Future Challenges of the Lubricants Industry

FUCHS Capital Market Day 2018
18 June 2018 | Dr. Lutz Lindemann, CTO
Markets
Markets
Development Global Lubricants Demand (million tons)*

<table>
<thead>
<tr>
<th>Year</th>
<th>Demand (million tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>35.9</td>
</tr>
<tr>
<td>2008</td>
<td>35.7</td>
</tr>
<tr>
<td>2009</td>
<td>31.9</td>
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<tr>
<td>2010</td>
<td>34.4</td>
</tr>
<tr>
<td>2011</td>
<td>35.1</td>
</tr>
<tr>
<td>2012</td>
<td>35.1</td>
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<tr>
<td>2013</td>
<td>35.4</td>
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<tr>
<td>2014</td>
<td>35.5</td>
</tr>
<tr>
<td>2015</td>
<td>35.6</td>
</tr>
<tr>
<td>2016</td>
<td>35.7</td>
</tr>
<tr>
<td>2017</td>
<td>36.1</td>
</tr>
</tbody>
</table>

*Without Marine Oils
Markets
Development Regional Lubricants Breakdown

Demand (Million Tons)*

- Asia-Pacific & MEA
- Americas
- Europe

<table>
<thead>
<tr>
<th>Region</th>
<th>2007</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia-Pacific &amp; MEA</td>
<td>35.9</td>
<td>36.1</td>
</tr>
<tr>
<td>Americas</td>
<td>32%</td>
<td>27%</td>
</tr>
<tr>
<td>Europe</td>
<td>45%</td>
<td>54%</td>
</tr>
</tbody>
</table>

*Without Marine Oils
## Markets
### Development Regional Lubricants Demand

<table>
<thead>
<tr>
<th>Region</th>
<th>2017 : 2016 Variance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>-0.1</td>
</tr>
<tr>
<td>Latin America</td>
<td>-2.0</td>
</tr>
<tr>
<td>Western Europe</td>
<td>1.4</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>0.5</td>
</tr>
<tr>
<td>Middle East</td>
<td>-0.3</td>
</tr>
<tr>
<td>Africa</td>
<td>-3.0</td>
</tr>
<tr>
<td>Asia-Pacific</td>
<td>2.8</td>
</tr>
<tr>
<td>World</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Markets
Regional Per-Capita Lubricants Demand (kg)
Markets
Ranking Top 20 Lubricants Countries (KT)

CAGR  4.1%  -1.2%  2.6%  -1.0%

2017  2007
### Markets
Development European Lubricants Breakdown

#### Demand (Million Tons)*

<table>
<thead>
<tr>
<th>Region</th>
<th>2007</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Europe</td>
<td>8.4</td>
<td>6.8</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>57%</td>
<td>55%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Region</th>
<th>2007 Percentage</th>
<th>2017 Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>14%</td>
<td>13%</td>
</tr>
<tr>
<td>UK</td>
<td>10%</td>
<td>(10%)</td>
</tr>
<tr>
<td>France</td>
<td>8%</td>
<td>(9%)</td>
</tr>
<tr>
<td>Russia</td>
<td>18%</td>
<td>(19%)</td>
</tr>
<tr>
<td>Other Eastern Europe</td>
<td>18%</td>
<td>(16%)</td>
</tr>
<tr>
<td>Other Western Europe</td>
<td>23%</td>
<td>(25%)</td>
</tr>
<tr>
<td>Ukraine</td>
<td>5%</td>
<td>(5%)</td>
</tr>
<tr>
<td>Poland</td>
<td>4%</td>
<td>(3%)</td>
</tr>
</tbody>
</table>

*Demand (Million Tons)*

- **Western Europe**: 8.4 million tons (57%) in 2007, 6.8 million tons (55%) in 2017
- **Eastern Europe**: 57% in 2007, 55% in 2017

- **Germany**: 14% in 2007, 13% in 2017
- **UK**: 10% in 2007, (10%) in 2017
- **France**: 8% in 2007, (9%) in 2017
- **Russia**: 18% in 2007, (19%) in 2017
- **Other Eastern Europe**: 18% in 2007, (16%) in 2017
- **Other Western Europe**: 23% in 2007, (25%) in 2017
- **Ukraine**: 5% in 2007, (5%) in 2017
- **Poland**: 4% in 2007, (3%) in 2017
Top 20 lubricants manufacturers

