

HOW TO IMPROVE ENERGY EFFICIENCY OF PAPER MAKING UP TO 9 %:

CASE STUDY

如何将造纸业能源效率提高至 9% 个案研究

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I. INTRODUCTION 介绍

Reducing the energy intensity of growth has been a major priority of China since the 11FYP (2006-2010) with the initial focus on improving the industrial energy efficiency. Thus, various initiatives have contributed to a steady decline of energy intensity of China's economy over the last decade. The latest numbers show an electricity demand growth of only 3.8 % partly caused by decline in heavy industry production and hence industrial electricity demand. Yet, energy conservation efforts in industry have had an effect in the decoupling of energy demand and economic growth and also reduction of air pollution and GHG emissions by reducing overall energy demand¹.

自十一五计划中国聚焦在改善能源效率以来降低能源耗损已经成为其任务的重中之重，所以之后的十年里各种措施的实行已将中国经济的能源强度稳步降低。最新数据显示用力需求的上升，其中只有 3.8%是因重工业产能和工业用电需求的降低带来的。然而节能已经有效作用于降低工业能耗、经济增长、减少污染和温室气体的减排上。

During the 11 FYP, the average energy intensity of China's pulp and paper industry dropped 18 % and is predicted to drop 20 % by the end of 2015 compared to the intensity in 2010. Nonetheless, a wide gap exists between China and other developed economies in the best available technologies in use in the pulp and paper sector².

十一五计划期间，中国纸浆造纸业的平均能源损耗下降 18%，预计 2015 年年同期下降 20%。尽管如此，中国在纸浆造纸业可行技术的利用上与其他发达国家相比还是有巨大差距。

Unlike in most of the countries producing paper, Chinese paper mills produce more than 50 % of the energy consumed with coal. Relatively cheap domestic coal has traditionally ensured cheap steam and electricity for paper mills. All in all, around 600,000 industrial boilers are fuelled in coal, indicating also the scale of the air pollution challenge.

与大多数国家的造纸业不同，中国纸厂用煤量是其他国家的 1.5 倍。也就是国内廉价的煤产出廉价的蒸汽和电力。总之，约 60 万台工业锅炉用煤作为燃料，给空气污染带来巨大的挑战。

¹ Green, F. and Stern, N. (2015) Policy brief: China's "new normal"

² Kong et al (2013) Analysis of energy-efficiency opportunities for pulp and paper industry in China

Simultaneously to energy intensity efforts, China has introduced emission trading schemes (ETS). These, schemes introduce price to CO₂ emissions and potential offsetting mechanism, which can utilise projects that decrease energy consumption outside the companies that are included in the ETS.

同时，中国加入了排放交易体系，该体系介绍了二氧化碳排放的代价和潜在的补救措施，如降低体系中提及的企业的能源损耗。

Our presentation addresses potential of industrial air system energy efficiency in existing paper mills. The benefits of energy efficiency are manifold—lower energy bills, improved air quality, reduced greenhouse gases, increased energy security, and a deferred need to invest in new infrastructure. It is widely accepted that energy efficiency is economically attractive still the actions for energy savings are yet to be adopted. The estimations are based on numerous reports studying different types of paper mills in China and elsewhere. In addition, realised case projects with measurable results are presented. The conclusion of the work discusses economical feasibility and potential co-benefits of the projects.

我们的演讲将针对现有的纸厂工业通风的能源效率来展开的。节能可以带来诸多好处，能源成本的降低，空气质量的提升，减少温室效应，提高能源安全和一些基础设施的未来应用。能源效率带来的经济效益和为节能所采取的一些措施都是被广泛认可的。演讲中的数据预估分析都是基于中国和其他国家的纸厂的一些数据报告得来的。另外也会提到一些完成的项目案例。作业的结论分析了经济可行性和为项目带来的潜在收益。

II. TECHNO-ECONOMICAL POTENTIAL

技术-经济潜在性

There are 2738 paper producers in China as of Aug 2012³. The total energy usage of industry is 180 PJ and production 92.7 Mt in 2010. For pulp production the energy intensity was 13.2 GJ/tonne and for paper 24.3 GJ/tonne (LBNL, 2014). Comparable numbers are 10-30 % lower for US or European paper mills according to different reports.

截止至 2012 年八月中国共有 2738 家造纸企业。工业能源使用量达到 180PJ，到 2010 的产量达至 92.7 吨。纸浆生产能源强度为 13.2GJ/t，造纸生产能源强度为 24.3GJ/t，据不同报告显示，其能源利用高于欧美造纸业 10-30%。

The total fuel savings potential with a closed hood, optimised air system and heat recovery is almost 9 % of the industry's energy consumption (LBNL, 2014) and more than 5 % of the CO₂ emission reduction potential. If an example mill produces 300 000 adt/a, which corresponds to 7 300 000 GJ/a of energy consumption of which the industrial air system savings potential is 650 000 GJ/a. This estimation is in line with our realised projects.

