

Improving Mechanical Pulping Business Potential by Operating Single Layer Grinding Surfaces on Electricity Market

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Outline

- Motivation
- Industrial demand response
- New grinding technology as an enabler
- Economy of demand response
- Conclusions

Motivation

- Climate change and limited fossil resources
 - Energy systems are increasingly penetrated by carbon free renewable energy sources (RES)
 - Weather dependent RES generation is heavily intermittent and does not correspond to power consumption
 - In the new price situation, controllable thermal power generation needed to balance the grid is economically unprofitable, especially cyclic operation of thermal plants
 - As a new solution, electricity storages and demand response provide time shift of power consumption



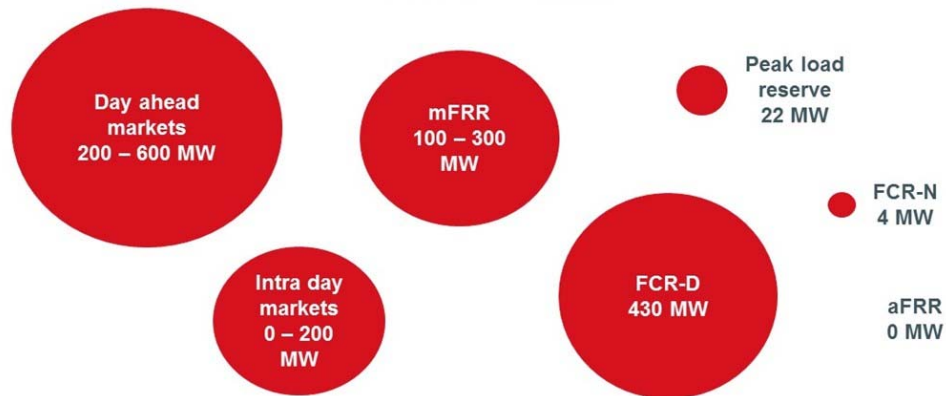
Industrial demand response

- From the viewpoint of power system balance, demand response can substitute investments in expensive new peak load capacity (peak shaving by shifting consumption)
- Prerequisites for substantial demand response
 - High power intensity
 - Higher production capacity than average need
 - Natural apparent (electrical) energy storages



Industrial demand response

DSR participation in Finland status 18.1.2018



Source: Fingrid.fi



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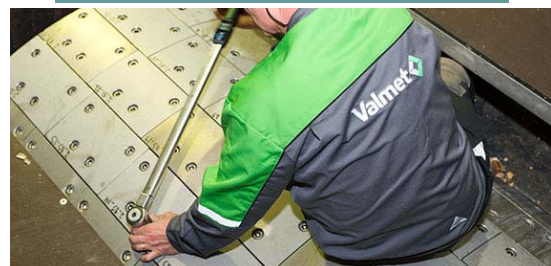
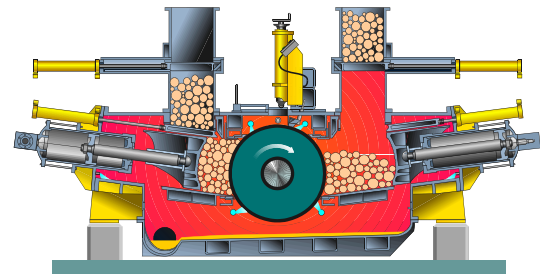
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New grinding surfaces as an enabler

- New energy efficient single layer grinding surface technology

- Grinding product "Galileo technology"
- Energy savings in the range of 150 - 500 kWh/ton when the energy consumption with a conventional grinding surfaces is 1300-1500 kWh/ton
- Production increase of the grinders, which typically is 30% without additional investments



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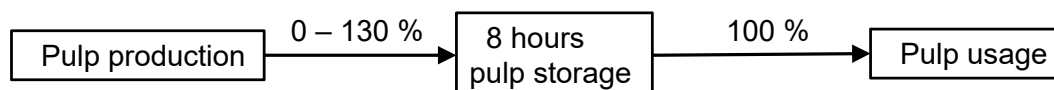
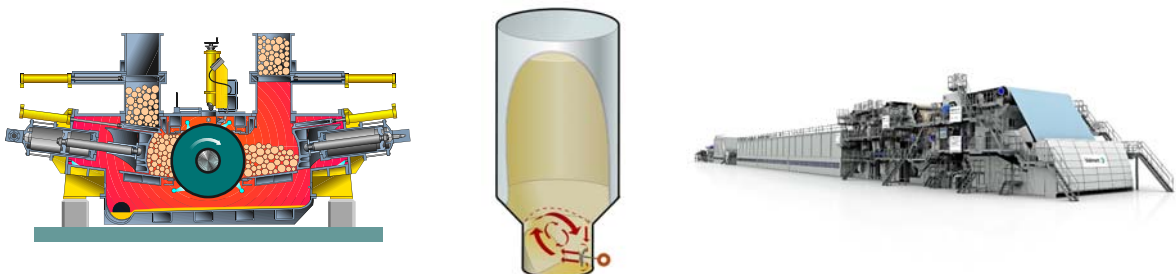
Pulp tower as an apparent electricity energy storage

