number of internet users in India was estimated to be around 190 million in June 2014, and is growing rapidly since then.

India has the third largest Internet population in the world today, after China with 620 million, and the US with 275 million. It took 20 years from the introduction of the Internet to reach 100 million users. The second 100 million reached within three years, and the third in less than a year.

MEASURES TO BUILD THE SMART CITIES:

1. **Retrofitting 500 acres:** Planning in an existing built-up area in a municipal ward, preparing plan with citizen participation (example: Connaught Place in Delhi, Bhendi Bazaar in Mumbai).

2. **Greenfield 250 acres:** Introduce smart solutions in a vacant area using innovative planning (example: land pooling/land reconstitution in Outer Delhi, GIFT city in Gujarat).

3. **Redevelopment 50 acres:** Replacement of existing built-up area and preparing a new layout plan with enhanced infrastructure by way of mixed land use (example: Kidwai Nagar in Delhi).

SMART CITY DESIGN

MADUMITHA.C (142016), 3rd YEAR, EEE-B

Features:

Some typical features of comprehensive development in Smart Cities are described below.

Promoting mixed land use in area based developments–planning for 'unplanned areas' containing a range of compatible activities and land uses close to one another in order to make land use more efficient. The States will enable some flexibility in land use and building bye-laws to adapt to change.

Housing and inclusiveness - expand housing opportunities for all.

Creating walkable localities –reduce congestion, air pollution and resource depletion, boost local economy, promote interactions and ensure security. The road network is created or refurbished not only for vehicles and public transport, but also for pedestrians and cyclists, and necessary administrative services are offered within walking or cycling distance.

Preserving and developing open spaces - parks, playgrounds, and recreational spaces in order to enhance the quality of life of citizens, reduce the urban heat effects in Areas and generally promote eco-balance.

Promoting a variety of transport options - Transit Oriented Development (TOD), public transport and last mile Para-transport connectivity.

Making governance citizen-friendly and cost effective - increasingly rely on online services to bring about accountability and transparency, especially using mobiles to reduce cost of services and providing services without having to go to municipal offices. Forming e-groups to listen to people and obtain feedback and use online monitoring of programs and activities with the aid of cyber tour of worksites.

Giving an identity to the city - based on its main economic activity, such as local cuisine, health, education, arts and craft, culture, sports goods, furniture, hosiery, textile, dairy, etc.

Applying Smart Solutions to infrastructure and services in area-based development in order to make them better. For example, making Areas less vulnerable to disasters, using fewer resources, and providing cheaper services.

Strategy

The strategic components of area-based development in the Smart Cities Mission are city improvement (retrofitting), city renewal (redevelopment) and city extension (green field development) plus a Pan-city initiative in which Smart Solutions are applied covering larger parts of the city. Below are given the descriptions of the three models of Area-based smart city development:

Retrofitting will introduce planning in an existing built-up area to achieve smart city objectives, along with other objectives, to make the existing area more efficient and loveable. In retrofitting, an area consisting of more than 500 acres will be identified by the city in consultation with citizens. Depending on the existing level of infrastructure services in the identified area and the vision of the residents, the cities will prepare a strategy to become smart. Since existing structures are largely to remain intact in this model, it is expected that more intensive infrastructure service levels and a large number of smart applications will be packed into the retrofitted smart city. This strategy may also be completed in a shorter time frame, leading to its replication in another part of the city.

Redevelopment will affect a replacement of the existing built-up environment and enable co-creation of a new layout with enhanced infrastructure using mixed land use and increased density. Redevelopment envisages an area of more than 50 acres, identified by Urban Local Bodies (ULBs) in consultation with citizens. For instance, a new layout plan of the identified area will be prepared with mixed land use, higher FSI and high ground coverage. Two examples of the redevelopment model are the Saifee Burhani Upliftment Project in Mumbai (also called the Bhendi Bazaar Project) and the redevelopment of East Kidwai Nagar in New Delhi being undertaken by the National Building Construction Corporation.

