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受賞報告講演要旨

Siemens Gamesa Renewable Power Private Limited,
Manufacturing Units-India

Siemens Gamesa Renewable Power Pvt. Ltd, (SGRP) India

SGRE - Mission, Vision & Values

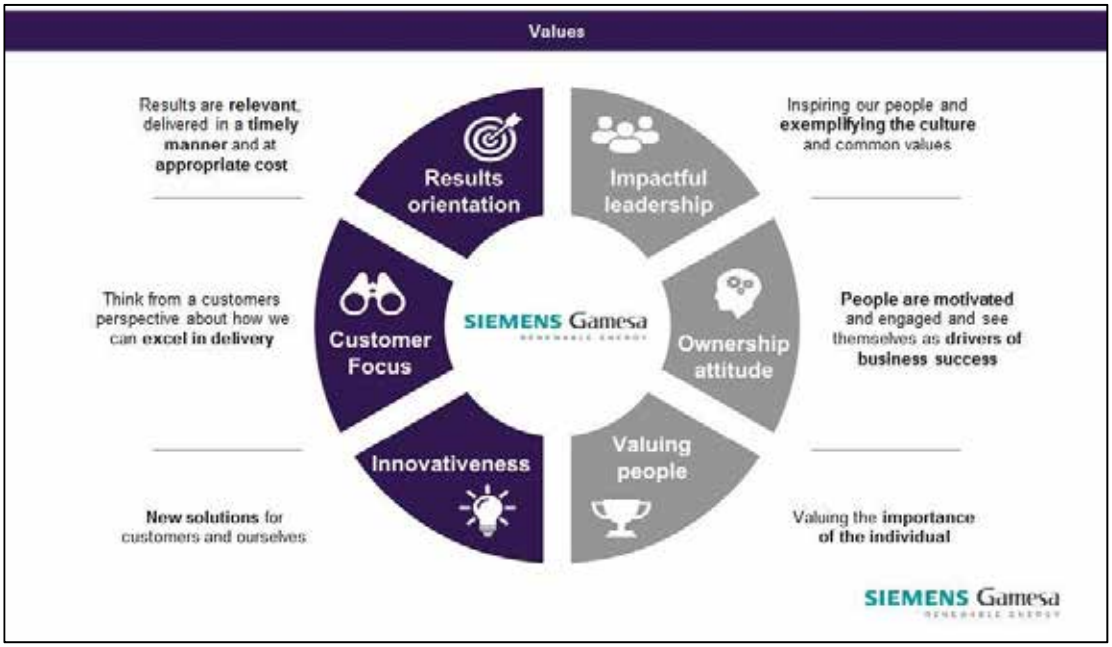
Mission

"We make real what matters – **Clean energy** for generations to come"

Vision

"To be **global leader** in the renewable **energy industry driving** the transition towards a sustainable world"

Values



1. Company profile

1.1 Brief history of Siemens Gamesa Renewable Power Private Limited (SGRP)

In 1995, Gamesa Corporación Tecnológica diversified into wind power, installing its first wind turbine in Spain and quickly grew into one of the leading manufacturers of wind turbines worldwide with production centres at USA, China, India, Brazil and Spain. Siemens wind power, the present owner of SGRP has been directly involved in the wind power industry since 2004 when it acquired the Danish Bonus Energy and grew as the global market leader for offshore business.

Siemens Gamesa Renewable Energy (SGRE) was formed in April 2017, with the merger of Gamesa Corporación Tecnológica and Siemens wind power. SGRE is a global technological leader in the wind industry with an installed base of +90 GW worldwide, a reach in over 75 countries and a team of more than 23,000 professionals. SGRE designs, manufactures, installs, commissions and maintains Onshore and Offshore wind turbines across the world.

SGRP is a part of SGRE and one of the largest renewable energy companies in India with sales of INR 55.23 billion in the year 2018-19 with the installed capacity of more than 6000 MW. Present in India since 2009 and has been positioned as No.1 wind turbine manufacturer in the country for the three consecutive years (2014-15, 2015-16 and 2016-17). Our sales volume and revenue have grown steadily over the years and we have done more than2000 MW in one single year (2016-17), which is industry bench mark with a revenue of INR 129 billion.

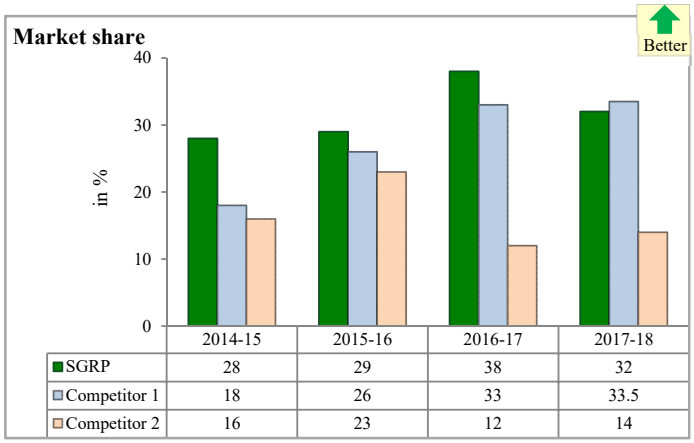


Figure 1.1 - Market share

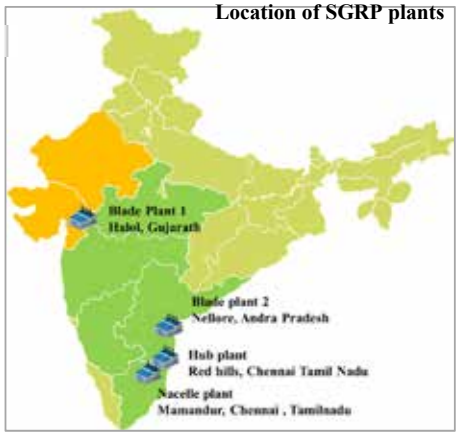


Figure 1.2 - Plant locations

SGRP's Industrial Operations (IO) has 4 manufacturing plants in India - Blade plants in Gujarat & Andhra Pradesh and Nacelle & Hub plant in Chennai, as shown in Figure 1.2 with the employee strength of 1027. SGRP - Industrial Operations journey from 2009 is given in below Table 1.1.

Table 1.1 – IO journey

Year	Industrial Operations journey
2009	Established 1st manufacturing facility at Redhills, Chennai
2011	Established Blade facility at Halol, Gujarat
2013	Established Nacelle facility at Mamandur, Chennai
2015	TQM journey Started
2016	Established Blade facility at Nellore, Andhra Pradesh
2017	Siemens Gamesa merger
2018	Deming Prize diagnosis examination
2019	Deming Prize On-site examination and won the award

Industrial Operations at SGRP is responsible for manufacturing and supply of wind turbine components such as Nacelle, Hub and Blades with right quality, optimal cost and on time delivery. Industrial Operations embarked on TQM journey in 2015 at all its manufacturing units as a strategic initiative.

1.2 Organization and roles

(1) SGRP corporate organization structure

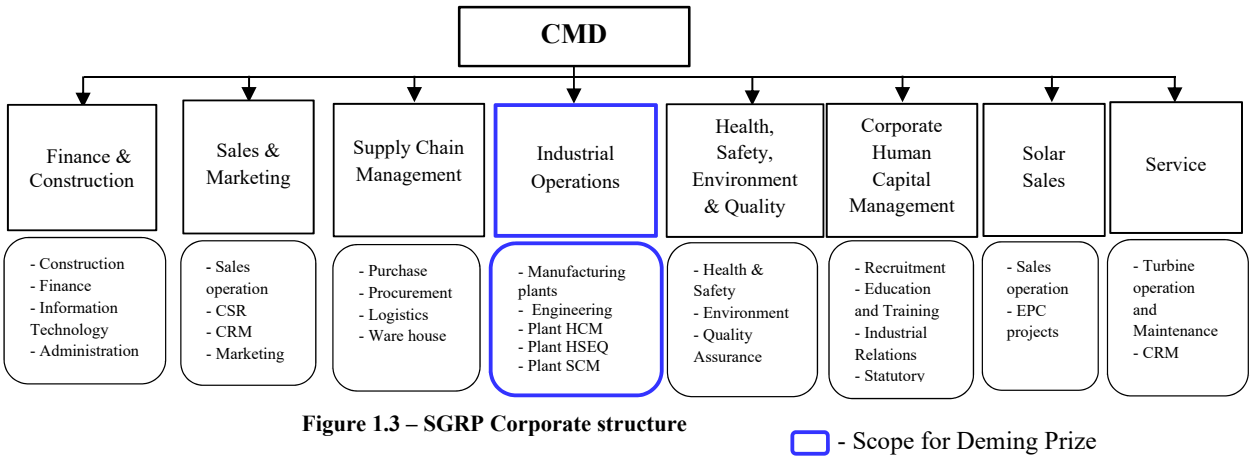


Figure 1.3 – SGRP Corporate structure

(2) Industrial Operations (IO) organization structure

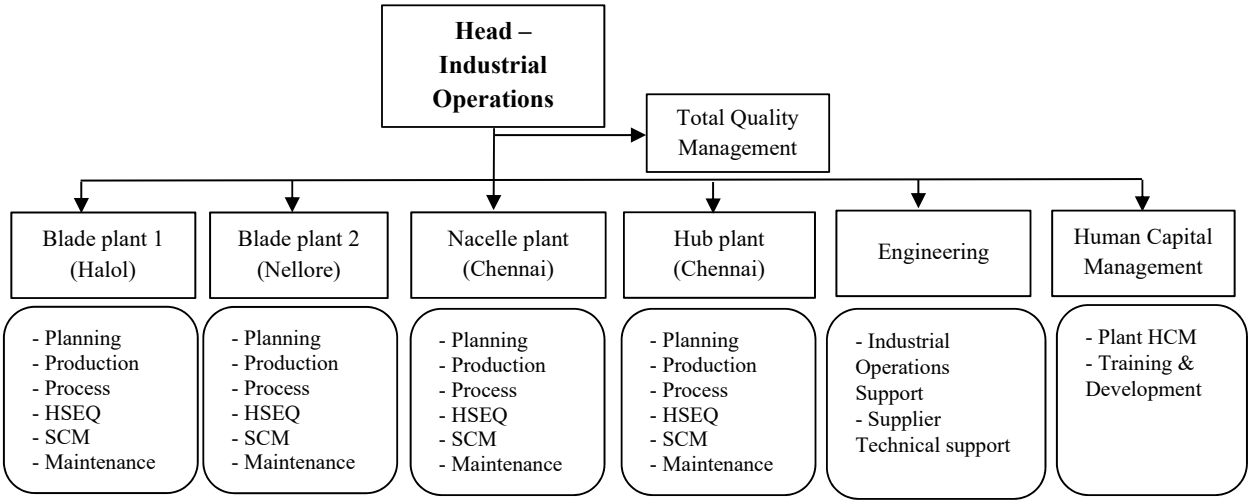


Figure 1.4 – IO structure

(3) Support functions structure

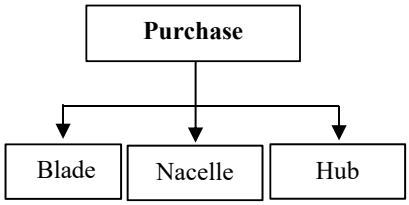


Figure 1.5 - Purchase structure

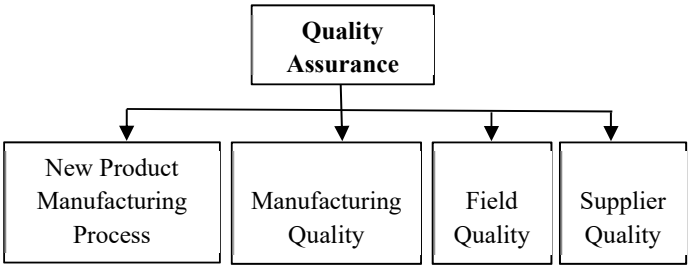


Figure 1.6 - QA structure

1.3 Products and Customers

(1) Products

SGRP manufactures three major wind turbine parts in-house namely, Nacelle, Hub and Blade. We make these parts for Kilo Watt (KW) and Maga Watt (MW) range turbines with multiple variants.

