

# Opportunities and Future Challenges in Green Low-Carbon Transformation for European Papermaking Enterprises

欧洲造纸企业绿色低碳转型中的机遇与未来挑战

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# Political Regulations to cut CO2 emissions

## 政治法规以减少二氧化碳排放

- Europe created the EU-ETS Emission Trade System, starting 2005
- 欧洲于2005年启动了欧盟排放交易体系(EU-ETS)。
- For each ton of CO2, an emission certificate must be bought at the end of the year
- 对于每吨二氧化碳， 必须在年底购买相应的排放配额。



# Political Regulations to cut CO2 emissions

## 政治法规以减少二氧化碳排放

- Presently, a limited quantity of certificates are distributed free of charge by the member states of the EU.
- 目前， 欧盟成员国正在免费发放一定数量的证书。
- Additional certificates are sold by the member states with a fixed price
- 附加证书由成员国以固定价格出售。



# Political Regulations to cut CO2 emissions

## 政治法规以减少二氧化碳排放

- The number of certificates free of charge are reduced regularly.
- 免费证书的数量会定期减少。
- Big emitters must buy certificates at auction.
- 主要排放源必须通过拍卖购买排放配额。
- Low emitters can sell their certificates at auction.
- 低排放者可以将其排放配额在拍卖会上出售。



# Political Regulations to cut CO2 emissions

## 政治法规以减少二氧化碳排放

- Present cost of certificate: roughly 70€ per ton of CO2.
- 目前碳排放证书的成本：每吨二氧化碳约70欧元。
- Expected cost range 2027 – 2035: 200€ to 300€/to CO2.
- 预计成本范围 2027–2035：200€ 至 300€/吨二氧化碳。



# Political Regulations to cut CO2 emissions 政治法规以减少二氧化碳排放

- Average sale price per ton of paper in Germany 790 €/t.
- 德国每吨纸张的平均销售价格为**790**欧元/吨。
- Average generation of CO2 per ton of paper in Germany: 0.6t/t.
- 德国每吨纸张生产过程中平均产生的二氧化碳量：**0.6**吨/吨。
- Keeping the CO2 generation lesser than number of certificates will prevent price increase.
- 保持二氧化碳排放量低于排放权证书数量，可防止价格上涨。



# Political Regulations to cut CO2 emissions 政治法规以减少二氧化碳排放

- So lot of challenges
- 面临诸多挑战
- But also some opportunities
- 但同时也存在一些机遇。



# Challenges

## 挑战

- The cost of production will increase
- 生产成本将增加
- Competition will be stronger
- 竞争将更加激烈。
- You have to transform faster than your competitor!
- 你必须比竞争对手更快地实现转型！



# Opportunities 机会

- Many small steps will lead to the green low-carbon transformation.
- 许多小步骤将共同推动绿色低碳转型。
- Let us concentrate on saving drying energy, as this is 70% of the total energy need.
- 让我们专注于节约干燥能耗，因为这占总能耗需求的70%。
- European mills have started doing the first steps.
- 欧洲的造纸厂已经开始采取初步行动。



# Opportunities

## 机会

- Reduce specific energy consumption.
- 降低单位能耗。
- Reduce requirement for energy.
- 降低能源需求。
- Substitute fossil fuels by electricity.
- 用电力替代化石燃料。



# Application Cases

- eNIR dryers for coat drying
- **eNIR** 干燥机用于涂层干燥
- eNIR dryers for profiling
- **eNIR** 干燥机用于材料表征
- eNIR dryers for impingement pre heating
- **eNIR** 冲击式预热干燥机



# Application Cases

## 应用案例

- Steam reduction with digital twins
- 蒸汽减压与数字孪生技术
- Steam reduction with improved on-line felt washing
- 蒸汽减压与改进的在线毛毡清洗
- Steam reduction with specialized bentonite for improved dewatering
- 采用专用膨润土进行蒸汽减压以提升脱水效果



# Substitute fossil fuels by electricity

## 用电力替代化石燃料

- electric enhanced near infra red eNIR dryer instead of gas fired infrared or standard NIR near infrared dryers.
- 采用电加热增强型近红外（eNIR）干燥机，替代燃气加热红外干燥机或标准近红外（NIR）干燥机。
  - eNIR dryer emits with peak wavelength of 1.45  $\mu\text{m}$ .
  - eNIR 干燥机发射的峰值波长为 1.45 微米。
  - eNIR dryer evaporate twice as much per kW as NIR or gas fired infrared emit
  - eNIR干燥机每千瓦的蒸发量是NIR或燃气红外加热器的两倍。



# Substitute fossil fuels by electricity

## 用电力替代化石燃料

- electric enhanced near infra red eNIR dryer instead of gas fired infrared for coat drying.
- 采用电加热近红外（eNIR）干燥机替代燃气红外干燥机用于涂层干燥。
  - Improved coating hold out reduces energy requirement.
  - 改进的涂层附着力降低了能源需求。
- Binder and pigment saving due to improved coating hold out.
- 由于涂层附着力提升，可节省粘合剂和颜料。



