Alliance for an Energy Efficient Economy

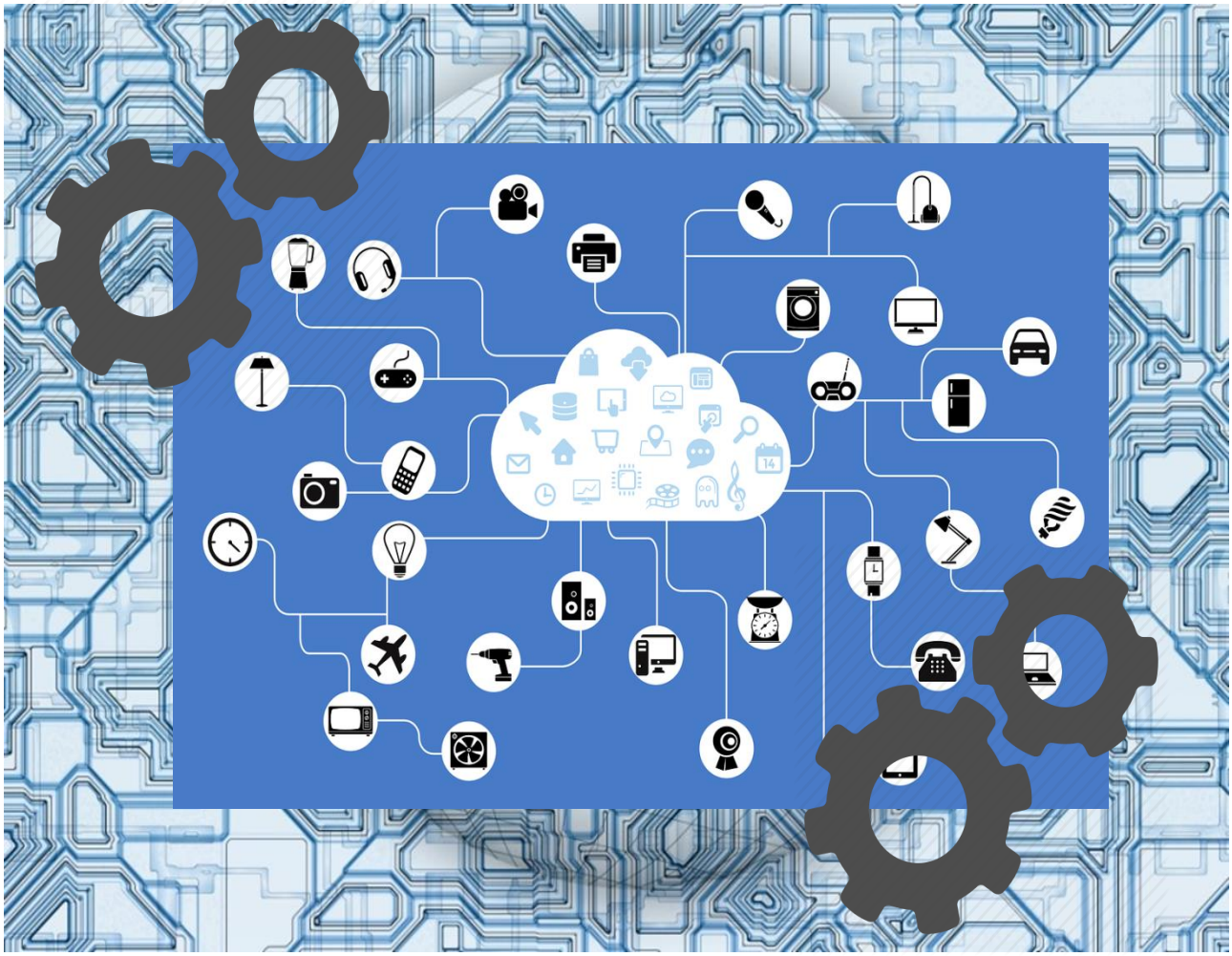
Sustainability Outlook

SHAKTI SUSTAINABLE ENERGY FOUNDATION

PAT Pulse

Tracking the Perform-Achieve-Trade Scheme for Energy Efficiency

June 2016



Asset Optimization to Drive the Next Wave of Energy Efficiency in India

Achieving energy efficiency in industries is a priority for India from the perspective of cost savings as well as climate change. The Perform-Achieve-Trade (PAT) scheme was formulated to achieve this objective by facilitating a market based mechanism for promoting energy efficiency.

'PAT Pulse' is a quarterly briefing series on PAT with DCs, policy makers, catalysts and industry experts to capture the pulse of the energy efficiency market in India created by Sustainability Outlook and Alliance for Energy Efficient Economy (AEEE) in collaboration with Shakti Sustainable Energy Foundation. The objective of this stakeholder briefing series is to provide evidence based, market assessment tool to present the stakeholder view point, enable higher uptake of PAT through peer learning and incubate industry and policy action on energy efficiency.

In this brief

With increasing resource scarcity and increasing competition, Indian manufacturing industries would necessarily need to keep up with the global advancements. With the advent of cyber-physical systems which facilitate global networks for businesses incorporating machinery, warehousing systems and production facilities, while continuously focussing on resource productivity and efficiency, a fourth Industrial Revolution spurred by Smart Manufacturing is inevitable. Internet of Things would act as a key enabler smart manufacturing - the next big leap influencing energy efficiency. The current IoT based SM solutions (for applications within the factory's fence) focus predominantly on asset optimization. Achieving performance efficiency and cost savings through optimization of Overall Equipment Effectiveness is likely to define the next wave of Industrial Energy Efficiency. In this issue of PAT Pulse, we have explored the prevalence, drivers, business case and key challenges for IoT based Smart Manufacturing (SM) solutions in Indian industry.

Policy and market updates

The issue also provides updates on PAT cycle 2 sectors and targets as announced by Bureau of Energy Efficiency (BEE). It also provides a brief snapshot of key news and events in the industrial energy efficiency domain.

Asset Optimization to Drive the Next Wave of Energy Efficiency in India

Highlights:

- Achieving performance efficiency and cost savings through optimization of Overall Equipment Effectiveness will define the next wave of Industrial Energy Efficiency.
- The market penetration of IoT based smart manufacturing solutions will increase from current levels of ~5% to 30% by 2020 and this would be driven by reduction in the cost of technologies.
- Increasing awareness about the potential and business case of IoT based smart manufacturing solutions will be crucial to reach the next stage of Industrial energy efficiency.
- Skill building would be required for enhancing the ease of using IoT based smart manufacturing solutions at the factory operators' end and for developing good quality data scientists at the solution providers' end.

The Fourth Industrial Revolution will be spurred by Smart Manufacturing

We live in an age of data and smart technologies. The pace of change experienced by the globe with the evolution of Internet has been exponential. Industries have seen complete disruptions owing to this. For example, conventional retail stores are increasingly facing the heat owing to development of e-commerce websites. Banking today is just a matter of a few finger clicks when compared to the completely manual process that was followed as recently as 15 years ago. Hiring a taxi and getting the most optimum deal for it is easier than it has ever been before. The manufacturing sector will not be cocooned from such changes.

As per the Make in India Initiative, the country is expected to rank amongst the world's top three growth economies and amongst the top three manufacturing destinations by 2020[1]. Unlike other sectors like IT, the manufacturing sector has not witnessed any major disruptions in the past few decades[2]. However, the pressures are building up on industries to optimize their efficiency with resources becoming increasingly scarce, competition getting fiercer and technology advancing at a an incredible pace. In order to fulfill the Make in India vision and to stay competitive, the Indian manufacturing sector would necessarily need to keep up with advancements in this sector globally.

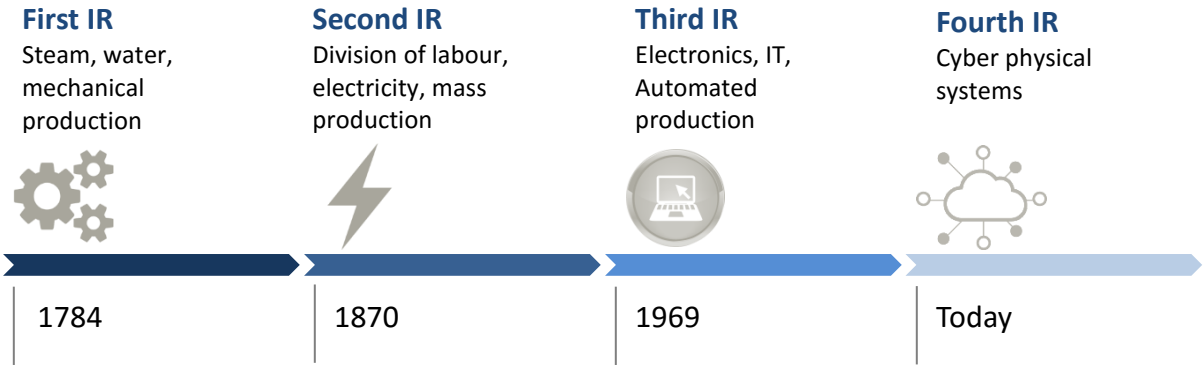
It is predicted that 20.8 billion things could be connected by 2020. WEF predicts a Fourth Industrial Revolution with the advent of cyber-physical systems which facilitate global networks for businesses incorporating machinery, warehousing systems and production facilities, while continuously focussing on resource productivity and efficiency.

The number of sensors shipped increased more than five times from 4.2 billion in 2012 to 23.6 billion in 2014[3]. The World Economic Forum has identified that we are on the cusp of a fourth industrial revolution. The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial

[1] http://www.makeinindia.com/article/-/v/direct-foreign-investment-towards-india-s-growth , Accessed on May 20, 2016
[2] Knud Lasse Leuth, Will the industrial internet disrupt the smart factory of the future?, March 2015 http://iot-analytics.com/industrial-internet-disrupt-smart-factory/ , Accessed on May 15, 2016
[3] Elfrink, Wim. "The Internet of Things: Capturing the Accelerated Opportunity". October 2014. http://blogs.cisco.com/ioe/the-internet-of-things-capturing-the-accelerated-opportunity

Revolution is inevitable with the advent of cyber-physical systems which facilitate global networks for businesses incorporating machinery, warehousing systems and production facilities, while continuously focusing on resource productivity and efficiency[4].

Figure 1: Industrial Revolution (IR) Timeline



Source: WEF

Such systems which will be enabled by Information and Communication Technology (ICT) will additionally improve the visibility on energy consumption and GHG emissions for industries. A radical transformation within manufacturing is possible only if it is known where inefficiency occurs throughout the processes and workflows within a factory. Such ICT technologies can provide the data, which can be used to change behaviours, processes, capabilities and systems[5].

So it is clear that the fourth industrial revolution will be spurred by Smart Manufacturing.

Smart Manufacturing: The Next Big Leap Influencing Energy Efficiency

The American Council for Energy-Efficient Economy defines Smart Manufacturing (SM) as "*the use of information and communications technology to integrate all aspects of manufacturing, from the device level to the supply chain level, for the purpose of achieving superior control and productivity*"[6]. SM involves utilization of data communicated by equipment and processes within the product value chain and its conversion in to real insights in order to make real time decisions and achieve the traditional goals of manufacturing of improvement of productivity. O'Donnovan has elucidated SM by calling it data-driven manufacturing where data is acquired through ICT infrastructure such as sensors in the factory and synthesized to drive informed decision making[7]. Such a digital **transformation can be enabled through technologies such as Internet of Things (IoT), machine learning, SMAC (Social, Mobility, Analytics, Cloud) technologies.** For the purpose of this brief we have focussed on SM solutions with regards to their applications within the factory's fence in order to have a better definition of boundary conditions.

