

Best Practices Manual for Pulp & Paper Sector

Volume 14



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Foreword

I am delighted to share this Best Practices Manual, which captures the pulp and paper industry's continuing efforts to improve energy efficiency, resource productivity and environmental performance. In my capacity as Chairman of CII Papertech 2026, I have the honour of seeing this crucial resource launched during our conference, which brings together professionals and leaders in the field to exchange knowledge and shape the future direction of this vital sector. As the Indian pulp and paper industry moves towards a more resource-efficient and low-carbon future, the focus is increasingly shifting from individual efficiency initiatives to integrated approaches encompassing energy, water, raw materials, digitalisation and process optimisation. Equally important is the ability to replicate proven solutions across mills with different technologies, capacities and operating conditions. As a result, we must continually evolve by implementing best practices and cutting-edge technologies that can increase production while reducing environmental impacts.



The “Best Practices Manual for Pulp & Paper Sector, Volume 14” is being published to support the transformation of the Indian paper industry through knowledge sharing, proven technologies and practical industry experiences. It aims to help paper mills improve competitiveness, resource efficiency and environmental performance while guiding the sector towards a more sustainable, innovative and future-ready direction. This manual serves as a testament to the collective efforts of our industry to meet these challenges head-on. It brings together an array of case studies highlighting the most effective energy efficiency measures and technologies currently being implemented across the sector. These real-world examples not only showcase the innovation and dedication of our industry but also provide invaluable insights into achieving excellence in energy management.

As we move forward, it is imperative that we continue to share knowledge and collaborate on best practices. By doing so, we can ensure that the pulp and paper industry remains a leader in sustainable industrial practices, driving progress while preserving the environment for future generations.

I would like to extend my sincere thanks to all the contributors who have made this manual possible. Your dedication and expertise are what make this industry great, and I am confident that this manual will serve as an invaluable tool for years to come. Let us continue to work together to achieve excellence in energy efficiency and make our industry a beacon of sustainability.

Mr. Ganesh Bhadti

Chairman, CII Papertech 2026 and
Executive Director-Operations and Projects,
Seshasayee Paper and Boards Limited

Message From Vice Chairman

It gives me great pleasure to present the 14th Volume of the “Best Practices Manual for Pulp & Paper Sector”, a compilation of practical initiatives, technologies and experiences that reflect the continuous efforts of the Indian paper industry towards improving operational efficiency, resource productivity and environmental performance.

The Indian pulp and paper sector is undergoing a significant transformation. Rising energy costs, increasing expectations on resource efficiency, evolving environmental regulations and the growing importance of decarbonisation are encouraging mills to look beyond conventional efficiency measures and adopt a more integrated approach to plant performance. In this context, sharing and replicating proven best practices across the industry can play an important role in accelerating this transition.

The “Best Practices Manual for Pulp & Paper Sector, Volume 14” offers practical solutions and proven approaches to help paper mills improve operational excellence, resource efficiency and overall performance. By presenting successful industry practices, innovative technologies and implementation insights, the publication enables mills to identify improvement opportunities, learn from proven experiences and replicate suitable best practices across their operations. This volume brings together examples of such practical initiatives and demonstrates that meaningful improvements can emerge from both large technology interventions and relatively simple operational measures. The experiences documented here provide valuable reference points for plant heads, energy managers, technical professionals, maintenance teams, and sustainability leaders across the sector. An important message emerging from these case studies is that energy efficiency need not always require large capital investments. Significant improvements can also be achieved through better process control, optimisation, monitoring, maintenance practices, and data-driven decision-making.

I am confident that this publication will encourage greater exchange of knowledge and facilitate the wider adoption of successful practices across Indian paper mills. I also encourage industry stakeholders, technology providers and technical institutions to continue contributing their experiences, innovations and learnings so that the collective knowledge base of the sector continues to grow.

I congratulate all the contributing organisations and professionals for their efforts in bringing together this valuable collection of sectoral best practices.

With best wishes for a more efficient, competitive and sustainable Indian paper industry.



Mr. S.V.R Krishnan

Vice Chairman, CII Papertech 2026 and
Chief Executive Officer
Sripathi Paper and Boards Private Limited

Message From President- IPMA

I am delighted to present the “Best Practices Manual for Pulp and Paper Sector, Volume 14”, a comprehensive manual that highlights the industry’s commitment, inventiveness, and collective expertise. This handbook is the result of a great deal of research, collaboration, and dedication from numerous experts and stakeholders in the Indian pulp and paper industry.

India’s pulp and paper industry is an important contributor to the country’s manufacturing and packaging ecosystem and plays a critical role in meeting the growing demand for paper and paper-based products. At the same time, mills are operating in an increasingly demanding environment characterised by pressure on energy costs, resource availability, environmental performance, and global competitiveness. To ensure that the industry not only thrives but also contributes to creating a cleaner and more sustainable India, the Indian pulp and paper industry has adopted cutting-edge technologies, eco-friendly practices, and responsible sourcing of raw materials.

This publication, which brings together industry best practices and case studies, is a shining example of what can be accomplished through creativity and collaboration. It highlights the best energy-saving practices and innovations implemented across various paper mills, along with documented experiences and reported benefits.

I would like to sincerely thank everyone who has contributed to making this handbook possible. The strength of this industry lies in our commitment, expertise, and knowledge, and I have no doubt that this handbook will serve as a valuable resource for many years to come.

Let’s continue collaborating to achieve greater energy efficiency and make our sector a shining example of sustainability.



Pawan Agarwal

President, Indian Paper Manufacturers Association (IPMA), and
Managing Director, Naini Papers Ltd.

Acknowledgement

We wish to express our sincere appreciation to all stakeholders for their invaluable contributions to this manual.

We sincerely thank the following organisations for sharing the technical information for the identified best practices:

- Chandpur Enterprises Ltd
- Elspec Engineering India Pvt. Ltd.
- Naini Papers Ltd.
- Ncon Turbo Tech Pvt. Ltd.
- Neopascal Technologies Pvt. Ltd.
- Netique Infotech Private Limited
- Optipid Consulting
- Sirpur Paper Mills Ltd
- Supreme Energy Solutions

We also sincerely thank the following technical committee members of CII Papertech 2026 for their contribution towards bringing out the “Best Practices Manual for Pulp & Paper Sector, Volume 14”.

- Mr Ganesh Bhadti (Chairman, Papertech 2026 and Executive Director- Operations and Projects, Seshasayee Paper and Boards Limited)
- Mr S.V.R. Krishnan (Vice Chairman, Papertech 2026 and CEO, Sripathi Paper and Boards)
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- Mr Mukesh Kumar Tyagi (Director, Naini Paper Ltd.)
- Mr Anuj Kumar Tayal (Sr. Vice President, West Coast Paper Mills Ltd.)
- Dr B.P. Thapliyal (Secretary General, Indian Agro & Recycled Paper Mills Association)
- Mr Nandkumar D.M. (President Elof Hansson India Pvt. Ltd.)
- Mr D. Radhakrishnan (Chief Manager, Seshasayee Paper and Boards Limited)

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List of Abbreviations

Abbreviation / Term	Expanded Form
A	Amperes
AI	Artificial Intelligence
AKD	Alkyl Ketene Dimer
APC	Advanced Process Control
APP	Asia Pulp & Paper
bar	Bar
BRSR	Business Responsibility and Sustainability Reporting
C1S	Coated One Side
CD	Cross Direction
CDM	Clean Development Mechanism
CEA	Central Electricity Authority
CF	Circulating Fluidized
CFBC	Circulating Fluidised Bed Combustion
CFM	Cubic Feet per Minute
CM	Combined Margin
CNY	Chinese Yuan
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
Cobb60	Cobb Water Absorption Test
CPCB	Central Pollution Control Board
CCTS	Carbon Credit Trading Scheme
dB(A)	A-weighted Decibels
DCF	Drag Chain Feeder
DCS	Distributed Control System

°C	Degrees Celsius
ERP	Enterprise Resource Planning
ESG	Environmental, Social, and Governance
FC	Fixed Carbon
VM	Volatile Matter
FY	Financial Year
GCV	Gross Calorific Value
GHG	Greenhouse Gas
GSM	Grams per Square Meter
HT	High Tension
ID (Fan)	Induced Draft Fan
IEC	International Electrotechnical Commission
₹	Indian Rupee
kg/cm ² (g)	Kilograms per Square Centimeter (Gauge)
KLB	Kraft Linerboard
kPa	Kilopascal
KPI	Key Performance Indicator
kW	Kilowatt
kWh	Kilowatt-hour
LOI	Loss on Ignition
LV	Low Voltage
MCR	Maximum Continuous Rating
MD	Machine Direction
MG	Machine Glazed
ML	Machine Learning
MV	Medium Voltage

MWh	Megawatt-hour
NRV	Non-Return Valve
O&M	Operations and Maintenance
OEM	Original Equipment Manufacturer
PLC	Programmable Logic Controller
PM	Paper Machine
PPEs	Personal Protective Equipment
PQ	Power Quality
PRV	Pressure Reducing Valve
PTs	Pressure Transmitters
QCS	Quality Control System
RCF	Recycled Content Fiber
RMS	Root Mean Square
RPM	Revolutions Per Minute
SAP	Systems, Applications, and Products
SCADA	Supervisory Control and Data Acquisition
SPCB	State Pollution Control Board
STATCOM	Static Synchronous Compensator
t	Tonnes
T&D	Transmission and Distribution
TM	Tissue Machine
TPD	Tonnes Per Day
TPH	Tonnes Per Hour
TUP	Tissue Utility / Production
VFD	Variable Frequency Drive / Variable Frequency Drives
WAEF	Weighted Average Emission Factor
WBT	Wet Bulb Temperature

Executive Summary

Sustainable practices are now more important than ever for the Indian pulp and paper industry. This best practices manual presents practical energy-saving and resource-efficiency practices being implemented across the pulp and paper sector. This handbook is a crucial tool for promoting improvements in energy performance as the business tries to strike a balance between expansion and environmental responsibility. This handbook seeks to move the industry toward more sustainable and effective operations by providing practical examples and useful ideas.

The manual includes 11 case studies that were gathered from high-performing paper manufacturing companies and technology suppliers. The manual draws on data from energy-saving initiatives implemented across leading Indian paper mills in addition to the case studies implemented in paper mills of countries like China, Indonesia, South Africa, Canada, Czech Republic. These case studies provide important insights into the real-world uses of these technologies by highlighting the various strategies used by various mills to meet their unique energy constraints.

By adopting the best practices and learning from the experiences of the industry leaders featured in these case studies, other mills can replicate these successes, contributing to the overall goal of a more sustainable and energy-efficient industry.

This manual is intended for use by industry professionals and all stakeholders involved in the pulp and paper sector. It aims to inspire ongoing efforts to improve energy efficiency and environmental performance, ultimately supporting the industry's long-term sustainability goals. As the Indian pulp and paper industry continues to evolve, this best practices manual will be an invaluable tool for guiding the sector towards a more efficient and sustainable future.

Case Study No.	Name of the roject	Applicable area
1A	Retrofit Of Liquid-Ring Vacuum Pumps With Magnetic-Levitation (Maglev) Turbine Vacuum Pumps — China Paper, Yueyang Forest & Paper Co., Ltd	Paper machine
1B	Replacing Liquid-Ring Vacuum Pumps With Maglev Turbine Vacuum Pumps — Asia Pulp And Paper (APP) Indonesia, Perawang Tissue Mill By Nanjing Cigu Technology Co., Ltd. (CIGU)	Paper machine
2	Recovering Wasted Steam Energy: A Back Pressure Turbine Retrofit at a Kraft Paper Mill in Chennai	Steam system
3	From Problem to Solution – OxyBooster's Impact for Paper Mill Fuel Cost Reduction: The Sustainable Way – A Case study	Boiler
4	Papyrus360 Optrim: Deckle Matching Software for Paper Manufacturing	Paper machine
5	AI-Driven Strategies to Enhance Production and Quality: South African Mill	Paper machine
6	Power Quality Optimisation in a RCF based Mill: Customised Harmonic Mitigation and Power Factor Improvement	Electrical system
7	Solving Micro Outages and Improving Production Efficiency in the Recycling Industry	Electrical system
8	Reduction of power consumption in Compressors	Compressor
9	Optimisation of Compressed Air System through Compressor stoppage	Compressor
10	Data Visualisation and Live Analysis for Headbox & Wire	Paper machine

How To Use The Manual

The objective of this manual is to showcase the best energy consumption figures achieved by some of the leading paper manufacturing units in India and pave the way for the remaining paper mills in the country to achieve similar energy related Key Performance Parameters (KPIs). The publication also acts as a catalyst to promote activities in the Indian Pulp & Paper industry towards continuously improving the performance of individual units and achieving world class levels (with thrust on energy, water & environmental management).

To set a clear goal for improving the performance and move towards international standards, the best practices adopted in some Indian pulp & paper plants and latest technologies from suppliers have been included as a part of the "Best Practices Manual for Pulp & Paper Sector".

These best practices may be considered for implementation after suitably fine-tuning the requirements of individual units.

Suitable latest technologies may be considered for implementation in existing and future pulp & paper plants for achieving world class energy efficiency. Further investigation needs to be done for the suitability of these technologies for individual plant conditions.

Therefore, Indian pulp & paper plants should view this manual positively and utilise the opportunity to improve the performance and "Make Indian Pulp and Paper Industry World Class".

Sectoral Overview of Paper Industry

Scale & Raw Material Mix

Out of around 850–900 Paper Mills in India, currently only about 550 are operational. Of these, the non-wood sectors (Agro + RCF) collectively contribute around 80% of the country's Paper and Paper Board production while the remaining production comes from wood-based paper mills (around 20%).

Production, Economic & Employment Impact

The Indian Paper Industry accounts for about 5% of global paper production (3rd largest producer in the world), with estimated production of around 23 million tonnes per annum (TPA). In terms of composition by volume, about 20% of the units are wood based mills, 74% are recovered paper / recycled fibre-based mills and around 6% are employing agro residue (bagasse / wheat straw) as the raw material in their mills for production purposes. The Indian Paper Industry provides direct employment to 5 lakh persons, and indirectly to around 15 lakh, and has an annual turnover of over ₹ 1,00,000 crores.

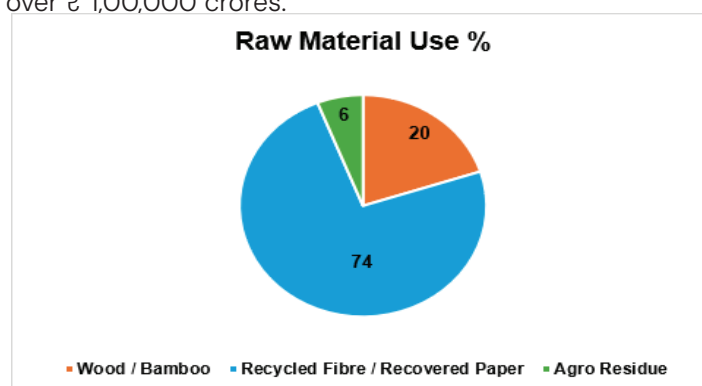


Figure 1 Estimated Production in Terms of Raw Material Used
Source: IPMA

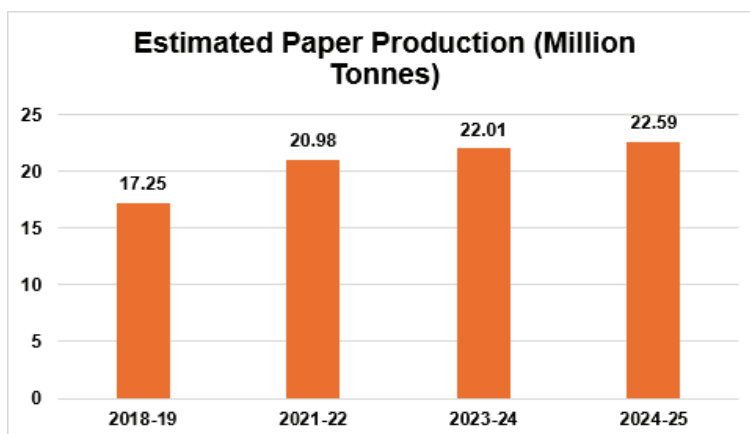


Figure 2 Estimated Paper Production in India
Source: IPMA

The type of raw material, GSM produced, and type of pulping process adopted has a deep impact on the energy consumption of the paper mills. Hence, in the case of paper sector, it is important to compare the energy performance of the paper mills against each other while considering the different raw material mix and product mix being deployed by them.

Best Practices Manual for Pulp & Paper Manufacturing Units

Case study 1A: Retrofit of Liquid-Ring Vacuum Pumps with Magnetic-Levitation (Maglev) Turbine Vacuum Pumps — China Paper, Yueyang Forest & Paper Co., Ltd.

40.2%	6.89 M kWh	₹ 551 Lakh	4,892 t
Energy Saving	Saved Per Year	Annual Saving *	CO₂ Avoided/Yr

* Valued at an indicative Indian HT industrial tariff of ₹8.00/kWh. See Section 3.7 for the full currency basis and tariff sensitivity.

1. Project at a glance

Mill	China Paper — Yueyang Forest & Paper Co., Ltd., Yueyang, Hunan Province, China
Product / grade	Cultural paper for printing, writing and office applications
Installed base	4 paper machines
Technology	CIGU magnetic-levitation (maglev) turbine vacuum pumps replacing liquid-ring vacuum pumps on the paper-machine vacuum dewatering sections
Scope of retrofit	4 liquid-ring vacuum pumps replaced with 4 maglev turbine vacuum pumps
Result	40.2% reduction in vacuum-system electricity (2,143 kW → 1,281 kW average) and complete elimination of sealing-water consumption
Annual electricity saving	6.89 million kWh (≈ 20,690 kWh per operating day)
Annual monetary benefit	₹ 551 Lakh at ₹8.00/kWh (Indian basis) · ₹ 675 Lakh as actually realised in China
CO₂ avoided	≈ 4,892 tCO ₂ per year (CEA grid emission factor basis)
Payback period	12–30 months (1–2.5 years)
Replication potential	High — applicable to any cultural paper, tissue or packaging machine using liquid-ring vacuum pumps

2. Background / Baseline Scenario

China Paper (Yueyang) is a leading cultural paper manufacturer, producing high-quality paper products for printing, writing and office applications. The company operates multiple paper machines at its Yueyang facility, where the vacuum dewatering systems — serving the wire (forming) section, suction couch rolls, suction / uhle boxes, and press felts — were traditionally served by conventional liquid-ring vacuum pumps.

Liquid-ring pumps use clean water as a continuous sealing medium. They are simple and robust, but they carry the well-known industry pain points described in Section I: very low isothermal efficiency; continuous consumption of sealing (make-up) water; scaling and corrosion inside the casing; vacuum that degrades as sealing-water temperature rises and water quality worsens; frequent mechanical-seal and bearing failures; and periodic acid-washing shutdowns. The vacuum system typically consumes 15–20% of total paper-machine power, so its electricity and water cost — and its impact on runnability — were material.

