



PILOTING ENERGY MANAGEMENT IN YUNNAN

In 2015, IIP worked with three energy-intensive factories in Yunnan Province, China, helping them to implement an energy management system and cut their energy use. Here we document the challenges, benefits and methodology of our pilot project, which ran from August 2015 to April 2016, and discuss how similar enterprises can apply the learnings to secure energy efficiency in their own plants.

BACKGROUND TO THE PROJECT

China has been working on industrial energy efficiency for a decade. Initially the major focus was the replacement of outdated equipment but, to improve the results, the Chinese Government stipulated in its 12th Five-Year Plan (2011–2015) that all significant energy consumers should establish an energy management system (EnMS). While this new rule encouraged the development of policies, regulations and guidelines, there were limited changes on the factory floor. The barriers for enterprises included a limited understanding about EnMS and its value, previous unsuccessful attempts, and a paucity of skilled third-party service providers.

To demonstrate how EnMS could be implemented successfully, IIP was invited by the Industrial and Information Commission (IIC) in Yunnan Province to conduct a pilot project. The aim of this project was to establish an effective EnMS in three pilot enterprises. Dozens of enterprises submitted applications to be part of the project. Yunnan IIC helped screen and shortlist five candidates, from which IIP then selected the final three. The three enterprises were chosen based on the following criteria:

- they had a strong willingness to participate in the project
- they had a certain level of potential for energy efficiency improvements
- they were typical of an industrial enterprise in Yunnan
- they were willing to share the results with their peers after the project ended
- they already had some experience in energy efficiency.

The project by numbers

Across the three pilot facilities, around **30,000 metric tons of greenhouse gases** were avoided as a result of the project.

One of the pilot facilities, Luoping Zinc and Electricity Company Ltd, made energy savings of around **800,000 kWh** between August 2015 and January 2016, amounting to savings of around **RMB 320,000**.

Yunnan Province has 399 enterprises that are large enough to classify as a “Top-10,000 Enterprise” and they consumed a total of around **58 million tons of coal equivalent (tce)** of energy in 2014. If they all implemented an effective energy management system, they could save at least **4.6 million tce** per year; while the whole of China could save **184 million tce** annually.

THE THREE INDUSTRIAL ENTERPRISES SELECTED

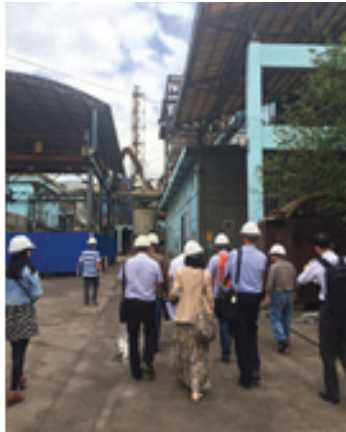
Zexin Aluminum Company Ltd. produces around 300,000 tons of aluminum per year. It has more than 1,000 employees and total assets of around 4 billion RMB. Its main energy sources are electricity and diesel. It was founded in 2011 by Yunnan Metallurgy Group and Yunnan Aluminum Group, and is located in Fuyuan County of Qujing Municipality.

Dachunshu Cement Company Ltd. has two cement production lines with an annual production capacity of 1.2 million tons of cement clinker and 1.5 million tons of cement. Its main energy sources are coal, electricity and diesel. Founded in 2003 with

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The aluminum electrolysis facility at Zexin.



The project team conducted a preliminary energy review at the sulfuric acid facility at Luoping.



The cement production line at Dachunshu.

an initial investment of 300 million RMB, the company has 283 employees. It is a wholly-owned subsidiary of Yunnan Cement and Building Material Group and is located in Yimen County in the Yuxi Municipality.

Luoping Zinc and Electricity Company Ltd. is a state-owned enterprise that does lead and zinc mining and smelting, hydropower generation, and sulfur and phosphorus chemical production. IIP's EnMS pilot project worked with its sulfuric acid production facility only. The company is located in Luoping County in the Qujing Municipality and has 373 employees. In 2007, it was listed on the Shenzhen Stock Exchange Market.

All three pilot factories are in energy-intensive industrial sectors. Zexin and Dachunshu are significant energy consumers under the National Program of Top-10,000 Enterprises. All three enterprises suffered financial losses as the Chinese economy slowed over the past two years, and they were also under pressure to achieve the government's energy targets. Prior to the project, each of the three enterprises had made some attempts to improve energy efficiency, with good results, but there was still great potential for savings.

