NRDC

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THE TEXTILE INDUSTRY LEAPS FORWARD WITH CLEAN BY DESIGN: Less Environmental Impact with Bigger Profits

CLEAN by Design

In partnership with

IFC International Finance Corporation WORLD BANK GROUP

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About NRDC
The Natural Resources Defense Council (NRDC) is an international nonprofit environmental organization with more than 1.4 million members and online activists. Since 1970, our lawyers, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. NRDC has offices in New York City, Washington, D.C., Los Angeles, San Francisco, Chicago, Bozeman, MT, and Beijing. Visit us at www.nrdc.org and follow us on Twitter @NRDC.

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Executive Summary

The Clean by Design program is an innovative green supply chain initiative to leverage the purchasing power of multi-national corporations to reduce the environmental impacts of their manufacturing abroad.

Working with a number of prominent global apparel retailers and brands, the program has focused first in the textile sector, which is notorious for its energy and water intensity and for its high pollution load. Clean by Design reduces the environmental footprint of textile mills with a business-friendly model that focuses on increasing production efficiencies, which saves factories money. At the end of 2013, with success at more than twenty pilot factories in hand, Clean by Design was poised to come to scale.

The 2014 scale-up was launched in Shaoxing and the Guangzhou area, two cities in China with a large concentration of textile mills, in partnership with the International Finance Corporation (IFC). After outreach by multinational apparel brands and government authorities, more than 100 mills attended trainings in the program. Thirty-three of these mills were selected for active tracking. These mills provided initial benchmarking information, hosted expert consultations, submitted implementation plans, undertook improvements, quantified their results, and completed reports that allowed full evaluation of their initiative.

Results from the program were stellar. Each and every mill we tracked in the program—the young and the old, the large and the small, woven/knitted/denim fabric, etc.—reduced environmental impact and made money with improvements that will continue to deliver both reduced resource use and economic benefits in the years to come. Maximum savings were extremely impressive: one mill reduced its water use by 36 percent. Another mill reduced its energy use by 22 percent. The top mill for economic returns earned 3.5 million dollars (21.7 million RMB) in the first year, with projects that paid themselves back in only 13 months.

With these successes in hand, the time is now ripe for more aggressive expansion of Clean by Design. NRDC will bring the program next to the greater Suzhou area, in Jiangsu Province, another city with a concentration of textile mills. We will solicit expanded multi-national participation through alignment with the Sustainable Apparel Coalition, an association representing more than 40 percent of global apparel production.

A few hundred mills is not bad, but there are an estimated 15,000 textile mills in China alone. What's more, the industry is quickly moving to other less developed countries, like Vietnam and Cambodia, where problems could get even worse. Responsible corporations urgently need to locate their key suppliers, track and assess their discharges and resource use, and require minimum environmental performance as a condition for doing business. Clean by Design provides business-friendly solutions to many of the problems they are likely to find.

In total, Clean by Design 2014 reduced more than:

61,000 TONS OF COAL

THE AVERAGE MILL REDUCED ITS ENERGY USE BY 6%, WITH THE TOP FIVE MILLS REDUCING THEIR ENERGY USE BY MORE THAN 10%

36 MILLION KWHS OF ELECTRICITY

400 TONS OF CHEMICALS

3 MILLION TONS OF WATER

THE AVERAGE MILL REDUCED 9% OF ITS WATER USE, WITH THE TOP FIVE MILLS REDUCING WATER CONSUMPTION BY MORE THAN 20%

FINANCIALLY, THE PROGRAM EXCEEDED EXPECTATIONS, DELIVERING:

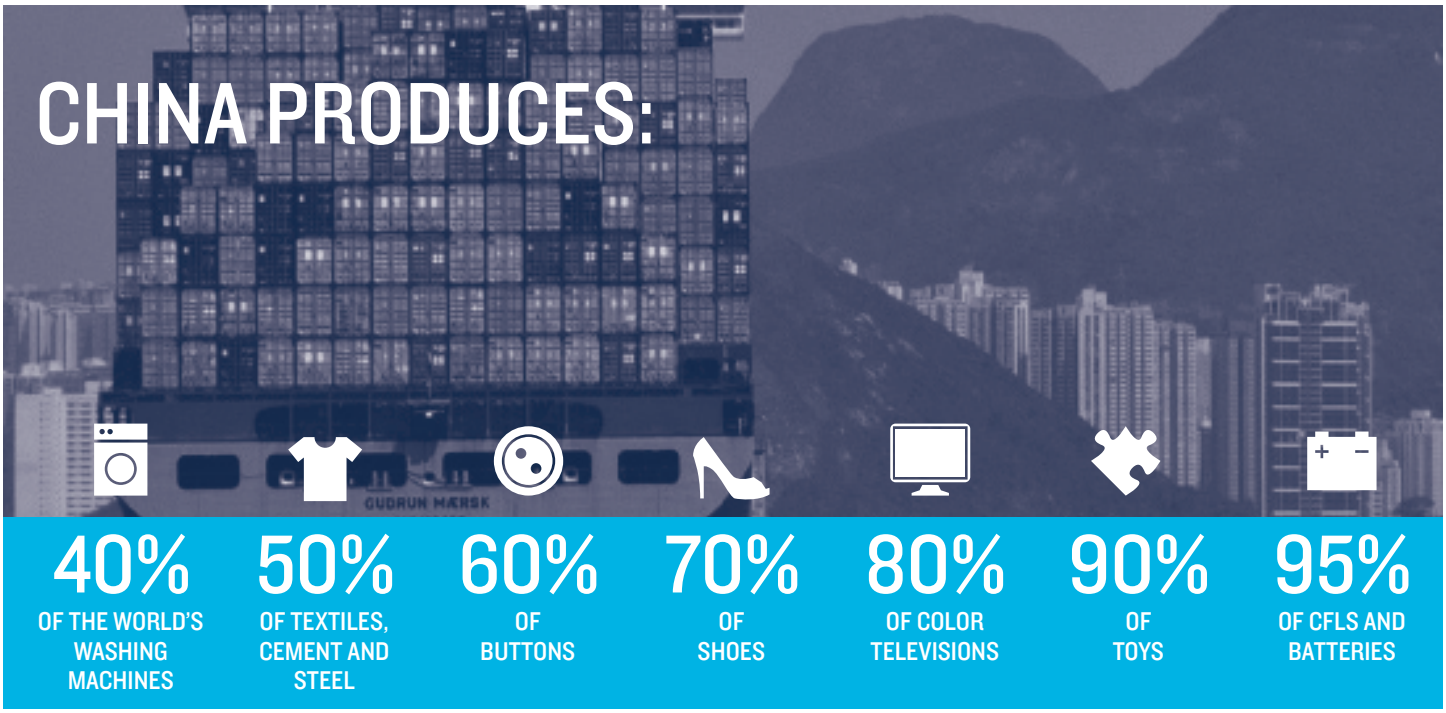
$14.7 MILLION DOLLARS ANNUALLY WITH FIVE YEAR SAVINGS PROJECTED AT $56.35 MILLION DOLLARS.

Introduction

Over the past two decades, as China has developed economically and as multinational corporations have concentrated much manufacturing there, China has become the epicenter of global manufacturing.

No one should be surprised to learn that this intensive concentration of the world's manufacturing has created serious pollution problems on location. After all, most industrial processes require considerable energy and water and release pollutants into the environment absent control devices and vigilant oversight. Sadly, because government authorities have lacked adequate manpower and technical capacity and, in some cases, adequate political will to curb these impacts, China and the world now face rapidly intensifying challenges of climate change, severe water shortages, and toxic chemical contamination. Nearly one third of the country's rivers are designated as too polluted for any direct human contact.[1] Water scarcity is an alarming, immediate threat, with more than 100 of China's cities experiencing grave water shortages.[2] Air pollution exceeds healthy levels in many of China's major cities. Last, but certainly not least, the nation ranks as the highest emitter of CO_2 in the world.[3]

Chinese citizens have become rightly alarmed by the health consequences of these air and water quality problems. Government is responding with a set of increasingly stringent programs to curtail the pollution problem, particularly in its Five Year planning documents. The 11th Five Year Plan, according to the China Textile Industry Association, successfully led to a number of tangible improvements in the textile sector: reduction of 37.5 percent in freshwater use per unit of production, increase in water reuse rates, and adoption of technologies including condensate and cooling water recovery in 50 percent of the dyeing and printing factories around the country, among other achievements. In its current 12th Five Year Plan, central government authorities area again focus extensively on textile manufacturing, providing the industry with a specific energy conservation plan, promoting cleaner production technologies, and presenting a specific outline for its scientific and technological progress.[4] These efforts reflect strong government commitment to textile dyeing and printing, which is regarded as a long-standing traditional pillar industry in China, whose healthy and sustainable development is of vital importance to people's livelihood.



Perhaps most notably, the Chinese government has recently required that 15,000 selected factories across the country release real-time environmental discharge and emission data to the public. A leading Chinese nongovernmental organization, the Institute of Public and Environmental Affairs (IPE), has facilitated access to this information with a pollution map (*www.ipe.org.cn/En/pollution/index.aspx*) and a user-friendly application for mobile phones (*www.ipe.org.cn/PollutionMapApp_DownLoad.aspx)* that citizens now use to identify the most major sources of pollution in their area during high air pollution days or when a major fish kill occurs nearby. There have been more than 2 million downloads of this application to date.

Citizens are also turning to the private sector—particularly multinational corporations—to pull its weight and better address industrial pollution problems caused by its manufacturing in China. Local organizations have posted pictures and video documentaries on social media and the internet. IPE has published reports about high pollution from selected industrial sectors across China (*www.ipe.org.cn/en/index.aspx*). Greenpeace International, for its part, launched a highly effective Zero Discharge campaign in China, which has delivered corporate commitments to zero discharge of toxic chemicals by 2020 by more than 20 major apparel retailers and brands around the world. Finally, NRDC has partnered with IPE to create a Corporate Information Transparency Index (CITI) that grades multinational corporations operating in China on their supply chain programs. (See Appendix A and "Green Supply Chain" report at *www.ipe.org.cn/en/about/notice_de_1.aspx?id=11649*)

Thirty three apparel retailers and brands were scored in CITI with H&M scoring the highest. Fourteen well-known brands, including Ralph Lauren, Victoria's Secret, DKNY, Abercrombie and Fitch, and Hugo Boss, among others, score at the bottom of the list with zero.

The CITI has already produced great success. As of March 2015, many Chinese and foreign brands have contacted IPE, collectively pushing more than 1,600 of their suppliers to issue statements on their specific pollution problems or to disclose their emissions data. Several hundred of these suppliers have taken corrective actions as well. These successes indicate the value of disclosure in motivating corporations to effectively address the environmental impacts of the factories in their supply chain abroad. See Appendix A for CITI Scores for Multi-national Apparel Retailers and Brands.

20th Century Corporate Social Responsibility Programs in a 21st Century World

Casual observers might think that large multinational corporations with global reputations to protect would have active programs to oversee and limit the environmental impacts of their manufacturing abroad. Indeed, there has been talk of the need for, and value of "sustainable" global business practices —particularly limiting pollution as well as energy and water use—since the 1987 Bruntland report and the landmark 1992 Earth Summit in Rio de Janeiro. And, in fact, nearly 30 years after Bruntland, there is a proliferation of glossy annual corporate social responsibility reports from multinational corporations, touting concern about environmental and social impacts, and there are more than 100 codes and certification schemes developed to promote reductions in environmental impacts.

Yet, on the ground, where it matters the most for China and the developing world, there is very little corporate engagement on supply chain impacts. In NRDC's experience, less than 5 percent of companies consider environmental performance in their procurement decision-making process.

The four prominent apparel companies that partnered with NRDC in Clean by Design 2014—Target, Gap Inc., Levi Strauss and Company, and H&M—are maturing their sourcing programs to become exceptions to this rule.

Clean By Design

A Business Friendly Solution that Reduces Environmental Impact and Saves Money

NRDC launched its Clean by Design initiative six years ago as an innovative "green supply chain" program to leverage the purchasing power of multi-national corporations to reduce the environmental impacts of factories in their suppliers abroad. Working with a number of prominent global apparel retailers and brands, we have focused this program first in the textile industry, notorious for its energy and water intensity and pollution load. China produces an enormous quantity of fabric for the world—more than 80 billion meters annually[5]—and is responsible for more than 50 percent of global production.

Clean by Design reduces the environmental footprint of textile mills—particularly energy and water use—with a business-friendly model that focuses on increasing production efficiencies, which saves the factory money.

The core of Clean by Design is a set of Ten Best Practices to reduce the industry's environmental footprint. Based on initial research by international experts at five Chinese textile mills, and then piloted at a dozen more, the Ten Best Practices are comprised of "low-hanging fruit" opportunities to improve environmental performance. They are easy to implement, low-cost, quick-return, and profitable. They have an established track record of success in other textile mills. Finally, the Ten Best Practices are dynamic and routinely updated to reflect the program's ever-expanding implementation experience.

Mills find that the Ten Best Practices hit the nail on the head quite often, directing them to the most promising areas to reduce resource use and operating costs. For their part, brands appreciate the program's quantitative nature, which benchmarks total resource use at the beginning and completion, thereby providing concrete estimates of the business value associated with the program. Finally, the program strives to maximize accountability and transparency to the public. NRDC staff or our third-party consultants visit each mill to review the results, and we report the environmental achievements so that they can be understood in detail by both government authorities and concerned citizens alike. Thus, the potential for improvement and real-world accomplishments in the program can inspire further improvement industry-wide.

TEXTILE MANUFACTURING: AN INDUSTRY WITH A LARGE ENVIRONMENTAL FOOTPRINT

Textile manufacturing—particularly the dyeing and finishing of fabric—has an enormous environmental impact. It is extremely water-intensive, using up to 250 tons of water for every ten thousand meters of fabric produced.[6] At more than 3 billion tons of water per year, this represents the third highest water consumption rate among Chinese industries after chemicals and papers.[7] The textile industry is also among the most energy-intensive industries in China, consuming 110 million tons of coal in 2012.[8]

Textile manufacturing is not only water- and energy-intensive but also discharges extremely high volumes of waste water and pollutant load as well. The industry ranks third among all industries in China for its 3 billion tons of annual waste water discharge and second for its chemical oxygen demand (COD) loading,[9] which accounts for nearly 20 percent of total industrial discharge of this contaminant so lethal to fish and aquatic life.[10] Furthermore, the textile industry uses a large variety of toxic chemicals in manufacturing; approximately 25 percent of the chemicals manufactured globally are applied in the textile industry,[11] and China is the largest consumer of textile chemicals in the world.[12]

2014: BRINGING CLEAN BY DESIGN TO SCALE

In late 2013, NRDC launched the effort to bring the successful Clean by Design program to scale. Working with four multinational apparel brand partners—Target, Gap Inc., Levi Strauss and Company, and H&M—we took the

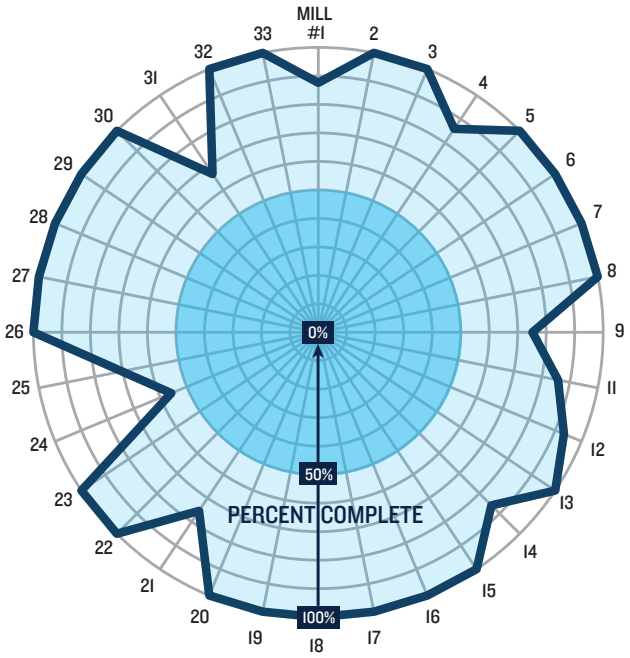
program to two locations in China with high concentrations of textile mills: Shaoxing City in Zhejiang Province, which has the greatest number of textile mills in China, and the Guangzhou metropolitan area of Guangdong Province. The IFC joined the team with its China Water Program. This program was created in 2012 to meet China's water, energy, and environmental challenges and has successfully developed several projects to demonstrate the business case for resource saving.

To move forward, we modified the project design to a more "light-handed" model that would lend itself better to scale. Rather than using our own experts to do all the work, we trained mill engineers and managers at workshops, assigned homework, and required them to develop their own implementation plans, providing additional expert assistance upon request. NRDC then reviewed results in full, all in an effort to support mill reduction initiatives with a minimum of individual visits and counseling.

More than 100 mills attended at least part of the Clean by Design 2014 trainings. We selected 37 of these mills for individual tracking and attention, nearly all of which (33 of the 37) completed the program. These mills—the Clean by Design class of 2014—provided initial benchmarking information, hosted expert consultations, submitted implementation plans, undertook improvements, and completed reports that allowed us to fully evaluate their results. NRDC or our consultant visited each active mill to collect and review the data needed to track implementation and to provide technical assistance as needed.

More than 90 percent of the 230 individual projects proposed for implementation by the mills were completed in 2014. (See Figure 2) Nearly all the rest are expected to be finished in 2015, and some projects will be brought to larger scale. Only 1 percent of the projects failed or proved too difficult to implement and have been eliminated. NRDC plans to visit selected 2014 mills in the coming 12 months to assess the status of implementation and maintenance of the reductions to date.

Figure 2: Projected completion rates for the 33 mills in Clean by Design 2014



Shaoxing training workshop

Guangdong training registration

Environmental and Economic Results

Clean by Design implemented more than 200 improvement projects at 33 mills in 2014.

WATER REDUCTIONS

All but two of the 33 mills in Clean by Design 2014 undertook efforts to reduce their water use, with a total of 53 projects.

- The average water saved at these mills was 9 percent, with the top five mills reducing their water consumption by more than 20 percent (Table 1 and Appendix B).

Most frequently, efforts targeting the reuse of process water and grey water yielded the largest and most cost-effective reductions.

TABLE 1: MILLS WITH THE LARGEST REDUCTIONS IN WATER USE IN CLEAN BY DESIGN 2014

MILL	PERCENTAGE WATER SAVINGS	BIGGEST CONTRIBUTING PROJECT
GUANGZHOU GUNZETAL	36.1%	Process water reuse
ZHEJIANG HUADONG	34.7%	Process water reuse
CHARMING FABRICS	26.6%	Cooling water reuse
ZHEJIANG JIAHUA	25.1%	Process water reuse
BEST PACIFIC	21.5%	Upgrade dye vats

The best mill of this group, Guangzhou Gunzetal Co., Ltd., which reduced its water by an impressive 36 percent, achieved this success mainly by engineering an inexpensive project with upfront costs of only $7,600 (48,000 RMB) that paid itself back in only 3 months! This amazing water-saving project collected slightly polluted rinse water at the mill and reused it after a simple treatment process of sedimentation and filtration. Guangzhou Gunzetal also shortened its dyeing process which contributed to this impressive reduction.

ENERGY SAVINGS

Every mill in Clean by Design 2014 reduced its energy use, thanks to a total of 173 individual projects.

- The average energy reduction for the mills was 6 percent, with the top five mills reducing by 10 percent or more (Table 2 and Appendix B).
- More than half the participating mills (19 of 33) reduced their energy use by 5 percent or more.

A larger range of project types was responsible for the greatest energy use reductions compared to water reductions. However, most frequently, efforts recovering heat from exhaust gas, water, and oil yielded the largest and most cost-effective reductions.

TABLE 2: MILLS WITH THE LARGEST REDUCTIONS IN ENERGY USE IN CLEAN BY DESIGN 2014

MILL	TOTAL ENERGY REDUCTION (%)	BIGGEST CONTRIBUTING PROJECT
ZHEJIANG HUILI	22%	Reuse heat from hot water
M3I	16%	Maintain steam traps/system
PROSPERITY	12%	Improve boiler efficiency
BEST PACIFIC	11%	Upgrade dye vats
SHAOXING MINGYU	10%	Recover heat from hot oil

The best of this group, Zhejiang Huili Dyeing & Finishing Co., Ltd., which reduced its energy use by nearly 22 percent, engineered a project that captured and reused the heat from its hot dyeing water. Although this project had a high up-front cost (approximately $500,000 (3 million RMB), it is highly profitable, delivering nearly $650,000 (4 million RMB) per year in returns, and it paid itself back in only 9 months.

Clean by Design 2014 is returning $14.73 million in operating costs annually to the participating mills.

ELECTRICITY SAVINGS

Ten mills undertook a total of 54 projects that reduced their electricity use in Clean by Design 2014.