With energy and water costs rising and in line with the group's sustainability commitments, the mill launched a retrofit to replace the liquid-ring vacuum pumps with oil-free, water-free maglev turbine vacuum pumps, targeting lower energy and water use, more stable vacuum and reduced maintenance.

Relevance to Indian mills

Indian integrated and agro-based paper mills run vacuum systems of directly comparable size and duty, and the vast majority still operate liquid-ring pumps.

Indian HT industrial tariffs (typically ₹6–9/kWh landed) are higher than the tariff realised in this case, so the same physical energy saving yields a proportionally larger monetary benefit in India.

India's grid is more carbon-intensive than China's, so the same kWh saved avoids roughly 25% more CO₂ in an Indian mill — quantified in Section 3.8.

I. General Introduction of Liquid Ring Vacuum Pumps for Paper Dehydration System

Liquid ring vacuum pumps have long been the conventional mainstream equipment for the vacuum dewatering section of paper machines in paper mills. They serve vacuum dewatering for the wire section, suction couch roll, suction boxes and press felts. Negative pressure removes moisture from the paper web and increases the dryness of paper before it enters the dryer section.

1. Working Principle

Clean water acts as the sealing medium. The rotating impeller forms an annular water seal. Periodic volume variation of the pump chambers realises gas suction, compression and exhaust, extracting humid air to generate the vacuum required by the process.

2. Traditional Advantages

The pump withstands high-humidity inlet air from the wet end of paper machines. Trace fibre and whitewater entrainment will not cause immediate pump damage. Featuring a simple structure and low initial procurement cost, it has been widely equipped on various paper machines for decades.

3. Inherent Disadvantages (Common Industry Pain Points)

Sn	Pain point	Description and typical values
1	Very low operating energy efficiency	High isothermal compression loss plus continuous consumption of circulating sealing water. Airflow cannot be adjusted efficiently under fluctuating load. Typical efficiency 30–50%. Vacuum systems account for approximately 15–20% of the paper machine's total power consumption, leading to high long-term electricity expense.
2	High water consumption and complicated circulating water system	Continuous make-up water is required, along with supporting circulation tanks, cooling pipelines and water treatment piping. Cultural paper machines typically consume 30–60 m ³ /h per pump. Whitewater mixing with sealing water causes scaling and corrosion inside pump casings.
3	Poor operational stability	Rising water temperature and deteriorated water quality directly reduce ultimate vacuum and pumping capacity, triggering cavitation. Once scaled, the pump must be shut down for acid cleaning, disrupting continuous paper machine operation.
4	Heavy maintenance workload	Bearings and mechanical seals suffer frequent wear, requiring regular inspection and spare-part replacement. Leakage issues increase wastewater discharge and environmental treatment costs.

5	Limited adjustability and high noise	Conventional liquid ring pumps have narrow energy-saving scope via frequency conversion and fail to match dynamic vacuum load changes caused by increased machine speed or adjusted basis weight. Operating noise is typically 85–95 dB(A).
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II. Necessity of Retrofit to Maglev Turbine Vacuum Pump

The maglev turbine vacuum pump adopts magnetic bearings, high-speed permanent magnet direct drive and a 3D flow turbine impeller. It operates oil-free and water-free in dry mode, representing the optimal upgrade solution for papermaking vacuum systems. The retrofit brings benefits in economy, production process, environmental protection and compliance:

1. Significant power cost reduction and outstanding economic benefits

Achieves 30–50% overall power saving compared with liquid ring pumps. The built-in intelligent variable frequency system adjusts rotation speed in real time according to paper machine speed and vacuum demand, with more prominent energy-saving performance under partial load. Elimination of the sealing water system further cuts process water consumption, circulation pump power and water treatment fees. Most projects deliver static payback periods of 1–2.5 years and sustainable cost reduction in the long run.

2. Improved vacuum system stability to ensure production capacity and paper quality

No process water medium completely eliminates vacuum fluctuation induced by water temperature variation and scaling. Stable negative pressure ensures uniform dewatering, better paper formation and lower web-break frequency.

3. Modular intelligent control system

Integrates anti-surge protection, remote monitoring and fault early warning. It supports 7×24 hours non-stop continuous operation and reduces unplanned downtime and connects to the mill DCS/SCADA for centralised control.

4. Greatly reduced maintenance investment and downtime losses

The maglev rotor runs without mechanical contact friction. No lubricating oil is needed and consumable parts are minimal. Removal of the sealing water system eliminates maintenance for tanks, pipelines and coolers. Compared with liquid ring pumps requiring frequent mechanical seal and bearing replacement and periodic acid washing, spare parts expenditure and labour costs are substantially lowered.

5. Water conservation and pollution reduction to meet environmental regulations

Dry operation eliminates wastewater generated by pump sealing water, lowering plant sewage discharge and chemical consumption for wastewater treatment. Oil-free operation avoids the risk of lubricant leakage contaminating whitewater systems and improves cleanliness of the paper machine wet end. This directly supports compliance with CPCB effluent norms and mill-level water-consumption reduction targets.

6. Optimised on-site working environment

Operating noise ≤ 80 dB(A), far quieter than aging liquid ring pumps. Without circulating water systems, water accumulation and water mist in pump houses are eliminated, improving working conditions.

3. Project Details

3.1 Details of the energy saving project

A retrofit of liquid-ring vacuum pumps with CIGU maglev turbine vacuum pumps was carried out at China Paper's Yueyang Forest & Paper mill. Four liquid-ring vacuum pumps were replaced with four maglev turbine vacuum pumps on the cultural paper production lines, installed machine-by-machine as the old pumps reached maintenance points, minimising production downtime. The project achieves a 40.2% reduction in vacuum-system power consumption, an annual electricity saving of 6.89 million kWh and an annual monetary benefit of ₹551 Lakh on an Indian tariff basis.

3.2 Detailed description of the project

Each retrofit replaces a liquid-ring vacuum-pump train with a CIGU maglev turbine vacuum pump: a high-speed permanent-magnet synchronous motor directly driving a 3D-flow turbine impeller, supported on active magnetic bearings and controlled by a built-in intelligent variable-frequency drive. The unit runs completely dry and oil-free — no sealing water, no circulation tank, no cooler, no water treatment.

Inlet-air humidity from the paper-machine wet end is handled without damage, and rotational speed is adjusted in real time to the vacuum demand of each section (wire, couch, uhle boxes, press felts), so the pump tracks load instead of running at fixed speed. The retrofit targets the vacuum system only — there are no modifications to the paper machine itself or to the process vacuum demand.

Cultural paper grades require stable, moderate vacuum levels for consistent formation and dewatering. The maglev turbine pumps provide precise vacuum control matched to grade-specific requirements, improving paper uniformity while reducing energy consumption.

3.3 Schematic diagram

A representative system schematic — the maglev turbine vacuum pump (magnetic bearing, PM motor, VFD and anti-surge / protection module) connected to the wire, couch, uhle-box and press vacuum headers — replaces the former multi-train liquid-ring plus sealing-water circulation and cooling loop. Four vacuum pump positions (VP01–VP04) serve the machine, discharging to atmosphere through separators and silencers, with no sealing-water circuit present.

3.4 Operating principle and other technology details

The maglev turbine vacuum pump generates vacuum by high-speed rotation of a 3D turbine impeller on magnetic bearings; active magnetic levitation removes mechanical-contact friction, so there is no lubricating oil and almost no wear. Rotational speeds of 20,000–40,000 rpm are typical, enabling high vacuum capacity from a compact unit, and magnetic bearing control maintains rotor position with sub-micron precision. The intelligent VFD matches rotational speed to the instantaneous vacuum load, giving its strongest savings under partial load.

An integrated control system provides anti-surge protection, remote monitoring and fault early warning, supporting 7×24 h non-stop operation. Integrated sensors monitor rotor position, vibration, temperature and motor current for real-time condition monitoring and predictive maintenance.

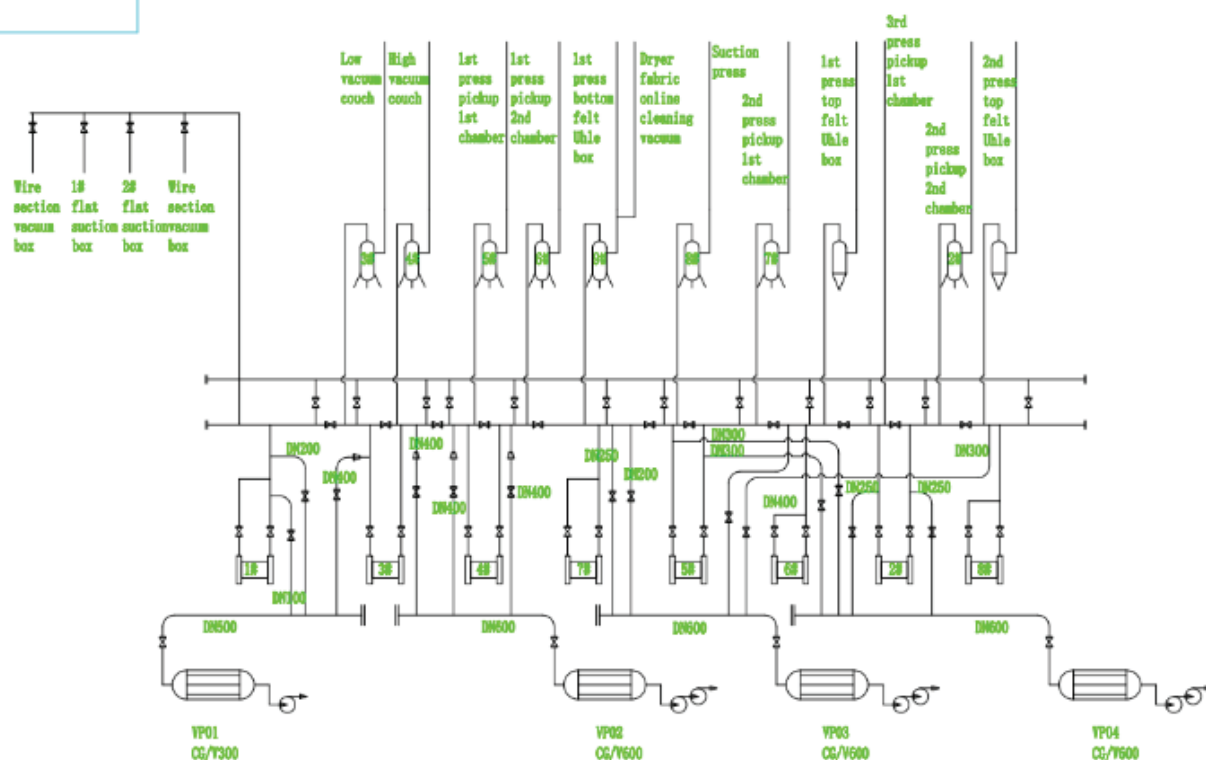


Figure 3 Representative system schematic of the maglev turbine vacuum pump installation

Key CGV-series product parameters (supplier data):

Vacuum range	≈ 10–70 kPa
Volume flow	up to ≈ 1,275 m ³ /min (CGV800)
Motor power	75–800 kW
Unit efficiency	up to ≈ 97%
Operating noise	≤ 80 dB(A)
Operation mode	24/7 unattended, dry and oil-free

3.5 Any modifications made for upgradation (auxiliary equipment, layout, utility)

Primarily a like-for-like replacement of the vacuum pump, plus the following auxiliary changes:

Removal of the sealing-water supply, circulation tank, cooling piping and water treatment associated with each liquid-ring pump.

New VFD / motor control panel and cable routing.

Revised inlet piping and silencer to suit the maglev unit's higher speed and dry operation.

Integration of the maglev controller into the mill DCS for centralised monitoring.

No change was made to the paper machine itself or to the process vacuum demand.

3.6 Project timelines (duration and process downtime)

The retrofit was executed in phases, machine-by-machine. Each individual changeover was scheduled during a planned maintenance window, so process downtime was limited to the short swap of one vacuum position at a time; the mill continued running throughout the programme. Commissioning and performance validation followed each installation, and no additional production loss was incurred.

Stage	Description
Evaluation and selection	Assessment of vacuum-system upgrade options; selection of maglev turbine technology.
Unit changeover	Machine-by-machine replacement, each completed within an existing planned maintenance window.
Auxiliary works	Decommissioning of sealing-water infrastructure; installation of VFD panel, revised inlet piping and silencer.
Commissioning	Performance validation and DCS integration after each installation.
Additional downtime	Nil — all work absorbed within scheduled maintenance shutdowns.

3.7 Improvements achieved: energy consumption before vs after implementation

Measured at the Yueyang mill, vacuum-system power consumption dropped to approximately 60% of the original value after the maglev retrofit — an average load reduction from 2,143 kW to 1,281 kW, a saving of 862 kW or 20,690 kWh per operating day.

Basis of currency conversion and tariff

Exchange rate applied	₹ 14.00 per CNY (indicative mid-market rate, July 2026; CNY/₹ traded in the range ₹13.87–14.26 during the month)
Tariff realised in China	CNY 0.70/kWh, equivalent to ₹ 9.80/kWh at the above rate
Indian reference tariff	₹ 8.00/kWh landed HT industrial cost, used for the India-adapted figures below
Operating hours assumed	8,000 hours per year
Currency unit	₹ Lakh (1 Lakh = ₹ 100,000; 100 Lakh = ₹ 1 Crore)

(a) Physical performance — as measured (independent of currency)

Parameter	Before retrofit	After retrofit	Improvement
Vacuum pump configuration	4 × liquid-ring pumps	4 × maglev turbine pumps	Dry, oil-free operation
Average vacuum-system load	2,143 kW	1,281 kW	862 kW reduction
Annual electricity consumption	17.14 million kWh	10.25 million kWh	6.89 million kWh saved
Daily electricity consumption	51,430 kWh/day	30,750 kWh/day	20,690 kWh/day saved
Energy saving rate	Baseline	59.8% of baseline	40.2% reduction
Sealing water consumption	Continuous supply required	Nil	100% eliminated
Wastewater from vacuum system	Requires treatment	Nil	Zero discharge
Noise level	85–95 dB(A)	≤ 80 dB(A)	Up to 15 dB(A) lower

(b) Monetary performance — as realised in China, converted to ₹

Parameter	Before retrofit	After retrofit	Saving
Annual operating cost (CNY)	CNY 12,000,000	CNY 7,176,000	CNY 4,824,000
Annual operating cost (₹)	₹ 16.80 Crore	₹ 10.05 Crore	₹ 6.75 Crore

(c) Indian replication scenario — same energy saving at Indian tariffs

The physical saving of 6.89 million kWh per year is a property of the technology, not of location. Applying Indian HT industrial tariffs to that same saving gives the monetary benefit an Indian mill of comparable size would realise:

Tariff (₹/kWh)	Before (₹ Lakh/yr)	After (₹ Lakh/yr)	Saving (₹ Lakh/yr)	Saving (₹ Crore/yr)
₹ 6.00	1,028.6	615.1	413.4	4.13
₹ 7.00	1,200.0	717.6	482.3	4.82
₹ 8.00 (reference)	1,371.4	820.1	551.2	5.51
₹ 9.00	1,542.9	922.6	620.1	6.20

At the ₹8.00/kWh reference tariff, the annual monetary benefit is ₹551 Lakh (₹5.51 Crore). Against the stated static payback of 12–30 months, with an indicative project investment in the range of ₹550–1,380 Lakh for a four-position retrofit.

3.8 Environmental and other benefits

Dry, oil-free operation eliminates sealing-water consumption and the associated wastewater and chemical treatment and removes the risk of lubricant leakage contaminating the whitewater system. The electricity reduction cuts CO₂ emissions in direct proportion — 40.2% of the vacuum system's carbon footprint.

Calculation of CO₂ emission reduction

Avoided CO₂ from an electricity-saving project is calculated by multiplying the electricity saved by the grid emission factor:

Formula

$$\text{CO}_2 \text{ avoided (tCO}_2\text{/year)} = \text{Electricity saved (MWh/year)} \times \text{Grid Emission Factor (tCO}_2\text{/MWh)}$$

Step 1 — Establish the electricity saved

Baseline consumption	17,142,857 kWh/yr	= 17,143 MWh/yr
Post-retrofit consumption	10,251,429 kWh/yr	= 10,251 MWh/yr
Electricity saved	6,890,000 kWh/yr	= 6,890 MWh/yr

Step 2 — Select the grid emission factor

The applicable factor is published by the Central Electricity Authority (CEA), Ministry of Power, in the CO₂ Baseline Database for the Indian Power Sector, Version 21.0 (December 2025), covering FY 2024–25. The database is computed using the CDM Executive Board's Tool to calculate the emission factor for an electricity system (Version 7.0). Two variants are relevant:

Emission factor variant	Value (tCO ₂ /MWh)	When to use
Weighted Average Emission Factor (WAEF)	0.710	GHG Protocol location-based Scope 2 accounting and BRSR Core reporting — the standard basis for reporting an energy-efficiency project's CO ₂ benefit. Used as the headline figure in this Case study.
Combined Margin (CM)	0.7383	CDM / CCTS carbon-credit baselines, where the project claims tradable Carbon Credit Certificates. A 50:50 weighted average of Operating Margin and Build Margin.

Step 3 – Compute the annual CO₂ reduction

Basis	Calculation	Result
CEA WAEF (headline)	6,890 MWh × 0.710 tCO ₂ /MWh	4,892 tCO ₂ /yr
CEA Combined Margin	6,890 MWh × 0.7383 tCO ₂ /MWh	5,087 tCO ₂ /yr
WAEF, grossed up for T&D losses (≈17%)	(6,890 ÷ 0.83) × 0.710 tCO ₂ /MWh	5,894 tCO ₂ /yr

Notes on the calculation:

The headline figure of 4,892 tCO₂/yr uses the WAEF without grossing up for transmission and distribution losses. This is the conservative and conventional basis for Scope 2 reporting, where the boundary is electricity consumed at the meter.

The grossed-up figure of 5,894 tCO₂/yr reflects the fact that a unit saved at the mill also avoids the generation needed to cover T&D losses. It is appropriate where the project boundary is drawn at the generation end; it should not be used for Scope 2 disclosure.

The Combined Margin figure of 5,087 tCO₂/yr applies only if the mill intends to monetise the reduction as Carbon Credit Certificates under the Carbon Credit Trading Scheme.

For reference, the same 6,890 MWh saved on the Chinese grid (emission factor ≈ 0.57 tCO₂/MWh) avoids about 3,927 tCO₂/yr. The Indian grid being more carbon-intensive, the identical retrofit delivers roughly 25% more CO₂ benefit in an Indian mill.

