Investor & analyst site visit

Leoben R&D Facility

Veitsch Plant

28 November 2018

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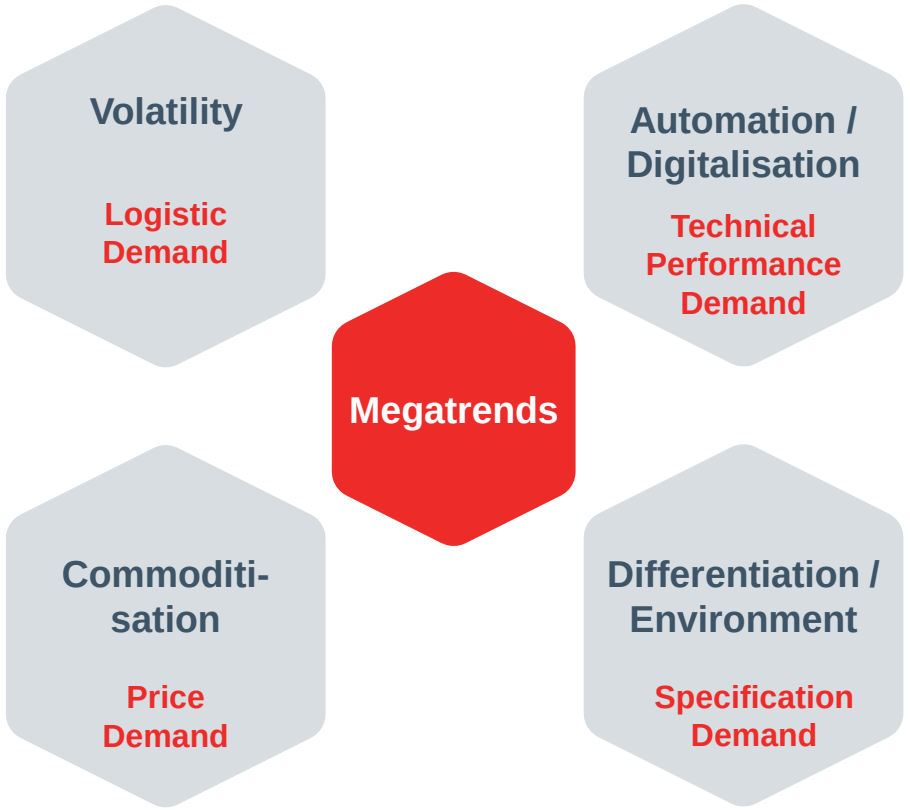
Today's agenda

09:00	Welcome – Stefan Borgas
09:05 – 09:15	Global trends in the refractory market – Reinhold Steiner
09:15 – 10:00	R&D presentation & Q&A – Stefan Schriebl
10:00 – 11:30	Tour of R&D facility – Christian Majcenovic, Stefan Schriebl
11:30 – 12:00	Prettachfeld tour Part 1: Simulation & water models – Gernot Hackl Part 2: Training centre & big data visualisation – Thomas Reiterer
12:00 – 13:00	Transfer to Veitsch Plant
13:00 – 13:30	Welcome, safety briefing & lunch
13:30 – 15:30	Veitsch Plant tour – Thomas Harm
15:30 – 17:10	Transfer by bus to Vienna Airport
18:25	BA flight departs to London

Overview

Reinhold Steiner –
Chief Sales Officer

Global trends in the refractory market



Serving all blue chip clients in every industry

RHI MAGNESITA

Steel			Cement	Glass	Metals
ArcelorMittal	NUCOR	TATA STEEL	LafargeHolcim	SCHOTT	VALE
GERDAU	OUTOKUMPU	BAOSTEEL	Votorantim	ArdaghGlass	bhpbilliton
NIPPON STEEL & SUMITOMO METAL	posco	ThyssenKrupp	HEIDELBERGCEMENT	Vitro	GLENCORE
NLMK	Severstal	AK Steel	CEMEX	rigolleau	RioTinto
Serving 1,060 of 1,250 plants[1]			Serving 1,376 of 1,537plants[1]	Serving 800 of 900 plants[1]	Serving 650 of 2,000 plants[1]

[1]ex-China

R&D and Leoben Technology Centre

Stefan Schriebl –
Head of R&D Europe

Top solution provider in the industry, investing in innovative technologies and digitalisation

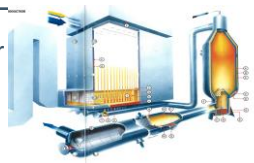
RHI MAGNESITA

1. **Continue investing in R&D** to create products, which have a distinct competitive advantage by costs or by product performance and defend current margin level sustainably

2. **Explore digitalisation & automation** across the value chain to create additional value for our customers and achieve cost reduction and gain additional margin to our company

3. Develop into a **system & solutions supplier** based on R&D, partnerships and selective acquisitions and **gain 50-100 basis points in margin**

Refractories are continuously consumed during finished goods production

Key industries	Applications	Replacement	% of clients' costs
Steel	Basic oxygen-, electric arc furnace casting ladles 	20 minutes to 2 months	~3.0%
Cement/Lime	Rotary Kiln 	Annually	~0.5%
Nonferrous metals	Copper-converter 	1 – 10 years	~0.2%
Glass	Glass furnace 	Up to 10 years	~1.0%
Energy/ Environmental/ Chemicals	Secondary reformer 	5 – 10 years	~1.5%

Refractory characteristics

Consumable product

Systems and solutions for complete refractory management

Demand correlated to output

Investment goods

Longer replacement cycles

Customized solutions based on the specific requirements of various industrial production processes

Complete lining concepts including refractory engineering

Wide areas of application

Mostly project driven demand cycles

Ongoing demand for repairs

A complex range of tailored refractory products are required for each application

Bricks

1 Permanent lining

2 Non-basic, ex. Alumina

3 Basic, ex. Mag-Carbon

Monolithics and pre casts

4 Mixes

5 Pre Castables

Functional products

6 Slide Gates

7 Nozzles

8 Purge Plugs

9 ISO

+Systems and machinery

Example of refractory application for steel ladle

The industry's largest dedicated research team, pushing the boundaries of what is possible

We drive innovation in every aspect of our business, from materials, robotics and Big Data, to bespoke new business models and efficient new processes, under extreme conditions.

Refractories

- Development and optimisation of refractory products and manufacturing processes
- Market driven project portfolio
- Plant technical support and quality control

Mineral

- Increase ore recovery, maximize mine useful life and minimize environmental impacts
- Development of high quality, low cost raw material sources

Fundamental research

- Fundamental research ensuring technology leadership
- Strong focus on innovation

Artificial Intelligence, Big Data & digitalisation

- Data analysis to foster a greater understanding of the correlation between steel production parameters, maintenance and refractory

Recycling as an opportunity

- Green technology applied to reprocessing, sorting and reusing recycled raw materials

Global research team of 270+ employees, of which 98 have masters and PHDs, working out of 2 corporate R&D centres and 5 local units

Investing €37m p.a. into technology-based solutions and ~€35m p.a. into customer production development

Hybrid approach: Large R&D Centres in close collaboration with local R&D Units

Proximity to customers enabling day-to-day support and corporate R&D for more complex / medium term programmes

Corporate R&D Centres
(Leoben, Contagem)

- Critical mass to tackle complex, multidsciplinary problems
- Technology Development R&D
- Strong supporting functions
- Incremental NPD & process improvements
- Good venue for customer meetings
- More career development opportunities within R&D

Local R&D Units
(York, Dalian, Hünenberg, Bhiwadi, Visakhapatnam)

- Providing strong local support to manufacturing, purchasing, sales and product management
- Faciliating the industrialisation of new products / processes
- Adaptating new products for emerging markets
- Facilitiating interaction with local customers

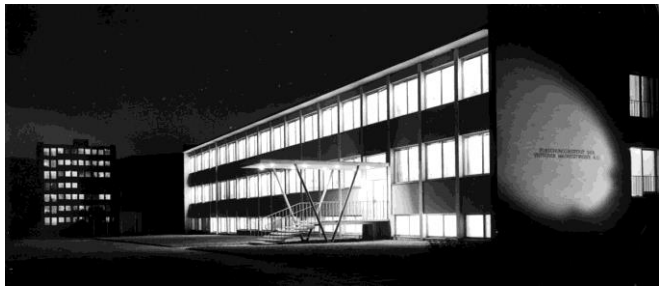
Global Technology Leadership

R&D activities are concentrated mainly in Europe at the Leoben Technology Centre

- The focus of a global, internal technology network
- Highly motivated, competent and creative team of refractory experts
- >170 international experts in Leoben
- Product innovation & development
- Maintaining close contact with international research institutes, universities & key customers

