Improvement work in Hydro Primary Metal

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Vice Precident
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A resource-rich and customer-oriented aluminium company

With robust positions across the value chain

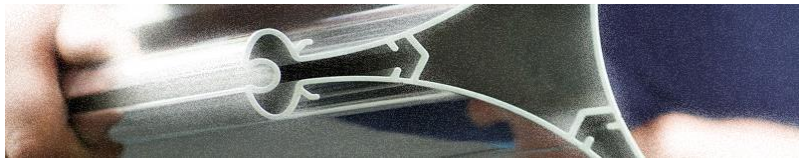
Bauxite & Alumina

Energy

Primary Metal

Rolled Products

Extruded Solutions



- Global provider of alumina, aluminium and aluminium products and solutions
- Leading businesses along the value chain; raw materials, energy, primary metal, rolled products, extruded solutions and recycling
- 35,000 employees at more than 150 locations in more than 40 countries on all continents
- Market cap ~NOK 110 billion/USD 14 billion
- Annual revenues ~NOK 137 billion (2016)*
- Included in Dow Jones Sustainability Indices, Global Compact 100, FTSE4Good

*) The sum of Hydro's and Sapa's individual turnover In 2016

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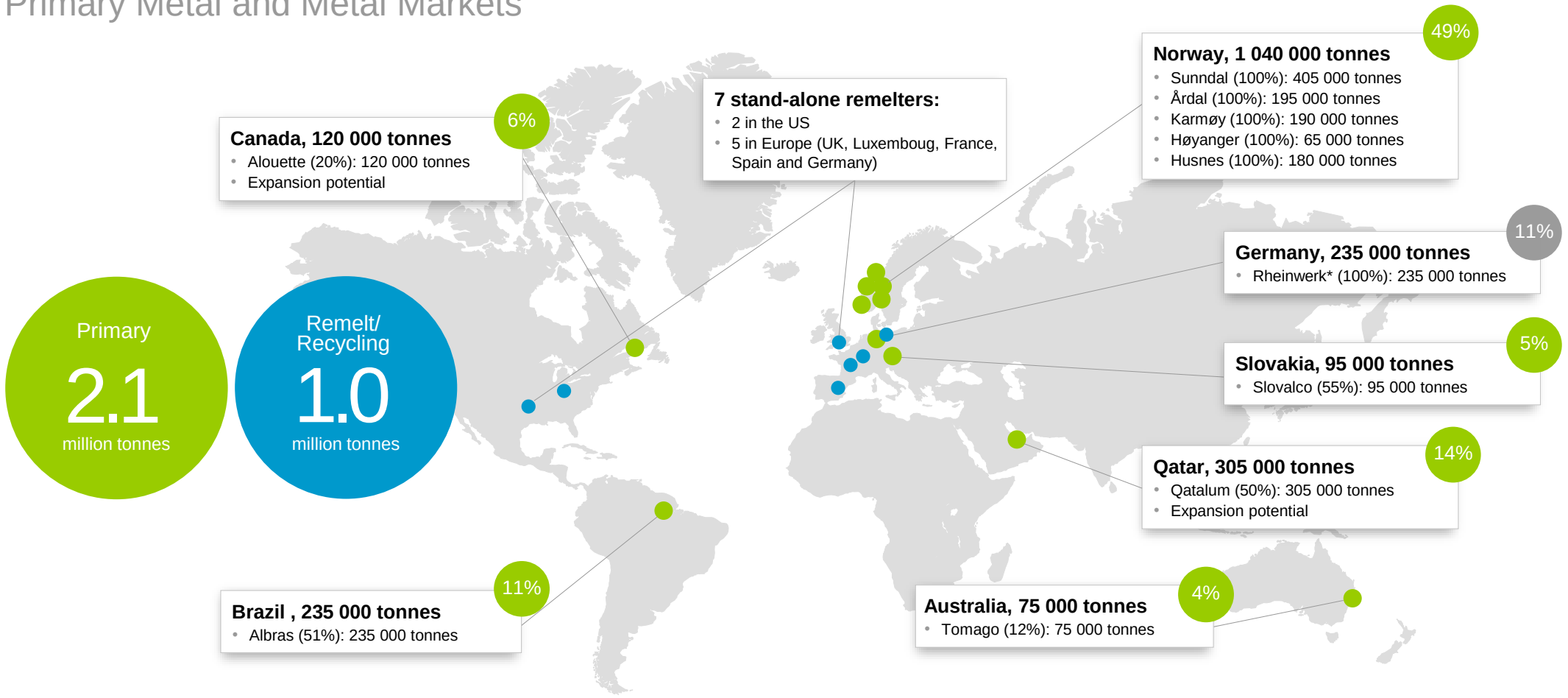
World-wide primary aluminium production network