(2) Customers

There are 3 types of customer groups namely, Independent Power Producers, Public Sector Units and Traditional customers.

Independent Power Producers: Core business is to produce and sell wind power with vast technical and domain knowledge.

Public Sector Units: Investment purpose, Renewable Purchase Obligations.

Traditional customers: Captive power consumption.

Few key Customers list is shown in Table 1.2.

Table 1.2 - Key Customers

Customers		
IPP	**PSU**	**Traditional Customers**
Sembcorp	Oil India Limited	Ramraj
Renew Power	GAIL	Eveready
KPR	NALCO	ITC
Ostro	PTC India	LMW
Orange	THDC	
Greenko	NTPC	
Tata Power		
Adani		
Mytrah		
Panama		

1.4 List of external awards

Table 1.3 - External awards

Year	Awards	Plants
2012	Golden peacock award for Occupational Health and Safety	Nacelle plant
	Green factory building, Platinum rating by Indian Green Building Council	Nacelle plant
	Environment, Health and Safety excellence award by CII	All plants
	Golden peacock environment management award	All plants
	The Greentech environment award	All plants
2014	Green factory building, Silver rating by Indian Green Building Council	Blade plant 1
	CII EHS excellence award	Nacelle plant
	The Golden peacock national training award	All plants
	Best manufacturer award for 2014 -15, by Indian Wind Power Association	All plants
	"Leading RE manufacturers –Wind" by UBM India private limited	All plants
2016	Par excellence award in national competition, NCQC	Blade plant 1, Nacelle and Hub plants
2017	Green factory building, Platinum rating by Indian Green Building Council	Blade plant 2
	Gold award in international QCC competition, ICQCC Manila, Philippines	Blade plant 1, Nacelle and Hub plants
	Gold award in national level Quality Circle convention by QCFI	Blade plant 1
	Platinum award in national level Quality Circle convention by ABK-AOTS	Hub plant
	Gold award in National level Quality Circle convention by ABK -AOTS	Blade plant 2
	Par Excellence award in National competition, NCQC	Nacelle and Blade plant 1
2019	5S Certification by QCFI - JUSE, Tokyo in May 2019	Blade plant 1, Halol
	Platinum and Diamond awards in National level Quality Circle convention by ABK-AOTS	Nacelle and Blade plant 2
	Gold award in International QCC competition, ICQCC Tokyo, Japan	Nacelle, Hub and Blade plant 1

1.5 Profile of the manufacturing plants

(1) Blade plant 1

Blade plant 1 was established to ensure cost economics through in-house blade manufacturing in the year 2011, located at Halol in Gujarat state. Plant is fully air conditioned, because manufacturing needs to be done in controlled environment condition (temperature and humidity). Blade plant 1 is spread over 67 acres with built up area of 42000 Sq. meters. The plant has the capacity to produce 700 MW per year with four lines of operations and the employee strength is around 440.

The key manufacturing processes involved are Prefabrication, Shell moulding, Finishing and Painting. The layout adopts a single piece flow and designed to keep zero inventory between stages and material movement between stages are kept at minimum level.

This plant is certified by DEWI for shop approval conforming that the wind turbine blades are manufactured in compliance with the requirements set forth in the certified design. The facility has a Skill Development Centre (DOUJOU) to enhance the basic blade manufacturing skills for new recruits and also serves as a centre for refresher training. The plant is certified for its 5S practices by QCFI-JUSE, Tokyo in May 2019.

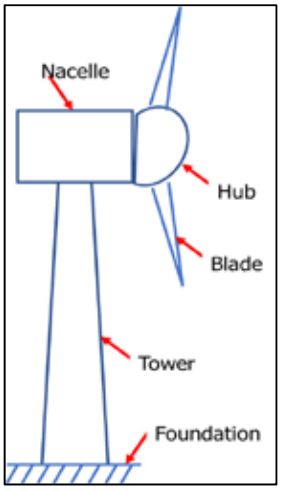


Figure 2.1 – wind turbine

(2) Blade plant 2

Blade plant 2 is situated at Nellore city in Andhra Pradesh state in southern part of India. Plant has started its operation in year 2016 with the objective to feed southern Indian windfarm requirements. The Plant has capacity to produce 700 MW per year with four lines of operations, two lines for exports and two lines for domestic. Blade plant 2 is spread over 150 acres with built up area of 57000 Sq. meters and the employee strength is around 400. Manufacutring process and Skill Development Centre (DOUJOU) of blade plant 2 is similar to Blade plant 1. This plant is recognised by SGRE corporate for prototype blade development of higher MW turbines for global market. Blade team also supports other SGRE global factories in streamlining the manufacturing process and people skill development activities.

(3) Nacelle plant

SGRP inaugurated the state-of-the art Nacelle assembly facility at Mamandur, Chennai in 2013 with an annual production capacity of 2000 MW. It has two assembly bays and a warehouse bay. The assembly line comprises of six main assembly and six pre-assembly stations. The layout adopts single piece assembly flow and is designed in such a manner that there are no inventories between stations and material movement between stations are kept at minimum level. The nacelle facility is spread across 10 acres with a built-up area of around 8000 Sq. meters and the employee strength is 144, including support functions. The nacelle is one of the most important part of a wind turbine, which houses key units such as Drive train, Yaw system, Control system etc. The Drive train is built with a main shaft that spins with the turbine blades and a gear box.

This facility operates with a semi - automatic conveyor system to support single piece assembly flow. Following the completion of assembly, the nacelle is subjected to shower test, which is unique and not done by any of our competitors. This facility has a Skill Development Centre (DOUJOU) to enhance the basic assembly skills for new recruits and serves as a centre for refresher training.

(4) Hub plant

Hub plant is located at Redhills, Chennai and established in the year 2009. This is the first Indian factory of SGRP and first 3 models of nacelles were produced from this plant. Since Nacelle production is shifted to a newly built facility at Mamandur, Chennai in the year 2013, this plant became a dedicated Hub manufacturing facility with an annual production capacity of 2000 MW. The Hub is one of the most important part of a wind turbine, which houses the electronic controlled pitch system. The blades are fastened to the Hub at the wind farm sites and the cylinders and actuators of the pitch system turns the blades to the desired angle to maximize wind capture.

From the inception, this plant has not recorded any reportable accident, which is a benchmarking performance in the industry. The Hub facility is spread across 2.5 acres with a built-up area of 1800 Sq. meters and the employee strength is 20. The Hub assembly comprises of six main assembly and four pre-assembly stations. The layout adopts single piece assembly flow and is designed in such a manner that there are no inventories between stations and material movement between stations are kept at minimum level.

1.6 Technical capabilities

(1) Blade plant 1 and 2

Blade plants have the capability to prototype and produce blade length up to 75 meters. Blade plants are following the latest process technology, Vacuum Assisted Resin Infusion Moulding for its consistent quality levels. This process assures better quality level than Pre–preg composite process. The blade bonding process is carried out as single stage closing for improved productivity. No other blade plant in India has this facility. To meet the customers' technical expectations, each blade is checked for structural bonding strength through Non-Destructive Testing (NDT). The tooling and fixtures except blade main moulds are developed locally.

(2) Nacelle and Hub plant

The Nacelle team handled 19 variants in a single year and developed prototypes of more than 5 models. The recent proto assembly of new model Nacelle was successfully completed by the team in a record time of less than two weeks. All the Nacelles and Hubs are tested for its performance (No load condition) using a test panel.

The Nacelle and Hub teams are continuously trained at Spain to become technically sound. The team is capable of developing its own customized special purpose tools, such as lifting fixtures, assembly fixtures and platforms. As a result of benchmarking visit, Nacelle Skill Development Centre was conceptualized and developed completely with in-house resources. The test rig for pretesting of electrical/electronic components has been developed in collaboration with the respective component manufacturers. The Nacelle shower test facility to ensure that all Nacelles are free from any water leakages was developed locally.

1.7 Quality accreditation

The Nacelle, Hub and Blade plant 1, Halol and Blade plant 2, Nellore are certified for Integrated Management Systems such as 1) ISO 9001:2015, 2) OHSAS 18001:2007 and 3) ISO 14001:2015.

2. Business objectives and strategies

2.1 Background

The wind industry in India has grown steadily over the years and a cumulative of 40 GW of wind power projects had been commissioned during last three decades. New economic policy introduced in 1993 by central government has pushed the GDP growth rate consistently which triggered rapid power demand in the country. Aligning with Kyoto protocol agreement, like many other countries India has been promoting renewable energy through many policies and subsidies to counter CO2 emissions and curb global warming. The present Government of India has launched National renewable energy agenda with a target to raise the renewable energy capacity from 68 GW to 175 GW by year 2022 in which 60 GW is wind power. Also, Government of India has committed to INDC in Paris conference (COP21) to reach a target of 40% of Indian power capacity from non-fossil fuels by year 2030.

All these positive developments supported Indian wind industry growth and the market size has increased which attracted huge investments from IPPs as well many OEMs entered in the market. While the Indian wind industry was growing steadily through many reforms and incentives, in-order to bring competitiveness in renewable industry, Government of India has introduced policy change from fixed tariff to reverse bidding auctions tariff in the year 2017 and also removed all incentives due to which the Indian wind industry is currently going through a slowdown process and has put all the OEMs under cost pressure needing cost effective new products and solutions.

(1) Strategic planning

A structured Strategic planning process as shown in Figure 2.2 is followed in SGRP to understand the above market developments to formulate Vision (refer Figure 2.1) and to develop objectives and strategies as listed in Table 2.1. TQM is adopted as a key strategic initiative to drive all strategies. This process is reviewed on yearly basis.

Figure 2.1 - SGRP vision

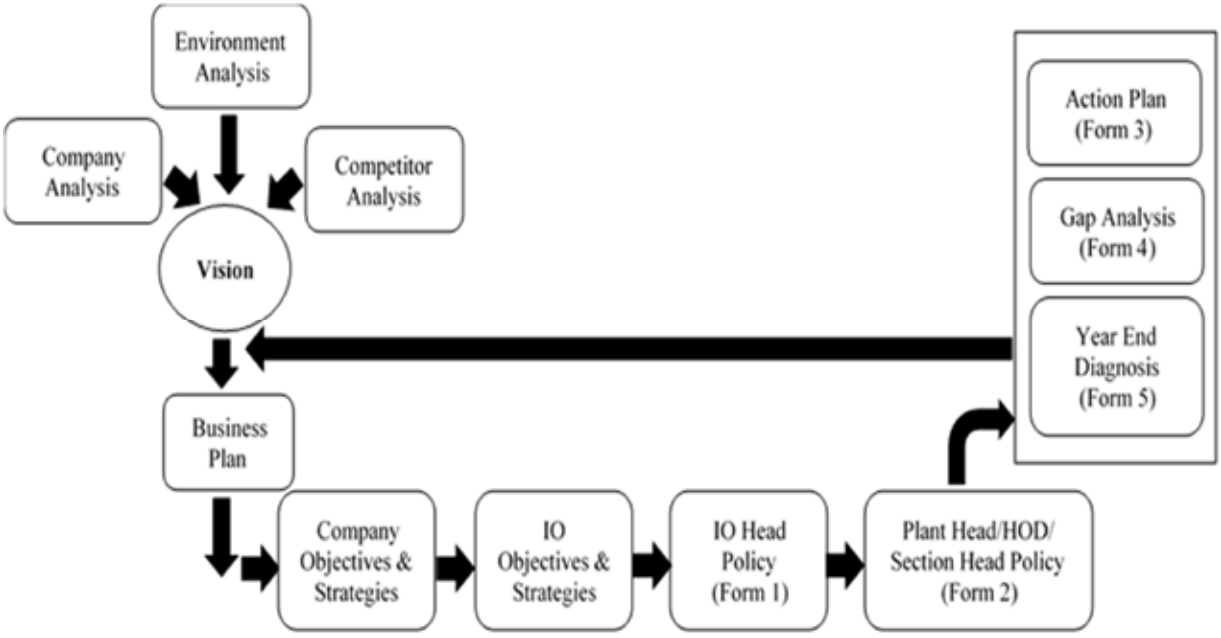


Figure 2.2 – Strategic planning process

Table 2.1 - Strategies and objectives

Vision	Vision Elements	SGRP Objectives	IO Objectives	Strategies		Product Engg.	Process Engg.	Production	Purchase	Quality	HCM
Achieving 4000MW / Year by 2020 through Quality Leadership	Business Competitiveness	Market Leader	Productivity Improvement	Introduce Takt time concept	Policy - I/O Head			●			
				Line Balancing			●	▲			
				Reduce Operation time			●	▲			
			Material Cost Reduction	Localization, Alternate source		▲			●	▲	
				Supplier Capacity buildup					●	▲	
			Inventory Reduction	Kanban implementation				▲	●		
			New Product Introduction	New Product selection		●					
				New Product Manufacturing Process Development (NPMPD)		●	▲	▲		▲	
	Quality Leadership	Profitability	Quality Improvement	Zero Rework				▲		●	
				Improve Process Capability				▲		●	
				Reduce Lot rejection and Line rejection of supply parts					▲	●	
				Field Quality Improvement				▲		●	
			Skill Enhancement	Skill / Competancy Development				▲			●