History of the Technology Centre and R&D

~60 year history



1959
Research Institute Veitscher-Magnesitwerke AG (VMAG)

2017
RHI Magnesita, Technology Center Leoben

1959

Research Institute Veitscher-Magnesitwerke AG (VMAG) founded

1993

Merger of VMAG with Radex Austria to form Veitsch-Radex AG; fusion of all research activities in Leoben

1999

Merging of the research centres of Didier-Werke AG and Veitsch-Radex AG in Leoben

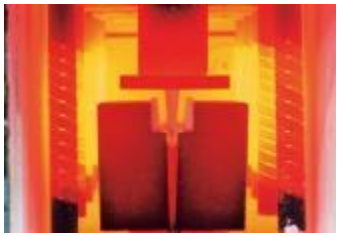
2001

RHI AG, Technology Centre Leoben

2017

RHI Magnesita, Technology Centre Leoben

R&D Europe after merger of RHI AG and Magnesita



Cooperations, partnerships & networks

Universities and external research capabilities

Austria: University of Leoben, TU Graz and University of Graz, TU Vienna and University of Vienna, Johannes Kepler University Linz, FH Wels
Brasil: Universidade Federal de Sao Carlos, Universidade Federal de Minas Gerais
France: University of Limoges, University of Orléans
Germany: DIFK (Deutsches Institut für Feuerfest und Keramik), DGFS (Deutsche Gesellschaft Feuerfest- und Schornsteinbau e. V.), Fraunhofer Gesellschaft, Helmholtz-Zentrum Dresden-Rossendorf (HZDR), University of Aachen, Aachen
Poland: AGH University of Science & Technology, Krakow
Portugal: University of Minho, Guimarã; University of Coimbra
South Korea: FactSAGE Steelmaking Consortium Seoul National University
Sweden: SWERIM AB – Swedish Research Institute for Mining, Metallurgy and Materials, Luleå
Switzerland: ETH – Eidgenössische Technische Hochschule Zürich
USA: Continuous Casting Center (CCC) Colorado School of Mines, Alfred University

Research programmes and sponsors

Horizon 2020, COMET (Competence Centers for Excellent Technologies), EU; EFRE (Europäischer Fonds für Regionale Entwicklung); FFG (Österreichische Forschungsfördungsgesellschaft); SFG (Steirische Wirtschaftsförderung); BMWF (Bundesministerium für Wissenschaft und Forschung); CDG (Christian Doppler Forschungsgesellschaft)

Other capabilities at Leoben

In addition to R&D activities, the Technology Centre carries out a series of support functions to assist production plants, sales and marketing departments:

- Logistics
- Purchasing
- Raw materials procurement
- Patents, IP
- Technology
- Quality management

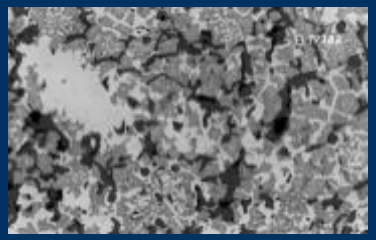
Analytical services

Mineralogy, chemistry, and physics

Investigations for product development and quality assurance

Standard testing for key characteristics

Post mortem analyses



Mineralogy

Chemistry

Physics

Refractory investigation and testing competence centres

Customer oriented, continuous innovation process in testing technologies

Hot testing up to 1700°C – variation of atmospheric conditions

Technical Service Department

Prototyping, small scale production, testing

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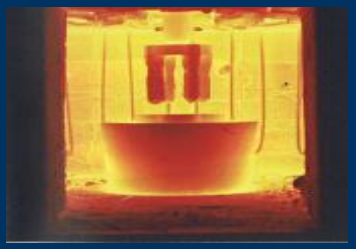
Raw material synthesis

In service simulations

Pilot plant - production of prototypes

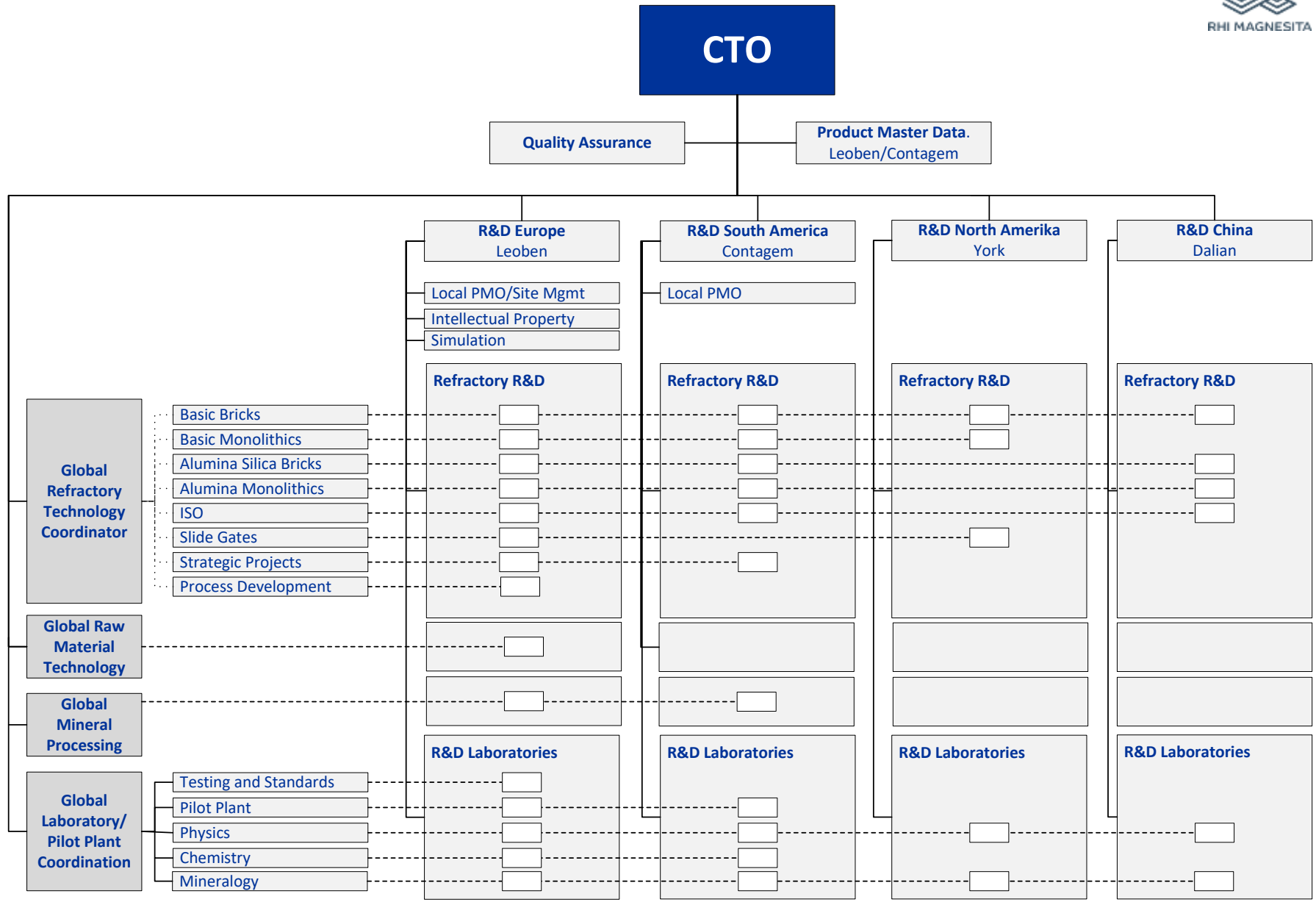


Product wear testing and studies

Material and product testing

Development of innovative test and simulation methods

R&D and technial activities with a global reach



Key R&D initiatives to discuss today

Merger benefits

Driving customer solutions

Artificial Intelligence, Big Data & digitalisation

Recycling

1. Merger benefits to our R&D business

Creating the industry's largest global R&D team; driving innovation

- **Fast local reaction time** combined with **strong global concept**
- Create a **sustainable competitive cost platform** through the most efficient use of the global production footprint – differentiate purpose of existing sites
- Create a climate which allows **innovation to thrive** and nurture "out of the box" thinking to develop next generation refractory solutions
- Continue investing 2.2 – 2.8% p.a. of sales in R&D and technical marketing:
  - R&D: €37m in 2017
  - Technical marketing: ~€35m in 2017
- Drive **high performance refractory products, automation and digitalisation** in our customers' industries generating additional revenues above average EBIT levels
- **Accelerate digitalisation** across the value chain
- **Access external technology acquisitions** capabilities around the world; leverage the "Technology Advisory Board"
- Increase **secondary raw materials usage**; aligned with new recycling strategy