# Substitute fossil fuels by electricity

## 用电力替代化石燃料

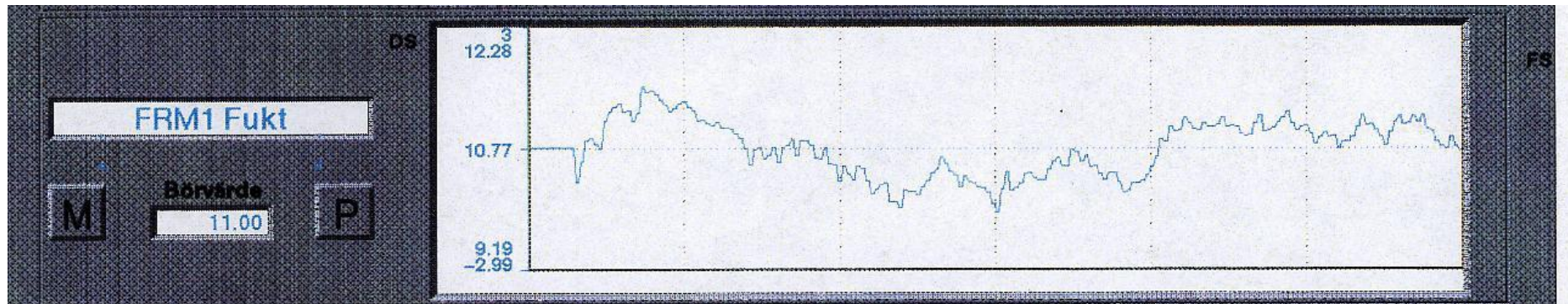
- Profiling with eNIR dryer instead of overdrying and remoistening with spray bar to reduce steam consumption.
- 使用**eNIR**干燥机进行干燥，而非通过喷水杆过度干燥后再重新加湿，以减少蒸汽消耗。
  - Speed increase between 6% and 18%.
  - 速度提升幅度介於**6%至18%**之間。
  - Reduction of specific steam consumption by 6% to 18%.
  - 蒸汽消耗量减少**6%至18%**。
  - Reduction of required steam pressure up to 8%.
  - 蒸汽压力降低幅度可达**8%**。



# Substitute fossil fuels by electricity

## 用电力替代化石燃料

- Moisture profile without remoisturing.
- 无需重新加湿的湿度分布。

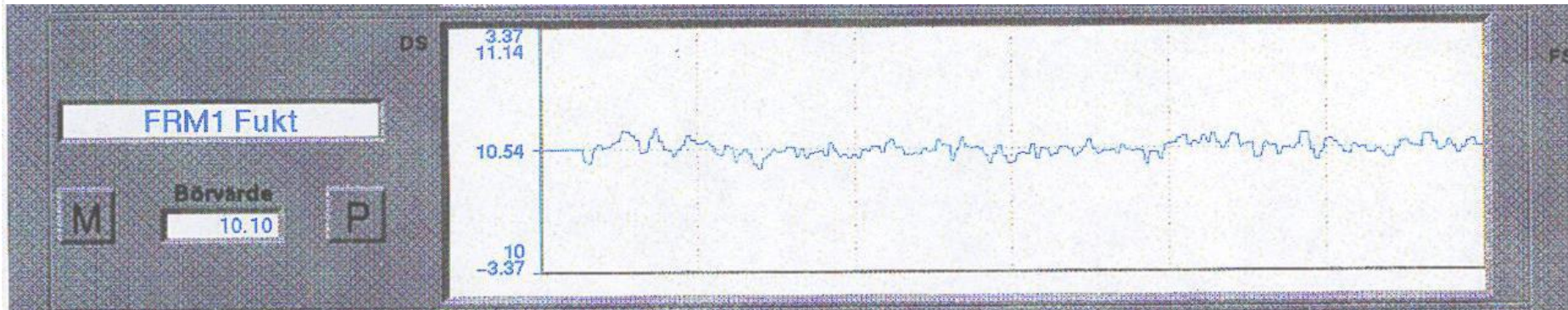


- Moisture profile without remoisturing.
- 无需重新加湿的湿度分布。



# Substitute fossil fuels by electricity 用电力替代化石燃料

- Moisture profile with profiling by eNIR.
- 水分含量分析，采用eNIR技术进行剖面分析。



- Steam pressure reduction of 5%.
- 蒸汽压力降低5%。



# Substitute fossil fuels by electricity

## 用电力替代化石燃料

- Pre heating heavy grades with eNIR between press and pre dryer to reduce steam consumption.
- 在压榨机与预干燥机之间使用eNIR对重质原料进行预加热，以减少蒸汽消耗。
  - Capacity increase 8% to 18% with same steam consumption.
  - 在蒸汽消耗量不变的情况下，产能提升8%至18%。
  - Reduction of specific steam consumption by 8% to 18%.
  - 蒸汽消耗量减少8%至18%。