- The average electricity reduction mills achieved was 4 percent, with the top five mills reducing their electricity by more than 6.5 percent.

Unlike the other categories, there was a very large diversity of types of electricity savings initiatives, many of which fell outside the scope of the Clean by Design Ten Best Practices. The best of these will be evaluated as future candidates for addition to the program.

The most impactful Best Practice electricity project contributed to a 9 percent reduction of the total electricity use at the M21 mill with an unusually inexpensive project on its compressed air system. This project cost only $1,275 (8,000 RMB) and paid itself back in less than a month! This improvement is now delivering more than $21,000/year (130,000 RMB) in savings.

TABLE 3: MILLS WITH THE LARGEST ELECTRICITY REDUCTIONS IN CLEAN BY DESIGN 2014

MILL	TOTAL ELECTRICITY REDUCTION (%)	BIGGEST CONTRIBUTING PROJECT
ZHEJIANG HUILI	13.9%	High efficiency motor
PACIFIC (PANYU)	10.7%	High efficiency motor
M21	8.7%	Compressed air system optimization
ZHEJIANG JIAHUA	7.0%	Auto control devices
M22	6.7%	Direct wet-setting

ECONOMIC BENEFIT

In total, Clean by Design 2014 returned $14.73 million in operating costs in total to the participating mills. Annual return per mill averaged $440,000. More than half of the mills (20 of 33) are saving more than $150,000 per year (938,000 RMB) from their improvements, with the top five mills saving more than $800,000 (5 million RMB). Six additional mills saved more than $500,000 per year (3.1 million RMB). (See Table 4).

Pacific (Panyu) Textiles Ltd. saw the biggest economic return of the Clean by Design 2014 class. This mill saved more than $3.5 million (22.8 million RMB) with 12 projects increasing motor and lighting efficiency, process water reuse, heat recovery from exhaust gas, and more.

Some of the most profitable projects at the Clean by Design 2014 mills were expensive and took more than a year to pay themselves back. Other highly profitable initiatives providing substantial annual returns paid themselves back quickly, however. These stars include:

- An initiative in Shaoxing Mingyu Printing & Dyeing Co., Ltd. to recover heat from heating oil that paid itself back in four months and is delivering more than $740,000 (4.6 million RMB) annually in savings.
- An initiative in Zhejiang Huili Dyeing & Finishing Co., Ltd. to reuse heat from hot water, which paid itself back in 9 months and is delivering more than $650,000 (4.1 million RMB) annually in savings;
- An initiative in Shaoxing Huashen Textile Dyeing & Finishing Co., Ltd. to recover heat from setting machines that paid itself back in one month and is delivering more than $470,000 per year (2.95 million RMB) in savings; and
- A process water reuse initiative in Pacific (Panyu) Textiles Ltd. that paid itself back in less than 3 months and is delivering nearly $400,000 per year (2.5 million RMB) in savings

MORE REDUCTIONS TO COME

The resource reductions and economic returns of the Clean by Design 2014 class reflect permanent improvements that will continue to accumulate in the coming five to ten years and beyond, multiplying their impact substantially.

Furthermore, some mills experimented with improvements at a pilot scale in 2014 and are expected to deliver more reductions as they expand the improvements. NRDC estimates that nearly all of the participating mills will save even more energy and water by expanding these pilots, along with implementing projects currently under consideration but not yet underway.

Willing to spend 15 cents (1 RMB) to save a ton of water? Four 2014 Clean by Design projects did so. And 27 more projects this year were able to reduce their water usage for less than $1.50 (10 RMB) per ton! That's less than half the cost of a single cup of cappuccino at Starbuck's.

TABLE 4: MILLS WITH THE LARGEST ECONOMIC RETURNS IN CLEAN BY DESIGN 2014

MILL NAME	NUMBER OF PROJECTS	SINGLE BIGGEST CONTRIBUTING PROJECT	TOTAL ECONOMIC BENEFIT ($)	OVERALL PAYBACK PERIOD (MONTHS)
PACIFIC (PANYU)	13	High efficiency motor	$3,637,000	12.8
SHAOXING MINGYU	6	Heat recovery from heating oil	$1,056,000	6.1
ZHEJIANG HUILI	9	Reuse heat from waste hot water	$916,000	13.8
DONGGUAN SHATIN LAKE SIDE	6	Condensate Recovery	$840,000	10.0
BEST PACIFIC	5	Introduce high efficient low liquor ratio dye vat (25 vats)	$836,000	37.6
KAIPING XINDI	6	Introduce high efficient FRD computerized dyeing machine	$755,000	13.2
ZHEJIANG JIAHUA	9	Process/grey water reuse	$742,000	7.9
ZHEJIANG YICHUANG	7	Auto Control Devices	$703,000	14.4
SHAOXING HUASHEN	7	Heat Recovery from Exhaust Gas	$657,000	1.8
M31	10	Maintain and upgrade steam traps/system	$654,000	6.5
ZHEJIANG HUANFA	5	Heat Recovery from Exhaust Gas	$504,000	24.4

The Ten Best Practices

A total of 210 improvement projects were undertaken at the 33 mills that participated in Clean by Design 2014. Approximately 70 percent of these projects (140 of 210) fit squarely into the Ten Best Practices and contributed 70 percent of the total water and energy reductions, with only a 40% of total investment, as well. Outside of the Ten Best Practices, process and equipment upgrades were largely responsible for the rest of the improvements. Some of these initiatives were costly compared to the Ten Best Practices, while we are considering adopting others for Clean by Design 2015.

Four best practices are designed to deliver water savings—metering/leak detection, condensate recovery, cooling water recovery, and process water reuse. Process water reuse led the pack for water reductions, contributing 76 percent of the total 2014 water best practices with 13 projects (Figure 6). All ten of the best practices deliver energy savings. (The four water best practices reduce hot water and thereby contribute to both.) Heat recovery from exhaust gas/heating oil contributed the most to the program's best practice energy reductions at 29 percent with a total of 10 initiatives. (Figure 7)

Table 5 and Figure 8 illustrate the frequency with which each of the Ten Best Practices was adopted by the 2014 Clean by Design mills, as well as their relative contribution to the program's total economic benefit. Insulation initiatives were by far the most frequently adopted improvement option, followed by steam systems/traps maintenance. Heat recovery from exhaust gas and heating oil yielded the highest economic return.

Payback periods across the Ten Best Practices ranged widely in Clean by Design 2014 but were heavily dominated by projects with very short return; more than half of all the projects paid themselves back in less than seven months, and nine of these paid themselves back in less than one month. Less than 10 percent of the 140 Best Practice initiatives required more than a two-year payback period. (Figure 9)

Figure 6: Percentage of Water Savings Contributed by Each Best Practice to Clean by Design 2014

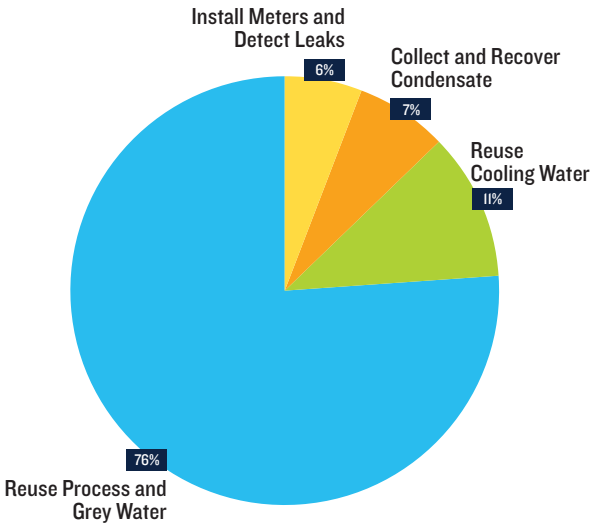


Figure 7: Percentage of Energy Savings Contributed by Each Best Practice to Clean by Design 2014

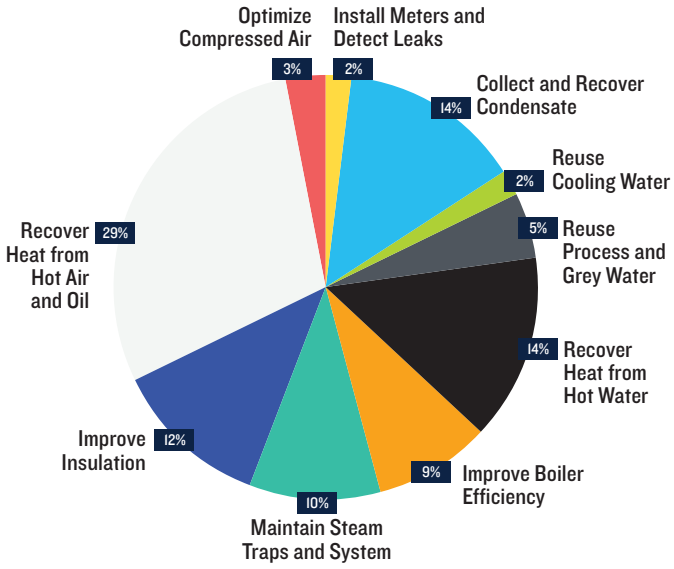


Figure 10 illustrates the relationship between initial investment and economic return in Clean by Design 2014 for each best practice category. (Payback is complete when the line crosses the horizontal axis at zero.) This figure shows that there is no consistent relationship between the size of upfront investment, on average, and long-term return. Steam traps (dark blue line) and insulation projects (yellow), for example, cost nearly the same (on average) up front, but steam traps yield faster payback than improved insulation. Boiler efficiency improvements (red line) are moderate in cost and take longest to pay back. Three years out, however, profit from these improvements in 2014 was in the lower range of net economic benefit.

We expect the frequencies and impacts of the Ten Best Practices to vary by year, since participating mills will enter the program with different levels of existing efficiency improvements.

We will continue to monitor these trends in cost and impact in coming years of Clean by Design to determine whether these patterns are maintained.

Figure 8: Percent Contribution to Total Economic Benefits from the Ten Best Practices

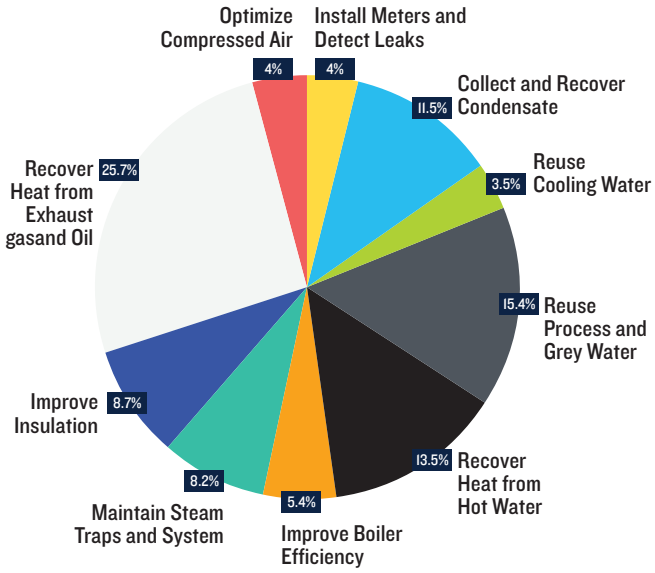
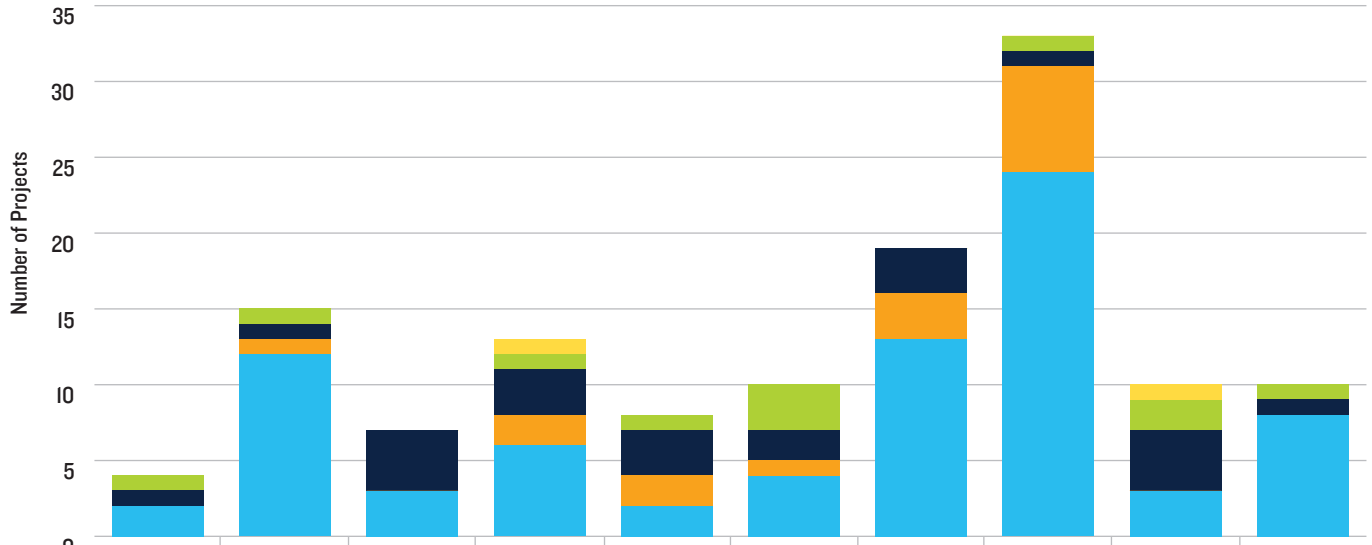


TABLE 5 :TEN BEST PRACTICE FREQUENCY AND CONTRIBUTION TO TOTAL ECONOMIC BENEFIT IN 2014

	Number of Projects	Annual Economic Benefit	Percent Contribution to Total Economic Benefits from 10 Best Practices
1 Install Meters and Detect Leaks	15*	$307,000 (¥1,920,000)	4.0%
2 Collect and Recover Condensate	15	$897,000 (¥5,620,000)	11.5%
3 Reuse Cooling Water	7	$270,000 (¥1,690,000)	3.5%
4 Reuse Process and Grey Water	13	$1,056,000 (¥7,490,000)	15.4%
5 Recover Heat from Hot Water	8	$1,056,000 (¥6,610,000)	13.5%
6 Improve Boiler Efficiency	10	$424,000 (¥2,660,000)	5.4%
7 Maintain Steam Traps and System	19	$639,000 (¥4,000,000)	8.2%
8 Improve Insulation	33	$679,000 (¥4,250,000)	8.7%
9 Recover Heat from Exhaust Gas and Heating Oil	10	$2,001,000 (¥12,540,000)	25.7%
10 Optimize Compressed Air	10	$316,000 (¥1,980,000)	4.0%
TOTAL TEN BEST PRACTICE PROJECTS	140	$7,784,000 (¥48,760,000)	100%

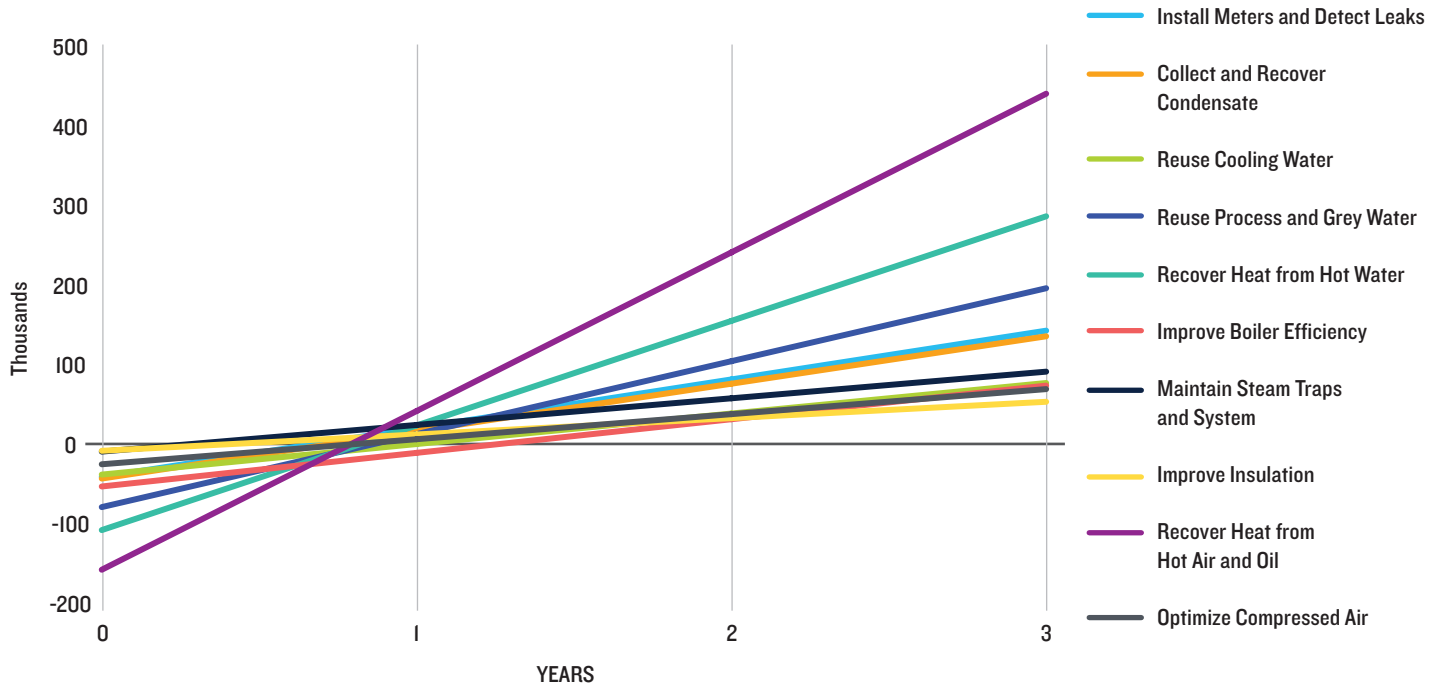
*The economic benefit of only 4 of these 15 metering projects could be quantified and included in the program total.

Figure 9: Project Payback Period by Best Practice Category



	Install Meters and Detect Leaks	Collect and Recover Condensate	Reuse Cooling Water	Reuse Process and Grey Water	Recover Heat from Hot Water	Improve Boiler Efficiency	Maintain Steam Traps and System	Improve Insulation	Recover Heat from Hot Air and Oil	Optimize Com-pressed Air
> 48 months	0	0	0	1	0	0	0	0	1	0
25-48 months	1	1	0	1	1	3	0	1	2	1
13-24 months	1	1	4	3	3	2	3	1	4	1
8-12 months	0	1	0	2	2	1	3	7	0	0
< 7months	2	12	3	6	2	4	13	24	3	8

Figure 10: Average Net Economic Benefit Trends of the Ten Best Practices



Mill Experiences in Applying Ten Best Practices

INSTALL METERS AND DETECT LEAKS

Routinely measuring water, steam, and electricity consumption in total and at the process and equipment levels underpins all Clean by Design recommendations. Meters at key locations inside a mill—supplemented by measurement software to automate data collection and analysis—best enable factory management to closely track resource and energy consumption for specific processes and to identify resource-intensive processes and leaks.

Thirteen mills in Clean by Design 2014 upgraded their metering and benchmarking systems. In most cases, it was not possible to quantify specific savings from this improved management approach. However, in three cases, mills soon identified leaks to prioritize for attention, which led to excellent quantified results. One additional mill used its new meters to establish maximum water use levels and subsequently reduced its use by carefully monitoring exceedances.

Seeing what your eyes cannot see

The chief engineer from one Clean by Design 2014 mill asked for help determining why his monthly energy cost had increased by one-third over three years without a similar level of increase in production. To solve this problem, Clean by Design experts started diagnosing by reading their data and checking the metering system. Issues were identified right away only through this simple step. Our engineers read the steam meters at a workshop that was not running and discovered that steam was still flowing through the pipes at 6 tons per day, costing the mill $32,000 (200,000 RMB) per year! With four identical workshops in total, this mill was losing almost $130,000 (800,000 RMB) in steam leakage. Mill staff immediately addressed the problem. This finding truly impressed the mill, which then installed new water meters and added meter reading to the daily checklist. They soon noticed a sudden jump in daily water consumption, and launched a three-day investigation of possible leaks. Finally, staff discovered the cause—an exploded water trap caused by heavy rain on the roof, where the leak would not have been noticed for weeks or even months without metering. This mill achieved total water reductions of 9 percent and energy reductions of 1 percent with its expanded metering practice.

Clean by Design experts strongly promote the installation of meters to monitor resource use, but many mills do not share this enthusiasm. Many engineers think that leaks are too small to be worth fixing and that anything worth knowing can be seen with their own eyes. Our experience contradicts this conventional opinion.