THE CORE APPROACH

Over the course of its work in China, IIP has developed an effective EnMS methodology and a toolbox for Chinese enterprises, which have been well-received by local partners. The core of IIP's EnMS methodology is to institutionalize an energy management culture and help enterprises save costs and increase economic benefits, rather than just meet the requirements or targets set by the government. IIP also develops customized solutions for enterprises to reflect their different situations and needs, and focuses on capacity building so they can continue to improve energy efficiency over the long-term.

THE PROJECT (MAY 2015–APRIL 2016)

Over the course of the pilot, IIP worked directly with the three enterprises, helping them to develop, implement and monitor their EnMS.

Stage 1: Project preparation and launch

IIP selected the participating enterprises, designed customized plans, and assembled the expert team, which launched the project in each of the three enterprises. IIP held meetings with the management teams to assess their needs, conducted preliminary energy reviews, and delivered a high-quality EnMS training workshop in every enterprise.

Stage 2: Energy review

Energy reviews are the most important feature of an effective EnMS. Under the guidance of the expert team, the three enterprises conducted energy reviews. Based on the results, they developed tailored goals for energy efficiency and related action plans.

Stage 3: Implementation

The implementation of the action plans included retrofitting equipment, adjusting operations and improving management. The basic EnMS was established at this stage.

Stage 4: Analysis

The best practices and lessons learned were summarized, with some written into corporate regulations and operation guides. Planning for the next phase of energy efficiency work commenced.

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The launch of the project at Luoping Zinc and Electricity.



Discussion about energy efficiency opportunities at Zexin.

THE PROJECT TEAM

The chief expert on the project team was Liu Libo, Deputy General Secretary of the Expert League at the China Energy Saving Association. His work experience includes working on the development of ISO50001 and GB/T23331, and coaching enterprises on EnMS.

Dong Qingguo, Deputy General Manager at Yunnan Weilv Environment and Technology Company Ltd., helped with local coordination.

IIP also invited a number of other experts to participate in the project on specific tasks, including Richard Hart of EnerNOC, an energy service company based in the US, who delivered training and conducted preliminary energy reviews, and Zhang Jintong of the China Chemical Association.

RESULTS: ENERGY AND COST SAVINGS¹

Zexin Aluminum Company Ltd.

Zexin was founded in 2011 and has a new facility, meaning more advanced energy standards could be applied as part of the EnMS project.

Its aluminum electrolysis requires a large amount of energy. For example, in August 2015, Zexin's monthly electricity consumption was 360 million kWh. Any improvement from this baseline would bring huge savings.

Table 1: Energy saved through the EnMS project at Zexin

Timeline	Energy use (tce)	Electricity (kWh) (million)	Diesel (ton)	Water (ton)	Energy use/ton Al (tce)
August 2015 (start of the EnMS Project)	44,357	360.69	18.125	24,220	1.597
January 2016 (EnMS established)	43,657	355	17.19	25,810	1.591
July 2016 (6 months after EnMS was established, projection)	43,042	350	17	5,000	1.572

As shown in Table 1, in January 2016, when the EnMS had just been established, Zexin's unit energy consumption had already been reduced by 0.375 percent compared to August 2015. This equated to savings of 5.7 million kWh per month, or 2.276 million RMB.² Looking at the more long-term results, between January and July 2015, Zexin had consumed an average of 13,026 kWh power to produce one ton of aluminum, but between August 2015 and February 2016 this figure had dropped to 12,757 kWh.³

From January to July 2015, the average rectification efficiency was 98.2 percent, but by August 2015–February 2016, it had gone up

¹ The figures in this section were reported by the three participating enterprises. IIP does not take responsibility for the accuracy of these figures.

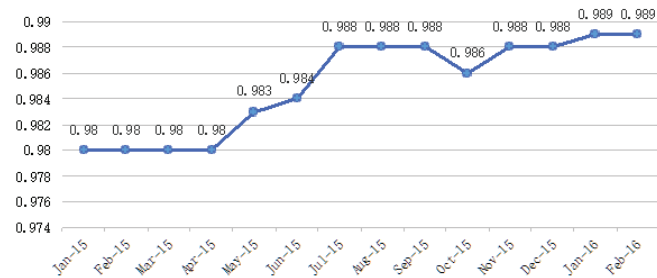
² Zexin was charged by the electricity company at an average rate of 0.4 yuan per kWh in 2015.

