

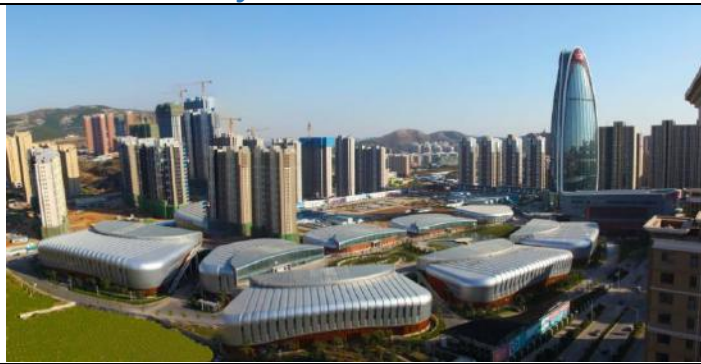
Global Energy Management System Implementation: Case Study

China



China National Heavy-duty Truck Group Co., Ltd.

CNHTC formed a long-term mechanism of systematic energy saving through the EnMS project and achieved economic benefits of USD 59.1 million in 4 years.



CNHTC Science and Technology Building Park (the test room and laboratory in the near end)

Company Profile:

CNHTC, founded in 1956, produces heavy trucks, special vehicles, buses, dedicated vehicles, engines, axles, gearboxes, etc. Its MAN technology MC series engines reach Euro V emission standard and cover 140-560 hp. Its products are best sold at home and abroad, and its export volume has ranked the first in the industry for 13 consecutive years.

CNHTC promises to reduce energy consumption and greenhouse gas emissions, adheres to sustainable development, and strives to produce the best quality and low consumption products with the least consumption to protect the environment and conserve resources. It plans to reduce the energy consumption of each heavy-duty truck by 20% and achieve a reuse rate of water over 95% from 2016 to 2020.

"Build green factories, make energy saving vehicles, and take the road of sustainable development."

—Chairman Wang Bozhi

Business Benefits Achieved

In the past four years of the implementation of EnMS during 2013-2016, the unit consumption of the product was reduced by 6.5% on an annual average, with the business benefits reaching USD 59.1 million and the carbon dioxide emissions reduced by 99.6 thousand tons. Through EnMS, the full and systematic energy saving are realized, the long-term mechanism and the whole process control mechanism of key energy consumptions are established, and the energy management becomes more refined. With the active participation of production, technology, process, quality, and equipment teams, the workers' consciousness of energy saving has been constantly improved, and a large number of backbones have been cultivated.

Case Study Snapshot	
Industry	Automotive
Product/Service	Truck, bus, special vehicle
Location	Ji'nan, China
Energy Management System	GB/T 23331-2012 (ISO 50001)
Energy Performance Improvement Period	2013-2016
Energy Performance Improvement (%)	6.5%
Total energy cost savings over improvement period	USD 59.1 million
Cost to implement EnMS	USD 17.23 million
Payback period (years) on EnMS implementation	~1.2 years
Total Energy Savings	1171024(GJ)
Total CO₂-e emission reduction	99600 tons



Awarding at the Side Meeting of the 8th Clean Energy Ministerial (CEM8) on June 1, 2017

EnMS Development and Implementation

In 2013, CNHTC launched EnMS in 12 production enterprises in Ji'nan area which passed certification in 2014, and the energy performance of these enterprises has improved significantly. So in 2015, 6 enterprises in other regions began to implement EnMS, and passed certification the next year.

Institutional Arrangement

CNHTC and its secondary enterprises set up full-time departments which were equipped with full-time energy managers. After EnMS was launched, the management representative was served by the deputy general manager of production, and the post of part-time energy manager was added in the production workshop. At present, there are 82 full-time energy managers and 220 part-time energy managers at all levels of the Company.

In order to reinforce the strength of building EnMS project at the group level, 5 full-time staff with



The front row are members of the working group, and the back row are some of the energy managers of the secondary enterprises

strong ability have been selected from the secondary enterprises to form the EnMS working group of the Company.