The CEA factor is revised annually. Mills should use the version corresponding to their reporting year, and must use the same version consistently for baseline and compliance-year calculations.

Grid emission intensity:

- India: 0.710 tCO₂/MWh (CEA Weighted Average Emission Factor)
- China: 0.57 tCO₂/MWh

The project saves 6,890 MWh a year. On the Indian grid this avoids about 4,892 tonnes of CO₂ a year; on the Chinese grid, about 3,927 tonnes.

Summary of environmental benefits

Impact area	Outcome	Basis
Electricity	6.89 million kWh/year avoided	Measured 40.2% reduction in vacuum-system consumption
Carbon emissions	≈ 4,892 tCO ₂ /year avoided	CEA WAEF 0.710 tCO ₂ /MWh, FY 2024–25 (Version 21.0)
Fresh water	Sealing water for vacuum generation fully eliminated	Previously in the order of tens of cubic metres per hour per pump
Wastewater	Zero discharge from the vacuum system	Sealing-water circuit removed entirely; supports CPCB effluent compliance
Chemicals	Reduced dosing for vacuum-system effluent treatment	No contaminated sealing water to treat
Workplace noise	≤ 80 dB(A), against 85–95 dB(A) previously	Manufacturer rating and site condition
Plant footprint	Water piping, tanks and coolers removed; floor space released	Maglev units are substantially more compact

Additional process benefits: stable vacuum improves dewatering uniformity and paper formation and reduces web breaks; 7×24 h unattended operation reduces unplanned downtime; and the integrated control system provides real-time performance monitoring and predictive maintenance alerts.

3.9 Challenges faced during the implementation

应用案例

Application case

造纸行业——文化纸

Paper industry - Cultural paper

参数 Parameter	改造前 Before transformation	改造后 After transformation
设备方案 Equipment scheme	水环泵	磁悬浮真空泵
台数 Number of tables	4台	4台
年运行费用 Annual operating cost	1200万元	717.6万元
节能率 Energy saving rate	40.2%	
年节约电量 Annual electricity saving	6890万度	

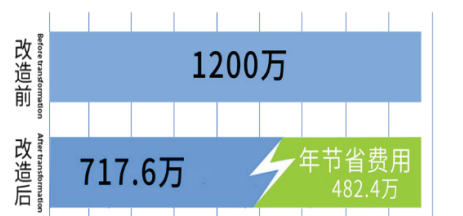


Figure 4 Installed CIGU maglev turbine vacuum pumps at the Yueyang mill, with the before/after cost comparison

Key challenges in a live cultural paper mill: coordinating each swap within planned downtime to avoid production loss; matching the maglev unit's higher speed and dry characteristics to existing piping and silencers; and integrating a new supplier's controller with the mill DCS. These were addressed through careful project planning, staged commissioning, revised inlet and silencer design, controller integration testing, and hands-on training for operations and maintenance staff. No significant technical issues were encountered, and the maglev units demonstrated stable operation from commissioning.

3.10 Project photographs

Photographs of the installed CIGU maglev turbine vacuum pumps at the Yueyang mill show compact, clean installations without the water piping, tanks and pumps previously associated with liquid-ring systems. The maglev units are significantly smaller than the pumps they replaced, freeing floor space for other uses.

3.11 Replication potential

Replication potential: HIGH

The same retrofit applies to virtually any cultural paper, tissue or packaging paper machine that uses liquid-ring vacuum pumps for the wire, couch, uhle-box and press-felt dewatering sections. The technology is independent of paper grade and machine speed.

Indian mills with older liquid-ring pumps, high landed electricity cost, or stringent water and effluent discharge norms will see the strongest economic and environmental returns.

The retrofit can be executed machine-by-machine during planned maintenance, minimising production disruption, and is therefore well suited to phased capital allocation.

Screening criterion	Indicator of strong retrofit potential
Existing vacuum equipment	Liquid-ring pumps, particularly older or oversized units
Paper grade	Any — cultural, tissue, writing/printing, kraft or packaging
Operating regime	High annual operating hours (continuous production, $\geq 7,000$ h/yr)
Electricity tariff	Landed HT industrial cost of ₹ 6/kWh or above
Water and discharge regime	Water-scarce region or stringent CPCB / SPCB effluent limits
Maintenance profile	Recurring mechanical-seal, bearing and wear-ring replacement, periodic acid washing

3.12 Energy saving and other details

Sr. No.	Parameters	Unit	Before	After
1.	Process / operating vacuum	kPa	Unstable; falls as sealing-water temperature rises and casing scales	Stable at demand setpoint under VFD control
2.	Power	kW	2,143 (avg., liquid-ring)	1,281 (avg., maglev)
3.	Steam consumption	—	No change — outside project boundary	No change — outside project boundary
4.	Energy saving	kW / kWh per day	—	862 kW ($\approx 20,690$ kWh/day); $\approx 40.2\%$ reduction; 6.89 million kWh/yr
5.	Monetary benefits	₹ Lakh	—	≈ 551 /year at ₹8.00/kWh (India basis) ≈ 675 /year as realised in China
6.	Investment	₹ Lakh	—	≈ 550 – $1,380$ (derived from 12–30 month payback; supplier quotation to be confirmed)
7.	Payback	Months	—	12–30 (1–2.5 years)
8.	Other benefits (environment)	—	—	Sealing water eliminated entirely; zero wastewater from vacuum system; CO ₂ cut $\approx 4,892$ t/year; noise ≤ 80 dB(A); fewer web breaks; floor space released

Note: physical quantities (kW, kWh, kPa, tCO₂) are as measured. Monetary values are converted at ₹14.00 per CNY and, for the India basis, valued at an indicative landed HT industrial tariff of ₹8.00/kWh; mills should substitute their own tariff using the sensitivity table in Section 3.7(c).

Contact Details

Technology supplier	Nanjing Cigu Technology Co., Ltd. (CIGU)
Technology	Maglev turbine vacuum pumps, CGV series
Mill	Yueyang Forest & Paper Co., Ltd., China
Indian representative / partner	Neopascal Technologies Pvt. Ltd. (Navi Mumbai)
	Deepak Dubey – deepak@neopascal.com +91-91366-07666

Case study 1B: Retrofit of liquid-ring vacuum pumps with Magnetic-Levitation (Maglev) Turbine Vacuum Pumps — Asia Pulp and Paper (APP) Indonesia, Perawang Tissue Mill by Nanjing Cigu Technology Co., Ltd. (CIGU)

65%	38.0 M kWh	₹ 3,042 Lakh	26,999 t
Less Power Used	Saved Each Year	Saved Each Year *	CO ₂ Avoided/Yr

* At an Indian power rate of ₹8.00 per kWh. The mill's own reported saving is about ₹2,400 Lakh a year. Section 3.7 explains both.

1. Project at a glance

Mill	APP Indonesia, Perawang Tissue Mill. Also rolled out at OKI, Lontar, BRW and PRW mills.
Product	Tissue paper
Scale	More than 30 vacuum pump positions replaced
What was done	Liquid-ring vacuum pumps were replaced with CIGU maglev turbine vacuum pumps (CGV series)
Result	Vacuum system power fell about 65%, from 6,652 kW to 2,311 kW. Sealing water use fell to zero.
Power saved	4,341 kW, or 104,184 kWh a day, or about 38.0 million kWh a year
Money saved	About ₹ 2,400 lakh a year as reported by the mill. ₹ 3,042 lakh a year at an Indian rate of ₹8.00/kWh.
Investment	About ₹ 3,000 to ₹ 4,500 lakh
CO ₂ avoided	About 26,999 tonnes a year
Payback	12 to 30 months
Can other mills copy it?	Yes. APP has already repeated it across five of its own mills.

2. Background / Baseline Scenario

Asia Pulp & Paper (APP) Indonesia is one of the world's largest integrated pulp and paper producers. It runs several tissue and paper mills, including Perawang, OKI, Lontar and Indah Kiat.

Every paper machine needs vacuum to pull water out of the wet sheet. Vacuum is used at the wire section, the couch roll, the suction boxes and the press felts. At the Perawang tissue mill this job was done by liquid-ring vacuum pumps.

Liquid-ring pumps are simple and tough. But they have well-known problems. They waste a lot of power. They need clean water all the time. That water gets dirty and must be treated. Scale builds up inside the pump, so vacuum drops and the pump must be shut down for acid cleaning. Seals and bearings wear out often.

A paper machine's vacuum system uses about 15–20% of the machine's total power. So these losses cost real money. Power and water prices were rising, and APP had sustainability targets to meet. The mill decided to replace the old pumps with maglev turbine vacuum pumps. These run dry — no water, no oil.

Why this matters for Indian mills

Perawang is a tissue mill, but the same vacuum system is used on every paper machine, whatever the grade.

Most Indian mills still use liquid-ring vacuum pumps.

Indian power costs ₹6–9 per kWh. That is higher than the rate behind the mill's own figures, so an Indian mill saves more money from the same change.

This case is larger than most single Indian sites, but the saving scales with the number of pumps. A mill with four pumps can expect about one-eighth of these numbers.

1. General Introduction of Liquid Ring Vacuum Pumps for Paper Dehydration System

Liquid ring vacuum pumps have been the standard choice for paper machine vacuum systems for many years. They create the suction that pulls water out of the paper web before it reaches the dryer section.

1. Working Principle

The pump is part-filled with water. A spinning impeller throws that water outwards into a ring against the pump wall. Because the casing is off-centre, the space between the impeller blades grows and shrinks as it turns. Growing space pulls air in. Shrinking space squeezes the air out. This continuous action creates the vacuum.

2. Traditional Advantages

The pump handles very wet air from the paper machine without trouble. Small amounts of fibre and whitewater will not damage it. It is simple to build and cheap to buy. That is why mills have used it for decades.

3. Inherent Disadvantages (Common Industry Pain Points)

#	Problem	What it means
1	Wastes a lot of power	Only 30–50% of the power put in does useful work. The rest is lost as heat. The pump also runs at fixed speed, so it cannot slow down when the machine needs less vacuum. The vacuum system uses 15–20% of the paper machine's total power.
2	Uses a lot of water	The pump needs clean water all the time. The mill must also run tanks, coolers and pipework to supply it. Whitewater mixes with the sealing water and causes scale and corrosion inside the pump.
3	Vacuum is unstable	As the sealing water heats up and gets dirty, the vacuum drops and cavitation starts. Once scale forms, the pump must be stopped and acid-cleaned. That interrupts the paper machine.
4	High maintenance	Bearings and mechanical seals wear out and need regular replacement. Leaks add to wastewater and treatment costs.
5	Hard to adjust	Fitting a variable speed drive to a liquid-ring pump saves little. The pump cannot follow changes in machine speed or paper basis weight.

II. Necessity of Retrofit to Maglev Turbine Vacuum Pump

A maglev turbine vacuum pump works in a completely different way. A high-speed motor spins a turbine wheel. The shaft floats on magnetic bearings, so nothing touches and nothing rubs. There is no water and no oil inside. A built-in variable frequency drive (VFD) changes the speed to match what the paper machine needs. The gains are as follows:

1. Big cut in power bills

The pump uses 30–50% less power than a liquid-ring pump. At Perawang the actual saving was higher, at about 65%. The pump slows down when the machine needs less vacuum, so the saving is largest at part load. Removing the sealing water system also saves the power used by water pumps and the cost of treating that water. Payback is usually 1 to 2.5 years.

2. Steadier vacuum, better paper

There is no water inside, so vacuum does not drift when water heats up or scale forms. Steady vacuum means the sheet dries evenly. Paper formation improves and web breaks drop.

3. Smart controls built in

The controller protects the pump against surge, allows remote monitoring and warns of faults early. It runs 24 hours a day without an operator and connects to the mill DCS.

4. Much less maintenance

Nothing touches inside the pump, so there is almost no wear. No lubricating oil is needed. There are no mechanical seals, bearings or wear rings to change, and no acid washing. There are also no water tanks, pipes or coolers to look after. Spare parts and labour costs fall sharply.

5. Saves water and cuts pollution

The pump uses no water at all, so it produces no wastewater. This lowers effluent volume and the chemicals needed to treat it. Being oil-free, there is no risk of oil leaking into the whitewater system. This helps a mill meet CPCB discharge limits.

6. Better working conditions

Noise is 80 dB(A) or lower. With no water system, there is no water on the floor and no mist in the pump house.

3. Project Details

3.1 Details of the energy saving project

Liquid-ring vacuum pumps at APP Indonesia were replaced with CIGU maglev turbine vacuum pumps. The work was piloted at the Perawang tissue mill and then scaled up. CGV series units were used, including CGV200 and CGV300 ratings.

Pumps were changed one at a time, as each old pump reached a maintenance point. This kept downtime to a minimum. The programme now covers Perawang and other APP mills at OKI, Lontar, BRW and PRW. The measured results in this Case study come from the Perawang tissue mill.



Nothing was changed on the paper machine itself. The vacuum levels required by the process stayed the same.

3.3 Schematic diagram

3.4 Operating principle and technology details

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The control system provides anti-surge protection, remote monitoring and early fault warning. It runs 24 hours a day, 7 days a week, without an operator.

Main product data for the CGV series (supplier figures):

Vacuum range	About 10–70 kPa
Air flow	Up to about 1,275 m ³ /min (CGV800)
Motor size	75 to 800 kW
Efficiency	Up to about 97%
Noise	80 dB(A) or lower
Running mode	24 hours a day, dry and oil-free, no operator needed

3.5 Modifications made for the upgrade

The pump itself was a straight swap. These extra changes were also needed:

The sealing water supply, tank, cooling pipes and water treatment were removed.

A new VFD and motor control panel was installed, with new cabling.

Inlet pipework and silencers were changed to suit the new pump.

The pump controller was linked to the mill DCS.

3.6 Project timeline and downtime

The work was done in phases, one machine at a time. The first CIGU maglev unit at Perawang was on machine TM61. It was commissioned on 24 October, 2023. More units followed through 2024. The last positions in this set, TM21, TM46 and the TUP lines, started up between September and October 2024.

Each swap was scheduled inside a planned maintenance window. So, downtime was limited to the short changeover of one vacuum position at a time. The mill kept running throughout the programme.

3.7 Improvements achieved: before vs after

The figures below were measured from DCS data at the Perawang tissue mill. Vacuum system power fell from an average of 6,652 kW to 2,311 kW. That is a saving

of 4,341 kW, or about 65%.

(a) Measured results

Parameter	Before	After	Change
Pumps	Liquid-ring	Maglev turbine (30 units)	Runs dry, no oil
Average power	6,652 kW	2,311 kW	4,341 kW less
Power used per day	159,648 kWh	55,464 kWh	104,184 kWh saved
Power used per year	58.27 million kWh	20.24 million kWh	38.03 million kWh saved
Power saving	Baseline	34.7% of before	65.3% less
Sealing water	Needed all the time	None	100% removed
Wastewater	Needs treatment	None	Zero discharge
Noise	Higher	80 dB(A) or less	Quieter

Yearly figures assume continuous running, 24 hours a day, 365 days a year.

(b) Machine by machine

The table below shows a sample of the installed units. The full programme covers more than 30 vacuum positions, so the sample does not add up to the total row.

Machine	Started	Before (kW)	After (kW)	Saving (kW)
TM61	24-Oct-23	245	46	199
TM72	05-Sep-24	315	112	203
TM81	04-Sep-24	315	107	208
TM82	03-Sep-24	315	107	208
TM91	12-Jul-24	400	227	173
TM92	15-Jul-24	400	227	173
TM21	30-Sep-24	225	52	173
TM46	02-Oct-24	245	57	188
TUP1	12-Sep-24	320	127	193
TUP2	13-Sep-24	185	90	95
TOTAL (30 units)	—	6,652	2,311	4,341

Individual machines saved between about 51% and 81% of their vacuum power. TM61 did best, dropping from 245 kW to 46 kW.

(c) Money saved

The mill reports a saving of about ₹2,400 Lakh a year. That works out to a power rate of about ₹6.31 per kWh. Indian mills pay more than this. The table below shows the same power saving valued at Indian rates. A mill should use its own rate.

Power rate	Before (₹ Lakh/yr)	After (₹ Lakh/yr)	Saving (₹ Lakh/yr)	Payback at ₹3,000–4,500 Lakh
₹ 6.00 / kWh	3,496.30	1,214.70	2,281.60	16 to 24 months
₹ 7.00 / kWh	4,079.00	1,417.10	2,661.90	14 to 20 months
₹ 8.00 / kWh (used here)	4,661.70	1,619.50	3,042.20	12 to 18 months
₹ 9.00 / kWh	5,244.40	1,822.00	3,422.40	11 to 16 months

At ₹8.00 per kWh an Indian mill of this size would save ₹3,042 Lakh a year, or about ₹30 Crore. Payback would be 12 to 18 months.

3.8 Environmental and other benefits

The pump uses no water, so there is no wastewater from the vacuum system and no chemicals to treat it. At this scale the sealing water saved runs to thousands of cubic metres a day. The pump uses no oil, so oil cannot leak into the whitewater. Less power used also means less CO₂ in the same proportion of about 65%.

How the CO₂ saving is calculated

The method is simple. Multiply the power saved by the grid emission factor. The emission factor tells you how much CO₂ the grid gives off for each unit of electricity.

Formula

CO₂ avoided (tonnes per year) = Power saved (MWh per year) × Grid Emission Factor (tCO₂ per MWh)

Step 1 — Find the power saved

Power saved per day	104,184 kWh	4,341 kW × 24 h
Days per year	365	Continuous running
Power saved per year	38,027,160 kWh	= 38,027 MWh

Step 2 — Pick the emission factor

The Central Electricity Authority (CEA) publishes the emission factor every year for the Indian grid. The latest is Version 21.0, published December 2025, covering FY 2024–25. Two values are given:

Which factor	Value (tCO₂/MWh)	When to use it
Weighted Average (WAEF)	0.710	For normal reporting of energy savings, including Scope 2 and BRSR Core. This is the one used here.
Combined Margin (CM)	0.7383	Only if the mill wants to sell the saving as carbon credits under the CCTS scheme.

Step 3 — Do the multiplication

Basis	Sum	Answer
CEA Weighted Average — used here	38,027 × 0.710	26,999 tCO ₂ a year
CEA Combined Margin	38,027 × 0.7383	28,075 tCO ₂ a year
Weighted Average, plus grid losses (17%)	(38,027 ÷ 0.83) × 0.710	32,529 tCO ₂ a year

Points to note:

The figure used here is 26,999 tonnes a year. It counts only the power saved at the mill meter. This is the normal and safer basis for reporting.

The third line adds the power lost in transmission lines. Use this only if the boundary is drawn at the power station, not for Scope 2 reporting.

The Combined Margin figure is only for carbon credit claims.

This calculation uses the Indian grid factor, because this manual is for Indian mills. The actual CO₂ avoided at Perawang depends on the Indonesian grid factor, which is different.