³ These figures came from Zexin's presentation at the Project Summary Workshop on March 24, 2016.

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to 98.8 percent. Both parameters are advanced in the aluminum electrolysis industry (see Figure 1).⁴

Figure 1: Change of efficiency of AC-DC rectification



Zexin achieved these benefits with minimal investment, instead focusing on improved operations and management. It strengthened its incentive policy to encourage every worker's contribution, and institutionalized best practices by writing them into equipment operation instructions. In 2016, Zexin plans to implement a retrofit project and two new operation and management improvement measures. The projected monthly saving for these changes is 5 million kWh, or 2 million RMB.

Luoping Zinc and Electricity Company Ltd.

Luoping Zinc and Electricity faces the challenge of a sluggish market and fluctuating production volumes. It reported that, as a result of establishing an EnMS, its unit electricity consumption has been decreasing. Its unit electricity consumption was 142 kWh in January 2016, a decrease of 8.34 percent from the 155 kWh reported in August 2015.

Table 2: Unit electricity consumption improvement

Date	Electricity consumption per ton of H_2SO_4 (kWh/ton)
August 2015	155
January 2016	142
July 2016 (projection)	138

Luoping Zinc and Electricity started from a comparatively lower level but, through the EnMS project, it was able to improve its overall management and competency.

Dachunshu Cement Company Ltd.

Dachunshu has suffered as a result of market fluctuation, and its production volumes have therefore been relatively unstable. However, since the implementation of the pilot, its unit energy consumption has decreased while the productivity of key equipment has increased (see Table 3).

In October–December 2015, Dachunshu took measures to manage its energy consumption. Within just two months, it achieved outstanding results, saving 1.19 million kWh of electricity, which equates to around RMB 476,000, and raw coal savings of 1,281 tons (in tce), the equivalent of around RMB 889,000.⁵

Table 3: Energy saved through the EnMS project, 2015

		Jan–Sept	Oct–Dec	Improvement
Output of clinker (ton)		474,700	222,400	–
Output of cement (ton)		486,200	193,800	–
Unit electricity consumption (kWh/ton)	Clinker	61.94	61.31	–0.63
	Cement	89.72	84.30	–5.42
Output per hour	Vertical mill #2	224.18	239.05	14.87
	Kiln #2	99.2	117.29	18.09
	Cement line	53.61	57.03	3.42
Coal consumption	Coal for kiln #2 (kg/t)	175.76	169.94	–5.82
	Coal in ce for kiln #2 (kgce/t)	111.45	105.69	–5.76
Clinker consumption (kg/t)	PSA32.5	586	565	–20.67
	PO42.5	799	794	–5.33

It is noteworthy that Dachunshu also had good results saving water.

⁴ Ibid

⁵ Figures from Dachunshu's presentation at the Project Summary Workshop on March 24, 2016.

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It achieved this through improved water management, such as more frequent meter checks and drainage inspection, the adjustment of valves and plugging leakages. In comparison with the baseline during January to November 2015, Dachunshu decreased water usage by 68 percent from December 2015 to February 2016. This meant a cost savings of 0.63 yuan per ton of cement.

In 2016, Dachunshu plans to produce 870,000 tons of cement, expecting to save about RMB 548,100 by reducing water use (see Table 4).⁶

Table 4: Water saved through better water management

Period	Water	Cement output (ton)	Unit water	Water saved (%)
January–November 2015	201,809	589,169	0.34	62
December 2015–February 2016	22,133	167,736	0.13	

Dachunshu saved both energy and water through improved management and operations, and with little cash investment. Though Dachunshu has an ambitious plan to upgrade some of its equipment, by the time it reported the effectiveness of the newly-established EnMS it hadn't yet carried out any upgrades. In 2016, as more measures are taken, it is expected that Dachunshu's EnMS will demonstrate even greater value.