[4] Industries 4.0 working group, Securing the future of German manufacturing industry: Recommendations for implementing the strategic initiative INDUSTRIE 4.0, April 2014, Pg. 5
[5] The Climate Group, SMART 2020: Enabling the low carbon economy in the information age, 2008, Pg. 14
[6] Ethan A. Rogers, The Energy Savings of Smart Manufacturing, July 2014, http://aceee.org/research-report/ie1403 Accessed on May 15, 2016
[7] O'Donovan et al. , An industrial big data pipeline for data-driven analytics maintenance applications in large-scale smart manufacturing facilities , Journal of Big Data 2015 2:25

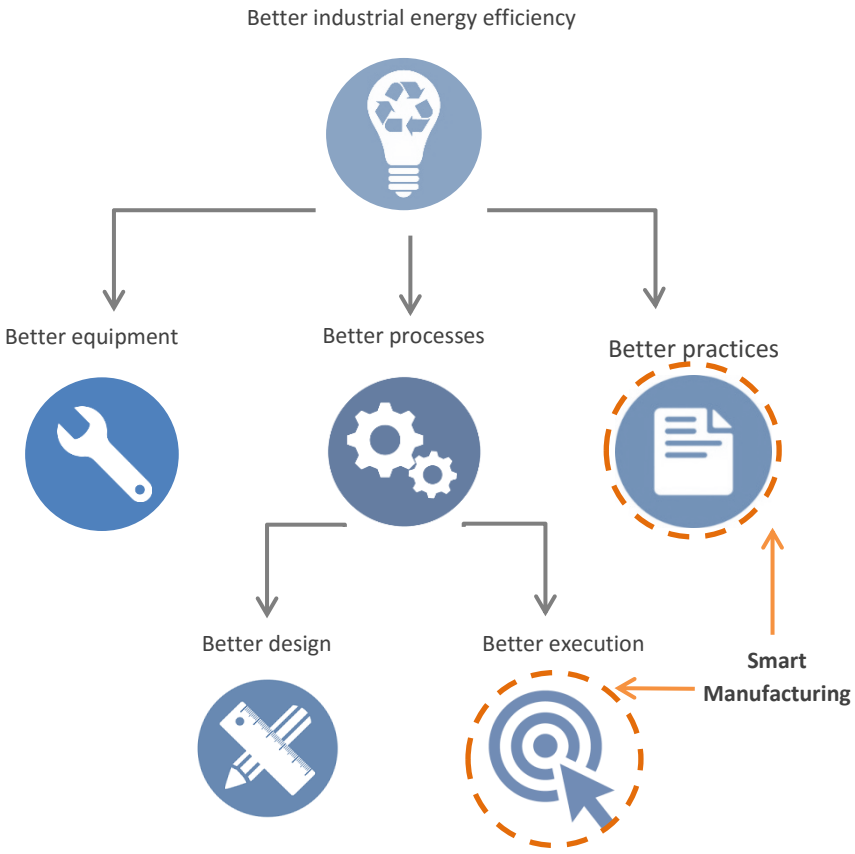
Figure 2: Simplified Features of IoT Based Smart Manufacturing Solutions

The Economist Intelligence Unit in their report "Intelligent Manufacturing: Targeting better energy efficiency" has identified that energy efficiency can be brought about by better equipment, better processes and better practices. Better processes could be achieved by better process design and better process execution. Smart manufacturing solutions enable better process execution and better practices by utilizing intelligent insights that are born out of the data collected from multiple areas within the factory.

Smart manufacturing solutions enable better process execution and better practices by utilizing intelligent insights that are born out of the data collected from multiple areas within the factory

Good quality data is at the heart of SM and acquisition of the same could be achieved through the internet, wireless technology or conventional wire connected technology.

Figure 3: Influence of Smart Manufacturing on Manufacturing Efficiency



SM solutions don't look to change the core process of the factory but just look at how the existing capacity and process can be utilized better**. S**imply put, they look to reduce the non-value added time from the production process and improve the flow within the factory using data as a driver.

Internet of Things as a Key Enabler for Smart Manufacturing

In India the Union government's department of electronics and information technology, in its draft policy, aims to create a $15 billion IoT industry in India by 2020[8]. Cisco's 2013 report on "Internet of Everything" states that, the highest percentage (27%) of value in future IoT revenue will be in manufacturing[9]. **With such impetus on IoT, the market conditions would be favourable for solution providers to tap in to the Indian market for smart manufacturing.**

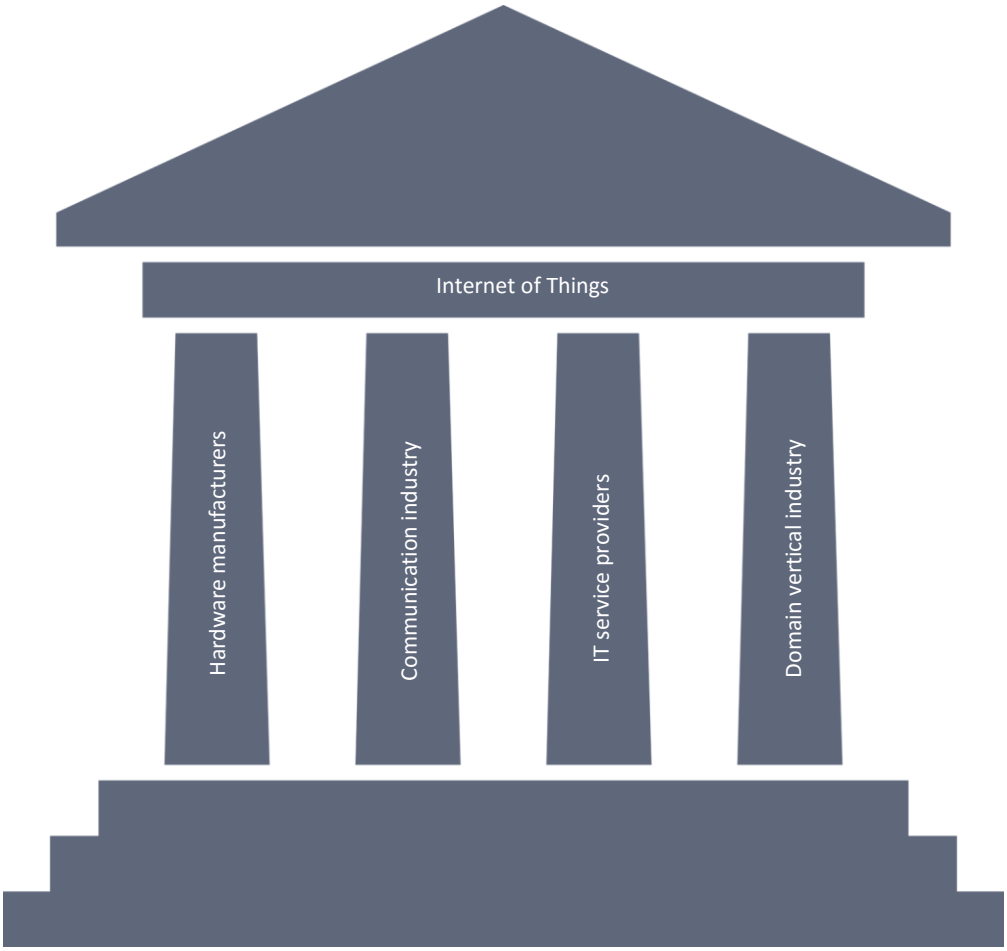
It is important to appreciate that the Internet of Things as a technology is pretty unique as it entails the collaboration of four distinct industries. There are:

1. **Sensor manufacturers**: They are responsible for accurately capturing information
2. **Communications industry**: They are responsible for transfer of information
3. **Information Technology Service providers**: They are responsible for analysing and presenting the information
4. **Specific domain of application**: Expertise in specific manufacturing sectors, for example, any of the PAT sectors

These four solution/service providers need to work together to come up with a common robust solution.

[8] http://deity.gov.in/content/internet-things , Accessed on May 18, 2016
[9] Cisco, The Internet of Everything: Global Private Sector Economic Analysis, 2013, Pg. 9

Figure 4: The Four Pillars of the IoT Industry

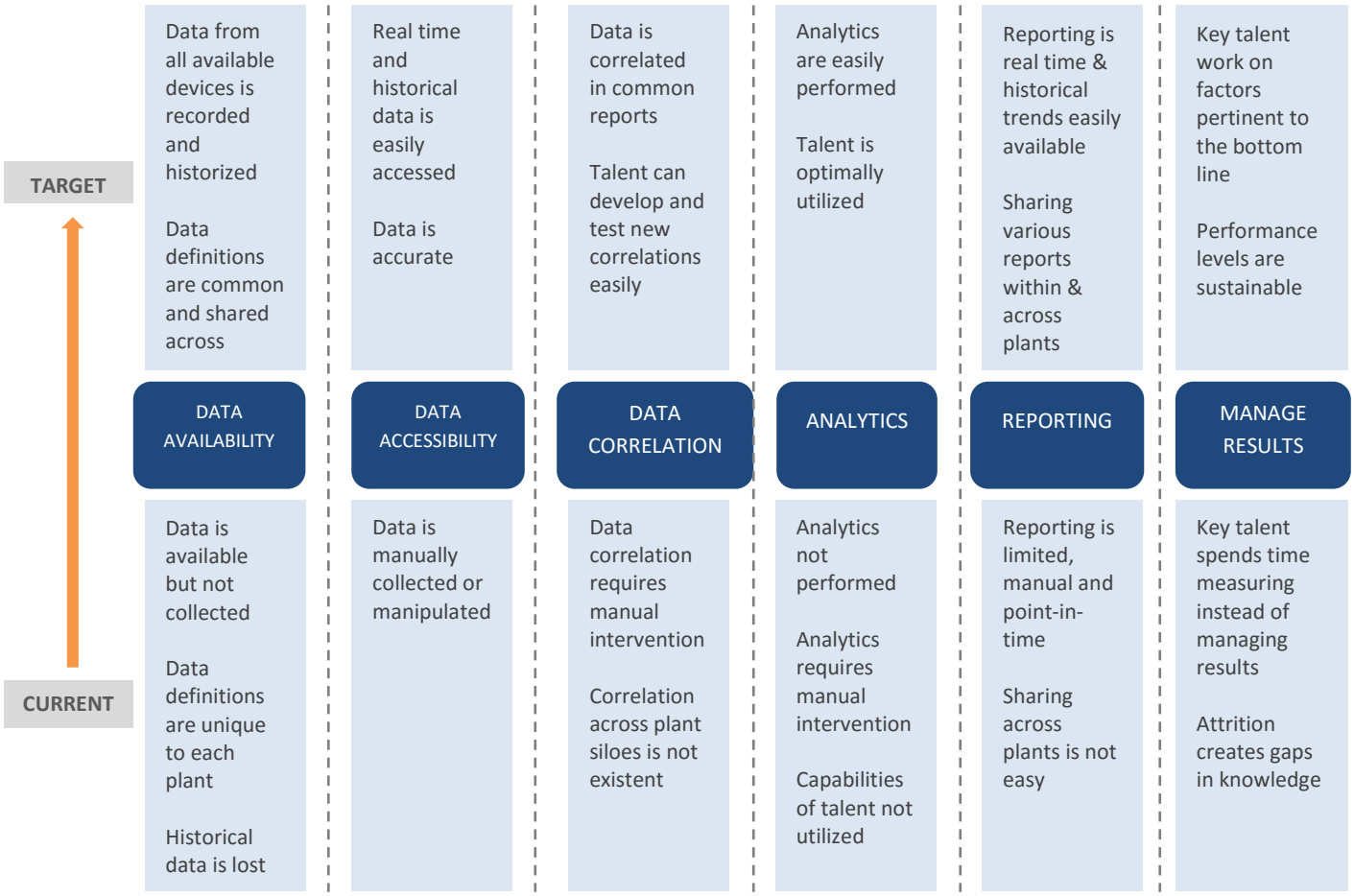


For the purpose of this brief we have focused primarily on **IoT based Smart Manufacturing solutions**.

Good Quality Data Drives the Development of Intelligence

Good quality data is what the entire concept of IoT and Smart Manufacturing rest on. The process flow of IoT starts off with assets within a factory communicating data regarding their condition, time of operation, production, etc. by means of sensors that would be installed on the asset. Furthermore, some of this data may also be provided manually through some digital device. All of this raw data is captured and transferred through network connectivity elements such as a mobile communication network, Bluetooth, Wi-Fi, Ethernet, etc. This data is stored in a database platform. The analytics platform takes the data from the storage and picks out only the useful bit and synthesizes it in to information which can be communicated to the end user. Finally, this information is provided to the user through applications which present the data through reports, dashboards, etc. on the graphical user interface of mobile devices, computers, etc.

