Project Risk Mgt at Linde Engineering.
ECRI Sponsors Meeting

London, June 2018
Andreas Soellner
What is our business?
Financial highlights by division
Operating margin increased in both divisions

<table>
<thead>
<tr>
<th></th>
<th>2016</th>
<th>2017</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gases Division</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue</td>
<td>in EUR m</td>
<td>14,892</td>
<td>14,988</td>
</tr>
<tr>
<td>Operating profit¹</td>
<td>in EUR m</td>
<td>4,210</td>
<td>4,268</td>
</tr>
<tr>
<td>Operating margin</td>
<td>%</td>
<td>28.3</td>
<td>28.5</td>
</tr>
<tr>
<td>Number of employees as at 31/12</td>
<td></td>
<td>52,907</td>
<td>51,138</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2016</th>
<th>2017</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Engineering Division</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue</td>
<td>in EUR m</td>
<td>2,351</td>
<td>2,388</td>
</tr>
<tr>
<td>Operating profit¹</td>
<td>in EUR m</td>
<td>196</td>
<td>220</td>
</tr>
<tr>
<td>Operating margin</td>
<td>%</td>
<td>8.3</td>
<td>9.2</td>
</tr>
<tr>
<td>Number of employees as at 31/12</td>
<td></td>
<td>6,432</td>
<td>6,144</td>
</tr>
</tbody>
</table>

¹ EBIT (before non-recurring items) adjusted for amortisation of intangible assets and depreciation of tangible assets
² Basis points
Integrated Gases and Engineering model
Synergies built on strong engineering foundation

Gases Division

2017 revenue: EUR 15.0 bn
Optimised CAPEX and OPEX for own assets
Strong competitive position
Solution partner for customers

Risk balancing
Capture business through plant sales or outsourcing contracts
Capitalization on decapitation opportunities

Operations
Long and successful track record in the execution of industrial-scale projects
Competitive costs and energy efficiency

Synergies

Engineering Division

2017 revenue: EUR 2.4 bn
Technology leadership built on synergies, channelling engineering expertise into gases business
Four technology fields (air separation, hydrogen & syngas, natural gas, petrochemicals)

Customers
Early identification of new projects
Strong customer relationships

Innovation
Ongoing optimisation of application technologies and solutions
Detailed insights into customer processes
Linde Engineering
Core competence is the treatment of gases

Liquefaction
Separation
Thermal Cracking

Components
Standardised plants
EPC plants
Services

Air
Hydrocarbons
Natural gas
Tail gases
Exhaust fumes

Hydrogen
Oxygen
Rare gases
Nitrogen
Carbon monoxide
Carbon dioxide
Synthesis gas
Olefins
Engineering Division
2017 order intake by plant type

<table>
<thead>
<tr>
<th>Order intake by plant type (in EUR m)</th>
<th>2016</th>
<th>2017</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas plants</td>
<td>796 (35.3%)</td>
<td>839 (35.1%)</td>
<td>374 (16.6%)</td>
<td>543 (22.7%)</td>
</tr>
<tr>
<td>Air separation units</td>
<td>651 (28.8%)</td>
<td>619 (25.9%)</td>
<td>152 (6.7%)</td>
<td>179 (7.5%)</td>
</tr>
<tr>
<td>Hydrogen and syngas plants</td>
<td>284 (12.6%)</td>
<td>210 (8.8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,257</td>
<td>2,390</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Major operating entities

<table>
<thead>
<tr>
<th>Entity</th>
<th>Location</th>
<th>Employees as of 10/2017</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEHQ</td>
<td>Pullach/Germany</td>
<td>1,855</td>
<td>Engineering Manufacturing</td>
</tr>
<tr>
<td></td>
<td>Schalchen/Germany</td>
<td>774</td>
<td></td>
</tr>
<tr>
<td>LEDD</td>
<td>Dresden/Germany</td>
<td>426</td>
<td>Engineering</td>
</tr>
<tr>
<td>LENA</td>
<td>USA</td>
<td>484</td>
<td>Engineering</td>
</tr>
<tr>
<td>LEH</td>
<td>Hangzhou/China</td>
<td>227</td>
<td>Engineering</td>
</tr>
<tr>
<td>LED</td>
<td>Dalian/China</td>
<td>419</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>LEI</td>
<td>India</td>
<td>987</td>
<td>Engineering</td>
</tr>
</tbody>
</table>

