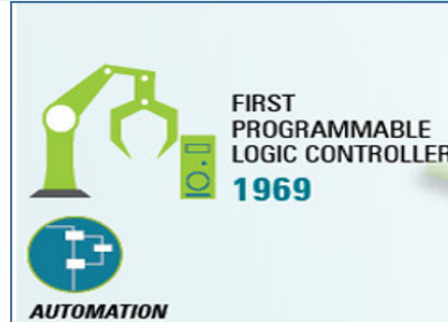
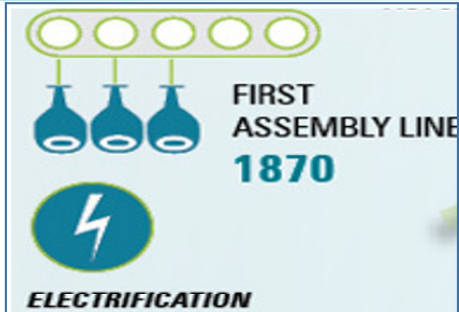
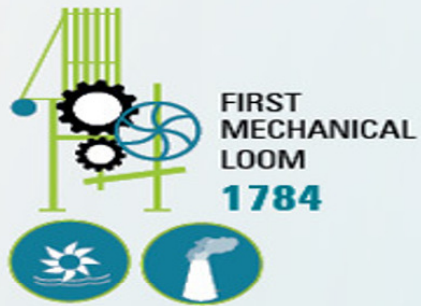