COLLECT AND RECOVER CONDENSATE

In the dyeing process, textile mills rely on a large amount of saturated steam. Some of that steam condenses into water (condensate) over the course of its use. This condensate is very high in temperature and purity and very valuable for reuse. One of the best places to collect large volumes of condensate in woven fabric mills is in the drying cylinders, which use steam heat. Knit fabric mills find large sources of condensate primarily in steam traps.

Fourteen mills in Clean by Design 2014 engineered projects to better collect and reuse their condensate. All of these projects delivered both energy and water savings, and two-thirds reduced total mill energy consumption by 1 percent in a single project!

You don't always need to spend a lot of money to save a lot of money

There are sometimes fairly painless opportunities to save a lot of money with a very small investment. Shaoxing Changsheng Thread Manufacturing Co., Ltd., which has invested millions in reducing its environmental impact, couldn't believe it when our engineers suggested that they could capture a significant additional amount of hot, high-quality condensate water and reuse it in the process for less than $16,000 (100,000 RMB). They did a "secret" lab experiment to test the project, with unexpected and thrilling results. The test indicated that 30 percent of their steam turned to condensate and could be recovered through this project! This project debunked the common belief that only costly investments yield good environmental results. This inexpensive project, which paid itself back in four months, is now reducing 4.57 percent of water, 3 percent of energy each year and saving $41,600 (261,000 RMB) annually.

REUSE COOLING WATER

Non-contact cooling water should always be recycled. It is high in quality and temperature and can thus be reused in various processes, such as in desizing, scouring, washing, and rinsing. Given the typical discharge temperature of 45°C and the considerable water volume, cooling water can provide an extremely cost-effective opportunity to reduce resource use and save money. Discharge of hot cooling water stresses the waste water treatment system as well. It is highly beneficial to keep these large quantities of hot, clean water out of the treatment system.

Seven mills in Clean by Design 2014 enhanced their cooling water collection and reuse. The single most cost-effective project was a cooling and condensate water recovery project at Mill M21. This mill spent less than 1 RMB (16 cents) per ton of water saved, and reduced water use by 4.5 percent through a project that is now saving them $20,000 per year (124,500 RMB).

Payback times of less than one month?!

Most Chinese textile mills reuse at least some of their cooling water. However, very often there is room for much more. Among others, Mill M21 took advantage of Clean by Design to find those new opportunities.

Like many mills, Mill M21 used fresh water to spray mercerized fabric. Through another Clean by Design project, mill staff realized that quality of cooling water was good enough to reuse. So, they investigated the possibility of reusing cooling and condensate water from various equipment back into the mercerizing spraying process. After installing just a few new pipes, Mill M21 successfully replaced all of this spraying water with recycled cooling water and condensate.

With three sets of mercerizing lines, this simple yet effective project now saves Mill M21 11,340 tons of fresh water every year. An initial investment of only $1,100 (7,000 RMB), is now saving more than ten times that amount-- $19,800 (124,000 RMB)-- every year! The project paid itself back in less than a month. In additional benefit, this improvement cuts down the amount of hot waste water discharged to the treatment system as well.

REUSE PROCESS AND WASTE WATER

Fabric is rinsed many times during processes—in pretreatment, dyeing, and more. At some factories, darker colors go through as many as eight rinses, with each rinse consuming six or seven tons of water per ton of fabric. Industry data indicates that 60 to 75 percent of total water consumption at dyeing and printing mills comes from rinsing. Yet final rinse waters, which are relatively clean, can often be beneficially reused in earlier rinses. Partially treated waste water can also sometimes to beneficially reused.

Process and waste water reuse was a star of the Clean by Design 2014 program. In fact, three of the top five largest water reduction initiatives involved reuse of process/waste water, and this Best Practice was responsible for fully 76 percent of the total water saved in Ten Best Practices in the program. Process/waste water reuse also proved one of the most cost-effective options and comprised half of the top ten most cost-efficient water savings initiatives this year. Thirteen mills engineered projects to recycle and reuse process or waste water, eight of which had payback periods of less than one year.

Waste water discharge requirements create big savings opportunities when resolved with creativity and ambition

As with many mills, the Zhejiang Huadong Textile Dyeing & Printing Co., Ltd. mill was facing a new, strict limit for its COD discharge to a centralized waste water treatment plan. Whereas the standard had been 500 mg/l, new regulations stipulated 200 mg/l. Meeting this new level would require an expensive upgrade of the mill's existing pretreatment works.

However, the owner of Zhejiang Huadong, an engineer himself with great knowledge in textile manufacturing and passion for saving energy and reducing emissions, looked for innovative solutions. He found that he could reduce the COD level in his waste water to much below 200mg/L with only a 10 percent increase in operating costs. At 80 mg/L, he could reuse this treated waste water in the manufacturing process rather than discharge it to the environment. The solid theoretical knowledge of our experts helped resolve some remaining questions and broaden his thoughts before the project was successfully designed, piloted, and implemented.

The project had a relatively high upfront cost of $574,000 (3.6 million RMB), and it returns $115,000 (720,000 RMB) per year with a payback period of five years. Absent this innovative additional treatment, the mill would have been forced to undertake a costly waste water treatment upgrade that provided no financial return at all.

RECOVER HEAT FROM HOT WATER

During manufacturing, large quantities of very hot water (as high as 80° C) are discharged from dyeing, rinsing, and finishing fabric. If this water is too poor in quality to reuse directly, the heat from this water can be beneficially captured and used to preheat incoming water for the next hot rinse or process use. The capturing of heat from hot water also provides an important second benefit of reducing the temperature of waste water prior to treatment.

Eight mills engineered projects to recover heat from hot water in Clean by Design 2014. Although as a class, these projects took longer to pay back than most, they also delivered larger average returns.

Neither too hot nor too cold!

Most textile mills in China have a common problem: their waste water, with a temperature of 50 to 60°C (122 to 140°F), is too hot to discharge to their waste water treatment plants but not hot enough to bother recovering the heat. Thus, in most cases, mills use cooling towers to lower temperatures or just discharge this problematic water to the waste water treatment plants without benefit.

Zhejiang Huili Dyeing & Finishing Co., Ltd. is one of the strongest mills in Hangzhou-Shaoxing area in energy efficiency and emission reduction and the only mill in Clean by Design 2014 with senior professional personnel for energy management. Because the heat recovery equipment the mill needed was so expensive—nearly $500,000 (3.1 million RMB)—even with their excellent experience and enthusiasm, the engineers were nervous and hesitated to make such a big investment. Our experts checked the calculations and confirmed that this was indeed a superb project. Now implemented, the project has paid itself back in just nine months and is now providing a large revenue stream back to the mill. It has lowered the plant's energy use (and hence fuel bills) by 18.5 percent!

Based on this experience, other mills that have considered heat recovery from "lukewarm" water to be cost ineffective should review their calculations.

IMPROVE BOILER EFFICIENCY

On-site boilers provide major opportunities to improve resource use and reduce environmental impacts at many textile mills. Burner calibration, insulation of casing and doors, and installing automated oxygen controls are three common and useful improvements. Heat recovery from boiler stacks to reuse in making steam is also included in the boiler efficiency best practice.

Ten mills undertook efforts to improve boiler efficiency in Clean by Design 2014. Half of these projects paid themselves back in less than one year.

A hot spot indeed for waste heat!

Most mills know there is a lot of valuable heat to recover at their boilers, but many feel they have done all they can—they have already installed systems that capture the high temperature to heat incoming water for steam, for example, and have economizers in place.

Those that have not undertaken these improvements have a valuable opportunity to reduce costs and lower emissions. With the encouragement of Clean by Design engineers, Mill M20 for example installed a waste heat steam boiler and reduced its annual coal burning by 436 tons—or 4.5 percent! The waste heat at this mill is now being used to make steam for its dyeing machines.

Even mills that have already installed equipment, particularly economizers, should take a second look; the economic benefit from older economizers is likely in decline and could be beneficially upgraded. After discussion with Clean by Design engineers, Mill M16 chose to replace a poor-performing old boiler economizer. Their investment of $19,000 (120,000 RMB) in new equipment delivered an annual economic return of more than $28,000 (176,700 RMB) and it paid itself back within eight months. That's 290 tons of coal saved from burning every year!

MAINTAIN STEAM TRAPS AND SYSTEM

Mills have extensive steam systems that distribute heat to processes. The inevitable small leaks and inefficiencies that arise from the on going need to reconfigure pipes and equipment can add up to significant waste. While steam valve leaks are relatively easy to discover, steam trap dysfunction is much harder to find and it is often overlooked. Steam traps have also often been improperly installed, leading to considerable energy losses and system problems. Ninteen steam projects were undertaken in Clean By Design in 2014, and all but two paid themselves back in less than one year.

Steam system improvement increases line production capacity by 50 percent!

One mill in Clean by Design 2014 had more than 200 drying cylinders, with every 30 cylinders making up a group. The mill thought that these drying lines should not have any problems since they are controlled by an automatic system. However, several lines were not drying the fabric as required, and workers had opened the steam valves to 100 percent, which consumed quite a lot of extra steam, even though 50 percent should suffice according to the automatic control system. Workers mistakenly thought that it was the dysfunction of automatic system causing the problem.

We tested drying cylinder temperatures right away when we discovered this problem. We found that although the 30 drying cylinders should be maintained at 120°C (248°F), eight were below 80°C (176°F) with three of them at room temperature. Further investigation of root cause revealed that water was trapped in the low-temperature cylinders. This water was preventing hot steam from entering the cylinder and reducing the temperature below requirements, thus resulting in low drying performance. The weight of this water was also impeding the cylinder's rotation, slowing production on the line.

Drying cylinders rely on a top valve to control incoming steam, as well as a steam trap at the bottom to release the condensed water. The steam traps at the bottom, which cannot be inspected with the naked eye, were causing the mill's problem.

Our experts discovered that a flaw in the drying cylinder's design was creating problems with the steam traps. Working with mill staff, we modified the structure of all the drying cylinders to prevent further problems. As a result, this mill reduced nearly 15,000 tons of steam and more than 7 percent of energy. The biggest savings, however, were in increased production capacity. Because the cylinders could now dry and rotate at capacity, line production capacity could be increased by 50 percent.

IMPROVE INSULATION

Insulation was by far the most frequently used Best Practice in Clean by Design 2014 and was used by more than 70 percent of the 2014 mills (24 of 33). It was the least expensive improvement opportunity and the one with the shortest payback period; 85 percent of the 2014 insulation initiatives cost less than $16,000 (100,000 RMB), and more than half of these (18 of 33) returned that investment in six months or less.

Many commonly overlooked opportunities to improve

Regarding insulation, most mills think first and foremost about their pipes. Whereas pipes are undoubtedly important to insulate, there are several commonly overlooked other areas all mills should explore for insulation.

Drying cylinders One Clean by Design 2014 mill in Guangdong saved 3.5 percent on energy use by improving insulation to drying cylinders alone! Before this project, their drying cylinders' effective working area were only 20 to 30 percent, and people at the mill did not think it could be improved. With an investment of only $10,800 (68,000 RMB) for insulation at outset, the mill saved $20,000 (125,100 RMB) in annual energy costs. This simple project paid itself back in just half a year.

Dye vats The temperature of dye vats outer walls can reach up to 176°F (80°C), releasing a tremendous amount of heat, wasting energy, and creating a hazardous working environment as well. However, many mills believe that it is impractical to insulate their dye vats because they need to both raise and reduce the vat temperature during the dyeing process. They believe that vat insulation would have adverse impacts when the temperature needs to be reduced. Staff at the Zhejiang Huanfa Textile Printing & Dyeing Co. Ltd. mill felt insulation was very important from Clean by Design workshop trainings and decided to try it out. Zhejiang Huanfa applied this project to only two of their 28 dye vats at first. When this pilot confirmed the calculations, Zhejiang Huanfa insulated the rest of mill's dye vats. This project then reduced mill's steam consumption by 4,500 tons per year and cut their energy consumption by 2.2 percent annually.

Steam valves Shaoxing Mingyu Printing & Dyeing Co., Ltd. considered steam valves insulation too complicated to implement. When testing the valves, our experts found that problems at one of the valves alone cost $430 (2,700 RMB) per year, consuming the heat loss equivalent of 3.6 tons of coal. This might sound like a small number, but the cost of insulating this valve is even smaller! This project cost only $32 (200 RMB)! With more than 130 similar valves, the mill is now keeping a lot of money in its pocket.

RECOVER HEAT FROM EXHAUST GAS AND HEATING OIL

Hot flue gas leaving the setting machine or other process equipment such as air compressors is a large source of heat energy that can be captured and used. Ten mills undertook efforts to recover heat from exhaust gas or hot oil in their production processes. Although many mills feel they have too much heat and are not motivated to collect more, a few mills expanded the use of recovered heat in Clean by Design 2014.

Overlooked places to pick up some heat, and a great new place to use it!

As most mill engineers know, setting machines are inefficient, releasing 60 percent of their hot air without recovery. Nonetheless, few mills have taken steps to recover their heat from this source; they consider it too complicated or dangerous. In Clean by Design 2014, a few mills installed exhaust gas recovery devices. At Shaoxing Huashen Textile Dyeing & Finishing Co., Ltd., setting machines are fueled with natural gas instead of coal, lending themselves well to heat recovery. This mill retrofitted two of their new setting machines to recover the exhaust hot air for use as inlet air and successfully reduced those setting machines' energy consumption by 15%. With this great success in hand, they have now improved all six of their setting machines. The annual economic return from these six total retrofits is more than $470,000 (3 million RMB) with an up-front cost of less than $47,800 (300,000 RMB). This project paid itself back in less than 40 days!

In some mills, the problem is not finding new sources for heat recovery. They have too many sources, in fact! The problem is where to utilize the recovered hot air. Pacific (Panyu) Textiles Ltd. innovatively used captured heat from 12 setting machines as an energy resource for thermal-driven air conditioning. The result is quite impressive. This project cost a total of $734,000 (4.6 million RMB) at the outset. Yet, the economic benefit achieved from energy saved is also quite large—almost $360,000 (2.2 million RMB) annually. Thus, even with the high cost of the air conditioner, money saved from reduced energy consumption still paid the investment back in two years. And workers will now benefit from the air conditioning.

OPTIMIZE COMPRESSED AIR

Electricity is estimated to account for no more than 20 percent of the total energy consumption at a typical dyeing and finishing mill. However, electricity is quite expensive and even small savings on electricity can significantly reduce the overall operating costs of textile manufacturing.

One practice, optimizing the compressed air system, results in sufficient electricity savings to qualify as a Clean by Design Best Practice.

Nine mills undertook improvement projects to their compressed air systems. Three of these projects paid themselves back in less than one month!

Opportunity knocks when a line is down

Compressed air leakage is a serious problem that mills tend to ignore no matter how many times it is emphasized in training. When Clean by Design experts visited Shaoxing Changsheng Thread Manufacturing Co., Ltd., we twice suggested that that the system be investigated for energy efficiency, but staff did not take action. On the third visit, however, opportunity knocked. Most workshops were not running because of a holiday. Since no compressed air was required for production that day, any flow measured in the compressed air system would be from leakage.

Clean by Design engineers found that more than 50 percent of compressed air was being wasted through leakage. Ideally, the leakage rate should be within 10 percent. The finding was so shocking to the Clean by Design expert and mill engineers that we measured six times—four tests by the our expert and two tests by the mill.

The mill addressed the problem immediately and quickly lowered the leakage rate to 20 percent within a week by replacing aging pipes and fixing leaks in connecting devices. These repairs, which cost a mere $1,600 (10,000 RMB), reduced the total electricity consumption by nearly 2 percent and delivered savings of more than $6,300 (39,500 RMB) annually, paying itself back in only 3 months!

It is important to note that Shaoxing Changsheng Thread Manufacturing is a small mill that only has one operating air compressor, while a moderate mill typically has five to six air compressors. Thus, when this project is applied to bigger mills, the number will be enormous.

Ready for More: Projects Beyond the Ten Best Practices

Thirty percent of the total reductions in water and energy were delivered in projects beyond the Ten Best Practices.

Clean by Design's Ten Best Practices deliver results through specific improvements to a factory's steam, hot water, and compressed air infrastructure and through such green initiatives as recycling and reusing water and heat wherever possible. This year, approximately 30 percent of the total reductions in water and energy use delivered in the program were achieved with projects beyond the scope of the Ten Best Practices. (These projects cost 60 percent of the total investment.) The best of these other types of opportunities in 2014 included: enhancing automation, improving process management, purchasing equipment upgrades, and changing basic chemicals ingredients and recipes to reduce resource use.

AUTOMATION

Automation across the whole factory or on key pieces of equipment can deliver very meaningful savings in water and energy use at a mill while at the same time enhancing right-first-time dyeing rates and product quality. Many mills in Clean by Design 2014 improved their level of automation and are now running their machines more precisely according to predetermined sets of process specifications. Several mills installed temperature detectors in their setting machines, for example. Others installed humidity detectors to avoid wastefully over-drying their fabric. One mill fully automated and centralized all of its process equipment and electricity system; this was one of the most expensive projects undertaken in all of Clean by Design, but it will pay itself back in only a little bit more than two years and subsequently provide a large profit.

Automation is particularly helpful in the dyeing process itself, which some mills in China still manage without electronic tools through a dye master. Computer technology now enables dyeing machines to be precisely controlled in temperature and rate of temperature rise, as well as salt content, pH, and more. Chemical dosing and mixing can also now be automatically undertaken with great benefit. Once predetermined optimized parameters are programmed into the computer, the whole process can be handled automatically, dramatically improving right-first-time dye rates and thereby reducing resource use.

PROCESS MANAGEMENT

Automation is not the only way to improve process operations; to the contrary, for many mills, perhaps the most promising way to reduce cost and resource use is to improve process oversight and management routines. These improvements require astute observation and a change in thinking, however, rather than a simple purchase order. They also require improved worker discipline and standardization to ensure that improvements become routine as well. For these reasons, process management improvements are sometimes a more difficult starting point for mills than other opportunities to improve.

One particularly promising area is to minimize or reduce the time that machines are running empty without load/production. Guangzhou Donghaipeng Dyeing & weaving Co., Ltd. in Clean by Design 2014 undertook an excellent effort in this regard and as a result lowered its electricity use by nearly 2.5 percent. After taking measurements, the mill found that each of its eight setting machines was idling more than two hours each day. The mill revised its production schedule, and, with very little up-front cost, this initiative is now delivering $30,000 in economic benefit in reduced electricity costs every year.

IMPROVED LIGHTING

Many mills have converted to more energy efficient lighting in their factories, nowadays substituting old candescent or even old fluorescent lighting with more energy saving LED lights. These investments are generally quick, easy, and inexpensive, but they often do not deliver as much in energy savings as other initiatives available to the mill.

EQUIPMENT UPGRADES

We have seen two major kinds of common equipment upgrades: the purchase of more energy efficient motors/ variable speed drives, and the purchase of more energy/ water efficient processing equipment, such as low liquor ratio dye machines and increased efficiency printing machines. In most cases, these upgrades are relatively costly, but they generally have a high return and provide substantial economic benefit to the mills. Thus for mills that can afford them, they are a very good investment.

PROCESS MODIFICATION

An additional promising area of improvement in textile mills is to review and upgrade dyeing processes recipes. Many new dyes and chemicals have been made available on the market that offer substantial improvements; some can operate at lower temperatures, which reduces energy use, and some require less rinsing, which reduces both water and energy consumption at the same time. Enzyme-based formulations are particularly promising in pre-treatment processing such as desizing, and high affinity dyes rinse away in much lower concentrations to waste water. Both these and other chemistry innovations offer a cost effective way to decrease COD loading to the treatment plant as well. Ten mills in the 2014 Clean by Design program made positive changes to their dyeing processes and recipes that resulted in substantial improvement in their environmental performance.substantial economic benefit to the mills. Thus for mills that can afford them, they are a very good investment.

Endnotes

1 The State Environmental Protection Administration, China, Report on the State of the Environment in China, 2013. June 5, 2014. (In Chinese). http://jcs.mep.gov.cn/hjzl/zkgb/2013zkgb/201406/t20140605_276490.htm

2 China's Ministry of Water Resources: Opinions on Strengthening City Water Usage Projects and Related Matters, November 23, 2006. http://www.mwr.gov.cn/zwzc/tzgg/tzgs/200611/t20061123_157416.html

3 U.S. Energy Information Administration, "China," U.S. Energy Information Administration, February 4, 2014, http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=90&pid=44&aid=8

4 China Textile Industry Association: Summary of Technological Advances for the Textile Industry during the 12th Five-year Plan, April 2, 2011

5 China National Textile and Apparal Council 2014.

6 China National Textile and Apparel Council 2014.

7 We estimated that textile industry in China consumes more than 3 billion tons per year based on its 2.9 billion tons of wastewater discharge. Actual water consumption may be more than wastewater discharge, if it is supplemented by recycled water from the collection and reuse of condensate and cooling water. The quantity of water withdrawn, however, should equal the amount of wastewater discharged.