SUMMARY OF RESULTS AND KEY LESSONS

Effective EnMS established

The three pilot enterprises all successfully established an effective EnMS, and their energy management teams now have a sense of the systematic methodology required to maintain it. The enterprises developed energy indicators systems, drafted action plans, implemented retrofit projects and developed a number of policies and regulations. Their EnMS will help them solidify the best practices and make them standard operating procedures so they can continuously improve energy efficiency.

Energy managers are more capable

At the start of the project, the three participating enterprises were asked to put together energy teams. All of them put forward their general managers to head these teams. Further, a chief engineer or deputy general manager was allocated to lead the day-to-day work

of the energy team. The managers of each department were also members of the energy team, and they all had at least one dedicated person who acted as energy manager or coordinator.

The project helped build the capacity of the energy teams, with the chief engineer/deputy general manager and the energy manager/coordinator becoming much more capable. The enterprises already had some experience in energy efficiency but it was largely reactive. Through this project, they learned an effective methodology and they will now be able to improve energy efficiency continuously, systematically and proactively. During the course of the pilot they also had to coordinate among different departments, gather support from top management and ensure the execution of policies at the plant level which has improved their skills in communication and coordination.

A simple but effective methodology

In many Chinese enterprises, EnMS means excessive paperwork. Every line of GB/T23331 (the Chinese version of ISO50001) is mechanically followed, resulting in the development of many documents – such as an energy management handbook, procedures files, a variety of policies and regulations. In many cases, enterprises are certified or reviewed based on these documents rather than on the results of an EnMS, so enterprises and/or their service providers mostly focus on the development of documents. The execution of these documents is very poor. Energy policies, regulations and instructions can also seem too complicated and confusing, especially to factory workers. As a result of these challenges, new policies tend to exist only on paper rather than in practice. One of the goals of this project was to address these barriers, including by developing an EnMS methodology that connects theory and practice, is easy to implement, and brings meaningful changes to the energy use in factories.

The expert team focused on the essentials of an EnMS, including an indicators system, key policies and significant energy users. Under the guidance of experts, the enterprises' energy teams were encouraged to build their own energy management systems. They took account of the real situation and the EnMS they established generated great value.⁷ In developing the work plan, the project team worked directly with the enterprises to make sure the technical assistance was customized and could meet their practical needs. The project team did not follow every aspect of GB/T23331, but flexibly applied the essential parts. For instance, Zexin placed the emphasis on the frontline and made great efforts to mobilize staff and institutionalize best practices into operation manuals.

⁶ Ibid.

⁷ For the details of the methodology, please refer to Liu Libo's *Ten Thumb Rules to Establish EnMS*.

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Creating an energy efficiency culture

A good energy culture is necessary to improve energy efficiency continuously. This project focused on mobilizing staff in the pilot factories. The enterprises developed a number of manuals to instruct factory workers on the most efficient way of operating equipment. Incentive policies were strengthened to encourage every employee to save energy, and the enterprises also organized a variety of communications activities, events and training to both promote staff's awareness and build their capacity.

Reducing costs

For government or non-profit organizations, energy efficiency tends to be a policy objective related to mitigating climate change. But for business, energy efficiency means cutting costs and increasing the economic benefits. To this end, the project team sent a very clear message to the three participating enterprises: 'We have come here to help you save money and become more economically competent.' The enterprises welcomed this message and actively worked with the project team. In the current macro-economic environment, all three enterprises face a host of challenges. They have a strong need to reduce their costs. As energy costs represent a large component of their overall costs, we were able to garner their support to actively reduce them through better energy management. The project team also helped them identify low-cost and no-cost opportunities for energy efficiency.

Support from senior management

Having the support of senior management was one of the most important criteria for selecting the three enterprises as we knew it would be critical to the project's success. Fortunately, the general managers of all three enterprises headed their energy teams and were committed to energy efficiency. They supported the project by allocating human and financial resources, adopting a number of new policies (such as incentive plans), coordinating among different departments in the factory, and obtaining support from their parent companies and the government.

Capacity building and engagement

In China, enterprises often hire energy service companies or consulting companies to help them establish their EnMS. These service providers manage the whole process, although the enterprises usually assign a project manager to work with them. Throughout the process, the enterprises are not deeply involved and employees often do not have a clear idea about their objectives or even the EnMS itself. At the end of the project, the service providers submit documents to their clients, and the work is terminated. This project,

on the other hand, engaged as many people as possible. The project team respected the experience and input of all the people working in the factories, from managers to general factory workers. The energy teams were asked to learn by doing. Under the guidance of experts, they conducted energy reviews, developed action plans, trained factory workers, and drafted a number of policies and regulations. As a result, their capacity was enhanced, especially that of the energy managers, and it is expected they will now be able to independently and continuously improve energy efficiency at their plants.