2. On-site technical experts consult, develop and deliver innovative solutions directly to clients

340+ technical engineers across 90 countries, working on-site with clients to provide custom-made solutions, installation support, recycling, post-mortem analysis and more

A combination of…

High quality raw materials

Continuous investments in R&D

World-class products

On-site technical consulting

…ensures customers

- Improve efficiency
- Improve quality
- Increase productivity
- Reduce costs
- Reduce working capital
- Reduce energy and other raw materials consumption
- Reduce environmental footprint

3. R&D initiatives: Industry 4.0 and Digitalisation

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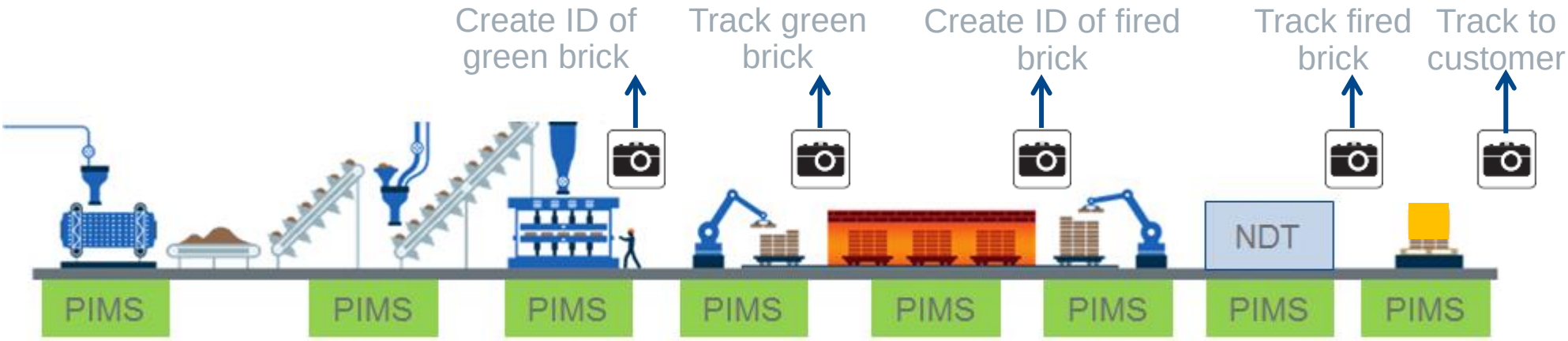
Fully automated refractory system

3. R&D initiatives: BRICK DATA Hub – single item tracking

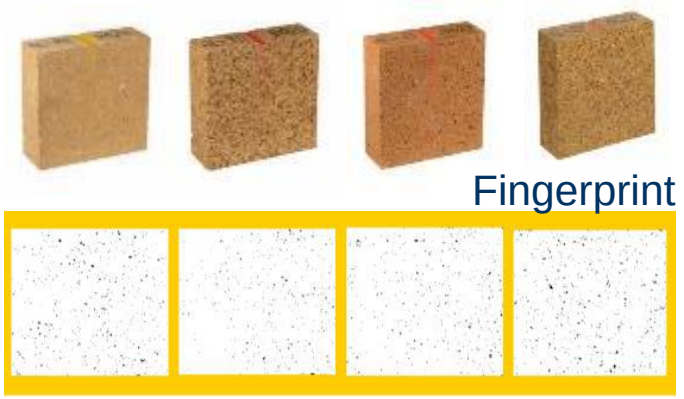
Results

- Data from all process steps are collected for each individual brick
- Tracing bricks from tunnel kiln to Non Destructive Testing (100% quality check)
- Fingerprint in lab-trials successful => production conditions



Next steps and outlook

- Tracing brick from press to packaging
- The vision is to track every brick to our customer



3. R&D initiatives: Automated Process Optimisation

Using artificial intelligence to analyse and understand relevant information; forming the basis of the refractory wear model

Input

Residual lining thickness

Lining thickness data during lifetime
(e.g. determined by laser measuring device)

Production parameter

Refractory wear relevant data of every heat (e.g. tapping temperature, power on time,…)

Maintenance data

Gunning data (amount of mix, areas,…)
Other repair methods (e.g. bank repair)

Refractory Lining

Lining design
Brick qualities

AI analytics software

Output

Forecast of refractory lifetime

Forecast of lining lifetime without maintenance

Maintenance proposal

Timing of maintenance to reach targeted lifetime
(e.g. method, schedule, required time,..)

Production parameter

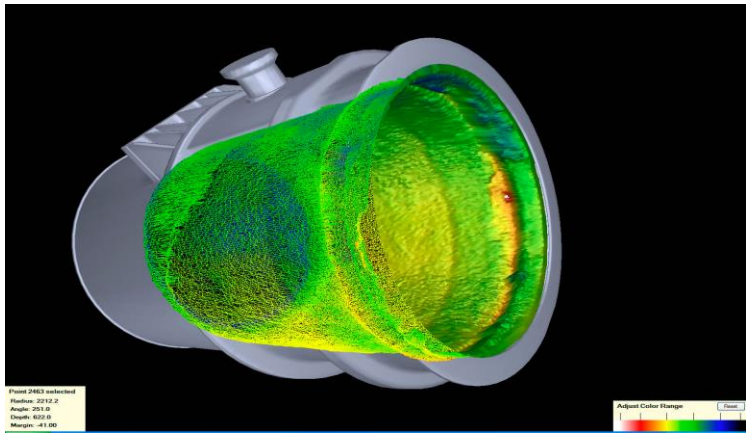
Identification of top wear relevant parameters

Cause and effect analysis

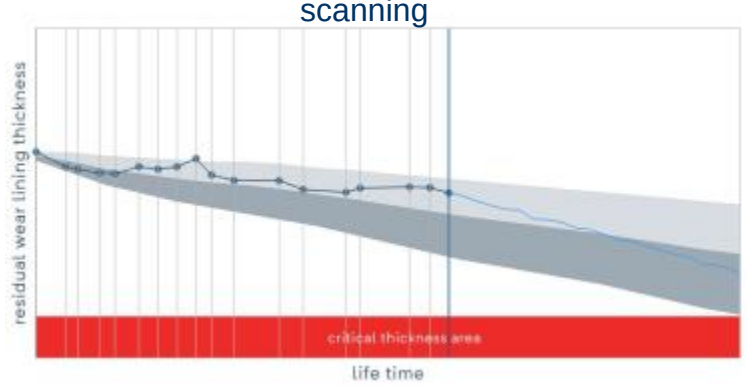
Holistic understanding of refractory wear mechanism
(e.g. impact of lance movements on refractory wear)

3. R&D initiatives: Automated Process Optimisation (“APO”)

Fostering a greater understanding of the correlation between steel production parameters, maintenance and refractory by analysing data on a central master computer, using artificial intelligence (“AI”) methods.