- A top-10 ranking lubricants manufacturer
- Number 1 among the independent lubricants companies
Global Lubricants Market

Global Industry Structure

- "Independents"
- "Majors"
Product Split
Global Lubricants Market

Worldwide car population approx. 750 mn t

2000

-36% reduction yearly consumption/car

Each year additional 40 mn vehicles

Worldwide car population approx. 1,143 mn t

2017

36.4 mn t

Greases 3%

Process Oils 12%

MWF/CP 6%

Industrial Oils 23%

Automotive Oils 56%

36.1 mn t

Greases 3%

Process Oils 8%

MWF/CP 6%

Industrial Oils 26%

Automotive Oils 57%

better efficiency
Analysis of Tribosystem – the way

Lubrication problem

Any reference?
Design, loads, environment etc

yes

no

recommendation

Analysis of the tribosystem

Rheology
- Shear viscosity
- Viscosity elasticity
- pour point
- VT behaviour

Tribology
- friction
- wear
- load
- Friction surface

Chemistry
- Material compatibility
- Corrosion protection
- ageing

Physics
- Mech. stability
- Oil evaporation
- Noise behaviour
- Oil separation.

Environment
- toxicology
- Odor/texture
- Skin comp.
- Biodegradability

Simulation with Screening-Methods (Experience form customer & FUCHS)

Selection/Development of an appropriate formulation

Test rig(s)

Field trial

supply

update

update
Technology Regions

- US
- Japan
- Europe
Organizational Structure

- Product Management
- R&D
- IT
- EH&S
- Marketing
- KHT
- Quality Management
- Industrial Sales
- Purchasing
- Sustainability
- Manufacturing
- HR
- Sales
Organisational concept – Globalisation and Networking
Matrix structure with global Key Working Groups (16 + 3)
02 Challenges and Market Impact
## Future Trends – 3.5 disruptions at a time

<table>
<thead>
<tr>
<th>Digitalization</th>
<th>3D printing</th>
<th>Sustainability</th>
<th>E-Mobility</th>
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<td>Medical engineering</td>
<td>Independence of mineral oil</td>
<td>Autonomous Driving</td>
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<td>Steel Industry</td>
<td>Reduction of CO2-foot print</td>
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<td></td>
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<td>Germany?</td>
</tr>
<tr>
<td>China</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Europe?</td>
<td></td>
<td></td>
<td></td>
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</table>
03 Digitalization
Digitalization

1. Sensoric – condition monitoring, control, prediction

2. Statistics / Simulation
   - Explorative statistics (Data Mining, Big Data)
   - System modelling (chemical, tribological, logistic, manufacturing)

3. Business Models
New Technologies
CPS (Cyber Physical Systems)
Digitalization will fundamentally change our value creation

...to a more integrated value chain due to data integration and feedback loops
<table>
<thead>
<tr>
<th><strong>Internet of Things</strong></th>
<th><strong>Big Data</strong></th>
<th><strong>Analytics</strong></th>
<th><strong>Machine Learning</strong></th>
<th><strong>Blockchain</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecting things with people and processes</td>
<td>Manage vast amounts of big data</td>
<td>Insights that enable transformative actions</td>
<td>Intelligence enabled by learnings from data</td>
<td>Blockchain services embedded into business apps</td>
</tr>
</tbody>
</table>
digitized product development & lubricant production

- From empirically-driven product development to simulation approaches
- Application-linked data such as field data or test field results serve as a statistical/Big Data backbone
- Circle the application-linked data back into the development process for precise product development
eCommerce

- eCommerce involves facilitation of the sale of goods and services via electronic networks such as the internet.

- Our eCommerce vision is driven by the idea that more than 80% of our customer create less than 20% of revenue. Therefore, transforming the interaction with these 80% to a streamlined & digitized contact leverages the globalized effort to reduce the complexity in all areas of our business.
eCommerce

1. A subsidiary’s Master Web-Shop:
   A Customer’s Exclusive Log-In
   - Any Customer: ePO placement
     - Fuchs distributors (all product lines)
     - Small ordering volume OEMs (e.g. first fill)
     - EDI customers (as an alternative to EDI)
     - SME, any other customer who needs a secured/simple way to place an PO

2. Microsite: Shop in Shop Concept
   - Customers, who already have their own web shop
     - OEMs: Integration with OEMs’, their aftermarket divisions
     - Large rental fleets
     - Large e-retails (i.e. AutoZone)

3. Webshop as a service Concept
   - Customers, who don’t have any web shop
     - Small sole proprietors
     - Small private label customers
     - Low volume – high potential customers
smart services: objectives

- Make the lubricant talk in real-time by introducing online condition monitoring via sensors
- Combine lubricants data with machine data (e.g. vibration or load) to generate a holistic view
- Empower customers to take immediate actions to keep the lubricant and the machine healthy, preventing unplanned downtime
- inoviga is working on technologies to make lubrication-related smart services possible
Fluid Vision Technologies started with the idea to provide an easy and economical inline measurement of coolants.