Summary of environmental benefits

Area	Benefit	Basis
Electricity	38.03 million kWh saved a year	65% less vacuum system power, measured from DCS
CO ₂	About 26,999 tonnes avoided a year	CEA factor 0.710 tCO ₂ /MWh, FY 2024–25
Water	Sealing water use cut to zero	Thousands of cubic metres a day at this scale
Wastewater	No discharge from the vacuum system	Water circuit fully removed
Chemicals	Less dosing needed for effluent treatment	No dirty sealing water to treat

Oil	No risk of oil reaching the whitewater	Pump runs oil-free
Noise	80 dB(A) or less	Supplier rating and site reading
Space	Tanks, pipes and coolers removed	Better housekeeping, floor space freed

The mill also reports steadier vacuum, more even drying, better paper formation, fewer web breaks and less unplanned downtime.

3.9 Challenges faced

Three main challenges came up in a live tissue mill. First, each pump swap had to fit inside planned downtime, so no production was lost. Second, the existing pipework and silencers had to be matched to the faster, dry-running pump. Third, a new supplier's controller had to be linked to the mill DCS.

All three were handled by commissioning in stages, redesigning the inlet pipe and silencer, and testing the controller link before start-up.

3.10 Project photographs

The photographs below show installed CIGU maglev turbine vacuum pumps at APP Indonesia mills. The units are compact and the area is free of the water pipes, tanks and coolers the old system needed.



Figure 6 Installed CIGU maglev turbine vacuum pumps at APP Indonesia



Figure 7 Installed CIGU maglev turbine vacuum pumps at APP Indonesia

3.11 Replication potential

Replication potential: HIGH

Any paper machine that uses liquid-ring vacuum pumps can make the same change. It works for tissue, cultural, writing, printing, kraft and packaging grades.

APP has already repeated the retrofit across five of its own mills — Perawang, OKI, Lontar, BRW and PRW — and across many machine positions.

Indian mills with old pumps, high power costs or tight effluent limits will gain the most.

Pumps can be changed one at a time during planned maintenance. So, the spend can be spread over several years.

Check this	Good sign for a retrofit
Existing pumps	Liquid-ring pumps, especially old or oversized ones
Paper grade	Any grade
Running hours	Continuous running, 7,000 hours a year or more
Power rate	₹ 6 per kWh or higher
Water and effluent	Water shortage, or tight CPCB / SPCB discharge limits
Maintenance record	Frequent seal, bearing and wear ring changes, and acid washing

3.12 Energy saving and other details

Sn	Parameters	Unit	Before	After
1	Process / operating vacuum	kPa	Unstable. Drops as sealing water heats up and scale forms.	Steady at the set level (about –35 kPa ultimate), controlled by VFD
2	Power	kW	6,652 (average, liquid-ring)	2,311 (average, maglev)
3	Steam consumption	—	No change — outside project scope	No change — outside project scope
4	Energy saving	kW / kWh per day	—	4,341 kW (about 104,184 kWh a day); 65% less; 38.03 million kWh a year
5	Monetary benefits	₹ Lakh	—	About 2,400 a year as reported by the mill
				About 3,042 a year at ₹8.00/kWh in India
6	Investment	₹ Lakh	—	About 3,000 to 4,500
7	Payback	Months	—	12–30 (1 to 2.5 years). At ₹8.00/kWh in India: 12 to 18 months.
8	Any other benefits (related to environment)	—	—	Sealing water eliminated (thousands of m ³ a day); no oil leakage risk; about 26,999 tonnes less CO ₂ a year; noise 80 dB(A) or less; fewer web breaks; floor space freed

Note: kW, kWh and kPa figures are as measured at the Perawang tissue mill. Yearly figures assume continuous running. Indian money figures use ₹8.00 per kWh; use your own rate from the table in Section 3.7(c). CO₂ is calculated on the Indian grid factor.

4. Contact Details

Technology supplier	Nanjing Cigu Technology Co., Ltd. (CIGU)
Technology	Maglev turbine vacuum pumps, CGV series
Mill	APP Indonesia, Perawang Tissue Mill (also OKI, Lontar, BRW, PRW)
Indian representative / partner	Neopascal Technologies Pvt. Ltd. (Navi Mumbai) Deepak Dubey – deepak@neopascal.com +91-91366-07666

Case study 2: Recovering Wasted Steam Energy: A Back Pressure Turbine Retrofit at a Kraft Paper Mill in Chennai

Sukraft Paper, kraft paper unit in Chennai, has replaced a conventional Pressure Reducing Valve (PRV) with a 650 kW back pressure steam turbine. The retrofit converts what was once a pure throttling loss into roughly 11,000 units of clean, captive electricity every day — while simultaneously delivering steam to the paper machine's dryer section at closer to its ideal temperature. The result is an estimated ₹1.04 lakh in daily electricity savings, more consistent paper quality, and virtually no increase in coal consumption.

LOCATION	TURBINE INSTALLED	DAILY GENERATION	DAILY SAVINGS
Chennai, Tamil Nadu	650 kW Back Pressure	≈ 11,000 units	≈ ₹1,04,500

Plant Profile

Paper Mill manufactures high-GSM kraft paper at its Chennai facility, drawing saturated steam from a coal-fired boiler for both its paper machine dryers and, since the retrofit, its captive turbine.

Industry	Paper manufacturing
Product	High-GSM kraft paper (120–250 GSM)
Boiler Steam Conditions	21 kg/cm ² (g), 200–220°C, saturated
Steam Consumption	7–17 TPH (varies with grade and production load)
Required Dryer Steam	140–160°C saturated (average ~150°C)

The Challenge: Energy Thrown Away Across a PRV

Before the retrofit, boiler steam at 21 kg/cm²(g) and 220°C was reduced through a Pressure Reducing Valve to 4.2 kg/cm²(g) for use in the paper machine. While the PRV brought pressure down to a usable level, it did nothing to recover the energy in that pressure drop — and the steam leaving the valve, at around 180°C, remained far hotter than the dryer cylinders actually needed.

No energy recovery: the full pressure drop across the PRV was a pure throttling loss.

Steam stayed highly superheated, with dryer inlet temperatures around 180°C.

Kraft paper quality is sensitive to excess heat — dryer cylinders need saturated steam in the 140–160°C range (average ~150°C), and higher temperatures make it harder to hold consistent GSM and sheet quality.

With no desuperheater in place, there was no straightforward way to correct this without added equipment and cost.

The Solution: A 650 kW Back Pressure Steam Turbine

The PRV was replaced with a 650 kW back pressure steam turbine. Instead of simply throttling the pressure drop away, the turbine extracts useful work from it — turning a generator to produce captive electricity — while still reducing steam pressure from around 18–20 kg/cm²(g) for downstream use. In doing so, the turbine also absorbs roughly 30°C of the steam's superheat, delivering it to the paper machine much closer to the temperature the dryer cylinders are designed for.



Figure 8 Back Pressure Turbine

Because the turbine itself removes the excess superheat as a by-product of generating power, a separate desuperheater was not required — simplifying the retrofit and keeping additional capital cost low.

The complete turbine-generator train at Sukraft Paper Mill, tapping high-pressure boiler steam and delivering reduced-pressure steam to the paper machine.

Results at a Glance

Parameter	Outcome
Turbine Capacity	650 kW back pressure steam turbine, installed in place of the existing PRV
Electrical Generation	≈ 11,000 units (kWh) per day
Daily Savings	≈ ₹1,04,500 per day, at an electricity tariff of ₹9.5/kWh
Coal Consumption	Increased by only 1–2% — no meaningful change in fuel use
Dryer Steam Temperature	Reduced from ~180°C to ~150°C, matching the paper machine's requirement
Desuperheater	Not required
Paper Quality	Consistent high-GSM kraft paper (120–250 GSM) output
Plant Efficiency	PRV throttling losses eliminated; steam delivered at process-matched conditions

Why Back Pressure Turbines Make Sense

Wherever a plant already reduces steam pressure through a PRV to serve a process — as is common across paper, textile, sugar, food processing, and pharmaceutical plants — that pressure drop represents recoverable energy. A back pressure turbine captures it as electricity without changing how much steam reaches the process, and, as at the Kraft Paper Mill, can even improve steam quality at the point of use. With coal consumption essentially unchanged and payback typically within one year for retrofits of this kind, it is one of the more straightforward cogeneration upgrades available to process industries running a boiler and a PRV side by side.

Technology Partner: NCON Turbo Tech Pvt. Ltd., Bangalore

Case study 3: From Problem to Solution – OxyBooster’s Impact for Paper Mill Fuel Cost Reduction: The Sustainable way – A Case study

Introduction

A 450 TPD Writing and printing paper mill in Punjab has a 28 MW captive power plant with a 130 TPH, 110 kg/cm², 545 Deg.C – Circulating fluidised bed combustion boiler. This boiler was procured around 2019 and designed for 70% Indian coal and 30 % Biomass.

With coal quality deteriorating year by year with very buoyant prices especially during the year 2023 –24, forced the unit to look for alternate fuel and also reduce the percentage of coal and increase the biomass mix percentage to optimize the fuel cost.

The Problem

the paper mill wanted to decrease the coal percentage and increase biomass so as to achieve an optimum fuel cost. as per the boiler OEM, there were certain constraints with the boiler design to increase the biomass percentage beyond 25% with the present boiler construction configuration. The result of increase in biomass percentage by the paper mill boiler operation team resulted in the boiler parameters were getting affected and the combustion became unstable.

- Some of the operational challenges faced and reported were:-
- Drop in furnace O₂ level below 1.0% – excess CO in furnace
- Excess furnace +ve pressure
- Uncontrolled super heater temperature and high attemperation.
- Higher unburnt carbon in ash
- Frequent soot deposition in super heater / economiser zone leading to frequent tube failures.
- Excess fuel inventory in the furnace due to incomplete combustion

The Paper Mill was running the boiler with fuel combination, for an average steam Generation per day of 2695.7 tonnes/day:-

Table 1 Types of fuel consumed and its parameters

Sl No	Particulars	Average GCV	Average Quantity per Day, Tonnes	% firing on weight basis
1	Indian coal	3596	389.2	73.3%
2	Rice husk	3473	66.43	12.5%
3	Khuddi	3114	5.23	1%
4	Straw dust (In house)	3348	35.5	6.7%
5	Wood dust (In house)	2524	34.86	6.6%
	Total per day		531.2 Tonnes	

The best achieved fuel ratio mix of fuel firing was:-

Indian Coal	-	73.3 %
Mix Biomass	-	26.7%

The Cause – for Combustion imbalance

The main cause of the furnace performance disturbances was due to different burning characteristics of input fuel with heterogeneous nature, especially with respect to – GCV, FC/VM ratio, Ash, Moisture etc. As different fuels have different ignition temperature, the Volatile release and Carbon (Fixed & Free) burn out differs within the furnace leading to non-uniform temperature profile across the bed and furnace. This in turn leads to higher heat losses – Higher Unburnt Carbon in Ash, Higher Radiation, Higher dry flue gas losses etc.

Due to the above reasons as well as boiler design constraints, it was not possible to increase the percentage of biomass and reduce the percentage of coal, without modification in the boiler feeding system as well as furnace design. Modifying the boiler to take higher percentage of biomass involved capital cost and a few months of boiler shut down, which would lead to heavy production losses.

The paper mill approached Supreme Energy Solutions, Trichy for a solution to increase the biomass percentage, without any shut down or modification in boiler.

The Solution – Oxy-Booster Bio Enzyme Combustion performance enhancer

Based on the operation inputs from the paper mill, Supreme energy solutions, Trichy visited site to check the suitability of enhancing biomass percentage and suggested use of **Oxy-Booster O2 Swift®** which is a bio enzyme combustion performance enhancer, which could be added along with the fuel mix, and it can be deployed without any modification or stoppage of the boiler.

What is Oxy-Booster

Oxy-Booster is an agglomerated bio enzyme treated configured material, 100% eco-friendly, non-toxic, non-reactive and safe biomaterial, that synchronizes the heat input of various heterogeneous energy inputs in the furnace and maintains thermal equilibrium, by reducing the undue heat losses.

Composition of Oxy-Booster

Oxy-Booster consists of different waste chips of soft & hard wood, twigs, dried leaves etc., pyrolysis processed derivative bio carbon all treated with proprietary bio enzyme.

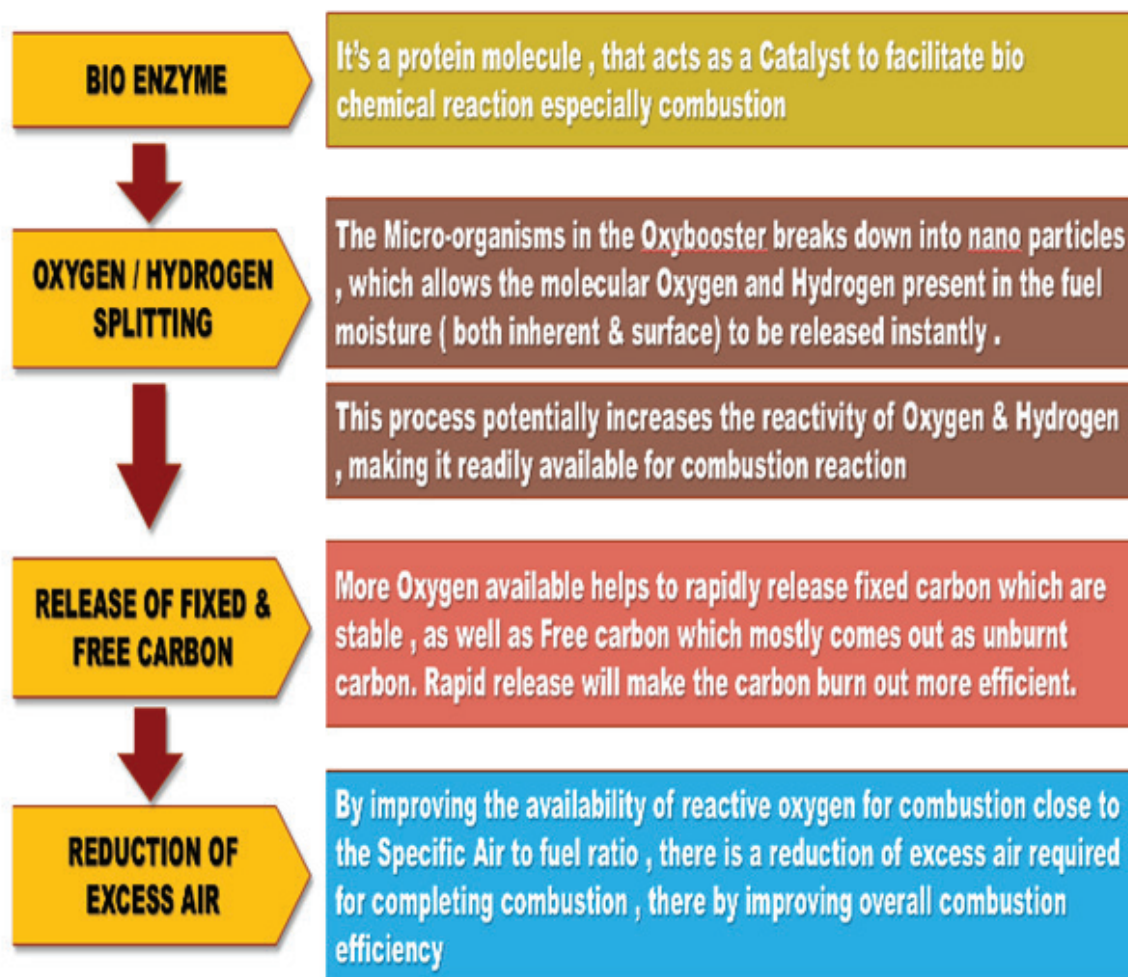


Figure 9 Impact of Bio enzyme in the Furnace

It is 100% biomaterial and contains no chemicals, non-toxic and is safe to handle and use by human beings, without any special PPEs.

How does Oxy-Booster act inside the furnace

The bio enzyme in the Oxy-Booster when it enters the furnace along with the fuel / fuel mix, it splits up into millions of nanoparticles, which triggers a series of rapid reactions as shown in figure below: –

Solution tailor made for Paper Mill fuel cost reduction challenge

Key Performance Indicators (KPI)

Increasing firing of biomass mix – from existing 26.7 % to 30%

Reducing firing of coal – From existing 73.3% to 70%

Without any modification in the boiler and feeding system.

To achieve the above, use – 101 kg per day of **Oxy-Booster O2 Swift®** per day.

Feeding system for Oxy-Booster

The CFBC boiler had two feeding points with pressurized drag chain feeder (DCF 1 & DCF 2). Oxy-Booster dosing was recommended in the DCF. Since the DCF was pressurized, a special feeder was fabricated at site, which consisted of a hopper of 6 kgs capacity and two manually operated gate valves.

About 4.20 kgs of Oxy-Booster O2 Swift® per hour was equally distributed and fed to the 2 DCF's through the feeder arrangement.



Figure 11 Installation of feeding system for Oxy-booster

Before dosing both the gate valves were kept in close condition and required quantity of Oxy-Booster was fed into the hopper. First, the top valve was open and quantity of Oxy-Booster contained in the hopper was emptied inside the intermittent pipe. Then the top gate valve was closed, and the bottom gate valve was opened to feed the Oxy-Booster Material into the drag chain feeder to transport along with mix fuel into the furnace. The feeding process is shown in Figure 10.



Figure 10 Feeding system for Oxy-booster

Result Achieved

Within first four days of feeding Oxy-Booster, the team could achieve a reduction in Coal Percentage firing from – 73.3% to 68.9 % → a drop of 4.4 % and simultaneously increasing biomass mix firing percentage from – 26.7 % to 31.1%.

Over a 30-day period of running with Oxy-Booster, the coal firing percentage dropped to 63.5 %, a drop of 10.2% and proportionately the biomass mix firing percentage increased to 36.5%. The guaranteed KPI versus parameters achieved during the 30-day performance run with Oxy-Booster is summarized below: –

Table 2 KPI Guaranteed vs Achieved

KPI Parameters	As Guaranteed	Achieved During Performance Run
Coal firing percentage reduction	From 73.3% to 70%	From 73.3% to 63.5 %
Biomass mix firing percentage Increase	From 26.7% to 30%	From 26.7% to 36.5 %
Oxy-Booster O2 Swift® consumption per day, kgs	101 kgs	100.97 kgs

The total average steam flow and fuel consumption is tabulated below: –

Average Steam generation for the 30 day performance run = 2786.4 tonnes/day

Table 3 Average Steam flow and fuel consumption

SI No	Particulars	Average GCV	Average Quantity per Day, Tonnes	% firing on weight basis
1	Indian coal	3623	374.9	63.5 %
2	Rice husk	3500	119.8	20.3%
3	Pith (In house)	2118	9.97	1.68%

Sl No	Particulars	Average GCV	Average Quantity per Day, Tonnes	% firing on weight basis
4	Straw dust (In house)	3392	47.9	8.11%
5	Wood Dust (In house)	2610	37.4	6.33%
	Total per Day		589.97 Tonnes	

The achieved fuel ratio mix of fuel firing with **Oxy-Booster O2 Swift®** was: –

Indian coal	–	63.5 %
Mix biomass	–	36.5 %

Other Key performance features with **Oxy-Booster O2 Swift® feeding** were: –

Total combustion air quantity reduction – A saving of 2.7 TPH and 64.8 tonnes per day was saved.