8 China Statistical Yearbook 2014. The yearbook states that the industry consumes 78 million tons of coal equivalent, which we converted to an estimate of tons of average coal with a 1.4 x conversion factor.

9 China Statistical Yearbook 2011. Chemical oxygen demand (COD) is an indicator of total organic chemical load. COD is highly damaging to aquatic ecosystems, since it takes dissolved oxygen out of the water column and thereby smothers fish and other aquatic life. COD is the pollutant most commonly causing fish kills in rivers, lakes, and streams.

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12 United Nations Environment Programme (UNEP). Global Chemical Outlook: Towards Sound Management of Chemicals Trends and changes, 2013. http://www.unep.org/chemicalsandwaste/Portals/9/Mainstreaming/GCO/Rapport_GCO_calibri_greendot_20131211_web.pdf

Appendix A

Corporate Scorecard for Supply Chain Responsibility

In 2014, to sharpen the focus of multinational corporations on their supply chain impacts, NRDC partnered with the Institute of Public and Environmental Affairs (IPE) to develop a quantitative supply chain score card evaluation system called the Corporate Information Transparency Index (CITI). This index ranks companies on the extent to which they scrutinize their suppliers for environmental compliance problems, follow up with corrective action orders, promote environmental information disclosure by their suppliers, and respond to public concerns about their supplier base.

CITI Criteria		Communication and Follow-up		Compliance and Corrective Action			Extend Green Supply Chain		Data Disclosure and Target Setting		Responsible Recycling	Total
		Basic Communication	Discuss Industry Pollution Problems	Establish Screening Mechanism	Corrective Actions	Self-Monitoring Data	Identify Main Polluting Sectors	Extend Management Upstream	Energy and Emission Target	PRTR	Recycling Used Products	
No.	Brand	10	10	12	12	8	10	10	10	12	6	100
1	H&M	10	10	12	9	2	5	5	0	9	1.5	63.5
2	Esquel	10	10	12	12	2	7.5	2.5	2.5	3	1.5	63
3	M&S	10	10	12	6	2	5	2.5	0	9	1.5	58
4	GAP	10	10	12	9	2	5	5	2.5	0	0	55.5
4	C&A	10	10	12	6	0	10	5	2.5	0	0	55.5
6	Adidas	10	10	9	9	0	5	0	0	9	0	52
7	Burberry	10	10	9	9	0	2.5	2.5	2.5	6	0	51.5
8	Target	10	10	12	3	0	5	5	0	6	0	51
8	Walmart	10	10	12	9	0	2.5	5	2.5	0	0	51
10	Puma	10	10	9	6	0	7.5	0	5	3	0	50.5
10	Nike	10	10	9	9	0	5	2.5	5	0	0	50.5
12	Uniqlo	10	10	12	9	0	5	0	0	0	1.5	47.5
13	ZARA	10	10	6	6	0	5	2.5	0	3	0	42.5
14	Esprit	10	10	9	6	0	5	0	0	0	0	40
15	Li-Ning	10	7.5	9	6	0	5	0	0	0	0	37.5
15	Levi's	10	10	9	6	0	2.5	0	0	0	0	37.5
17	IKEA	10	7.5	9	3	0	2.5	0	2.5	0	1.5	36
18	Mizuno	10	7.5	9	6	0	0	0	0	0	0	32.5
19	Ann Taylor	7.5	7.5	6	6	0	2.5	0	2.5	0	0	32

CITI Criteria		Communication and Follow-up		Compliance and Corrective Action			Extend Green Supply Chain		Data Disclosure and Target Setting		Responsible Recycling	Total
		Basic Communication	Discuss Industry Pollution Problems	Establish Screening Mechanism	Corrective Actions	Self-Monitoring Data	Identify Main Polluting Sectors	Extend Management Upstream	Energy and Emission Target	PRTR	Recycling Used Products	
No.	Brand	10	10	12	12	8	10	10	10	12	6	100
20	The North Face	10	10	6	0	0	2.5	0	0	0	0	28.5
20	Timberland	10	10	6	0	0	2.5	0	0	0	0	28.5
20	Lee Jeans	10	10	6	0	0	2.5	0	0	0	0	28.5
23	Youngor	10	10	3	3	0	0	0	0	0	0	26
24	Jack & Jones	7.5	5	6	6	0	0	0	0	0	0	24.5
25	Disney	10	7.5	3	0	0	0	0	0	0	0	20.5
26	Toread	7.5	2.5	3	6	0	0	0	0	0	0	19
27	Lafuma	7.5	5	0	0	0	0	0	0	0	0	12.5
27	Tommy Hilfiger	5	7.5	0	0	0	0	0	0	0	0	12.5
27	CK	5	7.5	0	0	0	0	0	0	0	0	12.5
30	Primark	5	5	0	0	0	0	0	0	0	0	10
30	Tesco	5	5	0	0	0	0	0	0	0	0	10
30	Benetton	5	5	0	0	0	0	0	0	0	0	10
30	Carrefour	5	5	0	0	0	0	0	0	0	0	10
34	Sears	2.5	2.5	0	0	0	0	0	0	0	0	5
34	Kmart	2.5	2.5	0	0	0	0	0	0	0	0	5
36	Armani	2.5	0	0	0	0	0	0	0	0	0	2.5
36	Fifth and Pacific	2.5	0	0	0	0	0	0	0	0	0	2.5
36	Next	2.5	0	0	0	0	0	0	0	0	0	2.5
39	HUGO BOSS	0	0	0	0	0	0	0	0	0	0	0
39	Abercrombie & Fitch	0	0	0	0	0	0	0	0	0	0	0
39	361°	0	0	0	0	0	0	0	0	0	0	0
39	Kappa	0	0	0	0	0	0	0	0	0	0	0
39	Guess	0	0	0	0	0	0	0	0	0	0	0
39	Anta	0	0	0	0	0	0	0	0	0	0	0
39	Cortefiel	0	0	0	0	0	0	0	0	0	0	0
39	DKNY	0	0	0	0	0	0	0	0	0	0	0
39	Victoria's Secret	0	0	0	0	0	0	0	0	0	0	0
39	Macy's	0	0	0	0	0	0	0	0	0	0	0
39	J.C. Penney	0	0	0	0	0	0	0	0	0	0	0
39	Giordano	0	0	0	0	0	0	0	0	0	0	0
39	Meters/bonwe	0	0	0	0	0	0	0	0	0	0	0
39	Polo Ralph Lauren	0	0	0	0	0	0	0	0	0	0	0

Appendix B

Comprehensive Results Summary

Mill Name/Code	Water saving (t/y)	Water Reduction	Energy savings (tons of raw coal/y)	Energy Reduction	Electricity Savings (Kwh/y)	Electricity Reduction	Investment ($)	Economic Benefit ($)	Payback Period (months)
Kaiping Panther	18,399	0.8%	640	1.9%	N/A	N/A	110,000	91,000	14
Prosperity	30,000	4.8%	1352	12.3%	N/A	N/A	482,000	204,000	28
Guangzhou Changshun	8,700	1.6%	110	3.0%	N/A	N/A	119,000	92,000	15
Charming Fabrics	163,000	26.6%	238	1.3%	27	0.3%	217,000	131,000	20
Best Pacific	500,200	21.5%	3091	10.8%	428	3.9%	2,620,000	836,000	38
Guangzhou Donghaipeng	N/A	N/A	1261	8.9%	342	3.3%	166,000	142,000	14
Foshan Datang	27,300	8.3%	1220	7.1%	N/A	N/A	113,000	170,000	8
M08	67,500	7.5%	254	1.0%	1	0.0%	25,000	146,000	2
Zengcheng Guangying	57,692	7.0%	628	3.2%	53	0.4%	99,000	92,000	13
Foshan Sanshui Haotong	46,800	8.4%	71	0.6%	N/A	N/A	31,000	66,000	6
Pacific (Panyu)	555,124	4.1%	12138	2.6%	24891	10.7%	3,880,000	3,637,000	13
Guangzhou Suixin	11,600	1.6%	292	5.8%	N/A	N/A	128,000	151,000	10
Chip Tak Textiles	7,500	2.5%	150	1.5%	56	0.6%	40,000	30,000	16
Guangzhou Gunzetal	62,100	36.1%	160	6.5%	14	0.4%	37,000	71,000	6
Dongguan Shatin Lake Side	47,000	0.7%	6884	7.4%	1882	2.9%	700,000	840,000	10
M16	4,950	0.3%	687	5.7%	138	0.8%	46,000	84,000	7
Kaiping Xindi	19,820	2.4%	1299	2.3%	188	2.0%	832,000	755,000	13
Guangzhou Xinliyi	25,060	6.9%	121	1.6%	199	2.0%	105,000	48,000	26
Guangzhou Xinsheng	27,600	3.2%	1856	4.3%	662	2.4%	669,000	253,000	32
M20	40,000	7.2%	716	7.3%	N/A	N/A	148,000	117,000	15
M21	17,885	7.2%	175	4.0%	160	8.7%	49,000	72,000	8
M22	30,400	6.1%	530	6.1%	989	6.7%	110,000	170,000	8
Shaoxing Changsheng	11,000	5.0%	383	7.8%	45	1.9%	65,000	92,000	9
Zhejiang Huadong	528,000	34.7%	838	2.7%	2012	6.2%	873,000	426,000	25
Zhejiang Huanfa	65,500	7.6%	2666	9.6%	N/A	N/A	1,026,000	504,000	24
Zhejiang Huili	40,000	4.6%	4446	21.6%	1290	13.9%	1,052,000	916,000	14
Shaoxing Huashen	40,000	3.8%	1959	7.9%	150	1.5%	177,000	657,000	3
Zhejiang Jiahua	317,275	25.1%	2156	9.7%	830	7.0%	488,000	742,000	8
M29	56,628	5.2%	2072	6.4%	N/A	N/A	405,000	389,000	12
Shaoxing Mingyu	N/A	N/A	5469	10.4%	1352	6.6%	533,000	1,056,000	6
M31	46,080	13.9%	4463	15.8%	N/A	N/A	354,000	654,000	6
Zhejiang Yichuang	51,200	4.20%	1965	9.70%	943	5.20%	841,000	703,000	14
Zhejiang Yongfeng	136,000	12.70%	498	1.70%	N/A	N/A	258,000	208,000	15

Appendix C

Individual Mill Achievements

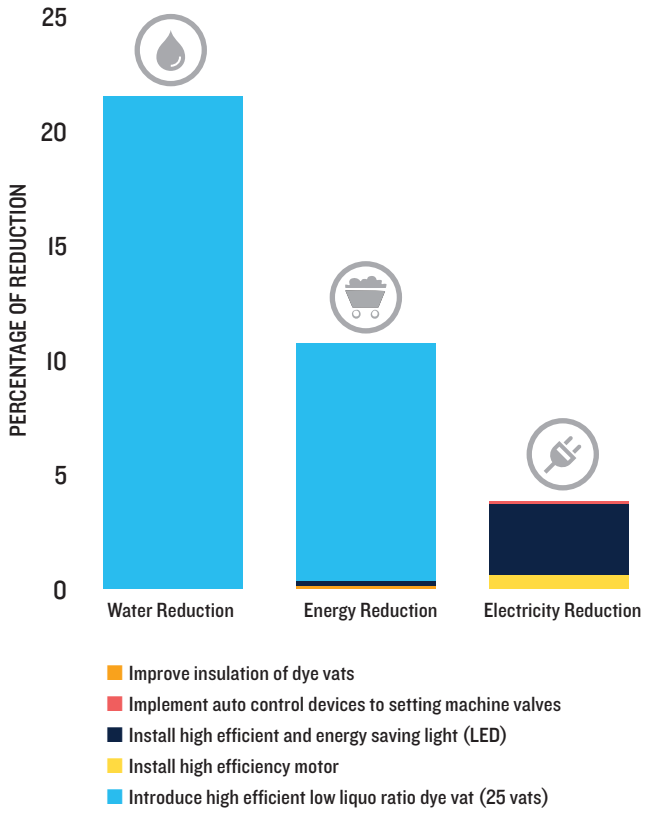
BEST PACIFIC INTERNATIONAL HOLDINGS LTD., DONGGUAN CITY, GUANGDONG PROVINCE

is a private textile mill established in 2003 that dyes and finishes high-grade knitted spandex. It is a large-sized mill with 1,800 employees. Best Pacific has a very sophisticated 3-level metering system that provides great assistance to them in monitoring their resource usage.

In Clean by Design 2014, Best Pacific completed a total of five projects which delivered water, energy, and electricity reduction. One project that introduced 25 sets of high efficient low liquor ratio dye vats helped the mill reduce its water consumption by 21.5 percent and energy consumption by 10 percent! Best Pacific also undertook an important project for environmental compliance and changed the type of fuel in in its setting machine as required by the government during the Clean by Design 2014 initiative. In prior years, the mill had undertaken successful heat recovery projects and introduced a high efficient air conditioner to save energy and reduce coal consumption.

Insulation of dye vats

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
3,091 tons/year

WATER SAVING:
500,200 tons/year

WASTE WATER REDUCTION:
500,200 tons/year

TOTAL INVESTMENT:
2,620,000 dollars

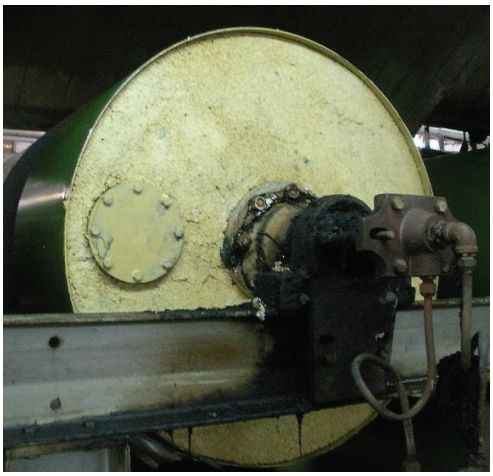
ECONOMIC BENEFITS:
836,000 dollars/year

PAYBACK PERIOD:
38 months

GUANGZHOU CHANGSHUN TEXTILE CO., LTD., GUANGZHOU CITY, GUANGDONG PROVINCE

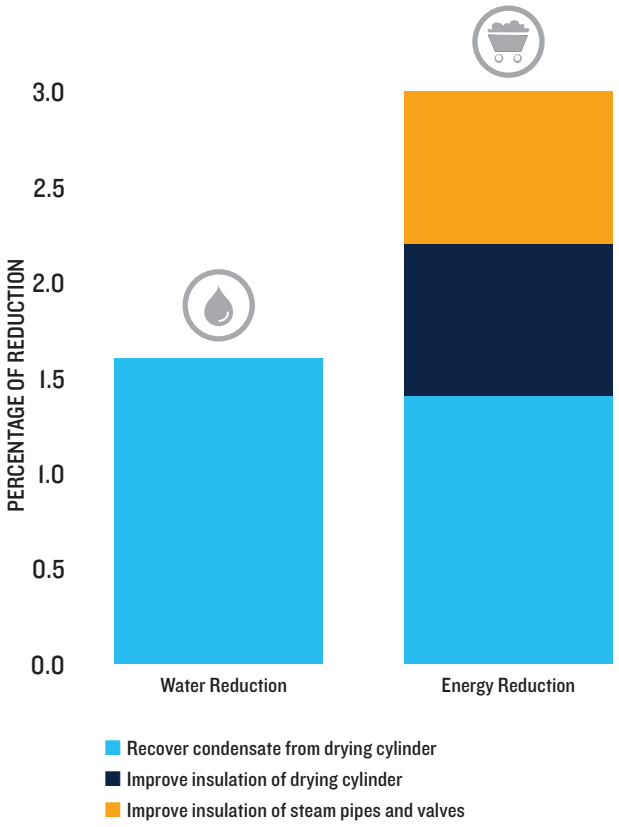
is a private textile mill established in 2004 that dyes cotton yarn. It is a small-sized mill with 200 employees.

In Clean by Design 2014, Guangzhou Changshun completed six projects in total. Among these projects, three achieved water and energy savings and three reduced dye stuff consumption by 66 tons annually. Results shown in the chart* and table below.



Insulation on drying cylinder

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
110 tons/year

WATER SAVING:
8,700 tons/year

WASTE WATER REDUCTION:
8,700 tons/year

TOTAL INVESTMENT:
119,000 dollars

ECONOMIC BENEFITS:
92,000 dollars/year

PAYBACK PERIOD:
15 months

* The chart illustrates only contributions from those projects that have water, energy, or electricity reductions larger than 1%.

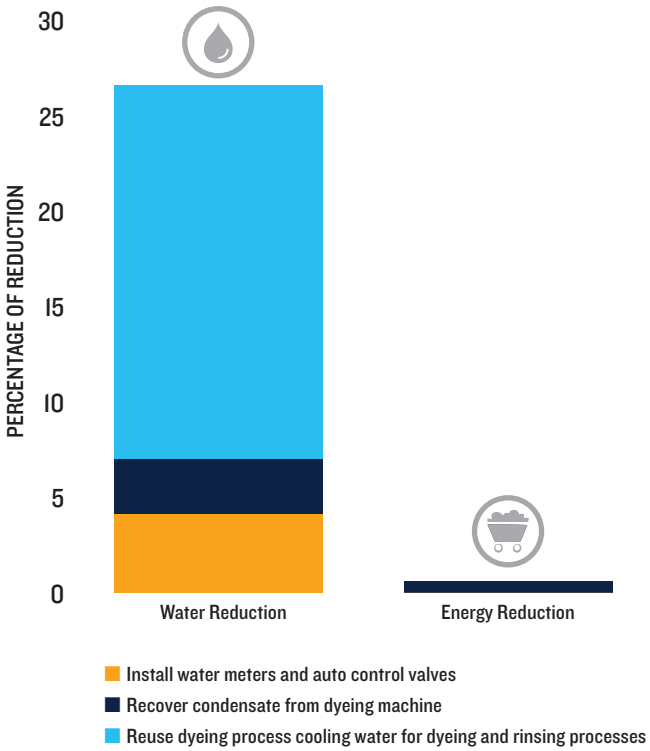
CHARMING FABRICS CO., LTD., JIANGMEN CITY, GUANGDONG PROVINCE

is an older private textile mill established in 1993 that dyes and finishes woven fabric. It is a medium-sized mill with 700 employees.

In Clean by Design 2014, Charming Fabrics completed six projects in total that mostly reduced water use. One of these projects, which collected cooling water for reuse from the dyeing process, contributed 20 percent water reduction. Together with contribution from other projects, the mil achieved a total of 27 percent water reduction. Achievement result shown in the chart* and table below.

Newly installed cooling water recovery tanks

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
238 tons/year

WATER SAVING:
163,000 tons/year

WASTE WATER REDUCTION:
163,000 tons/year

TOTAL INVESTMENT:
217,000 dollars

ECONOMIC BENEFITS:
131,000 dollars/year

PAYBACK PERIOD:
20 months

* This chart illustrates only contributions from those projects that have water, energy, or electricity reductions larger than 1%.

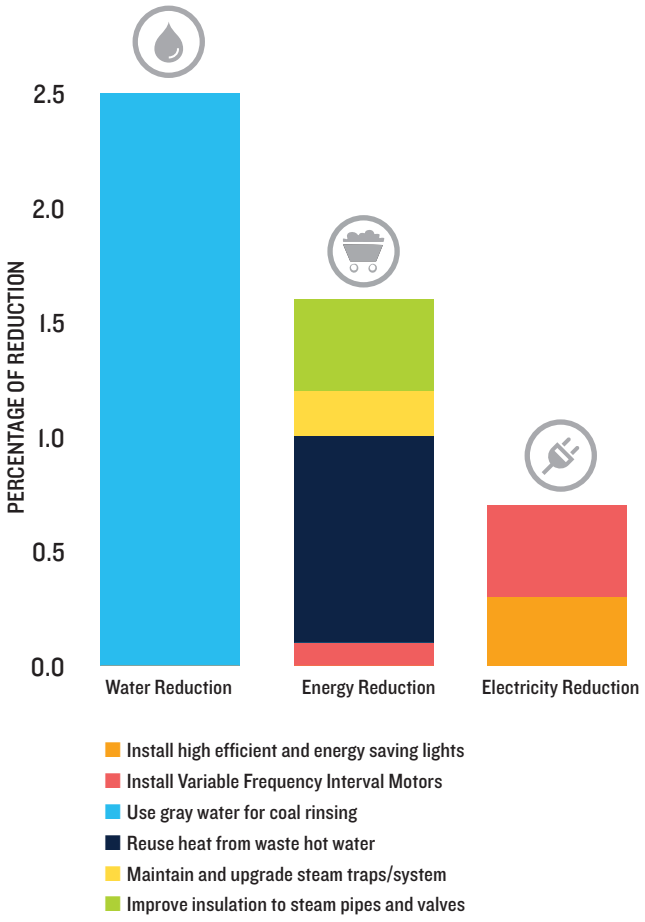
CHIP TAK TEXTILES (TAISHAN) CO., LTD., JIANGMEN CITY, GUANGDONG PROVINCE

is a private textile mill established in 2009 that dyes and finishes denim. It is a medium-sized mill with 400 employees.