- Normally there is storage capacity for 8 hours production in grinding lines
- Pulp can be stored 8 hours without quality decrease

The new production capacity can be utilized as demand response without jeopardizing continuous paper or board production



Single layer groundwood line



Investment incentives for demand response

- Profitability is needed to realize market-based demand response
- Investment profitability consists of two stages
 - 1) Investment incentives for upgrading the pulping line to achieve the original pulping capacity with 30% reduced machine capacity and power consumption
 - 2) Investment incentives for upgrading the rest of the pulping line to achieve 30% surplus capacity production for demand response purposes



1) Investment needed for the original pulping capacity

- The investment cost is mill dependent and typical payback time requirement is one year
- By assuming the total energy cost to be 40 EUR/MWh and taken into account 23% mean energy savings, the investment cost is roughly 80 kEUR/MW
- The original pulp capacity is achieved by upgrading 77% of the pulping line
- Payback time is OK for pulping industry



2) Investment for demand response capacity

- By upgrading the rest 23% of the line, full demand response capacity for the extended line is achieved with 23% of the initial investment cost, i.e. 19 kEUR/MW
- This investment cost is low compared to peak production capacity, e.g. 910 kUS\$/MW for gas turbine
- The comparison is valid for 5.5 operation hours per day

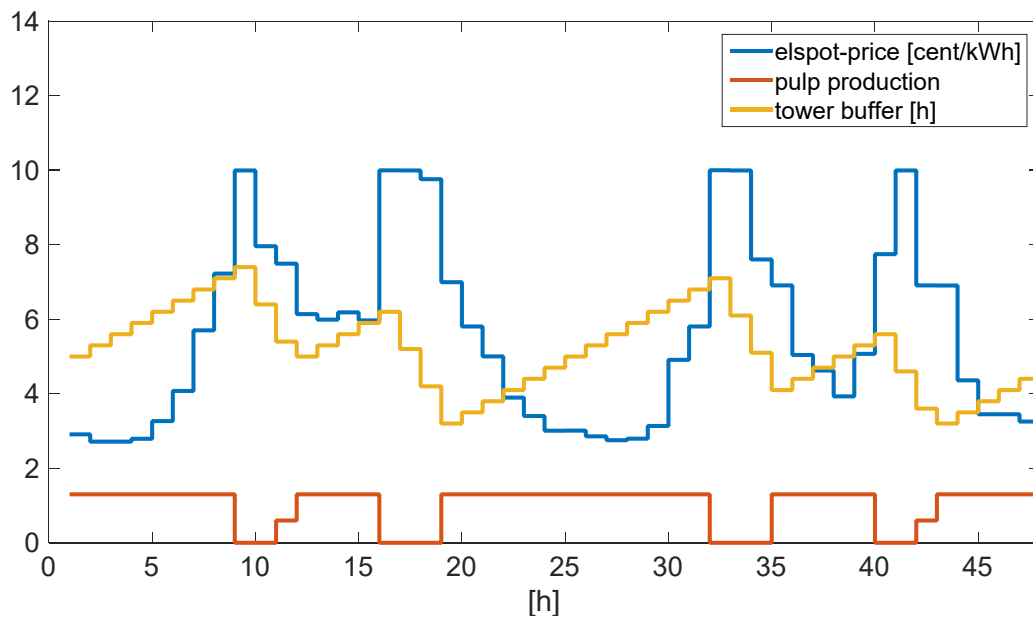


What are the savings on the Day-Ahead market (Elspot)?

- Optimal time scheduling of energy use against Elspot energy prices in Finland 2016
- Economic Linear Programming optimization of energy usage under constraints
 - continuous pulp usage, 100%
 - grinding load capacity, 0-130%
 - pulp tower size (max 8 h, min 2 h and every day initial capacity 5 h buffer)



Two days optimization result example 7.-8.1.2016



What are the savings on the Day-Ahead market (Elspot)?

- The daily energy cost savings varies from near zero to over 19% (example), being 8.9% for the entire year
- These savings are directed to the already reduced energy consumption of the new grinding surface, and only to the energy cost but not to the transmission fees or taxes, and are roughly 2.7% savings of initial annual energy costs



What are the savings on the Day-Ahead market (Elspot)?