● - Primary responsibility ▲ - Secondary responsibility

2.2 TQM introduction

SGRP introduced TQM at all manufacturing plants to bring more customer focus, process orientation, total employee involvement and encourage Continuous Improvement culture in every domain of Industrial Operations and it is implemented under the guidance of Japanese Sensei.

2.3 TQM implementation

TQM office with dedicated manpower for TQM implementation at all manufacturing plants is established and executed through the plant specific TQM organization. TQM Organization at SGRP comprises of TQM steering committee, TQM secretariat with champions and department coordinators.

TQM model of SGRP is developed with an integrated approach of leveraging 5 key pillars namely, a) Policy Deployment, b) Daily Routine Management, c) Standard Operating Procedure, d) Continuous Improvements and e) Supplier Support. We build this framework on a strong foundation of employee skills and leadership drive to reach quality excellence, thereby delighting our customers with our world-class products and services. (Ref. Figure 2.3)

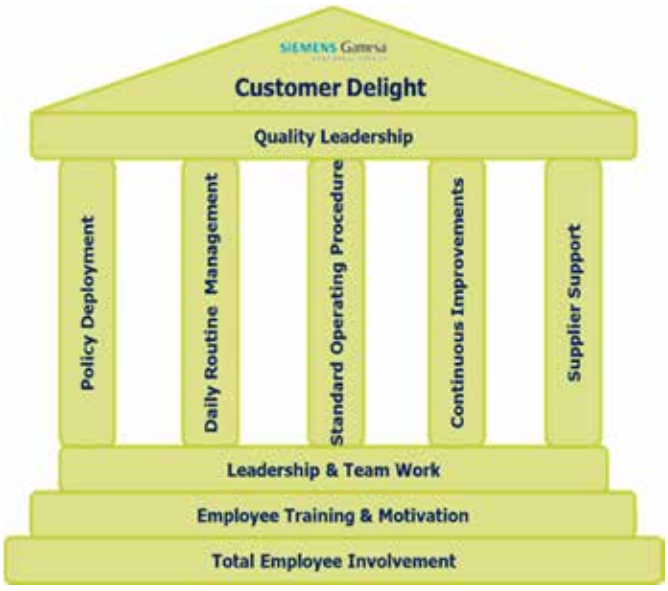


Figure 2.3 - TQM model

The TQM implementation at all manufacturing plants are executed in four phases namely i) Introduction and Promotion phase, ii) Deployment and Consolidation phase, iii) Improvement phase and iv) Sustenance phase. The major activities carried out during different phases are given in the below Table 2.2.

Table 2.2 - TQM implementation phases

TQM implementation			
Introduction and Promotion phase	**Deployment and Consolidation phase**	**Improvement phase**	**Sustenance phase**
2015	**2016**	**2017**	**2018**
Objective	**Objective**	**Objective**	**Objective**
Roll out TQM practices, Track results	Improve the results, Consolidate and hold the gain	Strengthen TQM practices	Sustain TQM practices
TQM Activities	**TQM Activities**	**TQM Activities**	**TQM Activities**
Launch of TQM	Launch of Knowledge Management Portal	Structured Competency Assessment	Relation between Result oriented KPI and Process oriented KPI assessed through Four Student model
Training on basics of TQM	Technician skill development	Process capability improvements	Strengthening of SQC
Development of TQM model	Employee opinion survey	Application of DOE	Upgradation of NPMPD process
Implementation of TEI	Internal customer satisfaction survey	Participating in International QCC conventions	
Introduction of SOP and QCPC	Launch of machine availability improvement	KANBAN Implementation	
Policy Deployment and Daily Routine Management	Measure of Performance (MOP) for critical process	Strengthening of New Product Productionization (NPP) and pFMEA	
Benchmarking visit	TQM seminars / TQM training at JUSE, Japan	Strengthening of Process and Product audit	
Problem Data Bank	Benchmarking visits to Deming awarded companies	DOUJOU centre for technician	
QCC / QIT conventions	Extending TQM to key suppliers	Takt time concept practiced at Blade plants	
Supplier support activities	IT tools and application	DOE projects	
	Productivity and Quality improvements	Competency mapping and development	
Effects	**Effects**	**Effects**	**Effects**
TQM awareness created among all employees	Skill level of technician improved	KANBAN implementation for 100% local supplier parts	Reduction in rework
Total Employee Involvement Projects	Actions to address employees' concerns	8 hours Takt time achieved at Blade Plants with 4 lines operation	Variation in the process is reduced
Teams participating at external competitions on Kaizen, QCC and QIT	Implementation of IT tools	Teams received awards in National and International Conventions on QCC	Increased usage of higher-level statistical tools
DRM practiced at all manufacturing locations.	Productivity improvements	Productivity increased by 1.6 times	
	Quality improvements	Zero rework hours achieved at Shop floor - Nacelle and Hub plants	
	Supplier QIT projects		
	Teams participating in National level conventions on QCC		
Challenge left	**Challenge left**	**Challenge left**	
Increasing employee participation in TEI projects	Improving knowledge on problem solving using high end Statistical tools	Increase number of "JUKURENKOU"	
No structured Daily Management	New Product Productionization	New product launch	
	Competency development of staff	Process capability improvement	

3. Policy deployment and Daily routine management

3.1 Background

Earlier, the management objectives, targets and their achievements of SGRP were set, monitored and tracked through Gamesa Management By Objectives (GMBO) system. Though this system is good to analyse the performances at the end of the year, sometime more focus given to functional objectives rather than management objectives, hence deployment across the organization was not ensured. Policy Deployment (PD) is an important element of overall process of TQM and is one of the management tools. The PD process provides an opportunity to continually improve SGRP's performance by deploying the vision, objectives & strategies and targets from corporate level to lower level and aligning the entire organization for achieving breakthrough improvements.

3.2 Policy deployment process

The system flow chart of PD in Industrial Operations is shown below in Figure 3.1.

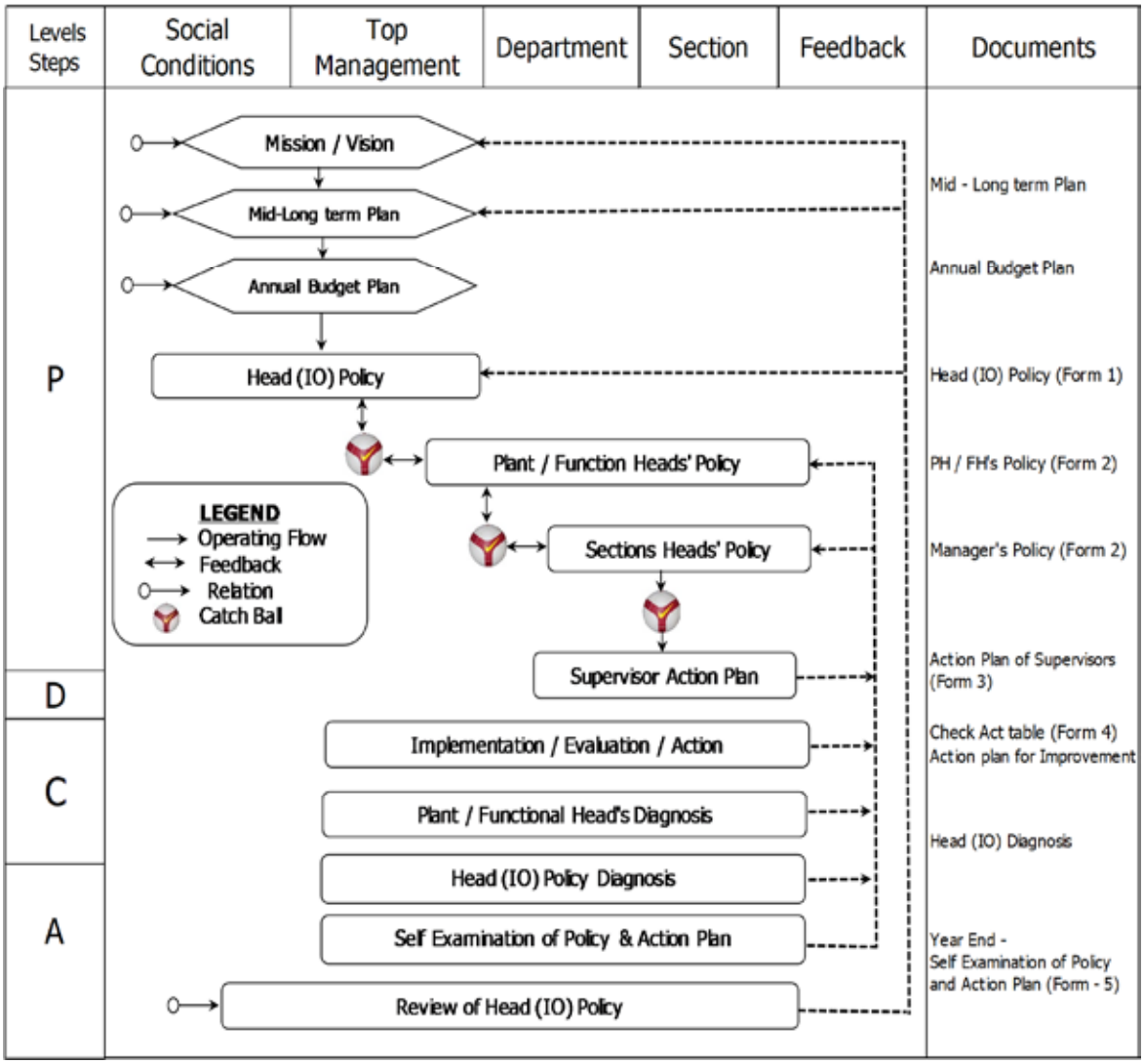


Figure 3.1 - PD process flow

(1) Policy formulation

IO objectives and strategies are developed and aligned to company's business plan. The head – IO (Form 1) annual policy is derived from the corporate annual budget plan through catch balling process. For each key policy item, the head - IO annual policy is set with the target and major measures (means or guidelines) in the format called Form 1.