- Engineering operations
- Representative & sales offices
Air Separation Plants

Product portfolio

- Modular air separation plants, standardised and pre-fabricated
- Customised air separation units, individually designed to meet customer-specific demands

Key features

- 3,000 plants built in 80 countries, thereof 400 plants owned & operated by Linde Gases
- Highly energy efficient plants
- High safety and quality standards
- Superior plant availability and low life-cycle cost
Hydrogen & Synthesis Gas Plants

Product portfolio

- Production of hydrogen, CO, CO₂, synthesis gas, ammonia and methanol from any hydrocarbon feedstock
- Syngas processing plants (gas separation and purification)

Key features

- 500 plants built worldwide, more than 100 plants operated by Linde Gases
- Entire process chain for small, medium and large scale production and treatment of synthesis gas and H₂/CO
- Utilisation of all petrochemical feedstock, from natural gas through heavy oil to coal
- Highly efficient process (e.g. ammonia)
Petrochemical Plants

Product portfolio

— Steam cracking: cracking furnaces and olefins separation/purification
— Refinery and steam cracking integration
— Acetylene, butadiene and aromatics (BTX) recovery
— Olefins: Oxidative Coupling of Methane (OCM)
— Polyolefins (polyethylene & polypropylene)
— Linear Alpha Olefins
— Complex revamp
— Technical services for operation petrochemicals plants

Key features

— Comprehensive portfolio for olefin production and derivatives
— Linde olefins technology recognised as leading
— Excellent market position and key references
— New products/technology development
Natural Gas Plants

Product portfolio

— Natural gas processing
— Liquefaction of natural gas
— Liquefied Natural Gas (LNG) regasification terminals and bunkering
— LNG satellite stations (Cryostar)
— On-board re-liquefaction of natural gas (Cryostar)

Key features

— Leading in the area of small- to midscale LNG plants
— Covering the full LNG value chain
— Manufacturer of cryogenic key equipment
Enterprise Risk Management – Project Risk Management

CORPORATE RISK MANAGEMENT
Linde Group, Corporate Centre

ENTERPRISE RISK MANAGEMENT
LE, within Finance

PROJECT RISK MANAGEMENT
responsibility by Project Manager supported by Project Risk Manager
Objectives of Commercial Project Risk Management

- management of the risk assessment process
- ensure the availability of suitable reporting tools
- provide risk management support for risk owners across LE
- facilitation/coordination/reporting of risk assessments
- monitor and ensure progress on follow-up actions identified in the project risk workshop (within responsibility of Sales / Project Manager)
- oversight/review of risk assessments prepared by others (e.g. project managers)
- provide risk and performance metrics
- promote a risk aware culture and an appropriate risk balance within LE
### Risk Management Method based on Project Criticality

<table>
<thead>
<tr>
<th>project size</th>
<th>&lt; 10 Mio. €</th>
<th>≥ 10 Mio. €</th>
<th>≥ 40 Mio. €</th>
<th>≥ 100 Mio. €</th>
<th>≥ 500 Mio. €</th>
</tr>
</thead>
<tbody>
<tr>
<td>project criticality</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>method</td>
<td>estimate</td>
<td>simplified risk register</td>
<td>risk register</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **E, EP**
- **EPC**
Risk Management Process
What’s new in our process?

risk monitoring
• standard reports
• KPI’s

risk planning
• 5 RWS
• participants of RWS
• timing of RWS

risk handling
• job sheets
• follow up of mitigation measures

risk analysis
• human factor
• voting system

risk identification
• standard risk register
• focus on mitigation action
• responsibility and due date
### Risk Workshops per Risk Category