In Clean by Design 2014, Chip Tak Textile completed six projects in total that reduced water, energy, and electricity savings. Achievement results are shown in the chart and table below. In prior years, this mill had undertaken projects, which include condensate recovery and boiler efficiency improvement, to reduce water and energy consumption.

Better Insulation of steam pipes and valves

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
150 tons/year

WATER SAVING:
7,500 tons/year

WASTE WATER REDUCTION:
7,500 tons/year

TOTAL INVESTMENT:
40,000 dollars

ECONOMIC BENEFITS:
30,000 dollars/year

PAYBACK PERIOD:
16 months

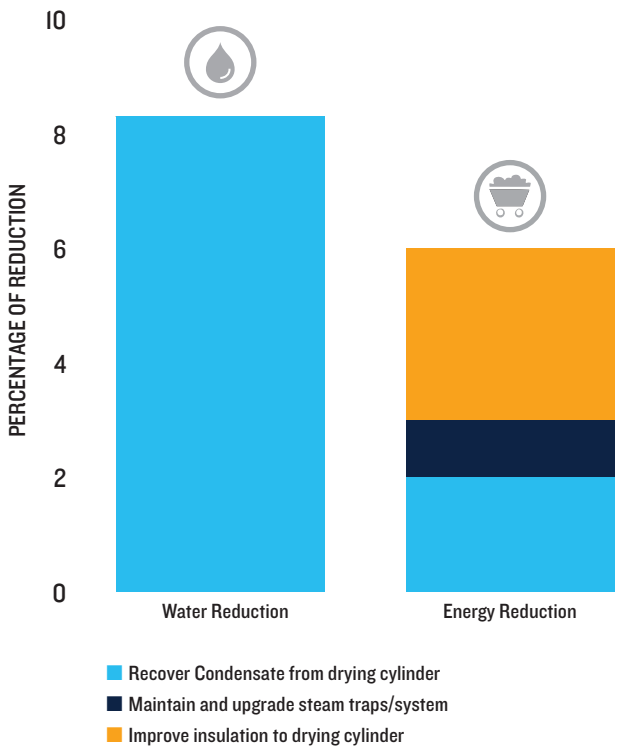
FOSHAN DATANG PRINTING & DYEING CLOTHING FABRIC CO., LTD., FOSHAN CITY, GUANGDONG PROVINCE

is a private textile mill established in 2006 that dyes and finishes denim. It is a medium-sized mill with 300 employees.

In Clean by Design 2014 Foshan Datang completed six projects in total that reduced both water and energy. One project that recovered condensate from drying cylinder reduced the mill's water consumption by 8 percent in addition to 2 percent of energy consumption reduction. Achievement results are shown in the chart* and table below. In previous years, this mill had adopted the cold pad batch dyeing process, reused heat from waste mercerizing water, and implemented efficiency retrofit projects to achieve water and energy savings.

Holding tank for condensate recovery

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
1,220 tons/year

WATER SAVING:
27,300 tons/year

WASTE WATER REDUCTION:
27,300 tons/year

TOTAL INVESTMENT:
113,000 dollars

ECONOMIC BENEFITS:
170,000 dollars/year

PAYBACK PERIOD:
8 months

* This chart illustrates only contributions from those projects that have water, energy, or electricity reductions larger than 1%.

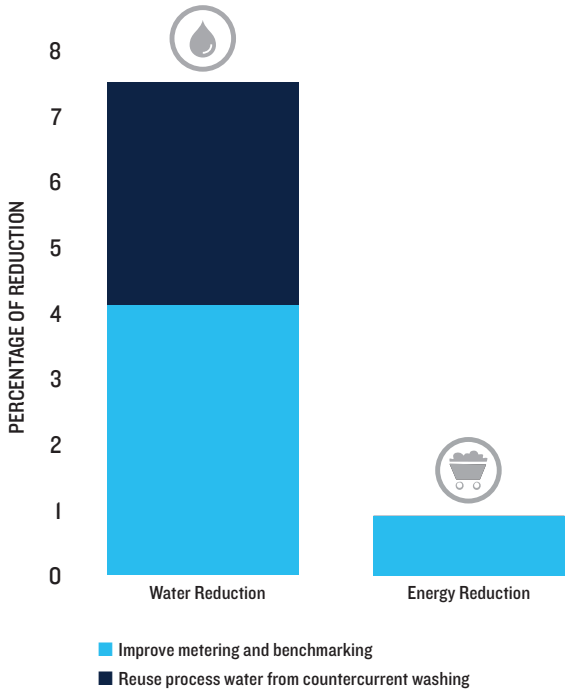
MILL M08

is a private textile mill established in 2007 that dyes and finishes both yarn and woven cloth. It is a medium-sized mill with 200 employees.

In Clean by Design 2014, Mill M08 completed four projects that focused mostly on water savings. One project to install water meters enabled the mill to better plan its water use and reduced water consumption by 4 percent. This initiative paid back the price of the extra meters in just 21 days! Another project that paid itself back in a very short time—36 days—reused process water and cut down the mill's water consumption by 3 percent and energy consumption by 1 percent. Results shown in the chart* and table below. This mill had previously implemented a number of projects that are considered best practices in Clean by Design 2014, including drying cylinder insulation, countercurrent rinsing, installing online temperature detector, and cooling water recovery.

Installed water meters

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
254 tons/year

WATER SAVING:
67,500 tons/year

WASTE WATER REDUCTION:
67,500 tons/year

TOTAL INVESTMENT:
25,000 dollars

ECONOMIC BENEFITS:
146,000 dollars/year

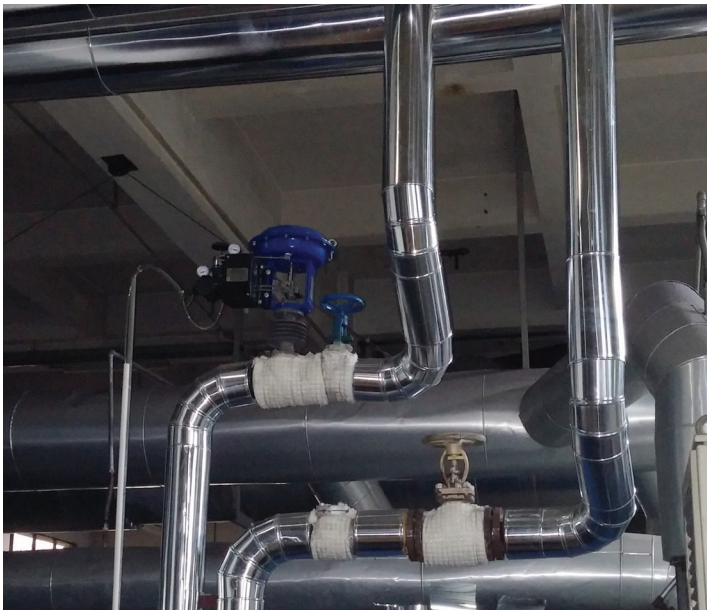
PAYBACK PERIOD:
2 months

* The chart illustrates only contributions from those projects that have water, energy, or electricity reductions larger than 1%.

GUANGZHOU DONGHAIPENG DYEING & WEAVING CO., LTD., GUANGZHOU CITY, GUANGDONG PROVINCE

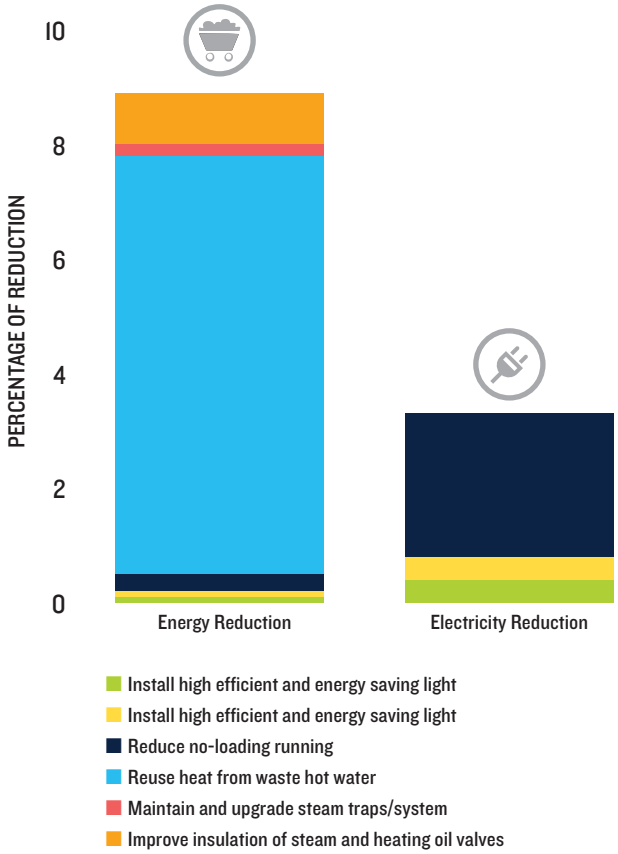
is a private textile mill established in 2001 that dyes and finishes high-grade knitted fabrics. It is a medium-sized mill with 300 employees.

In Clean by Design 2014, Guangzhou Donghaipeng completed six projects achieving water and energy saving. A systematic energy and material metering system and central analysis system was installed, which helps the plant to manage energy & chemical demand and consumption, and more accuratly assess the energy and water conservation results. In prior years, the mill introduced air-flow dyeing machines, recovered heat from its setting machine, and reclaimed water to reduce use. It also installed online temperature control devices.



Metering and control system

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
1,261 tons/year

WATER SAVING:
N/A

WASTE WATER REDUCTION:
N/A

TOTAL INVESTMENT:
166,000 dollars

ECONOMIC BENEFITS:
142,000 dollars/year

PAYBACK PERIOD:
14 months

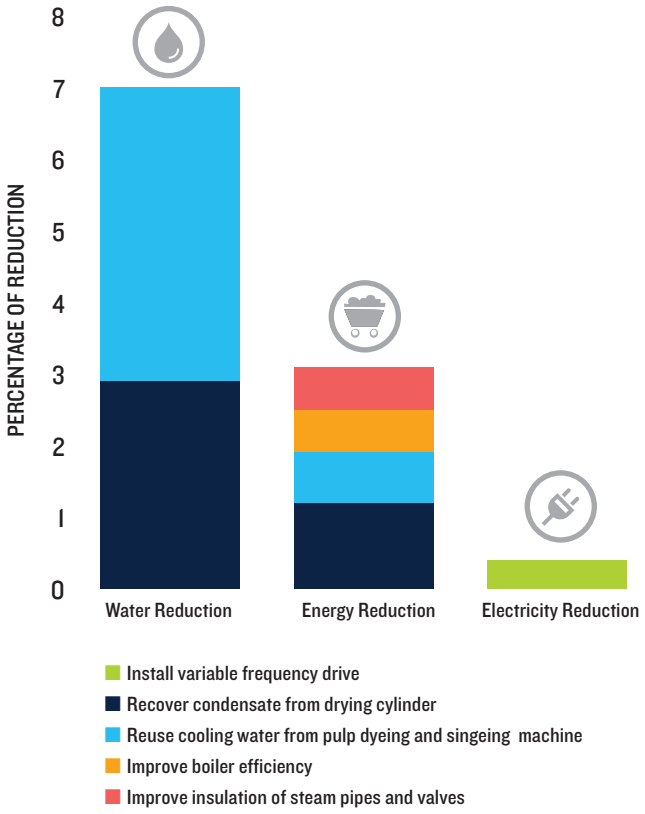
GUANGZHOU ZENGCHENG GUANGYING CLOTHING CO., LTD., ZENGCHENG CITY, GUANGDONG PROVINCE

is an older vertically integrated private textile mill established in 1996 that weaves, dyes, and finishes denim and cuts and sews blue jeans. It is a large-sized mill with 3,000 employees.

In Clean by Design 2014, Zengcheng Guangying completed five projects which delivered considerable water and energy savings and a little bit of electricity savings as well. These projects together reduced the mill's water consumption by 7 percent and energy consumption by 3 percent.

Condensate recovery

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
628 tons/year

WATER SAVING:
57,692 tons/year

WASTE WATER REDUCTION:
57,692 tons/year

TOTAL INVESTMENT:
99,000 dollars

ECONOMIC BENEFITS:
92,000 dollars/year

PAYBACK PERIOD:
13 months

GUANGZHOU GUNZETAL CO., LTD., GUANGZHOU CITY, GUANGDONG PROVINCE

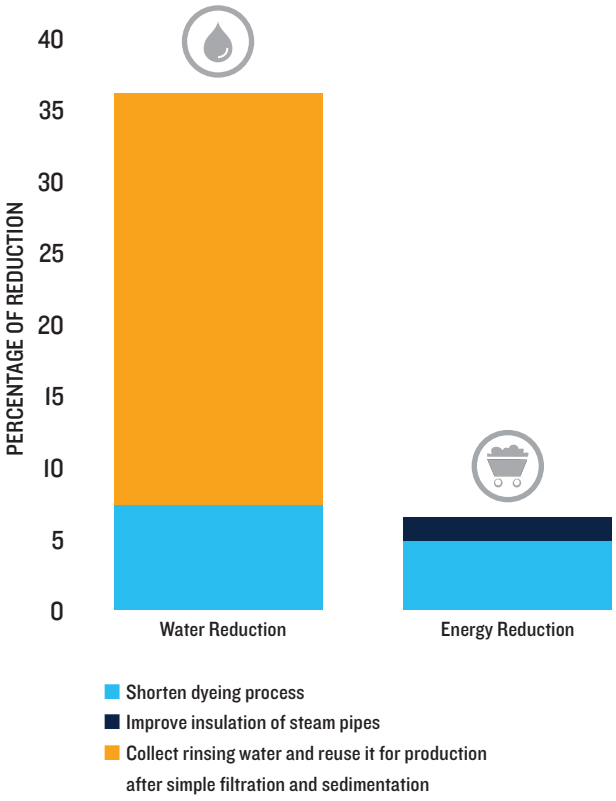
is an older private textile mill established in 1998 company that makes polyester sewing thread. It is a small-sized mill with 300 employees.

In Clean by Design 2014, Guangzhou Gunzetal undertook five projects in total. Among those projects, one project that reused rinsing water reduced the mill's water consumption by 29 percent just by itself was very inexpensive and saved significant energy as well!

Results shown in the chart* and table below. In prior years, this mill had achieved water and energy savings through reusing reclaimed water, insulating pipes, and improving dyeing process techniques.

Collect rinsing water and reuse it for production after simple filtration and sediment

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
160 tons/year

WATER SAVING:
62,100 tons/year

WASTE WATER REDUCTION:
62,100 tons/year

TOTAL INVESTMENT:
37,000 dollars

ECONOMIC BENEFITS:
71,000 dollars/year

PAYBACK PERIOD:
6 months

* This chart illustrates only contributions from those projects that have water, energy, or electricity reductions larger than 1%.

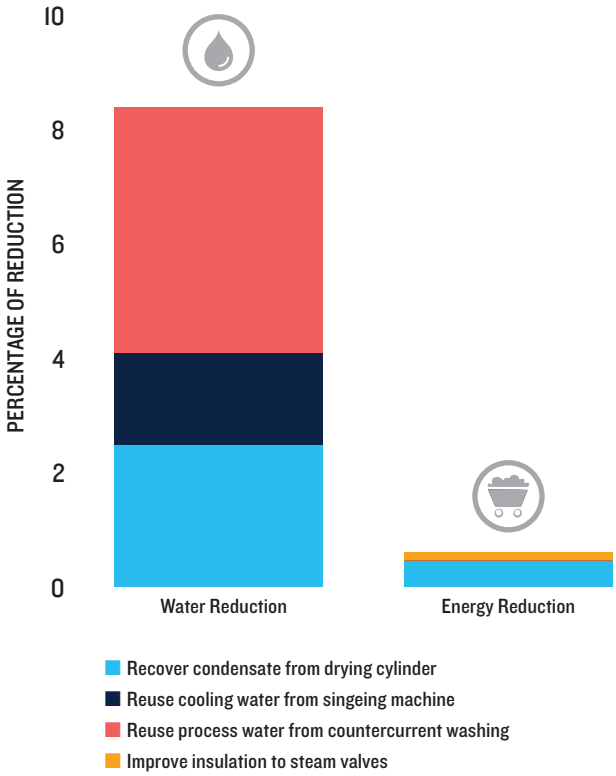
FOSHAN SANSHUI HAOTONG PRINTING & DYEING CO. LTD., FOSHAN CITY, GUANGDONG PROVINCE

is a private textile mill established in 2006 that dyes and prints woven cloth. It is a medium-sized mill with 300 employees.

During Clean by Design 2014, Foshan Sanshui Haotong undertook six projects in total achieving water, energy, and dyestuff savings. The chemical recycling project is now saving 12 tons of dye stuff and $15,300 (96,000 RMB) every year. Total payback period for all the projects completed at the mill was only 6 months. See water and energy reduction result from the chart* and table below. In prior years, the mill had implemented projects to reuse its process water and introduced an alkali recovery system which reduced water, energy, and chemical (alkali) consumption as well.

Counter current rinsing retrofit

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
71 tons/year

WATER SAVING:
46,800 tons/year

WASTE WATER REDUCTION:
46,800 tons/year

TOTAL INVESTMENT:
31,000 dollars

ECONOMIC BENEFITS:
66,000 dollars/year

PAYBACK PERIOD:
6 months

* This chart illustrates only contributions from those projects that have water, energy, or electricity reductions larger than 1%.

PACIFIC (PANYU) TEXTILES LTD., GUANGZHOU CITY, GUANGDONG PROVINCE

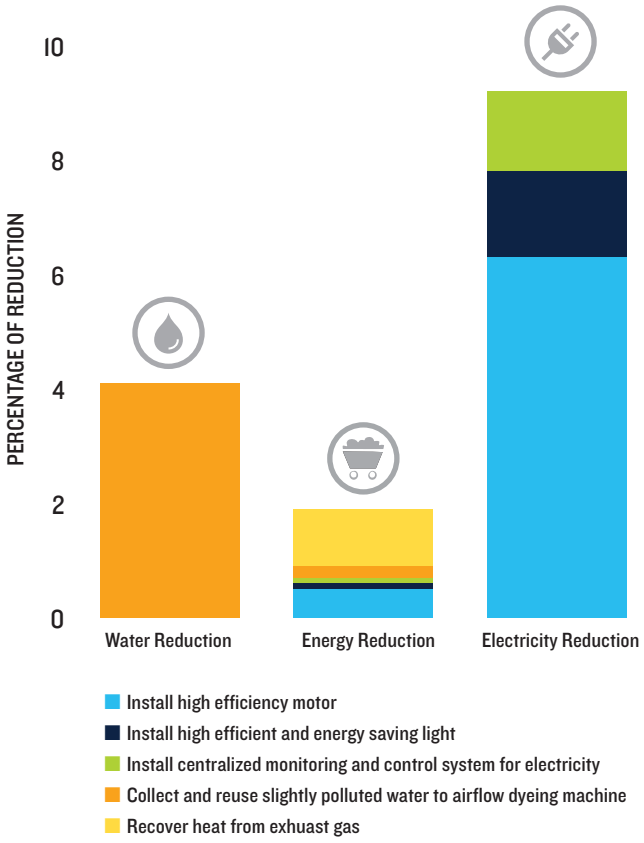
is an older private textile mill established in 1997 that dyes and prints woven cloth. It is a large-sized mill with 6,500 employees.

During Clean by Design 2014, Pacific (Panyu) completed thirteen projects. These projects reduced water and energy and particularly electricity usage, bringing a total economic benefit of $3,636,000 (22,800,000 RMB) for the mill. See results of these savings in the chart* and table below. In prior years, Pacific (Panyu) had undertaken a great number of projects, which included retrofitting its setting machines and introducing new equipment to reduce its water and energy consumption.

Heat recovery system on setting machine

Other noteworthy projects this mill also undertook were to use solar panels to produce steam, to use waste heat to produce cooling air in its air conditioners, and to install a high efficiency waste heat recovery system for its setting machines.

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
12,138 tons/year

WATER SAVING:
555,124 tons/year

WASTE WATER REDUCTION:
555,124 tons/year

TOTAL INVESTMENT:
3,880,000 dollars

ECONOMIC BENEFITS:
3,637,000 dollars/year

PAYBACK PERIOD:
13 months

* This chart illustrates only contributions from those projects that have water, energy, or electricity reductions larger than 1%.