Greenfield development will introduce most of the Smart Solutions in a previously vacant area (more than 250 acres) using innovative planning, plan financing and plan implementation tools (e.g. land pooling/ land reconstitution) with provision for affordable housing, especially for the poor. Greenfield developments are required around cities in order to address the needs of the expanding population. One well known example is the GIFT City in Gujarat. Unlike retrofitting and redevelopment, green field developments could be located either within the limits of the ULB or within the limits of the local Urban Development Authority (UDA).

Pan-city development envisages application of selected Smart Solutions to the existing city-wide infrastructure. Application of Smart Solutions will involve the use of technology, information and data to make infrastructure and services better. For example, applying Smart Solutions in the transport sector (intelligent traffic management system) and reducing average commute time or cost of citizens will have positive effects on productivity and quality of life of citizens. Another example can be waste water recycling and smart metering which can make a huge contribution to better water management in the city.

The smart city proposal of each shortlisted city is expected to encapsulate either a retrofitting or redevelopment or green field development model, or a mix thereof and a Pan-city feature with Smart Solution(s). It is important to note that pan-city is an additional feature to be provided. Since smart city is taking a compact area approach, it is necessary that all the city residents feel there is something in it for them also. Therefore, the additional requirement of some (at least one) city-wide smart solution has been put in the scheme to make it inclusive. For North Eastern and Himalayan States, the area proposed to be developed will be one-half of what is prescribed for any of the alternative models - retrofitting, redevelopment or green field development

SMART CITY APPLICATIONS

SG. THAIYAL NAYAGI (142015), EEE – III year

A city equipped with basic infrastructure to give a decent quality of life, a clean and sustainable environment through application of some smart solutions is called smart city. A smart city is an urban development vision to integrate multiple information and communication technology (ICT) and Internet of Things (IOT) solutions in a secure fashion to manage a city's assets – the city's assets include, but are not limited to, local departments' information systems, schools, libraries, transportation systems, hospitals, power plants, water supply networks, waste management, law enforcement, and other community services. The goal of building a smart city is to improve quality of life by using urban informatics and technology to improve the efficiency of services and meet resident's needs. ICT allows city officials to interact directly with the community and the city infrastructure and to monitor what is happening in the city, how the city is evolving, and how to enable a better quality of life. Through the use of sensors integrated with real-time monitoring systems, data are collected from citizens and devices – then processed and analyzed. The information and knowledge gathered are keys to tackling inefficiency. An important cluster of Smart City technological companies exists in Israel with Tel Aviv being awarded the World Smart City Award in 2014. Israeli companies are implementing Smart City solutions worldwide. In China, ZTE Corporation have more than 150 cities with Smart Solutions. The main carrier for all the technology, usually, is the street lighting system, that is available all over the city and can be used to control multiple systems. Kingsun Optoelectronic is the major supplier for smart street light in China. Smart city assures water and electricity supply, sanitation and solid waste management, efficient urban mobility and public transport, robust IT connectivity, e-governance and citizen participation, safety and security of citizens. Public information, electronic service delivery, citizens' engagement, waste to energy & fuel, waste to compost, 100% treatment of waste water, smart meters & management, monitoring water quality, renewable source of energy, efficient energy and green building, smart parking, intelligent traffic management system. The next step is identification of the 100 cities and for this a city challenge competition to be conducted by Bloomberg Philanthropies is envisaged. The current plan looks to select 20 cities this year followed by 40 each in the next two years. Smart Cities Council India has been formed. It is part of the US-based Smart Cities Council, which is a consortium of smart city practitioners and experts, with a 100-plus member and advisor organizations operating in over 140 countries. A Special Purpose Vehicle will be created for each city to implement Smart City action plan. The SPV will be signed with the urban local body, state government and the Centre for implementation of the project. After government announces the guidelines, states will be asked to nominate names of cities for a 'City Challenge Competition' and the chosen ones will get Central fund of Rs 100 corer each year for 5 years. Area-based development includes

1. Retrofitting 500 acres: Planning in an existing built-up area in a municipal ward, preparing plan with citizen participation (example: Connaught Place in Delhi, Bhendi Bazar in Mumbai).

2. Greenfield 250 acres: Introduce smart solutions in a vacant area using innovative planning (example: land pooling/land reconstitution in Outer Delhi, GIFT city in Gujarat).