- When taking into account the lower investment cost, the payback time of the demand response investment is slightly under 2 years
- Not currently OK for pulping industry but a starting economic boom gives possibilities
- What changes when heavily intermittent power generation grows from 3.6% to 19% of power consumption?



Day-Ahead market in Germany (EPEXSPOT)

- The energy cost savings are 9.1% for the entire year 2016
- The payback time of the demand response investment is roughly 1.9 years
 - There were not so high price peaks in Germany but sometimes high negative prices
 - Different situation in Finland where similar transmission lines and integrated markets does not exist

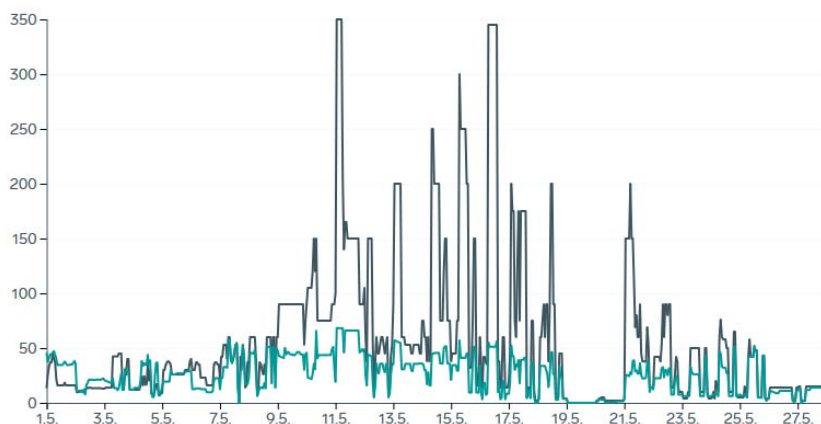


Further work

- The fast loading response and the natural start-stop operation of the grinder enables operation on more valuable electricity markets
- Optimization of demand response utilization on the Intraday and Balancing Power markets provides more profitable operation and significant stabilization possibilities for power systems



Further work

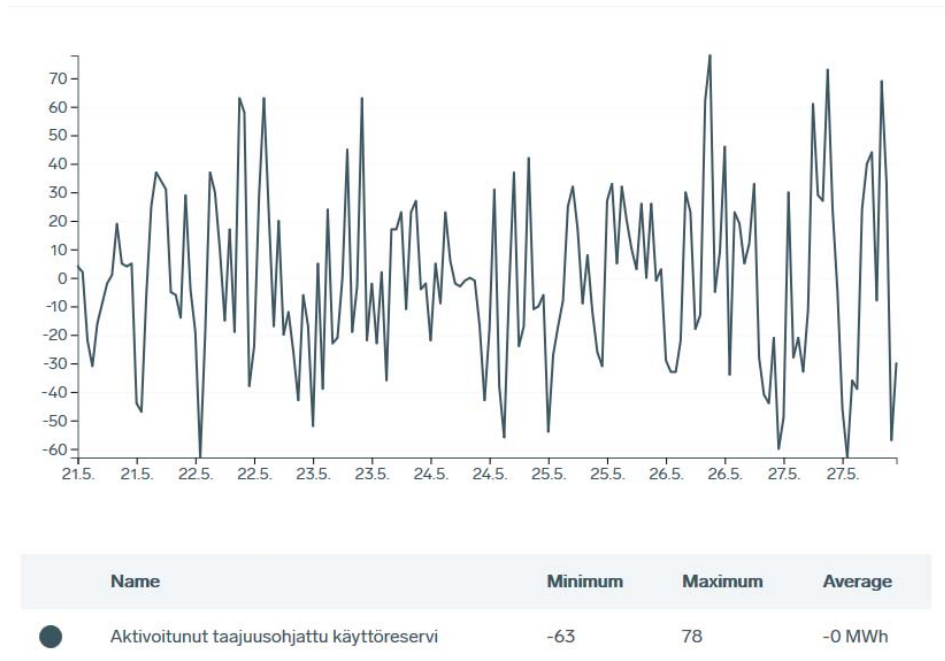


Kuvaaja	Minimi	Maksimi	Keskiarvo
● Taajuusohjatun käyttöreservin hinta tuntimarkkinoilla	0	350.00	55.17 €/MW
● Taajuusohjatun käyttöreservin määrä tuntimarkkinoilla	0	68	25 MW

Source: Fingrid.fi



Further work



Source: Fingrid.fi



Conclusion

- The relatively short payback times for additional investments in demand response are though not attractive for the industry now
- The fast loading response and the natural start-stop operation of the grinder enables operation on more valuable electricity markets that enhance the possibilities of introducing 310 MW of climate neutral and resource efficient demand response to the Finnish electrical energy system