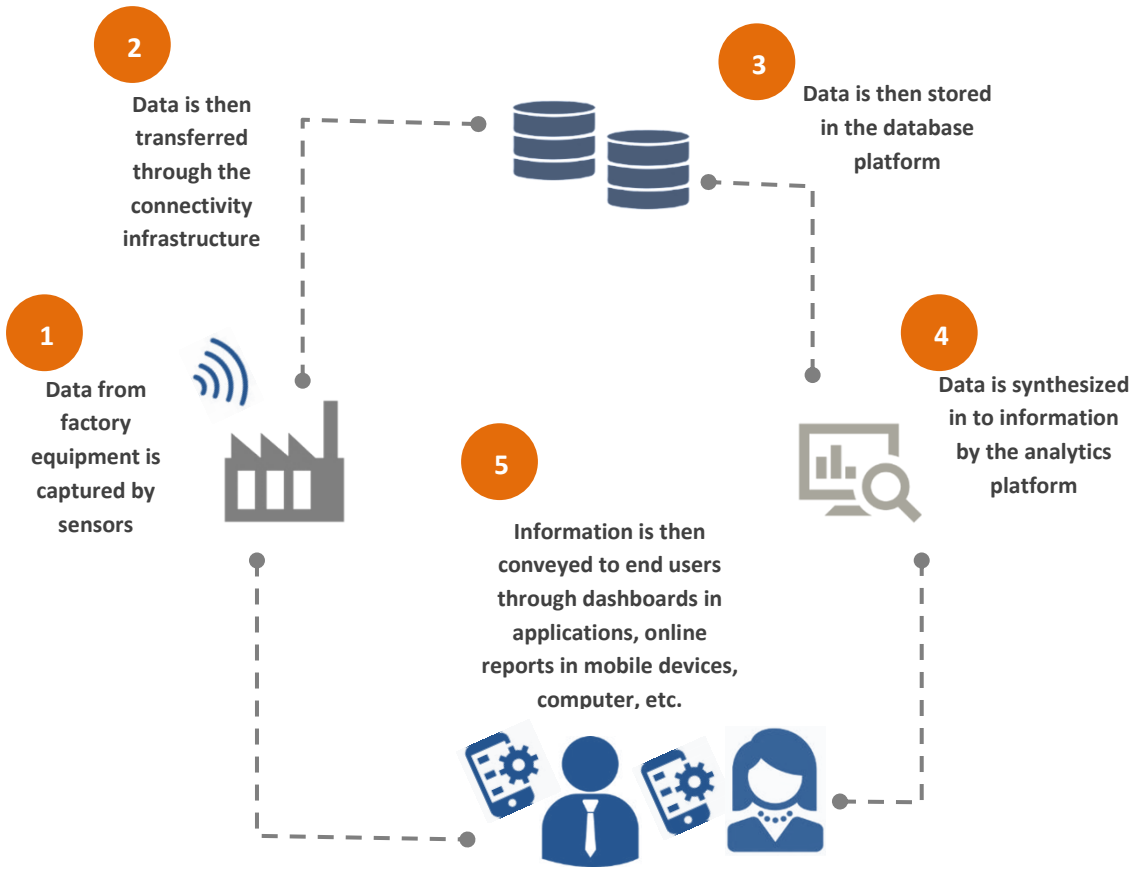
Figure 5: Data capability and maturity model[10]



Going further, this information could be used for machine learning and building predictive capabilities within the solution that is being provided. Also, this information could be transmitted to an automation actuator that performs an action based on the inputs provided to it.

[10] Source: Alcoa, The SMART Manufacturing Business Case, 2012, Pg. 8

Figure 6: The Layers of Data in IoT Based Smart Manufacturing Solutions



Asset Optimization: An Emerging Area for Smart Manufacturing Solutions

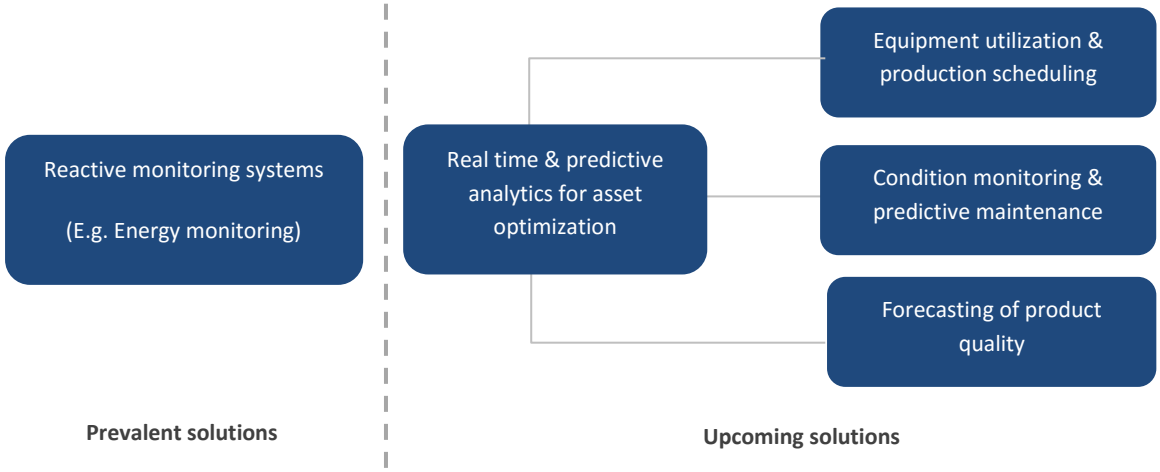
Currently there are a host of solutions in the market that capture raw data and present it in a usable form to the users. However, what sets IoT based smart technologies apart is that they provide insight and actionable information to the end users as also possess capabilities for predicting future conditions based on historical data that is assimilated over a period of time. Essentially these technologies digitize the data that may be readily available at factories and build on it to build intelligence in to the factory's value chain.

What sets IoT based smart technologies apart is that they provide insight and actionable information to the end users as also possess capabilities for predicting future conditions

The IoT based SM solutions for applications within the factory's fence which are coming up in the market today focus predominantly on asset optimization. Gaining visibility on entire operations of a plant on a single screen as also monitoring parameters such as machine idling time and predictive maintenance are areas which are upcoming. Most of these are currently carried out in a manual fashion through logbooks, etc. Asset optimization directly influences energy efficiency. Instances of machine failures and under-utilization of machines also have a significant impact on energy efficiency. GE announced that it has realized more than USD 1 billion in incremental revenues in 2014 by helping customers improve asset performance and business operation through industrial internet capabilities and services[11].

[11] GE press release. GE to Open Up Predix Industrial Internet Platform to All Users, October 9, 2014. http://www.genewsroom.com/pressreleases/ ge-open-predix-industrial-internet-platform-all-users-278755 Accessed on May 20, 2016

Figure 7: Areas of Application for Smart Technologies



Potential of Improving Overall Equipment Effectiveness (OEE)

For any manufacturing unit, the overall equipment effectiveness (OEE) is an important indicator of asset utilization. OEE can be described as the ratio of actual running hours of a given equipment or process when compared to the planned running hours of the same. The deviation from planned operation is owing to non-value added tasks such as waiting, machine changeovers, stoppages, and maintenance and quality issues in the product. Global averages for OEE are at 60-70% with the world class units hovering at around 85%[12]. In India the average OEEs range from as low as 35%[13] in aluminium manufacturing to as high as 89%[14] for machine component manufacturing. The monetary impact of improvement in these numbers could be significant.

Equipment Utilization and Scheduling Can Instantly Impact Energy Efficiency

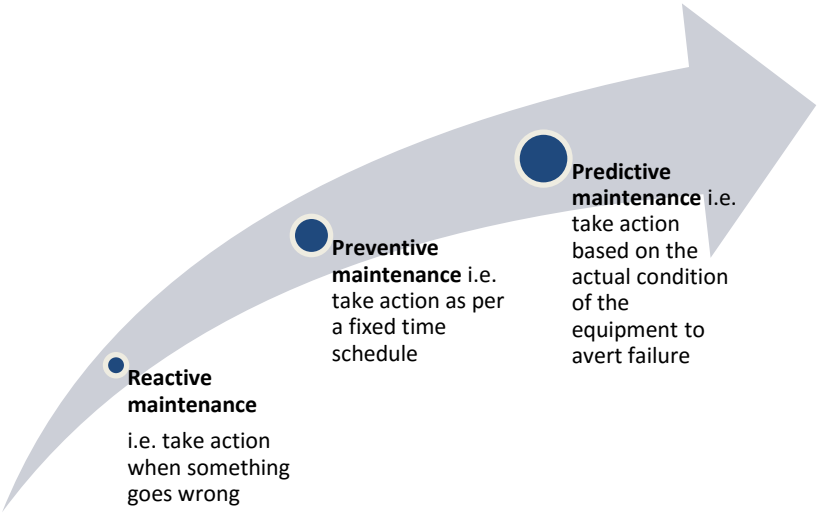
Given the number of machines that exist in a typical process oriented factory along with complex material flows, it is cumbersome to get a real time picture on how effectively is each machine running when compared to its output and with minimal idling time. Furthermore, synthesizing all of this real time information to come up with optimal production schedules and other systematic action points can be a further challenge. Also sometimes plants maybe located at remote locations and may necessitate remote monitoring. Also, with regards to energy efficiency, a machine that runs without producing any output clearly is a waste of the energy that is used to run it. IoT driven SM solutions can help for each of these points.

Predictive Maintenance has Direct Economic Benefits

Today machine maintenance is carried out by technicians either when problems arise (reactive maintenance) or at fixed intervals as a routine (preventive maintenance). When problems arise and the machine has to be serviced, it leads to production delays and a high service effort which consequently leads to high cost. Industrial maintenance accounts for over 30% of a factory's annual operating costs and between 60-75% of a machines lifecycle cost[15]. One can gain better visibility on equipment's conditions by monitoring certain parameters such as temperature, current, voltage, revolutions per minute, etc. For instance, looking at the vibrations of rotary equipment can give good visibility about its condition. Today's IoT based SM solutions not only look to report on such parameters in real time but also look to carry out mathematical analysis on this bulk data, compare the results with critical values and predict when a components could fail

[12] Knud Lasse Leuth, Will the industrial internet disrupt the smart factory of the future?, March 2015 http://iot-analytics.com/industrial-internet-disrupt-smart-factory/ , Accessed on May 15, 2016
[13] Palanisamy, Vino, Implementing Overall Equipment Effectiveness in a Process Industry, Indian Journal of Science and Technology, Vol 6 (6S) | June 2013
[14] Bangar, Sahu, Batham, Improving Overall Equipment Effectiveness by Implementing Total Productive Maintenance in Auto Industry", International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 6, June 2013
[15] O'Donovan et al. , An industrial big data pipeline for data-driven analytics maintenance applications in large-scale smart manufacturing facilities , Journal of Big Data 2015 2:25

so that action can be initiated much before the failure actually occurs (predictive maintenance). Also, with such forecasts in hand the technician can liaise with the production department and can plan for materials and scheduling of the maintenance in a much better fashion thereby ensuring that unexpected downtimes and consequent losses are reduced.



- IoT enabled solutions can also help in conducting systematic root cause analysis and assimilate the learning for making the factory operation even more intelligent.
- Predictive maintenance primarily enables factory owners to optimize the maintenance and support costs.
- Also it enables the factories to optimize their insurance premium where they could actually go for usage based insurance since there is much more clarity on the state of the equipment.