Digital representation of ladle lining based on laser scanning



Example of APO’s lifetime prediction

Customer risks:

- Unforeseen downtime for relining / excessive maintenance – casting interruption and delayed delivery
- Inefficient processes – increased energy costs
- Unsafe operations

APO’s AI computes digital twins of the refractory lining and features:

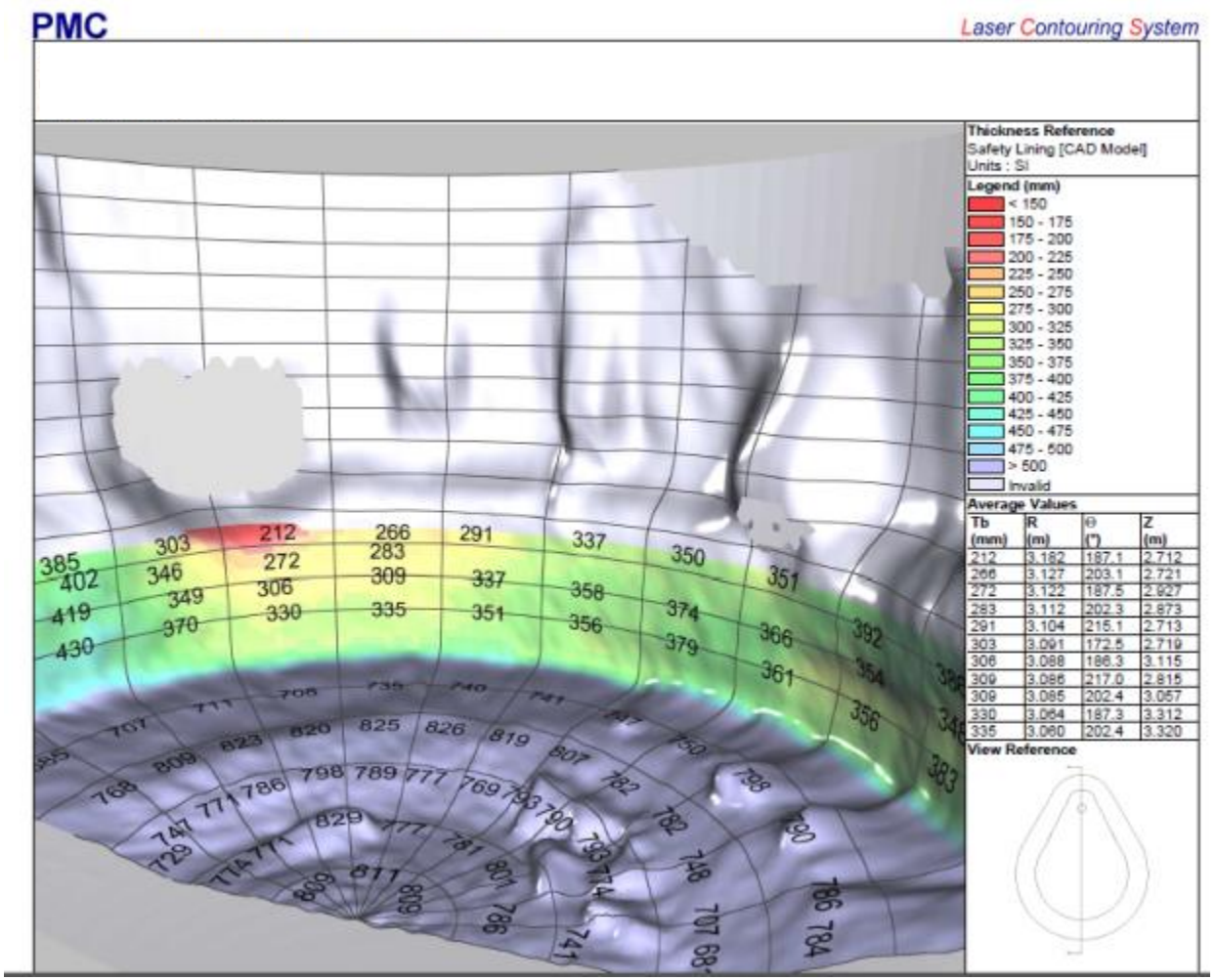
- Refractory wear model
- Identification of wear influencing parameters
- Refractory benchmarking
- Automated maintenance

Customer benefit:

- Matching refractory cycles with plant cycles enables better use of refractory products by optimising thermal plant cycles scheduling thereby reducing refractory waste and saving energy costs