DIGITAL APPLICATIONS IN INDIAN POWER SECTOR AND BENEFITS FROM DIGITAL TRANSFORMATION

*PANKAJ BATRA, EX-CHAIRPERSON AND MEMBER (PLANNING), CEA
DIGITAL TRANSFORMATION IN POWER SECTOR
28TH JANUARY 2019*

EVOLUTION OF TECHNOLOGY



1st

Industrial Revolution-1
driven by
Mechanization & Steam Power

2nd

Industrial Revolution-2
driven by
Mass Production

3rd

Industrial Revolution-3
driven by
Computer & Automation

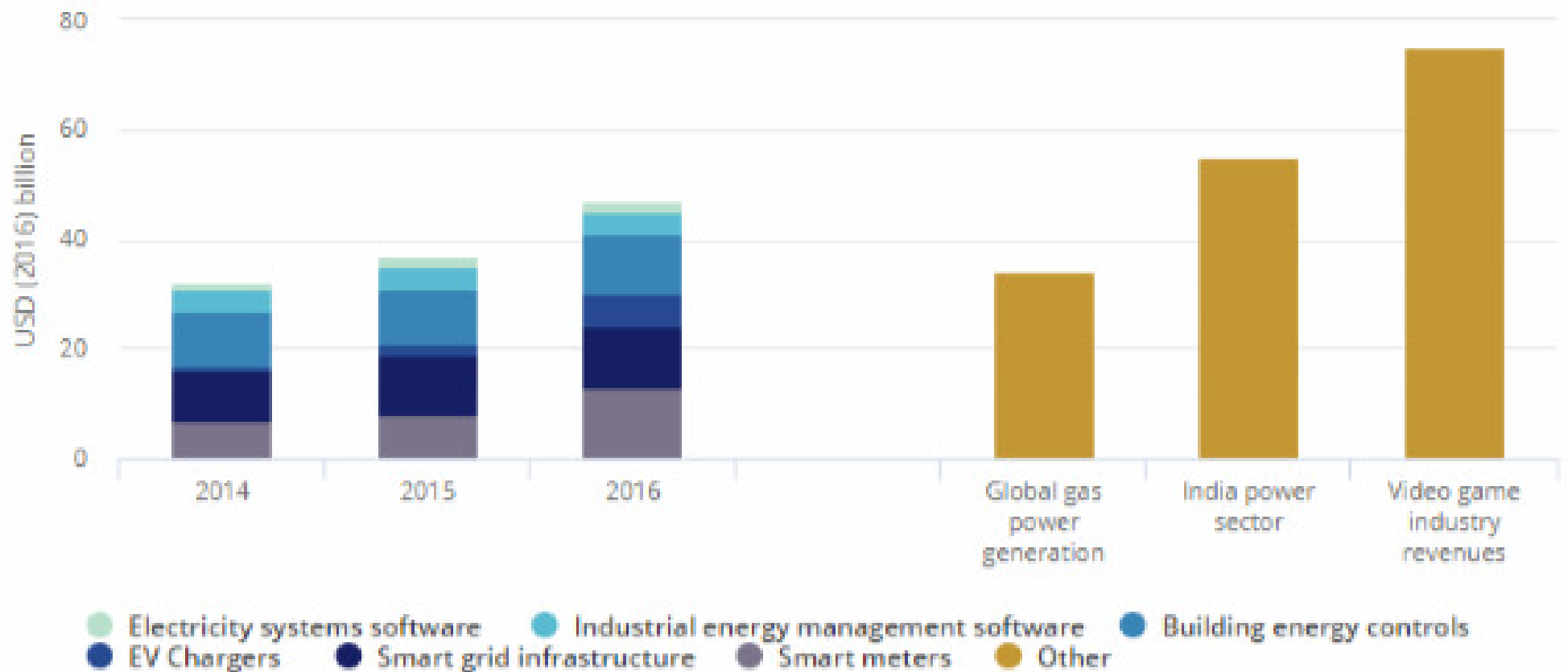
4th

Industrial Revolution-4
driven by
Cyber Physical Systems

FOURTH INDUSTRIAL REVOLUTION

- The **Fourth Industrial Revolution** (4IR) is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres, collectively referred to as cyber-physical systems.
- It is marked by emerging technology breakthroughs in a number of fields, including robotics, artificial intelligence, nanotechnology, quantum computing, biotechnology, the Internet of Things, the Industrial Internet of Things (IIoT), Blockchain, fifth-generation wireless technologies (5G), additive manufacturing/3D printing and fully autonomous vehicles.

Investments in digital electricity infrastructure and software



Digitalization and Energy, IEA 2017

Sources: IEA analysis based on MarketsandMarkets (2016), Internet of Things in Utility Market; BNEF (2016), Digital Energy Market Outlook.

DIGITAL TRANSFORMATION IN *GENERATION* IN INDIA

COURTESY NTPC

ANALYTICS IN THE POWER PLANT CONTEXT

(COURTESY NTPC)

Operations Optimization

- **M**easure, **V**isualize and **I**mprove operational parameters
- Get the last penny from your process

Maintenance Optimization

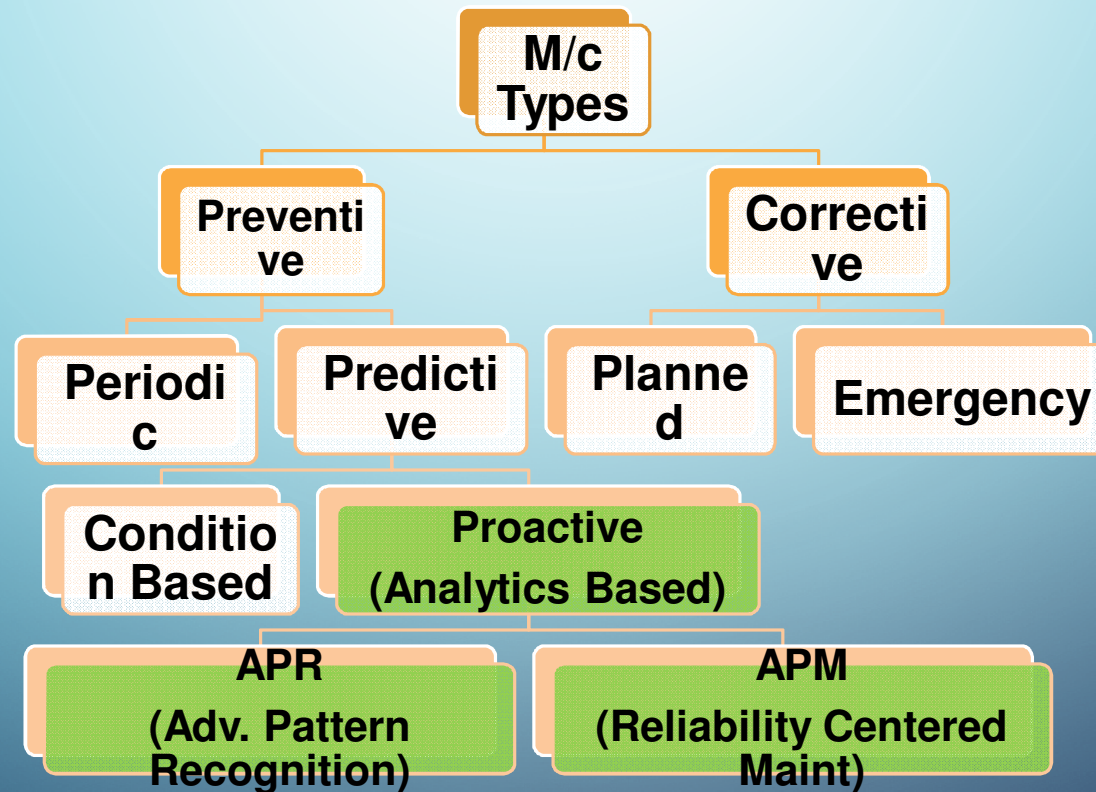
- Strike the right mix of **A**vailability, **C**ost of **M**aintenance & **R**isk