³ China Technical Association of Paper Industry

如果拥有密闭汽罩，优质的通风系统和热回收，将能回收能源损耗的 9%并将减少 5%的二氧化碳排放。如果以纸厂制造 300,000adt/a 为例，相当于 7,300,000GJ/a 的能源损耗，其工业通风系统能节约 650,000GJ/a。这个预估值正好与我们现有的方案一致。

TM Systems is specialised in industrial air solutions that can at the same time add volume of production. Example projects are presented more detail in the seminar. One of the projects was an excessive rebuilt of a copying paper machine purchased used abroad. Our solution included engineering and installation of closed hood, surrounding air systems, four heat recovery towers for replacement air and machine hall as well as auxiliaries. The mill was located in northern hemisphere, thus the recovered heat could be utilised for heating of the premises for four months per year.

TM 专业从事工业通风解决方案，同时增加产量。研讨会将讲述更多的项目案例。其中一个项目是国外一台复写纸机的改造。我们的方案包括工程设计和密闭汽罩、边围通风、四台热回收塔（可代替厂房和人员）的安装。该纸厂位于北半球，所以回收的热能可供每年四个月的极夜情况所使用。

As a result, the total energy saving was 57 GJ. In this case, the monetary saving was significant since the electricity and steam were bought from external company. However, the savings would have been even greater, if the customer had decided to utilise the recovered heat for process fluids. This would have resulted in savings higher than 72 GJ i.e. 25 % higher energy savings than the ones realised, yet the additional investment would have been only 12.5 % more.

结果显示，总节能 57GJ。如果这样的话，将为经济的节约带来重大的意义，因为电力和蒸汽能从企业外部购买。但是，如果客户想从工艺液体中回收利用热能，这将更节能，能节约至少 72GJ 的能源，也就是比原来的方案节约 25%，但是额外的投资只能达到 12.5%。

In fact, for rebuild projects, the knowledge on potential of utilisation of the excess heat energy is the key for the most feasible projects. The request for original project comes from the customer, yet efforts for further improvements and innovative new solutions is TM Systems' speciality. The projects range from engineering services to turn-key deliveries of complete ventilation systems. The Finnish-based technology and the worldwide supplier and manufacturing network are the pillars of TM Systems' operations and facilitate tailor-made deliveries to customers.

事实上，其余热回收的专业知识是改造项目的关键。我们根据客户的需求定制，TM 的专长在于持续改善和方案革新。项目范围从工程服务到整个交钥匙工程。芬兰技术、全球供应链和制造网是 TM 运营的支柱促使定制方案交至客户手中。

In addition to energy and consequent monetary savings, there were significant co-benefits of energy efficiency efforts. The projects often lead to closed process cycles resulting reduced water usage and emissions to water systems. In this case, the end-product quality was improved as a consequent of better controlled air flows above the drying paper and avoided dripping of condensates.

除节能和降低成本之外，还具有其他重大的效益。工程方案可以使工艺能源循环，降低工艺水的使用和排放。这样一来，最终产品质量将得到更好的改善，纸张减少了冷凝水的滴落使其更干燥。