3. Redevelopment 50 acres: Replacement of existing built-up area and preparing a new layout plan with enhanced infrastructure by way of mixed land use (example: Kidwai Nagar in Delhi).

A technological Smart City is not just one concept but there are different combinations of technological infrastructure that build a concept of smart city. Human infrastructure (i.e., creative occupations and workforce, knowledge networks, voluntary organizations) is a crucial axis for city development.

SMART GRID

T. MUTHUMATHI (132023), FINAL YEAR, EEE- 'B'

Maybe you have heard of the Smart Grid on the news or from your energy provider. But not everyone knows what the grid is, let alone the Smart Grid. "The grid," refers to the electric grid, a network of transmission lines, substations, transformers and more that deliver electricity from the power plant to your home or business. It's what you plug into when you flip on your light switch or power up your computer. Our current electric grid was built in the 1890s and improved upon as technology advanced through each decade. Today, it consists of more than 9,200 electric generating units with more than 1 million megawatts of generating capacity connected to more than 300,000 miles of transmission lines. Although the electric grid is considered an engineering marvel, we are stretching its patchwork nature to its capacity. To move forward, we need a new kind of electric grid, one that is built from the bottom up to handle the groundswell of digital and computerized equipment and technology dependent on it—and one that can automate and manage the increasing complexity and needs of electricity in the 21st Century.

What Makes a Grid "Smart?"

In short, the digital technology that allows for two-way communication between the utility and its customers, and the sensing along the transmission lines is what makes the grid smart. Like the Internet, the Smart Grid will consist of controls, computers, automation, and new technologies and equipment working together, but in this case, these technologies will work with the electrical grid to respond digitally to our quickly changing electric demand.

What does a Smart Grid do?

The Smart Grid represents an unprecedented opportunity to move the energy industry into a new era of reliability, availability, and efficiency that will contribute to our economic and environmental health. During the transition period, it will be critical to carry out testing, technology improvements, consumer education, development of standards and regulations, and information sharing between projects to ensure that the benefits we envision from the Smart Grid become a reality. The benefits associated with the Smart Grid include:

- More efficient transmission of electricity
- Quicker restoration of electricity after power disturbances
- Reduced operations and management costs for utilities, and ultimately lower power costs for consumers
- Reduced peak demand, which will also help lower electricity rates
- Increased integration of large-scale renewable energy systems
- Better integration of customer-owner power generation systems, including renewable energy systems
- Improved security

Today, an electricity disruption such as a blackout can have a domino effect—a series of failures that can affect banking, communications, traffic, and security. This is a particular threat in the winter, when homeowners can be left without heat. A smarter grid will add resiliency to our electric power System and make it better prepared to address emergencies such as severe storms, earthquakes, large solar flares, and terrorist attacks. Because of its two-way interactive capacity, the Smart Grid will allow for automatic rerouting when equipment fails or outages occur. This will minimize outages and minimize the effects when they do happen. When a power outage occurs, Smart Grid technologies will detect and isolate the outages, containing them before they become large-scale blackouts. The new technologies will also help ensure that electricity recovery resumes quickly and strategically after an emergency—routing electricity to emergency services first, for example. In addition, the Smart Grid will take greater advantage of customer-owned power generators to produce power when it is not available from utilities. By combining these "distributed generation" resources, a community could keep its health center, police department, traffic lights, phone System, and grocery store operating during emergencies. In addition, the Smart Grid is a way to address an aging energy infrastructure that needs to be upgraded or replaced. It’s a way to address energy efficiency, to bring increased awareness to consumers about the connection between electricity use and the environment. And it’s a way to bring increased national security to our energy System—drawing on greater amounts of home-grown electricity that is more resistant to natural disasters and attack.

Giving Consumers Control

The Smart Grid is not just about utilities and technologies; it is about giving you the information and tools you need to make choices about your energy use. If you already manage activities such as personal banking from your home computer, imagine managing your electricity in a similar way. A smarter grid will enable an unprecedented level of consumer participation. For example, you will no longer have to wait for your monthly statement to know how much electricity you use. With a smarter grid, you can have a clear and timely picture of it. "Smart meters," and other mechanisms, will allow you to see how much electricity you use, when you use it, and its cost. Combined with real-time pricing, this will allow you to save money by using less power when electricity is most expensive. While the potential benefits of the Smart Grid are usually discussed in terms of economics, national security, and renewable energy goals, the Smart Grid has the potential to help you save money by helping you to manage your electricity use and choose the best times to purchase electricity. And you can save even more by generating your own power.