# Substitute fossil fuels by electricity 用电力替代化石燃料

- Warming up to 65° C, electric consumption in this specific case: 24 kWh/t
- 加热至65° C时，本案例的电能消耗量为：24千瓦时/吨。



Paper run  
纸张供应

Reverse side emitter under first bottom drying cylinder  
反面发射器位于第一个底部干燥滚筒下方



# Substitute fossil fuels by electricity

## 用电力替代化石燃料

- Pre heating heavy grades with eNIR between press and pre dryer to reduce steam consumption.
- 在压榨机与预干燥机之间使用eNIR对重质原料进行预加热，以减少蒸汽消耗。
  - In given case, the total steam consumption is reduced by 3% and substituted by electricity.
  - 在该案例中，蒸汽总消耗量减少了3%，并被电力替代。
  - Warming up to 85C with 72 kWh/t we substituted 7.8% of the steam.
  - 将温度升至85°C，每吨消耗72千瓦时，我们替代了7.8%的蒸汽。
  - We achieved evaporation rates up to 840g water per kWh through improved energy transfer between cylinder and paper.
  - 通过优化气缸与纸张之间的能量传递，我们实现了最高达840克水每千瓦时的蒸发率。



# Reduce requirement for energy

## 降低能源需求

- Optimizing the drying by using a very special digital twin reduces the steam consumption by up to 8%.
- 通过使用一种非常特殊的数字孪生技术优化干燥过程，可将蒸汽消耗量减少多达8%。
- Smurfit WestRock Townsend Hook published end of 2022 that the total CO2 footprint of their paper mill was reduced by 5% through steam reduction of 8%
- 斯穆菲特·韦斯特洛克·汤森德·霍克于2022年底宣布，通过减少8%的蒸汽消耗量，其造纸厂的总占地面积减少了5%。



## Reduce requirement for energy 降低能源需求

- With optimum online felt washing we achieved with our customers an increase of dry content after press by 0.5% to 1%.
- 通过采用最优的在线毛毡清洗工艺，我们与客户合作实现了压榨后干含量提升0.5%至1%的显著效果。
- This reduces the required steam consumption by 1% to 3%.
- 这将使所需的蒸汽消耗量减少1%至3%。



## Reduce requirement for energy 降低能源需求

- With optimum sticky scavenging using specialty bentonite we clarified circuit water.
- 通过使用特种膨润土进行最佳粘性清除，我们成功净化了循环水。
- Through improved dewatering on containerboard machines we achieved increased dry content after press by 0.5% to 1%.
- 通过改进瓦楞纸板机的脱水工艺，我们实现了压榨后干含量提升0.5%至1%。
- This reduces the required steam consumption by 1% to 3%.
- 这将使所需的蒸汽消耗量减少1%至3%。



# Reduce requirement for energy

## 降低能源需求

- Pre heating and profiling with eNIR emitters reduces the steam requirement between 8% and 15%.
- 使用eNIR发射器进行预热和温度控制可将蒸汽需求量降低8%至15%。
- Improved drying algorithm reduce steam requirement by another 3% to 8%.
- 改进的干燥算法可将蒸汽需求量再降低3%至8%。
- Optimized felt washing and sticky scavenging by special bentonite increase dry content after press by 1% to 2% - reducing steam requirement by 3% to 6%.
- 通过使用特殊膨润土优化毛毡清洗和粘性物质清除过程，可使压榨后干含1%至2%，从而减少蒸汽需求量3%至6%。



## Reduce requirement for energy 降低能源需求

- Required steam pressure drops by 14% to 32% - allowing the use of very energy efficient heat pumps with high COP.
- 所需蒸汽压力降低**14%至32%**——这使得能够使用具有高能效比（**COP**）的节能型热泵。
- For coated paper and board additional savings of fossile fuels are feasible.
- 对于涂布纸和纸板，进一步节约化石燃料是可行的。



# Reduce requirement for energy

## 降低能源需求

- Coating colours with ultra high application solids (72+%)
- 涂层颜色，具有超高的固体含量（72%以上）
  - Reduces the requirement for infrared drying
  - 减少对红外线干燥的需求
- Strongly reduces the most expensive energy.
- 显著降低最昂贵的能源消耗。



# Reduce requirement for energy

## 降低能源需求

- Produce barrier paper for food wrap
- 生产食品包装用阻隔纸
  - Substitutes plastic food packaging
  - 替代塑料食品包装
- Produces thus less CO2 than manufacturing plastic packaging.
- 因此，其产生的二氧化碳比制造塑料包装少。



# Low Carbon Transition

## 降低能源需求

- Many small steps are feasible today and are done today
- 今天可以采取许多小步骤，而且这些步骤今天就可以实施。
- All together many small steps lead to the total decarbonisation of the paper production.
- 所有这些小步骤的积累最终将实现造纸生产的完全脱碳。
- In the future even at same manufacturing cost.
- 未来即使在相同的制造成本下。



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