(2) Policy deployment

Head – IO policies in Form 1 are deployed to all plant / functional heads and plant / functional heads to section heads (managers) using Form 2. The Managing Points (MP) are in the Form 2 are derived from the PD and from the role descriptions. Each MP has targets defined through catch balling process. catch balling process is a key activity that enables

- Communicating targets and measures to all the stake holders
- Securing ownership / commitment to targets
- Reflecting reality of the Gemba and ensures feasibility
- Resource requirement to achieve target

Action plan (Form 3) for each actionable major measure is made for each employee to achieve the MPs. A clear link is established from head – IO policy to the supervisor level.

(3) Check / Action

The achievement of targets for the MPs and implementation of action plans (Form 3) are reviewed by the concerned superior at defined frequency. The gap against the target is recorded in the tracking sheet and for each gap, actions are implemented through PDCA cycle (Form 4). All permanent actions are standardized. Once in a quarter, head - IO reviews all plant / functional heads performance and suggest area for improvements.

(4) Year - end diagnosis

In addition to the periodic reviews, at end of every year, Year–end diagnosis (Form 5) is done by plant / functional heads to capture the 'Things Gone Right' (TGR) and 'Things Gone Wrong' (TGW). Head - IO carries out diagnosis on head - IO's policies, also meets respective plant / functional heads to review their Form 5 and provides inputs / guidance / support as required for achieving the head - IO's policies. The year-end diagnosis outputs are considered in next year Form 1 / Form 2s.

The profound principle of management in Policy deployment is PDCA approach. PDCA cycle leads to the identification of suitable measures in achieving the policies / objectives in long term. PDCA cycle helps us in identifying the key success factors and appropriateness of the objectives and targets. The four-student model (FSM) applies at three layers of PD process at SGRP, 1) EVP policy 2) HOD's managing points and 3) managing points of functional and the quadrants of FSM is declared by alphabets A, B, C and D with percentage of achievement.

Organization capability is built through continuous improvement culture using PDCA approach. SGRP's Industrial Operations processes such as NPMPD, New Component Development, Quality Improvement and the success factors like Skills and Competencies to develop new product with lesser dependency on SGRE are continuously improved through PDCA approach. Also, employee skill and competency are continuously enhanced through training and development. The success of SGRP's capability is defined and measured through sustainable results achieved year-on-year and product-after-product.

3.3 Daily Routine Management (DRM)

The main purpose of DRM is to achieve the managing points (MPs) and checking points (CPs) of each employee, which are derived from PD and role descriptions. After introduction of TQM, the DRM was further strengthened through defining the purpose, role for all employees. DRM is a team work / effort which brings discipline among the team and synergy effect. Strengthened DRM practice brings the habit of gap analysis and gives alert in advance to take course correction in actions to achieve MPs and CPs of an employee.

3.4 Effects

- Implementation of policy management has rendered the system transparent
- Systems, methods and procedures have been aligned plant wide and have enabled successful deployment of business plans
- Empowerment of people through PD and DRM
- Involvement/ownership of policy items across the company

4. New Product Manufacturing Process Development (NPMPD)

4.1 Background

In SGRP, every 2 to 3 years a new product is launched to meet the market growth and customer demand in terms of quality, cost and delivery. In our TQM journey, we had introduced "New Product Manufacturing Process Development" process with stage gate model approach to enhance quality, cost and delivery of the new product.

Based on the design input (Drawings and specifications) from Spain, productionization of the new product is being carried out in India by the cross functional team (CFT) formed with engineering, purchase, production, manufacturing quality, process and quality assurance with well-defined roles and responsibilities. Every product developed is certified for compliance to international and country specific standards' requirements (if any) for quality, safety, performance and serviceability of its design life, which is 20 years.

4.2 Major activities

(1) Introduction of New Product Manufacturing Process Development

Prior to the introduction of TQM, we followed the "New Product Introduction" process as shown in Figure 4.1 for the productionization of new product. During this period, we faced delays in component development and proto production due to no CFT formation, no target settings, no periodical reviews and just sending the drawings given by Spain corporate team to suppliers and manufacturing plants for production without completing the manufacturing feasibility study. Proto to pre-serial to serial production stages are defined based on the number of products manufactured like one number for proto, four numbers for pre-serial and serial production after that.

Figure 4.1 – New product introduction process

To overcome these problems, in 2015, we introduced the "New Product Productionization" (NPP) process with stage gate model approach. Each gate is reviewed by high-level review team to move to the next gate. Associated risks involved in this process are assessed and addressed through PDPC tool.

The CFT is responsible for studying the manufacturing feasibility, interference study in 3D CAD model, development of local suppliers, process FMEA development, SOPs and QCPCs to meet the NPP requirements. This new process was followed for model 3 development in the year 2016.

We changed the name of the process from “New Product Productionization” (NPP) to "New Product Manufacturing Process Development" (NPMPD) to make it more meaningful i.e. development of manufacturing process for new product, so that it suits the actual activities performed during the entire cycle.

① New product request

The marketing team requests for a new product based on the competitor analysis, customer requirements and change of law. SGRP’s leadership team consisting of marketing, wind and site, engineering, IO, project, service, finance, quality and purchase reviews the request and finalizes request based on business plan.

Based on the inputs from the Indian team, the Spain technology team proposes new products for the Indian market. The Indian leadership team reviews these proposed products and chooses one product by considering business requirements. The Spain corporate team develops new products based on India’s input and releases bill of material and drawings.

② Stage - 1: CFT formation, Feasibility study and Set targets

A CFT is formed with engineering, quality, and purchase for feasibility study of drawings with respect to local manufacturability of new components, in-house manufacturability and interference study of new parts. QCD - Quality (re-work manhours), Cost (material cost) and Lead time (time to mass production) targets are being set for the project.

③ Stage - 2: Manufacturing process design and Sourcing of components

a) Manufacturing process design

Operation Description (OD) / Visual Work Instructions (VWI) were provided by the Spain corporate team which describes the assembly / manufacturing sequences for each station. ODs / VWIs for all stations are studied by the process team to prepare the process FMEA for identified critical operations and evaluate the potential failure of the process and its effects. Manufacturing process is being finalized by developing SOPs and QCPC based on process FMEA.

b) Sourcing of components

The purchase team identifies the regional suppliers and the engineering team assesses the technical capability of the suppliers. The quality assurance team ensures the quality management system, productionization and quality of the components at the supplier place as per the drawings and specifications.

④ Stage - 3: Proto make

A proto is built based on SOPs / QCPC and the progress of the proto is tracked during daily meetings with all stakeholders. Incidences are studied by the cross functional team to identify the root cause of the problems. Containment solutions are being implemented and the effectiveness of the solution is verified. All proto incidences are studied, recorded and if needed, corrective actions are implemented and standardized.

⑤ Stage - 4: Initial production

The effectiveness of the corrective actions for proto incidences are verified during the initial production. Incidences, if any, during the initial production are studied by the CFT to identify the root cause of the problems. Identified corrective actions are implemented and the effectiveness of the solution is verified and standardized.

⑥ Stage - 5: Mass production

After all the feedback pertaining to the design changes received during the proto assembly / manufacturing are addressed, QCD targets are met, then the new product is initiated for mass production.

(2) Productionization Reviews (PRs)

Productionization review is a structured way of reviewing the different stages of NPMPD which helps in identifying the hindering factors pro-actively for timely completion of the new product. The separate high-level review team, formed from engineering, quality, purchase and production team reviews the results presented by CFT during productionization reviews to take appropriate decisions to move on further. Effective utilization of PRs through CFT approach has helped in early detection of flaws / gaps in manufacturability and processes which saves the development cost, time and delivery of end product.

① **Productionization Review - 1 (PR - 1):** To review the feasibility of the new product components with respect to local manufacturability, in-house manufacturing, study of interference and targets.

② **Productionization Review - 2 (PR - 2):** To review the process FMEA and sourcing of components.

③ **Productionization Review - 3 (PR - 3):** To review the deviations during proto assembly/ manufacturing and identify necessary corrective actions.

④ **Productionization Review - 4 (PR - 4):** To review the deviations during initial production and the effectiveness of corrective actions identified in PR - 3.

(3) Application and lessons learned

The application of NPMPD process to the new products has greatly contributed to achieve QCD targets. Lessons learned from each new product are analysed by CFT in terms of TGR and TGW to identify and implement the process and product improvement actions and to use in the subsequent new products.

(4) Effects

① Tangible

Development and Implementation of NPMPD system in new products realises the results in terms of mass production lead time reduction about 30% and the rework manhours has been reduced by about 60% compare to before the introduction of TQM.

② Intangible

- This process helps us to smooth and fast ramp-up production
- Customer (External & Internal) focus increased in all processes
- Thinking became data based and problem solving became structured
- Continuous improvement culture with cross functional team approach

5. Manufacturing management

5.1 Background

Prior to TQM practices all the four plants are certified for Integrated Management Systems (ISO9001, ISO14001 and OHSAS18001) to ensure Quality standards in manufacturing processes. The major processes in blade manufacturing are Prefabrication, Shell moulding, Finishing and Painting whereas Nacelle and Hub plants have assembly and testing processes.

5.2 Major activities

(1) Quality improvements

① Institutionalization of SGRP's manufacturing systems

Earlier, Operational Descriptions (OD), Visual Work Instructions (VWI), Work Instructions (WI) and control plans are used to produce products in our manufacturing plants, which explains only "what to do" aspects to the technician. In our TQM journey we understand the importance and criticality of SOP and QCPC to produce quality products. SOP covers "how to do" and "who to do" aspects also to the technician. While TQM implementation, "Product Quality is built-in through Standard Operating Procedure (SOP) and Quality Control Process Chart (QCPC)" is the basis on which our manufacturing system has been developed. SOPs are prepared by Process engineer along with technicians taking inputs from ODs, VWIs and WIs. Technicians are educated in the use of SOPs to ensure a standardized way of doing the activities, thus avoiding variations in the product quality. QCPC is to check process and product parameters during entire manufacturing processes as well as in the final product. QCPC specifies the control items of the process and product along with method of control, control specifications, tool of control, sampling methods and responsibility. SOP specifies technicians' activities and QCPC specifies supervisors and quality inspectors' activities. SGRP considers SOPs and QCPCs are important assets of the company.

Further, manufacturing quality at every manufacturing process stage is also ensured through reviews by different levels in DRM. Manufacturing quality is continually improved through actions derived from problem solving methodologies such as QC story and DOE application.

② Utilization of problem-solving methodology

Earlier, problems were solved by the technicians and supervisors based on their knowledge and experience, in which the real root cause may not be identified. As part of TQM implementation, the problems are resolved by the technician team (QC Circles) and cross functional team (QITs) with Gemba data analysis through QC story methodology and using higher level tool DOE, wherever applicable. All our technicians are trained on 7 QC tools and extensively use them for collection and analysis of the data before arriving the root causes and countermeasures. For process optimizations and breakthrough improvements in process & product, DOE is applied with appropriate factors and levels.

(2) Breakthrough improvement activities

① Manufacturing Technology upgradation

Technology upgradation in manufacturing plants plays an important role in improving product quality, productivity and manufacturing processes. To improve our product quality and production capacity, we identified and implemented technology upgradation projects, such as automated conveyor system in Nacelle plant and infusion technology, Laser measurement system and multiple layer cutting system in Blade plants.

② Low-cost automation

Introduction of low-cost automation projects is another improvement measure taken to improve quality and to minimize rework. The low-cost automation has given breakthrough improvements in quality by reducing technician dependency for manufacturing components.

③ DOE application

As part of our TQM initiatives, DOE is used in Blade plants to eliminate rework and to optimize the process parameters. Extensive training on DOE is imparted to all key stakeholders in the organization by our Japanese Sensei.

④ Process capability improvement

Zero defect in the final stage of manufacturing process was achieved by addressing each failure mode through revising the SOPs and QCPC. Further to improve the manufacturing process, emphasis given to improve the capability of the process.

