HYDRO’S APPROACH TO SUSTAINABILITY

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Hydro
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Building industries that matter

A leading industrial company with basis in renewable energy and aluminium

- Global provider of aluminium raw materials, products and solutions and of renewable energy
- First-class operations within renewable energy, raw materials, primary aluminium metal, rolled products, extruded solutions and recycling
- 34,000 employees at 140 locations in 40 countries
- Market cap ~USD 9 billion (as per January ‘21)
- Annual revenues ~USD 15 billion (2020)
- Included in Dow Jones Sustainability Indices, Global Compact 100, FTSE4Good
Introduction

Strong increase in sustainability, environment and climate awareness

Action and improvement needed on waste, recycling and emissions (CO₂) to defend aluminium’s position
Sustainability challenges and opportunities in the aluminium value chain
Hydro’s 2030 sustainability targets

Social responsibility
Strengthening local communities and our business partners

Environment
- 1:1 rehabilitation
- Tailings dry backfill
- Utilize 10% of bauxite residue
- 50% reduction in key non-GHG air emissions

Climate
Cut CO₂ emissions by 30%

Sustainability in the marketplace: our greener products portfolio
Tailings dry backfill in operation
Bauxite residue: from waste to products

Steel Industry
- Alternative iron ore
- % Utilization*: 20

Agriculture
- Soil conditioner
- % Utilization: 10

Civil Construction
- Cement, concrete, aggregates, components, pavers
- % Utilization: 50

Oil and Gas
- Proppant
- % Utilization: 20

% Utilization (potential) = used BR (ton) / total generation (ton)
Cement industry with largest potential
Sources of Hydro’s 15 Mt CO₂-emissions

- Process emissions: 3.2
- Electricity production: 6.4
- Fossil fuel combustion: 3.7
- Other*: 1.6

Emission data is as reported in Hydro annual report for 2017 with Extruded Solutions emissions included.

* Casthouses, re-melting, anode baking, furnaces etc.

Hydro’s certified 4.0 low-carbon aluminium

- Fuel switch
- Alumina
- Anode
- Power generation
- Smelting
- Casting
- Other: 0.6

Maximum 4.0 kg CO₂/kg Al
Alunorte fuel switch project

Converting boilers and calciners to natural gas, LNG

- Gas as single Fuel
- According to NFPA 85
- Emissions limits shall comply with European standards
- NOx emissions control using steam injection
Primary aluminium production can come under pressure

All energy sources need to be based on renewable energy
Electrolysis climate technology roadmap

Build on the Hall-Heroult process and existing plants:
- Convert to renewable power
- Optimise operations
- Energy consumption
- Industry 4.0
- Broad portfolio R&D incl. bio carbon

Intermediate phase:
- Conclude on viability of R&D work
- Continue power conversion
- Further optimising operations
- CO₂ capture and storage or utilization, CCUS
- DAC solutions

New technology in «new» plants:
- Inert anodes
- Chloride/other innovative processes
- CCUS and DAC solutions

2020
2035
Towards Zero
2050
Energy consumption – Karmøy tech pilot

Successful validation test: EC < 12.4 / 11.8 kWh, CO₂ < 1.4 kg – technology element deployment
Towards autonomy

Digital twins

Optimizing production by combining:

• Physics-based models
• Sensor data
• Advanced analytics algorithms

Process data

Domain competence

Cell Measurements
Set Points
Cell controller
Inputs
ALMIN
Model update
Model
Measurements
Inputs
Estimator
Estimated outputs
Measurements

Number of manual interventions

Reference cells

Digital twin control

Number per 20 pots per month

VERIFICATION
jan 2017 - mar 2018
A new approach to the chloride process

CO₂ to CO conversion

- e.g. with hydrogen: \(3\text{CO}_2 + 3\text{H}_2 = 3\text{CO} + 3\text{H}_2\text{O}\)
- or electrolysis: \(3\text{CO}_2 = 3\text{CO} + 1.5\text{O}_2\)

Aluminium chloride production

\[3\text{Cl}_2 \rightarrow 2\text{AlCl}_3\]

Aluminium chloride electrolysis

\[2\text{AlCl}_3 \rightarrow 2\text{Al} + 3\text{CO}_2\]
Carbon capture from electrolysis

A medium to longer term solution towards zero-CO2 Hall-Héroult electrolysis

- Direct Air Capture (potentially utilizing waste heat from electrolysis or off-site)
- Off Gas Capture utilizing waste heat from electrolysis
Recycling - a part of the solution

Aluminium’s recyclability is a fantastic competitive advantage

Challenge: Our approach:

- 5% to recycle
- 75% still in use
- 100% equal quality
Encouraging recycling project portfolio

- Double EBITDA
- Use additional 500 kt post-consumer scrap per year

• Pilot for faster learning of industrial alloy sorting
• Screw-extruder under development for compacting thin and difficult scrap
• Possible future source of scrap and profit
• Recycling-friendly aluminium food packaging
Our premium low-carbon products

REDUXA
Certified, low-carbon aluminium with a maximum carbon footprint of 4.0 kg CO2 per kg aluminium

CIRCAL
Range of prime quality aluminium made with a minimum of 75% recycled, post-consumer scrap
Strong interest in greener aluminium

House of Choice, Sweden, Scandinavia’s first zero-energy hotel, Photo: White Arkitekter
Summing up
Increased sustainability awareness is about to change our industry

Directional 2050 Outlook

- IAI: around 165 Mtpy Al demand
  - 65 Mtpy recycled (40%)
  - 100 Mtpy primary
- A net-zero industry
- Clean energy sources
- New-builds with zero-emission technology
- Al-industry will receive few offsets and struggle competing for bio resources
- Existing and modern HH-smelters with on-site CCUS or off-site DAC

- Zero-emission technology
- Recycling (Hydrogen/electric)
- Hall-Heroult + DAC
- CCS/offsets/bio
We are aluminium