Before the implementation of EnMS, the energy management responsibilities were only borne by the above full-time departments and energy managers; during the implementation of EnMS, the Company clearly assigned the related responsibilities to production, technology, process, quality, equipment, human resources, business management and other departments in the framework of EnMS according to the needs in the whole management process, and the main backbones of the departments were incorporated into the energy review team. In the EnMS project, the high-level commitment is achieved through the manager representative.

Energy Review

In early implementation of the EnMS, the team members lacked overall awareness of the EnMS and the Company hired a consulting firm to provide technical support. Under the guidance of experts, the forging workshop arranged two day shifts on two same production lines onto one production line to sustain continuous production of day shift and night shift. The power consumption per unit forging was greatly reduced. This changed our original ideas of energy saving management as only solving leakage and venting. We put this case into the category of local continuous production, along these ideas, the review team found more ideas of energy saving management: economic batch quantity, synchronous production (avoid local overtime working), centralized scheduling, improving the production takt, standardizing energy using operation at key points, strengthening equipment operation and maintenance management, reducing excess production capacity and changing charging mode for energy using (heating charged by operation flow in lieu of by area). In the first year of the implementation of EnMS, the Company has achieved a gratifying effect of energy saving.

As found in conclusion, the energy review from workshop is better and more effective. Therefore, in

early 2014, it was required that the energy review must start from the workshop, and the review group would enroll the first-line operation foreman. In this way the energy review was promoted. The thought of review also added the process energy saving, including the adoption of new energy saving process and the appropriate reduction of high technical parameters. In 2015, the demand side management was introduced, and the energy saving was further expanded.

System Planning

According to the requirements for operation control, in order to identify various opportunities of energy saving (especially those of energy saving management), the Company have developed various operation and maintenance specifications at all levels, including management systems, business process, operating protocols. 2016 was defined as the "year of standardization", and the standards were explained and deployed through large-scale training courses. The Company pays more attention on the operation control, fully considers the executability, measurability, traceability and controllability of the norms, identifies the measurement demand plan, adopts online monitoring and other measurement means, and plans to develop intervention mechanism for abnormal fluctuations of energy performance.

"Construction of the energy management system provides the guarantee for the completion of the task of reducing manufacturing costs" - Chen Shiming, Director of Casting Workshop

Cost-benefit analysis:

Investment in EnMS establishment: USD 4.73 million for technical transformation, USD 240 thousand for new metering instruments, USD 140 thousand for e training, USD 610 thousand for construction of the energy management center, USD 40 thousand for consultation; USD 120 thousand for certification, recertification and review, USD 30 thousand for energy audit, USD 30 thousand for travel expenses for the group review, USD 11.29 million for wages of

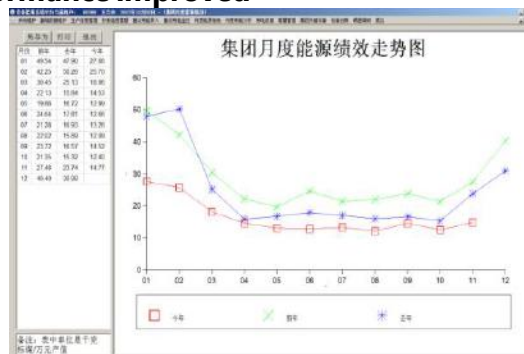
part-time and full-time management staff, USD 17.23 million in total.

Several important energy saving projects

Implementation unit	Project name	Year	Investment (10 thousand yuan)	Average annual savings(10 thousand yuan)
Power	Ground source heat pump	2016	1200	310
Power	Chilled water storage and waste heat utilization	2015	387	180
Casting and forging	Forging II 6300 tons gas to electricity	2014	530	203
Gearbox	Energy Management Center	2014	200	
Truck	Energy Management Center	2016	120	

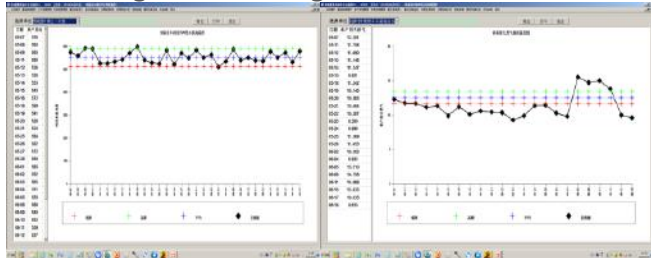
From 2013 to 2016, a total economic benefit of 59.1 million U.S. dollars was realized.