In year 2018, SGRP enhanced the statistical application in daily work by introducing control charts for identified CTQs, tracking Cpk for CTQs, DOE to eliminate chronic problems, N7 tools to analyse verbal data to facilitate fact-based decisions to improve manufacturing processes.

(3) Production capacity enhancement

Earlier in all our manufacturing plants, production was measured by numbers at all stages and stations. Number of parts and sub assembly produced at each line and stations were measured. After TQM implementation, productivity improvement became major MOP of all the plants. Line balancing and takt time production concepts were introduced to measure and improve the production capacity of the plant. Also, operation time reduction projects including MUDA elimination were implemented through ECRS (Eliminate, Combine, Re-arrange and Simplify) concept and QC story approach. Introduction of line balancing and takt time production at SGRP blade plants are the first of its kind concept in blade manufacturing industry across the world, resulted in breakthrough improvements in blade productivity and thus production capacity enhancement.

① Line balancing

a) Blade plant 1

After TQM introduction, the entire blade production sequence was studied for splitting into sub-processes so that the outputs could be tracked at the end of each sub-processes. The working hours of each sub process varies from 24 hours to 88 hours. This bad line balancing affects the blade production, also due to this long working hours, the technicians are bound to make mistakes. To overcome this, the complete production line was balanced by adding or reducing the number of work stations / mould to improve operation time per blade of each processes. The operation time per blade of all sub-processes was further reduced by MUDA elimination and process improvements.

b) Nacelle and Hub plants

Difference in operation time between stations was significantly high which caused bottlenecks and affects smooth flow of assembly. Hence line balancing acitivities such as work study and time & motion study are inititated to improve the assembly flow.

Work study was conducted in all stations to map Value Added (VA), Non - Value Added (NVA) activities and Kaizens done to eliminate the MUDA. Detailed time study was done for individual assembly stations to explore the possibilities of reducing operation time and shifting / sharing work between assembly stations. Variations in work content between technicians of the same assembly station were significantly high and hence load leveling activities were carried out to even out the work load of technicians. Time and motion study was carried out based on observations from the study and maintain equal work load between the individual technicians of an assembly. Sharing of work between technicians was given emphasis to arrive at standardized work.

② Establishment of 8 hours takt time production system

a) Blade plants

Takt time production concept was introduced in both blade plants to improve the production capacity further. Each manufacturing process working hour is divided into 8 hours job territory, hence the technicians became specialist (JUKURENKOU) by repeatedly doing this 8-hour job. These job experts are performing the operations consistently

to make good quality of the product at all stages. Improvement projects were implemented at each sub-process using QC story approach to eliminate MUDA, also to achieve uniform operation time per blade for each process. This uniform operation time per blade in each process fetched standard output rate for each production lines, so that the takt time production is achieved. To meet the market demand, Blade plant 1 is established with 8 hours takt time production and Blade plant 2 with 16 hours takt time production.

(4) Manufacturing cost reduction

Manufacturing cost is the cost of converting raw material into saleable product. It includes all cost except the raw material and component cost, overheads and other fixed expenses. Manufacturing cost can be broadly grouped under (1) Energy cost, (2) Consumable cost and (3) Direct and Indirect labor cost. To operate the plant at an optimum level various manufacturing cost reduction projects such as installation of solar panels, variable frequency drive, cooling tower efficiency and blade cooling system etc., are implemented on continuous basis.

(5) Enhancement of DRM

DRM system is strengthened in all our manufacturing plants by having cell DRMs (Technicians) in the shifts and plant DRM (Executives) in the morning to set, share and improve information on productivity, quality, cost, delivery, safety and morale in the plant. Effective practice of DRM has improved the alignment and direction to the team and manufacturing process efficiency.

6. Human Capital Management (HCM)

6.1. Background

SGRP is a manufacturing company and HCM is a very important function. HCM is responsible for manpower planning & budgeting, recruitment, employee retention, employee welfare, Total Employee Involvement (TEI), Skill and Competency development across Industrial Operations (IO).

Skill sets required for wind industry is unique and is different from other industries. The major challenge is the availability of skilled manpower from the market. There are no specific academic courses available for technicians (Operators) to work in blade manufacturing and nacelle assembly. Hence, HCM function strategized and created a skill development model to train fresh ITI people of different trades through the in-house Skill Development Centre by training them in Blade manufacturing and Nacelle assembly.

6.2 Major activities

SGRP strongly trusts “Employee Performance” is not alone depending upon skill / competency but also depending upon his/her “willingness” (WILL).

HCM is responsible for employee skill and competency development and “will” enhancement.

Performance of an employee = (Skill or Competencies) x (WILL)

The following activities undertaken to improve the skills.

(1) Potential skill development for technician

SGRP decided to focus on overall skill development as a thanks-giving to technicians’ commitment, instead of providing training for performing task. We are happy that this activity creates skill expertise in the Indian society. Keeping this as an aim, SGRP implemented potential skill development process which includes both generic and technical skill.

Policy

Make all the technicians “Expert (JUKURENKOU)” in their respective field / area

Under this policy, systematic Education and Training is provided to our technicians.

① Skill assessment

a) Generic skills are categorized as Safety awareness, Suggestions, 5S, QC story, Team work and Self-discipline. Technicians are assessed by supervisor with four scale rating. Based on the assessment the levels are updated in the technician’s skill card.

b) Technical skills vary from plant to plant and process to process. Supervisor assesses the technicians with four scale rating. Based on the assessment the levels are updated in the technician’s skill card.

Technicians are assessed on a scale of L1 to L4 (Level 1 – can work but need help, Level 2 – can work but need help sometimes, Level 3 – can work independently, Level 4 – can work and train others). Supervisor assesses the existing skill levels based on one-to-one discussion with the technician and set yearly target. The final target is to make all the technicians as “Expert - L4” (JUKURENKOU). The progress towards the target is recorded in the ‘Technician skill card’.

② Skill development

a) Off the job training - Off-JT (Classroom training)
After skill assessment, Training and Development section of HCM discusses with respective supervisors to prioritize the classroom training requirements and design the training modules. Based on the inputs, Education and Training plan (E&T) is prepared to provide classroom training.

Training and Development section head is responsible for executing classroom training. Immediate feedback about training is taken from the trainees and the result is reflected in the next course. Effectiveness of classroom training is evaluated upon completion of six months and plan for retraining, if required.

b) On the job training (OJT)
Supervisor prepares training requirements based on the skill assessment and executes the same in shop floor through OJT for technicians. OJT is provided in shop floor and some of the training is provided in DOUJOU as well. The technicians are trained extensively in DOUJOU to become JUKURENKOU. For example, "To eliminate the product defects in the painting area", Training and Development section created a painting DOUJOU to provide on-the-job training for trainees/technicians by the supervisors. Variation of skill levels within / across the department are statistically analysed to initiate actions, if required.

(2) Potential competency development for executives

① Competency assessment

Competencies are categorized into behavioural and functional competencies.

a) Behavioural competencies: SGRP has eight behavioural competencies which are common for all executives. For example, Team work and collaboration, Interpersonal relations and Communication.

b) Functional competencies: Functional competencies varies from function to function which are required for an executive to do the job effectively. For example, "Product knowledge and Process knowledge" are some of the competencies identified for Blade production.

Executives are assessed with four scale rating. Manager assesses the existing competency levels based on one-to-one discussion with executives and set yearly target. For behavioural competencies, Training and Development section provides evaluation criteria to the manager for assessing the executives. Based on the assessment, the levels are updated in the executive competency card and evaluated every year.

② Competency development

a) Classroom training
After competency assessment, Training and Development section head discusses with the respective managers to prioritize the classroom training requirements and training modules are prepared in consultation with the expert faculty (Internal and External). Immediate feedback about training is taken from the trainees and the result is reflected in the next course. Effectiveness of classroom training is evaluated upon completion of six months and plan for retraining, if required. The PDCA for classroom E&T is followed similar to skill development.

b) On the job training
Manager prepares the training requirements based on the competency assessment and executes the same in the department through OJT (Assignments, coaching, etc.,).

(3) "Will" enhancement
The following motivational initiatives undertaken to improve employee willingness:

①Communication

a) Town hall meeting
Town hall meeting is conducted every month as a part of TQM initiative. Plant achievements, challenges faced by the industry and our company, major customer issues, if any, employee participation and contribution towards TQM initiatives are communicated to employees by the respective Plant head / Head - IO. Similarly, CMD communicates organization level achievements and challenges from time-to-time.

A quarterly town hall meeting (webcast) is conducted by global CEO on business results, performance and future plan. In all these meetings, employees have opportunity to ask questions / queries to the management.

b) HCM communication with technicians
HCM representative communicates whenever there is a new or change in the HCM policies through an open meeting at shop floor to all technicians at all plants.

②Employee welfare

a) Employee welfare committee

Organization is committed to employee welfare. Welfare committee consists of technicians and executives meets every month to listen employees' issues, employee opinion survey feedback etc. and address them suitably. Based on the inputs received in the welfare committee the actions are initiated by HCM with other support functions. For example, policies such as long service award, employee girl child education support, scholarship to employee children were introduced.

b) Long service award

To recognize and appreciate the long-term commitment, dedication and loyalty of the employees who have achieved significant milestone years of service in the organization (5 years / 10 years / 15 years / 20 years and 25 years). The eligible employees are recognized in an organized function with an appreciation certificate and award by head of the department, quarterly. So far 573 employees were recognized.

c) Employee girl child education support

To promote and encourage education of girl children, financial assistance is extended to employee's children (technician to senior engineer levels) through this policy. Girl children studying from kindergarten to post graduation are supported towards the payment of school fees. 232 employees' girl children are benefited so far.

d) Scholarship to employee children

To recognize the meritorious academic performance of employee's children studying in schools, scholarship is provided.

e) Employee annual medical checkup

Every year, to upkeep the employees' health, a free employee annual medical checkup camp is organized at all plants for regular / contract employees and trainees. Based on the report, employees are advised for further medical treatment, if required.

f) Group Mediclaim insurance

Employees are covered under group Mediclaim policy for in-patient medical treatment. This scheme provides medical benefits to employee, his / her spouse and two children. Employees also have the option to include their parents and in-laws.

g) Group personal accident insurance and Group life insurance

Personal accident insurance benefit the employees in the event of partial / permanent disablement. Group life insurance benefits to employee's family in the event of loss of life of employee which is unique among the industries in India.

(4) Events and Celebrations

During the family day celebration employees and their families join the event and children showcase their extracurricular activities. The family day is creating bonding with the organization. During the day employee family visit the factory and feel proud of their family member contribution to SGRP.

Some of the employee engagement activities such as festival celebration, women's day and drawing competition for employees' children is conducted, which is reflecting our culture and creating bonding with the employees and families.

Every year voluntary blood donation camp is organized in all plants towards the noble cause of donating blood to the hospitals through NGO.

(5) Employee recognition

Employees are appreciated and motivated, to continue their good performance through monthly Reward and Recognition (R&R) program. Technicians also get opportunities to present their projects at National and International level competitions which increases their morale.

Technicians are provided with an opportunity to execute new projects, globally. Considering the skill level of the technicians, global team has assigned the responsibility of executing new proto type rotor blades in India, for global market. Executives are identified and sponsored for acquiring higher education, also nominated to participate in global leadership program.

(6) Enhancement of Total Employee Involvement (TEI)

A focused approach towards 'Total Employee Involvement' initiatives are initiated in all plants such as:

① **Suggestion Scheme – Technician:** All technicians / trainees working in the plants are participating in suggestion scheme. Participation Target: 6 Suggestions / technician / year.

② **Suggestion Scheme – Executives (Kaizen):** All engineers and managers are encouraged to participate in workplace improvements.

③ **Quality Control Circle (QCC) -** All technicians / trainees working in the plants are participating in QCC, technicians are motivated to participate at the internal convention, State level, National and International competitions.