Timely maintenance of equipment does not only save costs associated with over-maintenance or under-maintenance but also prolongs the life of the machinery by preventing the number of times the machine enters in to a state of disrepair

The amount of energy used by a machine can increase if its conditions are not optimal i.e. if it operates in an inefficient state. When a component within a machine nears failure, wastage of the energy consumed is manifested in the form of abnormal vibrations, sound and heat. Also, machines that do not run at expected specifications can adversely impact the quality of the output. Thus, costs associate with rejections and rework can be optimized. Timely maintenance of equipment does not only save costs associated with over-maintenance or under-maintenance but also prolongs the life of the machinery by preventing the number of times the machine enters in to a state of disrepair[16].

Forecasting of Product Quality Enables Timely Correction of Flaw

Monitoring of quality of output on a real time basis with predictions for rejections is another area where IoT based SM solutions could help. The sooner a defect is detected the easier it is to correct it as well as prevent its occurrence in the rest of the production. Rejections and the rework not only impact time of delivery but are also a cause of use of excess resources. The solutions that are coming up in these areas today provide end users with information which they can act upon. A further evolution of this would be automation based on this information so that the equipment in question can take actions on itself.

[16] O'Donovan et al. , An industrial big data pipeline for data-driven analytics maintenance applications in large-scale smart manufacturing facilities , Journal of Big Data 2015 2:25

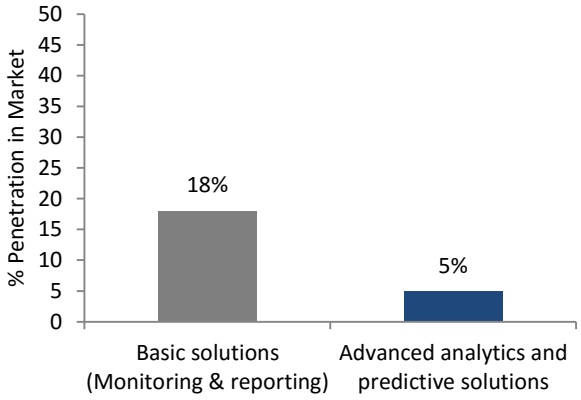
Smart Manufacturing Solutions Currently have Low Penetration in India

All factories today are under pressure to cut production costs and improve their bottom-line. Moreover, businesses today want to gain better visibility across their organization in a centralized manner so that they can make informed decisions. Given the monetary benefits linked with smart technologies, it makes financial sense to implement such solutions. Also, most of the IoT based solutions that are gaining traction in the market are not sector specific and can be configured to any industry depending on the clients' requirements and the specific use case for which they are being deployed.

Most of the IoT based solutions that are gaining traction in the market are not sector specific and can be configured to any industry depending on the requirements and the specific use case

Yet, currently the manufacturing sector (including PAT sectors) is still trying to transition to digital data capture from the predominantly manual processes. **The basic solutions that provide monitoring and reporting options have a market penetration of about 15-20%.** Unless data is captured accurately and is reliable, analytics solutions cannot be applied to it. **However, as per market estimates, solutions which provide advanced analytics and predictive modelling currently have a penetration of less than 5% across the industries.**

Figure 8: Estimated Current Market Penetration of Data Based Manufacturing Solutions



Trailblazing Sectors: Iron & Steel and Power Generation

Any manufacturing unit that has sizable consumption of resources such as energy, water, chemicals etc. and has already implemented low-hanging interventions for efficiency and are likely to look at smart manufacturing solutions going forward. Manufacturing units that have some form of digitized data collection system (such as e.g. SCADA system) are likely to find it easier to adopt IoT based SM solutions

IoT based solutions that are available today are easier to install in factories that already capture information in a digitized form.

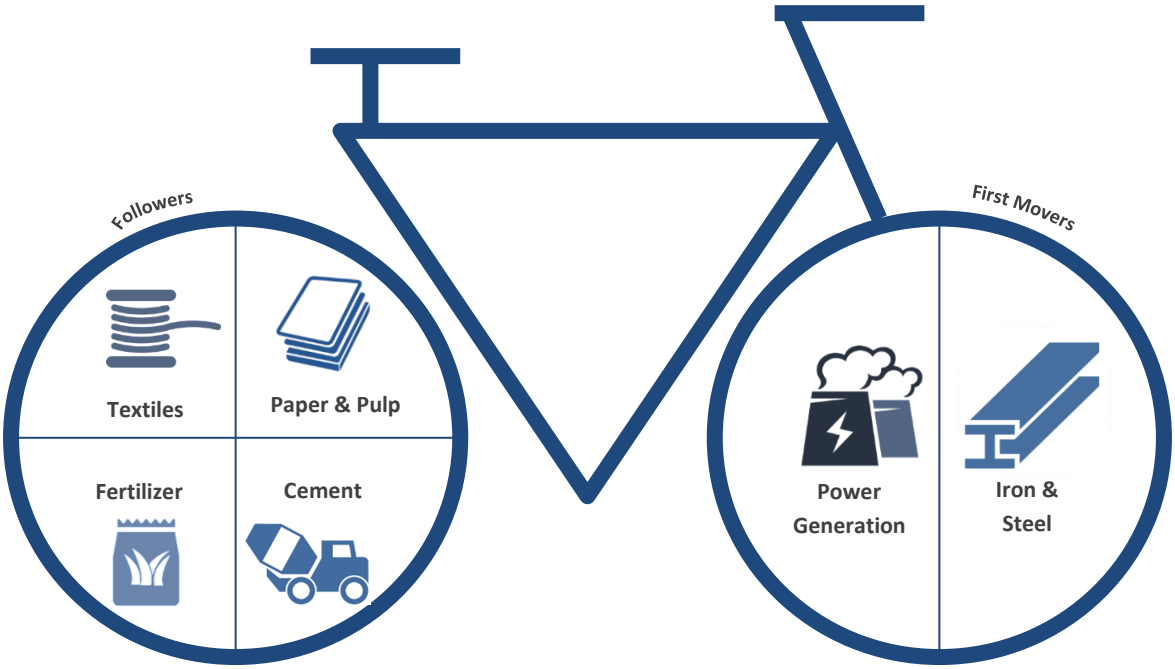
Within PAT sectors iron and steel and power generation have seen the highest amount of interest so far in IoT based smart manufacturing solutions. In both these sectors, the optimized operation of equipment based on their design specification and monitoring of various sections within the plant are the areas where IoT based SM solutions find applications. In the iron & steel sector, the heavy machinery involved in movement of material (such as cranes, etc.) provides an opportunity for IoT based solutions.

The pace of uptake is highest in sectors which collect a fair bit of data owing to regulations, etc. (E.g. Online monitoring of wastewater quality & quantity). However there is a massive opportunity to leverage this data for better decision making.

Other PAT sectors such as textiles, paper & pulp, fertilizers and cement have also shown some interest and depending on their size have initiated pilots for implementation of IoT based SM solutions.

Among non-PAT sectors, the automotive sector which has usually been at the helm of digitization has seen good uptake of IoT based solutions. Retail, transportation, oil & gas, pharmaceuticals, utilities, health care, consumer goods, smart cities, renewable energy generation and consumer electronics have also seen increasing interest. The rest of the sectors yet need to be handheld and nudged slightly.

Figure 9: PAT Sectors that are using IoT Based SM Solutions



However, it is important to note that certain specific utilities that exist across sectors such as boilers and steam distribution systems, compressed air systems and water and waste waste water treatment which exist across industries may see quicker uptake of IoT based SM solutions and present many case studies for other interested factories to use.

Utilities that exist across sectors such as boilers & steam distribution systems, compressed air systems and water and waste water treatment may see quicker uptake

The uptake of IoT based SM solutions is much stronger in the west which itself will drive Indian factories to follow suit. Further, India's good cellular infrastructure already is paving the way for ensuring reliability of data transfer. The large sized players with larger budgets for improvements are the first movers for IoT based solutions and they are implementing pilots to gauge the effectiveness of such solutions. So it is safe to say that an evolution is taking place at the supply side with solution providers improving their offerings as well as at the demand side with factories venturing out of their comfort zones. Also, sectors maybe at a threat of being completely disrupted by new technologies which may necessitate the shift towards new solutions.

Business Case for Smart Manufacturing: Potentially 10-15% Energy Savings, 12-15% of Productivity Improvements

The definition of a precise business case for IoT based SM solutions is difficult because they could find multiple applications within a factory and the net outcome could be difficult to quantify (e.g. quantifying the impact on life of the machinery). Also, the same solution may not be applicable to one factory as it is to another. However, through our interactions with multiple solution providers and the results observed so far are very encouraging:

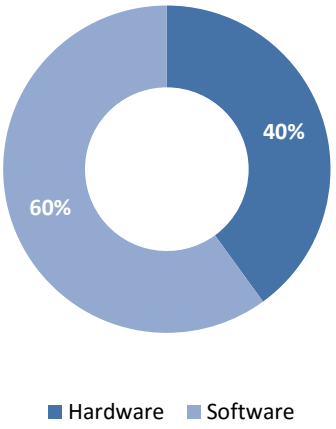
- **Savings in energy to the tune of at least 10-15% could be anticipated**
- **Energy monitoring and management solutions alone have the potential to reduce energy costs by 4-5%.**
- **Operations and maintenance expenditure could be reduced by 2-5%.**
- **Productivity improvements are also estimated to be at a minimum of 12-15% by just basic monitoring of equipment and streamlining of production schedule.**

Figure 10: Estimated Benefits from IoT Based SM Solutions

60% of solution costs linked to software component

Almost all solution providers offer end-to-end solutions that include the hardware as well as software costs. However, most solution providers are specialists in the software component. Hence, they form strong collaborations with various hardware suppliers in order to offer a complete solution to the end customer. The price of the solutions can usually be bifurcated in to one pertaining to the initial installation and one pertaining to an ongoing subscription of sorts. The price point is dependent on the use case in the factory, the complexity of assets, the number of sensors required, the sensitivity of sensors, etc. **Currently the solutions that are available in the market could be priced in a range of INR 50,000 for a small scale machine to INR 3,50,00,000 for a large complex factory.**

Figure 11: Estimated Cost Break-up of IoT Based SM Solutions



Payback Ranges from 12 – 60 months; Depending on Complexity of Solution and Extent of Coverage

The payback periods for smart manufacturing solutions are difficult to predict in a simplistic manner. For example, one manufacturer was able to recover the investment made within a span of 9 months by just analyzing the downtime of the equipment. Advanced analytics was not even used in this case. However, on an average such investments could be recovered in anywhere between **12-60 months**. This could also be attributed to the fact that for predictive modelling to start taking shape, a fair bit of historical data is a pre-requisite. Investing in such technologies is like investing in to ones past and present in order to secure the future of the factory.