KAIPING PANTHER TEXTILES CO., LTD., JIANGMEN CITY, GUANGDONG PROVINCE

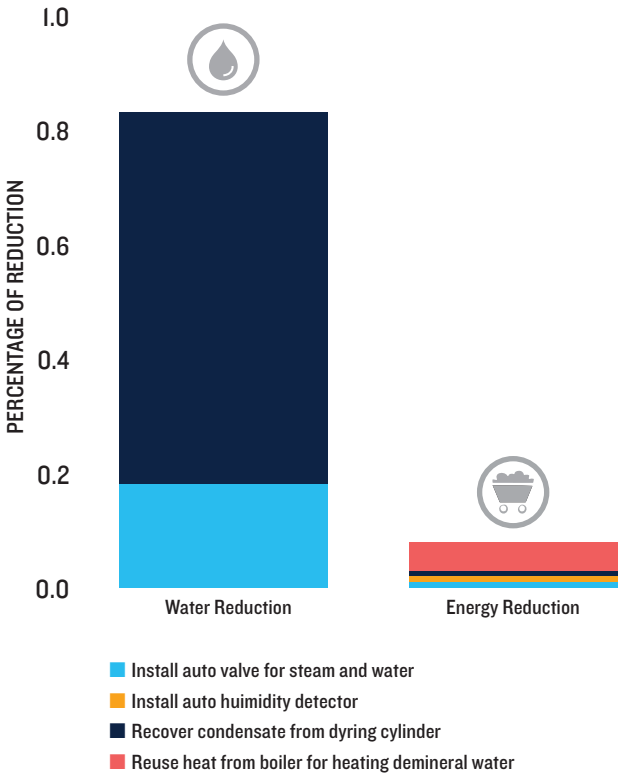
is an older private textile mill established in 1995 company that dyes and prints woven cloth. It is a large-sized with 4,000 employees.

During Clean by Design 2014, Kaiping Panther completed six projects in total. A condensate recovery project reduced considerable water use. Although the percentage of energy saved in the boiler efficiency improvement project is not large, the cost effectiveness of the project was very impressive. Only $3.90 (24.6 RMB) was spent per ton of coal savings. Although the percentage of energy saved from this project is low, the total quantity was quite high, reflecting the very large size of this mill. See saving result of the quantifiable projects from the chart* and table below. Also during Clean by Design 2014, this mill converted the fuel used in its setting machines to natural gas as requested by government authorities.

Flash steam heat recovery in boiler gland sealing

In prior years, Kaiping Panther had implemented a number of efficiency improvement projects that included upgrading its dyeing process and recovering heat from waste water, setting machines, and its oil boiler.

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
640 tons/year

WATER SAVING:
18,399 tons/year

WASTE WATER REDUCTION:
18,399 tons/year

TOTAL INVESTMENT:
110,000 dollars

ECONOMIC BENEFITS:
91,000 dollars/year

PAYBACK PERIOD:
14 months

* This chart illustrates only contributions from those projects that have water, energy, or electricity reductions larger than 1%.

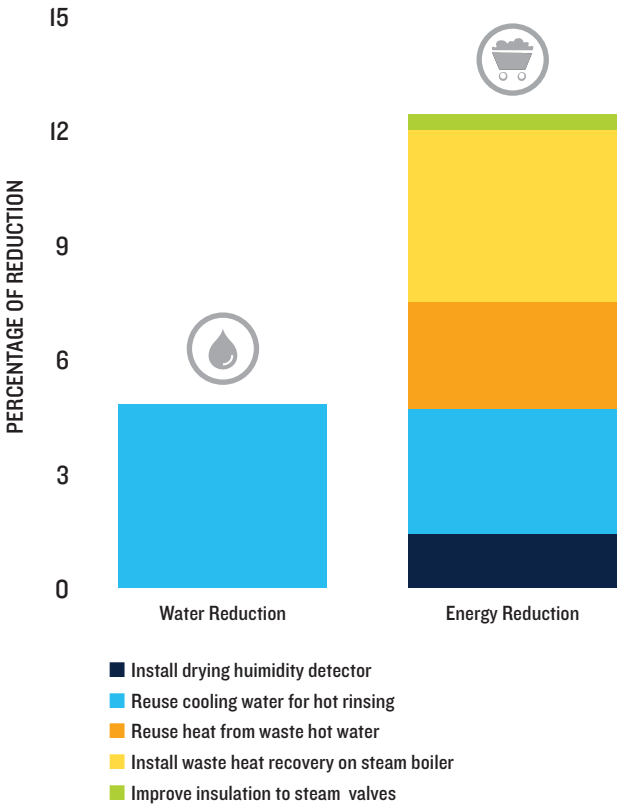
PROSPERITY TEXTILE (HK) LIMITED, SHAOGUAN CITY, GUANGDONG PROVINCE

is an older private textile mill established in 1995 that weaves, dyes, and finishes denim. It is a medium-sized mill with 750 employees.

In Clean by Design 2014, Prosperity completed six projects. Those projects were able to reduce the mill's energy consumption by an impressive 12 percent in addition to reducing water consumption by nearly 5 percent. Saving results are shown in the chart and table below. In prior years, Prosperity had installed a counter current rinsing retrofit, upgraded its steam trap system, and undertaken an initiative to recover dyestuff.

Waste heat boiler

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
1,352 tons/year

WATER SAVING:
30,000 tons/year

WASTE WATER REDUCTION:
30,000 tons/year

TOTAL INVESTMENT:
482,000 dollars

ECONOMIC BENEFITS:
204,000 dollars/year

PAYBACK PERIOD:
28 months

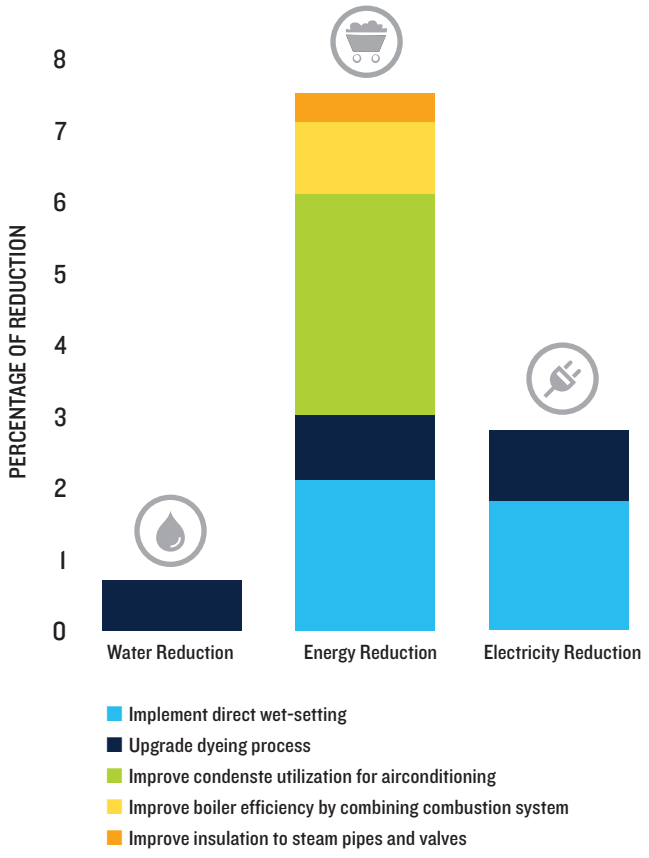
DONGGUAN SHATIN LAKE SIDE TEXTILES PRINTING & DYEING CO., LTD., DONGGUAN CITY, GUANGDONG PROVINCE

is an older private textile mill established in 1998 that dyes yarn and knitted cloth. It is a large-sized mill with 2,200 employees.

In Clean by Design 2014, Dongguan Shatin Lake Side completed six projects. Energy (fuel) reductions were most substantial, followed by electricity. A small percentage of water was saved as well. Two initiatives to upgrade equipment required an investment of only $42,700 (268,000 RMB) together and are now providing nearly 10 times that sum in economic benefit of $409,000 (2,564,000 RMB) every year. One of the projects paid itself back within 2 months and the other paid itself back in only 27 days! In previous years, Dongguan Shatin Lake Side had undertaken projects to recover condensate, insulate dye vats, and had renovated motors frequency conversion to reduce its energy consumption.

Lithium bromide air conditioner that uses condensate

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
6,884 tons/year

WATER SAVING:
47,000 tons/year

WASTE WATER REDUCTION:
47,000 tons/year

TOTAL INVESTMENT:
700,000 dollars

ECONOMIC BENEFITS:
840,000 dollars/year

PAYBACK PERIOD:
10 months

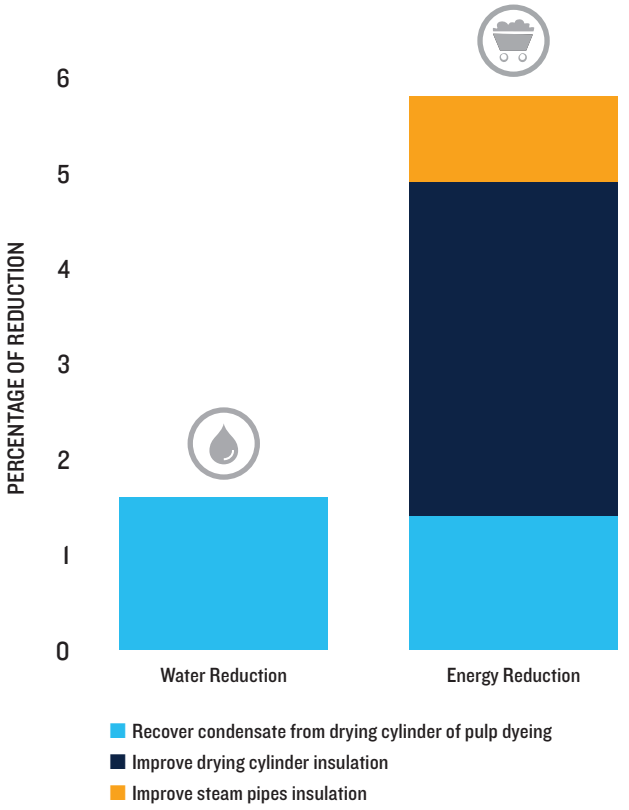
GUANGZHOU SUIXIN INDUSTRIAL CO., LTD., GUANGZHOU CITY, GUANGDONG PROVINCE

is a private textile mill established in 2000 that dyes yarn. It is a medium-sized mill with 380 employees.

In Clean by Design 2014, Guangzhou Suixin undertook six projects in total, three of which reduced water and energy use. The project to improve drying cylinder insulation was particularly effective. In addition, the mill undertook two impressive dye use reduction projects, which automated chemical mixing and distribution and upgraded dye recipes. These had a large impact on chemical use, reducing consumption by nearly 100 tons of chemicals and now saving the company about $100,000 (636,200 RMB) per year. Other work had previously been done at the mill to reduce dye usage as well. See the chart* and table below for water and energy reduction.

Drying cylinders with insulation on side face

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
292 tons/year

WATER SAVING:
11,600 tons/year

WASTE WATER REDUCTION:
11,600 tons/year

TOTAL INVESTMENT:
128,000 dollars

ECONOMIC BENEFITS:
151,000 dollars/year

PAYBACK PERIOD:
10 months

* This chart illustrates only contributions from those projects that have water, energy, or electricity reductions larger than 1%.

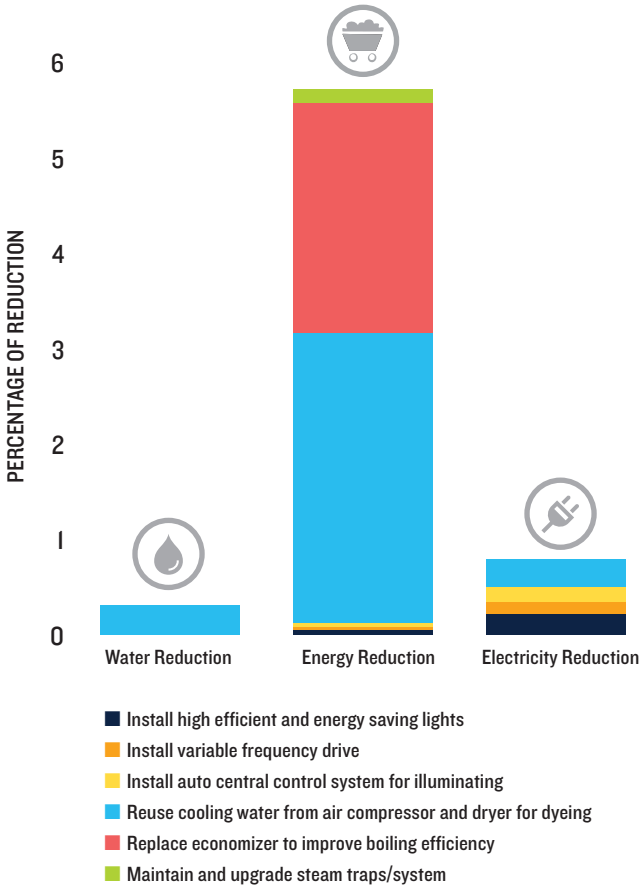
MILL M16

is an older private textile mill established in 1994 that dyes yarn. It is a medium-sized mill with 460 employees.

In Clean by Design 2014, Mill M16 completed six projects in total focused largely on energy and electricity savings. The mill improved its boiler efficiency by changing an aged economizer with an investment of $19,000 (120,000 RMB) at outset. With the savings from reduced coal consumption, this project paid itself back within 8 months and continues to bring an economic benefit of $28,000 (176,700 RMB) every year. In prior years, this mill had undertaken other successful efforts to recover heat from hot water and had improved its boiler efficiency through changes in its internal design and through recovering heat from its exhaust gas.

Inactive cooling water towers after reforming cooling system

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
687 tons/year

WATER SAVING:
4,950 tons/year

WASTE WATER REDUCTION:
4,950 tons/year

TOTAL INVESTMENT:
46,000 dollars

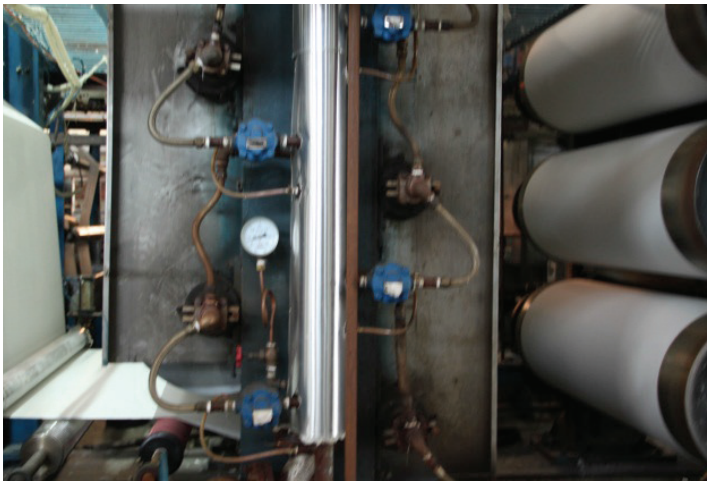
ECONOMIC BENEFITS:
84,000 dollars/year

PAYBACK PERIOD:
7 months

KAIPING XINDI DYEING CO., LTD., KAIPING CITY, GUANGDONG PROVINCE

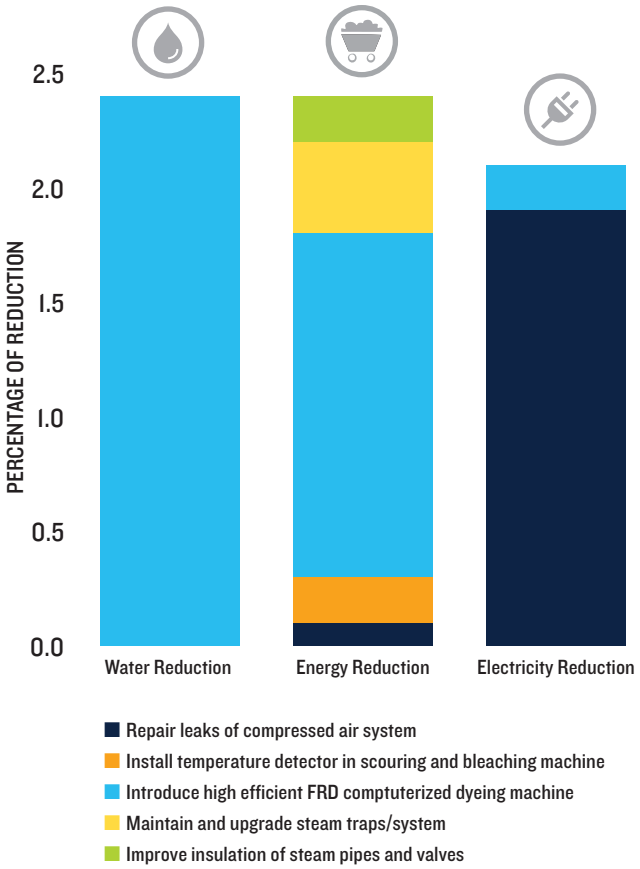
is a private textile mills established in 2000 company that dyes and finishes woven cloth. It is a small-sized mill with 300 employees.

In Clean by Design 2014, Kaiping Xindi completed six projects in total and achieved reductions in water, energy, and electricity alike. One very impactful project that introduced highly efficient computerized jig-dyeing machine not only greatly reduced water, energy, and electricity consumption, it also saved 189 tons of dye stuff every year. In prior years, this mill had undertaken work to reuse grey water and had also recovered heat from its hot rinsing water. It had added drying cylinders to make its processes more efficient as well.



Upgraded steam trap system

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
1,299 tons/year

WATER SAVING:
19,820 tons/year

WASTE WATER REDUCTION:
19,820 tons/year

TOTAL INVESTMENT:
832,000 dollars

ECONOMIC BENEFITS:
755,000 dollars/year

PAYBACK PERIOD:
13 months

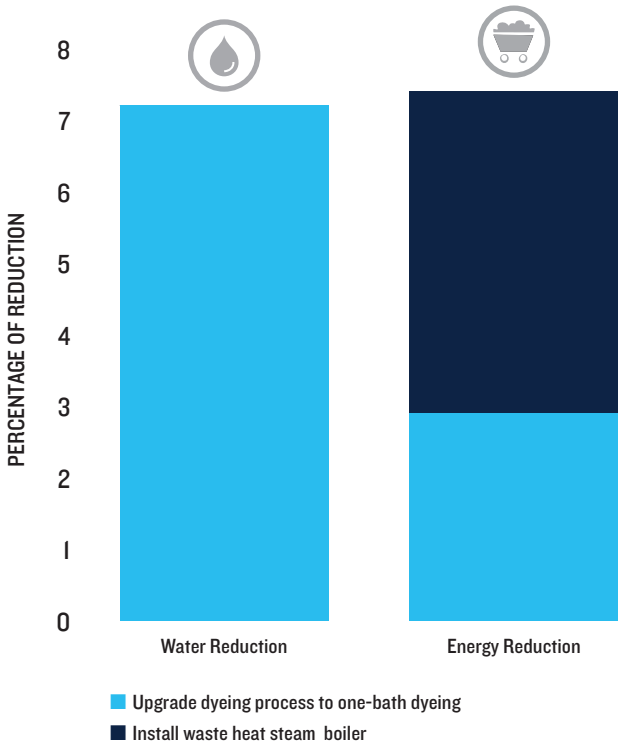
MILL M20

is a private textile mill established in 2000 that dyes and finishes knitted fabric. It is a small-sized mill with 230 employees.

In Clean by Design 2014, Mill M20 completed five projects in total, although the benefits from some of these projects could not be quantified. Two quantifiable projects were able to cut down the mill's water consumption by 7 percent and energy consumption by 7 percent. Together, these improvements bring a total economic benefit of $117,000 (732,000 RMB) annually. In addition to this resource efficiency work, this mill undertook a waste gas compliance project to treat their air emissions. From previous years, this mill had already installed low liquor ratio dyeing machines to reduce its water and energy use.