The sensor-part is in the validation phase.

Company acquired in 2018
DMG Mori – mwf monitoring

- DMG wants to include the lubricant status into their condition analyzer app
- FUCHS is asked to provide a sensor
FUCHS Meter

- FUCHS Meter so far is a prototype
- Converting the prototype to a product is the next step
- Design will be reviewed
- Aspects like connectivity, automated asset recognition and many more need to be developed
bringing it all together for new business models
Delivering new value propositions through sensors smart services

Online sensors and data analytics tools allow for new, data driven ("smart") services

- Monitoring the lubricants in real-time
- Monitor the health status of the machine through monitoring the lubricant
- Take immediate actions to keep the lubricant and the machine healthy, preventing unplanned downtime
- Predictive Maintenance of lubricants
- “Lubrication as a service”: customers to pay for performance instead for a product
In Short

- Connecting Value chains incl. condition monitoring will result in new business models
- Today we sell technical solutions to our customers
- Today we offer excellent customer service in logistics and customer service
- **Tomorrow** we offer availability, performance or availability of systems – holistic approach
04 Sustainability
Sustainability is substantial part of our industry

- Raw material choice
- Additional regulatory from EU and China – Life Cycle Assessment
- Upcycling to be considered as part of our business model
- Customer requirements
- CO2 Footprint as part of product specifications

KEY to quantify sustainability we need frameworks, models and common understanding in the industry
Code of Responsible Conduct for Business
Subscriber
Responsible Care

FUCHS is a signatory to the Responsible Care Global Charter of the International Council of Chemical Associations (ICCA). FUCHS is committed to this initiative.

Chemie³

FUCHS is engaged in the Chemie³ sustainability initiative of the German Chemical Industry Association (VCI), the German Mining, Chemical and Energy Industrial Union (IG BCE) and the German Chemical Industry Employers‘ Federation (BACV).

Wittenberg-Zentrum für Globale Ethik/econsense

FUCHS is engaged in a cross-industrial initiative of German companies with the objective of creating sustainability networks in emerging and developing nations. This initiative has been set up by the sustainability network econsense and the WZGE.
Sustainability
Engagement with Academic Institutions

University of Mannheim

Presentations / Lectures at the Sustainable Business Summit

Financial support of the endowed chair of CSR at the University of Mannheim

Cooperation with Student Initiatives

University of Mannheim
Sustainability Initiative Lubricants Industry

- Proposed and named by FUCHS, the lubricants industry sustainability initiative **NaSch*** was established in Germany in 2016

- **Founding Members**: FUCHS, BANTLEON, ROWE, KLÜBER LUBRICATION, ZELLER+GMELIN, Lube/Oil associations VSI&UNITI

- **Objective**: Creation of sustainability standards, KPIs, **benchmarks** for the lubricants industry to emphasize its social value

- UEIL cooperation with NaSch carrying sustainability forward to the level of the Union of the **European lubricants industry**

*Nachhaltigkeitsinitiative Schmierstoffindustrie*
Sustainability
Awards
Sustainability
FUCHS Corporate Carbon Footprint* (in kilogram CO2e per ton produced)

- Scope 1: Direct emissions through own energy generation
- Scope 2: Indirect emissions through purchased energy
- Scope 3: Indirect emissions along the value chain

*FUCHS Production Locations 2014
Sustainability
FUCHS Corporate Carbon Footprint (in kilogramm CO₂e per ton produced)
Sustainability
Raw Materials

- Petrochemical industry will see a significant change
- Sustainability aspects will become part of future requirements
  - Paris Agreement
  - EU-Ecolabel – includes sustainability requirements
  - Customer requirements i.e. OEM’s require → CO₂ Footprint must
  - Availability of some raw materials will be limited – disruptive changes in technology
  - new requirements for different applications

Need for sustainable raw materials / backwards integration
The "Advanced Biomass Value (ABV)" project is a joint interdisciplinary initiative with 8 partners, focused on isolating lipids from rapidly growing algae and turning them into high-quality lubricants. The remaining algae biomass is used to produce bio-kerosene using yeast. Any further remains are then incorporated into CO₂-adsorbing materials. Therefore, no waste accumulates.