Primary Metal and Metal Markets



Attributable capacity: 2.1 million mt. Consolidated capacity: 2.4 million tonnes (Slovalco and Albras are consolidated). The smelters have an additional remelt capacity: 0.5 million tonnes.
Consolidated casthouse capacity: 2.9 million tonnes. Qatalum is equity accounted in Hydro's results.
* Rheinwerk smelter is included in the Rolled Products division for logistical reasons

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Hydro Primary Metals improvement work last 10 years

2006: Decision to create Aluminium Metal Production System – AMBS. Learning from Automotive industry and Elkem.

2008: Dramatic drop in aluminium prices

2009: $300 program launched

2009-2017: Industry leading results from improvment work.

2017: More value from AMBS through digitalization

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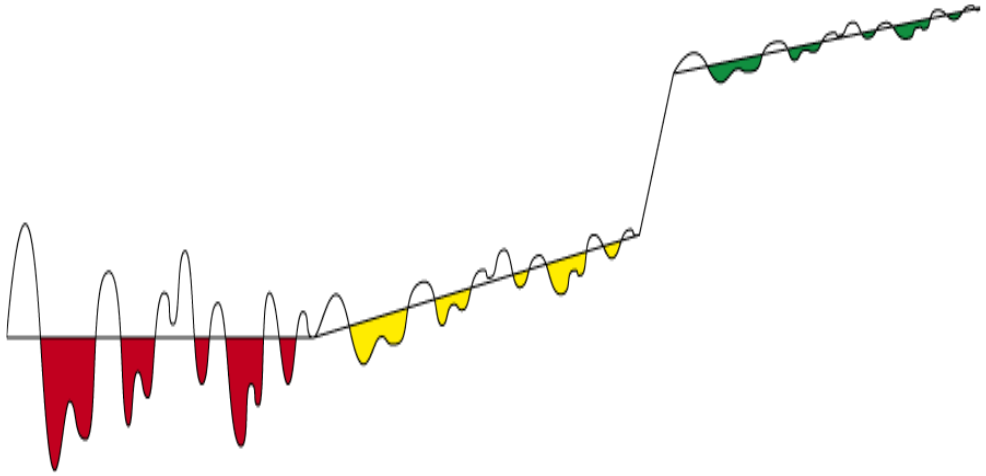
AMBS is a Lean Six Sigma concept

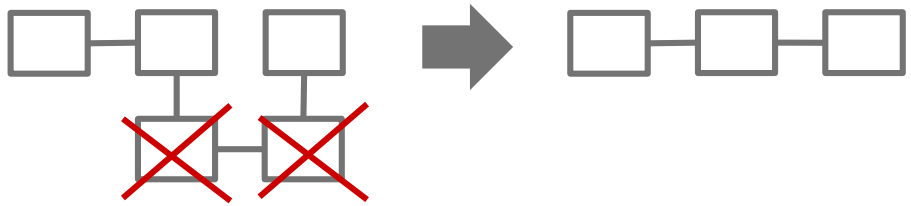
Six Sigma:

Reduce variation through the use of a defined set of statistical methodes



Lean:

Remove waste from value stream through continuous improvement



Six Sigma and lean have complementary goals

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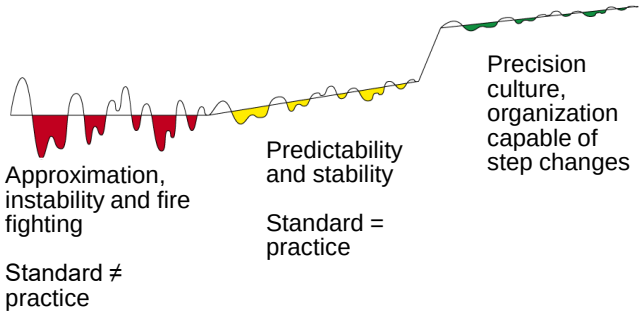
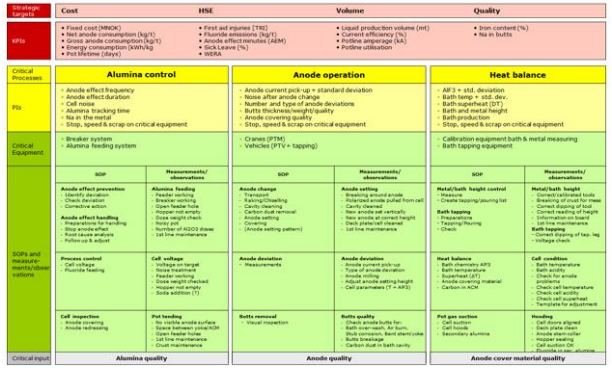
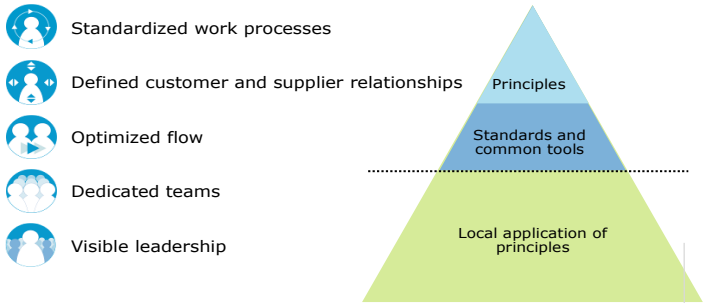
Aluminium Metal Business System, AMBS, is our common platform for operation and improvements.







WHY?
In control & capable

WHAT?
The critical processes

HOW?
The AMBS Principles

Our results are created by our employees. The competence, motivation and performance of the individuals are our most important resource, and this resource has to be given attention accordingly.

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How to improve?

The content of the 5 principles

World class performance

Principles	Standardized work processes	Defined C/S relationships	Optimized flow	Dedicated teams	Visible leadership
Rules in use	Critical processes are defined Standards are described and followed up Standards are continuously improved	Critical C/S agreements are defined Meeting structure have been est. Direct, two way communication	Bottlenecks are prioritized and planned Flow follows a simple and direct route Defect are not forward to next operation	The work is org. in dedicated teams Roles and resp. are defined The teams define their targets Continuous improvement work	Leaders are clear and visible Leaders motivate and involve Leaders challenge, coach and support Leaders follow up and give feedback
Methods & Tools	SPC and 5xWHY OPL SOP SOP WOC PDCA	Customer & supplier agreements Meeting structure	SMED Value stream mapping TPM Network analysis 5S	TPM & CP Groups Competance matrix Visual targets Roles & responsibility Dedicated area teams	Meeting facilitation Feedback & recognition systems My Way WOC

Hydro Values

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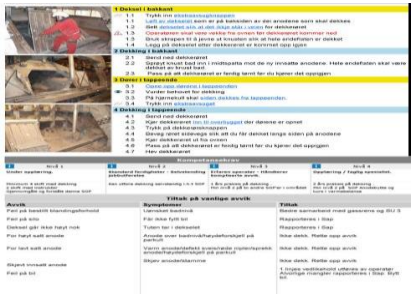
AMPS principle # 1 – Standardized work

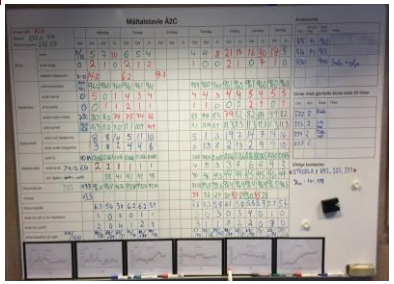
Example from electrolysis

Implementation of new SOP

Standardization of critical processes

Measuring and work observation





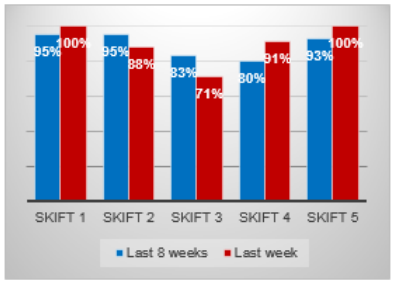
Analysis:

- Line
- Cell
- Team
- Individual

Critical process groups:

	Area A	Area B	Area C
Anode operation			
Alumina control			
Heat balance			
NN			

Need of change



Training of shifts and individuals

Change of standard

Production with existing standards

AMPS Principle #4 – Dedicated teams

World-class production requires optimal use of our most important resource – the motivation and competence of the individual

I do best work if:

…I have ownership to the tasks and results of my area

…I'm recognized for my achievements

…I have a challenging job

…I'm learning and developing

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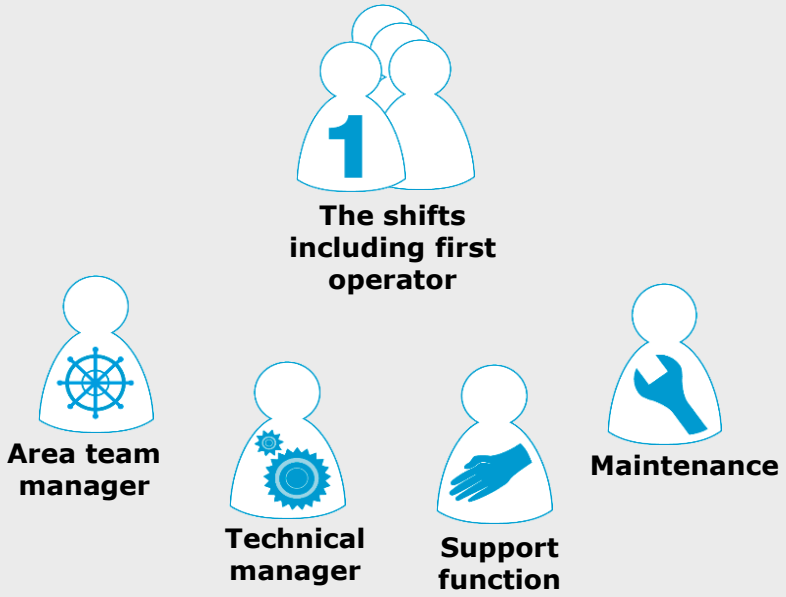
AMPS Principle #4 – Dedicated teams

Work on all levels is organized in area teams



Management structure

Area manager

- Overall responsible for the team
- Development of employees
- Prioritization of resources

Technical manager

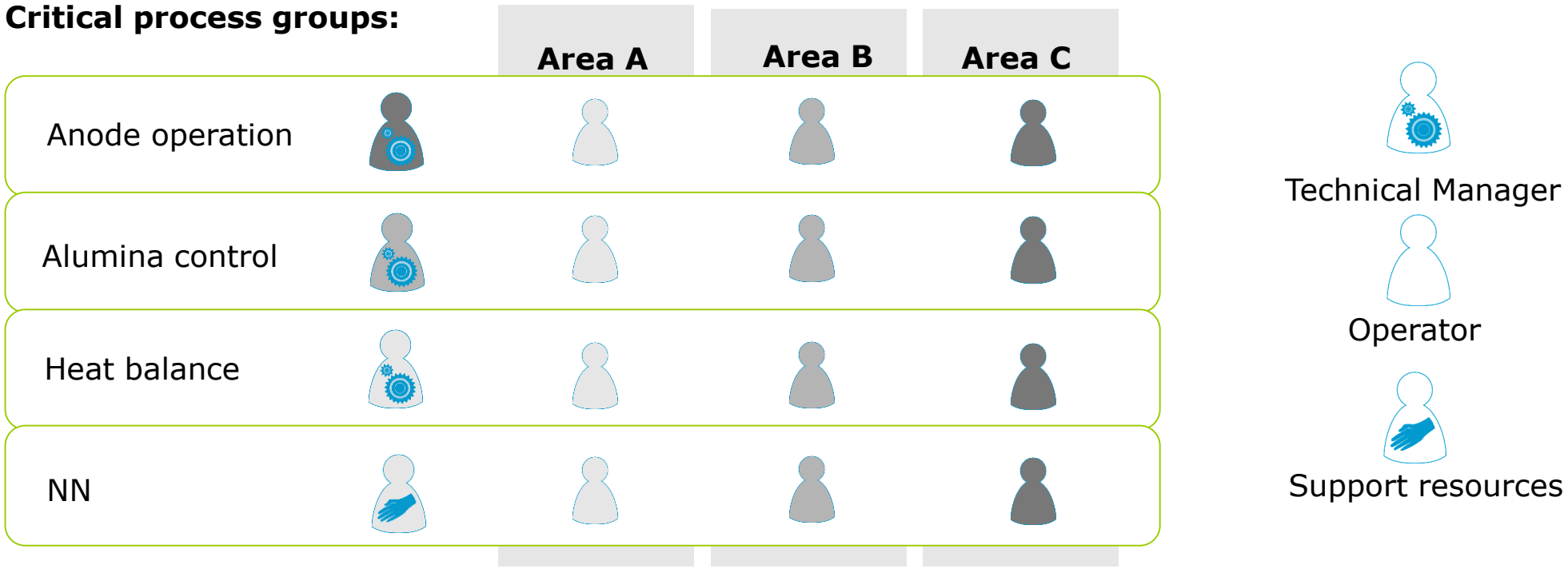
- Technical responsibility
- Standardization
- Improvement