QCC steering committee is formed to act as a secretariat at IO level and plant level to strengthen and enhance the practice of QCC. The major activities of the committee are to prepare the annual QCC schedule, preparing promotional activities, training plan and ensuring training to the supporters and promoters.

④ **Quality Improvement Team (QIT) -** Executives are encouraged to form teams for handling projects towards specific issues faced by plant or opportunity for improvement or addressing customer complaints. Executives are motivated to participate at the internal convention, State level and National level competitions.

⑤ **Participation in National / International Conventions -** So far, 22 QCC/QIT teams have participated in State level competitions, 15 teams in National level competitions and 6 teams in International Conventions in Manila and Tokyo, all won many awards. Similarly, 29 teams / individuals have participated in Kaizen / Poka-yoke competitions in India.

(7) Employee morale

① Employee retention and career development

a) Trainee / Technician career development

Based on the skill and performance of the trainees (fresh ITIs) / technicians are progressed to senior technician and thereafter to zone leader / supervisor.

b) Executives career development

Career progression model has been implemented for progressing Junior engineers / GETs / MTs / engineers / executives to move to next levels based on the skill and performance. Executives are identified and sponsored for acquiring higher education and they are encouraged to participate in global leadership program.

② Employee Opinion Survey (EOS)

The purpose of EOS is for enhancing the "will" (morale up) of the employees. With this aim, EOS is conducted among the technicians and executives once in a year in all the plants. Based on the results action plan is prepared to address the low score questions. An action plan is prepared in discussion with focused group consisting of management and employees to take countermeasures for enhancing employees Will and Morale.

6.3 Effects

- Overall potential skill level (L4) improved from 31% to 54%
- QCC participation improved from 72% to 100%

7. Quality Assurance

7.1 Background

SGRP's Integrated Management System aims to achieve an organization that ensures the occupational health and safety of their employees and the protection of the environment, while increasing productivity and quality of its operations. All the manufacturing plants are certified for ISO 9001: 2015 to ensure that the customer expectations are met with the quality management system. Apart from the integrated management system practiced, SGRP has chosen the TQM in year 2015 to excel quality culture in the IO. This is targeted to continually improve the quality of all processes and products through TEI. This results in increased customer satisfaction hence improved business results.

7.2 Major activities

(1) QA in manufacturing

Quality in manufacturing is assured through Process and Product audits.

① Process audit

Till year 2016, in all manufacturing plants, audit was carried out once in a year as a comprehensive audit covering both process and product parameters by Spain auditor using the "Quality capacity assessment" checklist. This checklist covers the activities of incoming inspection of supplier parts, production documentation, process adherence, and handling of failure analysis. The audit result is declared as percentage of maximum possible score.
The above audit did not cover all process steps, key elements and carried out once in a year, hence the focus was diluted. To overcome these gaps and increase in customer expectations in quality, exclusive audit of all manufacturing processes made for Nacelle, Hub and Blade plants by in-house auditors with the periodicity of twice a year against specific checklists.

Auditors verifies the adherence of SOPs, QCPC, document revisions, closure of previous audit gaps, operator's skill level, calibration of instruments, 5S, DRM boards. While audit, homework points given based on the observation and shared to plant team to take actions and close the gaps effectively. Process audit also provides inputs for improving the SOPs and QCPC. The selection of line for process audit is prioritized based on new product, new production line and line in which field complaints originated.

② Product audit

Till year 2016, there was no separate product audit and few product parameters are covered in process audit itself. From 2017, to make the product audit more effective, it was upgraded by the introduction of exclusive and elaborate product audit process to strengthen and improve the product quality.

Product audit is carried out on Nacelle, Hub and Blade, with the periodicity of once in six months. Through this, product parameters are verified as per specified checklist, observations and homework points are shared to plant stakeholders for further actions, if required. The product audit for the performance parameters score are declared as maximum possible score of 4. For attribute parameter, the score is 1 for OK and 0 for Not OK situations. For variable parameters, scoring is done based on whether the actual reading falls under which band of tolerance.

(2) QA in NPMPD

After introduction of TQM, QA is taking part in new product manufacturing development process in the following manner.

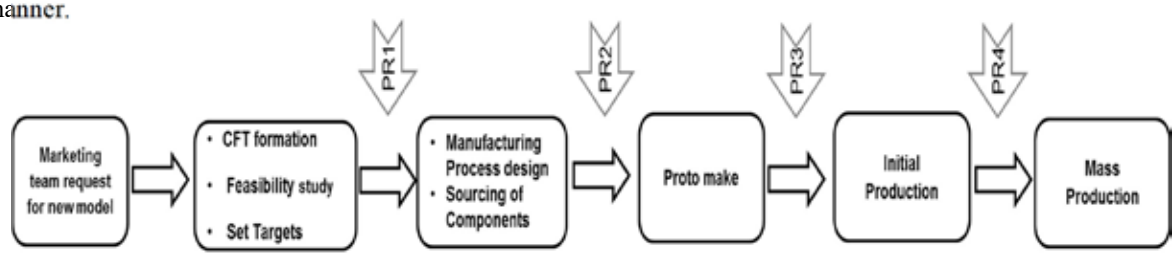


Figure 7.1 - NPMPD process

① **Participation in Feasibility study -** Joint review of drawings for local manufacturability and in-house manufacturing and provide past quality data for target setting.

② **Participation in productionization review -** The review and approval of QCD targets takes place in PR - 1.

In PR - 2, the manufacturing process design outputs such as SOPs, QCPCs, process FMEA and the component sourcing process is reviewed to ensure that the process has capacity and capability to achieve QCD targets. The Incidents during proto and initial production are reviewed and feedback on actions are provided in PR - 3 and PR - 4 respectively. The effectiveness of corrective actions is reviewed and approved for mass production.

(3) Field Quality improvements - Warranty within 3 months

In SGRP, warranty period is 2 years for wind turbines. For QA, one of the responsibilities is to reduce the warranty claims and actions are regularly reviewed and monitored. The failures occurring within 3 months are considered as a manufacturing issue and same is monitored to initiate corrective action at manufacturing plants. The CFT consists of quality, manufacturing plant, wind farm operations and engineering are involving for problem solving. Team analyses details for root cause identification, finalization of immediate and corrective actions.

(4) Supplier quality improvement

Supplier quality function is involved in support and development of new suppliers and new components through Production Part Approval Process (PPAP) approach and this activity done with support of engineering and purchase function.

① Part quality improvement

a) Incoming quality - Parts are inspected at incoming stage and monitored on daily basis. In case of any rejection and rework, appropriate immediate action, root cause analysis and corrective action are initiated at supplier premises. Effectiveness of corrective action is monitored in further supplies.

② Supplier support activities

Ensuring supplier quality is a key part of our TQM strategy. We have a dedicated pillar in our TQM model for supplier support activities. These activities are enlarged to change the approach from audit oriented to supplier support oriented and this is demonstrated by the introducing preparatory activities for supplier audit, verification of 5S, TEI and employee morale at supplier end.

a) Support to supplier part development - This activity involves part qualification by key phases like feasibility study, proto and pre-serial component development and Part Submission Warrant Approval (PSWA) with support of engineering, purchase, production and plant quality functions.

b) Supplier process audit and Supplier grading - Process audit is carried out on suppliers who supplies critical parts. Audit is carried out to verify the adherence of QCPC, SOPs, previous audit gaps and effective implementation of corrective actions. Supplier provides action plan to close the identified homework points and verification of those actions done to complete the audit. The audit outcome provides inputs for improving their QCPC, SOPs and supplier grading score.

Suppliers are evaluated for their performance by grading, namely A, B and C and it is based on their 1) systematic approach towards problem resolution, 2) number of rejections and 3) health, safety and environmental friendliness. Supplier grading is the average score of 100 points, over the last four quarters resulting as A (90-100 points) excellent, B (65-89) good and C (0-64) improvement required supplier. These grading is communicated to suppliers to understand the gaps and take appropriate actions.

Supplier quality team is responsible for upgrading the supplier from lower grade to upper grade by 1) visiting supplier place to audit their process to identify the gaps. 2) handhold and train them on QC story methodology to identify the root cause, initiating corrective action to ensure the defect is not recurring and 3) homework points raised during supplier visits are periodically reviewed and required support is provided.

c) Supplier training - Suppliers are invited for supplier meet and TQM summit organized by SGRP to disseminate the changes in requirements on the quality, delivery level from suppliers. Suppliers visited SGRP's manufacturing facilities to witness the best practices and suitable trainings organized for selective suppliers in topics such as QCPC, SOP, Kaizen, 7QC tools, QC story methodology to improve the quality performance and training on Kanban to improve on time delivery.

Class room practice given by the supplier quality team from global and regional QA members on new component development and to improvise HSE requirements. Also, to emphasis the need of Early Supplier Involvement (ESI) from concept stage to part development. TQM implementation at key critical suppliers done as two phases, during 2016 – 2019 and the syllabus for the same is made available.

7.3 Effects

- Incoming lot rejection reduced from 5.5% to 0.27%
- Line rejection reduced from 0.38% to 0.004%
- Warranty within three months become zero for Nacelle, Hub and Blade

8. Purchase

8.1 Supplier development

(1) Background

Purchase function is responsible for procuring the raw materials for nacelle, hub and blade. The products of wind turbine require many strategic items which are characterized by high value and high criticality. These items are not easily available in the market. To counterbalance the supply risk, we build partnership with suppliers by reserving a portion of the suppliers' capacity and to schedule the order quantities as and when required to meet the business demand. Identification of potential suppliers and development of new components are carried out as per Components Supply Management (CSM) procedure which is led by purchase with the support from QA and engineering. We maintain a supplier base for raw material supplies and services from various geographic locations supplying commodities such as castings, electrical, hydraulics, fabrications and composites for producing wind turbine generators.

8.2 SGRP Supplier development policy

Purchase is committed in setting up efficient, effective, economical and sustainable supplier base. We treat all our suppliers as supply partners with focused long-term business relationship for the mutual benefit.

8.3 Major activities

(1) Schedule adherence activities

① Introduction of Kanban for domestic raw materials

Kanban system has been implemented to all domestic suppliers to sustain 100% schedule adherence and to avoid material shortages. The size of Kanban is determined by daily demand and the size of the container. The number of Kanban is determined by the transit lead time. With Kanban Implementation, raw material inventory reduced to two days, in addition to eliminating material shortages

② Improved raw material ordering system for imported raw materials

SGRP imports materials from global suppliers for nacelle, hub and blade. The weekly delivery schedule and monthly forecast are shared to all import sources to block their capacity and organize their in-house resources (materials & manpower) in time. Material deliveries are reviewed once in every three months to improve the transit lead-time, safety stock and packing size to ensure that the raw materials are received as per the delivery schedule. Purchase department conducts review with logistics team to track the shipment arrival dates and take next course

of action in advance if any delays. To control inventory, stock levels at various stages (under customs clearance, in-transit and ready for dispatch at supplier end) are monitored daily. Both immediate and long-term actions are identified to control inventory.

(2) New component development

Spain corporate team releases the Bill of Materials (BoM) through local engineering department. Developments of new components are carried out as per CSM procedure which is led by purchase along with engineering and QA. Detailed BoM analysis done to decide the sourcing strategy. Based on the feasibility study, purchase decides to prioritize the development activity and launch CSM projects. Engineering team assess the technical capabilities of selected suppliers and QA access the quality of system as well product at supplier end to meet the specification and drawing. Purchase identifies the supplier for all the parts which is required for development and RFQ is shared and request suppliers to submit commercial offer. Contract is released for the finalized suppliers for proto, initial production and mass production.