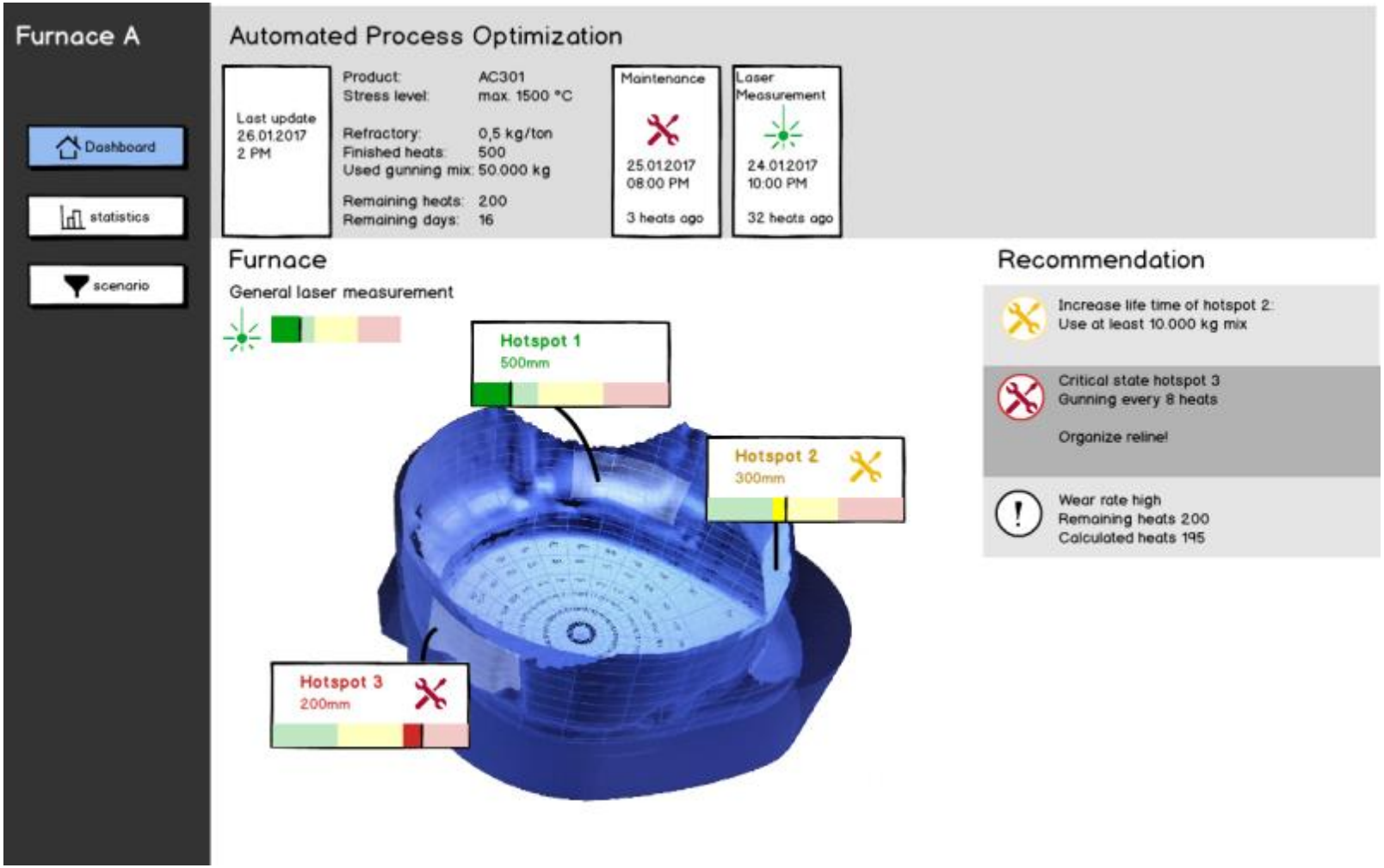
3. R&D Initiatives: APO

3D lining representation of Laser Contouring System



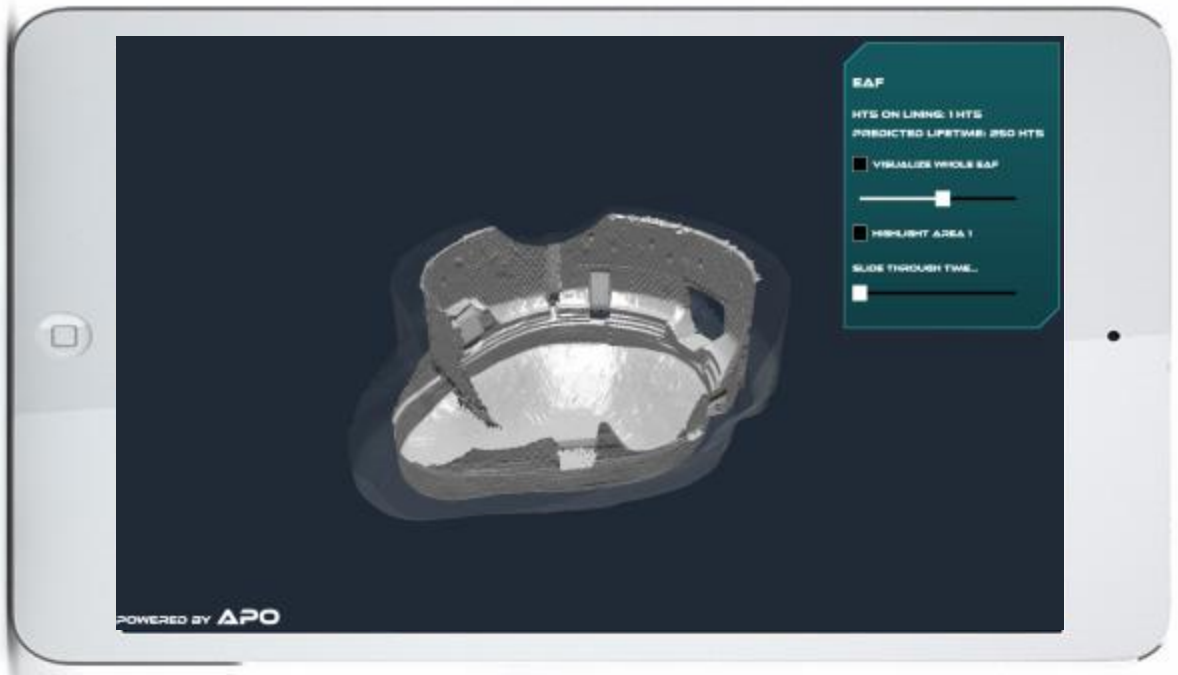
3. R&D Initiatives: APO

Management information tool



3. R&D Initiatives: APO

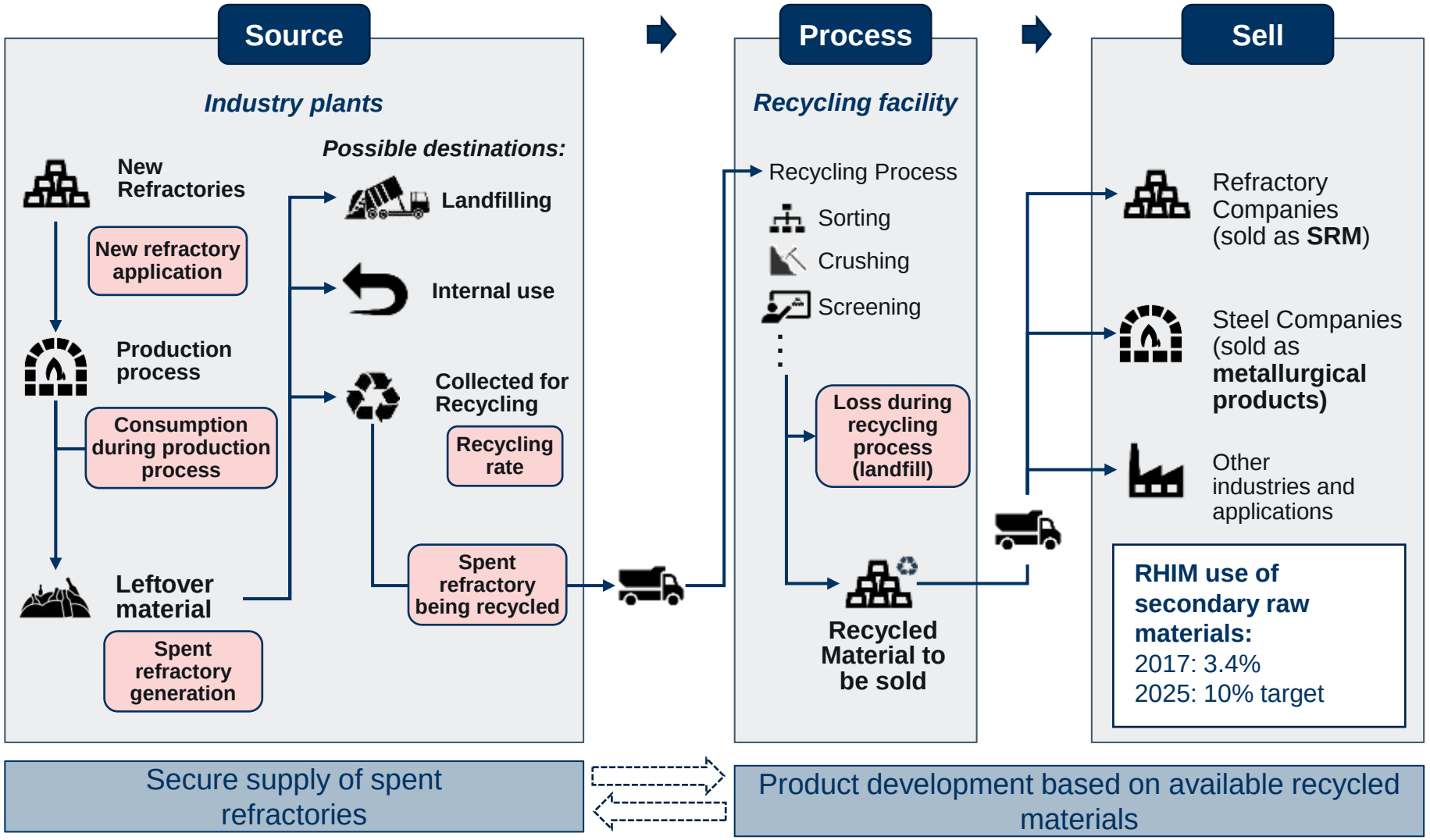
Real time information on mobile devices



- Predictable lining lifetime
- Reduction of refractory consumption
- Increasing breakout safety
- Optimized Steel plant logistics
- Daily Reports

4. R&D initiatives: Recycling of refractories

Driving positive change in the industry



4. R&D initiatives: Recycling of refractories

Business model & process approach

Refractory consumers

Steel plants

Cement plants

Glass plants

Etc.