Illustrative Use Cases of IoT Based Smart Manufacturing Solutions

Use Case	Illustrative Scenario	Impact Category	Impact	Solution Provider
Textile plant enhances revenue through monitoring solution	In a leading textile plant with capacity of 1.4lakhmeter/day, a machine supplied by world's best bleaching machine manufacturer was able to produce 94% of Grade A textile. There is approximately INR 100/meter difference between Grade A & Grade B textile. On implementation of the Intelligent Plant Framework (IPF) solution (a platform which provides real time visibility of the complete plant) it was observed that there were frequent stoppages of small duration that were never coming to notice for the mid and senior management.	 Improved production scheduling	By addressing this stoppage issue, the factory improved their quality levels with Grade A textile occupying 97.8% of the total production. This enabled the factory to generate additional revenue of INR 0.5 million/day or INR194 million/year).	**Covacsis Technologies Pvt. Ltd.** (Source: http://www.covacsis.com/case-study/impact-of-stoppage-analysis.pdf)
Captive power plant optimizes fan speeds through real time analytics solution	A 235MW captive power plant in a steel plant had fans that are used for air cooling the condensers. Though these fans utilized the latest VFD technology, their speeds were not being controlled effectively. A real time analytics engine was implemented which was capable of recommending the optimal speed of the fan array to the operators. The analytics engine was also able to understand the vibrational pattern of the fan motor and provide early warnings of potential failure. The solution was non-invasive and required no additional capital expenditure.	 Increased Equipment utilization  Condition monitoring & Predictive maintenance	The solution resulted in direct 18% reduction of energy consumption of the cooling process in the form of 3000 units saved per day. It also reduced the unplanned shutdown of the plant and reduced the risk in operations. The optimal speed recommended by the analytics engine was much lower than the maximum speed which reduced the wear and tear of the motors and prolonged their life.	**Altiux** (Source: http://www.altiux.com/_include/whitepaper/Altiux%20Case%20Study%20-%20Using%20Analytics%20to%20Reduce%20the%20Energy%20Consumption.pdf)
Condition monitoring at iron & steel manufacturer	The key parameters for optimization of a plant are throughput, product quality, machine availability and efficiency. Small flaws, such as temperature imbalances in a furnace or the wrong tension setting on a steel roller, can lead to defective products, customer dissatisfaction and costly delays. An iron and steel manufacturer was keen to spot emerging equipment and product-quality problems early. The solution provider created a solution that analyzed large volumes of production control data to seek patterns in equipment operations, product quality, failure patterns etc.	 Condition Monitoring  Improvement of product quality	The reduction of incidences of production shutdowns linked to equipment failure and product defects enabled savings of at least USD 2 million for every 0.1% improvement in production efficiency. The solution has also helped in embedding of process knowledge into equipment and process optimization algorithms.	**IBM** (Source: http://www-05.ibm.com/sk/optimalizacia-investicneho-procesu/pdf/E_U_Presentation_Sanna.pdf)

Use Case	Illustrative Scenario	Impact Category	Impact	Solution Provider
Productivity improvement at a plastic component manufacturing unit	A plastic component manufacturing factory was facing challenges such as unavailability of real time data for decision making, cumbersome manual production log entries and delayed response to machine failures resulting in longer downtimes. They implemented an IoT based SM solution which enabled them to have real time real time dashboards to view production information for all machines, real time monitoring of production, rejections and downtimes, overall equipment effectiveness, detailed analytical reports & graphs, real time alarms and escalation for quicker response times to problems on the Shopfloor and historical trend Analysis.	 Improved production scheduling  Increased equipment utilization	With the help of monitoring solution the factory personnel eliminated inefficiencies on the shop floor and received alarms in real time for critical production issues. This resulted in productivity improvement by 30% and digitization of manual entries has saved over three person years at the factory.	**Entrib Technologies Pvt. Ltd.** (Source: Shopworx case study "Manufacturer of Plastic Parts for Consumer Electronics; Improving Shop Floor productivity with ShopWorx' Real Time Monitoring Solution")
Enhancing product quality intelligently	One of the Largest adhesive manufacturer in the world wanted to increase the quality and yield of the factory lines by controlling 2 parameters - viscosity and softening points. The IoT signal intelligence platform set up by the solution provider was ingested with 3 years of sensor data regarding plant operations from temperature sensors, rpm sensors, torque sensors and pressure sensors which were strapped on to industrial mixers. The platform's ensemble models enabled filtering of useful signals from noise and specifically identified the contributors to quality. This process was eventually scaled to 33 plants, 1400 manufacturing lines and 16 event types and cumulatively 20 million sensor events were analysed.	 Improvement of product quality	The manufacturer has realized more than USD 140 million of savings from preventing defective products across 3 years	**Flutura Business Solutions Private Limited** (Source: https://www.flutura.com/stories.php?transformation-story2)
Ensuring timely receipt of spare parts	One of the World's largest manufacturers of Shale field equipment and natural gas/diesel engines was heavily dependent on OEMs to minimize asset failures and downtime. There was a specific problem that they wanted to solve for: How to proactively auto generate spare part requests triggered by sensor events and thereby reduce inefficiencies? The solution provider's Prognostics/Diagnostics platform	 Condition monitoring & Predictive maintenance	Knowing the forecast of spares helped the manufacturer to plan for its acquisition.	**Flutura Business Solutions Private Limited** (Source: https://www.flutura.com/stories.php?transformation-story2)

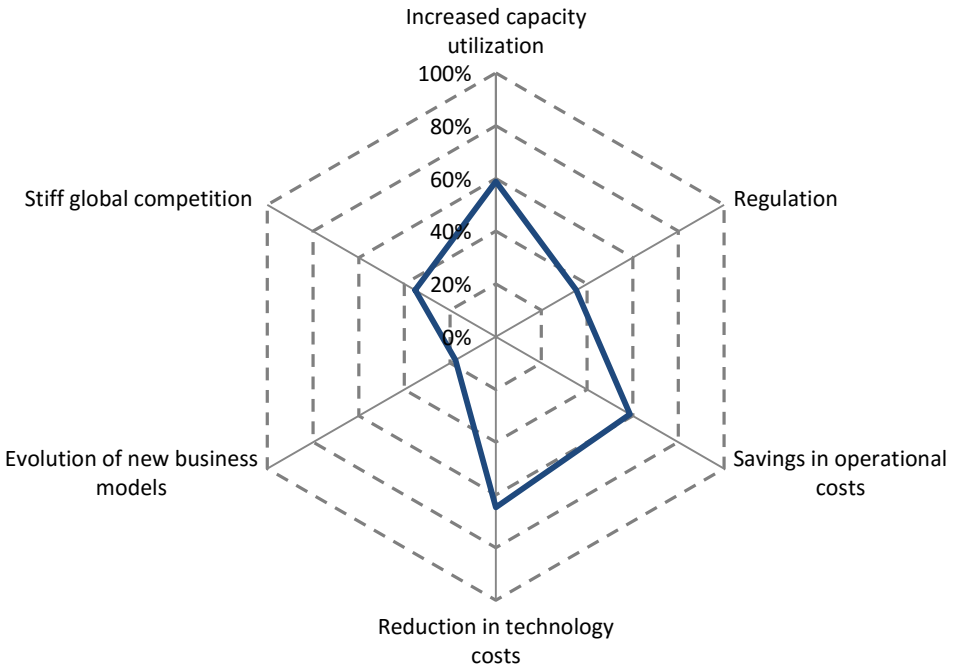
Use Case	Illustrative Scenario	Impact Category	Impact	Solution Provider
	ingested signals from a variety of frontline industrial assets in real time like - Acidizing units, Fracking pumps, chemical additive units, blenders, large generators,. The specific signals analyzed include Pressure signals , Oil temperature signals, horse power signals, rpm signals, discharge pressure signals to find Anomalies to Potential Fault Modes, predict Failures & Maintenance Requirement and Forecast Spares requirement.			
Predictive maintenance of compressed air systems	After the implementation of a IoT based predictive maintenance solution for a compressed air system, an operations analyst at a unit received an alert that a power cylinder did not reach normal operating temperature after a compressor was restarted. After further investigation, the analyst noticed that there was a 500 F difference between the exhaust temperate for cylinder 1 and the other cylinders. The history for the unit showed that cylinder 1 typically operated near the same temperature as the other cylinders and that the unit was currently operating at 76% of its rated brake horsepower load. This information prompted the analyst to contact the team at the station. Conditions on the pipeline demanded that the unit continue to run to meet a critical need for storage injections. After pipeline conditions improved, the gas control team approved taking the unit offline. The team at the station found a bad fuel valve, and promptly replaced it.	 Condition monitoring & Predictive maintenance	The use of IoT based SM solutions prevented recurrences of the incidents that almost caused compressor failures at a given station. Intangible benefits also included increased customer confidence, improved reliability and asset availability.	**Columbia pipeline group and Rovisys** (Source: https://www.plantengineering.com/single-article/predictive-maintenance-for-gas-pipeline-compressors/6b0eb1d148595946a81ee5fe8b21aae9.html)

Reducing Technology Costs Coupled with the Need to Optimize Performance Efficiency and Reduce Operational Costs Likely to be the Key Drivers for IoT Based SM Solutions

IoT and analytics based solutions provide the end users with the ability to find a needle in a haystack. Manufacturers are increasingly realizing the importance of data for gaining better visibility in to their operations and are analysing it for streamlining their processes. Such insight and information also enables manufacturers to make good decisions and respond better to market needs.

Through multiple conversations with experts[17] from the industry we gathered that the likely reduction in costs of technology components associated with IoT based SM solutions, would be the biggest driver for adoption of such technologies. Further, the need to fully utilize the current installed capacity of equipment and the persistent emphasis on reduction of operational costs would also compel industries to look at unconventional solutions.

Figure 12: Drivers for IoT Based SM Solutions in the Future



- **Reduction in technology costs**: The technology associated with IoT and analytics based solutions has evolved significantly in recent years. The technology associated with connectivity infrastructure is constantly improving. The solutions are getting smarter and increasingly able to sense only the intelligent data from the bulk of data that is collected and send it for storage. Hence, the cost of such technologies today is a fraction of what it used to be few years ago. The costs associated it will continue to go down in the future. This includes the cost of sensors, cost of controllers, cost of storage, cost of communication infrastructure and cost of smart devices coupled with development of new open source platforms. Consequently solution providers will be able to provide even more attractive price points which will drive their uptake across industries.

> Manufacturing units that have some form of digitized data collection system (such as e.g. SCADA system) are likely to find it easier to adopt IoT based SM solutions

[17] Sustainability Outlook and AEEE interviewed around 20 solution providers related to smart manufacturing for the purpose of this brief

- **Better capacity utilization**: Today's industrial structure is driven by performance so the focus is likely to shift from capacity addition to better capacity utilization of existing assets while maintaining the objective of making better quality products. The idea would be to do more with less. In time, non-adoption of such technologies could actually threaten the very existence of businesses.
- **Reduction in operational costs**: The reduction in operations and maintenance cost as well resource usage costs are going to be an important driver for uptake of smart technologies. IoT based SM solutions can directly impact energy efficiency too. With time, the business case will be better defined and the willingness of manufacturers to invest in such technologies would improve.
- **Global competitiveness**: The world is becoming flat and markets are increasingly becoming competitive in a global sense with manufacturers in the United States of America, China and European nations constantly enhancing their practices. Thus there is an ever present need for manufacturers in India to perform better, maintain an edge and protect their market share. Digitization is going to become a key feature for manufacturers to stay competitive.
- **Policy/Regulation** that can be enforced properly could be another driver in the future. If stringent targets for asset utilization and energy efficiency are mandated by law, then it would compel even the small and medium scale manufacturers to dive deeper in to their operations and identify avenues for improvement.
- **New business models**: The market is getting more innovative and competitive with entirely new business models and products that are being enabled by IoT and analytics based solutions E.g. In the future, assets could be provided on rent to manufacturers by original equipment manufacturers. These new models would drive the uptake of IoT based solutions.

Online monitoring of DCs

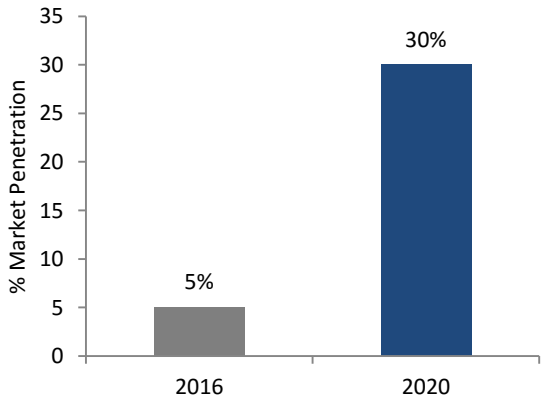
IoT based solutions could open up avenues for online monitoring of energy consumption of DCs. Also, the whole process of PAT validation and ECerts issuance could potentially become human independent and verifiable.

Starting at the periphery

IoT and analytics based solutions could be initiated at the peripheral components of a factory such as utilities. The approach should be to initially avoid the core process and look for opportunities in other resource hotspots.

The market is responding to these solutions today due to which they are slowly but surely gaining traction**. By 2020 the market penetration is likely to increase by at least 30% on an average across various industries in India (Fig 13).** This penetration is going to be much larger in the US and Europe. It is likely that the bigger players will continue to lead the way for such solutions.

