Technology provider and energy system change - Innovation and business opportunities

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220 years of industrial history in 2017
From cloth making to high-tech processes

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tr>
<td>1797</td>
<td>Tampereen Verkatehdas</td>
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<td>1841</td>
<td>Götaverken Raahe</td>
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<td>1856</td>
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<td>1858</td>
<td>Beloit</td>
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<td>1860</td>
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<td>1868</td>
<td>Sunds Defibrator</td>
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<tr>
<td>1942</td>
<td>1951 Valmet</td>
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<tr>
<td>1999</td>
<td>Metso created through merger of Valmet and Rauma</td>
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<td>2013</td>
<td>End of 2013 Demerger to Valmet and Metso</td>
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<tr>
<td>2015</td>
<td>2015 Metso Process Automation Systems to Valmet</td>
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Key figures in 2016

Orders received
EUR 3,139 million

Net sales
EUR 2,926 million

Comparable EBITA
EUR 196 million

Comparable EBITA margin
6.7%

Employees (on Dec 31, 2016)
12,012

Net sales by business line
- Services: 22%
- Automation: 40%
- Pulp and Energy: 28%
- Paper: 10%

Net sales by area
- North America: 12%
- South America: 22%
- EMEA: 22%
- China: 7%
- Asia-Pacific: 47%

Stable business = Services and Automation business lines
Capital business = Pulp and Energy, and Paper business lines
Customer needs drive our innovation process
Megatrends – impacting our business environment

Resource efficient and clean world
- Climate change, environmental awareness and resource scarcity drive the need to improve resource efficiency and lower emissions

Digitalization and new technologies
- Digitalization, automatization and new high impact technologies drive efficiency and new business models

Aware, urban and global customer
- Urbanization, increasing living standards, changing demographics, and globalization drive changes in consumer behavior
Market drivers

**Economic growth**
→ increased electricity demand

**Affordability**

**Aging power plants**

**Sustainability**
• Stable policies, incentives and regulations needed

**Security of supply**
• Increased focus

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**More capacity**
- Greenfield
- Repowering and rebuilds

**Biomass** has an important role in fulfilling renewables targets; CHP share will increase.
Increased demand for air pollution control

**EU:**
In 2030 ≥ 27% renewable energy
- Japan: In 2030 ≥ 20% renewable energy
- Indonesia: In 2025 ≥ 15%
- Philippines: In 2030, 50% of primary energy from renewables

**EU:**
- 53% of energy imported
  - almost 90% of crude oil
  - 66% of natural gas
  - 42% of solid fuel
  - 40% of nuclear fuel energy

In the EU, 45% of power generation capacity is more than 30 years old

Demand will increase by more than 2/3 in 2011-2035, an average annual rate of 2.2%
70% in non-OECD countries

In the USA, 50% of power generation capacity is more than 30 years old

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Demand will increase by more than 2/3 in 2011-2035, an average annual rate of 2.2%
Fuel prices – volatility in oil and gas prices

**Crude oil**

**Natural gas**

**Thermal coal**

**Biomass**
- Wood pellets
- Wood chips
- Wood waste
- Peat
- Recycled wood
Fuel technical challenges

Market interest

Technical challenge

Fossil
- Hard coal
- Lignite
- Petroleum coke

Wood biomass
- Northern wood
- Pulp & Paper sludges
- Wood pellets

Fast growing wood
- Willow
- Eucalyptus

Agro biomass
- Straw
- Sunflower hulls
- Corn Stover
- Miscanthus

Recycled fuels
- MSW
- Recycled wood

Fuel Cl- content
- 0.01%
- 0.05%
- 0.1%
- 1.0%
Balancing in between different kind of fuels

- Fuel prices are changing
- Renewable targets may have affect to feasibility => incentives
- Fuel availability
- Local fuels
- By selecting several design fuels the future risk is less

**Sustainability**: CO\textsubscript{2} neutral or low-carbon fuels
**Affordability**: low price or negative price (gate fee) fuels
**Security**: easy available and easy to storage fuels
Customer needs drive Valmet’s R&D work

- Increase production efficiency
- Provide high-value end products and new revenue streams
- Improve safety
- Reduce emissions, energy and water consumption
- Reduce investment and operational costs
- Maximize value of raw materials
- Improve usability
Our R&D focus areas

• Ensure advanced and competitive technologies and services:
  – We develop cost competitive, leading process and automation technologies and services

• Enhance raw material, water and energy efficiency:
  – We combine process technology, automation and services to reduce raw material, water and energy consumption in customers’ production processes

• Promote renewable materials:
  – We develop solutions to replace fossil materials with renewable ones and to produce new high-value end products
Cooperation with our customers and partners