#### Engineering & Technology
- standards & requirements
- technical design concept
- LDs & make-good
- design of existing plant (revamps only)
- layout concept
- HSE concept
- commissioning & start-up concept
- other technology & conceptual design risks
- technology & conceptual design opportunities

#### Contractual & Commercial
- contract concept
- terms of contract
- other contractual & commercial risks
- change order concept
- commercial & contractual opportunities

#### Project Environment
- cultural & heritage
- weather & climatic conditions
- economical & business environment
- political environment
- social environment
- geological risks
- other environmental risks
- project environment opportunities

#### Project Execution & Management
- project execution concept
- organization
- internal performance
- external performance
- time schedule
- other project execution risks
- project execution opportunities
- (pre-) commissioning and test run

#### Procurement & Logistics
- procurement
- inspection & expediting
- logistics
- procurement & logistics opportunities

#### Construction
- construction concept
- performance of construction subcontractor(s) or partner(s)
- brownfield risks
- site installation & temp. facilities
- other construction risks
- construction opportunities
Participants of the Risk Workshop

*extended number of participants with criticality 4
The new Risk Register is at the core of the LE Project Risk activities

Proposal phase

- Risk Workshops
- Mitigation measures
- Contingency calculation

Execution phase

- Risk / Contingency update

<table>
<thead>
<tr>
<th>Risk ID</th>
<th>Risk title</th>
<th>Risk description</th>
<th>Risk applicable</th>
<th>Risk factor</th>
<th>Date of observation</th>
<th>Management Measure</th>
<th>DRI</th>
<th>Due date</th>
<th>Measure status</th>
<th>Probability (post MM)</th>
<th>Impact (post MM)</th>
<th>Risk level (post MM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30200</td>
<td>Heavy rainfall and thunderstorms with wind gusts</td>
<td>Lightning warnings and heavy rain might lead to disruption during construction work and therefore to productivity loss and delays during construction.</td>
<td>yes</td>
<td>27.04.17</td>
<td>- Cost has to be considered in estimate</td>
<td>- Time has to be considered in schedule</td>
<td>- Include contract bad weather clause</td>
<td>A.B./GCP</td>
<td>19.05.2017</td>
<td>ongoing</td>
<td>Possible</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

Probability

- 0 % - 5 %: Very Unlikely
- 5 % - 15 %: Unlikely
- 15 % - 25 %: Possible
- 25 % - 50 %: Likely
- 50 % - 80 %: Probable

Impact

- Negligible
- Minor
- Moderate
- Serious
- Major

Semi-quantitative expert assessment of remaining risk after successful mitigation

Risk mapping matrix

Risk level: mEuro

- not relevant
- 0 - 0.02: low
- 0.2 - 1: medium
- 1 - 5.5: high
- 5.5 - 40: very high
- > 40: extreme
Voting Tool:

- an anonymous voting system makes participants independent from others in decision making
- differences in risk view become easier visible (in case of high variances)
- input optional, no obligation to vote when no profound judgement possible
Activities after Risk Workshops

overview of the risk register to all related participants

job sheets for the DRI (direct responsible individual)

in the job sheet: management measure, due dates

feedback to supervisory board, project controlling and risk management

overdue management measures influence KPI figures of the project

Example for a job sheet (A.B._20180315_Risk_Register_Project):

<table>
<thead>
<tr>
<th>risk ID</th>
<th>risk title</th>
<th>risk description</th>
<th>risk type</th>
<th>date of observation</th>
<th>management measure</th>
<th>DRI</th>
<th>due date</th>
<th>measure status</th>
</tr>
</thead>
</table>
Risk Management within Linde
Risk Report

Risk Workshop Results

“First of its kind” items

1. Country/client
   Only construction of small plant in NZ up to now
2. Technology: Urea, ATR
   First time construction of urea package and ATR
3. Urea EPC sub Chengda
   First time execution with subcontractor
4. Construction non-urea
   First time construction with subcontractor