Source → **Process** → **Sell**

Metallurgical Products

Eco-Minerals

Refractory companies

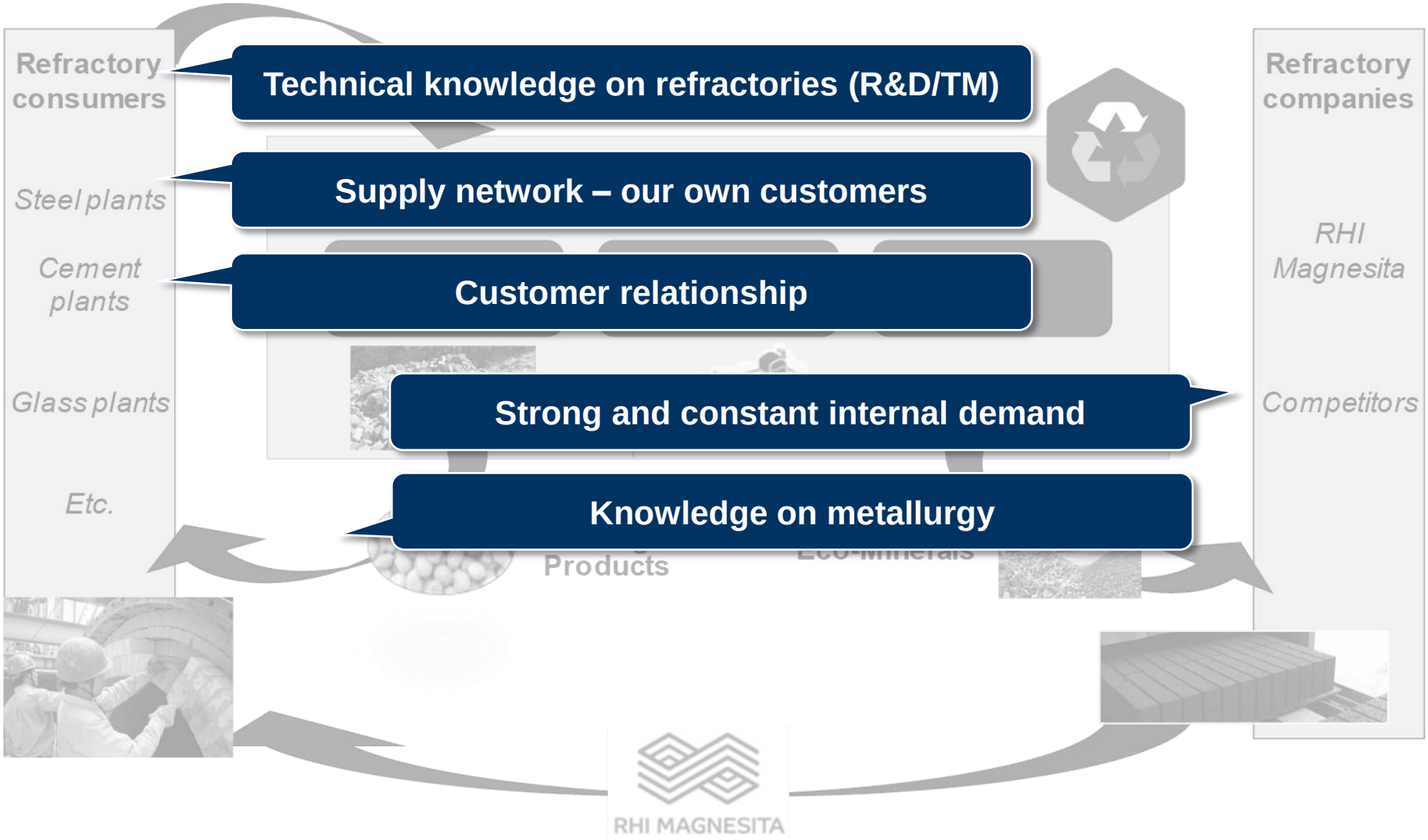
RHI Magnesita

Competitors

RHI MAGNESITA

4. R&D initiatives: Recycling of refractories

Our competitive advantages

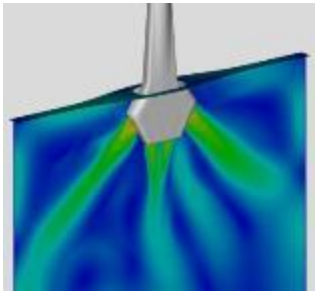


Training Centre & Simulation

Modelling & Simulation

Computational Fluid Dynamics (CFD)

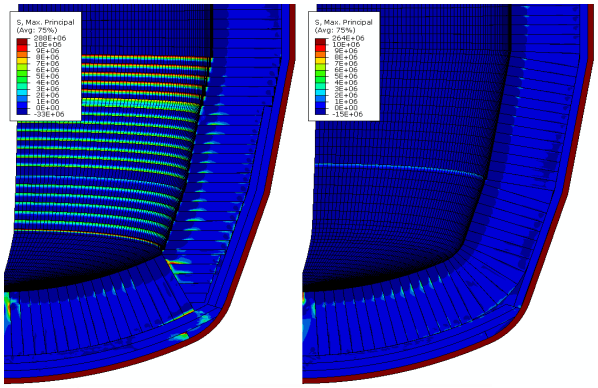
- Single and multiphase flows in metallurgical aggregates (purging in vessels)
- Temperature distributions in furnace linings (transient heat-up and cool-down processes)
- Reactive flows (combustion, burner designs)



Flow pattern in a thin slab caster mould

Finite Element Method (FEM)

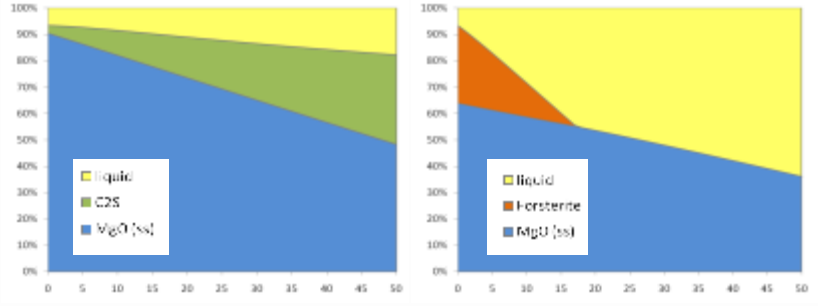
- Calculation of deformations and stresses (thermal expansions)
- Material behaviour



Stress distribution in converter lining: Bottom with joint vs. diverted base

Chemical Thermodynamics

- Thermodynamic information of complex multicomponent systems



Prediction of mineral phase distribution and liquid phase formation in dependence of slag infiltration level for two different tundish mixes


RHI Magnesita
Training Center Cement
RHI MAGNESITA

Our Objectives

- Share knowledge and expertise on the correct installation of refractories
- Generate an added value for customers from the cement (and lime) industry
- Intensify collaboration with those customers
- Demonstrate RHI Magnesita´s expertise and reliability
- To be a high-quality service partner

Our Offer

- Assistance to improve availability and productivity of cement kilns
- People development in a very specialised field
- Realistic industrial set-up without drawbacks (noise, dust, light)
- Practical exercises: hands-on experience for all participants in small groups (max 15 persons)
- Full-scale rotary kiln model (Ø 4m), fully operational DAT bricking rig and mixers

Q&A

10:00 – 11:30 Tour of R&D facility – Christian Majcenovic, Stefan Schriebl

11:30 – 12:00 Prettachfeld tour

Part 1: Simulation & water models – Gernot Hackl

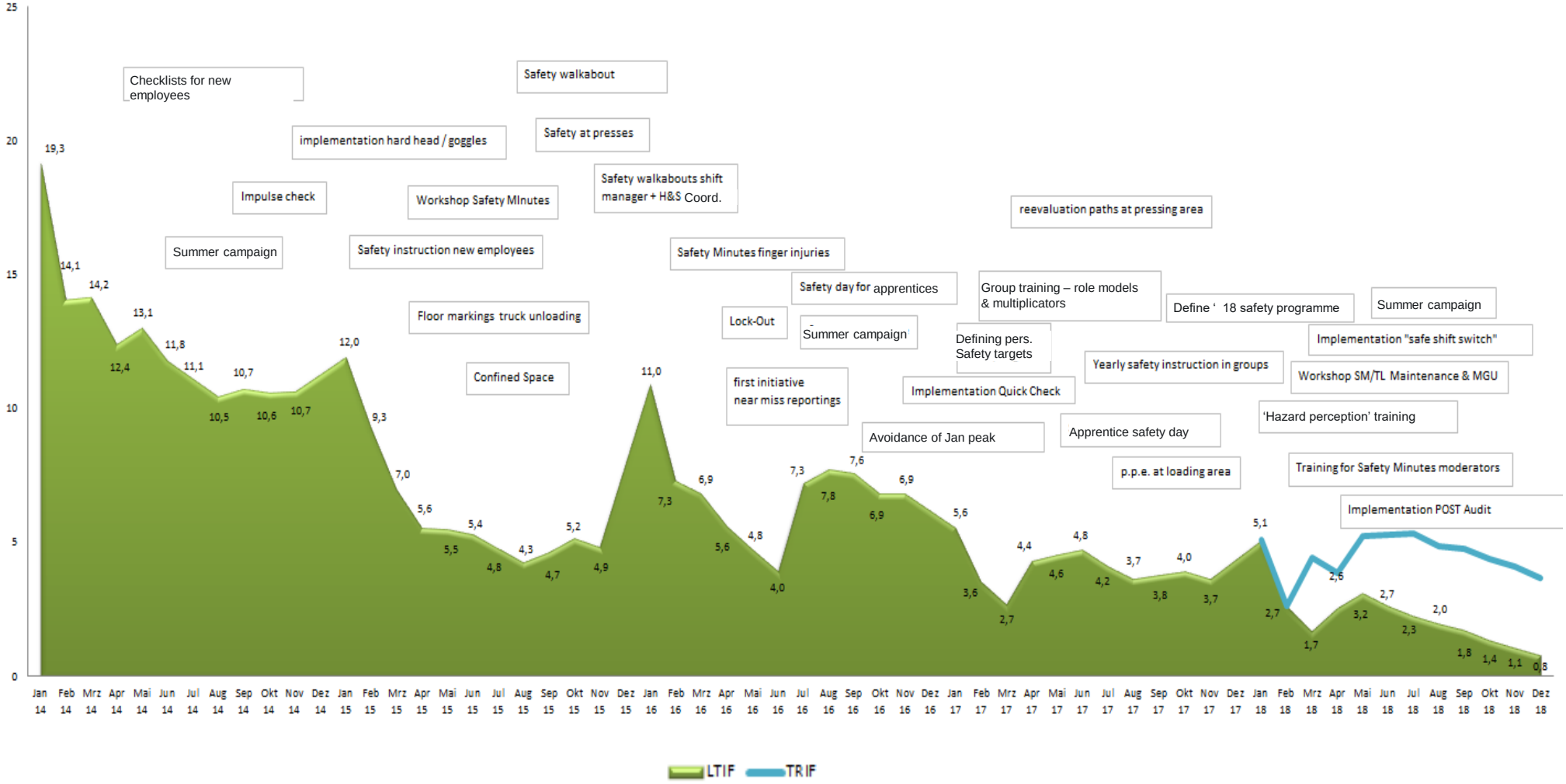
Part 2: Training centre & big data visualisation – Thomas Reiterer