How to build successful R&D and innovation partnerships

- Mutual business potential, win-win
- Complementing value chains and access to new competences
- Agreement on targets, IPR, and sharing of costs, risks and rewards
- Trust and open information sharing
- Pilot facilities to mitigate risks and speed up time-to-market
- Public funding
Selected process innovations and customer references
Valmet biomass solutions

Products for biomass combustion and conversion

HYBEX BFB

CYMIC CFB

CFB Gasifier

BioPower

Bio oil

Black pellets

Valmet DNA DCS
High temperature corrosion
FuelDiet™ - CorroStop + on-line KCl measurement

Report

Control
Monitor
Predict

Corrosion risk index
CorroStop+

Wall thickness (mm)
Nominal original wall thickness
The minimum allowed wall thickness, $S_{\text{min}}$

Year 1
Year 2
Year 3
Year 4
Year 5

23 Feb 02 Mar 09 Mar 16 Mar 23 Mar 30 Mar 06 Apr 13 Apr 20 Apr
Multifuel case 1: CYMIC CFB for SAPPI

- Project driver: 1) replacing old coal fired capacity
  2) produces process steam to the mill
- Will turn gradually from 100% coal to 100% biomass
- Multifuel case: 5 design fuels
- This 30 MW$_e$ CFB was delivered in 18 months from contract to commercial operation
Multifuel case 2: CYMIC CFB for Hamburger

- Project driver: 1) to burn mill own rejects and fulfilling EU waste co-firing emission limits
  2) produces process steam to the mill

- Multifuel case: 5 design fuels

- Mill own fuels contain remarkable amount of chlorine – in normal operation point Cl content of fuel mixture is 0.3 %

- Technical challenge is to mitigate high temperature corrosion
Long-term R&D co-operation with partners produces results – pyrolysis as an example

1980’s
The first laboratory studies by VTT

1990’s
The first laboratory studies by VTT

2007
Technology development consortium - Valmet, UPM and VTT
The first cold model tests at Valmet’s R&D Center in Tampere

2009
Fortum joins the development consortium
Oil production at Valmet’s R&D Center

2010
Combustion tests
Planning for a commercial-scale demonstration plant

2012
Contract of Joensuu bio-oil plant with Fortum

2013
Commissioning of Fortum’s Joensuu plant

2015
Test runs in Joensuu
R&D projects on pyrolysis oil upgrading

2017
Oil production at Valmet’s R&D Center
Key technology to Äänekoski bioproduct mill

• New bioproduct mill with 1.3 million tons pulp production
  – Production at the new mill started in August 2017
  – EUR 1.2 billion investment is the largest investment of the forest industry in Finland

• Valmet delivered key technology
  – Recovery boiler, pulp drying line, gasification plant, lime kiln, sulfuric acid plant and a mill wide Valmet DNA automation system and machine and drive controls for pulp drying
  – Recovery boiler, pulp drying line and lime kiln are the largest in Europe

• All equipment latest technology and highly energy-efficient
  – Lime kiln fuelled by biogas from gasification plant, pulp mill being totally fossil fuel-free
  – High power features in recovery boiler, thus mill being able to sell more bioelectricity to the market compared to own consumption
  – Sulfuric acid plant represents Valmet's latest innovations of new technology, producing sulfuric acid from odorous gases, enabling the bioproduct mill to be nearly self-sufficient in sulfuric acid

Photo: Metsä Group
Valmet Industrial Internet

Dialogue with data
Valmet has a long history in the digitalization of process industries

1960
The Airmatic
a pneumatic measurement and control system

1970
Elmatic-100 system, electronic instrumentation

1980’s
Damatic, the first Distributed Control System (DCS)
Sensodec Condition Monitoring System
Dematic XD, modular second generation DCS

1990’s
PaperIQ, QCS
metsoDNA, Dynamic Network of Applications

2000’s
Multivariable Model Predictive Controls (MPC)
24/7 ProCenter for DCS/QCS
PaperIQ Select

2010’s
Metso PQV web inspection system

2015
Valmet DNA

2015
Valmet IQ

2017
Augmented and virtual reality applications

Advantages to customer industries:

- Distributing controls & gathering performance data
- Embedded intelligence & advanced information
- Increasing availability
- Increasing productivity through information services
- Benchmarking and best practice sharing capability
Today, customers are extensively utilizing our Industrial Internet capabilities

- **780** Valmet-supplied lines with Valmet DCS
- **400** Condition Monitoring (CM) references with over 70,000 I/O tags
- **350** Advanced process control installations
- **520** Online connections with customers
- **90** Performance agreements with remote connections
- **Ongoing** Co-creation of advanced analytics with customers
We want to become the most desired Industrial Internet partner for our customers

Valmet develops its Industrial Internet solutions building on the unique combination of process technology, services and automation.

