BASF Antwerp: Chemical Verbund production in the heart of Europe

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BASF’s Verbund site Antwerp...

... is the second-largest Verbund site of BASF

... has competitive advantages through unique Verbund site integration

... is continuously improving cost structures by technological and operational excellence

... has lean and reliable logistics

... supplies into growth markets
Agenda

1. BASF’s Antwerp site at a glance

2. Leveraging Verbund advantages

3. Positioned for further growth
Global Verbund sites of BASF
Antwerp is BASF’s second-largest Verbund site
BASF Antwerp – Ideally located in the heart of Europe
The Benelux chemical cluster

BASF Antwerp: Suppliers and customers at arm’s length

Shell
Shin-Etsu
LyondellBasell
Dow
Exxon Mobil

Huntsman
LyondellBasell

Dow

Covestro
Lanxess
Borealis
Ineos

Total
BP Chemical
Versalis

Exxon Mobil

Shell
ELLBA

Ineos

Exxon Mobil

Sabic
Celanese

Borealis

Ineos
Dow
Solvay/SolVin

Propylene pipeline
Ethylene pipeline
### BASF Verbund site Antwerp at a glance

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>~€6 billion in 2015 (including Group-internal sales)</td>
</tr>
<tr>
<td>Site area</td>
<td>6 km²</td>
</tr>
<tr>
<td>Production facilities</td>
<td>more than 50 production plants (including third-party plants)</td>
</tr>
<tr>
<td>Investments*</td>
<td>~€150 million p.a.</td>
</tr>
<tr>
<td>Sales volumes</td>
<td>7.8 million metric tons</td>
</tr>
<tr>
<td>Volume handled</td>
<td>15.6 million metric tons</td>
</tr>
<tr>
<td>Employees BASF</td>
<td>~3,000</td>
</tr>
</tbody>
</table>

* Average last five years
Safety first
Maintain focus on safe behavior

LTI frequency rate*

<table>
<thead>
<tr>
<th>Year</th>
<th>Industry Belgium**</th>
<th>Chemical industry Belgium**</th>
<th>VIBNA***</th>
<th>BASF site Antwerp****</th>
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<td>10</td>
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<td>1</td>
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<td>2006</td>
<td>22</td>
<td>7</td>
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<td>0.5</td>
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<td>2008</td>
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<td>2014</td>
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<td>5</td>
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<td>0.3</td>
</tr>
<tr>
<td>2015</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>0.3</td>
</tr>
</tbody>
</table>

*B Lost Time Injuries (LTI) per 1 million hours worked
** As from 2005, based on data from Fund of Occupational Accidents.
*** VIBNA: Association of Industrial Companies in Northern Antwerp
**** As from 2011, including Styrolution Belgium N.V. and EuroChem Antwerpen N.V.
Antwerp’s contribution to BASF segments
Involved in BASF’s core chemical activities
Antwerp’s contribution to BASF segments

Key products

- **Chemicals**
  - Petrochemicals
    - Ethylene
    - Propylene
    - Benzene
    - Acrylic acid
  - Monomers
    - MDI
    - Ammonia
    - Caprolactam
  - Intermediates
    - Amines
    - Formaldehyde

- **Performance Products**
  - Care Chemicals
    - Superabsorbents
    - Surfactants
  - Performance Chemicals
    - Polyisobutylene

- **Functional Materials & Solutions**
  - Performance Materials
    - Polyether polyols

- **Agricultural Solutions**

- **Oil & Gas**
Agenda

1  BASF’s Antwerp site at a glance

2  Leveraging Verbund advantages

3  Positioned for further growth
We add value as one company

Production Verbund

Technology Verbund

Customer Verbund

People Verbund
Production Verbund – What is it?
A unique concept and competitive advantage of BASF

- The Verbund is all about intelligent interlinking of production plants, energy flows and infrastructure
- It allows BASF to reduce its raw material and energy use
- >€1 billion of global annual cost savings through Verbund
Verbund Simulation
Verbund means efficiency and flexibility – if steered intelligently

Verbund simulator enables
- Optimized operations
- Efficient utilization of assets
- Management of value chains

Verbund proved flexible in 2008/2009 crisis
- Capacity reductions
- Flexible placement of people
- Retained profitability
- Flying start out of the crisis

Verbund does allow for portfolio changes
- e.g. fertilizers, styrenics
Verbund generates >€1 billion global cost savings p.a.* and supports sustainability
A competitive advantage of BASF

**Energy Verbund**
>€300 million annual cost savings globally

**Logistics Verbund**
>€600 million annual cost savings globally

**Infrastructure Verbund**
>€100 million annual cost savings globally

BASF Antwerp

80% of the entire energy demand from exothermic processes; reduction of 2.4 million metric tons of CO₂

Combi terminal saves 150,000 truck loads (equaling 300,000 metric tons of CO₂)

Shared use of on-site facilities (e.g. fire department, security, waste water treatment)