First operator

- Responsible for actions on shift
- Running operator work

AMPS Principle # 4 – Dedicated teams

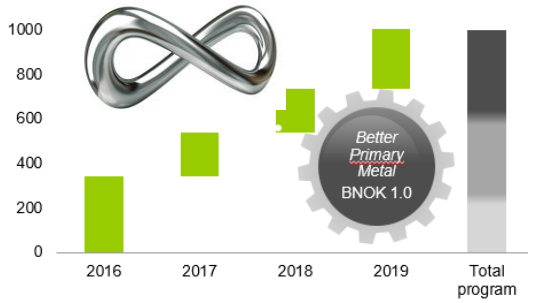
Improvement of common critical processes is organized in Critical process groups across the area teams



Success criterias

Basic in place…

Strategic foundation



Need for change is key

Improvement programs drives continuous improvement speed

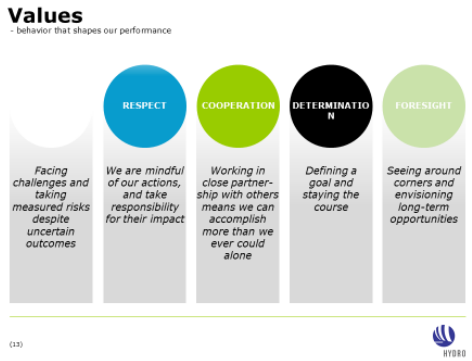
Management commitment

Motivation and ability to drive implementation

Ownership to concept & implementation

Long term perspective

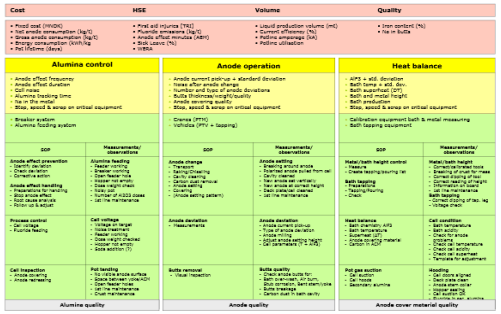
Values



People the most important asset for continuous improvement

Company values more important than national culture

Critical processes



Critical processes in control & capable

Excellence based on competence

Processes to transform competence to cash

Success criterias

Top 4 beyond basics…

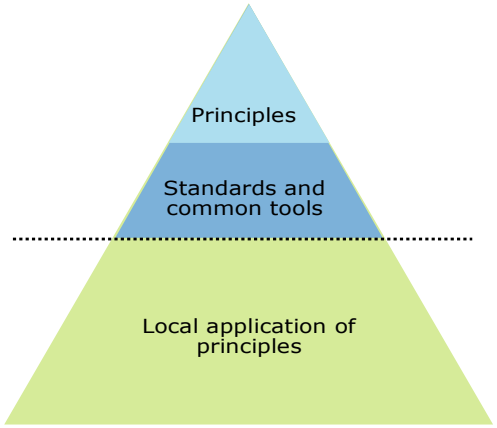
The principles are our DNA

- Standardized work processes
- Defined customer and supplier
- Optimized flow
- Dedicated teams
- Visible leadership

Principles are mandatory – tools to be used where needed

Principles drive organizational and leadership development

Local application – cross plant learning



Concept allow flexibility in local application – drives motivation, ownership and adaption to local technology.