Approach used to determine whether energy performance improved



The consumption amount and cost of certain energy per unit of product was set at the executive level, i.e., the grassroots units of production, such as the amount of natural gas used for painting each cab, the electricity consumption and electricity charges for smelting of per ton of liquid iron. This approach

provides better flexibility and easier measurement and calculation. The Company requires daily measurement and daily control of key energy-consuming units at the grassroots level.



Trend chart of daily energy performance of casting line melting furnace and body painting line

After the establishment of energy management center, peak, flat and valley levels can be measured and new energy performance parameter - electric consumption per unit can be set to truly reflect the actual needs of enterprises with benefit as the center. Hangzhou Engine Casting Co., Ltd. raised the utilization rate of valley electricity from 30% to 80% in 2016, with added benefits of USD 455 thousand in that year.

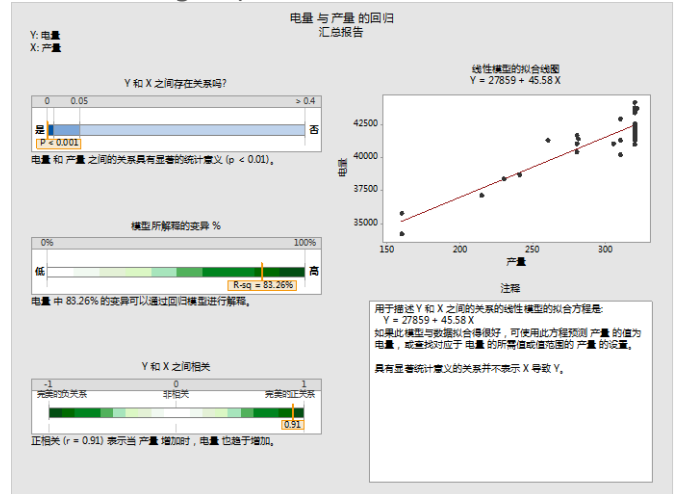
Considering that the output of heavy-duty truck industry fluctuates a lot, which has a great impact on energy performance, the Company introduced statistical analysis methods such as regression analysis and established normalized energy performance parameters for main energy use to eliminate the impact of factors such as output and environmental changes, and objectively evaluate energy performance and effectiveness of operational control.

Approach used to validate results

At the executive level, energy performance is affected by various factors. Therefore, it is feasible to conduct daily measurement on major energy use. If abnormal fluctuations occur, it is convenient to find the cause in time. The Company formulated the management methods for abnormal performance fluctuation on key energy-consuming days to define responsibilities, formulate procedures and form guidelines.

For monthly and annual energy performance measurement and verification, regression analysis, t-

test and scattergram analysis and EXCEL, SPSS, MiniTab and other tools are commonly used at all levels of the group.



In addition, the Company also hired a third-party energy auditing company to conduct energy audits on major energy-consuming entities and hired Shandong Energy Conservation Association to analyze and verify the energy performance of the Group Company.

Steps taken to maintain operational control and sustain energy performance improvement

The engine test process conducts statistical analysis of the quality problems in the test process and the time of failure occurrence, optimizes the test running-in process, gradually adjusts the running-in time from 60 minutes to 35 minutes under the premise of ensuring the quality and reduces energy consumption.