ID Fan RPM Reduction – The ID Fan RPM reduced by 14% during performance test, signifying reduction in Power cost.

O2 Level in furnace – In spite of increase in Biomass percentage firing by 10.2%, the Oxygen level inside the furnace did not drop below 3.3 %.

No capacity deration – In a normal boiler operation, when coal is replaced with biomass, there ought to be some boiler capacity deration. But with **Oxy-Booster O2 Swift®**, there was no such capacity reduction, and boiler was being operated to its full MCR.

Loss on Ignition (LOI %) – The LOI prior to performance run was 0.68% and during the performance run it marginally increased to 0.71%. Normally when there is a coal to biomass switch, due to inadequate free board available, the LOI % drastically increases, which did not happen in this case.

Environmental Impact & Carbon Footprint Reduction

CO2 Emissions prior to use of Oxy-Booster (Assuming Indian coal having total carbon of 37%) is tabulated below: –

Table 4 CO₂ emissions before and after

Sl No	Particulars	Before Use of Oxy-Booster	During Oxy-Booster Run	Remarks
1	Coal consumption, tonnes per day	389.2	374.9	
2	Total carbon assumed	37%	37%	
3	CO ₂ emissions per day, tCO ₂ e	528.01	508.61	= 44/12 X Carbon % X Fuel qty
4	CO ₂ emission reduced per day, tCO ₂ e	–	19.40	
5	CO ₂ emissions reduction per annum, tCO ₂ e	–	6402	330 days operation
6	Equivalent number of trees planted per day in terms of CO ₂ absorption	–	776	A 4-Year-old tree absorbs 25 kgs of CO ₂ per Annum (Average)

SI No	Particulars	Before Use of Oxy-Booster	During Oxy-Booster Run	Remarks
7	Equivalent number of trees planted per annum in terms of CO2 absorption	-	2,56,080	

7.0 Conclusion

Fuel switch from fossil fuel to biomass or any other alternate fuel option is possible in an economically and technically viable way with Oxy-Booster bio enzyme combustion enhancer, that too without any major modification in the boiler and feeding system.

Oxy-Booster also helps achieve the ESG initiatives of any company by reducing the CO2 footprint, reducing the combustion air and reducing water needed for steam attemperation.

Case study 4: Papyrus360 Optrim: Deckle Matching Software for Paper Manufacturing

Abstract

The Paper manufacturing industries face significant production losses due to inefficient deckle planning and trim waste. Papyrus360 Optrim, developed by Netique Infotech Private Limited, is a specialized optimization software that automates deckle matching and trim optimization for paper mills. The software employs optimization techniques to determine the best possible order combinations while minimizing trim loss and maximizing machine utilization. This report analyses the software architecture, working methodology, business impact, implementation process, and benefits to the paper manufacturing industry.

I. Introduction

The paper manufacturing industry produces paper rolls of different widths according to customer requirements. Since customer orders rarely match the exact deckle width of a paper machine, manufacturers experience trim losses during cutting. Traditional manual deckle planning depends heavily on experienced planners and often results in suboptimal machine utilization.

Papyrus360 Optrim addresses this challenge through automated optimization, enabling production planners to generate efficient cutting combinations within minutes.

II. Background

Netique Infotech Private Limited is a Bengaluru-based software company specializing in digital solutions for the paper manufacturing industry. Under its Papyrus360 platform, the company offers ERP systems, production planning tools, process optimization software, and deckle matching solutions. According to the company, Optrim has evolved from its earlier Netique Deckle Matcher and has been refined through decades of paper industry experience.

Company: Netique Infotech Private Limited

Product: Papyrus360 Optrim (formerly Netique Deckle Matcher)

Industry: Information Technology and Paper Manufacturing Solutions

Headquarters: Bengaluru, Karnataka, India

Netique Infotech specializes in software solutions, process optimization, automation, ERP systems, besides consulting services for the paper industry and trading activities. The company combines industry knowledge with information technology to improve operational efficiency and productivity in paper mills.

III. Problem Statement

Paper mills commonly experience:

High trim loss

Increased production costs

Low machine utilization

Manual production planning

Delayed order execution

Difficulty handling multiple machine constraints

Wastage of raw materials.

These operational problems reduce profitability and production efficiency

IV. Proposed Solution

Papyrus360 Optrim provides automated deckle optimization by:

Importing customer orders

Considering machine deckle sizes

Applying optimization algorithms

Selecting the best order combinations

Minimizing trim waste

Generating production schedules and reports

The system integrates with ERP and order management software to streamline production planning.

V. System Architecture

The software architecture consists of:

User Interface

Order Management Module

Optimization Engine

Database

Reporting Dashboard

ERP/SAP Integration Layer

VI. Working Methodology

Customer orders are imported.

Machine specifications are loaded.

Cutter limitations are applied.

Optimization algorithms generate combinations.

Trim loss is calculated.

Best production plan is selected.

Reports are generated for planners and management.

VII. Major Features

Automated deckle matching

Trim optimization

Multiple paper machine support

Multiple cutter configurations

Interactive dashboards

Analytics and reports

ERP integration

Stock roll utilization

Flexible production parameters

High-speed optimization

Improved customer delivery performance.

Better decision-making through analytics

VIII. Results and Benefits

Expected organizational benefits include:

Table 5 Performance Indicators Before vs After

Performance Indicator	Before	After Implementation
Planning time	Several hours	Few minutes
Trim waste	High	Reduced
Machine utilization	Moderate	Improved
Manual dependency	High	Low
Decision making	Manual	Data-driven

Table 6 Calculation sheet for savings

S No	Particulars	Working	Unit
1	Trim Savings		
	Production Capacity / Day- in MT	300	MT
	No of Days	320	
	Annual Production - in MT	96,000	MT
	Deckle Loss in case of Manual Planning - @ 4%	3,840	MT
	Deckle Loss in case of Optrim Software - @ 2.5%	2,400	MT
	Savings by using Optrim Deckle Matching Software- Per Annum	1,440	MT
	Contribution / MTonnes of Paper - ₹	10,000	₹
	Total Savings in ₹ Per annum	1,44,00,000	₹
	Say	144.00	₹ in lakhs
2			
a.	Power Savings		
	Power consumption / Tonnes of Paper	450.00	kW
	With 4% of deckle loss (450 x 1.04)	468.00	kW
	With 2.5% of deckle loss (450 x 1.025)	461.25	kW
	Power Savings / Tonnes of Paper	6.75	kW
	Power Savings on Total Saving Qty	9,720.00	kW
	Power Cost / kW	8.00	₹
	Total Savings in ₹ / Per annum	77,760.00	₹
	Say	0.78	₹ in lakhs
b	Steam Savings		
	Steam Consumption / tonnes of paper	2.50	MT

S No	Particulars	Working	Unit
	With 4% of deckle loss (2.5 x 1.04)	2.60	MT
	With 2.5% of deckle loss (2.5 x 1.025)	2.56	MT
	Power Savings / tonnes of Paper	0.04	
	Steam Savings on Total Saving Qty	54.00	kW
	Steam Cost / tonnes	2,000.00	₹
	Total Savings in ₹ / Per annum	1,08,000.00	₹
	Say	1.08	₹ in Lakhs
Overall Savings		145.86	₹ in Lakhs
Software Licence Cost		5.50	₹ in Lakhs
Savings / Annum		140.36	₹ in Lakhs

Table 7 Parameters Before vs After, investment and benefits

Sr. No.	Parameters	Before	After
1.	Trim Waste	3–5%	1–1.5%
2.	Power	More than 5% loss	1 – 1.5% Savings
3.	Steam consumption	More than 5% loss	1 – 1.5% Savings
4.	Energy saving	More than 5% loss	1 – 1.5% Savings
5.	Monetary benefits	₹ 1.20 Crores per annum	
6.	Investment	₹ 10.00 Lakhs per annum	
7.	Payback	10 – 90 Days	
8.	Any other benefits (related to environment), if any	Effluent Treatment Plant load is reduced to the extent of Trim Savings.	

IX. Limitations

Requires accurate production data.

Initial employee training is necessary.

ERP integration requires configuration.

Optimization quality depends on order quality.

X. Future Scope

Future improvements may include:

Artificial Intelligence-based optimization

Machine Learning demand prediction

Cloud deployment

Mobile monitoring applications

Predictive production analytics

XI. Customer Success

Papyrus360 highlights feedback from paper manufacturers including JK Paper, Mehali Paper Mills, and Emami Paper Mills, where customers reported improved deckle utilization, smoother planning, and satisfactory software performance after implementation.

XII. Conclusion

Papyrus360 Optrim is a domain-specific optimization software designed for paper manufacturers. By automating deckle matching and trim optimization, the software reduces production waste, improves machine utilization, and enhances production planning efficiency. The solution demonstrates how industry-specific optimization software can significantly improve operational performance in manufacturing environments. The solution can also result in energy and power savings across various stages of the production process.

Case study 5: AI-Driven Strategies To Enhance Production And Quality: South African Mill



BACKGROUND

The Mill is located in South Africa and plays a significant role in South Africa's paper industry. It produces approximately 380,000 tonnes annually, primarily focusing on newsprint and kraft linerboard (KLB) used for packaging. The mill utilizes a legacy Bellmer machine for its PM1 line, which is known for producing KLB, premium, unbleached, 100% virgin fiber paper is used to create robust corrugated board and boxes. It provides the high-strength outer layer (liner) essential for the transportation of industrial goods and heavy agricultural produce.

THE CHALLENGE OF MAINTAINING QUALITY

- The managers at PM1 Mill have faced challenges in
- High variation in paper quality on the MD and CD
- High cull after grade changes, sheet break and machine upsets
- Moisture instability
- Frequent stock flow disturbances
- Steam demand fluctuations
- Machine speed restrictions
- Intermittent short circulation instability

Although DCS and QCS controls were available, the machine could not sustain stable operation because disturbances originated from the process itself rather than the control loops. This challenge was identified during OPTIPID paper machine optimisation program.

OBJECTIVE :

Reduce	Increase
Basis weight variation	Machine stability
Moisture variation	Production
Grade change time	Product quality
Steam disturbances	Process consistency

During OPTIPID's audit, following activities were carried out

Process data analytics

Loop performance analysis

QCS analysis

Reel report analysis

Dynamic bump testing

Stock stability analysis

Machine response analysis

Process spectrum analysis

Root cause analysis

Training the mill engineers

This comprehensive approach showed that the remaining variability was caused by instability in the short circulation system rather than by poor controller tuning. After the audit, the following issues were identified.

Stock flow and consistency variations

Unstable mixing chest & silo level variations

Headbox dynamics and vacuum variations

Sluggish steam pressure and differential pressure controls

Chemical flow variations and associated control-logic issues

Faulty instruments – sticky valves / NRV jam

Intermittent process disturbances

SOLUTION :

To proactively address these issues, the mill decided to implement OPTIPID Optimization services to enhance 228 control loops across the stock preparation, wet-end, and dry-end sections of one of their machines. OPTIPID

gathered data over an extended period to capture a wide range of operating scenarios, addressing various problems related to different grades and operating conditions throughout all process sections.

KPI :

To quantify the operational issues and prioritize corrective actions, OPTIPID conducted a comprehensive KPI-based performance assessment. The OPTIPID unique methodology for calculating Key Performance Indicator (KPI) analysis, as provided by performance optimization, identifies issues and offers recommendations with prioritized solutions. After addressing the identified problems, the KPI index showed a significant reduction, as illustrated in following table:

Process Indexes

Parameters	Goal	Before	After	Improvement
 Loop Tuning Index	<15	>42	<28	44% ↑
 Top Stock Stability Index	<0.3	1.38	0.687	51% ↑
 Bottom Stock Stability Index	<0.3	1.48	0.561	58% ↑
 Mid Stock Stability Index	<0.3	1.27	0.518	63% ↑
 Weight Response Index	<1.5	4.231	1.508	40% ↑
 Moisture Response Index	<1.5	4.029	1.32	41% ↑
 Weight MDL 2 Sigma	—	1.5	0.82	46% ↑
 Moisture MDL 2 Sigma	—	0.62	0.38	39% ↑

FINDINGS AND IMPROVEMENT PLAN

The following is a list of recommendations aimed at improving and sustaining the performance of this machine.

Improvement Plan

Description	Responsibility	Priority	Benefits
 Consistency Dilution Water Pressure Control Improvement	 Process / Eng	High	✓ Better consistency resulting better weight and moisture MD
 Refiner improvement program	 Process	High	✓ Better quality (PM1 team already planned)
 Maintain the Machine Chest Consistency 3.0 -3.2%	 Process	High	✓ Better mixing at Silo resulting better weight and moisture MD
 Install VSD for Stock flow pump	 Management	Medium	✓ Better thin and thick stock mixing at Silo resulting MD and CD
 Broke Consistency improvement	 Process/Eng	High	✓ Better cons control at mid ply mixing level will improve MD
 Couch Pit improvement	 Process/Eng	Medium	✓ Better broke management resulting stable machine
 Acid spill chest operation during running	 Process	Low	✓ Stable operation
 Save all supply, sweetener stock and dilution water logic	 Process/Eng	Medium	✓ Stable save all operation resulting stable quality
 Waste plant consistency stabilization	 Process	High	✓ Better furnish management resulting stable quality
 Silo operation improvement	 Process	High	✓ Better thin & thick stock mixing resulting less MDS variation
 Headbox DP Control	 Process/Eng	Medium	✓ Maintain a uniform pressure distribution
 Install chemical dilution water pressure control	 Eng	High	✓ Maintain a uniform chemical
 Low & Medium vacuum fan operation improvement	 Process/Eng	High	✓ Drainage improvement resulting stable quality & production
 Vacuum settings to be reviewed and improved	 Process	Medium	✓ Improved drainage
 Vacuum transmitter ranges to be reviewed and corrected	 Eng	Medium	✓ Improved drainage visibility
 Steam section vacuum transmitter can be installed	 Eng	Medium	✓ Improve steam and condensate operations
 Auto Grade change operation	 Optipid	High	✓ Less disturbance
 APC can be installed	 Eng	Medium	✓ Reduced retention variation.
 Faulty Valves to be repaired / replaced	 Inst	Low	✓ Better Operation
 Maintain the proper set points in all the control loops	 Process	High	✓ Better cons maintenance will sustain the machine performance
 CD dilution profiler target profile feature can be utilized	 Process	High	✓ Sustain the CD performance

After implementing the recommended corrective actions and control improvements, significant operational improvements were observed across the machine. This improvement resulted in reduced paper rejects and better time to target issues such as grade changes, faster sheet break recovery, and better startups. The below table shows that more than 50% issues were reduced during grade change, break recovery and faster startups.

Response Improvement

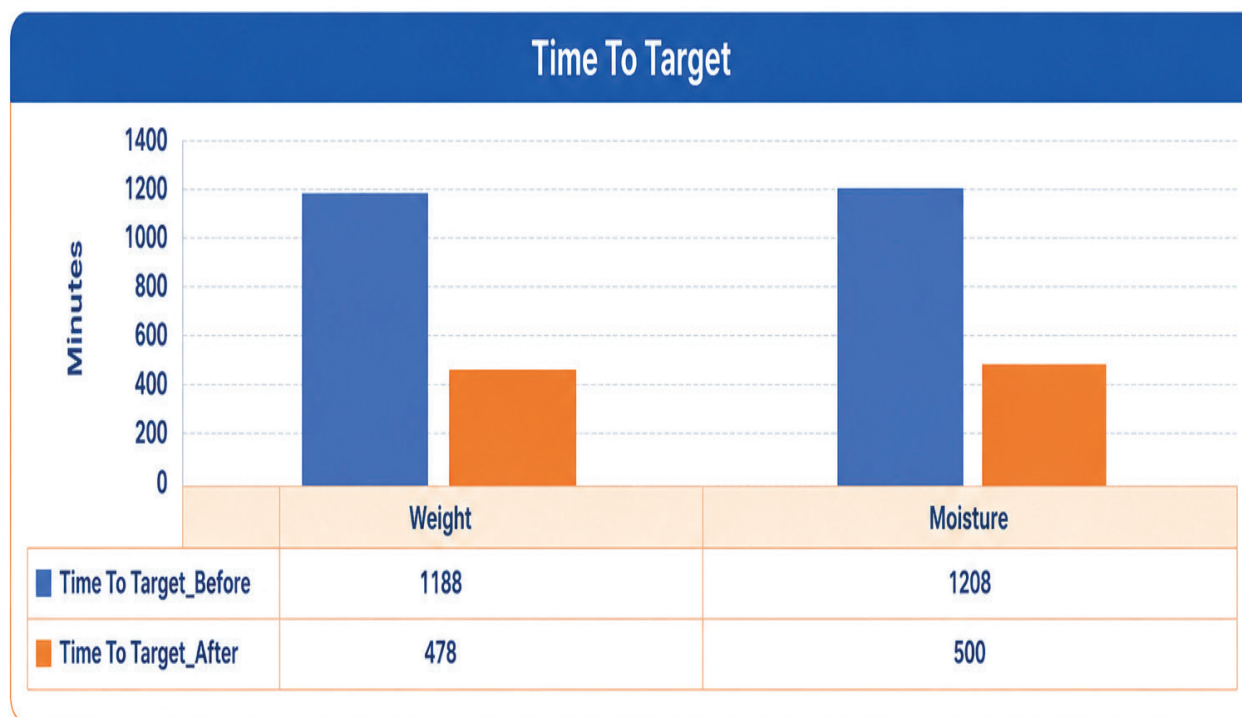
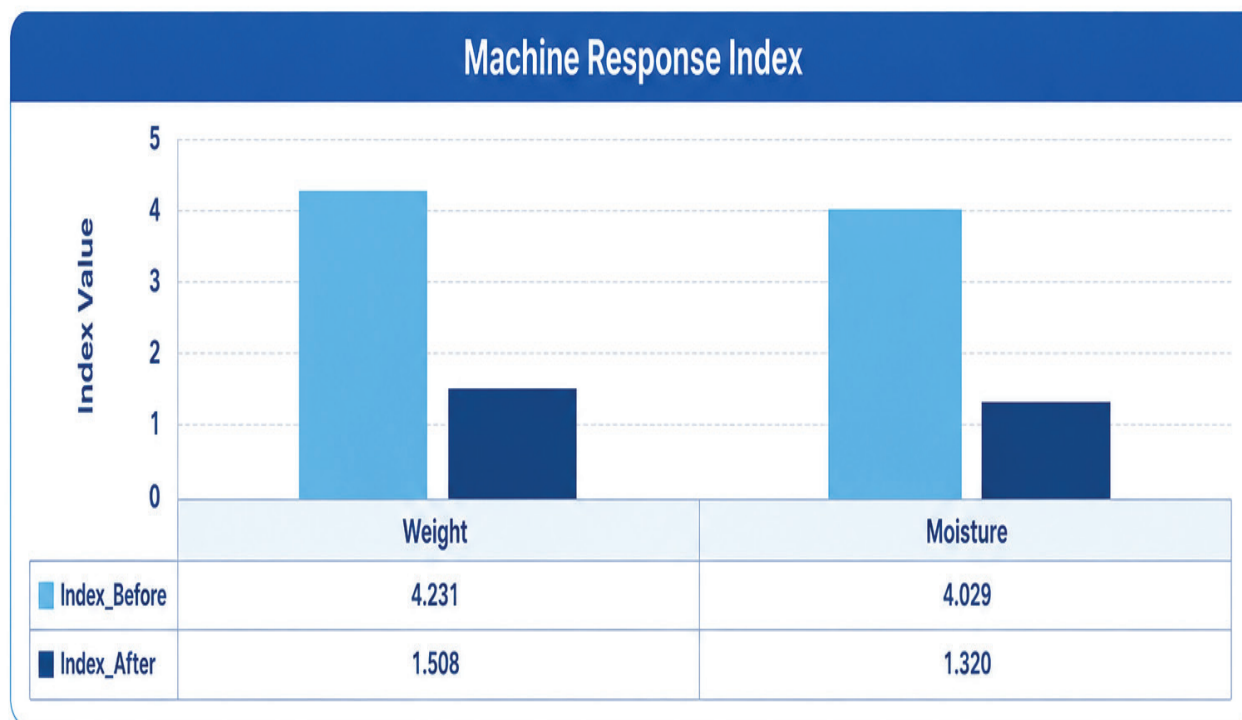