Support from local government and a local energy service company

The project was supported by the Yunnan Industrial and Information Commission (IIC) and the energy conservation centers at both provincial and municipal levels. Particularly in the early stage, the endorsement of local government gave IIP a lot of credibility, which we used to build good relationships with all three enterprises. By the end of the project, Yunnan IIC had contributed greatly to the dissemination of best practices and the results of the project. In March of 2016, Yunnan IIC, the National Energy Conservation Center and IIP organized a project summary workshop to share best practices. Around 150 representatives from business, government and NGOs attended the workshop, some of them local and some from other provinces. The success of the project inspired the participants in many ways. We also invited Yunnan Weilv Environment and Technology Company to participate in the project. The company is based in Kunming and provides consulting services to Yunnan's enterprises on cleaner production, environmental production and energy efficiency. It helped us coordinate with organizations, including the three participating enterprises. As it is a local company, its support was very helpful. Weilv also benefited from the project: by working with the project team, its employees improved their capacity and will be able to help other local enterprises develop and implement EnMS independently in future.

CHALLENGES

The project term was too short

Although the EnMS methodology was not difficult to understand or implement, and the three enterprises successfully established their EnMS in a short timeframe, the project could have generated better results if the project term was longer. The project ran over six months, hardly enough time to carry out bigger retrofits or make many significant changes in management. It also meant that Luoping Zinc and Electricity only received limited technical support from the expert team after the project ended. Further, as production volumes at the factories fluctuate seasonally, it would have been optimum to work with the enterprises over a full year.

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Overall management within the enterprises

It is usually easier for enterprises with good basic management to establish effective EnMS, and vice versa. However, the three participating enterprises all had different management capabilities. Zexin easily grasped the experts' advice and quickly executed it. It was especially helpful that Tang Bo, the Chief Engineer, was already an energy efficiency champion. He is a talented expert in areas like AC-DC rectification and aluminum electrolysis, and he has excellent leadership skills. In another facility with less management capability, the project team worked very hard to push things forward. By the end of the project, the facility not only successfully established the EnMS but also improved their overall management and the morale of the staff.

The impact of the Chinese economy

All three enterprises have endured financial losses as a result of the slowing economy. While energy efficiency measures can help them cut costs, they were too cash-constrained to invest in more expensive energy efficiency projects that have good economic returns. Production at Dachunshu and Luoping Zinc and Electricity is also unstable due to market fluctuation. For example, at Dachunshu, only one of the two cement production lines was in operation, and the production of sulfuric acid was greatly affected by the demands of its long-term clients. The instability of production compromises the benefits of this project to some degree.

RECOMMENDATIONS FOR FUTURE

Reduce paperwork

Many enterprises develop their EnMS in order to meet government requirements, rather than for their own economic benefits. They mechanically follow national standards, which results in new

documentation only, rather than a practical EnMS that makes them more energy efficient. This is partly because the government mandates that all Top-10,000 enterprises certify their EnMS, resulting in many enterprises preparing only the required papers for certification. In the 13th Five-Year Plan, it is recommended that EnMS certification is optional for enterprises, allowing more flexibility. Government could also develop some incentives to encourage enterprises to undertake EnMS.

Let the market play a more important role

The market needs to play a more important role to scale up EnMS. If service providers can help enterprises cut costs through EnMS, more will get involved. Government can help prepare the market, such as by establishing good case studies, disseminating best practices, publishing guidelines and standards, setting entry requirements and building the capacity of service providers.

Improve the capacity of service providers

The primary reason that EnMS is not being adequately scaled up is related to the weak capacity of EnMS-consulting companies. Many have experience in cleaner production assessments or specific retrofit projects but limited practical experience with EnMS. They may also be selling their services for a low cost in order to win more clients, but in doing so they provide lower quality service. As a result, many companies have become skeptical about EnMS and do not want to invest in it, except to meet government requirements. It is critical to build the capacity of service providers in the 13th Five-Year Plan.

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