Customer’s process  Valmet’s competence network  Valmet experts

Process technology  Industrial Internet solutions  Services  Automation
Customer benefits

Improve performance and planning efficiency with combined offering

- More production in pulp process, debottlenecking
- Stabilization in process
  - Short term Control loop performance/Advanced Process Controls
  - Mid/long term Advanced Planning
- Improved planning ability for pulp line to account for disturbances or changes
- Simplification of complex interactions in pulp and paper processes
- Process know-how
- Analyzers and measurements provide crucial process information
- Control loop performance ensures well performing foundation

Production increase

* Based on full scope implementation

- 1-5%

Chemical reduction

5-15%

Energy reduction

2-7%

Savings potentials

2-5 M€/a

Energy reduction

2-7%

Savings potentials

2-5 M€/a

Production increase

* Based on full scope implementation
Valmet Industrial Internet – a meaningful dialogue with data

Building blocks

- Applications and services
- Automation and IT platform
- Ecosystem
- Process technology
Valmet Industrial Internet offering
Applications and services

Data visualization, reporting and guidance
- Equipment and process performance reporting
- Fleet performance reporting
- Visualization and guidance with augmented and virtual reality

Asset reliability optimization
- Process component tracking and monitoring
- Predictive and prescriptive diagnostics
- Overall equipment efficiency optimization

Operations performance optimization
- Real time analytics to improve quality and reduce variable cost
- Advanced Process Control (APC) and mill or plant- wide optimization
- Fleet performance optimization

Valmet Performance Center
- On-demand expert support
- Remote analytics, monitoring and optimization
- Data discovery and analysis
Valmet Performance Center
The channel for data-driven performance improvement

- Secured data connection between the mill and Valmet Performance Center
  - Pulp (Sundsvall)
  - Paper and board (Jyväskylä)
  - Energy (Tampere)
  - Tissue (Karlstad)
- Continuous remote monitoring, controls fine tuning and optimization.
- On-demand expert remote support
  - Ticket system for support request
  - Direct link from Valmet Customer Portal
- Data discovery process for defining root causes for process variations
- The channel for data-driven reliability and performance services
Data discovery process is suitable for defining root causes for frequent process variations (capacities, consumptions, quality, runnability, life time, etc.) as a part of performance agreement.

- **Data collection and profiling**
  - Data is collected from different sources and integrated to Valmet data discovery platform and cleaned: Data from DCS, MCS, QCS, CMS, laboratory data, WIS data, ERP and MES data, maintenance data, consumable usage data

- **Dialogue with data by Valmet experts**
  - Valmet experts will review the data, create first hypothesis of root cause and define priority for further analysis.

- **Workshop by Valmet and Customer’s experts**
  - Valmet experts and customer expert work together with data scientist to analyze root causes for given challenges
  - Outcome of the workshop is joint implementation plan
  - Workshop is organized virtually in Collaboration room

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**Data discovery process**

- **Customer challenge(s)**
- **Data profiling**
- **Preparation meeting**
- **Discovery workshop**
- **Execution of results**
Coming: Valmet Customer Portal
Will take digital customer collaboration into a new level

Production panel collects all KPI dashboards and Industrial Internet applications in one view

Need help?
Our experts are always close to you. You can also search for a solution.

Contact our Valmet Performance Center
Average response time 5 min

+345 345 678 9

You can also send us a message, or use

Video    Chat    Email

Call, chat or place ticket for on-demand support in Valmet Performance Center.
Augmented reality

HoloLens applications open a new era of remote support

- Mixed Reality vision as you walk in the mill
  - Measurements and Valmet DNA tools available virtually

- Real time remote support
  - Video call to local Control room in the mill
  - Video call to remote Valmet Performance Center (secure connection)

- HoloLens can be integrated to the existing mill automation infrastructure

- Contact control room locally or Valmet expert in performance center
Valmet-driven Solution Ecosystem
Working together with partners and customers for value adding solutions

- A digital ecosystem is an independent group of actors sharing standardized digital platforms for mutual benefits.
- In addition to participating in digital ecosystem(s) Valmet is building a solution ecosystem with leading industry players.
- Our aim is to orchestrate co-creation of new solutions through the open ecosystem of partners and customers.