Year	Yield	Diesel saved per unit (Kg)	Cost saved per unit (yuan)	Cost saved (10 thousand yuan)
2015	11141	15.32	112.88	125.8

2016	27313	15.69	113.88	311.1
2017	57262	4.8	35.36	202.5

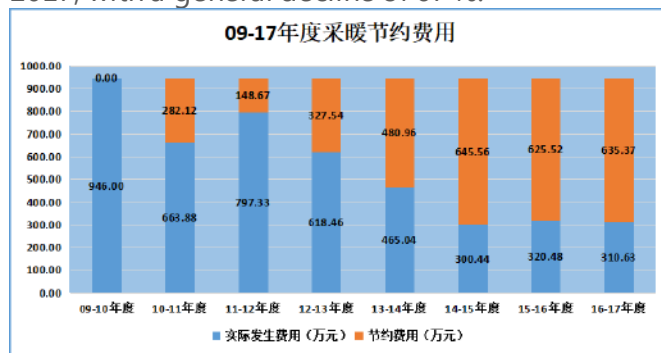
Rubber injection molding machine in the vulcanization workshop needs preheating and is the key energy-consuming equipment. Previously the operator started more equipment to shorten the production time, which led to high yield per unit because the equipment can not be continuously operated. They changed the mode of production organization, arranged the production plan clearly to the specific equipment, formulated the operating rules and monitored the measurement through the "vulcanization industrial control parameter inquiry system". The power consumption per Kg of sizing material was reduced from 2.79KWH to 2.70KWH, saving 99,000 KWH electricity annually.

产品硫化日期	设备号	硫化开始日期	硫化开始时间	硫化结束日期	硫化结束时间	设备运行时间(分钟)
2017-5-27 10:05:39	101	170527	94659	170527	100857	2159
2017-5-27 10:31:33	101	170527	101252	170527	103451	2200
2017-5-27 10:57:56	101	170527	103916	170527	110115	2200
2017-5-27 10:49:19	102	170527	103239	170527	105238	1959
2017-5-27 10:25:49	102	170527	100908	170527	103908	2000
2017-5-27 10:02:53	102	170527	94613	170527	100612	1959
2017-5-27 11:13:14	102	170527	105633	170527	111633	2000
2017-5-27 8:51:44	102	170527	83503	170527	85503	1959
2017-5-27 9:16:03	102	170527	85922	170527	91922	2000
2017-5-27 9:39:45	102	170527	92305	170527	94304	1959
2017-5-27 8:59:59	103	170527	84718	170527	90318	1600
2017-5-27 9:24:08	103	170527	91128	170527	92727	1959
2017-5-27 9:50:41	103	170527	93801	170527	95400	1559
2017-5-27 10:12:54	103	170527	100013	170527	101613	1600
2017-5-27 10:42:38	103	170527	102958	170527	104957	1959
2017-5-27 11:08:58	103	170527	105315	170527	110914	1959
2017-5-27 10:29:04	105	170527	101024	170527	103223	2200
2017-5-27 10:53:13	105	170527	103433	170527	105632	2200
2017-5-27 11:17:26	105	170527	105846	170527	112045	2200
2017-5-27 10:04:54	105	170527	94614	170527	100812	2159
2017-5-27 8:52:24	105	170527	83343	170527	85542	2200
2017-5-27 9:16:19	105	170527	85739	170527	91938	2200
2017-5-27 9:40:42	105	170527	92202	170527	94401	2200
2017-5-27 10:02:23	106	170527	93543	170527	100541	2959
2017-5-27 8:58:54	106	170527	83214	170527	90212	2959

For the body painting line, it was found in the review that it is neither necessary to immediately start the online devices at the same time when getting on duty nor necessary to switch off them at the same time when getting off duty. The startup & shutdown time of each device in order was calculated, the operating instruction was modified, and a form designed so that the operator may record the startup & shutdown time of each device on a piece of paper per shift. During the inspection, it was found that there was fabrication of startup & shutdown records, so the method was changed. A piece of paperboard was hung near each switch for records when switching on or off the device. The problem of records fabrication in operation was solved.

The gearbox company changed heating charges by area to by flow in winter and started to pay attention

to the heating valve which had been ignored before. Through continuous exploration, the factory heating standards and operating instructions were developed and tour-inspection was carried out as per the required time interval to control valve opening. The heating costs decreased year by year, from 9.46 million yuan in 2010 to 3.1 million yuan in 2017, with a general decline of 67 %.