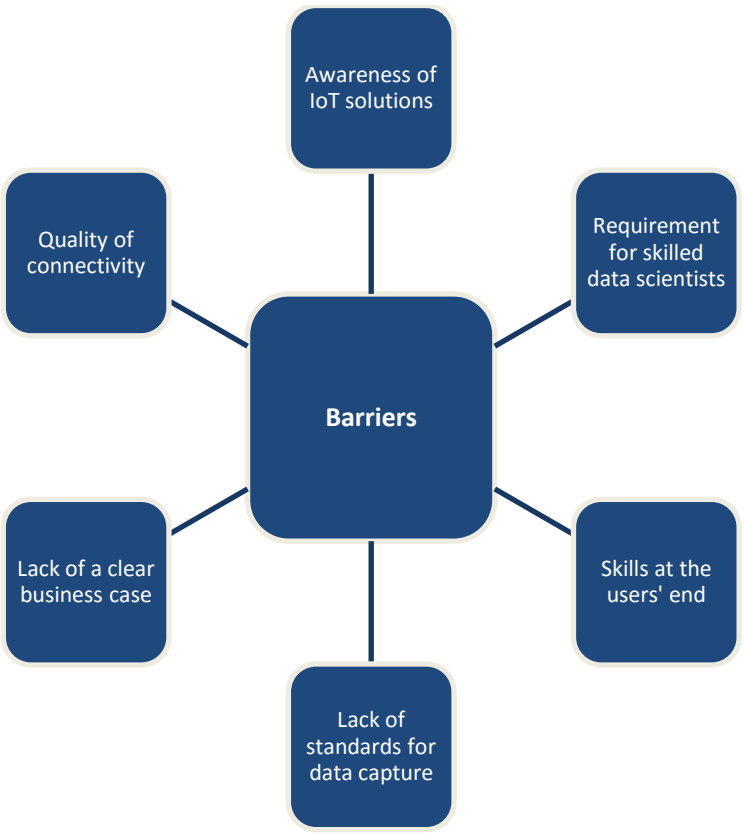
Figure 13: Current and expected penetration of IoT Based SM Solutions



Change Management and Definition of a Clear Business Case Could be the Biggest Challenges for Uptake of Smart Manufacturing Solutions

The biggest barrier that currently hampers the uptake of IoT based SM solutions is the lack of awareness about the solutions available in the market, their features and their likely benefits. Further, due to the nascence of the solution the clear cut quantification of benefits linked to it may not be very. Thus the construction of a business case becomes difficult.

Figure 14: Barriers for uptake of IoT Based SM Solutions

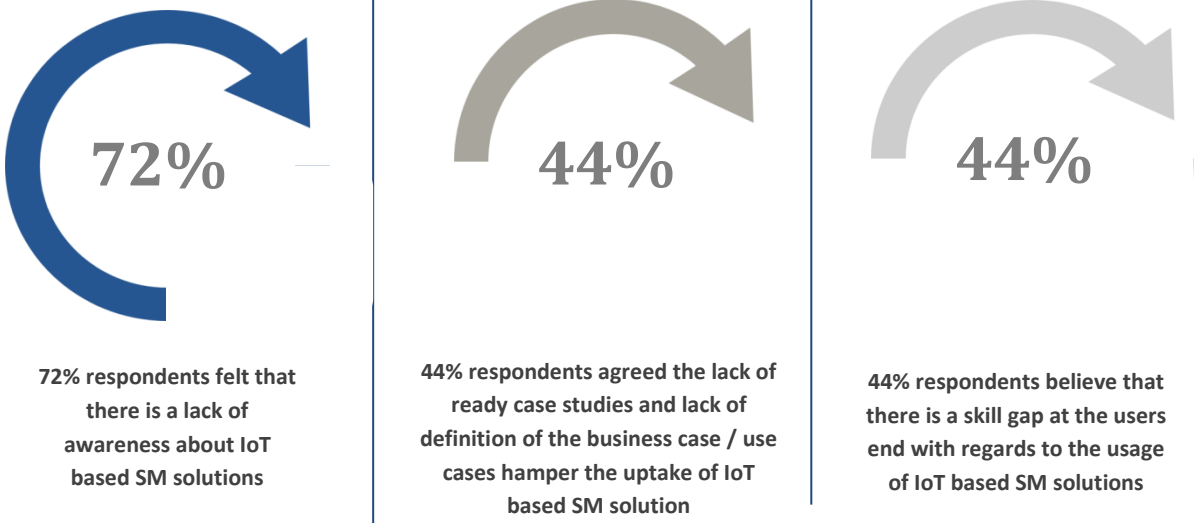


- **Awareness about capabilities of IoT based SM solutions**: Implementing IoT based SM solutions in manufacturing requires a complete change in the thought process of the people who run the show. This change need to happen at every level within the factory, right from the management to the floor supervisors. At the management level there needs to be willingness to work on a new technology as also be ready for slightly longer payback periods. Traditionally in India, paying for software is a bit of an alien concept which is something that needs to evolve. At the same time, on the shop-floor level the operators need to be brought on board and involved even in the pilot implementation phase, to make them see how IoT based SM solutions (if used well) would make their jobs easier and not more complicated. Also, it is far easier to incorporate new technologies in a new plant. However, in India there are lots of brownfield projects where technology change or upgrade is challenging and necessarily requires a massive component of change management for people. Today, positions within the management as well as the shop-floor are being filled in my younger people, who might naturally have a higher propensity to work on such solutions.

Implementing Pilot project to garner confidence

Today solution providers encourage their customers to go for small scale pilot projects, where by both parties involved can get a hang of the problem being addressed and can arrive at tangible results for the same.

- **Definition of clear business case / use case**: The success of IoT based SM solutions is also heavily reliant on a clear definition of the use case for which it is being deployed. The management hence needs to be aware of what exactly they want to monitor and how are they going to utilize the data and insights that would flow out the new solution. This is further compounded by the lack of clear quantification of savings and perceived high cost of implementation. Under these circumstances, stating the business case becomes challenging. Also current pricing of certain high end solutions is high. IoT as a technology would become more promising and persuasive when there are larger volumes of data to be handled. For lower volumes, the cost of the infrastructure (cloud and amount of devices to be managed) may not be attractive.
- **Skill gap at the operator level**: In India, most of the people on the factory shop floor are likely to not be technology savvy. It is essential for all such personnel to upgrade their skills so that they can make good use of the insights provided by IoT based SM solutions and tap into them to get the best possible outcome.



- **Standardization of data capture** from machines and associated protocols is a concern especially for solution providers. As IoT based SM solutions will gain traction, the interoperability of various systems and devices may pose a challenge to realization of a larger scale IoT which could result in disparate islands of solutions[18].
- **Quality of communication**: Availability of consistently robust communication infrastructure is crucial to the success of implementation of IoT based solutions. For example, poor cellular and internet connectivity especially in remote places could hamper the monitoring of equipment within the factory. Also, if connectivity is intermittent the system needs to be designed such that data is transferred in a smart and efficient manner.

Data science: an upcoming field

Data science is a new and upcoming field which involves extraction of meaning and insight from bulk data.

- **Lack of data scientists**: For the projected growth in IoT, there would be a need of 200,000 personnel who are skilled in data science and can manage such complex solutions[19]. Data science is a new and upcoming field which involves extraction of meaning and insight from bulk data. Data scientists would typically be required by solution providers to design their offerings. Owing to this field's recentness, there is a dearth of skilled data scientists in

[18] Mindtree, Making sense of interoperability: Protocols and Standardization initiatives in IOT, http://www.cymbet.com/pdfs/Low_power_IoT_ComNet_2013_Mindtree.pdf, Accessed on May 19, 2016
[19] http://www.fractalanalytics.com/news/how-india-building-its-analytics-talent, Accessed on May 19, 2016

the market today. Good data scientists need to have a unique bunch of strong skills in areas as diverse as mathematics, statistics, business, technology and also a keen sense of grasping the nuances of any specific domain.

Busting the myths related to Smart Manufacturing solutions

- **Threat to data security**

The security of data is critical. Given its criticality, solution providers today provide ample protection to ensure a safe and secure platform for the user.

- **High Downtime for installation**

The installation of IoT based solutions in fact is non-invasive and can be deployed in days with minimal downtimes at the plant owing to evolution of advanced meters and sensors.

Key Trends that are Likely to Emerge

With a growing young work force as an asset, India would be poised to capitalize on the wave of industrial smart technologies. As smart technologies will gain traction in the market, some key trends are likely to shape their direction.

- With use cases becoming clearer and increasing traction in the market for such solutions, the number of solution providers will increase too. These are likely to not be sector specific. However, they would need to continue to tweak and tailor their solution for each factory and not just every sector. Solutions that can be easily interpreted and have a low resource footprint will have an edge over the rest.
- Manufacturers will continue to seek end to end solutions. Hence, the market which may be fragmented at present will get increasingly consolidated.
- Hardware costs in particular will reduce. The kinds of sensors and their sensitivity will improve and move towards more rugged designs.
- Owing to the nascence of the market today, solution providers mainly provide solutions that give insights on current operations and predict what could happen. Going forward, these insights will be fed back in to the equipment in order to enable machine learning and initiate self-correction by the machine. Thus, automation based on analytics would be a key area that would emerge over the next few years.
- There could be a need for reorganization of the skilled labour of today.

Way Forward

The way forward for IoT based SM solutions would necessarily need to commence with improvement of awareness about available solutions. This could be addressed by solution providers by **making more case studies and project references** available to manufacturers which could help them gain confidence. Further, if the solutions are implemented in units that belong to an industrial cluster, it would help in spreading the experience through word of mouth among various factories within the cluster.

Also, to make factories more ready for such solutions, the **skill sets of the operational staff** needs to be enhanced through classroom and shop floor trainings using aid such as manuals, videos, hands on sessions that give out step by step procedures in a simplistic manner. Training could be provided to factory personnel on following topics:

- Basic computer and software skills
- Data entry and its quality(if applicable) and its importance

- Mobile applications and their interpretation
- Basic appreciation for IoT / Digitally connected assets
- Basic appreciation for analyzing data signals from assets and how to act on them based on insights provided by the IoT solution
- Guidance on customizing reports
- Cross functional skills cutting across engineering, operations, analytics, data

Such capacity building on this front needs to happen on an ongoing basis to address the attrition within the factory.

Which kind of factories would want to go for SMART solutions?

- Factories that have the right attitude towards change and evolution and understand the value of data as a change enabler
- Factories that are incurring heavy losses in terms of equipment downtime, scheduling problems, quality issues
- Companies that have remote operations and assets
- Factories that may need more of real-time data and analysis
- Factories that are already recording good quality data in some form or shape (be it electronically or manually). For example, factories that are already using some enterprise-wide software, SCADA systems, etc.
- Factories that have more installations of latest machinery, which usually come with data capturing capabilities
- Companies that are setting up greenfield factories so that the change management involved with new processes can be more smooth

Another likely possibility is that in the future the **influence of IoT based SM solutions on energy efficiency would move beyond the fence** of the factories to the entire value chain of manufacturing. The future will see evolution of solutions that enable everything to be connected and executed in real time. As per the principles of modern lean manufacturing processes, if the flow of material is perfect, production should be able to run at the speed of customer demand as opposed to following the conventional method of creating projections. IoT based solutions could be leveraged to connect everything and make the entire supply chain lean and responsive by manufacturing only that which is purchased by the customer. This would impact energy efficiency positively by avoiding wastages that occur due to waiting, work in progress, inventory, over production and under production within the factory as well as on the logistics side. The technologies and practices of smart manufacturing will complete the evolution of manufacturing from a supply-side-focused mass production to demand-driven mass customization[20].

We live in an increasingly connected world where technology is providing us with the opportunity to overcome human errors and to also utilize the capabilities of the human brain for more value added jobs. It is for us to approach such technologies in smart manner armed with the right use cases and tap in to them to extract maximum benefits from them. IoT and analytics based solutions today maybe an abstract statement for manufacturing plants, like the smartphone was until a few years ago. But it will become a necessity about 5-6 years from now and will be converted from a good-to-have item to something that would be absolutely essential in all sectors. The top management at the DCs' side will need to commit to their engagement in the process of piloting and implementation of IoT based SM solutions. Cross functional communication and data flow would be need to be facilitated by cross functional teams for reaping maximum benefits from such solutions. There are a fair bit of challenges and expectations that solution providers would need to overcome. Serious thought would also be required for re-skilling at many different levels. The main idea is that it is not factories and manufacturing that needs to be smart; it is also people that need to get smart.