Insulation on Waste Heat Boiler

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
716 tons/year

WATER SAVING:
40,000 tons/year

WASTE WATER REDUCTION:
40,000 tons/year

TOTAL INVESTMENT:
148,000 dollars

ECONOMIC BENEFITS:
117,000 dollars/year

PAYBACK PERIOD:
15 months

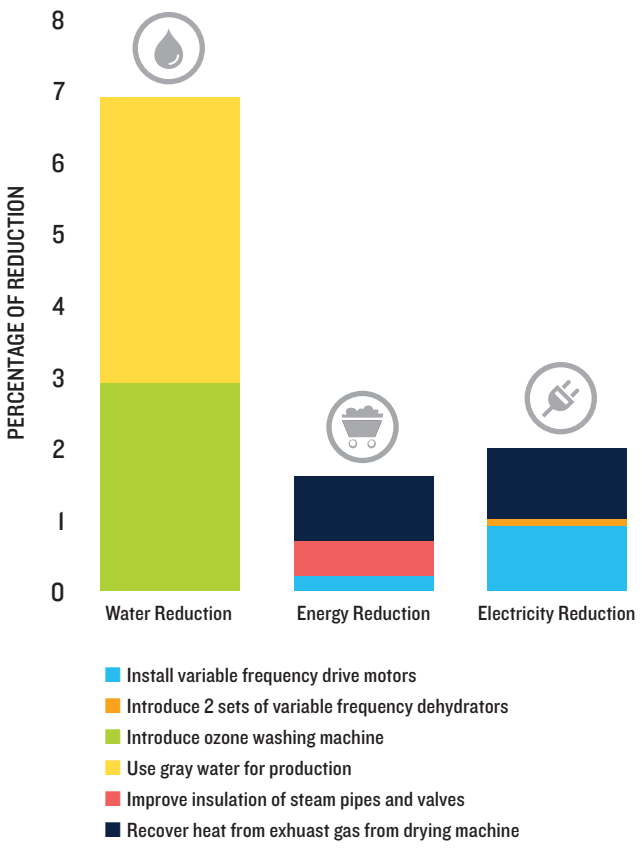
GUANGZHOU XINLIYI DENIM LAUNDRY CO., LTD., GUANGZHOU CITY, GUANGDONG PROVINCE

is a private denim laundry established in 2003 that bleaches and stone washes blue jeans. It is a small-sized mill with 200 employees.

In Clean by Design 2014, Guangzhou Xinliyi completed six projects that saved water, energy, and electricity for the mill. They saved more than 30 percent of steam in their dryers by recovering the heat from the outlet air. See results of these projects from chart and table below. In previous years, this mill had already undertaken successful efforts to reuse reclaimed water and had invested in new machines for drying and processing that reduced water and energy use.

Heat recovery from drying machines

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
121 tons/year

WATER SAVING:
25,060 tons/year

WASTE WATER REDUCTION:
25,060 tons/year

TOTAL INVESTMENT:
105,000 dollars

ECONOMIC BENEFITS:
48,000 dollars/year

PAYBACK PERIOD:
26 months

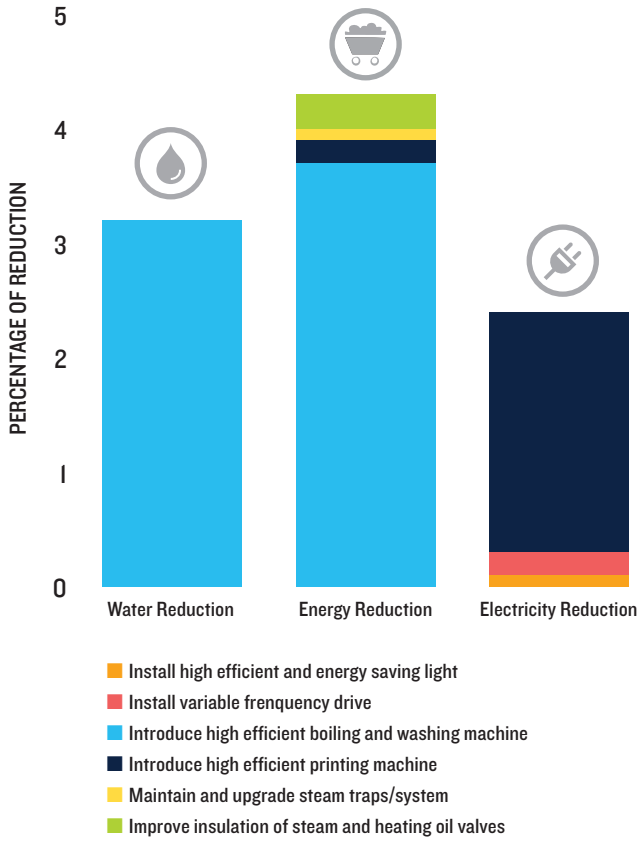
GUANGZHOU XINSHENG INDUSTRIAL CO., LTD., GUANGZHOU CITY, GUANGDONG PROVINCE

is an older private textile mill that dyes, prints, and finishes knitted fabrics. It is a medium-sized mill with 400 employees.

In Clean by Design 2014, Guangzhou Xinsheng completed six projects in total. In one project, the mill replaced batch scouring and rinsing machines with continuous machines, which had particularly high impact. The mill also upgraded to a high efficiency printing machine. With these and other projects, the mill was able to reduce its water consumption by 3 percent, energy consumption by 4 percent, and electricity consumption by 2 percent. See results of savings from the chart and table below. This mill had previously undertaken a major project to recover heat from the exhaust gas from the setting machines and conduction oil boiler and had introduced continuous process equipment to improve production and resource efficiency.

The new type of continuous oil removing and scouring/rinsing machine

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
1,856 tons/year

WATER SAVING:
27,600 tons/year

WASTE WATER REDUCTION:
27,600 tons/year

TOTAL INVESTMENT:
669,000 dollars

ECONOMIC BENEFITS:
253,000 dollars/year

PAYBACK PERIOD:
32 months

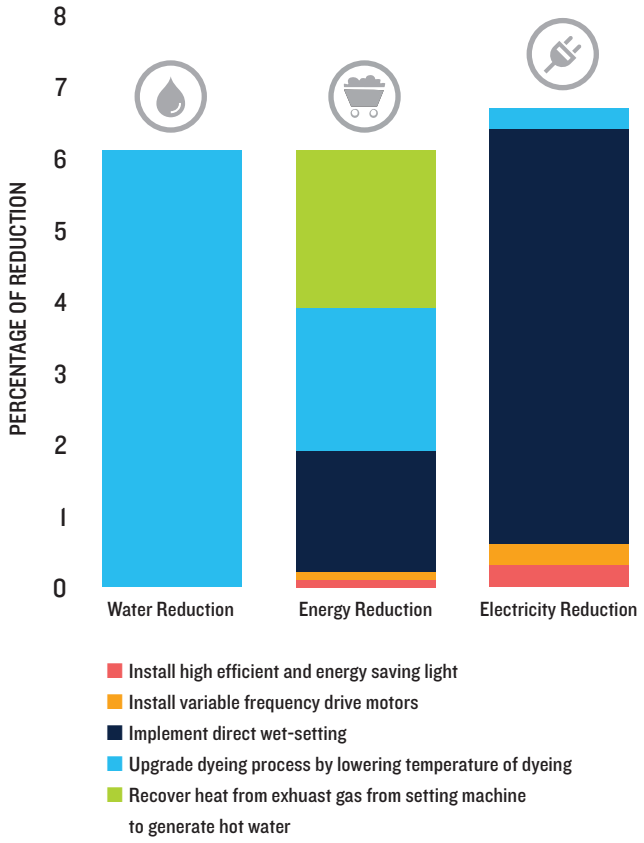
MILL M22

is a private textile mill established in 2002 that dyes and finishes knitted fabrics. It is a small-sized mill with 170 employees.

In Clean by Design 2014, Mill M22 completed five projects in total and achieved great savings in water, energy, and electricity. One particularly high impact project implemented direct wet-setting process instead of dry-setting and successfully cut down the energy consumption by 2 percent and electricity consumption by 5.8 percent. This project is now saving $108,600 (680,800 RMB) every year and paid itself back in just 2 months. Another successful initiative was to upgrade the dyeing process to operate at lower temperature. Finally, during Clean by Design 2014, the mill undertook a project to replace its coal with biomass for the steam boiler. Mill M22 had previously undertaken a successful project to reuse rinsing water which cost very little and saved considerable water.

Heat recovery from setting machine exhaust gas

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
530 tons/year

WATER SAVING:
30,400 tons/year

WASTE WATER REDUCTION:
30,400 tons/year

TOTAL INVESTMENT:
110,000 dollars

ECONOMIC BENEFITS:
170,000 dollars/year

PAYBACK PERIOD:
8 months

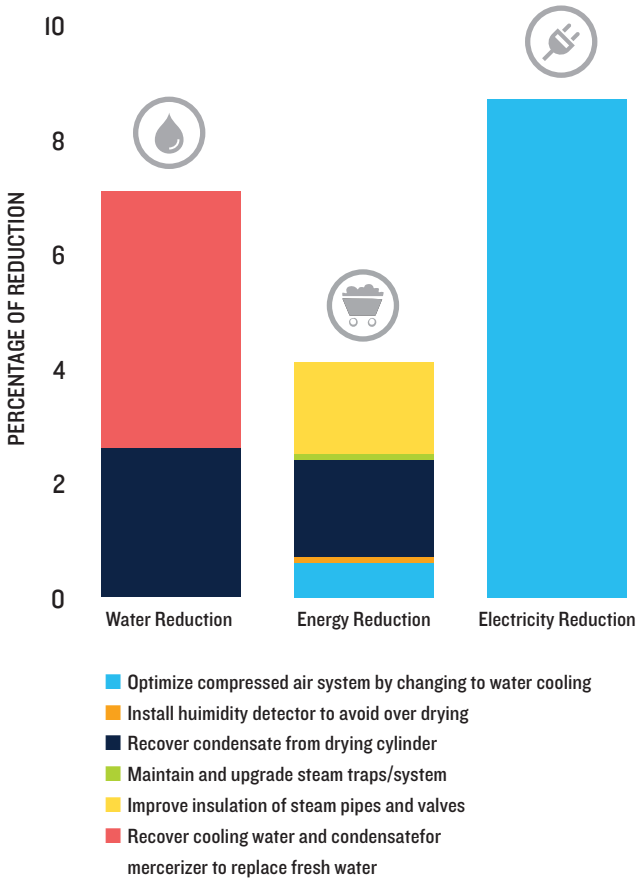
MILL M21

is a private textile mill established in 2007 that dyes and finishes woven and denim fabrics. It is a medium-sized mill with 330 employees.

In Clean by Design 2014, Mill M21 completed six projects in total and achieved great savings in all water, energy, and electricity. Money saved from the cooling water reuse project was able to pay the investment back in just 21 days! This project is now bringing an annual economic benefit of $19,900 (124,500 RMB). This mill had previously undertaken a number of efficiency improvement projects including exhaust gas heat recovery, condensate recovery, and more.

Cooling water recovery pipes system

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
175 tons/year

WATER SAVING:
17,885 tons/year

WASTE WATER REDUCTION:
17,885 tons/year

TOTAL INVESTMENT:
49,000 dollars

ECONOMIC BENEFITS:
72,000 dollars/year

PAYBACK PERIOD:
8 months

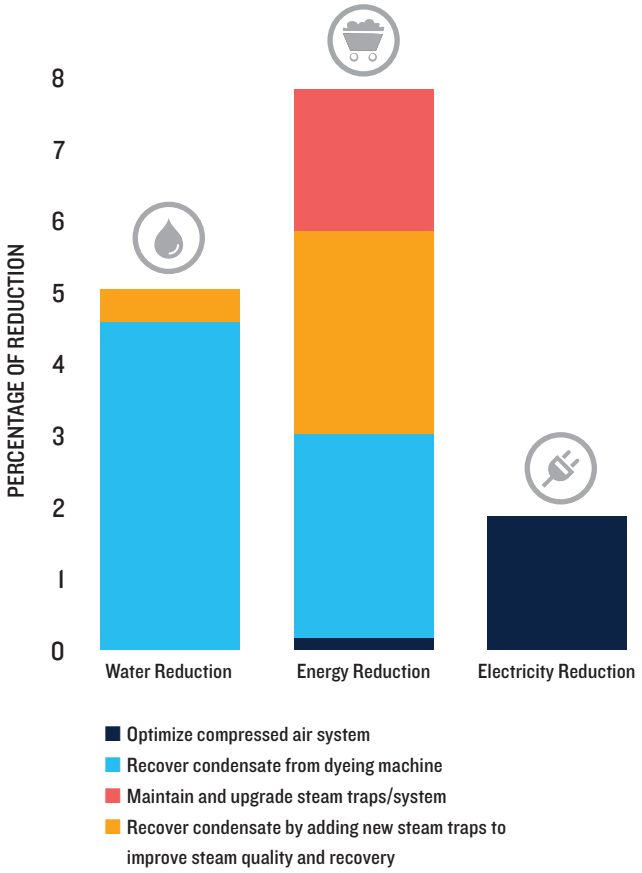
SHAOXING CHANGSHENG THREAD MANUFACTURING CO., LTD., SHAOXING CITY, ZHEJIANG PROVINCE

is an older private textile mill established in 1997 that dyes and finishes thread. It is a small-sized mill with 280 employees.

In Clean by Design initiative 2014, Changsheng Thread completed five projects in total. One impressive condensate recovery project achieved 4.6 percent of water reduction and 2.8 percent of energy reductions alone. Another compressed air system optimization project achieved 2 percent of electricity reduction, in addition to its energy (fuel) reduction. See achievement results in the chart* and table below. This mill has plans to implement a number of addition projects that it designed in Clean by Design 2014 in 2015.

Compressed air leakage detecting and optimizing

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
383 tons/year

WATER SAVING:
11,000 tons/year

WASTE WATER REDUCTION:
10,000 tons/year

TOTAL INVESTMENT:
65,000 dollars

ECONOMIC BENEFITS:
92,000 dollars/year

PAYBACK PERIOD:
9 months

* This chart illustrates only contributions from those projects that have water, energy, or electricity reductions larger than 1%.

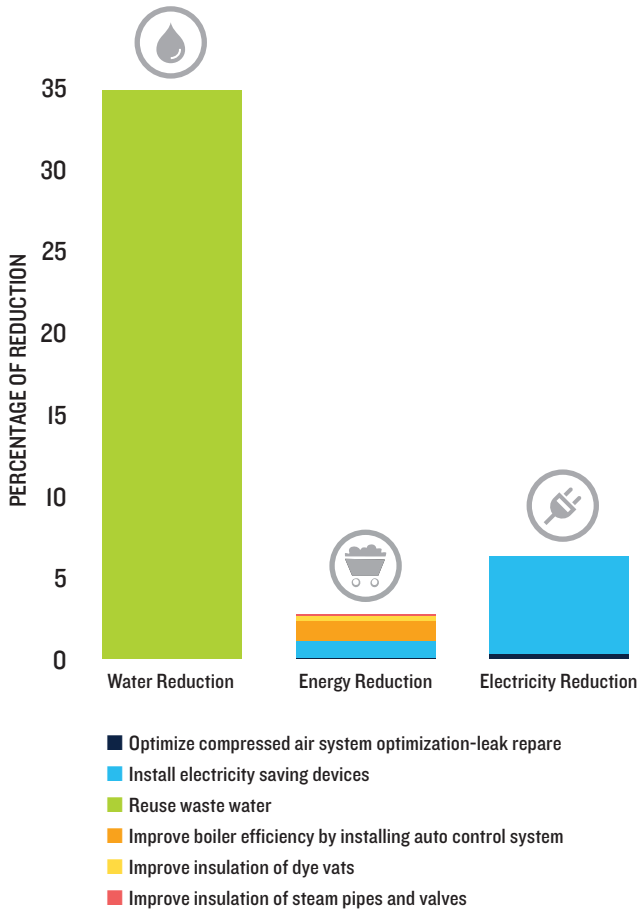
ZHEJIANG HUADONG TEXTILE DYEING & PRINTING CO., LTD., SHAOXING CITY, ZHEJIANG PROVINCE

is a private textile mill established in 2000 that prints, dyes, and finishes both woven and knitted rayon and cotton fabrics. It is a large-sized mill with 800 employees.

In Clean by Design initiative 2014, Zhejiang Huadong completed six projects in total, with a particularly effective project reusing waste water to achieve great reductions. The waste water reuse project has brought down the mill's water consumption by as much as 35 percent! The mill also installed an electricity balance and quality management system, which delivered impressive electricity savings as well. In addition to these resource saving initiatives, this mill undertook an effort to improve exhaust gas emissions from its setting machines during Clean by Design 2014.

Centralized waste water treatment and reuse system

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
838 tons/year

WATER SAVING:
528,000 tons/year

WASTE WATER REDUCTION:
528,000 tons/year

TOTAL INVESTMENT:
873,000 dollars

ECONOMIC BENEFITS:
426,000 dollars/year

PAYBACK PERIOD:
25 months

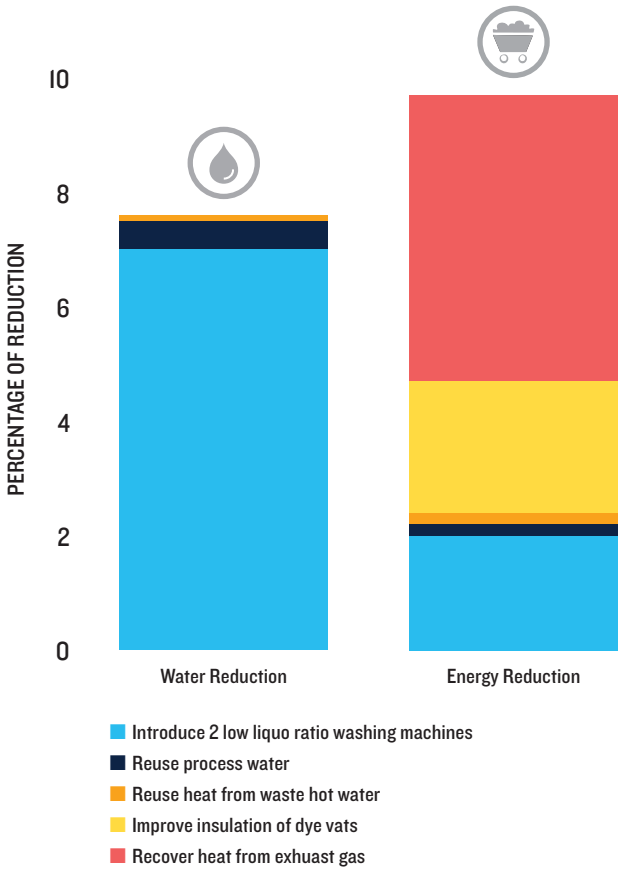
ZHEJIANG HUANFA TEXTILE PRINTING & DYEING CO. LTD., SHAOXING CITY, ZHEJIANG PROVINCE

is a private textile mill established in 2001 that dyes and finishes high-grade knitted fabrics. It is a medium-sized mill with 450 employees.

In Clean by Design initiative 2014, Zhejiang Huanfa completed five projects that reduced both water and energy use, including a series of retrofits such as improving the insulation on dyeing vats, heat recovery from high temperature hot water, and heat recovery from setting machine exhaust. These projects delivered a great annual economic benefit of $504,000 (3.16 million RMB) and reduced the mill's energy consumption by 10 percent.

Hot water discharge under high pressure and heat recovery system

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
2,666 tons/year

WATER SAVING:
65,500 tons/year

WASTE WATER REDUCTION:
65,500 tons/year

TOTAL INVESTMENT:
1,026,000 dollars

ECONOMIC BENEFITS:
504,000 dollars/year

PAYBACK PERIOD:
24 months

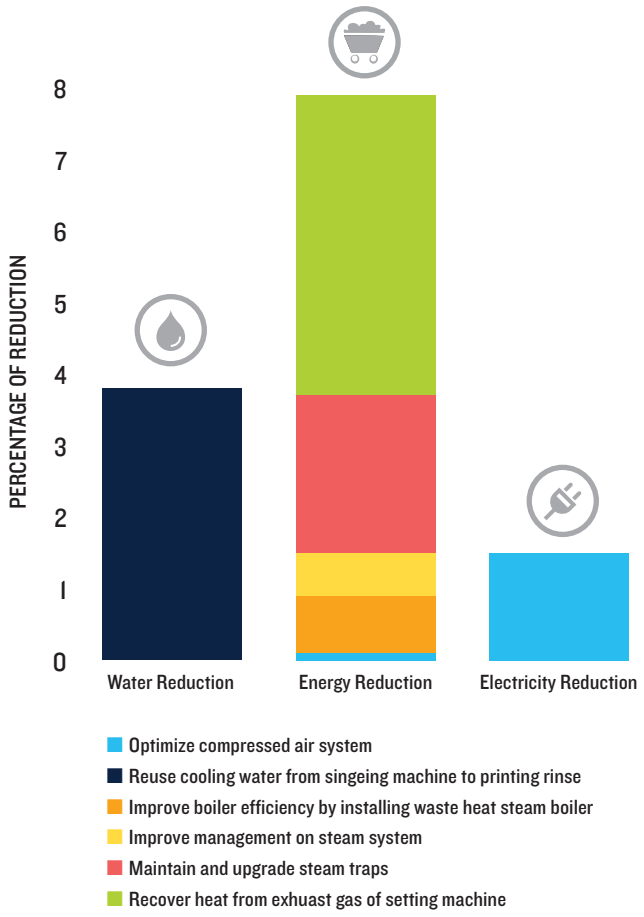
SHAOXING HUASHEN TEXTILE DYEING & FINISHING CO., LTD., SHAOXING CITY, ZHEJIANG PROVINCE

is a private textile mill established in 2001 dyes and finishes knitted fabrics. It is a medium-sized mill with 350 employees.