Business Optimization

- Enterprise level O&M Optimization
- Market Intelligence
 - Demand Forecasting
 - Solar Power Prediction
- Portfolio Management
 - Resource planning

ANALYTICS: MAINTENANCE OPTIMIZATION

(COURTESY NTPC)



DIGITAL TWIN

(COURTESY NTPC)



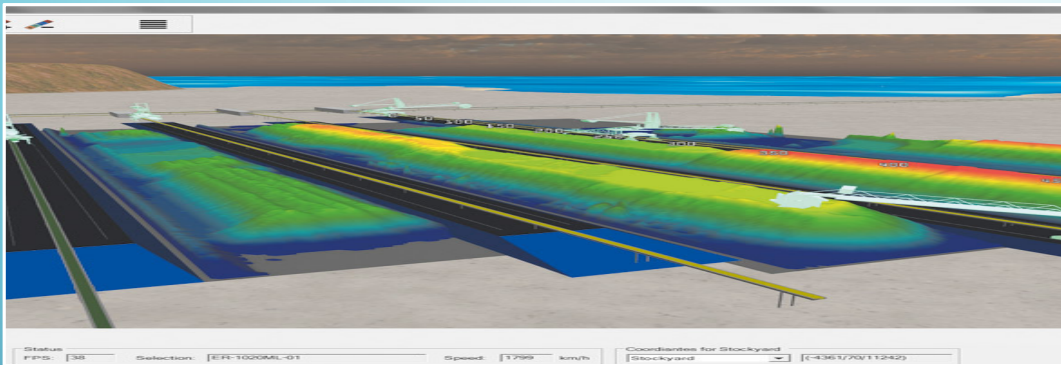
Dimensional Model
3D modeling
Software

- Walk Through
- One Stop Documentation

Functional Model
First Principle
Software

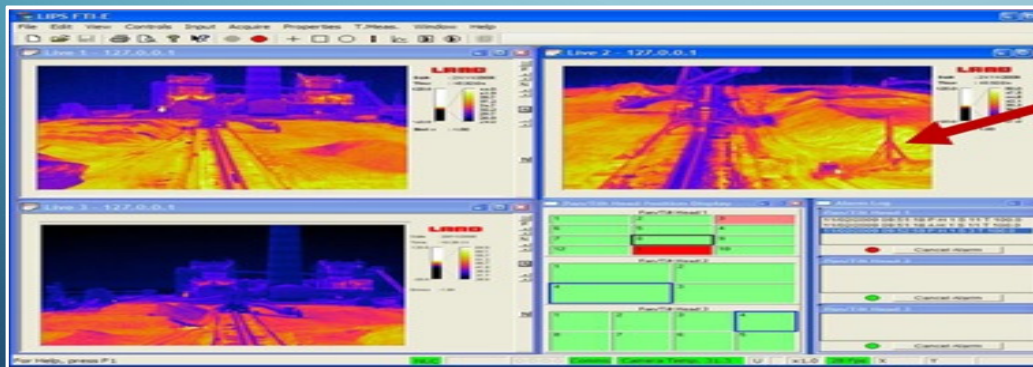
- “What Ifs” to evaluate operating scenarios.

ADVANCED MONITORING OF STOCKYARD : 3 D STOCK PROFILING & HOT SPOT DETECTION (COURTESY NTPC)



3D Profiling

Operator can visualize
Exact replica of the coal
heap
Cross sectional volume
and other details
available in a particular
heap of coal.



Hot Spot Detection

Different Color Gradient
indicates the different
thermograms or
temperature zones of the
stock yard.

DIGITAL TRANSFORMATION IN *TRANSMISSION* IN INDIA

COURTESY POWERGRID

POWERGRID EFFORTS

- **Wide Area Monitoring System (WAMS)**
- **Digital Substation and Substation Automation**
- **FACTS (Flexible AC Transmission System)**
- **NTAMC:** State-of-the-art 'National Transmission Asset Management Centre' (NTAMC) at Manesar, Haryana, set up for managing the assets and monitoring various parameters remotely on real time basis

WIDE AREA MONITORING SYSTEM

- Phasor Measurement Units (PMUs) are installed across the power system network for measurement. The time synchronized measurements of PMUs at different locations measure the voltage, current and phase angle - 1400 Nos. PMUs installed along with analytics and applications in 32 control centre.
- PMUs measure the voltage, current and phase angle of a particular location as well as of the adjacent location and gives a direct indication of whether the angular stability limit is being approached.
- WAMS therefore provides a comprehensive view of the entire grid and improves situational awareness of the system operator.
- Improves reliability and utilization of the grid.

DIGITAL SUBSTATION AND SUBSTATION AUTOMATION

- Input parameters like voltages, currents are taken through optical fibres and processed for Protection and Control functions.
- Use of fibre optic cables eliminates most of the copper cabling and cable trench requirements, thus reducing capital cost and construction period.
- Reliability of the system is comparatively higher and maintenance is easier.
- In India, more than 50 substations are already digitalised.