[20] American Council for an Energy-Efficient Economy, The Energy Savings Potential of Smart Manufacturing, 2014, Pg. 11

Snapshot of Solution Providers Currently Active for Smart Manufacturing

Solution provider	Description of solution
Wipro Eco Energy https://wiproecoenergy.com	Wipro EcoEnergy provides intelligent and sustainable solutions for enterprise-wide energy operations and efficiency management. Wipro offers customized solutions using their "Managed Energy Services" engagement model to provide a Capital Expenditure light efficiency solution for all phases of manufacturing. Under this they take the ownership of identifying savings opportunities, developing the best fit custom solution, deploying site instrumentation, deploying software and then delivering time bound savings.
Flutura Business Solutions Private Limited https://www.flutura.com	Flutura, a pioneer in Industrial IOT provides a leading Machine Intelligence Platform Cerebra for managing and optimizing machine performance. Cerebra enables industrial and commercial machinery manufacturers create new business models around predictive maintenance for their equipment. Equipment owners leverage Cerebra for optimizing performance of their machines in their production operations. Cerebra's state of the art machine diagnostics and prognostics algorithms enable asset health assessment, calibration, performance bench marking, safety risk assessment, condition based maintenance and other asset centric functions. Flutura has partnered with several sensor, gateway providers and telecom providers to offer end to end Industrial IOT solutions to industrial machinery manufacturers and owners.
Entrib Technologies Pvt. Ltd. http://www.entrib.com	Entrib is working to equip Manufacturing Companies with greater control using their "Industrial" Internet of Things innovation - ShopWorx. ShopWorx is a real Time Monitoring, Communication Improvement, Process Optimization and Trend Analytics Solution for operation of a Manufacturing Shop Floor to achieve efficiency improvement and cost reduction.
Machine Pulse http://machinepulse.in/	MachinePulse product offerings are as an M2M provider and its Data Analytics solutions have been recognized by several industrial stalwarts and organizations like CIO Review and Gartner. Their offering called FactoryPulse is desined for providing meaningful insights pertaining to asset optimization using IoT by improving plant performance, reducing downtimes and costs of O&M activities.
ETAmation Insights Private Limited http:// etamation.com/	ETAmation Insights (P) Limited provides industrial and enterprise clients Resource Efficiency solutions to maximize machine assets efficiency. They provide end to end solutions for asset management and performance tracking, condition analytics and predictive maintenance, energy management and energy efficiency, identification of theft, damage, leakage and failure.
HARMAN Connected Services http://services.harman.com/services/analytics/	Harman connected services has been the analytics powerhouse of world's top insights providers – from largest CPG market research firms to largest life sciences companies. Their offering, BI Factory is a methodical business performance management and optimization engine. It enables the factory to build KPIs and measure impact, implement intuitive advanced visualization, employ graphical scenario planning and ensure cross channel timely insights delivery.
Aeris http://www.aeris.com/	Aeris is a pioneer in the machine-to-machine market. They are both a technology provider and a cellular network operator delivering comprehensive IoT / M2M services to leading global brands. Their offering AerVoyance provides IoT analytics to effectively manage customer's IoT/M2M deployment using an intuitive, visual presentation. It is designed to help address the challenges of gaining visibility and insight into devices, connectivity, and billing information.

Associates Information Technologies (P) Ltd. Ripples Industrial IoT Solutions http://www.ripplesiot.com	Their technology called Ripples is an Industrial IoT solution which combines the power of multi-sided platform, smart sensors and predictive data analytics. Ripples can facilitate data capture, data analysis and data sharing that can add new dimensions in the way you are working, making it smart. Ripples acts as an Industrial IoT platform, multi-location business intranet, collaborating work force and, capturing information on your valuableassets and decoding them to actionable insights
Briston Technomach Ltd. BRISTON Connect • Automate • Optimize http://bristontech.com	Briston creates affordable & innovative IoT based solutions for businesses that make their operations more efficient and create more value for their customers. Their area of operation is focussed on energy. Briston bring operational efficiencies through highly accurate monitoring of fuel consumption of generator sets and their condition, thereby providing a close control and significant saving in the overall operational costs.
Altiux altiux http://www.altiux.com/	Altiux leverages its expertise in M2M, IoT, Mobility, Big data, Cloud and Analytics build products and solutions for manufacturing units amongst many other verticals. Altiux' s solutions help clients achieve; Better visibility to shop floor processes, increased Automation, preventive Maintenance, smarter energy management and integrated supply chain management.
Altizon ALTIZON http://altizon.com/	Altizon is an Industrial Internet Platform company focussed on making Enterprises Internet of Things(IoT) ready. Their offering the Datonis IoT Platform, enable real time monitoring of assets and energy to improve the Overall Equipment Efficiency as also perform predictive modelling for forecasting production and maintenance. The solutions can be operated in remote locations as well.
Eco Axis ecoaxis measure analyze improve http://ategroup.com/solutions/ecoaxis/	EcoAxis' solutions provide customers with enhanced operational productivity, improved performance, reduced equipment life cycle cost, and greater energy efficiency. EcoAxis' SuperAxis™ Smart Manufacturing Suite is a Software as a Service (SaaS) offering to industrial customers which enables Role-based analytics for plant operations and management, Condition-based maintenance, OEE, production, productivity, availability, losses, KPIs, Energy & resource management, Remote monitoring for plants, discrete equipment, and utilities, Enterprise-wide deployment (including multi-plant) and benchmarking and Integrated MIS
comMIT comMIT Resource Conservation Monitoring & Management Integrated Tool http://commit.ckinetics.com/	comMIT is a Sustainability Information Service for managing and monitoring resource utilization efficiency. comMIT helps enterprises in benchmarking of performance, tracking all their facilities at one place, build analytics as also build customised tools that can be used to mobile devices.
Covacsis Technologies Pvt. Ltd. COVACSIS intelligence differentiates http://www.covacsis.com/	COVACSIS Technologies Pvt Ltd is the first company in the world to conceptualize, design and implement the Intelligent Plant Framework (IPF) targeting manufacturing industries. IPF™ is a state-of-the-art platform that provides a 360° visibility of the manufacturing floor in real time. It captures all micro events across all locations on the plant floor and models them into key and extremely relevant business KPI's.
ABB http://new.abb.com/cpm	ABB provides its customers with off-the-shelf software tools, tailored solutions and consultancy to make them benefit from access to integrated real-time and historical information across their entire operation. They offer numerous solutions for collaborative production management such as manufacturing execution system, OEE software, energy manager to name a few.

SAP http://www.sap.com/pc/tech/internet-of-things/software/predictive-maintenance/index.html	SAP's offerings for asset management and maintenance help organizations efficiently manage their physical assets in terms of performance, risk and expenditure leading to increased asset usage, reduced unplanned downtime, reduced maintenance costs and better technician safety. With SAP Predictive Maintenance and Service, customers can analyze large volumes of operational data and apply predictive insights in real time – for the foresight one needs to increase asset availability and satisfaction levels.
Cisco http://www.cisco.com/c/en/us/solutions/industries/manufacturing/connected-factory.html	The Cisco Connected Factory Solution is a portfolio of validated, proven architectures, capabilities, and market-leading technologies and services. This solution is designed to help industrial companies improve operational cost efficiency improve production uptime along many other onjectives.
IBM http://www-03.ibm.com/software/products/en/predictive-maintenance	IBM's offerings pertaining to asset analytics and predictive maintenance use powerful analytics in combination with data integration and management to help organizations reduce operational costs and improve asset performance.
HCL http://www.hcltech.com/Internet-of-Things-IoT/	HCL has developed end to end IoT offerings for organizations across different IoT adoption levels. HCL offers solutions for connected supply chain, proactive plant maintenance, remote asset tracking and monitoring.
GE https://www.ge.com/digital	GE's efficiency analyser helps customers achieve multiple benefits such as reduce of equipment downtime and maintenance costs, improvement of labor efficiencies and productivity, increase of productivity of processes by identifying bottlenecks and increase yield, Increase quality, reduce scrap
Bosch https://www.bosch-si.com/solutions/manufacturing/industry-4-0/industry-4-0.html	Bosch's software solutions for connected manufacturing and logistics enable customers to increase productivity, improve support during maintenance, and carry out monitoring and tracking in near real time. Bosch's solutions support manufacturers and users alike, helping them achieve competitive advantages in production and logistics.

PAT Pulse
[JUNE 2016]

Alliance for an Energy Efficient Economy

Sustainability Outlook

POLICY UPDATE

Status and Way Forward for PAT Scheme

According to the latest update by Bureau of Energy Efficiency, a saving of nearly 8.67 million TOE and mitigation of about 31 million tonne of CO_2 has been verified across 428 Designated Consumers (DCs) after the end of PAT Cycle I.
The savings in Million TOE for the 8 notified sectors in PAT Cycle I is tabulated below.

S. No.	Sectors	No. of DCs	Savings (Million TOE)	% Increase in savings
1	Aluminum	10	0.73	59%
2	Cement	75	1.44	76%
3	Chlor-Alkali	22	0.10	100%
4	Fertilizer	29	0.83	73%
5	Iron & Steel	60	2.10	41%
6	Paper & Pulp	26	0.26	117%
7	Textile	82	0.12	71%
8	Thermal Power Plant	124	3.06	(-)5%
	Total	428	8.64	29%

Note: Information available for 428 out of 478 participating DCs in PAT Phase 1

For the next cycle of PAT, 11 sectors have been notified, with addition of DISCOMS, refinery and railways in the list of sectors for PAT Cycle II. The total energy consumption for the 11 sectors is 227 MTOE and they have been given the target to achieve energy saving of 8.869 MTOE. The baseline year for PAT Cycle II has been set as 2014-2015. The Measurement and Verification would be done from April 2019 to 31st July 2019 for PAT Cycle II extending from 2016-17 to 2018-19.

S. No.	Sector	No. of DCs in PAT I	Additional DC in PAT Cycle-II	Total no. of DCs PAT-II
1	Aluminum	10	2	12
2	Cement	85	26	111
3	Chlor-Alkali	22	2	24
4	Fertilizer	29	8	37
5	Iron & Steel	67	4	71
6	Paper & Pulp	31		29
7	Textile	90	9	99
8	Thermal Power Plant	144	10	154
9	Refinery	NA		18
10	DISCOMS	NA		44
11	Railways	NA		22
	Total	478		621