For FUCHS, the participation in the projects opens up new access routes to different raw materials that ensure a stable, reliable supply. With an eye on dwindling resources, this also makes economic sense. The project is funded with € 5 million by the German Federal Ministry of Education and Research (BMBF) "BioProFi" program under the leadership of the Technical University (TU) of Munich.
Within the “Waste2Value” project, FUCHS is investigating the application of residual-based materials in lubricant products.

**Project “ZeroCarbFP” / Idea: “Waste2Value”**

In the “ZeroCarbFP (Zero Carbon Footprint)” alliance, 14 partners from various industries are working on a project to convert carbon-containing industrial waste streams into valuable materials, using microorganisms. The project is supported by the German Federal Ministry of Education and Research (BMBF) from 2012-2021 with a budget of € 48 million. The idea of the project is “Waste2Value”.

For FUCHS, the focus of research activities lies in the field of functional base oils and additives. Complex molecules to be gained through enzymatic modification for use as base fluids or additives.

Within the "Waste2Value" project, FUCHS is investigating on the application of the residual-based materials in lubricant products.
05 E-Mobility
Technologies to reduce automotive CO₂-emission
New Technologies – e-Mobility

- Politics, legislation and industry require and push the e-mobility
  - VW-Strategy: Together 2025: 30 % of the cars will be e-cars by 2025
  - Netherlands and Norway decided, that starting with 2025 no new car with combustion engines will be approved anymore
  - China: 10% (2019), 12% (2020) Quota by law

- Alternatives to “traditional“ e-mobility:
  - Hybrid-technology
  - H2-cells (BMW, Toyota)
  - Combustion engine remains by using environmental friendly fuel: Power to Liquids: fuel from \( \text{CO}_2 \) und H2 (H2 from water via renewable energy)
China EV-Sales 2016: Est 2017 +70%
507,000 cars (+53%), Market Share 1.8%

23 mn passenger cars 2017
0.8 mn EV cars
3.4% market share
10% (2019), 12% (2020) quota by law

507,000 cars sold
336,000 passenger cars
171,000 commercial vehicles (esp. busses)
409,000 battery electric vehicles (= 80%)
98,000 plug-in hybrids
10% (2019), 12% (2020) Quota by law

Source: CleanTechnica
E-mobility ramp up scenario

- Paris Climate Agreement „COP21“: from 2050 on, CO₂ emissions shall not exceed CO₂ absorption
- Existing world car fleet 2017: 1000 Mio cars
- Annual production 2016: 72 Mio cars – in 2030 81 Mio cars
- Time to replace conventional cars with „clean“ cars: 14 years (20 years incl. expected fleet growth 0.9%/a OICA Statistics)
- Based on an average model life cycle of 6 years, OEMs shall be prepared to provide the majority of their car fleet based on new/clean technology from 2030 onward
- i.e. the 2nd model generation from now should be „clean“ cars
E-mobility ramp up scenario - Europe

- Not only new cars shall meet CO₂ emission targets by 2050, but also the existing car fleet at this time need to comply accordingly.
- As a consequence: By 2028, e-cars will have 30-35% market share in the EU, combustion 28%, Hybrid 40%.
- Car population stable 255 Mio cars (EU-Statista).
- Significant influence on market demands in automotive and metal processing oils.
- The scenario neglects that EU is far away in providing the needed infrastructure and energy supply (renewable).
E-mobility ramp up scenario - USA

- USA car population around 270 Mio cars – stable car population
  - no predictability of political behavior
  - terminates the “Paris Climate Agreement”
  - Average reduction of market demand by 2%/a the past 5 years
  - Next 4-8 years no dramatic change due to e-mobility to be expected
E-mobility ramp up scenario - China