"Industrial Internet for Paper Machines", Tekes project for 2017-2020, targets for tight partner networks of Valmet and SME’s and research centers.
Energy optimization with remote support for paper and board machine
Energy optimization with remote support for paper and board machine

- **Service description**
  - Process optimization both remotely and on-site to save energy
  - An operator application integrated to the machine control system
  - Energy usage shown in real time and compared to best achieved performance
  - Grade-specific energy consumption and history reports
  - Continuous monitoring and reporting by Valmet Performance Center experts

- **Benefits**
  - Increased awareness and understanding of energy used in the process
  - Improvement opportunities can be identified
  - Energy savings in electricity and steam
  - Significant cost savings
Energy optimization with remote support
Results for a containerboard customer (name confidential)

Corrugating Medium 105 g/m²

Electricity Consumption [kWh/t]
Steam Consumption [t/t]

Oct 2014              Feb 2015
Oct 2014               Feb 2015

Electricity consumption reduction from 235 kWh/t to 200 kWh/t
Steam consumption reduction from 1.55 t/t to 1.3 t/t

Results

15% energy savings in electricity
16% energy savings in steam
3M€/a value

Key facts of the containerboard machine
• Grade: recycled fluting
• Basis weight 90–150 g/m²
• Design speed 1,200 m/min
• Trim width 6,660 mm
• Start-up 2014
Energy optimization with remote support
How it was done for a containerboard customer (name confidential)

Customer need

• To secure the energy efficiency of their board machine

1 Data collection and remote data analysis

• Valmet’s experts reviewed the steam & condensate and air systems on site
• Remote data analysis was conducted based on end product grammage, production and steam consumption data

2 Findings and recommendations

• The most optimal running point for highest production with lowest energy consumption was identified and reviewed with the customer
• To reduce electricity and steam consumption, Valmet’s experts recommended balancing of former section dewatering and retuning of control loops

3 Measures

• Valmet’s experts tuned the process both remotely and on-site:
  – Machine direction moisture control
  – Steam pressure and pressure difference control loops
  – Former vacuum controls
Boiler inspection management system
Boiler inspection management system
Service description and benefits

- **Service description**
  - A part of systematic approach for evaluating the thickness of boiler tubes
  - Visual overview on tube thickness for easy reading and understanding
  - Evaluation by Valmet experts
  - Yearly reports follow and predict tube thickness five years ahead

- **Benefits**
  - Comprehensive condition report with conclusions by Valmet experts
  - Possibility to proactive actions and control over maintenance costs
  - Increased ability to predict lifetime of tubes and decrease risk for unplanned tube leaks
  - Increased boiler availability and reliability and improved condition management
Boiler inspection management system

General impact of availability for a CFB boiler

Cost savings are created through
- Availability and risk management based on all relevant data
- A systematic approach to evaluating boiler tubes' thickness

Results
One tube leakage results in 1.5% availability decrease.

Avoiding unplanned shutdown for corrective maintenance due to tube leakages saves operating costs in the same.
- Quality losses
- Customer satisfaction
- Higher energy cost

Knowledge about individual tube’s wall thickness allows predicting its lifetime and proactive maintenance actions.
# Boiler inspection management system

## How it was done for Sappi Kirkniemi CFB boiler

<table>
<thead>
<tr>
<th>Customer need</th>
<th>1 Data collection</th>
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<tbody>
<tr>
<td>• To ensure availability by minimizing risk of unplanned tube leaks in the power boiler at the paper mill</td>
<td>• Valmet experts set up data management platform with equipment hierarchies and collection of base history data</td>
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<tr>
<td></td>
<td>• Inspections data and boiler wall thickness data collected into the analysis platform</td>
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<tr>
<th>2 Analysis &amp; findings</th>
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<tr>
<td>• Analyzing inspections history and operational data for condition and risk assessment, lifetime estimation, and inspections and repair planning by Valmet experts</td>
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<th>3 Data modeling, visualization</th>
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<tr>
<td>• Data integration in Valmet cloud with advanced VR or 3D visualization, content tailored to each user group.</td>
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<th>4 Measures</th>
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<td>• Result are used to optimize boiler pressure component maintenance to ensure correct actions at the correct time</td>
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<th>5 Sustaining performance</th>
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<tr>
<td>• Providing annual analysis reports and evaluation of boiler condition and risks management</td>
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© Valmet   |   Industrial Internet
Continuous dialogue with data – way forward
Valmet Industrial Internet roadmap
Way forward through co-creation with customers

- Integrated customer portal and mobility
- Growing fleet of intelligent machines and more diagnostics embedded into processes
- Valmet Performance Center as a platform for digital services and big data analytics
- New contributing technologies
  - Mixed reality through Microsoft HoloLens
  - Location detection technologies
- Data driven applications and services through advanced analytics, machine learning and AI.
  - For reliability and performance improvement
- Advanced process controls for all process areas and mill wide optimization
- Vertical and horizontal integration through strong ecosystem of partners