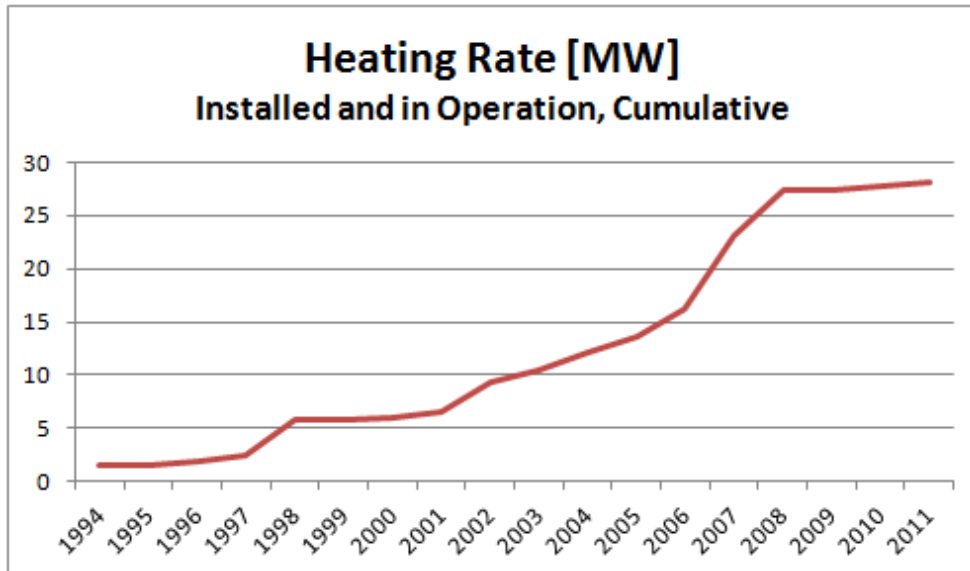


Figure: Projects realised by TM Systems - cumulative energy savings installed and in operation at paper mills worldwide

图表：TM 的项目，全球已安装设备并正在运行的纸厂累计数量

A recent report⁴ estimates that under the 13th Five-Year Plan China will need to invest at least RMB2 trillion per year in green sectors in order to meet the targets announced by China's Ministry of Environment. Governmental initiatives are of great help for industry having to consider its competitiveness in global markets. Unlike other industries in China pulp and paper industry has achieved smaller energy efficiency measures than other energy intensive industries. The governmental initiatives like ETS offer market based mechanism to support energy savings investments in industry. Realised CO₂ ton prices are 35 yuan/eqvCO₂tons⁵ i.e. estimated benefit per tonne for air systems is ca 1 % of the total cost.

最近报告预计在十三五计划中，为达到中国环境部门的目标，中国每年将投入至少 2 亿元在环保上。政府的干预有效的使工业企业去深思其在全球市场的竞争力。与其他能源密集型工业相比，中国纸浆造纸业在能源效率方面收获颇小。像 ETS 提供基于市场机制的政府举措，以支持工业节能投资。已实现的二氧化碳吨的价格是 35 元/ eqvCO₂tons 即估计每吨利于空气系统是 CA 总成本的 1%

⁴ People's Bank of China and UNEP (2015) Establishing China's Green Financial System

⁵ Partnership for Market Readiness, May 2015 Newsletter, www.thepmr.org

III. CONCLUSIONS 结论

Pulp and paper industry has been identified as one of the energy intensive industries having challenging targets for improving energy intensity. Independent institutes have estimated the energy efficiency potential for industrial air systems to result 9 % energy savings. Our results show that we have decreased energy consumption of example projects for more than 10 %. The key for achieving the most benefits of an energy savings project is the innovative engineering of utilisation of the excess heat energy.

纸浆造纸行业已经被定为能源密集型工业，改善能源密集度是一个挑战。独立学院预计潜在能源效率可提升至 9%。我们的结果显示我们的项目能将能源损耗降低至少 10%。达到节能效益的关键在于余热有效利用的创新设计。

It has been estimated that most of the mill renovations will be realised in Asia and in particularly in China in the coming decade⁶. Currently, the annual average of machine rebuilds is 2 %, yet more than 2 200 operating machines in Asia have never had rebuild of any type. TM Systems estimates that our solution fit to 2,000 paper machines in China. Consequently, the overall energy efficiency improvement potential is estimated to be at 4 PJ/a. Thus far, our heat recovery solutions have helped achieve almost 7 TWh/a of savings globally in energy consumption for our customers (www.tmsystems.com).

预计在接下来的十年里亚洲将迎来纸厂的全面革新，尤其是中国。目前年平均设备改造率是 2%，然而在亚洲至少有 2200 台纸机从未进行过任何改造。TM 的解决方案将满足 2,000 台纸机的需求。因此纵观能源效率的改善预计达到每年 4PJ。迄今为止，我们的热回收解决方案在全球为我们的客户已解决每年 7TWh 的能耗。
(www.tmsystems.com).

Just recently, Premier Li Keqiang stated⁷: "In 2014, China's energy consumption and carbon dioxide emission per unit of GDP dropped by 29.9 % and 33.8 % over 2005. The binding targets on energy conservation and emissions reduction set in the Twelfth Five-Year Plan could well be achieved as scheduled." With the state of art technology applied for rebuilds of existing paper mills and help of ETS and other monetary initiatives these targets could indeed be achieved.

最近，李克强总理发表申明：“2014 年，中国能源损耗和二氧化碳排放占国内生产总值已降至 29.9%和 33.8%，十二五计划制定的节能减排目标已很好的达成。”工艺技术对于现有纸厂改造的应用、ETS 的辅助和其他经济驱动，这些目标可以直接达成。

⁶ Power, T. (2014) The present and future landscape of paper machine upgrades

⁷ The State Council statement June 12, 2015