Light blue for the actual cost, orange for the cost saved, the cost has been basically maintained stable at a low level in the past three years

The aluminum alloy smelting and die-casting process in the casting workshop changed the two long shifts to three short shifts and then to four short shifts so that the equipment may continue operating while the workers have rest, so as to avoid frequent replacement of aluminum alloy models and improve production efficiency. The slag was cleaned per charge of furnace to improve thermal efficiency. The combustion efficiency of furnaces was monitored; the standard operating procedures were formulated, the "Pit Furnace Operation Record" was maintained and gas consumption per charge monitored. The energy performance was significantly improved. The natural gas consumption per charge decreased from 674 cubic meters to 342 cubic meters, with a decline of 49.2%, and 1.5 million yuan of annual energy cost was saved.

Development and use of professional expertise, training, and communications

Training: (1) Prior to the annual energy review, a large-scale energy system training course is held and well-known domestic experts hired to give lectures. From 2015 onwards, half-day communication classes

have been arranged, where participants share their cases in group for discussion. (2) Internal auditor training is carried out prior to the group audit and cross audit each year.

Communication: (1) Internal communication based on group audit and cross audit. The backbones of each unit will participate in important audit. Each audit is a real exercise and is recorded in the form of video to make video tutorials; the group audit along with cross audit plays the effect of promotion and exchange. (2) Internal communication on special topics: Symposium on the key energy consumptions (such as painting, heat treatment, casting and forging, etc.) shared by several enterprises organized by the Group. (3) Energy-saving achievements exhibition tour. (4) External communication carried out on the platform of Energy Conservation Association. The Company also participated in special exchange of EnMS. (5) Appointed by Energy Conservation Association to carry out energy-saving diagnosis and counseling at SMEs. (6) Internal and external communications in WeChat group, including those at the national, provincial, municipal, association, and enterprise levels.

Tools & Resources

Tools: (1) The energy management center was set up by the Group and major energy-consuming enterprises. (2) CNHTC learnt the successful experience of operation and continuous improvement of quality management system for many years, and adopted the process method to plan for, control and improve the system operation process.

Resources: Received the guidance and assistance of provincial and municipal energy saving authorities, bonuses and policy support funds of energy saving and emission reduction of USD 2.19 million; participated in Sino-German cooperation projects, where the Chinese and German experts carried out in-depth energy-saving diagnosis at enterprises to further expand ideas of energy saving.

Lessons Learned

- (1) High-level commitment and the role of the team are crucial.
- (2) It is very important to profoundly interpret the standard and complete the course "from beginner to master" of EnMS.
- (3) Energy saving in terms of management and process has great potential. It is necessary to carefully plan the operation and control and fully reflect the changing nature of management and the managers' ingenuity.
- (4) It is necessary to pay high attention to ability and awareness and attach importance to communication. The process of EnMS implementation is also a process of personnel training.
- (5) It is necessary to "build the Management System along the path of energy saving" and always keep in mind the purpose of energy saving, and avoid separation of the two.

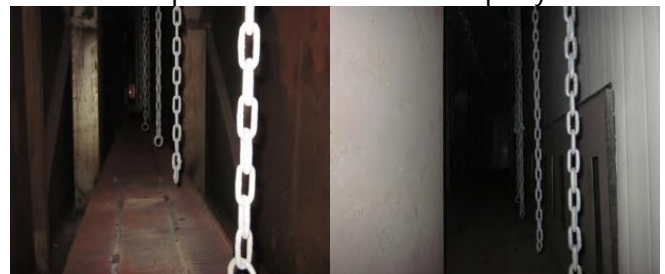
Quotes

Continuously & deeply to make EnMs forward, and contribute to sustainable development of enterprise! —Chairman Wang Bozhi

Visuals



Opening ceremony of energy training course
Group audit of the truck company



Previously the drying channel is of low energy efficiency due to too large a volume After transformation