FACTS (FLEXIBLE AC TRANSMISSION SYSTEM)

- Enhanced controllability and stability of the transmission system.
- Increase of the power transfer capabilities.
- **Series compensation** : Since the current through the transmission line directly "drives" the MVAR output from the capacitor, the compensation concept is "self-regulating". Extremely cost effective solution. 40 Series capacitors are already installed in India, in lines of 400 kV and above.
- **Dynamic Compensation** : Increases system stability and power quality by providing voltage control and support, Reactive power control, Power oscillation damping as well as Power transfer capacity increase. 18 Nos. SVC / Statcoms are installed / under implementation.

DIGITAL TRANSFORMATION IN *DISTRIBUTION* IN INDIA

CEA AND OTHERS

DISTRIBUTION

- **Distribution Management System (DMS) - Distribution SCADA (Supervisory Control and Data Acquisition System).**
- **Outage Management System (OMS)**
- **Advanced Distribution Management System (ADMS) -** fault location, isolation and restoration; volt/var optimization; load reduction through voltage reduction; peak demand management; and support for micro grids and electric vehicles.

DISTRIBUTION

- Data available consumer wise and transformer-wise would be of immense help
- accurate season-wise demand forecasting (hourly/15 minute)
- Accurate distribution planning,
- optimal procurement of power and optimal utilization of the distribution system.
- Monitoring the performance of the distribution system and calculate reliability indices like SAIDI, SAIFI, CAIDI, etc.

PROSUMERS AND ENGAGED CONSUMERS

- Prosumers can sell power back to the grid
- Control of consumption of power through mobile apps.
- For example, scheduling the home's washing machine cycle can mean savings for the consumer.
- Engagement of consumers in the process of demand generation balancing.

DISTRIBUTED ENERGY RESOURCES (DER)

- DERs, along with smart inverters and advanced distribution management systems, can add flexibility and resilience to the grid.
- In times of hurricanes and storms, DER with energy storage, along with equivalent load can split into islands of self-supporting microgrids, which run autonomously.
- Buying and selling of electricity between the DER owning consumers using blockchain technology is being experimented with.

DISTRIBUTED ENERGY RESOURCES (DER)

- Delhi Government unveiled a draft Solar Policy 2017, which included **Virtual Net Metering** and **Group Net Metering**.
- In **Virtual Net Metering**, consumers, who do not have a suitable roof for installing a solar system, can be beneficial owners of a part of a collectively owned solar system.
- In **Group Net Metering**, surplus energy exported to the grid from a solar plant in excess of 100 percent of imported energy can be adjusted in any other electricity service connection(s) of the consumer within the NCT of Delhi, provided these connections are in the same DISCOM territory.
- Cleanmax Solar controls 24 percent of the domestic market, as in July 2018, and has already installed nearly 450 megawatt in various factory premises. It is growing at present at more than 100% per year.
- Target, a discount retail chain, added over 40 MW of solar to its portfolio in 2017. The business now has more than 200 MW of installed capacity.

ELECTRIC VEHICLES

- Electric vehicles accounted for just 1% of U.S. and global light-duty vehicle purchases in 2016, but sales are growing rapidly. Customer interest is rising as prices fall and driving ranges increase.
- China, the U.K., France, and India have all announced plans to phase out fossil-fuel-powered vehicles.
- Increased EV penetration would actually have benefits in managing the grid. EVs with onboard batteries could help utilities balance the grid, integrate renewables, through regulating the rate of charging, in accordance with the quantum of power available in the grid due to the intermittent renewable, or even feeding back to the grid, when required.

SMART GRID

- The grid would become “smart”, with digitalization. Model Smart Grid Regulations were formulated by Forum of Regulators in 2015.
- The benefits associated with the Smart Grid include:
 1. More efficient transmission of electricity
 2. Quicker restoration of electricity after power disturbances
 3. Reduced operations and management costs for utilities, and ultimately lower power costs for consumers
 4. Reduced peak demand, which will also help lower electricity rates
 5. Increased integration of large-scale renewable energy systems
 6. Better integration of customer-owner power generation systems, including renewable energy systems
 7. Improved security

CYBER SECURITY

- **December 2015 Ukraine power grid cyberattack** is considered to be the first known successful cyberattack on a power grid. Hackers were able to successfully compromise information systems of three energy distribution companies in Ukraine and temporarily disrupt electricity supply to the end consumers.
- Cyber attacks followed in 2016 and 2017.
- The world is gearing up to meet this challenge. **Computer Emergency Response Teams (CERT)** have been formed in each country since early 1990s. CERT is an expert group that handles computer security incidents. CERT-IN has also been formed in 2004, but its activities have picked up in the last few years.

THANK YOU