Table 8 Machine response Before Vs After

Machine Response	Index Before	Index After
Weight	4.231	1.508
Moisture	4.029	1.32
Response Time	Time To Target Before	Time To Target After
Weight	1188	478
Moisture	1208	500
Weight	Before Tuning	After Tuning
Response Index	4.231	1.508
Time to Target	1188	478
Moisture	Before Tuning	After Tuning
Response Index	4.029	1.32
Time to Target	1208	500

RESULTS AND DISCUSSION

There were few findings for loop performance as below

PM1 is using 102 loops for the operation out of 228 loops

13 loops were identified as valve problem

113 loops were identified as tuning problem which has been tuned

126 loops are not being used (valve out of range or manual)

Few control loops from consistency, vacuum, chemical and steam are 100% valve opening intermittently

Potential Problem 1 – Loop Tuning

PM1 achieved all the loops improvement following the fine-tuning of the control loops. The following figure illustrates a typical improvement achieved after loop tuning

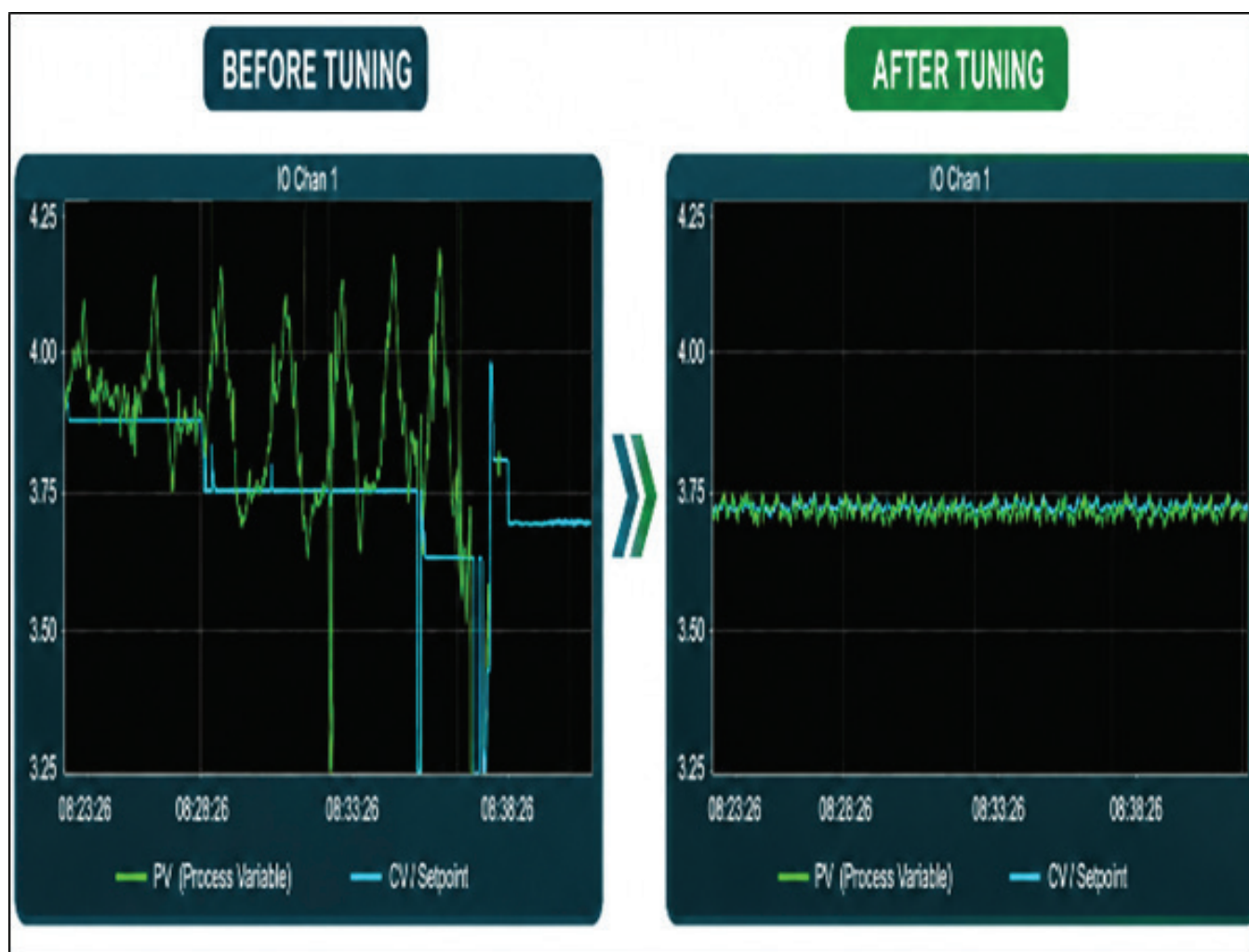


Figure 12 Consistency variation reduced after loop tuning

Potential Problem 2 – Process

After modifying few lines and fine tuning of loop, we observed that all the steam pressure and differential pressure were stabilised and it was noticed that the moisture 2 sigma variations has come down drastically after fine tuning of steam section.

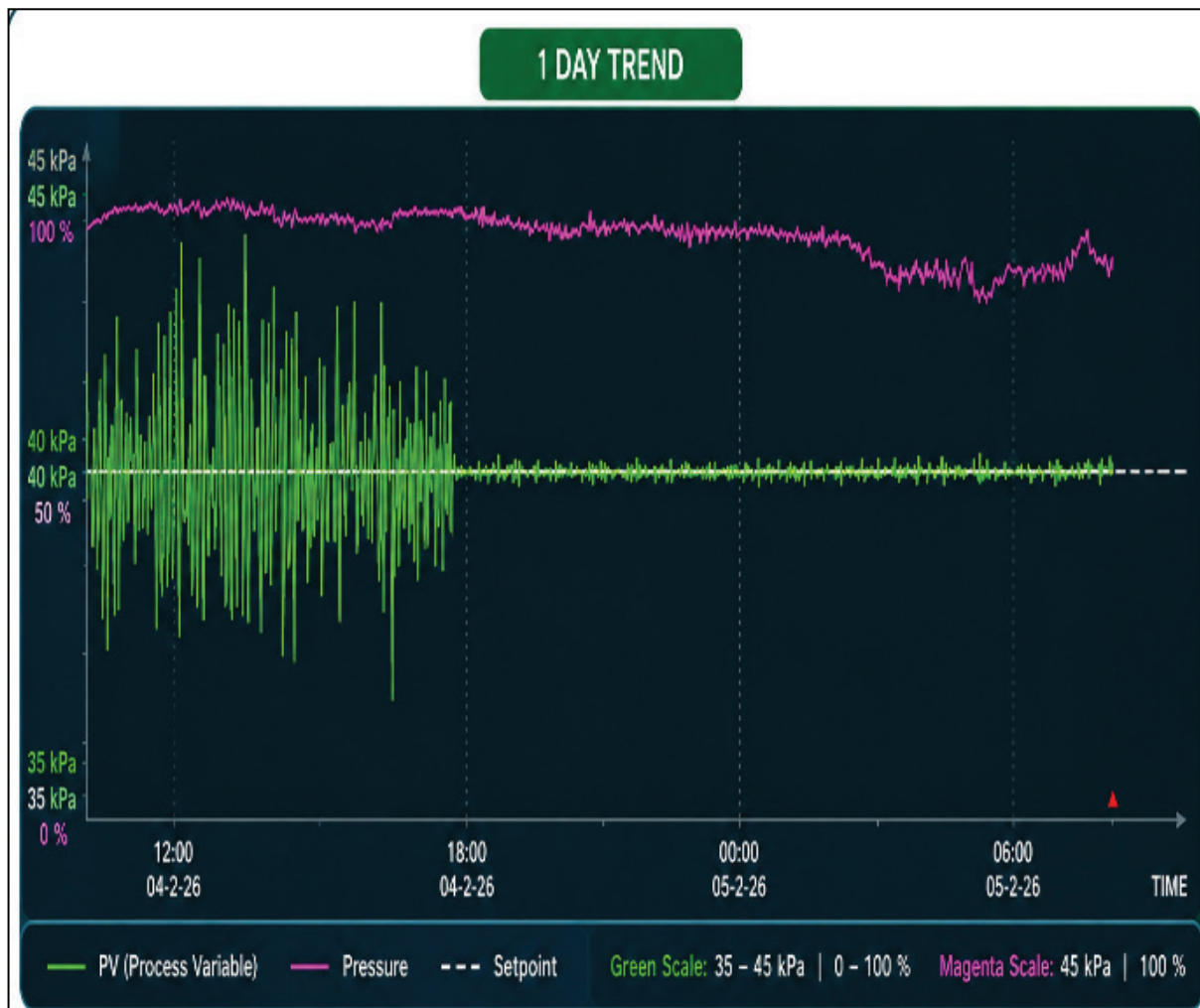


Figure 13 Steam pressure stabilized after fine tuning

Potential Problem 3 – Grade Change Tuning

It was observed that the centricleaner pressure settings also impacted the mixing of thick and thin stock at the fan pump suction, which in turn caused weight and moisture variations in the machine. The diagram below illustrates the silo and its components, along with the pictorial explanation how centricleaner pressure settings impact on achieving uniform mixing.

Result



Figure 15 Grade Change time reduction

The following figure illustrates the areas where issues were identified and highlights the day-wise reduction in weight variation

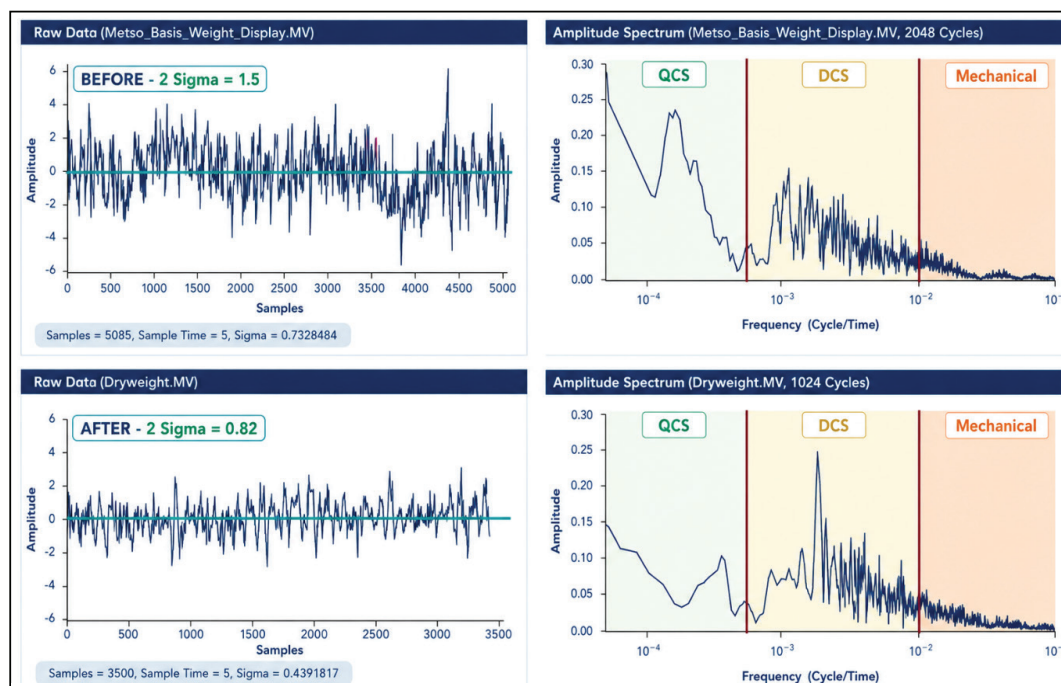


Figure 14 Weight Variation Reduction

PM1 achieved 48% reduction in weight variation after corrective actions and stock related loops from DCS & Level 2 tuning from QCS.

PM1 achieved 72% reduction in moisture variation after corrective actions and steam related loops from DCS & Level 2 tuning from QCS.

The following figure illustrates the areas where issues were identified and highlights the day-wise reduction in weight variation

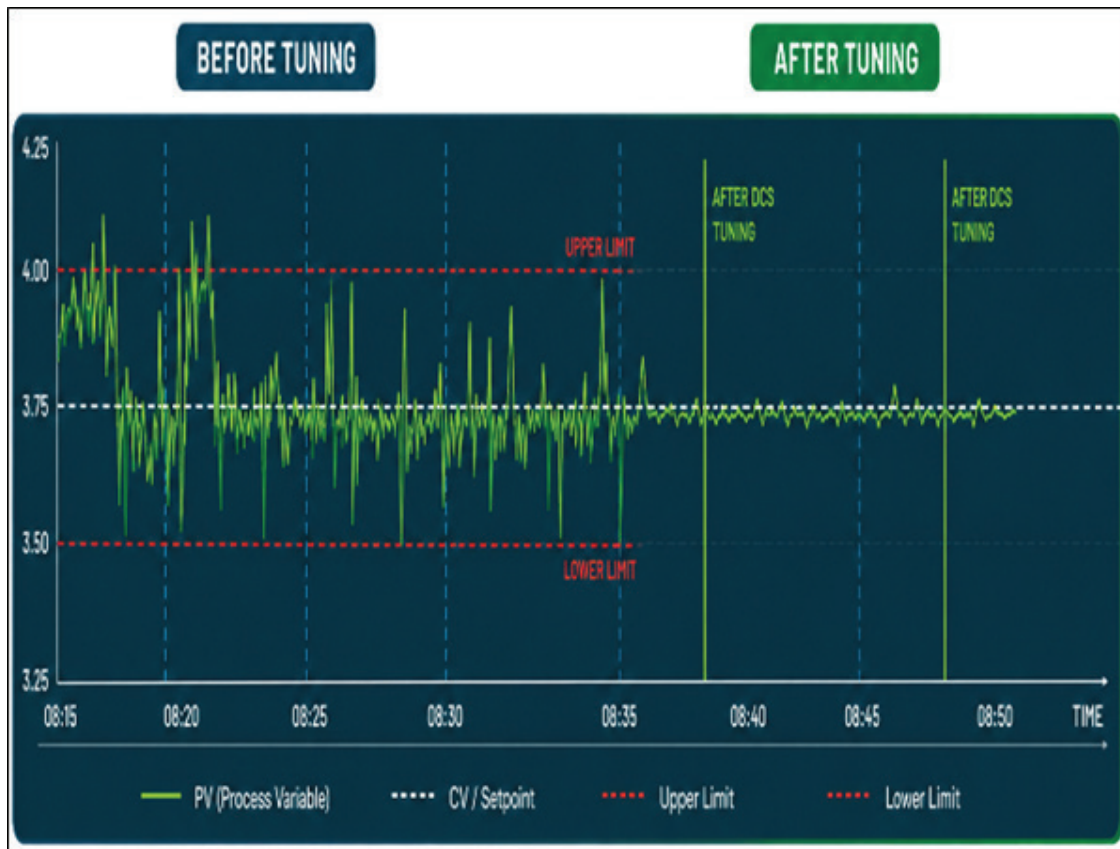


Figure 16 Moisture variation reduction

ECONOMIC REVIEW

After these problems were solved, process variability was reduced by as much as 70 percent and the mill experienced fewer sheet breaks and lower grade recovery times that resulted in more product making it to market. The mill would see gains of 0.4 million US Dollars per year through only reduction in culls. Other benefits can be calculated from

- Reduced startup losses
- Reduced grade change recovery time
- Improved steam efficiency
- Better machine stability
- Reduced operator intervention
- Improved production availability
- Reduced off-spec production

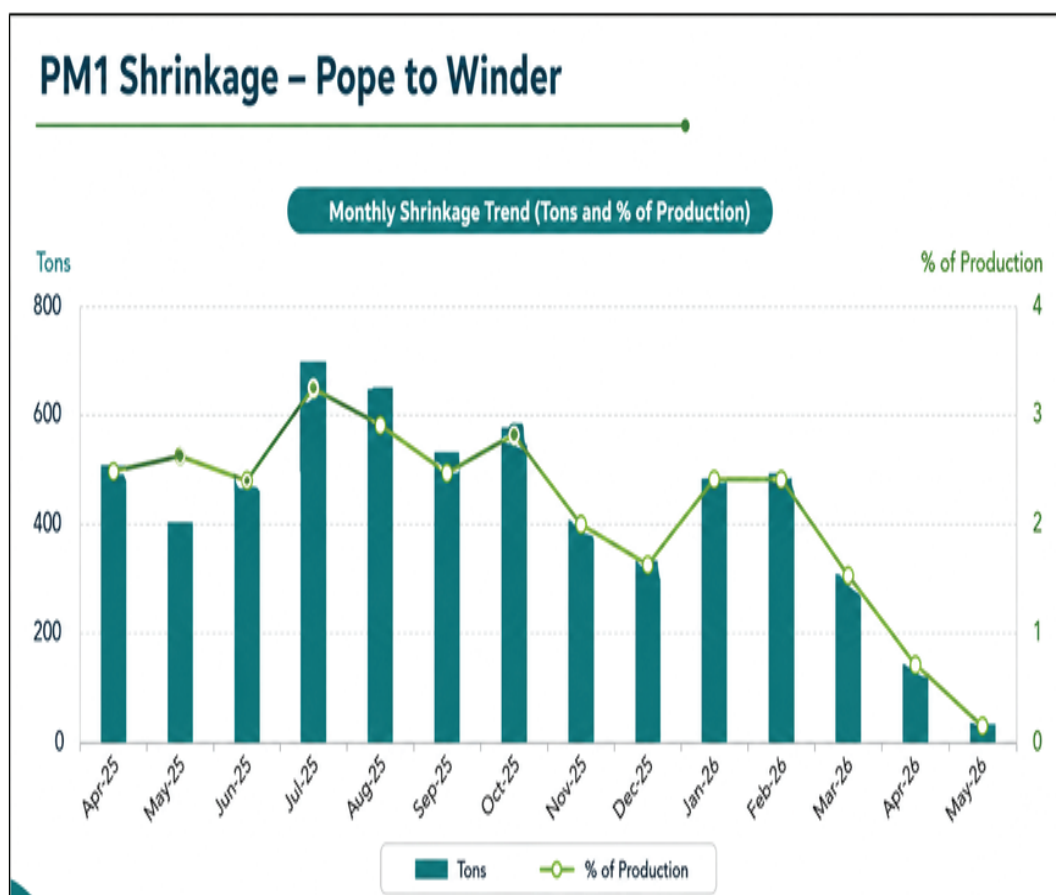


Figure 17 PM-1 Shrinkage reduction

CONCLUSION

The PM1 optimization project demonstrated the potential for focused process control optimization, MD/CD profile tuning, and improvements in automatic grade change practices to enhance the operational stability and performance of the paper machine.