* Savings include only tangible synergies.
BASF Antwerp – Energy Verbund
State-of-the-art energy efficiency

Verbund of energy-producing and energy-consuming processes reduces net energy demand
BASF Antwerp – Logistics Verbund
Reliable and lean logistics

15,6 million metric tons*

Train
3%
- Railcar in 1%
- Railcar out 2%

Road
12%
- Road/intermodal in 1%
- Road out 7%
- Intermodal out 4%

Ship
57%
- Vessel in 29%
- Barge in 10%
- Vessel out 3%
- Barge out 14%
- Container out 1%

Pipe
28%
- In 10%
- Out 18%

Continuously improving logistics:
costs, reliability, lead time, sustainability

* Volume handled 2015
BASF Antwerp – Infrastructure Verbund
Effective use of common infrastructure

Cost savings through joint use of infrastructure and utilities
Most of the cracker output in Antwerp is used for downstream value capture

- **Cracker products**
  - Ethylene
  - Propylene
  - Butadiene
  - Raffinates
  - Benzene

- **Value chains of the BASF Verbund**

- **Merchant Market**
Verbund site Antwerp – Key value chains
Creating synergies along the value chain

- Steamcracker -

**Ethylene**
- Ethylene oxide
  - Ethylene glycol
  - Surfactants
  - Ethanol amine
  - Ethylene amine

**Propylene**
- Acrylic acid
  - Acrylates
  - Pure acrylic acid
  - Superabsorbents

**Benzene**
- Nitrobenzene
- Aniline
- MDI
  - Nitric acid
  - Hydrogen
  - Formaldehyde
  - Phosgene
MDI – Key value chain
Integrated world-scale plant

MDI (Methylene diphenyl diisocyanate) + Polyether polyols = Rigid & microcellular polyurethane foams

MDI is mainly used captively; further value capture by BASF polyurethane systems
MDI – Product applications
Supplying into growth markets

Key facts

- MDI demand expected to grow above GDP (2015-2020)
- Growth driven by:
  - Increasing demand for energy efficiency
  - Increasing standard of living (e.g. footwear, furniture, performance textiles)
  - Transportation and construction
MDI production – Cost excellence

Continuous process improvements in MDI

Significant capacity increase thanks to incremental process innovations

Process improvement program MDI/Antwerp

- Target:
  - Increase production output by continuous process improvement via incremental steps

- Expected benefits:
  - Increased sales
  - Production cost* reduction

Annual EBIT improvement: ~ €50 million p.a.

* Production cost = Personnel, maintenance and energy cost (inflation-adjusted)
Acrylic acid – Key value chain
Value chain contributes significantly to cash flow

Each value chain step represents a potential merchant market outlet
Acrylic acid – Product applications
Supplying into growth markets

Key facts
- Acrylic acid demand expected to grow above GDP (2015-2020)
- Growth driven by emerging markets; rising middle class leads to increased demand for diapers, coatings & paints, adhesives, construction, textiles

About 2/3 of BASF’s acrylic acid is used captively
Acrylic acid – Technology
Leveraging the BASF Technology Verbund

Focused R&D to continuously improve acrylic acid process

- Highly selective and efficient process catalysts
- Proprietary technology for new process
  - Higher yield
  - Lower energy consumption
  - Lower investment costs
- In addition, four radically new processes being investigated in research; one based on renewable raw materials
Acrylic acid – Cost excellence
Leading technology strengthens profitability

Acrylic acid production technology benchmark
Industry average costs = 100; normalized

Key facts

- Lower production cost than industry average
- Efficiency gains:
  - run-time extension
  - higher throughput
  - lower energy consumption
- Proprietary technology, new process protected by 280 active patent families
- 4 out of 6 production sites already equipped: Ludwigshafen, Antwerp, Nanjing and Camaçari (Brazil)

BASF with best-in-class acrylic acid process
BASF Antwerp – Hydrogen peroxide-based propylene oxide plant
First world-scale HPPO plant*

Propylene oxide production without any by-products, except water
Butadiene extraction plant
Successful startup in September 2014

Key facts

- Production capacity of 155,000 metric tons p.a.
- Securing BASF’s internal supply of butadiene in Europe
- Taking advantage of merchant market opportunities

Strengthening of Antwerp Verbund site
Innovation: SAVIVA™
Highly efficient Superabsorbent Polymers (SAP)

SAVIVA™ – based on a pioneering SAP technology platform

- SAVIVA™ the next generation of SAP
- Round-shaped particles with micro-pores initiates innovative liquid distribution mechanism

Compared to other SAPs SAVIVA™ leads to:

- Efficiency gains:
  - SAP reduction
  - Fluff reduction
  - Reduction of storage, packaging and transportation costs

- Improved sustainability:
  - Better carbon footprint due to SAP and weight reduction
  - Enabler for future diaper designs offering a new level of comfort and dryness
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▶ BASF’s Verbund site Antwerp is positioned for further growth