After TQM introduction, we applied this system to new model 4. The results of QCD are, cost target 100% achieved and schedule adherence 94% (earlier model 87%). To acquire required quality level at early stages, we upgraded the new component development process by introducing,

- Design / process approval
- Proto sample approval
- Initial sample approval
- Mass production approval

(3) Localization

Localization is the process of adapting the product or content to a specific location or market. Local suppliers are identified and developed for nacelle, hub and blade parts through CSM projects to achieve the cost, lead time and inventory reduction compared to import materials. All CSM projects are led by purchase, require mandatory participation of supplier quality and engineering team. Localization is mainly for material cost reduction, schedule adherence and better communications between SGRP and suppliers.

Import contents were high around 94% in 2015. To reduce the import parts, localization process initiated as a strategic activity which resulted in reduction of imports from 94% to 1% in three years.

(4) Supplier capacity enhancement

Sourcing is the process of getting the goods and / or services as per SGRP needs to fulfill the business model. SGRP need additional suppliers to drive a competition, increase the capacity, or to meet the business objectives. It requires significant work in management which includes several steps such as creating the initial list of potential suppliers, evaluating the suitability to the SGRP's goals and objectives, supplier pre-selection, commercial discussion and finalization, final supplier selection and as final step, the reviewing and approval.

To meet the company vision, the robust supplier base needs to be established to support the business plan. Supplier capacity enhancement is executed through additional supplier development or improving the existing supplier capacity by CAPEX Investment. Additional supplier developed through CSM procedure, led by purchase.

8.4 Effects

- Supplier schedule adherence from 93% to 100% for both domestic and imports
- Raw material inventory reduced by about 45% for imports
- Supplier capacity enhanced by 2.5 times for blade and 2 times for nacelle and hub.

9. Corporate Social Responsibility (CSR)

9.1 Background

SGRP is committed to ensure that CSR activities are carried out in accordance with a set of values, principles, criteria and attitudes aimed at achieving the sustained creation of values for the shareholders, employees, clients and for the entire company. SGRP engages a dedicated team focusing only on corporate social activities. The team conducts various programs focusing on Education, Health, Livelihood and Sport around our corporate office, manufacturing facilities and wind farms. SGRP conducts some of the CSR activities partnering with our key customers. Many programs are continuous ones conducted in regular intervals contributing to the society sustainably.
Now, before initiation of any CSR program the Participatory Rural Appraisal (PRA) is conducted to understand and analyze the need of the society. The inputs gathered in the PRA are used to plan the CSR activities.

9.2 Major activities

Industrial Operations work together with corporate CSR team in providing support to the society on health care, education and livelihood around the manufacturing plants. Employees from plants also participate in other CSR programs organized by the corporate team.

(1) Support on health care

SGRP conducts health camps for the rural people living in remote village who do not have easy access to hospitals.

The objective of health camp includes

- General medical checkup – Height and weight balance, blood test, general diagnosis and issuance of basic medicines.
- Medical assistance to ensure proper anti natal care – Payment for first trimester scan, anomaly scan, blood test and supplement medicine
- Education on seasonal diseases and precautions to avoid it

Other health care support includes mobile health care to rural villages, veterinary health camps nearer to the wind farms and blood donation camps organized at the plants and corporate office where in employees voluntarily donate blood.

(2) Support on education

SGRP initiated academic excellence program to support and encourage outstanding students from government schools and the selection is based on criteria such as single / no parents or students with poor background or through written examination.

- Scholarships to school children - Students were given INR15,000 to pay for their school fees
- Donation of school bags and notebooks
- Career guidance – external consultant provides exposure on different courses and job opportunities available in the market to choose better career path
- Training on effective communication - external trainer educates students on written and oral communication on English language

Other education support includes providing sanitation and infrastructure facilities to schools.

① Blade plant 1

Blade plant 1 contributes to many CSR activities such as academic excellence programs and health camps. 115 students were benefited through academic excellence programs and 239 people benefited through health camps.

② Blade plant 2

Blade plant 2 organizing and participating in many CSR programs such as scholarship, career guidance and effective communication. 250 benches were donated to nine schools, 20 students were benefitted out of scholarship programs and career guidance given to 525 students living around Nellore where the Blade plant 2 is located.

(3) Support on livelihood

Livelihood projects supports on the basic lifestyle improvement in the society and build skills through vocational training.

① Nacelle and Hub plant

A permanent carpentry unit was established inside the nacelle plant to recycle the packing wood in to school furniture and the same is supplied to government schools in and around our plants and wind farms (Ref. Figure 9.1). From the date of commencement 2.36 million kilograms of scrap wood has been recycled and made around 11,800 desks and benches, benefiting around 35,000 students. During the years, more than 130 unemployed youth were trained / employed in turning scrap woods to school benches and chairs. Nacelle plant also involved in converting the waste tarpaulins to rain coats and distributed to school students.

Figure 9.1 – CSR activities

The CSR benefits overview is given in Table 9.1.

Table 9.1 - CSR benefits

CSR benefits					
	Year	**2015**	**2016**	**2017**	**2018**
Education	Number of schools	43	55	6	10
	Beneficiaries	606	950	20	110
Health	Number of villages	36	46	37	37
	Beneficiaries	8059	31889	28419	26692
Livelihood – Women empowerment	Number of villages	-	5	27	27
	Beneficiaries	-	300	1620	1800
Livelihood – Vocational training	Number of schools	60	80	120	60
	Students benefited	3812	6762	8125	3450
Sports	Centers	9	11	12	12
	Beneficiaries	370	1570	1800	1800
	Total beneficiaries	**12847**	**41471**	**39984**	**33852**

10. Information Technology

10.1 Background

SGRE as a global company moving towards end to end digitalization and IT transformation to become a complete digital company which includes the latest technology such as cloud computing and IoT. Information Technology made use at SGRP manufacturing plants in the process of collecting data from different sources, consolidation of data, analysis of data and retrieval of data from ERP and other applications. The company is integrated with SAP modules from corporate, but still the SAP system is customized to the legal and the tax requirement of SGRP. Many IT projects are executed in line with the business requirement.

IT Focus on

- Establishing common system and standards in all the plants
- Implementing standardized and process-based solutions
- Proactively use IT for data collection, analysis, decision making and knowledge sharing
- Developing customized solutions specific to our requirement
- Systematic upgradation and improvement of IT infrastructure
- Maintenance and support to IT applications
- Technology upgradation (Infrastructure and applications)

10.2 Major activities

IT utilization activities are categorized into support to daily activities, support to enhancement and support to decision making. SGRP has initiated many new customized projects for our local requirement and enhanced the existing projects to bring in process transparency, data accuracy, automation, digitalization and TEI across the plants.

(1) Support to daily activities

① **Problem Data Bank (PDB)** – PDB a customized IT portal, where in problems and improvement ideas are registered across the plants. The progress of registered problems is tracked and monitored. The implemented solution is also registered in the tool for future reference to all plants. PDB brought in transparency on the process and responsibility. The tool is designed with automated alerts to the stakeholders and reports to support the users.

② **Digitalization of shop floor SOPs** – Online shop floor SOP portal where shop floor SOPs are maintained for technicians for any time reference at the Shop floor, which increases the morale of the technicians.

(2) Support to enhancement

① **Knowledge Management Portal (KMP)** – One interactive website developed for all the TQM references and all completed improvement projects with complete accessibility and retrievability for all the users. KMP is integrated with PDB to access all the completed solutions for deployment. The portal has advanced quick search feature for quick retrieval of already implemented solutions across the plants. The events and achievements as part of the portal inspire and motivate employees.

(3) Support to decision making

Kaizen dashboard – It is an enhancement to the existing PDB. This additional feature gives clarity on how each plant is progressing on their problem solving and continuous improvement.

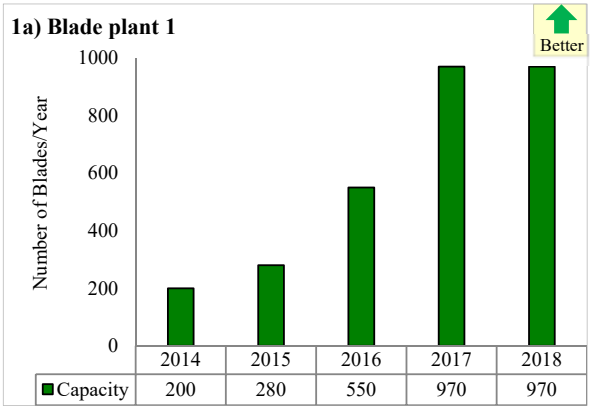
11. Effects and future plan

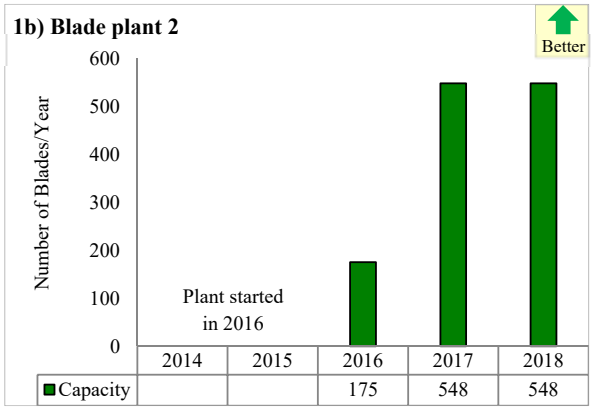
11.1 Effects

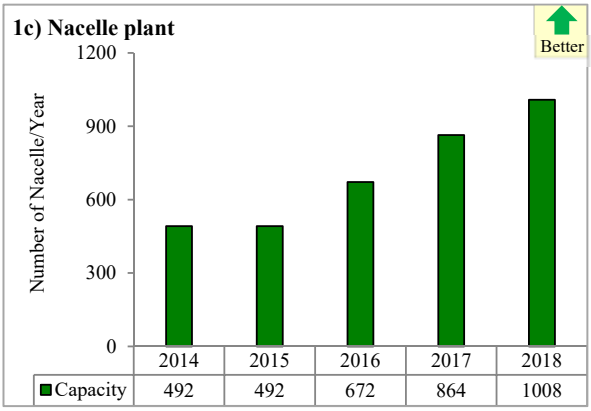
The TQM practices in Siemens Gamesa Renewable Power Private Limited have facilitated in achieving the objectives of every function in the Industrial Operations.

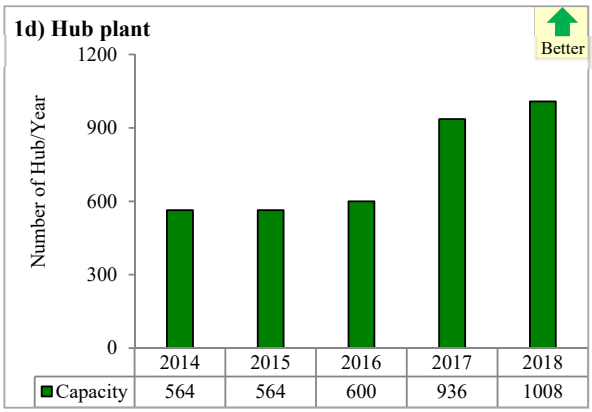
Some key effects of operational results in terms of Productivity, Quality, Cost, Delivery and Morale are highlighted below