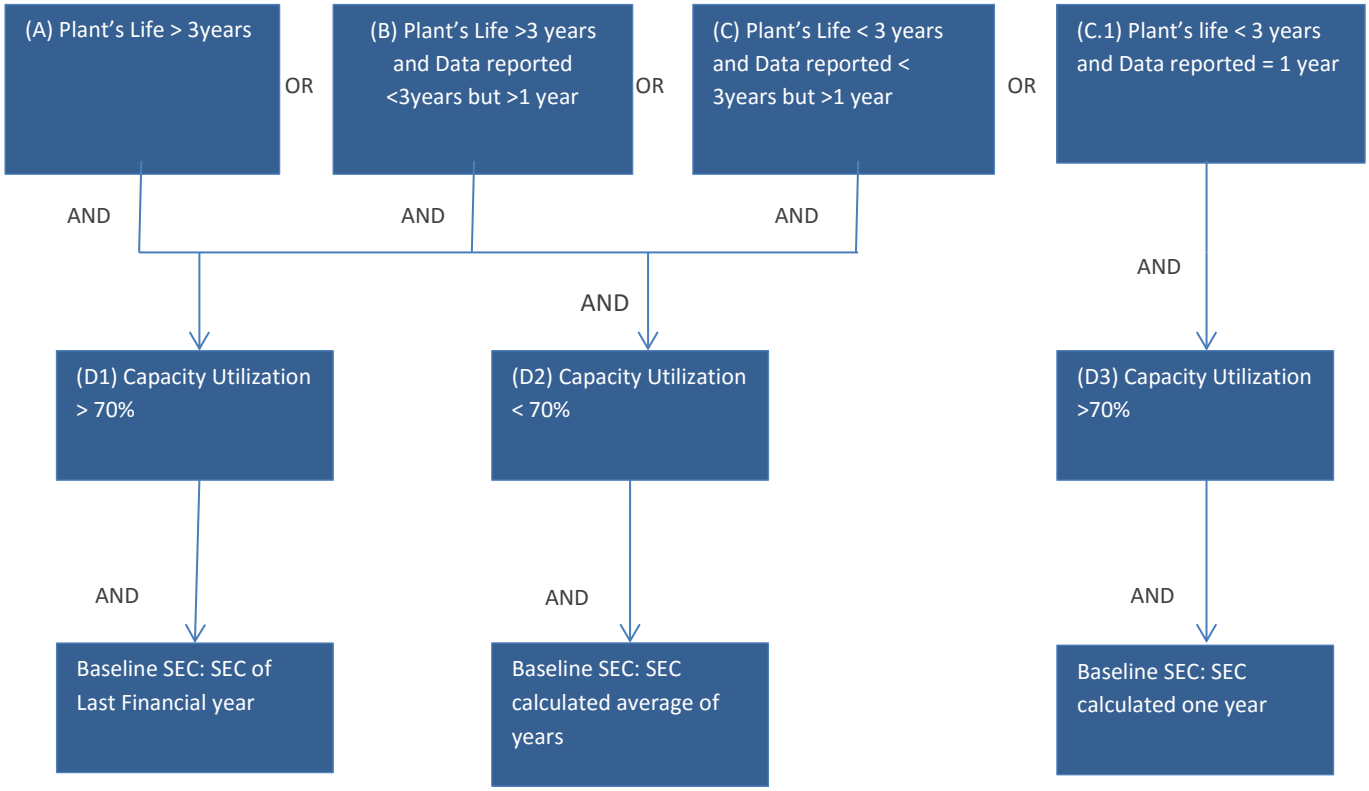
The scrutiny period after the M & V phase is likely to extend till 31st December post which the ESCerts would be issued and traded. The scrutiny phase would include 45 days of scrutiny by SDA, followed by 2 months of scrutiny by BEE and another period of 45 days for BEE's recommendation to the Central Government.

The ESCerts issued as a result of surpassing energy efficiency improvement targets in the first cycle can be traded during second cycle, while the one from second cycle can be transacted in the next cycle.

The key learning from the experience from PAT cycle last phase brought about amendment in the EC Act, the timeline for monitoring, reporting and verification was extended, it was deemed necessary to link Inspection Rules, 2010 with Check verification under the Perform Achieve Trade (PAT) Scheme to increase the domain of SDA's in the check verification process. As a way forward, 8 orientation workshops at 8 SDAs for introduction of PAT and to improve the understanding of data reporting and compliance activities for the new DCs and about 20 regional workshops at four regions on Pat rules and targets for the second phase are in the pipeline.
Source: https://beeindia.gov.in/sites/default/files/PAT_Status_Powerline_Conference_09-05-2016_-_Copy.pdf

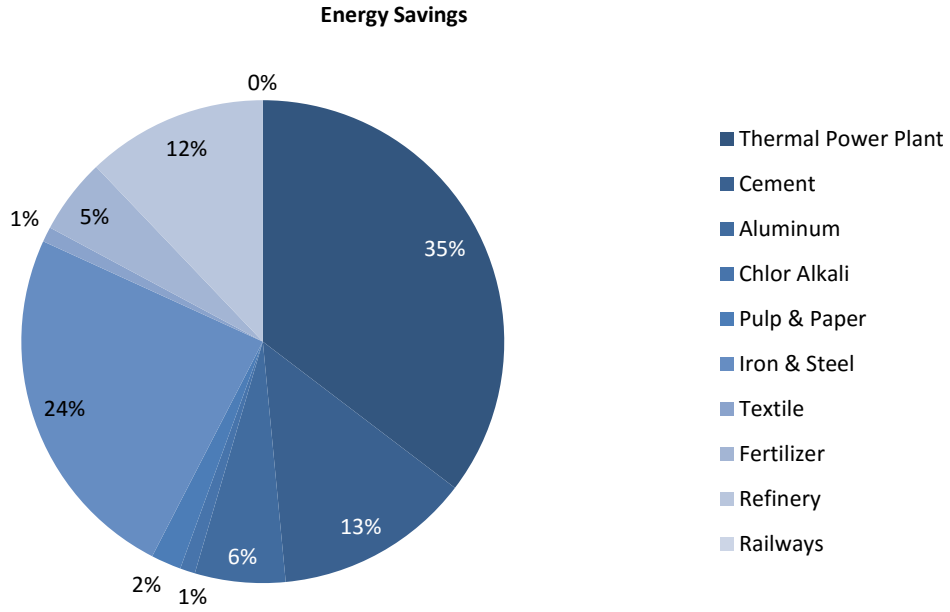
SEC Targets for the Petroleum Refineries

According to the latest updates by BEE, the Baseline Specific Energy Consumption for DCs in the petroleum refineries sector would be fixed by the following method.



For the new DCs in PAT Cycle II, last financial year of three year reported data was decided to be considered as the baseline year.

The refinery sector consuming 18.5 Million TOE of energy has been given the target to achieve energy savings of 1.10 Million TOE as per the sectoral target for PAT Cycle-II. The energy savings for 10 of the sectors identified for the PAT Cycle II can be seen as in the figure given below.



The DCs identified as per the EC Act schedule list of 15 energy intensive industries and other establishment, are expected to appoint energy managers , who would be solely responsible for efficient use of energy and energy conservation. The DCs are also expected to implement techno-economic viable recommendations, comply with the SEC norms and submit reports on the steps taken other than getting energy audits by accredited energy auditors. The refinery wise target is tabulated below.

S.No.	REFINERY	2014-15 (Submitted by Refineries)			5.97% Reduction		
		MBN[21]	Crude T'put Th.Bbls	NRGF	Target MBN	MBN Reduction	% Reduction
1	RIL-DTA	50.9986	217778	9.3592	48.7585	2.24	4.39
2	RIL-SEZ	51.9504	260659	10.2586	49.6259	2.32	4.47
3	EOL	64.0900	142936	6.7898	60.5522	3.54	5.52
4	HMEL	71.5700	51829	9.1914	67.1582	4.41	6.16
5	NRL	74.0800	19659	6.8615	69.3533	4.73	6.38
6	PANIPAT	73.1075	103709	5.6067	68.5041	4.60	6.30
7	BARAUNI	81.5084	43727	5.4943	75.7862	5.72	7.02
8	MATHURA	77.6819	62237	5.0721	72.4844	5.20	6.69
9	GUJARAT	76.6785	96614	6.1183	71.6144	5.06	6.60
10	BPCL-MR	78.2458	95818	4.4566	72.9725	5.27	6.74
11	HALDIA	71.7170	55695	5.3785	67.2870	4.43	6.18
12	BPCL-Kochi	78.3944	78496	4.2178	73.1011	5.29	6.75
13	MRPL	83.5806	108063	5.6517	77.5638	6.02	7.20
14	HPCL-VISAKH	81.6838	65350.4	4.4128	75.9370	5.75	7.04
15	BORL	85.3144	44618	8.3414	79.0453	6.27	7.35
16	HPCL-MUMBAI	87.8100	53971	5.3405	81.1688	6.64	7.56
17	CPCL	92.5762	76025	4.4791	85.1945	7.38	7.97
18	BONGAIGAON	99.8950	17729	4.8351	91.3000	8.59	8.60

Source: https://beeindia.gov.in/sites/default/files/PAT_MD_12_May.pdf

[21] Thousand British Thermal Unit per Barrel per Energy Factor (MBTU/BBL/NRGF)

NEWSWIRE

Key News Highlights

Steps to Ensure Energy Efficiency by MSMEs

May 5, 2016:

Shri Piyush Goyal, Minister of State (IC) for Power, Coal & New and Renewable Energy, stated that the Ministry of Power through BEE has undertaken the following steps to ensure energy efficient energy consumption by Micro, Small and Medium Enterprises (MSMEs):

- Implementation of BEE-SME energy efficiency programme since XI Plan period in various energy intensive clusters. Preparation of 375 technology specific bankable DPRs enlisting energy efficient technologies through technology gap assessment study conducted across 25 high energy intensive clusters belonging to 12 SME sectors followed by energy audits in 1250 units.
- Demonstration of 100 projects based on Best Available Energy Efficiency Technologies in 5 clusters during XII Plan. Implementation of energy efficient activities under Global Environment Fund (GEF) funded multilateral projects in 15 different energy intensive clusters.
- Implementation of a project funded by GEF through United Nations Industrial Development Organization for energy efficiency in MSMEs, to enable adoption of energy efficient technologies in 10 clusters in the country by EESL.

It was further stated that Ministry of Micro, Small and Medium Enterprises (MSMEs) is also implementing a scheme under National Manufacturing Competiveness Programme (NMCP), named, "Technology and Quality Upgradation Support (TEQUP) to MSMEs", to support units which intend to implement energy efficient and eco-friendly technology. Under this scheme, the Government intends to provide financial support worth 25% of the project cost for implementing Energy Efficient Technology (EET), subjected to a maximum of Rs. 10 lakhs. It was also highlighted that the MSMEs do not falls under the ambit of Energy Conservation Act, 2001.

Source: http://www.pib.nic.in/newsite/mbErel.aspx?relid=144892

AP to Set Up Energy Efficiency Firm Soon

Apr 3, 2016:

The state of Andhra Pradesh is likely to soon establish a company responsible for implementation of energy efficiency programmes on a larger scale to be par with the global practices. The company smilar to EESL would have public sector utilities like APGenco, APTransco, and Discoms and State Energy Conservation Mission (SECM) as partners. The company would enhance energy efficiency by taking forward programmes like Agricultural Demand Side Management (AgDSM) programme, Domestic Efficient Lighting Programme (DELP) and municipal street lighting.

The AgDSM project would involve installation of nearly 2 lakh energy efficient pumps in phased manner resulting in a saving of nearly Rs. 635 crore. The state also targets to install an additional 2.25 lakh LED streetlights to reach a total of 5.5 lakh LED streetlights across 110 municipalities. Energy efficient fan scheme will also be launched in Vijaywada and Narsapur soon.

Source: http://www.thehindu.com/news/national/telangana/ap-to-set-up-energy-efficiency-firm-soon/article8428328.ece

DATEBOOK

Workshop on Operation, Maintenance and Energy Efficiency in Electrical System

Date	22 - 24 June2016
Location	Mumbai, India
Type of event	Workshop
Organiser	CII
Key themes	Latest trends in operation & maintenance of electrical equipment, sharing of best practices in electrical system operation, disseminate latest techniques and advancements in the field of energy management.
Link	http://www.cii.in/events.aspx

15th Energy Efficiency Summit

Date	22 - 24 August, 2016
Location	Hyderabad, India
Type of event	Summit
Organiser	ACEEE
Key themes	Facilitation of improvement in energy efficiency in Indian industry and help them achieve the target set as part of PAT scheme, ddissemination of information related to the latest trends, Energy Efficiency technologies, products & services.
Link	http://www.greenbusinesscentre.com/site/ciigbc/viewevent.jsp?eventid=499702&event=dd

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About Shakti Sustainable Energy Foundation
Shakti Sustainable Energy Foundation works to strengthen the energy security of India by aiding the design and implementation of policies that support energy efficiency and renewable energy

About Sustainability Outlook

Sustainability Outlook, a division of cKinetics is a market access, insight and collaboration platform tracking actions related towards enhanced resource management in the Indian economy. Sustainability Outlook provides market analysis and data tracking services, news and intelligence updates, and creates momentum towards specialised sustainability interventions by facilitating a structured process for multi-party collaboration.

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About AEEE

AEEE is an industry association created for the specific purpose of convening companies and organizations (manufacturing companies, end users, service providers, utilities, academic and R&D institutes and other non-profit organisations) interested in creating a thriving energy efficiency sector in India and providing a unique platform to actively participate and support in energy efficiency policy formulation and analysis.

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