Following implementation of the optimization measures, rejects were reduced from approximately 500 tonnes/month to below 100 tonnes/month, representing a significant reduction in production losses. In addition, sheet breaks were reduced by approximately 15%, contributing to improved machine availability and more stable operation.

The improvements indicate that systematic optimization of process control and machine operating parameters can deliver measurable gains in product quality, production stability, and resource utilization. The case also highlights the potential for data-driven process optimization to address operational variability and improve overall paper machine performance.

TESTIMONIAL FROM PLANT

OPTIPID's Optimization Services reduced paper culls from Average 500 tonnes/month to 100 tonnes/month and reduce product quality variability by up to 70%. To maximize production, quality and costs management, mill managers wanted to proactively find and correct control issues before they could negatively affect performance.

Muhammad Mangerah – Mill Manager

Case study 6: Power Quality Optimization in a RCF based Mill: Customized Harmonic Mitigation and Power Factor Improvement



BACKGROUND

One of Canada's premier paper recycling companies faced operational stoppages caused by persistent power quality issues, necessitating a solution to eradicate these disruptions. ADM Engineering was commissioned to conduct power quality studies and deliver an analysis report pinpointing the root cause of the problem. The customer was looking for an optimal and cost-effective solution.

Industry: Pulp & Paper Location: Canada, Ontario Project Timeline: 2023-2025

CHALLENGE

The challenge facing ADM was to diagnose the cause of PQ issues the mill was facing at both LV and MV levels. ELSPEC G4500 power quality meters were utilized to gain a precise insight into the behaviour of the electrical network. ELSPEC G4500 analysers record high-resolution data that can detect disturbances in the electrical network impacting production, which is impossible with many other available meters in the market.

The mill is powered by two 27kV feeders sourced from the utility, linked by a tie breaker. In routine operations, the facility depends on these two distinct feeds, with the tie breaker left open, ensuring redundancy in the event of a failure in either of the utility feeds

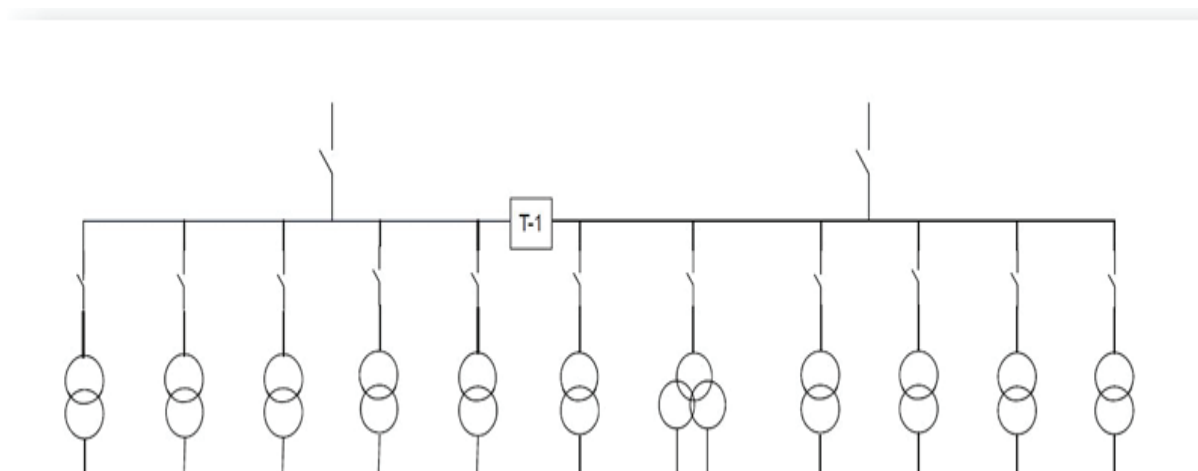


Figure 18 Power distribution within the facility

Following multiple audits aimed at understanding loads and their behaviour, alongside on-site measurements and subsequent data analysis, the root cause was pinpointed.



Figure 19 RMS Values on one of the transformers

The culprit was identified as poor lagging power factor on MV transformers and high harmonic levels stemming from the plant's nonlinear loads across all LV transformers.

Contactors-based plain capacitors exacerbate Power Quality (PQ) issues by introducing transients and resonance into the system, thereby magnifying harmonics. Although removing these capacitors could resolve numerous challenges, the customer faces constraints: disconnecting them would lead to increased demand, resulting in higher bills. Additionally, they cannot operate all loads when supplied by a single feeder at 27 KV when the tie breaker is closed—thus, without problematic capacitors, they faced a larger issue, being forced to lower production. These power quality issues posed a threat to electrical system reliability, equipment lifespan, and resulted in significant financial losses.



Figure 20 Harmonics on one of the transformers

Based on these findings, ADM recommended the utilization of ELSPEC equalizer systems to enhance power factor on MV transformers, the deployment of customized Active Dynamic Filters (ADM) for all LV transformers experiencing high harmonics and advised disconnecting all traditional contactor-based plain capacitors in the plant.

SOLUTION

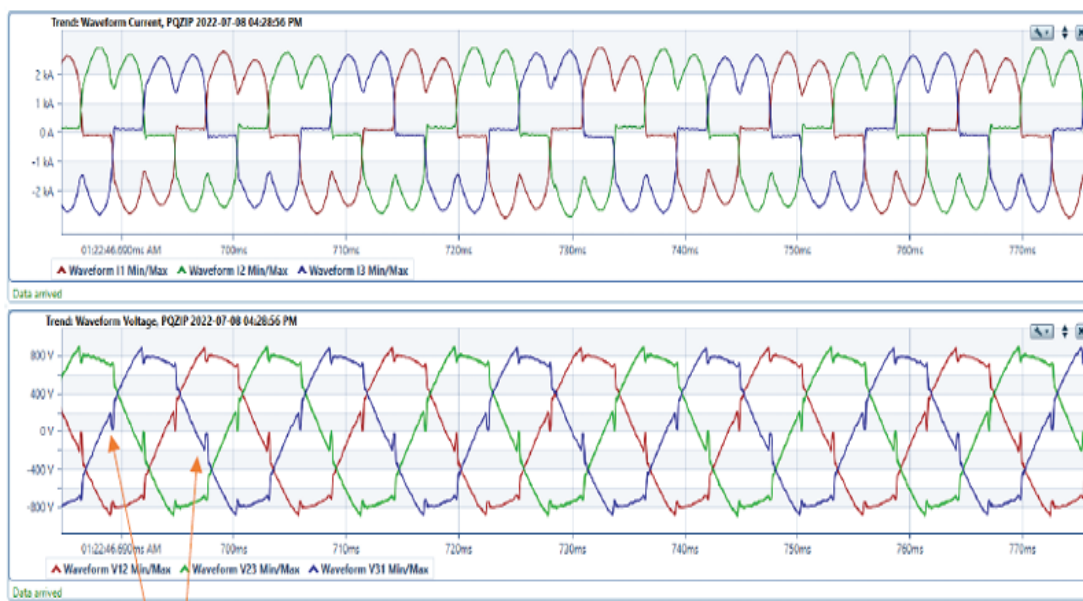


Figure 21 Sample waveforms on one of the transformers

While some competitors offered STATCOM solutions to address power quality issues at 27KV, and others proposed uniform, one-size-fits-all solutions for all transformers, ADM chose a better bottom-up approach. This strategy aimed to safeguard all downstream transformers from excessive harmonics by implementing customized solutions for each unit, as well as cleaning power at the upstream 27KV level. Recognizing the unique power quality characteristics and load profiles of individual transformers, ADM conducted thorough studies to precisely determine the necessary specifications for each case. While this approach presented greater challenges, requiring numerous studies and more intricate installation processes compared to STATCOM, ADM remained committed to delivering the more optimal solutions for the customer's needs and consequently designed and manufactured overall 4770 A indoor and outdoor-rated COMSYS Active filters in various sizes and ELSPEC designed and manufactured overall 6 MVAR outdoor-rated Equalizer Systems for MV transformers. The constrained space within the electrical room posed a challenge for installing all of the solutions indoors.

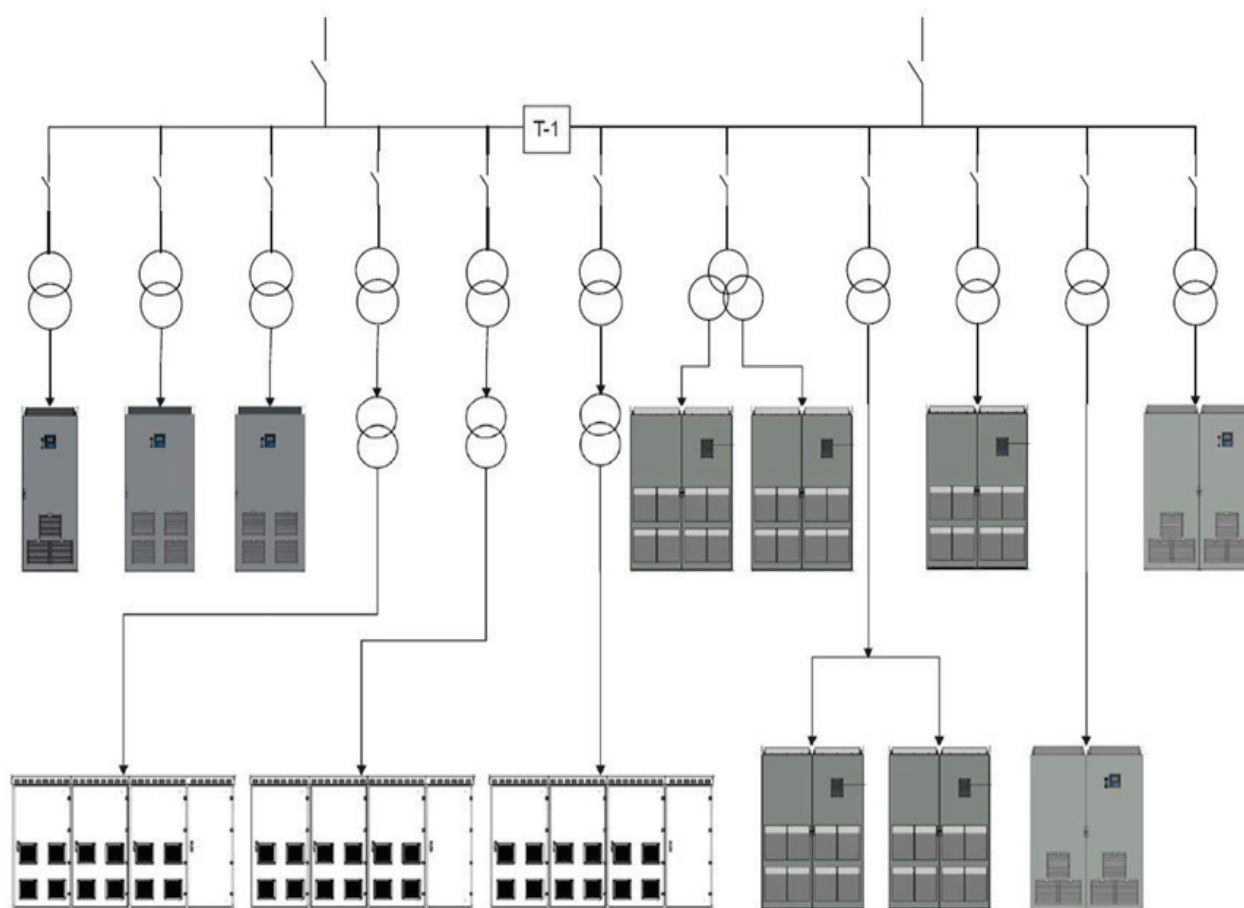




Figure 22 Photos of installation

WHAT HELPED THE TECHNOLOGY BE SUCCESSFUL

Utility pressure and PQ challenges interrupting operation

Customer's desire for continues improvement

Customizable solution making project implementation feasible

Multiple (+15) onsite meetings

Providing cost effective solutions and optimizing size of equipment by studies

Good established relationship and trust built from previous projects

Customer experience with products

Case study 7: Solving Micro Outages and Improving Production Efficiency in The Recycling Industry



OVERVIEW

The recycled packaging industry plays a significant role in food safety and convenience markets. Packaging production utilizes an exceptional amount of recycled content in Europe and around the world. To keep this success going, the recycled packaging industry must strike and constantly maintain a fine balance between sustainability, performance, and cost. Power quality disturbances, such as sags and swells, harmonics, voltages drops, over-voltages, voltage fluctuations, frequency variations and transients are common power quality issues and are major contributors to financial losses of modern industrial and commercial users. They can cause manufacturing interruptions, loss of production, product damage and waste of energy. Realizing the potential magnitude of losses due to these disturbances, more and more industrial and commercial customers seek continuous detection, analysis, and solutions for solving power quality disturbances. Huhtamaki is a leading Nordic packaging company that operates in 38 countries and 114 locations around the world. Huhtamaki recycled packaging plant in the Czech Republic experienced micro-outages on the electrical network. Their machines showed frequent failures caused by voltage drops. They decided to approach ELSPEC.

Advanced power quality analysis unveils the issues

ELSPEC with its agent in the Czech Republic, Blue Panther, conducted an in-depth power quality audit using the ELSPEC G4500 portable power quality analyzer to conduct a detailed analysis on a single transformer. The analysis revealed voltage drops coming mainly from production machines, operating in peak current consumption, which destabilized the plant's internal power supply network. The recommendation was to install an ELSPEC power factor correction system – The Equalizer – for reactive power compensation. In addition, an energy savings audit generated using the unique Simulation Software which simulates the effect of the Equalizer system and voltage reduction on the customer's network, using a patent-protected algorithm was presented. Calculations are based on real cycle by cycle measurements, and so the software accurately predicts upcoming savings using the system.

ELSPEC G4500 Analyzer Measure, Store & Analyze with Best Accuracy



- Records 5,000 power parameters continuously
- Records at rates of ½ cycles, 10/12 cycles, 150/180 cycles, 10 min and 2 hours.
- Exceeds memory limitations – The only solution with the ability to measure, store & analyze waveform signals continuously with no memory limitations.
- Complies with IEC 61000-4-30 CLASS A

The Equalizer - Real Time Reactive Power Compensation System

The Equalizer is a real-time high-performance power quality solution for dynamic load compensation for substantial energy efficiency. ELSPEC's all in one Equalizer is a highly accurate real time power quality solution to compensate reactive power, eliminate voltage drops, harmonics filtration, reduce voltage flickering & fluctuations, enhance machinery lifetime, and improve production quality. The Equalizer offers multiple features in one simple solution. This is a unique system that compensates low to medium voltage loads in real time.

Exceeding the Expectations

Installing the Equalizer reactive power compensation system led to:

Electrical network stability improved significantly.

Machine failures caused by voltage drops were eliminated.

In the longer term, machine malfunctions have decreased.

Higher-than-expected energy saving was achieved.

Based on the above, the customer ordered additional audits for other transformers. These audits revealed additional energy saving possibilities, resulting from merging the production power supply to one of the two transformers. The reason for this merge was in order to relocate the transformer for the construction of a new production line. Installing 4 additional equalizer systems in the facility led to high production efficiency. The ability to produce the same product at much lower cost placed this plant in the 2nd place at performance out of all plants under the customer's holding.



Case study 8: Reduction of power consumption in Compressors

Introduction of the Plant:

- **Sirpur Paper Mills Ltd**, incorporated in 1938, is one of the largest manufacturers of variety and colour paper in India. In 2018, the mill was acquired by JK Organization.
- Comprises writing, printing, typewriting, duplicating, cream wove, maplitho, ledger, bank account book paper, bond, parchment, fancy wrapping, pastel, industrial kraft, laminating grade kraft, base papers, duplex boards, triplex boards
- Paper production of 385 TPD with 4 machines.
- Integrated pulp mill with 320 TPD capacity.

Background / Baseline Scenario:

The existing compressed air system consisted of one 110 kW instrument air compressor (commissioned in 2010) located in an unsafe old building and two 75 kW Service air compressors, all 3 running to meet plant air demand.

The 110-kW instrument compressor had become unreliable due to ageing, resulting in frequent trips, low air incidents, and operational interruptions and difficult for operator/maintenance crew movement as it was in an unsafe old building.

There was also no dryer bypass system in compressor pipeline layout and total daily power consumption of the old system (Running of Instrument and 1 Service compressor) was 3500–3600 kWh/day, leading to high energy costs.

Project Details:

- A new 130 kW instrument air compressor was procured and commissioned and existing old compressor and dryers also shifted to near CF boiler.
- Existing pipelines were also rerouted as per requirement to eliminate sudden drop of air pressure when sudden air demand occurs.
- All three old compressors were stopped, and the plant air system was optimized to run on the new, efficient unit.
- Continuous load monitoring was conducted to ensure reliability, pressure stability, and performance consistency.
- System pressure settings and air distribution were optimized for uniform supply.
- Dryer bypass system provided for maintenance of dryers.

Project timeline: 3 months.