Veitsch Plant

Thomas Harm –
Plant Manager, Veitsch

Occupational safety: LTIF & TRIF trend

Safety is our number one priority



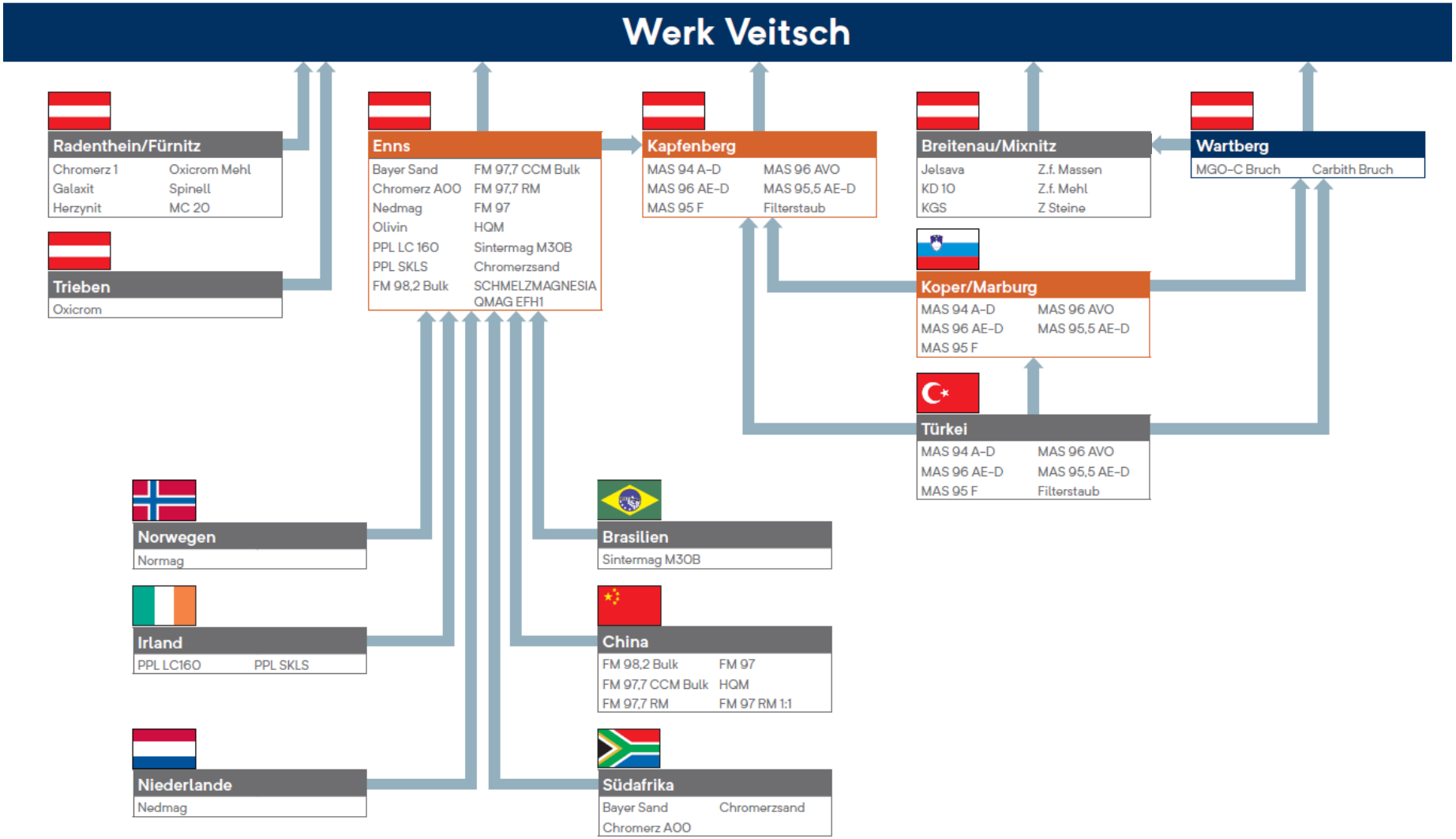
Veitsch plant

Fully automated refractory plant

- Optimised use of space – shaped by the valley
- Three manufacturing lines
  - Mixes (MU – unformed magnesia)
  - Fired bricks (MGG – formed fired magnesia)
  - Carbon bonded bricks (MGU – formed unfired magnesia)
- 2017 refractory production: 233Kt
- 2017 turnover: ~€170m
- Production of >2,600 products
- 190 permanent employees
- >140 different raw materials processed according to 500 recipes

Raw materials input

We process more than 140 different raw materials according to 500 recipes



Product lines

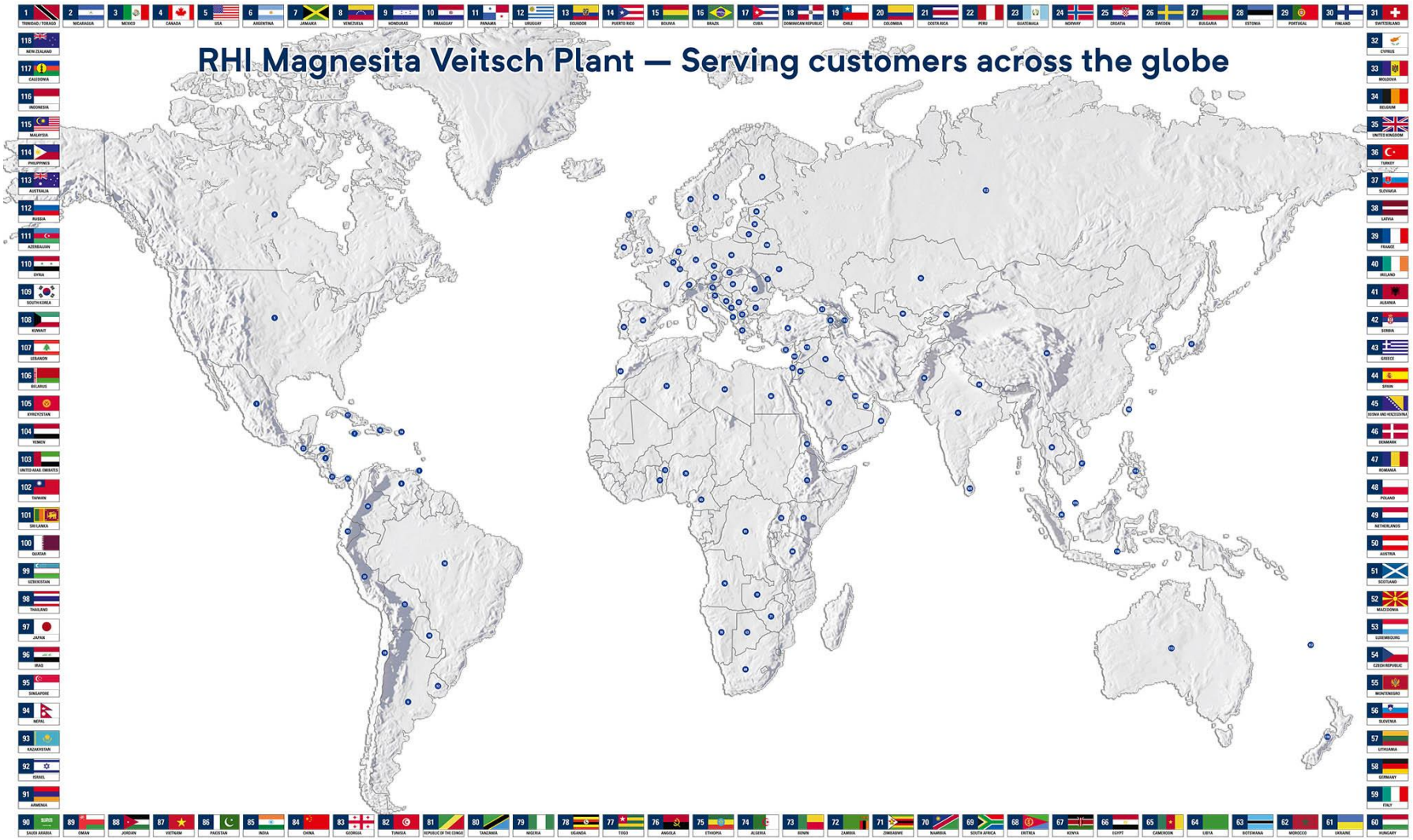
MU: Mixes for steel and cement industry: High product diversity – small lot sizes