Top 10 Technology risks

<table>
<thead>
<tr>
<th>risk title</th>
<th>risk level (post MM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth due to urea package</td>
<td>medium</td>
</tr>
<tr>
<td>Liquidated damages due to penalized milestones</td>
<td>medium</td>
</tr>
<tr>
<td>Insufficient product quality/rate: urea</td>
<td>medium</td>
</tr>
<tr>
<td>Procurement opportunities: Availability of high quality subcontractor</td>
<td>opp- medium</td>
</tr>
</tbody>
</table>

Top 20 risks

<table>
<thead>
<tr>
<th>risk title</th>
<th>risk level (post MM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth due to urea package</td>
<td>medium</td>
</tr>
<tr>
<td>Insufficient product quality/rate: urea</td>
<td>medium</td>
</tr>
<tr>
<td>Value engineering measures related to other technical design concepts</td>
<td>opp- medium</td>
</tr>
<tr>
<td>Insufficient support of licensors</td>
<td>medium</td>
</tr>
<tr>
<td>Earthquake factors may be reduced</td>
<td>opp- medium</td>
</tr>
<tr>
<td>Claims due to increased quantities</td>
<td>opp- medium</td>
</tr>
<tr>
<td>Ongoing Measures (with projected finalisation date in the past highlighted in orange)</td>
<td></td>
</tr>
<tr>
<td>Risk ID</td>
<td>risk title</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>601003</td>
<td>Short bidding and bid evaluation times during proposal phase</td>
</tr>
<tr>
<td>107001</td>
<td>Insufficient commissioning &amp; start-up concept: urea</td>
</tr>
<tr>
<td>606147</td>
<td>Earthquake factors may be reduced</td>
</tr>
<tr>
<td>602006</td>
<td>Claims due to increased quantities</td>
</tr>
</tbody>
</table>

finalised measures: 78
ongoing measures 25
The Overall KPI weighted by the risk score, tells, how many open measures are delayed, divided by numbers of projects. (open, but deadline is exceeded)

The project KPI shows how many open measures are delayed, weighted by the risk score. (Still open, but deadline is exceeded)

The number above the bar tells how many measures are still open for each project. (delayed and in time)

Weighting:
- not relevant 1
- awareness 1
- low 1
- medium 6
- high 30
- very high 207

- Crit. 2 EPC, 3 and 4
Guideline for Contingency Drawdown

- introduction of upper and lower contingency thresholds per cost category

- lower threshold: $\Sigma$ minimum of contingency range [Mio. €] of corresponding risk levels
- upper threshold: $\Sigma$ maximum of contingency range [Mio. €] of corresponding risk levels

### Example

<table>
<thead>
<tr>
<th>risk level</th>
<th>Mio. €</th>
</tr>
</thead>
<tbody>
<tr>
<td>not relevant</td>
<td>0 – 0.02</td>
</tr>
<tr>
<td>Low</td>
<td>0.02 – 0.2</td>
</tr>
<tr>
<td>medium</td>
<td>0.2 – 1</td>
</tr>
<tr>
<td>high</td>
<td>1 – 5.5</td>
</tr>
<tr>
<td>very high</td>
<td>5.5 – 40</td>
</tr>
</tbody>
</table>

- upper threshold
- selected value
  (e.g. 75% contingency (linear interpolation))
- lower threshold

### Targets
1. Profit trend with few fluctuations
2. Avoidance of excessive constraints for project managers
3. More consistent evaluation by introducing guidelines
Profit and Contingency Tracking
Risk Analysis on Linde Engineering Level

- risk registers of different projects, combined in one database

- comparable standard
- frequency of risks
- updating the risk register (eliminate uncommon risks, adopt frequent risks)

- evaluation of
  - top risks on group level
  - for entity
  - for region
  - for product line
Thank you for your attention