Challenge cross-plant learning when mature

AMBS support capability

AMBS support capability is key to support improvements and develop approach

Measure progress

	Sunndal	Årdal	Høyanger	Karmøy	Kurri	Slovalco	ALL
Amperage	1,79	3,38	2,23	0,84	1,49	-0,65	1,52
Current efficiency	-3,84	-0,12	-2,31	12,01	0,84	-3,76	0,43
Energy cons DC	-0,81	4,02	-0,75	8,38	0,95	1,86	2,34
Net Anode cons	10,61	-8,10	6,55	5,96	10,57	1,14	4,78
Gross Anode cons	14,49	-3,47	5,86	4,46	5,11	2,73	5,70
Scrap rate baked anodes	0,28	3,42			-0,45	-0,14	0,59
Anode service (% total butts price paid)				5,22			0,90
Gross metal loss - Product 1	0,16	0,72	-0,33	1,68	-1,80	2,20	0,48
Total scrap rate - Product 1	0,41	0,09	1,44	1,28	0,30	0,36	0,53
Gross metal loss - Product 2	3,57	2,05		3,13	4,99	3,24	3,21
Total scrap rate - Product 2	0,07	0,68		-0,36	0,34	0,53	0,22
Fixed costs Plant KPI	17,67	53,08	-1,46	18,96	6,39	-5,01	17,81
TOTAL	44,40	55,75	11,23	61,57	28,72	2,51	38,49
Total BP Target	40,73	49,77	29,28	20,13	65,27	7,25	37,18

Link proactive indicators to strategic target

Deployment to shift level

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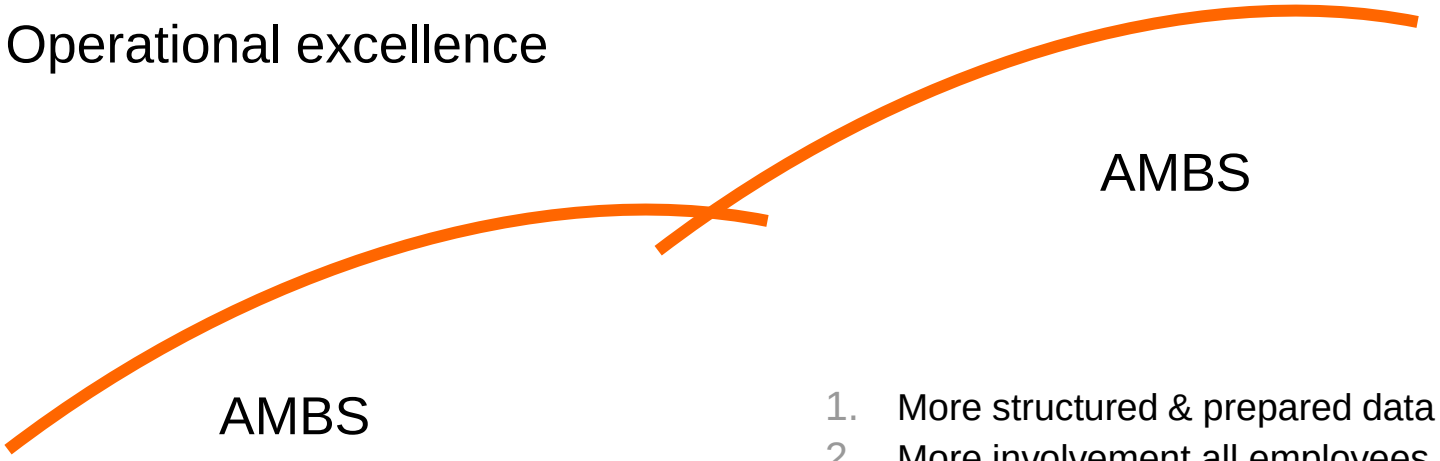
We will capture more value from AMBS through digitalization



1. More structured & prepared data
2. More involvement all employees
3. Better improvement work

Questions?