In Clean by Design 2014, Shaoxing Huashen completed seven projects achieving savings in water, energy, and electricity. The heat recovery from exhaust gas of setting machine was noteworthy because it reduced the energy consumption by 4 percent solely and it paid itself back in just one month. See results of savings in the chart* and table below. During Clean by Design 2014, this mill also changed over its setting machine to use natural gas, in response to government authority request.

High efficiency heat recovery system on setting machines

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
1,959 tons/year

WATER SAVING:
40,000 tons/year

WASTE WATER REDUCTION:
44,000 tons/year

TOTAL INVESTMENT:
177,000 dollars

ECONOMIC BENEFITS:
657,000 dollars/year

PAYBACK PERIOD:
3 months

* This chart illustrates only contributions from those projects that have water, energy, or electricity reductions.

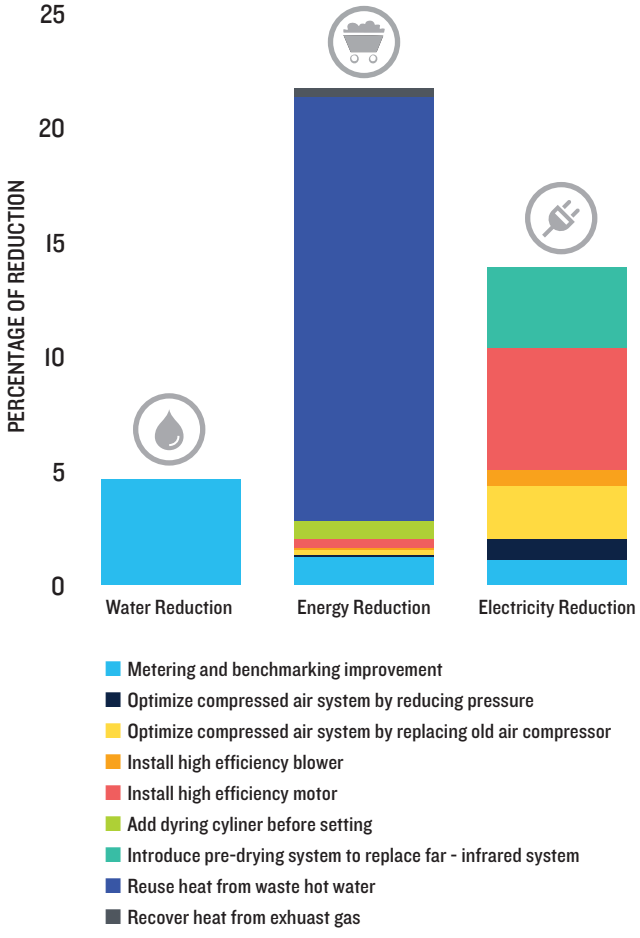
ZHEJIANG HUILI DYEING & FINISHING CO., LTD., HANGZHOU CITY, ZHEJIANG PROVINCE

is a private textile mill established in 2003 that dyes and finishes both knit and woven fabrics. It is a large-sized mill with 1,000 employees.

In Clean by Design 2014, Zhejiang Huili completed nine projects achieving great savings in water, energy, and electricity, one of which—heat recovery from high temperature waste dyeing water—reduced the energy consumption by 18.5 percent alone. Although this improvement required a large initial investment, it also delivered large economic returns and had a quick payback of only a little more than 1 year. During Clean by Design 2014, Zhejiang Huili also undertook two compliance projects to change the fuel used in its setting machines and to cover its waste water treatment unit to prevent the escape of waste gas.

Centralized high efficiency waste water heat recovery system

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
4,446 tons/year

WATER SAVING:
40,000 tons/year

WASTE WATER REDUCTION:
40,000 tons/year

TOTAL INVESTMENT:
1,052,000 dollars

ECONOMIC BENEFITS:
916,000 dollars/year

PAYBACK PERIOD:
14 months

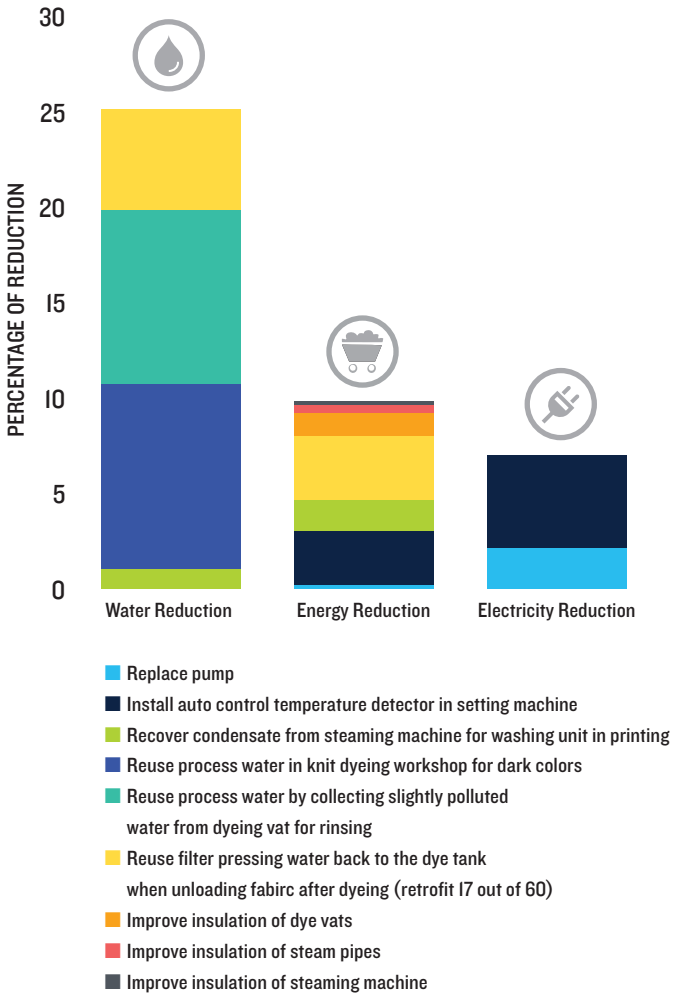
ZHEJIANG JIAHUA PRINTING & DYEING CO., LTD., SHAOXING CITY, ZHEJIANG PROVINCE

is a new private textile mill established in 2012 company that dyes and finishes knitted fabrics. It is a medium-sized mill with 500 employees.

In Clean by Design 2014, Zhejiang Jiahua completed nine projects achieving great savings in water, energy, and electricity. These projects reduced the mill's water consumption by 25 percent, energy consumption by 10 percent, and electricity consumption by 7 percent. With a total investment of $488,000 (3.06 million RMB), these projects are delivering a total annual economic benefit of $742,000 (4.65 million RMB).

Water squeeze and recovery system

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
2,156 tons/year

WATER SAVING:
317,275 tons/year

WASTE WATER REDUCTION:
317,275 tons/year

TOTAL INVESTMENT:
488,000 dollars

ECONOMIC BENEFITS:
742,000 dollars/year

PAYBACK PERIOD:
8 months

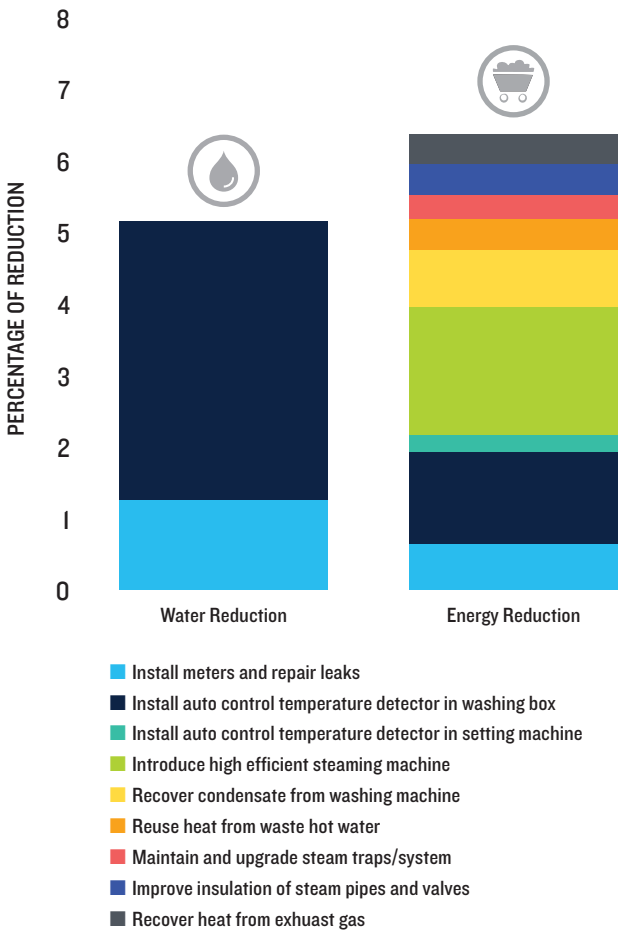
MILL M29

is a private textile mill established in 2007 that dyes and finishes corduroy fabrics. It is a medium-sized mill with 420 employees.

In Clean by Design 2014, Mill M29 completed nine projects achieving great savings in water and energy. Among these projects, three projects that relate to the steam system and they achieved a reduction in energy consumption of 2.5 percent. Also during Clean by Design 2014, this mill converted the fuel used in its setting machines to natural gas as requested by government authorities.

Condensate water recovery

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
2,072 tons/year

WATER SAVING:
56,628 tons/year

WASTE WATER REDUCTION:
56,628 tons/year

TOTAL INVESTMENT:
405,000 dollars

ECONOMIC BENEFITS:
389,000 dollars/year

PAYBACK PERIOD:
12 months

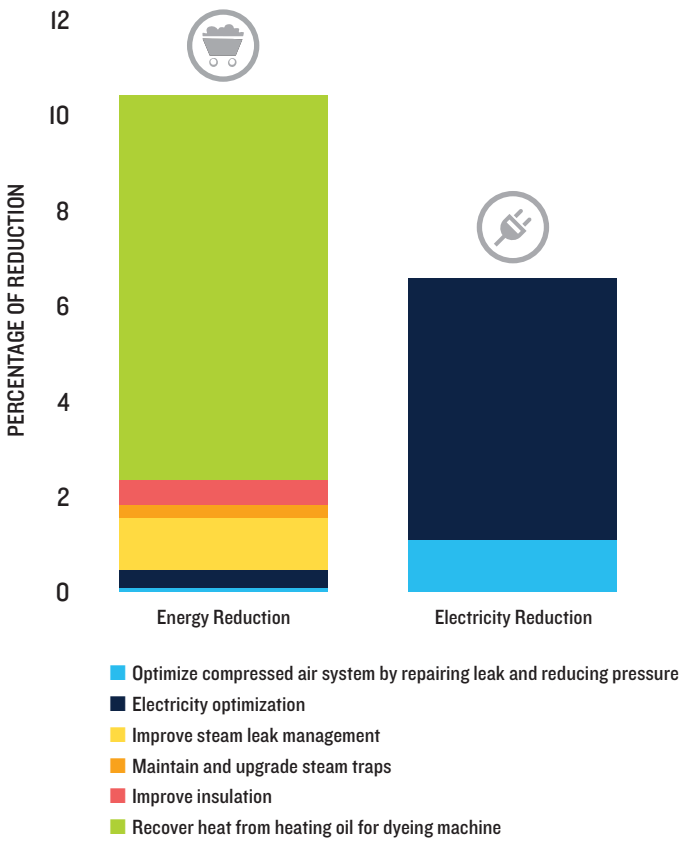
SHAOXING MINGYU PRINTING & DYEING CO., LTD., SHAOXING CITY, ZHEJIANG PROVINCE

is a private textile mill established in 2009 that dyes and finishes knitted fabrics. It is a medium-sized mill with 400 employees.

In Clean by Design 2014, Shaoxing Mingyu completed six projects in total focusing on energy reduction. Although they did not implement any project that reduced water consumption, a total of 10 percent reduction in energy consumption was achieved.

Optimize the heating structure and insulation

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
5,469 tons/year

WATER SAVING:
N/A

WASTE WATER REDUCTION:
42,900 tons/year

TOTAL INVESTMENT:
533,000 dollars

ECONOMIC BENEFITS:
1,056,000 dollars/year

PAYBACK PERIOD:
6 months

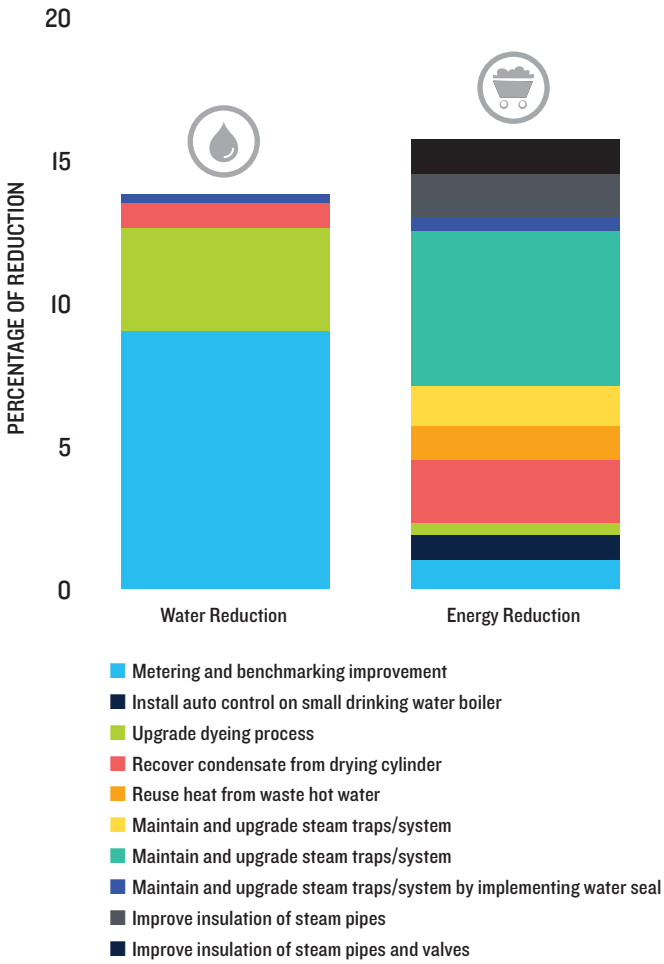
MILL M31

is an older textile mill established in 1978 that dyes and finishes woven fabrics. It is a large-sized mill.

In Clean by Design 2014 Mill M31 completed ten projects achieving both water and energy savings. Two prominent projects captured heat from hot water and maintained/upgraded the steam traps and steam system in the mill. These projects helped the mill reduce its water consumption by 14 percent and energy consumption by 16 percent. With an investment of $354,000 (2.22 million RMB) at the outset, these projects are now delivering an annual economic benefit of nearly twice that amount -- $654,000 (4.1 million RMB).

Updated steam trap system for drying cylinders

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
4,463 tons/year

WATER SAVING:
46,080 tons/year

WASTE WATER REDUCTION:
65,431 tons/year

TOTAL INVESTMENT:
354,000 dollars

ECONOMIC BENEFITS:
654,000 dollars/year

PAYBACK PERIOD:
6 months

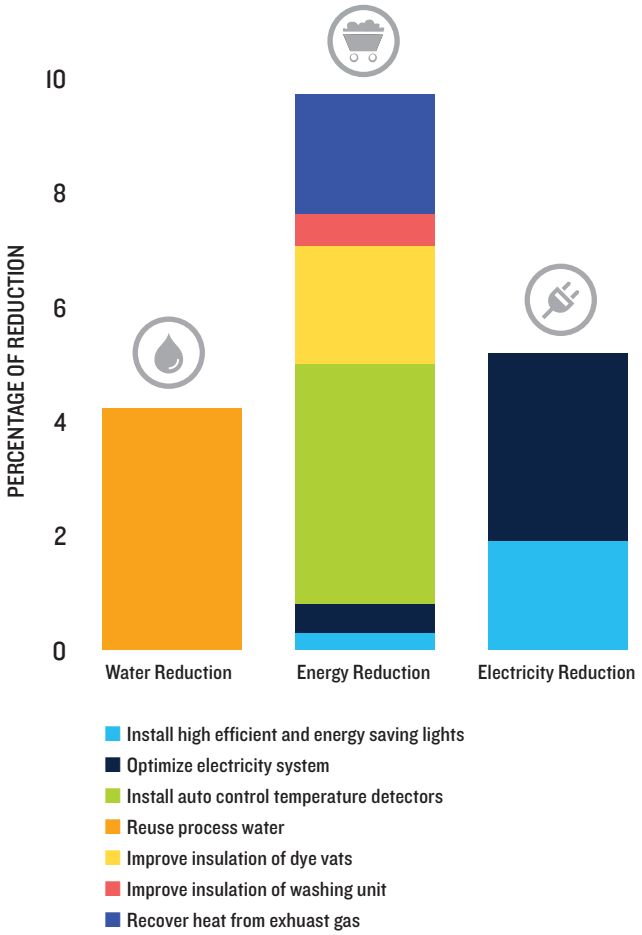
ZHEJIANG YICHUANG PRINTING & DYEING CO., LTD., SHAOXING CITY, ZHEJIANG PROVINCE

is a private textile mill established in 2002 that dyes and prints woven fabrics. It is a medium-sized mill with 420 employees.

In Clean by Design 2014 Zhejiang Yichuang completed seven projects achieving success in water, energy, and electricity savings. Among those projects, two projects that improved equipment insulation have reduced the mill's energy consumption by 3 percent. In addition to resource efficiency improvements, this mill also undertook a compliance initiative to install an exhaust gas waste oil collection system on its setting machines.

Good thermal insulation dyeing machine

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
1,965 tons/year

WATER SAVING:
51,200 tons/year

WASTE WATER REDUCTION:
51,200 tons/year

TOTAL INVESTMENT:
841,000 dollars

ECONOMIC BENEFITS:
703,000 dollars/year

PAYBACK PERIOD:
14 months

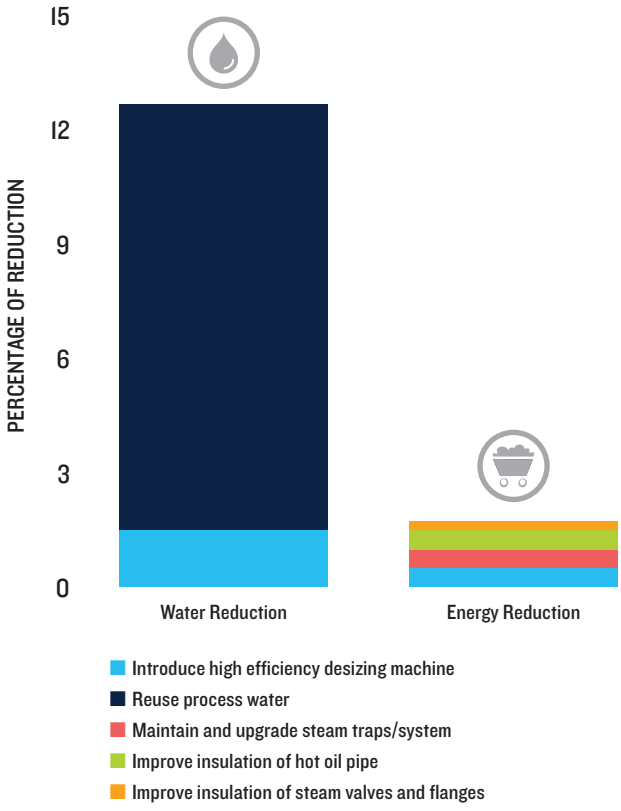
ZHEJIANG YONGFENG WEAVING & DYEING CO., LTD., SHAOXING CITY, ZHEJIANG PROVINCE

is a private textile mill established in 2006 that dyes and finishes woven fabric. It is a medium-sized mill with 600 employees.

In Clean by Design 2014 Zhejiang Yongfeng completed five projects largely targeting water use reductions that saved a small amount of energy as well. The most significant project reused process water which reduced 11 percent in water consumption. It is now delivering an annual economic benefit of $91,900 (576,000 RMB). This project, together with another project that introduced a high efficiency desizing machine, delivered a total of 13 percent water reduction. In addition to these water and energy savings, this mill also reduced chemical use each year with the introduction of a high efficiency de-sizing machine.

Process water reuse system

Total and Individual Project Contribution to Resources Reduction



Achievements

ENERGY SAVING (COAL):
498 tons/year

WATER SAVING:
136,000 tons/year

WASTE WATER REDUCTION:
136,000 tons/year

TOTAL INVESTMENT:
258,000 dollars

ECONOMIC BENEFITS:
208,000 dollars/year

PAYBACK PERIOD:
15 months

Appendix D

List of Participating Mills in Clean by Design 2014

BEST PACIFIC INTERNATIONAL HOLDINGS LTD.
CHARMING FABRICS CO., LTD.
CHIP TAK TEXTILES (TAISHAN) CO., LTD.
DEYAO XIANGSHENG WEAVING & DYEING CO., LTD.
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