(1) Production Capacity Enhancement

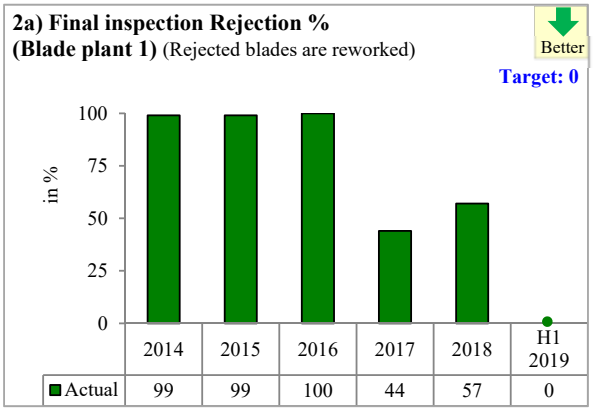


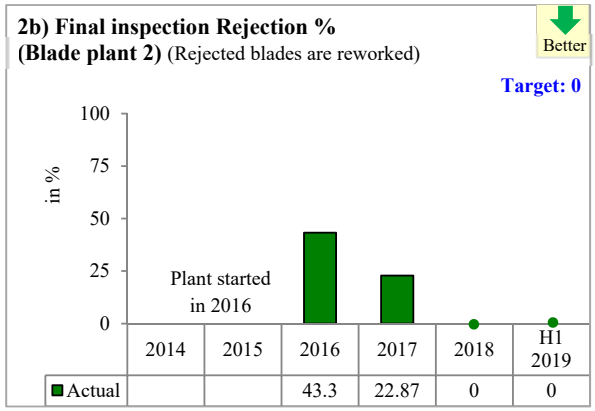






(2) Quality Improvement

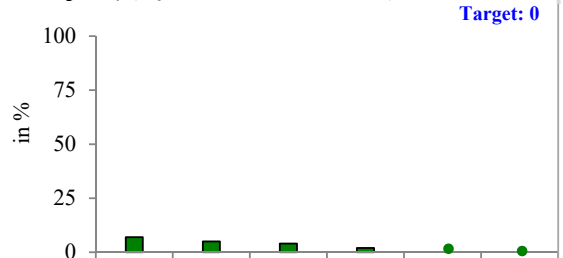




2c) Final Inspection Rejection %
(Nacelle plant) (Rejected nacelles are reworked)

Better

Target: 0

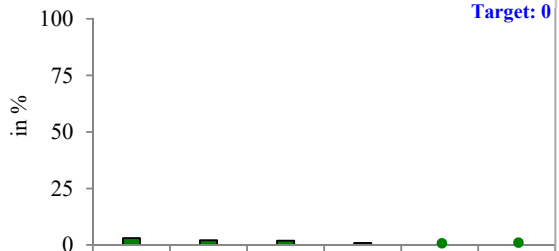


	2014	2015	2016	2017	2018	H1 2019
Actual	7	5	4	2	0	0

2d) Final Inspection Rejection %
(Hub plant) (Rejected hubs are reworked)

Better

Target: 0

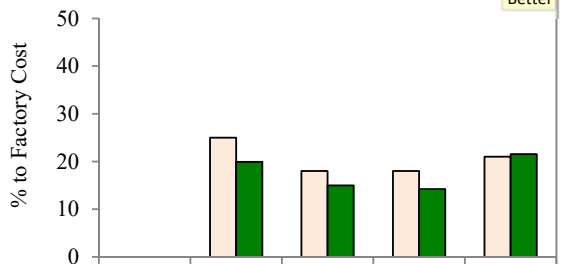


	2014	2015	2016	2017	2018	H1 2019
Actual	3.04	2.11	1.92	0.9	0	0

(3) Cost – Manufacturing cost

3a) Blade 1 plant

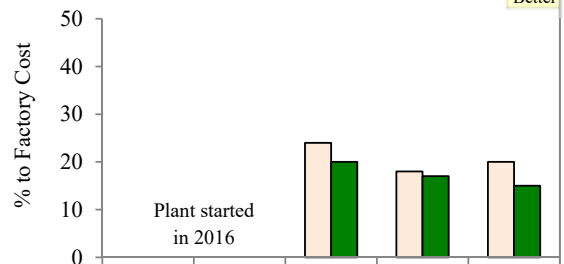
Better



	2014	2015	2016	2017	2018
Target		25	18	18	21
Actual		19.93	14.98	14.22	21.55

3b) Blade 2 plant

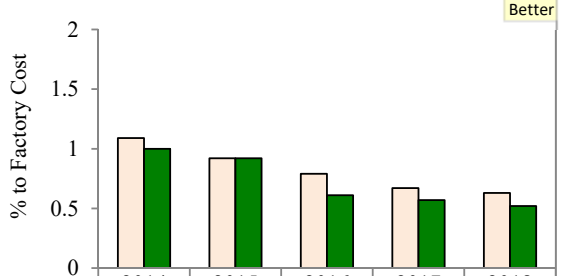
Better



	2014	2015	2016	2017	2018
Target			24	18	20
Actual			20	17	15

3c) Nacelle plant

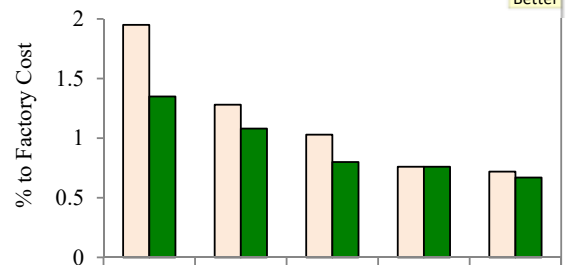
Better



	2014	2015	2016	2017	2018
Target	1.09	0.92	0.79	0.67	0.63
Actual	1	0.92	0.61	0.57	0.52

3d) Hub plant

Better

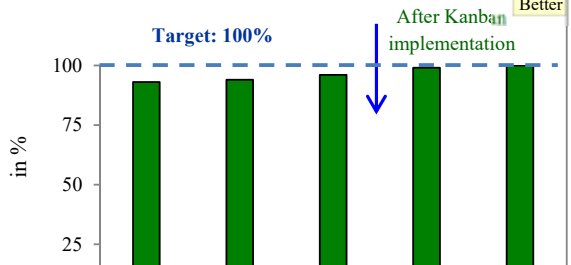


	2014	2015	2016	2017	2018
Target	1.95	1.28	1.03	0.76	0.72
Actual	1.35	1.08	0.80	0.76	0.67

(4) Delivery

4a) Domestic supplier schedule adherence

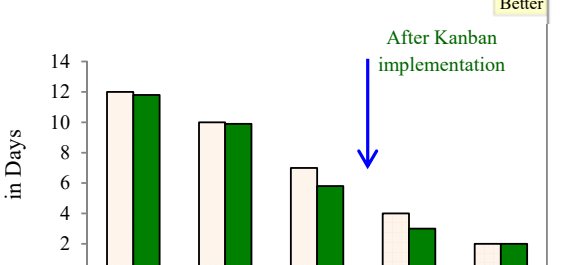
Better



	2014	2015	2016	2017	2018
Actual	93	94	96	99	100

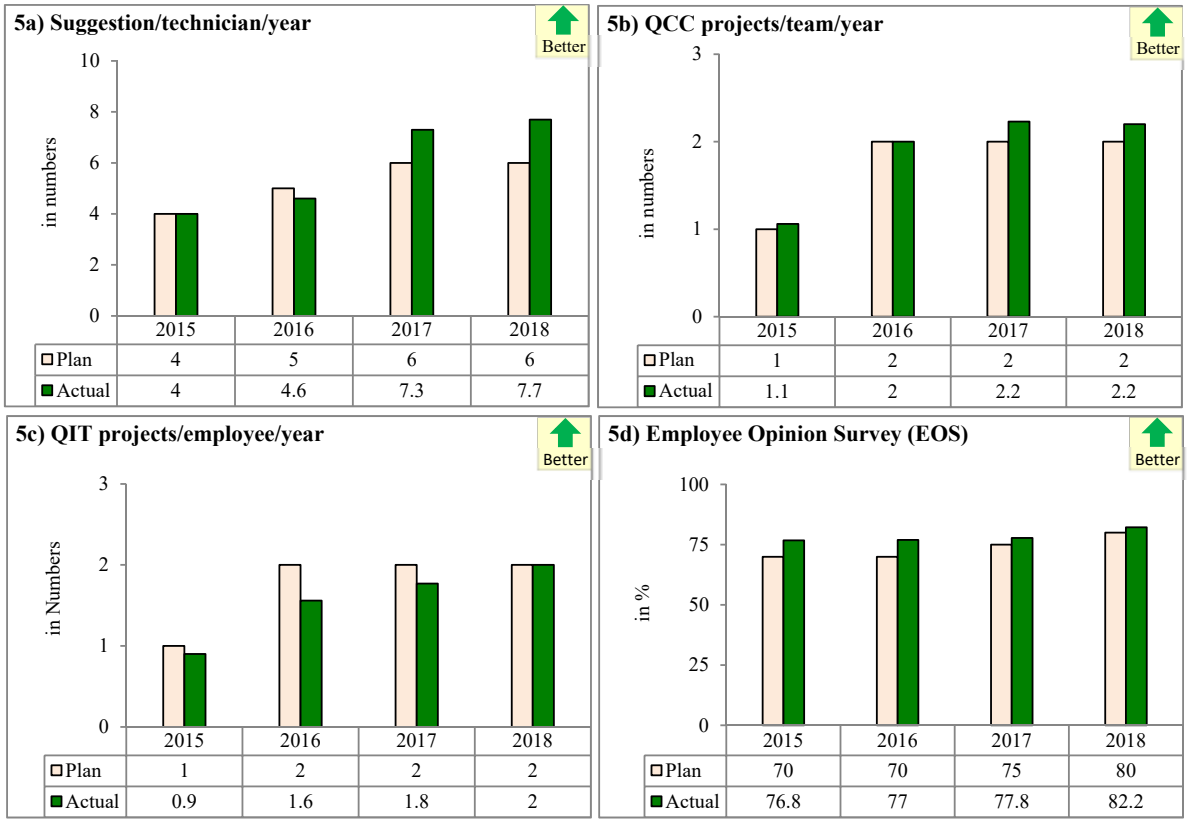
4b) Raw material inventory - Domestic

Better



	2014	2015	2016	2017	2018
Plan	12	10	7	4	2
Actual	11.8	9.9	5.8	3	2

(5) Morale



13.2 Future plan

(1) Introduction of new product model: 3x MW in Year 2020
(2) Increase manufacturing spread
(3) Export Blade, Nacelle and Hub
(4) Deployment of TQM in other divisions of SGRP
(5) Offshore projects

Terminology and Glossary

Abbreviations		
A	ABP	Annual Budget Plan
	AEP	Annual Energy Production
B	BoM	Bill of Material
C	CoE	Cost of Energy
	COP	Conference of Parties
	CSM	Components Supply Management
E	E&T	Education and Training
	ECRS	Eliminate, Combine, Rearrange and Simplify
	EHS	Environment, Health & Safety
	EOS	Employee Opinion Survey
	EVP	Executive Vice President
G	GMBO	Gamesa Management By Objectives
	GW	Gigawatt
H	HCM	Human Capital Management
	HSE	Health, Safety and Environment
	HSEQ	Health, Safety, Environment and Quality
I	ICSS	Internal Customer Satisfaction Survey
	INDC	Intended Nationally Determined Contribution
	IO	Industrial Operations
	IPP	Independent Power Producers
L	LLT	Long Lead Time
	LPS	Lightening Protection System
M	M Orders	Manufacturing Orders
	MOP	Measure of Performance
	MPP	Master Production Plan
	MW	Megawatt
	MY	Model Year
N	NCD	New Component Development
	NPD	New Product Development
	NPP	New Product Productionization
	NPMPD	New Product Manufacturing Process Development
O	OD	Operational Description
	OEM	Original Equipment Manufacturer
	Off JT	Off the Job Training
P	PESTLE	Political, Economic, Societal, Technological, Legal and Environment
	PR	Productionization Review
	PRA	Participatory Rural Appraisal
	PSU	Public Sector Units
Q	QCD	Quality, Cost and Delivery
	QA	Quality Assurance
R	RFQ	Request For Quotation
	R & R	Reward and Recognition
S	SG	Siemens Gamesa
	SGRE	Siemens Gamesa Renewable Energy (Global)
	SGRP	Siemens Gamesa Renewable Power Private Limited (India)
	SHG	Self Help Groups
	T&D	Training and Development
U	UPS	Uninterruptible Power Supply
V	VFD	Variable Frequency Drive
	VWI	Visual Work Instruction
W	WTG	Wind Turbine Generator