Improvements achieved:

- Daily consumption of the new compressor: **3270–3350 kWh/day**
- Power consumption by the old three compressors: **3350–3450 kWh/day**
- Net saving: **80 to 100 kWh/day**

Improved Reliability: Eliminated frequent low-air trips caused by the old 110 kW compressor

Challenges, if any, were faced during the implementation: During trial run, standby compressors were running on low air pressure frequently. To avoid this, boiler ash handling system conveying cycles taken on probe mode and optimized the timers.

Energy saving and/or other details (in table, as applicable):

Table 9 Details of Energy saving and monetary saving

Sr. No.	Parameters	Unit	Before	After
1.	Power	kWh	3350–3450 kWh/day	3270–3350 kWh/day
2.	Power saving	kWh	80 to 100 kWh/day	
3.	Monetary benefits	₹ lakhs/annum	₹1.5 lakh per annum (approx.)	

3.1 Contact Details:

Details of the key contact persons:

Contact	Mr. Umesh Chandra Mishra, Chief Manager, Power Block.	Mr. Kiran Kumar, Manager. O&M.	Mr. BR Sravan Kumar, Dy Manager, O&M
Email	umesh.mishra@spm.jkmail.com	kiran.nagabelli@spm.jkmail.com	sravan.kumar@spm.jkmail.com
Mob	9621178728	8208711039	9912686877

Case study 9: Optimisation of Compressed Air System through Compressor stoppage

Background / Baseline Scenario:

- Earlier, the 132 kW GA 132 compressor was running continuously for 24 hours per day at around 4.5 bar pressure.
- During the study, it was observed that compressed air demand could be reduced by improving operating practices and optimizing the ash handling system.
- After the changes, this compressor was stopped and the required air was managed through the optimized compressed air network. Compressor loading hours in the compressed air network were also reduced from 90 hours to 83.88 hours.

Modifications Made for Upgradation

- Dome opening time and cycle delay time were optimized in the ash handling system of Boiler No. 3, 4, 5 and 6.
- Compressed air consumption points were reviewed, and avoidable air use was reduced.
- Compressor set pressure was reduced from 7.3 bar to 6.9 bar wherever operation allowed.

Improvements Achieved

- The 132 kW compressor, which was earlier running continuously, was completely stopped.
- Compressor loading hours in compressed air network Compressor house reduced from 90 hours to 83.88 hours.
- Maintenance requirements were also reduced due to lower compressor running hours.
- Overall compressed air utilization improved and more controlled.
- Power consumption reduced, which also helps in reducing indirect carbon emissions.

Challenges Faced During Implementation

- The main challenge was to ensure that all users received sufficient compressed air after stopping the compressor.
- Pressure reduction trials had to be done carefully so that plant operation was not affected.
- The team had to monitor critical air users during the trial period.
- Coordination with operation teams was required for ash handling timing changes.

Compressed Air Optimization – Compressor GA 132 Shutdown

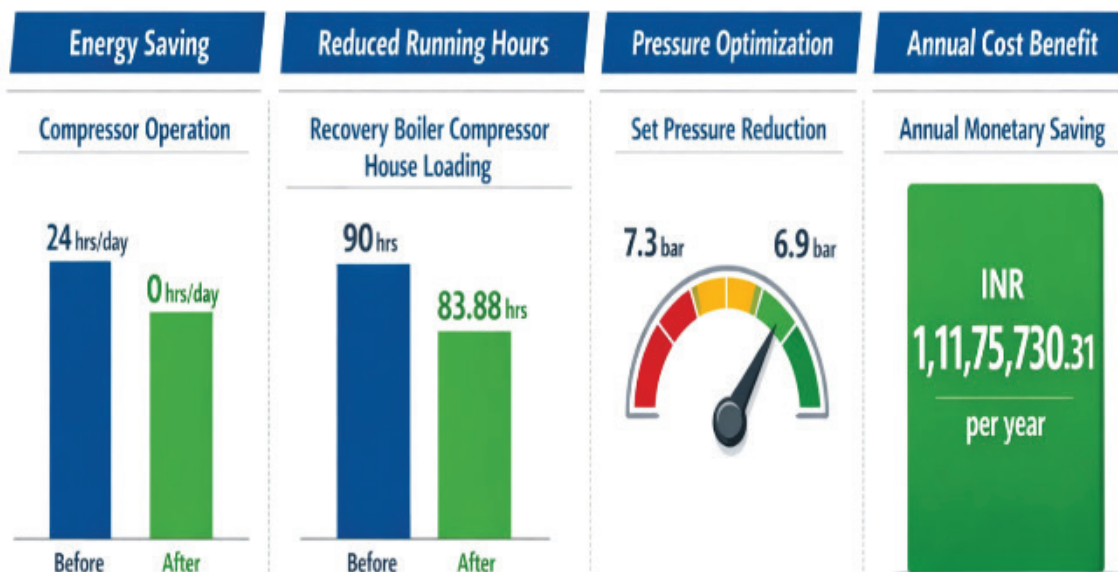


Figure 23 Energy saving and Cost benefits

Energy Saving and Other Details

Table 10 Parameters Before vs After

Sr. No.	Parameters	Unit	Before	After
1	Oxygen plant compressor operation	hours/day	24	0
2	Compressor motor rating	kW	132	Compressor shutdown
3	Recovery Boiler Compressor House loading hours	hours	90	83.88
4	Set pressure	bar	7.3	6.9
5	Generated compressed air at 95% efficiency	CFM	978.5	Requirement met through optimized system
6	Cost saving per day	₹/day	–	30,618.44
7	Annual monetary benefit	₹year	–	1,11,75,730.31
8	Investment	₹ lakh	Minimal / operational optimization based	
9	Payback	months	Immediate / less than one month	
10	Other benefits	–	Reduced energy use, lower maintenance cost, improved reliability and reduced indirect emissions	

Case study 10: Data Visualization and Live Analysis for Headbox & Wire

Background / Baseline Scenario: Chandpur Paper (A unit of Chandpur Enterprises Ltd.) is located in Uttar Pradesh and manufactures poster paper and chromo (c1s) paper. The unit produces an impressive 120 (TPD) using the top-notch machinery sourced from global leaders, ensuring precision and accuracy. The mill uses electricity from the grid as well as rooftop 850.98 kW solar plant. Bagasse and biomass are the main fuel for boiler, which provides steam for drying paper on the paper machine.

Often several process parameters are manually controlled, but from an operator point of view, useful information is not easily available. In the proposed system, several such small KPIs have been made available for the shop floor operators enabling them to optimise operations easily.

Proposed System: Using a PLC based system data from various flow meters, PTs, VFDs, etc. is collected and outcome is displayed on a monitor, as shown in the attached image.

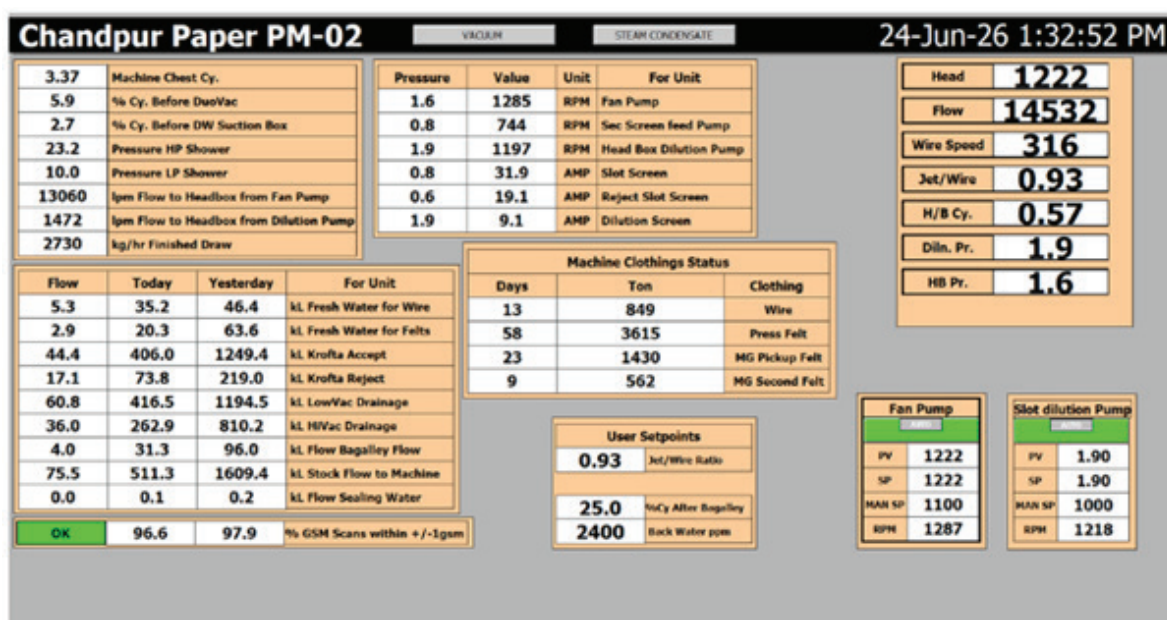


Figure 24 PLC based Dashboard

Reference Case study: Often the operators control the shower water in various paper machine showers based upon the pressure indicated in pressure gauge. A minor higher or lower pressure may result in significant flow variation. Hence, the total flow as calculated by the sum of different flow meters for wire part as well as for the press (felt) section is displayed on the monitor. Operators are free to use adequate pressure to ensure cleanliness of machine clothing, but they also know that the water is being consumed and hence a self-check is implemented. Similarly, the stock flow through headbox has been displayed on the monitor. Having known the flow through headbox, machine draw etc., it is possible to compute the headbox consistency, thus eliminating the need for the chemists to take samples from headbox and do it manually.

As the mill manufactures 35–70 GSM paper with 42 GSM as anchor GSM, a range of ± 1.0 GSM was chosen as control range. So, paper within this range is shown as “OK” and outside this range is shown as “NOT OK” on the monitor. Also the data for the current day and yesterday is displayed as percentage for how much time the paper GSM was OK. In case the display readings drop, the operators can take appropriate action in time.

Also, using the web dryness after the wire part, and flow values from various flow meters, the value of consistency at various positions of wire (before DW suction Box, before DuoVac etc.) is calculated by PLC and displayed on

the monitor. This acts as a live drainage analysis for the wire part. This helps in optimizing vacuum on wire part ensuring desired dewatering.

To the best of the plant team's knowledge, such a system is not known to have been installed in any other mill in India so far. All calculations have been included in the PLC programming and installed at the paper machine operator's desk.

Outcome: It was observed that after installation of this system the formation improved significantly (due to head box flow), fluctuations in water consumption reduced, and also improved Cobb60 stability. A drop in AKD consumption by 1.5-2.0 kg/T was also observed. Optimization (reduction) of wire part vacuum keeping an eye in drainage helped at least 20% increase in wire life. Annual savings from both AKD consumption reduction and wire life increase work to the tune of ₹ 30 lakh. Besides this, better acceptance of paper by the consumers cannot be explained in monetary value.

Replication Potential: This approach can be implemented on all paper machines without any problem.

Cost of project: Approx. ₹ 15.0 lakh (Including field instruments) per machine.

Payback: Less than 6 months.

Year of Installation: 2025

Contact	Mr. D. K. Singhal
Email	deveshksinghal@gmail.com

Conclusion and Way Forward

The publication “Best Practices Manual for Pulp & Paper Sector, Volume 14” provides a comprehensive and in-depth analysis of actual operational practices, technological advancements, and physical efficiencies achieved across various pulp and paper manufacturing facilities.

Through systematic evaluation of real-world trials and retrofits, these case studies identify critical performance gaps in equipment networks and outline practical, field-tested opportunities for improving productivity, resource efficiency, and environmental sustainability in the paper manufacturing sector

Key Conclusions

Energy Efficiency & Waste Heat Recovery: Major efficiency gains may be achieved by systematically eliminating throttling and thermodynamic design losses. For instance, replacing conventional pressure-reducing valves (PRVs) with back-pressure steam turbines converts steam throttling losses into captive electricity (~11,000 kWh/day) while absorbing excess superheat to deliver optimal saturated steam temperatures (~150°C) to the dryers. Furthermore, replacing inefficient liquid-ring vacuum pumps with maglev turbine vacuum pumps cuts vacuum system energy requirements by 40% to 65%. Plant auxiliary loads can be further minimized by retrofitting cooling tower fans with Variable Frequency Drives (VFDs) and consolidating older compressor systems into a single efficient air compressor network.

Raw Material & Production Optimization: Production yields and material utilization can be greatly enhanced through advanced mathematical modelling and digitized visual software controls rather than chemical-only interventions. Implementing automated deckle matching software (such as Papyrus360 Optrim) reduces paper machine trim waste from 3–5% down to 1–1.5%. Advanced AI-driven loop tuning reduces basis weight and moisture variability, allowing mills to slash monthly paper rejects/culls from an average of 500 tonnes to under 100 tonnes. Real-time PLC dashboards installed at the operator desk provide live drainage and headbox consistency calculations, stabilizing paper GSM and significantly reducing AKD chemical consumption.

Environmental Impact & Decarbonization: Decarbonization and water conservation can be achieved through targeted technology upgrades. Utilizing bio-enzyme combustion enhancers (such as Oxy-Booster) allows boilers to safely switch fuel mixes by reducing coal and increasing biomass firing to 36.5%, achieving a CO₂ emission reduction of 6,402 tonnes per annum. Additionally, upgrading to dry-running maglev vacuum pumps completely eliminates vacuum sealing-water consumption, preventing the generation of contaminated wastewater

Way Forward

Technology Upgradation: Mills must actively consider investing in modern digital and mechanical technologies to bridge efficiency gaps. Key investments include AI-based process optimization for control loops, PLC-based data visualization dashboards, and magnetic-levitation direct-drive turbo impellers. These technologies not only boost thermodynamic and electrical efficiency but also extend the operational life of critical machine components, such as increasing wire life by at least 20%.

Policy & Regulatory Alignment: To align with regulatory standards like the Central Pollution Control Board (CPCB) effluent norms and state laws, mills should target zero-wastewater discharge configurations in their vacuum systems. Carbon accounting for efficiency projects should follow established methodologies, referencing the Central Electricity Authority (CEA) CO₂ Baseline Database for the Indian Power Sector to compute verified location-based Scope 2 carbon reductions and potential tradable Carbon Credit Certificates under the Carbon Credit Trading Scheme (CCTS).

Capacity Building and Partner Collaboration: Implementation of high-impact efficiency retrofits is accelerated by partnering with specialized technology providers. Mill operators and engineers must be systematically trained on dynamic bump testing, process spectrum analysis, and root-cause analysis to sustain long-term operational

improvements.

Sustainable Sourcing and Operations: Boilers operators should optimize their fuel inventories by sourcing sustainable biomass and in-house waste materials (such as rice husk, pith, wood dust, and straw dust) to mitigate volatile coal prices. Utilizing safe, non-toxic bio-materials to enhance boiler combustion helps mills hit environmental, social, and governance (ESG) goals without requiring costly, months-long boiler shut downs for physical modifications.

Continuous Benchmarking: Ongoing monitoring and verification of key indicators such as specific energy savings (kW/kWh), payback periods, and monetary savings provide transparency. Projects like maglev pump retrofits and back-pressure turbines show robust static payback periods typically between 6 to 30 months, demonstrating that aggressive sustainability investments are highly viable.

NOTES

About CII Energy Efficiency Council:

The CII Energy Efficiency Council, part of the CII–Green Business Centre, has been driving energy efficiency and low-carbon transformation across Indian industry for over three decades. It works with industry and government to accelerate the adoption of energy efficient technologies, renewable energy, decarbonization solutions and sustainable business practices.

With experience across 20+ industrial sectors, CII Energy Efficiency has undertaken 2,600+ energy audits, trained 100,000+ professionals and facilitated `3.5 billion+ in annual recurring energy savings. Its work spans energy audits, technology adoption, net-zero and decarbonization, resource efficiency and policy advocacy, supporting industry in becoming more competitive, resilient and sustainable.

Learn more by logging on to – <https://energy.greenbusinesscentre.com/>

About CII Green Business Centre:

The CII–Sohrabji Godrej Green Business Centre (CII–GBC) is CII's Developmental Institute for Green Practices and Businesses, focused on offering world-class advisory services dedicated to the conservation of natural resources. Its mission is to help India emerge as a global leader in green business by 2030.

The Green Business Centre in Hyderabad, Telangana, is housed in one of the greenest buildings in the world. Established in 2004, the Green Business Centre was inaugurated by His Excellency, the late Dr. A. P. J. Abdul Kalam, the then President of India, on 14 July 2004.

The Centre promotes sustainable practices and supports businesses through a comprehensive range of services, including Green Buildings (IGBC), Energy Transition Services, GreenPro Certification, GreenCo Rating System, Green Entrepreneurship Council (GEC), Council on Green Mobility, Green Cooling Council, Solar Vendor Rating Program (VRP) and more.

The Green Business Centre has registered over 20,000 green building projects (through the Indian Green Building Council – IGBC), certified 15,800+ GreenPro products, conducted 2,600+ energy audits globally, registered 1,600+ manufacturing facilities under GreenCo, and engaged with 300+ cleantech startups across India, Sweden, Australia, Ethiopia, Bangladesh & Japan.

CII GBC with all its councils has contributed to reducing 55 million tons of CO₂ emissions, saving 198 billion litres of water and 65 billion kWh of energy annually.

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About CII:

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the development of India, partnering Industry, Government and civil society through advisory and consultative processes.

CII is a non-government, not-for-profit, industry-led and industry-managed organisation, with over 10,500 members from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 365,000 enterprises from 332 national and regional sectoral industry bodies.

For more than 130 years, CII has been engaged in shaping India's development journey and works proactively on transforming Indian Industry's engagement in national development. CII charts change by working closely with the Government on policy issues, interfacing with thought leaders, and enhancing efficiency, competitiveness, and business opportunities for industry through a range of specialised services and strategic global linkages. It also provides a platform for consensus-building and networking on key issues.

Through its dedicated Centres of Excellence and Industry competitiveness initiatives, promotion of innovation and technology adoption, and partnerships for sustainability, CII plays a transformative part in shaping the future of the nation. Extending its agenda beyond business, CII assists industry to identify and execute corporate citizenship programmes across diverse domains, including affirmative action, livelihoods, diversity management, skill development, empowerment of women, and sustainable development, to name a few.

For 2026–27, CII has identified “Accelerating Competitiveness: Growth, Resilience, Inclusion, Sustainability, Trust” as its theme, prioritising five key pillars. During the year, CII will align its policy advocacy, institutional initiatives, partnerships, and outreach to support Indian industry in strengthening these five interconnected pillars of competitiveness.

With 70 offices, including 12 Centres of Excellence, in India, and 9 overseas offices in Australia, Egypt, Germany, Indonesia, Singapore, UAE, UK, and USA, as well as institutional partnerships with 255 counterpart organisations in 102 countries, CII serves as a reference point for Indian industry and the international business community.

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