Building and Testing the Smart Grid

The Smart Grid will consist of millions of pieces and parts—controls, computers, power lines, and new technologies and equipment. It will take some time for all the technologies to be perfected, equipment installed, and systems tested before it comes fully on line. And it won’t happen all at once—the Smart Grid is evolving, piece by piece, over the next decade or so. Once mature, the Smart Grid will likely bring the same kind of transformation that the Internet has already brought to the way we live, work, play, and learn.

SOLAR POWER FOR ATM

PRIYANKA 3 YEAR C SEC

PROBLEM ADDRESSED

Today ATMs have become an important part of the delivery channel for banks. Ensuring that they run efficiently throughout the day/night requires a great effort on the part of the banks and its partner vendors.

Apart from several problems being faced, ensuring that these ATMs have electrical power at all times can be a tough call especially in states/districts, which are deficit in power. This problem is further aggravated in semi-urban and rural areas.

It has been observed that power is available in these places for 3 to 4 hours only, in a 24 hours cycle, at unpredictable time of day/night in bits and pieces. Many a times, even if the power is there, the Grid voltage is so low that it is as good as not available. Consequently, the UPS batteries are not charged sufficiently, resulting in the ATM being down for several hours in a stretch.

This ultimately results in a huge revenue loss for the banks as your customers start using another bank's ATM. There can be significant loss because of Issuer Transactions and a loss as well of the revenue opportunity because of missed Acquirer Transactions. It also results in customer dissatisfaction and in-efficient use of the infrastructure created by the bank.

SOLUTION OFFERED

To fight the problem in power shortage or failure that leads to the malfunctioning of the ATMs in the semi-urban and rural areas, Isoft Technologies Ltd. innovates a realistic and guaranteed solution. We offer availability of power to your bank's ATMs and Branches all the time as solving the shortage of electricity of the ATMs and branches of any bank is our prime objective.

To enable the ease of work, we offer solar power to ATMs across India, especially in the semi-urban and the rural areas where there is always power failure that results into incompetent functioning of the branches and ATMs of the banks. With our solar UPS backup, we ensure that no power failure can disturb the ATM experience for our customers.

SOLUTION WE OFFER

As a company, Isoft Technology Ltd. runs with the philosophy of having transparency, efficiency and aspiration at and for work. Our skilled workforce has been working dexterously in bringing about changes in the finances and its transaction structure with installing Solar ATMs in India, and especially in the rural and semi-urban locations.

We understand the immediate and 24-hour response that is expected as well as required from the ATMs around any location. The rural and the semi-urban areas suffer mostly because of the frequent power cuts that happen in these areas. Using solar power to ATMs in India, the issue of irregular availability of transaction facilities in these ATMs can be easily warded off.

The vision of Isoft Technology Ltd. is to see every nook and corner having Solar ATM in India, so that no power failure can deter transactions at any point, no matter how remote the area is. For those regions where grid power is available at times only for 3-4 hours, having solar ATM banks in India enables smooth banking and ATM transactions during the peak hours daily. Providing solar UPS ATMs in India, Isoft offers unique value proposition that is backed up by up-to-date technological support. Here is an intelligent controller guaranteeing up time by monitoring and managing station using a SIM card that not only ensures regular check on the real-time power supply through technology but, safety of the bank as well.

 To fight power shortage or power failure issue that leads to malfunctioning of ATMs in semi-urban and rural areas, Isoft comes in offering 24X7 power solutions to banks and their ATMS on demand.

 Solar ATMs in India is the call of this hour to ensure effective and sustainable banking solutions through the ATMs. Isoft technologies endeavors to bring about cost effective, result oriented and practical solutions to meet with the existing problem faced by innumerable banks in swift operations of ATMs at the semi-urban or rural areas owing to irregular power supply.