MGG: Bricks for cement rotary kilns: Highly competitive products

MGU: Bricks for steel linings: High product diversity

Veitsch customers

Shipping globally to 118 countries



Appendix

Providing everything, for everyone, everywhere

RHI MAGNESITA

€2.7bn
2017 adjusted pro-forma revenue

10,000
Customers served globally

14,000
Employees spread over 37 countries

35
Main production sites across 16 countries

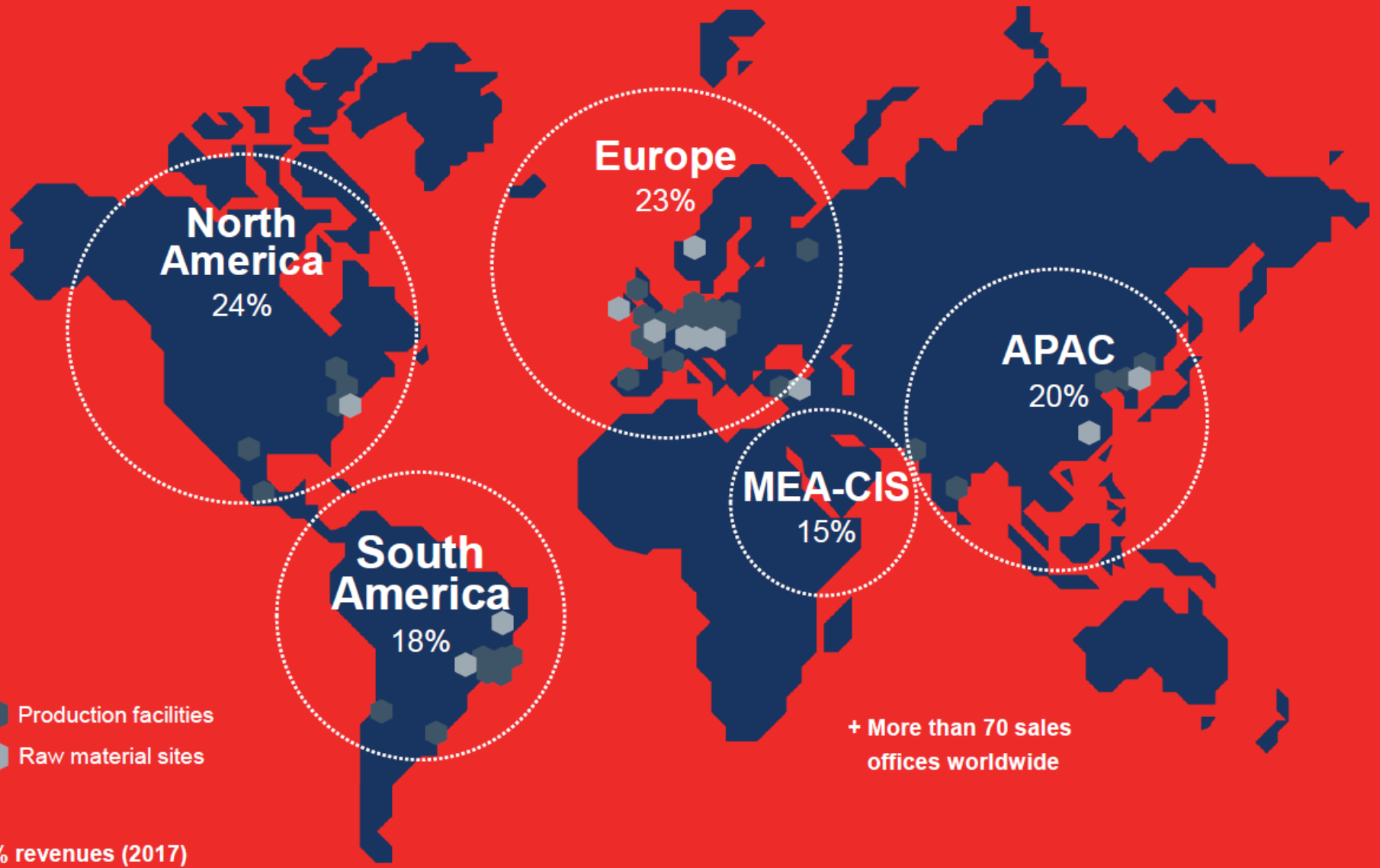
180
Countries shipped worldwide

13
Raw material sites in 4 continents

€37m
Annual investment in Research

Optimally positioned to reach clients everywhere

RHI MAGNESITA

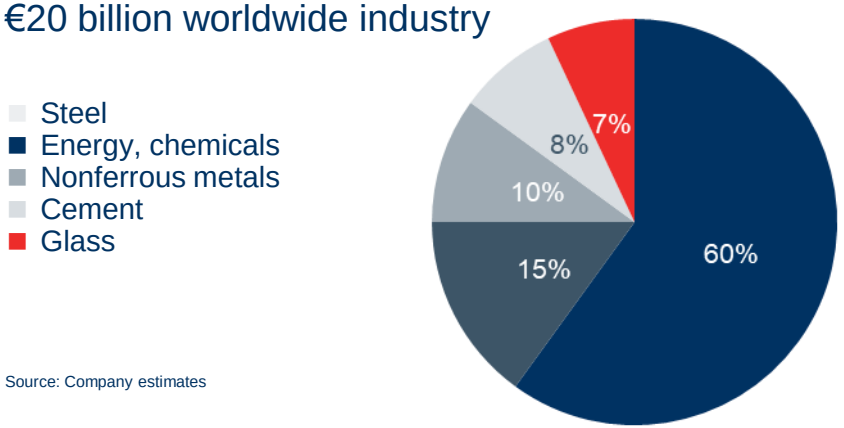


% revenues (2017)

Refractories are critical to all high-temperature industrial processes

- Refractories are critical consumable or investment goods for high-temperature manufacturing processes
- Refractory materials consumed whilst protecting clients' production processes, retaining physical and chemical characteristics when exposed to extreme conditions
- Critical, yet represent less than 3% of COGS in steel manufacturing and less than 1% in other applications

Main end markets
€20 billion worldwide industry



Source: Company estimates

Global refractory industry

Source: Company estimates of market share in US$

Extend market position in high quality applications and strengthen non-basic mixes and functional products

Portfolio	Main Applications	Opportunity
Basic Products	**Steel:** steel making **Industrial:** Nonferrous metals	Strong capability and logistics: production in all continents and short lead-time to everyone, everywhere Production of world-class mag-carbon bricks – combining the best raw materials with continuous investments in R&D allows us to develop a high-performance product which enhances client productivity
Non-basic products	**Steel:** blast furnace & reheating furnaces and direct reduction **Industrial:** bricks & castables	Estimated global market of €4 billion+ RHI Magnesita has a complete non-basic product portfolio Strong presence in South America. Great opportunity to expand in North America and Europe
Functional Products	**Steel:** continuous and ingot casting **Industrial:** Nonferrous metals	Technical expertise, complete product portfolio, solutions beyond refractory products such as mechanisms A global plant footprint allows optimisation of supply chain Continuously growing business with a combined global market share of ~20%; significant growth potential
Engineering Solutions	**Steel:** tundish efficiency improvement **Industrial:** raw material testing & experimenting	Service provider and strong partner with the capability to provide solutions beyond refractories Tailor made solutions for all customer requirements Simulations and modelling for improvement of customer processes (water modelling; fluid dynamics)

RHI MAGNESITA

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