- China e-mobility share given by law eff. 2019 10%, 12% from 2020 onwards expectation 30-40% to come due to massive urbanization push
  - In 15 years 38-40 mn cars produced thereof 16 mn EV cars – 24 mn ICE (2016 22 mn) – CAGR 6-8%
  - 172 mn cars registered in China – (Ministry of Public Security bulletin 01/2016)
  - China Center on Energy and Transportation – University of California – Car population in 2030 around 400 mn cars – correlates with 7% CAGR car population
  - Assumption in 2030 car population 160 EV - 240 mn ICE
  - Average demand per car/ICE will reduce by 1.2% year
ICE- vs. EV-Powertrain: Different Value Creation (€)
Example: VW Golf 2016 vs. VW e-Golf 2025 lost value chains

Gasoline Engine 2016
1.4 L, 110 kw
7speed DCTF
4,400 €

Electric Drive 2025
130 kw
Battery 70 kwh
8,900 €

Source: FEV/FAZ, 29.11.16
## What’s different

<table>
<thead>
<tr>
<th>Powertrain Applications</th>
<th>ICE</th>
<th>Hybrid</th>
<th>Battery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine oil</td>
<td>✓</td>
<td>✓</td>
<td>–</td>
</tr>
<tr>
<td>Transmission oil</td>
<td>✓</td>
<td>✓</td>
<td>✓ / –</td>
</tr>
<tr>
<td>Greases</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Specialty greases</td>
<td>✓</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Lubricants for Auxiliary systems</td>
<td>✓</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Cooling &amp; functional liquids</td>
<td>✓</td>
<td>+</td>
<td>+</td>
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- Omitted ✓ Required + Increased
E-Mobility/New Materials/Efficiency

Impact on demand next 15 years

- **Europe** ⇒ decrease automotive: 18%
  - decrease metal processing oils 30%
  - stable: industrial 0%
  - decrease total market: 10% = 400 KT

- **USA** ⇒ decrease ≈ 20% (efficiency, e-mobility) = 1200 KT
E-Mobility/New Materials/Efficiency

**Impact on demand next 15 years**

- **China**
  - automotive increase ≈ 15-20%
  - metal processing stable in MPO
  - industrial increase 15%
  - increase overall: 10% = 700 KT

- **ROW**
  - unchanged or not predictable

⇒ Ø decrease in demand worldwide by 900 KT – 5% overall
06 E-Mobility – set up
E-Mobility @ FUCHS

Coordination of all R&D activities with E-Mobility perspective:

- Cross functional project development work
- Holistic coordination over all applications and project segments
- Regional R&D support on the 3 main R&D hubs with coordinative responsibility

Products remain in the car e.g. gear oil

Supplies for car production e.g. metal working fluids
E-Mobility Drives New Technologies

- Electric Aggregates
  - Electrical Steering
  - Electric Oil pumps
  - Electric Compressors
  - E-Clutch Booster
  - E-Brake Booster
- E-Mobility
  - Hybridized Automatic transmissions
    - Electrified Converter Automatic Transmissions
    - Electrified Double Clutch Transmissions
    - Electrified Constant Velocity transmissions
  - E-Engine with Reduction Gearbox
  - E-Drive Train
  - E-Axle
  - E-Engine High Rotational Speed
  - E-Engine Standard Rotational Speed
## E-mobility
### Impact on lubricants

<table>
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<tr>
<th>Automotive</th>
<th>Industrial applications</th>
</tr>
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<tbody>
<tr>
<td>• Decline of engine oil- and gear oil-usage</td>
<td>• General trend to weight reduction</td>
</tr>
<tr>
<td>• Increase in grease demand as new applications come up</td>
<td>• Lightweight materials - car body will change from steel to more Aluminum, thermoplastics and CFK</td>
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</table>
| • New specifications, Behaviour of fluid chemistry under influence of electric currents and influence on electromagnetic fields | • Optimized geometry of the parts  
  – Less machining allowances  
  – Tighter tolerances  
  – Higher requirements on die filling and surface quality |
| • low friction/high speed, reduced noise etc, yellow metal compatibility, | |
| • New applications e.g. battery cooling, cooling lubricants | |

### Opportunities

- Collaboration

### Challenges
FUCHS – Quo Vadis

- FUCHS with a broad range of abilities in many fields sees a lot of opportunities to develop the business especially in the digital world

- The changes in the market environment will create new opportunities due to our technical level, international set up, high flexibility, our committed employees and broad customer base – unique

- Sustainability as an established element in FUCHS’ mindset offers opportunities to be ahead competition
Thank you for your attention