 Isoft guarantees 24X7 powers back up the year through, which means zero transaction loss due to power failure. If the grid power remains available only for 3 to 4 hours in a 24 hours cycle, it is sufficient for the system we have to acquire back up and deliver unhindered power supply.

 We have been providing up-to-date technology for our unique value proposition through our solar bank ATMs. We ensure guaranteed up time through intelligent controller that manages as well as monitors the energy supplying devices that are existing and thereby ensures not only a regular check on the real-time power supply through our technology, but the safety of the bank network as well.

KEY BENEFITS

There are more than one benefits of using our technology of solar ATMs such as:

 Uninterrupted power back up and supply in the solar ATM using the solar energy to run the systems.

 Customer service and back up in offering power solutions in rural and semi-urban Bank ATMs.

 Practical and worthy utilization of the already existing infrastructure, tapping the resource of grid power for 3 to 4 hours in a 24-hour cycle and offering solar power for ATM running in the rural areas in India.

 Help in creating additional capacity for bank's infrastructure to help in acquiring more business without further additional costs to solve electricity problems in Bank ATMs.

 No Cape for the project.

SOLAR POWER AND ITS APPLICATIONS IN DESIGNING OF ATM

KAVIYA 2-year B sec

In India, semi-urban and rural areas that contribute to a majority of the landscape, are often impacted by the lack of power and non-availability of ATM fit notes. Since normal ATMs consume high power, require air-conditioners and ATM fit currencies, banks find it difficult to deploy ATMs in such places.

In order to address this problem, Vortex developed a solar ATM that not only consumes less power, but is also operational without air-conditioners. Moreover, it takes care of soiled teller grade notes as well.

According to the CEO of Vortex, Vijay Babu, more and more banks are now coming forward to deploy these ATMs. In the initial stage, at least 400 solar ATMs called gram tellers were installed in 17 states of the country. The State Bank of India, owing to its exemplary performance and substantial energy savings, played a pioneering role in promoting it.

Indus India Bank was the first private bank in India to launch the solar-powered ATM at their Opera House branch in Mumbai. While the Catholic Syrian Bank has placed an order for 50 gram tellers, Bank of Maharashtra and City Union Bank are adopting solar ATMs too. From 2010 to 2013, the number of such ATMs has increased to 100 and now, they are present in different parts of the country.

Vortex, which is looking to venture into Asia, is likely to install 5,000 solar ATMs in India by 2015. Elaborating on the measures that need to be taken to reduce the cost of deploying ATM machines, Babu adds that there is a need for technological advancements to address such issues.

In order to function smoothly, all that the gram teller requires is merely five hours of good sunshine per day, as it uses solar panels to convert sun rays into electrical energy. During the day, the facility uses solar power and in the same time, spare batteries are also charged. These batteries provide power to the ATM in the absence of sunlight, while the extra power generated during the day is exported to an internal grid for other uses. It is the solar inverter and charge controller which manages the switch between solar, battery and grid power. The complete functioning of the system is monitored from a distant area. A single gram teller unit saves over ninety per cent of the annual expenditure of maintaining a traditional ATM, half of whose annual bill of ` 1, 44, 000 (US$2,530) goes in air-conditioning, electricity and generator running prices.

The ATMs survive power fluctuations too since there is a built-in battery back-up for four hours. They can also function in temperatures ranging from 0 to 50 degree centigrade and without air-conditioning.

According to reports, the government is now planning to start a mini-banking facility in each of India's 600,000 villages, with an aim of opening about 25 million savings accounts in villages.

Meanwhile, Washington-based World Bank's International Finance Corporation

(IFC) has predicted that by 2015, the ATM market in India is expected to grow three-fold.

As Vortex began developing the new ATM, it arrived at the following list of requirements for it:

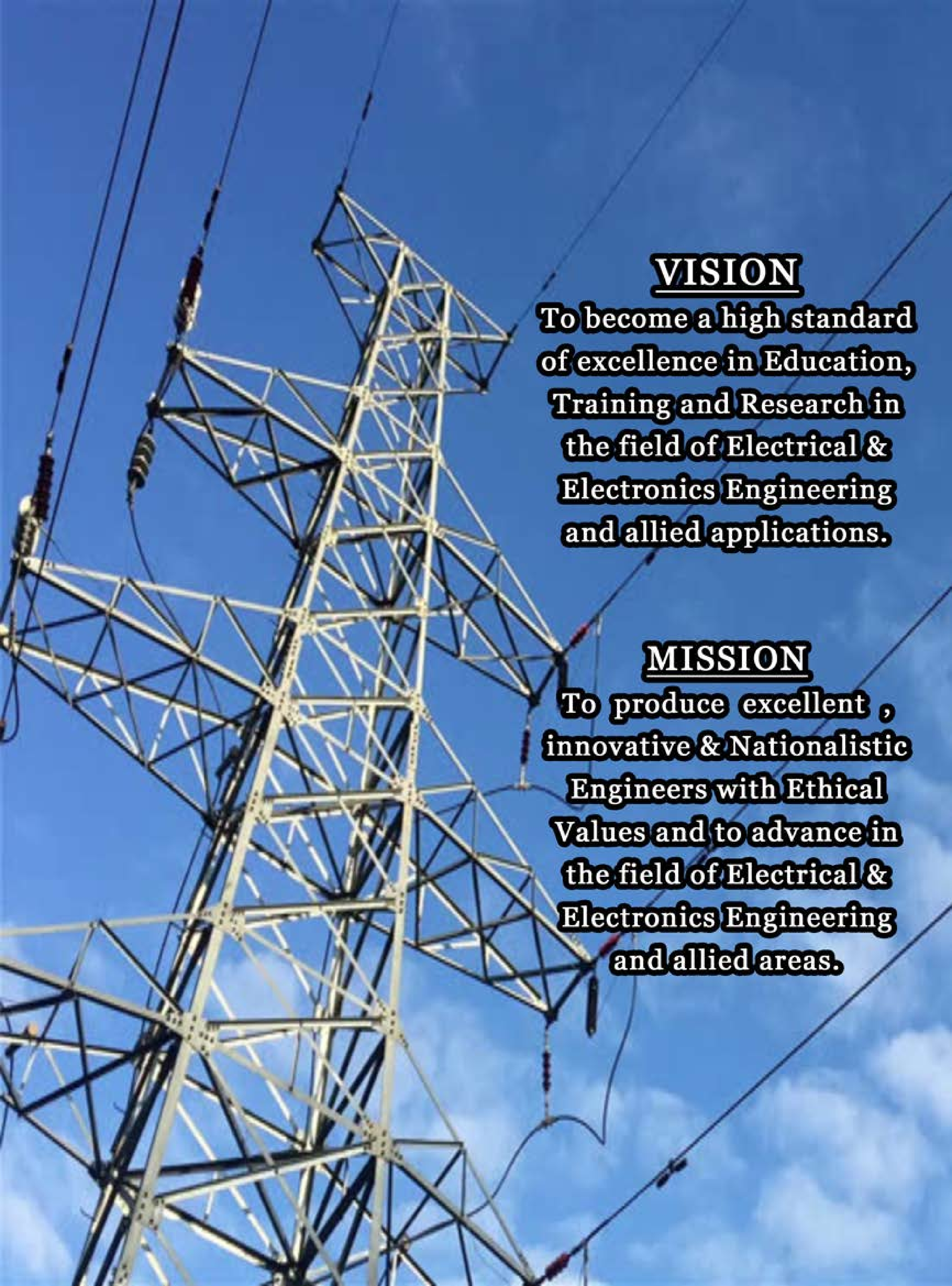
It needed to cost less than conventional ATMs.

It needed to consume less energy.

It needed to be independent of the air-conditioned environment that conventional ATMs require.

It needed to be able to dispense soiled notes, as the supply of fresh notes to rural areas is very limited.

this product has large potential in geographies such as Africa, which face infrastructure and fiscal constraints similar to India, helping them minimize cost while maximizing energy efficiency. With the wide range of benefits, it offers, Vortex's new ATM is poised to revolutionize banking all over the world.


VISION
To become a high standard
of excellence in Education,
Training and Research in
the field of Electrical &
Electronics Engineering
and allied applications.
MISSION
To produce excellent ,
innovative & Nationalistic
Engineers with Ethical
Values and to advance in
the field of Electrical &
Electronics Engineering
and allied areas.